Williams Crossing

Preliminary Stormwater Site Plan Report

March 6, 2024

Prepared for

Sage-Lacey I, LLC
9505 19th Avenue SE, Suite 118
Everett, WA 98208

LAURA G. BARTENHAGEN
40111

03/06/2024

Submitted by

ESM Consulting Engineers, LLC
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Table of Contents

Figures

Appendices

Project Engineer's Certification (City of Lacey)

I hereby state that this Drainage Control Plan for Williams Crossing has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that the City of Lacey does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

Section Tab #1

1. PROPOSED PROJECT DESCRIPTION

The proposed Williams Crossing project is located north of the intersection of 15th Avenue NE & Century Court NE within Section 09, Township 18 North, Range 01 West, W.M.), 5216, 5224, & 5228 NE 15th Avenue, City of Lacey, WA 98516. The site is located on parcels 11809310100, 11809310700 and 11809310600 with 18.7 acres of split-zoned property that is zoned High Density Residential District (HD), Moderate Density Residential District (MD) and the Low Density Residential (LD 0-4) in the City of Lacey. The existing site is generally forested on the north side of the site with cleared areas in the south containing lawn, limited tree coverage, and an existing single-family residence (located on parcel 11809310600). The south region of the site is proposed to be cleared and the existing single-family home will be demolished for the development of 12 apartment buildings (262 units) with associated parking, utility services, and stormwater facilities.

This project has been designed in accordance with the City of Lacey 2022 Stormwater Design Manual (SWM). Refer to Figure 1.1 and 1.3 for a vicinity map and proposed conditions, respectively.

Flow control mitigation will be achieved with an onsite stormwater infiltration facility. Runoff from all improvements onsite will be collected and conveyed to this facility for full infiltration. Refer to Section 5 of this report for more information.

Water quality treatment is required for this project and will be provided through the use of a StormFilter cartridge system as well as infiltration. Refer to Section 4 of this report for more information.

A Geotechnical Engineering Report was prepared by GeoResources, LLC, dated March 26, 2020, for this project that documents site-specific soil stratigraphy and groundwater conditions. Based on the report, some of the soils located onsite are suitable for infiltration at a recommended preliminary infiltration rate of 4 inches per hour. An infiltration evaluation was performed by Earth Solutions NW, LLC on February 13, 2024, which recommends 3 inches per hour for test pit 2. This infiltration rate will be used for the proposed development as it also provides water quality treatment. The geotechnical reports are included in Appendix B.

Discussion of Core Requirements

All core requirements apply to the new and replaced hard surfaces and converted vegetation areas, according to Figure 2.1 from the SWM. Below, each core requirement is listed and how the project satisfies them. Additionally, the SWM follows the Best Management Practice (BMP) numbering of the current Ecology SWMMWW so BMPs referenced within this report will also use the Ecology BMP numbering (example: BMP T5.13 - Post-Construction Soil Quality and Depth).

Core Requirement #1 - Preparation of Stormwater Site Plans

This document fulfills the requirements of a preliminary Stormwater Site Plan to be finalized with construction plans.

Core Requirement #2 - Construction Stormwater Pollution Prevention

The Construction Stormwater Pollution Prevention Plan (SWPPP) and clear and grade Temporary Erosion and Sediment Control (TESC) plans will be provided under separate cover with the final version of this report.

Core Requirement #3 - Source Control of Pollution

There are no pollutants expected from construction activities. The construction equipment will have spill prevention kits to prevent hydraulic fluids from spilling onto the project site.

Core Requirement #4 - Preservation of Natural Drainage Systems and Outfalls

Any runoff generated by the site itself (in the existing condition) infiltrates based on the geotechnical reports provided for the project site. Stormwater from the project site will be collected and conveyed to an onsite infiltration facility located downstream of developed site areas. This project will not alter the downstream run-on collection system.

Core Requirement #5 - On-site Stormwater Management

Figure 2.3 of the SWM was followed to determine to what extent and what onsite BMPs are necessary. A copy of this figure is provided at the end of Section 1 in this report. The project triggers Core Requirements 1 – 9. The project chooses to meet the Low Impact Development (LID) performance standard and is required to apply soil preservation and amendments. The project is not required to meet the BMPs in List #1, List #2, or List #3.

The LID performance standard requires that stormwater discharges match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8 percent of the 2-year peak flow to 50 percent of the 2-year flow according to Chapter 2.2.5 of the SWM.

This LID performance standard can be met through any flow control BMP(s) desired to achieve the LID Performance Standard and must also apply the post-construction soil quality and depth BMP. Projects selecting this option cannot use rain gardens. To meet the LID performance standard, an infiltration pond will be utilized to fully infiltrate runoff from onsite project areas.

Below is a discussion of the proposed BMPs in place to manage stormwater. In summary, BMP T5.13: Post-Construction Soil Quality and Depth and Infiltration are the On-site Stormwater Management BMPs, for which the project will amend with imported topsoil.

Amend with Imported Topsoil

Lawn areas - amend to 3-5% organic content. Use imported topsoil mix comprised primarily of sand or sandy loam and containing 3-5% organic matter (typically ~25% compost).

- Scarify or till existing subgrade in two directions to a 6-inch depth
- Place 3 inches of topsoil mix on surface.
- Water or roll to compact soil to 85% maximum.
- Rake smooth and remove surface rocks over 1 inch in diameter.

Landscape areas - amend to 10% organic content. Use imported topsoil mix comprised primarily of sand or sandy loam and containing 10% organic matter (typically ~40% compost).

- Scarify or till existing subgrade in two directions 6-inch depth.
- Place 3 inches of topsoil mix on surface and till into 2 inches of soil.
- Place additional 3 inches of topsoil mix on the surface to achieve a finished, uncompacted depth of 12 inches.
- Rake smooth and remove surface rocks over 2 inches in diameter.
- Mulch planting beds with 2 inches organic mulch.

Core Requirement #6 - Runoff Treatment

The project is located within the Palm Street basin, which has issues with bacteria – fecal coliform and dissolved oxygen. The project will fully mitigate collected stormwater runoff from onsite project areas with Enhanced Basic water quality treatment through implementation of StormFilters using PhosphoSorb Media as shown on the plans as well as through infiltration.

Core Requirement #7 - Flow Control

The project will mitigate all collected stormwater runoff by use of full infiltration. As a result, the project causes less than a 0.15 cubic feet per second (cfs) or greater increase in the 100-year flow frequency, as estimated using an approved continuous simulation model and 15-minute time steps. Therefore, the project is exempt from core requirement #7.

Core Requirement #8 - Wetlands Protection

Two wetland units (Wetland A & B) are present on the site and are connected offsite to the north of the property which and considered as one wetland (Category III with a 110-foot buffer). The project improvements are located approximately 280 feet away from the limit of the nearest wetland unit. The requirement for wetland protection applies to projects whose stormwater discharges into a wetland, either directly or indirectly, through a conveyance system. This project does not meet that criterion. Stormwater from the project will be treated by fully infiltrating all site stormwater from onsite project areas. Precautions will also be taken during construction to ensure the wetland is not adversely impacted by construction activities.

Core Requirement #9 - Operations and Maintenance

The Operations and Maintenance Manual will be included with the final version of this report.

Special Reports and Studies

The following relevant reports have been prepared for the project and are included with this submittal in Appendix B.

- Geotechnical Engineering Report by GeoResources, LLC., dated March 26, 2020.

- Wetland And Stream Report Williams Crossing Project by David Evans and Associates, Inc, dated September 27, 2023.

- Infiltration Evaluation by Earth Solutions NW, LLC, dated February 13, 2024.

Figure 1.1 - Vicinity Map

Legend

Roads - Major
- Major Roads
- Ramp
- I 5; US 101

Roads (Large Scale)

Railroads

County Border

Scale 1: 34,808

0 1500 3000

Feet

THURSTON COUNTY
WASHINGTON
SINCE 1852

Map Created Using GeoData Public Website

Published: 12/12/2023

Note:

Thurston County GeoData Center

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product. ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness for use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map. Authorized for 3rd Party reproduction for personal use only.

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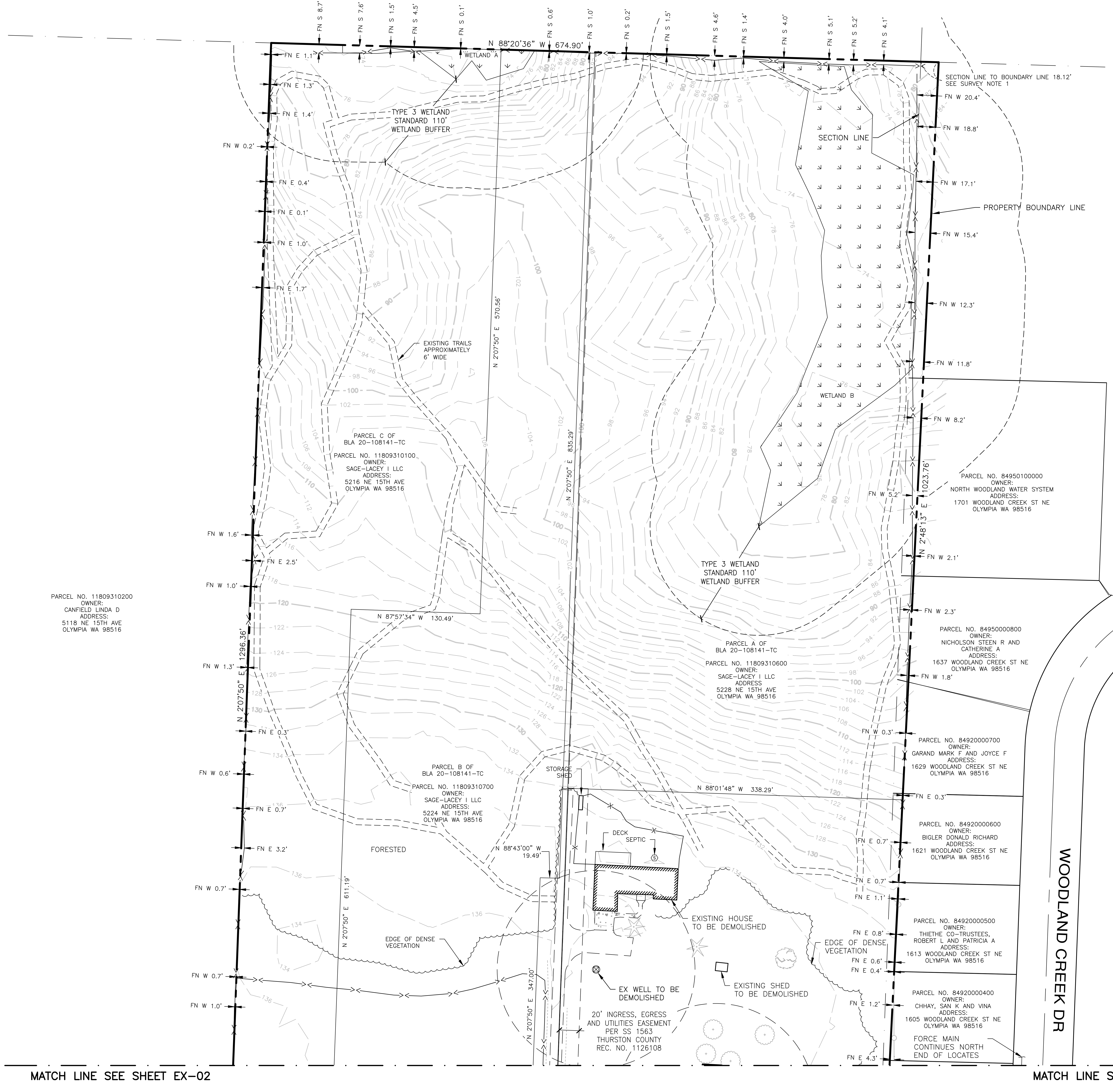
A PORTION OF THE SECTION 09, T. 18 N., R. 1 W., W.M.



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SCALE: 1" = 50'

50 25 0 50 100

CONTOUR INTERVAL = 2'

LEGEND

- FENCE GATE END
- LIGHT POST WITH ARM
- MAIL BOX
- STREET SIGN
- GAS VALVE
- POWER CONDUIT
- POWER GUY ANCHOR
- POWER GUY POLE
- POWER JUNCTION BOX
- POWER METER
- POWER POLE WITH DROP
- POWER POLE WITH DROP, LIGHT AND TRANSFORMER
- POWER POLE WITH DROP AND LIGHT
- STORM CATCH BASIN
- STORM CULVRET
- STORM YARD DRAIN
- SANITARY SEWER MANHOLE
- COS SANITARY SEWER CLEANOUT
- CENTERLINE RIGHT OF WAY
- SECTION LINE
- EDGE OF RIGHT OF WAY
- ADJACENT PROPERTY LINES
- SURVEY BOUNDARY
- CENTERLINE ASPHALT
- ROAD STRIPING
- CURB LINE
- GRADE BREAK
- STORM DITCH
- BARBED WIRE FENCE
- BOARD FENCE
- CHAIN LINK FENCE
- GUARD RAIL
- EDGE RIP RAP
- EDGE LANDSCAPING
- EDGE GRAVEL
- EDGE VEGETATION
- BC FOUND BRASS CAP
- FOUND CONCRETE MONUMENT
- FOUND MONUMENT IN CASE
- FOUND REBAR AND CAP
- SET NAIL
- SET PK
- TELEPHONE MANHOLE
- TELEPHONE POLE
- CEDAR
- FIR
- HOLLY
- WATER FIRE HYDRANT
- IR WATER IRRIGATION CONTROL VALVE
- WATER METER
- WATER VALVE
- PRIVATE WELLHEAD
- FO FIBER OPTIC UNDERGROUND
- G GAS UNDERGROUND
- POWER STRUCTURE
- P POWER UNDERGROUND
- OHP OHP POWER OVERHEAD
- S SANITARY SEWER
- FM SANITARY SEWER FORCE MAIN
- D STORM DRAINAGE
- TELEPHONE STRUCTURE
- T TELEPHONE UNDERGROUND
- W WATER UNDERGROUND

BASIS OF HORIZONTAL DATUM:

WASHINGTON COORDINATE SYSTEM (WCS) – SOUTH ZONE (BASED UPON NAD 83/2011) UTILIZING THE WASHINGTON STATE REFERENCE NETWORK (WSRN) IN JULY OF 2023.

BASIS OF VERTICAL DATUM:

NGVD29 BASED ON GPS OBSERVATIONS (NAVD 88) AND THEN LOWERED 3.41' TO NGVD 29 HOLDING MOUNTAIN TO COAST'S VERTICAL DATUM CONVERSION UTILIZED DURING TOPOGRAPHIC MAPPING, VERIFIED BY ESM.

LEGAL DESCRIPTION

PARCELS A, B AND C OF BOUNDARY LINE ADJUSTMENT NO. BLA 20–108141–TC RECORDED DECEMBER 1, 2020 UNDER RECORDING NOS. 4804473 AND 4804474;

IN THURSTON COUNTY, WASHINGTON

SURVEY INSTRUMENTATION :

SURVEYING PERFORMED IN CONJUNCTION WITH THIS SURVEY DOCUMENT UTILIZED ALL OR A PORTION OF THE FOLLOWING EQUIPMENT:

FIELD TRAVERSE AND/OR GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

ELECTRONIC TOTAL STATIONS, INCLUDING TOPCON PS–103A, LEICA TCRA 1105 PLUS, TRIMBLE S5.

TRIMBLE R8, TOPCON GR–5 GNSS EQUIPMENT.

FARO FOCUS S350 LASER SCANNER.

PROCEDURE USED : FIELD TRAVERSE WORK COMPLIES WITH CURRENT STANDARDS AS OUTLINED IN WAC–332–130–070, –080 AND –090. ALL INSTRUMENTS MAINTAINED TO MANUFACTURER'S SPECIFICATIONS AS REQUIRED BY WAC–332–130–100.

SURVEY NOTES:

1. THE EAST BOUNDARY OF THE SUBJECT PROPERTY AS DEPICTED HEREON AS WELL AS SHOWN ON SHORT SUBDIVISION NO. SS–1563, THURSTON COUNTY RECORDING NO. 1126108, WAS ESTABLISHED AND CONVEYED BY QUIT CLAIM DEED, THURSTON COUNTY RECORDING NO. 728418, WHEREIN THE OWNER(S) OF THE ADJACENT PLATTED LOTS AND TRACTS TO THE EAST (WOODLAND CREEK ADD. DIV. TWO, REC. NO. 711874) CONVEYED A STRIP OF LAND ALONG THE SECTION LINE TO THE OWNERS OF THE PROPERTY ABUTTING TO THE WEST, THE DIMENSIONS OF WHICH ARE SHOWN HEREON. THEREFORE, NO GAPS OR OVERLAPS WERE OBSERVED DURING THE COURSE OF THIS SURVEY.

2. TOPOGRAPHIC SURVEY MAPPING CONTAINED HEREON WAS ORIGINALLY PREPARED BY MOUNTAIN 2 COAST LAND SURVEYING IN NOVEMBER OF 2020 AND VERIFIED BY ESM CONSULTING ENGINEERS IN JULY, 2023.

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4. BURIED UTILITIES AS SHOWN HEREON WERE LOCATED AND MARKED IN THE FIELD BY APPLIED PROFESSIONAL SERVICES (APS) IN JULY 2023. THE LOCATIONS OF SAID UTILITIES SHOULD BE CONSIDERED APPROXIMATE AND SHOULD BE VERIFIED IN THE FIELD PRIOR TO ANY EXCAVATION OR CONSTRUCTION IN THE VICINITY.

Figure 1.2 - Existing Conditions (1 of 2)

REVISIONS		
NO.	DESCRIPTION/DATE	BY

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SAGE-LACEY I, LLC

WILLIAMS CROSSING

EXISTING CONDITIONS

CITY OF LACEY

WASHINGTON

JOB NO.: 2345-002-023
DWG. NAME: EX-01
DESIGNED BY: LGB
DRAWN BY: JJH
CHECKED BY:
DATE: 03/06/2024
DATE OF PRINT:

EX-01

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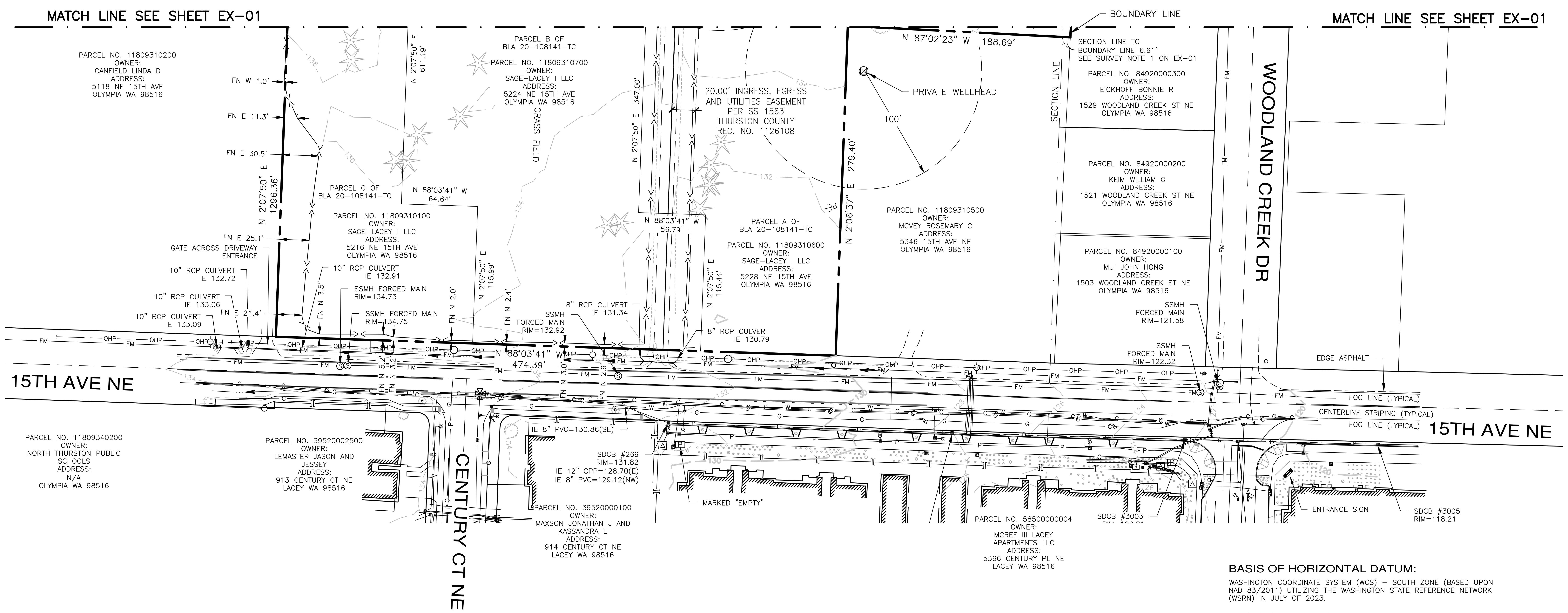

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P◑	POWER GUY POLE
PB	POWER JUNC BOX
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— — — —	EDGE RIP RAP
— — — —	EDGE LANDSCAPING
— — — — —	EDGE GRAVEL
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Figure 1.2 - Existing Conditions (2 of 2)

REVISIONS

NO.	DESCRIPTION/DATE	BY

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SAGE-LACEY I, LLC

WILLIAMS CROSSING

EXISTING CONDITIONS

CITY OF LACEY WASHINGTON

JOB NO.:	2345–002–023
DWG. NAME:	EX–02
DESIGNED BY:	LGB
DRAWN BY:	JJH
CHECKED BY:	
DATE:	03/06/2024
DATE OF PRINT:	

EX-02

3 OF 8 SHEETS

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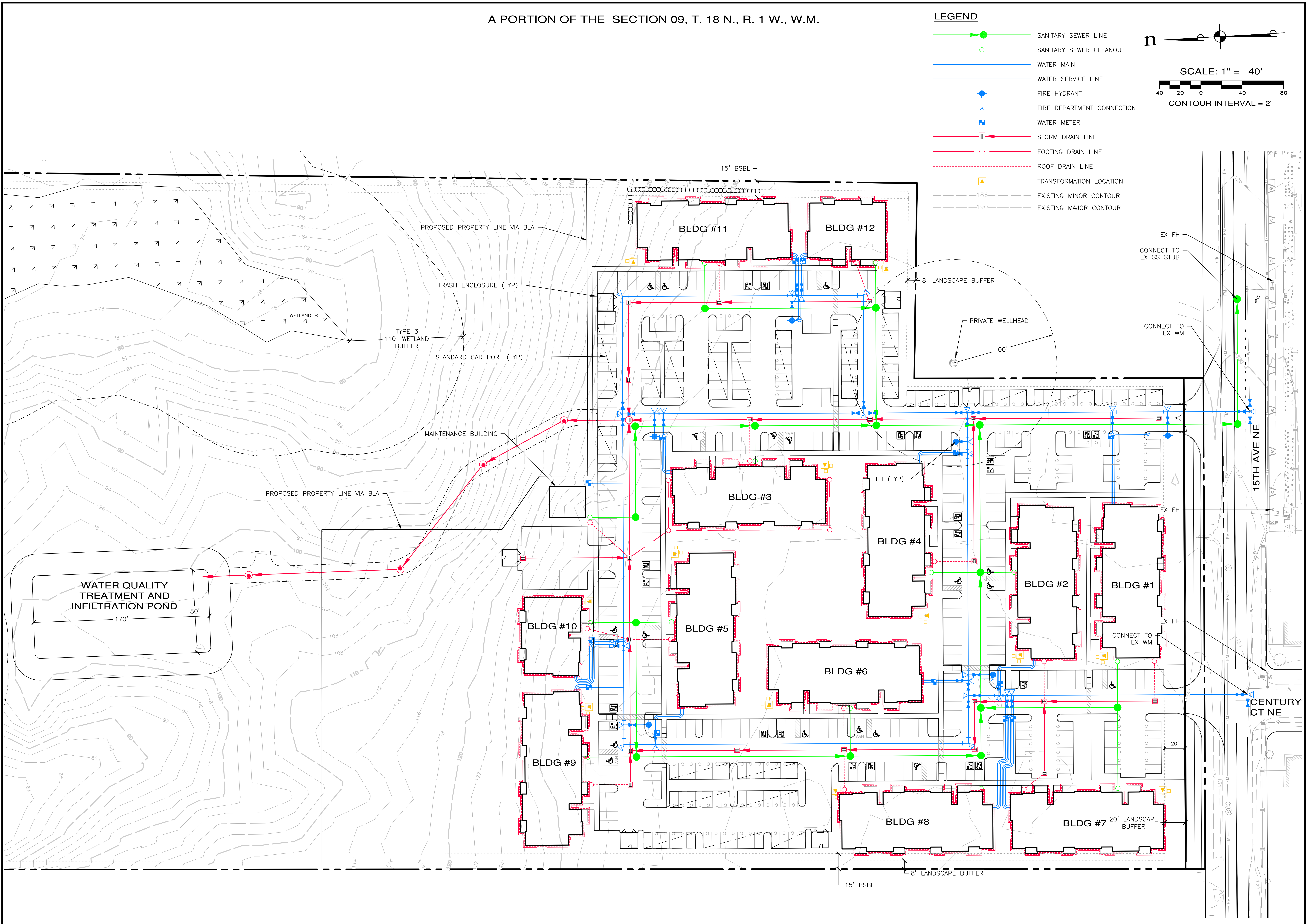

Figure 1.3 - Proposed Conditions

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NO.	DESCRIPTION/DATE	BY

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SAGE-LACEY I, LLC

WILLIAMS CROSSING

PRELIMINARY COMPOSITE UTILITY PLAN

CITY OF LACEY WASHINGTON

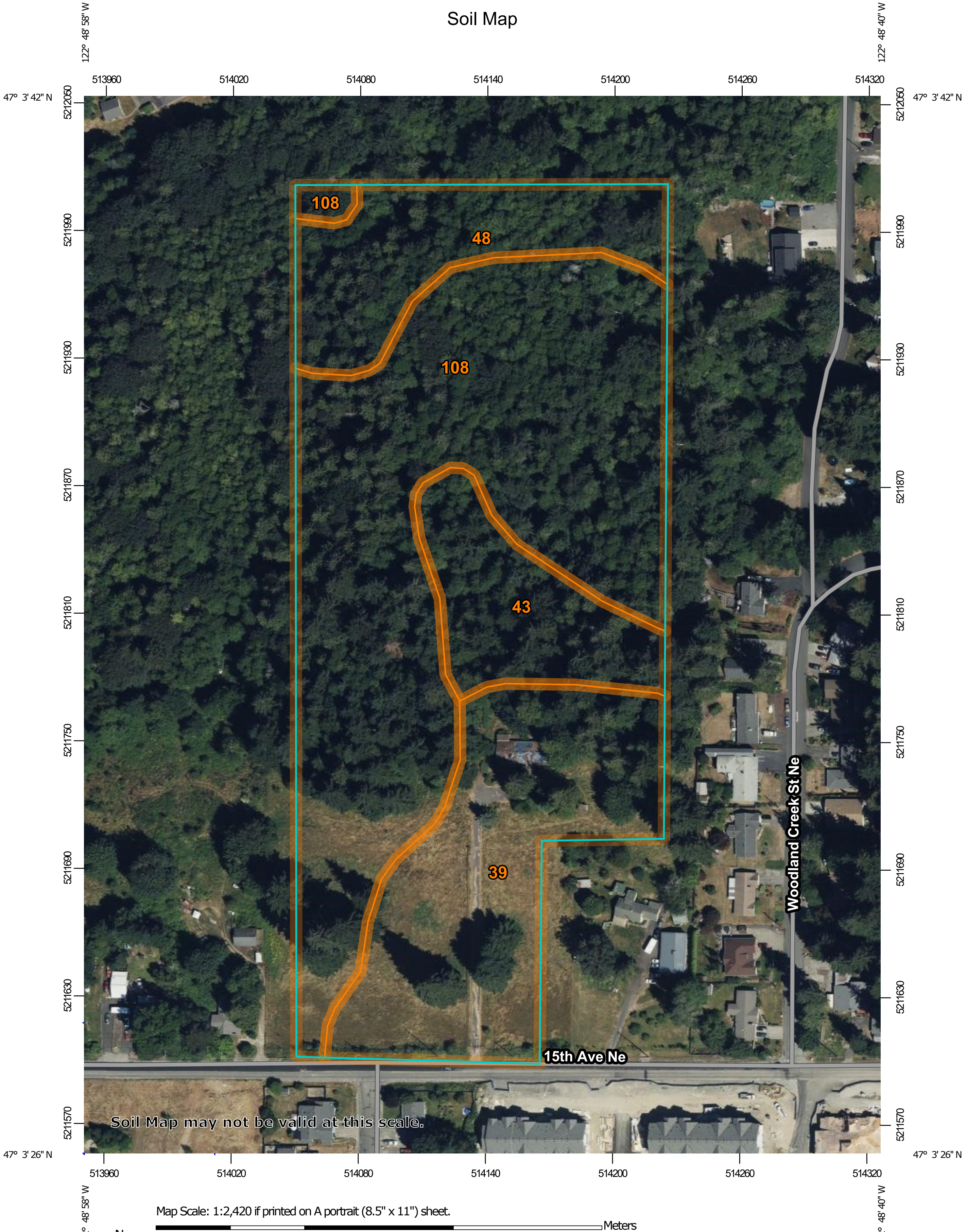
JOB NO.:	2345-002-023
DWG. NAME:	UT-01
DESIGNED BY:	LGB
DRAWN BY:	JJH
CHECKED BY:	
DATE:	03/06/2024
DATE OF PRINT:	

UT-01

5 OF 8 SHEETS

Figure 1.4 - Web Soil Survey

Soil Map



Map Scale: 1:2,420 if printed on A portrait (8.5" x 11") sheet.

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

Figure 1.4 - Web Soil Survey

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:
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: Thurston County Area, Washington
Survey Area Data: Version 17, Aug 29, 2023

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

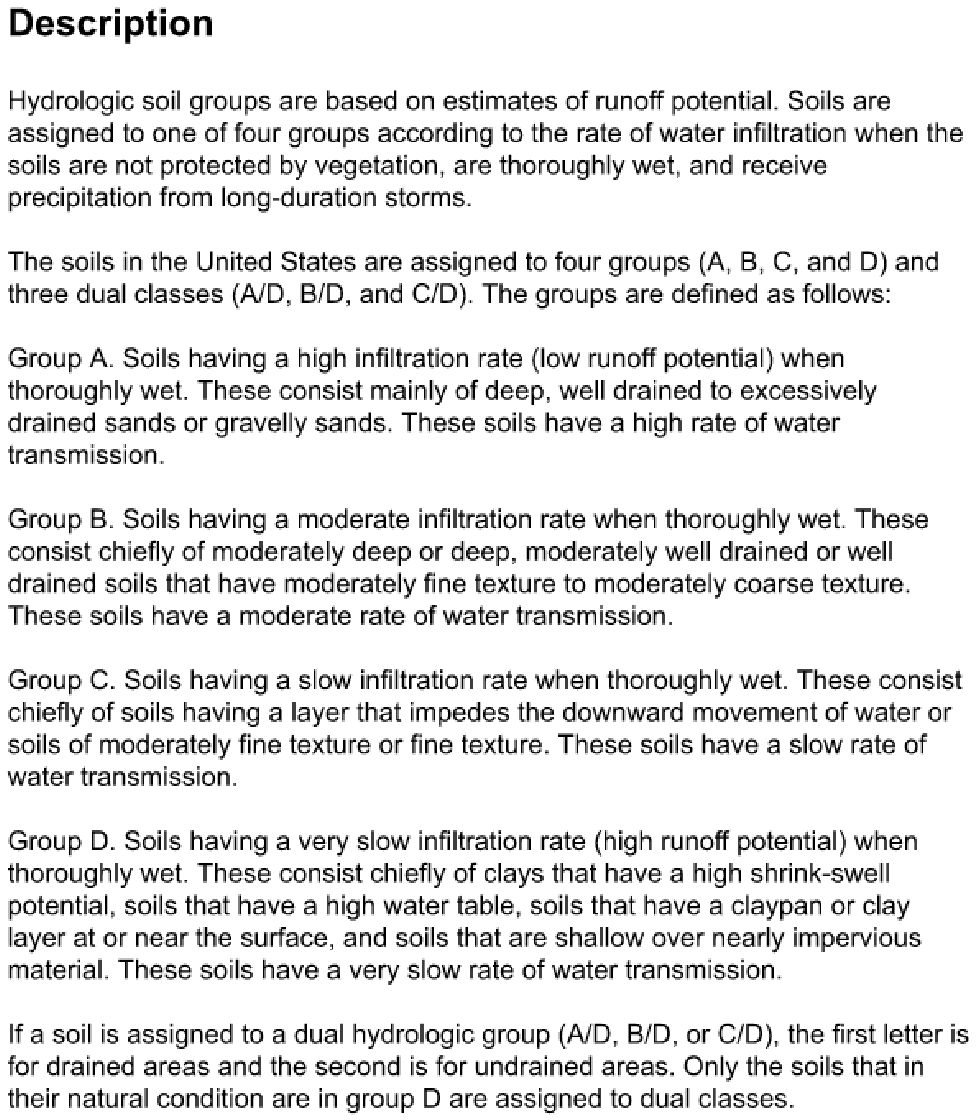
Date(s) aerial images were photographed: Jul 31, 2022—Aug 8, 2022

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.

Figure 1.4 – Web Soil Survey

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
39	Giles silt loam, 3 to 15 percent slopes	4.0	24.3%
43	Hoogdal silt loam, 15 to 30 percent slopes	1.7	10.4%
48	Indianola loamy sand, 15 to 30 percent slopes	2.1	13.1%
108	Skipopa silt loam, 3 to 15 percent slopes	8.5	52.2%
Totals for Area of Interest		**16.3**	**100.0%**



Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

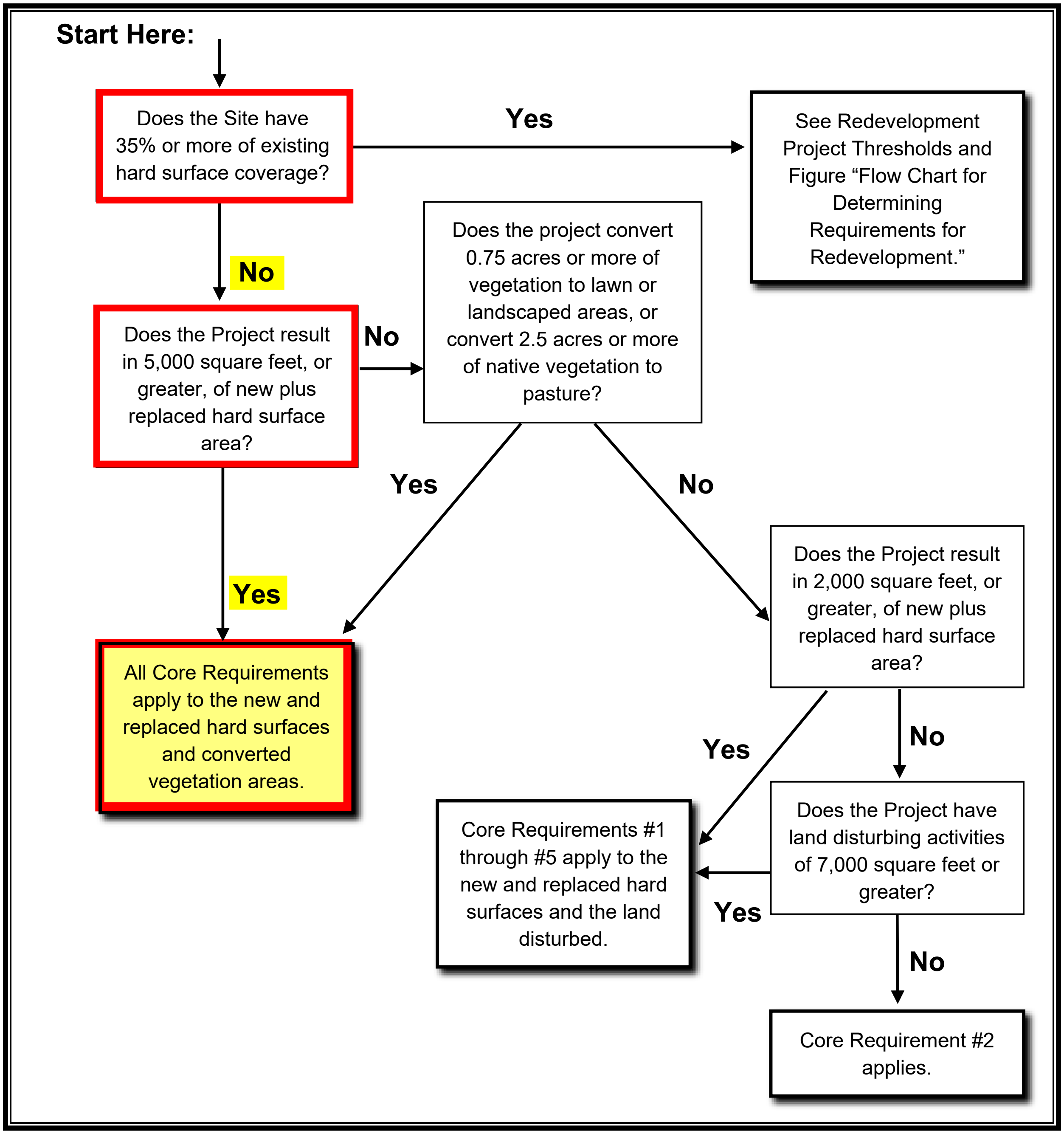


Figure 2.1. Flow Chart for Determining Requirements for New Development.

concerning minimum flows needed to maintain beneficial uses, watersheds must retain the majority of their natural vegetation cover and soils, and developments must minimize their disruption of the natural hydrologic cycle in order to avoid significant natural resource degradation in lowland streams.

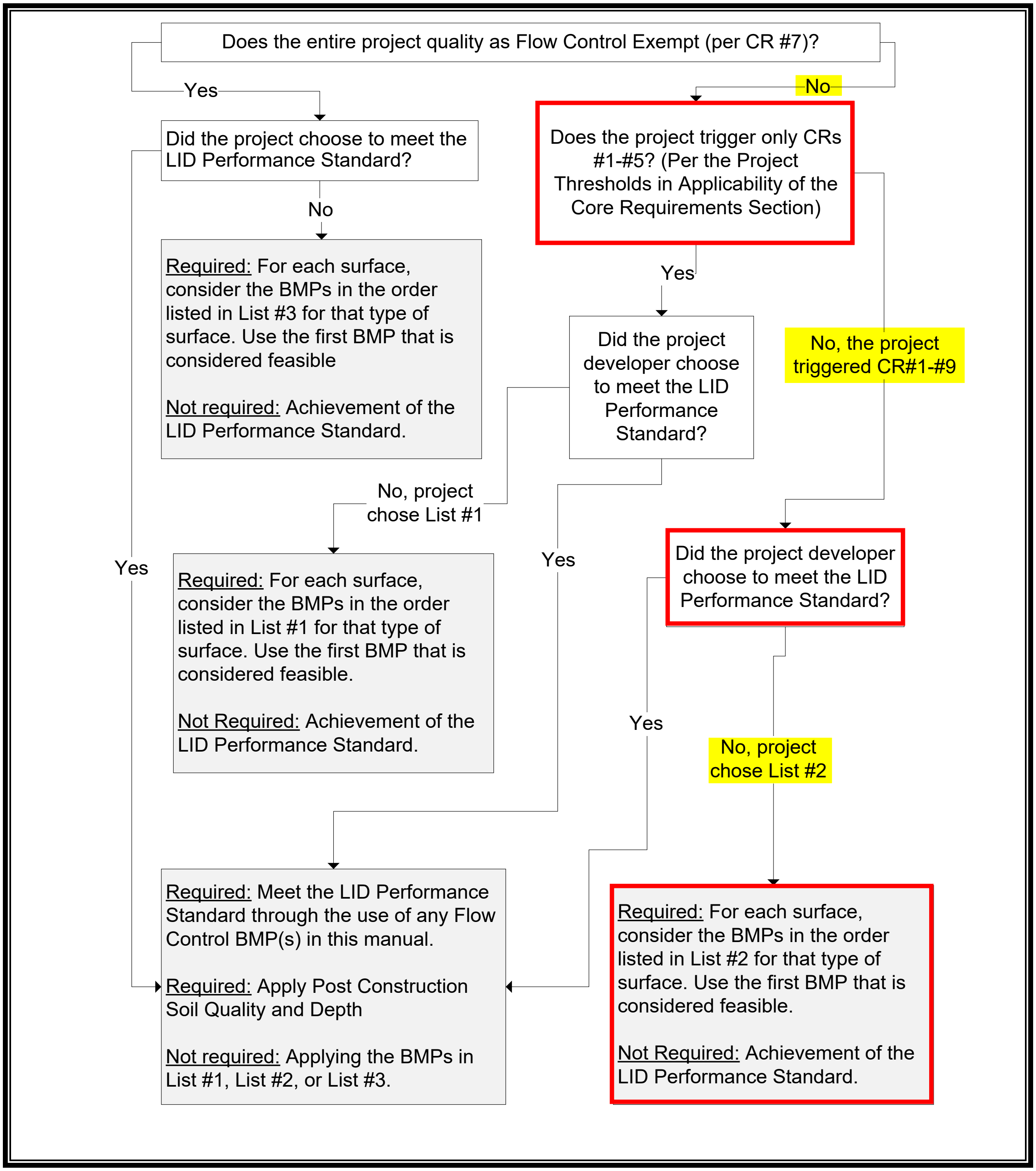


Figure 2.3. Flow Chart for Determining Core Requirement #5 Requirements.

Section Tab #2

2. EXISTING CONDITIONS DESCRIPTION

Approximately 60% of the existing project site is currently undeveloped and forested. The remaining approximate 40% has been cleared with a portion of it developed as a single-family residence. Stormwater runoff does not appear to enter the site from the adjacent properties or from 15th Avenue NE located along the property border to the south. Stormwater from the site appears to generally infiltrate onsite and any generated runoff that does not infiltrate would discharge at the northern end of the property into one of two locations where wetland extends into the property.

The geotechnical reports indicate that the soils onsite in the vicinity of proposed development are suitable for infiltration as it consists of glacial outwash material.

Refer to the figures of the previous section of this report for more information regarding the existing features of the site and the geotechnical reports in Appendix B for more information.

According to NRCS's Web Soil Survey, the onsite soils are Giles Silt Loam with 3 to 15 percent slopes, Hoogdal Silt Loam with 15 to 30 percent slopes, Indianola Loamy Sand with 15 to 50 percent slopes and Skipopa Silt Loam with 3 to 15 percent slopes. Refer to Figure 1.4 for the Web Soil Survey.

According to pre-application notes for the project, the site is located within the Palm Street Basin, which may contain elevated concentrations of fecal coliform bacteria and dissolved oxygen.

Section Tab #3

3. VICINITY ANALYSIS AND SUBBASIN DESCRIPTION

Qualitative Analysis

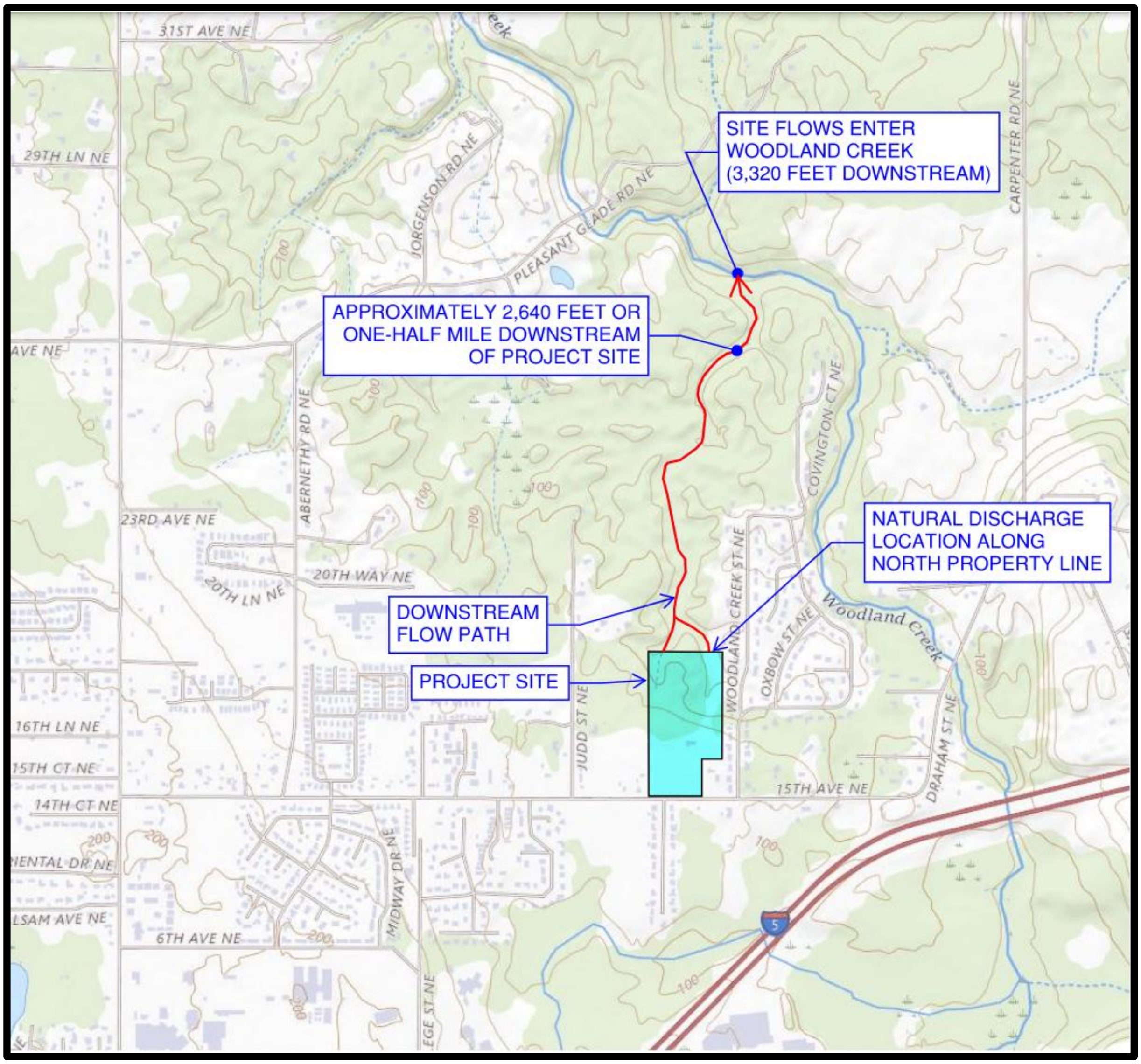
A qualitative analysis of the downstream reach from the project site to the receiving water and upstream of the site is required to characterize any potential offsite flow to the site or downstream backwatering effects. A downstream analysis of the project for a minimum of one-half of a mile is required as part of the qualitative analysis. The project site has a single threshold discharge area (TDA). In existing condition, flows from the site are believed to disperse and infiltrate as runoff drains north across the property. Any runoff that is not infiltrated would discharge at the northern property limit into the adjacent parcel to the north. Portions of non-infiltrated site runoff would enter the northern parcel via a wetland that extends into the property from the northern parcel. Any remaining site runoff would enter the northern parcel by sheet flow and eventually drain into a wetland located on the northern parcel. After site flows have discharged into the northern parcel, they are conveyed north through wetland and forested surface coverage before eventually draining into Woodland Creek, located approximately 3,320 feet downstream (refer to Figure 3.1 for map illustrating the downstream flowpath).

A qualitative analysis of potential run-on to the project site from upstream areas was conducted to determine if any backwater effects would be caused by the project. Based upon review of available information, no appreciable amount of run-on was found to enter the project area. A roadside ditch that is located along the north side of 15th Avenue NE intercepts any potential run-on from the south. The adjacent property to the west drains north for approximately 900 feet and then drains northeast for approximately 95 feet where it enters the subject property downstream of proposed site improvements. Parcel #11809310500 is located along the southwest corner of the subject property and based on topographic information, drains to the southeast away from the subject property and toward the roadside ditch along 15th Avenue NE. Woodland Creek Subdivision is located along the western border of the subject property and based on topographic information, drains to the east and north away from the subject property. Surface flows from the west side of Woodland Creek Subdivision eventually drain into the existing conveyance system located along Woodland Creek Street NE which ultimately discharges these flows into Woodland Creek located along the subdivision's eastern limit.

Within the downstream reach of the project site, Woodland Creek has been identified as a 303(d) listed impaired water body. The creek is identified as being impaired due to Temperature, Dissolved Oxygen, PH, and Bacteria – Fecal Coliform.

There were no apparent drainage or conveyance issues identified within the half-mile downstream corridor.

Figure 3.1 – Downstream Flowpath Map



Section Tab #4

4. FLOW CONTROL AND WATER QUALITY FACILITY SIZING

Figure 2.3 Flow Chart for Determining Core Requirement #5 Requirements, of the SWM was followed to determine to what extent and what onsite BMPs are required. The project triggers Core Requirements #1 – 9. Projects that satisfy these criteria shall either utilize on-site stormwater management BMPs from List #2 or demonstrate compliance with the LID Performance Standards.

The project proponent has chosen to follow List #2, which requires that, for each type of surface, the BMPs shall be considered in the order listed for that type of surface and the first feasible BMP shall be implemented.

Lawn and Landscape areas:

1. *Post-Construction Soil Quality and Depth in accordance with BMP T5.13: Post Construction Soil Quality and Depth.*

   All disturbed areas which will not receive hard surfacing in the post-developed condition shall utilize amended soils.

Roofs:

1. *Full Dispersion in accordance with BMP T5.30: Full Dispersion, or Downspout Full Infiltration Systems in accordance with BMP T5.10A: Downspout Full Infiltration.*

   Dispersion BMPs shall be placed no closer than 50 feet from top of slopes steeper than 15 percent and greater than 10 feet high. The slope of the flow path must be no steeper than 15 percent for any 20-foot reach of the flow path. Slopes up to 20 percent are allowed where flow spreaders are located upstream of the dispersion area and at sites where vegetation can be established. Ground slopes in the downstream vicinity of the project are in excess of 20 percent. Therefore, full Dispersion is deemed infeasible.

2. Full Infiltration is deemed feasible for the project based on the findings within the Geotechnical Engineering Report and the Infiltration Evaluation (Appendix B). An infiltration pond is proposed to infiltrate all runoff from new rooftop surface areas.

Other Hard Surfaces:

1. *Full dispersion in accordance with BMP T5.30: Full Dispersion*

   Because ground slopes in the downstream vicinity of the project are in excess of 20 percent, full Dispersion is deemed not feasible.

2. *Permeable pavement in accordance with BMP T5.15: Permeable Pavements*

   Per the geotechnical reports, infiltration has been deemed feasible for stormwater management of other hard surfaces. In lieu of implementing permeable pavement, runoff from other hard surfaces will be routed to an infiltration pond for full infiltration. Prior to infiltration, these surfaces areas will receive water quality treatment.

Part A - Predeveloped Site Hydrology

The existing 18.7 acres site is predominantly trees, shrubs, and grass vegetation. The onsite soil types are mapped as Giles Silt Loam (Type B soils), Hoogdal Silt Loam (Type D soils), Indianola Loamy Sand (Type A soils), and Skipopa Silt Loam (Type D soils). Type A and B soils are conducive to infiltration. Since Indianola Loamy Sand (Type A soils) are located at the downstream end of the site, runoff from the site is anticipated to infiltrate. Stormwater runoff will continue to infiltrate in developed condition.

Refer to Table 4.1 below for the predeveloped hydrology model Land Use basin input.

Table 4.1: Hydrology Model - Predeveloped Land Cover Types

Drainage Basin	Roads Flat (ac)	A B, Lawn, Flat (ac)	A B, Forest, Mod (ac)	Total (ac)
Basin 1 (onsite)	0	0	10.0	10.0
Bypass (offsite)	0.153	0.386	0	0.539

Part B - Developed Site Hydrology

The project chooses to use the List Approach in lieu of meeting the LID Performance Standard. According to Figure 2.3 of the SWM, the project would therefore need to select from the BMPs shown in List #2 based on feasibility and implement BMP T5.13 for Post-Construction Soil Quality and Depth.

There is insufficient onsite vegetated flowpath area with slopes of 15% or less to which target impervious surfaces may be dispersed. Therefore, full Dispersion is not feasible. Full Infiltration is feasible and will be implanted for stormwater management of all runoff from the project surface areas (roofs, road, parking, and landscaped areas). Runoff from new onsite project areas will be collected in catch basins and conveyed in pipes to an infiltration pond for full infiltration.

Table 4.2 below includes a summary of proposed development areas used in the hydrology model for sizing.

Table 4.2: Hydrology Model - Developed Land Cover Types

Drainage Basin	Roads Flat (ac)	Roof Tops Flat (ac)	Sidewalks Flat (ac)	A B, Lawn, Flat (ac)	A B, Lawn, Mod (ac)	Total (ac)
Basin 1 (onsite)	3.630	1.950	0	2.770	1.650	5.580
Bypass (offsite)	0.399	0	0.075	0.065	0	0.539

Part C – Performance Standards

The 2012 Western Washington Hydrology Model (WWHM) is an approved hydrology model to size detention, infiltration, and water quality treatment facilities.

The Standard Flow Control Requirement of the SWM is as follows:

> *Stormwater discharges shall match developed discharge durations to predeveloped durations for the range of pre-developed discharge rates from 50%*

of the 2-year peak flow up to the full 50-year peak flow. The pre-developed condition to be matched shall be a forested land cover.

Conveyance facilities for this site are designed to convey the 25-year, 24-hour peak flow rate and contain the 100-year storm event within the catch basins.

Part D – Flow Control System

Since the project (including bypass flow) does not result in 0.15 cfs or greater increase in the 100-year flow frequency, as estimated using an approved continuous simulation model and 15-minute time steps, the project is exempt from core requirement #7 (flow control).

Infiltration

Site runoff will be routed to an infiltration pond located in the northern region of the site. Based on the geotechnical reports included in Appendix B, the factored, long-term infiltration rate to be used for sizing the proposed infiltration facility is 4 inches per hour. The bottom of the infiltration pond will be lined with a designed soils treatment layer with an infiltration rate of 3 inches per hour. The proposed infiltration facility was sized accordingly by running simulations with the Western Washington Hydrology Model (WWHM) to infiltrate 100 percent of the onsite runoff volume generated by the WWHM runoff series.

The WWHM calculations are contained in Appendix A, the proposed basins are shown in Figure 4.2 and a summary of the infiltration pond volumes are shown in Table 4.3.

Table 4.3 - Volumes (Cu Ft)

	Modeled	Provided
Infiltration Pond	80,151	98,321

Bypass Flow

On some sites, topography can make it difficult or costly to collect all target surface runoff for conveyance to the onsite flow control facility. Compensatory mitigation by the flow control facility must be provided so that the net effect at the point of convergence downstream is the same with or without the bypass. This mitigation may be waived if the existing site conditions 100-year peak discharge from the area of the bypassed target surfaces is increased by no more than 0.15 cfs and flow control BMPs are applied to the impervious surfaces. To compensate for bypass target surface areas, the bypass areas have been included in sizing model for the proposed infiltration facility (POC #1). The 100-year peak discharge from the bypass area was also analyzed to ensure that it does not exceed 0.40 cfs (POC #2).

Part E - Water Quality System

This project proposes to create more than 5,000 square feet of Pollution Generating Hard Surface (PGHS); therefore, stormwater treatment is required. Additionally, Enhanced Water Quality Treatment is required for this project site because the proposed development is Multifamily use. Phosphorous control is also required since the infiltration facility is located within one-quarter mile of a fresh water body (wetland).

Water Quality Treatment will be provided within the infiltration pond with the addition of a layer of Bioretention Soil Mix and coarse compost along the bottom of the pond. BSM is the treatment medium that has pollutant removal mechanisms such as filtration, adsorption, and biological action. A Contech StormFilter with Phosphosorb media will be provided upstream of the pond for removal of phosphorous prior to infiltration.

The following calculation determines the appropriate facility size given its tributary basin and the WQ offline flow provided from WWHM.

WQ offline Flow: 287.57 gpm (0.6407 cfs)
Loading Rate: 18.79 gpm/cartridge
Min. # Cartridges: 16

Proposed StormFilter: Conc. Catch Basin StormFilter with sixteen 27” Phosphosorb Cartridges

A Contech Vault StormFilter Cartridge System with sixteen 27” cartridges are proposed in northern region of the site to treat runoff from onsite project areas.

Section Tab #5

5. AESTHETIC CONSIDERATIONS FOR FACILITIES

The stormwater facility for this project, an open infiltration pond, will be vegetated to blend in with surrounding vegetation. The retention system will also be located in a area surrounded by forest coverage within the northern part of the site and away from proposed buildings, parking areas or adjacent properties. Black vinyl perimeter fencing will be provided for the pond as well. The proposed water quality treatment facility will be located below ground level and will therefore not require any additional aesthetic considerations.

Section Tab #6

6. CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Conveyance facilities for this site are designed to convey the 25-year, 24-hour peak flow rate and contain the 100-year storm event within the catch basins. A full conveyance and backwater analysis of the proposed stormwater conveyance system will be included with the final version of this report.

Section Tab #7

7. COVENANTS, DEDICATIONS, EASEMENTS

All applicable covenants, dedications, and easements will be included with the final version of this report.

Section Tab #8

8. AGREEMENTS AND GUARANTEES

Performance bonding or other appropriate financial instruments shall be provided as determined necessary by the City of Lacey during final design.

Section Tab #9

9. OTHER PERMITS OR CONDITIONS PLACED ON THE PROJECT

Other permits for this project are listed below.

City of Lacey

- Land Clearing Application
- Building Permit

Department of Ecology

- NPDES

Appendix A

APPENDIX A – HYDROLOGY MODEL ANALYSIS AND RESULTS

The project was modeled using WWHM 2012, an approved hydrology model.

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	WilliamsCrossing 12-18-2023
Site Name:	Williams Crossing
Site Address:	
City:	Lacey
Report Date:	12/18/2023
Gage:	Woodard Creek
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

Pre-Dev Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Mod	10
Pervious Total	10
Impervious Land Use	acre
Impervious Total	0
Basin Total	10

Element Flows To:

Surface	Interflow	Groundwater

Pre-Dev Bypass

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	0.386
Pervious Total	0.386
Impervious Land Use	acre
ROADS FLAT	0.153
Impervious Total	0.153
Basin Total	0.539

Element Flows To:

Surface	Interflow	Groundwater

Pre-Dev Bypass Flowrates

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	0.386
Pervious Total	0.386
Impervious Land Use	acre
ROADS FLAT	0.153
Impervious Total	0.153
Basin Total	0.539

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Dev Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	2.77
A B, Lawn, Mod	1.65
Pervious Total	4.42
Impervious Land Use	acre
ROADS FLAT	3.63
ROOF TOPS FLAT	1.95
Impervious Total	5.58
Basin Total	10

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Dev Bypass

Bypass: Yes

GroundWater: No

Pervious Land Use	acre
A B, Lawn, Flat	0.065
Pervious Total	0.065

Impervious Land Use	acre
ROADS FLAT	0.399
SIDEWALKS FLAT	0.075
Impervious Total	0.474

Basin Total	0.539

Element Flows To:

Surface	Interflow	Groundwater

-Dev Bypass Flowrates

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	0.065
Pervious Total	0.065
Impervious Land Use	acre
ROADS FLAT	0.399
SIDEWALKS FLAT	0.075
Impervious Total	0.474
Basin Total	0.539

Element Flows To:

Surface	Interflow	Groundwater

Routing Elements

Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	167.00 ft.	
Bottom Width:	80.00 ft.	
Depth:	6 ft.	
Volume at riser head:	0.0000 acre-feet.	
Infiltration On		
Infiltration rate:	3	
Infiltration safety factor:	1	
Wetted surface area On		
Total Volume Infiltrated (ac-ft.):		1147.375
Total Volume Through Riser (ac-ft.):		0
Total Volume Through Facility (ac-ft.):		1147.375
Percent Infiltrated:		100
Total Precip Applied to Facility:		0
Total Evap From Facility:		0
Side slope 1:	0 To 1	
Side slope 2:	0 To 1	
Side slope 3:	0 To 1	
Side slope 4:	0 To 1	
Discharge Structure		
Riser Height:	0 ft.	
Riser Diameter:	0 in.	
Element Flows To:		
Outlet 1	Outlet 2	

Pond Hydraulic Table

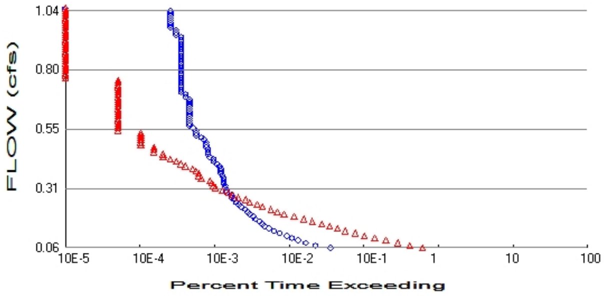
Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
110.00	0.306	0.000	0.000	0.000
110.07	0.306	0.020	0.000	0.927
110.13	0.306	0.040	0.000	0.927
110.20	0.306	0.061	0.000	0.927
110.27	0.306	0.081	0.000	0.927
110.33	0.306	0.102	0.000	0.927
110.40	0.306	0.122	0.000	0.927
110.47	0.306	0.143	0.000	0.927
110.53	0.306	0.163	0.000	0.927
110.60	0.306	0.184	0.000	0.927
110.67	0.306	0.204	0.000	0.927
110.73	0.306	0.224	0.000	0.927
110.80	0.306	0.245	0.000	0.927
110.87	0.306	0.265	0.000	0.927
110.93	0.306	0.286	0.000	0.927
111.00	0.306	0.306	0.000	0.927
111.07	0.306	0.327	0.000	0.927
111.13	0.306	0.347	0.000	0.927
111.20	0.306	0.368	0.000	0.927
111.27	0.306	0.388	0.000	0.927
111.33	0.306	0.408	0.000	0.927
111.40	0.306	0.429	0.000	0.927
111.47	0.306	0.449	0.000	0.927
111.53	0.306	0.470	0.000	0.927
111.60	0.306	0.490	0.000	0.927
111.67	0.306	0.511	0.000	0.927

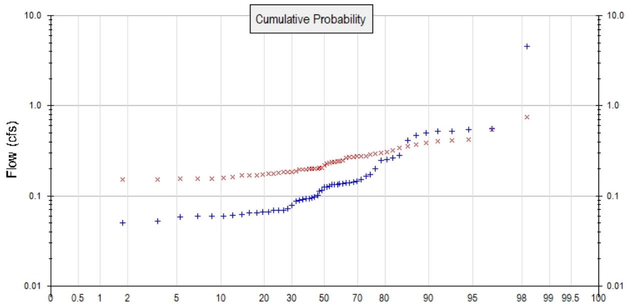
111.73	0.306	0.531	0.000	0.927
111.80	0.306	0.552	0.000	0.927
111.87	0.306	0.572	0.000	0.927
111.93	0.306	0.593	0.000	0.927
112.00	0.306	0.613	0.000	0.927
112.07	0.306	0.633	0.000	0.927
112.13	0.306	0.654	0.000	0.927
112.20	0.306	0.674	0.000	0.927
112.27	0.306	0.695	0.000	0.927
112.33	0.306	0.715	0.000	0.927
112.40	0.306	0.736	0.000	0.927
112.47	0.306	0.756	0.000	0.927
112.53	0.306	0.777	0.000	0.927
112.60	0.306	0.797	0.000	0.927
112.67	0.306	0.817	0.000	0.927
112.73	0.306	0.838	0.000	0.927
112.80	0.306	0.858	0.000	0.927
112.87	0.306	0.879	0.000	0.927
112.93	0.306	0.899	0.000	0.927
113.00	0.306	0.920	0.000	0.927
113.07	0.306	0.940	0.000	0.927
113.13	0.306	0.961	0.000	0.927
113.20	0.306	0.981	0.000	0.927
113.27	0.306	1.001	0.000	0.927
113.33	0.306	1.022	0.000	0.927
113.40	0.306	1.042	0.000	0.927
113.47	0.306	1.063	0.000	0.927
113.53	0.306	1.083	0.000	0.927
113.60	0.306	1.104	0.000	0.927
113.67	0.306	1.124	0.000	0.927
113.73	0.306	1.145	0.000	0.927
113.80	0.306	1.165	0.000	0.927
113.87	0.306	1.185	0.000	0.927
113.93	0.306	1.206	0.000	0.927
114.00	0.306	1.226	0.000	0.927
114.07	0.306	1.247	0.000	0.927
114.13	0.306	1.267	0.000	0.927
114.20	0.306	1.288	0.000	0.927
114.27	0.306	1.308	0.000	0.927
114.33	0.306	1.329	0.000	0.927
114.40	0.306	1.349	0.000	0.927
114.47	0.306	1.369	0.000	0.927
114.53	0.306	1.390	0.000	0.927
114.60	0.306	1.410	0.000	0.927
114.67	0.306	1.431	0.000	0.927
114.73	0.306	1.451	0.000	0.927
114.80	0.306	1.472	0.000	0.927
114.87	0.306	1.492	0.000	0.927
114.93	0.306	1.513	0.000	0.927
115.00	0.306	1.533	0.000	0.927
115.07	0.306	1.554	0.000	0.927
115.13	0.306	1.574	0.000	0.927
115.20	0.306	1.594	0.000	0.927
115.27	0.306	1.615	0.000	0.927
115.33	0.306	1.635	0.000	0.927
115.40	0.306	1.656	0.000	0.927
115.47	0.306	1.676	0.000	0.927
115.53	0.306	1.697	0.000	0.927

115.60	0.306	1.717	0.000	0.927
115.67	0.306	1.738	0.000	0.927
115.73	0.306	1.758	0.000	0.927
115.80	0.306	1.778	0.000	0.927
115.87	0.306	1.799	0.000	0.927
115.93	0.306	1.819	0.000	0.927
116.00	0.306	1.840	0.000	0.927
116.07	0.306	1.860	0.000	0.927

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	10.386
Total Impervious Area:	0.153

Mitigated Landuse Totals for POC #1

Total Pervious Area:	4.485
Total Impervious Area:	6.054

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.118795
5 year	0.255583
10 year	0.407956
25 year	0.708347
50 year	1.042443
100 year	1.506223

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.225441
5 year	0.309255
10 year	0.372481
25 year	0.46167
50 year	0.535212
100 year	0.615143

Since the project (including bypass flow) does not result in 0.15 cfs or greater increase in the 100-year flow frequency, as estimated using an approved continuous simulation model and 15-minute time steps, the project is exempt from core requirement #7 (flow control).

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.253	0.200
1957	0.201	0.322
1958	0.087	0.168
1959	0.079	0.219
1960	0.151	0.391
1961	0.562	0.155
1962	0.060	0.170
1963	0.413	0.372
1964	0.472	0.249
1965	0.245	0.203

1966	0.049	0.144
1967	0.125	0.177
1968	0.069	0.152
1969	0.136	0.267
1970	0.097	0.156
1971	0.127	0.171
1972	0.546	0.243
1973	0.069	0.185
1974	0.114	0.267
1975	0.072	0.200
1976	0.089	0.197
1977	0.095	0.292
1978	0.165	0.267
1979	0.094	0.290
1980	0.133	0.232
1981	0.279	0.277
1982	0.135	0.237
1983	0.133	0.410
1984	0.092	0.188
1985	0.065	0.197
1986	0.125	0.198
1987	0.524	0.277
1988	0.060	0.167
1989	0.092	0.278
1990	0.146	0.303
1991	0.517	0.307
1992	4.598	0.756
1993	0.114	0.175
1994	0.066	0.200
1995	0.141	0.236
1996	0.265	0.354
1997	0.501	0.543
1998	0.133	0.338
1999	0.066	0.202
2000	0.060	0.184
2001	0.052	0.158
2002	0.060	0.180
2003	0.064	0.163
2004	0.062	0.183
2005	0.058	0.156
2006	0.070	0.203
2007	0.138	0.420
2008	0.101	0.240
2009	0.173	0.228
2010	0.141	0.402
2011	0.050	0.152

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	4.5981	0.7556
2	0.5618	0.5431
3	0.5464	0.4200
4	0.5244	0.4098
5	0.5173	0.4021
6	0.5009	0.3906
7	0.4723	0.3723
8	0.4130	0.3541

9	0.2788	0.3376
10	0.2652	0.3217
11	0.2533	0.3070
12	0.2453	0.3031
13	0.2008	0.2916
14	0.1733	0.2895
15	0.1655	0.2780
16	0.1509	0.2771
17	0.1462	0.2769
18	0.1415	0.2674
19	0.1408	0.2674
20	0.1380	0.2667
21	0.1359	0.2492
22	0.1352	0.2429
23	0.1332	0.2404
24	0.1329	0.2370
25	0.1326	0.2362
26	0.1272	0.2316
27	0.1254	0.2278
28	0.1251	0.2193
29	0.1144	0.2032
30	0.1135	0.2029
31	0.1013	0.2020
32	0.0968	0.2002
33	0.0946	0.2002
34	0.0937	0.1997
35	0.0922	0.1979
36	0.0915	0.1972
37	0.0890	0.1970
38	0.0865	0.1881
39	0.0792	0.1846
40	0.0725	0.1841
41	0.0698	0.1827
42	0.0688	0.1796
43	0.0687	0.1774
44	0.0657	0.1748
45	0.0657	0.1711
46	0.0651	0.1697
47	0.0644	0.1682
48	0.0624	0.1671
49	0.0604	0.1633
50	0.0600	0.1577
51	0.0597	0.1562
52	0.0595	0.1555
53	0.0582	0.1546
54	0.0522	0.1521
55	0.0501	0.1516
56	0.0487	0.1440

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0594	701	11960	1706	Fail
0.0693	442	8129	1839	Fail
0.0793	330	5618	1702	Fail
0.0892	259	3856	1488	Fail
0.0991	212	2739	1291	Fail
0.1090	182	1993	1095	Fail
0.1190	146	1502	1028	Fail
0.1289	123	1109	901	Fail
0.1388	104	866	832	Fail
0.1488	91	681	748	Fail
0.1587	85	537	631	Fail
0.1686	78	403	516	Fail
0.1786	70	306	437	Fail
0.1885	65	228	350	Fail
0.1984	58	168	289	Fail
0.2083	54	136	251	Fail
0.2183	51	112	219	Fail
0.2282	44	86	195	Fail
0.2381	41	73	178	Fail
0.2481	38	58	152	Fail
0.2580	36	51	141	Fail
0.2679	33	41	124	Fail
0.2779	33	34	103	Pass
0.2878	28	30	107	Pass
0.2977	28	25	89	Pass
0.3076	27	20	74	Pass
0.3176	27	19	70	Pass
0.3275	26	18	69	Pass
0.3374	26	17	65	Pass
0.3474	26	13	50	Pass
0.3573	25	12	48	Pass
0.3672	24	12	50	Pass
0.3771	24	11	45	Pass
0.3871	24	10	41	Pass
0.3970	23	8	34	Pass
0.4069	21	7	33	Pass
0.4169	19	6	31	Pass
0.4268	19	5	26	Pass
0.4367	17	4	23	Pass
0.4467	16	4	25	Pass
0.4566	16	3	18	Pass
0.4665	16	3	18	Pass
0.4764	15	3	20	Pass
0.4864	15	2	13	Pass
0.4963	15	2	13	Pass
0.5062	14	2	14	Pass
0.5162	13	2	15	Pass
0.5261	11	2	18	Pass
0.5360	11	2	18	Pass
0.5460	11	1	9	Pass
0.5559	10	1	10	Pass
0.5658	9	1	11	Pass
0.5757	9	1	11	Pass
0.5857	9	1	11	Pass

Note: OK to Fail, since as noted on Page 13, the project is exempt from core requirement #7 (flow control).

0.5956	9	1	11	Pass
0.6055	9	1	11	Pass
0.6155	9	1	11	Pass
0.6254	9	1	11	Pass
0.6353	9	1	11	Pass
0.6453	9	1	11	Pass
0.6552	9	1	11	Pass
0.6651	9	1	11	Pass
0.6750	9	1	11	Pass
0.6850	8	1	12	Pass
0.6949	8	1	12	Pass
0.7048	7	1	14	Pass
0.7148	7	1	14	Pass
0.7247	7	1	14	Pass
0.7346	7	1	14	Pass
0.7446	7	1	14	Pass
0.7545	7	1	14	Pass
0.7644	7	0	0	Pass
0.7743	7	0	0	Pass
0.7843	7	0	0	Pass
0.7942	7	0	0	Pass
0.8041	7	0	0	Pass
0.8141	7	0	0	Pass
0.8240	7	0	0	Pass
0.8339	7	0	0	Pass
0.8438	7	0	0	Pass
0.8538	7	0	0	Pass
0.8637	7	0	0	Pass
0.8736	7	0	0	Pass
0.8836	7	0	0	Pass
0.8935	7	0	0	Pass
0.9034	7	0	0	Pass
0.9134	7	0	0	Pass
0.9233	7	0	0	Pass
0.9332	7	0	0	Pass
0.9431	6	0	0	Pass
0.9531	6	0	0	Pass
0.9630	6	0	0	Pass
0.9729	5	0	0	Pass
0.9829	5	0	0	Pass
0.9928	5	0	0	Pass
1.0027	5	0	0	Pass
1.0127	5	0	0	Pass
1.0226	5	0	0	Pass
1.0325	5	0	0	Pass
1.0424	5	0	0	Pass

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

Water Quality

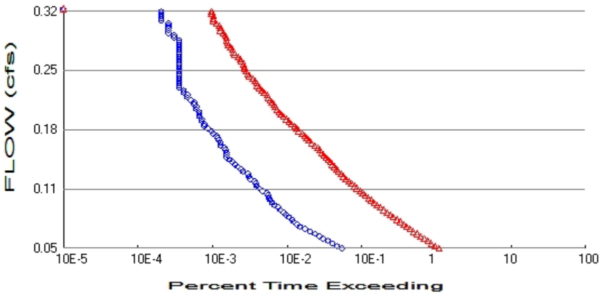
Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.9344 acre-feet
On-line facility target flow: 1.1233 cfs.
Adjusted for 15 min: 1.1233 cfs.
Off-line facility target flow: 0.6407 cfs.
Adjusted for 15 min: 0.6407 cfs.

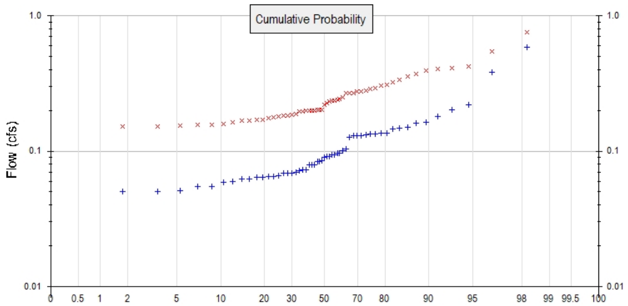
Flowrate for sizing Contech StormFilter
(internal bypass to allow off-line flows)

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Trapezoidal Pond 1 POC	☐	1044.11			☐	100.00			
Total Volume Infiltrated		1044.11	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2

Total Pervious Area:	0.386
Total Impervious Area:	0.153

Mitigated Landuse Totals for POC #2

Total Pervious Area:	0.065
Total Impervious Area:	0.474

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.090303
5 year	0.141999
10 year	0.186258
25 year	0.255644
50 year	0.318528
100 year	0.392305

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.225441
5 year	0.309255
10 year	0.372481
25 year	0.46167
50 year	0.535212
100 year	0.615143

POC #2 demonstrates that the net increase in flow frequency for the offsite bypass areas is 0.22 cfs, so less than the maximum 0.40 cfs threshold for the 100-year return period.

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1956	0.085	0.200
1957	0.181	0.322
1958	0.069	0.168
1959	0.079	0.219
1960	0.147	0.391
1961	0.092	0.155
1962	0.055	0.170
1963	0.218	0.372
1964	0.148	0.249
1965	0.104	0.203
1966	0.047	0.144

1967	0.069	0.177
1968	0.062	0.152
1969	0.134	0.267
1970	0.065	0.156
1971	0.072	0.171
1972	0.162	0.243
1973	0.068	0.185
1974	0.091	0.267
1975	0.072	0.200
1976	0.079	0.197
1977	0.094	0.292
1978	0.131	0.267
1979	0.094	0.290
1980	0.130	0.232
1981	0.149	0.277
1982	0.083	0.237
1983	0.133	0.410
1984	0.073	0.188
1985	0.064	0.197
1986	0.096	0.198
1987	0.162	0.277
1988	0.055	0.167
1989	0.090	0.278
1990	0.127	0.303
1991	0.203	0.307
1992	0.583	0.756
1993	0.079	0.175
1994	0.066	0.200
1995	0.084	0.236
1996	0.133	0.354
1997	0.385	0.543
1998	0.131	0.338
1999	0.065	0.202
2000	0.059	0.184
2001	0.051	0.158
2002	0.058	0.180
2003	0.064	0.163
2004	0.062	0.183
2005	0.050	0.156
2006	0.070	0.203
2007	0.136	0.420
2008	0.101	0.240
2009	0.096	0.228
2010	0.136	0.402
2011	0.050	0.152

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	0.5826	0.7556
2	0.3848	0.5431
3	0.2184	0.4200
4	0.2030	0.4098
5	0.1805	0.4021
6	0.1625	0.3906
7	0.1618	0.3723
8	0.1491	0.3541
9	0.1482	0.3376

10	0.1468	0.3217
11	0.1363	0.3070
12	0.1356	0.3031
13	0.1342	0.2916
14	0.1331	0.2895
15	0.1325	0.2780
16	0.1310	0.2771
17	0.1310	0.2769
18	0.1304	0.2674
19	0.1269	0.2674
20	0.1040	0.2667
21	0.1012	0.2492
22	0.0964	0.2429
23	0.0961	0.2404
24	0.0942	0.2370
25	0.0936	0.2362
26	0.0919	0.2316
27	0.0909	0.2278
28	0.0898	0.2193
29	0.0850	0.2032
30	0.0836	0.2029
31	0.0834	0.2020
32	0.0794	0.2002
33	0.0792	0.2002
34	0.0789	0.1997
35	0.0731	0.1979
36	0.0723	0.1972
37	0.0720	0.1970
38	0.0696	0.1881
39	0.0688	0.1846
40	0.0687	0.1841
41	0.0683	0.1827
42	0.0656	0.1796
43	0.0652	0.1774
44	0.0647	0.1748
45	0.0643	0.1711
46	0.0636	0.1697
47	0.0624	0.1682
48	0.0619	0.1671
49	0.0594	0.1633
50	0.0584	0.1577
51	0.0551	0.1562
52	0.0548	0.1555
53	0.0509	0.1546
54	0.0502	0.1521
55	0.0501	0.1516
56	0.0470	0.1440

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0452	1068	21187	1983	Fail
0.0479	909	18815	2069	Fail
0.0507	789	16726	2119	Fail
0.0534	691	15023	2174	Fail
0.0562	591	13409	2268	Fail
0.0590	527	11980	2273	Fail
0.0617	459	10751	2342	Fail
0.0645	398	9582	2407	Fail
0.0672	343	8659	2524	Fail
0.0700	292	7841	2685	Fail
0.0728	264	7091	2685	Fail
0.0755	242	6391	2640	Fail
0.0783	229	5789	2527	Fail
0.0810	206	5178	2513	Fail
0.0838	187	4693	2509	Fail
0.0866	175	4232	2418	Fail
0.0893	160	3817	2385	Fail
0.0921	148	3462	2339	Fail
0.0949	131	3099	2365	Fail
0.0976	123	2865	2329	Fail
0.1004	117	2633	2250	Fail
0.1031	112	2411	2152	Fail
0.1059	108	2189	2026	Fail
0.1087	104	2017	1939	Fail
0.1114	92	1848	2008	Fail
0.1142	83	1697	2044	Fail
0.1169	76	1558	2050	Fail
0.1197	74	1429	1931	Fail
0.1225	72	1308	1816	Fail
0.1252	63	1200	1904	Fail
0.1280	60	1115	1858	Fail
0.1308	58	1029	1774	Fail
0.1335	50	955	1910	Fail
0.1363	47	905	1925	Fail
0.1390	43	846	1967	Fail
0.1418	39	795	2038	Fail
0.1446	36	747	2075	Fail
0.1473	33	695	2106	Fail
0.1501	30	648	2160	Fail
0.1528	30	610	2033	Fail
0.1556	30	565	1883	Fail
0.1584	29	534	1841	Fail
0.1611	28	503	1796	Fail
0.1639	25	460	1840	Fail
0.1667	25	414	1656	Fail
0.1694	24	384	1600	Fail
0.1722	23	359	1560	Fail
0.1749	22	339	1540	Fail
0.1777	20	310	1550	Fail
0.1805	19	279	1468	Fail
0.1832	17	262	1541	Fail
0.1860	15	247	1646	Fail
0.1887	15	222	1480	Fail
0.1915	14	208	1485	Fail

POC #2 is expected to fail as it is used to demonstrate that bypass areas create less than a 0.40 cfs net increase in flow frequency for the 100-year return period between pre-developed and post-developed conditions.

0.1943	14	192	1371	Fail
0.1970	13	176	1353	Fail
0.1998	13	162	1246	Fail
0.2026	13	152	1169	Fail
0.2053	12	143	1191	Fail
0.2081	12	136	1133	Fail
0.2108	11	130	1181	Fail
0.2136	11	123	1118	Fail
0.2164	10	116	1160	Fail
0.2191	9	111	1233	Fail
0.2219	9	105	1166	Fail
0.2246	8	96	1200	Fail
0.2274	8	90	1125	Fail
0.2302	7	84	1200	Fail
0.2329	7	78	1114	Fail
0.2357	7	76	1085	Fail
0.2384	7	72	1028	Fail
0.2412	7	67	957	Fail
0.2440	7	61	871	Fail
0.2467	7	58	828	Fail
0.2495	7	55	785	Fail
0.2523	7	52	742	Fail
0.2550	7	52	742	Fail
0.2578	7	51	728	Fail
0.2605	7	47	671	Fail
0.2633	7	46	657	Fail
0.2661	7	43	614	Fail
0.2688	7	39	557	Fail
0.2716	7	38	542	Fail
0.2743	7	36	514	Fail
0.2771	7	34	485	Fail
0.2799	7	32	457	Fail
0.2826	7	31	442	Fail
0.2854	7	30	428	Fail
0.2882	6	30	500	Fail
0.2909	6	29	483	Fail
0.2937	5	27	540	Fail
0.2964	5	25	500	Fail
0.2992	5	25	500	Fail
0.3020	5	24	480	Fail
0.3047	5	22	440	Fail
0.3075	4	20	500	Fail
0.3102	4	20	500	Fail
0.3130	4	20	500	Fail
0.3158	4	19	475	Fail
0.3185	4	19	475	Fail

POC #2 is expected to fail as it is used to demonstrate that bypass areas create less than a 0.40 cfs net increase in flow frequency for the 100-year return period between pre-developed and post-developed conditions.

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

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

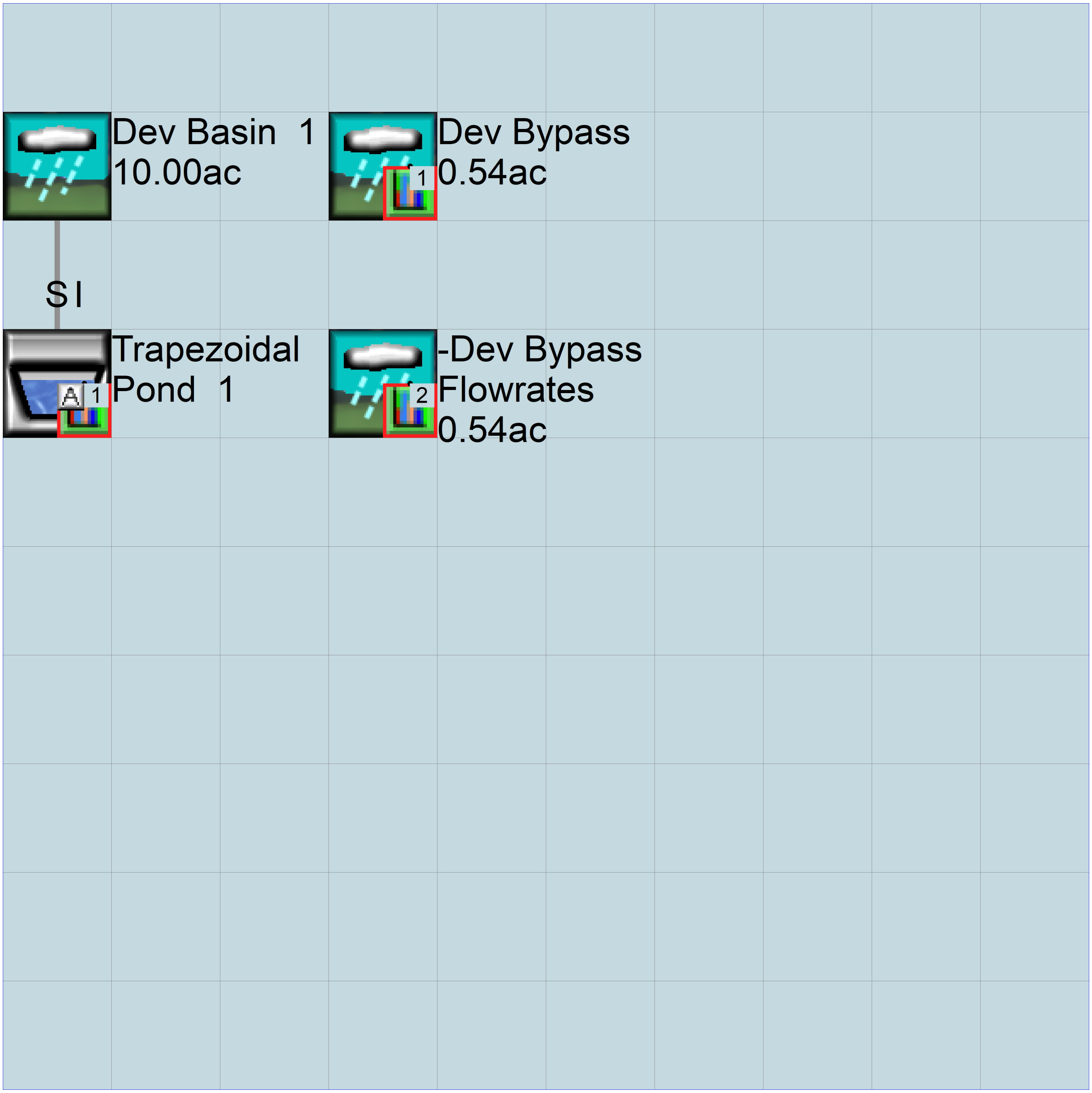
IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2011 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
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<-ID->                                                              ***
WDM        26   WilliamsCrossing 12-18-2023.wdm
MESSU      25   PreWilliamsCrossing 12-18-2023.MES
           27   PreWilliamsCrossing 12-18-2023.L61
           28   PreWilliamsCrossing 12-18-2023.L62
           30   POCWilliamsCrossing 12-18-20231.dat
           31   POCWilliamsCrossing 12-18-20232.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       2
      PERLND       7
      IMPLND       1
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Pre-Dev Basin  1            MAX                    1    2   30    9
    2        Pre-Dev Bypass Flowrates    MAX                    1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
    2     A/B, Forest, Mod        1    1    1    1   27    0
    7     A/B, Lawn, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    2         0    0    1    0    0    0    0    0    0    0    0    0
```

```
    7         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    2         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    2         0    0    0    0    0    0    0    0    0    0    0
    7         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    2              0         5         2       400       0.1       0.3     0.996
    7              0         5       0.8       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    2              0         0         2         2         0         0         0
    7              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    2            0.2       0.5      0.35         0       0.7       0.7
    7            0.1       0.5      0.25         0       0.7      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    2              0         0         0         0         3         1         0
    7              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    1      ROADS/FLAT             1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
```

```
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Pre-Dev Basin  1***
PERLND   2                          10     COPY   501     12
PERLND   2                          10     COPY   501     13
Pre-Dev Bypass***
PERLND   7                       0.386     COPY   501     12
PERLND   7                       0.386     COPY   501     13
IMPLND   1                       0.153     COPY   501     15
Pre-Dev Bypass Flowrates***
PERLND   7                       0.386     COPY   502     12
PERLND   7                       0.386     COPY   502     13
IMPLND   1                       0.153     COPY   502     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
```

```
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2011 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   WilliamsCrossing 12-18-2023.wdm
MESSU      25   MitWilliamsCrossing 12-18-2023.MES
           27   MitWilliamsCrossing 12-18-2023.L61
           28   MitWilliamsCrossing 12-18-2023.L62
           31   POCWilliamsCrossing 12-18-20232.dat
           30   POCWilliamsCrossing 12-18-20231.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       7
      PERLND       8
      IMPLND       1
      IMPLND       4
      IMPLND       8
      RCHRES       1
      COPY       502
      COPY         1
      COPY       501
      COPY       601
      DISPLY       2
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    2        -Dev Bypass Flowrates       MAX                    1    2   31    9
    1        Trapezoidal Pond  1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  502        1    1
  501        1    1
  601        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
    7     A/B, Lawn, Flat         1    1    1    1   27    0
    8     A/B, Lawn, Mod          1    1    1    1   27    0
  END GEN-INFO
```

```
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    7         0    0    1    0    0    0    0    0    0    0    0    0
    8         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    8         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    7         0    0    0    0    0    0    0    0    0    0    0
    8         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    7              0         5       0.8       400      0.05       0.3     0.996
    8              0         5       0.8       400       0.1       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    7              0         0         2         2         0         0         0
    8              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                            ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    7            0.1       0.5      0.25         0       0.7      0.25
    8            0.1       0.5      0.25         0       0.7      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    7              0         0         0         0         3         1         0
    8              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    1      ROADS/FLAT             1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    4         0    0    1    0    0    0
    8         0    0    1    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    4         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
    4              0         0
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    4              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Dev Basin  1***
PERLND   7                        2.77     RCHRES   1      2
PERLND   7                        2.77     RCHRES   1      3
PERLND   8                        1.65     RCHRES   1      2
PERLND   8                        1.65     RCHRES   1      3
IMPLND   1                        3.63     RCHRES   1      5
IMPLND   4                        1.95     RCHRES   1      5
Dev Bypass***
PERLND   7                       0.065     COPY   501     12
PERLND   7                       0.065     COPY   601     12
PERLND   7                       0.065     COPY   501     13
PERLND   7                       0.065     COPY   601     13
IMPLND   1                       0.399     COPY   501     15
IMPLND   1                       0.399     COPY   601     15
IMPLND   8                       0.075     COPY   501     15
IMPLND   8                       0.075     COPY   601     15
-Dev Bypass Flowrates***
PERLND   7                       0.065     COPY   502     12
PERLND   7                       0.065     COPY   502     13
IMPLND   1                       0.399     COPY   502     15
IMPLND   8                       0.075     COPY   502     15

******Routing******
```

```
PERLND   7                        2.77     COPY     1     12
PERLND   8                        1.65     COPY     1     12
IMPLND   1                        3.63     COPY     1     15
IMPLND   4                        1.95     COPY     1     15
PERLND   7                        2.77     COPY     1     13
PERLND   8                        1.65     COPY     1     13
RCHRES   1                           1     COPY   501     17
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                          in  out                            ***
    1     Trapezoidal Pond-007    2    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *     *  *  *  *  *        *  *  *  *  *        ***
    1        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1              1      0.03       0.0     110.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
```

```
     (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.306703  0.000000  0.000000  0.000000
  0.066667  0.306703  0.020447  0.000000  0.927778
  0.133333  0.306703  0.040894  0.000000  0.927778
  0.200000  0.306703  0.061341  0.000000  0.927778
  0.266667  0.306703  0.081788  0.000000  0.927778
  0.333333  0.306703  0.102234  0.000000  0.927778
  0.400000  0.306703  0.122681  0.000000  0.927778
  0.466667  0.306703  0.143128  0.000000  0.927778
  0.533333  0.306703  0.163575  0.000000  0.927778
  0.600000  0.306703  0.184022  0.000000  0.927778
  0.666667  0.306703  0.204469  0.000000  0.927778
  0.733333  0.306703  0.224916  0.000000  0.927778
  0.800000  0.306703  0.245363  0.000000  0.927778
  0.866667  0.306703  0.265810  0.000000  0.927778
  0.933333  0.306703  0.286257  0.000000  0.927778
  1.000000  0.306703  0.306703  0.000000  0.927778
  1.066667  0.306703  0.327150  0.000000  0.927778
  1.133333  0.306703  0.347597  0.000000  0.927778
  1.200000  0.306703  0.368044  0.000000  0.927778
  1.266667  0.306703  0.388491  0.000000  0.927778
  1.333333  0.306703  0.408938  0.000000  0.927778
  1.400000  0.306703  0.429385  0.000000  0.927778
  1.466667  0.306703  0.449832  0.000000  0.927778
  1.533333  0.306703  0.470279  0.000000  0.927778
  1.600000  0.306703  0.490725  0.000000  0.927778
  1.666667  0.306703  0.511172  0.000000  0.927778
  1.733333  0.306703  0.531619  0.000000  0.927778
  1.800000  0.306703  0.552066  0.000000  0.927778
  1.866667  0.306703  0.572513  0.000000  0.927778
  1.933333  0.306703  0.592960  0.000000  0.927778
  2.000000  0.306703  0.613407  0.000000  0.927778
  2.066667  0.306703  0.633854  0.000000  0.927778
  2.133333  0.306703  0.654301  0.000000  0.927778
  2.200000  0.306703  0.674747  0.000000  0.927778
  2.266667  0.306703  0.695194  0.000000  0.927778
  2.333333  0.306703  0.715641  0.000000  0.927778
  2.400000  0.306703  0.736088  0.000000  0.927778
  2.466667  0.306703  0.756535  0.000000  0.927778
  2.533333  0.306703  0.776982  0.000000  0.927778
  2.600000  0.306703  0.797429  0.000000  0.927778
  2.666667  0.306703  0.817876  0.000000  0.927778
  2.733333  0.306703  0.838323  0.000000  0.927778
  2.800000  0.306703  0.858770  0.000000  0.927778
  2.866667  0.306703  0.879216  0.000000  0.927778
  2.933333  0.306703  0.899663  0.000000  0.927778
  3.000000  0.306703  0.920110  0.000000  0.927778
  3.066667  0.306703  0.940557  0.000000  0.927778
  3.133333  0.306703  0.961004  0.000000  0.927778
  3.200000  0.306703  0.981451  0.000000  0.927778
  3.266667  0.306703  1.001898  0.000000  0.927778
  3.333333  0.306703  1.022345  0.000000  0.927778
  3.400000  0.306703  1.042792  0.000000  0.927778
  3.466667  0.306703  1.063238  0.000000  0.927778
  3.533333  0.306703  1.083685  0.000000  0.927778
  3.600000  0.306703  1.104132  0.000000  0.927778
  3.666667  0.306703  1.124579  0.000000  0.927778
  3.733333  0.306703  1.145026  0.000000  0.927778
  3.800000  0.306703  1.165473  0.000000  0.927778
  3.866667  0.306703  1.185920  0.000000  0.927778
  3.933333  0.306703  1.206367  0.000000  0.927778
  4.000000  0.306703  1.226814  0.000000  0.927778
  4.066667  0.306703  1.247260  0.000000  0.927778
  4.133333  0.306703  1.267707  0.000000  0.927778
  4.200000  0.306703  1.288154  0.000000  0.927778
  4.266667  0.306703  1.308601  0.000000  0.927778
  4.333333  0.306703  1.329048  0.000000  0.927778
  4.400000  0.306703  1.349495  0.000000  0.927778
  4.466667  0.306703  1.369942  0.000000  0.927778
  4.533333  0.306703  1.390389  0.000000  0.927778
```

```
  4.600000  0.306703  1.410836  0.000000  0.927778
  4.666667  0.306703  1.431283  0.000000  0.927778
  4.733333  0.306703  1.451729  0.000000  0.927778
  4.800000  0.306703  1.472176  0.000000  0.927778
  4.866667  0.306703  1.492623  0.000000  0.927778
  4.933333  0.306703  1.513070  0.000000  0.927778
  5.000000  0.306703  1.533517  0.000000  0.927778
  5.066667  0.306703  1.553964  0.000000  0.927778
  5.133333  0.306703  1.574411  0.000000  0.927778
  5.200000  0.306703  1.594858  0.000000  0.927778
  5.266667  0.306703  1.615305  0.000000  0.927778
  5.333333  0.306703  1.635751  0.000000  0.927778
  5.400000  0.306703  1.656198  0.000000  0.927778
  5.466667  0.306703  1.676645  0.000000  0.927778
  5.533333  0.306703  1.697092  0.000000  0.927778
  5.600000  0.306703  1.717539  0.000000  0.927778
  5.666667  0.306703  1.737986  0.000000  0.927778
  5.733333  0.306703  1.758433  0.000000  0.927778
  5.800000  0.306703  1.778880  0.000000  0.927778
  5.866667  0.306703  1.799327  0.000000  0.927778
  5.933333  0.306703  1.819773  0.000000  0.927778
  6.000000  0.306703  1.840220  0.000000  0.927778
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL      REPL
COPY   602 OUTPUT MEAN   1 1     48.4      WDM    902 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
```

```
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 13:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.1563E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 13:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -6.881E+04    2.5754     2.5754       2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 14: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.3126E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 14: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.157E+05    4.3301     4.3301       2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 14:15

RCHRES:     1
```

```
The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.4439E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 14:15

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.551E+05    5.8045  5.8045E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 14:30

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.5354E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 14:30

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.825E+05    6.8315  6.8315E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 14:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.5636E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 14:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.910E+05    7.1484  7.1484E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 15: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.5559E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 15: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.887E+05    7.0613  7.0613E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 15:15

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.5290E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 15:15

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
```

```
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.806E+05    6.7597     6.7597       2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 15:30

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.4845E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 15:30

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.673E+05    6.2597  6.2597E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 15:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.4343E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 15:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.522E+05    5.6968  5.6968E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 16: 0
```

```
RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1          V2        VOL
91 7.9269E+04 8.0160E+04 8.3835E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 16: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.370E+05    5.1257  5.1257E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 16:15

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1          V2        VOL
91 7.9269E+04 8.0160E+04 8.3317E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 16:15

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.214E+05    4.5444  4.5444E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 16:30

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:
```

```
NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.2767E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 16:30

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -1.049E+05    3.9268     3.9268       2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 16:45

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.2143E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 16:45

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -8.621E+04    3.2264  3.2264E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 17: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.1469E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 17: 0

RCHRES:     1
```

```
Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -6.599E+04    2.4697  2.4697E+00      2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1990/11/26 17:15

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91 7.9269E+04 8.0160E+04 8.0760E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1990/11/26 17:15

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 2.6720E+04 -4.471E+04    1.6734  1.6734E+00      2
```

Disclaimer

Legal Notice

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Local (360)943-0304

www.clearcreeksolutions.com

Appendix B

APPENDIX B – OTHER REPORTS

Geotechnical Engineering Report by GeoResources, LLC., dated March 26, 2020.

Wetland And Stream Report Williams Crossing Project by David Evans and Associates, Inc, dated September 27, 2023.

Infiltration Evaluation by Earth Solutions NW, LLC, dated February 13, 2024.

GEORESOURCES
earth science & geotechnical engineering
5007 Pacific Hwy E., Suite 16 | Fife, WA 98424 | 253.896.1011 | www.georesources.rocks

March 26, 2020

Three's Company LLC
17403-162nd Avenue SE
Renton, Washington 98058
(425) 226-3999

Attn: Mr. Brian Reas
reascrew@comcast.net

Geotechnical Engineering Report
Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600,-700, & -100
Doc ID: ThreesCompanyLLC.15thAveNE.RG

INTRODUCTION

This geotechnical engineering report summarizes our site observations, subsurface explorations, laboratory testing, and engineering analyses, and provides geotechnical recommendations and design criteria for the proposed multi-family residential development to be constructed at 5224, 5228, and 5216 – 15th Avenue NE in the Olympia area of Thurston County, Washington. The general location of the site is shown on the attached Site Location Map, Figure 1.

Our understanding of the project is based on our email discussions with your civil engineer Mr. Chris Cramer of Patrick Harron & Associates; our December 31, 2019 and February 11, 2020 site visits and subsurface explorations; our understanding of the Thurston County Development Codes; our understanding of the 2016 Thurston County Drainage Design and Erosion Control Manual (TCDDECM); and our experience in the site area. The site consists of three contiguous tax parcels, one of which is currently developed with an existing single-family residence. In addition, two wetlands have been delineated in the lower, northern portion of the site. We understand that the proposed development may include several multi-family residential buildings, single-family residential structures, paved access roads and parking stalls, associated utilities, and stormwater facilities. We understand that the multi-family residential buildings will likely be three-story, wood-framed structures and we anticipate that the single-family residences will be one- to two-story, wood-framed structures. The proposed structures will likely be supported by conventional shallow foundations.

SCOPE OF SERVICES

The purpose of our services was to evaluate the surface and subsurface conditions across the site as a basis for providing geotechnical recommendations and design criteria for the proposed residential development. Specifically, the scope of services for this project included the following:

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

2. Exploring the subsurface conditions across the site by monitoring the excavation of nine test pits at select locations and by monitoring the drilling of two borings that were completed as groundwater monitoring wells;
3. Collecting select soil samples from the explorations and conducting grain size analyses and moisture content determinations, as appropriate;
4. Describing surface and subsurface conditions, including soil type, depth to groundwater, and estimate of high groundwater, if encountered;
5. Addressing the appropriate criteria for Geologic Hazards per the current Thurston County Geologic Hazard Areas Title 24.15;
6. Providing geotechnical conclusions and recommendations regarding site grading activities including: site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut and fill slopes, and drainage and erosion control measures;
7. Providing recommendations for seismic design parameters, including 2015 IBC site class;
8. Providing geotechnical conclusions and design criteria for shallow foundations, including shallow foundation parameters and floor slabs, including bearing capacity and subgrade modulus, as appropriate;
9. Providing recommendations for cast-in-place subgrade walls, including lateral earth pressures and applicable seismic surcharges;
10. Providing recommendations for erosion and sediment control during wet weather grading and construction; and,
11. Preparing this written *Geotechnical Engineering Report* summarizing our site observations and conclusions, and our geotechnical recommendations and design criteria, along with the supporting data.

The above scope of work was summarized in our *Proposal for Geotechnical Engineering* Services dated December 10, 2019. We received written authorization to proceed by you on December 12, 2019. We understand that groundwater monitoring is being required through the wet season (October 1 through April 30) and we are currently monitoring both wells at the site. Once our monitoring is complete, we will summarize the results in an addendum letter.

SITE CONDITIONS

Surface Conditions

The site is located at 5224, 5228, and 5216 – 15th Avenue NE in the Lacey area of Thurston County, Washington. The parcels, when combined, are generally rectangular in shape, measure approximately 475 to 675 feet wide (east to west) by approximately 1,025 to 1,300 feet deep (north to south), and encompasses approximately 18.73 acres. The site is bounded by existing residential development to the east and west, an undeveloped forested parcel to the north, and 15th Avenue NE to the south. The southeast portion of the site is currently developed with a single-family residence.

Based off information obtained from the from a site survey completed by MTN2COAST, LLC dated November 6, 2019 and generally confirmed in the field, the site generally slopes down from south to north. From 15th Avenue NE, the site gently slopes up to the north at about 3 percent before sloping back down to the north at about 3 to 5 percent. North of the existing residence, in the central portion of the site, the site slopes more steeply down to the north at about 15 to 40 percent. These steeper slopes have a vertical relief of about 15 to 50 feet. A more gently sloping ridgeline cuts across the northern portion of the site trending southwest to northeast. The ridge slopes down to the northeast at about 3 to 10 percent with side slopes of about 20 to 35 percent. The lower northeast and northwest corners of the site are generally flat to gently sloping down to then northeast and north at about 4 to 6 percent. Total topographic relief across the site is on the order of 64 feet. The existing site configuration and topography is shown on the Site & Exploration Map, Figure 2.

Vegetation across the upper southern half of the site generally consists of grassy areas with scattered coniferous trees. The northern, sloping portion of the site is generally vegetated with a medium to dense stand of fir, cedar, and deciduous trees with a moderate to dense understory of ferns, salal, evergreen huckleberries, and blackberries. No areas of surficial erosion, seeps, springs, or deep-seated slope movement was observed during our site visits. Some small areas of standing water were observed across the lower, northern portion of a trail/footpath that winds across the site.

Site Soils

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey maps the site as being underlain by Giles silt loam (39), Hoogdal silt loam (43), Indianola loamy sand (48), and Skipopa silt loam (108) soils. The Giles soils, mapped as underlying the upper southeastern portion of the site, are derived from volcanic ash and glacial outwash and form on slopes of 3 to 15 percent. These soils have a "slight" erosion hazard when exposed and are included in hydrologic soils group B. The Hoogdal soils, mapped along the more steeply sloping, central portion of the site, are derived from loess and glaciolacustrine deposits, form on slopes of 15 to 30 percent, have a "moderate" erosion hazard when exposed, and are included in hydrologic soils group D. The Indianola soils, underlying the northeastern and northwestern corners of the site, are derived from sandy glacial outwash and form on slopes of 15 to 30 percent. These soils have a "moderate" erosion hazard when exposed and are included in hydrologic soils group A. The Skipopa soils, mapped in the upper southwestern and lower northern portions of the site, are derived from volcanic ash over glaciomarine deposits, form on slopes of 3 to 15 percent, have a "slight" erosion hazard when exposed, and are included in hydrologic soils group D. A copy of the soils map for the site vicinity is provided as Figure 3.

Site Geology

The *Geologic Map of the Lacey 7.5-minute Quadrangle, Thurston County, Washington (Logan et al., 2003)* maps the site as being underlain by Vashon recessional sand and minor silt (Qgos). These soils were generally deposited during the most recent Vashon Stade of the Fraser Glaciation, some 12,000 to 15,000 years ago. The recessional outwash is typically comprised of poorly-sorted, lightly stratified mixture of sand and gravel that was deposited by meltwater streams emanating from the retreating ice mass. Because the recessional outwash soils were not subsequently overridden by the ice mass, they are considered to be normally-consolidated and generally provide moderate strength and compressibility characteristics, where undisturbed. Infiltration characteristics of outwash depends on the distribution of sand and gravel particles, but is generally favorable. An excerpt of the above reference geologic map is attached as Figure 4.

Subsurface Explorations

On December 31, 2019 a representative from GeoResources, LLC (GeoResources) visited the site and monitored the excavation of nine test pits to depths of about 8.5 to 13 feet below the existing ground surface. We returned to the site on February 11, 2020 to monitor the drilling of two borings to 36.5 to 51.5 feet below the existing ground surface. The test pits were excavated by a licensed earthwork contractor operating a track-mounted excavator and the borings were drilled by a licensed drilling contractor operating a small track-mounted drill rig, both working under contract for GeoResources.

The specific number, locations, and depths of our explorations were selected based on the configuration of the proposed development and were adjusted in the field based on consideration for underground utilities, existing site conditions, site access limitations, and encountered stratigraphy. Representative soil samples obtained from the test pits were placed in sealed plastic bags and then taken to our laboratory for further examination and testing as deemed necessary. Soil densities presented on the test pit logs are based on the difficulty of excavation and our experience. The test pits were backfilled with the excavated soils and bucket tamped, but not otherwise compacted, while the borings were completed as groundwater monitoring wells by the driller in general accordance with Washington State Department of Ecology requirements.

During drilling, soil samples were obtained at 2½- and 5-foot depth intervals in accordance with Standard Penetration Test (SPT) as per the test method outlined by ASTM D1586. The SPT method consists of driving a standard 2-inch-diameter split-spoon sampler 18-inches into the soil with a 140-pound hammer. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or “SPT blow count”. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The subsurface explorations completed as part of this evaluation indicate the subsurface conditions at specific locations only, as actual subsurface conditions can vary across the site. Furthermore, the nature and extent of such variation would not become evident until additional explorations are performed or until construction activities have begun.

The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) and ASTM D2488. The approximate locations of our explorations are indicated on the attached Site & Exploration Map, Figure 2. The USCS is included in Appendix A as Figure A-1, while descriptive logs of the soils encountered are included as Figures A-2 through A-6.

Subsurface Conditions

Our test pit explorations encountered relatively uniform subsurface conditions that, in our opinion, generally agree with the mapped stratigraphy within the site vicinity. In general, our test pits encountered about 0.1 to 1 foot of topsoil overlying about 1 to 3 feet of brown silty sand in a loose, moist condition. We interpret these soils to be consistent with weathered outwash. Underlying the weathered soils, our explorations encountered brown-grey sand to sand with silt in a loose to medium dense, moist condition to the full depth explored. We interpret these soils to be consistent with recessional outwash. Overlying the outwash in Test Pits TP-2 and TP-7, we encountered about 1 to 8.5 feet of brown to tan silt in a medium stiff, moist condition. We interpret these soils to be consistent with recessional lacustrine or slackwater deposits.

Our borings encountered similar subsurface conditions across the site. Boring B-1, located in the lower, northern portion of the site encountered about 1.5 feet of silty topsoil overlying about 4 feet of mottled tan silt in a stiff, moist condition. Underlying these upper fine-grained soils, our boring encountered sand to sand with silt in a loose to medium dense, moist to wet condition to the full depth explored. Silt interbeds were encountered within these sandy soils at about 16 and 30 feet below the ground surface. Boring B-2, in the upper portion of the site, encountered about 1 foot of sandy dark brown topsoil overlying about 1.5 feet of tan to brown silty sand in a loose, moist condition. Underlying these upper soils, our exploration encountered grey brown sand to sand with silt in a medium dense, moist condition to the full depth explored. We interpret these soils to be consistent with weathered outwash over recessional outwash.

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the test pits to determine soil index and engineering properties encountered. Laboratory testing included visual soil classification per ASTM D2488, moisture content determinations per ASTM D2216, and grain size analyses per ASTM D6913 standard procedures. The results of the laboratory tests are included in Appendix B.

Groundwater Conditions

Groundwater seepage was not observed in our test pit explorations at the time of excavation. However, groundwater was encountered in our lower boring (B-1) at about 31 feet below the ground surface at the time of drilling. A small seepage zone was also observed in Boring B-1 at about 16 feet below ground surface where fine grained soils were encountered. We interpret the observed groundwater seepage to be associated with a localized perched groundwater table and the lower groundwater to be more representative of regional levels. Perched groundwater typically develops when the vertical infiltration of precipitation through a more permeable soil is slowed at depth by a deeper, less permeable soil type. We anticipate fluctuations in the local groundwater levels will occur in response to precipitation patterns, off-site construction activities, and site utilization.

ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our data review, site reconnaissance, subsurface explorations and our experience in the area, it is our opinion that the site is suitable for the proposed residential development. Infiltration into the recessional sand soils appears to be feasible at the site, especially in the upper portion of the site. Discontinuous impermeable fine-grained deposits were encountered within the recessional sands in the northern portion of the site and may limit facility siting and depths if proposed in those areas. Pertinent conclusions and geotechnical recommendations regarding the design and construction of the proposed development are presented below.

Landslide Hazard Areas – Per TCC 24.03.010

According to the Thurston County Code 24.03.010 , landslide hazard areas means those areas which are potentially subject to risk of mass movement due to a combination of geologic, topographic, and hydrologic factors; and where the vertical height is fifteen feet or more, excluding those wholly manmade slopes created under the design and inspection of a geotechnical professional. The following areas are considered to be subject to landslide hazards:

A. Any area with a combination of:
    1. Slopes of fifteen percent or steeper, and
    2. Impermeable subsurface material (typically silt and clay), frequently interbedded with granular soils (predominantly sand and gravel), and

   3. Springs or seeping groundwater during the wet season (November to February);
- B. Steep slopes of forty percent or greater;
- C. Any areas located on a landslide features which has shown movement during the Holocene Epoch (post glacial) or which is underlain by mass wastage debris from that period of time;
- D. Known hazard areas, such as areas of historic failures, including areas of unstable, old and recent landslides;
- E. Breaks between landslide hazard areas shall be considered part of the landslide hazard area under the following condition: The length of the break is twice the height or less than the height of the slope below or above the break, whichever is greater; and the combined height is fifteen feet or more. When this condition is present, the upper and lower landslide hazard areas and the break shall be combined into one landslide hazard area.

Slopes of 15 percent or steeper are present across the central and northern portions of the site. Our lower boring encountered fine grained deposits interbedded with more granular soil; however, we would not interpret these to be adverse contacts based on the depth at which they were encountered. No evidence of springs or groundwater seepage along the slopes at the site were observed during our site visit. Groundwater was encountered at approximately Elevation 73 feet at the location of Boring B-1. This elevation is approximately the same as the wetlands delineated in the lower northern portion of the site.

No evidence of seepage on slopes, landslide activity, or significant erosion was observed at the site at the time of our visit. Slopes of 40 percent or steeper with 15 feet or more of vertical relief were not observed or mapped at the site. No planes of weakness, geomorphic features, tension cracks, or structural failure indicative of slope failure, toppling or leaning tress, gullying or surface erosion were observed at the site at the time of our visit. No areas of soft or liquefiable soils, alluvial deposits, or areas at risk of seismically induce mass movement were observed or mapped at or within 300 feet of the site.

Based on the above, it does appear that the site has one of the above listed indicators (slopes of forty percent); however, no evidence of landslide activity was observed at the site. Therefore, it is our opinion that no prescriptive buffer should be required by the County. Building setbacks in accordance with the 2015 International Building Code (IBC) may still be required by the Thurston County building department.

Recommended Setback from Steep Slopes

The 2015 International Building Code (IBC), Section 1808.7 requires a building setback from slopes that are steeper than 3H:1V (Horizontal: Vertical) or 33 percent with greater than 10 feet in vertical height, unless evaluated and reduced and/or a structural setback is provided by a licensed geotechnical engineer. The setback distance is calculated based on the vertical height of the slope. The typical 2015 IBC setback from the top of the slope equals one third the height of the slope or 40 feet, whichever is less, while a setback from the toe of the slope equals one half the height of the slope or 15 feet, whichever is less.

As stated above, portions of the site steeper than 33 percent. These slopes have vertical heights on the order of 10 to 15 feet in the northeastern portion of the site. Per the 2015 IBC, these slopes should have a minimum setback of 4 to 5 feet from the top of the slopes and 5 to 8 feet from the toe of the slopes.

Where the setback from the top of the slope cannot be met, a structural setback may be used. A structural setback is created by deepening the foundation elements so that, when measured horizontally from the font of the foundation to the face of the slope, the top of slope setback discussed above is met. If necessary, we can provide structural setback recommendations at your request.

Erosion Hazards – Per TCC 24.03.010

According to the TCC Critical Areas 24.03.010, an erosion hazard area means land characterized by soil types that are subject to severe erosion when disturbed. These include, but are not limited to, those identified by the United States Department of Agriculture Soil Conservation Service Soil Classification System, with a water erosion hazard of “severe” or “high” (See Table 24.15-3, Erosion Soils of Thurston County). These areas may not be highly erodible until or unless the soil is disturbed by activities such as clearing or grading.

As previously stated, the site is underlain by Giles silt loam (39) and Skipopa silt loam (108) which both have a “slight” erosion hazard when exposed and Hoogdal silt loam (43) and Indianola loamy sand (48) which have a “moderate” erosion hazard when exposed. No evidence of active or ongoing erosion was observed at the time of our site visits. In our opinion, the site does not have an active erosion hazard.

Seismic Design

The site is located in the Puget Sound region of western Washington, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca and North American plates. The Juan de Fuca plate is subducting beneath the North American plate at the Cascadia Subduction Zone (CSZ). This produces both intercrustal (between plates) and intracrustal (within a plate) earthquakes. In the following sections we discuss the design criteria and potential hazards associated with the regional seismicity.

Seismic Site Class

Based on our observations and the subsurface units mapped at the site, we interpret the structural site conditions to correspond to a seismic Site Class “D” in accordance with the 2015 IBC documents and American Society of Civil Engineers (ASCE) standard 7-10 Chapter 20 Table 20.3-1. This is based on the range of SPT (Standard Penetration Test) blow counts for the soils encountered in our borings. These conditions are assumed to be representative for the subsurface across the site.

Design parameters

The U.S. Geological Survey (USGS) completed probabilistic seismic hazard analyses (PSHA) for the entire country in November 1996, which were updated and republished in 2002 and 2008. We used the *ATC Hazard by Location* website to estimate seismic design parameters at the site. Table 1, below, summarizes the recommended design parameters.

TABLE 1:
2015 IBC PARAMETERS FOR DESIGN OF SEISMIC STRUCTURES

Spectral Response Acceleration (SRA) and Site Coefficients	Short Period	1 Second Period
Mapped SRA	S_s = 1.319	S_1 = 0.536
Site Coefficients (Site Class D)	F_a = 1.000	F_v = 1.500
Maximum Considered Earthquake SRA	S_{MS} = 1.319	S_{M1} = 0.804
Design SRA	S_{DS} = 0.880	S_{D1} = 0.536

Peak Ground Acceleration

The mapped peak ground acceleration (PGA) for this site is 0.5g. To account for site class, the PGA is multiplied by a site amplification factor (F_{PGA}) of 1.0. The resulting site modified peak ground acceleration (PGA_M) is 0.5g. In general, estimating seismic earth pressures (k_h) by the Mononobe-Okabe method are taken as 50 percent of the PGA_M, or 0.25g.

Seismic Hazards

Earthquake-induced geologic hazards may include liquefaction, lateral spreading, slope instability, and ground surface fault rupture. Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure in soils. The increase in pore water pressure is induced by seismic vibrations. Liquefaction primarily affects geologically recent deposits of loose, uniformly graded, fine-grained sands and granular silts that are below the groundwater table. Based on our review of the Department of Natural Resources Liquefaction Susceptibility Map (Geologic Information Portal) the site appears to be in an area mapped as having a “low to moderate” susceptibility to liquefaction (Figure 5). In our opinion, this coincides with the conditions observed in the explorations performed at the site. Because of the relatively low susceptibility of site soils to liquefaction, it is our opinion that the likelihood of lateral spreading is also low.

Based on our review of the Department of Natural Resources Geologic Hazards Map (Geologic Information Portal), the site is located about 2 miles northeast of the Olympia structure faults (Figure 6). No evidence of ground fault rupture was observed in the subsurface explorations or out site reconnaissance. Therefore, in our opinion, the proposed structure should have no greater risk for ground fault rupture than other structures located in the area.

Foundation Support

Based on the subsurface conditions encountered across the site and our understanding of the preliminary plans, we recommend that spread footings be founded on the medium dense native soils or on structural fill that extends to suitable native soils.

The soil at the base of the footing excavations should be disturbed as little as possible. All loose, soft or unsuitable material should be removed or recompacted, as appropriate. A representative from our firm should observe the foundation excavations to determine if suitable bearing surfaces have been prepared.

We recommend a minimum width of 24 inches for isolated footings and at least 18 inches for continuous wall footings. All footing elements should be embedded at least 18 inches below grade for frost protection. Footings founded as described above on the medium dense sand or on imported clean "**Structural Fill**" may be designed with a maximum allowable bearing pressure of 2,000 psf (pounds per square foot). The weight of the footing and any overlying backfill may be neglected. The allowable bearing value may be increased by one-third for transient loads such as those induced by seismic events or wind loads.

Lateral loads may be resisted by friction on the base of footings and floor slabs and as passive pressure on the sides of footings. We recommend that an allowable coefficient of friction of 0.35 be used to calculate friction between the concrete and the underlying soil. Passive pressure may be determined using an allowable equivalent fluid density of 300 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

We estimate that settlements of footings designed and constructed as recommended will be less than 1 inch, for the anticipated load conditions, with differential settlements between comparably loaded footings of ½ inch or less. Most of the settlements should occur essentially as loads are being applied; however, disturbance of the foundation subgrade during construction could result in larger settlements than predicted. We recommend that all foundations be provided with footing drains constructed in accordance with the 2015 IBC Section 1805.4.2.

Floor Slab Support

Slab-on-grade floors, where constructed, should be supported on the medium dense recessional outwash or on structural fill prepared as described above. Any areas of old fill material should be evaluated during grading activity for suitability of structural support. Areas of significant organic debris should be removed.

We recommend that floor slabs be directly underlain by a minimum 4-inch thick capillary break that consists of clean, granular material, such as pea gravel or ⅝-inch clean crushed rock and should contain less than 2 percent fines. This layer should be placed in one lift and compacted to an unyielding condition.

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

A subgrade modulus of 200 pounds per cubic inch (pci) may be used for floor slab design. We estimate that settlement of the floor slabs designed and constructed as recommended, will be ½-inch or less over a span of 50 feet.

Cast-in-Place Subgrade/Basement Walls

The lateral pressures acting on retaining walls (such as basement or grade separation walls) will depend upon the nature and density of the soil behind the wall as well as the presence or absence of hydrostatic pressure. Below we provide recommended design values and drainage recommendations for retaining walls.

Design Values

For walls backfilled with granular well-drained soil and a level backslope, the design active pressure may be taken as 35 pcf (equivalent fluid density). For walls that are braced or otherwise restrained, the design at rest pressure may be taken as 55 pcf. For the condition of an inclined back slope, higher lateral pressures would act on the walls. For a 3H:1V (Horizontal to Vertical) slope above the wall, the active pressure may be taken as 48 pcf; for a 2H:1V back slope condition, a wall design pressures of 55 pcf may be assumed If basement walls taller than 6 feet are required, as seismic surcharge of 10H should be included where required by the code. If walls will be constructed with a backslope and will be braced or otherwise restrained against movement, we should be notified so that we can evaluate the anticipated conditions and recommend an appropriate at-rest earth pressure.

Lateral loads may be resisted by friction on the base of footings and as passive pressure on the sides of footings and the buried portion of the wall, as described in the "**Foundation Support**" section of this report.

Wall Drainage

Adequate drainage behind retaining structures is imperative. Positive drainage which controls the development of hydrostatic pressure can be accomplished by placing a zone of drainage behind the walls. Granular drainage material should contain less than 2 percent fines and at least 30 percent retained on the US No. 4 sieve.

A minimum 4-inch diameter perforated or slotted PVC pipe should be placed in the drainage zone along the base and behind the wall to provide an outlet for accumulated water and direct accumulated water to an appropriate discharge location. We recommend that a nonwoven geotextile filter fabric be placed between the soil drainage material and the remaining wall backfill to reduce silt migration into the drainage zone. The infiltration of silt into the drainage zone can, with time, reduce the permeability of the granular material. The filter fabric should be placed such that it fully separates the drainage material and the backfill, and should be extended over the top of the drainage zone. Typical wall drainage and backfilling details are shown on Figure 7.

A geocomposite drain mat may also be used instead of free draining soils, provided it is installed in accordance with the manufacturer's instructions. A soil drainage zone should extend horizontally at least 18 inches from the back of the wall. The drainage zone should also extend from the base of the wall to within 1 foot of the top of the wall. The soil drainage zone should be compacted to approximately 90 percent of the maximum dry density (MDD), as determined in accordance with ASTM D1557. Over-compaction should be avoided as this can lead to excessive lateral pressures on the wall.

Temporary Excavations

All job site safety issues and precautions are the responsibility of the contractor providing services/work. The following cut/fill slope guidelines are provided for planning purposes only. Temporary cut slopes will likely be necessary during grading operations or utility installation. All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements including Washington Administrative Code (WAC) and Washington Industrial Safety and Health Administration (WISHA). Excavation, trenching, and shoring is covered under WAC 296-155 Part N.

Based on WAC 296-155-66401, it is our opinion that the loose to medium dense outwash soils on the site would be classified as Type C soils. According to WAC 296-155-66403, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be sloped at a maximum inclination of 1½H:1V or flatter from the toe to top of the slope. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest.

Where it is not feasible to slope the site soils back at these inclinations, a retaining structure should be considered. Retaining structures greater than 4-feet in height (bottom of footing to top of structure) or that have slopes of greater than 15 percent above them, should be engineered per Washington Administrative Code (WAC 51-16-080 item 5). This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that GeoResources assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

Permanent Cut and Fill Slopes

Fill slopes constructed on grades that are steeper than 5H:1V should be constructed in accordance with Appendix J of the 2015 IBC and should utilize proper keying and benching methods. The benches should be 1½ times the width of the equipment used for grading and be a maximum of 3 feet in height. Subsurface drainage may be required in areas where significant seepage is encountered during grading. Collected drainage should be directed to an appropriate discharge point. Surface drainage should be directed away from all slope faces.

Permanent slopes in soil should be no steeper than 2H:1V. All permanent slopes should be protected from erosion as soon as feasible after grading is completed. Typical erosion control methods per the 2016 Thurston County Drainage Design and Erosion Control Manual should be sufficient for proposed site grading activities. Additionally, permanent slopes should be planted with a hardy vegetative groundcover, mulched, or armored with quarry spalls as soon as feasible after grading is completed.

Site Drainage

All ground surfaces, pavements and sidewalks at the site should be sloped away from the structures. Surface water runoff should be controlled by a system of curbs, berms, drainage swales, and or catch basins, and conveyed to an appropriate discharge point.

We recommend that footing drains are installed for the residence in accordance with the 2015 IBC, Section 1805.4.2, and basement walls (if utilized) have a wall drain as describe above. The roof drain should not be connected to the footing drain.

Stormwater Infiltration

Based on our subsurface explorations and our site observations, it is our opinion that onsite infiltration of stormwater runoff generated by the proposed development is feasible in the well-graded to poorly graded sand with variable silt and gravel content encountered across the upper, southern portions of the site.

Prior to the selection of an infiltration facility location, all minimum vertical separation and horizontal separation requirements should be considered. Per the 2016 TCDDECM, Volume III, Section 2.3, a minimum vertical separation of 1 foot is required between the bottom of a non-treatment infiltration Best Management Practice (BMP) and the top of an impermeable layer, such as hard pan, that serves 10,000 square feet (sf) of hard surfacing or less. A minimum of 3 feet of vertical separation is required for non-treatment infiltration BMPs serving 10,000 sf or more. Infiltration BMPs that provide water quality treatment for the stormwater require a minimum vertical separation of 5 feet between the bottom of the facility and the top of a restrictive layer, such as a seasonal high water table (2016 TCDDECM, Volume I, Section 4.7.3.3). Per Volume V, Chapter 2.2.6.8.1 of the 2016 TCDDECM, permeable pavement should not be located where seasonal high groundwater or an underlying impermeable/low permeable layer would create saturated conditions within 1 foot of the bottom of the lowest gravel base course. Based on our subsurface explorations, it is our opinion the above minimum vertical separation criteria could be met in the upper southern portions of the site. Vertical separation criteria could potentially be met in the lower, northern portion of the site but will be dependent on the proposed site grading. However, horizontal setback would also have to be considered, especially from steep slopes.

Soil gradation analyses were completed in accordance with ASTM D6913 and a site specific infiltration rate was determined in accordance with the Volume III Appendix III-A Method 3 – Soil Grain Size Analysis Method. Based on the Massmann equation we recommend a preliminary infiltration rate for the sand with silt soils of 4 inches per hour be used. Correction factors for testing method (0.4) and plugging (0.8) have been applied to this value in accordance with the 2016 TCDDECM. A factor of safety for geometry and below grade facilities should be applied by the civil engineer in accordance with the 2016 TCDDECM.

While the above recommended infiltration rate is suitable for the design of permeable pavement sections, the infiltration rate may not be suitable for treatment of runoff from the pollution generating surfaces. Appropriate soil amendments should be added to the soils below permeable pavement, if used, for water quality treatment in accordance with the 2016 DDECM.

We recommend that a representative from our firm be onsite at the time of excavation of the proposed infiltration facilities to verify that the soils encountered during construction are consistent with the soils observed in our subsurface explorations. In-situ infiltration testing should be performed at the time of stormwater design to verify the recommended infiltration rate within the proposed facility locations.

Appropriate design, construction, and maintenance are required to ensure the infiltration rate can be effectively maintained over time. It should be noted that special care is required during the grading and construction periods to avoid fine sediment contamination of the infiltration system. This may be accomplished through the use of an alternative stormwater management location during construction or by leaving the bottom of the system 1 to 2 feet higher than the design elevation and subsequently excavating to the finished grade after paving and landscaping installation are complete. All contractors, builders, and subcontractors working on the site should be advised to avoid allowing “dirty” stormwater to flow into the stormwater system during construction and landscaping activities. No concrete trucks should be washed or cleaned onsite.

All proposed infiltration facilities should be designed and constructed in accordance with the 2016 TCDDECM. All minimum separation, setback requirements, and infeasibility criteria per the 2016 TCDDECM should be considered prior to the selection, design, and location of any stormwater facility for the proposed development. The slopes located in the central portion of the site slope down to the north at greater than 15 percent. Per Volume V Appendix E of the 2016 TCDDECM, slopes steeper than 15 percent with greater than 10 feet of vertical relief are required to be setback at least 50 feet from the top of the slope.

EARTHWORK RECOMMENDATIONS

Site Preparation

All structural areas on the site to be graded should be stripped of vegetation, organic surface soils, and other deleterious materials including existing structures, foundations or abandoned utility lines. Organic topsoil is not suitable for use as structural fill, but may be used for limited depths in non-structural areas. Based on our subsurface exploration, we anticipate that stripping depth will likely range from about 6 to 12 inches. Areas of thicker topsoil or organic debris may be encountered in areas of heavy vegetation or depressions.

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

We recommend that a member of our staff evaluate the exposed subgrade conditions after removal of vegetation and topsoil stripping is completed and prior to placement of structural fill. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment during dry weather or probed with a ½-inch diameter steel T-probe during wet weather conditions.

Soft, loose or otherwise unsuitable areas delineated during proof-rolling or probing should be recompacted, if practical, or over-excavated and replaced with structural fill. The depth and extent of overexcavation should be evaluated by our field representative at the time of construction. The areas of old fill material should be evaluated during grading operations to determine if they need mitigation, recompaction, or removal.

Structural Fill

All material placed as fill associated with mass grading, as utility trench backfill, under building areas, or under roadways should be placed as structural fill. The structural fill should be placed in horizontal lifts of appropriate thickness to allow adequate and uniform compaction of each lift. Structural fill should be compacted to at least 95 percent of maximum dry density (MDD) as determined in accordance with ASTM D1557.

The appropriate lift thickness will depend on the structural fill characteristics and compaction equipment used, but it is typically limited to 4- to 6-inches for hand operated equipment. For planning purposes, we recommend a maximum loose-lift thickness of 12 inches for heavier equipment such as hoe-packs or drum rollers. We recommend that the appropriate lift thickness be evaluated by our field representative during construction. We recommend that our representative be present during site grading activities to observe the work and perform field density tests.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend a material such as well-graded sand and gravel with less than 5 percent (by weight) passing the US No. 200 sieve based on that fraction passing the ¾-inch sieve, such as *Gravel Backfill for Walls* (WSDOT 9-03.12(2)). If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, higher fines content (up to 10 to 12 percent) may be acceptable.

Material placed for structural fill should be free of debris, organic matter, trash, and cobbles greater than 6-inches in diameter. The moisture content of the fill material should be adjusted as necessary for proper compaction.

Suitability of On-Site Materials as Fill

During dry weather construction, any non-organic onsite soil may be considered for use as structural fill, provided it meets the criteria described above in the "**Structural Fill"** section and can be compacted as recommended. If the soil material is over optimum moisture at the time of excavation, it will be necessary to aerate or dry the soil prior to placement as structural fill. We generally did not observe the site soils to be excessively moist at the time of our subsurface explorations.

The recessional outwash encountered in our explorations is generally comparable to *Common Borrow* (WSDOT Standard Specification 9-03.14(3)). These soils should be suitable for use as structural fill provided the moisture content is maintained within 2 to 3 percent of the optimum moisture level. Because of the fines content in the shallow recessional lacustrine soils encountered in the lower portion of the site, we do not recommend that these soils be used for structural fill. These shallow, silty soils may be used as fill in non-structural areas.

We recommend that completed graded-areas be restricted from traffic or protected prior to wet weather conditions. The graded areas may be protected by paving, placing asphalt-treated base, a layer of free-draining material such as pit run sand and gravel or clean crushed rock material containing less than 5 percent fines, or some combination of the above.

Erosion Control

Weathering, erosion and the resulting surficial sloughing and shallow land sliding are natural processes. As noted, no evidence of surficial raveling or sloughing was observed at the site. To manage and reduce the potential for these natural processes, we recommend erosion protection measures be in place prior to grading activity on the site. Erosion hazards can be mitigated by applying Best Management Practices (BMP's) outlined in the 2016 TCDDECM. To manage and reduce the potential for these natural processes, we recommend the following:

- No drainage of concentrated surface water or significant sheet flow onto or near the steep slope area.
- No fill should be placed within any buffers or setback areas unless retained by engineered retaining walls or constructed as an engineered fill.
- Grading should be limited to providing surface grades that promote surface flows away from the top of slope to an appropriate discharge location.

If the recommended erosion and sediment control BMPs are properly implemented and maintained, it is our opinion that the planned development should not increase the potential for erosion of the site.

Wet Weather and Wet Condition Considerations

In the Puget Sound area, the wet season generally begins October 1st and continues through about April 30th, although rainy periods could occur at any time of year. Therefore, it is strongly encouraged that earthwork be scheduled during the dry weather months. Most of the soil at the site does not contain sufficient fines to produce an unstable mixture when wet. Soils with high fines contents are highly susceptible to changes in water content and tends to become unstable and impossible to proof-roll and compact if the moisture content exceeds the optimum.

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

- The ground surface in and surrounding the construction area should be sloped as much as possible to promote runoff of precipitation away from work areas and to prevent ponding of water.
- Work areas or slopes should be covered with plastic when not being worked. The use of sloping, ditching, sumps, dewatering, and other measures should be employed as necessary to permit proper completion of the work.
- Earthwork should be accomplished in small sections to minimize exposure to wet conditions. That is, each section should be small enough so that the removal of unsuitable soils and placement and compaction of clean structural fill could be accomplished on the same day. The size of construction equipment may have to be limited to prevent soil disturbance. It may be necessary to excavate soils with a backhoe, or equivalent, and locate them so that equipment does not pass over the excavated area. Thus, subgrade disturbance caused by equipment traffic would be minimized.
- Fill material should consist of clean, well-graded, sand and gravel, of which not more than 5 percent fines by dry weight passes the No. 200 mesh sieve, based on wet-sieving (ASTM D1140) the fraction passing the ¾-inch mesh sieve. The gravel content should range from between 20 and 50 percent retained on a No. 4 mesh sieve. The fines should be non-plastic.
- No exposed soil should be left uncompacted and exposed to moisture. A smooth-drum vibratory roller, or equivalent, should roll the surface to seal out as much water as possible.
- In-place soil or fill soil that becomes wet and unstable and/or too wet to suitably compact should be removed and replaced with clean, granular soil (see gradation requirements above).
- Excavation and placement of structural fill material should be observed on a full-time basis by a geotechnical engineer (or representative) experienced in wet weather/wet condition earthwork to determine that all work is being accomplished in accordance with the project specifications and our recommendations.
- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

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

LIMITATIONS

We have prepared this report for use by Three’s Company, LLC, and other members of the design team, for use in the design of a portion of this project. The data used in preparing this report and this report should be provided to prospective contractors for their bidding or estimating purposes only. Our report, conclusions and interpretations are based on our subsurface explorations, data from others and limited site reconnaissance, and should not be construed as a warranty of the subsurface conditions.

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

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

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

◆ ◆ ◆

We have appreciated the opportunity to be of service to you on this project. If you have any questions or comments, please do not hesitate to call at your earliest convenience.

Respectfully submitted,
GeoResources, LLC

Jordan L. Kovash, GIT
Staff Geologist in Training

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3/26/2020

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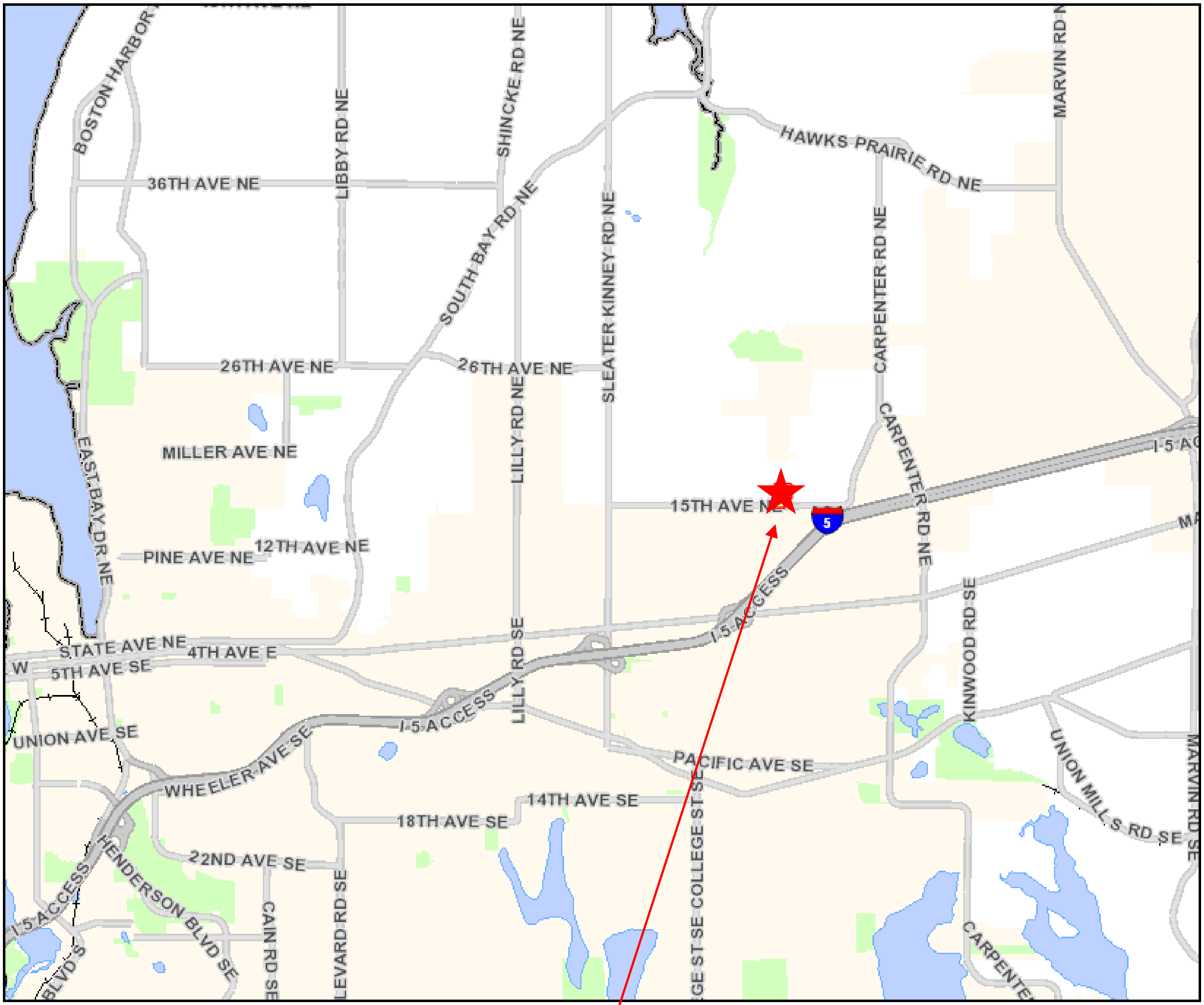
JLK:DCB:EWH/jlk
Doc ID: ThreesCompanyLLC.15thAveNE.RG
Attachments:
- Figure 1: Site Location Map
- Figure 2: Site & Exploration Map
- Figure 3: NRCS Soils Map
- Figure 4: Geologic Map
- Figure 5: Liquefaction Susceptibility Map
- Figure 6: Active Faults & Folds Map
- Figure 7: Typical Wall Drainage & Backfill Detail
- Appendix A - Subsurface Explorations
- Appendix B - Laboratory Test Results



Approximate Site Location

Map created from Thurston County Public GIS (http://www.geodata.org/parcelinfo/#)

N
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Not to Scale

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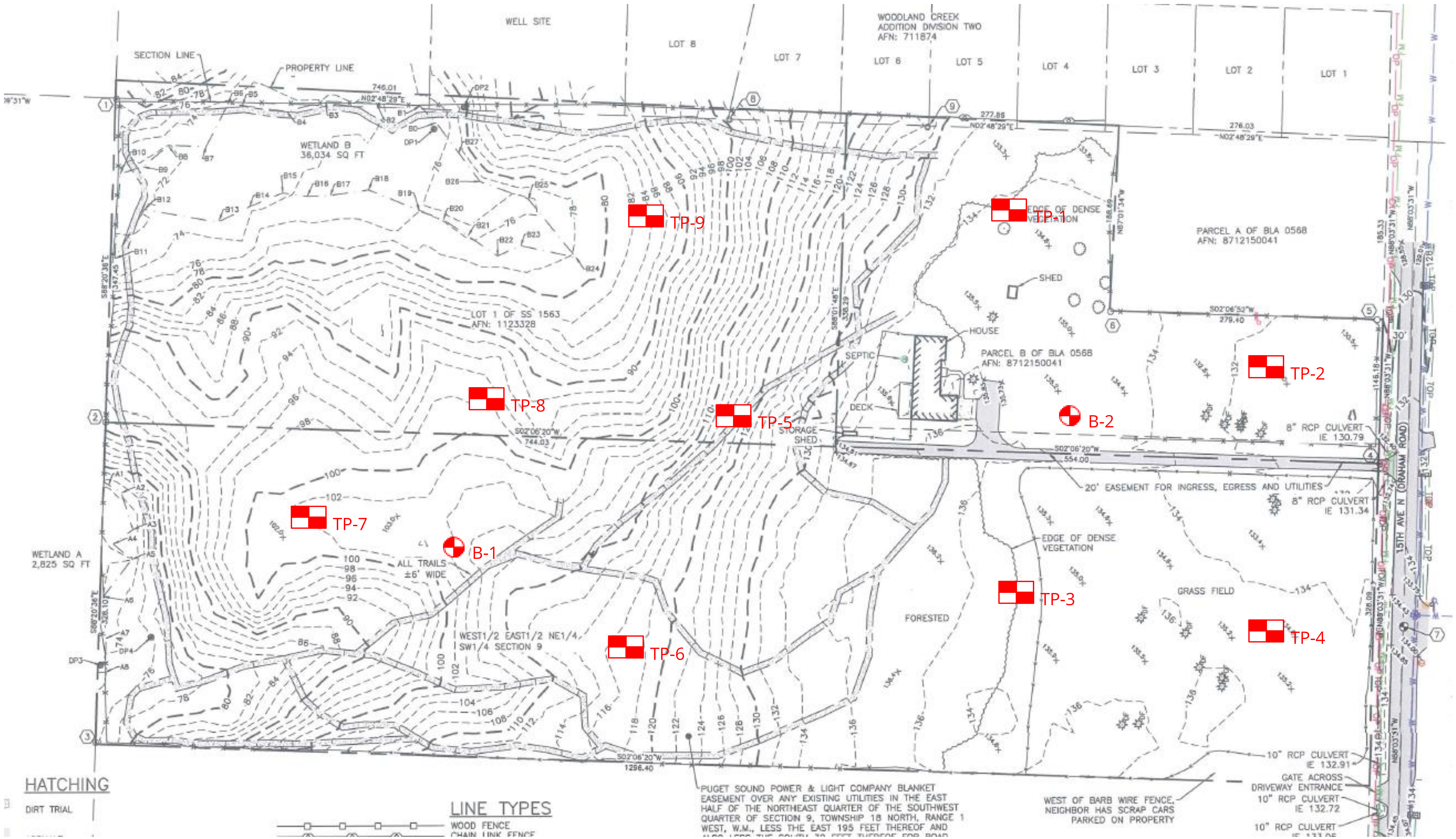
Site Location Map

Proposed Residential Development
5224, 5228, 5216 – 15th Avenue NE
Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure 1



Notes:
Site Survey prepared by MTN2COAST, LLC dated November 6, 2019

Scale 1:120

← NORTH

🟥 TP-1 Exploration number and approximate location (GeoResources 2019)
● B-1 Exploration number and approximate location (GeoResources 2020)

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Site & Exploration Map

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Thurston County, Washington
PN: 11809310-600, -700, & -100

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Approximate Site Location

Map created from Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Soil Type	Soil Name	Parent Material	Slopes	Erosion Hazard	Hydrologic Soils Group
39	Giles Silt Loam	Volcanic ash and glacial outwash	3 to 15	Slight	B
43	Hoogdal silt loam	Loess and glaciolacustrine deposits	15 to 30	Moderate	D
48	Indianola loamy sand	Sandy glacial outwash	15 to 30	Moderate	A
108	Skipopa silt loam	Volcanic ash over glaciolacustrine deposits	3 to 15	Slight	D

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NRCS Soils Map

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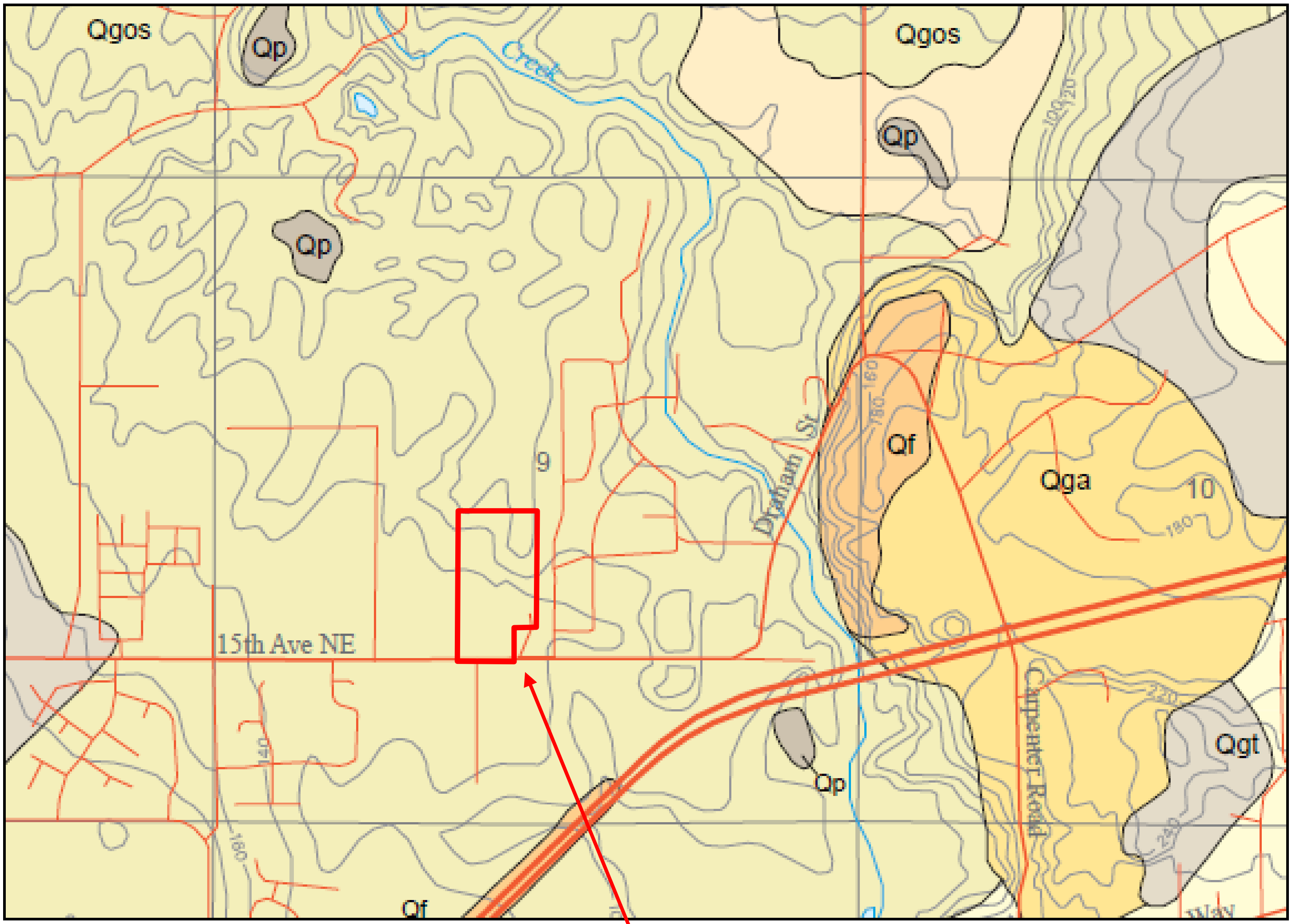

Approximate Site Location

An excerpt from *Geologic Map of the Lacey 7.5-minute Quadrangle, Thurston County, Washington* by Robert L. Logan, Timothy J. Walsh, Henry W. Schasse, and Michael Polenz (2003)

Qf	Fill
Qp	Peat
Qgos	Vashon recessional sand and minor silt

Not to Scale

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Geologic Map

Proposed Residential Development
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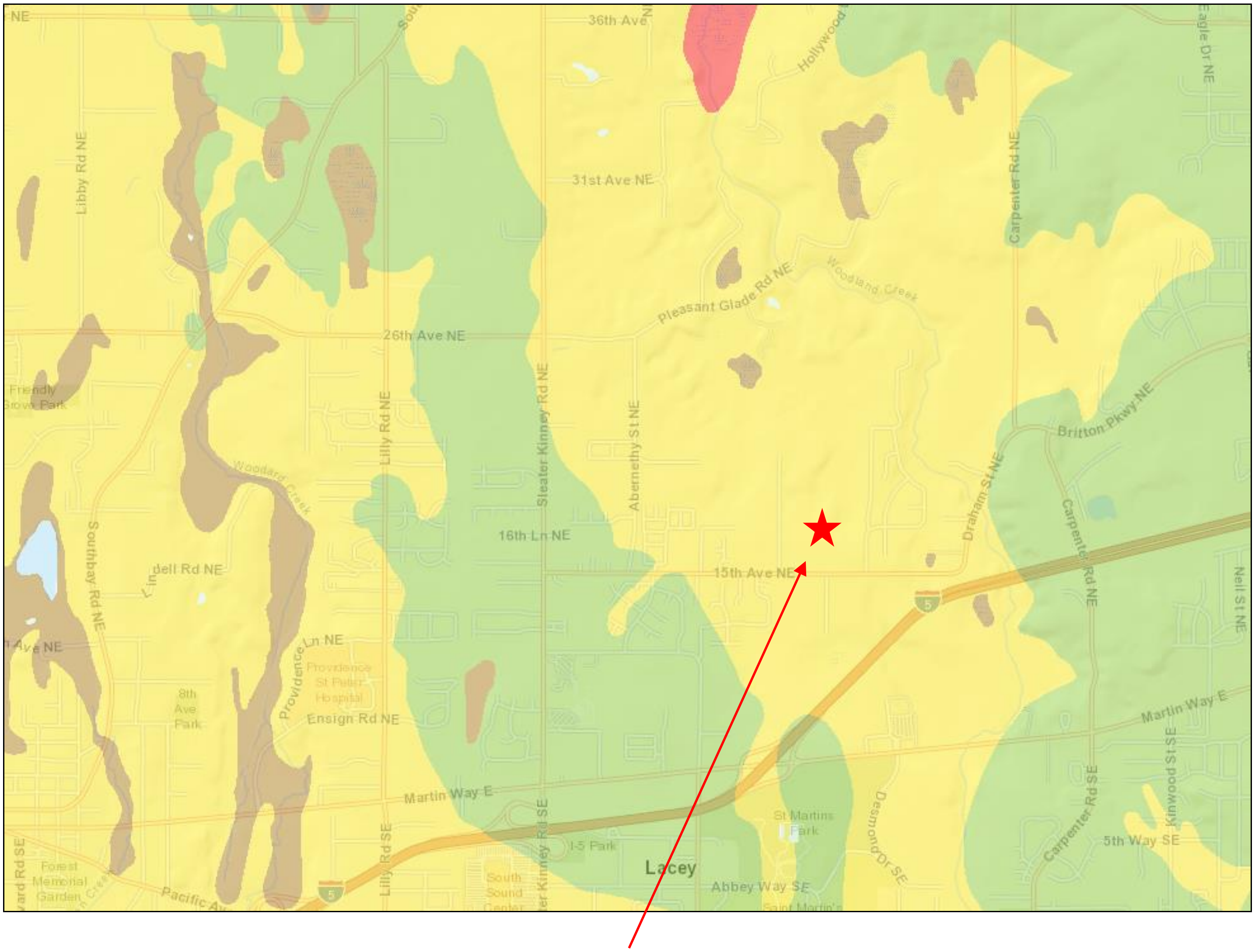

Approximate Site Location

Map created from Washington DNR Geologic Information Portal (https://geologyportal.dnr.wa.gov/)

Liquefaction Susceptibility

🟥 High

🟨 Low to moderate

🟩 Very low

🟫 Peat

🟦 Water

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WA DNR Liquefaction Susceptibility Map

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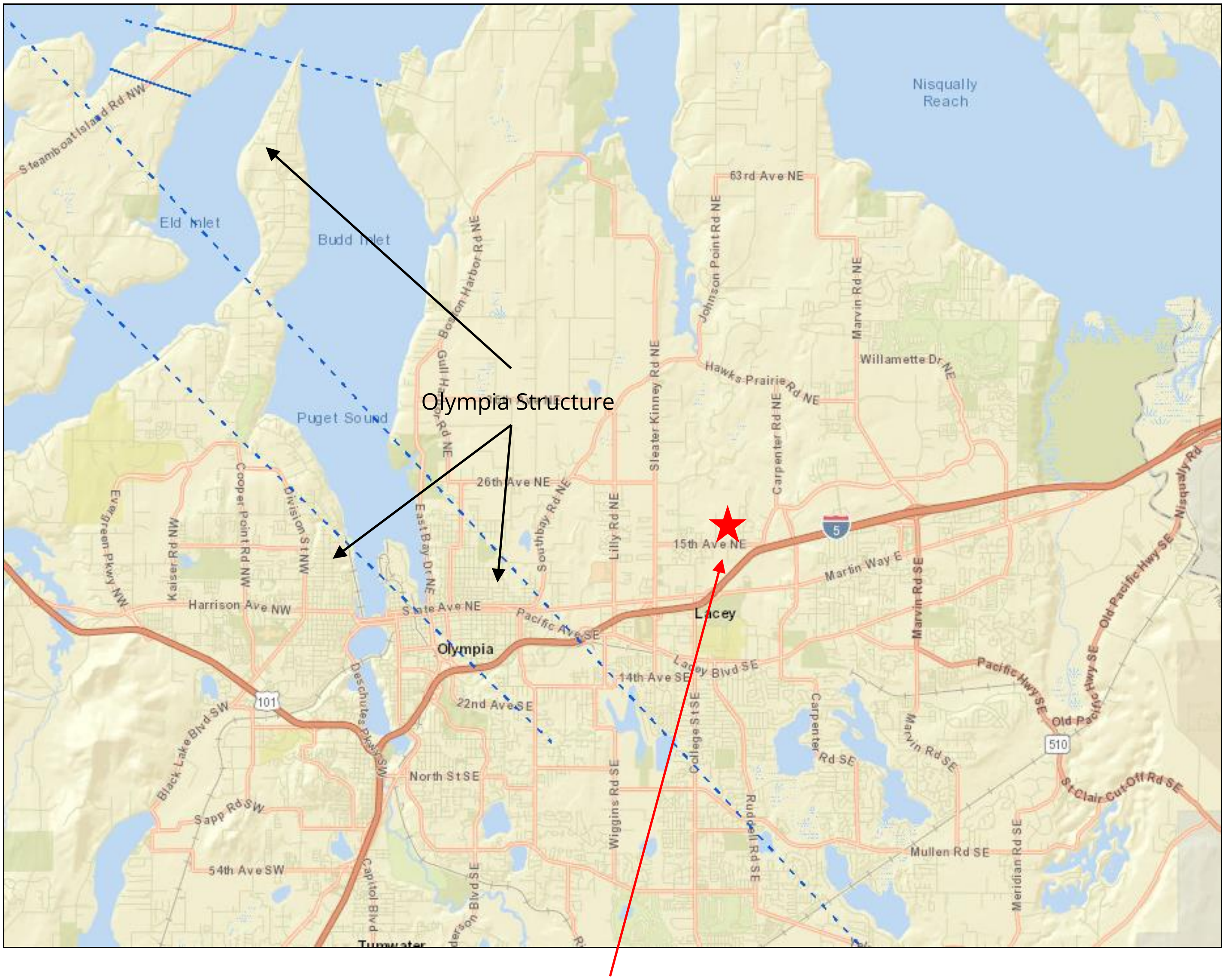

Approximate Site Location

Map created from Washington DNR Geologic Information Portal (https://geologyportal.dnr.wa.gov/)

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WA DNR Active Faults & Folds Map

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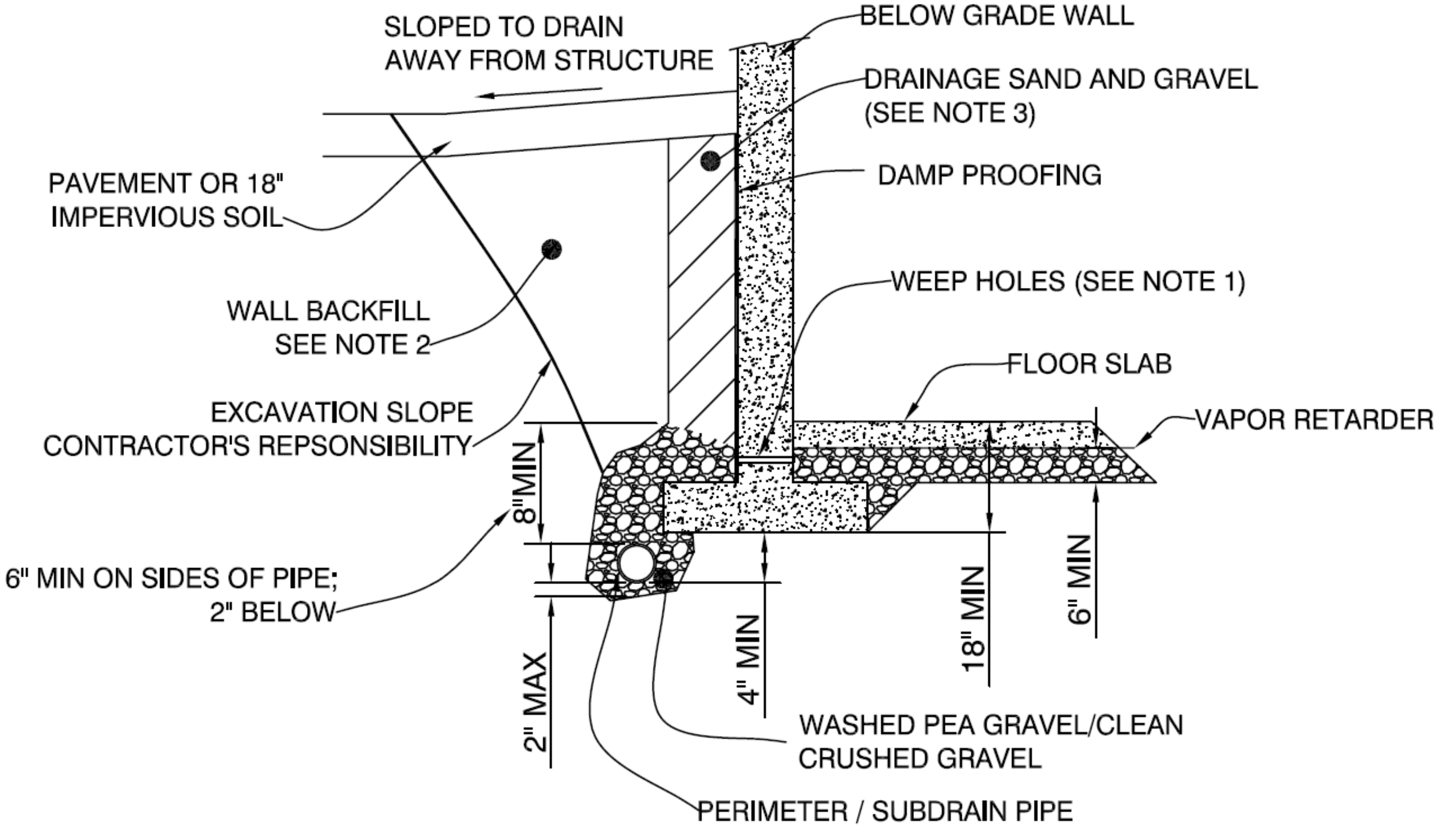
Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure 6



Notes

1. Washed pea gravel/crushed rock beneath floor slab could be hydraulically connected to perimeter/subdrain pipe. Use of 1" diameter weep holes as shown is one applicable method. Crushed gravel should consist of 3/4" minus. Washed pea gravel should consist of 3/8" to No. 8 standard sieve.

2. Wall backfill should meet WSDOT Gravel Backfill for walls Specification 9-03-12(2).

3. Drainage sand and gravel backfill within 18" of wall should be compacted with hand-operated equipment. Heavy equipment should not be used for backfill, as such equipment operated near the wall could increase lateral earth pressures and possibly damage the wall. The table below presents the drainage sand and gravel gradation.

4. All wall back fill should be placed in layers not exceeding 4" loose thickness for light equipment and 8" for heavy equipment and should be densely compacted. Beneath paved or sidewalk areas, compact to at least 95% Modified Proctor maximum density (ASTM: 01557-70 Method C). In landscaping areas, compact to 90% minimum.

5. Drainage sand and gravel may be replaced with a geocomposite core sheet drain placed against the wall and connected to the subdrain pipe. The geocomposite core sheet should have a minimum transmissivity of 3.0 gallons/minute/foot when tested under a gradient of 1.0 according to ASTM 04716.

6. The subdrain should consist of 4" diameter (minimum), slotted or perforated plastic pipe meeting the requirements of AASHTO M 304; 1/8-inch maximum slot width; 3/16- to 3/8-inch perforated pipe holes in the lower half of pipe, with lower third segment unperforated for water flow; tight joints; sloped at a minimum of 6"/100' to drain; cleanouts to be provided at regular intervals.

7. Surround subdrain pipe with 8 inches (minimum) of washed pea gravel (2" below pipe" or 5/8" minus clean crushed gravel. Washed pea gravel to be graded from 3/8-inch to No.8 standard sieve.

8. See text for floor slab subgrade preparation.

Materials

Drainage Sand and Gravel

Sieve Size	% Passing by Weight
¾"	100
No 4	28 – 56
No 8	20 – 50
No 50	3 – 12
No 100	0 – 2

¾" Minus Crushed Gravel

Sieve Size	% Passing by Weight
¾"	100
½"	75 – 100
¼"	0 – 25
No 100	0 – 2
(by wet sieving)	(non-plastic)

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Typical Wall Drainage & Backfill Detail

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Appendix A

Subsurface Explorations

SOIL CLASSIFICATION SYSTEM

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

NOTES:

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

SOIL MOISTURE MODIFIERS:

Dry-	Absence of moisture, dry to the touch
Moist-	Damp, but no visible water
Wet-	Visible free water or saturated, usually soil is obtained from below water table

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Unified Soils Classification System

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Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F	March 2020	Figure A-1

Test Pit TP-1

Location: East of existing residence
Approximate Elevation: 134’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	3.5	SM	Brown silty SAND (loose, moist) (Weathered recessional outwash)
3.5	-	10.0	SM	Brown-grey poorly graded SAND (loose, moist)(recessional outwash)

Terminated at 10 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 3 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-2

Location: south of existing residence
Approximate Elevation: 136’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	1.5	ML	Brown SILT with sand (medium stiff, moist) (Recessional lacustrine/slackwater)
1.5	-	7.5	SP	Brown-grey poorly graded SAND (loose) (Recessional outwash)
7.5	-	13.0	SP-SM	Brown-grey poorly graded SAND with some chunks of silty sand (loose, moist) (Recessional outwash)

Terminated at 13 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 4 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-3

Location: West of existing residence
Approximate Elevation: 132’

Depth (ft)			Soil Type	Soil Description
0.0	-	1.0	-	Dark brown topsoil
1.0	-	3.0	SM	Brown silty SAND (loose, moist) (Weathered recessional outwash)
3.0	-	10.5	SP	Brown-grey poorly graded SAND (loose, moist) (Recessional outwash)

Terminated at 10.5 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 3.5 feet below ground surface.
No groundwater seepage observed at time of excavation.

Logged by: DC

Excavated on: December 31, 2019

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Test Pit Logs

Proposed Residential Development
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Thurston County, Washington
PN: 11809310-600, -700, & -100

Doc ID: ThreesCompanyLLC.15thAveNE.F | March 2020 | Figure A-2

Test Pit TP-4

Location: SW corner of site
Approximate Elevation: 136’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.8	-	Dark brown topsoil
0.8	-	2.5	SM	Brown silty SAND (loose, moist) (Weathered recessional outwash)
2.5	-	10.0	SP	Brown-grey poorly graded SAND (loose, moist) (recessional outwash)

Terminated at 10 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 3 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-5

Location: Central portion of site, halfway down slope
Approximate Elevation: 102’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	8.5	SP	Brown-grey poorly graded SAND (loose to medium dense, moist) (Recessional outwash)

Terminated at 8.5 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 2 feet below ground surface.
No groundwater seepage observed at time of excavation.

Test Pit TP-6

Location: Western edge, central portion of site
Approximate Elevation: 92’

Depth (ft)			Soil Type	Soil Description
0.0	-	0.5	-	Dark brown topsoil
0.5	-	3.0	SM	Brown-tan silty SAND (loose, moist) (Weathered recessional outwash)
3.0	-	10.5	SP	Brown-grey poorly graded SAND (loose to medium dense, moist) (Recessional outwash)

Terminated at 10.5 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 5 feet below ground surface.
No groundwater seepage observed at time of excavation.

Logged by: DC **Excavated on: December 31, 2019**

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Test Pit Logs

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Thurston County, Washington
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Test Pit TP-7

Location: NW corner of site
Approximate Elevation: 84’

Depth (ft)	Soil Type	Soil Description
0.0 - 0.5	-	Dark brown topsoil
0.5 - 9.0	MH	Tan-grey SILT (medium stiff, moist) (Recessional lacustrine deposits)
9.0 - 11.0	SP	Brown-grey poorly graded SAND (medium dense, moist) (Recessional outwash)

Terminated at 11 feet below ground surface.
No iron oxide staining or mottling observed.
No caving observed at the time of excavation.
No groundwater seepage observed at time of excavation.

Test Pit TP-8

Location: North portion of site, base of slope
Approximate Elevation: 74’

Depth (ft)	Soil Type	Soil Description
0.0 - 1.0	-	Dark brown topsoil
1.0 - 3.5	SM	Brown-tan silty SAND (loose, moist) (Weathered recessional outwash)
3.5 - 12.0	SP-SM	Brown-grey poorly graded SAND with silt (loose to medium dense, moist) (Recessional outwash)

Terminated at 12 feet below ground surface.
Mottling/iron oxide staining observed at about 7 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed at time of excavation.

Test Pit TP-9

Location: West central portion of site
Approximate Elevation: 78’

Depth (ft)	Soil Type	Soil Description
0.0 - 0.1	-	Dark brown topsoil
0.1 - 10.0	SP	Brown-grey poorly graded SAND (loose to medium dense, moist) (Recessional outwash)

Terminated at 10 feet below ground surface.
No iron oxide staining or mottling observed.
Major caving observed at approximately 5 feet below ground surface.
No groundwater seepage observed at time of excavation.

Logged by: DC

Excavated on: December 31, 2019

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Test Pit Logs

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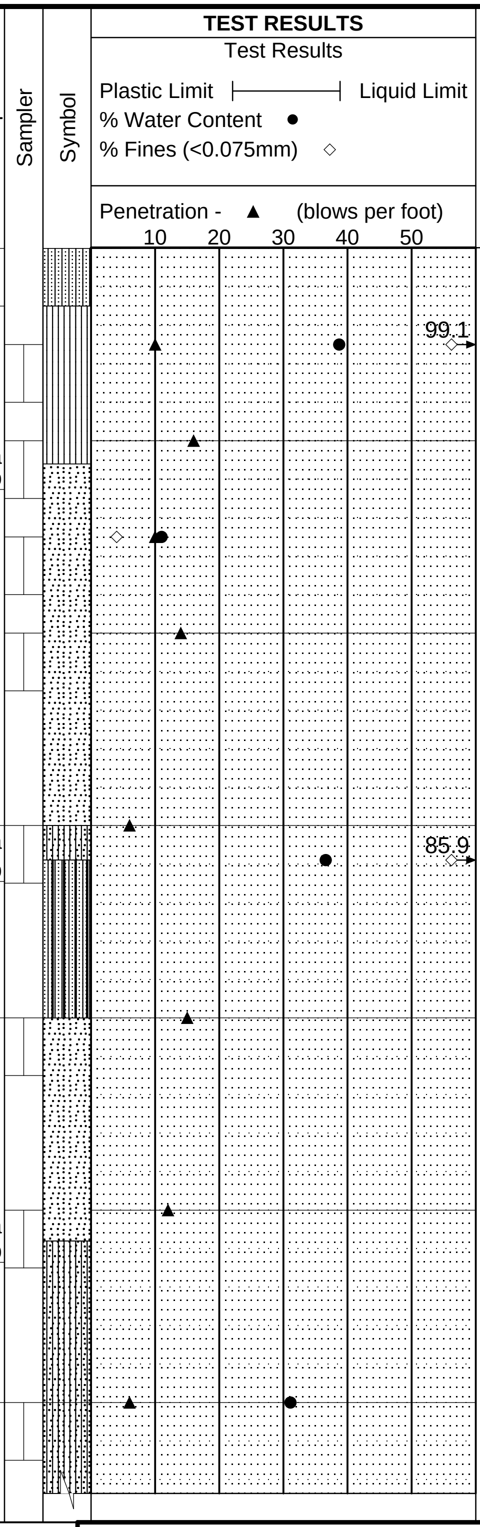
PN: 11809310-600, -700, & -100

TOTAL DEPTH: 36.5
TOP ELEVATION: 104
LATITUDE:
LONGITUDE:
DRILLING METHOD: HSA
DRILLING COMPANY: Boretec 1, Inc
DRILL RIG: EC 95 Track Drill
NOTES: NW portion of site
LOGGED BY: JLK
HAMMER TYPE: cat head
HAMMER WEIGHT: 140 lbs

Depth: 0, 5, 10, 15, 20, 25, 30
Elevation: 100, 95, 90, 85, 80, 75

SOIL DESCRIPTION	DRILLING NOTES	Sample	Blow Count	Ground Water
Grey brown silty SAND/sandy SILT (loose, moist) (Topsoil)				
Mottled tan sandy SILT, some gravel (loose, moist to wet) (Slackwater)		1 2a	3 5 5 3 7 9	
Grey brown SAND (medium dense, moist) (Recessional Outwash)		2b 3 4	5 5 5 6 7 7	
Grey brown silty fine SAND (loose, moist)		5a	5 4 2	
Grey brown sandy SILT (medium stiff, moist to wet) (Slackwater) (ML)		5b		
Grey SAND (medium dense, moist) (Recessional Outwash)		6 7a	5 7 8 4 6 6	
Grey silty fine SAND (medium dense, moist to wet)		7b		
Mottled grey brown silty SAND sandy SILT (medium stiff, moist to wet) (Slackwater)		8	1 2 4	ATD



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

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

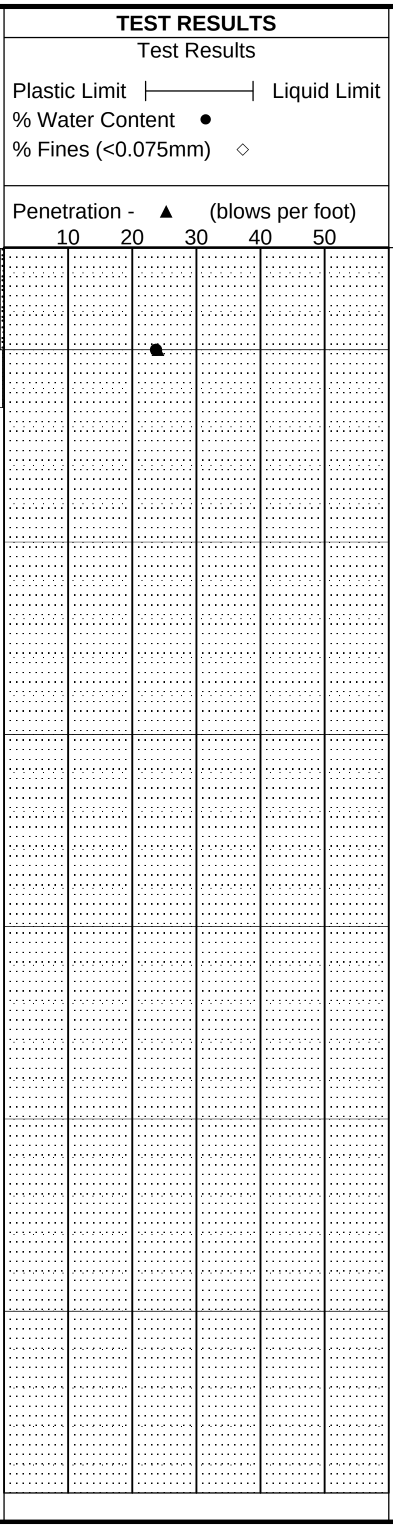
LOG OF BORING B-1

JOB: ThreesCompanyLLC.15thAveNE Sheet 1 of 2

GeoResources, LLC **FIG.A-5**

TOTAL DEPTH: 36.5
TOP ELEVATION: 104
LATITUDE:
LONGITUDE:
DRILLING METHOD: HSA
DRILLING COMPANY: Boretec 1, Inc
DRILL RIG: EC 95 Track Drill
NOTES: NW portion of site
LOGGED BY: JLK
HAMMER TYPE: cat head
HAMMER WEIGHT: 140 lbs

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Sampler	Symbol	TEST RESULTS	Blow Count	Ground Water
	70								
35		Grey silty SAND (medium dense, wet) (Recessional Outwash)		9				4 10 14	
		Bottom of Boring Completed2/11/2020							
	65								
40									
	60								
45									
	55								
50									
	50								
55									
	45								
60									
	40								



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

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

LOG OF BORING B-1

JOB: ThreesCompanyLLC.15thAveNE Sheet 2 of 2

GeoResources, LLC FIG. A-5

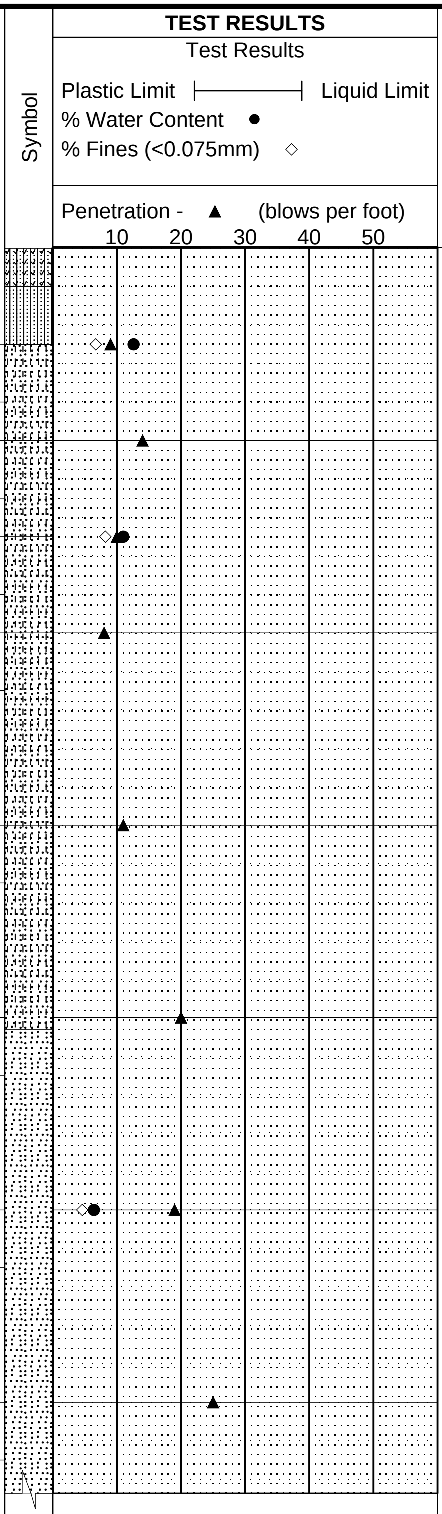
TOTAL DEPTH: 51.5
TOP ELEVATION: 135
LATITUDE:
LONGITUDE:

DRILLING METHOD: HSA
DRILLING COMPANY: Boretec 1, Inc
DRILL RIG: EC 95 Track Drill
NOTES:

LOGGED BY: JLK
HAMMER TYPE: cat head
HAMMER WEIGHT: 140 lbs

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Blow Count	Ground Water
0	135	Dark brown to brown silty SAND (loose, moist) (Topsoil)				
		Tan to brown silty SAND (loose, moist) (Weathered Recessional Outwash)				
		Tan to brown SAND with silt (loose, moist) (SP-SM) (Recessional Outwash)		1	4 4 5	
5	130	Grey brown SAND with silt (medium dense, moist)		2	5 7 7	
		Grey to grey brown SAND with silt and siltier interbeds (loose to medium dense, moist) (SP-SM)		3	6 5 5	
10	125	(loose, moist)		4	4 4 4	
15	120	(medium dense, moist)		5	4 5 6	
20	115	Grey brown SAND (medium dense, moist) (SP)		6b 6a	7 10 10	
25	110			7	7 9 10	
30	105			8	9 11 14	

Sampler | Symbol



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

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

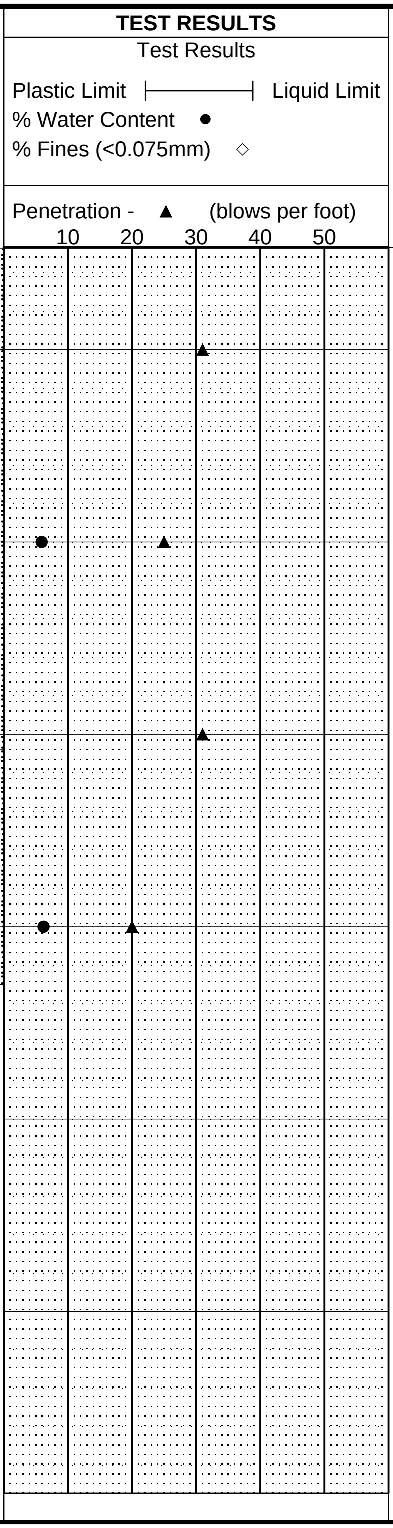
LOG OF BORING B-2

JOB: ThreesCompanyLLC.15thAveNE *Sheet 1 of 2*

GeoResources, LLC **FIG.A-6**

TOTAL DEPTH: 51.5
TOP ELEVATION: 135
LATITUDE:
LONGITUDE:
DRILLING METHOD: HSA
DRILLING COMPANY: Boretec 1, Inc
DRILL RIG: EC 95 Track Drill
NOTES:
LOGGED BY: JLK
HAMMER TYPE: cat head
HAMMER WEIGHT: 140 lbs

Depth	Elevation	SOIL DESCRIPTION	DRILLING NOTES	Sample	Sampler	Symbol	TEST RESULTS	Blow Count	Ground Water
35	100	(dense, moist)		9				10 14 17	
40	95	(medium dense, moist)		10				7 11 14	
45	90	(dense, moist) Grey brown fine SAND (dense, moist) (SP)		11a 11b				9 16 15	
50	85	Grey brown SAND (medium dense, moist) (SP) Bottom of Boring Completed2/11/2020		12				9 10 10	
55	80								
60	75								



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

Proposed Residential Development
5224, 5228, 5216 NE 15th Ave
Olympia, Washington

LOG OF BORING B-2

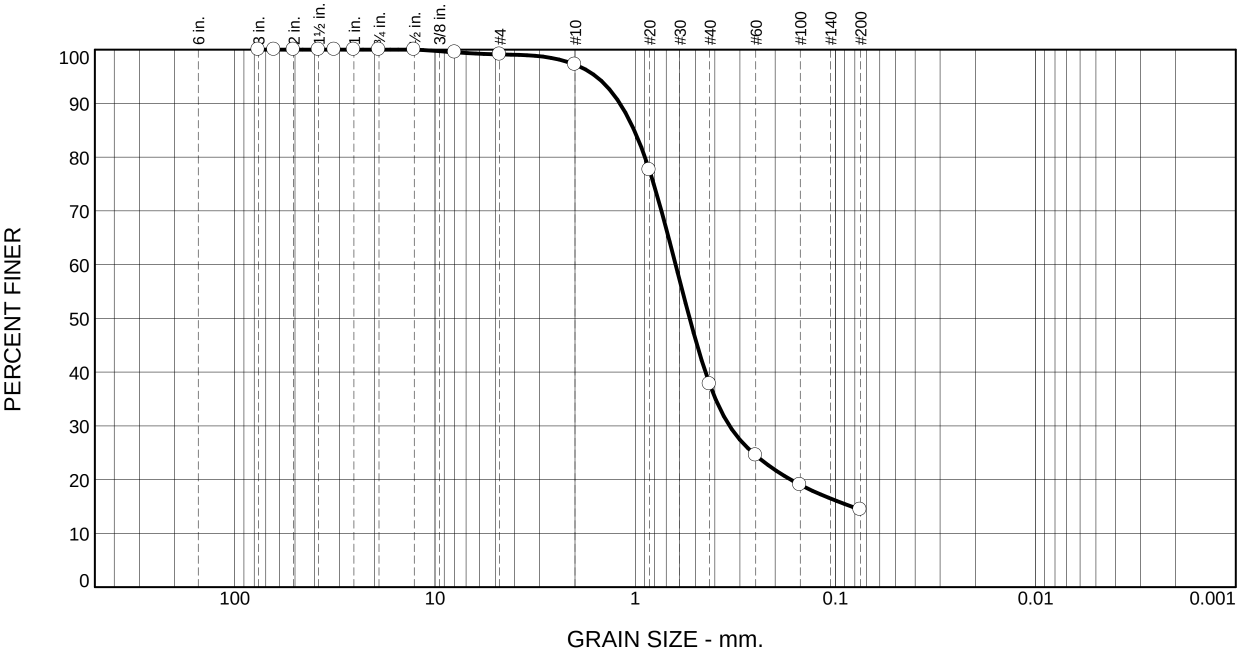
JOB: ThreesCompanyLLC.15thAveNE Sheet 2 of 2

GeoResources, LLC FIG. A-6

Appendix B

Laboratory Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	1.9	59.4	23.4	14.4	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	99.5		
#4	99.1		
#10	97.2		
#20	77.6		
#40	37.8		
#60	24.5		
#100	19.0		
#200	14.4		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}=	1.1930	D_{85}=	1.0117	D_{60}=	0.6282
D_{50}=	0.5348	D_{30}=	0.3379	D_{15}=	0.0831
D_{10}=		C_u=		C_c=	

Remarks

NM:12.6%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-1 S-2

Sample Number: 099034 **Depth:** 3.5-10'

Date Sampled: 12/31/2019

GeoResources, LLC

Fife, WA

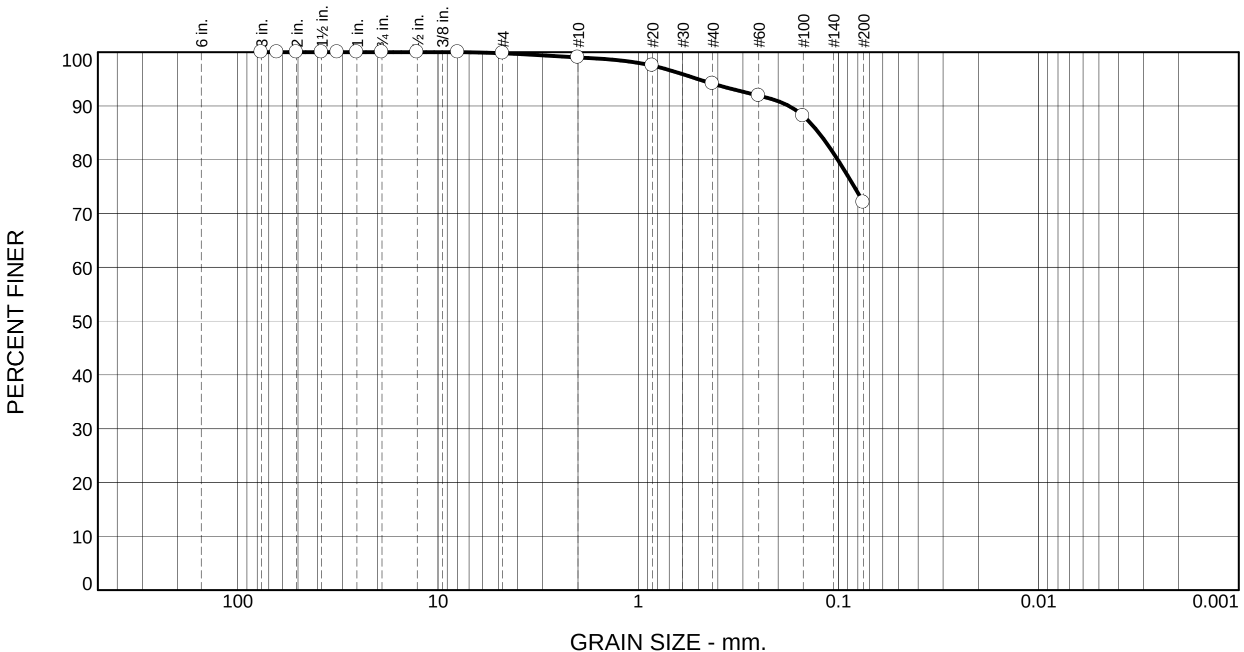
Client: Three's Company LLC

Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-1

Tested By: ____________________ **Checked By:** ____________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.8	4.9	22.0	72.1	

Test Results (ASTM D 6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	99.8		
#10	99.0		
#20	97.5		
#40	94.1		
#60	91.9		
#100	88.2		
#200	72.1		

* (no specification provided)

Material Description

SILT with Sand (ML)

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 0.1768 D_{85}= 0.1251 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

NM: 25.4%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020
Tested By: DC
Checked By: DCB
Title: PM

Location: TP-2 S-1
Sample Number: 099035 **Depth:** 0.5-1.5
Date Sampled: 12/31/2019

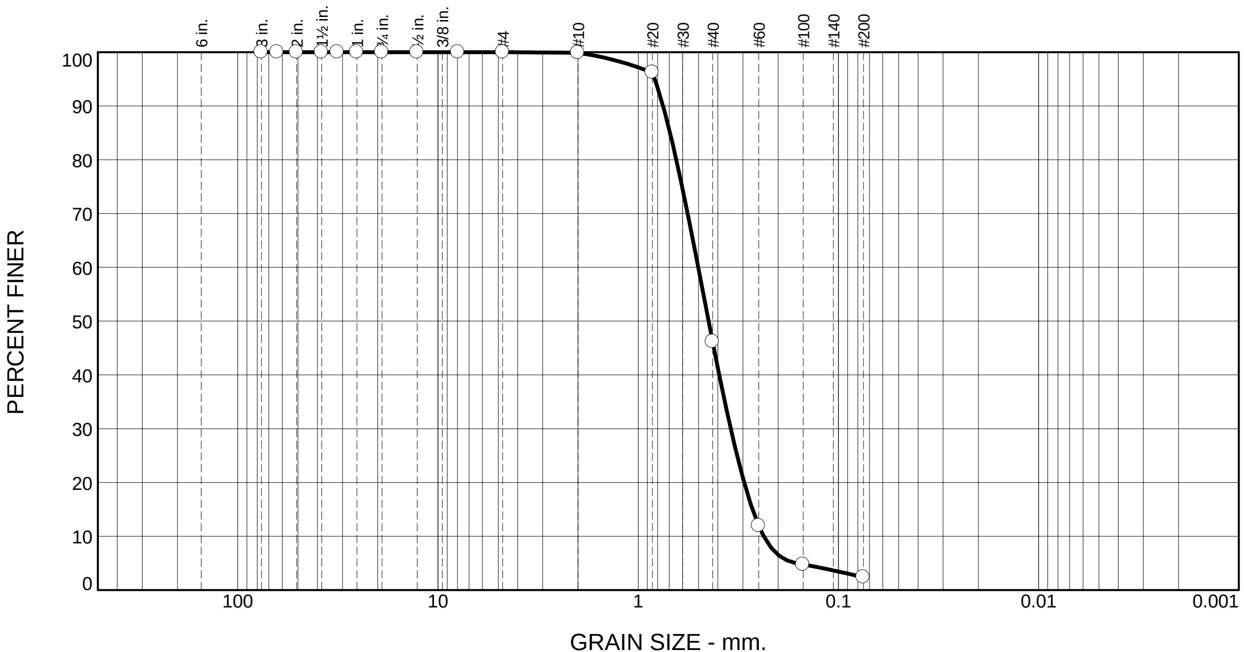
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-2

Tested By: ______________________ **Checked By:** ______________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	53.7	43.8	2.4	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.9		
#20	96.2		
#40	46.2		
#60	11.9		
#100	4.7		
#200	2.4		

* (no specification provided)

Material Description

poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.7509	D_{85}= 0.6930	D_{60}= 0.5015
D_{50}= 0.4451	D_{30}= 0.3449	D_{15}= 0.2688
D_{10}= 0.2359	C_u= 2.13	C_c= 1.01

Remarks

NM: 4.3%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020
Tested By: DC
Checked By: DCB
Title: PM

Location: TP-3 S-1
Sample Number: 099038 **Depth:** 3-10'
Date Sampled: 12/31/2019

GeoResources, LLC

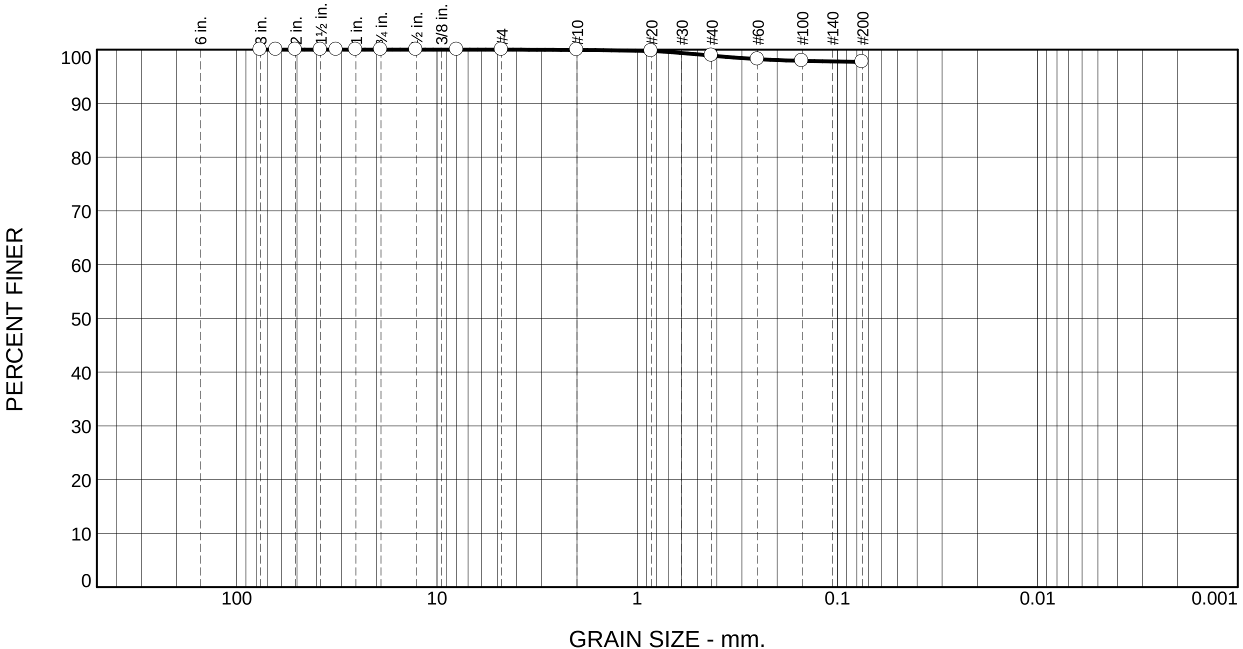
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-3

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

Tested By: ____________________ **Checked By:** ____________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.1	1.2	97.7	

Test Results (ASTM D 6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	100.0		
#20	99.8		
#40	98.9		
#60	98.2		
#100	97.9		
#200	97.7		

* (no specification provided)

Material Description

SILT (MH)

Atterberg Limits (ASTM D 4318)

PL= 33 **LL=** 52 **PI=** 19

Classification

USCS (D 2487)= MH **AASHTO (M 145)=** A-7-5(24)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

NM: 22.1%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-7 S-1
Sample Number: 099042 **Depth:** 1-9'
Date Sampled: 12/31/2019

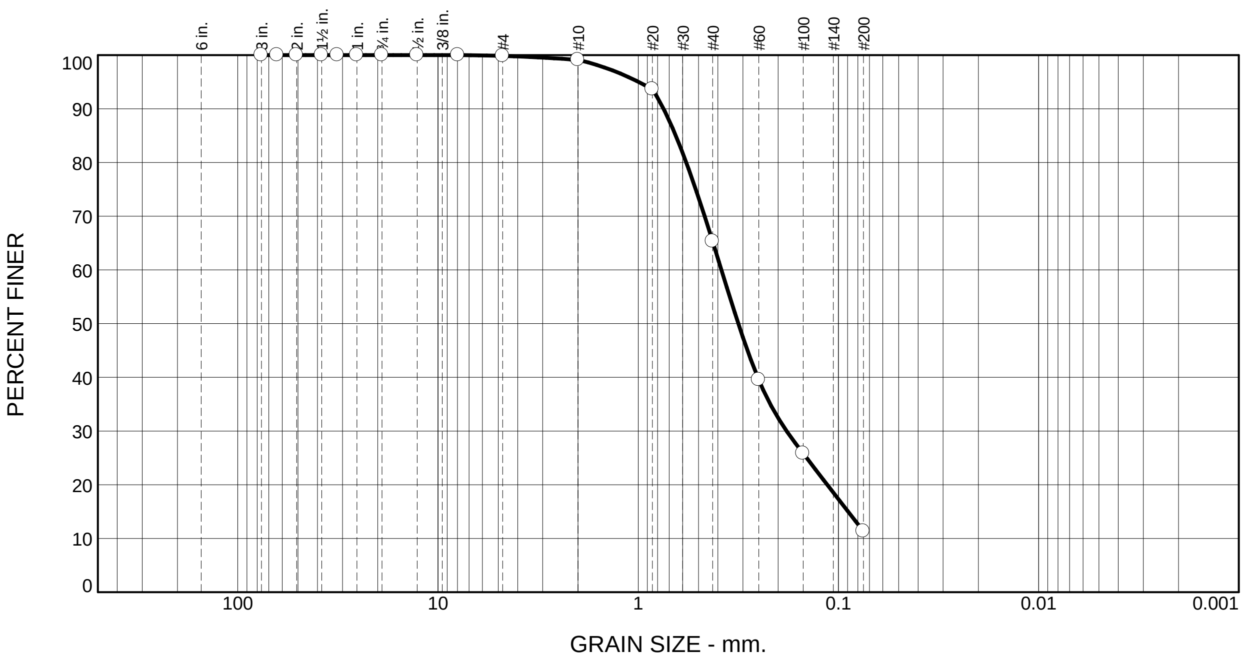
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-4

Tested By: ____________________ **Checked By:** ____________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.7	33.8	54.0	11.3	

Test Results (ASTM D 6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	99.8		
#10	99.1		
#20	93.6		
#40	65.3		
#60	39.5		
#100	25.8		
#200	11.3		

* (no specification provided)

Material Description

Poorly graded SAND with silt (SP-SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}=	0.7467	D_{85}=	0.6488	D_{60}=	0.3840
D_{50}=	0.3162	D_{30}=	0.1814	D_{15}=	0.0894
D_{10}=		C_u=		C_c=	

Remarks

NM: 18.3%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-8 S-2
Sample Number: 099043 **Depth:** 3.5-12
Date Sampled: 12/31/2019

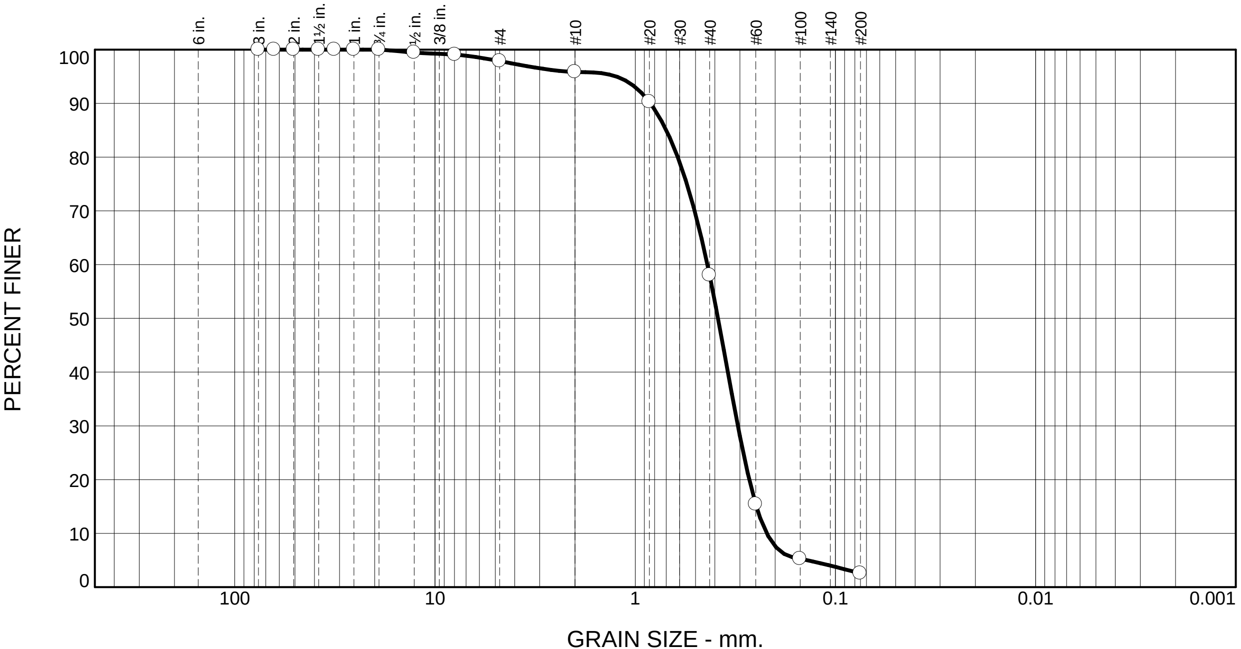
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-5

Tested By: ____________________ **Checked By:** ____________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.1	2.1	37.8	55.5	2.5	

Test Results (ASTM D 6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	99.4		
.3125	99.1		
#4	97.9		
#10	95.8		
#20	90.3		
#40	58.0		
#60	15.4		
#100	5.3		
#200	2.5		

* (no specification provided)

Material Description

poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.8395	D_{85}= 0.6988	D_{60}= 0.4359
D_{50}= 0.3858	D_{30}= 0.3071	D_{15}= 0.2482
D_{10}= 0.2201	C_u= 1.98	C_c= 0.98

Remarks

NM:6.0%

Date Received: 1/2/2020 **Date Tested:** 1/10/2020

Tested By: DC

Checked By: DCB

Title: PM

Location: TP-9 S-1

Sample Number: 099045 **Depth:** 1-10'

Date Sampled: 12/31/2019

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

GeoResources, LLC

Fife, WA

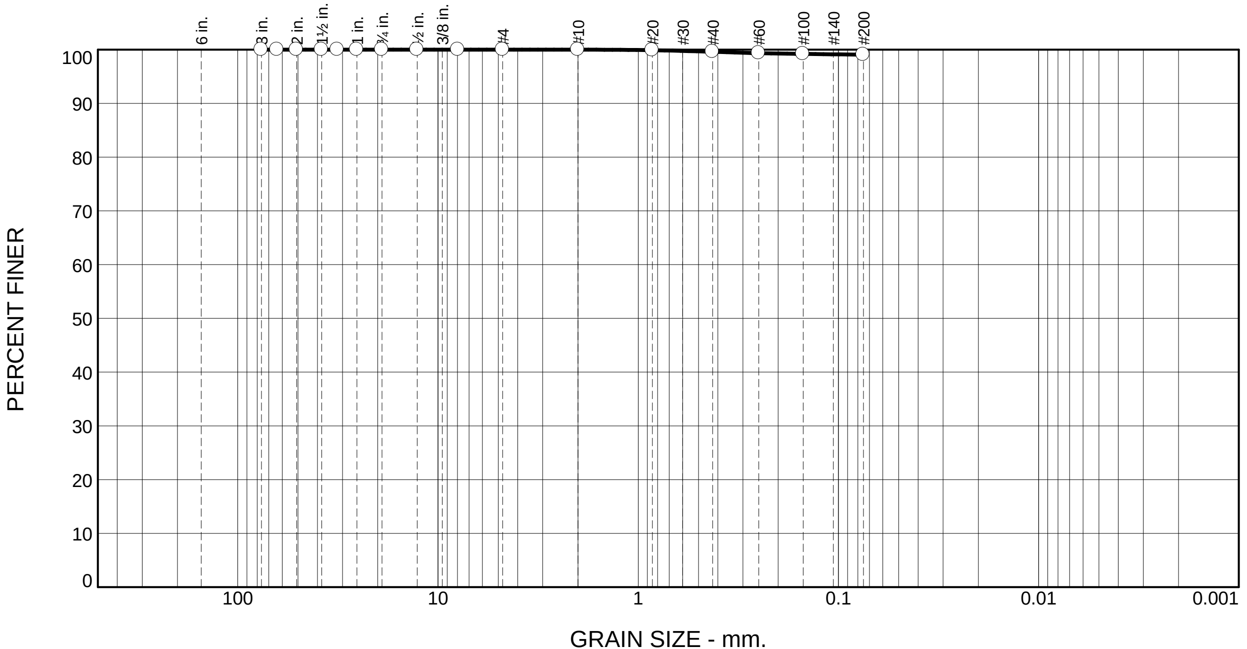
Client: Three's Company LLC

Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-6

Tested By: ______________________ **Checked By:** ______________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	0.5	99.1	

Test Results (ASTM D 6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.6		
#60	99.4		
#100	99.2		
#200	99.1		

* (no specification provided)

Material Description

Mottled tan sandy SILT (stiff, moist) (Slackwater) (ML)

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}=	D_{85}=	D_{60}=
D_{50}=	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

NM: 38.7%
SAMPLE ID: 099244

Date Received: 2/11/2020 **Date Tested:** 2/19/2020

Tested By: JLK

Checked By: DCB

Title: PM

Source of Sample: B-1 **Depth:** 2.5 **Date Sampled:** 2/11/2020
Sample Number: 1

GeoResources, LLC

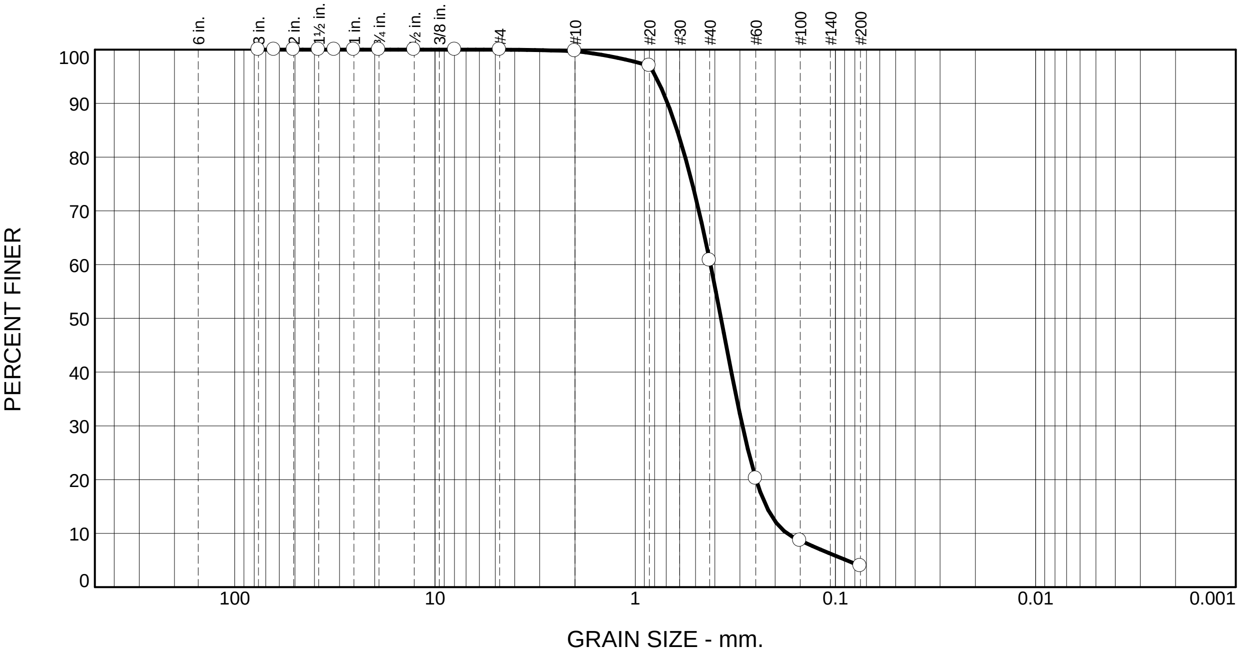
Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development

Project No: ThreesCompanyLLC.15thAveNE **Figure** B-7

Tested By: ____________________ **Checked By:** ____________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	38.9	56.8	4.0	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.7		
#20	97.0		
#40	60.8		
#60	20.2		
#100	8.7		
#200	4.0		

* (no specification provided)

Material Description

Poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 0.6880 D_{85}= 0.6173 D_{60}= 0.4207
D_{50}= 0.3727 D_{30}= 0.2914 D_{15}= 0.2212
D_{10}= 0.1743 C_u= 2.41 C_c= 1.16

Remarks

NM: 11.0%
SAMPLE ID: 099247

Date Received: 2/11/2020 **Date Tested:** 2/19/2020
Tested By: JLK
Checked By: DCB
Title: PM

Source of Sample: B-1 **Depth:** 7.5 **Date Sampled:** 2/11/2020
Sample Number: 3

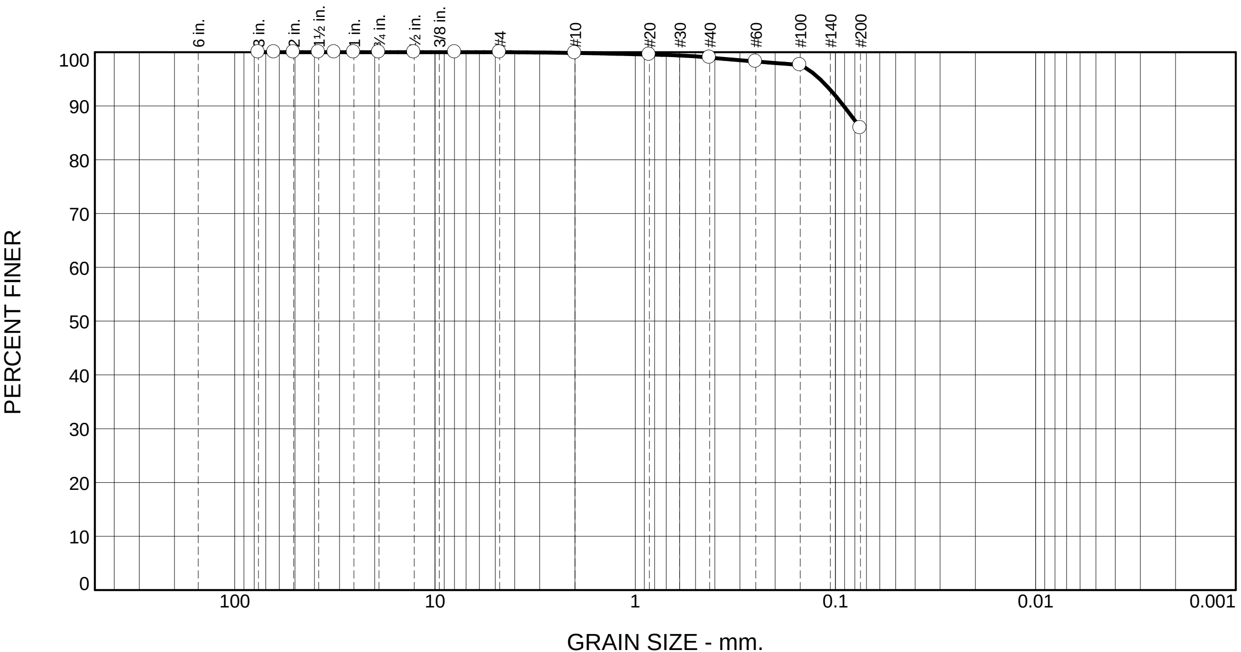
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-8

Tested By: ______________________ **Checked By:** ______________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.9	13.1	85.9	

Test Results (ASTM D 6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.9		
#20	99.6		
#40	99.0		
#60	98.3		
#100	97.6		
#200	85.9		

* (no specification provided)

Material Description

Grey brown sandy SILT (medium stiff, moise to wet) (Slackwater) (ML)

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 0.0909 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

NM: 36.6%
SAMPLE ID: 099250

Date Received: 2/11/2020 **Date Tested:** 2/19/2020
Tested By: JLK
Checked By: DCB
Title: PM

Source of Sample: B-1 **Depth:** 15.9 **Date Sampled:** 2/11/2020
Sample Number: 5b

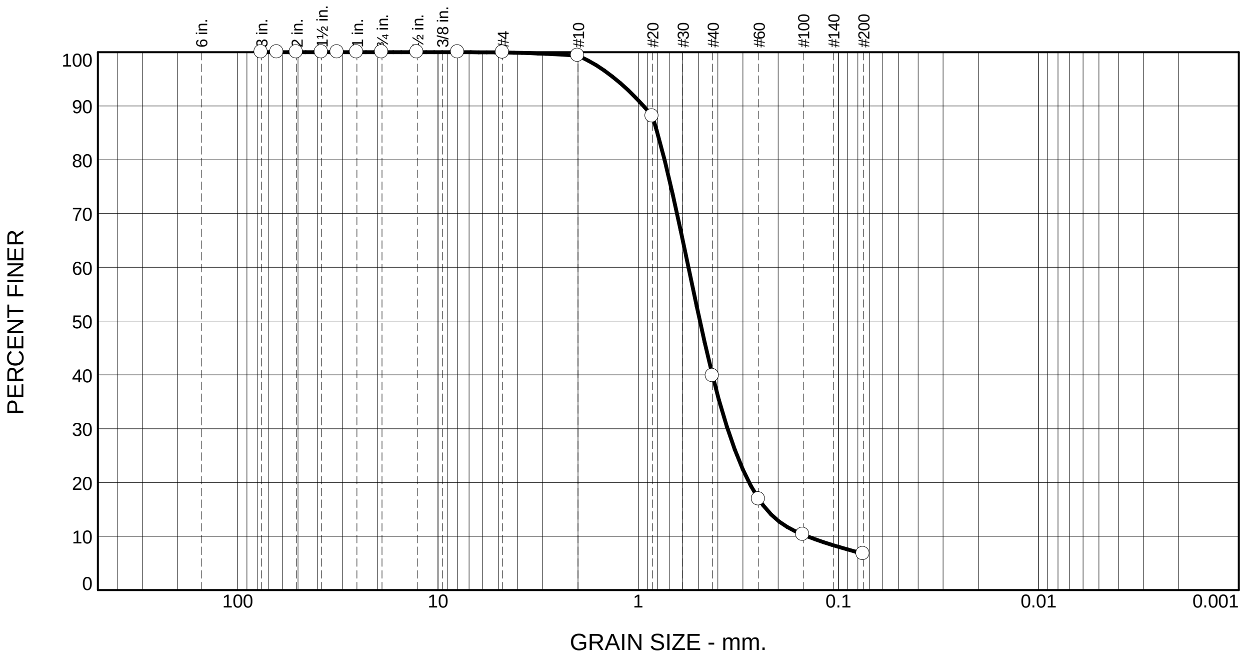
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-9

Tested By: ____________________ **Checked By:** ____________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	59.6	33.1	6.7	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.4		
#20	88.1		
#40	39.8		
#60	16.9		
#100	10.3		
#200	6.7		

* (no specification provided)

Material Description

Slightly mottled tan to brown SAND with silt (loose, moist) (SP-SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.9408	D_{85}= 0.8015	D_{60}= 0.5611
D_{50}= 0.4918	D_{30}= 0.3579	D_{15}= 0.2287
D_{10}= 0.1432	C_u= 3.92	C_c= 1.59

Remarks

NM: 12.6%
SAMPLE ID: 099256

Date Received: 2/11/2020 **Date Tested:** 2/19/2020
Tested By: JLK
Checked By: DCB
Title: PM

Source of Sample: B-2 **Depth:** 2.5 **Date Sampled:** 2/11/2020
Sample Number: 1

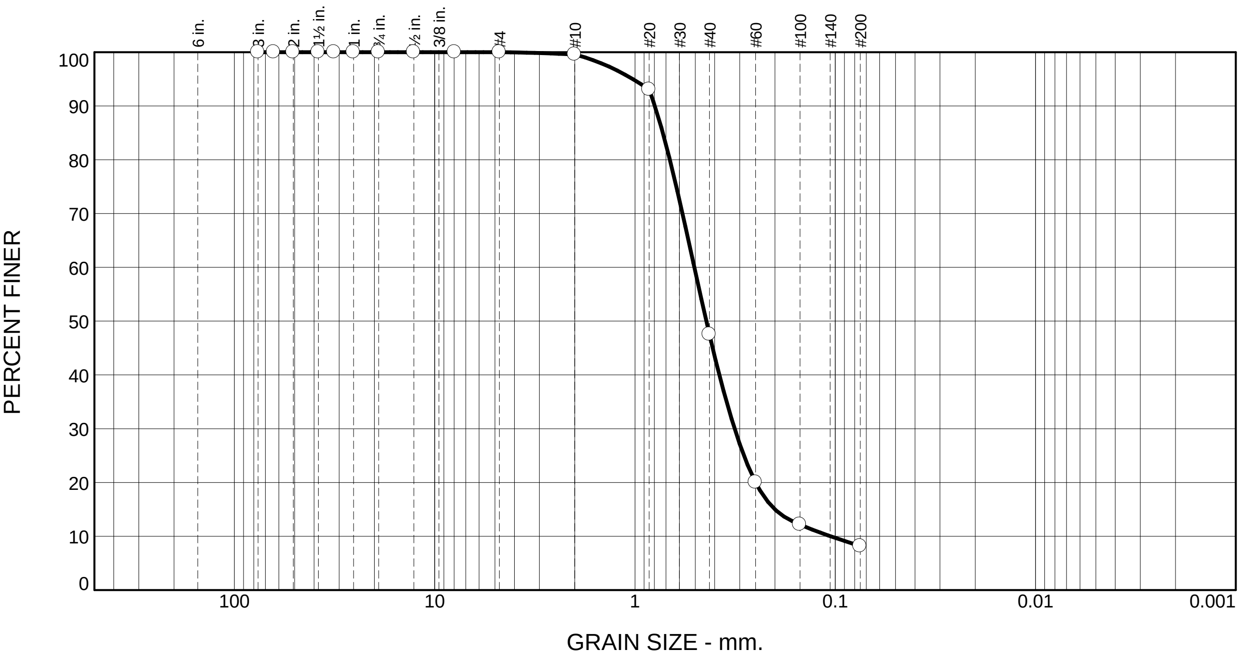
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-10

Tested By: ____________________ **Checked By:** ____________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.4	52.1	39.3	8.2	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	100.0		
#10	99.6		
#20	93.1		
#40	47.5		
#60	20.0		
#100	12.2		
#200	8.2		

* (no specification provided)

Material Description

Grey to grey brown SAND with silt and siltier interbeds (loose to medium dense, moist) (SP-SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.7950 D_{85}= 0.7253 D_{60}= 0.5053
D_{50}= 0.4403 D_{30}= 0.3180 D_{15}= 0.2000
D_{10}= 0.1055 C_u= 4.79 C_c= 1.90

Remarks

NM: 11.0%
SAMPLE ID: 099258

Date Received: 2/11/2020 **Date Tested:** 2/19/2020
Tested By: JLK
Checked By: DCB
Title: PM

Source of Sample: B-2 **Depth:** 7.5 **Date Sampled:** 2/11/2020
Sample Number: 3

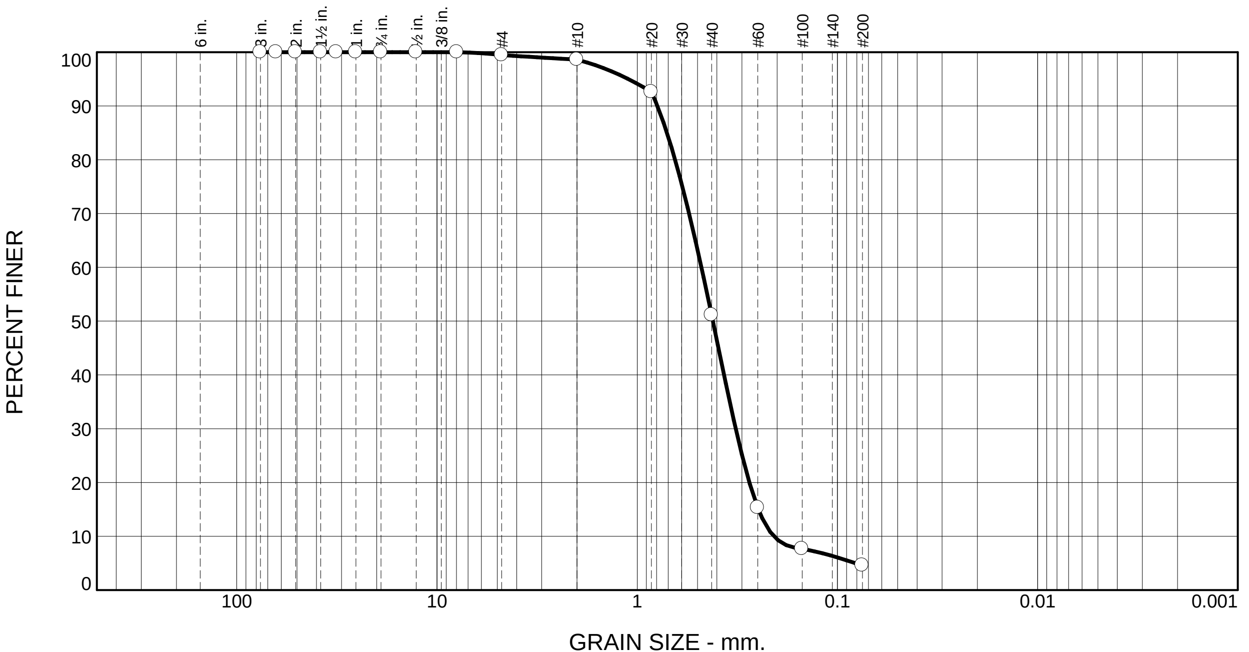
GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-11

Tested By: __________________________ **Checked By:** __________________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.9	47.5	46.5	4.6	

Test Results (ASTM D 6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	100.0		
.75	100.0		
.5	100.0		
.3125	100.0		
#4	99.5		
#10	98.6		
#20	92.6		
#40	51.1		
#60	15.3		
#100	7.6		
#200	4.6		

* (no specification provided)

Material Description

Poorly graded SAND (SP)

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 0.7924	D_{85}= 0.7097	D_{60}= 0.4779
D_{50}= 0.4188	D_{30}= 0.3221	D_{15}= 0.2482
D_{10}= 0.2077	C_u= 2.30	C_c= 1.05

Remarks

NM:6.4%
SAMPLE ID: 099263

Date Received: 2/11/2020 **Date Tested:** 2/19/2020
Tested By: JLK
Checked By: DCB
Title: PM

Source of Sample: B-2 **Depth:** 25 **Date Sampled:** 2/11/2020
Sample Number: 7

GeoResources, LLC

Fife, WA

Client: Three's Company LLC
Project: Proposed Residential Development
Project No: ThreesCompanyLLC.15thAveNE **Figure** B-12

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

Tested By: ____________________ **Checked By:** ____________________

WETLAND AND STREAM REPORT
WILLIAMS CROSSING PROJECT

Thurston County, Washington

Applicant:

Sage Homes NW, LLC
c/o Ryan Kohlmann
9505 19th Avenue SE, Suite 118, Everett, WA 98208

SHNW0000-0002

Prepared by:

Gray Rand
Senior Scientist, PWS

O. Gray Rand III
2039

DAVID EVANS AND ASSOCIATES, INC.
14432 SE Eastgate Way, Suite 400
Bellevue, WA 98007

September 2023

EXECUTIVE SUMMARY

At the request of Sage Homes NW, LLC (applicant), David Evans and Associates, Inc. (DEA) conducted a wetland and stream delineation for the proposed Williams Crossing residential plat development (project) located at 5216, 5224, and 5228 NE 15th Avenue, Olympia, WA. The applicant proposes to construct a private residential development on three separate parcels:

- Parcel 11809310100, 5126 NE 15th Ave, Olympia, WA 98516
- Parcel 11809310600, 5224 NE 15th Ave, Olympia, WA 98516
- Parcel 11809310700, 5228 NE 15th Ave, Olympia, WA 98516

Each parcel will support 13 or 14 separate single family dwellings, for a total of 41 structures, plus access roads, utilities, stormwater treatment areas, and amenities.

DEA's delineation confirmed the presence of two wetland units (Wetland A and B) that had been previously delineated by Agua Tierra in 2019. The wetland units are connected just offsite to the north of the property. Portions of the boundaries of both wetlands were changed by DEA. Wetlands were rated using the Washington State Department of Ecology (Ecology) rating system for Western Washington. Based on this system, the wetland units were rated together as a Category III wetland. No streams were identified on the property. The wetland was rated with a habitat score of 7, which results in a standard wetland buffer of 260 feet under Thurston County (County) Code and a buffer width of 110 feet under Lacey Municipal Code. The proposed project avoids all direct impacts to the wetlands or their buffers.

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Acronyms and Abbreviations

CARP	Critical Area Review Permit
City	City of Lacey
County	Thurston County
DEA	David Evans and Associates, Inc.
DOI	U.S. Department of the Interior
Ecology	Washington State Department of Ecology
GIS	Geographic Information System
HGM	Hydrogeomorphic
LMC	Lacey Municipal Code
NHP	Natural Heritage Program
NRCS	Natural Resource Conservation Service
NWI	National Wetlands Inventory
PFO	Palustrine Forested
PHS	Priority Habitats and Species
TCC	Thurston County Code
TPA	Tree protection area
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WRIA	Water Resource Inventory Area

1.0 INTRODUCTION

The applicant (Sage Homes Northwest) proposes to construct a private residential development on three separate lots in Thurston County, northeast of Olympia, Washington (**Figure 1**, Vicinity Map). Parcels involved with the development are as follows:

- Parcel 11809310100, 5126 NE 15th Ave, Olympia, WA 98516
- Parcel 11809310600, 5224 NE 15th Ave, Olympia, WA 98516
- Parcel 11809310700, 5228 NE 15th Ave, Olympia, WA 98516

Each parcel will support 13 or 14 separate single family dwellings, for a total of 41 structures, plus access roads, utilities, stormwater treatment areas, and amenities. As shown in **Figure 1**, Vicinity Map, the project is located in Section 09 of Township 18 North Range 1 West. The parcels are located within Thurston County and plan to connect with City of Lacey (City) utility.

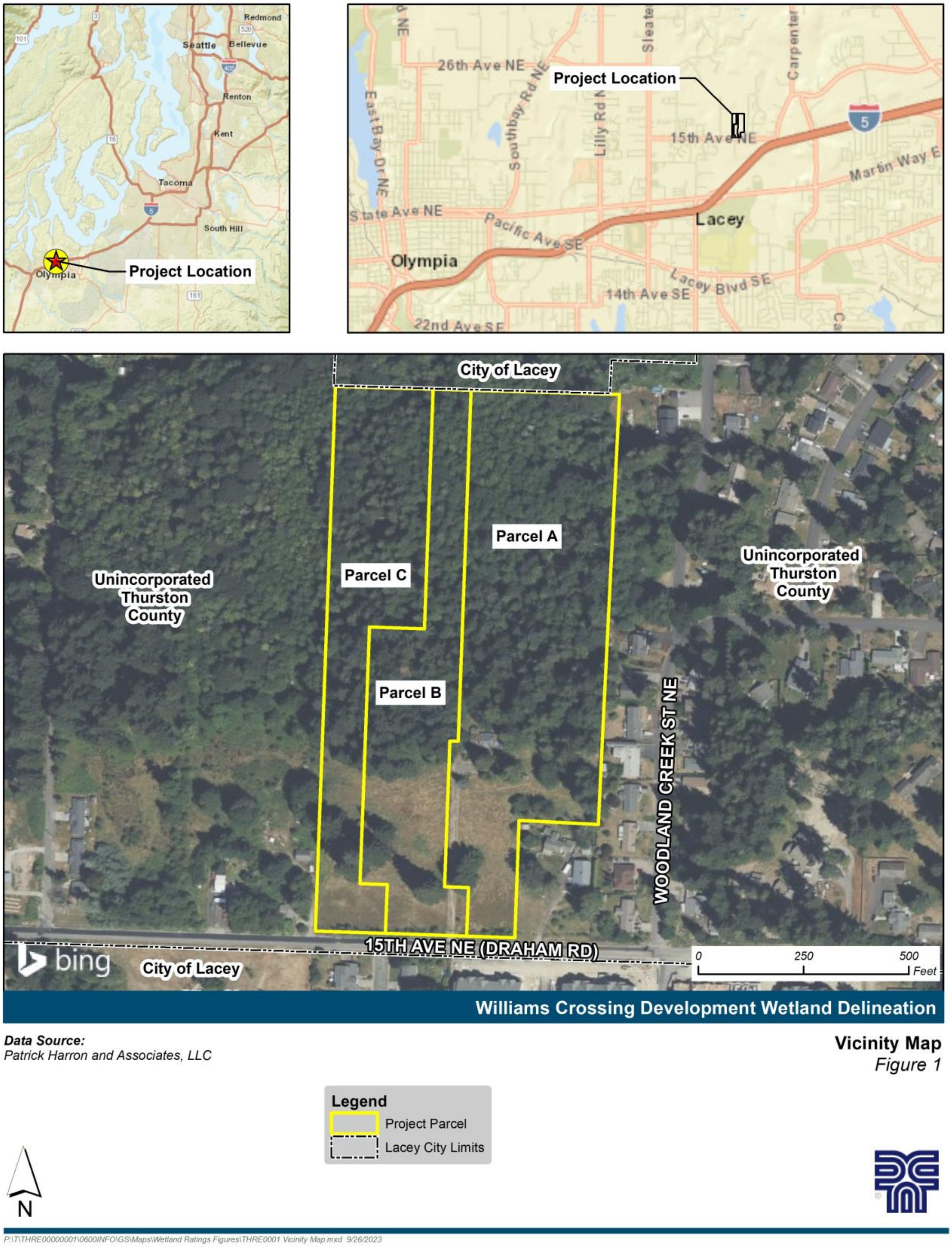
The project vicinity is generally characterized by second growth coniferous forest with a mix of low density rural and high density urban developments. Located north of Lacey between Olympia and the rapidly developing Hawks Prairie area, the project is bordered on the north by City of Lacey park property. The local topography slopes north/northeast toward the Woodland Creek drainage.

1.1 REPORT LIMITATIONS

This report is intended to update the previously submitted wetland report for the Williams Crossing project (Agua Tierra 2019) and allow the applicant to complete their Critical Area Review Permit (CARP) application process. This report and its author, Gray Rand, meet the submittal requirements for streams and wetlands as described in the existing critical area ordinance for the County. Mr. Rand is a Professional Wetland Scientist certified by the Society of Wetland Scientists and has more than 20 years of experience with wetlands and local critical areas in Puget Sound.

The wetland boundaries described herein are the professional opinion of David Evans and Associates, Inc. (DEA) staff based on the circumstances and site conditions at the time of this study. Local, state, and federal jurisdictions make final determinations of jurisdictional boundaries.

Figure 1. Project Vicinity Map



2.0 METHODOLOGY

2.1 PRELIMINARY RESEARCH

Published information about local critical areas was reviewed for evidence of wetlands and streams located in the project vicinity. Information reviewed included, but was not limited to, the following:

- National Wetland Inventory (NWI) data access through the U.S. Fish and Wildlife Service (USFWS) NWI data portal. U.S. Department of the Interior (DOI) April 2021.
- Natural Resource Conservation Service (NRCS) Web Soil Survey website, accessed April 2021 (NRCS 2019).
- Washington State Department of Fish and Wildlife (WDFW) – Priority Habitats and Species (PHS) Online Mapper, accessed April 2021. Olympia, Washington (WDFW 2019a). http://wdfw.wa.gov/mapping/phs/
- Washington State Department of Fish and Wildlife (WDFW) – Salmonscape Online Mapper. Accessed April 2021. Olympia, Washington (WDFW 2019b). http://apps.wdfw.wa.gov/salmonscape/map.html
- A Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region. Washington Department of Fisheries (Williams et al. 1975).
- Washington State Department of Natural Resources (WDNR) Natural Heritage Program (NHP) data (accessed 2019): WA Wetlands of High Conservation Value Map Viewer. Available at: https://wadnr.maps.arcgis.com/apps/webappviewer/index.html?id=5cf9e5b22f584ad7a4e2aebc63c47bda
- Thurston County GeoData Center, Show Me Everything Map. Accessed April 2021. https://map.co.thurston.wa.us/Html5Viewer/Index.html?viewer=uMap.Main
- Wetland Delineation and Buffer Rating Report for Three’s Company (Agua Tierra Land and Water Services, 2019)

2.2 FIELD INVESTIGATION

An on-site investigation of the project study area was conducted on April 14, 2021. The studied area includes sections of the following Thurston County parcels:

- 11809310600
- 11809310700
- 11809310100

In addition, offsite wetland and stream conditions were visually assessed on May 28, 2021 on a parcel to the north owned by the City of Lacey (Parcel #11809240400).

Wetlands and streams were delineated and mapped according to state and federal laws. Wetland resources were delineated using guidelines and methods described in the U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual (Environmental Laboratory 1987) as amended with the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys and Coast Region (Regional Supplement) (USACE 2010).

In general, the wetland delineation consisted of three main tasks: (1) assessing vegetation, soil, and hydrologic characteristics to identify areas meeting wetland criteria; (2) evaluating constructed drainage features to determine whether they would be regulated as jurisdictional wetlands, streams, or ditches: and (3) marking wetland boundaries. Wetland boundaries were identified in the field by a DEA biologist and surveyed in the field by MTN2COAST, LLC Surveying.

Biologists used several tools to identify and classify plants and soils examined within the study area, and to conduct a rainfall analysis in accordance with the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valley, and Coast Region (USACE 2010). Plant indicator status and scientific plant names were identified using the National Wetland Plant List (Lichvar et al. 2016). Soil characteristics were recorded and classified using methods prescribed by the Natural Resources Conservation Service (NRCS) Field Book for Describing and Sampling Soils (NRCS 2012). Hydric soil conditions were assessed using Field Indicators of Hydric Soils in the United States, Version 8.1 (NRCS 2018). Vegetation, soil, and hydrology information was recorded in the field on wetland data forms and are provided in **Appendix A**. Weather during the delineation was drier than normal, as shown in the results of the Corps Antecedent Precipitation Tool, also included in **Appendix A**.

Wetlands delineated within the study area were classified according to the United States Fish and Wildlife (USFWS) Cowardin classification system (Cowardin et al. 1979), Ecology's Western Washington Wetland Rating System (Hruby 2014), and the hydrogeomorphic approach (HGM) (Brinson 1993).

No streams or ditches were delineated on the subject property. Wetland buffers were determined in the study area based on the habitat score of the wetlands according to the Washington State Wetland Rating System for Western Washington (Ecology 2014), Table 24.30-1 of the Thurston County Code (TCC), and Table 14T-19 of the Lacey Municipal Code (LMC).

2.3 WETLAND REGULATORY REQUIREMENTS

Due to the project's parcels being located within Thurston County, but planning to connect with City of Lacey utilities, both jurisdictions' codes were considered for the purposes for this critical areas report.

Thurston County Code (TCC 24.03.010) defines a wetland as:

> *"Wetland" or "wetlands" means areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, and other areas meeting the definition of wetland under RCW 36.70A.030, as amended. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from non-wetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may*

> *include those artificial wetlands intentionally created from non-wetland areas in order to mitigate conversion of natural wetlands. Areas below the ordinary high water mark (OHWM) of a water body, including but not limited to marine waters, lakes, ponds, streams, and rivers, may also qualify as wetlands if they meet the criteria of the 1987 U.S. Army Corps of Engineers Wetlands Delineation Manual and the 2008 Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region.*

TCC 24.30.030 describes the how the County requires wetlands to be rated according to the Washington State Wetland Rating System for Western Washington (Hruby 2014), which classifies wetlands as Category I through IV, based on functional score and unique characteristics. Standard wetland buffer widths in Thurston County are outlined in TCC 24.30.045 and are based primarily on how well a wetland performs (scores) habitat and water quality functions. Specific buffer widths are described in Table 24.30-1 of the TCC, which is summarized in **Table 1** below.

Table 1. Thurston County Standard Wetland Buffer Widths*

The Larger of the Buffers for Habitat and Water Quality Applies											
BUFFER TO PROTECT HABITAT											
Rating for habitat from Hruby (2014)	L,L,L	L,L,L	M,L,L	M,M,L	H,L,L	M,M,M	H,M,L	H,M,M	H,H,L	H,H,M	H,H,H
Buffer width for habitat for all wetlands except estuarine wetlands and coastal lagoons	100’	120’	140’	160’	180’	200’	220’	240’	260’	280’	300’
Buffer width with mitigation under 24.30.050 TCC	100’	100’	105’	120’	135’	150’	165’	180’	195’	210’	225’
Buffer width for estuarine wetlands and lagoons	220 feet										
Buffer to Maintain Water Quality											
Wetlands of high conservation value, bogs, and wetlands containing sensitive plant species documented by the DNR Natural Heritage Program.	250 feet										
Wetlands that rate 3 for habitat, score 7 or less for water quality, are less than 10,000 square feet in size and are not a functional part of a mosaic wetland, do not support priority wildlife species, and do not drain to a stream or a Category I or II wetland.	50 feet										

*Table 24.30-1 of the TCC.

The County did raise the issue of tree protection within their March 11, 2020 letter. Pursuant to TCC 24.30.065, trees within wetland buffers with driplines that extend beyond the upland edge (furthest from the wetland) of buffers with a wildlife habitat rating of five points or more under the Wetland Rating System for Western Washington shall be protected as follows:

A. A tree protection area extending a minimum of five feet beyond the dripline of trees twelve inches or greater in diameter (at four and one-half feet above the ground) and stands of trees shall be established and protected from disturbance during site development.

B. Tree protection areas shall be identified on all applicable site development and construction drawings submitted to the County.

C. Temporary fencing at least thirty inches tall shall be erected along the perimeter of the tree protection areas prior to the initiation of any clearing or grading. The fencing shall be posted with signage clearly identifying the tree protection area as a no entry area. If the tree protection area spans more than 0.25 miles, the perimeter of the protection area may be staked and flagged rather than fenced. The fencing or stakes shall remain in place throughout site development.

D. Clearing, grading, filling or other development activities are prohibited within the tree protection area.

E. Vehicle travel, parking and storage of construction materials and fuel are prohibited in tree protection areas.

F. The County may authorize use of alternate tree protection techniques that provide an equal or greater level of protection.

The City of Lacey Municipal Code (LMC 14.28.030) defines a wetland as:

> *"Wetlands" are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Wetlands do not include those artificial wetlands intentionally created from non-wetland sites, including, but not limited to, irrigation and drainage ditches, grass lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from non-wetland areas to mitigate the conversion of wetlands. For identifying and delineating a regulated wetland, local government shall use the approved federal wetland delineation manual and applicable regional supplements.*

LMC Chapter 14.28 describes the City of Lacey (City) measures of wetlands protection. The City also requires wetlands to be rated according to the Washington State Wetland Rating System for Western Washington (Hruby 2014). Standard wetland buffer widths in the City are outlined in LMC 14.28.280 and are determined primarily by habitat function scores. Specific buffer widths are described in Table 14T-19 and Table 14T-69 of the LMC, which are summarized in **Table 2** and **Table 3** below.

Table 2. City of Lacey Wetland Buffer Table*

Wetland Category and Type	Buffer Width (in feet) Based on Habitat Score		
	3-5 (Low)	6--7 (Medium)	8--9 (High)
I: Estuarine and Coastal Lagoons	150 (buffer width not based on habitat scores)		
I: Bogs and Wetlands of High Conservation Value	190		225
I: All Others	75	110	225
II: Estuarine and Coastal Lagoons	110 (buffer width not based on habitat scores)		
II: All	75	110	225
III: All	60	110	225
IV: All	40		

*Table 14T-19 of the LMC.

Table 14T-69. The following wetland buffer requirements if habitat corridor is not provided per subsection (C)(1) of this section or minimization measures per subsection (C)(2)(b) of this section are not implemented:

Table 3. City of Lacey Wetland Buffer Table*

Wetland Category and Type	Buffer Width (in feet) Based on Habitat Score		
	3-5 (Low)	6--7 (Medium)	8--9 (High)
I: Estuarine and Coastal Lagoons	200 (buffer width not based on habitat scores)		
I: Bogs and Wetlands of High Conservation Value	250		300
I: All Others	100	150	300
II: Estuarine and Coastal Lagoons	150 (buffer width not based on habitat scores)		
II: All	100	150	300
III: All	80	150	300
IV: All	50		

*Table 14T-69 of the LMC.

Additional portions of the TCC critical areas code and of the LMC wetlands protection code address criteria for reducing or increasing buffer width. The applicant is not proposing to reduce the standard buffer width, nor are there conditions present that would require increased wetland buffer width per TCC 24.30.055 or LMC 14.28.290 (e.g., steep slopes and/or inadequate vegetative cover).

3.0 RESULTS

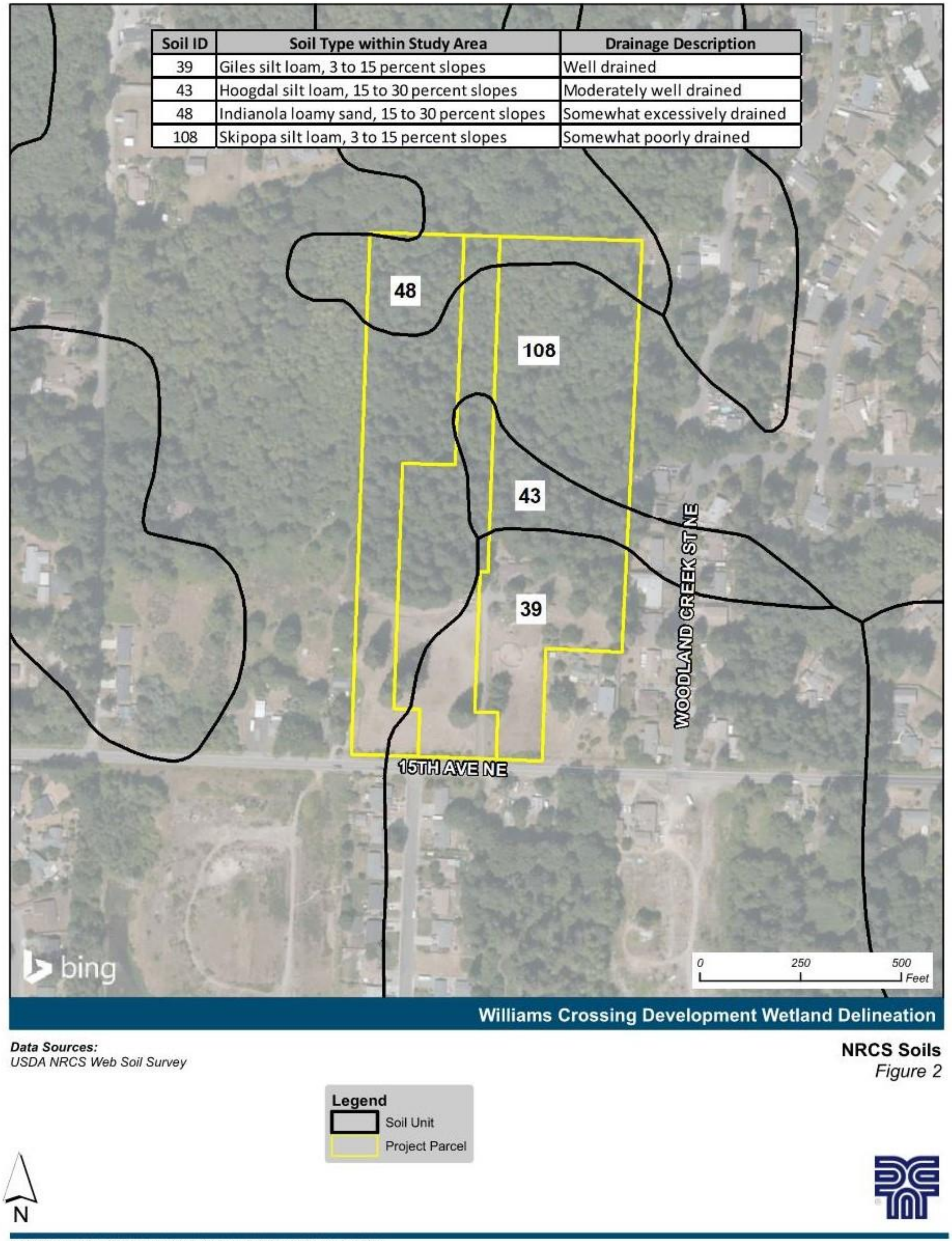
3.1 PROJECT SOILS

Soils in the study area are dominated by Giles silt loam, Skipopa silt loam, Hoogdal silt loam, and Indianola loamy sand as indicated on the Soils Map (**Figure 2**) (NRCS 2021). None of these soil series are considered hydric (NRCS 2021). Indianola series is a somewhat excessively drained material that was formed in sandy glacial outwash. Skipopa series soils are somewhat poorly drained soils formed in volcanic ash over glaciolacustrine deposits.

3.2 WDFW PRIORITY HABITAT AND SPECIES (PHS) DATA

The WDFW PHS program provides comprehensive information on important fish, wildlife, and habitat resources to local governments, state and federal agencies, private landowners, and consultants, and tribal biologists for land use planning purposes. A review of WDFW PHS online database identified no documented occurrences of PHS on the property in question. The entire township covering the property is identified as having one or more records for big brown bat, little brown bat, and Yuma myotis (WDFW 2021b). Woodland Creek, approximately ¼ mile northeast of the property, is identified in the database as supporting a variety of priority fish species, including steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*), cutthroat trout (*O. clarki*), chum salmon (*O. keta*), and Chinook salmon (*O. tshawytscha*). (WDFW 2021b).

Figure 2. Soils in the Project Vicinity



Soil ID	Soil Type within Study Area	Drainage Description
39	Giles silt loam, 3 to 15 percent slopes	Well drained
43	Hoogdal silt loam, 15 to 30 percent slopes	Moderately well drained
48	Indianola loamy sand, 15 to 30 percent slopes	Somewhat excessively drained
108	Skipopa silt loam, 3 to 15 percent slopes	Somewhat poorly drained

Data Sources:
USDA NRCS Web Soil Survey

NRCS Soils
Figure 2

P:\T\THRE00000001\0600INFO\GS\Maps\Wetland Ratings Figures\THRE0001 NRCS Soils.mxd 4/29/2021

3.3 WDNR NATIONAL HERITAGE PROGRAM (NHP) DATA

A review of the WDNR Wetlands of High Conservation Value Map Viewer did not reveal any wetlands in the study area (WDNR 2021a).

3.4 WETLANDS

National Wetland Inventory

A review of the NWI online interactive map revealed one feature on the property, which was a riverine wetland associated with a tributary to Woodland Creek (DOI 2021). The NWI map is shown in **Figure 3**.

Figure 3. National Wetland Inventory

Wetland Field Survey Results

DEA confirmed the two previously delineated wetland units within the study area. **Table 4. Wetland Survey Summary**

provides a summary of the wetlands and their characteristics. The location of the delineated wetlands are depicted in **Figure 4.** Wetland data sheets are contained within **Appendix A.** The wetland rating form(s) are provided in **Appendix B.** The two delineated wetland units are connected approximately 150 feet offsite to the north. Based on this information, the wetland units were rated together as one wetland, including the offsite portions. More specific information about each wetland unit is included in the summary sheets in **Figure 5**. **Appendix C** includes photographs of the wetlands and streams in the study area.

Table 4. Wetland Survey Summary

Wetland	HGM Class	Cowardin Class	Ecology Rating	Total Score	Water Quality	Hydrology	Habitat	TCC Standard Local Buffer (ft)	LMC Standard Local Buffer (ft)
A/B	Depressional	PFO	III	18	7	4	7	260	110

Figure 4. Delineated Wetlands and Streams within the Study Area

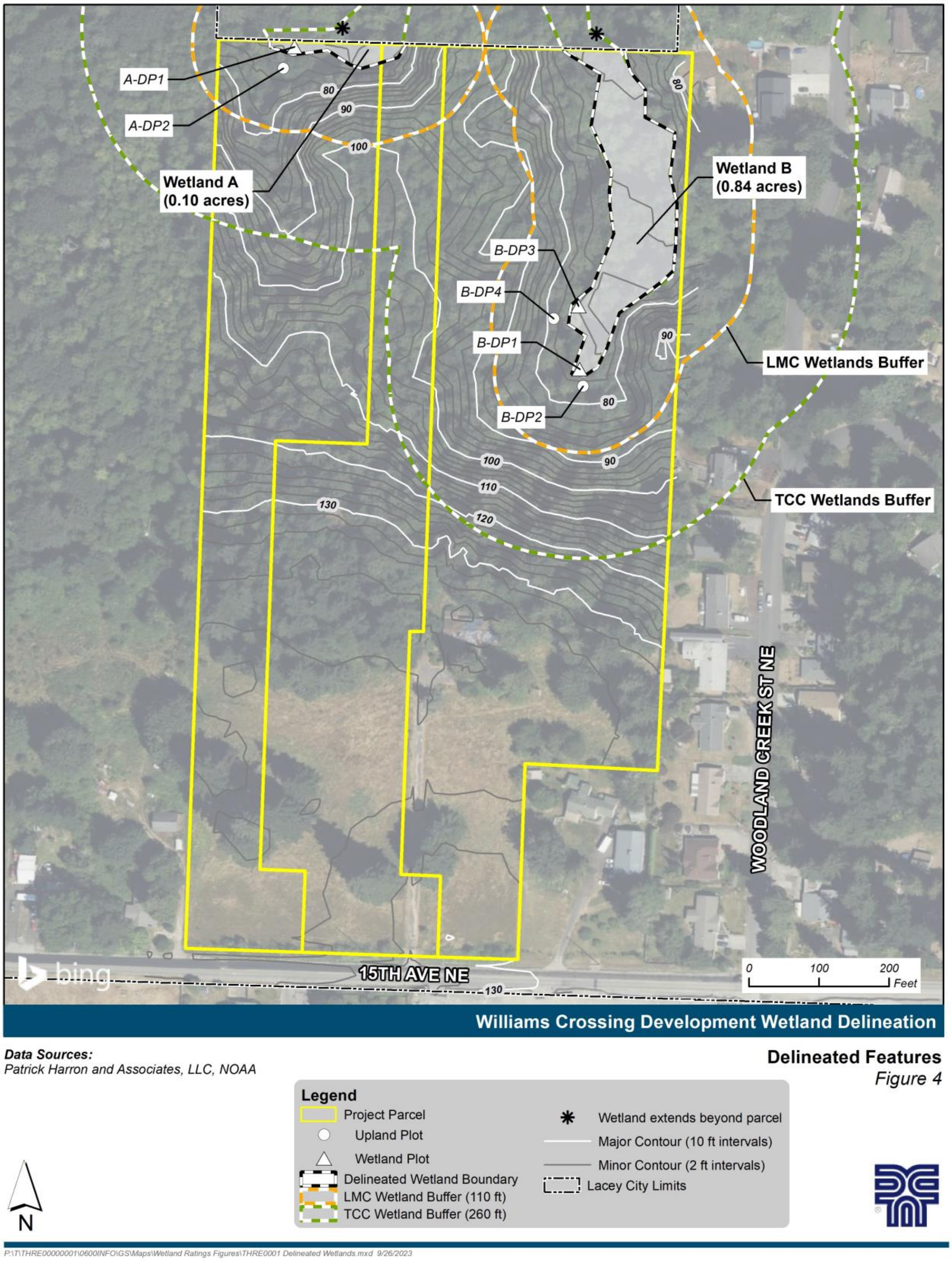


Figure 5. Wetland Information Summary

<table>
<tr><th colspan="5">WETLAND A/B – INFORMATION SUMMARY</th></tr>
<tr><td colspan="5">Location: Williams Crossing (Lat. 47.298291° N Long. -122.589703° W).</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td colspan="2">Wetland A looking north from north property boundary</td><td colspan="3">Wetland B looking north from near center of wetland</td></tr>
<tr><td>WRIA / HUC</td><td colspan="4">WRIA 15- Deschutes /HUC #171100190502 Woodland Creek-Frontal Henderson Watershed</td></tr>
<tr><td>Western WA Ecology Rating</td><td colspan="4">III</td></tr>
<tr><td>Wetland Size (acre)</td><td colspan="4">Onsite = (Wetland A unit) 0.1 acre; (Wetland B unit) 0.84 acre ; Offsite = estimated total 3.7 acres</td></tr>
<tr><td>Cowardin Classifications</td><td colspan="4">PFO</td></tr>
<tr><td>HGM Classification</td><td colspan="4">Depressional</td></tr>
<tr><td>Wetland Data Sheet(s)</td><td colspan="4">A-DP-1; B-DP-1 and B-DP-3</td></tr>
<tr><td>Upland Data Sheet(s)</td><td colspan="4">A-DP-2; B-DP-2 and B-DP-4</td></tr>
<tr><td>Dominant Vegetation</td><td colspan="4">Red alder, western red cedar, salmonberry, lady fern</td></tr>
<tr><td>Soils</td><td colspan="4">Soil Survey data: Indianola loamy sand and Skipopa silt loam
Field data: Depleted Below Dark Surface (A11) and Sandy Redox (S5)</td></tr>
<tr><td>Hydrology</td><td colspan="4">Assumed Source: Precipitation, groundwater, and adjacent area runoff.
Field Data: Saturation (A3) and Geomorphic Position (D2)</td></tr>
<tr><th colspan="5">Wetland Functions Summary</th></tr>
<tr><td>Function</td><td>Water Quality</td><td>Hydrologic</td><td>Habitat</td><td></td></tr>
<tr><td colspan="4"><i>Circle the appropriate ratings</i></td><td></td></tr>
<tr><td>Site Potential</td><td>H [✓ M] L</td><td>H [✓ M] L</td><td>H M [✓ L]</td><td></td></tr>
<tr><td>Landscape Potential</td><td>H [✓ M] L</td><td>H M [✓ L]</td><td>[✓ H] M L</td><td></td></tr>
<tr><td>Value</td><td>[✓ H] M L</td><td>H M [✓ L]</td><td>[✓ H] M L</td><td>TOTAL</td></tr>
<tr><td>Score Based on Ratings</td><td>7</td><td>4</td><td>7</td><td>18</td></tr>
<tr><th colspan="5">General Description and Comments</th></tr>
<tr><td colspan="5">Wetland is a large depressional forested system with a robust shrub and herbaceous understory. The wetland units combine offsite and continue to the north. A small seasonal stream channel begins to appear in the wetland approximately 400 feet north of the property boundary. This stream channel appears intermittently between large areas of inundated wetland on the offsite property. While the wetland forested vegetation is dominated by younger deciduous forest, some mature forest is present in the buffer on the property.</td></tr>
</table>

3.5 STREAMS

No streams were identified on the property. While the NWI map does display a riparian feature that starts on the property, DEA did not locate any defined stream channel that demonstrated any evidence of scour, bed, or bank features on the property, within either wetland unit, or immediately offsite. Based on visual reconnaissance of the property to the north, a small seasonal stream channel begins to appear in the wetland approximately 400 feet north of the property boundary. This stream channel appears intermittently between large areas of inundated wetland on the offsite property. The observed sections of channel average two feet wide and have a barely defined bed and bank, with minimal signs of scour and flow.

4.0 IMPACTS

The project, as proposed, will not result in any direct impacts to streams or wetlands or their buffers. The site plan proposed as part of the ongoing land use application (**Appendix D**) has not changed and remains a minimum of 280 feet away from either Wetland A or B. This is outside of the LMC buffer of 110 feet based off of DEA's habitat rating, as well as outside of the TCC buffer of 260 feet based on the same rating. Due to the small 20-foot difference of the TCC buffer width to the proposed site plan, potential impacts of Wetland A and B are explored below with considerations of additional sections of the TCC.

According to TCC 24.30.065, a tree protection area (TPA) extending a minimum of five feet beyond the dripline of trees at least 12 inches in diameter that are within the wetland buffer must be identified on the site plans. The current TCC standard wetland buffer on the site, based on DEA's habitat rating, is 260 feet. Based on measurements in the field, DEA observed driplines of larger trees in the TCC wetland buffer averaging 10-25 feet in width, with the widest approximately 30 feet. At the locations closest to proposed development (Buildings 11, 36, and 37), observed driplines were a maximum of 10-20 feet wide (10 feet in proximity to Buildings 36 and 37 and 20 feet in proximity to Building 11). The current site plan in **Appendix D** identifies a TPA varying between 15 and 35 feet wide, based on the dripline widths observed in the field.

Stormwater from the proposed project will be treated by infiltration to groundwater, thus having no surface runoff affects to either wetland unit. The project proposes a combination of infiltration technologies, including collection and tightlining to galleries and porous surfaces collected in infiltration trenches. Therefore, no untreated water will impact wetlands and streams from the proposed project.

5.0 MITIGATION

Mitigation actions typically taken by an applicant or property owner are usually required by code to occur in the following sequence:

1. Avoiding the impact altogether by not taking a certain action or parts of actions;
2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation; by using appropriate technology; or by taking affirmative steps, such as project redesign, relocation, or timing, to avoid or reduce impacts;
3. Rectifying the impact to the critical area by repairing, rehabilitating, or restoring the affected environment to the conditions existing at the time of the initiation of the project;

4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and/or
5. Compensating for the impact by replacing or providing substitute resources or environments.

As currently designed, the proposed project has no permanent or temporary impacts to streams, wetlands or their buffers. Stormwater impacts are also avoided by maximizing use of infiltration for water quality treatment. Therefore, all impacts have been avoided.

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APPENDICES

Appendix A

Wetland Data Sheets

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WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: Williams Crossing City/County: Lacey/Thurston Sampling Date: 04/14/2021

Applicant/Owner: Three's Company State: WA Sampling Point: A-DP-1

Investigator(s): R. Pratt O. G. Rand Section, Township, Range: S09T18NR1W

Landform (hillslope, terrace, etc.): valley bottom Local relief (concave, convex, none): concave Slope (%): 1

Subregion (LRR): A Lat: 47.0612 Long: -122.8142 Datum: WGS84

Soil Map Unit Name: Indianola Loamy Sand NWI classification: PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, or Hydrology ☐, significantly disturbed? Are “Normal Circumstances” present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐	**Is the Sampled Area within a Wetland?**	**Yes** ☒	**No** ☐
Hydric Soil Present?	Yes ☒	No ☐			
Wetland Hydrology Present?	Yes ☒	No ☐			

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1. *western red cedar (Thuja plicata)*	45	yes	FAC
2. *red alder (Alnus rubra)*	35	yes	FAC
3.			
4.			
50% = 40, 20% = 16	80	= Total Cover	
Sapling/Shrub Stratum (Plot size: _____)			
1. *salmonberry (Rubus spectabilis)*	10	yes	FAC
2.			
3. _____			
4. _____			
5. _____			
50% = 5, 20% = 2	10	= Total Cover	
Herb Stratum (Plot size: _____)			
1. *Pacific waterleaf (Hydrophyllum tenuipes)*	40	yes	FAC
2. *common ladyfern (Athyrium cyclosorum)*	10	yes	FAC
3. _____			
4. _____			
5. _____			
6. _____			
7. _____			
8. _____			
9. _____			
10. _____			
11. _____			
50% = 25, 20% = 10	50	= Total Cover	
Woody Vine Stratum (Plot size: _____)			
1. _____			
2. _____			
50% = _____, 20% = _____	_____	= Total Cover	
% Bare Ground in Herb Stratum _____			

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	5	(A)
Total Number of Dominant Species Across All Strata:	5	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	100	(A/B)

Prevalence Index worksheet:

	Total % Cover of:	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

☐ 1 – Rapid Test for Hydrophytic Vegetation

☒ 2 - Dominance Test is >50%

☐ 3 - Prevalence Index is ≤3.0[1]

☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ 5 - Wetland Non-Vascular Plants[1]

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: Williams Crossing

SOIL

Sampling Point: A-DP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 2/1	100					clay loam	
8-15	10YR4/2	90	10YR5/3	10			silty clay	redox

[1] Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☒ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☒ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☐ Depth (inches): _____

Water Table Present? Yes ☐ No ☐ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 12

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: Williams Crossing   City/County: Lacey/Thurston   Sampling Date: 04/14/2021
Applicant/Owner: Three's Company   State: WA   Sampling Point: A-DP-2
Investigator(s): R. Pratt O. G. Rand   Section, Township, Range: S09T18NR1W
Landform (hillslope, terrace, etc.): Hillslope   Local relief (concave, convex, none): concave   Slope (%): 2
Subregion (LRR): A   Lat: 47.0612   Long: -122.8142   Datum: WGS84
Soil Map Unit Name: Indianola Loamy Sand   NWI classification: upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?**	**Yes** ☐ **No** ☒
Hydric Soil Present?	Yes ☐ No ☒		
Wetland Hydrology Present?	Yes ☐ No ☒		

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1. *western red cedar (Thuja plicata)*	60	yes	FAC
2. *red alder (Alnus rubra)*	15	yes	FAC
3.			
4.			
50% = 37.5, 20% = 15	75	= Total Cover	
Sapling/Shrub Stratum (Plot size: _____)			
1. *salmonberry (Rubus spectabilis)*	30	yes	FAC
2.			
3. _____			
4. _____			
5. _____			
50% = 15, 20% = 6	30	= Total Cover	
Herb Stratum (Plot size: _____)			
1. *youth on age (Tolmiea menziesii)*	25	yes	FAC
2. *common bedstraw (Galium aparine)*	10	yes	FACU
3. *western swordfern (Polystichum munitum)*	5	no	FACU
4. _____			
5. _____			
6. _____			
7. _____			
8. _____			
9. _____			
10. _____			
11. _____			
50% = 20, 20% = 8	40	= Total Cover	
Woody Vine Stratum (Plot size: _____)			
1. _____			
2. _____			
50% = _____, 20% = _____	_____	= Total Cover	
% Bare Ground in Herb Stratum _____			

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	4	(A)
Total Number of Dominant Species Across All Strata:	5	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	80	(A/B)

Prevalence Index worksheet:

	Total % Cover of:	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ 5 - Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: Williams Crossing

SOIL

Sampling Point: A-DP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 3/3	100					loam	
6-13	7.5YR3/3						silt loam	
13-15	7.5YR4/3						silt loam	sand

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soils Present? **Yes** ☐ **No** ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: some indication of saturation at 20", shallow slope above wetland edge.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: Williams Crossing City/County: Lacey/Thurston Sampling Date: 04/14/2021
Applicant/Owner: Three's Company State: WA Sampling Point: B-DP-1
Investigator(s): R. Pratt O. G. Rand Section, Township, Range: S09T18NR1W
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope (%): 2
Subregion (LRR): A Lat: 47.0608 Long: -122.8142 Datum: WGS84
Soil Map Unit Name: Skipopa Silt Loam NWI classification: PFO
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐, significantly disturbed? Are “Normal Circumstances” present? Yes ☒ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?**	**Yes** ☒ **No** ☐
Hydric Soil Present?	Yes ☒ No ☐		
Wetland Hydrology Present?	Yes ☒ No ☐		

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1. *red alder (Alnus rubra)*	30	yes	FAC
2. *Douglas-fir (Pseudotsuga menziesii)*	10	yes	FACU
3. *western red cedar (Thuja plicata)*	10	yes	FAC
4. _____	_____	____	____
50% = 25, 20% = 10	50	= Total Cover	
Sapling/Shrub Stratum (Plot size: _____)			
1. *Indian plum (Oemleria cerasiformis)*	5	no	FACU
2. *red elderberry (Sambucus racemosa)*	2	no	FACU
3. *salmonberry (Rubus spectabilis)*	30	yes	FAC
4. _____	_____	____	____
5. _____	_____	____	____
50% = 18.5, 20% = _____	37	= Total Cover	
Herb Stratum (Plot size: _____)			
1. *false lily-of-the-valley (Maianthemum dilatatum)*	5	yes	FAC
2. *spotted touch-me-not (Impatiens capensis)*	5	yes	FACW
3. *Pacific bleeding heart (Dicentra formosa)*	5	yes	FACU
4. *Pacific waterleaf (Hydrophyllum tenuipes)*	5	yes	FAC
5. _____	_____	____	____
6. _____	_____	____	____
7. _____	_____	____	____
8. _____	_____	____	____
9. _____	_____	____	____
10. _____	_____	____	____
11. _____	_____	____	____
50% = 10, 20% = 4	20	= Total Cover	
Woody Vine Stratum (Plot size: _____)			
1. _____	_____	____	____
2. _____	_____	____	____
50% = _____, 20% = _____	_____	= Total Cover	
% Bare Ground in Herb Stratum _____			

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	6	(A)
Total Number of Dominant Species Across All Strata:	8	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	75	(A/B)

Prevalence Index worksheet:

	Total % Cover of:		Multiply by:
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is $\leq$3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ 5 - Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: Williams Crossing

SOIL

Sampling Point: B-DP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 2/2	100					silt loam	
8-12	10YR2/2	60	10YR 4/4	30	c	m	loam	redox loam
12-15	2.5YR 4/3	100					loam	
15-20	10YR 5/2	80	7.5YR 4/6	20			loam	sandy loam

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☒ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☒ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stresses Plants (D1) **(LRR A)**
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
☒ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☒ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) **(LRR A)**
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☐ Depth (inches): _____
Water Table Present? Yes ☐ No ☐ Depth (inches): _____
Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 15

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks*:* Weather drier than normal prior to delineation. See results from Corps Antecedent Precipitation Tool attached to report.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: Williams Crossing City/County: Lacey/Thurston Sampling Date: 04/14/2021
Applicant/Owner: Three's Company State: WA Sampling Point: B-DP-2
Investigator(s): R. Pratt O. G. Rand Section, Township, Range: S09T18NR1W
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope (%): 2
Subregion (LRR): A Lat: 47.0608 Long: -122.8142 Datum: WGS84
Soil Map Unit Name: Skipopa Silt Loam NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?**	**Yes** ☐ **No** ☒
Hydric Soil Present?	Yes ☐ No ☒		
Wetland Hydrology Present?	Yes ☐ No ☒		

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1. *red alder (Alnus rubra)*	40	yes	FAC
2. *5western red cedar (Thuja plicata)*	15	yes	FAC
3.			
4.			
50% = 27.5, 20% = 10	55	= Total Cover	
Sapling/Shrub Stratum (Plot size: _____)			
1. *Indian plum (Oemleria cerasiformis)*	60	yes	FACU
2. *salmonberry (Rubus spectabilis)*	20	yes	FAC
3. _____			
4. _____			
5. _____			
50% = 30, 20% = 12	60	= Total Cover	
Herb Stratum (Plot size: _____)			
1. *stinging nettle (Urtica dioica)*	25	yes	FAC
2. *western swordfern (Polystichum munitum)*	5	no	FACU
3. *false lily-of-the-valley (Maianthemum dilatatum)*	25	yes	FAC
4. *youth on age (Tolmiea menziesii)*	10	no	FAC
5. _____			
6. _____			
7. _____			
8. _____			
9. _____			
10. _____			
11. _____			
50% = 32.5, 20% = 13	65	= Total Cover	
Woody Vine Stratum (Plot size: _____)			
1. _____			
2. _____			
50% = _____, 20% = _____	_____	= Total Cover	
% Bare Ground in Herb Stratum _____			

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	5	(A)
Total Number of Dominant Species Across All Strata:	6	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	83	(A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ 5 - Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: Williams Crossing

SOIL

Sampling Point: B-DP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-13	10YR 3/2	100					loam	
13-15	10YR3/3	100					loam	

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)

☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soils Present? **Yes** ☐ **No** ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)

☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stresses Plants (D1) **(LRR A)**
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) **(LRR A)**
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____
Water Table Present? Yes ☐ No ☒ Depth (inches): _____
Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks*:* No hydrology indicators - up slope of wetland edge.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: Williams Crossing City/County: Lacey/Thurston Sampling Date: 04/14/2021
Applicant/Owner: Three's Company State: WA Sampling Point: B-DP-3
Investigator(s): R. Pratt O. G. Rand Section, Township, Range: S09T18NR1W
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope (%): 2
Subregion (LRR): A Lat: 47.0608 Long: -122.8142 Datum: WGS84
Soil Map Unit Name: Skipopa Silt Loam NWI classification: PFO
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐	**Is the Sampled Area within a Wetland?** **Yes** ☒ **No** ☐
Hydric Soil Present?	Yes ☒	No ☐	
Wetland Hydrology Present?	Yes ☒	No ☐	

Remarks:

VEGETATION – Use scientific names of plants

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: _____)			
1. *red alder (Alnus rubra)*	40	yes	FAC
2. *western red cedar (Thuja plicata)*	20	yes	FAC
3.			
4.			
50% = 30, 20% = 12	60	= Total Cover	
Sapling/Shrub Stratum (Plot size: _____)			
1. *Indian plum (Oemleria cerasiformis)*	15	yes	FACU
2.			
3. _____			
4. _____			
5. _____			
50% = 7.5, 20% = 3	15	= Total Cover	
Herb Stratum (Plot size: _____)			
1. *false lily-of-the-valley (Maianthemum dilatatum)*	40	yes	FAC
2. *Pacific bleeding heart (Dicentra formosa)*	20	yes	FACU
3. *spotted touch-me-not (Impatiens capensis)*	30	yes	FACW
4. _____			
5. _____			
6. _____			
7. _____			
8. _____			
9. _____			
10. _____			
11. _____			
50% = 45, 20% = 18	90	= Total Cover	
Woody Vine Stratum (Plot size: _____)			
1. _____			
2. _____			
50% = _____, 20% = _____	_____	= Total Cover	
% Bare Ground in Herb Stratum _____			

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	4	(A)
Total Number of Dominant Species Across All Strata:	6	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	67	(A/B)

Prevalence Index worksheet:

	Total % Cover of:	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

☐ 1 – Rapid Test for Hydrophytic Vegetation
☒ 2 - Dominance Test is >50%
☐ 3 - Prevalence Index is ≤3.0[1]
☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
☐ 5 - Wetland Non-Vascular Plants[1]
☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Project Site: Williams Crossing

SOIL

Sampling Point: B-DP-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/2	100					loam	
2-12	10YR4/1	90	10YR5/3	10			sandy loam	redox

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains.

[2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☒ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☒ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☐ Depth (inches): _____

Water Table Present? Yes ☐ No ☐ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 18

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks*:* Weather drier than normal prior to delineation. See results from Corps Antecedent Precipitation Tool attached to report.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site: Williams Crossing City/County: Lacey/Thurston Sampling Date: 04/14/2021
Applicant/Owner: Three's Company State: WA Sampling Point: B-DP-4
Investigator(s): R. Pratt O. G. Rand Section, Township, Range: S09T18NR1W
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope (%): 2
Subregion (LRR): A Lat: 47.0608 Long: -122.8142 Datum: WGS84
Soil Map Unit Name: Skipopa Silt Loam NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐, significantly disturbed? Are “Normal Circumstances” present? Yes ☒ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☒	**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☒
Hydric Soil Present?	Yes ☐ No ☒	
Wetland Hydrology Present?	Yes ☐ No ☒	

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1. *red alder (Alnus rubra)*	40	yes	FAC
2. *western red cedar (Thuja plicata)*	10	yes	FAC
3.	_____	____	____
4.	_____	____	____
50% = 25, 20% = 10	50	= Total Cover	
Sapling/Shrub Stratum (Plot size: _____)			
1. ____	_____	____	____
2.	_____	____	____
3. _____	_____	____	____
4. _____	_____	____	____
5. _____	_____	____	____
50% = _____, 20% = _____	_____	= Total Cover	
Herb Stratum (Plot size: _____)			
1. *Swordfern (Polystichum munitum)*	60	yes	FACU
2. *Pacific bleeding heart (Dicentra formosa)*	30	yes	FACU
3. *spotted touch-me-not (Impatiens capensis)*	10	no	FACW
4. *false lily-of-the-valley (Maianthemum dilatatum)*	5	no	FAC
5. *stinging nettle (Urtica dioica)*	25	no	FAC
6. _____	_____	____	____
7. _____	_____	____	____
8. _____	_____	____	____
9. _____	_____	____	____
10. _____	_____	____	____
11. _____	_____	____	____
50% = 45, 20% = 18	130	= Total Cover	
Woody Vine Stratum (Plot size: _____)			
1. _____	_____	____	____
2. _____	_____	____	____
50% = _____, 20% = _____	_____	= Total Cover	
% Bare Ground in Herb Stratum _____			

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	2	(A)
Total Number of Dominant Species Across All Strata:	4	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	67	(A/B)

Prevalence Index worksheet:

	Total % Cover of:	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	10	x2 =	20
FAC species	80	x3 =	240
FACU species	90	x4 =	360
UPL species	_____	x5 =	_____
Column Totals:	180 (A)		620 (B)

Prevalence Index = B/A = 3.4

Hydrophytic Vegetation Indicators:

- ☐ 1 – Rapid Test for Hydrophytic Vegetation
- ☐ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ 5 - Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☒

Remarks:

Project Site: Williams Crossing

SOIL

Sampling Point: B-DP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 4/3	70	10YR3/3	30			loam	

[1] Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soils Present? **Yes** ☐ **No** ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stresses Plants (D1) **(LRR A)**
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) **(LRR A)**
☐ Frost-Heave Hummocks (D7)

Field Observations:

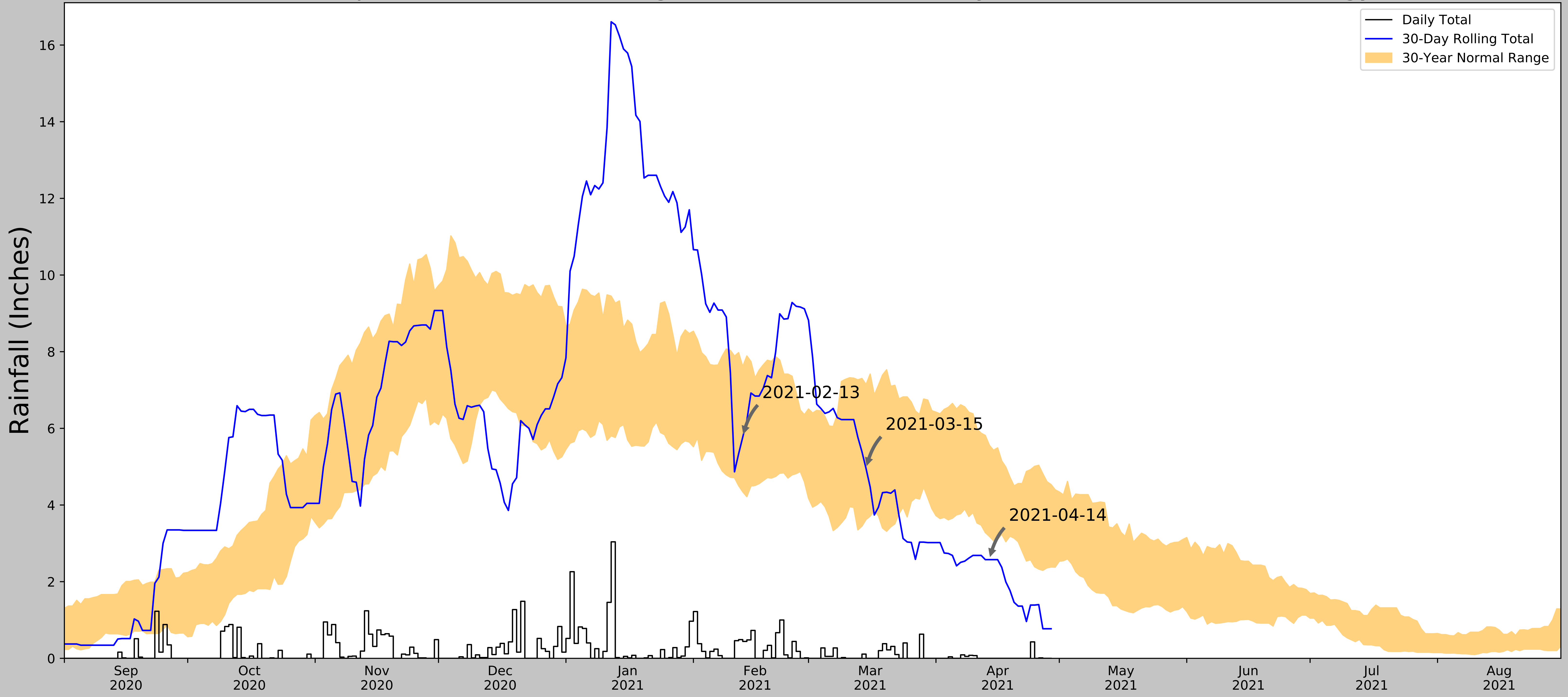
Surface Water Present? Yes ☐ No ☒ Depth (inches): _____
Water Table Present? Yes ☐ No ☒ Depth (inches): _____
Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



Coordinates	47.060848, -122.812763
Observation Date	2021-04-14
Elevation (ft)	76.52
Drought Index (PDSI)	Incipient drought (2021-03)
WebWIMP H_2O Balance	Wet Season

30 Days Ending	30th %ile (in)	70th %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2021-04-14	3.183071	5.556299	2.574803	Dry	1	3	3
2021-03-15	3.622047	7.141733	4.948819	Normal	2	2	4
2021-02-13	4.346063	7.610236	5.775591	Normal	2	1	2
Result							Drier than Normal - 9

Figure and tables made by the
Antecedent Precipitation Tool
Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
OLYMPIA AP	46.9733, -122.9033	187.992	7.401	111.472	4.156	11350	90
SHELTON	47.2, -123.1	21.982	16.575	54.538	8.363	2	0
WAUNA 3 W	47.3725, -122.7028	17.06	22.143	59.46	11.281	1	0

Appendix B

Wetland Rating Form

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RATING SUMMARY – Western Washington

Name of wetland (or ID #): Williams Crossing - Wetland A/B Date of site visit: 4/14/21

Rated by G. Rand Trained by Ecology? __ Yes X No Date of training 2005

HGM Class used for rating Depressional Wetland has multiple HGM classes? X Y ____N

NOTE: Form is not complete without the figures requested *(figures can be combined)*.

Source of base aerial photo/map Google Earth Pro/Thurston County GIS

OVERALL WETLAND CATEGORY III (based on functions X or special characteristics___)

1. Category of wetland based on FUNCTIONS

_______**Category I** – Total score = 23 - 27

_______**Category II** – Total score = 20 - 22

X **Category III** – Total score = 16 - 19

_______**Category IV** – Total score = 9 - 15

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
			Circle the appropriate ratings	
Site Potential	H [✓ M] L	H [✓ M] L	H M [✓ L]	
Landscape Potential	H [✓ M] L	H M [✓ L]	[✓ H] M L	
Value	[✓ H] M L	H M [✓ L]	[✓ H] M L	**TOTAL**
Score Based on Ratings	7	4	7	18

Score for each function based on three ratings
(order of ratings is not important)

9 = H,H,H
8 = H,H,M
7 = H,H,L
7 = H,M,M
6 = H,M,L
6 = M,M,M
5 = H,L,L
5 = M,M,L
4 = M,L,L
3 = L,L,L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	CATEGORY
Estuarine	I II
Wetland of High Conservation Value	I
Bog	I
Mature Forest	I
Old Growth Forest	I
Coastal Lagoon	I II
Interdunal	I II III IV
None of the above	NA

Wetland name or number A/B

Maps and figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	1
Hydroperiods	D 1.4, H 1.2	1
Location of outlet *(can be added to map of hydroperiods)*	D 1.1, D 4.1	1
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	D 2.2, D 5.2	2
Map of the contributing basin	D 4.3, D 5.3	4
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	3
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	5
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	6

Riverine Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Ponded depressions	R 1.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	R 2.4	
Plant cover of trees, shrubs, and herbaceous plants	R 1.2, R 4.2	
Width of unit vs. width of stream *(can be added to another figure)*	R 4.1	
Map of the contributing basin	R 2.2, R 2.3, R 5.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	R 3.1	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	R 3.2, R 3.3	

Lake Fringe Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	L 1.1, L 4.1, H 1.1, H 1.4	
Plant cover of trees, shrubs, and herbaceous plants	L 1.2	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	L 2.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	L 3.1, L 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	L 3.3	

Slope Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Plant cover of **dense** trees, shrubs, and herbaceous plants	S 1.3	
Plant cover of **dense, rigid** trees, shrubs, and herbaceous plants *(can be added to figure above)*	S 4.1	
Boundary of 150 ft buffer (can be added to another figure)	S 2.1, S 5.1	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	S 3.1, S 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	S 3.3	

HGM Classification of Wetlands in Western Washington

For questions 1-7, the criteria described must apply to the entire unit being rated.

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in questions 1-7 apply, and go to Question 8.

1. Are the water levels in the entire unit usually controlled by tides except during floods?

[✓ NO – go to 2] **YES** – the wetland class is **Tidal Fringe** – go to 1.1

1.1 Is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)?

NO – Saltwater Tidal Fringe (Estuarine) **YES – Freshwater Tidal Fringe**

If your wetland can be classified as a Freshwater Tidal Fringe use the forms for ***Riverine*** *wetlands. If it is Saltwater Tidal Fringe it is an* ***Estuarine*** *wetland and is not scored. This method* ***cannot*** *be used to score functions for estuarine wetlands.*

2. The entire wetland unit is flat and precipitation is the only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit.

[✓ NO – go to 3] **YES** – The wetland class is **Flats**

If your wetland can be classified as a Flats wetland, use the form for ***Depressional*** *wetlands.*

3. Does the entire wetland unit **meet all** of the following criteria?

__The vegetated part of the wetland is on the shores of a body of permanent open water (without any plants on the surface at any time of the year) at least 20 ac (8 ha) in size;

__At least 30% of the open water area is deeper than 6.6 ft (2 m).

[✓ NO – go to 4] **YES –** The wetland class is **Lake Fringe** (Lacustrine Fringe)

4. Does the entire wetland unit **meet all** of the following criteria?

___The wetland is on a slope (*slope can be very gradual*),

___The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks,

___The water leaves the wetland **without being impounded**.

[✓ NO – go to 5] **YES –** The wetland class is **Slope**

NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3 ft diameter and less than 1 ft deep).

5. Does the entire wetland unit **meet all** of the following criteria?

___The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river,

___The overbank flooding occurs at least once every 2 years.

Wetland name or number A/B

[✓ NO – go to 6] **YES** – The wetland class is **Riverine**

NOTE: The Riverine unit can contain depressions that are filled with water when the river is not flooding

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.*

[✓ NO – go to 7] **YES** – The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

[✓ NO – go to 8] **YES** – The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a Depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within the wetland unit being scored.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	HGM class to use in rating
Slope + Riverine	Riverine
[✓ Slope + Depressional]	[✓ Depressional]
Slope + Lake Fringe	Lake Fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake Fringe	Depressional
Riverine + Lake Fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE

If you are still unable to determine which of the above criteria apply to your wetland, or if you have ***more than 2 HGM classes*** *within a wetland boundary, classify the wetland as Depressional for the rating.*

Small areas of sloped wetland along the edges of the units transition into the larger main depressional portion of the wetland.

Wetland name or number A/B

DEPRESSIONAL AND FLATS WETLANDS

Water Quality Functions - Indicators that the site functions to improve water quality

D 1.0. Does the site have the potential to improve water quality?	
D 1.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression (QUESTION 7 on key) with no surface water leaving it (no outlet). points = 3 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet. [✓ points = 2] Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 1 Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch. points = 1	2
D 1.2. The soil 2 in below the surface (or duff layer) is true clay or true organic *(use NRCS definitions)*. Yes = 4 [✓ No = 0]	0
D 1.3. Characteristics and distribution of persistent plants (Emergent, Scrub-shrub, and/or Forested Cowardin classes): Wetland has persistent, ungrazed, plants > 95% of area [✓ points = 5] Wetland has persistent, ungrazed, plants > ½ of area points = 3 Wetland has persistent, ungrazed plants > $^{1}/_{10}$ of area points = 1 Wetland has persistent, ungrazed plants < $^{1}/_{10}$ of area points = 0	5
D 1.4. Characteristics of seasonal ponding or inundation: *This is the area that is ponded for at least 2 months. See description in manual.* Area seasonally ponded is > ½ total area of wetland points = 4 Area seasonally ponded is > ¼ total area of wetland points = 2 Area seasonally ponded is < ¼ total area of wetland [✓ points = 0]	0
Total for D 1 Add the points in the boxes above	7

Rating of Site Potential If score is:____**12-16 = H** _X_**6-11 = M** ____**0-5 = L** *Record the rating on the first page*

D 2.0. Does the landscape have the potential to support the water quality function of the site?	
D 2.1. Does the wetland unit receive stormwater discharges? Yes = 1 [✓ No = 0]	0
D 2.2. Is > 10% of the area within 150 ft of the wetland in land uses that generate pollutants? Yes = 1 [✓ No = 0]	0
D 2.3. Are there septic systems within 250 ft of the wetland? House NW of Wetland A and houses east of Wetland B on septic. [✓ Yes = 1] No = 0	1
D 2.4. Are there other sources of pollutants coming into the wetland that are not listed in questions D 2.1-D 2.3? Source________________ Yes = 1 [✓ No = 0]	0
Total for D 2 Add the points in the boxes above	1

Rating of Landscape Potential If score is:____**3 or 4 = H** _X_**1 or 2 = M** ____**0 = L** *Record the rating on the first page*

D 3.0. Is the water quality improvement provided by the site valuable to society?	
D 3.1. Does the wetland discharge directly (i.e., within 1 mi) to a stream, river, lake, or marine water that is on the 303(d) list? [✓ Yes = 1] No = 0	1
D 3.2. Is the wetland in a basin or sub-basin where an aquatic resource is on the 303(d) list? [✓ Yes = 1] No = 0	1
D 3.3. Has the site been identified in a watershed or local plan as important for maintaining water quality (*answer YES if there is a TMDL for the basin in which the unit is found*)? [✓ Yes = 2] No = 0	2
Total for D 3 Add the points in the boxes above	4

Rating of Value If score is:_X_**2-4 = H** ____**1 = M** ____**0 = L** *Record the rating on the first page*

DEPRESSIONAL AND FLATS WETLANDS

Hydrologic Functions - Indicators that the site functions to reduce flooding and stream degradation

D 4.0. Does the site have the potential to reduce flooding and erosion?	
D 4.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression with no surface water leaving it (no outlet) points = 4 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet [✓ points = 2] Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch points = 1 Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 0	2
D 4.2. Depth of storage during wet periods: *Estimate the height of ponding above the bottom of the outlet. For wetlands with no outlet, measure from the surface of permanent water or if dry, the deepest part.* Marks of ponding are 3 ft or more above the surface or bottom of outlet points = 7 Marks of ponding between 2 ft to < 3 ft from surface or bottom of outlet points = 5 Marks are at least 0.5 ft to < 2 ft from surface or bottom of outlet [✓ points = 3] The wetland is a "headwater" wetland points = 3 Wetland is flat but has small depressions on the surface that trap water points = 1 Marks of ponding less than 0.5 ft (6 in) points = 0	3
D 4.3. Contribution of the wetland to storage in the watershed: *Estimate the ratio of the area of upstream basin contributing surface water to the wetland to the area of the wetland unit itself.* The area of the basin is less than 10 times the area of the unit points = 5 The area of the basin is 10 to 100 times the area of the unit [✓ points = 3] The area of the basin is more than 100 times the area of the unit points = 0 Entire wetland is in the Flats class points = 5	3
Total for D 4 Add the points in the boxes above	8

Rating of Site Potential If score is:___**12-16 = H** _X_**6-11 = M** ___**0-5 = L** *Record the rating on the first page*

D 5.0. Does the landscape have the potential to support hydrologic functions of the site?	
D 5.1. Does the wetland receive stormwater discharges? Yes = 1 [✓ No = 0]	0
D 5.2. Is >10% of the area within 150 ft of the wetland in land uses that generate excess runoff? Yes = 1 [✓ No = 0]	0
D 5.3. Is more than 25% of the contributing basin of the wetland covered with intensive human land uses (residential at >1 residence/ac, urban, commercial, agriculture, etc.)? Yes = 1 [✓ No = 0]	0
Total for D 5 Add the points in the boxes above	0

Rating of Landscape Potential If score is:___**3 = H** ___**1 or 2 = M** _X_**0 = L** *Record the rating on the first page*

D 6.0. Are the hydrologic functions provided by the site valuable to society?	
D 6.1. The unit is in a landscape that has flooding problems. *Choose the description that best matches conditions around the wetland unit being rated. Do not add points. Choose the highest score if more than one condition is met.* The wetland captures surface water that would otherwise flow down-gradient into areas where flooding has damaged human or natural resources (e.g., houses or salmon redds): • Flooding occurs in a sub-basin that is immediately down-gradient of unit. points = 2 • Surface flooding problems are in a sub-basin farther down-gradient. points = 1 Flooding from groundwater is an issue in the sub-basin. points = 1 The existing or potential outflow from the wetland is so constrained by human or natural conditions that the water stored by the wetland cannot reach areas that flood. *Explain why* ______________ points = 0 There are no problems with flooding downstream of the wetland. points = 0	0
D 6.2. Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan? Yes = 2 No = 0	0
Total for D 6 Add the points in the boxes above	0

Rating of Value If score is:___**2-4 = H** ___**1 = M** _X_**0 = L** *Record the rating on the first page*

Wetland name or number A/B

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that site functions to provide important habitat

H 1.0. Does the site have the potential to provide habitat?

H 1.1. Structure of plant community: *Indicators are Cowardin classes and strata within the Forested class.* Check the Cowardin plant classes in the wetland. *Up to 10 patches may be combined for each class to meet the threshold of ¼ ac or more than 10% of the unit if it is smaller than 2.5 ac. Add the number of structures checked.*

____Aquatic bed — 4 structures or more: points = 4
____Emergent — 3 structures: points = 2
____Scrub-shrub (areas where shrubs have > 30% cover) — 2 structures: points = 1
__X__Forested (areas where trees have > 30% cover) — 1 structure: points = 0

If the unit has a Forested class, check if:

__X__The Forested class has 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the Forested polygon

1

H 1.2. Hydroperiods

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ ac to count (*see text for descriptions of hydroperiods*).

____Permanently flooded or inundated — 4 or more types present: points = 3
__X__Seasonally flooded or inundated — 3 types present: points = 2
____Occasionally flooded or inundated — 2 types present: points = 1
__X__Saturated only — 1 type present: points = 0
____Permanently flowing stream or river in, or adjacent to, the wetland
____Seasonally flowing stream in, or adjacent to, the wetland
____**Lake Fringe wetland** — **2 points**
____**Freshwater tidal wetland** — **2 points**

1

H 1.3. Richness of plant species

Count the number of plant species in the wetland that cover at least 10 ft^2.

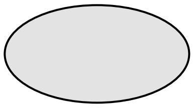
Different patches of the same species can be combined to meet the size threshold and you do not have to name the species. ***Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle***

If you counted: > 19 species — points = 2
[✓ 5 - 19 species] — points = 1
< 5 species — points = 0

1

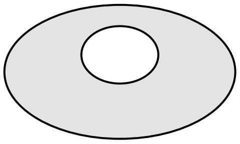
H 1.4. Interspersion of habitats

Decide from the diagrams below whether interspersion among Cowardin plants classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, moderate, low, or none. *If you have four or more plant classes or three classes and open water, the rating is always high.*

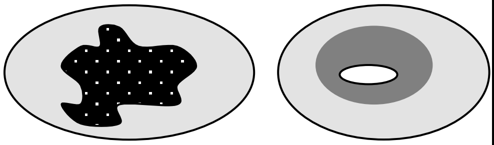


[✓ **None** = 0 points]

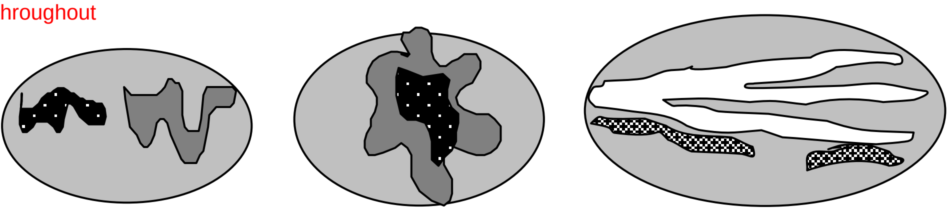
Continuous forest habitat throughout wetland.



Low = 1 point



Moderate = 2 points



All three diagrams in this row are **HIGH** = 3points

0

H 1.5. Special habitat features:

Check the habitat features that are present in the wetland. *The number of checks is the number of points.*

X Large, downed, woody debris within the wetland (> 4 in diameter and 6 ft long).

X Standing snags (dbh > 4 in) within the wetland

____Undercut banks are present for at least 6.6 ft (2 m) **and/or** overhanging plants extends at least 3.3 ft (1 m) over a stream (or ditch) in, or contiguous with the wetland, for at least 33 ft (10 m)

____Stable steep banks of fine material that might be used by beaver or muskrat for denning (> 30 degree slope) OR signs of recent beaver activity are present *(cut shrubs or trees that have not yet weathered where wood is exposed)*

____At least ¼ ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated *(structures for egg-laying by amphibians)*

X Invasive plants cover less than 25% of the wetland area in every stratum of plants (*see H 1.1 for list of strata*)

3

Total for H 1 — Add the points in the boxes above — 6

Rating of Site Potential If score is:____**15-18 = H** ____**7-14 = M** X **0-6 = L** *Record the rating on the first page*

H 2.0. Does the landscape have the potential to support the habitat functions of the site?

H 2.1. Accessible habitat (include *only habitat that directly abuts wetland unit*).

Calculate: % undisturbed habitat 33 **+** [(% moderate and low intensity land uses)/2] 4 **=** 37 %

If total accessible habitat is:

358 ac - accessible undisturbed = 33%
92 ac - accessible low/moderate = 8%
Area of 1km circle around wetlands = 1083 acres

> $^1/_3$ (33.3%) of 1 km Polygon [✓ points = 3]
20-33% of 1 km Polygon points = 2
10-19% of 1 km Polygon points = 1
< 10% of 1 km Polygon points = 0

3

H 2.2. Undisturbed habitat in 1 km Polygon around the wetland.

Calculate: % undisturbed habitat 47 **+** [(% moderate and low intensity land uses)/2] 5 **=** 52 %

509 ac und./1083 = 47%
111 ac. low/mod/1083 = 10%

Undisturbed habitat > 50% of Polygon [✓ points = 3]
Undisturbed habitat 10-50% and in 1-3 patches points = 2
Undisturbed habitat 10-50% and > 3 patches points = 1
Undisturbed habitat < 10% of 1 km Polygon points = 0

3

H 2.3. Land use intensity in 1 km Polygon: If
> 50% of 1 km Polygon is high intensity land use points = (- 2)
≤ 50% of 1 km Polygon is high intensity [✓ points = 0]

0

Total for H 2 — Add the points in the boxes above — 6

Rating of Landscape Potential If score is: X **4-6 = H** ____**1-3 = M** ____**< 1 = L** *Record the rating on the first page*

H 3.0. Is the habitat provided by the site valuable to society?

H 3.1. Does the site provide habitat for species valued in laws, regulations, or policies? *Choose only the highest score that applies to the wetland being rated.*

Site meets ANY of the following criteria: [✓ points = 2]

- It has 3 or more priority habitats within 100 m (see next page)
- It provides habitat for Threatened or Endangered species (any plant or animal on the state or federal lists)
- It is mapped as a location for an individual WDFW priority species
- It is a Wetland of High Conservation Value as determined by the Department of Natural Resources
- It has been categorized as an important habitat site in a local or regional comprehensive plan, in a Shoreline Master Plan, or in a watershed plan

Site has 1 or 2 priority habitats (listed on next page) within 100 m points = 1

Site does not meet any of the criteria above points = 0

2

Rating of Value If score is: X **2 = H** ____**1 = M** ____**0 = L** *Record the rating on the first page*

WDFW Priority Habitats

Priority habitats listed by WDFW (see complete descriptions of WDFW priority habitats, and the counties in which they can be found, in: Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp. http://wdfw.wa.gov/publications/00165/wdfw00165.pdf or access the list from here: http://wdfw.wa.gov/conservation/phs/list/)

Count how many of the following priority habitats are within 330 ft (100 m) of the wetland unit: ***NOTE:*** *This question is independent of the land use between the wetland unit and the priority habitat.*

— **Aspen Stands:** Pure or mixed stands of aspen greater than 1 ac (0.4 ha).

— **Biodiversity Areas and Corridors**: Areas of habitat that are relatively important to various species of native fish and wildlife (*full descriptions in WDFW PHS report*).

— **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock.

X — **Old-growth/Mature forests:** Old-growth west of Cascade crest – Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) > 32 in (81 cm) dbh or > 200 years of age. Mature forests – Stands with average diameters exceeding 21 in (53 cm) dbh; crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80-200 years old west of the Cascade crest.

— **Oregon White Oak:** Woodland stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158 – see web link above*).

X — **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.

— **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161 – see web link above*).

X — **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

— **Nearshore**: Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. (*full descriptions of habitats and the definition of relatively undisturbed are in WDFW report – see web link on previous page).*

— **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.

— **Cliffs:** Greater than 25 ft (7.6 m) high and occurring below 5000 ft elevation.

— **Talus:** Homogenous areas of rock rubble ranging in average size 0.5 - 6.5 ft (0.15 - 2.0 m), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.

X — **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 20 in (51 cm) in western Washington and are > 6.5 ft (2 m) in height. Priority logs are > 12 in (30 cm) in diameter at the largest end, and > 20 ft (6 m) long.

Note: All vegetated wetlands are by definition a priority habitat but are not included in this list because they are addressed elsewhere.

Wetland name or number A/B

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Wetland Type *Check off any criteria that apply to the wetland. Circle the category when the appropriate criteria are met.*	**Category**
SC 1.0. Estuarine wetlands Does the wetland meet the following criteria for Estuarine wetlands? — The dominant water regime is tidal, — Vegetated, and — With a salinity greater than 0.5 ppt Yes –Go to **SC 1.1** [✓ No= **Not an estuarine wetland**]	
SC 1.1. Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151? Yes = **Category I** No - Go to **SC 1.2**	**Cat. I**
SC 1.2. Is the wetland unit at least 1 ac in size and meets at least two of the following three conditions? — The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. (If non-native species are *Spartina*, see page 25) — At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. — The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands. Yes = **Category I** No = **Category II**	**Cat. I** **Cat. II**
SC 2.0. Wetlands of High Conservation Value (WHCV) SC 2.1. Has the WA Department of Natural Resources updated their website to include the list of Wetlands of High Conservation Value? [✓ Yes **–** Go to **SC 2.2**] No **–** Go to **SC 2.3** SC 2.2. Is the wetland listed on the WDNR database as a Wetland of High Conservation Value? Yes **= Category I** [✓ No **= Not a WHCV**] SC 2.3. Is the wetland in a Section/Township/Range that contains a Natural Heritage wetland? http://www1.dnr.wa.gov/nhp/refdesk/datasearch/wnhpwetlands.pdf Yes **– Contact WNHP/WDNR and go to SC 2.4** No **= Not a WHCV** SC 2.4. Has WDNR identified the wetland within the S/T/R as a Wetland of High Conservation Value and listed it on their website? Yes **= Category I** No **= Not a WHCV**	**Cat. I**
SC 3.0. Bogs Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below. **If you answer YES you will still need to rate the wetland based on its functions.*** SC 3.1. Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16 in or more of the first 32 in of the soil profile? Yes – Go to **SC 3.3** [✓ No – Go to **SC 3.2**] SC 3.2. Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? Yes – Go to **SC 3.3** [✓ No = **Is not a bog**] SC 3.3. Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least a 30% cover of plant species listed in Table 4? Yes = **Is a Category I bog** No – Go to **SC 3.4** **NOTE:** If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16 in deep. If the pH is less than 5.0 and the plant species in Table 4 are present, the wetland is a bog. SC 3.4. Is an area with peats or mucks forested (> 30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann spruce, or western white pine, AND any of the species (or combination of species) listed in Table 4 provide more than 30% of the cover under the canopy? Yes = **Is a Category I bog** No **= Is not a bog**	**Cat. I**

SC 4.0. Forested Wetlands

Does the wetland have at least 1 contiguous acre of forest that meets one of these criteria for the WA Department of Fish and Wildlife's forests as priority habitats? ***If you answer YES you will still need to rate the wetland based on its functions.***

- **Old-growth forests** (west of Cascade crest): Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 in (81 cm) or more.
- **Mature forests** (west of the Cascade Crest): Stands where the largest trees are 80- 200 years old OR the species that make up the canopy have an average diameter (dbh) exceeding 21 in (53 cm).

Mature trees are present in the buffer but not within the wetland.

Yes = **Category I** [✓ No = **Not a forested wetland for this section**]

Cat. I

SC 5.0. Wetlands in Coastal Lagoons

Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?

- The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks
- The lagoon in which the wetland is located contains ponded water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon *(needs to be measured near the bottom)*

Yes – Go to **SC 5.1** [✓ No = **Not a wetland in a coastal lagoon**]

Cat. I

SC 5.1. Does the wetland meet all of the following three conditions?

- The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species on p. 100).
- At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland.
- The wetland is larger than $^1/_{10}$ ac (4350 ft^2)

Yes = **Category I** No = **Category II**

Cat. II

SC 6.0. Interdunal Wetlands

Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership or WBUO)? ***If you answer yes you will still need to rate the wetland based on its habitat functions.***

In practical terms that means the following geographic areas:

- Long Beach Peninsula: Lands west of SR 103
- Grayland-Westport: Lands west of SR 105
- Ocean Shores-Copalis: Lands west of SR 115 and SR 109

Yes – Go to **SC 6.1** [✓ No = **not an interdunal wetland for rating**]

Cat I

SC 6.1. Is the wetland 1 ac or larger and scores an 8 or 9 for the habitat functions on the form (rates H,H,H or H,H,M for the three aspects of function)? Yes = **Category I** No – Go to **SC 6.2**

Cat. II

SC 6.2. Is the wetland 1 ac or larger, or is it in a mosaic of wetlands that is 1 ac or larger?

Yes = **Category II** No – Go to **SC 6.3**

Cat. III

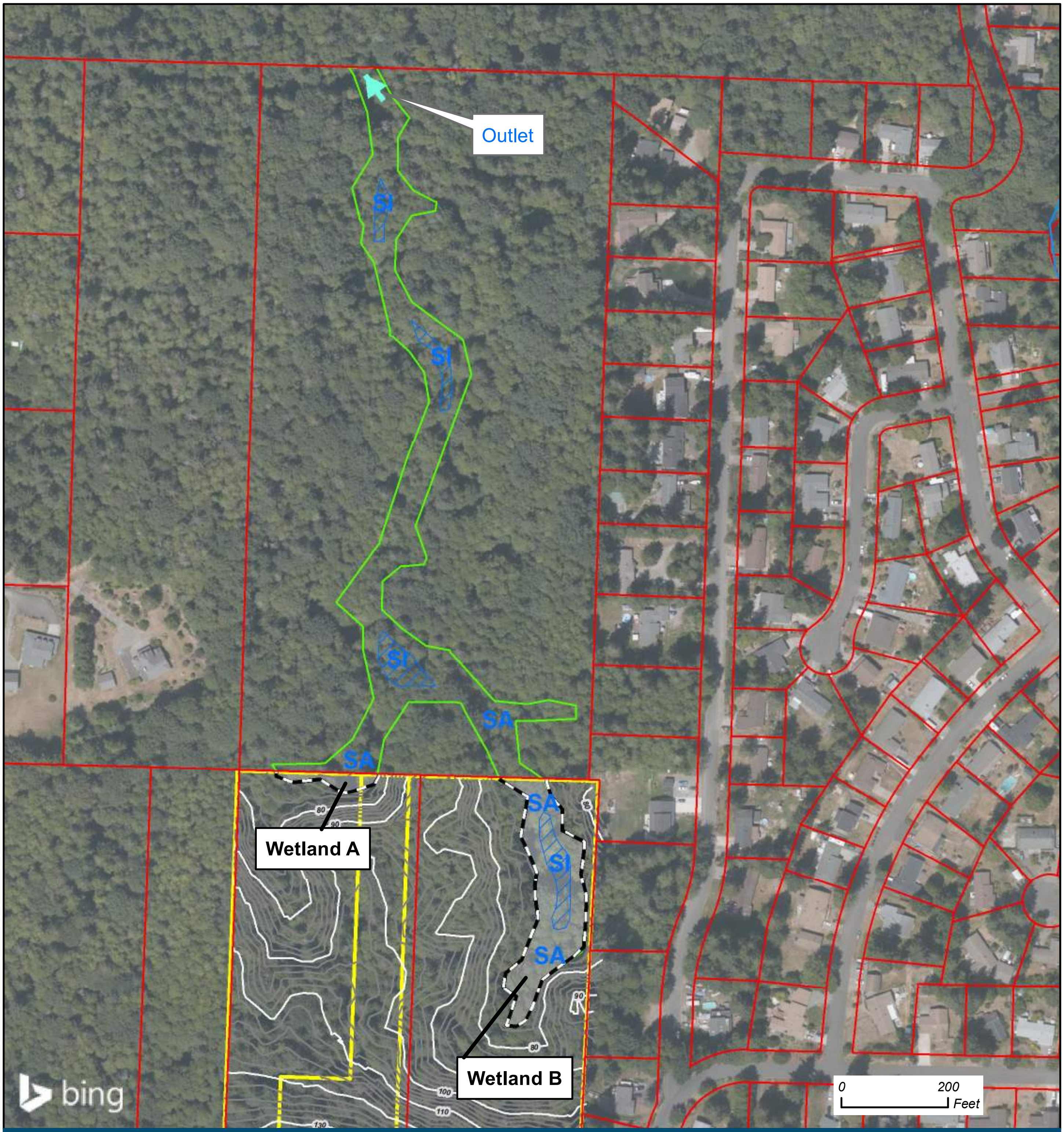
SC 6.3. Is the unit between 0.1 and 1 ac, or is it in a mosaic of wetlands that is between 0.1 and 1 ac?

Yes = **Category III** No = **Category IV**

Cat. IV

Category of wetland based on Special Characteristics
If you answered No for all types, enter "Not Applicable" on Summary Form

NA



Williams Crossing Development Wetland Delineation

Hydroperiods and Outlet

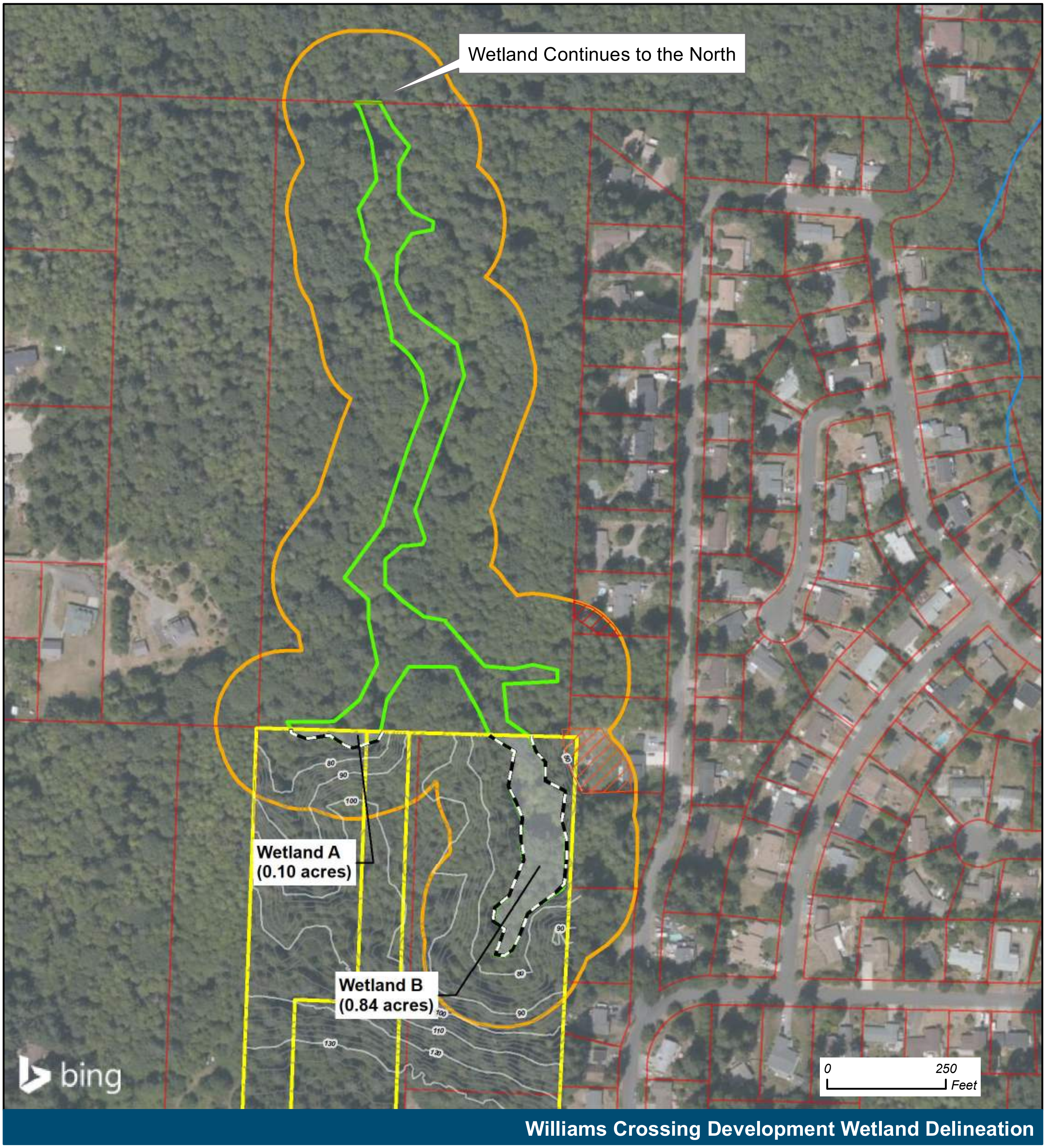
Rating Figure 1

Data Sources:
Patrick Harron and Associates, LLC, NOAA
Thurston County GIS
PNW Lidar Consortium

Legend

▭	Delineated Wetland Boundary	🟥	Parcels
━	Updated Tax Lots (Proposed Development)	━	Major Contour (10 ft intervals)
▨	Seasonally Inundated	━	Minor Contour (2 ft intervals)
SA	Saturated	🟩	Estimated Wetland Boundary

N



Williams Crossing Development Wetland Delineation

150-foot Buffer and Pollutant-Contributing Areas

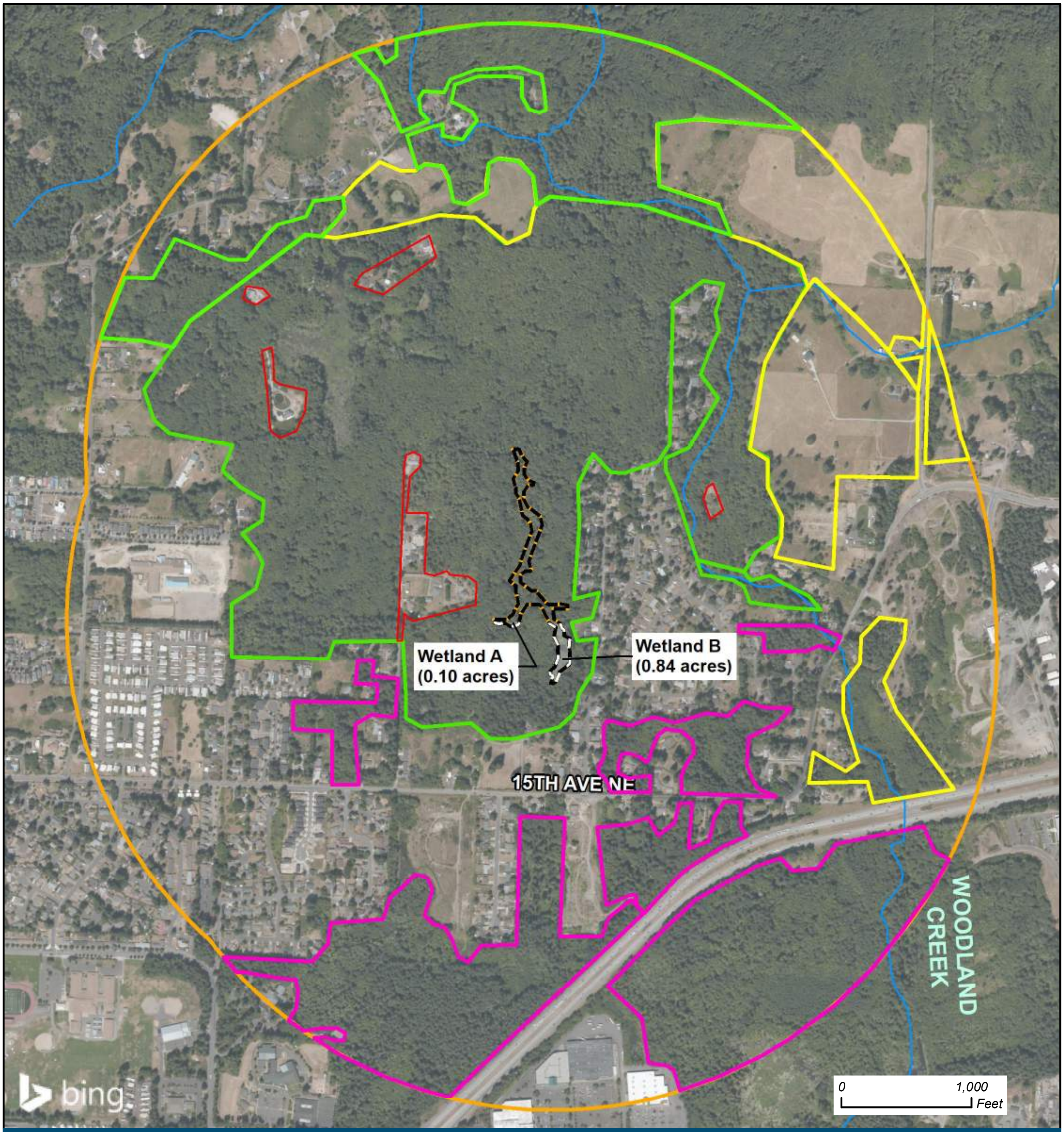
Rating Figure 2

Data Sources:
Patrick Harron and Associates, LLC, NOAA
Thurston County GIS

Legend

▨	Delineated Wetland Boundary	🟧	150-Foot Buffer
—	Major Contour (10 ft intervals)	🟥	Parcels
—	Minor Contour (2 ft intervals)	—	Updated Tax Lots (Proposed Development)
🟩	Overall Wetland Boundary	▨	Pollutant-Contributing Area

N



Williams Crossing Development Wetland Delineation

Data Sources:
Patrick Harron and Associates, LLC, NOAA
Thurston County GIS

Legend

- ⬚ Delineated Wetland Boundary
- ⬚ Estimated Wetland Boundary
- 🟧 1 Km Buffer
- 🟩 Accessible Undisturbed Habitat
- 🟨 Low/Moderate Habitat (eastern polygons non-accessible)
- 🟥 Developed
- 🟪 Non-accessible Undisturbed Habitat

N

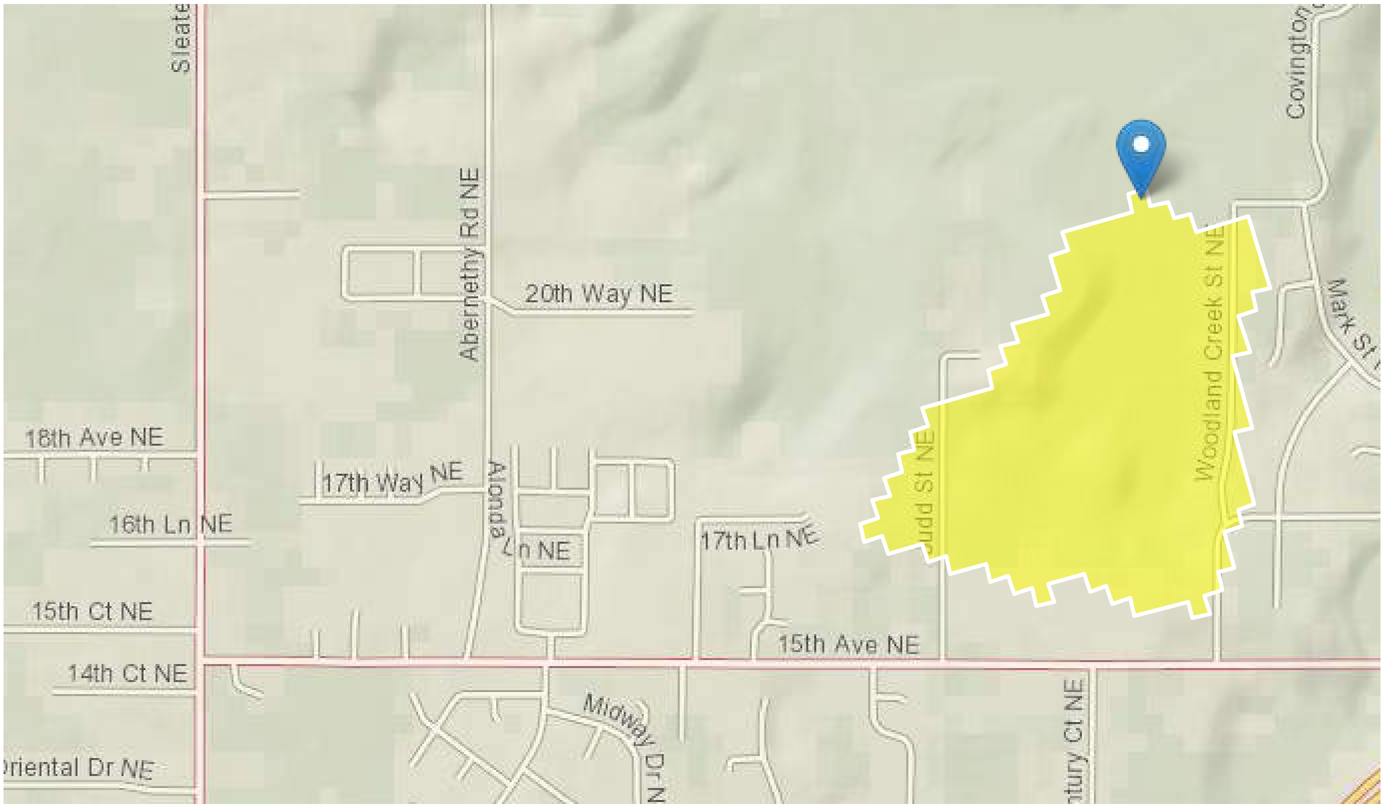
Habitat Polygons
Rating Figure ***3***

P:\T\THRE00000001\0600INFO\GS\Maps\Wetland Ratings Figures\THRE0001 Rating Figure 3.mxd 6/3/2021

Figure 4 - Contributing Basin to Wetland Units A/B and Offsite Wetland

StreamStats Report - Williams Crossing Wetlands A/B

Region ID: WA
Workspace ID: WA20210603182811563000
Clicked Point (Latitude, Longitude): 47.06458, -122.81354
Time: 2021-06-03 11:28:29 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CANOPY_PCT	Percentage of drainage area covered by canopy as described in OK SIR 2009_5267	75.7	percent
DRNAREA	Area that drains to a point on a stream	0.11	square miles
PRECIP	Mean Annual Precipitation	50	inches
PRECPRIS10	Basin average mean annual precipitation for 1981 to 2010 from PRISM	47.1	inches
RELIEF	Maximum - minimum elevation	56.3	feet

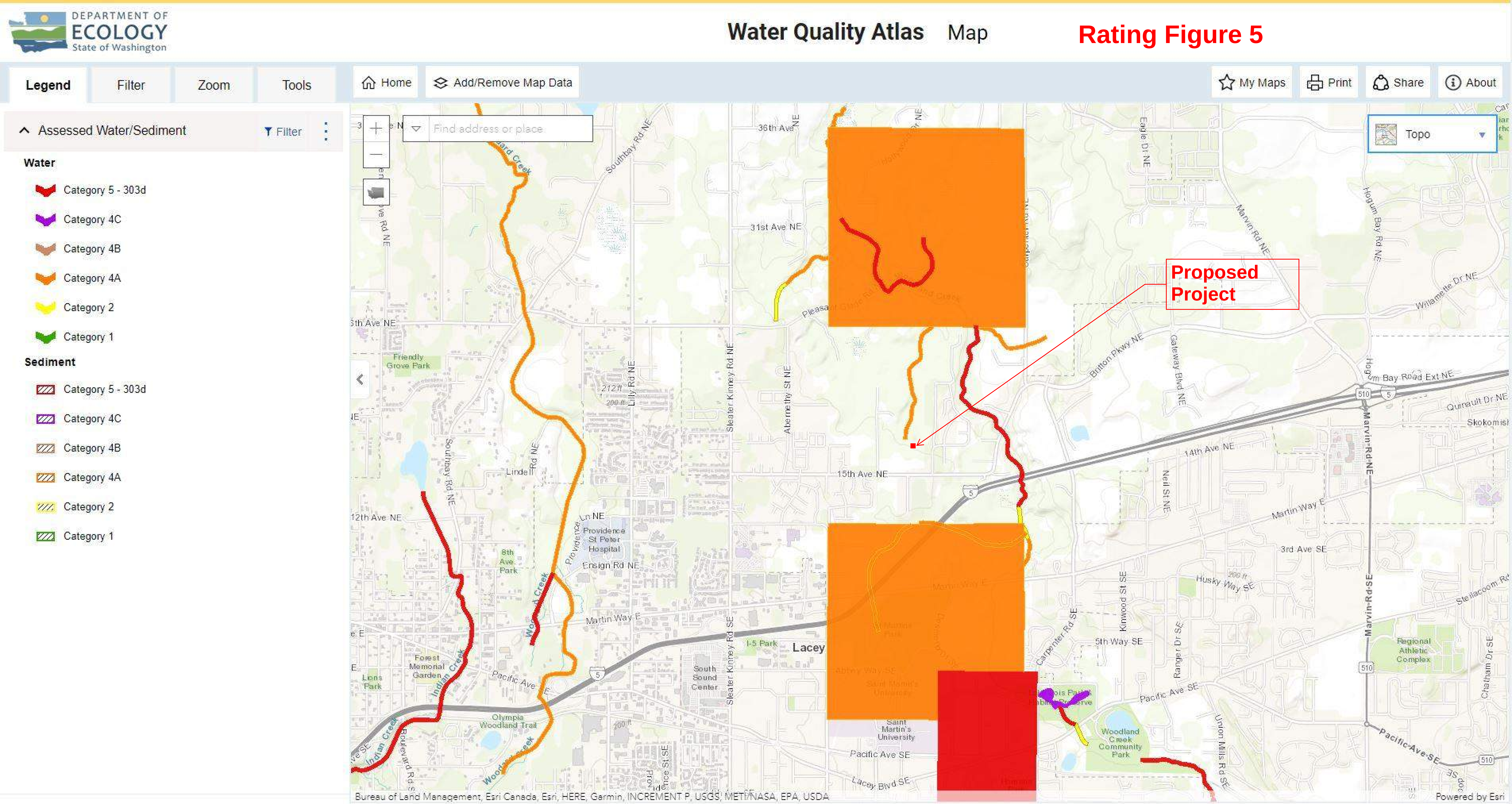
USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

USGS Software Disclaimer: This software has been approved for release by the U.S. Geological Survey (USGS). Although the software has been subjected to rigorous review, the USGS reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.5.3
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.2

Rating Figure 5



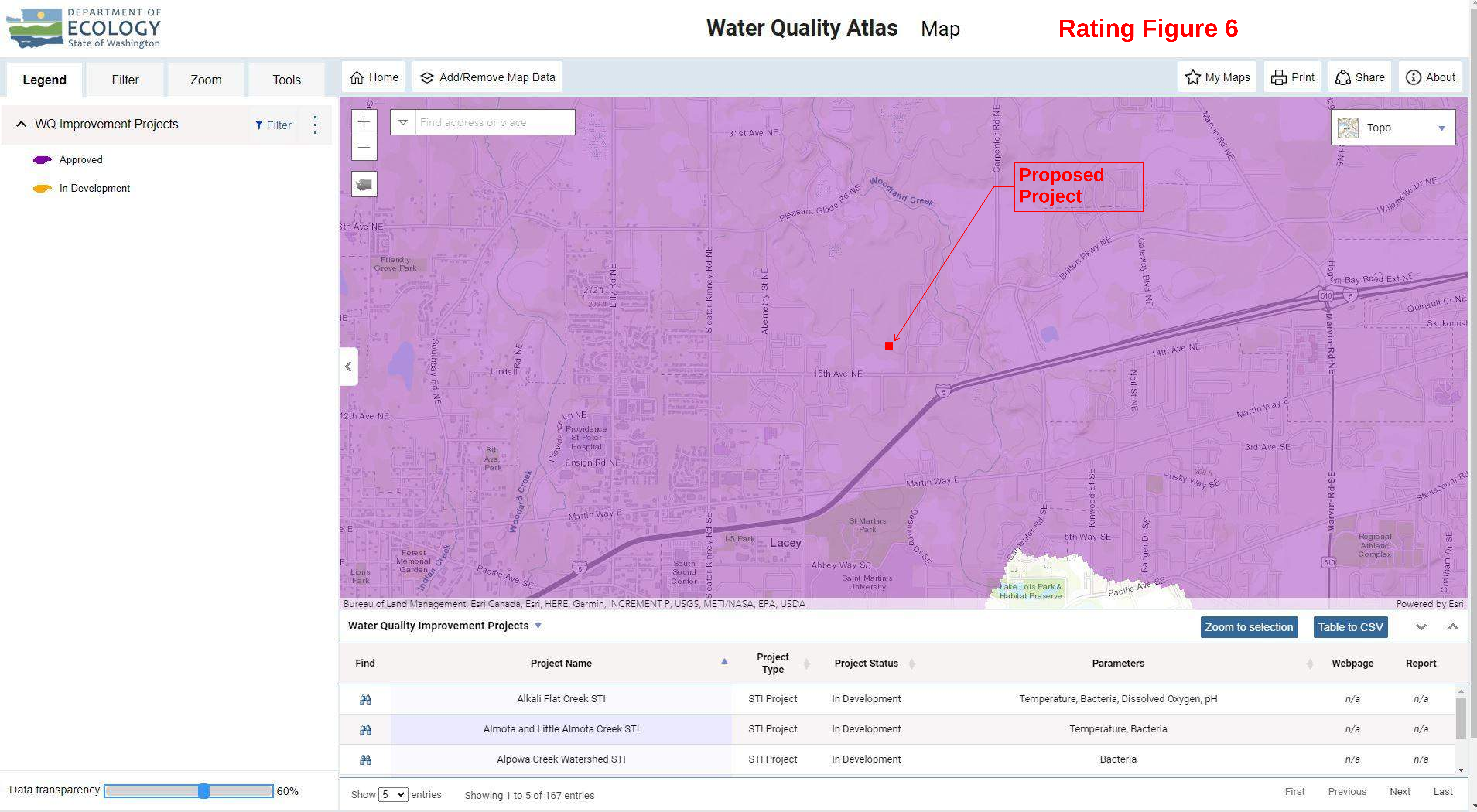
Assessed Water/Sediment

Water

- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Sediment

- ▨ Category 5 - 303d
- ▨ Category 4C
- ▨ Category 4B
- ▨ Category 4A
- ▨ Category 2
- ▨ Category 1



Rating Figure 6

WQ Improvement Projects Filter

- ● Approved
- ● In Development

Water Quality Improvement Projects

Find	Project Name	Project Type	Project Status	Parameters	Webpage	Report
🔍	Alkali Flat Creek STI	STI Project	In Development	Temperature, Bacteria, Dissolved Oxygen, pH	n/a	n/a
🔍	Almota and Little Almota Creek STI	STI Project	In Development	Temperature, Bacteria	n/a	n/a
🔍	Alpowa Creek Watershed STI	STI Project	In Development	Bacteria	n/a	n/a

Show 5 entries Showing 1 to 5 of 167 entries

Appendix C

Photographs

Photograph 1. View looking at south end of Wetland B.

Photograph 2. View looking north at south end of Wetland B.

Photograph 3. View looking north at Wetland B.

Photograph 4. View looking at herb understory in Wetland B

Photograph 5. View looking at small pond (likely excavated historically) within Wetland B. Pond is approximately 400 square feet in size.

Photograph 6. View looking at north end of Wetland B.

Photograph 7. View looking northwest at Wetland A.

Photograph 8. View looking north at Wetland A offsite.

Photograph 9. View looking at understory in Wetland A.

Photograph 10. View looking north at location where Wetland A and Wetland B merge offsite.

Photograph 11. View looking at buffer between Wetland A and B.

Photograph 12. View looking at first occurrence of stream channel on offsite City of Lacey property.

Photograph 13. View looking across wetland on offsite City of Lacey property.

Photograph 14. View looking at buffer habitat on offsite wetland.

Appendix D

Project Site Plan

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WILLIAMS CROSSING

SEC 9, T 13 N, R 1 W, W. M.

PROJECT INFORMATION:

DEVELOPER/OWNER:

THREE'S COMPANY, LLC
BRIAN D. REAS, PE
17403 162ND AVE SE
RENTON, WA 98058
PH: 425.226.3999
EMAIL: reascrew@comcast.net

CIVIL ENGINEER/PRIMARY CONTACT:

PATRICK HARRON & ASSOCIATES, LLC
CONTACT: CHRIS CRAMER P.E.
8270 28TH COURT NE
LACEY, WA 98516
PH: 360.459.1102
EMAIL: chris@patrickharron.com

GEOTECHNICAL ENGINEER

GEORESOURCES
CONTACT: DANA C. BIGGERSTAFF, PE
5007 PACIFIC HWY E, STE 16
FIFE, WA 98424
PH: 253.896.1011
EMAIL: danab@georesources.us

SURVEYOR

MTN2COAST, LLC
CONTACT: BLAIR PRIGGE, PLS
2320 MOTTMAN RD SW #106
TUMWATER, WA 98512
PH: 360.239.1497
EMAIL: blair@mtn2coast.com

DATUM

HORIZONTAL:
WASHINGTON STATE PLANE COORDINATES, SOUTH ZONE, NAD 83/2011 BASED ON GPS TIES THROUGH THE WASHINGTON STATE REFERENCE NETWORK.

VERTICAL:
NGVD 29 BASED ON GPS TIES THROUGH THE WASHINGTON STATE REFERENCE NETWORK. CONVERSION FROM NGVD 29 TO NAVD 88 ADD 3.41 FEET.

0 60 120
HORIZONTAL SCALE

LEGEND

▬▬▬	PROPOSED PROPERTY LINE
▬ ‐ ‐ ▬	PROPERTY LINE
▬ ‐ ‐ ‐ ▬	RIGHT OF WAY
░	PROPOSED CURB, GUTTER, AND SIDEWALK
▒	PROPOSED STANDARD IMPERVIOUS ASPHALT PAVEMENT
▨	PROPOSED PERVIOUS ASPHALT PAVEMENT

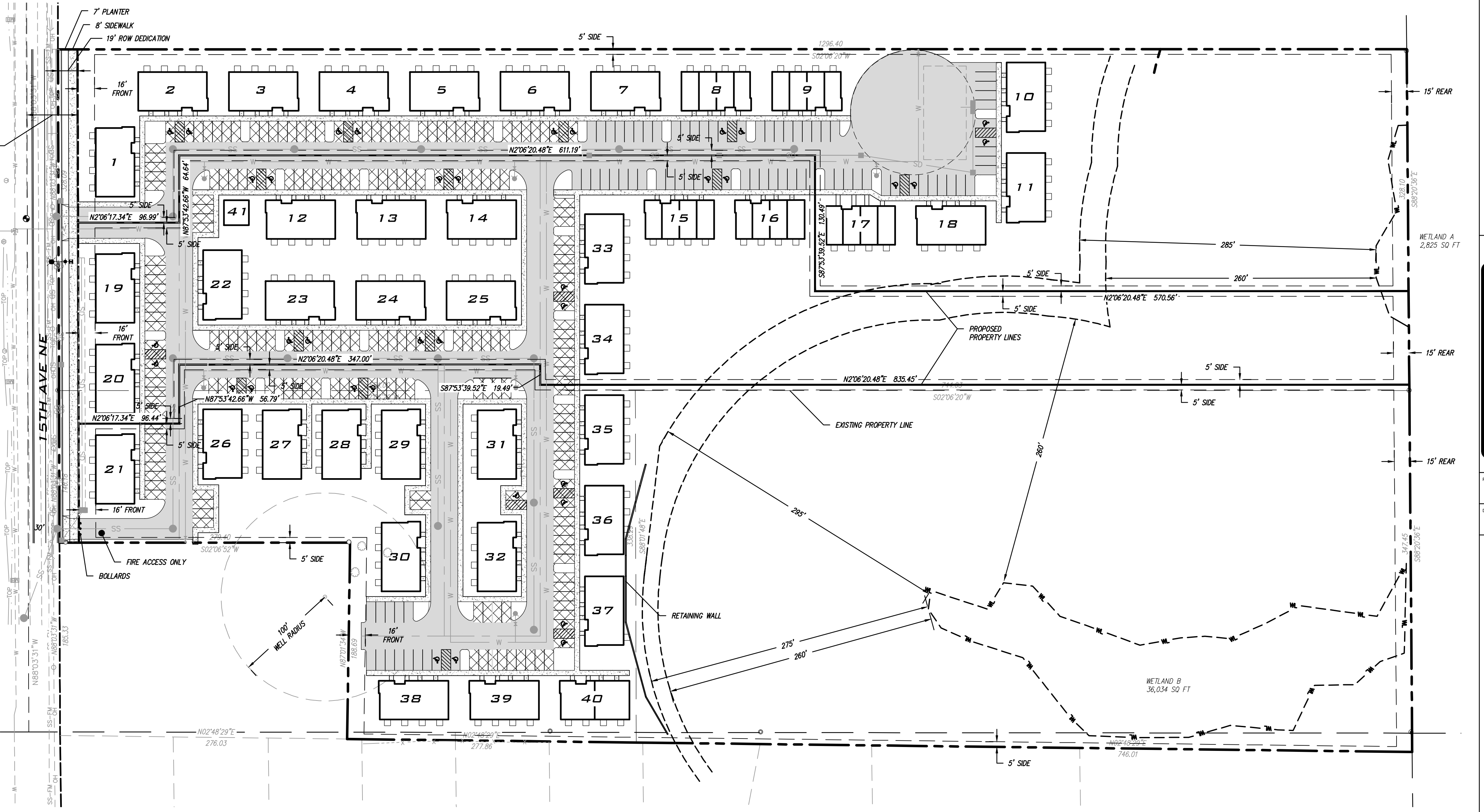
DEVELOPMENT DATA:

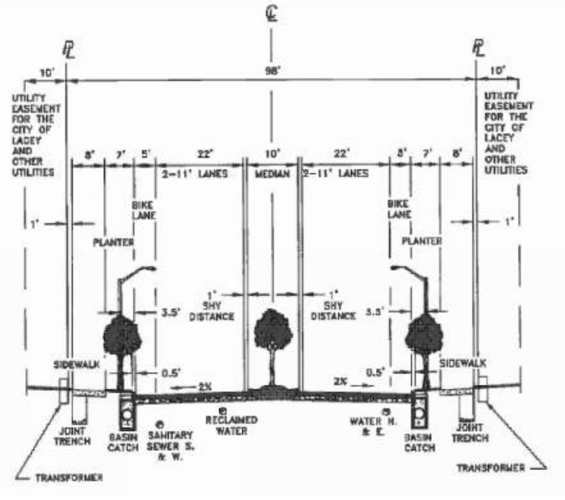
PROPERTY AREA TOTAL:	814,600 SF (18.7 ACRES)

PARCEL NUMBER:	11809310100
PARCEL AREA:	425,602 SF (9.77 AC)
SITE ADDRESS:	5216 NE 15TH AVE, OLYMPIA, 98516
ZONING:	MD, MODERATE-DENSITY RESIDENTIAL HD
ABBREV. LEGAL:	9-18-1W W2 E2 NE SW EXCEPT S30F FOR DRAHAM RD

PARCEL NUMBER:	11809310600
PARCEL AREA:	133,574 SF (3.07 AC)
SITE ADDRESS:	5224 NE 15TH AVE, OLYMPIA, 98516
ZONING:	HD, HIGH DENSITY RESIDENTIAL
ABBREV. LEGAL:	9-18-1W PT NE4 SW4 PTN LOT 2 SS-1563 AKA LOT B BLA-0568 6/230

PARCEL NUMBER:	11809310700
PARCEL AREA:	255,424 SF (5.86 AC)
SITE ADDRESS:	5228 NE 15TH AVE, OLYMPIA, 98516
ZONING:	LD 0-4, LOW-DENSITY RESIDENTIAL
ABBREV. LEGAL:	9-18-1W NE SW L1 OF SS1563





4-2.2 ARTERIAL STREET DESIGN

CALL 48 HOURS BEFORE YOU DIG
811

THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL EXISTING UTILITIES. THE CONTRACTOR SHALL VERIFY ALL UTILITY LOCATIONS PRIOR TO CONSTRUCTION BY CALLING THE UNDERGROUND LOCATE LINE AT 1-800-424-5555 OR 811 (CELL) A MINIMUM OF 48 HOURS PRIOR TO ANY EXCAVATION.

R#	DATE	DESCRIPTION	BY
△			
△			
△			
△			
△			
△			
△			

CHRISTIAN M. CRAMER
41796
6/10/21

CITY OF LACEY - SITE PLAN REVIEW

SITE PLAN

PATRICK HARRON & ASSOCIATES, LLC
Civil Engineering & Planning
8270 28th Court NE, Suite 201, Lacey, WA 98516
Phone : 360.459.1102 / Fax: 360.459.1013
Web : patrickharron.com

PROJ. NO. 19527	DSN. BY: CMC
DWN. BY: DAW	CHK. BY: CMC

WILLIAMS CROSSING

THREE'S COMPANY, LLC
5224 NE 15TH AVE NE
LACEY, WA 98516

DATE:	6/10/21
SCALE:	AS SHOWN
DRAWING NO.	C1.0
	1 OF 3

Jun 10, 2021 3:40:22PM - User Chris Cramer
P:\2019\19527 Williams Crossing\Drawing\Working\SPR\19527 C1.0.dwg

Earth Solutions NW LLC
Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

February 13, 2024
ES-9532.01

Sage Homes Northwest, LLC
9505 – 19th Avenue Southeast, Suite 118
Everett, Washington 98208

Attention: Albert Torrico

Subject: Infiltration Evaluation
Williams Crossing
5224, 5228, and 5216 – 15th Avenue Northeast
Thurston County (Olympia), Washington

Dear Albert:

Earth Solutions NW, LLC (ESNW) has prepared this infiltration evaluation for the proposed project. ESNW performed our work in general accordance with the scope of services outlined in our proposal dated November 21, 2023, which was authorized on November 28, 2023. A summary of the subsurface exploration, laboratory analyses, and an evaluation of infiltration feasibility and related considerations are provided in this letter report.

ESNW is currently conducting a seasonal groundwater monitoring program at the subject site to supplement this letter and to further characterize on-site infiltration feasibility. The results of the seasonal groundwater monitoring program have the potential to influence the design parameters given in this letter, which should be reevaluated at the end of the monitoring period. Upon completion of the seasonal monitoring period, an additional summary letter will be provided.

Project & Site Description

The subject site is located on the north side of 15th Avenue Northeast at the intersection with Century Court Northeast, in the Olympia area of unincorporated Thurston County, Washington. The site consists of three adjoining tax parcels (Thurston County Parcel Nos. 11809310-600, -700, and -100) totaling about 18.7 acres of land area. The approximate site location is depicted on Plate 1 (Vicinity Map).

The property is currently developed with a single-family residence and associated improvements. The relatively large site is mostly undeveloped and vacant, vegetated with mature trees, understory growth, and a mixture of native plant species. The site is bordered to the east and west by similarly developed residential lots, to the north by undeveloped and forested land, and to the south by 15th Avenue Northeast.

Per Thurston County GIS mapping and ESNW site experience, topography is relatively level across the southern portion of the project site. North of the existing residence, surface grades descend at moderate gradients to the north for a total of about 70 feet of topographic relief within the parcel boundaries.

Formal site plans were not available for review at the time of letter preparation. However, we understand that a large-scale stormwater infiltration facility is proposed in the northwest portion of the project site as part of the overall site development plans, which was the focus of this letter.

Subsurface Conditions

To explore the subsurface and to characterize the on-site soil and geologic conditions as they relate to infiltration feasibility, an ESNW representative observed, logged, and sampled three borings and three test pits, all targeted at requested locations within the proposed infiltration facility footprint. The borings were completed on November 7, 2023 using a track-mounted drill rig and operators retained by ESNW. The test pits were completed on December 27, 2023 using a trackhoe and operator retained by ESNW. The borings were advanced to a maximum depth of 31.5 feet below the existing ground surface (bgs), and the test pits were advanced to a maximum depth of 18 feet bgs.

The approximate locations of the explorations are depicted on Plate 2 (Subsurface Exploration Plan). Please refer to the attached exploration logs for a more detailed description of subsurface conditions. Representative soil samples collected at the exploration locations were analyzed in general accordance with Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures. Representative soil samples were analyzed for stormwater treatment potential in the form of organic content (OC) and cation exchange capacity (CEC) testing.

Topsoil and Fill

Due to the sampling methods utilized in hollow-stem auger drilling, topsoil thicknesses were not observed at the boring locations. At the test pit locations, however, topsoil was encountered within the upper 10 to 12 inches of existing grades. Deeper or shallower pockets of topsoil may be encountered locally across the site. The topsoil was characterized by its dark brown color, the presence of fine organic material, and small root intrusions.

Fill was not observed at the November and December 2023 exploration sites.

Native Soil

Underlying the topsoil at the test locations, native soils were variable in composition and consistent with typical recessional outwash sand and silt deposits. Based on blow counts recorded during the drilling, the site soils are chiefly in a medium dense condition.

Soil compositions observed across numerous distinct soil strata included poorly graded sand, silty sand, sandy silt, and silt (USCS: SP, SM, and ML). Laminations and interbeds ranging in thickness from inch-scale to foot-scale were observed at variable depths at the exploration sites.

In general, at the test pit locations, silt-dominant soils were encountered immediately below the topsoil and extended to depths between six and ten and one-half feet bgs. Underlying the silts, sand-dominant soils were encountered and generally extended to depths between 15 and 17 feet bgs. Thin, inch-scale laminations were observed within the upper one to two feet of the sand-dominant soils described above. Thicker, foot-scale interbeds of silt-dominant soils were encountered beginning at 15 to 17 feet bgs. At test locations TP-2 and TP-3, relatively free-draining, sand-dominant soils were exposed again below the foot-scale silty interbeds and extended to the termination depth of the explorations. Test pit TP-1 was terminated within a section of silt-dominant soils due to maximum excavator reach.

Laboratory analyses of representative soil samples indicate that fines contents ranged between about 4 and 98 percent. The in-situ moisture content ranged from moist to wet at the time of the exploration.

Geologic Setting

The referenced geologic map indicates the site is underlain by recessional sand and minor silt deposits of Late Vashon age (Qgos).

As reported on the geologic map, the mapped recessional deposits consist of moderately well-sorted fine- to medium-grained sand with minor silt, deposited in and around the margins of glacial lakes. This geologic unit is thought to have been deposited largely during deglaciation when there was stagnant ice occupying much of the southern Puget Lowland.

The referenced WSS resource indicates the site is mantled by the following USDA soil units: Giles silt loam on slopes from 0 to 15 percent, Hoogdal silt loam on slopes from 15 to 30 percent, Indianola loamy sand on slopes from 15 to 30 percent, and Skipopa silt loam on slopes from 3 to 15 percent. Skipopa and Giles series soils surface about 80 percent of the project site.

Per the referenced USDA soil survey report, surface water runoff, erosivity, parent material, and geomorphic position for the identified soil types are as follows:

- Giles series soils maintain slow runoff and slight erosion hazard, formed in volcanic ash and glacial outwash on terraces.

- Hoogdal series soils maintain medium runoff and moderate erosion hazard, formed in loess and glaciolacustrine sediments on terrace escarpments.

- Indianola series soils maintain medium runoff and moderate erosion hazard, formed in sandy glacial drift on terrace escarpments.

- Skipopa series soils maintain slow runoff and slight erosion hazard, formed in volcanic ash and loess over glaciolacustrine sediments on terraces.

Based on conditions observed during the fieldwork, in our opinion, the native soils are representative of stratified recessional outwash deposits and are consistent with the geologic and soil mapping resources reviewed in this section.

Groundwater

Groundwater was observed at two exploration sites completed during the November and December 2023 fieldwork: at boring B-2, heavy groundwater seepage was delineated at approximately 30 feet bgs. At test pit TP-1, light groundwater seepage was observed at about 6 feet bgs, and, after completion of a small-scale Pilot Infiltration Test (which added roughly 2,500 gallons of water to the test hole earlier in the day), heavy seepage was observed perched at about 17 feet bgs.

Groundwater monitoring wells were installed at boring locations B-1, B-2, and B-3. All three wells were installed to their respective bottom of boring depths (31.5 feet bgs at all locations), and the bottom 20 feet of the wells were screened. Seasonal groundwater monitoring services provided by ESNW were ongoing at the time this letter was prepared.

Zones of perched groundwater seepage are common within glacial deposits and should be expected within site excavations at depth, particularly during the wet season. Groundwater seepage rates and elevations may fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the winter, spring, and early summer months.

Infiltration Evaluation

Based on the results of our investigation, the proposed infiltration facility is underlain by a thick sequence of stratified recessional sand and silt deposits. Large volumes of relatively free-draining sand-dominant soils were observed, and provided adequate separation from the seasonal water table and/or low permeability soil layers is maintained, it is our opinion that full infiltration is considered feasible from for this project from a geotechnical standpoint.

Design Infiltration Rates

To provide design infiltration rates for the proposed infiltration facility, ESNW completed two small-scale Pilot Infiltration Tests (PITs) in general accordance with the requirements of the City of Lacey 2022 Stormwater Design Manual (2022 COLSDM) for which the project is vested. Small-scale PITs were utilized instead of large-scale PITs in this case due to the high infiltration rate of the native soils and limited access to a water source.

The PITs were completed at test locations TP-1 and TP-2 at depths of approximately 9 and 10 feet bgs, respectively, as requested by the project civil engineer and within representative sections of the native recessional sand deposits. Both PITs were completed within the previously described sand-dominant soil strata (USCS: SP) of the identified recessional deposits, which were classified in the lab as USDA soil type: *slightly gravelly sand* at the testing depths within both PIT locations.

The following table presents the measured (K_{sat} initial) and design (K_{sat} design) infiltration rates, as well as the required correction factors for site variability and number of locations tested (CF_v), test method (CF_t), and the degree of influent control to prevent siltation and bio-buildup (CF_m).

Test Pit ID	Test Depth	K_{sat} initial	CF_v	CF_t	CF_m	K_{sat} design
TP-1	9 ft	82 in/hr	0.33	0.5	0.9	12 in/hr
TP-2	10 ft	21 in/hr				3 in/hr

In consideration of the variability between measured rates, design rates, and the soil types outlined in the table above, we recommend a conservative, **facility-wide design infiltration rate of 3 in/hr** be utilized for this project. ESNW must be provided with the opportunity to observe soil conditions at the facility subgrade as they are exposed during construction to confirm suitable soils are exposed across the facility footprint.

Based on the results of our in-situ infiltration testing, the identified sand-dominant recessional outwash deposits present an excellent opportunity for full on-site stormwater infiltration, and the proposed facility should be designed to interface with these soils beginning at depths between about 7.5 and 10.5 feet bgs.

Depth to Bedrock, Water Table, or Impermeable Layer

Per the 2022 COLSDM (Chapter 7 – Section 7.2.2 – Step 2), the base of all infiltration basins, trenches, or galleries shall be a minimum of five feet above the seasonal high groundwater levels, bedrock, dense glacial till ("hardpan"), or other low permeability layer. Reduced vertical separation down to three feet may be considered pending further analyses of groundwater mounding potential, facility geometry, volumetric capacity, and overflow/bypass design. Groundwater mounding analyses may be necessary and should consider the results of the seasonal groundwater monitoring program, which was ongoing at the time of letter preparation.

Subsurface conditions observed during the fieldwork indicate the native soils are stratified with alternating layers of silt- and sand-dominant soils that are variable in thickness and depth. As noted in the *Native Soil* section of this letter, laboratory analyses of representative soil samples indicate that fines contents ranged between about 4 and 98 percent. Silt-dominant soil layers with high fines content are considered "low permeability layers," and should be considered in the infiltration BMP design.

In our opinion, due to the sampling methods employed in hollow-stem auger drilling (under typical conditions, 18 inches of sample recovered for every 5 feet of drilling), there is a distinct possibility that the thicker (i.e. one- to two-foot thick), silt-dominant interbeds observed at the test pit locations were completely bypassed by the exploratory drilling and sampling. Test pit excavations provide an opportunity for "continuous" observation of the soil profile, and therefore provide higher resolution data for use in geotechnical design. In our opinion, the general lack of similar, one- to two-foot thick silty interbeds on the boring logs may not be representative of actual conditions regarding the presence of low permeability layering. In this case, it is pertinent to rely on the test pit observations in the evaluation of vertical separation from hydraulically restrictive soil layers.

Based on the test pit observations, sections of favorable sand for which the design infiltration rates were provided above were observed as follows:

- Test Pit TP-1 between 7.5 and 17 feet bgs (9.5 feet of exposure)
- Test Pit TP-2 between 9 and 15.5 feet bgs (6.5 feet of exposure)
- Test Pit TP-3 between 10.5 and 15 feet bgs (4.5 feet of exposure)

It is important to note that the subsurface exploration activities expose a small fraction of surface area within the proposed facility footprint, and that the native soils – while relatively consistent in geological terms (recessional outwash soil deposits encountered throughout subsurface explorations across the site) – are subject to wide variations in fines content over short lateral and vertical distances, as evidenced by the test pit observations and supporting sieve analyses.

As such, it is our opinion that a contingency should be provided in the budget to account for potential overexcavations necessary to expose favorable soils in areas of the infiltration facility footprint. Where silt-dominant soils may be exposed at infiltration BMP facility subgrades, the excavation would likely need to be further advanced to expose free-draining, granular soils (similar to those tested in this evaluation).

Soil Suitability for Infiltration Treatment

In accordance with the requirements of the 2022 COLSDM (Chapter 8 – Section 8.6.3), we evaluated the native soil for runoff treatment feasibility based on the required soil suitability criteria. In our evaluation, the native soils do not meet the requirements for use as a treatment BMP, and a separate treatment BMP upstream of the infiltration BMP will likely be necessary.

Soil Suitability Criteria #1

Soil suitability criteria #1 states that the measured (K_{sat} initial) soil infiltration rate must be 9 inches per hour or less to be utilized for infiltration treatment. Based on the in-situ infiltration testing (and the measured and design rates provided in the table above), measured soil infiltration rates exceed the maximum allowable threshold of 9 in/hr as required by the 2022 COLSDM.

Soil Suitability Criteria #2

Soil suitability criteria #2 includes requirements for cation exchange capacity (CEC), organic content (OC), depth of soil used for treatment, and the use of waste fill materials.

Representative soil samples collected at the test locations were analyzed for their CEC and OC, the results of which are outlined in the table below.

Test Pit ID	Sample Depth	OC (%)	CEC (meq/100 g)
TP-1	11.0 ft	0.5	5.0
TP-2	12.0 ft	0.8	4.2

Per the 2022 COLSDM, CEC of the treatment soil must be at least 5 milliequivalents per 100 grams of dry soil, and OC of the treatment soil must be at least 1.0 percent. Based on the laboratory analyses and the thresholds outlined above, the tested soils do not meet the CEC and OC requirements for infiltration treatment.

Because the CEC and OC requirements are not met, further evaluation of the depth of soil used for treatment will have to be considered in design of the facility.

Based on our review of Thurston County online GIS mapping, the entire site is located within a Category II (“high aquifer sensitivity”) Critical Aquifer Recharge Area (CARA), and a Category I (“extreme aquifer sensitivity”) CARA is identified along the northern site boundary. As such, and because the soil does not meet the design requirements for infiltration treatment, a separate treatment BMP upstream of the infiltration BMP will likely be necessary to meet the 2022 COLSDM and Thurston County design standards.

Limitations & Additional Services

This letter report has been prepared for the exclusive use of Sage Homes Northwest, LLC, and its representatives. The recommendations and conclusions provided in this letter report are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. A warranty is neither expressed nor implied. If the design assumptions outlined herein either change or are incorrect, ESNW should be contacted to review the recommendations provided in this letter report. ESNW should be contacted to review the final design to confirm that our geotechnical recommendations have been incorporated into the plans.

ESNW should be retained to provide additional consultation services as needed during future design phases of the project. ESNW can also provide earthwork observations and testing services during the construction phase of this project. Variations in the soil and groundwater conditions observed at the exploration locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions provided in this letter report if variations are encountered.

We appreciate the opportunity to be of service to you and trust this letter meets your current needs. Should you have any questions, or require additional information, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Brian C. Snow, L.G.
Project Geologist

Stephen H. Avril
Project Manager

KYLE R. CAMPBELL
STATE OF WASHINGTON
27674
REGISTERED PROFESSIONAL ENGINEER
02/13/2024

Kyle R. Campbell, P.E.
Senior Principal Engineer

Attachments: Plate 1 – Vicinity Map
Plate 2 – Subsurface Exploration Plan
Subsurface Exploration Logs
Grain Size Distribution Report
Organic Content Report
AmTest Analysis Report

cc: Sage Homes Northwest, LLC
Attention: Larry Calvin

References:

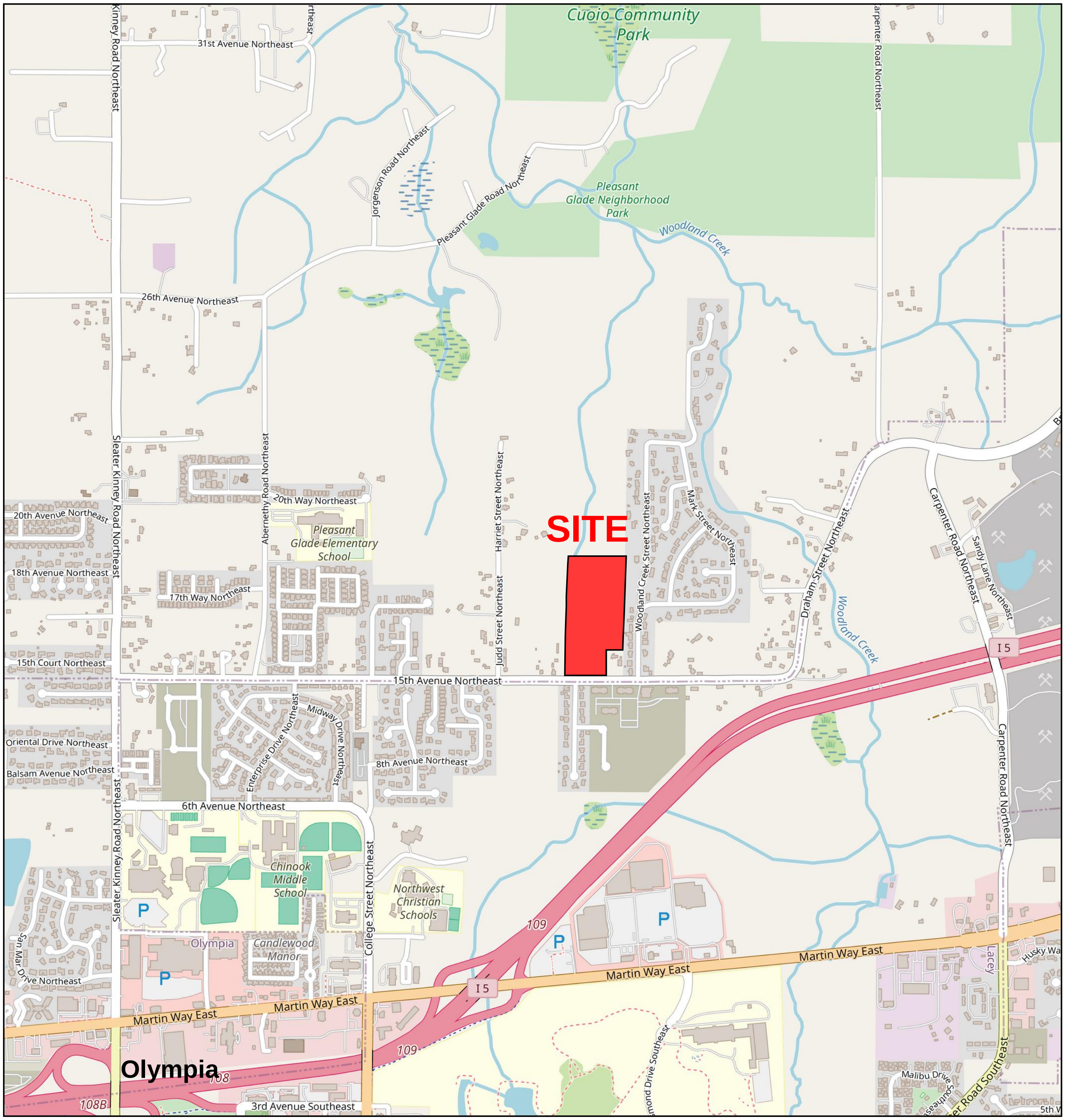
- Geotechnical Engineering Report, prepared by GeoResources, LLC, Project No. 11809310-600,-700, & -100 ThreesCompanyLLC.15thAveNE.RG, dated March 26, 2020

- Geologic Map of the Lacey 7.5-minute Quadrangle, Thurston County, Washington, by Logan, R.L., Walsh, T.J., Schasse, H.W., and Polenz, M., dated 2003

- NRCS Web Soil Survey

- Soil Survey of Thurston County, Washington, prepared by the United States Department of Agriculture, issued June 1990

- City of Lacey Stormwater Design Manual, June 2022 Edition



Reference:
Thurston County, Washington
OpenStreetMap.org

NORTH

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

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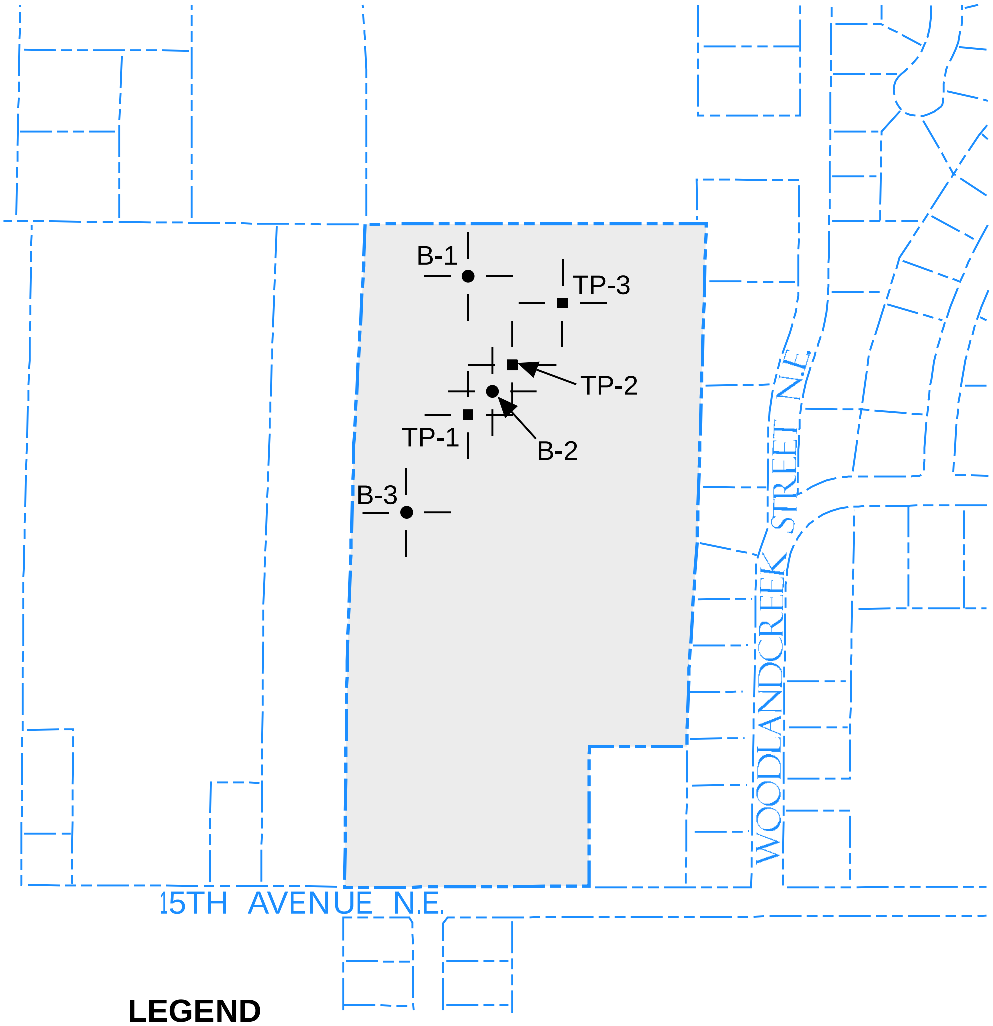
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Williams Crossing
Thurston County (Olympia), Washington

Drawn MRS	Date 01/29/2024	Proj. No. 9532.01
Checked BCS	Date Jan. 2024	Plate 1



LEGEND

TP-1 ■	Approximate Location of ESNW Test Pit, Proj. No. ES-9532.01, Dec. 2023
B-1 ●	Approximate Location of ESNW Boring, Proj. No. ES-9532, Nov. 2023
▨	Subject Site

NOT - TO - SCALE

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

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Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Subsurface Exploration Plan
Williams Crossing
Thurston County (Olympia), Washington

Drawn MRS	Date 01/29/2024	Proj. No. 9532.01
Checked BCS	Date Jan. 2024	Plate 2

Coarse-Grained Soils - More Than 50% Retained on No. 200 Sieve	Gravels - More Than 50% of Coarse Fraction Retained on No. 4 Sieve	< 5% Fines	▨	**GW**	Well-graded gravel with or without sand, little to no fines
			▨	**GP**	Poorly graded gravel with or without sand, little to no fines
		> 12% Fines	▨	**GM**	Silty gravel with or without sand
			▨	**GC**	Clayey gravel with or without sand
	Sands - 50% or More of Coarse Fraction Passes No. 4 Sieve	< 5% Fines	▨	**SW**	Well-graded sand with or without gravel, little to no fines
			▨	**SP**	Poorly graded sand with or without gravel, little to no fines
		> 12% Fines	▨	**SM**	Silty sand with or without gravel
			▨	**SC**	Clayey sand with or without gravel
Fine-Grained Soils - 50% or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less Than 50		▨	**ML**	Silt with or without sand or gravel; sandy or gravelly silt
			▨	**CL**	Clay of low to medium plasticity; lean clay with or without sand or gravel; sandy or gravelly lean clay
			▨	**OL**	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		▨	**MH**	Elastic silt with or without sand or gravel; sandy or gravelly elastic silt
			▨	**CH**	Clay of high plasticity; fat clay with or without sand or gravel; sandy or gravelly fat clay
			▨	**OH**	Organic clay or silt of medium to high plasticity
Highly Organic Soils			▨	**PT**	Peat, muck, and other highly organic soils
Fill			▨	**FILL**	Made Ground

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch

Damp - Perceptible moisture, likely below optimum MC

Moist - Damp but no visible water, likely at/near optimum MC

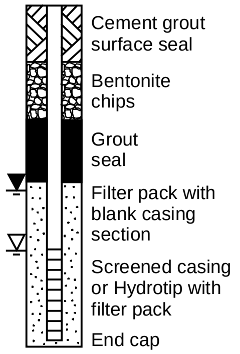
Wet - Water visible but not free draining, likely above optimum MC

Saturated/Water Bearing - Visible free water, typically below groundwater table

Symbols

▽ ATD = At time of drilling

▼ Static water level (date)



Terms Describing Relative Density and Consistency

Coarse-Grained Soils:

Density	SPT blows/foot
Very Loose	< 4
Loose	4 to 9
Medium Dense	10 to 29
Dense	30 to 49
Very Dense	≥ 50

Fine-Grained Soils:

Consistency	SPT blows/foot
Very Soft	< 2
Soft	2 to 3
Medium Stiff	4 to 7
Stiff	8 to 14
Very Stiff	15 to 29
Hard	≥ 30

Test Symbols & Units

Fines = Fines Content (%)

MC = Moisture Content (%)

DD = Dry Density (pcf)

Str = Shear Strength (tsf)

PID = Photoionization Detector (ppm)

OC = Organic Content (%)

CEC = Cation Exchange Capacity (meq/100 g)

LL = Liquid Limit (%)

PL = Plastic Limit (%)

PI = Plasticity Index (%)

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

Modifier Definitions

Percentage by Weight (Approx.)	Modifier
< 5	Trace (sand, silt, clay, gravel)
5 to 14	Slightly (sandy, silty, clayey, gravelly)
15 to 29	Sandy, silty, clayey, gravelly
≥ 30	Very (sandy, silty, clayey, gravelly)

Classifications of soils in this geotechnical report and as shown on the exploration logs are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D2487 and D2488 were used as an identification guide for the Unified Soil Classification System.

Earth Solutions NW LLC

Earth Solutions NWLLC
Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

EXPLORATION LOG KEY

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

TEST PIT NUMBER TP-1

PAGE 1 OF 1

PROJECT NUMBER ES-9532.01

PROJECT NAME Williams Crossing

DATE STARTED 12/27/23 **COMPLETED** 12/27/23

GROUND ELEVATION

EXCAVATION CONTRACTOR NW Excavating

LATITUDE 47.06028 **LONGITUDE** -122.81417

LOGGED BY BCS **CHECKED BY** SHA

GROUND WATER LEVEL:

NOTES

∇ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS Ferns/forest

AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL -minor to moderate root intrusions
1.0			ML		Gray SILT, dense, wet -trace iron oxide staining -blocky cuttings
5	GB	MC = 37.2 Fines = 97.6			[USDA Classification: LOAM]
6.0			SM		Gray silty SAND, dense, wet -very light groundwater seepage -inch-scale interbedding to ~7.5'
	GB	MC = 21.8			
7.5			SP		Gray poorly graded SAND, dense, moist -massive soil structure -infiltration test [USDA Classification: slightly gravelly SAND]
	GB	MC = 12.4 Fines = 3.6			
10					
	GB	MC = 13.9 CEC=5.0 meq/100g OC=0.5			
15	GB	MC = 20.9			
					-heavy post-test groundwater seepage
17.0			ML		Tan sandy SILT, dense, wet [USDA Classification: LOAM]
18.0	GB	MC = 32.1 Fines = 53.6			

Test pit terminated at 18.0 feet below existing grade due to max reach. Groundwater seepage encountered at 6.0 and 17.0 feet during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC

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TEST PIT NUMBER TP-2

PAGE 1 OF 1

PROJECT NUMBER ES-9532.01

PROJECT NAME Williams Crossing

DATE STARTED 12/27/23 **COMPLETED** 12/27/23

GROUND ELEVATION

EXCAVATION CONTRACTOR NW Excavating

LATITUDE 47.06038 **LONGITUDE** -122.81401

LOGGED BY BCS **CHECKED BY** SHA

GROUND WATER LEVEL:

NOTES

∇ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS Ferns/forest

AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	Dark brown TOPSOIL -minor to moderate root intrusions
			SM	3.0	Brown silty SAND, medium dense, moist to wet
5	GB	MC = 37.4	ML	7.0	Gray SILT, dense, wet -trace iron oxide staining -mm-scale laminations -blocky cuttings
	GB	MC = 16.8	SM	9.0	Gray silty SAND, dense, moist -inch-scale interbedding to 9'
10	GB GB	MC = 10.2 Fines = 4.7 MC = 23.8 CEC=4.2 meq/100g OC=0.8	SP	13.0	Gray poorly graded SAND, dense, moist -infiltration test [USDA Classification: slightly gravelly SAND] -moderate caving from 10' - 15' -increasing moisture
15	GB	MC = 10.2 Fines = 16.1	SM	15.5	Gray silty SAND, dense, moist [USDA Classification: loamy SAND]
	GB	MC = 33.2 Fines = 69.9	ML	17.0	Gray sandy SILT, dense, wet -moderate iron oxide staining [USDA Classification: LOAM]
	GB	MC = 4.9	SP	18.0	Gray poorly graded SAND, dense, damp

Test pit terminated at 18.0 feet below existing grade due to max reach. No groundwater encountered during excavation. Caving observed from 10.0 to 15.0 feet.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC
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Branch Office: Pasco, WA

TEST PIT NUMBER TP-3

PAGE 1 OF 1

PROJECT NUMBER ES-9532.01
PROJECT NAME Williams Crossing
DATE STARTED 12/27/23 **COMPLETED** 12/27/23
GROUND ELEVATION
EXCAVATION CONTRACTOR NW Excavating
LATITUDE 47.06083 **LONGITUDE** -122.81369
LOGGED BY BCS **CHECKED BY** SHA
GROUND WATER LEVEL:
NOTES
∇ **AT TIME OF EXCAVATION**
SURFACE CONDITIONS Forest
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	Dark brown TOPSOIL -minor root intrusions
			SM	2.0	Brown silty SAND, loose to medium dense, moist
5	GB	MC = 41.3	ML	10.5	Gray SILT, dense, wet -trace iron oxide staining -mm and cm scale laminations -blocky cuttings
10	GB GB	MC = 14.1 MC = 11.7	SP	15.0	Gray poorly graded SAND, dense, moist -slight caving 10.5' - 15'
15	GB	MC = 31.2	ML	16.0	Gray sandy SILT, dense, wet -strong iron oxide staining near top of layer
	GB	MC = 9.7	SP	17.0	Gray poorly graded SAND, dense, moist

Test pit terminated at 17.0 feet below existing grade due to max reach. No groundwater encountered during excavation. Caving observed from 10.5 to 15.0 feet.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

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Branch Office: Pasco, WA

BORING NUMBER B-1

PAGE 1 OF 2

PROJECT NUMBER ES-9532

PROJECT NAME Williams Crossing

DATE STARTED 11/7/23 **COMPLETED** 11/7/23

GROUND ELEVATION

DRILLING CONTRACTOR Boretec1, Inc.

LATITUDE 47.06083 **LONGITUDE** -122.81427

LOGGED BY BCS **CHECKED BY** SHA

GROUND WATER LEVEL:

NOTES

∇ **AT TIME OF DRILLING**

SURFACE CONDITIONS Forest

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0				ML			Gray SILT, loose, wet
5	SS	100	3-3-3 (6)				-trace iron oxide staining
10	SS	100	6-7-9 (16)	SP		10.0	Gray poorly graded SAND, medium dense, damp to moist
15	SS	78	6-5-6 (11)	SM		15.0	Gray silty fine SAND, medium dense, moist
20	SS	100	8-9-11 (20)	SP		20.0	Gray poorly graded SAND, medium dense, damp to moist
25						25.0	

(Continued Next Page)

BORING NUMBER B-1

PROJECT NUMBER ES-9532
PROJECT NAME Williams Crossing
DATE STARTED 11/7/23 **COMPLETED** 11/7/23
GROUND ELEVATION
DRILLING CONTRACTOR Boretec1, Inc.
LATITUDE 47.06083 **LONGITUDE** -122.81427
LOGGED BY BCS **CHECKED BY** SHA
GROUND WATER LEVEL:
NOTES
∇ **AT TIME OF DRILLING**
SURFACE CONDITIONS Forest
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
25	SS	89	5-7-5 (12)	SM		Gray silty fine SAND, medium dense, moist
30	SS		6-7-7 (14)	SP	30.0	Gray poorly graded SAND, medium dense, damp to moist
					31.5	

Boring terminated at 31.5 feet below existing grade. No groundwater encountered during drilling. 2" PVC standpipe installed to bottom of boring. Lower 20.0 feet slotted. Well ID: BPG883. Boring backfilled with silica sand and bentonite chips.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

BORING NUMBER B-2

PROJECT NUMBER ES-9532
PROJECT NAME Williams Crossing
DATE STARTED 11/7/23 **COMPLETED** 11/7/23
GROUND ELEVATION
DRILLING CONTRACTOR Boretec1, Inc.
LATITUDE 47.06022 **LONGITUDE** -122.81404
LOGGED BY BCS **CHECKED BY** SHA
GROUND WATER LEVEL:
NOTES
∇ **AT TIME OF DRILLING**
SURFACE CONDITIONS Forest
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						Gray silty SAND, medium dense, moist
5	☒ SS	100	7-8-8 (16)	SM		
10	☒ SS	100	4-5-6 (11)			10.0 Gray poorly graded SAND, medium dense, damp to moist
15	☒ SS	100	5-5-6 (11)	SP		
20	☒ SS	100	7-8-8 (16)			
25						

(Continued Next Page)

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BORING NUMBER B-2

PAGE 2 OF 2

PROJECT NUMBER ES-9532
PROJECT NAME Williams Crossing
DATE STARTED 11/7/23 **COMPLETED** 11/7/23
GROUND ELEVATION
DRILLING CONTRACTOR Boretec1, Inc.
LATITUDE 47.06022 **LONGITUDE** -122.81404
LOGGED BY BCS **CHECKED BY** SHA
GROUND WATER LEVEL:
NOTES
∇ **AT TIME OF DRILLING**
SURFACE CONDITIONS Forest
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
25	SS	100	6-7-9 (16)	SP		Gray poorly graded SAND, medium dense, damp to moist *(continued)* -minor variations in sand grain size between fine and medium sand
30	SS		3-3-4 (7)	ML	30.0 31.5	Tan SILT with sand, loose, wet -heavy perched groundwater seepage -trace iron oxide staining

Boring terminated at 31.5 feet below existing grade. Groundwater seepage encountered at 30.0 feet during drilling. 2" PVC standpipe installed to bottom of boring. Lower 20.0 feet slotted. Well ID: BPG884. Boring backfilled with silica sand and bentonite chips.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

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BORING NUMBER B-3

PROJECT NUMBER ES-9532

PROJECT NAME Williams Crossing

DATE STARTED 11/7/23 **COMPLETED** 11/7/23

GROUND ELEVATION

DRILLING CONTRACTOR Boretec1, Inc.

LATITUDE 47.05956 **LONGITUDE** -122.81470

LOGGED BY BCS **CHECKED BY** SHA

GROUND WATER LEVEL:

NOTES

∇ **AT TIME OF DRILLING**

SURFACE CONDITIONS Forest

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				SM		Gray silty SAND, medium dense, damp to moist
5	☒ SS	67	5-7-9 (16)			-light iron oxide staining
10					10.0	
	☒ SS	89	5-7-9 (16)	SP		Gray poorly graded SAND, medium dense, damp
15	☒ SS	100	5-6-7 (13)			
20	☒ SS	100	7-6-6 (12)			
25						

(Continued Next Page)

BORING NUMBER B-3

PROJECT NUMBER ES-9532

PROJECT NAME Williams Crossing

DATE STARTED 11/7/23 **COMPLETED** 11/7/23

GROUND ELEVATION

DRILLING CONTRACTOR Boretec1, Inc.

LATITUDE 47.05956 **LONGITUDE** -122.81470

LOGGED BY BCS **CHECKED BY** SHA

GROUND WATER LEVEL:

NOTES

▽ **AT TIME OF DRILLING**

SURFACE CONDITIONS Forest

AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
25	SS	100	5-5-4 (9)	SP		Gray poorly graded SAND, medium dense, damp *(continued)*
30	SS	100	5-9-9 (18)		31.5	

Boring terminated at 31.5 feet below existing grade. No groundwater encountered during drilling. 2" PVC installed to bottom of boring. Lower 20.0 feet slotted. Well ID: BPG885. Boring backfilled with silica sand and bentonite chips.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

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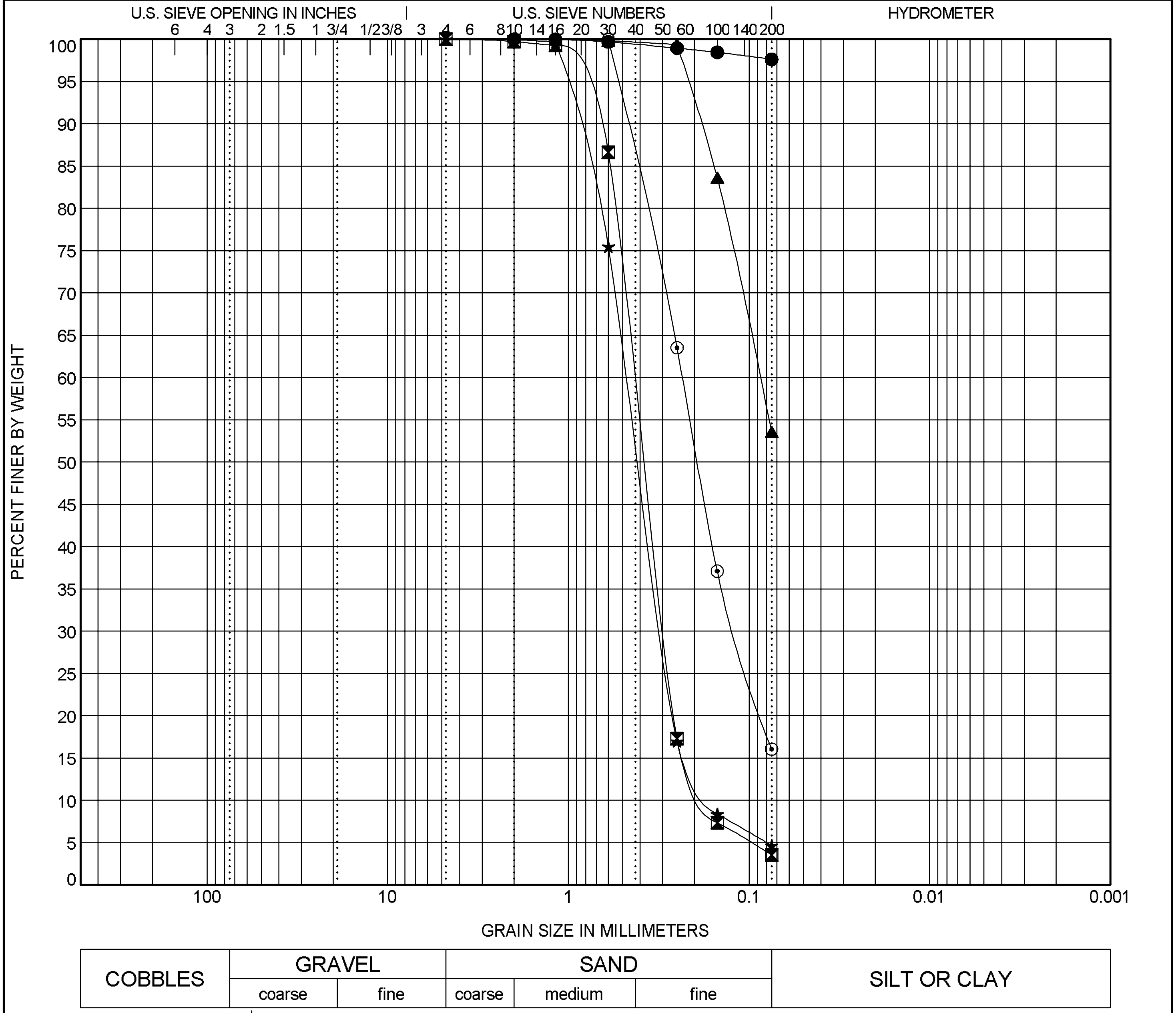
Branch Office: Pasco, WA

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-9532.01 **PROJECT NAME** Williams Crossing



Specimen Identification		Classification	Cc	Cu
● TP-01	5.00ft.	**USDA: Gray Loam. USCS: ML.**		
☒ TP-01	9.00ft.	**USDA: Gray Slightly Gravelly Sand. USCS: SP.**	**1.17**	**2.49**
▲ TP-01	18.00ft.	**USDA: Tan Loam. USCS: Sandy ML.**		
★ TP-02	10.00ft.	**USDA: Gray Slightly Gravelly Sand. USCS: SP.**	**1.17**	**2.88**
⊙ TP-02	14.50ft.	**USDA: Gray Loamy Sand. USCS: SM.**		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-01	5.0ft.	**2**							**97.6**	
☒ TP-01	9.0ft.	**4.75**	**0.429**	**0.293**	**0.172**				**3.6**	
▲ TP-01	18.0ft.	**1.18**	**0.087**						**53.6**	
★ TP-02	10.0ft.	**4.75**	**0.476**	**0.304**	**0.165**				**4.7**	
⊙ TP-02	14.5ft.	**1.18**	**0.234**	**0.119**					**16.1**	

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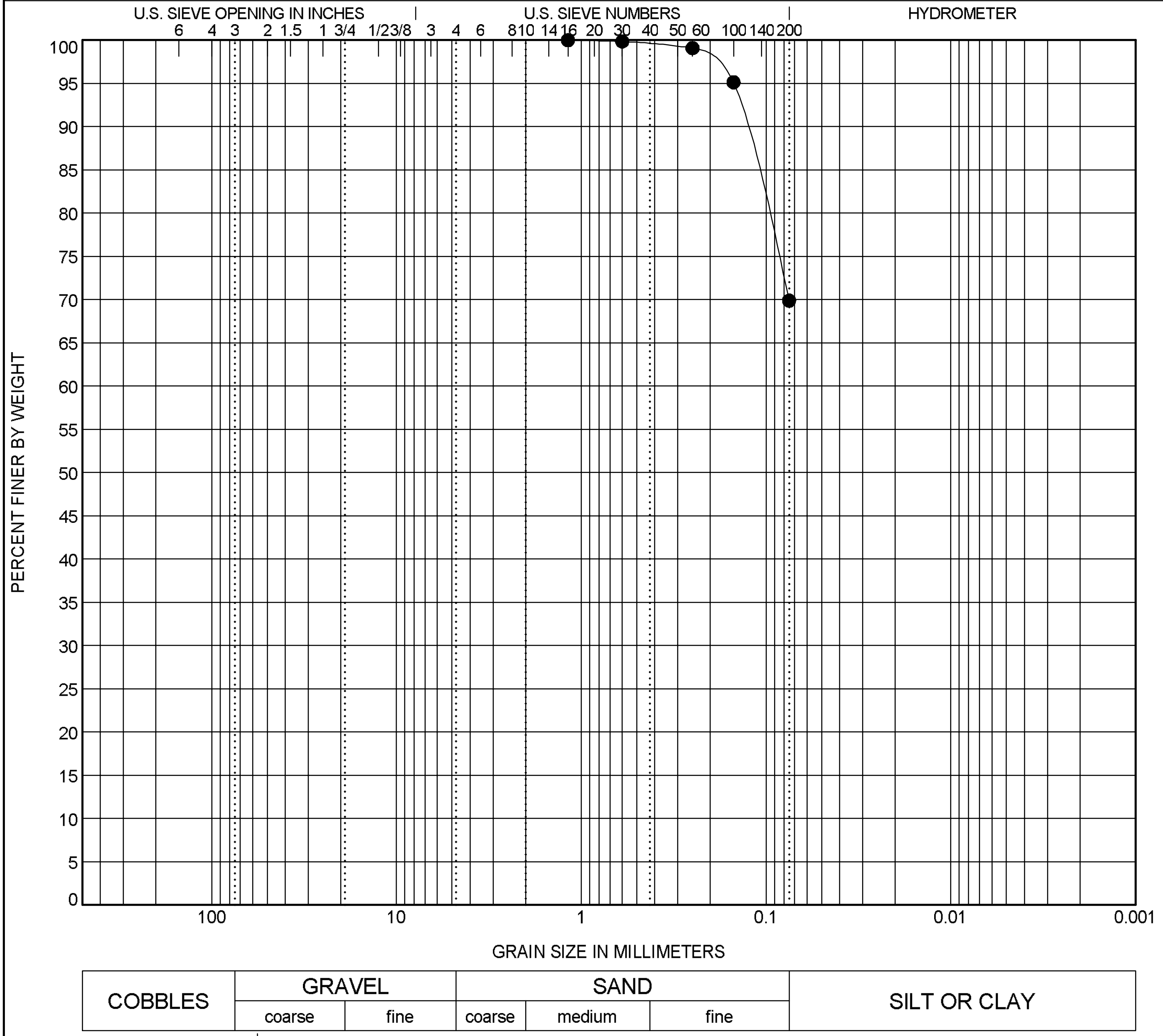
GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-9532.01 **PROJECT NAME** Williams Crossing



	Specimen Identification		Classification	Cc	Cu
●	TP-02	16.00ft.	**USDA: Gray Loam. USCS: Sandy ML.**		

	Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-02	16.0ft.	1.18							69.9	

Earth Solutions NW LLC

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SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER ES-9532.01 **PROJECT NAME** Williams Crossing

Borehole, Depth	Sample Location	Date Test Completed	Water Content (%)	Ash Content (%)	Organic Content (%)
TP-01, 11.0'		1/14/24	13.9	99.5	0.5
TP-02, 12.0'		1/14/24	23.8	99.2	0.8

AMTEST
LABORATORIES

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664

Professional Analytical Services

Jan 24 2024
EARTH SOLUTIONS NW
15365 NORTHEAST 90TH STREET
SUITE 100
REDMOND, WA 98052
Attention: BRIAN SNOW

Dear BRIAN SNOW:

Enclosed please find the analytical data for your WILLIAMS CROSSING project.

The following is a cross correlation of client and laboratory identifications for your convenience.

CLIENT ID	MATRIX	AMTEST ID	TEST
TP-1 @ 11 FT	Soil	24-A000681	CONV
TP-2 @ 12 FT	Soil	24-A000682	CONV

Your samples were received on Thursday, January 11, 2024. At the time of receipt, the samples were logged in and properly maintained prior to the subsequent analysis.

The analytical procedures used at AmTest are well documented and are typically derived from the protocols of the EPA, USDA, FDA or the Army Corps of Engineers.

Following the analytical data you will find the Quality Control (QC) results.

Please note that the detection limits that are listed in the body of the report refer to the Practical Quantitation Limits (PQL's), as opposed to the Method Detection Limits (MDL's).

If you should have any questions pertaining to the data package, please feel free to contact me.

Sincerely,

Aaron W Young

Aaron Young
Vice President

Project #: ES-9532.01

BACT = Bacteriological
CONV = Conventionals
MET = Metals
ORG = Organics
NUT=Nutrients
DEM=Demand
MIN=Minerals

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

AMTEST LABORATORIES

Professional Analytical Services

ANALYSIS REPORT

EARTH SOLUTIONS NW
15365 NORTHEAST 90TH STREET
REDMOND, WA 98052
Attention: BRIAN SNOW
Project Name: WILLIAMS CROSSING
Project #: ES-9532.01
All results reported on an as received basis.

Date Received: 01/11/24
Date Reported: 1/24/24

AMTEST Identification Number **24-A000681**
Client Identification **TP-1 @ 11 FT**
Sampling Date **12/27/23**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	5.0	meq/100g		0.5	SW-846 9081	CM	01/23/24

AMTEST Identification Number **24-A000682**
Client Identification **TP-2 @ 12 FT**
Sampling Date **12/27/23**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	4.2	meq/100g		0.5	SW-846 9081	CM	01/23/24

Aaron W Young

Aaron Young
Vice President

QC Summary for sample numbers: 24-A000681 to 24-A000682

DUPLICATES

SAMPLE #	ANALYTE	UNITS	SAMPLE VALUE	DUP VALUE	RPD
24-A000520	Cation Exchange Capacity	meq/100g	7.1	6.1	15.

STANDARD REFERENCE MATERIALS

ANALYTE	UNITS	TRUE VALUE	MEASURED VALUE	RECOVERY
Cation Exchange Capacity	meq/100g	2.0	2.0	100. %
Cation Exchange Capacity	meq/100g	2.0	1.9	95.0 %

BLANKS

ANALYTE	UNITS	RESULT
Cation Exchange Capacity	meq/100g	< 0.5
Cation Exchange Capacity	meq/100g	< 0.5

AMTEST
LABORATORIES

AmTest Chain of Custody Record

13600 NE 126th PL, Suite C, Kirkland, WA 98034
Ph (425) 885-1664 Fx (425) 820-0245
www.amtestlab.com

Chain of Custody No. 5000

Client Name & Address:
Earth Solutions NW, LLC
15365 Northeast 90th Street, Suite 100
Redmond, Washington 98052

Invoice To:
Attention: Ms. Laura Aby
lauraa@esnw.com

Contact Person: Brian Snow

Invoice Contact:

Phone No: 425-449-4704

PO Number:

Fax No:

Invoice Ph/Fax:

E-mail: brians@esnw.com

Invoice E-mail:

Report Delivery: (Choose all that apply)
Mail / Fax / [✓ Email] / Posted Online

Data posted to online account: YES / NO
Web Login ID:

Special Instructions:

Requested TAT: **(Rush must be pre-approved by lab)**
[✓ Standard] RUSH (5 Day / 3 Day / 48 HR / 24 HR)

Temperature upon Receipt: 15.3°C

Project Name: Williams Crossing

Project Number: ES-9532.01

AmTest ID	Client ID (35 characters max)	Date Sampled	Time Sampled	Matrix	No. of containers	CEC									QA/QC
681	TP-1 @ 11 ft	12/27/23			1	☑									
682	TP-2 @ 12 ft	12/27/23			1	☑									
						☐									
						☐									
						☐									
						☐									
						☐									
						☐									
						☐									
						☐									

Analysis Requested

Collected/Relinquished By:	Date	Time	Received By:	Date	Time
	1-11-24	11:06	KH	1/11/24	1106
Relinquished By:	Date	Time	Received By:	Date	Time
Relinquished By:	Date	Time	Received By:	Date	Time

COMMENTS: