



Bull Run TREATMENT PROJECTS

Filtration

Technical Memorandum

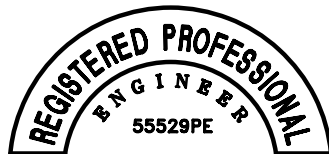
Subject: Sandy Pump Station Addition - Stormwater Analysis

PWB Project #s: W02229

Date: September 5, 2025

To: AJ Thorne
Public Works Director
City of Sandy

From: Rafael Gaeta, PE
Project Engineer
Emerio Design



EXPIRES 6/30/27

1 Introduction

The purpose of this memorandum is to outline the effects of adding the Sandy Pump Station to the Bull Run Filtration Facility on the current designed function of the onsite stormwater management system. Both treatment and flow control will be provided for new pump station areas by this onsite stormwater management system. The added Sandy Pump Station will be located directly north of onsite Area 40 and directly west of the proposed roundabout located adjacent to the Carpenter Lane entrance to the site. The pump station will consist of a station building, pump housing area, and surrounding paved surfaces.

2 Impervious Area Summary

The Sandy Pump Station will add 9,305 SF of paved and roof area to the site. Of this area, 1,650 SF of will be constructed of grasscrete as an impervious area reduction strategy. The original T3-2022-16220 stormwater report included the impervious area from the Fire Pump Station (988 SF) and the Pleasant Home Pump Station (6,495 SF), which have both been removed from the project. The resulting increase in onsite impervious area due to the pump station addition is 172 SF, as summarized in the table below. Impervious surface areas for each structure include associated pavement.

Table 1. Impervious Area Summary	
	Impervious Area (SF)
Sandy Pump Station(Added)	+9,305 SF
Grasscrete Area (Subtracted from above)	-1,650 SF
Pleasant Home Pump Station (Removed)	-6,495 SF
Fire Pump Station (Removed)	-988 SF
Net Change in Impervious Area	+172 SF

As a result of its location, the added impervious surfaces associated with the Sandy Pump Station will pass through Pond D on the route to Point of Discharge #1. This report contains an analysis of the water quality, flow control, and conveyance facilities and systems located in this flow path, and their ability to manage the increase in onsite impervious area as currently designed.

3 Facility Analysis

3.1 Stormwater Design Requirements

The analysis and design methods and standards used in this memorandum are outlined in the Bull Run Filtration Facility Report dated April 15, 2025. Additionally, all attachments to this memorandum are revised versions of attachments that are a part of the 2025 report. The 2025 report was used for analysis in place of the previously mentioned report from 2022 as it reflects the most up to date design methods and standards used for the Bull Run Filtration Facility site.

The addition of the Sandy Pump Station will affect the capacities of a grassy swale facility, a detention pond, a conveyance ditch, and a series of pipe segments. Below are excerpts from the April 15, 2025 report outlining design requirements for each of the affected facilities and systems.

As a project designed under Hierarchy Level 2, the following stormwater treatment performance standards apply per Table 1-2 of the Portland SWMM (City of Portland 2020 Stormwater Management Manual):

- *Achieve 70% TSS removal from the runoff resulting from 90% of the average annual rainfall.*
- *Use a pollution reduction facility that will reduce pollutants of concern in watersheds with a TMDL or on DEQ's 303(d) list of impaired waters.*

The project uses a combination of vegetated stormwater management facilities – planters, basins, filter strips, grassy swales, and an ecoroof – to achieve the stormwater treatment performance standards. Each of these facilities are allowed per Table 2-9 of the Portland SWMM and sized in accordance with the presumptive design approach (use of the PAC Tool) or performance-based design approach to meet the water quality design requirements of the Portland SWMM.

The grassy swales are a rate-based facility and are designed to meet the requirements of Portland SWMM Table 2-12.

The flow control performance standards for this project, as outlined in the MCDCM (Multnomah County Design and Construction Manual), include matching post-development peak flow rates to pre-development peak flow rates for larger design storm events (5-, 10-, and 25-year), as well as matching the post-development peak flow rate for the 2-year design storm event to ½ of the pre-development peak flow rate.

This project uses six dry detention ponds, a sloped basin, and an ecoroof to achieve stormwater flow control requirements for the project site. These stormwater management facilities are allowed for flow control per the Portland SWMM, Table 2-9.

Per the SDFDM (City of Portland 2020 Sewer and Drainage Facilities Design Manual), piped flows must be conveyed without surcharge during the 10-year design storm and maintain a minimum 6 inches of freeboard within the system during the 25-year design storm. The onsite piped system exceeds that standard and is designed to convey the 25-year design storm without surcharging. This is a conservative design approach, creating conveyance capacity beyond that specified in the MCDCM and SDFDM. The 25-year design storm was also used to size all conveyance ditches, per Table 6-1 in the SDFDM.

3.2 Facility Analysis Results

The Sandy Pump Station runoff will initially be collected by Ditch 3 and routed through the Grassy Swale A3. This swale was analyzed for its ability to treat the additional impervious area. As shown in the swale sizing spreadsheet located in Attachment B, the swale has adequate capacity to treat the additional runoff without any revisions to the current design per Table 2-12 of the Portland SWMM by operating with an average flow depth of 0.27 ft and a residence time of 11.75 minutes.

The flow control HydroCAD models of Pond D and Point of Discharge #1 were both updated with the impervious area addition. Peak flows are analyzed at the Point of Discharge, while Pond D is one of several facilities that contribute to meeting flow control performance standards at the Point of Discharge. The resulting Pond D performance and Point of Discharge #1 flows are shown below.

Table 2. Pond D Performance Summary

Storm Event (year)	Pre-Development Peak Flow (cfs)	Post-Development Peak Inflow (cfs)	Underdrain Pump Rate (cfs)	Total Inflow (cfs)	Post-Development Peak Outflow (cfs)	Pond Water Elevation (ft)	Pond Storage (CF)	Drawdown Time (hr)
2	1.8	3.0	0.7	3.7	1.3	695.27	14244	21.7
5	2.7	4.1	0.7	4.8	1.8	695.59	16672	26.4
10	3.3	4.8	0.7	5.5	2.1	695.86	18819	27.3
25	4.4	6.2	0.7	6.9	2.5	696.43	23581	27.8
Lower orifice 5.0" dia, IE = 689.78								
Upper orifice 3" h X 10" w, IE= 695.25								

Table 3. Post-Development Points of Discharge Flow Summary

Point of Discharge #1 - Culvert Discharge			
Design Event (year)	Pre-Development Peak Flow (cfs)	Target Post-Development Peak Flow (cfs)	Actual Post-Development Peak Flow (cfs)
2	6.4	3.2	3.2
5	9.7	9.7	4.2
10	11.9	11.9	5.5
25	16.2	16.2	7.8
POD #1 Tributaries: Pond A, Pond C, Pond D, Ecoroof, Subbasin 1A, Subbasin 2A			

As shown in the tables above, Pond D performs adequately, and peak flows will not exceed pre-developed rates at Point of Discharge #1 while managing the additional impervious area per the standards outlined in the MCDCM. No revisions to the current flow control design are required. See Appendix C for HydroCAD plots of the analysis summarized by the tables above.

The portion of the conveyance system that manages the additional impervious runoff from the pump station was analyzed for its conveyance capacity. This analysis was completed using HydroCAD to develop flows and analyze ditch segments, and a conveyance spreadsheet to analyze pipe segments. See Attachment D for plots of these two analysis documents. The results of this analysis show that all affected pipe segments adequately convey the additional runoff under open channel flow conditions, while Ditch 3 adequately conveys the additional runoff with an average flow depth of 0.39 ft and freeboard of 0.61, meeting standards set by the SDFDM. No revisions to the current conveyance system design is required.

4 Conclusion

The addition of the Sandy Pump Station will have no negative effects on the onsite stormwater management system, and will require no revisions to the relevant treatment, flow control, or conveyance facilities.

List of Attachments

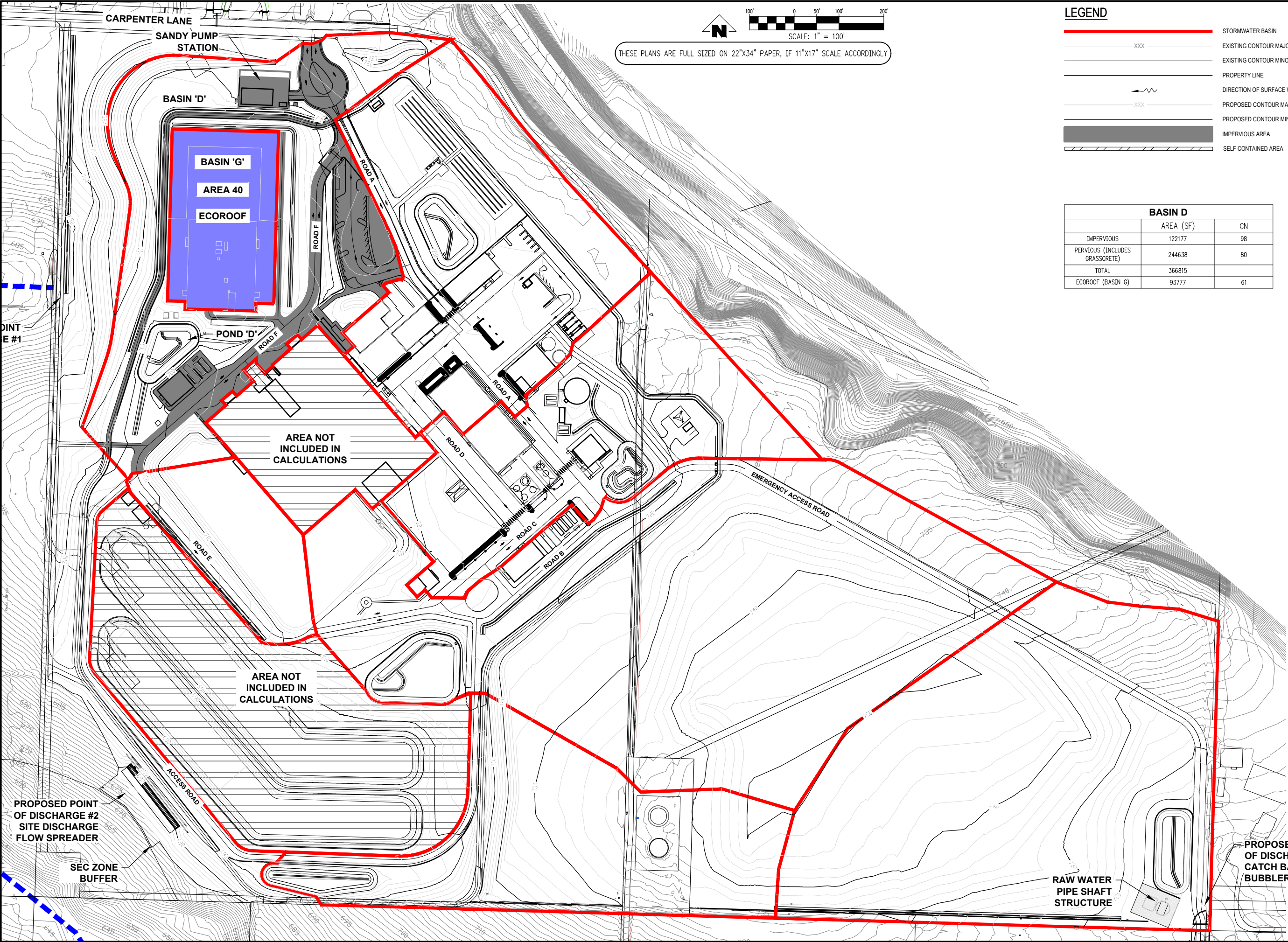
Attachment A: Stormwater Drainage Basin Maps

Attachment B: Swale A3 Water Quality Analysis

Attachment C: Flow Control Analysis (Pond D and Point of Discharge #1)

Attachment D: Conveyance System Analysis

Attachment A: Stormwater Drainage Basin Maps



THESE PLANS ARE FULL SIZED ON 22"x34" PAPER, IF 11"x17" SCALE ACCORDINGLY

LEGEND

STORMWATER BASIN

EXISTING CONTOUR MAJOR

EXISTING CONTOUR MINOR

PROPERTY LINE

DIRECTION OF SURFACE WATER FLOW

PROPOSED CONTOUR MAJOR

PROPOSED CONTOUR MINOR

IMPERVIOUS AREA

SELF CONTAINED AREA

BASIN D		
	AREA (SF)	CN
IMPERVIOUS	122177	98
PERVIOUS (INCLUDES GRASSCRETE)	244638	80
TOTAL	366815	
ECOROOF (BASIN G)	93777	61

BULL RUN FILTRATION FACILITY

MULTNOMAH COUNTY, OREGON

SITE STORMWATER DRAINAGE BASIN MAP

FLOW CONTROL

D AND G

REVISIONS	
NO.	DESCRIPTION

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BEAVERTON, OREGON 97008
TEL: (503) 746-9812
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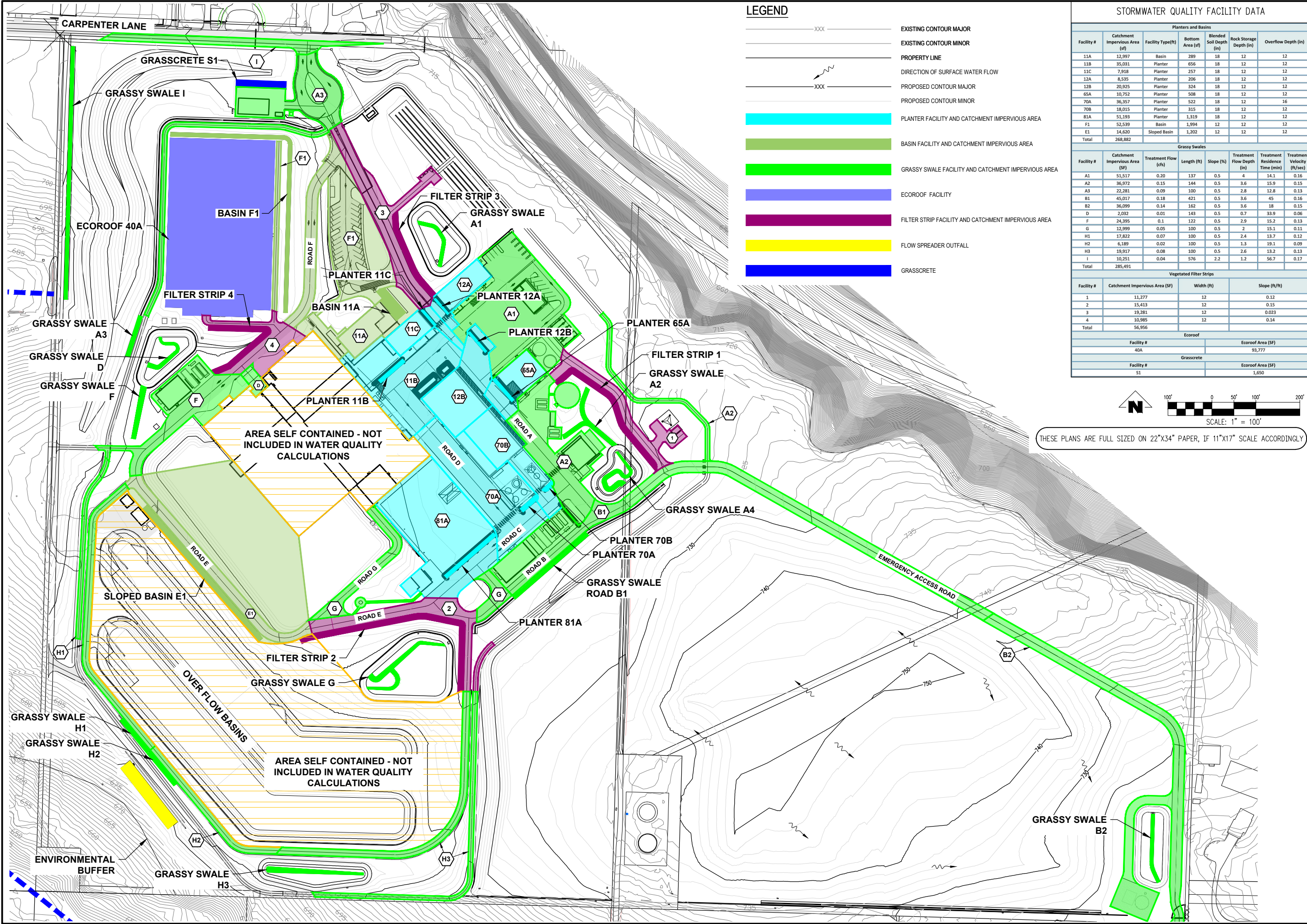
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OF

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FILE P:\0596-003 Bull Run WTP Filtration Facility\docs\civil\Stormwater\Site Storm Report\Pump Station Memo\0596-003 Figure 3.4 Proposed Storm Basin Map D, Layout: Figure 3.4-Basin D, Plot Date: 7/21/2025 10:48 AM, by: Josh Meyer

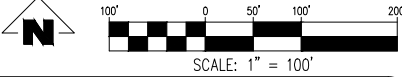


LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPERTY LINE
- DIRECTION OF SURFACE WATER FLOW
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PLANTER FACILITY AND CATCHMENT IMPERVIOUS AREA
- BASIN FACILITY AND CATCHMENT IMPERVIOUS AREA
- GRASSY SWALE FACILITY AND CATCHMENT IMPERVIOUS AREA
- ECOROOF FACILITY
- FILTER STRIP FACILITY AND CATCHMENT IMPERVIOUS AREA
- FLOW SPREADER OUTFALL
- GRASSCRETE

STORMWATER QUALITY FACILITY DATA

Planters and Basins							
Facility #	Catchment Impervious Area (sf)	Facility Type(ft)	Bottom Area (sf)	Blended Soil Depth (in)	Rock Storage Depth (in)	Overflow Depth (in)	
11A	12,997	Basin	289	18	12	12	
11B	35,031	Planter	656	18	12	12	
11C	7,918	Planter	257	18	12	12	
12A	8,535	Planter	206	18	12	12	
12B	20,925	Planter	324	18	12	12	
65A	10,752	Planter	508	18	12	12	
70A	36,357	Planter	522	18	12	16	
70B	18,015	Planter	315	18	12	12	
81A	51,193	Planter	1,319	18	12	12	
F1	52,539	Basin	1,994	12	12	12	
E1	14,620	Sloped Basin	1,202	12	12	12	
Total	268,882						
Grassy Swales							
Facility #	Catchment Impervious Area (SF)	Treatment Flow (cfs)	Length (ft)	Slope (%)	Treatment Flow Depth (in)	Treatment Residence Time (min)	Treatment Velocity (ft/sec)
A1	51,517	0.20	137	0.5	4	14.1	0.16
A2	36,972	0.15	144	0.5	3.6	15.9	0.15
A3	22,281	0.09	100	0.5	2.8	12.8	0.13
B1	45,017	0.18	421	0.5	3.6	45	0.16
B2	36,099	0.14	162	0.5	3.6	18	0.15
D	2,032	0.01	143	0.5	0.7	33.9	0.06
F	24,395	0.1	122	0.5	2.9	15.2	0.13
G	12,999	0.05	100	0.5	2	15.1	0.11
H1	17,822	0.07	100	0.5	2.4	13.7	0.12
H2	6,189	0.02	100	0.5	1.3	19.1	0.09
H3	19,917	0.08	100	0.5	2.6	13.2	0.13
I	10,251	0.04	576	2.2	1.2	56.7	0.17
Total	285,491						
Vegetated Filter Strips							
Facility #	Catchment Impervious Area (SF)	Width (ft)			Slope (ft/ft)		
1	11,277	12			0.12		
2	15,413	12			0.15		
3	19,281	12			0.023		
4	10,985	12			0.14		
Total	56,956						
Ecoroof							
Facility #					Ecoroof Area (SF)		
40A					93,777		
Grasscrete							
Facility #					Ecoroof Area (SF)		
S1					1,650		



THESE PLANS ARE FULL SIZED ON 22"x34" PAPER, IF 11"x17" SCALE ACCORDINGLY

BULL RUN FILTRATION FACILITY

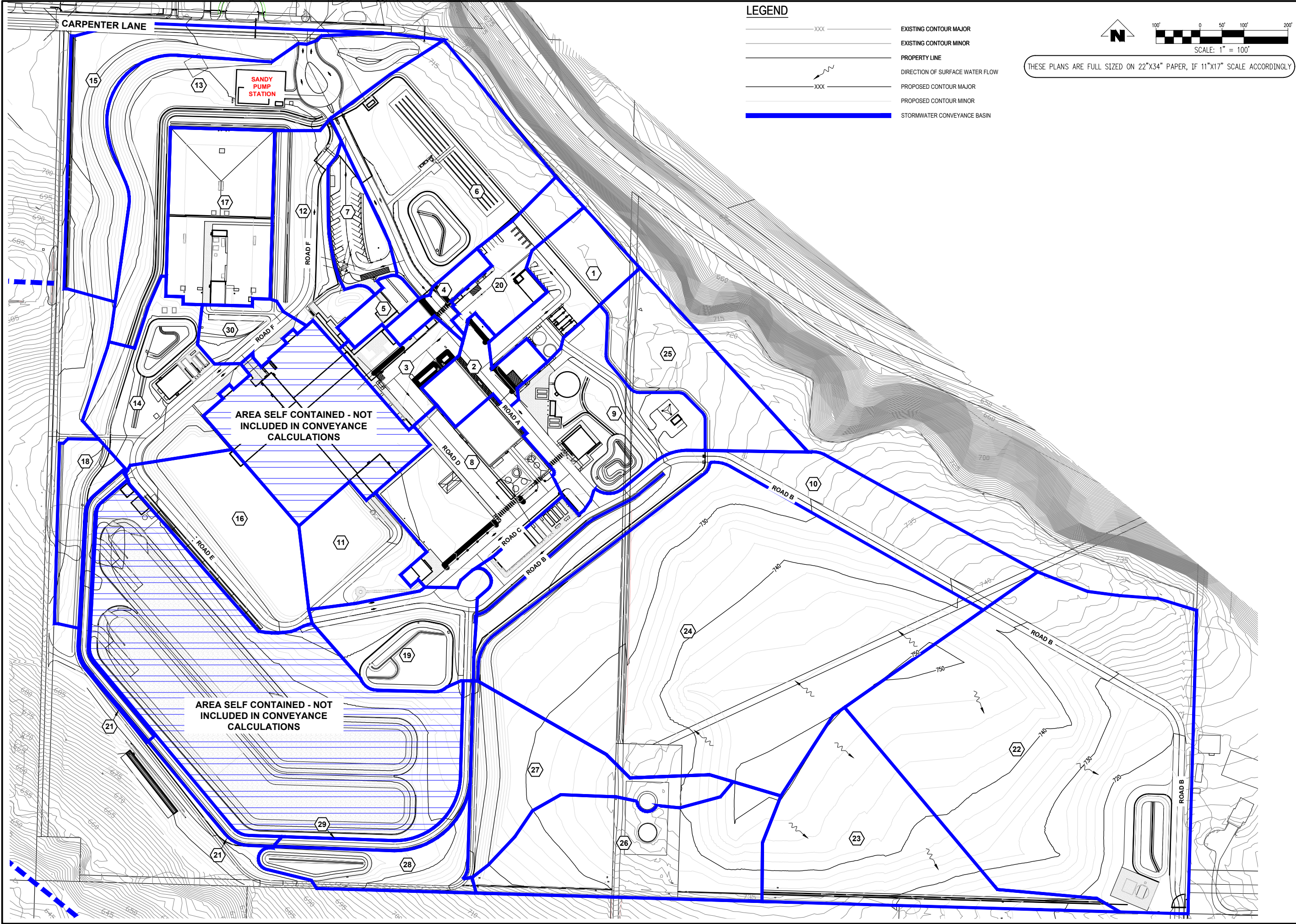
MULTNOMAH COUNTY, OREGON

SITE STORMWATER DRAINAGE BASIN MAP WATER QUALITY

REVISIONS	
NO.	DESCRIPTION

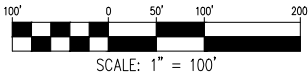
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LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPERTY LINE
- DIRECTION OF SURFACE WATER FLOW
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- STORMWATER CONVEYANCE BASIN



THESE PLANS ARE FULL SIZED ON 22"x34" PAPER, IF 11"x17" SCALE ACCORDINGLY

BULL RUN FILTRATION FACILITY

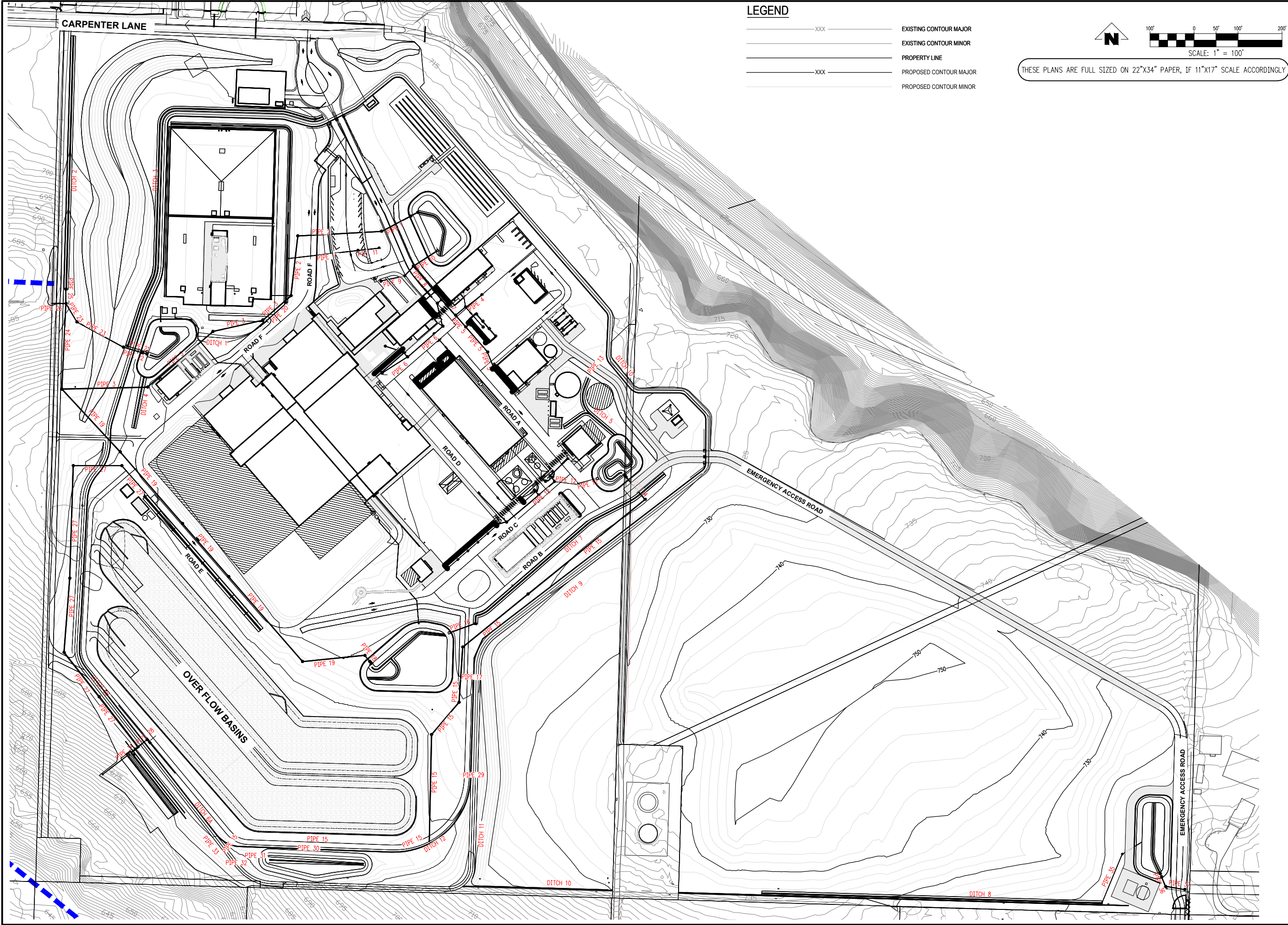
SITE STORMWATER
DRAINAGE BASIN MAP
CONVEYANCE

MULTNOMAH COUNTY, OREGON

REVISIONS

NO.	DATE	DESCRIPTION

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NO.

DATE

DESCRIPTION

REVISIONS

**SITE CONVEYANCE
SYSTEM MAP**

BULL RUN FILTRATION FACILITY

MULTNOMAH COUNTY, OREGON

FILE P: \\0596-003 Bull Run WTP Filtration Facility\docs\civil\Stormwater\Site Storm Report\pump Station Memo\0596-003 Figure 6 Conveyance System Layout Figure 6, Plot Date: 7/1/2023 3:31 PM, by: Josh Meyer

Attachment B: Swale A3 Water Quality Analysis

Bull Run Filtration Facility
Grassy Swale A3

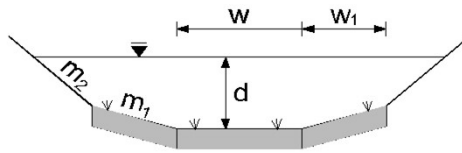
**Water Quality
Area**

Total Impervious = 0.687 ac

**Water Quality
Flow**

= 0.12 cfs

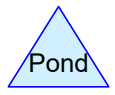
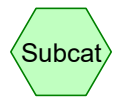
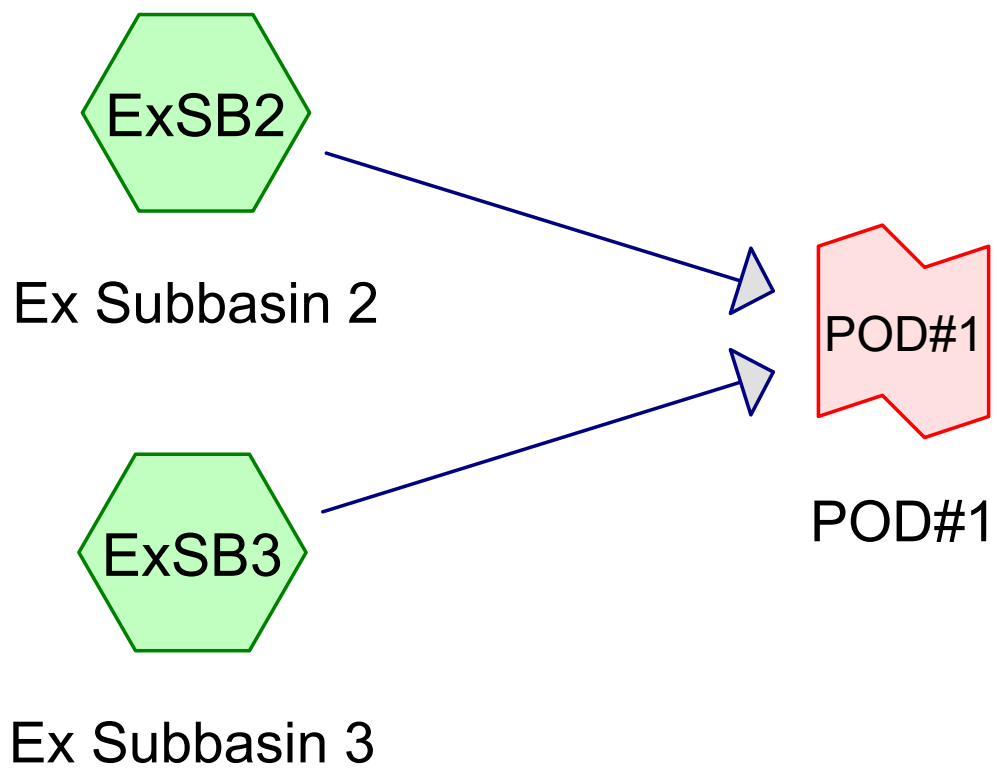
**Biofilter
Swale**



Water Quality Event

Transverse Properties	X-Sectional Properties
Q = 0.12 cfs	w = 2.0'
s = 0.50%	w ₁ = 2.0'
n = 0.250	m ₁ = 4:1
L = 100.0 LF	m ₂ = 2.5:1
v = 0.14 fps	d = 0.27' ✓
t = 11.75 min ✓	

Attachment C: Flow Control Analysis (Pond D and Point of Discharge #1)



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 2-Year Rainfall=2.80"

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Page 2

Summary for Subcatchment ExSB2: Ex Subbasin 2

Runoff = 6.3 cfs @ 8.25 hrs, Volume= 193,950 cf, Depth= 1.22"
Routed to Link POD#1 : POD#1

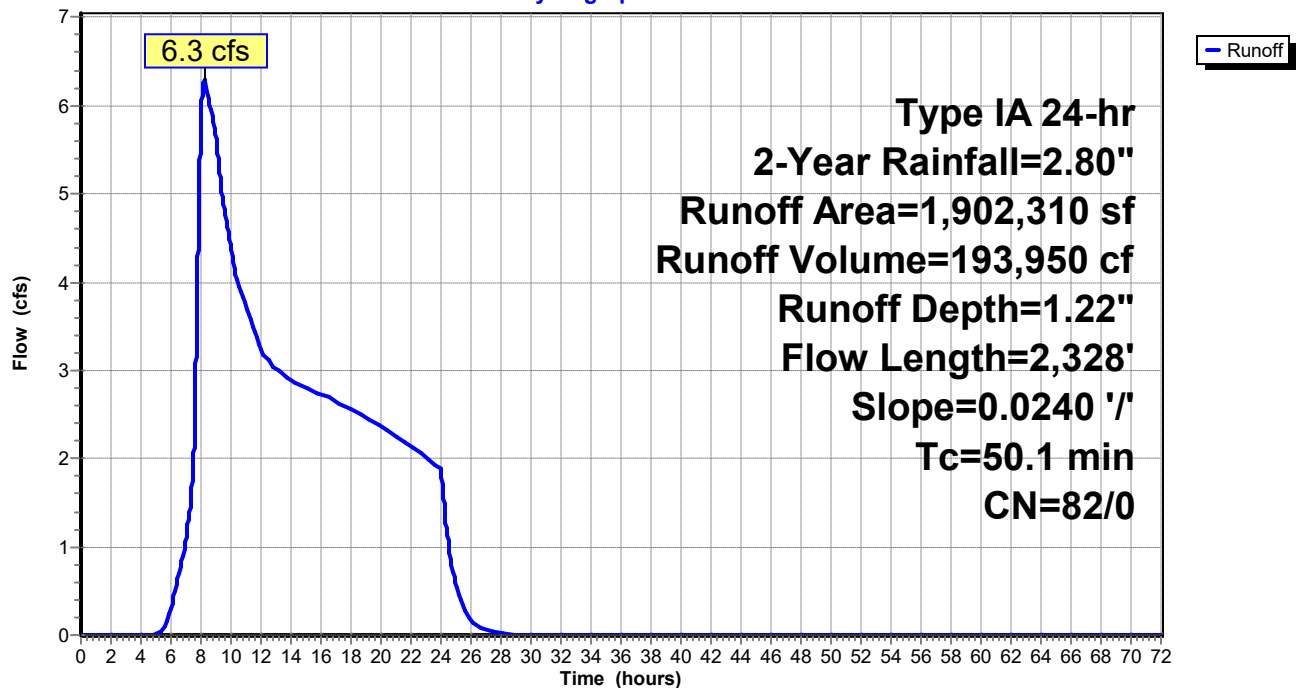
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

Area (sf)	CN	Description
1,902,310	82	Row crops, SR + CR, Good, HSG C
1,902,310	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	300	0.0240	0.19		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
24.2	2,028	0.0240	1.39		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
50.1	2,328	Total			

Subcatchment ExSB2: Ex Subbasin 2

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Subcatchment ExSB3: Ex Subbasin 3

Runoff = 0.1 cfs @ 8.01 hrs, Volume= 3,103 cf, Depth= 1.22"
Routed to Link POD#1 : POD#1

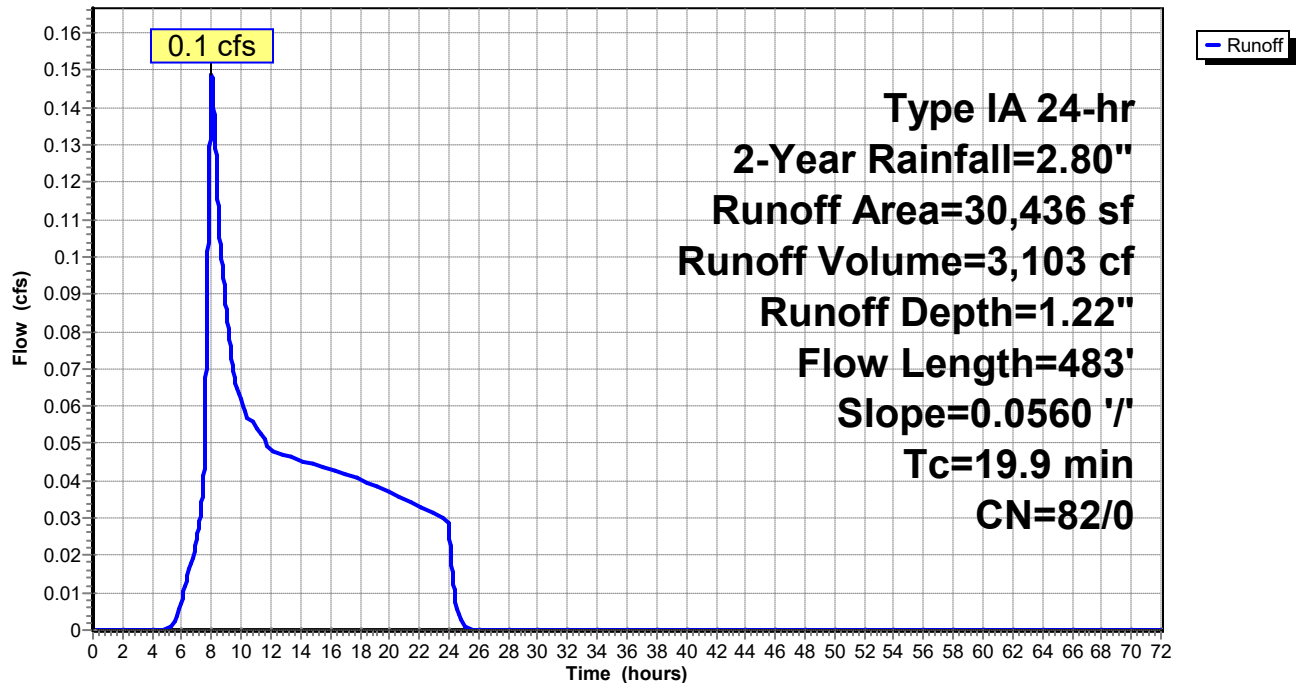
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

Area (sf)	CN	Description
30,436	82	Row crops, SR + CR, Good, HSG C
30,436	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.5	300	0.0560	0.27		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
1.4	183	0.0560	2.13		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
19.9	483	Total			

Subcatchment ExSB3: Ex Subbasin 3

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

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Type IA 24-hr 2-Year Rainfall=2.80"

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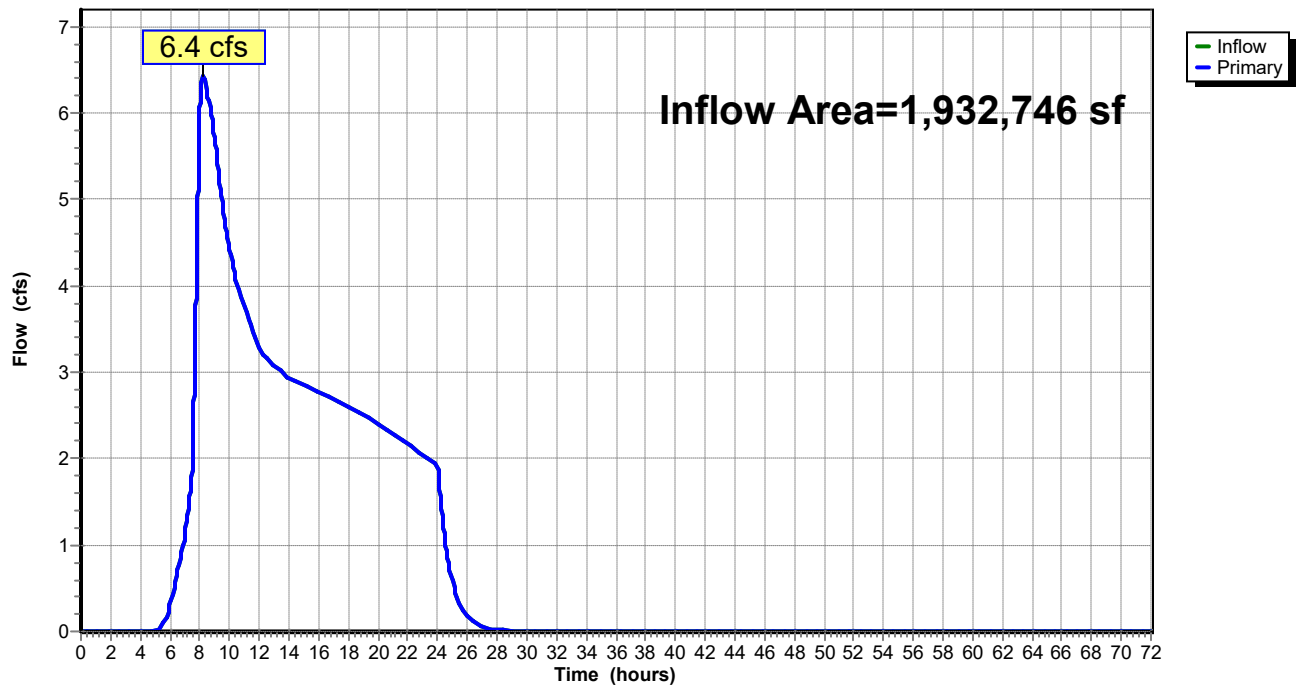
Summary for Link POD#1: POD#1

Inflow Area = 1,932,746 sf, 0.00% Impervious, Inflow Depth = 1.22" for 2-Year event
Inflow = 6.4 cfs @ 8.24 hrs, Volume= 197,053 cf
Primary = 6.4 cfs @ 8.24 hrs, Volume= 197,053 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POD#1: POD#1

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 5-Year Rainfall=3.40"

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Page 5

Summary for Subcatchment ExSB2: Ex Subbasin 2

Runoff = 9.5 cfs @ 8.21 hrs, Volume= 269,556 cf, Depth= 1.70"
Routed to Link POD#1 : POD#1

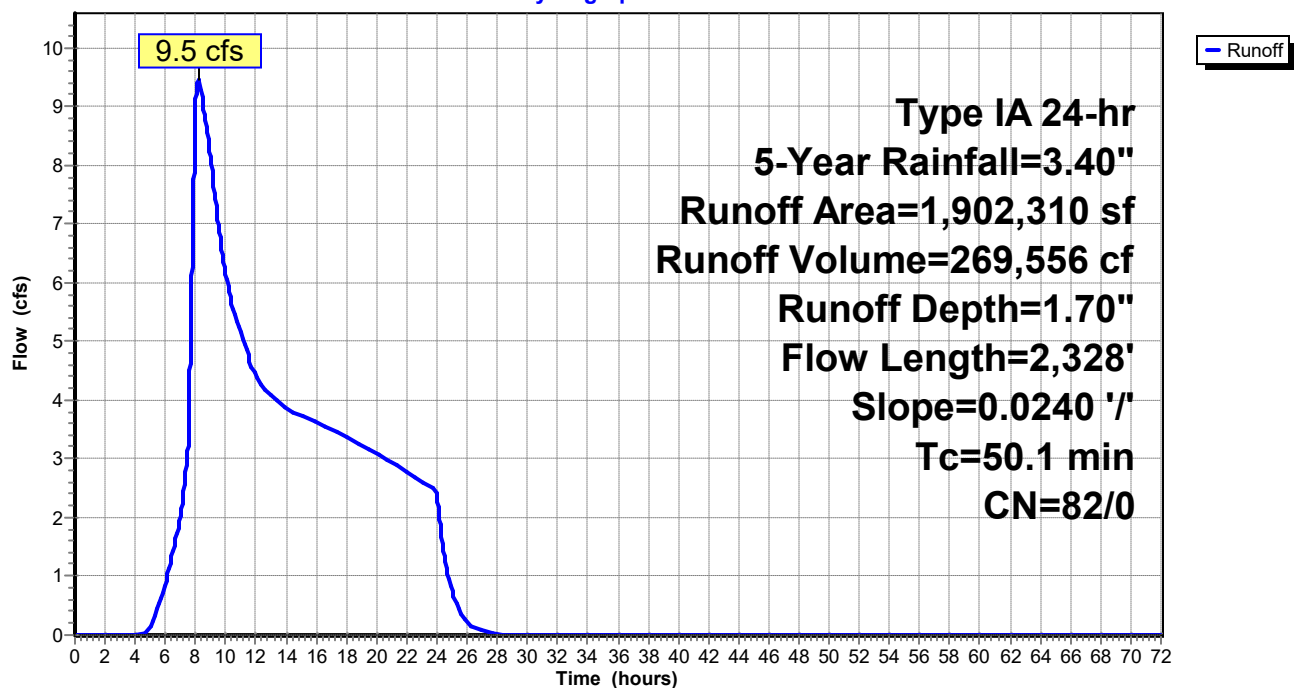
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

Area (sf)	CN	Description
1,902,310	82	Row crops, SR + CR, Good, HSG C
1,902,310	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	300	0.0240	0.19		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
24.2	2,028	0.0240	1.39		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
50.1	2,328	Total			

Subcatchment ExSB2: Ex Subbasin 2

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment ExSB3: Ex Subbasin 3

Runoff = 0.2 cfs @ 8.01 hrs, Volume= 4,313 cf, Depth= 1.70"
Routed to Link POD#1 : POD#1

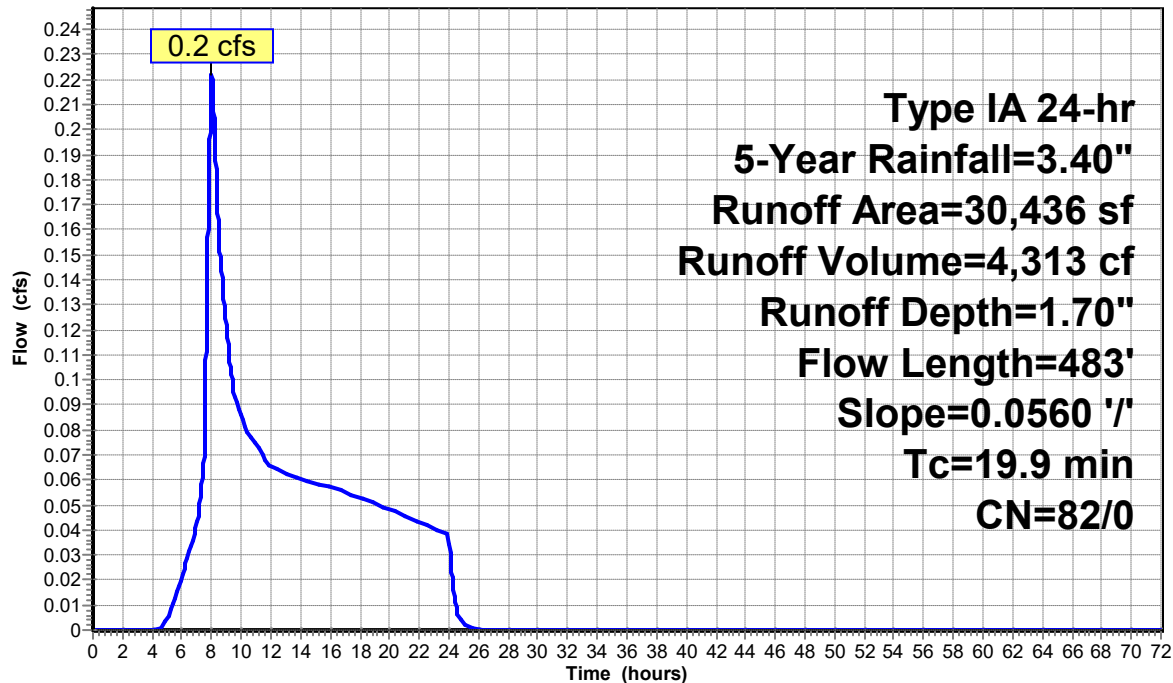
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

Area (sf)	CN	Description
30,436	82	Row crops, SR + CR, Good, HSG C
30,436	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.5	300	0.0560	0.27		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
1.4	183	0.0560	2.13		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
19.9	483	Total			

Subcatchment ExSB3: Ex Subbasin 3

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 5-Year Rainfall=3.40"

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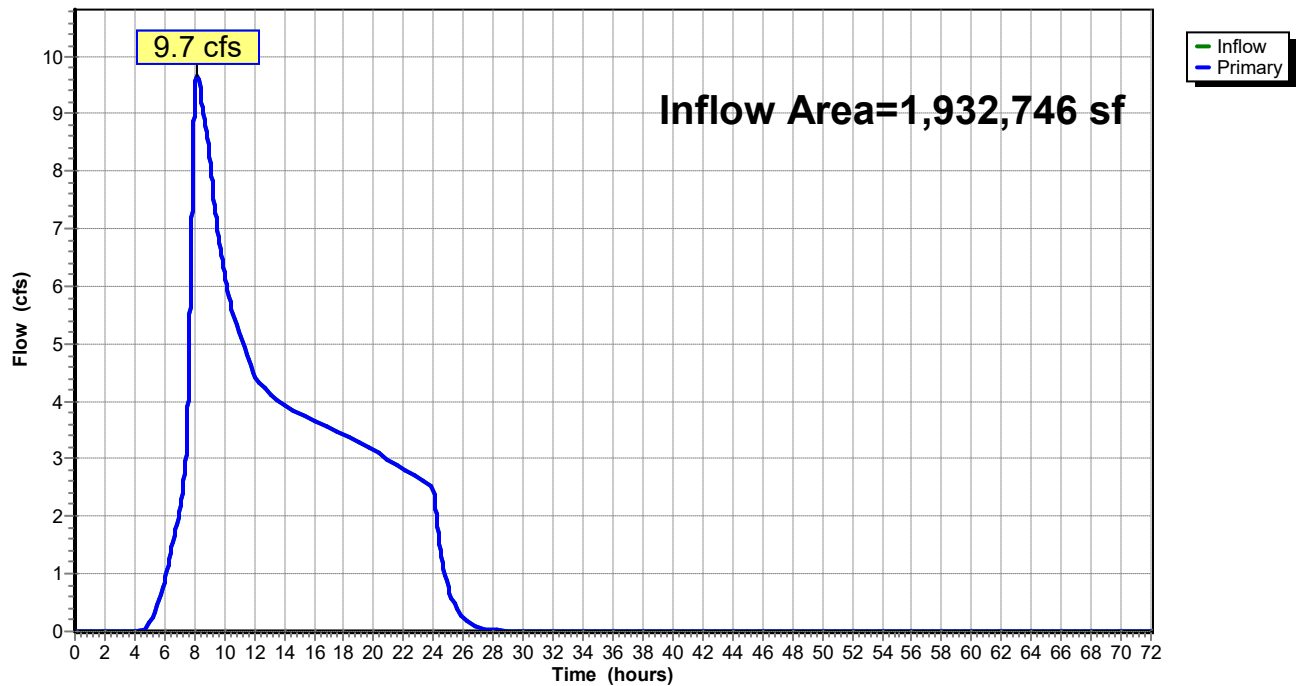
Summary for Link POD#1: POD#1

Inflow Area = 1,932,746 sf, 0.00% Impervious, Inflow Depth = 1.70" for 5-Year event
Inflow = 9.7 cfs @ 8.20 hrs, Volume= 273,868 cf
Primary = 9.7 cfs @ 8.20 hrs, Volume= 273,868 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POD#1: POD#1

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment ExSB2: Ex Subbasin 2

Runoff = 11.7 cfs @ 8.19 hrs, Volume= 322,300 cf, Depth= 2.03"
Routed to Link POD#1 : POD#1

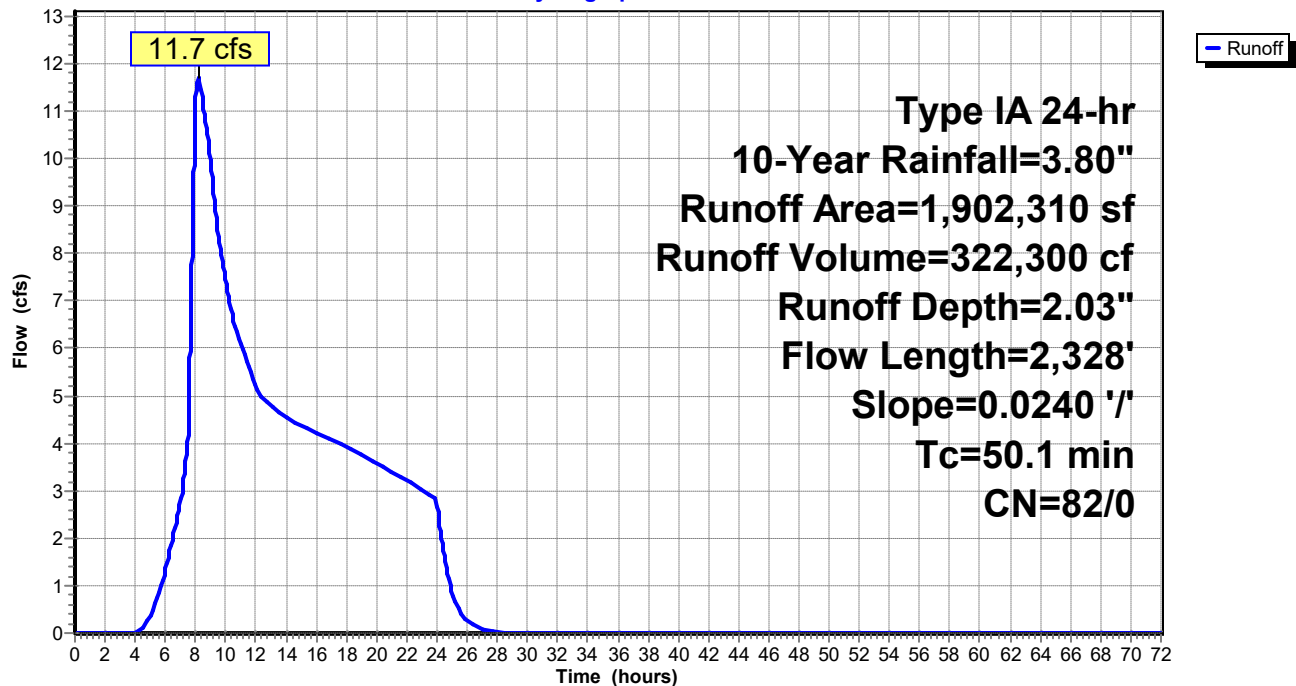
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

Area (sf)	CN	Description
1,902,310	82	Row crops, SR + CR, Good, HSG C
1,902,310	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	300	0.0240	0.19		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
24.2	2,028	0.0240	1.39		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
50.1	2,328	Total			

Subcatchment ExSB2: Ex Subbasin 2

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

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Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment ExSB3: Ex Subbasin 3

Runoff = 0.3 cfs @ 8.01 hrs, Volume= 5,157 cf, Depth= 2.03"
Routed to Link POD#1 : POD#1

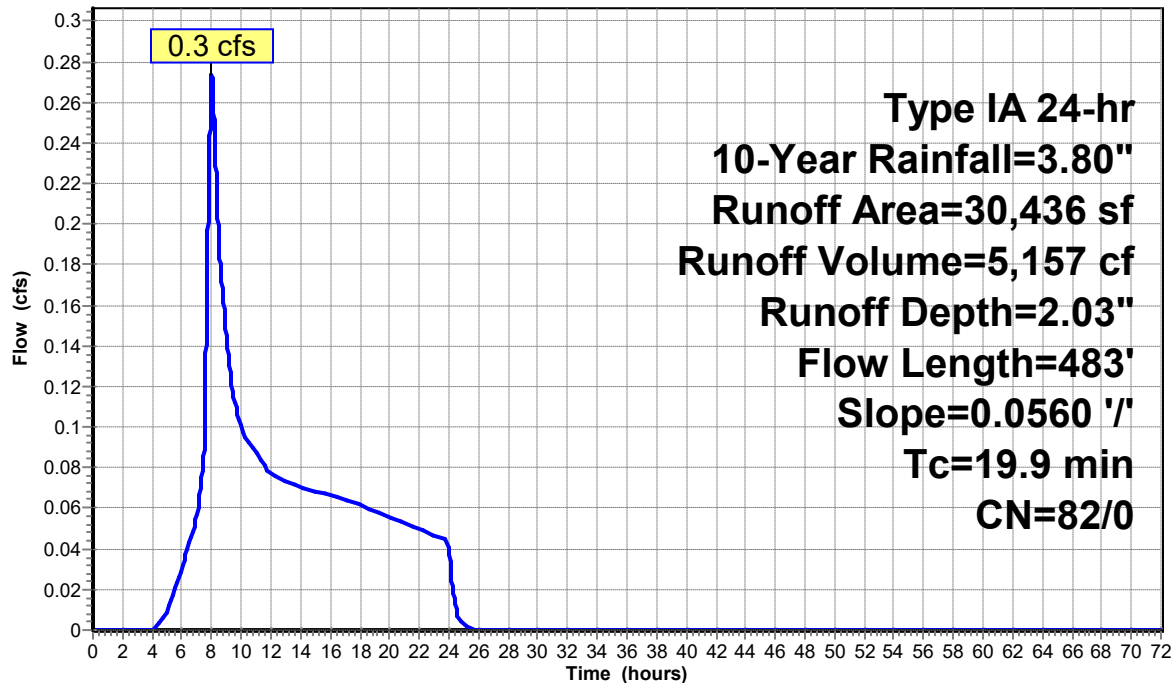
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

Area (sf)	CN	Description
30,436	82	Row crops, SR + CR, Good, HSG C
30,436	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.5	300	0.0560	0.27		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
1.4	183	0.0560	2.13		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
19.9	483	Total			

Subcatchment ExSB3: Ex Subbasin 3

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 10-Year Rainfall=3.80"

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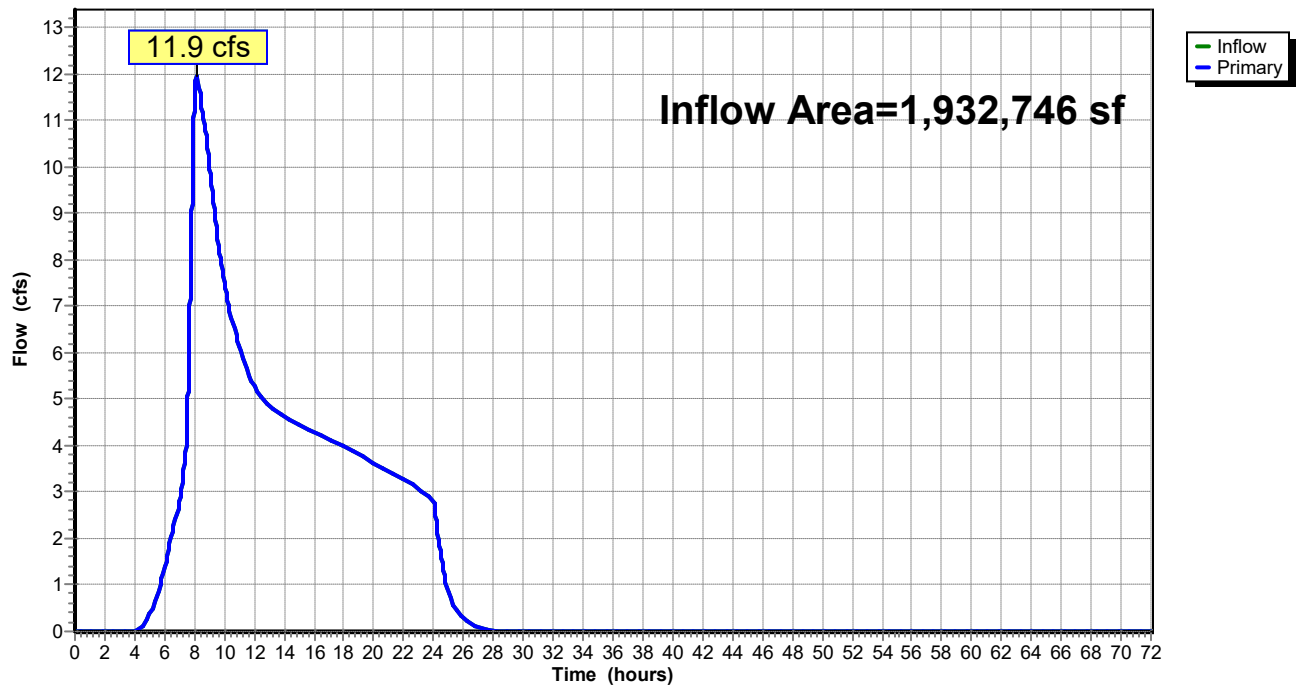
Summary for Link POD#1: POD#1

Inflow Area = 1,932,746 sf, 0.00% Impervious, Inflow Depth = 2.03" for 10-Year event
Inflow = 11.9 cfs @ 8.18 hrs, Volume= 327,457 cf
Primary = 11.9 cfs @ 8.18 hrs, Volume= 327,457 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POD#1: POD#1

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment ExSB2: Ex Subbasin 2

Runoff = 15.8 cfs @ 8.17 hrs, Volume= 417,885 cf, Depth= 2.64"
Routed to Link POD#1 : POD#1

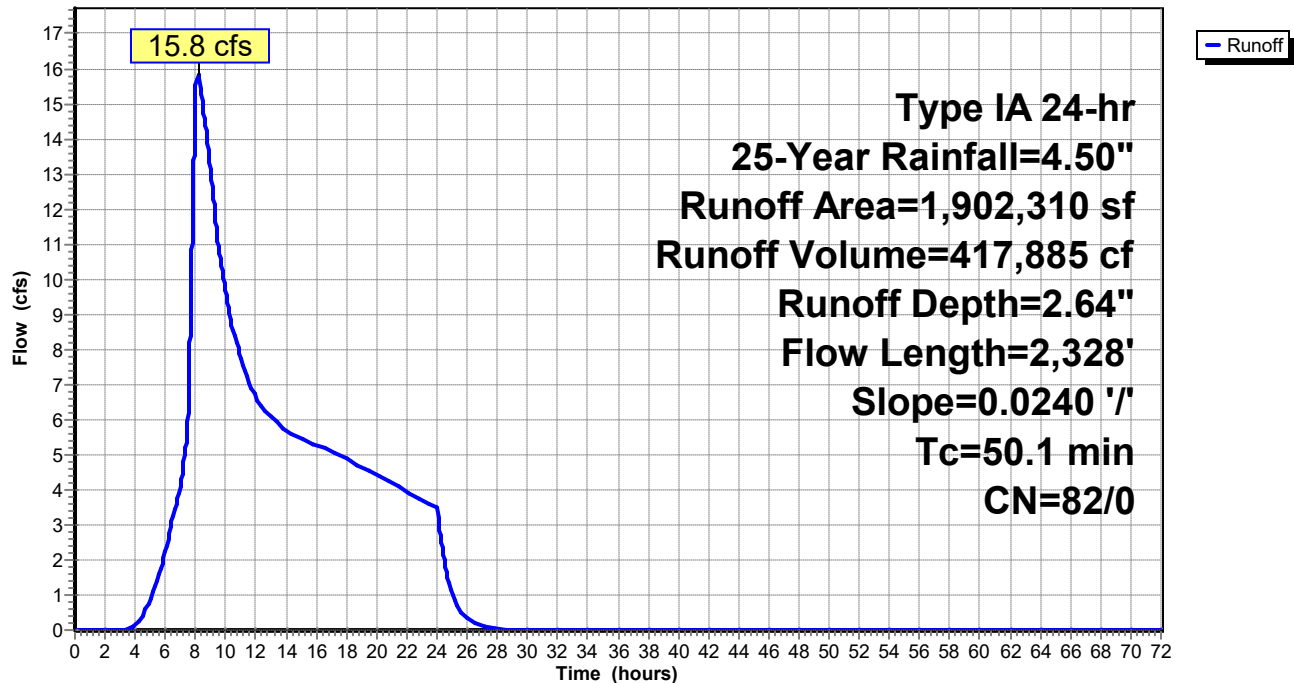
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

Area (sf)	CN	Description
1,902,310	82	Row crops, SR + CR, Good, HSG C
1,902,310	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	300	0.0240	0.19		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
24.2	2,028	0.0240	1.39		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
50.1	2,328	Total			

Subcatchment ExSB2: Ex Subbasin 2

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment ExSB3: Ex Subbasin 3

Runoff = 0.4 cfs @ 8.01 hrs, Volume= 6,686 cf, Depth= 2.64"
Routed to Link POD#1 : POD#1

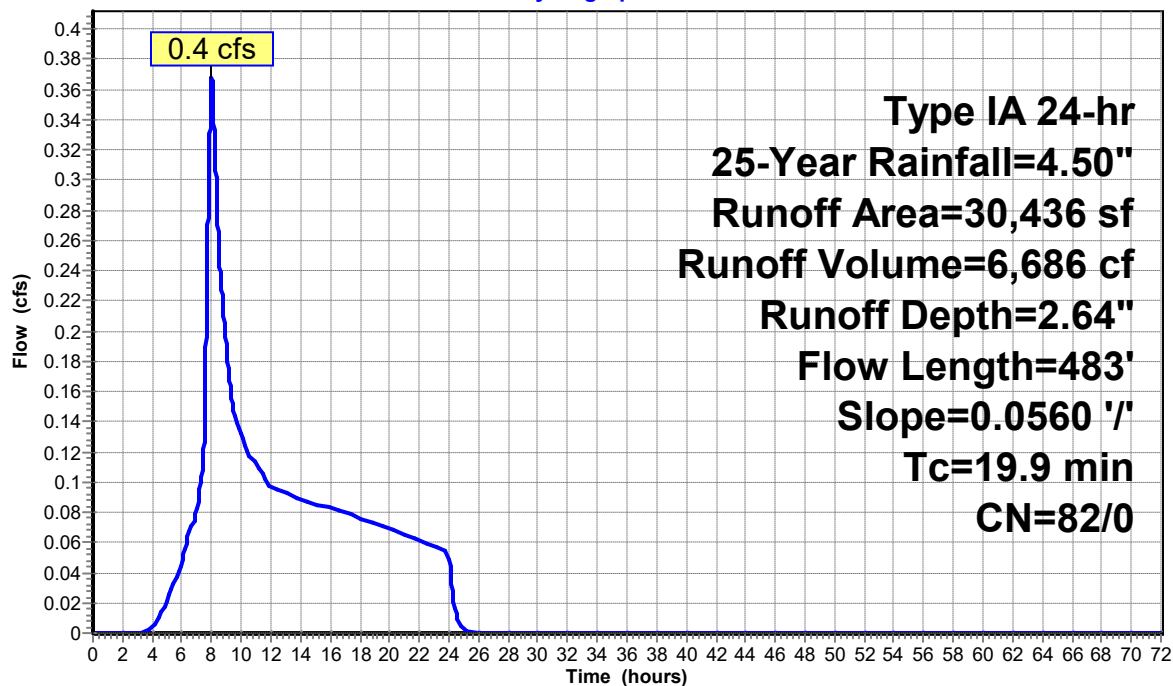
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

Area (sf)	CN	Description
30,436	82	Row crops, SR + CR, Good, HSG C
30,436	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.5	300	0.0560	0.27		Sheet Flow, Sheetflow Cultivated: Residue>20% n= 0.170 P2= 2.80"
1.4	183	0.0560	2.13		Shallow Concentrated Flow, Shallow Flow Cultivated Straight Rows Kv= 9.0 fps
19.9	483	Total			

Subcatchment ExSB3: Ex Subbasin 3

Hydrograph



Bull Run Filt Proj - Ex Run-off Flow Current

Type IA 24-hr 25-Year Rainfall=4.50"

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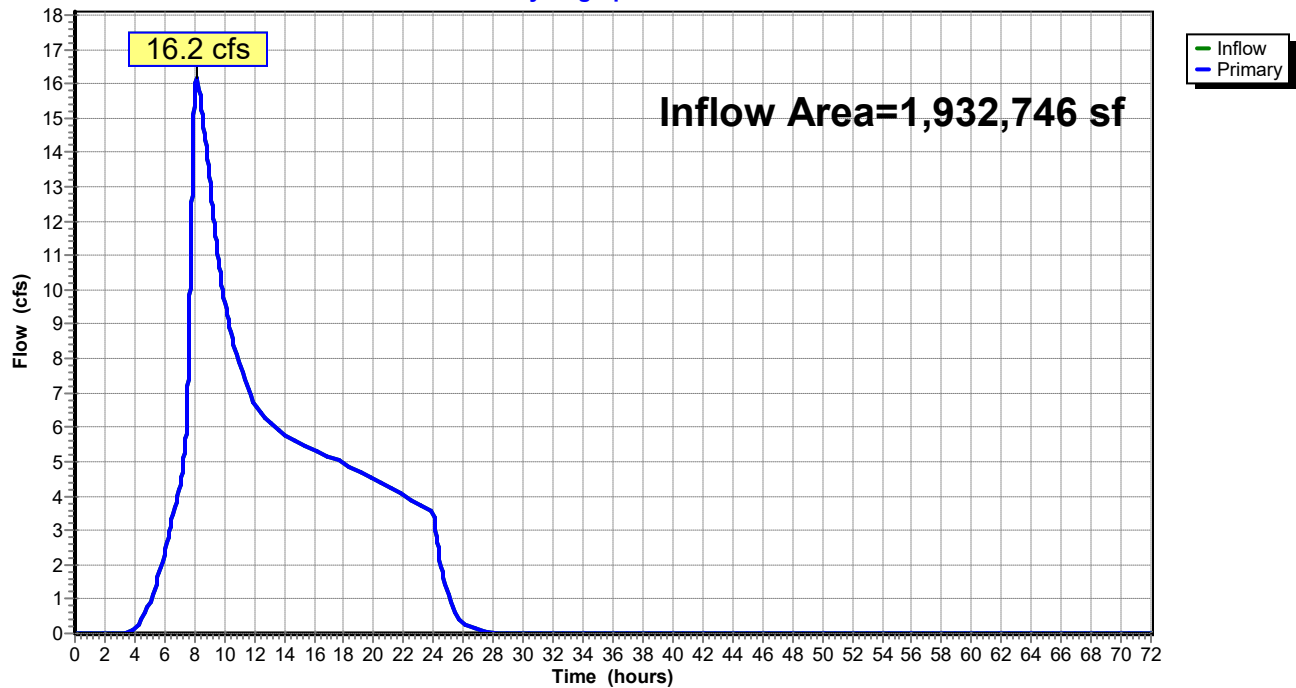
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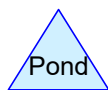
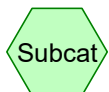
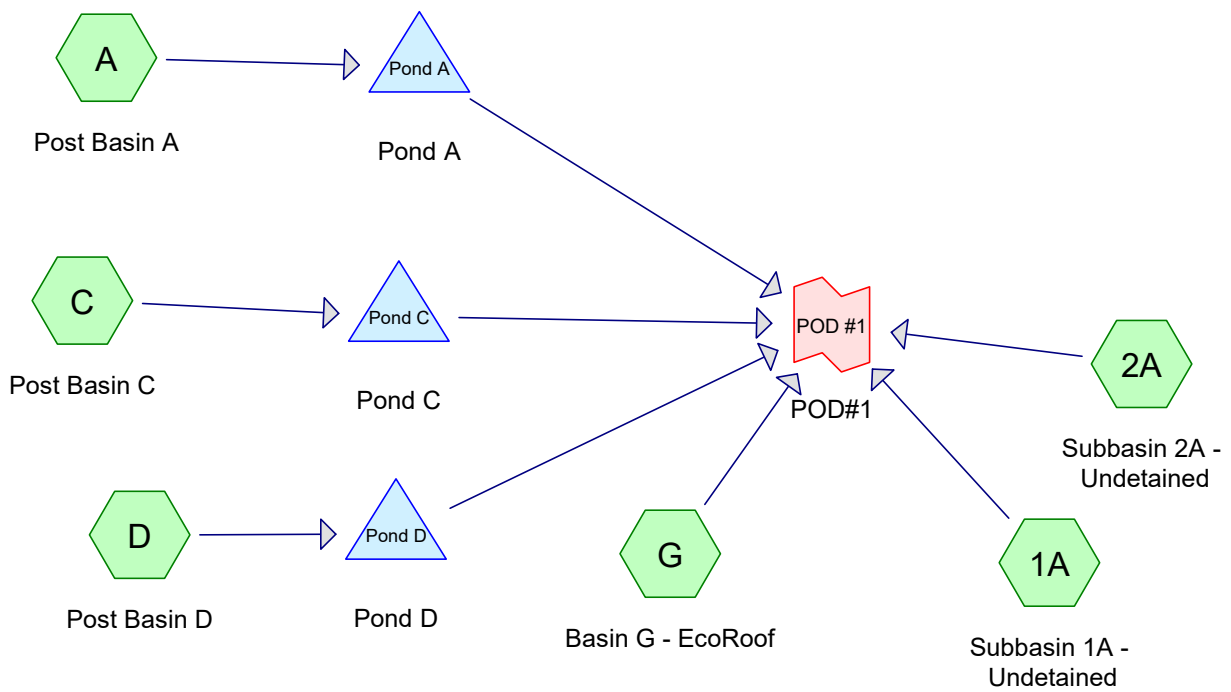
Inflow Area = 1,932,746 sf, 0.00% Impervious, Inflow Depth = 2.64" for 25-Year event
Inflow = 16.2 cfs @ 8.16 hrs, Volume= 424,571 cf
Primary = 16.2 cfs @ 8.16 hrs, Volume= 424,571 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POD#1: POD#1

Hydrograph





Routing Diagram for Bull Run Post Discharge Point 1
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Bull Run Post Discharge Point 1

Prepared by Emerio Design

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Type IA 24-hr 2-Year Rainfall=2.80"

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Page 2

Summary for Subcatchment 1A: Subbasin 1A - Undetained

Runoff = 0.6 cfs @ 7.98 hrs, Volume= 10,743 cf, Depth= 1.25"
Routed to Link POD #1 : POD#1

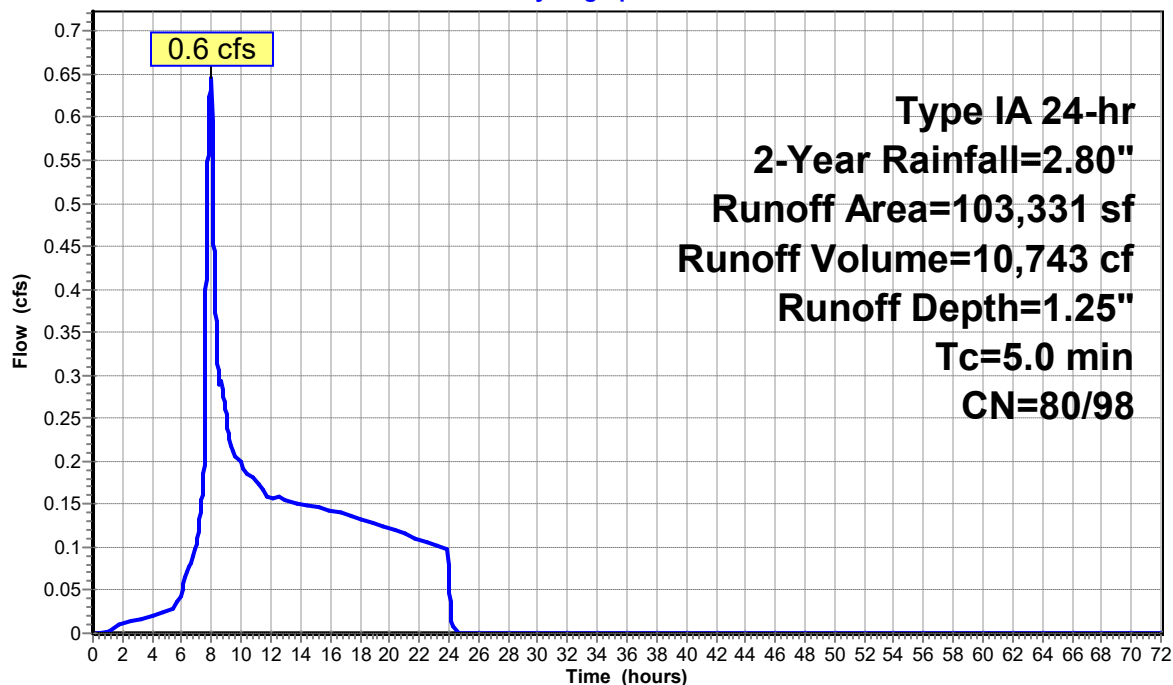
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

	Area (sf)	CN	Description
	93,080	80	>75% Grass cover, Good, HSG D
*	10,251	98	Impervious
	103,331	82	Weighted Average
	93,080	80	90.08% Pervious Area
	10,251	98	9.92% Impervious Area

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

Subcatchment 1A: Subbasin 1A - Undetained

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 2-Year Rainfall=2.80"

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Page 3

Summary for Subcatchment 2A: Subbasin 2A - Undetained

Runoff = 0.2 cfs @ 8.01 hrs, Volume= 5,374 cf, Depth= 1.13"
Routed to Link POD #1 : POD#1

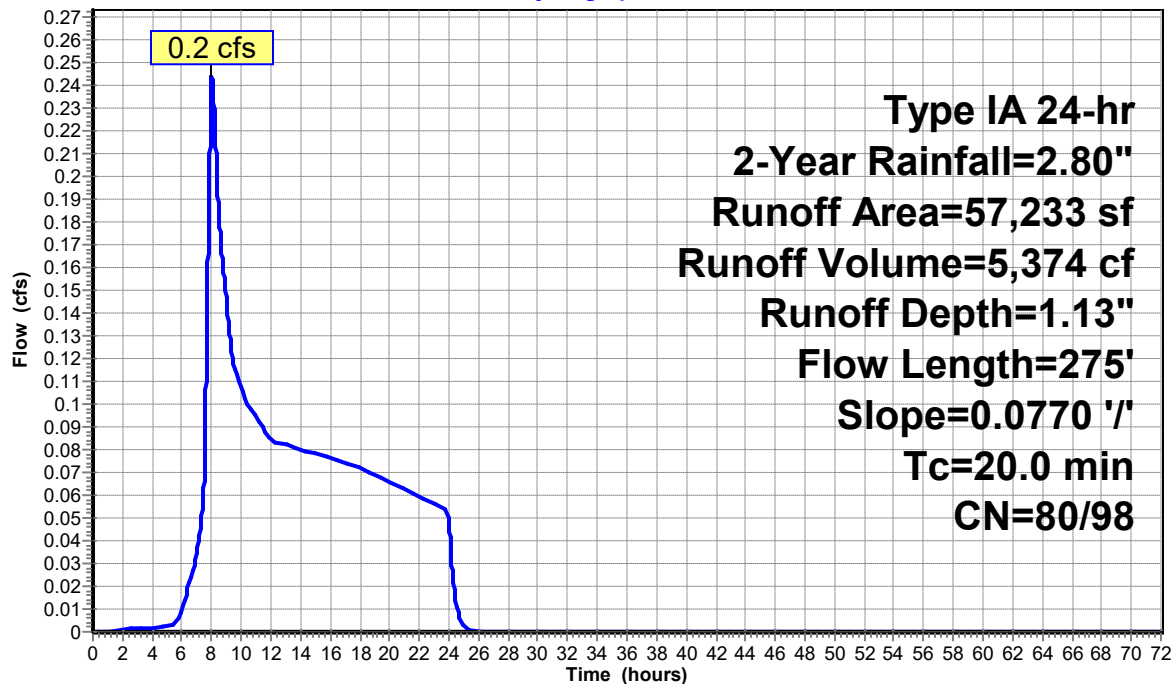
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

	Area (sf)	CN	Description
	56,269	80	>75% Grass cover, Good, HSG D
*	964	98	Impervious Area
	57,233	80	Weighted Average
	56,269	80	98.32% Pervious Area
	964	98	1.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0	275	0.0770	0.23		Sheet Flow, Grass: Dense n= 0.240 P2= 2.80"

Subcatchment 2A: Subbasin 2A - Undetained

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Subcatchment A: Post Basin A

Runoff = 3.5 cfs @ 7.92 hrs, Volume= 53,466 cf, Depth= 1.84"
Routed to Pond Pond A : Pond A

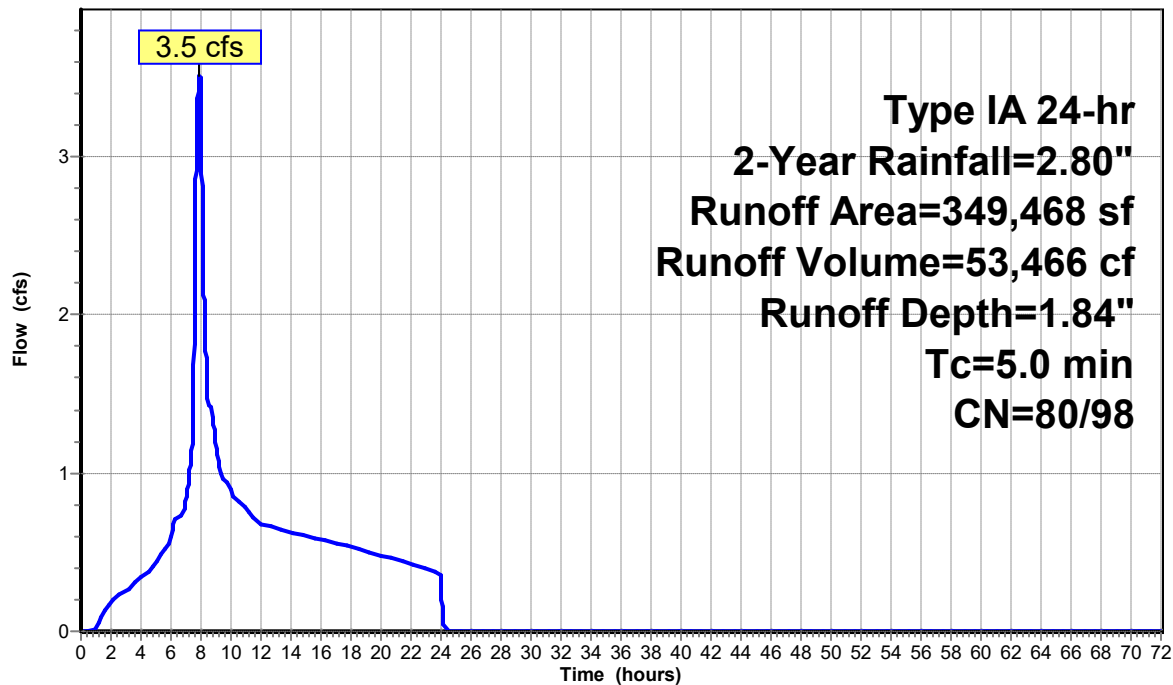
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

	Area (sf)	CN	Description
*	174,806	98	Impervious Area
	174,662	80	>75% Grass cover, Good, HSG D
	349,468	89	Weighted Average
	174,662	80	49.98% Pervious Area
	174,806	98	50.02% Impervious Area

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

Subcatchment A: Post Basin A

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Subcatchment C: Post Basin C

Runoff = 4.8 cfs @ 7.98 hrs, Volume= 80,429 cf, Depth= 1.26"
Routed to Pond Pond C : Pond C

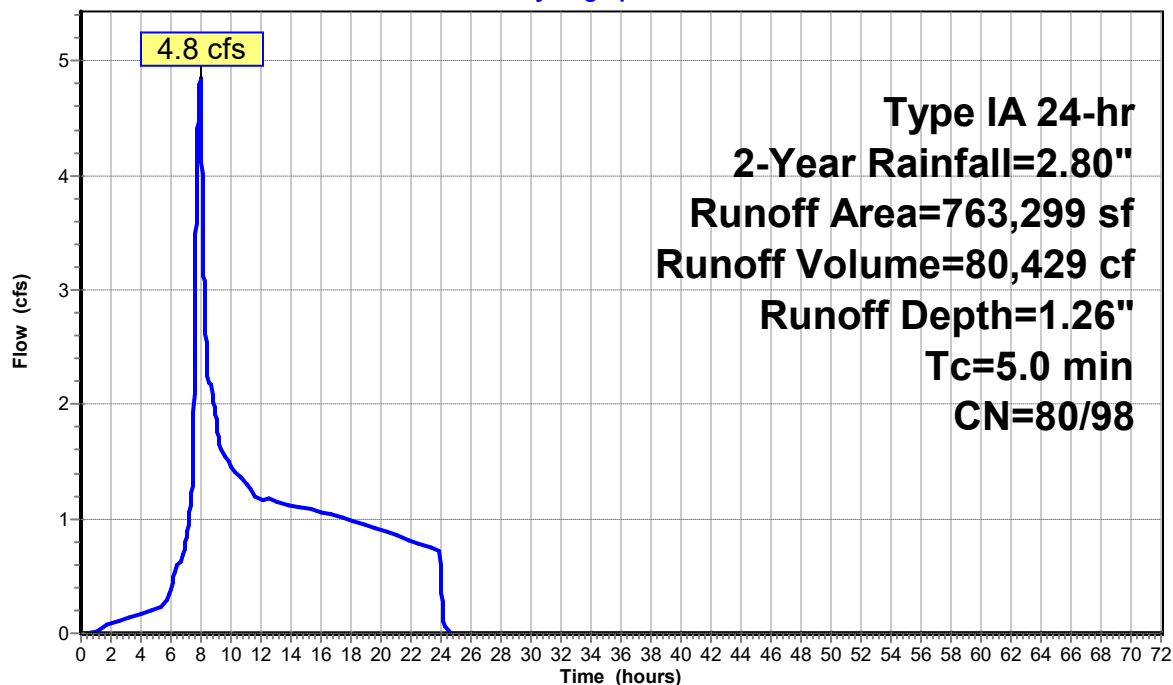
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

	Area (sf)	CN	Description
*	84,476	98	Impervious Area
	678,823	80	>75% Grass cover, Good, HSG D
	763,299	82	Weighted Average
	678,823	80	88.93% Pervious Area
	84,476	98	11.07% Impervious Area

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

Subcatchment C: Post Basin C

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Subcatchment D: Post Basin D

Runoff = 3.1 cfs @ 7.94 hrs, Volume= 48,625 cf, Depth= 1.59"
Routed to Pond Pond D : Pond D

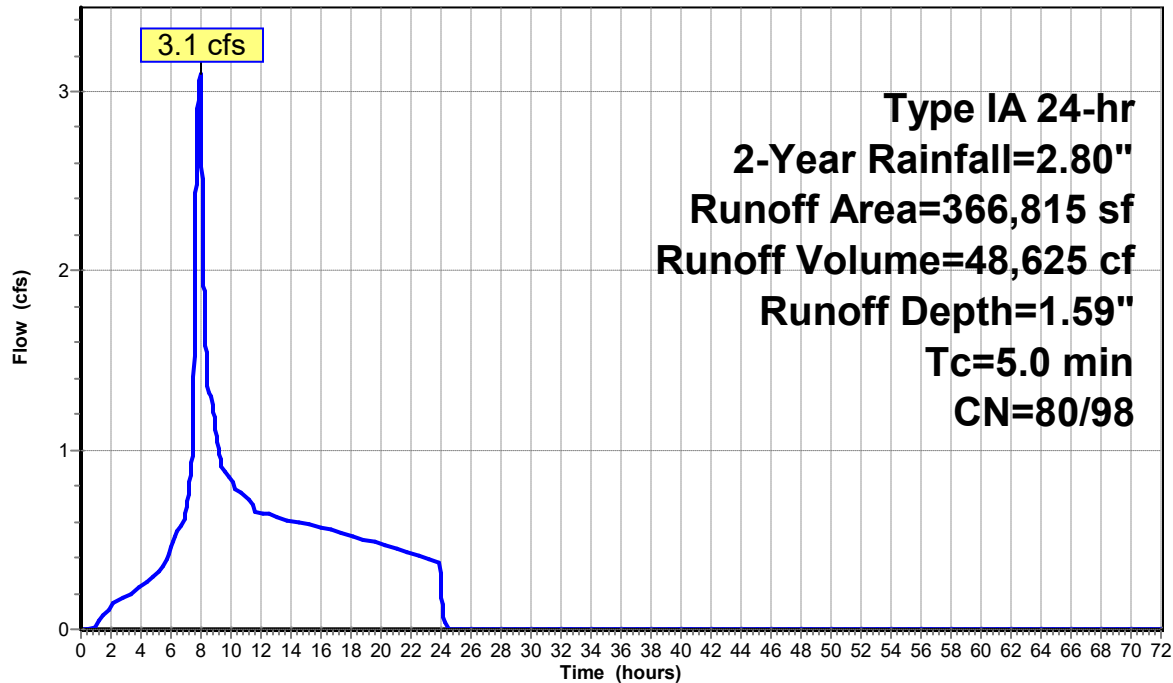
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Subcatchment G: Basin G - EcoRoof

Runoff = 0.0 cfs @ 18.05 hrs, Volume= 2,285 cf, Depth= 0.29"
Routed to Link POD #1 : POD#1

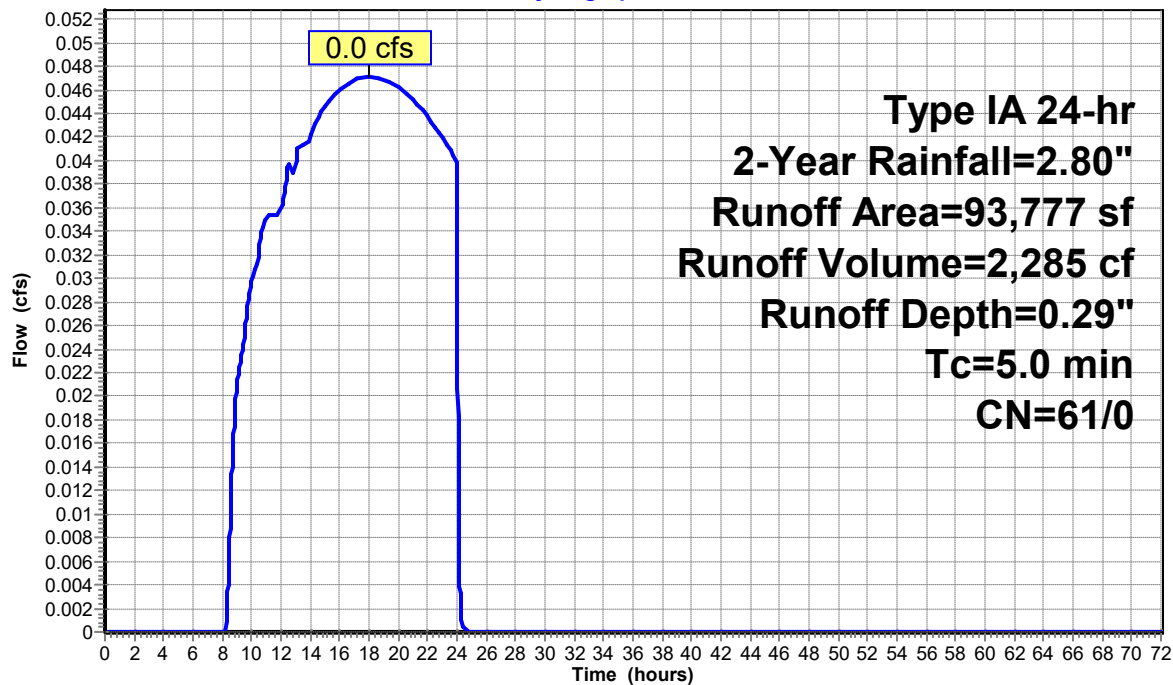
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

	Area (sf)	CN	Description
*	93,777	61	Ecoroof
	93,777	61	100.00% Pervious Area

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

Subcatchment G: Basin G - EcoRoof

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Pond Pond A: Pond A

Inflow Area = 349,468 sf, 50.02% Impervious, Inflow Depth = 1.84" for 2-Year event
 Inflow = 3.5 cfs @ 7.92 hrs, Volume= 53,466 cf
 Outflow = 0.5 cfs @ 18.40 hrs, Volume= 53,466 cf, Atten= 85%, Lag= 628.7 min
 Primary = 0.5 cfs @ 18.40 hrs, Volume= 53,466 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 709.54' @ 18.40 hrs Surf.Area= 10,192 sf Storage= 16,455 cf

Plug-Flow detention time= 345.0 min calculated for 53,466 cf (100% of inflow)
 Center-of-Mass det. time= 345.0 min (1,064.2 - 719.2)

Volume	Invert	Avail.Storage	Storage Description
#1	707.50'	38,422 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
707.50	6,093	0	0
708.00	7,022	3,279	3,279
709.00	9,017	8,020	11,298
710.00	11,205	10,111	21,409
711.00	13,583	12,394	33,803
711.33	14,412	4,619	38,422

Device	Routing	Invert	Outlet Devices
#1	Primary	698.43'	18.0" Round Culvert L= 138.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 698.43' / 696.24' S= 0.0159 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	696.43'	2.4" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	709.54'	13.0" W x 6.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	710.17'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=0.5 cfs @ 18.40 hrs HW=709.54' (Free Discharge)

- 1=Culvert (Passes 0.5 cfs of 24.3 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.5 cfs @ 16.58 fps)
- 3=Orifice/Grate (Controls 0.0 cfs)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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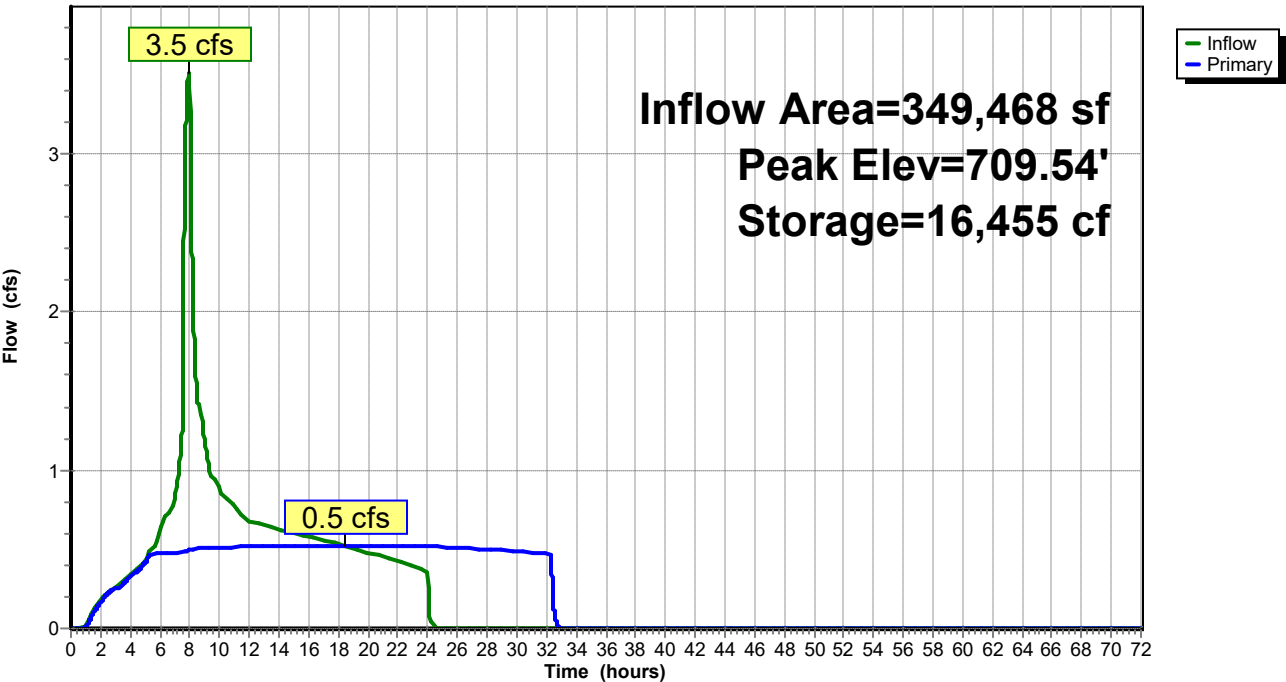
Type IA 24-hr 2-Year Rainfall=2.80"

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Pond Pond A: Pond A

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Pond Pond C: Pond C

Inflow Area = 763,299 sf, 11.07% Impervious, Inflow Depth = 1.26" for 2-Year event
 Inflow = 4.8 cfs @ 7.98 hrs, Volume= 80,429 cf
 Outflow = 0.8 cfs @ 21.48 hrs, Volume= 80,429 cf, Atten= 83%, Lag= 810.1 min
 Primary = 0.8 cfs @ 21.48 hrs, Volume= 80,429 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 705.34' @ 21.48 hrs Surf.Area= 21,292 sf Storage= 26,883 cf

Plug-Flow detention time= 365.3 min calculated for 80,429 cf (100% of inflow)
 Center-of-Mass det. time= 365.3 min (1,164.0 - 798.7)

Volume	Invert	Avail.Storage	Storage Description
#1	704.00'	102,369 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
704.00	18,273	0	0
704.50	19,886	9,540	9,540
705.50	21,555	20,721	30,260
706.50	23,281	22,418	52,678
707.50	25,063	24,172	76,850
708.50	25,975	25,519	102,369

Device	Routing	Invert	Outlet Devices
#1	Primary	700.29'	15.0" Round Culvert L= 178.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 700.29' / 699.40' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	698.29'	3.7" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	705.34'	10.0" W x 5.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	706.27'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=0.8 cfs @ 21.48 hrs HW=705.34' (Free Discharge)

- 1=Culvert (Passes 0.8 cfs of 9.0 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.8 cfs @ 11.18 fps)
- 3=Orifice/Grate (Orifice Controls 0.0 cfs @ 0.16 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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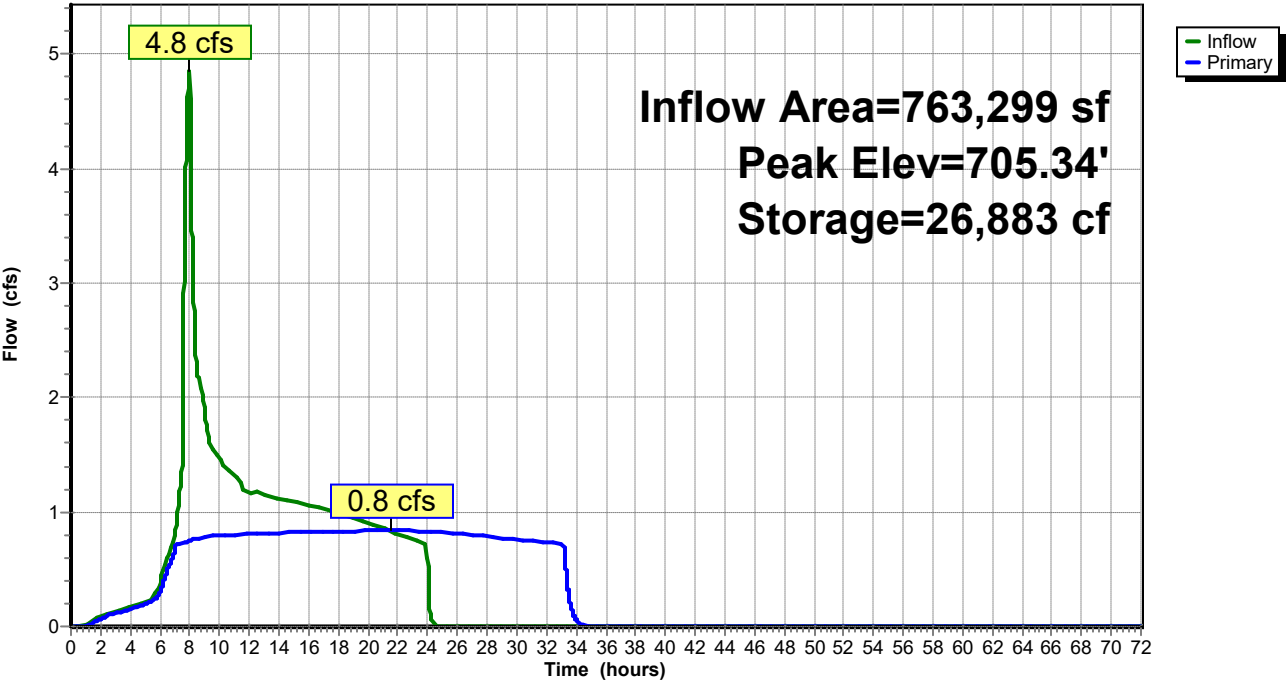
Type IA 24-hr 2-Year Rainfall=2.80"

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Pond Pond C: Pond C

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Pond Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 7.19" for 2-Year event
 Inflow = 3.8 cfs @ 7.94 hrs, Volume= 219,721 cf, Incl. 0.7 cfs Base Flow
 Outflow = 1.3 cfs @ 13.42 hrs, Volume= 219,490 cf, Atten= 66%, Lag= 329.0 min
 Primary = 1.3 cfs @ 13.42 hrs, Volume= 219,490 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 695.27' @ 13.42 hrs Surf.Area= 7,447 sf Storage= 14,244 cf

Plug-Flow detention time= 75.7 min calculated for 219,486 cf (100% of inflow)
 Center-of-Mass det. time= 73.0 min (1,920.1 - 1,847.2)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.3 cfs @ 13.42 hrs HW=695.27' (Free Discharge)

- 1=Culvert (Passes 1.3 cfs of 7.9 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 1.3 cfs @ 9.30 fps)
- 3=Orifice/Grate (Orifice Controls 0.0 cfs @ 0.48 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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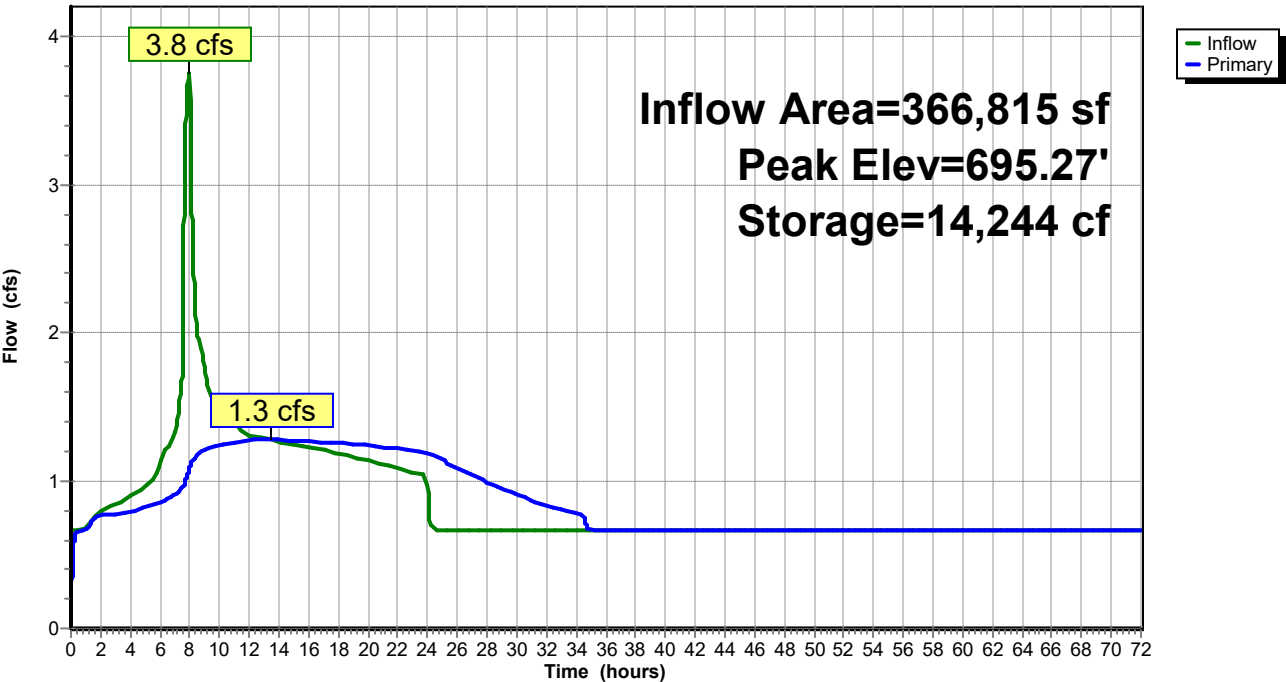
Type IA 24-hr 2-Year Rainfall=2.80"

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Pond Pond D: Pond D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 2-Year Rainfall=2.80"

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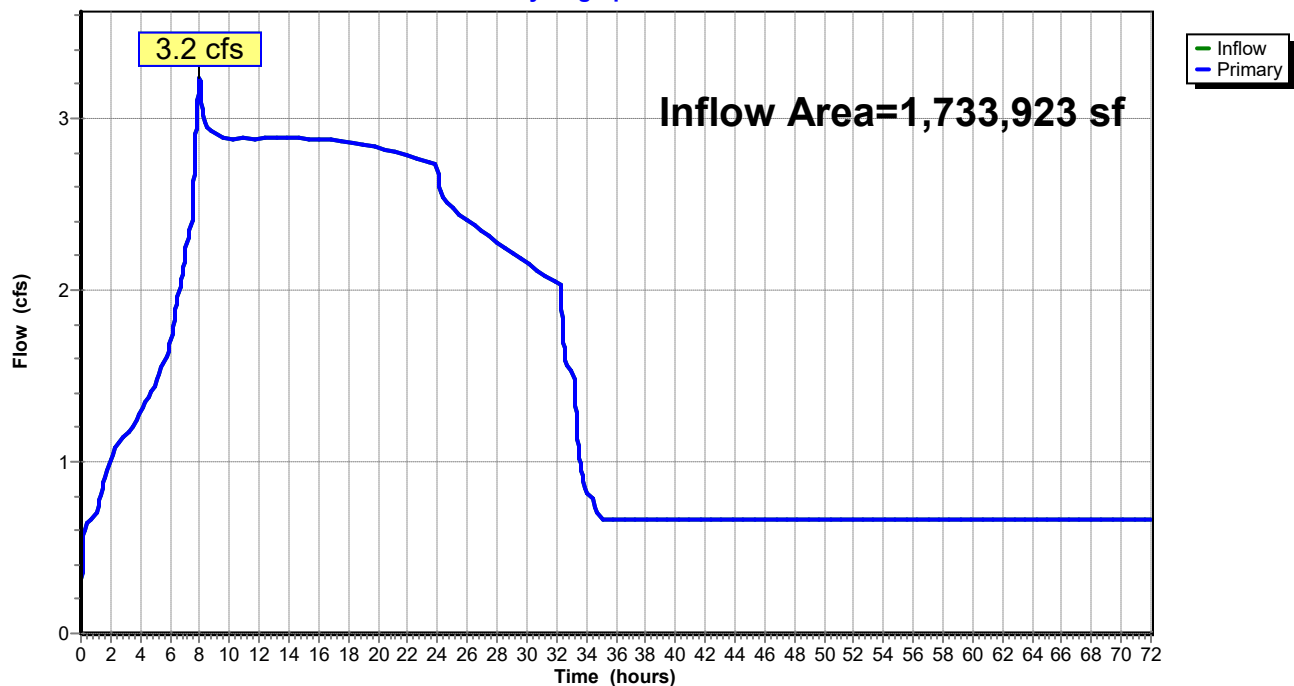
Summary for Link POD #1: POD#1

Inflow Area = 1,733,923 sf, 22.65% Impervious, Inflow Depth > 2.57" for 2-Year event
Inflow = 3.2 cfs @ 8.00 hrs, Volume= 371,788 cf
Primary = 3.2 cfs @ 8.00 hrs, Volume= 371,788 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POD #1: POD#1

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment 1A: Subbasin 1A - Undetained

Runoff = 0.9 cfs @ 7.97 hrs, Volume= 14,786 cf, Depth= 1.72"
Routed to Link POD #1 : POD#1

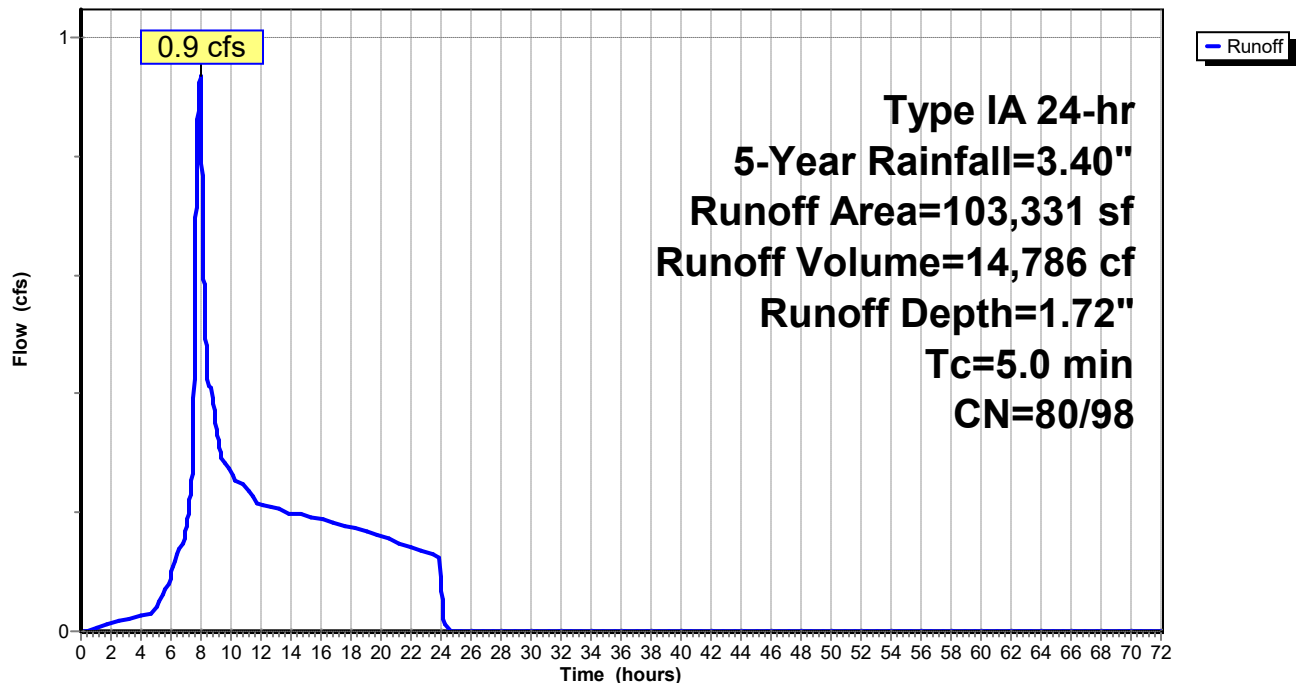
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

	Area (sf)	CN	Description
	93,080	80	>75% Grass cover, Good, HSG D
*	10,251	98	Impervious
	103,331	82	Weighted Average
	93,080	80	90.08% Pervious Area
	10,251	98	9.92% Impervious Area

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

Subcatchment 1A: Subbasin 1A - Undetained

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment 2A: Subbasin 2A - Undetained

Runoff = 0.4 cfs @ 8.01 hrs, Volume= 7,557 cf, Depth= 1.58"
Routed to Link POD #1 : POD#1

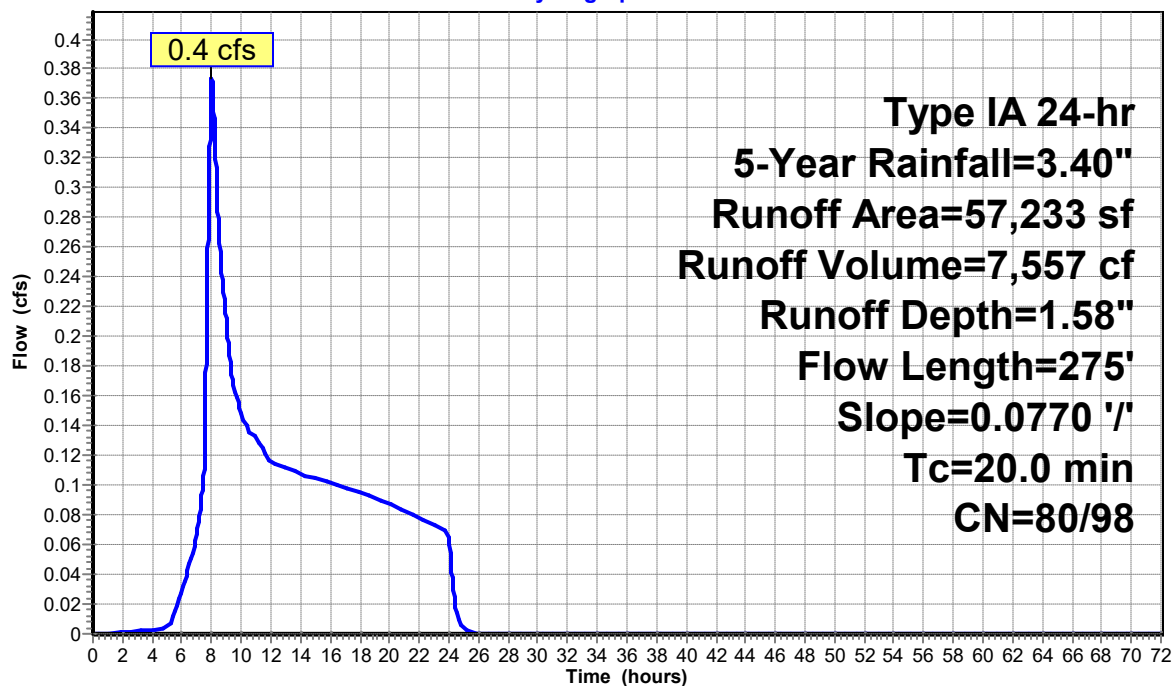
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

	Area (sf)	CN	Description
	56,269	80	>75% Grass cover, Good, HSG D
*	964	98	Impervious Area
	57,233	80	Weighted Average
	56,269	80	98.32% Pervious Area
	964	98	1.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0	275	0.0770	0.23		Sheet Flow, Grass: Dense n= 0.240 P2= 2.80"

Subcatchment 2A: Subbasin 2A - Undetained

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment A: Post Basin A

Runoff = 4.6 cfs @ 7.91 hrs, Volume= 68,799 cf, Depth= 2.36"
Routed to Pond Pond A : Pond A

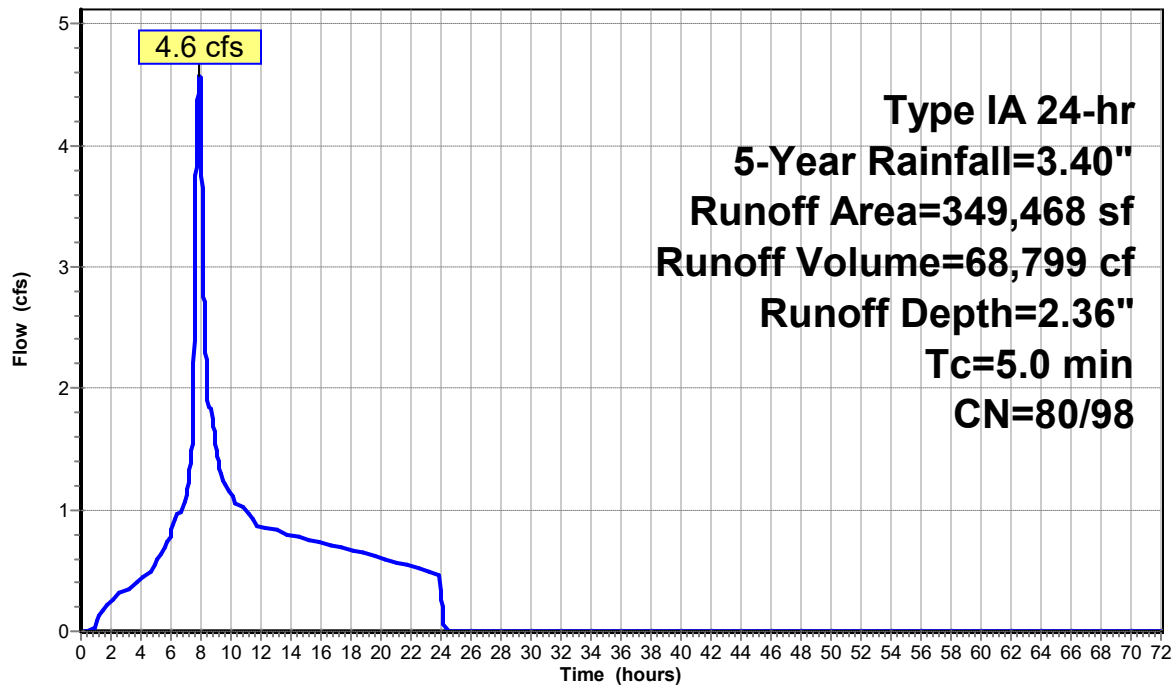
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	174,806	98	Impervious Area
	174,662	80	>75% Grass cover, Good, HSG D
	349,468	89	Weighted Average
	174,662	80	49.98% Pervious Area
	174,806	98	50.02% Impervious Area

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

Subcatchment A: Post Basin A

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment C: Post Basin C

Runoff = 7.0 cfs @ 7.96 hrs, Volume= 110,393 cf, Depth= 1.74"
Routed to Pond Pond C : Pond C

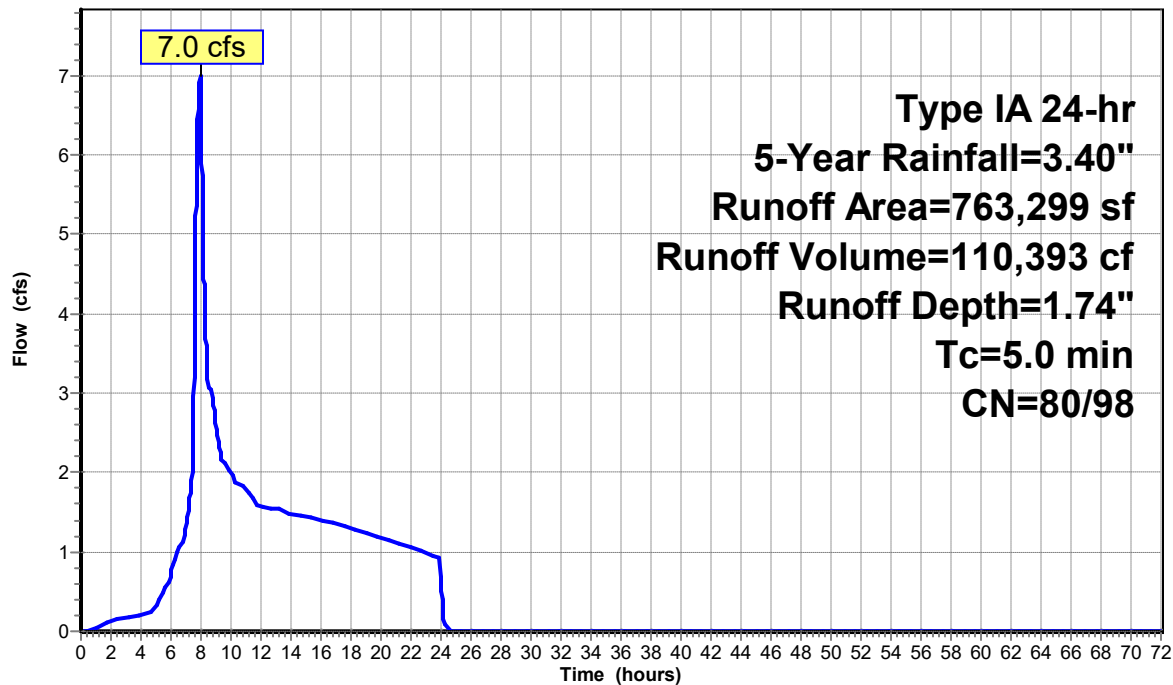
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	84,476	98	Impervious Area
	678,823	80	>75% Grass cover, Good, HSG D
	763,299	82	Weighted Average
	678,823	80	88.93% Pervious Area
	84,476	98	11.07% Impervious Area

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

Subcatchment C: Post Basin C

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment D: Post Basin D

Runoff = 4.2 cfs @ 7.93 hrs, Volume= 63,993 cf, Depth= 2.09"
Routed to Pond Pond D : Pond D

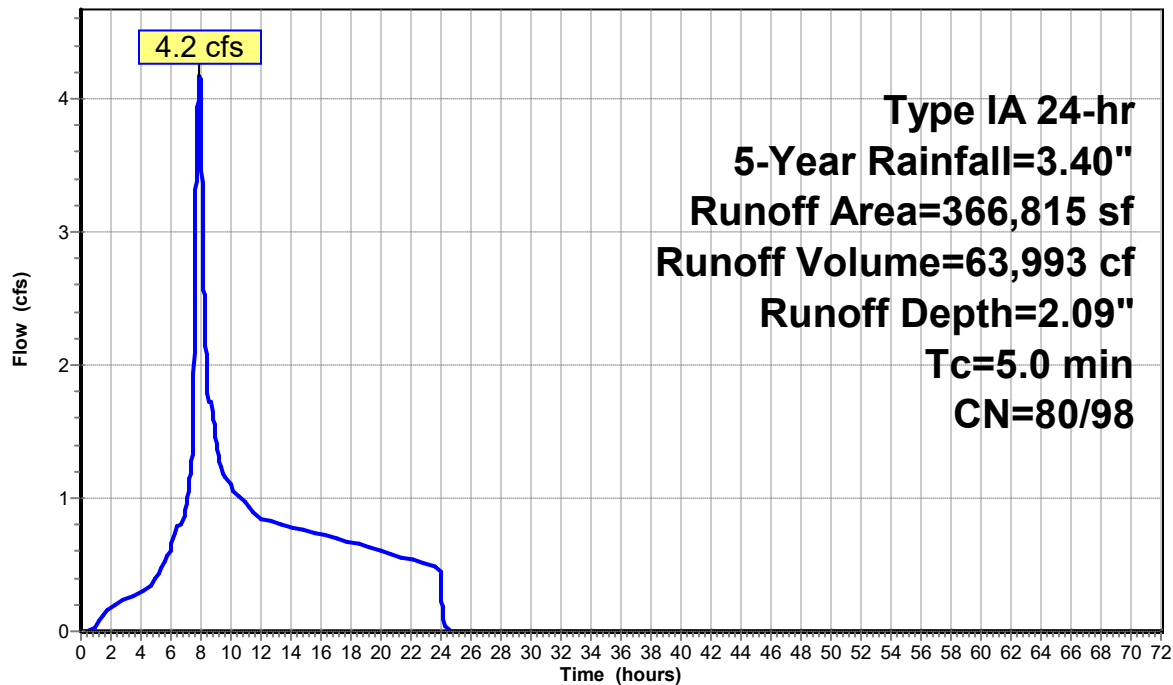
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment G: Basin G - EcoRoof

Runoff = 0.1 cfs @ 16.53 hrs, Volume= 4,130 cf, Depth= 0.53"
Routed to Link POD #1 : POD#1

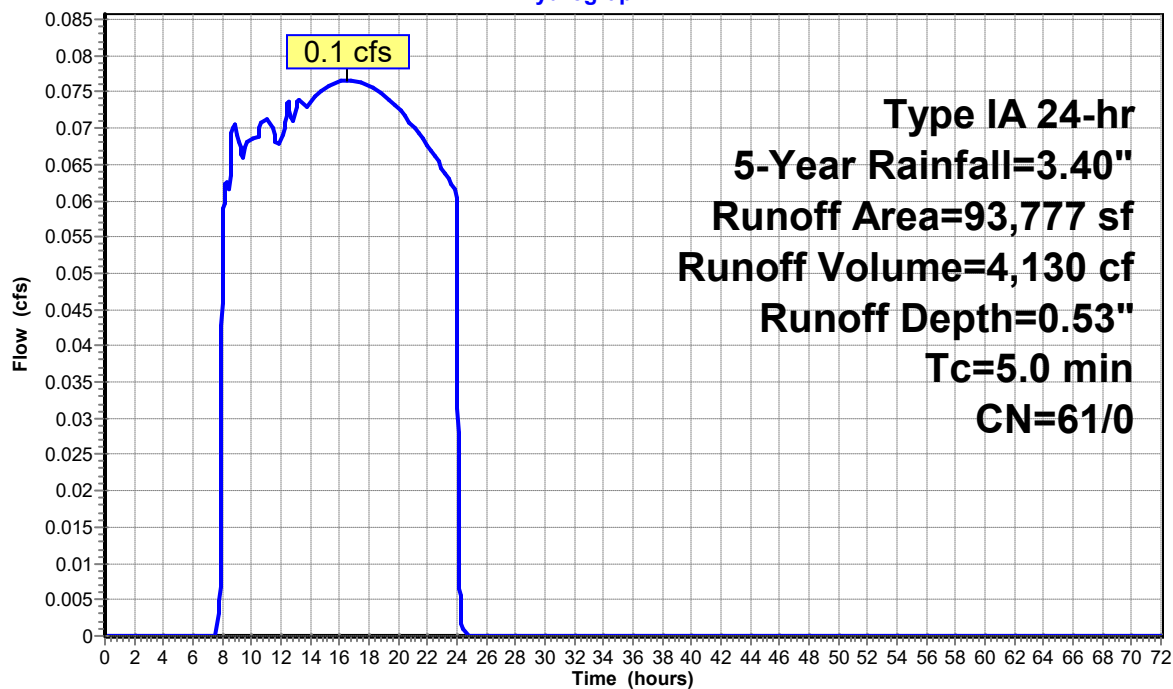
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	93,777	61	Ecoroof
	93,777	61	100.00% Pervious Area

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

Subcatchment G: Basin G - EcoRoof

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Pond Pond A: Pond A

Inflow Area = 349,468 sf, 50.02% Impervious, Inflow Depth = 2.36" for 5-Year event
 Inflow = 4.6 cfs @ 7.91 hrs, Volume= 68,799 cf
 Outflow = 1.0 cfs @ 11.16 hrs, Volume= 68,799 cf, Atten= 79%, Lag= 194.7 min
 Primary = 1.0 cfs @ 11.16 hrs, Volume= 68,799 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 709.79' @ 11.16 hrs Surf.Area= 10,741 sf Storage= 19,083 cf

Plug-Flow detention time= 323.8 min calculated for 68,799 cf (100% of inflow)
 Center-of-Mass det. time= 323.8 min (1,036.9 - 713.2)

Volume	Invert	Avail.Storage	Storage Description
#1	707.50'	38,422 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
707.50	6,093	0	0
708.00	7,022	3,279	3,279
709.00	9,017	8,020	11,298
710.00	11,205	10,111	21,409
711.00	13,583	12,394	33,803
711.33	14,412	4,619	38,422

Device	Routing	Invert	Outlet Devices
#1	Primary	698.43'	18.0" Round Culvert L= 138.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 698.43' / 696.24' S= 0.0159 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	696.43'	2.4" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	709.54'	13.0" W x 6.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	710.17'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.0 cfs @ 11.16 hrs HW=709.79' (Free Discharge)

- 1=Culvert (Passes 1.0 cfs of 24.5 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.5 cfs @ 16.77 fps)
- 3=Orifice/Grate (Orifice Controls 0.4 cfs @ 1.65 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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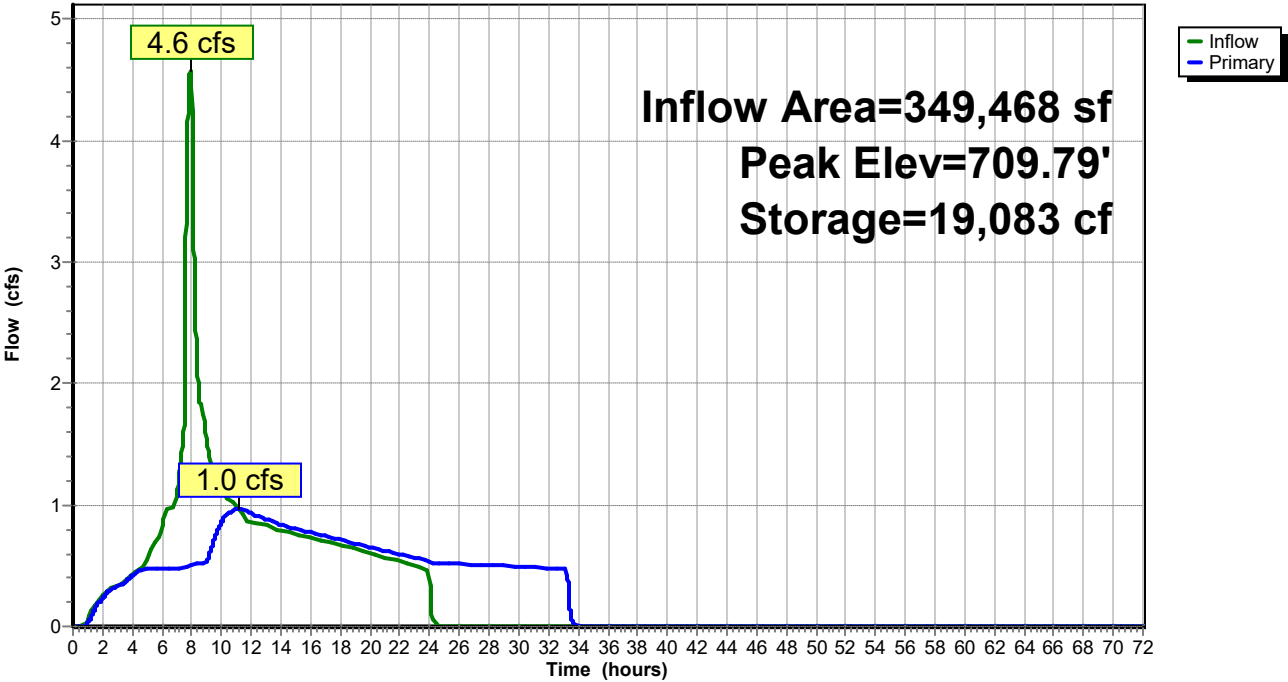
Type IA 24-hr 5-Year Rainfall=3.40"

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Pond Pond A: Pond A

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Pond Pond C: Pond C

Inflow Area = 763,299 sf, 11.07% Impervious, Inflow Depth = 1.74" for 5-Year event
 Inflow = 7.0 cfs @ 7.96 hrs, Volume= 110,393 cf
 Outflow = 1.4 cfs @ 15.50 hrs, Volume= 110,393 cf, Atten= 80%, Lag= 452.0 min
 Primary = 1.4 cfs @ 15.50 hrs, Volume= 110,393 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 705.68' @ 15.50 hrs Surf.Area= 21,874 sf Storage= 34,269 cf

Plug-Flow detention time= 367.1 min calculated for 110,393 cf (100% of inflow)
 Center-of-Mass det. time= 367.1 min (1,150.8 - 783.7)

Volume	Invert	Avail.Storage	Storage Description
#1	704.00'	102,369 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
704.00	18,273	0	0
704.50	19,886	9,540	9,540
705.50	21,555	20,721	30,260
706.50	23,281	22,418	52,678
707.50	25,063	24,172	76,850
708.50	25,975	25,519	102,369

Device	Routing	Invert	Outlet Devices
#1	Primary	700.29'	15.0" Round Culvert L= 178.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 700.29' / 699.40' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	698.29'	3.7" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	705.34'	10.0" W x 5.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	706.27'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.4 cfs @ 15.50 hrs HW=705.68' (Free Discharge)

- 1=Culvert (Passes 1.4 cfs of 9.3 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.9 cfs @ 11.56 fps)
- 3=Orifice/Grate (Orifice Controls 0.6 cfs @ 1.95 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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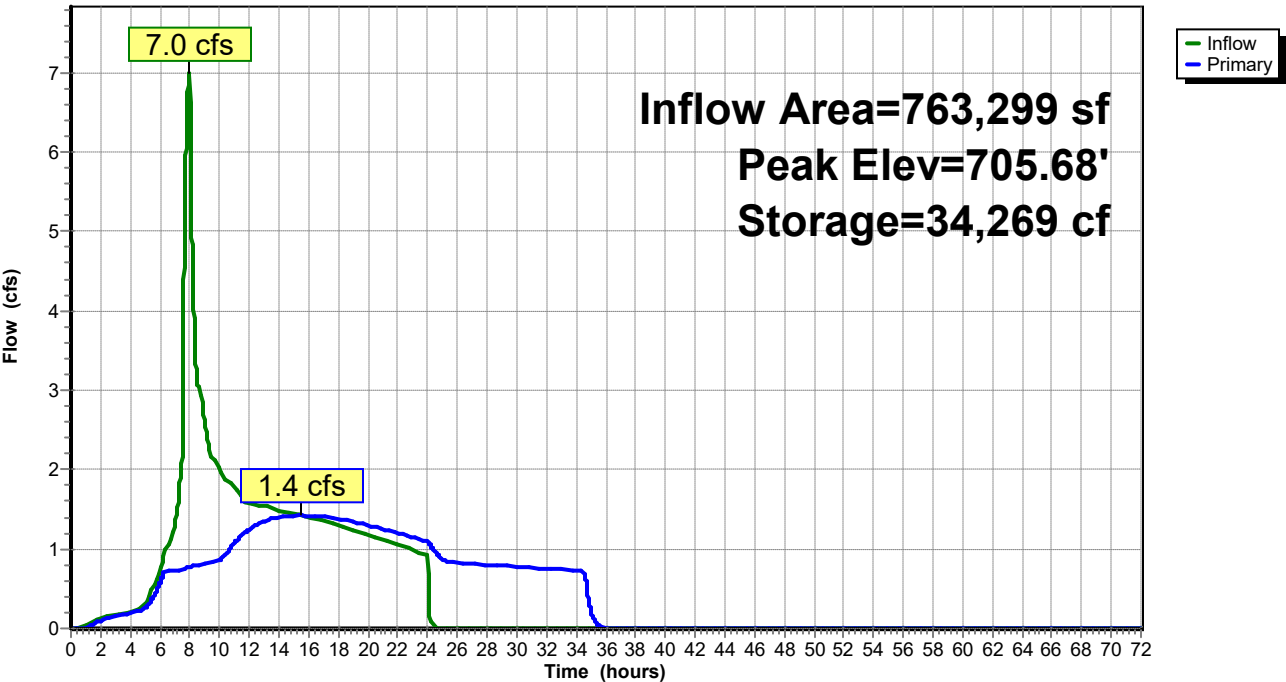
Type IA 24-hr 5-Year Rainfall=3.40"

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Pond Pond C: Pond C

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Pond Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 7.69" for 5-Year event
 Inflow = 4.8 cfs @ 7.93 hrs, Volume= 235,088 cf, Incl. 0.7 cfs Base Flow
 Outflow = 1.8 cfs @ 9.81 hrs, Volume= 234,857 cf, Atten= 63%, Lag= 112.5 min
 Primary = 1.8 cfs @ 9.81 hrs, Volume= 234,857 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 695.59' @ 9.81 hrs Surf.Area= 7,794 sf Storage= 16,672 cf

Plug-Flow detention time= 83.5 min calculated for 234,821 cf (100% of inflow)
 Center-of-Mass det. time= 81.0 min (1,854.0 - 1,773.0)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.8 cfs @ 9.81 hrs HW=695.59' (Free Discharge)

- 1=Culvert (Passes 1.8 cfs of 8.3 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 1.3 cfs @ 9.71 fps)
- 3=Orifice/Grate (Orifice Controls 0.5 cfs @ 2.27 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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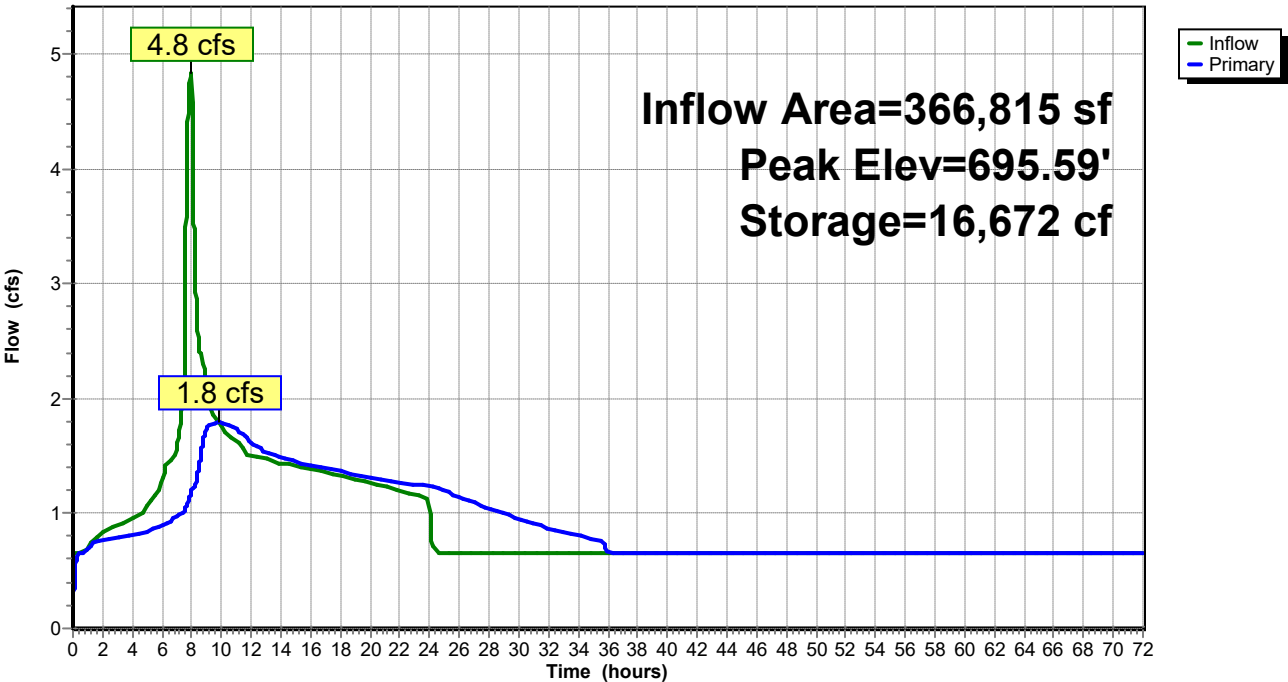
Type IA 24-hr 5-Year Rainfall=3.40"

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Pond Pond D: Pond D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 5-Year Rainfall=3.40"

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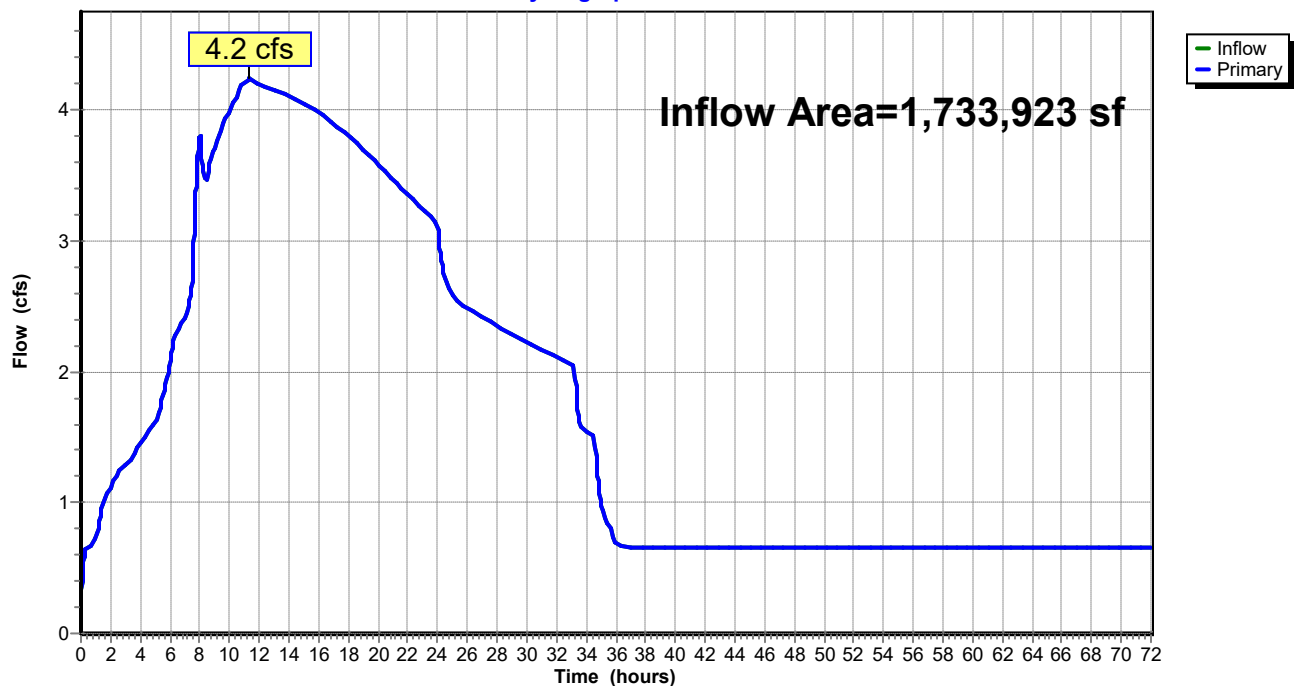
Summary for Link POD #1: POD#1

Inflow Area = 1,733,923 sf, 22.65% Impervious, Inflow Depth > 3.05" for 5-Year event
Inflow = 4.2 cfs @ 11.35 hrs, Volume= 440,523 cf
Primary = 4.2 cfs @ 11.35 hrs, Volume= 440,523 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POD #1: POD#1

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment 1A: Subbasin 1A - Undetained

Runoff = 1.1 cfs @ 7.96 hrs, Volume= 17,610 cf, Depth= 2.05"
Routed to Link POD #1 : POD#1

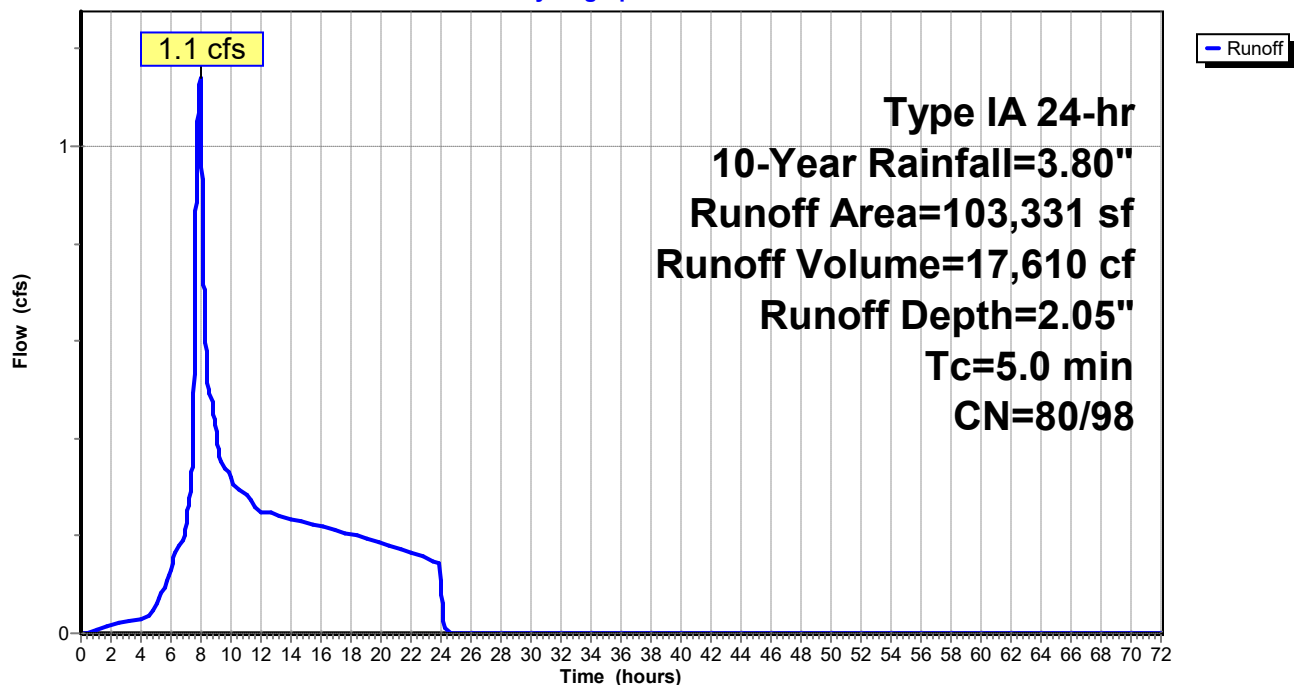
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

	Area (sf)	CN	Description
	93,080	80	>75% Grass cover, Good, HSG D
*	10,251	98	Impervious
	103,331	82	Weighted Average
	93,080	80	90.08% Pervious Area
	10,251	98	9.92% Impervious Area

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

Subcatchment 1A: Subbasin 1A - Undetained

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment 2A: Subbasin 2A - Undetained

Runoff = 0.5 cfs @ 8.01 hrs, Volume= 9,091 cf, Depth= 1.91"
Routed to Link POD #1 : POD#1

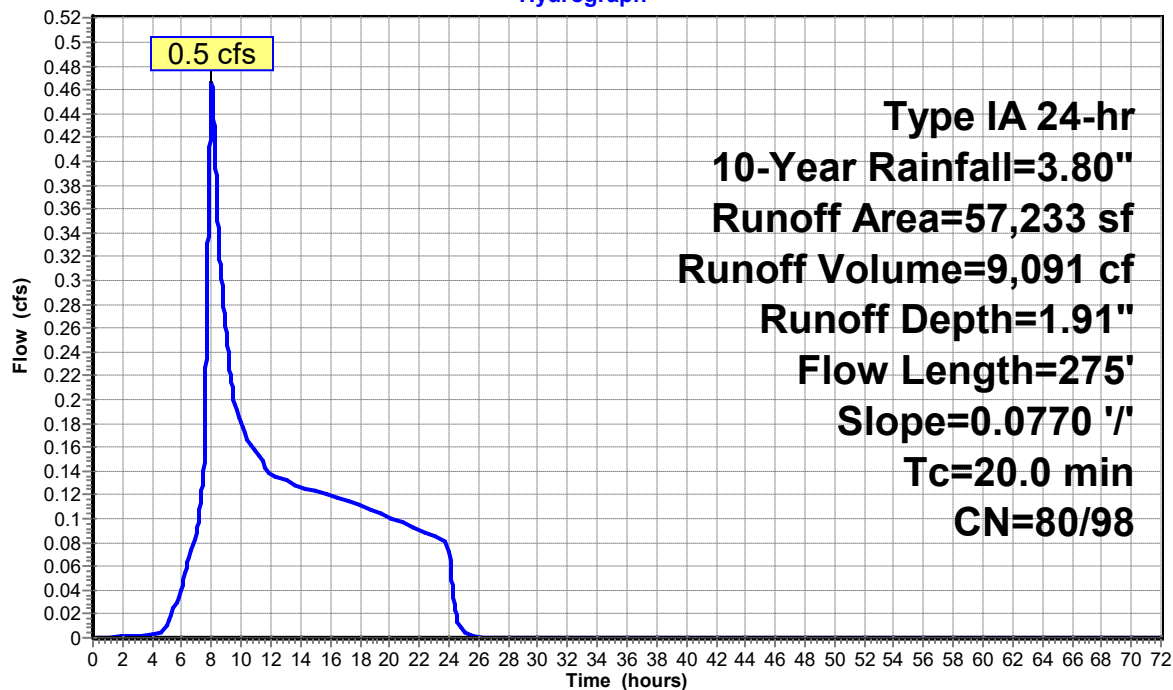
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

	Area (sf)	CN	Description
	56,269	80	>75% Grass cover, Good, HSG D
*	964	98	Impervious Area
	57,233	80	Weighted Average
	56,269	80	98.32% Pervious Area
	964	98	1.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0	275	0.0770	0.23		Sheet Flow, Grass: Dense n= 0.240 P2= 2.80"

Subcatchment 2A: Subbasin 2A - Undetained

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment A: Post Basin A

Runoff = 5.3 cfs @ 7.91 hrs, Volume= 79,269 cf, Depth= 2.72"
Routed to Pond Pond A : Pond A

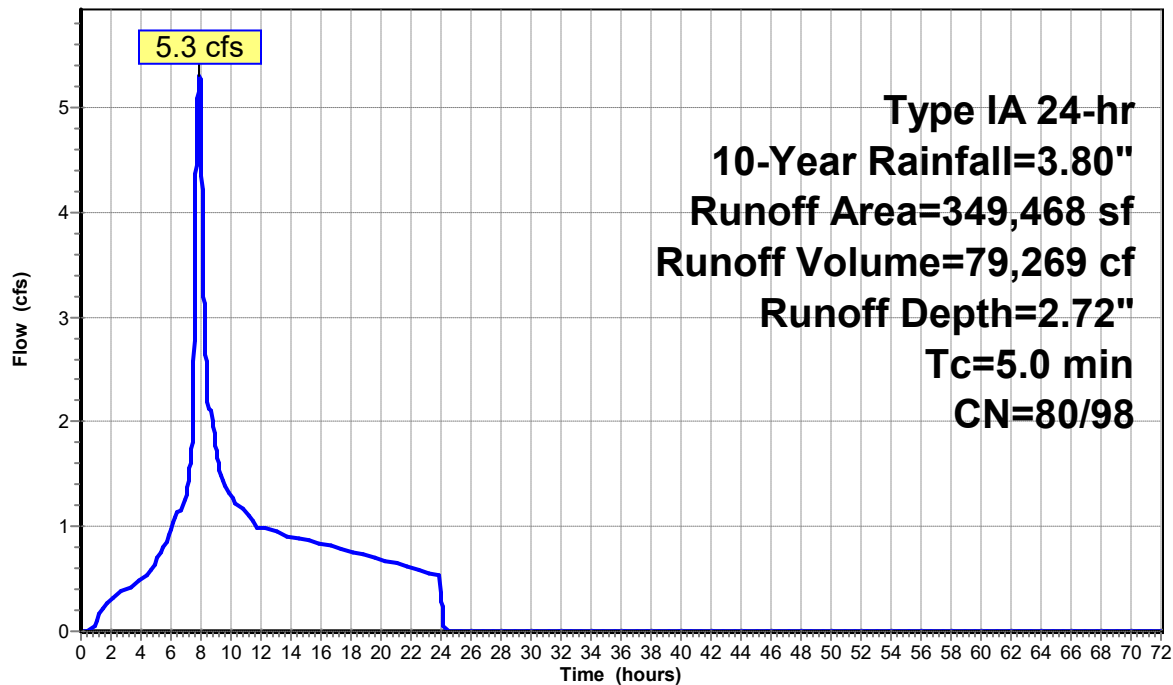
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

	Area (sf)	CN	Description
*	174,806	98	Impervious Area
	174,662	80	>75% Grass cover, Good, HSG D
	349,468	89	Weighted Average
	174,662	80	49.98% Pervious Area
	174,806	98	50.02% Impervious Area

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

Subcatchment A: Post Basin A

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment C: Post Basin C

Runoff = 8.5 cfs @ 7.96 hrs, Volume= 131,313 cf, Depth= 2.06"
Routed to Pond Pond C : Pond C

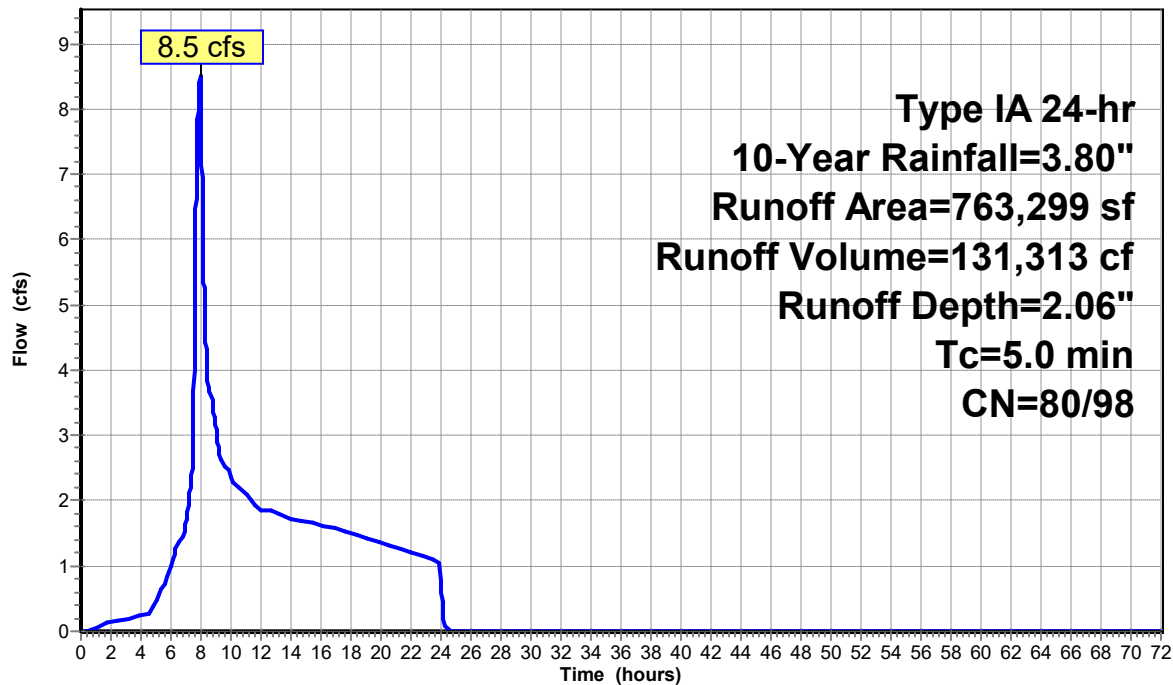
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

	Area (sf)	CN	Description
*	84,476	98	Impervious Area
	678,823	80	>75% Grass cover, Good, HSG D
	763,299	82	Weighted Average
	678,823	80	88.93% Pervious Area
	84,476	98	11.07% Impervious Area

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

Subcatchment C: Post Basin C

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment D: Post Basin D

Runoff = 4.9 cfs @ 7.93 hrs, Volume= 74,580 cf, Depth= 2.44"
Routed to Pond Pond D : Pond D

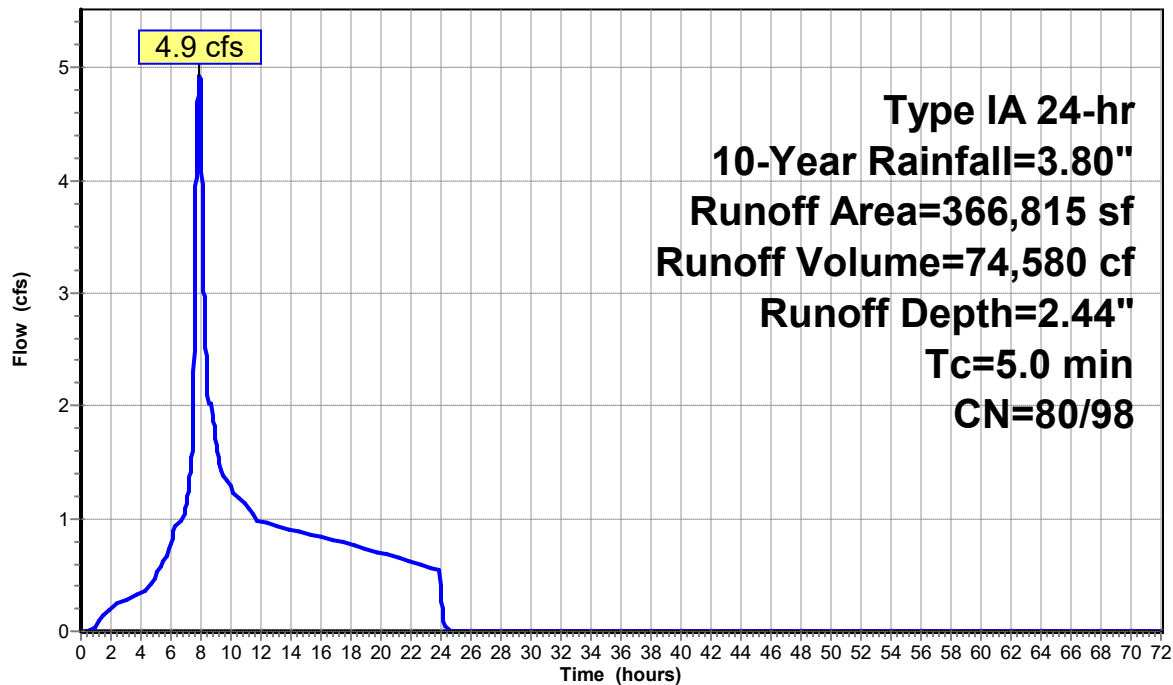
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment G: Basin G - EcoRoof

Runoff = 0.1 cfs @ 8.01 hrs, Volume= 5,573 cf, Depth= 0.71"
Routed to Link POD #1 : POD#1

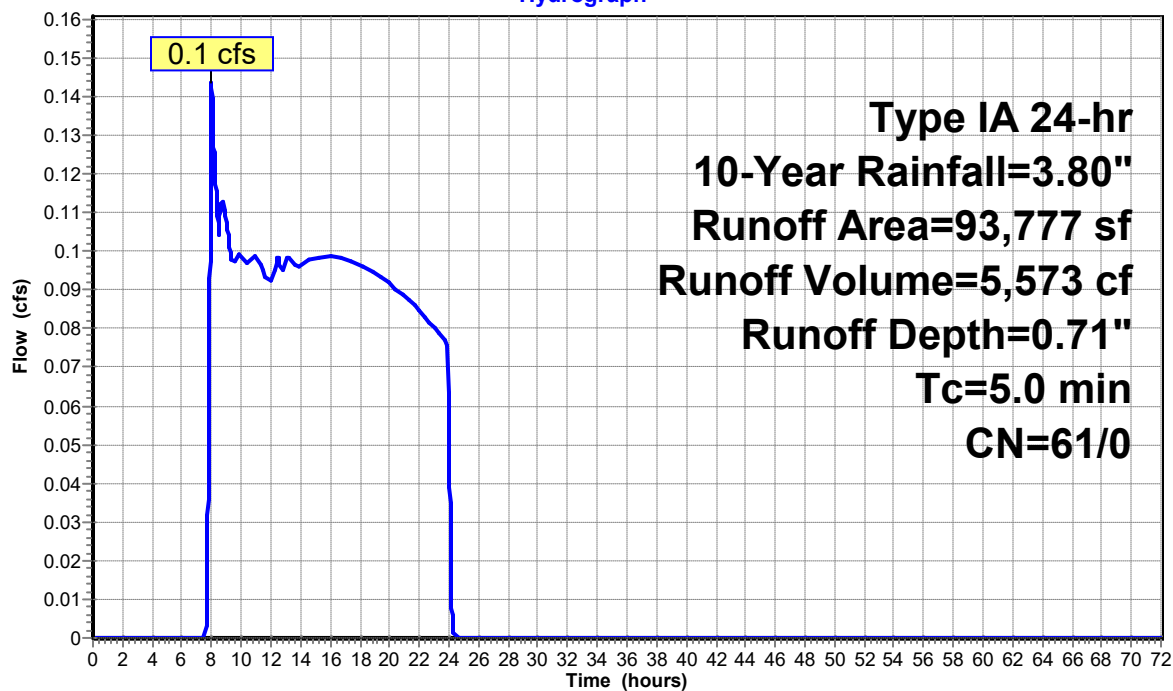
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

	Area (sf)	CN	Description
*	93,777	61	Ecoroof
	93,777	61	100.00% Pervious Area

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

Subcatchment G: Basin G - EcoRoof

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Pond Pond A: Pond A

Inflow Area = 349,468 sf, 50.02% Impervious, Inflow Depth = 2.72" for 10-Year event
 Inflow = 5.3 cfs @ 7.91 hrs, Volume= 79,269 cf
 Outflow = 1.3 cfs @ 9.90 hrs, Volume= 79,269 cf, Atten= 75%, Lag= 119.3 min
 Primary = 1.3 cfs @ 9.90 hrs, Volume= 79,269 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 709.91' @ 9.90 hrs Surf.Area= 11,005 sf Storage= 20,396 cf

Plug-Flow detention time= 297.0 min calculated for 79,258 cf (100% of inflow)
 Center-of-Mass det. time= 297.1 min (1,006.7 - 709.6)

Volume	Invert	Avail.Storage	Storage Description
#1	707.50'	38,422 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
707.50	6,093	0	0
708.00	7,022	3,279	3,279
709.00	9,017	8,020	11,298
710.00	11,205	10,111	21,409
711.00	13,583	12,394	33,803
711.33	14,412	4,619	38,422

Device	Routing	Invert	Outlet Devices
#1	Primary	698.43'	18.0" Round Culvert L= 138.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 698.43' / 696.24' S= 0.0159 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	696.43'	2.4" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	709.54'	13.0" W x 6.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	710.17'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.3 cfs @ 9.90 hrs HW=709.91' (Free Discharge)

- 1=Culvert (Passes 1.3 cfs of 24.7 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.5 cfs @ 16.86 fps)
- 3=Orifice/Grate (Orifice Controls 0.8 cfs @ 2.01 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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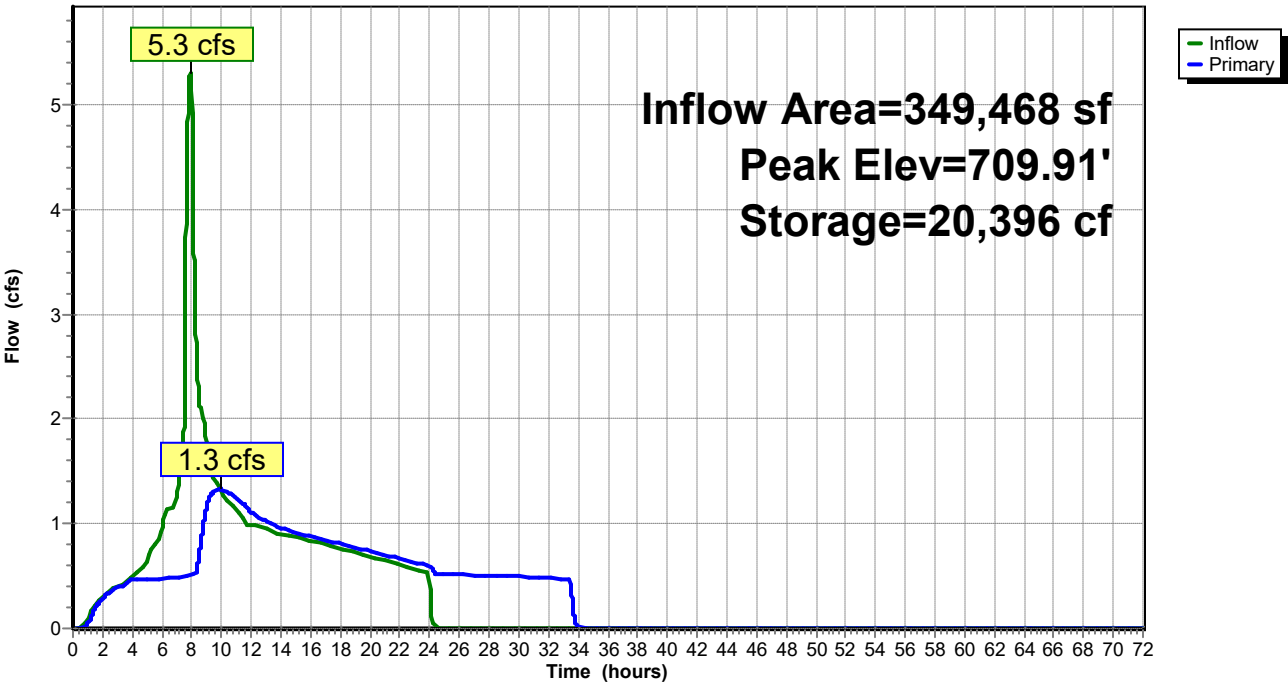
Type IA 24-hr 10-Year Rainfall=3.80"

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Pond Pond A: Pond A

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Pond Pond C: Pond C

Inflow Area = 763,299 sf, 11.07% Impervious, Inflow Depth = 2.06" for 10-Year event
 Inflow = 8.5 cfs @ 7.96 hrs, Volume= 131,313 cf
 Outflow = 1.8 cfs @ 13.39 hrs, Volume= 131,313 cf, Atten= 79%, Lag= 326.2 min
 Primary = 1.8 cfs @ 13.39 hrs, Volume= 131,313 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 705.84' @ 13.39 hrs Surf.Area= 22,145 sf Storage= 37,732 cf

Plug-Flow detention time= 341.3 min calculated for 131,295 cf (100% of inflow)
 Center-of-Mass det. time= 341.4 min (1,116.8 - 775.4)

Volume	Invert	Avail.Storage	Storage Description
#1	704.00'	102,369 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
704.00	18,273	0	0
704.50	19,886	9,540	9,540
705.50	21,555	20,721	30,260
706.50	23,281	22,418	52,678
707.50	25,063	24,172	76,850
708.50	25,975	25,519	102,369

Device	Routing	Invert	Outlet Devices
#1	Primary	700.29'	15.0" Round Culvert L= 178.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 700.29' / 699.40' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	698.29'	3.7" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	705.34'	10.0" W x 5.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	706.27'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.8 cfs @ 13.39 hrs HW=705.84' (Free Discharge)

- 1=Culvert (Passes 1.8 cfs of 9.4 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.9 cfs @ 11.72 fps)
- 3=Orifice/Grate (Orifice Controls 0.9 cfs @ 2.63 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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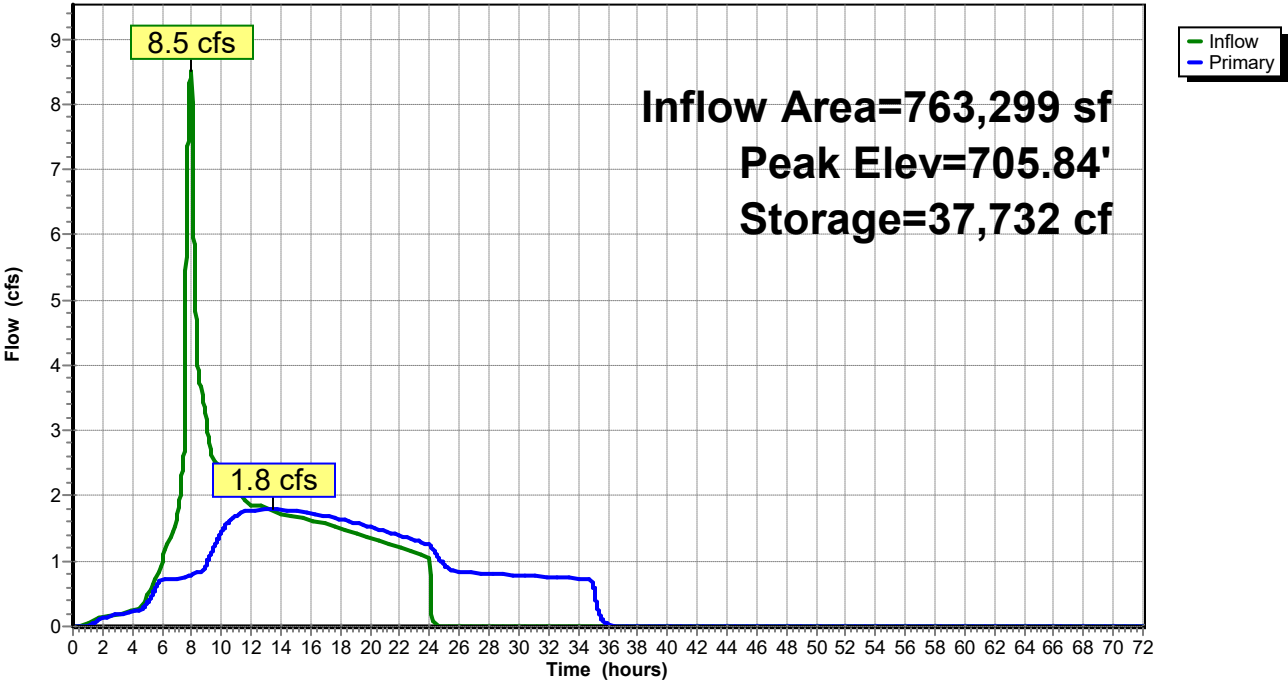
Type IA 24-hr 10-Year Rainfall=3.80"

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Pond Pond C: Pond C

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Pond Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 8.04" for 10-Year event
 Inflow = 5.6 cfs @ 7.93 hrs, Volume= 245,676 cf, Incl. 0.7 cfs Base Flow
 Outflow = 2.1 cfs @ 9.33 hrs, Volume= 245,445 cf, Atten= 63%, Lag= 84.2 min
 Primary = 2.1 cfs @ 9.33 hrs, Volume= 245,445 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 695.86' @ 9.33 hrs Surf.Area= 8,088 sf Storage= 18,819 cf

Plug-Flow detention time= 85.7 min calculated for 245,441 cf (100% of inflow)
 Center-of-Mass det. time= 83.2 min (1,810.1 - 1,727.0)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.1 cfs @ 9.33 hrs HW=695.86' (Free Discharge)

- 1=Culvert (Passes 2.1 cfs of 8.7 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 1.4 cfs @ 10.05 fps)
- 3=Orifice/Grate (Orifice Controls 0.7 cfs @ 3.45 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Post Discharge Point 1

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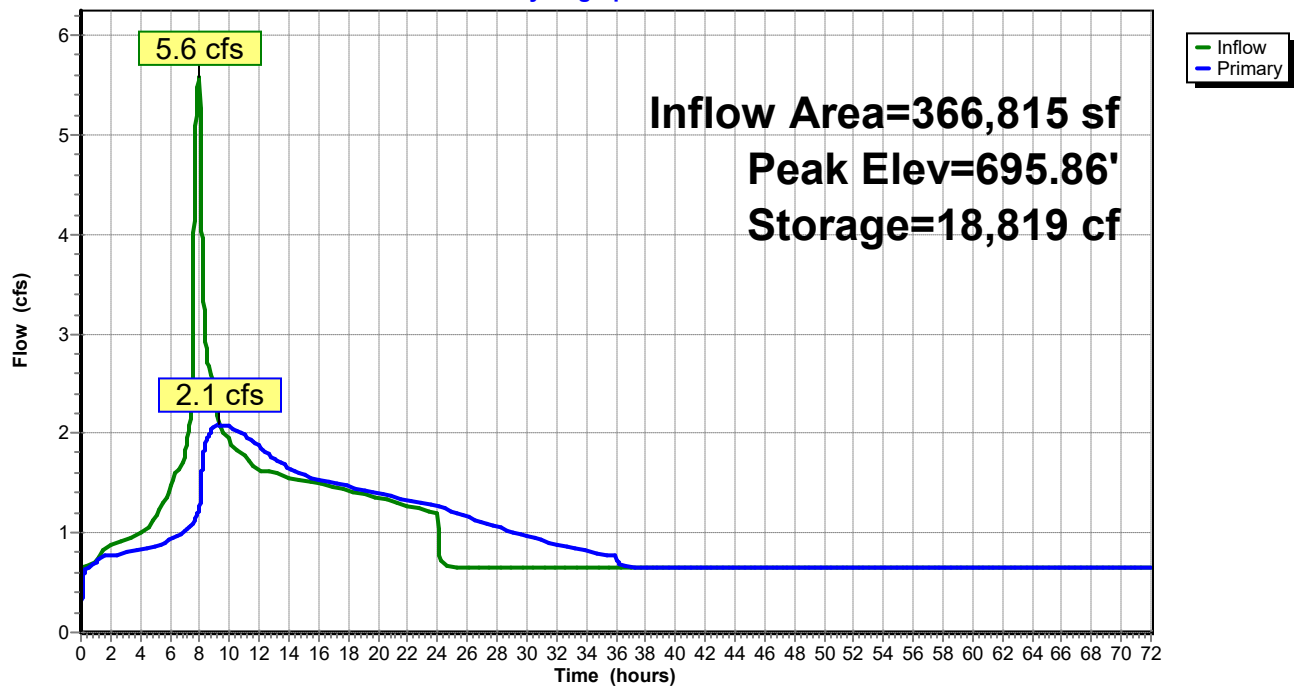
Type IA 24-hr 10-Year Rainfall=3.80"

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Pond Pond D: Pond D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 10-Year Rainfall=3.80"

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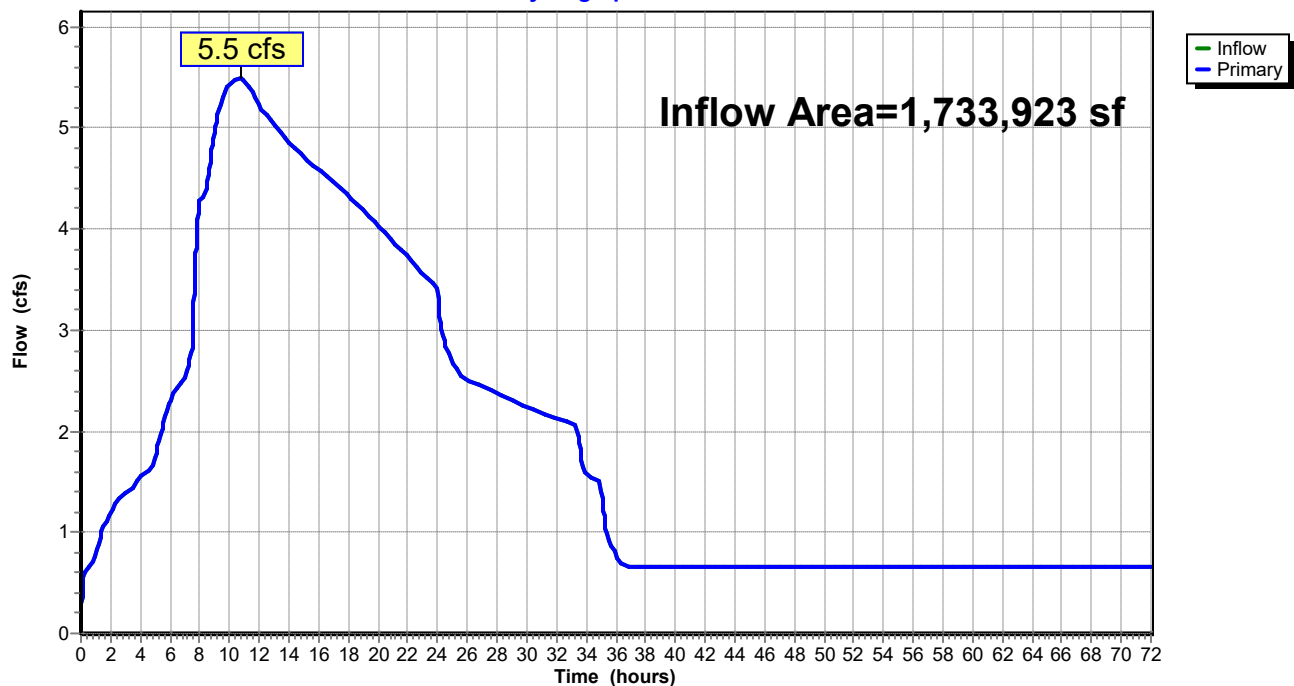
Summary for Link POD #1: POD#1

Inflow Area = 1,733,923 sf, 22.65% Impervious, Inflow Depth > 3.38" for 10-Year event
Inflow = 5.5 cfs @ 10.71 hrs, Volume= 488,300 cf
Primary = 5.5 cfs @ 10.71 hrs, Volume= 488,300 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POD #1: POD#1

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 1A: Subbasin 1A - Undetained

Runoff = 1.5 cfs @ 7.95 hrs, Volume= 22,736 cf, Depth= 2.64"
Routed to Link POD #1 : POD#1

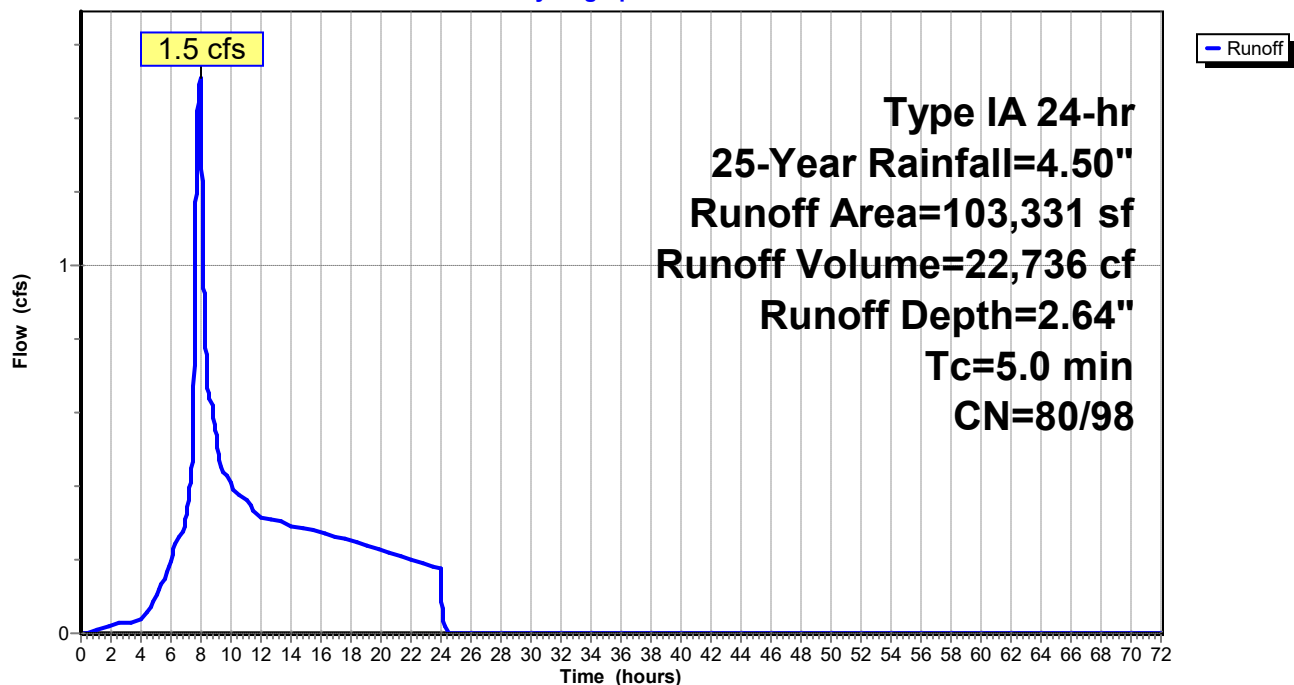
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
	93,080	80	>75% Grass cover, Good, HSG D
*	10,251	98	Impervious
	103,331	82	Weighted Average
	93,080	80	90.08% Pervious Area
	10,251	98	9.92% Impervious Area

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

Subcatchment 1A: Subbasin 1A - Undetained

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 2A: Subbasin 2A - Undetained

Runoff = 0.6 cfs @ 8.01 hrs, Volume= 11,885 cf, Depth= 2.49"
Routed to Link POD #1 : POD#1

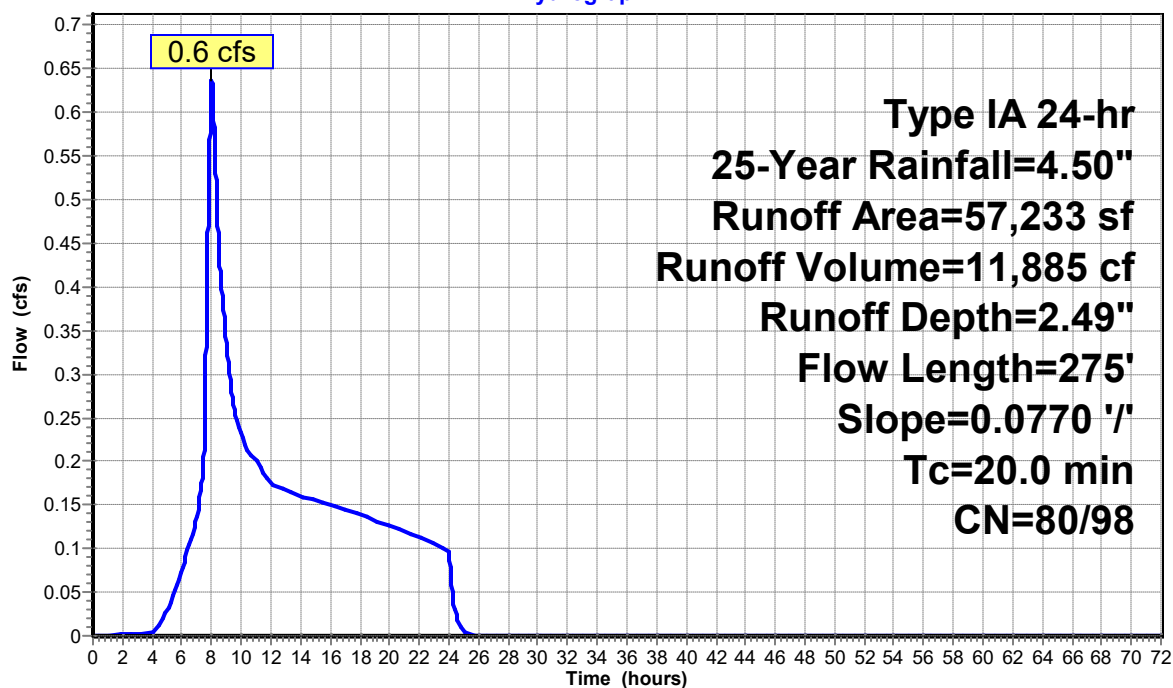
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
	56,269	80	>75% Grass cover, Good, HSG D
*	964	98	Impervious Area
	57,233	80	Weighted Average
	56,269	80	98.32% Pervious Area
	964	98	1.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0	275	0.0770	0.23		Sheet Flow, Grass: Dense n= 0.240 P2= 2.80"

Subcatchment 2A: Subbasin 2A - Undetained

Hydrograph



Runoff

Bull Run Post Discharge Point 1

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment A: Post Basin A

Runoff = 6.6 cfs @ 7.91 hrs, Volume= 97,943 cf, Depth= 3.36"
Routed to Pond Pond A : Pond A

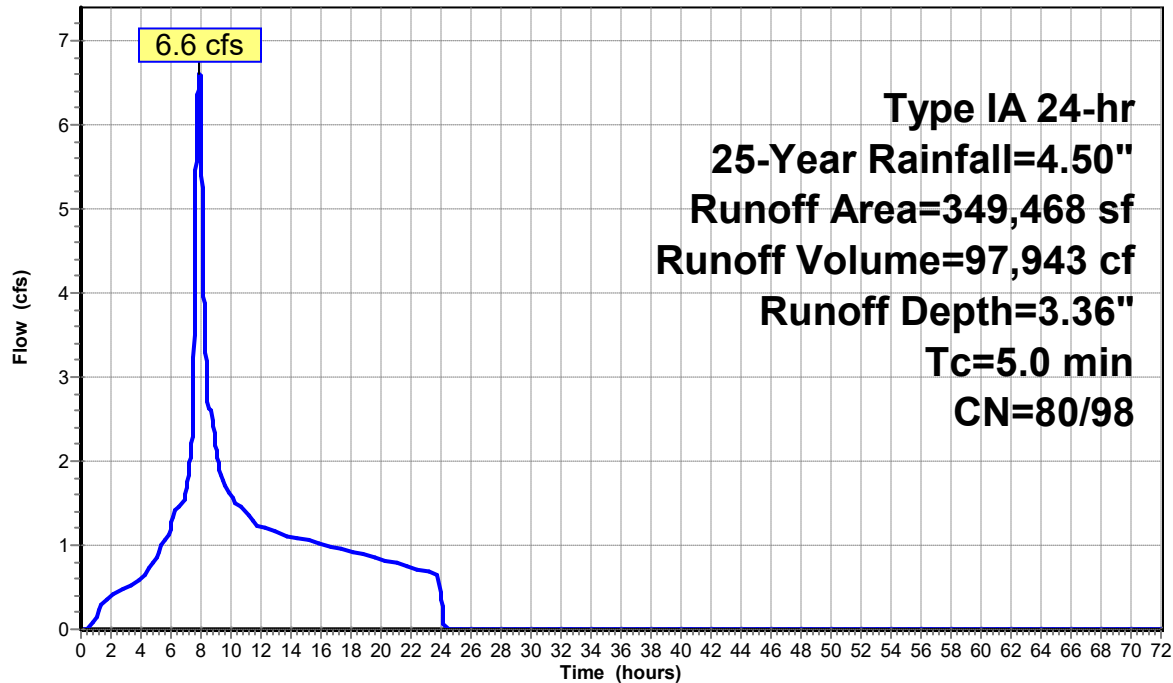
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	174,806	98	Impervious Area
	174,662	80	>75% Grass cover, Good, HSG D
	349,468	89	Weighted Average
	174,662	80	49.98% Pervious Area
	174,806	98	50.02% Impervious Area

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

Subcatchment A: Post Basin A

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment C: Post Basin C

Runoff = 11.3 cfs @ 7.94 hrs, Volume= 169,263 cf, Depth= 2.66"
Routed to Pond Pond C : Pond C

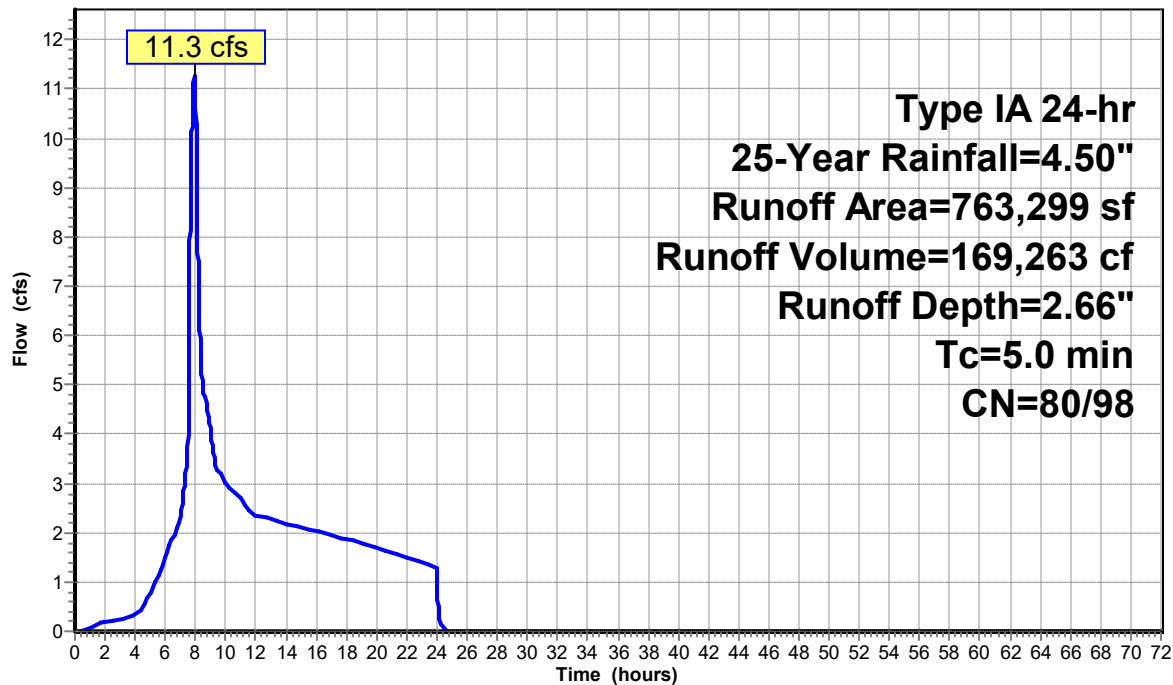
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	84,476	98	Impervious Area
	678,823	80	>75% Grass cover, Good, HSG D
	763,299	82	Weighted Average
	678,823	80	88.93% Pervious Area
	84,476	98	11.07% Impervious Area

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

Subcatchment C: Post Basin C

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment D: Post Basin D

Runoff = 6.3 cfs @ 7.92 hrs, Volume= 93,596 cf, Depth= 3.06"
Routed to Pond Pond D : Pond D

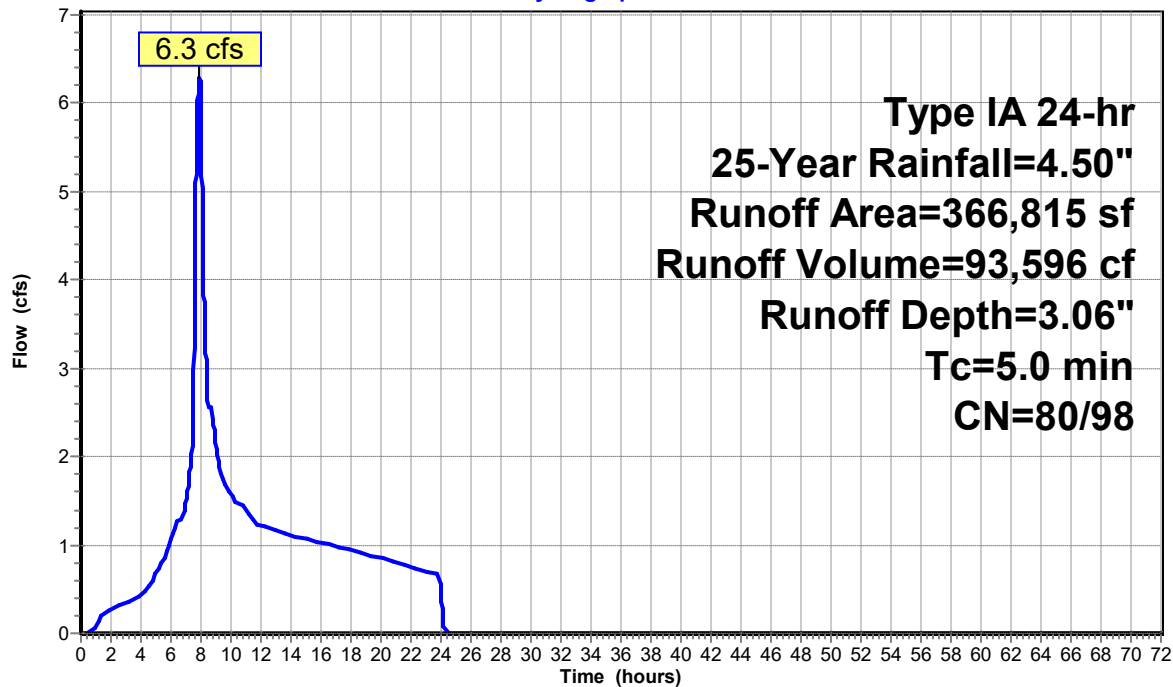
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment G: Basin G - EcoRoof

Runoff = 0.3 cfs @ 8.00 hrs, Volume= 8,434 cf, Depth= 1.08"
Routed to Link POD #1 : POD#1

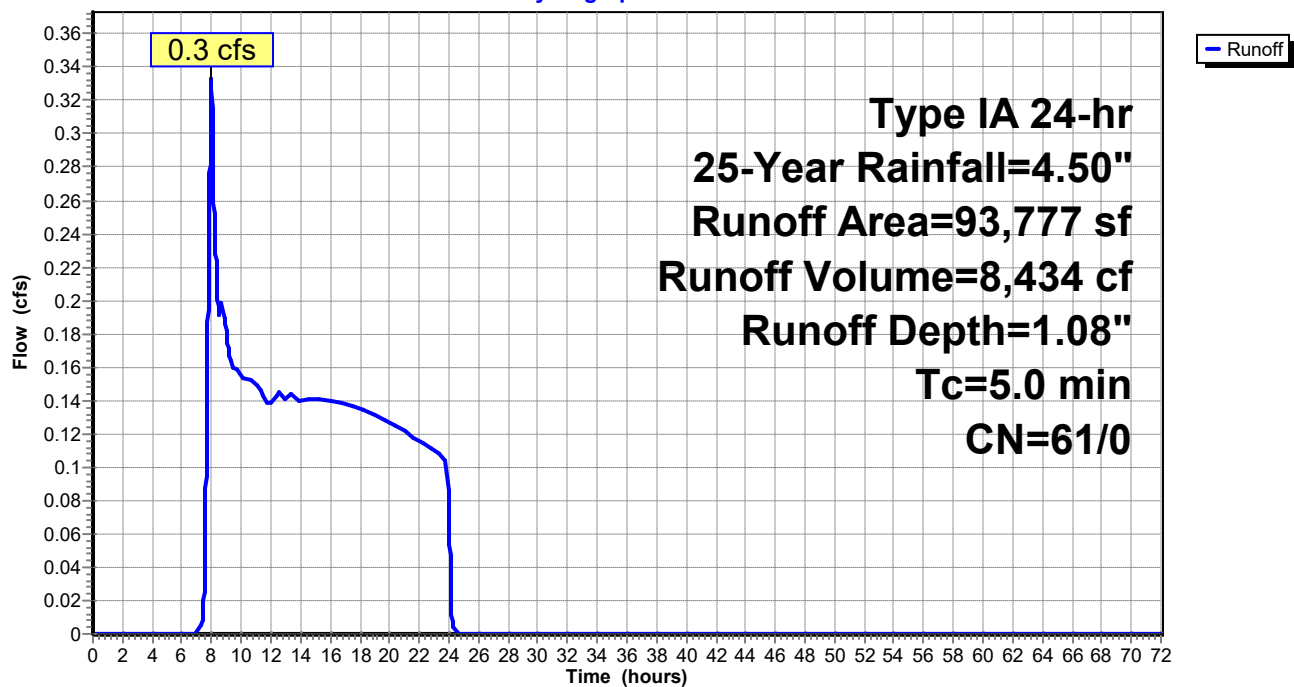
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	93,777	61	Ecoroof
	93,777	61	100.00% Pervious Area

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

Subcatchment G: Basin G - EcoRoof

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Pond Pond A: Pond A

Inflow Area = 349,468 sf, 50.02% Impervious, Inflow Depth = 3.36" for 25-Year event
 Inflow = 6.6 cfs @ 7.91 hrs, Volume= 97,943 cf
 Outflow = 2.2 cfs @ 9.01 hrs, Volume= 97,943 cf, Atten= 67%, Lag= 66.1 min
 Primary = 2.2 cfs @ 9.01 hrs, Volume= 97,943 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 710.17' @ 9.01 hrs Surf.Area= 11,609 sf Storage= 23,349 cf

Plug-Flow detention time= 259.7 min calculated for 97,943 cf (100% of inflow)
 Center-of-Mass det. time= 259.7 min (963.8 - 704.2)

Volume	Invert	Avail.Storage	Storage Description
#1	707.50'	38,422 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
707.50	6,093	0	0
708.00	7,022	3,279	3,279
709.00	9,017	8,020	11,298
710.00	11,205	10,111	21,409
711.00	13,583	12,394	33,803
711.33	14,412	4,619	38,422

Device	Routing	Invert	Outlet Devices
#1	Primary	698.43'	18.0" Round Culvert L= 138.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 698.43' / 696.24' S= 0.0159 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	696.43'	2.4" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	709.54'	13.0" W x 6.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	710.17'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.2 cfs @ 9.01 hrs HW=710.17' (Free Discharge)

- 1=Culvert (Passes 2.2 cfs of 24.9 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.5 cfs @ 17.05 fps)
- 3=Orifice/Grate (Orifice Controls 1.6 cfs @ 3.01 fps)
- 4=Overflow (Weir Controls 0.0 cfs @ 0.02 fps)

Bull Run Post Discharge Point 1

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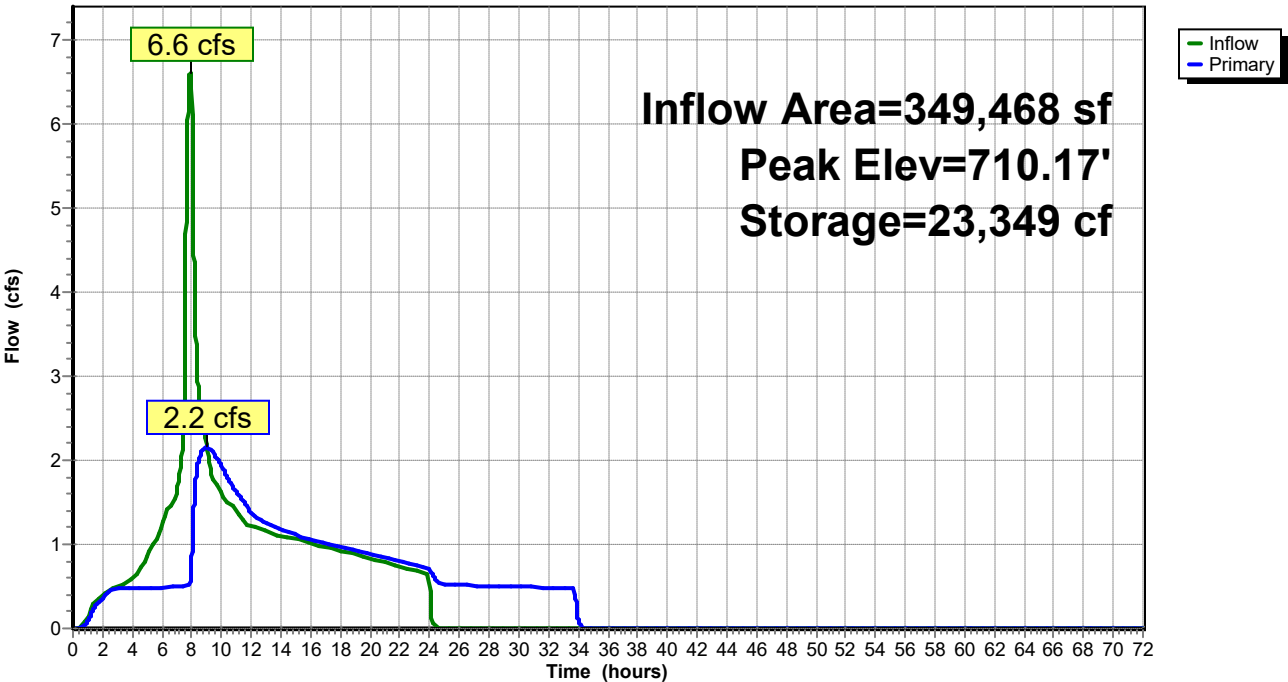
Type IA 24-hr 25-Year Rainfall=4.50"

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Pond Pond A: Pond A

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Pond Pond C: Pond C

Inflow Area = 763,299 sf, 11.07% Impervious, Inflow Depth = 2.66" for 25-Year event
 Inflow = 11.3 cfs @ 7.94 hrs, Volume= 169,263 cf
 Outflow = 2.4 cfs @ 11.68 hrs, Volume= 169,263 cf, Atten= 79%, Lag= 224.4 min
 Primary = 2.4 cfs @ 11.68 hrs, Volume= 169,263 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 706.27' @ 11.68 hrs Surf.Area= 22,885 sf Storage= 47,376 cf

Plug-Flow detention time= 320.4 min calculated for 169,263 cf (100% of inflow)
 Center-of-Mass det. time= 320.4 min (1,083.6 - 763.2)

Volume	Invert	Avail.Storage	Storage Description
#1	704.00'	102,369 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
704.00	18,273	0	0
704.50	19,886	9,540	9,540
705.50	21,555	20,721	30,260
706.50	23,281	22,418	52,678
707.50	25,063	24,172	76,850
708.50	25,975	25,519	102,369

Device	Routing	Invert	Outlet Devices
#1	Primary	700.29'	15.0" Round Culvert L= 178.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 700.29' / 699.40' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	698.29'	3.7" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	705.34'	10.0" W x 5.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	706.27'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.4 cfs @ 11.68 hrs HW=706.27' (Free Discharge)

- 1=Culvert (Passes 2.4 cfs of 9.8 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.9 cfs @ 12.17 fps)
- 3=Orifice/Grate (Orifice Controls 1.5 cfs @ 4.21 fps)
- 4=Overflow (Weir Controls 0.0 cfs @ 0.06 fps)

Bull Run Post Discharge Point 1

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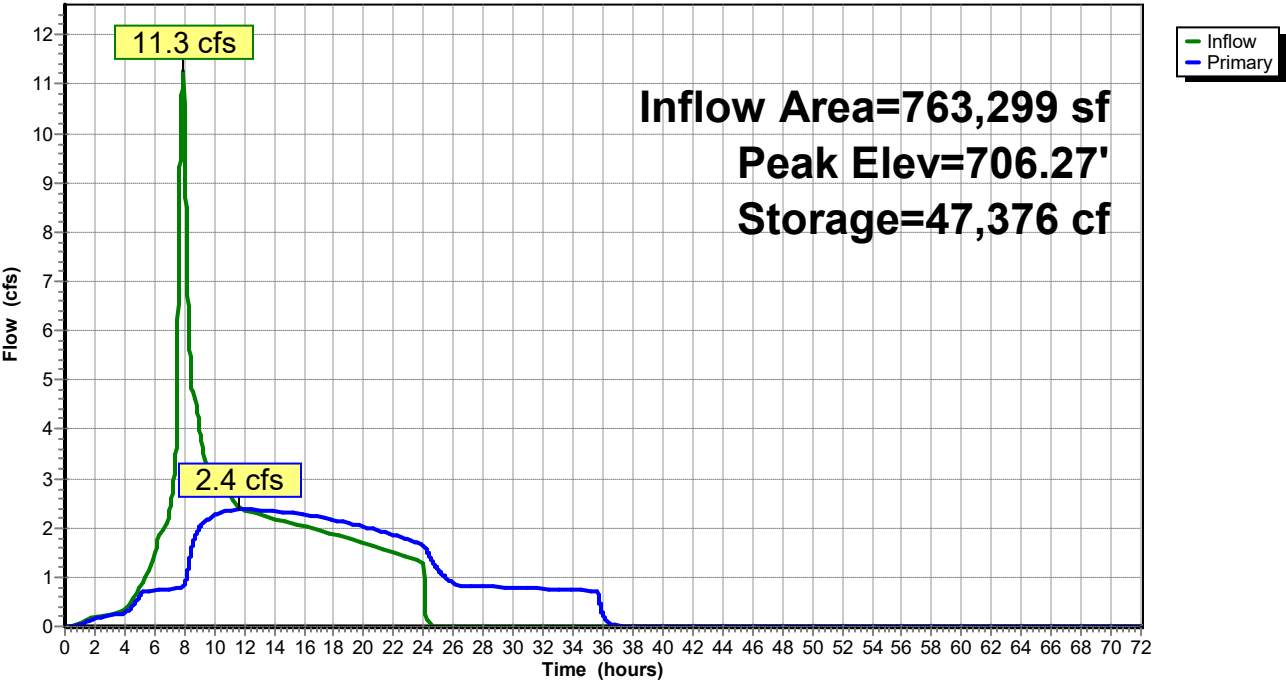
Type IA 24-hr 25-Year Rainfall=4.50"

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Pond Pond C: Pond C

Hydrograph



Bull Run Post Discharge Point 1

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Pond Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 8.66" for 25-Year event
 Inflow = 6.9 cfs @ 7.92 hrs, Volume= 264,692 cf, Incl. 0.7 cfs Base Flow
 Outflow = 2.6 cfs @ 9.13 hrs, Volume= 264,461 cf, Atten= 62%, Lag= 72.7 min
 Primary = 2.6 cfs @ 9.13 hrs, Volume= 264,461 cf
 Routed to Link POD #1 : POD#1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 696.43' @ 9.13 hrs Surf.Area= 8,729 sf Storage= 23,581 cf

Plug-Flow detention time= 89.7 min calculated for 264,457 cf (100% of inflow)
 Center-of-Mass det. time= 87.3 min (1,740.3 - 1,653.0)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.6 cfs @ 9.13 hrs HW=696.43' (Free Discharge)

- 1=Culvert (Passes 2.6 cfs of 9.4 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 1.5 cfs @ 10.72 fps)
- 3=Orifice/Grate (Orifice Controls 1.1 cfs @ 5.10 fps)
- 4=Overflow (Weir Controls 0.1 cfs @ 0.62 fps)

Bull Run Post Discharge Point 1

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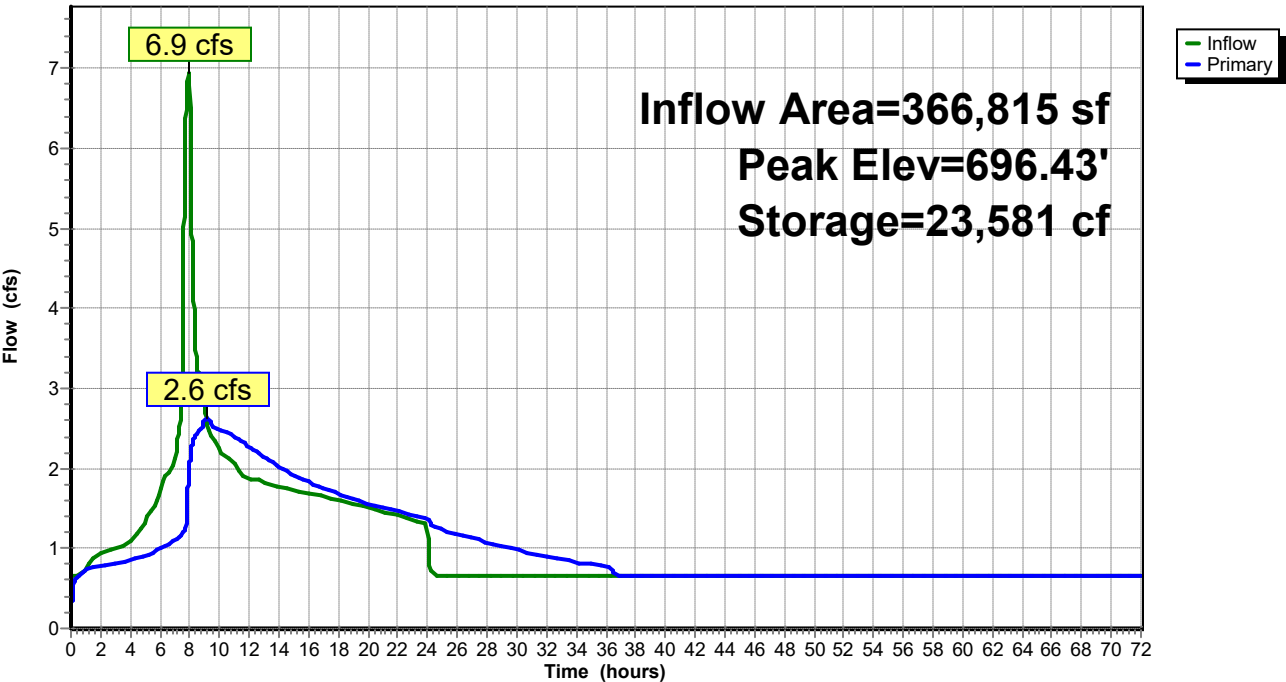
Type IA 24-hr 25-Year Rainfall=4.50"

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Pond Pond D: Pond D

Hydrograph



Bull Run Post Discharge Point 1

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Type IA 24-hr 25-Year Rainfall=4.50"

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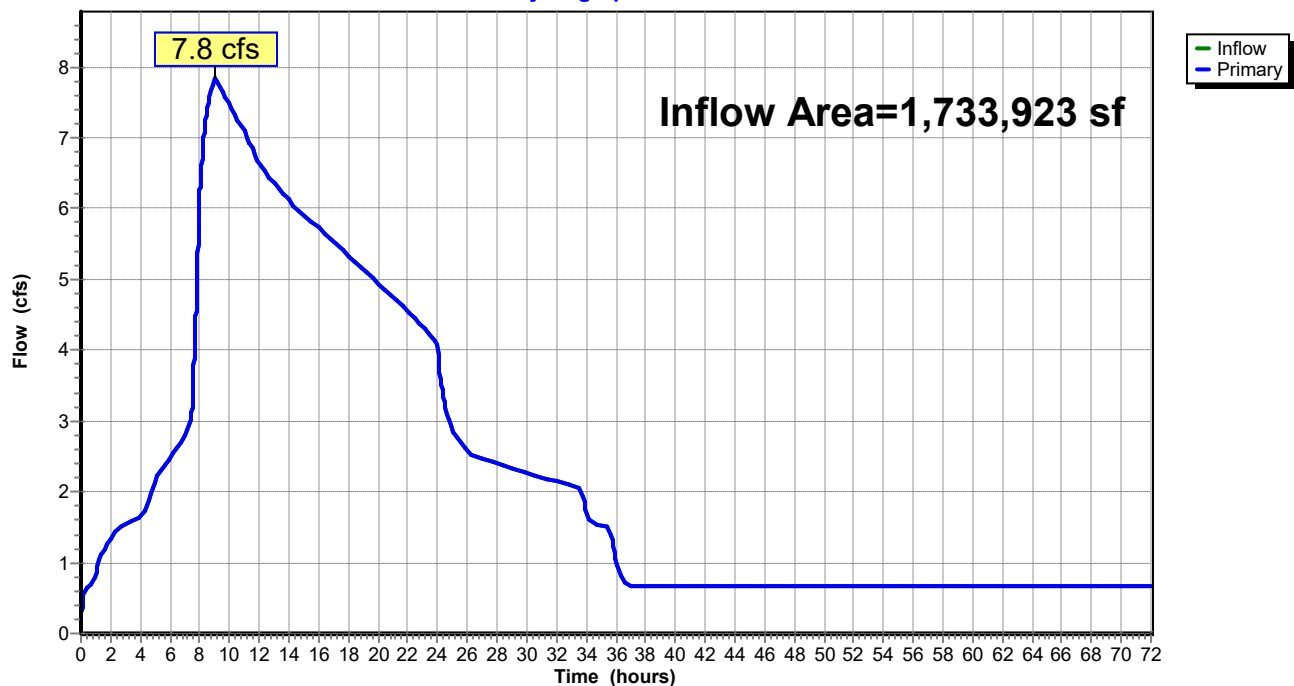
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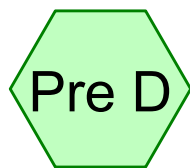
Inflow Area = 1,733,923 sf, 22.65% Impervious, Inflow Depth > 3.98" for 25-Year event
Inflow = 7.8 cfs @ 9.05 hrs, Volume= 574,722 cf
Primary = 7.8 cfs @ 9.05 hrs, Volume= 574,722 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

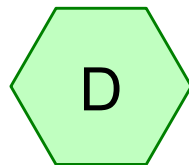
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Hydrograph

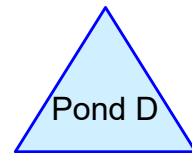




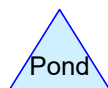
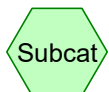
Pre Dev Basin D



Post Basin D



Pond D



Routing Diagram for Bull Run Filtration Detention Ponds Current

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Bull Run Filtration Detention Ponds Current

Prepared by Emerio Design

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Type IA 24-hr 2-Year Rainfall=2.80"

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Page 2

Summary for Subcatchment D: Post Basin D

Runoff = 3.1 cfs @ 7.94 hrs, Volume= 48,625 cf, Depth= 1.59"
Routed to Pond Pond D : Pond D

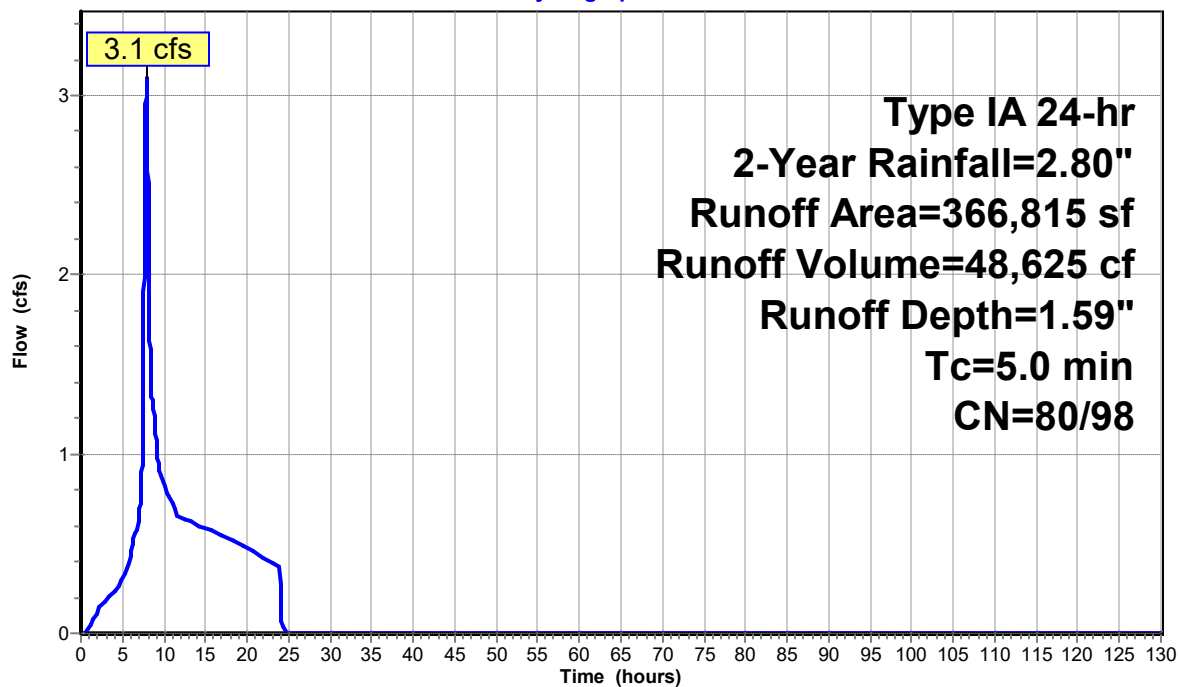
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Year Rainfall=2.80"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Subcatchment Pre D: Pre Dev Basin D

Runoff = 1.8 cfs @ 8.01 hrs, Volume= 37,399 cf, Depth= 1.22"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

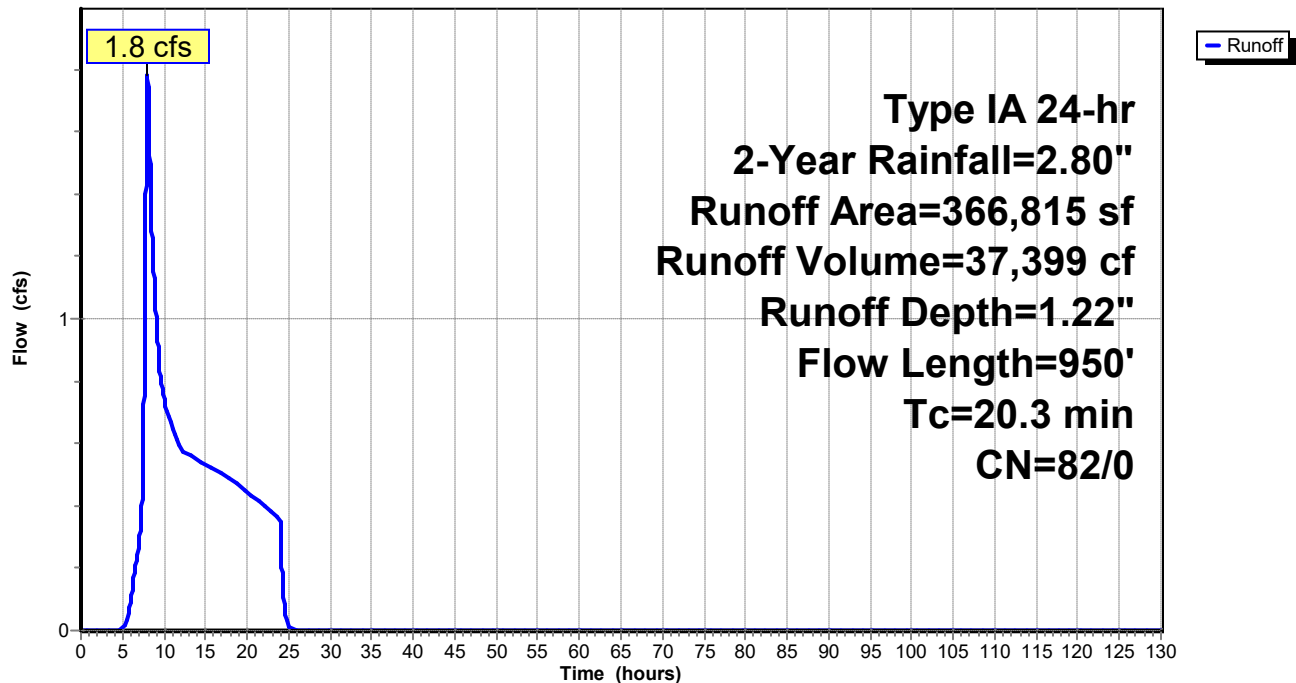
Type IA 24-hr 2-Year Rainfall=2.80"

Area (sf)	CN	Description
366,815	82	Row crops, SR + CR, Good, HSG C
366,815	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	100	0.0200	0.14		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 2.80"
8.7	850	0.0330	1.63		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
20.3	950	Total			

Subcatchment Pre D: Pre Dev Basin D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 2-Year Rainfall=2.80"

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Summary for Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 11.70" for 2-Year event
 Inflow = 3.8 cfs @ 7.94 hrs, Volume= 357,529 cf, Incl. 0.7 cfs Base Flow
 Outflow = 1.3 cfs @ 13.42 hrs, Volume= 357,298 cf, Atten= 66%, Lag= 329.0 min
 Primary = 1.3 cfs @ 13.42 hrs, Volume= 357,298 cf

Routing by Stor-Ind method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 695.27' @ 13.42 hrs Surf.Area= 7,447 sf Storage= 14,244 cf

Plug-Flow detention time= 48.8 min calculated for 357,294 cf (100% of inflow)
 Center-of-Mass det. time= 45.9 min (3,517.0 - 3,471.1)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.3 cfs @ 13.42 hrs HW=695.27' (Free Discharge)

1=Culvert (Passes 1.3 cfs of 7.9 cfs potential flow)
 2=Orifice/Grate (Orifice Controls 1.3 cfs @ 9.30 fps)
 3=Orifice/Grate (Orifice Controls 0.0 cfs @ 0.48 fps)
 4=Overflow (Controls 0.0 cfs)

Bull Run Filtration Detention Ponds Current

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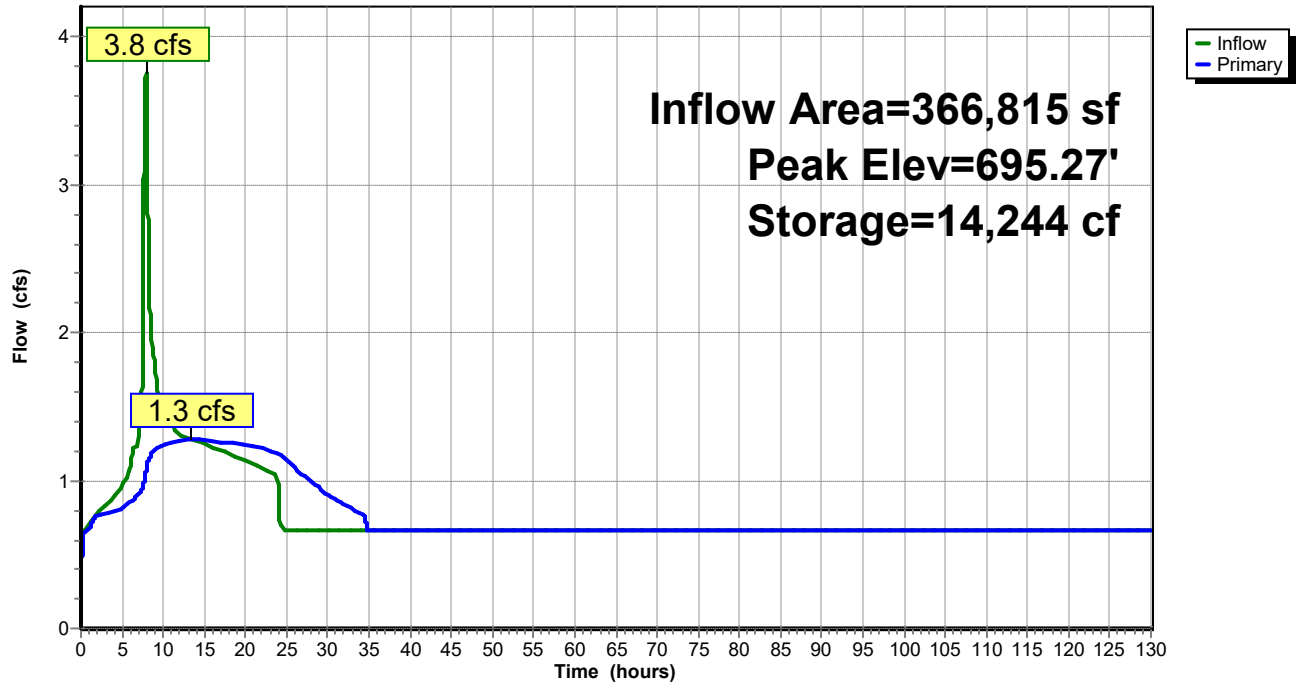
Type IA 24-hr 2-Year Rainfall=2.80"

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Pond Pond D: Pond D

Hydrograph



Bull Run Filtration Detention Ponds Current

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Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment D: Post Basin D

Runoff = 4.2 cfs @ 7.93 hrs, Volume= 63,993 cf, Depth= 2.09"
Routed to Pond Pond D : Pond D

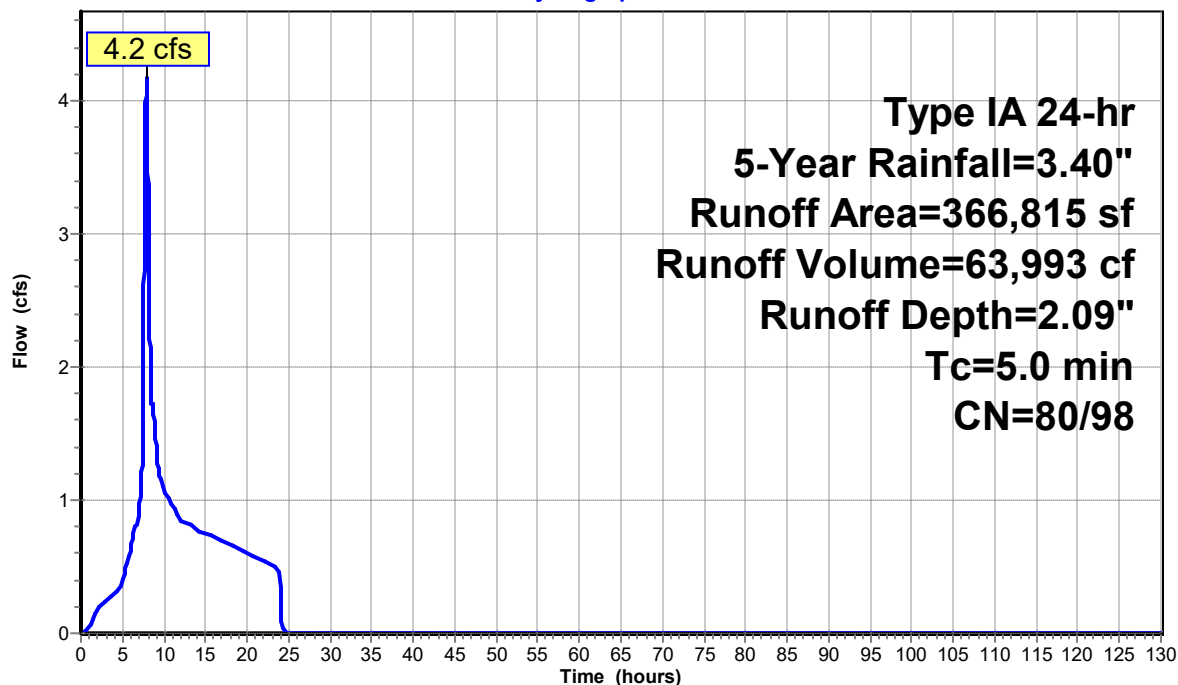
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 5-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Subcatchment Pre D: Pre Dev Basin D

Runoff = 2.7 cfs @ 8.01 hrs, Volume= 51,977 cf, Depth= 1.70"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

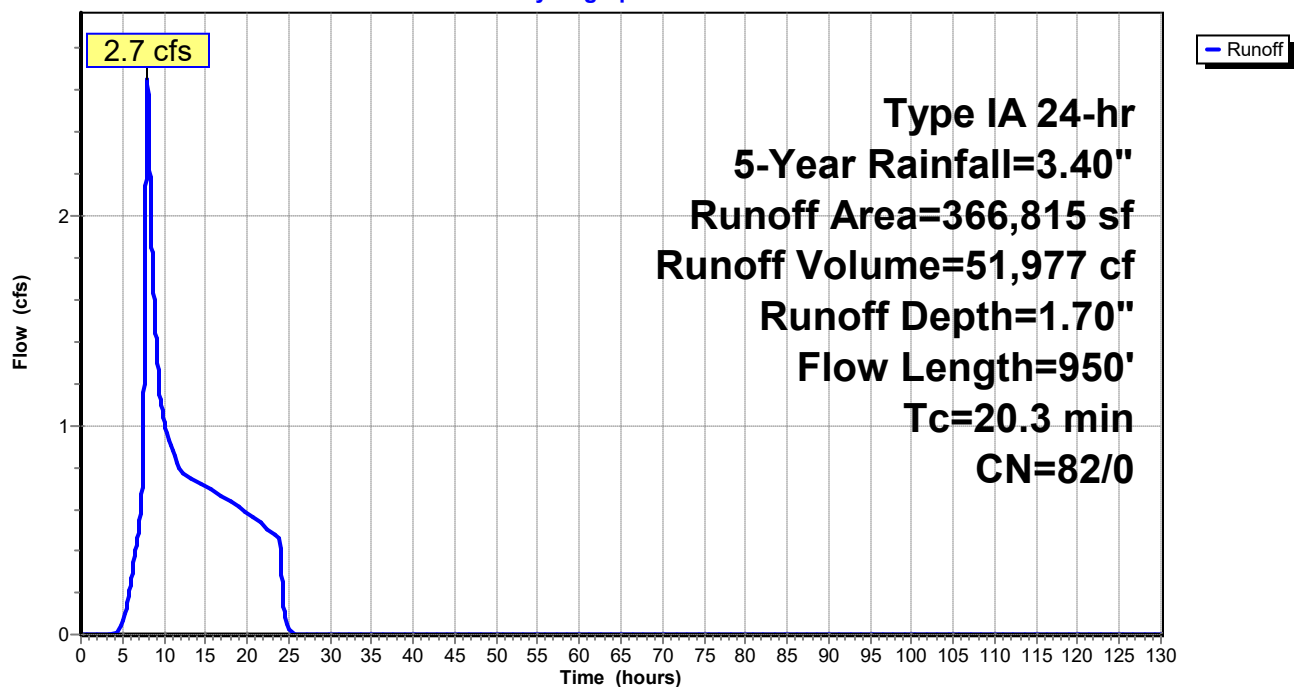
Type IA 24-hr 5-Year Rainfall=3.40"

Area (sf)	CN	Description
366,815	82	Row crops, SR + CR, Good, HSG C
366,815	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	100	0.0200	0.14		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 2.80"
8.7	850	0.0330	1.63		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
20.3	950	Total			

Subcatchment Pre D: Pre Dev Basin D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 5-Year Rainfall=3.40"

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Summary for Pond Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 12.20" for 5-Year event
 Inflow = 4.8 cfs @ 7.93 hrs, Volume= 372,896 cf, Incl. 0.7 cfs Base Flow
 Outflow = 1.8 cfs @ 9.81 hrs, Volume= 372,665 cf, Atten= 63%, Lag= 112.5 min
 Primary = 1.8 cfs @ 9.81 hrs, Volume= 372,665 cf

Routing by Stor-Ind method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 695.59' @ 9.81 hrs Surf.Area= 7,794 sf Storage= 16,672 cf

Plug-Flow detention time= 54.8 min calculated for 372,661 cf (100% of inflow)

Center-of-Mass det. time= 52.0 min (3,409.4 - 3,357.4)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

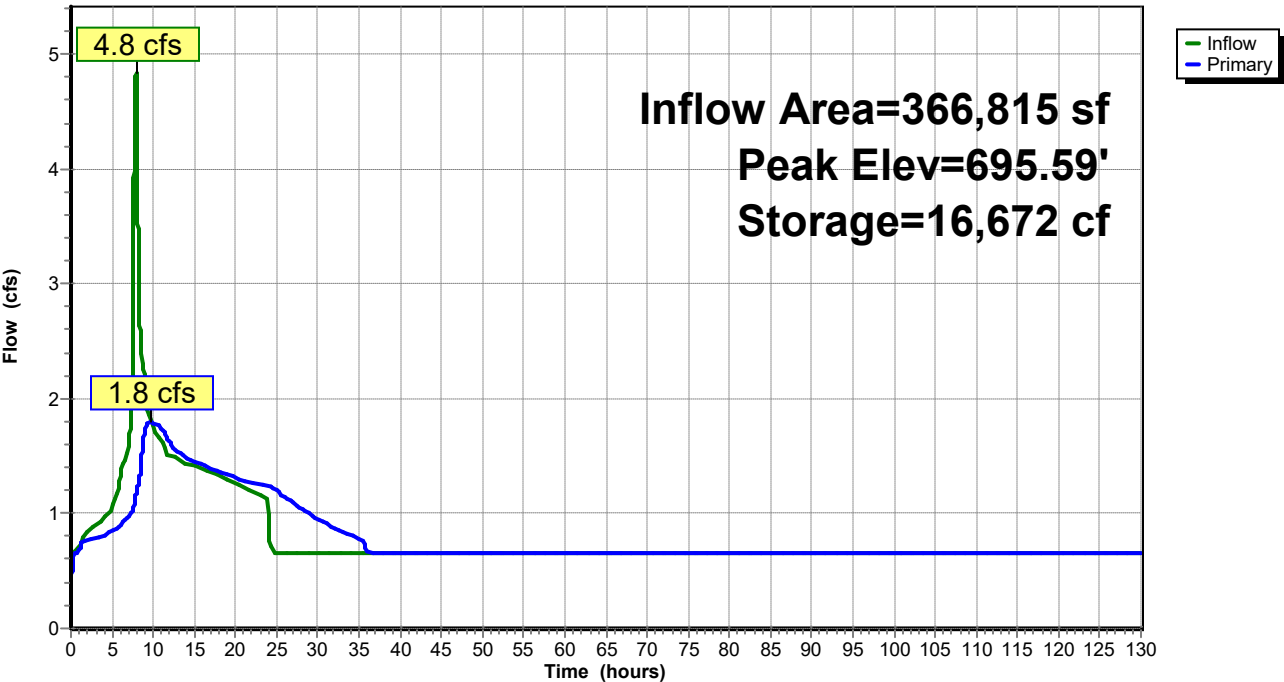
Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=1.8 cfs @ 9.81 hrs HW=695.59' (Free Discharge)

1=Culvert (Passes 1.8 cfs of 8.3 cfs potential flow)
 2=Orifice/Grate (Orifice Controls 1.3 cfs @ 9.71 fps)
 3=Orifice/Grate (Orifice Controls 0.5 cfs @ 2.27 fps)
 4=Overflow (Controls 0.0 cfs)

Pond Pond D: Pond D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment D: Post Basin D

Runoff = 4.9 cfs @ 7.93 hrs, Volume= 74,580 cf, Depth= 2.44"
Routed to Pond Pond D : Pond D

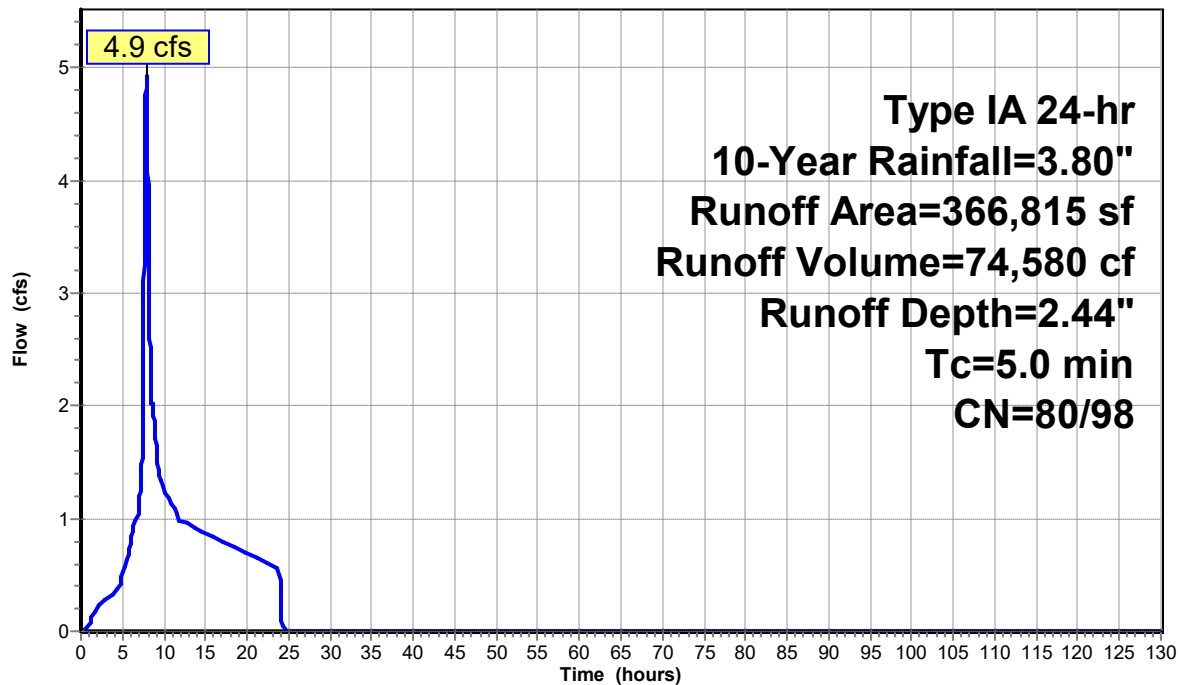
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Runoff

Bull Run Filtration Detention Ponds Current

Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Subcatchment Pre D: Pre Dev Basin D

Runoff = 3.3 cfs @ 8.01 hrs, Volume= 62,148 cf, Depth= 2.03"

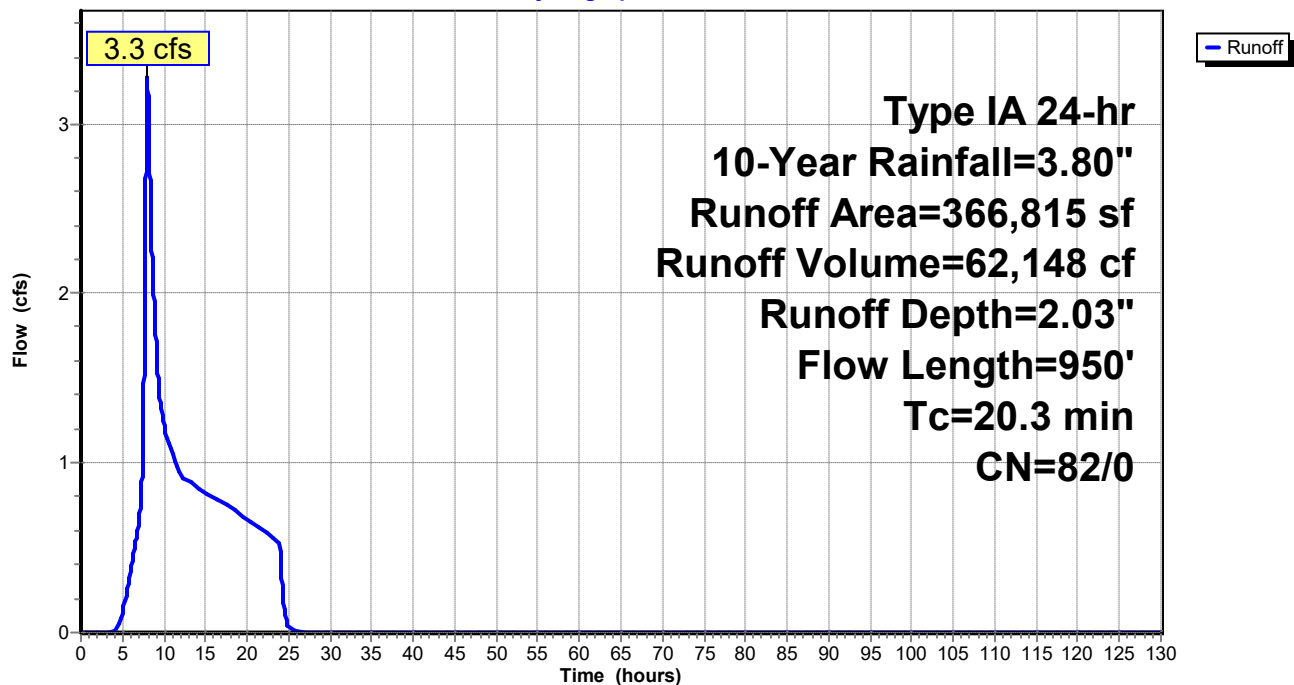
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 10-Year Rainfall=3.80"

Area (sf)	CN	Description
366,815	82	Row crops, SR + CR, Good, HSG C
366,815	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	100	0.0200	0.14		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 2.80"
8.7	850	0.0330	1.63		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
20.3	950	Total			

Subcatchment Pre D: Pre Dev Basin D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 10-Year Rainfall=3.80"

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Summary for Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 12.55" for 10-Year event
 Inflow = 5.6 cfs @ 7.93 hrs, Volume= 383,484 cf, Incl. 0.7 cfs Base Flow
 Outflow = 2.1 cfs @ 9.33 hrs, Volume= 383,253 cf, Atten= 63%, Lag= 84.2 min
 Primary = 2.1 cfs @ 9.33 hrs, Volume= 383,253 cf

Routing by Stor-Ind method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 695.86' @ 9.33 hrs Surf.Area= 8,088 sf Storage= 18,819 cf

Plug-Flow detention time= 57.0 min calculated for 383,249 cf (100% of inflow)
 Center-of-Mass det. time= 54.2 min (3,338.4 - 3,284.2)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

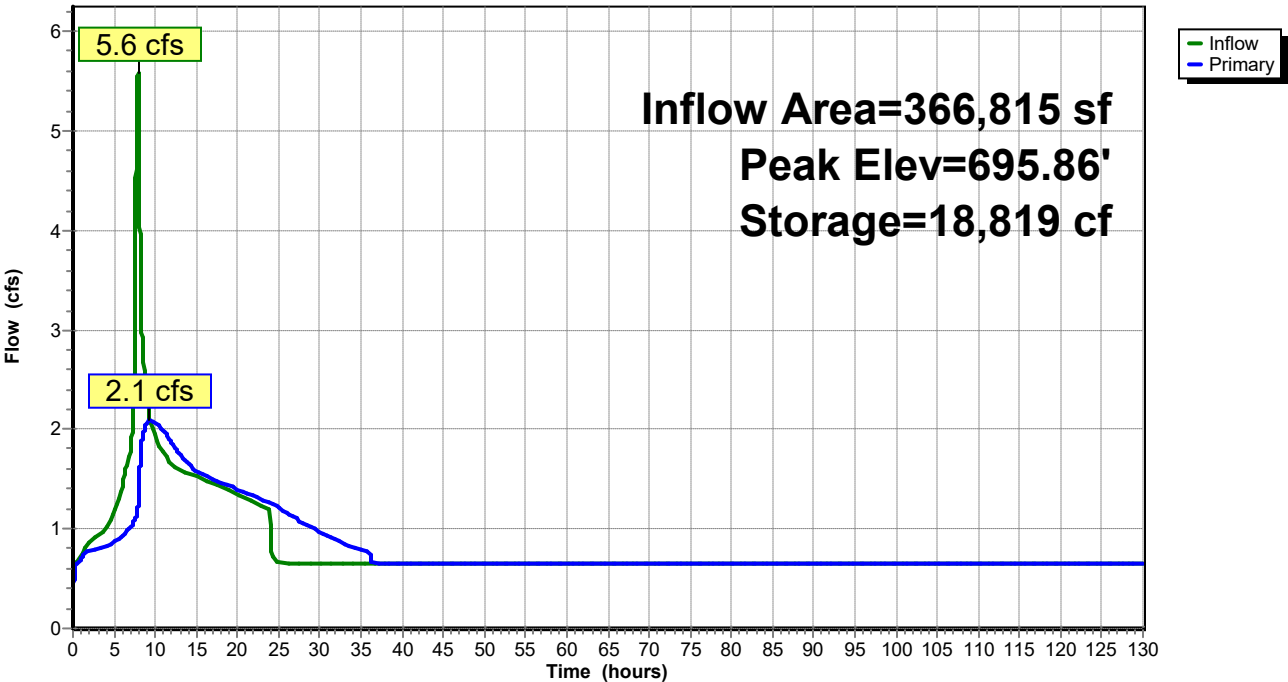
Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.1 cfs @ 9.33 hrs HW=695.86' (Free Discharge)

- 1=Culvert (Passes 2.1 cfs of 8.7 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 1.4 cfs @ 10.05 fps)
- 3=Orifice/Grate (Orifice Controls 0.7 cfs @ 3.45 fps)
- 4=Overflow (Controls 0.0 cfs)

Pond Pond D: Pond D

Hydrograph



Bull Run Filtration Detention Ponds Current

Prepared by Emerio Design

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment D: Post Basin D

Runoff = 6.3 cfs @ 7.92 hrs, Volume= 93,596 cf, Depth= 3.06"
Routed to Pond Pond D : Pond D

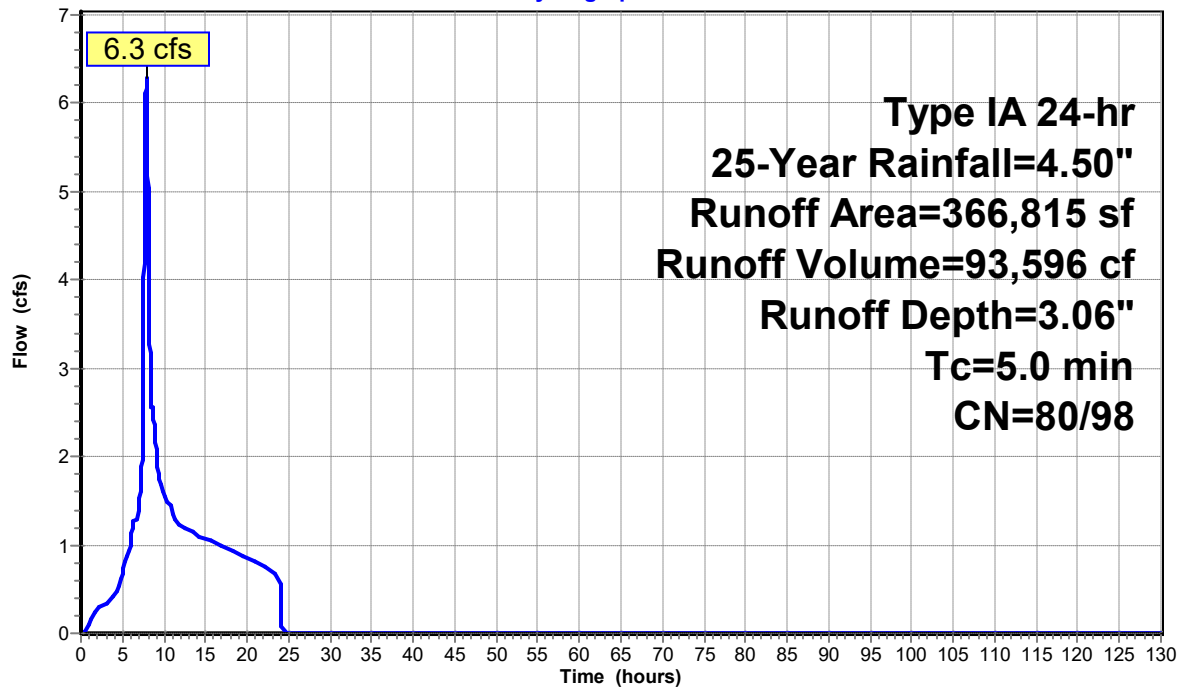
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	122,177	98	Impervious Area
	244,638	80	>75% Grass cover, Good, HSG D
	366,815	86	Weighted Average
	244,638	80	66.69% Pervious Area
	122,177	98	33.31% Impervious Area

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

Subcatchment D: Post Basin D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment Pre D: Pre Dev Basin D

Runoff = 4.4 cfs @ 8.01 hrs, Volume= 80,579 cf, Depth= 2.64"

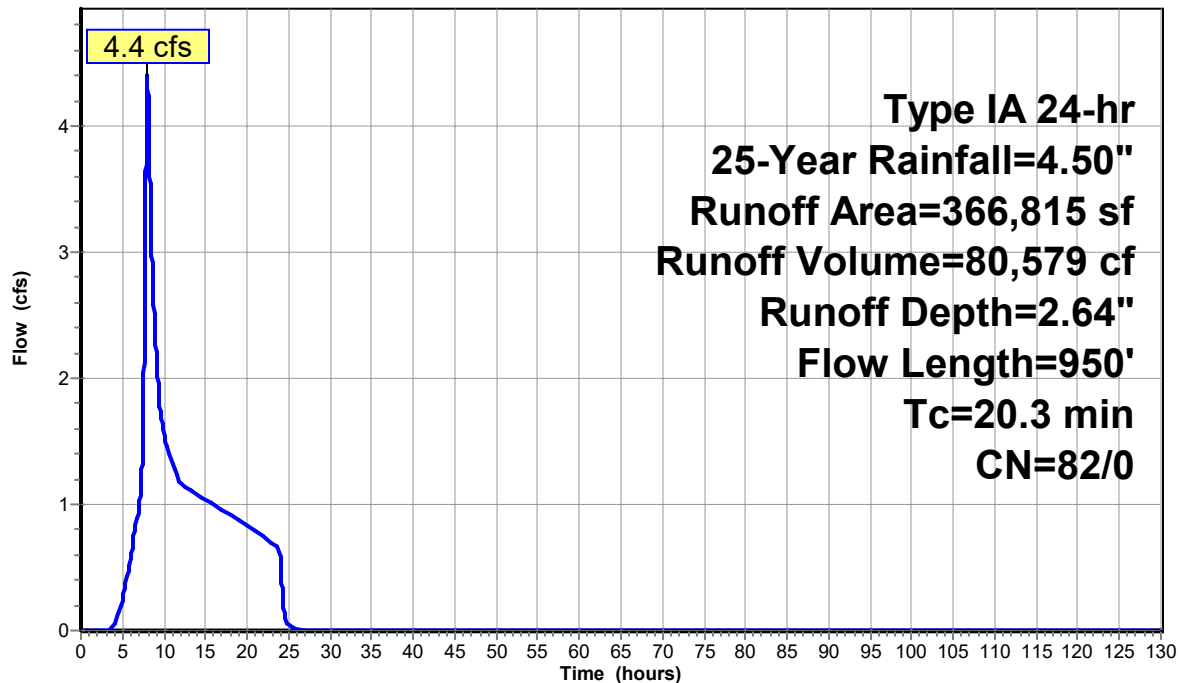
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

Area (sf)	CN	Description
366,815	82	Row crops, SR + CR, Good, HSG C
366,815	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	100	0.0200	0.14		Sheet Flow, Cultivated: Residue>20% n= 0.170 P2= 2.80"
8.7	850	0.0330	1.63		Shallow Concentrated Flow, Cultivated Straight Rows Kv= 9.0 fps
20.3	950	Total			

Subcatchment Pre D: Pre Dev Basin D

Hydrograph



Bull Run Filtration Detention Ponds Current

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Pond D: Pond D

Inflow Area = 366,815 sf, 33.31% Impervious, Inflow Depth > 13.17" for 25-Year event
 Inflow = 6.9 cfs @ 7.92 hrs, Volume= 402,500 cf, Incl. 0.7 cfs Base Flow
 Outflow = 2.6 cfs @ 9.13 hrs, Volume= 402,269 cf, Atten= 62%, Lag= 72.7 min
 Primary = 2.6 cfs @ 9.13 hrs, Volume= 402,269 cf

Routing by Stor-Ind method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 696.43' @ 9.13 hrs Surf.Area= 8,729 sf Storage= 23,581 cf

Plug-Flow detention time= 61.0 min calculated for 402,265 cf (100% of inflow)

Center-of-Mass det. time= 58.3 min (3,220.2 - 3,162.0)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.6 cfs @ 9.13 hrs HW=696.43' (Free Discharge)

1=Culvert (Passes 2.6 cfs of 9.4 cfs potential flow)
 2=Orifice/Grate (Orifice Controls 1.5 cfs @ 10.72 fps)
 3=Orifice/Grate (Orifice Controls 1.1 cfs @ 5.10 fps)
 4=Overflow (Weir Controls 0.1 cfs @ 0.62 fps)

Bull Run Filtration Detention Ponds Current

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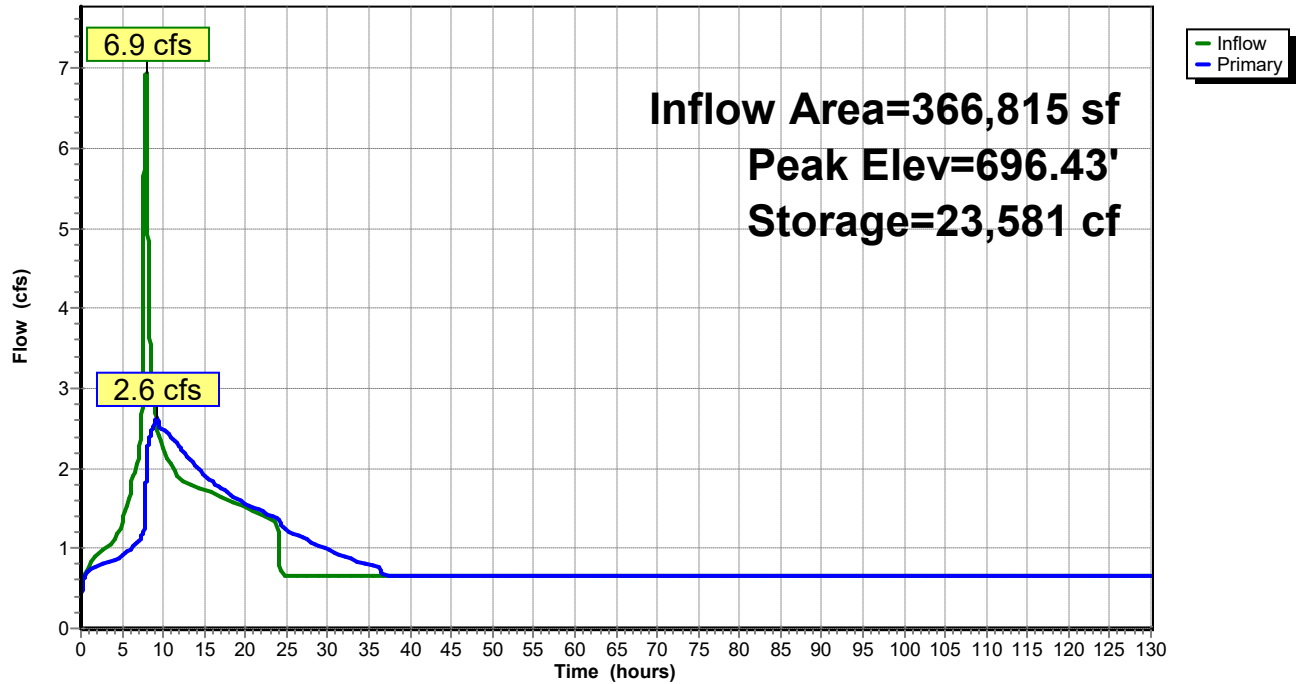
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Printed 7/1/2025

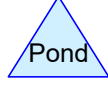
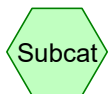
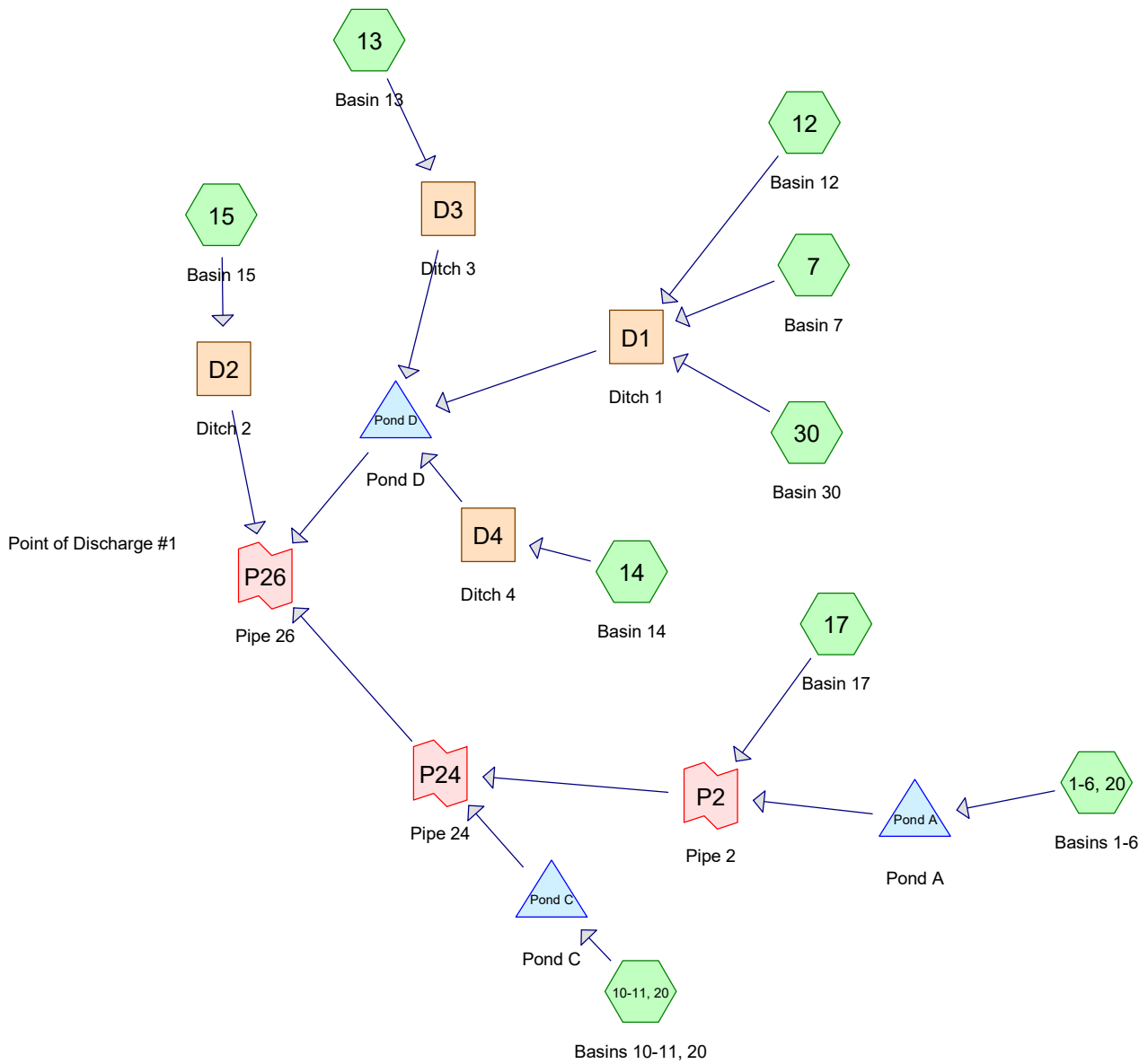
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Pond Pond D: Pond D

Hydrograph



Attachment D: Conveyance System Analysis



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 1-6, 20: Basins 1-6

Runoff = 6.5 cfs @ 7.91 hrs, Volume= 96,619 cf, Depth= 3.32"
Routed to Pond Pond A : Pond A

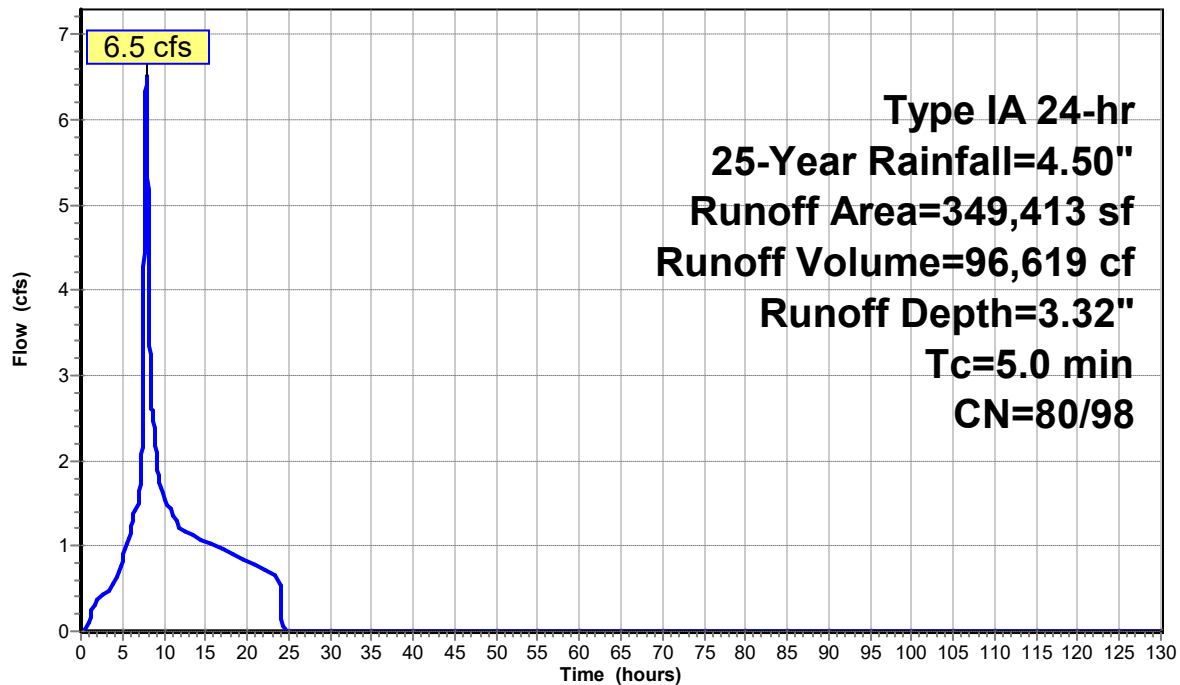
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	166,070	98	Impervious Area
	183,343	80	>75% Grass cover, Good, HSG D
	349,413	89	Weighted Average
	183,343	80	52.47% Pervious Area
	166,070	98	47.53% Impervious Area

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

Subcatchment 1-6, 20: Basins 1-6

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 7: Basin 7

Runoff = 0.8 cfs @ 7.88 hrs, Volume= 11,119 cf, Depth= 4.26"
Routed to Reach D1 : Ditch 1

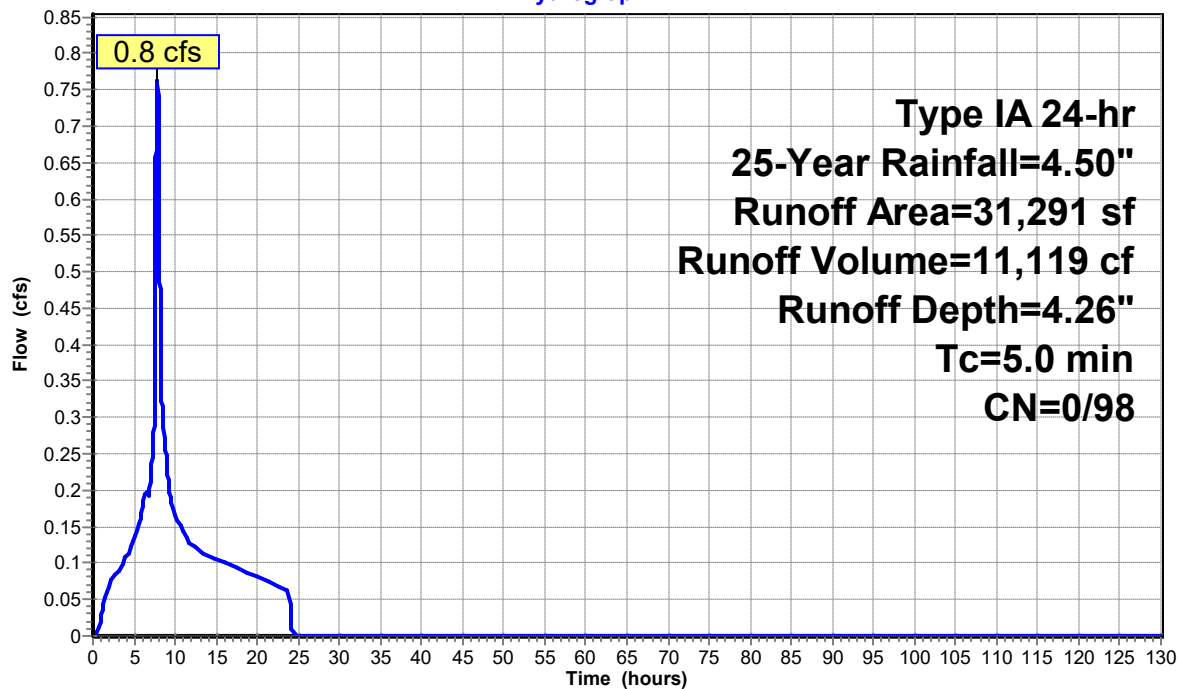
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	31,291	98	Impervious Area
	31,291	98	100.00% Impervious Area

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

Subcatchment 7: Basin 7

Hydrograph



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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 10-11, 20: Basins 10-11, 20

Runoff = 11.3 cfs @ 7.94 hrs, Volume= 169,420 cf, Depth= 2.66"
Routed to Pond Pond C : Pond C

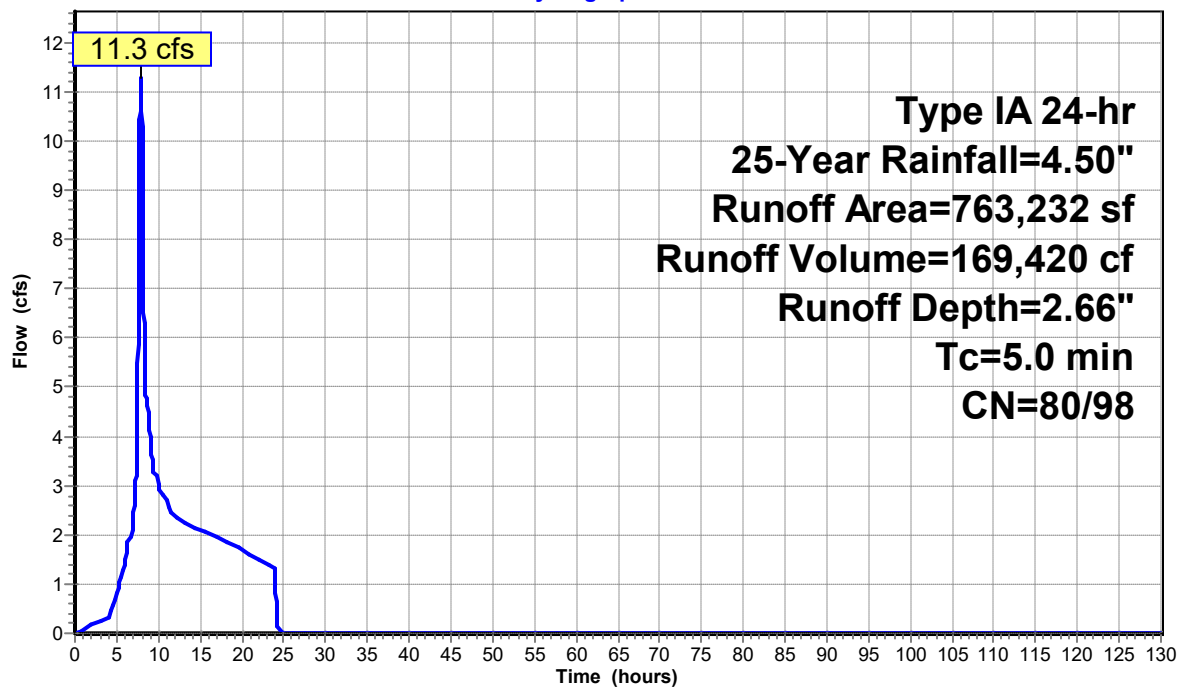
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	85,609	98	Impervious
*	677,623	80	Pervious
	763,232	82	Weighted Average
	677,623	80	88.78% Pervious Area
	85,609	98	11.22% Impervious Area

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

Subcatchment 10-11, 20: Basins 10-11, 20

Hydrograph



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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 12: Basin 12

Runoff = 1.1 cfs @ 7.92 hrs, Volume= 16,859 cf, Depth= 3.05"
Routed to Reach D1 : Ditch 1

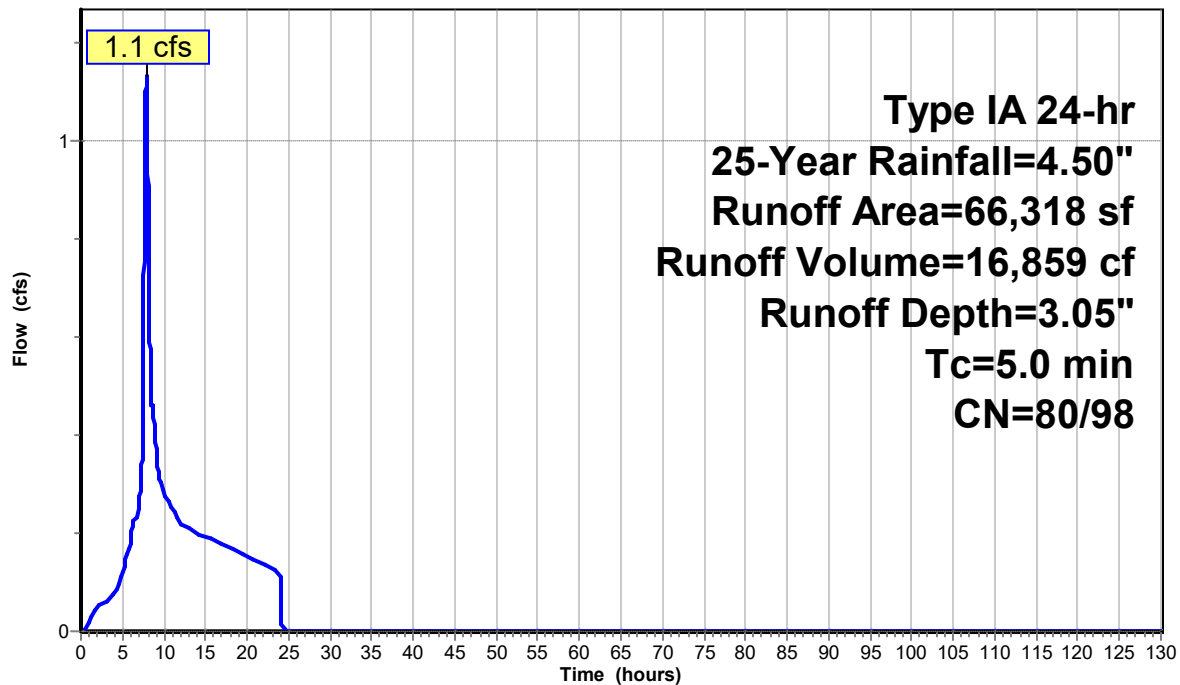
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	21,671	98	Impervious Area
*	44,647	80	Pervious
	66,318	86	Weighted Average
	44,647	80	67.32% Pervious Area
	21,671	98	32.68% Impervious Area

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

Subcatchment 12: Basin 12

Hydrograph



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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 13: Basin 13

Runoff = 2.4 cfs @ 7.93 hrs, Volume= 36,416 cf, Depth= 2.82"
Routed to Reach D3 : Ditch 3

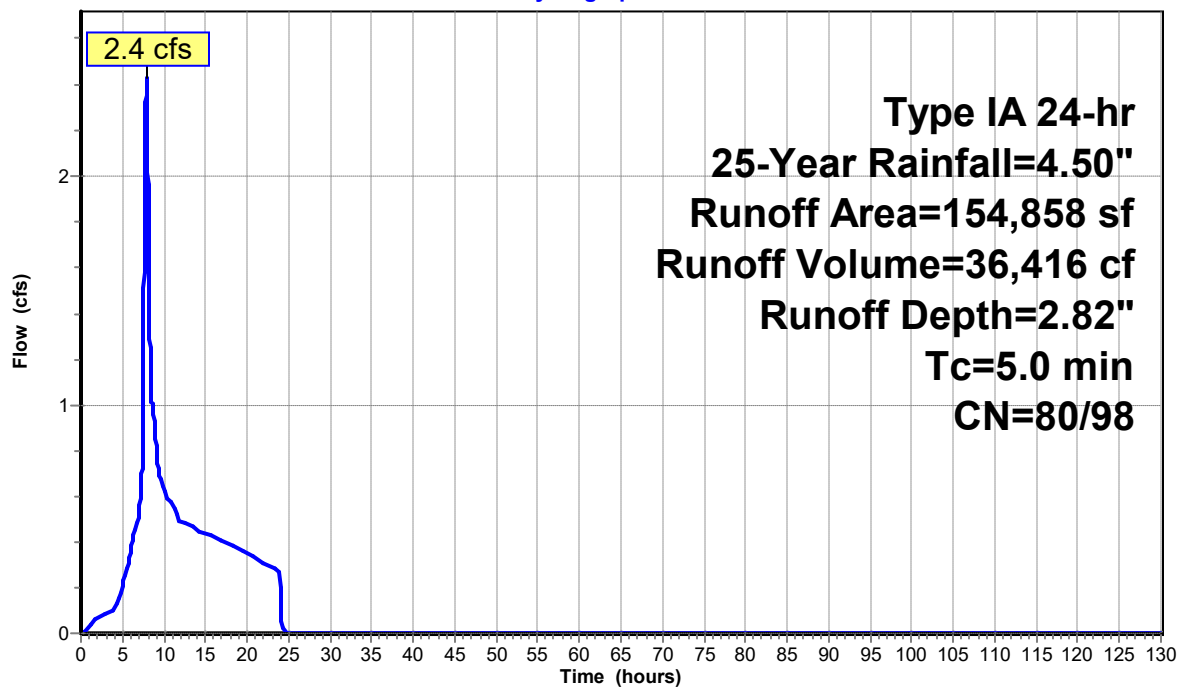
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	30,960	98	Impervious Area
*	123,898	80	Pervious
	154,858	84	Weighted Average
	123,898	80	80.01% Pervious Area
	30,960	98	19.99% Impervious Area

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

Subcatchment 13: Basin 13

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 14: Basin 14

Runoff = 1.5 cfs @ 7.92 hrs, Volume= 22,055 cf, Depth= 3.00"
Routed to Reach D4 : Ditch 4

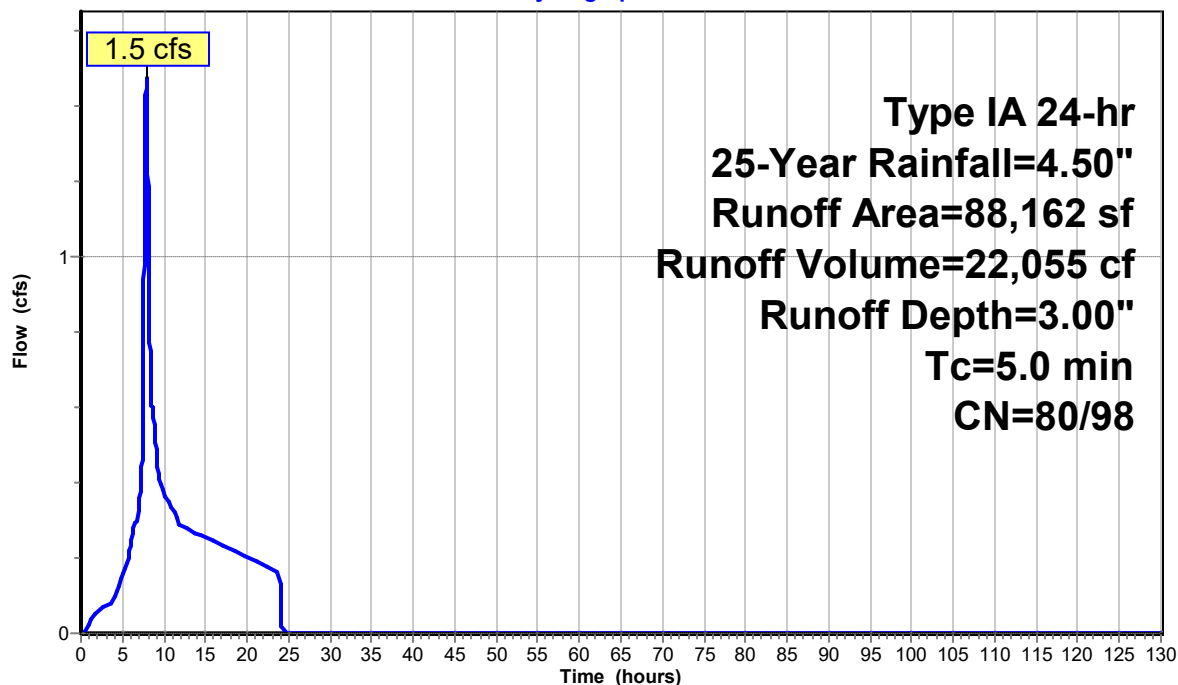
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	26,436	98	Impervious Area
*	61,726	80	Pervious Area
	88,162	85	Weighted Average
	61,726	80	70.01% Pervious Area
	26,436	98	29.99% Impervious Area

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

Subcatchment 14: Basin 14

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 15: Basin 15

Runoff = 1.5 cfs @ 7.95 hrs, Volume= 22,737 cf, Depth= 2.64"
Routed to Reach D2 : Ditch 2

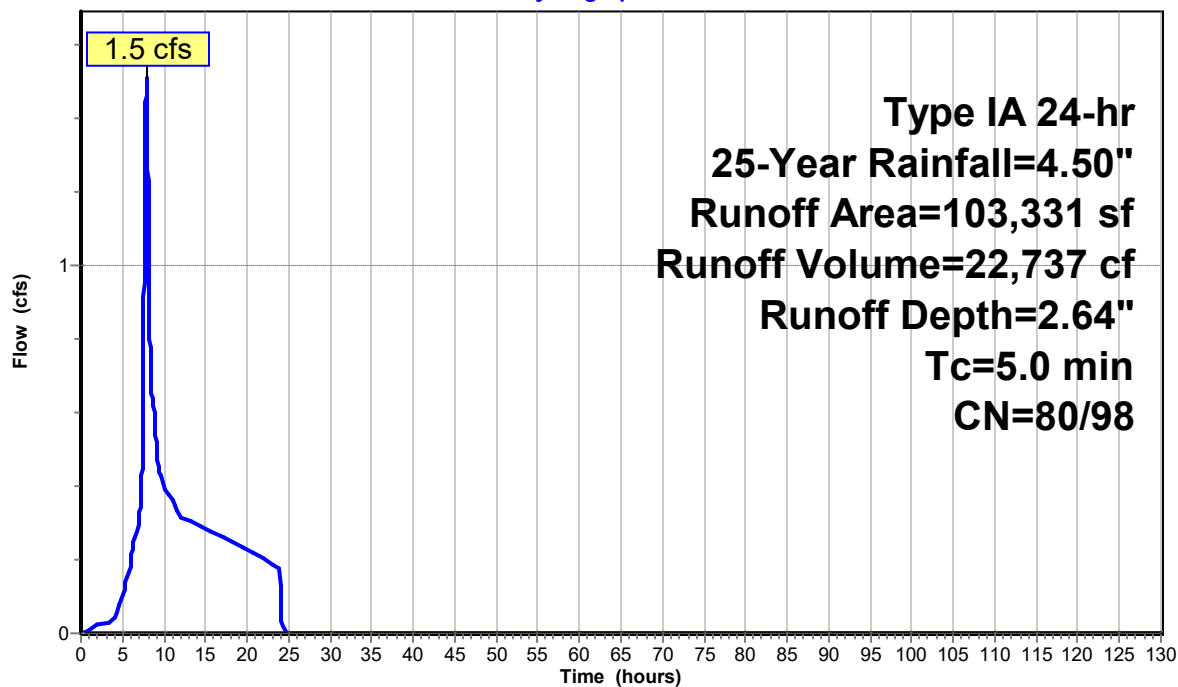
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
	93,073	80	>75% Grass cover, Good, HSG D
*	10,258	98	Impervious
	103,331	82	Weighted Average
	93,073	80	90.07% Pervious Area
	10,258	98	9.93% Impervious Area

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

Subcatchment 15: Basin 15

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 17: Basin 17

Runoff = 0.3 cfs @ 8.00 hrs, Volume= 8,434 cf, Depth= 1.08"
Routed to Link P2 : Pipe 2

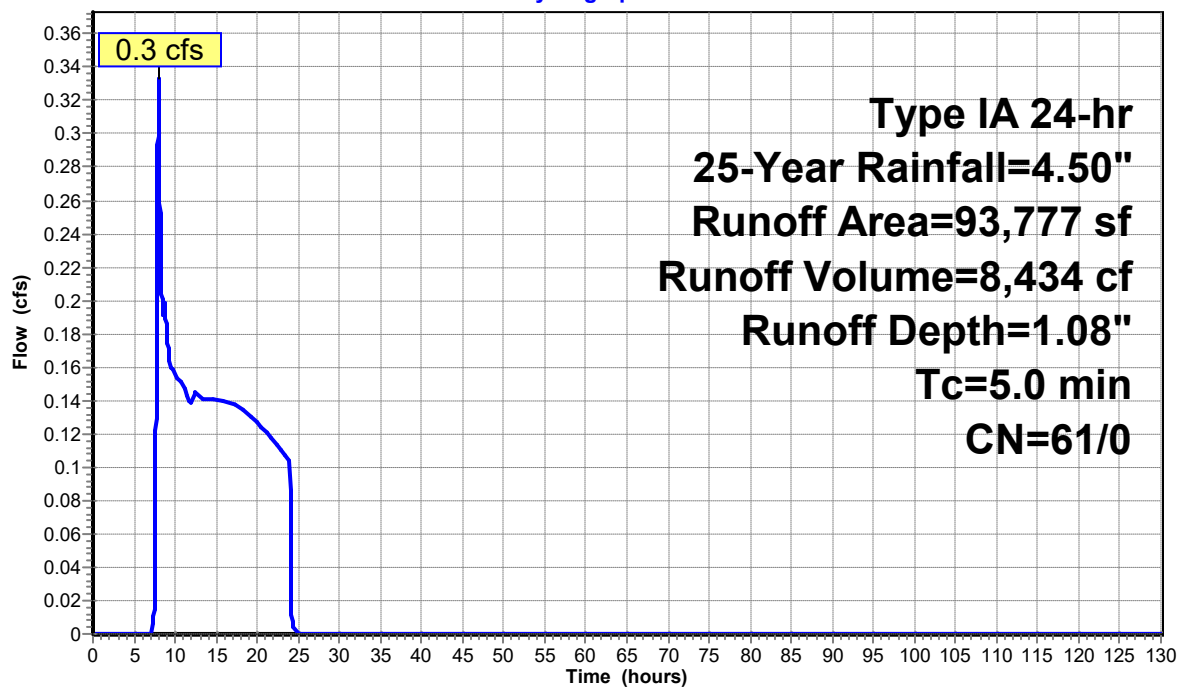
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	93,777	61	Ecoroof
	93,777	61	100.00% Pervious Area

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

Subcatchment 17: Basin 17

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Subcatchment 30: Basin 30

Runoff = 0.5 cfs @ 7.91 hrs, Volume= 6,937 cf, Depth= 3.24"
Routed to Reach D1 : Ditch 1

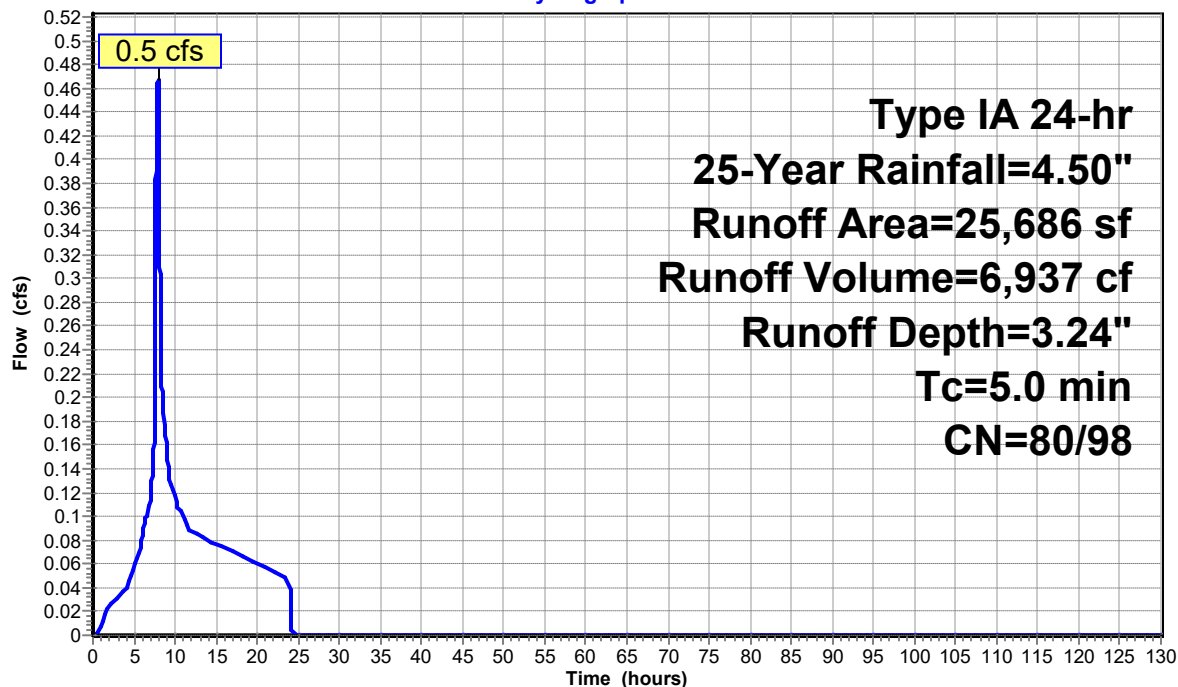
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-130.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	11,103	98	Impervious Area
*	14,583	80	Pervious
	25,686	88	Weighted Average
	14,583	80	56.77% Pervious Area
	11,103	98	43.23% Impervious Area

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

Subcatchment 30: Basin 30

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Reach D1: Ditch 1

Inflow Area = 123,295 sf, 51.96% Impervious, Inflow Depth = 3.40" for 25-Year event
Inflow = 2.4 cfs @ 7.91 hrs, Volume= 34,914 cf
Outflow = 2.4 cfs @ 7.93 hrs, Volume= 34,914 cf, Atten= 0%, Lag= 1.7 min
Routed to Pond Pond D : Pond D

Routing by Stor-Ind+Trans method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

Max. Velocity= 2.91 fps, Min. Travel Time= 1.0 min

Avg. Velocity= 1.53 fps, Avg. Travel Time= 1.9 min

Peak Storage= 143 cf @ 7.92 hrs

Average Depth at Peak Storage= 0.28' , Surface Width= 3.70'

Bank-Full Depth= 1.00' Flow Area= 5.0 sf, Capacity= 29.0 cfs

Custom cross-section, Length= 176.0' Slope= 0.0187 '/'

Constant n= 0.025 Earth, clean & straight

Inlet Invert= 702.30', Outlet Invert= 699.00'



‡

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-4.00	1.00	0.00
-1.00	0.00	1.00
1.00	0.00	1.00
4.00	1.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	2.0	0.0	0	0.0
1.00	5.0	8.3	8.0	880	29.0

Bull Run Conveyance 2

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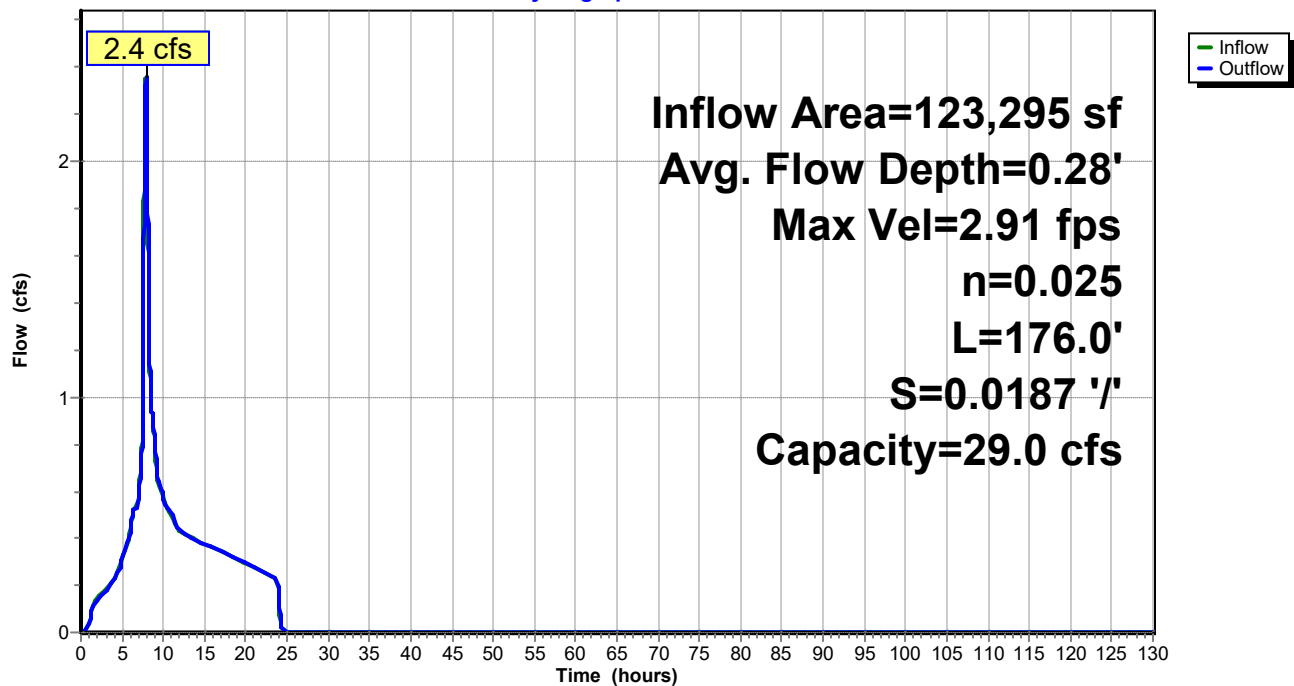
Type IA 24-hr 25-Year Rainfall=4.50"

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Reach D1: Ditch 1

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Reach D2: Ditch 2

Inflow Area = 103,331 sf, 9.93% Impervious, Inflow Depth = 2.64" for 25-Year event
Inflow = 1.5 cfs @ 7.95 hrs, Volume= 22,737 cf
Outflow = 1.5 cfs @ 8.05 hrs, Volume= 22,737 cf, Atten= 1%, Lag= 6.3 min
Routed to Link P26 : Pipe 26

Routing by Stor-Ind+Trans method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

Max. Velocity= 2.58 fps, Min. Travel Time= 3.7 min

Avg. Velocity= 1.27 fps, Avg. Travel Time= 7.5 min

Peak Storage= 336 cf @ 7.99 hrs

Average Depth at Peak Storage= 0.21', Surface Width= 3.65'

Bank-Full Depth= 1.00' Flow Area= 6.0 sf, Capacity= 37.2 cfs

Custom cross-section, Length= 576.0' Slope= 0.0222 '/'

Constant n= 0.025 Earth, clean & straight

Inlet Invert= 703.59', Outlet Invert= 690.82'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-5.00	1.00	0.00
-1.00	0.00	1.00
1.00	0.00	1.00
5.00	1.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	2.0	0.0	0	0.0
1.00	6.0	10.2	10.0	3,456	37.2

Bull Run Conveyance 2

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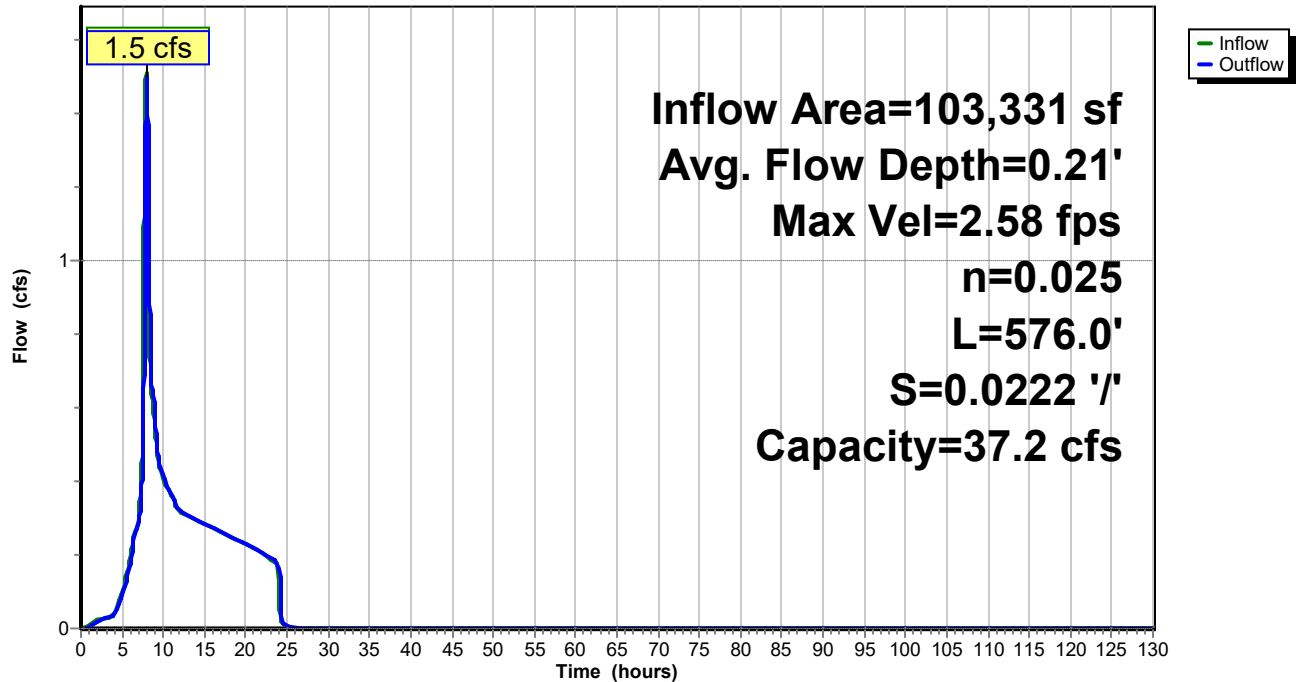
Type IA 24-hr 25-Year Rainfall=4.50"

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Reach D2: Ditch 2

Hydrograph



Bull Run Conveyance 2

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Summary for Reach D3: Ditch 3

Inflow Area = 154,858 sf, 19.99% Impervious, Inflow Depth = 2.82" for 25-Year event
Inflow = 2.4 cfs @ 7.93 hrs, Volume= 36,416 cf
Outflow = 2.4 cfs @ 8.08 hrs, Volume= 36,416 cf, Atten= 1%, Lag= 8.6 min
Routed to Pond Pond D : Pond D

Routing by Stor-Ind+Trans method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

Max. Velocity= 1.74 fps, Min. Travel Time= 5.1 min

Avg. Velocity= 0.84 fps, Avg. Travel Time= 10.5 min

Peak Storage= 734 cf @ 8.00 hrs

Average Depth at Peak Storage= 0.39' , Surface Width= 5.11'

Bank-Full Depth= 1.00' Flow Area= 6.0 sf, Capacity= 17.7 cfs

Custom cross-section, Length= 530.0' Slope= 0.0050 '/'

Constant n= 0.025 Earth, clean & straight

Inlet Invert= 707.64', Outlet Invert= 704.99'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-5.00	1.00	0.00
-1.00	0.00	1.00
1.00	0.00	1.00
5.00	1.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	2.0	0.0	0	0.0
1.00	6.0	10.2	10.0	3,180	17.7

Bull Run Conveyance 2

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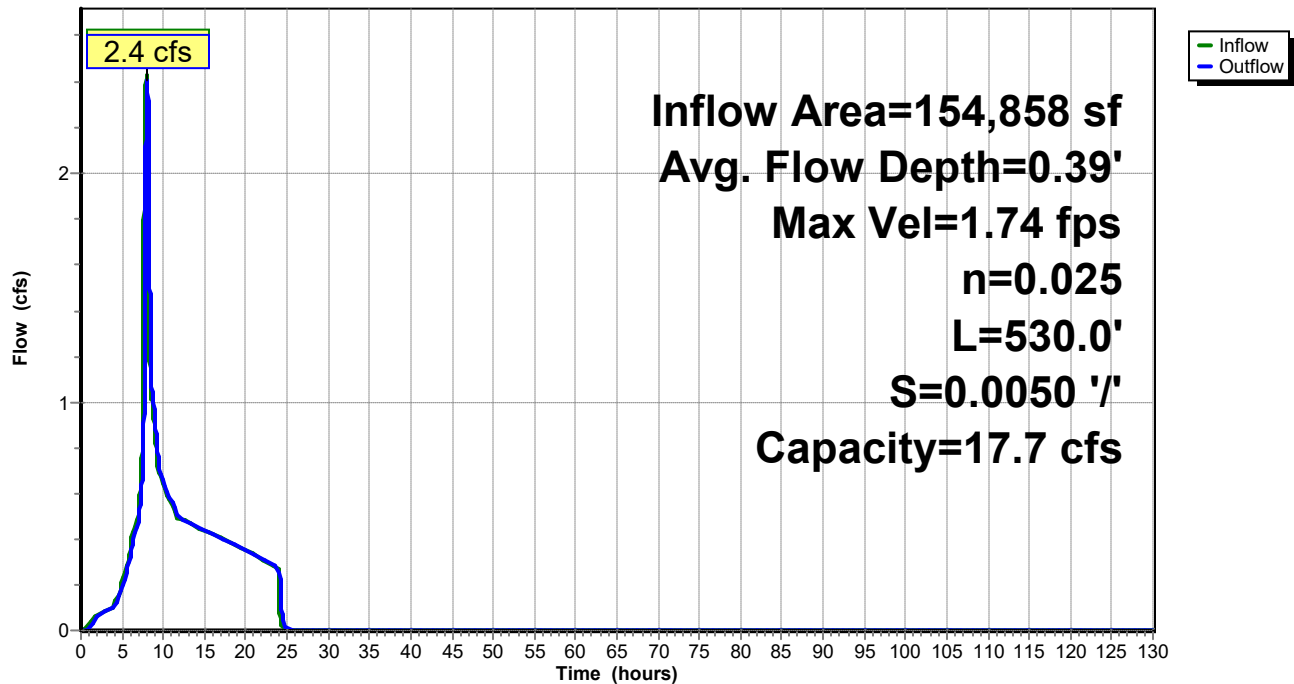
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Reach D3: Ditch 3

Hydrograph



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Summary for Reach D4: Ditch 4

Inflow Area = 88,162 sf, 29.99% Impervious, Inflow Depth = 3.00" for 25-Year event
Inflow = 1.5 cfs @ 7.92 hrs, Volume= 22,055 cf
Outflow = 1.5 cfs @ 7.96 hrs, Volume= 22,055 cf, Atten= 0%, Lag= 2.2 min
Routed to Pond Pond D : Pond D

Routing by Stor-Ind+Trans method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

Max. Velocity= 1.52 fps, Min. Travel Time= 1.3 min

Avg. Velocity= 0.81 fps, Avg. Travel Time= 2.4 min

Peak Storage= 116 cf @ 7.94 hrs

Average Depth at Peak Storage= 0.30', Surface Width= 4.42'

Bank-Full Depth= 1.00' Flow Area= 6.0 sf, Capacity= 17.7 cfs

Custom cross-section, Length= 119.0' Slope= 0.0050 '/'

Constant n= 0.025 Earth, clean & straight

Inlet Invert= 697.63', Outlet Invert= 697.03'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-5.00	1.00	0.00
-1.00	0.00	1.00
1.00	0.00	1.00
5.00	1.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	2.0	0.0	0	0.0
1.00	6.0	10.2	10.0	714	17.7

Bull Run Conveyance 2

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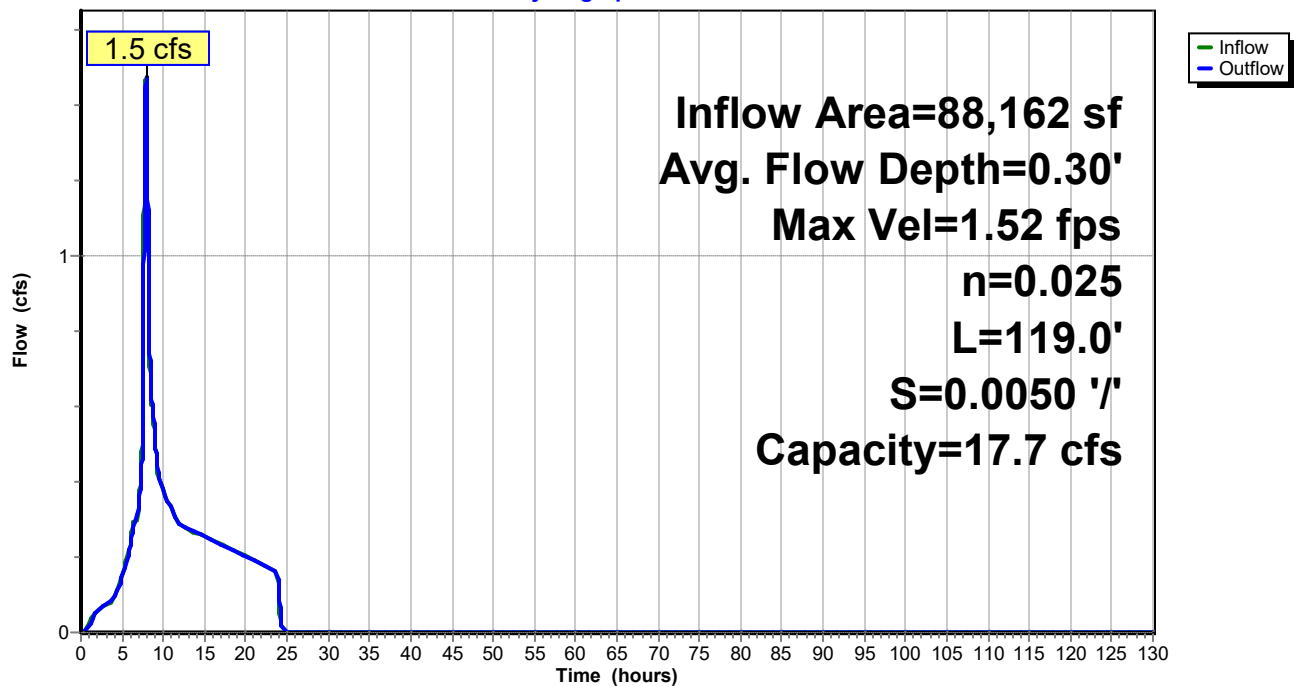
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Reach D4: Ditch 4

Hydrograph



Bull Run Conveyance 2

Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Pond Pond A: Pond A

Inflow Area = 349,413 sf, 47.53% Impervious, Inflow Depth = 3.32" for 25-Year event
 Inflow = 6.5 cfs @ 7.91 hrs, Volume= 96,619 cf
 Outflow = 2.1 cfs @ 9.04 hrs, Volume= 96,619 cf, Atten= 68%, Lag= 68.1 min
 Primary = 2.1 cfs @ 9.04 hrs, Volume= 96,619 cf
 Routed to Link P2 : Pipe 2

Routing by Stor-Ind method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 710.14' @ 9.04 hrs Surf.Area= 11,540 sf Storage= 23,009 cf

Plug-Flow detention time= 261.5 min calculated for 96,612 cf (100% of inflow)
 Center-of-Mass det. time= 261.5 min (968.7 - 707.2)

Volume	Invert	Avail.Storage	Storage Description
#1	707.50'	38,422 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
707.50	6,093	0	0
708.00	7,022	3,279	3,279
709.00	9,017	8,020	11,298
710.00	11,205	10,111	21,409
711.00	13,583	12,394	33,803
711.33	14,412	4,619	38,422

Device	Routing	Invert	Outlet Devices
#1	Primary	698.43'	18.0" Round Culvert L= 138.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 698.43' / 696.24' S= 0.0159 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	696.43'	2.4" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	709.54'	13.0" W x 6.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	710.17'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.1 cfs @ 9.04 hrs HW=710.14' (Free Discharge)

- 1=Culvert (Passes 2.1 cfs of 24.9 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.5 cfs @ 17.03 fps)
- 3=Orifice/Grate (Orifice Controls 1.6 cfs @ 2.88 fps)
- 4=Overflow (Controls 0.0 cfs)

Bull Run Conveyance 2

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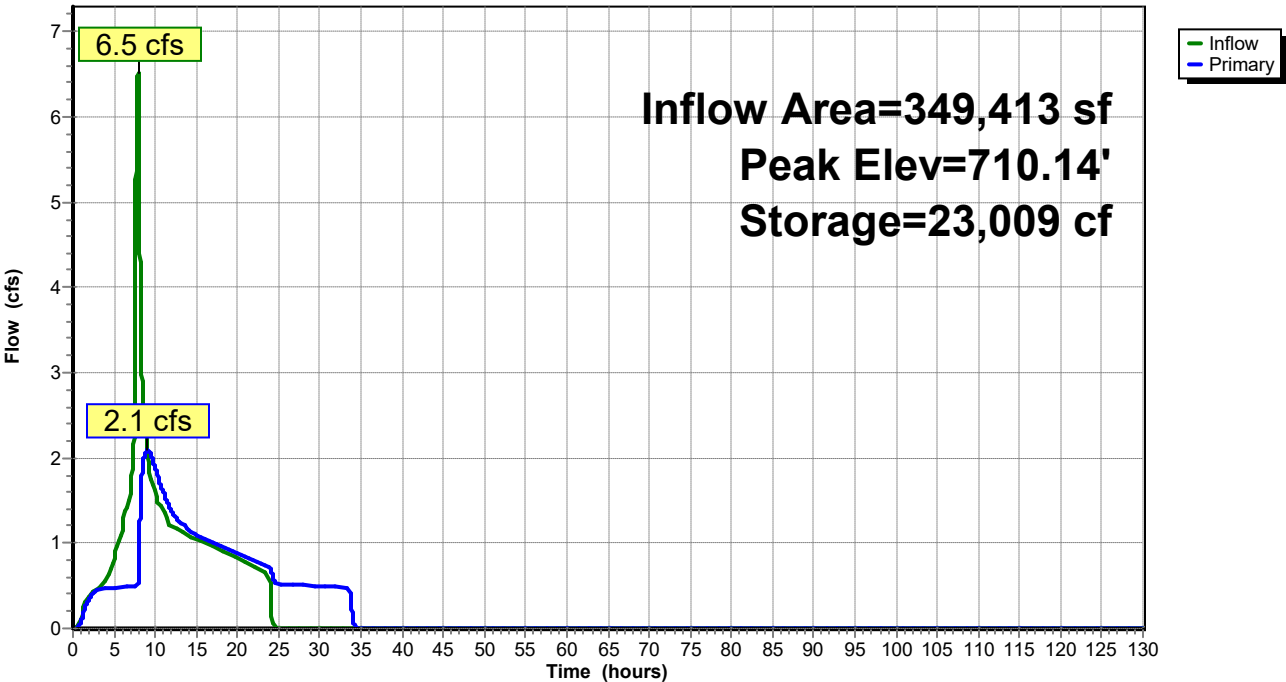
Type IA 24-hr 25-Year Rainfall=4.50"

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Pond Pond A: Pond A

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Pond Pond C: Pond C

Inflow Area = 763,232 sf, 11.22% Impervious, Inflow Depth = 2.66" for 25-Year event
 Inflow = 11.3 cfs @ 7.94 hrs, Volume= 169,420 cf
 Outflow = 2.4 cfs @ 11.67 hrs, Volume= 169,420 cf, Atten= 79%, Lag= 223.7 min
 Primary = 2.4 cfs @ 11.67 hrs, Volume= 169,420 cf
 Routed to Link P24 : Pipe 24

Routing by Stor-Ind method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 706.27' @ 11.67 hrs Surf.Area= 22,888 sf Storage= 47,419 cf

Plug-Flow detention time= 320.3 min calculated for 169,420 cf (100% of inflow)
 Center-of-Mass det. time= 320.3 min (1,083.2 - 762.9)

Volume	Invert	Avail.Storage	Storage Description
#1	704.00'	102,369 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
704.00	18,273	0	0
704.50	19,886	9,540	9,540
705.50	21,555	20,721	30,260
706.50	23,281	22,418	52,678
707.50	25,063	24,172	76,850
708.50	25,975	25,519	102,369

Device	Routing	Invert	Outlet Devices
#1	Primary	700.29'	15.0" Round Culvert L= 178.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 700.29' / 699.40' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	698.29'	3.7" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	705.34'	10.0" W x 5.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	706.27'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.4 cfs @ 11.67 hrs HW=706.27' (Free Discharge)

- 1=Culvert (Passes 2.4 cfs of 9.8 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.9 cfs @ 12.17 fps)
- 3=Orifice/Grate (Orifice Controls 1.5 cfs @ 4.22 fps)
- 4=Overflow (Weir Controls 0.0 cfs @ 0.15 fps)

Bull Run Conveyance 2

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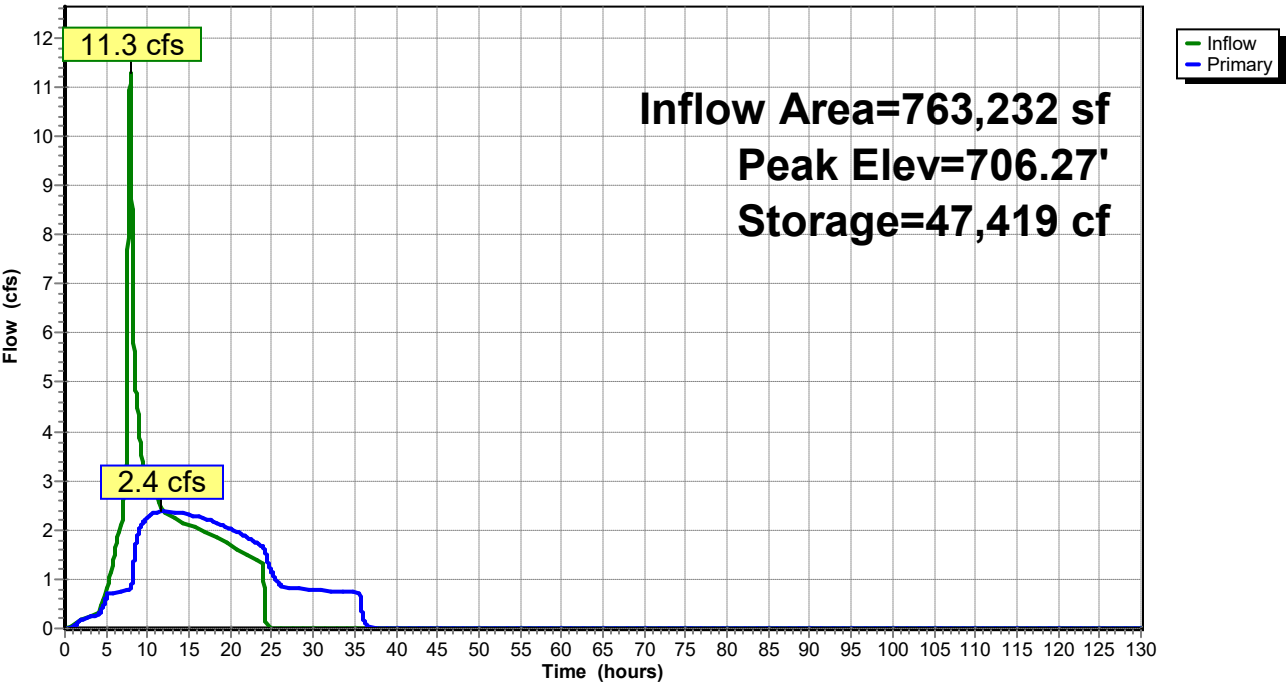
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Pond Pond C: Pond C

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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Summary for Pond Pond D: Pond D

Inflow Area = 366,315 sf, 33.16% Impervious, Inflow Depth > 13.18" for 25-Year event
 Inflow = 6.8 cfs @ 8.00 hrs, Volume= 402,290 cf, Incl. 0.7 cfs Base Flow
 Outflow = 2.6 cfs @ 9.27 hrs, Volume= 402,059 cf, Atten= 62%, Lag= 75.9 min
 Primary = 2.6 cfs @ 9.27 hrs, Volume= 402,059 cf
 Routed to Link P26 : Pipe 26

Routing by Stor-Ind method, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 696.42' @ 9.27 hrs Surf.Area= 8,716 sf Storage= 23,486 cf

Plug-Flow detention time= 61.0 min calculated for 402,055 cf (100% of inflow)

Center-of-Mass det. time= 58.3 min (3,223.2 - 3,164.9)

Volume	Invert	Avail.Storage	Storage Description
#1	693.00'	38,765 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
693.00	5,145	0	0
694.00	6,120	5,633	5,633
695.00	7,152	6,636	12,269
696.00	8,241	7,697	19,965
697.00	9,386	8,814	28,779
698.00	10,587	9,987	38,765

Device	Routing	Invert	Outlet Devices
#1	Primary	691.78'	15.0" Round Culvert L= 120.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 691.78' / 691.26' S= 0.0043 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	689.78'	5.0" Horiz. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#3	Device 1	695.25'	10.0" W x 3.0" H Vert. Orifice/Grate C= 0.620 Limited to weir flow at low heads
#4	Device 1	696.39'	15.0" Horiz. Overflow C= 0.620 Limited to weir flow at low heads

Primary OutFlow Max=2.6 cfs @ 9.27 hrs HW=696.42' (Free Discharge)

1=Culvert (Passes 2.6 cfs of 9.4 cfs potential flow)
 2=Orifice/Grate (Orifice Controls 1.5 cfs @ 10.71 fps)
 3=Orifice/Grate (Orifice Controls 1.1 cfs @ 5.07 fps)
 4=Overflow (Weir Controls 0.1 cfs @ 0.52 fps)

Bull Run Conveyance 2

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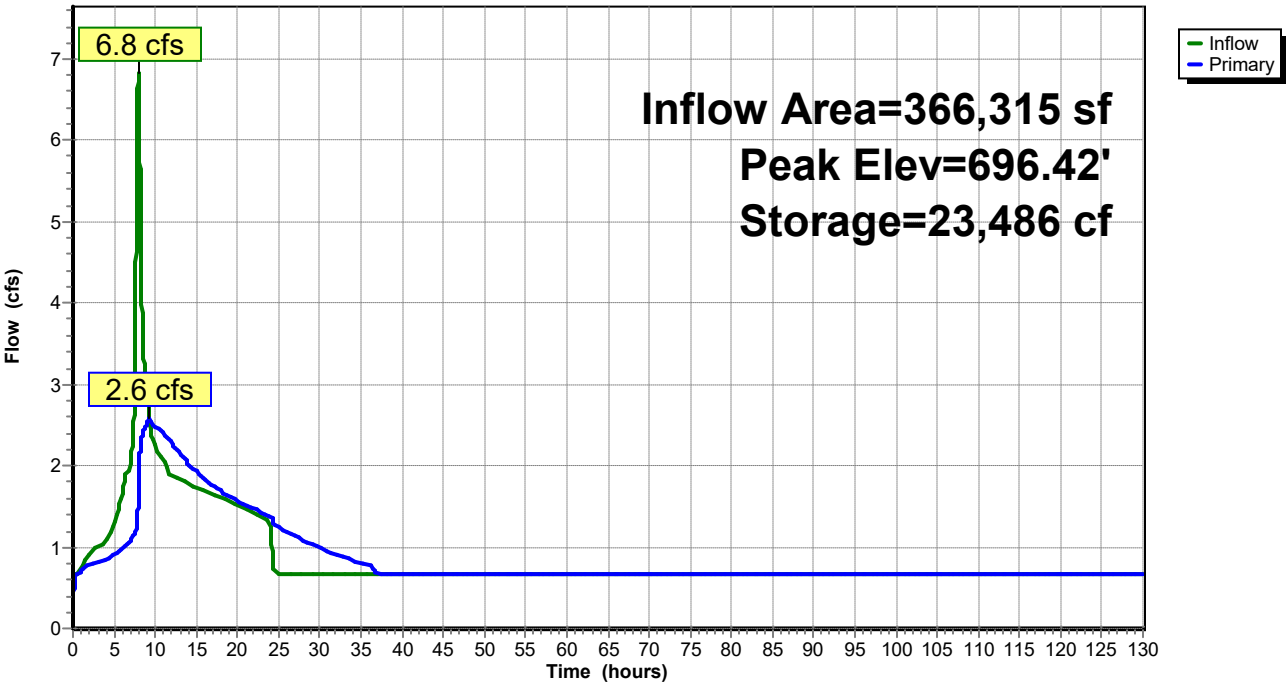
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Pond Pond D: Pond D

Hydrograph



Bull Run Conveyance 2

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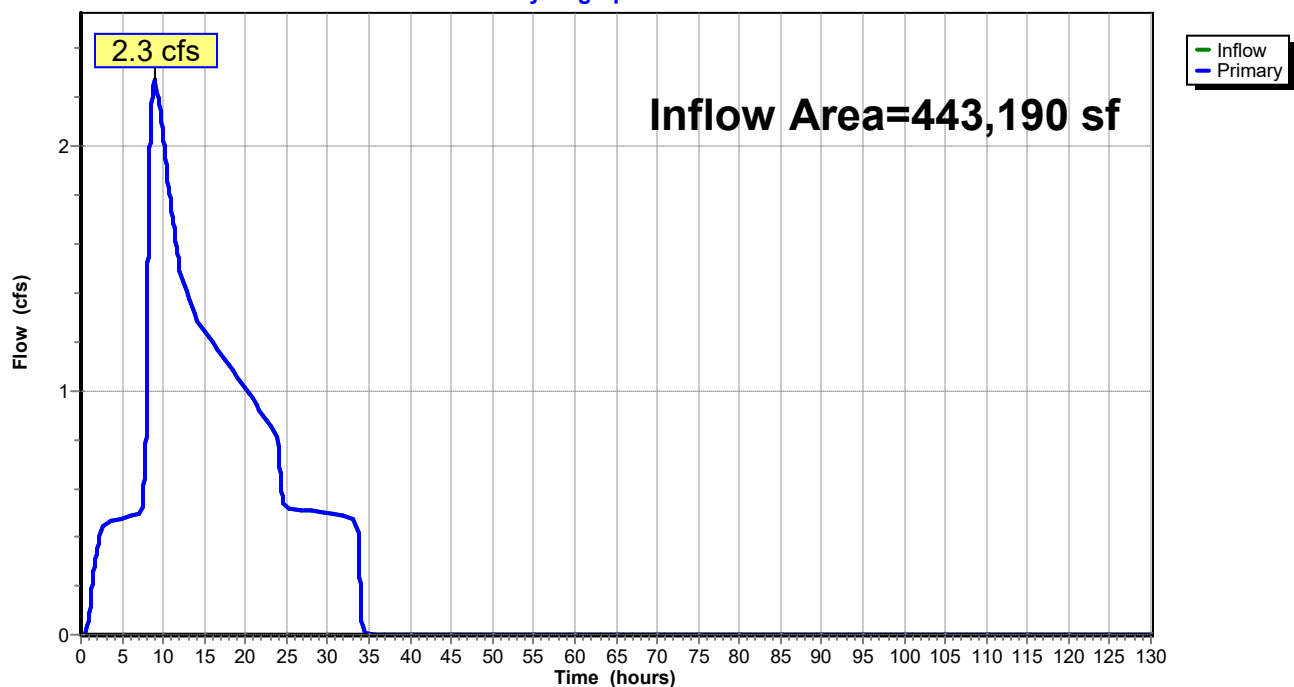
Summary for Link P2: Pipe 2

Inflow Area = 443,190 sf, 37.47% Impervious, Inflow Depth = 2.84" for 25-Year event
Inflow = 2.3 cfs @ 8.99 hrs, Volume= 105,054 cf
Primary = 2.3 cfs @ 8.99 hrs, Volume= 105,054 cf, Atten= 0%, Lag= 0.0 min
Routed to Link P24 : Pipe 24

Primary outflow = Inflow, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

Link P2: Pipe 2

Hydrograph



Bull Run Conveyance 2

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Type IA 24-hr 25-Year Rainfall=4.50"

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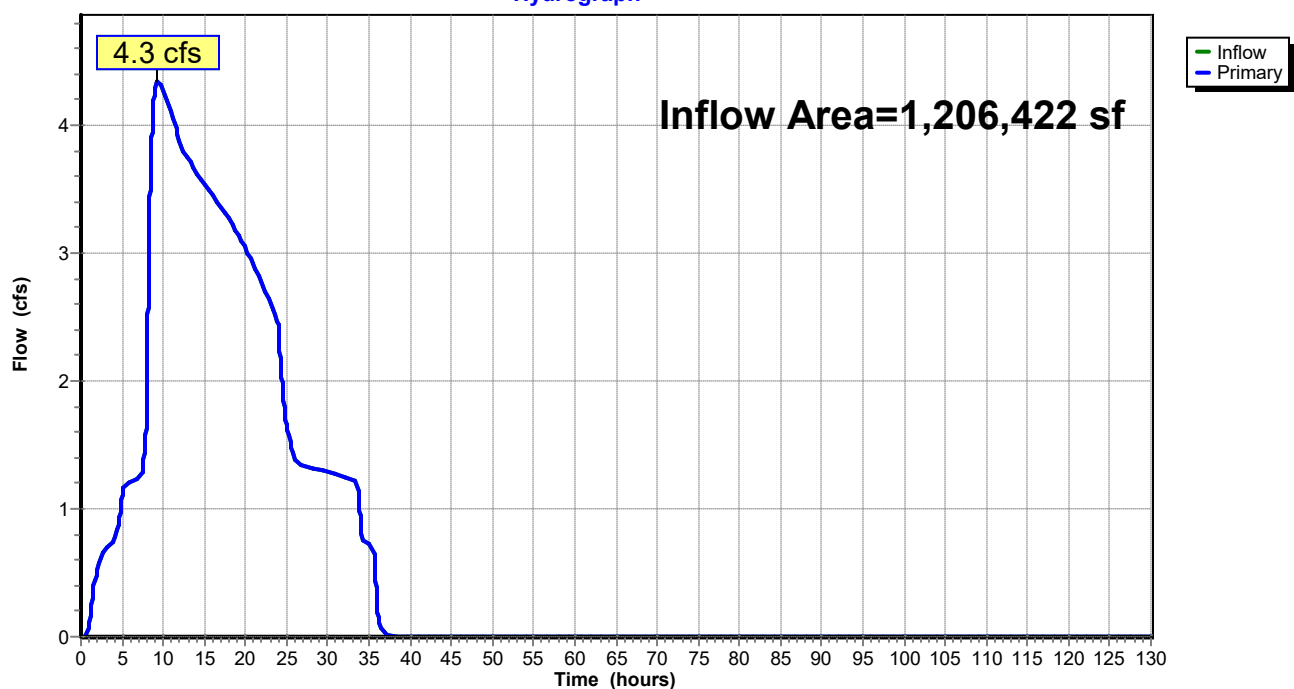
Summary for Link P24: Pipe 24

Inflow Area = 1,206,422 sf, 20.86% Impervious, Inflow Depth = 2.73" for 25-Year event
Inflow = 4.3 cfs @ 9.35 hrs, Volume= 274,473 cf
Primary = 4.3 cfs @ 9.35 hrs, Volume= 274,473 cf, Atten= 0%, Lag= 0.0 min
Routed to Link P26 : Pipe 26

Primary outflow = Inflow, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

Link P24: Pipe 24

Hydrograph



Bull Run Conveyance 2

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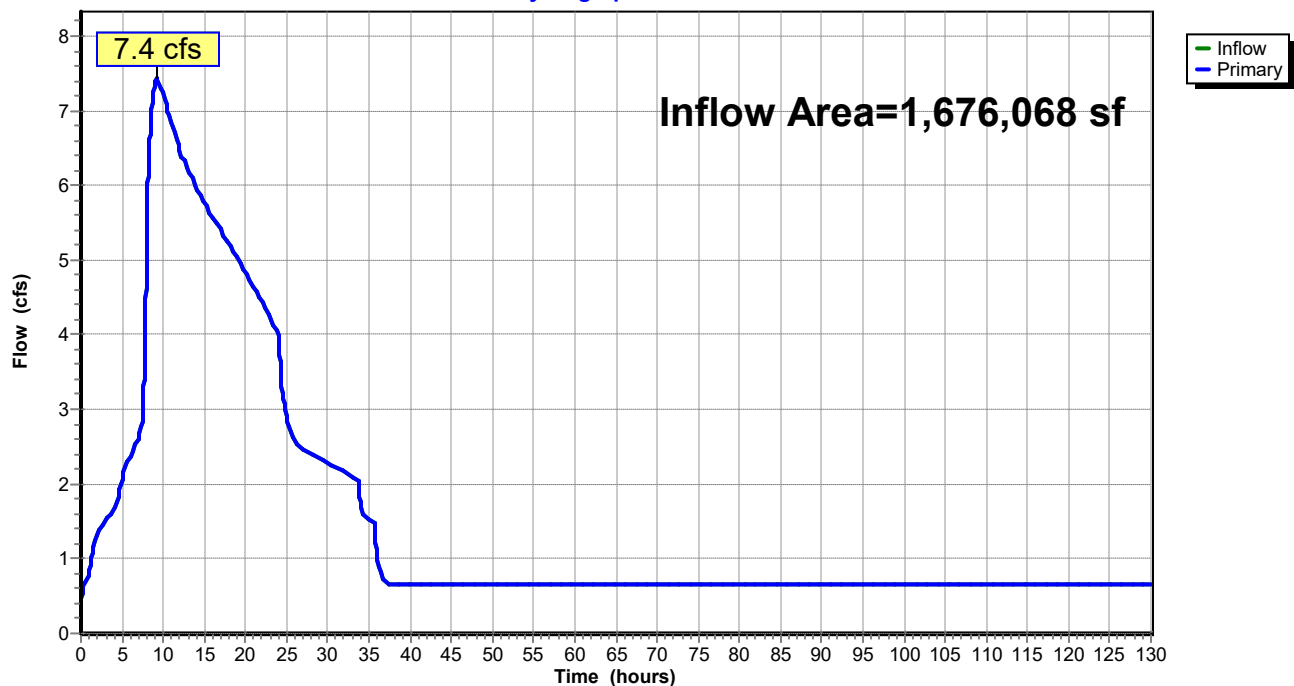
Summary for Link P26: Pipe 26

Inflow Area = 1,676,068 sf, 22.87% Impervious, Inflow Depth > 5.01" for 25-Year event
Inflow = 7.4 cfs @ 9.19 hrs, Volume= 699,269 cf
Primary = 7.4 cfs @ 9.19 hrs, Volume= 699,269 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-130.00 hrs, dt= 0.01 hrs

Link P26: Pipe 26

Hydrograph



Project: Bull Run Filtration Facility Piped Conveyance Analysis															
Date: 4/9/2025															
Pipe Information and Calculations															
Pipe Number	Tributary Basins	Description	Q (Calc'd) "Q"	Pipe Dia. (inch) "D"	Pipe Dia. (ft) "D"	Manning's number "n"	Slope "S" %	Slope "S"	Area Full (Calc'd) "Af"	Wetted Perimeter (Calc'd) "WPF"	Hydraulic Radius (Calc'd) "Rf"	Velocity Full (Calc'd) "Vf"	Flow Rate Full (Calc'd) "Qf"	% Pipe Capacity Used (Calc'd) "Q/Qf"	Velocity @ Q/Qf (Calc'd) "V"
Conveyance Analysis															
1	1-6, 20	To Pond A Flow Control MH	2.1	15	1.25	0.013	7.39	0.0739	1.227	3.927	0.313	14.348	17.608	11.9%	1.71
2	1-6, 20	From Pond A Flow Control MH	2.1	15	1.25	0.013	0.95	0.0095	1.227	3.927	0.313	5.144	6.313	33.3%	1.71
3	1-6, 17, 20		2.3	15	1.25	0.013	0.26	0.0026	1.227	3.927	0.313	2.691	3.303	69.6%	1.87
4	20		0.9	12	1.00	0.013	0.50	0.0050	0.785	3.142	0.250	3.216	2.526	35.6%	1.15
5	1, 2		1.7	12	1.00	0.013	0.53	0.0053	0.785	3.142	0.250	3.311	2.601	65.4%	2.16
6	3		0.8	10	0.83	0.013	0.63	0.0063	0.545	2.618	0.208	3.197	1.744	45.9%	1.47
7	1-3, 20		3.4	18	1.50	0.013	0.26	0.0026	1.767	4.712	0.375	3.039	5.371	63.3%	1.92
8	1-4, 20		3.8	18	1.50	0.013	0.26	0.0026	1.767	4.712	0.375	3.039	5.371	70.8%	2.15
9	5		0.3	10	0.83	0.013	0.56	0.0056	0.545	2.618	0.208	3.014	1.644	18.2%	0.55
10	1-5, 20		4.1	18	1.50	0.013	0.26	0.0026	1.767	4.712	0.375	3.039	5.371	76.3%	2.32
11	7		0.7	10	0.83	0.013	0.56	0.0056	0.545	2.618	0.208	3.014	1.644	42.6%	1.28
12	8		2.6	15	1.25	0.013	0.51	0.0051	1.227	3.927	0.313	3.769	4.626	56.2%	2.12
13	25		1.1	12	1.00	0.013	0.44	0.0044	0.785	3.142	0.250	3.017	2.370	46.4%	1.40
14	8, 9, 25	To Pond B Flow Control MH	1.6	18	1.50	0.013	0.50	0.0050	1.767	4.712	0.375	4.215	7.448	21.5%	0.91
15	8, 9, 25	From Pond B Flow Control MH	1.6	18	1.50	0.013	0.49	0.0049	1.767	4.712	0.375	4.172	7.373	21.7%	0.91
16	10		2.8	15	1.25	0.013	4.78	0.0478	1.227	3.927	0.313	11.540	14.161	19.8%	2.28
17	24		6.5	15	1.25	0.013	1.10	0.0110	1.227	3.927	0.313	5.536	6.793	95.7%	5.30
18	10, 11, 19, 24	To Pond C Flow Control MH	2.4	15	1.25	0.013	0.60	0.0060	1.227	3.927	0.313	4.088	5.017	47.8%	1.96
19	10, 11, 19, 24	From Pond C Flow Control MH	2.4	15	1.25	0.013	0.87	0.0087	1.227	3.927	0.313	4.923	6.042	39.7%	1.96
20	7, 12		1.9	10	0.83	0.013	1.00	0.0100	0.545	2.618	0.208	4.028	2.197	86.5%	3.48
21	13		2.4	12	1.00	0.013	0.79	0.0079	0.785	3.142	0.250	4.043	3.175	75.6%	3.06
22	7, 12, 13, 14, 30	To Pond D Flow Control MH	2.6	12	1.00	0.013	0.60	0.0060	0.785	3.142	0.250	3.523	2.767	94.0%	3.31
23	7, 12, 13, 14, 30	From Pond D Flow Control MH	2.6	15	1.25	0.013	0.43	0.0043	1.227	3.927	0.313	3.461	4.247	61.2%	2.12
24	1-6, 10, 11, 17, 19, 20, 24		4.3	15	1.25	0.013	2.51	0.0251	1.227	3.927	0.313	8.362	10.262	41.9%	3.50
25	15		1.5	12	1.00	0.013	4.94	0.0494	0.785	3.142	0.250	10.110	7.940	18.9%	1.91
26	1-7, 10-13, 17, 19, 20, 24, 30		7.4	18	1.50	0.013	0.78	0.0078	1.767	4.712	0.375	5.264	9.302	79.6%	4.19
27	16		1.4	12	1.00	0.013	0.50	0.0050	0.785	3.142	0.250	3.216	2.526	55.4%	1.78
28	16, 18, 21, 24		1	12	1.00	0.013	12.00	0.1200	0.785	3.142	0.250	15.757	12.375	8.1%	1.27
29	26, 27		3.1	12	1.00	0.013	1.00	0.0100	0.785	3.142	0.250	4.549	3.572	86.8%	3.95
30	26, 27, 29		3.5	15	1.25	0.013	0.68	0.0068	1.227	3.927	0.313	4.352	5.341	65.5%	2.85
31	26-29	To Pond H Flow Control MH	1.3	12	1.00	0.013	2.00	0.0200	0.785	3.142	0.250	6.433	5.052	25.7%	1.66
32	26-29	From Pond H Flow Control MH	1.3	12	1.00	0.013	10.76	0.1076	0.785	3.142	0.250	14.920	11.718	11.1%	1.66
33	8, 9, 25-29		2.8	18	1.50	0.013	1.00	0.0100	1.767	4.712	0.375	5.960	10.533	26.6%	1.58
34	8, 9, 16, 18, 21, 24-29		3.7	30	2.50	0.013	0.41	0.0041	4.909	7.854	0.625	5.365	26.334	14.1%	0.75
35	23		2	12	1.00	0.013	1.30	0.0130	0.785	3.142	0.250	5.186	4.073	49.1%	2.55
36	22, 23	To Pond E Flow Control MH	3	15	1.25	0.013	0.45	0.0045	1.227	3.927	0.313	3.541	4.345	69.0%	2.44
37	22, 23	From Pond E Flow Control MH	3	15	1.25	0.013	0.45	0.0045	1.227	3.927	0.313	3.541	4.345	69.0%	2.44

STORMWATER DRAINAGE CONTROL CERTIFICATE

Land Use Planning Division



www.multco.us/landuse ▪ Email: land.use.planning@multco.us ▪ Phone: (503) 988-3043

> 500 SQUARE FEET OF NEW / REPLACED IMPERVIOUS SURFACES

NOTE TO PROPERTY OWNER/APPLICANT: Please have an Oregon Licensed Professional Engineer fill out this Certificate and attach a signed site plan, stamped and signed storm water system details, and stamped and signed storm water calculations used to support the conclusion. Please note that replacement of existing structures does not provide a credit to the square footage threshold.

Property Address or Legal Description: 1S4E22-00400 & 1S4E22D-00100, 35320 SE Carpenter Lane, Gresham

Description of Project: Replace approved Pleasant Valley Pump Station with Sandy Pump Station (+172 SF impervious surface)

The following stormwater drainage control system will be required:

- ☐ Use of Gutter, downspout, and splash block drainage control system;
- ☐ Natural Infiltration Process; or
- ☒ Construction of an on-site storm water drainage control system.

The rate of stormwater runoff attributed to the new/replaced development for a 10-year/24-hour storm event will be no greater than that which existed prior to any development as measured from the property line or from the point of discharge into a water body with the use of the designated system [MCC 39.6235].

I certify the attached signed site plan showing the areas needed for the chosen system type, stamped and signed storm water system design details, and stamped and signed calculations dated 07/2025 will meet the requirements listed above.

Signature: _____

Print Name: Rafael Gaeta

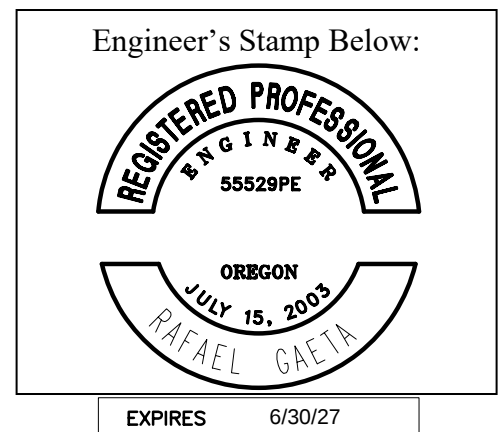
Business Name: Emerio Design

Address: 6445 SW Fallbrook Place, Suite 110

Phone #: 503-746-8812

Email: rafael@emeriodesign.com

Date: 7/1/25



NOTE TO ENGINEER: Please check one box above. Multnomah County does not use the City of Portland's storm water ordinance. As part of your review, MCC 39.6235 requires that you must consider all new, replaced, and existing structures and impervious areas and determine that the newly generated stormwater from the new or replaced impervious surfaces is in compliance with Multnomah County Code for a 10-year/24-hour storm event. This Storm Water Drainage Control Certificate does not apply to shingle or roof replacement on lawfully established structures.

§ 39.6235 STORMWATER DRAINAGE CONTROL.

(A) Persons creating new or replacing existing impervious surfaces exceeding 500 square feet shall install a stormwater drainage system as provided in this section. This subsection (A) does not apply to shingle or roof replacement on lawful structures.

(B) The provisions of this section are in addition to and not in lieu of any other provision of the code regulating stormwater or its drainage and other impacts and effects, including but not limited to regulation thereof in the SEC overlay.

(C) The provisions of this section are in addition to and not in lieu of stormwater and drainage requirements in the Multnomah County Road Rules and Design and Construction Manual, including those requirements relating to impervious surfaces and proposals to discharge stormwater onto a county right-of-way.

(D) The stormwater drainage system required in subsection (A) shall be designed to ensure that the rate of runoff for the 10-year 24-hour storm event is no greater than that which existed prior to development at the property line or point of discharge into a water body.

(E) At a minimum, to establish satisfaction of the standards in this section and all other applicable stormwater-related regulations in this code, the following information must be provided to the planning director:

(1) A site plan drawn to scale, showing the property line locations, ground topography (contours), boundaries of all ground disturbing activities, roads and driveways, existing and proposed structures and buildings, existing and proposed sanitary tank and drainfields (primary and reserve), location of stormwater disposal, trees and vegetation proposed for both removal and planting and an outline of wooded areas, water bodies and existing drywells;

(2) Documentation establishing approval of any new stormwater surcharges to a sanitary drainfield by the City of Portland Sanitarian and/or any other agency authorized to review waste disposal systems;

(3) Certified statement, and supporting information and documentation, by an Oregon licensed Professional Engineer that the proposed or existing stormwater drainage system satisfies all standards set forth in this section and all other stormwater drainage system standards in this code; and

(4) Any other report, information, plan, certification or documentation necessary to establish satisfaction of all standards set forth in this section and all other applicable stormwater-related regulations in this code, such as, but not limited to, analyses and explanations of soil characteristics, engineering solutions, and proposed stream and upland environmental protection measures.