90% Prep Drainage Report

for

Garbarino

Prepared for

Milestone NW
11232 NE 15th St., Suite 101
Bellevue, WA 98004

Prepared by

Land Development Consultants, Inc
20210 142nd Ave NE
Woodinville, WA 98072
(425) 806-1869

August 4, 2020
Job No: 15-104

1.0 PROJECT OVERVIEW

The Garbarino project includes parcels #1246700321, #1236700329 and is addressed at 10042 136th Ave NE, Redmond, WA within the Rose Hill neighborhood. The project site is located within the southeast quarter of the southwest quarter of Section 34, Township 26 N, Range 5 E, W.M. See the Vicinity Map, Figure 1, for the exact location of the site.

The site area includes 2.72 acres which will be disturbed during development. The project proposes to construct 15 single-family lots and associated infrastructure, according to rustic roads street standards.

According to the King County and USGS Soil Survey, the site is underlain with Alderwood Gravelly Sandy Loam with 0 to 8 percent slopes and 8 to 15 percent slopes. Please refer to Appendix 3-C for detailed soil information. The soil has low to moderate runoff potential and a slight to moderate erosion potential. Slopes on the areas to be developed range from 0 to 15 percent.

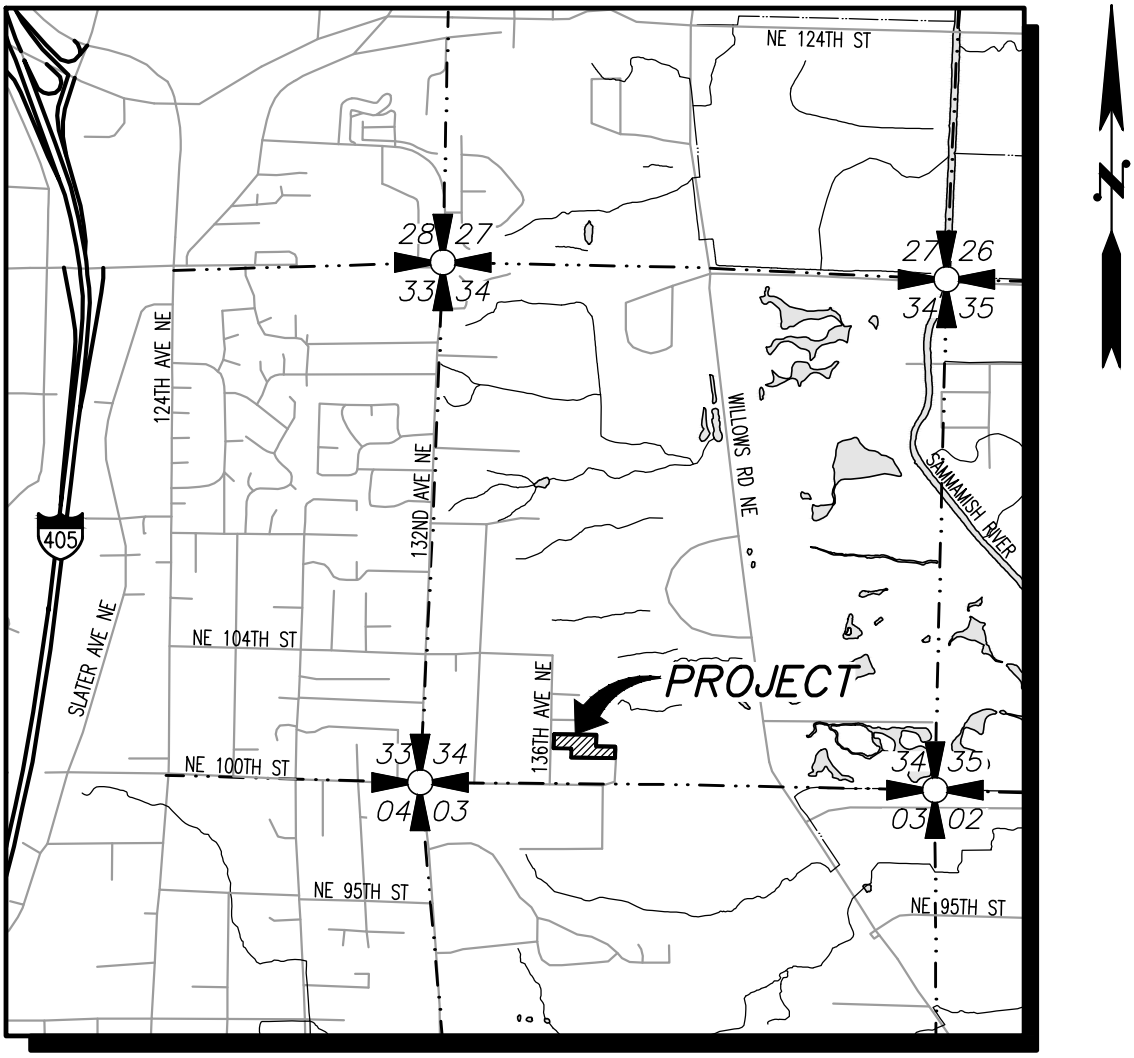
Runoff currently exits the site via overland flow across the eastern property boundary. Flows continue easterly down a steep grade where they enter the City of Redmond storm drainage network in the Willows Creek center office complex at the base of the slope. Flows eventually reach the Sammamish River. Per King County I map due diligence research, drainage complaints have been filed for four parcels in the immediate vicinity of the site. The parcels associated with these complaints all lie generally upstream of the site and will not be affected by proposed development activities or resulting changes in post-development hydrology. For a visual depiction of drainage complaints in the vicinity of the site, refer to Appendix 3-G.

According to City of Redmond Erosion Hazard Area Map (see appendix H), Frequently Flooded Area Map (see appendix I), Landslide Hazard Area Map (see appendix J), Seismic Hazard Area Map (see appendix K), Stream Classification Map (see appendix L), and Wetland Map (see appendix M) the project site does not belong to any hazardous

areas. Within the offsite easement for storm and sewer discharge, there are some mapped steep slope areas. Storm, sewer, and maintenance access are proposed to be constructed within the steep slope area and its buffer, which is allowed per RZC 21.64.060.D.2.b. A retaining wall is proposed within a portion of a steep slope area to provide adequate width for the necessary utility maintenance access. The approval for the wall construction will be addressed through a separate land use permit application for alteration of geologic hazard (AGHA). The AGHA was granted and the approval letter is provided in Appendix 10-B.

A drainage plan has been devised for the Rose Hill neighborhood. The proposed stormwater discharge plan for the site complies with the Rose Hill stormwater discharge plan in Figure 3.1 (Appendix 3-F). The site is located in a Wellhead Protection Zone 4 (see appendix 3-D).

Flow control will be achieved by means of a Combined Detention/Wetvault located at the eastern end of the site. The proposed Combined Detention/Wetvault will comply with flow control requirements found in the City of Redmond 2019 Stormwater Management Technical Notebook and the 2014 DOE Manual. Water quality will be achieved through the use of dead storage within the Combined Detention/Wetvault facility.



VICINITY MAP

SCALE: 1"=2000'

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Structural
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Survey

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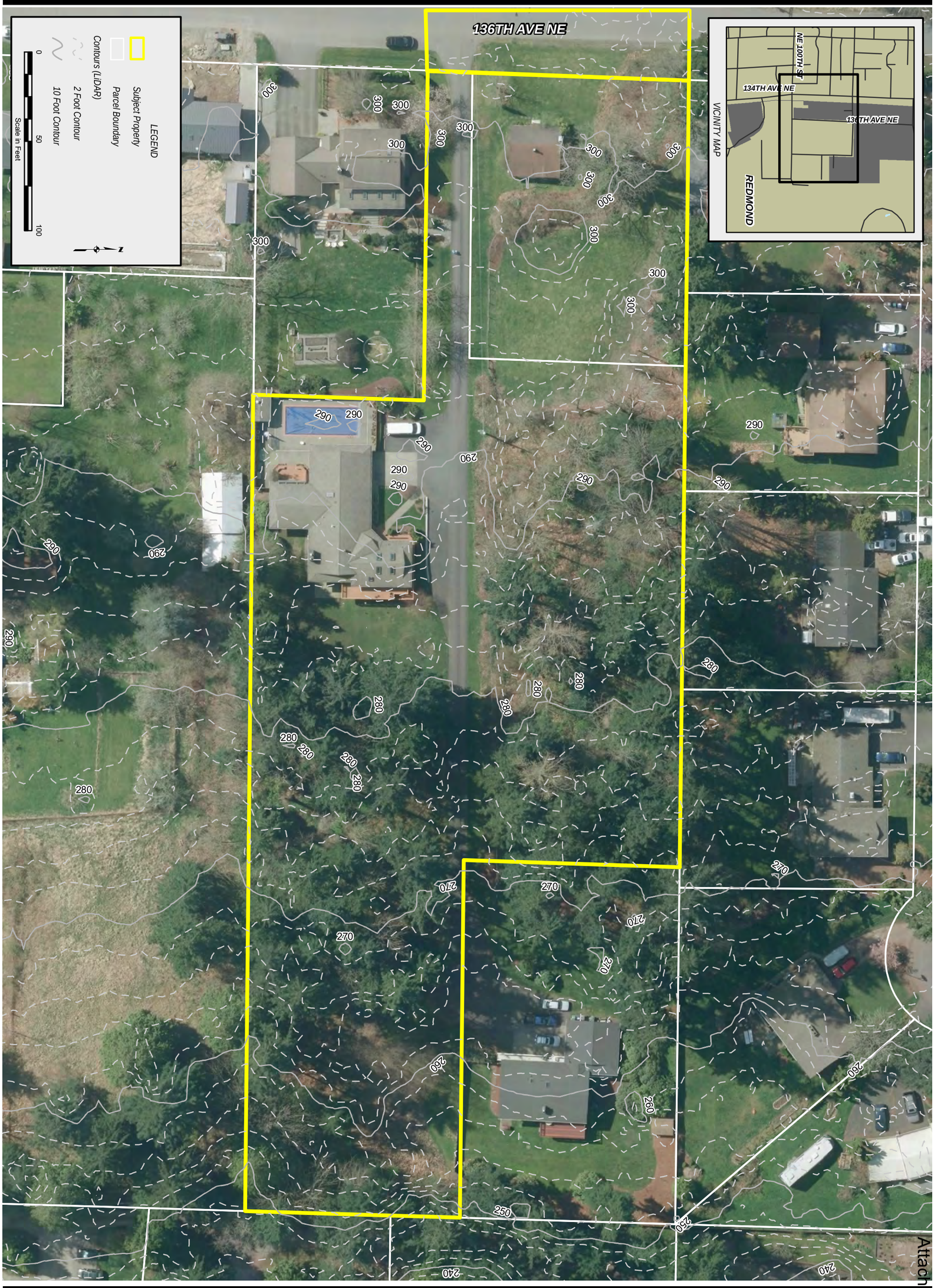
MILESTONE NW

GARBARINO

VICINITY MAP

15-104F01.mxd | MOD: 11/09/2015 | TPA



Attachment 13

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F2.0
DESIGNER: T.ABBOTT
DRAWING BY: T.ABBOTT
DATE: 11-09-15
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE: 2.0

MILESONTE NW

GARBARINO

EXISTING CONDITIONS MAP

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Fx. 425.482.2893

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SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

This project is vested under the Redmond Municipal Code (RMC), Redmond Zoning Code (RZC), specific zoning code referenced RIN, and the Redmond Stormwater Technical Notebook. The 2014 Ecology Manual as modified by the Western Washington Phase II Municipal Stormwater Permit regulates issues not addressed by the RMC, RZC and Stormwater Notebook. Existing residential construction exists on the properties; however, this project will be considered new development per Section 2.4 of the 2019 City of Redmond Stormwater Technical Notebook, which notes that all single-family developments including the subdivision of property will be classified as such. Figure I-2.4.1 of the 2019 Redmond Stormwater Technical Notebook was utilized to determine the applicability minimum requirements for the project. The project proposed to add more than 10,000 square feet of new impervious surface and more than 5,000 SF of new PGIS, designating the project as "New Development" per Figure I-2.4.1. See copy of Figure I-2.4.1 in Appendix 2-A for the highlighted assumptions of the project designation based on proposed landcover quantities. All minimum requirements apply to the new impervious surfaces and converted pervious surfaces. The minimum requirements are addressed as follows.

Requirement #1: Preparation of Stormwater Site Plans

This drainage report and associated plans contains all information and requirements for Stormwater Site Plans listed in Chapter 3, Volume I of the 2014 Ecology Manual. The project is listed in a Wellhead Zone as shown in the City of Redmond Wellhead Protection Zone Map. See copy attached in appendix 3-D for reference. As per section 2.5.6 of the 2019 City of Redmond Stormwater Management Technical Notebook, "Basic" treatment facilities are required by this project.

Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP)

The Construction Stormwater Pollution Prevention Plan will be included as a separate document at a future submittal.

Requirement #3: Source Control of Pollution

Source control BMPs are not required for residential development per the 2014 Ecology Manual.

Requirement #4: Preservation of Natural Drainage System and Outfalls

Natural drainage patterns will be maintained onsite and discharge from the project site will occur in historical patterns across the easterly property line. All discharge from the site is within the same threshold discharge basin. The proposed discharge of the site's runoff will not cause significant adverse impact to downstream receiving waters or downgradient properties. Mitigated flows will be released at required rates and durations.

Requirement #5: On-Site Stormwater Management

See Section 4 of this report for how this minimum requirement is addressed.
Pending the Geotechnical investigation of the site soils and underlying geology onsite stormwater management BMP's will be more fully addressed in a future submittal.
Preliminary investigation of USGS soil mapping indicates that the site is underlain by till soils, and onsite stormwater management will be limited to applications of soil augmentation per COR Det. 632 on all disturbed area to be landscaped.

Requirement #6: Runoff Treatment

See Section 4 of this report for how this minimum requirement is addressed. A Combined Detention/Wetvault will be utilized to address basic water quality treatment requirements.

Requirement #7: Flow Control

See Section 4 of this report for how this minimum requirement is addressed. Flow Control requirements will be met for the project with a Combined Detention/Wetvault that will release flow at required, mitigated rates based an approved continuous runoff model (WWHM 4).

Requirement #8: Wetlands Protection

Per the City's Critical Areas Mapping, there are no wetlands on the project site.

Requirement #9: Operations and Maintenance

A Maintenance and Operations Manual will be created for this project. Please refer to Appendix 10-A in Section 10 for this document.

APPENDIX 2-A

FLOW CHART

FOR DETERMINING REQUIREMENTS OF NEW DEVELOPMENTS

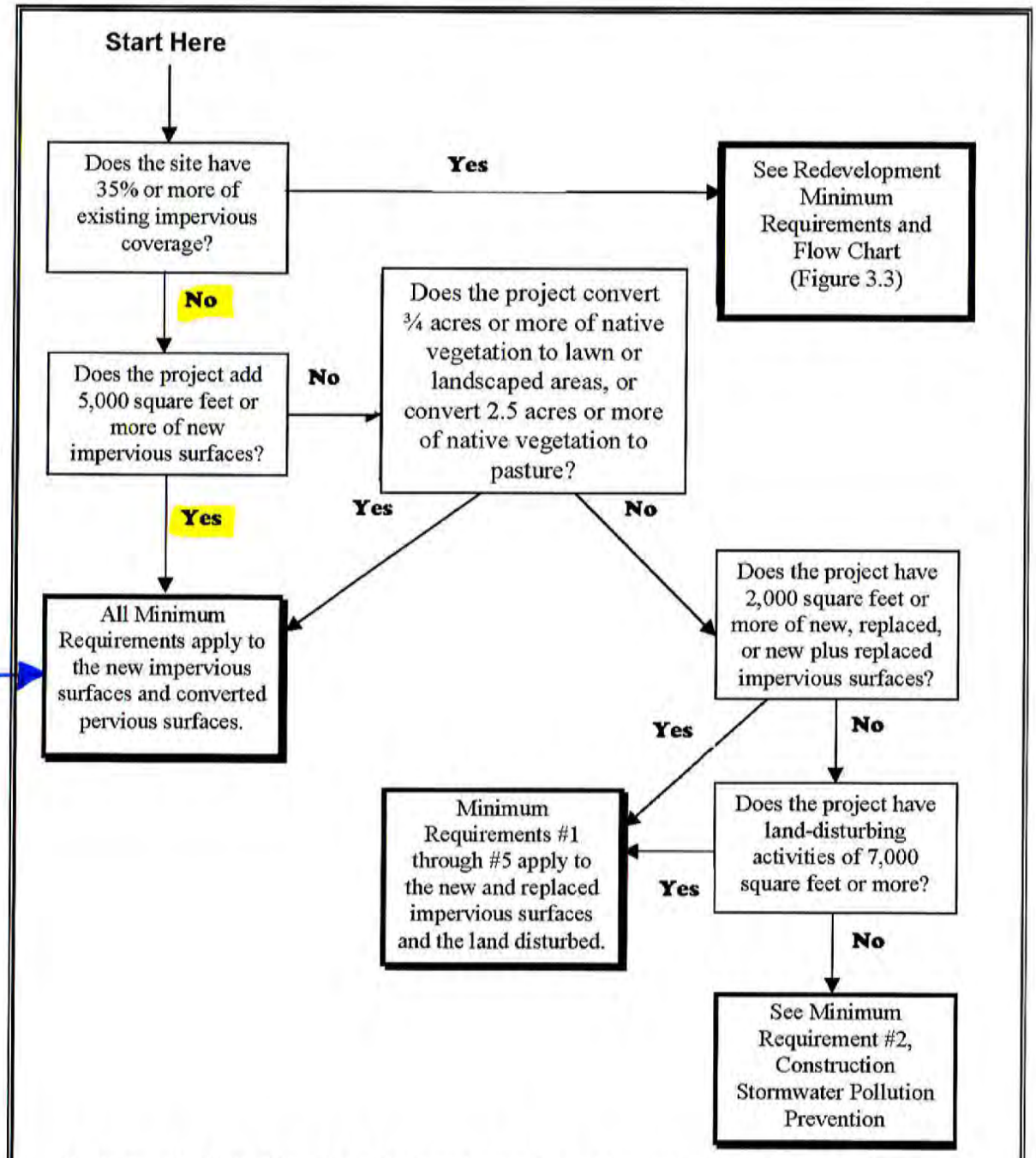


Figure 3.2 Flow Chart for Determining Requirements for New Development

3.0 OFF-SITE ANALYSIS

On Wednesday November 11, 2015, A Downstream Analysis was performed at the site. The weather was dry and approximately 49°F. The ground was damp due to continual rain over the previous days, no overland flow or pooling was observed. Per King County Imap diligence research no drainage complaints were found on or adjacent to the site within a 0.25-mile analysis. The following observations were verified during this visit.

Upstream Analysis

From the site observation and evaluation of available, King County LiDAR and aerial photography, there is no appreciable upstream run-on flow adjacent parcels to the site.

Field Inspection/Downstream Analysis

Flow path #1:

Onsite stormwater runoff flows generally west to east. On the east side of the property there are two flow paths that carry runoff from the site; (1) Southeastern Culvert and ❹ Northeastern culvert described below. Both enter a 12" concrete culvert❶ and travel east to where the culvert outfalls into an open drainage channel. Flows follow this channel easterly down a steep slope to where they enter the City of Redmond storm drainage network via structure with trash rack❷ at the base of the slope. Stormwater flows through a 12" PVC pipe from the structure to a catch basin❸ in the parking lot behind PRO Sports Club parcel #9430050050. The flows collected in the City of Redmond MS4, cross Willows Road and are conveyed east to the Sammamish River.

Flow path #2:

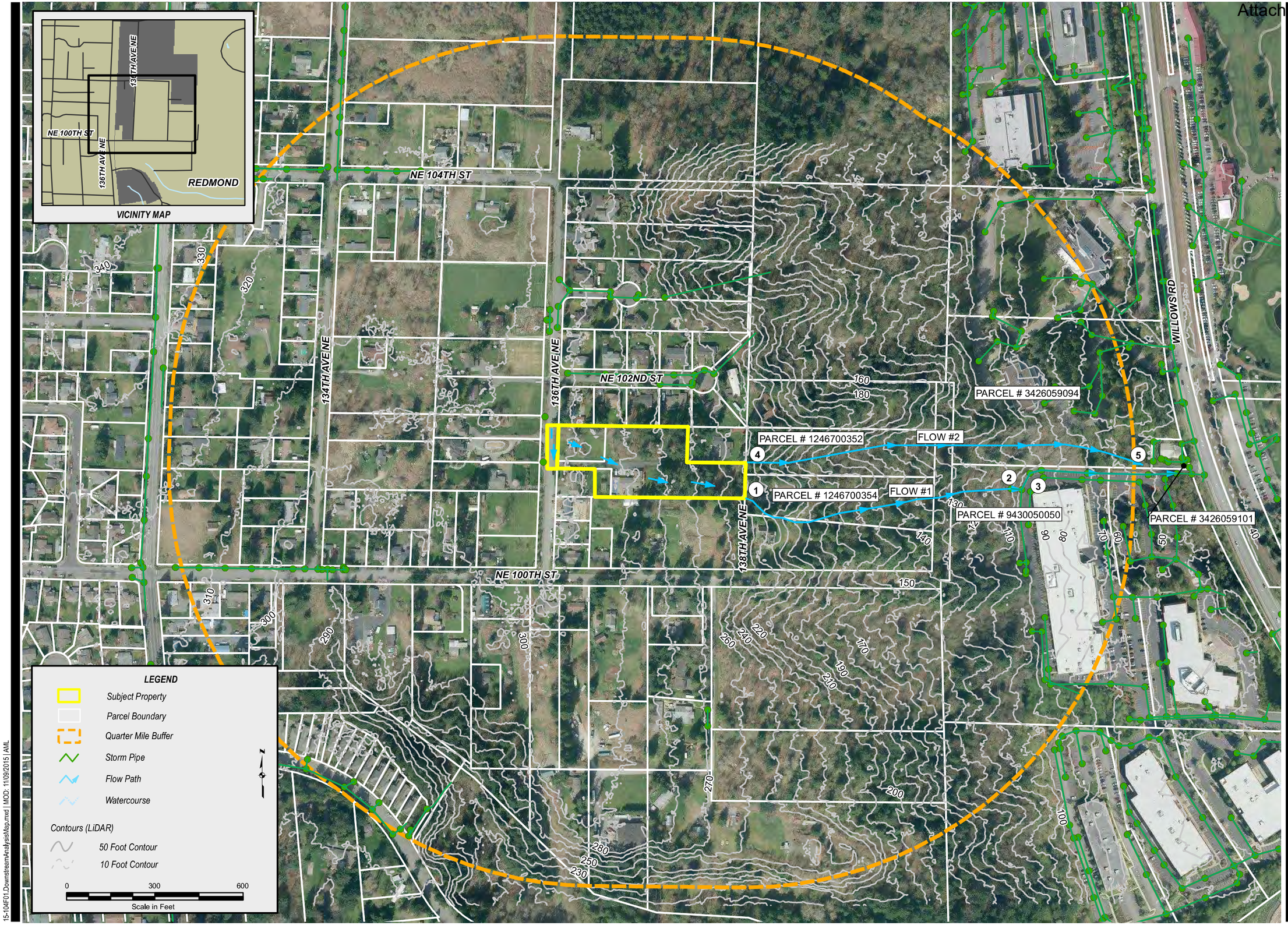
The Northeastern portion of the runoff❹ flows over the Eastern property boundary via overland flow and crosses a gravel access easement via sheet flow. Runoff enters a defined ravine and drains roughly 500ft down the steeply sloped hill of parcel #1246700352 and then splits into two channels. The southern channelized flow to❺ is

collected on parcel #34260559101 where it enters the City of Redmond storm drainage network on the private property of parcel #34260559101. At this point, flow crosses the 0.25 mile boundary of analysis. See Figure 6, Downstream Analysis Map, located in Appendix 3-A, for a detailed map of the downstream flow paths.

APPENDIX 3-A

DOWNSTREAM

ANALYSIS & MAPPING



15-104F01.DownstreamAnalysisMap.mxd | MOD: 11/09/2015 | AML

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

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MILESTONE NW

GARBARINO
DOWNSTREAM ANALYSIS MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F2.0
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 11-11-15
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
3.0

Stormwater flows under 138th Ave NE here via a culvert❶. The culvert outfalls into the brush in the center of the photo.

Stormwater enters this structure❷ at the base of the hill

Discharge ❹ looking downgradient on parcel #1246700352

Natural channel❺ looking upstream on parcel #3426059094

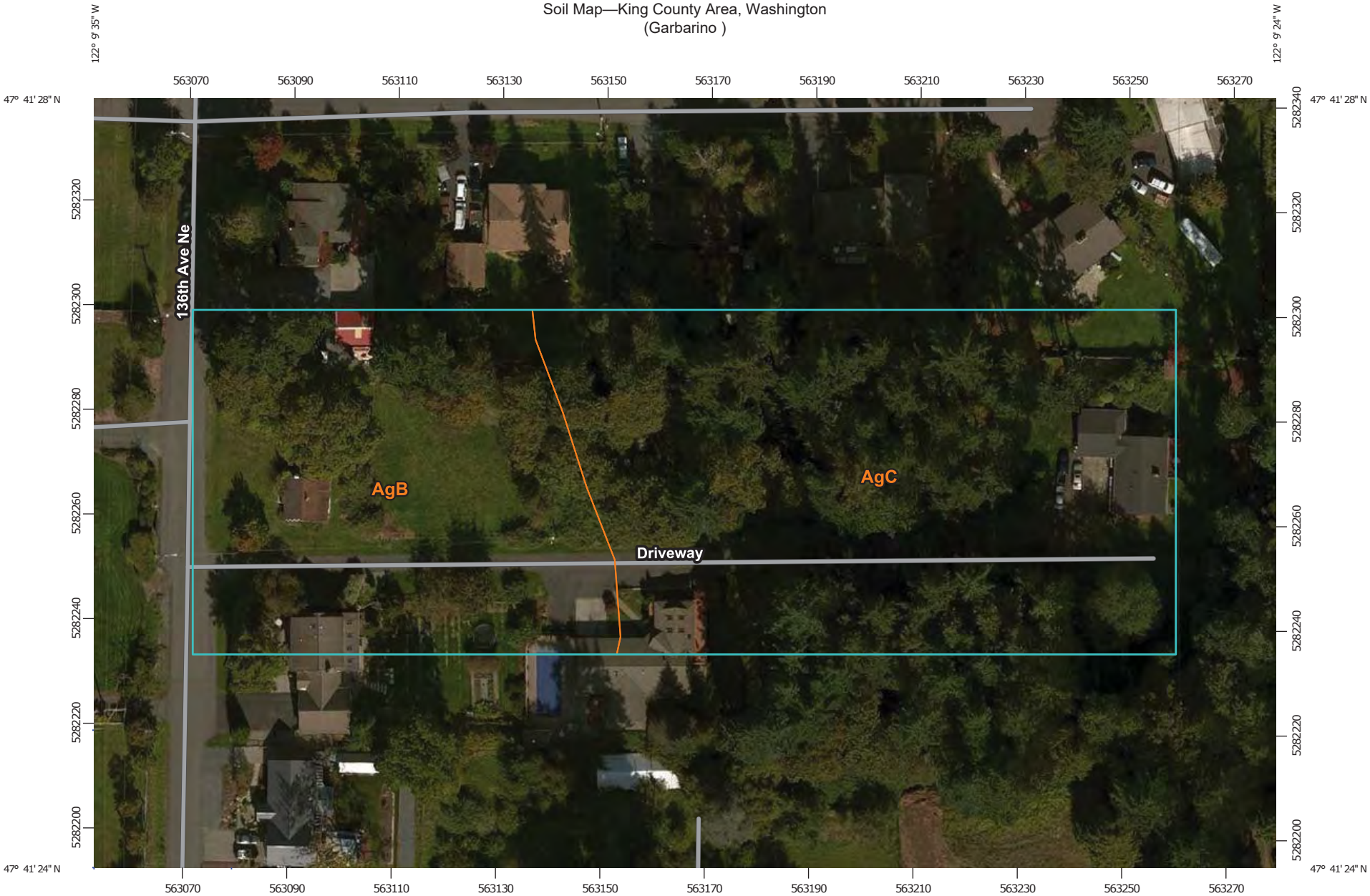
APPENDIX 3-B

CRITICAL AREAS MAPPING

APPENDIX 3-C

SCS AND USGS SOIL SURVEY MAPPING

Soil Map—King County Area, Washington
(Garbarino)



Map Scale: 1:1,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 11, Sep 14, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 31, 2013—Oct 6, 2013

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

King County Area, Washington (WA633)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AgB	Alderwood gravelly sandy loam, 0 to 8 percent slopes	1.2	39.7%
AgC	Alderwood gravelly sandy loam, 8 to 15 percent slopes	1.9	60.3%
Totals for Area of Interest		**3.1**	**100.0%**

King County Area, Washington

AgC—Alderwood gravelly sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t626
Elevation: 50 to 800 feet
Mean annual precipitation: 20 to 60 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 160 to 240 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Alderwood and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alderwood

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope, talf
Down-slope shape: Linear, convex
Across-slope shape: Convex
Parent material: Glacial drift and/or glacial outwash over dense glaciomarine deposits

Typical profile

A - 0 to 7 inches: gravelly sandy loam
Bw1 - 7 to 21 inches: very gravelly sandy loam
Bw2 - 21 to 30 inches: very gravelly sandy loam
Bg - 30 to 35 inches: very gravelly sandy loam
2Cd1 - 35 to 43 inches: very gravelly sandy loam
2Cd2 - 43 to 59 inches: very gravelly sandy loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B

Other vegetative classification: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XS301WA), Limited Depth Soils (G002XF303WA)

Minor Components

Everett

Percent of map unit: 5 percent
Landform: Eskers, kames, moraines
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Crest, base slope
Down-slope shape: Convex
Across-slope shape: Convex

Indianola

Percent of map unit: 5 percent
Landform: Eskers, kames, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Shalcar

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Norma

Percent of map unit: 2 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave

Data Source Information

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 11, Sep 14, 2015

King County Area, Washington

AgB—Alderwood gravelly sandy loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t625
Elevation: 50 to 800 feet
Mean annual precipitation: 25 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 160 to 240 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Alderwood and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alderwood

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest, talf
Down-slope shape: Linear, convex
Across-slope shape: Convex
Parent material: Glacial drift and/or glacial outwash over dense glaciomarine deposits

Typical profile

A - 0 to 7 inches: gravelly sandy loam
Bw1 - 7 to 21 inches: very gravelly sandy loam
Bw2 - 21 to 30 inches: very gravelly sandy loam
Bg - 30 to 35 inches: very gravelly sandy loam
2Cd1 - 35 to 43 inches: very gravelly sandy loam
2Cd2 - 43 to 59 inches: very gravelly sandy loam

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B

Other vegetative classification: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XF303WA), Limited Depth Soils (G002XS301WA)

Minor Components

Mckenna

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave

Everett

Percent of map unit: 5 percent
Landform: Eskers, kames, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, crest
Down-slope shape: Convex
Across-slope shape: Convex

Shalcar

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Norma

Percent of map unit: 2 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave

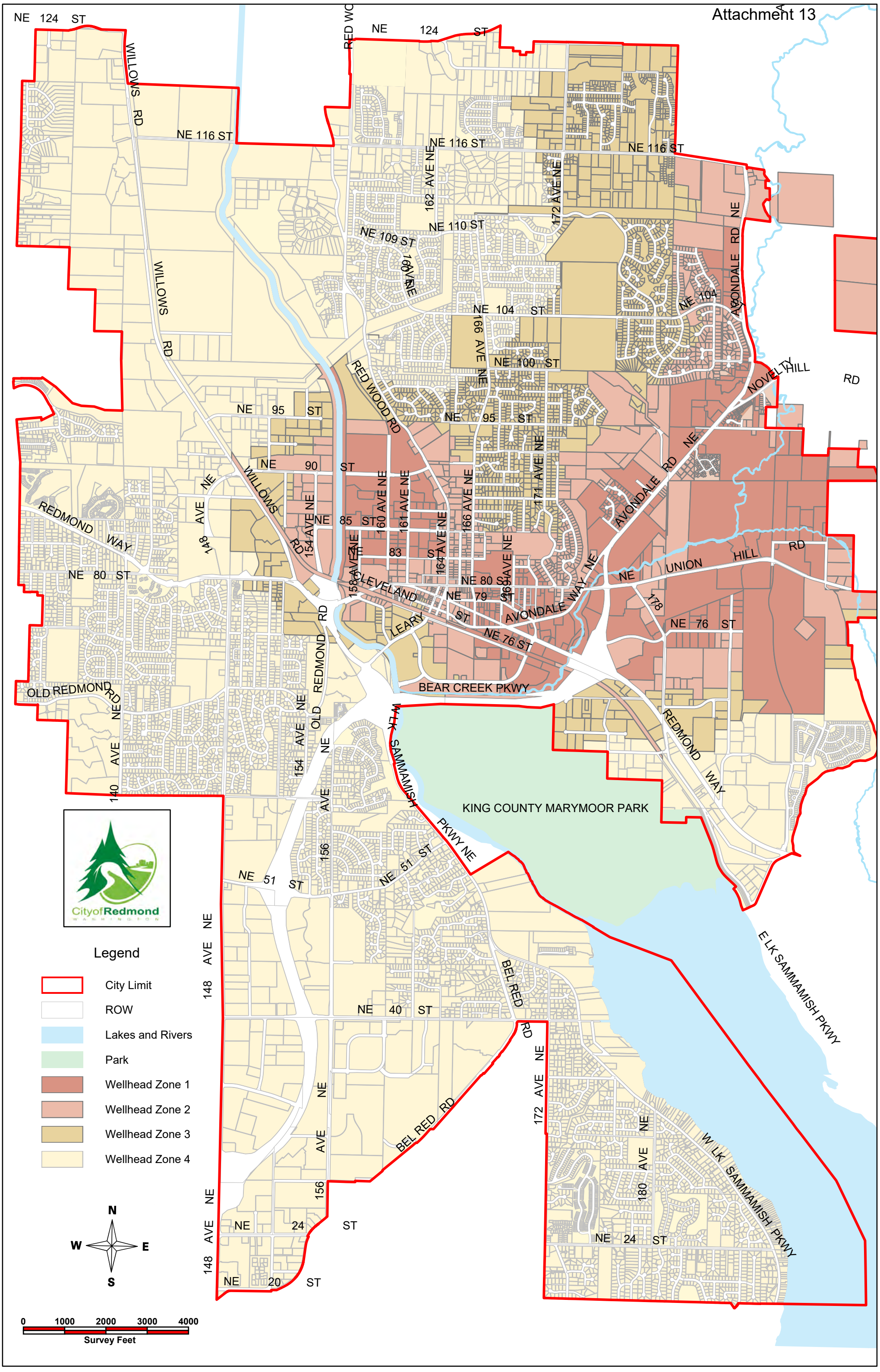
Data Source Information

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 11, Sep 14, 2015

APPENDIX 3-D

REDMOND WELLHEAD PROTECTION MAP

Attachment 13



APPENDIX 3-E

REDMOND WATERSHED MAP

Attachment 13

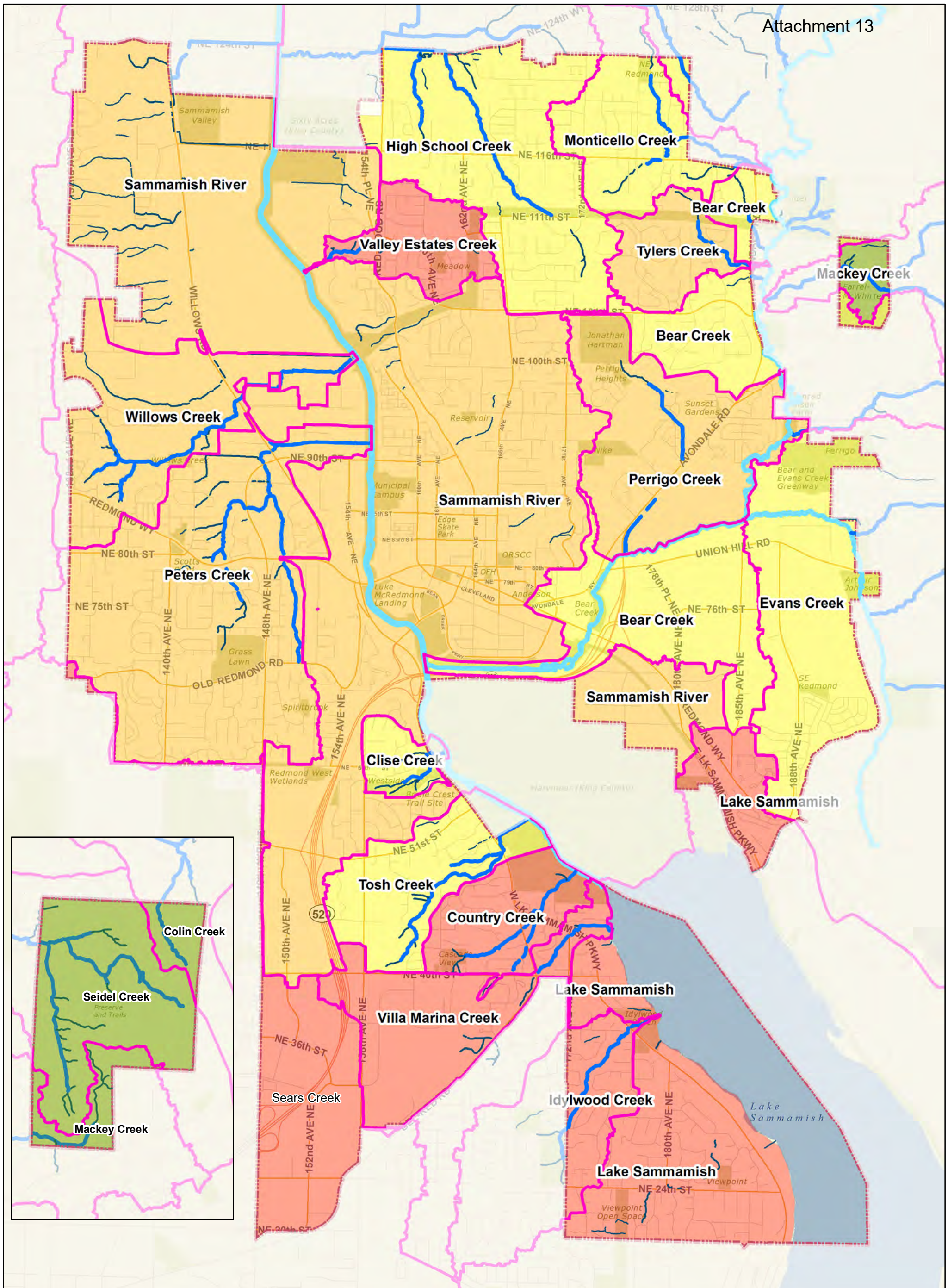


Figure 4.3 - Management Priorities for Watersheds in the City of Redmond

City of Redmond, Washington
09/11/2013

0 3,000 6,000 Feet

CityofRedmond WASHINGTON

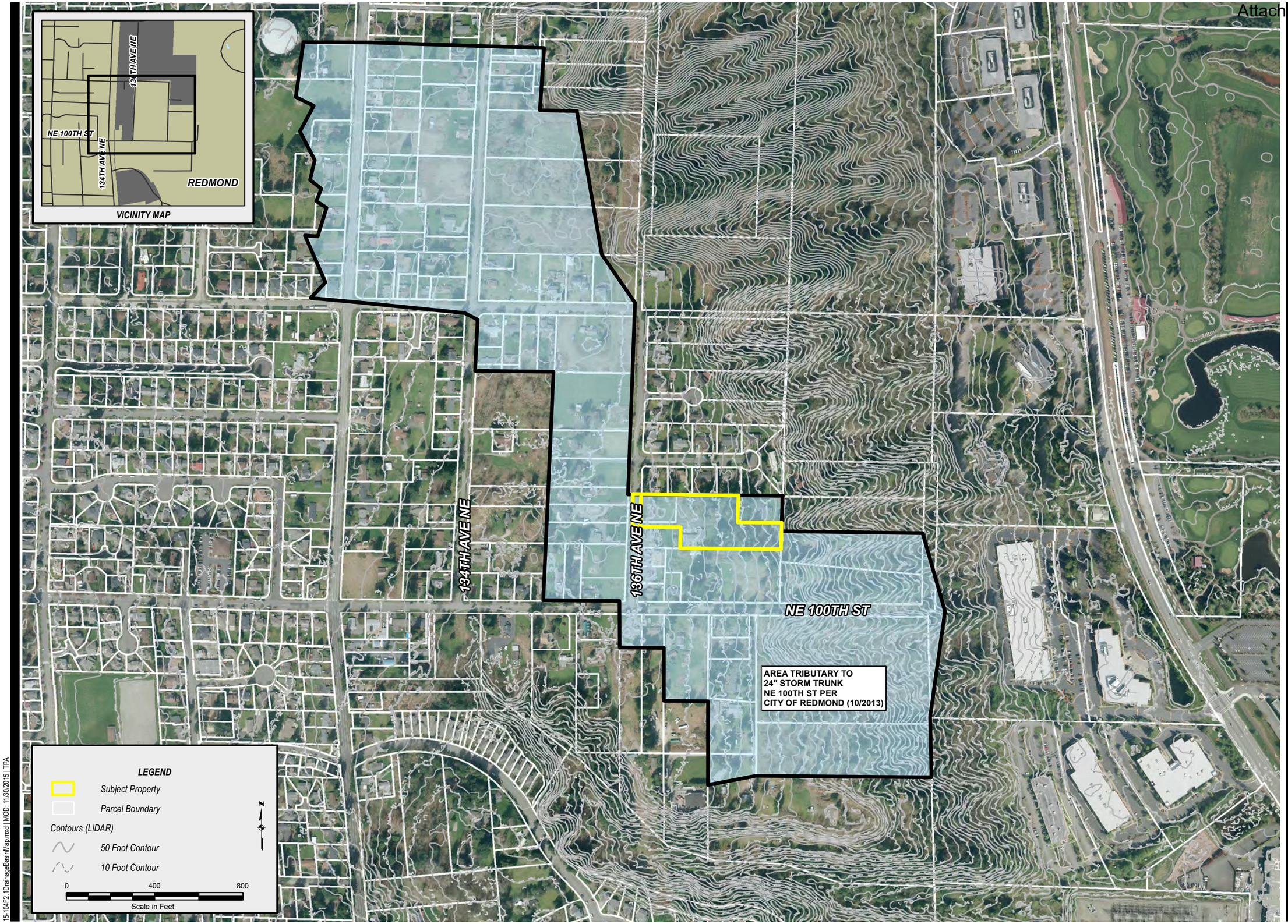
Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Protection
- Highest Restoration
- Restoration
- Restoration/Development

APPENDIX 3-F

REDMOND DRAINAGE BASIN MAP



15-104F2.1DrainageBasinMap.mxd | MOD: 11/30/2015 | TPA

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

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Commercial
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MILESTONE NW

GARBARINO
ROSE HILL DRAINAGE BASIN

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

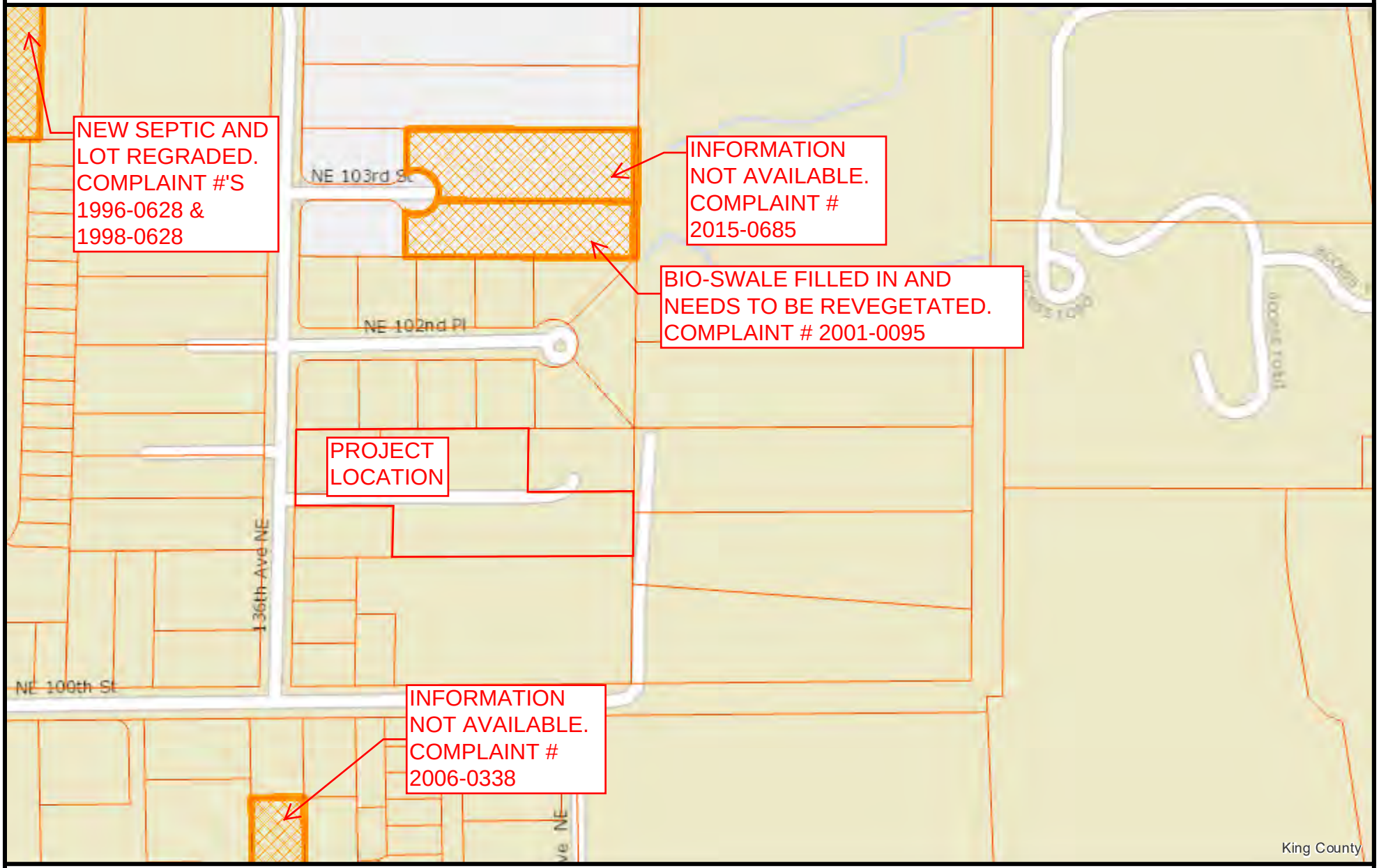
REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F2.1
DESIGNER: T.ABBOTT
DRAWING BY: T.ABBOTT
DATE: 11-30-15
SCALE: AS SHOWN
JURISDICTION: REDMOND CO.

FIGURE:
3.1

APPENDIX 3-G

DRAINAGE COMPLAINTS

Garbarino - Drainage Complaints



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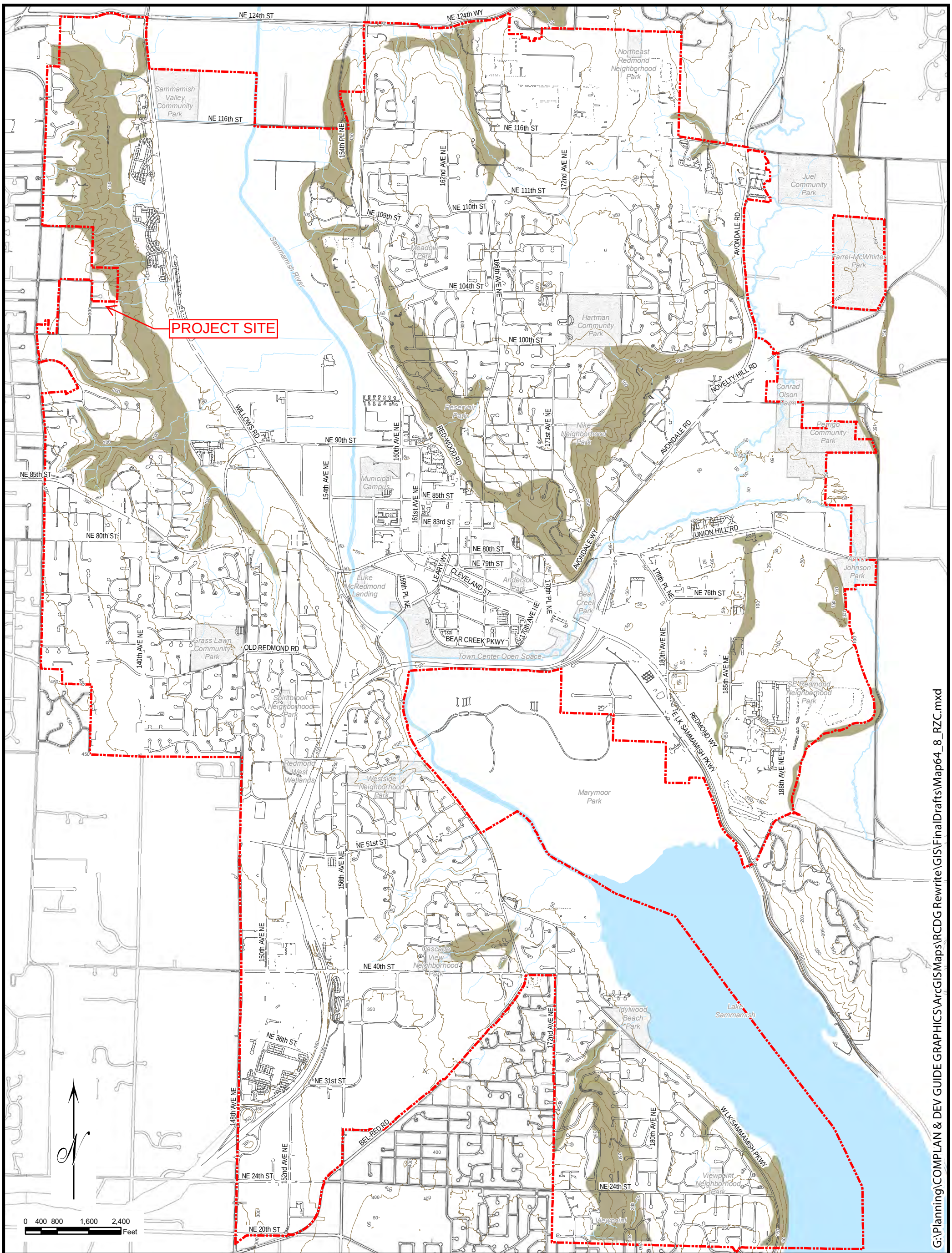
Date: 11/30/2015 Notes:

N

King County GIS Center

APPENDIX 3-H

EROSION HAZARD AREA MAP



City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.8 Erosion Hazard Areas

Legend:

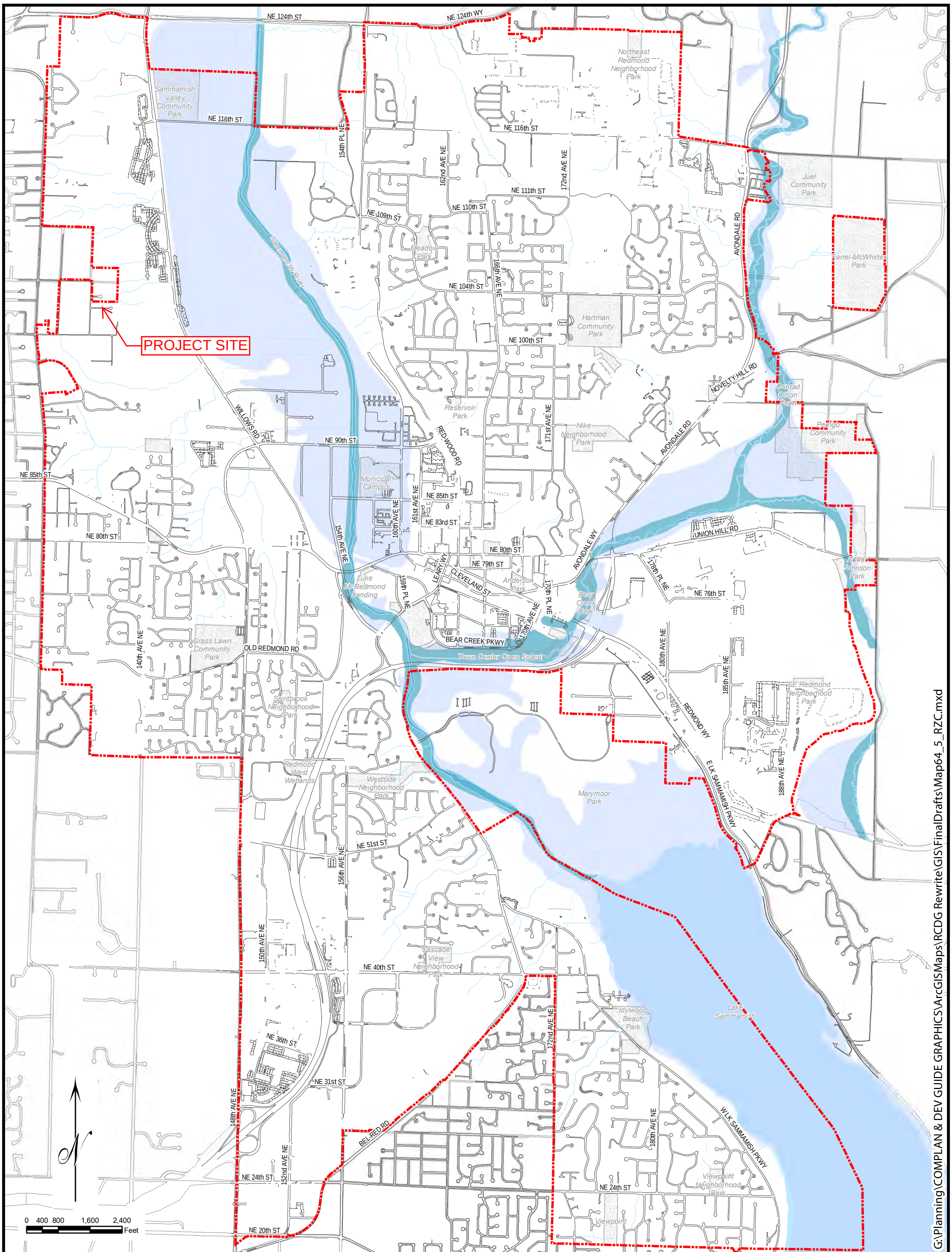
- Erosion Hazard Areas
- Contours
- Redmond City Limits

Sources:
SCS Soil Survey

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

APPENDIX 3-I

FREQUENTLY FLOODED AREA MAP



G:\Planning\COMPLAN & DEV GUIDE GRAPHICS\ArcGISMaps\RCDG Rewrite\GIS\FinalDrafts\Map64_5_RZC.mxd

City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.5 Frequently Flooded Areas

Legend:

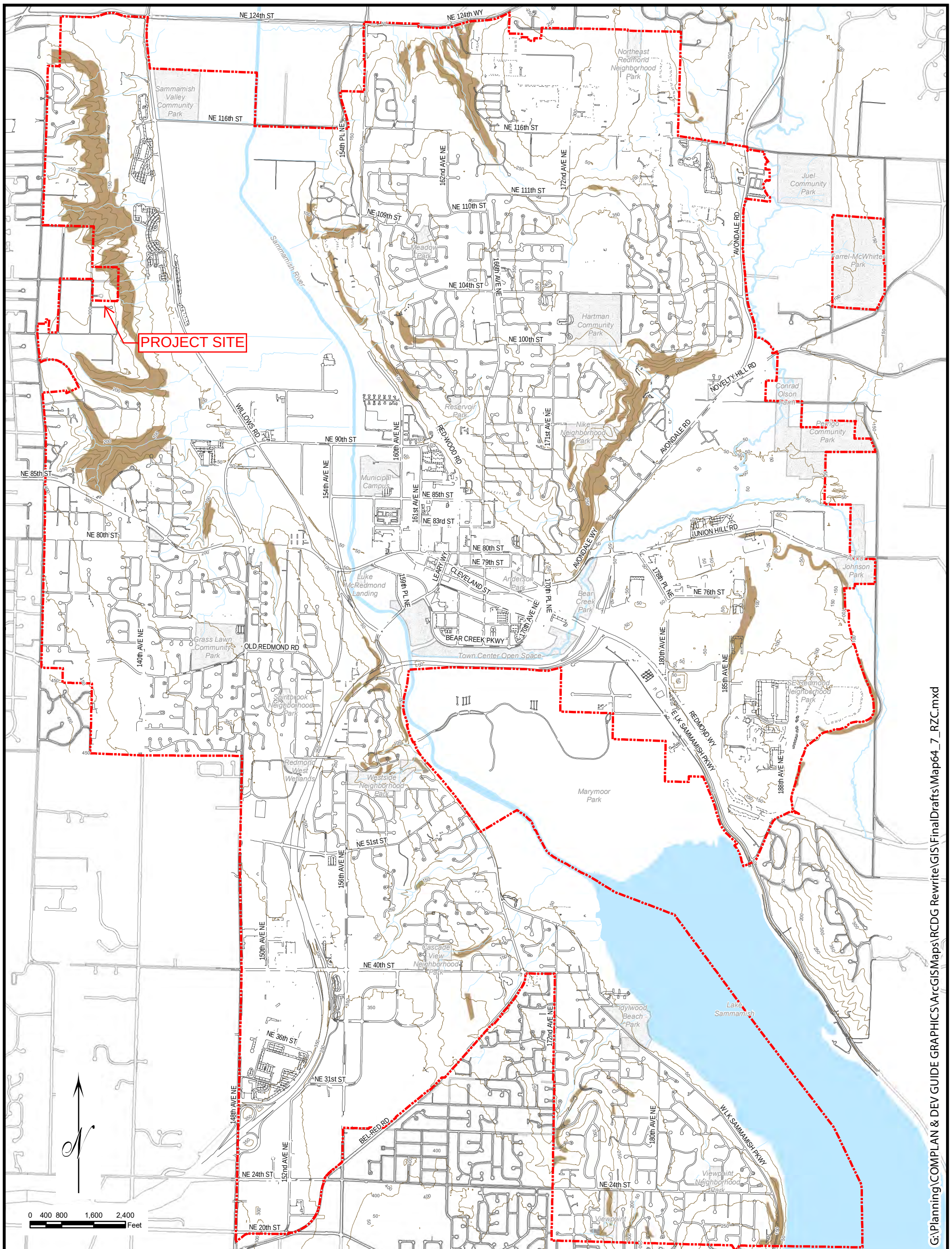
- 100 Year Floodplain
- FEMA Floodway
- Redmond City Limits

Sources:
FEMA Flood Insurance Rate Maps

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

APPENDIX 3-J

LANDSLIDE HAZARD AREA MAP



City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.7 Landslide Hazard Areas

Legend:

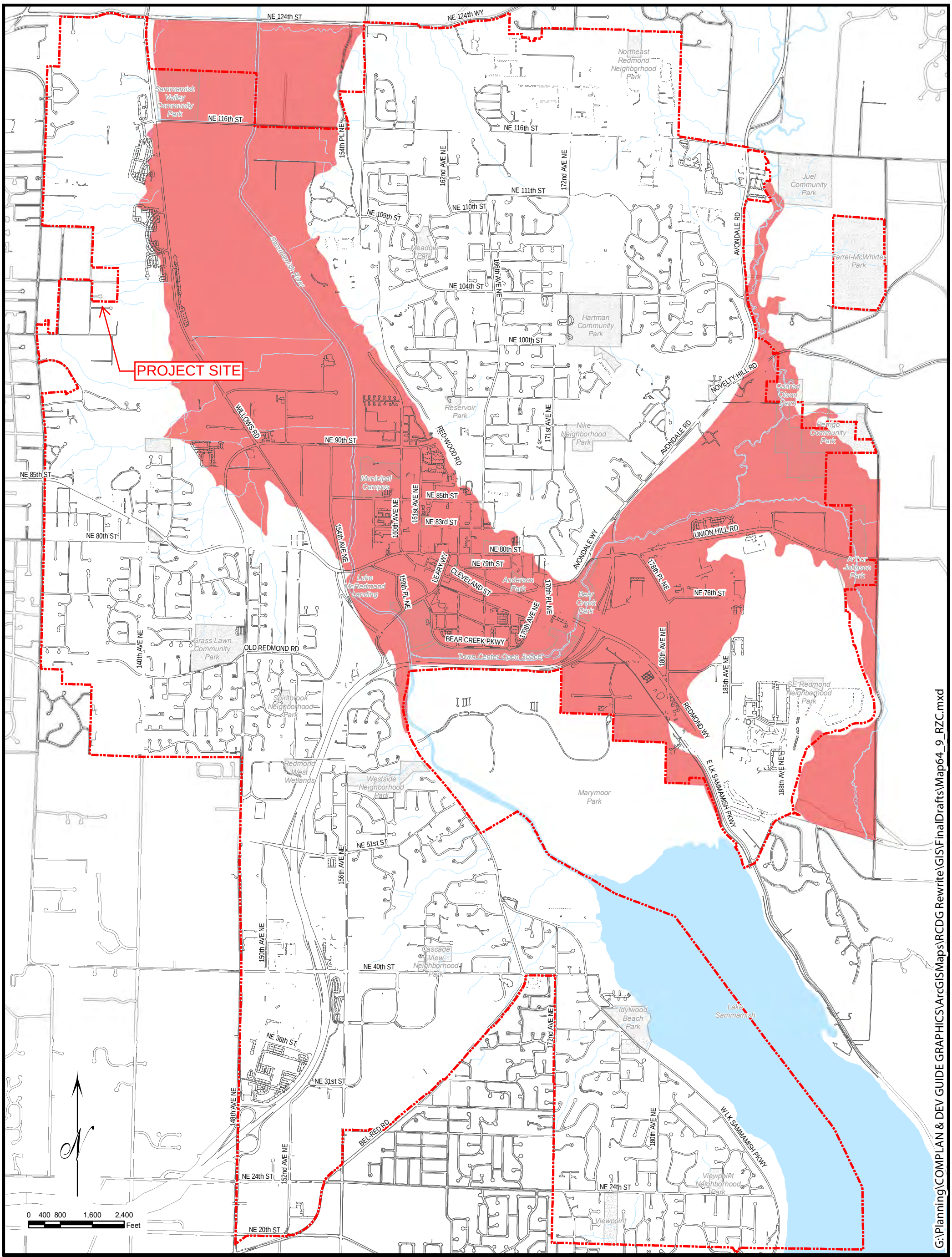
- Landslide Hazard Areas
- Contours
- Redmond City Limits

Sources:
USGS Topographic Maps
USGS Geologic Maps

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criterial or standards of the CAO, the criteria shall prevail.

APPENDIX 3-K

SEISMIC HAZARD AREA MAP



City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.9 Seismic Hazard Areas

Legend:

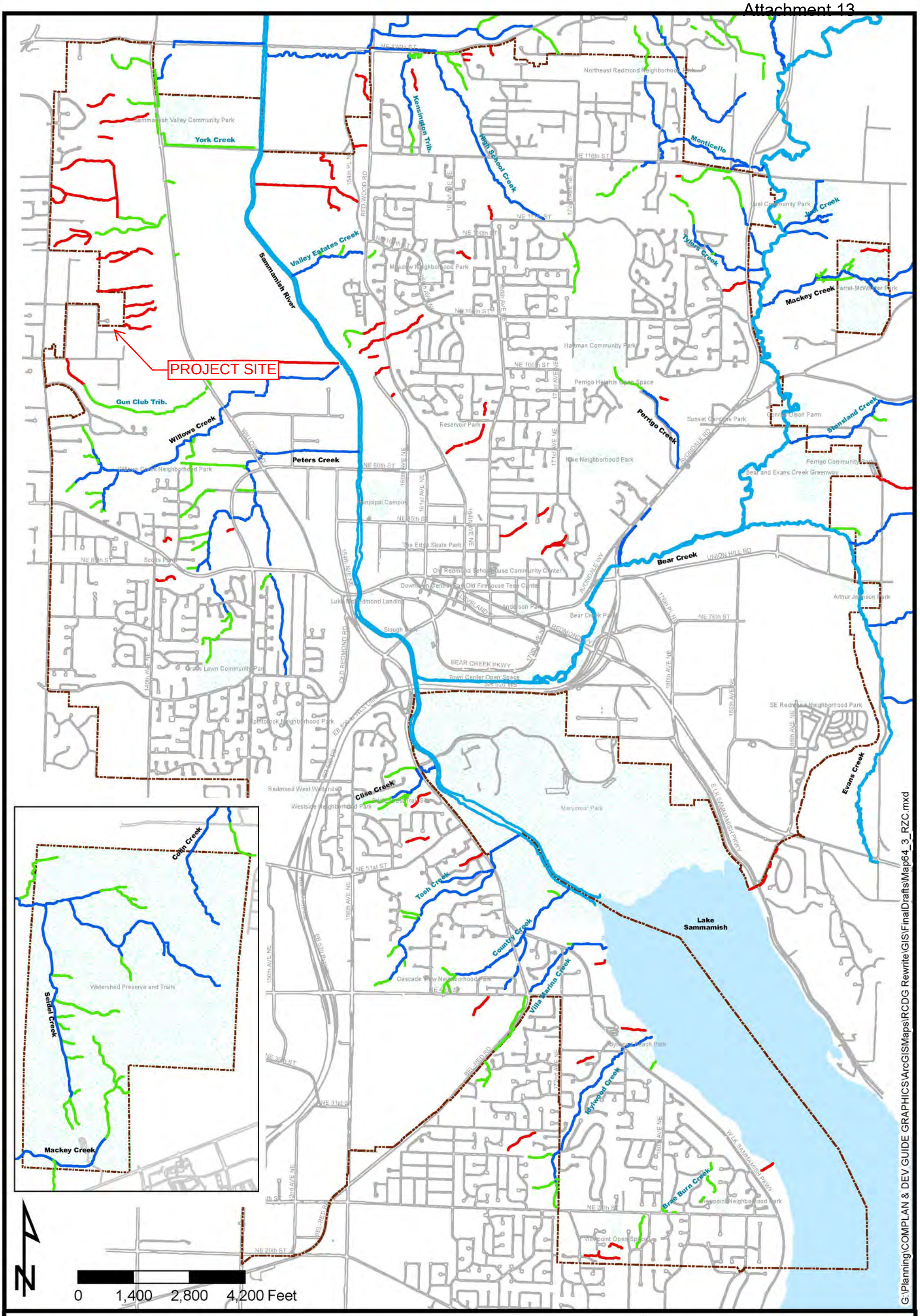
- Seismic Hazard Areas
- Redmond City Limits

Sources:
USGS Geologic Maps

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

APPENDIX 3-L

STREAM CLASSIFICATION MAP



City of Redmond

Critical Areas Map
Effective: September 1, 2012

Map 64.3 Streams Classification

Legend:

- Class I
- Class II
- Class III
- Class IV

Stream Official USGS Stream Name
Stream Informal Stream Name

Sources:
City of Redmond Public Works, Natural Resources Division
City of Redmond GIS Services
Washington Trout / Wild Fish Conservancy
King County GIS

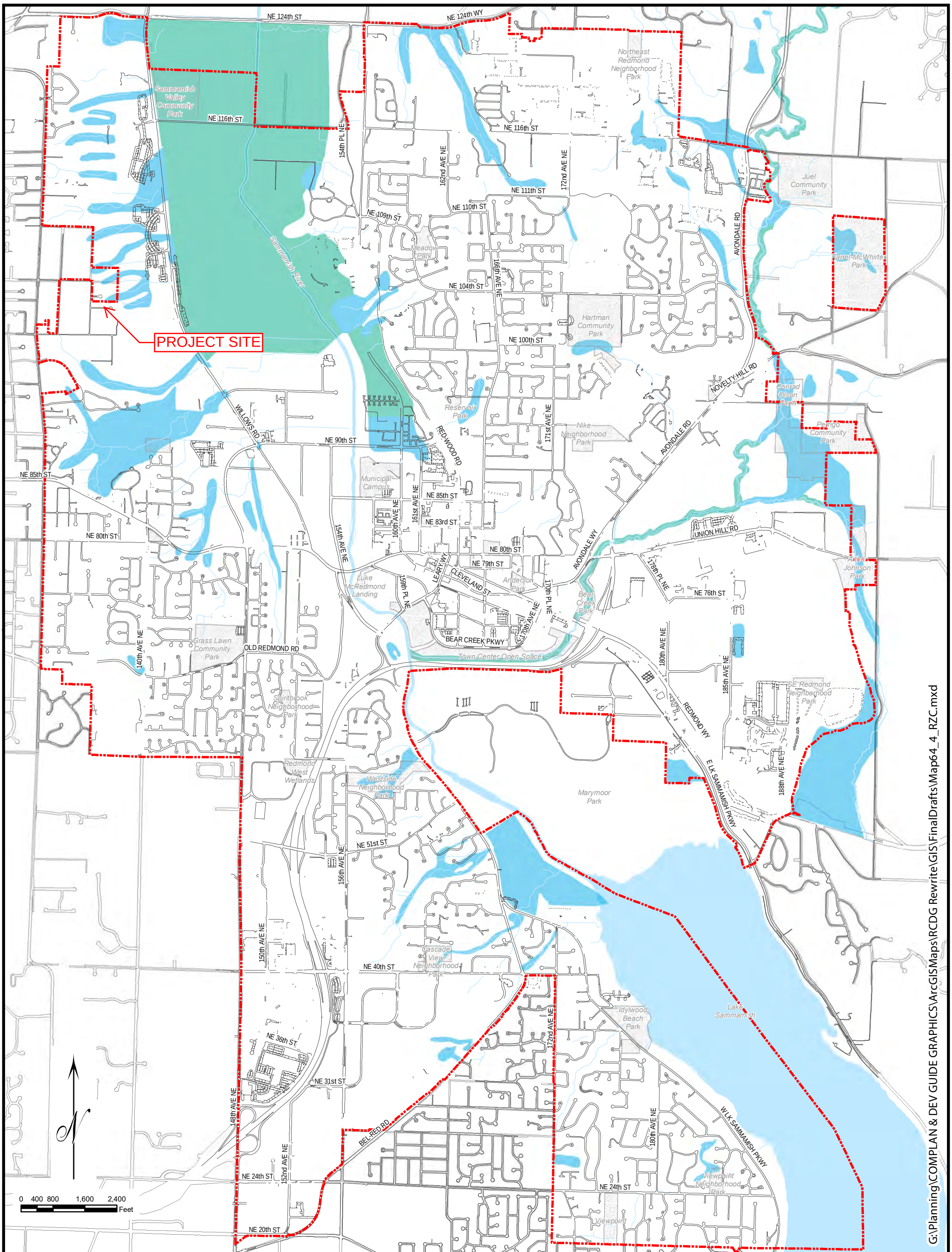
Note: This map shall be used as a general guide representing the approximate location of streams, per RZC 21.64.010(E)(2). The map does not necessarily ensure the presence or absence of streams. In the event of a conflict between the map and the criteria of the Critical Areas Ordinance (CAO), the criteria shall prevail. Consult the CAO (RZC 21.64) for reporting requirements

Note: Gaps in illustrated streams may indicate culverts, pipes, ponds, etc.

Note: Informal stream names may not conform to USGS policies and may change in the future.

APPENDIX 3M

WETLAND MAP



City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.4 Wetlands

Legend:

- Mixed Wetland/Upland
- Wetland
- Redmond City Limits

Sources:
USGS National Wetland Inventory
Aerial Photo Interpretation
SCS Soil Survey
City of Redmond

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

4.0 FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

The flow control and water quality requirements are vested under the Redmond Municipal Code (RMC), Redmond Zoning Code (RZC) and Redmond Stormwater Technical Notebook (2019). The 2014 Ecology Manual as modified by the Western Washington Phase II Municipal Stormwater Permit regulates issues not addressed by the RMC, RZC and Stormwater Notebook.

4.1 Pre-Developed Hydrology

(Onsite Basin)

The Onsite Basin is approximately 2.60 acres and is primarily covered with trees, some lawn area associated with existing landscaping and an existing residence. All acreage will be modeled as "forested" in the pre-developed condition.

Modeled Land Coverage:

Till Forested = 2.60 Acres

Frontage Basin

The Frontage Basin is approximately 0.09 acres. Frontage improvements associated with the project and pre-existing pavement in the 136th Ave NE ROW will be collected and routed to the onsite detention system in the developed condition. The 136th Ave NE frontage basin runoff currently flows west into a shallow swale/depression in the 136th Ave NE ROW. It is assumed that the small amount of flow from the pavement in the 136th Ave ROW that is tributary to this shallow swale infiltrates in this shallow depression as there is no visible outlet to the shallow swale/depression.

Because the frontage basin includes an area of pre-existing pavement (approximately 0.03 acres), this area has been included in the predeveloped modeling land cover. The existing pervious area to be converted in the developed condition has been modeled in the forested condition. WWHM modeled areas for this frontage basin in the predeveloped condition have been entered as follows:

Modeled Land Coverage:

Till Forested = 0.09 Acres

Basin areas and land covers for all predeveloped basins are additionally itemized and quantified in the spreadsheets below. For visual representation of the site basins in the predeveloped condition see Figure 3.0, "Predeveloped Hydrology Map".

Basin Calcs	LDC, Inc.	
	20210 142nd Ave NE Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Existing Basin(s)	Date:	5/14/2019
		Calc. By:	SJW

Existing Basins

Modeled Basin

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
Onsite Basin	**2.60**	**0%**	**0.00**	**0.00**	**2.60**
Total Onsite Area	**2.60**	**0%**	**0.00**	**0.00**	**2.60**

136th Ave NE Frontage	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
Frontage	0.09	100%	0.00	0.00	0.09
Total	**0.09**	**0%**	**0.00**	**0.00**	**0.09**

Total Predeveloped Modeled Area	**2.69**	**0%**	**0**	**0**	**2.69**

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

LDC
THE CIVIL ENGINEERING GROUP
Commercial
Infrastructure
Residential
14201 NE 200th St., #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.462.2893
www.LDCcorp.com

MILESTONE NW

GARBARINO

PREDEVELOPED HYDROLOGY MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F3.0
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 1-21-16
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
4.0

15-104F03PredevelopedHydrologyMap.mxd | MOD: 1/21/2016 | TPA

4.2 Developed Site Hydrology

The developed site for Garbarino will consist of impervious surface roofs, driveways, sidewalks, pavement, and landscaped areas. The Developed Site Hydrology for the site is are shown in Figure 4.

All developed basin runoff is conveyed to a single Combined Detention/Wetvault. Individual Basins are identified below, and are the basis for the developed condition and the Combined Detention/Wetvault sizing in WWHM. For visual representation of all basins in the forthcoming section, see Figure 4.0 "Developed Hydrology Map."

Water quality is provided via a Wetvault as identified within the Water Quality section 4.3.

Onsite Basin

In the developed condition the Onsite Basin is approximately 2.48 acres and includes the developed project site and open space. A portion of the basin cannot be collected and has been modeled as bypass. The Combined Detention/Wetvault will be constructed in the open space (Tract B) located on the southeast portion of the plat.

Modeled Land Coverage:

Till Lawn =	1.11 Acres
Pavement =	0.39 Acres
Roofs =	0.65 Acres
Driveway =	0.15 Acres
Sidewalk =	0.18 Acres

Bypass

In the developed condition a portion of the Onsite Basin in Tract B cannot be collected and has been modeled as bypass. See Figure 4.0 "Developed Hydrology Map" for the location of this bypass area. The following area coverages have been modeled as bypass in WWHM:

Modeled Land Coverage:

Till Lawn =	0.11 Acres
Pavement =	0.01 Acres

Frontage Basin

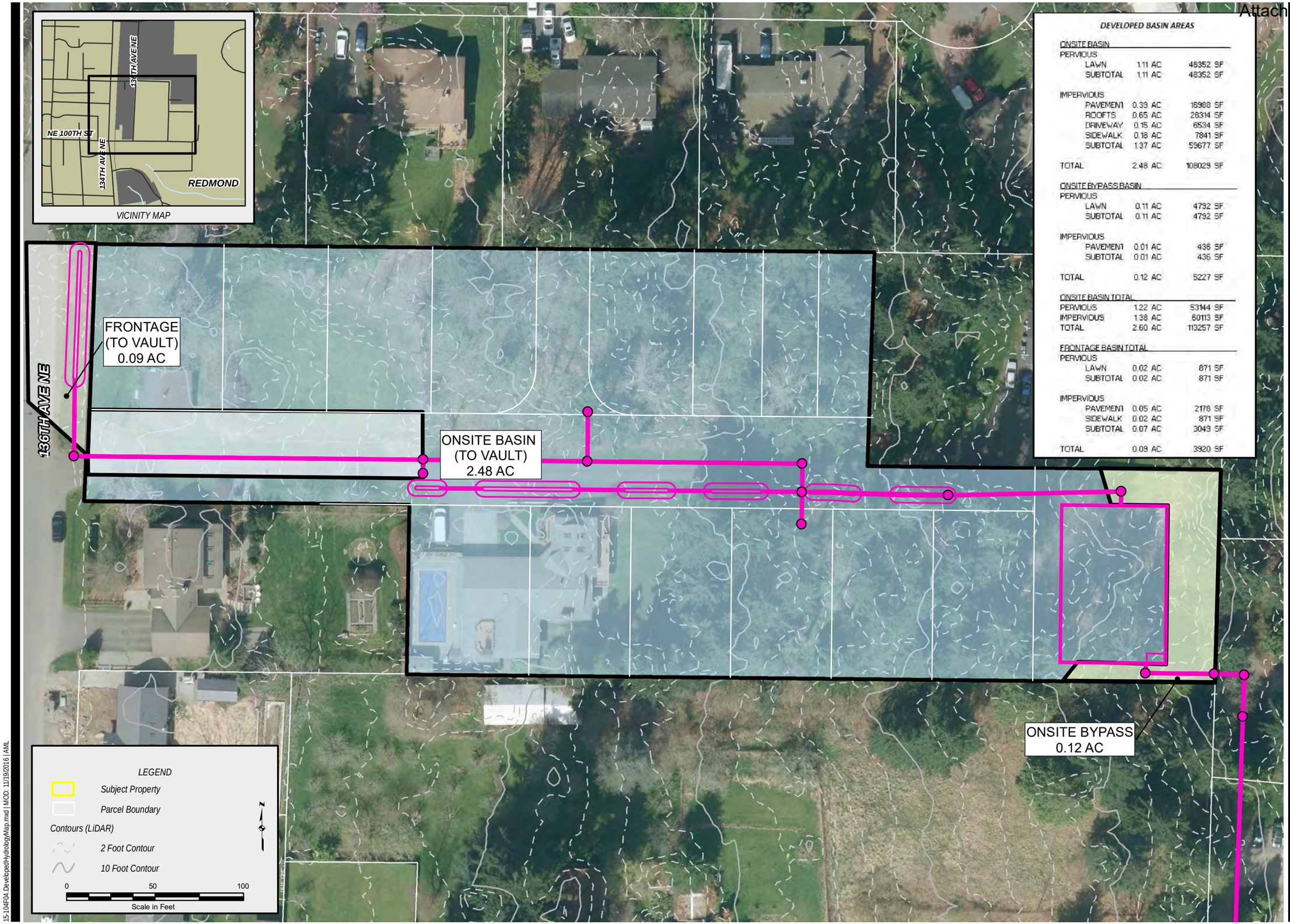
Runoff from the 136th Ave NE frontage improvements associated with the project will be collected and routed to the Combined Detention/Wetvault. The following area coverages have been modeled to account for this frontage area in WWHM:

Modeled Land Coverage:

Till Lawn =	0.02 Acres
Pavement =	0.05 Acres
Sidewalk =	0.02 Acres

Upstream Off-Site - **Developed Condition**

Based on topographical data that is no upstream drainage that flows onto the site.



DEVELOPED BASIN AREAS

ONSITE BASIN		
PERVIOUS		
LAWN	1.11 AC	48352 SF
SUBTOTAL	1.11 AC	48352 SF
IMPERVIOUS		
PAVEMENT	0.39 AC	16988 SF
ROOFTS	0.65 AC	28314 SF
DRIVEWAY	0.15 AC	6534 SF
SIDEWALK	0.18 AC	7841 SF
SUBTOTAL	1.37 AC	59677 SF
TOTAL	2.48 AC	108029 SF
ONSITE BYPASS BASIN		
PERVIOUS		
LAWN	0.11 AC	4792 SF
SUBTOTAL	0.11 AC	4792 SF
IMPERVIOUS		
PAVEMENT	0.01 AC	436 SF
SUBTOTAL	0.01 AC	436 SF
TOTAL	0.12 AC	5227 SF
ONSITE BASIN TOTAL		
PERVIOUS	1.22 AC	53144 SF
IMPERVIOUS	1.38 AC	60113 SF
TOTAL	2.60 AC	113257 SF
FRONTAGE BASIN TOTAL		
PERVIOUS		
LAWN	0.02 AC	871 SF
SUBTOTAL	0.02 AC	871 SF
IMPERVIOUS		
PAVEMENT	0.05 AC	2178 SF
SIDEWALK	0.02 AC	871 SF
SUBTOTAL	0.07 AC	3049 SF
TOTAL	0.09 AC	3920 SF

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

LDC
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Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

Commercial
Infrastructure
Residential

MILESTONE NW

GARBARINO

DEVELOPED HYDROLOGY MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F4.1
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 9-9-19
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
4.1

15-104F04.DevelopedHydrologyMap.mxd | MOD: 11/19/2016 | AML

Basin Calcs	LDC, Inc.	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Developed Basin(s)	Date:	5/14/2019
		Calc. By:	SJW

Developed Basin

Onsite Basin (routed to Vault)

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)	PGIS (Acres)
Lots	**1.62**	**55%**	**0.89**	**0.73**	**0.00**	**0.14**
Roofs	0.65	100.0%	0.65	0.00	0.00	0.00
Patio	0.10	100.0%	0.10	0.00	0.00	0.00
Lawn/Landscape	0.73	0.0%	0.00	0.73	0.00	0.00
Driveways	0.14	100.0%	0.14	0.00	0.00	0.14
ROW / Access Tracts	**0.59**	**68%**	**0.40**	**0.19**	**0.00**	**0.32**
Pavement	0.32	100%	0.32	0.00	0.00	0.32
Sidewalk	0.08	100%	0.08	0.00	0.00	0.00
Lawn/Landscape	0.19	0%	0.00	0.19	0.00	0.00
Driveways	0.00	0%	0.00	0.00	0.00	0.00
Open Space/Tracts	**0.27**	**27%**	**0.07**	**0.20**	**0.00**	**0.07**
Pavement	0.07	0%	0.07	0.00	0.00	0.07
Sidewalk	0.00	0%	0.00	0.00	0.00	0.00
Lawn/Landscape	0.20	0%	0.00	0.20	0.00	0.00
Total Onsite To Vault	**2.48**	**55%**	**1.37**	**1.11**	**0.00**	**0.54**
Onsite Bypass	**0.12**	**8%**	**0.01**	**0.11**	**0.00**	**0.01**
Pavement	0.01	0%	0.01	0.00	0.00	0.01
Lawn/Landscape	0.11	0%	0.00	0.11	0.00	0.00
Total Bypass	**0.12**	**8%**	**0.01**	**0.11**	**0.00**	**0.01**
Total Developed Area Onsite	**2.60**	**53%**	**1.38**	**1.22**	**0.00**	**0.55**

Offsite Frontge - 136th Ave NE

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)	PGIS (Acres)
Frontage (to Vault)*	0.09	78%	0.07	0.02	0.00	0.01
Total To Vault	**2.57**	**56%**	**1.44**	**1.13**	**0.00**	**0.55**

* Includes 0.03 acres of existing pavement in 1`36th Ave that will remain in the developed condition.

4.3 Design Standards for Water Quality

The flow control and water quality requirements are vested under the 2019 Redmond Stormwater Technical Notebook and the 2014 DOE Manual.

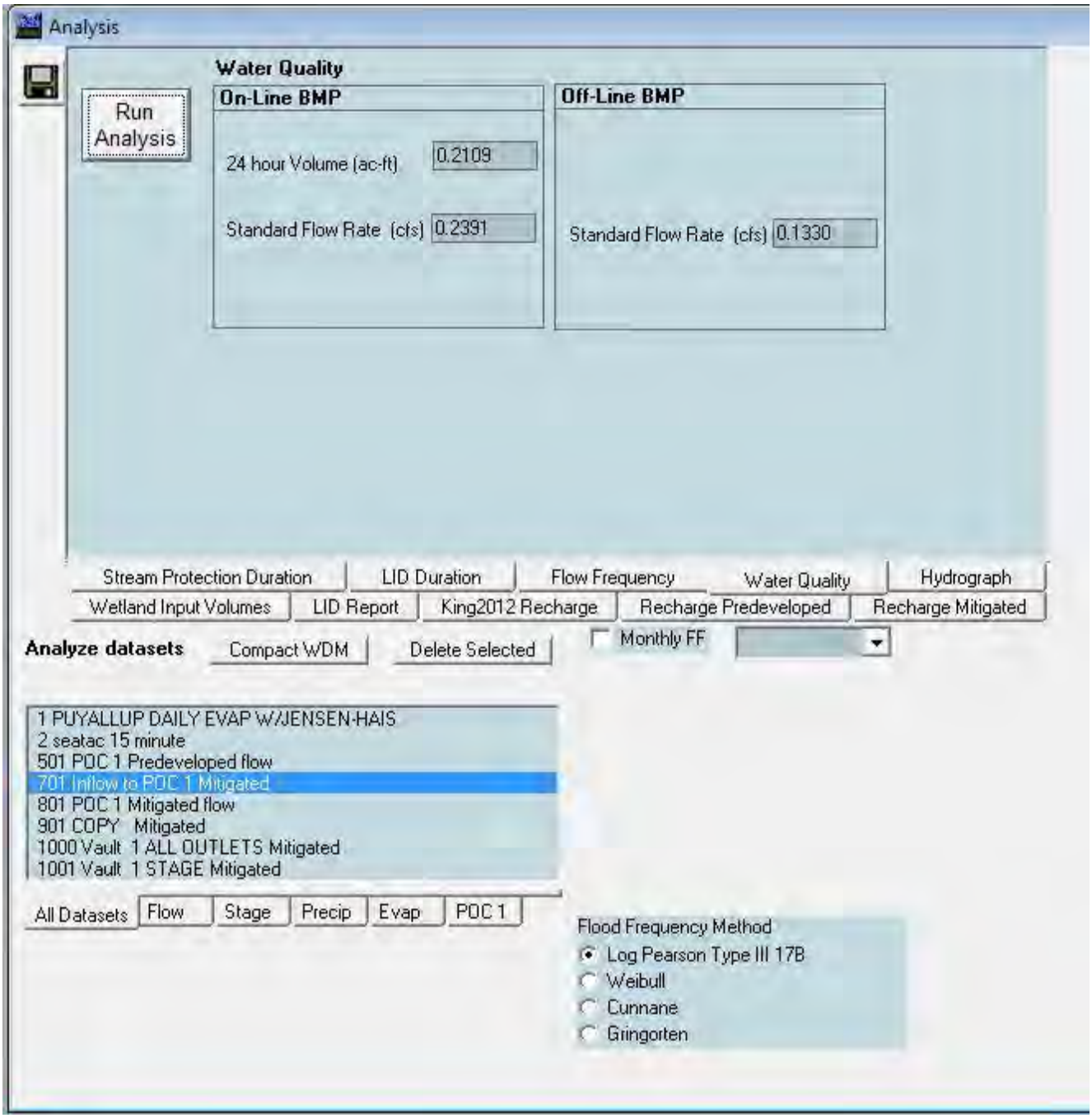
LID BMP's such as infiltration, permeable pavement, and biofiltration and bio-retention are likely not feasible on the site due to hard-pan glacial till soils according to USGS and NRCS Soil Survey research. As LID BMP's are not feasible, other than perforated downspout stubs and the application of BMP T5.13 (or COR equivalent COR Stnd. Detail 632) on landscaped areas, the water quality minimum requirements will be met through use of a Combined Detention/Wetvault and associated dead storage volume. Neither Enhanced nor phosphorus treatment is required, so "Basic" treatment is the minimum treatment level.

4.3.1 On-Site Stormwater Management

According to USGS and NRCS soils data, infiltration is not likely feasible on the site due to hard pan glacial till soils. LID BMP's such as infiltration and permeable pavement will not be used to manage stormwater onsite. Dispersion is also infeasible due to steep slopes onsite. In effort to meet LID standards to the maximum feasible extent given site soil and slope constraints, perforated roof downspouts according to Section 2.5.5 in the 2019 City of Redmond Technical Notebook in conjunction with soil augmentation according to City of Redmond standard detail 632 will be used to manage roof runoff.

4.4 Water Quality Treatment Sizing

According to water quality treatment design flow calculations (see WWHM output), the WQT Design Flow (based on the 6-month, 24-hour storm event using the WWHM 701 data series) a water quality storage volume of 0.2109 ac-ft (9,186 CF) is required. Dead storage area of 2,024 SF with a 5' storage depth (10,120 CF) has been provided within the Combined Detention/Wetvault.


Analysis
Run Analysis
Water Quality
On-Line BMP
24 hour Volume (ac-ft) 0.2109
Standard Flow Rate (cfs) 0.2391
Off-Line BMP
Standard Flow Rate (cfs) 0.1330
Stream Protection Duration
LID Duration
Flow Frequency
Water Quality
Hydrograph
Wetland Input Volumes
LID Report
King2012 Recharge
Recharge Predeveloped
Recharge Mitigated
Analyze datasets
Compact WDM
Delete Selected
Monthly FF
1 PUYALLUP DAILY EVAP W/JENSEN-HAIS
2 seatac 15 minute
501 POC 1 Predeveloped flow
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
901 COPY Mitigated
1000 Vault 1 ALL OUTLETS Mitigated
1001 Vault 1 STAGE Mitigated
All Datasets
Flow
Stage
Precip
Evap
POC 1
Flood Frequency Method
Log Pearson Type III 17B
Weibull
Cunnane
Gringorten

4.4 Flow Control System

Flow control for the project site will be achieved through the use of a Combined Detention/Wetvault located in Tract B at the eastern end of the site. The facility was sized using WWHM and the total aggregate site areas identified in the Predeveloped and Developed Hydrology sections above. The flow control was designed as a standalone detention facility, meeting the release rates and durations required for the proposed site. Based on the system sizing, a detention vault providing 32,538 cf of detention at 8.5' deep, not including 1' of freeboard, is required. The proposed vault will be providing 32,912 cf, which exceeds the required detention volume. Water quality will be achieved by providing dead storage at 5' depth across 1 cell (23'x87') of dead storage area. The critical detention and Wetvault statistics as modeled in WWHM are as follows:

Modeled Combined Detention/Wetvault

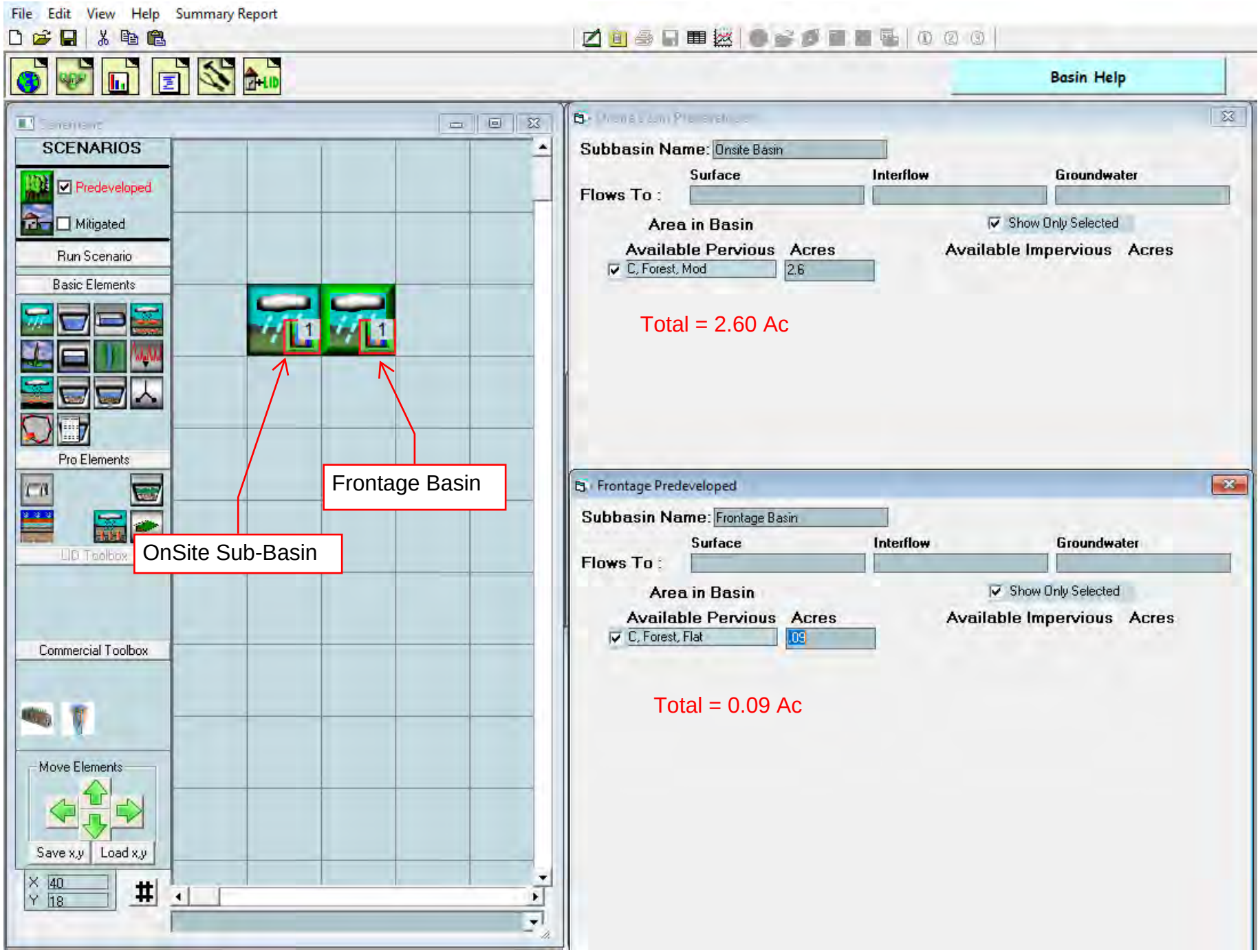
Facility Dimensions:	87' x 44'
Facility Bottom Area:	3,828 ft^2
Facility Internal Sides:	Vertical
Facility Bottom Elev.:	245.00
Facility Begin Live Storage:	245.50
Effective Depth:	9.5'
Riser Height:	8.5'
Top of Riser Elevation:	254.00
Dead Storage Depth:	5'
Dead Storage Area:	2,024 ft^2
WQ Volume Required:	9,186 ft^3
WQ Volume Provided:	10,120 ft^3

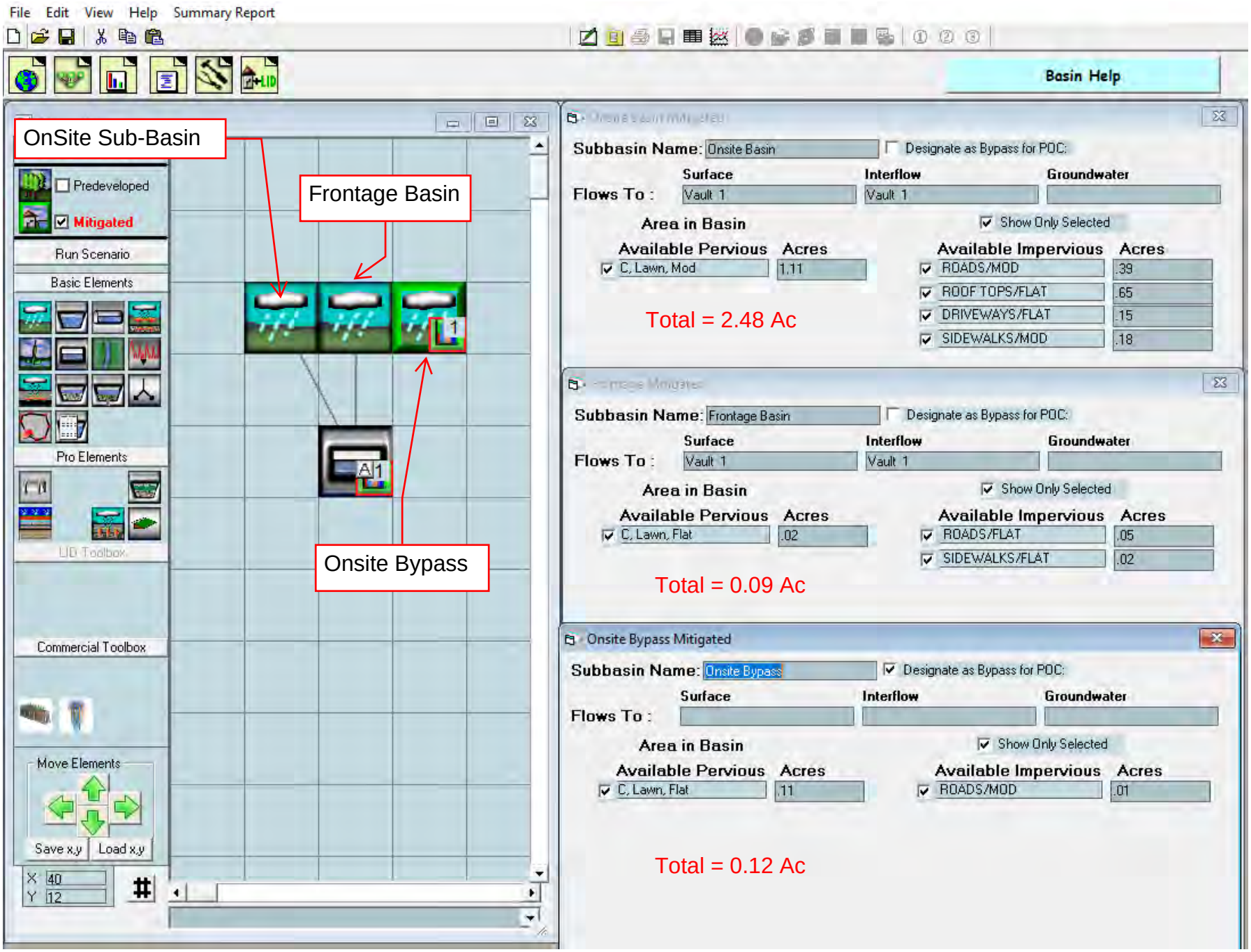
Flow Rates and Water Surface Elevations by Storm Event

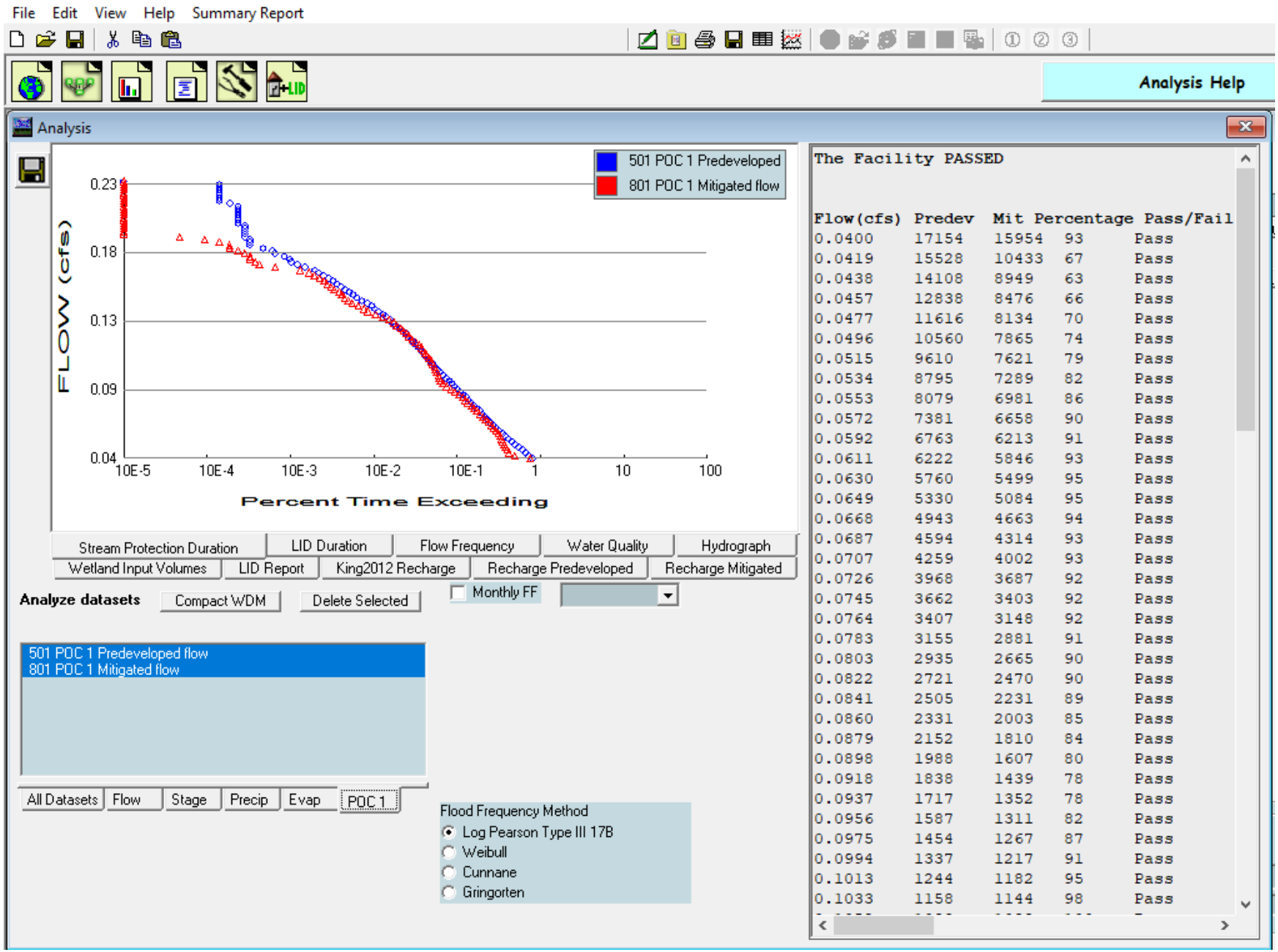
Storm Event	Predeveloped Rate (cfs)	Unmitigated Rate (cfs)	Mitigated Rate (cfs)	Water Surface Elevations
2-Year	0.0800	0.6693	0.0545	250.66
10-Year	0.1638	1.0329	0.1122	252.29
50-Year	0.2298	1.3892	0.1864	253.96

APPENDIX 4-A

HYDROLOGIC MODELING
CALCULATIONS and COMBINED DETENTION/WETVAULT OUTPUT
FROM WWHM4


File Edit View Help Summary Report
Basin Help
SCENARIOS
Predeveloped
Mitigated
Run Scenario
Basic Elements
Pro Elements
LID Toolbox
Commercial Toolbox
Move Elements
Save x,y
Load x,y
X 40
Y 18
Frontage Basin
OnSite Sub-Basin
Subbasin Name: Onsite Basin
Flows To :
Surface
Interflow
Groundwater
Area in Basin
Show Only Selected
Available Pervious
Acres
Available Impervious
Acres
C, Forest, Mod
2.6
Total = 2.60 Ac
Frontage Predeveloped
Subbasin Name: Frontage Basin
Flows To :
Surface
Interflow
Groundwater
Area in Basin
Show Only Selected
Available Pervious
Acres
Available Impervious
Acres
C, Forest, Flat
.09
Total = 0.09 Ac


File Edit View Help Summary Report
Basin Help
OnSite Sub-Basin
Frontage Basin
Onsite Bypass
Predeveloped
Mitigated
Run Scenario
Basic Elements
Pro Elements
LID Toolbox
Commercial Toolbox
Move Elements
Save x,y
Load x,y
X 40
Y 12
Subbasin Name: Onsite Basin
Designate as Bypass for POC:
Flows To : Surface Vault 1 Interflow Vault 1 Groundwater
Area in Basin
Show Only Selected
Available Pervious Acres
C, Lawn, Mod 1.11
Available Impervious Acres
ROADS/MOD .39
ROOF TOPS/FLAT .65
DRIVEWAYS/FLAT .15
SIDEWALKS/MOD .18
Total = 2.48 Ac
Subbasin Name: Frontage Basin
Designate as Bypass for POC:
Flows To : Surface Vault 1 Interflow Vault 1 Groundwater
Area in Basin
Show Only Selected
Available Pervious Acres
C, Lawn, Flat .02
Available Impervious Acres
ROADS/FLAT .05
SIDEWALKS/FLAT .02
Total = 0.09 Ac
Onsite Bypass Mitigated
Subbasin Name: Onsite Bypass
Designate as Bypass for POC:
Flows To : Surface Interflow Groundwater
Area in Basin
Show Only Selected
Available Pervious Acres
C, Lawn, Flat .11
Available Impervious Acres
ROADS/MOD .01
Total = 0.12 Ac



The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0400	17154	15954	93	Pass
0.0419	15528	10433	67	Pass
0.0438	14108	8949	63	Pass
0.0457	12838	8476	66	Pass
0.0477	11616	8134	70	Pass
0.0496	10560	7865	74	Pass
0.0515	9610	7621	79	Pass
0.0534	8795	7289	82	Pass
0.0553	8079	6981	86	Pass
0.0572	7381	6658	90	Pass
0.0592	6763	6213	91	Pass
0.0611	6222	5846	93	Pass
0.0630	5760	5499	95	Pass
0.0649	5330	5084	95	Pass
0.0668	4943	4663	94	Pass
0.0687	4594	4314	93	Pass
0.0707	4259	4002	93	Pass
0.0726	3968	3687	92	Pass
0.0745	3662	3403	92	Pass
0.0764	3407	3148	92	Pass
0.0783	3155	2881	91	Pass
0.0803	2935	2665	90	Pass
0.0822	2721	2470	90	Pass
0.0841	2505	2231	89	Pass
0.0860	2331	2003	85	Pass
0.0879	2152	1810	84	Pass
0.0898	1988	1607	80	Pass
0.0918	1838	1439	78	Pass
0.0937	1717	1352	78	Pass
0.0956	1587	1311	82	Pass
0.0975	1454	1267	87	Pass
0.0994	1337	1217	91	Pass
0.1013	1244	1182	95	Pass
0.1033	1158	1144	98	Pass

WWHM2012
PROJECT REPORT

Project Name: 20200414 90% test_2 cell
Site Name: Garbarino
Site Address:
City : Redmond
Report Date: 2/22/2020
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 : Onsite Basin
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Mod	2.6
Pervious Total	2.6

Impervious Land Use	acre
Impervious Total	0
Basin Total	2.6

Element Flows To:

Surface	Interflow	Groundwater

Name : Frontage
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	.09

Pervious Total **0.09**

Impervious Land Use	**acre**
Impervious Total	**0**
Basin Total	**0.09**

Element Flows To:

Surface	**Interflow**	**Groundwater**

MITIGATED LAND USE

Name : Onsite Basin
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Mod	**1.11**
Pervious Total	**1.11**

Impervious Land Use	**acre**
ROADS MOD	**0.39**
ROOF TOPS FLAT	**0.65**
DRIVEWAYS FLAT	**0.15**
SIDEWALKS MOD	**0.18**
Impervious Total	**1.37**
Basin Total	**2.48**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Vault 1	Vault 1	

Name : Frontage
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	**.02**

Pervious Total **0.02**

Impervious Land Use	**acre**
ROADS FLAT	**0.05**
SIDEWALKS FLAT	**0.02**

Impervious Total **0.07**

Basin Total **0.09**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Vault 1	Vault 1	

Name : Onsite Bypass
Bypass: Yes

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	**.11**

Pervious Total **0.11**

Impervious Land Use	**acre**
ROADS MOD	**0.01**

Impervious Total **0.01**

Basin Total **0.12**

Element Flows To:

Surface	**Interflow**	**Groundwater**

Name : Vault 1
Width : 44 ft.
Length : 87 ft.
Depth: 9.5 ft.
Discharge Structure
Riser Height: 8.5 ft.
Riser Diameter: 12 in.
Orifice 1 Diameter: 0.8125 in. **Elevation:** 0 ft.
Orifice 2 Diameter: 1.125 in. **Elevation:** 5 ft.
Orifice 3 Diameter: 1.125 in. **Elevation:** 6.45 ft.

Element Flows To:

Outlet 1 **Outlet 2**

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.087	0.000	0.000	0.000
0.1056	0.087	0.009	0.005	0.000
0.2111	0.087	0.018	0.008	0.000
0.3167	0.087	0.027	0.010	0.000
0.4222	0.087	0.037	0.011	0.000
0.5278	0.087	0.046	0.013	0.000
0.6333	0.087	0.055	0.014	0.000
0.7389	0.087	0.064	0.015	0.000
0.8444	0.087	0.074	0.016	0.000
0.9500	0.087	0.083	0.017	0.000
1.0556	0.087	0.092	0.018	0.000
1.1611	0.087	0.102	0.019	0.000
1.2667	0.087	0.111	0.020	0.000
1.3722	0.087	0.120	0.021	0.000
1.4778	0.087	0.129	0.021	0.000
1.5833	0.087	0.139	0.022	0.000
1.6889	0.087	0.148	0.023	0.000
1.7944	0.087	0.157	0.024	0.000
1.9000	0.087	0.167	0.024	0.000
2.0056	0.087	0.176	0.025	0.000
2.1111	0.087	0.185	0.026	0.000
2.2167	0.087	0.194	0.026	0.000
2.3222	0.087	0.204	0.027	0.000
2.4278	0.087	0.213	0.027	0.000
2.5333	0.087	0.222	0.028	0.000
2.6389	0.087	0.231	0.029	0.000
2.7444	0.087	0.241	0.029	0.000
2.8500	0.087	0.250	0.030	0.000
2.9556	0.087	0.259	0.030	0.000
3.0611	0.087	0.269	0.031	0.000
3.1667	0.087	0.278	0.031	0.000
3.2722	0.087	0.287	0.032	0.000
3.3778	0.087	0.296	0.032	0.000
3.4833	0.087	0.306	0.033	0.000
3.5889	0.087	0.315	0.033	0.000
3.6944	0.087	0.324	0.034	0.000
3.8000	0.087	0.333	0.034	0.000
3.9056	0.087	0.343	0.035	0.000
4.0111	0.087	0.352	0.035	0.000
4.1167	0.087	0.361	0.036	0.000
4.2222	0.087	0.371	0.036	0.000
4.3278	0.087	0.380	0.037	0.000
4.4333	0.087	0.389	0.037	0.000
4.5389	0.087	0.398	0.038	0.000
4.6444	0.087	0.408	0.038	0.000
4.7500	0.087	0.417	0.039	0.000
4.8556	0.087	0.426	0.039	0.000
4.9611	0.087	0.436	0.039	0.000
5.0667	0.087	0.445	0.049	0.000

5.1722	0.087	0.454	0.055	0.000	2yr = 0.054453 cfs
5.2778	0.087	0.463	0.059	0.000	
5.3833	0.087	0.473	0.062	0.000	
5.4889	0.087	0.482	0.066	0.000	
5.5944	0.087	0.491	0.068	0.000	
5.7000	0.087	0.500	0.071	0.000	
5.8056	0.087	0.510	0.074	0.000	
5.9111	0.087	0.519	0.076	0.000	
6.0167	0.087	0.528	0.078	0.000	
6.1222	0.087	0.538	0.080	0.000	
6.2278	0.087	0.547	0.082	0.000	
6.3333	0.087	0.556	0.084	0.000	
6.4389	0.087	0.565	0.086	0.000	
6.5444	0.087	0.575	0.099	0.000	
6.6500	0.087	0.584	0.105	0.000	
6.7556	0.087	0.593	0.111	0.000	10yr=0.1121712 cfs
6.8611	0.087	0.602	0.115	0.000	
6.9667	0.087	0.612	0.120	0.000	
7.0722	0.087	0.621	0.124	0.000	
7.1778	0.087	0.630	0.128	0.000	
7.2833	0.087	0.640	0.131	0.000	
7.3889	0.087	0.649	0.135	0.000	
7.4944	0.087	0.658	0.138	0.000	
7.6000	0.087	0.667	0.141	0.000	
7.7056	0.087	0.677	0.144	0.000	
7.8111	0.087	0.686	0.147	0.000	
7.9167	0.087	0.695	0.150	0.000	
8.0222	0.087	0.705	0.153	0.000	
8.1278	0.087	0.714	0.156	0.000	
8.2333	0.087	0.723	0.159	0.000	
8.3389	0.087	0.732	0.161	0.000	
8.4444	0.087	0.742	0.164	0.000	50yr=0.186361 cfs
8.5500	0.087	0.751	0.285	0.000	
8.6556	0.087	0.760	0.806	0.000	
8.7611	0.087	0.769	1.456	0.000	
8.8667	0.087	0.779	2.008	0.000	
8.9722	0.087	0.788	2.326	0.000	
9.0778	0.087	0.797	2.573	0.000	
9.1833	0.087	0.807	2.784	0.000	
9.2889	0.087	0.816	2.981	0.000	
9.3944	0.087	0.825	3.164	0.000	
9.5000	0.087	0.834	3.337	0.000	
9.6056	0.087	0.844	3.501	0.000	
9.7111	0.000	0.000	3.658	0.000	

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:2.69
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:1.24
Total Impervious Area:1.45

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.079972
5 year	0.130994
10 year	0.163791
25 year	0.202798
50 year	0.229814
100 year	0.255046

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.054453
5 year	0.086094
10 year	0.112171
25 year	0.151682
50 year	0.186361
100 year	0.22596

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

Year	Predeveloped	Mitigated
1949	0.092	0.046
1950	0.109	0.059
1951	0.175	0.149
1952	0.055	0.032
1953	0.044	0.040
1954	0.068	0.041
1955	0.109	0.041
1956	0.088	0.079
1957	0.071	0.043
1958	0.079	0.044
1959	0.067	0.037
1960	0.121	0.122
1961	0.066	0.063
1962	0.041	0.031
1963	0.057	0.041
1964	0.080	0.043
1965	0.053	0.074
1966	0.051	0.038
1967	0.122	0.054
1968	0.069	0.040
1969	0.067	0.038
1970	0.054	0.040
1971	0.061	0.047
1972	0.133	0.112
1973	0.059	0.070
1974	0.065	0.043
1975	0.091	0.045
1976	0.065	0.041

1977	0.009	0.032
1978	0.055	0.051
1979	0.033	0.030
1980	0.155	0.121
1981	0.049	0.040
1982	0.101	0.097
1983	0.087	0.042
1984	0.052	0.036
1985	0.031	0.035
1986	0.137	0.067
1987	0.121	0.100
1988	0.048	0.036
1989	0.032	0.034
1990	0.289	0.133
1991	0.154	0.107
1992	0.063	0.056
1993	0.061	0.034
1994	0.021	0.031
1995	0.088	0.060
1996	0.203	0.147
1997	0.157	0.141
1998	0.038	0.041
1999	0.171	0.110
2000	0.061	0.043
2001	0.011	0.029
2002	0.071	0.074
2003	0.105	0.044
2004	0.113	0.141
2005	0.084	0.042
2006	0.094	0.075
2007	0.218	0.195
2008	0.266	0.144
2009	0.124	0.077

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

Rank	Predeveloped	Mitigated
1	0.2888	0.1950
2	0.2664	0.1487
3	0.2181	0.1469
4	0.2025	0.1440
5	0.1750	0.1410
6	0.1710	0.1408
7	0.1567	0.1329
8	0.1553	0.1224
9	0.1538	0.1212
10	0.1372	0.1120
11	0.1327	0.1100
12	0.1244	0.1071
13	0.1225	0.0995
14	0.1212	0.0974
15	0.1206	0.0792
16	0.1129	0.0773
17	0.1090	0.0750
18	0.1088	0.0740
19	0.1050	0.0735

20	0.1012	0.0703
21	0.0942	0.0671
22	0.0917	0.0632
23	0.0907	0.0599
24	0.0879	0.0589
25	0.0877	0.0565
26	0.0867	0.0535
27	0.0837	0.0511
28	0.0803	0.0475
29	0.0786	0.0464
30	0.0706	0.0452
31	0.0706	0.0437
32	0.0690	0.0435
33	0.0681	0.0432
34	0.0674	0.0431
35	0.0672	0.0429
36	0.0664	0.0428
37	0.0652	0.0424
38	0.0648	0.0418
39	0.0627	0.0413
40	0.0613	0.0410
41	0.0611	0.0410
42	0.0609	0.0410
43	0.0589	0.0408
44	0.0567	0.0405
45	0.0549	0.0404
46	0.0549	0.0401
47	0.0541	0.0397
48	0.0535	0.0382
49	0.0523	0.0381
50	0.0514	0.0367
51	0.0491	0.0362
52	0.0478	0.0359
53	0.0444	0.0349
54	0.0413	0.0342
55	0.0382	0.0338
56	0.0332	0.0324
57	0.0316	0.0320
58	0.0310	0.0312
59	0.0206	0.0306
60	0.0110	0.0302
61	0.0094	0.0293

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0400	17154	15954	93	Pass
0.0419	15528	10433	67	Pass
0.0438	14108	8949	63	Pass
0.0457	12838	8476	66	Pass
0.0477	11616	8134	70	Pass
0.0496	10560	7865	74	Pass

0.0515	9610	7621	79	Pass
0.0534	8795	7289	82	Pass
0.0553	8079	6981	86	Pass
0.0572	7381	6658	90	Pass
0.0592	6763	6213	91	Pass
0.0611	6222	5846	93	Pass
0.0630	5760	5499	95	Pass
0.0649	5330	5084	95	Pass
0.0668	4943	4663	94	Pass
0.0687	4594	4314	93	Pass
0.0707	4259	4002	93	Pass
0.0726	3968	3687	92	Pass
0.0745	3662	3403	92	Pass
0.0764	3407	3148	92	Pass
0.0783	3155	2881	91	Pass
0.0803	2935	2665	90	Pass
0.0822	2721	2470	90	Pass
0.0841	2505	2231	89	Pass
0.0860	2331	2003	85	Pass
0.0879	2152	1810	84	Pass
0.0898	1988	1607	80	Pass
0.0918	1838	1439	78	Pass
0.0937	1717	1352	78	Pass
0.0956	1587	1311	82	Pass
0.0975	1454	1267	87	Pass
0.0994	1337	1217	91	Pass
0.1013	1244	1182	95	Pass
0.1033	1158	1144	98	Pass
0.1052	1093	1098	100	Pass
0.1071	1026	1047	102	Pass
0.1090	960	994	103	Pass
0.1109	894	936	104	Pass
0.1128	837	891	106	Pass
0.1148	776	843	108	Pass
0.1167	730	802	109	Pass
0.1186	680	742	109	Pass
0.1205	633	678	107	Pass
0.1224	595	614	103	Pass
0.1244	560	571	101	Pass
0.1263	511	526	102	Pass
0.1282	475	487	102	Pass
0.1301	431	452	104	Pass
0.1320	390	401	102	Pass
0.1339	359	370	103	Pass
0.1359	333	322	96	Pass
0.1378	303	273	90	Pass
0.1397	274	224	81	Pass
0.1416	246	183	74	Pass
0.1435	222	162	72	Pass
0.1454	202	140	69	Pass
0.1474	179	118	65	Pass
0.1493	153	105	68	Pass
0.1512	133	95	71	Pass
0.1531	120	88	73	Pass
0.1550	108	82	75	Pass
0.1570	96	71	73	Pass
0.1589	86	65	75	Pass

0.1608	77	59	76	Pass
0.1627	69	54	78	Pass
0.1646	62	48	77	Pass
0.1665	54	41	75	Pass
0.1685	47	36	76	Pass
0.1704	42	28	66	Pass
0.1723	32	14	43	Pass
0.1742	26	9	34	Pass
0.1761	22	8	36	Pass
0.1780	21	7	33	Pass
0.1800	18	7	38	Pass
0.1819	14	6	42	Pass
0.1838	13	5	38	Pass
0.1857	10	4	40	Pass
0.1876	7	4	57	Pass
0.1895	7	3	42	Pass
0.1915	7	2	28	Pass
0.1934	6	1	16	Pass
0.1953	6	0	0	Pass
0.1972	6	0	0	Pass
0.1991	6	0	0	Pass
0.2011	6	0	0	Pass
0.2030	5	0	0	Pass
0.2049	5	0	0	Pass
0.2068	5	0	0	Pass
0.2087	5	0	0	Pass
0.2106	5	0	0	Pass
0.2126	5	0	0	Pass
0.2145	5	0	0	Pass
0.2164	4	0	0	Pass
0.2183	3	0	0	Pass
0.2202	3	0	0	Pass
0.2221	3	0	0	Pass
0.2241	3	0	0	Pass
0.2260	3	0	0	Pass
0.2279	3	0	0	Pass
0.2298	3	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.2109 **acre-feet** ← Water Quality Volume = 9,186 ft^3
On-line facility target flow: 0.2391 **cfs.**
Adjusted for 15 min: 0.2391 **cfs.**
Off-line facility target flow: 0.133 **cfs.**
Adjusted for 15 min: 0.133 **cfs.**

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5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Onsite Conveyance

Conveyance sizing and design were completed based on runoff established from SBUH analysis as allowed by City reference to WSDOT Hydrology Manual. The SBUH model has been established and run in StormShed 3G (as approved by the WSDOT Hydrology Manual, and approved by CoR), and utilizes Mannings, Darcy Weisbach, and Hazen Williams (for pressure calculations) to track friction losses and transitional losses for HGL calculations, consistent with guidance from DOE and WSDOT. Partial flows are computed to establish velocities and HGL within the pipes. For a delineation of all conveyance basins, see Figure 5.0, "Conveyance Basin Map."

Pipe Network

Backwater

Backwater/loss evaluation reveals that 50-year event flows are carried completely within the pipe and swale system as designed per COR STN 8.4.3 and there are no locations within the conveyance system where hydraulic grade is above system maximum elevations during the target events. The 50-year water surface elevation of 254.00 was used as a conservative estimate for all tailwater considerations in the Combined Detention/Wetvault. The following tables in summarize the Stormshed 3G data from each storm event. Stormshed 3G data in each event can be found in Appendix 5-B.

Table 5.3 - HGL Analysis: 50-Year Event

CB #	HGL	CB Rim EL	Difference (ft)
CB-1	254.25	257.10	2.85
CB-2B	258.40	262.00	3.60
CB-2A	260.03	265.09	5.06
CB-2	271.88	274.25	2.37
CB-6	271.88	274.75	2.87
CB-3	271.96	274.43	2.47
CB-4	281.22	286.54	5.32
CB-5	283.08	286.00	2.92
CB-16A	287.67	292.10	4.43
CB-16B	288.05	291.94	3.89
CB-16	297.17	303.09	5.92
INTAKE	302.03	303.45	1.32

Onsite Culvert Capacity

A Manning's equation evaluation was performed on the smallest diameter culvert with the shallowest slope onsite. For the purposes of conservative sizing, the 50-year peak flow from all onsite conveyance basins was used as a conservative estimate for peak flow evaluated in the culvert. The 50-year peak flow for each conveyance basin can be found in the Stormshed data found in Appendix 5-B. Evaluation indicates that the pipe capacity provided is greater than the pipe capacity required and thus is adequately designed. Manning's equation analysis of the pipe can be found in Appendix 5-B. A summary of the pipe capacity is as follows:

<u>Intake (STA 11+66.52) to Outfall (STA 11+90.02):</u>

Diameter:	12"
Minimum Slope:	5.15%
Pipe Capacity:	8.78 cfs
50-Year Maximum Pipe Flow:	1.55 cfs (100 yr, Umitigated – WWHM 701)
Evaluation:	System Adequate

Onsite Swale Capacity

A Manning's equation evaluation was performed on the swale with the shallowest slope onsite (Swale 1 as indicated on Figure 5.0, "Conveyance Basin Map") and on the swale with the greatest slope. The 50-year peak flow from all onsite conveyance basins was used as a conservative estimate for peak flow evaluated in the swale. The 50-year peak flow for each conveyance basin can be found in the Stormshed data found in Appendix 5-B. Manning's n values of 0.030 for each swale were obtained from WSDOT Hydraulics Manual Appendix 4-1.III.B.2 under the assumption that the swales are 24" in width and will retain a maintained, grassed land cover in the developed condition. Due to the potential for erosive flows, stabilization will be provided by means of a permanent erosion control blanket to be installed within proposed swales.

Evaluation indicates that greater than 0.5' freeboard is attained in the swale design in the 50-year storm event and thus is adequately designed. Manning's equation analysis of the swale can be found in Appendix 5-B. A summary of the swale capacity is as follows:

<u>Swale 1 (STA 12+09.85 to STA 12+30.71):</u>

Bottom Width:	2'
Depth:	1.5'
Side Slopes:	2:1 (MAX)
Channel slope:	5.78%
50-Year Maximum Flow:	1.39 cfs (WWHM 701– See Appendix 5-B)
Flow Depth:	0.18'
Freeboard:	1.32'
Maximum Velocity:	3.35 fps
Evaluation:	System Adequate

Swale 2 (STA 13+81.31 to STA 14+09.73):

Bottom Width:	2’
Depth:	1.5’
Side Slopes:	2:1 (MAX)
Channel slope:	10.98%
50-Year Maximum Flow:	1.39 cfs (WWHM 701 – See Appendix 5-B)
Flow Depth:	0.15’
Freeboard:	1.35’
Maximum Velocity:	4.14 fps
Evaluation:	System Adequate

Combined Detention/Wetvault Release

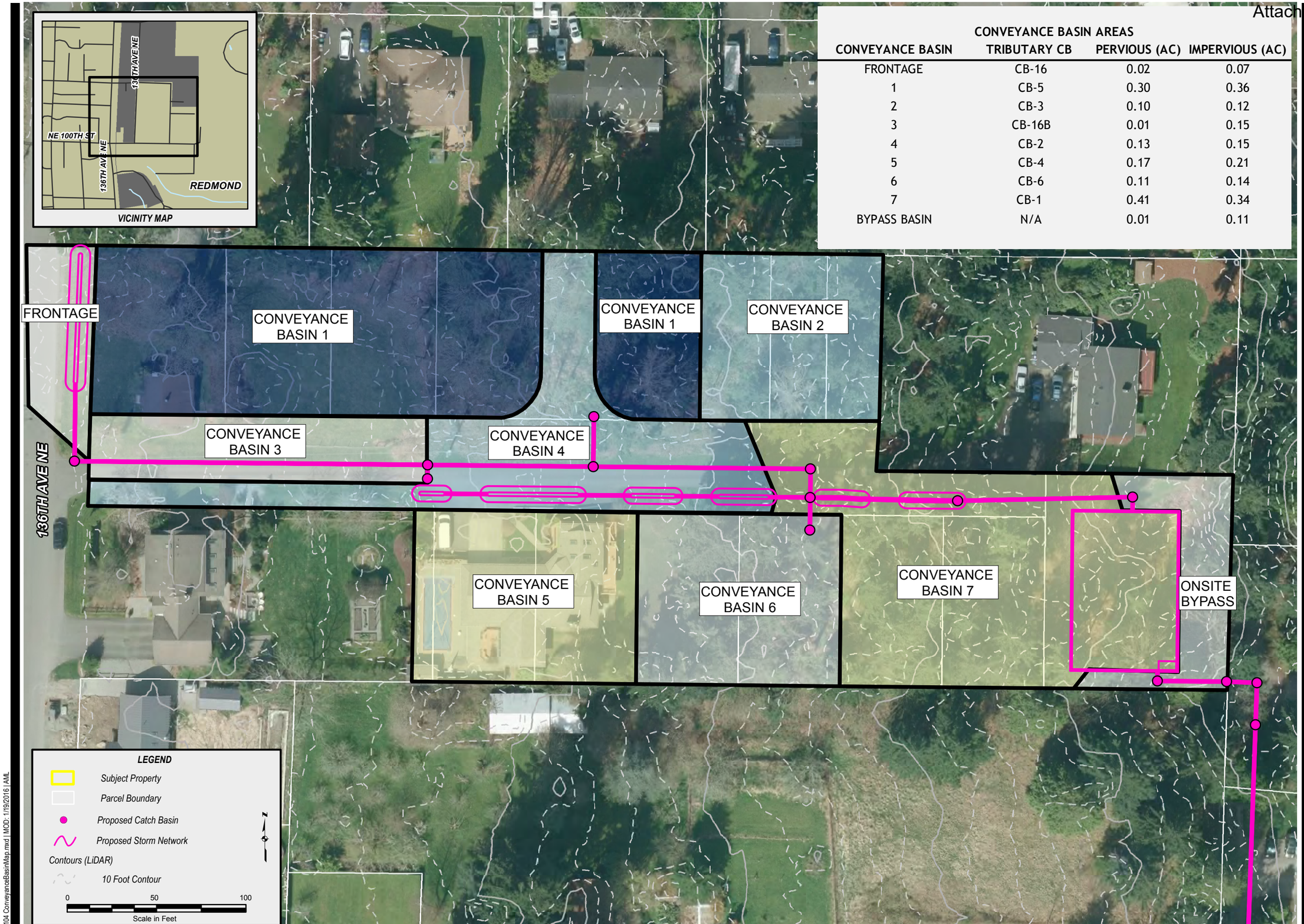
The Combined Detention/Wetvault discharge system is comprised of the primary flow intake(s), the Combined Detention/Wetvault detention volume, the Combined Detention/Wetvault outfall and the control structure. The conveyance capacity analysis for the pipe downstream of the Combined Detention/Wetvault was performed as a Manning’s equation evaluation of the Combined Detention/Wetvault discharge pipe. The smallest diameter (12”) pipe at the shallowest slope was analyzed against the 100-year unmitigated flow. A screen shot of the 100-Year Storm unmitigated release from the Combined Detention/Wetvault (from the WWHM 701 data series) can be found below.

Combined Detention/Wetvault Discharge Pipe (CB-8 to CB-9):

Diameter:	12”
Minimum Slope:	0.60%
Pipe Capacity:	3.00 cfs
100-Year Maximum Pipe Flow:	1.55 cfs (100 yr, Umitigated – WWHM 701)
Evaluation:	System Adequate

APPENDIX 5-A

STORMSHED 3G CONVEYANCE MODELING CALCULATIONS



CONVEYANCE BASIN AREAS

CONVEYANCE BASIN	TRIBUTARY CB	PERVIOUS (AC)	IMPERVIOUS (AC)
FRONTAGE	CB-16	0.02	0.07
1	CB-5	0.30	0.36
2	CB-3	0.10	0.12
3	CB-16B	0.01	0.15
4	CB-2	0.13	0.15
5	CB-4	0.17	0.21
6	CB-6	0.11	0.14
7	CB-1	0.41	0.34
BYPASS BASIN	N/A	0.01	0.11

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

LDC
THE CIVIL ENGINEERING GROUP
Commercial
Infrastructure
Residential
14201 NE 200th St. #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

MILESONTE NW

GARBARINO

CONVEYANCE BASIN MAP

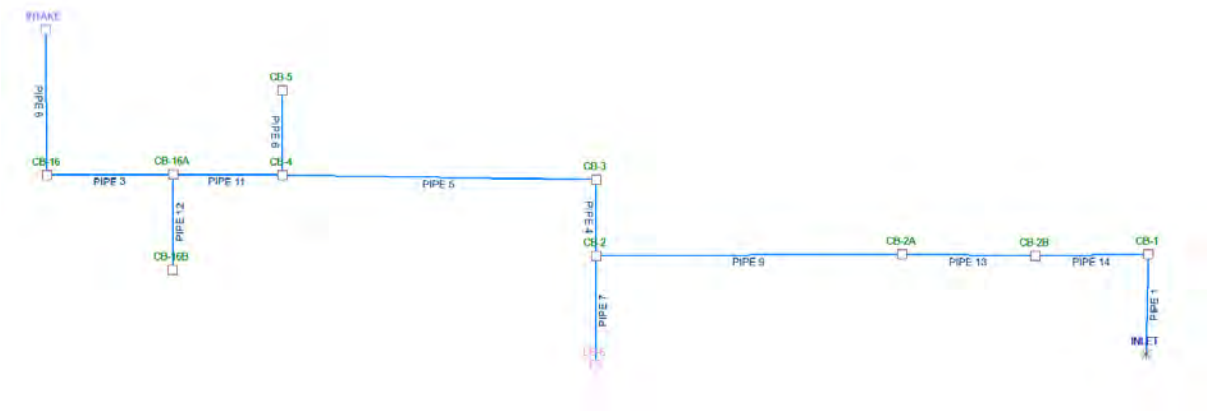
PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F5.0
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 1-19-16
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
5.0

15-104 ConveyanceBasinMap.mxd | MOD: 1/19/2016 | AML

Garbarino 50-year Storm



ROUTEHYD [] THRU [GARBARINO] USING [50 YEAR] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
PIPE 6	0.66	0.4514	15.8902	0.0284	0.116	0.116	12 in Diam	8.8894	20.232	0.00	BASIN 1
PIPE 12	0.16	0.1278	11.2462	0.0114	0.0749	0.0749	12 in Diam	4.7843	14.3191	0.00	BASIN 3
PIPE 8	0.09	0.0677	18.6408	0.0036	0.0439	0.0439	12 in Diam	5.6006	23.7342	0.00	FRONTAGE
PIPE 3	0.18	0.1354	11.1472	0.0121	0.0776	0.0776	12 in Diam	4.8093	14.193	0.00	FRONTAGE
PIPE 11	0.72	0.5239	14.2535	0.0368	0.1309	0.1309	12 in Diam	8.6477	18.1482	0.00	BASIN 5
PIPE 5	1.76	1.2361	14.2317	0.0869	0.1991	0.1991	12 in Diam	11.1239	18.1203	0.00	BASIN 5
PIPE 4	1.98	1.3866	4.0957	0.3385	0.401	0.401	12 in Diam	4.7101	5.2148	0.00	BASIN 2
PIPE 7	0.25	0.1721	14.3693	0.012	0.077	0.077	12 in Diam	6.1816	18.2955	0.00	BASIN 6
PIPE 9	2.51	1.7494	19.3005	0.0906	0.2034	0.2034	12 in Diam	15.2719	24.5742	0.00	BASIN 4
PIPE 13	2.73	1.8999	9.6683	0.1965	0.3006	0.3006	12 in Diam	9.5598	12.3101	0.00	BASIN 2
PIPE 14	2.98	2.0719	14.3652	0.1442	0.2561	0.2561	12 in Diam	13.0437	18.2903	0.00	BASIN 6
PIPE 1	3.73	2.5647	7.2975	0.3514	0.4091	0.4091	12 in Diam	8.4844	9.2915	0.00	BASIN 7

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							254.00
CB-1	INLET	254.2086	0.1081	0.1497	------	254.2502	257.1000
CB-2B	CB-1	258.3902	------	0.0094	------	258.3996	262.0000
CB-2A	CB-2B	260.0091	------	0.0197	------	260.0288	265.0900
CB-2	CB-2A	271.3808	------	0.4606	0.0340	271.8753	274.2500
CB-3	CB-2	271.9441	0.0385	0.0503	------	271.9560	274.4300
CB-4	CB-3	280.6316	------	0.0046	0.5808	281.2170	286.5400
CB-5	CB-4	283.0828	------	------	------	283.0828	286.0000
CB-16A	CB-4	287.4739	------	0.0024	0.1911	287.6674	292.1000
CB-16B	CB-16A	288.0504	------	------	------	288.0504	291.9400
CB-16	CB-16A	296.5190	------	0.6492	------	297.1682	303.0900
INTAKE	CB-16	302.0267	------	------	------	302.0267	303.4500
CB-6	CB-2	271.8768	------	------	------	271.8768	274.7500

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
PIPE 1	1.2086	1.2086	2.56	1.0000	0.6864	0.4091	Outlet Control
PIPE 14	0.8902	0.8902	2.07	1.1702	0.6161	0.2561	SuperCrit flow, Inlet end controls
PIPE 13	0.8591	0.8591	1.90	0.8996	0.5877	0.3006	SuperCrit flow, Inlet end controls
PIPE 9	0.7608	0.7608	1.75	0.8788	0.5630	0.2034	SuperCrit flow, Inlet end controls
PIPE 4	1.3249	1.3249	1.39	1.2553	0.4983	0.4010	Outlet Control
PIPE 5	0.6316	0.6316	1.24	1.2360	0.4691	0.1991	SuperCrit flow, Inlet end controls
PIPE 6	0.3328	0.3328	0.45	1.2170	0.2783	0.1160	SuperCrit flow, Inlet end controls
PIPE 11	0.3739	0.3739	0.52	1.2170	0.3004	0.1309	SuperCrit flow, Inlet end controls
PIPE 12	0.5704	0.5704	0.13	0.5674	0.1439	0.0749	Outlet Control M1 Backwater
PIPE 3	0.1790	0.1790	0.14	0.5674	0.1502	0.0776	SuperCrit flow, Inlet end controls
PIPE 8	0.0767	0.0767	0.07	0.8282	0.1056	0.0439	SuperCrit flow, Inlet end controls
PIPE 7	18.7968	18.7968	0.17	18.7953	0.1698	0.0770	Outlet Control

Basin Conveyance Data

BASIN 1 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.2546	8.00	0.0892	0.66	SBUH
10 year	0.3595	8.00	0.1246	0.66	SBUH
25 yr	0.4206	8.00	0.1453	0.66	SBUH
50 year	0.4514	8.00	0.1557	0.66	SBUH
100 year	0.5289	8.00	0.1819	0.66	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 1

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.30 ac	**DCIA**	0.36 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.30 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.36 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 2 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.0849	8.00	0.0297	0.22	SBUH
10 year	0.1198	8.00	0.0415	0.22	SBUH
25 yr	0.1402	8.00	0.0484	0.22	SBUH
50 year	0.1505	8.00	0.0519	0.22	SBUH
100 year	0.1763	8.00	0.0606	0.22	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 2

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.10 ac	**DCIA**	0.12 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.10 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.12 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 3 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.079	8.00	0.0268	0.16	SBUH
10 year	0.1053	8.00	0.036	0.16	SBUH
25 yr	0.1203	8.00	0.0412	0.16	SBUH
50 year	0.1278	8.00	0.0439	0.16	SBUH
100 year	0.1466	8.00	0.0505	0.16	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 3

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.01 ac	**DCIA**	0.15 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.01 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.15 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 4 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.1072	8.00	0.0376	0.28	SBUH
10 year	0.1517	8.00	0.0526	0.28	SBUH
25 yr	0.1777	8.00	0.0614	0.28	SBUH
50 year	0.1907	8.00	0.0658	0.28	SBUH
100 year	0.2236	8.00	0.0769	0.28	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 4

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.13 ac	**DCIA**	0.15 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.13 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.15 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 5 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.1473	8.00	0.0516	0.38	SBUH
10 year	0.2078	8.00	0.072	0.38	SBUH
25 yr	0.243	8.00	0.0839	0.38	SBUH
50 year	0.2607	8.00	0.0899	0.38	SBUH
100 year	0.3053	8.00	0.105	0.38	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 5

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.17 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.21 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 6 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.0974	8.00	0.0341	0.25	SBUH
10 year	0.1372	8.00	0.0475	0.25	SBUH
25 yr	0.1604	8.00	0.0554	0.25	SBUH
50 year	0.1721	8.00	0.0593	0.25	SBUH
100 year	0.2014	8.00	0.0693	0.25	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 6

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.11 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.14 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 7 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.2702	8.00	0.0957	0.75	SBUH
10 year	0.3885	8.00	0.1352	0.75	SBUH
25 yr	0.4578	8.00	0.1584	0.75	SBUH
50 year	0.4928	8.00	0.1701	0.75	SBUH
100 year	0.5809	8.00	0.1996	0.75	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 7

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.41 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.34 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

FRONTAGE EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.0405	8.00	0.0139	0.09	SBUH
10 year	0.0551	8.00	0.0189	0.09	SBUH
25 yr	0.0635	8.00	0.0218	0.09	SBUH
50 year	0.0677	8.00	0.0233	0.09	SBUH
100 year	0.0782	8.00	0.0269	0.09	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: FRONTAGE

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.02 ac	86.00
Pervious Composited CN (AMC 2)		86.00

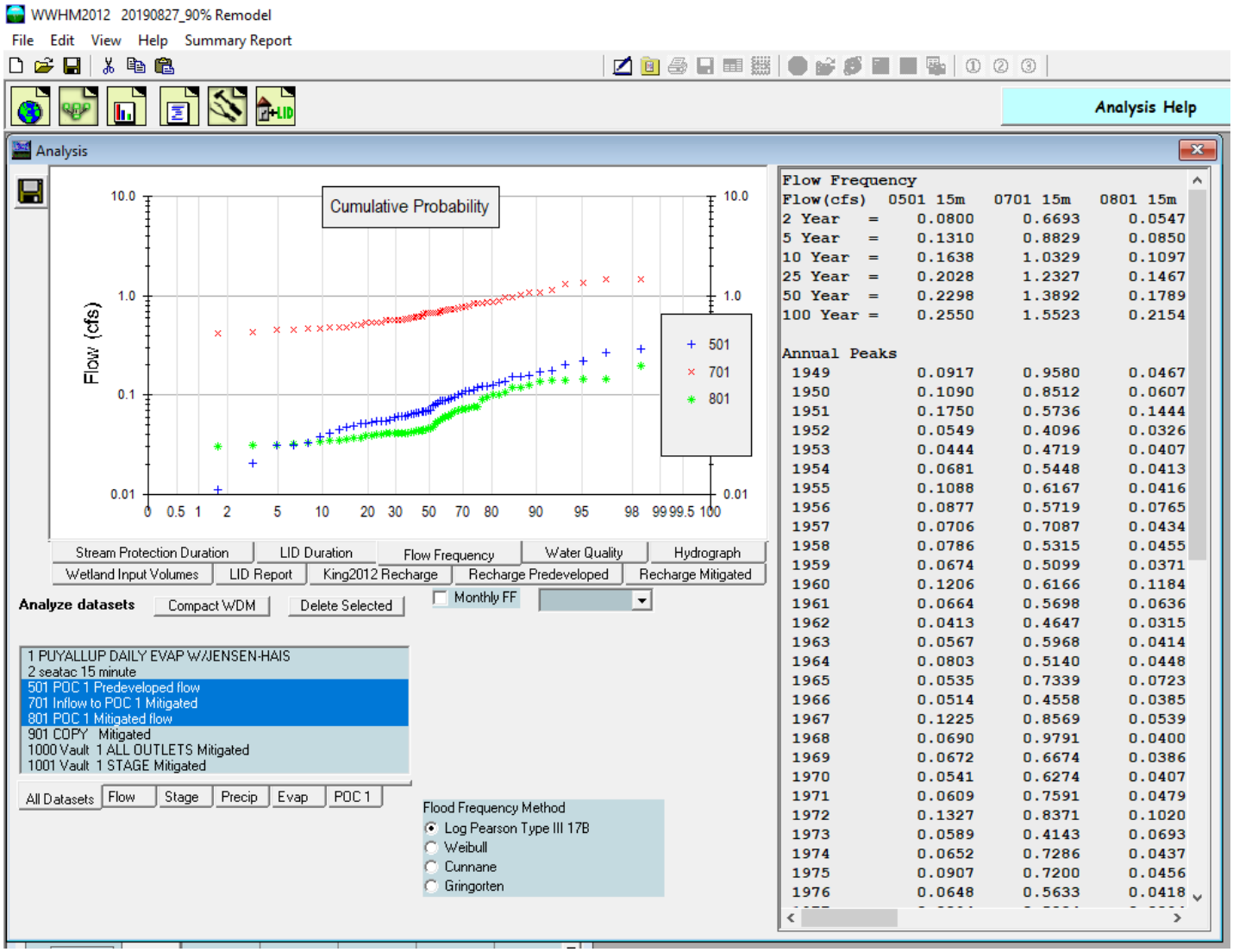
Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.07 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

APPENDIX 5-B

CONVEYANCE CAPACITY CALCULATIONS



Flow Frequency

Flow(cfs)	0501 15m	0701 15m	0801 15m
2 Year =	0.0800	0.6693	0.0547
5 Year =	0.1310	0.8829	0.0850
10 Year =	0.1638	1.0329	0.1097
25 Year =	0.2028	1.2327	0.1467
50 Year =	0.2298	1.3892	0.1789
100 Year =	0.2550	1.5523	0.2154

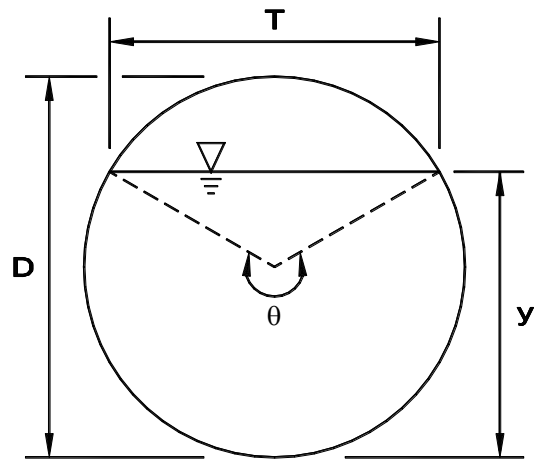
Annual Peaks

1949	0.0917	0.9580	0.0467
1950	0.1090	0.8512	0.0607
1951	0.1750	0.5736	0.1444
1952	0.0549	0.4096	0.0326
1953	0.0444	0.4719	0.0407
1954	0.0681	0.5448	0.0413
1955	0.1088	0.6167	0.0416
1956	0.0877	0.5719	0.0765
1957	0.0706	0.7087	0.0434
1958	0.0786	0.5315	0.0455
1959	0.0674	0.5099	0.0371
1960	0.1206	0.6166	0.1184
1961	0.0664	0.5698	0.0636
1962	0.0413	0.4647	0.0315
1963	0.0567	0.5968	0.0414
1964	0.0803	0.5140	0.0448
1965	0.0535	0.7339	0.0723
1966	0.0514	0.4558	0.0385
1967	0.1225	0.8569	0.0539
1968	0.0690	0.9791	0.0400
1969	0.0672	0.6674	0.0386
1970	0.0541	0.6274	0.0407
1971	0.0609	0.7591	0.0479
1972	0.1327	0.8371	0.1020
1973	0.0589	0.4143	0.0693
1974	0.0652	0.7286	0.0437
1975	0.0907	0.7200	0.0456
1976	0.0648	0.5633	0.0418

Open Channel Flow Calculator For Circular Pipes	*Land Development Consultants, Inc.*	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Onsite Culvert	Date:	2/3/2016
		Calc. By:	TPA

Pipe Diameter (D) =	12	in
Pipe Slope (S) =	5.15	%
Flow Depth (y) =	1.00	ft
Flowrate (Q) =	**8.78**	**cfs**
Mannings Coeff. (n) =	0.012	
Theta Angle (θ) =	6.28	rad
Wetted Area (A) =	0.79	ft^2
Wet. Perimeter (P) =	3.14	ft
Hydraulic Radius (R) =	0.25	ft
Top Width (T) =	0.00	ft
Flow Velocity =	11.18	fps



Solve | Reset Form

Formulas:

Theta Angle (θ): If y ≥ r : $\theta = 2\pi - 2a\cos(\frac{y-r}{r})$ where: r = Pipe Radius

If y ≤ r : $\theta = 2a\cos(\frac{r-y}{r})$ where: r = Pipe Radius

Wetted Area (A): $A = \frac{1}{8}(\theta - \sin\theta)d^2$

Wetted Perimeter (P): $P = \frac{1}{2}\theta d$

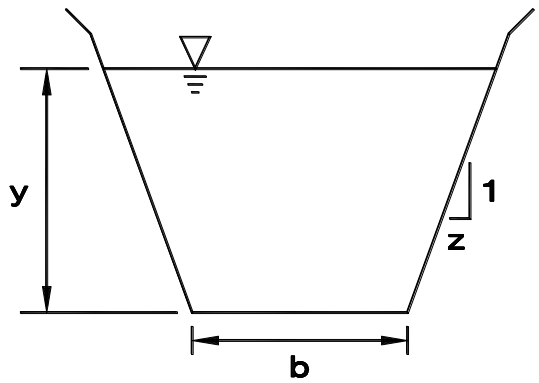
Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = \sin\left(\theta/2\right)d$

Open Channel Flow Calculator For Triangular/Trapezoidal Channels	*Land Development Consultants, Inc.*	
	20210 142nd Ave NE Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-109
Description:	Swale (STA. 12+10 to STA. 12+31)	Date:	8/10/2018
		Calc. By:	SJW

Bottom Width (b) =	2.00	ft
Side Slopes (z) =	2.00	:1
Channel Slope (S) =	5.78	%
Flow Depth (y) =	**0.18**	**ft**
Flowrate (Q) =	1.39	cfs
Mannings Coeff. (n) =	0.030	
Wetted Area (A) =	0.41	ft^2
Wet. Perimeter (P) =	2.79	ft
Hydraulic Radius (R) =	0.15	ft
Top Width (T) =	2.71	ft
Flow Velocity =	3.35	fps



Solve | Reset Form

Formulas:

Wetted Area (A): $A = (b + zy)y$

Wetted Perimeter (P): $P = b + 2y\sqrt{1 + z^2}$

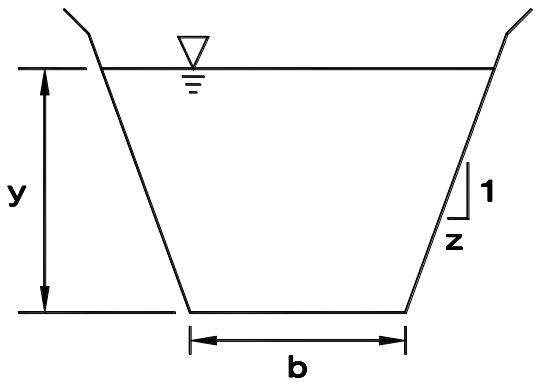
Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = b + 2zy$

Open Channel Flow Calculator For Triangular/Trapezoidal Channels	*Land Development Consultants, Inc.*	
	20210 142nd Ave NE Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Swale (STA. 13+81 to STA. 14+10)	Date:	8/10/2018
		Calc. By:	SJW

Bottom Width (b) =	2.00	ft
Side Slopes (z) =	2.00	:1
Channel Slope (S) =	10.98	%
Flow Depth (y) =	**0.15**	**ft**
Flowrate (Q) =	1.39	cfs
Mannings Coeff. (n) =	0.030	
Wetted Area (A) =	0.34	ft^2
Wet. Perimeter (P) =	2.65	ft
Hydraulic Radius (R) =	0.13	ft
Top Width (T) =	2.59	ft
Flow Velocity =	4.14	fps



Solve | Reset Form

Formulas:

Wetted Area (A): $A = (b + zy)y$

Wetted Perimeter (P): $P = b + 2y\sqrt{1 + z^2}$

Hydraulic Radius (R): $R = \frac{A}{P}$

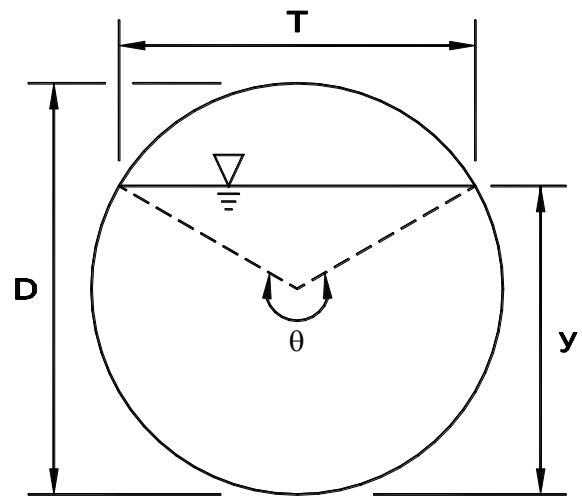
Top Width (T): $T = b + 2zy$

Open Channel Flow Calculator For Circular Pipes	Land Development Consultants, Inc.	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name: Garbarino
Description: Vault Discharge Line CB-8 to CB-9

Project No.: 15-104
Date: 1/19/2016
Calc. By: TPA

Pipe Diameter (D) =	12	in
Pipe Slope (S) =	0.60	%
Flow Depth (y) =	1.00	ft
Flowrate (Q) =	**3.00**	**cfs**
Mannings Coeff. (n) =	0.012	
Theta Angle (θ) =	6.28	rad
Wetted Area (A) =	0.79	ft^2
Wet. Perimeter (P) =	3.14	ft
Hydraulic Radius (R) =	0.25	ft
Top Width (T) =	0.00	ft
Flow Velocity =	3.82	fps



Solve | Reset Form

Formulas:

Theta Angle (θ): If y ≥ r : $\theta = 2\pi - 2a\cos(\frac{y-r}{r})$ where: r = Pipe Radius

If y ≤ r : $\theta = 2a\cos(\frac{r-y}{r})$ where: r = Pipe Radius

Wetted Area (A): $A = \frac{1}{8}(\theta - \sin\theta)d^2$

Wetted Perimeter (P): $P = \frac{1}{2}\theta d$

Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = \sin\left(\theta/2\right)d$

6.0 SPECIAL REPORTS AND STUDIES

A Geotechnical Report will be submitted as an additional document separately from this Report.

7.0 OTHER PERMITS

Other permits that may be required for the proposed development are as follows:

- Clearing and Grading Permit
- National Pollution Discharge Elimination System (NPDES)
- Right-of-Way permit
- Utility Permit
- Building Permits

8.0 EROSION AND SEDIMENT CONTROL ANALYSIS AND DESIGN

The Stormwater Pollution Prevention Plan for the project, which is written according to the guidelines of Volume II, Section 3 of the 2014 DOE Manual and the requirements of the 2019 Redmond Stormwater Technical Notebook, will be submitted as a separate document as project design progresses.

9.0 BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

A Bond Quantities Worksheet will be completed as necessary for a future submittal.

10.0 OPERATIONS AND MAINTENANCE MANUAL

The proposed storm drainage system consists of swales, buried pipes, catch basins and a Combined Detention/Wetvault facility, each of which will require periodic maintenance and inspection. An Operations and Maintenance Manual will be submitted to the City as a separate document.

APPENDIX 10-B

GEOTECHNICAL REPORT AND AGHA APPROVAL

Aspect CONSULTING

July 7, 2020

Ms. Cindy Wellborn, PE
City of Redmond
15670 NE 85th Street
Redmond, Washington, 98073

Re: Geologic Hazard Area Exception Review
Garbarino Plat
10030 and 10042 136th Avenue NE
Redmond, Washington 98052
Project No. 160422, Task 20-06

Dear Cindy:

This letter presents Aspect Consulting, LLC's (Aspect) review comments regarding the proposed geologic hazard area exception for the Garbarino Property project (Project). The Project includes the construction of a cast-in-place retaining wall within a steep-slope environmentally critical area (ECA) located along the east side of 138th Avenue NE north of the intersection with NE 100th Street. Aspect provided a review letter dated May 27, 2020, with recommendations for additional geotechnical evaluation for project compliance with Redmond Zoning Code (RZC) provisions.

These services were authorized by the City of Redmond (City) on May 5, 2020, with additional budget authorized on June 30, 2020, to review response comments, as part of our Consultant Agreement for On-Call Geotechnical Engineering Services with the City.

Documents Reviewed

These documents were provided by the City for our review:

- Riley Group, Response to City of Redmond's Comments Garbarino Short Plat, dated June 10, 2020.

Review Comments

Our review focused on conformance with the Project Geotechnical Report, Redmond Zoning Code (RZC) provisions, and geotechnical engineering standard of practice. In our opinion, the Riley Group response provides sufficient geotechnical evaluation to address our review comments from our May 27, 2020, review letter. We recommend that the City consider project approval.

Limitations

Work for this project was performed for the City of Redmond (Client), and this letter was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This letter does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

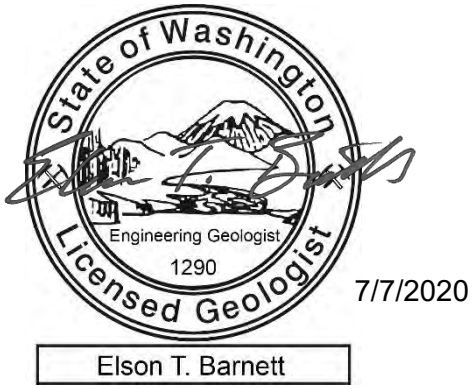
We appreciate the opportunity to perform these services.

Closing

Please contact us if you have any questions concerning our review.

Sincerely,

Aspect consulting, LLC



7/7/2020

7/7/2020

Elson T. "Chip" Barnett, LEG
Senior Engineering Geologist
ebarnett@aspectconsulting.com

Erik O. Andersen, PE
Principal Geotechnical Engineer
eandersen@aspectconsulting.com

Attachments: Appendix A – Report Limitations and Guidelines for Use

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APPENDIX A

Report Limitations and Guidelines for Use

REPORT LIMITATIONS AND GUIDELINES FOR USE

Geoscience is Not Exact

The geoscience practices (geotechnical engineering, geology, and environmental science) are far less exact than other engineering and natural science disciplines. It is important to recognize this limitation in evaluating the content of the report. If you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or property, you should contact Aspect Consulting, LLC (Aspect).

This Report and Project-Specific Factors

Aspect's services are designed to meet the specific needs of our clients. Aspect has performed the services in general accordance with our agreement (the Agreement) with the Client (defined under the Limitations section of this project's work product). This report has been prepared for the exclusive use of the Client. This report should not be applied for any purpose or project except the purpose described in the Agreement.

Aspect considered many unique, project-specific factors when establishing the Scope of Work for this project and report. You should not rely on this report if it was:

- Not prepared for you;
- Not prepared for the specific purpose identified in the Agreement;
- Not prepared for the specific subject property assessed; or
- Completed before important changes occurred concerning the subject property, project, or governmental regulatory actions.

If changes are made to the project or subject property after the date of this report, Aspect should be retained to assess the impact of the changes with respect to the conclusions contained in the report.

Reliance Conditions for Third Parties

This report was prepared for the exclusive use of the Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against liability claims by third parties with whom there would otherwise be no contractual limitations. Within the limitations of scope, schedule, and budget, our services have been executed in accordance with our Agreement with the Client and recognized geoscience practices in the same locality and involving similar conditions at the time this report was prepared

Property Conditions Change Over Time

This report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by events such as a change in property use or occupancy, or by natural events, such as floods, earthquakes, slope instability, or groundwater fluctuations. If any of the described events may have occurred following the issuance of the report, you should contact Aspect so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical, Geologic, and Environmental Reports Are Not Interchangeable

The equipment, techniques, and personnel used to perform a geotechnical or geologic study differ significantly from those used to perform an environmental study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually address any environmental findings, conclusions, or recommendations (e.g., about the likelihood of encountering underground storage tanks or regulated contaminants). Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding the subject property.

We appreciate the opportunity to perform these services. If you have any questions, please contact the Aspect Project Manager for this project.

RILEYGROUP

June 10, 2020

Mr. Greg Arms
Milestone Northwest
227 Bellevue Way Northeast, Suite 183
Bellevue, Washington 98004

Subject: Response to City of Redmond's Comments
Garbarino Short Plat
10042 136th Avenue Northeast
Redmond, Washington 9803
RGI Project No. 2015-198

References: Critical Area Evaluation and Geotechnical Engineering Report for Garbarino Short Plat, prepared by The Riley Group, Inc. dated January 22, 2016.
Garbarino Construction Plan (RD-02), prepared by LDC, Inc. dated June 5, 2019
Geologic Hazard Area Exception Review, prepared by Aspect Consulting for the City of Redmond dated May 27, 2020

Dear Mr. Arms:

As requested, The Riley Group, Inc. (RGI) has reviewed the city's review comments and performed additional field exploration and slope stability analysis. The following are our responses to the city's comments:

1. Slope Stability Analysis

RGI performed a slope stability analysis by using a computer program, Slide version 6.0, which was developed by Rocscience. The slope profile for cross section A-A' through the middle of the retaining wall was produced from the referenced plan. The soil parameters used for the analysis are estimated from *Geotechnical Properties of Geologic Materials,* by Jon W. Koloski, et al. (1989). Safety factors of 1.695 and 1.082 were obtained under both static and seismic condition, respectively.

The results of the slope stability analysis indicate that the slope will be stable after the retaining wall is built under both static and seismic condition. Therefore, RGI doesn't believe that the slope stability will be affected by constructing a retaining wall. The results of the slope stability analysis are attached.

2. Additional Exploration

Additional exploration including three hand auger borings to a maximum of 5.5 feet were performed in the proposed retaining wall area and eastern portion of the site. The location of the hand auger borings are shown in the site plan. The soil encountered in the

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Bothell, Washington 98011
Phone 425.415.0551 • Fax 425.415.0311

www.riley-group.com

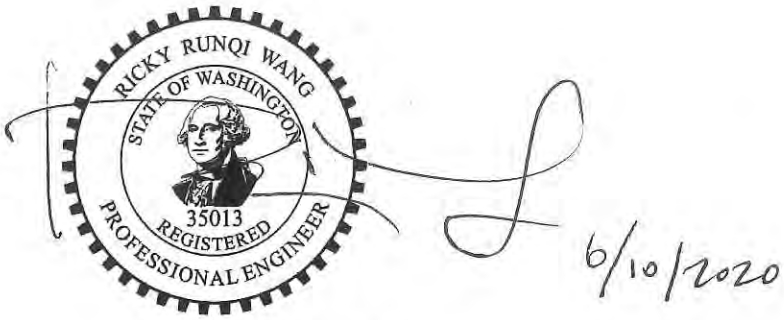
hand auger boring includes fill over native soil which is silty gravel with sand (outwash). The native soil in the proposed retaining wall area and the eastern portion of the site is confirmed to be outwash instead of glacial till. The native soil in the western portion of the site is glacial till.

RGI recommends that the proposed retaining wall foundation be supported on firm native soil. This condition needs to be verified in the field by a geotechnical engineer during construction.

If you have any questions or require additional information, please contact us.

Respectfully submitted,

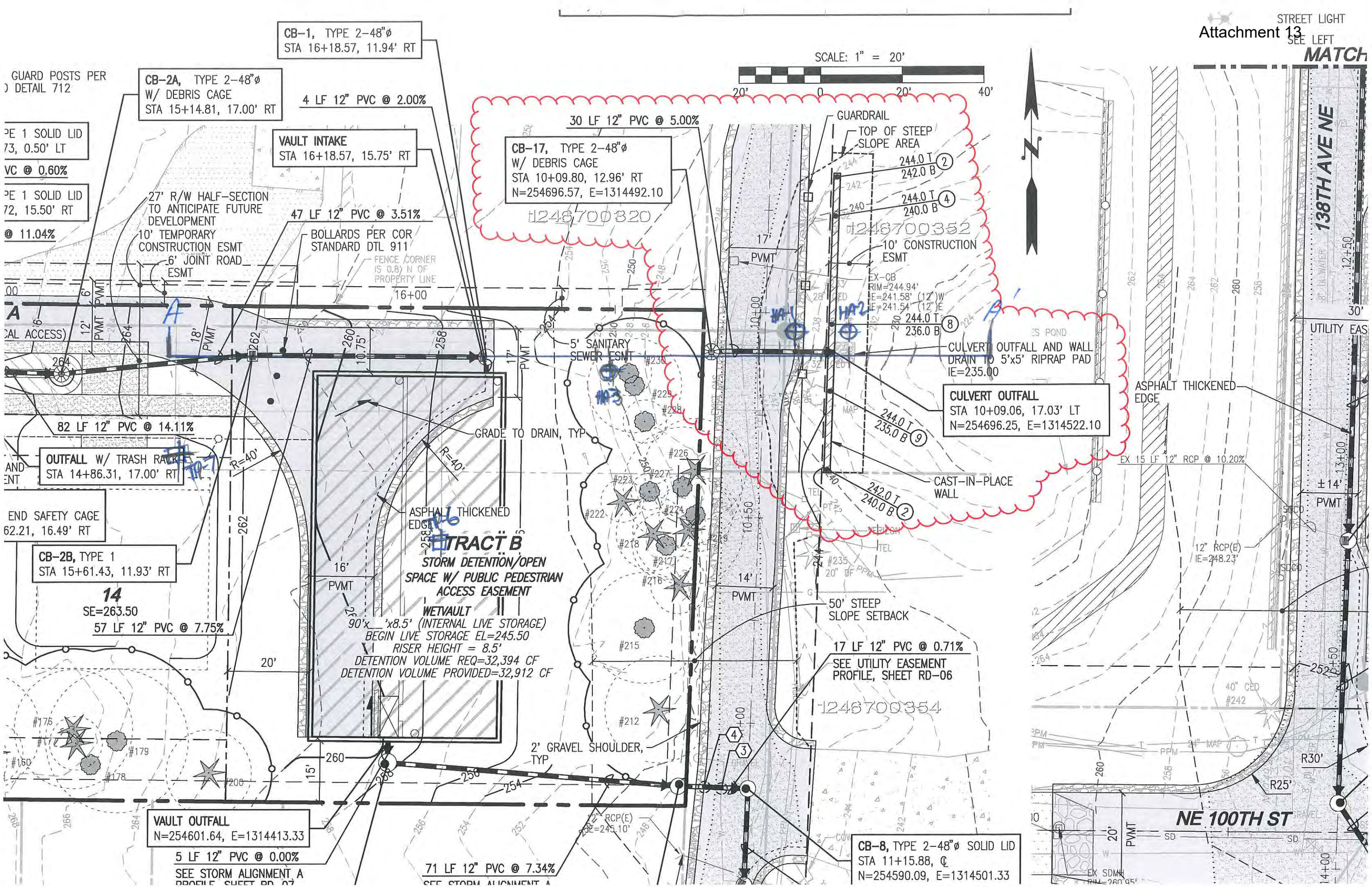
THE RILEY GROUP, INC.



Ricky R. Wang, Ph.D., P.E.
Principal Engineer

Attachments: Site Plan
Hand Auger Boring Logs
Grain Size Analysis
Slope Stability Analysis

Attachment 13



Project Name: **Garbarino Plat** Project Number: **2015-198-1** Client: **Milestone Northwest**	RILEYGROUP Hand Auger No.: **HA-1** **Sheet 1 of 1**

Date(s) Drilled: **5/29/2020**	Logged By: **ELW**	Surface Conditions: **Ferns**
Drilling Method(s): **Hand Auger**	Drill Bit Size/Type: **N/A**	Total Depth of Borehole: **2.5 feet bgs**
Drill Rig Type: **N/A**	Drilling Contractor: **N/A**	Approximate Surface Elevation: **240**
Groundwater Level: **Not Encountered**	Sampling Method(s): **Auger**	Hammer Data : **N/A**
Borehole Backfill: **Cuttings**	Location: **10042 136th Avenue Northeast, Redmond, Washington**	

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
240	0					TPSL		12" topsoil	
						Fill		Reddish brown silty SAND with trace gravel, loose, moist (Fill)	
								26% fines	21
								Trace metal debris	
								Hand Auger terminated due to rock obstruction	
235	5								

Project Name: **Garbarino Plat** Project Number: **2015-198-1** Client: **Milestone Northwest**	RILEYGROUP Hand Auger No.: **HA-2** **Sheet 1 of 1**

Date(s) Drilled: **5/29/2020**	Logged By: **ELW**	Surface Conditions: **Ferns**
Drilling Method(s): **Hand Auger**	Drill Bit Size/Type: **N/A**	Total Depth of Borehole: **5.5 feet bgs**
Drill Rig Type: **N/A**	Drilling Contractor: **N/A**	Approximate Surface Elevation: **234**
Groundwater Level: **Not Encountered**	Sampling Method(s): **Auger**	Hammer Data : **N/A**
Borehole Backfill: **Cuttings**	Location: **10042 136th Avenue Northeast, Redmond, Washington**	

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
234	0					TPSL		10" topsoil	
						SM		Reddish brown silty SAND with some gravel, loose to medium dense, moist	
								Becomes tan, medium dense	
									13
229	5							25% fines	21
								Hand Auger terminated at 5.5' due to rock obstruction.	

Project Name: **Garbarino Plat**
Project Number: **2015-198-1**
Client: **Milestone Northwest**

RILEYGROUP

Hand Auger No.: HA-3

Sheet 1 of 1

Date(s) Drilled: **5/29/2020**	Logged By: **ELW**	Surface Conditions: **Ferns**
Drilling Method(s): **Hand Auger**	Drill Bit Size/Type: **N/A**	Total Depth of Borehole: **4.5 feet bgs**
Drill Rig Type: **N/A**	Drilling Contractor: **N/A**	Approximate Surface Elevation: **250**
Groundwater Level: **Not Encountered**	Sampling Method(s): **Auger**	Hammer Data : **N/A**
Borehole Backfill: **Cuttings**	Location: **10042 136th Avenue Northeast, Redmond, Washington**	

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
250	0					TPSL		8" topsoil	
						Fill		Gray silty SAND with some gravel, medium dense, moist (Fill)	
								Becomes brown	
									23
						GM		Reddish brown silty GRAVEL with some sand, loose to medium dense, wet	
								12% fines	9
								Hand Auger terminated at 4.5' due to rock obstruction	
245	5								

Project Name: **Gabarino Short Plat** Project Number: **2015-198** Client: **Milestone NW**	RILEYGROUP Test Pit No.: TP-6 **Sheet 1 of 1**

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **10 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Fill		Fill, concrete debris	12% Moisture
				SM		Reddish-brown Silty SAND with gravel and roots	16% Moisture
	5			SM		Silty SAND with gravel, dense to very dense (TILL)	10% Moisture
	10					Test pit terminated at 10 feet	
	15						

Project Name: **Garbarino Plat**
Project Number: **2015-198-1**
Client: **Milestone Northwest**

RILEYGROUP

Key to Log of Boring

Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample ID	Sampling Resistance, blows/ft	Recovery (%)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Moisture (%)
1	2	3	4	5	6	7	8	9	10

COLUMN DESCRIPTIONS

1. Elevation (feet): Elevation (MSL, feet).
2. Depth (feet): Depth in feet below the ground surface.
3. Sample Type: Type of soil sample collected at the depth interval shown.
4. Sample ID: Sample identification number.
5. Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6. Recovery (%): Core Recovery Percentage is determined based on a ratio of the length of core sample recovered compared to the cored interval length.
7. USCS Symbol: USCS symbol of the subsurface material.
8. Graphic Log: Graphic depiction of the subsurface material encountered.
9. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
10. Moisture (%): Moisture, expressed as a water content.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

AF
Silty GRAVEL (GM)
Silty SAND (SM)
Topsoil

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

THE RILEY GROUP, INC.
17522 Bothell Way NE
Bothell, WA 98011

PHONE: (425) 415-0551
FAX: (425) 415-0311

Attachment 13

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Garbarino Plat	SAMPLE ID/TYPE	HA-1
PROJECT NO.	2015-198-1	SAMPLE DEPTH	1'
TECH/TEST DATE	EW 5/29/2020	DATE RECEIVED	5/29/2020

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	286.2
Wt Dry Soil & Tare (gm)	(w2)	239.2
Weight of Tare (gm)	(w3)	16.0
Weight of Water (gm)	(w4=w1-w2)	47.0
Weight of Dry Soil (gm)	(w5=w2-w3)	223.2
Moisture Content (%)	(w4/w5)*100	21

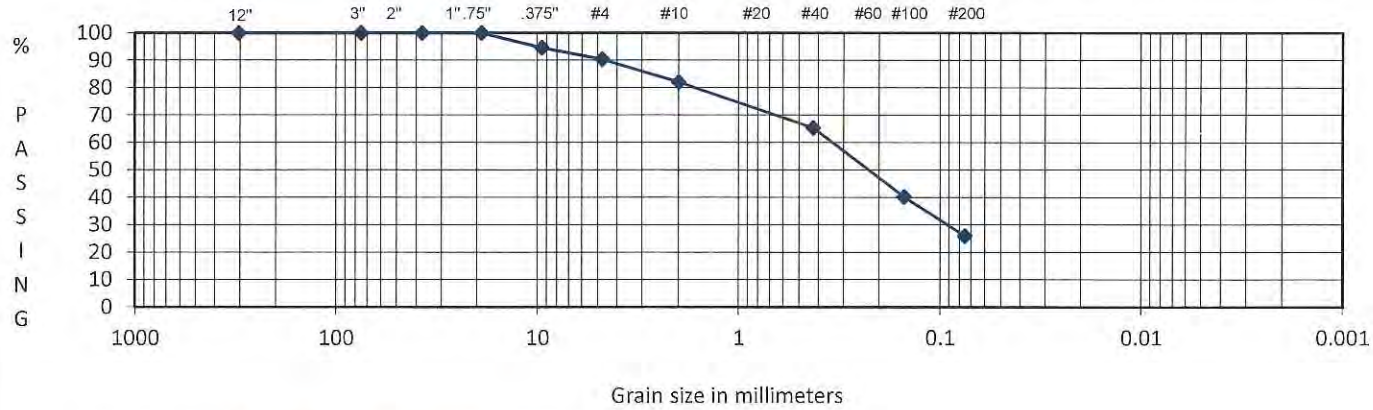
Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

Weight Of Sample (gm)		239.2
Tare Weight (gm)		16.0
Total Dry Weight (gm)	(W6)	223.2

% COBBLES	0.0
% C GRAVEL	0.0
% F GRAVEL	9.6
% C SAND	8.3
% M SAND	16.7
% F SAND	39.4
% FINES	26.0
% TOTAL	100.0
D10 (mm)	
D30 (mm)	
D60 (mm)	
Cu	
Cc	

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	16.0	0.00	0.00	100.00	cobbles
3.0"	16.0	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	16.0	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	16.0	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	27.9	11.90	5.33	94.67	fine gravel
#4	37.4	21.40	9.59	90.41	coarse sand
#10	56.0	40.00	17.92	82.08	medium sand
#20					medium sand
#40	93.3	77.30	34.63	65.37	fine sand
#60					fine sand
#100	149.3	133.30	59.72	40.28	fine sand
#200	181.2	165.20	74.01	25.99	fines
PAN	239.2	223.20	100.00	0.00	silt/clay



DESCRIPTION	Silty SAND with trace gravel
USCS	SM

Prepared For:
Milestone Northwest

Reviewed By:
RW

RILEYGROUP

THE RILEY GROUP, INC.
17522 Bothell Way NE
Bothell, WA 98011

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FAX: (425) 415-0311

Attachment 13

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Garbarino Plat	SAMPLE ID/TYPE	HA-2
PROJECT NO.	2015-198-1	SAMPLE DEPTH	5'
TECH/TEST DATE	EW 5/29/2020	DATE RECEIVED	5/29/2020

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	333.0
Wt Dry Soil & Tare (gm)	(w2)	277.5
Weight of Tare (gm)	(w3)	15.9
Weight of Water (gm)	(w4=w1-w2)	55.5
Weight of Dry Soil (gm)	(w5=w2-w3)	261.6
Moisture Content (%)	(w4/w5)*100	21

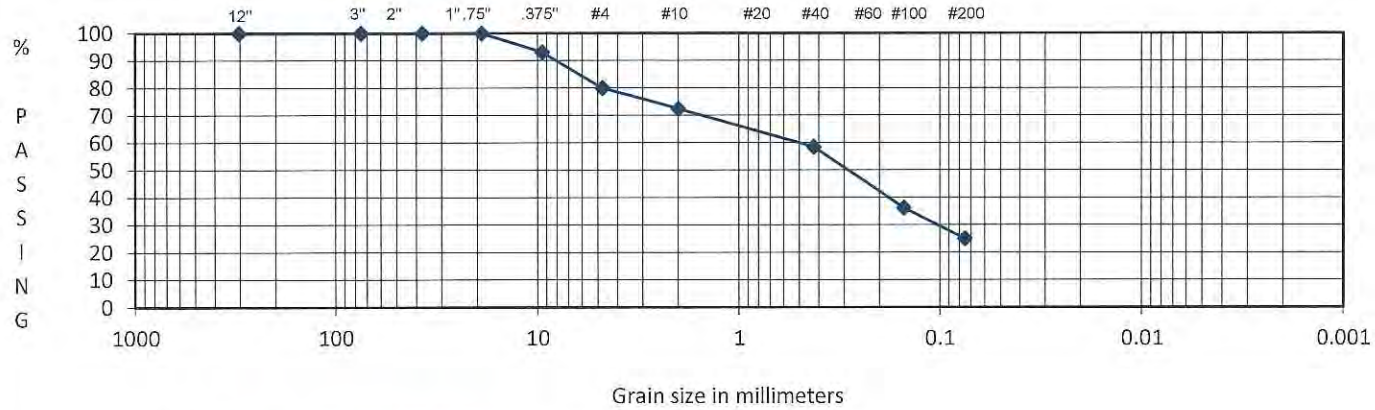
Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

	Weight Of Sample (gm)	277.5
	Tare Weight (gm)	15.9
(W6)	Total Dry Weight (gm)	261.6

% COBBLES	0.0
% C GRAVEL	0.0
% F GRAVEL	20.0
% C SAND	7.6
% M SAND	13.9
% F SAND	33.5
% FINES	25.0
% TOTAL	100.0
D10 (mm)	
D30 (mm)	
D60 (mm)	
Cu	
Cc	

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.9	0.00	0.00	100.00	cobbles
3.0"	15.9	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.9	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	15.9	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	33.9	18.00	6.88	93.12	fine gravel
#4	68.1	52.20	19.95	80.05	coarse sand
#10	88.0	72.10	27.56	72.44	medium sand
#20					medium sand
#40	124.4	108.50	41.48	58.52	fine sand
#60					fine sand
#100	182.7	166.80	63.76	36.24	fine sand
#200	212.1	196.20	75.00	25.00	fines
PAN	277.5	261.60	100.00	0.00	silt/clay



DESCRIPTION	Silty SAND with some gravel
USCS	SM

Prepared For:
Milestone Northwest

Reviewed By:
RW

RILEYGROUP

THE RILEY GROUP, INC.
17522 Bothell Way NE
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Attachment 13

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Garbarino Plat	SAMPLE ID/TYPE	HA-3
PROJECT NO.	2015-198-1	SAMPLE DEPTH	4'
TECH/TEST DATE	EW 5/29/2020	DATE RECEIVED	5/29/2020

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	521.9
Wt Dry Soil & Tare (gm)	(w2)	479.4
Weight of Tare (gm)	(w3)	16.1
Weight of Water (gm)	(w4=w1-w2)	42.5
Weight of Dry Soil (gm)	(w5=w2-w3)	463.3
Moisture Content (%)	(w4/w5)*100	9

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

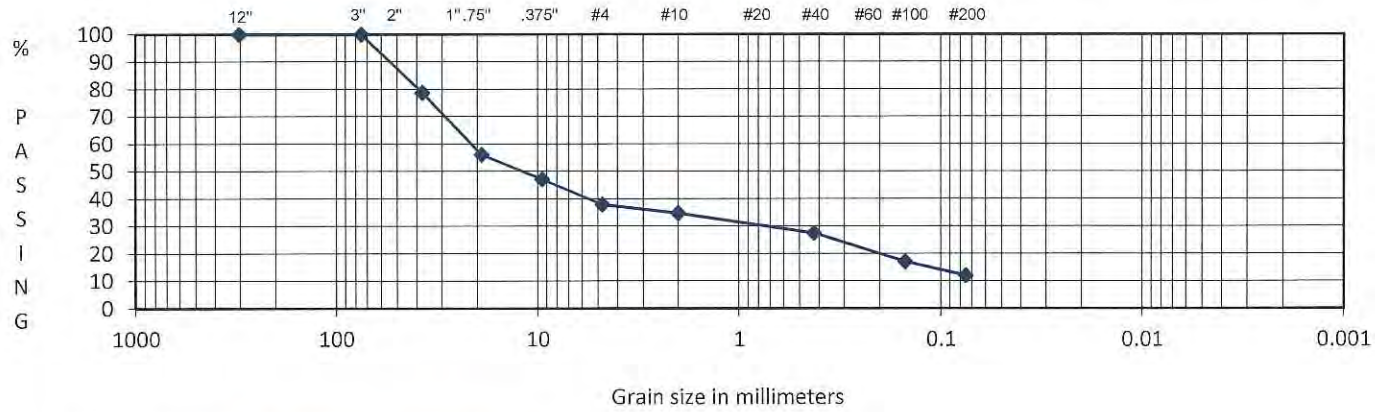
	Weight Of Sample (gm)	479.4
	Tare Weight (gm)	16.1
(W6)	Total Dry Weight (gm)	463.3

% COBBLES	0.0
% C GRAVEL	43.8
% F GRAVEL	18.2
% C SAND	3.3
% M SAND	7.3
% F SAND	15.4
% FINES	12.0
% TOTAL	100.0

D10 (mm)	0.06
D30 (mm)	0.7
D60 (mm)	21
Cu	350.0
Cc	0.4

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	16.1	0.00	0.00	100.00	cobbles
3.0"	16.1	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	114.9	98.80	21.33	78.67	coarse gravel
1.0"					coarse gravel
0.75"	219.2	203.10	43.84	56.16	fine gravel
0.50"					fine gravel
0.375"	260.8	244.70	52.82	47.18	fine gravel
#4	303.6	287.50	62.05	37.95	coarse sand
#10	318.7	302.60	65.31	34.69	medium sand
#20					medium sand
#40	352.3	336.20	72.57	27.43	fine sand
#60					fine sand
#100	400.1	384.00	82.88	17.12	fine sand
#200	423.6	407.50	87.96	12.04	fines
PAN	479.4	463.30	100.00	0.00	silt/clay



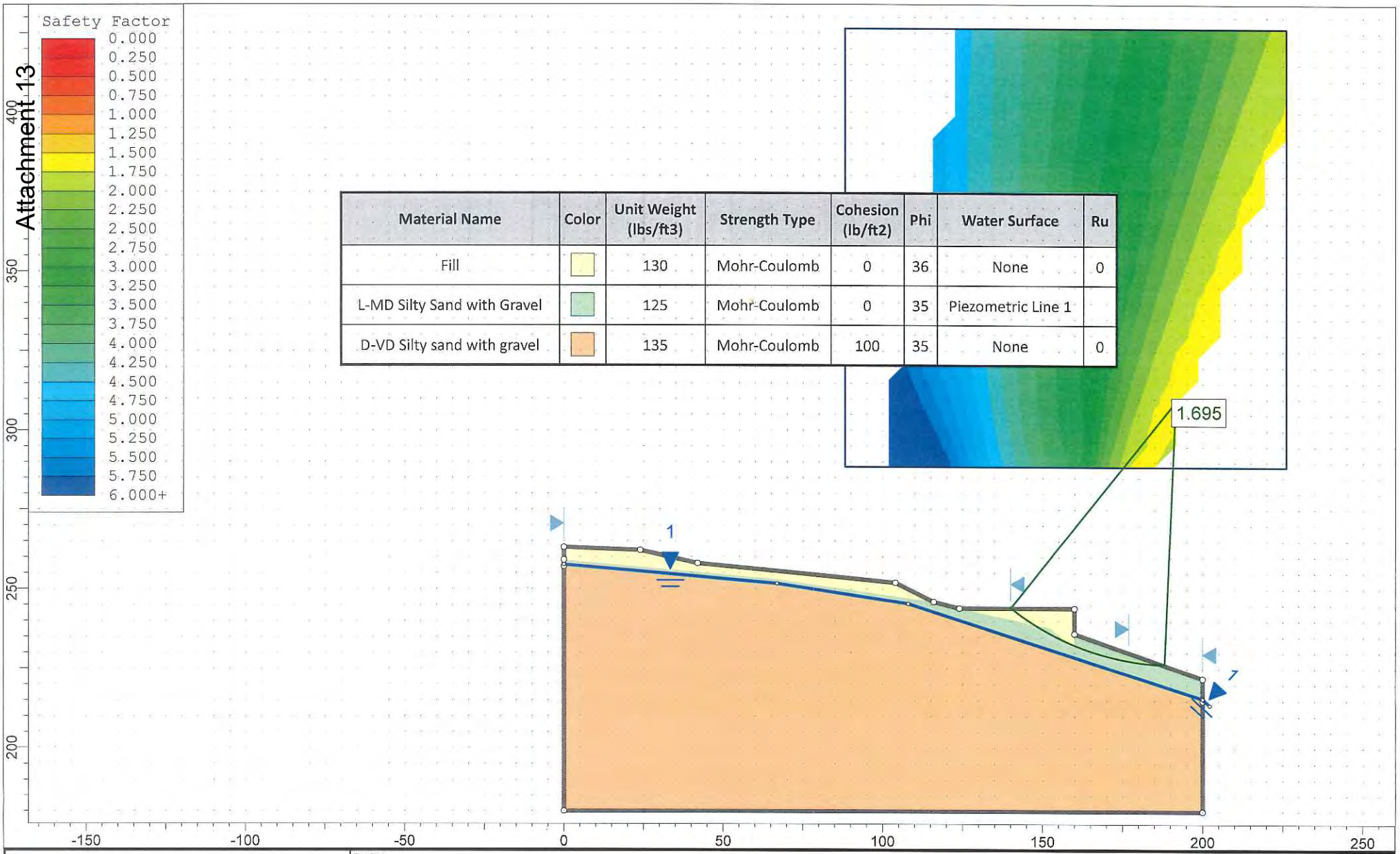
DESCRIPTION	Silty GRAVEL with some sand
USCS	GM

Prepared For:
Milestone Northwest

Reviewed By:
RW

RILEYGROUP

Attachment 13

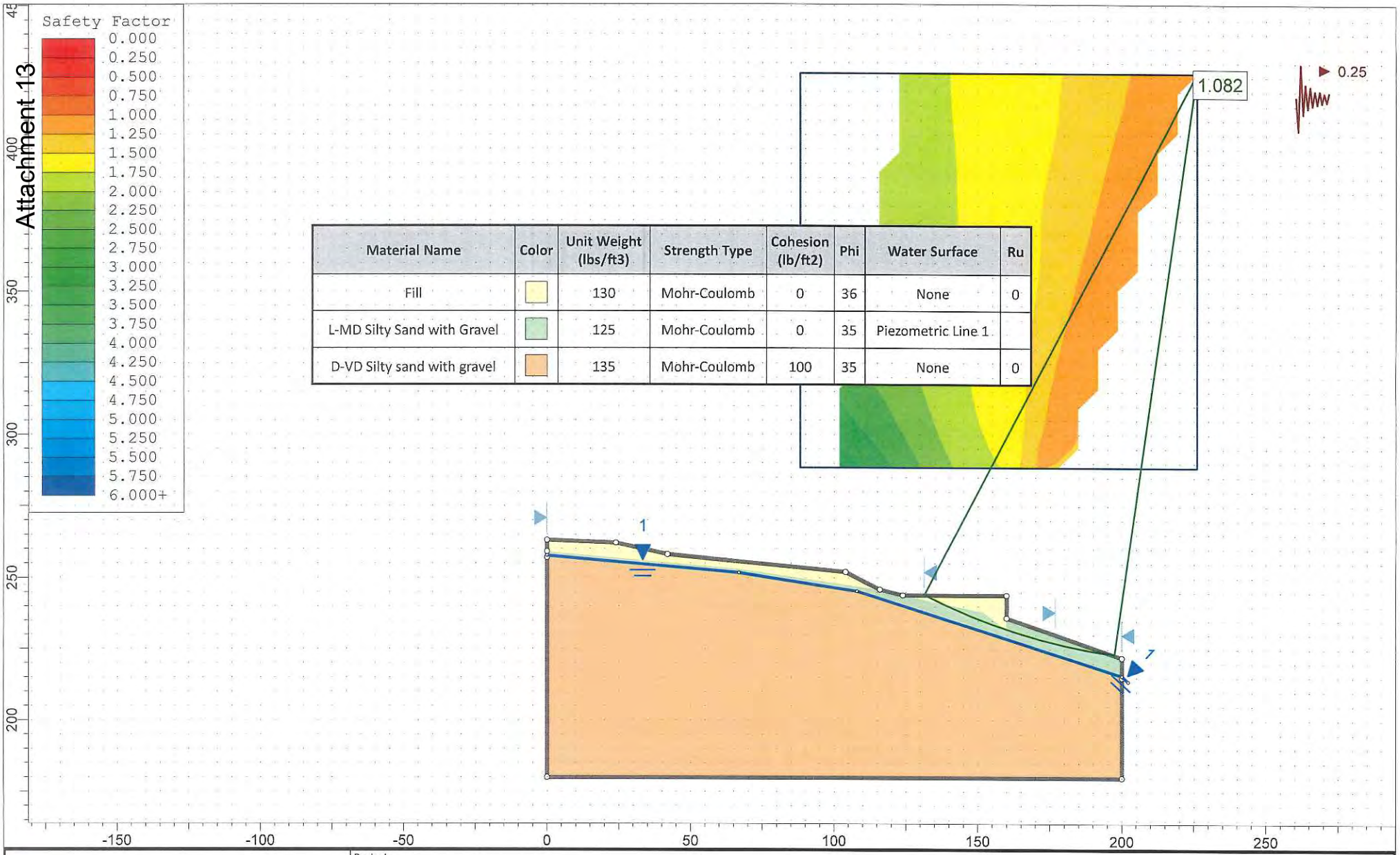


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface	Ru
Fill		130	Mohr-Coulomb	0	36	None	0
L-MD Silty Sand with Gravel		125	Mohr-Coulomb	0	35	Piezometric Line 1	
D-VD Silty sand with gravel		135	Mohr-Coulomb	100	35	None	0

Project	Garbarino Plat		
Analysis Description	Static Conditions		
Drawn By: ELW	Scale: 1:499	Company: Riley Group, Inc.	
Date: 6/9/2020, 1:02:16 PM		File Name: Static.slim	

SLIDEINTERPRET 6.009

Attachment 13



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Water Surface	Ru
Fill		130	Mohr-Coulomb	0	36	None	0
L-MD Silty Sand with Gravel		125	Mohr-Coulomb	0	35	Piezometric Line 1	
D-VD Silty sand with gravel		135	Mohr-Coulomb	100	35	None	0

rocscience

SLIDEINTERPRET 6.009

Project	Garbarino Plat		
Analysis Description	Seismic Conditions		
Drawn By: ELW	Scale: 1:554	Company: Riley Group, Inc.	
Date: 6/9/2020, 1:02:16 PM		File Name: Seismic.slim	

RILEYGROUP

March 25, 2020

Mr. Greg Arms
Milestone Northwest
227 Bellevue Way Northeast, Suite 183
Bellevue, Washington 98004

Subject: **Geotechnical Report Addendum B – Retaining Wall Recommendation**
Garbarino Short Plat
10042 136th Avenue Northeast
Redmond, Washington 9803
RGI Project No. 2015-198

References: Critical Area Evaluation and Geotechnical Engineering Report for Garbarino Short Plat, prepared by The Riley Group, Inc. dated January 22, 2016.
Grading, Storm Drainage and Transportation Plan, prepared by LDC, Inc. dated June 5, 2019

Dear Mr. Arms:

The Riley Group, Inc. (RGI) was asked to provide recommendation for a retaining wall about 70 feet long and up to 9 feet tall along the east side of 138th Avenue Northeast. The retaining wall will be used to support the new roadway and utilities. Per the City of Redmond's comment, a geotechnical evaluation must be conducted to identify the risks of damage from the proposal, both on-site and off-site, and to identify measures to eliminate or reduce risk. The proposal must not increase the occurrence of the potential geologic hazard.

On March 25, 2020, RGI's geotechnical engineer performed a site reconnaissance to evaluate the stability of the site in the proposed retaining wall area. During the field evaluation, no indications of recent landslide activity were observed. No seeps or springs were observed on the slope face. Trees with curved trucks were observed that is consistent with surficial creep. Much of the slope is heavily vegetated with mature trees and undergrowth and the native soil is very dense glacial till, reducing the potential of landslide hazard. Based on our evaluation, the proposed retaining wall will not affect the slope stability or increase the risk of landslide hazard.

The following recommendation should be used for retaining wall design and construction. The magnitude of earth pressure development on retaining walls will partly depend on the quality of the wall backfill. RGI recommends placing and compacting wall backfill as structural fill. Wall drainage will be needed behind the wall face. A typical retaining wall drainage detail is shown on Figure B-1. The retaining wall foundation subgrade should be supported on competent native soil. If loose soil is encountered at subgrade, it should be removed and replaced by a geotechnical engineer. The subgrade should be verified by a geotechnical engineer during construction.

With wall backfill placed and compacted as recommended, and drainage properly installed, RGI recommends using the values in the following table for design.

Corporate Office
17522 Bothell Way Northeast
Bothell, Washington 98011
Phone 425.415.0551 • Fax 425.415.0311

www.riley-group.com

Retaining Wall Design

Design Parameter	Value
Allowable Bearing Capacity – Native soil or structural fil	2,500 psf
Active Earth Pressure (unrestrained walls)	35 pcf
At-rest Earth Pressure (restrained walls)	50 pcf
Friction Coefficient	0.3
Passive Earth Pressure	150 pcf

A safety factor of 1.5 has been included in the friction coefficient and passive earth pressure. The passive earth pressure also included effect due to the sloped condition.

A vertical surcharge of 150 psf uniform load should be used for retaining wall design. For seismic design, an additional uniform load of 7 times the wall height (H) for unrestrained walls and 14H for restrained walls should be applied to the wall surface.

If you have any questions or require additional information, please contact us.

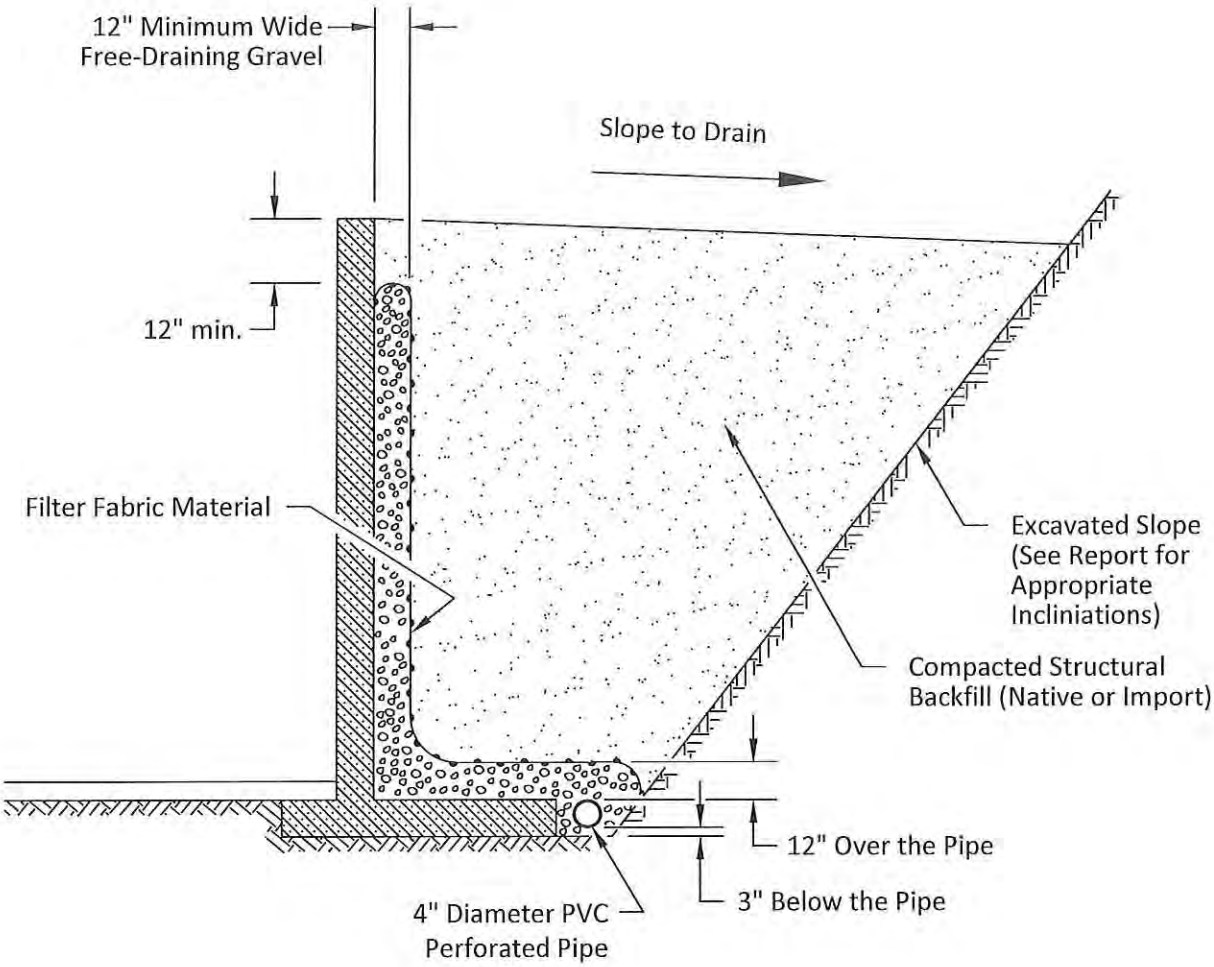
Respectfully submitted,

THE RILEY GROUP, INC.

3/25/2020

Ricky R. Wang, Ph.D., P.E.
Principal Engineer

Attachment: Figure B-1, Retaining Wall Drainage Detail



Not to Scale

RILEYGROUP Corporate Office 17522 Bothell Way Northeast Bothell, Washington 98011 Phone: 425.415.0551 Fax: 425.415.0311	Garbarino Short Plat		Figure B-1
	RGI Project Number 2015-198	Retaining Wall Drainage Detail	Date Drawn: 03/2020
	Address: 10042 136th Avenue Northeast, Redmond, Washington 98033		

Attachment 13

CRITICAL AREA EVALUATION AND GEOTECHNICAL ENGINEERING REPORT

PREPARED BY:

THE RILEY GROUP, INC.
17522 BOTHELL WAY NORTHEAST
BOTHELL, WASHINGTON 98011

PREPARED FOR:

MILESTONE NORTHWEST
227 BELLEVUE WAY NORTHEAST, SUITE 183
BELLEVUE, WASHINGTON 98004

RGI PROJECT NO. 2015-198

GARBARINO SHORT PLAT
10042 136TH AVENUE NORTHEAST
REDMOND, WASHINGTON 98033

JUNE 19, 2018

RILEYGROUP

June 19, 2018

Mr. Greg Arms
Milestone Northwest
227 Bellevue Way Northeast, Suite 183
Bellevue, Washington 98004

Subject: **Critical Area Evaluation and Geotechnical Engineering Report**
Garbarino Short Plat
10042 136th Avenue Northeast
Redmond, Washington 98033
RGI Project No. 2015-198

Dear Mr. Arms:

As requested, The Riley Group, Inc. (RGI) has prepared this Geotechnical Engineering Report (GER) for the above-referenced site. Our services were completed in accordance with our proposal PRP2015-327 dated December 29, 2015 and authorized by you on December 30, 2015. The information in this GER is based on our understanding of the proposed construction, and the soil and groundwater conditions encountered in the test pits completed by RGI at the site on January 13, 2016.

RGI recommends the project plans and specifications be submitted for a general review so that RGI may confirm that the recommendations in this GER are interpreted and implemented properly in the construction documents. RGI also recommends that a representative of our firm be present on site during portions of the project construction to confirm that the soil and groundwater conditions are consistent with those that form the basis for the engineering recommendations in this GER.

If you have any questions or require additional information, please contact us.

Respectfully submitted,

THE RILEY GROUP, INC.

RICKY RUNQI WANG
STATE OF WASHINGTON
35013
REGISTERED
PROFESSIONAL ENGINEER

6/19/2018

Kristina M. Weller, PE
Principal Geotechnical Engineer

Ricky R. Wang, PhD, PE
Principal Engineer

Corporate Office
17522 Bothell Way Northeast
Bothell, Washington 98011
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Executive Summary

This Executive Summary should be used in conjunction with the entire GER for design and/or construction purposes. It should be recognized that specific details were not included or fully developed in this section, and this GER must be read in its entirety for a comprehensive understanding of the items contained herein. Section 7.0 should be read for an understanding of limitations.

RGI's geotechnical scope of work included the advancement of eight test pits to depths up to 10 feet below ground surface (bgs).

Based on the information obtained from our subsurface exploration, the site is suitable for development of the proposed project. The following geotechnical considerations were identified.

Soil Conditions: The soils encountered include up to 3 feet loose to medium dense silty sand over glacial till consisting of very dense silty sand with gravel.

Groundwater: Groundwater seepage was not encountered during our field exploration.

Foundations: Foundations for the proposed buildings can be supported on conventional continuous and spread footings bearing on medium dense to dense native soil or new structural fill.

Slab-on-grade: Slab-on-grade floors for the proposed building can be supported on medium dense to dense native soil or new structural fill.

Pavements: The following pavement sections are recommended for the site access road and driveways:

- **For the site public access road**: 7 inches of hot mix asphalt concrete (HMA) Class ½ inch PG64-22
- **Flexible** : 2 inches of HMA over 6 inches of CRB over compacted subgrade
- **Concrete**: 5 inches of concrete over 4 inches of CRB over compacted subgrade

1.0 Introduction

This Geotechnical Engineering Report (GER) presents the results of the geotechnical engineering services provided for the proposed Garbarino Short Plat in Redmond, Washington. The purpose of this GER is to assess subsurface conditions and provide geotechnical recommendations for the construction of 15 single-family residences, the stormwater detention vault and the access roadway. Our scope of services included field explorations, laboratory testing, engineering analyses, and preparation of this GER.

The recommendations in the following sections of this GER are based upon our current understanding of the proposed site development as outlined below. If actual features vary or changes are made, RGI should review them in order to modify our recommendations as required. In addition, RGI requests to review the site grading plan, final design drawings and specifications when available to verify that our project understanding is correct and that our recommendations have been properly interpreted and incorporated into the project design and construction.

2.0 Project Description

The site is located at 10042 136th Avenue Northeast in Redmond, Washington. The approximate location of the site is shown on Figure 1. The site is currently occupied by two single-family residences on the western portion of the site and a shared paved driveway.

RGI understands that the client plans to demolish the existing residences and develop the property into 15 single-family residential lots including an access road and stormwater detention vault. Our understanding of the project is based on the preliminary project plans prepared by LDC dated December 1, 2015. Based on our experience with similar construction, RGI anticipates that the proposed buildings will be supported on perimeter walls with bearing loads of 2 to 3 kips per linear foot, and a series of columns with a maximum load up to 20 kips. Slab-on-grade floor loading of 250 pounds per square foot (psf) are expected. RGI also expects that site grading will be needed to reach the final grades.

3.0 Field Exploration and Laboratory Testing

3.1 Field Exploration

On January 13, 2016, RGI observed the excavation of eight test pits to a maximum depth of 10 feet bgs. Test pits TP-1 to TP-5 were excavated with an excavator in the northern portion of the site and TP-6 to TP-8 were excavated in the southern portion of the site. The approximate exploration locations are shown on Figure 2.

Field logs of each exploration were prepared by the geologist who continuously observed the excavation. These logs included visual classifications of the materials encountered during excavation as well as our interpretation of the subsurface conditions between samples. The test pit logs included in Appendix A represent an interpretation of the field logs and include modifications based on laboratory observation and analysis of the samples.

3.2 LABORATORY TESTING

During the field investigation, a representative portion of each recovered sample was sealed in containers and transported to our laboratory for further visual and laboratory examination. Samples retrieved from the test pits were tested for moisture content and grain size analysis to aid in soil classification and provide input for the recommendations provided in this GER. The results and descriptions of the laboratory tests are enclosed in Appendix A.

4.0 Site Conditions

4.1 SURFACE

The site is an irregular-shaped shaped land approximately 2.71 acres in size. The site is bound to the north, east, and south by existing residences, to the west by 136th Avenue Northeast and residence.

The western portion of the site is occupied by two single-family residences. The site slopes to the east with an overall elevation difference of 50 feet and an average slope gradient of 10 percent. The existing paved driveway through the middle of the site divides the site into two portions. The driveway is shared by the two residences proposed for demolition and the residence on the northeast corner that is not part of the proposed development. There is a steep slope with slope gradients over 40 percent about 15 feet to the northeast corner of the property. There is a private driveway between the top of the slope and the eastern property line

4.2 GEOLOGY

Review of the *Geologic Map of King County, Washington* by Derek B. Booth, etc, (2002) indicates that the soil in the project vicinity is mapped as till (Map Unit Qvt) that consists of dense to very dense compact diamict of silt, sand, and subrounded to well-rounded gravel glacially transported and deposited under ice. The native soils encountered at the site are similar to the descriptions in the geology map.

4.3 SOILS

The soils encountered during our field exploration include up to 3 feet of loose to medium dense silty sand with gravel over glacial till consisting of very dense silty sand with gravel. The eastern portion of the site encountered 3 feet of fill consisting of concrete debris on the surface in test pits TP-6 and TP-7 area.

More detailed descriptions of the subsurface conditions encountered are presented in the test pit logs included in Appendix A. Sieve analysis was performed on one selected soil sample. The grain-size distribution curves are included in Appendix A.

4.4 GROUNDWATER

Light to moderate groundwater seepage was encountered at 2.5 to 6 feet below grade in most of the test pits during our field exploration. The seepage is perched on the top of the very dense glacial till encountered across the site.

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the explorations were performed. In addition, perched water can develop within seams and layers contained in fill soils or higher permeability soils overlying less permeable soils following periods of heavy or prolonged precipitation.

4.5 SEISMIC CONSIDERATIONS

Based on the 2012 International Building Code (IBC), RGI recommends the follow seismic parameters in Table 1 be used for design.

Table 1 IBC Seismic Parameters

2012 IBC Parameter	Value
Site Soil Class[1]	C[2]
Site Latitude	47.69054 N
Site Longitude	122.15928 W
Maximum considered earthquake spectral response acceleration parameters (g)	S_s =1.254, S_1 =0.482
Spectral response acceleration parameters adjusted for site class (g)	S_{ms} =1.254, S_{m1} =0.635
Design spectral response acceleration parameters (g)	S_{ds} =0.836, S_{d1} =0.423

1 Note: In general accordance with the USGS *2012 International Building Code*. IBC Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.

2 Note: The *2012 International Building Code* requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope of our services does not include the required 100 foot soil profile determination. Test pits extended to a maximum depth of 10 feet, and this seismic site class definition considers that very dense soil continues below the maximum depth of the subsurface exploration.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations from a seismic event. Liquefaction mainly affects geologically recent deposits of fine-grained sands that are below the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction, thus reducing or eliminating the soil's strength.

RGI reviewed the results of the field and laboratory testing and assessed the potential for liquefaction of the site's soil during an earthquake. Since the site is underlain by glacial till, RGI considers that the possibility of liquefaction during an earthquake is minimal.

4.6 GEOLOGIC HAZARD AREAS

RGI reviewed the City of Redmond Critical Areas Codes. The review indicates that the site is mapped as geologic hazard area due to site topography and soil conditions. The steep slope area to the east of the site are subject to severe erosion and potential landslides when cleared. Based on the soil conditions encountered in our explorations and reviewing the topographic survey, no geologic hazard areas are located on the proposed development site.

4.6.1 SITE RECONNAISSANCE

On January 12 and 13, 2016, RGI's geologist performed a site reconnaissance to evaluate the stability of the site slopes. During our field observations, no indications of recent landslide activity were observed. No seeps or springs were observed on the slope face. Trees with curved trucks were observed that is consistent with surficial creep. Much of the slope is heavily vegetated with mature trees and undergrowth, reducing the potential of shallow debris flow failures.

4.6.2 RECOMMENDATIONS

Based on current development plan, the nearest residential lot will be about 120 feet from the edge of the steep slope. Between the lots and the eastern property line, there will be a stormwater detention vault. To install the detention vault, an excavation with sloped cuts about 18 to 20 feet deep will be necessary. The edge of the slope cut will be approximately 25 feet away from the top of the steep slope. The storm and sewer utility lines will be extended from the southeast portion of the site and extend in the existing driveway to the connection point in the Northeast 100th Street right-of-way. Based on the soil conditions and our experience working in the area, the excavation and earthwork will not have an adverse effect on the steep slope located off-site to the east. The steep slope setback may be reduced to 15 feet for the slope located off-site to the east of the northeast corner of the site.

The utility lines and the connection point for the storm and sewer located in the Northeast 100th Street right-of-way is also located near steep slope areas to the east of the site, however this slope is approximately 10 feet in height and was created by grading on the adjacent lot. The installation of the sewer and storm utilities in this area should not have an adverse effect on the slope. We understand the existing driveway will be paved and the areas disturbed landscaped after the installation of the utilities. RGI observed the construction of both the sewer and storm lines that extend from the end of Northeast 100th Street down the slope to the parking lot behind the building off of Willows Road. The soil conditions consist of very dense silty sand with gravel. Slopes in this material are typically stable at the gradients observed in the slopes to the east of the site.

5.0 Discussion and Recommendations

5.1 GEOTECHNICAL CONSIDERATIONS

Based on our observations, explorations and analysis, the site is suitable for the proposed construction from a geotechnical standpoint. RGI recommends that foundations for the proposed buildings be supported on conventional spread footings bearing on medium dense to dense native soil or new structural fill. Slab-on-grade floors and pavement section can be similarly supported.

Detailed recommendations regarding the above issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

5.2 EARTHWORK

The site earthwork is expected to consist of grading the site to establish lot and roadway grades, installing the detention vault and utilities, and preparing the slab subgrade. The earthwork should take place in the dry season (June through September).

5.2.1 EROSION AND SEDIMENT CONTROL

Potential sources or causes of erosion and sedimentation depend on construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. The impacts on erosion-prone areas can be reduced by implementing an erosion and sedimentation control plan. The plan should be designed in accordance with applicable city and/or county standards.

RGI recommends the following erosion control Best Management Practices (BMPs):

- Scheduling site preparation and grading for the drier summer and early fall months and undertaking activities that expose soil during periods of little or no rainfall

- Establishing a quarry spall construction entrance
- Installing siltation control fencing or anchored straw or coir wattles on the downhill side of work areas
- Covering soil stockpiles with anchored plastic sheeting
- Revegetating or mulching exposed soils with a minimum 3-inch thickness of straw if surfaces will be left undisturbed for more than one day during wet weather or one week in dry weather
- Directing runoff away from exposed soils and slopes
- Minimizing the length and steepness of slopes with exposed soils and cover excavation surfaces with anchored plastic sheeting (Graded and disturbed slopes should be tracked in place with the equipment running perpendicular to the slope contours so that the track marks provide a texture to help resist erosion and channeling. Some sloughing and raveling of slopes with exposed or disturbed soil should be expected.)
- Decreasing runoff velocities with check dams, straw bales or coir wattles
- Confining sediment to the project site
- Inspecting and maintaining erosion and sediment control measures frequently (The contractor should be aware that inspection and maintenance of erosion control BMPs is critical toward their satisfactory performance. Repair and/or replacement of dysfunctional erosion control elements should be anticipated.)

Permanent erosion protection should be provided by reestablishing vegetation using hydroseeding and/or landscape planting. Until the permanent erosion protection is established, site monitoring should be performed by qualified personnel to evaluate the effectiveness of the erosion control measures. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

5.2.2 STRIPPING

Stripping efforts should include removal of pavements, vegetation, organic materials, and deleterious debris from areas slated for building, pavement, and utility construction. The test pits encountered 6 to 12 inches of topsoil and rootmass in the north portion of the site. Deeper areas of stripping and excavation up to 5 feet may be required to remove the unsuitable fill soils and underlying relic topsoil on the southeast portion of the site.

5.2.3 EXCAVATIONS

All temporary cut slopes associated with the site and utility excavations should be adequately inclined to prevent sloughing and collapse. The site soils consist of silty sand with gravel and density generally increases with depth. The cut for the detention vault is expected to be 18 to 20 feet below the existing grade.

Accordingly, for excavations more than 4 feet but less than 12 feet in depth, the temporary side slopes should be laid back with a minimum slope inclination of 1.5H:1V (Horizontal:Vertical) in the loose to medium dense fill, 1H:1V in the medium dense native soils and 3/4H:1V in very dense glacial till.

Based on the soil conditions encountered in test pit, TP-6, the excavation for the detention vault will encounter up to 5 feet of fill and medium dense native soils underlain by glacial till. We expect the fill thickness will decrease to the east and south. We expect temporary cut easements or shoring will be necessary to complete the excavation on the eastern portion of the south side of the vault. The remaining areas should stay within the site and not disturb the save trees located on the east and south property lines.

If there is insufficient room to complete the excavations in this manner using temporary shoring to support the excavations should be considered. Shoring recommendations are provided in the following section of this GER.

For open cuts at the site, RGI recommends:

- No traffic, construction equipment, stockpiles or building supplies are allowed at the top of cut slopes within a distance of at least 5 feet from the top of the cut
- Exposed soil along the slope is protected from surface erosion using waterproof tarps and/or plastic sheeting
- Construction activities are scheduled so that the length of time the temporary cut is left open is minimized
- Surface water is diverted away from the excavation
- The general condition of slopes should be observed periodically by a geotechnical engineer to confirm adequate stability and erosion control measures

In all cases, however, appropriate inclinations will depend on the actual soil and groundwater conditions encountered during earthwork. Ultimately, the site contractor must be responsible for maintaining safe excavation slopes that comply with applicable OSHA or WISHA guidelines.

5.2.4 Site Preparation

RGI anticipates that some areas of loose or soft soil will be exposed upon completion of stripping and grubbing. Proofrolling and subgrade verification should be considered an essential step in site preparation. After stripping, grubbing, and prior to placement of structural fill, RGI recommends proofrolling building and pavement subgrades and areas to receive structural fill. These areas should moisture condition and compacted to a firm and unyielding condition in order to achieve a minimum compaction level of 95 percent of the modified proctor maximum dry density as determined by the American Society of Testing and Materials D1557-09 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (ASTM D1557).

Proofrolling and adequate subgrade compaction can only be achieved when the soils are within approximately ± 2 percent moisture content of the optimum moisture content. Soils which appear firm after stripping and grubbing may be proofrolled with a heavy compactor, loaded double-axle dump truck, or other heavy equipment under the observation of an RGI representative. This observer will assess the subgrade conditions prior to filling. The need for or advisability of proofrolling due to soil moisture conditions should be determined at the time of construction. In wet areas it may be necessary to hand probe the exposed subgrades in lieu of proofrolling with mechanical equipment.

Subgrade soils that become disturbed due to elevated moisture conditions should be overexcavated to reveal firm, non-yielding, non-organic soils and backfilled with compacted structural fill. If earthwork is completed during the wet season (typically November through May) it will be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork will require additional mitigative measures beyond that which would be expected during the drier summer and fall months.

5.2.5 STRUCTURAL FILL

Once stripping, clearing and other preparing operations are complete, cuts and fills can be made to establish desired building grades. Prior to placing fill, RGI recommends proof-rolling as described above. RGI recommends fill below the foundation and floor slab, behind retaining walls, and below pavement and hardscape surfaces be placed in accordance with the following recommendations for structural fill.

The suitability of excavated site soils and import soils for compacted structural fill use will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines (that portion passing the U.S. No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve. Soils containing more than about 5 percent fines cannot be consistently compacted to a dense, non-yielding condition when the moisture content is more than 2 percent above or below optimum. Optimum moisture content is that moisture that results in the greatest compacted dry density with a specified compactive effort.

Organic debris excavated in the south portion of the site is not suitable to be used as structural fill. Non-organic site soils are only considered suitable for structural fill provided that their moisture content is within about 2 percent of the optimum moisture level as determined by ASTM D1557. Excavated site soils may not be suitable for re-use as structural fill depending on the moisture content and weather conditions at the time of construction. If soils are stockpiled for future reuse and wet weather is anticipated, the stockpile should be protected with plastic sheeting that is securely anchored. Even during dry weather, moisture conditioning (such as, windrowing and drying) of site soils to be reused as structural fill may be required. Even during the summer, delays in grading can

occur due to excessively high moisture conditions of the soils or due to precipitation. If wet weather occurs, the upper wetted portion of the site soils may need to be scarified and allowed to dry prior to further earthwork, or may need to be wasted from the site.

The soils encountered on site are moisture sensitive and may require moisture conditioning prior to use as structural fill. If on-site soils are or become unusable, it may become necessary to import clean, granular soils to complete site work that meet the grading requirements listed in Table 2 to be used as structural fill.

Table 2 Structural Fill Gradation

U.S. Sieve Size	Percent Passing
4 inches	100
No. 4 sieve	75 percent
No. 200 sieve	5 percent *

*Based on minus 3/4 inch fraction.

Prior to use, an RGI representative should observe and test all materials imported to the site for use as structural fill. Structural fill materials should be placed in uniform loose layers not exceeding 12 inches and compacted as specified in Table 3. The soil's maximum density and optimum moisture should be determined by ASTM D1557.

Table 3 Structural Fill Compaction ASTM D1557

Location	Material Type	Minimum Compaction Percentage	Moisture Content Range	
Foundations	On-site granular or approved imported fill soils:	95	+2	-2
Retaining Wall Backfill	On-site granular or approved imported fill soils:	92	+2	-2
Slab-on-grade	On-site granular or approved imported fill soils:	95	+2	-2
General Fill (non-structural areas)	On-site soils or approved imported fill soils:	90	+3	-2
Pavement – Subgrade and Base Course	On-site granular or approved imported fill soils:	95	+2	-2

Placement and compaction of structural fill should be observed by RGI. A representative number of in-place density tests should be performed as the fill is being placed to confirm that the recommended level of compaction is achieved.

5.2.6 CUT AND FILL SLOPES

All permanent cut and fill slopes should be graded with a finished inclination no greater than 2H:1V. Upon completion of construction, the slope face should be trackwalked, compacted and vegetated, or provided with other physical means to guard against erosion.

Final grades at the top of the slopes must promote surface drainage away from the slope crest. Water must not be allowed to flow in an uncontrolled fashion over the slope face. If it is necessary to direct surface runoff towards the slope, it should be controlled at the top of the slope, piped in a closed conduit installed on the slope face, and taken to an appropriate point of discharge beyond the toe of the slope. All fill placed for slope construction should meet the structural fill requirements as described in Section 5.2.5.

5.2.7 WET WEATHER CONSTRUCTION CONSIDERATIONS

RGI recommends that preparation for site grading and construction include procedures intended to drain ponded water, control surface water runoff, and to collect shallow subsurface seepage zones in excavations where encountered. It will not be possible to successfully compact the subgrade or utilize on-site soils as structural fill if accumulated water is not drained prior to grading or if drainage is not controlled during construction. Attempting to grade the site without adequate drainage control measures will reduce the amount of on-site soil effectively available for use, increase the amount of select import fill materials required, and ultimately increase the cost of the earthwork phases of the project. Free water should not be allowed to pond on the subgrade soils. RGI anticipates that the use of berms and shallow drainage ditches, with sumps and pumps in utility trenches, will be required for surface water control during wet weather and/or wet site conditions.

5.3 FOUNDATIONS

Following site preparation and grading, the proposed building foundations can be supported on conventional spread footings bearing on medium dense native soil or new structural fill. Where loose existing fill soils or other unsuitable soils are encountered in the proposed building footprint, they should be overexcavated and backfilled with structural fill.

Perimeter foundations exposed to weather should be at a minimum depth of 18 inches below final exterior grades. Interior foundations can be constructed at any convenient depth below the floor slab. Finished grade is defined as the lowest adjacent grade within 5 feet of the foundation for perimeter (or exterior) footings and finished floor level for interior footings.

Table 4 Foundation Design

Design Parameter	Value
Allowable Bearing Capacity	2,500 psf[1]
Friction Coefficient	0.30
Passive pressure (equivalent fluid pressure)	250 pcf[2]
Minimum foundation dimensions	Columns: 24 inches Walls: 16 inches

1. psf = pounds per square foot
2. pcf = pounds per cubic foot

The allowable foundation bearing pressures apply to dead loads plus design live load conditions. For short-term loads, such as wind and seismic, a 1/3 increase in this allowable capacity may be used. At perimeter locations, RGI recommends not including the upper 12 inches of soil in the computation of passive pressures because it can be affected by weather or disturbed by future grading activity. The passive pressure value assumes the foundation will be constructed neat against competent soil or backfilled with structural fill as described in Section 5.2.5. The recommended base friction and passive resistance value includes a safety factor of about 1.5.

With spread-footing foundations designed in accordance with the recommendations in this section, maximum total and differential post-construction settlements of 1 inch and 1/2 inch, respectively, should be expected.

5.4 RETAINING WALL

If retaining walls are needed for the residences or the detention vault, RGI recommends cast-in-place concrete walls be used. If retaining walls are necessary for grade changes between lots, modular block walls may be used. RGI can provide recommendations and design of modular block walls once the wall configurations and heights are known. Walls over 3 feet in height typically require geogrid and walls over 4 feet may require a separate permit.

The magnitude of earth pressure development on retaining walls will partly depend on the quality of the wall backfill. RGI recommends placing and compacting wall backfill as structural fill. Wall drainage will be needed behind the wall face. A typical retaining wall drainage detail is shown on Figure 3 for backfilled walls.

With wall backfill placed and compacted as recommended, and drainage properly installed, RGI recommends using the values in the following table for design.

Table 5 Retaining Wall Design

Design Parameter	Value
Detention Vault Allowable Bearing Capacity	4,000 psf
Active Earth Pressure (unrestrained walls)	35 pcf
At-rest Earth Pressure (restrained walls)	50 pcf

For seismic design, an additional uniform load of 7 times the wall height (H) for unrestrained walls and 14H for restrained walls should be applied to the wall surface. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 5.3.

5.5 SLAB-ON-GRADE CONSTRUCTION

Once site preparation has been completed as described in Section 5.2, suitable support for slab-on-grade construction should be provided. Immediately below the floor slab, RGI recommends placing a 4-inch-thick capillary break layer of clean, free-draining pea gravel, washed rock, or crushed rock that has less than 5 percent passing the U.S. No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab. Where moisture by vapor transmission is undesirable, an 8- to 10-millimeter-thick plastic membrane should be placed on a 4-inch-thick layer of clean gravel or rock. For the anticipated floor slab loading, we estimate post-construction floor settlements of ¼- to ½-inch.

5.6 DRAINAGE

5.6.1 SURFACE

Final exterior grades should promote free and positive drainage away from the building area. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building area. For non-pavement locations, RGI recommends providing a minimum drainage gradient of 3 percent for a minimum distance of 10 feet from the building perimeter. In paved locations, a minimum gradient of 1 percent should be provided unless provisions are included for collection and disposal of surface water adjacent to the structure.

5.6.2 SUBSURFACE

RGI recommends installing perimeter foundation as details shown on Figure 4. The foundation or retaining wall drains and roof downspouts should be tightlined separately to an approved discharge facility. Subsurface drains must be laid with a gradient sufficient to promote positive flow to a controlled point of approved discharge.

5.6.3 INFILTRATION

The site is underlain by glacial till and seasonal seepage was observed at the interface with the glacial till. Based on the subsurface conditions, infiltration will not be feasible on the site. The current site development includes bioswales on the sides of the roadway that will be underlain by glacial till soils and surface water will be routed to the detention vault with the outflow to the existing storm system in Northeast 100th Street.

5.7 UTILITIES

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) specifications. For site utilities located within the right-of-ways, bedding and backfill should be completed in accordance with City of Redmond specifications. At a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 5.2.5. Where utilities occur below unimproved areas, the degree of compaction can be reduced to a minimum of 90 percent of the soil's maximum density as determined by ASTM D1557. The onsite excavated soil may be suitable for re-use as structural fill depending on time of the construction. If the construction occurs in winter, imported structural fill may be required for trench backfill as recommended Table 2.

5.8 PAVEMENTS

Pavement subgrades should be prepared as described in Section 5.2 of this GER and as discussed below. Regardless of the relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy construction equipment to verify this condition.

With the pavement subgrade prepared as described above, the following minimum pavement sections are required in accordance with the City of Redmond Code:

- **For the site public access road**: 7 inches of hot mix asphalt concrete (HMA) Class ½ inch PG64-22

RGI recommends the following pavement sections for parking and drive areas paved with flexible asphalt concrete surfacing.

- **For driveway areas**: 2 inches of HMA over 6 inches of crushed rock base (CRB)

The asphalt paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for Hot Mix Asphalt Class 1/2 inch and CRB surfacing. If concrete drive way is preferred, the following section can be used.

- **For driveway area**: 5 inches of concrete over 4 inches of CRB

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability.

For optimum pavement performance, surface drainage gradients of no less than two percent are recommended. Also, some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

6.0 Additional Services

RGI is available to provide further geotechnical consultation throughout the design phase of the project. RGI should review the final design and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and incorporated into project design and construction.

RGI is also available to provide geotechnical engineering and construction monitoring services during construction. The integrity of the earthwork and construction depends on proper site preparation and procedures. In addition, engineering decisions may arise in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this scope of work. If these services are desired, please let us know and we will prepare a proposal.

7.0 Limitations

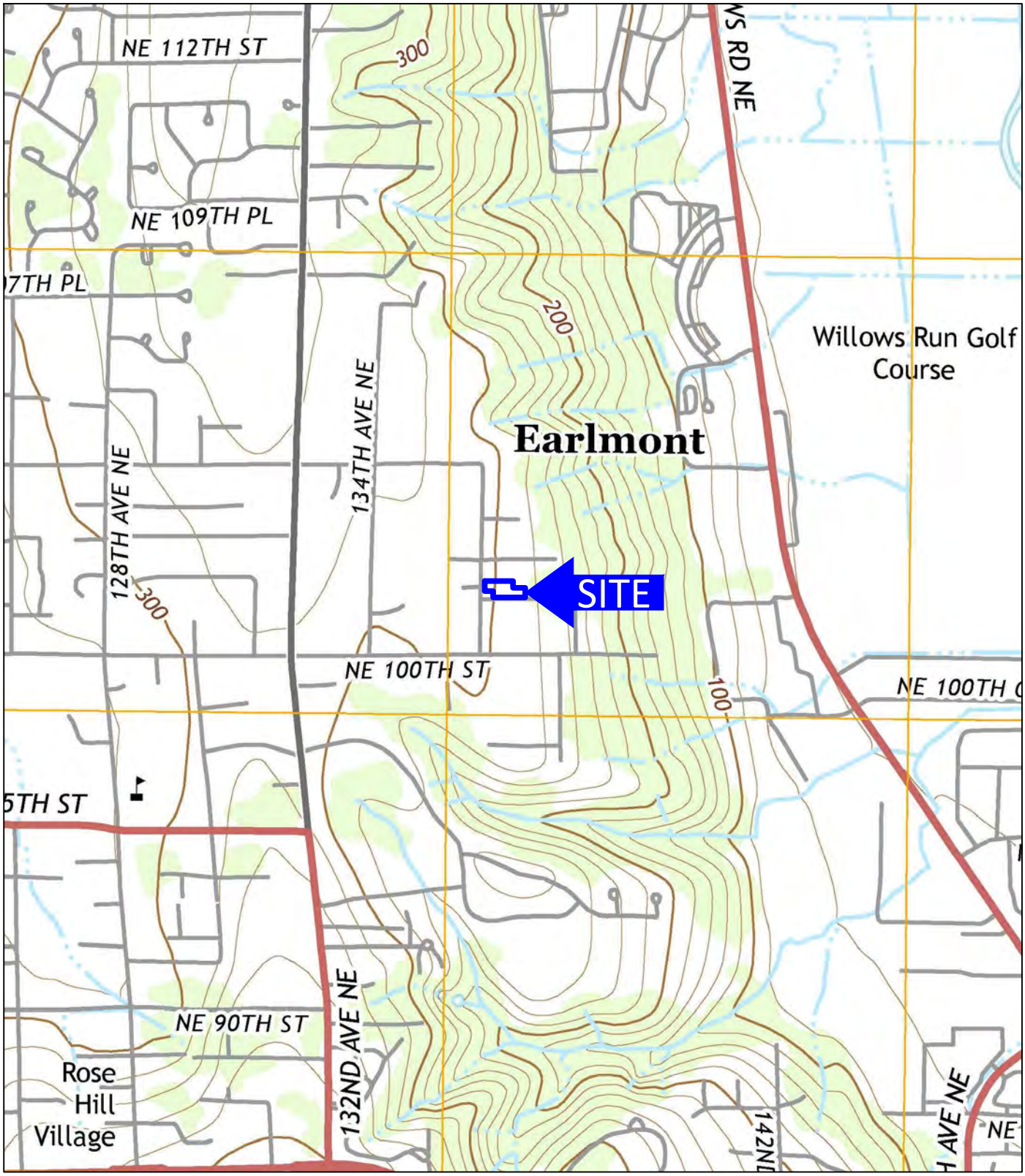
This GER is the property of RGI, Milestone Northwest, and their designated agents. Within the limits of the scope and budget, this GER was prepared in accordance with generally accepted geotechnical engineering practices in the area at the time this report was issued. This GER is intended for specific application to the Garbarino Short Plat project at 10042 136th Avenue Northeast in Redmond, Washington, and for the exclusive use of Milestone Northwest and their authorized representatives. No other warranty, expressed or implied, is made. Site safety, excavation support, and dewatering requirements are the responsibility of others.

The scope of services for this project does not include either specifically or by implication any environmental or biological (for example, mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, we can provide a proposal for these services.

The analyses and recommendations presented in this GER are based upon data obtained from the test exploration performed on site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations

appear evident, RGI should be requested to reevaluate the recommendations in this GER prior to proceeding with construction.

It is client's responsibility to see that all parties to the project, including the designers, contractors, subcontractors, are made aware of this GER in its entirety. The use of information contained in this GER for bidding purposes should be done at the contractor's option and risk.



USGS, 2014, Kirkland, Washington
7.5-Minute Quadrangle

Approximate Scale: 1"=1000'

0 500 1000 2000

N

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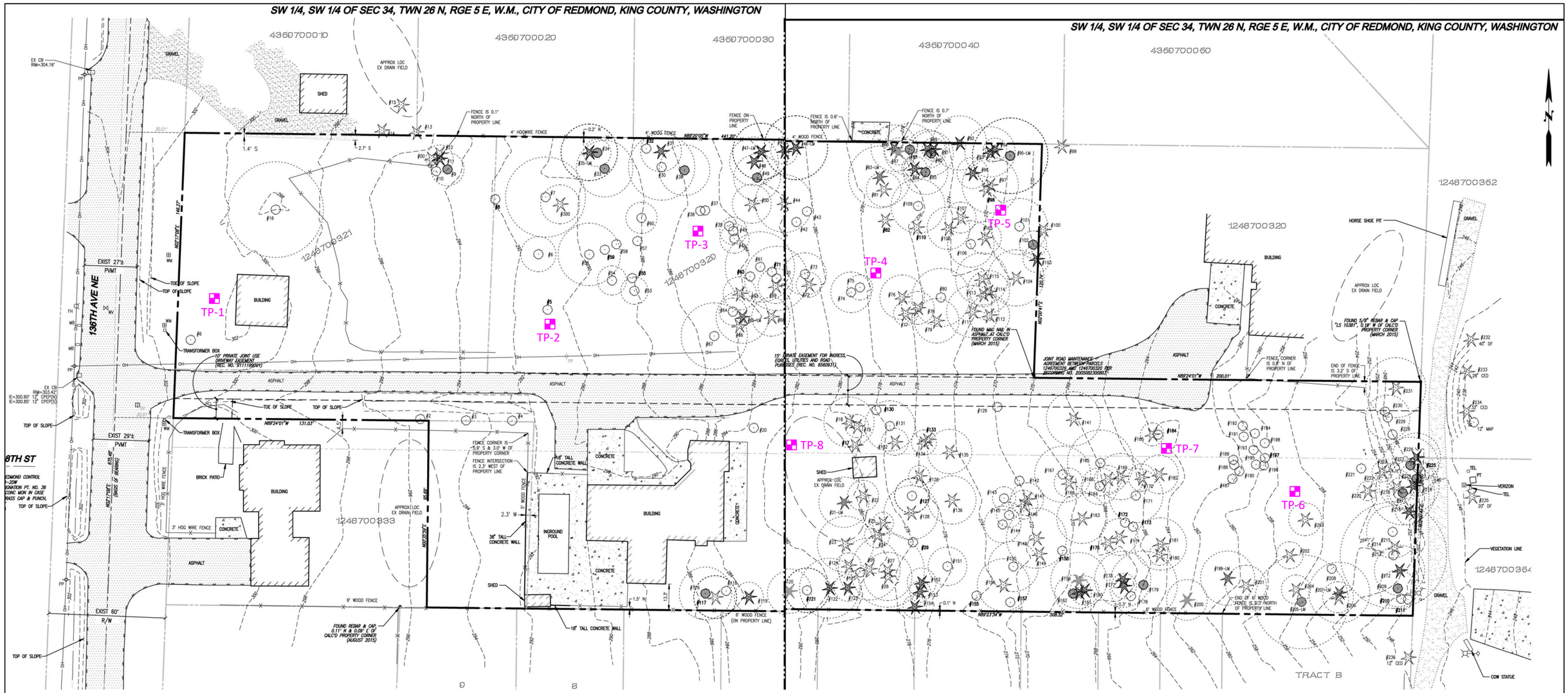
17522 Bothell Way Northeast
Bothell, Washington 98011
Phone: 425.415.0551
Fax: 425.415.0311

Garbarino Short Plat		Figure 1
RGI Project Number 2015-198	Site Vicinity Map	Date Drawn: 01/2016
Address: 10042 136th Avenue Northeast, Redmond, Washington 98033		



Approximate Scale: 1"=50'

0 25 50 100

N

= TP-1 to TP-8 Test Pits excavated by RGI on 1/15/2016

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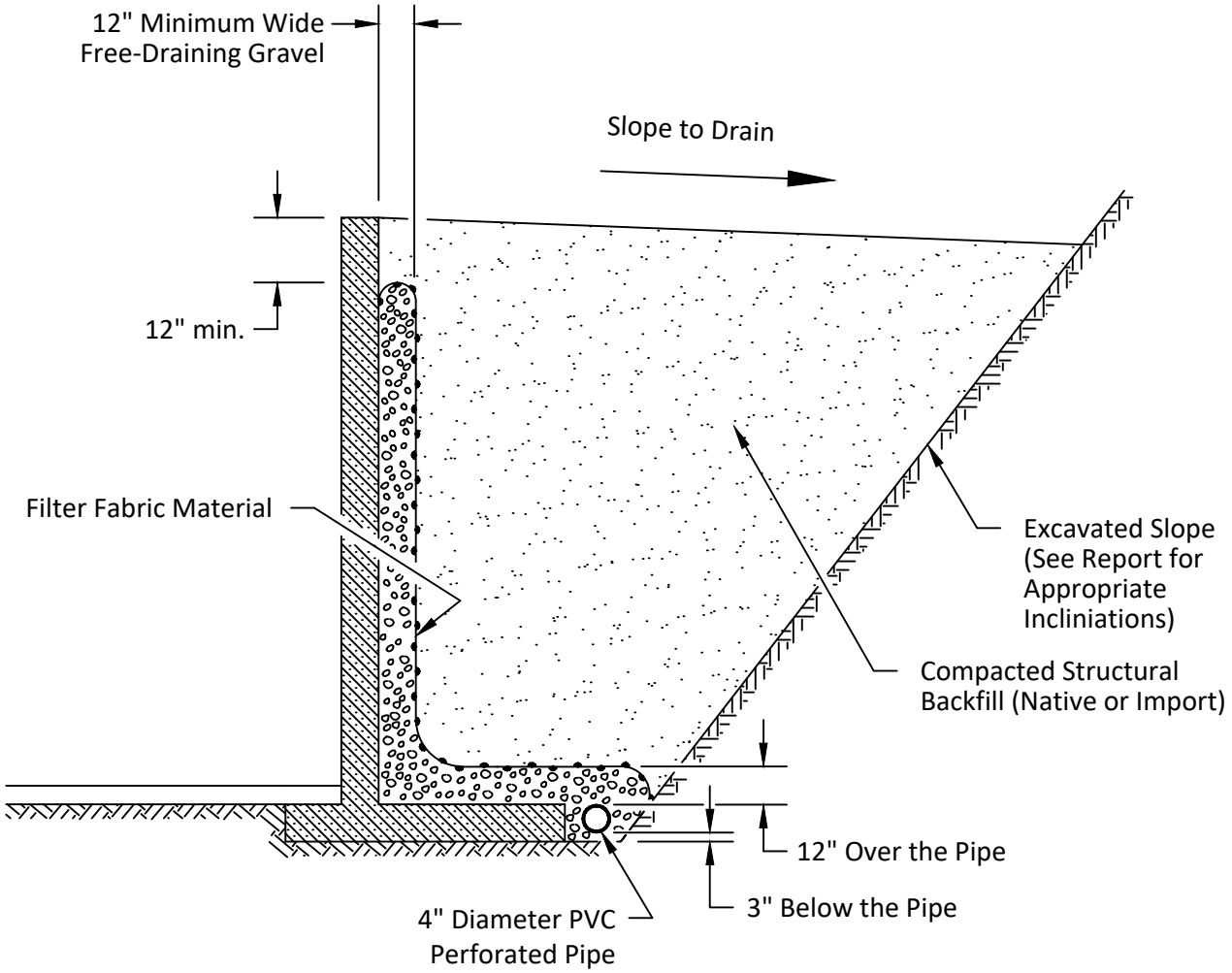
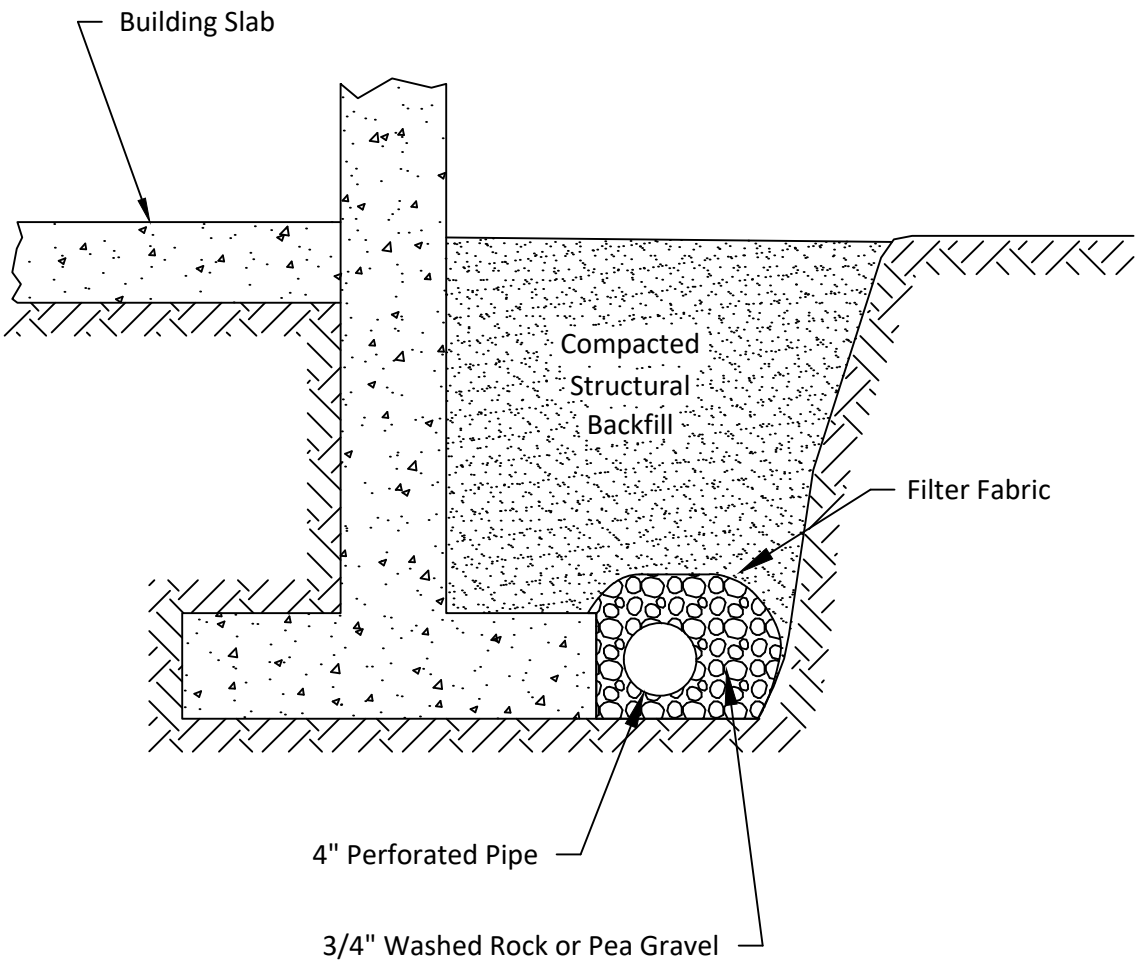
Garbarino Short Plat		Figure 2
RGI Project Number 2015-198	Geotechnical Exploration Plan	Date Drawn: 01/2016
Address: 10042 136th Avenue Northeast, Redmond, Washington 98033		



Not to Scale

Corporate Office 17522 Bothell Way Northeast Bothell, Washington 98011 Phone: 425.415.0551 Fax: 425.415.0311	Garbarino Short Plat	Figure 3
	RGI Project Number 2015-198 / Retaining Wall Drainage Detail	Date Drawn: 01/2016
	Address: 10042 136th Avenue Northeast, Redmond, Washington 98033	



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Garbarino Short Plat		Figure 4
RGI Project Number 2015-198	Typical Footing Drain Detail	Date Drawn: 01/2016
Address: 10042 136th Avenue Northeast, Redmond, Washington 98033		

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

On January 8, 2016, RGI explored the subsurface soil conditions at the site by observing the excavation of 8 test pits to a depth of 10 feet bgs. The test pit locations are shown on Figure 2. The test pit locations were approximately determined by measurements from existing property lines and paved roads.

A geologist from our office conducted the field exploration and classified the soil conditions encountered, maintained a log of each test exploration, obtained representative soil samples, and observed pertinent site features. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS).

Representative soil samples obtained from the explorations were placed in closed containers and taken to our laboratory for further examination and testing. As a part of the laboratory testing program, the soil samples were classified in our in house laboratory based on visual observation, texture, and the limited laboratory testing described below.

Moisture Content Determinations

Moisture content determinations were performed in accordance with the American Society of Testing and Materials D2216-10 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (ASTM D2216) on representative samples obtained from the exploration in order to aid in identification and correlation of soil types. The moisture content of typical sample was measured and is reported on the test pit logs.

Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses for the greater than 75 micrometer portion of the samples were performed in accordance with American Society of Testing and Materials D422 Standard Test Method for Particle-Size Analysis of Soils (ASTM D422) on four of the samples, the results of which are attached in Appendix A.

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-1

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Grass**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **9.5 feet bgs**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Grass		Grass Front Yard	
				SM		Reddish Brown Silty SAND with gravel and roots, moist, loose to medium dense	
			S-1	SM		Brownish Grey Silty SAND with gravel (Weathered TILL), moist, medium dense to dense	Seepage Encountered between 2.5 to 3 feet. 12% Moisture
				SM		Grey Silty SAND with gravel (TILL), moist, dense to very dense	
	5						
			S-2				8% Moisture
						Test Pit Terminated at 9.5 feet	
	10						
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-2

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **10 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Topsoil		Forest Ground Cover (Ivy, Grass and Sticker Bushes)	
				SM		Reddish Brown Silty SAND with gravel and roots, moist, loose to medium dense	
			S-1				23% Moisture
			S-2	SM		Brownish Grey Silty SAND with gravel (Weathered TILL), moist, medium dense to dense	Seepage Encountered between 3 to 3.5 feet.
				SM		Grey SIlty SAND with gravel (TILL), moist, dense to very dense	21% Moisture
	5						
			S-3				6% Moisture
	10					Test Pit Terminated at 10 feet	
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-3

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **9 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Topsoil		Forest Ground Cover (Ivy, Grass and Stickers)	
				SM		Brown Silty SAND with gravel and roots, moist loose to medium dense	
			S-1	SM		Brownish Grey Silty SAND with gravel (Weathered TILL), moist, medium dense to dense	16% Moisture Seepage Encountered at 3 feet
				SM		Grey Silty SAND with gravel (TILL), moist, dense to very dense	
	5						
			S-2				7% Moisture
						Test Pit Terminated at 9 feet	
	10						
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-4

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **9.5 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Topsoil		Forest Ground Cover (Ivy, Grass and Tree Limbs)	
				SM		Brown Silty SAND with gravel and roots, moist, loose to medium dense	
			S-1				20% Moisture Seepage encountered between 2.5 to 3 feet
				SM		Brownish Grey SIlty SAND with gravel (Weathered TILL), moist, medium dense to dense	
				SM		Grey Silty SAND with gravel (TILL), moist, dense to very dense	
	5						
			S-2				5% Moisture
						Test Pit Terminated at 9.5 feet	
	10						
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-5

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **9 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Topsoil		Forest Ground Cover (Ivy, Grass and Tree Limbs)	
				SM		Brown Silty SAND with gravel and roots, moist, loose to medium dense	
				SM		Brownish Grey Silty SAND with gravel (Weathered TILL), moist, medium dense to dense	
				SM		Grey Silty SAND with gravel (TILL), moist, dense to very dense	
	5						8% Moisture
							8% Moisture
						Test Pit Terminated at 9 feet	
	10						
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-6

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **10 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Fill		Fill, concrete debris	
							12% Moisture
				SM		Reddish-brown Silty SAND with gravel and roots	
							16% Moisture
	5			SM		Silty SAND with gravel, dense to very dense (TILL)	
							10% Moisture
	10					Test pit terminated at 10 feet	
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-7

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **10 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Fill		Fill, concrete debris found	
				SM		Brown Silty SAND with roots, moist, loose to medium dense	20% Moisture
	5						Seepage encountered between 5.5 to 6 feet
				SM		Grey Silty SAND with gravel (TILL), moist, dense to very dense	
							9% Moisture
	10					Test Pit Terminated at 10 feet	
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Test Pit No.: TP-8

Sheet 1 of 1

Date(s) Excavated: **1/15/2016**	Logged By **PL**	Surface Conditions: **Forest Ground Cover**
Excavation Method: **Bucket Excavator**	Bucket Size: **2'**	Total Depth of Excavation: **10 feet**
Excavator Type: **Track Mounted**	Excavating Contractor: **Northwest Trucking and Excavating**	Approximate Surface Elevation
Groundwater Level: **Not Encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **10042 136th Northeast, Rerdmond, Washington 98033**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Grass		Grass	
				SM		Light Brown Silty SAND with gravel, dense	28% Moisture
				SM		Grey Silty SAND with gravel (TILL), moist, dense to very dense	5% Moisture
	5						
						Test Pit Terminated at 8 feet	
	10						
	15						

Project Name: **Gabarino Short Plat**
Project Number: **2015-198**
Client: **Milestone NW**

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Key to Logs

Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8

COLUMN DESCRIPTIONS

1. Elevation (feet): Elevation (MSL, feet).
2. Depth (feet): Depth in feet below the ground surface.
3. Sample Type: Type of soil sample collected at the depth interval shown.
4. Sample Number: Sample identification number.
5. USCS Symbol: USCS symbol of the subsurface material.
6. Graphic Log: Graphic depiction of the subsurface material encountered.
7. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
8. REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

AF

Grass and/or topsoil

Silty SAND (SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Continuous
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Attachment 13

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Gabarino Short Plat	SAMPLE ID/TYPE	TP-2 S-2
PROJECT NO.	2015-198	SAMPLE DEPTH	3'
TECH/TEST DATE	PL 1/18/2016	DATE RECEIVED	1/15/2016

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	833.8
Wt Dry Soil & Tare (gm)	(w2)	694.4
Weight of Tare (gm)	(w3)	15.6
Weight of Water (gm)	(w4=w1-w2)	139.4
Weight of Dry Soil (gm)	(w5=w2-w3)	678.8
Moisture Content (%)	(w4/w5)*100	21

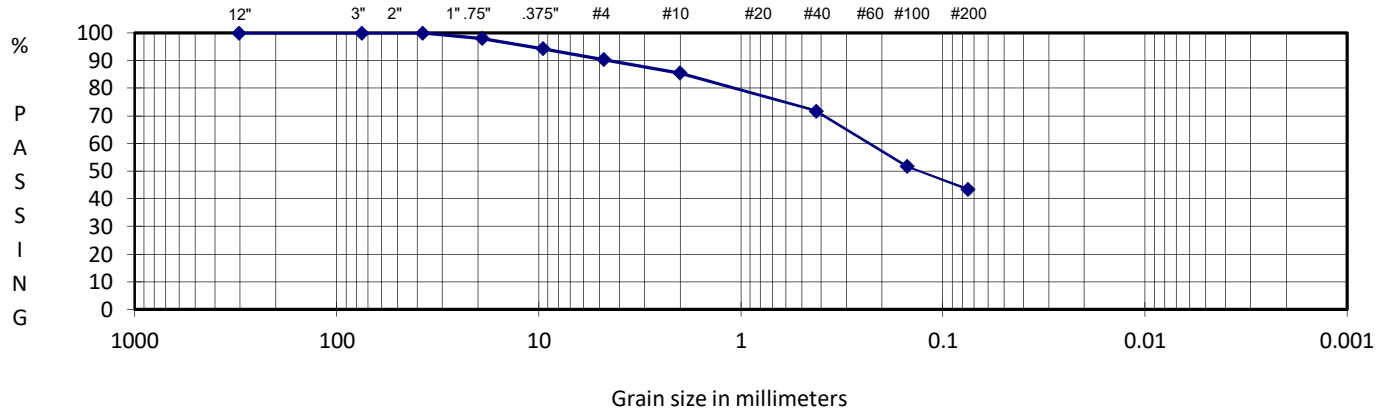
Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

	Weight Of Sample (gm)	694.4
	Tare Weight (gm)	15.6
(W6)	Total Dry Weight (gm)	678.8

% COBBLES	0.0
% C GRAVEL	2.0
% F GRAVEL	7.7
% C SAND	4.8
% M SAND	13.8
% F SAND	28.4
% FINES	43.3
% TOTAL	100.0
D10 (mm)	0.0045
D30 (mm)	0.025
D60 (mm)	0.24
Cu	53.3
Cc	0.6

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.6	0.00	0.00	100.00	cobbles
3.0"	15.6	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.6	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	29.4	13.80	2.03	97.97	fine gravel
0.50"					fine gravel
0.375"	54.5	38.90	5.73	94.27	fine gravel
#4	81.4	65.80	9.69	90.31	coarse sand
#10	114.2	98.60	14.53	85.47	medium sand
#20					medium sand
#40	207.6	192.00	28.29	71.71	fine sand
#60					fine sand
#100	343.4	327.80	48.29	51.71	fine sand
#200	400.5	384.90	56.70	43.30	fines
PAN	694.4	678.80	100.00	0.00	silt/clay



DESCRIPTION	Silty SAND with trace gravel
USCS	SM

Prepared For:
Milestone NW

Reviewed By: RW

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Attachment 13

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Gabarino Short Plat	SAMPLE ID/TYPE	TP-5 S-1
PROJECT NO.	2015-198	SAMPLE DEPTH	5'
TECH/TEST DATE	PL 1/18/2016	DATE RECEIVED	1/15/2016

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	812.4
Wt Dry Soil & Tare (gm)	(w2)	751.8
Weight of Tare (gm)	(w3)	15.7
Weight of Water (gm)	(w4=w1-w2)	60.6
Weight of Dry Soil (gm)	(w5=w2-w3)	736.1
Moisture Content (%)	(w4/w5)*100	8

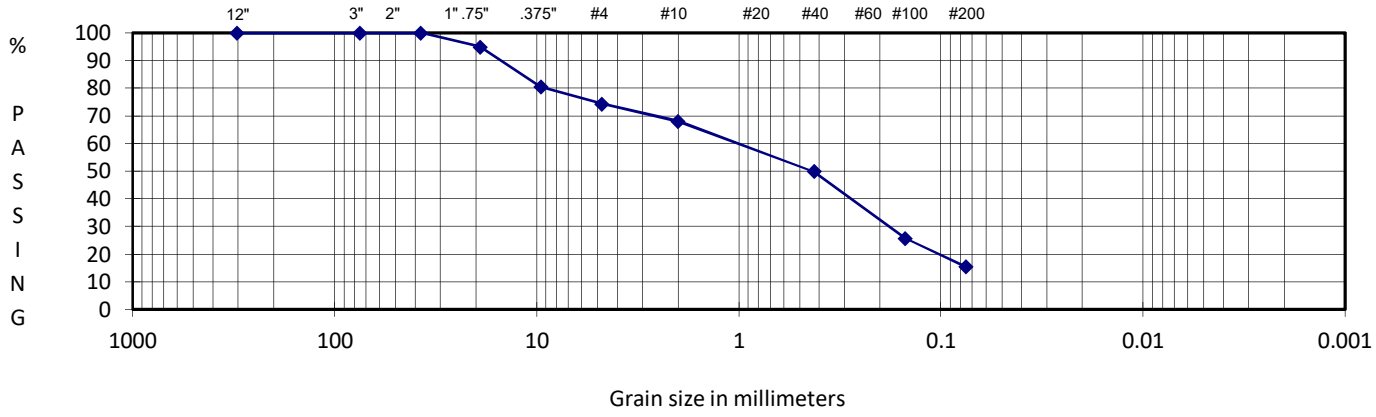
Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

	Weight Of Sample (gm)	751.8
	Tare Weight (gm)	15.7
(W6)	Total Dry Weight (gm)	736.1

% COBBLES	0.0
% C GRAVEL	5.1
% F GRAVEL	20.7
% C SAND	6.2
% M SAND	18.2
% F SAND	34.4
% FINES	15.4
% TOTAL	100.0
D10 (mm)	0.056
D30 (mm)	0.18
D60 (mm)	1
Cu	17.9
Cc	0.6

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.7	0.00	0.00	100.00	cobbles
3.0"	15.7	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.7	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	53.3	37.60	5.11	94.89	fine gravel
0.50"					fine gravel
0.375"	159.8	144.10	19.58	80.42	fine gravel
#4	205.4	189.70	25.77	74.23	coarse sand
#10	251.4	235.70	32.02	67.98	medium sand
#20					medium sand
#40	385.4	369.70	50.22	49.78	fine sand
#60					fine sand
#100	563.4	547.70	74.41	25.59	fine sand
#200	638.5	622.80	84.61	15.39	fines
PAN	751.8	736.10	100.00	0.00	silt/clay



DESCRIPTION	Silty SAND with some gravel
USCS	SM

Prepared For:
Milestone NW

Reviewed By: RW

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Attachment 13

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Gabarino Short Plat	SAMPLE ID/TYPE	TP-6 S-2
PROJECT NO.	2015-198	SAMPLE DEPTH	5'
TECH/TEST DATE	PL 1/18/2016	DATE RECEIVED	1/15/2016

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	939.9
Wt Dry Soil & Tare (gm)	(w2)	812.6
Weight of Tare (gm)	(w3)	15.9
Weight of Water (gm)	(w4=w1-w2)	127.3
Weight of Dry Soil (gm)	(w5=w2-w3)	796.7
Moisture Content (%)	(w4/w5)*100	16

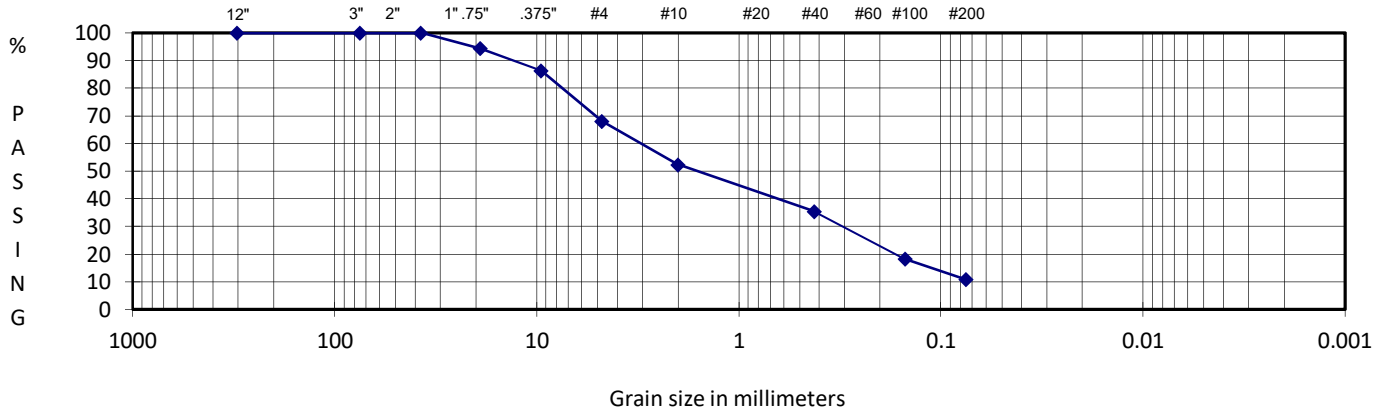
Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

	Weight Of Sample (gm)	812.6
	Tare Weight (gm)	15.9
(W6)	Total Dry Weight (gm)	796.7

% COBBLES	0.0
% C GRAVEL	5.7
% F GRAVEL	26.4
% C SAND	15.7
% M SAND	16.9
% F SAND	24.6
% FINES	10.8
% TOTAL	100.0
D10 (mm)	0.07
D30 (mm)	0.31
D60 (mm)	3.1
Cu	44.3
Cc	0.4

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.9	0.00	0.00	100.00	cobbles
3.0"	15.9	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.9	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	61.1	45.20	5.67	94.33	fine gravel
0.50"					fine gravel
0.375"	125.4	109.50	13.74	86.26	fine gravel
#4	271.2	255.30	32.04	67.96	coarse sand
#10	396.1	380.20	47.72	52.28	medium sand
#20					medium sand
#40	530.5	514.60	64.59	35.41	fine sand
#60					fine sand
#100	668.5	652.60	81.91	18.09	fine sand
#200	726.5	710.60	89.19	10.81	fines
PAN	812.6	796.70	100.00	0.00	silt/clay



DESCRIPTION	Gravelly SAND with some silt
USCS	SP-SM

Prepared For:
Milestone NW

Reviewed By: RW

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Attachment 13

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Gabarino Short Plat	SAMPLE ID/TYPE	TP-8 S-1
PROJECT NO.	2015-198	SAMPLE DEPTH	2'
TECH/TEST DATE	PL 1/18/2016	DATE RECEIVED	1/15/2016

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	826.5
Wt Dry Soil & Tare (gm)	(w2)	651.5
Weight of Tare (gm)	(w3)	15.6
Weight of Water (gm)	(w4=w1-w2)	175.0
Weight of Dry Soil (gm)	(w5=w2-w3)	635.9
Moisture Content (%)	(w4/w5)*100	28

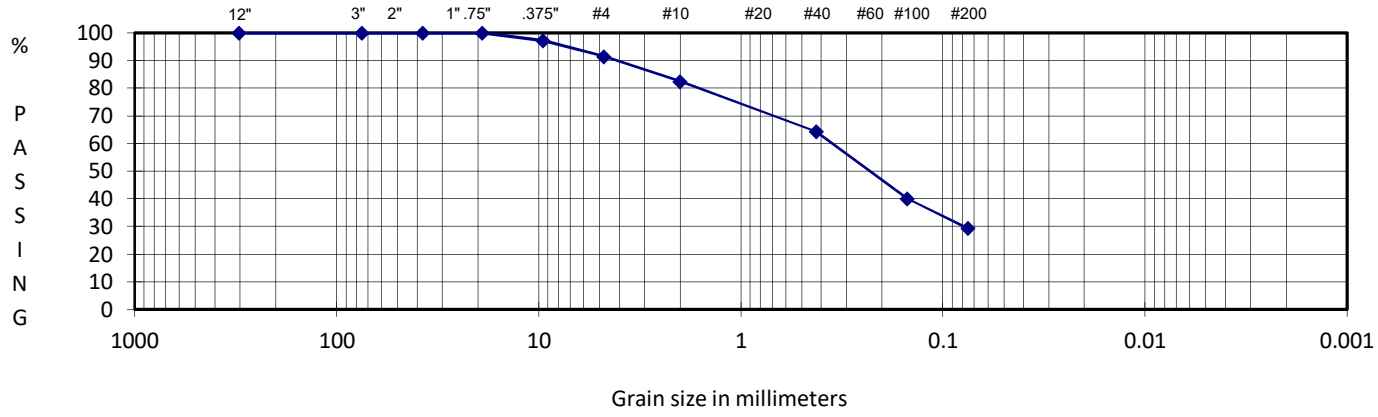
Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

	Weight Of Sample (gm)	651.5
	Tare Weight (gm)	15.6
(W6)	Total Dry Weight (gm)	635.9

% COBBLES	0.0
% C GRAVEL	0.0
% F GRAVEL	8.6
% C SAND	9.1
% M SAND	18.0
% F SAND	35.0
% FINES	29.3
% TOTAL	100.0
D10 (mm)	0.024
D30 (mm)	0.082
D60 (mm)	0.35
Cu	14.6
Cc	0.8

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.6	0.00	0.00	100.00	cobbles
3.0"	15.6	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.6	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	15.6	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	33.4	17.80	2.80	97.20	fine gravel
#4	70.3	54.70	8.60	91.40	coarse sand
#10	128.0	112.40	17.68	82.32	medium sand
#20					medium sand
#40	242.7	227.10	35.71	64.29	fine sand
#60					fine sand
#100	397.0	381.40	59.98	40.02	fine sand
#200	465.2	449.60	70.70	29.30	fines
PAN	651.5	635.90	100.00	0.00	silt/clay



DESCRIPTION	Silty SAND with trace gravel
USCS	SM

Prepared For:
Milestone NW

Reviewed By: RW

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