PRELIMINARY STORM DRAINAGE REPORT

FOR

27TH Ave SE Townhomes
Puyallup, Washington

June 2025

Prepared for:
Loyd Enterprises, Inc
34667 Pacific Highway S
Federal Way, WA 98003

Prepared by:
Daniel Smith, P.E., Senior Project Manager
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Puyallup, WA 98372
(253) 848-4282

Approved By:
Daniel Smith, P.E., Senior Project Manager

REPORT #24208

"I hereby state that this Drainage and Erosion/Sediment Control Plan for the 27th Ave SE Townhomes project 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 of professional engineers. I understand that City of Puyallup does not and will not assume liability for the sufficiency, suitability or performance of drainage facilities prepared by me."

This analysis is based on data and records either supplied to, or obtained by, C.E.S. NW, Inc. These documents are referenced within the text of the analysis. The analysis has been prepared utilizing procedures and practices within the standard accepted practices of the industry.

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STORM DRAINAGE

1. Project Overview

This report accompanies the preliminary site plans, as submitted to the City of Puyallup for review and approval. This document provides site information, and the analysis used to prepare the storm drainage design for the 27th Ave SE Townhome project. The *Washington State Department of Ecology Stormwater Management Manual for Western Washington, 2019 (Manual),* and the City of Puyallup's modifications to that document establishes the methodology and design criteria used for this project.

The 27th Ave SE Townhome project proposes 12 townhomes on a 0.73-acre parcel (0419032099). The project site is accessed from 27th Ave SE with a new commercial driveway approach. Access to the site is through and 30-foot existing easement (AFN 9512270701). The project is located in the Puyallup River Water Resources Inventory Area (WRIA 10). The Vicinity Map has been included in Appendix 'A' of this report. The project summary is as follows:

Permit Applied for – Preliminary
Address – 113 27th Ave SE Puyallup, WA 98374
Parcel Numbers – 0419032099
Legal description – (Per statutory warranty deed filed under recording number 201910110806).

> The west 33 feet of block 77, and the east 50 feet of block 78, Frank R. Spinning's first addition to the Town of Puyallup, according to the plat thereof recorded in Book 4 of Plats, page 86, in Pierce County, Washington.
>
> Situate in the County of Pierce, State of Washington.

Currently, the property is a vacant parcel as depicted on the pre-developed basin map (Appendix 'B'). The property has frontage access from 27th Ave SE, and only a new driveway approach is approved along the roadway. The project site proposes approximately 11,409 sq.ft. of rooftops and 13,714 sq.ft. of pavement, patios and walkways; therefore, according to Figure I-3.1 of Volume I of the Manual, the project must evaluate all minimum requirements; see Section 5 of

this report for a detailed discussion of each of the minimum requirements. Permeable pavement (BMP T5.15) and an infiltration trench gallery (BMP T5.10A) provide flow control. Runoff treatment is provided by the permeable pavement. All disturbed areas which are not converted to impervious surface will have soil amended (BMP T5.13).

2. Existing Conditions Summary

In the existing condition, the site is vacant and covered with sparse trees and grass. The existing topography is relatively flat at the center of the site then slopes steeply towards its property lines. Elevations range between 292-314 (NAVD 88). Stormwater runoff from this site sheet flows to the northwest and southeast where it is collected by neighboring properties. Currently the site is accessed by an easement, across parcel 0419032105, from 27th Ave SE.

Onsite soils are identified as Everette very gravely sandy loam and Kitsap silt loam (13C and 20B Type A and C soils respectively) by the USDA SCS maps of Pierce County, Washington. A description of the USDA soils and a copy of the soil map for this portion of Pierce County have been included in Appendix 'A' of this report. A geotechnical engineer's report has been prepared by ESNW, dated January 28, 2025, which documents silty gravel, well graded gravel and poorly graded gravel with silt and sand. Groundwater seepage was not observed when the test pits were dug in November 2024. A soil gran analysis from multiple test pits was performed and a recommended design infiltration rate of 22-inches per hour was provided. A copy of the geotechnical report is included in Appendix 'D'.

There are no known aquifer recharge or wellhead protection areas that affect this property. There are no known well or septic systems onsite. If a septic system or well is discovered onsite during construction, it will be decommissioned per Tacoma-Pierce County Health Department standards. The parcel and all the proposed improvements are located within Zone X, which is considered outside of the 100-year floodplain, per FEMA Map # 53053C0341E. A copy of the FIRM Panel map can be found in Appendix 'B' of this report.

3. Off-site Analysis Report

A quarter mile downstream analysis is required by the City of Puyallup. The project achieves flow control and LID performance standards with permeable pavement (BMP T5.15) and a downspout

infiltration trench (BMP T5.10A). Runoff that is not fully infiltrated onsite sheet-flows either to the offsite storm pond immediately east of the site or towards S Meridian west of the site. The storm pond outfalls to the closed conveyance system in 27th Ave SE that flows west into S Meridian's conveyance system where it joins with the remaining runoff from the site. The runoff ultimately outfalls to SR 512's conveyance system and the Puyallup River approximately 2 miles north of the site. No adverse impacts are anticipated to the downstream system since the majority of the site runoff is infiltrated onsite.

4. Permanent Stormwater Control Plan

Existing Site Hydrology

The existing topography is relatively flat at the center of the site then slopes steeply towards its northwestern and eastern property lines. The site is vacant and covered with sparse trees and grass, and onsite soils are identified as Everette very gravely sandy loam and Kitsap silt loam (Type A and C soils respectively). To demonstrate that the project meets both the Department of Ecology's and LID Performance standards, the pre-developed basin (0.825-acres) is modeled as 0.482-acres A/B, forest steep and 0.343-acres C, forest, mod with the WWHM computer program. The Pre-developed Basin Map is included in Appendix "B".

The following is a summary of the pre-developed flow rates:

2-year..... 0.008-cfs
10-year..... 0.015-cfs
50-year..... 0.020-cfs
100-year..... 0.022-cfs

A copy of the WWHM modeling report is provided in Appendix "C".

Developed Site Hydrology

Under the developed conditions, the project site proposes 11,409 sq.ft. of rooftops and 13,714 sq.ft. of pavement patios and walkways. The landscape and yard areas are modeled as "pasture" since soil amendments (BMP T5.13) are applied these areas. Runoff from rooftops is mitigated with an infiltration trench gallery (BMP T5.10A) and the remaining impervious areas are mitigated

with permeable pavement (BMP T5.15) within the drive-aisles. The post developed basin is summarized in the table below:

Sub-Basin	Land-use	WWHM Description	Area (acre)
Basin A	Lateral Flow Landscaping to Permeable Pavement	C, Pasture, Flat.	0.064
Basin B	Lateral Flow Driveways to Permeable Pavement	Driveways, Flat	0.031
Basin C	Lateral Flow Walkways to Permeable Pavement	Walkways, Flat	0.045
Basin D	Permeable Pavement	Permeable Pavement Element	0.236
Basin E	Rooftops to Infiltration Trench	Rooftops, Flat	0.262
Bypass A	Landscaping (Everett Soils)	A/B, Pasture, Steep	0.102
Bypass B	Landscaping (Kitsap Soils)	C, Pasture, Mod.	0.083
Bypass C	Walkway	Sidewalk, Flat	0.002
Total			**0.825**

Table 1 – Post Developed Basin

The following is a summary of the unmitigated post developed flow rates:

2-year.....0.122-cfs
10-year.....0.194-cfs
50-year.....0.269-cfs
100-year.....0.304-cfs

A copy of the WWHM modeling report is provided in Appendix "C".

Facility Sizing

The infiltration trench (BMP T5.10A) mitigates runoff from the proposed rooftops and is modelled with the recommended design infiltration rate of 22-inches per hour. As calculated by the WWHM computer program a 52-foot long by 6-foot wide by 3-foot deep trench can fully infiltrate the roof runoff, and two 20-foot long by 6-foot wide by 3-foot deep trenches are proposed. Permeable pavement (BMP T5.15) mitigates the lateral flow areas summarized in Table 1 of this report. As calculated by WWHM computer program 4-inch think permeable asphalt over 8-inches of

permeable ballast is required and provided. A copy of the WWHM computer modeling report is provided in Appendix "C".

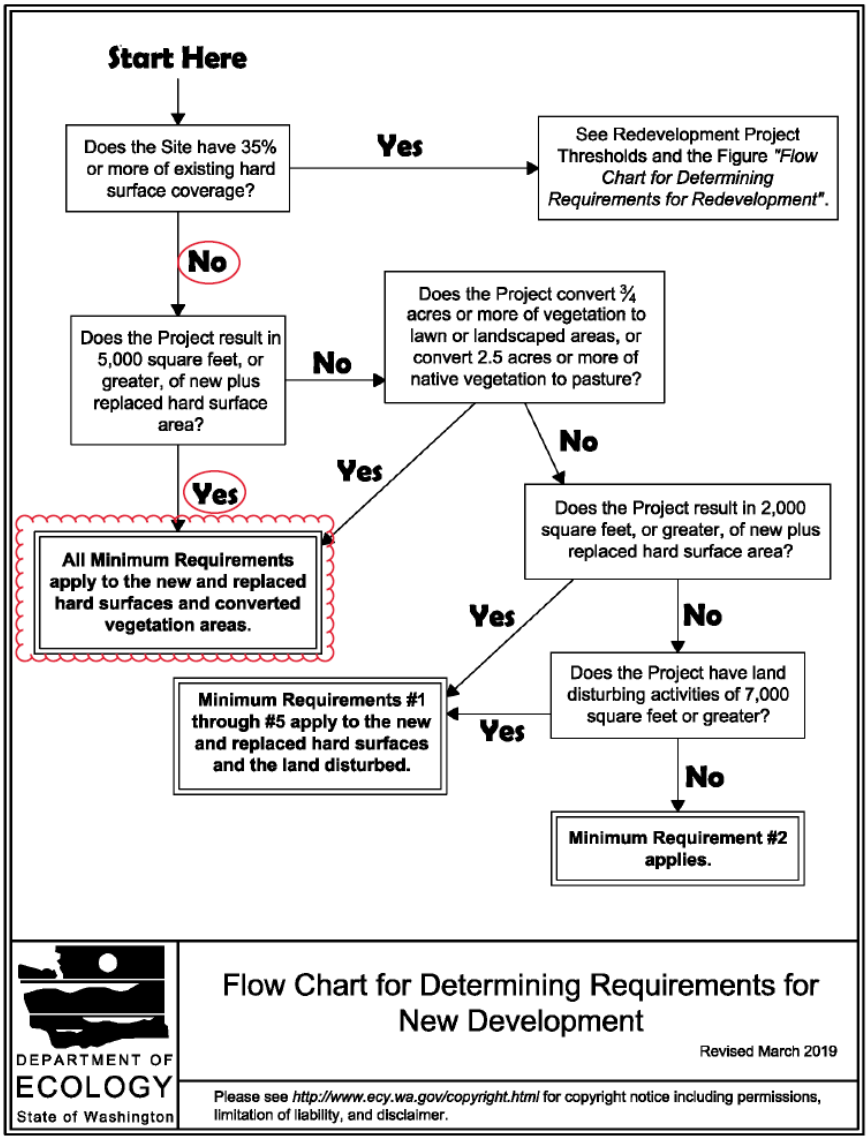
Conveyance Calculations

The project proposes a 6-inch PVC downspout conveyance system to direct runoff to the proposed infiltration trench. Conveyance calculations will be provided in the final engineering report.

5. Discussion of Minimum Requirements

The project proposes more than 5,000 sq.ft. of impervious surfaces; therefore, as required by Figure I-3.1 of Volume I of the Manual each minimum requirement applies.

Figure I-3.1: Flow Chart for Determining Requirements for New Development



The following is a summary of the minimum requirements as described in Section I-3.3 of Volume I of the Manual.

5.1 Minimum Requirement #1: Preparation of a Stormwater Site Plan

This report is the preliminary Stormwater Site Plan prepared for this project.

5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)

A SWPP Plan will be provided with the final engineering submittal.

5.3 Minimum Requirement #3: Source Control of Pollution

Permanent source control BMPs are required for the development's daily operations, and the stormwater facilities must be maintained as described in the Operations and Maintenance Manual. A source control manual will be provided with the final engineering submittal.

5.4 Minimum Requirement #4: Preservation of Natural Drainage System and Outfalls

Under existing conditions, stormwater runoff sheet-flows either to the offsite storm pond immediately east of the site or towards S Meridian west of the site. The offsite storm pond outfalls to the closed conveyance system in 27th Ave SE that flows west into S Meridian's conveyance system where it joins with the remaining runoff from the site. The runoff ultimately outfalls to SR 512's conveyance system and the Puyallup River approximately 2 miles north of the site. Under the proposed conditions the majority of the site's runoff is infiltrated to the underlying soils. Runoff that bypasses the proposed stormwater BMPs proceeds along the existing conditions flow paths. A detailed downstream analysis is provided in Section 3 of this report.

5.5 Minimum Requirement #5: Onsite Stormwater Management

This project must meet minimum requirements 1-9; therefore, this project will evaluate List 2 for onsite stormwater management compliance or meet the LID performance standard. The project meets the LID Performance standard with an infiltration trench gallery (BMP T5.10A) and permeable pavement (BMP T5.15). All disturbed areas which are not converted to impervious areas shall apply soil amendment per Ecology BMP T5.13.

5.6 Minimum Requirement #6: Runoff Treatment

The project proposes more than 5,000 sq.ft. of pollution generating impervious surfaces (PGIS); therefore, runoff treatment is required. The native soils must meet the site suitability criteria from Volume V Section 5.6 of the Manual, or a 6-inch sand treatment layer will be required in accordance with Table V-6.1 of the Manual. Cation exchange capacity and organic content testing will be provided with the final engineering submittal.

5.7 Minimum Requirement #7: Flow Control

Flow control is provided by infiltrating runoff from the site with an infiltration trench gallery (BMP T5.10A) and permeable pavement (BMP T5.15). Flow control facility sizing is discussed in Section 4 of this report.

5.8 Minimum Requirement #8: Wetlands Protection

This requirement is not applicable to the project since there are no existing wetlands onsite or adjacent to the site.

5.9 Minimum Requirement #9: Operation and Maintenance

An Operation and Maintenance Manual will be provided with the final engineering submittal.

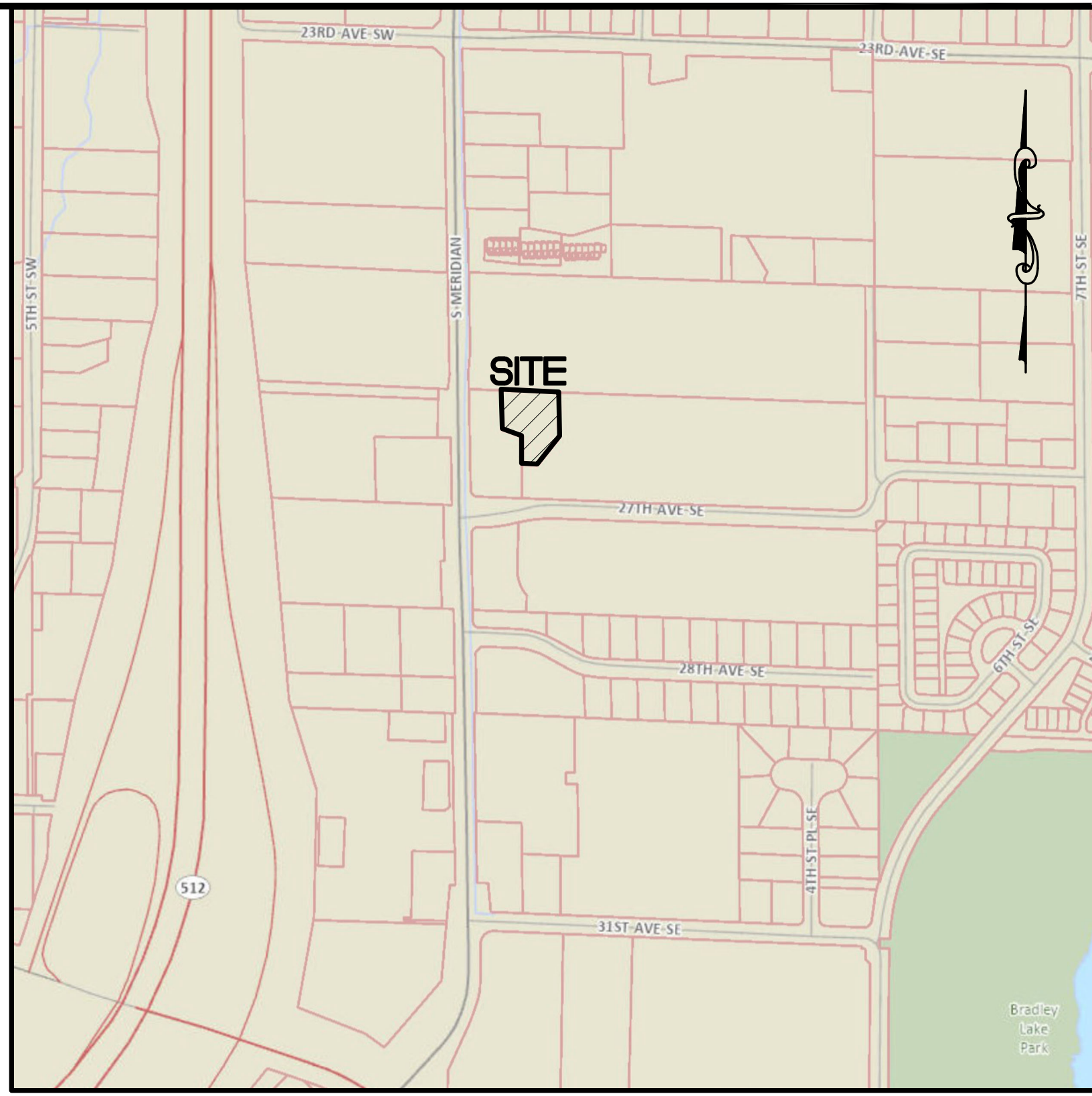
6. Other Permits

Other necessary permits and approvals include:

- Site Development permit
- SEPA application
- Building permits

APPENDIX A

General Exhibits



VICINITY MAP

NTS


122° 17' 35" W
122° 17' 30" W
47° 10' 0" N
47° 9' 56" N
553580
553590
553600
553610
553620
553630
553640
553650
553660
553670
553680
5223950
5223940
5223930
5223920
5223910
5223900
5223890
5223880
5223870
5223860
5223850
5223840
5223830
13C
20B
Soil Map may not be valid at this scale.
Map Scale: 1:663 if printed on A portrait (8.5" x 11") sheet.
N
Meters
0 5 10 20 30
Feet
0 30 60 120 180
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Pierce County Area, Washington
Survey Area Data: Version 20, Aug 27, 2024

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.

Map Unit Legend

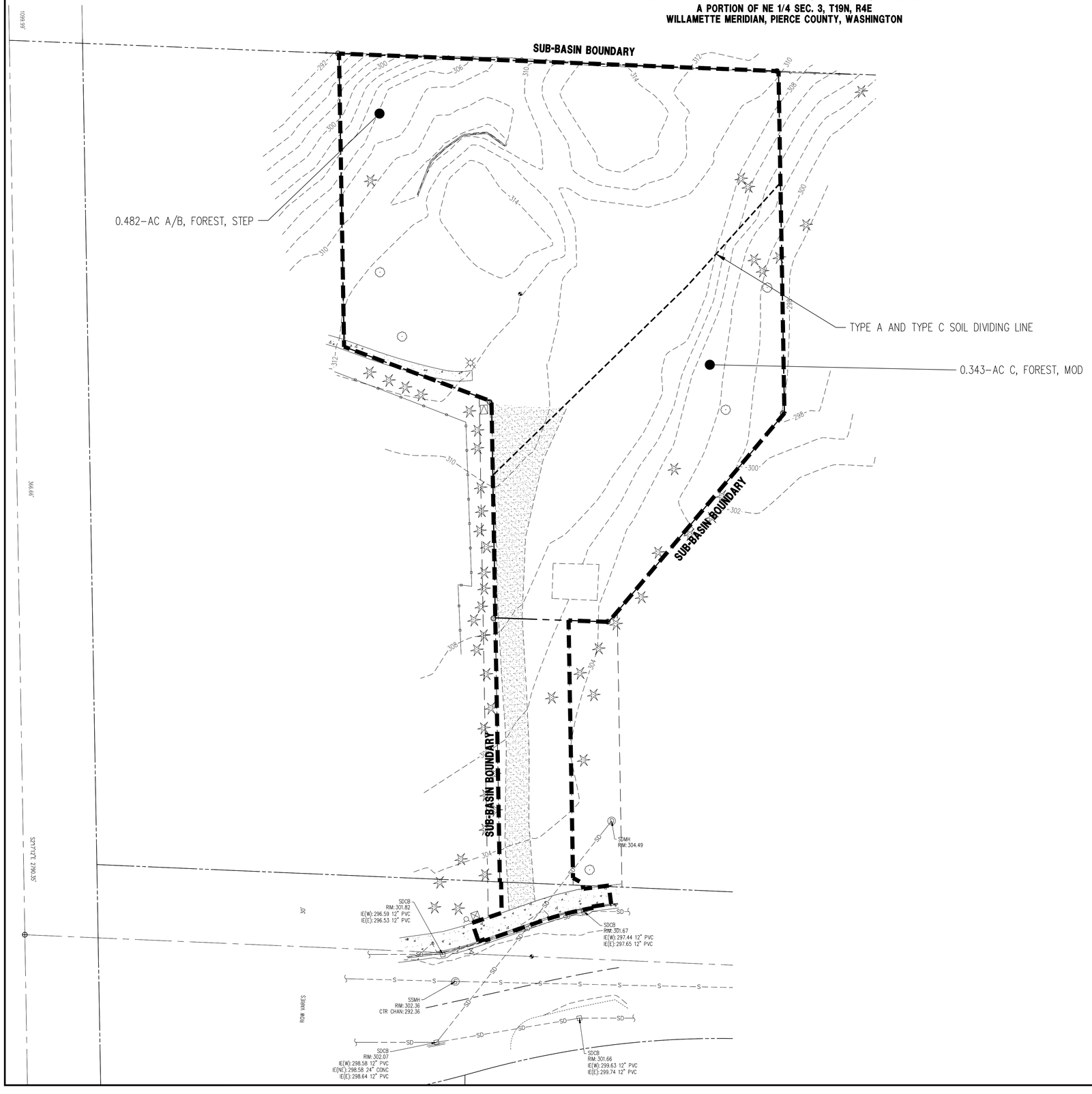
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
13C	Everett very gravelly sandy loam, 8 to 15 percent slopes	0.7	65.4%
20B	Kitsap silt loam, 2 to 8 percent slopes	0.4	34.6%
Totals for Area of Interest		**1.1**	**100.0%**

APPENDIX B

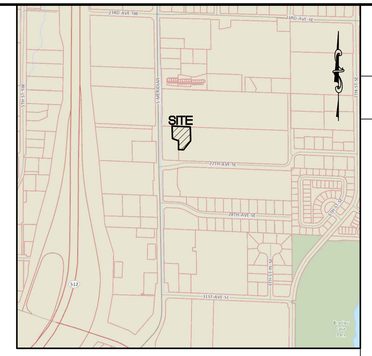
Basin Exhibits

27TH AVE SE TOWNHOMES

A PORTION OF NE 1/4 SEC. 3, T19N, R4E
WILLAMETTE MERIDIAN, PIERCE COUNTY, WASHINGTON



20 0 10 20 40
1 inch = 20 feet.



VICINITY MAP
NTS

LEGEND

EXISTING	DESCRIPTION	PROPOSED
⊕	MONUMENT	⊕
	MONUMENT LINE	
	PROPERTY LINE	
	RIGHT OF WAY LINE	
	EASEMENT LINE	
	BUILDING SETBACK LINE	
-o-o-	CHAIN LINK FENCE	-o-o-
-□-□-	WOOD FENCE	-□-□-
-x-x-	WIRE FENCE	-x-x-
	CURB & GUTTER	
	EDGE OF PAVEMENT	
300	CONTOURS	300
	STREET SIGN	
□	STORM DRAIN CATCH BASIN	
Ⓓ	STORM DRAIN MANHOLE	
○	STORM DRAIN CLEANOUT	
SD	STORM DRAIN LINE	SD
RD	ROOF DRAIN LINE	RD
Ⓢ	SANITARY SEWER MANHOLE	●
○	SANITARY SEWER CLEANOUT	•
S	SANITARY SEWER LINE	S
SS	SANITARY SEWER STUB	SS
	FIRE HYDRANT	
⊠	WATER VALVE	
Ⓦ	WATER METER	
	THRUST BLOCKING	
W	WATER MAIN	W
	PERMEABLE ASPHALT	
	CEMENT CONCRETE	

No.	Revision:	Int.	Date:

DANIEL PAUL SMITH — STATE OF WASHINGTON — 47023 — REGISTERED PROFESSIONAL ENGINEER

C.E.S. NW INC.
CIVIL ENGINEERING & SURVEYING
429 – 29TH ST. NE, SUITE D
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PH: (253) 848-4282
ceservices@cesnwinc.com

Project: **27TH AVE SE TOWNHOMES**
PRE-DEVELOPED BASIN MAP

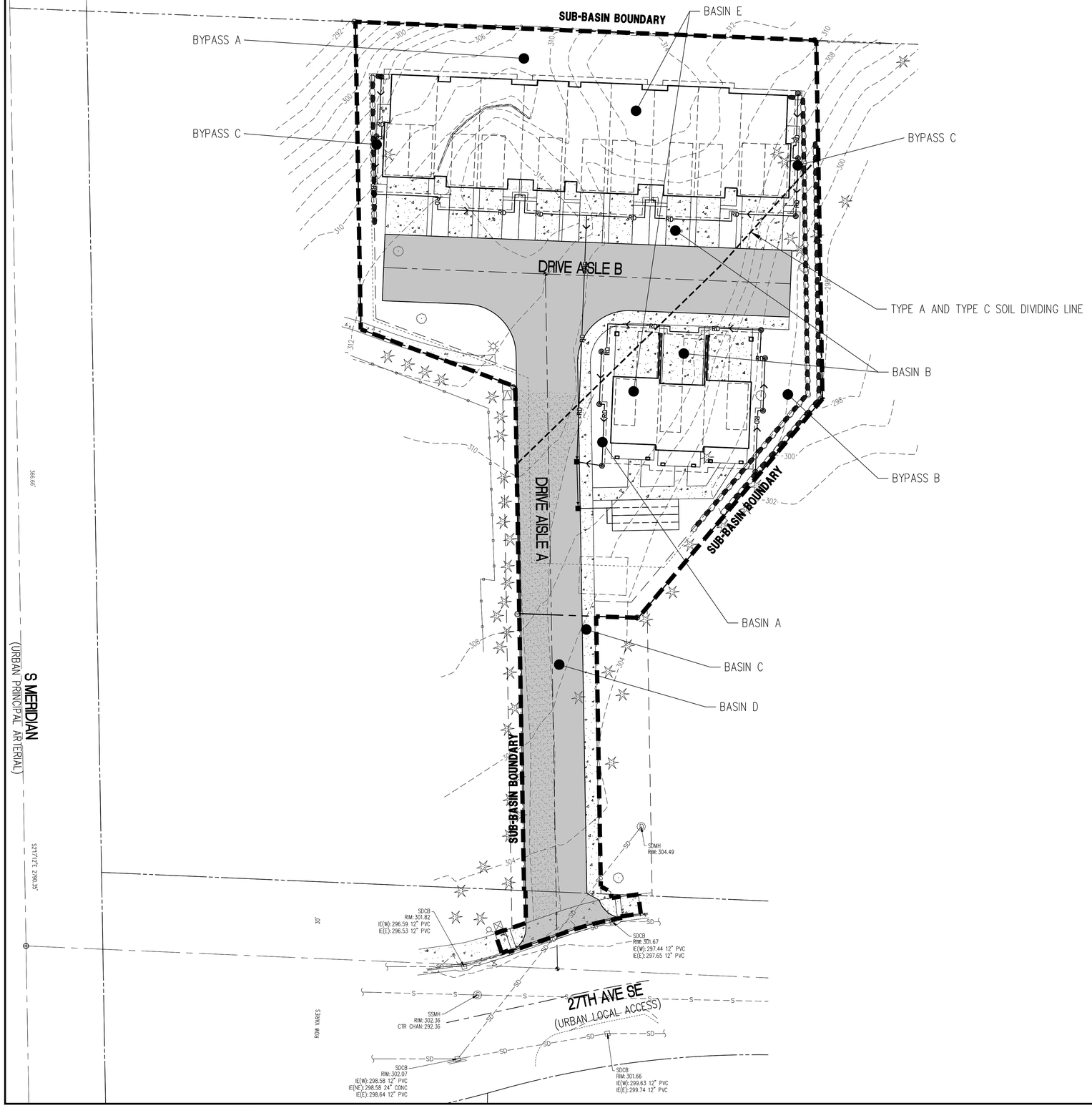
Client: **LLOYD ENTERPRISES**

Designed:	DPS
Drawn:	LBJ
Checked:	DPS
Scale:	1"=20'
Date:	06/06/26
Job No.:	24208

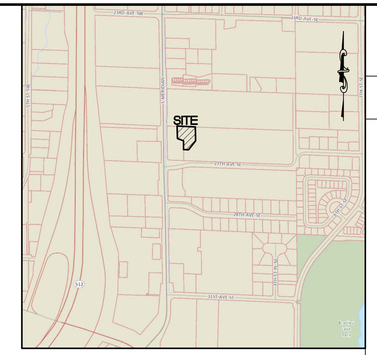
Sheet No.:
B1
1 of 2 Sheets

27TH AVE SE TOWNHOMES

A PORTION OF NE 1/4 SEC. 3, T19N, R4E
WILLAMETTE MERIDIAN, PIERCE COUNTY, WASHINGTON



20 0 10 20 40
1 inch = 20 feet.



VICINITY MAP
NTS

Sub-Basin	Land-use	WWHM Description	Area (acre)
Basin A	Lateral Flow Landscaping to Permeable Pavement	C, Pasture, Flat.	0.064
Basin B	Lateral Flow Driveways to Permeable Pavement	Driveways, Flat	0.031
Basin C	Lateral Flow Walkways to Permeable Pavement	Walkways, Flat	0.045
Basin D	Permeable Pavement	Permeable Pavement Element	0.236
Basin E	Rooftops to Infiltration Trench	Rooftops, Flat	0.262
Bypass A	Landscaping (Everett Soils)	A/B, Pasture, Steep	0.102
Bypass B	Landscaping (Kitsap Soils)	C, Pasture, Mod.	0.083
Bypass C	Walkway	Sidewalk, Flat	0.002
Total			**0.825**

POST DEVELOPED BASIN TABLE 1

LEGEND

EXISTING	DESCRIPTION	PROPOSED
⊕	MONUMENT	⚽
	MONUMENT LINE	
	PROPERTY LINE	
	RIGHT OF WAY LINE	
	EASEMENT LINE	
	BUILDING SETBACK LINE	
-○-	CHAIN LINK FENCE	-○-
-□-	WOOD FENCE	-□-
-x-x-	WIRE FENCE	-x-x-
	CURB & GUTTER	
	EDGE OF PAVEMENT	
300	CONTOURS	300
	STREET SIGN	
□	STORM DRAIN CATCH BASIN	
Ⓓ	STORM DRAIN MANHOLE	
○	STORM DRAIN CLEANOUT	
SD	STORM DRAIN LINE	SD
RD	ROOF DRAIN LINE	RD
Ⓢ	SANITARY SEWER MANHOLE	●
○	SANITARY SEWER CLEANOUT	•
S	SANITARY SEWER LINE	S
SS	SANITARY SEWER STUB	SS
	FIRE HYDRANT	
	WATER VALVE	
W	WATER METER	
	THRUST BLOCKING	
W	WATER MAIN	W
	PERMEABLE ASPHALT	
	CEMENT CONCRETE	

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Project: 27TH AVE SE TOWNHOMES
POST DEVELOPED BASIN MAP

Client: LLOYD ENTERPRISES

Designed: DPS
Drawn: LBJ
Checked: DPS

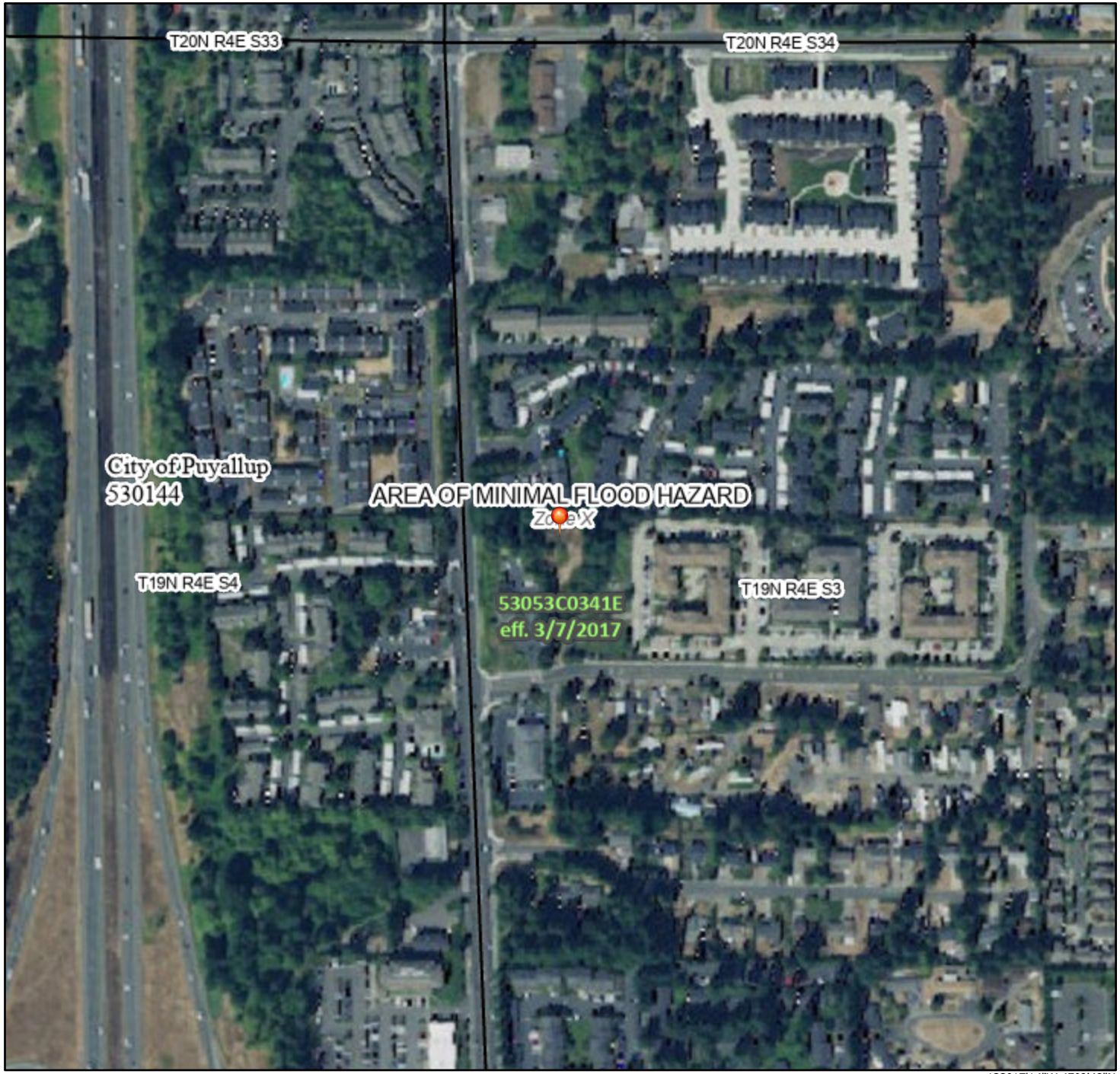
Scale: 1"=20'
Date: 06/06/25
Job No.: 24208

Sheet No.:
B2
2 of 2 Sheets

National Flood Hazard Layer FIRMette

FEMA

122°17'51"W 47°10'12"N



122°17'14"W 47°9'48"N

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/15/2025 at 5:46 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

APPENDIX C

Computer Printouts

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: 24208

Site Name:	27th TH
Site Address:	
City:	Puyallup
Report Date:	6/6/2025
Gage:	40 IN EAST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2024/06/28
Version:	4.3.1

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

PreDev

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Steep	0.482
C, Forest, Mod	0.343
Pervious Total	0.825

Impervious Land Use	acre
Impervious Total	0
Basin Total	0.825

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

Mitigated Land Use

Roof Tops

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROOF TOPS FLAT	0.262
Impervious Total	0.262
Basin Total	0.262

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

Infiltration Trench	Infiltration Trench

Yards to Pavement

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Pasture, Flat	.064

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

Permeable Pavement	Permeable Pavement	

Driveway to Pavement

Bypass:	No
Impervious Land Use	acre
DRIVEWAYS FLAT	0.031

Element Flow Componant:
Surface
Componant Flows To:
Permeable Pavement

Walkways to Pavement

Bypass:	No
Impervious Land Use	acre
SIDEWALKS FLAT	0.045

Element Flow Componant:
Surface
Componant Flows To:
Permeable Pavement

Bypass

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Mod	0.083
A B, Pasture, Steep	0.102
Pervious Total	0.185

Impervious Land Use	acre
SIDEWALKS FLAT	0.002
Impervious Total	0.002
Basin Total	0.187

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

Mitigated Routing

Infiltration Trench

Bottom Length:	52.00 ft.
Bottom Width:	6.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	3
Pour Space of material for first layer:	0.32
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	22
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	110.126
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	110.127
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	3 ft.
Riser Diameter:	12 in.
Element Outlets:	
Outlet 1	Outlet 2
Outlet Flows To:	

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.007	0.000	0.000	0.000
0.0444	0.007	0.000	0.000	0.158
0.0889	0.007	0.000	0.000	0.158
0.1333	0.007	0.000	0.000	0.158
0.1778	0.007	0.000	0.000	0.158
0.2222	0.007	0.000	0.000	0.158
0.2667	0.007	0.000	0.000	0.158
0.3111	0.007	0.000	0.000	0.158
0.3556	0.007	0.000	0.000	0.158
0.4000	0.007	0.000	0.000	0.158
0.4444	0.007	0.001	0.000	0.158
0.4889	0.007	0.001	0.000	0.158
0.5333	0.007	0.001	0.000	0.158
0.5778	0.007	0.001	0.000	0.158
0.6222	0.007	0.001	0.000	0.158
0.6667	0.007	0.001	0.000	0.158
0.7111	0.007	0.001	0.000	0.158
0.7556	0.007	0.001	0.000	0.158
0.8000	0.007	0.001	0.000	0.158
0.8444	0.007	0.001	0.000	0.158
0.8889	0.007	0.002	0.000	0.158
0.9333	0.007	0.002	0.000	0.158
0.9778	0.007	0.002	0.000	0.158

1.0222	0.007	0.002	0.000	0.158
1.0667	0.007	0.002	0.000	0.158
1.1111	0.007	0.002	0.000	0.158
1.1556	0.007	0.002	0.000	0.158
1.2000	0.007	0.002	0.000	0.158
1.2444	0.007	0.002	0.000	0.158
1.2889	0.007	0.003	0.000	0.158
1.3333	0.007	0.003	0.000	0.158
1.3778	0.007	0.003	0.000	0.158
1.4222	0.007	0.003	0.000	0.158
1.4667	0.007	0.003	0.000	0.158
1.5111	0.007	0.003	0.000	0.158
1.5556	0.007	0.003	0.000	0.158
1.6000	0.007	0.003	0.000	0.158
1.6444	0.007	0.003	0.000	0.158
1.6889	0.007	0.003	0.000	0.158
1.7333	0.007	0.004	0.000	0.158
1.7778	0.007	0.004	0.000	0.158
1.8222	0.007	0.004	0.000	0.158
1.8667	0.007	0.004	0.000	0.158
1.9111	0.007	0.004	0.000	0.158
1.9556	0.007	0.004	0.000	0.158
2.0000	0.007	0.004	0.000	0.158
2.0444	0.007	0.004	0.000	0.158
2.0889	0.007	0.004	0.000	0.158
2.1333	0.007	0.004	0.000	0.158
2.1778	0.007	0.005	0.000	0.158
2.2222	0.007	0.005	0.000	0.158
2.2667	0.007	0.005	0.000	0.158
2.3111	0.007	0.005	0.000	0.158
2.3556	0.007	0.005	0.000	0.158
2.4000	0.007	0.005	0.000	0.158
2.4444	0.007	0.005	0.000	0.158
2.4889	0.007	0.005	0.000	0.158
2.5333	0.007	0.005	0.000	0.158
2.5778	0.007	0.005	0.000	0.158
2.6222	0.007	0.006	0.000	0.158
2.6667	0.007	0.006	0.000	0.158
2.7111	0.007	0.006	0.000	0.158
2.7556	0.007	0.006	0.000	0.158
2.8000	0.007	0.006	0.000	0.158
2.8444	0.007	0.006	0.000	0.158
2.8889	0.007	0.006	0.000	0.158
2.9333	0.007	0.006	0.000	0.158
2.9778	0.007	0.006	0.000	0.158
3.0222	0.007	0.007	0.035	0.158
3.0667	0.007	0.007	0.182	0.158
3.1111	0.007	0.007	0.389	0.158
3.1556	0.007	0.008	0.637	0.158
3.2000	0.007	0.008	0.907	0.158
3.2444	0.007	0.008	1.183	0.158
3.2889	0.007	0.009	1.447	0.158
3.3333	0.007	0.009	1.683	0.158
3.3778	0.007	0.009	1.879	0.158
3.4222	0.007	0.010	2.029	0.158
3.4667	0.007	0.010	2.138	0.158
3.5111	0.007	0.010	2.251	0.158
3.5556	0.007	0.011	2.347	0.158

3.6000	0.007	0.011	2.439	0.158
3.6444	0.007	0.011	2.528	0.158
3.6889	0.007	0.011	2.614	0.158
3.7333	0.007	0.012	2.697	0.158
3.7778	0.007	0.012	2.777	0.158
3.8222	0.007	0.012	2.856	0.158
3.8667	0.007	0.013	2.932	0.158
3.9111	0.007	0.013	3.006	0.158
3.9556	0.007	0.013	3.078	0.158
4.0000	0.007	0.014	3.149	0.158

Permeable Pavement

Pavement Area:0.2360 acre.Pavement Length:101.40 ft.

Pavement Width:	101.40 ft.
	Pavement slope 1:0 To 1
Pavement thickness:	0.33
Pour Space of Pavement:	0.3
Material thickness of second layer:	0.67
Pour Space of material for second layer:	0.3
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	22
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	127.918
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	127.918
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	6.941
Discharge Structure	
Riser Height:	2 ft.
Riser Diameter:	1216.8 in.
Notch Type:	Rectangular
Notch Width:	10.140 ft.
Notch Height:	0.917 ft.
Element Outlets:	
Outlet 1	Outlet 2
Outlet Flows To:	

Permeable Pavement Hydraulic Table

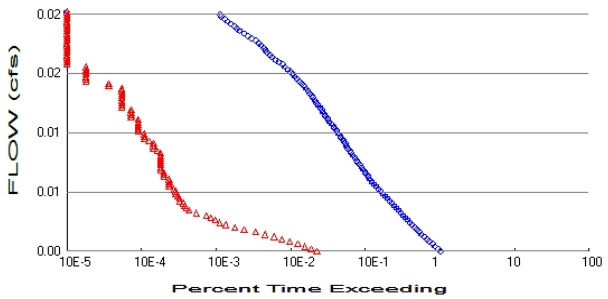
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.236	0.000	0.000	0.000
0.0222	0.236	0.001	0.000	5.236
0.0444	0.236	0.003	0.000	5.236
0.0667	0.236	0.004	0.000	5.236
0.0889	0.236	0.006	0.000	5.236
0.1111	0.236	0.007	0.000	5.236
0.1333	0.236	0.009	0.000	5.236
0.1556	0.236	0.011	0.000	5.236
0.1778	0.236	0.012	0.000	5.236
0.2000	0.236	0.014	0.000	5.236
0.2222	0.236	0.015	0.000	5.236
0.2444	0.236	0.017	0.000	5.236
0.2667	0.236	0.018	0.000	5.236
0.2889	0.236	0.020	0.000	5.236
0.3111	0.236	0.022	0.000	5.236
0.3333	0.236	0.023	0.000	5.236
0.3556	0.236	0.025	0.000	5.236
0.3778	0.236	0.026	0.000	5.236
0.4000	0.236	0.028	0.000	5.236
0.4222	0.236	0.029	0.000	5.236
0.4444	0.236	0.031	0.000	5.236
0.4667	0.236	0.033	0.000	5.236
0.4889	0.236	0.034	0.000	5.236
0.5111	0.236	0.036	0.000	5.236

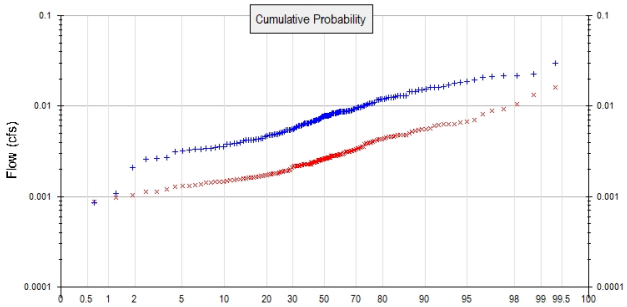
0.5333	0.236	0.037	0.000	5.236
0.5556	0.236	0.039	0.000	5.236
0.5778	0.236	0.041	0.000	5.236
0.6000	0.236	0.042	0.000	5.236
0.6222	0.236	0.044	0.000	5.236
0.6444	0.236	0.045	0.000	5.236
0.6667	0.236	0.047	0.000	5.236
0.6889	0.236	0.048	0.000	5.236
0.7111	0.236	0.050	0.000	5.236
0.7333	0.236	0.052	0.000	5.236
0.7556	0.236	0.053	0.000	5.236
0.7778	0.236	0.055	0.000	5.236
0.8000	0.237	0.056	0.000	5.236
0.8222	0.237	0.058	0.000	5.236
0.8444	0.237	0.059	0.000	5.236
0.8667	0.237	0.061	0.000	5.236
0.8889	0.237	0.063	0.000	5.236
0.9111	0.237	0.064	0.000	5.236
0.9333	0.237	0.066	0.000	5.236
0.9556	0.237	0.067	0.000	5.236
0.9778	0.237	0.069	0.000	5.236
1.0000	0.237	0.074	0.000	5.236
1.0222	0.237	0.079	0.000	5.236
1.0444	0.237	0.085	0.000	5.236
1.0667	0.237	0.090	0.000	5.236
1.0889	0.237	0.095	0.015	5.236
1.1111	0.237	0.101	0.159	5.236
1.1333	0.237	0.106	0.381	5.236
1.1556	0.237	0.111	0.659	5.236
1.1778	0.237	0.116	0.985	5.236
1.2000	0.237	0.122	1.351	5.236
1.2222	0.237	0.127	1.754	5.236
1.2444	0.237	0.132	2.190	5.236
1.2667	0.237	0.138	2.657	5.236
1.2889	0.237	0.143	3.154	5.236
1.3111	0.237	0.148	3.678	5.236
1.3333	0.237	0.153	4.229	5.236
1.3556	0.237	0.159	4.804	5.236
1.3778	0.237	0.164	5.404	5.236
1.4000	0.237	0.169	6.026	5.236
1.4222	0.237	0.174	6.671	5.236
1.4444	0.237	0.180	7.337	5.236
1.4667	0.237	0.185	8.024	5.236
1.4889	0.237	0.190	8.731	5.236
1.5111	0.237	0.196	9.458	5.236
1.5333	0.237	0.201	10.20	5.236
1.5556	0.237	0.206	10.96	5.236
1.5778	0.237	0.211	11.75	5.236
1.6000	0.237	0.217	12.55	5.236
1.6222	0.237	0.222	13.37	5.236
1.6444	0.238	0.227	14.20	5.236
1.6667	0.238	0.233	15.05	5.236
1.6889	0.238	0.238	15.92	5.236
1.7111	0.238	0.243	16.80	5.236
1.7333	0.238	0.248	17.70	5.236
1.7556	0.238	0.254	18.62	5.236
1.7778	0.238	0.259	19.55	5.236
1.8000	0.238	0.264	20.50	5.236

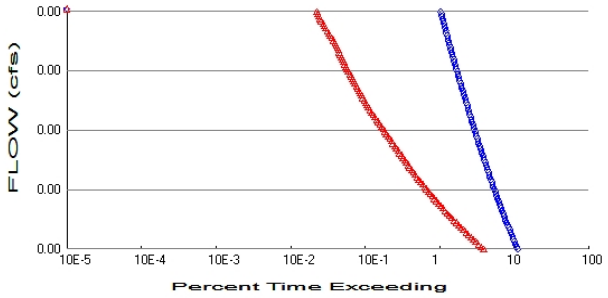
1.8222	0.238	0.270	21.46	5.236
1.8444	0.238	0.275	22.43	5.236
1.8667	0.238	0.280	23.42	5.236
1.8889	0.238	0.286	24.42	5.236
1.9111	0.238	0.291	25.44	5.236
1.9333	0.238	0.296	26.47	5.236
1.9556	0.238	0.301	27.52	5.236
1.9778	0.238	0.307	28.58	5.236
2.0000	0.238	0.312	29.65	5.236

Analysis Results

POC 1







\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.825
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.249
Total Impervious Area: 0.576041

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.007784
5 year	0.012152
10 year	0.014785
25 year	0.017759
50 year	0.019724
100 year	0.021493

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.002636
5 year	0.004241
10 year	0.005552
25 year	0.007521
50 year	0.009233
100 year	0.011173

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1902	0.006	0.002
1903	0.005	0.002
1904	0.010	0.006
1905	0.004	0.002
1906	0.002	0.001
1907	0.012	0.004
1908	0.009	0.003
1909	0.009	0.003
1910	0.012	0.004
1911	0.008	0.002
1912	0.030	0.016
1913	0.012	0.004
1914	0.003	0.003
1915	0.005	0.002
1916	0.008	0.002
1917	0.003	0.001
1918	0.008	0.003
1919	0.006	0.002
1920	0.008	0.002
1921	0.009	0.003
1922	0.009	0.004
1923	0.007	0.002
1924	0.003	0.001
1925	0.004	0.002
1926	0.008	0.003
1927	0.006	0.002
1928	0.006	0.002
1929	0.012	0.004
1930	0.008	0.002
1931	0.007	0.002
1932	0.006	0.002
1933	0.006	0.003
1934	0.016	0.006
1935	0.007	0.002
1936	0.007	0.002
1937	0.011	0.004
1938	0.006	0.002
1939	0.001	0.001
1940	0.007	0.002
1941	0.004	0.002
1942	0.011	0.003
1943	0.005	0.002
1944	0.012	0.006
1945	0.009	0.003
1946	0.005	0.003
1947	0.004	0.001
1948	0.017	0.005
1949	0.014	0.005
1950	0.004	0.002
1951	0.005	0.002
1952	0.022	0.008
1953	0.019	0.007
1954	0.007	0.002
1955	0.006	0.002
1956	0.003	0.001
1957	0.010	0.003

1958	0.021	0.007
1959	0.013	0.005
1960	0.004	0.001
1961	0.013	0.005
1962	0.007	0.002
1963	0.003	0.001
1964	0.004	0.003
1965	0.015	0.004
1966	0.004	0.001
1967	0.007	0.003
1968	0.007	0.003
1969	0.006	0.002
1970	0.010	0.003
1971	0.015	0.004
1972	0.010	0.010
1973	0.013	0.004
1974	0.008	0.003
1975	0.016	0.006
1976	0.009	0.005
1977	0.004	0.001
1978	0.014	0.005
1979	0.004	0.002
1980	0.008	0.003
1981	0.008	0.002
1982	0.004	0.001
1983	0.013	0.004
1984	0.006	0.003
1985	0.009	0.004
1986	0.008	0.003
1987	0.015	0.006
1988	0.009	0.003
1989	0.008	0.003
1990	0.010	0.003
1991	0.008	0.003
1992	0.010	0.003
1993	0.010	0.003
1994	0.015	0.005
1995	0.003	0.001
1996	0.017	0.006
1997	0.007	0.002
1998	0.008	0.003
1999	0.001	0.001
2000	0.006	0.002
2001	0.003	0.002
2002	0.012	0.006
2003	0.010	0.003
2004	0.009	0.003
2005	0.018	0.009
2006	0.005	0.002
2007	0.005	0.002
2008	0.008	0.003
2009	0.005	0.002
2010	0.005	0.002
2011	0.004	0.001
2012	0.006	0.003
2013	0.005	0.002
2014	0.003	0.002
2015	0.007	0.005

2016	0.003	0.001
2017	0.012	0.004
2018	0.021	0.007
2019	0.022	0.009
2020	0.007	0.003
2021	0.011	0.003
2022	0.004	0.002
2023	0.009	0.003
2024	0.023	0.013
2025	0.008	0.003
2026	0.013	0.004
2027	0.005	0.002
2028	0.004	0.002
2029	0.009	0.003
2030	0.016	0.005
2031	0.005	0.002
2032	0.003	0.001
2033	0.005	0.002
2034	0.005	0.002
2035	0.018	0.005
2036	0.010	0.003
2037	0.003	0.001
2038	0.009	0.004
2039	0.001	0.002
2040	0.005	0.002
2041	0.006	0.002
2042	0.019	0.006
2043	0.009	0.003
2044	0.012	0.003
2045	0.008	0.002
2046	0.009	0.003
2047	0.007	0.002
2048	0.009	0.003
2049	0.008	0.003
2050	0.006	0.002
2051	0.008	0.004
2052	0.005	0.002
2053	0.009	0.003
2054	0.011	0.005
2055	0.004	0.002
2056	0.004	0.001
2057	0.006	0.002
2058	0.007	0.002
2059	0.013	0.005

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0301	0.0163
2	0.0227	0.0134
3	0.0218	0.0105
4	0.0216	0.0093
5	0.0213	0.0088
6	0.0207	0.0082
7	0.0194	0.0070
8	0.0185	0.0068
9	0.0182	0.0066
10	0.0179	0.0063

11	0.0171	0.0063
12	0.0165	0.0063
13	0.0162	0.0062
14	0.0160	0.0061
15	0.0160	0.0057
16	0.0155	0.0056
17	0.0153	0.0055
18	0.0152	0.0054
19	0.0145	0.0053
20	0.0144	0.0053
21	0.0144	0.0050
22	0.0132	0.0048
23	0.0131	0.0048
24	0.0129	0.0048
25	0.0129	0.0047
26	0.0128	0.0047
27	0.0126	0.0046
28	0.0125	0.0046
29	0.0124	0.0046
30	0.0122	0.0045
31	0.0121	0.0044
32	0.0120	0.0043
33	0.0119	0.0043
34	0.0118	0.0043
35	0.0117	0.0043
36	0.0110	0.0042
37	0.0107	0.0041
38	0.0107	0.0040
39	0.0107	0.0039
40	0.0104	0.0039
41	0.0103	0.0038
42	0.0101	0.0038
43	0.0100	0.0035
44	0.0100	0.0035
45	0.0097	0.0035
46	0.0096	0.0034
47	0.0096	0.0034
48	0.0095	0.0033
49	0.0092	0.0033
50	0.0092	0.0032
51	0.0091	0.0032
52	0.0090	0.0032
53	0.0090	0.0032
54	0.0088	0.0031
55	0.0088	0.0031
56	0.0087	0.0031
57	0.0087	0.0031
58	0.0087	0.0030
59	0.0086	0.0030
60	0.0086	0.0030
61	0.0086	0.0029
62	0.0086	0.0029
63	0.0086	0.0029
64	0.0086	0.0029
65	0.0085	0.0029
66	0.0083	0.0028
67	0.0083	0.0028
68	0.0083	0.0028

69	0.0083	0.0028
70	0.0082	0.0028
71	0.0081	0.0028
72	0.0080	0.0027
73	0.0080	0.0027
74	0.0079	0.0027
75	0.0079	0.0027
76	0.0078	0.0027
77	0.0078	0.0027
78	0.0078	0.0026
79	0.0078	0.0026
80	0.0077	0.0026
81	0.0077	0.0026
82	0.0076	0.0026
83	0.0073	0.0026
84	0.0073	0.0025
85	0.0072	0.0025
86	0.0071	0.0025
87	0.0070	0.0025
88	0.0070	0.0024
89	0.0070	0.0024
90	0.0069	0.0024
91	0.0069	0.0024
92	0.0068	0.0024
93	0.0068	0.0024
94	0.0066	0.0024
95	0.0066	0.0023
96	0.0066	0.0023
97	0.0065	0.0023
98	0.0065	0.0023
99	0.0064	0.0023
100	0.0064	0.0023
101	0.0064	0.0023
102	0.0063	0.0023
103	0.0062	0.0022
104	0.0061	0.0022
105	0.0060	0.0022
106	0.0060	0.0022
107	0.0059	0.0022
108	0.0059	0.0022
109	0.0057	0.0022
110	0.0056	0.0021
111	0.0055	0.0021
112	0.0055	0.0020
113	0.0055	0.0019
114	0.0055	0.0019
115	0.0054	0.0019
116	0.0052	0.0019
117	0.0052	0.0019
118	0.0051	0.0019
119	0.0050	0.0018
120	0.0049	0.0018
121	0.0049	0.0018
122	0.0049	0.0018
123	0.0048	0.0018
124	0.0048	0.0018
125	0.0048	0.0018
126	0.0047	0.0017

127	0.0046	0.0017
128	0.0044	0.0017
129	0.0044	0.0017
130	0.0043	0.0017
131	0.0043	0.0016
132	0.0043	0.0016
133	0.0042	0.0016
134	0.0042	0.0016
135	0.0042	0.0016
136	0.0042	0.0016
137	0.0040	0.0016
138	0.0039	0.0016
139	0.0038	0.0015
140	0.0038	0.0015
141	0.0038	0.0015
142	0.0036	0.0015
143	0.0035	0.0015
144	0.0035	0.0014
145	0.0034	0.0014
146	0.0034	0.0014
147	0.0034	0.0014
148	0.0034	0.0013
149	0.0033	0.0013
150	0.0032	0.0013
151	0.0031	0.0013
152	0.0027	0.0012
153	0.0026	0.0011
154	0.0026	0.0011
155	0.0021	0.0010
156	0.0011	0.0010
157	0.0009	0.0009
158	0.0006	0.0007

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0006	613285	213071	34	Pass
0.0007	593341	196561	33	Pass
0.0007	573951	181382	31	Pass
0.0007	555668	167698	30	Pass
0.0008	537829	154956	28	Pass
0.0008	521098	143432	27	Pass
0.0008	505143	132906	26	Pass
0.0009	490019	123322	25	Pass
0.0009	475504	114402	24	Pass
0.0009	461487	106037	22	Pass
0.0010	447970	98447	21	Pass
0.0010	435006	91577	21	Pass
0.0010	422319	85262	20	Pass
0.0011	409854	79334	19	Pass
0.0011	398109	74015	18	Pass
0.0011	386807	69195	17	Pass
0.0012	376115	64597	17	Pass
0.0012	365755	60497	16	Pass
0.0012	355894	56675	15	Pass
0.0013	346309	53024	15	Pass
0.0013	337002	49683	14	Pass
0.0013	328083	46647	14	Pass
0.0013	319440	43850	13	Pass
0.0014	311075	41290	13	Pass
0.0014	302875	38814	12	Pass
0.0014	295008	36509	12	Pass
0.0015	287363	34448	11	Pass
0.0015	280050	32465	11	Pass
0.0015	273014	30614	11	Pass
0.0016	266255	28808	10	Pass
0.0016	259663	27235	10	Pass
0.0016	253236	25761	10	Pass
0.0017	246865	24410	9	Pass
0.0017	240827	23113	9	Pass
0.0017	235065	21916	9	Pass
0.0018	229359	20797	9	Pass
0.0018	223708	19723	8	Pass
0.0018	218279	18736	8	Pass
0.0019	212905	17756	8	Pass
0.0019	207808	16847	8	Pass
0.0019	202766	16005	7	Pass
0.0020	197891	15230	7	Pass
0.0020	193127	14443	7	Pass
0.0020	188473	13723	7	Pass
0.0021	184041	13019	7	Pass
0.0021	179775	12382	6	Pass
0.0021	175620	11784	6	Pass
0.0022	171687	11152	6	Pass
0.0022	167753	10604	6	Pass
0.0022	163986	10111	6	Pass
0.0023	160274	9634	6	Pass
0.0023	156673	9141	5	Pass
0.0023	153183	8676	5	Pass

0.0024	149748	8199	5	Pass
0.0024	146368	7789	5	Pass
0.0024	143100	7407	5	Pass
0.0025	139831	7025	5	Pass
0.0025	136673	6659	4	Pass
0.0025	133626	6349	4	Pass
0.0026	130690	6066	4	Pass
0.0026	127754	5812	4	Pass
0.0026	124873	5584	4	Pass
0.0027	122158	5340	4	Pass
0.0027	119333	5108	4	Pass
0.0027	116674	4912	4	Pass
0.0028	114070	4735	4	Pass
0.0028	111577	4538	4	Pass
0.0028	109139	4357	3	Pass
0.0029	106812	4183	3	Pass
0.0029	104486	4029	3	Pass
0.0029	102325	3880	3	Pass
0.0030	100109	3733	3	Pass
0.0030	98004	3585	3	Pass
0.0030	95899	3422	3	Pass
0.0031	93849	3276	3	Pass
0.0031	91854	3147	3	Pass
0.0031	89915	3031	3	Pass
0.0032	88087	2920	3	Pass
0.0032	86259	2827	3	Pass
0.0032	84431	2734	3	Pass
0.0033	82658	2637	3	Pass
0.0033	80996	2554	3	Pass
0.0033	79334	2486	3	Pass
0.0034	77727	2417	3	Pass
0.0034	76120	2346	3	Pass
0.0034	74625	2263	3	Pass
0.0035	73184	2171	2	Pass
0.0035	71688	2063	2	Pass
0.0035	70248	1957	2	Pass
0.0036	68863	1861	2	Pass
0.0036	67533	1788	2	Pass
0.0036	66259	1704	2	Pass
0.0037	64985	1625	2	Pass
0.0037	63766	1559	2	Pass
0.0037	62547	1505	2	Pass
0.0038	61329	1431	2	Pass
0.0038	60110	1365	2	Pass
0.0038	58946	1318	2	Pass
0.0039	57838	1276	2	Pass
0.0039	56675	1238	2	Pass

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0039	56675	1238	2	Pass
0.0041	52005	1045	2	Pass
0.0042	47728	861	1	Pass
0.0044	43789	691	1	Pass
0.0045	40249	536	1	Pass
0.0047	37141	421	1	Pass
0.0049	34315	333	0	Pass
0.0050	31628	249	0	Pass
0.0052	29224	188	0	Pass
0.0053	27113	131	0	Pass
0.0055	25218	99	0	Pass
0.0057	23446	75	0	Pass
0.0058	21861	62	0	Pass
0.0060	20421	54	0	Pass
0.0061	19041	47	0	Pass
0.0063	17761	41	0	Pass
0.0065	16543	30	0	Pass
0.0066	15368	24	0	Pass
0.0068	14365	22	0	Pass
0.0069	13446	21	0	Pass
0.0071	12559	20	0	Pass
0.0073	11745	18	0	Pass
0.0074	10986	18	0	Pass
0.0076	10227	17	0	Pass
0.0077	9540	16	0	Pass
0.0079	8897	16	0	Pass
0.0080	8282	15	0	Pass
0.0082	7778	13	0	Pass
0.0084	7241	13	0	Pass
0.0085	6764	13	0	Pass
0.0087	6377	13	0	Pass
0.0088	6055	11	0	Pass
0.0090	5767	11	0	Pass
0.0092	5453	11	0	Pass
0.0093	5159	10	0	Pass
0.0095	4913	10	0	Pass
0.0096	4656	10	0	Pass
0.0098	4421	10	0	Pass
0.0100	4225	10	0	Pass
0.0101	4022	10	0	Pass
0.0103	3779	10	0	Pass
0.0104	3576	10	0	Pass
0.0106	3398	9	0	Pass
0.0108	3225	8	0	Pass
0.0109	3084	8	0	Pass
0.0111	2960	8	0	Pass
0.0112	2828	7	0	Pass
0.0114	2716	6	0	Pass
0.0116	2570	6	0	Pass
0.0117	2428	6	0	Pass
0.0119	2311	5	0	Pass
0.0120	2209	5	0	Pass
0.0122	2092	5	0	Pass

0.0124	1977	5	0	Pass
0.0125	1860	5	0	Pass
0.0127	1758	5	0	Pass
0.0128	1670	4	0	Pass
0.0130	1576	4	0	Pass
0.0132	1513	4	0	Pass
0.0133	1450	4	0	Pass
0.0135	1370	3	0	Pass
0.0136	1286	3	0	Pass
0.0138	1222	3	0	Pass
0.0140	1169	3	0	Pass
0.0141	1109	3	0	Pass
0.0143	1052	3	0	Pass
0.0144	1002	3	0	Pass
0.0146	942	3	0	Pass
0.0148	892	3	0	Pass
0.0149	838	2	0	Pass
0.0151	780	2	0	Pass
0.0152	726	1	0	Pass
0.0154	667	1	0	Pass
0.0156	631	1	0	Pass
0.0157	584	1	0	Pass
0.0159	551	1	0	Pass
0.0160	504	1	0	Pass
0.0162	467	1	0	Pass
0.0164	430	0	0	Pass
0.0165	384	0	0	Pass
0.0167	344	0	0	Pass
0.0168	313	0	0	Pass
0.0170	292	0	0	Pass
0.0172	269	0	0	Pass
0.0173	254	0	0	Pass
0.0175	238	0	0	Pass
0.0176	223	0	0	Pass
0.0178	206	0	0	Pass
0.0180	189	0	0	Pass
0.0181	166	0	0	Pass
0.0183	149	0	0	Pass
0.0184	132	0	0	Pass
0.0186	115	0	0	Pass
0.0188	105	0	0	Pass
0.0189	97	0	0	Pass
0.0191	87	0	0	Pass
0.0192	80	0	0	Pass
0.0194	71	0	0	Pass
0.0196	65	0	0	Pass
0.0197	62	0	0	Pass

Model Default Modifications

Total of 0 changes have been made.

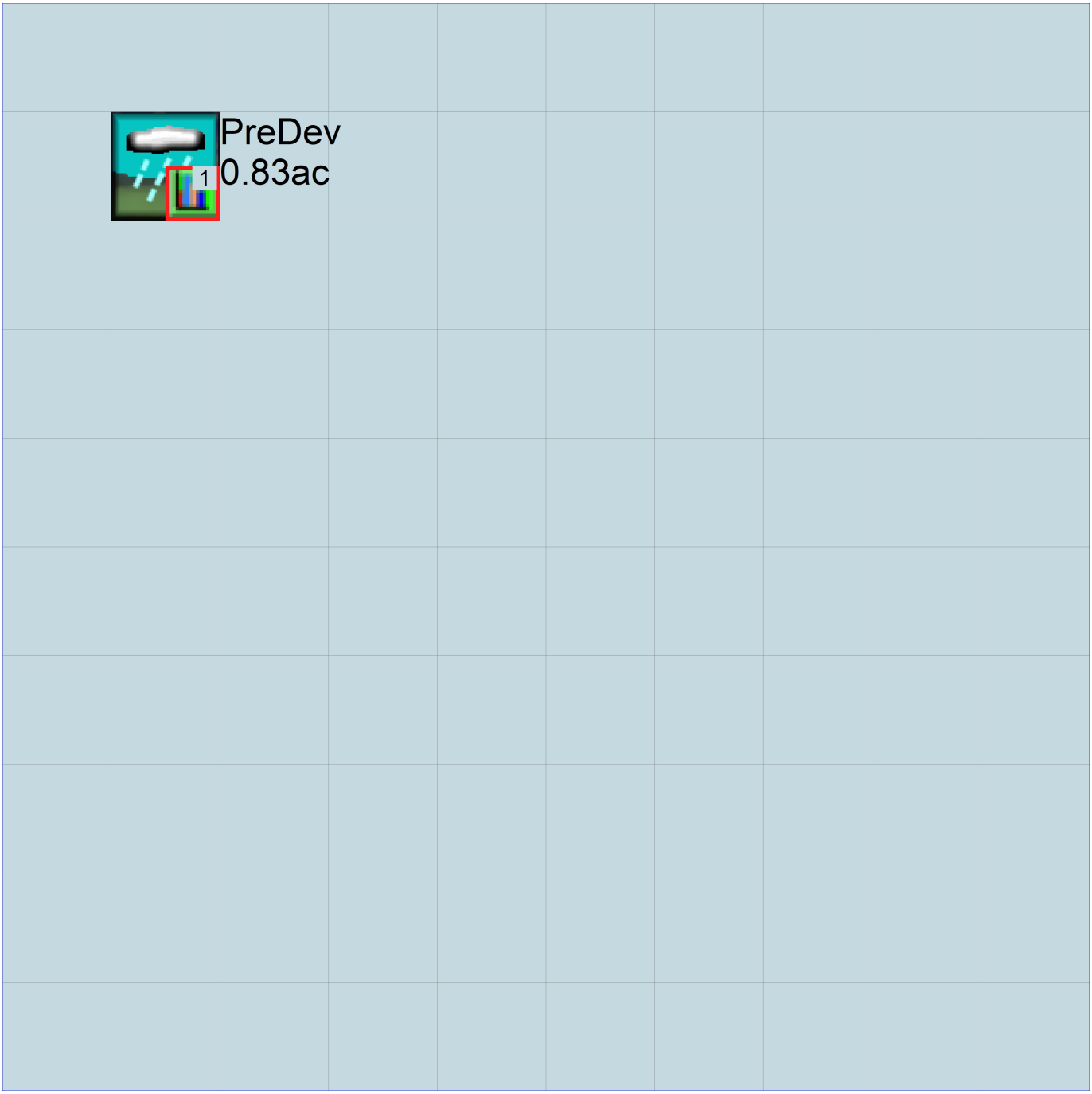
PERLND Changes

No PERLND changes have been made.

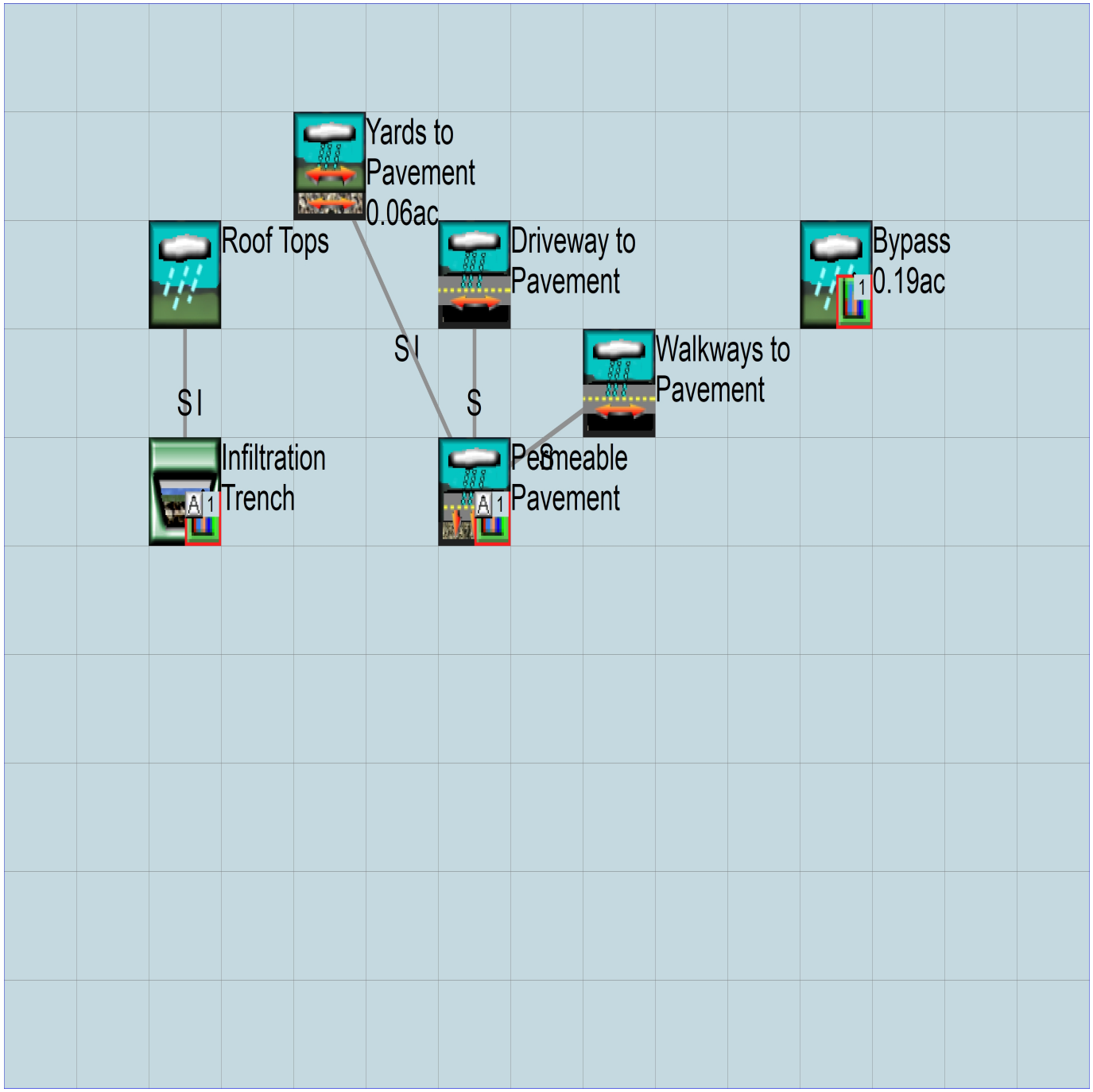
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 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   24208.wdm
MESSU       25   Pre24208.MES
            27   Pre24208.L61
            28   Pre24208.L62
            30   POC242081.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       3
      PERLND      11
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        PreDev                     MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         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           ***
    3     A/B, Forest, Steep      1    1    1    1   27    0
   11     C, Forest, 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 ***
    3         0    0    1    0    0    0    0    0    0    0    0    0
   11         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  *********
```

```
    3         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   11         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 ***
    3         0    0    0    0    0    0    0    0    0    0    0
   11         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
    3              0         5         2       400      0.15       0.3     0.996
   11              0       4.5      0.08       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    3              0         0         2         2         0         0         0
   11              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    3            0.2       0.5      0.35         0       0.7       0.7
   11            0.2       0.5      0.35         6       0.5       0.7
  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
    3              0         0         0         0         3         1         0
   11              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                 in  out           ***
  END GEN-INFO
  *** Section IWATER***

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

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

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

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

  IWAT-PARM3
```

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
PreDev***
PERLND   3                       0.482     COPY   501     12
PERLND   3                       0.482     COPY   501     13
PERLND  11                       0.343     COPY   501     12
PERLND  11                       0.343     COPY   501     13

******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



<-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    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              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
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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 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   24208.wdm
MESSU       25   Mit24208.MES
            27   Mit24208.L61
            28   Mit24208.L62
            30   POC242081.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       4
      PERLND      38
      IMPLND      17
      IMPLND      18
      PERLND      14
      PERLND       6
      IMPLND       8
      RCHRES       1
      IMPLND      16
      RCHRES       2
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Infiltration Trench         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         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           ***
   38     C, Pasture, Flat        1    1    1    1   27    0
   14     C, Pasture, Mod         1    1    1    1   27    0
    6     A/B, Pasture, Steep     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 ***
   38         0    0    1    0    0    0    0    0    0    0    0    0
   14         0    0    1    0    0    0    0    0    0    0    0    0
    6         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  *********
   38         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   14         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    6         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 ***
   38         0    0    0    0    0    0    0    0    0    0    0
   14         0    0    0    0    0    0    0    0    0    0    0
    6         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
   38              0       4.5      0.06       400      0.05        0.5      0.996
   14              0       4.5      0.06       400       0.1        0.5      0.996
    6              0         5       1.5       400      0.15        0.3      0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   38              0         0         2         2         0         0         0
   14              0         0         2         2         0         0         0
    6              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   38          0.15       0.4       0.3         6       0.5       0.4
   14          0.15       0.4       0.3         6       0.5       0.4
    6          0.15       0.5       0.3         0       0.7       0.4
  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
   38              0         0         0         0       2.5          1         0
   14              0         0         0         0       2.5          1         0
    6              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           ***
    4      ROOF TOPS/FLAT         1    1    1   27    0
   17      DRIVEWAYS/FLAT         1    1    1   27    0
   18      SIDEWALKS/FLAT         1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
   16      Porous Pavement        1    1    1   27    0
```

```
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
     4         0    0    1    0    0    0
    17         0    0    1    0    0    0
    18         0    0    1    0    0    0
     8         0    0    1    0    0    0
    16         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
     4         0    0    4    0    0    4    1    9
    17         0    0    4    0    0    0    1    9
    18         0    0    4    0    0    0    1    9
     8         0    0    4    0    0    0    1    9
    16         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     ***
     4         0    0    0    0    0
    17         0    0    0    0    0
    18         0    0    0    0    0
     8         0    0    0    0    0
    16         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
     4          400      0.01       0.1       0.1
    17          400      0.01       0.1       0.1
    18          400      0.01       0.1       0.1
     8          400      0.01       0.1       0.1
    16          400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
     4             0         0
    17             0         0
    18             0         0
     8             0         0
    16             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
     4             0         0
    17             0         0
    18             0         0
     8             0         0
    16             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                <--Area-->     <-Target->   MBLK   ***
<Name>   #                <-factor->     <Name>   #   Tbl#   ***
Roof Tops***
IMPLND   4                     0.262     RCHRES   1      5
```

```
IMPLND  16                      0.236     RCHRES   2      5
Yards to Pavement***
PERLND  38                     0.2711     IMPLND  16     54
PERLND  38                     0.2711     IMPLND  16     55
Driveway to Pavement***
IMPLND  17                     0.1313     IMPLND  16     53
Walkways to Pavement***
IMPLND  18                     0.1906     IMPLND  16     53
Bypass***
PERLND  14                      0.083     COPY   501     12
PERLND  14                      0.083     COPY   601     12
PERLND  14                      0.083     COPY   501     13
PERLND  14                      0.083     COPY   601     13
PERLND   6                      0.102     COPY   501     12
PERLND   6                      0.102     COPY   601     12
PERLND   6                      0.102     COPY   501     13
PERLND   6                      0.102     COPY   601     13
IMPLND   8                      0.002     COPY   501     15
IMPLND   8                      0.002     COPY   601     15

******Routing******
IMPLND   4                      0.262     COPY     1     15
PERLND  38                      0.064     COPY     1     12
PERLND  38                      0.064     COPY     1     13
IMPLND  17                      0.031     COPY     1     15
IMPLND  18                      0.045     COPY     1     15
RCHRES   1                          1     COPY   501     17
RCHRES   2                          1     COPY   501     17
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



<-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     Infiltration Tre-005    2    1    1    1   28    0    1
    2     Permeable Paveme-006    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
    2         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
    2         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
    2        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      0.01       0.0       0.0       0.5       0.0
    2              2      0.02       0.0       0.0       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
    2            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
   92    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.007163  0.000000  0.000000  0.000000
  0.044444  0.007163  0.000102  0.000000  0.158889
  0.088889  0.007163  0.000204  0.000000  0.158889
  0.133333  0.007163  0.000306  0.000000  0.158889
  0.177778  0.007163  0.000407  0.000000  0.158889
  0.222222  0.007163  0.000509  0.000000  0.158889
  0.266667  0.007163  0.000611  0.000000  0.158889
  0.311111  0.007163  0.000713  0.000000  0.158889
  0.355556  0.007163  0.000815  0.000000  0.158889
  0.400000  0.007163  0.000917  0.000000  0.158889
  0.444444  0.007163  0.001019  0.000000  0.158889
  0.488889  0.007163  0.001121  0.000000  0.158889
  0.533333  0.007163  0.001222  0.000000  0.158889
  0.577778  0.007163  0.001324  0.000000  0.158889
  0.622222  0.007163  0.001426  0.000000  0.158889
  0.666667  0.007163  0.001528  0.000000  0.158889
  0.711111  0.007163  0.001630  0.000000  0.158889
  0.755556  0.007163  0.001732  0.000000  0.158889
  0.800000  0.007163  0.001834  0.000000  0.158889
  0.844444  0.007163  0.001935  0.000000  0.158889
  0.888889  0.007163  0.002037  0.000000  0.158889
  0.933333  0.007163  0.002139  0.000000  0.158889
  0.977778  0.007163  0.002241  0.000000  0.158889
  1.022222  0.007163  0.002343  0.000000  0.158889
  1.066667  0.007163  0.002445  0.000000  0.158889
  1.111111  0.007163  0.002547  0.000000  0.158889
  1.155556  0.007163  0.002649  0.000000  0.158889
  1.200000  0.007163  0.002750  0.000000  0.158889
  1.244444  0.007163  0.002852  0.000000  0.158889
  1.288889  0.007163  0.002954  0.000000  0.158889
  1.333333  0.007163  0.003056  0.000000  0.158889
  1.377778  0.007163  0.003158  0.000000  0.158889
  1.422222  0.007163  0.003260  0.000000  0.158889
  1.466667  0.007163  0.003362  0.000000  0.158889
  1.511111  0.007163  0.003463  0.000000  0.158889
  1.555556  0.007163  0.003565  0.000000  0.158889
  1.600000  0.007163  0.003667  0.000000  0.158889
  1.644444  0.007163  0.003769  0.000000  0.158889
  1.688889  0.007163  0.003871  0.000000  0.158889
  1.733333  0.007163  0.003973  0.000000  0.158889
  1.777778  0.007163  0.004075  0.000000  0.158889
  1.822222  0.007163  0.004177  0.000000  0.158889
  1.866667  0.007163  0.004278  0.000000  0.158889
```

```
1.911111  0.007163  0.004380  0.000000  0.158889
1.955556  0.007163  0.004482  0.000000  0.158889
2.000000  0.007163  0.004584  0.000000  0.158889
2.044444  0.007163  0.004686  0.000000  0.158889
2.088889  0.007163  0.004788  0.000000  0.158889
2.133333  0.007163  0.004890  0.000000  0.158889
2.177778  0.007163  0.004991  0.000000  0.158889
2.222222  0.007163  0.005093  0.000000  0.158889
2.266667  0.007163  0.005195  0.000000  0.158889
2.311111  0.007163  0.005297  0.000000  0.158889
2.355556  0.007163  0.005399  0.000000  0.158889
2.400000  0.007163  0.005501  0.000000  0.158889
2.444444  0.007163  0.005603  0.000000  0.158889
2.488889  0.007163  0.005705  0.000000  0.158889
2.533333  0.007163  0.005806  0.000000  0.158889
2.577778  0.007163  0.005908  0.000000  0.158889
2.622222  0.007163  0.006010  0.000000  0.158889
2.666667  0.007163  0.006112  0.000000  0.158889
2.711111  0.007163  0.006214  0.000000  0.158889
2.755556  0.007163  0.006316  0.000000  0.158889
2.800000  0.007163  0.006418  0.000000  0.158889
2.844444  0.007163  0.006519  0.000000  0.158889
2.888889  0.007163  0.006621  0.000000  0.158889
2.933333  0.007163  0.006723  0.000000  0.158889
2.977778  0.007163  0.006825  0.000000  0.158889
3.022222  0.007163  0.007143  0.035147  0.158889
3.066667  0.007163  0.007462  0.182234  0.158889
3.111111  0.007163  0.007780  0.389839  0.158889
3.155556  0.007163  0.008098  0.637321  0.158889
3.200000  0.007163  0.008417  0.907676  0.158889
3.244444  0.007163  0.008735  1.183559  0.158889
3.288889  0.007163  0.009053  1.447495  0.158889
3.333333  0.007163  0.009372  1.683468  0.158889
3.377778  0.007163  0.009690  1.879270  0.158889
3.422222  0.007163  0.010008  2.029388  0.158889
3.466667  0.007163  0.010327  2.138326  0.158889
3.511111  0.007163  0.010645  2.251735  0.158889
3.555556  0.007163  0.010963  2.347596  0.158889
3.600000  0.007163  0.011282  2.439693  0.158889
3.644444  0.007163  0.011600  2.528438  0.158889
3.688889  0.007163  0.011918  2.614172  0.158889
3.733333  0.007163  0.012237  2.697182  0.158889
3.777778  0.007163  0.012555  2.777713  0.158889
3.822222  0.007163  0.012873  2.855973  0.158889
3.866667  0.007163  0.013192  2.932146  0.158889
3.911111  0.007163  0.013510  3.006389  0.158889
3.955556  0.007163  0.013828  3.078843  0.158889
4.000000  0.007163  0.014147  3.149630  0.158889
4.044444  0.007163  0.014465  3.218861  0.158889
END FTABLE  1
FTABLE      2
 91    5
   Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
0.000000  0.236041  0.000000  0.000000  0.000000
0.022222  0.236041  0.000787  0.000000  5.236183
0.044444  0.236041  0.001574  0.000000  5.236183
0.066667  0.236041  0.002360  0.000000  5.236183
0.088889  0.236041  0.003147  0.000000  5.236183
0.111111  0.236041  0.003934  0.000000  5.236183
0.133333  0.236041  0.004721  0.000000  5.236183
0.155556  0.236041  0.005508  0.000000  5.236183
0.177778  0.236041  0.006294  0.000000  5.236183
0.200000  0.236041  0.007081  0.000000  5.236183
0.222222  0.236041  0.007868  0.000000  5.236183
0.244444  0.236041  0.008655  0.000000  5.236183
0.266667  0.236041  0.009442  0.000000  5.236183
0.288889  0.236041  0.010228  0.000000  5.236183
0.311111  0.236041  0.011015  0.000000  5.236183
0.333333  0.236041  0.011802  0.000000  5.236183
```

0.355556	0.236041	0.012589	0.000000	5.236183
0.377778	0.236041	0.013376	0.000000	5.236183
0.400000	0.236041	0.014162	0.000000	5.236183
0.422222	0.236041	0.014949	0.000000	5.236183
0.444444	0.236041	0.015736	0.000000	5.236183
0.466667	0.236041	0.016523	0.000000	5.236183
0.488889	0.236041	0.017310	0.000000	5.236183
0.511111	0.236041	0.018097	0.000000	5.236183
0.533333	0.236041	0.018883	0.000000	5.236183
0.555556	0.236041	0.019670	0.000000	5.236183
0.577778	0.236041	0.020457	0.000000	5.236183
0.600000	0.236041	0.021244	0.000000	5.236183
0.622222	0.236041	0.022031	0.000000	5.236183
0.644444	0.236041	0.022817	0.000000	5.236183
0.666667	0.236041	0.023604	0.000000	5.236183
0.688889	0.236041	0.024391	0.000000	5.236183
0.711111	0.236041	0.025178	0.000000	5.236183
0.733333	0.236041	0.025965	0.000000	5.236183
0.755556	0.236041	0.026751	0.000000	5.236183
0.777778	0.236041	0.027538	0.000000	5.236183
0.800000	0.236041	0.028325	0.000000	5.236183
0.822222	0.236041	0.029112	0.000000	5.236183
0.844444	0.236041	0.029899	0.000000	5.236183
0.866667	0.236041	0.030685	0.000000	5.236183
0.888889	0.236041	0.031472	0.000000	5.236183
0.911111	0.236041	0.032259	0.000000	5.236183
0.933333	0.236041	0.033046	0.000000	5.236183
0.955556	0.236041	0.033833	0.000000	5.236183
0.977778	0.236041	0.034619	0.000000	5.236183
1.000000	0.236041	0.039865	0.000000	5.236183
1.022222	0.236041	0.045110	0.000000	5.236183
1.044444	0.236041	0.050355	0.000000	5.236183
1.066667	0.236041	0.055601	0.000000	5.236183
1.088889	0.236041	0.060846	0.015259	5.236183
1.111111	0.236041	0.066092	0.159147	5.236183
1.133333	0.236041	0.071337	0.381299	5.236183
1.155556	0.236041	0.076582	0.659915	5.236183
1.177778	0.236041	0.081828	0.985240	5.236183
1.200000	0.236041	0.087073	1.351329	5.236183
1.222222	0.236041	0.092318	1.754062	5.236183
1.244444	0.236041	0.097564	2.190367	5.236183
1.266667	0.236041	0.102809	2.657833	5.236183
1.288889	0.236041	0.108054	3.154507	5.236183
1.311111	0.236041	0.113300	3.678763	5.236183
1.333333	0.236041	0.118545	4.229219	5.236183
1.355556	0.236041	0.123791	4.804683	5.236183
1.377778	0.236041	0.129036	5.404111	5.236183
1.400000	0.236041	0.134281	6.026582	5.236183
1.422222	0.236041	0.139527	6.671272	5.236183
1.444444	0.236041	0.144772	7.337439	5.236183
1.466667	0.236041	0.150017	8.024413	5.236183
1.488889	0.236041	0.155263	8.731582	5.236183
1.511111	0.236041	0.160508	9.458384	5.236183
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```
  1.911111  0.236041  0.254925  25.44574  5.236183
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  2.000000  0.236041  0.275906  29.65078  5.236183
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END FTABLES

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<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    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              RCHRES   2     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
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<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
RCHRES   2 HYDR   RO     1 1        1      WDM   1004 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1005 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1006 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1007 STAG     ENGL      REPL
END EXT TARGETS

MASS-LINK
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  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

  MASS-LINK       53
IMPLND     IWATER SURO                     IMPLND         EXTNL  SURLI
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  MASS-LINK       54
PERLND     PWATER SURO                     IMPLND         EXTNL  SURLI
  END MASS-LINK   54

  MASS-LINK       55
PERLND     PWATER IFWO                     IMPLND         EXTNL  SURLI
  END MASS-LINK   55
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END MASS-LINK

END RUN
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Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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APPENDIX D

Other Studies

Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

GEOTECHNICAL ENGINEERING STUDY
PROPOSED TOWNHOMES
113 – 27TH AVENUE SOUTHEAST
PUYALLUP, WASHINGTON

ES-10212

15365 NE 90th Street, Suite 100 • Redmond, WA 98052 • (425) 449-4704
3130 Varney Lane, Suite 105 • Pasco, WA 99301 • (509) 905-0275
esnw.com

PREPARED FOR

LLOYD ENTERPRISES, INC.

January 28, 2025

Adam Z. Shier, L.G.
Project Geologist

KEVEN D. HOFFMANN
STATE OF WASHINGTON
53734
REGISTERED
PROFESSIONAL ENGINEER

01/28/2025

Keven D. Hoffmann, P.E.
Associate Principal Engineer

GEOTECHNICAL ENGINEERING STUDY
PROPOSED TOWNHOMES
113 – 27TH AVENUE SOUTHEAST
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Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

Earth Solutions NW LLC
Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

January 28, 2025
ES-10212

Lloyd Enterprises, Inc.
PO Box 3889
Federal Way, Washington 98063

Attention: Randy Lloyd

Greetings:

Earth Solutions NW, LLC (ESNW) is pleased to present this report to support the proposed development. Based on the results of our investigation, construction of the proposed residential development is feasible from a geotechnical standpoint. Subsurface exploration indicates the site is underlain predominantly by recessional outwash deposits. The native soils were observed in a chiefly moist and medium dense to dense condition extending to the termination depth of all subsurface explorations advanced across the site. Slight caving was noted at representative subsurface exploration locations within the recessional outwash deposits due to the cohesionless nature of the native soil.

Based on our findings, the proposed townhome structures may be constructed on conventional continuous and spread footing foundations bearing upon competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. Native soil conditions considered suitable for support of the proposed structures will likely be encountered beginning at a depth of about two to three feet below existing grades. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soil to the specifications of structural fill or overexcavation and replacement with suitable structural fill will be necessary.

The gravel-dominant native soils exhibit excellent infiltration characteristics and are suitable to support large-scale infiltration design. Further discussion can be found within the *Preliminary Infiltration Design* section of this study.

Pertinent geotechnical recommendations for the proposed residential development are provided in this report. We appreciate the opportunity to be of service to you on this project. Please call if you have any questions about this report or if we can be of further assistance.

Sincerely,

EARTH SOLUTIONS NW, LLC

Adam Z. Shier, L.G.
Project Geologist

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(Continued)

ES-10212

GEOTECHNICAL ENGINEERING STUDY
PROPOSED TOWNHOMES
113 – 27TH AVENUE SOUTHEAST
PUYALLUP, WASHINGTON

ES-10212

INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed residential development to be constructed at 113 – 27th Avenue Southeast, in Puyallup, Washington. The purpose of this study was to develop geotechnical recommendations to aid with the design and construction of the subject project. The following tasks were completed as part of our scope of services for this project:

- Subsurface exploration to characterize the soil and groundwater conditions.
- Preliminary infiltration evaluation based primarily on our field observations and laboratory analyses, including estimated infiltration rates using the Soil Grain Size Analysis method.
- Laboratory testing of representative soil samples collected on site.
- Engineering analyses for the proposed residential development.
- Preparation of this report.

Project Description

According to the referenced preliminary site plan, the site is proposed to be developed with nine townhome units. An ingress/egress and utilities easement will be maintained from 27th Avenue Southeast. The stormwater tract is currently proposed in the southern section of the subject area.

At the time of report submission, specific building load plans were not available for review; however, based on our experience with similar developments, the proposed residential structures will likely be two to three stories in height and constructed using relatively lightly loaded wood framing supported on conventional foundations. Perimeter footing loads will likely be about 1 to 2 kips per linear foot. Slab-on-grade loading is anticipated to be approximately 150 pounds per square foot (psf).

If the above design assumptions either change or are incorrect, ESNW should be contacted to review the recommendations provided in this report. ESNW should be afforded the opportunity to review final designs to confirm that our geotechnical recommendations have been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is located north of 27th Avenue Southeast, approximately 200 feet east of the intersection of South Meridian, in Puyallup, Washington. The approximate site location is illustrated on Plate 1 (Vicinity Map). The overall site area consists of one tax parcel (Pierce County Parcel No. 0419032099), totaling a gross site area of approximately 0.73 acres.

The subject site is currently unoccupied, and vegetation consists of field grass, mature trees, and brush. Based on review of readily available topographic information, site topography generally descends towards the north and northwest with total elevation change of about 35 feet across the subject site (with varying slope inclinations). Isolated portions of the site contain steep slope areas of 40 percent (or greater) inclination and vertical elevation change of at least 10 feet. Further discussion on pertinent geologically hazardous areas can be found in the *Geologic Hazard Areas* section of this report.

Subsurface

An ESNW representative observed, logged, and sampled four test pits and three soil borings across the site. The subsurface explorations were completed to assess and classify the site soils and to characterize the groundwater conditions within areas proposed for new development. The borings were completed on November 20, 2024, with a maximum drilling depth of about 18 feet below the existing ground surface (bgs). The test pits were completed on November 26, 2024, with a maximum excavation depth of about 15 feet bgs.

The approximate subsurface exploration locations are depicted on Plate 2 (Subsurface Exploration Plan). Please refer to the subsurface exploration logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the subsurface exploration locations were analyzed in general accordance with both Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil was encountered at one of the test pit locations within the upper six inches of existing grades. Deeper or shallower pockets of topsoil may be encountered locally across the site. The topsoil was characterized by a dark brown color, the presence of fine organic material, and small root intrusions.

Limited fill was observed at two of the test pit locations and one of the boring locations in proximity to previous site development. The fill extended from the surface to a depth of roughly one-and-one-half-foot bgs at the test pit locations and a depth of about seven feet at the boring location. The observed fill is likely attributed to the previous site development and consisted primarily of silty sand and silty gravel (USCS: SM and GM, respectively).

Native Soil

Underlying topsoil and limited fill, native soils consisted primarily of silty gravel, well-graded gravel with variable silt and sand content, poorly graded gravel with silt and sand, and silty sand with gravel (USCS: GM, GW, GW-GM, GP-GM, and SM, respectively). The native soils were observed to be in a chiefly moist and medium dense to dense condition and extended to the maximum termination depth of 18 feet bgs. Slight caving was noted at the test pit locations due to the cohesionless nature of the native soil.

Geologic Setting

The referenced geologic map resource identifies recessional outwash (Qgo) deposits as the primary geologic unit underlying the site. As reported on the geologic map resource, the recessional outwash is described as silt, clay, sand, and gravel deposited by glacial meltwater. Additionally, recessional outwash gravels, locally known as Steilacoom gravel (Qgo_{sg}), are mapped immediately north and west of the subject site. As reported on the geologic map resource, the Steilacoom gravel outwash is described as pebbles with boulders.

The referenced Web Soil Survey (WSS) identifies two distinct soil types across the subject site: Everett very gravelly sandy loam, 8 to 15 percent slopes, is mapped across the northern two-thirds of the site; and Kitsap silt loam, 2 to 8 percent slopes, is mapped within the southern one-third of the site. Everett series soils are associated with moraines, eskers, and kames and are derived from sandy and gravelly glacial outwash. The Kitsap series soils are associated with terraces and are derived from glaciolacustrine deposits.

Based on the subsurface investigation, the soil conditions observed at the test pit and boring locations generally correlate with recessional outwash, specifically the Steilacoom gravel deposits outlined in this section.

Groundwater

During the November 2024 subsurface explorations, groundwater seepage was not encountered at the subsurface exploration locations. Groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. Groundwater seepage flow rates are typically higher during the winter, spring, and early summer months. Therefore, perched groundwater seepage should be expected in site excavations, particularly if excavations are made during the wetter months of the year.

Two groundwater monitoring standpipe piezometers and one groundwater monitoring well were installed during the subsurface explorations for groundwater monitoring purposes. ESNW is currently contracted to complete groundwater monitoring services during the 2024–2025 wet season. ESNW will evaluate the seasonal high groundwater table elevation and prepare a summary letter once the 2024–2025 wet season concludes and the monitoring data is analyzed.

GEOLOGIC HAZARD AREAS

ESNW understands that the City of Puyallup recognizes areas susceptible to the processes of landslides, erosion, seismic, and volcanic activity as geologically hazardous areas, as outlined in Chapter 21.06 of the Puyallup Municipal Code (PMC). Based on our investigation, the site contains a landslide hazard area.

Slope Reconnaissance

During our site visits, ESNW completed a reconnaissance across the on-site slope areas to identify signs of instability. The sloped areas on the site are generally vegetated with mature trees, saplings, and groundcover, which consists primarily of ferns and shrubs. No obvious signs of recent erosion or soil movement were observed during the slope reconnaissance. Based on our investigation, the observed slope areas generally exhibit good stability in the current condition and configuration.

Landslide Hazard Areas

PMC 21.06.1210 defines a landslide hazard area as an area subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include any areas susceptible to landslide because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors, and include, at a minimum, the following:

1. Areas of historic failures, such as:

    a. Those areas delineated by the USDA NRCS as having a significant limitation for building site development;

    b. Those coastal areas mapped as class “u” (unstable), “uos” (unstable old slides), and “urs” (unstable recent slides) in the Department of Ecology Washington Coastal Atlas; or

    c. Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the United States Geological Survey or Washington Department of Natural Resources.

2. Areas with all three of the following characteristics:

    a. Slopes steeper than 15 percent;

    b. Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and

    c. Springs or groundwater seepage.

3. Areas that have shown movement during the Holocene epoch (from 10,000 years ago to the present) or which are underlain or covered by mass wastage debris of this epoch.

4. Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials.

5. Slopes having gradients steeper than 80 percent subject to rockfall during seismic shaking.

6. Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action, including stream channel migration zones.

7. Areas that show evidence of or are at risk from snow avalanches.

8. Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding.

9. Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of bedrock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least 10 feet of vertical relief.

Criteria “1” through “8” either do not apply to the site or refer to geologic conditions which are not present on the site. Criterion “9” applies to the descending slope located in proximity to the northern property boundary. As such, the site contains a landslide hazard area, as defined by the PMC, due to the presence of the slope.

Slope Stability Analysis

Due to the proximity of the proposed project to an identified landslide hazard area, ESNW evaluated slope stability across the subject site with primary focus on areas likely to be influenced by the proposed modifications and the landslide hazard area. Global slope stability analysis was completed using the 2024 GeoStudio Slope/W modeling program to reflect existing and proposed conditions in both static and seismic scenarios, including foundation loading where applicable. The analysis focused primarily on deep-seated rotational failures and was completed using topographic data available through the referenced documents. One cross-section (A-A’) was prepared and is depicted on Plate 2 (Subsurface Exploration Plan).

The soil stratigraphy was modeled as one distinct soil unit based on conditions observed during the subsurface explorations. We utilized relatively conservative strength parameters in our slope modeling, which are outlined in the table below. Additional modeling parameters are presented in Appendix C. Groundwater was not included in the modeling, since a pervasive groundwater condition was not observed during the November 2024 subsurface explorations.

Soil Unit	Density	Unit Weight (pcf)	Cohesion (psf)	Internal Friction Angle (deg)
Outwash	Medium dense	135	0 (static) 0 (seismic)	36

Our analyses indicate the proposed site modifications will improve overall slope stability by reducing slope loading, as the proposed site modification and excavation will reduce the overall soil mass and driving forces for downslope failure. Safety factors for the proposed condition (including new foundation and seismic loading) reflect an improvement over the existing condition. In our opinion, the proposed development and positioning of the new residential townhome structures should be considered feasible from a geotechnical standpoint.

Our analyses indicate the proposed townhome construction will not have an adverse impact on global slope stability (and will instead have a positive impact), and the site will maintain acceptable factor-of-safety (FOS) values in the post-construction condition. In general, the modeling suggests the site is stable, and in our opinion, the identified 20-foot rear yard setback is adequate from a geotechnical standpoint.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed townhome development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include site preparation and earthwork, utility installation, foundation support, slab-on-grade support, the suitability of using on-site soils as structural fill, and stormwater facility installation and drainage.

Subsurface exploration indicates the site is underlain by native gravel soils consisting primarily of recessional outwash gravels. The native soils were observed to be in a chiefly dry and medium dense to dense condition and extended to the maximum termination depth of 18 feet bgs. Slight caving was noted at the subsurface exploration locations due to the cohesionless nature of the native soil.

In general, competent native soil suitable for support of foundations will likely be encountered beginning at depths of about two to three feet bgs across the site. The proposed structures can be constructed on conventional continuous and spread foundations supported on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil.

The gravel-dominant native soils exhibit excellent infiltration characteristics and are suitable to support large-scale infiltration design. The local groundwater table was not observed during the November 2024 exploration. Further discussion can be found within the *Preliminary Infiltration Design* section of this study.

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, and site clearing and stripping activities. Subsequent earthwork activities will involve mass site grading and installation of infrastructure and stormwater management improvements.

Temporary Erosion Control

The following temporary erosion and sediment control (TESC) Best Management Practices (BMPs) are offered:

- Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide a stable access entrance surface. Placing geotextile fabric underneath the quarry spalls will provide greater stability, if needed.

- Silt fencing should be placed around the construction site perimeter.

- When not in use, soil stockpiles should be covered or otherwise protected.

- Temporary measures for controlling surface water runoff, such as interceptor trenches, sumps, or swales, should be installed prior to beginning earthwork activities.

- Dry soils disturbed during construction should be wetted to minimize dust and airborne soil erosion.

Additional TESC BMPs, as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities. TESC BMPs must be actively monitored, and may be modified during construction as site conditions require and in consultation with the site erosion control lead, to ensure BMPs are performing as intended.

Excavations and Slopes

Based on the soil conditions observed at the subsurface exploration locations, excavation activities are likely to expose cohesionless native gravel soils beginning at depths of approximately 12 to 36 inches below the existing ground surface. In accordance with Federal Occupation Safety and Health Administration and Washington Industrial Safety and Health Act soil classifications and maximum allowable temporary slope inclinations, the native cohesionless gravel is classified as Type C soil and should be sloped no steeper than one-and-one-half to one horizontal (1.5H:1V) during construction.

Permanent slopes should be planted with vegetation to both enhance stability and minimize erosion and should maintain a gradient of 2H:1V or flatter. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions and to provide additional excavation and slope recommendations, as necessary. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations.

In-situ and Imported Soil

The in-situ soils encountered at the subject site have a low sensitivity to moisture and were generally in a dry to moist condition at the time of exploration. Soils anticipated to be exposed on site will likely be too dry to attain adequate compaction in situ and will require moisture conditioning (through the addition of water) prior to use as structural fill. An ESNW representative should be contacted to determine the suitability of in-situ soils for use as structural fill at the time of construction.

Imported soil intended for use as structural fill should be evaluated by ESNW during construction. The imported soil must be workable to the optimum moisture content, as determined by the Modified Proctor Method (ASTM D1557), at the time of placement and compaction. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway, permanent slope, retaining wall, and utility trench backfill areas. Structural fill placed and compacted during site grading activities should meet the following specifications and guidelines:

- Structural fill material — Granular soil*
- Moisture content — At or slightly above optimum**
- Relative compaction — 95 percent (Modified Proctor)
- Loose lift thickness (maximum) — 12 inches

* *Existing soil may not be suitable for use as structural fill unless at (or slightly above) the optimum moisture content at the time of placement and compaction.*

** *Soil shall not be placed dry of the optimum moisture content and should be evaluated by ESNW during construction.*

With respect to underground utility installations and backfill, local jurisdictions may dictate the soil type(s) and compaction requirements. Areas of otherwise unsuitable material and debris should be removed from structural areas and replaced with structural fill.

Foundations

The proposed structures can be constructed on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. Provided site earthwork activities are completed in accordance with the recommendations provided above, suitable soil conditions are expected to be exposed at foundation subgrade elevations.

Where loose or unsuitable soil conditions are encountered at foundation subgrade elevations, compaction of the soils to the specifications of structural fill or overexcavation and replacement with suitable structural fill will likely be necessary. An ESNW representative should be contacted to confirm suitability of foundation subgrades at the time of construction.

Provided the structures will be supported as described above, the following parameters may be used for design of the new foundations:

- Allowable soil bearing capacity — 2,500 psf
- Passive earth pressure — 300 pcf
- Coefficient of friction — 0.40

A one-third increase in the allowable soil bearing capacity may be assumed for short-term wind and seismic loading conditions. The passive earth pressure and coefficient of friction values include a safety factor of 1.5. With structural loading as expected, total settlement in the range of one inch is anticipated, with differential settlement of about one-half inch. The majority of the settlement should occur during construction as dead loads are applied.

Seismic Design

The 2021 International Building Code (2021 IBC) recognizes ASCE 7-16 (formally known as the Minimum Design Loads and Associated Criteria for Buildings and Other Structures manual) for seismic design, specifically with respect to earthquake loads. Based on the soil conditions encountered at the test pit and boring locations, the parameters and values provided below are recommended for seismic design per the 2021 IBC.

Parameter	**Value**
Site Class	D*
Mapped short period spectral response acceleration, S_S (*g*)	1.264
Mapped 1-second period spectral response acceleration, S_1 (*g*)	0.436
Short period site coefficient, F_a	1.0
Long period site coefficient, F_v	1.864**
Adjusted short period spectral response acceleration, S_{MS} (*g*)	1.264
Adjusted 1-second period spectral response acceleration, S_{M1} (*g*)	0.813**
Design short period spectral response acceleration, S_{DS} (*g*)	0.843
Design 1-second period spectral response acceleration, S_{D1} (*g*)	0.542**

* *Assumes dense native soil conditions, encountered to a maximum depth of 18 feet bgs during the November 2024 field exploration, remain dense to at least 100 feet bgs. Based on our experience with the project geologic setting (recessional deposits) across the Puget Sound region, site soils are likely consistent with this assumption.*

** *Values assume F_v may be determined using linear interpolation per Table 11.4-2 in ASCE 7-16.*

Liquefaction Susceptibility

The referenced liquefaction susceptibility map indicates the subject site possesses very low liquefaction susceptibility. Liquefaction is a phenomenon that can occur within a soil profile as a result of an intense ground shaking or loading condition. Most commonly, liquefaction is caused by ground shaking during an earthquake. Sand or silt soil profiles that are loose, cohesionless, and present below the groundwater table are most susceptible to liquefaction. During the ground shaking, the soil contracts, and porewater pressure increases. The increased porewater pressure occurs quickly and without sufficient time to dissipate, resulting in water flowing upward to the ground surface and a liquefied soil condition. Soil in a liquefied condition possesses very little shear strength in comparison to the drained condition, which can result in a loss of foundation support for structures.

In our opinion, site susceptibility to liquefaction may be considered low. This opinion is based on the lack of shallow groundwater conditions and the relatively dense, gravel-dominant characteristics of the native soil.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed structures should be supported on firm and unyielding subgrades. Unstable or yielding subgrade areas should be recompacted or overexcavated and replaced with suitable structural fill prior to slab construction.

Where free-draining native gravel soils are not exposed at the subgrade, a capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining material should have a fines content of 5 percent or less defined as the percent passing the number 200 sieve, based on the minus three-quarters-inch fraction. In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If used, the vapor barrier should consist of a material specifically designed to function as a vapor barrier and should be installed in accordance with the manufacturer’s specifications.

Retaining Walls

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters may be used for design:

- Active earth pressure (unrestrained condition) 35 pcf (equivalent fluid)
- At-rest earth pressure (restrained condition) 55 pcf
- Traffic surcharge* (passenger vehicles) 70 psf (rectangular distribution)
- Passive earth pressure 300 pcf (equivalent fluid)
- Coefficient of friction 0.40
- Seismic surcharge 8H psf**
- Allowable soil bearing capacity 2,500 psf

* *Where applicable.*
** *Where H equals the retained height (in feet).*

The above passive earth pressure and coefficient of friction values include a safety factor of 1.5 and are based on a level backfill condition and level grade at the wall toe. Revised design values will be necessary if sloping grades are to be used above or below retaining walls. Additional surcharge loading from adjacent foundations, sloped backfill, or other relevant loads should be included in the retaining wall design.

Retaining walls should be backfilled with free-draining material that extends along with the height of the wall and a distance of at least 18 inches behind the wall. The upper 12 inches of the wall backfill may consist of less permeable soil if desired. A sheet drain may be considered instead of free-draining backfill. A perforated drainpipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 3. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Drainage

Finish grades must be designed to direct surface drain water away from structures and slopes. Water must not be allowed to pond adjacent to structures or slopes. Grades adjacent to buildings should be sloped away from the buildings at a gradient of either at least 2 percent for a horizontal distance of 10 feet or the maximum allowed by adjacent structures.

In our opinion, foundation drains should be installed along building perimeter footings. A typical foundation drain detail is provided on Plate 4. However, due to the well-drained nature of the native recessional outwash, elimination of footing drains may be feasible from a geotechnical standpoint. ESNW should be consulted to further evaluate the need for footing drains at the time of foundation construction. If buildings will incorporate crawlspaces rather than slab-on-grade, it is our opinion that a crawlspace drain system can be used in lieu of perimeter footing drains. The crawlspace drain must provide positive drainage to an appropriate outlet.

Preliminary Infiltration Design

From a geotechnical standpoint, infiltration is considered feasible where targeted within the native outwash gravels, such as those exposed at the subsurface exploration locations. Per local mapping designations, the on-site soils are primarily associated with the Everett very gravelly sandy loam soil series and are assigned to hydrologic soil group A. In accordance with Option 3 in Volume V of the 2019 Stormwater Management Manual for Western Washington (2019 SWMMWW), the Soil Grain Size Analysis method was used to determine design infiltration rates. The table below depicts sample locations and depths, encountered soil types, appropriate safety factors, and calculated design rates (based on the Massmann [2003] equation).

Test Location ID	Test Depth	K_{sat} initial	CF_v	CF_t	CF_m	K_{sat} design
B-1	10.0 ft	>100 in/hr	0.9	0.5	0.9	>30 in/hr
B-1	15.0 ft	>100 in/hr				>30 in/hr
TP-3	9.0 ft	92 in/hr				>30 in/hr
TP-3	15.0 ft	55 in/hr				22 in/hr
TP-4	3.0 ft	>>100 in/hr				>>30 in/hr
TP-4	10.0 ft	>>100 in/hr				>>30 in/hr

Based on utilization of the Soil Grain Size Analysis method, design infiltration rates of between 22.0 in/hr and greater than 30 in/hr were calculated for the native outwash gravels. **It is our opinion that the lowest rate (22 in/hr) be used for preliminary sizing and initial design** of facilities that will target the native outwash gravels. As project plans develop, it may prove beneficial to re-evaluate the recommendations provided herein, which could yield higher recommended design infiltration rates based on review of specific facility locations, depths, and groundwater table conditions. Regardless of the allowable design methods allowed by the 2019 SWMMWW, ESNW recommends completion of in-situ testing, prior to acceptance of the final stormwater design, as a means to lower the risk associated with infiltration designs based solely on grain size analysis.

An ESNW representative should be requested to confirm soil conditions are as anticipated, provide confirmation testing, and provide additional recommendations as necessary, during construction. Infiltration facilities must also maintain adequate separation from the underlying groundwater table. Groundwater monitoring wells were installed at representative test pit and boring locations to allow for seasonal groundwater level monitoring during the 2024–2025 wet season. ESNW would be pleased to provide additional consulting services pertaining to infiltration feasibility and design, if requested.

Preliminary Pavement Sections

The performance of site pavements is largely related to the condition of the underlying subgrade. To ensure adequate pavement performance, the subgrade should be in a firm and unyielding condition when subjected to proofrolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications previously detailed in this report. Soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas containing unsuitable or yielding subgrade conditions will require remedial measures, such as overexcavation and/or placement of thicker crushed rock or structural fill sections, prior to pavement.

We anticipate new pavement sections will be subjected primarily to passenger vehicle traffic. For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

- A minimum of two inches of hot-mix asphalt (HMA) placed over four inches of crushed rock base (CRB).

- A minimum of two inches of HMA placed over three inches of asphalt-treated base (ATB).

Heavier traffic areas generally require thicker pavement sections depending on site usage, pavement life expectancy, and site traffic. For preliminary design purposes, the following pavement sections for occasional truck traffic and access roadways may be considered:

- Three inches of HMA placed over six inches of CRB.

- Three inches of HMA placed over four and one-half inches of ATB.

The HMA, ATB, and CRB materials should conform to WSDOT and/or City of Puyallup specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557. Final pavement design recommendations, including recommendations for heavy traffic areas, access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by the City of Puyallup may supersede the recommendations provided in this report.

If an inverted crown will be used for roadway surfaces, drainage measures should be included in the design to prevent accumulation of water in the subgrade adjacent to catch basins. Such measures should consist of finger drains extending from the catch basins.

Utility Support and Trench Backfill

In our opinion, the on-site soil will generally be suitable for support of utilities. Use of the native soil as structural backfill in the utility trench excavations will depend on the in-situ moisture content at the time of placement and compaction. If native soil is placed below the optimum moisture content, settlement will likely occur once wet weather impacts the trenches. As such, backfill soils should be properly moisture conditioned, as necessary, to ensure acceptability of the soil moisture content at the time of placement and compaction. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report or to the applicable requirements of the presiding jurisdiction. Due to the presence of gravel outwash soils, particles larger than six inches in size should be removed and not used as utility trench backfill material.

LIMITATIONS

This study has been prepared for the exclusive use of Lloyd Enterprises, Inc., and its representatives. The recommendations and conclusions provided in this study 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. No warranty, express or implied, is made. Variations in the subsurface conditions observed at the test locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions provided in this study if variations are encountered.

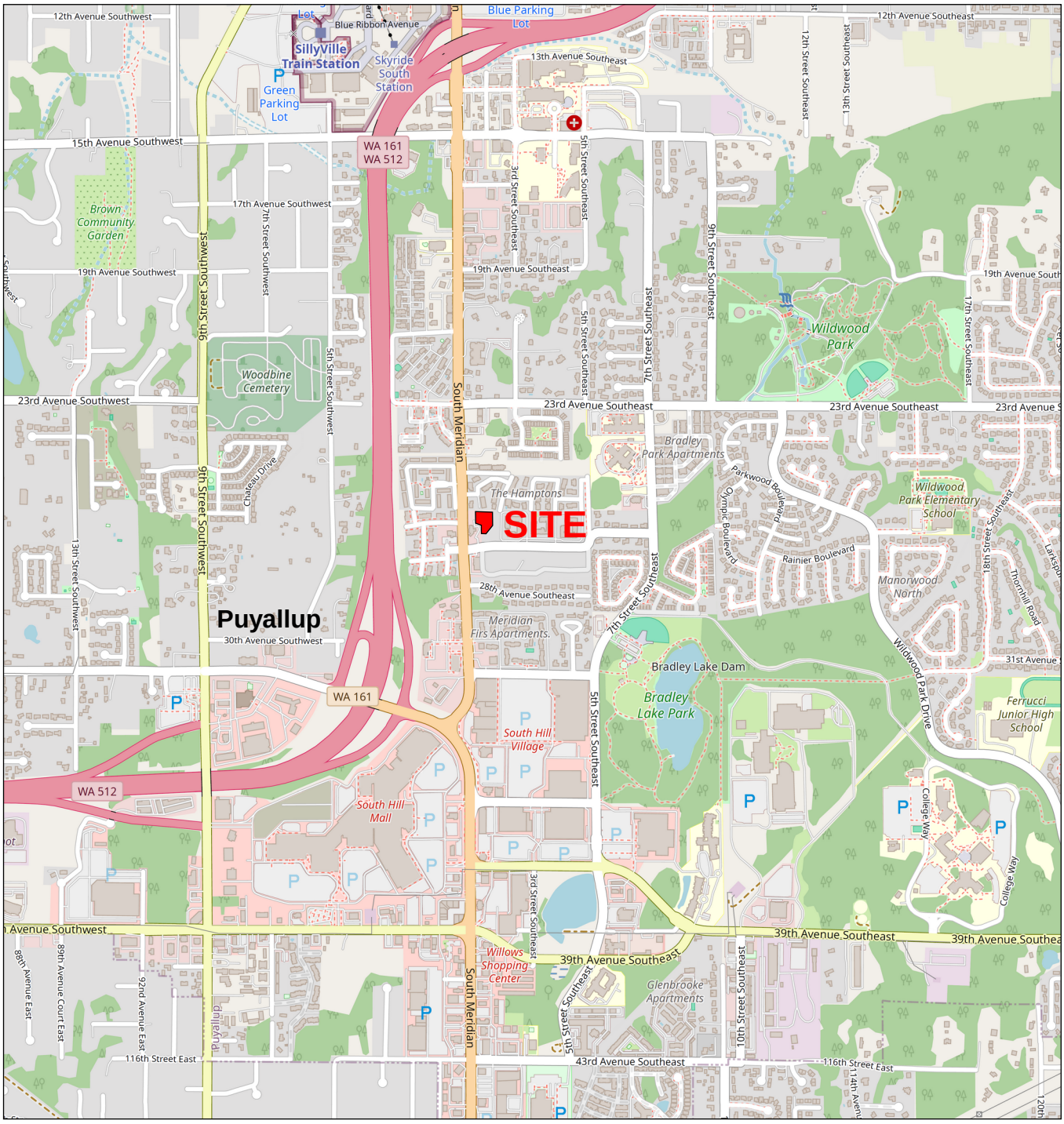
Additional Services

ESNW should have an opportunity to review the final design with respect to the geotechnical recommendations provided in this report. ESNW should also be retained to provide testing and consultation services during construction.

REFERENCES

The following documents were reviewed as part of the preparation of this study:

- 2019 Stormwater Management Manual for Western Washington
- Chapter 21.06, Article XII of the Puyallup Municipal Code
- Geologic Map of the Tacoma 1:100,000-Scale Quadrangle, Washington, prepared by James E. Schuster et al., dated 2015
- Liquefaction Susceptibility Map of Pierce County, Washington, by Palmer, S.P. et al., dated September 2004
- Preliminary Site Plan (9 Units), prepared by CES NW, Inc., dated November 5, 2024
- Web Soil Survey, maintained by the Natural Resources Conservation Service under the United States Department of Agriculture



Reference:
Pierce 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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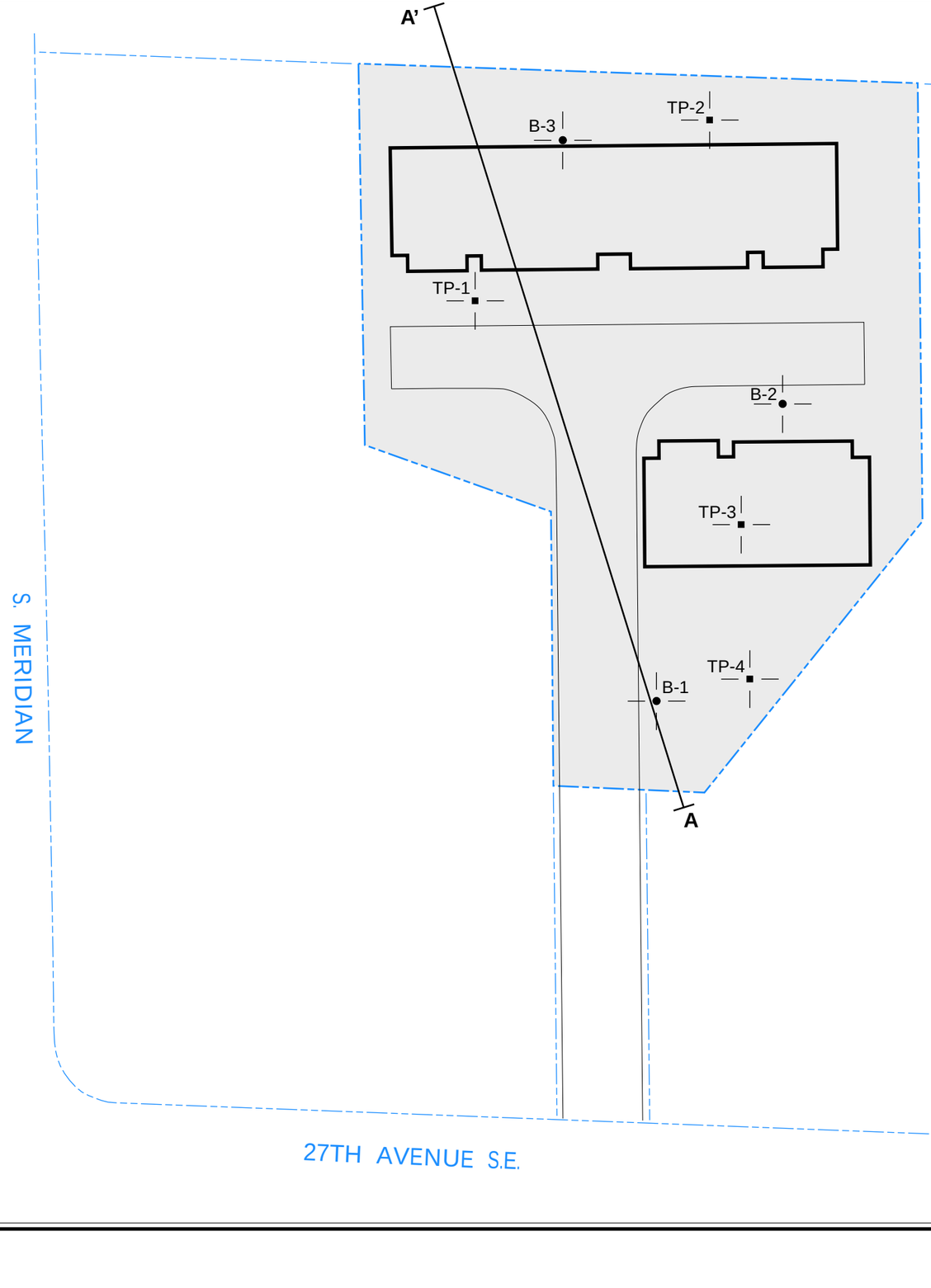
Vicinity Map
27th Avenue S.E. Townhomes
Puyallup, Washington

Drawn MRS	Date 12/27/2024	Proj. No. 10212
Checked AZS	Date Dec. 2024	Plate 1



LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-10212, Nov. 2024

B-1 — Approximate Location of ESNW Boring, Proj. No. ES-10212.01, Nov. 2024

Subject Site

Proposed Building

NORTH

NOT - TO - SCALE

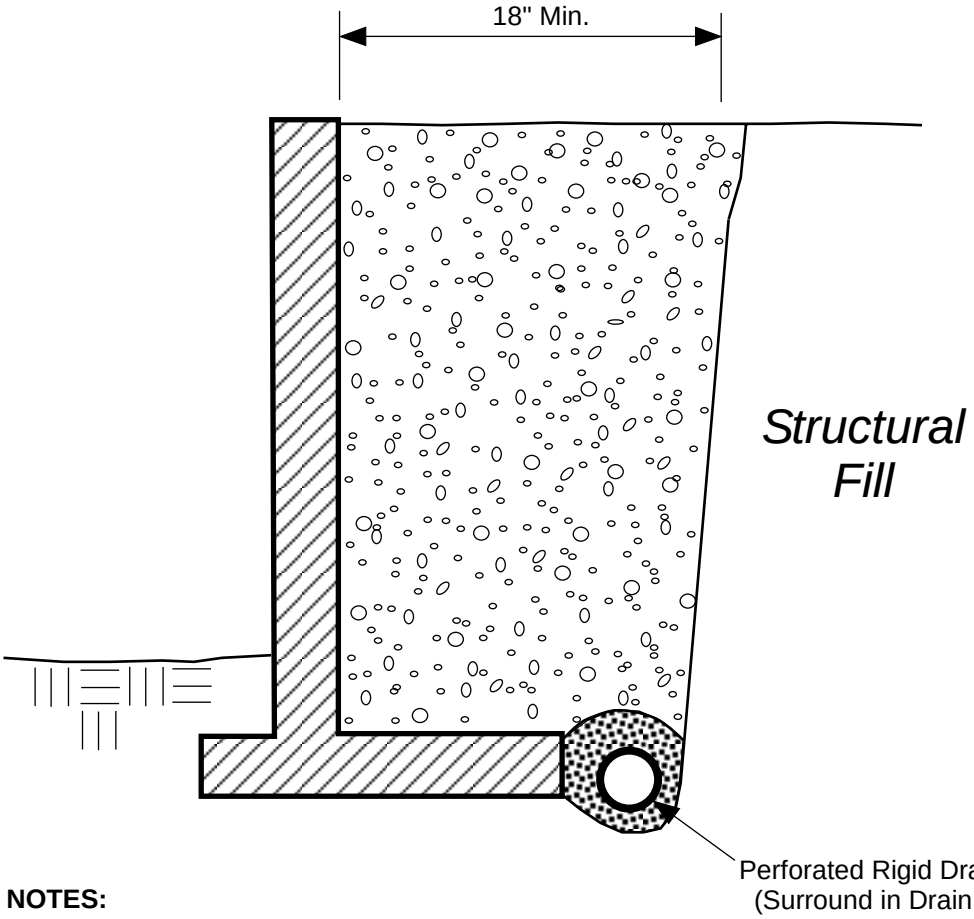
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided 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.

Subsurface Exploration Plan
27th Avenue S.E. Townhomes
Puyallup, Washington

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Drawn	MRS
Checked	AZS
Date	01/22/2025
Proj. No.	10212
Plate	2



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Free-draining Structural Backfill

1-inch Drain Rock

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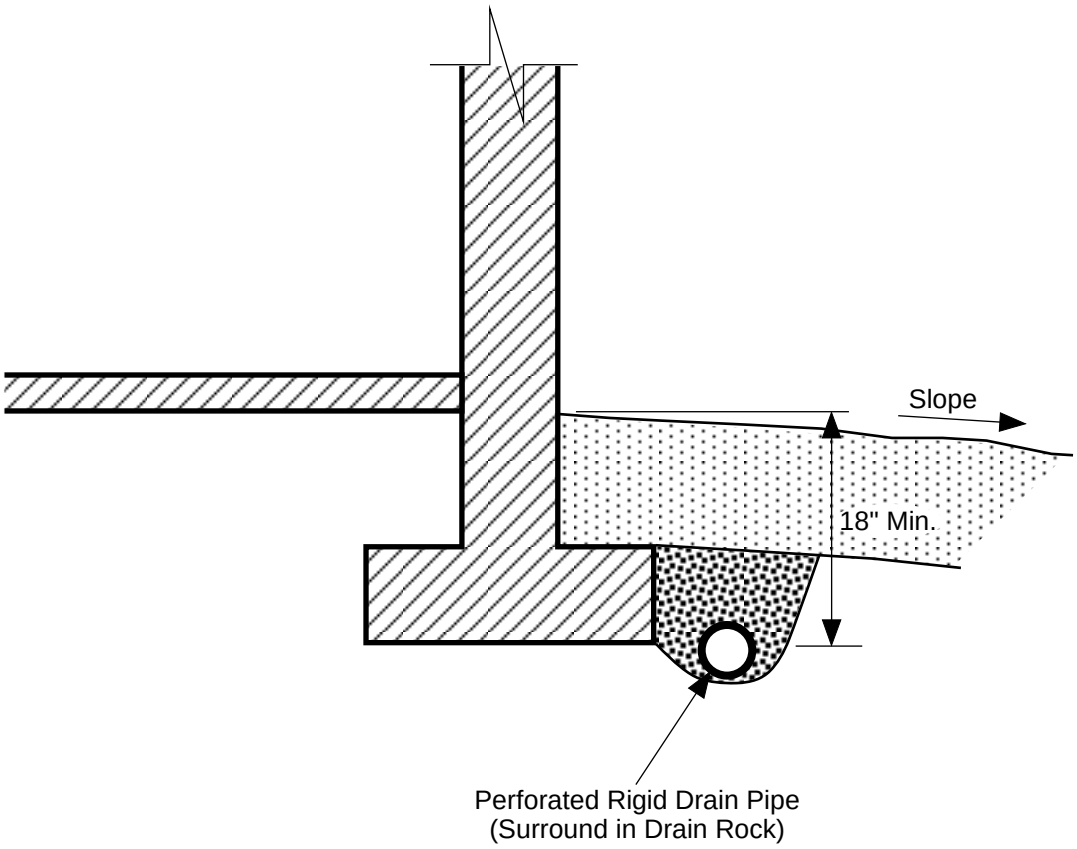
Retaining Wall Drainage Detail
27th Avenue S.E. Townhomes
Puyallup, Washington

Drawn MRS	Date 12/27/2024	Proj. No. 10212
Checked AZS	Date Dec. 2024	Plate 3



NOTES:

- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Surface Seal: native soil or other low-permeability material.

1-inch Drain Rock

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Footing Drain Detail
27th Avenue S.E. Townhomes
Puyallup, Washington

Drawn MRS	Date 12/27/2024	Proj. No. 10212
Checked AZS	Date Dec. 2024	Plate 4

Appendix A

Subsurface Exploration Logs

ES-10212

Subsurface conditions on site were explored on November 20 and 26, 2024. On November 20, 2024, three borings were advanced to a maximum depth of about 18 feet bgs using a hollow-stem auger drill rig and operators retained by ESNW. On November 26, 2024, four test pits were excavated to a maximum depth of approximately 15 feet bgs using a trackhoe and operator retained by ESNW. The approximate locations of the exploration sites are illustrated on Plate 2 of this study. The subsurface exploration logs are provided in this Appendix.

The final logs represent the interpretations of the field logs and the results of laboratory analyses. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

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

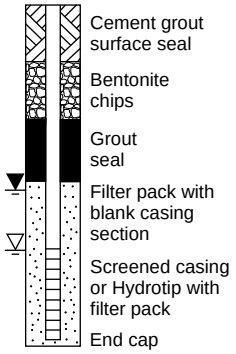
Wet - Water visible but not free draining, likely above optimum MC

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

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

BORING NUMBER B-1

PROJECT NUMBER ES-10212.01 **PROJECT NAME** 27th Avenue S.E. Townhomes
DATE STARTED 11/20/24 **COMPLETED** 11/20/24 **GROUND ELEVATION**
DRILLING CONTRACTOR Geologic Drill Partners **LATITUDE** 47.16625 **LONGITUDE** -122.29241
LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**
NOTES ▽ **AT TIME OF DRILLING**
SURFACE CONDITIONS Field grass **AFTER DRILLING**

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0							
					SM		Brown silty SAND with gravel, medium dense, moist to wet (Fill)
2.5	SS	6	15-15-12 (27)	MC = 20.3			
5.0	SS	22	3-5-9 (14)	MC = 15.0			
7.5							
	SS	44	18-20-16 (36)	MC = 2.8	GW-GM		Gray well-graded GRAVEL with silt, dense, moist
9.5							
10.0	SS	11	8-12-8 (20)	MC = 5.8 Fines = 14.6	SM		Gray silty SAND with gravel, medium dense, moist [USDA Classification: very gravelly coarse sandy LOAM]
12.5							
13.0							
					GM		Gray silty GRAVEL with sand, medium dense to very dense, moist
15.0							

(Continued Next Page)

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15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

BORING NUMBER B-1

PROJECT NUMBER ES-10212.01 **PROJECT NAME** 27th Avenue S.E. Townhomes

DATE STARTED 11/20/24 **COMPLETED** 11/20/24 **GROUND ELEVATION**

DRILLING CONTRACTOR Geologic Drill Partners **LATITUDE** 47.16625 **LONGITUDE** -122.29241

LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES ▽ **AT TIME OF DRILLING**

SURFACE CONDITIONS Field grass **AFTER DRILLING**

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
15.0							
	SS	33	10-14-15 (29)	MC = 6.4 Fines = 12.9	GM		Gray silty GRAVEL with sand, medium dense to very dense, moist *(continued)* [USDA Classification: extremely gravelly coarse sandy LOAM]
17.5							
	SS	17	50/6"	MC = 7.5			18.0

Boring terminated at 18.0 feet below existing grade. No groundwater encountered during drilling. 2" PVC standpipe installed to bottom of boring. Lower 10.0 feet slotted. Well ID: BQN 110. Boring backfilled with bentonite/sand.

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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Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

BORING NUMBER B-2

PROJECT NUMBER ES-10212.01 **PROJECT NAME** 27th Avenue S.E. Townhomes
DATE STARTED 11/20/24 **COMPLETED** 11/20/24 **GROUND ELEVATION**
DRILLING CONTRACTOR Geologic Drill Partners **LATITUDE** 47.16650 **LONGITUDE** -122.29222
LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**
NOTES ▽ **AT TIME OF DRILLING**
SURFACE CONDITIONS Field grass **AFTER DRILLING**

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0							
					GM		Brown silty GRAVEL, medium dense, moist to wet
2.5	SS	6	5-8-5 (13)	MC = 19.3			
5.0	SS	18	5-7-50/5"	MC = 9.7			
7.0							
7.5							Gray well-graded GRAVEL with silt and sand, dense, moist
	SS	11	3-14-21 (35)	MC = 1.7	GW-GM		
10.0	SS	11	22-22-21 (43)	MC = 6.9			
12.5							
12.5							Boring terminated at 12.5 feet below existing grade due to refusal on cobbles. No groundwater encountered during drilling. Boring backfilled with bentonite.

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-10212.01 **PROJECT NAME** 27th Avenue S.E. Townhomes

DATE STARTED 11/20/24 **COMPLETED** 11/20/24 **GROUND ELEVATION**

DRILLING CONTRACTOR Geologic Drill Partners **LATITUDE** 47.16672 **LONGITUDE** -122.29252

LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES ▽ **AT TIME OF DRILLING**

SURFACE CONDITIONS Field grass **AFTER DRILLING**

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					GM		Gray silty GRAVEL, dense, moist
2.5	SS	11	14-16-27 (43)	MC = 4.6			
5.0	SS	11	46-27-21 (48)	MC = 5.3			
7.0							Boring terminated at 7.0 feet below existing grade due to refusal on gravel. No groundwater encountered during drilling. Boring backfilled with bentonite.

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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TEST PIT NUMBER TP-1

PROJECT NUMBER ES-10212 **PROJECT NAME** 27th Avenue S.E. Townhomes

DATE STARTED 11/26/24 **COMPLETED** 11/26/24 **GROUND ELEVATION**

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.16655 **LONGITUDE** -122.29262

LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES ▽ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS Ivy **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, roots
				0.5	Brown well-graded GRAVEL with sand, loose to medium dense, moist
					-probed 1/2"
	GB	MC = 5.4 Fines = 1.5			[USDA Classification: extremely gravelly coarse SAND]
					-probed 1/2"
5					-becomes gray
	GB	MC = 5.0	GW		
	GB	MC = 3.9			
10					
	GB	MC = 3.1			
15				15.0	

Test pit terminated at 15.0 feet below existing grade. No groundwater encountered 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.

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TEST PIT NUMBER TP-2

PROJECT NUMBER ES-10212 **PROJECT NAME** 27th Avenue S.E. Townhomes

DATE STARTED 11/26/24 **COMPLETED** 11/26/24 **GROUND ELEVATION**

EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.16668 **LONGITUDE** -122.29243

LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**

NOTES ▽ **AT TIME OF EXCAVATION**

SURFACE CONDITIONS Field grass **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			GM		Brown silty GRAVEL, loose to medium dense, moist (Fill) -probed 1/2"- 1" -roots -bricks and glass debris
1.5					Gray well-graded GRAVEL with sand, medium dense, dry to moist -probed 1/2"
	GB	MC = 2.8			
5					-slight caving 0' to 10.5'
	GB	MC = 4.3	GW		
10					
	GB	MC = 2.3			
15	GB	MC = 1.8			
15.0					Test pit terminated at 15.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to 10.5 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

TEST PIT NUMBER TP-3

PROJECT NUMBER ES-10212 **PROJECT NAME** 27th Avenue S.E. Townhomes
DATE STARTED 11/26/24 **COMPLETED** 11/26/24 **GROUND ELEVATION**
EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.16641 **LONGITUDE** -122.29233
LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**
NOTES ▽ **AT TIME OF EXCAVATION**
SURFACE CONDITIONS Brush **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Gray silty SAND with gravel, medium dense, moist (Fill)
					-probed 1"
					1.5
					Brown well-graded GRAVEL with silt and sand, medium dense, moist
	GB	MC = 3.3			
5					-probed 1/2"
			GW-GM		-becomes gray
	GB	MC = 6.5 Fines = 6.6			[USDA Classification: extremely gravelly loamy coarse SAND]
10					
	GB	MC = 5.7			
					13.0
			GP-GM		Poorly graded GRAVEL with silt and sand, medium dense, moist
15	GB	MC = 6.6 Fines = 7.8			[USDA Classification: extremely gravelly coarse sandy LOAM]
					15.0
					Test pit terminated at 15.0 feet below existing grade. No groundwater encountered 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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Branch Office: Pasco, WA

TEST PIT NUMBER TP-4

PROJECT NUMBER ES-10212 **PROJECT NAME** 27th Avenue S.E. Townhomes
DATE STARTED 11/26/24 **COMPLETED** 11/26/24 **GROUND ELEVATION**
EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 47.16624 **LONGITUDE** -122.29225
LOGGED BY AZS **CHECKED BY** KDH **GROUND WATER LEVEL:**
NOTES ▽ **AT TIME OF EXCAVATION**
SURFACE CONDITIONS Groundcover **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			GM		Brown silty GRAVEL, medium dense, moist -probed 1/2"
				2.0	
	GB	MC = 4.5 Fines = 3.7	GW		Gray well-graded GRAVEL with sand, loose to medium dense, moist [USDA Classification: extremely gravelly coarse sandy LOAM] -probed 1/2" -moderate to severe caving TOH to BOH
5				5.0	
	GB	MC = 2.8	GW-GM		Gray well-graded GRAVEL with silt, loose to medium dense, moist
10	GB	MC = 3.6 Fines = 5.0		10.0	[USDA Classification: extremely gravelly silt LOAM]

Test pit terminated at 10.0 feet below existing grade due to caving. No groundwater during excavation. Caving observed from from TOH to BOH.

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.

Appendix B

Laboratory Test Results

ES-10212

Earth Solutions NW LLC
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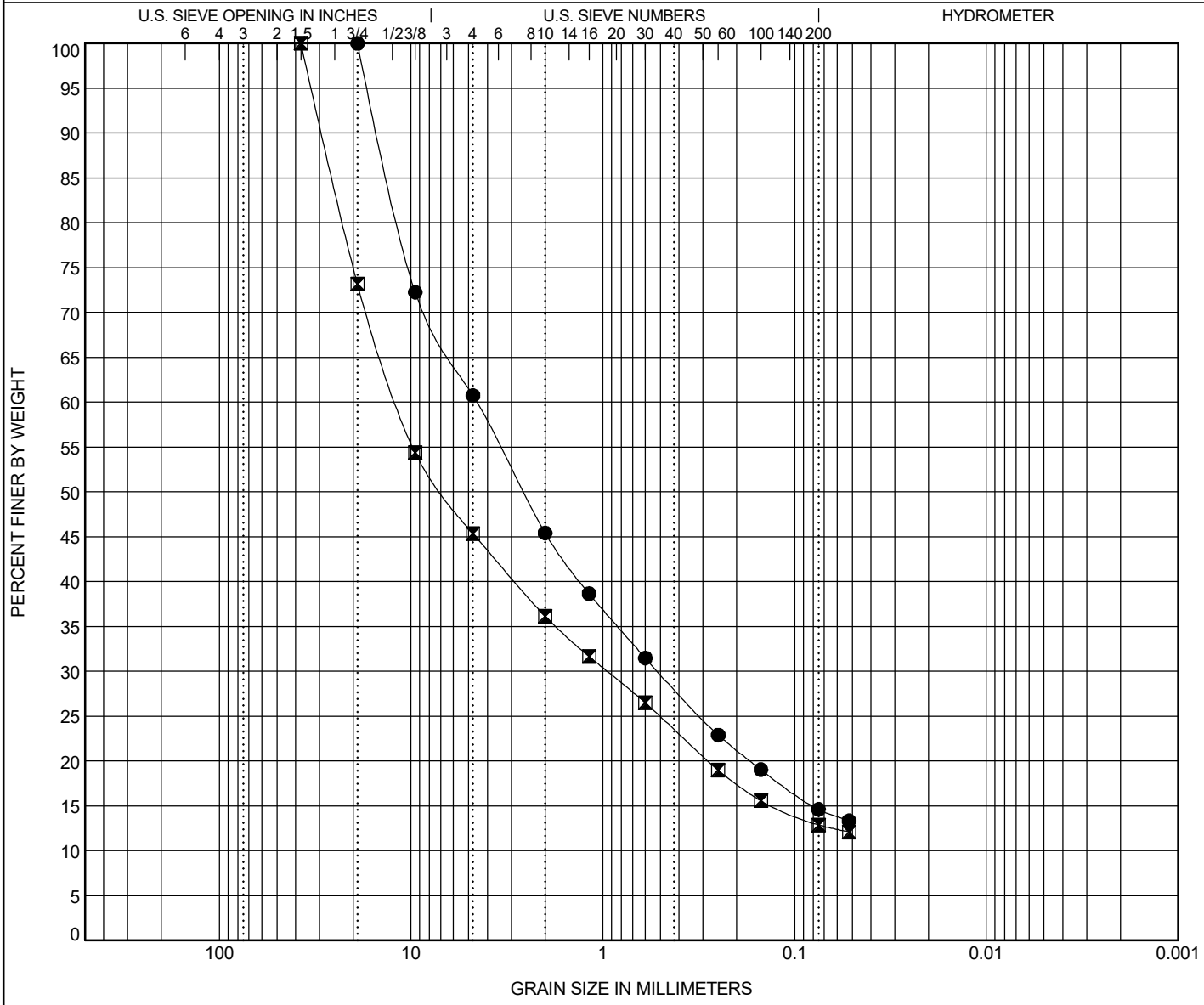
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-10212.01 **PROJECT NAME** 27th Avenue S.E. Townhomes



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	Cc	Cu
●	B-01	10.00ft.	**USDA: Gray Very Gravelly Coarse Sandy Loam. USCS: SM with Gravel.**		
⊠	B-01	15.00ft.	**USDA: Gray Extremely Gravelly Coarse Sandy Loam. USCS: GM with Sand.**		

	Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	B-01	10.0ft.	**19**	**4.55**	**0.515**					**14.6**	
⊠	B-01	15.0ft.	**37.5**	**11.686**	**0.949**					**12.9**	

GRAIN SIZE USDA ES-10212.01 27TH AVENUE S.E. TOWNHOMES.GPJ GINT US LAB.GDT 12/4/24

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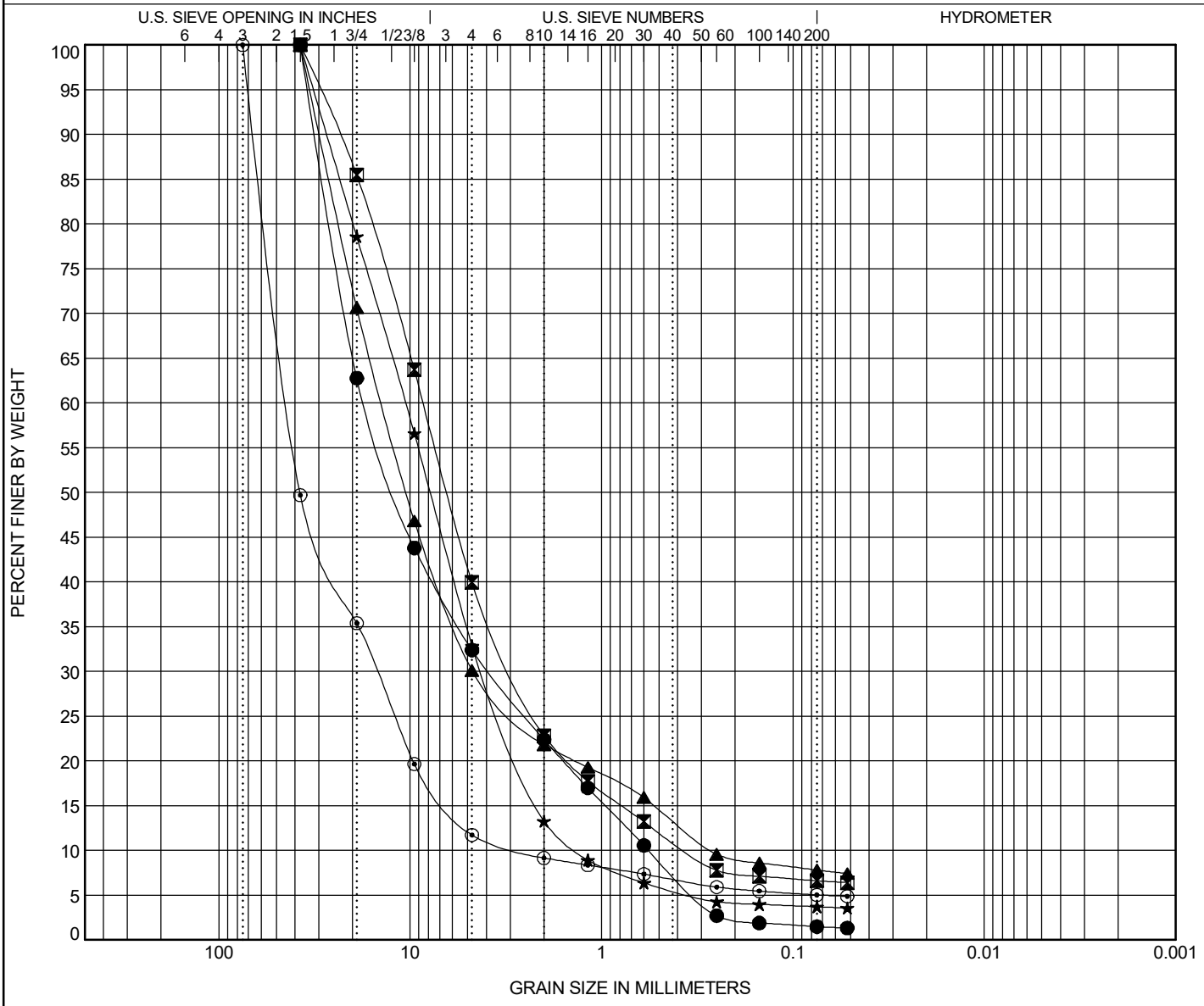
GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-10212 **PROJECT NAME** 27th Avenue S.E. Townhomes



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

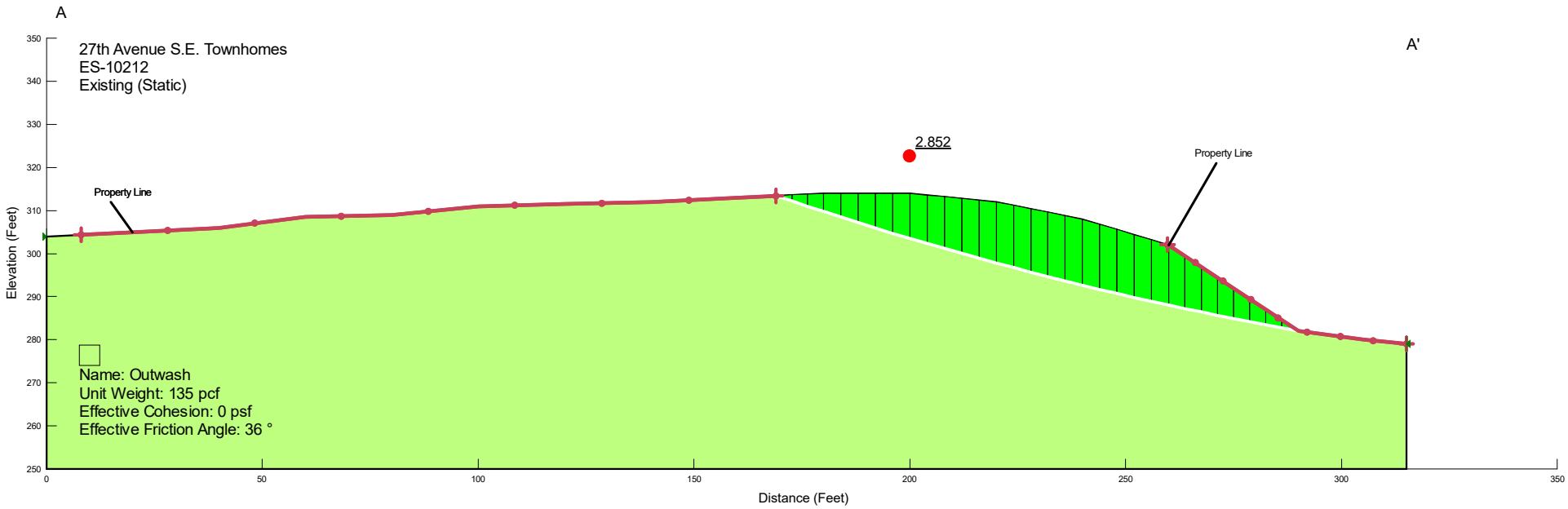
Specimen Identification			Classification	Cc	Cu
●	TP-01	3.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.	1.54	30.47
⊠	TP-03	9.00ft.	USDA: Gray Extremely Gravelly Loamy Coarse Sand. USCS: GW-GM with Sand.	2.71	23.86
▲	TP-03	15.00ft.	USDA: Gray Extremely Gravelly Coarse Sandy Loam. USCS: GP-GM with Sand.	5.95	52.56
★	TP-04	3.00ft.	USDA: Gray Extremely Gravelly Coarse Sandy Loam. USCS: GW with Sand.	1.23	7.87
⊙	TP-04	10.00ft.	USDA: Gray Extremely Gravelly Silt Loam. USCS: GW-GM.	1.96	16.30

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-01	3.0ft.	37.5	17.165	3.859	0.563				1.5	
⊠	TP-03	9.0ft.	37.5	8.527	2.873	0.357				6.6	
▲	TP-03	15.0ft.	37.5	13.935	4.69	0.265				7.8	
★	TP-04	3.0ft.	37.5	10.571	4.185	1.344				3.7	
⊙	TP-04	10.0ft.	75	43.215	14.982	2.651				5.0	

Appendix C

Slope/W Computer Output

ES-10212


A
A'
27th Avenue S.E. Townhomes
ES-10212
Existing (Static)
2.852
Property Line
Property Line
Name: Outwash
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Elevation (Feet)
Distance (Feet)
350
340
330
320
310
300
290
280
270
260
250
0
50
100
150
200
250
300
350

Slope Stability

File Information

File Version: 11.06
Tool Version: 24.1.0.1406
Title: Cedar Cove
Created By: Adam Shier
Last Edited By: Adam Shier
Revision Number: 97
Date: 01/23/2025
Time: 10:02:22 AM
File Name: 27th ave townhomes existing (Static).gsz
Directory: C:\Users\adam.shier\Desktop\SLope W\
Last Solved Date: 01/23/2025
Last Solved Time: 10:02:23 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Slope Stability

Kind: SLOPE/W
Analysis Type: Morgenstern-Price
Settings
    Side Function
        Intercolumn force function option: Half-Sine
    PWP Conditions from: (none)
    Unit Weight of Water: 62.430189 pcf
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Optimize Critical Slip Surface Location: No
    Tension Crack Option: (none)
Distribution
    F of S Calculation Option: Constant
Convergence
    Geometry Settings
        Minimum Slip Surface Depth: 4 ft
        Minimum Slip Surface Volume: 35.314667 ft³

Number of Columns: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Under-Relaxation Criteria
Initial Rate: 1
Minimum Rate: 0.1
Rate Reduction Factor: 0.65
Reduction Frequency (iterations): 50
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Outwash

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (8, 304.4) ft
Left-Zone Right Coordinate: (169, 313.45) ft
Left-Zone Increment: 8
Right Type: Range
Right-Zone Left Coordinate: (259.67204, 302.09839) ft
Right-Zone Right Coordinate: (315, 279) ft
Right-Zone Increment: 8
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 304) ft
Right Coordinate: (315, 279) ft

Seismic Coefficients

Horz Seismic Coef.: 0

Geometry

Name: 2D Geometry

Settings

View: 2D

Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	304 ft
Point 2	20 ft	305 ft
Point 3	40 ft	306 ft
Point 4	60 ft	308.5 ft
Point 5	80 ft	309 ft
Point 6	100 ft	311 ft
Point 7	120 ft	311.5 ft
Point 8	140 ft	312 ft
Point 9	160 ft	313 ft
Point 10	180 ft	314 ft
Point 11	200 ft	314 ft
Point 12	220 ft	312 ft
Point 13	240 ft	308 ft
Point 14	260 ft	302 ft
Point 15	275 ft	292 ft
Point 16	290 ft	282 ft
Point 17	305 ft	280 ft
Point 18	315 ft	279 ft
Point 19	315 ft	250 ft
Point 20	0 ft	250 ft

Regions

	Material	Points	Area
Region 1	Outwash	20,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19	17,560 ft²

Slip Results

Slip Surfaces Analysed: 345 of 405 converged

Current Slip Surface

Slip Surface: 386

Factor of Safety: 2.852

Volume: 1,218.9642 ft³

Weight: 164,560.17 lbf

Resisting Moment: 95,208,558 lbf·ft

Activating Moment: 33,386,797 lbf·ft

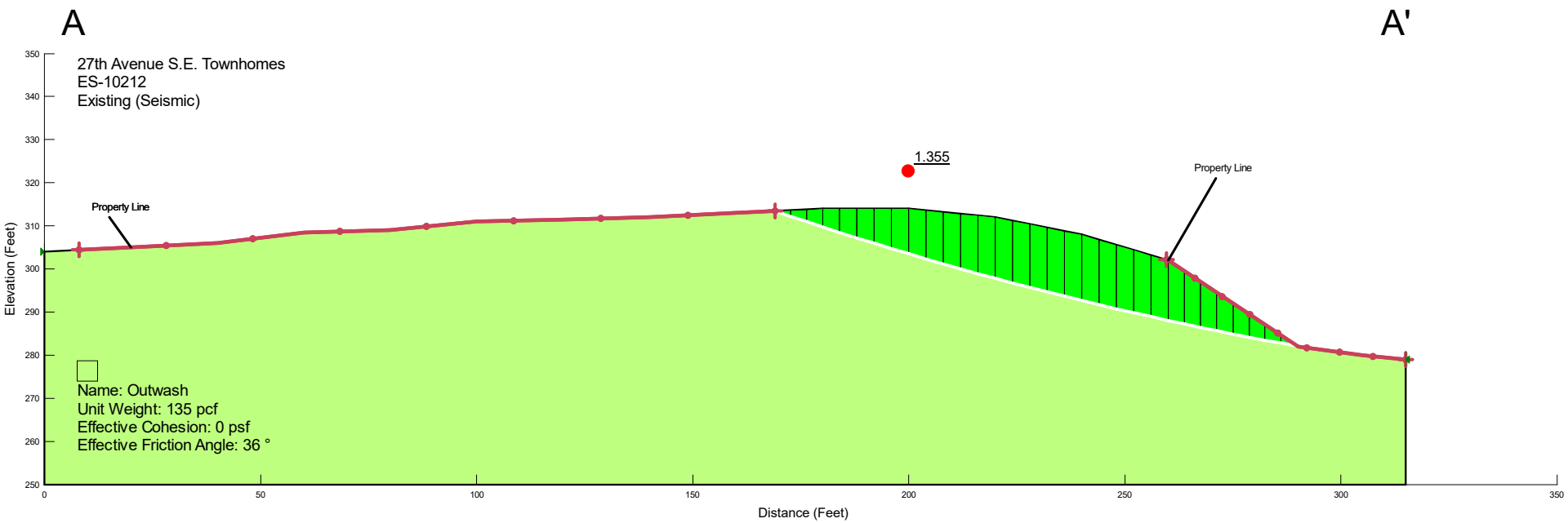
Resisting Force: 112,272.38 lbf

Activating Force: 39,370.541 lbf
Slip Rank: 1 of 405 slip surfaces
Exit: (289.81024, 282.12651) ft
Entry: (169, 313.45) ft
Radius: 821.29911 ft
Center: (434.93857, 1,090.5014) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	170.83333 ft	312.82738 ft	0 psf	88.546972 psf	64.333141 psf	0 psf	0 psf	Outwash
Column 2	174.50000 ft	311.59177 ft	0 psf	264.04968 psf	191.84332 psf	0 psf	0 psf	Outwash
Column 3	178.16667 ft	310.37534 ft	0 psf	436.70207 psf	317.28263 psf	0 psf	0 psf	Outwash
Column 4	182.00000 ft	309.12450 ft	0 psf	602.003 psf	437.38078 psf	0 psf	0 psf	Outwash
Column 5	186.00000 ft	307.84095 ft	0 psf	760.04827 psf	552.20739 psf	0 psf	0 psf	Outwash
Column 6	190.00000 ft	306.57991 ft	0 psf	915.69393 psf	665.29058 psf	0 psf	0 psf	Outwash
Column 7	194.00000 ft	305.34127 ft	0 psf	1,069.2213 psf	776.83476 psf	0 psf	0 psf	Outwash
Column 8	198.00000 ft	304.12493 ft	0 psf	1,220.8826 psf	887.02311 psf	0 psf	0 psf	Outwash
Column 9	202.00000 ft	302.93079 ft	0 psf	1,346.0142 psf	977.93655 psf	0 psf	0 psf	Outwash
Column 10	206.00000 ft	301.75873 ft	0 psf	1,444.6576 psf	1,049.6052 psf	0 psf	0 psf	Outwash
Column 11	210.00000 ft	300.60868 ft	0 psf	1,541.7274 psf	1,120.1305 psf	0 psf	0 psf	Outwash
Column 12	214.00000 ft	299.48052 ft	0 psf	1,637.2303 psf	1,189.5175 psf	0 psf	0 psf	Outwash
Column 13	218.00000 ft	298.37416 ft	0 psf	1,731.1263 psf	1,257.7369 psf	0 psf	0 psf	Outwash
Column 14	222.00000 ft	297.28953 ft	0 psf	1,798.155 psf	1,306.4361 psf	0 psf	0 psf	Outwash
Column 15	226.00000 ft	296.22651 ft	0 psf	1,837.974 psf	1,335.3663 psf	0 psf	0 psf	Outwash
Column 16	230.00000 ft	295.18504 ft	0 psf	1,875.5041 psf	1,362.6335 psf	0 psf	0 psf	Outwash
Column 17	234.00000 ft	294.16502 ft	0 psf	1,910.5363 psf	1,388.0859 psf	0 psf	0 psf	Outwash
Column 18	238.00000 ft	293.16637 ft	0 psf	1,942.8478 psf	1,411.5615 psf	0 psf	0 psf	Outwash
Column 19	242.00000 ft	292.18901 ft	0 psf	1,946.6853 psf	1,414.3496 psf	0 psf	0 psf	Outwash
Column 20	246.00000 ft	291.23286 ft	0 psf	1,921.6355 psf	1,396.1499 psf	0 psf	0 psf	Outwash
Column 21	250.00000 ft	290.29786 ft	0 psf	1,892.9808 psf	1,375.331 psf	0 psf	0 psf	Outwash

Column 22	254.00000 ft	289.38391 ft	0 psf	1,860.5775 psf	1,351.7887 psf	0 psf	0 psf	Outwash
Column 23	258.00000 ft	288.49096 ft	0 psf	1,824.3202 psf	1,325.4462 psf	0 psf	0 psf	Outwash
Column 24	261.87500 ft	287.64555 ft	0 psf	1,696.891 psf	1,232.8634 psf	0 psf	0 psf	Outwash
Column 25	265.62500 ft	286.84635 ft	0 psf	1,478.334 psf	1,074.0725 psf	0 psf	0 psf	Outwash
Column 26	269.37500 ft	286.06542 ft	0 psf	1,256.3131 psf	912.76489 psf	0 psf	0 psf	Outwash
Column 27	273.12500 ft	285.30272 ft	0 psf	1,031.1301 psf	749.15988 psf	0 psf	0 psf	Outwash
Column 28	276.85128 ft	284.56279 ft	0 psf	804.57542 psf	584.55826 psf	0 psf	0 psf	Outwash
Column 29	280.55384 ft	283.84534 ft	0 psf	577.02905 psf	419.23614 psf	0 psf	0 psf	Outwash
Column 30	284.25640 ft	283.14551 ft	0 psf	347.40406 psf	252.40382 psf	0 psf	0 psf	Outwash
Column 31	287.95896 ft	282.46325 ft	0 psf	116.0283 psf	84.299493 psf	0 psf	0 psf	Outwash


A
A'
27th Avenue S.E. Townhomes
ES-10212
Existing (Seismic)
1.355
Property Line
Property Line
Name: Outwash
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Elevation (Feet)
Distance (Feet)
350
340
330
320
310
300
290
280
270
260
250
0
50
100
150
200
250
300
350

Slope Stability

File Information

File Version: 11.06
Tool Version: 24.1.0.1406
Title: Cedar Cove
Created By: Adam Shier
Last Edited By: Adam Shier
Revision Number: 97
Date: 01/23/2025
Time: 09:59:22 AM
File Name: 27th ave townhomes existing (Seismic).gsz
Directory: C:\Users\adam.shier\Desktop\SLope W\
Last Solved Date: 01/23/2025
Last Solved Time: 10:04:07 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Slope Stability

Kind: SLOPE/W
Analysis Type: Morgenstern-Price
Settings
- Side Function
  - Intercolumn force function option: Half-Sine
- PWP Conditions from: (none)
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 2 ft
  - Minimum Slip Surface Volume: 35.314667 ft³

Number of Columns: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Under-Relaxation Criteria
Initial Rate: 1
Minimum Rate: 0.1
Rate Reduction Factor: 0.65
Reduction Frequency (iterations): 50
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Outwash

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (8, 304.4) ft
Left-Zone Right Coordinate: (169, 313.45) ft
Left-Zone Increment: 8
Right Type: Range
Right-Zone Left Coordinate: (259.67204, 302.09839) ft
Right-Zone Right Coordinate: (315, 279) ft
Right-Zone Increment: 8
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 304) ft
Right Coordinate: (315, 279) ft

Seismic Coefficients

Horz Seismic Coef.: 0.25

Geometry

Name: 2D Geometry

Settings

View: 2D

Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	304 ft
Point 2	20 ft	305 ft
Point 3	40 ft	306 ft
Point 4	60 ft	308.5 ft
Point 5	80 ft	309 ft
Point 6	100 ft	311 ft
Point 7	120 ft	311.5 ft
Point 8	140 ft	312 ft
Point 9	160 ft	313 ft
Point 10	180 ft	314 ft
Point 11	200 ft	314 ft
Point 12	220 ft	312 ft
Point 13	240 ft	308 ft
Point 14	260 ft	302 ft
Point 15	275 ft	292 ft
Point 16	290 ft	282 ft
Point 17	305 ft	280 ft
Point 18	315 ft	279 ft
Point 19	315 ft	250 ft
Point 20	0 ft	250 ft

Regions

	Material	Points	Area
Region 1	Outwash	20,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19	17,560 ft²

Slip Results

Slip Surfaces Analysed: 385 of 405 converged

Current Slip Surface

Slip Surface: 386

Factor of Safety: 1.355

Volume: 1,218.9642 ft³

Weight: 164,560.17 lbf

Resisting Moment: 89,258,755 lbf·ft

Activating Moment: 65,855,552 lbf·ft

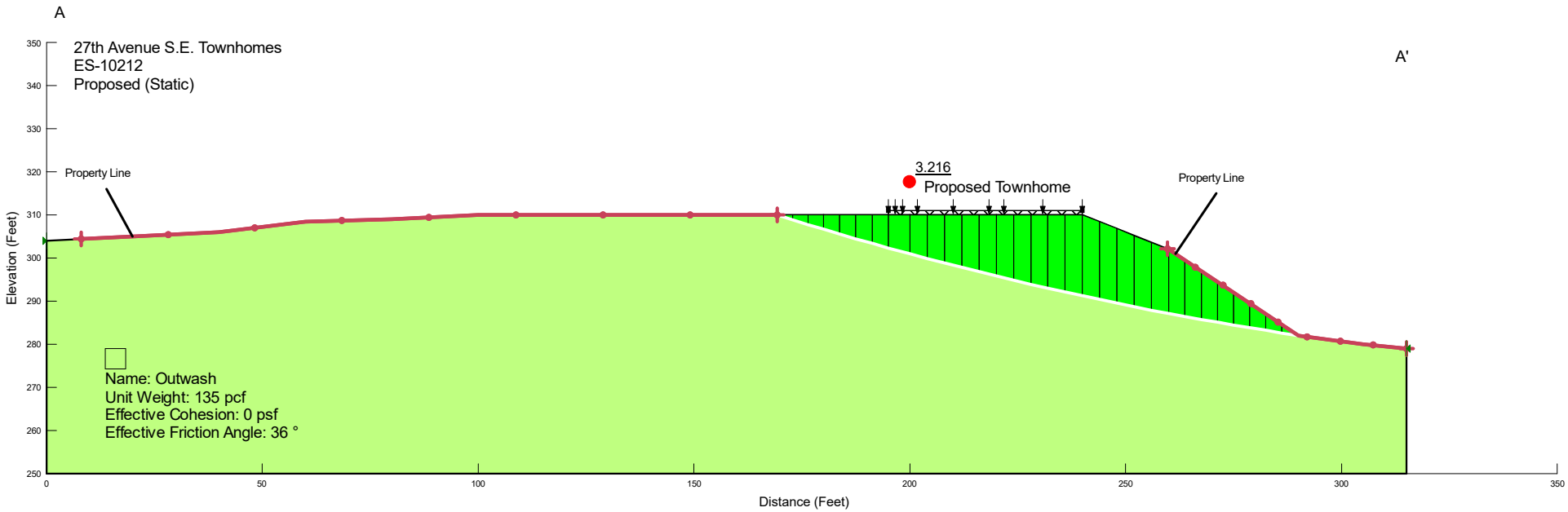
Resisting Force: 105,318.99 lbf

Activating Force: 77,711.766 lbf
Slip Rank: 1 of 405 slip surfaces
Exit: (289.81024, 282.12651) ft
Entry: (169, 313.45) ft
Radius: 821.29911 ft
Center: (434.93857, 1,090.5014) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	170.83333 ft	312.82738 ft	0 psf	80.559833 psf	58.530145 psf	0 psf	0 psf	Outwash
Column 2	174.50000 ft	311.59177 ft	0 psf	237.27442 psf	172.38996 psf	0 psf	0 psf	Outwash
Column 3	178.16667 ft	310.37534 ft	0 psf	387.17556 psf	281.29951 psf	0 psf	0 psf	Outwash
Column 4	182.00000 ft	309.12450 ft	0 psf	526.32782 psf	382.39954 psf	0 psf	0 psf	Outwash
Column 5	186.00000 ft	307.84095 ft	0 psf	655.53627 psf	476.27498 psf	0 psf	0 psf	Outwash
Column 6	190.00000 ft	306.57991 ft	0 psf	780.59471 psf	567.13525 psf	0 psf	0 psf	Outwash
Column 7	194.00000 ft	305.34127 ft	0 psf	903.0953 psf	656.13714 psf	0 psf	0 psf	Outwash
Column 8	198.00000 ft	304.12493 ft	0 psf	1,024.8827 psf	744.6209 psf	0 psf	0 psf	Outwash
Column 9	202.00000 ft	302.93079 ft	0 psf	1,126.3236 psf	818.322 psf	0 psf	0 psf	Outwash
Column 10	206.00000 ft	301.75873 ft	0 psf	1,209.5154 psf	878.76438 psf	0 psf	0 psf	Outwash
Column 11	210.00000 ft	300.60868 ft	0 psf	1,298.0389 psf	943.08043 psf	0 psf	0 psf	Outwash
Column 12	214.00000 ft	299.48052 ft	0 psf	1,393.3609 psf	1,012.3359 psf	0 psf	0 psf	Outwash
Column 13	218.00000 ft	298.37416 ft	0 psf	1,496.4685 psf	1,087.248 psf	0 psf	0 psf	Outwash
Column 14	222.00000 ft	297.28953 ft	0 psf	1,584.9465 psf	1,151.531 psf	0 psf	0 psf	Outwash
Column 15	226.00000 ft	296.22651 ft	0 psf	1,657.1283 psf	1,203.9742 psf	0 psf	0 psf	Outwash
Column 16	230.00000 ft	295.18504 ft	0 psf	1,733.4054 psf	1,259.3928 psf	0 psf	0 psf	Outwash
Column 17	234.00000 ft	294.16502 ft	0 psf	1,810.8423 psf	1,315.6539 psf	0 psf	0 psf	Outwash
Column 18	238.00000 ft	293.16637 ft	0 psf	1,885.8431 psf	1,370.1452 psf	0 psf	0 psf	Outwash
Column 19	242.00000 ft	292.18901 ft	0 psf	1,930.1175 psf	1,402.3124 psf	0 psf	0 psf	Outwash
Column 20	246.00000 ft	291.23286 ft	0 psf	1,939.1072 psf	1,408.8438 psf	0 psf	0 psf	Outwash
Column 21	250.00000 ft	290.29786 ft	0 psf	1,934.3011 psf	1,405.352 psf	0 psf	0 psf	Outwash

Column 22	254.00000 ft	289.38391 ft	0 psf	1,914.3154 psf	1,390.8315 psf	0 psf	0 psf	Outwash
Column 23	258.00000 ft	288.49096 ft	0 psf	1,879.1183 psf	1,365.2593 psf	0 psf	0 psf	Outwash
Column 24	261.87500 ft	287.64555 ft	0 psf	1,744.5087 psf	1,267.4598 psf	0 psf	0 psf	Outwash
Column 25	265.62500 ft	286.84635 ft	0 psf	1,514.0175 psf	1,099.9981 psf	0 psf	0 psf	Outwash
Column 26	269.37500 ft	286.06542 ft	0 psf	1,277.6318 psf	928.2538 psf	0 psf	0 psf	Outwash
Column 27	273.12500 ft	285.30272 ft	0 psf	1,038.7339 psf	754.68434 psf	0 psf	0 psf	Outwash
Column 28	276.85128 ft	284.56279 ft	0 psf	801.5819 psf	582.38334 psf	0 psf	0 psf	Outwash
Column 29	280.55384 ft	283.84534 ft	0 psf	568.08794 psf	412.74005 psf	0 psf	0 psf	Outwash
Column 30	284.25640 ft	283.14551 ft	0 psf	337.90713 psf	245.5039 psf	0 psf	0 psf	Outwash
Column 31	287.95896 ft	282.46325 ft	0 psf	111.63109 psf	81.104737 psf	0 psf	0 psf	Outwash


A
27th Avenue S.E. Townhomes
ES-10212
Proposed (Static)
A'
Property Line
3.216
Proposed Townhome
Property Line
Name: Outwash
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Elevation (Feet)
Distance (Feet)
350
340
330
320
310
300
290
280
270
260
250
0
50
100
150
200
250
300
350

Slope Stability

File Information

File Version: 11.06
Tool Version: 24.1.0.1406
Title: Cedar Cove
Created By: Adam Shier
Last Edited By: Adam Shier
Revision Number: 103
Date: 01/23/2025
Time: 10:05:44 AM
File Name: 27th ave townhomes proposed (Static).gsz
Directory: C:\Users\adam.shier\Desktop\SLope W\
Last Solved Date: 01/23/2025
Last Solved Time: 10:05:45 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Slope Stability

Kind: SLOPE/W
Analysis Type: Morgenstern-Price
Settings
- Side Function
  - Intercolumn force function option: Half-Sine
- PWP Conditions from: (none)
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 4 ft
  - Minimum Slip Surface Volume: 35.314667 ft³

Number of Columns: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.01
Under-Relaxation Criteria
Initial Rate: 1
Minimum Rate: 0.1
Rate Reduction Factor: 0.65
Reduction Frequency (iterations): 50
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Outwash

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (8, 304.4) ft
Left-Zone Right Coordinate: (169.31731, 310) ft
Left-Zone Increment: 8
Right Type: Range
Right-Zone Left Coordinate: (259.68335, 302.12666) ft
Right-Zone Right Coordinate: (315, 279) ft
Right-Zone Increment: 8
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 304) ft
Right Coordinate: (315, 279) ft

Seismic Coefficients

Horz Seismic Coef.: 0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 250 pcf
Direction: Vertical

Coordinates

	X	Y
	195 ft	311 ft
	240 ft	311 ft

Geometry

Name: 2D Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	304 ft
Point 2	20 ft	305 ft
Point 3	40 ft	306 ft
Point 4	60 ft	308.5 ft
Point 5	80 ft	309 ft
Point 6	100 ft	310 ft
Point 7	120 ft	310 ft
Point 8	140 ft	310 ft
Point 9	160 ft	310 ft
Point 10	180 ft	310 ft
Point 11	200 ft	310 ft
Point 12	220 ft	310 ft
Point 13	240 ft	310 ft
Point 14	260 ft	302 ft
Point 15	275 ft	292 ft
Point 16	290 ft	282 ft
Point 17	305 ft	280 ft
Point 18	315 ft	279 ft
Point 19	315 ft	250 ft
Point 20	0 ft	250 ft

Regions

	Material	Points	Area
Region 1	Outwash	20,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19	17,250 ft²

Slip Results

Slip Surfaces Analysed: 321 of 405 converged

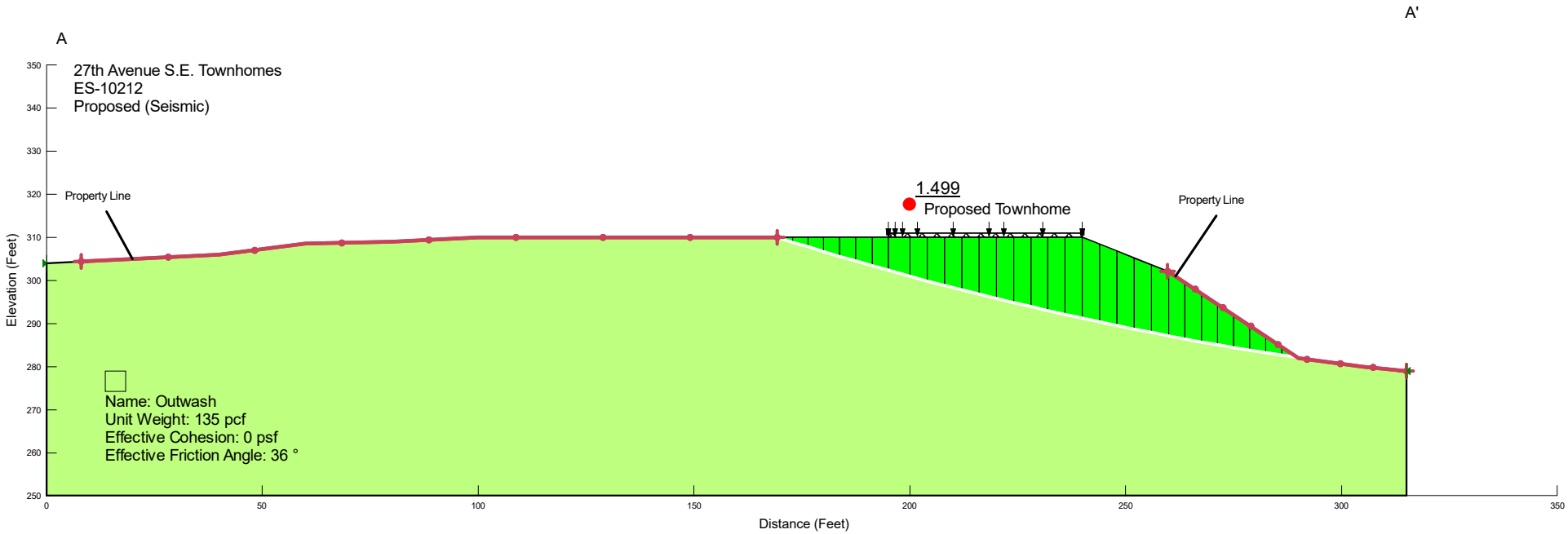
Current Slip Surface

Slip Surface: 386
Factor of Safety: 3.216
Volume: 1,267.5859 ft³
Weight: 171,124.1 lbf
Resisting Moment: 1.0250855e+08 lbf·ft
Activating Moment: 31,860,652 lbf·ft
Resisting Force: 126,058.57 lbf
Activating Force: 39,225.732 lbf
Slip Rank: 1 of 405 slip surfaces
Exit: (289.93599, 282.04267) ft
Entry: (169.31731, 310) ft
Radius: 792.6777 ft
Center: (408.06406, 1,065.869) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	171.09776 ft	309.44224 ft	0 psf	70.324472 psf	51.093719 psf	0 psf	0 psf	Outwash
Column 2	174.65866 ft	308.33590 ft	0 psf	210.04392 psf	152.60584 psf	0 psf	0 psf	Outwash
Column 3	178.21955 ft	307.24788 ft	0 psf	347.75041 psf	252.65546 psf	0 psf	0 psf	Outwash
Column 4	181.87500 ft	306.15021 ft	0 psf	486.98979 psf	353.8188 psf	0 psf	0 psf	Outwash
Column 5	185.62500 ft	305.04379 ft	0 psf	627.66191 psf	456.02307 psf	0 psf	0 psf	Outwash
Column 6	189.37500 ft	303.95743 ft	0 psf	766.10634 psf	556.60884 psf	0 psf	0 psf	Outwash
Column 7	193.12500 ft	302.89104 ft	0 psf	902.32446 psf	655.5771 psf	0 psf	0 psf	Outwash
Column 8	197.50000 ft	301.67399 ft	0 psf	1,293.5486 psf	939.81808 psf	0 psf	0 psf	Outwash
Column 9	202.00000 ft	300.44672 ft	0 psf	1,451.4783 psf	1,054.5607 psf	0 psf	0 psf	Outwash
Column 10	206.00000 ft	299.38104 ft	0 psf	1,588.9936 psf	1,154.4714 psf	0 psf	0 psf	Outwash
Column 11	210.00000 ft	298.33769 ft	0 psf	1,723.9805 psf	1,252.5452 psf	0 psf	0 psf	Outwash
Column 12	214.00000 ft	297.31657 ft	0 psf	1,856.4399 psf	1,348.7825 psf	0 psf	0 psf	Outwash
Column 13	218.00000 ft	296.31760 ft	0 psf	1,986.3724 psf	1,443.184 psf	0 psf	0 psf	Outwash
Column 14	222.00000 ft	295.34068 ft	0 psf	2,113.7786 psf	1,535.75 psf	0 psf	0 psf	Outwash

Column 15	226.00000 ft	294.38575 ft	0 psf	2,238.6587 psf	1,626.4808 psf	0 psf	0 psf	Outwash
Column 16	230.00000 ft	293.45270 ft	0 psf	2,361.013 psf	1,715.3763 psf	0 psf	0 psf	Outwash
Column 17	234.00000 ft	292.54148 ft	0 psf	2,480.8414 psf	1,802.4368 psf	0 psf	0 psf	Outwash
Column 18	238.00000 ft	291.65199 ft	0 psf	2,598.1438 psf	1,887.6619 psf	0 psf	0 psf	Outwash
Column 19	242.00000 ft	290.78417 ft	0 psf	2,371.4366 psf	1,722.9495 psf	0 psf	0 psf	Outwash
Column 20	246.00000 ft	289.93793 ft	0 psf	2,277.0151 psf	1,654.3483 psf	0 psf	0 psf	Outwash
Column 21	250.00000 ft	289.11322 ft	0 psf	2,179.5881 psf	1,583.5634 psf	0 psf	0 psf	Outwash
Column 22	254.00000 ft	288.30996 ft	0 psf	2,079.1554 psf	1,510.5948 psf	0 psf	0 psf	Outwash
Column 23	258.00000 ft	287.52808 ft	0 psf	1,975.7164 psf	1,435.442 psf	0 psf	0 psf	Outwash
Column 24	261.87500 ft	286.79065 ft	0 psf	1,807.9271 psf	1,313.5359 psf	0 psf	0 psf	Outwash
Column 25	265.62500 ft	286.09632 ft	0 psf	1,575.7667 psf	1,144.8616 psf	0 psf	0 psf	Outwash
Column 26	269.37500 ft	285.42062 ft	0 psf	1,340.6822 psf	974.06266 psf	0 psf	0 psf	Outwash
Column 27	273.12500 ft	284.76351 ft	0 psf	1,102.6725 psf	801.13846 psf	0 psf	0 psf	Outwash
Column 28	276.86700 ft	284.12627 ft	0 psf	862.25594 psf	626.46561 psf	0 psf	0 psf	Outwash
Column 29	280.60100 ft	283.50876 ft	0 psf	619.44463 psf	450.05286 psf	0 psf	0 psf	Outwash
Column 30	284.33500 ft	282.90955 ft	0 psf	373.72843 psf	271.5296 psf	0 psf	0 psf	Outwash
Column 31	288.06900 ft	282.32859 ft	0 psf	125.10539 psf	90.894384 psf	0 psf	0 psf	Outwash


A
A'
27th Avenue S.E. Townhomes
ES-10212
Proposed (Seismic)
Property Line
1.499
Proposed Townhome
Property Line
Name: Outwash
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Elevation (Feet)
Distance (Feet)
350
340
330
320
310
300
290
280
270
260
250
0
50
100
150
200
250
300
350

Slope Stability

File Information

File Version: 11.06
Tool Version: 24.1.0.1406
Title: Cedar Cove
Created By: Adam Shier
Last Edited By: Adam Shier
Revision Number: 104
Date: 01/23/2025
Time: 10:10:18 AM
File Name: 27th ave townhomes proposed (Seismic).gsz
Directory: C:\Users\adam.shier\Desktop\SLope W\
Last Solved Date: 01/23/2025
Last Solved Time: 10:10:20 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Slope Stability

Kind: SLOPE/W
Analysis Type: Morgenstern-Price
Settings
- Side Function
  - Intercolumn force function option: Half-Sine
- PWP Conditions from: (none)
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 4 ft
  - Minimum Slip Surface Volume: 35.314667 ft³

Number of Columns: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.01
Under-Relaxation Criteria
Initial Rate: 1
Minimum Rate: 0.1
Rate Reduction Factor: 0.65
Reduction Frequency (iterations): 50
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Outwash

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 36 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (8, 304.4) ft
Left-Zone Right Coordinate: (169.31731, 310) ft
Left-Zone Increment: 8
Right Type: Range
Right-Zone Left Coordinate: (259.68335, 302.12666) ft
Right-Zone Right Coordinate: (315, 279) ft
Right-Zone Increment: 8
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 304) ft
Right Coordinate: (315, 279) ft

Seismic Coefficients

Horz Seismic Coef.: 0.25

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 250 pcf
Direction: Vertical

Coordinates

	X	Y
	195 ft	311 ft
	240 ft	311 ft

Geometry

Name: 2D Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	304 ft
Point 2	20 ft	305 ft
Point 3	40 ft	306 ft
Point 4	60 ft	308.5 ft
Point 5	80 ft	309 ft
Point 6	100 ft	310 ft
Point 7	120 ft	310 ft
Point 8	140 ft	310 ft
Point 9	160 ft	310 ft
Point 10	180 ft	310 ft
Point 11	200 ft	310 ft
Point 12	220 ft	310 ft
Point 13	240 ft	310 ft
Point 14	260 ft	302 ft
Point 15	275 ft	292 ft
Point 16	290 ft	282 ft
Point 17	305 ft	280 ft
Point 18	315 ft	279 ft
Point 19	315 ft	250 ft
Point 20	0 ft	250 ft

Regions

	Material	Points	Area
Region 1	Outwash	20,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19	17,250 ft²

Slip Results

Slip Surfaces Analysed: 379 of 405 converged

Current Slip Surface

Slip Surface: 386
Factor of Safety: 1.499
Volume: 1,267.5859 ft³
Weight: 171,124.1 lbf
Resisting Moment: 97,140,757 lbf·ft
Activating Moment: 64,641,320 lbf·ft
Resisting Force: 119,477.57 lbf
Activating Force: 79,915.763 lbf
Slip Rank: 1 of 405 slip surfaces
Exit: (289.93599, 282.04267) ft
Entry: (169.31731, 310) ft
Radius: 792.6777 ft
Center: (408.06406, 1,065.869) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	171.09776 ft	309.44224 ft	0 psf	65.403275 psf	47.518261 psf	0 psf	0 psf	Outwash
Column 2	174.65866 ft	308.33590 ft	0 psf	195.55605 psf	142.07978 psf	0 psf	0 psf	Outwash
Column 3	178.21955 ft	307.24788 ft	0 psf	324.11296 psf	235.48185 psf	0 psf	0 psf	Outwash
Column 4	181.87500 ft	306.15021 ft	0 psf	454.38932 psf	330.13316 psf	0 psf	0 psf	Outwash
Column 5	185.62500 ft	305.04379 ft	0 psf	586.30753 psf	425.97735 psf	0 psf	0 psf	Outwash
Column 6	189.37500 ft	303.95743 ft	0 psf	716.43986 psf	520.52402 psf	0 psf	0 psf	Outwash
Column 7	193.12500 ft	302.89104 ft	0 psf	844.78069 psf	613.7691 psf	0 psf	0 psf	Outwash
Column 8	197.50000 ft	301.67399 ft	0 psf	1,212.6509 psf	881.04244 psf	0 psf	0 psf	Outwash
Column 9	202.00000 ft	300.44672 ft	0 psf	1,362.5465 psf	989.948 psf	0 psf	0 psf	Outwash
Column 10	206.00000 ft	299.38104 ft	0 psf	1,493.4305 psf	1,085.0408 psf	0 psf	0 psf	Outwash
Column 11	210.00000 ft	298.33769 ft	0 psf	1,622.2471 psf	1,178.6315 psf	0 psf	0 psf	Outwash
Column 12	214.00000 ft	297.31657 ft	0 psf	1,748.989 psf	1,270.7149 psf	0 psf	0 psf	Outwash
Column 13	218.00000 ft	296.31760 ft	0 psf	1,873.6488 psf	1,361.2856 psf	0 psf	0 psf	Outwash
Column 14	222.00000 ft	295.34068 ft	0 psf	1,996.2191 psf	1,450.338 psf	0 psf	0 psf	Outwash

Column 15	226.00000 ft	294.38575 ft	0 psf	2,116.692 psf	1,537.8668 psf	0 psf	0 psf	Outwash
Column 16	230.00000 ft	293.45270 ft	0 psf	2,235.0599 psf	1,623.8661 psf	0 psf	0 psf	Outwash
Column 17	234.00000 ft	292.54148 ft	0 psf	2,351.3148 psf	1,708.3302 psf	0 psf	0 psf	Outwash
Column 18	238.00000 ft	291.65199 ft	0 psf	2,465.4487 psf	1,791.2533 psf	0 psf	0 psf	Outwash
Column 19	242.00000 ft	290.78417 ft	0 psf	2,253.0217 psf	1,636.9161 psf	0 psf	0 psf	Outwash
Column 20	246.00000 ft	289.93793 ft	0 psf	2,165.9128 psf	1,573.6277 psf	0 psf	0 psf	Outwash
Column 21	250.00000 ft	289.11322 ft	0 psf	2,075.7298 psf	1,508.106 psf	0 psf	0 psf	Outwash
Column 22	254.00000 ft	288.30996 ft	0 psf	1,982.462 psf	1,440.343 psf	0 psf	0 psf	Outwash
Column 23	258.00000 ft	287.52808 ft	0 psf	1,886.0982 psf	1,370.3305 psf	0 psf	0 psf	Outwash
Column 24	261.87500 ft	286.79065 ft	0 psf	1,727.9308 psf	1,255.4152 psf	0 psf	0 psf	Outwash
Column 25	265.62500 ft	286.09632 ft	0 psf	1,507.7421 psf	1,095.4388 psf	0 psf	0 psf	Outwash
Column 26	269.37500 ft	285.42062 ft	0 psf	1,284.2542 psf	933.06531 psf	0 psf	0 psf	Outwash
Column 27	273.12500 ft	284.76351 ft	0 psf	1,057.4554 psf	768.28632 psf	0 psf	0 psf	Outwash
Column 28	276.86700 ft	284.12627 ft	0 psf	827.8305 psf	601.45407 psf	0 psf	0 psf	Outwash
Column 29	280.60100 ft	283.50876 ft	0 psf	595.38351 psf	432.57144 psf	0 psf	0 psf	Outwash
Column 30	284.33500 ft	282.90955 ft	0 psf	359.61681 psf	261.27691 psf	0 psf	0 psf	Outwash
Column 31	288.06900 ft	282.32859 ft	0 psf	120.51744 psf	87.561042 psf	0 psf	0 psf	Outwash