



Monroe West

Drainage Report

Prepared for
South Lake Ridge LLC co/Land Pro Group
Contact: Ryan Larsen
10515 20th St SE #202
Lake Stevens, WA 98258
(360) 631-1820

Prepared by



Shea Bowdish

Approved by
Tom Abbott, PE



June 2025

Job No: 24-0086

Table of Contents

Section	Title	
1	Project Overview	1-1
2	Temporary Erosion and Sediment Control Design	2-1
3	Downstream Analysis	3-1
4	Detention and Water Quality Treatment Design	4-1
5	Conveyance Analysis and Design	5-1
6	Operations and Maintenance Manual	6-1
7	Special Reports and Studies	7-1

Appendices

#	Title
1	Project Overview
2	Temporary Erosion and Sediment Control Design
3	Downstream Analysis
4	Detention and Water Quality Treatment Design
5	Conveyance Analysis and Design
6	Operations and Maintenance Manual
7	Special Reports and Studies

Figures

#	Title
1	Vicinity Map
2	Existing Conditions Map
3	Downstream Analysis Map
4	Predeveloped Hydrology Map
5	Developed Hydrology Map

SECTION 1: PROJECT OVERVIEW

The proposed Monroe West project is an approximately 9.77-acre site. The proposed project is a single-family Residential development on one parcel located on parcel #28063600101300, and #28063600200600, and addressed at 18614 134th St SE, Monroe, WA. The project proposes to construct 39 single family lots and site amenities. Road A is proposed to serve all lots onsite right-of-way with additional private access Tract serving 4 lots. Emergency and standard access drives along with associated private and public utilities are proposed to serve project development. Frontage improvements along 134th St SE consisting of sidewalk improvements to City standards are proposed. See the Vicinity Map in Appendix 1 for visual representation of the subject property.

Existing Site

The parcel #28063600101300 and #28063600200600 are currently two occupied single-family residences with driveway access on the north end of the lots onto 134th St SE, both lots contain main dwelling and accessory buildings on north end of property. Existing ground cover is a combination of trees, grass, and gravel. The property to the west of the site was recently improved with a similar residential project.

The proposed development will exist within the bounds of a single stormwater threshold discharge basin as all site runoff from developed surfaces meets within ¼ mile from the project site downstream.

A Geotechnical Report has been prepared by Terra Associates dated September 2024 on the site. Please reference the geotechnical report for detailed soils information. They did not observe any indication of landslide hazards on the project site. On Monroe's online map viewer, it is noted that the site is within the "No Infiltration Available Layer". This is consistent with the Geotechnical Engineer's onsite soil borings and findings of till soils underlying the site.

Proposed Development

The proposed residential project will construct 39 single family lots and site amenities. Emergency and standard access drives along with associated private and public utilities are proposed to serve project development. Frontage improvements consisting of new sidewalk and planter along a portion of 134th St SE as well as full frontage improvements along the remaining portion of 134th St SE are proposed.

Proposed Drainage System

This project is designed to comply with the 2019 Department of Ecology Stormwater Manual for Western Washington (2019 DOE SWMWW) as well as the City of Monroe and Surface Water Engineering Standards (SWES). Stormwater will be mitigated via a detention vault that is proposed to be located at the southern part of the development.

Prior to discharge, a StormFilter water quality treatment unit will be used to treat stormwater runoff to water quality treatment requirements. Onsite development including frontage improvements will disturb 9.88 AC that will be collected to the detention vault for mitigation and stormwater quality treatment. This area is considered to be within the Onsite Basin for stormwater modeling.

Proposed new pollution generating impervious surfaces (PGIS) will exceed the 5,000 SF threshold and thus basic water quality treatment will be provided via a water quality treatment structure that treats stormwater runoff after discharge from the stormwater detention vault. A StormFilter water quality treatment unit is proposed for this purpose. See Section 4.0 for additional discussion regarding proposed stormwater management and water quality treatment measures.

The proposed detention vault and water quality treatment system will discharge into an existing public drainage system located west of the site. The existing drainage system flows generally west and then southeast to an outfall that then drains downhill into a wetland area that takes storm water from the surrounding areas. Drainage flows west through an unnamed channel until reaching French Creek, a tributary of the Skykomish River.

Erosion/Sedimentation Control

Erosion control measures that will be utilized during construction will include a combination of silt fence, storm drain inlet protection, interceptor swales, and sediment ponds. See Section 2.0 for discussion of how SWPP Elements are addressed.

Minimum Requirements

Per the 2019 DOE Manual, Minimum Requirements 1-9 apply to the proposed development.

Minimum Requirement #1: Preparation of Stormwater Site Plans

This report along with the construction plans satisfies the minimum requirement.

Minimum Requirement #2: Construction Stormwater Pollution Prevention

See Section 2 of this Report for the SWPPP BMP Elements, and the SWPP (submitted as a separate document) for a complete discussion of erosion control BMP's and their use specific to the site.

Minimum Requirement #3: Source of Pollution

Permanent source control BMPs are not applicable for the subject site since the associated activities for the new residence do not fall within the types of facilities listed within Volume IV of the DOE Manual (Residential developments are not required to implement source control BMP's). BMPs for erosion and sedimentation control will be specified in the Construction Plans and the CSWPP.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

Flow from the site will preserve its natural drainage pattern to a large offsite wetland complex to the southeast.

Minimum Requirement #5: On-Site Stormwater Management

The project proposes BMP T5.13 soils to be underlain within all pervious areas that are disturbed by development. Generally, all other infiltration-related BMPs are infeasible per Geotechnical Evaluation. Generally, other dispersion-related BMPs are considered infeasible due to the proximity of slopes to the developed impervious coverage of the site and the lack of available dispersion length. Please see Section 4.5 for additional discussion of Onsite Stormwater Management and Low Impact Development BMP feasibility.

Minimum Requirement #6: Runoff Treatment

As the project will exceed the 5,000 SF threshold of new/replaced PGIS, the project is required to provide basic water quality treatment. A StormFilter water quality treatment unit will be installed downstream of the detention vault to meet this requirement.

Minimum Requirement #7: Flow Control

The project will exceed the 10,000 SF new/replaced impervious threshold and is required to provide flow control. A concrete detention vault will be installed within Tract 999. This vault will gravity discharge at a historic, mitigated rate into existing drainage infrastructure to the west of the project site. Please see Section 4.0 for additional flow control modeling and parameters for detention sizing.

Minimum Requirement #8: Wetlands Protection

No wetland areas on site.

Minimum Requirement #9: Operation and Maintenance

See Operations and Maintenance in Section 6 of this report.

SECTION 2: TEMPORARY EROSION AND SEDIMENT CONTROL DESIGN

SWPPP Design Elements

A Construction Stormwater Pollution Prevention Plan (SWPPP) will be provided prior to construction. Construction SWPPP Elements #1 through #13 are addressed below.

Element #1 – Mark Clearing Limits

All clearing limits will be delineated with high visibility plastic fence and/or silt fence. See sheets ER-01 of the construction plans for locations and details.

Element #2 – Establish Construction Access

Stabilized construction accesses will be installed as shown on the plans. See sheets ER-01 and ER-02 of the construction plans for locations and details.

Element #3 – Control Flow Rates

Detention of construction period runoff will be provided by means of sediment ponds on the site. See sheets ER-01 of the construction plans for location and details for flow and sediment control BMP's.

Element #4 – Install Sediment Controls

Silt fence, catch basin protection, and the temporary sediment pond will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the construction plans for locations and details.

Element #5 – Stabilize Soils

Exposed soils will be stabilized as specified in the Grading and Erosion Control Notes with temporary and permanent seeding, mulching, and plastic covering. See sheet ER-02 of the construction plans for notes.

Element #6 – Protect Slopes

Slopes are steep on the subject site. Slopes shall be protected as specified under Element #5.

Element #7 – Protect Drain Inlets

Storm drain inlet protection will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the construction plans for locations and details.

Element #8 – Stabilize Channels and Outlets

Temporary channels shall be stabilized with check dams. See sheets ER-01 and ER-02 of the construction plans for locations and details.

Element #9 – Control Pollutants

Pollutants shall be controlled as specified in Volume IV of the 2019 DOE Manual—Source Control BMPs to address potential sources of pollution which may exacerbate possible soil/groundwater contamination identified onsite.

Element #10 – Control De-Watering

There will be no de-watering as a part of this project. See sheet ER-02 of the construction plans for notes.

Element #11 – Maintain BMPs

Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the construction plans for the Construction Sequence and notes.

Element #12: Manage the Project

The Grading and Erosion Control Notes specify seasonal work limitations. Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the construction plans for the Construction Sequence and notes.

Element #13: Protect on-site stormwater management BMPs

On-site stormwater management BMPs used for runoff from roofs and other hard surfaces are not feasible due to soil conditions and proposed project density.

SECTION 3: DOWNSTREAM ANALYSIS

Task 1. Study Area Definition and Maps

Snohomish County Bare Earth LiDAR, survey, and 2022 aerial photography were the best topographical references available for the area containing the site. The limits of the downstream analysis extend roughly 0.25 miles beyond the subject property's natural discharge location.

Task 2. Resource Review

All of the resources below have been reviewed for existing and potential issues near the project site:

Adopted Basin Plans

No Adopted Basin Plans were located that include the project site.

Drainage Basin

This site is in the Snohomish basin, within the French Creek subbasin, within the Snohomish watershed. Discharge from the proposed development will discharge into an unnamed wetland area. Water will then travel through existing drainage and eventually discharge into Lake Tye.

Floodplain / Floodway (FEMA) maps

Per FEMA Floodplain map #53061C1100F the subject property is not within a floodplain.

Critical Areas Map

There are no critical areas or wetlands on site.

Drainage Complaints

No relevant issues were identified near the proposed site.

Road Drainage Problems

No issues were identified near the proposed site.

Soil Survey

Site soils are classified as Tokul Gravelly medial Loam (0 to 8 percent slopes) which is classified as Hydrologic Soil Group B, and Tokul Gravelly medial Loam (8 to 15 percent slopes) which is classified as Hydrologic Soil Group B.

Per the Geotech report, the site lies within an area where infiltration is considered infeasible.

Wetland Inventory Maps

No wetlands on site.

Migrating River Studies

Migrating River Studies are not considered applicable to the proposed development.

Section 303d List of Polluted Waters

Washington State Department of Ecology's Water Quality Assessment for Washington does not contain a listing for any water source within 0.25 miles from the project site.

Water Quality Problems

French Creek contains a Category 5 listing due to low dissolved oxygen levels. Downstream water quality will not be affected as runoff from the site will be treated to county standards.

Stormwater Compliance Plans

Not applicable to the proposed project.

Task 3. Field Inspection/Downstream Analysis

On January 3rd, 2025, a Downstream Analysis was performed at the site. The weather consisted of 45°F, cloudy skies, and scattered showers. The following observations were verified during the visit.

The subject property areas consist primarily of steep (greater than 40% in areas) slopes covered in forested vegetation, grass, pavement and two existing homes with one accessory building each. Both Homes sit on the North end of the property off of 134th St SE.

One flow path has been identified leaving the southwest corner of the project site. Water flows off the steep grade into an existing stormwater catch basin and travels into the existing stormwater detention center (Image 1) sitting below the cul de sac on 185th Dr SE. Water then travels south across Rainier View Rd SE (Image 2) through existing stormwater infrastructure and then behind the row of houses traveling southeast down Rainier View Rd SE (Image 3) where it eventually discharges down the hill into the wetland area past the ¼ mile boundary of this analysis (Image 4 and 5). See Figure 3.0, “Downstream Analysis Map” in Appendix 3 for a visual representation of current discharge.

Task 4. Drainage System Description and Problem Descriptions

Based on the information available and all the resources available including visual inspection of the downstream flow path to the ¼-mile boundary, there is no evidence of existing or anticipated downstream drainage problems. All flows are adequately carried through natural channels to the quarter mile buffer of analysis.

Task 5. Mitigation of Existing or Potential Drainage Problems

No evidence of existing or potential problems with downstream drainage conveyance infrastructure was found. Mitigation is not required.

SECTION 4: DETENTION AND WATER QUALITY TREATMENT DESIGN

4.1 Predeveloped Site Hydrology

The pre-developed and developed conditions were modeled in WWHM for the purpose of peak flow determination for direct discharge. Based on the site location, the WWHM used the Everett Gage with a Precipitation Scale factor of 1.200. For visual representation of the listed basins, see Figure 4.0, "Predeveloped Hydrology Map".

Onsite Basin:

The predeveloped condition applied to the Onsite Basin results in a forested land cover condition. The values as modeled in WWHM are as follows:

Table 1: Predeveloped Conditions: Onsite Basin

Onsite Basin	
<u>Ground Cover</u>	<u>Area (acre)</u>
Forest, steep	7.81
Total	7.81

Bypass Basin:

The predeveloped condition applied to the Bypass Basin results in a forested land cover condition. The values as modeled in WWHM are as follows:

Table 2: Predeveloped Conditions: Bypass Basin

Bypass Basin	
<u>Ground Cover</u>	<u>Area (acre)</u>
Forest, steep	0.19
Total	0.19

4.2 Developed Site Hydrology

In the developed condition, the proposed apartment project will construct a single-family residential development with 39 lots and site amenities. Road A will allow access to lots along with Tract 998 private access to 4 lots. Emergency and standard access drives along with associated private and public utilities are proposed to serve project development. Frontage improvements along 134th St SE are proposed.

In compliance with the City of Monroe SWES and the 2019 DOE Manual, all runoff from onsite developed/disturbed surfaces will be collected, treated, and discharged directly to existing/historic flow paths or will bypass detention and be mitigated within the proposed flow control system.

Onsite Basin:

The developed Onsite Basin is 7.81 acres and includes the entirety of the developed site within its boundaries. In the developed condition, the Onsite Basin has been modeled using WWHM with the following areas and ground cover designations:

Table 3: Developed Conditions: Onsite Basin

Onsite Basin	
Ground Cover	Area (acre)
Roof, flat	3.00
Driveway, Moderate	0.38
Sidewalks, Moderate	0.29
Pasture, Moderate	2.99
Roads, Moderate	1.15
Total	7.81

Bypass Basin:

The developed Bypass Basin is 0.19 acres and includes frontage right-of-way areas that cannot be collected due to topography as well as landscaped areas off the back of lots 18 through 25 that will not be collected. In the developed condition, the Bypass Basin has been modeled using WWHM with the following areas and ground cover designations:

Table 4: Developed Conditions: Bypass Basin

Bypass Basin	
Ground Cover	Area (acre)
Sidewalks, Mod	0.01
Pasture, Mod	0.13
Roads, Mod	0.05
Total	0.19

4.3 Detention Facility Design

The proposed detention vault facility used for mitigating developed condition flows was designed in compliance with the City of Monroe SWES and the 2019 DOE requirements to model hydrologic conditions and detention in a continuous runoff model (WWHM2012) where the following evaluation parameters are employed:

“Flow duration is computed by counting the number of flow values that exceed a specified flow level. The specified flow levels used by WWHM in the flow duration analysis are listed below.

1. 50% of the 2-year predevelopment peak flow.
2. 100% of the 2-year predevelopment peak flow.
3. 100% of the 50-year predevelopment peak flow.

There are three criteria by which flow duration values are compared:

1. *If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 50% and 100% of the 2-year predevelopment peak flow values (100 Percent Threshold) then the flow duration requirement has not been met.*
2. *If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 100% of the 2-year and 100% of the 50-year predevelopment peak flow values more than 10 percent of the time (110 Percent Threshold) then the flow duration requirement has not been met.*
3. *If more than 50 percent of the flow duration levels exceed the 100 percent threshold then the flow duration requirement has not been met.”*

Detention Vault Facility

The proposed cast in place concrete detention facility detains, and releases collected storm water runoff from the Onsite Basin. The facility is located in Tract 999 and will be accessible and maintainable via Tract 998. Flows from the Onsite Basin are

collected and conveyed to the detention vault via a proposed network of catch basins and storm water conveyance pipes. Detailed WWHM output is provided in Appendix 4. A summary of the detailed statistics and inputs used for modeling the system in WWHM2012 can be found below.

Table 5: Detention Vault Design Summary

Detention Vault	
Live Storage Bottom Area (modeled)	8,000 SF
Live Storage Bottom Area (provided)	8,002 SF
Number of Cells	3
Cell Dimensions	(3 x 16.67' x 160')
Begin Live Storage Elevation	256.00
Riser Height	9.00'
Volume (modeled)	72,000 CF
Volume (provided)	72,014 CF
Top of Riser Elevation	265.50
Top Outside of Vault Elevation	274.00

See table below for the flow rates and water surface elevations by storm event for the detention vault.

Table 6: Flow Rates and Water Surface Elevations by Storm Event

Storm Event	Predeveloped Rate (cfs)	Mitigated Rates (cfs)	Water Surface Elevation (ft)
2-Year	0.4216	0.2803	260.40
10-Year	0.9125	0.4975	262.60
50-Year	1.5698	0.7696	263.97
100-Year	1.9287	0.9133	265.04

4.4 Water Quality Treatment

StormFilter

Water Quality Treatment for the Onsite Basin is accomplished through a StormFilter structure located downstream of the detention vault. A summary of design criteria is provided below:

Table 7: StormFilter Design Summary

StormFilter	
Tributary Area	7.81 AC
Tributary PGIS Area	1.53 AC
Water Quality Flow Rate (2 yr mitigated peak)	0.2824 cfs
WQ Treatment Capacity	0.3000 cfs
Number of Cartridges	11
Cartridge Height	18"
Internal Drop	2.3'
Peak Flow Rate	0.9167 cfs
Peak Flow Storm Event	100-year

4.5 Onsite Stormwater Management

The project does not meet the LID performance standard and minimum requirements 1-9 are required for the project but choose to implement List #2 to evaluate low impact design. The following BMP's below are assessed for implementation:

Lawn and Landscaped Areas:

1. *Post-Construction Soil Quality and Depth*
 - BMP T5.13 soils will be applied to all permeable and landscaped areas in developed condition.

i.Conclusion: Feasible

Roofs:

1. *Downspout Full Infiltration per BMP T5.10A or Downspout Full Dispersion per BMP T5.30*
 - Infiltration is not feasible on site which has been confirmed by testing found in the geotechnical report and thus BMP T5.10A is infeasible. Due to site specific constraints including building location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site per BMP T5.30.

i.Conclusion: Infeasible
2. *Bioretention*
 - Due to spatial constraints provided by the development footprint and infiltration infeasibility as confirmed by testing in the geotechnical report, a bioretention facility cannot be designed to provide the required horizontally projected surface area.

i.Conclusion: Infeasible
3. *Downspout Dispersion per BMP T5.10B.*
 - Due to site specific constraints including building location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site.

i.Conclusion: Infeasible
4. *Perforated Stub-Out Connections per BMP T5.10C.*
 - No stub-out connections will be implemented in the design as soils are not suitable for infiltration as well as the site's proximity to steep slopes.

i.Conclusion: Infeasible

Other Hard Surfaces:

1. *Full Dispersion per BMP T5.30*
 - Due to site specific constraints including building and fire lane location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site.
i.Conclusion: Infeasible

2. *BMP T5.15 Permeable Pavement*
 - Infiltration is not feasible on site which has been confirmed by testing found in the geotechnical report.
i.Conclusion: Infeasible

3. *Bioretention*
 - Due to spatial constraints provide by the development footprint and infiltration infeasibility as confirmed by testing in the geotechnical report, a bioretention facility cannot be designed to provide the required horizontally projected surface area.
i.Conclusion: Infeasible

4. *Sheet Flow Dispersion or Concentrated Flow Dispersion in accordance with BMP T5.12 or BMP T5.11*
 - Due to site specific constraints including building location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site.
i.Conclusion: Infeasible

SECTION 5: CONVEYANCE DESIGN

The stormwater conveyance system is comprised of a network of open/closed grate catch basins, buried pipe, a concrete detention vault, and a StormFilter water quality unit. Catch basins have been located such that each section of storm drainage pipe may adequately convey associated tributary area flows.

5.1 Onsite Collection and Conveyance

The onsite collection and conveyance systems were designed for the 50-year 24-hour storm event with the Rational Method utilizing Autodesk's Storm Sanitary Analysis 2024. This analysis was performed to ensure that during the 50-year, 24-hour storm event, there would be no significant catch basin overtopping. The table below shows a summary of the conveyance basin area used in the analysis. See Appendix 5 for the Conveyance Basins Map for a visual representation of measured areas.

Basin	Impervious (AC)	Pervious (AC)	Total (AC)
1	0.06	0.01	0.07
2	0.05	0.01	0.06
3	0.09	0.02	0.11
4	0.10	0.02	0.12
5	0.04	0.01	0.05
6	0.18	0.02	0.20
7	0.34	0.23	0.57
8	0.16	0.02	0.18
9	0.09	0.01	0.10
10	0.36	0.24	0.60
11	0.09	0.00	0.09
12	0.10	0.02	0.12
13	0.08	0.01	0.09
14	0.12	0.02	0.14
15	0.25	0.17	0.42
16	0.17	0.12	0.29
17	0.32	0.04	0.36
18	0.46	0.31	0.77
19	0.40	0.26	0.66

According to the initial modeling, the proposed system had conveyance issues upstream of the detention vault. All conveyance pipes were initially sized at 12" Diameter. To fix conveyance issues 5 pipe runs were upsized to 18" diameter which resulted in a resolution of all overtopping/flooding. See Appendix 5 for the SSA model and layout and SSA model Results.

SECTION 6: OPERATIONS AND MAINTENANCE MANUAL

The proposed storm drainage system consists of buried pipes, catch basins, a detention vault, and a StormFilter water quality treatment structure. These facilities will require periodic maintenance and inspection. Inspection and maintenance procedures are contained on the following pages.

SECTION 7: SPECIAL REPORTS AND STUDIES

The following studies were conducted in preparation of this Report:

- Geotechnical Report, Monroe West, Terra Associates, Inc., January 3, 2025

Appendix 1: Project Overview

1. Vicinity Map
2. Existing Conditions Map
3. Proposed Development Map

MONROE WEST CONSTRUCTION PLANS MONROE, WASHINGTON

LEGEND AND ABBREVIATIONS

EXISTING SYMBOLS	DESCRIPTION	ABBREVIATIONS
○	FOUND MONUMENT AS NOTED	IE INVERT ELEVATION
○	EXISTING CORNER MONUMENT AS NOTED	INV INVERT ELEVATION
□	CATCH BASIN	AP APPLE
⊕	STORM MANHOLE	C CEDAR
<	CULVERT/INVERT OF STORM PIPE	F FIR
⊕	WATER METER	H HEMLOCK
⊕	WATER VALVE	M MAPLE
⊕	FIRE HYDRANT	U UNKNOWN
⊕	IRRIGATION CONTROL VALVE	(C) CALCULATED
⊕	SEWER MANHOLE	(M) MEASURED
⊕	SKIN	(C.O.C.) CENTER OF CHANNEL
⊕	MAILBOX	(EX. C.C.) EXTRUDED CONC. CURB
⊕	GAS METER	
⊕	LIGHT STANDARD	
⊕	ELECTRIC MANHOLE	
⊕	GUY ANCHOR	
⊕	GUY POLE	
⊕	TELCO MANHOLE	
⊕	TELCO RISER	
⊕	POWER TRANSFORMER	
⊕	CONIFEROUS TREE	
⊕	DECIDUOUS TREE	

PROPOSED STORM SYMBOLS	DESCRIPTION	PROPOSED WATER SYMBOLS	DESCRIPTION
⊕	SD CAP	⊕	WATER CAP
⊕	TYPE 1 CATCH BASIN, GRATED LID	⊕	CONCRETE THRUST BLOCKING
⊕	TYPE 1 CATCH BASIN, SOLID LID	⊕	11.25° BEND
⊕	TYPE 2 CATCH BASIN, GRATED LID	⊕	22.5° BEND
⊕	TYPE 2 CATCH BASIN, SOLID LID	⊕	45° BEND
⊕	BEEHIVE MANHOLE COVER	⊕	90° BEND
⊕	SQUARE YARD DRAIN	⊕	VALVE
⊕	ROUND YARD DRAIN	⊕	HYDRANT ASSEMBLY
⊕	STORM CLEAN OUT	⊕	BLOW-OFF VALVE
⊕	STORM PIPE	⊕	REDUCER
⊕		⊕	AIR-VAC ASSEMBLY
⊕		⊕	WATER METER
⊕		⊕	WATER PIPE

PROPOSED SEWER SYMBOLS	DESCRIPTION	PROPOSED SURVEY SYMBOLS	DESCRIPTION
⊕	SEWER CAP	⊕	SURVEY MONUMENT
⊕	SEWER CLEANOUT	⊕	IN PROPOSED ROAD
⊕	SEWER MANHOLE		
⊕	SEWER PIPE		

CONTACT LIST

DEVELOPER: SOUTH LAKE RIDGE, LLC 10515 20TH ST SE #202 LAKE STEVENS, WA 98258 CONTACT: RYAN LARSEN PHONE: (360) 631-1820 EMAIL: rlarsen@landprogrp.com	CIVIL ENGINEER: SOLID GROUND ENGINEERING 8105 166TH AVE NE REDMOND, WA 98052 CONTACT: TOM ABBOTT, PE PHONE: (425) 281-8324 EMAIL: tabbot@solidgroundpnw.com
GEOTECHNICAL ENGINEER: TERRA ASSOCIATES 12220 113TH AVE NE, SUITE 130 KIRKLAND, WA 98034 CONTACT: CAROLYN DECKER, PE PHONE: (206) 255-4988 EMAIL: cdecke@terra-associates.com	LANDSCAPE ARCHITECT: ORIGIN DESIGN GROUP, LLC 1031 185TH AVE NE SNOHOMISH, WA 98290 CONTACT: KRISTAL LOWE PHONE: (425) 346-1905 EMAIL: kristal@origindesigngroup.com
SURVEYOR: PACIFIC COAST SURVEYS 16300 MILL CREEK BLVD STE G4 MILL CREEK, WA 98012 CONTACT: DOUGLAS ROUPE, PLS PHONE: (425) 512-7099 EMAIL: doug@pcsurveys.net	WETLAND BIOLOGIST: WETLAND RESOURCES, INC. 9505 19TH AVE SE, SUITE 106 EVERETT, WA 98208 CONTACT: JOHN LAUFENBERG PHONE: (425) 238-8811 EMAIL: john@wetlandresources.com

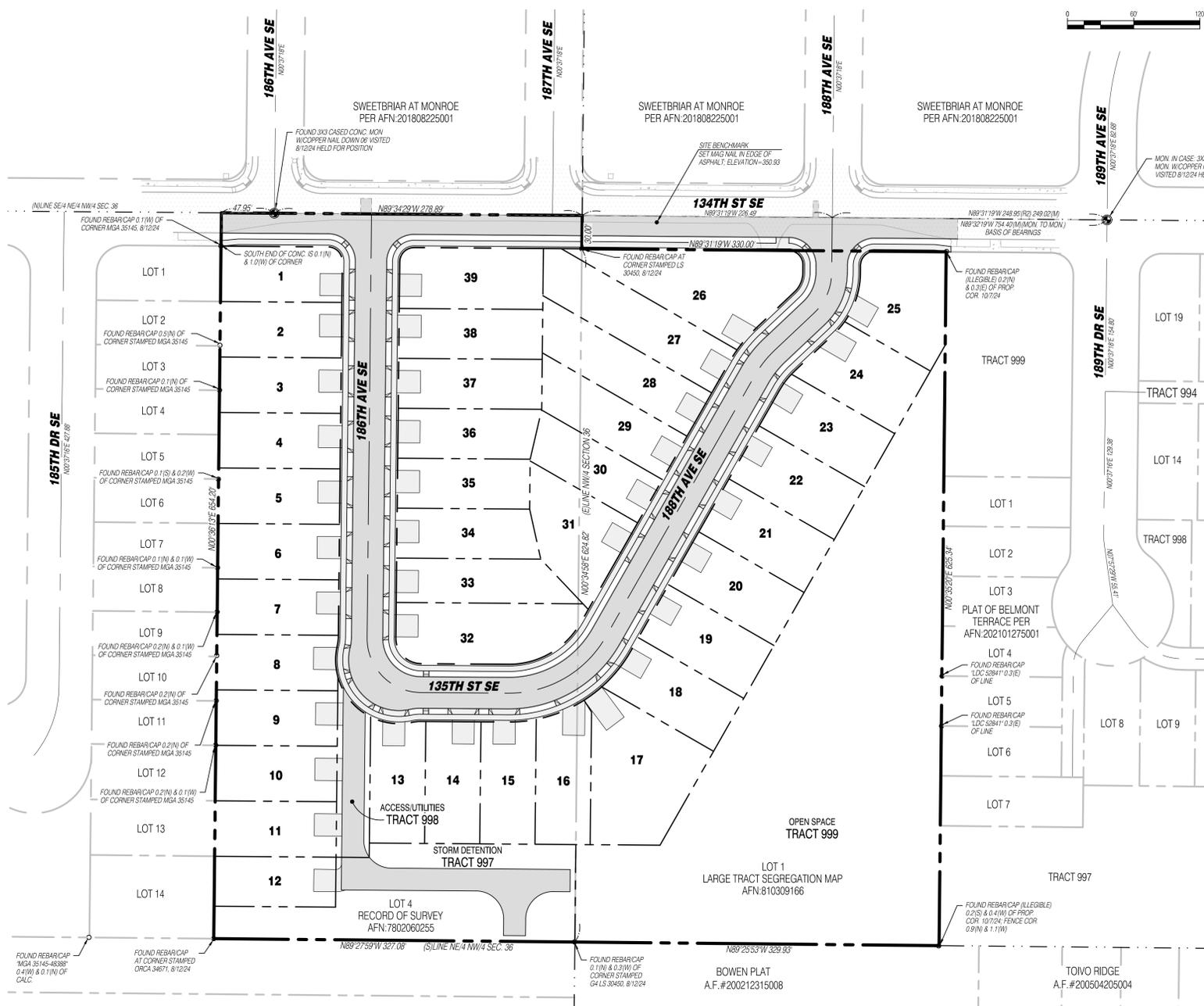
EARTHWORK QUANTITIES

STRIPPING:	13,000 CY
CUT:	20,300 CY
FILL:	65,400 CY
NET:	45,100 CY (FILL)
DISTURBED AREA:	349,399 SF (8.02 AC)

THE ABOVE QUANTITIES ARE FOR PERMITTING PURPOSES. CONTRACTOR TO VERIFY.

PROJECT INFORMATION

TAX PARCELS:	2806360200000 & 28063600101300
SITE ADDRESS:	18614 134TH ST SE, MONROE, WA 98272
SITE AREA:	420,254 SF (9.65 AC)
PROPOSED ZONING:	R7
PROPOSED LAND USE:	SINGLE FAMILY RESIDENTIAL
FUTURE LAND USE:	LOW DENSITY SFR
PROPOSED LOTS:	39 LOTS
BUILDING SETBACKS:	10' FRONT 20' GARAGE 5' SIDE 10' REAR 10' ACCESS TRACT/EASEMENT
WATER:	CITY OF MONROE WATER SYSTEM
SEWER:	CITY OF MONROE SEWER SERVICE
POWER:	SNOHOMISH COUNTY PUD
GAS:	PUGET SOUND ENERGY
TELEPHONE:	ZIPPLY
CABLE:	COMCAST
SCHOOL DISTRICT:	MONROE SCHOOL DISTRICT NO 103
FIRE DISTRICT:	SNOHOMISH REGIONAL FIRE & RESCUE



SOIL TYPE AND VEGETATIVE COVER

SOILS:	TOKUL GRAVELLY MEDIAL LOAM
VEGETATIVE COVER:	LANDSCAPED GRASS LAWN AND TREES

TABLE OF CONTENTS

1	COVER SHEET	10-12	ROAD, GRADING AND DRAINAGE PROFILES	24-25	SANITARY SEWER NOTES AND DETAILS
2	EXISTING CONDITIONS MAP	13	ROAD SECTIONS	26	WATER PLAN
3	TESC PLAN	14	STORM DETENTION VAULT PLAN	27	WATER PROFILES
4	TESC NOTES AND DETAILS	15	STORM DETENTION VAULT DETAILS	28	WATER NOTES AND DETAILS
5	HORIZONTAL CONTROL PLAN	16	CHANNELIZATION PLAN	29	MAILBOX PLAN
6-7	DETAILED GRADING	17-20	NOTES AND DETAILS	L-1 - L-7	LANDSCAPE PLANS
8	ROAD AND GRADING PLAN	21	SANITARY SEWER PLAN		
9	STORM DRAINAGE PLAN	22-23	SANITARY SEWER PROFILES		

SURVEY DISCLAIMER

THE TOPOGRAPHIC SURVEY WAS PERFORMED BY PACIFIC COAST SURVEYS. SOLID GROUND ENGINEERING ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

SURVEY INFORMATION

LEGAL DESCRIPTION
 PARCEL NO: 2806360200000
 PER CHICAGO INSURANCE COMPANY COMMITMENT NUMBER 500151982, DATED JUNE 6, 2024.
 LOT 4 SURVEY RECORDED UNDER AUDITORS FILE NUMBER 7802060255 RECORDS OF SNOHOMISH COUNTY ALSO KNOWN AS THE EAST HALF OF THE SOUTHEAST QUARTER OF THE NORTHEAST QUARTER OF THE NORTHWEST QUARTER SECTION 36, TOWNSHIP 28 NORTH, RANGE 6 EAST, W.M., SITUATE IN THE COUNTY OF SNOHOMISH, STATE OF WASHINGTON

VERTICAL DATUM
 NAVD 88 (NAVD 88 - 3.67' = NGVD29)
 FOUND WSDOT BRASS DISK SURFACE MONUMENT IN TRAFFIC SIGNAL BASE AT THE S.E. QUADRANT OF THE INTERSECTION OF HWY 2 AND MAIN STREET.
 WSDOT DESIGNATION NO. BM31002-86
 PER GPS OBSERVATIONS.
 ELEV. = 72.24'

EQUIPMENT & PROCEDURES
 METHOD OF SURVEY:
 SURVEY PERFORMED BY FIELD TRAVERSE AND REAL TIME KINEMATIC GPS POSITIONING UTILIZING THE HIGN SMARTNET NETWORK

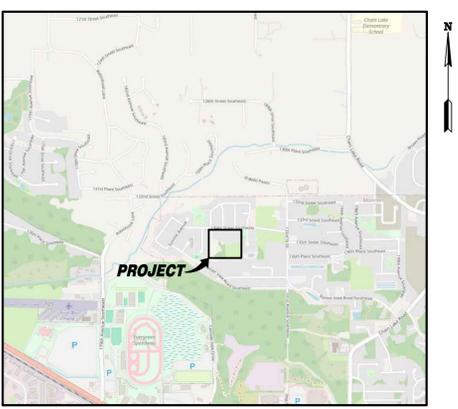
PRECISION:
 MEETS OR EXCEEDS STATE STANDARDS SET BY WAC 332-130-080 THROUGH 332-130-110

BASIS OF BEARING:
 THE MONUMENTED CENTERLINE OF 134TH ST SE AS SHOWN HEREON PER SWEETBRIAR AT MONROE RECORDED UNDER AFN: 201808225001.

BEARING = NORTH 89°32'29" WEST

SURVEY REFERENCES
 (R1) RECORD OF SURVEY - AFN: 7802060255
 (R2) PLAT OF SWEETBRIAR AT MONROE - AFN: 201808225001
 (R3) PLAT OF BELMONT TERRACE - AFN: 202101275001
 (R4) RECORD OF SURVEY - AFN: 3808025004
 (R5) PLAT OF TROMBLEY HILL - AFN: 9812155001
 (R6) PLAT OF SKYCROFT - AFN: 202007085003

NOTES
 1.) THIS SURVEY HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF PARTIES WHOSE NAMES APPEAR HEREON ONLY, AND DOES NOT EXTEND TO ANY UNNAMED THIRD PARTIES WITHOUT EXPRESS RECERTIFICATION BY THE LAND SURVEYOR OF RECORD.
 2.) BOUNDARY LINES SHOWN AND CORNERS SET REPRESENT DEED LOCATIONS, OWNERSHIP LINES MAY VARY. NO GUARANTEE OF OWNERSHIP IS EXPRESSED OR IMPLIED.



VICINITY MAP
 SCALE: NOT TO SCALE



ENGINEERS STAMP

REVISIONS	DESCRIPTION	DATE

SGE
 Solid Ground Engineering
 8105 166th Ave NE
 Redmond, WA 98052

COVER SHEET

SOUTH LAKE RIDGE, LLC
MONROE WEST
 18614 134TH ST SE, MONROE, WA

DRAWN BY:	AJP
CHECKED BY:	TPA
DATE:	1-14-25
JURISDICTION:	CITY OF MONROE
JOB NUMBER:	24-0086

CS-01
1 OF 29



NE 1/4, NW 1/4, SEC 36, T28N, R6E, WM, SNOHOMISH COUNTY, WASHINGTON
 NW 1/4, NE 1/4, SEC 36, T28N, R6E, WM, SNOHOMISH COUNTY, WASHINGTON

LEGEND AND ABBREVIATIONS

EXISTING SYMBOLS	DESCRIPTION	ABBREVIATIONS
⊙	FOUND MONUMENT AS NOTED	IE INVERT ELEVATION
○	EXISTING CORNER MONUMENT AS NOTED	INV INVERT ELEVATION
□	CATCH BASIN	AP APPLE
⊕	STORM MANHOLE	C CEDAR
⊗	CULVERT/INVERT OF STORM PIPE	FIR
⊘	WATER METER	H HEMLOCK
⊙	WATER VALVE	M MAPLE
⊙	FIRE HYDRANT	U UNKNOWN
⊙	IRRIGATION CONTROL VALVE	(C) CALCULATED
⊙	SEWER MANHOLE	(M) MEASURED
⊙	SIGN	(C.C.C.) CENTER OF CHANNEL
⊙	MAILBOX	(EX. C.C.) EXTRUDED CONC. CURB
⊙	GAS METER	
⊙	LIGHT STANDARD	
⊙	ELECTRIC MANHOLE	
⊙	GUY ANCHOR	
⊙	TUY POLE	
⊙	TELCO MANHOLE	
⊙	TELCO RISER	
⊙	POWER TRANSFORMER	
⊙	CONIFEROUS TREE	
⊙	DECIDUOUS TREE	

SURVEY INFORMATION

LEGAL DESCRIPTION

PARCEL NO. 2803602200600
 PER CHICAGO INSURANCE COMPANY COMMITMENT NUMBER 500151982, DATED JUNE 6, 2024.
 LOT 4, SURVEY RECORDED UNDER AUDITOR'S FILE NUMBER 7802060255 RECORDS OF SNOHOMISH COUNTY ALSO KNOWN AS THE EAST HALF OF THE SOUTHEAST QUARTER OF THE NORTHEAST QUARTER OF THE NORTHWEST QUARTER SECTION 36, TOWNSHIP 28 NORTH, RANGE 6 EAST, W.M., SITUATE IN THE COUNTY OF SNOHOMISH, STATE OF WASHINGTON

VERTICAL DATUM

NAVD 88 (NAVD 88 - 3.67' - NGVD29)
 FOUND WSDOT BRASS DISK SURFACE MONUMENT IN TRAFFIC SIGNAL BASE AT THE S.E. QUADRANT OF THE INTERSECTION OF HWY 2 AND MAIN STREET.
 WSDOT DESIGNATION NO. BM131002-86
 PER GPS OBSERVATIONS.
 ELEV. = 72.24'

EQUIPMENT & PROCEDURES

METHOD OF SURVEY:
 SURVEY PERFORMED BY FIELD TRAVERSE AND REAL TIME KINEMATIC GPS POSITIONING UTILIZING THE HUG SMARTNET NETWORK

INSTRUMENTATION:
 LEICA TS16 ROBOTIC ELECTRONIC TOTAL STATION
 LEICA VIVA GNSS GS08 RECEIVER
 ALL EQUIPMENT HAS BEEN MAINTAINED IN ADJUSTMENT TO MANUFACTURER'S SPECIFICATIONS AS REQUIRED BY WAC 331-130-100

PRECISION:
 MEETS OR EXCEEDS STATE STANDARDS SET BY WAC 332-130-080 THROUGH 332-130-110

BASIS OF BEARING:
 THE MONUMENTED CENTERLINE OF 134TH ST SE AS SHOWN HEREON PER SWEETBRIAR AT MONROE RECORDED UNDER AFN 201808225001.

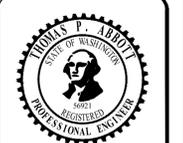
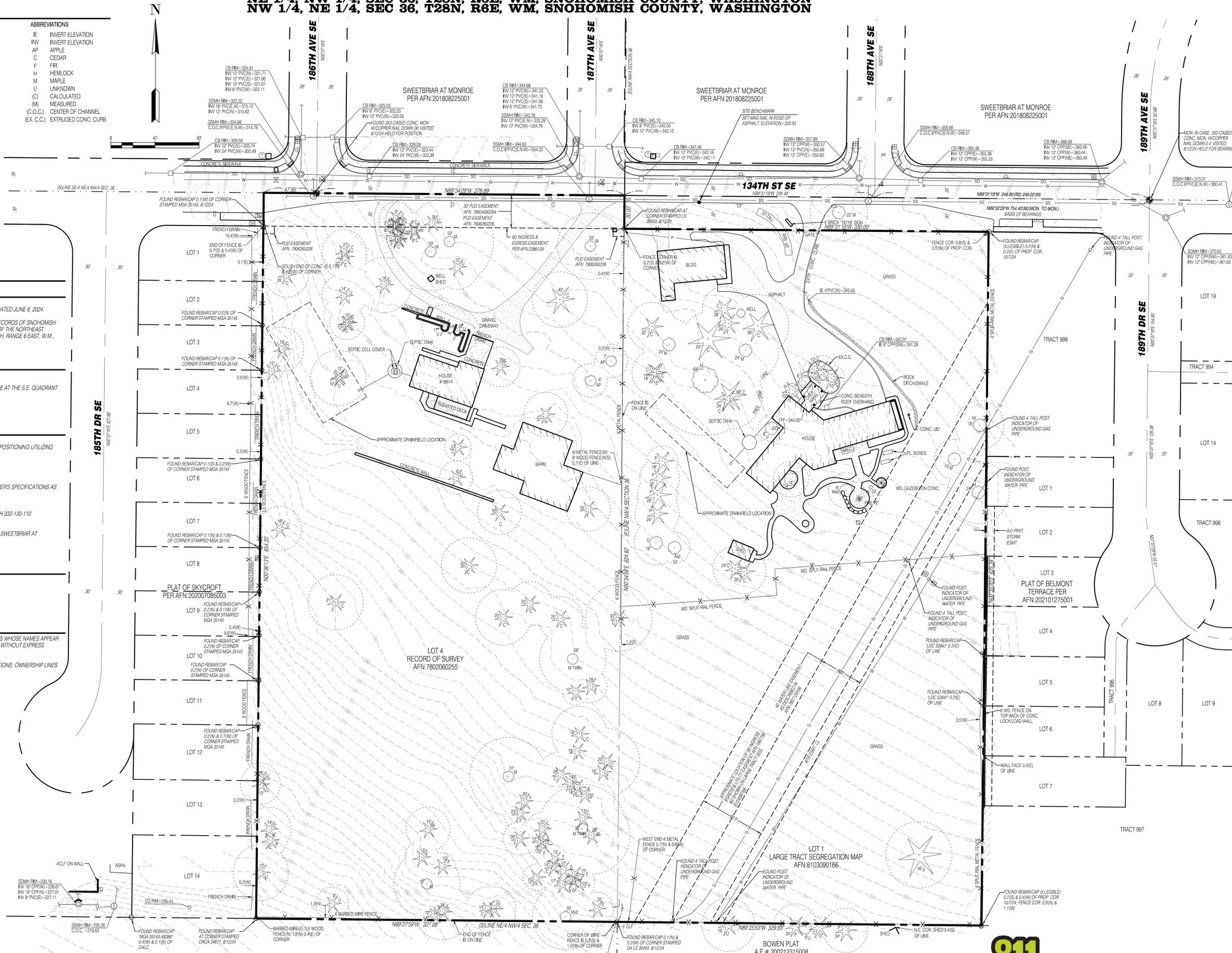
BEARING = NORTH 89°32'29" WEST

SURVEY REFERENCES

- (R1) RECORD OF SURVEY - AFN 7802060255
- (R2) PLAT OF SWEETBRIAR AT MONROE - AFN 201808225001
- (R3) PLAT OF BELMONT TERRACE - AFN 202101275001
- (R4) RECORD OF SURVEY - AFN 5808023004
- (R5) PLAT OF TROMBLEY HILL - AFN 9812155001
- (R6) PLAT OF SKYCROFT - AFN 202007085003

NOTES

- 1) THIS SURVEY HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF PARTIES WHOSE NAMES APPEAR HEREON ONLY, AND DOES NOT EXTEND TO ANY UNNAMED THIRD PARTIES WITHOUT EXPRESS RECERTIFICATION BY THE LAND SURVEYOR OF RECORD.
- 2) BOUNDARY LINES SHOWN AND CORNERS SET REPRESENT DEED LOCATIONS; OWNERSHIP LINES MAY VARY. NO GUARANTEE OF OWNERSHIP IS EXPRESSED OR IMPLIED.



ENGINEERS STAMP

REVISIONS

#	DATE	DESCRIPTION

S&G
 Solid Ground Engineering
 8105 168th Ave NE
 Redmond, WA 98052

EXISTING CONDITIONS MAP

SOUTH LAKE RIDGE, LLC
MONROE WEST
 18614 134TH ST SE, MONROE, WA

DRAWN BY:	AJP
CHECKED BY:	TPA
DATE:	1-14-25
JURISDICTION:	CITY OF MONROE
JOB NUMBER:	24-0086

EC-01
2 OF 23

SURVEY DISCLAIMER
 THE TOPOGRAPHIC SURVEY WAS PERFORMED BY PACIFIC COAST SURVEYS. SOLID GROUND ENGINEERING ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

UTILITY NOTE
 THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

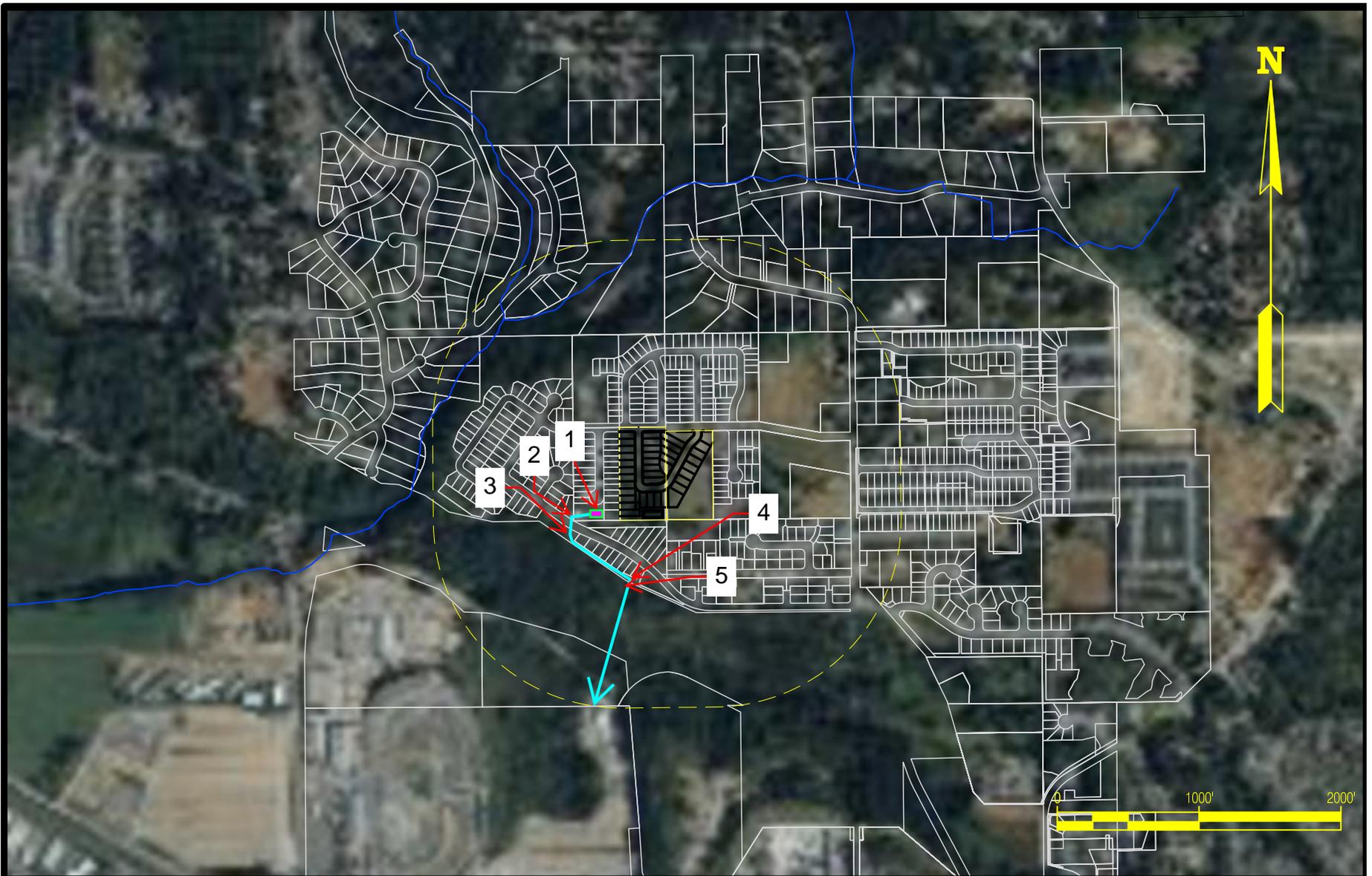


Appendix 2: Temporary Erosion and Sediment Control Design

1. TESC Plans

Appendix 3: Downstream Analysis

1. Downstream Analysis Map
2. Downstream Analysis Site Visit Pictures
3. USDA Soils Map & Description



Solid Ground Engineering

8105 166th Ave NE
Redmond, WA 98052

SOUTH LAKE RIDGE, LLC

MONROE WEST

DOWNSTREAM ANALYSIS MAP

JOB NUMBER:	24-0086	DATE:	01/09/2025
JURISDICTION:	MONROE	PROJECT:	OSMP

Page 24 of 120

Downstream Analysis Photographs

Image 1: Water flows off site to existing detention system east of the southeast corner of the property.



Image 2: Water flows south across Rainier View Rd SE



Image 3: Flows then travel southeast following this path behind houses south of Rainier View Rd SE



Image 4: flows then converge with another site



Image 5: flows then discharge down the hill side into a wetland area



Appendix 4: Detention and Water Quality Design Analysis

1. Predeveloped Hydrology Map
2. Developed Hydrology Map
3. StormFilter Detail
4. WWHM2012 Output – Detention Vault

NE 1/4, NW 1/4, SEC 36, T28N, R6E, WM, SNOHOMISH COUNTY, WASHINGTON
 NW 1/4, NE 1/4, SEC 36, T28N, R6E, WM, SNOHOMISH COUNTY, WASHINGTON

LEGEND AND ABBREVIATIONS

EXISTING SYMBOLS	DESCRIPTION	ABBREVIATIONS
○	FOUND MONUMENT AS NOTED	IE INVERT ELEVATION
○	EXISTING CORNER MONUMENT AS NOTED	INV INVERT ELEVATION
□	CATCH BASIN	AP APPLE
⊕	STORM MANHOLE	C CEDAR
⊕	CULVERT/INVERT OF STORM PIPE	FIR
⊕	WATER METER	H HEMLOCK
⊕	WATER VALVE	M MAPLE
⊕	FIRE HYDRANT	U UNKNOWN
⊕	IRRIGATION CONTROL VALVE	(C) CALCULATED
⊕	SEWER MANHOLE	(C.C.C.) CENTER OF CHANNEL (EX. C.C.) EXTRUDED CONC. CURB
⊕	SIGN	
⊕	MAILBOX	
⊕	GAS METER	
⊕	LIGHT STANDARD	
⊕	ELECTRIC MANHOLE	
⊕	GUY ANCHOR	
⊕	TUY POLE	
⊕	TELCO MANHOLE	
⊕	TELCO RISER	
⊕	POWER TRANSFORMER	
⊕	CONIFEROUS TREE	
⊕	DECIDUOUS TREE	

SURVEY INFORMATION

LEGAL DESCRIPTION

PARCEL NO. 280360220600
 PER CHICAGO INSURANCE COMPANY COMMITMENT NUMBER 500151982, DATED JUNE 6, 2024.
 LOT 4, SURVEY RECORDED UNDER AUDITOR'S FILE NUMBER 7802060255 RECORDS OF SNOHOMISH COUNTY ALSO KNOWN AS THE EAST HALF OF THE SOUTHEAST QUARTER OF THE NORTHEAST QUARTER OF THE NORTHWEST QUARTER SECTION 36, TOWNSHIP 28 NORTH, RANGE 6 EAST, W.M., SITUATE IN THE COUNTY OF SNOHOMISH, STATE OF WASHINGTON

VERTICAL DATUM

NAVD 88 (NAVD 88 - 3.67' - NGVD29)
 FOUND WSDOT BRASS DISK SURFACE MONUMENT IN TRAFFIC SIGNAL BASE AT THE S.E. QUADRANT OF THE INTERSECTION OF HWY 2 AND MAIN STREET.
 WSDOT DESIGNATION NO. BM131002-86
 PER GPS OBSERVATIONS.
 ELEV. = 72.24'

EQUIPMENT & PROCEDURES

METHOD OF SURVEY:
 SURVEY PERFORMED BY FIELD TRAVERSE AND REAL TIME KINEMATIC GPS POSITIONING UTILIZING THE HIGN SMARTNET NETWORK

INSTRUMENTATION:
 LEICA TS16 ROBOTIC ELECTRONIC TOTAL STATION
 LEICA VIVA GNSS GS08 RECEIVER
 ALL EQUIPMENT HAS BEEN MAINTAINED IN ADJUSTMENT TO MANUFACTURER'S SPECIFICATIONS AS REQUIRED BY WAC 331-130-100

PRECISION:
 MEETS OR EXCEEDS STATE STANDARDS SET BY WAC 332-130-080 THROUGH 332-130-110

BASIS OF BEARING:
 THE MONUMENTED CENTERLINE OF 134TH ST SE AS SHOWN HEREON PER SWEETBRIAR AT MONROE RECORDED UNDER AFN 201808225001.

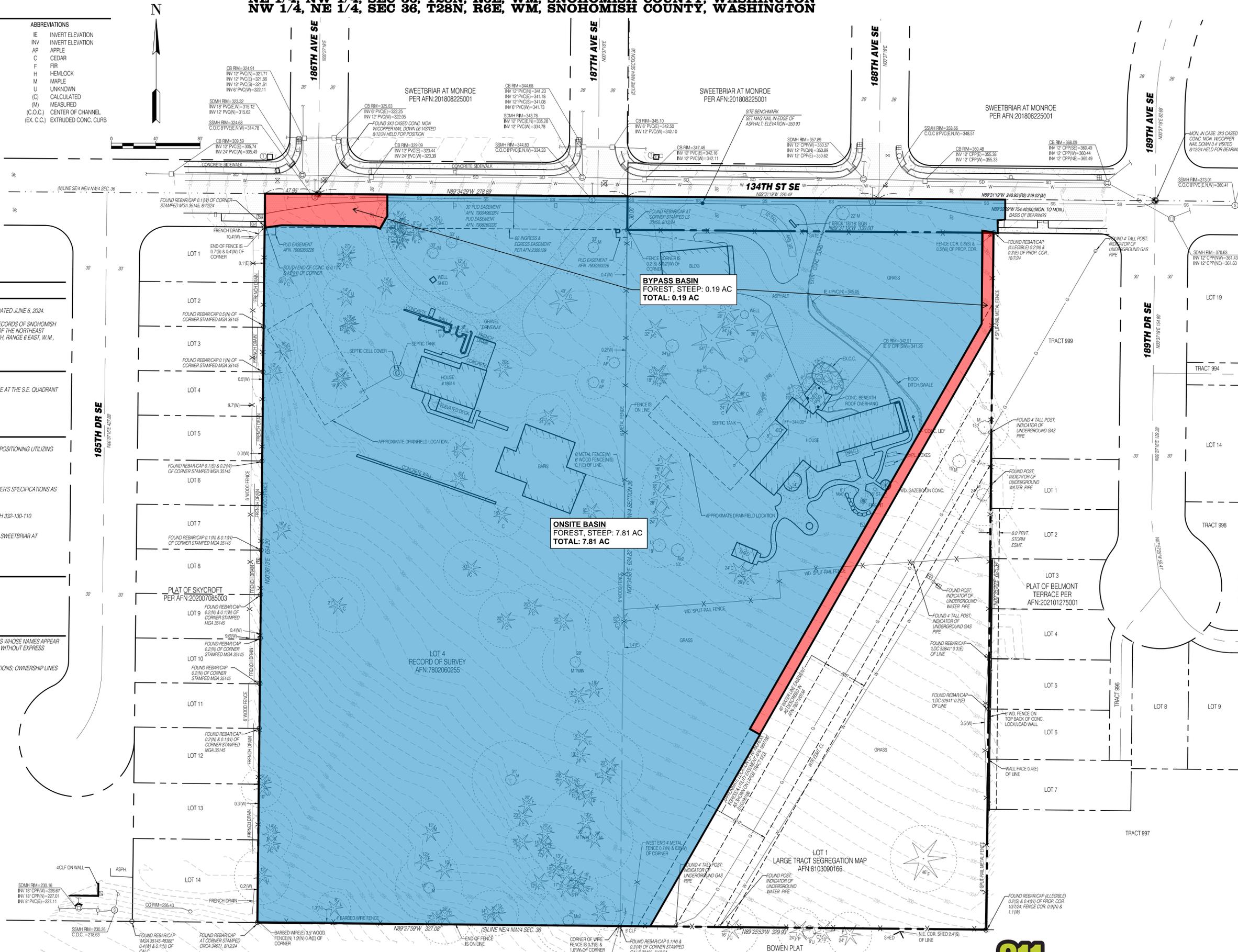
BEARING = NORTH 89°32'29" WEST

SURVEY REFERENCES

- (R1) RECORD OF SURVEY - AFN 7802060255
- (R2) PLAT OF SWEETBRIAR AT MONROE - AFN 201808225001
- (R3) PLAT OF BELMONT TERRACE - AFN 202101275001
- (R4) RECORD OF SURVEY - AFN 5808025004
- (R5) PLAT OF TROMBLEY HILL - AFN 9812155001
- (R6) PLAT OF SKYCROFT - AFN 202007085003

NOTES

- 1) THIS SURVEY HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF PARTIES WHOSE NAMES APPEAR HEREON ONLY, AND DOES NOT EXTEND TO ANY UNNAMED THIRD PARTIES WITHOUT EXPRESS RECERTIFICATION BY THE LAND SURVEYOR OF RECORD.
- 2) BOUNDARY LINES SHOWN AND CORNERS SET REPRESENT DEED LOCATIONS; OWNERSHIP LINES MAY VARY. NO HUARANTEE OF OWNERSHIP IS EXPRESSED OR IMPLIED.



ENGINEERS STAMP

REVISIONS

#	DATE	DESCRIPTION

SGE
 Solid Ground Engineering
 8105 168th Ave NE
 Redmond, WA 98052

PREDEVELOPED HYDROLOGY MAP

SOUTH LAKE RIDGE, LLC
MONROE WEST
 18614 134TH ST SE, MONROE, WA

DRAWN BY: AJP
 CHECKED BY: TPA
 DATE: 1-14-25
 JURISDICTION: CITY OF MONROE
 JOB NUMBER: 24-0086

EC-01
2 OF 23

SURVEY DISCLAIMER

THE TOPOGRAPHIC SURVEY WAS PERFORMED BY PACIFIC COAST SURVEYS. SOLID GROUND ENGINEERING ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.



WWHM2012
PROJECT REPORT

General Model Information

WWHM2012 Project Name: Monroe West Vault Sizing_20250417

Site Name:

Site Address:

City:

Report Date: 6/2/2025

Gage: Everett

Data Start: 1948/10/01

Data End: 2009/09/30

Timestep: 15 Minute

Precip Scale: 1.200

Version Date: 2024/06/28

Version: 4.3.1

POC Thresholds

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

High Flow Threshold for POC1: 50 Year

Landuse Basin Data
Predeveloped Land Use

Onsite

Bypass:	No
GroundWater:	No
Pervious Land Use C, Forest, Steep	acre 7.81
Pervious Total	7.81
Impervious Land Use	acre
Impervious Total	0
Basin Total	7.81

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

Bypass

Bypass:	No
GroundWater:	No
Pervious Land Use C, Forest, Steep	acre 0.19
Pervious Total	0.19
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.19

Element Flow Components:

Surface	Interflow	Groundwater
Component Flows To:		
POC 1	POC 1	

Mitigated Land Use

Onsite Basin

Bypass:	No
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 2.99
Pervious Total	2.99
Impervious Land Use	acre
ROADS MOD	1.15
ROOF TOPS FLAT	3
DRIVEWAYS MOD	0.38
SIDEWALKS MOD	0.29
Impervious Total	4.82
Basin Total	7.81

Element Flow Components:

Surface	Interflow	Groundwater
Component Flows To:		
Vault 1	Vault 1	

Bypass

Bypass:	Yes
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 0.13
Pervious Total	0.13
Impervious Land Use ROADS MOD SIDEWALKS MOD	acre 0.05 0.01
Impervious Total	0.06
Basin Total	0.19

Element Flow Components:

Surface	Interflow	Groundwater
Component Flows To:		
POC 1	POC 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1

Width: 100 ft.
 Length: 80 ft.
 Depth: 10 ft.
 Discharge Structure
 Riser Height: 9 ft.
 Riser Diameter: 24 in.
 Notch Type: Rectangular
 Notch Width: 0.010 ft.
 Notch Height: 1.000 ft.
 Orifice 1 Diameter: 2.063 in. Elevation:0 ft.
 Orifice 2 Diameter: 1.813 in. Elevation:3.55 ft.
 Orifice 3 Diameter: 2.906 in. Elevation:6 ft.
 Element Outlets:
 Outlet 1 Outlet 2
 Outlet Flows To:

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.183	0.000	0.000	0.000
0.1111	0.183	0.020	0.038	0.000
0.2222	0.183	0.040	0.054	0.000
0.3333	0.183	0.061	0.066	0.000
0.4444	0.183	0.081	0.077	0.000
0.5556	0.183	0.102	0.086	0.000
0.6667	0.183	0.122	0.094	0.000
0.7778	0.183	0.142	0.101	0.000
0.8889	0.183	0.163	0.108	0.000
1.0000	0.183	0.183	0.115	0.000
1.1111	0.183	0.204	0.121	0.000
1.2222	0.183	0.224	0.127	0.000
1.3333	0.183	0.244	0.133	0.000
1.4444	0.183	0.265	0.138	0.000
1.5556	0.183	0.285	0.144	0.000
1.6667	0.183	0.306	0.149	0.000
1.7778	0.183	0.326	0.153	0.000
1.8889	0.183	0.346	0.158	0.000
2.0000	0.183	0.367	0.163	0.000
2.1111	0.183	0.387	0.167	0.000
2.2222	0.183	0.408	0.172	0.000
2.3333	0.183	0.428	0.176	0.000
2.4444	0.183	0.448	0.180	0.000
2.5556	0.183	0.469	0.184	0.000
2.6667	0.183	0.489	0.188	0.000
2.7778	0.183	0.510	0.192	0.000
2.8889	0.183	0.530	0.196	0.000
3.0000	0.183	0.551	0.199	0.000
3.1111	0.183	0.571	0.203	0.000
3.2222	0.183	0.591	0.207	0.000
3.3333	0.183	0.612	0.210	0.000
3.4444	0.183	0.632	0.214	0.000
3.5556	0.183	0.653	0.224	0.000
3.6667	0.183	0.673	0.251	0.000

3.7778	0.183	0.693	0.266	0.000
3.8889	0.183	0.714	0.279	0.000
4.0000	0.183	0.734	0.290	0.000
4.1111	0.183	0.755	0.300	0.000
4.2222	0.183	0.775	0.310	0.000
4.3333	0.183	0.795	0.319	0.000
4.4444	0.183	0.816	0.327	0.000
4.5556	0.183	0.836	0.335	0.000
4.6667	0.183	0.857	0.343	0.000
4.7778	0.183	0.877	0.351	0.000
4.8889	0.183	0.897	0.358	0.000
5.0000	0.183	0.918	0.365	0.000
5.1111	0.183	0.938	0.372	0.000
5.2222	0.183	0.959	0.379	0.000
5.3333	0.183	0.979	0.385	0.000
5.4444	0.183	0.999	0.392	0.000
5.5556	0.183	1.020	0.398	0.000
5.6667	0.183	1.040	0.404	0.000
5.7778	0.183	1.061	0.410	0.000
5.8889	0.183	1.081	0.416	0.000
6.0000	0.183	1.101	0.422	0.000
6.1111	0.183	1.122	0.504	0.000
6.2222	0.183	1.142	0.541	0.000
6.3333	0.183	1.163	0.571	0.000
6.4444	0.183	1.183	0.597	0.000
6.5556	0.183	1.204	0.621	0.000
6.6667	0.183	1.224	0.642	0.000
6.7778	0.183	1.244	0.662	0.000
6.8889	0.183	1.265	0.682	0.000
7.0000	0.183	1.285	0.700	0.000
7.1111	0.183	1.306	0.717	0.000
7.2222	0.183	1.326	0.734	0.000
7.3333	0.183	1.346	0.750	0.000
7.4444	0.183	1.367	0.766	0.000
7.5556	0.183	1.387	0.781	0.000
7.6667	0.183	1.408	0.796	0.000
7.7778	0.183	1.428	0.810	0.000
7.8889	0.183	1.448	0.824	0.000
8.0000	0.183	1.469	0.838	0.000
8.1111	0.183	1.489	0.853	0.000
8.2222	0.183	1.510	0.868	0.000
8.3333	0.183	1.530	0.884	0.000
8.4444	0.183	1.550	0.900	0.000
8.5556	0.183	1.571	0.915	0.000
8.6667	0.183	1.591	0.931	0.000
8.7778	0.183	1.612	0.947	0.000
8.8889	0.183	1.632	0.962	0.000
9.0000	0.183	1.652	0.978	0.000
9.1111	0.183	1.673	1.774	0.000
9.2222	0.183	1.693	3.206	0.000
9.3333	0.183	1.714	4.991	0.000
9.4444	0.183	1.734	6.940	0.000
9.5556	0.183	1.754	8.860	0.000
9.6667	0.183	1.775	10.56	0.000
9.7778	0.183	1.795	11.92	0.000
9.8889	0.183	1.816	12.87	0.000
10.000	0.183	1.836	13.54	0.000
10.111	0.183	1.857	14.36	0.000

10.222

0.000

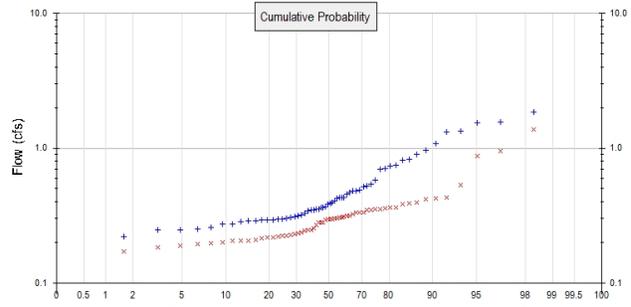
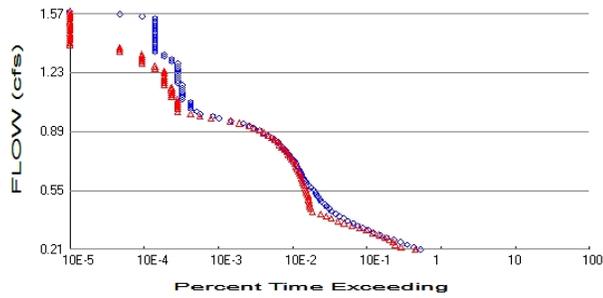
0.000

15.02

0.000

Analysis Results

POC 1



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area: 8
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1

Total Pervious Area: 3.12
Total Impervious Area: 4.88

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.421554
5 year	0.68778
10 year	0.912516
25 year	1.259747
50 year	1.569783
100 year	1.928664

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.280267
5 year	0.400248
10 year	0.49749
25 year	0.643043
50 year	0.769641
100 year	0.913335

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.454	0.247
1950	0.519	0.280
1951	0.362	0.218
1952	0.345	0.185
1953	0.311	0.193
1954	1.559	0.298
1955	0.525	0.334
1956	0.431	0.346
1957	0.578	0.395
1958	1.546	0.245

1959	0.384	0.301
1960	0.409	0.349
1961	1.849	0.314
1962	0.428	0.282
1963	0.700	0.223
1964	0.485	0.216
1965	0.301	0.292
1966	0.220	0.200
1967	0.433	0.237
1968	0.537	0.391
1969	1.342	0.246
1970	0.272	0.210
1971	0.485	0.323
1972	0.349	0.306
1973	0.293	0.234
1974	0.819	0.229
1975	0.369	0.206
1976	0.306	0.316
1977	0.274	0.217
1978	0.291	0.190
1979	0.824	0.351
1980	0.389	0.205
1981	0.288	0.222
1982	0.397	0.420
1983	0.703	0.226
1984	0.351	0.362
1985	0.482	0.362
1986	1.075	0.873
1987	0.469	0.530
1988	0.292	0.312
1989	0.363	0.163
1990	0.321	0.332
1991	0.346	0.331
1992	0.296	0.269
1993	0.293	0.206
1994	0.249	0.297
1995	0.350	0.353
1996	0.750	0.384
1997	1.313	1.378
1998	0.252	0.197
1999	0.285	0.297
2000	0.249	0.358
2001	0.112	0.171
2002	0.328	0.308
2003	0.259	0.225
2004	0.421	0.428
2005	0.316	0.302
2006	0.906	0.426
2007	0.734	0.283
2008	0.968	0.953
2009	0.300	0.253

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.8489	1.3777
2	1.5586	0.9535
3	1.5459	0.8727

4	1.3417	0.5302
5	1.3128	0.4278
6	1.0750	0.4260
7	0.9676	0.4196
8	0.9057	0.3949
9	0.8245	0.3909
10	0.8186	0.3840
11	0.7501	0.3625
12	0.7336	0.3621
13	0.7032	0.3581
14	0.7001	0.3529
15	0.5780	0.3506
16	0.5369	0.3493
17	0.5252	0.3456
18	0.5193	0.3343
19	0.4854	0.3320
20	0.4850	0.3309
21	0.4819	0.3226
22	0.4690	0.3161
23	0.4542	0.3143
24	0.4329	0.3122
25	0.4313	0.3078
26	0.4277	0.3056
27	0.4214	0.3018
28	0.4092	0.3008
29	0.3966	0.2979
30	0.3893	0.2971
31	0.3845	0.2965
32	0.3686	0.2919
33	0.3630	0.2825
34	0.3620	0.2820
35	0.3510	0.2803
36	0.3503	0.2688
37	0.3492	0.2534
38	0.3462	0.2471
39	0.3448	0.2463
40	0.3276	0.2454
41	0.3215	0.2375
42	0.3164	0.2342
43	0.3106	0.2289
44	0.3062	0.2260
45	0.3014	0.2254
46	0.2996	0.2226
47	0.2958	0.2218
48	0.2928	0.2175
49	0.2926	0.2167
50	0.2918	0.2159
51	0.2909	0.2095
52	0.2881	0.2062
53	0.2850	0.2061
54	0.2742	0.2053
55	0.2718	0.1996
56	0.2587	0.1971
57	0.2520	0.1934
58	0.2490	0.1897
59	0.2489	0.1847
60	0.2205	0.1709
61	0.1120	0.1626

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2108	11302	9595	84	Pass
0.2245	9150	6141	67	Pass
0.2382	7409	5200	70	Pass
0.2520	6021	4795	79	Pass
0.2657	4877	4273	87	Pass
0.2794	3938	3737	94	Pass
0.2931	3210	3136	97	Pass
0.3069	2671	2588	96	Pass
0.3206	2227	2120	95	Pass
0.3343	1874	1712	91	Pass
0.3481	1597	1334	83	Pass
0.3618	1395	1057	75	Pass
0.3755	1180	875	74	Pass
0.3892	1031	708	68	Pass
0.4030	900	605	67	Pass
0.4167	811	505	62	Pass
0.4304	719	395	54	Pass
0.4441	662	371	56	Pass
0.4579	611	363	59	Pass
0.4716	573	358	62	Pass
0.4853	526	354	67	Pass
0.4991	499	350	70	Pass
0.5128	474	345	72	Pass
0.5265	449	338	75	Pass
0.5402	430	329	76	Pass
0.5540	410	322	78	Pass
0.5677	382	312	81	Pass
0.5814	344	302	87	Pass
0.5951	329	295	89	Pass
0.6089	312	288	92	Pass
0.6226	300	279	93	Pass
0.6363	285	271	95	Pass
0.6501	275	265	96	Pass
0.6638	266	256	96	Pass
0.6775	255	248	97	Pass
0.6912	245	241	98	Pass
0.7050	236	231	97	Pass
0.7187	228	218	95	Pass
0.7324	213	208	97	Pass
0.7461	200	197	98	Pass
0.7599	192	186	96	Pass
0.7736	175	178	101	Pass
0.7873	166	166	100	Pass
0.8011	155	152	98	Pass
0.8148	146	143	97	Pass
0.8285	135	135	100	Pass
0.8422	122	122	100	Pass
0.8560	112	112	100	Pass
0.8697	99	99	100	Pass
0.8834	85	88	103	Pass
0.8971	77	77	100	Pass
0.9109	64	64	100	Pass
0.9246	55	55	100	Pass

0.9383	46	41	89	Pass
0.9521	32	31	96	Pass
0.9658	22	17	77	Pass
0.9795	18	12	66	Pass
0.9932	12	9	75	Pass
1.0070	11	6	54	Pass
1.0207	9	6	66	Pass
1.0344	9	6	66	Pass
1.0481	9	6	66	Pass
1.0619	9	6	66	Pass
1.0756	7	6	85	Pass
1.0893	7	5	71	Pass
1.1031	7	5	71	Pass
1.1168	7	5	71	Pass
1.1305	7	5	71	Pass
1.1442	7	5	71	Pass
1.1580	7	4	57	Pass
1.1717	6	4	66	Pass
1.1854	6	4	66	Pass
1.1991	6	4	66	Pass
1.2129	6	4	66	Pass
1.2266	6	4	66	Pass
1.2403	6	4	66	Pass
1.2541	6	3	50	Pass
1.2678	6	3	50	Pass
1.2815	6	2	33	Pass
1.2952	5	2	40	Pass
1.3090	5	2	40	Pass
1.3227	4	2	50	Pass
1.3364	4	2	50	Pass
1.3501	3	1	33	Pass
1.3639	3	1	33	Pass
1.3776	3	1	33	Pass
1.3913	3	0	0	Pass
1.4051	3	0	0	Pass
1.4188	3	0	0	Pass
1.4325	3	0	0	Pass
1.4462	3	0	0	Pass
1.4600	3	0	0	Pass
1.4737	3	0	0	Pass
1.4874	3	0	0	Pass
1.5011	3	0	0	Pass
1.5149	3	0	0	Pass
1.5286	3	0	0	Pass
1.5423	3	0	0	Pass
1.5561	2	0	0	Pass
1.5698	1	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

Appendix 5: Conveyance Analysis

1. Basin Map

2. Autodesk Storm & Sanitary Analysis 2024

Project Description

File Name -df.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method Rational
Time of Concentration (TOC) Method User-Defined
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:05:00 days hh:mm:ss
Routing Time Step 30 seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins.....	19
Nodes.....	20
<i>Junctions</i>	2
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	16
<i>Storage Nodes</i>	1
Links.....	21
<i>Channels</i>	0
<i>Pipes</i>	18
<i>Pumps</i>	0
<i>Orifices</i>	3
<i>Weirs</i>	0
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period..... 50 year(s)

Subbasin Summary

SN Subbasin ID	Area	Weighted Runoff Coefficient	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 Sub-01	0.07	0.7200	0.75	0.54	0.04	0.46	0 00:05:00
2 Sub-02	0.06	0.7200	0.75	0.54	0.03	0.39	0 00:05:00
3 Sub-03	0.11	0.7200	0.75	0.54	0.06	0.72	0 00:05:00
4 Sub-04	0.12	0.7200	0.75	0.54	0.07	0.78	0 00:05:00
5 Sub-05	0.05	0.7200	0.75	0.54	0.03	0.33	0 00:05:00
6 Sub-06	0.20	0.7200	0.75	0.54	0.11	1.30	0 00:05:00
7 Sub-07	0.57	0.7200	0.75	0.54	0.31	3.71	0 00:05:00
8 Sub-08	0.18	0.7200	0.75	0.54	0.10	1.17	0 00:05:00
9 Sub-09	0.10	0.7200	0.75	0.54	0.05	0.65	0 00:05:00
10 Sub-10	0.60	0.7200	0.75	0.54	0.33	3.91	0 00:05:00
11 Sub-11	0.09	0.7200	0.75	0.54	0.05	0.59	0 00:05:00
12 Sub-12	0.12	0.7200	0.75	0.54	0.07	0.78	0 00:05:00
13 Sub-13	0.09	0.7200	0.75	0.54	0.05	0.59	0 00:05:00
14 Sub-14	0.14	0.7200	0.75	0.54	0.08	0.91	0 00:05:00
15 Sub-15	0.42	0.7200	0.75	0.54	0.23	2.73	0 00:05:00
16 Sub-16	0.29	0.7200	0.75	0.54	0.16	1.89	0 00:05:00
17 Sub-17	0.36	0.7200	0.75	0.54	0.20	2.34	0 00:05:00
18 Sub-18	0.77	0.7200	0.75	0.54	0.42	5.01	0 00:05:00
19 Sub-19	0.66	0.7200	0.75	0.54	0.36	4.30	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft ²)	Peak Inflow (cfs)	Max HGL Elevation (ft)	Max Surcharge (ft)	Min Freeboard (ft)	Time of Peak Flooding (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	CB-2	Junction	326.60	331.30	326.60	331.30	10.00	2.57	326.93	0.00	4.37	0 00:00	0.00	0.00
2	CB-7	Junction	300.08	303.62	300.08	303.62	10.00	14.12	300.98	0.00	2.65	0 00:00	0.00	0.00
3	Out-01	Outfall	256.50					0.37	256.50					
4	Vault	Storage Node	256.00	266.00	260.75		0.00	20.48	261.77				0.00	0.00

Link Summary

SN Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Reported Surcharged (min)	Reported Condition
1	Pipe - (121)	Pipe	CB-17 CB-16	243.58	356.99	344.62	5.0800	12.000	0.0120	0.31	8.70	0.04	9.13	0.13	0.13	0.00	Calculated
2	Pipe - (122)	Pipe	CB-16 CB-15	173.76	344.62	332.49	6.9800	12.000	0.0120	1.06	10.20	0.10	8.47	0.22	0.22	0.00	Calculated
3	Pipe - (123)	Pipe	CB-15 CB-14	36.40	332.49	328.10	12.0600	12.000	0.0120	1.74	13.40	0.13	11.80	0.24	0.24	0.00	Calculated
4	Pipe - (124)	Pipe	CB-14 CB-2	26.45	328.10	326.60	5.6700	12.000	0.0120	2.12	9.19	0.23	9.52	0.33	0.33	0.00	Calculated
5	Pipe - (125)	Pipe	CB-12 CB-2	25.85	326.80	326.60	0.7700	12.000	0.0120	0.45	3.40	0.13	3.37	0.25	0.25	0.00	Calculated
6	Pipe - (127)	Pipe	CB-2 CB-4	181.38	326.60	305.71	11.5200	12.000	0.0120	2.56	13.10	0.20	13.00	0.30	0.30	0.00	Calculated
7	Pipe - (49)	Pipe	CB-4A CB-4	26.44	307.46	305.71	6.6200	12.000	0.0120	3.07	9.93	0.31	11.14	0.38	0.38	0.00	Calculated
8	Pipe - (50)	Pipe	CB-4 CB-3B	157.35	305.71	293.69	7.6400	12.000	0.0120	6.75	10.67	0.63	14.40	0.58	0.58	0.00	Calculated
9	Pipe - (52)	Pipe	CB-3 CB-1	168.26	293.44	270.79	13.4600	18.000	0.0120	20.00	41.75	0.48	23.81	0.73	0.49	0.00	Calculated
10	Pipe - (53)	Pipe	CB-1 Vault	35.20	270.79	262.00	24.9700	18.000	0.0120	20.48	56.87	0.36	29.53	0.62	0.41	0.00	Calculated
11	Pipe - (54)	Pipe	CB-3A CB-3	37.34	294.17	293.44	1.9500	18.000	0.0120	16.99	15.91	1.07	10.53	1.41	0.94	0.00	> CAPACITY
12	Pipe - (55)	Pipe	CB-7A CB-7	30.21	301.83	300.08	5.7900	12.000	0.0120	0.56	9.29	0.06	6.52	0.17	0.17	0.00	Calculated
13	Pipe - (56)	Pipe	CB-7 CB-8	95.46	300.08	294.74	5.5900	18.000	0.0120	13.68	26.92	0.51	15.82	0.75	0.50	0.00	Calculated
14	Pipe - (57)	Pipe	CB-5A CB-5	26.44	328.83	325.68	11.9100	12.000	0.0120	4.98	13.32	0.37	15.72	0.42	0.42	0.00	Calculated
15	Pipe - (58)	Pipe	CB-5 CB-6	128.34	325.68	308.30	13.5400	12.000	0.0120	8.92	14.20	0.63	19.10	0.57	0.57	0.00	Calculated
16	Pipe - (59)	Pipe	CB-6 CB-7	74.10	308.30	300.08	11.0900	12.000	0.0120	13.72	12.86	1.07	19.14	0.92	0.92	0.00	> CAPACITY
17	Pipe - (87)	Pipe	CB-8 CB-3A	26.35	294.74	294.17	2.1600	18.000	0.0120	14.15	16.74	0.85	10.73	1.06	0.71	0.00	Calculated
18	Pipe - (88)	Pipe	CB-3B CB-3	50.40	293.69	293.44	0.5000	12.000	0.0120	2.94	2.72	1.08	4.25	1.00	1.00	7.00	SURCHARGED
19	Orifice-01	Orifice	Vault Out-01		256.00	256.50		2.060		0.26							
20	Orifice-02	Orifice	Vault Out-01		256.00	256.50		2.906		0.00							
21	Orifice-03	Orifice	Vault Out-01		256.00	256.50		1.813		0.11							

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft ²)	Peak Flow (cfs)	Peak Flow Intercepted (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-1	FHWA HEC-22 GENERIC	N/A	On Sag	1	270.79	273.98	270.79	10.00	0.59	N/A	N/A	N/A	7.00	0.00	273.98
2	CB-12	FHWA HEC-22 GENERIC	N/A	On Sag	1	326.80	330.05	326.80	10.00	0.46	N/A	N/A	N/A	7.00	1.93	330.17
3	CB-14	FHWA HEC-22 GENERIC	N/A	On Sag	1	328.10	331.30	328.10	10.00	0.39	N/A	N/A	N/A	7.00	1.74	331.42
4	CB-15	FHWA HEC-22 GENERIC	N/A	On Sag	1	332.49	335.69	332.49	10.00	0.72	N/A	N/A	N/A	7.00	2.61	335.85
5	CB-16	FHWA HEC-22 GENERIC	N/A	On Sag	1	344.62	347.82	344.62	10.00	0.78	N/A	N/A	N/A	7.00	2.76	347.99
6	CB-17	FHWA HEC-22 GENERIC	N/A	On Sag	1	356.99	360.19	356.99	10.00	0.33	N/A	N/A	N/A	7.00	1.54	360.29
7	CB-3	FHWA HEC-22 GENERIC	N/A	On Sag	1	293.44	297.19	293.44	10.00	0.65	N/A	N/A	N/A	7.00	0.00	297.19
8	CB-3A	FHWA HEC-22 GENERIC	N/A	On Sag	1	294.17	297.39	294.17	10.00	3.91	N/A	N/A	N/A	7.00	496.04	322.21
9	CB-3B	FHWA HEC-22 GENERIC	N/A	On Sag	1	293.69	298.03	293.69	10.00	1.17	N/A	N/A	N/A	7.00	45.64	300.33
10	CB-4	FHWA HEC-22 GENERIC	N/A	On Sag	1	305.71	310.66	305.71	10.00	1.30	N/A	N/A	N/A	7.00	55.99	313.48
11	CB-4A	FHWA HEC-22 GENERIC	N/A	On Sag	1	307.46	310.66	307.46	10.00	3.71	N/A	N/A	N/A	7.00	447.77	333.07
12	CB-5	FHWA HEC-22 GENERIC	N/A	On Sag	1	325.68	329.02	325.68	10.00	5.01	N/A	N/A	N/A	7.00	816.32	369.86
13	CB-5A	FHWA HEC-22 GENERIC	N/A	On Sag	1	328.83	331.35	328.83	10.00	6.64	N/A	N/A	N/A	7.00	1431.71	402.96
14	CB-6	FHWA HEC-22 GENERIC	N/A	On Sag	1	308.30	313.62	308.30	10.00	5.53	N/A	N/A	N/A	7.00	994.54	363.37
15	CB-7A	FHWA HEC-22 GENERIC	N/A	On Sag	1	301.83	305.04	301.83	10.00	0.59	N/A	N/A	N/A	7.00	0.00	305.04
16	CB-8	FHWA HEC-22 GENERIC	N/A	On Sag	1	294.74	297.94	294.74	10.00	0.78	N/A	N/A	N/A	7.00	5.20	298.22

Subbasin Hydrology

Subbasin : Sub-01

Input Data

Area (ac) 0.07
Weighted Runoff Coefficient 0.72

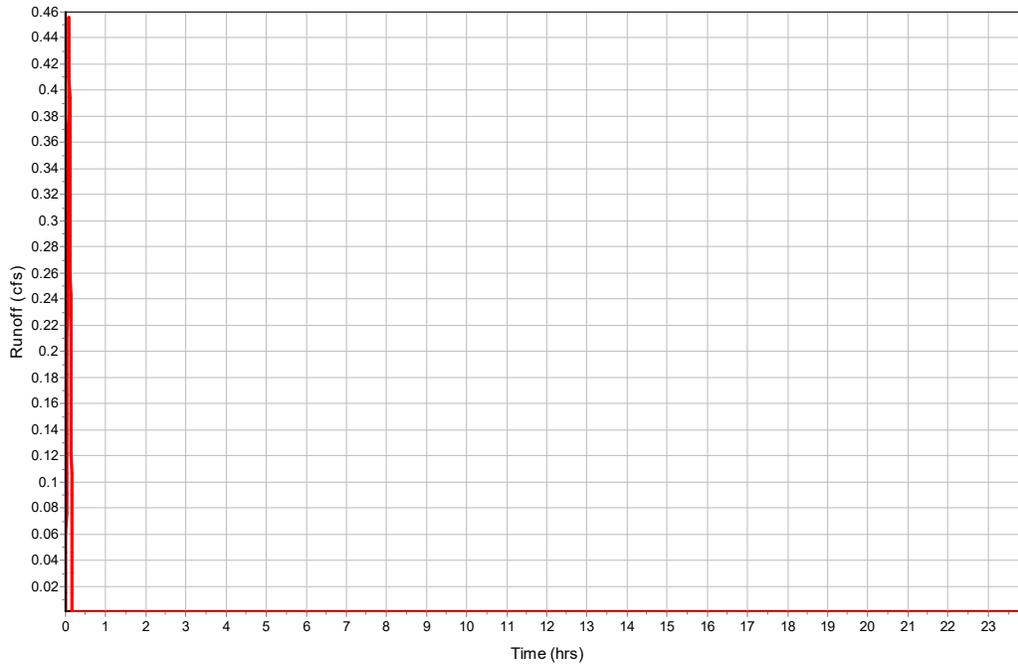
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.07	-	0.72
Composite Area & Weighted Runoff Coeff.	0.07		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.46
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-02

Input Data

Area (ac) 0.06
Weighted Runoff Coefficient 0.72

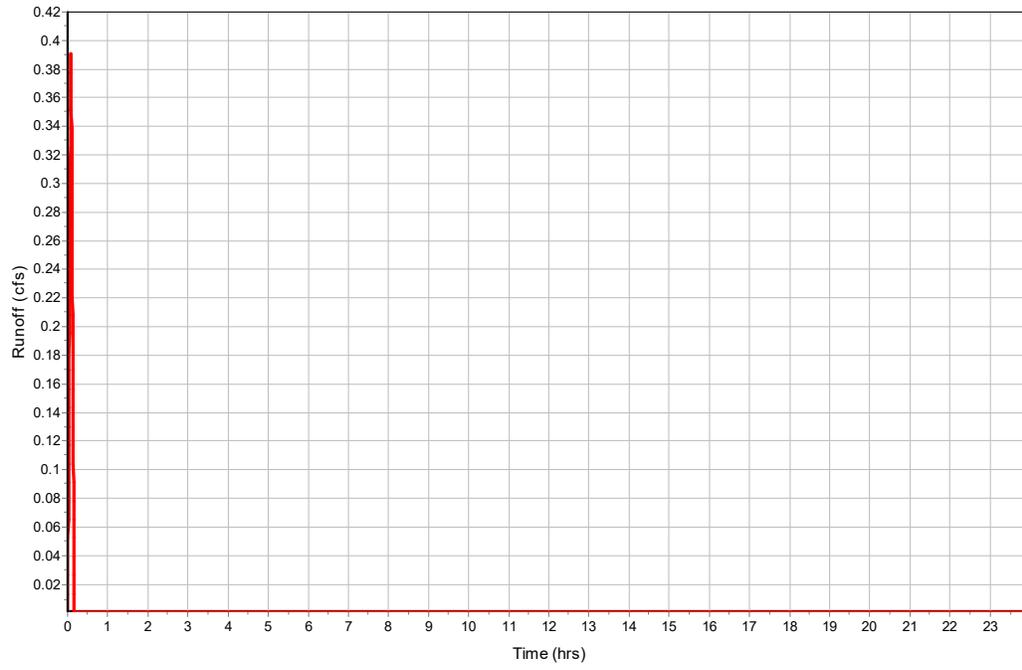
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.06	-	0.72
Composite Area & Weighted Runoff Coeff.	0.06		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.39
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-03

Input Data

Area (ac) 0.11
Weighted Runoff Coefficient 0.72

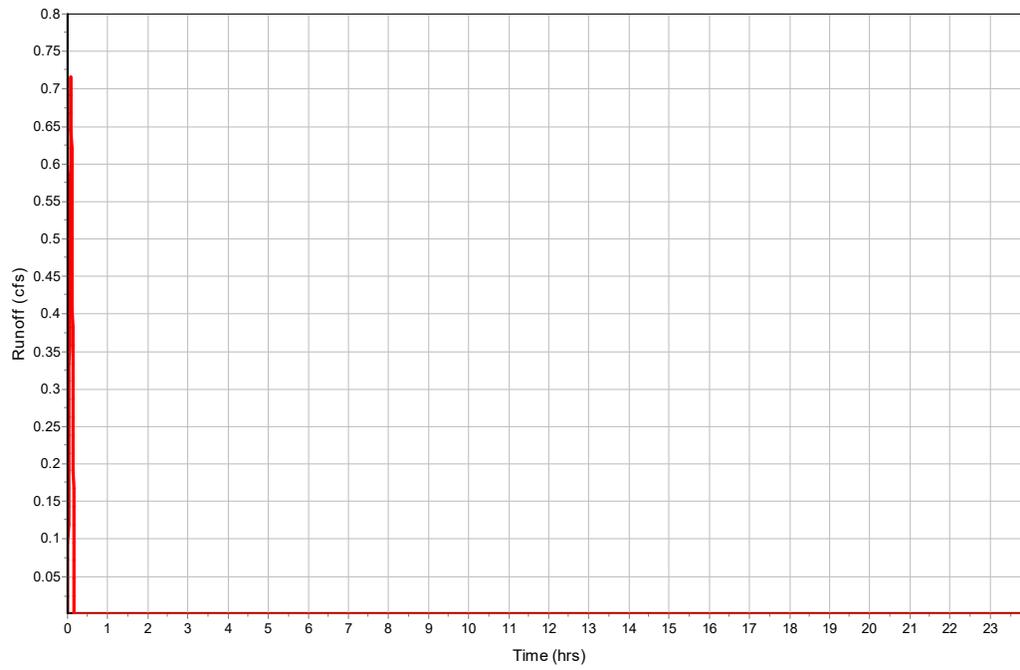
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.09	-	0.72
Composite Area & Weighted Runoff Coeff.	0.09		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.72
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-04

Input Data

Area (ac) 0.12
Weighted Runoff Coefficient 0.72

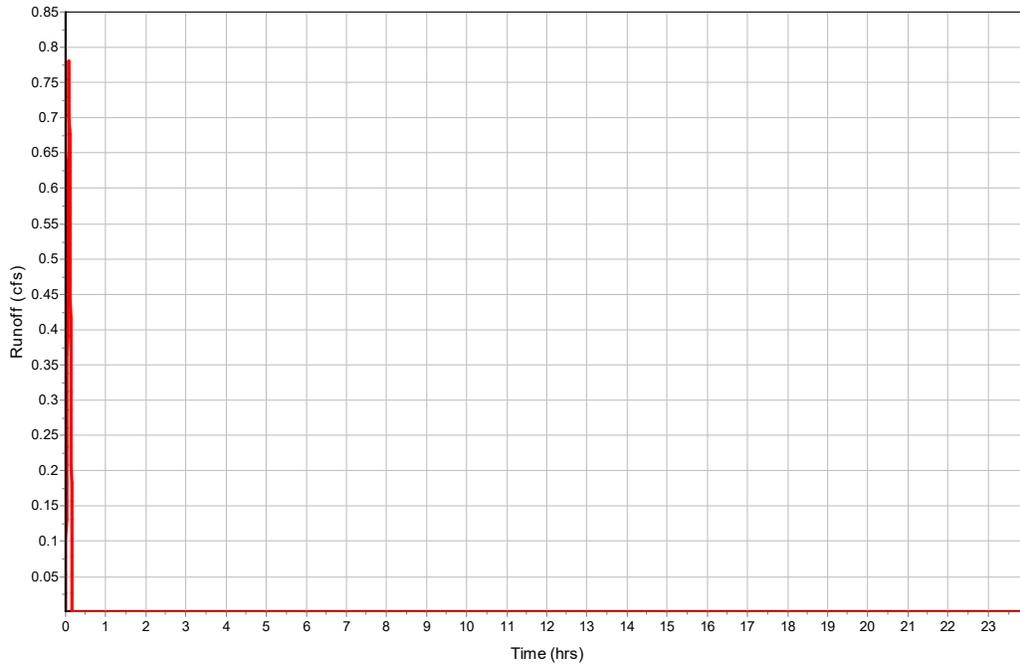
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.1	-	0.72
Composite Area & Weighted Runoff Coeff.	0.1		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.78
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-05

Input Data

Area (ac) 0.05
Weighted Runoff Coefficient 0.72

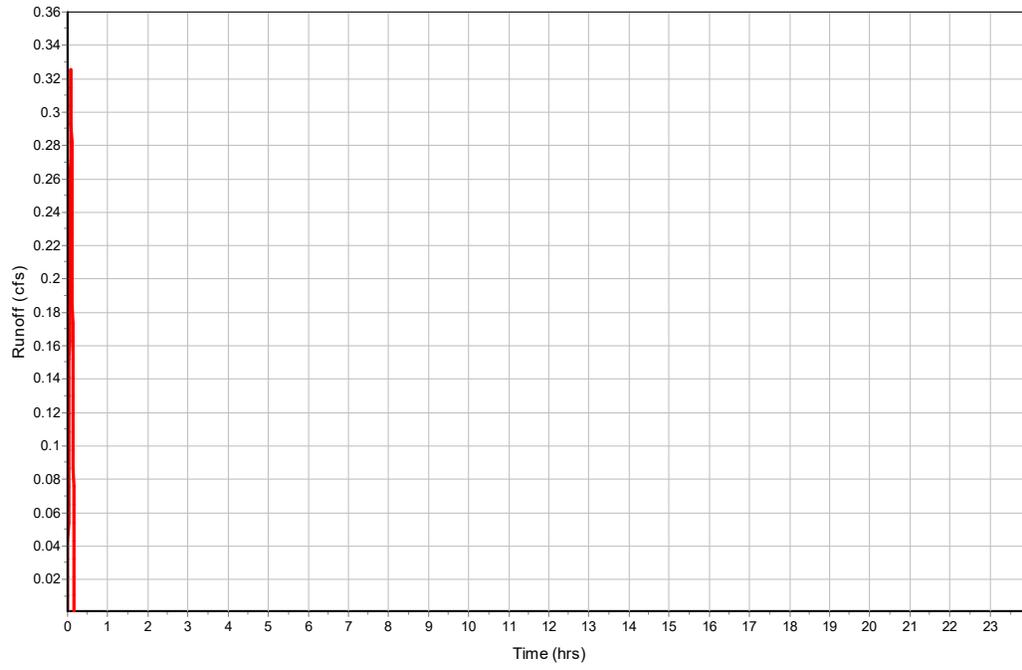
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.2	-	0.72
Composite Area & Weighted Runoff Coeff.	0.2		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.33
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-06

Input Data

Area (ac) 0.2
Weighted Runoff Coefficient 0.72

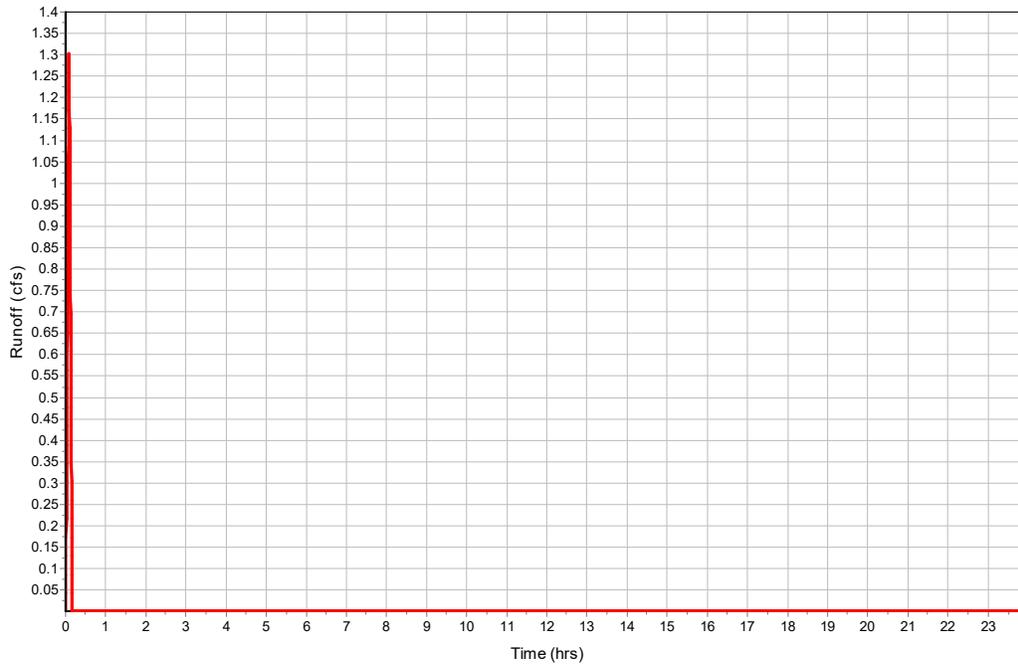
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.14	-	0.72
Composite Area & Weighted Runoff Coeff.	0.14		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 1.3
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-07

Input Data

Area (ac) 0.57
Weighted Runoff Coefficient 0.72

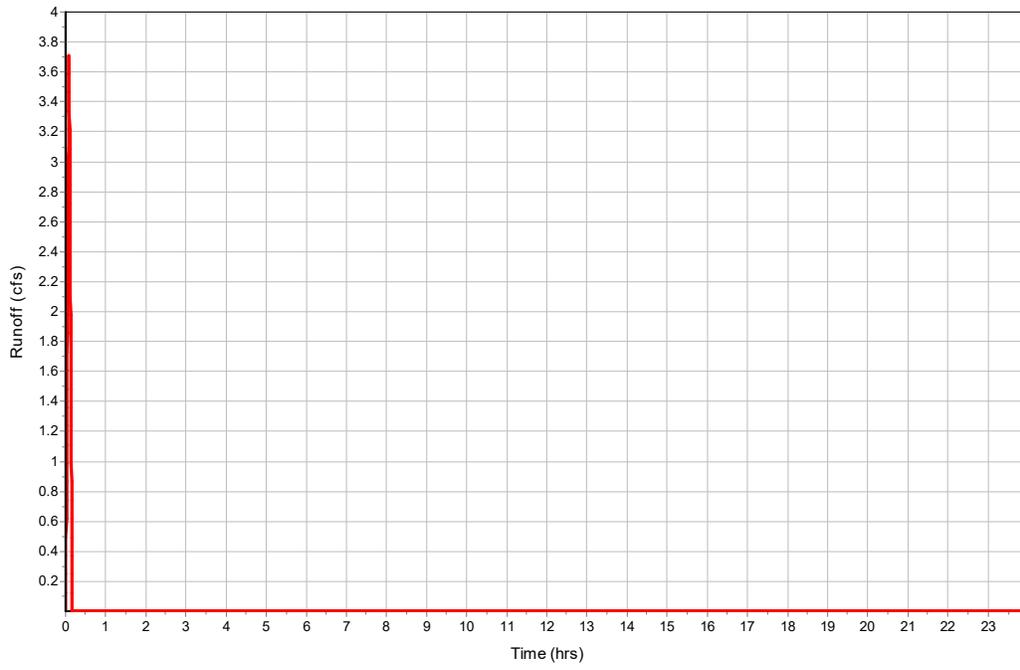
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.46	-	0.72
Composite Area & Weighted Runoff Coeff.	0.46		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 3.71
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-08

Input Data

Area (ac) 0.18
Weighted Runoff Coefficient 0.72

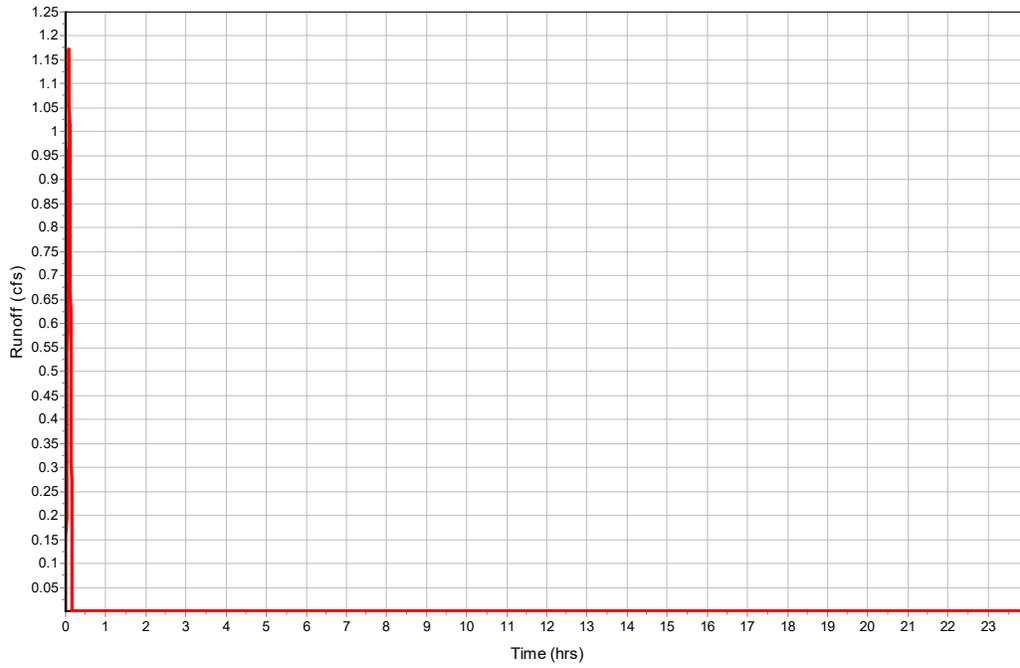
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.12	-	0.72
Composite Area & Weighted Runoff Coeff.	0.12		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 1.17
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-09

Input Data

Area (ac) 0.1
Weighted Runoff Coefficient 0.72

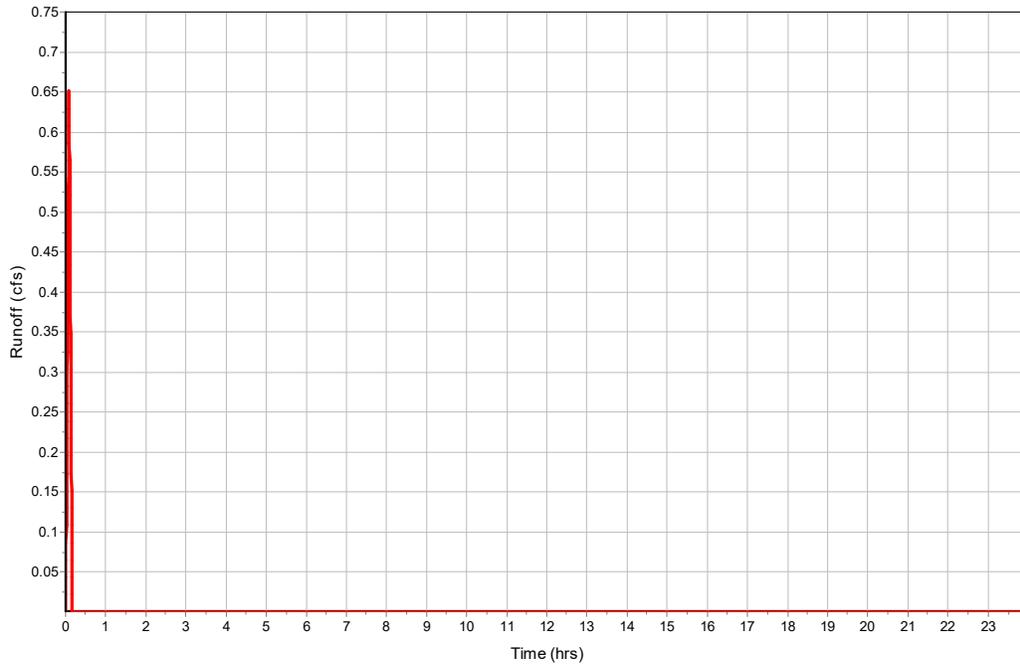
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.06	-	0.72
Composite Area & Weighted Runoff Coeff.	0.06		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.65
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-10

Input Data

Area (ac) 0.6
Weighted Runoff Coefficient 0.72

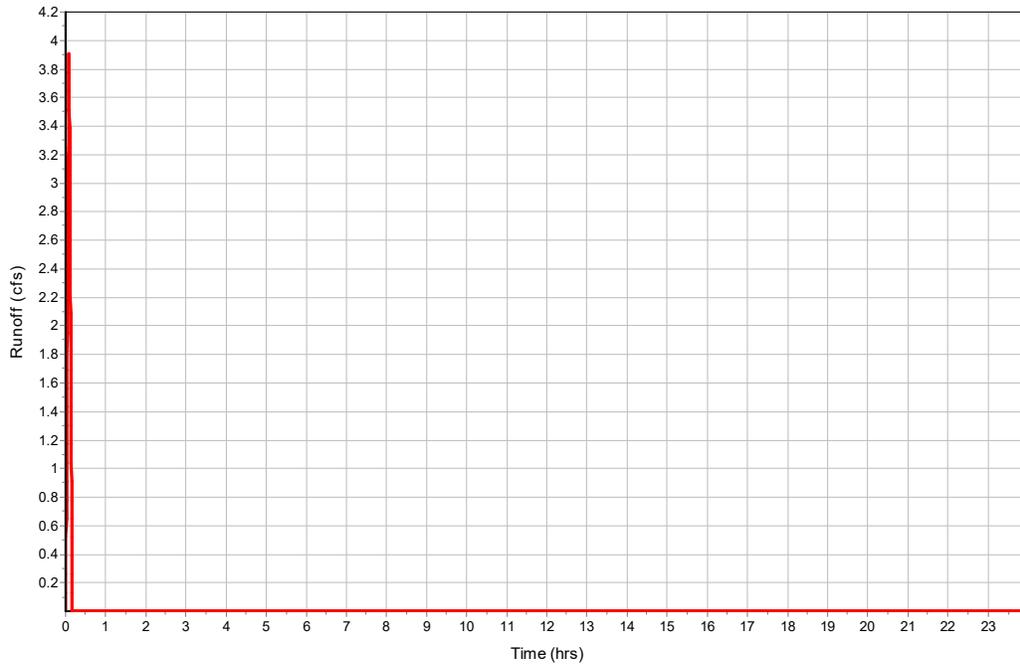
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.48	-	0.72
Composite Area & Weighted Runoff Coeff.	0.48		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 3.91
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-11

Input Data

Area (ac) 0.09
Weighted Runoff Coefficient 0.72

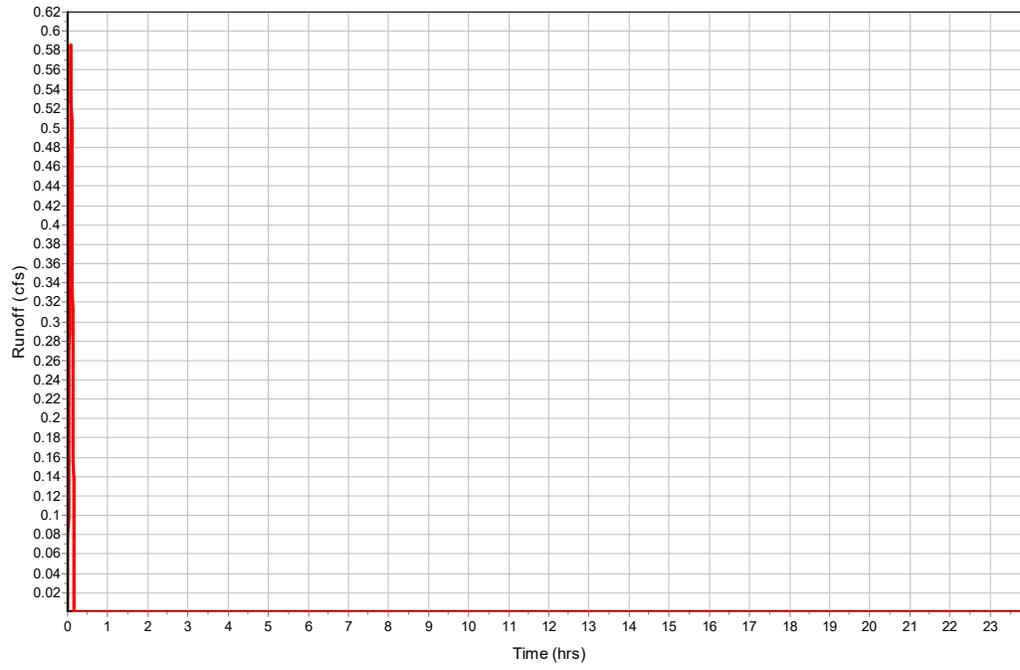
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.08	-	0.72
Composite Area & Weighted Runoff Coeff.	0.08		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.59
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-12

Input Data

Area (ac) 0.12
Weighted Runoff Coefficient 0.72

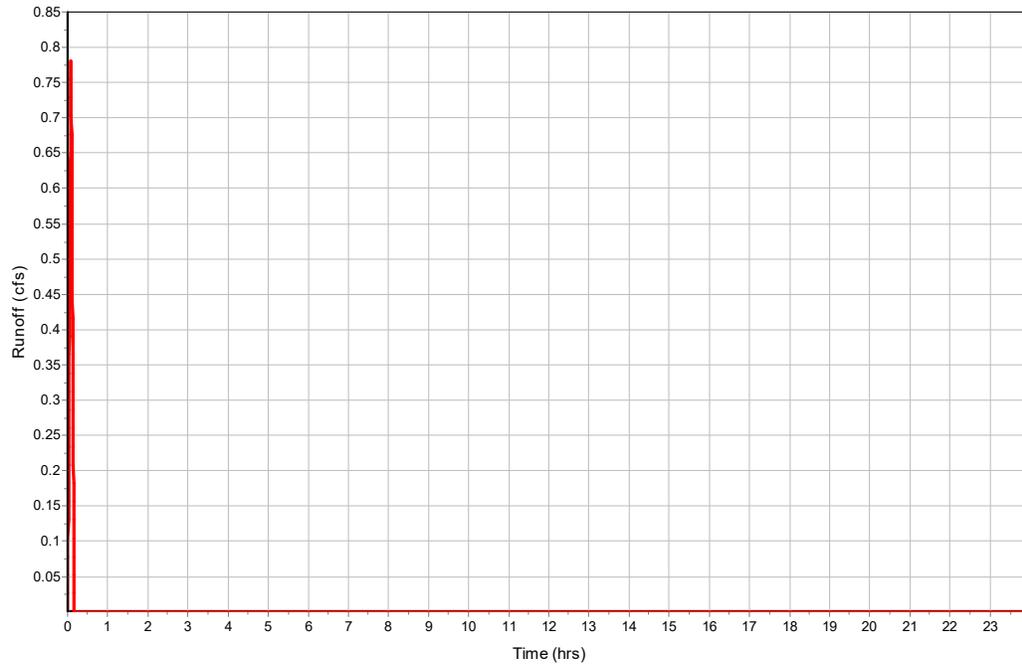
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.08	-	0.72
Composite Area & Weighted Runoff Coeff.	0.08		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.78
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-13

Input Data

Area (ac) 0.09
Weighted Runoff Coefficient 0.72

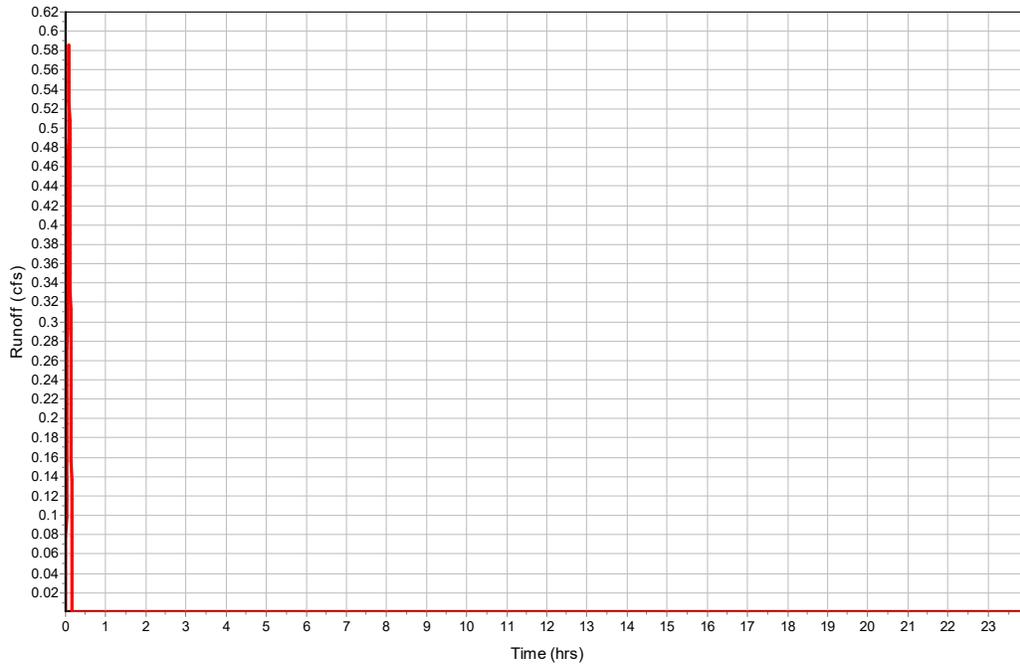
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.07	-	0.72
Composite Area & Weighted Runoff Coeff.	0.07		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.59
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-14

Input Data

Area (ac) 0.14
Weighted Runoff Coefficient 0.72

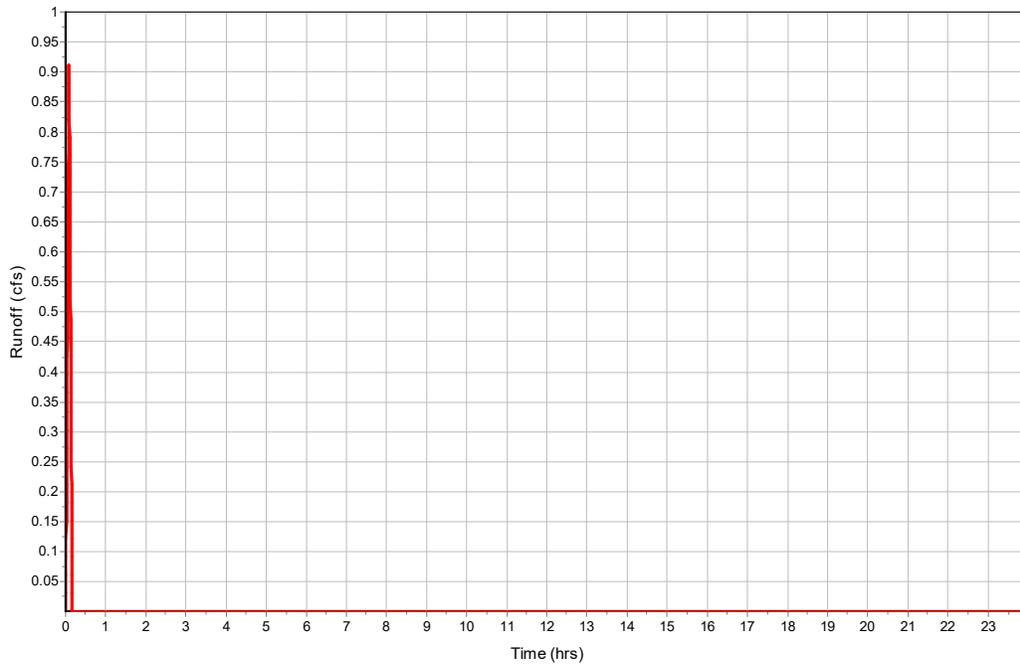
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.14	-	0.72
Composite Area & Weighted Runoff Coeff.	0.14		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 0.91
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-15

Input Data

Area (ac) 0.42
Weighted Runoff Coefficient 0.72

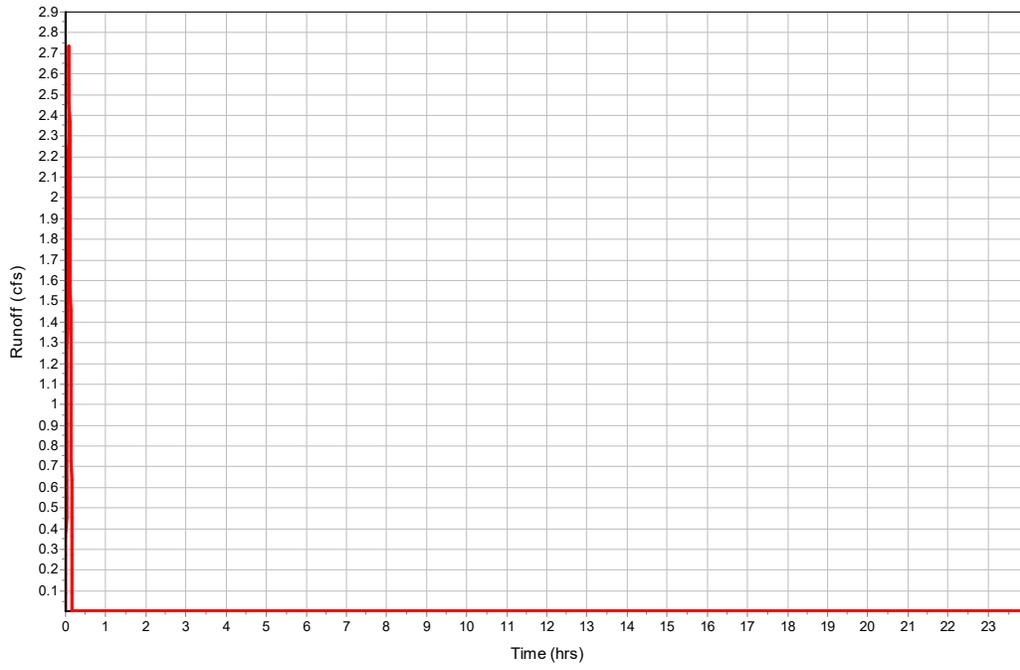
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.49	-	0.72
Composite Area & Weighted Runoff Coeff.	0.49		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 2.73
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-16

Input Data

Area (ac) 0.29
Weighted Runoff Coefficient 0.72

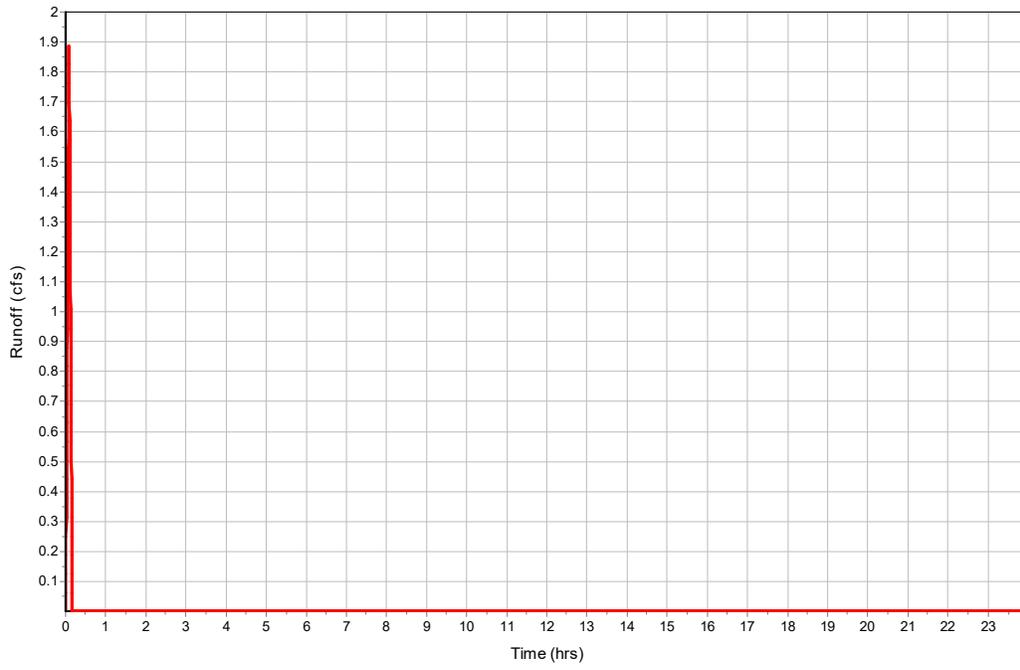
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.33	-	0.72
Composite Area & Weighted Runoff Coeff.	0.33		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 1.89
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-17

Input Data

Area (ac) 0.36
Weighted Runoff Coefficient 0.72

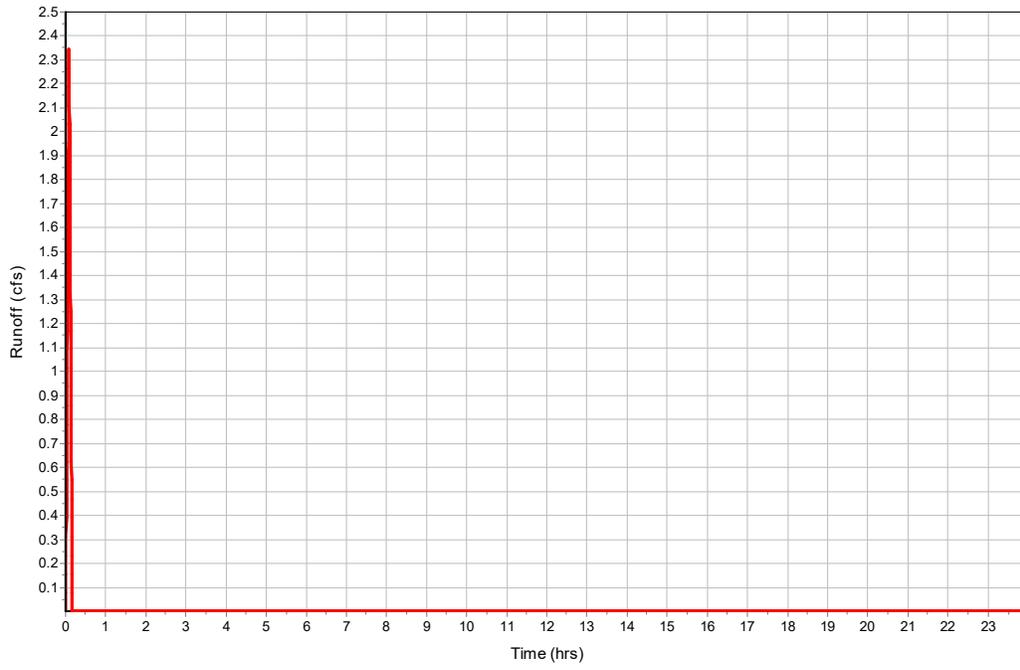
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.35	-	0.72
Composite Area & Weighted Runoff Coeff.	0.35		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 2.34
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-18

Input Data

Area (ac) 0.77
Weighted Runoff Coefficient 0.72

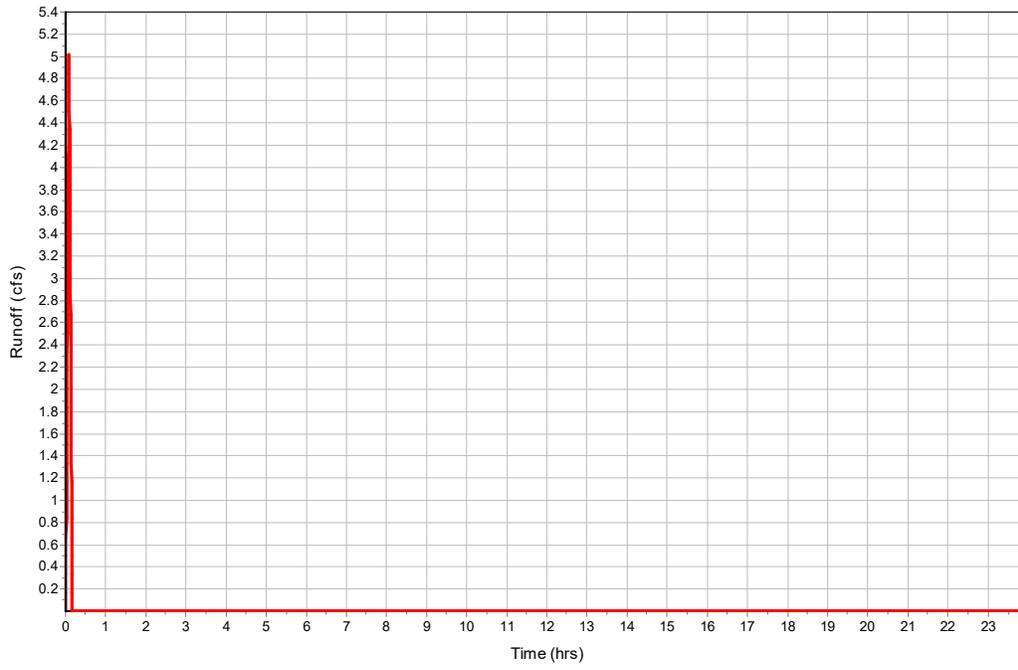
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.9	-	0.72
Composite Area & Weighted Runoff Coeff.	0.9		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 5.01
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Subbasin : Sub-19

Input Data

Area (ac) 0.66
Weighted Runoff Coefficient 0.72

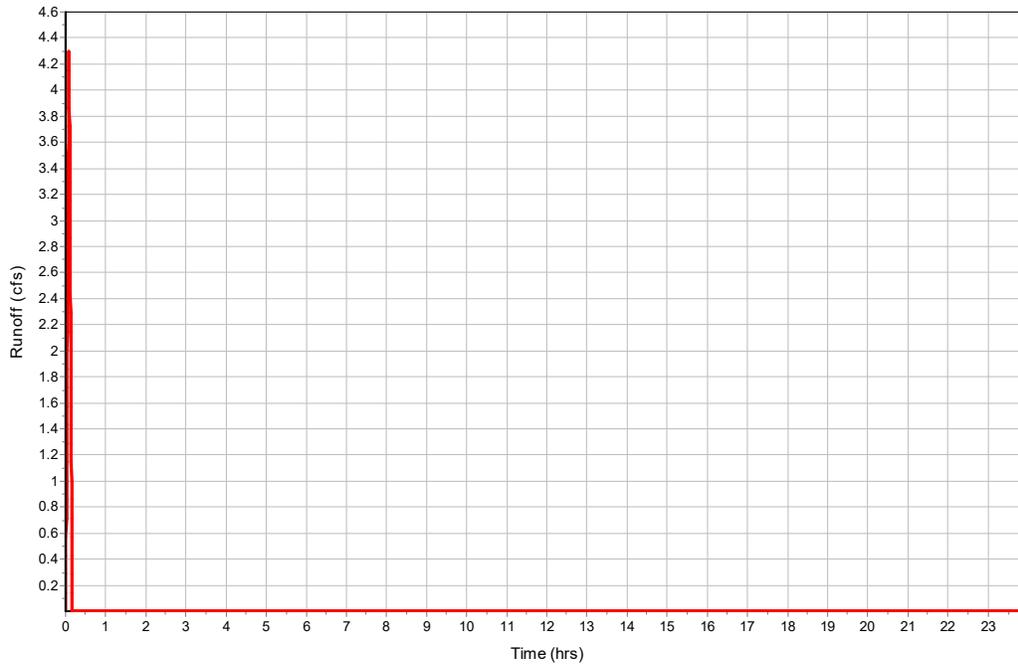
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.63	-	0.72
Composite Area & Weighted Runoff Coeff.	0.63		0.72

Subbasin Runoff Results

Total Rainfall (in) 0.75
Total Runoff (in) 0.54
Peak Runoff (cfs) 4.3
Rainfall Intensity 9.041
Weighted Runoff Coefficient 0.72
Time of Concentration (days hh:mm:ss) 0 00:05:00

Runoff Hydrograph



Junction Input

SN Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft ²)	Minimum Pipe Cover (in)
1 CB-2	326.60	331.30	4.70	326.60	0.00	331.30	0.00	10.00	44.35
2 CB-7	300.08	303.62	3.54	300.08	0.00	303.62	0.00	10.00	24.51

Junction Results

SN Element ID	Peak Inflow	Peak Lateral	Max HGL Elevation	Max HGL Depth	Max Surcharge Depth	Min Freeboard	Average HGL Elevation	Average HGL Depth	Time of Max HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-in)	(min)
1 CB-2	2.57	0.00	326.93	0.33	0.00	4.37	326.60	0.00	0 00:05	0 00:00	0.00	0.00
2 CB-7	14.12	0.00	300.98	0.90	0.00	2.65	300.08	0.00	0 00:07	0 00:00	0.00	0.00

Pipe Input

SN Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1 Pipe - (121)	243.58	356.99	0.00	344.62	0.00	12.37	5.0800	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2 Pipe - (122)	173.76	344.62	0.00	332.49	0.00	12.13	6.9800	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3 Pipe - (123)	36.40	332.49	0.00	328.10	0.00	4.39	12.0600	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4 Pipe - (124)	26.45	328.10	0.00	326.60	0.00	1.50	5.6700	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5 Pipe - (125)	25.85	326.80	0.00	326.60	0.00	0.20	0.7700	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6 Pipe - (127)	181.38	326.60	0.00	305.71	0.00	20.89	11.5200	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7 Pipe - (49)	26.44	307.46	0.00	305.71	0.00	1.75	6.6200	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8 Pipe - (50)	157.35	305.71	0.00	293.69	0.00	12.02	7.6400	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
9 Pipe - (52)	168.26	293.44	0.00	270.79	0.00	22.65	13.4600	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
10 Pipe - (53)	35.20	270.79	0.00	262.00	6.00	8.79	24.9700	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
11 Pipe - (54)	37.34	294.17	0.00	293.44	0.00	0.73	1.9500	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
12 Pipe - (55)	30.21	301.83	0.00	300.08	0.00	1.75	5.7900	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
13 Pipe - (56)	95.46	300.08	0.00	294.74	0.00	5.34	5.5900	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
14 Pipe - (57)	26.44	328.83	0.00	325.68	0.00	3.15	11.9100	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
15 Pipe - (58)	128.34	325.68	0.00	308.30	0.00	17.38	13.5400	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
16 Pipe - (59)	74.10	308.30	0.00	300.08	0.00	8.22	11.0900	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
17 Pipe - (87)	26.35	294.74	0.00	294.17	0.00	0.57	2.1600	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
18 Pipe - (88)	50.40	293.69	0.00	293.44	0.00	0.25	0.5000	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1 Pipe - (121)	0.31	0 00:05	8.70	0.04	9.13	0.44	0.13	0.13	0.00		Calculated
2 Pipe - (122)	1.06	0 00:05	10.20	0.10	8.47	0.34	0.22	0.22	0.00		Calculated
3 Pipe - (123)	1.74	0 00:05	13.40	0.13	11.80	0.05	0.24	0.24	0.00		Calculated
4 Pipe - (124)	2.12	0 00:05	9.19	0.23	9.52	0.05	0.33	0.33	0.00		Calculated
5 Pipe - (125)	0.45	0 00:05	3.40	0.13	3.37	0.13	0.25	0.25	0.00		Calculated
6 Pipe - (127)	2.56	0 00:05	13.10	0.20	13.00	0.23	0.30	0.30	0.00		Calculated
7 Pipe - (49)	3.07	0 00:06	9.93	0.31	11.14	0.04	0.38	0.38	0.00		Calculated
8 Pipe - (50)	6.75	0 00:05	10.67	0.63	14.40	0.18	0.58	0.58	0.00		Calculated
9 Pipe - (52)	20.00	0 00:06	41.75	0.48	23.81	0.12	0.73	0.49	0.00		Calculated
10 Pipe - (53)	20.48	0 00:06	56.87	0.36	29.53	0.02	0.62	0.41	0.00		Calculated
11 Pipe - (54)	16.99	0 00:07	15.91	1.07	10.53	0.06	1.41	0.94	0.00		> CAPACITY
12 Pipe - (55)	0.56	0 00:05	9.29	0.06	6.52	0.08	0.17	0.17	0.00		Calculated
13 Pipe - (56)	13.68	0 00:07	26.92	0.51	15.82	0.10	0.75	0.50	0.00		Calculated
14 Pipe - (57)	4.98	0 00:06	13.32	0.37	15.72	0.03	0.42	0.42	0.00		Calculated
15 Pipe - (58)	8.92	0 00:06	14.20	0.63	19.10	0.11	0.57	0.57	0.00		Calculated
16 Pipe - (59)	13.72	0 00:07	12.86	1.07	19.14	0.06	0.92	0.92	0.00		> CAPACITY
17 Pipe - (87)	14.15	0 00:06	16.74	0.85	10.73	0.04	1.06	0.71	0.00		Calculated
18 Pipe - (88)	2.94	0 00:02	2.72	1.08	4.25	0.20	1.00	1.00	7.00		SURCHARGED

Inlet Input

SN Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area (ft ²)	Grate Clogging Factor (%)
1 CB-1	FHWA HEC-22 GENERIC	N/A	On Sag	1	270.79	273.98	3.19	270.79	0.00	10.00	0.00
2 CB-12	FHWA HEC-22 GENERIC	N/A	On Sag	1	326.80	330.05	3.25	326.80	0.00	10.00	0.00
3 CB-14	FHWA HEC-22 GENERIC	N/A	On Sag	1	328.10	331.30	3.20	328.10	0.00	10.00	0.00
4 CB-15	FHWA HEC-22 GENERIC	N/A	On Sag	1	332.49	335.69	3.20	332.49	0.00	10.00	0.00
5 CB-16	FHWA HEC-22 GENERIC	N/A	On Sag	1	344.62	347.82	3.20	344.62	0.00	10.00	0.00
6 CB-17	FHWA HEC-22 GENERIC	N/A	On Sag	1	356.99	360.19	3.20	356.99	0.00	10.00	0.00
7 CB-3	FHWA HEC-22 GENERIC	N/A	On Sag	1	293.44	297.19	3.75	293.44	0.00	10.00	0.00
8 CB-3A	FHWA HEC-22 GENERIC	N/A	On Sag	1	294.17	297.39	3.22	294.17	0.00	10.00	0.00
9 CB-3B	FHWA HEC-22 GENERIC	N/A	On Sag	1	293.69	298.03	4.34	293.69	0.00	10.00	0.00
10 CB-4	FHWA HEC-22 GENERIC	N/A	On Sag	1	305.71	310.66	4.95	305.71	0.00	10.00	0.00
11 CB-4A	FHWA HEC-22 GENERIC	N/A	On Sag	1	307.46	310.66	3.20	307.46	0.00	10.00	0.00
12 CB-5	FHWA HEC-22 GENERIC	N/A	On Sag	1	325.68	329.02	3.34	325.68	0.00	10.00	0.00
13 CB-5A	FHWA HEC-22 GENERIC	N/A	On Sag	1	328.83	331.35	2.52	328.83	0.00	10.00	0.00
14 CB-6	FHWA HEC-22 GENERIC	N/A	On Sag	1	308.30	313.62	5.32	308.30	0.00	10.00	0.00
15 CB-7A	FHWA HEC-22 GENERIC	N/A	On Sag	1	301.83	305.04	3.21	301.83	0.00	10.00	0.00
16 CB-8	FHWA HEC-22 GENERIC	N/A	On Sag	1	294.74	297.94	3.20	294.74	0.00	10.00	0.00

Roadway & Gutter Input

SN Element ID	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1 CB-1	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
2 CB-12	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
3 CB-14	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
4 CB-15	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
5 CB-16	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
6 CB-17	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
7 CB-3	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
8 CB-3A	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
9 CB-3B	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
10 CB-4	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
11 CB-4A	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
12 CB-5	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
13 CB-5A	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
14 CB-6	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
15 CB-7A	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00
16 CB-8	N/A	0.0500	0.0130	0.0620	2.00	0.0000	7.00

Inlet Results

SN Element ID	Peak Flow	Peak Lateral Inflow	Peak Flow Intercepted	Peak Flow Bypassing Inlet	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Time of Max Depth Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1 CB-1	0.59	0.59	N/A	N/A	N/A	0.00	273.98	0.00	0 00:06	0.00	0.00
2 CB-12	0.46	0.46	N/A	N/A	N/A	1.93	330.17	0.12	0 00:05	0.00	0.00
3 CB-14	0.39	0.39	N/A	N/A	N/A	1.74	331.42	0.11	0 00:05	0.00	0.00
4 CB-15	0.72	0.72	N/A	N/A	N/A	2.61	335.85	0.15	0 00:05	0.00	0.00
5 CB-16	0.78	0.78	N/A	N/A	N/A	2.76	347.99	0.16	0 00:05	0.00	0.00
6 CB-17	0.33	0.33	N/A	N/A	N/A	1.54	360.29	0.10	0 00:05	0.00	0.00
7 CB-3	0.65	0.65	N/A	N/A	N/A	0.00	297.19	0.00	0 00:07	0.00	0.00
8 CB-3A	3.91	3.91	N/A	N/A	N/A	496.04	322.21	24.83	0 00:05	0.00	0.00
9 CB-3B	1.17	1.17	N/A	N/A	N/A	45.64	300.33	2.31	0 00:02	0.00	0.00
10 CB-4	1.30	1.30	N/A	N/A	N/A	55.99	313.48	2.82	0 00:05	0.00	0.00
11 CB-4A	3.71	3.71	N/A	N/A	N/A	447.77	333.07	22.41	0 00:06	0.00	0.00
12 CB-5	5.01	5.01	N/A	N/A	N/A	816.32	369.86	40.84	0 00:06	0.00	0.00
13 CB-5A	6.64	6.64	N/A	N/A	N/A	1431.71	402.96	71.61	0 00:06	0.00	0.00
14 CB-6	5.53	5.53	N/A	N/A	N/A	994.54	363.37	49.75	0 00:05	0.00	0.00
15 CB-7A	0.59	0.59	N/A	N/A	N/A	0.00	305.04	0.00	0 00:05	0.00	0.00
16 CB-8	0.78	0.78	N/A	N/A	N/A	5.20	298.22	0.28	0 00:05	0.00	0.00

Storage Nodes

Storage Node : Vault

Input Data

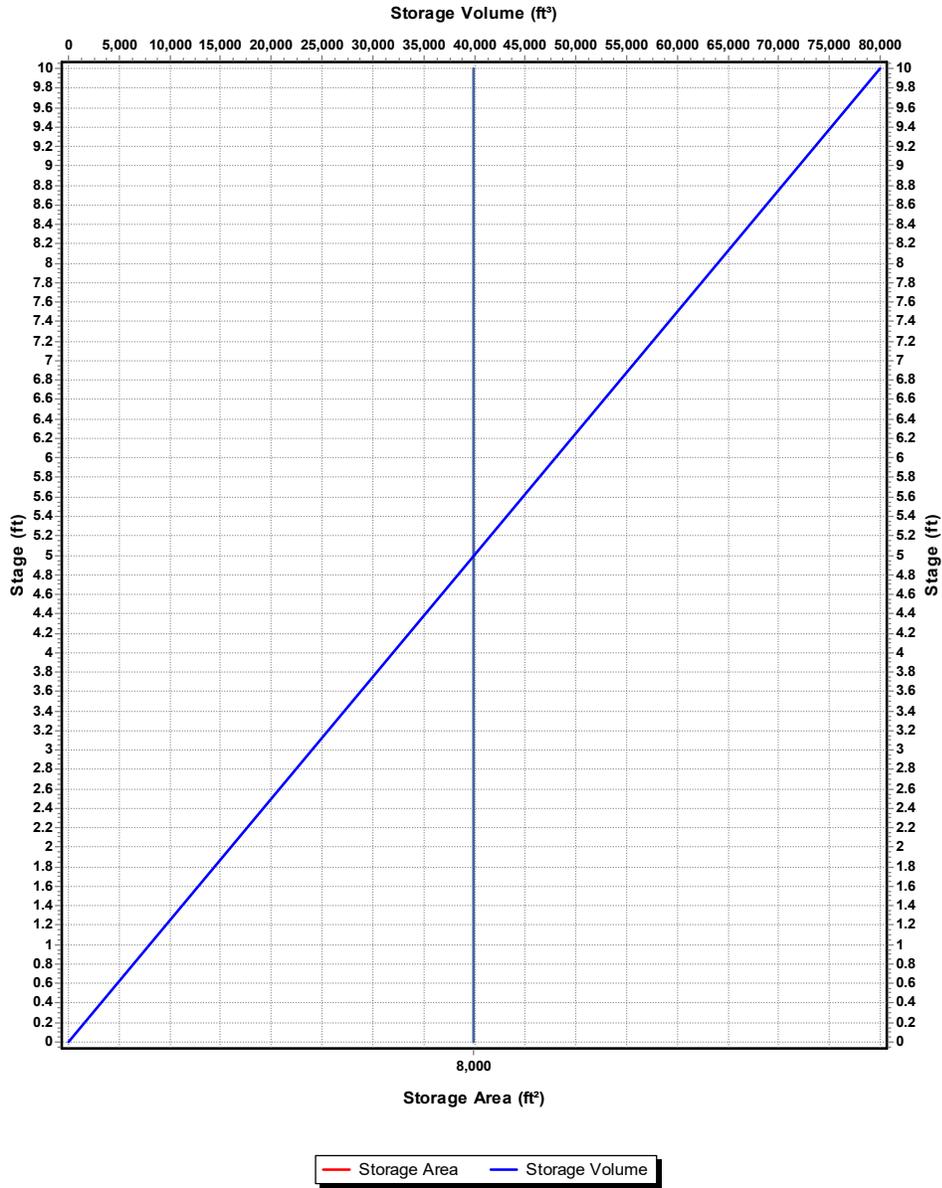
Invert Elevation (ft)	256.00
Max (Rim) Elevation (ft)	266.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	260.75
Initial Water Depth (ft)	4.75
Ponded Area (ft ²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-01

Stage	Storage	Storage
(ft)	Area	Volume
	(ft ²)	(ft ³)
0	8000	0
10	8000	80000

Storage Area Volume Curves



Storage Node : Vault (continued)

Outflow Orifices

SN Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-01	Side	CIRCULAR	No	2.06		256.50	0.61
2	Orifice-02	Side	CIRCULAR	No	2.91		262.50	0.61
3	Orifice-03	Side	CIRCULAR	No	1.81		260.05	0.61

Output Summary Results

Peak Inflow (cfs)	20.48
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.37
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	261.77
Max HGL Depth Attained (ft)	5.77
Average HGL Elevation Attained (ft)	260.24
Average HGL Depth Attained (ft)	4.24
Time of Max HGL Occurrence (days hh:mm)	0 00:12
Total Exfiltration Volume (1000-ft ³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Appendix 6: Operations and Maintenance Manual

1. Operations and Maintenance Manual

StormFilter Inspection and Maintenance Procedures



Maintenance Guidelines

The primary purpose of the Stormwater Management StormFilter® is to filter and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is a good practice to inspect the system after major storm events.

Maintenance Procedures

Although there are many effective maintenance options, we believe the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended::

1. Inspection

- Inspection of the vault interior to determine the need for maintenance.

2. Maintenance

- Cartridge replacement
- Sediment removal

Inspection and Maintenance Timing

At least one scheduled inspection should take place per year with maintenance following as warranted.

First, an inspection should be done before the winter season. During the inspection the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, a maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather.

In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine as-needed basis, in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs..





Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

Warning: In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct an inspection:

Important: Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit and the unit's role, relative to detention or retention facilities onsite.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as Regulatory Requirements, may need to be considered).

Please note Stormwater Management StormFilter devices installed downstream of, or integrated within, a stormwater storage facility typically have different operational parameters (i.e. draindown time). In these cases, the inspector must understand the relationship between the retention/detention facility and the treatment system by evaluating site specific civil engineering plans, or contacting the engineer of record, and make adjustments to the below guidance as necessary. Sediment deposition depths and patterns within the StormFilter are likely to be quite different compared to systems without upstream storage and therefore shouldn't be used exclusively to evaluate a need for maintenance.

1. Sediment loading on the vault floor.
 - a. If >4 " of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
 - a. If $>1/4$ " of accumulation, maintenance is required.
3. Submerged cartridges.
 - a. If >4 " of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.
 - a. While not required in all cases, inspection of the media within the cartridge may provide valuable additional information.
 - b. If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
 - a. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
6. Hazardous material release.
 - a. If hazardous material release (automotive fluids or other) is reported, maintenance is required.
7. Pronounced scum line.
 - a. If pronounced scum line (say $\geq 1/4$ " thick) is present above top cap, maintenance is required.

Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

Warning: In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

Method 1:

- A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

- B. Remove the used cartridges (up to 250 lbs. each) from the vault.



Important: Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

- C. Set the used cartridge aside or load onto the hauling truck.
- D. Continue steps a through c until all cartridges have been removed.

Method 2:

- A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.
- B. Unscrew the cartridge cap.
- C. Remove the cartridge hood and float.
- D. At location under structure access, tip the cartridge on its side.
- E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.
- F. Set the empty, used cartridge aside or load onto the hauling truck.
- G. Continue steps a through e until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used **empty** cartridges to Contech Engineered Solutions.

Related Maintenance Activities - Performed on an as-needed basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.

Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.



Inspection Report

Date: _____ Personnel: _____

Location: _____ System Size: _____ Months in Service: _____

System Type: Vault Cast-In-Place Linear Catch Basin Manhole Other: _____

Sediment Thickness in Forebay: _____ Date: _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Estimated Flow from Drainage Pipes (if available): _____

Cartridges Submerged: Yes No Depth of Standing Water: _____

StormFilter Maintenance Activities (check off if done and give description)

Trash and Debris Removal: _____

Minor Structural Repairs: _____

Drainage Area Report _____

Excessive Oil Loading: Yes No Source: _____

Sediment Accumulation on Pavement: Yes No Source: _____

Erosion of Landscaped Areas: Yes No Source: _____

Items Needing Further Work: _____

Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals.

Other Comments:

Review the condition reports from the previous inspection visits.

StormFilter Maintenance Report

Date: _____ Personnel: _____

Location: _____ System Size: _____

System Type: Vault Cast-In-Place Linear Catch Basin Manhole Other: _____

List Safety Procedures and Equipment Used: _____

System Observations

Months in Service: _____

Oil in Forebay (if present): Yes No

Sediment Depth in Forebay (if present): _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Drainage Area Report

Excessive Oil Loading: Yes No Source: _____

Sediment Accumulation on Pavement: Yes No Source: _____

Erosion of Landscaped Areas: Yes No Source: _____

StormFilter Cartridge Replacement Maintenance Activities

Remove Trash and Debris: Yes No Details: _____

Replace Cartridges: Yes No Details: _____

Sediment Removed: Yes No Details: _____

Quantity of Sediment Removed (estimate?): _____

Minor Structural Repairs: Yes No Details: _____

Residuals (debris, sediment) Disposal Methods: _____

Notes:



© 2020 CONTECH ENGINEERED SOLUTIONS LLC, A QUIKRETE COMPANY

800-338-1122

www.ContechES.com

All Rights Reserved. Printed in the USA.

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater and earth stabilization products. For information on other Contech division offerings, visit www.ContechES.com or call 800.338.1122.

Support

- Drawings and specifications are available at www.conteches.com.
- Site-specific design support is available from our engineers.

NOTHING IN THIS CATALOG SHOULD BE CONSTRUED AS A WARRANTY. APPLICATIONS SUGGESTED HEREIN ARE DESCRIBED ONLY TO HELP READERS MAKE THEIR OWN EVALUATIONS AND DECISIONS, AND ARE NEITHER GUARANTEES NOR WARRANTIES OF SUITABILITY FOR ANY APPLICATION. CONTECH MAKES NO WARRANTY WHATSOEVER, EXPRESS OR IMPLIED, RELATED TO THE APPLICATIONS, MATERIALS, COATINGS, OR PRODUCTS DISCUSSED HEREIN. ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND ALL IMPLIED WARRANTIES OF FITNESS FOR ANY PARTICULAR PURPOSE ARE DISCLAIMED BY CONTECH. SEE CONTECH'S CONDITIONS OF SALE (AVAILABLE AT WWW.CONTECHES.COM/COS) FOR MORE INFORMATION.

Table V-A.2: Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		(A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Piping	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway	Rock Missing	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
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 standards. Allows maintenance person safe access.
Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.4: Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
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 removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. 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	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)
Catch Basin	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.5: Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. 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. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. 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). 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	Top slab is free of holes and cracks. 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. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regouted and secure at basin wall.
	Settlement/ Mis-alignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See Table V-A.1: Maintenance Standards - Detention Ponds	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Cover/grate is in place, meets design standards, and is secured
	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 keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place, meets the design standards, and is installed and aligned with the flow path.

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

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches. Bars are missing or entire barrier missing. Bars are loose and rust is causing 50% deterioration to any part of barrier.	Bars in place with no bends more than 3/4 inch. Bars in place according to design. Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

Table V-A.7: Maintenance Standards - Energy Dissipators

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	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 or redesigned to 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.
	Other Defects	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.8: Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.

Table V-A.16: Maintenance Standards - Baffle Oil/Water Separators (API Type)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See Table V-A.5: Maintenance Standards - Catch Basins Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Appendix 7: Special Reports and Studies

1. N/A