

Appendix 6

Preliminary Stormwater Report

Salem ASR Expansion Facility Salem, OR

Preliminary Stormwater Report

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Preliminary Stormwater Report

SALEM ASR EXPANSION FACILITIES

SALEM, OR

1.0 Project Overview and Description

1.1. Size and Location of Project Site

The total project site subject to this stormwater report is ± 1.17 acres located at the existing City of Salem Water Facility adjacent to Woodmansee Park near 4550 Sunnyside Rd SE Salem, Marion County, Oregon, Tax Lot 200 and 300 of Marion County Assessor's Map 8 3W 10DB.

1.2. Property Scope and Proposed Improvements

The property is zoned RS (Single Family Residential). The proposed development involves demolishing the existing facility building, entrance driveway from Sunnyside Rd, and constructing a new water distribution facility building, parking lot, landscaped areas, stormwater facility, utilities, and other associated infrastructure.

1.3. Watershed Description

Current site runoff flows toward the north and northeast to Pringle Creek which flows across the western portion of the subject property from southwest to northeast ultimately draining to Willamette Slough in downtown Salem.

Runoff from the proposed development will be detained in a Green Stormwater Infrastructure (GSI) facility before being released at the allowable release rates.

1.4. Existing Site Conditions

The site currently contains an existing City of Salem Water Facility and is relatively flat, with on-site grades averaging 5-7% percent. The site slopes from a high point of ± 381.5 feet in the southwest corner to a low point of ± 367.50 feet at the northwest corner of the site.

1.5. Existing Trees and Native Vegetation Impact/Preservation

The interior of the site is relatively clear of vegetation, although the site contains approximately 37 trees. These existing trees will be removed as part of the proposed development and replaced as part of the City-approved landscaping plan.

1.6. Green Stormwater Infrastructure to the Maximum Extent Feasible (GSI/MEF)

This project is classified as a large project because it contains over 10,000 square feet of impervious area. As specified in Section 4.3 of the 2016 City of Salem *Public Works Design Standards*, large projects are required to use GSI to the Maximum Extent Feasible (GSI/MEF) to meet flow control and water quality treatment performance standards.

A proposed detention facility will be used to meet the GSI/MEF criteria for the proposed site. This project is treating over 80 percent of the new or replaced impervious surface and therefore meets the GSI/MEF requirement by using the discretionary approach outlined in section 4E.7 of the *Public Works Design Standards*.

See attached figures for more information on the two proposed facilities.

1.7. Regulatory Permits Required

Building and site work permits through the City of Salem will be required for the project.

1.8. Emergency Overflow Escape Route

The stormwater system has been designed to convey stormwater runoff from storms with intensities higher than the 10-year design storm through an overflow in the flow control ditch inlet that discharges directly to the public system. Emergency overland overflow should the stormwater system be overwhelmed.

2.0 Methodology

2.1. Soils and Geologic Features

The pre-developed site contains Jory Silty Clay Loam, McAlpin Silty Clay Loam, Nekia Silty Clay Loam (2-7% and 12-20% slopes), and Salkum Silty Clay Loams, belonging to Hydrologic Soil Groups C and B, per the Natural Resources Conservation Service (NRCS) Soil Resource Web Survey (Appendix B).

2.2. Hazardous Materials

We are not aware of any existing hazardous material contamination onsite.

3.0 Analysis

3.1. Computational Methods and Software Used

The Santa Barbara Urban Hydrograph (SBUH) method was used to analyze stormwater runoff from the site. This method uses the NRCS Type 1A 24-hour design storm for the region. HydroCAD 10.0-20 computer software aided in the analysis.

3.2. Design Assumptions

The design of the stormwater system was analyzed for runoff generated by the water quality design storm event, one-half of the 2-year 24-hour design storm event, the 10-year 24-hour design storm event, and the 100-year 24-hour design storm event.

The following 24-hour rainfall intensities were used for the design storm for the recurrence interval:

Table 3-1: Rainfall Intensities

Recurrence Interval (Years)	Total Precipitation Depth (Inches)
½ of 2 year	1.10
Water Quality	1.38
10 year	3.20
100 year	4.40

The following table outlines the Hydrologic Soil Group rating for the soil type:

Table 3-2: Hydrologic Soil Group Ratings

NRCS Map Unit Identification	NRCS Soil Classification (Percentage of Site)	Hydrologic Soil Group Rating
JoB	Jory Silty Clay Loam (35%)	C
MaA	McAlpin Silty Clay Loam (28%)	C
NeB	Nekia Silty Clay Loam, 2-7% Slopes (9%)	C
NeD	Nekia Silty Clay Loam, 12-20% Slopes (4%)	C
SIB	Salkum Silty Clay Loam (24)	B

The following CNs were used for this analysis:

- Pre-Developed – City of Salem Pre-Development CN=72 per *Public Works Design Standards*
- Post-Developed – CN=98 was used for all impervious area; CN=74 for pervious surfaces

A time of concentration (Tc) of 23.8 minutes was used for pre-developed hydrograph routing based on a sheet flow length of 280 feet and an average slope across the site of 7%.

The minimum Tc of 6 minutes, per Technical Release 55 (TR-55), was used as a direct entry in the stormwater system model for post-developed hydrograph routing.

3.3. Hydrology Calculations

Tables 3-3, 3-4, and 3-5 below summarize areas tributary to each facility and the calculated elevations within each facility for post-developed peak flow rates of the water quality and 100-year design storm events. Supporting HydroCAD calculations are provided in Appendix C.

3.4. Conveyance Capacity Calculations

The proposed drainage conveyance system has been designed to convey the peak flows for the 10-year 24-hour storm event.

3.5. Treatment Sizing

Water quality calculations are provided in Appendix C and summarized in Table 3-4 below, which shows that the water quality design storm event peak elevation is below the water quality overflow elevation for the facility, the peak flows will be full retained and infiltrate the water quality storm.

Table 3-3: Impervious Area Conveyed to Facility

Subbasin ID	Source (roof, road, other)	Contributing Area (square feet)	Facility Ownership (private/public)	Facility Type	Facility Size (square feet)
POST	Parking, Road, Roof	31,644 – Impervious 4,006 – Pervious	Private	Combination Swale/Rain Garden	±3,000 Combo Swale

Table 3-4: Water Quality Event Summary

Facility ID	Facility Bottom Elevation (feet)	Facility Peak Elevation (Water Quality Event) (feet)	Overflow Elevation (feet)
2S (Combination Swale/Rain Garden)	375.00	375.44	375.55

3.6. Flow Control Sizing

Post-developed peak flow HydroCAD calculations are shown in Appendix C and are summarized below. The onsite facility was modeled as two separate nodes although this will be constructed as one continuous facility.

The onsite facility is designed to fully infiltrate the water quality design storm conveying larger design storms through an overflow structure. A flow control structure contains a 1.1-inch orifice sized to satisfy the peak flow control requirements for post- to pre-developed 10-year design storm event. A 10-inch pipe is used to convey flows from the water quality overflow structure to the flow control structure. Storms

with greater intensity than the 10-year design storm are conveyed through a 10-inch orifice in the flow control structure. Refer to the attached figures for the post-developed stormwater facility layout and Appendix C for HydroCAD calculations.

Table 3-5 shows the peak elevation summary for the stormwater facilities during water quality and 100-year design storm events.

Table 3-5: Detention and Peak Elevation Summary

Facility ID	Orifice Diameter & Elevation	Overflow (feet)	Peak Elevation, ½ the 2-year Event (feet)	Peak Elevation, 10-year Event (feet)	Peak Elevation, 100 Year Event (feet)
2S (Water Quality)	10" Orifice Elevation: 375.55	375.55	375.28	375.69	375.74
3S (Drain Rock Storage)	0.3" Orifice Elevation: 368.00	373.00	371.80	373.17	373.17
4S (Flow Control Above Water Quality)	1.1" Orifice Elevation: 372.00	376.60	NA	376.32	376.66

3.7. Pre- Vs. Post-Developed Condition Results

All stormwater from replaced and newly created impervious area will be routed into the proposed onsite facility.

The following table summarizes the calculated runoff for pre- and post-developed peak flow rates for half the 2-year, 10-year, and 100-year design storm events. Supporting HydroCAD calculations are provided in Appendix C.

Table 3-6: Pre- Vs. Post-Developed Flow Rates

Peak Flow Rate (cubic feet per second)					
Half of the 2-Year Storm		10-Year Storm		100-Year Storm	
Pre	Post	Pre	Post	Pre	Post
0.00	0.00*	0.08	0.07	0.22	0.21

*Half of the 2-year design storm has been designed to be fully infiltrated under post-developed conditions.

4.0 Conclusion

This stormwater report describes the engineering and design process used for design of the stormwater facilities for this project. The GSI facility has been designed in compliance with the City of Salem's *Public Works Design Standards*. Supporting HydroCAD calculations are included in Appendix C.

Runoff from the new building, entry road, parking lot, and immediate surrounding areas will be conveyed to the proposed GSI facility discussed previously.

The proposed storm system has been designed to treat over 80 percent of the new or replaced impervious surface and therefore meets the GSI/MEF requirement by using the discretionary approach outlined in

4E.7 of the *Public Works Design Standards*. Detention has been provided in accordance with the *Public Works Design Standards* to detain the 10-year design storm event.

DRAFT

Figure 1: Vicinity Map

Figure 2: Pre-Developed Basin Map

Figure 3: Post-Developed Basin Map

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Appendix A: NRCS Soil Resource Web Survey Results

Appendix B: HydroCAD Analysis

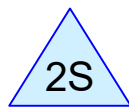
DRAFT



PRE-DEVELOPED



POST-DEVELOPED



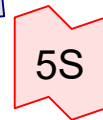
ONSITE
FACILITY-Below WQ



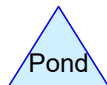
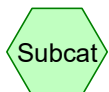
ROCK STORAGE



Flow control and storage
above WQ



POST-DEVELOPED
RELEASED



Routing Diagram for 7563 Prelim HydroCAD Model

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7563 Prelim HydroCAD Model

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Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.092	74	>75% Grass cover, Good, HSG C (POST)
0.818	72	City of Slaem Pre-Development; HSG C (PRE)
0.240	98	Entry Road (POST)
0.487	98	Paved parking, HSG C (POST)
1.637	84	TOTAL AREA

7563 Prelim HydroCAD Model

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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	4S	368.00	367.50	5.0	0.1000	0.010	10.0	0.0	0.0

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Type IA 24-hr Half 2-Year Rainfall=1.10"

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Page 4

Summary for Subcatchment POST: POST-DEVELOPED

Runoff = 0.13 cfs @ 7.98 hrs, Volume= 0.044 af, Depth= 0.65"

Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

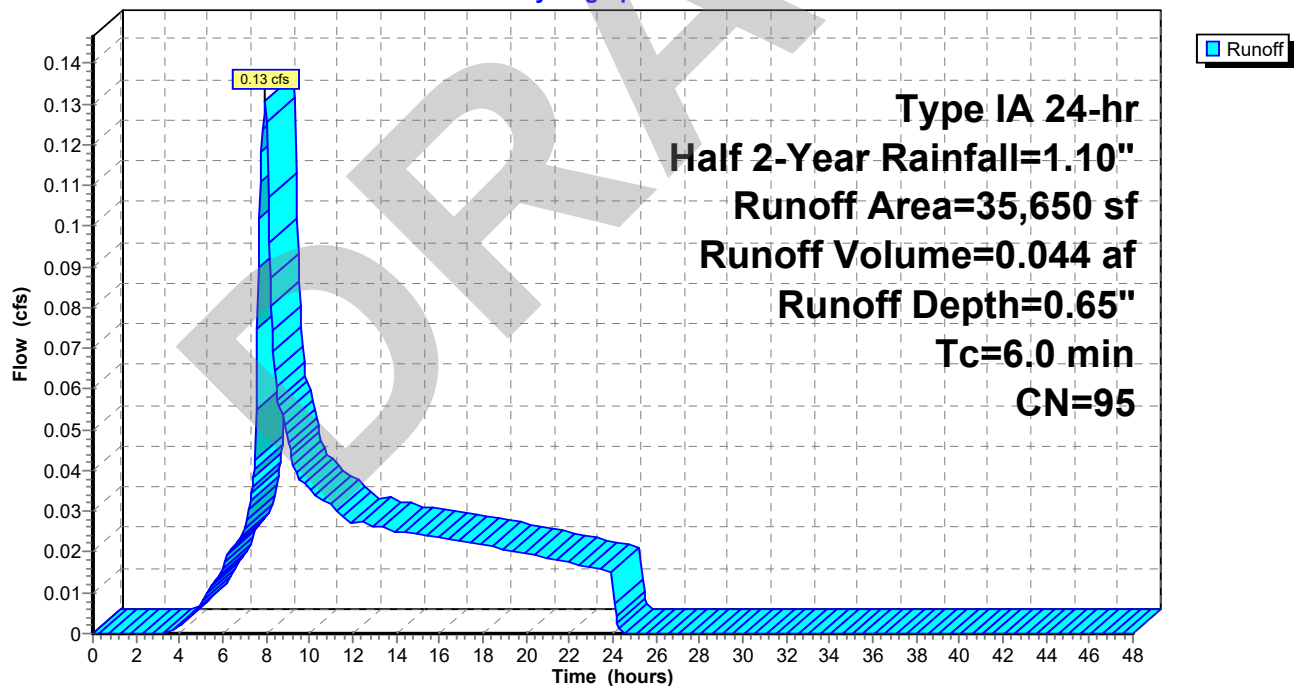
Type IA 24-hr Half 2-Year Rainfall=1.10"

Area (sf)	CN	Description
21,210	98	Paved parking, HSG C
3,175	74	>75% Grass cover, Good, HSG C
831	74	>75% Grass cover, Good, HSG C
* 10,434	98	Entry Road
35,650	95	Weighted Average
4,006	74	11.24% Pervious Area
31,644	98	88.76% Impervious Area

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

Subcatchment POST: POST-DEVELOPED

Hydrograph



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Summary for Subcatchment PRE: PRE-DEVELOPED

Runoff = 0.00 cfs @ 22.92 hrs, Volume= 0.002 af, Depth= 0.02"

Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

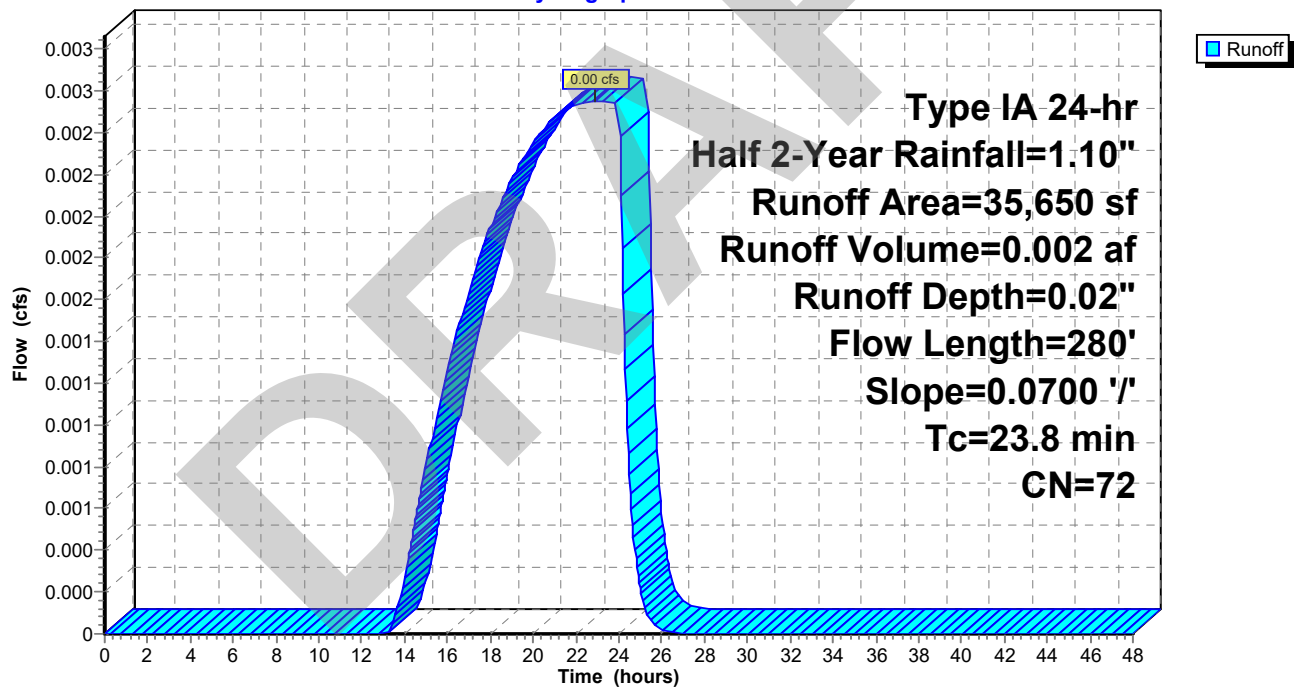
Type IA 24-hr Half 2-Year Rainfall=1.10"

	Area (sf)	CN	Description
*	35,650	72	City of Slaem Pre-Development; HSG C
	35,650	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	280	0.0700	0.20		Sheet Flow, Grass: Dense n= 0.240 P2= 2.20"

Subcatchment PRE: PRE-DEVELOPED

Hydrograph



7563 Prelim HydroCAD Model

Type IA 24-hr Half 2-Year Rainfall=1.10"

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Summary for Pond 2S: ONSITE FACILITY-Below WQ

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 0.65" for Half 2-Year event
 Inflow = 0.13 cfs @ 7.98 hrs, Volume= 0.044 af
 Outflow = 0.05 cfs @ 9.04 hrs, Volume= 0.044 af, Atten= 64%, Lag= 63.9 min
 Primary = 0.05 cfs @ 9.04 hrs, Volume= 0.044 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 375.28' @ 9.04 hrs Surf.Area= 1,007 sf Storage= 223 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 31.8 min (806.7 - 774.9)

Volume	Invert	Avail.Storage	Storage Description
#1	375.00'	863 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.00	600	0	0
375.75	1,700	863	863

Device	Routing	Invert	Outlet Devices
#1	Primary	375.00'	2.000 in/hr Exfiltration Through Growing Medium over Surface area
#2	Secondary	375.55'	10.0" Horiz. Overflow above WQ C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.05 cfs @ 9.04 hrs HW=375.28' (Free Discharge)
 ↑1=Exfiltration Through Growing Medium (Exfiltration Controls 0.05 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=375.00' (Free Discharge)
 ↑2=Overflow above WQ (Controls 0.00 cfs)

7563 Prelim HydroCAD Model

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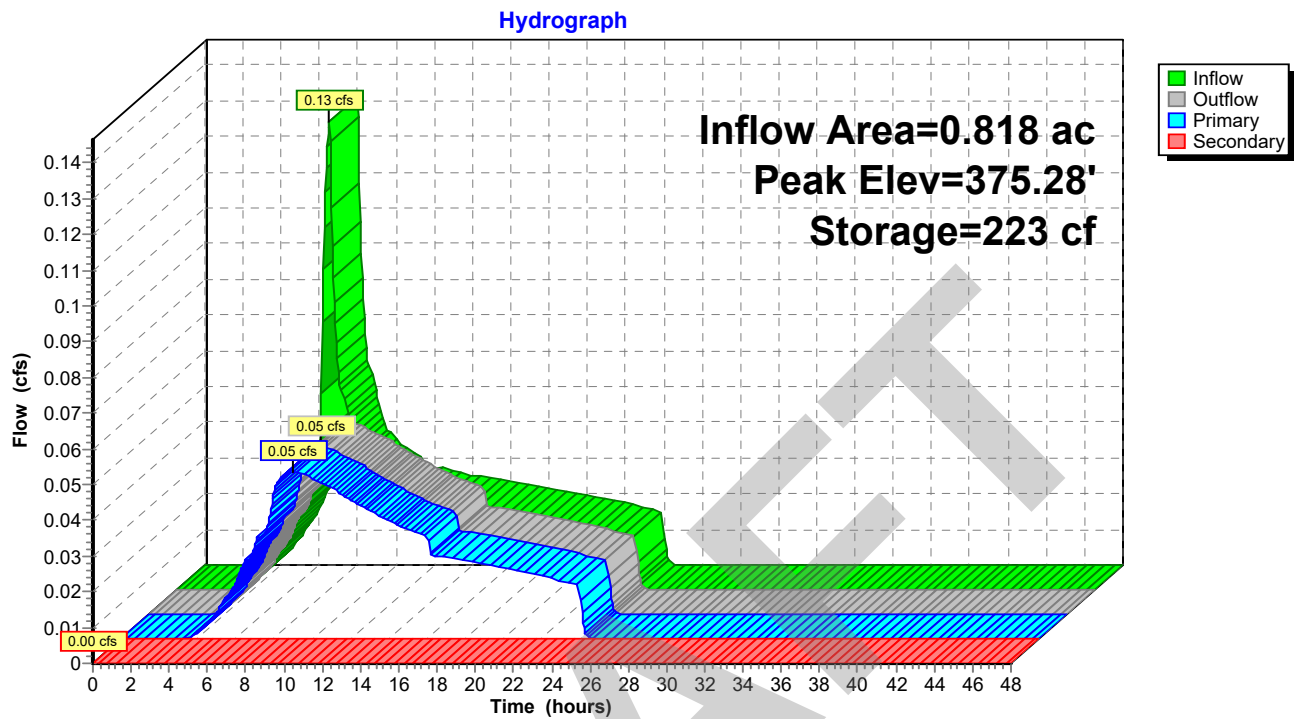
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Type IA 24-hr Half 2-Year Rainfall=1.10"

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Pond 2S: ONSITE FACILITY-Below WQ



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Type IA 24-hr Half 2-Year Rainfall=1.10"

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Summary for Pond 3S: ROCK STORAGE

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 0.65" for Half 2-Year event
 Inflow = 0.05 cfs @ 9.04 hrs, Volume= 0.044 af
 Outflow = 0.00 cfs @ 24.20 hrs, Volume= 0.015 af, Atten= 90%, Lag= 909.8 min
 Primary = 0.00 cfs @ 24.20 hrs, Volume= 0.015 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 371.80' @ 24.20 hrs Surf.Area= 1,800 sf Storage= 1,658 cf

Plug-Flow detention time= 1,142.5 min calculated for 0.015 af (34% of inflow)
 Center-of-Mass det. time= 833.3 min (1,640.0 - 806.7)

Volume	Invert	Avail.Storage	Storage Description
#1	369.50'	2,700 cf	Custom Stage Data (Prismatic) Listed below (Recalc) 6,750 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
369.50	1,800	0	0
373.25	1,800	6,750	6,750

Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	0.3" Vert. Orifice/Grate C= 0.600
#2	Secondary	373.00'	4.0" Vert. Overflow C= 0.600

Primary OutFlow Max=0.00 cfs @ 24.20 hrs HW=371.80' (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.00 cfs @ 9.37 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=369.50' (Free Discharge)
 ↑2=Overflow (Controls 0.00 cfs)

7563 Prelim HydroCAD Model

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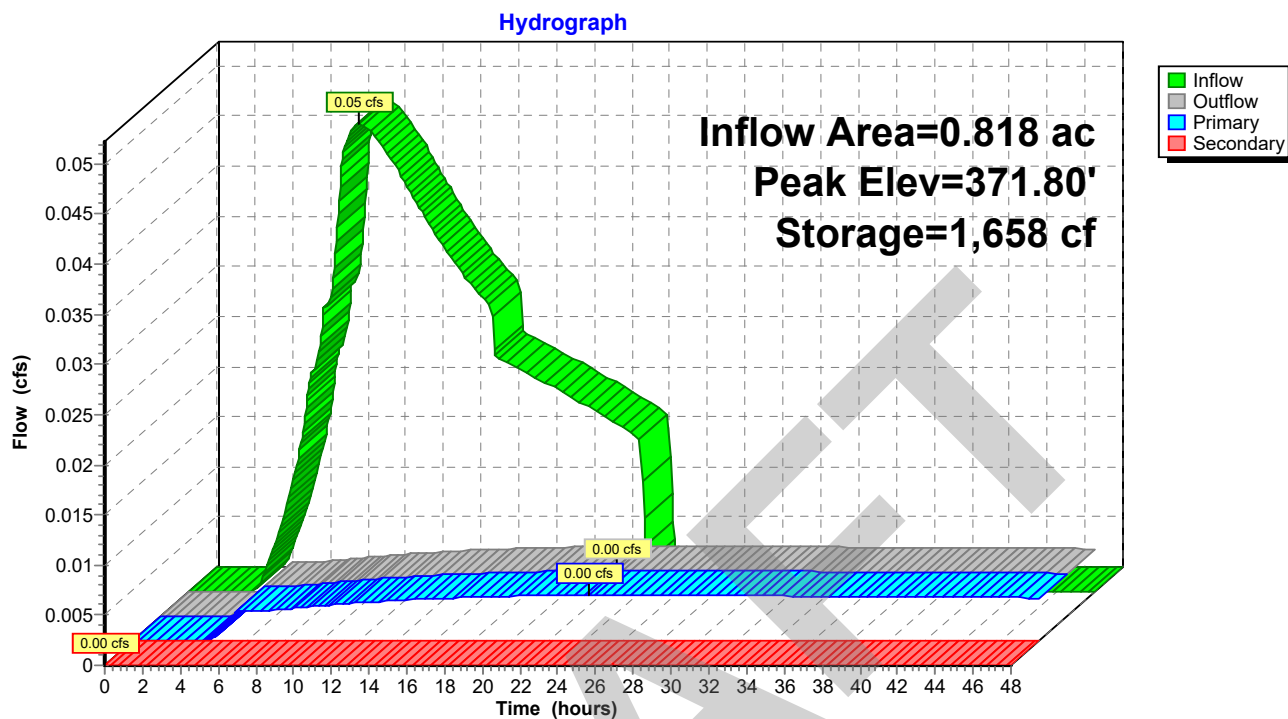
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Type IA 24-hr Half 2-Year Rainfall=1.10"

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Pond 3S: ROCK STORAGE



7563 Prelim HydroCAD Model

Type IA 24-hr Half 2-Year Rainfall=1.10"

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Summary for Pond 4S: Flow control and storage above WQ

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Peak Elev= 375.75' @ 0.00 hrs Surf.Area= 1,800 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)

Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	375.75'	3,063 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.75	1,800	0	0
377.00	3,100	3,063	3,063
Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	10.0" Round Outlet L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 368.00' / 367.50' S= 0.1000 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#2	Device 1	372.00'	1.1" Horiz. 10 yr orifice C= 0.600 Limited to weir flow at low heads
#3	Device 1	376.60'	10.0" Horiz. Overflow C= 0.600 Limited to weir flow at low heads

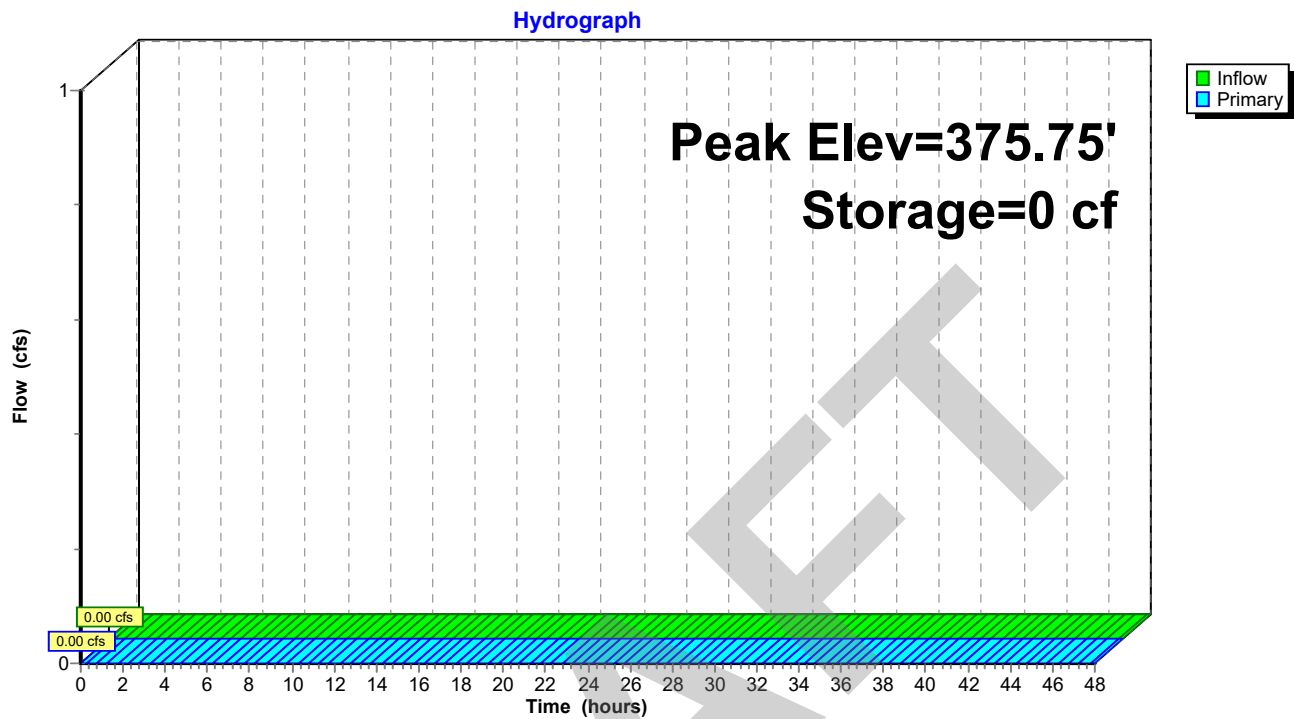
Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=375.75' (Free Discharge)

1=Outlet (Passes 0.00 cfs of 7.11 cfs potential flow)

2=10 yr orifice (Passes 0.00 cfs of 0.06 cfs potential flow)

3=Overflow (Controls 0.00 cfs)

Pond 4S: Flow control and storage above WQ



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Type IA 24-hr Half 2-Year Rainfall=1.10"

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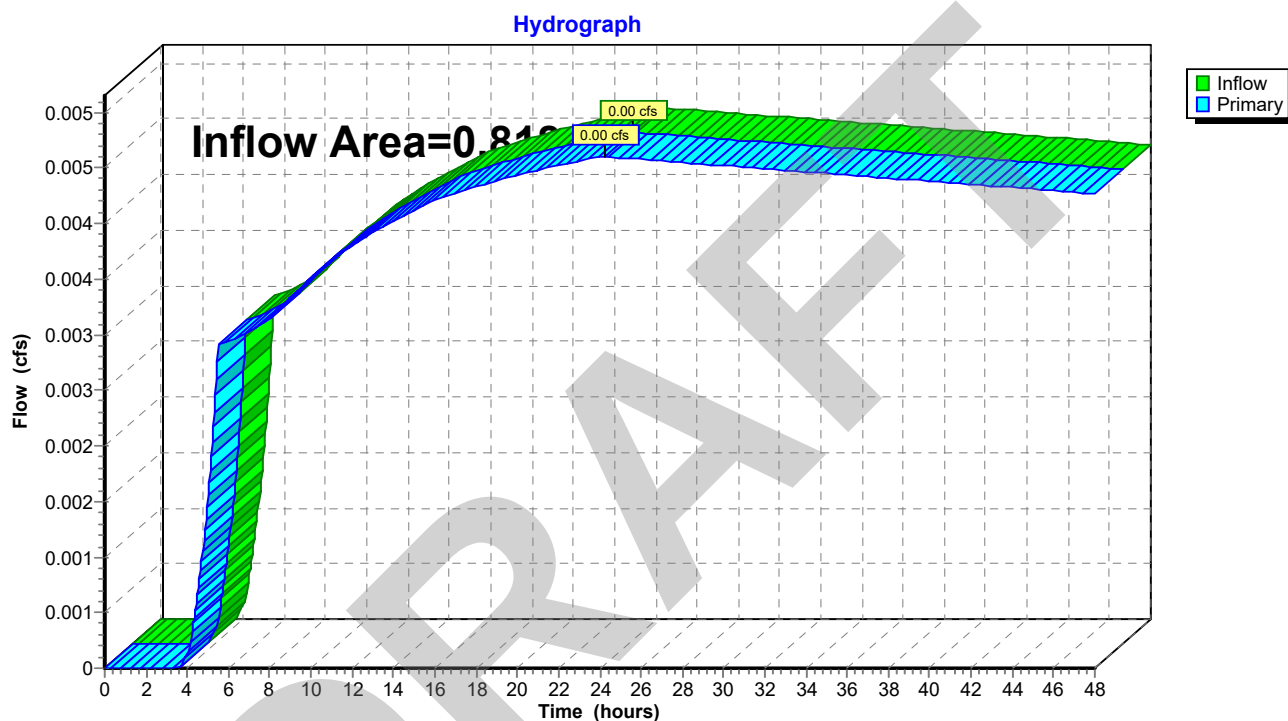
Page 12

Summary for Link 5S: POST-DEVELOPED RELEASED

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth > 0.22" for Half 2-Year event
Inflow = 0.00 cfs @ 24.20 hrs, Volume= 0.015 af
Primary = 0.00 cfs @ 24.20 hrs, Volume= 0.015 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link 5S: POST-DEVELOPED RELEASED



7563 Prelim HydroCAD Model

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Type IA 24-hr WQ Rainfall=1.38"

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Summary for Subcatchment POST: POST-DEVELOPED

Runoff = 0.18 cfs @ 7.97 hrs, Volume= 0.062 af, Depth= 0.90"

Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

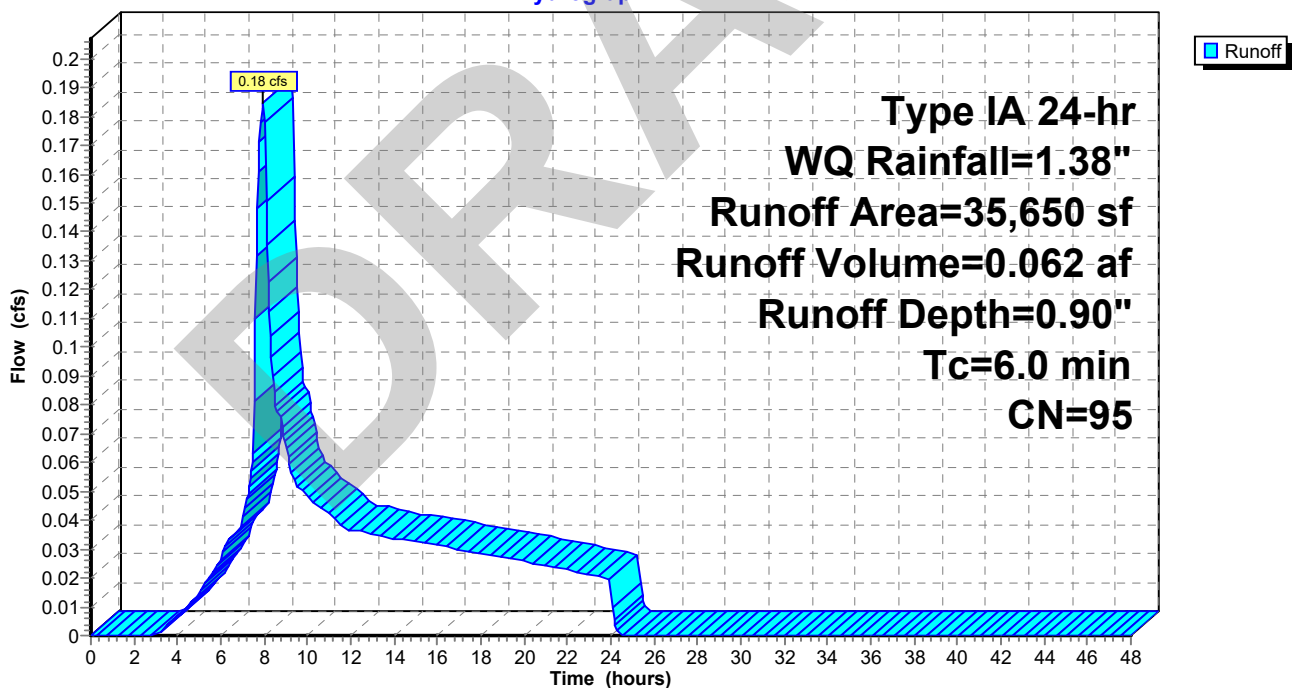
Type IA 24-hr WQ Rainfall=1.38"

Area (sf)	CN	Description
21,210	98	Paved parking, HSG C
3,175	74	>75% Grass cover, Good, HSG C
831	74	>75% Grass cover, Good, HSG C
* 10,434	98	Entry Road
35,650	95	Weighted Average
4,006	74	11.24% Pervious Area
31,644	98	88.76% Impervious Area

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

Subcatchment POST: POST-DEVELOPED

Hydrograph



7563 Prelim HydroCAD Model

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Type IA 24-hr WQ Rainfall=1.38"

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Summary for Subcatchment PRE: PRE-DEVELOPED

Runoff = 0.01 cfs @ 20.32 hrs, Volume= 0.006 af, Depth= 0.08"

Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

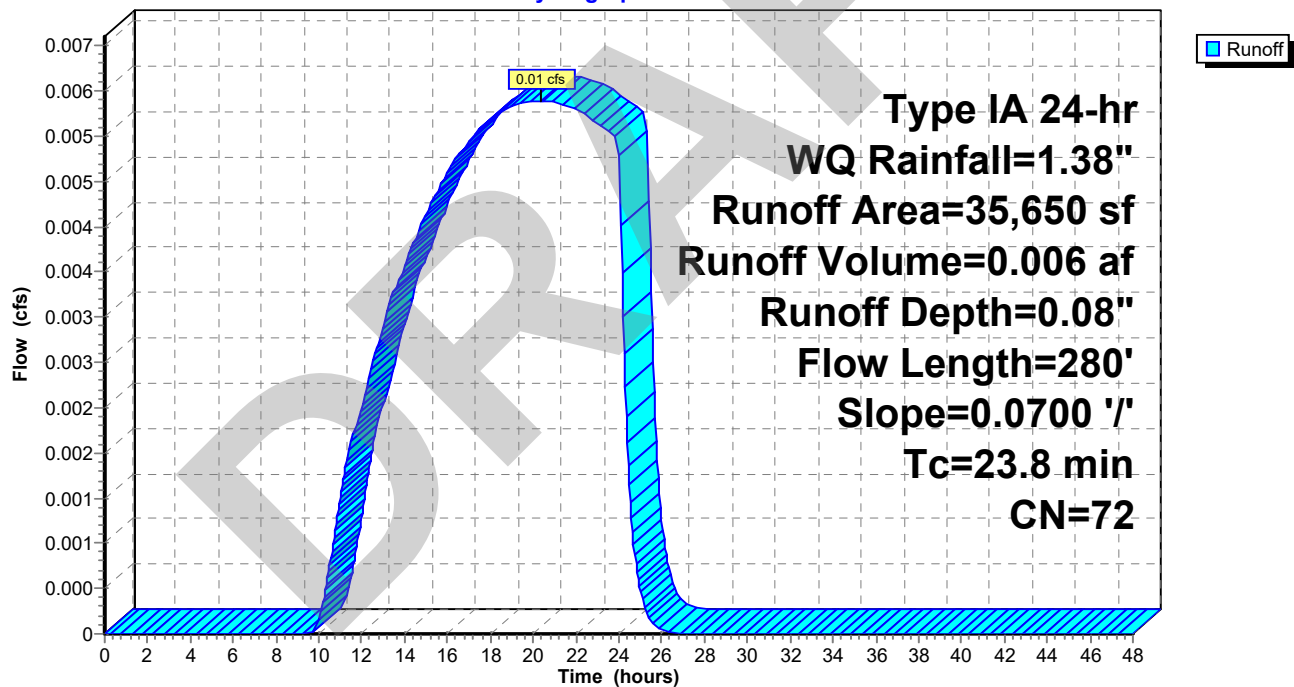
Type IA 24-hr WQ Rainfall=1.38"

	Area (sf)	CN	Description
*	35,650	72	City of Slaem Pre-Development; HSG C
	35,650	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	280	0.0700	0.20		Sheet Flow, Grass: Dense n= 0.240 P2= 2.20"

Subcatchment PRE: PRE-DEVELOPED

Hydrograph



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Type IA 24-hr WQ Rainfall=1.38"

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Summary for Pond 2S: ONSITE FACILITY-Below WQ

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 0.90" for WQ event
 Inflow = 0.18 cfs @ 7.97 hrs, Volume= 0.062 af
 Outflow = 0.06 cfs @ 9.24 hrs, Volume= 0.062 af, Atten= 69%, Lag= 76.1 min
 Primary = 0.06 cfs @ 9.24 hrs, Volume= 0.062 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 375.44' @ 9.24 hrs Surf.Area= 1,242 sf Storage= 404 cf

Plug-Flow detention time= 61.2 min calculated for 0.061 af (100% of inflow)
 Center-of-Mass det. time= 61.2 min (817.5 - 756.4)

Volume	Invert	Avail.Storage	Storage Description
#1	375.00'	863 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.00	600	0	0
375.75	1,700	863	863

Device	Routing	Invert	Outlet Devices
#1	Primary	375.00'	2.000 in/hr Exfiltration Through Growing Medium over Surface area
#2	Secondary	375.55'	10.0" Horiz. Overflow above WQ C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.06 cfs @ 9.24 hrs HW=375.44' (Free Discharge)
 ↑ **1=Exfiltration Through Growing Medium** (Exfiltration Controls 0.06 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=375.00' (Free Discharge)
 ↑ **2=Overflow above WQ** (Controls 0.00 cfs)

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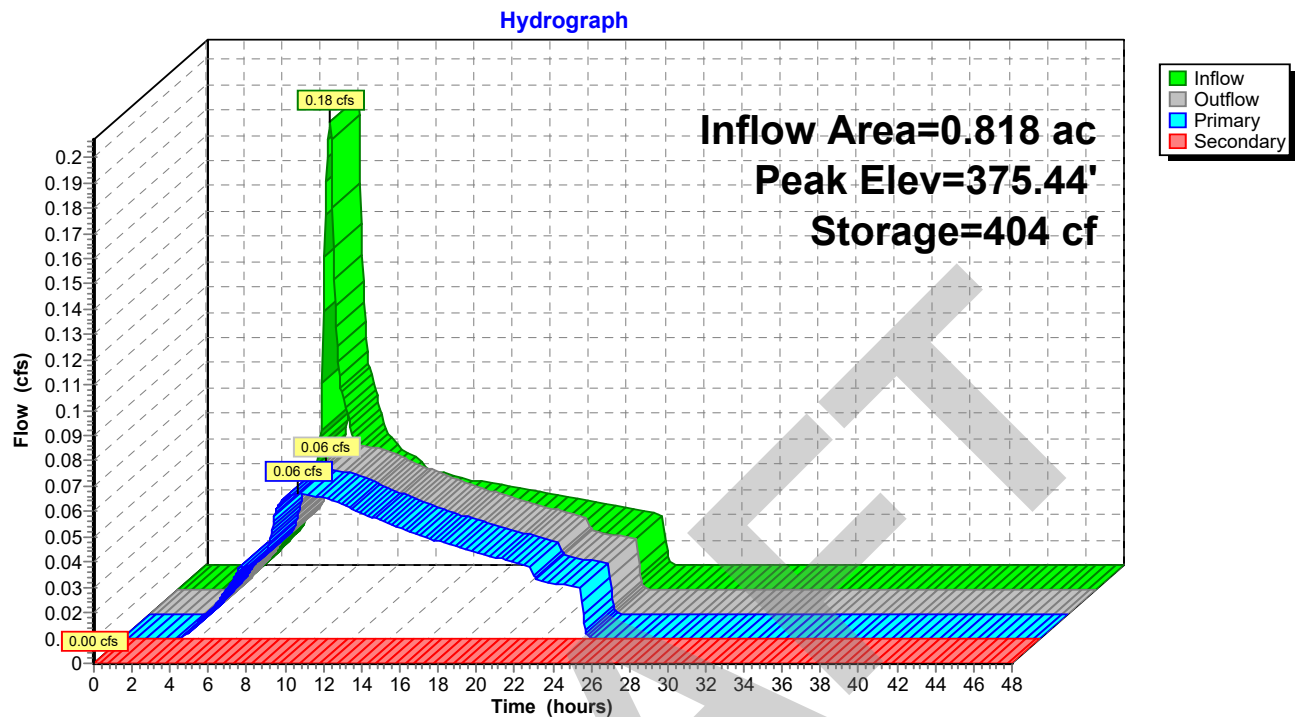
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Type IA 24-hr WQ Rainfall=1.38"

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Pond 2S: ONSITE FACILITY-Below WQ



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Type IA 24-hr WQ Rainfall=1.38"

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Summary for Pond 3S: ROCK STORAGE

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 0.90" for WQ event
 Inflow = 0.06 cfs @ 9.24 hrs, Volume= 0.062 af
 Outflow = 0.01 cfs @ 24.22 hrs, Volume= 0.017 af, Atten= 91%, Lag= 899.0 min
 Primary = 0.01 cfs @ 24.22 hrs, Volume= 0.017 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 372.80' @ 24.22 hrs Surf.Area= 1,800 sf Storage= 2,375 cf

Plug-Flow detention time= 1,177.7 min calculated for 0.017 af (27% of inflow)
 Center-of-Mass det. time= 824.2 min (1,641.8 - 817.5)

Volume	Invert	Avail.Storage	Storage Description
#1	369.50'	2,700 cf	Custom Stage Data (Prismatic) Listed below (Recalc) 6,750 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
369.50	1,800	0	0
373.25	1,800	6,750	6,750

Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	0.3" Vert. Orifice/Grate C= 0.600
#2	Secondary	373.00'	4.0" Vert. Overflow C= 0.600

Primary OutFlow Max=0.01 cfs @ 24.22 hrs HW=372.80' (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.01 cfs @ 10.53 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=369.50' (Free Discharge)
 ↑2=Overflow (Controls 0.00 cfs)

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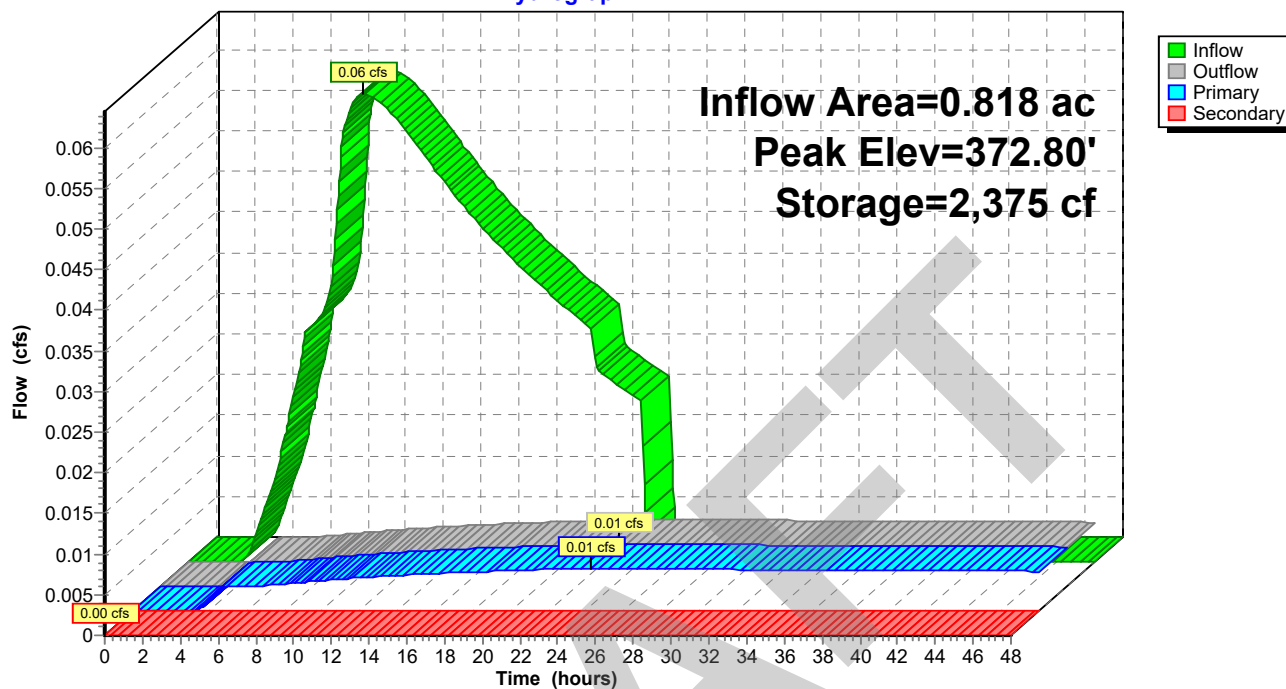
Type IA 24-hr WQ Rainfall=1.38"

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Pond 3S: ROCK STORAGE

Hydrograph



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Type IA 24-hr WQ Rainfall=1.38"

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Summary for Pond 4S: Flow control and storage above WQ

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Peak Elev= 375.75' @ 0.00 hrs Surf.Area= 1,800 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)

Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	375.75'	3,063 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.75	1,800	0	0
377.00	3,100	3,063	3,063

Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	10.0" Round Outlet L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 368.00' / 367.50' S= 0.1000 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#2	Device 1	372.00'	1.1" Horiz. 10 yr orifice C= 0.600 Limited to weir flow at low heads
#3	Device 1	376.60'	10.0" Horiz. Overflow C= 0.600 Limited to weir flow at low heads

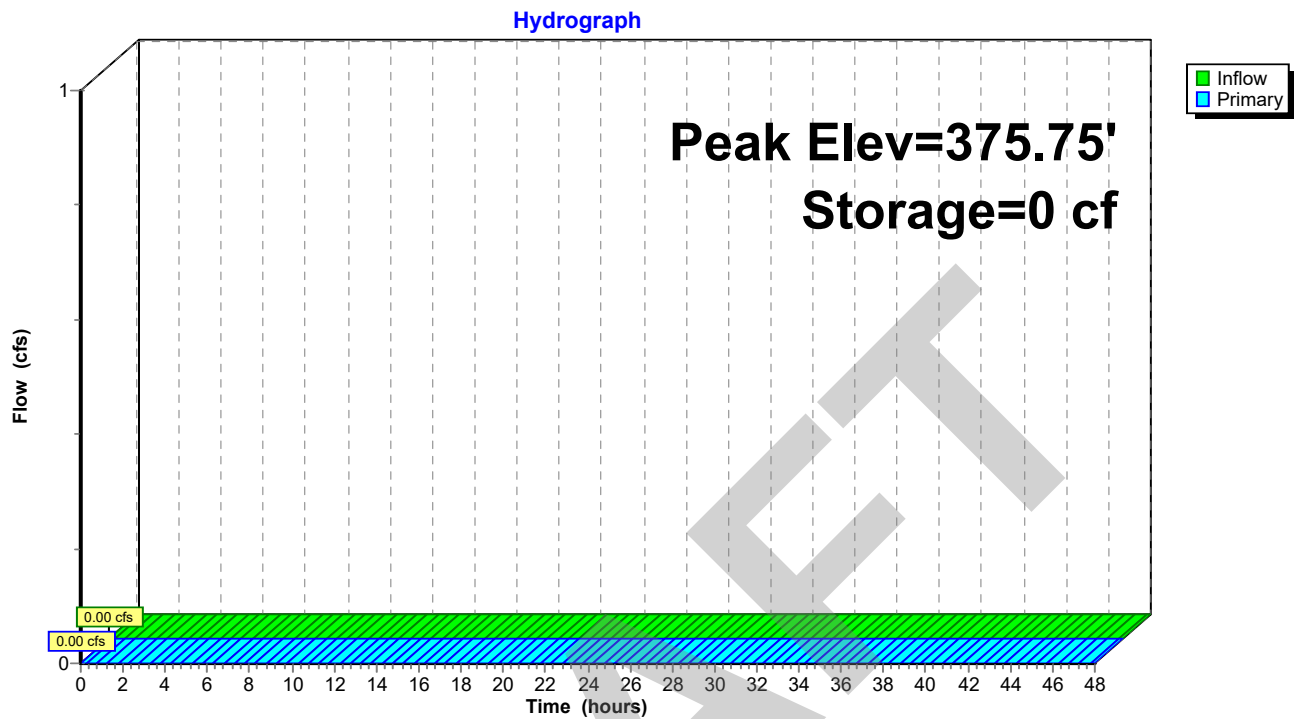
Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=375.75' (Free Discharge)

1=Outlet (Passes 0.00 cfs of 7.11 cfs potential flow)

2=10 yr orifice (Passes 0.00 cfs of 0.06 cfs potential flow)

3=Overflow (Controls 0.00 cfs)

Pond 4S: Flow control and storage above WQ



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Type IA 24-hr WQ Rainfall=1.38"

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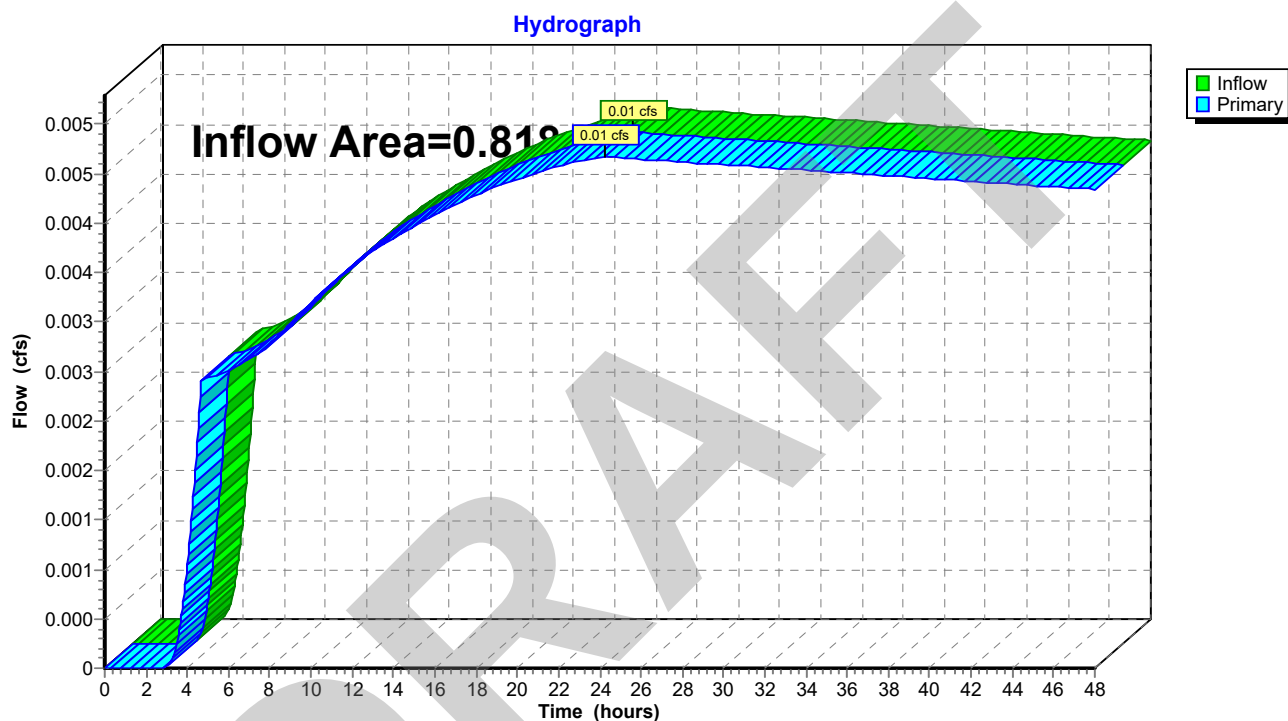
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Summary for Link 5S: POST-DEVELOPED RELEASED

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth > 0.25" for WQ event
Inflow = 0.01 cfs @ 24.22 hrs, Volume= 0.017 af
Primary = 0.01 cfs @ 24.22 hrs, Volume= 0.017 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link 5S: POST-DEVELOPED RELEASED



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Type IA 24-hr 10-Year Rainfall=3.20"

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Summary for Subcatchment POST: POST-DEVELOPED

Runoff = 0.55 cfs @ 7.93 hrs, Volume= 0.180 af, Depth= 2.64"

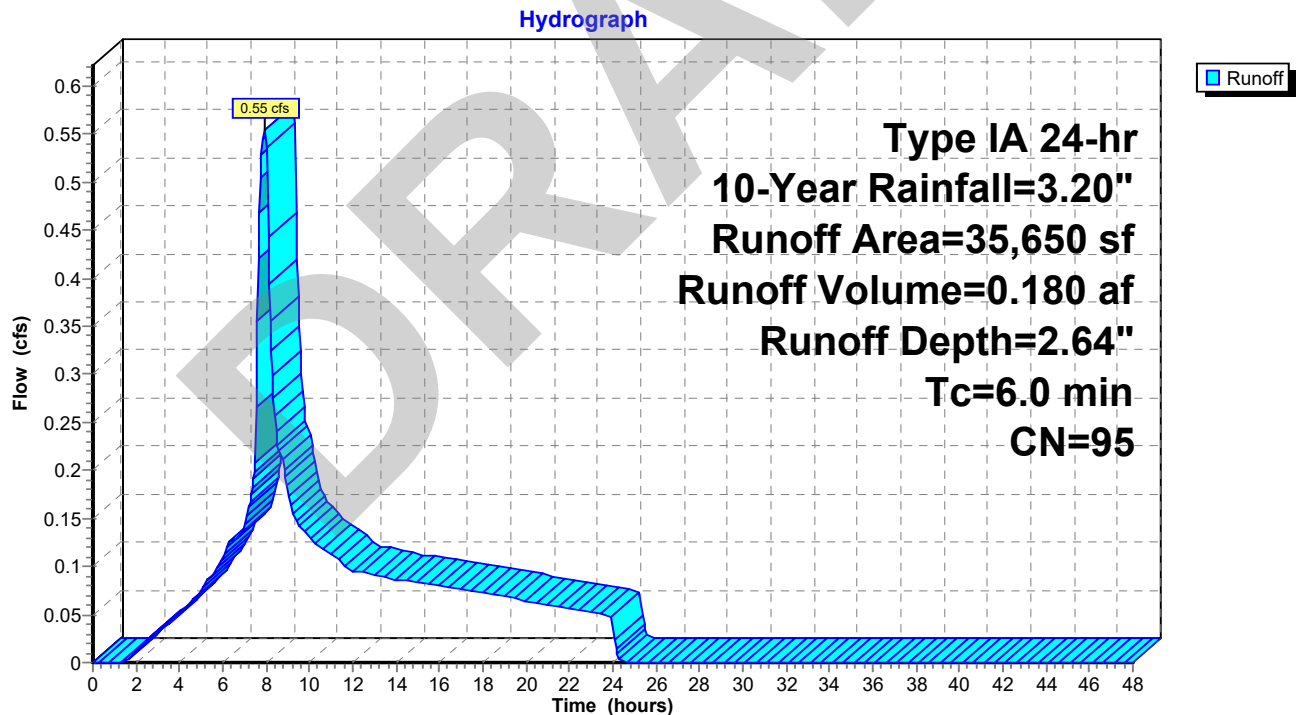
Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Type IA 24-hr 10-Year Rainfall=3.20"

Area (sf)	CN	Description
21,210	98	Paved parking, HSG C
3,175	74	>75% Grass cover, Good, HSG C
831	74	>75% Grass cover, Good, HSG C
* 10,434	98	Entry Road
35,650	95	Weighted Average
4,006	74	11.24% Pervious Area
31,644	98	88.76% Impervious Area

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

Subcatchment POST: POST-DEVELOPED



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Type IA 24-hr 10-Year Rainfall=3.20"

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Summary for Subcatchment PRE: PRE-DEVELOPED

Runoff = 0.09 cfs @ 8.15 hrs, Volume= 0.063 af, Depth= 0.93"

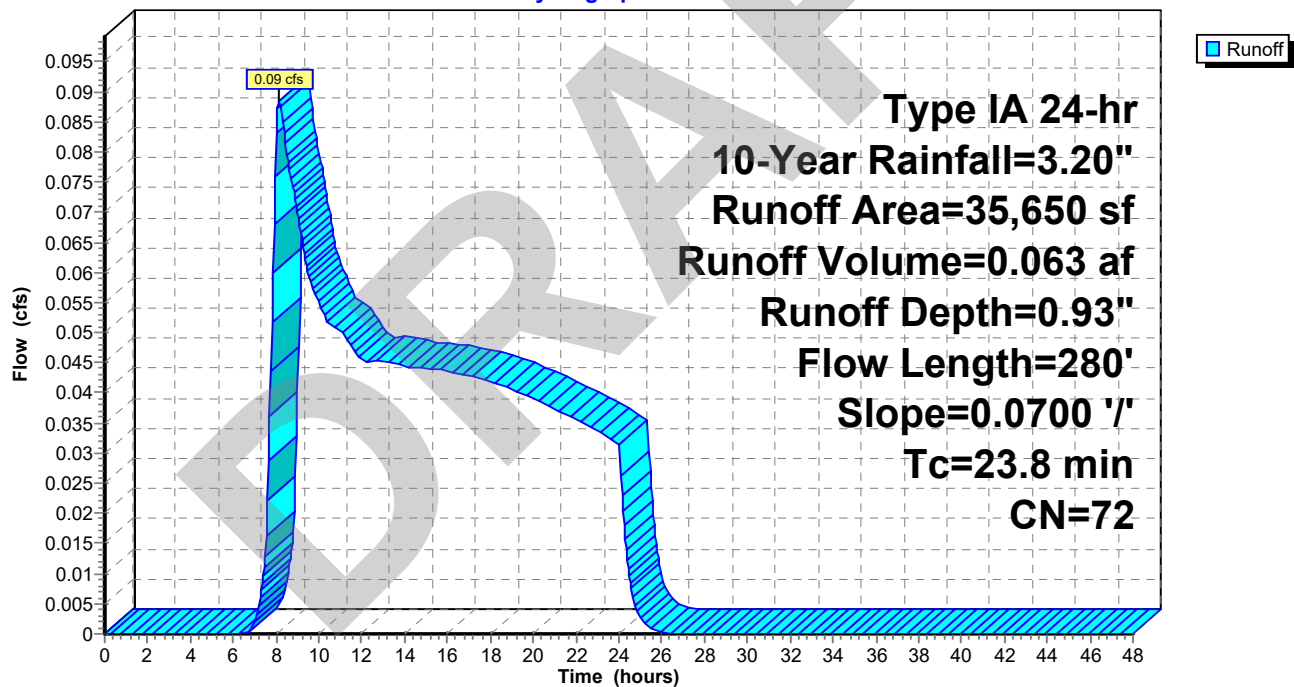
Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	35,650	72	City of Slaem Pre-Development; HSG C
	35,650	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	280	0.0700	0.20		Sheet Flow, Grass: Dense n= 0.240 P2= 2.20"

Subcatchment PRE: PRE-DEVELOPED

Hydrograph



7563 Prelim HydroCAD Model

Type IA 24-hr 10-Year Rainfall=3.20"

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Summary for Pond 2S: ONSITE FACILITY-Below WQ

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 2.64" for 10-Year event
 Inflow = 0.55 cfs @ 7.93 hrs, Volume= 0.180 af
 Outflow = 0.54 cfs @ 8.01 hrs, Volume= 0.180 af, Atten= 3%, Lag= 4.5 min
 Primary = 0.07 cfs @ 8.01 hrs, Volume= 0.120 af
 Secondary = 0.46 cfs @ 8.01 hrs, Volume= 0.060 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 375.69' @ 8.01 hrs Surf.Area= 1,617 sf Storage= 769 cf

Plug-Flow detention time= 85.3 min calculated for 0.180 af (100% of inflow)
 Center-of-Mass det. time= 85.4 min (788.8 - 703.4)

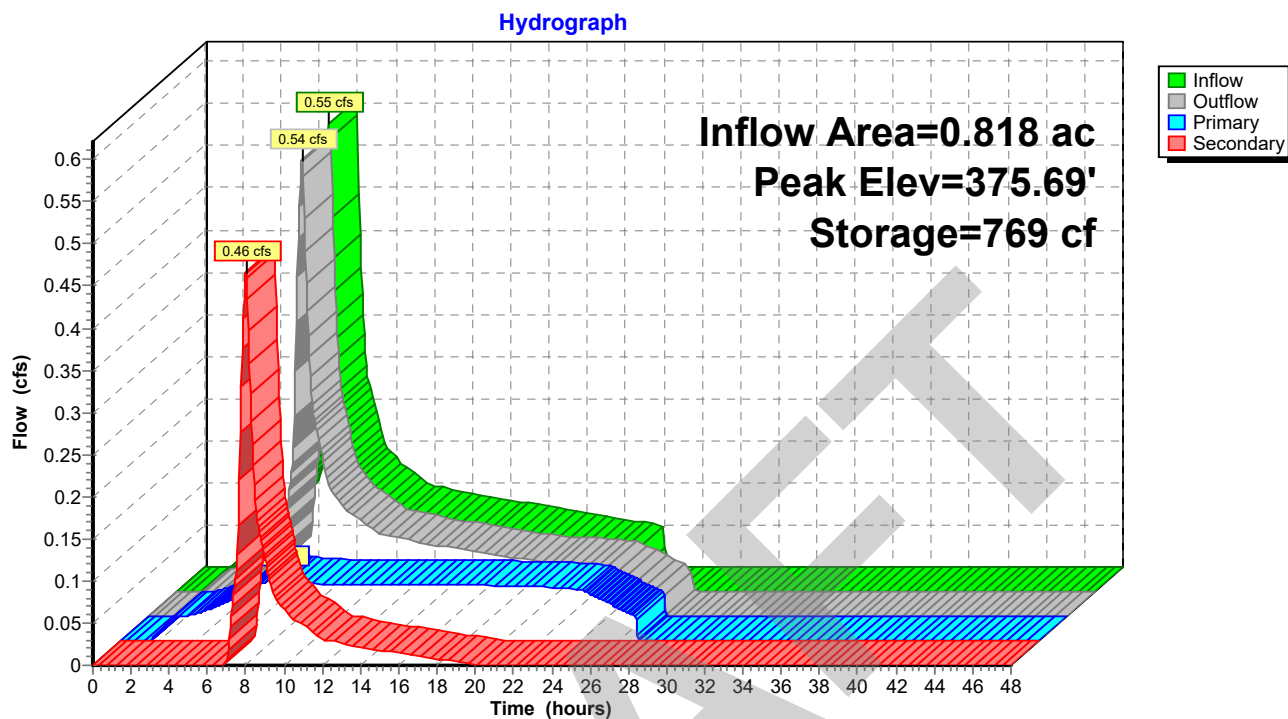
Volume	Invert	Avail.Storage	Storage Description
#1	375.00'	863 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.00	600	0	0
375.75	1,700	863	863

Device	Routing	Invert	Outlet Devices
#1	Primary	375.00'	2.000 in/hr Exfiltration Through Growing Medium over Surface area
#2	Secondary	375.55'	10.0" Horiz. Overflow above WQ C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.07 cfs @ 8.01 hrs HW=375.69' (Free Discharge)
 ↑1=Exfiltration Through Growing Medium (Exfiltration Controls 0.07 cfs)

Secondary OutFlow Max=0.46 cfs @ 8.01 hrs HW=375.69' (Free Discharge)
 ↑2=Overflow above WQ (Weir Controls 0.46 cfs @ 1.24 fps)

Pond 2S: ONSITE FACILITY-Below WQ



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Type IA 24-hr 10-Year Rainfall=3.20"

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Summary for Pond 3S: ROCK STORAGE

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 1.76" for 10-Year event
 Inflow = 0.07 cfs @ 8.01 hrs, Volume= 0.120 af
 Outflow = 0.07 cfs @ 17.70 hrs, Volume= 0.070 af, Atten= 12%, Lag= 581.5 min
 Primary = 0.01 cfs @ 17.70 hrs, Volume= 0.019 af
 Secondary = 0.06 cfs @ 17.70 hrs, Volume= 0.052 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 373.17' @ 17.70 hrs Surf.Area= 1,800 sf Storage= 2,639 cf

Plug-Flow detention time= 731.3 min calculated for 0.070 af (59% of inflow)
 Center-of-Mass det. time= 453.7 min (1,345.7 - 892.0)

Volume	Invert	Avail.Storage	Storage Description
#1	369.50'	2,700 cf	Custom Stage Data (Prismatic) Listed below (Recalc) 6,750 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
369.50	1,800	0	0
373.25	1,800	6,750	6,750

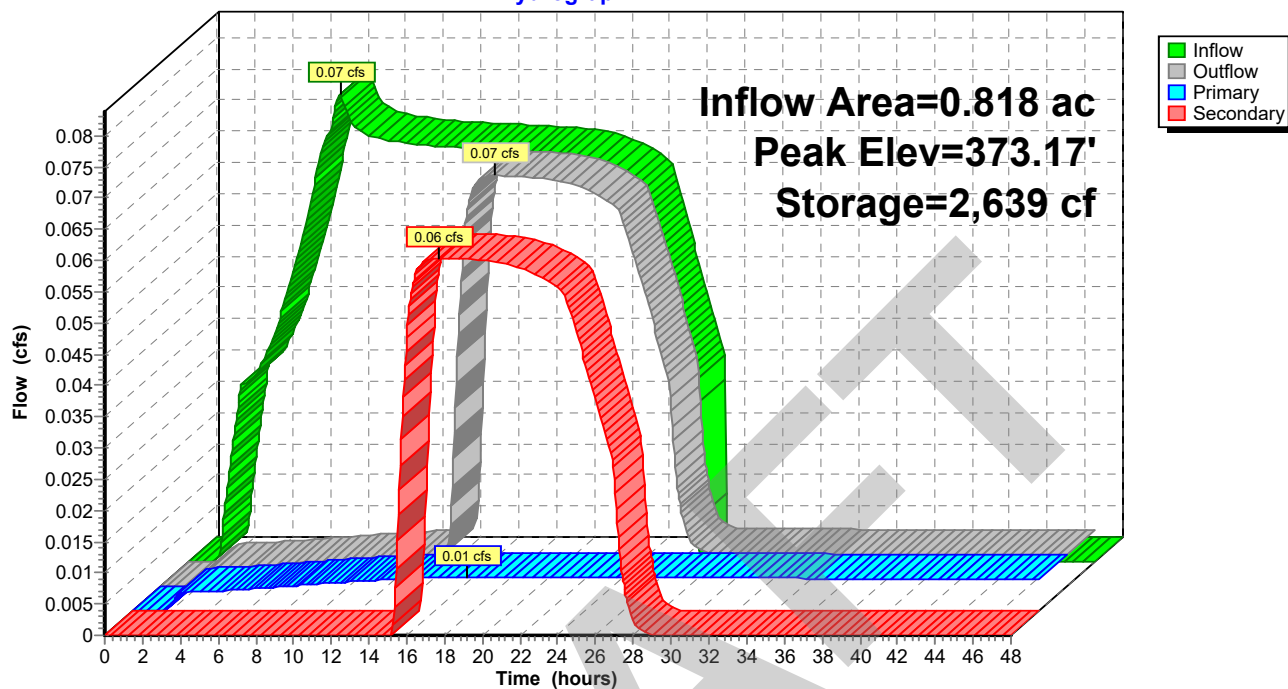
Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	0.3" Vert. Orifice/Grate C= 0.600
#2	Secondary	373.00'	4.0" Vert. Overflow C= 0.600

Primary OutFlow Max=0.01 cfs @ 17.70 hrs HW=373.17' (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.01 cfs @ 10.93 fps)

Secondary OutFlow Max=0.06 cfs @ 17.70 hrs HW=373.17' (Free Discharge)
 ↑2=Overflow (Orifice Controls 0.06 cfs @ 1.39 fps)

Pond 3S: ROCK STORAGE

Hydrograph



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Type IA 24-hr 10-Year Rainfall=3.20"

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Summary for Pond 4S: Flow control and storage above WQ

Inflow = 0.46 cfs @ 8.01 hrs, Volume= 0.112 af
 Outflow = 0.07 cfs @ 10.05 hrs, Volume= 0.112 af, Atten= 86%, Lag= 122.4 min
 Primary = 0.07 cfs @ 10.05 hrs, Volume= 0.112 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 376.32' @ 10.05 hrs Surf.Area= 2,397 sf Storage= 1,204 cf

Plug-Flow detention time= 165.9 min calculated for 0.112 af (100% of inflow)
 Center-of-Mass det. time= 165.7 min (1,064.2 - 898.5)

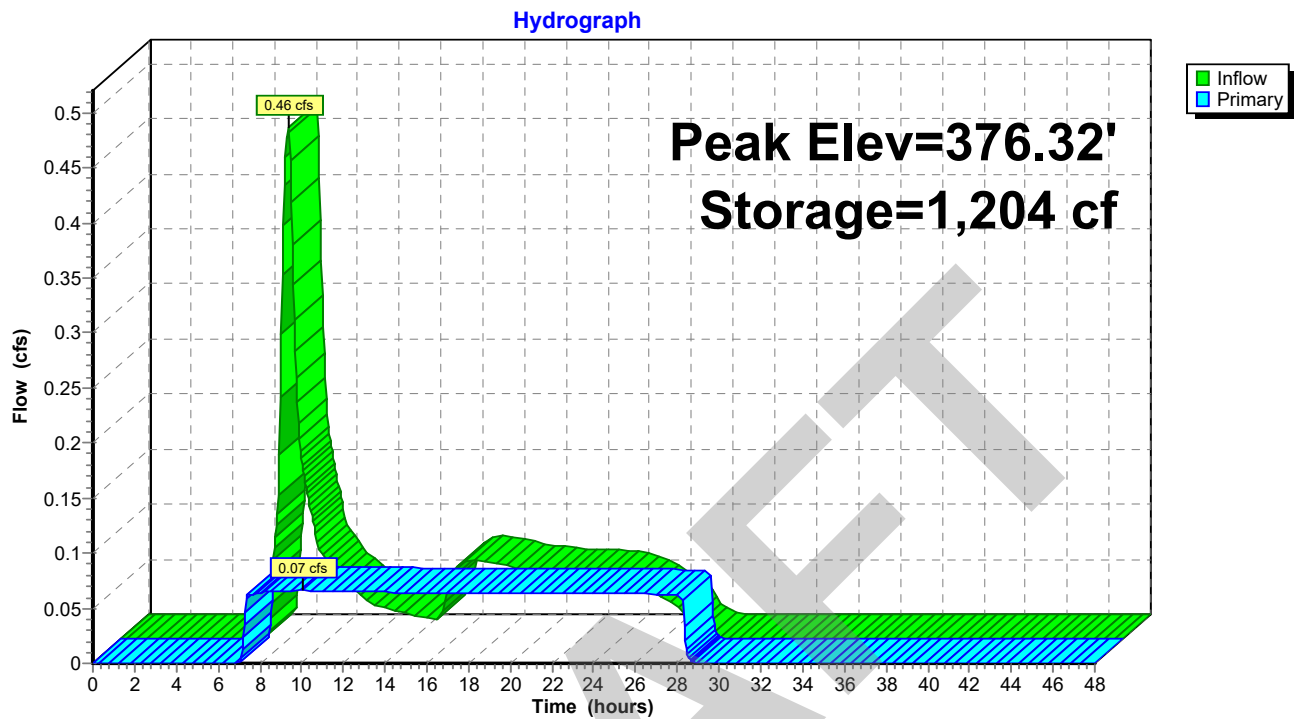
Volume	Invert	Avail.Storage	Storage Description
#1	375.75'	3,063 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.75	1,800	0	0
377.00	3,100	3,063	3,063

Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	10.0" Round Outlet L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 368.00' / 367.50' S= 0.1000 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#2	Device 1	372.00'	1.1" Horiz. 10 yr orifice C= 0.600 Limited to weir flow at low heads
#3	Device 1	376.60'	10.0" Horiz. Overflow C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.07 cfs @ 10.05 hrs HW=376.32' (Free Discharge)

- ↑ **1=Outlet** (Passes 0.07 cfs of 7.38 cfs potential flow)
- ↑ **2=10 yr orifice** (Orifice Controls 0.07 cfs @ 10.01 fps)
- ↑ **3=Overflow** (Controls 0.00 cfs)

Pond 4S: Flow control and storage above WQ

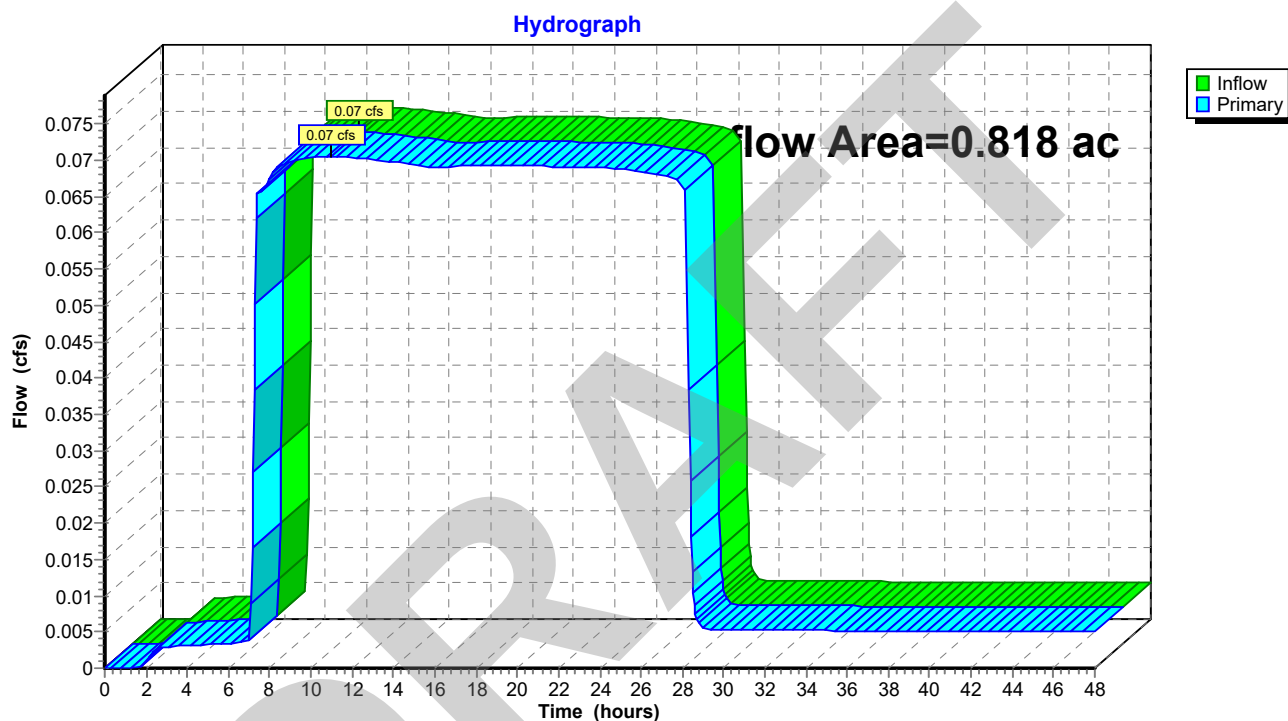


Summary for Link 5S: POST-DEVELOPED RELEASED

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth > 1.92" for 10-Year event
 Inflow = 0.07 cfs @ 10.95 hrs, Volume= 0.131 af
 Primary = 0.07 cfs @ 10.95 hrs, Volume= 0.131 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link 5S: POST-DEVELOPED RELEASED



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Type IA 24-hr 100 Rainfall=4.40"

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Summary for Subcatchment POST: POST-DEVELOPED

Runoff = 0.80 cfs @ 7.92 hrs, Volume= 0.261 af, Depth= 3.83"

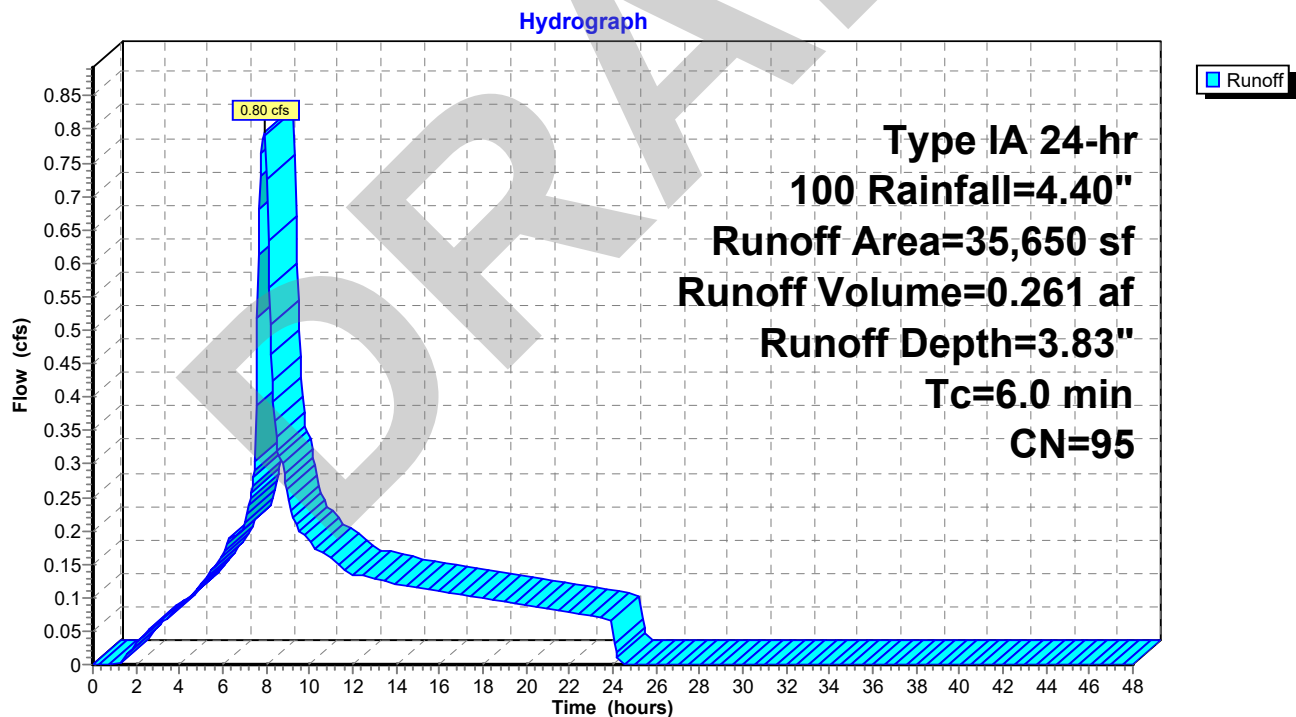
Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Type IA 24-hr 100 Rainfall=4.40"

Area (sf)	CN	Description
21,210	98	Paved parking, HSG C
3,175	74	>75% Grass cover, Good, HSG C
831	74	>75% Grass cover, Good, HSG C
* 10,434	98	Entry Road
35,650	95	Weighted Average
4,006	74	11.24% Pervious Area
31,644	98	88.76% Impervious Area

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

Subcatchment POST: POST-DEVELOPED



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Type IA 24-hr 100 Rainfall=4.40"

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Summary for Subcatchment PRE: PRE-DEVELOPED

Runoff = 0.22 cfs @ 8.07 hrs, Volume= 0.119 af, Depth= 1.75"

Runoff by SBUH method, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

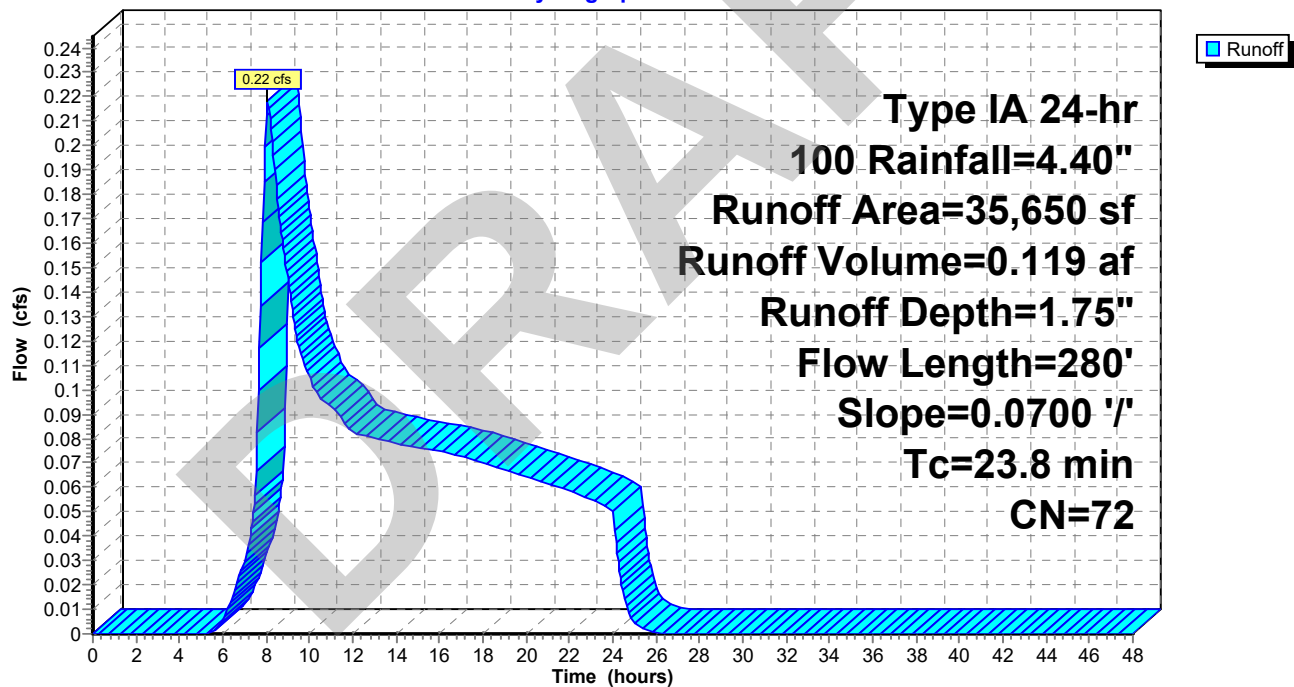
Type IA 24-hr 100 Rainfall=4.40"

	Area (sf)	CN	Description
*	35,650	72	City of Slaem Pre-Development; HSG C
	35,650	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	280	0.0700	0.20		Sheet Flow, Grass: Dense n= 0.240 P2= 2.20"

Subcatchment PRE: PRE-DEVELOPED

Hydrograph



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Type IA 24-hr 100 Rainfall=4.40"

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Summary for Pond 2S: ONSITE FACILITY-Below WQ

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 3.83" for 100 event
 Inflow = 0.80 cfs @ 7.92 hrs, Volume= 0.261 af
 Outflow = 0.78 cfs @ 8.00 hrs, Volume= 0.261 af, Atten= 2%, Lag= 4.3 min
 Primary = 0.08 cfs @ 8.00 hrs, Volume= 0.131 af
 Secondary = 0.70 cfs @ 8.00 hrs, Volume= 0.130 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 375.74' @ 8.00 hrs Surf.Area= 1,684 sf Storage= 844 cf

Plug-Flow detention time= 67.6 min calculated for 0.261 af (100% of inflow)
 Center-of-Mass det. time= 67.7 min (756.6 - 688.9)

Volume	Invert	Avail.Storage	Storage Description
#1	375.00'	863 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.00	600	0	0
375.75	1,700	863	863

Device	Routing	Invert	Outlet Devices
#1	Primary	375.00'	2.000 in/hr Exfiltration Through Growing Medium over Surface area
#2	Secondary	375.55'	10.0" Horiz. Overflow above WQ C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.08 cfs @ 8.00 hrs HW=375.74' (Free Discharge)
 ↑ **1=Exfiltration Through Growing Medium** (Exfiltration Controls 0.08 cfs)

Secondary OutFlow Max=0.70 cfs @ 8.00 hrs HW=375.74' (Free Discharge)
 ↑ **2=Overflow above WQ** (Weir Controls 0.70 cfs @ 1.42 fps)

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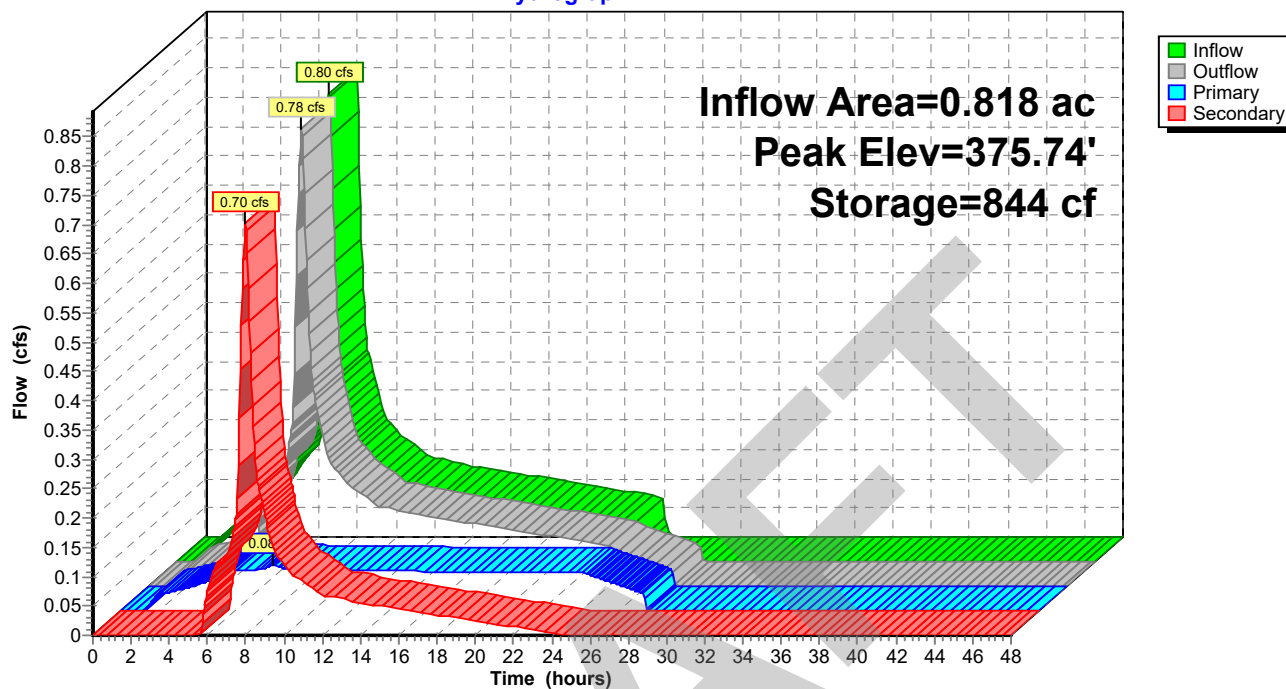
Type IA 24-hr 100 Rainfall=4.40"

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Pond 2S: ONSITE FACILITY-Below WQ

Hydrograph



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Type IA 24-hr 100 Rainfall=4.40"

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Summary for Pond 3S: ROCK STORAGE

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth = 1.92" for 100 event
 Inflow = 0.08 cfs @ 8.00 hrs, Volume= 0.131 af
 Outflow = 0.07 cfs @ 16.54 hrs, Volume= 0.081 af, Atten= 14%, Lag= 512.5 min
 Primary = 0.01 cfs @ 16.54 hrs, Volume= 0.019 af
 Secondary = 0.06 cfs @ 16.54 hrs, Volume= 0.062 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 373.17' @ 16.54 hrs Surf.Area= 1,800 sf Storage= 2,641 cf

Plug-Flow detention time= 706.4 min calculated for 0.081 af (62% of inflow)
 Center-of-Mass det. time= 434.7 min (1,314.0 - 879.2)

Volume	Invert	Avail.Storage	Storage Description
#1	369.50'	2,700 cf	Custom Stage Data (Prismatic) Listed below (Recalc) 6,750 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
369.50	1,800	0	0
373.25	1,800	6,750	6,750

Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	0.3" Vert. Orifice/Grate C= 0.600
#2	Secondary	373.00'	4.0" Vert. Overflow C= 0.600

Primary OutFlow Max=0.01 cfs @ 16.54 hrs HW=373.17' (Free Discharge)
 ↑ **1=Orifice/Grate** (Orifice Controls 0.01 cfs @ 10.93 fps)

Secondary OutFlow Max=0.06 cfs @ 16.54 hrs HW=373.17' (Free Discharge)
 ↑ **2=Overflow** (Orifice Controls 0.06 cfs @ 1.39 fps)

7563 Prelim HydroCAD Model

Prepared by AKS Engineering & Forestry

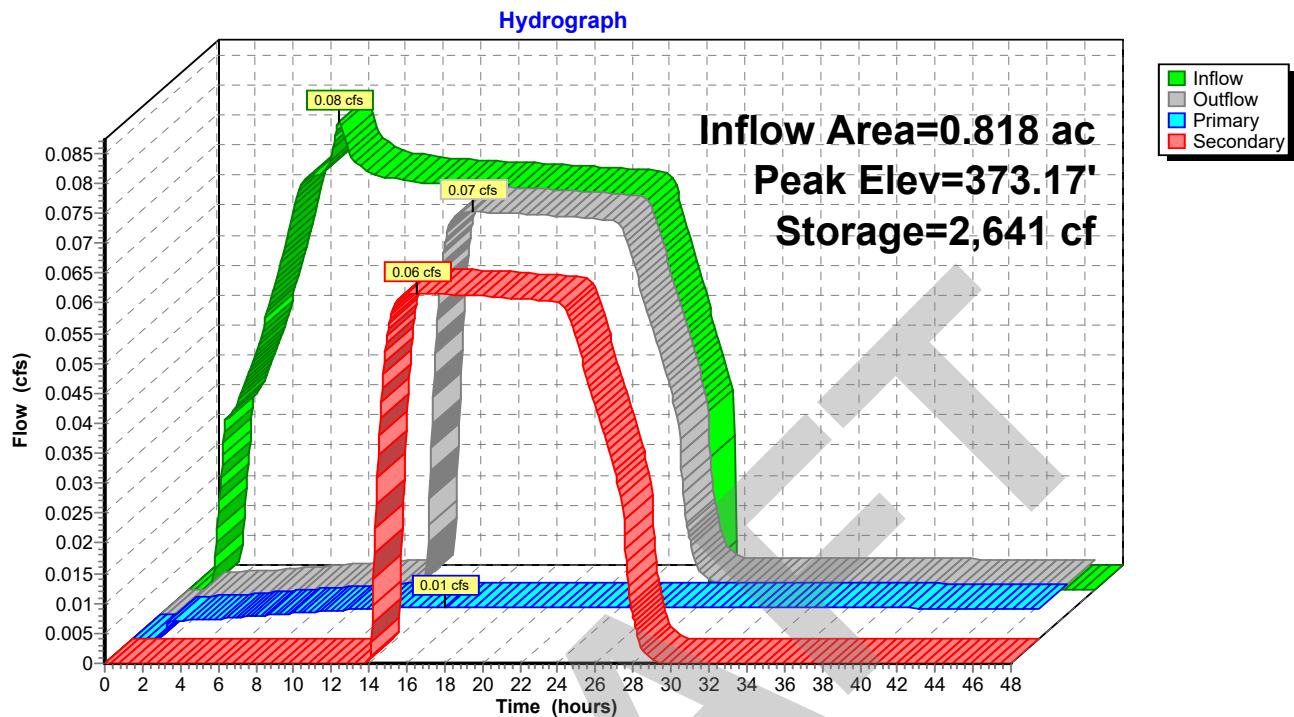
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Type IA 24-hr 100 Rainfall=4.40"

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Pond 3S: ROCK STORAGE



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Type IA 24-hr 100 Rainfall=4.40"

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Summary for Pond 4S: Flow control and storage above WQ

Inflow = 0.70 cfs @ 8.00 hrs, Volume= 0.192 af
 Outflow = 0.20 cfs @ 9.01 hrs, Volume= 0.192 af, Atten= 71%, Lag= 61.0 min
 Primary = 0.20 cfs @ 9.01 hrs, Volume= 0.192 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 376.66' @ 9.01 hrs Surf.Area= 2,749 sf Storage= 2,075 cf

Plug-Flow detention time= 313.6 min calculated for 0.192 af (100% of inflow)
 Center-of-Mass det. time= 313.7 min (1,142.7 - 829.1)

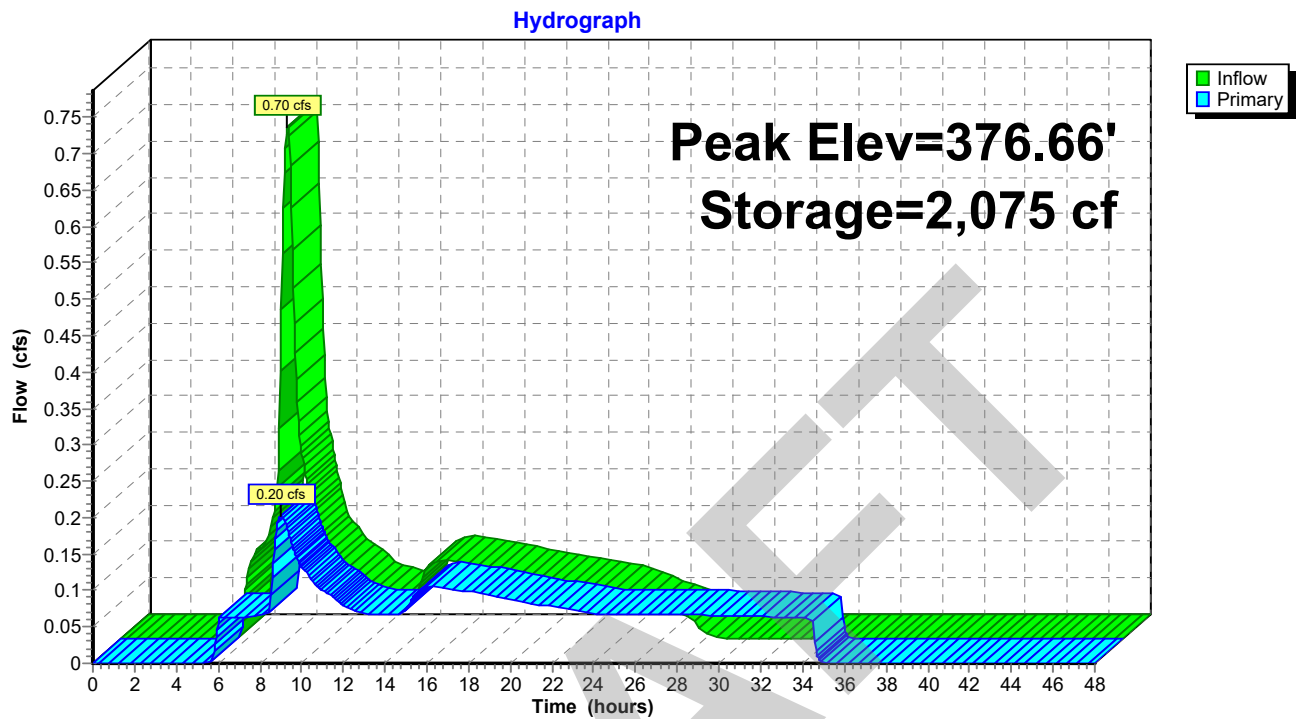
Volume	Invert	Avail.Storage	Storage Description
#1	375.75'	3,063 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
375.75	1,800	0	0
377.00	3,100	3,063	3,063

Device	Routing	Invert	Outlet Devices
#1	Primary	368.00'	10.0" Round Outlet L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 368.00' / 367.50' S= 0.1000 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#2	Device 1	372.00'	1.1" Horiz. 10 yr orifice C= 0.600 Limited to weir flow at low heads
#3	Device 1	376.60'	10.0" Horiz. Overflow C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.20 cfs @ 9.01 hrs HW=376.66' (Free Discharge)

- ↑ **1=Outlet** (Passes 0.20 cfs of 7.54 cfs potential flow)
- ↑ **2=10 yr orifice** (Orifice Controls 0.07 cfs @ 10.40 fps)
- ↑ **3=Overflow** (Weir Controls 0.13 cfs @ 0.82 fps)

Pond 4S: Flow control and storage above WQ



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Type IA 24-hr 100 Rainfall=4.40"

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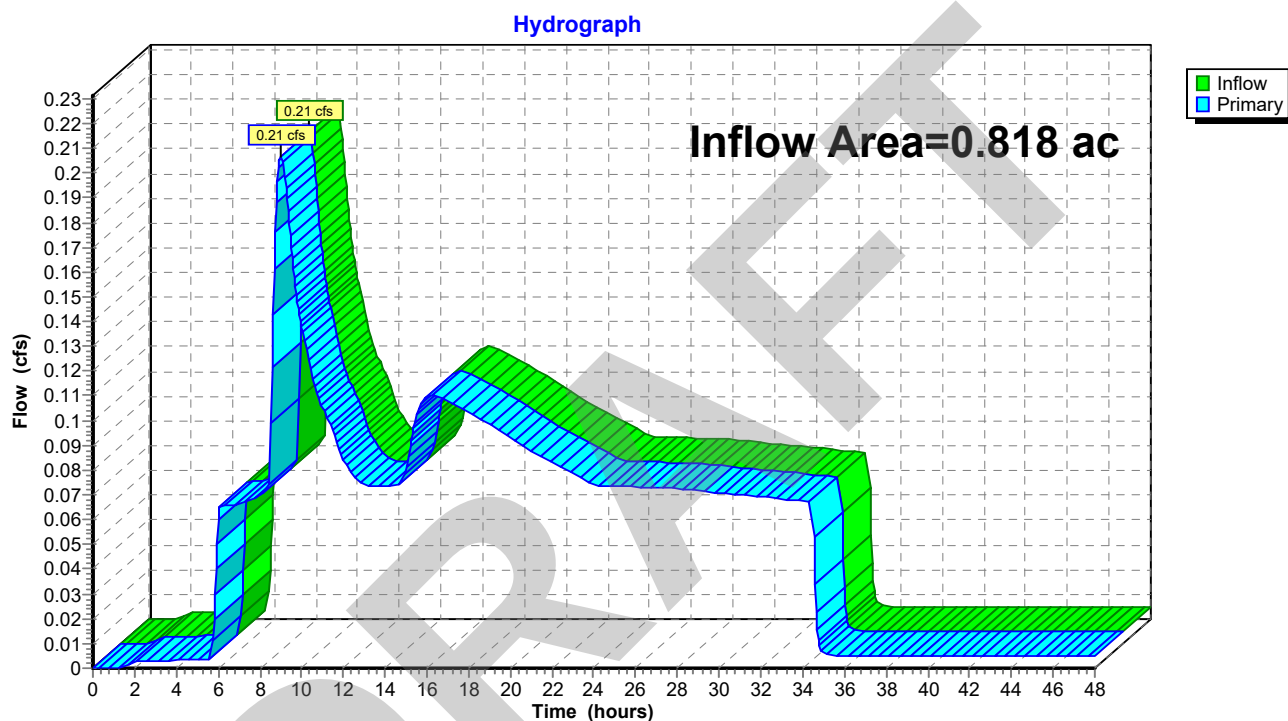
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Summary for Link 5S: POST-DEVELOPED RELEASED

Inflow Area = 0.818 ac, 88.76% Impervious, Inflow Depth > 3.09" for 100 event
Inflow = 0.21 cfs @ 9.01 hrs, Volume= 0.211 af
Primary = 0.21 cfs @ 9.01 hrs, Volume= 0.211 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link 5S: POST-DEVELOPED RELEASED



Appendix C: Operations & Maintenance Form

DRAFT

Appendix D: Reduced-Size Grading & Drainage Plan

DRAFT
