PRELIMINARY TECHNICAL INFORMATION REPORT

Lockwood Meadows Subdivision

La Center, Washington

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Technical Appendix:

CERTIFICATE OF ENGINEER

Lockwood Meadows Subdivision
Preliminary Drainage Report

The technical information and data contained in this report were prepared by the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

This document was:

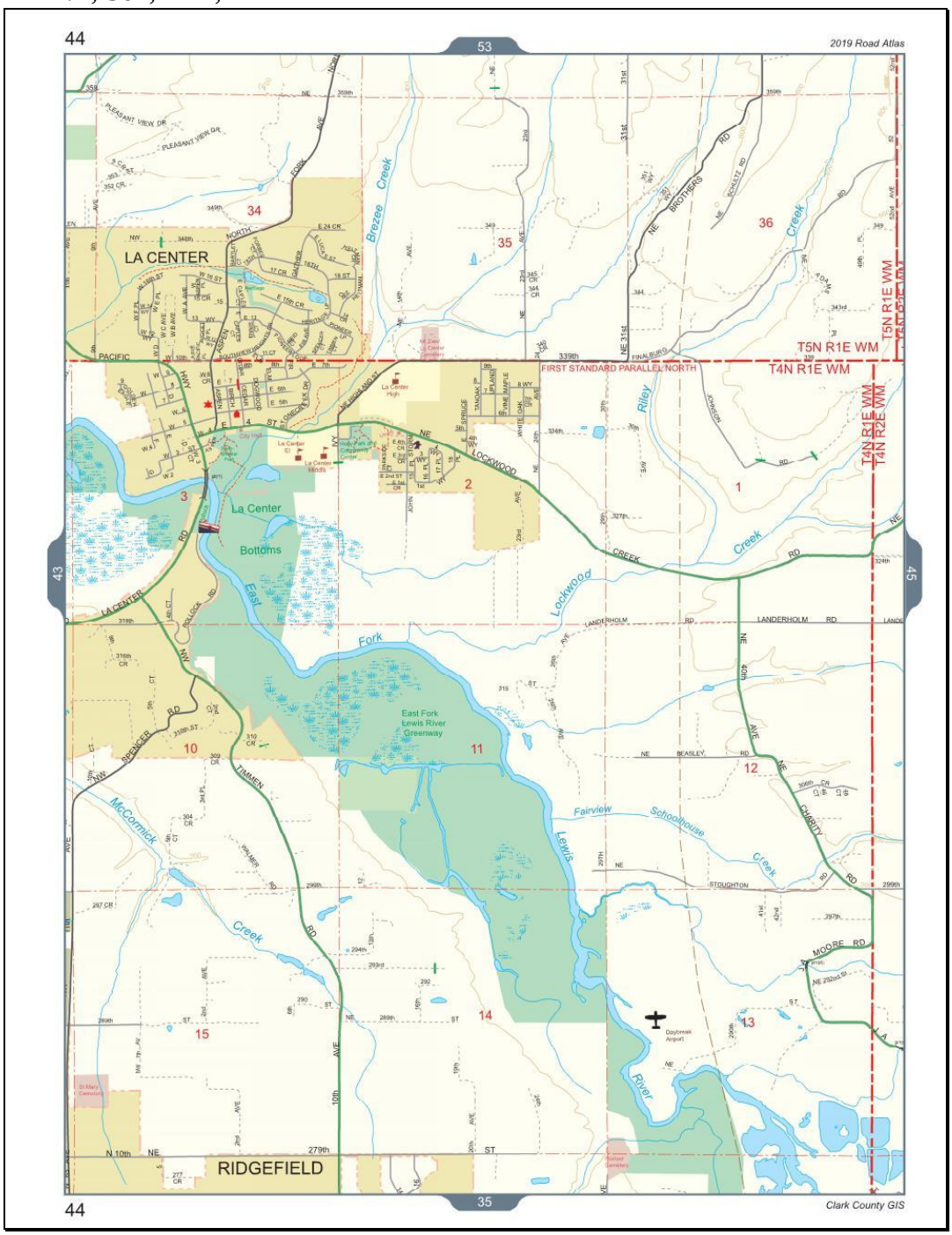
Prepared by: 

Jeffrey M. Whaley, EIT

VICINITY MAPS

(a) Site Location Map

Clark County Atlas
NE 1/4, S02, T4N, R1E



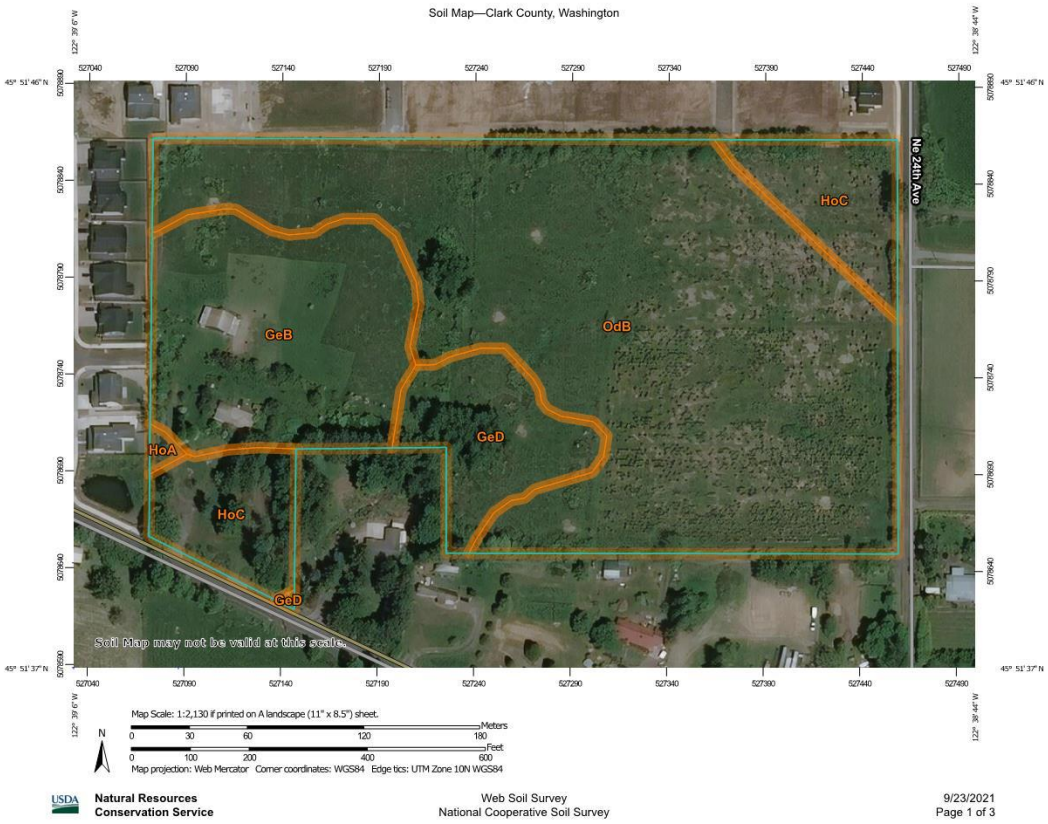
(b). Soils Map

USDA SCS Map 1" = 2130'

**Outlined Area of Interest (AOI) is an estimate of property boundary

Map Unit Legend:

GeB (Gee silt loam, 0-8% slopes):	19.4% of site
GeD (Gee silt loam, 8-20% slopes):	7.8% of site
HoA (Hillsboro silt loam, 0-3% slopes):	0.3% of site
HoC (Hillsboro silt loam, 8-15% slopes):	11.6% of site
OdB (Odne silt loam, 0-5%% slopes):	60.8% of site



SECTION A – PROJECT OVERVIEW

Lockwood Meadows Subdivision is a 19.8-acre site located on one parcel in La Center, WA. The site address is 2000 NE Lockwood Creek Road, La Center, WA 98629. It is identified by the Clark County Assessors office as parcel 209113000 and further identified within the NE ¼ of section 02, T4N, R1E of the Willamette Meridian in Clark County, Washington. NE Lockwood Creek Road borders the south, NE 24th Avenue borders the site to the east and the Heritage Country Estates borders the site to the north and west. There is currently a residence and Barn located onsite.

The site's existing topography is generally rolling with some steep areas near the northeast corner of the site. The site slopes down from this corner to the low point in the southwest border of the site. The proposed development will maintain the drainage patterns from the predeveloped conditions. There are two delineated wetlands both are category IV, wetland A is 0.05 acres and wetland B is 0.08 acres. Wetland A will be filled and a runoff generated from the roof and lawn of lots 6, 39, 40 and 41 will be routed to wetland B to maintain its hydrology.

Lockwood Meadows Subdivision proposes to subdivide one parcel into 71 lots. The site will be accessed by NE 24th avenue from the east and by E 4th street from the west. All roads installed onsite will be public and provide access to the lots. Individual driveway construction will be completed at the time of home construction.

The combined impervious area generated by the project includes approximately 270,413 ft^2 or roof area, 81,124 ft^2 of private driveway, 149,169 ft^2 of public road and 44,139 ft^2 public sidewalk, totaling 544,845 ft^2. The roof areas were calculated to be 50% of each lots area and the driveway areas were calculated to be 15% of each lots area. These areas were modelled to ensure that enough detention is provided for the maximum impervious surface area. The remaining area in each lot will be converted to lawn or landscaping totaling 257,147 ft^2 of pervious area.

Due to negligible infiltration rates onsite, the project will utilize a detention pond with a flow control structure to store and release stormwater runoff to a culvert that runs under Lockwood Creed Road. Stormwater runoff will be piped to a Stormfilter Vault for treatment before being routed to the detention pond.

SECTION B – QUANTITY CONTROL ANALYSIS AND DESIGN

Per Chapter 18.320 of the La Center Municipal Code (LCMC), the subdivision will be required to mitigate for stormwater runoff impacts generated as a result of the proposed improvements. The hydrologic analysis of this site was performed in accordance with the guidelines contained in LCMC and Chapters III-1 and III-2 of the Puget Sound Manual. The storm events were assumed to have a 24-hour duration and follow a Type 1A storm distribution. Rainfall depth for the 2, 10, 25, and 100-year 24-hour storm events are 2.4, 3.3, 3.8, and 4.5 inches respectively, as obtained from the Isopluvial maps for Clark County included in Appendix A. The detention facilities

have been designed to produce release rates for the entire site equal or less than the predevelopment peak runoff rates for the 2, 10, 25 and 100-year, 24-hour storm events as stated in LCMC Code Section 18.320.220 (3)(d)(i). In addition, the facilities have been designed utilizing Figure III-1.1 Volume Correction Factor from the Puget Sound Manual. This resulted in a correction factor of 1.31 for the detention facilities.

The live storage area of the stormwater facilities was assumed to be empty at the beginning of the design storm event. The hydrological analysis was completed using HydroCAD v 10.0, which allows the SCS TR-20 method of hydrograph routing to be utilized and the TR-55 method to determine the times of concentration. The soil characteristics were obtained from USDA NRCS website. As can be seen on the soils map located in the appendix of this report, there are multiple soil types covering this site. These soil types consist of hydrologic soil groups (HSG) D. The Runoff Curve Numbers (RCNs) that were used in the design of the project were taken from Table III-1.3 of the Puget Sound Manual. An RCN value of 81 was used for the HSG D soil covered in forested area across the site. RCN value of 90 was used for post-development landscaping and an RCN value of 98 was used for pavement and roofs.

Table 1 below shows a tabulation of the project site areas for pre- and post-developed conditions.

Table 1- Summary of Pre-Developed Areas

	Basin	**Impervious (sq-ft)**	**Pervious (sq-ft)**	**Total (sq-ft)**	**Total (acres)**
Pre-Developed Area					
	Onsite	8,994	792,998	801,992	18.4

Table 2- Summary of Post-Developed Areas

Existing hard surface to remain	0 ft^2
New hard surface	544,844 ft^2 (12.5 acre)
Replaced hard surface	0 ft^2
Native vegetation converted to lawn or landscaping	257,146 ft^2 (5.9 acre)
Native vegetation converted to pasture	0 ft^2
Total land-disturbing activity	801,992 ft^2 (18.4 acre)
Pollution-generating hard surface	272,761 ft^2 (6.26 acre)
Pollution-generating pervious surface	0 ft^2
Total pollution-generating surfaces	272,761 ft^2 (6.26 acre)
Total non-pollution-generating surfaces	529,230 ft^2 (12.15 acre)

For the post-development prelim analysis one basin was modeled. A majority of the runoff from the site will be routed to a pond in the southwest corner of the site. The

remaining runoff, the path and park area from Tract B, and the roof and lawn areas from lots 6, 39-41 will be piped and dispersed to Wetland B. RCN values of 90 for landscaping and 98 for the impervious areas were used.

Please refer to the HydroCAD stormwater model located in Appendix B, for tabulated acreage, imperviousness, curve numbers, length and grade of overland flow, and other hydrological parameters used in completing the analysis. Basin Maps are included in Appendix C.

Water quantity control for the development will be accomplished utilizing a detention facility. The detention pond will be constructed between in the southwest corner of the site and will be accessed by Lockwood Creek Road. It will include a simple control structure that will meter discharge to the culvert located in Lockwood Creek Road. The flow rate at the culvert will be equal to or less than the existing flow rates. See Appendix B for the HydroCAD printout.

SECTION C – CONVEYANCE SYSTEMS ANALYSIS AND DESIGN

The pipes for the conveyance system will be designed for the 100-year storm event per LCMC 18.320.220 and will be sized to carry flows from the contributing drainage areas upon full buildout while operating in an open flow regime. The conveyance calculations for the stormwater pipes will be included with the Final TIR.

SECTION D – RUNOFF WATER QUALITY TREATMENT

Runoff from pollution generating surfaces will be treated using a Peak Diversion Stormfilter vault. Stormfilter Media cartridge systems supplied by Contech Engineered Solutions will be used to treat stormwater runoff from the site's new roadways, driveways and sidewalk. All runoff will be treated through the vault before being piped to the detention facility. The number of required Stormfilter cartridges in the system will be based on the water quality treatment flow rate calculated for pollution generating and non-pollution generating surfaces and the treatment capacity of the filters supplied by Contech Engineered Solutions. Stormfilters have gained Washington Department of Ecology approval and have been allowed to be sized as offline systems because peak storms bypass the Stormfilter treatment chamber via an inlet/bypass assembly. See Appendix B for water quality flow rates from WWHM.

SECTION E – SOILS EVALUATION

There are five soil types located on this site. A soils map, obtained from USDA NRCS website is located before the narrative of this report. The soil types onsite consist of Gee silt loam, 0 to 8% slopes (GeB) and 8 to 20% slopes (GeD), Hillsboro silt loam, 0 to 3% slopes (HoA) and 8 to 15% slopes (HoC) and Odne silt loam, 0 to 5% slopes. These soils are in hydrologic soil group (HSG) D.

SECTION F – SPECIAL REPORTS AND STUDIES

A geotechnical report, a wetland and habitat report, and an archeological report were all completed for this site. All of these reports have been included as part of the subdivision application. The Geotechnical Report is provided in Appendix D.

SECTION G – OTHER PERMITS

A JARPA will be submitted to the Army Corps of Engineer's and Washington State Department of Ecology for wetland areas that are to be impacted as part of development of the site.

SECTION H – MAINTENANCE AND OPERATIONS MANUAL

All of the stormwater facilities associated with this development are to be owned & maintained by the Lockwood Meadows Homeowner's Association. A maintenance and operations manual is provided in Appendix E.

APPENDIX A

Design Criteria

Curve Numbers
Manning's "n" Values
Isopluvial Maps (2-, 10-, and 100-Year)
NRCS Soils Map

Table III-1.3 SCS Western Washington Runoff Curve Numbers
(Published by SCS in 1982) Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1A rainfall distribution, 24-hour storm duration.

LAND USE DESCRIPTION		CURVE NUMBERS BY HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land(1):	winter condition	86	91	94	95
Mountain open areas:	low growing brush & grasslands	74	82	89	92
Meadow or pasture:		65	78	85	89
Wood or forest land:	undisturbed	42	64	76	81
Wood or forest land:	young second growth or brush	55	72	81	86
Orchard:	with cover crop	81	88	92	94
Open spaces, lawns, parks, golf courses, cemeteries, landscaping.					
Good condition:	grass cover on ≥75% of the area	68	80	86	90
Fair condition:	grass cover on 50-75% of the area	77	85	90	92
Gravel roads & parking lots:		76	85	89	91
Dirt roads & parking lots:		72	82	87	89
Impervious surfaces, pavement, roofs etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds etc.	100	100	100	100
Single family residential(2):					
Dwelling Unit/Gross Acre	%Impervious(3)				
1.0 DU/GA	15				
1.5 DU/GA	20				
2.0 DU/GA	25				
2.5 DU/GA	30				
3.0 DU/GA	34				
3.5 DU/GA	38				
4.0 DU/GA	42				
4.5 DU/GA	46				
5.0 DU/GA	48				
5.5 DU/GA	50				
6.0 DU/GA	52				
6.5 DU/GA	54				
7.0 DU/GA	56				
PUD's, condos, apartments, commercial businesses & industrial areas	%impervious must be computed				
		Separate curve number shall be selected for pervious & impervious portions of the site or basin			

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Sec. 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

Table III-1.4 "n" AND "k" Values Used in Time Calculations for Hydrographs

"n_s" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel)	n_s
Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil)	0.011
Fallow fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover (s≤ 0.20 ft/ft)	0.06
Cultivated soil with residue cover (s> 0.20 ft/ft)	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods or forest with light underbrush	0.40
Woods or forest with dense underbrush	0.80

*Manning values for sheet flow only, from Overton and Meadows 1976 (See TR-55, 1986)

"k" Values Used in Travel Time/Time of Concentration Calculations

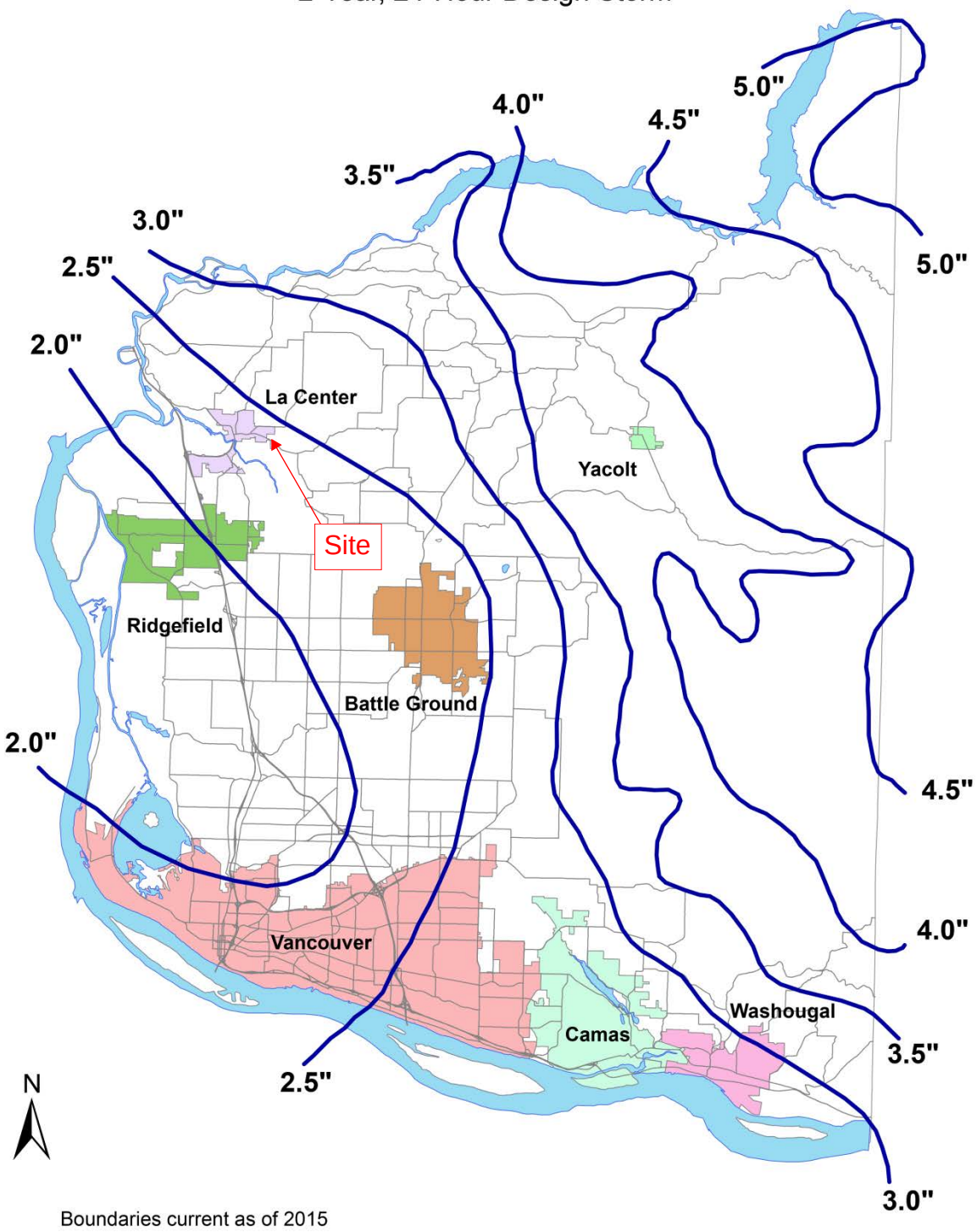
Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1)	k_s
1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n = 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (n = 0.030)	11
6. Nearly bare ground (n = 0.25)	13
7. Paved and gravel areas (n = 0.012)	27

Channel Flow (intermittent) (At the beginning of visible channels R = 0.2)	k_c
1. Forested swale with heavy ground litter (n = 0.10)	5
2. Forested drainage course/ravine with defined channel bed (n = 0.050)	10
3. Rock-lined waterway (n = 0.035)	15
4. Grassed waterway (n = 0.030)	17
5. Earth-lined waterway (n = 0.025)	20
6. CMP pipe (n = 0.024)	21
7. Concrete pipe (0.012)	42
8. Other waterways and pipe 0.508/n	

Channel Flow (Continuous stream, R = 0.4)	k_c
9. Meandering stream with some pools (n = 0.040)	20
10. Rock-lined stream (n = 0.035)	23
11. Grass-lined stream (n = 0.030)	27
12. Other streams, man-made channels and pipe 0.807/n**	

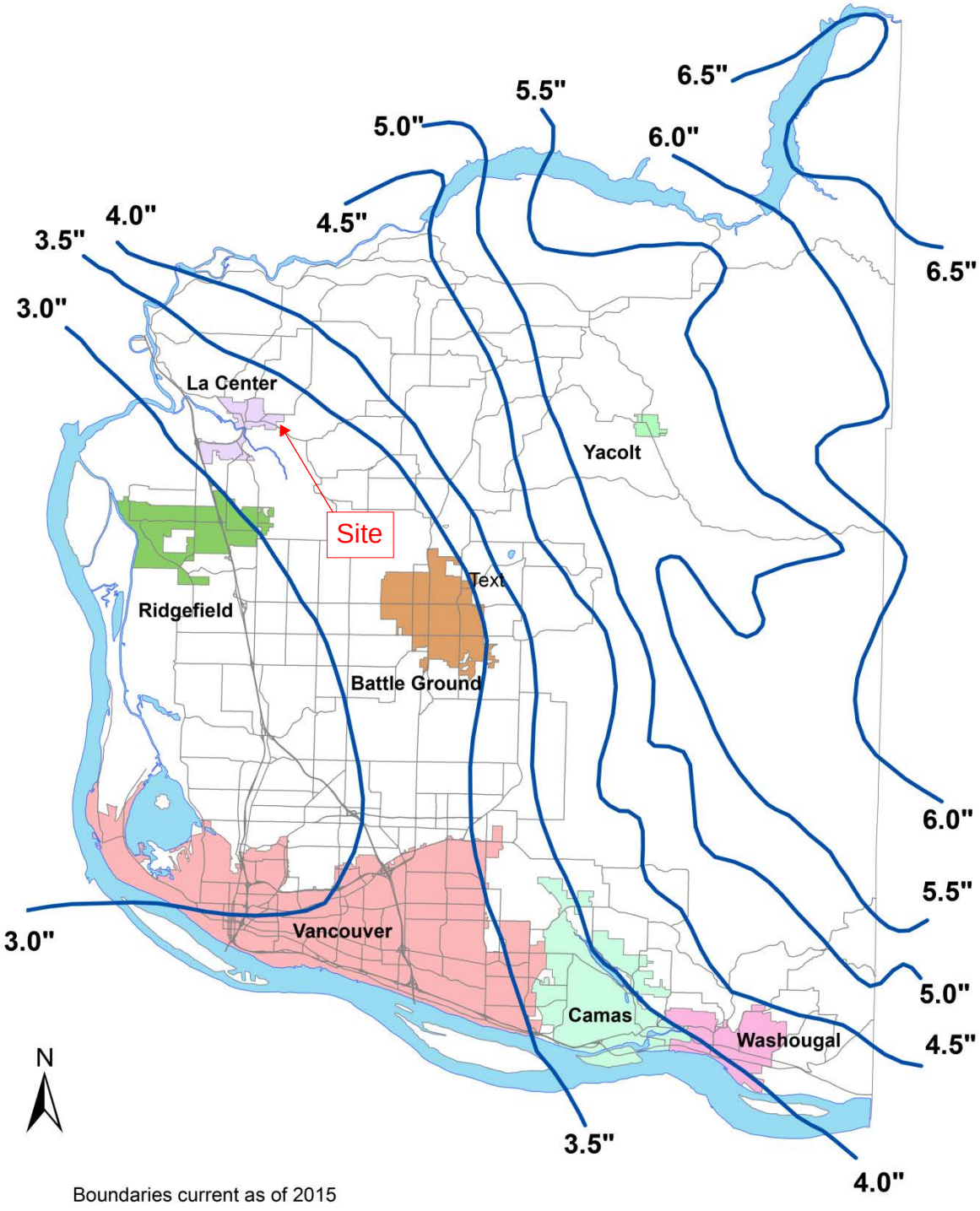
Isopluvial Map for Clark County

2-Year, 24-Hour Design Storm



Boundaries current as of 2015

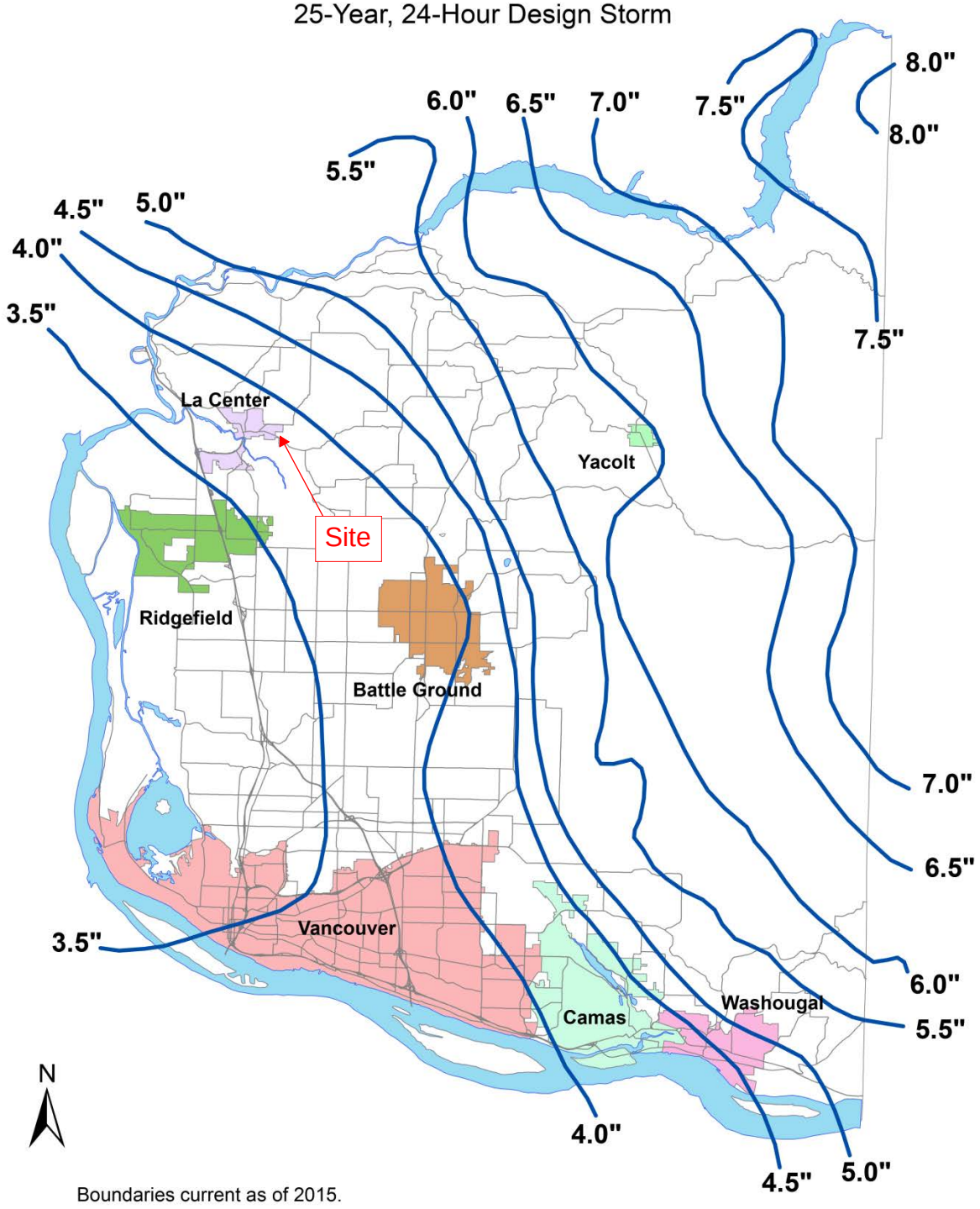
Isopluvial Map for Clark County
10-Year, 24-Hour Design Storm



Boundaries current as of 2015

Isopluvial Map for Clark County

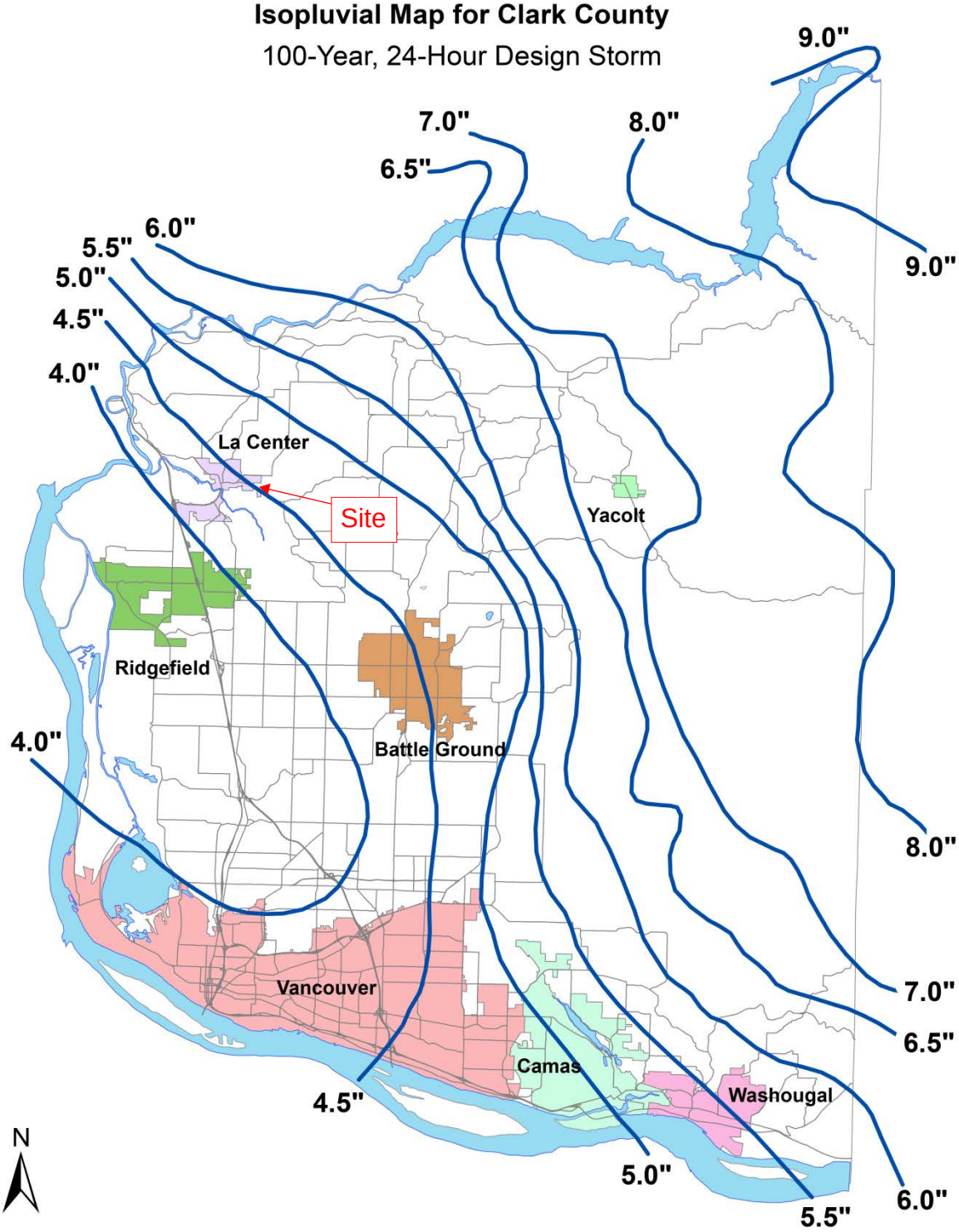
25-Year, 24-Hour Design Storm



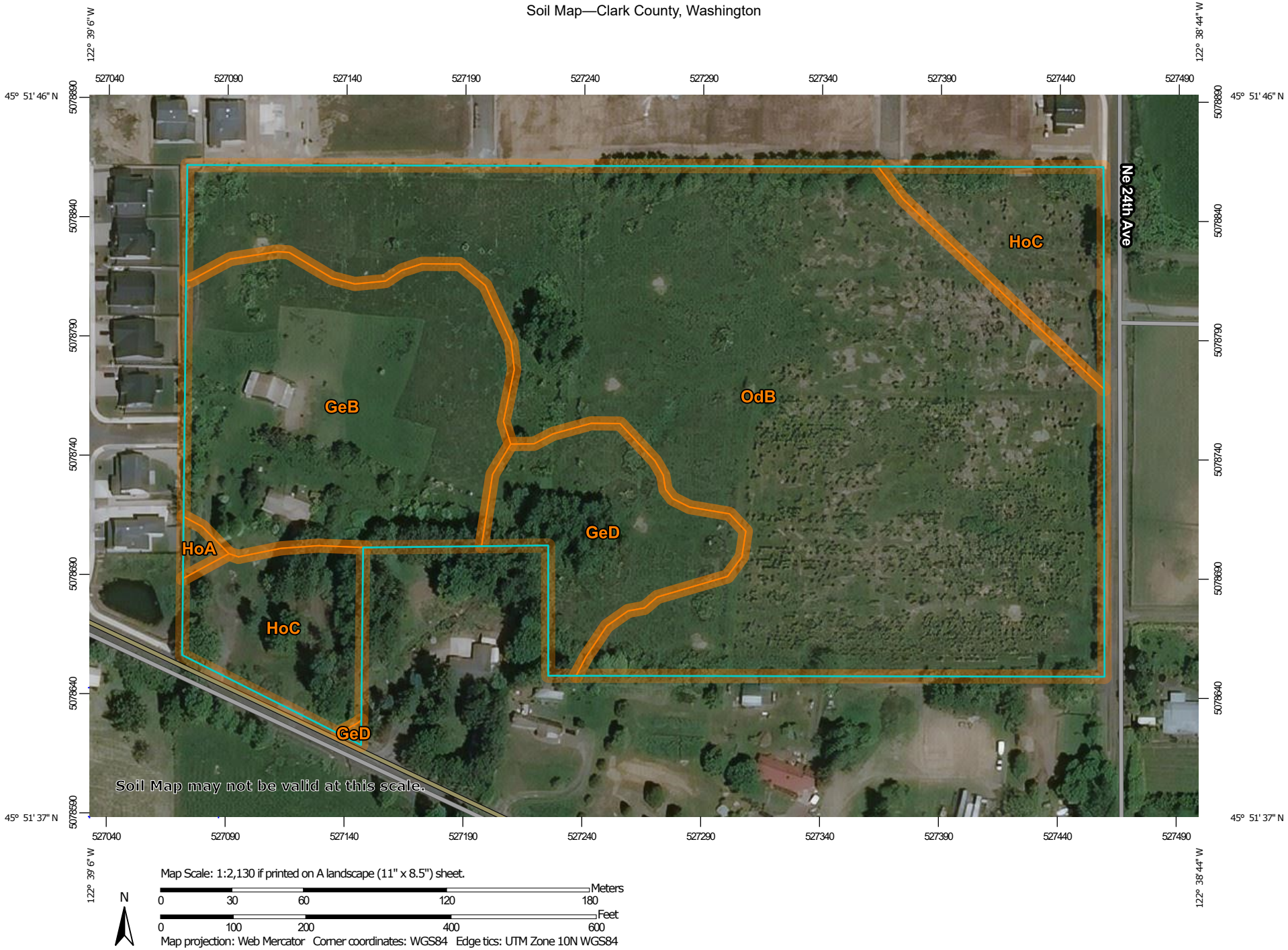
Boundaries current as of 2015.

Isopluvial Map for Clark County

100-Year, 24-Hour Design Storm



Boundaries current as of 2015.



Map Scale: 1:2,130 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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 1:20,000.

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: Clark County, Washington
Survey Area Data: Version 18, Jun 4, 2020

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

Date(s) aerial images were photographed: Jun 24, 2018—May 10, 2019

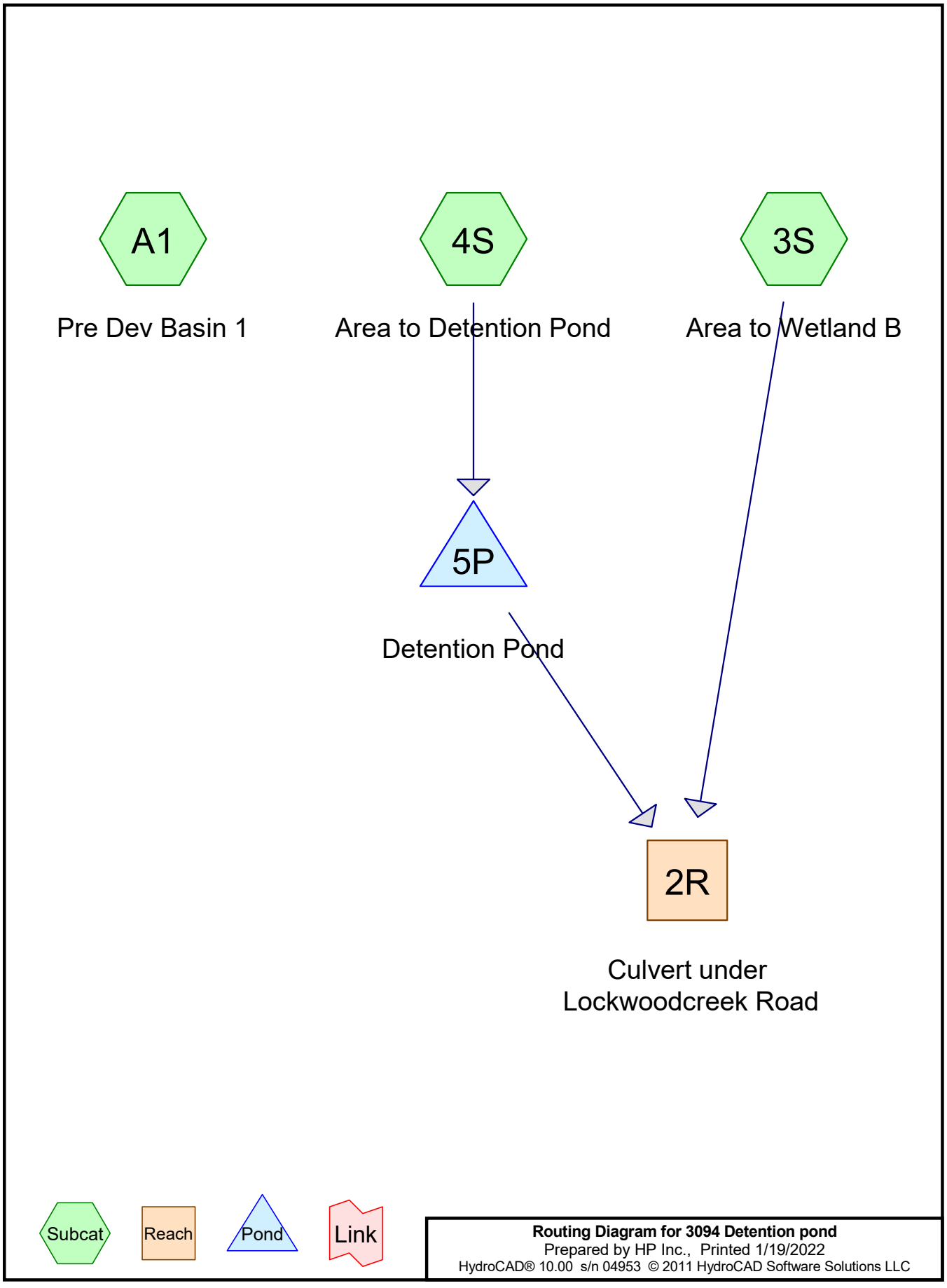
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
GeB	Gee silt loam, 0 to 8 percent slopes	3.8	19.4%
GeD	Gee silt loam, 8 to 20 percent slopes	1.5	7.8%
HoA	Hillsboro silt loam, 0 to 3 percent slopes	0.1	0.3%
HoC	Hillsboro silt loam, 8 to 15 percent slopes	2.3	11.6%
OdB	Odne silt loam, 0 to 5 percent slopes	12.0	60.8%
Totals for Area of Interest		**19.7**	**100.0%**

APPENDIX B

Stormwater Models



Routing Diagram for 3094 Detention pond
Prepared by HP Inc., Printed 1/19/2022

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
792,998	81	Undisturbed Forest HSG D (A1)
257,146	90	Landscaping (3S, 4S)
81,124	98	Driveway (4S)
8,993	98	Impervious (A1)
149,169	98	Road (4S)
270,413	98	Roof (3S, 4S)
44,139	98	Sidewalk (3S, 4S)
1,603,982	**88**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
792,998	HSG D	A1
810,984	Other	3S, 4S, A1
1,603,982		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Subcatch Numbers
0	0	0	0	81,124	81,124	Driveway	
0	0	0	0	8,993	8,993	Impervious	
0	0	0	0	257,146	257,146	Landscaping	
0	0	0	0	149,169	149,169	Road	
0	0	0	0	270,413	270,413	Roof	
0	0	0	0	44,139	44,139	Sidewalk	
0	0	0	792,998	0	792,998	Undisturbed Forest	
0	**0**	**0**	**792,998**	**810,984**	**1,603,982**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	2R	145.08	142.91	36.0	0.0603	0.012	24.0	0.0	0.0

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 3S: Area to Wetland B Runoff Area=35,802 sf 47.45% Impervious Runoff Depth=1.77"
Tc=6.0 min CN=94 Runoff=0.38 cfs 5,293 cf

Subcatchment 4S: Area to Detention Pond Runoff Area=766,189 sf 68.89% Impervious Runoff Depth=1.96"
Tc=6.0 min CN=96 Runoff=9.06 cfs 125,369 cf

Subcatchment A1: Pre Dev Basin 1 Runoff Area=801,991 sf 1.12% Impervious Runoff Depth=0.87"
Flow Length=300' Slope=0.1500 '/' Tc=27.2 min CN=81 Runoff=2.74 cfs 58,264 cf

Reach 2R: Culvert under Avg. Flow Depth=0.27' Max Vel=9.32 fps Inflow=2.39 cfs 112,190 cf
24.0" Round Pipe n=0.012 L=36.0' S=0.0603 '/' Capacity=60.17 cfs Outflow=2.39 cfs 112,184 cf

Pond 5P: Detention Pond Peak Elev=156.40' Storage=41,040 cf Inflow=9.06 cfs 125,369 cf
Outflow=2.29 cfs 106,897 cf

Total Runoff Area = 1,603,982 sf Runoff Volume = 188,925 cf Average Runoff Depth = 1.41"
65.47% Pervious = 1,050,144 sf 34.53% Impervious = 553,838 sf

Summary for Subcatchment 3S: Area to Wetland B

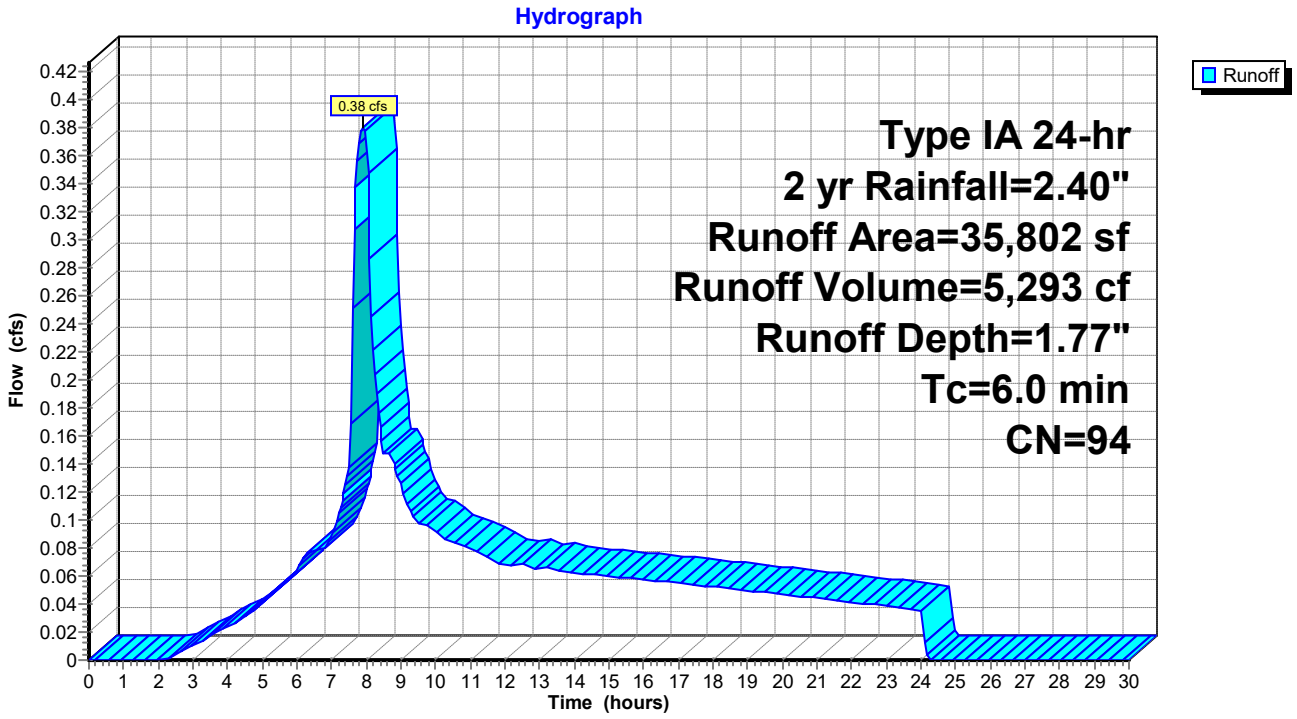
Runoff = 0.38 cfs @ 7.91 hrs, Volume= 5,293 cf, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 yr Rainfall=2.40"

	Area (sf)	CN	Description
*	18,814	90	Landscaping
*	0	98	Road
*	0	98	Driveway
*	15,318	98	Roof
*	1,670	98	Sidewalk
	35,802	94	Weighted Average
	18,814		52.55% Pervious Area
	16,988		47.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 3S: Area to Wetland B



Summary for Subcatchment 4S: Area to Detention Pond

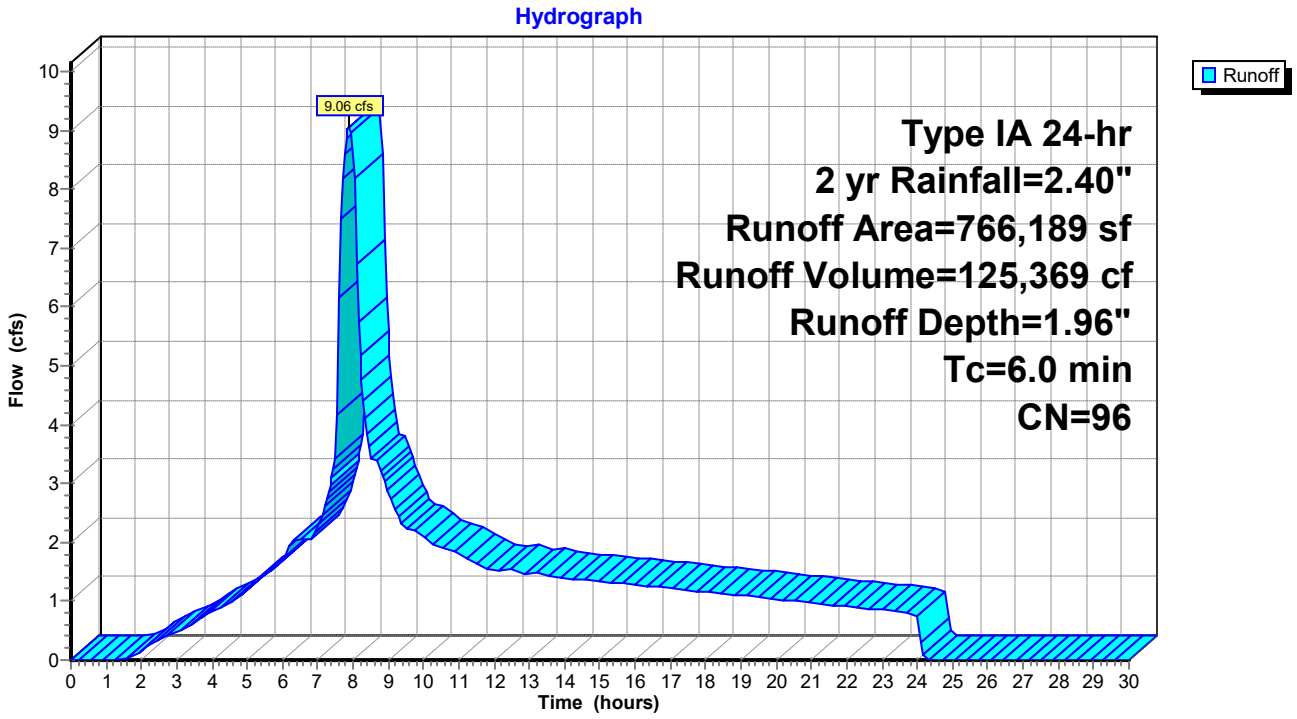
Runoff = 9.06 cfs @ 7.89 hrs, Volume= 125,369 cf, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 yr Rainfall=2.40"

	Area (sf)	CN	Description
*	238,332	90	Landscaping
*	149,169	98	Road
*	81,124	98	Driveway
*	255,095	98	Roof
*	42,469	98	Sidewalk
	766,189	96	Weighted Average
	238,332		31.11% Pervious Area
	527,857		68.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: Area to Detention Pond



Summary for Subcatchment A1: Pre Dev Basin 1

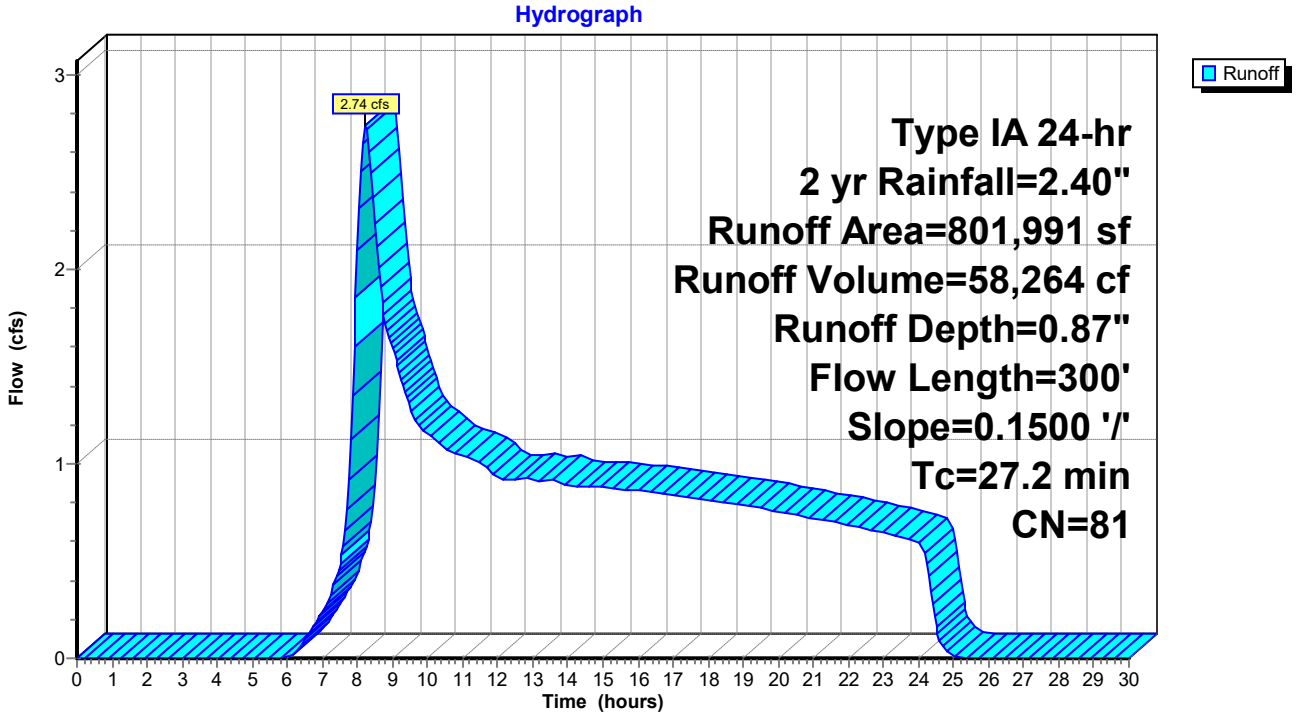
Runoff = 2.74 cfs @ 8.24 hrs, Volume= 58,264 cf, Depth= 0.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 yr Rainfall=2.40"

	Area (sf)	CN	Description
*	792,998	81	Undisturbed Forest HSG D
*	8,993	98	Impervious
	801,991	81	Weighted Average
	792,998		98.88% Pervious Area
	8,993		1.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.2	300	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.30"

Subcatchment A1: Pre Dev Basin 1



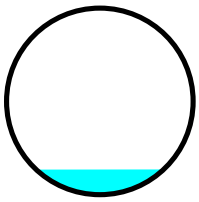
Summary for Reach 2R: Culvert under Lockwoodcreek Road

Inflow Area = 801,991 sf, 67.94% Impervious, Inflow Depth > 1.68" for 2 yr event
Inflow = 2.39 cfs @ 9.38 hrs, Volume= 112,190 cf
Outflow = 2.39 cfs @ 9.37 hrs, Volume= 112,184 cf, Atten= 0%, Lag= 0.0 min

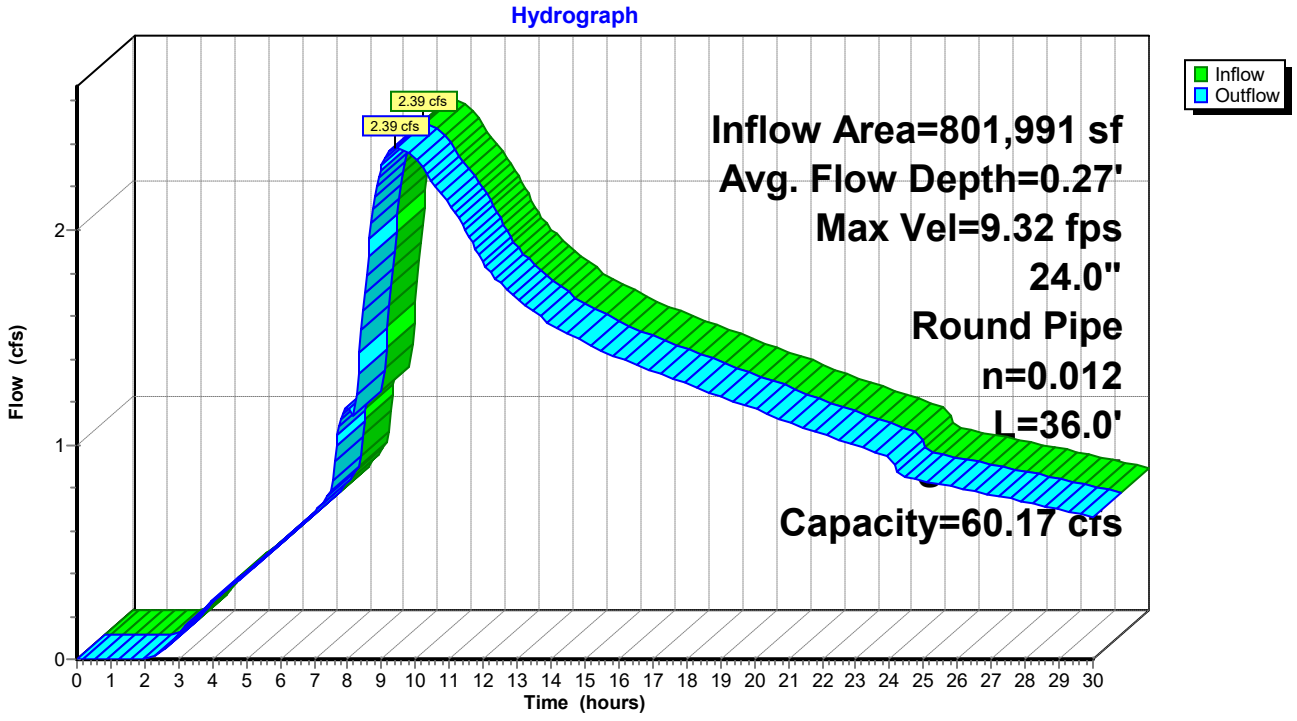
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.32 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 7.05 fps, Avg. Travel Time= 0.1 min

Peak Storage= 9 cf @ 9.37 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 60.17 cfs

24.0" Round Pipe
n= 0.012 Steel, smooth
Length= 36.0' Slope= 0.0603 '/'
Inlet Invert= 145.08', Outlet Invert= 142.91'



Reach 2R: Culvert under Lockwoodcreek Road



Summary for Pond 5P: Detention Pond

Inflow Area = 766,189 sf, 68.89% Impervious, Inflow Depth = 1.96" for 2 yr event
Inflow = 9.06 cfs @ 7.89 hrs, Volume= 125,369 cf
Outflow = 2.29 cfs @ 9.43 hrs, Volume= 106,897 cf, Atten= 75%, Lag= 92.2 min
Primary = 2.29 cfs @ 9.43 hrs, Volume= 106,897 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 156.40' @ 9.43 hrs Surf.Area= 10,359 sf Storage= 41,040 cf

Plug-Flow detention time= 360.6 min calculated for 106,897 cf (85% of inflow)
Center-of-Mass det. time= 262.2 min (966.4 - 704.2)

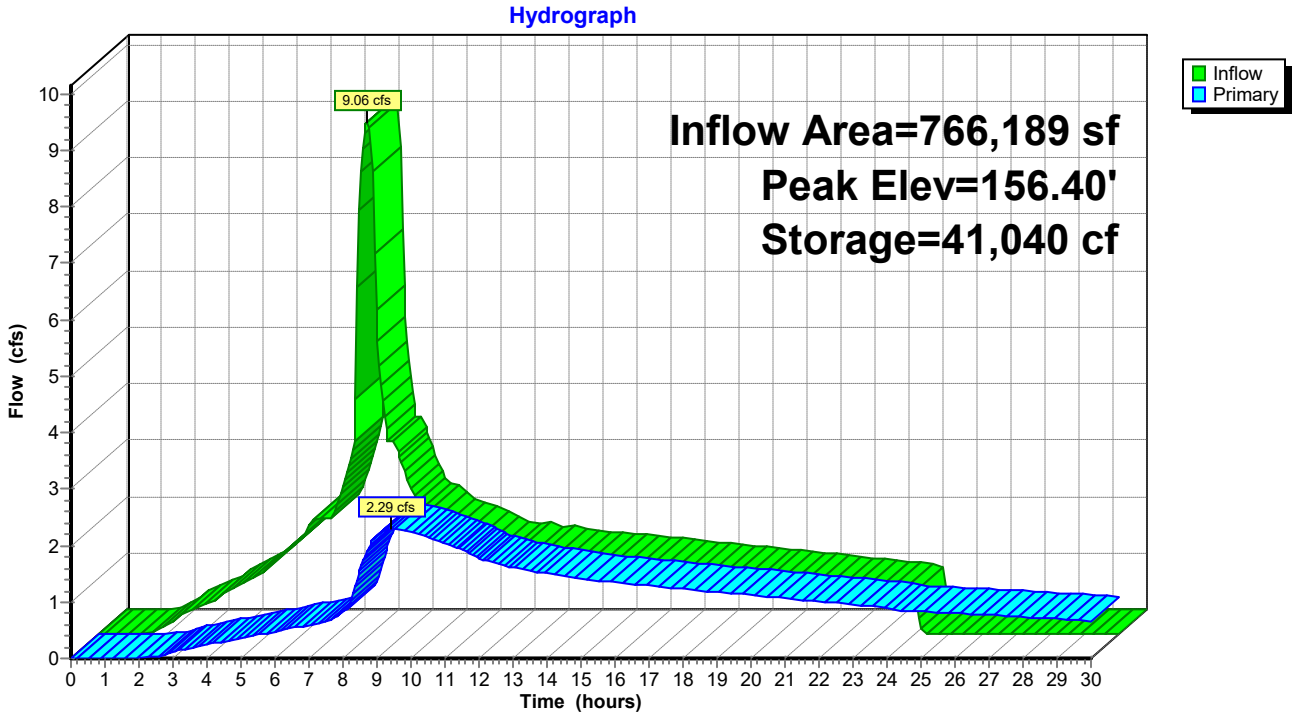
Volume	Invert	Avail.Storage	Storage Description
#1	151.00'	71,745 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.76

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	6,608	0	0
152.00	7,793	7,201	7,201
153.00	9,029	8,411	15,612
154.00	10,317	9,673	25,285
155.00	11,657	10,987	36,272
156.00	13,049	12,353	48,625
157.00	14,493	13,771	62,396
158.00	15,989	15,241	77,637
159.00	17,540	16,765	94,401

Device	Routing	Invert	Outlet Devices
#1	Primary	151.00'	**3.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	155.67'	**9.4" Vert. Orifice/Grate** C= 0.600
#3	Primary	156.35'	**5.7" Vert. Orifice/Grate** C= 0.600
#4	Primary	158.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.29 cfs @ 9.43 hrs HW=156.40' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.91 cfs @ 11.02 fps)
- **2=Orifice/Grate** (Orifice Controls 1.37 cfs @ 2.91 fps)
- **3=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.78 fps)
- **4=Orifice/Grate** (Controls 0.00 cfs)

Pond 5P: Detention Pond



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 3S: Area to Wetland B Runoff Area=35,802 sf 47.45% Impervious Runoff Depth=2.64"
Tc=6.0 min CN=94 Runoff=0.57 cfs 7,879 cf

Subcatchment 4S: Area to Detention Pond Runoff Area=766,189 sf 68.89% Impervious Runoff Depth=2.85"
Tc=6.0 min CN=96 Runoff=13.07 cfs 181,828 cf

Subcatchment A1: Pre Dev Basin 1 Runoff Area=801,991 sf 1.12% Impervious Runoff Depth=1.55"
Flow Length=300' Slope=0.1500 '/' Tc=27.2 min CN=81 Runoff=5.64 cfs 103,463 cf

Reach 2R: Culvert under Avg. Flow Depth=0.38' Max Vel=11.49 fps Inflow=4.84 cfs 170,018 cf
24.0" Round Pipe n=0.012 L=36.0' S=0.0603 '/' Capacity=60.17 cfs Outflow=4.84 cfs 170,012 cf

Pond 5P: Detention Pond Peak Elev=157.52' Storage=53,248 cf Inflow=13.07 cfs 181,828 cf
Outflow=4.63 cfs 162,138 cf

Total Runoff Area = 1,603,982 sf Runoff Volume = 293,171 cf Average Runoff Depth = 2.19"
65.47% Pervious = 1,050,144 sf 34.53% Impervious = 553,838 sf

Summary for Subcatchment 3S: Area to Wetland B

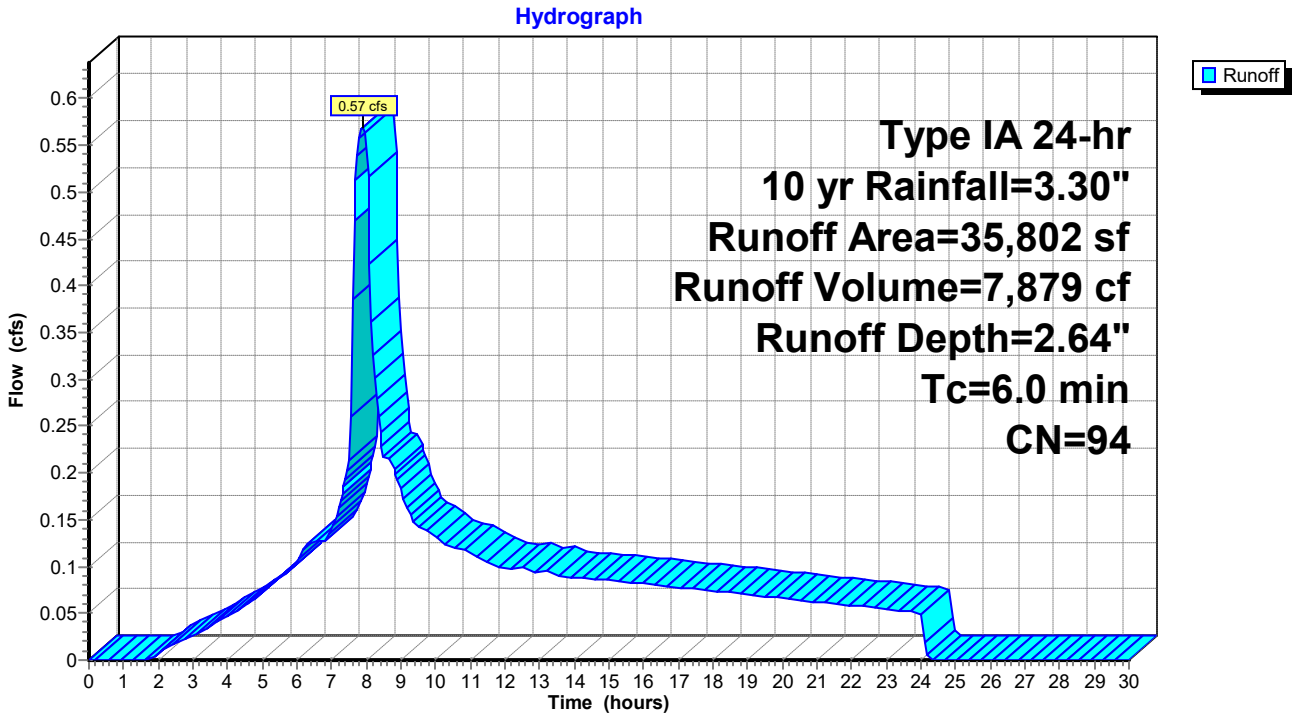
Runoff = 0.57 cfs @ 7.90 hrs, Volume= 7,879 cf, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 yr Rainfall=3.30"

	Area (sf)	CN	Description
*	18,814	90	Landscaping
*	0	98	Road
*	0	98	Driveway
*	15,318	98	Roof
*	1,670	98	Sidewalk
	35,802	94	Weighted Average
	18,814		52.55% Pervious Area
	16,988		47.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 3S: Area to Wetland B



Summary for Subcatchment 4S: Area to Detention Pond

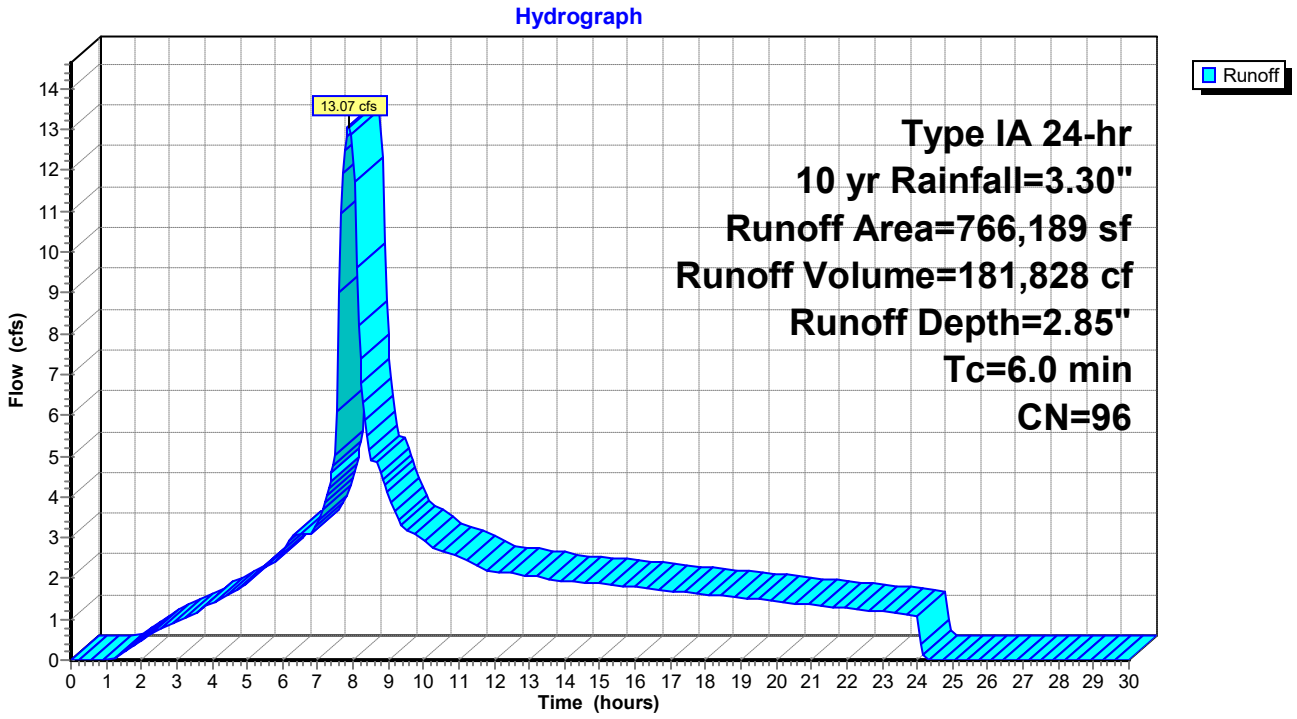
Runoff = 13.07 cfs @ 7.88 hrs, Volume= 181,828 cf, Depth= 2.85"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 yr Rainfall=3.30"

	Area (sf)	CN	Description
*	238,332	90	Landscaping
*	149,169	98	Road
*	81,124	98	Driveway
*	255,095	98	Roof
*	42,469	98	Sidewalk
	766,189	96	Weighted Average
	238,332		31.11% Pervious Area
	527,857		68.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: Area to Detention Pond



Summary for Subcatchment A1: Pre Dev Basin 1

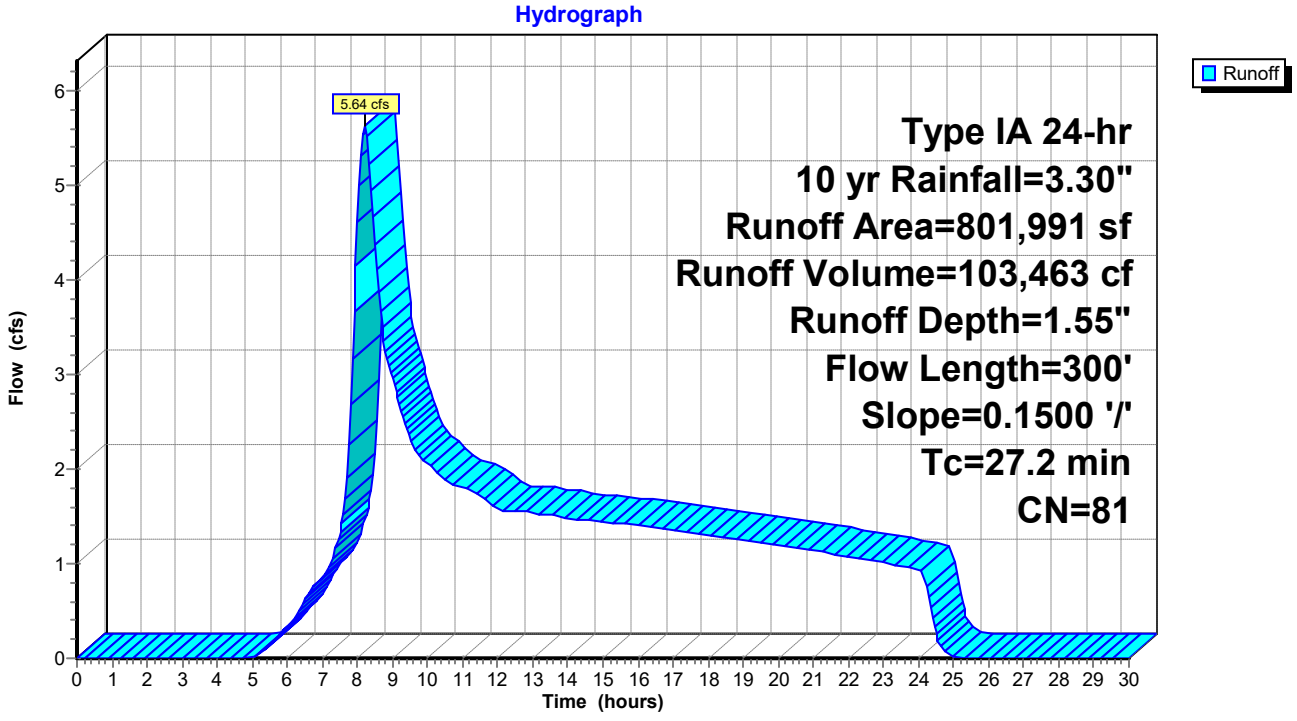
Runoff = 5.64 cfs @ 8.21 hrs, Volume= 103,463 cf, Depth= 1.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 yr Rainfall=3.30"

	Area (sf)	CN	Description
*	792,998	81	Undisturbed Forest HSG D
*	8,993	98	Impervious
	801,991	81	Weighted Average
	792,998		98.88% Pervious Area
	8,993		1.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.2	300	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.30"

Subcatchment A1: Pre Dev Basin 1



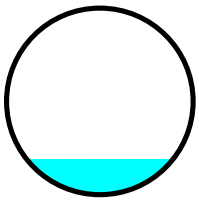
Summary for Reach 2R: Culvert under Lockwoodcreek Road

Inflow Area = 801,991 sf, 67.94% Impervious, Inflow Depth > 2.54" for 10 yr event
Inflow = 4.84 cfs @ 8.70 hrs, Volume= 170,018 cf
Outflow = 4.84 cfs @ 8.70 hrs, Volume= 170,012 cf, Atten= 0%, Lag= 0.2 min

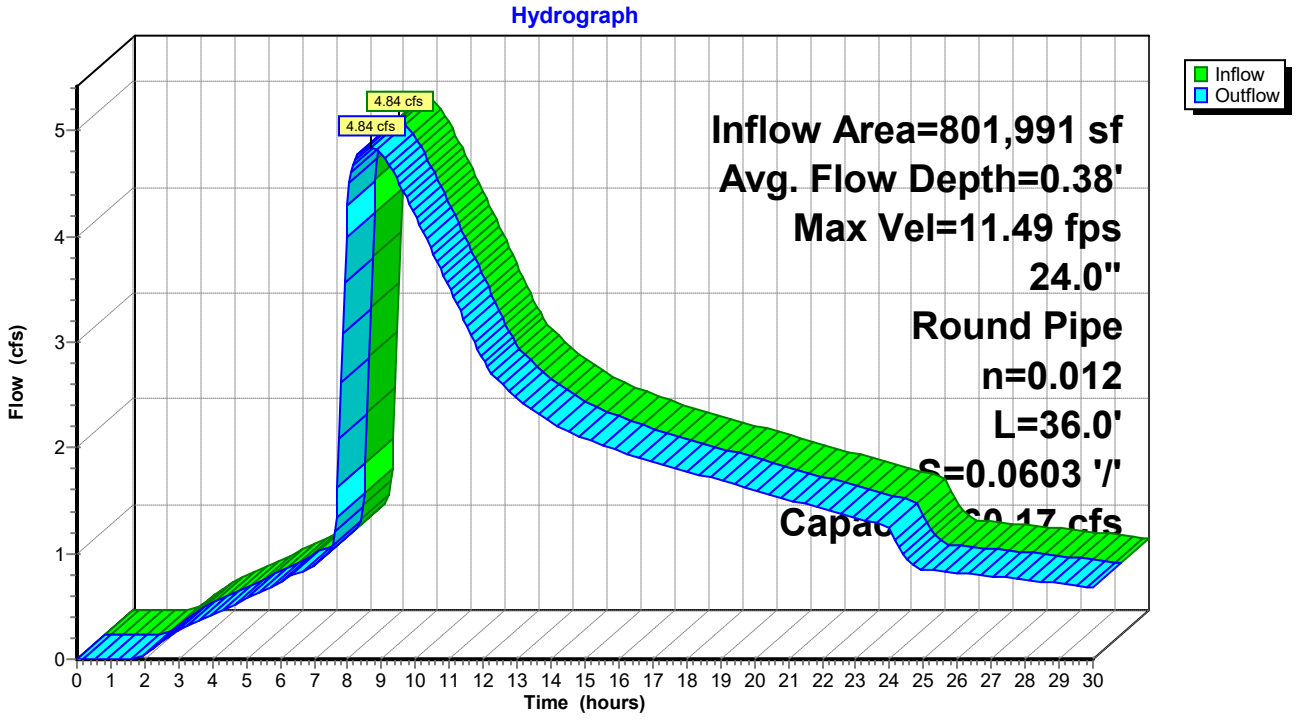
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 11.49 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 7.82 fps, Avg. Travel Time= 0.1 min

Peak Storage= 15 cf @ 8.69 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 60.17 cfs

24.0" Round Pipe
n= 0.012 Steel, smooth
Length= 36.0' Slope= 0.0603 '/'
Inlet Invert= 145.08', Outlet Invert= 142.91'



Reach 2R: Culvert under Lockwoodcreek Road



Summary for Pond 5P: Detention Pond

Inflow Area = 766,189 sf, 68.89% Impervious, Inflow Depth = 2.85" for 10 yr event
Inflow = 13.07 cfs @ 7.88 hrs, Volume= 181,828 cf
Outflow = 4.63 cfs @ 8.78 hrs, Volume= 162,138 cf, Atten= 65%, Lag= 53.9 min
Primary = 4.63 cfs @ 8.78 hrs, Volume= 162,138 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 157.52' @ 8.78 hrs Surf.Area= 11,601 sf Storage= 53,248 cf

Plug-Flow detention time= 277.2 min calculated for 162,138 cf (89% of inflow)
Center-of-Mass det. time= 201.8 min (891.1 - 689.2)

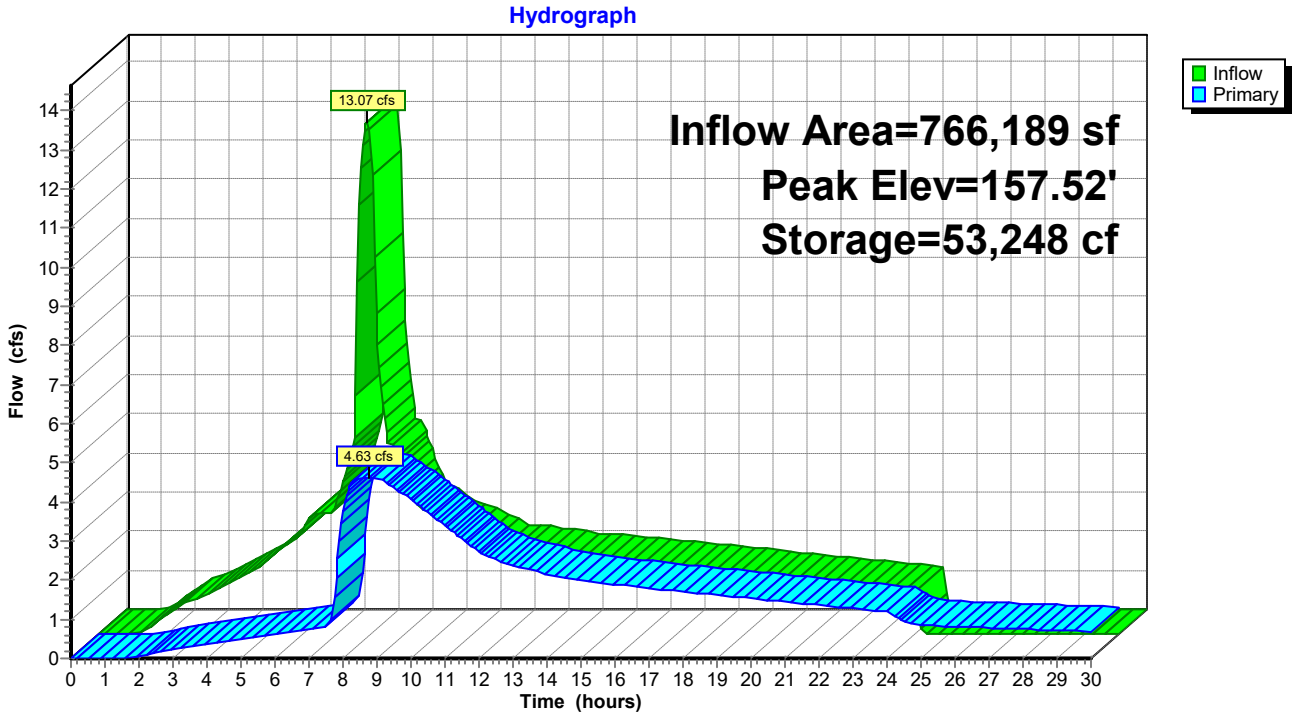
Volume	Invert	Avail.Storage	Storage Description
#1	151.00'	71,745 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.76

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	6,608	0	0
152.00	7,793	7,201	7,201
153.00	9,029	8,411	15,612
154.00	10,317	9,673	25,285
155.00	11,657	10,987	36,272
156.00	13,049	12,353	48,625
157.00	14,493	13,771	62,396
158.00	15,989	15,241	77,637
159.00	17,540	16,765	94,401

Device	Routing	Invert	Outlet Devices
#1	Primary	151.00'	**3.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	155.67'	**9.4" Vert. Orifice/Grate** C= 0.600
#3	Primary	156.35'	**5.7" Vert. Orifice/Grate** C= 0.600
#4	Primary	158.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.63 cfs @ 8.78 hrs HW=157.52' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 1.01 cfs @ 12.14 fps)
- **2=Orifice/Grate** (Orifice Controls 2.80 cfs @ 5.80 fps)
- **3=Orifice/Grate** (Orifice Controls 0.82 cfs @ 4.64 fps)
- **4=Orifice/Grate** (Controls 0.00 cfs)

Pond 5P: Detention Pond



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 3S: Area to Wetland B Runoff Area=35,802 sf 47.45% Impervious Runoff Depth=3.13"
Tc=6.0 min CN=94 Runoff=0.67 cfs 9,334 cf

Subcatchment 4S: Area to Detention Pond Runoff Area=766,189 sf 68.89% Impervious Runoff Depth=3.34"
Tc=6.0 min CN=96 Runoff=15.28 cfs 213,384 cf

Subcatchment A1: Pre Dev Basin 1 Runoff Area=801,991 sf 1.12% Impervious Runoff Depth=1.95"
Flow Length=300' Slope=0.1500 '/' Tc=27.2 min CN=81 Runoff=7.42 cfs 130,623 cf

Reach 2R: Culvert under Avg. Flow Depth=0.44' Max Vel=12.50 fps Inflow=6.46 cfs 202,614 cf
24.0" Round Pipe n=0.012 L=36.0' S=0.0603 '/' Capacity=60.17 cfs Outflow=6.46 cfs 202,608 cf

Pond 5P: Detention Pond Peak Elev=158.16' Storage=60,991 cf Inflow=15.28 cfs 213,384 cf
Outflow=6.18 cfs 193,280 cf

Total Runoff Area = 1,603,982 sf Runoff Volume = 353,340 cf Average Runoff Depth = 2.64"
65.47% Pervious = 1,050,144 sf 34.53% Impervious = 553,838 sf

Summary for Subcatchment 3S: Area to Wetland B

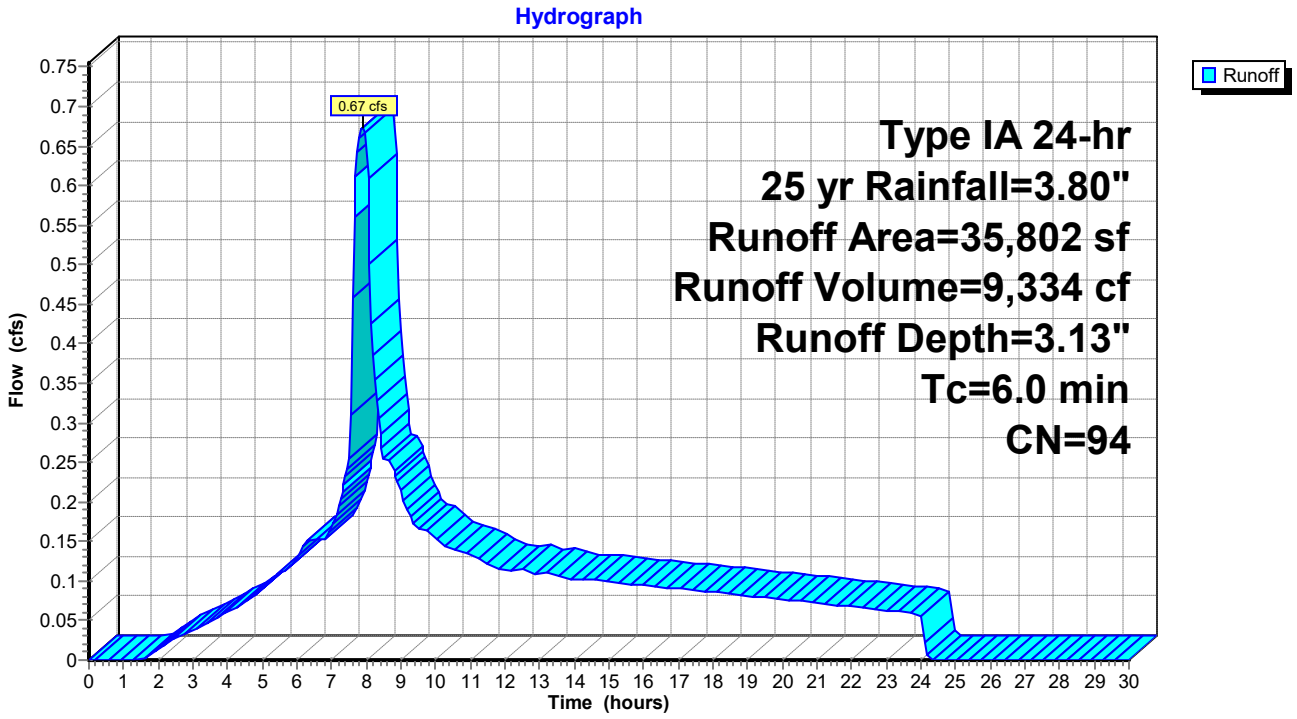
Runoff = 0.67 cfs @ 7.89 hrs, Volume= 9,334 cf, Depth= 3.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 yr Rainfall=3.80"

	Area (sf)	CN	Description
*	18,814	90	Landscaping
*	0	98	Road
*	0	98	Driveway
*	15,318	98	Roof
*	1,670	98	Sidewalk
	35,802	94	Weighted Average
	18,814		52.55% Pervious Area
	16,988		47.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 3S: Area to Wetland B



Summary for Subcatchment 4S: Area to Detention Pond

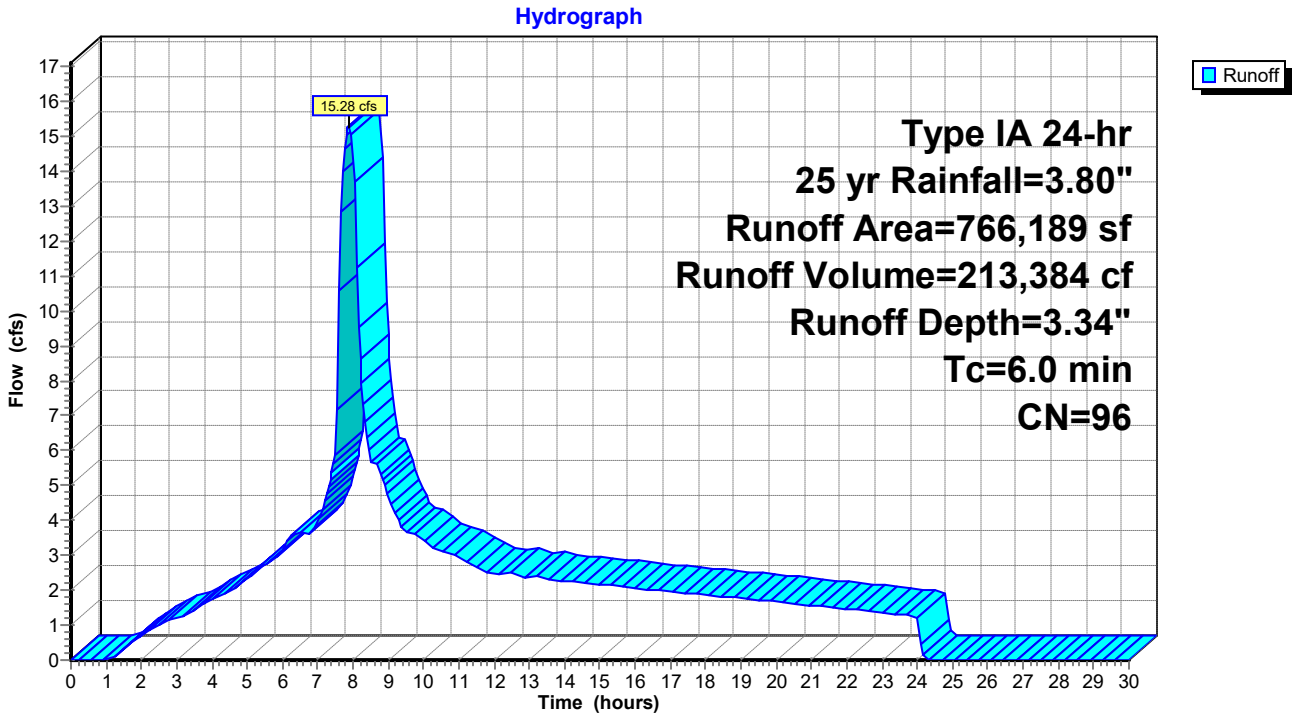
Runoff = 15.28 cfs @ 7.88 hrs, Volume= 213,384 cf, Depth= 3.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 yr Rainfall=3.80"

	Area (sf)	CN	Description
*	238,332	90	Landscaping
*	149,169	98	Road
*	81,124	98	Driveway
*	255,095	98	Roof
*	42,469	98	Sidewalk
	766,189	96	Weighted Average
	238,332		31.11% Pervious Area
	527,857		68.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: Area to Detention Pond



Summary for Subcatchment A1: Pre Dev Basin 1

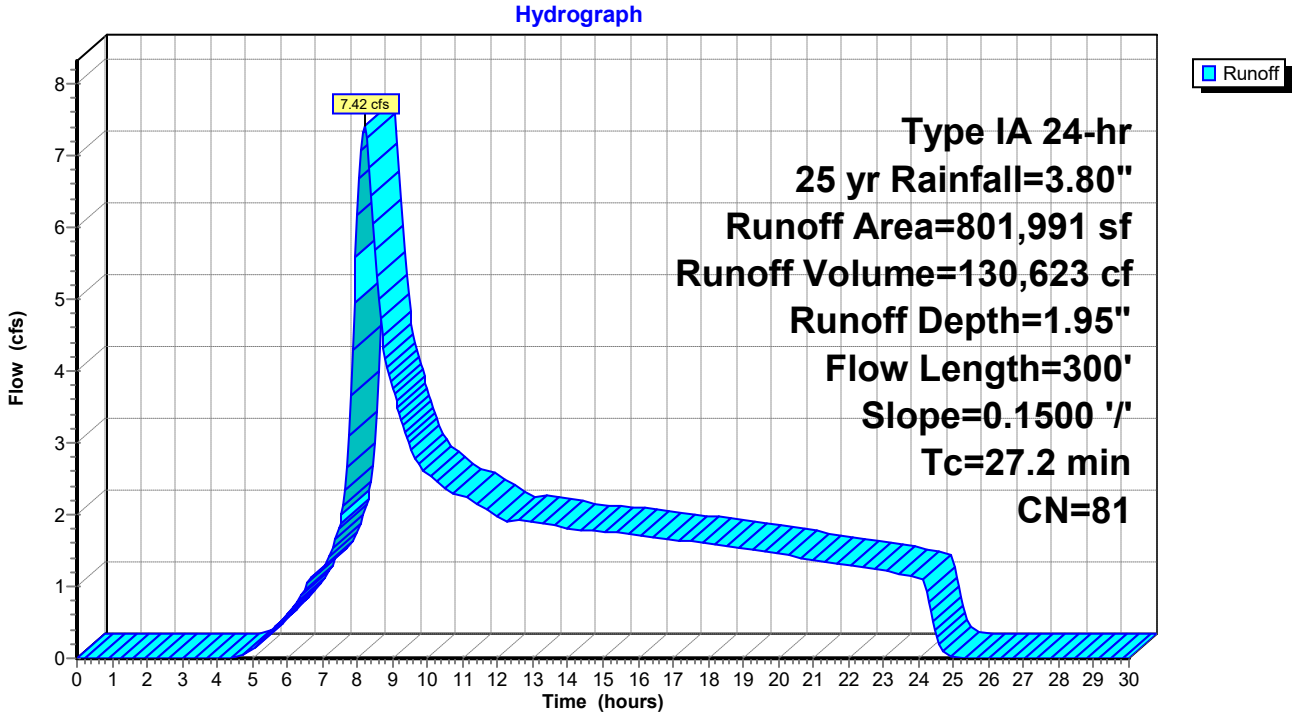
Runoff = 7.42 cfs @ 8.20 hrs, Volume= 130,623 cf, Depth= 1.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 yr Rainfall=3.80"

	Area (sf)	CN	Description
*	792,998	81	Undisturbed Forest HSG D
*	8,993	98	Impervious
	801,991	81	Weighted Average
	792,998		98.88% Pervious Area
	8,993		1.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.2	300	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.30"

Subcatchment A1: Pre Dev Basin 1



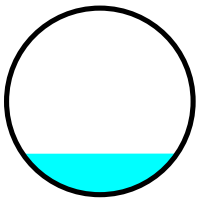
Summary for Reach 2R: Culvert under Lockwoodcreek Road

Inflow Area = 801,991 sf, 67.94% Impervious, Inflow Depth > 3.03" for 25 yr event
Inflow = 6.46 cfs @ 8.41 hrs, Volume= 202,614 cf
Outflow = 6.46 cfs @ 8.41 hrs, Volume= 202,608 cf, Atten= 0%, Lag= 0.2 min

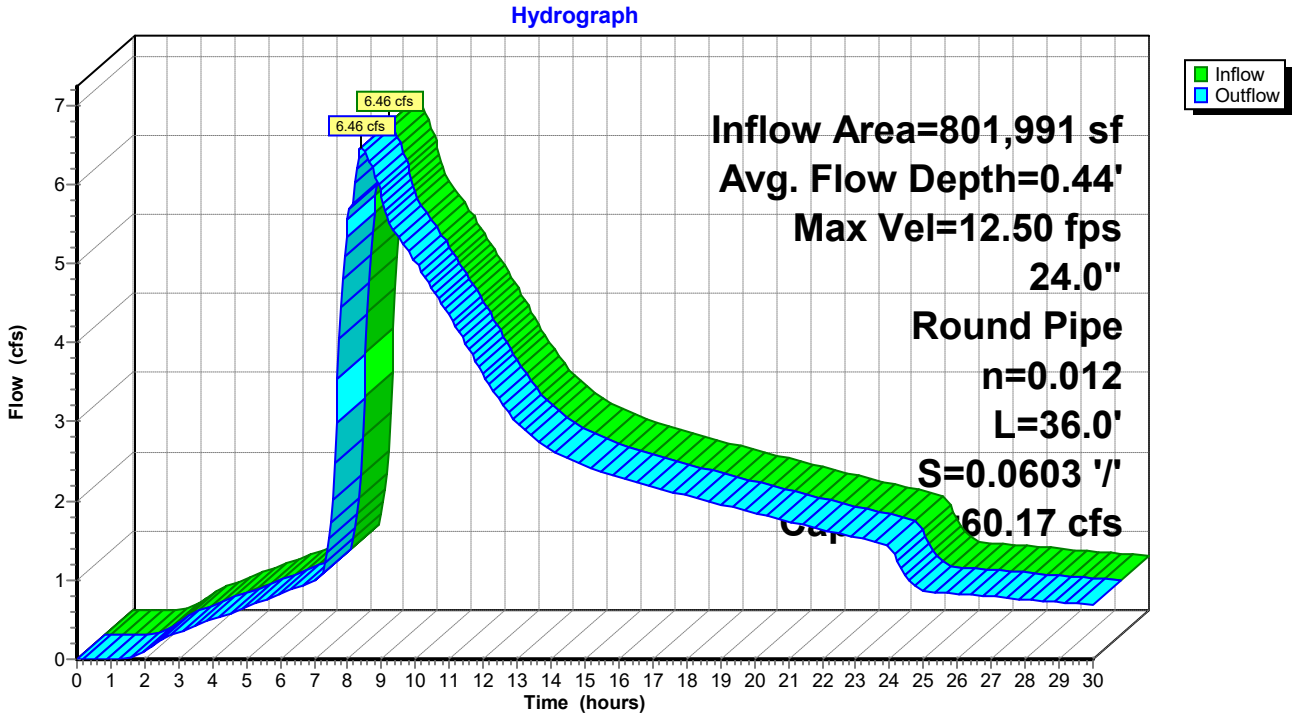
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 12.50 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 8.16 fps, Avg. Travel Time= 0.1 min

Peak Storage= 19 cf @ 8.41 hrs
Average Depth at Peak Storage= 0.44'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 60.17 cfs

24.0" Round Pipe
n= 0.012 Steel, smooth
Length= 36.0' Slope= 0.0603 '/'
Inlet Invert= 145.08', Outlet Invert= 142.91'



Reach 2R: Culvert under Lockwoodcreek Road



Summary for Pond 5P: Detention Pond

Inflow Area = 766,189 sf, 68.89% Impervious, Inflow Depth = 3.34" for 25 yr event
Inflow = 15.28 cfs @ 7.88 hrs, Volume= 213,384 cf
Outflow = 6.18 cfs @ 8.43 hrs, Volume= 193,280 cf, Atten= 60%, Lag= 32.8 min
Primary = 6.18 cfs @ 8.43 hrs, Volume= 193,280 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 158.16' @ 8.43 hrs Surf.Area= 12,343 sf Storage= 60,991 cf

Plug-Flow detention time= 251.7 min calculated for 192,958 cf (90% of inflow)
Center-of-Mass det. time= 185.6 min (869.0 - 683.4)

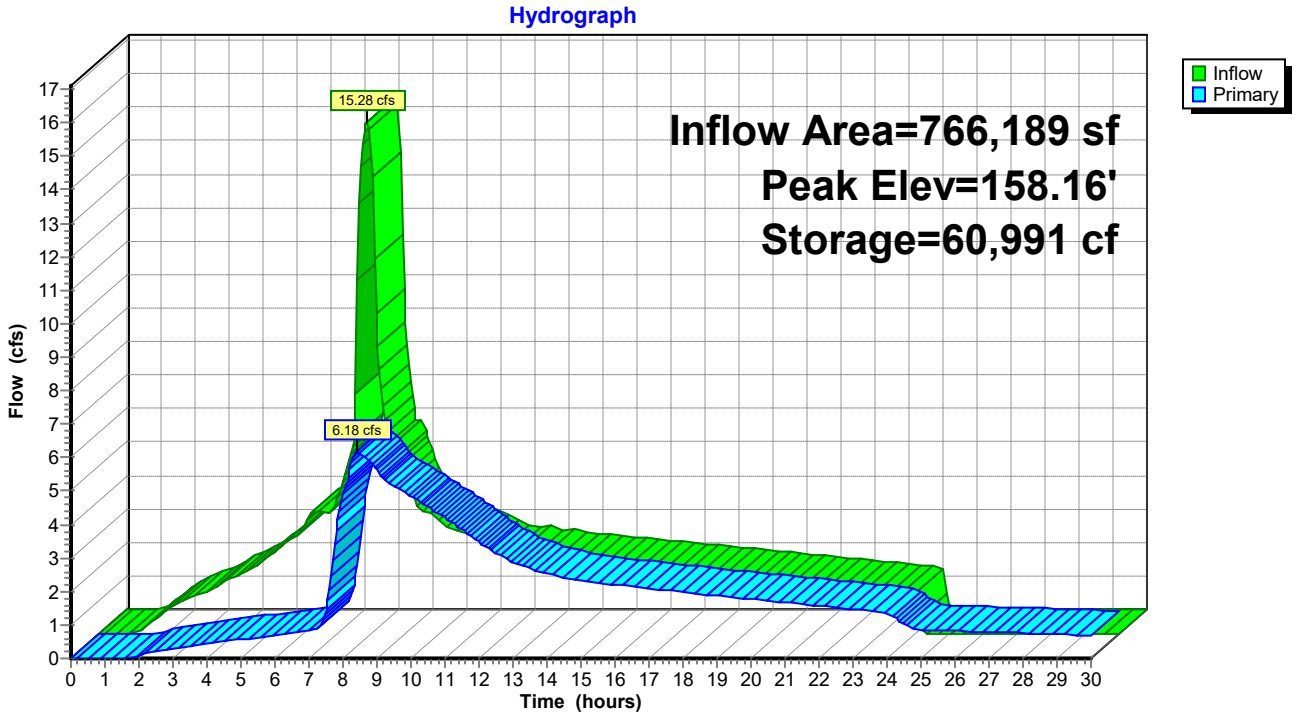
Volume	Invert	Avail.Storage	Storage Description
#1	151.00'	71,745 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.76

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	6,608	0	0
152.00	7,793	7,201	7,201
153.00	9,029	8,411	15,612
154.00	10,317	9,673	25,285
155.00	11,657	10,987	36,272
156.00	13,049	12,353	48,625
157.00	14,493	13,771	62,396
158.00	15,989	15,241	77,637
159.00	17,540	16,765	94,401

Device	Routing	Invert	Outlet Devices
#1	Primary	151.00'	**3.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	155.67'	**9.4" Vert. Orifice/Grate** C= 0.600
#3	Primary	156.35'	**5.7" Vert. Orifice/Grate** C= 0.600
#4	Primary	158.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=6.16 cfs @ 8.43 hrs HW=158.16' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 1.06 cfs @ 12.74 fps)
- **2=Orifice/Grate** (Orifice Controls 3.36 cfs @ 6.98 fps)
- **3=Orifice/Grate** (Orifice Controls 1.07 cfs @ 6.04 fps)
- **4=Orifice/Grate** (Weir Controls 0.67 cfs @ 1.31 fps)

Pond 5P: Detention Pond



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 3S: Area to Wetland B Runoff Area=35,802 sf 47.45% Impervious Runoff Depth=3.82"
Tc=6.0 min CN=94 Runoff=0.82 cfs 11,383 cf

Subcatchment 4S: Area to Detention Pond Runoff Area=766,189 sf 68.89% Impervious Runoff Depth=4.04"
Tc=6.0 min CN=96 Runoff=18.35 cfs 257,690 cf

Subcatchment A1: Pre Dev Basin 1 Runoff Area=801,991 sf 1.12% Impervious Runoff Depth=2.55"
Flow Length=300' Slope=0.1500 '/' Tc=27.2 min CN=81 Runoff=10.05 cfs 170,294 cf

Reach 2R: Culvert under Avg. Flow Depth=0.55' Max Vel=14.10 fps Inflow=9.79 cfs 248,509 cf
24.0" Round Pipe n=0.012 L=36.0' S=0.0603 '/' Capacity=60.17 cfs Outflow=9.79 cfs 248,503 cf

Pond 5P: Detention Pond Peak Elev=158.72' Storage=68,114 cf Inflow=18.35 cfs 257,690 cf
Outflow=9.35 cfs 237,126 cf

Total Runoff Area = 1,603,982 sf Runoff Volume = 439,367 cf Average Runoff Depth = 3.29"
65.47% Pervious = 1,050,144 sf 34.53% Impervious = 553,838 sf

Summary for Subcatchment 3S: Area to Wetland B

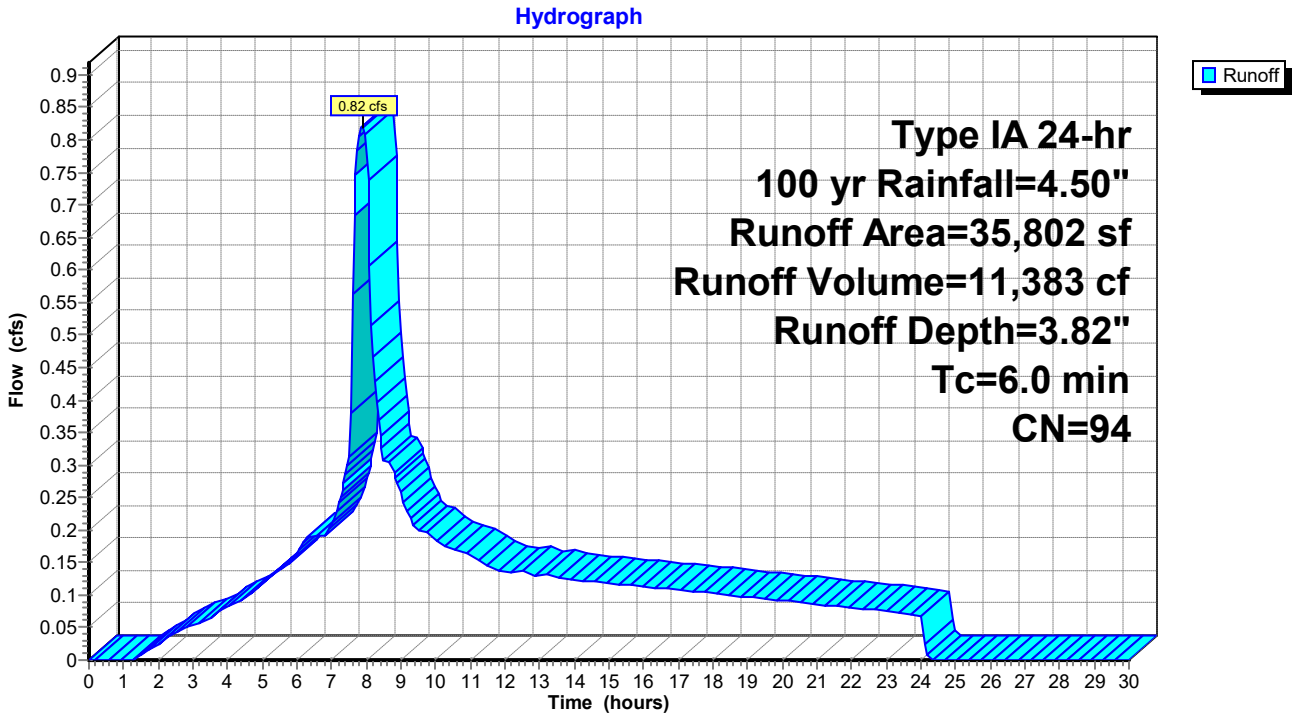
Runoff = 0.82 cfs @ 7.89 hrs, Volume= 11,383 cf, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 yr Rainfall=4.50"

	Area (sf)	CN	Description
*	18,814	90	Landscaping
*	0	98	Road
*	0	98	Driveway
*	15,318	98	Roof
*	1,670	98	Sidewalk
	35,802	94	Weighted Average
	18,814		52.55% Pervious Area
	16,988		47.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 3S: Area to Wetland B



Summary for Subcatchment 4S: Area to Detention Pond

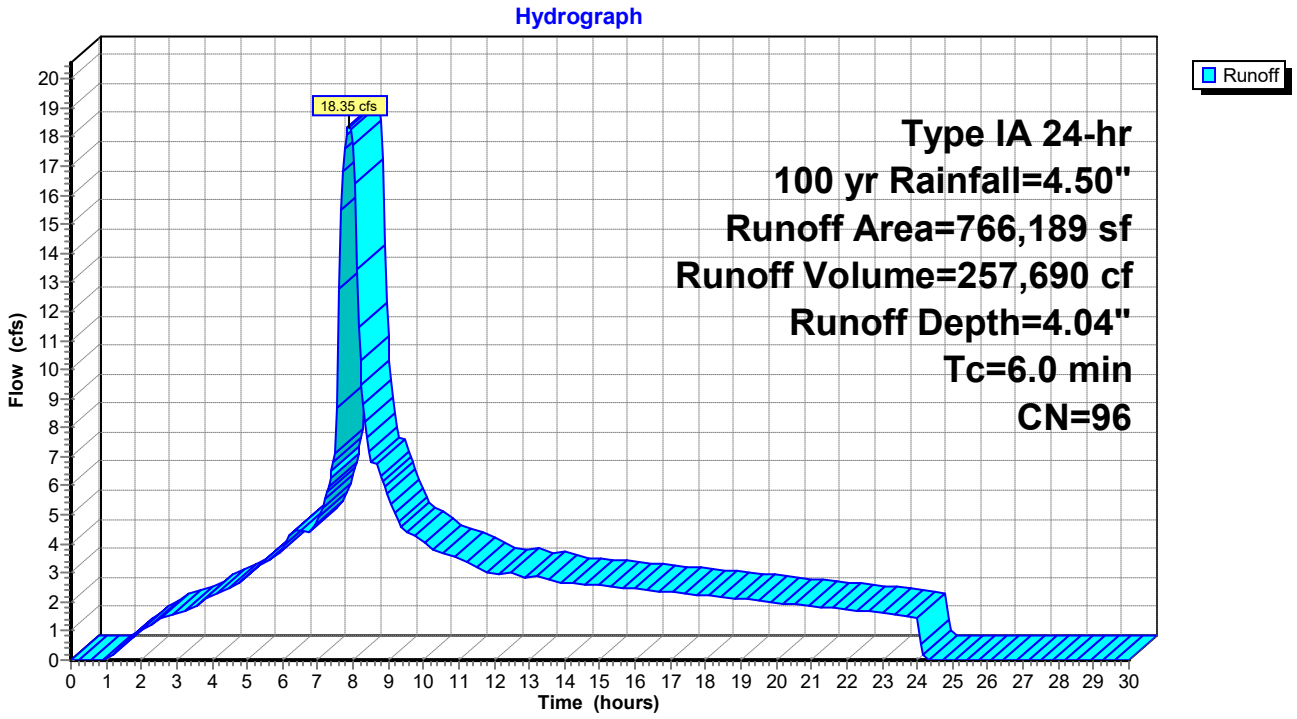
Runoff = 18.35 cfs @ 7.88 hrs, Volume= 257,690 cf, Depth= 4.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 yr Rainfall=4.50"

	Area (sf)	CN	Description
*	238,332	90	Landscaping
*	149,169	98	Road
*	81,124	98	Driveway
*	255,095	98	Roof
*	42,469	98	Sidewalk
	766,189	96	Weighted Average
	238,332		31.11% Pervious Area
	527,857		68.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: Area to Detention Pond



Summary for Subcatchment A1: Pre Dev Basin 1

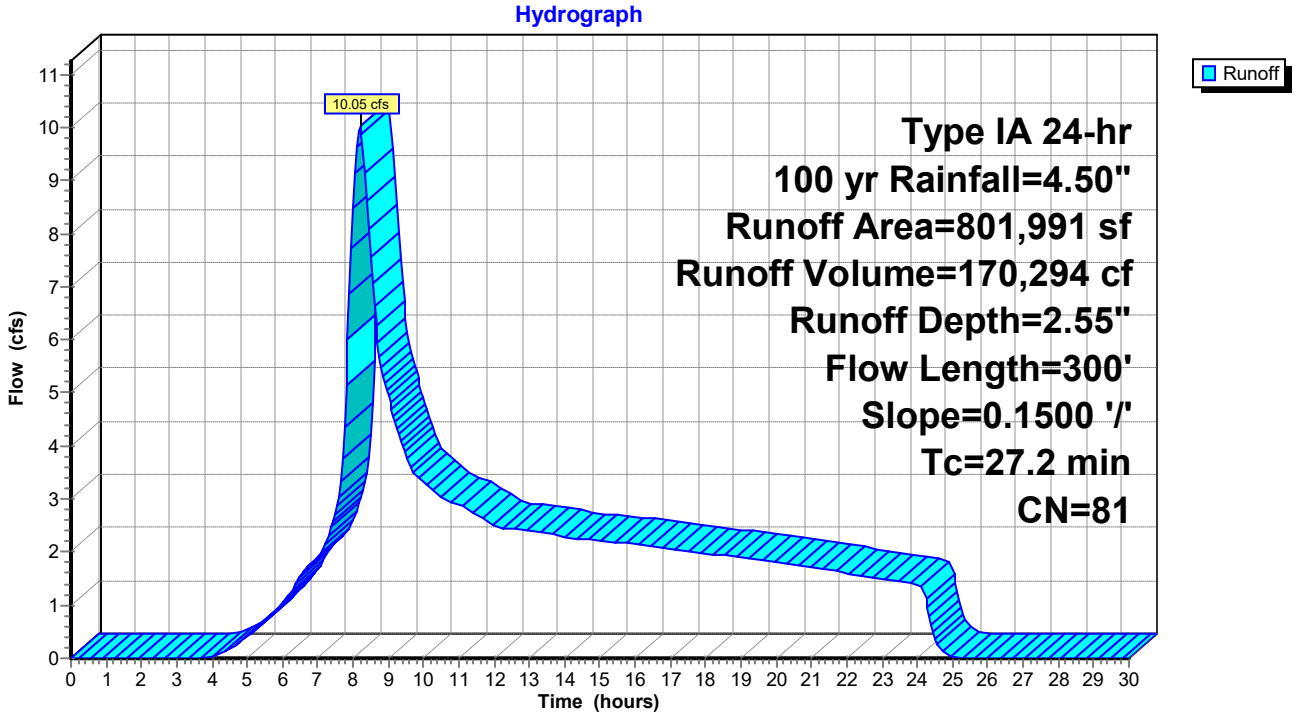
Runoff = 10.05 cfs @ 8.20 hrs, Volume= 170,294 cf, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 yr Rainfall=4.50"

	Area (sf)	CN	Description
*	792,998	81	Undisturbed Forest HSG D
*	8,993	98	Impervious
	801,991	81	Weighted Average
	792,998		98.88% Pervious Area
	8,993		1.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.2	300	0.1500	0.18		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.30"

Subcatchment A1: Pre Dev Basin 1



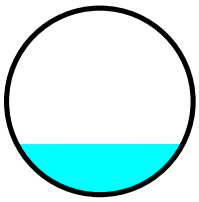
Summary for Reach 2R: Culvert under Lockwoodcreek Road

Inflow Area = 801,991 sf, 67.94% Impervious, Inflow Depth > 3.72" for 100 yr event
Inflow = 9.79 cfs @ 8.21 hrs, Volume= 248,509 cf
Outflow = 9.79 cfs @ 8.21 hrs, Volume= 248,503 cf, Atten= 0%, Lag= 0.0 min

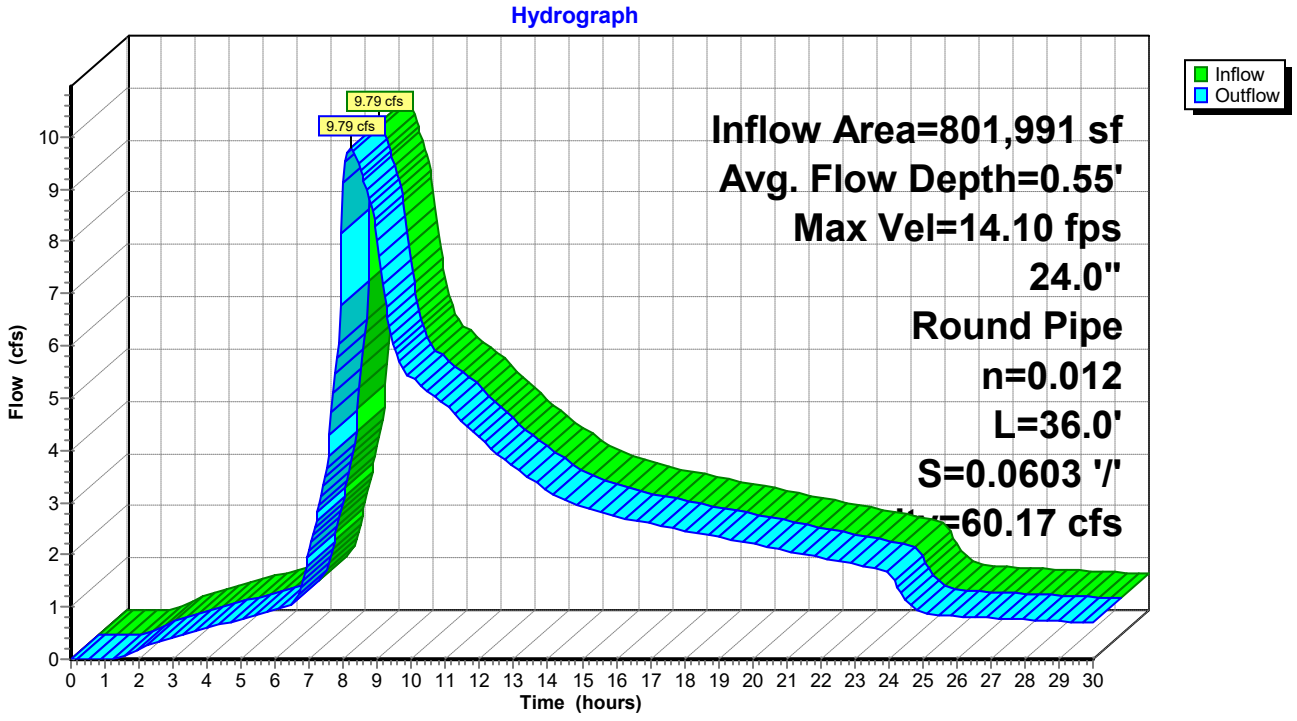
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.10 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 8.60 fps, Avg. Travel Time= 0.1 min

Peak Storage= 25 cf @ 8.21 hrs
Average Depth at Peak Storage= 0.55'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 60.17 cfs

24.0" Round Pipe
n= 0.012 Steel, smooth
Length= 36.0' Slope= 0.0603 '/'
Inlet Invert= 145.08', Outlet Invert= 142.91'



Reach 2R: Culvert under Lockwoodcreek Road



Summary for Pond 5P: Detention Pond

Inflow Area = 766,189 sf, 68.89% Impervious, Inflow Depth = 4.04" for 100 yr event
Inflow = 18.35 cfs @ 7.88 hrs, Volume= 257,690 cf
Outflow = 9.35 cfs @ 8.26 hrs, Volume= 237,126 cf, Atten= 49%, Lag= 23.0 min
Primary = 9.35 cfs @ 8.26 hrs, Volume= 237,126 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 158.72' @ 8.26 hrs Surf.Area= 13,005 sf Storage= 68,114 cf

Plug-Flow detention time= 222.8 min calculated for 236,731 cf (92% of inflow)
Center-of-Mass det. time= 165.9 min (843.0 - 677.1)

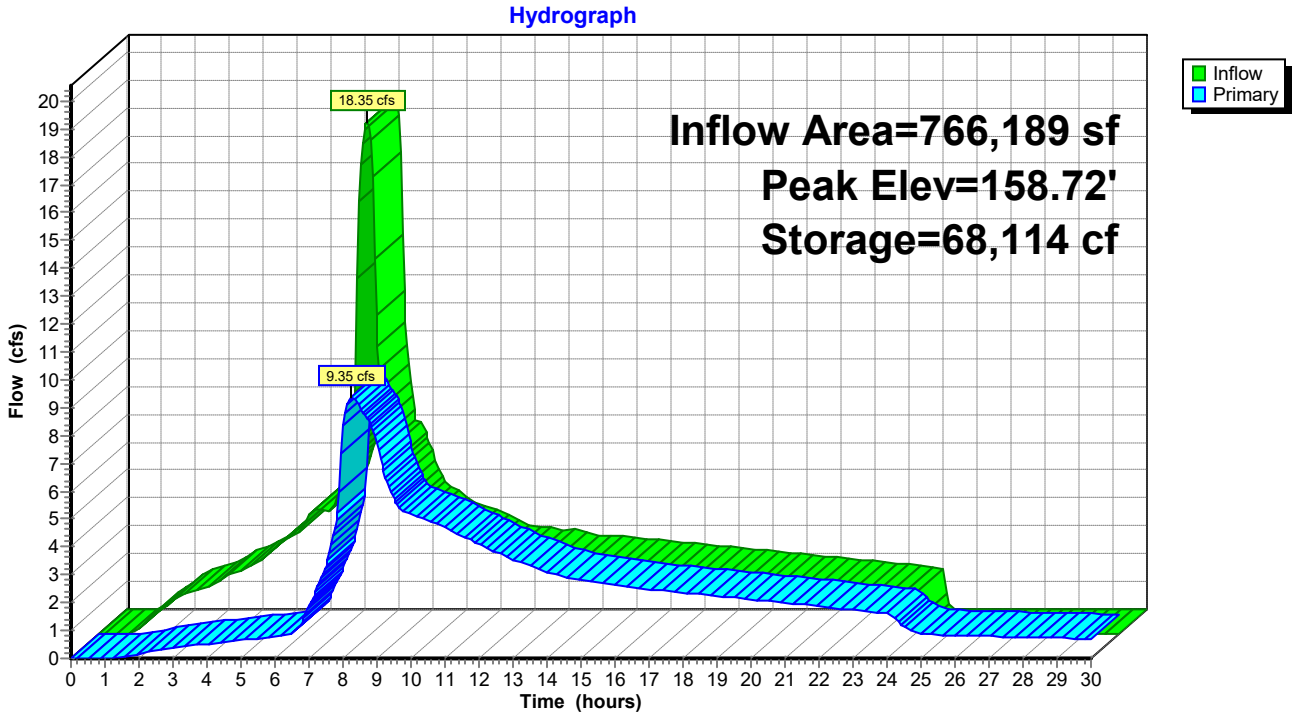
Volume	Invert	Avail.Storage	Storage Description
#1	151.00'	71,745 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 0.76

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	6,608	0	0
152.00	7,793	7,201	7,201
153.00	9,029	8,411	15,612
154.00	10,317	9,673	25,285
155.00	11,657	10,987	36,272
156.00	13,049	12,353	48,625
157.00	14,493	13,771	62,396
158.00	15,989	15,241	77,637
159.00	17,540	16,765	94,401

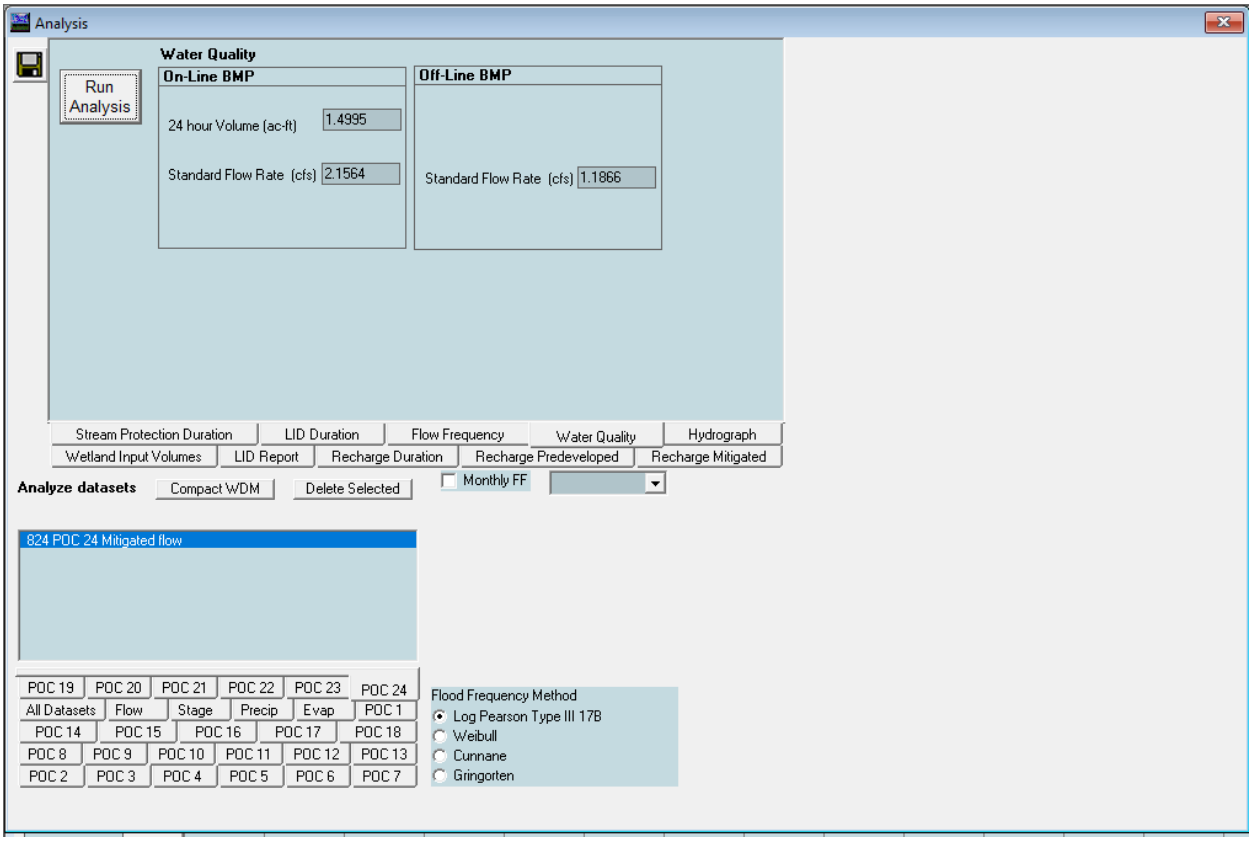
Device	Routing	Invert	Outlet Devices
#1	Primary	151.00'	**3.9" Vert. Orifice/Grate** C= 0.600
#2	Primary	155.67'	**9.4" Vert. Orifice/Grate** C= 0.600
#3	Primary	156.35'	**5.7" Vert. Orifice/Grate** C= 0.600
#4	Primary	158.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=9.35 cfs @ 8.26 hrs HW=158.72' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 1.10 cfs @ 13.24 fps)
- **2=Orifice/Grate** (Orifice Controls 3.79 cfs @ 7.86 fps)
- **3=Orifice/Grate** (Orifice Controls 1.25 cfs @ 7.04 fps)
- **4=Orifice/Grate** (Orifice Controls 3.22 cfs @ 4.10 fps)

Pond 5P: Detention Pond



StormFilter Vault WWHM WQ:



APPENDIX C

Basin Maps

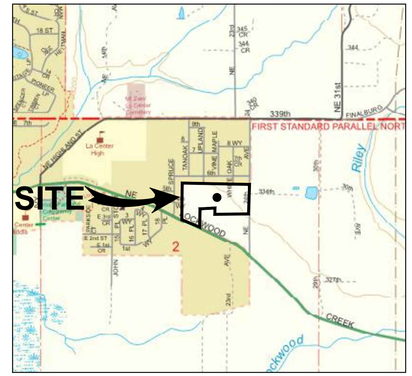
Pre-Developed
Post-Developed

Lockwood Meadows Subdivision

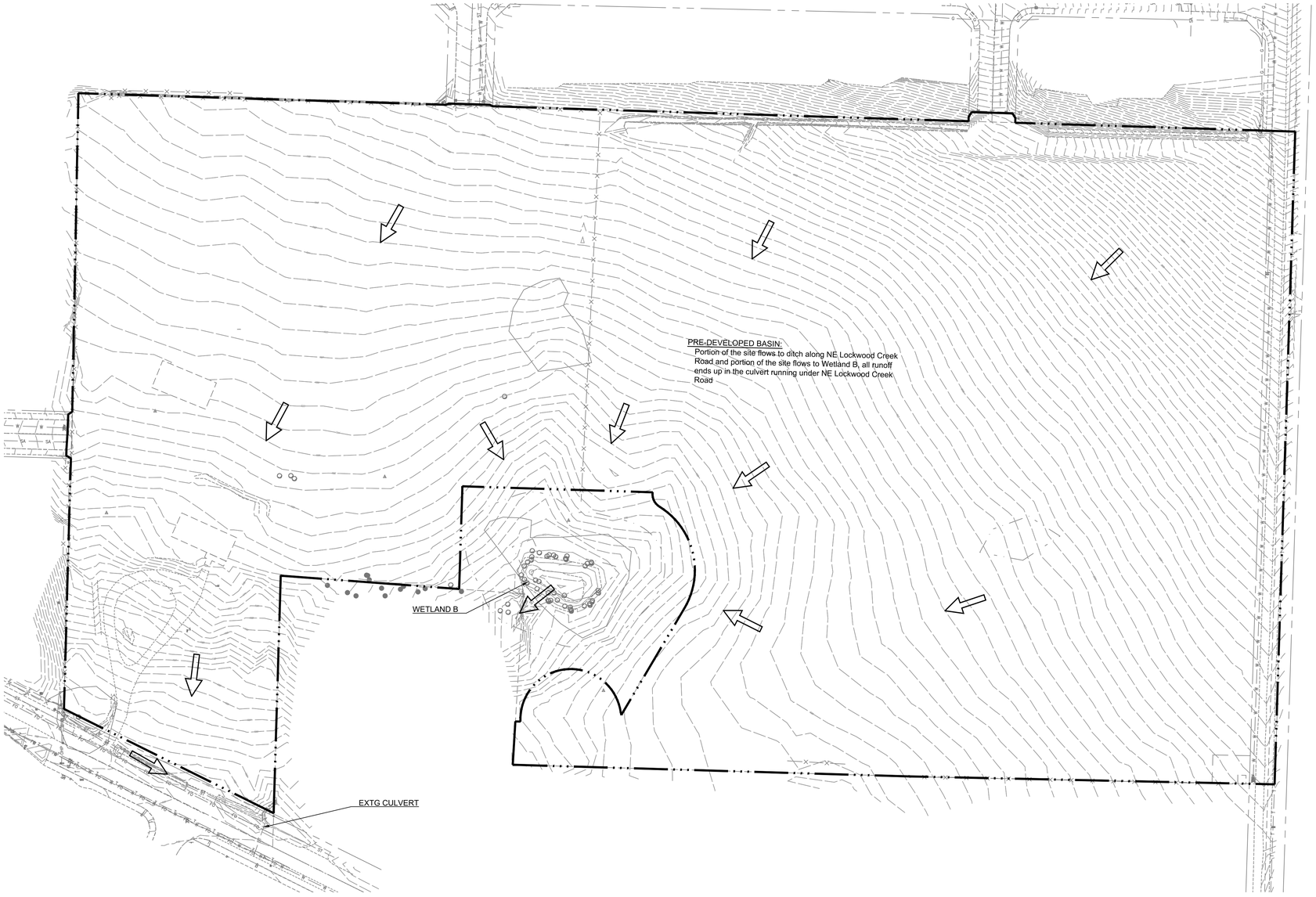
Located in the SW 1/4 Of Section 02, Township 4N, Range 1E, W.M.,
La Center, Washington

	Basin 1	Basin 2	Predeveloped
Roads, Moderate:	3.4245 AC	0.000 AC	0.2065 AC
Driveway, Moderate:	1.8623 AC	0.000 AC	0.0000 AC
Sidewalk, Moderate:	0.9750 AC	0.0383 AC	0.0000 AC
Rooftops, Flat:	5.8562 AC	0.3517 AC	0.0000 AC
HSGD, Lawn:	5.4714 AC	0.4319 AC	0.0000 AC
HSGD, Forest:	0.0000 AC	0.0000 AC	18.2047 AC
Total:	17.5893 AC	0.8219 AC	18.4112 AC

Basin Summary Table



VICINITY MAP
NOT TO SCALE



Scale 1" = 60'
60 30 0 60

GENERAL NOTES

OWNER/APLICANT:
Wapati Ventures LLC
10013 NE HAZEL DELL AVE PMB 504
VANCOUVER WA, 98685
Susanna S Hung Trust
710 Columbis St #414
Vancouver, WA 98660
(360) 450-8154
sshung_2000@yahoo.com

PROJECT CONTACT:
PLS Engineering
Contact: Travis Johnson, PE
604 W Evergreen Blvd
Vancouver, WA 98660
PH: (360) 944-6519
pm@plsengineering.com

SITE ADDRESS:
2000 NW Lockwood Creek Road
La Center, WA 98629

Parcel #: 209113000

PLS ENGINEERING
PLS | ENGINEERING | 604 W. Evergreen Blvd., Vancouver, WA 98660 | PH (360) 944-6519 | Fax (360) 944-6539

Pre Development Basin Map For:
Lockwood Meadows Subdivision
A Site Located in the City of La Center, Washington
Engineering - Surveying - Planning

Revisions

1	2	3	4	5	6

Project No.	3094
SCALE:	H: 1" = 60' V: N/A
DESIGNED BY:	JMW
DRAFTED BY:	JMW
REVIEWED BY:	TGJ

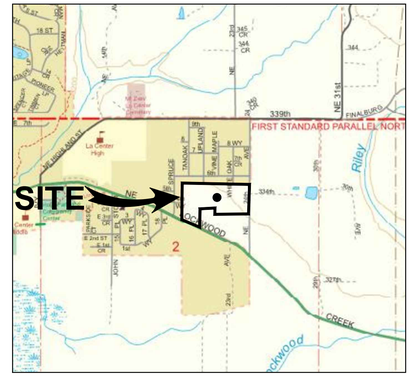
1
1

Lockwood Meadows Subdivision

Located in the SW 1/4 Of Section 02, Township 4N, Range 1E, W.M.,
La Center, Washington

	Basin 1	Basin 2	Predeveloped
Roads, Moderate:	3.4245 AC	0.000 AC	0.2065 AC
Driveway, Moderate:	1.8623 AC	0.000 AC	0.0000 AC
Sidewalk, Moderate:	0.9750 AC	0.0383 AC	0.0000 AC
Rooftops, Flat:	5.8562 AC	0.3517 AC	0.0000 AC
HSGD, Lawn:	5.4714 AC	0.4319 AC	0.0000 AC
HSGD, Forest:	0.0000 AC	0.0000 AC	18.2047 AC
Total:	17.5893 AC	0.8219 AC	18.4112 AC

Basin Summary Table



VICINITY MAP
NOT TO SCALE

Scale 1" = 60'
60 30 0 60

GENERAL NOTES

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10013 NE HAZEL DELL AVE PMB 504
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Contact: Travis Johnson, PE
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PH: (360) 944-6519
pm@plsengineering.com

SITE ADDRESS:
2000 NW Lockwood Creek Road
La Center, WA 98629

Parcel #: 209113000

PLS ENGINEERING

Post Development Basin Map For:
Lockwood Meadows Subdivision
A Site Located in the City of La Center, Washington
Engineering - Surveying - Planning | 604 W. Evergreen Blvd., Vancouver, WA 98660 | PH (360) 944-6519 | Fax (360) 944-6539

Revisions

1	2	3	4	5	6

Project No.	3094
SCALE:	H: 1" = 60' V: N/A
DESIGNED BY:	JMW
DRAFTED BY:	JMW
REVIEWED BY:	TGJ

1
1

APPENDIX D

Geotechnical Report

Geotechnical Site Investigation

Lockwood Meadows Subdivision

La Center, Washington

September 23, 2021

Geotechnical ■ Environmental ■ Special Inspections

Columbia West
Engineering, Inc

11917 NE 95th Street
Vancouver, Washington
98682
Phone: 360-823-2900
Fax: 360-823-2901

www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

GEOTECHNICAL SITE INVESTIGATION
LOCKWOOD MEADOWS SUBDIVISION
LA CENTER, WASHINGTON

Prepared For:

PLS Engineering
Attn: Nicolle Sicilia
604 W Evergreen Blvd
Vancouver, Washington 98660

Site Location:

2000 NE Lockwood Creek Road
Parcel No. 209113000
La Center, Washington

Prepared By:

Columbia West Engineering, Inc.
11917 NE 95th Street
Vancouver, Washington 98682
Phone: 360-823-2900
W.O. No. 21172

Date Prepared:

September 23, 2021

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Number	Title
A	Analytical Laboratory Test Reports
B	Exploration Logs
C	Soil Classification Information
D	Photo Log
E	Report Limitations and Important Information

GEOTECHNICAL SITE INVESTIGATION
LOCKWOOD MEADOWS SUBDIVISION
LA CENTER, WASHINGTON

1.0 INTRODUCTION

Columbia West Engineering, Inc. (Columbia West) was retained by PLS Engineering to conduct a geotechnical site investigation for the proposed Lockwood Meadows Subdivision project located in La Center, Washington. The purpose of the investigation was to observe and assess subsurface soil conditions at specific locations and provide geotechnical engineering analyses, planning, and design recommendations for proposed development. The specific scope of services was outlined in a proposal contract dated July 12, 2021. This report summarizes the investigation and provides field assessment documentation and laboratory analytical test reports. This report is subject to the limitations expressed in Section 7.0, *Conclusion and Limitations*, and Appendix E.

1.1 General Site Information

As indicated on Figures 1, 2 and 2A, the subject site is located at 2000 NE Lockwood Creek Road in La Center, Washington. The site is comprised of tax parcel number 209113000 totaling approximately 20 acres. The approximate latitude and longitude are N 45° 51' 42" and W 122° 38' 55", and the legal description is a portion of the NE ¼ of Section 02, T4N, R1E, Willamette Meridian. The current regulatory jurisdictional agency is the City of La Center.

1.2 Proposed Development

Correspondence with the design team and review of the preliminary site plan shown on Figure 2A indicates that proposed development at the Lockwood Meadows Subdivision includes the division of the referenced parcel into 71 new single-family residential lots, private asphalt access drives, public asphalt roadways, underground utilities, and stormwater facilities. Columbia West has not reviewed preliminary grading plans but understands that cut and fill may be proposed at the subject site. This report is based upon proposed development as described above and may not be applicable if modified.

2.0 REGIONAL GEOLOGY AND SOIL CONDITIONS

The subject site lies within the Willamette Valley/Puget Sound Lowland, a wide physiographic depression flanked by the mountainous Coast Range on the west and the Cascade Range on the east. Inclined or uplifted structural zones within the Willamette Valley/Puget Sound Lowland constitute highland areas and depressed structural zones form sediment-filled basins. The site is located in the northern portion of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

According to the *Geologic Map of the Ridgefield Quadrangle, Clark and Cowlitz Counties, Washington* (Russell C. Evarts, USGS Geological Survey Scientific Investigation Map 2844,

2004), near-surface soils are expected to consist of Pleistocene-aged, unconsolidated, rhythmically bedded, periglacial clay, silt, and fine- to medium-textured sand deposits derived from catastrophic outburst floods of Glacial Lake Missoula (Qfs). Fine-textured flood deposits are underlain by Pleistocene to Pliocene, unconsolidated to cemented, deeply weathered, pebble to boulder sedimentary conglomerate (QTc).

The Web Soil Survey (United States Department of Agriculture, Natural Resource Conservation Service [USDA NRCS], 2021 Website) identifies surface soils as Gee silt loam, Odne silt loam, and Hillsboro silt loam. Although soil conditions may vary from the broad USDA descriptions, Gee, Odne, and Hillsboro series soils are generally fine-textured clays and silts with very low permeability, moderate to high water capacity, and low shear strength. Gee, Odne, and Hillsboro soils are generally moisture sensitive, somewhat compressible, and described as having low to moderate shrink-swell potential. The erosion hazard is slight primarily based upon slope grade.

3.0 REGIONAL SEISMOLOGY

Recent research and subsurface mapping investigations within the Pacific Northwest appear to suggest the historic potential risk for a large earthquake event with strong localized ground movement may be underestimated. Past earthquakes in the Pacific Northwest appear to have caused landslides and ground subsidence, in addition to severe flooding near coastal areas. Earthquakes may also induce soil liquefaction, which occurs when elevated horizontal ground acceleration and velocity cause soil particles to interact as a fluid as opposed to a solid. Liquefaction of soil can result in lateral spreading and temporary loss of bearing capacity and shear strength.

There are at least four major known fault zones in the vicinity of the site that may be capable of generating potentially destructive horizontal accelerations. These fault zones are described briefly in the following text.

Portland Hills Fault Zone

The Portland Hills Fault Zone consists of several northwest-trending faults located along the northeastern margin of the Tualatin Mountains, also known as the Portland Hills, and the southwest margin of the Portland Basin. The fault zone is approximately 25 to 30 miles in length and is located approximately 17 miles southwest of the site. According to *Seismic Design Mapping, State of Oregon* (Geomatrix Consultants, 1995), there is no definitive consensus among geologists as to the zone fault type. Several alternate interpretations have been suggested.

According to the *USGS Earthquake Hazards Program*, the fault was originally mapped as a down-to-the-northeast normal fault but has also been mapped as part of a regional-scale zone of right-lateral, oblique slip faults, and as a steep escarpment caused by asymmetrical folding above a south-west dipping, blind thrust fault. The Portland Hills fault offsets Miocene Columbia River Basalts, and Miocene to Pliocene sedimentary rocks of the Troutdale Formation. No fault scarps on surficial Quaternary deposits have been described

along the fault trace, and the fault is mapped as buried by the Pleistocene-aged Missoula flood deposits.

However, evidence suggests that fault movement has impacted shallow Holocene deposits and deeper Pleistocene sediments. Seismologists recorded a M3.2 earthquake thought to be associated with the fault zone near Kelly Point Park in November 2012, a M3.9 earthquake thought to be associated with the fault zone near Kelly Point Park in April 2003, and a M3.5 earthquake possibly associated with the fault zone approximately 1.3 miles east of the fault in 1991. Therefore, the Portland Hills Fault Zone is generally thought to be potentially active and capable of producing possible damaging earthquakes.

Gales Creek-Newberg-Mt. Angel Fault Zone

Located approximately 33 miles southwest of the site, the northwest-striking, approximately 50-mile long Gales Creek-Newberg-Mt. Angel Structural Zone forms the northwestern boundary between the Oregon Coast Range and the Willamette Valley, and consists of a series of discontinuous northwest-trending faults. The southern end of the fault zone forms the southwest margin of the Tualatin basin. Possible late-Quaternary geomorphic surface deformation may exist along the structural zone (Geomatrix Consultants, 1995).

According to the *USGS Earthquake Hazards Program*, the Mount Angel fault is mapped as a high-angle, reverse-oblique fault, which offsets Miocene rocks of the Columbia River Basalts, and Miocene and Pliocene sedimentary rocks. The fault appears to have controlled emplacement of the Frenchman Spring Member of the Wanapum Basalts, and thus must have a history that predates the Miocene age of these rocks. No unequivocal evidence of deformation of Quaternary deposits has been described as a thick sequence of sediments deposited by the Missoula floods covers much of the southern part of the fault trace.

Although no definitive evidence of impacts to Holocene sediments have clearly been identified, the Mount Angel fault appears to have been the location of minor earthquake swarms in 1990 near Woodburn, Oregon, and a M5.6 earthquake in March 1993 near Scotts Mills, approximately four miles south of the mapped extent of the Mt. Angel fault. It is unclear if the earthquake occurred along the fault zone or a parallel structure. Therefore, the Gales Creek-Newberg-Mt. Angel Structural Zone is considered potentially active.

Lacamas Lake-Sandy River Fault Zone

The northwest-trending Lacamas Lake Fault and northeast-trending Sandy River Fault intersect north of Camas, Washington approximately 21 miles southeast of the site, and form part of the northeastern margin of the Portland basin. According to *Geology and Groundwater Conditions of Clark County Washington* (USGS Water Supply Paper 1600, Mundorff, 1964) and the *Geologic Map of the Lake Oswego Quadrangle* (Oregon DOGAMI Series GMS-59, 1989), the Lacamas Lake fault zone consists of shear contact between the Troutdale Formation and underlying Oligocene andesite-basalt bedrock. Secondary shear contact associated with the fault zone may have produced a series of prominent northwest-southeast geomorphic lineaments in proximity to the site.

According to the *USGS Earthquake Hazards Program* the fault has been mapped as a normal fault with down-to-the-southwest displacement and has also been described as a steeply northeast or southwest-dipping, oblique, right-lateral, slip-fault. The trace of the Lacamas Lake fault is marked by the very linear lower reach of Lacamas Creek. No fault scarps on Quaternary surficial deposits have been described. The Lacamas Lake fault offsets Pliocene-aged sedimentary conglomerates generally identified as the Troutdale formation, and Pliocene- to Pleistocene-aged basalts generally identified as the Boring Lava formation.

Recent seismic reflection data across the probable trace of the fault under the Columbia River yielded no unequivocal evidence of displacement underlying the Missoula flood deposits, however, recorded mild seismic activity during the recent past indicates this area may be potentially seismogenic.

Cascadia Subduction Zone

The Cascadia Subduction Zone has recently been recognized as a potential source of strong earthquake activity in the Portland/Vancouver Basin. This phenomenon is the result of the earth's large tectonic plate movement. Geologic evidence indicates that volcanic ocean floor activity along the Juan de Fuca ridge in the Pacific Ocean causes the Juan de Fuca Plate to perpetually move east and subduct under the North American Continental Plate. The subduction zone results in historic volcanic and potential earthquake activity in proximity to the plate interface, believed to lie approximately 20 to 50 miles west of the general location of the Oregon and Washington coast (Geomatrix Consultants, 1995).

4.0 GEOTECHNICAL AND GEOLOGIC FIELD INVESTIGATION

A geotechnical field investigation consisting of visual reconnaissance, nine test pits (TP-1 through TP-8 and STP-1) and two infiltration tests (IT-1 and IT-2) was conducted at the site on July 27, 2021. The test pits were explored with a track-mounted excavator. Subsurface soil profiles were logged in accordance with Unified Soil Classification System (USCS) specifications. Disturbed soil samples were collected from relevant soil horizons and submitted for laboratory analysis. Analytical laboratory test results are presented in Appendix A. Exploration locations are indicated on Figure 2. Subsurface exploration logs are presented in Appendix B. Soil descriptions and classification information are provided in Appendix C. A photo log is presented in Appendix D.

4.1 Surface Investigation and Site Description

The subject site is located at 2000 NE Lockwood Creek Road in La Center, Washington and is comprised of tax parcel 209113000, totaling approximately 20 acres. Site observations during exploration indicate the west half of the site is generally open and vegetated with grass and brush. An existing residence and appurtenant farm structures are located in the southwest area of the site. Surface water and hydrophytic vegetation were observed in lowland areas proposed for stormwater management at the approximate south-center of the site. Rows of young conifers occupying approximately 6 to 7 acres were observed on the eastern half of the property. An approximate one to- three-foot earth berm was observed at

the northern property boundary on the eastern half of the site. Berm material may be associated with development of Sunrise Terrace residential subdivision directly north of the subject site. The site is bounded by NE Lockwood Creek Road to the south, NE 24th Avenue to the east, and the Sunrise Terrace residential subdivision to the north and west. Field reconnaissance and review of site topographic mapping indicate the presence of south- and southwest-facing slopes with grades between 5 and 25 percent. Site elevations in the proposed development area range from 150 feet amsl at the southwest property corner to 250 feet amsl at the northeast property corner. Slope geometry and geomorphic features are discussed in greater detail in Section 5.2.2, *Slope Reconnaissance and Slope Stability Assessment*.

4.2 Subsurface Exploration and Investigation

Test pits were explored to a maximum depth of approximately 14 feet below ground surface (bgs). Exploration locations were selected to observe subsurface soil characteristics in proximity to proposed development areas and are indicated on Figure 2.

4.2.1 Soil Type Description

The field investigation indicated the presence of approximately 8 to 14 inches of sod and topsoil in the observed locations. Underlying the topsoil layer, subsurface soils resembling geologically mapped unconsolidated to compact glacial till (Qat) and native USDA Gee, Odne and Hillsboro soil series description were encountered. Subsurface lithology may generally be described by soil types identified in the following text. Field logs and observed stratigraphy for the encountered materials are presented in Appendix B, *Subsurface Exploration Logs*.

Soil Type 1 - Existing FILL

Soil Type 1 was observed to primarily consist of light brown to brown/gray, moist, apparent native soils and trace organic debris. Soil Type 1 was observed at the ground surface in STP-1 and along the northern property boundary on the eastern half of the site, extending to apparent depths of approximately one to- three feet bgs.

Soil Type 2 - SILT with Sand / Sandy SILT

Soil Type 2 was observed to consist of light brown to brown/gray, damp to moist, SILT with sand and sandy SILT. Soil Type 2 was observed below the topsoil layer in test pits TP-1 through TP-7 and extended to observed depths of approximately 7 to 14 feet bgs.

Soil Type 3 - Lean CLAY with Sand

Soil Type 3 was observed to primarily consist of brown and gray, moist, lean CLAY with sand. Soil Type 3 was observed below the topsoil layer in test pit TP-8, below Soil Type 2 in test pits TP-3 through TP-6, and interbedded in Soil Type 2 in test pit TP-7. Soil Type 3 extended to depths of approximately 13 to 14 feet bgs in the areas observed.

Soil Type 4 - Fat CLAY

Soil Type 4 was observed to primarily consist of brown and gray, moist, fat CLAY. Soil Type 4 was observed below Soil Type 3 in test pits TP-5 and TP-6 and extended to the maximum depths of exploration.

4.2.2 Groundwater

Groundwater was not encountered within test pit explorations to a maximum explored depth of approximately 14 feet bgs on July 27, 2021. Groundwater levels are often subject to seasonal variance and may rise during extended periods of increased precipitation or flooding.

Seeps and springs may become evident during site grading, primarily along slopes or in areas cut below existing grade. Structures, roads, and drainage design should be planned accordingly. Piezometer installation and long-term monitoring, beyond the scope of this investigation, would be necessary to provide more detailed groundwater information.

5.0 GEOLOGIC HAZARDS

City of La Center Municipal Code (*LCMC Development Code Section 18.300*) defines geologic hazard requirements for proposed development in areas subject to the City of La Center jurisdiction. Three potential geologic hazards are identified: (1) erosion hazard areas, (2) landslide hazard and steep slope areas, and (3) seismic hazard areas. Hazard mapping obtained from *Clark County Maps Online* indicates the presence of site slope grades of up to 25 percent at the northeast site corner.

Columbia West conducted a geologic hazard review to assess whether a geologic hazard is present at the site proposed for development, and if so, to provide mitigation recommendations. The geologic hazard review was based upon physical and visual reconnaissance, subsurface exploration, and review of maps and other published technical literature. The results of the geologic hazard review for potential geologic hazards are discussed in the following sections.

5.1 Erosion Hazard Areas

According to *Clark County Maps Online*, the *Soil Survey of Clark County, Washington* and field observations, an erosion hazard is not present on the subject site. Therefore, according to the *City of La Center Development Code,* a soil erosion hazard area is not present at the site. However, if there are erosion concerns, erosion can be successfully mitigated by preparation and adherence to a site-specific erosion control plan that identifies BMPs to be utilized to reduce potential impacts on site soils during construction. Concentrated drainage or water flow over the face of slopes should be prohibited, and adequate protection against erosion is required. Erosion control measures are discussed further in Section 6.15, *Erosion Control Measures*.

5.2 Landslide Hazard and Steep Slope Areas

To evaluate steep slope areas and assess whether landslide hazards are present at the site, Columbia West conducted a review of literature, subsurface exploration, and physical slope

reconnaissance. As mentioned previously, slope grades of up to 25 percent were observed at the northeast site corner.

5.2.1 Geologic Literature Review

Columbia West reviewed *Slope Stability of Clark County* (Washington Department of Natural Resources, Division of Geology and Earth Resources, Fiksdal, 1975) to assess site slope characteristics. The Fiksdal report identifies four levels of potential slope instability within Clark County: (1) stable areas – no slides or unstable slopes, (2) areas of potential instability because of underlying geologic conditions and physical characteristics associated with steepness, (3) areas of historical or still active landslides, and (4) older landslide debris. The site is mapped as (1) stable areas – no slides or unstable slopes.

Columbia West also reviewed the *Geologic Map of the Ridgefield Quadrangle, Clark County, Washington* (R.C. Evarts, Washington Division of Geology and Earth Resources, Scientific Investigations Map 2844, 2004), which indicates that no landslide deposits are mapped at the subject site or in the surrounding vicinity.

5.2.2 Slope Reconnaissance and Slope Stability Assessment

Review of topographic mapping published by *Clark County Maps Online* indicates that the subject site is located in an area that slopes regionally downgradient from north to south with no apparent toe or crest observed on the property or adjacent parcels.

The maximum grade change between the north and south property boundaries is approximately 100 feet with slope grades generally ranging from 5 to 25 percent. Slopes appear planar with no observed evidence of instability. There was no observed direct evidence of large-scale, mass slope movements or historic landslides. No landslide debris was observed within subsurface soils explored onsite and groundwater seeps or springs were not observed.

City of La Center Municipal Code defines a landslide hazard as areas meeting all three of the following characteristics: 1) slopes steeper than 15 percent; 2) hillsides intersecting geologic contacts with permeable sediment overlying low permeability sediment or bedrock, and; 3) any springs or groundwater seepage. The above-mentioned criteria were not observed during our field investigation or site research. Based upon the results of slope reconnaissance, subsurface exploration, and site research, slopes on the subject site do not appear to meet the definition of a landslide hazard according to *City of La Center Municipal Code*.

5.3 Seismic Hazard Areas

Seismic hazards include areas subject to severe risk of earthquake-induced damage. Damage may occur due to soil liquefaction, dynamic settlement, ground shaking amplification, or surface faulting rupture. These seismic hazards are discussed below.

5.3.1 Soil Liquefaction and Dynamic Settlement

According to the *Liquefaction Susceptibility Map of Clark County Washington* (Washington State Department of Natural Resources, 2004), the site is mapped as very low susceptibility

for liquefaction. Liquefaction, defined as the transformation of the behavior of a granular material from a solid to a liquid due to increased pore-water pressure and reduced effective stress, may occur when granular materials quickly compact under cyclic stresses caused by a seismic event. The effects of liquefaction may include immediate ground settlement and lateral spreading.

Soils most susceptible to liquefaction are generally saturated, cohesionless, loose to medium-dense sands within 50 feet of the ground surface. Recent research has also indicated that low plasticity silts and clays may also be subject to sand-like liquefaction behavior if the plasticity index determined by the Atterberg Limits analysis is less than 8. Potentially liquefiable soils located above the existing, historic, or expected ground water levels do not generally pose a liquefaction hazard. It is important to note that changes in perched ground water elevation may occur due to project development or other factors not observed at the time of investigation.

Based upon results of literature review, site-specific testing, and laboratory analysis, the potential for soil liquefaction is considered to be low.

5.3.2 Ground Shaking Amplification

Review of the *Site Class Map of Clark County, Washington* (Washington State Department of Natural Resources, 2004), indicates that site soils may be represented by Site Classes C and D as defined by the *ASCE 7, Chapter 20, Table 20.3-1*. However, subsurface exploration, in situ soil testing, and review of local well logs and geologic maps indicated that site soils exhibit characteristics of Site Class D. A designation of Site Class D indicates that minor amplification of seismic energy may occur during a seismic event due to subsurface conditions. However, this is typical for many areas within Clark County, does not constitute a geologic hazard in Columbia West's opinion, and will not prohibit development if properly accounted for during the design process.

5.3.3 Fault Rupture

Because there are no known geologic seismic faults within the site boundaries, fault rupture is unlikely.

6.0 DESIGN RECOMMENDATIONS

The geotechnical site investigation suggests the proposed development is generally compatible with surface and subsurface soils, provided the recommendations presented in this report are utilized and incorporated into the design and construction processes. The primary geotechnical concerns associated with the site are shallow groundwater, and fine-textured soils and drainage. Design recommendations are presented in the following text sections.

6.1 Site Preparation and Grading

Vegetation, organic material, unsuitable fill, and deleterious material that may be encountered should be cleared from areas identified for structures and site grading. Vegetation, other organic material, and debris should be removed from the site. Stripped topsoil should also be removed or used only as landscape fill in nonstructural areas with

slopes less than 25 percent. The stripping depth for sod and highly organic topsoil is anticipated to vary between approximately 8 and 14 inches. The required stripping depth may increase in areas of existing fill, heavy organics, or previously existing structures. Actual stripping depths should be determined based upon visual observations made during construction when soil conditions are exposed. The post-construction maximum depth of landscape fill placed or spread at any location onsite should not exceed one foot.

Previously disturbed soil, debris, or unconsolidated fill encountered during grading or construction activities should be removed completely and thoroughly from structural areas. This includes old remnant foundations, basement walls, utilities, associated soft soils, and debris. These materials and associated disturbed soils should also be completely removed from structural areas. Excavation areas should be backfilled with engineered structural fill.

The test pits excavated during site exploration were backfilled loosely with onsite soils. The test pits should be located and properly backfilled with structural fill during site improvements construction. Trees, stumps, and associated roots should also be removed from structural areas, individually and carefully. Resulting cavities and excavation areas should be backfilled with engineered structural fill.

Site grading activities should be performed in accordance with requirements specified in the *2018 International Building Code* (IBC), Chapter 18 and Appendix J, with exceptions noted in the text herein. Site preparation, soil stripping, and grading activities should be observed and documented by Columbia West.

6.1.1 Existing Fill

As previously discussed, and indicated on Figure 2, existing fill was observed in test pit exploration STP-1. Test pit exploration and field reconnaissance indicate that existing fill primarily consists of light brown to brown/gray, moist, apparent native soils and trace organic debris. Soil Type 1 was observed at the ground surface in STP-1 and along the northern property boundary on the eastern half of the site, extending to apparent depths of approximately one to- three feet bgs.

Existing fill and other previously disturbed soils or debris should be removed completely and thoroughly from structural areas. In some areas, existing fill may directly overlie vegetation and the original topsoil layer. This material should also be removed completely from structural areas. Upon removal of existing fill, Columbia West should observe the exposed subgrade. It should be noted that the limited scope of exploration conducted for this investigation cannot wholly eliminate uncertainty regarding the presence of unsuitable soils in areas not explored.

Based upon Columbia West's investigation, existing fill soils are not acceptable for reuse as structural fill.

6.2 Engineered Structural Fill

Areas proposed for fill placement should be appropriately prepared as described in the preceding text. Surface soils should be scarified and compacted prior to additional fill placement. Engineered structural fill should be placed in loose lifts not exceeding 12 inches

in depth and compacted using standard conventional compaction equipment. The soil moisture content should be within two percentage points of optimum conditions. A field density at least equal to 95 percent of the maximum dry density, obtained from the standard Proctor moisture-density relationship test (ASTM D698), is recommended for structural fill placement and scarified and recompacted subgrade.

Compaction of engineered structural fill should be verified by nuclear gauge field compaction testing performed in accordance with *ASTM D6938*. Field compaction testing should be performed for each vertical foot of engineered fill placed. Engineered fill placement should be observed by Columbia West.

Engineered structural fill placement activities should be performed during dry summer months if possible. Most clean native soils may be suitable for use as structural fill if adequately dried or moisture-conditioned to achieve recommended compaction specifications. Native clay soils with a plasticity index greater than 25 (Soil Type 4) should be evaluated and approved by Columbia West prior to use as structural fill. Native soils may require addition of moisture during periods of dry weather. Compacted fill soils should be covered shortly after placement.

Because they are moisture-sensitive, fine-textured soils are often difficult to excavate and compact during wet weather conditions. If adequate compaction is not achievable with clean native soils, import structural fill consisting of granular fill meeting WSDOT specifications for *Gravel Borrow 9-03.14*(*1*) is recommended.

Representative samples of proposed engineered structural fill should be submitted for laboratory analysis and approval by Columbia West prior to placement. Laboratory analyses should include particle-size gradation and standard Proctor moisture-density analysis.

6.3 Cut and Fill Slopes

Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes greater than six feet in height should be vertically keyed into existing subsurface soil. A typical fill slope cross-section is shown in Figure 3. Drainage implementations, including subdrains or perforated drainpipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. Extent, depth, and location of drainage may be determined in the field by Columbia West during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion.

Final cut or fill slopes at the site should not exceed 2H:1V or 10 feet in height without individual slope stability analysis. The values above assume a minimum horizontal setback for loads of 10 feet from top of cut or fill slope face or overall slope height divided by three (H/3), whichever is greater. A minimum slope setback detail for structures is presented in Figure 4.

Concentrated drainage or water flow over the face of slopes should be prohibited, and adequate protection against erosion is required. Fill slopes should be constructed by placing

fill material in maximum 12-inch level lifts, compacting as described in Section 6.2, *Engineered Structural Fill* and horizontally benching where appropriate. Fill slopes should be overbuilt, compacted, and trimmed at least two feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed and documented by Columbia West.

6.4 Foundations

Foundations for proposed structures are anticipated to consist of shallow continuous perimeter or column spread footings. Footings should be designed by a licensed structural engineer and conform to the recommendations below. Typical building loads are not expected to exceed approximately 3 kips per foot for perimeter footings or 10 kips per column. If actual loading exceeds anticipated loading, additional analysis should be conducted for the specific load conditions and proposed footing dimensions.

The existing ground surface should be prepared as described in Section 6.1, *Site Preparation and Grading*, and Section 6.2, *Engineered Structural Fill*. Foundations should bear upon firm native soil or engineered structural fill.

To evaluate bearing capacity for proposed structures, serviceability and reliability of shear resistance for subsurface soils was considered. Allowable bearing capacity is typically a function of footing dimension and subsurface soil properties, including settlement and shear resistance. Based upon in situ field testing and laboratory analysis, the estimated allowable bearing capacity for well-drained foundations prepared as described above is 1,500 psf. Bearing capacity may be increased by one-third for transient lateral forces such as seismic or wind. The estimated coefficient of friction between in situ compacted native soil or engineered structural fill and in-place poured concrete is 0.35. Lateral forces may also be resisted by an assumed passive soil equivalent fluid pressure of 250 psf/f against embedded footings. The upper six inches of soil should be neglected in passive pressure calculations.

Footings should extend to a depth at least 18 inches below lowest adjacent grade to provide adequate bearing capacity and protection against frost heave. Foundations constructed during wet weather conditions will require over-excavation of saturated subgrade soils and granular structural backfill prior to concrete placement. Over-excavation recommendations should be provided by Columbia West during foundation excavation and construction. Excavations adjacent to foundations should not extend within a 2H:1V angle projected down from the outside bottom footing edge without additional geotechnical analysis.

Foundations should not be permitted to bear upon undocumented fill or disturbed soil. Columbia West should observe foundation excavations prior to placing forms or reinforcing bar to verify subgrade support conditions are as anticipated in this report.

6.5 Slabs on Grade

Proposed structures may have slab-on-grade floors. Slabs should be supported on firm, competent, in situ soil or engineered structural fill. Disturbed soils and unsuitable fills in proposed slab locations should be removed and replaced with structural fill.

Preparation beneath slabs should be performed in accordance with the recommendations presented in Section 6.1, *Site Preparation and Grading* and Section 6.2, *Engineered Structural Fill*. Slabs should be underlain by at least 6 inches of 1 ¼"-0 crushed aggregate meeting *WSDOT 9-03.9*(*3*). Geotextile filter fabric conforming to *WSDOT 2010 Standard Specification M 41-10, 9-33.2*(*1*), *Geotextile Properties, Table 3: Geotextile for Separation or Soil Stabilization* may be used below the crushed aggregate to increase subgrade support. Base aggregate should be compacted to at least 95 percent of maximum dry density determined by the modified Proctor moisture-density relationship test (ASTM D1557).

For lightly loaded slabs not exceeding 200 psf, the modulus of subgrade reaction is estimated to be 150 psi/inch. Columbia West should be contacted for additional analysis if slab loading exceeds 200 psf. If desired, a moisture barrier may be constructed beneath the slabs. Slabs should be appropriately waterproofed in accordance with the desired type of finished flooring. Slab thickness and reinforcement should be designed by an experienced structural engineer in accordance with anticipated loads.

6.6 Static Settlement

Total long-term static footing displacement for shallow foundations constructed as described in this report is not anticipated to exceed approximately 1 inch. Differential settlement between comparably loaded footing elements is not expected to exceed approximately ½ inch over a span of 50 feet. The resulting vertical displacement after loading may be due to elastic distortion, dissipation of excess pore pressure, or soil creep.

6.7 Excavation

Soils at the site were explored to a maximum depth of 14 feet using a track-mounted excavator. Bedrock was not encountered and blasting or specialized rock-excavation techniques are not anticipated. Perched groundwater layers may exist at shallower depths depending on seasonal fluctuations in the water table. Recommendations as presented in Section 6.8, *Dewatering* should be considered where below-grade construction intersects the shallow groundwater table.

Based upon laboratory analysis and field testing, near-surface soils may be Washington State Industrial Safety and Health Administration (WISHA) Type C. For temporary open-cut excavations deeper than four feet, but less than 20 feet in soils of these types, the maximum allowable slope is 1.5H:1V. WISHA soil type should be confirmed during field construction activities by the contractor. Soil is often anisotropic and heterogeneous, and it is possible that WISHA soil types determined in the field may differ from those described above.

Site-specific shoring design may be required if open-cut excavations are infeasible or if excavations are proposed adjacent to existing infrastructure. Typical methods for stabilizing excavations consist of soldier piles and timber lagging, sheet pile walls, tiebacks and shotcrete, or pre-fabricated hydraulic shoring. Because lateral earth pressure distributions acting on below-grade structures are dependent upon the type of shoring system used, Columbia West should be contacted to conduct additional analysis when shoring type, excavation depths, and locations are known.

The contractor should be held responsible for site safety, sloping, and shoring. Columbia West is not responsible for contractor activities and excavation should be conducted in accordance with all applicable local, state, and federal laws.

6.8 Dewatering

Groundwater elevation and hydrostatic pressure should be carefully considered during design of utilities, retaining walls, or other structures that require below-grade excavation. Utility trenches in shallow groundwater areas or excavations and cuts that remain open for even short periods of time may undermine or collapse due to groundwater effects. Placement of layers of riprap or quarry spalls in localized areas on shallow excavation side slopes may be required to limit instability. Over-excavation and stabilization of pipe trenches or other excavations with imported crushed aggregate or gabion rock may also be necessary to provide adequate subgrade support.

Significant pumping and dewatering may be required to temporarily reduce the groundwater elevation to allow construction of proposed below-grade structures, installation of utilities, or placement of structural fills. Dewatering via a sump within excavation zones may be insufficient to control groundwater and provide excavation side slope stability. Dewatering may be more feasibly conducted by installing a system of temporary well points and pumps around proposed excavation areas or utility trenches. Depending on proposed utility depths, a site-specific dewatering plan may be necessary. Well pumps should remain functioning at all times during the excavation and construction period. Suitable back-up pumps and power supplies should be available to prevent unanticipated shut-down of dewatering equipment. Failure to operate pumps full-time may result in flooding of the excavation zones, resulting in damage to forms, slopes, or equipment.

6.9 Lateral Earth Pressure

Lateral earth pressures should be considered during design of retaining walls and below grade structures. Hydrostatic pressure and additional surcharge loading should also be considered. Wall foundation construction and bearing capacity should adhere to specifications provided previously in Section 6.4, *Foundations*. Retained material may include engineered structural backfill or undisturbed native soil. Structural wall backfill should consist of imported granular material meeting *Section 9-03.12*(*2*) of *WSDOT Standard Specifications*. Backfill should be prepared and compacted to at least 95 percent of maximum dry density as determined by the modified Proctor test (ASTM D1557). Recommended parameters for lateral earth pressures for retained soils and engineered structural backfill consisting of imported granular fill meeting WSDOT specifications for *Gravel Backfill for Walls 9-03.12*(*2*) are presented in Table 1.

The design parameters presented in Table 1 are valid for static loading cases only and are based upon in situ undisturbed native soils or compacted granular fill. The recommended earth pressures do not include surcharge loads, dynamic loading, hydrostatic pressure, or seismic design. If sloped backfill conditions are proposed, Columbia West should be contacted for additional analysis and associated recommendations.

If seismic design is required for unrestrained walls, seismic forces may be calculated by superimposing a uniform lateral force of $10H^2$ pounds per lineal foot of wall, where H is the total wall height in feet. The resultant force should be applied at 0.6H from the base of the wall.

Table 1. Recommended Lateral Earth Pressure Parameters for Level Backfill

Retained Soil	Equivalent Fluid Pressure for Level Backfill			Wet Density	Drained Internal Angle of Friction
	At-rest	Active	Passive		
Undisturbed native SILT with Sand and Sandy SILT (Soil Type 2)	61 pcf	42 pcf	319 pcf	115 pcf	28°
Undisturbed native Lean CLAY with Sand (Soil Type 3)	60 pcf	41 pcf	293 pcf	110 pcf	27°
Undisturbed Native Fat CLAY (Soil Type 4)	65 pcf	46 pcf	261 pcf	110 pcf	24°
Approved Structural Backfill Material WSDOT 9-03.12(2) compacted aggregate backfill	56 pcf	35 pcf	520 pcf	135 pcf	36°

**The upper 6 inches of soil should be neglected in passive pressure calculations. If exterior grade from top or toe of retaining wall is sloped, Columbia West should be contacted to provide location-specific lateral earth pressures.*

A continuous one-foot-thick zone of free-draining, washed, open-graded 1-inch by 2-inch drain rock and a 4-inch perforated gravity drainpipe is assumed behind retaining walls. Geotextile filter fabric should be placed between the drain rock and backfill soil. Specifications for drainpipe design are presented in Section 6.12, *Drainage*. If walls cannot be gravity drained, saturated base conditions and/or applicable hydrostatic pressures should be assumed.

Final retaining wall design should be reviewed and approved by Columbia West. Retaining wall subgrade and backfill activities should also be observed and tested for compliance with recommended specifications by Columbia West during construction.

6.10 Seismic Design Considerations

According to the *ASCE 7 Hazard Tool,* the anticipated peak ground and maximum considered earthquake spectral response accelerations resulting from seismic activity for the subject site are summarized in Table 2.

Table 2. Approximate Probabilistic Ground Motion Values for 'firm rock' sites based on subject property longitude and latitude

	2% Probability of Exceedance in 50 yrs
Peak Ground Acceleration	0.360 g
0.2 sec Spectral Acceleration	0.797 g
1.0 sec Spectral Acceleration	0.374 g

The listed probabilistic ground motion values are based upon "firm rock" sites with an assumed shear wave velocity of 2,500 ft/s in the upper 100 feet of soil profile. These values

should be adjusted for site class effects by applying site coefficients F_a and F_v and F_{PGA} as defined by *ASCE 7-16 and associated ASCE 7-16 Supplement 1, dated December 12, 2018, Tables 11.4-1, 11.4-2, and 11.8-1*. The site coefficients are intended to more accurately characterize estimated peak ground and respective earthquake spectral response accelerations by considering site-specific soil characteristics and index properties.

Localized peak ground accelerations exceeding the adjusted values may occur in some areas in direct proximity to an earthquake's origin. This may be a result of amplification of seismic energy due to depth to competent bedrock, compression and shear wave velocity of bedrock, presence and thickness of loose, unconsolidated alluvial deposits, soil plasticity, grain size, and other factors.

Identification of specific seismic response spectra is beyond the scope of this investigation. If site structures are designed in accordance with recommendations specified in the *2018 IBC*, the potential for peak ground accelerations in excess of the adjusted and amplified values should be understood.

6.11 Infiltration Testing Results and Soil Group Classification

To investigate the feasibility of subsurface disposal of stormwater, Columbia West conducted in situ infiltration testing at two locations within the project area on July 27, 2021. Results of in situ infiltration testing are presented in Table 3. The soil classification presented in Table 3 is based upon laboratory analysis. The infiltration rate is presented as a recommended coefficient of permeability (k) and has been reported without application of a factor of safety.

As indicated in Table 3, the tests were conducted in test pits TP-1 and TP-8 at a depth of approximately one-foot bgs. Soils in the tested location were observed and sampled to adequately characterize the subsurface profile. Tested native soils are classified as SILT with sand (ML) and lean CLAY with sand (CL) according to USCS specifications. Soil laboratory analytical test reports are provided in Appendix A.

Single-ring, falling head infiltration testing was performed by inserting a three-inch diameter pipe into the soil at the noted depth. The test was conducted by filling the apparatus with water and measuring time relative to changes in hydraulic head at regular intervals. Using Darcy's Law for saturated flow in homogenous media, the coefficient of permeability (k) was then calculated.

Table 3. Infiltration Test Results

Test Number	Location	Test Depth (feet bgs)	Groundwater Depth on 07/27/21 (feet bgs)	USCS Soil Type (*Indicates Visual Soil Classification)	Passing No. 200 Sieve (%)	WWHM Soil Group Classification**	Infiltration Rate (Coefficient of Permeability, k) (inches/hour)
IT-1.1	TP-1	1	Not Observed	ML, SILT with Sand*	-	4	< 0.06
IT-8.1	TP-8	1	Not Observed	CL, Lean CLAY with Sand*	-	4	< 0.06

** WWHM Classifications are Based Upon Subsurface Investigation and Infiltration Testing Conducted at the Locations Shown.

Columbia West also classified tested near-surface soils into a representative soil group based upon site-specific infiltration test results and review of published literature. As indicated in Table 3, observed near-surface infiltration rates were less than 0.06 inches per hour in the tested locations. Based upon review of USDA hydrologic soil group criteria (USDA, 2007), Appendix 2-A of the *2021 Clark County Stormwater Manual,* and the *Clark County WWHM Soil Groupings Memorandum* (Otak, 2010), measured infiltration rates generally meet the criteria for WWHM Soil Group 4. Therefore, based upon site-specific infiltration testing and review of published literature, tested near-surface soils may be appropriately classified as presented in Table 3.

Due to the presence of fine-textured, low permeability soils at the site, subsurface disposal of concentrated stormwater via infiltration is likely infeasible and is not recommended without further study.

6.12 Drainage

At a minimum, site drainage should include surface water collection and conveyance to properly designed stormwater management structures and facilities. Drainage design in general should conform to City of La Center regulations. Finished site grading should be conducted with positive drainage away from structures. Depressions or shallow areas that may retain ponding water should be avoided. Roof drains, low-point drains, and perimeter foundation drains are recommended for structures. Drains should consist of separate systems and gravity flow with a minimum two-percent slope away from foundations into an approved discharge location.

Perimeter foundation drains should consist of 3-inch perforated PVC pipe surrounded by a minimum of 1 ft^3 of clean, washed drain rock per linear foot of pipe and wrapped with geotextile filter fabric. Open-graded drain rock with a maximum particle size of 3 inches and less than 2 percent passing the No. 200 sieve is recommended. Geotextile filter fabric should consist of Mirafi 140N or approved equivalent, with AOS between No. 70 and No. 100 sieve. The water permittivity should be greater than 1.5/sec. Figure 5 presents a typical foundation drain. Perimeter drains may limit increased hydrostatic pressure beneath footings and assist in reducing potential perched moisture areas.

Subdrains should also be considered if portions of the site are cut below surrounding grades. Shallow groundwater, springs, or seeps should be conveyed via drainage channel or perforated pipe into an approved discharge. Recommendations for design and installation of perforated drainage pipe may be performed on a case-by-case basis by Columbia West during construction. Failure to provide adequate surface and sub-surface drainage may result in soil slumping or unanticipated settlement of structures exceeding tolerable limits. A typical perforated drainpipe trench detail is presented in Figure 6.

Site improvements construction in some areas may occur at or near the shallow groundwater table, particularly if work is conducted during wet-weather conditions. Dewatering may be necessary, and a drainage mat may be required to achieve sufficient elevation for fill placement. A typical drainage mat is shown on Figure 7. Columbia West should determine drainage mat location, extent, and thickness when subsurface conditions are exposed. Drainage mats may need to be constructed in conjunction with subdrains to convey captured water to an approved discharge location.

Drains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seeps become evident, the drainage provisions may require modification or additional drains. Columbia West should be consulted to provide appropriate recommendations.

6.13 Bituminous Asphalt and Portland Cement Concrete

Based upon correspondence with the client, proposed development will include new public asphalt-paved roadways. Columbia West recommends adherence to City of La Center paving guidelines for roadway improvements in the public right-of-way.

For dry weather construction, pavement surface sections should bear upon competent subgrade consisting of scarified and compacted native soil or engineered structural fill. Wet weather pavement construction is discussed in Section 6.14, *Wet Weather Construction Methods and Techniques*. Subgrade conditions should be evaluated and tested by Columbia West prior to placement of crushed aggregate base. Subgrade evaluation should include nuclear gauge density testing and wheel proof-roll observations conducted with a loaded 12-cubic yard, double-axle dump truck or equivalent. Nuclear gauge density testing should be conducted at 150-foot intervals or as determined by the onsite geotechnical engineer. Subgrade soil should be compacted to at least 95 percent of the modified Proctor dry density, as determined by *ASTM D1557*. Areas of observed deflection or rutting during proof-roll evaluation should be excavated to a firm surface and replaced with compacted crushed aggregate.

Aggregate base should consist of 1 ¼”-0 crushed aggregate meeting *WSDOT 9-03.9*(*3*) and be compacted to at least 95 percent of maximum dry density as determined by *ASTM D1557*. Aggregate base should also be subject to proof-roll observations as described above. Asphalt concrete pavement should be compacted to at least 91 percent of maximum Rice density. Nuclear gauge density testing should be conducted to verify adherence to recommended specifications. Testing frequency should be in accordance with WSDOT and City of La Center specifications.

Portland cement concrete curbs and sidewalks should be installed in accordance with City of La Center specifications. Curb and sidewalk aggregate base should consist of 1 ¼"-0 crushed aggregate meeting *WSDOT 9-03.9*(*3*) and be compacted to at least 95 percent of maximum dry density as determined by *ASTM D1557*. Curb and sidewalk base should also be subject to proof-roll observations as described above. Soft areas that deflect or rut should be stabilized prior to pouring concrete. Concrete should be tested during installation in accordance with *ASTM C171, C138, C231, C143, C1064, and C31*. This includes casting of cylinder specimen at a frequency of four cylinders per 100 cubic yards of poured concrete. Recommended field concrete testing includes slump, air entrainment, temperature, and unit weight.

6.14 Wet Weather Construction Methods and Techniques

Wet weather construction often results in significant shear strength reduction and soft areas that may rut or deflect. Installation of granular working layers may be necessary to provide a firm support base and sustain construction equipment. Granular layers should consist of all-weather gravel, 2x4-inch gabion, or other similar material (six-inch maximum size with less than five percent passing the No. 200 sieve).

Construction equipment traffic across exposed soil should be minimized. Equipment traffic induces dynamic loading, which may result in weak areas and significant reduction in shear strength for wet soils. Wet weather construction may also result in generation of significant excess quantities of soft wet soil. This material should be removed from the site or stockpiled in a designated area.

Construction during wet weather conditions may require increased base thickness. Over-excavation of subgrade soils or subgrade amendment with lime and/or cement may be necessary to provide a firm base upon which to place crushed aggregate. Geotextile filter fabric is also recommended. If soil amendment with lime or cement is considered, Columbia West should be contacted to provide appropriate recommendations based upon observed field conditions and desired performance criteria.

Crushed aggregate base should be installed in a single lift with trucks end-dumping from an advancing pad of granular fill. During extended wet periods, stripping activities may also need to be conducted from an advancing pad of granular fill. Once installed, the crushed aggregate base should be compacted with several passes from a static drum roller. A vibratory compactor is not recommended because it may further disturb the subgrade. Subdrains may also be necessary to provide subgrade drainage and maintain structural integrity.

Aggregate base should consist of 1 ¼"-0 crushed aggregate meeting *WSDOT 9-03.9*(*3*) and be compacted to at least 95 percent of maximum dry density according to the modified Proctor density test (ASTM D1557). Compaction should be verified by nuclear gauge density testing, conducted at 150-foot intervals or as determined by the onsite geotechnical engineer. Observation of a proof-roll with a loaded dump truck is also recommended as an indication of the compacted aggregate's performance.

It should be understood that wet weather construction is risky and costly. Columbia West should observe and document wet weather construction activities. Proper construction methods and techniques are critical to overall project integrity.

6.15 Erosion Control Measures

Based upon field observations and laboratory testing, the erosion hazard for site soils in flat to shallow-gradient portions of the property is likely to be low. The potential for erosion generally increases in sloped areas. Therefore, disturbance to vegetation in sloped areas should be minimized during construction activities. Soil is also prone to erosion if unprotected and unvegetated during periods of increases precipitation. Erosion can be minimized by performing construction activities during dry summer months.

Site-specific erosion control measures should be implemented to address the maintenance of exposed areas. This may include silt fence, biofilter bags, straw wattles, or other suitable methods. During construction activities, exposed areas should be well-compacted and protected from erosion with visqueen, surface tackifier, or other means, as appropriate. Temporary slopes or exposed areas may be covered with straw, crushed aggregate, or riprap in localized areas to minimize erosion. Erosion and water runoff during wet weather conditions may be controlled by application of strategically placed channels and small detention depressions with overflow pipes.

After grading, exposed surfaces should be vegetated as soon as possible with erosion-resistant native vegetation. Jute mesh or straw may be applied to enhance vegetation. Once established, vegetation should be properly maintained. Disturbance to existing native vegetation and surrounding organic soil should also be minimized during construction activities.

6.16 Soil Shrink/Swell Potential

Based upon laboratory analysis, near-surface soils contain as much as approximately 90 percent by weight passing the No. 200 sieve and exhibit a plasticity index ranging from 5 to 31 percent. This indicates the potential for soil shrinking or swelling and underscores the importance of proper moisture conditioning during fill placement. Medium to high plasticity soils should be placed and compacted at a moisture content approximately two percent above optimum as determined by laboratory analysis. As discussed previously in Section 6.2, *Engineered Structural Fill,* Columbia West should evaluate and assess all soils proposed for use as structural fill, particularly those with a plasticity index greater than 25, to determine suitability for the proposed end use.

6.17 Utility Installation

Utility installation may require subsurface excavation and trenching. Excavation, trenching and shoring should conform to federal (Occupational Safety and Health Administration) (OSHA) (29 CFR, Part 1926) and WISHA (WAC, Chapter 296-155) regulations. Site soils may slough when cut vertically and sudden precipitation events or perched groundwater may result in accumulation of water within excavation zones and trenches.

Utilities should be installed in general accordance with manufacturer's recommendations. Utility trench backfill should consist of *WSDOT 9-03.19 Bank Run Gravel for Trench Backfill* or *WSDOT 9-03.14*(*2*) *Select Borrow* with a maximum particle size of 2 ½-inches. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). The remaining backfill should be compacted to at least 95 percent of maximum dry density as determined by the standard Proctor moisture-density test (ASTM D698). Clean, free-draining, fine bedding sand is recommended for use in the pipe zone. With exception of the pipe zone, backfill should be placed in loose lifts not exceeding 12 inches in thickness.

Compaction of utility trench backfill material should be verified by nuclear gauge field compaction testing performed in accordance with *ASTM D6938*. Field compaction testing should be performed at 200-foot intervals along the utility trench centerline at the surface and midpoint depth of the trench. Compaction frequency and specifications may be modified for non-structural areas in accordance with recommendations of the site geotechnical engineer.

7.0 CONCLUSION AND LIMITATIONS

This geotechnical site investigation report was prepared in accordance with accepted standard conventional principles and practices of geotechnical engineering. This investigation pertains only to material tested and observed as of the date of this report and is based upon proposed site development as described in the text herein. This report is a professional opinion containing recommendations established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. Soil conditions may differ between tested locations or over time. Slight variations may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions are as anticipated in this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Columbia West cannot accept responsibility for deviations from recommendations described in this report. Future performance of structural facilities is often related to the degree of construction observation by qualified personnel. These services should be performed to the full extent recommended.

This report is not an environmental assessment and should not be construed as a representative warranty of site subsurface conditions. The discovery of adverse environmental conditions, or subsurface soils that deviate from those described in this report, should immediately prompt further investigation. The above statements are in lieu of all other statements expressed or implied.

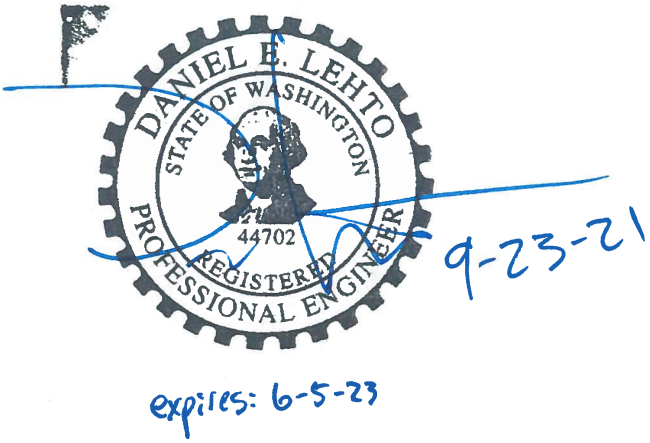
This report was prepared solely for the client and is not to be reproduced without prior authorization from Columbia West. Final engineering plans and specifications for the project should be reviewed and approved by Columbia West as they relate to geotechnical and grading issues prior to final design approval. Columbia West is not responsible for independent conclusions or recommendations made by other parties based upon

information presented in this report. Unless a particular service was expressly included in the scope, it was not performed and there should be no assumptions based upon services not provided. Additional report limitations and important information about this document are presented in Appendix E. This information should be carefully read and understood by the client and other parties reviewing this document.

Sincerely,

COLUMBIA WEST ENGINEERING, Inc.

Daniel E. Lehto, PE, GE
Principal



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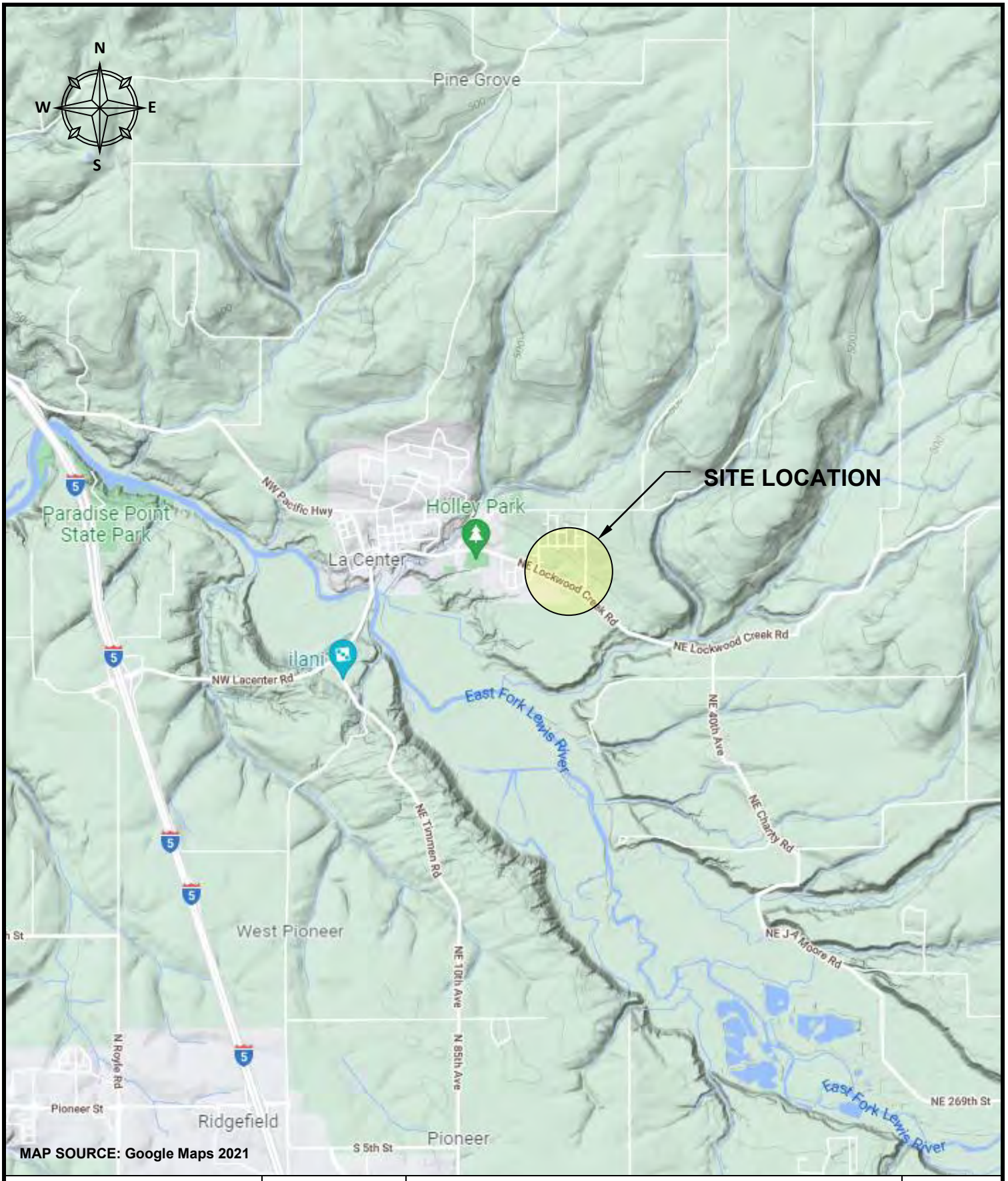
FIGURES



Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	Job No: 21172 Date: 8/6/21 Drawn: CWS Checked: DEL	SITE LOCATION MAP LOCKWOOD MEADOWS SUBDIVISION LA CENTER, WASHINGTON	FIGURE 1

Test Number	Location	Test Depth (feet bgs)	Groundwater Depth on 07/27/21 (feet bgs)	USCS Soil Type (*Indicated Visual Soil Classification)	Passing No. 200 Sieve (%)	WWHM Soil Group Classification **	Infiltration Rate (Coefficient of Permeability, k) (inches/hour)
IT-1.1	TP-1	1	Not Observed	ML, SILT with Sand*	-	4	< 0.06
IT-8.1	TP-8	1	Not Observed	CL, Lean CLAY with Sand*	-	4	< 0.06

SITE BOUNDARY LOCATION OF TEST PIT LOCATION OF INFILTRATION TEST

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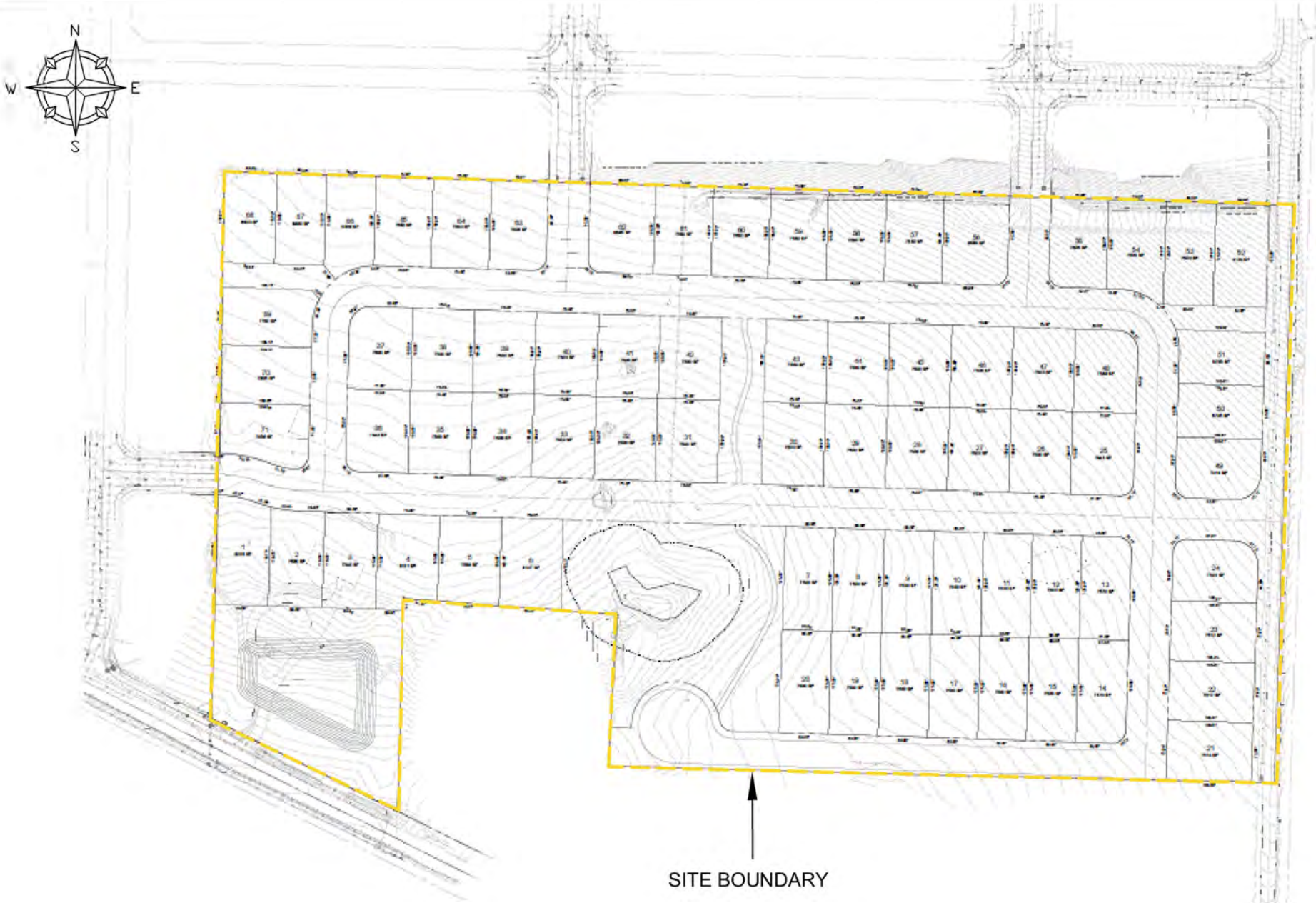
Columbia West Engineering, Inc

Job No: 21172
Date: 07/28/21
Drawn: EMU
Checked: CWS

EXPLORATION LOCATION MAP
LOCKWOOD MEADOWS SUBDIVISION

NOTES:
1. SITE LOCATION: 2000 NE LOCKWOOD CREEK ROAD IN LA CENTER, WASHINGTON.
2. SITE CONSISTS OF TAX PARCEL 209113000, TOTALING APPROXIMATELY 20 ACRES.
3. AERIAL PHOTO SOURCED FROM GOOGLE EARTH.
4. EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
5. TEST PITS BACKFILLED LOOSELY WITH ONSITE SOILS ON JULY 27, 2021.

FIGURE 2



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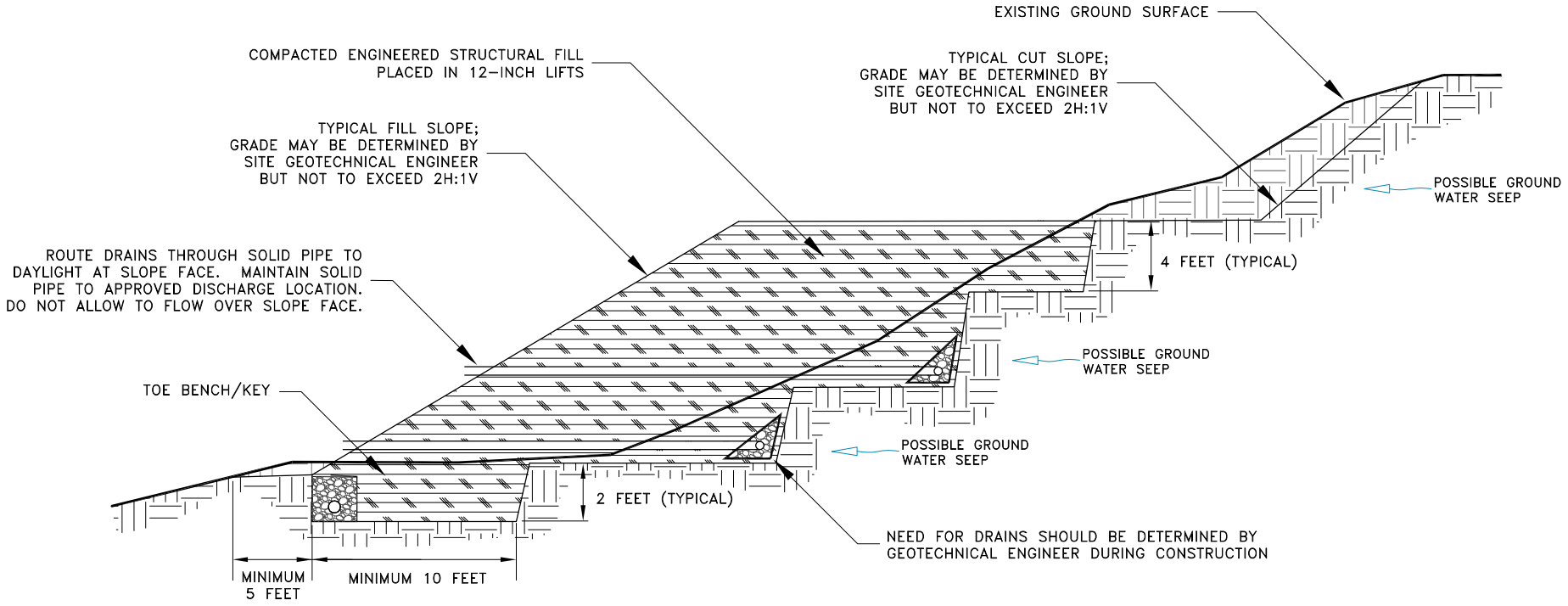
Job No: 21172
Date: 08/25/21
Drawn: EMU
Checked: CWS

PRELIMINARY SITE PLAN
LOCKWOOD MEADOWS
SUBDIVISION

NOTES:
1. PRELIMINARY SITE PLAN PROVIDED BY PLS ENGINEERING
2. SITE PLAN APPLIES TO PARCEL NO. 209113000

FIGURE
2A

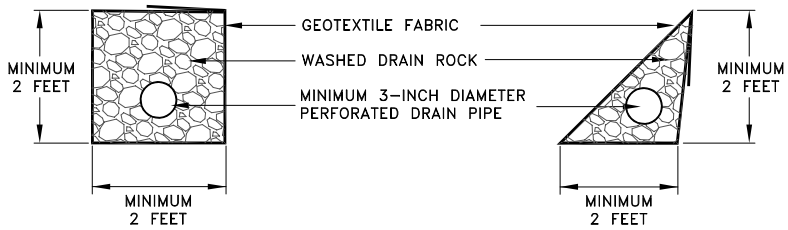


DRAIN SPECIFICATIONS

GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN No. 70 AND No. 100 SIEVE.

WASHED DRAIN ROCK SHALL BE OPEN–GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE No. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

TYPICAL DRAIN SECTION DETAIL



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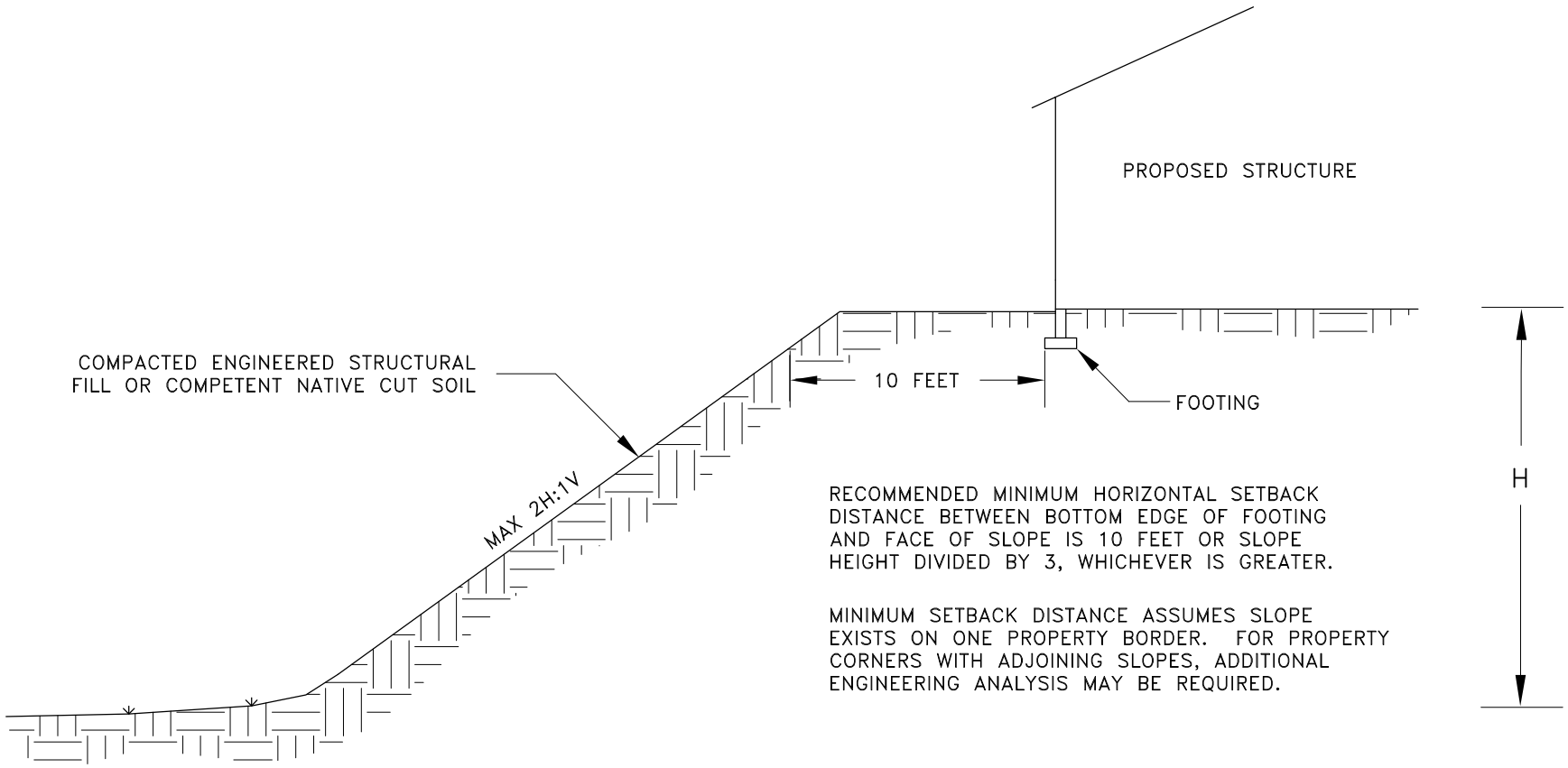
TYPICAL CUT AND FILL SLOPE CROSS SECTION

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL CUT AND FILL SLOPE CROSS SECTION AND MAY NOT BE SITE–SPECIFIC.

FIGURE 3



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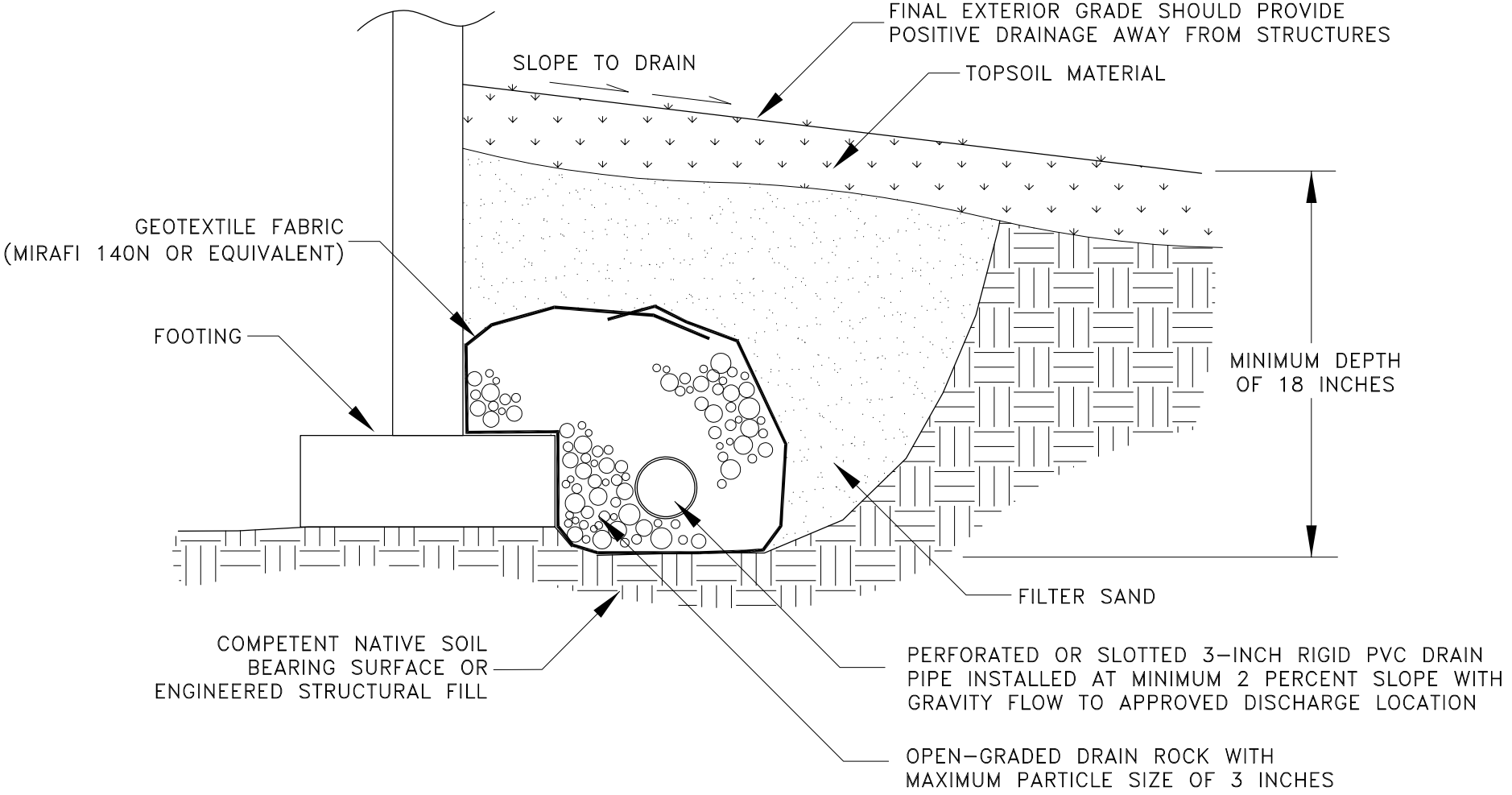
TYPICAL MINIMUM FOUNDATION SLOPE SETBACK DETAIL

NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FOUNDATION SETBACK DETAIL AND MAY NOT BE SITE-SPECIFIC.

FIGURE
4



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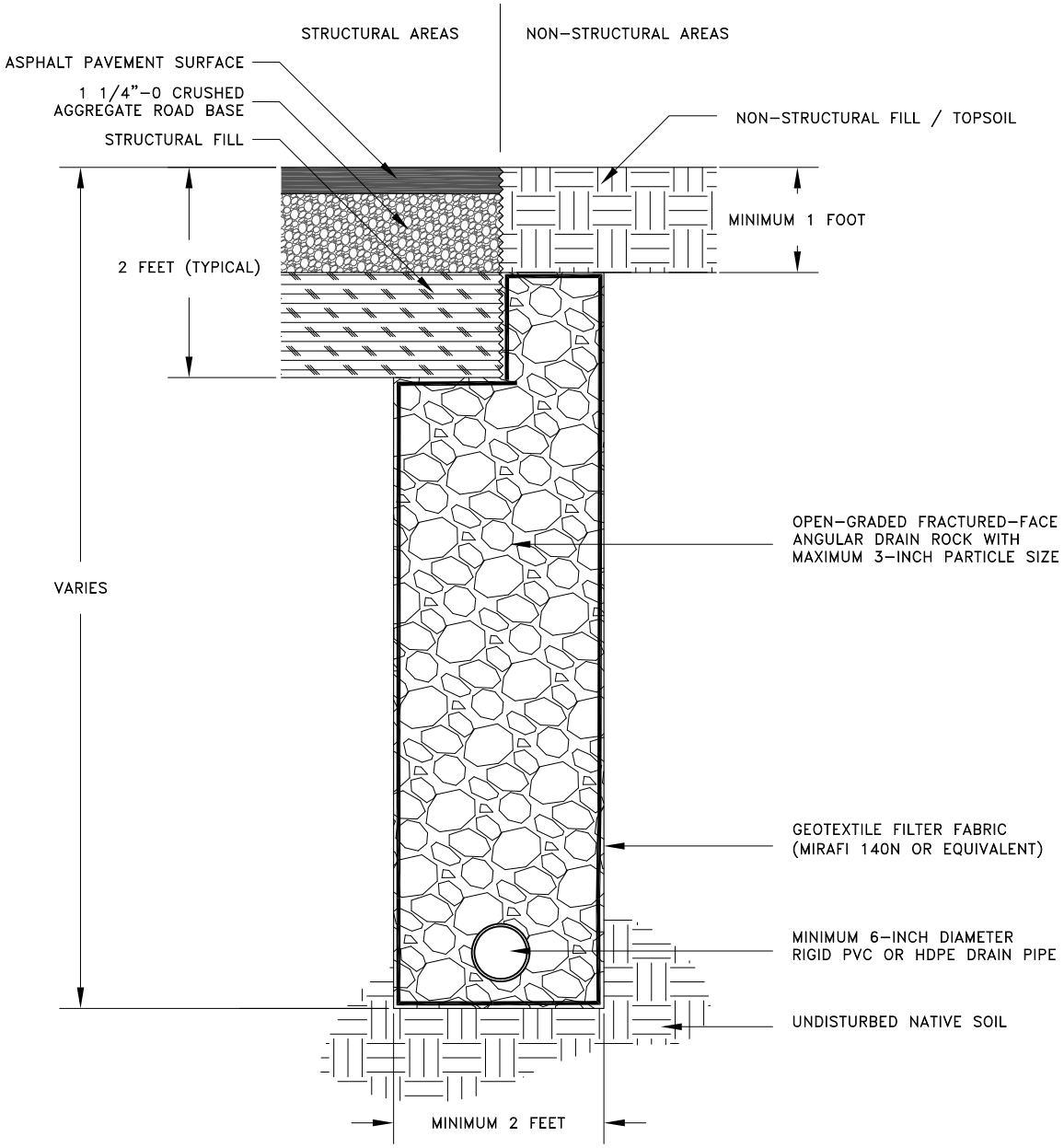
TYPICAL PERIMETER FOOTING DRAIN DETAIL

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL PERIMETER FOOTING DRAIN DETAIL AND MAY NOT BE SITE–SPECIFIC.

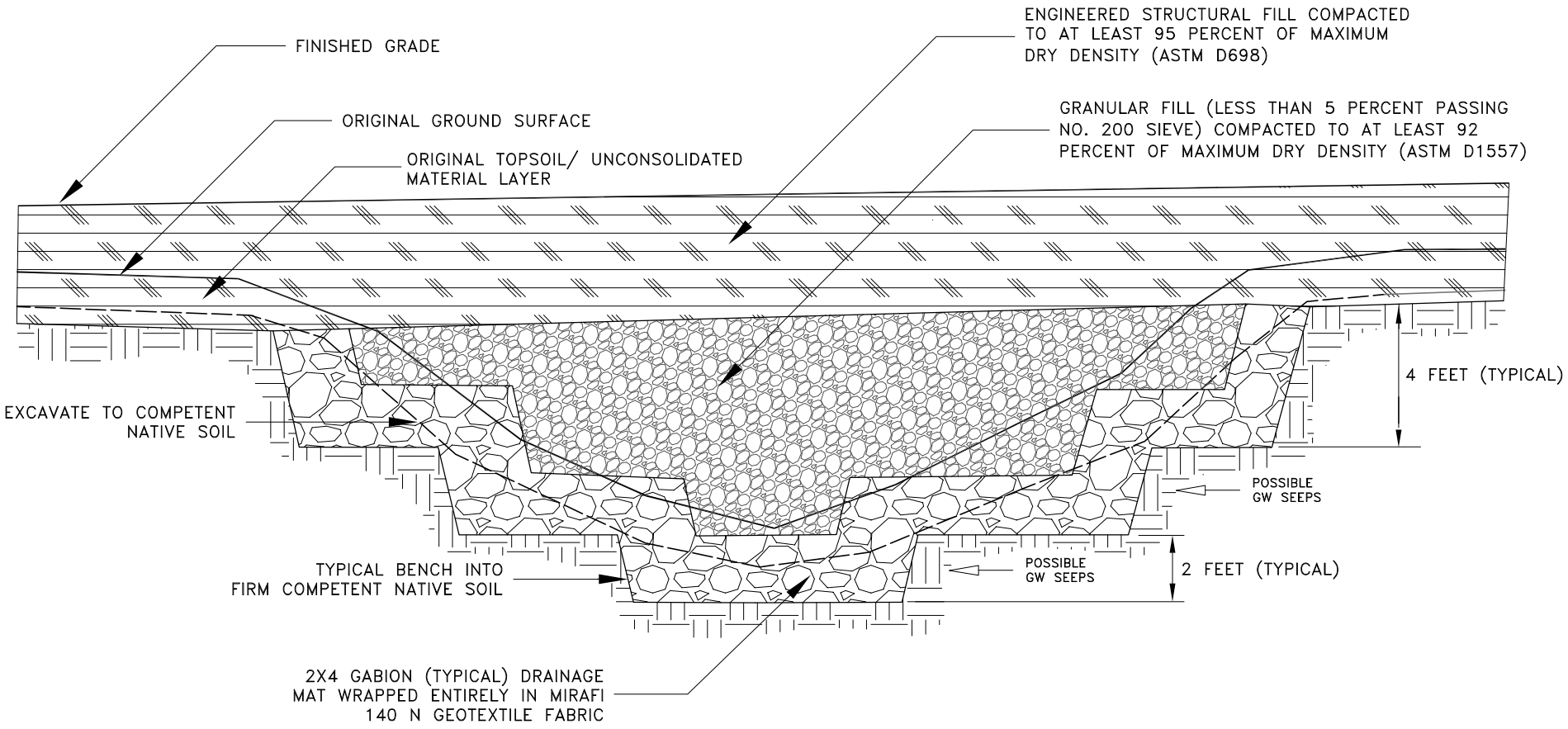
FIGURE
5



NOTE: LOCATION, INVERT ELEVATION, DEPTH OF TRENCH, AND EXTENT OF PERFORATED PIPE REQUIRED MAY BE MODIFIED BY THE GEOTECHNICAL ENGINEER DURING CONSTRUCTION BASED UPON FIELD OBSERVATION AND SITE–SPECIFIC SOIL CONDITIONS.

Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	TYPICAL PERFORATED DRAINPIPE TRENCH DETAIL	NOTES: 1. DRAWING IS NOT TO SCALE. 2. DRAWING REPRESENTS TYPICAL PERFORATED DRAIN PIPE TRENCH DETAIL AND MAY NOT BE SITE–SPECIFIC.	FIGURE 6

TYPICAL DRAINAGE MAT CROSS-SECTION



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TYPICAL DRAINAGE MAT CROSS SECTION

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL DRAINAGE MAT SECTION AND MAY NOT BE SITE–SPECIFIC.

FIGURE 7

APPENDIX A
LABORATORY TEST RESULTS

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0665
		REPORT DATE 08/20/21	FIELD ID TP1.1
		DATE SAMPLED 07/27/21	SAMPLED BY EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
SILT with Sand	Test Pit, TP-01 depth = 10 feet	ML, Silt with Sand
SPECIFICATIONS none		AASHTO CLASSIFICATION A-4(4)

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set

TEST PROCEDURE: ASTM D6913, Method A

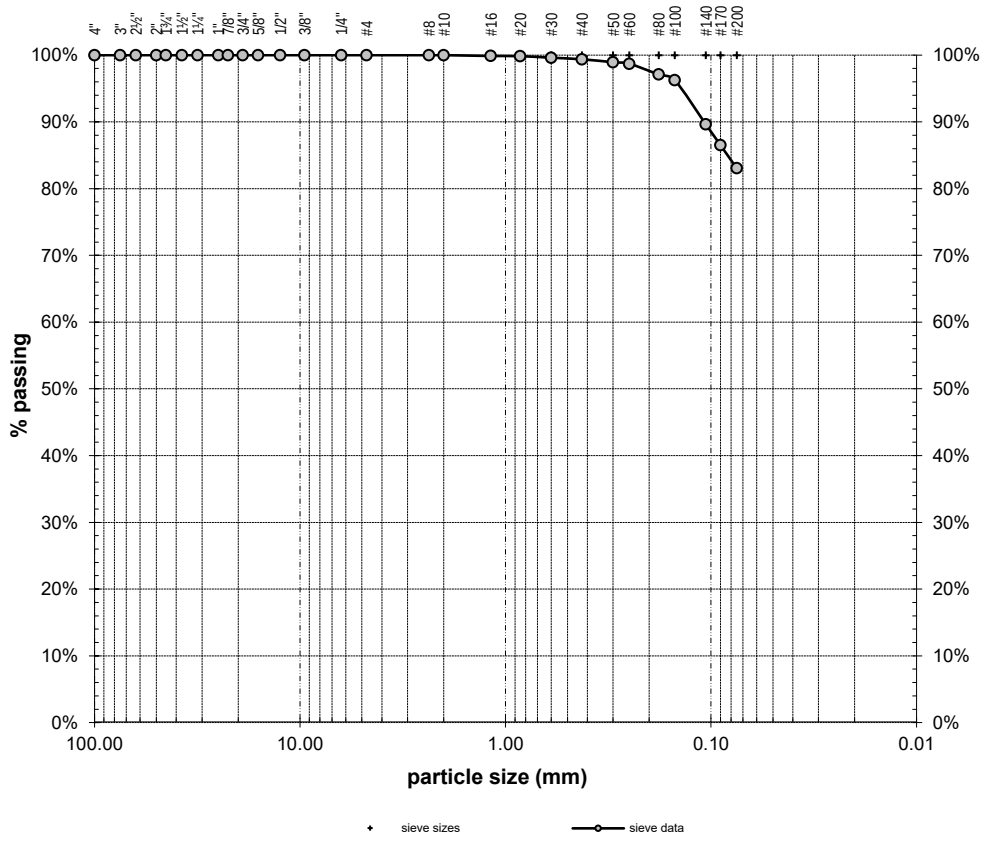
ADDITIONAL DATA

initial dry mass (g) =	164.39		
as-received moisture content =	35.0%	coefficient of curvature, C_C =	n/a
liquid limit =	32	coefficient of uniformity, C_U =	n/a
plastic limit =	27	effective size, $D_{(10)}$ =	n/a
plasticity index =	5	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel =	0.0%
% sand =	16.9%
% silt and clay =	83.1%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		100%		
	#20	0.850	100%			
	#30	0.600		100%		
	#40	0.425	99%			
	#50	0.300		99%		
	#60	0.250	99%			
	#80	0.180		97%		
	#100	0.150	96%			
	#140	0.106		90%		
	#170	0.090		87%		
	#200	0.075	83%			

DATE TESTED	TESTED BY
08/19/21	KMS/MKL

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0665
		REPORT DATE: 08/20/21	FIELD ID: TP1.1
		DATE SAMPLED: 07/27/21	SAMPLED BY: EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
SILT with Sand	Test Pit, TP-01 depth = 10 feet	ML, Silt with Sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit =	32
plastic limit =	27
plasticity index =	5

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	32.88	32.08	32.21	32.61
dry soil + pan weight, g =	30.04	29.37	29.41	29.70
pan weight, g =	20.87	20.91	20.89	21.06
N (blows) =	30	26	21	15
moisture, % =	31.0 %	32.0 %	32.9 %	33.7 %

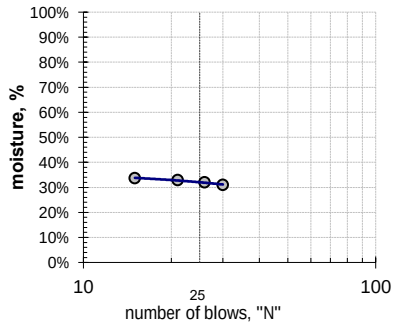
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

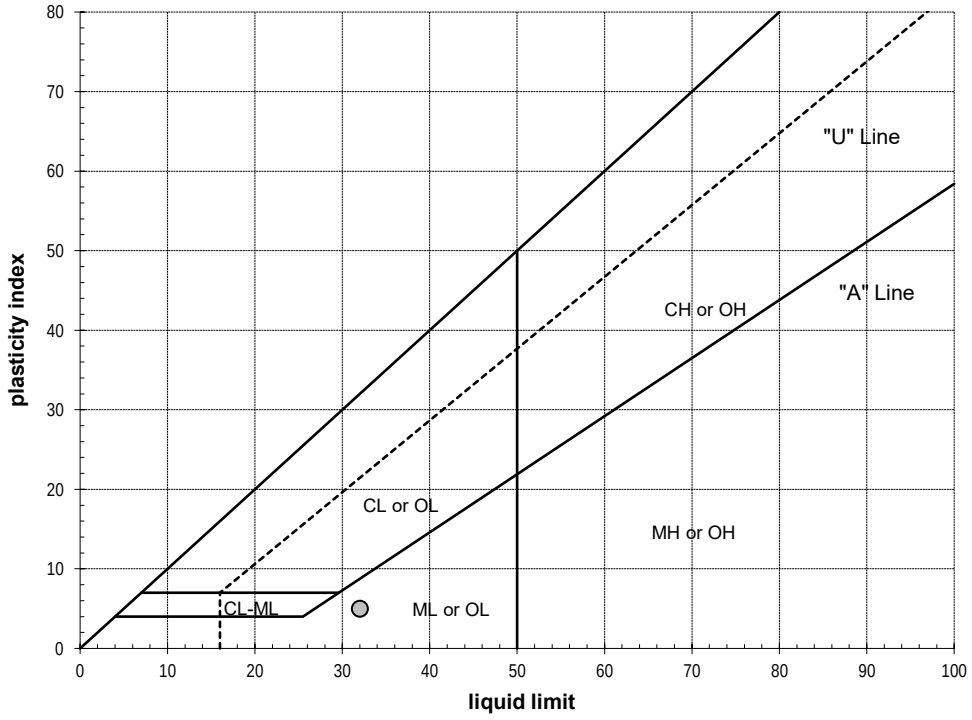
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.63	27.72		
dry soil + pan weight, g =	26.19	26.25		
pan weight, g =	20.95	20.79		
moisture, % =	27.5 %	26.9 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.0%
% sand =	16.9%
% silt and clay =	83.1%
% silt =	n/a
% clay =	n/a
moisture content =	35.0%

DATE TESTED	TESTED BY
08/19/21	KMS

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0666
		REPORT DATE 08/20/21	FIELD ID TP3.1
		DATE SAMPLED 07/27/21	SAMPLED BY EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy SILT	Test Pit, TP-03 depth = 4 feet	ML, Sandy Silt
SPECIFICATIONS none		AASHTO CLASSIFICATION A-6(8)

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set

TEST PROCEDURE: ASTM D6913, Method A

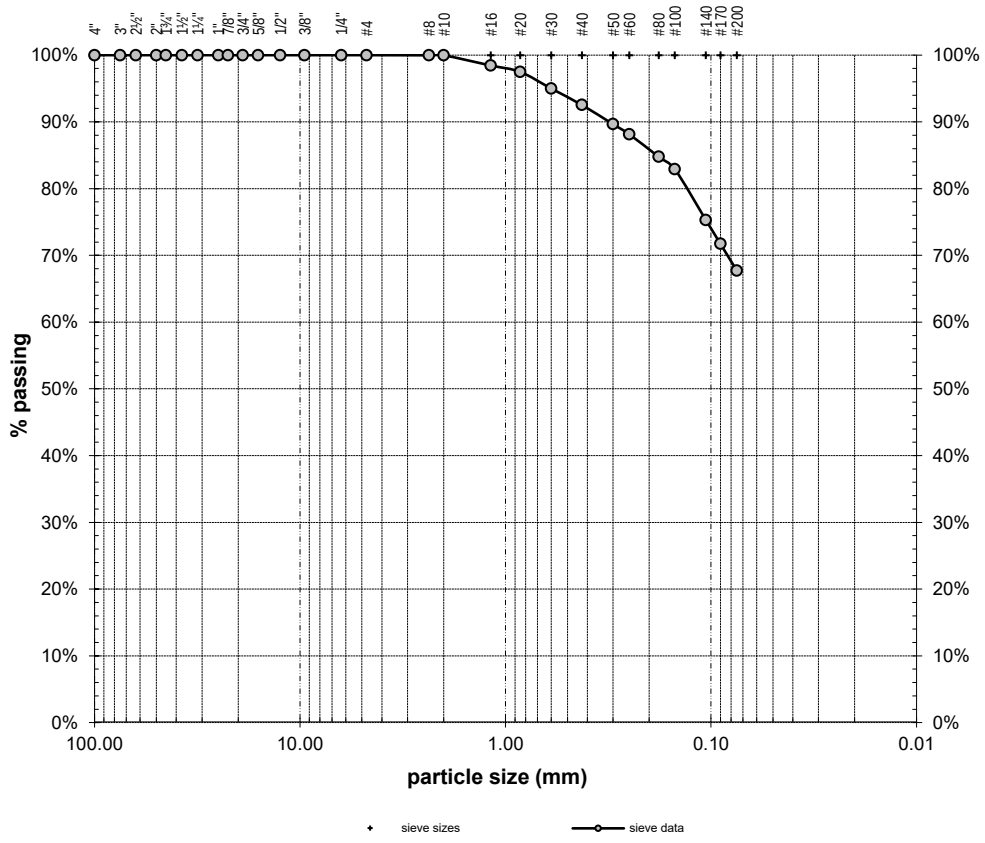
ADDITIONAL DATA

initial dry mass (g) =	162.94		
as-received moisture content =	35.6%	coefficient of curvature, C_C =	n/a
liquid limit =	40	coefficient of uniformity, C_U =	n/a
plastic limit =	27	effective size, $D_{(10)}$ =	n/a
plasticity index =	13	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel =	0.0%
% sand =	32.3%
% silt and clay =	67.7%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE		PERCENT PASSING			
			SIEVE		SPECS	
	US	mm	act.	interp.	max	min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		98%		
	#20	0.850	97%			
	#30	0.600		95%		
	#40	0.425	93%			
	#50	0.300		90%		
	#60	0.250	88%			
	#80	0.180		85%		
	#100	0.150	83%			
	#140	0.106		75%		
	#170	0.090		72%		
	#200	0.075	68%			

DATE TESTED	TESTED BY
08/19/21	KMS/MKL

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0666
		REPORT DATE: 08/20/21	FIELD ID: TP3.1
		DATE SAMPLED: 07/27/21	SAMPLED BY: EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy SILT	Test Pit, TP-03 depth = 4 feet	ML, Sandy Silt

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit =	40
plastic limit =	27
plasticity index =	13

LIQUID LIMIT DETERMINATION

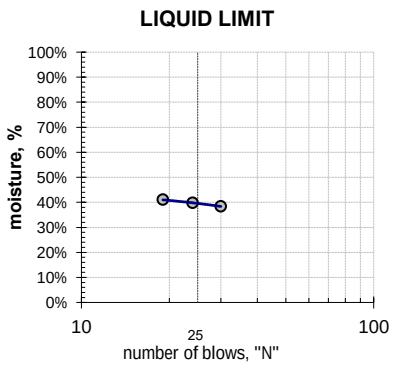
	❶	❷	❸	❹
wet soil + pan weight, g =	31.74	32.02	32.52	
dry soil + pan weight, g =	28.71	28.77	29.15	
pan weight, g =	20.81	20.61	20.93	
N (blows) =	30	24	19	
moisture, % =	38.4 %	39.8 %	41.0 %	

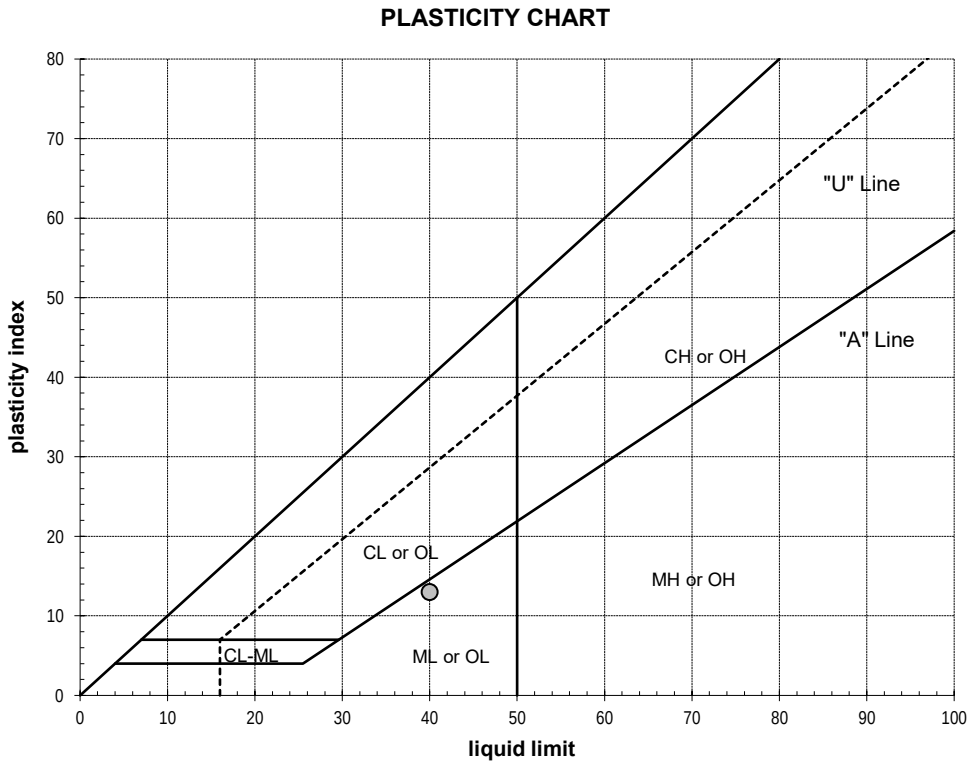
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.19	27.47		
dry soil + pan weight, g =	25.87	26.05		
pan weight, g =	20.91	20.76		
moisture, % =	26.6 %	26.8 %		





ADDITIONAL DATA

% gravel =	0.0%
% sand =	32.3%
% silt and clay =	67.7%
% silt =	n/a
% clay =	n/a
moisture content =	35.6%

DATE TESTED	TESTED BY
08/19/21	KMS

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0667
		REPORT DATE 08/20/21	FIELD ID TP6.1
		DATE SAMPLED 07/27/21	SAMPLED BY EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Fat CLAY	Test Pit, TP-06 depth = 12 feet	CH, Fat Clay
SPECIFICATIONS none		AASHTO CLASSIFICATION A-7-6(30)

LABORATORY TEST DATA

LABORATORY EQUIPMENT
Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set

TEST PROCEDURE
ASTM D6913, Method A

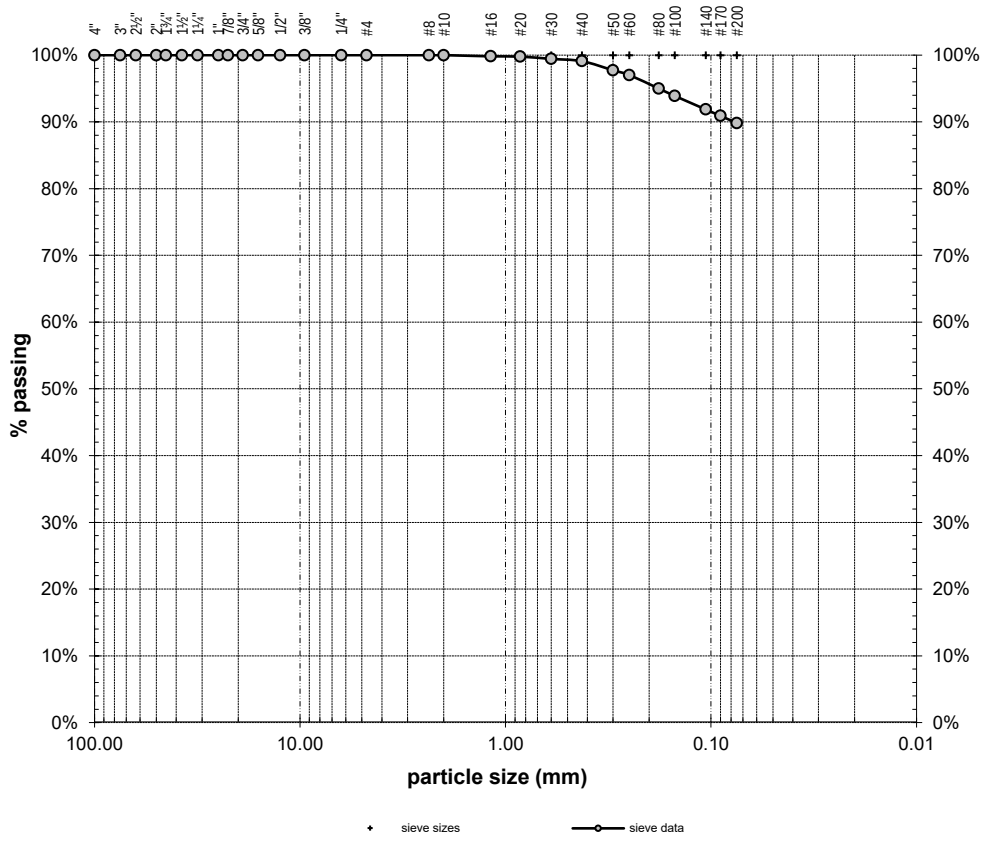
ADDITIONAL DATA

initial dry mass (g) =	168.09		
as-received moisture content =	35.3%	coefficient of curvature, C_C =	n/a
liquid limit =	52	coefficient of uniformity, C_U =	n/a
plastic limit =	21	effective size, $D_{(10)}$ =	n/a
plasticity index =	31	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel =	0.0%
% sand =	10.2%
% silt and clay =	89.8%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE		PERCENT PASSING			
			SIEVE		SPECS	
	US	mm	act.	interp.	max	min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		100%		
	#20	0.850	100%			
	#30	0.600		99%		
	#40	0.425	99%			
	#50	0.300		98%		
	#60	0.250	97%			
	#80	0.180		95%		
	#100	0.150	94%			
	#140	0.106		92%		
	#170	0.090		91%		
	#200	0.075	90%			

DATE TESTED	TESTED BY
08/19/21	KMS/MKL

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0667
		REPORT DATE: 08/20/21	FIELD ID: TP6.1
		DATE SAMPLED: 07/27/21	SAMPLED BY: EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Fat CLAY	Test Pit, TP-06 depth = 12 feet	CH, Fat Clay

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit = 52
plastic limit = 21
plasticity index = 31

LIQUID LIMIT DETERMINATION

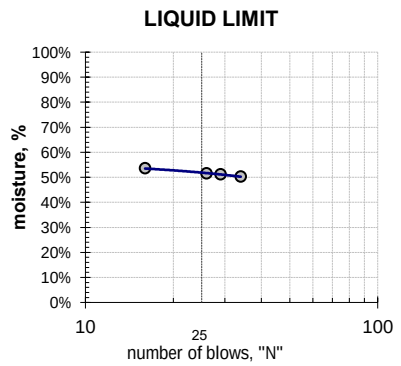
	❶	❷	❸	❹
wet soil + pan weight, g =	34.55	32.22	33.27	31.98
dry soil + pan weight, g =	29.95	28.41	29.07	28.08
pan weight, g =	20.81	20.96	20.92	20.80
N (blows) =	34	29	26	16
moisture, % =	50.3 %	51.1 %	51.5 %	53.6 %

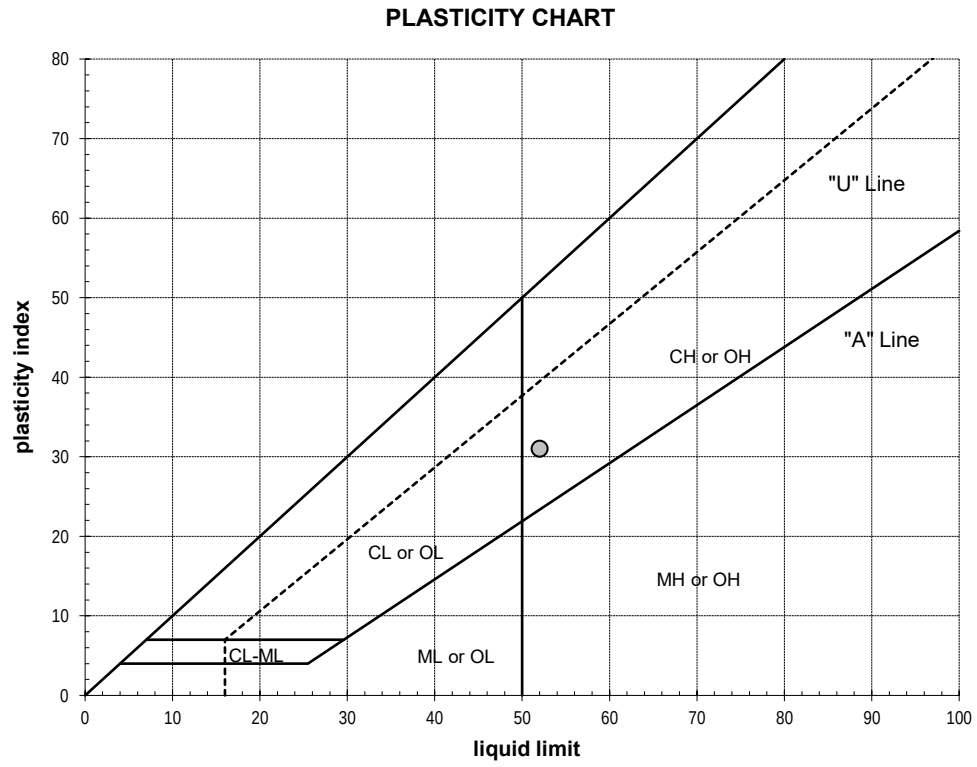
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.61	28.19		
dry soil + pan weight, g =	26.39	26.91		
pan weight, g =	20.61	20.79		
moisture, % =	21.1 %	20.9 %		





ADDITIONAL DATA

% gravel =	0.0%
% sand =	10.2%
% silt and clay =	89.8%
% silt =	n/a
% clay =	n/a
moisture content =	35.3%

DATE TESTED	TESTED BY
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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0668
		REPORT DATE 08/20/21	FIELD ID TP8.1
		DATE SAMPLED 07/27/21	SAMPLED BY EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY with Sand	Test Pit, TP-08 depth = 5 feet	CL, Lean Clay with Sand
SPECIFICATIONS none		AASHTO CLASSIFICATION A-6(11)

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set

TEST PROCEDURE: ASTM D6913, Method A

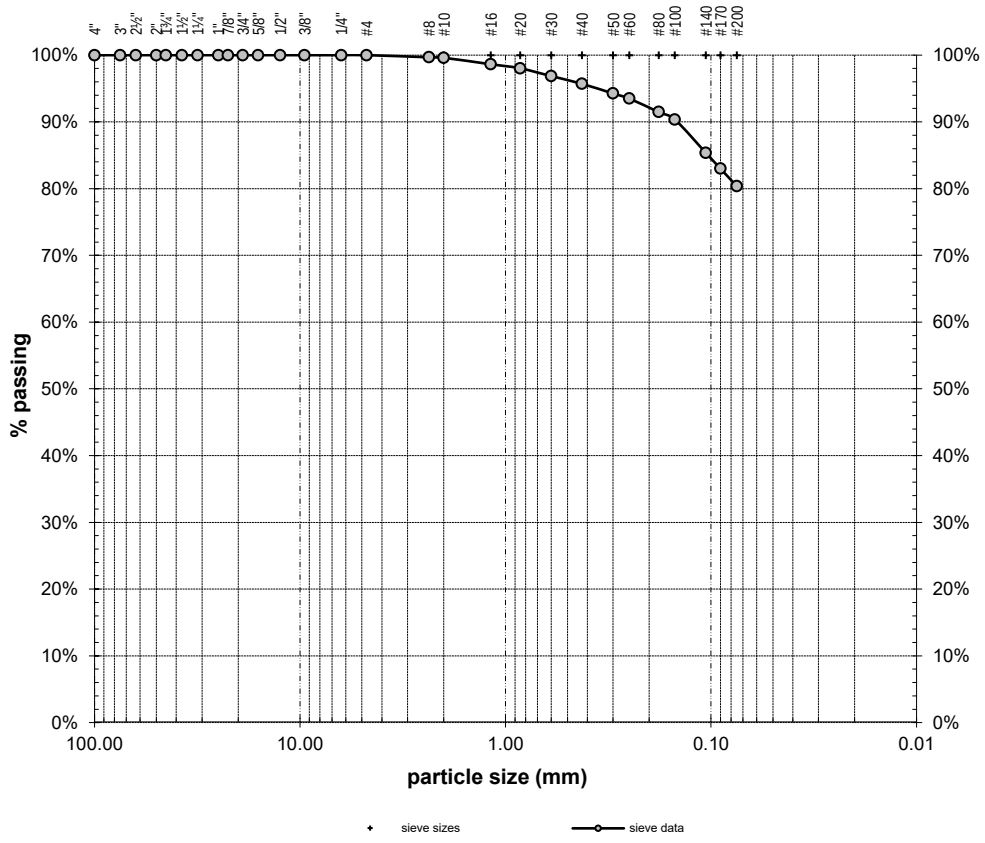
ADDITIONAL DATA

initial dry mass (g) =	177.81		
as-received moisture content =	29.0%	coefficient of curvature, C_C =	n/a
liquid limit =	37	coefficient of uniformity, C_U =	n/a
plastic limit =	23	effective size, $D_{(10)}$ =	n/a
plasticity index =	14	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel =	0.0%
% sand =	19.6%
% silt and clay =	80.4%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		99%		
	#20	0.850	98%			
	#30	0.600		97%		
	#40	0.425	96%			
	#50	0.300		94%		
	#60	0.250	93%			
	#80	0.180		91%		
	#100	0.150	90%			
	#140	0.106		85%		
	#170	0.090		83%		
	#200	0.075	80%			

DATE TESTED	TESTED BY
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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lockwood Meadows Subdivision La Center, Washington	PLS Engineering 604 W Evergreen Blvd Vancouver, Washington 98660	21172	S21-0668
		REPORT DATE: 08/20/21	FIELD ID: TP8.1
		DATE SAMPLED: 07/27/21	SAMPLED BY: EMU/CWS

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY with Sand	Test Pit, TP-08 depth = 5 feet	CL, Lean Clay with Sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit = 37
plastic limit = 23
plasticity index = 14

LIQUID LIMIT DETERMINATION

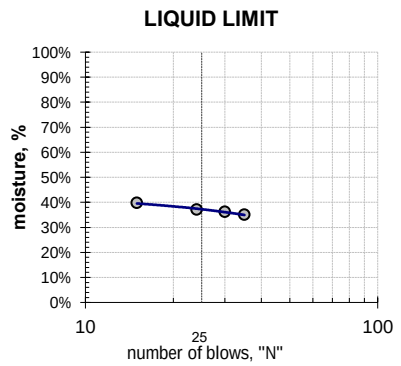
	❶	❷	❸	❹
wet soil + pan weight, g =	33.40	33.03	32.47	33.44
dry soil + pan weight, g =	30.11	29.69	29.31	29.86
pan weight, g =	20.71	20.48	20.78	20.85
N (blows) =	35	30	24	15
moisture, % =	35.0 %	36.3 %	37.1 %	39.7 %

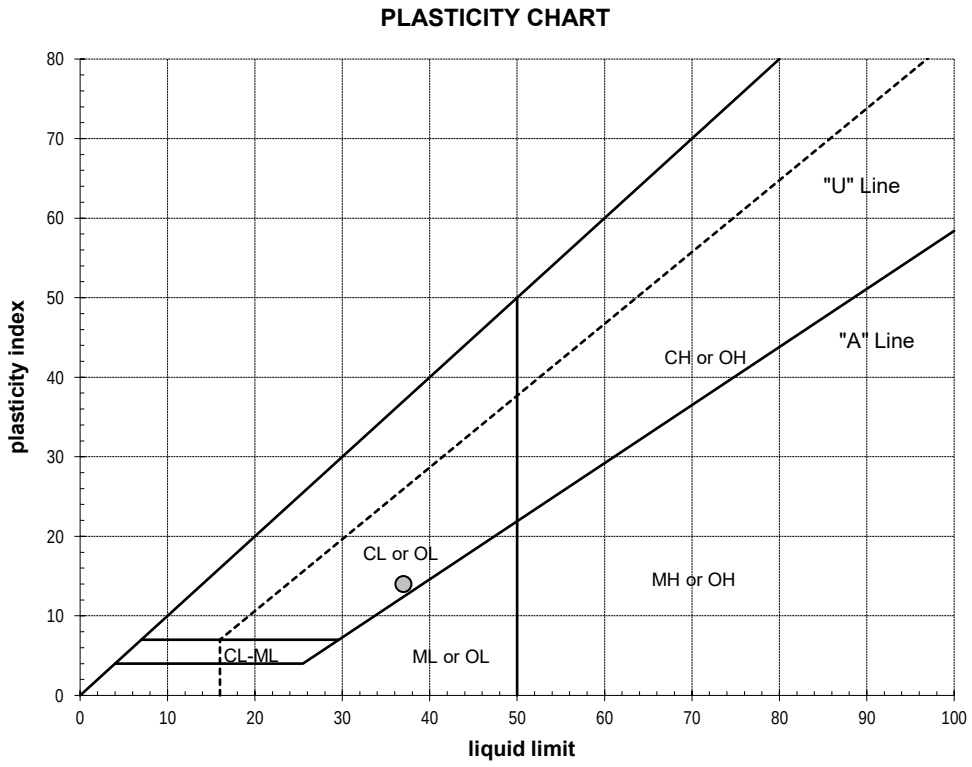
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.93	27.28		
dry soil + pan weight, g =	26.59	26.07		
pan weight, g =	20.80	20.60		
moisture, % =	23.1 %	22.1 %		





ADDITIONAL DATA

% gravel = 0.0%
% sand = 19.6%
% silt and clay = 80.4%
% silt = n/a
% clay = n/a
moisture content = 29.0%

DATE TESTED	TESTED BY
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APPENDIX B
SUBSURFACE EXPLORATION LOGS

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-1
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	156 ft amsl	Not Observed	0819	0842

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 10 inches of grass and topsoil.					
		Hillsboro Silt Loam	A-4(4)	ML		Light brown to brown, mottled, damp to moist, SILT with sand [Soil Type 2].					TP1.1 D = 1.0-ft k < 0.06 in/hr
5											
10	TP1.1					Becomes gray and moist at 10 feet.	35.0	83.1	32	5	
						Bottom of test pit at 14 feet bgs. Groundwater not observed on 07/27/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-2
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	188 ft amsl	Not Observed	0850	0920

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 10 inches of grass and topsoil.					
		Gee Silt Loam	A-4	ML		Light brown to gray, mottled, damp to moist, SILT with sand [Soil Type 2].					
5						Becomes brown and moist at 2.5 feet.					
10											
						Bottom of test pit at 13 feet bgs. Groundwater not observed on 07/27/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-3
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	190 ft amsl	Not Observed	0923	0947

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 10 inches of grass and topsoil.					
		Odne Silt Loam	A-6(8)	ML		Light brown, damp to moist, sandy SILT [Soil Type 2].					
						Becomes brown, mottled, and moist at 3 feet.					
	TP3.1						35.6	67.7	40	13	
5											
10			A-6	CL		Brown, moist, lean CLAY with sand [Soil Type 3].					
						Bottom of test pit at 13 feet bgs. Groundwater not observed on 07/27/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-4
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	182 ft amsl	Not Observed	0949	1015

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 to 14 inches of grass and topsoil.					
		Odne Silt Loam	A-6	ML		Light brown to brown, mottled, damp to moist, sandy SILT [Soil Type 2].					
5											
			A-6	CL		Brown to gray, moist, lean CLAY with sand [Soil Type 3].					
10											
						Bottom of test pit at 13 feet bgs. Groundwater not observed on 07/27/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-5
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	184 ft amsl	Not Observed	1022	1042

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 12 inches of grass and topsoil.					
		Gee Silt Loam	A-4	ML		Light brown to brown, mottled, damp to moist, SILT with sand [Soil Type 2].					
5											
			A-6	CL		Brown to gray, moist, lean CLAY with sand [Soil Type 3].					
10											
			A-7	CH		Brown, moist, fat CLAY [Soil Type 4].					
						Bottom of test pit at 14 feet bgs. Groundwater not observed on 07/27/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-6
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	184 ft amsl	Not Observed	1045	1102

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 10 inches of grass and topsoil.					
		Gee Silt Loam	A-4	ML		Light brown to gray, mottled, damp to moist, SILT with sand [Soil Type 2].					
5											
			A-6	CL		Brown, moist, lean CLAY with sand [Soil Type 3].					
10											
	TP6.1		A-7-6(30)	CH		Gray, moist, fat CLAY [Soil Type 4].	35.3	89.8	52	31	
						Bottom of test pit at 14 feet bgs. Groundwater not observed on 07/27/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-7
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	200 ft amsl	Not Observed	1117	1140

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 10 inches of grass and topsoil.					
		Odne Silt Loam	A-4	ML		Light brown to brown, mottled, damp to moist, SILT with sand [Soil Type 2].					
5											
			A-6	CL		Brown to gray, moist, lean CLAY with sand [Soil Type 3].					
10											
			A-4	ML		Brown to gray, moist, SILT with sand [Soil Type 2].					
						Bottom of test pit at 14 feet bgs. Groundwater not observed on 07/27/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Lockwood Meadows Subdivision	PLS Engineering		21172	TP-8
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**ENGINEER/GEOLOGIST**	**DATE**
La Center, Washington	L&S Contractors	Excavator	EMU / CWS	07/27/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	228 ft amsl	Not Observed	1145	1205

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 10 inches of grass and topsoil.					
		Hillsboro Silt Loam	A-6(11)	CL		Brown, mottled, damp to moist, lean CLAY with sand [Soil Type 3].					TP8.1 D = 1.0-ft k < 0.06 in/hr
5	TP8.1						29.0	80.4	37	14	
10						Becomes moist at 10 feet.					
						Bottom of test pit at 14 feet bgs. Groundwater not observed on 07/27/21.					
15											

APPENDIX C
SOIL CLASSIFICATION INFORMATION

SOIL DESCRIPTION AND CLASSIFICATION GUIDELINES

Particle-Size Classification

COMPONENT	ASTM/USCS		AASHTO	
	size range	sieve size range	size range	sieve size range
Cobbles	> 75 mm	greater than 3 inches	> 75 mm	greater than 3 inches
Gravel	75 mm – 4.75 mm	3 inches to No. 4 sieve	75 mm – 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm – 19.0 mm	3 inches to 3/4-inch sieve	-	-
Fine	19.0 mm – 4.75 mm	3/4-inch to No. 4 sieve	-	-
Sand	4.75 mm – 0.075 mm	No. 4 to No. 200 sieve	2.00 mm – 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm – 2.00 mm	No. 4 to No. 10 sieve	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve	-	-
Fine	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	< 0.075 mm	Passing No. 200 sieve	< 0.075 mm	Passing No. 200 sieve

Consistency for Cohesive Soil

CONSISTENCY	SPT N-VALUE (BLOWS PER FOOT)	POCKET PENETROMETER (UNCONFINED COMPRESSIVE STRENGTH, tsf)
Very Soft	2	less than 0.25
Soft	2 to 4	0.25 to 0.50
Medium Stiff	4 to 8	0.50 to 1.0
Stiff	8 to 15	1.0 to 2.0
Very Stiff	15 to 30	2.0 to 4.0
Hard	30 to 60	greater than 4.0
Very Hard	greater than 60	-

Relative Density for Granular Soil

RELATIVE DENSITY	SPT N-VALUE (BLOWS PER FOOT)
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Moisture Designations

TERM	FIELD IDENTIFICATION
Dry	No moisture. Dusty or dry.
Damp	Some moisture. Cohesive soils are usually below plastic limit and are moldable.
Moist	Grains appear darkened, but no visible water is present. Cohesive soils will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grains. Sand and silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is much wetter than optimum moisture content and is above plastic limit.

AASHTO SOIL CLASSIFICATION SYSTEM

TABLE 1. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing .075 mm)				Silt-Clay Materials (More than 35 Percent Passing 0.075)		
Group Classification	A-1	A-3	A-2	A-4	A-5	A-6	A-7
Sieve analysis, percent passing:							
2.00 mm (No. 10)	-	-	-				
0.425 mm (No. 40)	50 max	51 min	-	-	-	-	-
0.075 mm (No. 200)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid limit				40 max	41 min	40 max	41 min
Plasticity index	6 max	N.P.		10 max	10 max	11 min	11 min
General rating as subgrade	Excellent to good			Fair to poor			

Note: The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

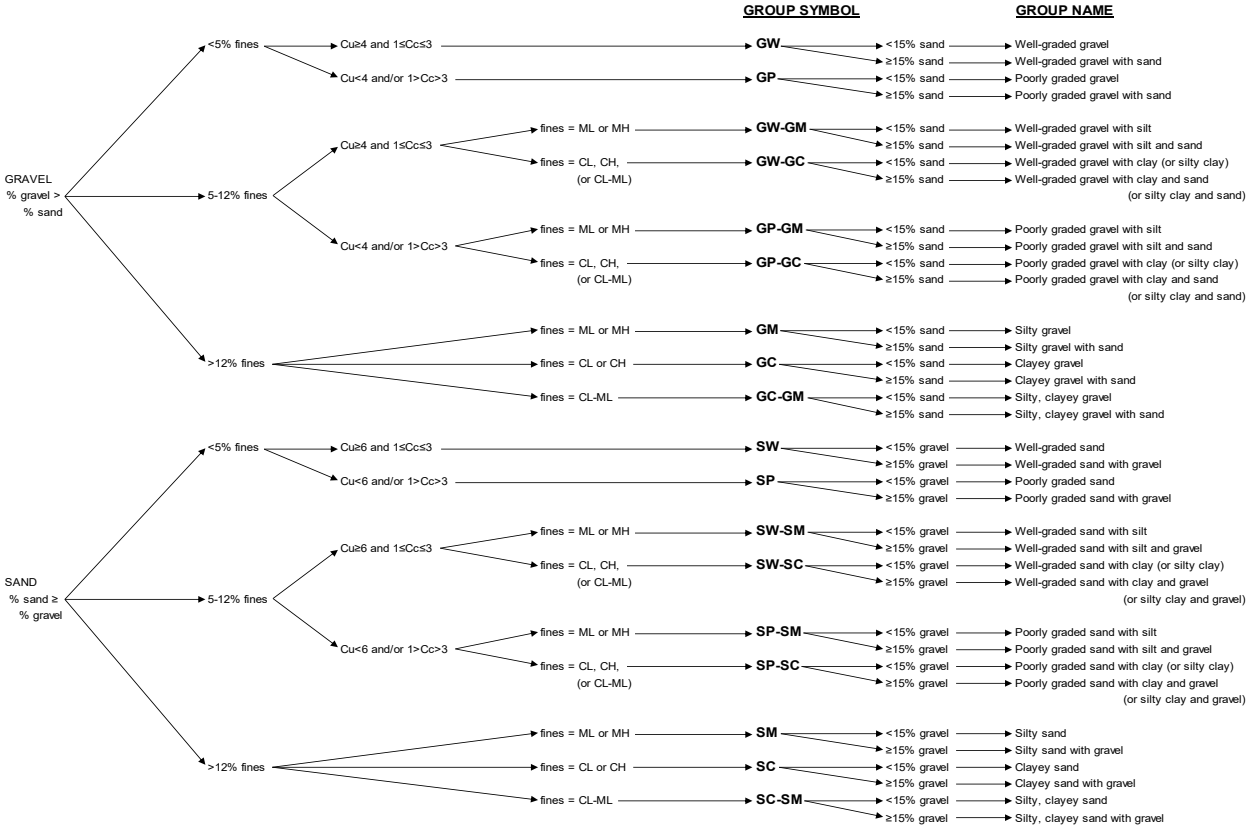
TABLE 2. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing 0.075 mm)							Silt-Clay Materials (More than 35 Percent Passing 0.075 mm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, percent passing:											
2.00 mm (No. 10)	50 max	-	-	-	-	-	-	-	-	-	-
0.425 mm (No. 40)	30 max	50 max	51 min	-	-	-	-	-	-	-	-
0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11min
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General ratings as subgrade	Excellent to Good							Fair to poor			

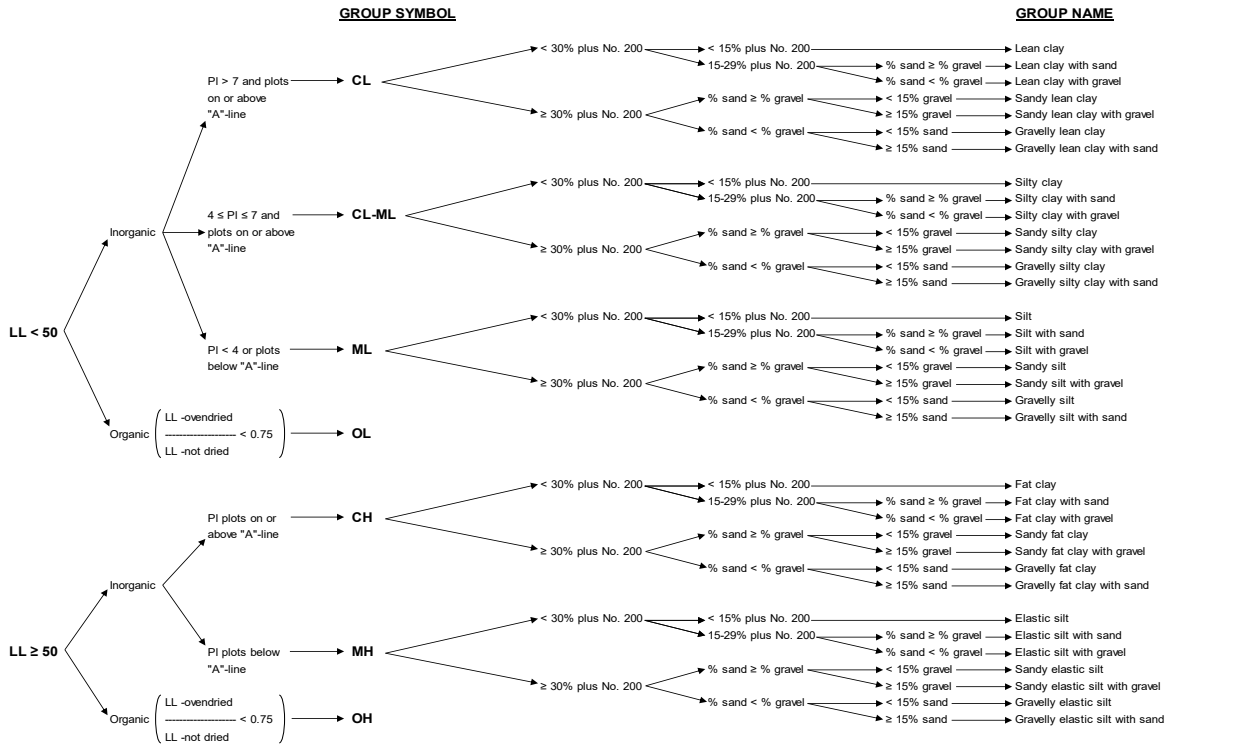
Note: Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

AASHTO = American Association of State Highway and Transportation Officials

USCS SOIL CLASSIFICATION SYSTEM



Flow Chart for Classifying Coarse-Grained Soils (More Than 50% Retained on No. 200 Sieve)



Flow Chart for Classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve)

APPENDIX D
PHOTO LOG

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

LOCKWOOD MEADOWS SUBDIVISION

JULY, 2021

LA CENTER, WASHINGTON

North Site View, Facing East

LOCKWOOD MEADOWS SUBDIVISION

JULY, 2021

LA CENTER, WASHINGTON

East Site View, Facing West

LOCKWOOD MEADOWS SUBDIVISION

JULY, 2021

LA CENTER, WASHINGTON

Central Site Area, Facing West

LOCKWOOD MEADOWS SUBDIVISION

JULY, 2021

LA CENTER, WASHINGTON

Typical Soil Profile, TP-5

APPENDIX E
REPORT LIMITATIONS AND IMPORTANT INFORMATION

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

Date: September 23, 2021
Project: Lockwood Meadows Subdivision
La Center, Washington

Geotechnical and Environmental Report Limitations and Important Information

Report Purpose, Use, and Standard of Care

This report has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and/or environmental consulting, and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This report has been prepared to meet the specific needs of specific individuals for the indicated site. It may not be adequate for use by other consultants, contractors, or engineers, or if change in project ownership has occurred. It should not be used for any other reason than its stated purpose without prior consultation with Columbia West Engineering, Inc. (Columbia West). It is a unique report and not applicable for any other site or project. If site conditions are altered, or if modifications to the project description or proposed plans are made after the date of this report, it may not be valid. Columbia West cannot accept responsibility for use of this report by other individuals for unauthorized purposes, or if problems occur resulting from changes in site conditions for which Columbia West was not aware or informed.

Report Conclusions and Preliminary Nature

This geotechnical or environmental report should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. The exploration and associated laboratory analysis of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the subject property. However, soil conditions may differ between tested locations at different seasonal times of the year, either by natural causes or human activity. Distinction between soil types may be more abrupt or gradual than indicated on the soil logs. This report is not intended to stand alone without understanding of concomitant instructions, correspondence, communication, or potential supplemental reports that may have been provided to the client.

Because this report is based upon observations obtained at the time of exploration, its adequacy may be compromised with time. This is particularly relevant in the case of natural disasters, earthquakes, floods, or other significant events. Report conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the subject property. Groundwater conditions, if presented in this report, reflect observed conditions at the time of investigation. These conditions may change annually, seasonally or as a result of adjacent development.

Additional Investigation and Construction QA/QC

Columbia West should be consulted prior to construction to assess whether additional investigation above and beyond that presented in this report is necessary. Even slight variations in soil or site conditions may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions do not differ materially or significantly from the interpreted conditions utilized for preparation of this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Actual subsurface conditions are more readily observed and discerned during the earthwork phase of construction when soils are exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this report or future

performance of structural facilities if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

Collected Samples

Uncontaminated samples of soil or rock collected in connection with this report will be retained for thirty days. Retention of such samples beyond thirty days will occur only at client's request and in return for payment of storage charges incurred. All contaminated or environmentally impacted materials or samples are the sole property of the client. Client maintains responsibility for proper disposal.

Report Contents

This geotechnical or environmental report should not be copied or duplicated unless in full, and even then only under prior written consent by Columbia West, as indicated in further detail in the following text section entitled *Report Ownership*. The recommendations, interpretations, and suggestions presented in this report are only understandable in context of reference to the whole report. Under no circumstances should the soil boring or test pit excavation logs, monitor well logs, or laboratory analytical reports be separated from the remainder of the report. The logs or reports should not be redrawn or summarized by other entities for inclusion in architectural or civil drawings, or other relevant applications.

Report Limitations for Contractors

Geotechnical or environmental reports, unless otherwise specifically noted, are not prepared for the purpose of developing cost estimates or bids by contractors. The extent of exploration or investigation conducted as part of this report is usually less than that necessary for contractor's needs. Contractors should be advised of these report limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this report, but should rely upon their own interpretations as to how subsurface conditions may affect cost, feasibility, accessibility and other components of the project work. If believed necessary or relevant, contractors should conduct additional exploratory investigation to obtain satisfactory data for the purposes of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface ground conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

Report Ownership

Columbia West retains the ownership and copyright property rights to this entire report and its contents, which may include, but may not be limited to, figures, text, logs, electronic media, drawings, laboratory reports, and appendices. This report was prepared solely for the client, and other relevant approved users or parties, and its distribution must be contingent upon prior express written consent by Columbia West. Furthermore, client or approved users may not use, lend, sell, copy, or distribute this document without express written consent by Columbia West. Client does not own nor have rights to electronic media files that constitute this report, and under no circumstances should said electronic files be distributed or copied. Electronic media is susceptible to unauthorized manipulation or modification, and may not be reliable.

Consultant Responsibility

Geotechnical and environmental engineering and consulting is much less exact than other scientific or engineering disciplines, and relies heavily upon experience, judgment, interpretation, and opinion often based upon media (soils) that are variable, anisotropic, and non-homogenous. This often results in unrealistic expectations, unwarranted claims, and uninformed disputes against a geotechnical or environmental consultant. To reduce potential for these problems and assist relevant parties in better understanding of risk, liability, and responsibility, geotechnical and environmental reports often provide definitive statements or clauses defining and outlining consultant responsibility. The client is encouraged to read these statements carefully and request additional information from Columbia West if necessary.

APPENDIX E

Operations and Maintenance Manual

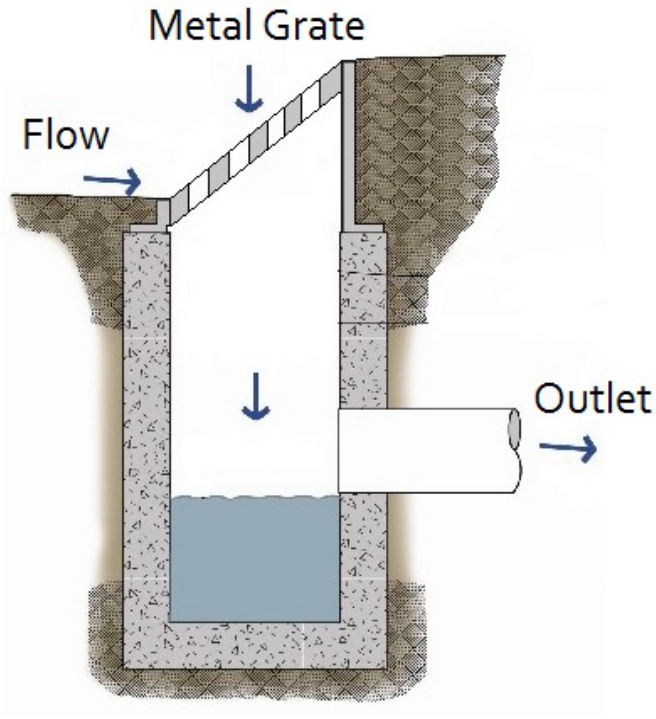
Field Inlet

A field inlet is a concrete structure fitted with a slotted grate to collect stormwater runoff and route it through underground pipes.

Field inlets typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some field inlets are fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

Facility objects that are typically associated with a field inlet include:

- access road or easement
- control structure/flow restrictor
- biofiltration wale
- detention pond
- infiltration trench



Key Operations and Maintenance Considerations

- The most common tool for cleaning field inlets is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.

- A field inlet may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a field inlet, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Field Inlet			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the field inlet by more than 10%.	No trash or debris located immediately in front of field inlet or on grate opening.
		Trash or debris (in the field inlet) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the field inlet.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the field inlet.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the field inlet.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering field inlet through cracks.	Pipe is regrouted and secure at basin wall.

Field Inlet			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation Inhibiting System	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	No contaminants or pollutants present.
Metal Grates	Grate Not in Place	Cover is missing or only partially in place. Any open field inlet requires maintenance.	Field inlet cover is closed.
	Grate Opening Unsafe	Grate with opening wider than 3 inches.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Catch Basin

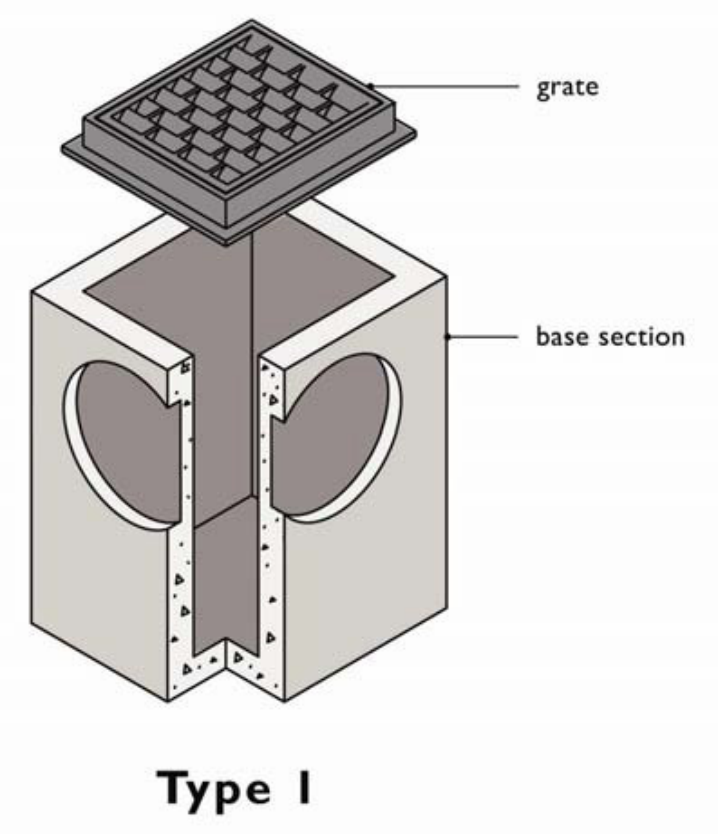
A catch basin is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two types.

A Type 1 catch basin is a rectangular box with approximate dimensions of 3'x2'x5'. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the gate to the bottom of the pipe is less than 5 feet.

A Type 2 catch basin, also commonly referred to as a storm manhole, is listed separately under "Manhole" in this book.

Catch basins typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or debris.

Catch basins are frequently associated with all stormwater facilities.



Key Operations and Maintenance Considerations

- The most common tool for cleaning catch basins is an industrial vacuum truck with a tank and vacuum hose (e.g. Vactor® truck) to remove sediment and debris from the sump.
- A catch basin may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Catch Basin			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.

	Basin Walls/ Bottom	Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation Inhibiting System	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	No contaminants or pollutants present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Metal Grates (If Applicable)	Grate Opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.
Oil/Debris Trap (If Applicable)	Dislodged	Oil or debris trap is misaligned with or dislodged from the outlet pipe.	Trap is connected to and aligned with outlet pipe.

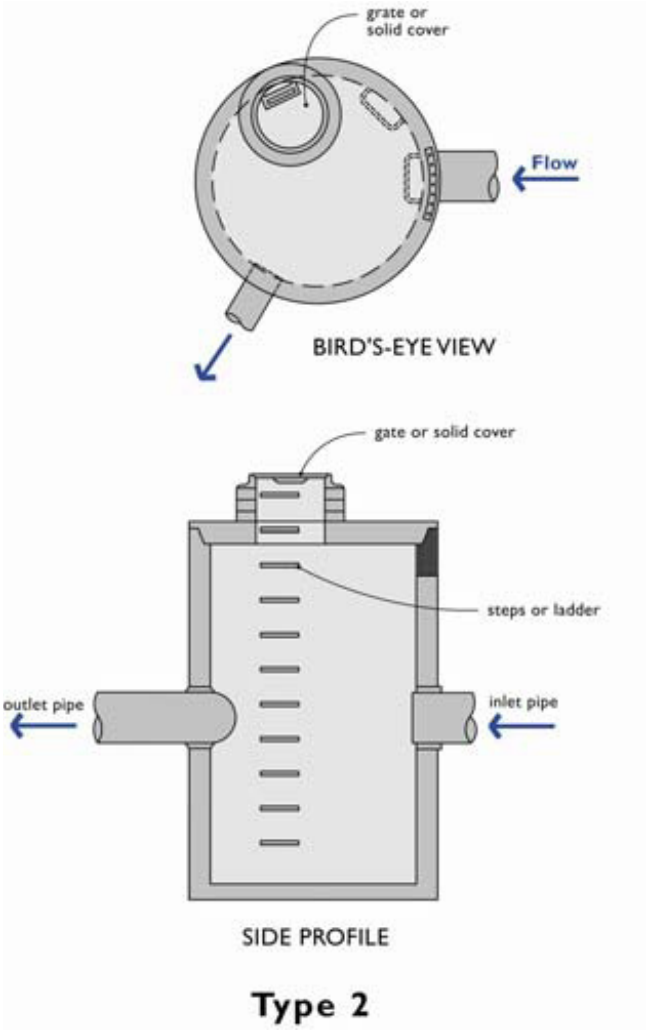
Manhole

A manhole is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Manholes can also be used as a junction in a pipe system and may have a solid lid. A manhole is also known as a Type 2 catch basin.

Manholes are round concrete structures ranging in diameter from 4 feet to 8 feet. They are used when the connecting conveyance pipe is 18 inches or greater or the depth from grate to pipe bottom exceeds 5 feet. Manholes typically have steps mounted on the side of the structure to allow access.

Manholes typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some manholes are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

Manholes are often associated with other stormwater facilities.



Key Operations and Maintenance Considerations

- The most common tool for cleaning manholes is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.
- A manhole may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a manhole, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Manhole			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris located immediately in front of manhole or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the basin.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into manhole.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering manhole through cracks.	Pipe is regrouted and secure at basin wall.

	Settlement/ Misalignment	If failure of manhole has created a safety, function, or design problem.	Manhole replaced or repaired to design standards.
	Vegetation Inhibiting System	Vegetation growing across and blocking more than 10% of the opening.	No vegetation blocking opening to manhole.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	No contaminants or pollutants present.
Manhole Cover	Cover Not in Place	Cover is missing or only partially in place. Any open manhole is a safety hazard and requires immediate maintenance.	Manhole cover is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to manhole wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate Opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

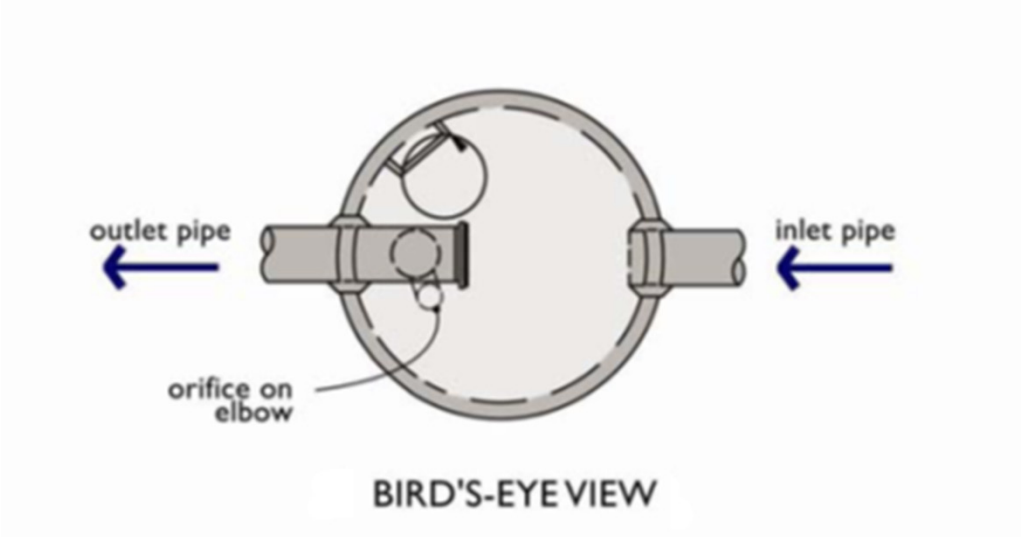
Control Structure/Flow Restrictor

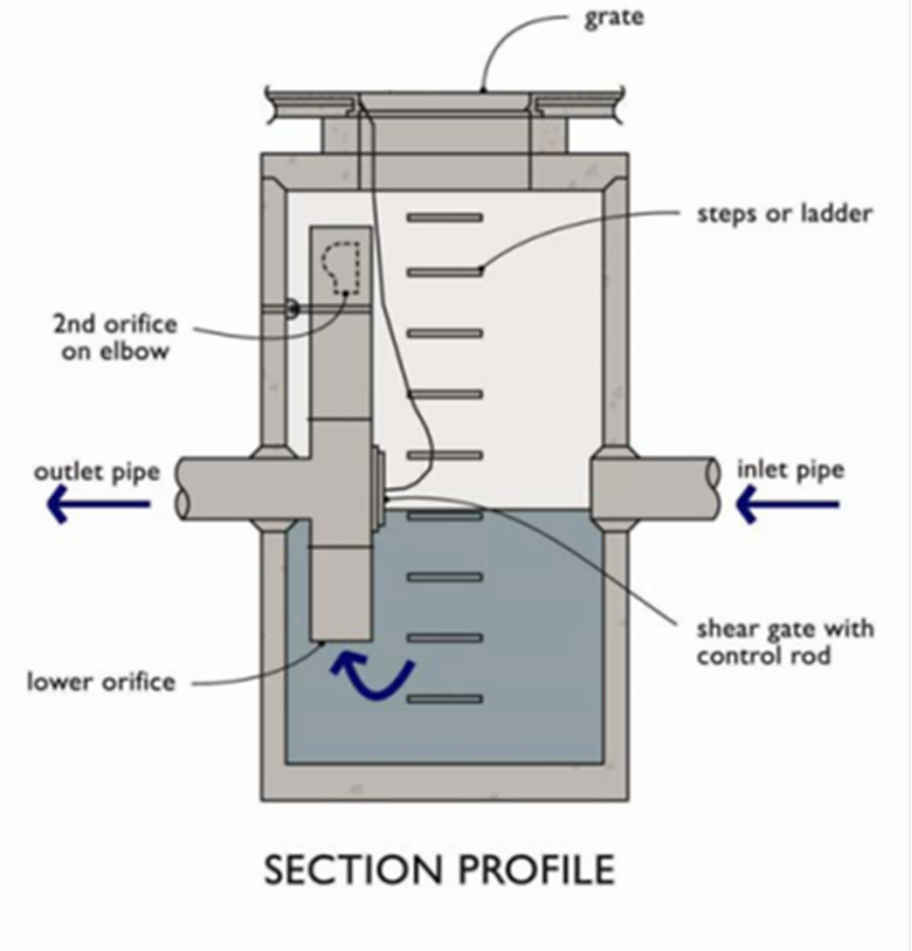
Flow control structures and flow restrictors direct or restrict flow in or out of facility components. Outflow controls on detention facilities are a common example where flow control structures slowly release stormwater at a specific rate. The flow is regulated by a combination of orifices (holes with specifically sized diameters) and weirs (plates with rectangular or "V" shaped notch). Lack of maintenance of the control structure can result in the plugging of an orifice. If these flow controls are damaged, plugged, bypassed, or not working properly, the facility could overtop or release water too quickly.

Control structures have a history of maintenance-related problems and it is imperative to establish a good maintenance program for them to function properly. Sediment typically builds up inside the structure, which blocks or restricts flow to the outlet. To prevent this problem, routinely clean out these structures and conduct regular inspections to detect the need for non-routine cleanout.

Facility objects that are typically associated with a control structure/flow restrictor include:

- detention ponds
- media cartridge filters
- closed detention system
- conveyance stormwater pipe





Key Operations and Maintenance Considerations

- Conduct regular inspections of control structures to detect the need for non-routine cleanout, especially if construction or land-disturbing activities occur in the contributing drainage area.
- The most common tool for cleaning control structures/flow restrictors is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.
- A control structure is an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a control structure, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

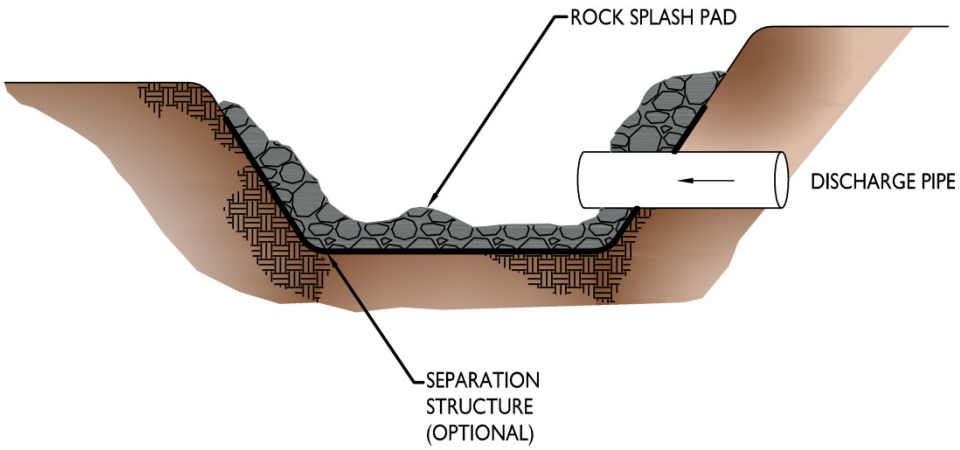
Control Structure/Flow Restrictor			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris has been removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design specifications. Allows maintenance person safe access.
Catch Basins	**See "Catch Basins"**		

Energy Dissipater / Outfall Protection

An energy dissipater is installed on or near the inlet or outlet to a closed pipe system to prevent erosion at these locations. There are a variety of designs, including wire gabion baskets, rock splash pads, trenches, and specially designed pools or manholes. The rock splash pad is typically constructed of 4- to 12-inch diameter rocks a minimum of 12 inches thick and is often lined with filter fabric. The rock pad should extend above the top of the pipe a minimum of 1 foot.

Facility features that are typically associated with energy dissipaters include:

- detention ponds
- infiltration basin
- wetponds
- treatment wetlands



Key Operations and Maintenance Considerations

- The most common tools for maintenance are hand tools such as rakes to redistribute rocks as necessary.
- Periodic removal of sediment or debris may be necessary.

Energy Dissipaters			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad has been replaced to design function.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad has been replaced to design function.
	Sediment	Sediment on top of rock pad exceeds 10% of the surface.	Rock pad has been cleared of sediment.
	Poisonous Plants and Noxious Weeds	Any poisonous plants or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Coordinate with Clark County Environmental Services Department, Vegetation Management Program.)	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Eradication of Class A weeds as required by State law. Control of Class B weeds designated by Clark County Weed Board. Control of other listed weeds as directed by local policies. Apply requirements of adopted IPM policy for the use of herbicides.
	Other Weeds	Other weeds (not listed on County/State noxious weed lists) are present on the rock pad.	Weeds have been removed per the routine maintenance schedule, following IPM protocols.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe is free of sediment and meets design specifications.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a “sheet flow” of water along trench). Intent is to prevent erosion damage.	Trench has been repaired or modified such that it does not discharge at concentrated points and meets design function.
	Perforations Plugged	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe has been cleaned or replaced and <25% of perforations are plugged.
	Water Flows Out Top of “Distributor” Catch Basin	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt per design specifications or redesigned to meet approved County standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/ Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
Catch Basins	**See "Catch Basins"**		

Stormwater Conveyance Pipe

Storm sewer pipes convey stormwater. Inlet and outlet stormwater pipes convey stormwater in, through, and out of stormwater facilities.

Pipes are built from many materials and are sometimes perforated to allow stormwater to infiltrate into the ground. Pipes are cleaned to remove sediment or blockages when problems are identified. Stormwater pipes must be clear of obstructions and breaks to prevent localized flooding. All stormwater pipes should be in proper working order and free of the possible defects listed below.

Key Operations and Maintenance Considerations

- The most common tool for cleaning stormwater conveyance pipes is a truck with a tank, vacuum hose, and a jet hose (Vactor® truck) to flush sediment and debris from the pipes.

Stormwater Conveyance Pipe			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	No contaminants or pollutants present.
	Drainage Slow	Decreased capacity that indicates slow drainage. Does not meet facility design infiltration rate. The Water Quality Design Storm Volume does not infiltrate within 48 hours (if perforated pipe). Water remains in the pipe for greater than 24 hours after the end of most moderate rainfall events.	Perforated drain pipe has been cleaned and drainage rates are per design specifications. (Do not allow removed sediment and water to discharge back into the storm sewer.)
	Obstructions, Including Roots	Root enters or deforms pipe, reducing flow.	Roots have been removed from pipe (using mechanical methods; do not put root-dissolving chemicals in storm sewer pipes). If necessary, vegetation over the line removed.
	Pipe Dented or Broken	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced per design standards.
	Pipe Rusted or Deteriorated	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired and/or replaced per design standards.
	Sediment & Debris	Sediment depth is greater than 20% of pipe diameter.	Pipe has been cleaned and is free of sediment/ debris. (Upstream debris traps installed where applicable.)
	Debris Barrier or Trash Rack Missing	Stormwater pipes > than 18 inches need debris barrier.	Debris barrier present on all stormwater pipes 18 inches and greater.

Stormwater Facility Discharge Points / Pipe Outlets

Stormwater facility discharge points may convey stormwater from the stormwater facility into open channels, ditches, ponds, streams, and wetlands. Stormwater facility discharge points need to be assessed to make sure stormwater is not causing any negative impacts to these drainage areas.

Key Operations and Maintenance Considerations

- The most common tools are hand tools to remove debris or to redistribute outfall protection rock.

(Source: USDA - Natural Resources Conservation Service - Illinois)

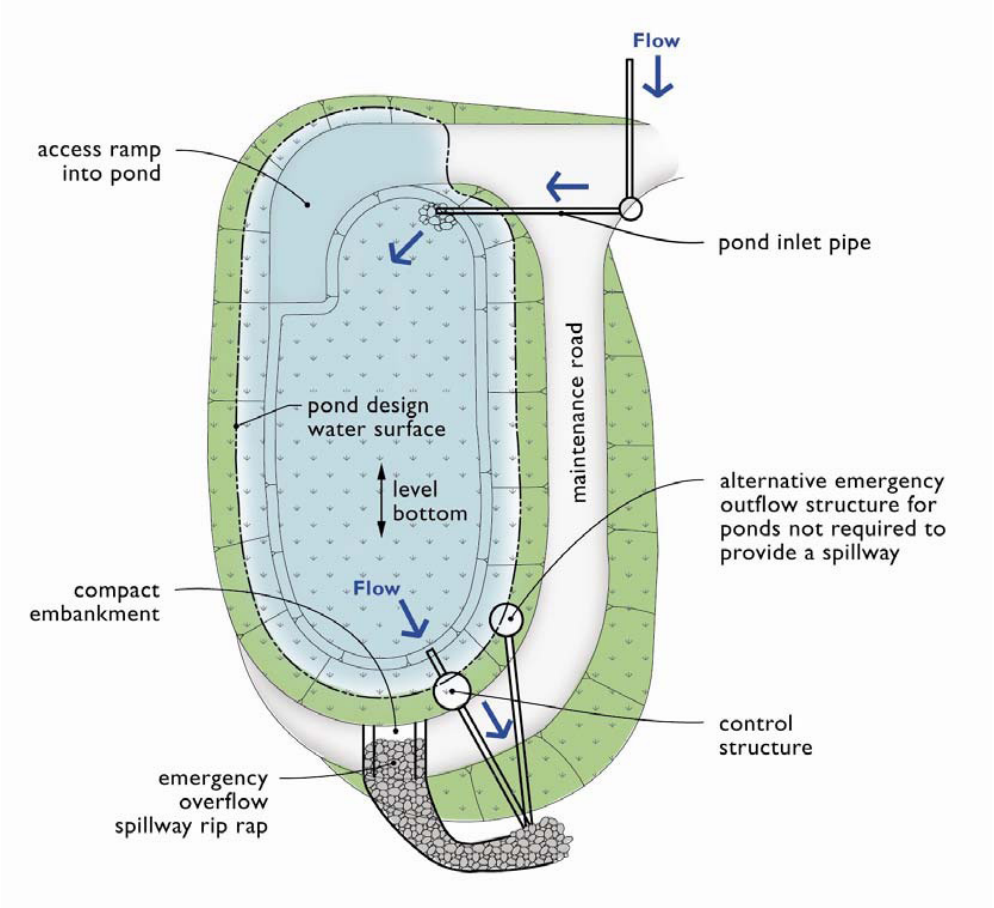
Facility Discharge Point			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
Monitoring	Contaminants in Discharge Water	Any evidence of oil, gasoline, contaminants or other pollutants. Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program.	Effluent discharge from facility is clear.
	Receiving Area Saturated	Water in receiving area is causing substrate to become saturated and unstable. • Report to Clark County Clean Water Program for Engineer Evaluation.	Receiving area is sound and not saturated.
	Ditch or Stream Banks Eroding (via Off Site Assessment)	Erosion, scouring, or headcuts in ditch or stream banks downstream of facility discharge point due to flow channelization or higher flows. • Report to Clark County Clean Water Program for Engineer Evaluation.	Ditch or stream banks are stable.
General	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design function.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design function.
	Obstructions, Including Roots	Roots or debris enters pipe or deforms pipe, reducing flow.	Roots have been removed from pipe (using mechanical methods; do not put root-dissolving chemicals in storm sewer pipes). If necessary, vegetation over the line removed.
	Pipe Rusted or Deteriorated	Any part of the pipe that is broken, crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced to design standards.
Internal (If Applicable)			
Energy Dissipater	**See "Energy Dissipater"**		

Detention Pond

A stormwater detention pond is an open basin built by excavating below existing ground or by constructing above-ground berms (embankments). The detention pond temporarily stores stormwater runoff during rain events and slowly releases it through an outlet (control structure). Detention ponds are typically designed to completely drain within 24 hours after the completion of a storm event. Styles vary greatly from well-manicured to natural appearing. Generally, more natural-appearing vegetation is preferred for reduced maintenance and enhanced wildlife habitat.

Facility objects that are typically associated with a detention pond include:

- access road or easement
- fence, gate, and water quality sign
- typical bioswale
- wet bioswale
- media filter cartridge
- control structure/flow restrictor
- energy dissipaters
- conveyance stormwater pipe



Example of a Manicured Detention Pond

Key Operations and Maintenance Considerations

- Maintenance is of primary importance if detention ponds are to continue to function well.
- Sediment should be removed when the standards in the defect table are exceeded. Sediments must be disposed in accordance with current local health department requirements and the Minimum Functional Standards for Solid Waste Handling. For additional guidance see Book 3, Appendix 3-E, Recommendations for Management of Street Waste.
- Handle sediments removed during the maintenance operation in a manner consistent with Book 3, Appendix 3-E, Recommendations for Management of Street Waste.
- If a shallow marsh has established, then contact Clark County Department of Environmental Services for advice.
- Maintenance of sediment forebays and attention to sediment accumulation within the pond is extremely important. Continually monitor sediment deposition in the basin. Owners, operators, and maintenance authorities should be aware that significant concentrations of metals (e.g., lead, zinc, and cadmium) as well as some organics such as pesticides, may be expected to accumulate at the bottom of these types of facilities. Regularly conduct testing sediment, especially near points of inflow, to determine the leaching potential and level of accumulation of potentially hazardous material before disposal.
- Slope areas that have become bare should be revegetated and eroded areas should be regraded prior to being revegetated.
- A common tool for cleaning detention ponds is a small bulldozer or excavator to remove built-up sediment and debris from the bottom of the pond during the dry season.

Plant Material

Table 1: Stormwater Tract "Low Grow" Seed Mix* for Detention Pond

Stormwater Tract "Low Grow" Seed Mix*		
Botanical Name	Common Name	% By Weight
Festuca arundinacea var.	Dwarf tall fescue	40%
Lolium perenne var. barclay	Dwarf perennial rye** 'Barclay'	30%
Festuca rubra	Red fescue	25%
Agrostis tenius	Colonial bentgrass	5%
Selected plants shall not include any plants from the State of Washington Noxious Weed List. Refer to clark.wa.gov/weed/ for a current list of noxious weeds.		

*Adapted from Ecology 2012, v.III, Ch 3.2.

** If wildflowers are used and sowing is done before Labor Day, the amount of dwarf perennial rye can be reduced proportionately to the amount of wildflower seed used.

Detention Pond			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Any trash and debris which exceed 1 cubic foot per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Site is free of trash and debris.
	Poisonous Plants and Noxious Weeds	Any poisonous plants or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Coordinate with Clark County Environmental Services Department, Vegetation Management Program.)	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Eradication of Class A weeds as required by State law. Control of Class B weeds designated by Clark County Weed Board. Control of other listed weeds as directed by local policies. Apply requirements of adopted IPM policy for the use of herbicides.
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vaccuming, or equipment movements). If trees are not interfering with access or maintenance, do not remove. Dead, diseased, or dying trees are identified. (Use a certified Arborist to determine health of tree or removal requirements.)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard trees.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. (Coordinate removal/cleanup with local water quality response agency.)	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with Clark County Maintenance and Operations department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies.)

Detention Pond			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted Clark County Operations and Maintenance policies.
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes have been stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation.	Dike is built back to the design elevation.
		If settlement is apparent, measure berm to determine amount of settlement.	
		Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue.	Piping eliminated. Erosion potential resolved.
		(Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	
Emergency Overflow/ Spillway and Berms Over 4 Feet in Height	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.

Detention Pond			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Rock Missing	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes have been stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.

Media Cartridge Filters

Media cartridge filters are passive, flow-through, stormwater treatment systems. They are comprised of one or more vaults that house rechargeable, media-filled filter cartridges. Stormwater passes through a filtering medium, which traps particulates and/or adsorb pollutants such as dissolved metals and hydrocarbons. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged into an open channel drainage way.

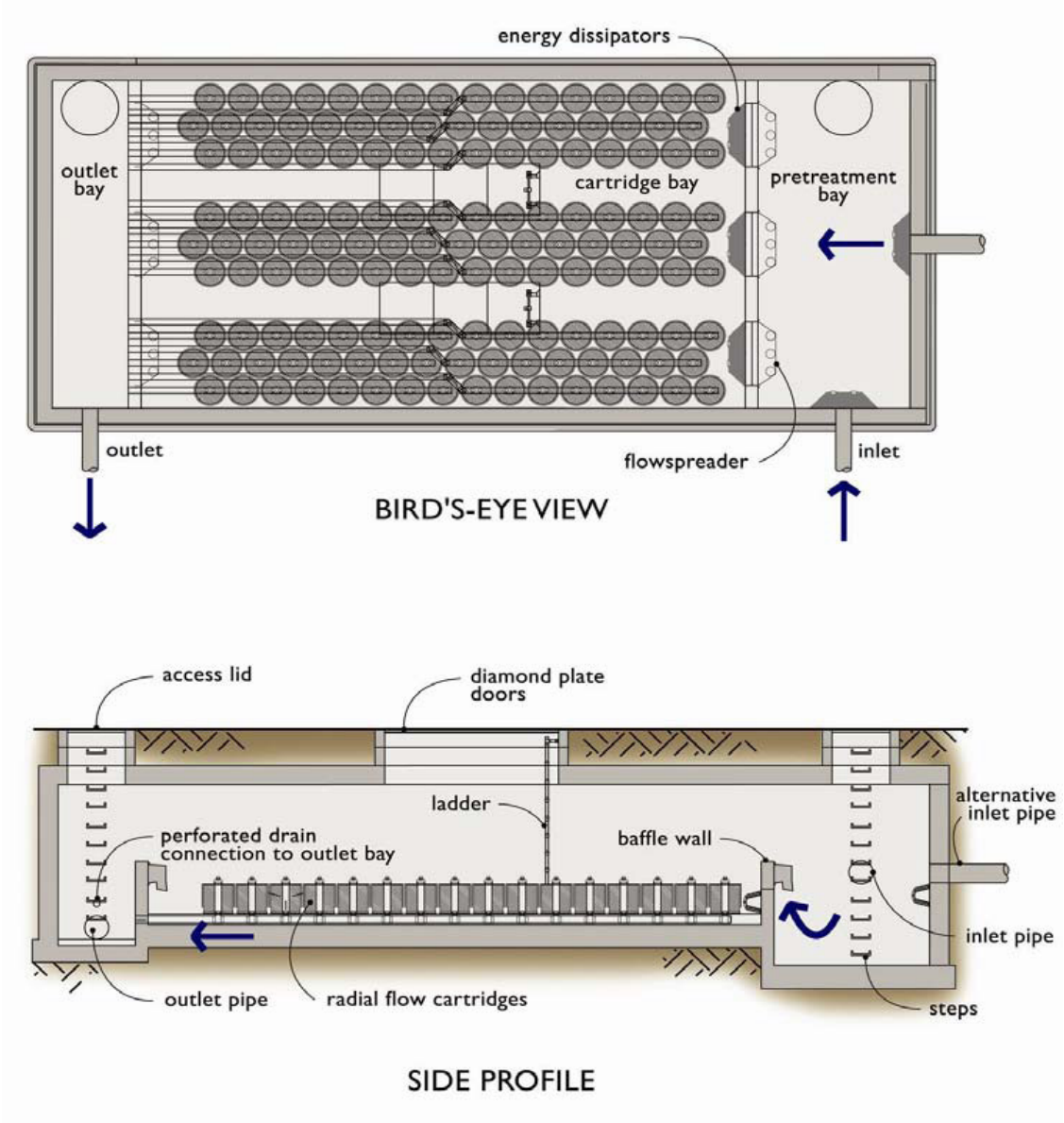
The filter media can be housed in cartridge filters enclosed in concrete vaults or catch basins. Structures will have vault doors or manhole lids (older designs) for maintenance access. Various types of filter media are available from system manufacturers.

StormFilter® units are an example of a proprietary manufactured media cartridge filter system that is common in Clark County. See manufacturer's publications for additional maintenance information.

Facility objects that are typically associated with a manufactured media filter system include:

- access road or easement
- control structure/flow restrictor
- conveyance stormwater pipe

Media Cartridge Filter Vault with Accumulated Sediment



Key Operations and Maintenance Considerations

- The most common tool for cleaning media cartridge filters is a truck with a tank and vacuum hose (e.g.Vactor® truck) to remove sediment and debris from the vault.
- Media cartridge filters are enclosed spaces where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.
- Cartridges require replacement when the individual cartridges no longer meet the specifications for pollutant removal.

Media Cartridge Filters			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
Forebay	Sediment Accumulation	Sediment accumulation exceeds 6 inches or 1/3 of available sump.	Sediment accumulation less than 6 inches.
Media Filter Vault	Sediment Accumulation on Top Media Filters (Cartridges)	Sediment depth exceeds 0.25-inches (on top of filter cartridges).	No sediment deposits which would impede permeability of the compost media. No sediment deposits on top of cartridges. (Sediment on cartridges likely indicates that cartridges are plugged and require maintenance.)
	Sediment Accumulation in Vault	Sediment depth exceeds 4 inches in chamber. Look for other indicators of clogged cartridges or overflow.	No sediment deposits in vault bottom of first chamber. Cartridges have been checked and replaced or serviced as needed.
	Trash and Debris Accumulation	Trash and debris accumulated in vault.	No trash or debris in vault.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris has been removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced to design specifications.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure; corrosion/deformation of cover.	Cover repaired or replaced to design specifications.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4 inch at the joint of the inlet/outlet pipe.
	Baffles Damaged	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets design specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Compost Media Clogging	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges have been replaced and drawdown time and overflow frequency are per design standards.

Media Cartridge Filters			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Short Circuiting	Flows do not properly enter filter cartridges.	Flows are properly entering filter cartridges. Cartridges have been replaced if necessary.
	Filter Cartridges Submerged	Filter vault does not drain within 24 hours following storm. Look for evidence of submergence due to backwater or excessive hydrocarbon loading.	Filter media have been checked and replaced if needed and vault drains down within 24 of a storm event. (If cartridges are plugged with oil, additional treatment or source control BMP may be needed.)

Compost-Amended Soil

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition.

Compaction from construction can reduce the soil's natural ability to provide these functions. Compost-amended soils are intended to replace these lost functions by establishing a minimum soil quality and depth in the post-development landscape.

Sufficient organic content is a key to soil quality. Soil organic matter can be attained through numerous amendments such as compost, composted woody material, biosolids, and forest product residuals. The full benefits of compost-amended soils are realized when desired soil media depths are maintained and soil compaction is minimized.

Key Operations and Maintenance Considerations

- Replenish soil media as needed (as a result of erosion) and address compacted, poorly draining soils.
- Site uses should protect vegetation and avoid soil compaction. Care should be taken to prevent compaction of soils via vehicular loads and/or excessive foot traffic, especially during wet conditions.
- The table below provides the recommended maintenance frequencies, standards, and procedures for compost-amended soils. The level of routine maintenance required and the frequency of corrective maintenance actions may increase for facilities prone to erosion due to site conditions such as steep slopes or topography tending to concentrate flows.

Compost-Amended Soil			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
Soil Media	Soils Waterlogged or Not Infiltrating	Soils become waterlogged, or otherwise do not appear to be infiltrating.	Soils have been aerated or amended such that infiltration occurs and soils to not remain completely saturated, per design specifications.
	Erosion/Scouring	Areas of potential erosion are visible, such as gullies or scouring.	Any eroded areas have been repaired, and sources of erosion addressed to prevent further soil erosion.
Vegetation	Vegetation in Poor Health	Less than 75% of planted vegetation is healthy with a generally good appearance.	At least 75% of planted vegetation is healthy with generally good appearance. Any conditions found that were deleterious to plant health have been corrected where possible. Routine maintenance schedule has been updated as necessary to ensure continued plant health and satisfactory appearance.
	Poisonous Plants and Noxious Weeds	Any poisonous plants or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Coordinate with Clark County Environmental Services Department, Vegetation Management Program.)	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Eradication of Class A weeds as required by State law. Control of Class B weeds designated by Clark County Weed Board. Control of other listed weeds as directed by local policies. Apply requirements of adopted IPM policy for the use of herbicides.
	Other Weeds Present	Other weeds (not listed on County/State noxious weed lists) are present on site.	Weeds have been removed per the routine maintenance schedule, following IPM protocols.

APPENDIX F

SWPPP

Stormwater Pollution Prevention Plan

For
Riverside Neighborhood Park

Prepared For
Southwest Regional Office
300 Desmond Drive
Lacey, WA 98503
(360) 407-6300

Owner	Developer	Operator/Contractor
ECM Riverside, LLC	9317 LLC	To Be Determined
340 Oswego Pointe Drive, Suite 208	9321 NE 72nd Ave. Bldg C #7	
Lake Oswego, OR 97034	Vancouver, WA 98665	

Project Site Location
34512 NW Pacific Highway
La Center, WA 98629

Certified Erosion and Sediment Control Lead
To be Determined

SWPPP Prepared By
PLS Engineering
Consulting Engineers and Planners
604 W. Evergreen Blvd
Vancouver, WA 98660
PH: (360) 944-6519
PM@plsengineering.com

SWPPP Preparation Date
October 23, 2020

Approximate Project Construction Dates
November 2020
November 2023

Contents

Appendix A Site plans

- Vicinity map (with all discharge points)
- Site plan with TESC measures

Appendix B Construction BMPs

- Possibly reference in BMPs, but likely it will be a consolidated list so that the applicant can photocopy from the list from the SWMMWW.

Appendix C Alternative Construction BMP list

- List of BMPs not selected, but can be referenced if needed in each of the 12 elements

Appendix D General Permit

Appendix E Site Log and Inspection Forms

Appendix F Engineering Calculations

1.0 Introduction

This Stormwater Pollution Prevention Plan (SWPPP) has been prepared for the Riverside Neighborhood Park Site Plan project in La Center, Washington. The Riverside Neighborhood Park is a 5.19-acre site located on the southwest side of Old Pacific Highway directly west of Larson Road in La Center, WA. The site address is 34512 NW Pacific Highway and is located in the SE ¼ of Section 33, T5N, R1E, Willamette Meridian. It is identified as Parcel Number 986028825 per the Clark County Assessor's records. The site currently consists of vacant fields, wetlands, and a stock watering pond. In addition, the site was previously used for residential purposes with an existing home having been removed sometime around 2014. A drainage ditch traverses along the south line of the parcel.

The site's existing topography is generally rolling with some steep areas near NW Pacific Hwy. It slopes down from the highway towards the drainage ditch, with the SW corner of the site as a low point. There is a high point near the south property line that separates the site into two drainage basins. The proposed development will maintain these drainage patterns by routing water to two separate facilities. Riverside Neighborhood Park will include picnic tables, play equipment, a basketball court, pedestrian paths, open space, and a drinking fountain. Infrastructure improvements to support the park will include lighting, a water lateral for the drinking fountain, paved driveway and parking area.

The purpose of this SWPPP is to describe the proposed construction activities and all temporary and permanent erosion and sediment control (TESC) measures, pollution prevention measures, inspection/monitoring activities, and recordkeeping that will be implemented during the proposed construction project. The objectives of the SWPPP are to:

1. Implement Best Management Practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity.

2. Prevent violations of surface water quality, ground water quality, or sediment management standards.

3. Prevent, during the construction phase, adverse water quality impacts including impacts on beneficial uses of the receiving water by controlling peak flow rates and volumes of stormwater runoff at the Permittee's outfalls and downstream of the outfalls.

This SWPPP was prepared using the Ecology SWPPP Template downloaded from the Ecology website. This SWPPP was prepared based on the requirements set forth in the Construction Stormwater General Permit and the *Stormwater Management Manual for Western Washington* (SWMMWW). The report is divided into seven main sections with several appendices that include stormwater related reference materials. The topics presented in the each of the main sections are:

- Section 1 – INTRODUCTION. This section provides a summary description of the project, and the organization of the SWPPP document.

- Section 2 – SITE DESCRIPTION. This section provides a detailed description of the existing site conditions, proposed construction activities, and calculated stormwater flow rates for existing conditions and post–construction conditions.

- Section 3 – CONSTRUCTION BMPs. This section provides a detailed description of the BMPs to be implemented based on the 12 required elements of the SWPPP (SWMMEW 2004).

- Section 4 – CONSTRUCTION PHASING AND BMP IMPLEMENTATION. This section provides a description of the timing of the BMP implementation in relation to the project schedule.

- Section 5 – POLLUTION PREVENTION TEAM. This section identifies the appropriate contact names (emergency and non-emergency), monitoring personnel, and the onsite temporary erosion and sedimentation control inspector

- Section 6 – INSPECTION AND MONITORING. This section provides a description of the inspection and monitoring requirements such as the parameters of concern to be monitored, sample locations, sample frequencies, and sampling methods for all stormwater discharge locations from the site.

- Section 7 – RECORDKEEPING. This section describes the requirements for documentation of the BMP implementation, site inspections, monitoring results, and changes to the implementation of certain BMPs due to site factors experienced during construction.

Supporting documentation and standard forms are provided in the following Appendices:

Appendix A – Site plans
Appendix B – Construction BMPs
Appendix C – Alternative Construction BMP list
Appendix D – General Permit
Appendix E – Site Log and Inspection Forms
Appendix F – Engineering Calculations

2.0 Site Description

2.1 Existing Conditions

The Riverside Neighborhood Park is a 5.19-acre site located on the southwest side of Old Pacific Highway directly west of Larson Road in La Center, WA. The site address is 34512 NW Pacific Highway and is located in the SE ¼ of Section 33, T5N, R1E, Willamette Meridian. It is identified as Parcel Number 986028825 per the Clark County Assessor's records. The site currently consists of vacant fields, wetlands, and a stock watering pond. In addition, the site was previously used for residential purposes with an existing home having been removed sometime around 2014. A drainage ditch traverses along the south line of the parcel.

2.2 Proposed Construction Activities

Current proposed development associated with this SWPPP includes the construction of a park along with the associated infrastructure. The site's existing topography is generally rolling with some steep areas near NW Pacific Hwy. It slopes down from the highway towards the drainage ditch, with the SW corner of the site as a low point. There is a high point near the south property line that separates the site into two drainage basins. The proposed development will maintain these drainage patterns by routing water to two separate facilities.

Riverside Neighborhood Park will include picnic tables, play equipment, a basketball court, pedestrian paths, open space, and a drinking fountain. Infrastructure improvements to support the park will include lighting, a water lateral for the drinking fountain, paved driveway and parking area.

3.0 Construction Stormwater BMPs

3.1 The 12 BMP Elements

3.1.1 Element #1 – Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction will be clearly marked before land-disturbing activities begin. Trees that are to be preserved, as well as all sensitive areas and their buffers, shall be clearly delineated, both in the field and on the plans. In general, natural vegetation and native topsoil shall be retained in an undisturbed state to the maximum extent possible. The BMPs relevant to marking the clearing limits that will be applied for this project include:

- Preserving Native Vegetation (BMP C101)
- Silt Fence (BMP C233)

Alternate BMPs for marking clearing limits are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.2 Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. The specific BMPs related to establishing construction access that will be used on this project include:

- Stabilized Construction Entrance (BMP C105)

Alternate construction access BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.3 Element #3 – Control Flow Rates

In order to protect the properties and waterways downstream of the project site, stormwater discharges from the site will be controlled. The specific BMPs for flow control that shall be used on this project include:

- The stormwater detention facility which will initially function as a Temporary Sediment Pond (BMP C241).

Alternate flow control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, the project must comply with Minimum Requirement 7 (Ecology 2005).

In general, discharge rates of stormwater from the site will be controlled where increases in impervious area or soil compaction during construction could lead to downstream erosion, or where necessary to meet local agency stormwater discharge requirements (e.g. discharge to combined sewer systems).

3.1.4 Element #4 – Install Sediment Controls

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site or prior to being discharged to an infiltration facility. The specific BMPs to be used for controlling sediment on this project include:

- Silt Fence (BMP C233)
- Storm Drain Inlet Protection (BMP C220)
- Detention facility to initially function as sediment control facility

Alternate sediment control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

In addition, sediment will be removed from paved areas in and adjacent to construction work areas manually or using mechanical sweepers, as needed, to minimize tracking of sediments on vehicle tires away from the site and to minimize washoff of sediments from adjacent streets in runoff.

Whenever possible, sediment laden water shall be discharged into onsite, relatively level, vegetated areas (BMP C240 paragraph 5, page 4-102).

In some cases, sediment discharge in concentrated runoff can be controlled using permanent stormwater BMPs (e.g., infiltration swales, ponds, trenches). Sediment loads can limit the effectiveness of some permanent stormwater BMPs, such as those used for infiltration or biofiltration; however, those BMPs designed to remove solids by settling (wet ponds or detention ponds) can be used during the construction phase. When permanent stormwater BMPs will be used to control sediment discharge during construction, the structure will be protected from excessive sedimentation with adequate erosion and sediment control BMPs. Any accumulated sediment shall be removed after construction is complete and the permanent stormwater BMP will be restabilized with vegetation per applicable design requirements once the remainder of the site has been stabilized.

The following BMPs will be implemented as end-of-pipe sediment controls as required to meet permitted turbidity limits in the site discharge(s). Prior to the implementation of these technologies, sediment sources and erosion control and soil stabilization BMP efforts will be maximized to reduce the need for end-of-pipe sedimentation controls.

- Temporary Sediment Pond (BMP C241)
- Construction Stormwater Filtration (BMP C251)
- Construction Stormwater Chemical Treatment (BMP C 250) (implemented only with prior written approval from Ecology).

3.1.5 Element #5 – Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

- Temporary and Permanent Seeding (BMP C120)
- Mulching (BMP C121)
- Nets and Blankets (BMP C122)
- Plastic Covering (BMP C123)
- Topsoiling (BMP C125)
- Surface Roughening (BMP C130)
- Dust Control (BMP C140)
- Early application of gravel base on areas to be paved

Alternate soil stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the

alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, no soils shall remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

In general, cut and fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

3.1.6 Element #6 – Protect Slopes

All cut and fill slopes will be designed, constructed, and protected in a manner than minimizes erosion. The following specific BMPs will be used to protect slopes for this project:

- Temporary and Permanent Seeding (BMP C120)

Alternate slope protection BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.7 Element #7 – Protect Drain Inlets

All storm drain inlets and culverts made operable during construction or inlets near the site that could potentially receive surface runoff from the construction site shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets and culverts that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

Drop Inlet Protection

- Block and Gravel Drop Inlet Protection
- Gravel and Wire Drop Inlet Protection
- Catch Basin Filter If the BMP options listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D), or if no BMPs are listed above but deemed necessary during construction, the Certified Erosion and Sediment Control Lead shall implement one or more of the alternative BMP inlet protection options listed in Appendix C.

3.1.8 Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. The specific BMPs for channel and outlet stabilization that shall be used on this project include:

- Outlet Protection (BMP C209)

Alternate channel and outlet stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, all temporary on-site conveyance channels shall be designed, constructed, and stabilized to prevent erosion from the expected peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour recurrence interval storm for the developed condition. Alternatively, the 10-year, 1-hour peak flow rate indicated by an approved continuous runoff simulation model, increased by a factor of 1.6, shall be used. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches shall be provided at the outlets of all conveyance systems.

3.1.9 Element #9 – Control Pollutants

All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the site will be kept clean, well organized, and free of debris. If required, BMPs to be implemented to control specific sources of pollutants are discussed below.

Vehicles, construction equipment, and/or petroleum product storage/dispensing:

- All vehicles, equipment, and petroleum product storage/dispensing areas will be inspected regularly to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- On-site fueling tanks and petroleum product storage containers shall include secondary containment.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- In order to perform emergency repairs on site, temporary plastic will be placed beneath and, if raining, over the vehicle.
- Contaminated surfaces shall be cleaned immediately following any discharge or spill incident.

Chemical storage:

- Any chemicals stored in the construction areas will conform to the appropriate source control BMPs listed in Volume IV of the Ecology stormwater manual. In Western WA, all chemicals shall have cover, containment, and protection provided on site, per BMPC153 for Material Delivery, Storage and Containment in SWMMWW 2005
- Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations for application procedures and rates shall be followed.

Excavation and tunneling spoils dewatering waste:

- Dewatering BMPs and BMPs specific to the excavation and tunneling (including handling of contaminated soils) are discussed under Element 10.

Demolition:

- Dust released from demolished sidewalks, buildings, or structures will be controlled using Dust Control measures (BMP C140).
- Storm drain inlets vulnerable to stormwater discharge carrying dust, soil, or debris will be protected using Storm Drain Inlet Protection (BMP C220 as described above for Element 7).
- Process water and slurry resulting from sawcutting and surfacing operations will be prevented from entering the waters of the State by implementing Sawcutting and Surfacing Pollution Prevention measures (BMP C152).

Concrete and grout:

- Process water and slurry resulting from concrete work will be prevented from entering the waters of the State by implementing Concrete Handling measures (BMP C151).

Sanitary wastewater:

- Portable sanitation facilities will be firmly secured, regularly maintained, and emptied when necessary.
- Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system or to the sanitary sewer as part of Wheel Wash implementation (BMP C106).

Solid Waste:

- Solid waste will be stored in secure, clearly marked containers.

Other:

- Other BMPs will be administered as necessary to address any additional pollutant sources on site.

The facility does not require a Spill Prevention, Control, and Countermeasure (SPCC) Plan under the Federal regulations of the Clean Water Act (CWA).

3.1.10 Element #10 – Control Dewatering

No dewatering is anticipated as part of this construction project. If it is necessary, appropriate BMP's will be implemented to ensure that dewatering water meets state water quality requirements before being discharged from the site.

3.1.11 Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMPs specifications (attached). Visual monitoring of the BMPs will be conducted at least once every calendar week and within 24 hours of any stormwater or non-stormwater discharge from the site. If the site becomes inactive, and is temporarily stabilized, the inspection frequency will be reduced to once every month.

All temporary erosion and sediment control BMPs shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation shall be permanently stabilized.

3.1.12 Element #12 – Manage the Project

Erosion and sediment control BMPs for this project have been designed based on the following principles:

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.
- Thoroughly monitor site and maintain all ESC measures.
- Schedule major earthwork during the dry season.

In addition, project management will incorporate the key components listed below:

As this project site is located west of the Cascade Mountain Crest, the project will be managed according to the following key project components:

Phasing of Construction

- The construction project is being phased to the extent practicable in order to prevent soil erosion, and, to the maximum extent possible, the transport of sediment from the site during construction.
- Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C 162).

Seasonal Work Limitations

- From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:
  - Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters; and
  - Limitations on activities and the extent of disturbed areas; and
  - Proposed erosion and sediment control measures.
- Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance.
- The following activities are exempt from the seasonal clearing and grading limitations:
  - Routine maintenance and necessary repair of erosion and sediment control BMPs;
  - Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
  - Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Coordination with Utilities and Other Jurisdictions

- Care has been taken to coordinate with utilities, other construction projects, and the local jurisdiction in preparing this SWPPP and scheduling the construction work.

Inspection and Monitoring

- All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:
  - Assess the site conditions and construction activities that could impact the quality of stormwater, and
  - Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.
- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP

- This SWPPP shall be retained on-site or within reasonable access to the site.
- The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
- The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

3.1.13 Element #13 – Protect Low Impact Development BMPs

- Protect all bioretention and rain garden BMP's from sedimentation through installation and maintenance of erosion control BMP's on portions of the site that drain into them. Restore the BMP's to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden bioretention/ rain garden soils, and replacing the removed soils with soils meeting the design specification.
- Prevent compacting bioretention and rain garden BMP's by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction by construction equipment.
- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff into permeable pavements or base materials.
- Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures from Book 4 of the manufacturer's procedures.
- Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils

3.2 Site Specific BMPs

Site specific BMPs are shown on the TESC Plan Sheets and Details in Appendix A. These site-specific plan sheets will be updated annually.

3.3 Additional Advanced BMPs

- The following BMPs are advanced and are only recommended if construction activities are complex enough to warrant them; or if the site has the potential for significant impacts to water quality. The following BMPs are directed at "end-of-pipe" treatment for sedimentation issues related to turbid runoff from construction

sites. Effective BMPs are most often the simple BMPs and focus on the minimization of erosion before sedimentation is an issue. The following BMPs will most likely be implemented only after other BMP options are exhausted, or if the construction activity is large and off-site sedimentation or turbid runoff occurs or is inevitable.

- For BMP 250, written pre-approval, through Ecology is required (see SWMMWW 2005):
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration.

4.0 Construction Phasing and BMP Implementation

The BMP implementation schedule will be driven by the construction schedule. The following provides a sequential list of the proposed construction schedule milestones and the corresponding BMP implementation schedule. The list contains key milestones such as wet season construction.

The BMP implementation schedule listed below is keyed to proposed phases of the construction project and reflects differences in BMP installations and inspections that relate to wet season construction. The project site is located west of the Cascade Mountain Crest. As such, the dry season is considered to be from May 1 to September 30 and the wet season is considered to be from October 1 to April 30.

- Estimate of Construction start date: Unknown
- Estimate of Construction finish date (Phase 1): Unknown
- Mobilize equipment on site: Unknown
- Mobilize and store all ESC and soil stabilization products: Unknown
- Install ESC measures: Unknown
- Install stabilized construction entrance: Unknown
- Begin clearing and grubbing: Unknown
- Demolish existing structures: Unknown
- Begin site grading Unknown
- Site grading ends Unknown
- Excavate and install new utilities and services: Unknown
- Excavation for building foundations Unknown
- Begin building construction: Unknown
- Complete utility construction Unknown
- Begin implementing soil stabilization and sediment control BMPs throughout the site in preparation for wet season: Unknown
- Wet Season starts: Unknown
- Site inspections and monitoring conducted weekly and for applicable rain events as detailed in Section 6 of this SWPPP: Unknown
- Implement Element #12 BMPs and manage site to minimize soil disturbance during the wet season: Unknown
- Complete road paving Unknown
- Building construction complete: Unknown
- Dry Season starts: Unknown

5.0 Pollution Prevention Team

5.1 Roles and Responsibilities

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead (CESCL) – primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Resident Engineer – For projects with engineered structures only (sediment ponds/traps, sand filters, etc.): site representative for the owner that is the project's supervising engineer responsible for inspections and issuing instructions and drawings to the contractor's site supervisor or representative
- Emergency Ecology Contact – individual to be contacted at Ecology in case of emergency.
- Emergency Owner Contact – individual that is the site owner or representative of the site owner to be contacted in the case of an emergency.
- Non-Emergency Ecology Contact – individual that is the site owner or representative of the site owner than can be contacted if required.
- Monitoring Personnel – personnel responsible for conducting water quality monitoring; for most sites this person is also the Certified Erosion and Sediment Control Lead.

5.2 Team Members

Names and contact information for those identified as members of the pollution prevention team are provided in the following table.

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	Unknown	
Resident Engineer	Travis Johnson	(360) 944-6519
Emergency Ecology Contact	Unknown	
Emergency Owner Contact	N/A Contact the engineer	(360) 944-6519
Non-Emergency Ecology Contact	Unknown	
Monitoring Personnel	Unknown	

6.0 Site Inspections and Monitoring

Monitoring includes visual inspection, monitoring for water quality parameters of concern, and documentation of the inspection and monitoring findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book. This SWPPP may function as the site log book if desired, or the forms may be separated and included in a separate site log book. However, if separated, the site log book but must be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.1 Site Inspection

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. The inspector will be a Certified Erosion and Sediment Control Lead (CESCL) per BMP C160. The name and contact information for the CESCL is provided in Section 5 of this SWPPP.

Site inspection will occur in all areas disturbed by construction activities and at all stormwater discharge points. Stormwater will be examined for the presence of suspended sediment, turbidity, discoloration, and oily sheen. The site inspector will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs to improve the quality of stormwater discharges. All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible.

6.1.1 Site Inspection Frequency

Site inspections will be conducted at least once a week and within 24 hours following any discharge from the site. For sites with temporary stabilization measures, the site inspection frequency can be reduced to once every month.

6.1.2 Site Inspection Documentation

The site inspector will record each site inspection using the site log inspection forms provided in Appendix E. The site inspection log forms may be separated from this SWPPP document, but will be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.2 Stormwater Quality Monitoring

The construction site is more than one acre in size and is therefore not subject to the general water quality monitoring requirements set forth in the 2005 Construction Stormwater General Permit (Appendix D).

The following text describes the monitoring for the proposed development.

6.2.1 Turbidity Sampling

Monitoring requirements for the proposed project will include turbidity sampling to monitor site discharges for water quality compliance with the 2005 Construction Stormwater General Permit(Appendix D), provided that site discharges occur. It should be noted that the site is designed such that all site runoff will be infiltrated so it is likely that discharges will be rare or may not occur at all. Sampling will be conducted at all discharge points at least once per calendar week.

Turbidity monitoring will follow the analytical methodologies described in Section S4 of the 2005 Construction Stormwater General Permit (Appendix D). The key benchmark values that require action are 25 NTU for turbidity (equivalent to 32 cm transparency) and 250 NTU for turbidity (equivalent to 6 cm transparency). If the 25 NTU benchmark for turbidity (equivalent to 32 cm transparency) is exceeded, the following steps will be conducted:

1. Ensure all BMPs specified in this SWPPP are installed and functioning as intended.
2. Assess whether additional BMPs should be implemented, and document revisions to the SWPPP as necessary.
3. Sample discharge location daily until the analysis results are less than 25 NTU (turbidity) or greater than 32 cm (transparency).

If the turbidity is greater than 25 NTU (or transparency is less than 32 cm) but less than 250 NTU (transparency greater than 6 cm) for more than 3 days, additional treatment BMPs will be implemented within 24 hours of the third consecutive sample that exceeded the benchmark value. Additional treatment BMPs to be considered will include, but are not limited to, off-site treatment, infiltration, filtration and chemical treatment.

If the 250 NTU benchmark for turbidity (or less than 6 cm transparency) is exceeded at any time, the following steps will be conducted:

1. Notify Ecology by phone within 24 hours of analysis (see Section 5.0 of this SWPPP for contact information).
2. Continue daily sampling until the turbidity is less than 25 NTU (or transparency is greater than 32 cm).
3. Initiate additional treatment BMPs such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours of the first 250 NTU exceedance.
4. Implement additional treatment BMPs as soon as possible, but within 7 days of the first 250 NTU exceedance.

5. Describe inspection results and remedial actions taken in the site log book and in monthly discharge monitoring reports as described in Section 7.0 of this SWPPP.

7.0 Reporting and Recordkeeping

7.1 Recordkeeping

7.1.1 Site Log Book

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book.

7.1.2 Records Retention

Records of all monitoring information (site log book, inspection reports/checklists, etc.), this Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements will be retained during the life of the construction project and for a minimum of three years following the termination of permit coverage in accordance with permit condition S5.C.

7.1.3 Access to Plans and Records

The SWPPP, General Permit, Notice of Authorization letter, and Site Log Book will be retained on site or within reasonable access to the site and will be made immediately available upon request to Ecology or the local jurisdiction. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of a written request for the SWPPP from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with permit condition S5.G.

7.1.4 Updating the SWPPP

In accordance with Conditions S3, S4.B, and S9.B.3 of the General Permit, this SWPPP will be modified if the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site or there has been a change in design, construction, operation, or maintenance at the site that has a significant effect on the discharge, or potential for discharge, of pollutants to the waters of the State. The SWPPP will be modified within seven days of determination based on inspection(s) that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

7.2 Reporting

7.2.1 Discharge Monitoring Reports

Discharge Monitoring Reports (DMRs) will be submitted to Ecology monthly. If there was no discharge during a given monitoring period, the Permittee shall submit the form as required, with the words "No discharge" entered in the place of monitoring results. The DMR due date is 15 days following the end of each month.

Water quality sampling results will be submitted to Ecology monthly on Discharge Monitoring Report (DMR) forms in accordance with permit condition S5.B. If there was no discharge during a given monitoring period, the form will be submitted with the words "no discharge" entered in place of the monitoring results. If a benchmark was exceeded, a brief summary of inspection results and remedial actions taken will be included. If sampling could not be performed during a monitoring period, a DMR will be submitted with an explanation of why sampling could not be performed.

7.2.2 Notification of Noncompliance

If any of the terms and conditions of the permit are not met, and it causes a threat to human health or the environment, the following steps will be taken in accordance with permit section S5.F:

1. Ecology will be immediately notified of the failure to comply.
2. Immediate action will be taken to control the noncompliance issue and to correct the problem. If applicable, sampling and analysis of any noncompliance will be repeated immediately and the results submitted to Ecology within five (5) days of becoming aware of the violation.
3. A detailed written report describing the noncompliance will be submitted to Ecology within five (5) days, unless requested earlier by Ecology.

Any time turbidity sampling indicates turbidity is 250 nephelometric turbidity units (NTU) or greater or water transparency is 6 centimeters or less, the Ecology regional office will be notified by phone within 24 hours of analysis as required by permit condition S5.A (see Section 5.0 of this SWPPP for contact information).

In accordance with permit condition S2.A, a complete application form will be submitted to Ecology and the appropriate local jurisdiction (if applicable) to be covered by the General Permit.

Appendix A – Site Plans

Appendix B – Construction BMPs

Stabilized Construction Entrance (BMP C105)

Temporary Sediment Pond (BMP C241)

Silt Fence (BMP C233)

Storm Drain Inlet Protection (BMP C220)

Bioretention Facility

Temporary and Permanent Seeding (BMP C120)

Mulching (BMP C121)

Nets and Blankets (BMP C122)

Plastic Covering (BMP C123)

Topsoiling (BMP C125)

Dust Control (BMP C140)

Early application of gravel base on areas to be paved

Temporary and Permanent Seeding (BMP C120)

Outlet Protection (BMP C209)

Appendix C – Alternative BMPs

The following includes a list of possible alternative BMPs for each of the 12 elements not described in the main SWPPP text. This list can be referenced in the event a BMP for a specific element is not functioning as designed and an alternative BMP needs to be implemented.

Element #1 - Mark Clearing Limits
High Visibility Plastic or Metal Fence (BMP C103)
Stake and Wire Fence (BMP C104)
Element #2 - Establish Construction Access
Wheel Wash (BMP C106)
Water Bars (BMP C203)
Element #3 - Control Flow Rates
Wattles (BMP C235)

Element #4 - Install Sediment Controls
Straw Bale Barrier (BMP C230)
Gravel Filter Berm (BMP C232)
Straw Wattles (BMP C235)
Portable Water Storage Tanks (Baker Tanks)
Construction Stormwater Chemical Treatment (BMP C250)
Construction Stormwater Filtration (BMP C251)

Element #5 - Stabilize Soils
Polyacrylamide (BMP C126)

Element #6 - Protect Slopes
Straw Wattles (BMP C235)
Surface Roughening (BMP C240)

Element #8 - Stabilize Channels and Outlets
Level Spreader (BMP C206)
Check Dams (BMP C207)

Element #9 – Control Pollutants
Concrete Handling (BMP C151)
Construction Stormwater Chemical Treatment (BMP C250)
Construction Stormwater Filtration (BMP C251)

Element #10 - Control Dewatering
Vegetated Filtration (BMP C236)
Additional Advanced BMPs to Control Dewatering:

Appendix D – General Permit

Appendix E – Site Inspection Forms (and Site Log)

The results of each inspection shall be summarized in an inspection report or checklist that is entered into or attached to the site log book. It is suggested that the inspection report or checklist be included in this appendix to keep monitoring and inspection information in one document, but this is optional. However, it is mandatory that this SWPPP and the site inspection forms be kept onsite at all times during construction, and that inspections be performed and documented as outlined below.

At a minimum, each inspection report or checklist shall include:

a. Inspection date/times

b. Weather information: general conditions during inspection, approximate amount of precipitation since the last inspection, and approximate amount of precipitation within the last 24 hours.

c. A summary or list of all BMPs that have been implemented, including observations of all erosion/sediment control structures or practices.

d. The following shall be noted:

   i. locations of BMPs inspected,

   ii. locations of BMPs that need maintenance,

   iii. the reason maintenance is needed,

   iv. locations of BMPs that failed to operate as designed or intended, and

   v. locations where additional or different BMPs are needed, and the reason(s) why

e. A description of stormwater discharged from the site. The presence of suspended sediment, turbid water, discoloration, and/or oil sheen shall be noted, as applicable.

f. A description of any water quality monitoring performed during inspection, and the results of that monitoring.

g. General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.

h. A statement that, in the judgment of the person conducting the site inspection, the site is either in compliance or out of compliance with the terms and conditions of the SWPPP and the NPDES permit. If the site inspection indicates that the site is out of compliance, the inspection report shall include a summary of the remedial actions required to bring the site back into compliance, as well as a schedule of implementation.

i. Name, title, and signature of person conducting the site inspection; and the following statement: "I certify under penalty of law that this report is true, accurate, and complete, to the best of my knowledge and belief".

When the site inspection indicates that the site is not in compliance with any terms and conditions of the NPDES permit, the Permittee shall take immediate action(s) to: stop, contain, and clean up the unauthorized discharges, or otherwise stop the noncompliance; correct the problem(s); implement appropriate Best Management Practices (BMPs), and/or conduct maintenance of existing BMPs; and achieve compliance with all applicable standards and permit conditions. In addition, if the noncompliance causes a threat to human health or the environment, the Permittee shall comply with the Noncompliance Notification requirements in Special Condition S5.F of the permit.

Site Inspection Form

General Information			
Project Name:			
Inspector Name:		**Title:** **CESCL # :**	
Date:		**Time:**	
Inspection Type:	□ After a rain event □ Weekly □ Turbidity/transparency benchmark exceedance □ Other		
Weather			
Precipitation	Since last inspection	In last 24 hours	
Description of General Site Conditions:			

Inspection of BMPs

Element 1: Mark Clearing Limits

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 2: Establish Construction Access

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 3: Control Flow Rates

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 4: Install Sediment Controls

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 5: Stabilize Soils						
BMP:						
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	
BMP:						
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	
BMP:						
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	
BMP:						
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 6: Protect Slopes						
BMP:						
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	
BMP:						
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	
BMP:						
Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 7: Protect Drain Inlets

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 8: Stabilize Channels and Outlets

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 9: Control Pollutants

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 10: Control Dewatering

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Water Quality Monitoring
Was any water quality monitoring conducted? □ Yes □ No If water quality monitoring was conducted, record results here:
If water quality monitoring indicated turbidity 250 NTU or greater; or transparency 6 cm or less, was Ecology notified by phone within 24 hrs? □ Yes □ No
If Ecology was notified, indicate the date, time, contact name and phone number below: Date: Time: Contact Name: Phone #:
General Comments and Notes Include BMP repairs, maintenance, or installations made as a result of the inspection.
Were Photos Taken? □ Yes □ No If photos taken, describe photos below:

Appendix F – Engineering Calculations