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24-0022-186

November 20, 2025

Ms. Holly A. Boyer, P.E.
Senior Utility Engineer
City of Gahanna
Engineering Department
200 S Hamilton Road
Gahanna, Ohio 43230

Re: 1201 Cherry Bottom Road
Academy Park – Development Plan (DP-25-12)
Stormwater Detention Waiver Request

Ms. Boyer,

We have been retained by POD Design and the City of Gahanna Division of Parks and Recreation to provide engineering design services for the Academy Park parking and facility improvements. The park is located inside the Big Walnut Creek floodplain as depicted in Exhibit A and currently does not have any stormwater BMPs in place. With the park land directly abutting and tributary to the Big Walnut Creek, we respectfully request a waiver from the City Stormwater Detention Regulations (1113.02 – Stormwater Management) in accordance with the City Regulations permitting waivers (113.02(e)(2)) for development area abutting and tributary to Big Walnut Creek on which surface water flows directly into the Big Walnut Creek. Our design will include a BMP per Ohio EPA Water Quality Regulations to treat stormwater runoff from the new impervious areas before releasing it to the Big Walnut Creek. Note that the storm water from the existing parking lot and the proposed parking lot expansion area drain into a ditch along the east side of the park that then flows directly into the Big Walnut Creek without crossing any other land parcels. By waiving detention requirements, the release of the peak flows associated with the park lands will enter the creek prior to the peak flow of the creek from upstream tributaries and eliminate adding to the peak.

Please find attached a stormwater management report to support our stance in the request for a waiver.

Thank you for your consideration regarding this request. Should you have questions or require additional information, do not hesitate to contact our office.

Sincerely,
ADVANCED CIVIL DESIGN

Curtis Echelberry
Project Manager

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THOMAS M. WARNER
E-64513
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STORM WATER MANAGEMENT REPORT
FOR
ACADEMY PARK IMPROVEMENTS

GAHANNA, OHIO

Prepared By:

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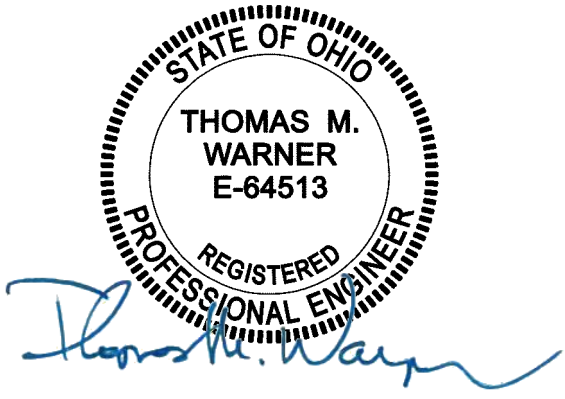
Date:
11/21/2025



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Site Summary:

The subject project includes various site improvements at the City of Gahanna's Academy Park property along the west side of Cherry Bottom Road, south of Coldwell Drive in the City of Gahanna. The project will consist of improvements to the existing parking lot, playground, path network and shelter building.

Design Methodology:

Stormwater management calculations within this report follow the guidance of the City of Gahanna's Stormwater Management Regulations for water quantity requirements, City of Gahanna's Stormwater Management Regulations and Ohio EPA regulations for water quality requirements. Hydrology and hydraulic were modeled with the HydroCAD software suite using TR-55 methodology and a Type-II rainfall distribution. Stormwater routing for the Johnstown Road Apartments was performed using the storage indication method.

The National Weather Service's Atlas 14's precipitation frequency estimates for the 1, 2, 5, 10, 25, 50, and 100-year storm events were used to evaluate rainfall and runoff on the proposed development. Design rainfall depths are given in Table 1.

Design Event	1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Rainfall Depth (in)	2.20	2.63	3.24	3.74	4.44	5.02	5.63

Table 1 - Design Storm Rainfall Depths

Existing Conditions:

Existing drainage conditions were evaluated using a combination of aerial photographs, surveyed topography, soil maps, and site photos. The total park land area existing drainage is split into an eastern watershed and a western watershed. The subject area (disturbed area) of the park is a part of the eastern watershed, tributary to the eastern drainage channel directly tributary to the Big Walnut Creek.

The Natural Resource Conservation Service Web Soil Survey identifies the predominant on-site soil as Crane silt loam, Eldean silt loam, Sloan silt loam, Udorthents, and Warsaw silt loam. These soils are classified within hydrologic group "B". Time of concentration for the drainage areas were computed using TR-55 methodology. Peak rates of runoff for the drainage areas were computed using the HydroCAD calculation suite. The table below includes the predeveloped conditions of the site area.

Tributary Area Name	**Area** (acre)	**CN**	**Tc** (min)	**Q1** (cfs)	**Q2** (cfs)	**Q5** (cfs)	**Q10** (cfs)	**Q25** (cfs)	**Q50** (cfs)	**Q100** (cfs)
Watershed	5.92	80	15.9	4.84	7.08	10.52	13.49	17.80	21.46	25.36

Table 2 - Pre-Developed Hydrology Summary

Critical Storm:

The City of Gahanna's Stormwater Management Regulations requires that the development follow its critical storm methodology. The allowable release rates are determined by utilizing the TR-55 methodology to calculate the percentage of increased in runoff volume due to the increase in impervious areas in the watershed. For all storm events up to and including the critical storm, runoff must be discharged from the site at a rate not to exceed the 1-year predeveloped runoff rate. Storm events with less frequent recurrence intervals from than the critical storm may not exceed the pre-developed peak rate from the same storm event. Using the TR-55 method, runoff volumes from a 2.2-inch rainfall event (1-yr) were calculated with composite pre-development and post-development curve

numbers computed as 80 and 91, respectively. The 90.5% increase in runoff volume due to the added impervious area of the development equates to a 10-yr critical storm event.

Ex. Impervious Area (ac.)	Ex. 1-Yr Runoff Volume (ac. ft.)	Prop. Impervious Area (ac.)	Prop. 1-Yr Runoff Volume (ac. ft.)	Percent Increase	Critical Storm
3.112	0.338	4.822	0.660	90.5%	10-Yr

Table 3 – Critical Storm Summary

The table below summarizes the allowable release rates for the watershed based on the 10-yr critical storm event calculated above.

AREA	1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Watershed	4.84	4.84	4.84	4.84	17.80	21.46	25.36

Table 4 – Allowable Release Rates

Post-Construction Conditions:

The land use of this development will remain a public park facility. The project is just upgrading the amenities of the park facility along with gaining some additional parking with the parking lot expansion. Part of the improvements will be installing storm catch basins and sewers in the existing and proposed parking lot areas to add surface and subsurface drainage to improve the life of the pavement areas. Along with that a water quality basin will be constructed to treat the collected water before releasing it into the Big Walnut Creek.

Storm Water Quantity Control:

The park is located inside the Big Walnut Creek floodplain as depicted in the tributary maps and currently does not have any stormwater BMPs in place. With the park land directly abutting and tributary to the Big Walnut Creek, we respectfully request a waiver from the City Stormwater Detention Regulations (1113.02 – Stormwater Management) in accordance with the City Regulations permitting waivers (113.02(e)(2)) for development area abutting and tributary to Big Walnut Creek on which surface water flows directly into the Big Walnut Creek. Our design does include a BMP per Ohio EPA Water Quality Regulations to treat stormwater runoff before releasing it to the Big Walnut Creek. Note that the stormwater from the existing parking lot and the proposed parking lot expansion area drain into a ditch along the east side of the park that then flows directly into the Big Walnut Creek without crossing any other land parcels. By waiving detention requirements, the release of the peak flows associated with the park lands will enter the creek prior to the peak flow of the creek from upstream tributaries and eliminate adding to the peak.

We have prepared Predevelopment runoff rates with a model of offsite flows directly tributary to the planned stormwater runoff outlet to evaluate how the two interact with different time intervals and tributary areas to show that waiving the detention require will not be detrimental to the channel.

Tributary Area Name	Area (acre)	CN	Tc (min)	Q1 (cfs)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
Onsite Watershed	5.92	80	15.9	4.84	7.08	10.52	13.49	17.80	21.46	25.36
Offsite Watershed	377.60	77	51.6	107.10	168.40	265.92	352.32	480.05	590.15	708.25
Composite	383.52	-	-	105.45	166.32	262.73	348.07	474.26	583.04	700.37

Table 5 - Pre-Developed Analysis

Tributary Area Name	Area (acre)	CN	Tc (min)	Q1 (cfs)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
Onsite Watershed	5.92	91	10	11.91	15.23	19.97	23.86	29.28	33.76	38.45
WQ Basin Release	5.92	-	-	9.07	13.46	18.39	22.25	27.57	31.96	36.54
Offsite Watershed	377.60	77	51.6	107.10	168.40	265.92	352.32	480.05	590.15	708.25
Composite	383.52	-	-	106.30	166.94	263.02	346.36	471.19	579.25	695.72

Table 6 - Post-Developed Analysis

The table below shows that the increase in runoff is greatest at the 1-yr event (0.85 cfs) but decreases in every storm event after to the point that the runoff during the 10-yr event and greater, are less than the pre-development composites.

Tributary Area Name	Q1 (cfs)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
Pre-Composite	105.45	166.32	262.73	348.07	474.26	583.04	700.37
Post-Composite	106.30	166.94	263.02	346.36	471.19	579.25	695.72

Table 7 – Comparison of Flows Pre to Post

The proposed post-development runoff rates are higher than those of the same storm events in the predevelopment condition. The analysis shows that due to the time interval due to not detaining those post-development storm events the overall composite flows both in flow and velocity are not detrimental to the outfall channel. We feel that the reason the 1, 2, and 5-yr events are showing higher composite release rates due to the water quality basin function releasing those events at a higher time interval getting closer to the offsite peak time interval. If you run the model without the water quality basin you get the following composite release rates, showing lower runoff rates due to the change in the time interval.

Tributary Area Name	Q1 (cfs)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
Pre-Composite	105.45	166.32	262.73	348.07	474.26	583.04	700.37
Post-Composite	106.30	166.94	263.02	346.36	471.19	579.25	695.72
Post-Composite Undetained	105.70	166.49	262.76	347.96	473.92	582.51	699.61

Table 8 – Comparison of Flows Pre to Post and without WQ Basin

Furthermore, looking at the channel analysis at the velocities within the channel to ensure that velocities are not a contributing factor to channel erosion. Higher velocities have a bigger impact on channel erosion than increase in volume. Below is a table comparing these velocities. The analysis shows that the velocities are nearly identical with a few minor differences of 0.01 fps +/- in a few of the storm events. These differences are not concerning as only the 1-yr event is showing greater velocity and not enough to be detrimental to the channel.

Tributary Area Name	Q1 (fps)	Q2 (fps)	Q5 (fps)	Q10 (fps)	Q25 (fps)	Q50 (fps)	Q100 (fps)
Pre-Composite	4.60	5.26	5.83	6.11	6.36	6.49	6.60
Post-Composite	4.61	5.26	5.83	6.10	6.35	6.49	6.59

Table 9 – Comparison of Channel Velocities Pre to Post

Storm Water Quality Control:

Per the Ohio EPA General Construction Permit, a stormwater best management practice (BMP) is required to treat the first flush runoff volume produced by a 0.90" rainfall event. The water quality volume was calculated using the equation below with runoff coefficients from the Ohio EPA's General Construction Permit. See Appendix E for full calculations.

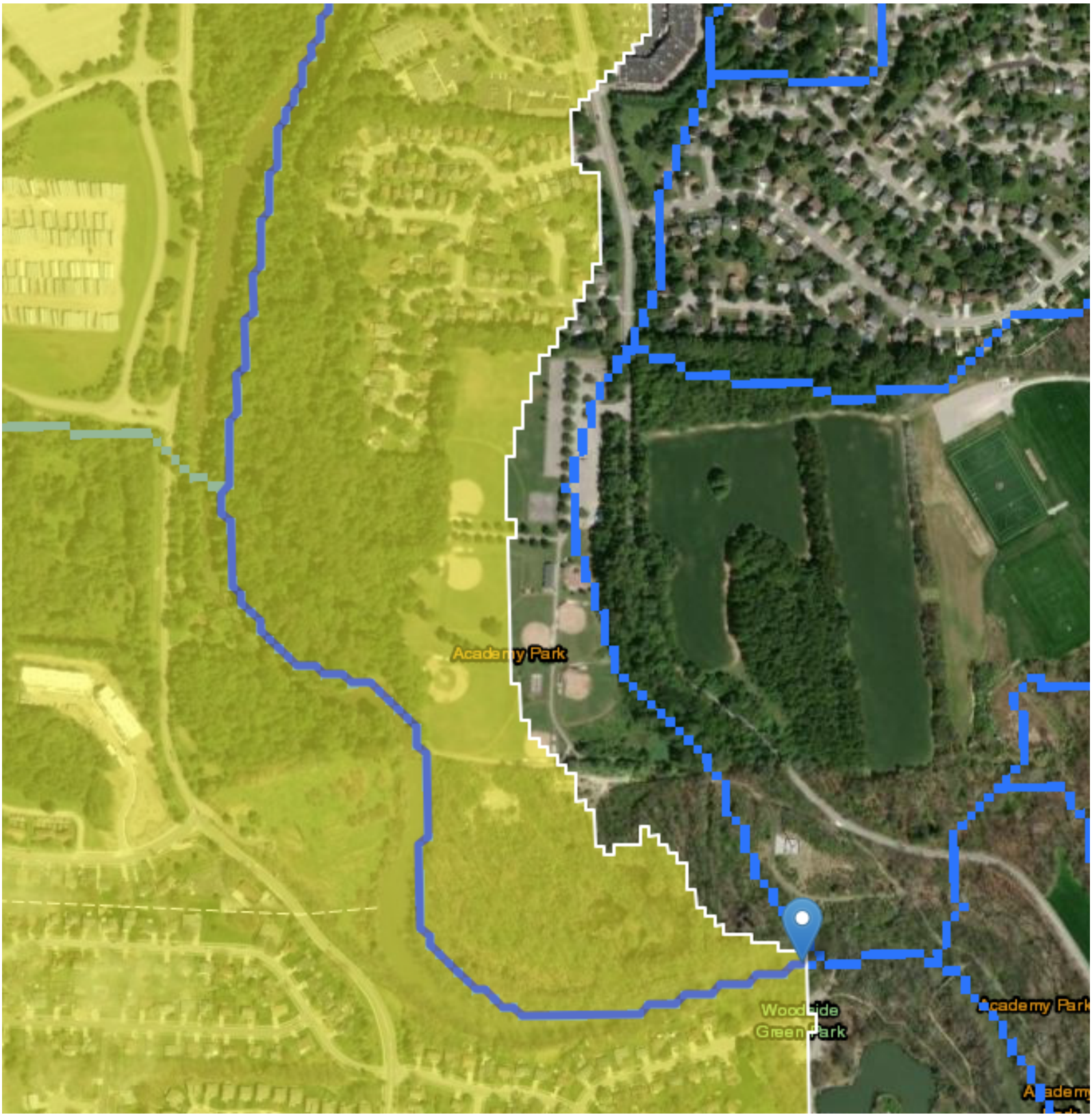
$$WQv = [(0.2 \times Rv1) + (Rv2 - Rv1)] \times P \times A / 12 = 7{,}052 \text{ cu. ft.}$$

Conclusion:

We feel the development meets the criteria listed in the City Regulations, Section 1113.02 Stormwater Management, subsection (1113.02(e)(1) – the runoff is controlled to ensure that it does not damage the receiving waters as outlines in Table 7, (2) – the site is directly abutting and tributary to the Big Walnut Creek, (4) – we are meeting the local, state and federal requirements by installing a water quality basin to treat the runoff per Ohio EPA regulation prior to releasing from the site.

APPENDIX A

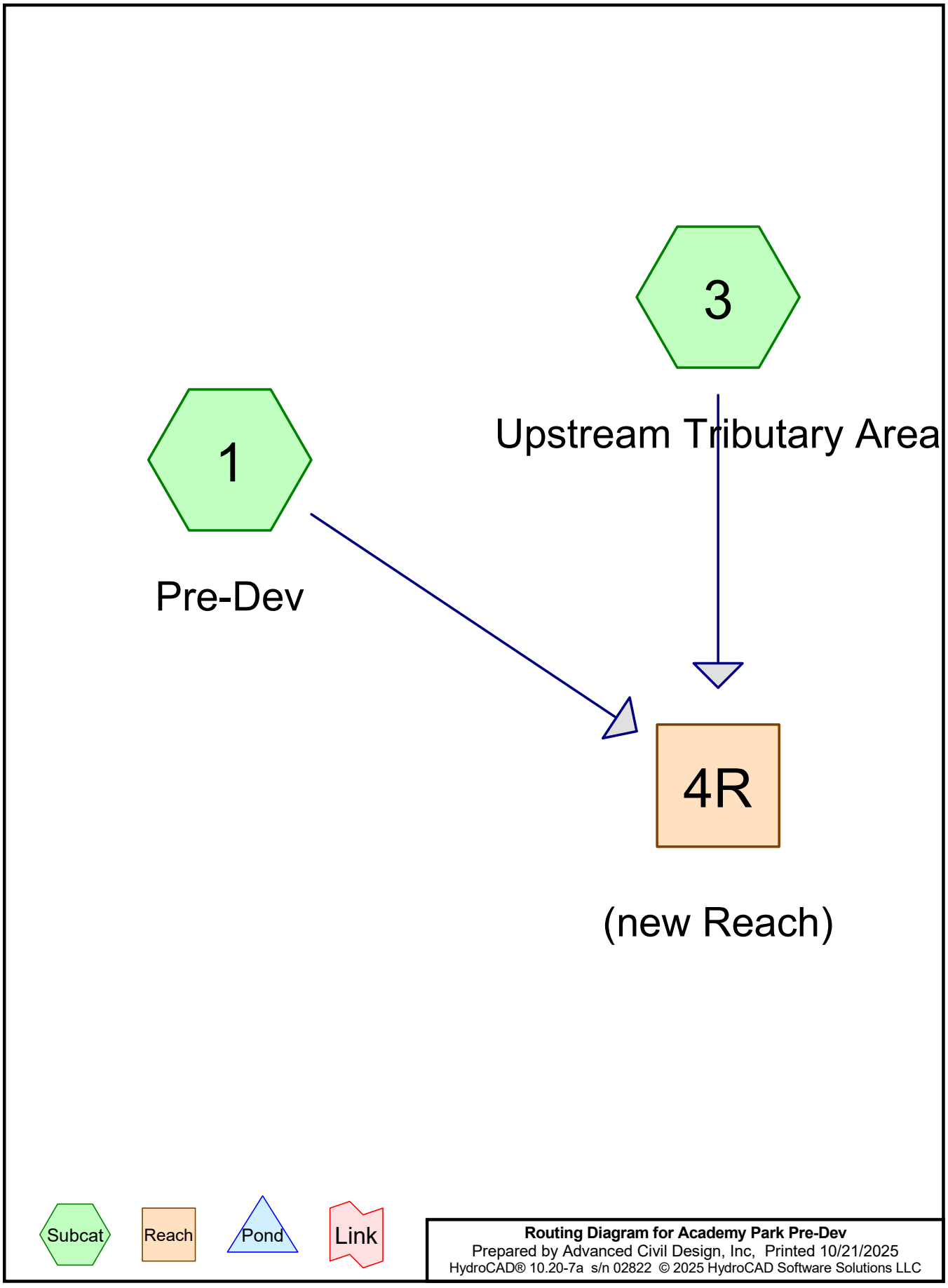
TRIBUTARY MAPS



Academy Park Tributary Divide

APPENDIX B

PRE-DEVELOPED HYDROCAD CALCULATIONS



Routing Diagram for Academy Park Pre-Dev
Prepared by Advanced Civil Design, Inc, Printed 10/21/2025
HydroCAD® 10.20-7a s/n 02822 © 2025 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-yr COL	Type II 24-hr		Default	24.00	1	2.20	2
2	2-yr COL	Type II 24-hr		Default	24.00	1	2.63	2
3	5-yr COL	Type II 24-hr		Default	24.00	1	3.24	2
4	10-yr COL	Type II 24-hr		Default	24.00	1	3.74	2
5	25-yr COL	Type II 24-hr		Default	24.00	1	4.44	2
6	50-yr COL	Type II 24-hr		Default	24.00	1	5.02	2
7	100-yr COL	Type II 24-hr		Default	24.00	1	5.63	2

Summary for Subcatchment 1: Pre-Dev

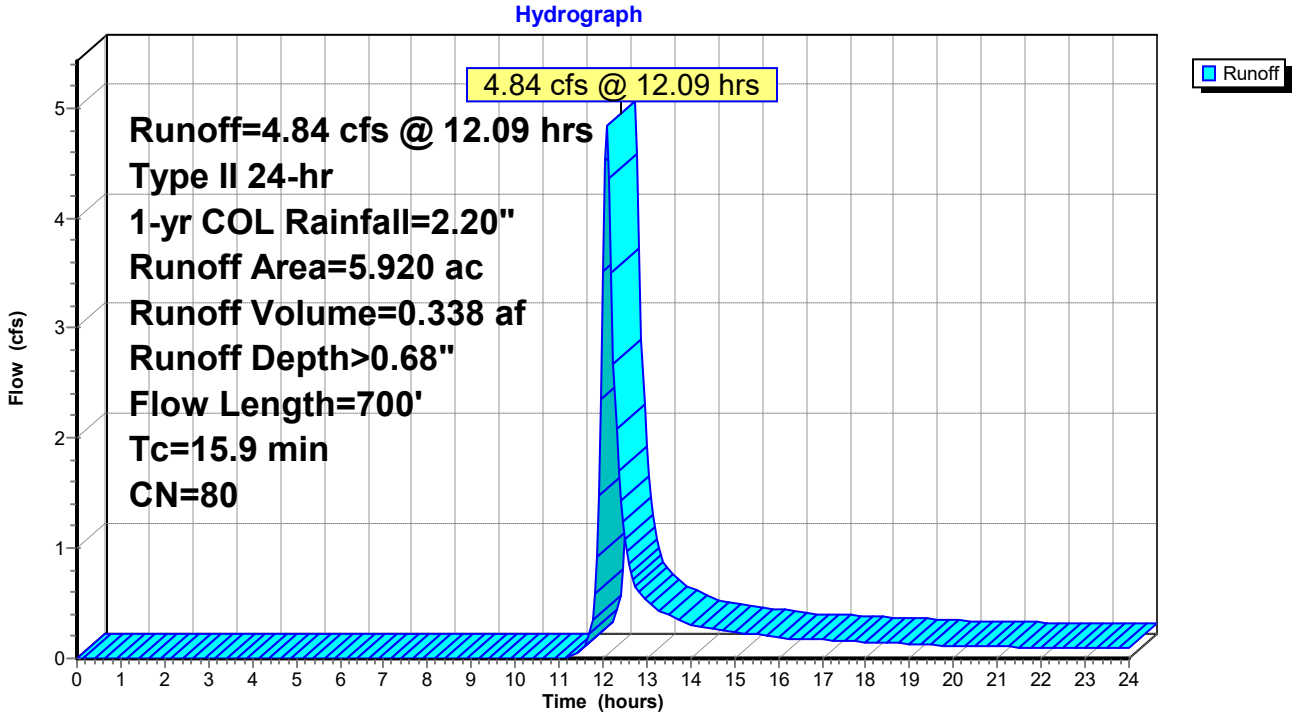
Runoff = 4.84 cfs @ 12.09 hrs, Volume= 0.338 af, Depth> 0.68"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr COL Rainfall=2.20"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Subcatchment 1: Pre-Dev



Summary for Subcatchment 3: Upstream Tributary Area

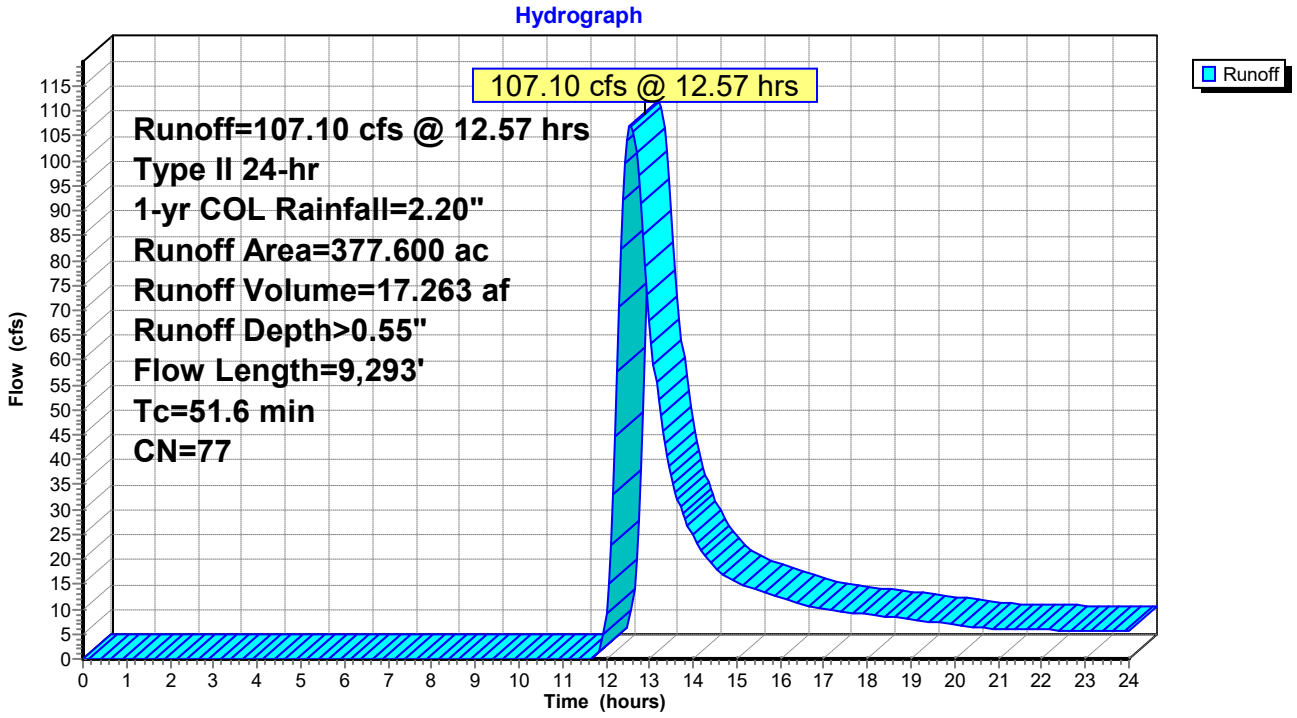
Runoff = 107.10 cfs @ 12.57 hrs, Volume= 17.263 af, Depth> 0.55"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr COL Rainfall=2.20"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



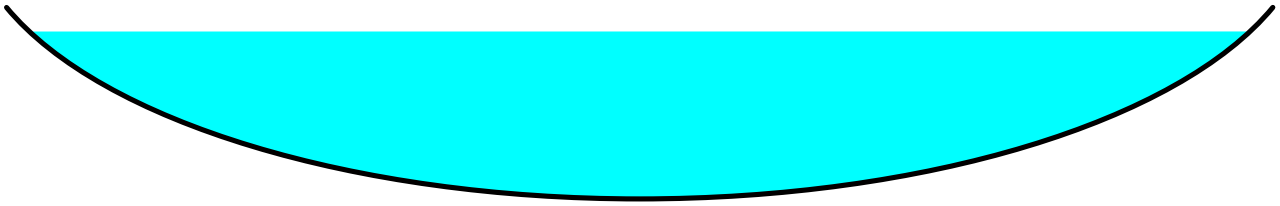
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 0.81% Impervious, Inflow Depth > 0.55" for 1-yr COL event
Inflow = 108.02 cfs @ 12.57 hrs, Volume= 17.601 af
Outflow = 105.45 cfs @ 12.66 hrs, Volume= 17.484 af, Atten= 2%, Lag= 5.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.60 fps, Min. Travel Time= 6.2 min
Avg. Velocity = 2.28 fps, Avg. Travel Time= 12.5 min

Peak Storage= 39,413 cf @ 12.66 hrs
Average Depth at Peak Storage= 1.75' , Surface Width= 19.65'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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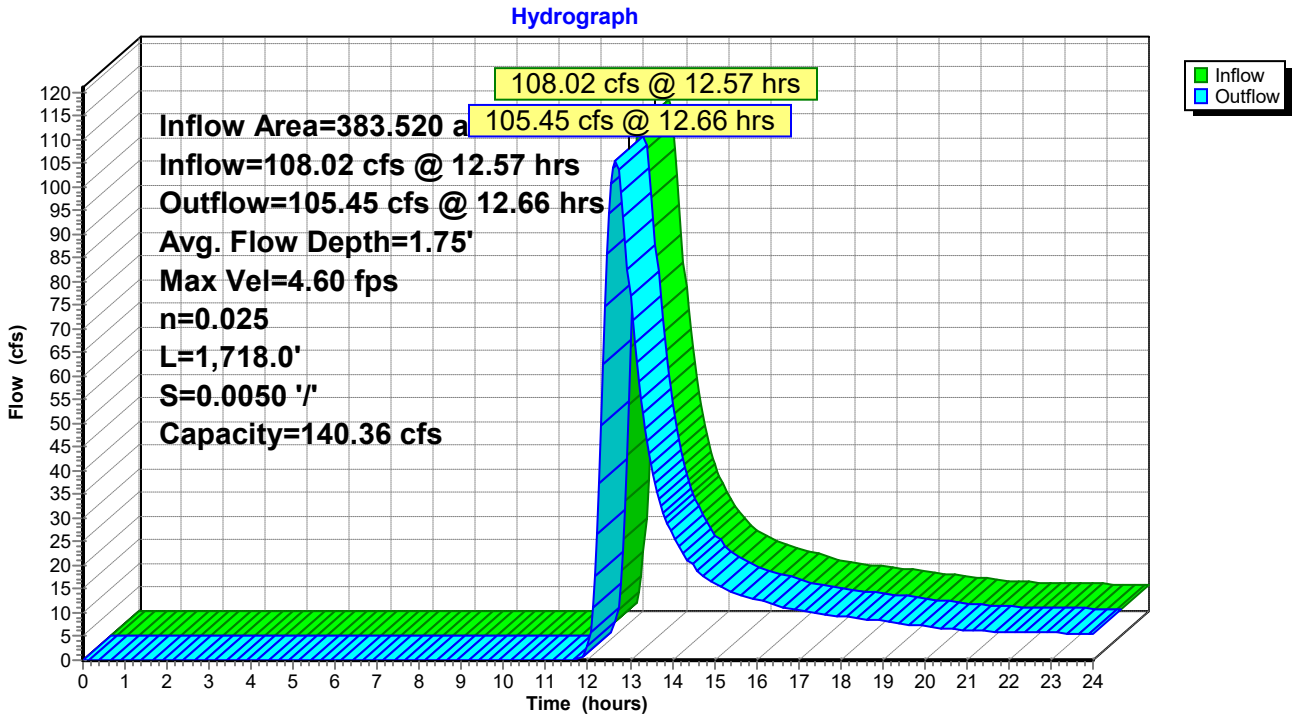
Reach 4R: (new Reach)



Summary for Subcatchment 1: Pre-Dev

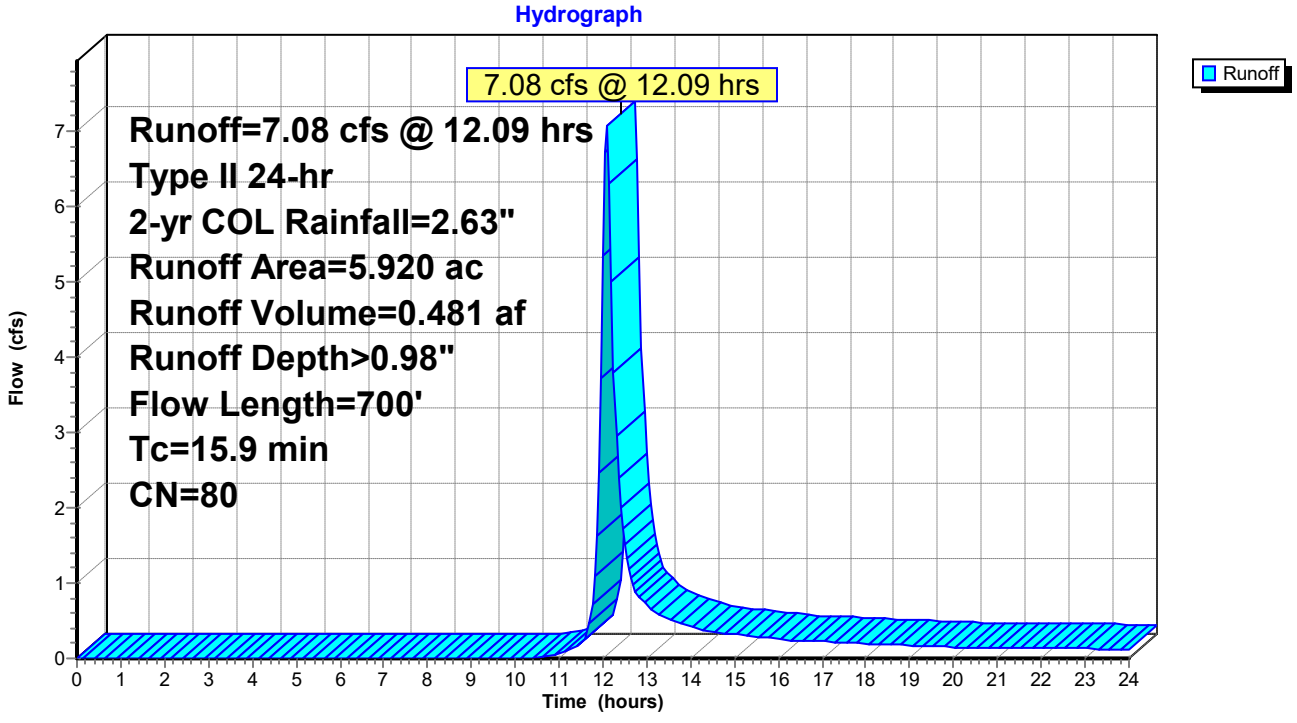
Runoff = 7.08 cfs @ 12.09 hrs, Volume= 0.481 af, Depth> 0.98"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr COL Rainfall=2.63"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Subcatchment 1: Pre-Dev



Summary for Subcatchment 3: Upstream Tributary Area

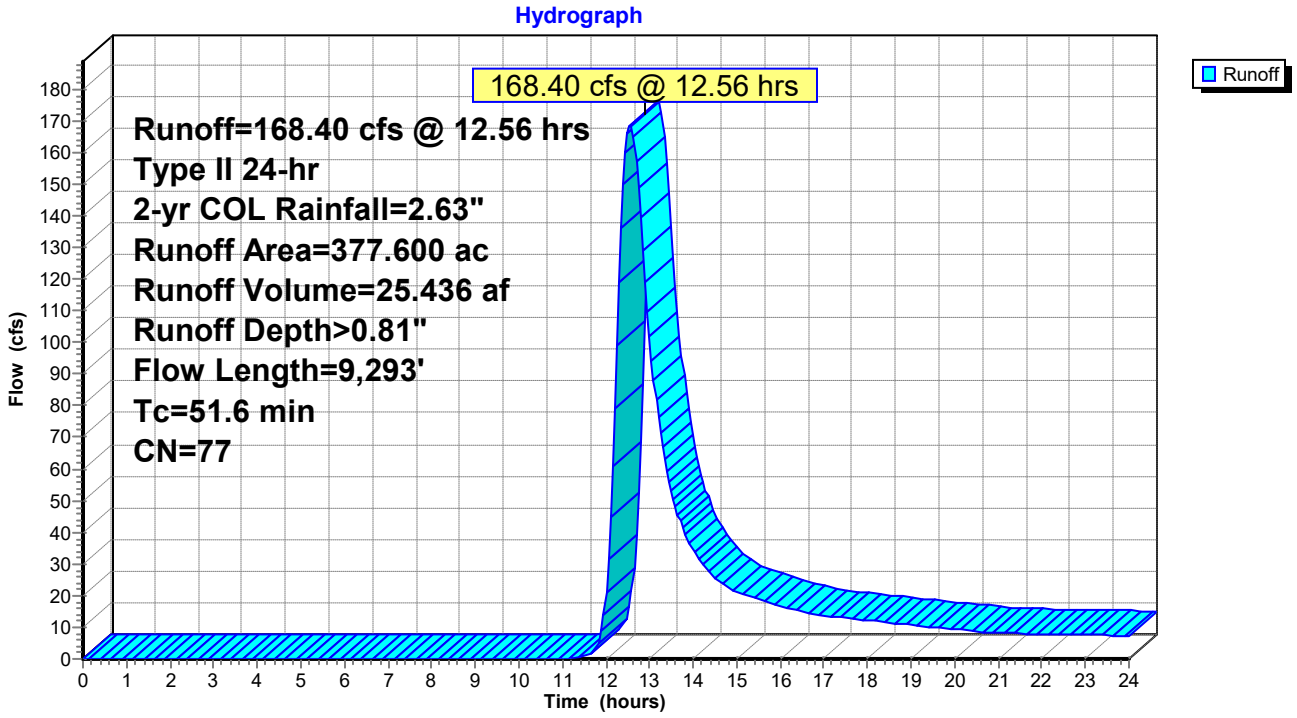
Runoff = 168.40 cfs @ 12.56 hrs, Volume= 25.436 af, Depth> 0.81"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr COL Rainfall=2.63"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



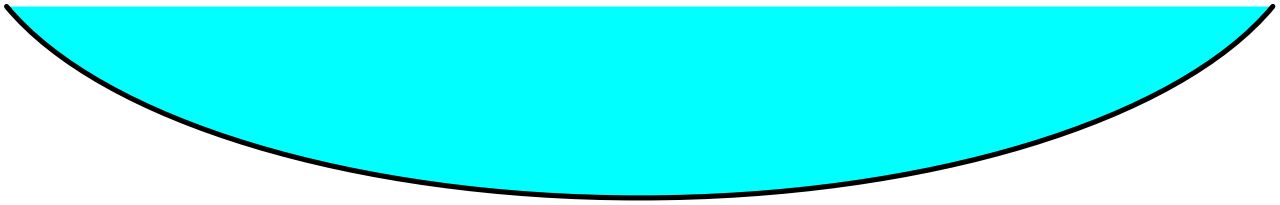
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 0.81% Impervious, Inflow Depth > 0.81" for 2-yr COL event
Inflow = 169.71 cfs @ 12.55 hrs, Volume= 25.918 af
Outflow = 166.32 cfs @ 12.63 hrs, Volume= 25.773 af, Atten= 2%, Lag= 4.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.26 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 2.45 fps, Avg. Travel Time= 11.7 min

Peak Storage= 54,326 cf @ 12.63 hrs
Average Depth at Peak Storage= 2.17' , Surface Width= 21.89'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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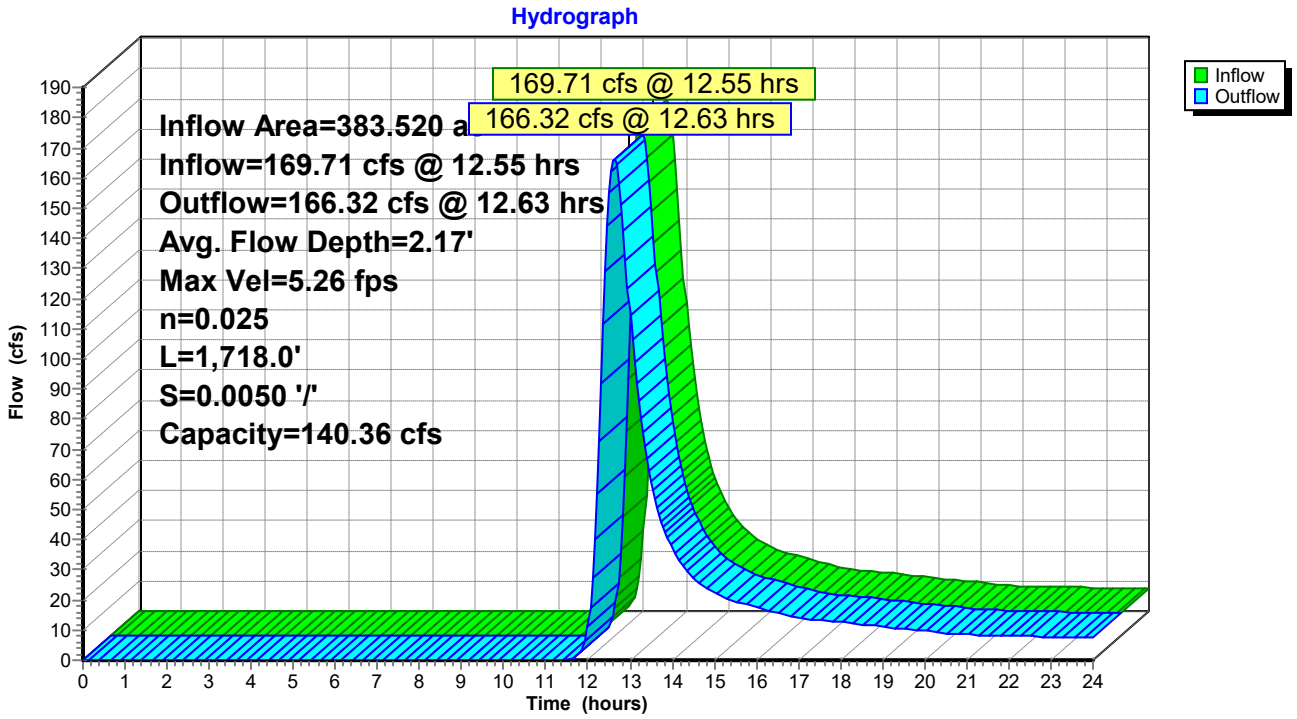
Reach 4R: (new Reach)



Summary for Subcatchment 1: Pre-Dev

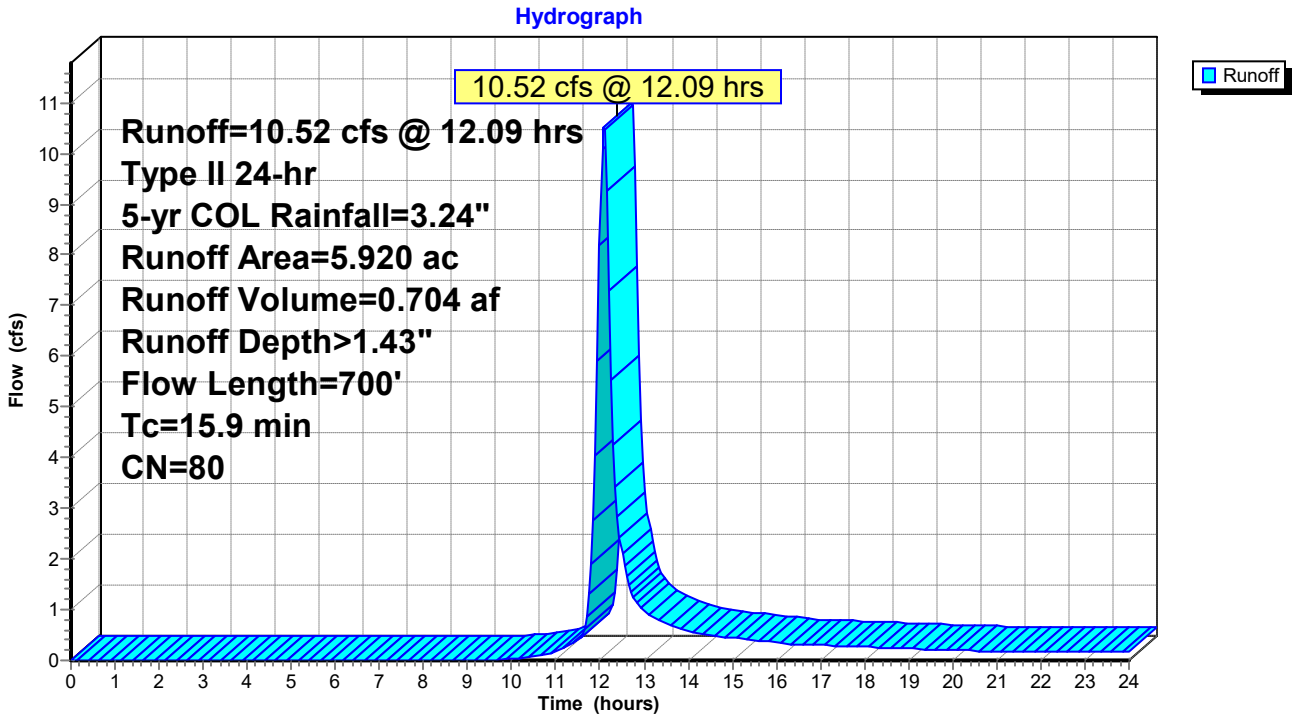
Runoff = 10.52 cfs @ 12.09 hrs, Volume= 0.704 af, Depth> 1.43"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-yr COL Rainfall=3.24"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Subcatchment 1: Pre-Dev



Summary for Subcatchment 3: Upstream Tributary Area

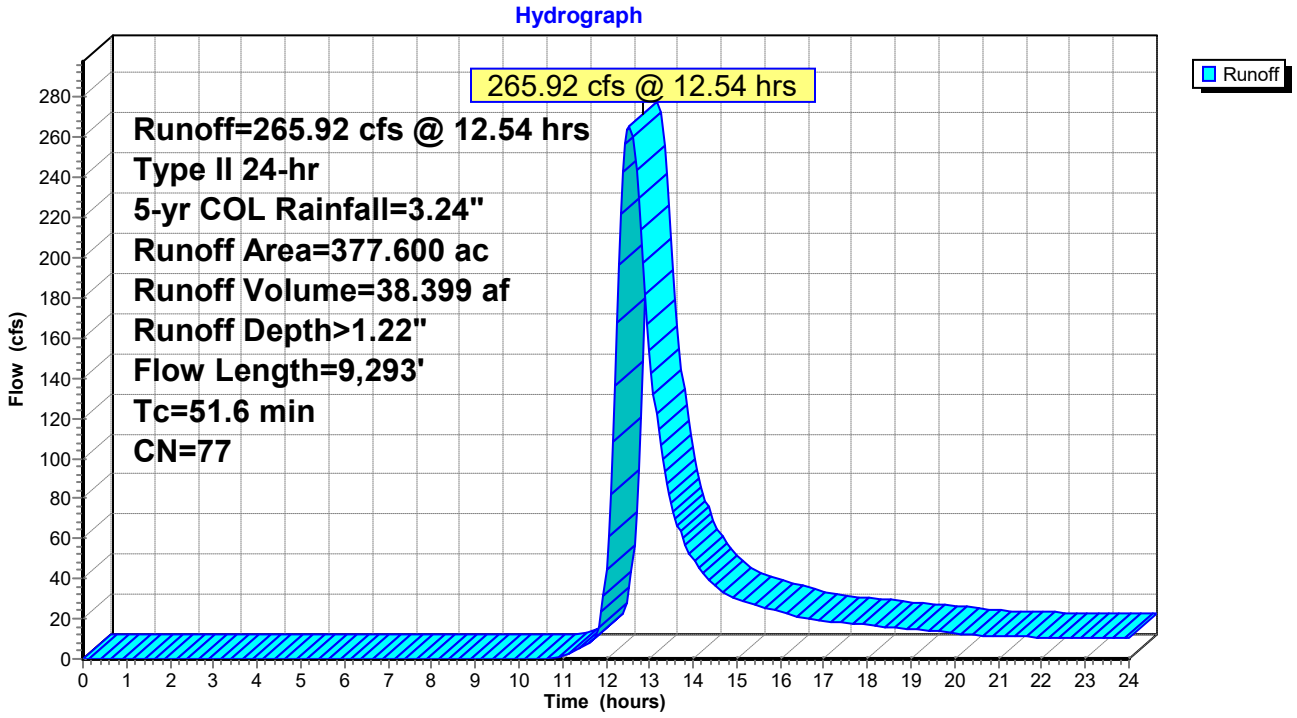
Runoff = 265.92 cfs @ 12.54 hrs, Volume= 38.399 af, Depth> 1.22"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-yr COL Rainfall=3.24"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



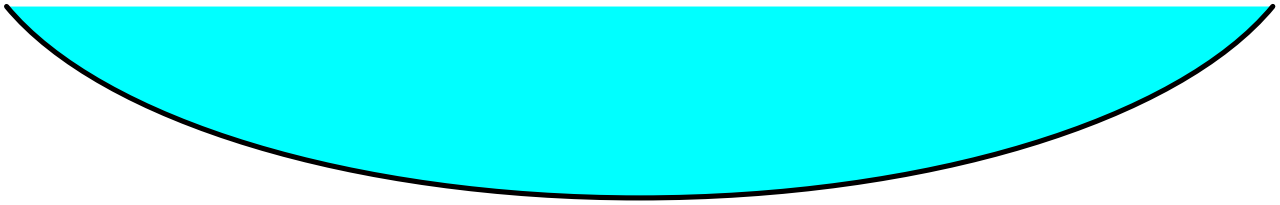
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 0.81% Impervious, Inflow Depth > 1.22" for 5-yr COL event
Inflow = 267.83 cfs @ 12.54 hrs, Volume= 39.103 af
Outflow = 262.73 cfs @ 12.61 hrs, Volume= 38.923 af, Atten= 2%, Lag= 4.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.83 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 2.63 fps, Avg. Travel Time= 10.9 min

Peak Storage= 77,439 cf @ 12.61 hrs
Average Depth at Peak Storage= 2.82' , Surface Width= 24.91'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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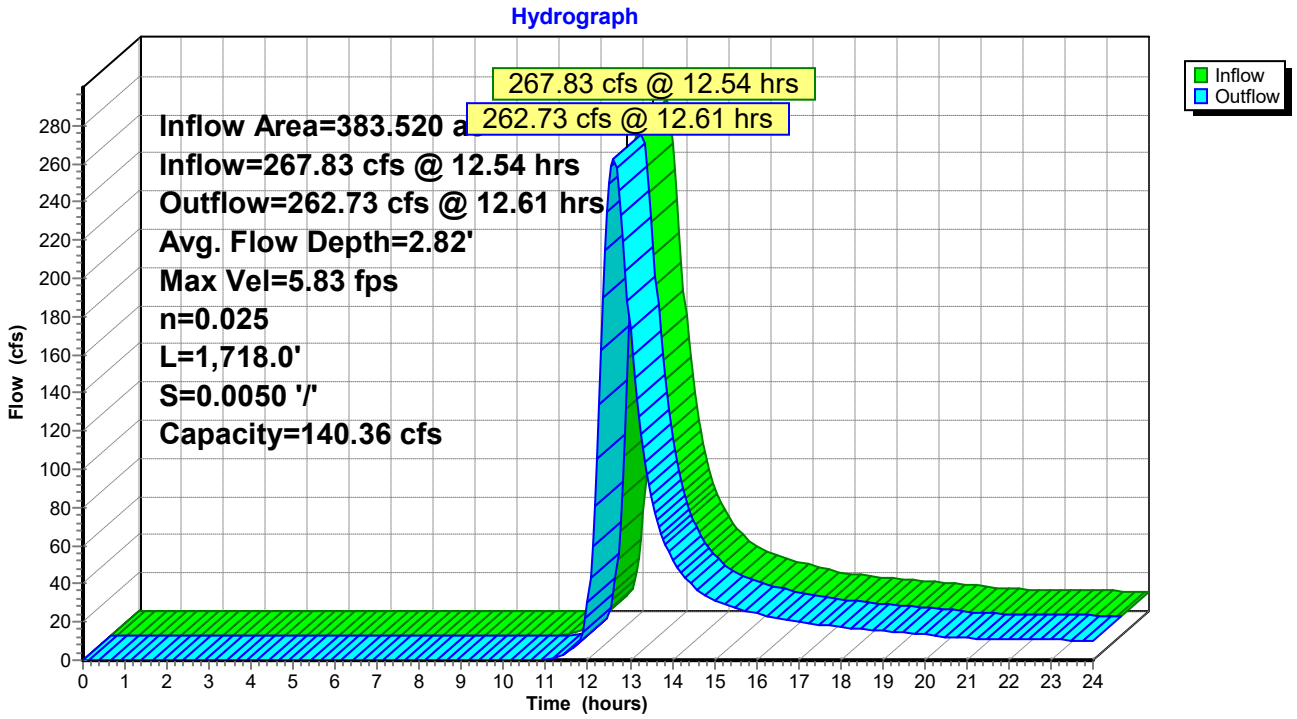
Reach 4R: (new Reach)



Summary for Subcatchment 1: Pre-Dev

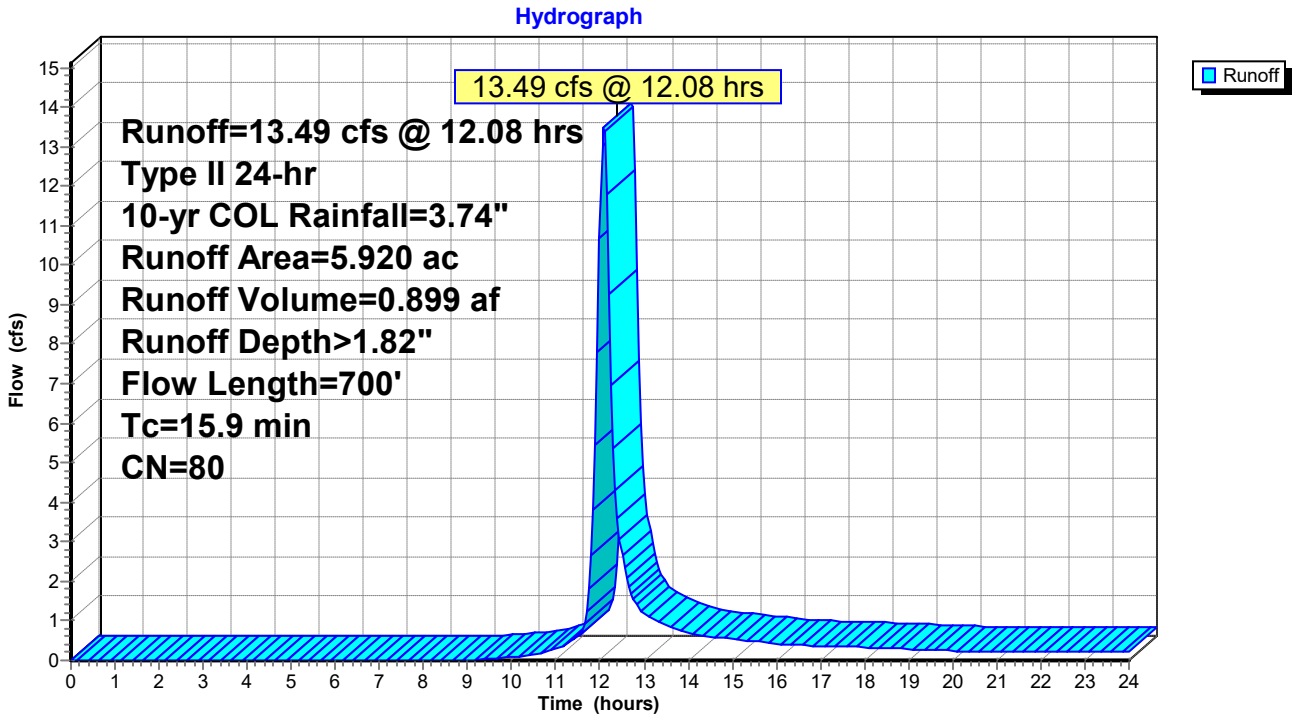
Runoff = 13.49 cfs @ 12.08 hrs, Volume= 0.899 af, Depth> 1.82"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr COL Rainfall=3.74"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Subcatchment 1: Pre-Dev



Summary for Subcatchment 3: Upstream Tributary Area

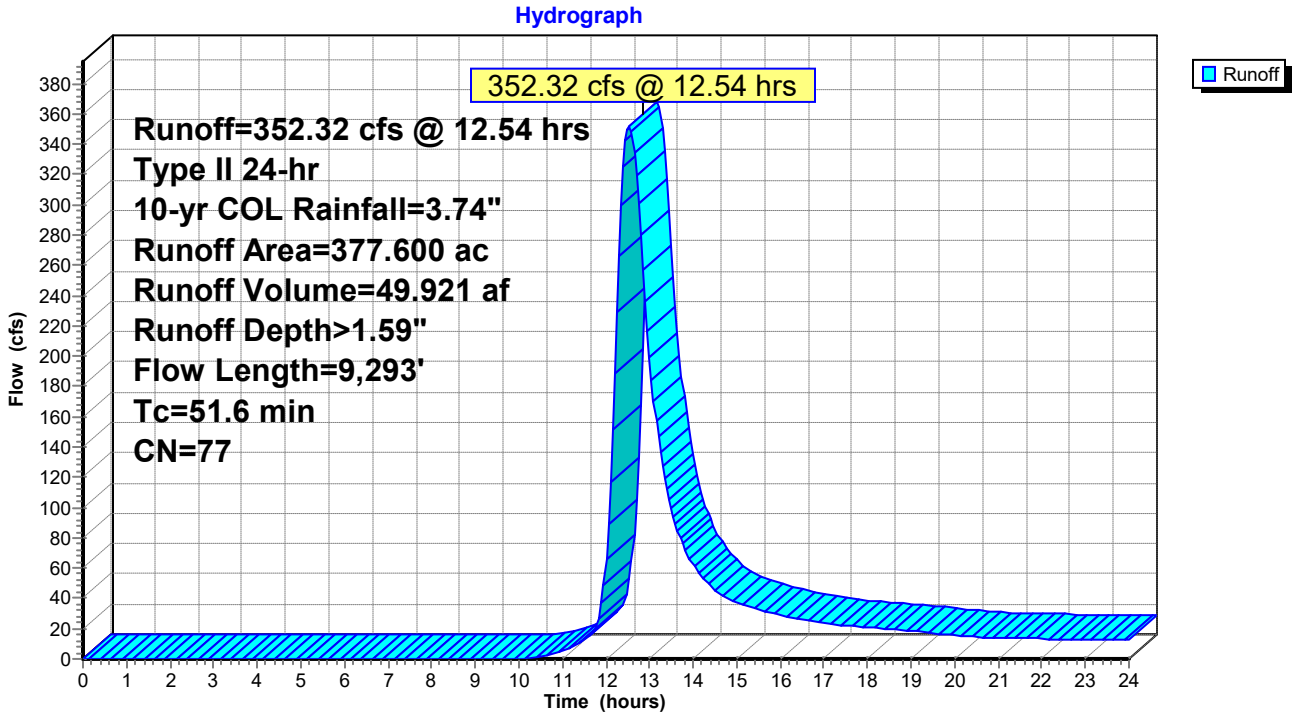
Runoff = 352.32 cfs @ 12.54 hrs, Volume= 49.921 af, Depth> 1.59"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr COL Rainfall=3.74"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



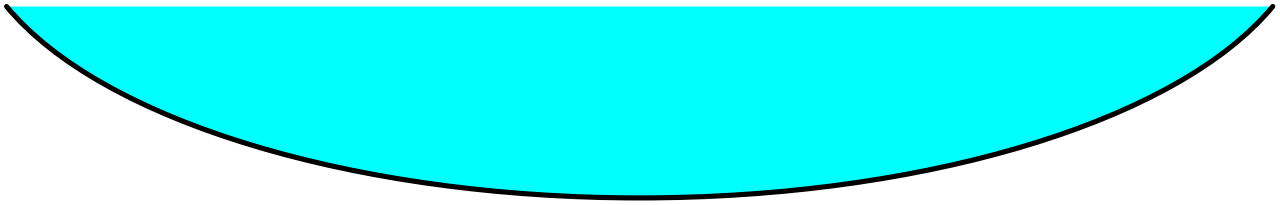
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 0.81% Impervious, Inflow Depth > 1.59" for 10-yr COL event
Inflow = 354.74 cfs @ 12.54 hrs, Volume= 50.820 af
Outflow = 348.07 cfs @ 12.60 hrs, Volume= 50.613 af, Atten= 2%, Lag= 3.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.11 fps, Min. Travel Time= 4.7 min
Avg. Velocity = 2.76 fps, Avg. Travel Time= 10.4 min

Peak Storage= 97,895 cf @ 12.60 hrs
Average Depth at Peak Storage= 3.38' , Surface Width= 27.31'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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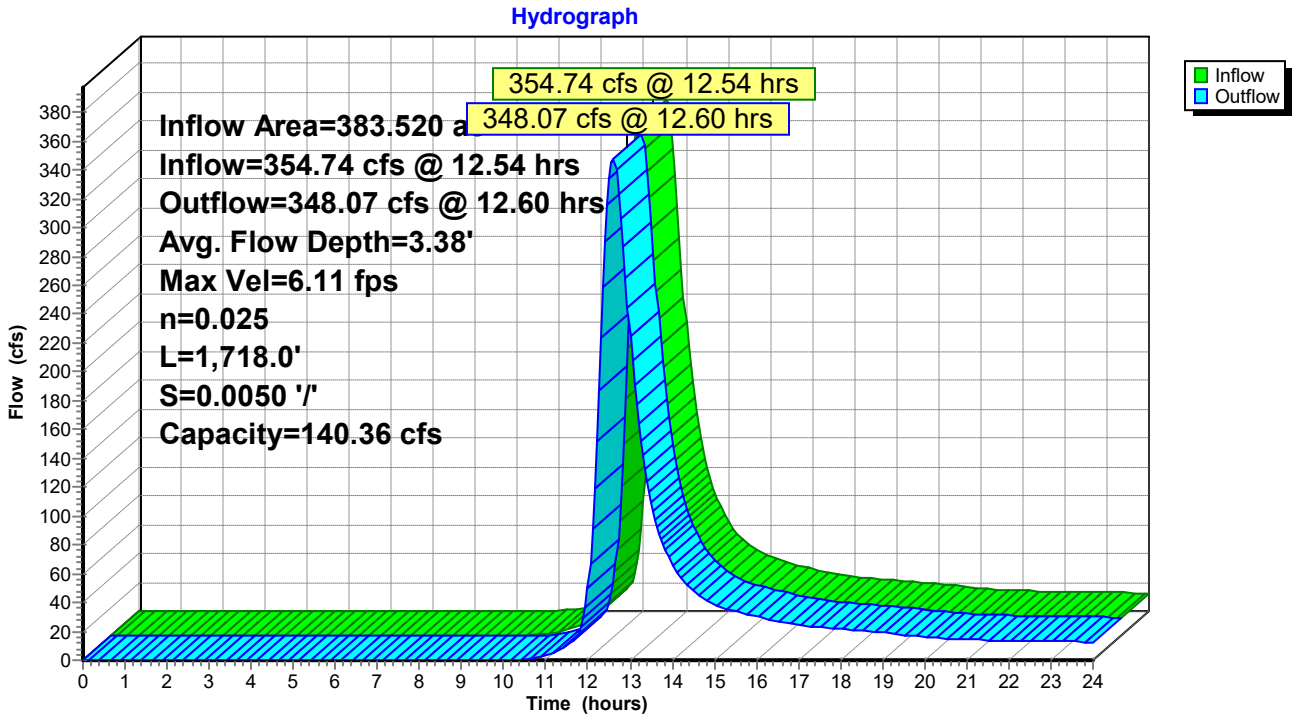
Reach 4R: (new Reach)



Summary for Subcatchment 1: Pre-Dev

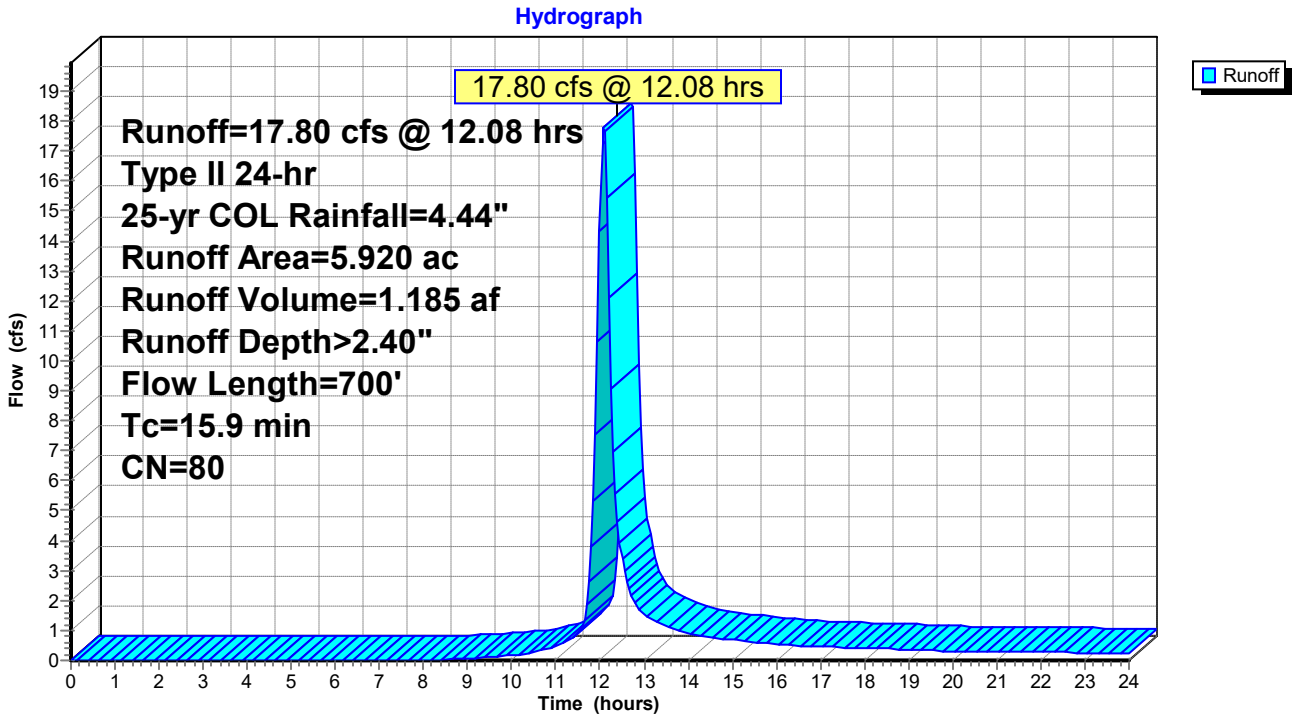
Runoff = 17.80 cfs @ 12.08 hrs, Volume= 1.185 af, Depth> 2.40"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr COL Rainfall=4.44"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Subcatchment 1: Pre-Dev



Summary for Subcatchment 3: Upstream Tributary Area

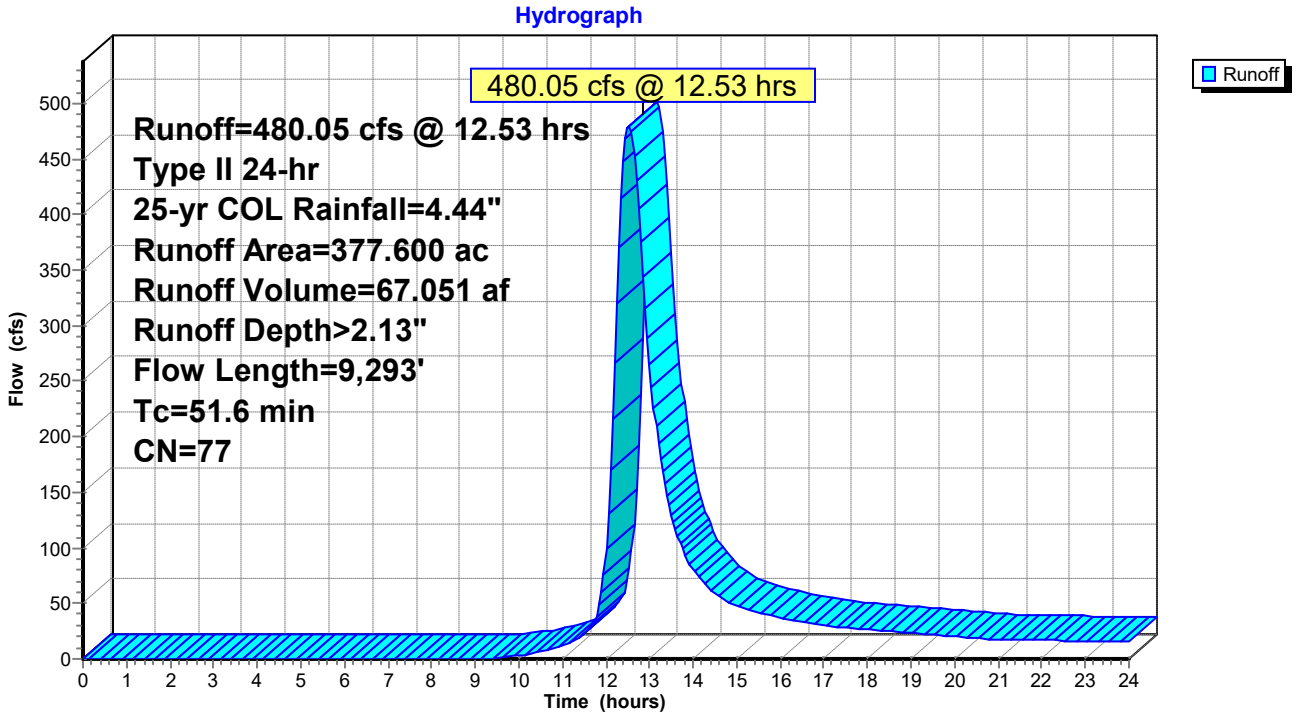
Runoff = 480.05 cfs @ 12.53 hrs, Volume= 67.051 af, Depth> 2.13"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr COL Rainfall=4.44"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



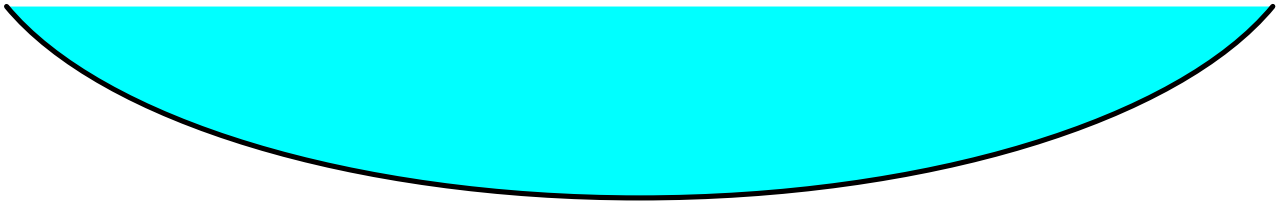
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 0.81% Impervious, Inflow Depth > 2.14" for 25-yr COL event
Inflow = 483.20 cfs @ 12.53 hrs, Volume= 68.236 af
Outflow = 474.26 cfs @ 12.59 hrs, Volume= 67.993 af, Atten= 2%, Lag= 3.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.36 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 2.92 fps, Avg. Travel Time= 9.8 min

Peak Storage= 128,143 cf @ 12.59 hrs
Average Depth at Peak Storage= 4.22' , Surface Width= 30.52'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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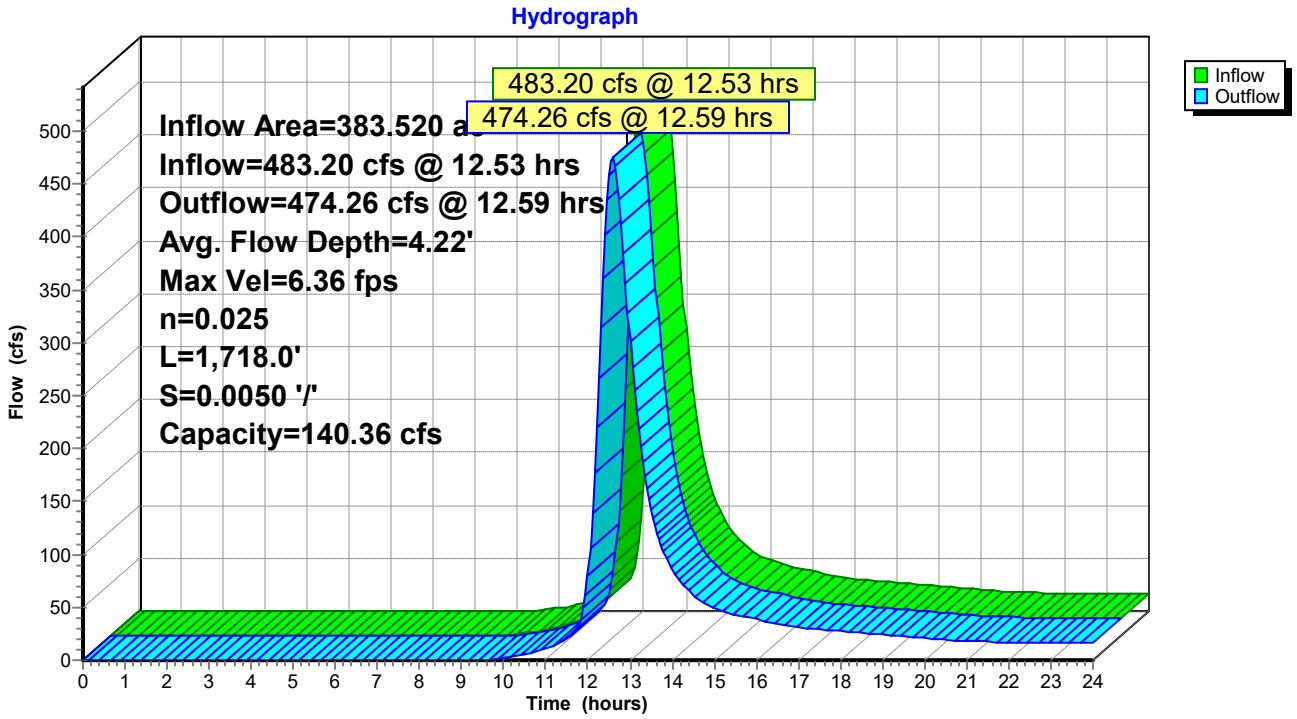
Reach 4R: (new Reach)



Summary for Subcatchment 1: Pre-Dev

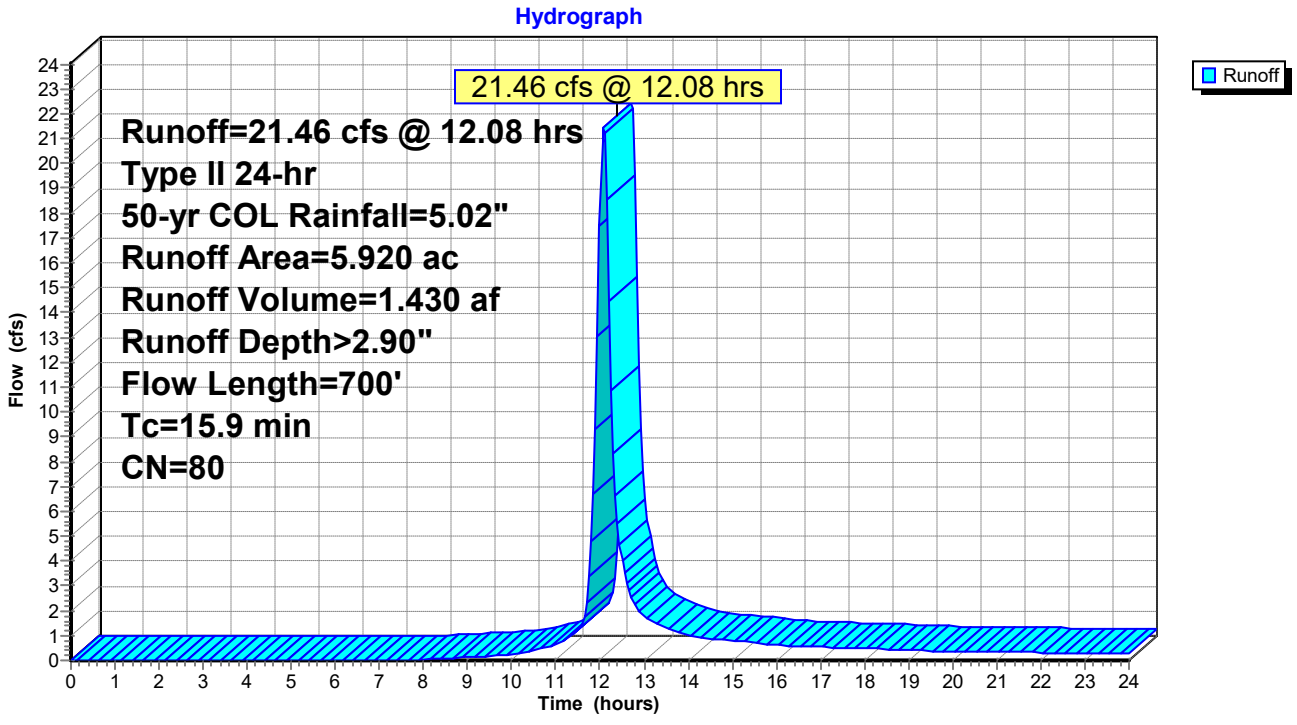
Runoff = 21.46 cfs @ 12.08 hrs, Volume= 1.430 af, Depth> 2.90"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-yr COL Rainfall=5.02"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Subcatchment 1: Pre-Dev



Summary for Subcatchment 3: Upstream Tributary Area

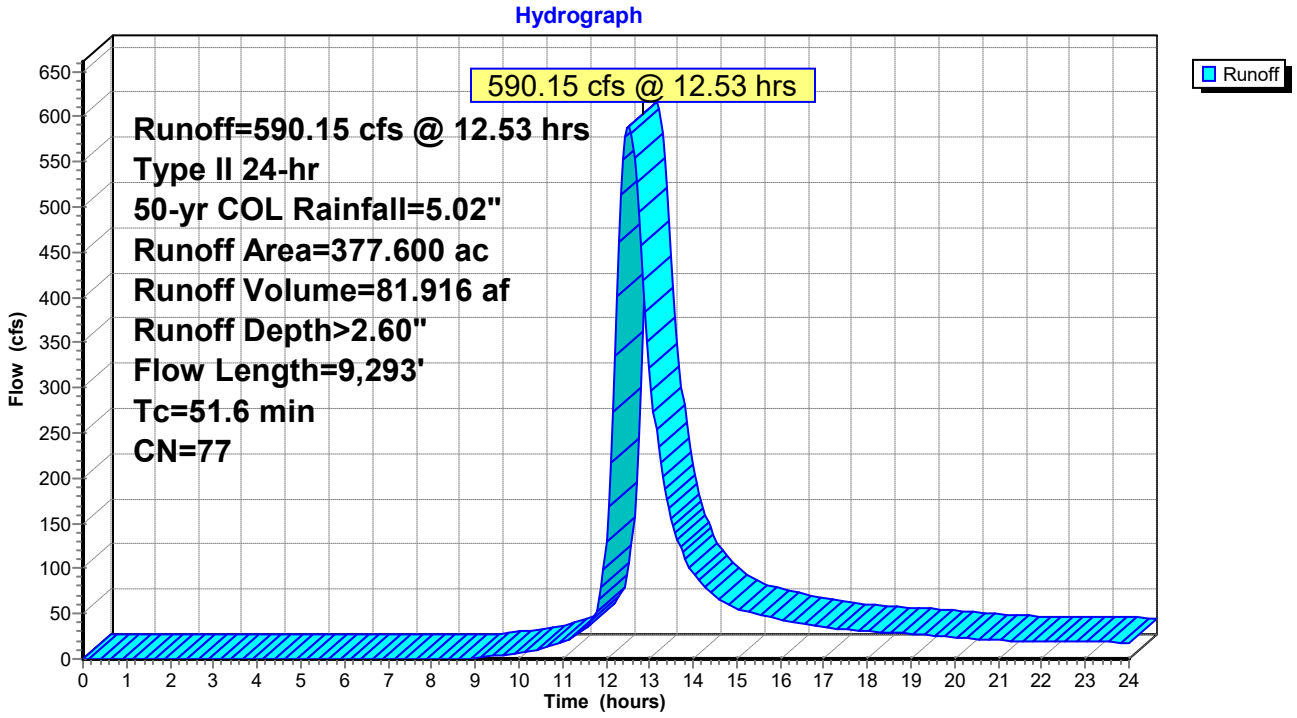
Runoff = 590.15 cfs @ 12.53 hrs, Volume= 81.916 af, Depth> 2.60"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-yr COL Rainfall=5.02"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



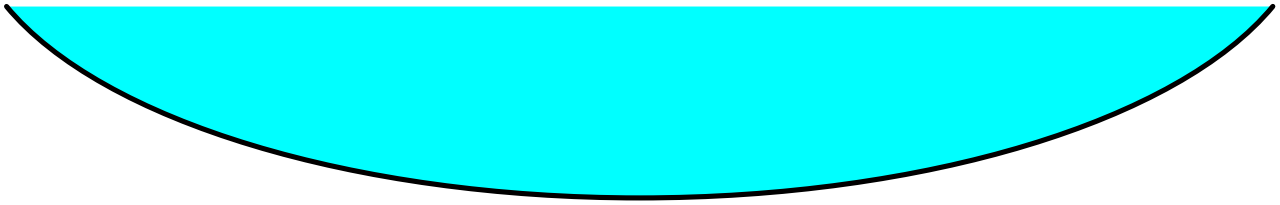
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 0.81% Impervious, Inflow Depth > 2.61" for 50-yr COL event
Inflow = 593.38 cfs @ 12.52 hrs, Volume= 83.347 af
Outflow = 583.04 cfs @ 12.59 hrs, Volume= 83.076 af, Atten= 2%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.49 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 3.03 fps, Avg. Travel Time= 9.4 min

Peak Storage= 154,220 cf @ 12.59 hrs
Average Depth at Peak Storage= 4.95' , Surface Width= 33.03'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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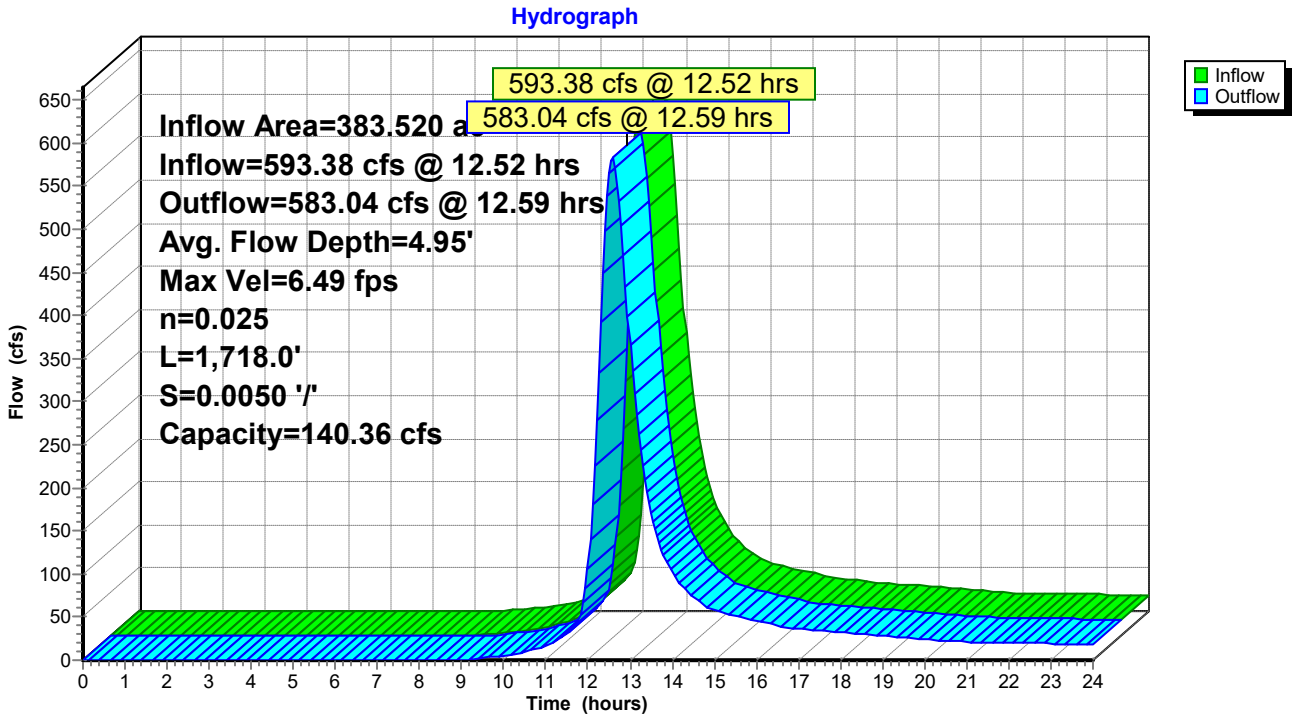
Reach 4R: (new Reach)



Summary for Subcatchment 1: Pre-Dev

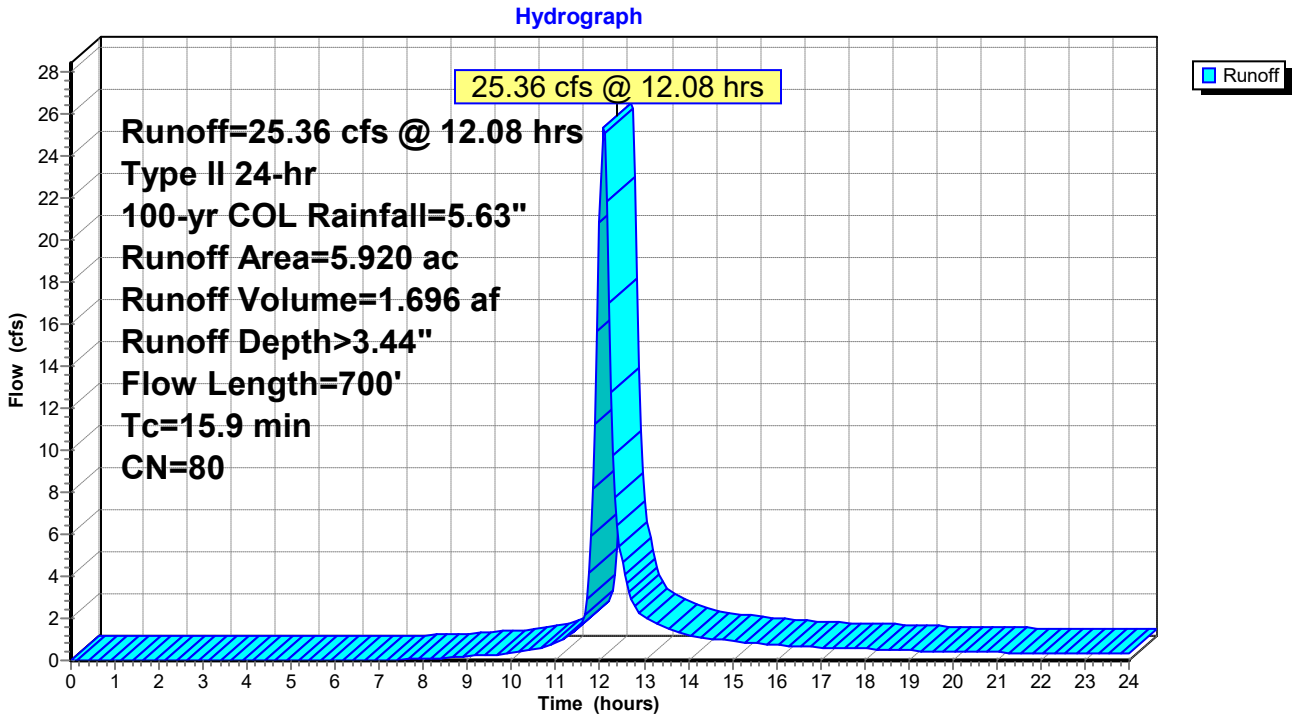
Runoff = 25.36 cfs @ 12.08 hrs, Volume= 1.696 af, Depth> 3.44"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr COL Rainfall=5.63"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Subcatchment 1: Pre-Dev



Summary for Subcatchment 3: Upstream Tributary Area

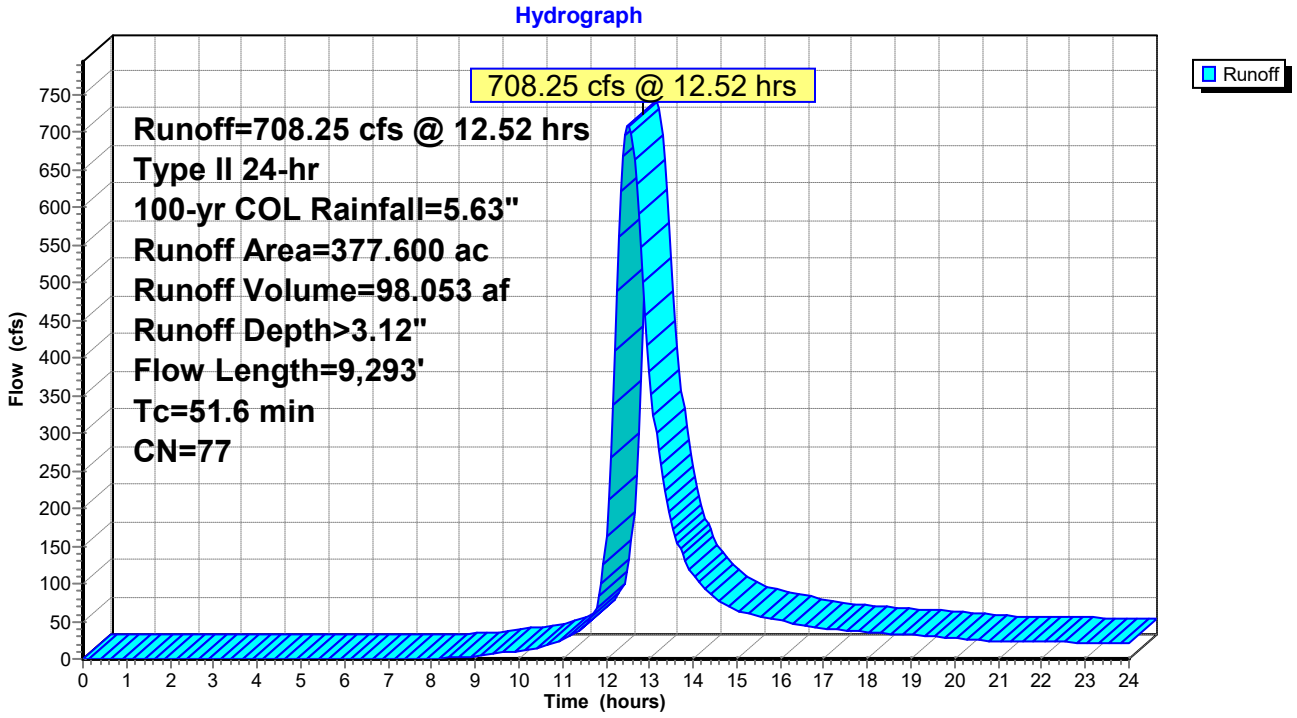
Runoff = 708.25 cfs @ 12.52 hrs, Volume= 98.053 af, Depth> 3.12"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr COL Rainfall=5.63"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



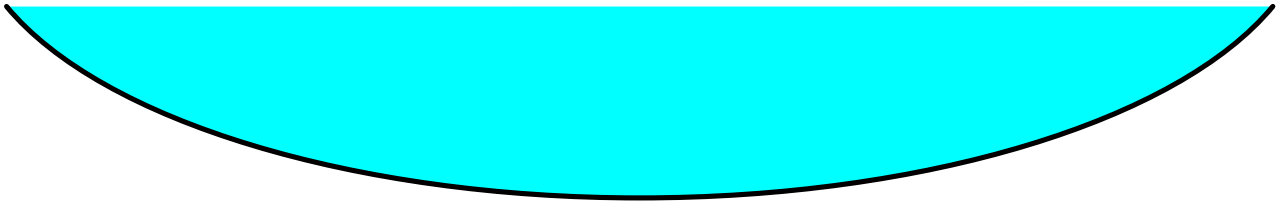
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 0.81% Impervious, Inflow Depth > 3.12" for 100-yr COL event
Inflow = 712.68 cfs @ 12.52 hrs, Volume= 99.748 af
Outflow = 700.37 cfs @ 12.58 hrs, Volume= 99.450 af, Atten= 2%, Lag= 3.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.60 fps, Min. Travel Time= 4.3 min
Avg. Velocity = 3.15 fps, Avg. Travel Time= 9.1 min

Peak Storage= 182,344 cf @ 12.58 hrs
Average Depth at Peak Storage= 5.73' , Surface Width= 35.55'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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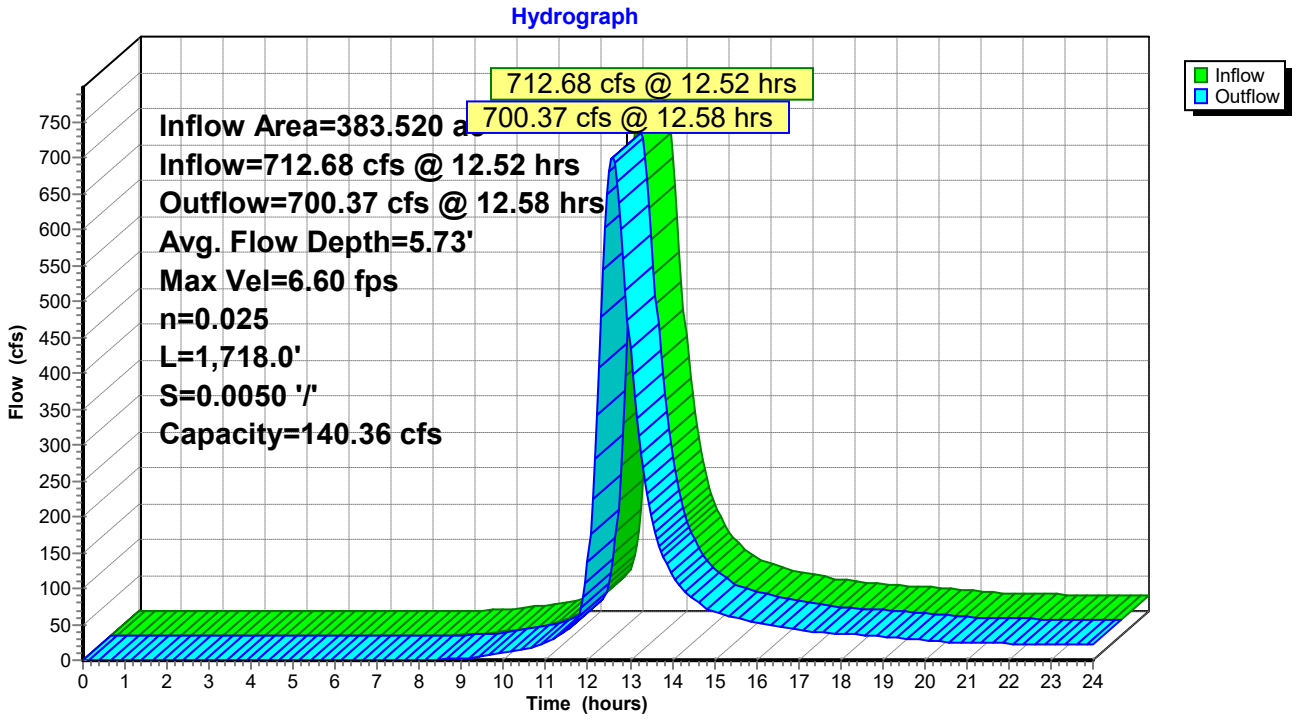
Reach 4R: (new Reach)



APPENDIX C

CRITICAL STORM CALCULATIONS

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-yr COL	Type II 24-hr		Default	24.00	1	2.20	2

Summary for Subcatchment 1: Pre-Dev

Runoff = 4.84 cfs @ 12.09 hrs, Volume= 0.338 af, Depth> 0.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr COL Rainfall=2.20"

Area (ac)	CN	Description
2.808	61	>75% Grass cover, Good, HSG B
3.112	98	Paved parking, HSG B
5.920	80	Weighted Average
2.808		47.43% Pervious Area
3.112		52.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	100	0.0300	0.18		**Sheet Flow, SHEET FLOW** Grass: Short n= 0.150 P2= 2.63"
6.7	600	0.0100	1.50		**Shallow Concentrated Flow, SCF** Grassed Waterway Kv= 15.0 fps
15.9	700	Total			

Summary for Subcatchment 2: Post-Dev

Runoff = 11.91 cfs @ 12.01 hrs, Volume= 0.660 af, Depth> 1.34"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr COL Rainfall=2.20"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Critical Storm Determination

PROJECT →	Academy Park	
BY →	CLE	DATE: 10/17/2025
CHECKED BY →		DATE:

P(in)= 2.2 Franklin

composite postdev CN 91 post dev area (ac)= 5.920

composite predev CN 80 pre dev area (ac)= 5.920

CALCULATIONS

Q_{pre}(in)=	0.71
Q_{post}(in)=	1.35
S_{pre}=	2.43
S_{post}=	0.97

Q=(P-0.2S)^2 / (P+.8S)

S= [1000/CN] - 10

% increase in runoff volume → ***90.5 %***

the critical storm is → ***10 year***

equal to or greater than	*and less than*	*The critical storm for discharge limitation will be*
-	10	1 year
10	20	2 years
20	50	5 years
50	100	10 years
100	250	25 years
250	500	50 years
500	-	100 years

post-developed

description	*Ac.*	*CN*
Pavement/Building	3.112	98
Grass	2.808	61
Composite		80

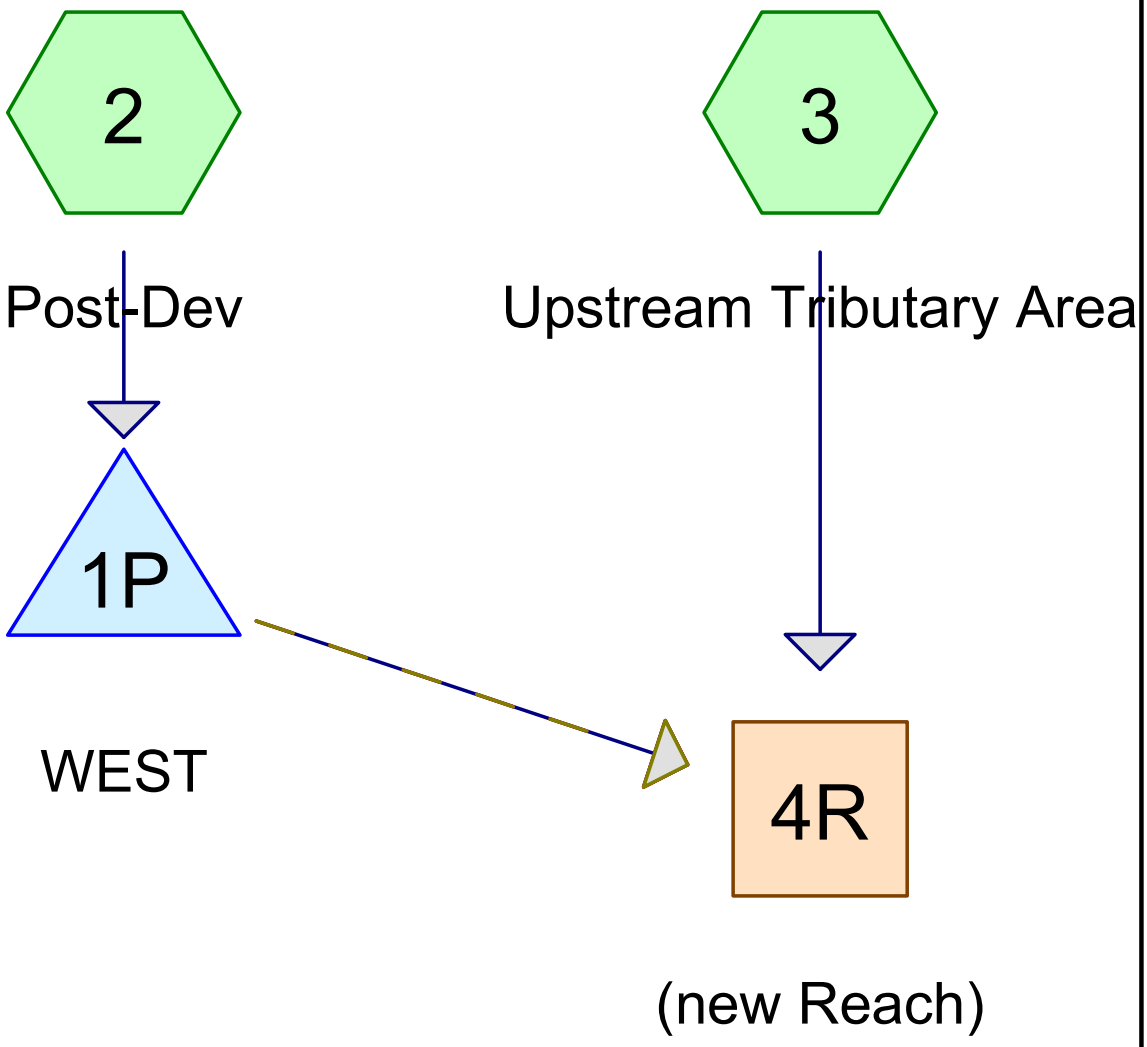
1.6

pre-developed conditions

description	*Ac.*	*CN*
Pavement/Building	4.822	98
Grass	1.098	61
Composite		91

APPENDIX D

POST-DEVELOPED HYDROCAD CALCULATIONS



Subcat Reach Pond Link

Routing Diagram for Academy Park Post-Dev
Prepared by Advanced Civil Design, Inc, Printed 10/21/2025
HydroCAD® 10.20-7a s/n 02822 © 2025 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-yr COL	Type II 24-hr		Default	24.00	1	2.20	2
2	2-yr COL	Type II 24-hr		Default	24.00	1	2.63	2
3	5-yr COL	Type II 24-hr		Default	24.00	1	3.24	2
4	10-yr COL	Type II 24-hr		Default	24.00	1	3.74	2
5	25-yr COL	Type II 24-hr		Default	24.00	1	4.44	2
6	50-yr COL	Type II 24-hr		Default	24.00	1	5.02	2
7	100-yr COL	Type II 24-hr		Default	24.00	1	5.63	2

Summary for Subcatchment 2: Post-Dev

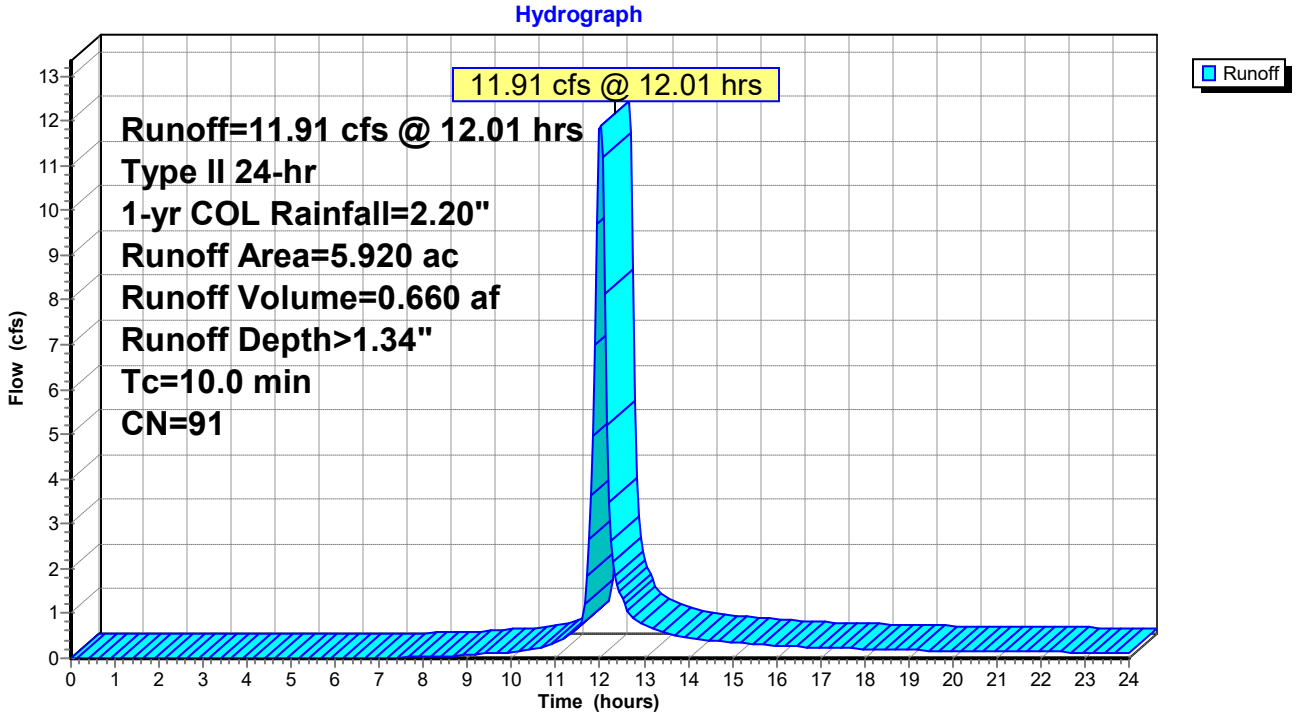
Runoff = 11.91 cfs @ 12.01 hrs, Volume= 0.660 af, Depth> 1.34"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr COL Rainfall=2.20"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Subcatchment 2: Post-Dev



Summary for Subcatchment 3: Upstream Tributary Area

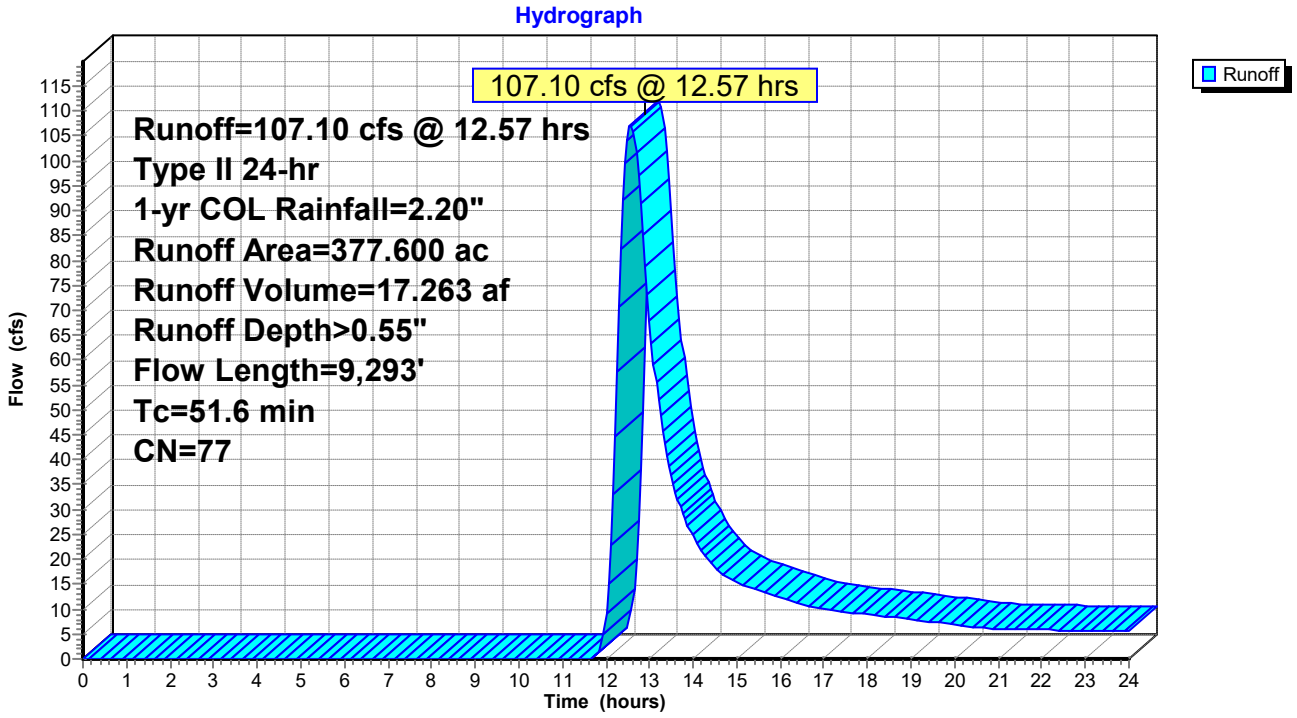
Runoff = 107.10 cfs @ 12.57 hrs, Volume= 17.263 af, Depth> 0.55"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr COL Rainfall=2.20"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



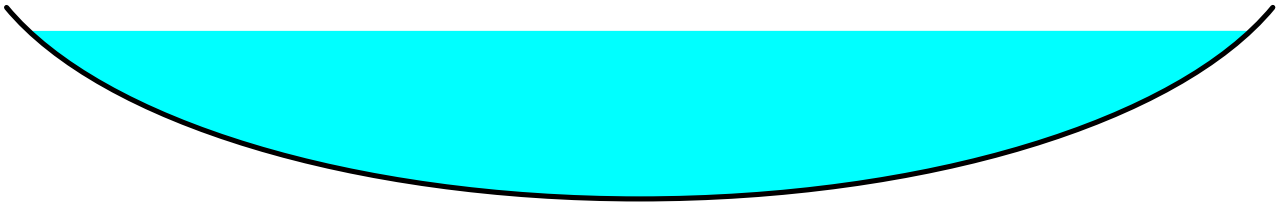
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 1.26% Impervious, Inflow Depth > 0.56" for 1-yr COL event
Inflow = 109.04 cfs @ 12.57 hrs, Volume= 17.756 af
Outflow = 106.30 cfs @ 12.65 hrs, Volume= 17.638 af, Atten= 3%, Lag= 5.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.61 fps, Min. Travel Time= 6.2 min
Avg. Velocity = 2.33 fps, Avg. Travel Time= 12.3 min

Peak Storage= 39,635 cf @ 12.65 hrs
Average Depth at Peak Storage= 1.76' , Surface Width= 19.69'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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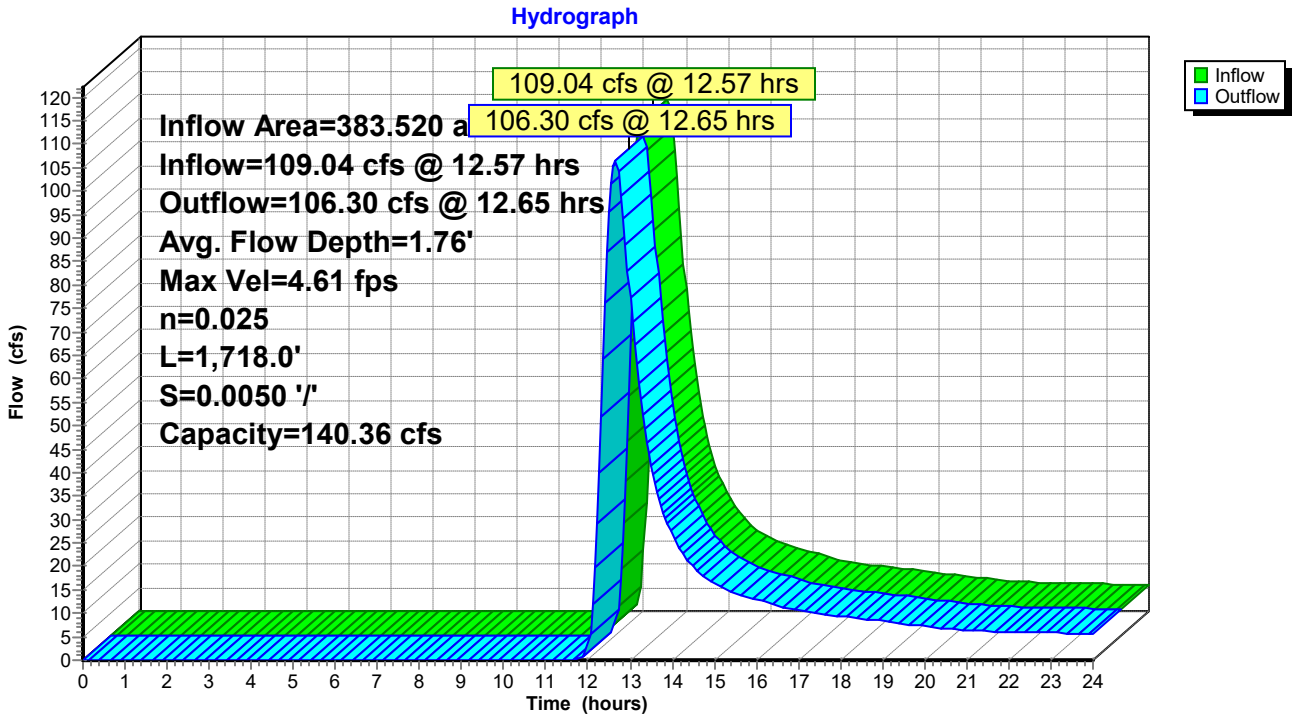
Reach 4R: (new Reach)



Summary for Pond 1P: WEST

Inflow Area = 5.920 ac, 81.45% Impervious, Inflow Depth > 1.34" for 1-yr COL event
Inflow = 11.91 cfs @ 12.01 hrs, Volume= 0.660 af
Outflow = 9.07 cfs @ 12.09 hrs, Volume= 0.493 af, Atten= 24%, Lag= 4.9 min
Primary = 1.14 cfs @ 12.09 hrs, Volume= 0.170 af
Routed to Reach 4R : (new Reach)
Secondary = 1.49 cfs @ 12.09 hrs, Volume= 0.219 af
Routed to Reach 4R : (new Reach)
Tertiary = 6.43 cfs @ 12.09 hrs, Volume= 0.104 af
Routed to Reach 4R : (new Reach)

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 803.34' @ 12.09 hrs Surf.Area= 5,825 sf Storage= 10,065 cf

Plug-Flow detention time= 141.6 min calculated for 0.492 af (75% of inflow)
Center-of-Mass det. time= 50.5 min (867.1 - 816.6)

Volume	Invert	Avail.Storage	Storage Description
#1	800.30'	16,557 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
800.30	1,320	0	0
801.30	2,342	1,831	1,831
802.30	3,961	3,152	4,983
803.30	5,748	4,855	9,837
804.30	7,692	6,720	16,557

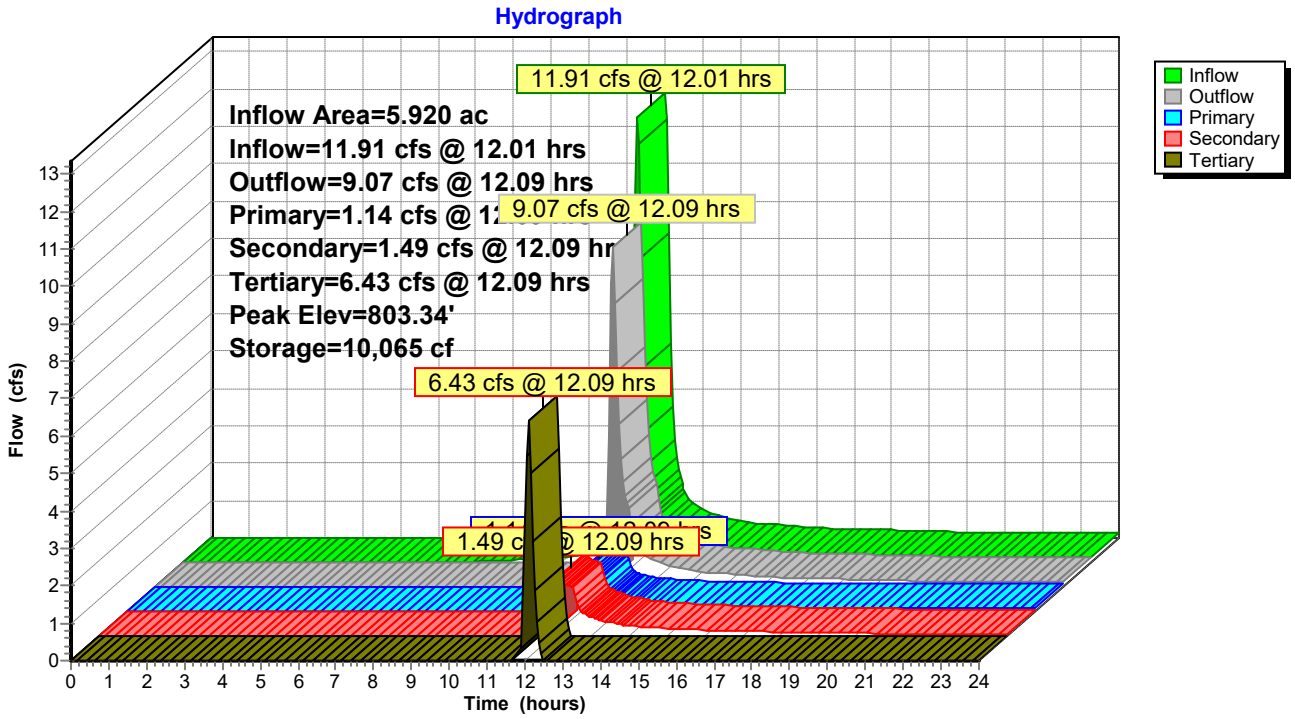
Device	Routing	Invert	Outlet Devices
#1	Primary	800.40'	**6.0" Round Culvert** L= 40.4' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 800.40' / 800.36' S= 0.0010 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Device 1	801.30'	**1.2" Vert. WQ Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	802.80'	**12.0" W x 6.0" H Vert. Window X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	803.30'	**1.5" x 5.0" Horiz. Grate X 9.00 columns** X 4 rows C= 0.600 Limited to weir flow at low heads
#5	Tertiary	803.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#6	Secondary	801.27'	**8.0" Round Culvert Secondary** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 801.27' / 801.05' S= 0.0028 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.35 sf
#7	Device 6	802.80'	**24.0" W x 6.0" H Vert. Window Secondary X 4.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.14 cfs @ 12.09 hrs HW=803.34' TW=800.62' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.14 cfs @ 5.83 fps)
  └─**2=WQ Orifice** (Passes < 0.05 cfs potential flow)
  └─**3=Window** (Passes < 4.94 cfs potential flow)
  └─**4=Grate** (Passes < 0.85 cfs potential flow)

Secondary OutFlow Max=1.49 cfs @ 12.09 hrs HW=803.34' TW=800.62' (Dynamic Tailwater)
└─**6=Culvert Secondary** (Barrel Controls 1.49 cfs @ 4.27 fps)
  └─**7=Window Secondary** (Passes 1.49 cfs of 9.89 cfs potential flow)

Tertiary OutFlow Max=6.32 cfs @ 12.09 hrs HW=803.34' TW=800.62' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 6.32 cfs @ 1.57 fps)

Pond 1P: WEST



Summary for Subcatchment 2: Post-Dev

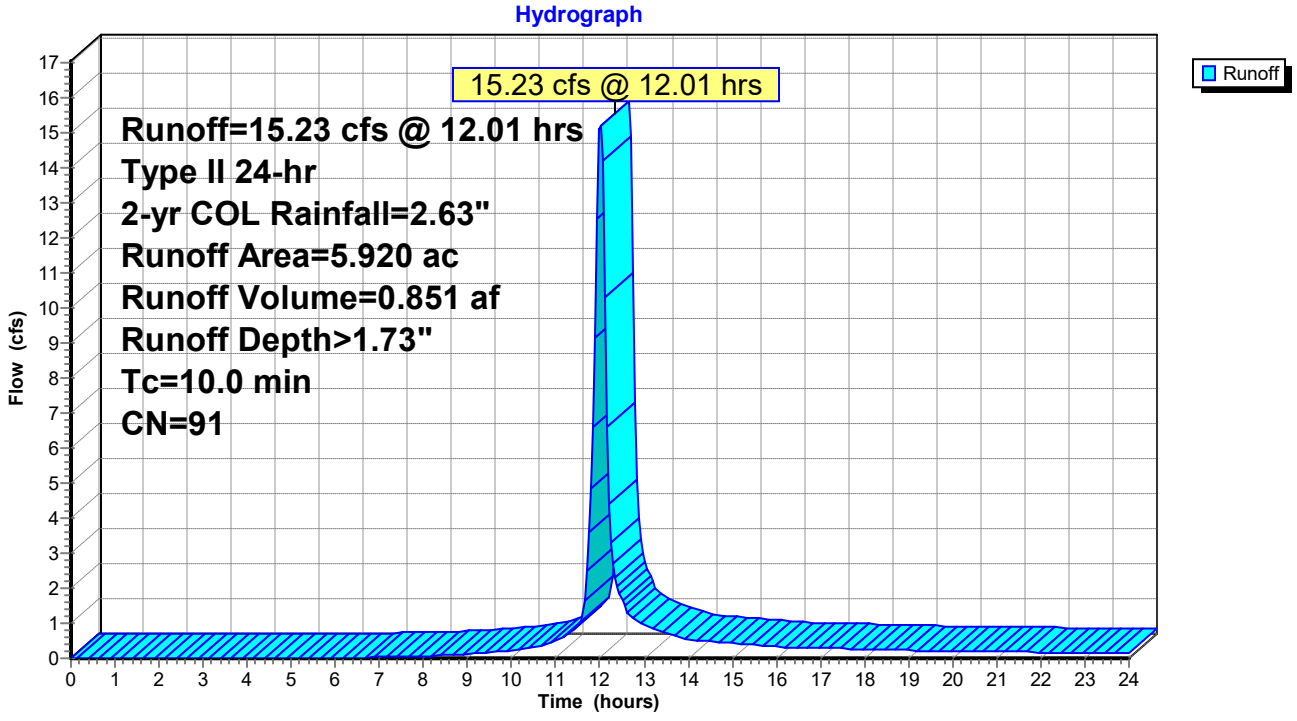
Runoff = 15.23 cfs @ 12.01 hrs, Volume= 0.851 af, Depth> 1.73"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr COL Rainfall=2.63"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Subcatchment 2: Post-Dev



Summary for Subcatchment 3: Upstream Tributary Area

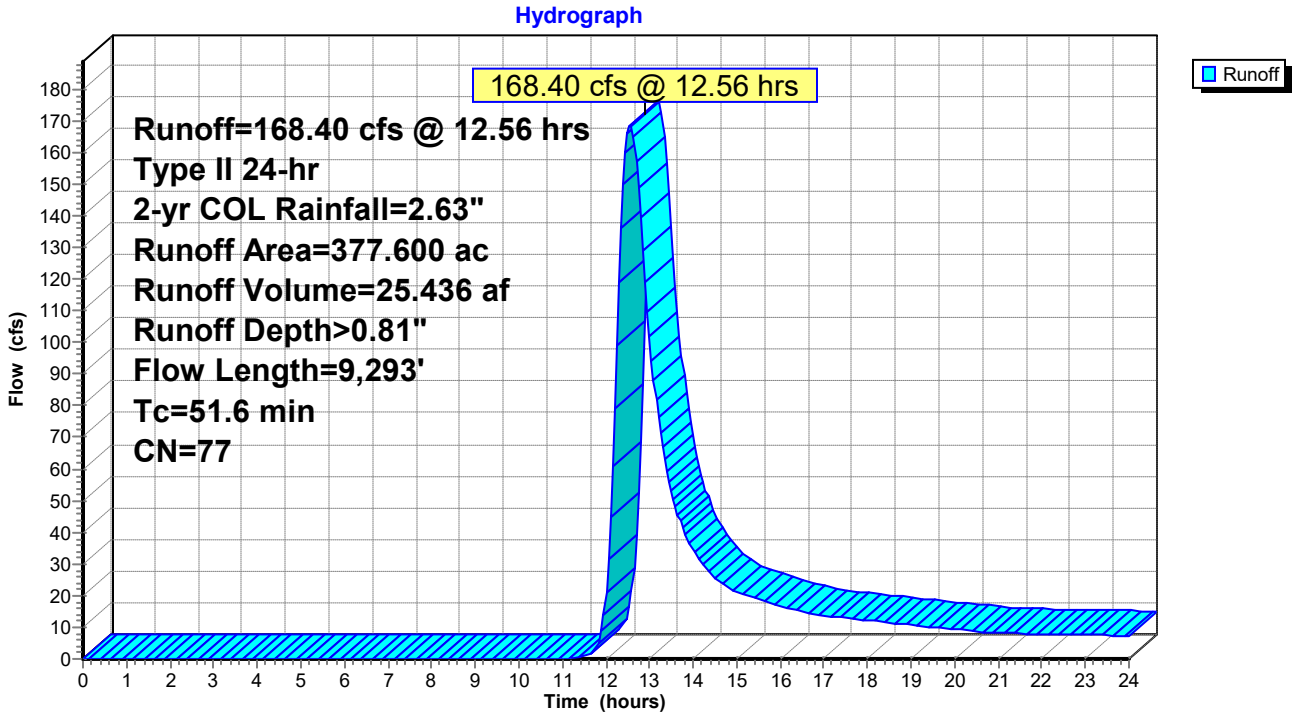
Runoff = 168.40 cfs @ 12.56 hrs, Volume= 25.436 af, Depth> 0.81"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr COL Rainfall=2.63"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



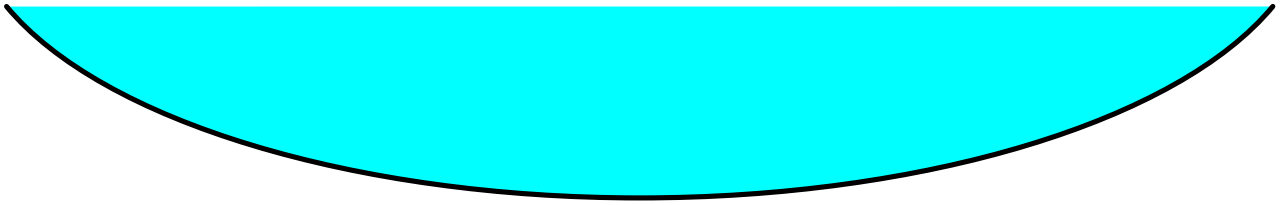
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 1.26% Impervious, Inflow Depth > 0.82" for 2-yr COL event
Inflow = 170.29 cfs @ 12.55 hrs, Volume= 26.120 af
Outflow = 166.94 cfs @ 12.63 hrs, Volume= 25.976 af, Atten= 2%, Lag= 4.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.26 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 2.49 fps, Avg. Travel Time= 11.5 min

Peak Storage= 54,476 cf @ 12.63 hrs
Average Depth at Peak Storage= 2.18' , Surface Width= 21.91'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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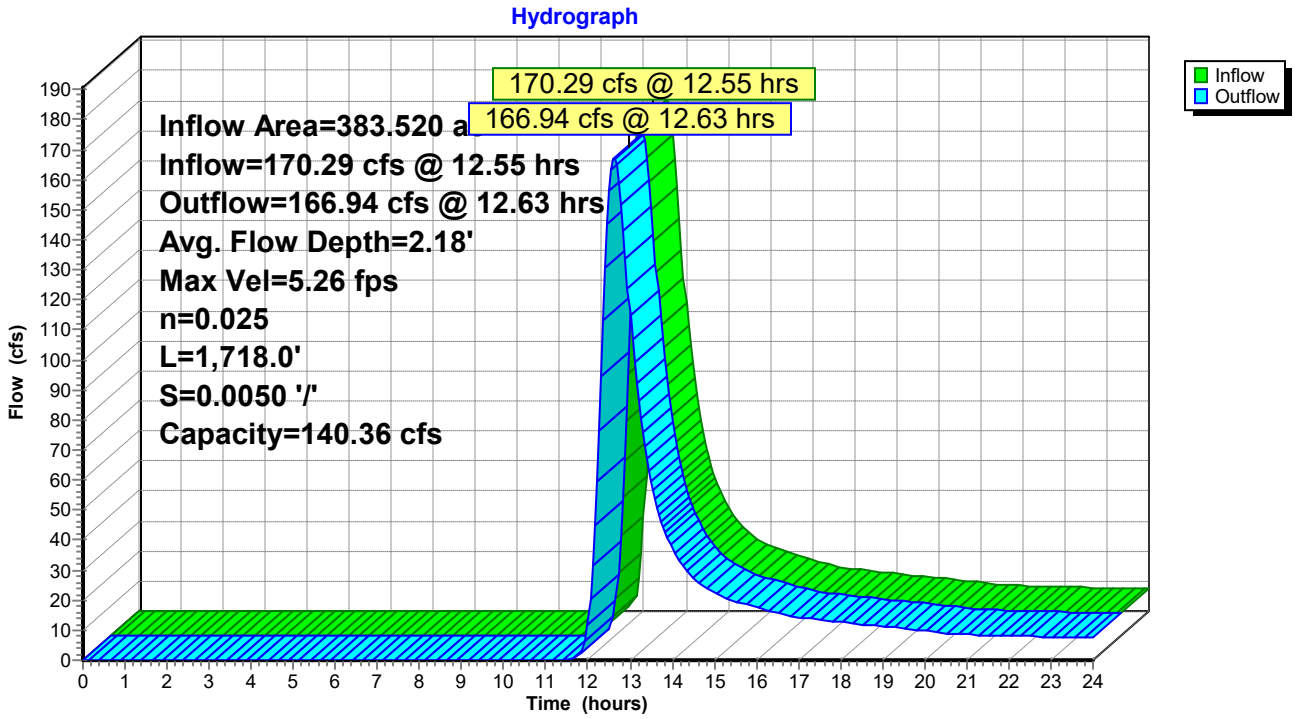
Reach 4R: (new Reach)



Summary for Pond 1P: WEST

Inflow Area = 5.920 ac, 81.45% Impervious, Inflow Depth > 1.73" for 2-yr COL event
Inflow = 15.23 cfs @ 12.01 hrs, Volume= 0.851 af
Outflow = 13.46 cfs @ 12.06 hrs, Volume= 0.684 af, Atten= 12%, Lag= 3.2 min
Primary = 1.18 cfs @ 12.07 hrs, Volume= 0.201 af
Routed to Reach 4R : (new Reach)
Secondary = 1.56 cfs @ 12.07 hrs, Volume= 0.275 af
Routed to Reach 4R : (new Reach)
Tertiary = 10.72 cfs @ 12.06 hrs, Volume= 0.208 af
Routed to Reach 4R : (new Reach)

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 803.48' @ 12.07 hrs Surf.Area= 6,089 sf Storage= 10,874 cf

Plug-Flow detention time= 121.0 min calculated for 0.684 af (80% of inflow)
Center-of-Mass det. time= 41.4 min (850.8 - 809.4)

Volume	Invert	Avail.Storage	Storage Description
#1	800.30'	16,557 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
800.30	1,320	0	0
801.30	2,342	1,831	1,831
802.30	3,961	3,152	4,983
803.30	5,748	4,855	9,837
804.30	7,692	6,720	16,557

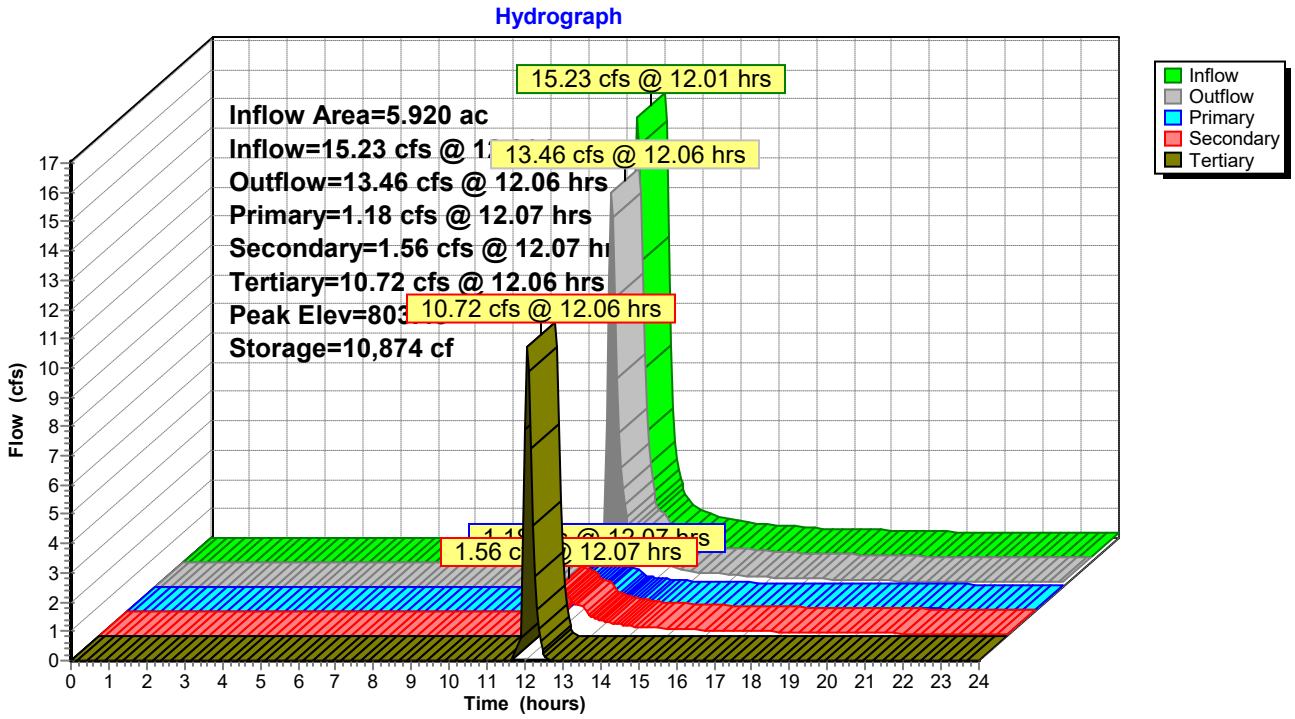
Device	Routing	Invert	Outlet Devices
#1	Primary	800.40'	**6.0" Round Culvert** L= 40.4' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 800.40' / 800.36' S= 0.0010 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Device 1	801.30'	**1.2" Vert. WQ Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	802.80'	**12.0" W x 6.0" H Vert. Window X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	803.30'	**1.5" x 5.0" Horiz. Grate X 9.00 columns** X 4 rows C= 0.600 Limited to weir flow at low heads
#5	Tertiary	803.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#6	Secondary	801.27'	**8.0" Round Culvert Secondary** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 801.27' / 801.05' S= 0.0028 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.35 sf
#7	Device 6	802.80'	**24.0" W x 6.0" H Vert. Window Secondary X 4.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.17 cfs @ 12.07 hrs HW=803.46' TW=800.87' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.17 cfs @ 5.96 fps)
  ├─**2=WQ Orifice** (Passes < 0.05 cfs potential flow)
  ├─**3=Window** (Passes < 6.10 cfs potential flow)
  └─**4=Grate** (Passes < 3.66 cfs potential flow)

Secondary OutFlow Max=1.55 cfs @ 12.07 hrs HW=803.46' TW=800.87' (Dynamic Tailwater)
└─**6=Culvert Secondary** (Barrel Controls 1.55 cfs @ 4.44 fps)
  └─**7=Window Secondary** (Passes 1.55 cfs of 12.19 cfs potential flow)

Tertiary OutFlow Max=10.37 cfs @ 12.06 hrs HW=803.46' TW=800.87' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 10.37 cfs @ 1.86 fps)

Pond 1P: WEST



Summary for Subcatchment 2: Post-Dev

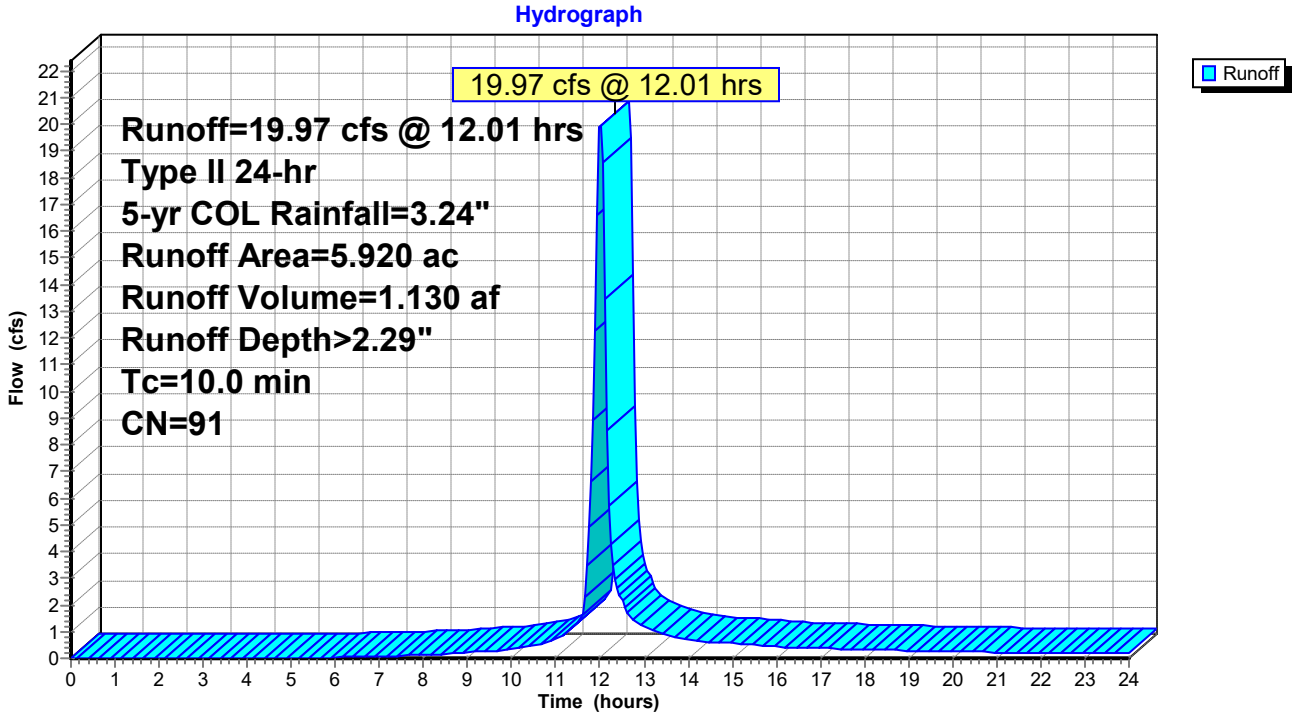
Runoff = 19.97 cfs @ 12.01 hrs, Volume= 1.130 af, Depth> 2.29"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-yr COL Rainfall=3.24"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Subcatchment 2: Post-Dev



Summary for Subcatchment 3: Upstream Tributary Area

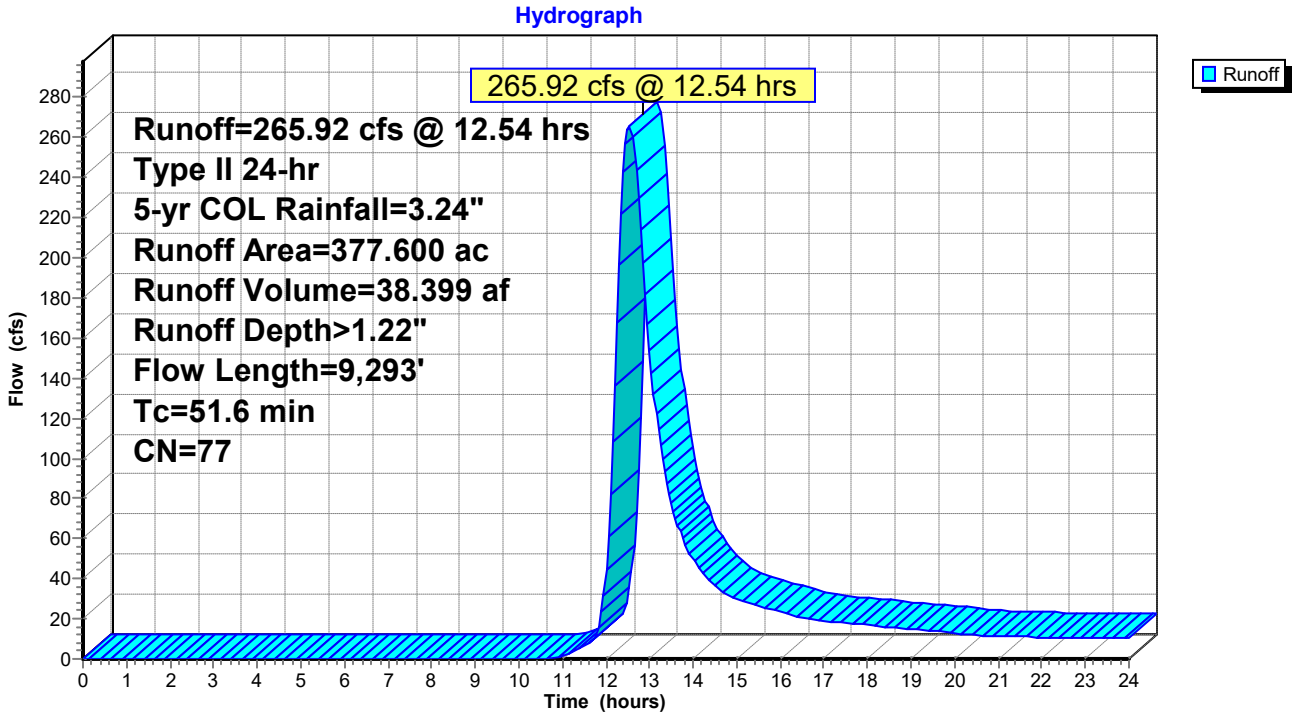
Runoff = 265.92 cfs @ 12.54 hrs, Volume= 38.399 af, Depth> 1.22"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-yr COL Rainfall=3.24"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



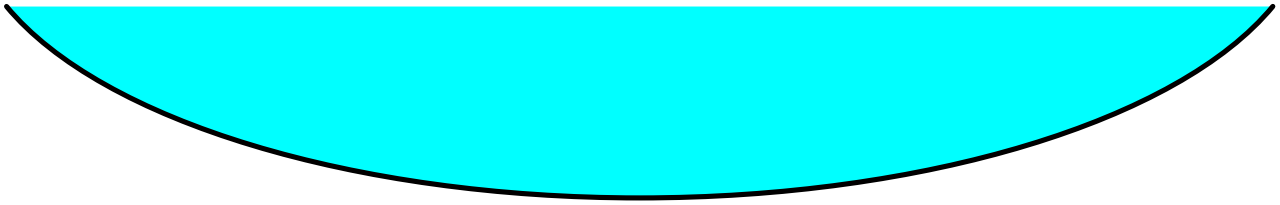
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 1.26% Impervious, Inflow Depth > 1.23" for 5-yr COL event
Inflow = 268.08 cfs @ 12.54 hrs, Volume= 39.361 af
Outflow = 263.02 cfs @ 12.61 hrs, Volume= 39.182 af, Atten= 2%, Lag= 4.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.83 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 2.69 fps, Avg. Travel Time= 10.6 min

Peak Storage= 77,507 cf @ 12.61 hrs
Average Depth at Peak Storage= 2.82' , Surface Width= 24.92'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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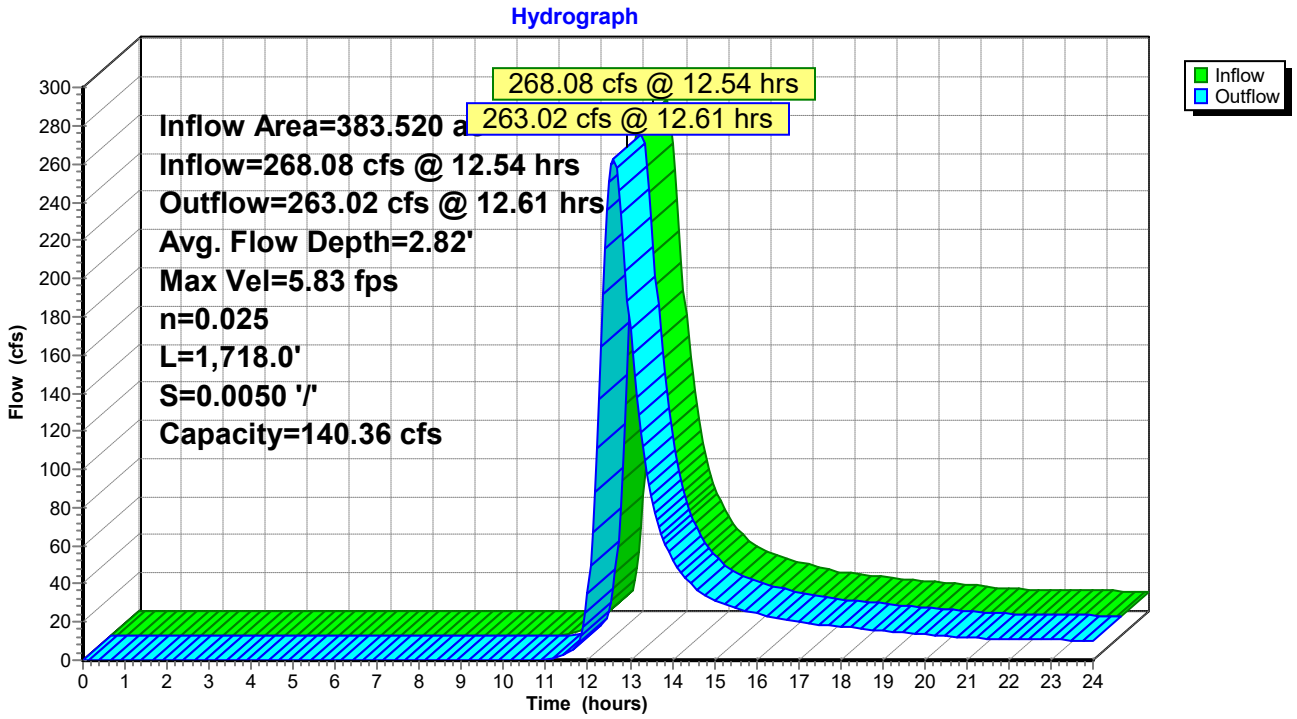
Reach 4R: (new Reach)



Summary for Pond 1P: WEST

Inflow Area = 5.920 ac, 81.45% Impervious, Inflow Depth > 2.29" for 5-yr COL event
Inflow = 19.97 cfs @ 12.01 hrs, Volume= 1.130 af
Outflow = 18.39 cfs @ 12.05 hrs, Volume= 0.963 af, Atten= 8%, Lag= 2.5 min
Primary = 1.19 cfs @ 12.00 hrs, Volume= 0.234 af
Routed to Reach 4R : (new Reach)
Secondary = 1.61 cfs @ 12.05 hrs, Volume= 0.335 af
Routed to Reach 4R : (new Reach)
Tertiary = 15.62 cfs @ 12.05 hrs, Volume= 0.394 af
Routed to Reach 4R : (new Reach)

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 803.61' @ 12.05 hrs Surf.Area= 6,345 sf Storage= 11,692 cf

Plug-Flow detention time= 101.8 min calculated for 0.961 af (85% of inflow)
Center-of-Mass det. time= 35.9 min (837.3 - 801.4)

Volume	Invert	Avail.Storage	Storage Description
#1	800.30'	16,557 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
800.30	1,320	0	0
801.30	2,342	1,831	1,831
802.30	3,961	3,152	4,983
803.30	5,748	4,855	9,837
804.30	7,692	6,720	16,557

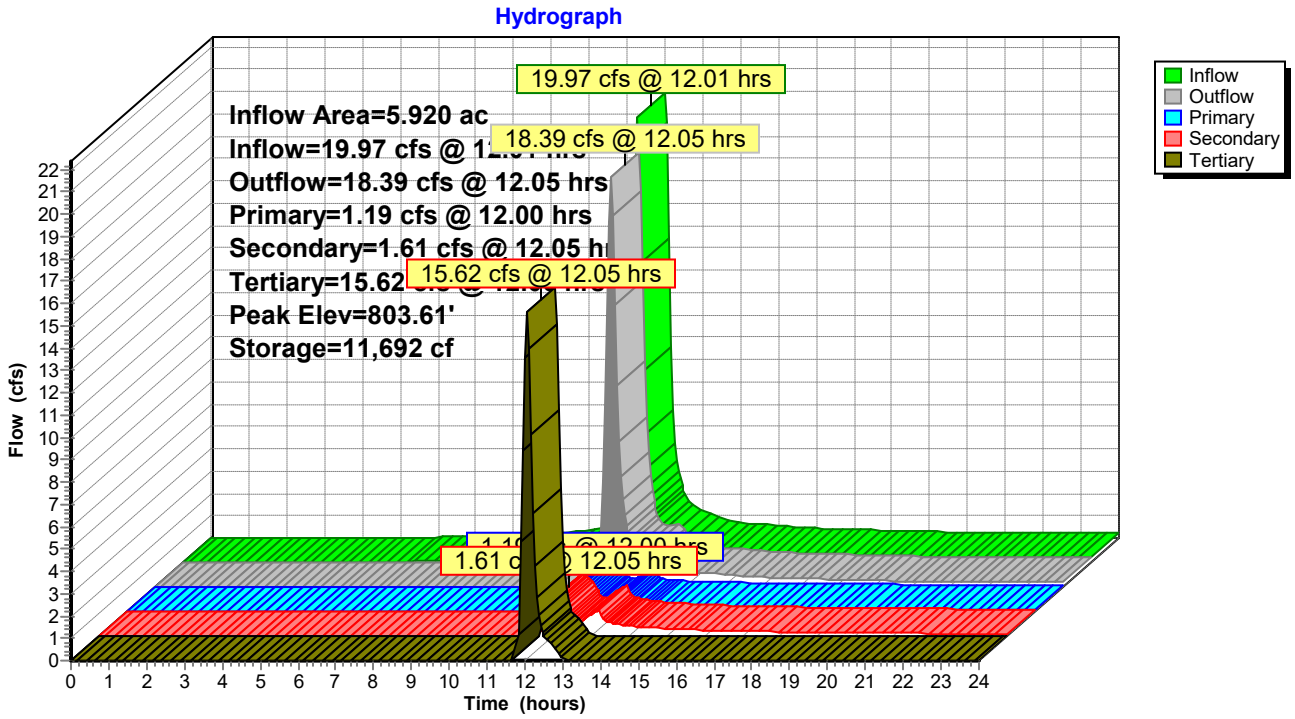
Device	Routing	Invert	Outlet Devices
#1	Primary	800.40'	**6.0" Round Culvert** L= 40.4' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 800.40' / 800.36' S= 0.0010 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Device 1	801.30'	**1.2" Vert. WQ Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	802.80'	**12.0" W x 6.0" H Vert. Window X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	803.30'	**1.5" x 5.0" Horiz. Grate X 9.00 columns** X 4 rows C= 0.600 Limited to weir flow at low heads
#5	Tertiary	803.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#6	Secondary	801.27'	**8.0" Round Culvert Secondary** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 801.27' / 801.05' S= 0.0028 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.35 sf
#7	Device 6	802.80'	**24.0" W x 6.0" H Vert. Window Secondary X 4.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.15 cfs @ 12.00 hrs HW=803.55' TW=801.04' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.15 cfs @ 5.86 fps)
  ├─**2=WQ Orifice** (Passes < 0.06 cfs potential flow)
  ├─**3=Window** (Passes < 6.72 cfs potential flow)
  └─**4=Grate** (Passes < 4.50 cfs potential flow)

Secondary OutFlow Max=1.61 cfs @ 12.05 hrs HW=803.60' TW=801.24' (Dynamic Tailwater)
└─**6=Culvert Secondary** (Barrel Controls 1.61 cfs @ 4.62 fps)
  └─**7=Window Secondary** (Passes 1.61 cfs of 14.22 cfs potential flow)

Tertiary OutFlow Max=15.53 cfs @ 12.05 hrs HW=803.60' TW=801.24' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 15.53 cfs @ 2.14 fps)

Pond 1P: WEST



Summary for Subcatchment 2: Post-Dev

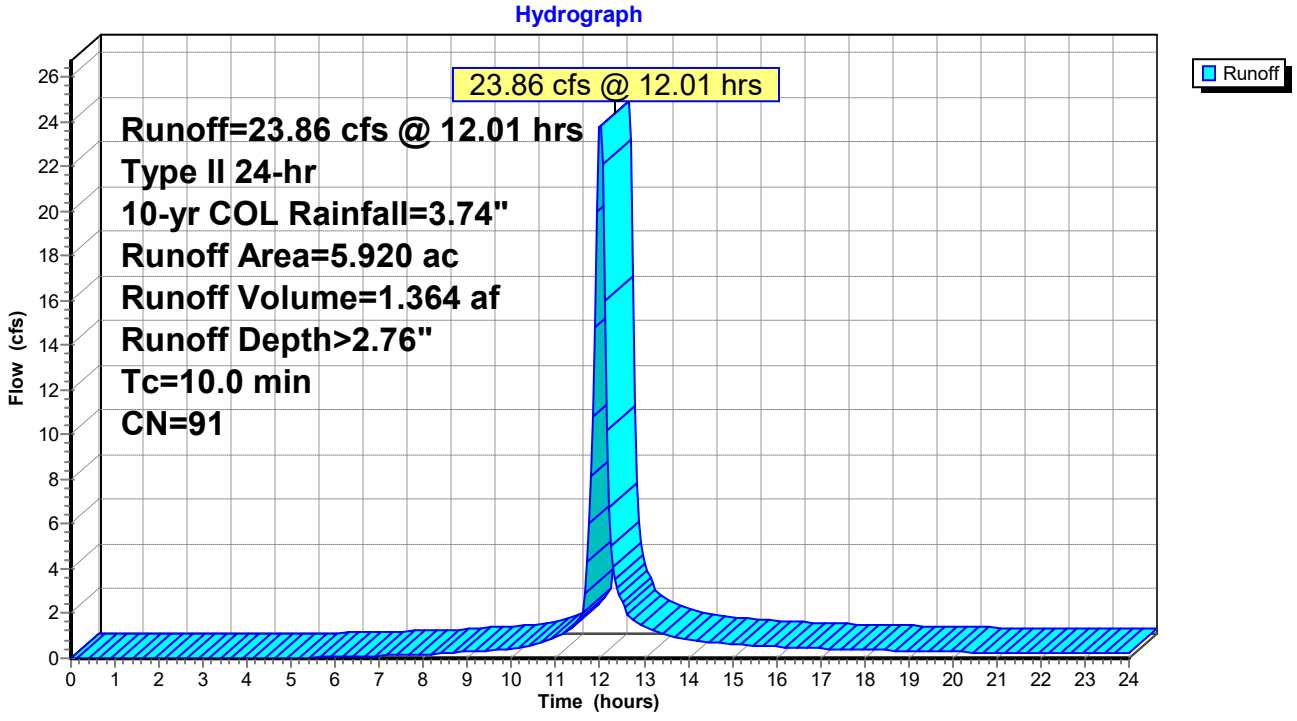
Runoff = 23.86 cfs @ 12.01 hrs, Volume= 1.364 af, Depth> 2.76"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr COL Rainfall=3.74"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Subcatchment 2: Post-Dev



Summary for Subcatchment 3: Upstream Tributary Area

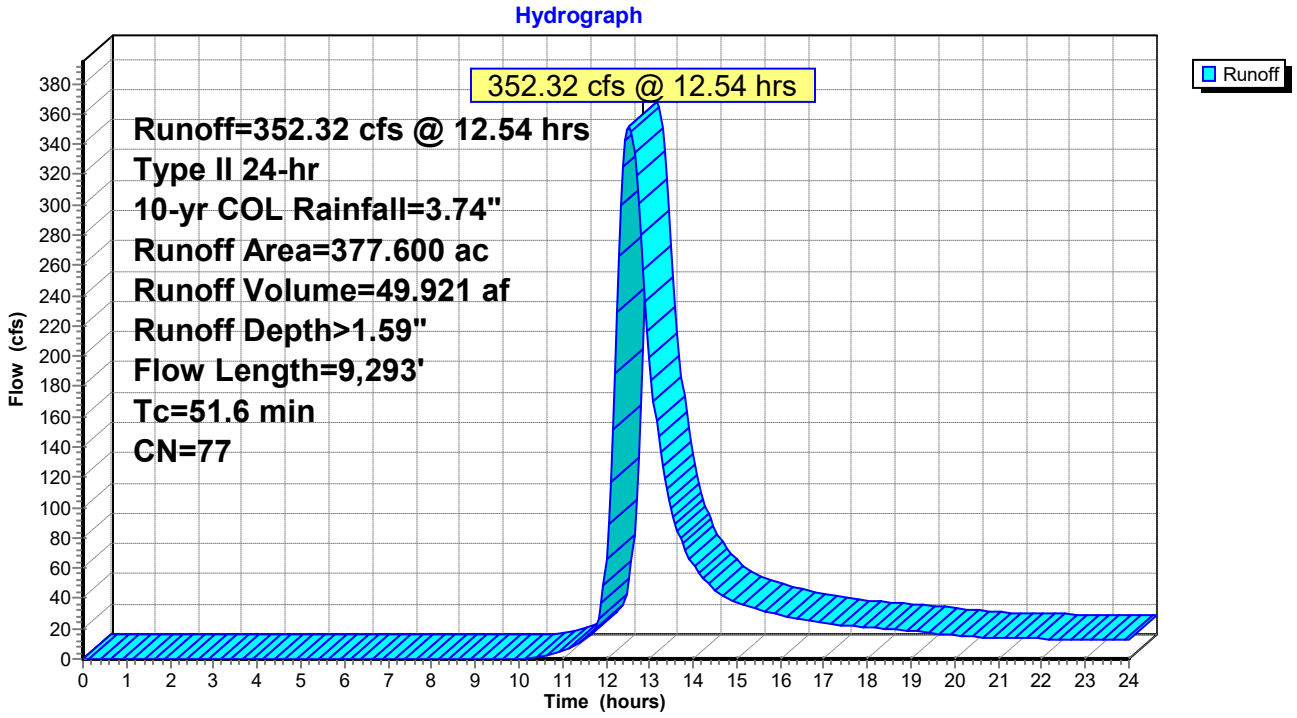
Runoff = 352.32 cfs @ 12.54 hrs, Volume= 49.921 af, Depth> 1.59"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr COL Rainfall=3.74"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



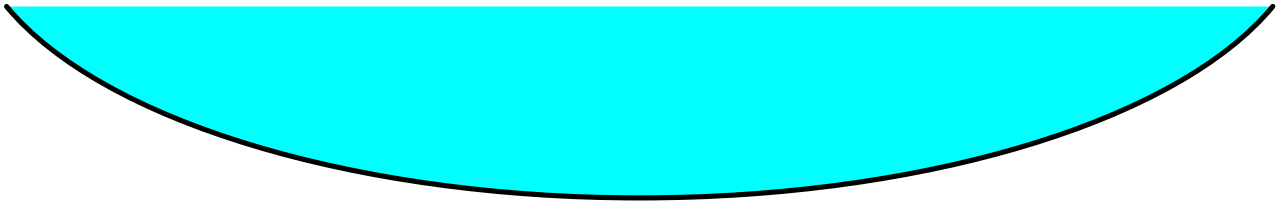
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 1.26% Impervious, Inflow Depth > 1.60" for 10-yr COL event
Inflow = 352.61 cfs @ 12.53 hrs, Volume= 51.116 af
Outflow = 346.36 cfs @ 12.60 hrs, Volume= 50.909 af, Atten= 2%, Lag= 4.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.10 fps, Min. Travel Time= 4.7 min
Avg. Velocity = 2.82 fps, Avg. Travel Time= 10.1 min

Peak Storage= 97,484 cf @ 12.60 hrs
Average Depth at Peak Storage= 3.37' , Surface Width= 27.27'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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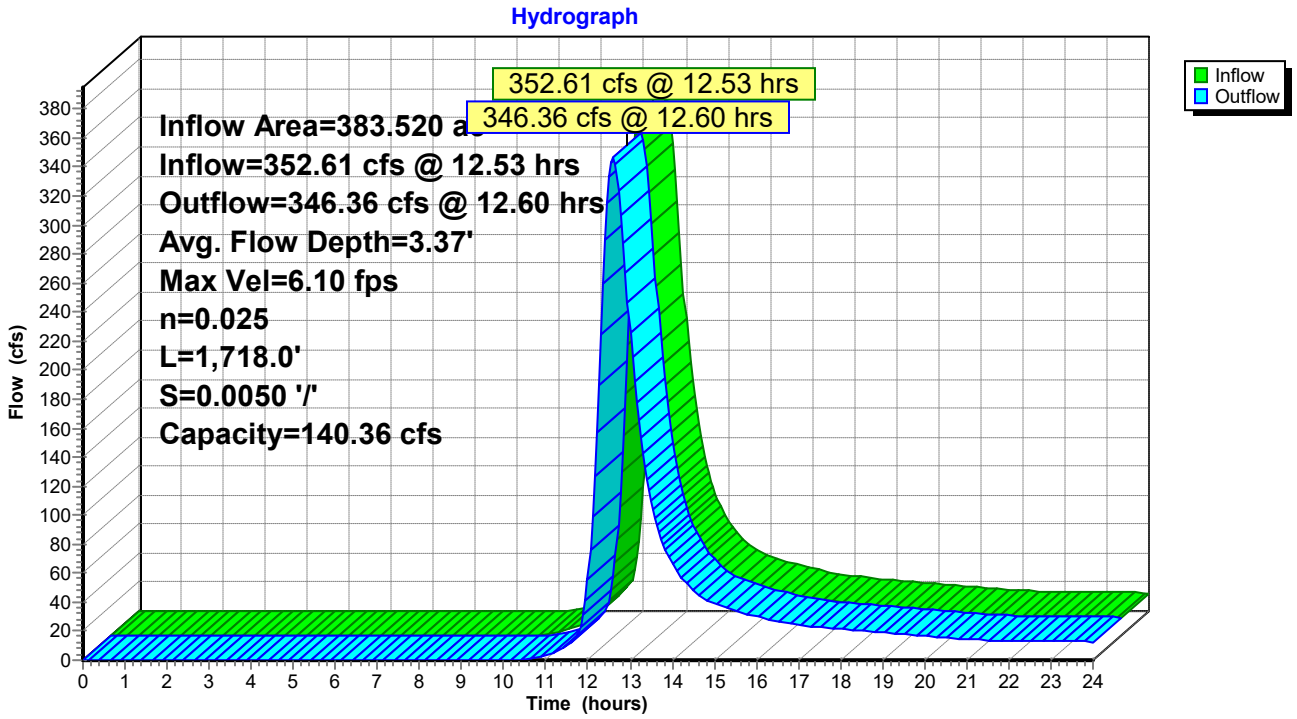
Reach 4R: (new Reach)



Summary for Pond 1P: WEST

Inflow Area = 5.920 ac, 81.45% Impervious, Inflow Depth > 2.76" for 10-yr COL event
Inflow = 23.86 cfs @ 12.01 hrs, Volume= 1.364 af
Outflow = 22.25 cfs @ 12.05 hrs, Volume= 1.195 af, Atten= 7%, Lag= 2.3 min
Primary = 1.15 cfs @ 11.96 hrs, Volume= 0.254 af
Routed to Reach 4R : (new Reach)
Secondary = 1.65 cfs @ 12.05 hrs, Volume= 0.371 af
Routed to Reach 4R : (new Reach)
Tertiary = 19.48 cfs @ 12.05 hrs, Volume= 0.570 af
Routed to Reach 4R : (new Reach)

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 803.70' @ 12.05 hrs Surf.Area= 6,517 sf Storage= 12,263 cf

Plug-Flow detention time= 92.2 min calculated for 1.193 af (87% of inflow)
Center-of-Mass det. time= 34.2 min (830.3 - 796.1)

Volume	Invert	Avail.Storage	Storage Description
#1	800.30'	16,557 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
800.30	1,320	0	0
801.30	2,342	1,831	1,831
802.30	3,961	3,152	4,983
803.30	5,748	4,855	9,837
804.30	7,692	6,720	16,557

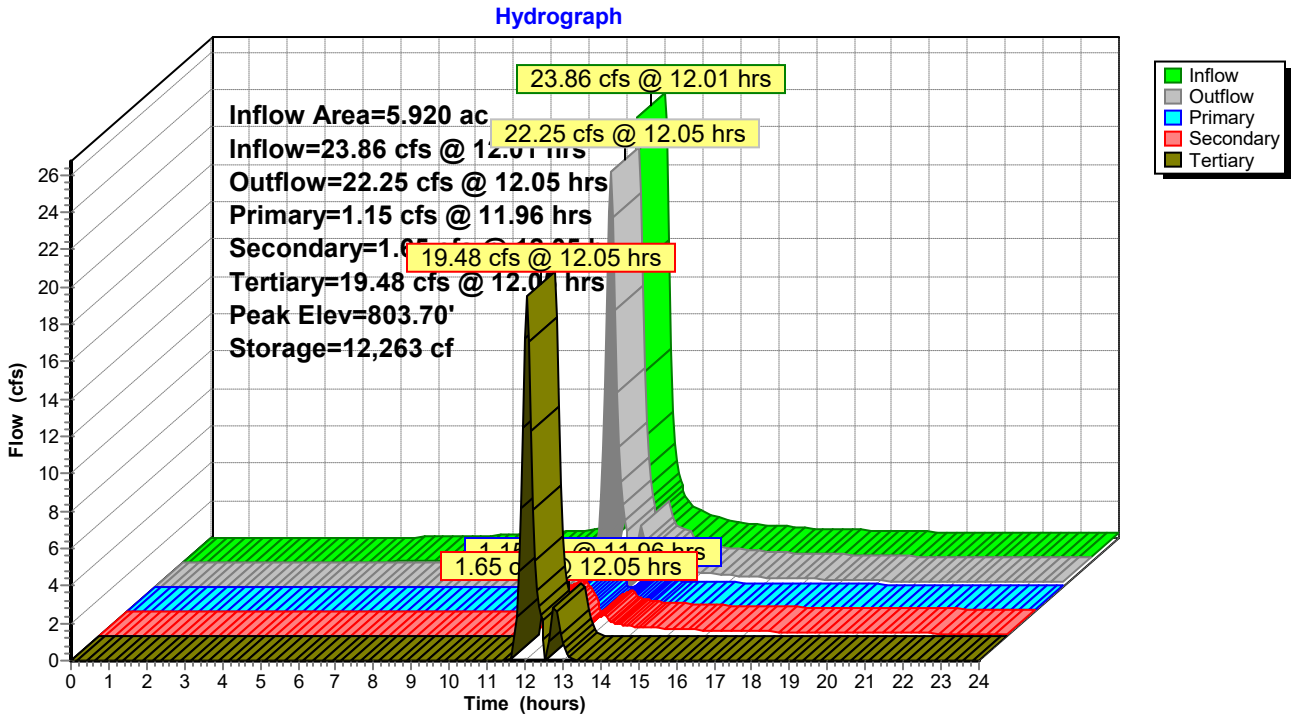
Device	Routing	Invert	Outlet Devices
#1	Primary	800.40'	**6.0" Round Culvert** L= 40.4' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 800.40' / 800.36' S= 0.0010 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Device 1	801.30'	**1.2" Vert. WQ Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	802.80'	**12.0" W x 6.0" H Vert. Window X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	803.30'	**1.5" x 5.0" Horiz. Grate X 9.00 columns** X 4 rows C= 0.600 Limited to weir flow at low heads
#5	Tertiary	803.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#6	Secondary	801.27'	**8.0" Round Culvert Secondary** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 801.27' / 801.05' S= 0.0028 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.35 sf
#7	Device 6	802.80'	**24.0" W x 6.0" H Vert. Window Secondary X 4.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.12 cfs @ 11.96 hrs HW=803.55' TW=801.17' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.12 cfs @ 5.71 fps)
  └─**2=WQ Orifice** (Passes < 0.06 cfs potential flow)
  └─**3=Window** (Passes < 6.74 cfs potential flow)
  └─**4=Grate** (Passes < 4.52 cfs potential flow)

Secondary OutFlow Max=1.65 cfs @ 12.05 hrs HW=803.69' TW=801.50' (Dynamic Tailwater)
└─**6=Culvert Secondary** (Barrel Controls 1.65 cfs @ 4.73 fps)
  └─**7=Window Secondary** (Passes 1.65 cfs of 15.36 cfs potential flow)

Tertiary OutFlow Max=19.43 cfs @ 12.05 hrs HW=803.69' TW=801.50' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 19.43 cfs @ 2.33 fps)

Pond 1P: WEST



Summary for Subcatchment 2: Post-Dev

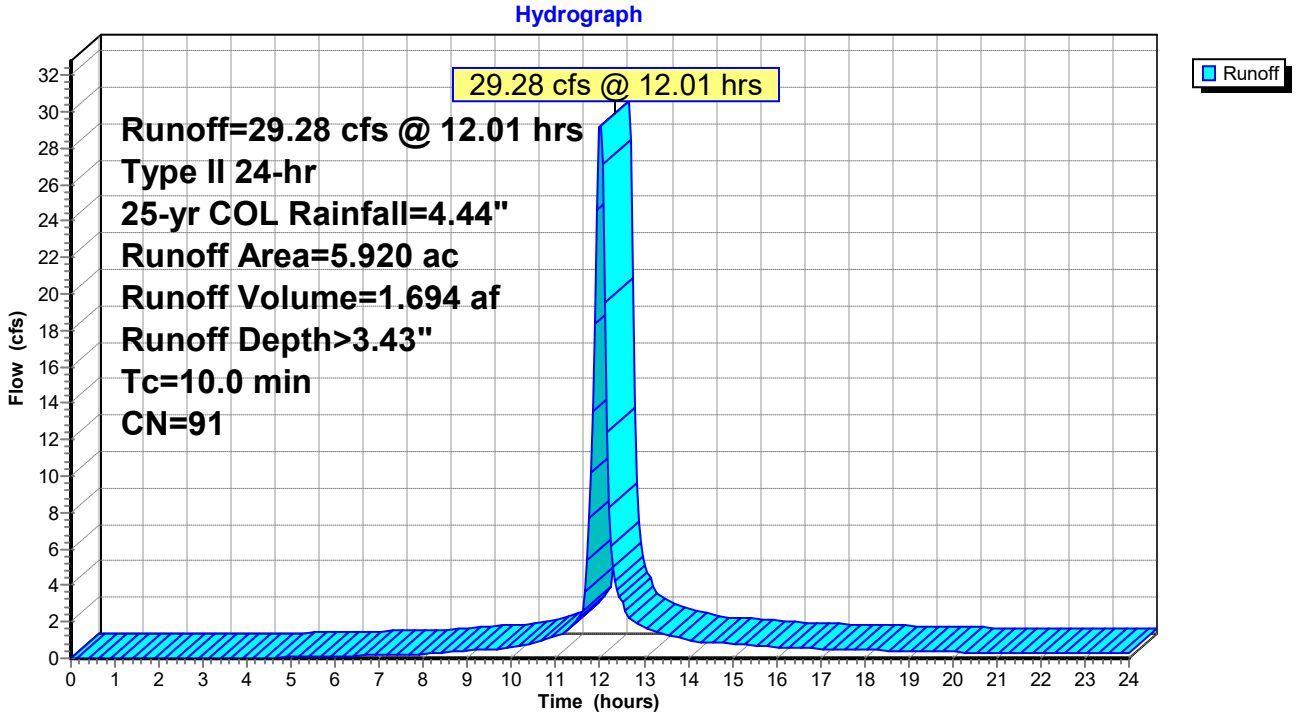
Runoff = 29.28 cfs @ 12.01 hrs, Volume= 1.694 af, Depth> 3.43"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr COL Rainfall=4.44"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Subcatchment 2: Post-Dev



Summary for Subcatchment 3: Upstream Tributary Area

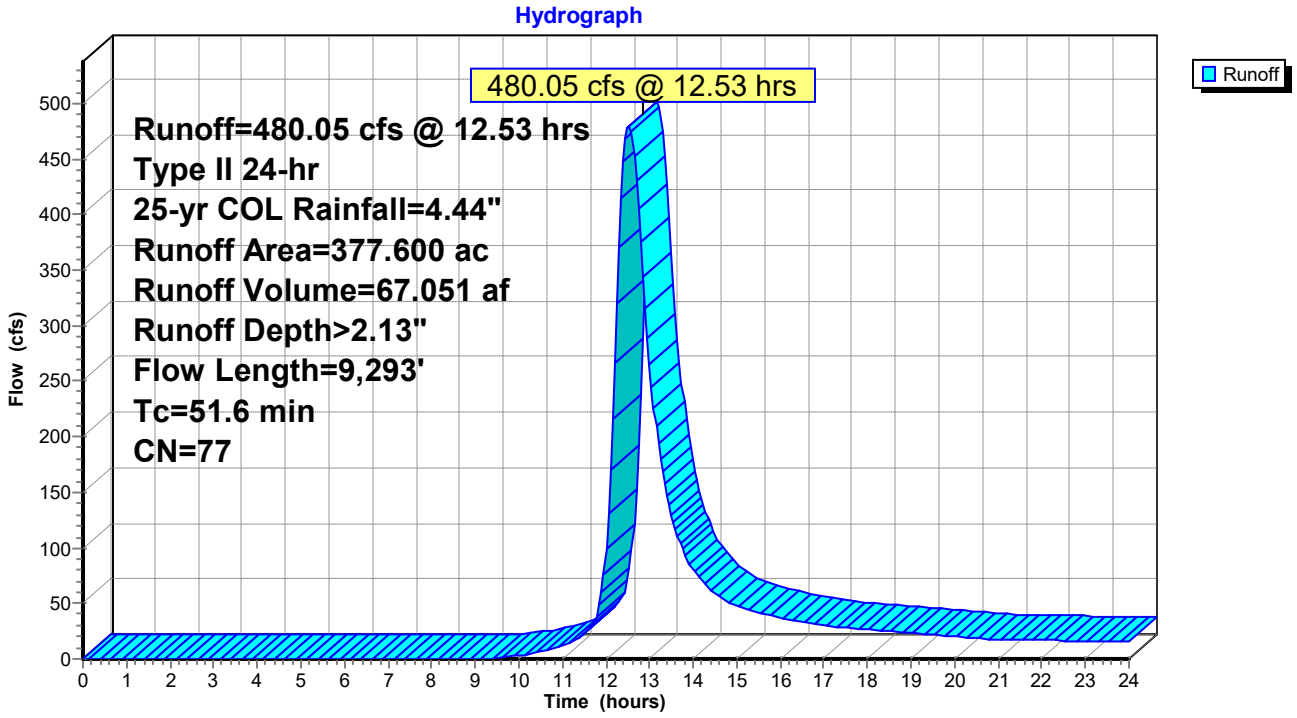
Runoff = 480.05 cfs @ 12.53 hrs, Volume= 67.051 af, Depth> 2.13"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr COL Rainfall=4.44"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



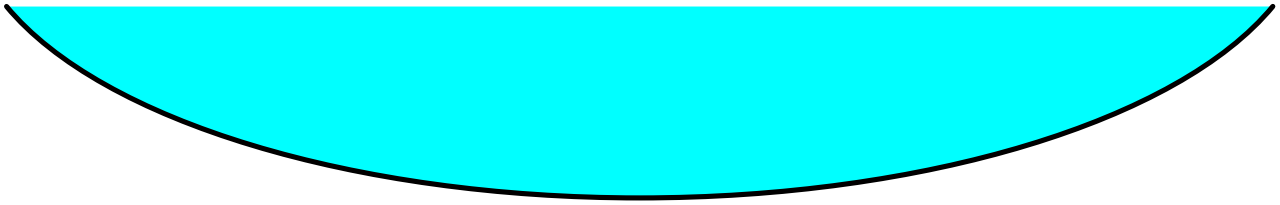
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 1.26% Impervious, Inflow Depth > 2.15" for 25-yr COL event
Inflow = 480.05 cfs @ 12.53 hrs, Volume= 68.577 af
Outflow = 471.19 cfs @ 12.59 hrs, Volume= 68.334 af, Atten= 2%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.35 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 2.98 fps, Avg. Travel Time= 9.6 min

Peak Storage= 127,408 cf @ 12.59 hrs
Average Depth at Peak Storage= 4.20' , Surface Width= 30.45'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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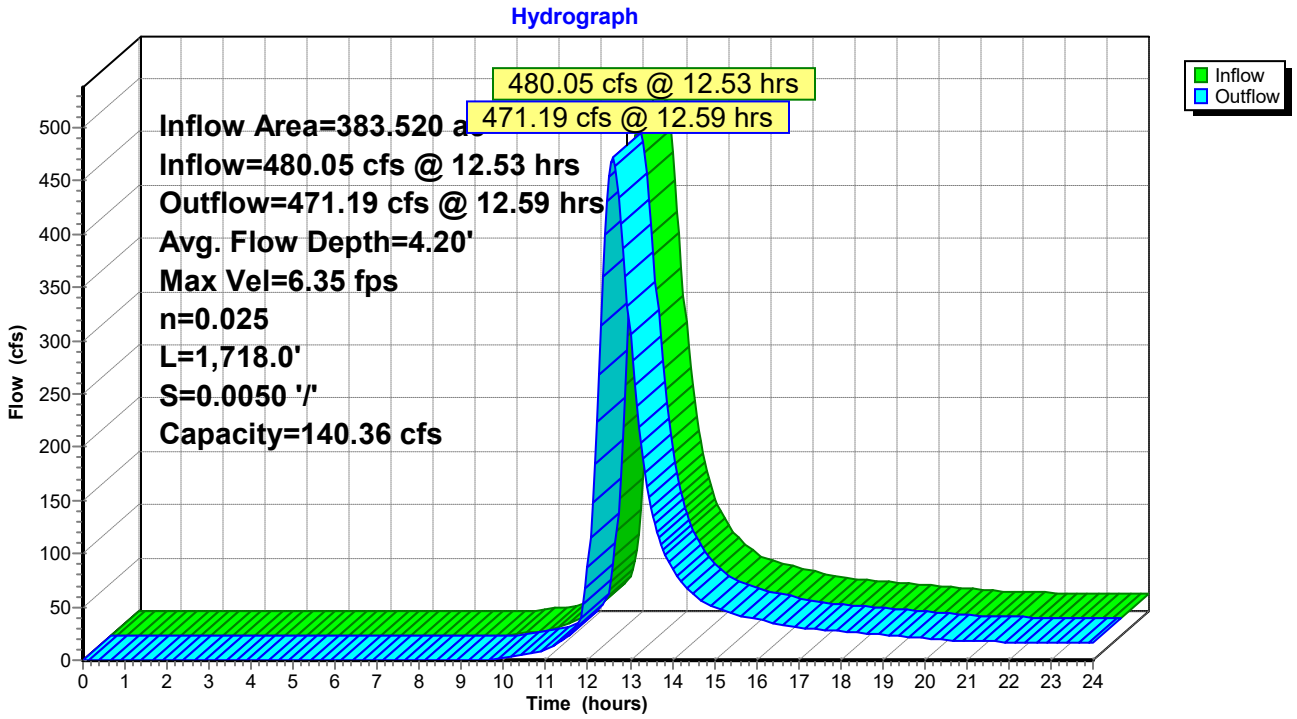
Reach 4R: (new Reach)



Summary for Pond 1P: WEST

Inflow Area = 5.920 ac, 81.45% Impervious, Inflow Depth > 3.43" for 25-yr COL event
Inflow = 29.28 cfs @ 12.01 hrs, Volume= 1.694 af
Outflow = 27.57 cfs @ 12.05 hrs, Volume= 1.525 af, Atten= 6%, Lag= 2.2 min
Primary = 1.12 cfs @ 11.95 hrs, Volume= 0.293 af
Routed to Reach 4R : (new Reach)
Secondary = 1.70 cfs @ 12.04 hrs, Volume= 0.444 af
Routed to Reach 4R : (new Reach)
Tertiary = 24.78 cfs @ 12.05 hrs, Volume= 0.788 af
Routed to Reach 4R : (new Reach)

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 803.93' @ 12.79 hrs Surf.Area= 6,968 sf Storage= 13,825 cf

Plug-Flow detention time= 83.6 min calculated for 1.525 af (90% of inflow)
Center-of-Mass det. time= 33.3 min (823.5 - 790.1)

Volume	Invert	Avail.Storage	Storage Description
#1	800.30'	16,557 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
800.30	1,320	0	0
801.30	2,342	1,831	1,831
802.30	3,961	3,152	4,983
803.30	5,748	4,855	9,837
804.30	7,692	6,720	16,557

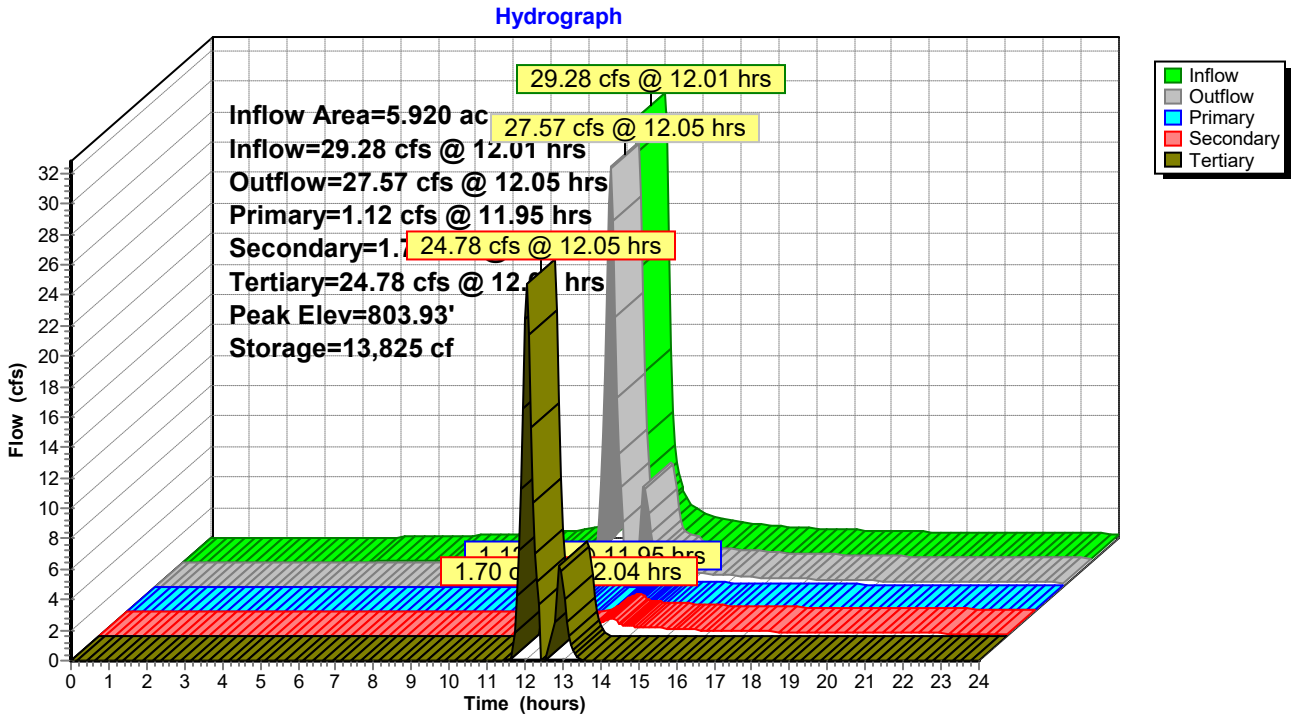
Device	Routing	Invert	Outlet Devices
#1	Primary	800.40'	**6.0" Round Culvert** L= 40.4' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 800.40' / 800.36' S= 0.0010 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Device 1	801.30'	**1.2" Vert. WQ Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	802.80'	**12.0" W x 6.0" H Vert. Window X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	803.30'	**1.5" x 5.0" Horiz. Grate X 9.00 columns** X 4 rows C= 0.600 Limited to weir flow at low heads
#5	Tertiary	803.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#6	Secondary	801.27'	**8.0" Round Culvert Secondary** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 801.27' / 801.05' S= 0.0028 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.35 sf
#7	Device 6	802.80'	**24.0" W x 6.0" H Vert. Window Secondary X 4.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.08 cfs @ 11.95 hrs HW=803.64' TW=801.44' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.08 cfs @ 5.50 fps)
  ├─**2=WQ Orifice** (Passes < 0.06 cfs potential flow)
  ├─**3=Window** (Passes < 7.36 cfs potential flow)
  └─**4=Grate** (Passes < 5.29 cfs potential flow)

Secondary OutFlow Max=1.67 cfs @ 12.04 hrs HW=803.79' TW=801.76' (Dynamic Tailwater)
└─**6=Culvert Secondary** (Outlet Controls 1.67 cfs @ 4.79 fps)
  └─**7=Window Secondary** (Passes 1.67 cfs of 16.51 cfs potential flow)

Tertiary OutFlow Max=24.55 cfs @ 12.05 hrs HW=803.80' TW=801.80' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 24.55 cfs @ 2.55 fps)

Pond 1P: WEST



Summary for Subcatchment 2: Post-Dev

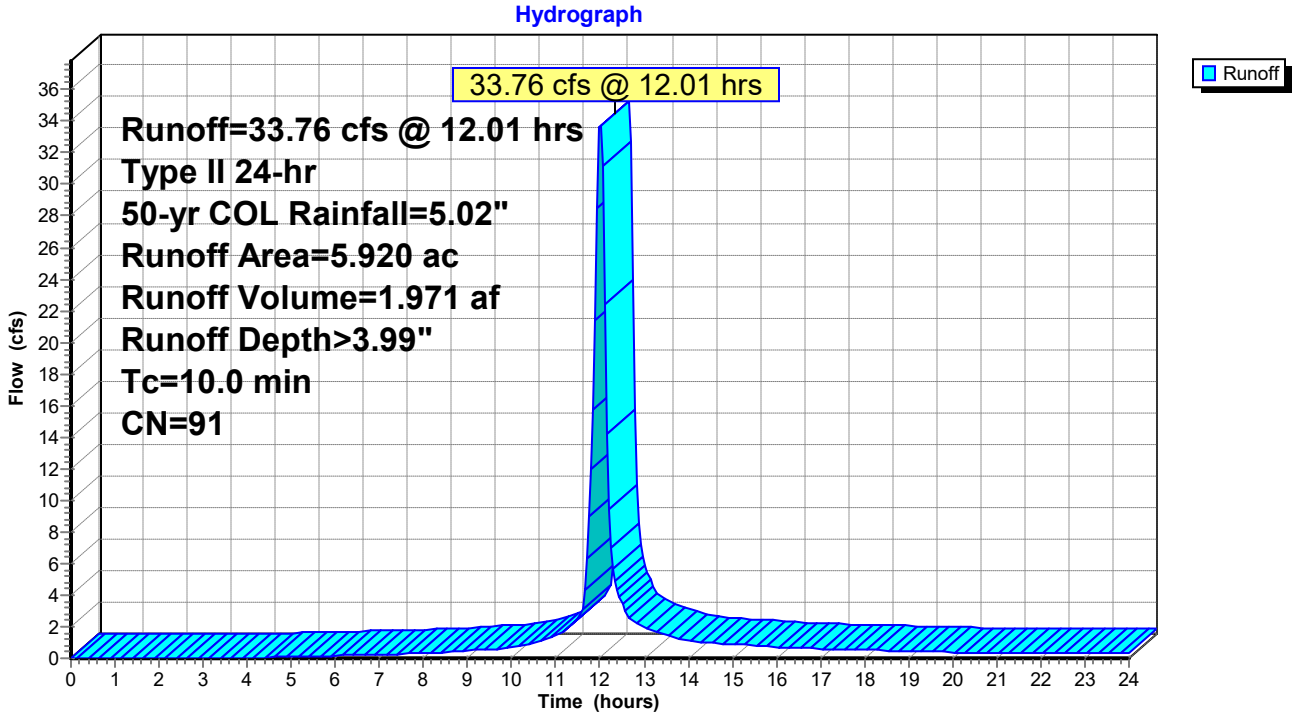
Runoff = 33.76 cfs @ 12.01 hrs, Volume= 1.971 af, Depth> 3.99"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-yr COL Rainfall=5.02"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Subcatchment 2: Post-Dev



Summary for Subcatchment 3: Upstream Tributary Area

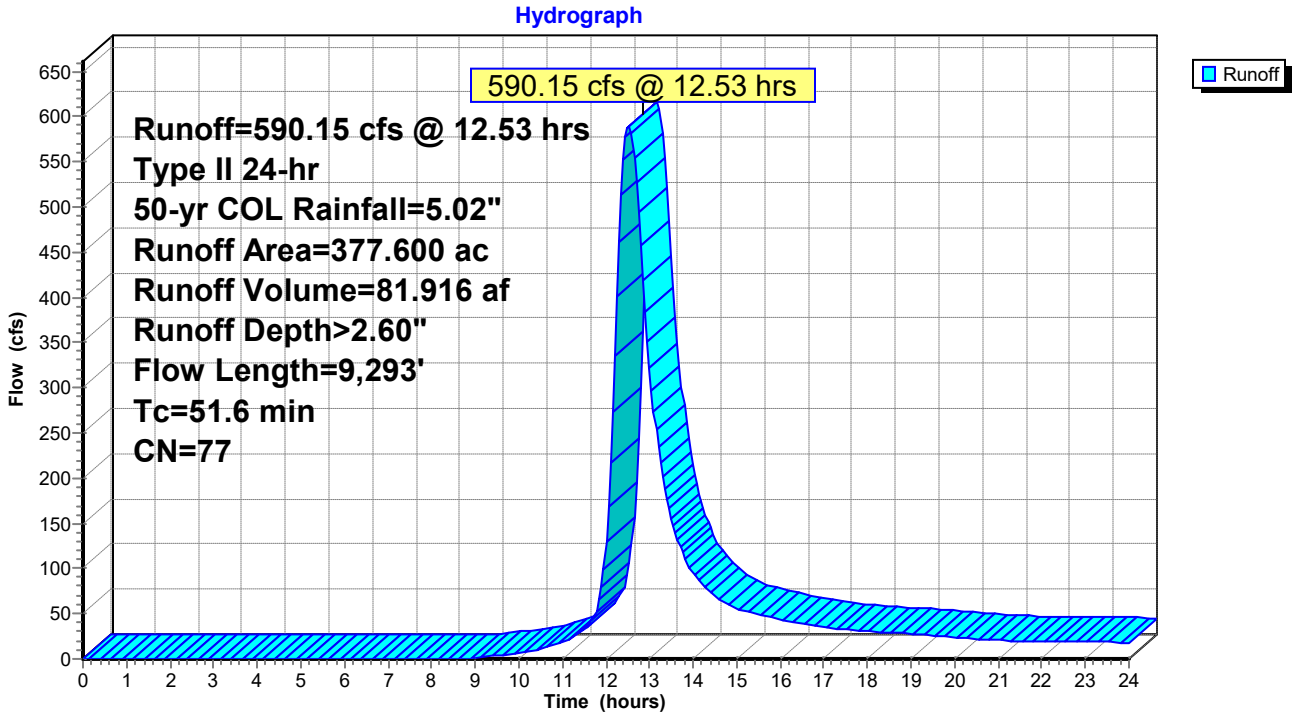
Runoff = 590.15 cfs @ 12.53 hrs, Volume= 81.916 af, Depth> 2.60"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-yr COL Rainfall=5.02"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



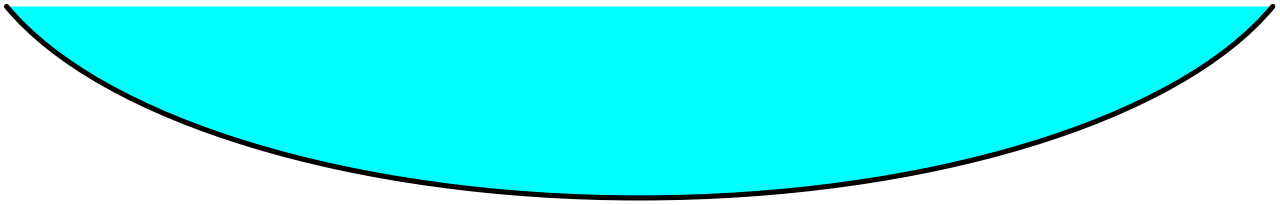
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 1.26% Impervious, Inflow Depth > 2.62" for 50-yr COL event
Inflow = 590.15 cfs @ 12.53 hrs, Volume= 83.718 af
Outflow = 579.25 cfs @ 12.59 hrs, Volume= 83.447 af, Atten= 2%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.49 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 3.09 fps, Avg. Travel Time= 9.3 min

Peak Storage= 153,311 cf @ 12.59 hrs
Average Depth at Peak Storage= 4.92' , Surface Width= 32.95'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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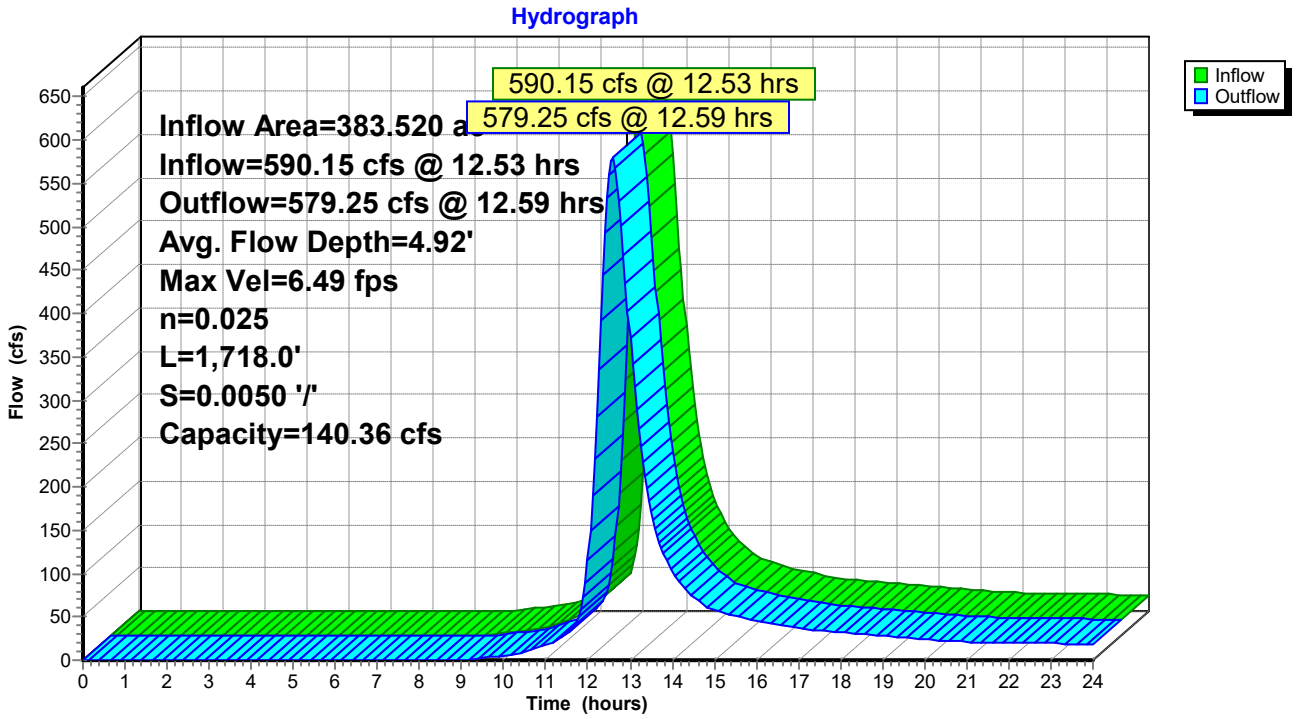
Reach 4R: (new Reach)



Summary for Pond 1P: WEST

Inflow Area = 5.920 ac, 81.45% Impervious, Inflow Depth > 3.99" for 50-yr COL event
Inflow = 33.76 cfs @ 12.01 hrs, Volume= 1.971 af
Outflow = 31.96 cfs @ 12.04 hrs, Volume= 1.801 af, Atten= 5%, Lag= 2.0 min
Primary = 1.09 cfs @ 11.95 hrs, Volume= 0.327 af
Routed to Reach 4R : (new Reach)
Secondary = 1.71 cfs @ 12.01 hrs, Volume= 0.507 af
Routed to Reach 4R : (new Reach)
Tertiary = 29.22 cfs @ 12.04 hrs, Volume= 0.967 af
Routed to Reach 4R : (new Reach)

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 804.27' @ 12.84 hrs Surf.Area= 7,638 sf Storage= 16,346 cf

Plug-Flow detention time= 77.8 min calculated for 1.801 af (91% of inflow)
Center-of-Mass det. time= 32.9 min (818.9 - 786.0)

Volume	Invert	Avail.Storage	Storage Description
#1	800.30'	16,557 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
800.30	1,320	0	0
801.30	2,342	1,831	1,831
802.30	3,961	3,152	4,983
803.30	5,748	4,855	9,837
804.30	7,692	6,720	16,557

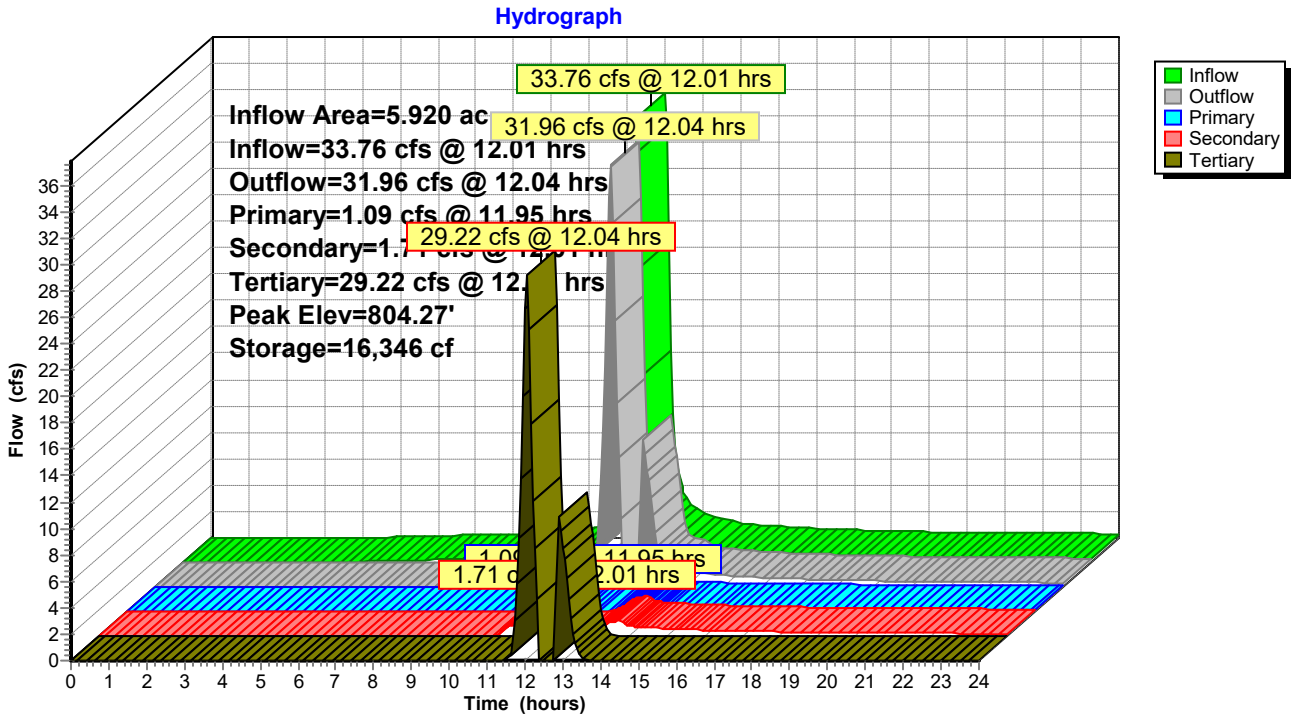
Device	Routing	Invert	Outlet Devices
#1	Primary	800.40'	**6.0" Round Culvert** L= 40.4' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 800.40' / 800.36' S= 0.0010 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Device 1	801.30'	**1.2" Vert. WQ Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	802.80'	**12.0" W x 6.0" H Vert. Window X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	803.30'	**1.5" x 5.0" Horiz. Grate X 9.00 columns** X 4 rows C= 0.600 Limited to weir flow at low heads
#5	Tertiary	803.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#6	Secondary	801.27'	**8.0" Round Culvert Secondary** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 801.27' / 801.05' S= 0.0028 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.35 sf
#7	Device 6	802.80'	**24.0" W x 6.0" H Vert. Window Secondary X 4.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.05 cfs @ 11.95 hrs HW=803.71' TW=801.63' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.05 cfs @ 5.35 fps)
  ├─**2=WQ Orifice** (Passes < 0.05 cfs potential flow)
  ├─**3=Window** (Passes < 7.77 cfs potential flow)
  └─**4=Grate** (Passes < 5.77 cfs potential flow)

Secondary OutFlow Max=1.65 cfs @ 12.01 hrs HW=803.85' TW=801.87' (Dynamic Tailwater)
└─**6=Culvert Secondary** (Outlet Controls 1.65 cfs @ 4.73 fps)
  └─**7=Window Secondary** (Passes 1.65 cfs of 17.15 cfs potential flow)

Tertiary OutFlow Max=28.85 cfs @ 12.04 hrs HW=803.88' TW=802.04' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 28.85 cfs @ 2.73 fps)

Pond 1P: WEST



Summary for Subcatchment 2: Post-Dev

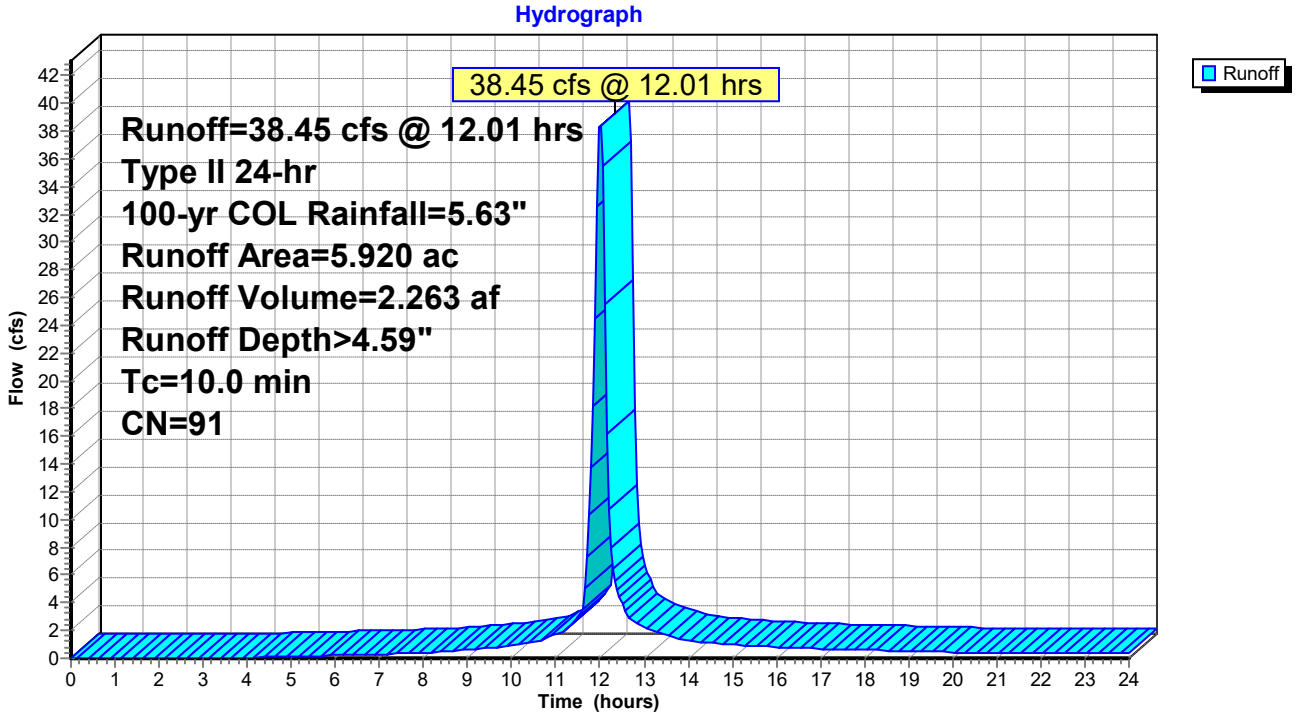
Runoff = 38.45 cfs @ 12.01 hrs, Volume= 2.263 af, Depth> 4.59"
Routed to Pond 1P : WEST

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr COL Rainfall=5.63"

Area (ac)	CN	Description
4.822	98	Paved parking, HSG B
1.098	61	>75% Grass cover, Good, HSG B
5.920	91	Weighted Average
1.098		18.55% Pervious Area
4.822		81.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Storm Sewer Min.**

Subcatchment 2: Post-Dev



Summary for Subcatchment 3: Upstream Tributary Area

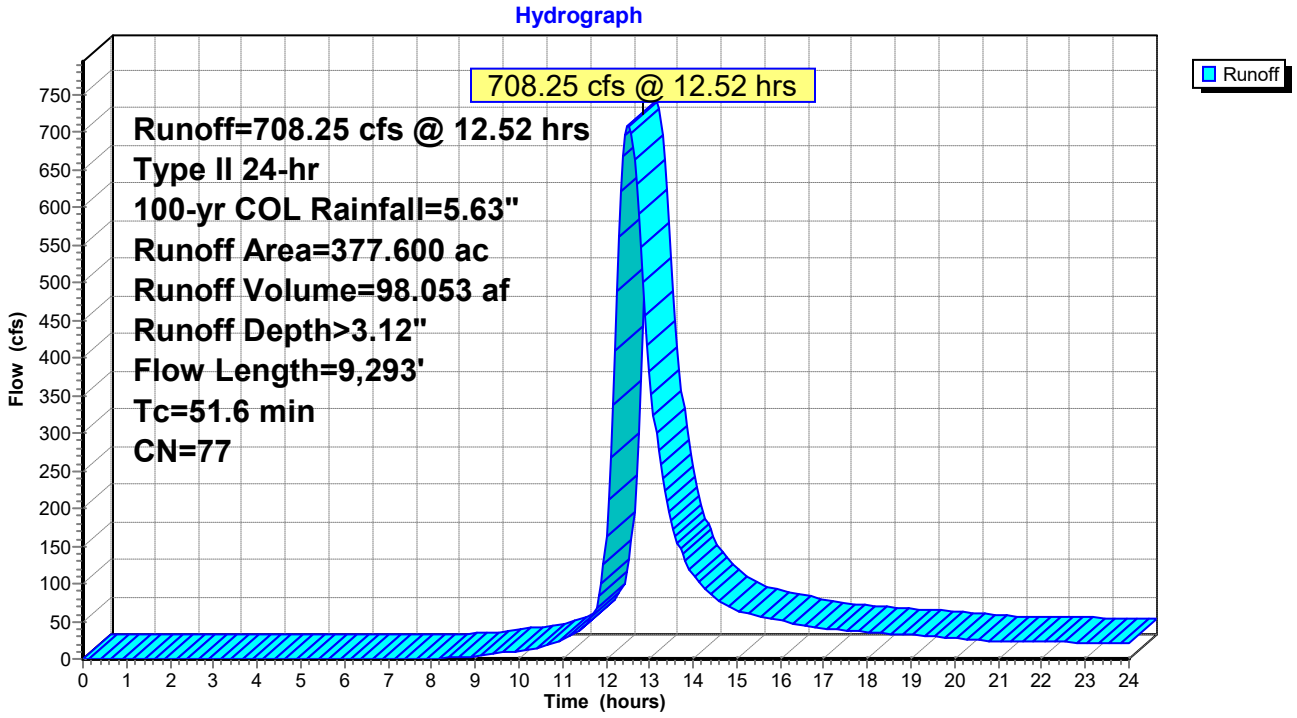
Runoff = 708.25 cfs @ 12.52 hrs, Volume= 98.053 af, Depth> 3.12"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr COL Rainfall=5.63"

	Area (ac)	CN	Description
*	377.600	77	
	377.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.6	9,293		3.00		**Direct Entry,**

Subcatchment 3: Upstream Tributary Area



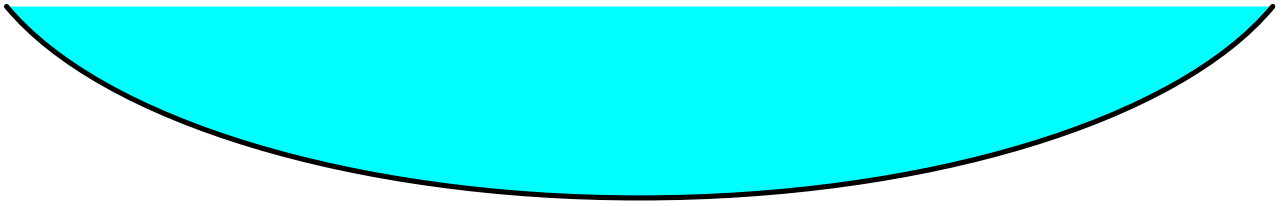
Summary for Reach 4R: (new Reach)

Inflow Area = 383.520 ac, 1.26% Impervious, Inflow Depth > 3.13" for 100-yr COL event
Inflow = 708.25 cfs @ 12.52 hrs, Volume= 100.146 af
Outflow = 695.72 cfs @ 12.59 hrs, Volume= 99.848 af, Atten= 2%, Lag= 3.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.59 fps, Min. Travel Time= 4.3 min
Avg. Velocity = 3.21 fps, Avg. Travel Time= 8.9 min

Peak Storage= 181,229 cf @ 12.59 hrs
Average Depth at Peak Storage= 5.70' , Surface Width= 35.45'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 140.36 cfs

21.00' x 2.00' deep Parabolic Channel, n= 0.025 Earth, clean & winding
Length= 1,718.0' Slope= 0.0050 '/'
Inlet Invert= 800.00', Outlet Invert= 791.41'



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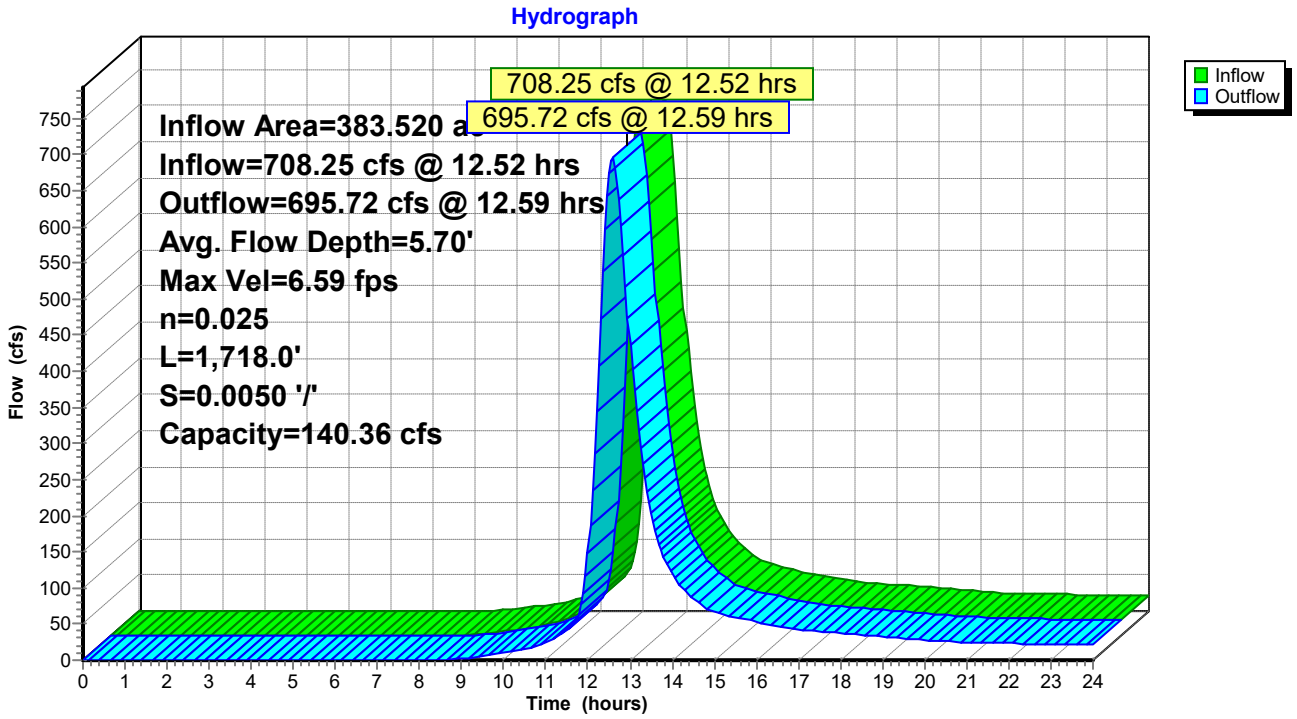
Reach 4R: (new Reach)



Summary for Pond 1P: WEST

Inflow Area = 5.920 ac, 81.45% Impervious, Inflow Depth > 4.59" for 100-yr COL event
Inflow = 38.45 cfs @ 12.01 hrs, Volume= 2.263 af
Outflow = 36.54 cfs @ 12.04 hrs, Volume= 2.094 af, Atten= 5%, Lag= 2.0 min
Primary = 1.06 cfs @ 11.95 hrs, Volume= 0.363 af
Routed to Reach 4R : (new Reach)
Secondary = 1.70 cfs @ 11.98 hrs, Volume= 0.573 af
Routed to Reach 4R : (new Reach)
Tertiary = 33.87 cfs @ 12.04 hrs, Volume= 1.157 af
Routed to Reach 4R : (new Reach)

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 805.85' @ 12.67 hrs Surf.Area= 7,692 sf Storage= 16,557 cf

Plug-Flow detention time= 72.7 min calculated for 2.094 af (93% of inflow)
Center-of-Mass det. time= 32.3 min (814.5 - 782.3)

Volume	Invert	Avail.Storage	Storage Description
#1	800.30'	16,557 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
800.30	1,320	0	0
801.30	2,342	1,831	1,831
802.30	3,961	3,152	4,983
803.30	5,748	4,855	9,837
804.30	7,692	6,720	16,557

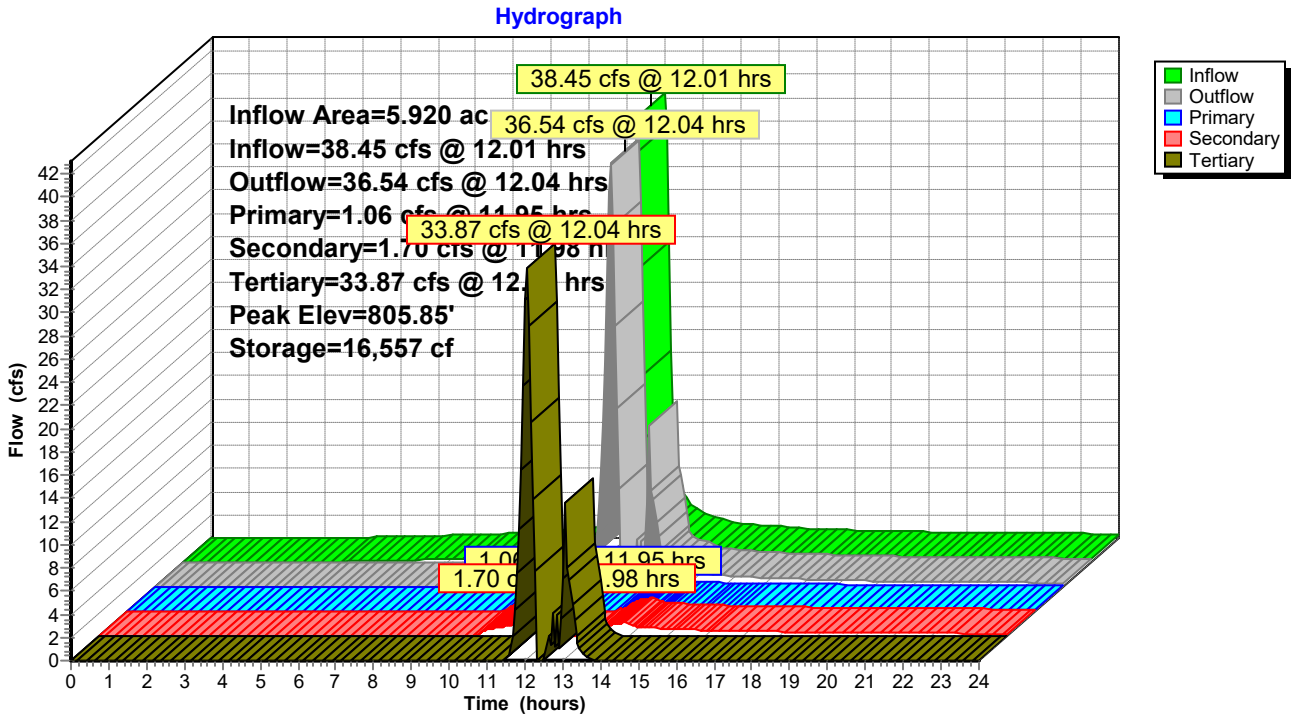
Device	Routing	Invert	Outlet Devices
#1	Primary	800.40'	**6.0" Round Culvert** L= 40.4' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 800.40' / 800.36' S= 0.0010 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.20 sf
#2	Device 1	801.30'	**1.2" Vert. WQ Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	802.80'	**12.0" W x 6.0" H Vert. Window X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	803.30'	**1.5" x 5.0" Horiz. Grate X 9.00 columns** X 4 rows C= 0.600 Limited to weir flow at low heads
#5	Tertiary	803.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#6	Secondary	801.27'	**8.0" Round Culvert Secondary** L= 78.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 801.27' / 801.05' S= 0.0028 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.35 sf
#7	Device 6	802.80'	**24.0" W x 6.0" H Vert. Window Secondary X 4.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.02 cfs @ 11.95 hrs HW=803.77' TW=801.81' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.02 cfs @ 5.18 fps)
  ├─**2=WQ Orifice** (Passes < 0.05 cfs potential flow)
  ├─**3=Window** (Passes < 8.15 cfs potential flow)
  └─**4=Grate** (Passes < 6.21 cfs potential flow)

Secondary OutFlow Max=1.62 cfs @ 11.98 hrs HW=803.87' TW=801.97' (Dynamic Tailwater)
└─**6=Culvert Secondary** (Outlet Controls 1.62 cfs @ 4.64 fps)
  └─**7=Window Secondary** (Passes 1.62 cfs of 17.40 cfs potential flow)

Tertiary OutFlow Max=33.37 cfs @ 12.04 hrs HW=803.96' TW=802.27' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Weir Controls 33.37 cfs @ 2.90 fps)

Pond 1P: WEST



APPENDIX E

WATER QUALITY CALCULATIONS

Academy Park

NPDES Water Quality Requirements

New Development WQv = (Rv * P * A) / 12
Redevelopment Development WQv = [(0.2 * Rv1) + (Rv2-Rv1)] * P * A / 12

1. Is this project New Development or Redevelopment?		
Answer:	Redevelopment	
WQv =	Water Quality Volume (ac.ft.)	
Rv1 =	Volumetric runoff coeficent for existing conditions	
Rv2 =	Volumetric runoff coeficent for proposed conditions	
P =	.90-in precipitation depth (inch)	
A =	Area draining into the BMP in acres	

2. Determine Percent Impervious (Pre)		
Land Use	Acre	% Total
Impervious	3.112	53%
Pervious	2.808	47%
Total Area	5.920	

2. Determine Percent Impervious (Post)		
Land Use	Acre	% Total
Impervious	4.822	81%
Pervious	1.098	19%
Total Area	5.920	

Water Quality Volume	WQv	=	[(	0.2	x	Rv1	) + (	Rv2	-	Rv1	)] x	P	x	A	/	12
	Volume					in.		Ac.								
ac.ft.	0.1619	=	[(	0.20	x	0.52	) + (	0.78	-	0.52	)] x	0.90	x	5.92	/	12
cu. ft.	**7,052**															

Water Quality Volume Required		
TWQv =	**7,052**	**CF**

3. Determine Runoff Coefficient	
Rv = 0.05 + 0.9 * i	
Rv1 =	0.52
Rv2 =	0.78

Dry Extended Detention Basin WQv Compliance Tool

version 3.1 2018-10-25

Project Summary

Project Name:	Academy Park				
Subwatershed ID/Label:	Detention Basin				
Submitted by:	C. Echelberry				
Date:	10/12/2025				
Subwatershed Drainage Area, A_{total} =	5.92	acres	=	257,875	ft2
Subwatershed Impervious Area, A_{imp} =	2.07	acres	=	90,169	ft2
Imperviousness fraction, i =	0.35			35	%
Water Quality Volume, WQv =	7,053	ft^3	=	0.16	ac-ft

Step 1 - Soil Suitability

Soil Series		HSG	D

Step 2 - Dry ED Basin Volume Requirements

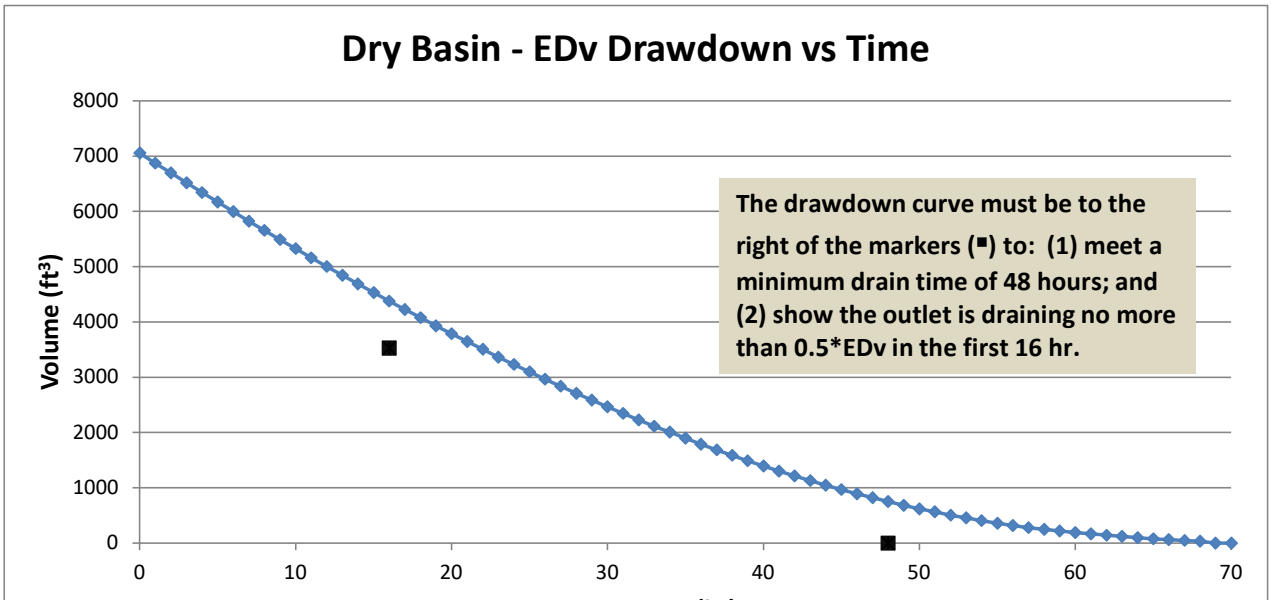
Extended Detention Volume, EDv =	7053	ft^3
Minimum Sediment Storage Volume, $V_{sediment}$ =	1411	ft^3
Minimum Forebay Volume, $V_{forebay}$ =	705	ft^3
Minimum Permanent Micropool Volume, $V_{micropool}$ =	705	ft^3

Step 3 - Basin Stage-Storage Relationship

	Elevation ft	Area ft^2		Incremental Volume ft^3	Cumulative Volume ft^3
Bottom of Permanent Micropool =	800.30	1320			
(include forebay area if below EDv)	801.30	2342		1,807	1,807
	802.30	3961		3,116	4,923
	803.30	5748		4,827	9,750
	804.30	7692		6,696	16,446

Step 4 - Outlet Elevations and Storage Volumes

WQ Orifice Invert Elevation =	801.30				
Elevation of Top of EDv =	803.15				
Secondary Outlet Invert Elevation =	803.30				OKAY
WQ Treatment Volume Provided, $V_{treatment}$ =	7,943	ft^3			
Treatment Vol Provided Relative to EDv, $V_{treatment}/EDv$ =	1.13		=	113%	OKAY
Permanent Pool Volume Provided, PPv =	1,807	ft^3			
Forebay Volume Provided, $V_{forebay}$ =	994	ft^3	=	1.41	
Is forebay volume below WQ outlet? (Yes or No)	Yes		=	141%	OKAY
Permanent Micropool Volume Provided, $V_{micropool}$ =	813	ft^3			
Ratio $V_{micropool}$ Provided to $V_{micropool}$ Required =	1.15		=	115%	OKAY
Sediment Storage Volume Provided, $V_{sediment}$ =	1,807	ft^3			
Ratio $V_{sediment}$ Provided to $V_{sediment}$ Required =	1.28		=	128%	OKAY

Step 5 - Outlet (Orifice) Sizing

Maximum Hydraulic Head, Hmax =	1.85	ft			
Orifice Coefficient, C =	0.6				
Target (Minimum) Draw-down Time, T_d =	48	hr			
Target Average Discharge, Q_{avg} =	0.04	cfs			
Average Hydraulic Head, H_{avg} =	0.93	ft			
Estimated Orifice Area, $A_{orifice}$ =	1.27	in^2	=	0.009	ft^2
Estimated Orifice Diameter, $D_{orifice}$ =	1.27	in	=	0.11	ft
Design Orifice Diameter, $D_{orifice}$ =	1.20	in	=	0.10	ft
Design Orifice Area, $A_{orifice}$ =	1.12	in^2	=	0.008	ft^2
Time to Completely Drain EDv, T_d =	69	hr	must be ≥ 48 hr		OKAY
Volume Drained in First 16 hr =	2,676	ft^3			
% of EDv =	37.9	%	must be ≤ 50%		OKAY