FINAL STORMWATER MANAGEMENT FACILITIES REPORT FOR

petsuites
STAY & PLAY

Site Address:

250 NW McNary Court
Lee's Summit, MO 64086

Developer:
TM Crowley
501 Pennsylvania Parkway Suite 160
Indianapolis, IN 46280
630-441-0165

Prepared By:

PREMIER
DESIGN GROUP
100 MIDLAND PARK DRIVE, WENTZVILLE, MO 63385
314.925.7444|WWW.PREMIERCIVIL.COM

Dated: January 20, 2021

STATE OF MISSOURI
STEVE
MARION
NUMBER
PE2006007195
PROFESSIONAL ENGINEER
1/27/21

STORMWATER FACILITIES MANAGEMENT REPORT
Table of Contents

Introduction

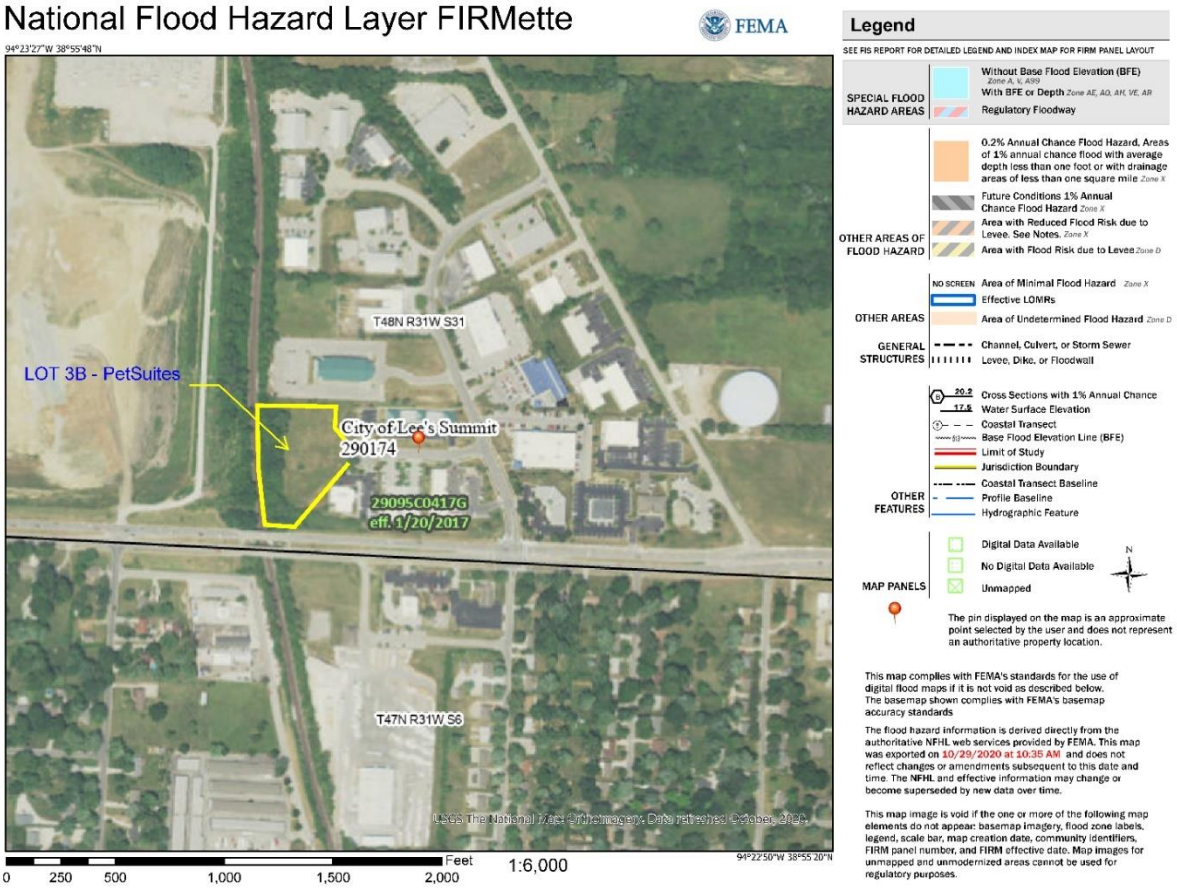
The proposed improvements that are depicted on the Final Development Plan provides the design for the proposed development for Petsuites located at 250 NW McNary court. The development will increase the impervious area of the site therefore changing the characteristics of the stormwater runoff. The information supplied in this report will provide evidence that the Post Developed Stormwater Runoff has been mitigated appropriately with the Best Management Practices proposed for this development.

Project Narrative

TM Crowley is developing the subject property for Petsuites of America. The property size is ±2.11 acres and is located at the west end of the cul-de-sac on McNary Court. The proposed building will consist of a veterinary clinic and PetSuites for a total of 14,100 sq. ft. The overall drainage patterns of the existing area drain east to west towards the existing railroad.

FEMA Classification

This property is classified as Zone "X" areas outside the 100 year floodplain per 29095C0417G map effective date of 1/20/2017. There are no known flooding issues associated with this property.



Wetland and USACE Involvement

There are no wetlands listed associated with the national wetlands inventory.

U.S. Fish and Wildlife Service
National Wetlands Inventory

National Wetlands Inventory Map

November 2, 2020

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

Soils Classification

USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

8/14/2020
Page 1 of 4

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 22, May 29, 2020

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

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	C	1.1	48.1%
10129	Sharpsburg-Urban land complex, 5 to 9 percent slopes	D	0.2	9.3%
10181	Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes	C	1.0	42.6%
Totals for Area of Interest			**2.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Site Area Calculations

Property Size	2.11 Acres
Pre-Development Condition	
2.11 Acres of Grass	CN=74
Post-Development Condition	
0.69 Acres of Impervious Area (Buildings and Pavement)	CN=98
1.42 Acres of Pervious Area	CN=74
"CN" Value Weighted Average	CN=82

Methodology

The methodology used for the project is Hydro CAD 10.10-3a for determination of SCS TR-55 hydrographs. The hydraulics for the project will be determined using Autodesk Civil 3D 2020 Storm Sewer Analysis. To determine the Storm Intensity and Frequency the overall project pre-development condition and post development condition was determined by the SCS method using NOAA's precipitation intensity data from their website.

Existing Condition Analysis

The summary of comprehensive control requirements shall be per 5601.5.A.4.and 5608.4 the "Comprehensive Control" release rate strategy. Assumed time of concentration associated with the areas were used to due to the minimal area to discharge locations.

The default strategy of comprehensive protection of the 1% (100 year event), 10% (10 year event) and 50% (2 year event) is being provided with this development. Comprehensive controls shall be the following:

- 50% storm peak rate less than nor equal to 0.5 cfs per site acre
- 10% storm peak rate less than nor equal to 2.0 cfs per site acre
- 1% storm peak rate less than nor equal to 3.0 cfs per site acre

Existing Conditions Summary Table

ID	RUNOFF (cfs)	TC	IMPERVIOUS AREA (ac.)	PERVIOUS AREA (ac.)	Total Area (ac.)	COMPOSITE CN
AREA A						
2-Year	2.79	30	0.99	0.175	1.17	94
10-Year	4.43	30	0.99	0.175	1.17	94
100-Year	6.58	30	0.99	0.175	1.17	94
AREA B						
2-Year	0.12	5	0.00	0.05	0.05	74
10-Year	0.24	5	0.00	0.05	0.05	74
100-Year	0.42	5	0.00	0.05	0.05	74
AREA C						
2-Year	0.35	5	0.00	0.15	0.15	74
10-Year	0.73	5	0.00	0.15	0.15	74
100-Year	1.27	5	0.00	0.15	0.15	74
AREA D						
2-Year	0.14	5	0.00	0.06	0.06	74
10-Year	0.29	5	0.00	0.06	0.06	74
100-Year	0.51	5	0.00	0.06	0.06	74
AREA E						
2-Year	6.56	20	1.84	0.325	2.17	94
10-Year	10.38	20	1.84	0.325	2.17	94
100-Year	15.41	20	1.84	0.325	2.17	94
AREA F						
2-Year	3.57	10	0.00	1.89	1.89	74
10-Year	7.6	10	0.00	1.89	1.89	74
100-Year	13.44	10	0.00	1.89	1.89	74
AREA G						
2-Year	0.04	10	0.00	0.02	0.02	74
10-Year	0.08	10	0.00	0.02	0.02	74
100-Year	0.14	10	0.00	0.02	0.02	74
AREA H						
2-Year	0.02	10	0.00	0.01	0.01	74
10-Year	0.04	10	0.00	0.01	0.01	74
100-Year	0.07	10	0.00	0.01	0.01	74

The site is an open field with a wooded area to the west. It is surrounded by commercial properties except the west which is railroad right of way. The existing runoff drains to the west. Due to the minimal TC and unknown relationship of discharge for the offsite basin we determined a 30 minute TC for Area A otherwise areas B, C and D were five minute time of concentrations. Area F, G, and H were given 10 minute time of concentrations representing the existing onsite conditions.

There are two points of interest associated with the existing conditions.

Existing Point of Interest #1

Point of Interest #1 – Existing Runoff to West of Site

This is in relationship to the property and the overland flow to the existing railway. The discharge associated with this is shown in Areas C, D, F, G and H. Area D drains offsite to the existing inlet at the street however its discharge associated with the project remains along with a small area of Area H that drains offsite however it is nominal of an area.

ID	RUNOFF (cfs)	TC	IMPERVIOUS AREA (ac.)	PERVIOUS AREA (ac.)	Total Area (ac.)	COMPOSITE CN
AREA C						
2-Year	0.35	5	0.00	0.15	0.15	74
10-Year	0.73	5	0.00	0.15	0.15	74
100-Year	1.27	5	0.00	0.15	0.15	74
AREA D						
2-Year	0.14	5	0.00	0.06	0.06	74
10-Year	0.29	5	0.00	0.06	0.06	74
100-Year	0.51	5	0.00	0.06	0.06	74
AREA F						
2-Year	3.57	10	0.00	1.89	1.89	74
10-Year	7.6	10	0.00	1.89	1.89	74
100-Year	13.44	10	0.00	1.89	1.89	74
AREA G						
2-Year	0.04	10	0.00	0.02	0.02	74
10-Year	0.08	10	0.00	0.02	0.02	74
100-Year	0.14	10	0.00	0.02	0.02	74
AREA H						
2-Year	0.02	10	0.00	0.01	0.01	74
10-Year	0.04	10	0.00	0.01	0.01	74
100-Year	0.07	10	0.00	0.01	0.01	74
2-Year	4.12					
10-Year	8.74					
100-Year	15.43					

The values listed at the bottom of the table are the combined runoff for the storm events for the existing conditions for the runoff onsite that leads offsite or to the existing storm sewers.

Existing Point of Interest #2

This point of interest is in relationship with the neighboring stormwater runoff that is collected in what appears to be a water quality basin. This is noted as area A. A longer time of concentration was provided to address the ponding area and reduced release rate and timing. We considering this 30 minute TC as conservative and protects the proposed project from potentially overcompensating with a larger TC and our calculations would not handle to the correct amount of stormwater.

ID	RUNOFF (cfs)	TC	IMPERVIOUS AREA (ac.)	PERVIOUS AREA (ac.)	Total Area (ac.)	COMPOSITE CN
AREA A						
2-Year	2.79	30	0.99	0.175	1.17	94
10-Year	4.43	30	0.99	0.175	1.17	94
100-Year	6.58	30	0.99	0.175	1.17	94

Allowable Release Rate Calculation

Due to this project providing the comprehensive control strategy that is listed in the existing condition analysis, our storm peak rate is based from the Existing Point of Interest #1. Since our site area is larger than the area listed in Existing Point of Interest #1 a table has been provided of the allowed release rates.

	Release Rate Per Acre (ac per cfs)	Site Area (ac.)	Allowable release rate (c.f.s.)
2 Year	0.50	2.11	1.06
10 Year	2.00	2.11	4.22
100 Year	3.00	2.11	6.33

Proposed Development Analysis

The proposed project will change the existing stormwater runoff by the increase of impervious area. The bypass areas have been mitigated to the maximum extent practical and the detention has accommodated for such areas. There is an overall reduction in the total runoff based on the proposed conditions as referenced in the Differential Runoff Table. The table was derived per the event tables from HydroCAD.

The proposed project will increase the impervious surface however it will reduce the runoff for the overall disturbed area per APWA 5600. This project proposes that areas that will route through the detention will meet the allowable release rate. The bypass areas consist of existing woodlands that will remain in place therefore to meet the requirements we would have to remove the existing vegetation in place.

Due to the orifice size for the WQv event designed at 1.5" the full water volume design cannot be obtained unless the orifice size is reduced to 0.67". Most municipalities in the Midwest with extended detention or channel protection requirements do not allow an orifice size less than 1.5". While we have a larger orifice size than the calculations state for the 40 hour extended detention, we are within 0.07 cfs of meeting the release rate.

Proposed Drainage Conditions Analysis

The proposed drainage area map that is referenced in the attachments provide a visual indicator for the runoff of each drainage area map. The proposed project will change the existing stormwater runoff by the increase of impervious area. The bypass areas have been mitigated to the maximum extent practical and the detention has accommodated for such areas. There is an overall reduction in the total runoff based on the proposed conditions as referenced in the Differential Runoff Table. The table was derived per the event tables from HydroCAD.

Proposed Runoff Table

Row Labels	Peak Runoff (cfs)	Impervious Area	Pervious Area	Total Area	Composite CN	TC
AREA 1						
2-Year	0.94	0.15	0.06	0.21	91	5
10-Year	1.52	0.15	0.06	0.21	91	5
100-Year	2.29	0.15	0.06	0.21	91	5
AREA 2						
2-Year	1.04	0.16	0.08	0.24	90	5
10-Year	1.71	0.16	0.08	0.24	90	5
100-Year	2.6	0.16	0.08	0.24	90	5
AREA 3						
2-Year	1.51	0.16	0.28	0.44	83	5
10-Year	2.73	0.16	0.28	0.44	83	5
100-Year	4.37	0.16	0.28	0.44	83	5
AREA 4						
2-Year	1.69	0.33	0	0.33	98	5
10-Year	2.57	0.33	0	0.33	98	5
100-Year	3.74	0.33	0	0.33	98	5
AREA 5						
2-Year	0.38	0.05	0.05	0.1	86	5
10-Year	0.66	0.05	0.05	0.1	86	5
100-Year	1.04	0.05	0.05	0.1	86	5
AREA 6						
2-Year	1.36	0.06	0.45	0.51	77	5
10-Year	2.7	0.06	0.45	0.51	77	5
100-Year	4.59	0.06	0.45	0.51	77	5
AREA 7						
2-Year	0.22	0.02	0.05	0.07	81	5
10-Year	0.41	0.02	0.05	0.07	81	5
100-Year	0.68	0.02	0.05	0.07	81	5
AREA TO AI 11						
2-Year	0.05	0	0.02	0.02	74	5
10-Year	0.1	0	0.02	0.02	74	5
100-Year	0.17	0	0.02	0.02	74	5
OFFSITE TO CI 12						
2-Year	6.56	1.844	0.325	2.17	94	20
10-Year	10.38	1.844	0.325	2.17	94	20
100-Year	15.41	1.844	0.325	2.17	94	20

Proposed Drainage Area Description

1. Area to proposed inlet south of building. Routed through storm sewer.
2. Area east of building routed to inlet. Routed through storm sewer.
3. Overland flow path east of basin and basin area. Parking area through opening in trash enclosure.
4. Proposed Building Footprint
5. Areas that have turf that have underdrain systems.
6. Area onsite to the west of the property that slope to the existing railroad right of way. This area bypasses the detention basin.

7. Area onsite that drain to the existing curb inlet in the cul-de-sac. This area bypasses the detention basin.
8. Area to AI 11 – Offsite Area to onsite.
9. Offsite Area to Curb Inlet in cul-de-sac.

Proposed Areas of Interest

The areas of interest and their corresponding runoff information is listed below. There are three points of interest for this project. The flowrate out of the basin, the discharge from the existing storm sewer outfall and the onsite areas that flow offsite due to the existing topography.

Proposed Area of Interest #1 – Discharge from Basin

Event	Inflow to Basin (ac.)	Peak Inflow (cfs)	Peak Elevation	Peak Storage (ac. ft.)	Peak Discharge (cfs)
DETENTION BASIN					
2-Year	1.32	5.56	995.85	0.117	0.75
10-Year	1.32	9.19	996.77	0.19	2.67
100-Year	1.32	14.04	997.94	0.313	7.56

Proposed Area of Interest #2 – Onsite to Offsite Discharge

Event	Peak Runoff (cfs)	Sum of Pervious	Impervious Area
AREA 6			
2-Year	1.36	0.45	0.06
10-Year	2.7	0.45	0.06
100-Year	4.59	0.45	0.06
AREA 7			
2-Year	0.22	0.05	0.02
10-Year	0.41	0.05	0.02
100-Year	0.68	0.05	0.02

Proposed Area of Interest #3 – Combined discharge existing storm sewer

Events	Peak Outflow
11-10	
2-Year	18.82
10-Year	31.26
100-Year	48.51

Worksheet 1 – Required Level of Service – Undeveloped Site

WORKSHEET 1 REQUIRED LEVEL OF SERVICE-UNDEVELOPED SITE

Project: PetSuites
Location: Lee's Summit, MO

By: M. Fogarty
Date: 8/12/2020

1. Runoff Curve Number

A. Predevelopment CN

Cover Description	Soil HSG	CN from Table 1	Area (ac.)	Product of CN x Area
Grass	C	80	2.11	168.8
				0
				0
		Totals:	2.11	168.80

Area-Weighted CN = total product/total area = 80 (Round to integer)

B. Postdevelopment CN

Cover Description	Soil HSG	CN from Table 1	Area (ac.)	Product of CN x Area
Building	C	98	0.32	31.36
Pavement	C	98	0.4	39.2
Green Space	C	80	1.39	111.2
		Totals:	2.11	181.76

Area-Weighted CN = total product/total area = 86 (Round to integer)

C. Level of Service (LS) Calculation

Predevelopment CN: 80

Postdevelopment CN: 86

Difference: 6

LS Required: 6

Change in CN	LS
17+	8
7 to 16	7
4 to 6	6
1 to 3	5
0	4
-7 to -1	3
-8 to -17	2
-18 to -21	1
-22 -	0

Worksheet 2 – Develop Mitigation Package(s) That Meets the Required Level of Service

WORKSHEET 2: DEVELOP MITIGATION PACKAGE(S) THAT MEETS THE REQUIRED LS

Project:	PetSuites	By:	M. Fogarty
Location:	Lee's Summit, MO	Date:	8/6/2020

1. Required LS (New Development, Wksht 1) or Total VR (Redevelopment, Worksheet 1) **6**

Note: Various BMP's may alter CN of proposed development, and LS, recalculate both if applicable.

2. Proposed BMP Option Package No. 1

Cover/BMP Description	Treatment Area (ac)	VR from Table 4.4 or 4.61	Product of VR X Area
Vegatative Basin	1.32	6	7.92
			0.00
Total2:	1.32	Total:	7.92
		*Weighted VR:	6.00

[1] VR calculated for final BMP only in treatment train.
[2] Total treatment area cannot exceed 100 percent of the actual site area.
* Blank in Redevelopment

Meets Required LS (Yes/No) **Yes** (If no, or additional options are being tested preceed below)

40 Hour Extended Detention/Channel Protection Calculations

Project: **PetSuites - Lee's Summit, MO** **PCE Project #** **2008920**

COMPUTATIONS FOR CP_V PROPOSED:

Site Acreage	Impervious Area	Percent Impervious
2.11 Ac.	0.69 Ac.	32.7 %

Impervious Areas						
Pavement Area		0.36	Ac.			
Roof Area	=	0.33	Ac.			
Total Impervious Area	=	0.69	Ac.			
Pervious Areas						
Grassed Areas	=	1.42	Ac.	Soil Type	=	C
Total Pervious Area	=	1.42	Ac.			

The following computational procedure follows the methodology detailed in Appendix D.11 of the Maryland Stormwater Design Manual.

1. Compute the time of concentration (tc) and the one year post-development runoff depth (Q_a) in inches.

From TR-55 T_c = 0.10 hours

2. Determine the curve number (See Hydrograph Report)

CN= 82

3. Determine the intial abstraction (Ia):

S = potential maximum retention after runoff begins (in)
S = (1000 ÷ 82.0) - 10
S = 2.20
Ia = Initial abstraction
Ia = 0.2 * S (200/CN) - 2
Ia = 0.2 * 2.20 (200 / 82.0) - 2
Ia = 0.44 0.44

4 Calculate Ia/P: For this method, the value of Ia/P must be in the range of:
0.1<=Ia/P=0.5. If Ia/P is less than 0.1 then set Ia/P to 0.1
If Ia/P is>0.5, then set Ia/P to 0.5

P=Channel Protection Storm Event Depth = 1.37 "
Ia/P = 0.44 / 1.37 = 0.320 Therefore use 0.10

5. Determine Qa (Runoff depth in watershed inches)

$$Q_a = \frac{(P - I_a)^2}{(P - I_a) + S}$$

$$Q_a = \frac{(1.37 - 0.44)^2}{(1.37 - 0.44) + 2.20}$$

Q_a = 0.28 cfs

COMPUTATIONS FOR CP_V PROPOSED:

Site Acreage	Impervious Area	Percent Impervious
2.11 Ac.	0.69 Ac.	32.7 %

Impervious Areas

Pavement Area		0.36	Ac.
Roof Area	=	0.33	Ac.
Total Impervious Area	=	0.69	Ac.

Pervious Areas

Grassed Areas	=	1.42	Ac.	Soil Type	=	C
Total Pervious Area	=	1.42	Ac.			

The following computational procedure follows the methodology detailed in Appendix D.11 of the Maryland Stormwater Design Manual.

1. Compute the time of concentration (tc) and the one year post-development runoff depth (Q_a) in inches.

From TR-55
T_c = 0.10 hour s

2. Determine the curve number (See Hydrograph Report)

CN = 82

3. Determine the intial abstraction (Ia):

S = potential maximum retention after runoff begins (in)

$$S = \frac{(100}{0} \div 82.0) - 10$$

$$S = 2.20$$

I_a = Initial abstraction

$$Ia = 0.2 * S \qquad \left(\frac{200/C}{N}\right) - 2$$

$$Ia = 0.2 * 2.20 \qquad \left(\frac{200}{82.0}\right) - 2$$

$$Ia = 0.44 \qquad 0.44$$

6. With T_c and I_a/P known, find the unit peak factor (q_u) using Figure D.11.1 (attached).

T_c = 0.1
I_a/P = 0.10
q_u = 990

7. Compute the one year post-development peak discharge q_i.

A = 2.11 Ac. A = 0.00329688 sq. miles
q_i = (q_u) (A) (Q_a)
q_i = (990) (0.003296875) (0.28)
q_i = 0.90 cfs

8. Find q_o/q_i from MARYLAND Stormwater Design Maunual Appendix D-11, Figur (Ratio of outflow to inflow)

q_u = 990 csm/in ,
T = 24 hours
Peak outflow discharge/peak inflow discharge q_0/q_i = 0.02

9. Compute the peak outflow discharge

q_o = $q_{o/}q_i$ x qi
q_o = (0.02) x 0.90
q_o = 0.02 cfs

10. Compute V_s/V_r; for type II rainfall distirbution (Ratio of storage to runoff volume)

$V_s/V_r = 0.683 - 1.43 (q_o/q_i) + 1.64 (q_o/q_i)^2 - 0.804 (q_o/q_i)^3$
$V_s/V_r = 0.683 - 1.43 (0.02) + 1.64 (0.02)^2 - 0.804 (0.02)^3$
V_s/V_r = 0.655

11. Compute the extended detention storage volume

V_s = V_s/V_r (Q_a) (1 / 12) (Ac) = ac-ft
V_s = 0.655 (0.28) (1 / 12) (2.11) = ac-ft
V_s = 0.03193 ac-ft
= 1,391 cf Required

Project: **PetSuites - Lee's Summit, MO** **PCE Project #** **2008**

COMPUTATIONS FOR CP_V PROPOSED:

Site Acreage	Impervious Area	Percent Impervious
2.11 Ac.	0.69 Ac.	32.7 %

Impervious Areas			
Pavement Area		0.36	Ac.
Roof Area	=	0.33	Ac.
Total Impervious Area	=	0.69	Ac.

Pervious Areas						
Grassed Areas	=	1.42	Ac.	Soil Type	=	C
Total Pervious Area	=	1.42	Ac.			

The following computational procedure follows the methodology detailed in Appendix D.11 of the Maryland Stormwater Design Manual.

1. Compute the time of concentration (tc) and the one year post-development runoff depth (Q_a) in inches.

From TR-55 T_c = 0.10 hours

2. Determine the curve number (See Hydrograph Report)

CN= 82

3. Determine the intial abstraction (Ia):

S = potential maximum retention after runoff begins (in)
S = (1000 ÷ 82.0) - 10
S = 2.20
Ia = Initial abstraction
Ia = 0.2 * S (200/CN) - 2
Ia = 0.2 * 2.20 (200 / 82.0)
Ia = 0.44 0.44

4 Calculate Ia/P: For this method, the value of Ia/P must be in the range of:

12. Define the CP_V Release Rate:

Known QI = 0.90 cfs
q_o = (q_0/q_i) q_i
q_o = (0.02 / 0.90) 0.90
q_o = 0.018 cfs

13. Compute the Channel Protection oriface size:

A_o = Q / [(C * (2 gh_o ^ 0.5)] C = 0.60
= 0.018 [4.81 * (2.50 ^ 0.5)] h_o = 2.50 ft
A_o = 0.0024 sf pi = 3.14

D_o = [(4 * Ao / pi)] * 0.5
D_o = 0.0551 ft = 0.661 in > 1.5 in

WORKSHEET 1 REQUIRED LEVEL OF SERVICE-UNDEVELOPED SITE

Project: PetSuites
Location: Lee's Summit, MO

By: M. Fogarty
Date: 8/12/2020

1. Runoff Curve Number

A. Predevelopment CN

Cover Description	Soil HSG	CN from Table 1	Area (ac.)	Product of CN x Area
Grass	C	80	2.11	168.8
				0
				0
		Totals:	2.11	168.80

Area-Weighted CN = total product/total area = 80 (Round to integer)

B. Postdevelopment CN

Cover Description	Soil HSG	CN from Table 1	Area (ac.)	Product of CN x Area
Building	C	98	0.32	31.36
Pavement	C	98	0.4	39.2
Green Space	C	80	1.39	111.2
		Totals:	2.11	181.76

Area-Weighted CN = total product/total area = 86 (Round to integer)

C. Level of Service (LS) Calculation

		Change in CN	**LS**
		17+	8
Predevelopment CN:	80	7 to 16	7
		4 to 6	6
Postdevelopment CN:	86	1 to 3	5
		0	4
Difference:	6	-7 to -1	3
		-8 to -17	2
LS Required:	6	-18 to -21	1
		-22 -	0

Summarization and Conclusions

Impacts to downstream sewers and streams have been mitigated to the maximum extent practical. This project provides filters via a vegetated basin for water quality which meets the KC APWA MARC Manual. This project will meet the requirements that were being set forth by the governing jurisdiction.

The listed waivers as shown below are being requested for the post developed condition to allow the increase from the allowable release rate due to the Bypass Areas associated with the existing vegetation to remain instead of routing those areas to the basin. This waiver would be for the 2 Year, 10 Year and 100 Year Events. The proposed project will increase the impervious surface however it will reduce the runoff for the overall disturbed area per APWA 5600. This project proposes that areas that will route through the detention will meet the allowable release rate. The bypass areas consist of existing woodlands that will remain in place therefore to meet the requirements we would have to remove the existing vegetation in place.

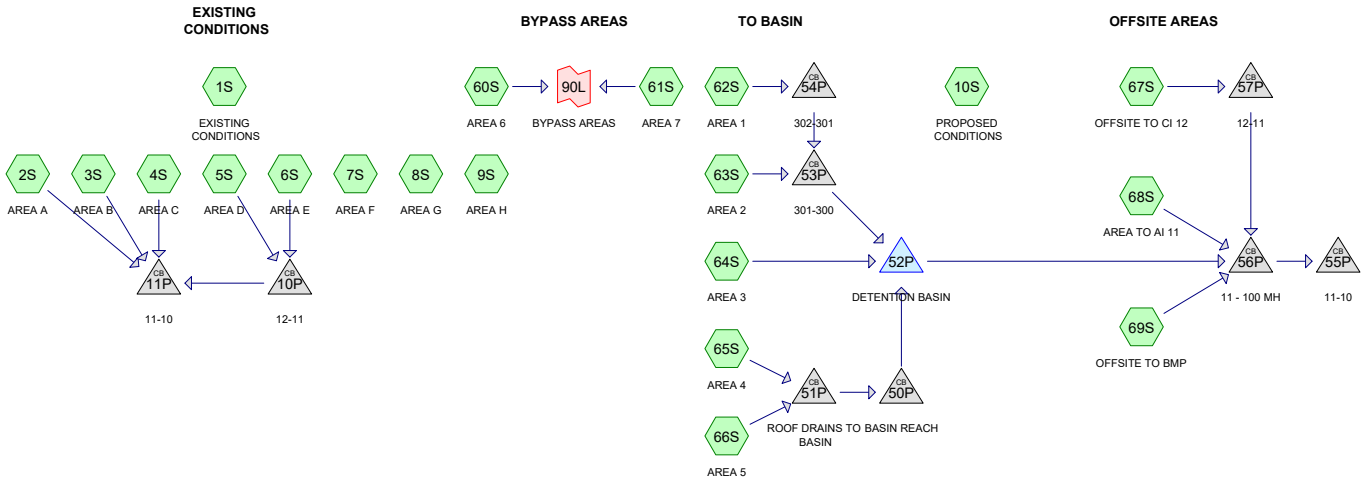
Due to the orifice size for the WQv event designed at 1.5" the full water volume design cannot be obtained unless the orifice size is reduced to 0.67". Most municipalities in the Midwest with extended detention or channel protection requirements do not allow an orifice size less than 1.5". While we have a larger orifice size than the calculations state for the 40 hour extended detention, we are within 0.07 cfs of meeting the release rate. Below is the final routing for the project.

	Existing Conditions	Post Developed Condition (No Detention) (c.f.s.)	Allowable release rate (c.f.s.)	Post Developed Routed through Detention (c.f.s.)	Bypass Areas (c.f.s.)	Post Developed Condition Final Routing (c.f.s.)	Differential Runoff Post Developed to Existing	Increase or Reduction for Runoff from Existing to Proposed Condition
2 Year	4.12	6.76	1.06	0.75	1.58	2.33	-1.79	Reduction
10 Year	8.74	12.44	4.22	2.67	3.11	5.78	-2.96	Reduction
100 Year	15.43	20.17	6.33	7.31	5.27	12.58	-2.85	Reduction

Appendix A Existing Drainage Area Map

Appendix B Proposed Drainage Area Map

Appendix C HydroCAD Hydrographs

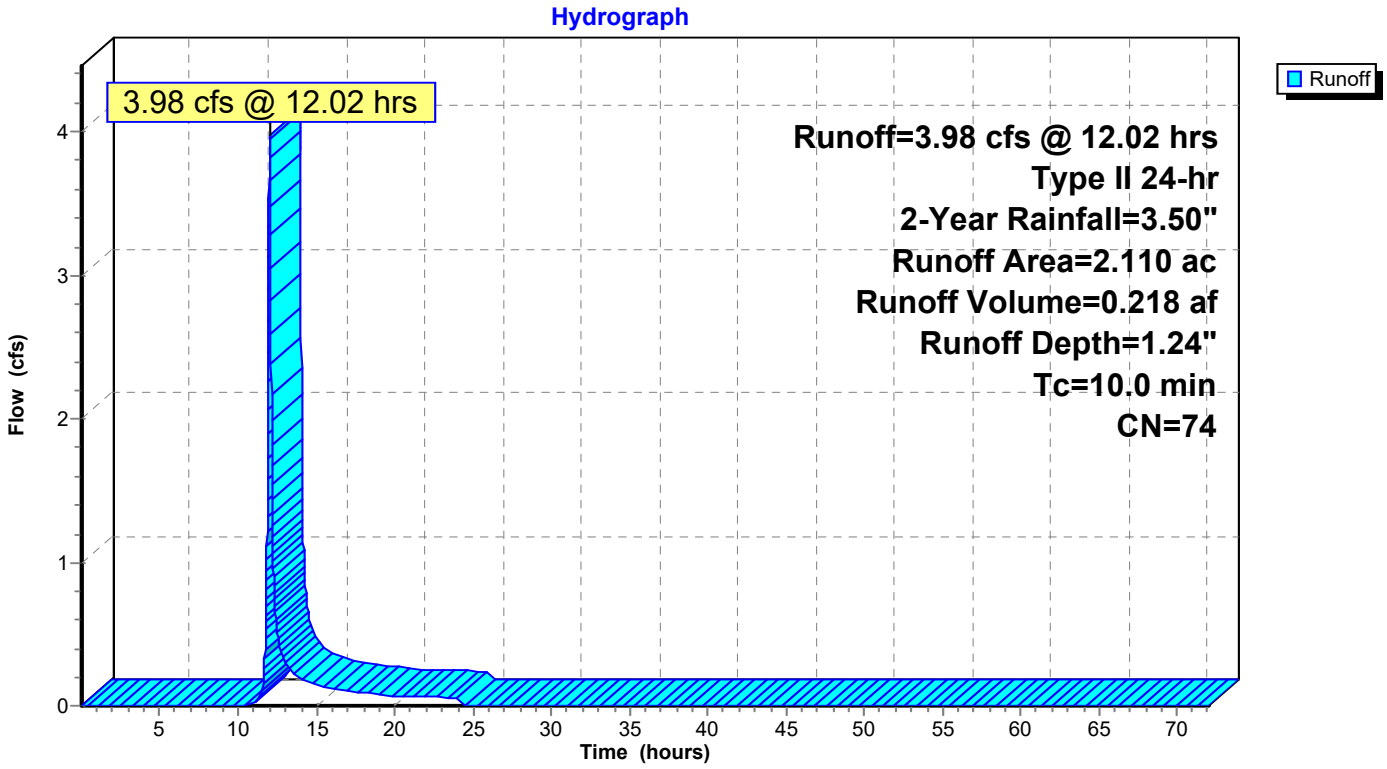


Subcat Reach Pond Link

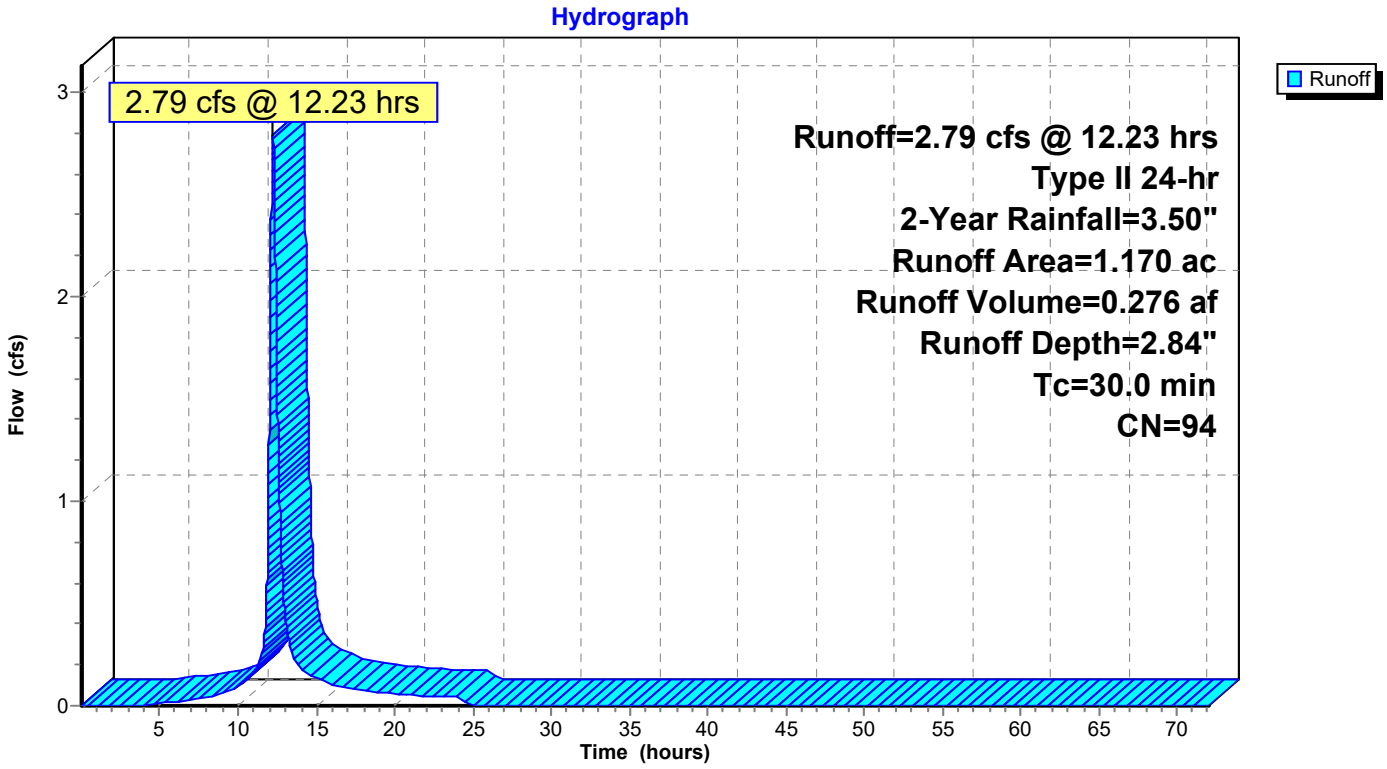
Routing Diagram for 2020-10-31 ANALYSIS
Prepared by Premier Design Group, Printed 11/3/2020

TABLE OF CONTENTS

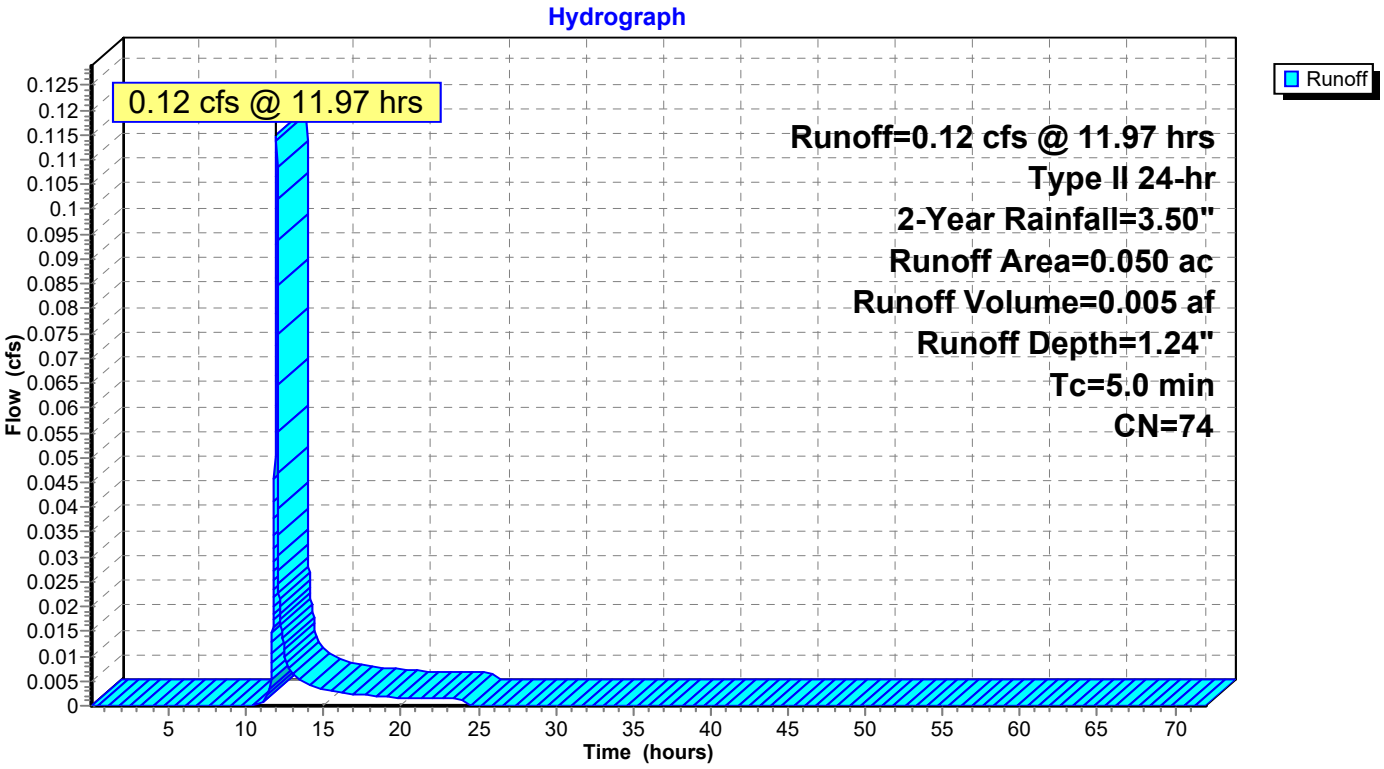
Subcatchment 1S: EXISTING CONDITIONS



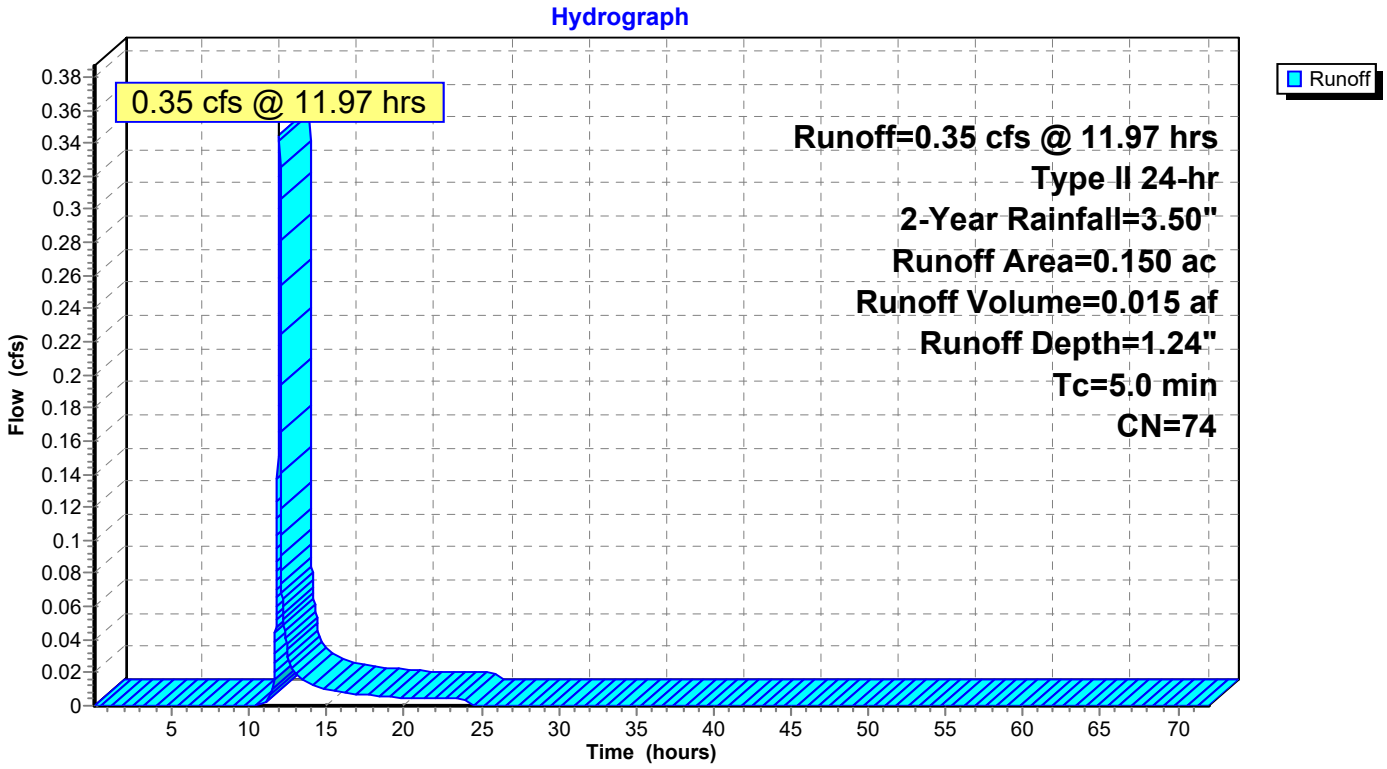
Subcatchment 2S: AREA A



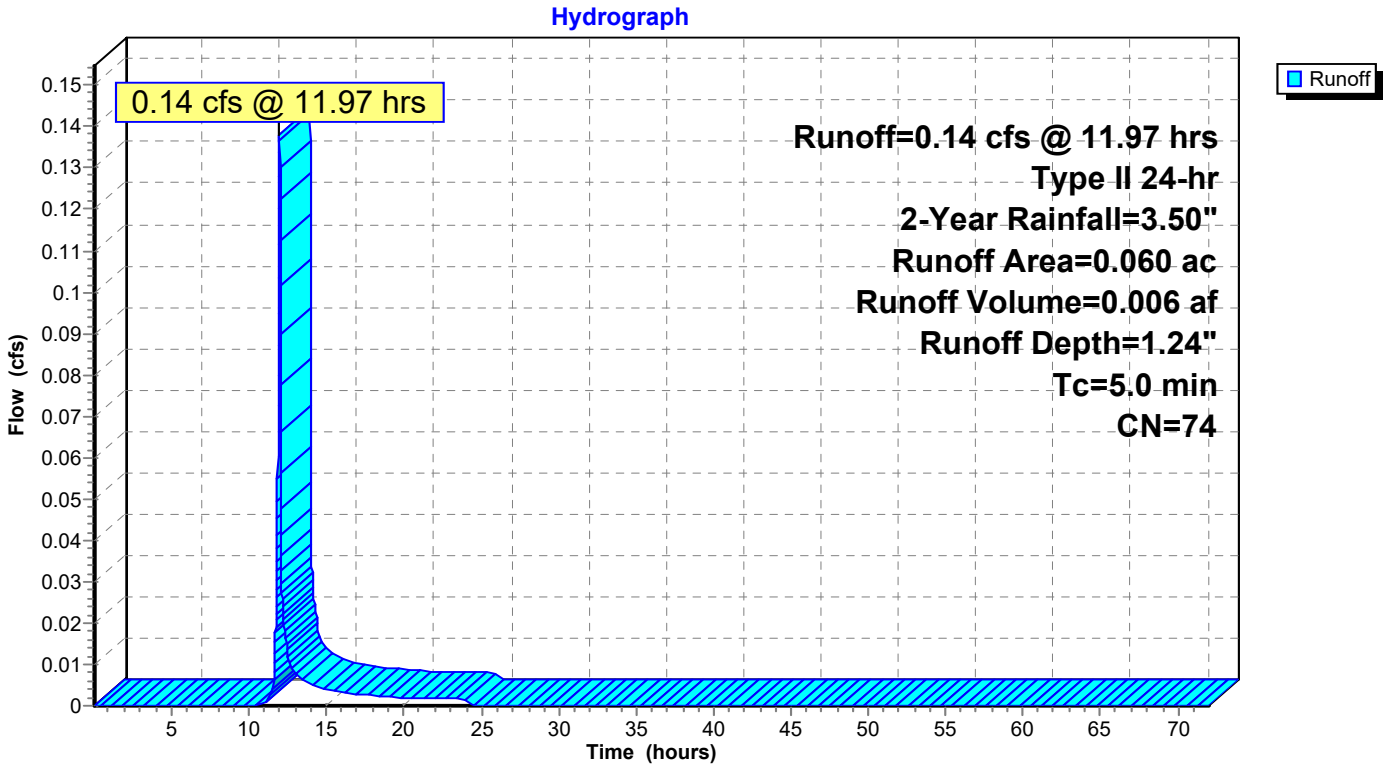
Subcatchment 3S: AREA B



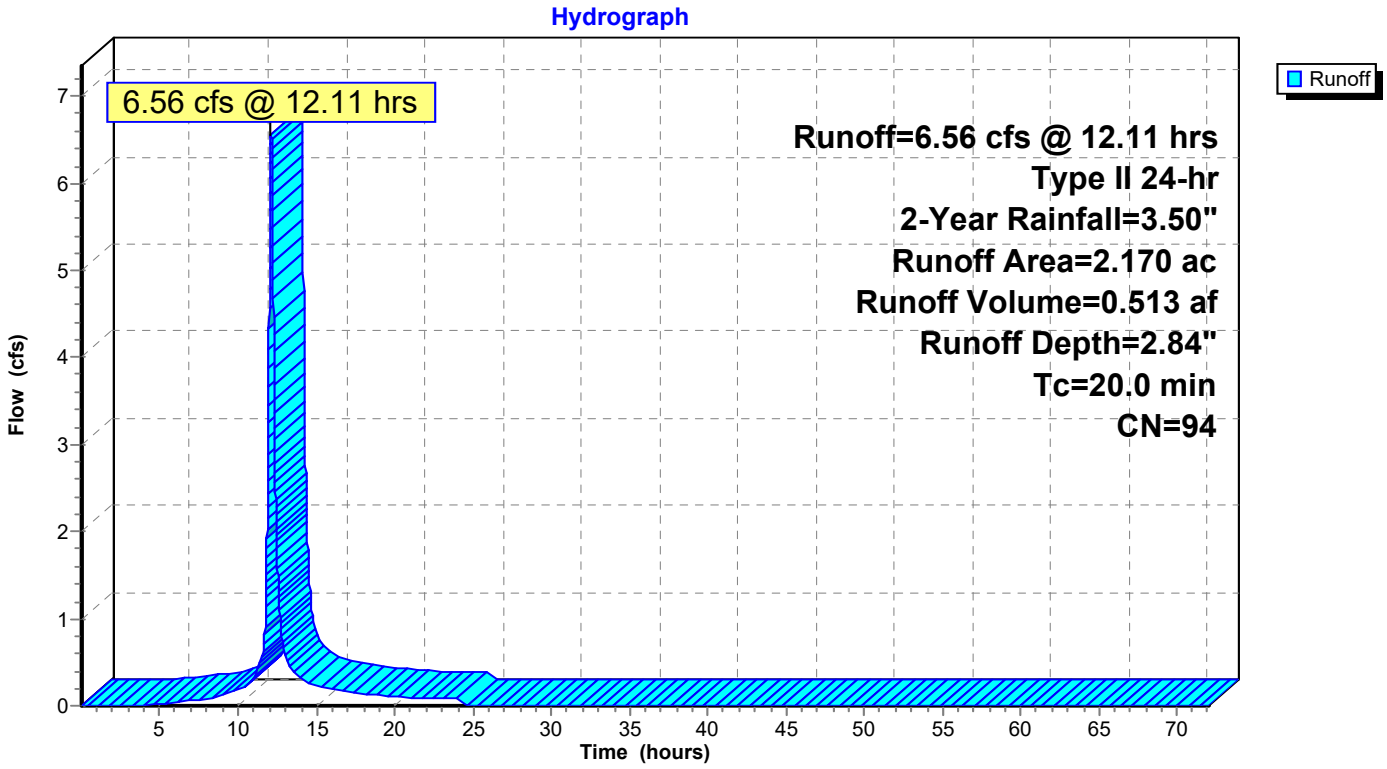
Subcatchment 4S: AREA C



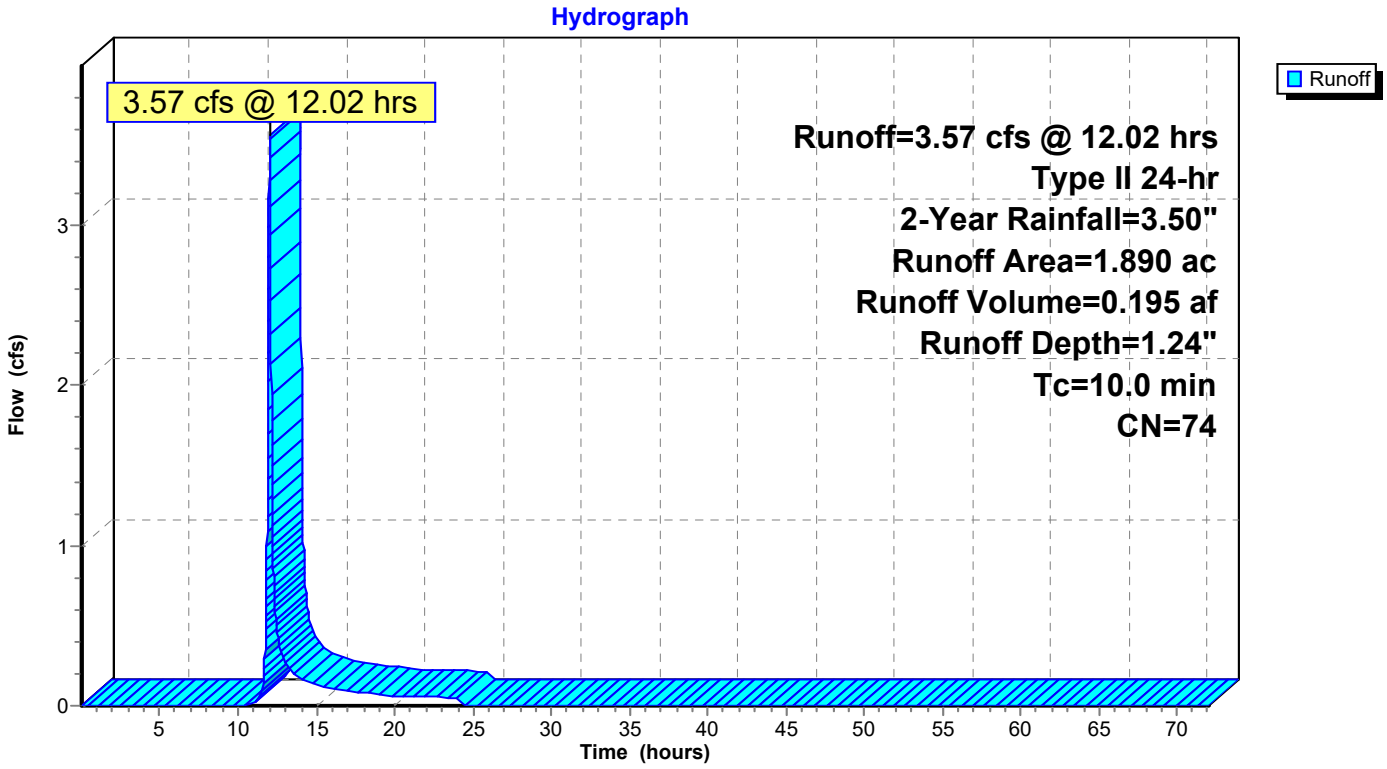
Subcatchment 5S: AREA D



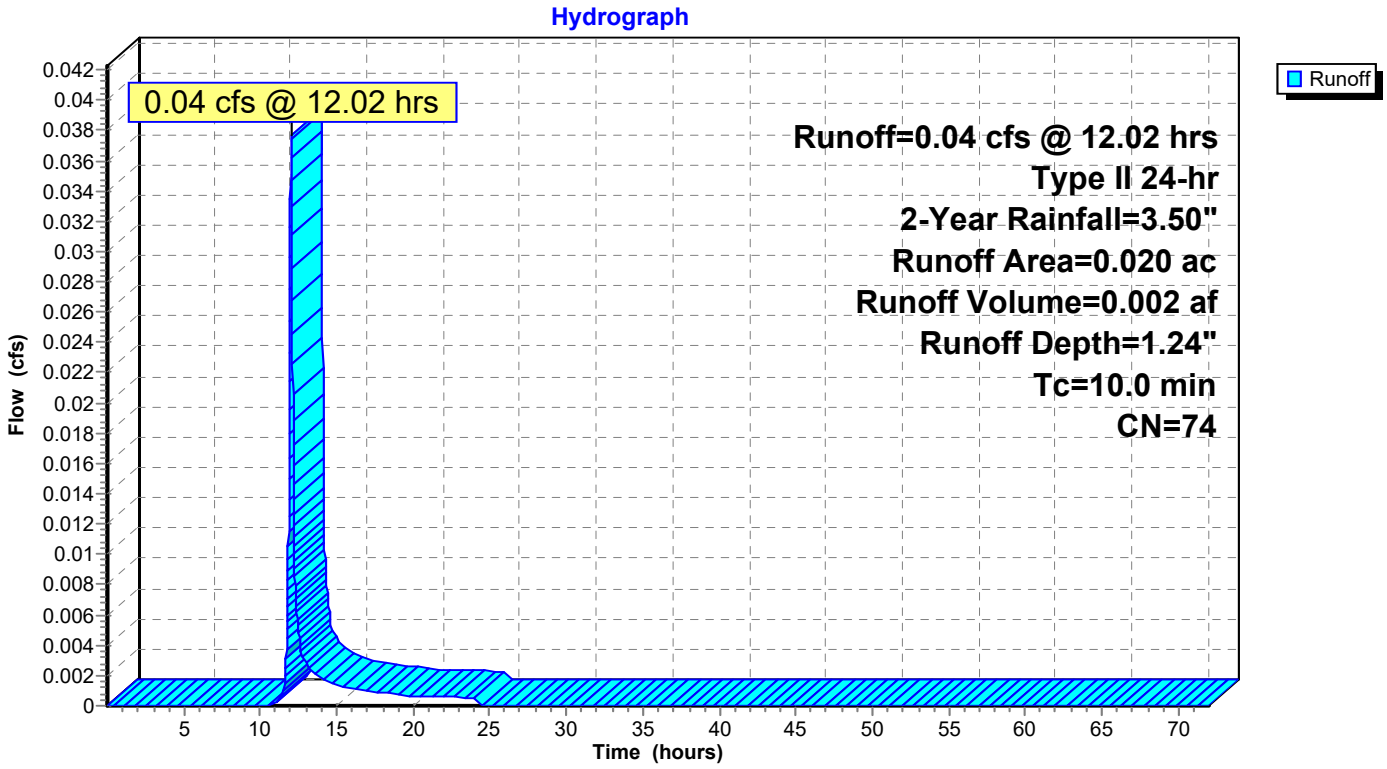
Subcatchment 6S: AREA E



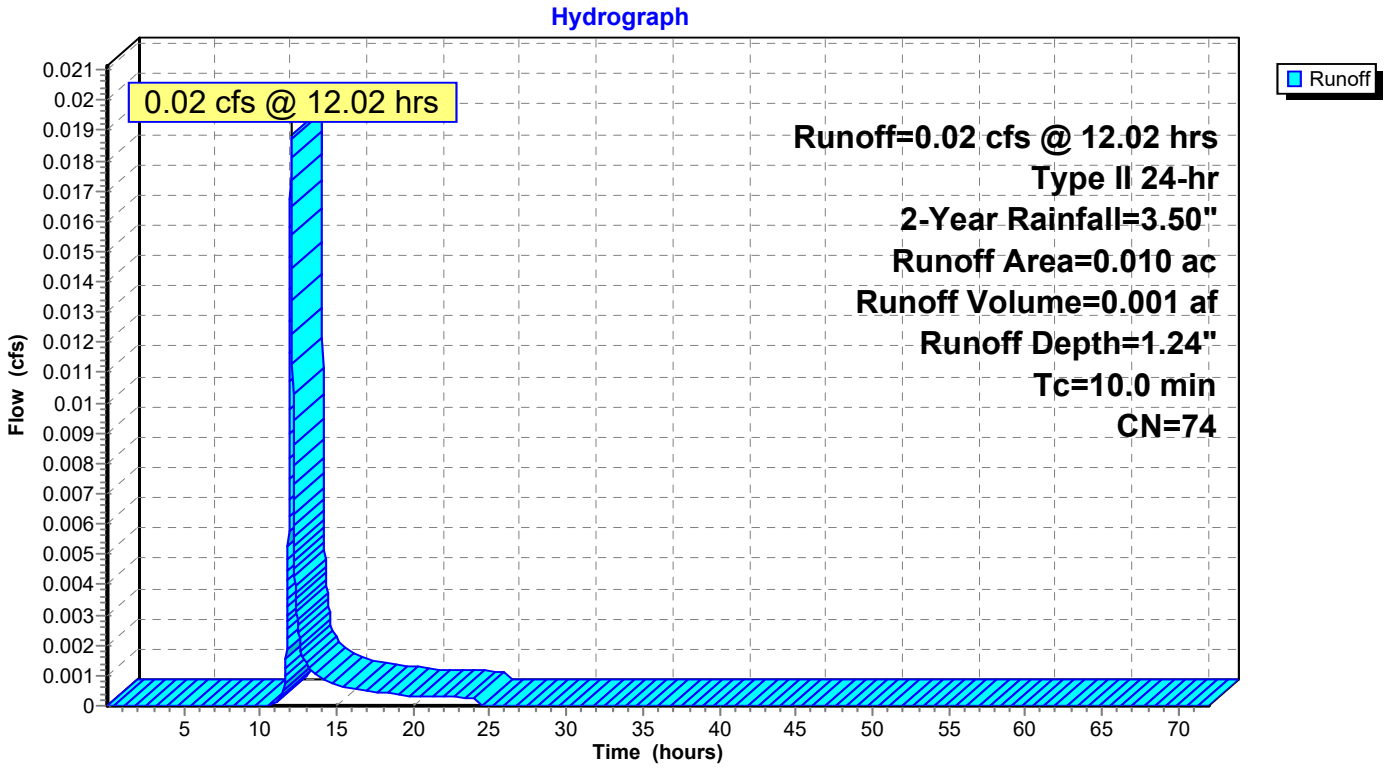
Subcatchment 7S: AREA F



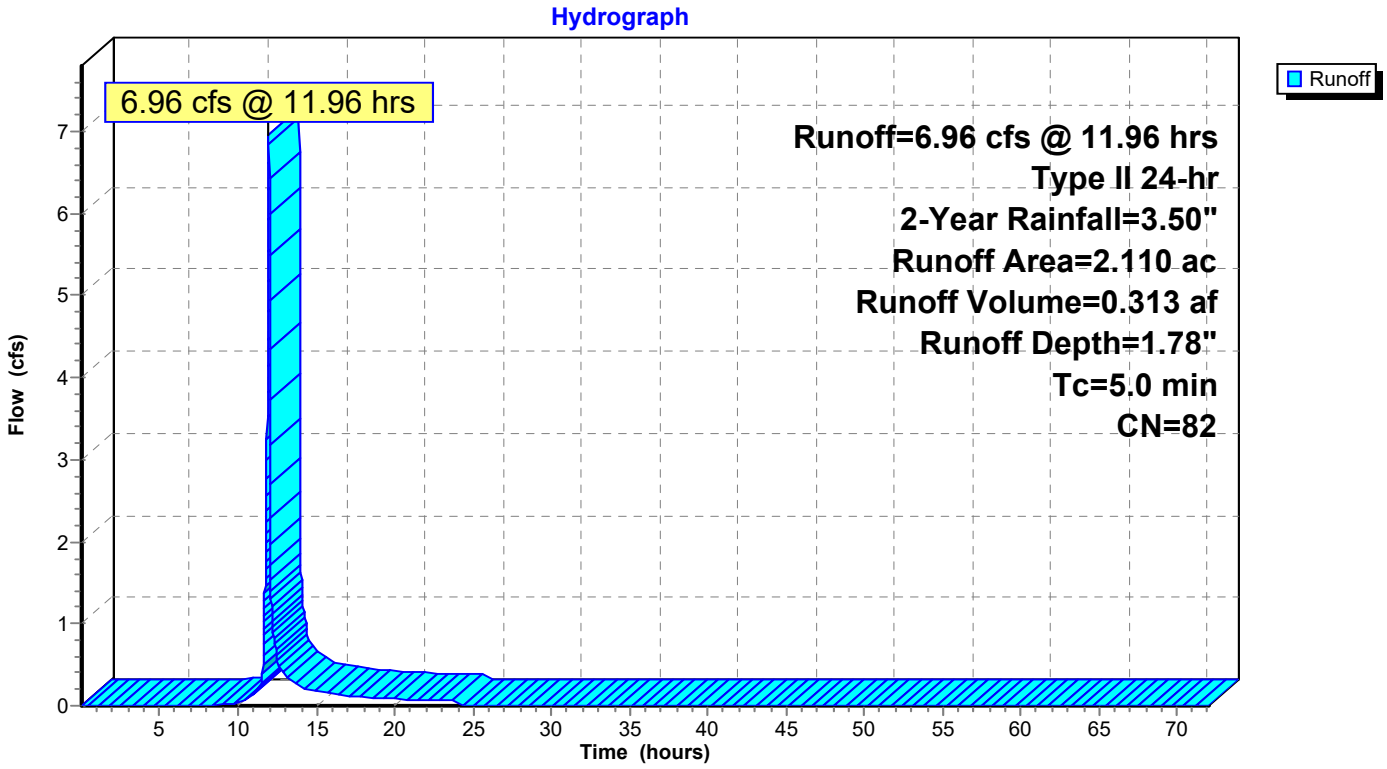
Subcatchment 8S: AREA G



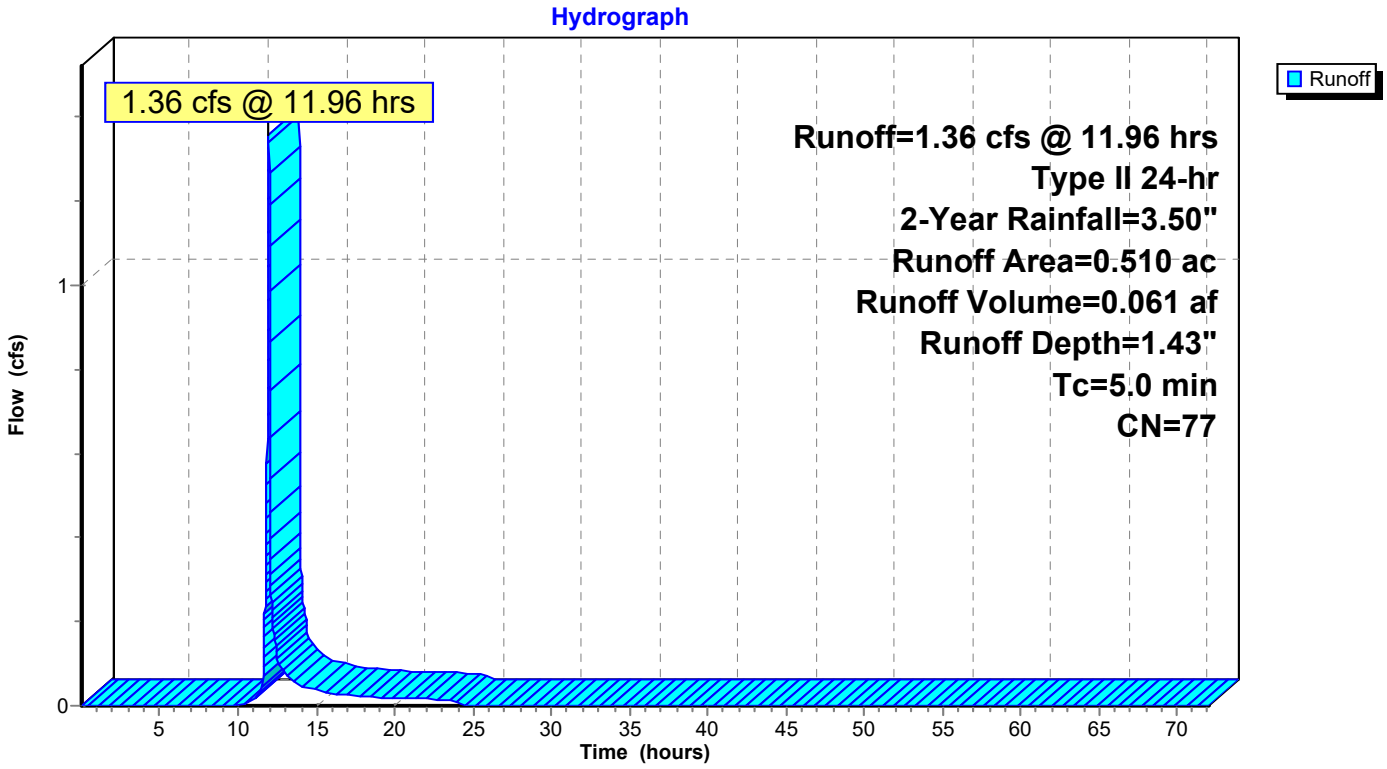
Subcatchment 9S: AREA H



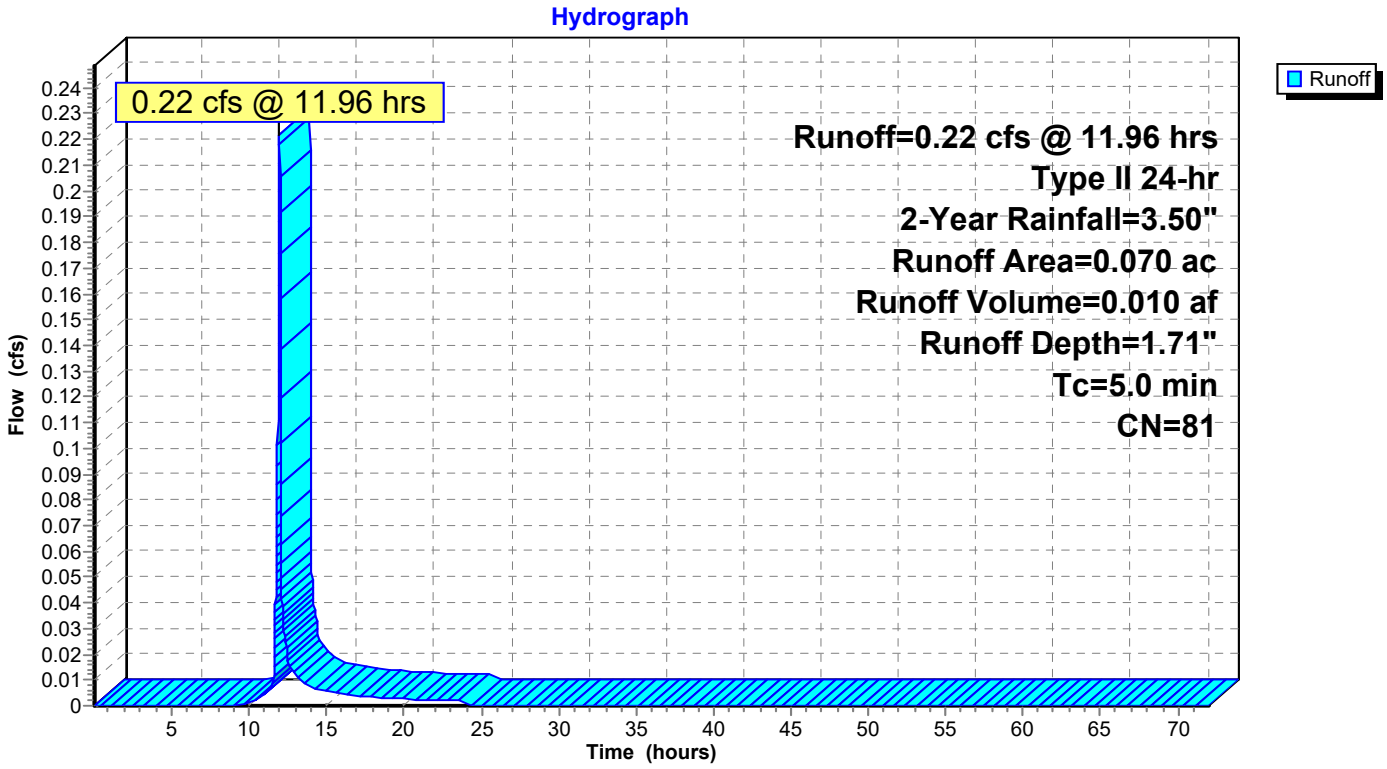
Subcatchment 10S: PROPOSED CONDITIONS



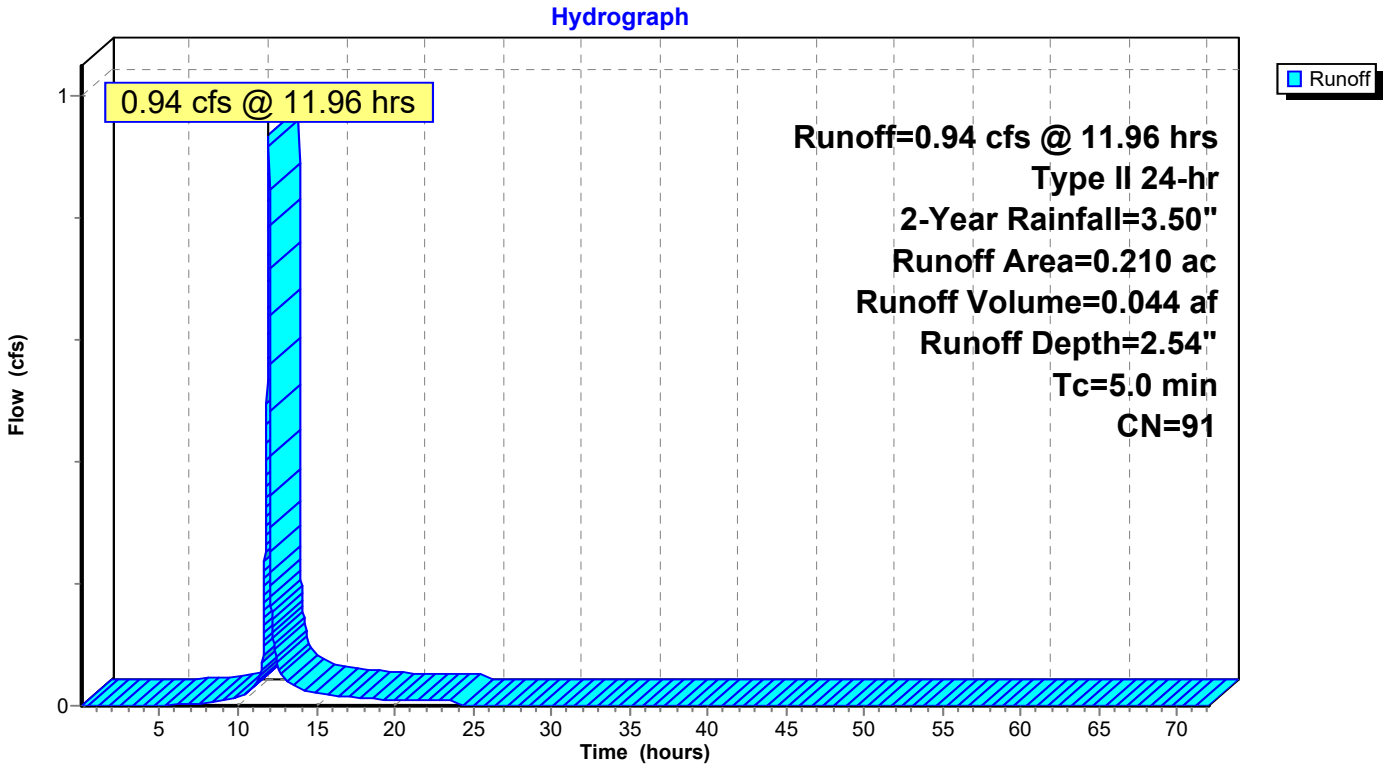
Subcatchment 60S: AREA 6



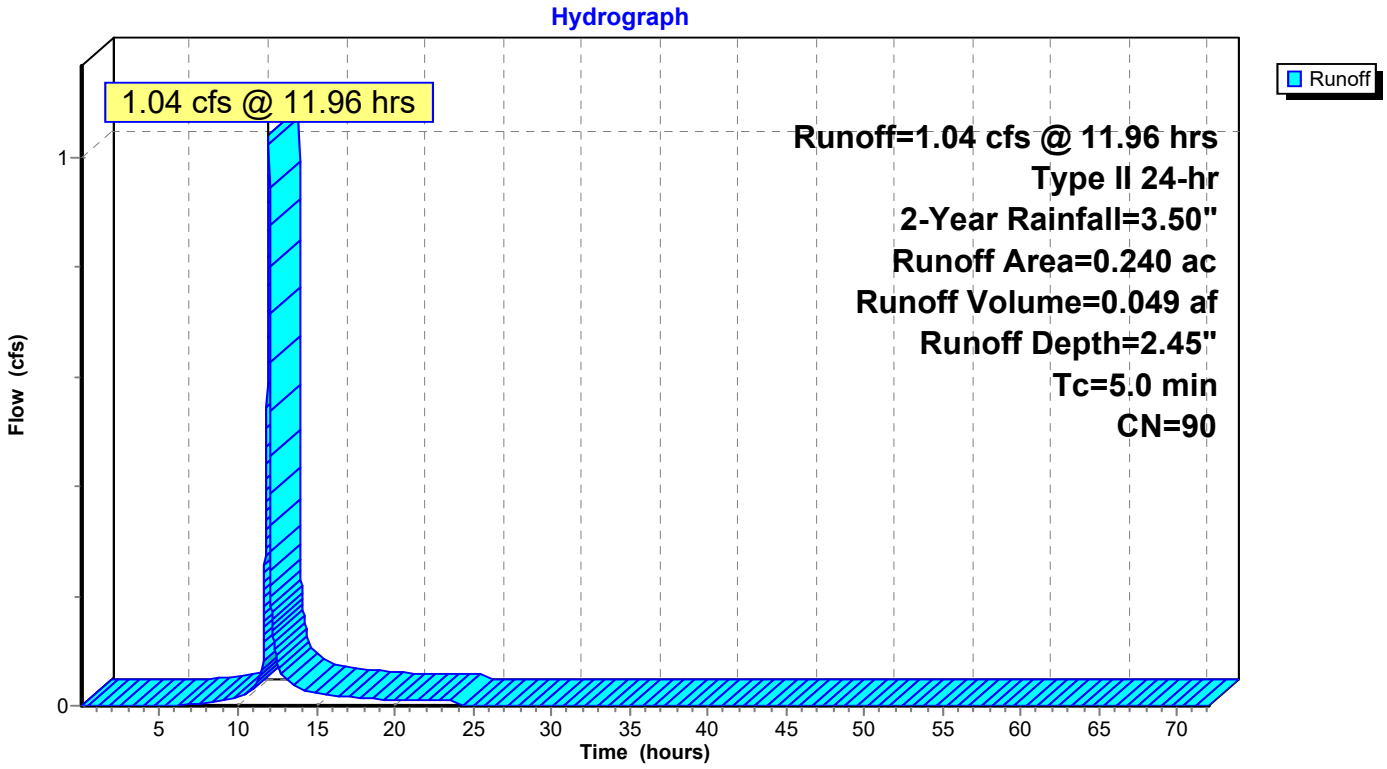
Subcatchment 61S: AREA 7



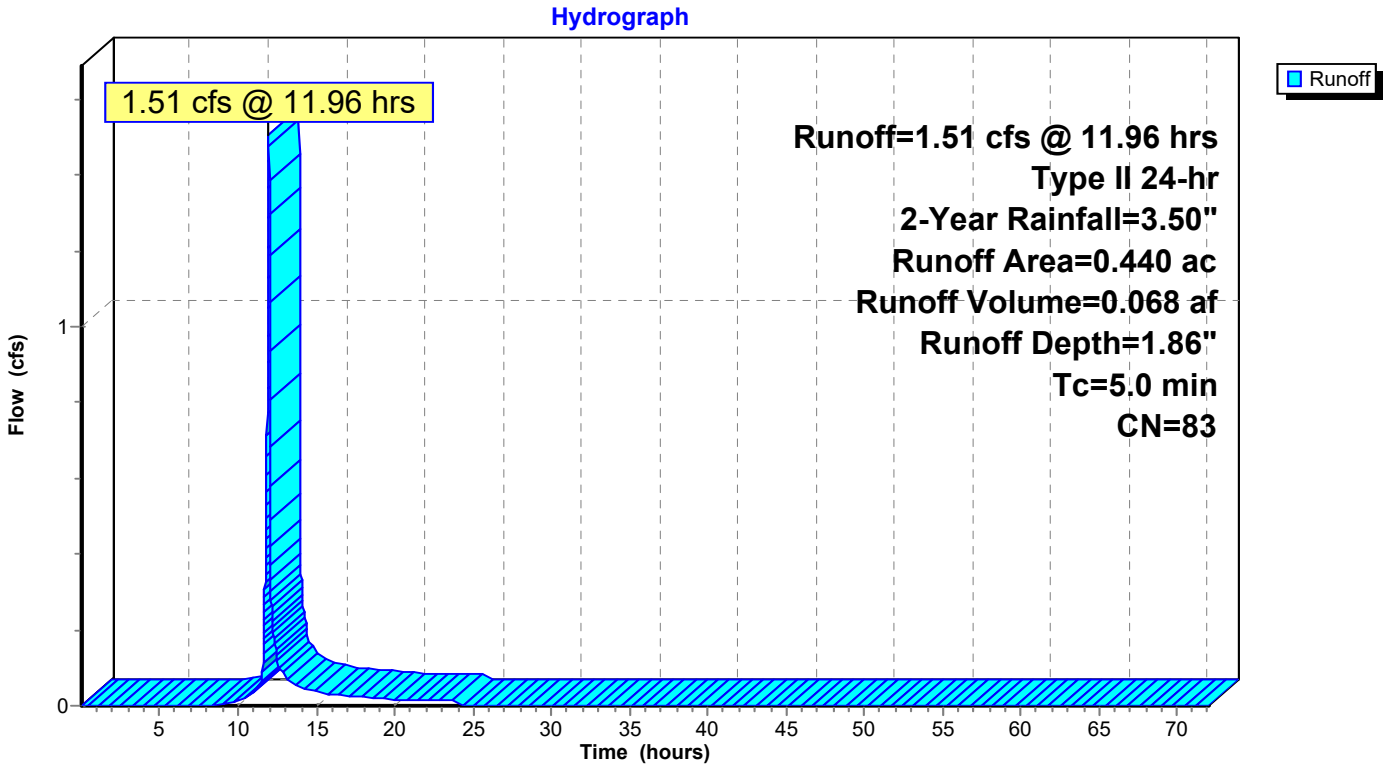
Subcatchment 62S: AREA 1



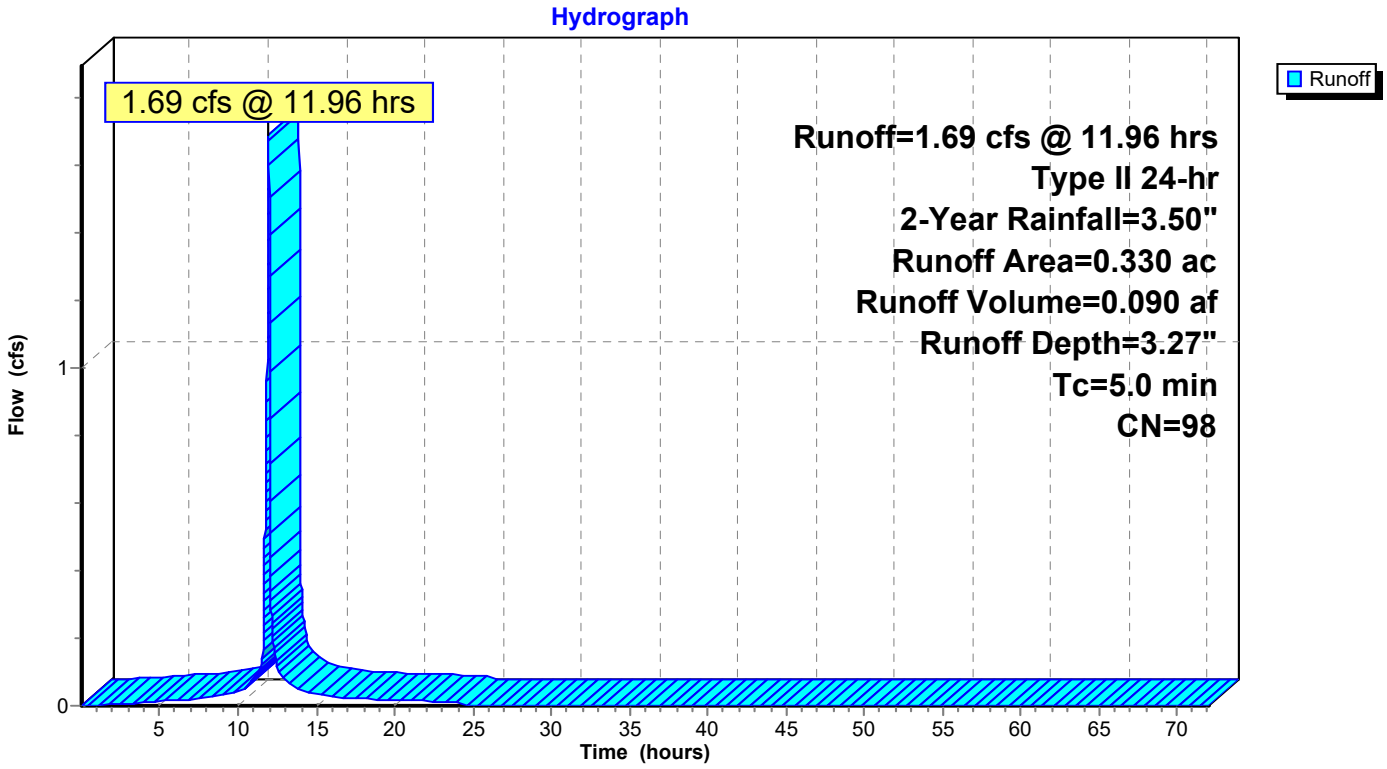
Subcatchment 63S: AREA 2



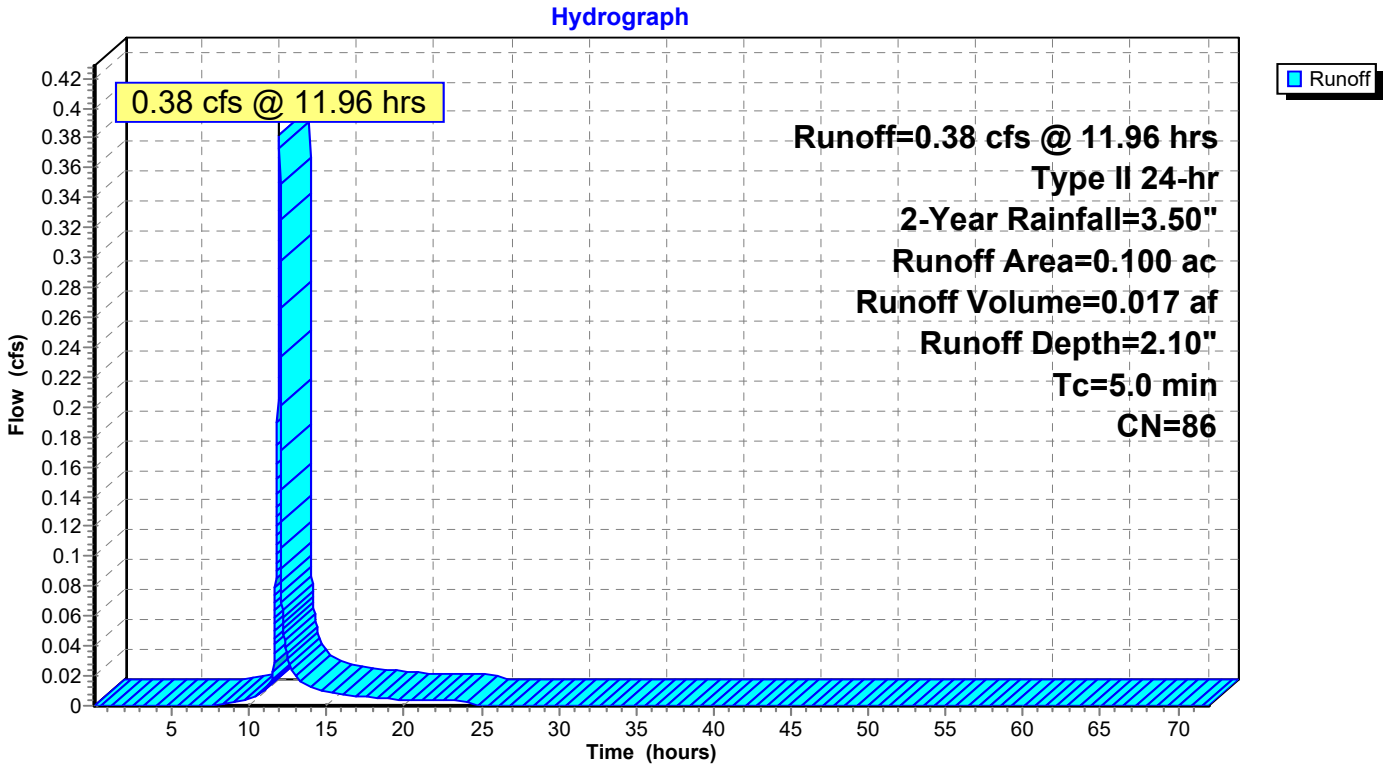
Subcatchment 64S: AREA 3



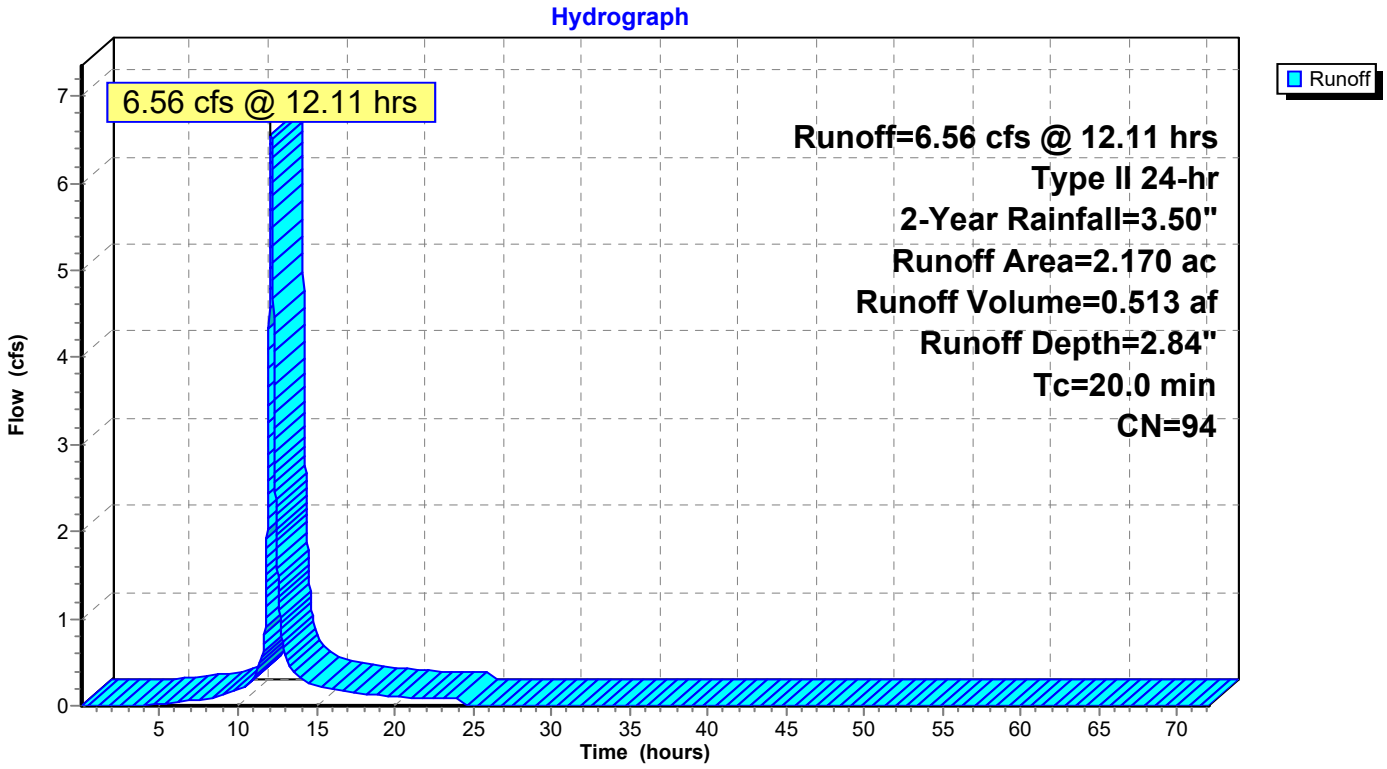
Subcatchment 65S: AREA 4



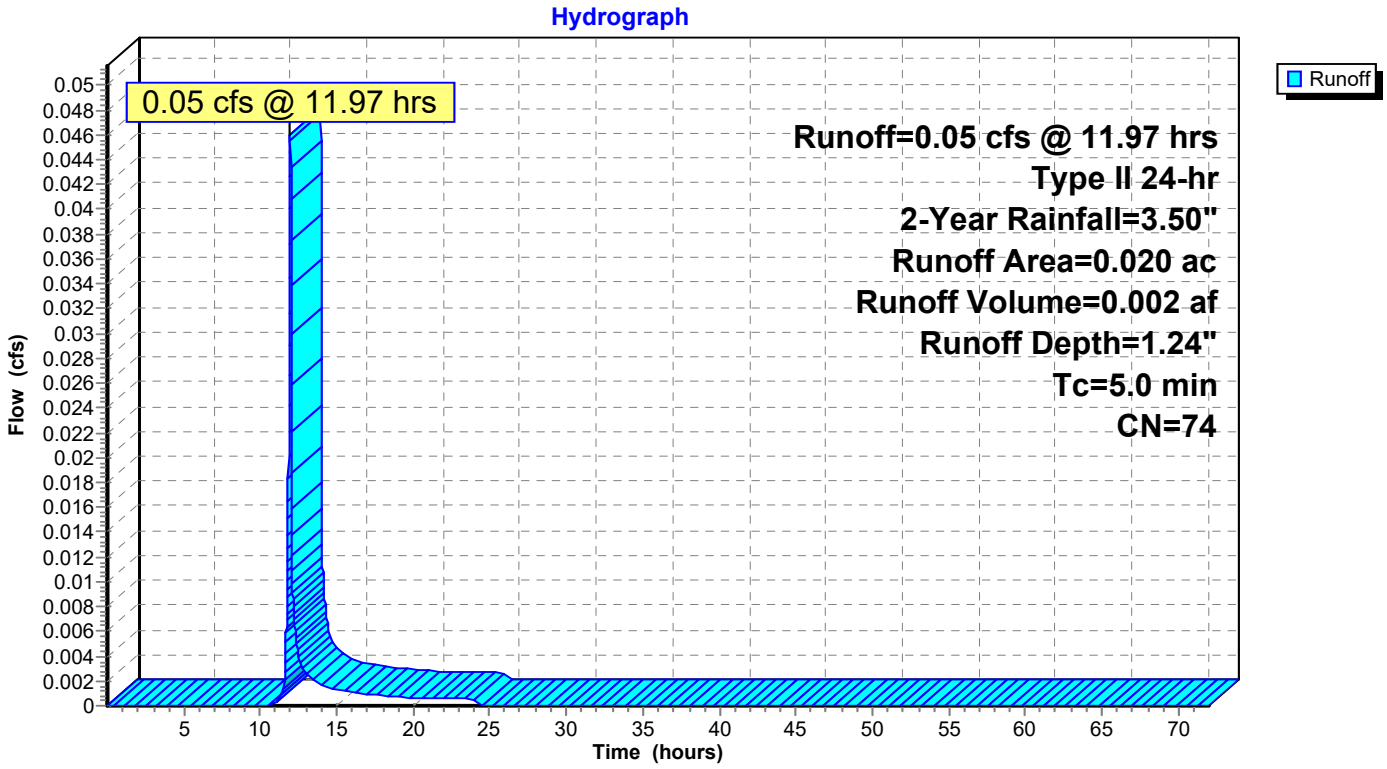
Subcatchment 66S: AREA 5



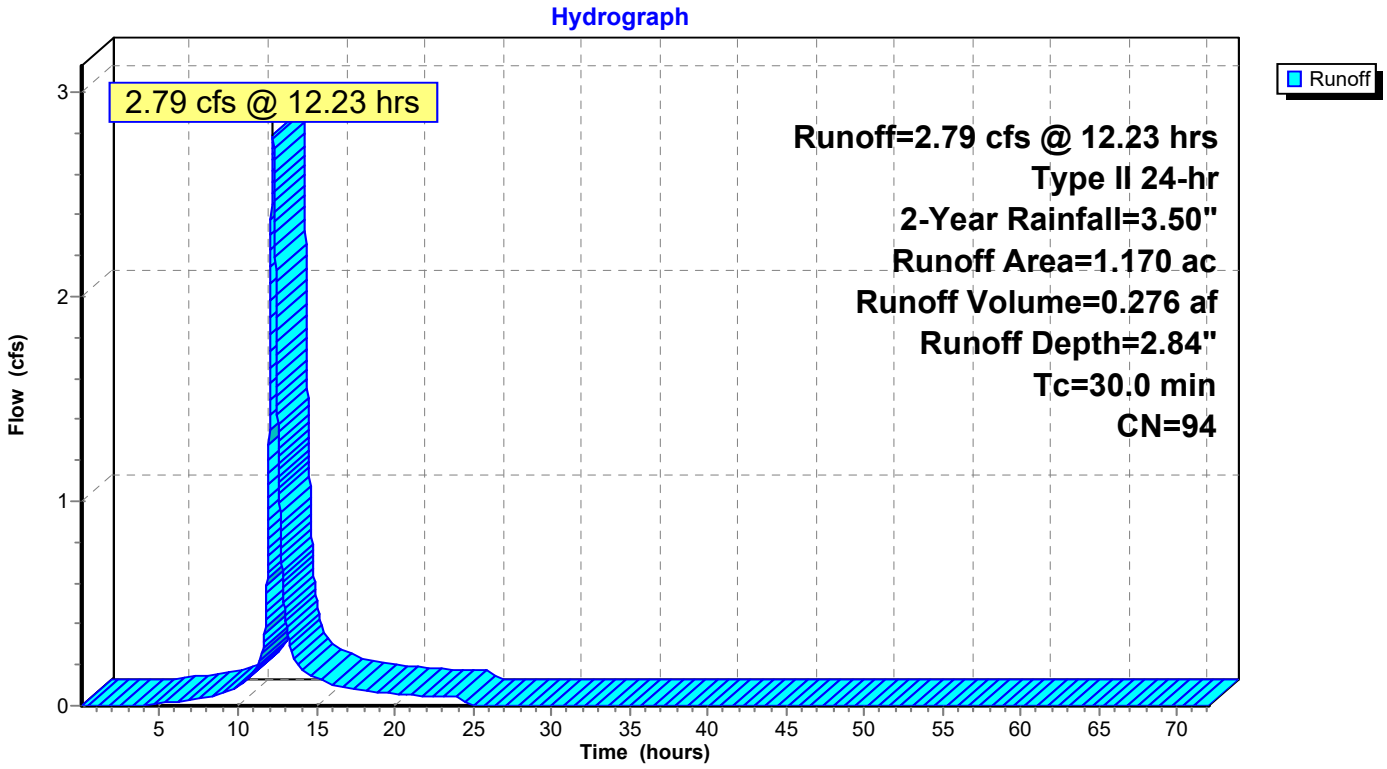
Subcatchment 67S: OFFSITE TO CI 12



Subcatchment 68S: AREA TO AI 11

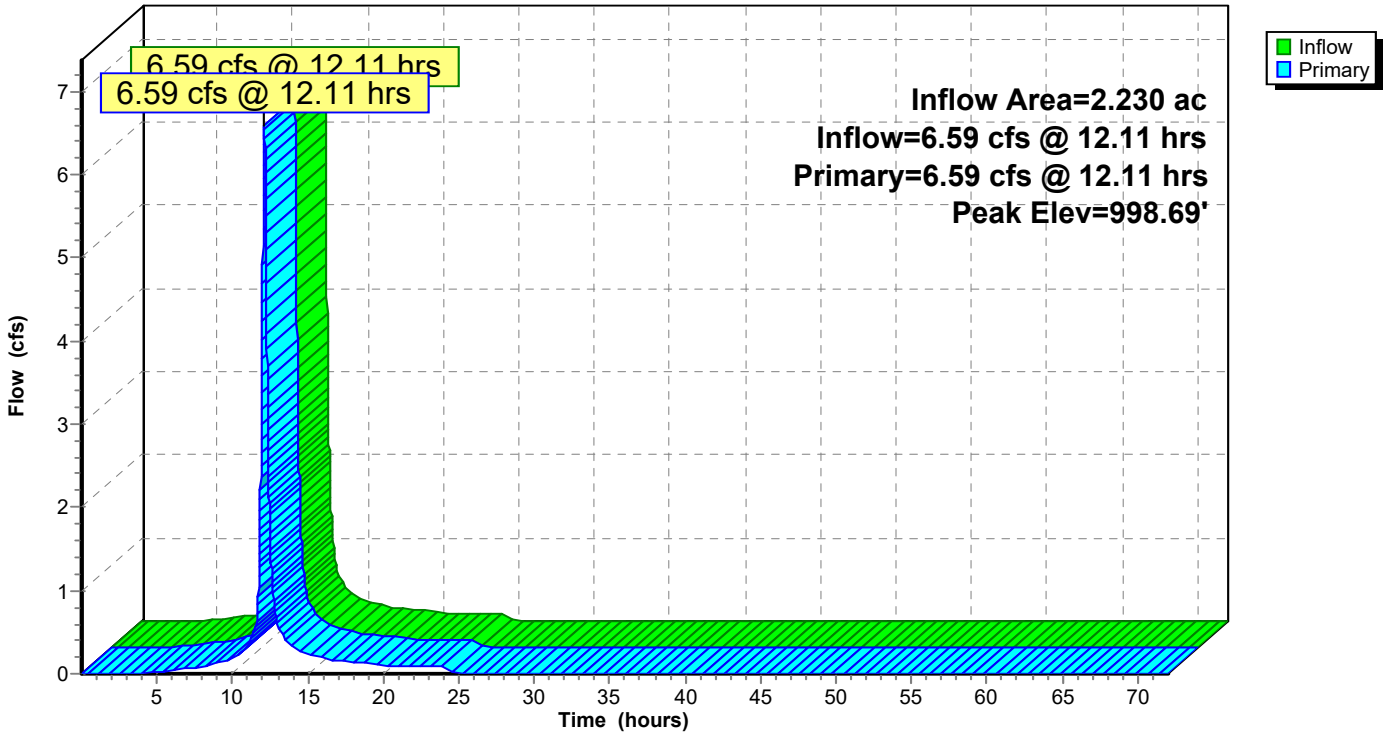


Subcatchment 69S: OFFSITE TO BMP



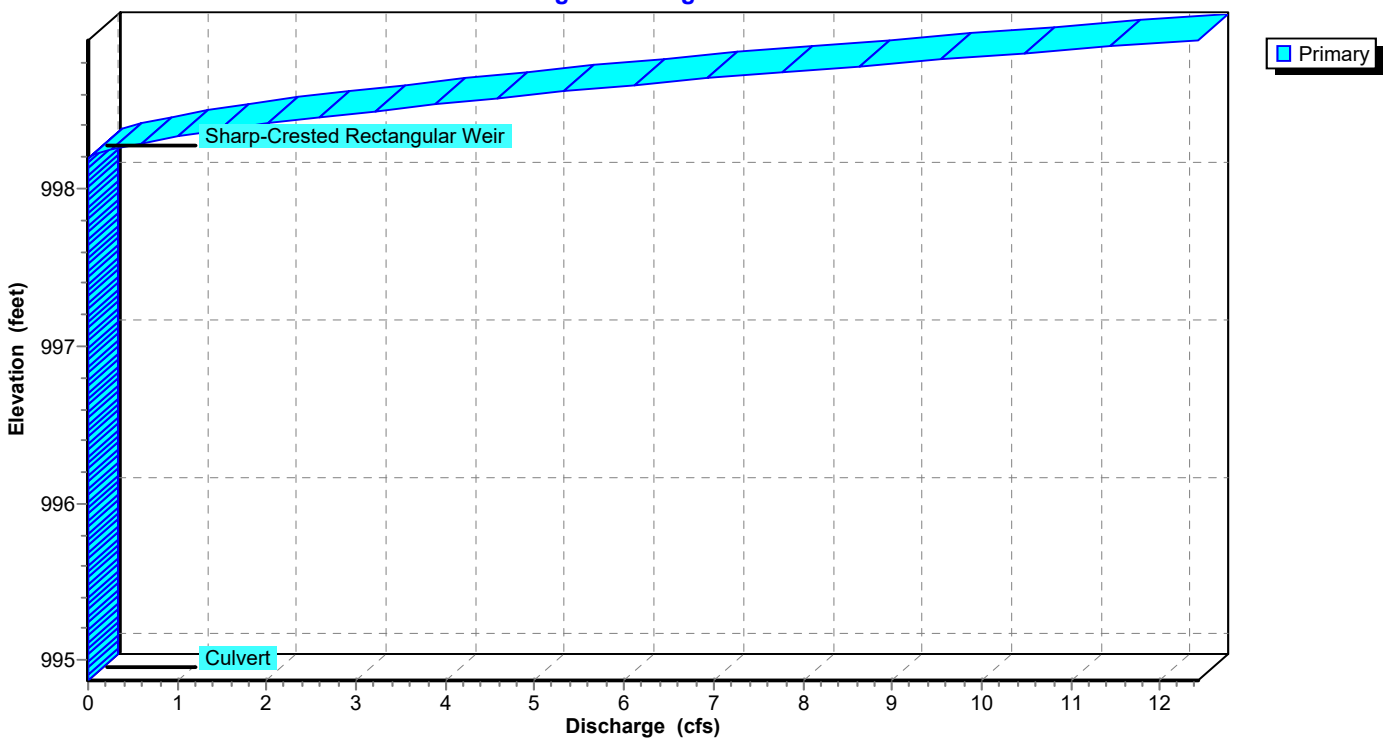
Pond 10P: 12-11

Hydrograph

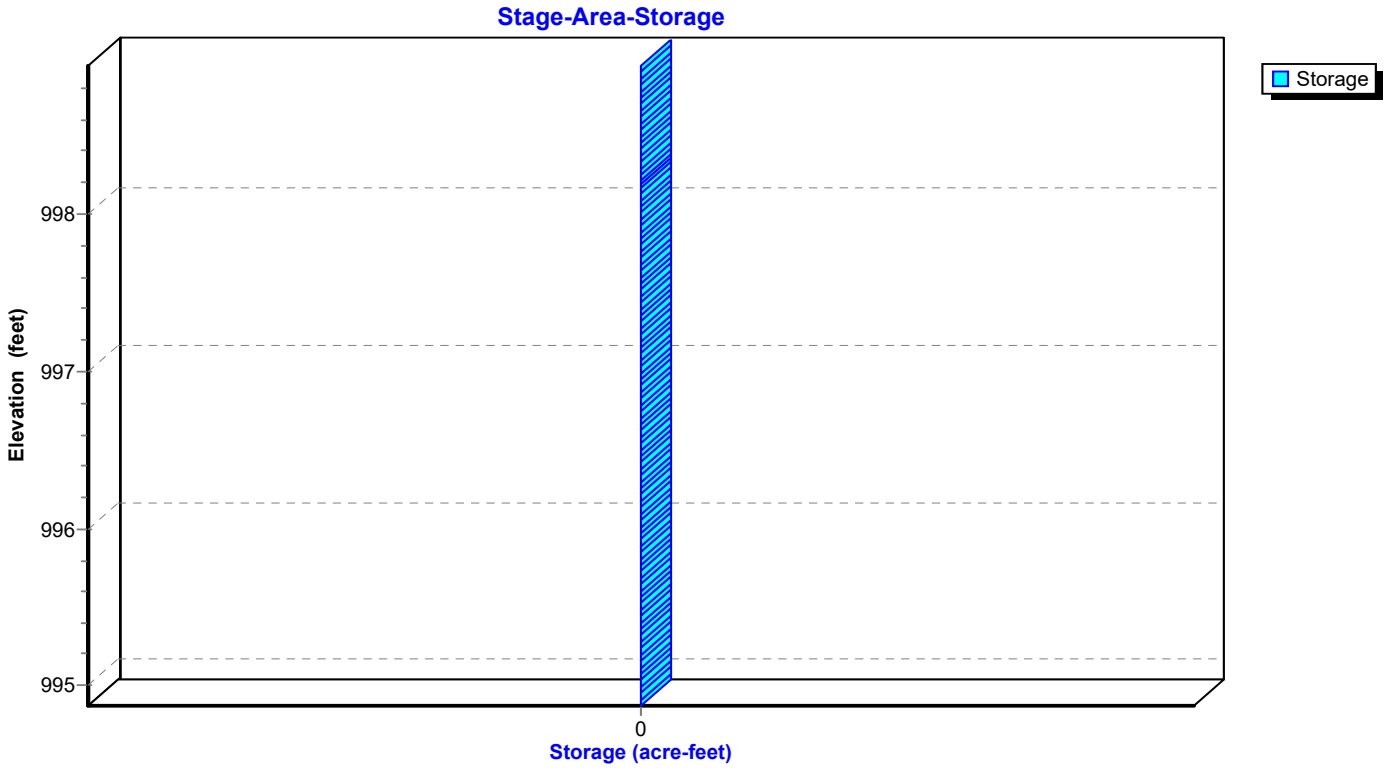


Pond 10P: 12-11

Stage-Discharge

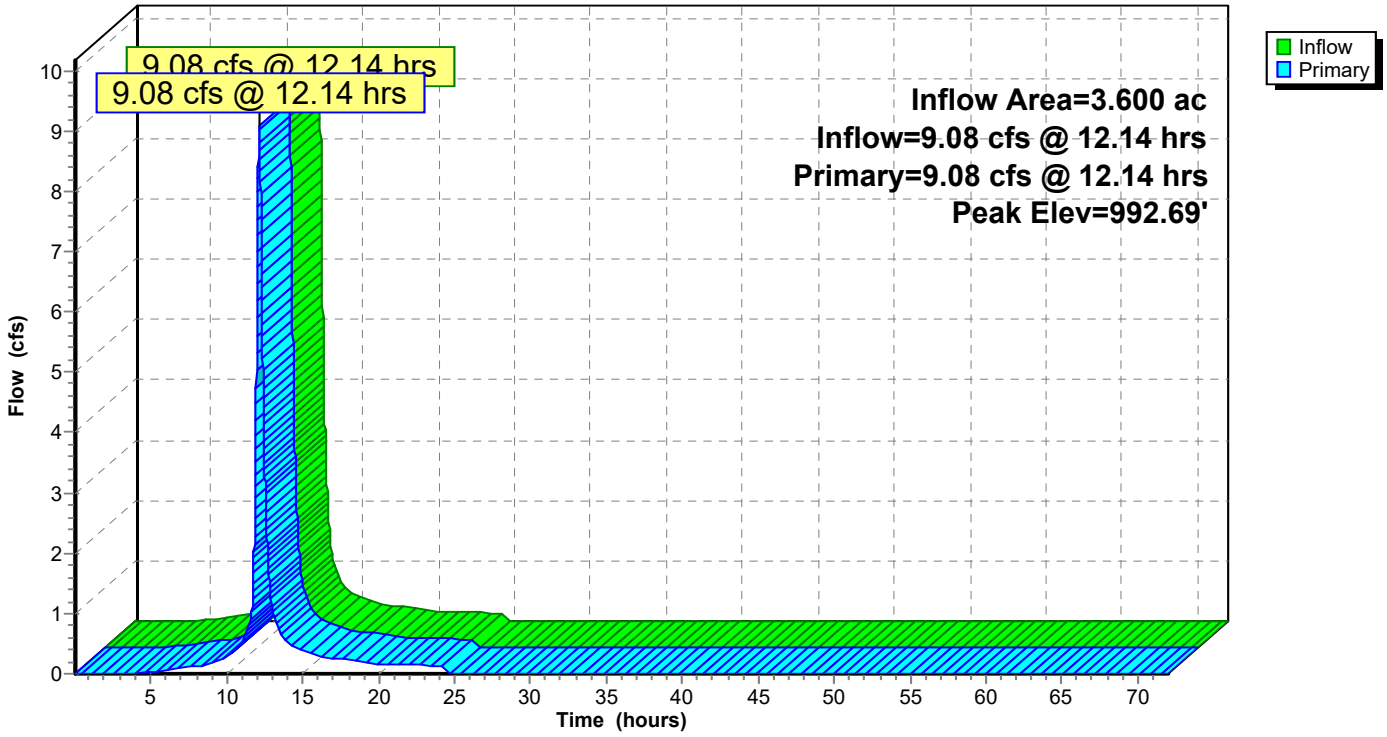


Pond 10P: 12-11



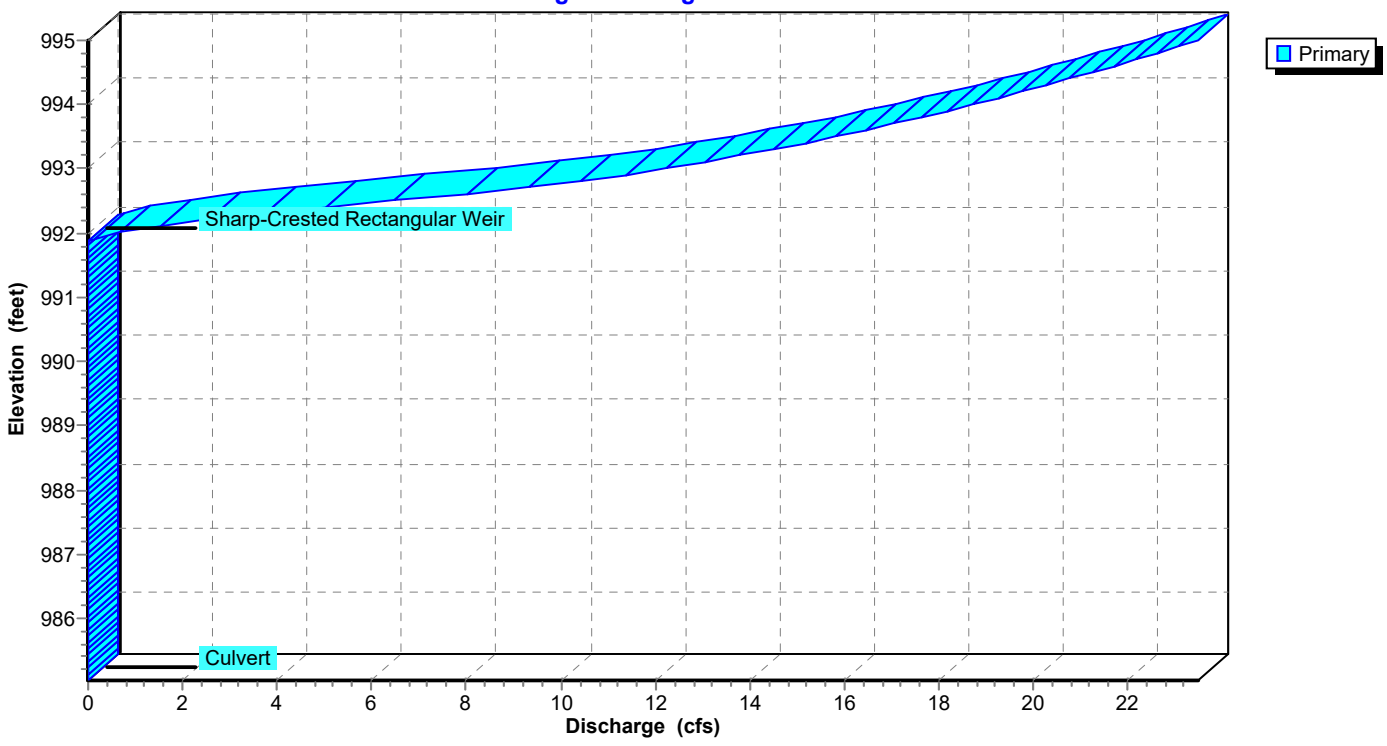
Pond 11P: 11-10

Hydrograph

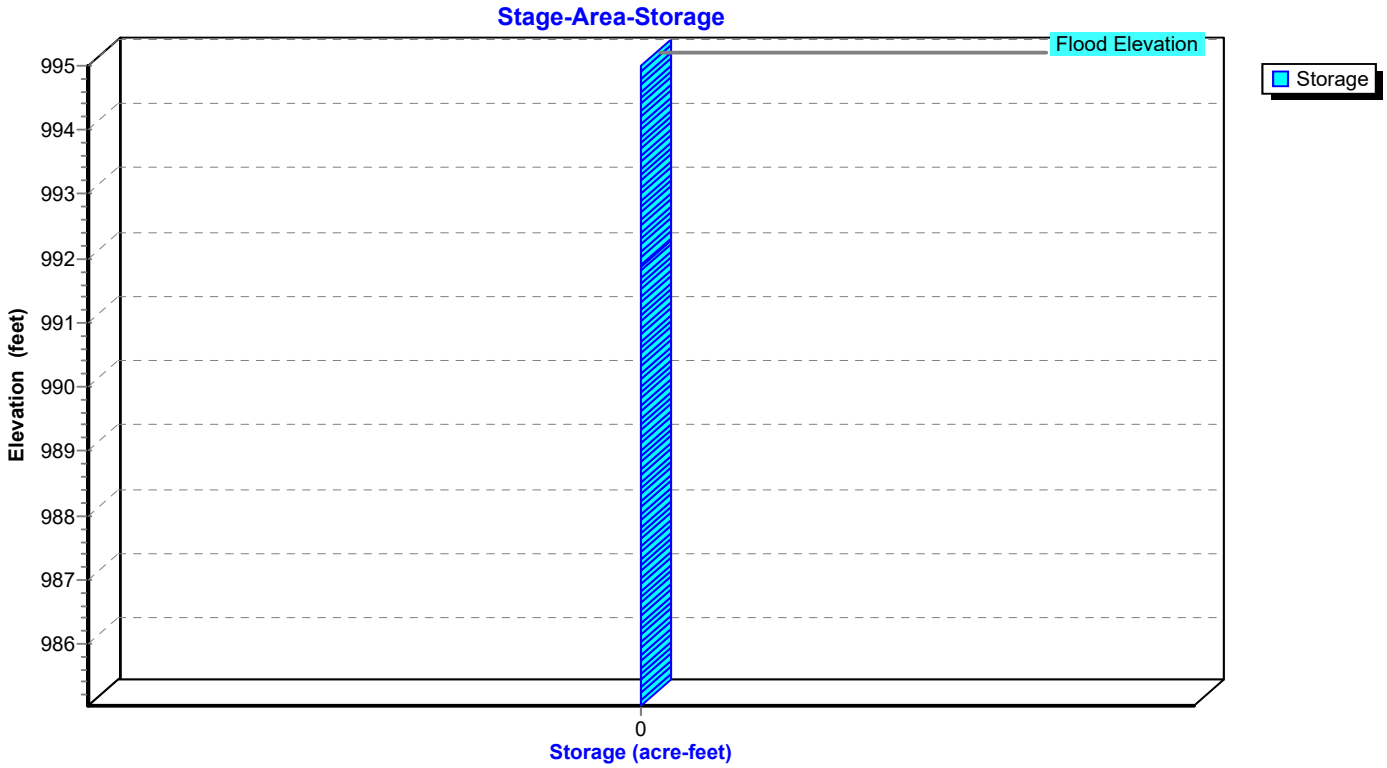


Pond 11P: 11-10

Stage-Discharge

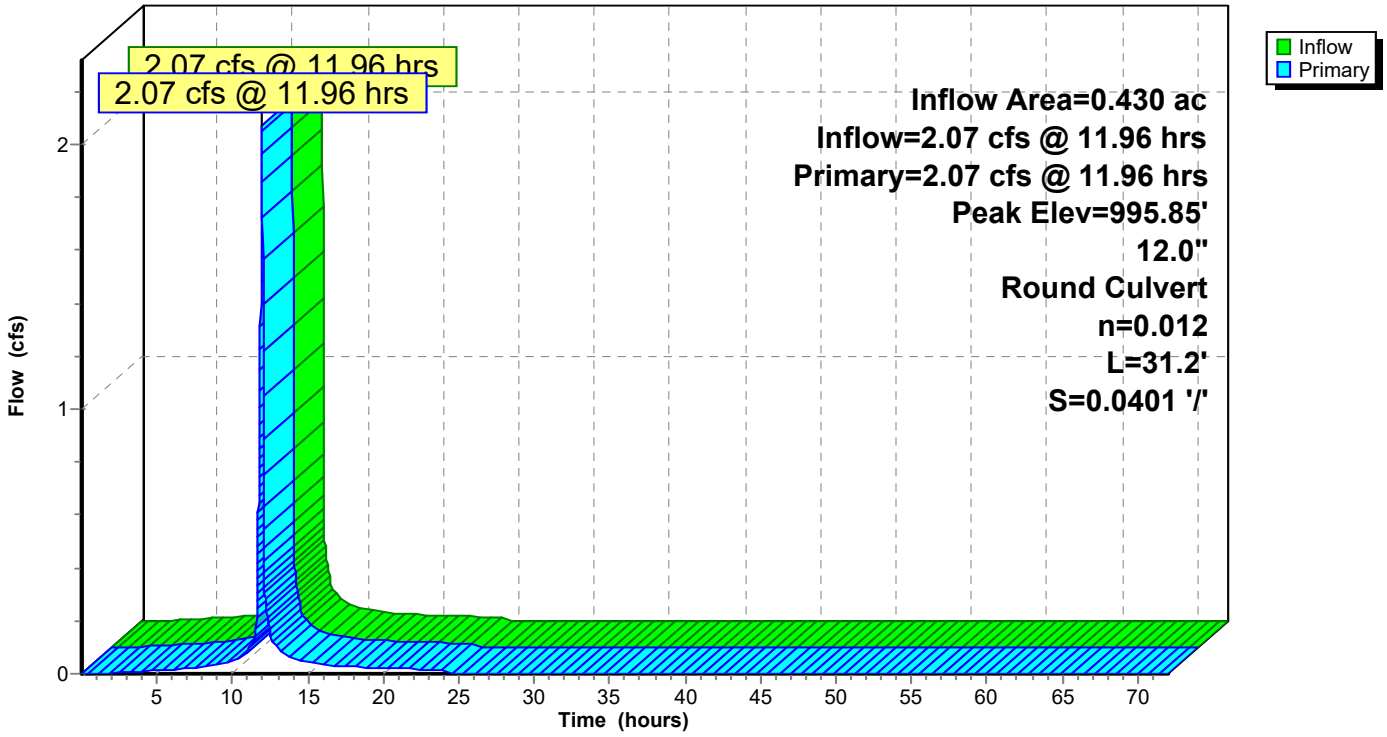


Pond 11P: 11-10



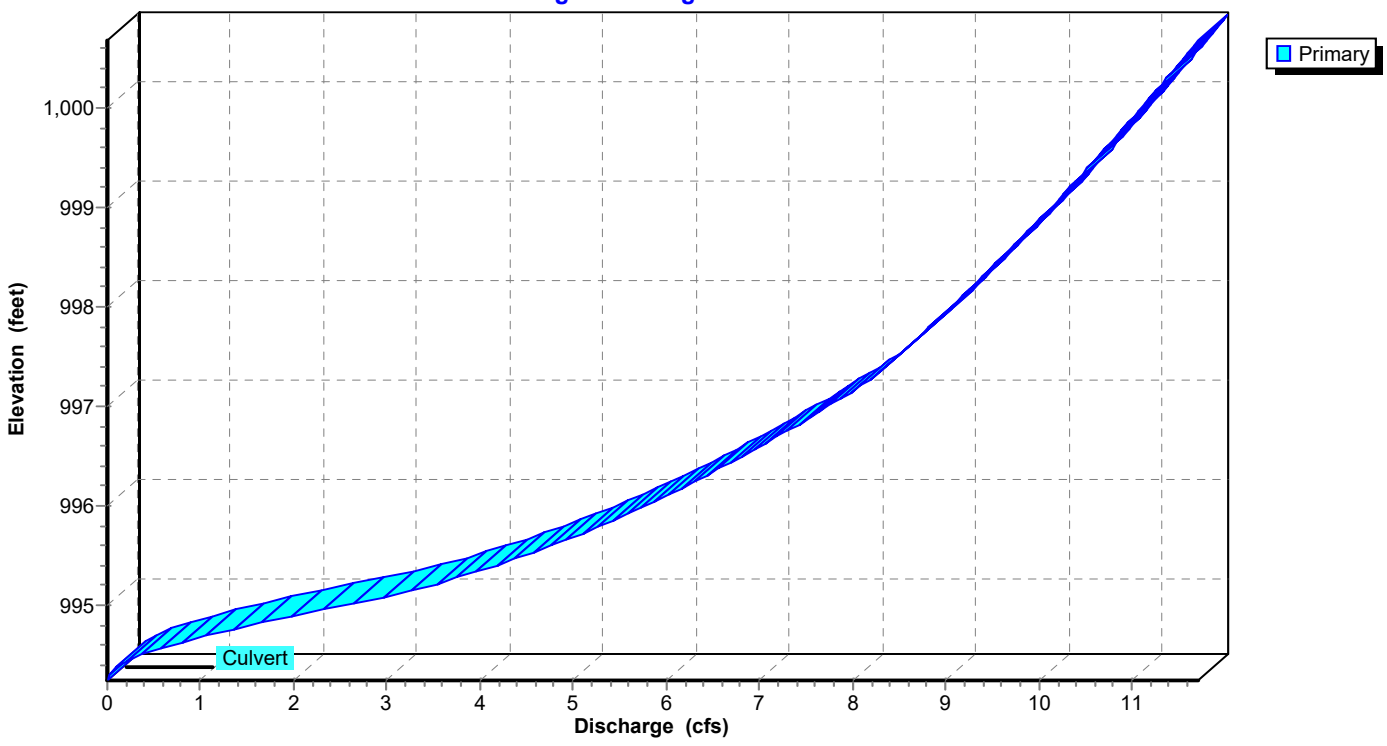
Pond 50P: BASIN REACH

Hydrograph

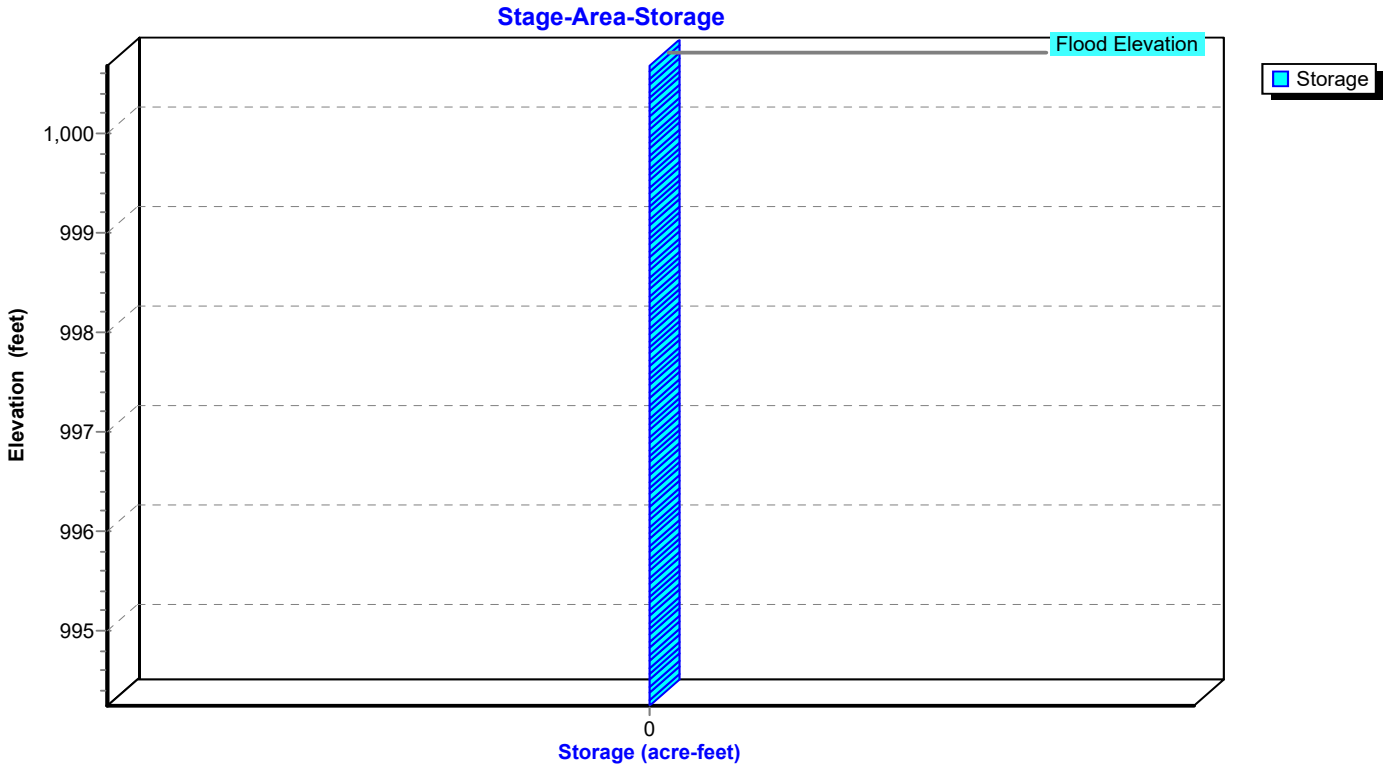


Pond 50P: BASIN REACH

Stage-Discharge

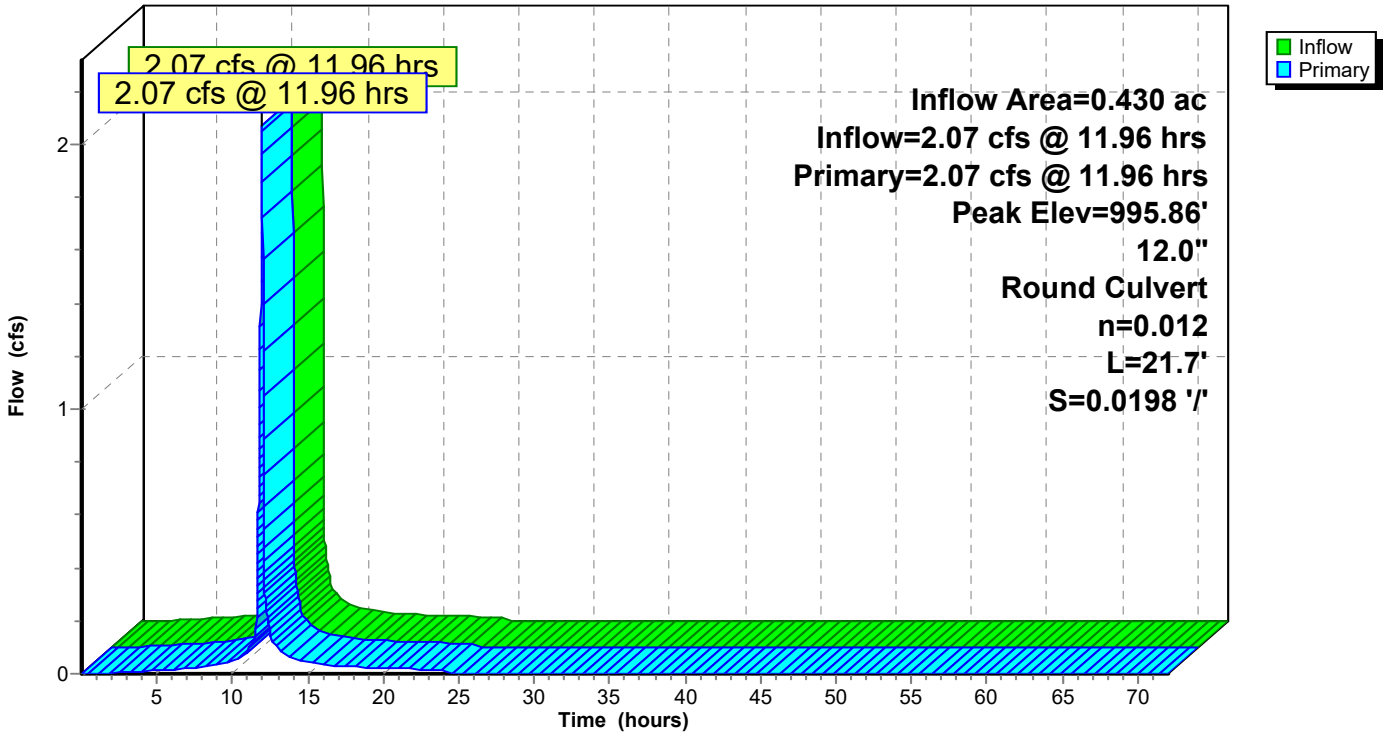


Pond 50P: BASIN REACH



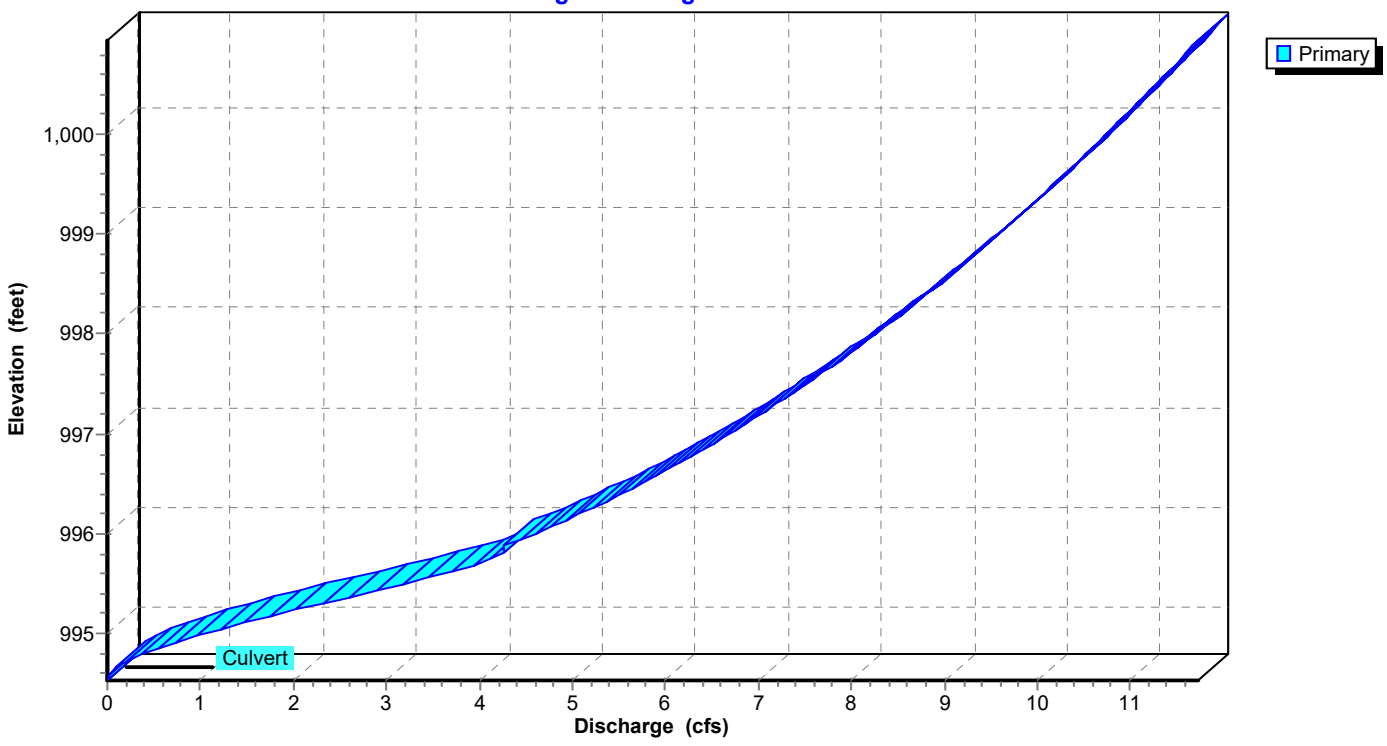
Pond 51P: ROOF DRAINS TO BASIN

Hydrograph

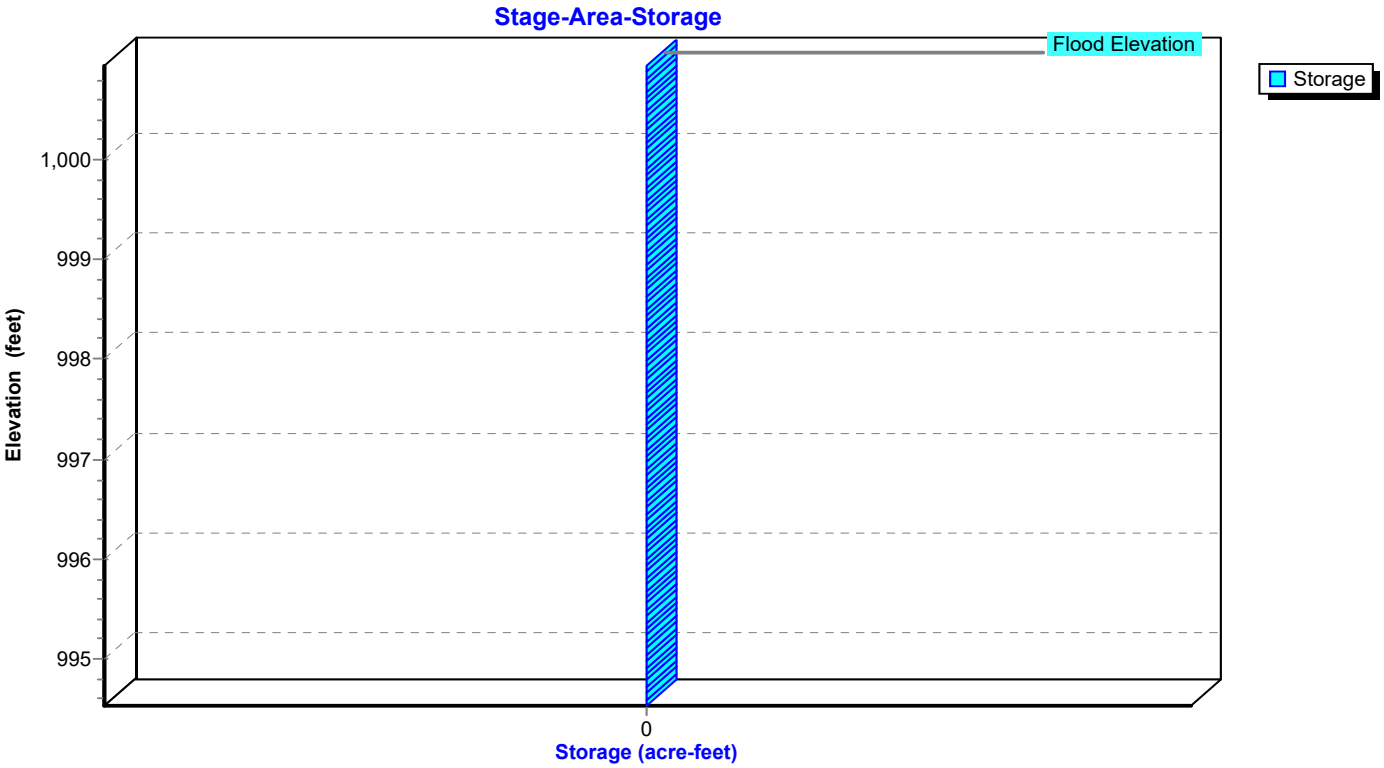


Pond 51P: ROOF DRAINS TO BASIN

Stage-Discharge

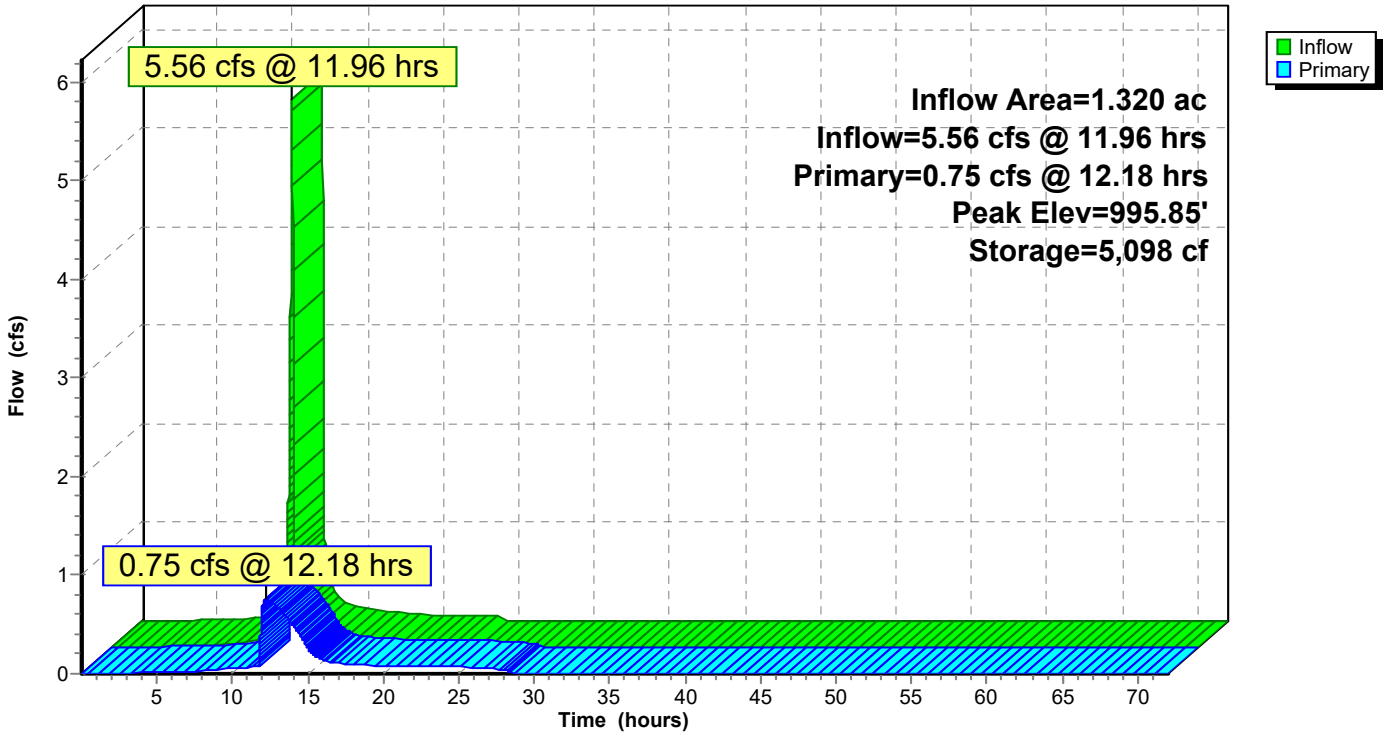


Pond 51P: ROOF DRAINS TO BASIN



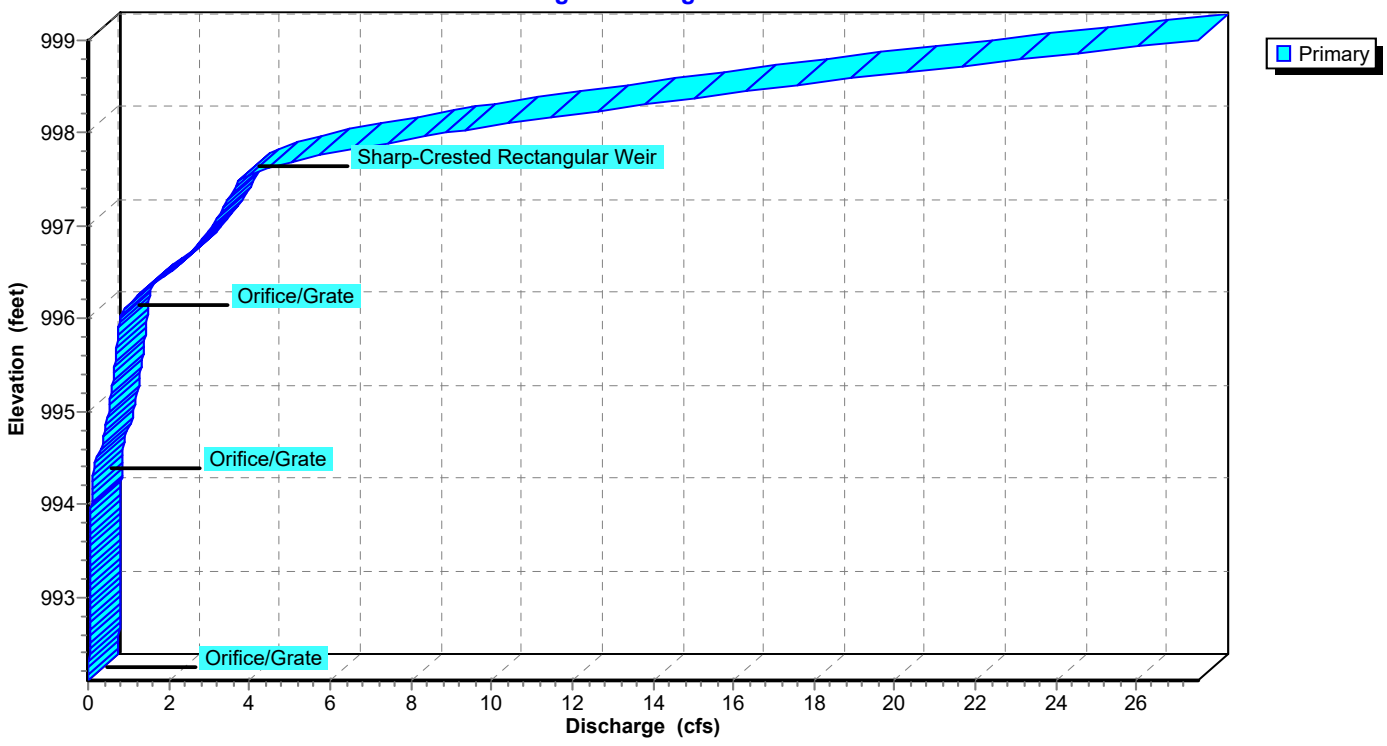
Pond 52P: DETENTION BASIN

Hydrograph

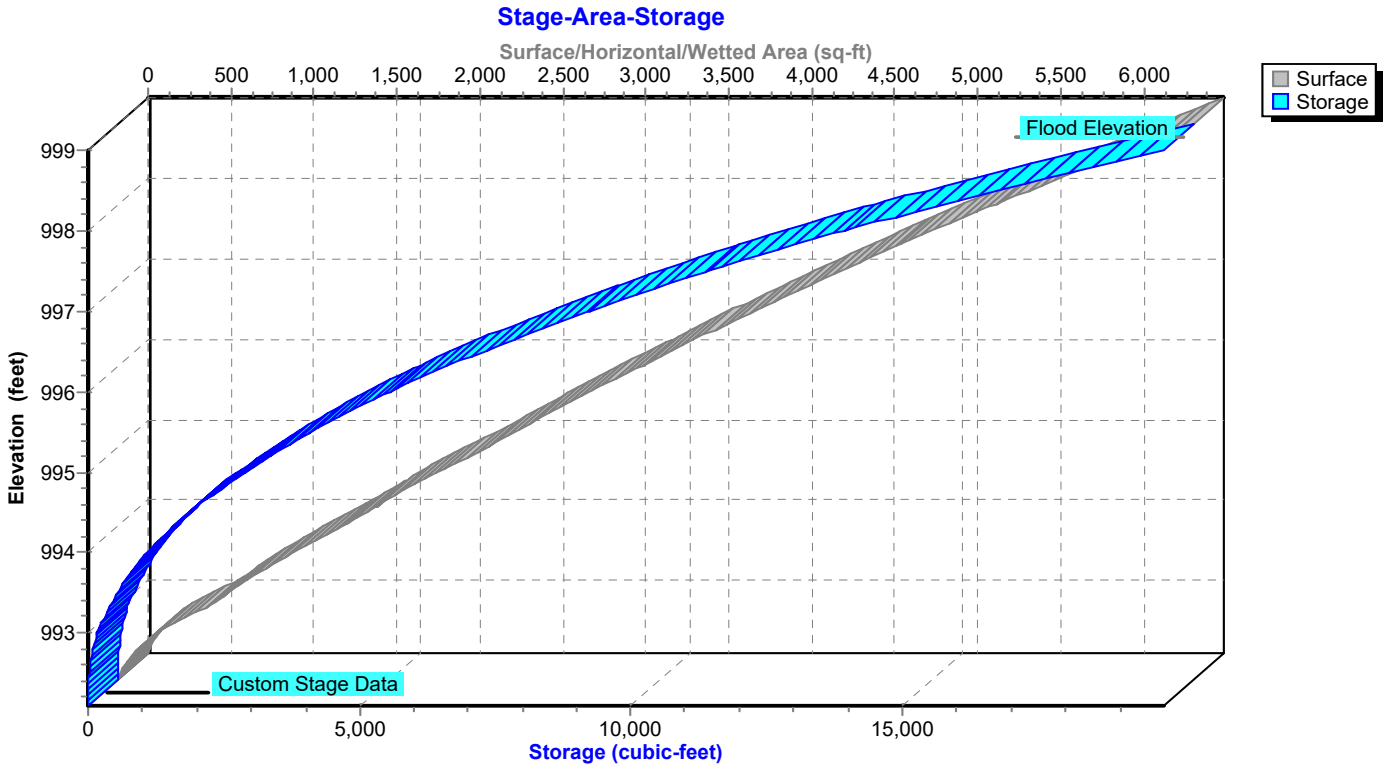


Pond 52P: DETENTION BASIN

Stage-Discharge

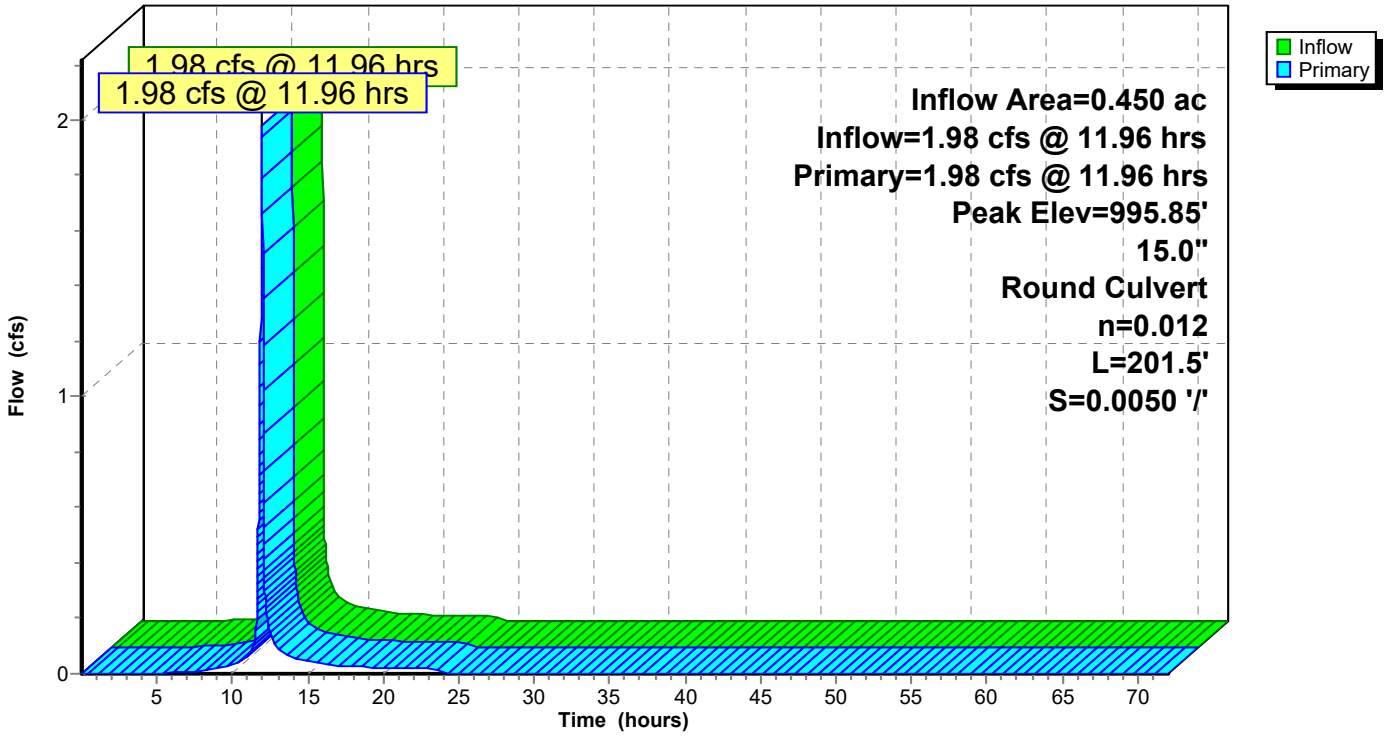


Pond 52P: DETENTION BASIN



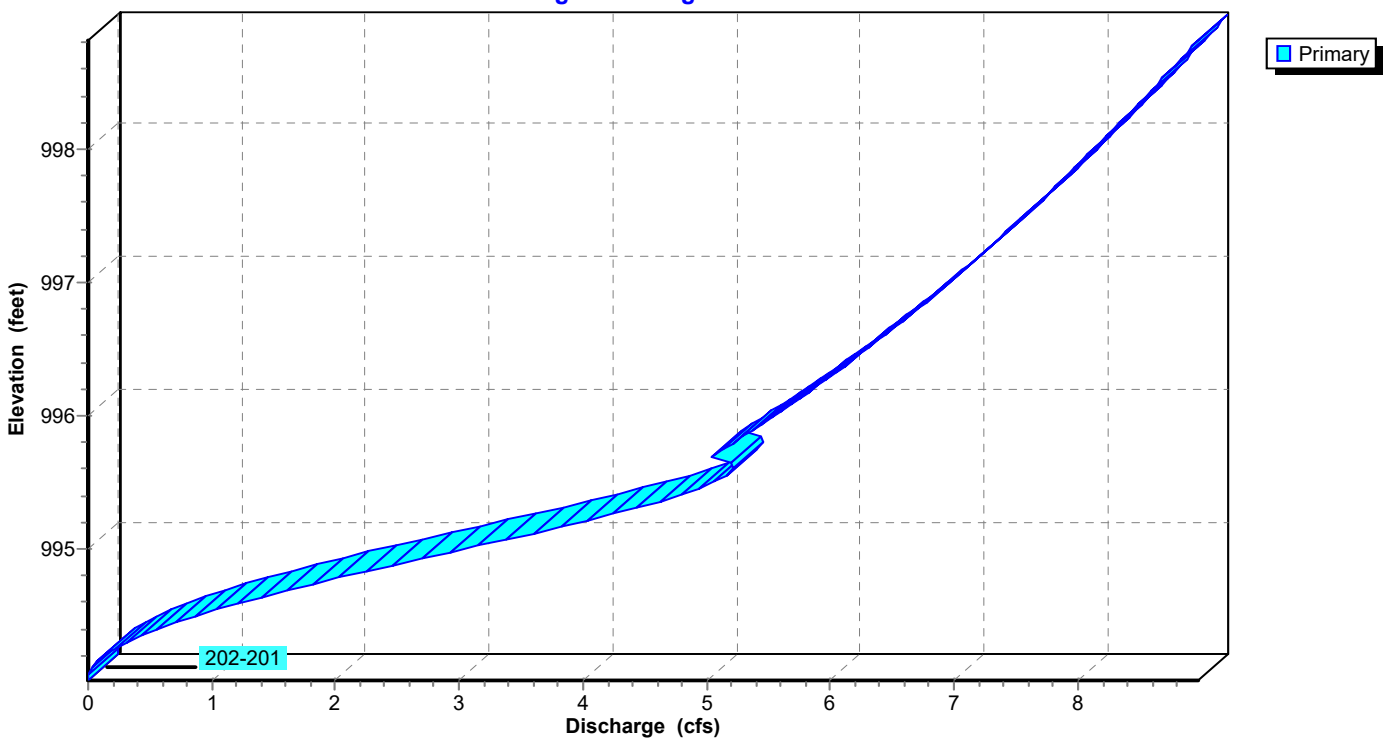
Pond 53P: 301-300

Hydrograph

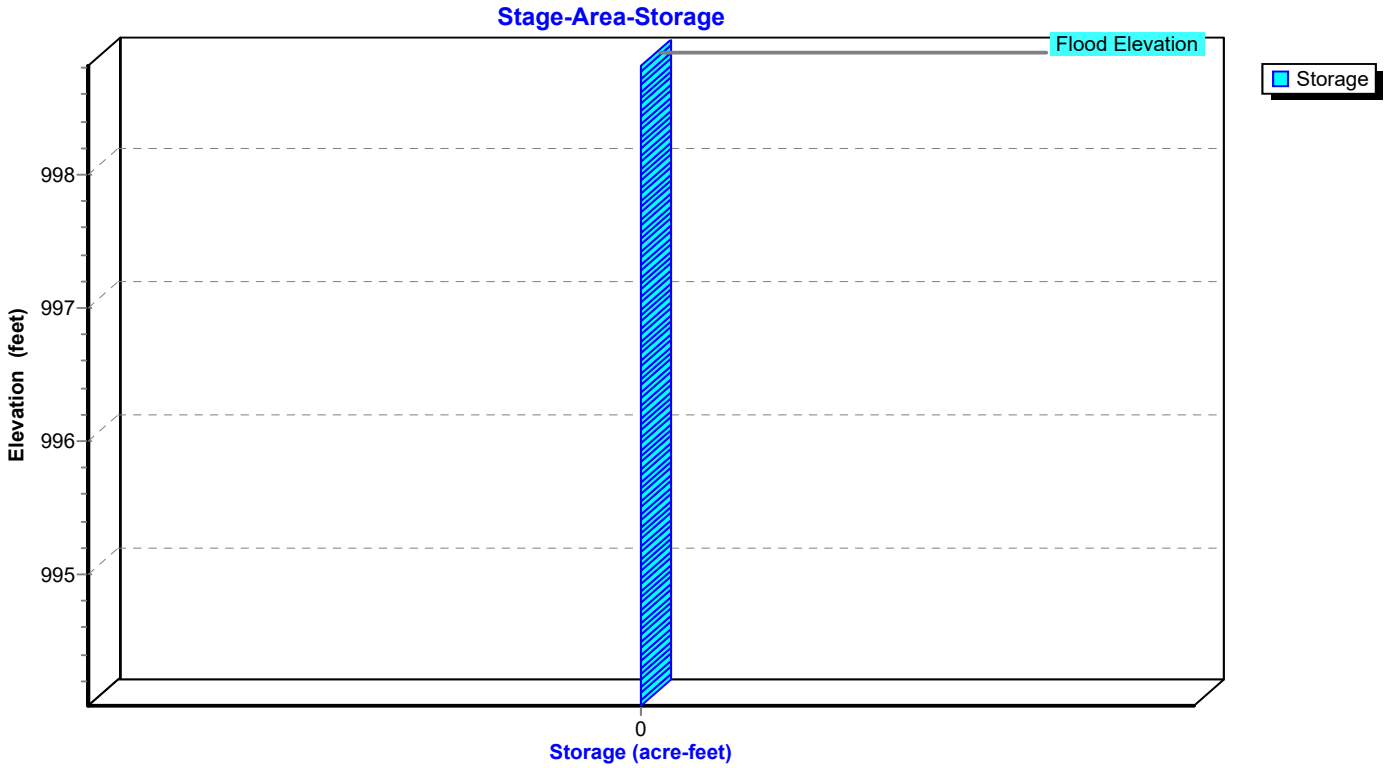


Pond 53P: 301-300

Stage-Discharge

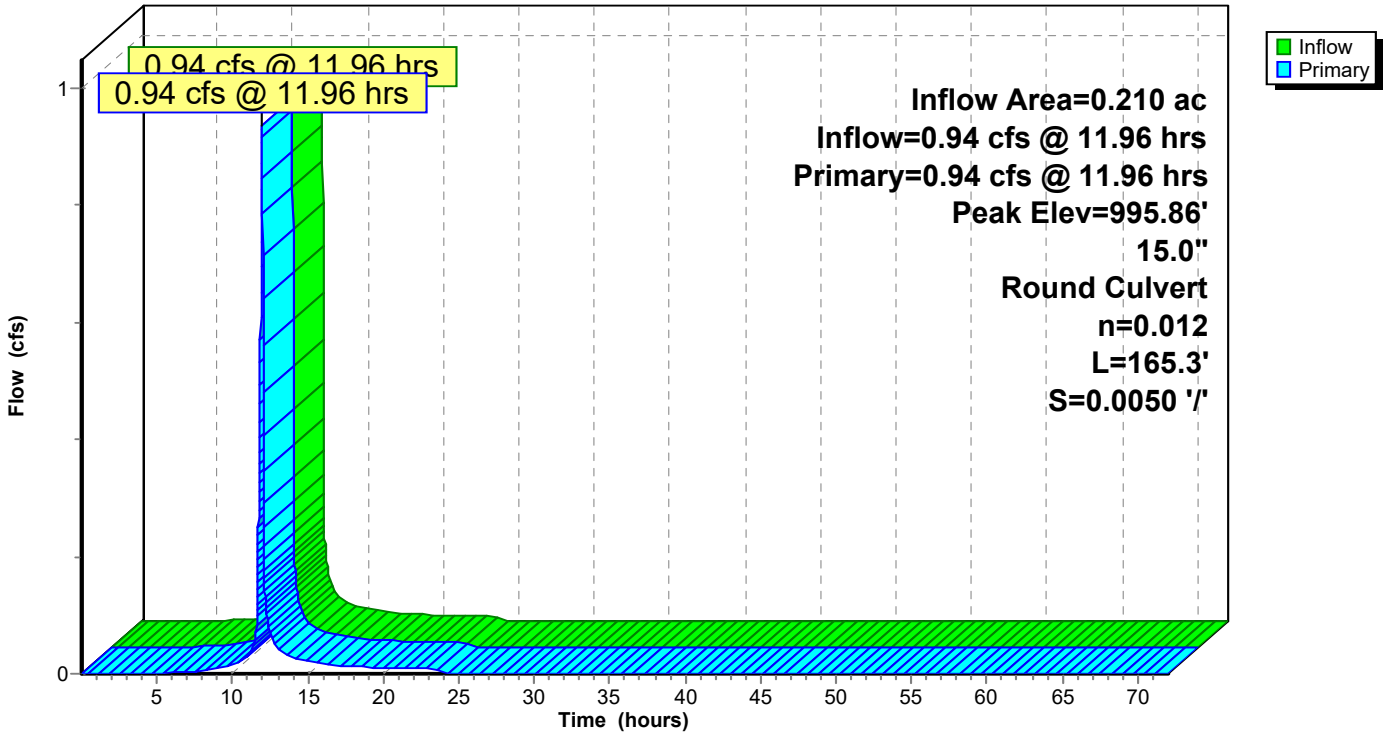


Pond 53P: 301-300



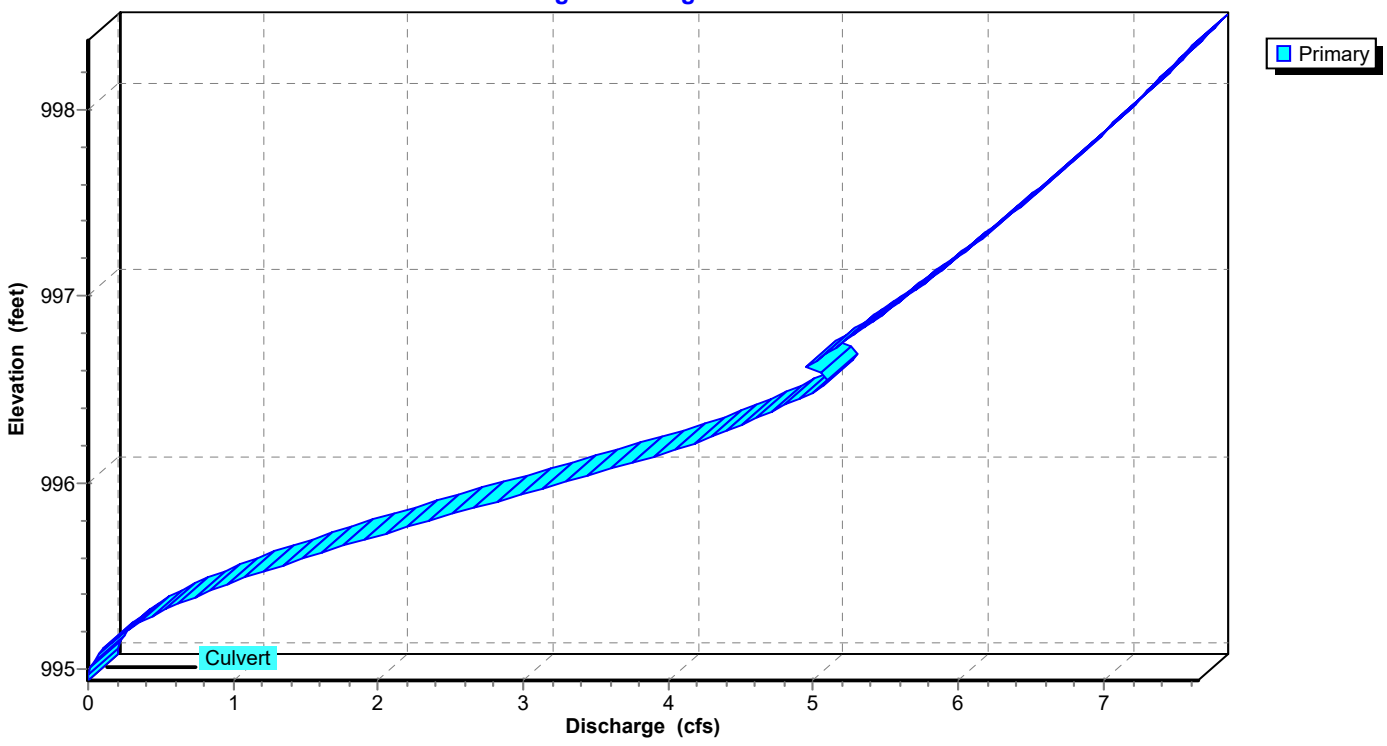
Pond 54P: 302-301

Hydrograph

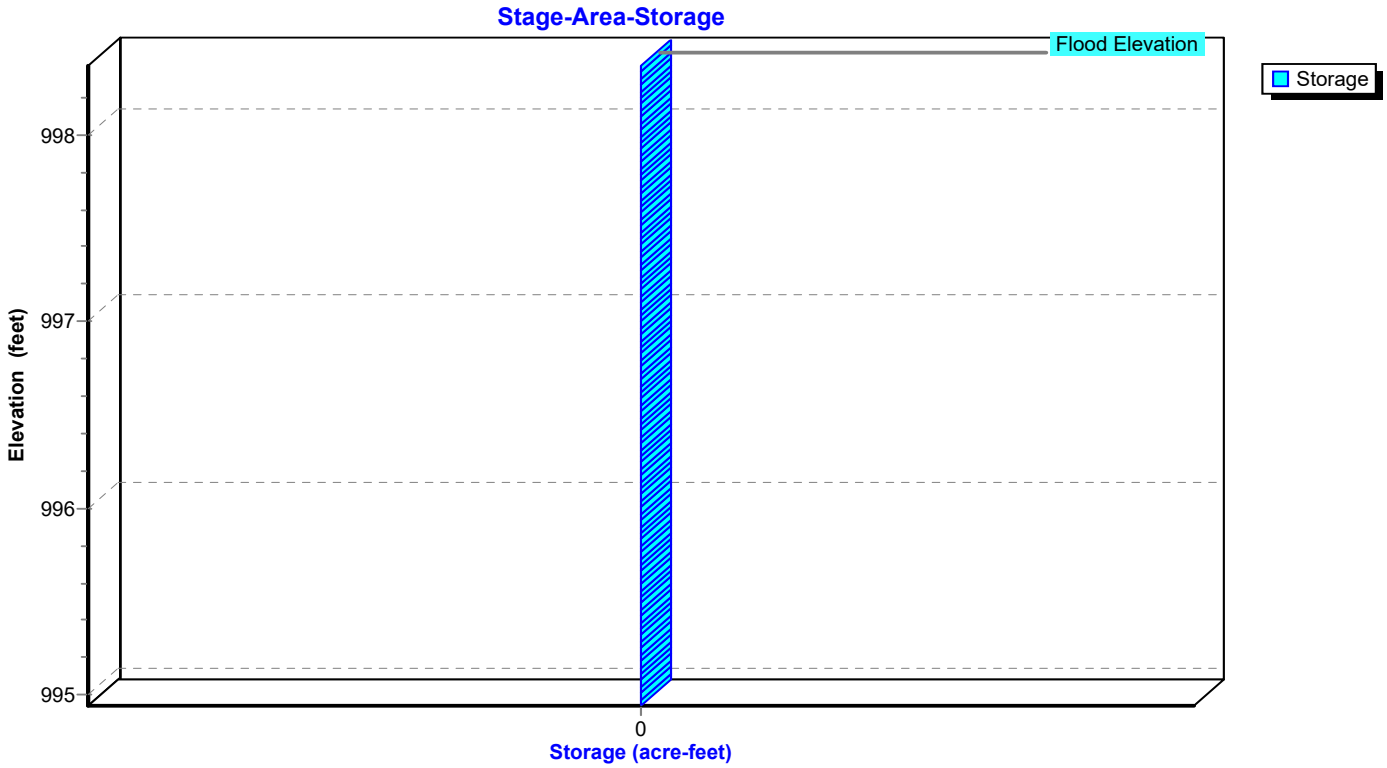


Pond 54P: 302-301

Stage-Discharge

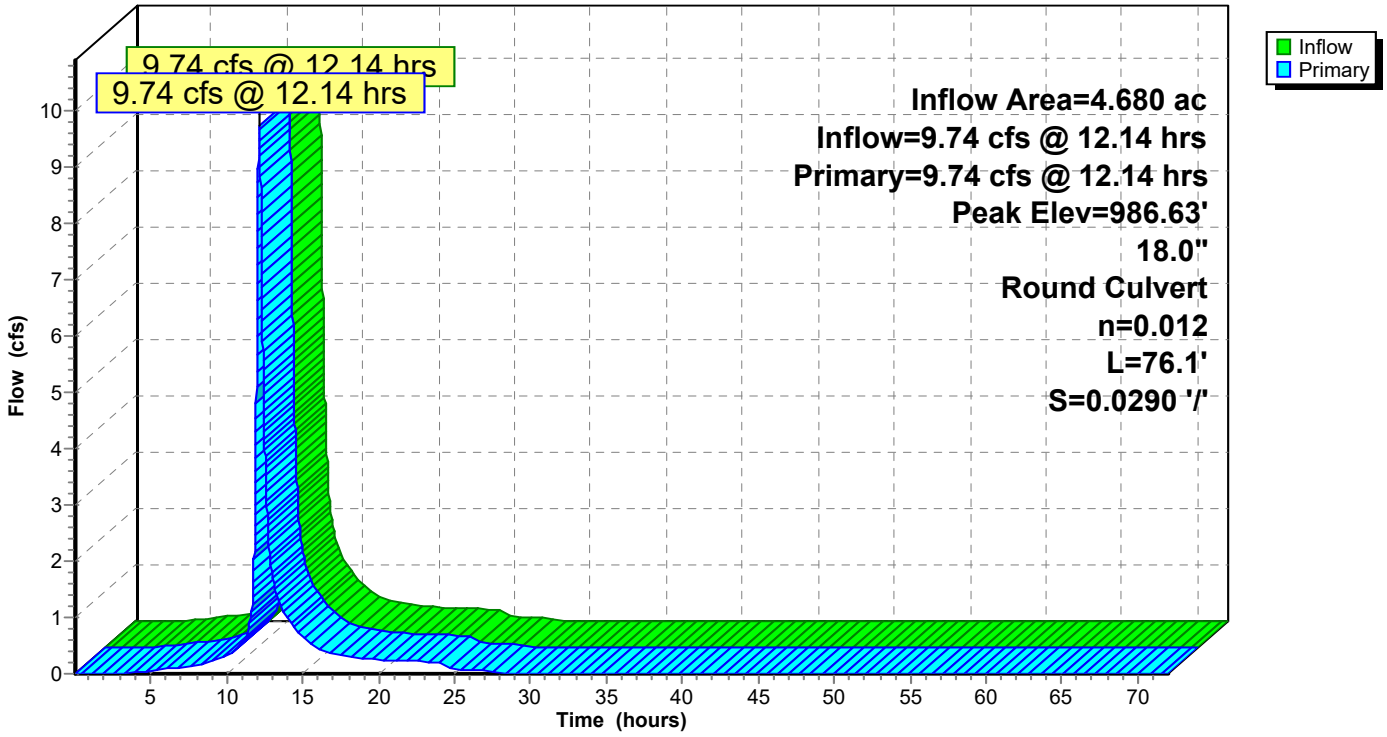


Pond 54P: 302-301



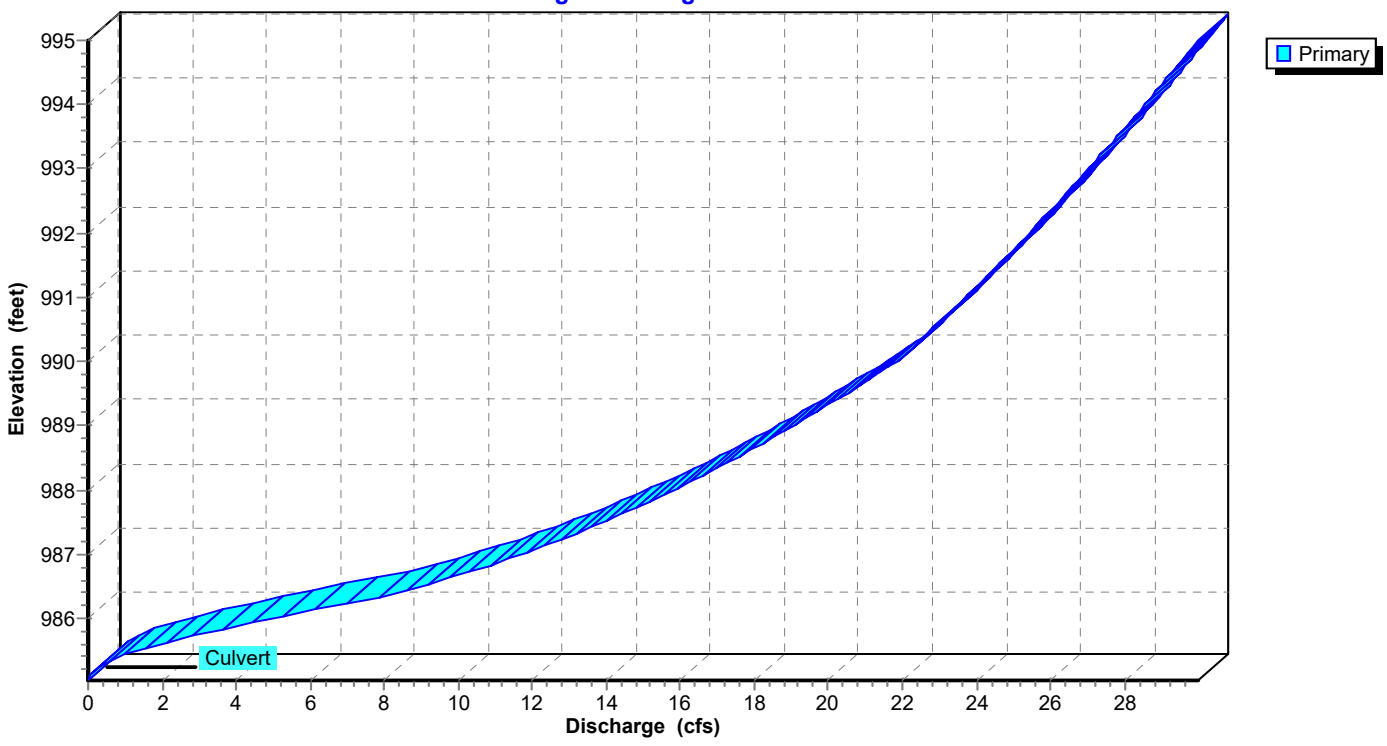
Pond 55P: 11-10

Hydrograph

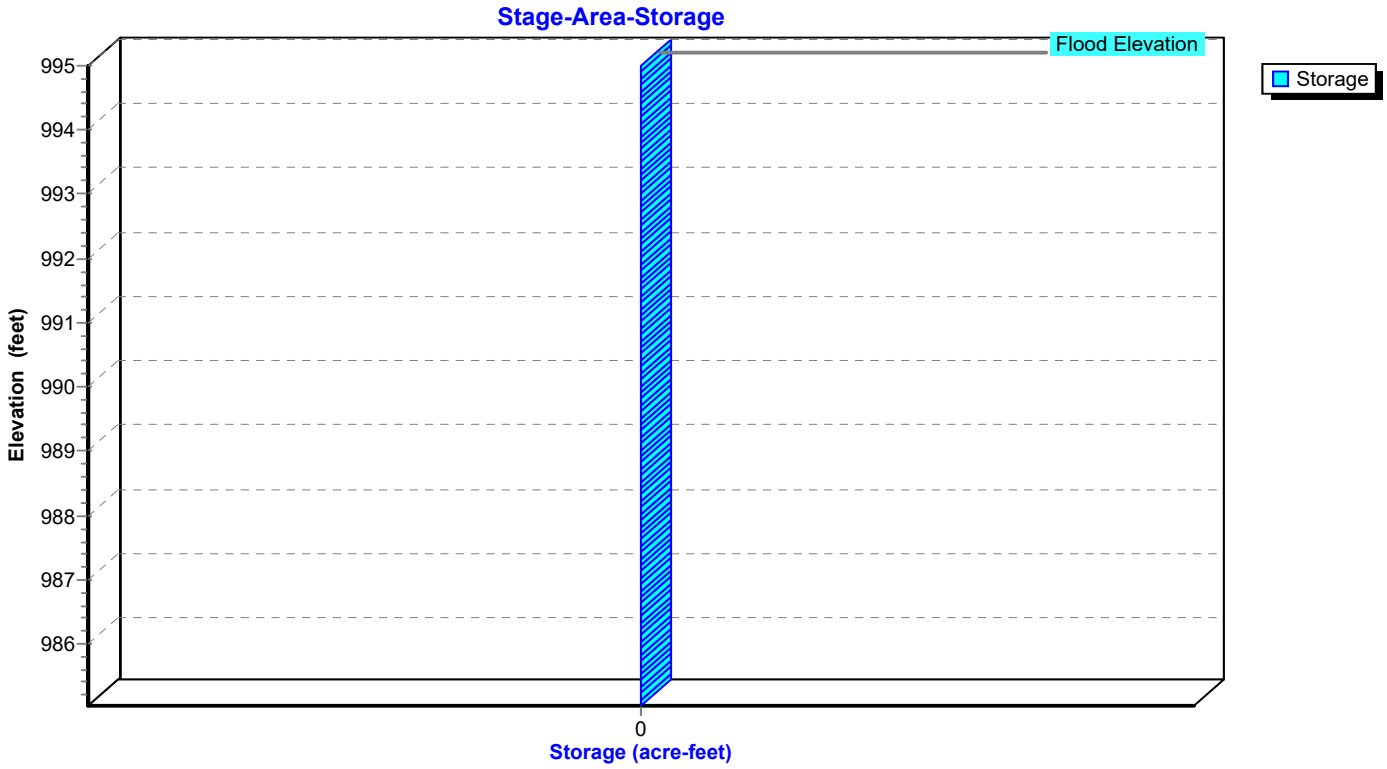


Pond 55P: 11-10

Stage-Discharge

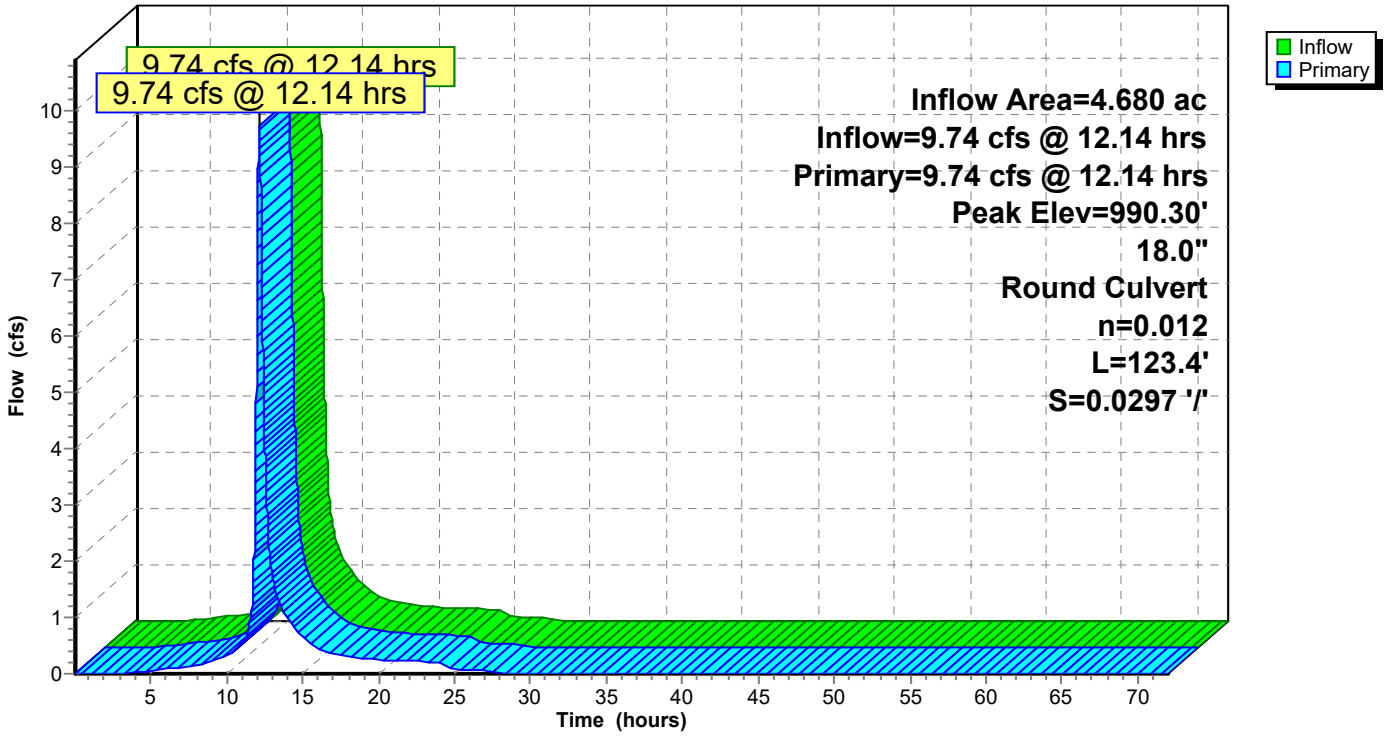


Pond 55P: 11-10



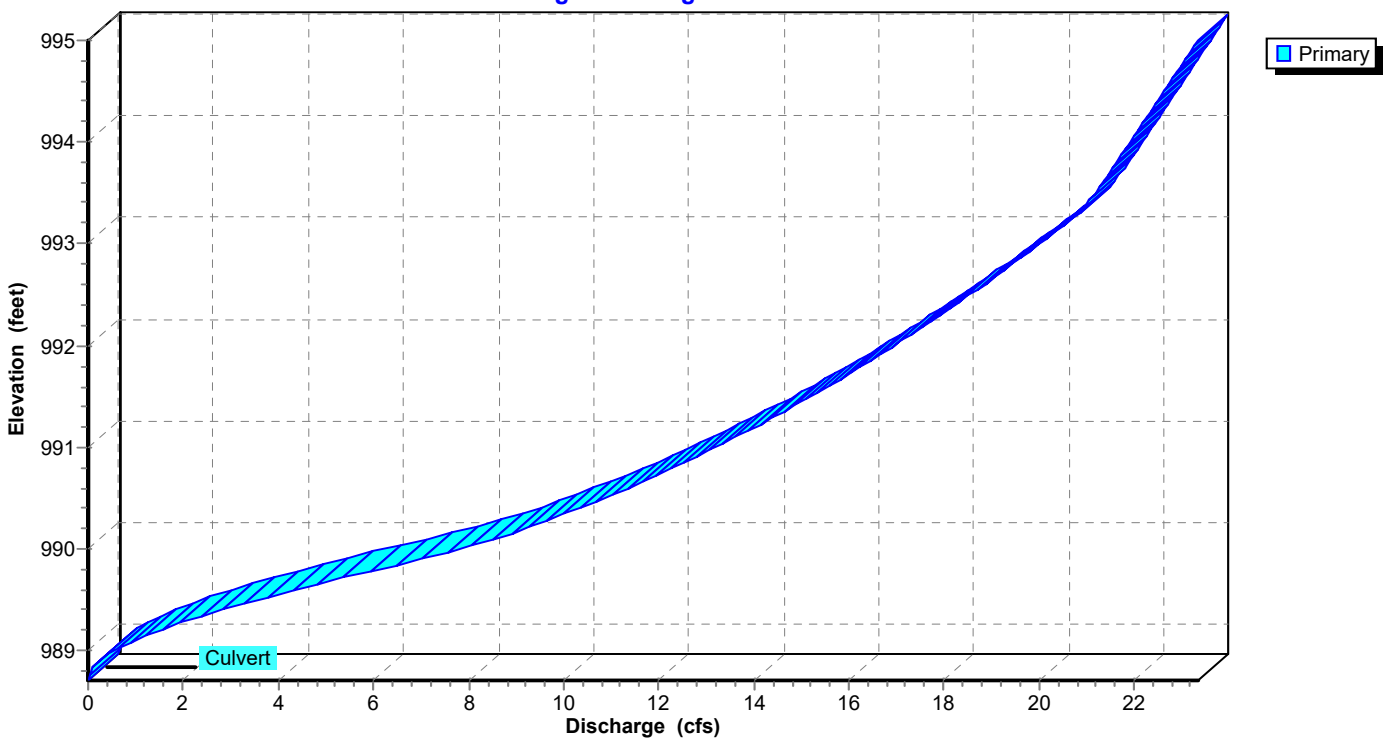
Pond 56P: 11 - 100 MH

Hydrograph

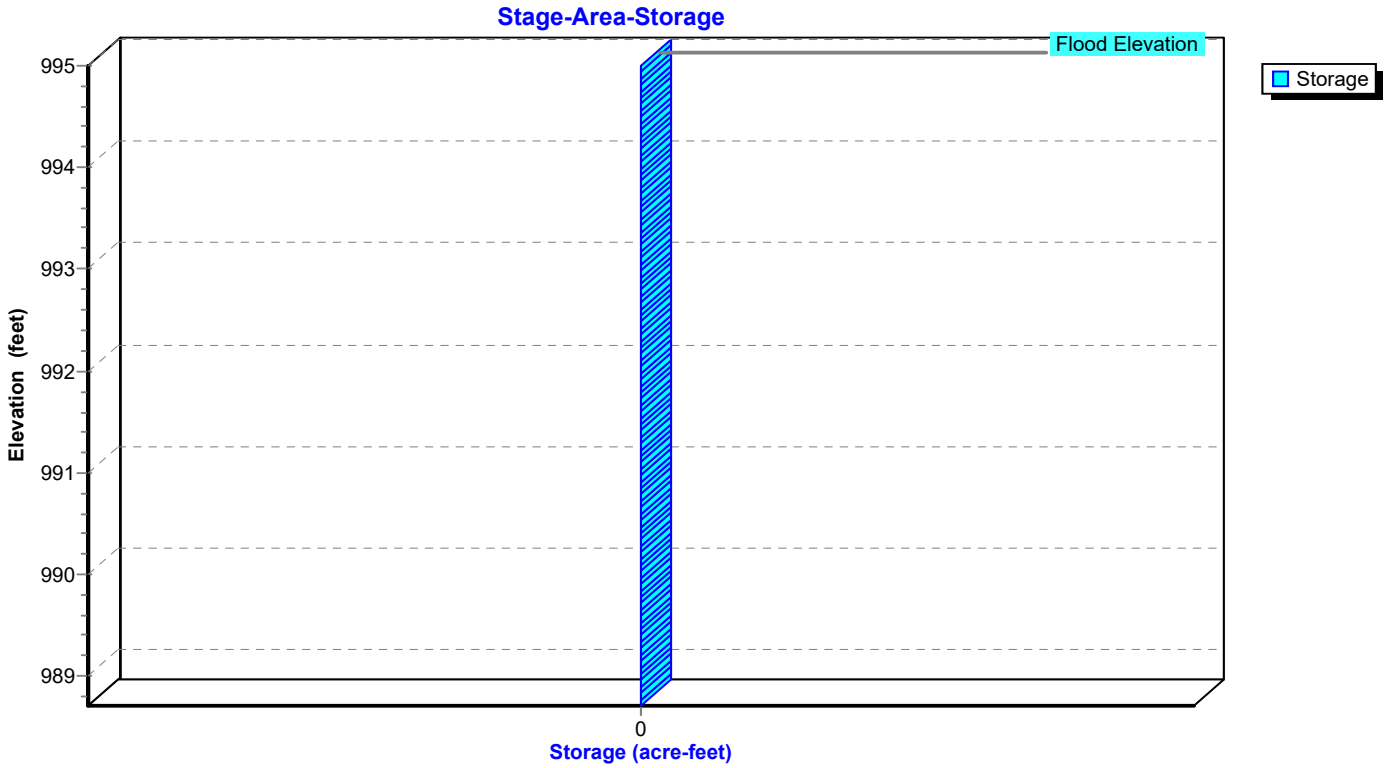


Pond 56P: 11 - 100 MH

Stage-Discharge

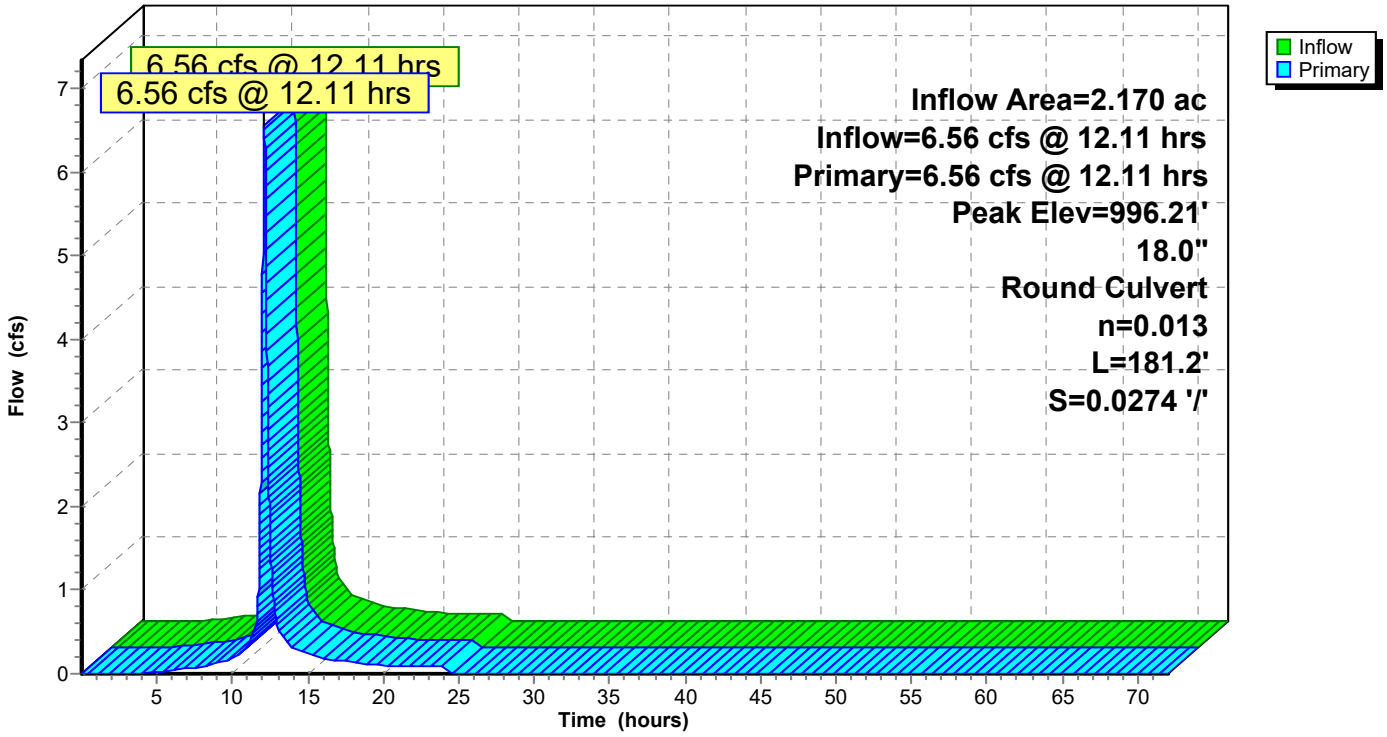


Pond 56P: 11 - 100 MH



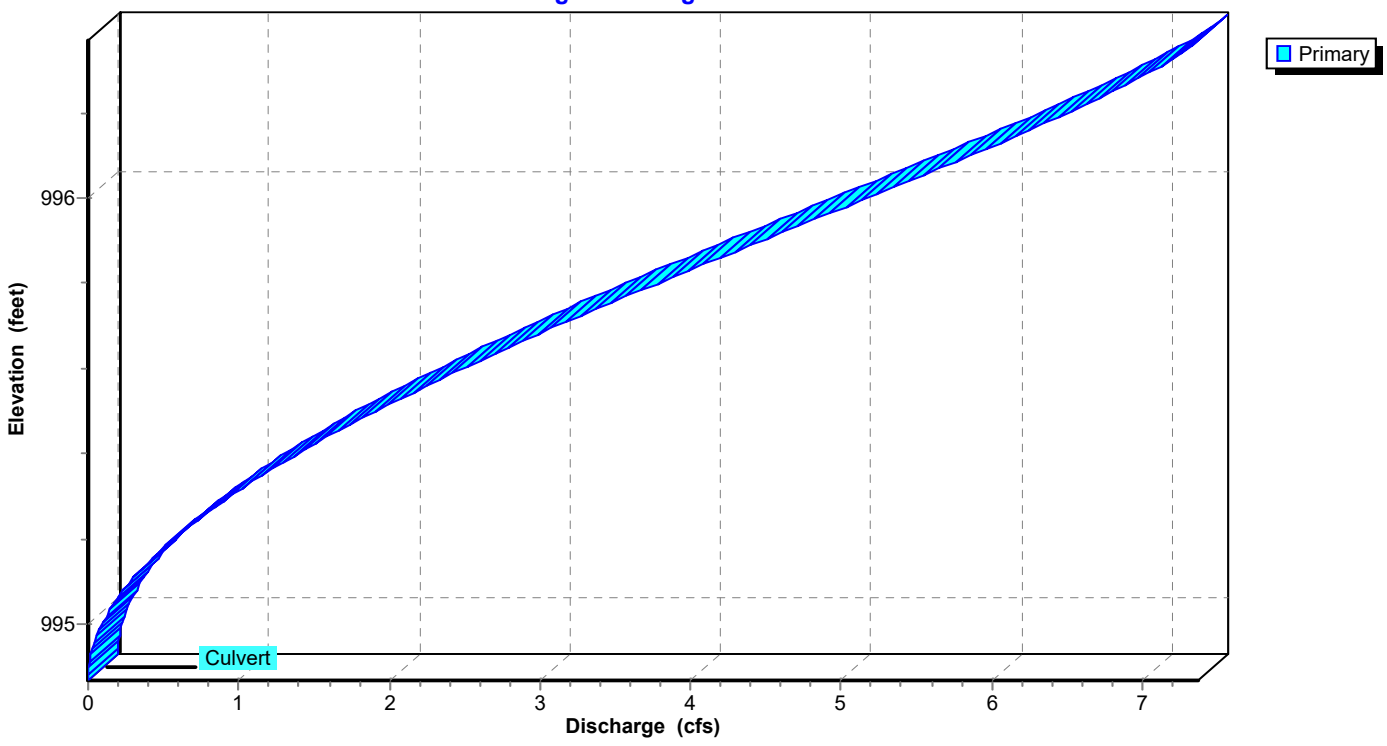
Pond 57P: 12-11

Hydrograph

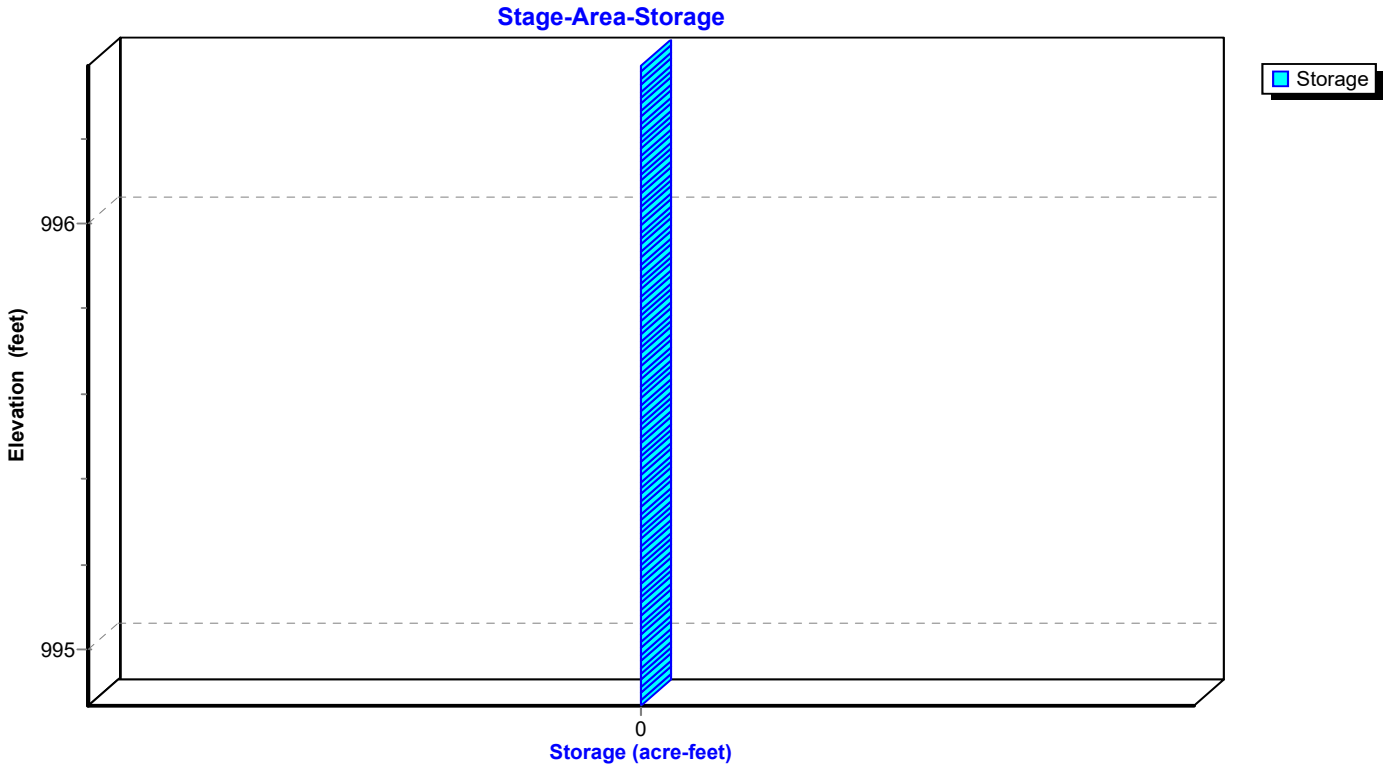


Pond 57P: 12-11

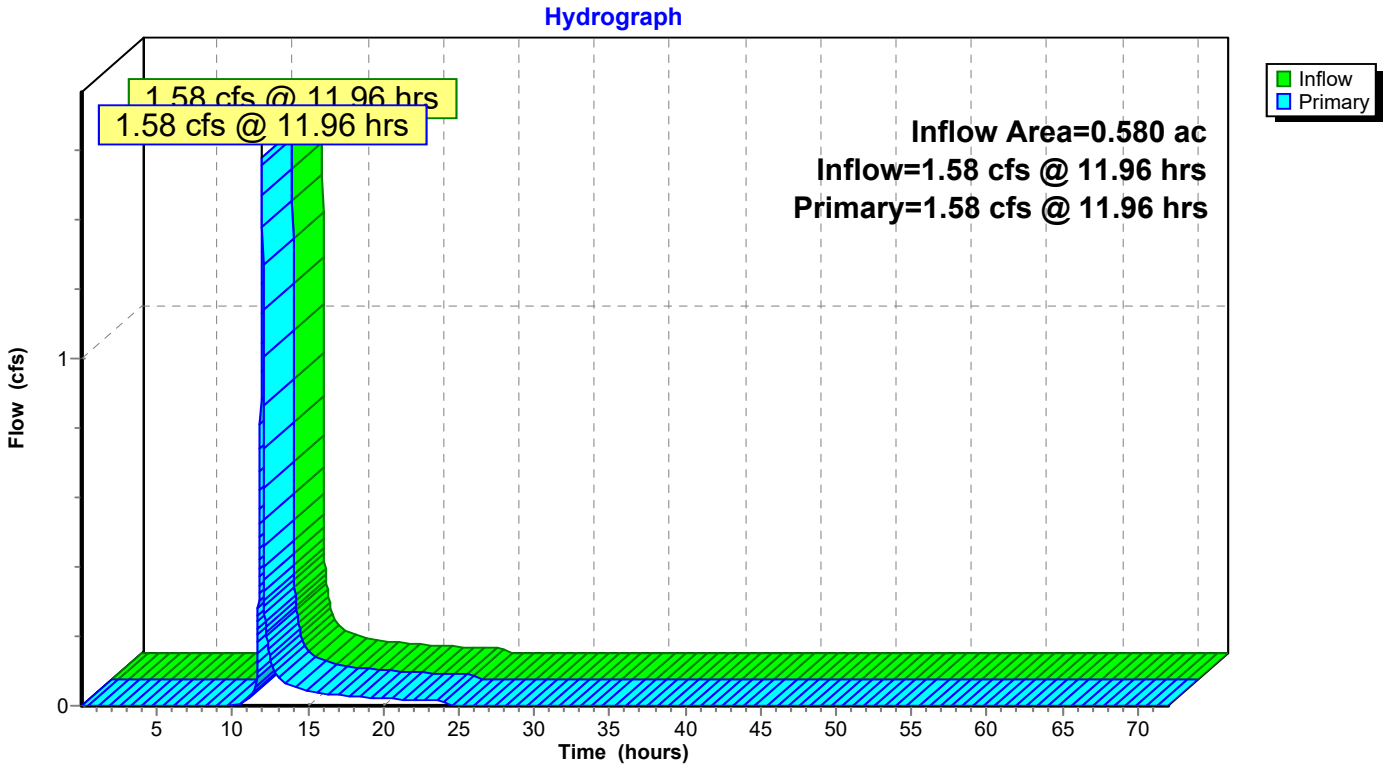
Stage-Discharge



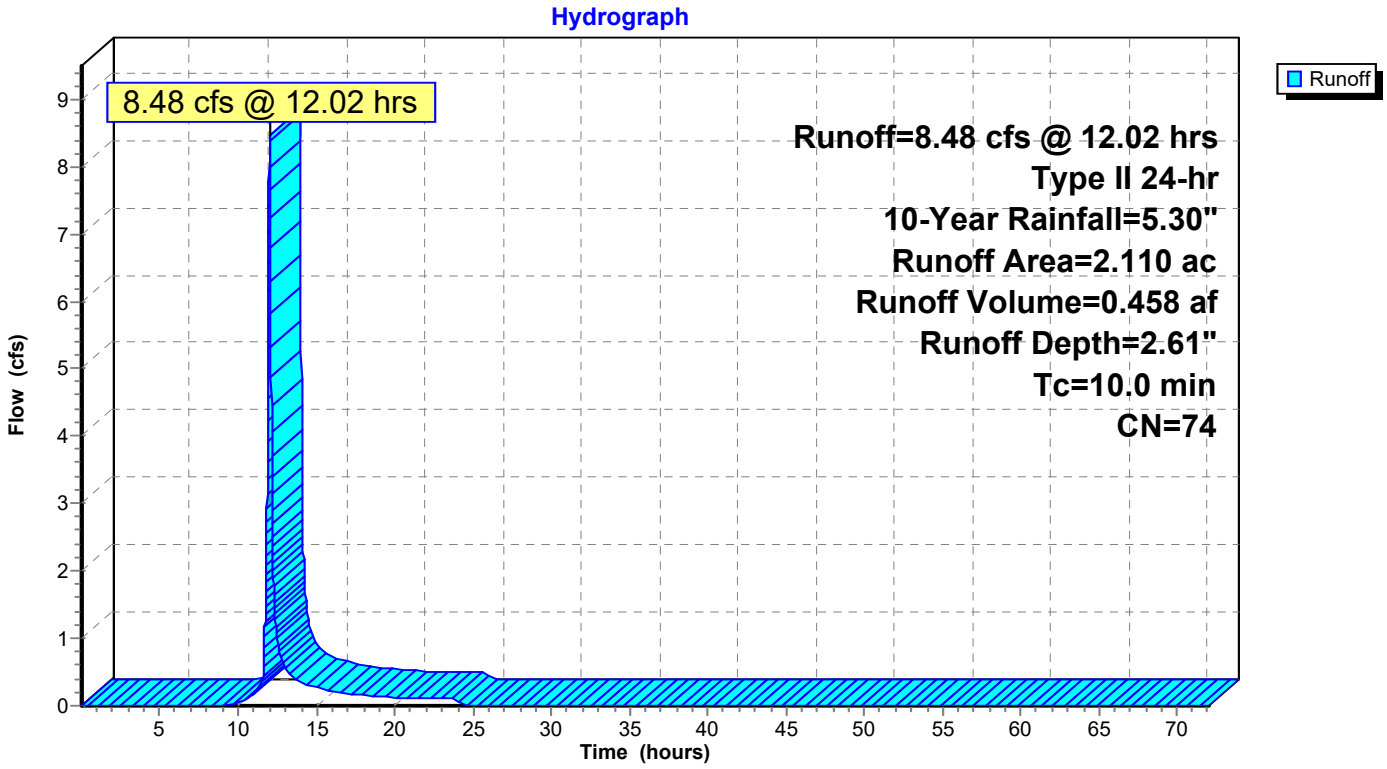
Pond 57P: 12-11



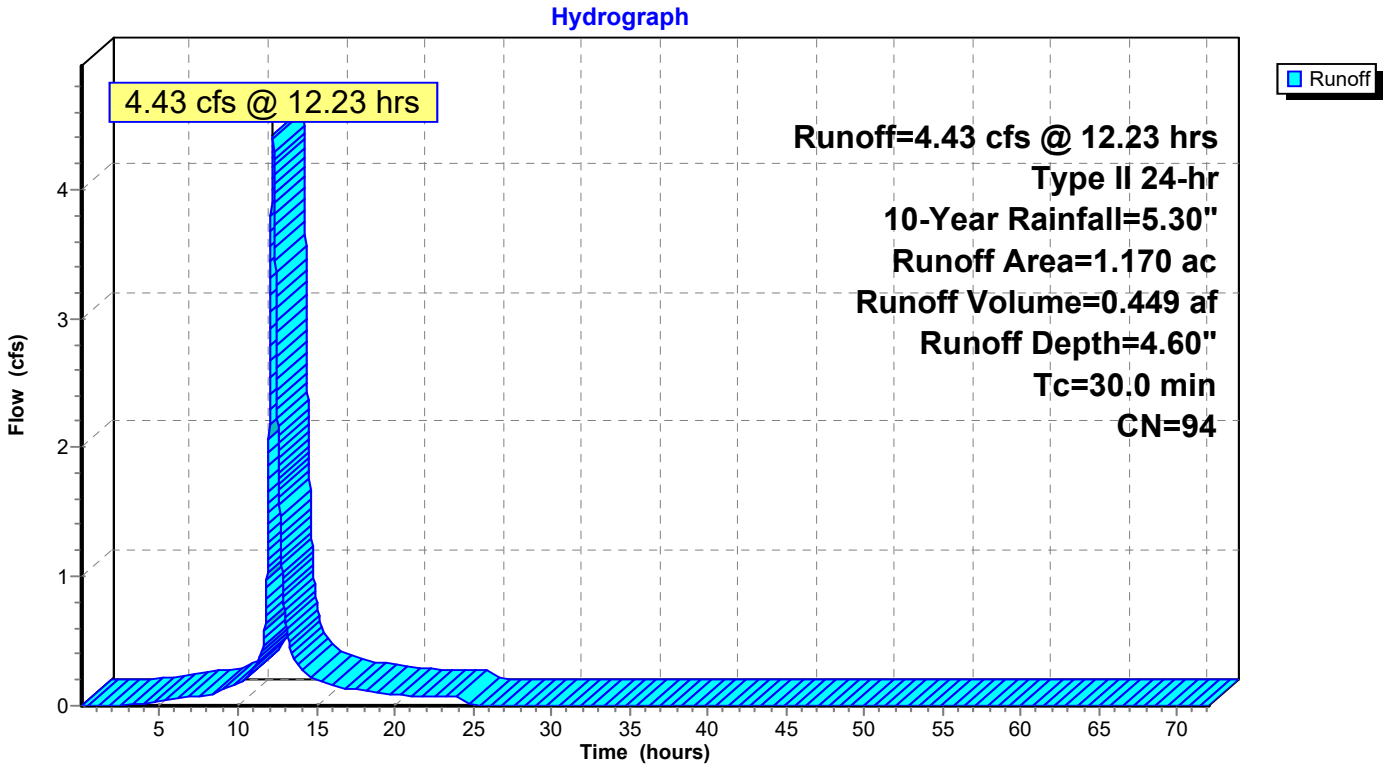
Link 90L: BYPASS AREAS



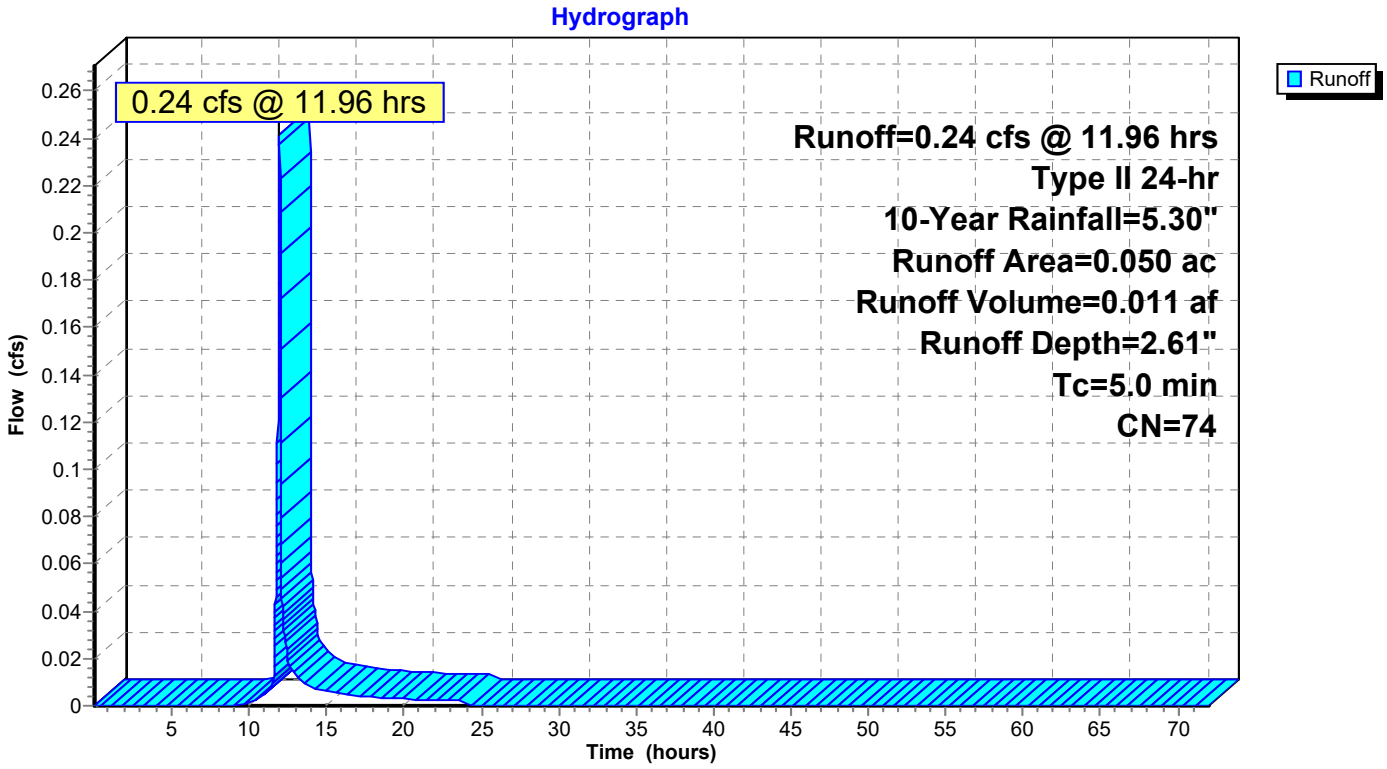
Subcatchment 1S: EXISTING CONDITIONS



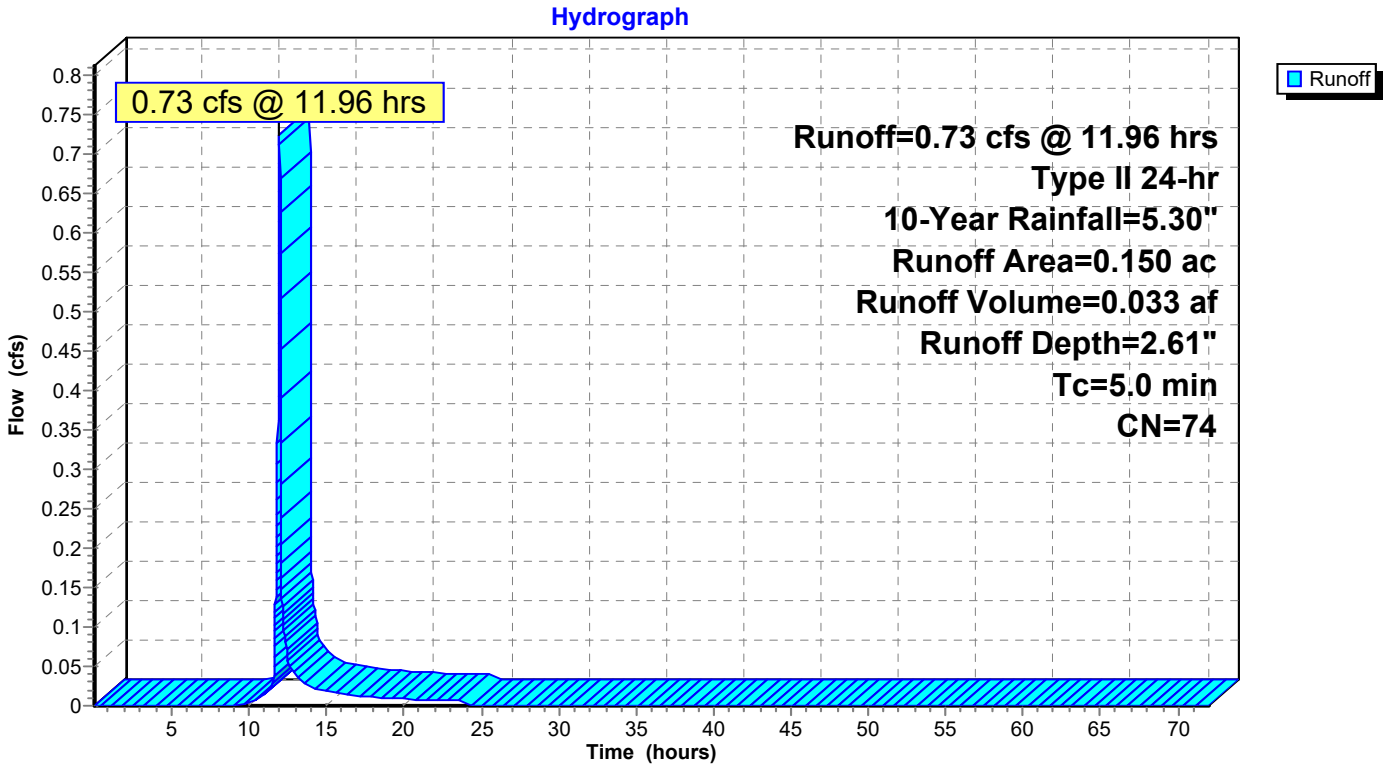
Subcatchment 2S: AREA A



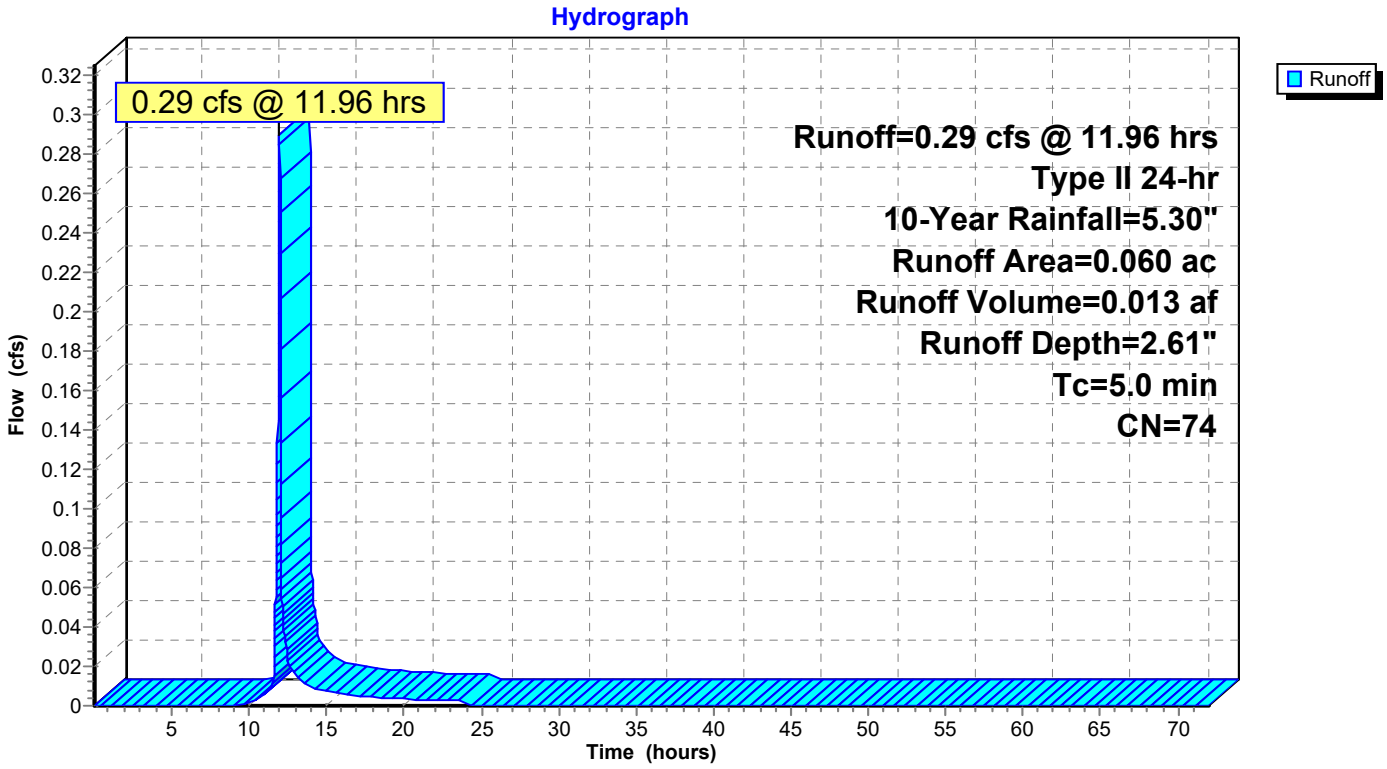
Subcatchment 3S: AREA B



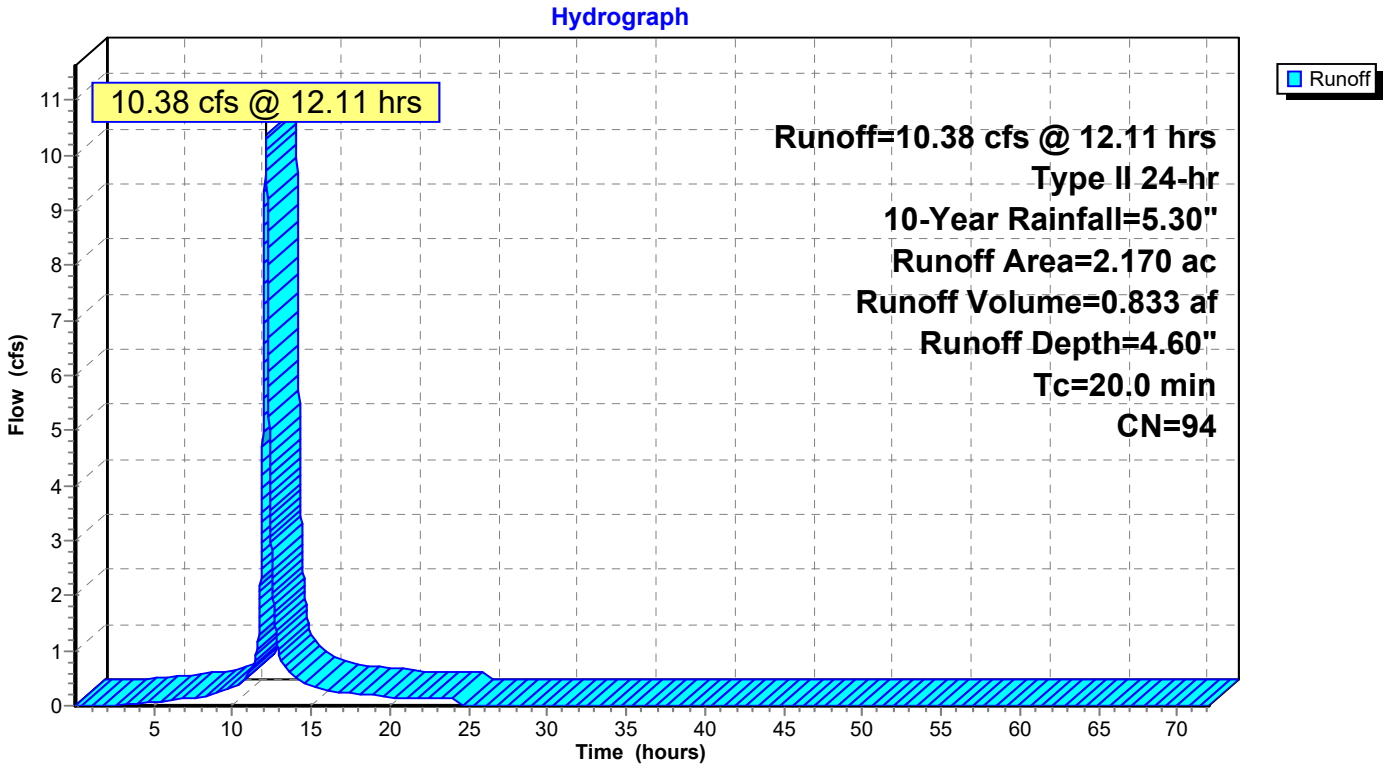
Subcatchment 4S: AREA C



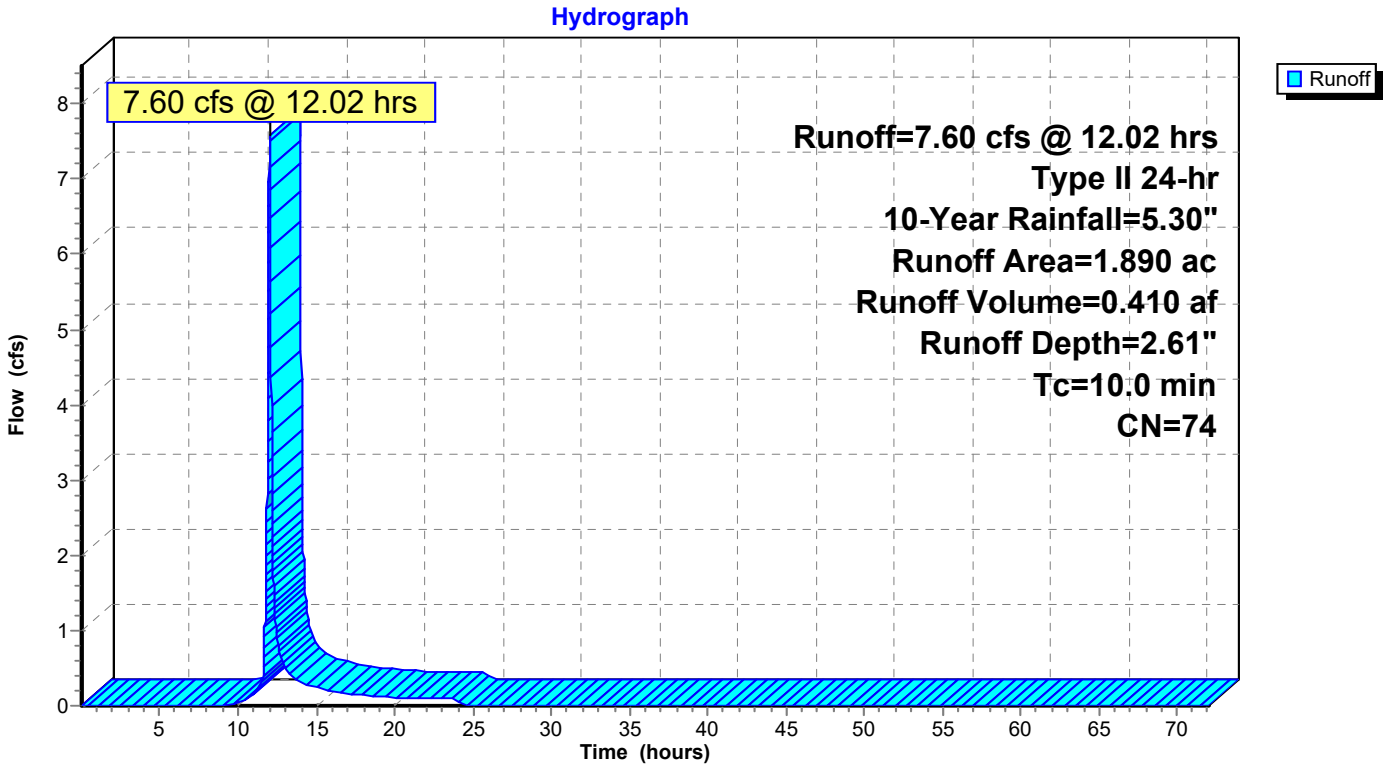
Subcatchment 5S: AREA D



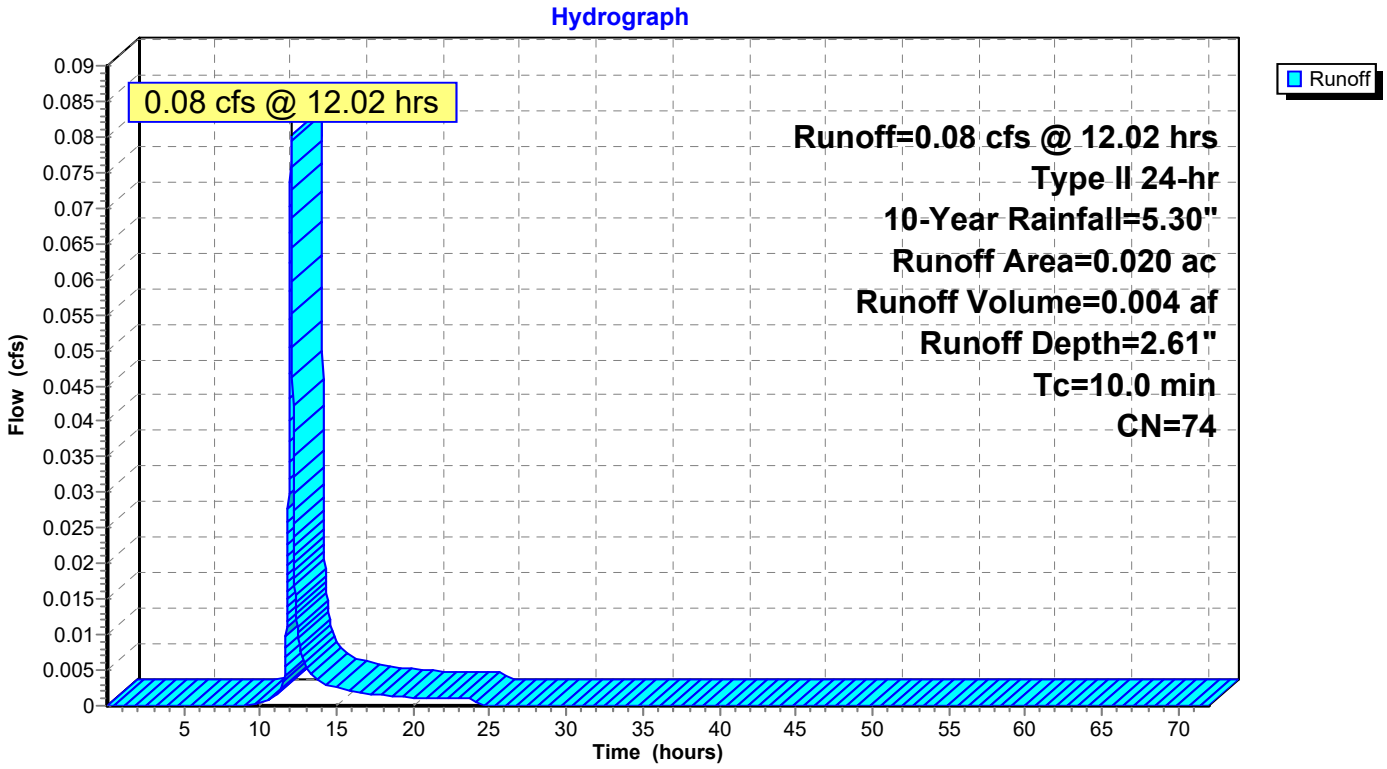
Subcatchment 6S: AREA E



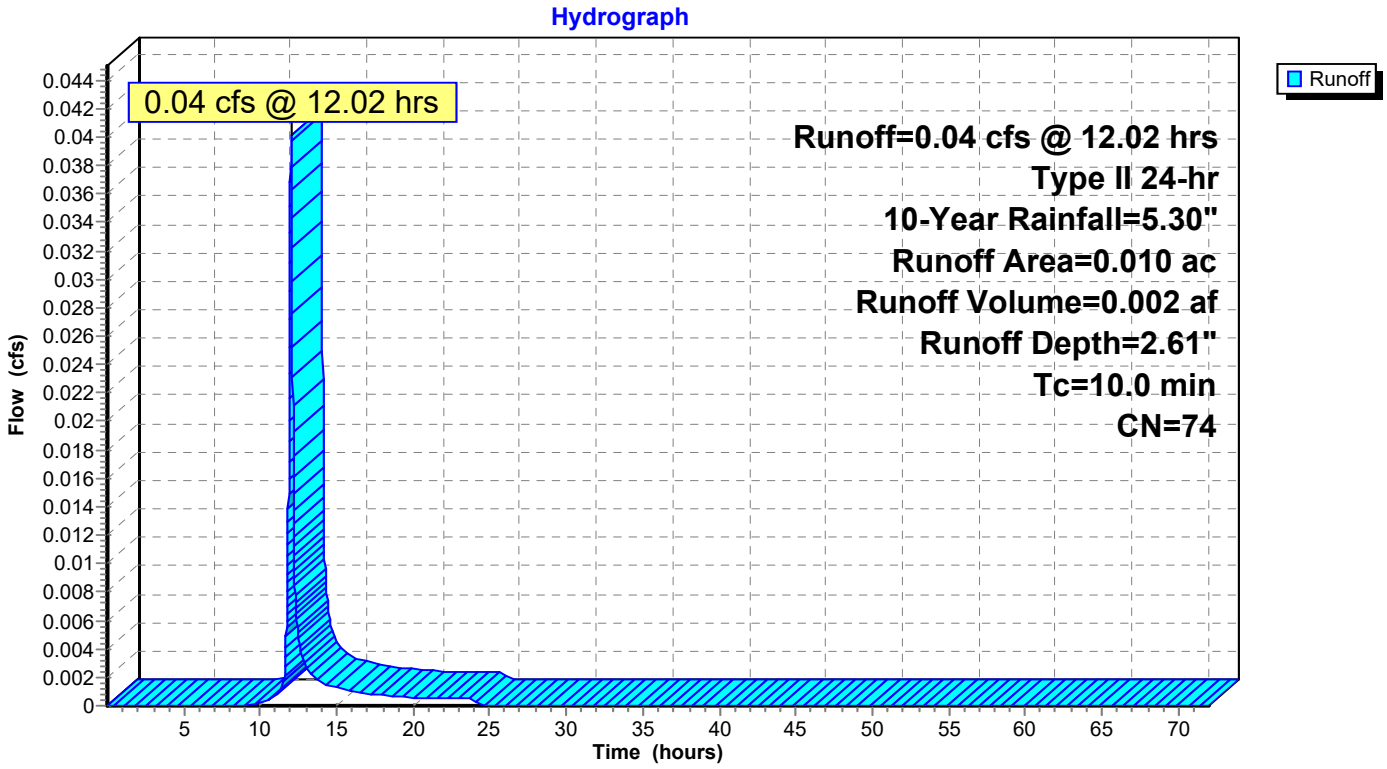
Subcatchment 7S: AREA F



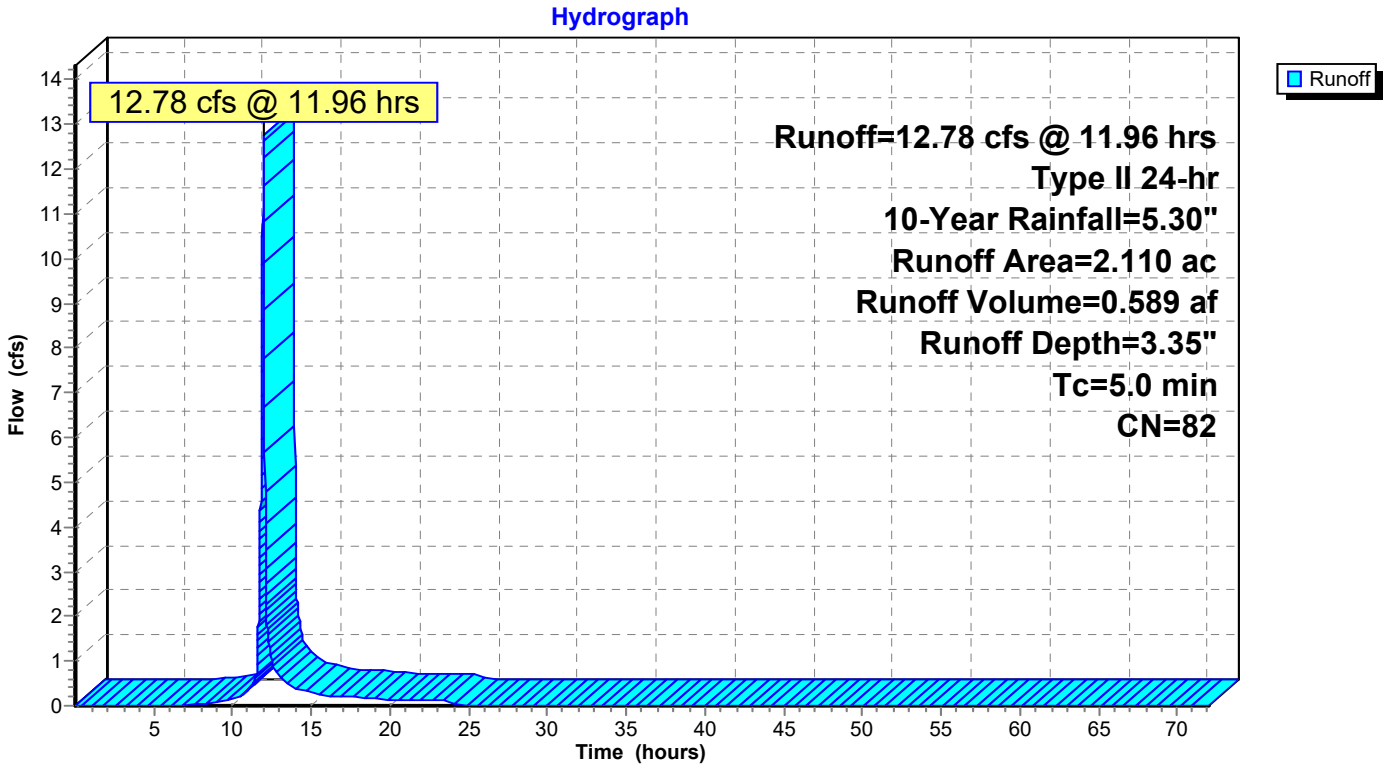
Subcatchment 8S: AREA G



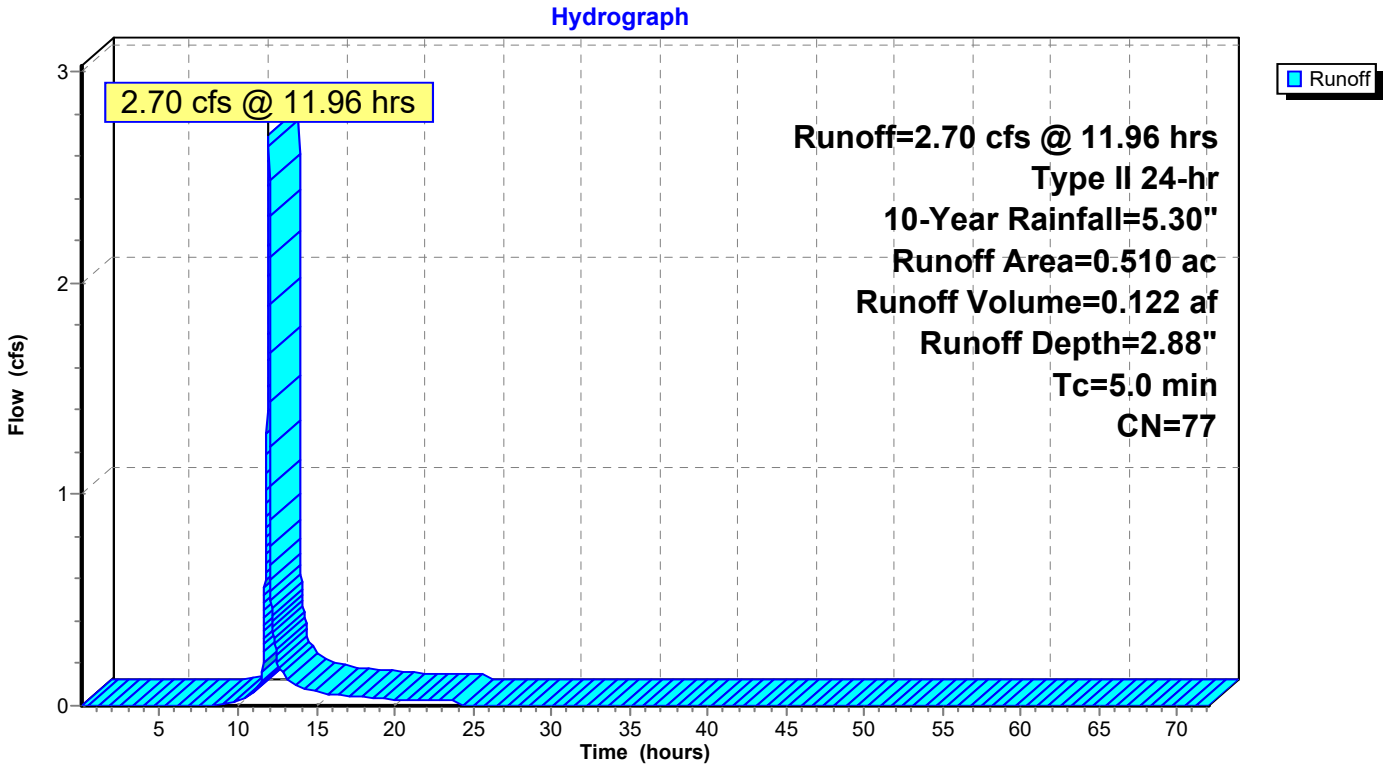
Subcatchment 9S: AREA H



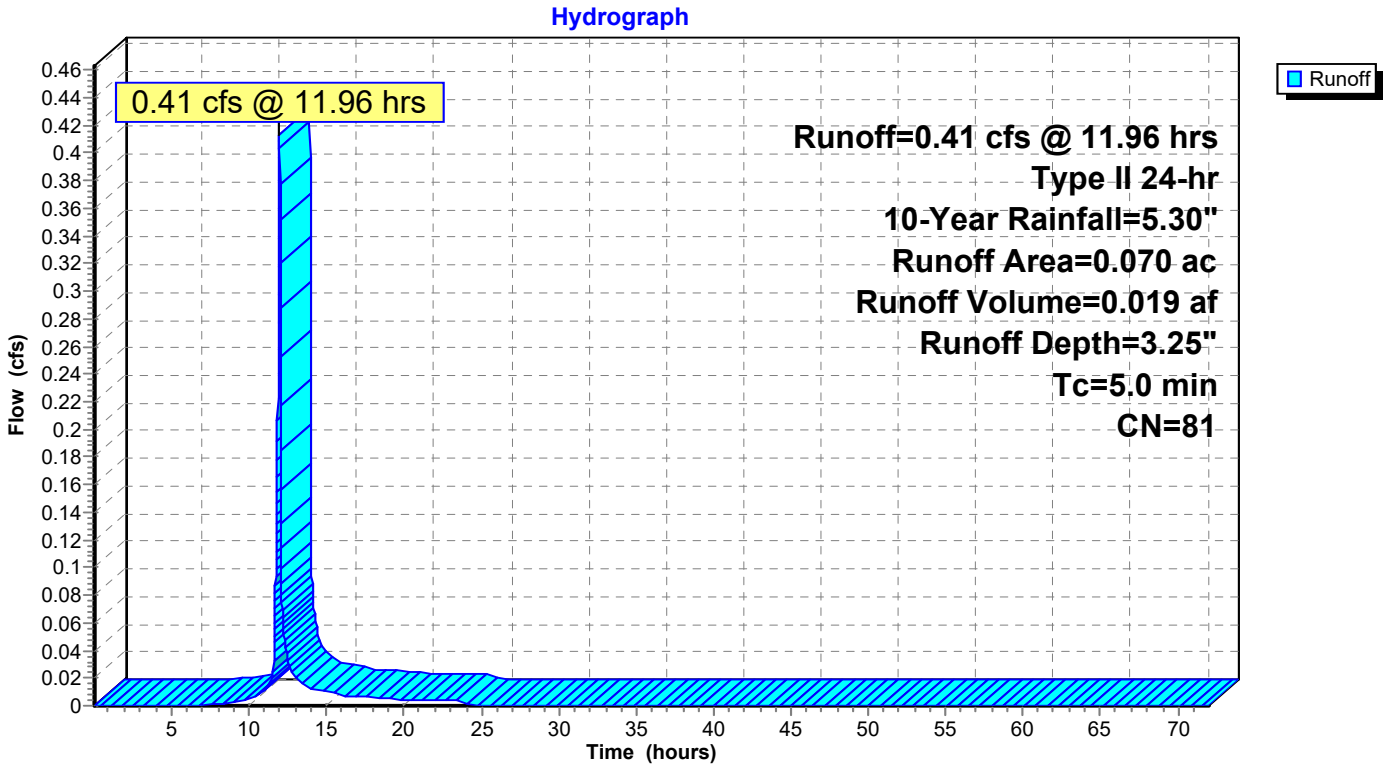
Subcatchment 10S: PROPOSED CONDITIONS



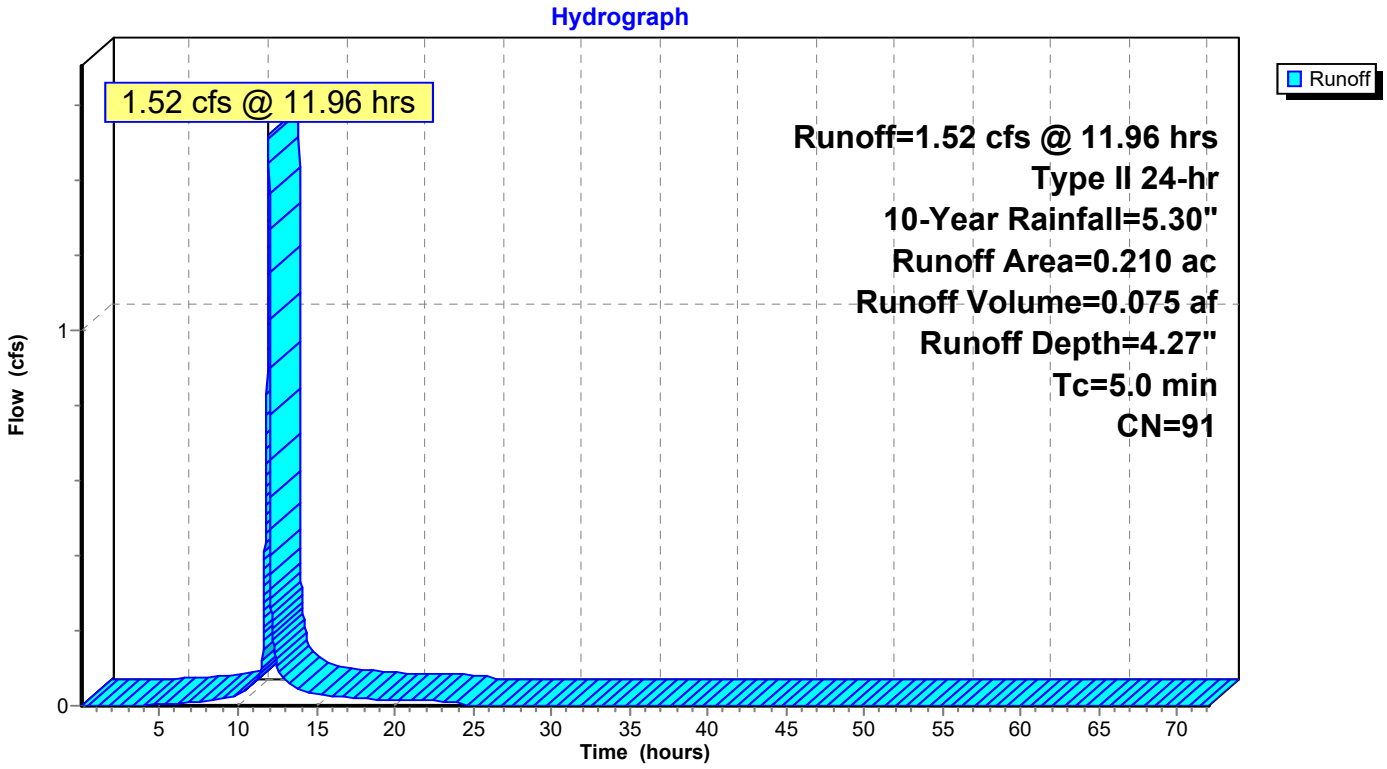
Subcatchment 60S: AREA 6



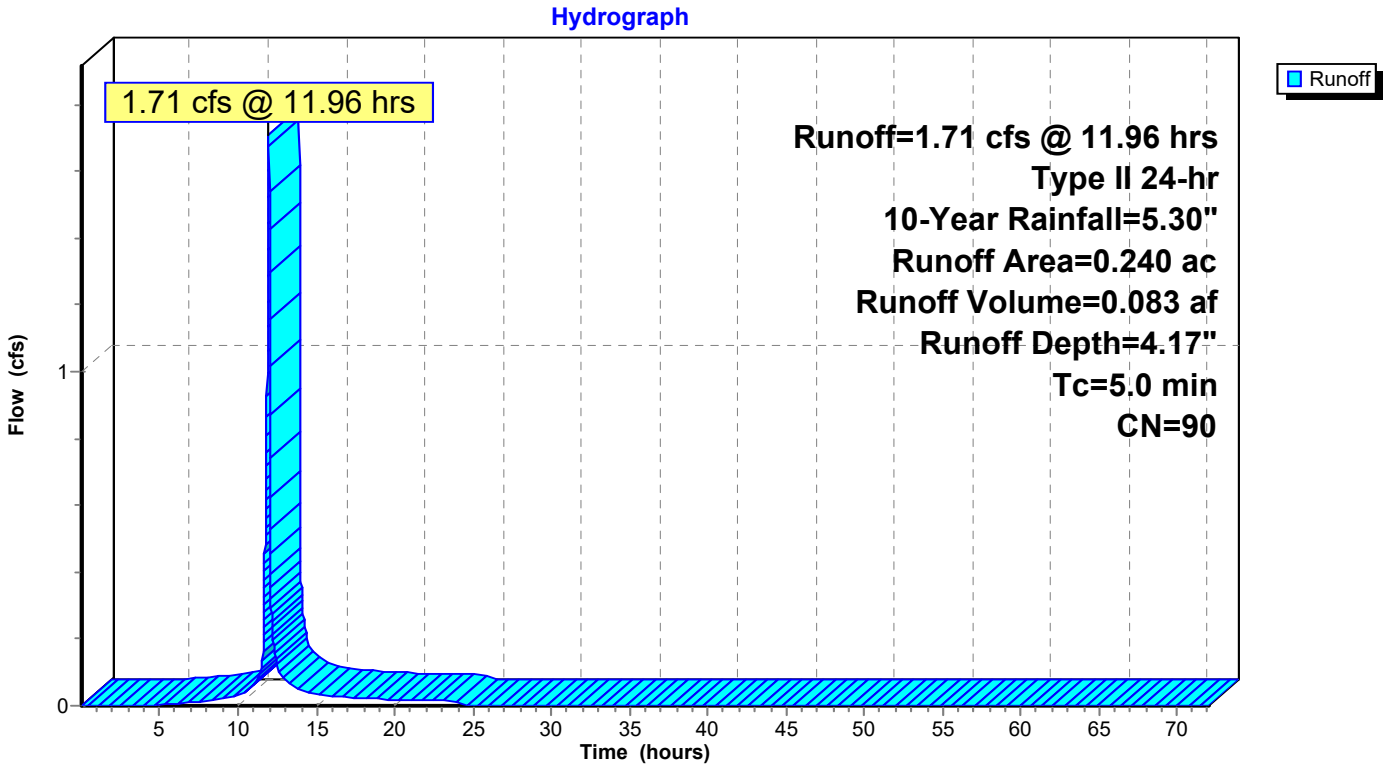
Subcatchment 61S: AREA 7



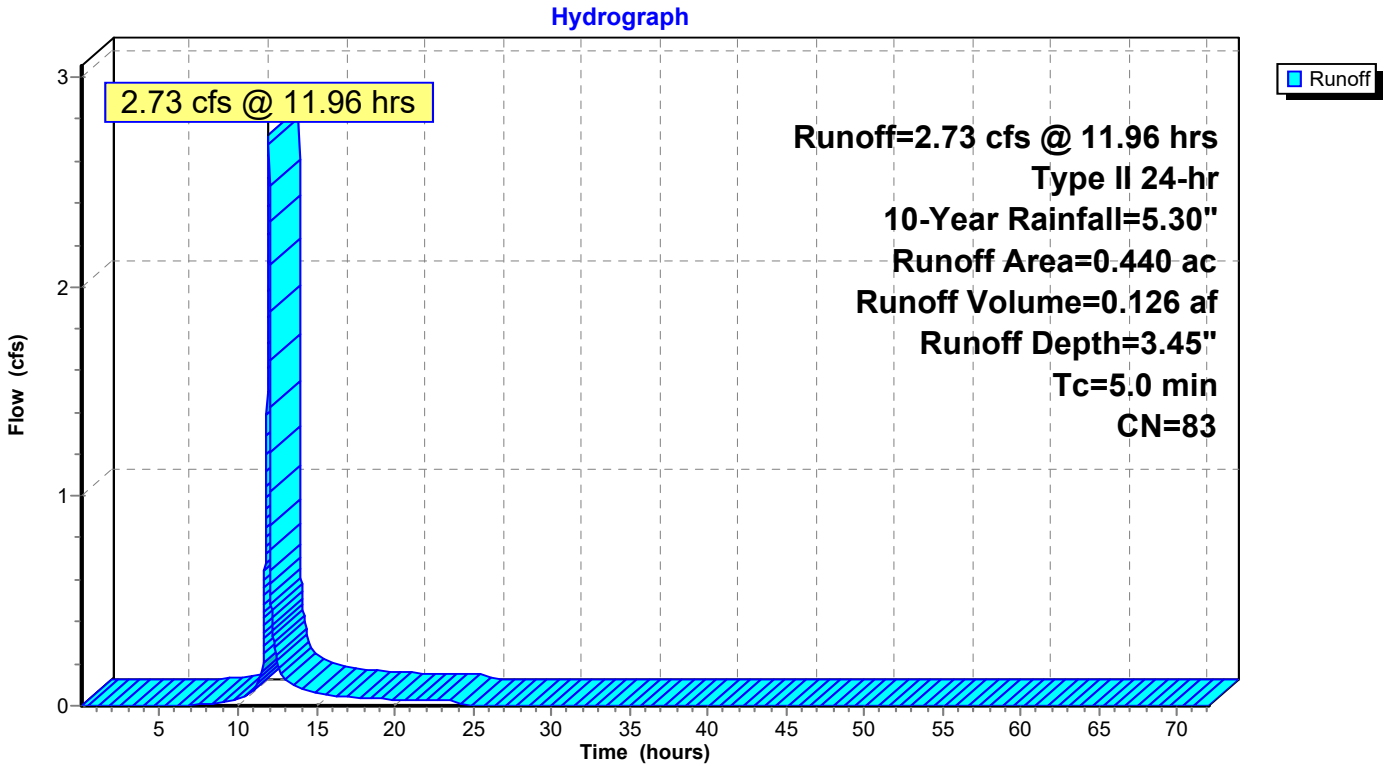
Subcatchment 62S: AREA 1



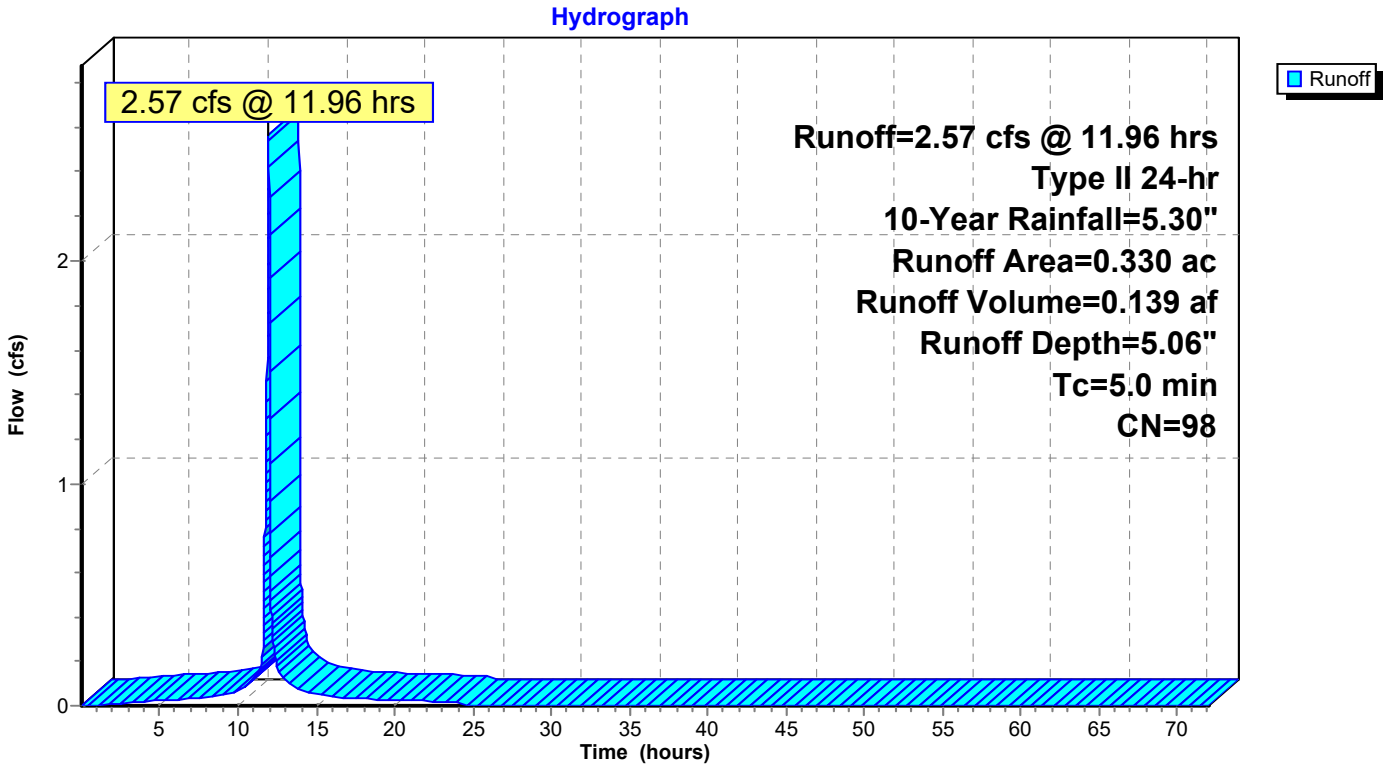
Subcatchment 63S: AREA 2



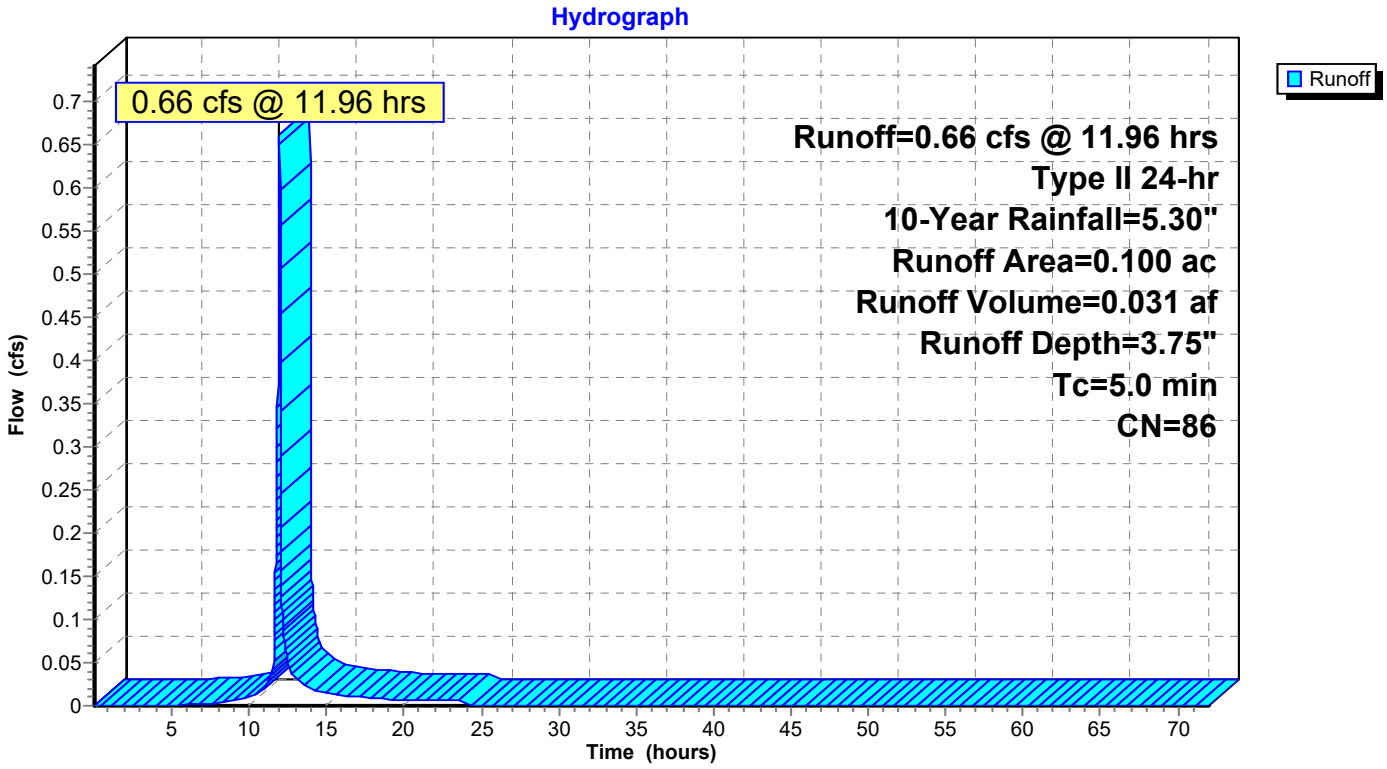
Subcatchment 64S: AREA 3



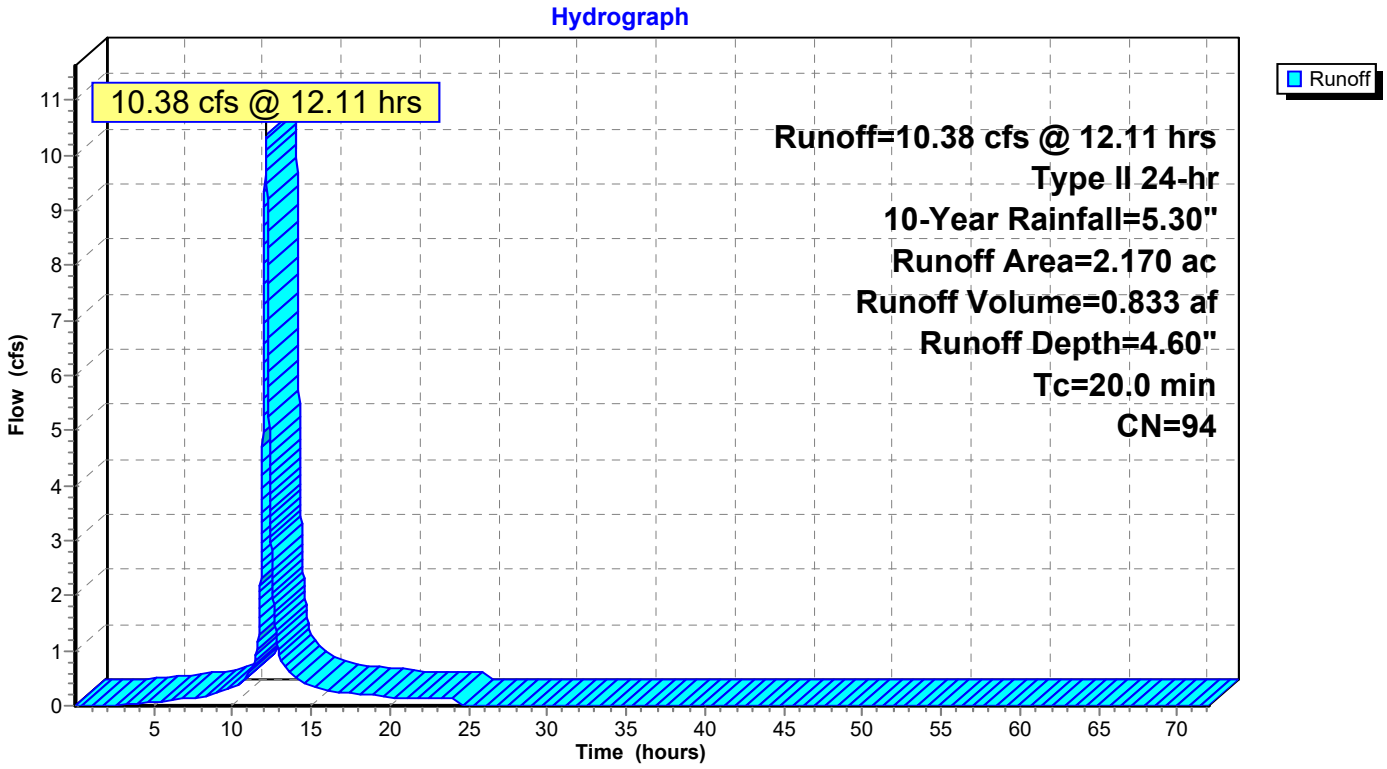
Subcatchment 65S: AREA 4



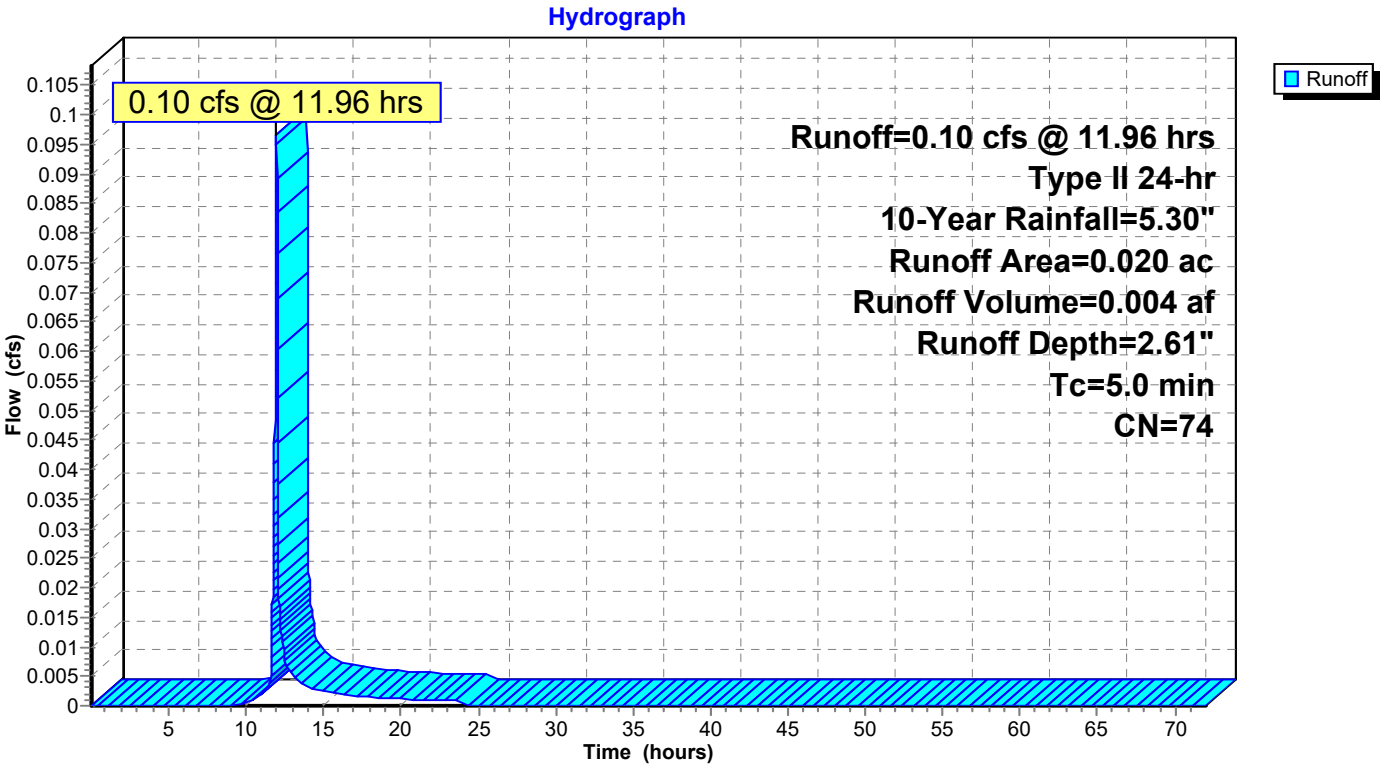
Subcatchment 66S: AREA 5



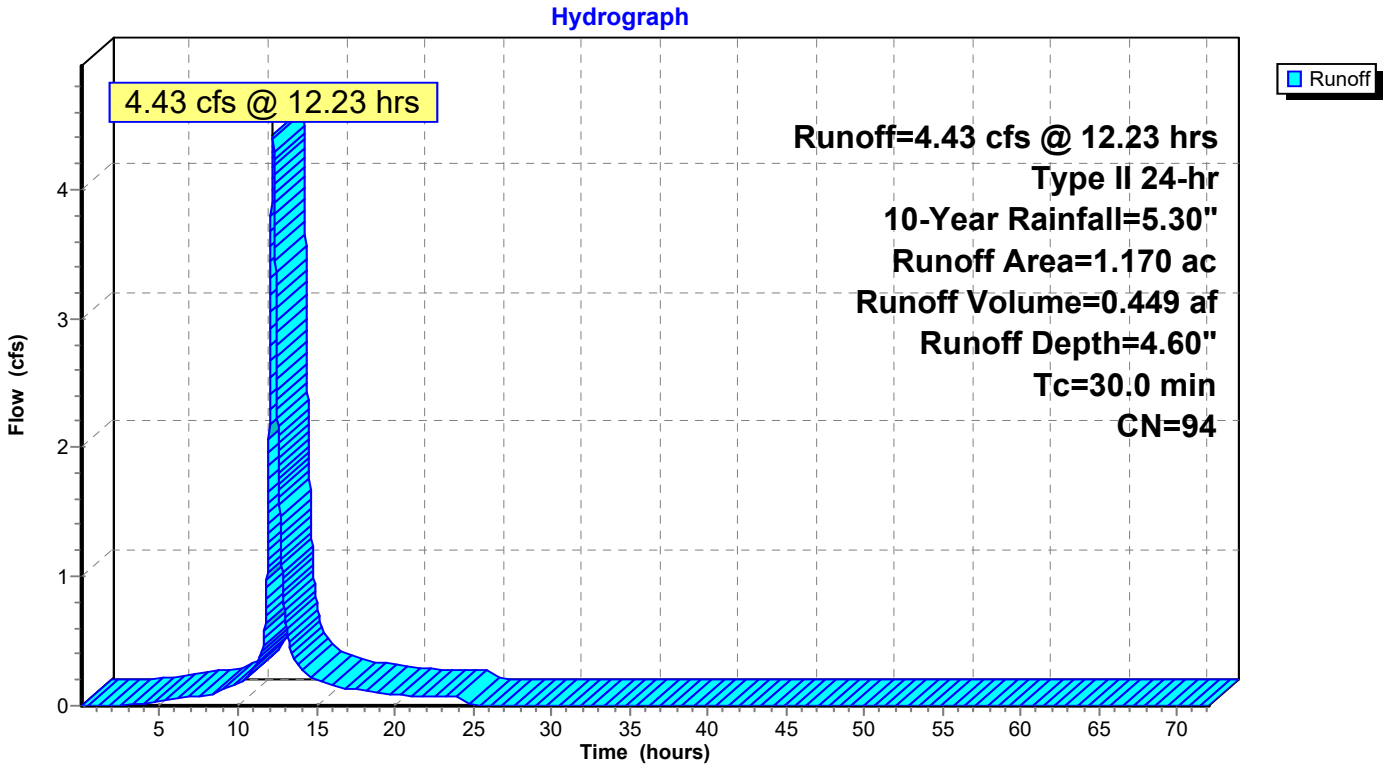
Subcatchment 67S: OFFSITE TO CI 12



Subcatchment 68S: AREA TO AI 11

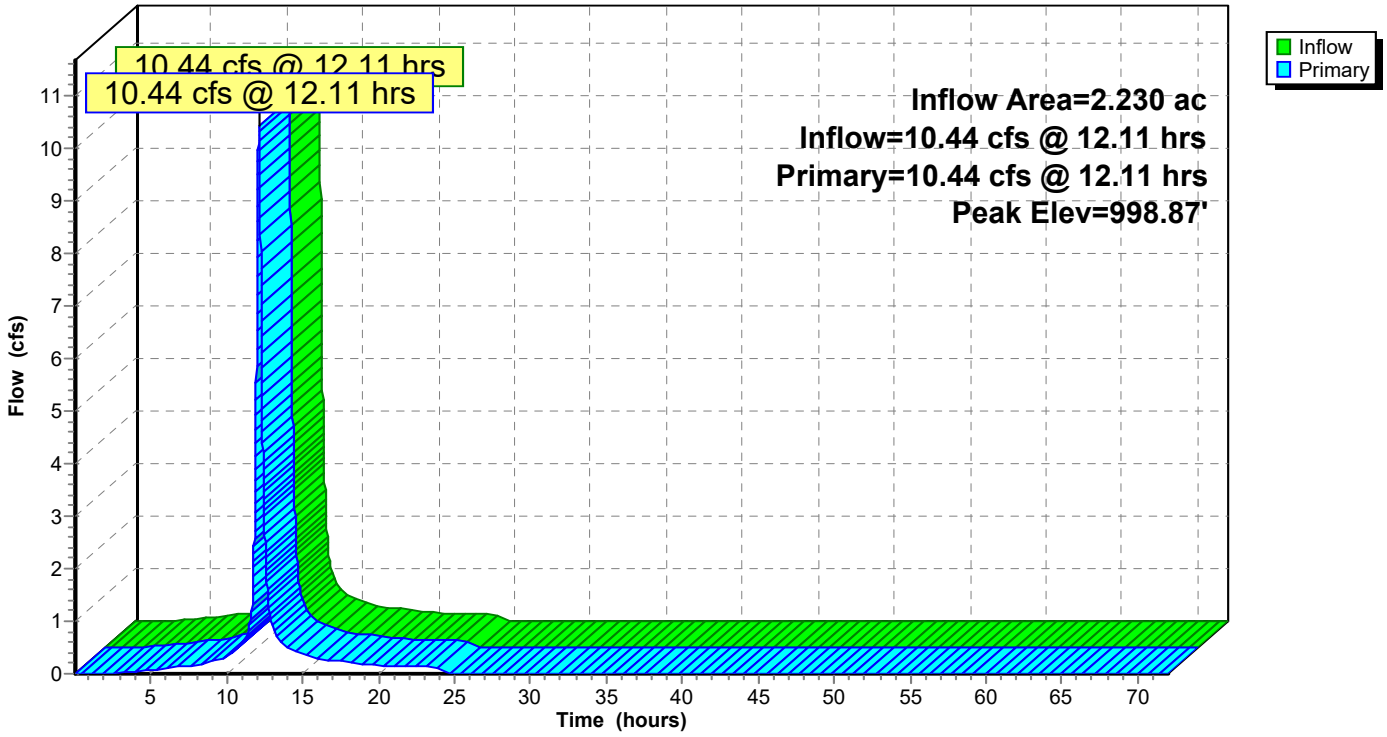


Subcatchment 69S: OFFSITE TO BMP



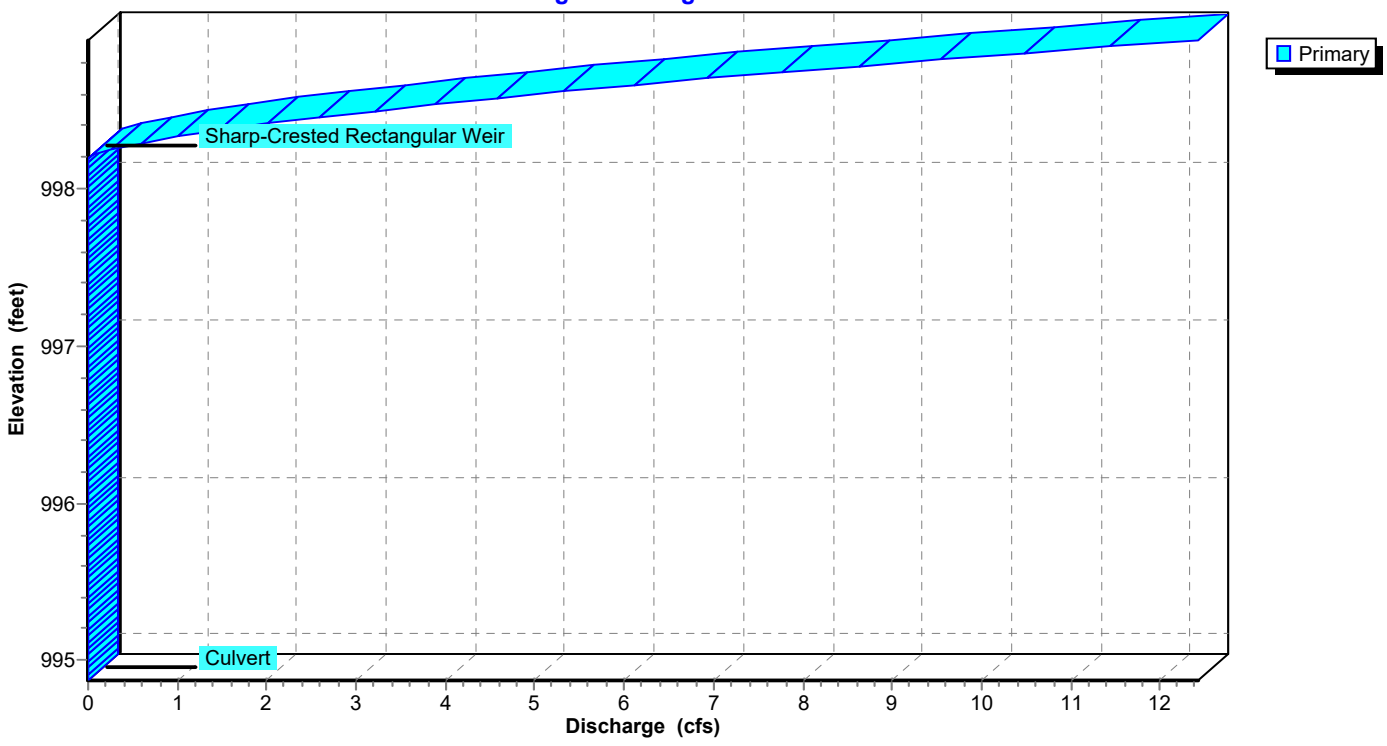
Pond 10P: 12-11

Hydrograph

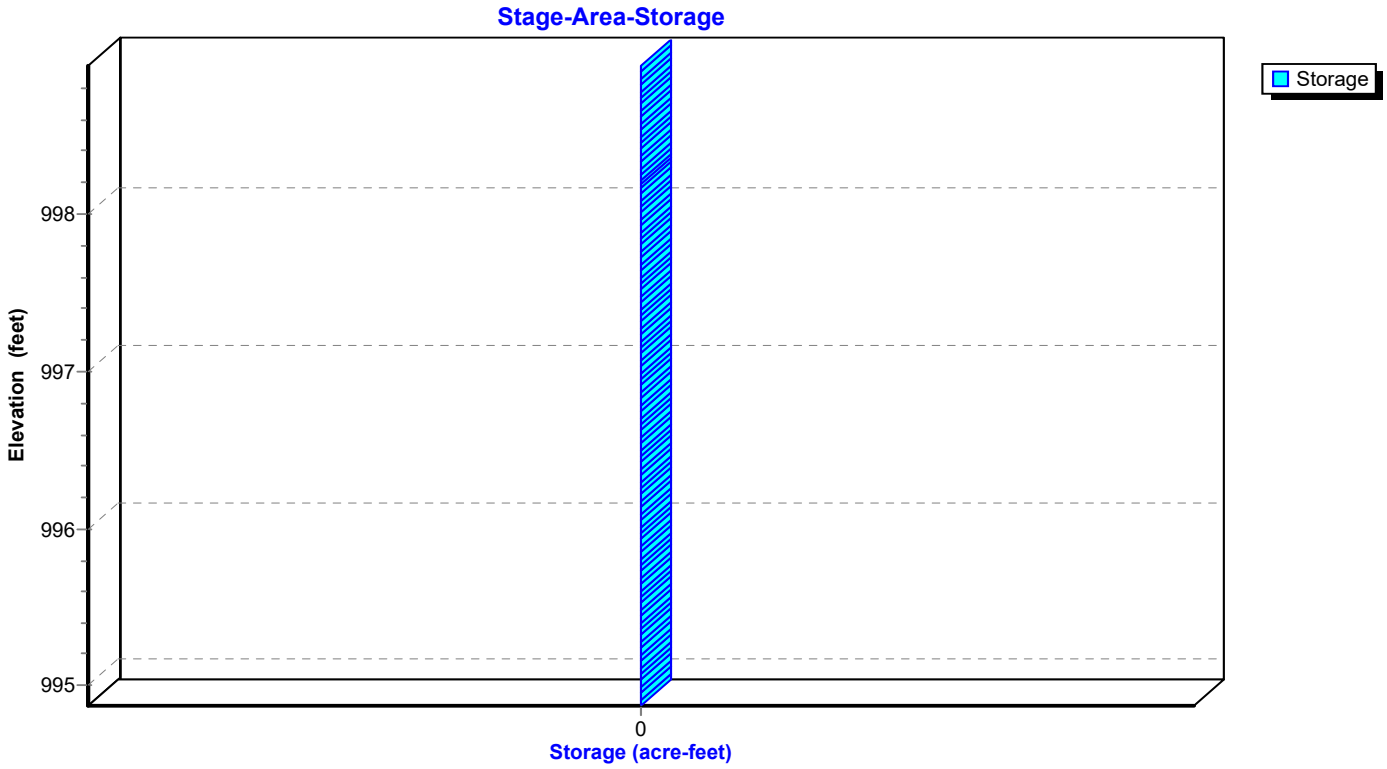


Pond 10P: 12-11

Stage-Discharge

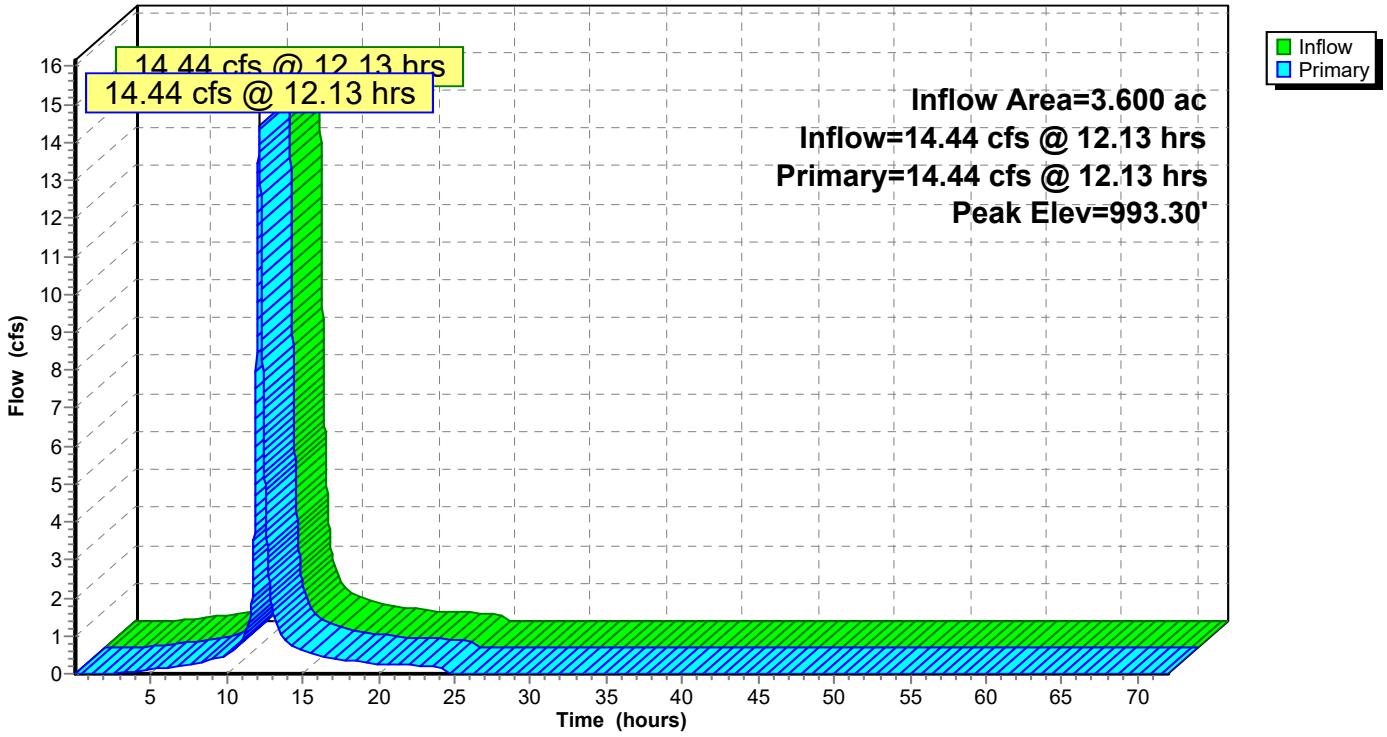


Pond 10P: 12-11



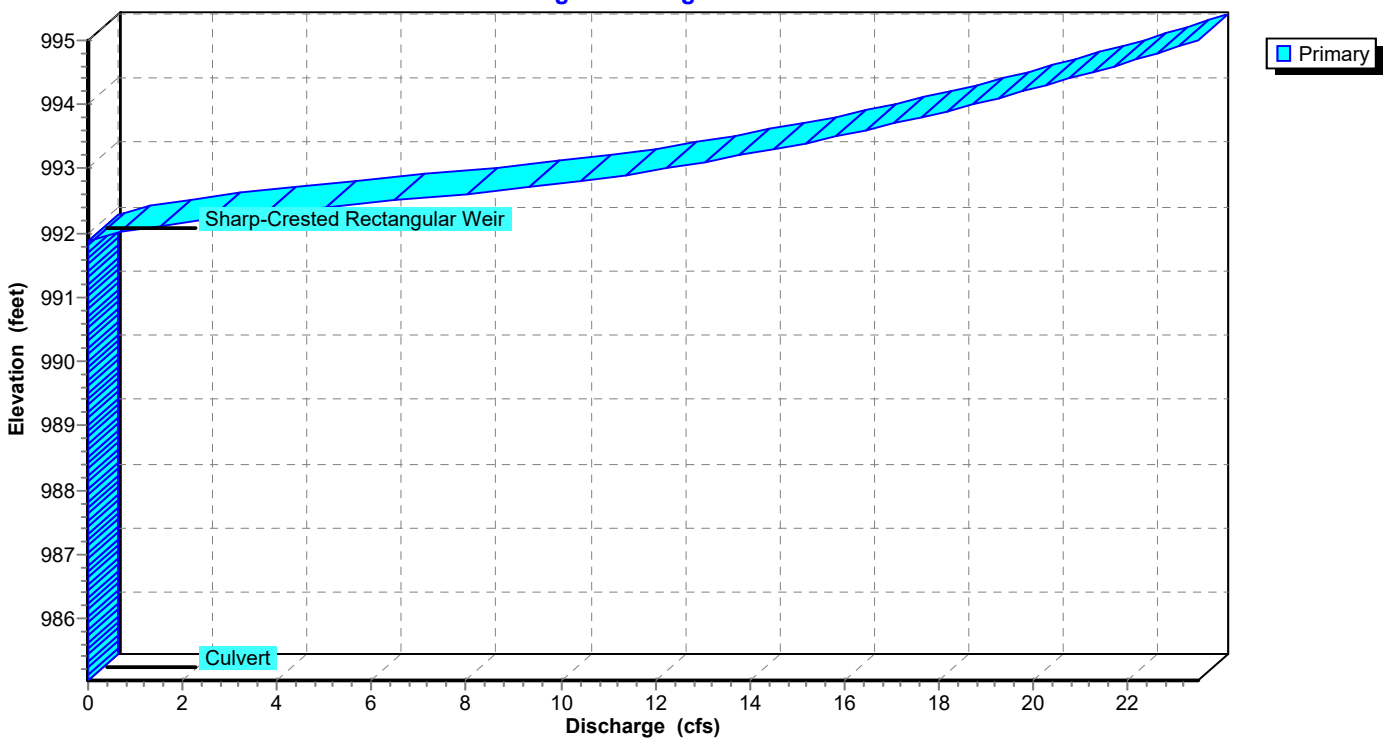
Pond 11P: 11-10

Hydrograph

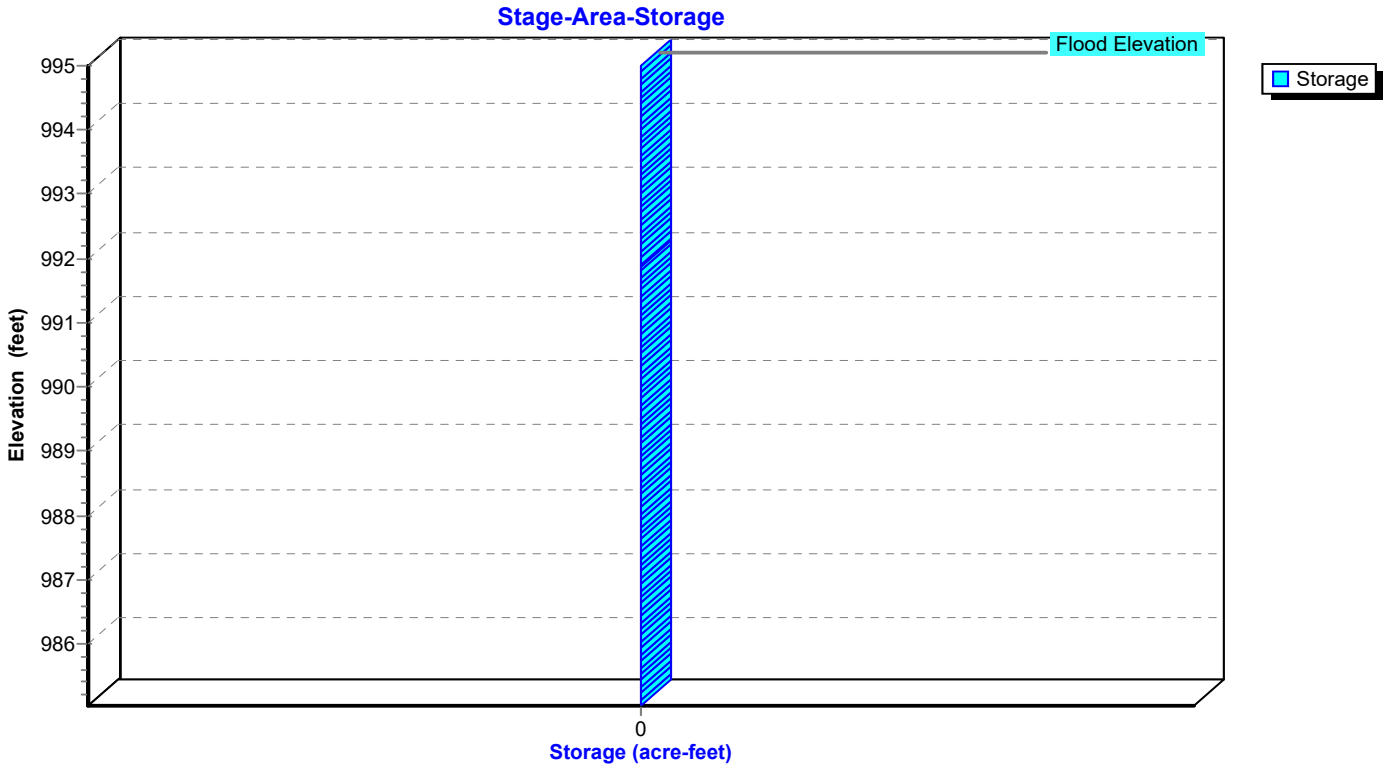


Pond 11P: 11-10

Stage-Discharge

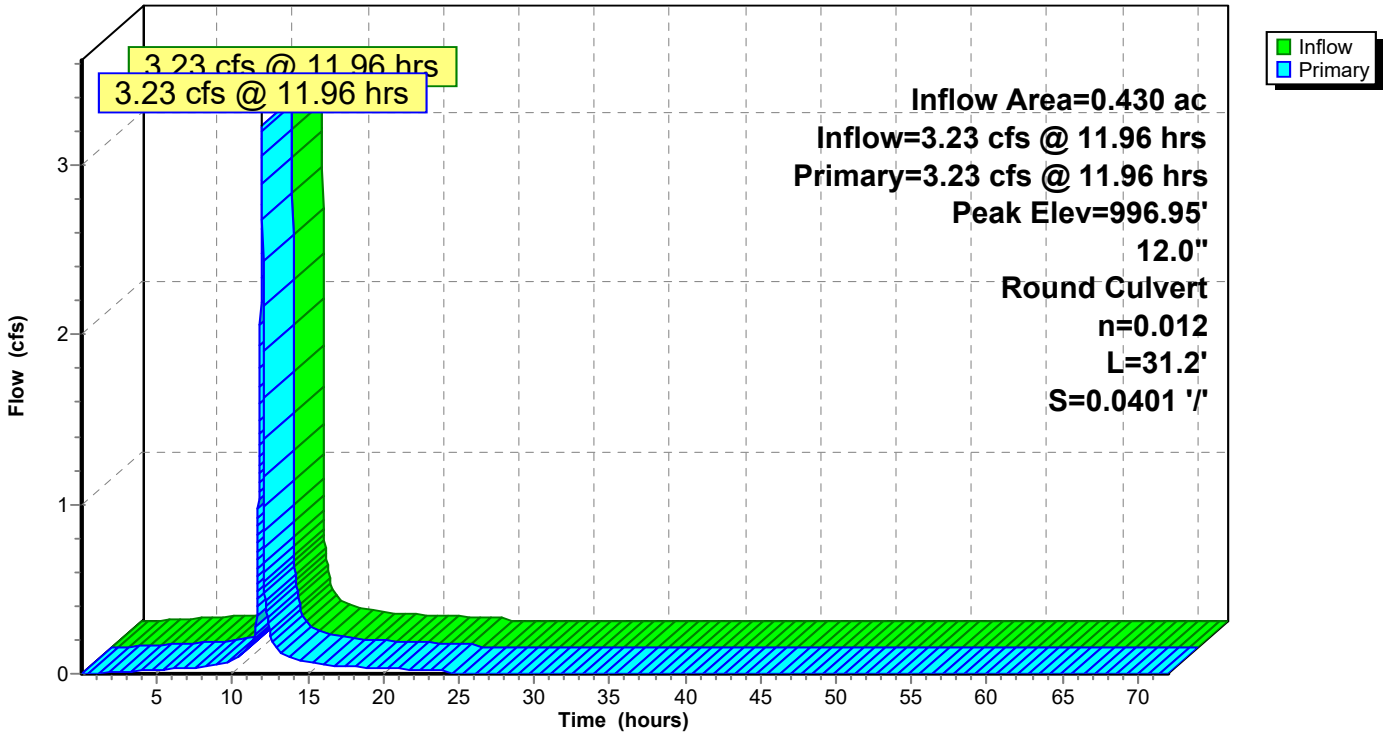


Pond 11P: 11-10



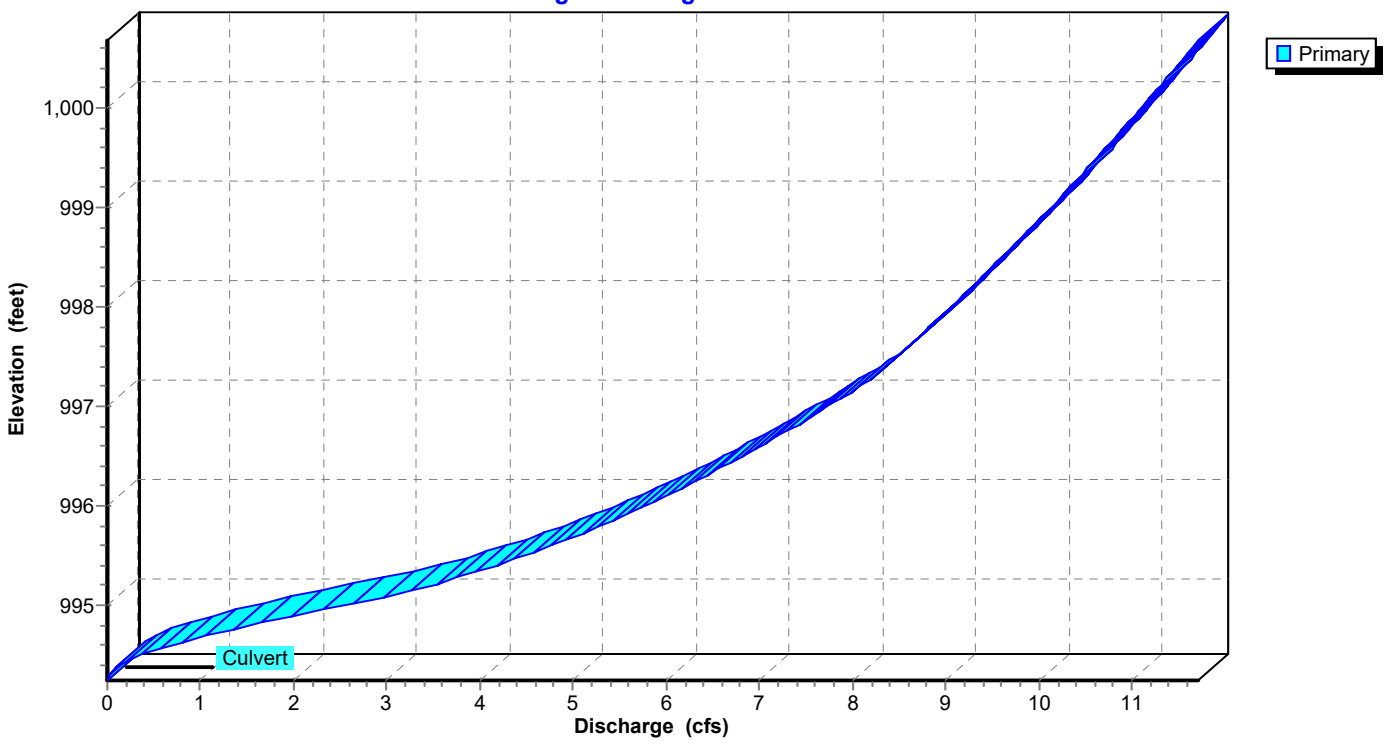
Pond 50P: BASIN REACH

Hydrograph

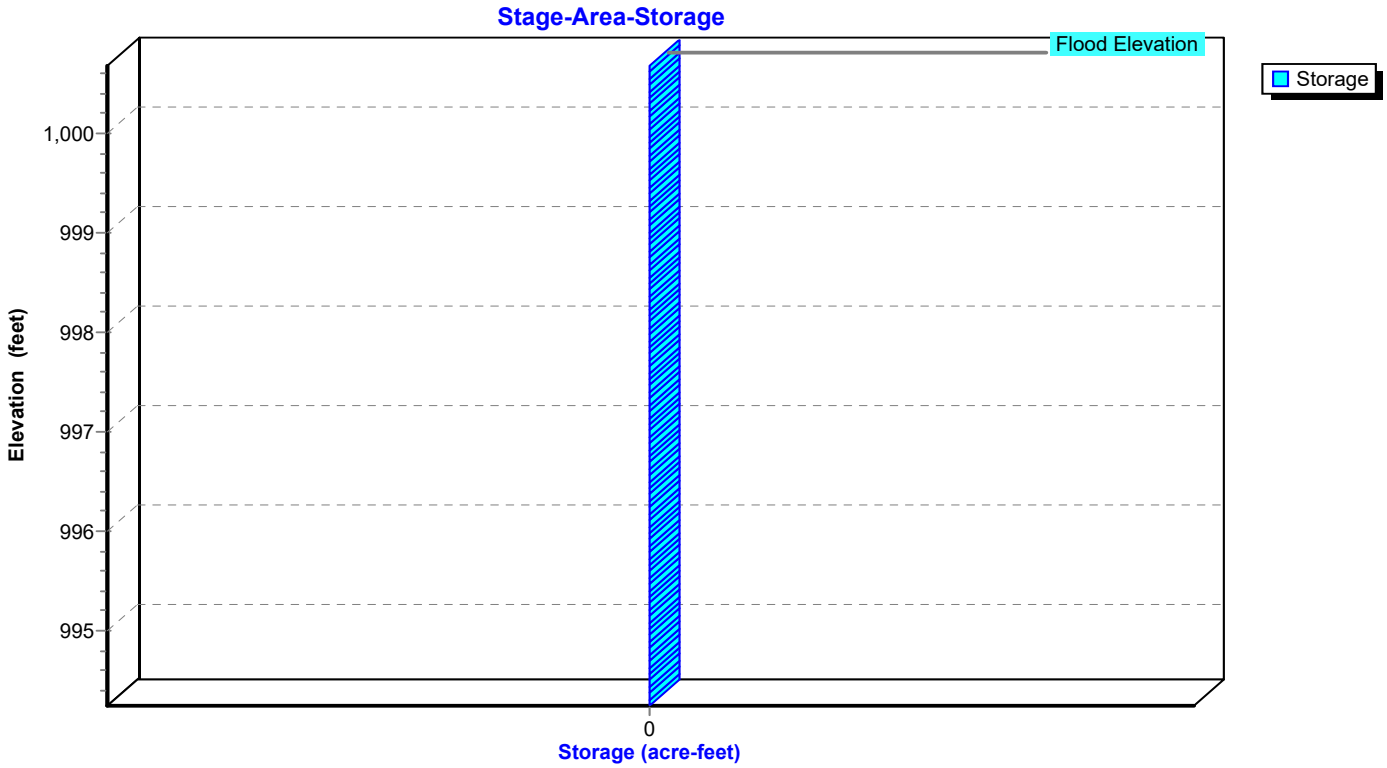


Pond 50P: BASIN REACH

Stage-Discharge

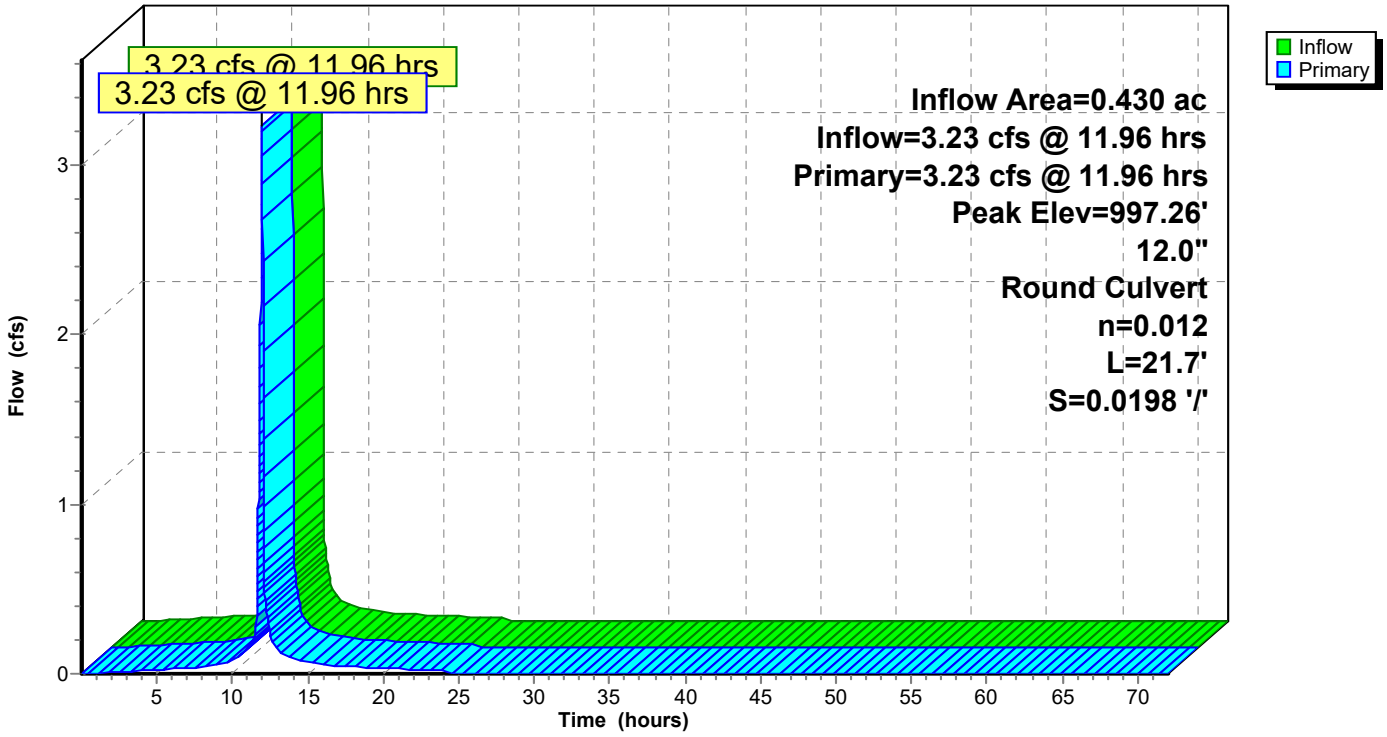


Pond 50P: BASIN REACH



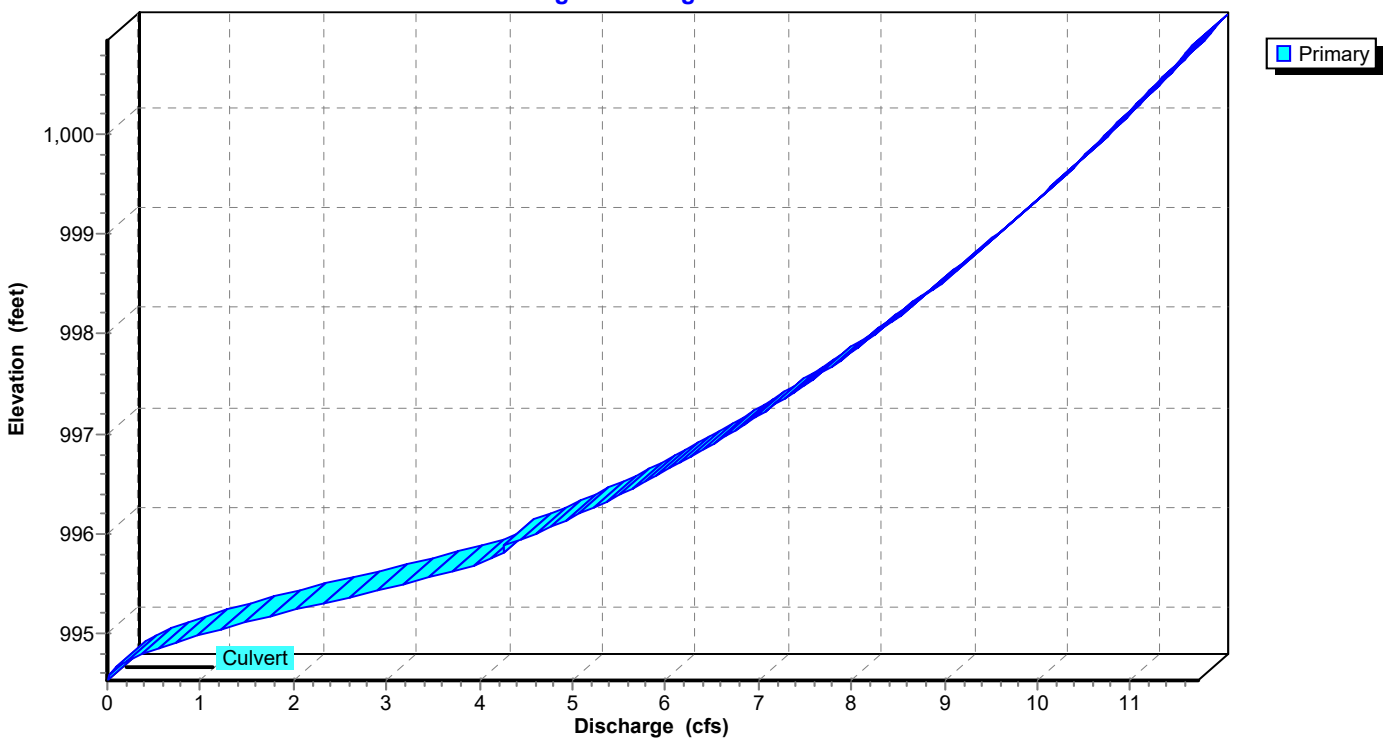
Pond 51P: ROOF DRAINS TO BASIN

Hydrograph

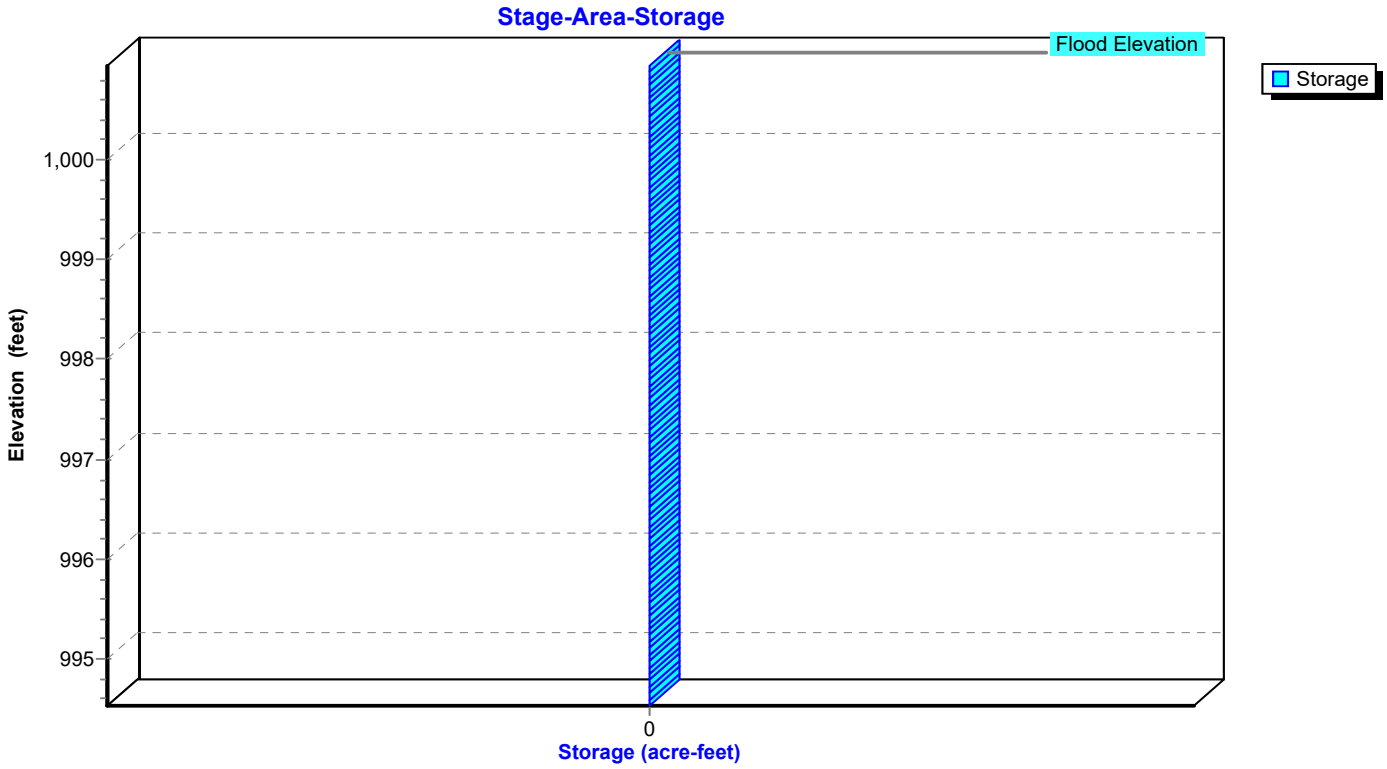


Pond 51P: ROOF DRAINS TO BASIN

Stage-Discharge

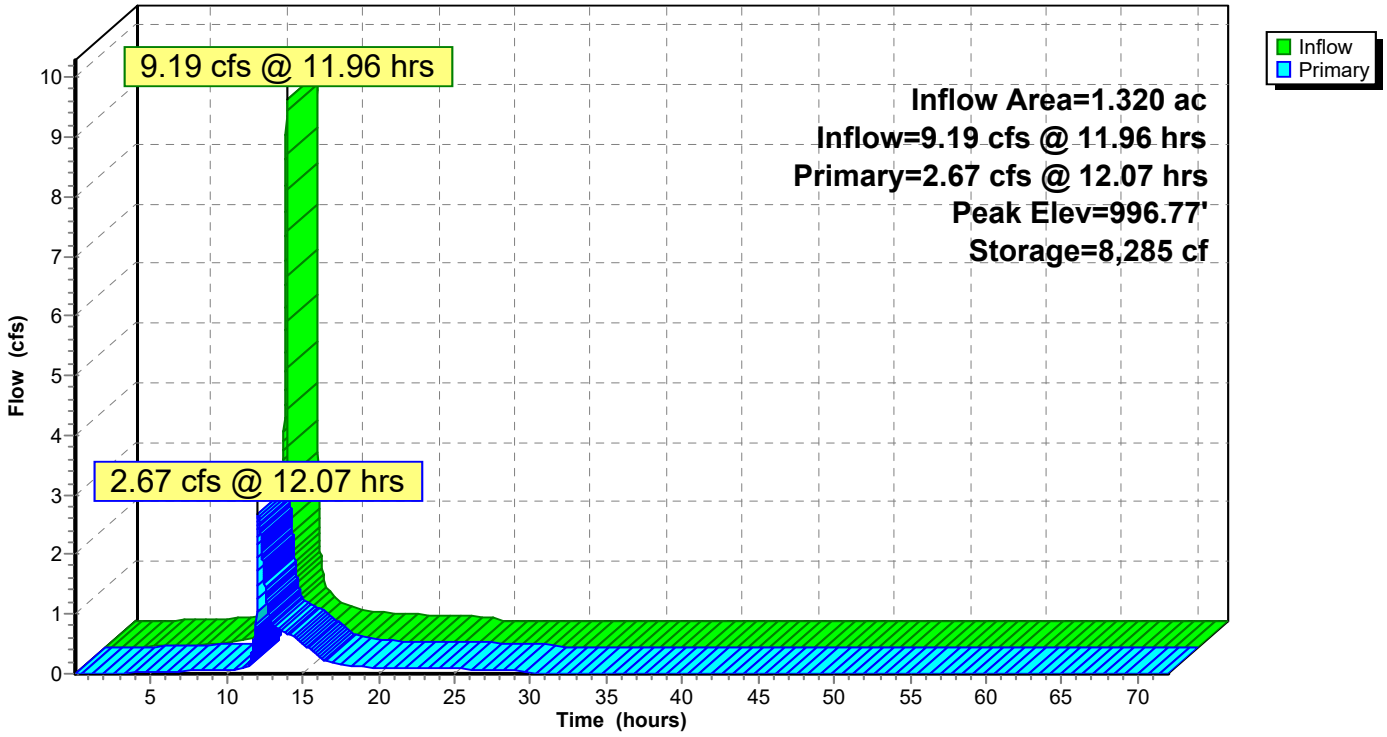


Pond 51P: ROOF DRAINS TO BASIN



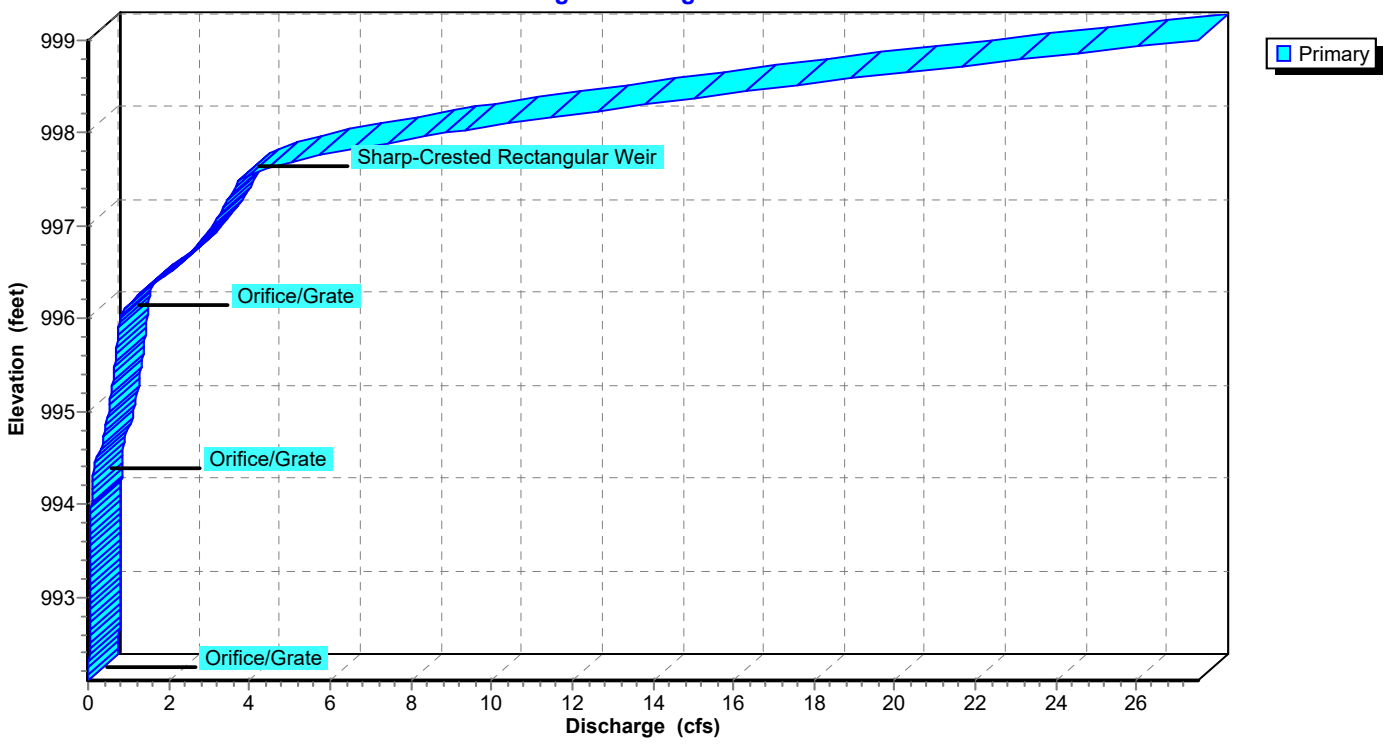
Pond 52P: DETENTION BASIN

Hydrograph

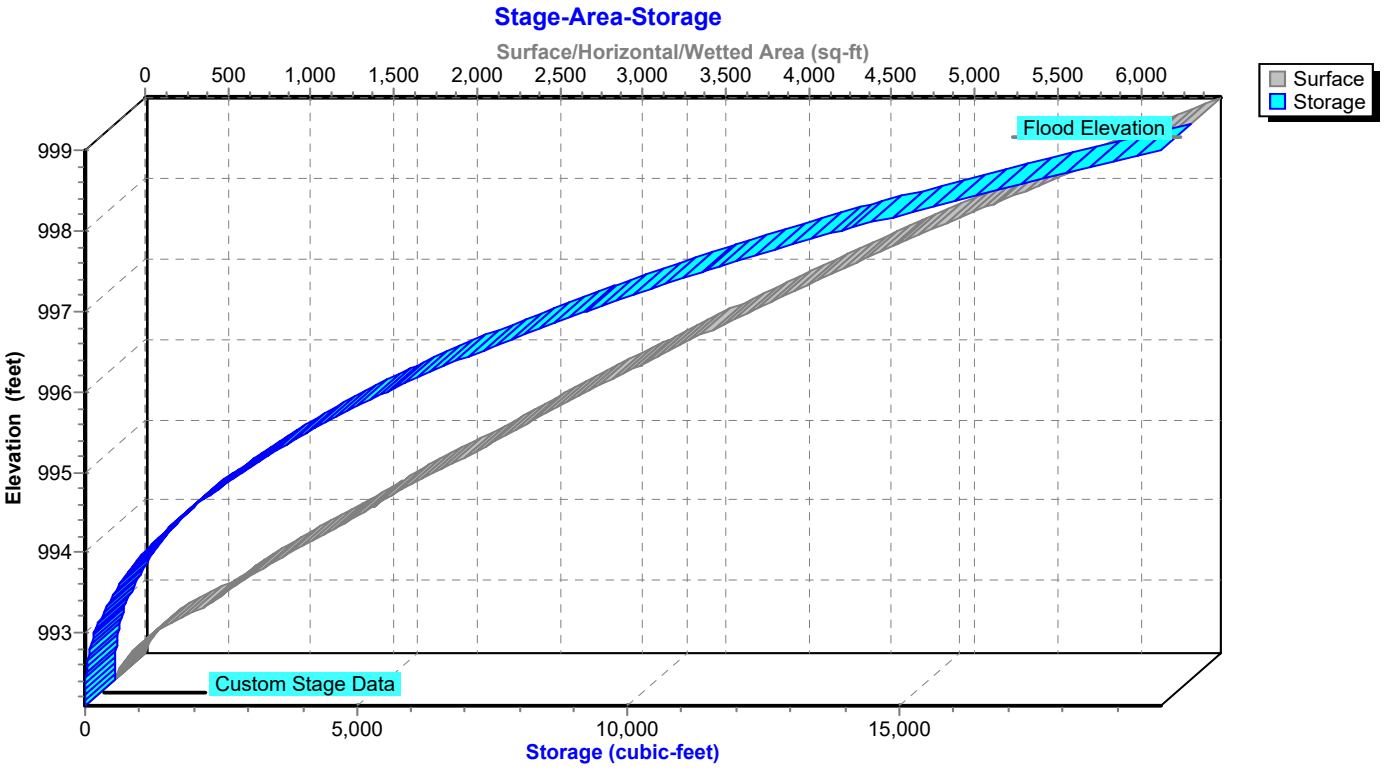


Pond 52P: DETENTION BASIN

Stage-Discharge

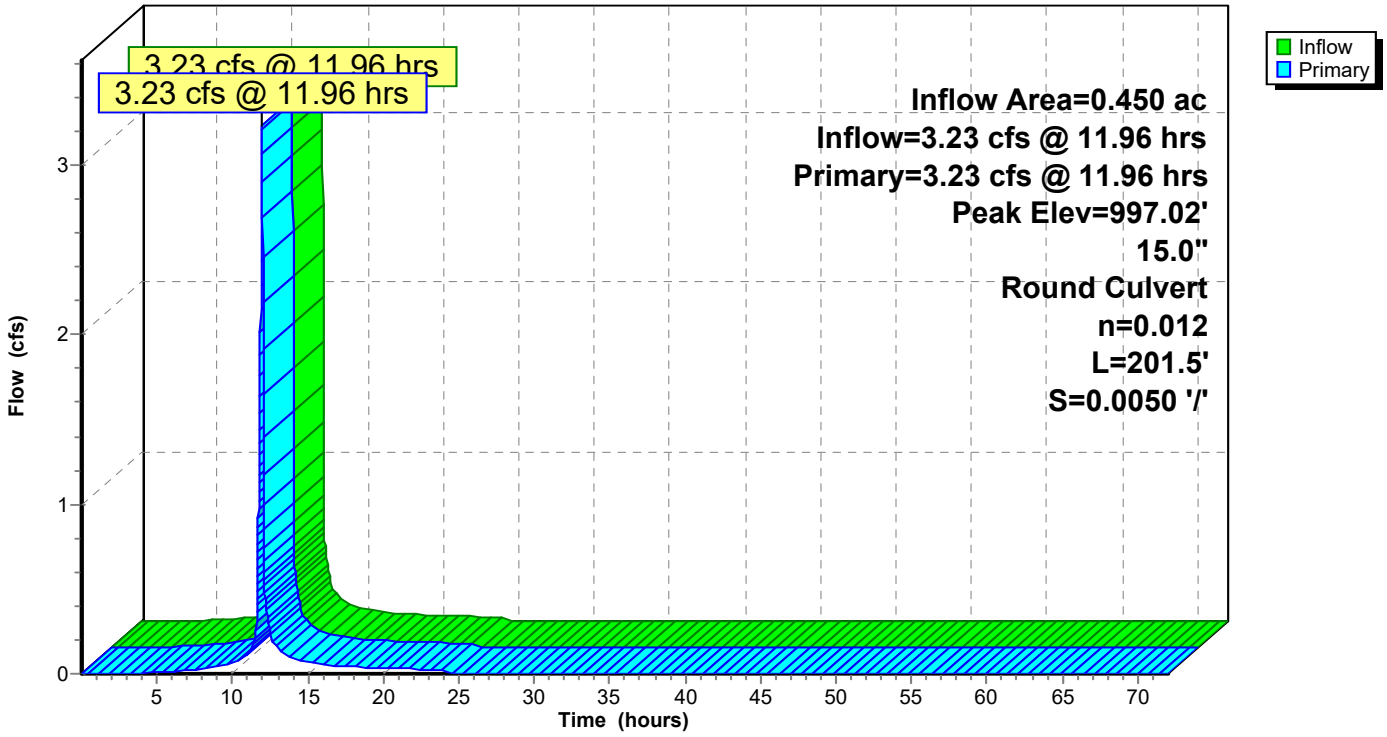


Pond 52P: DETENTION BASIN



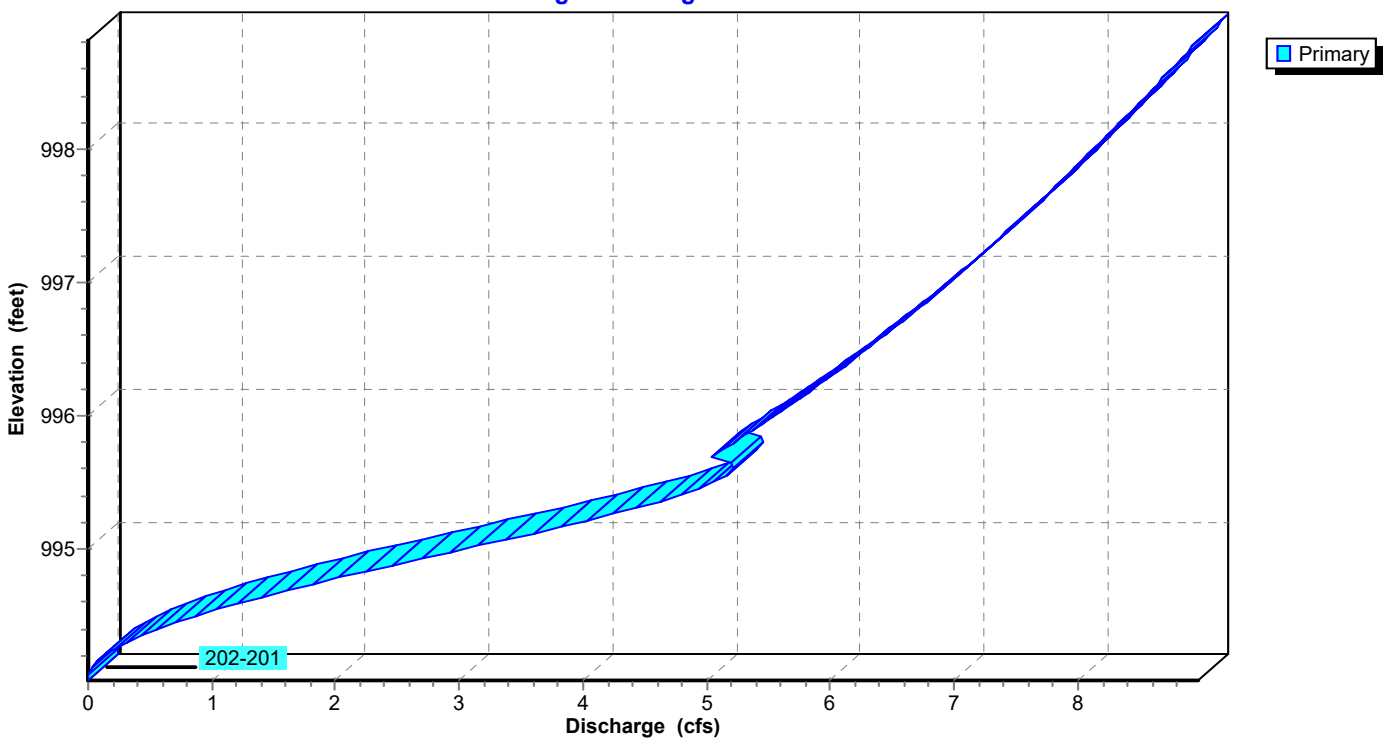
Pond 53P: 301-300

Hydrograph

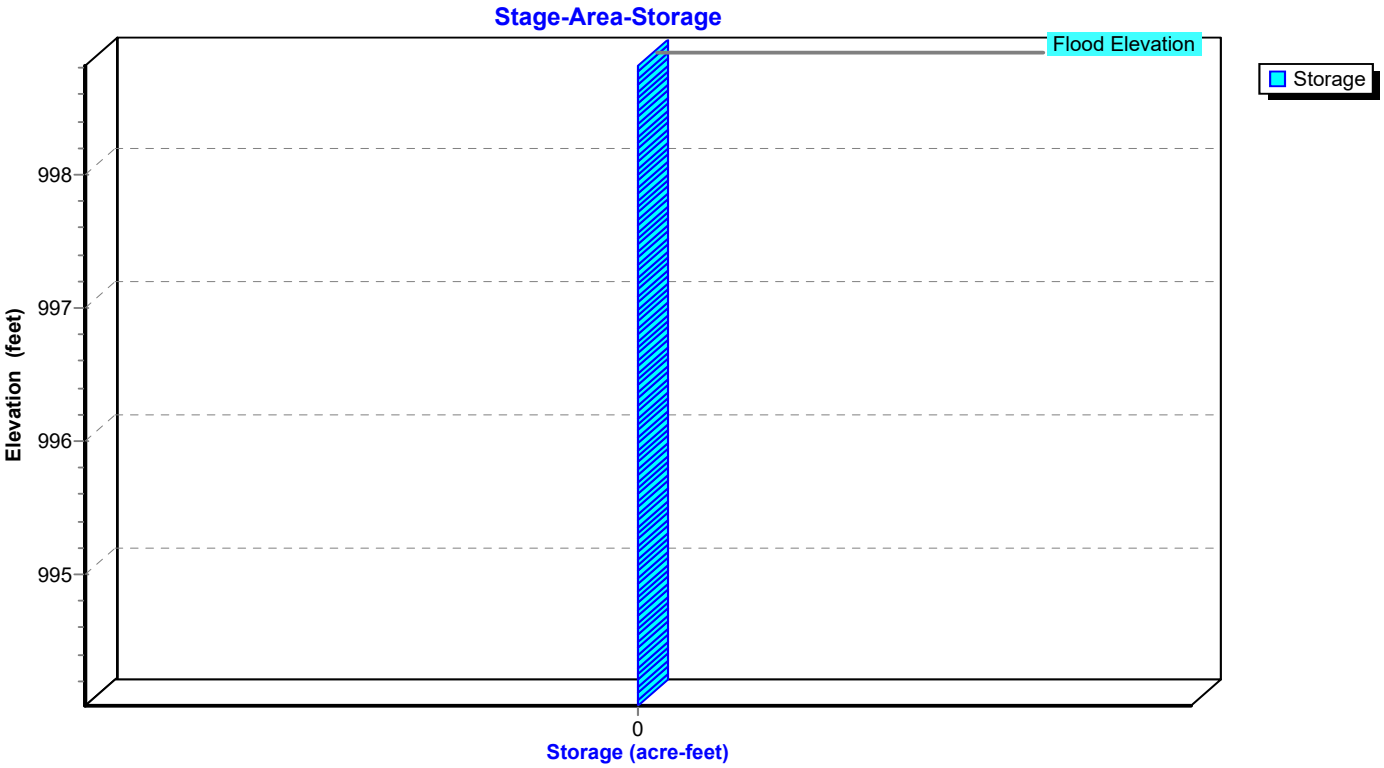


Pond 53P: 301-300

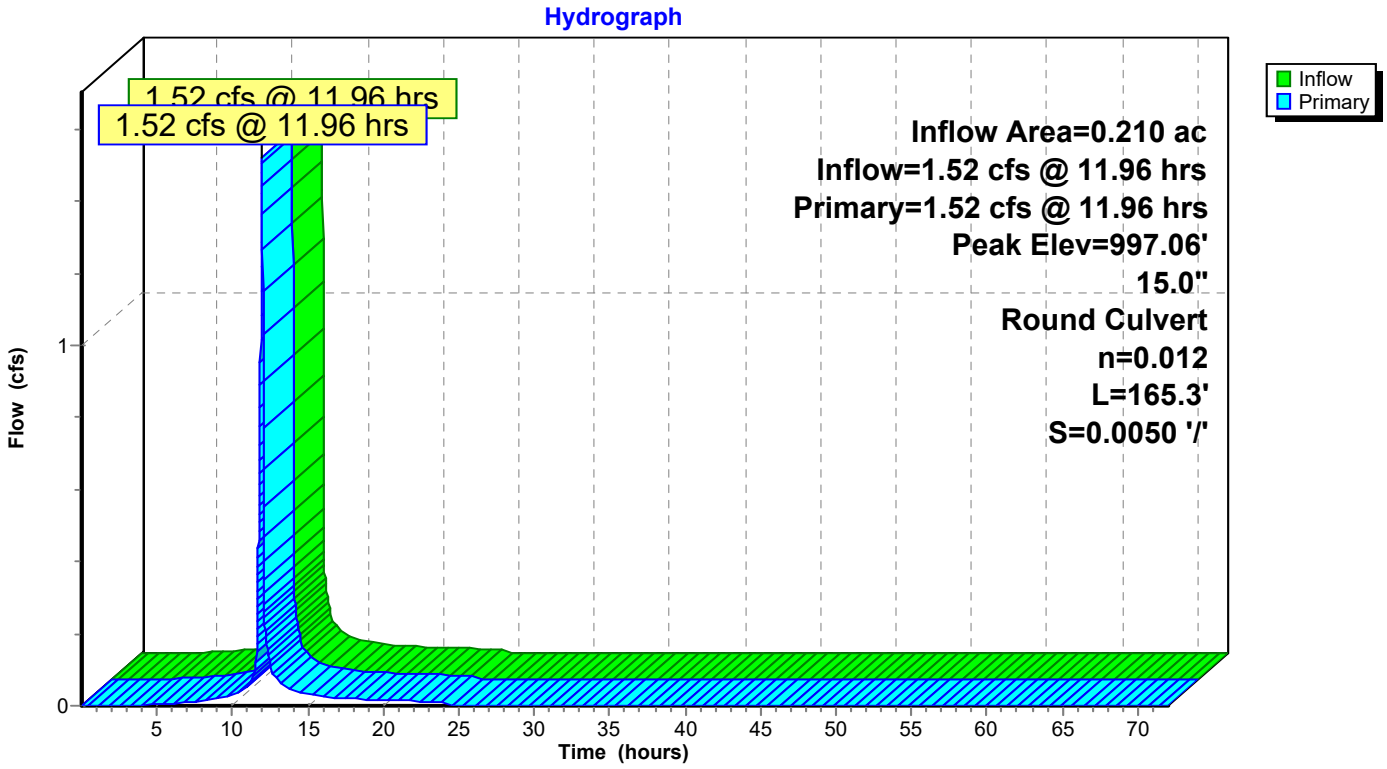
Stage-Discharge



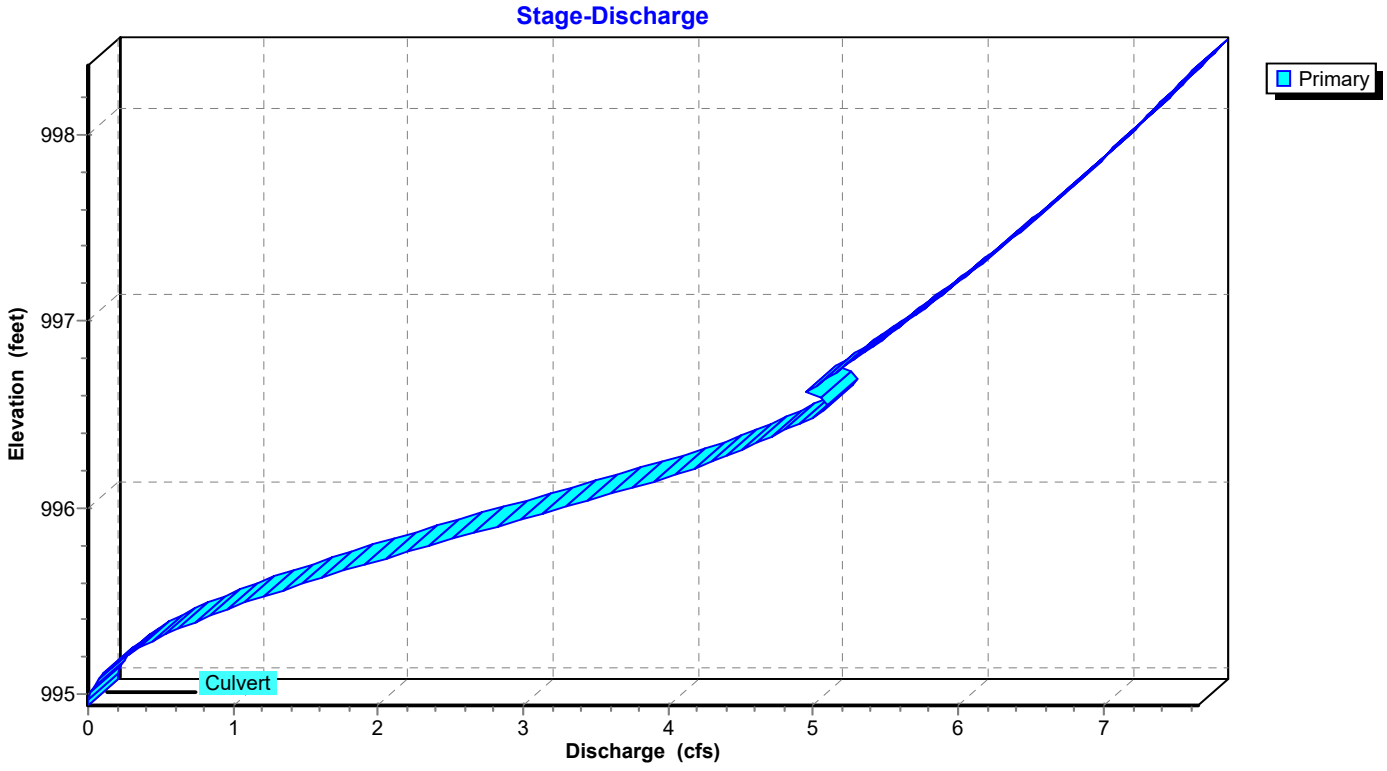
Pond 53P: 301-300



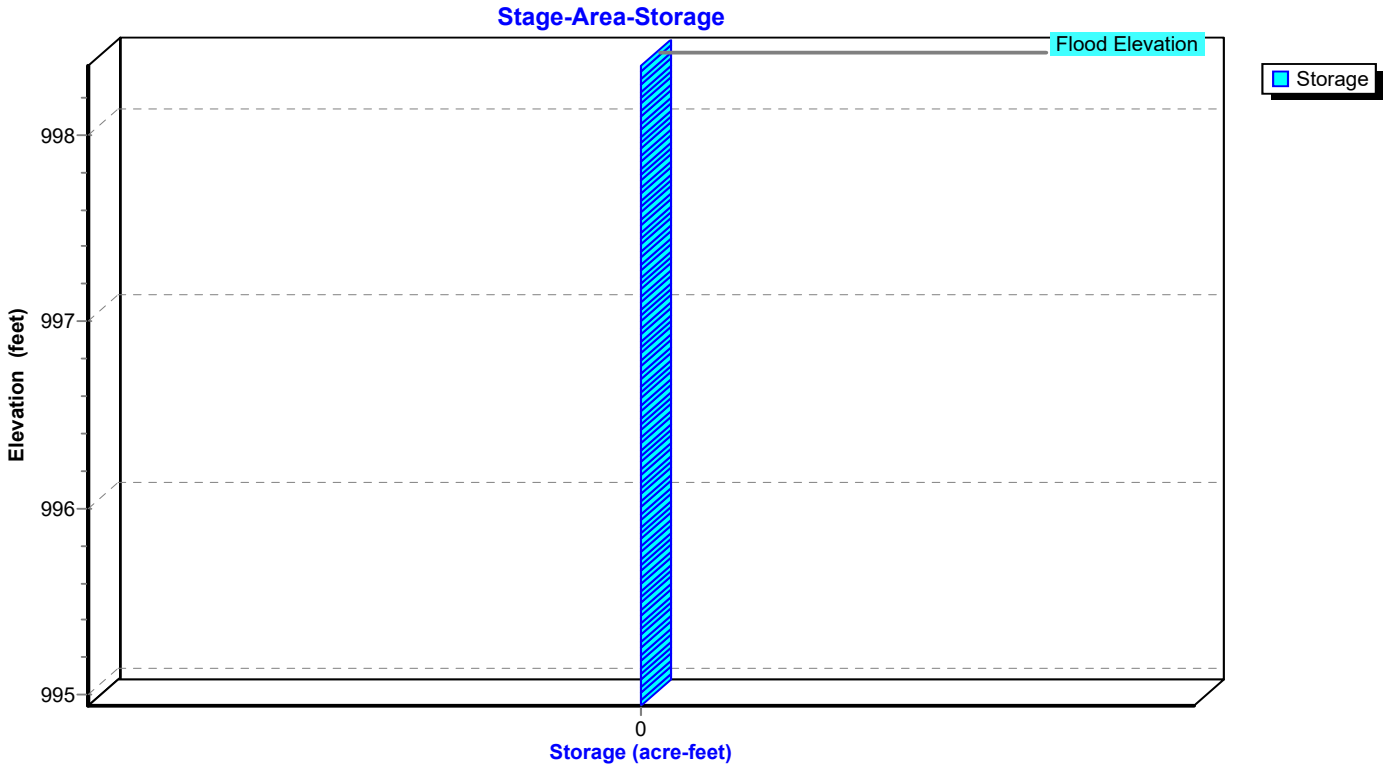
Pond 54P: 302-301



Pond 54P: 302-301

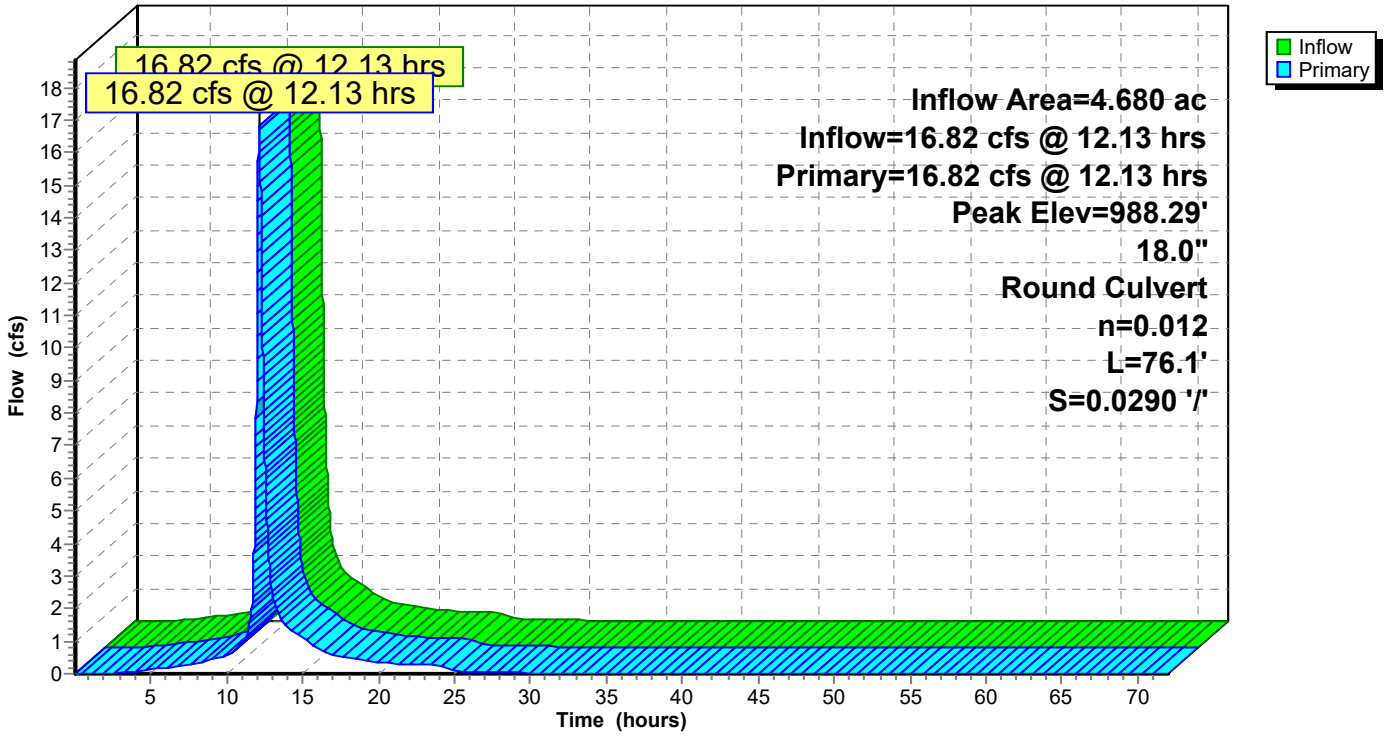


Pond 54P: 302-301



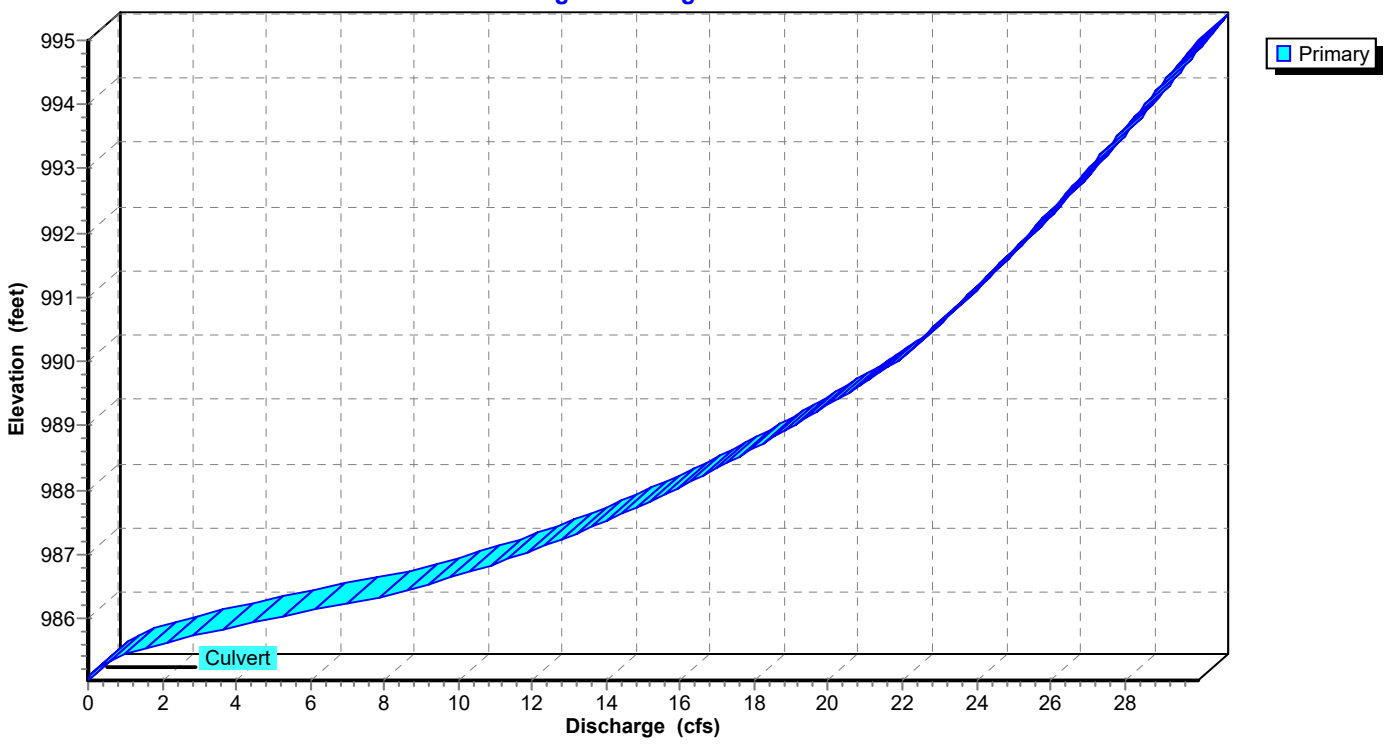
Pond 55P: 11-10

Hydrograph

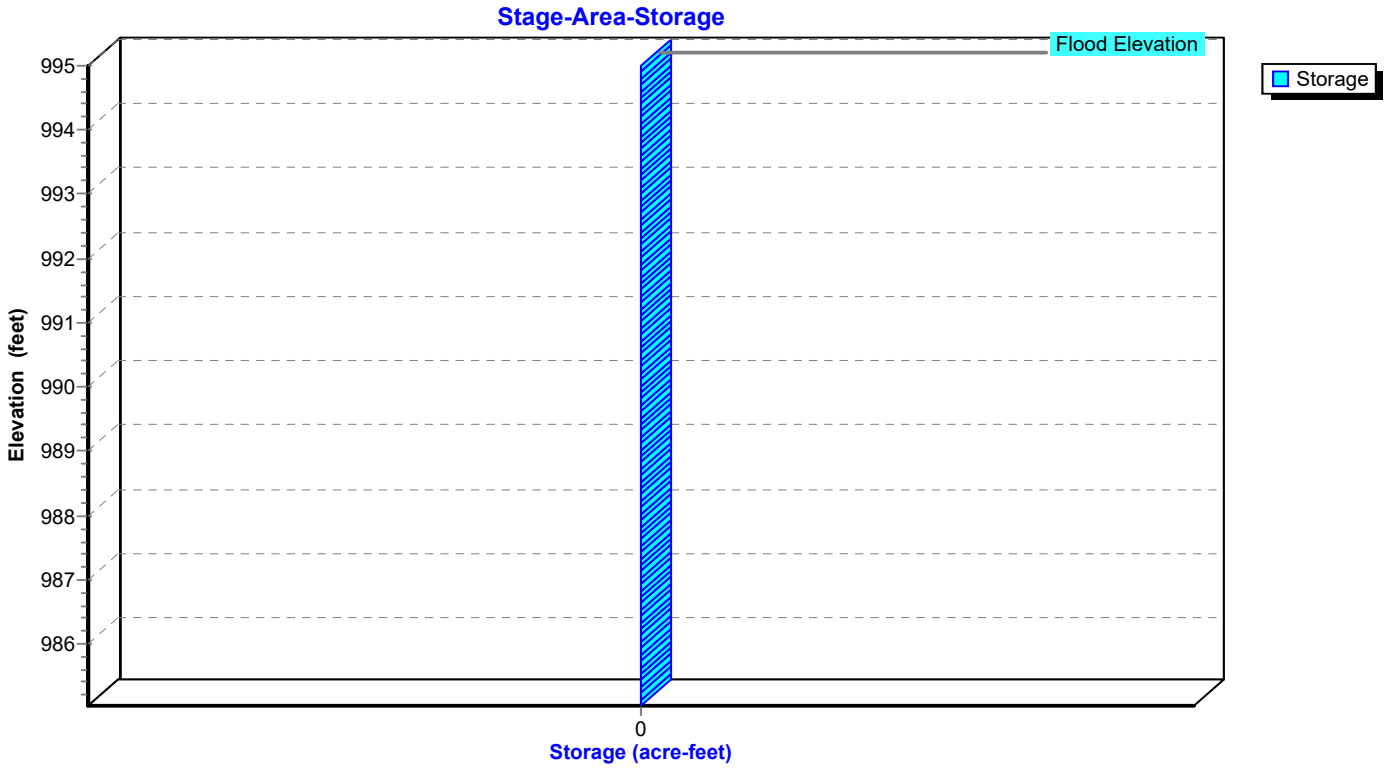


Pond 55P: 11-10

Stage-Discharge

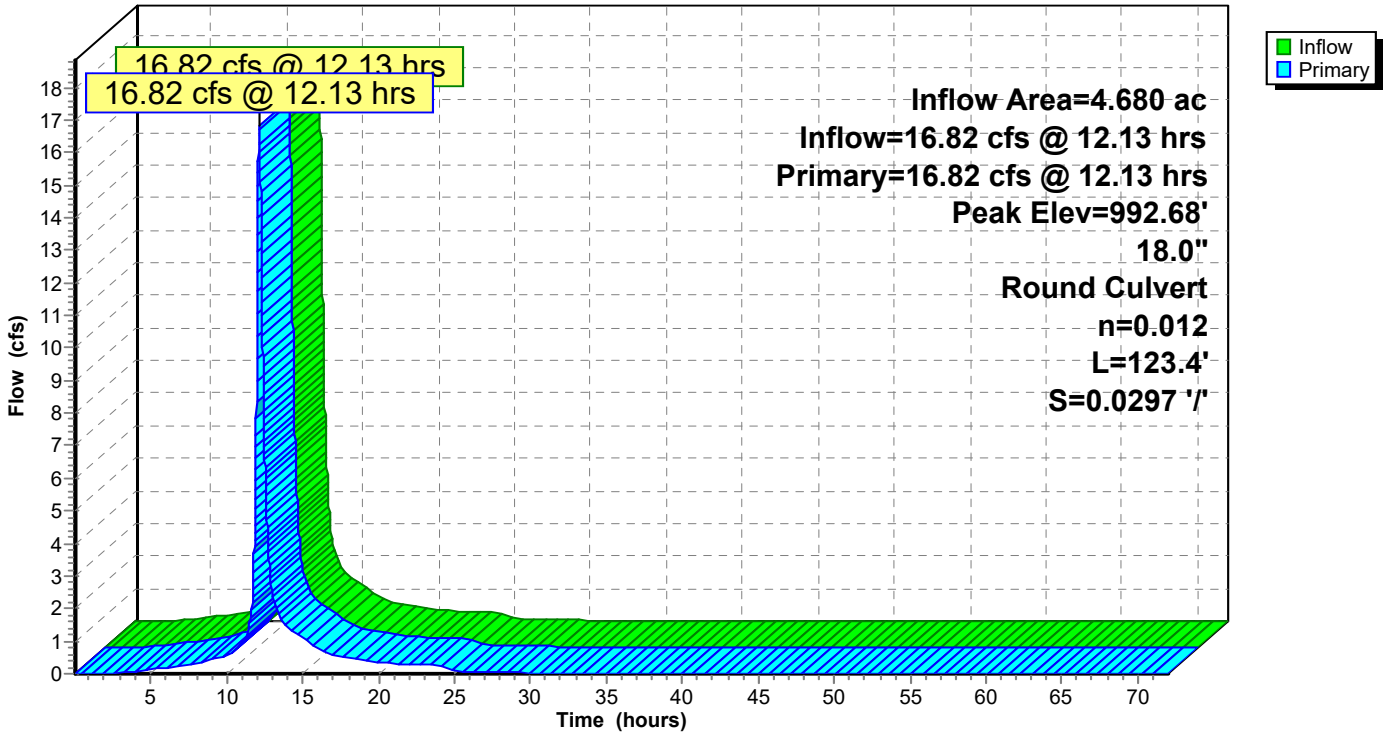


Pond 55P: 11-10



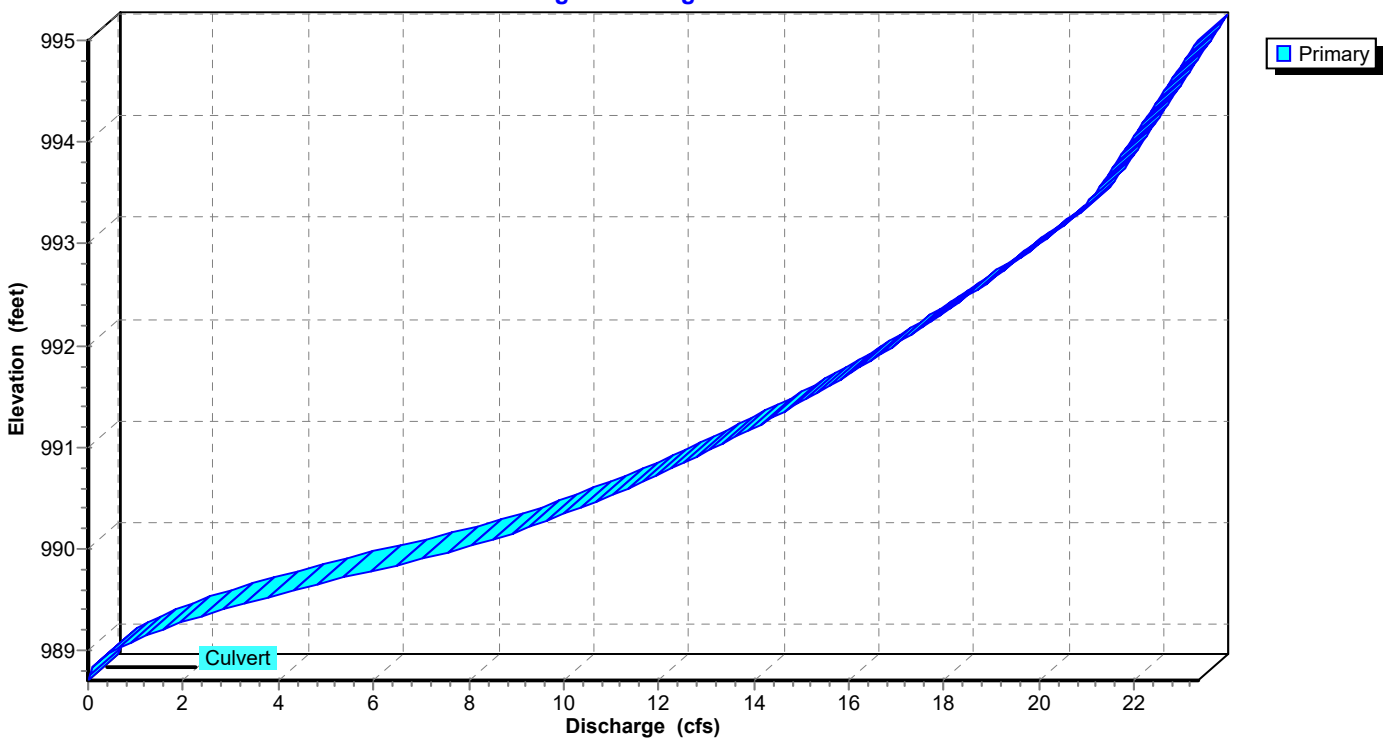
Pond 56P: 11 - 100 MH

Hydrograph

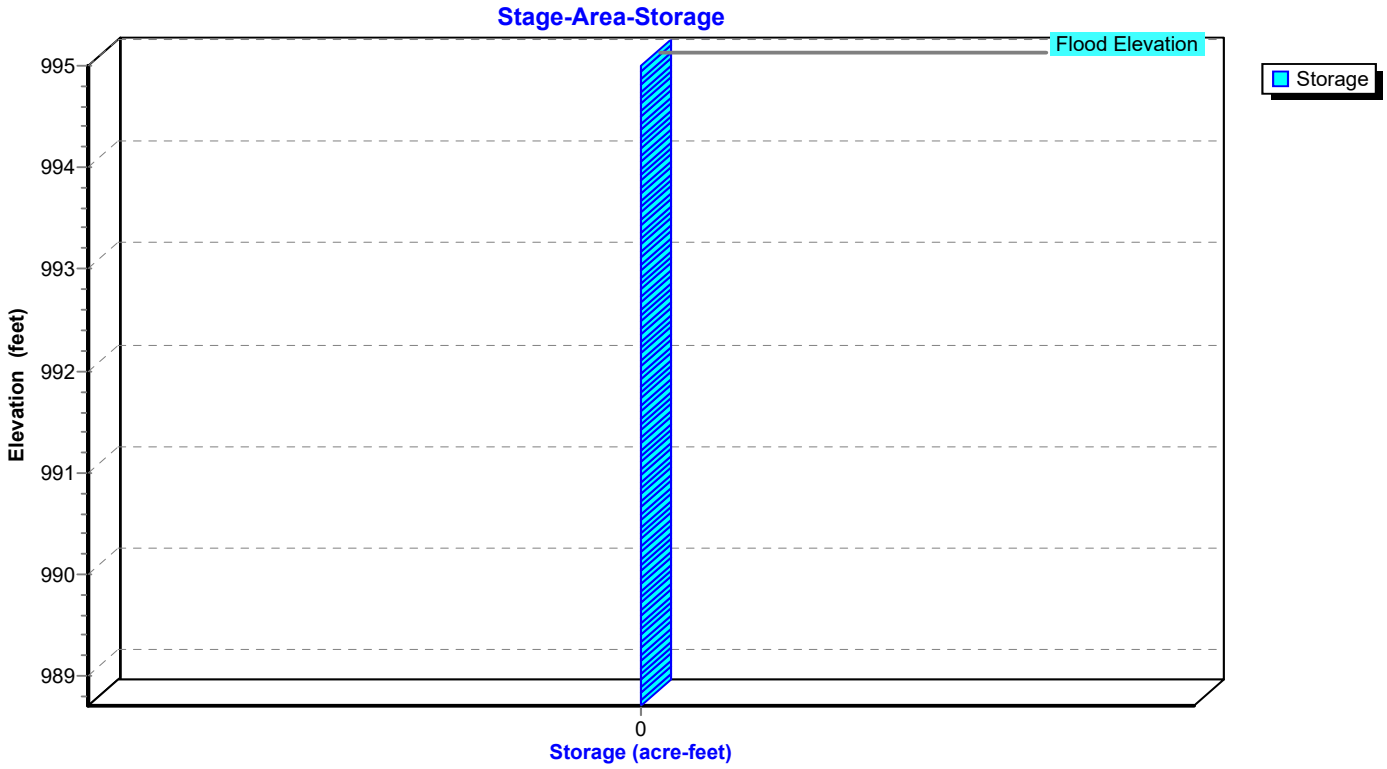


Pond 56P: 11 - 100 MH

Stage-Discharge

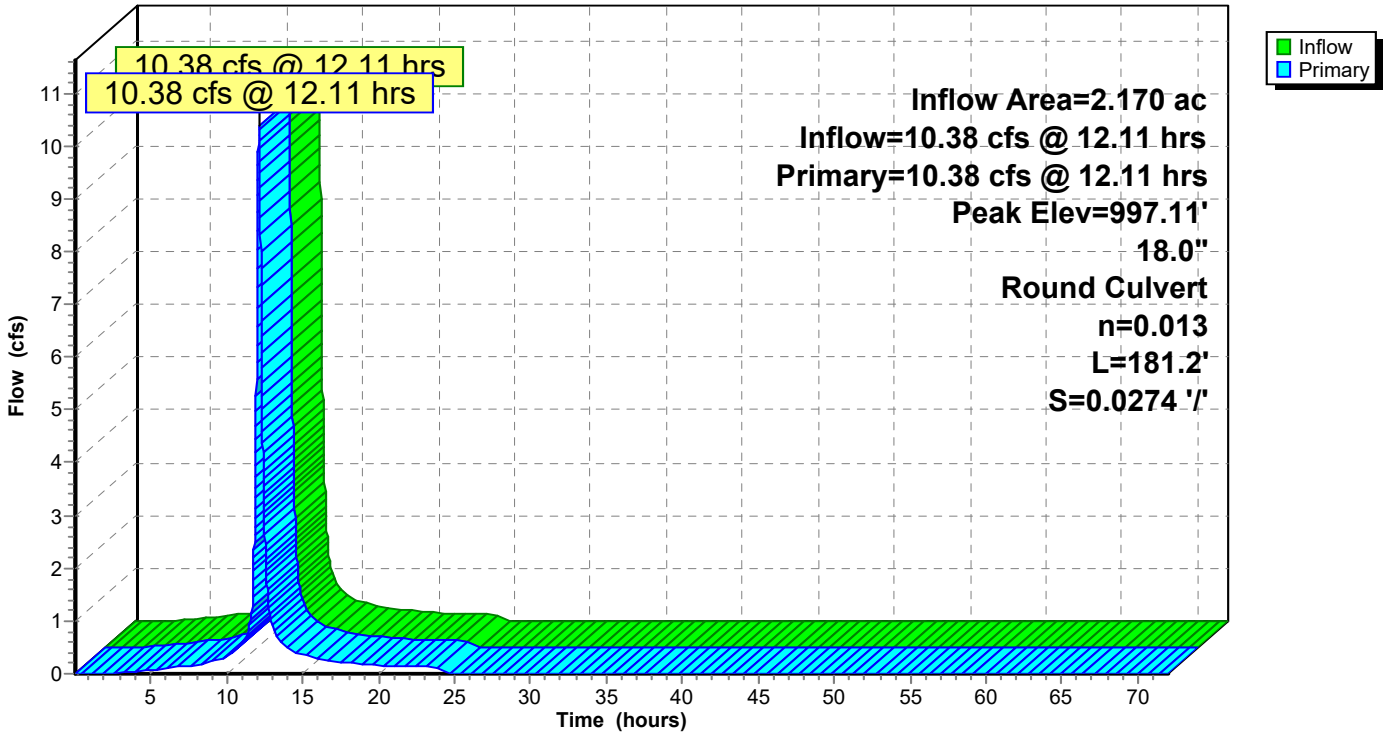


Pond 56P: 11 - 100 MH



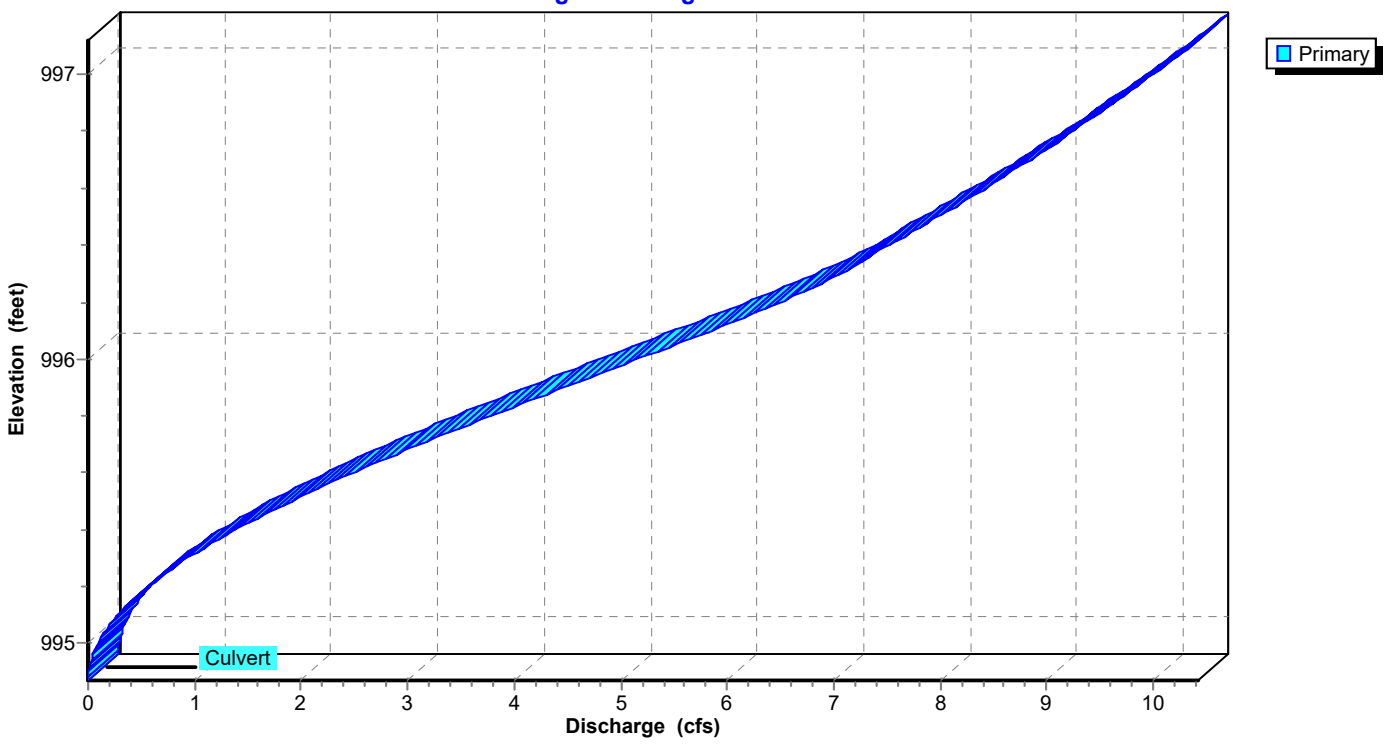
Pond 57P: 12-11

Hydrograph

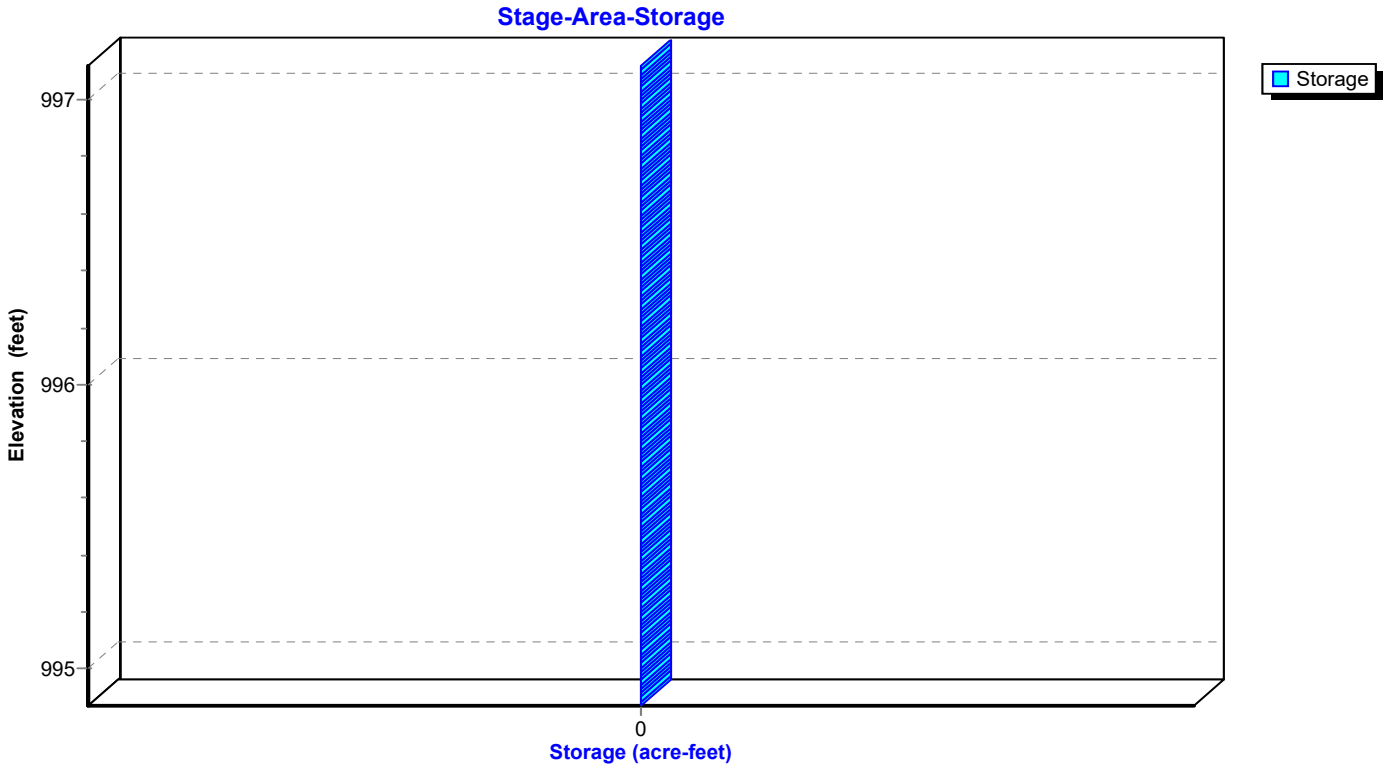


Pond 57P: 12-11

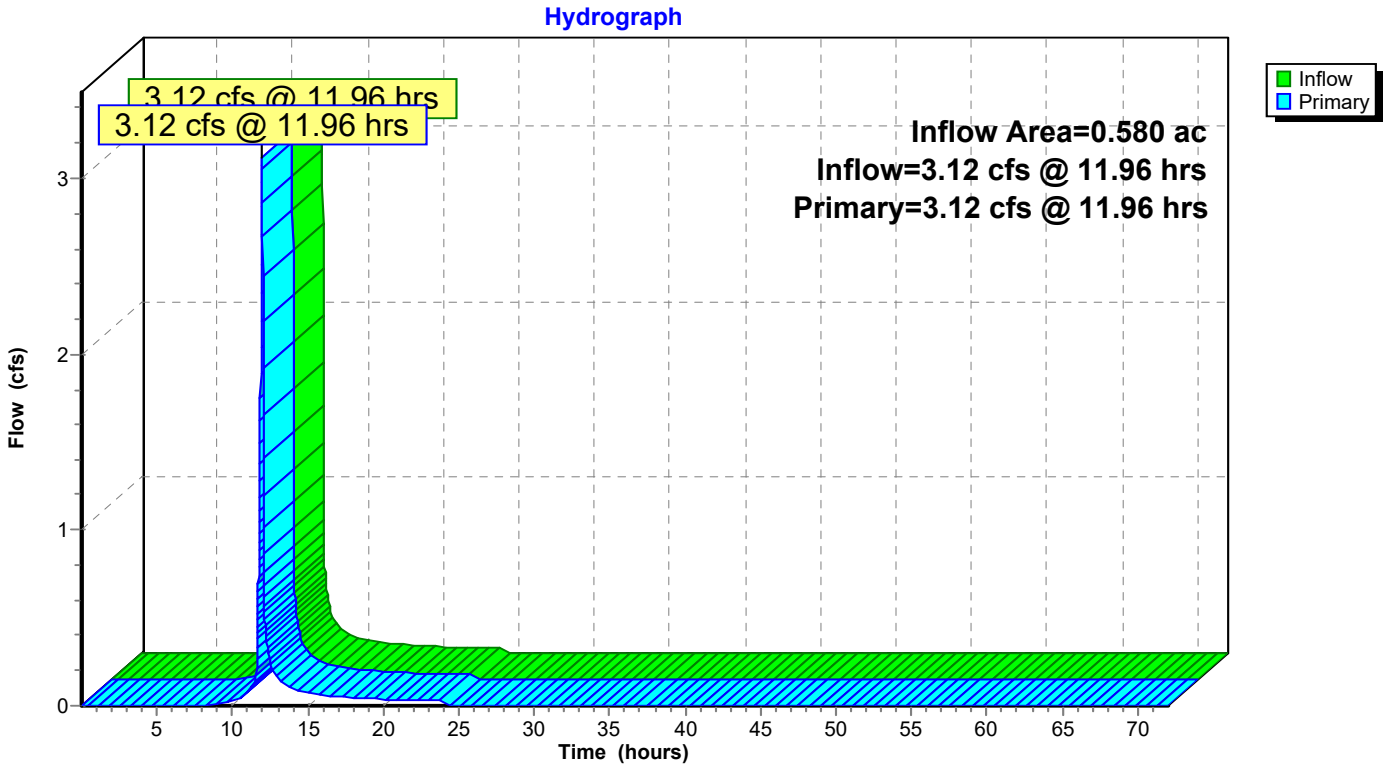
Stage-Discharge



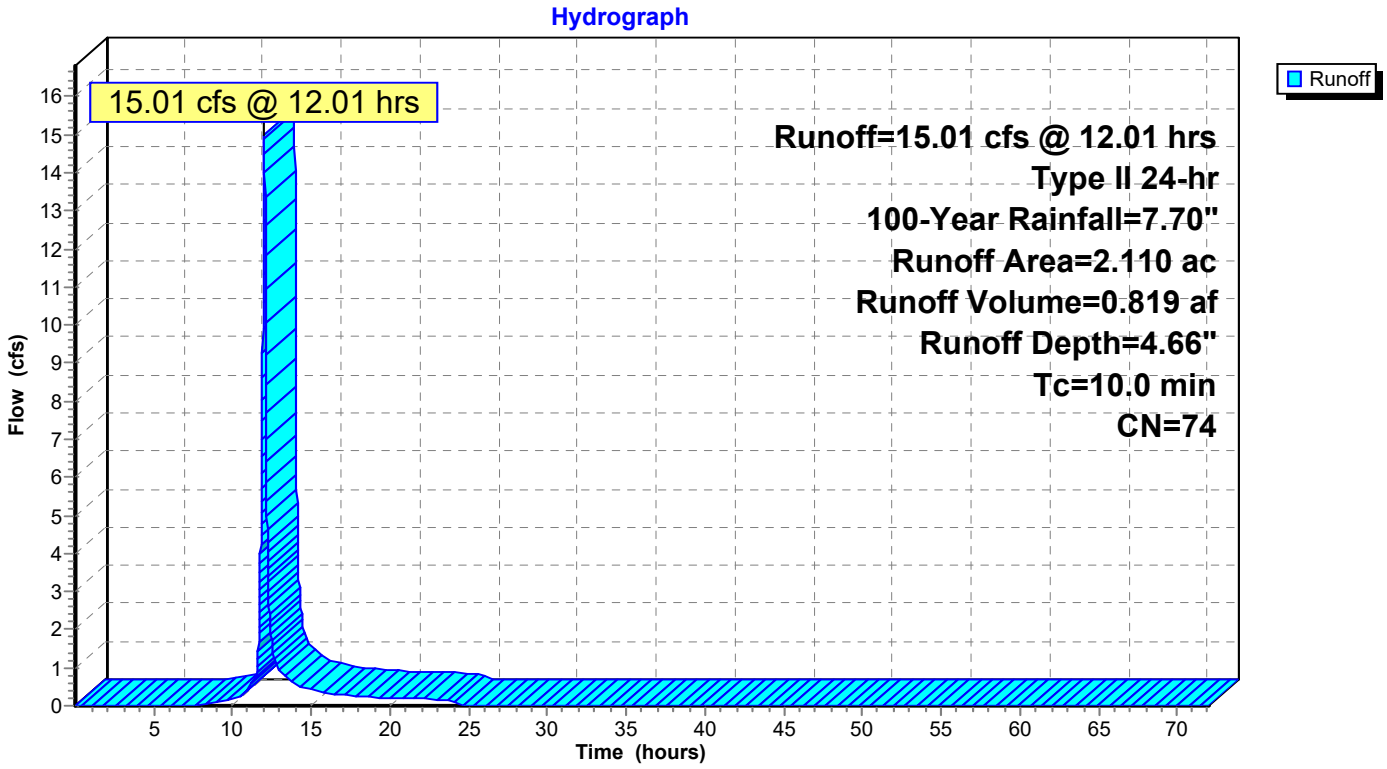
Pond 57P: 12-11



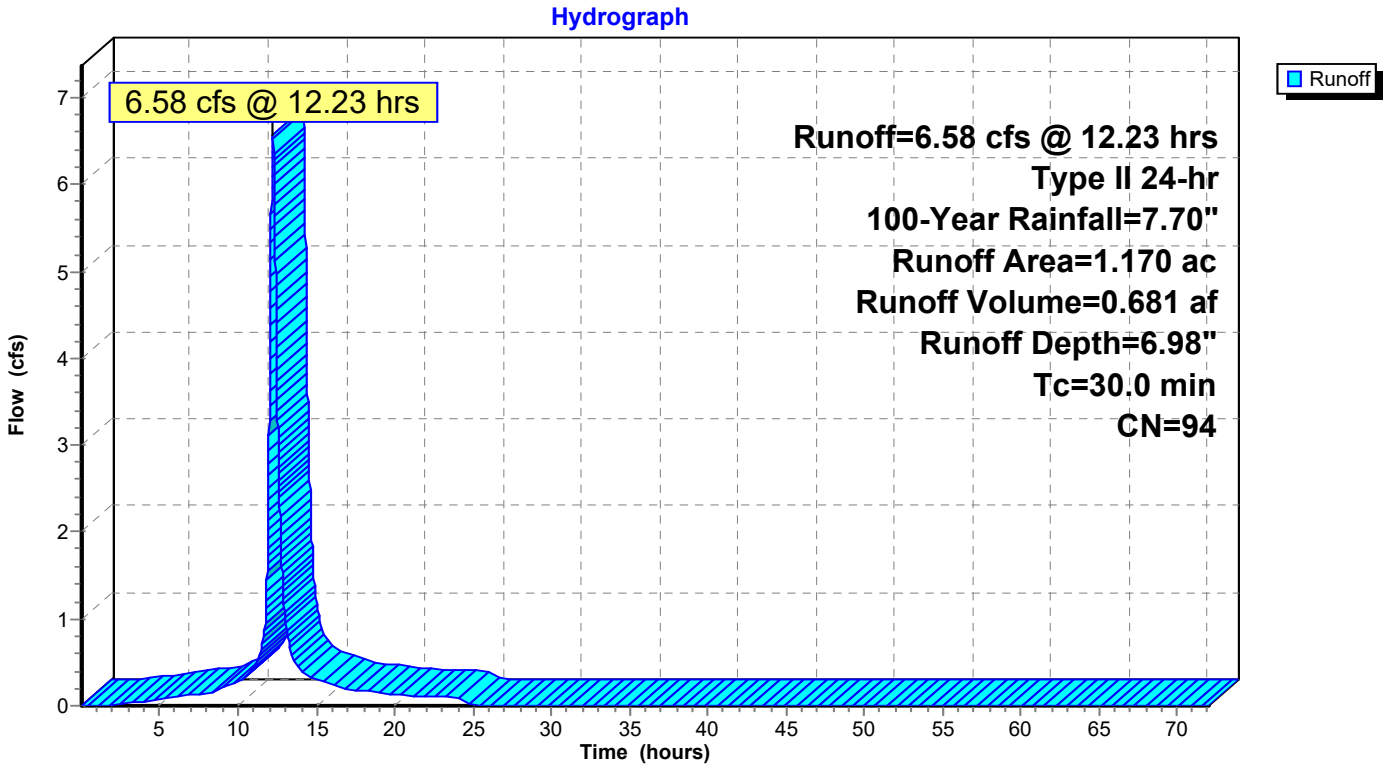
Link 90L: BYPASS AREAS



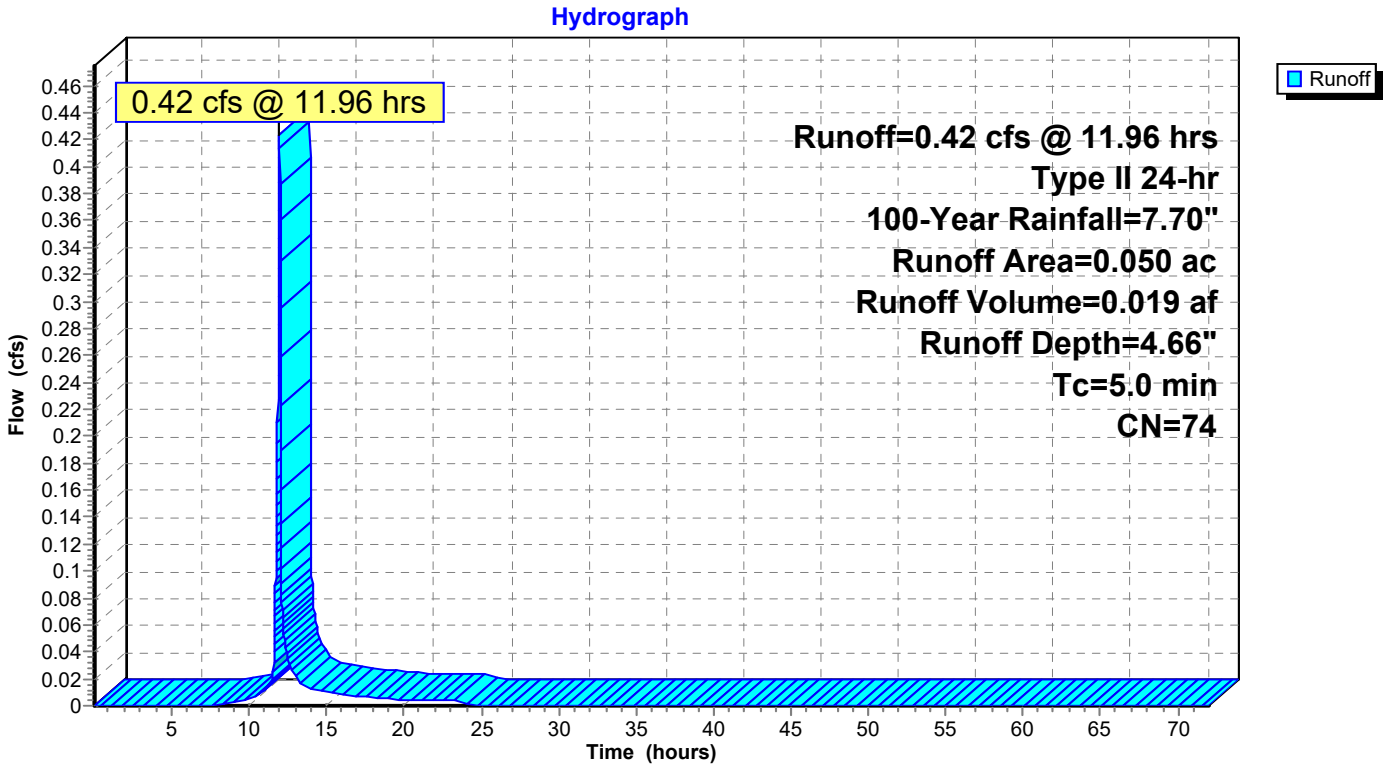
Subcatchment 1S: EXISTING CONDITIONS



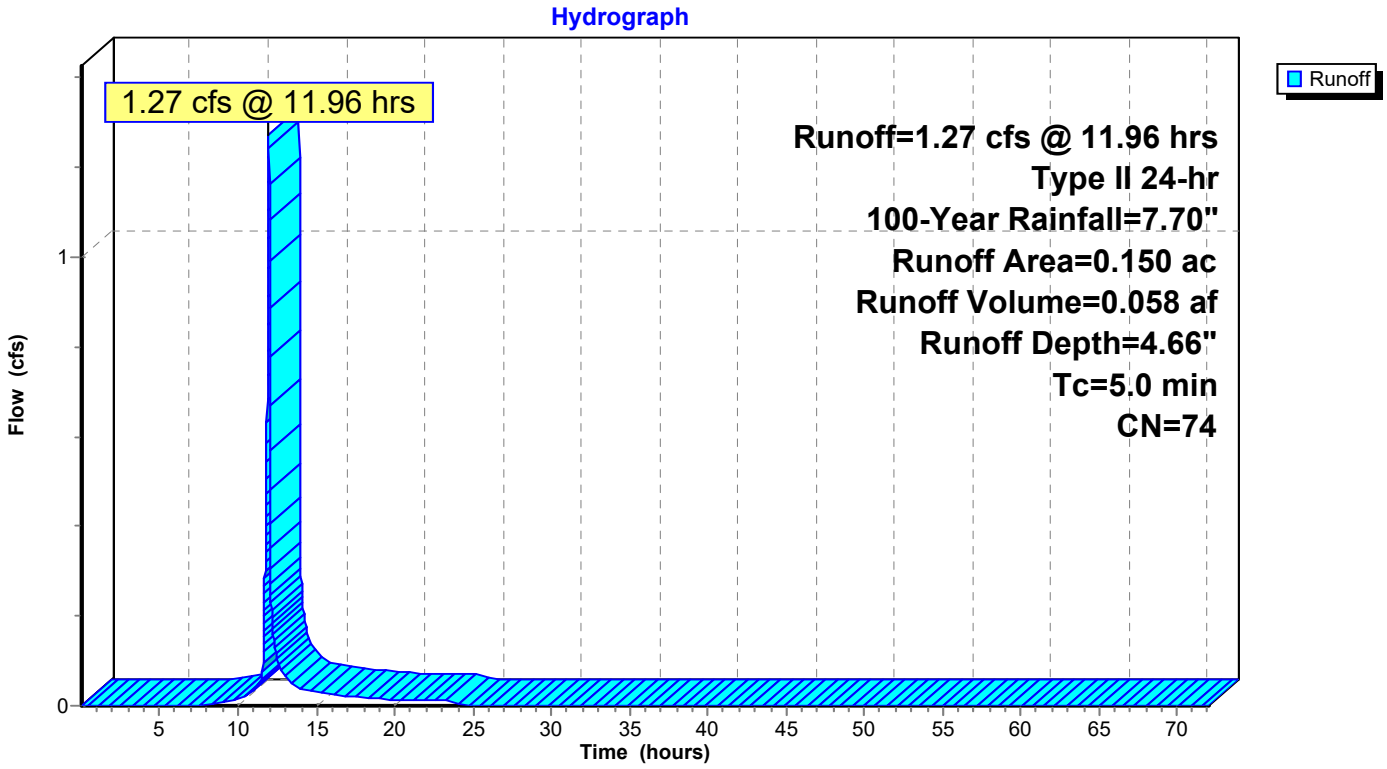
Subcatchment 2S: AREA A



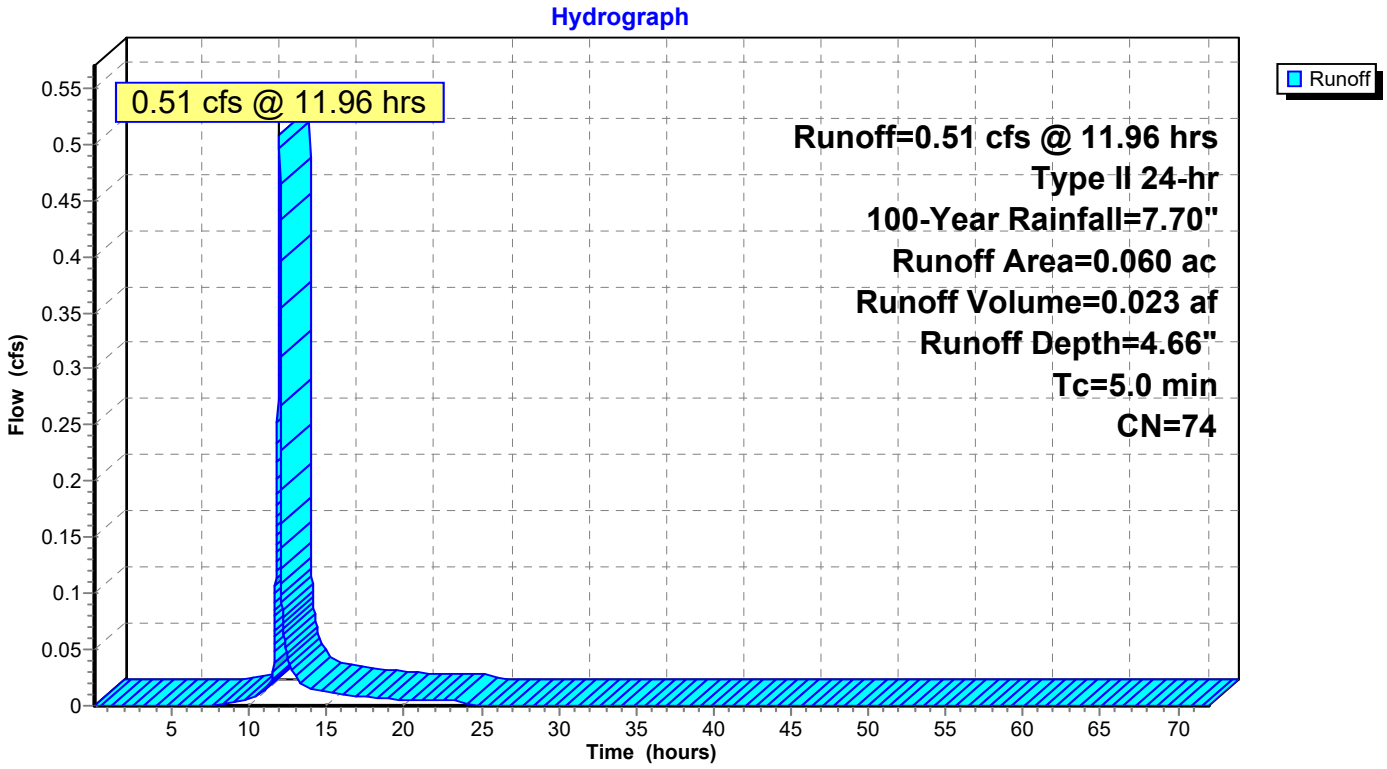
Subcatchment 3S: AREA B



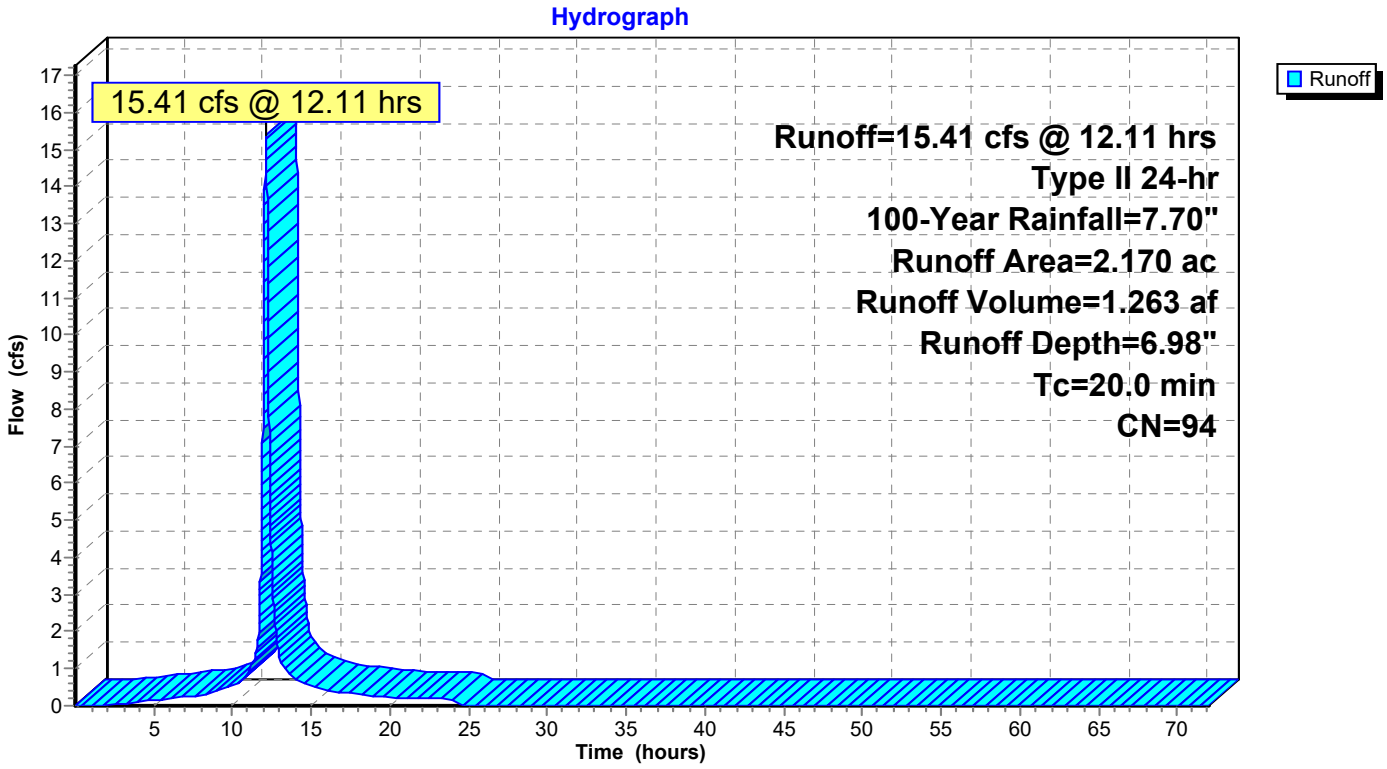
Subcatchment 4S: AREA C



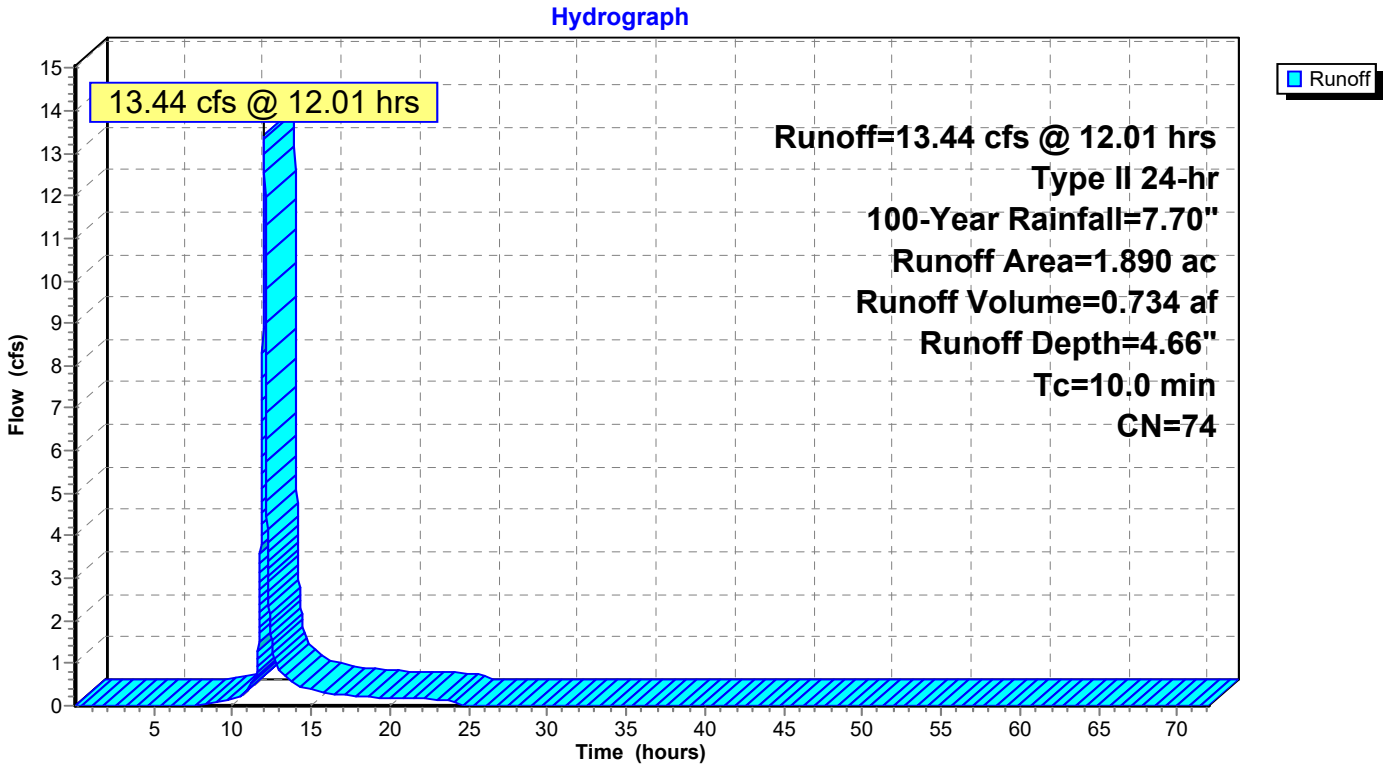
Subcatchment 5S: AREA D



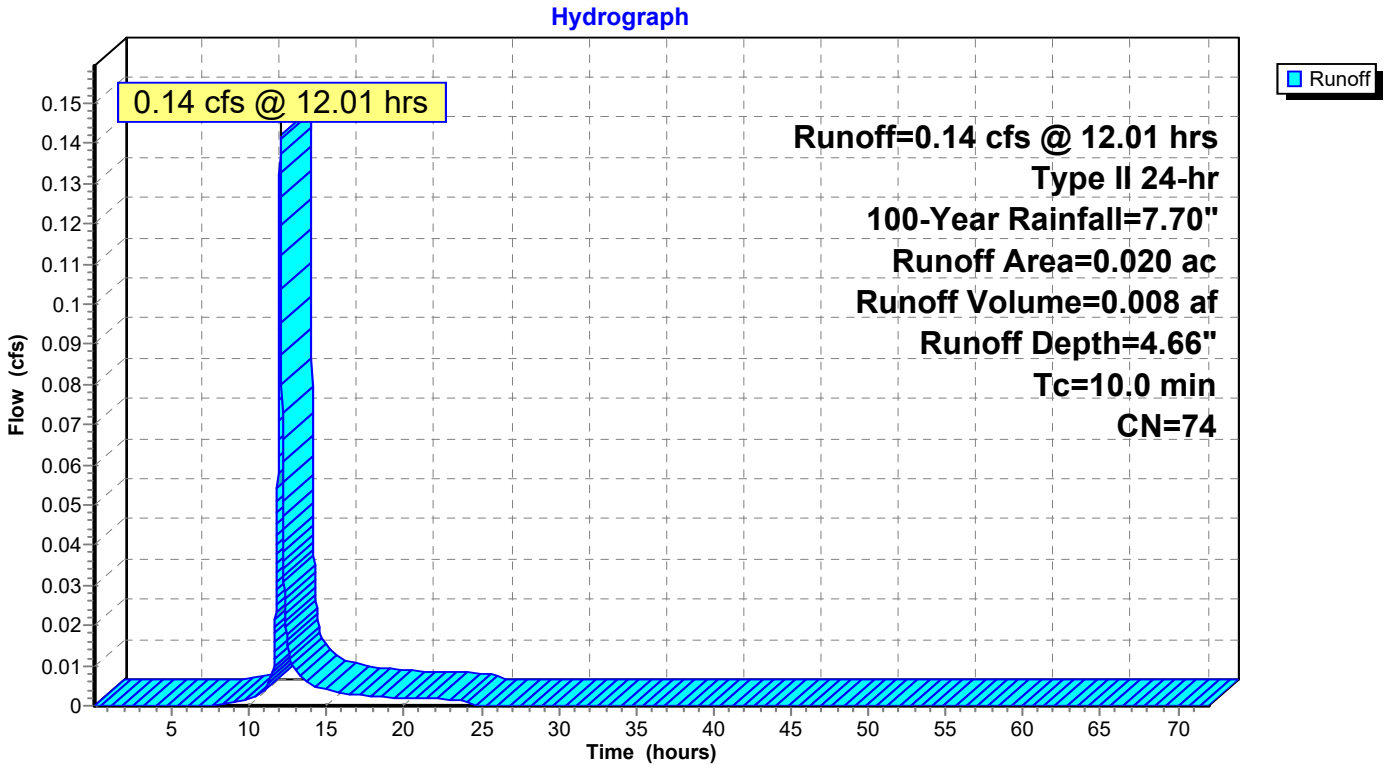
Subcatchment 6S: AREA E



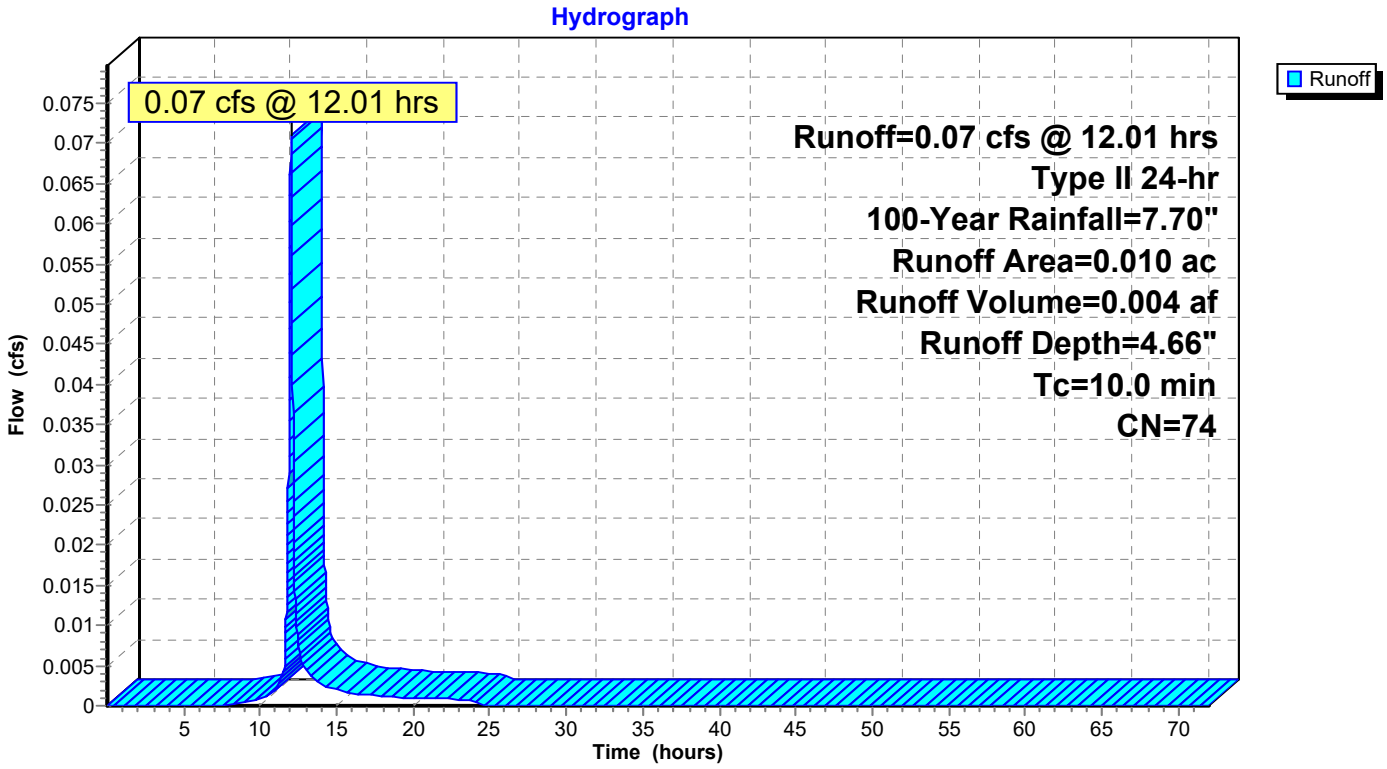
Subcatchment 7S: AREA F



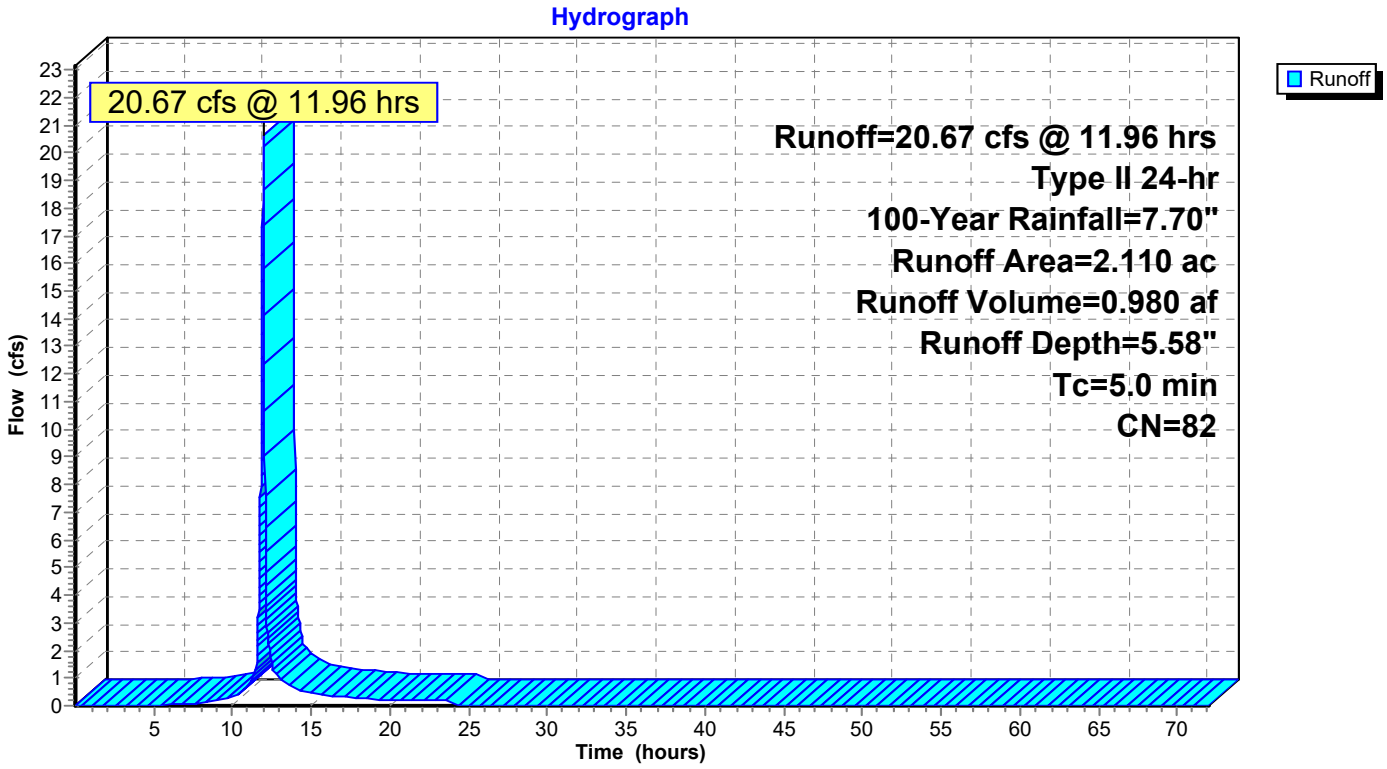
Subcatchment 8S: AREA G



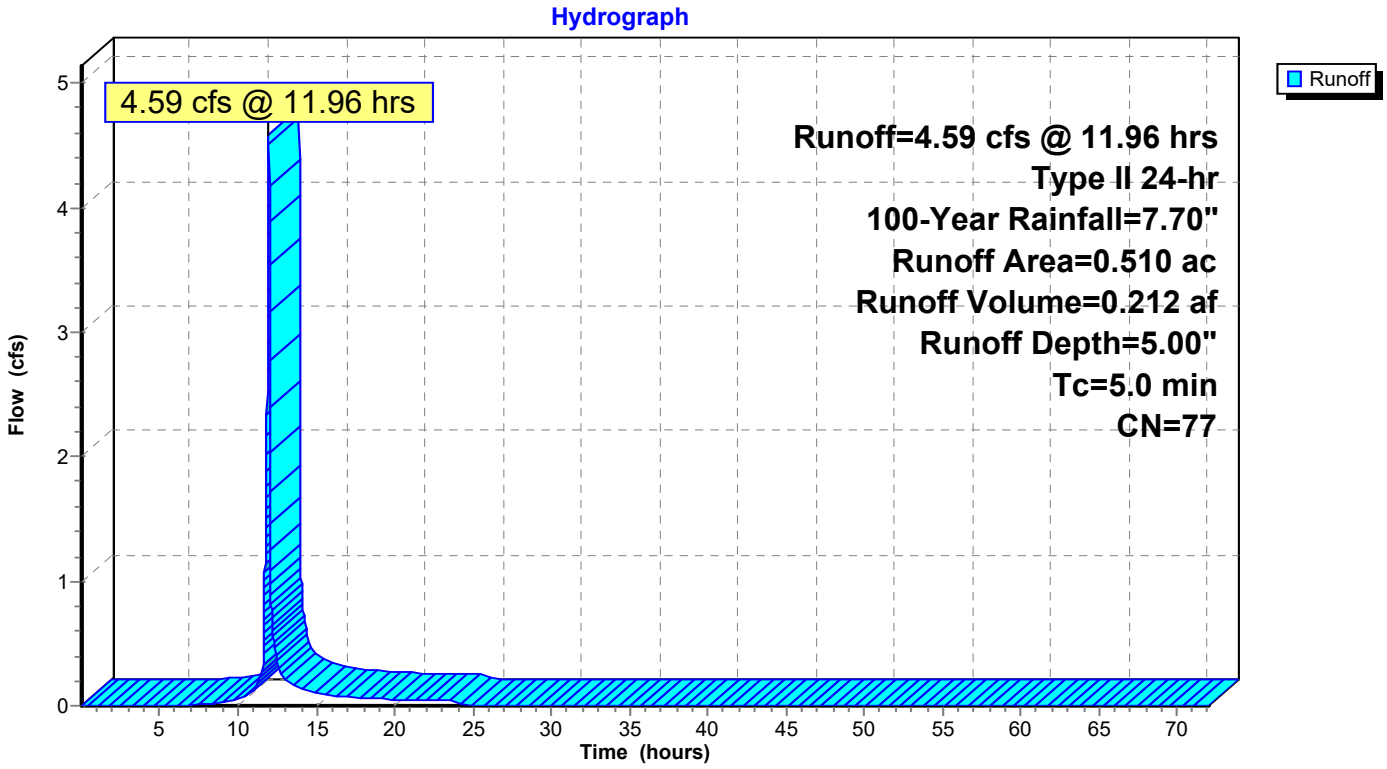
Subcatchment 9S: AREA H



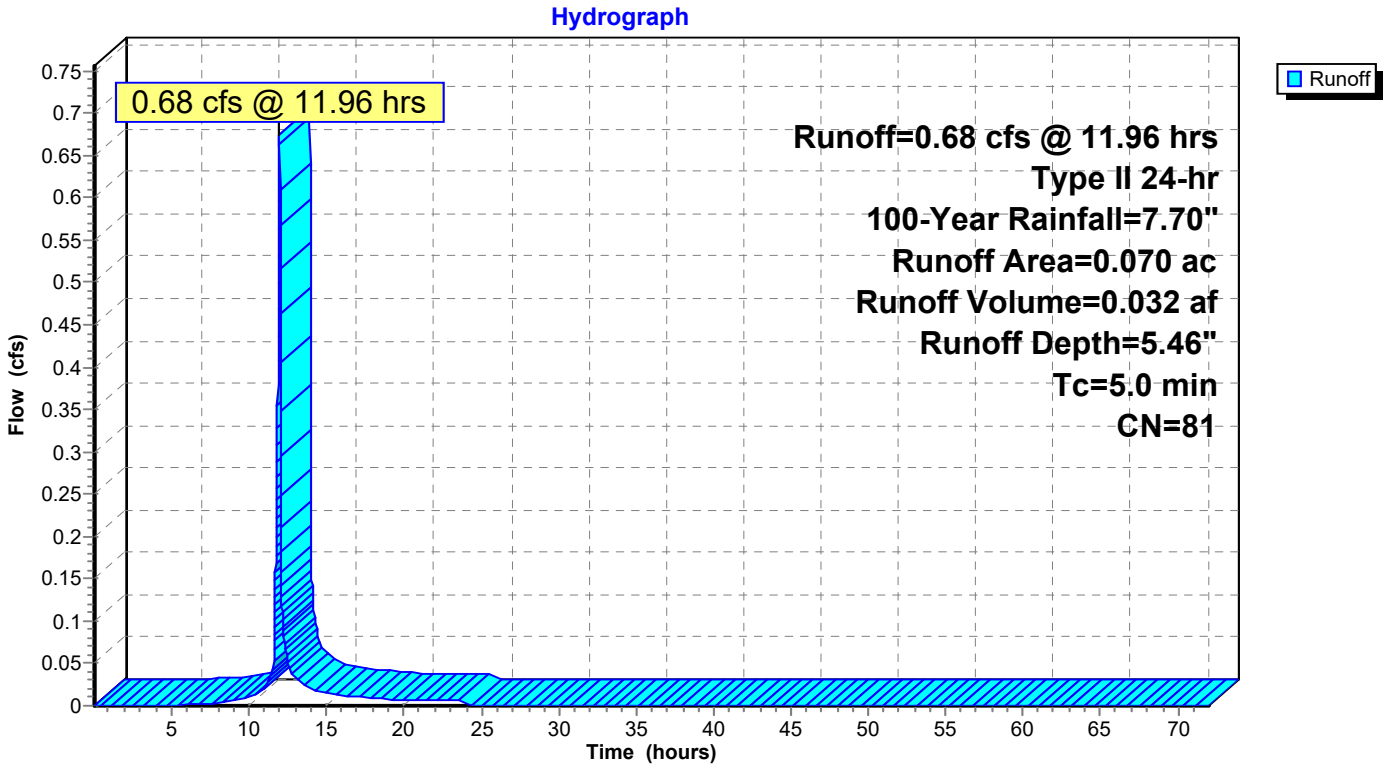
Subcatchment 10S: PROPOSED CONDITIONS



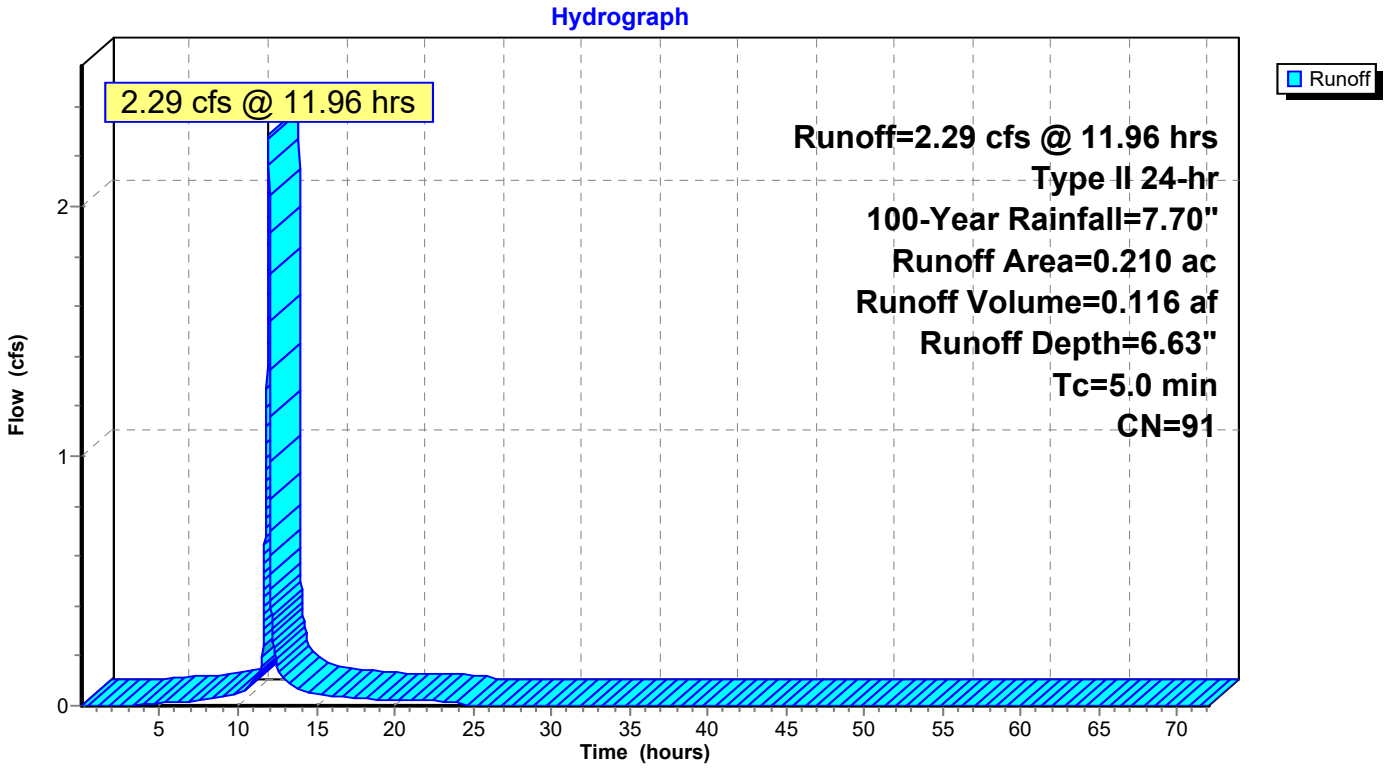
Subcatchment 60S: AREA 6



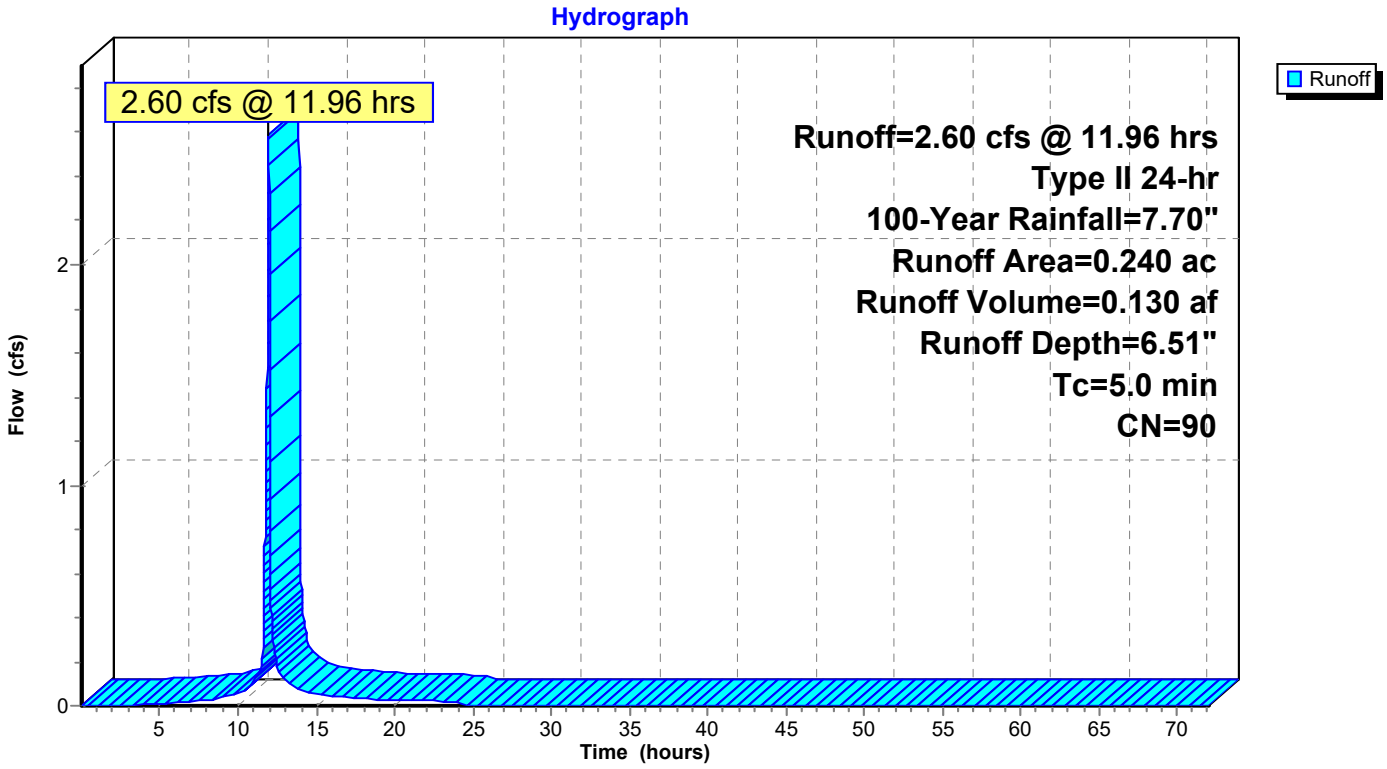
Subcatchment 61S: AREA 7



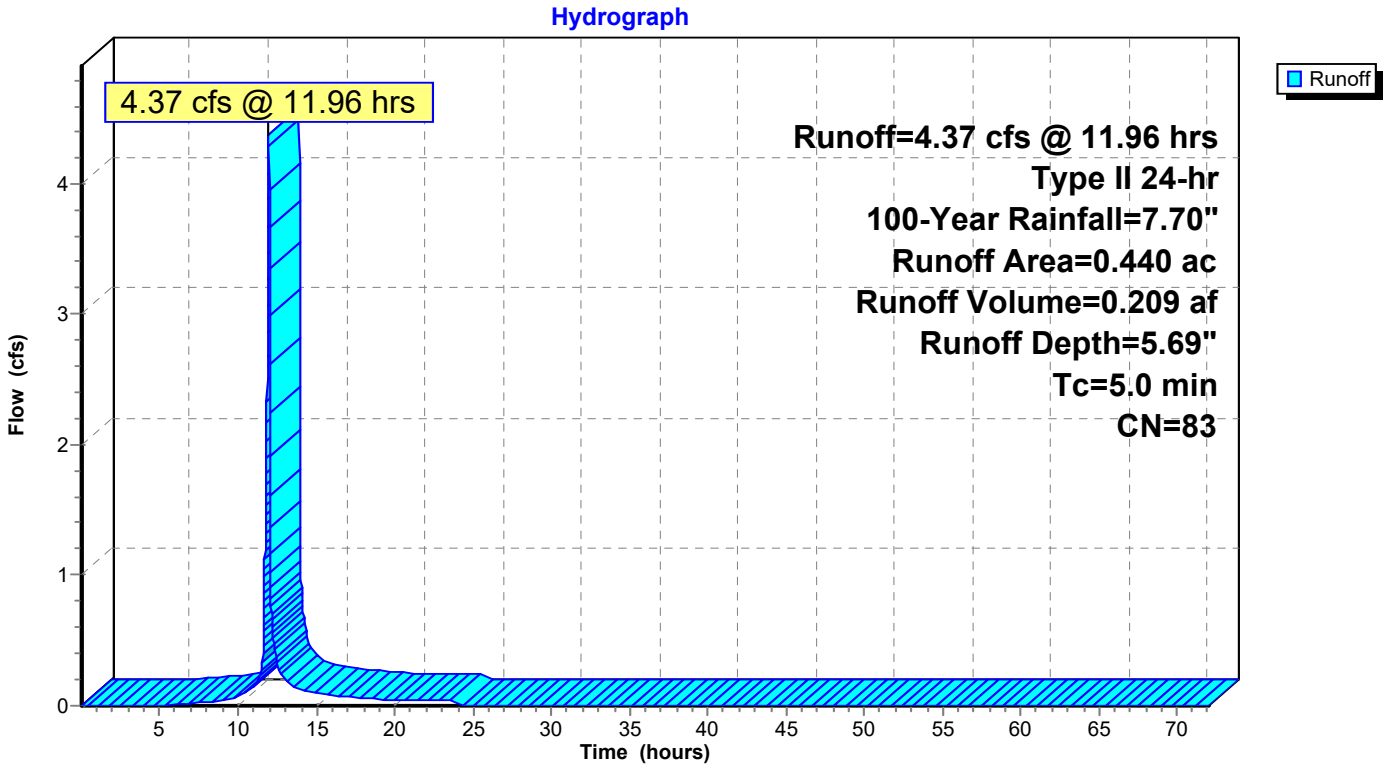
Subcatchment 62S: AREA 1



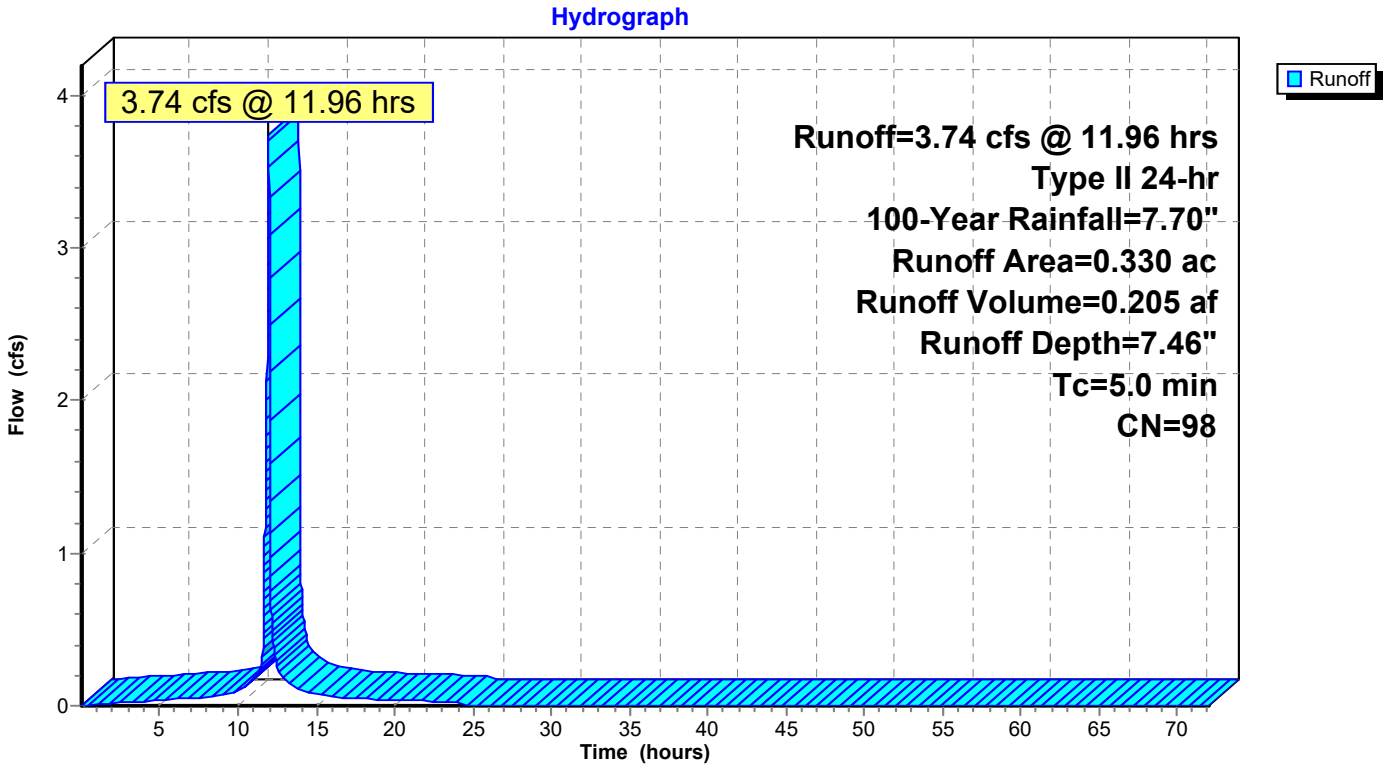
Subcatchment 63S: AREA 2



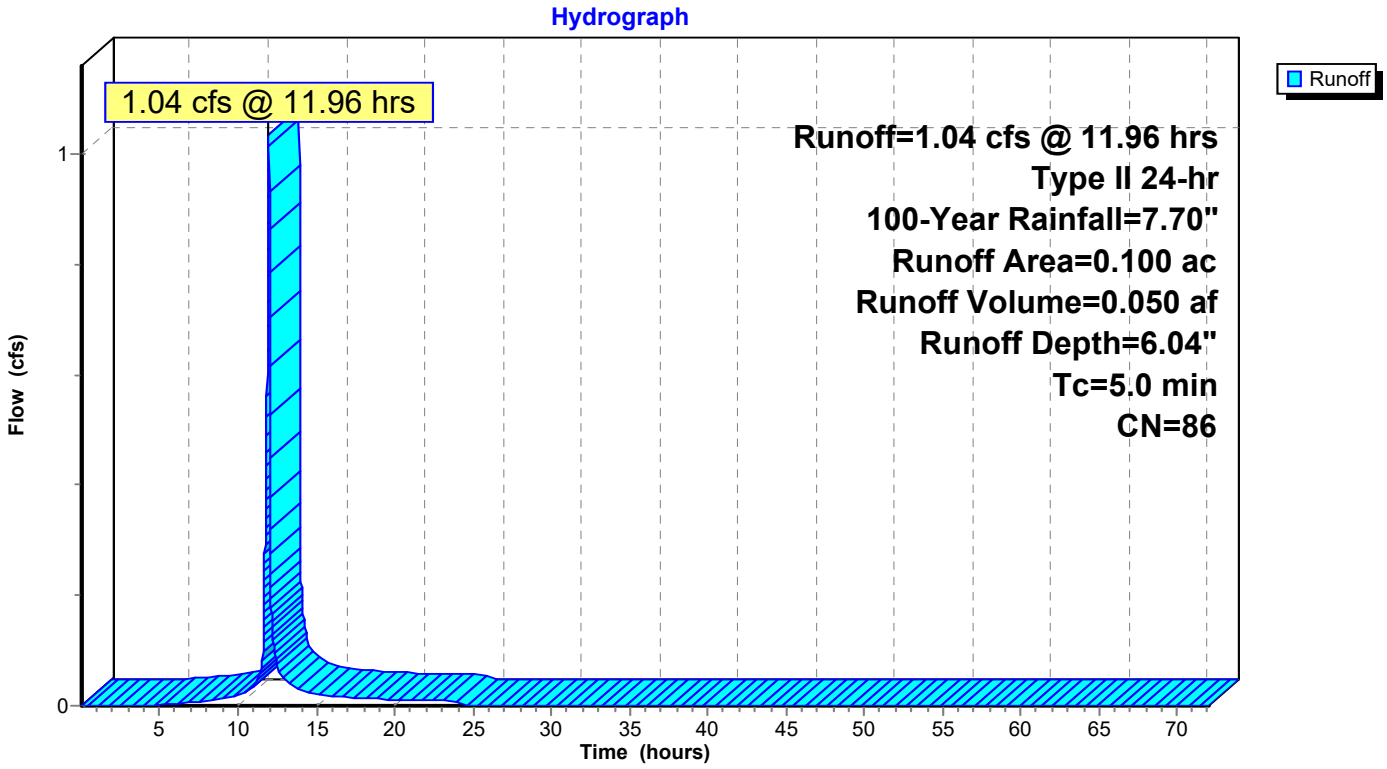
Subcatchment 64S: AREA 3



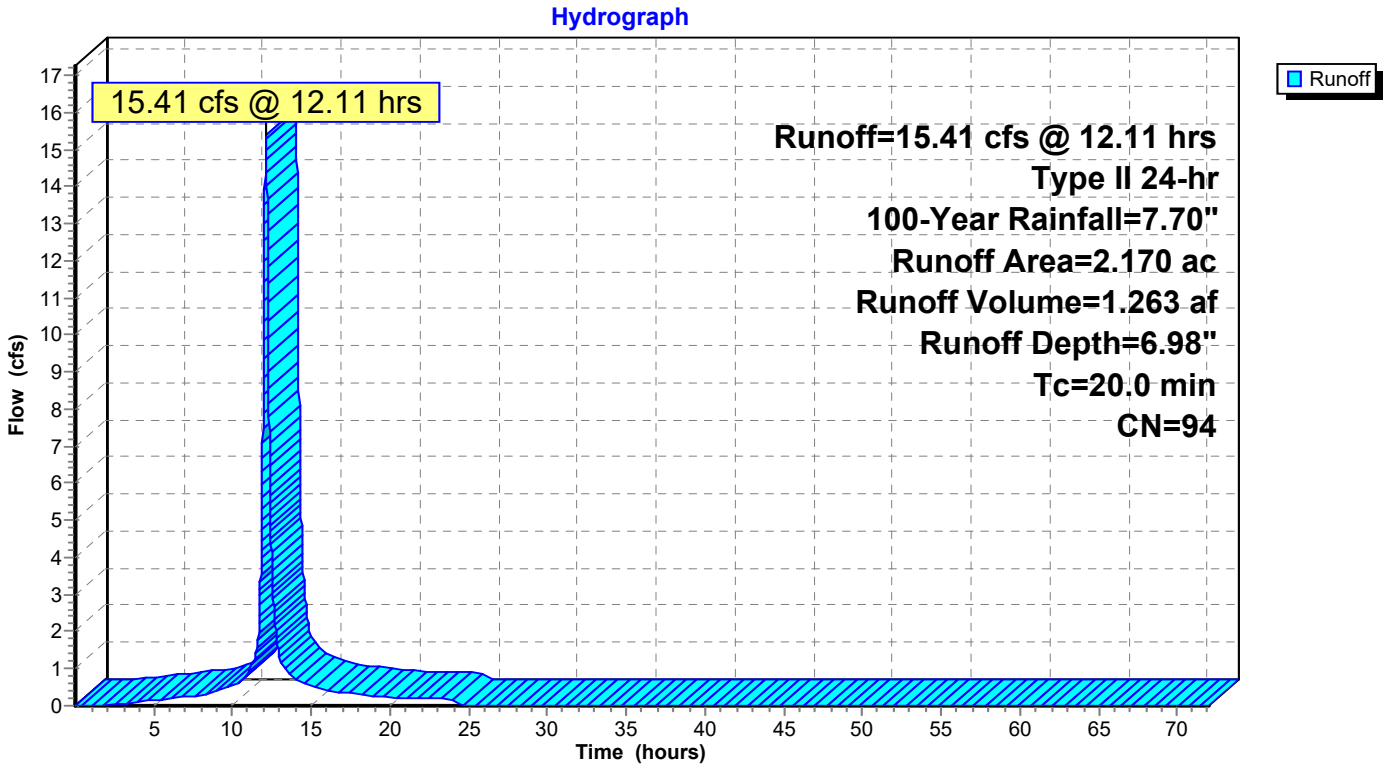
Subcatchment 65S: AREA 4



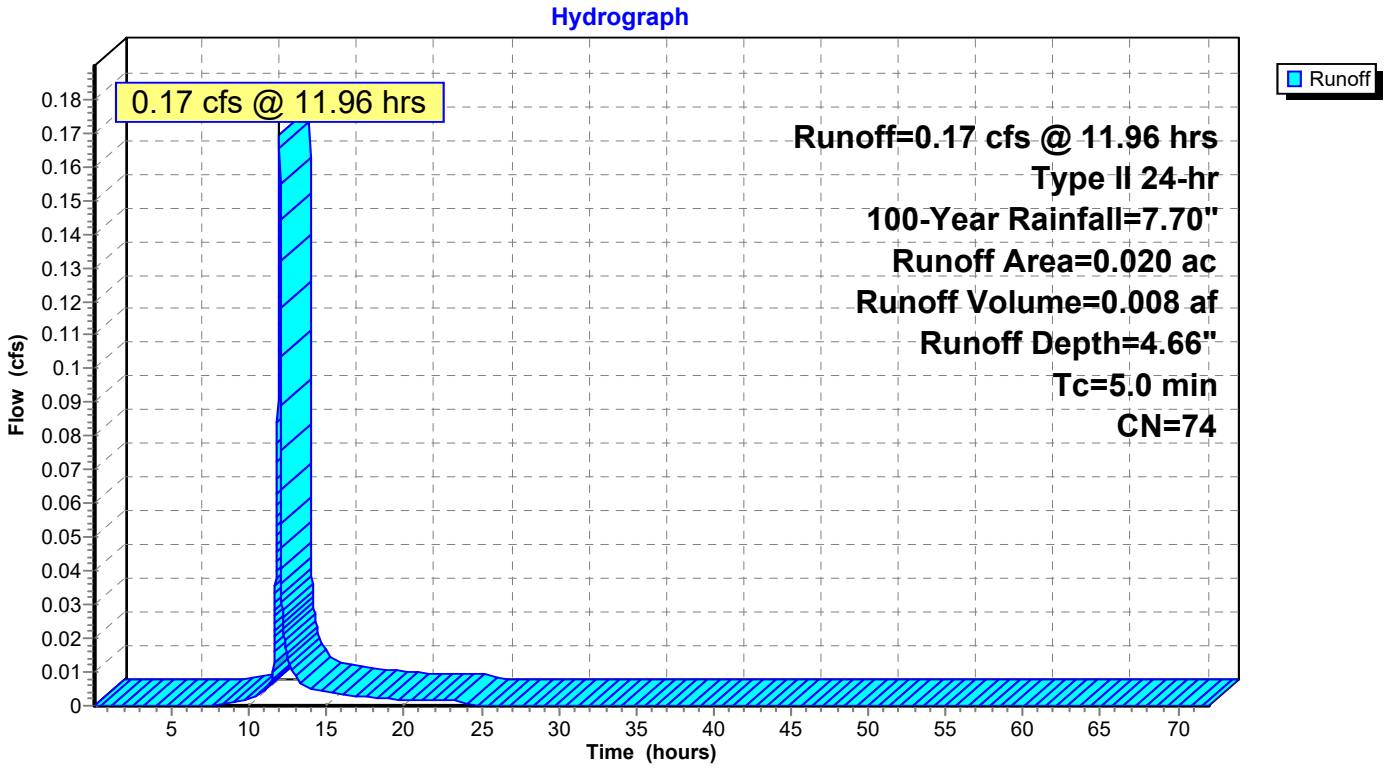
Subcatchment 66S: AREA 5



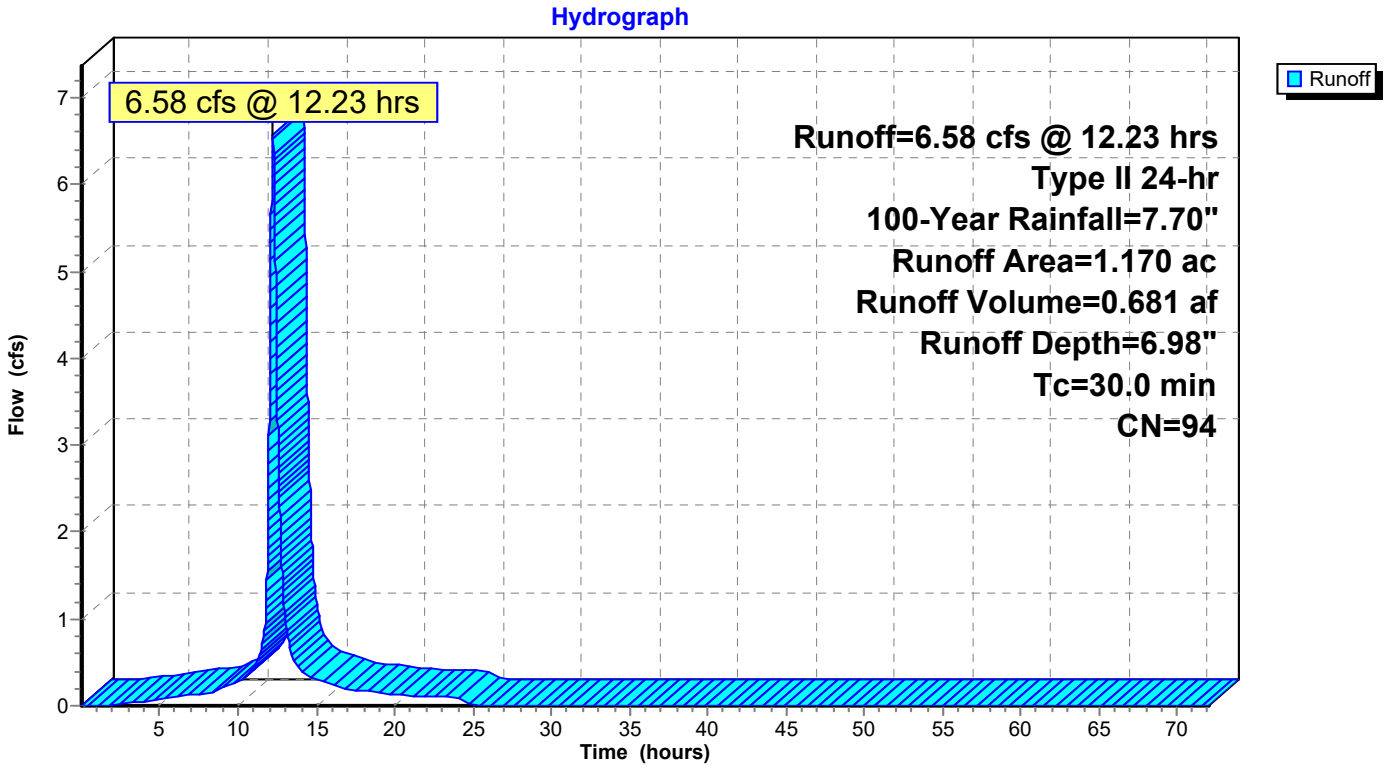
Subcatchment 67S: OFFSITE TO CI 12



Subcatchment 68S: AREA TO AI 11

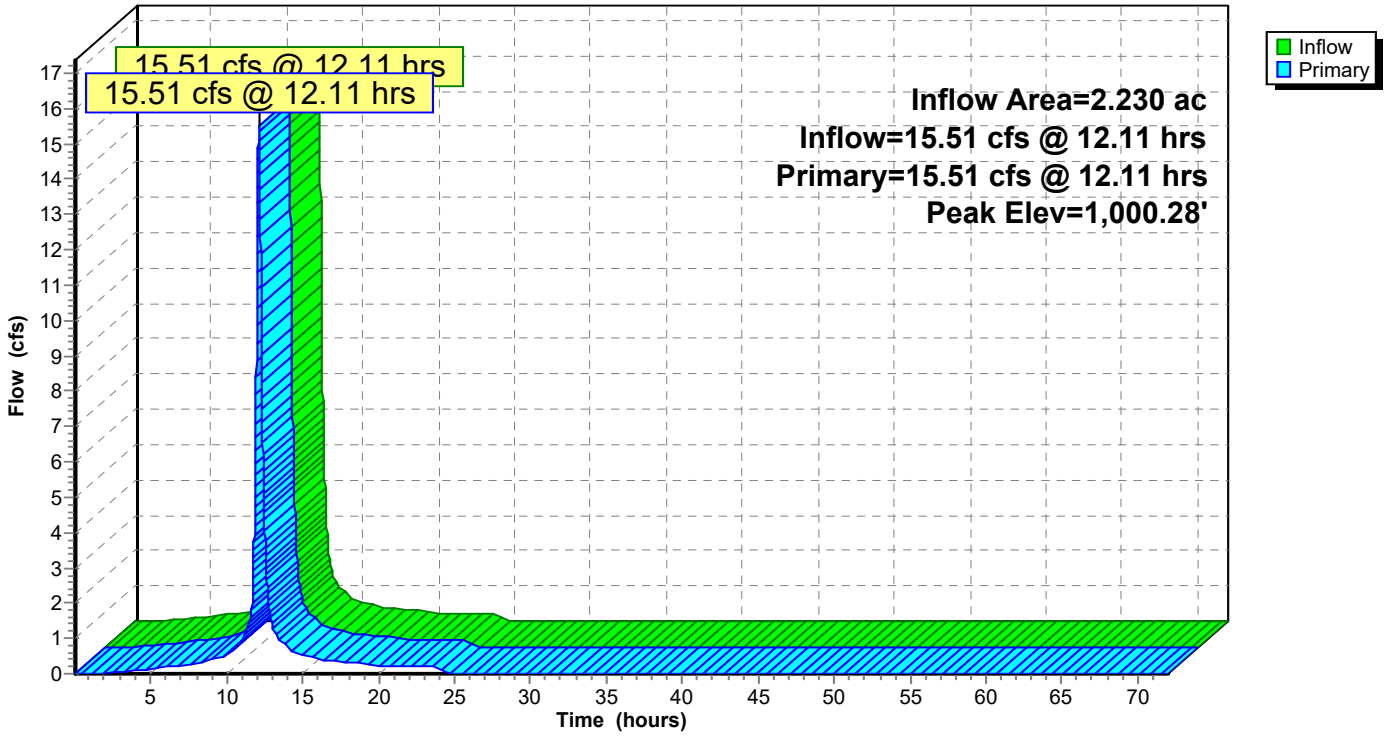


Subcatchment 69S: OFFSITE TO BMP



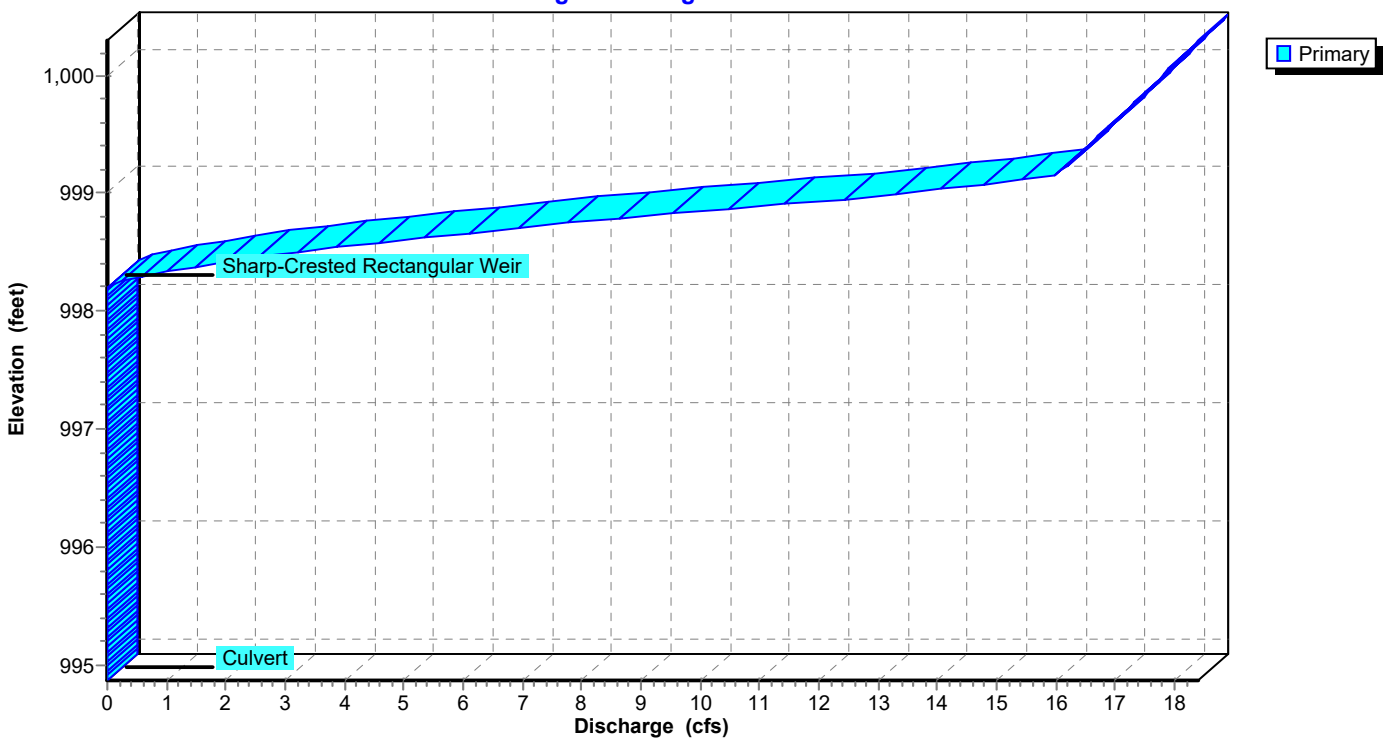
Pond 10P: 12-11

Hydrograph

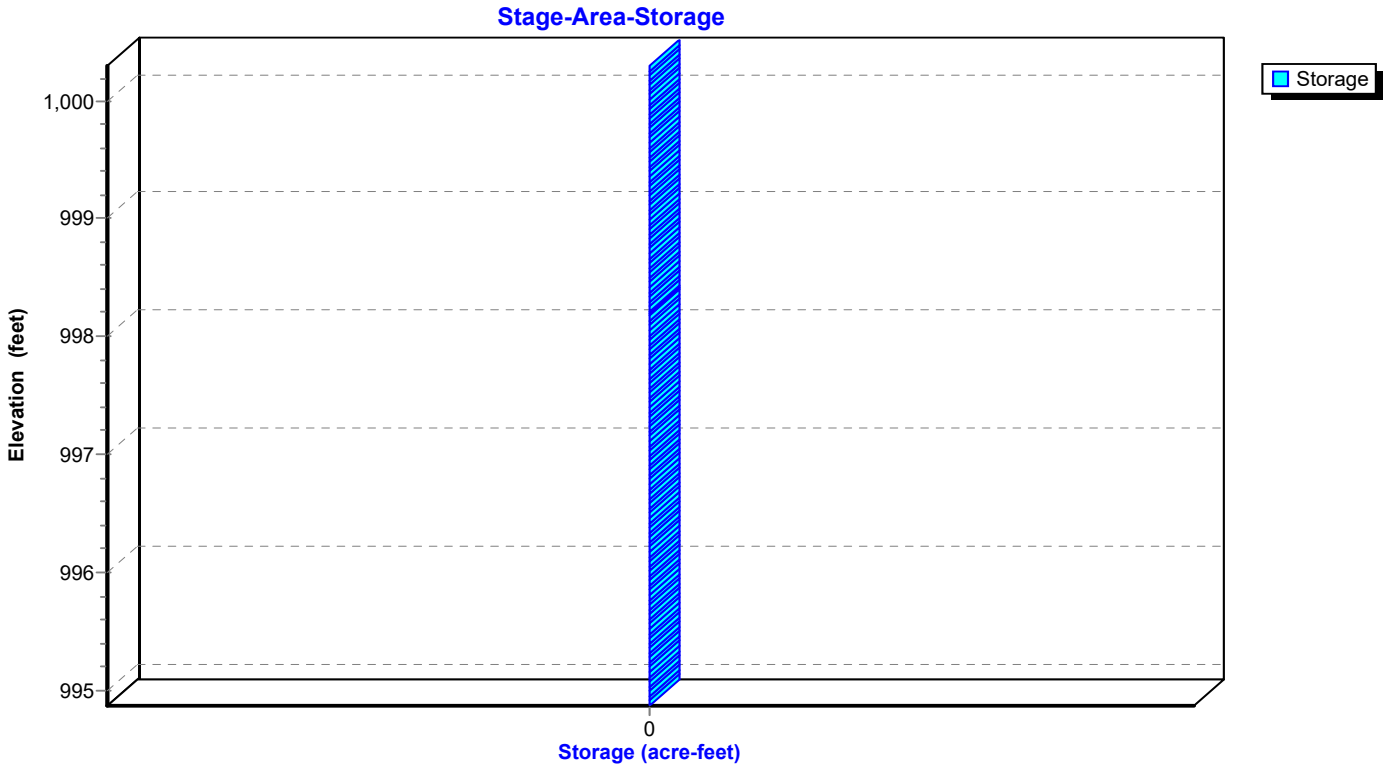


Pond 10P: 12-11

Stage-Discharge

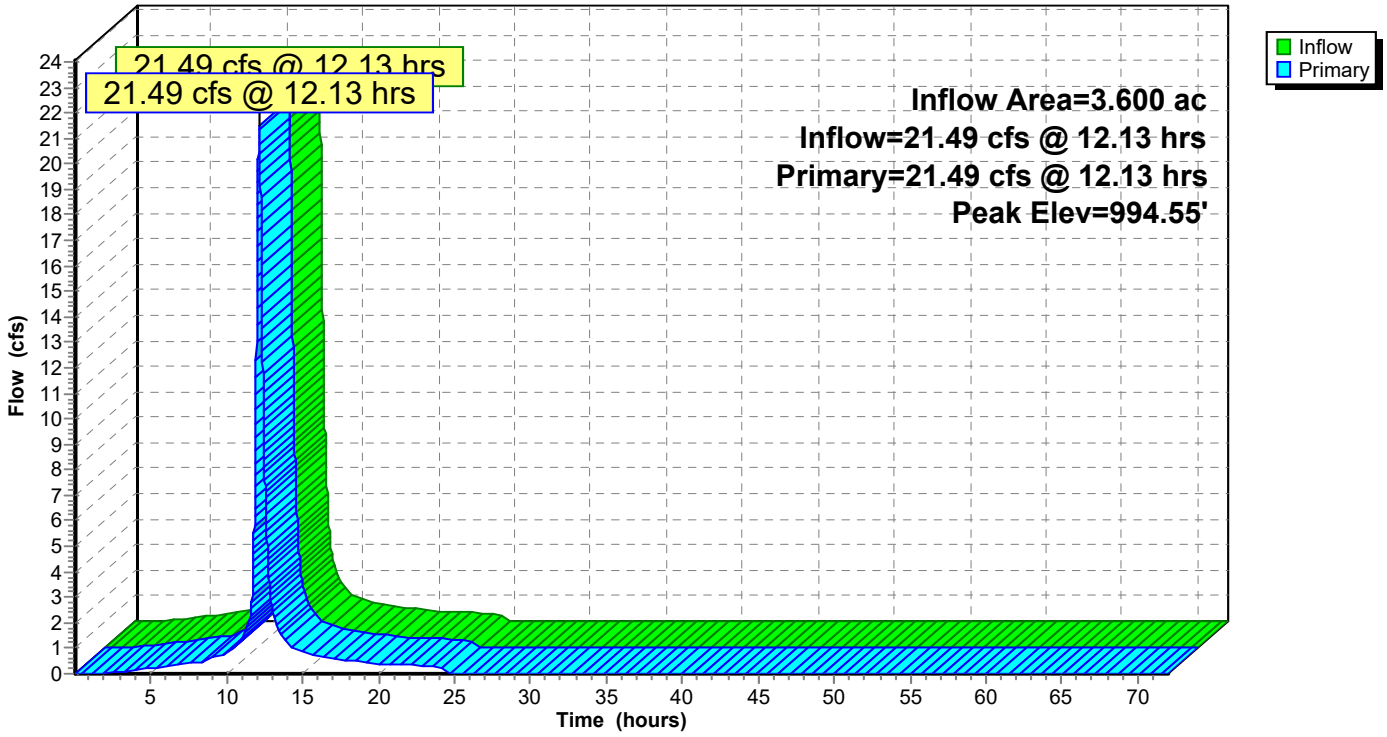


Pond 10P: 12-11



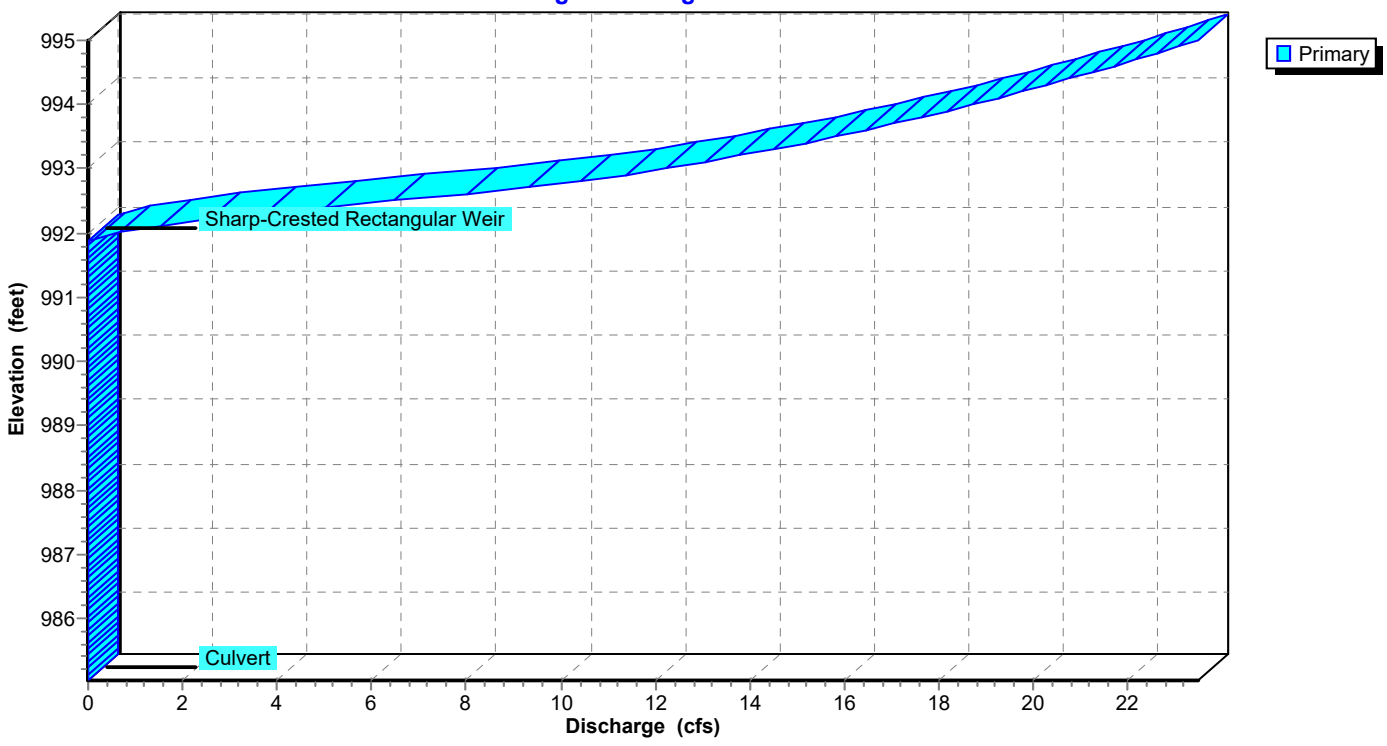
Pond 11P: 11-10

Hydrograph

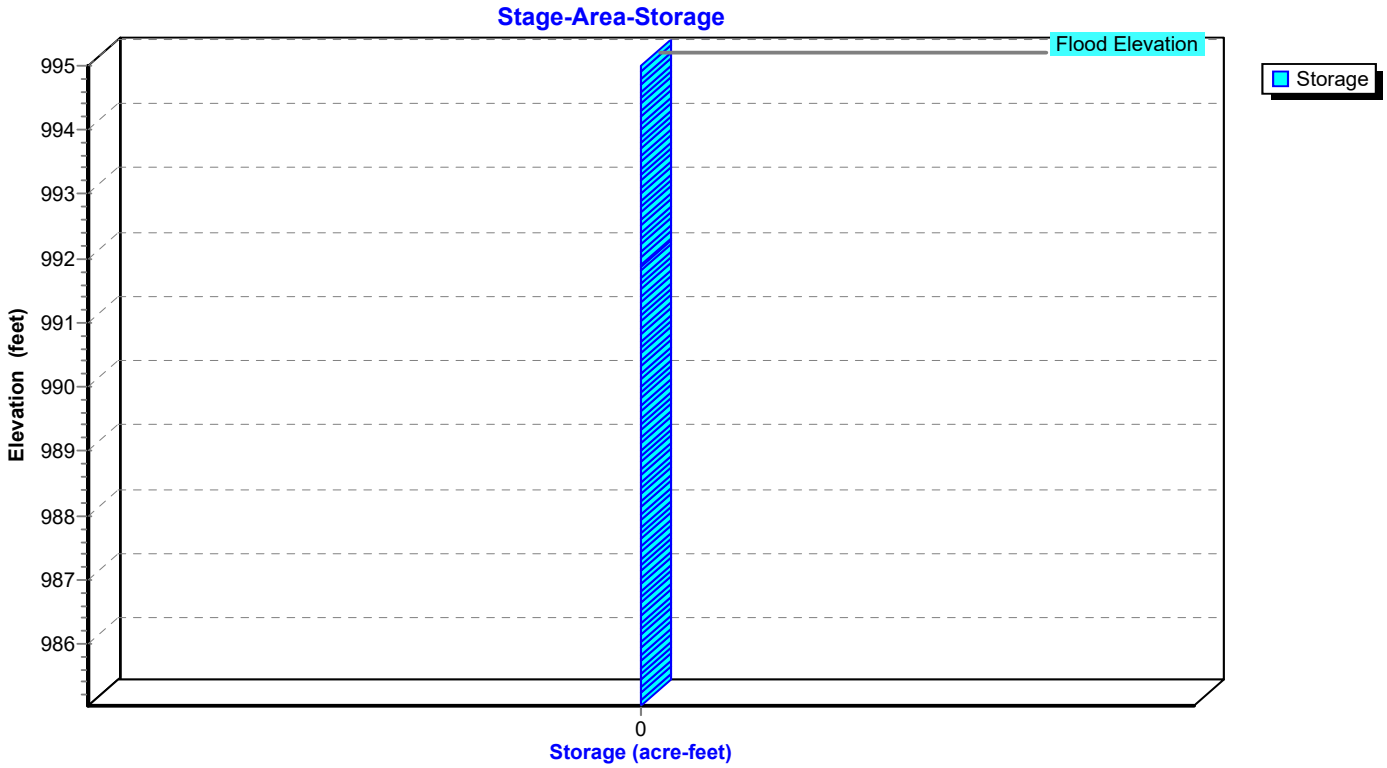


Pond 11P: 11-10

Stage-Discharge

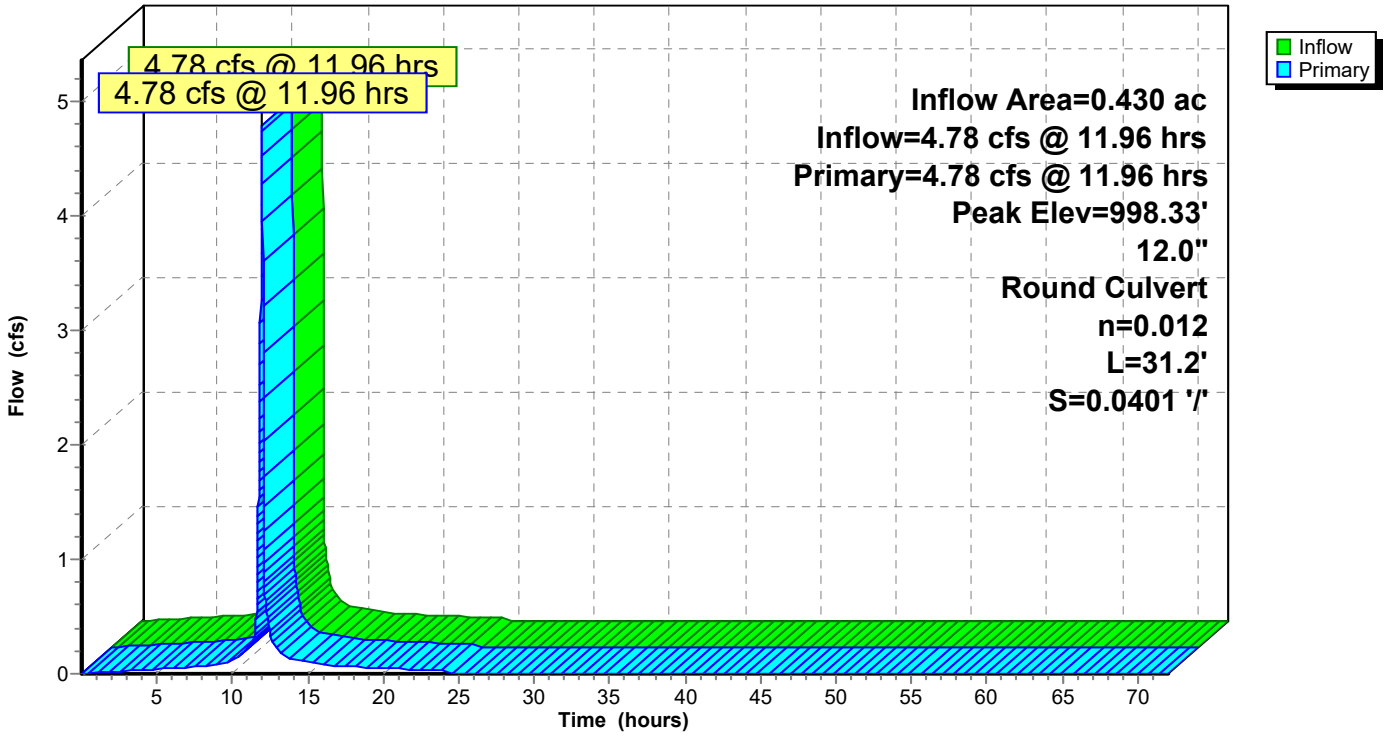


Pond 11P: 11-10



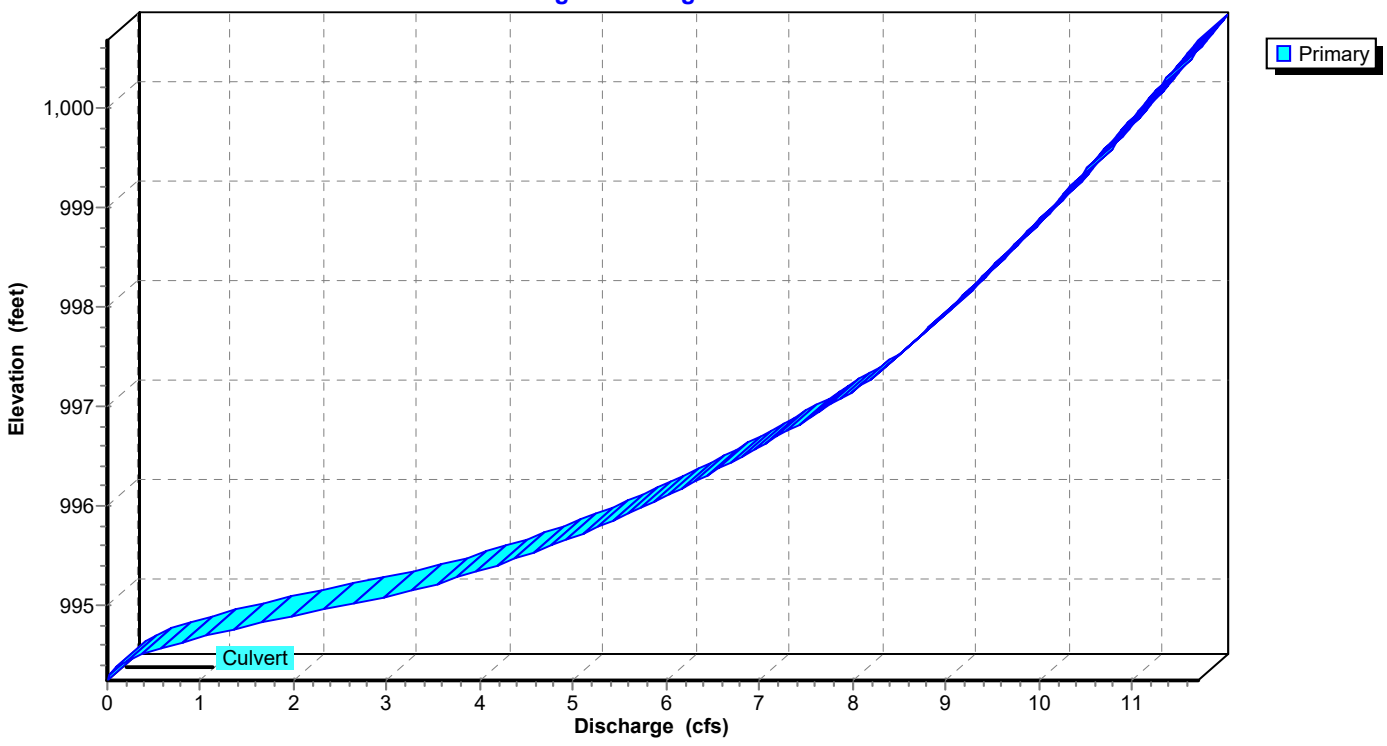
Pond 50P: BASIN REACH

Hydrograph

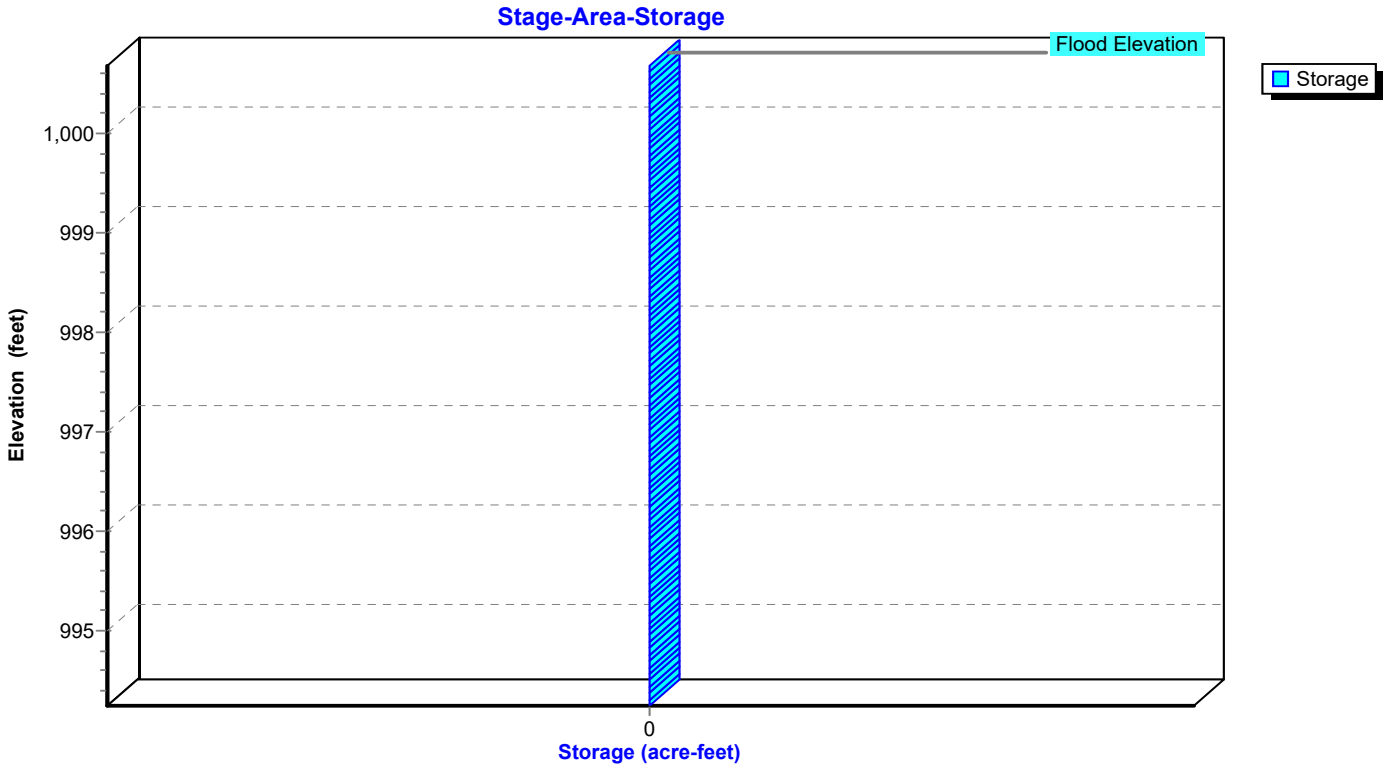


Pond 50P: BASIN REACH

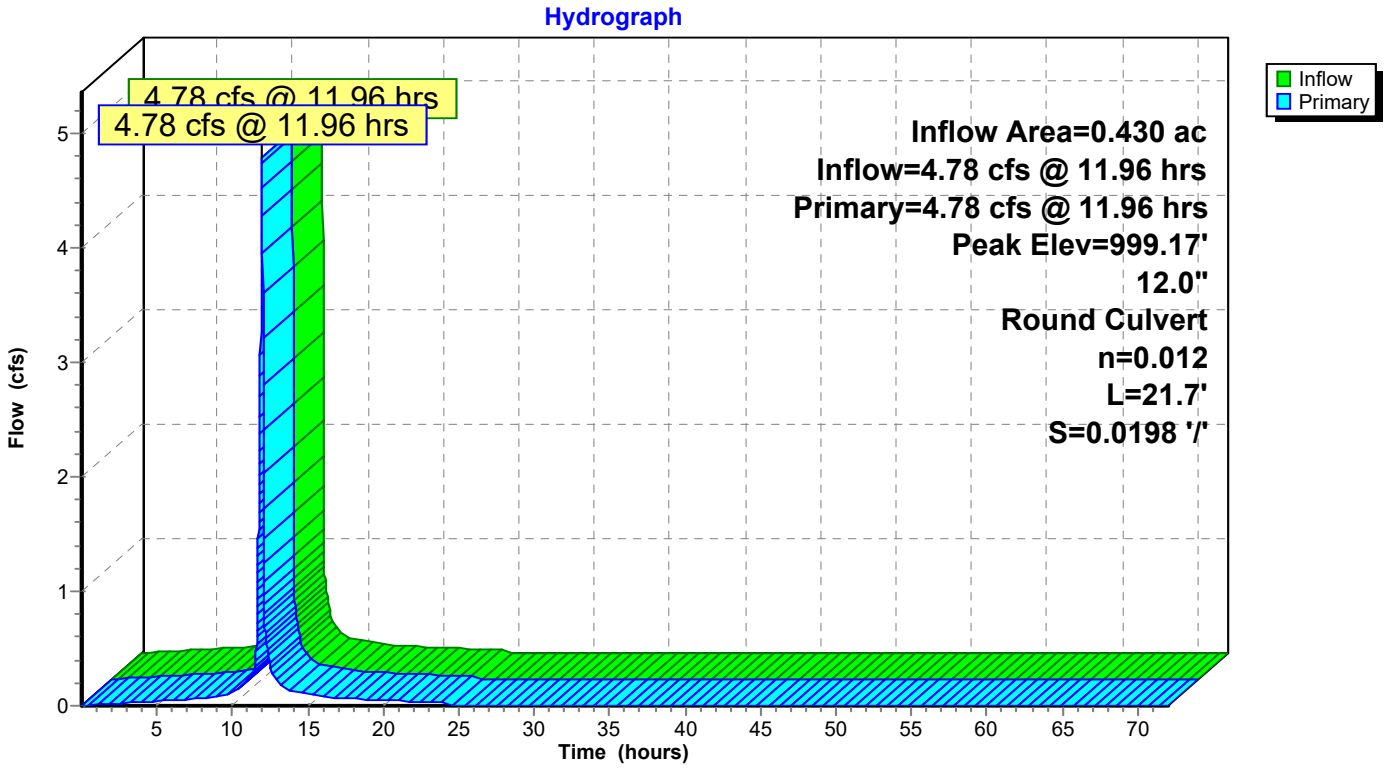
Stage-Discharge



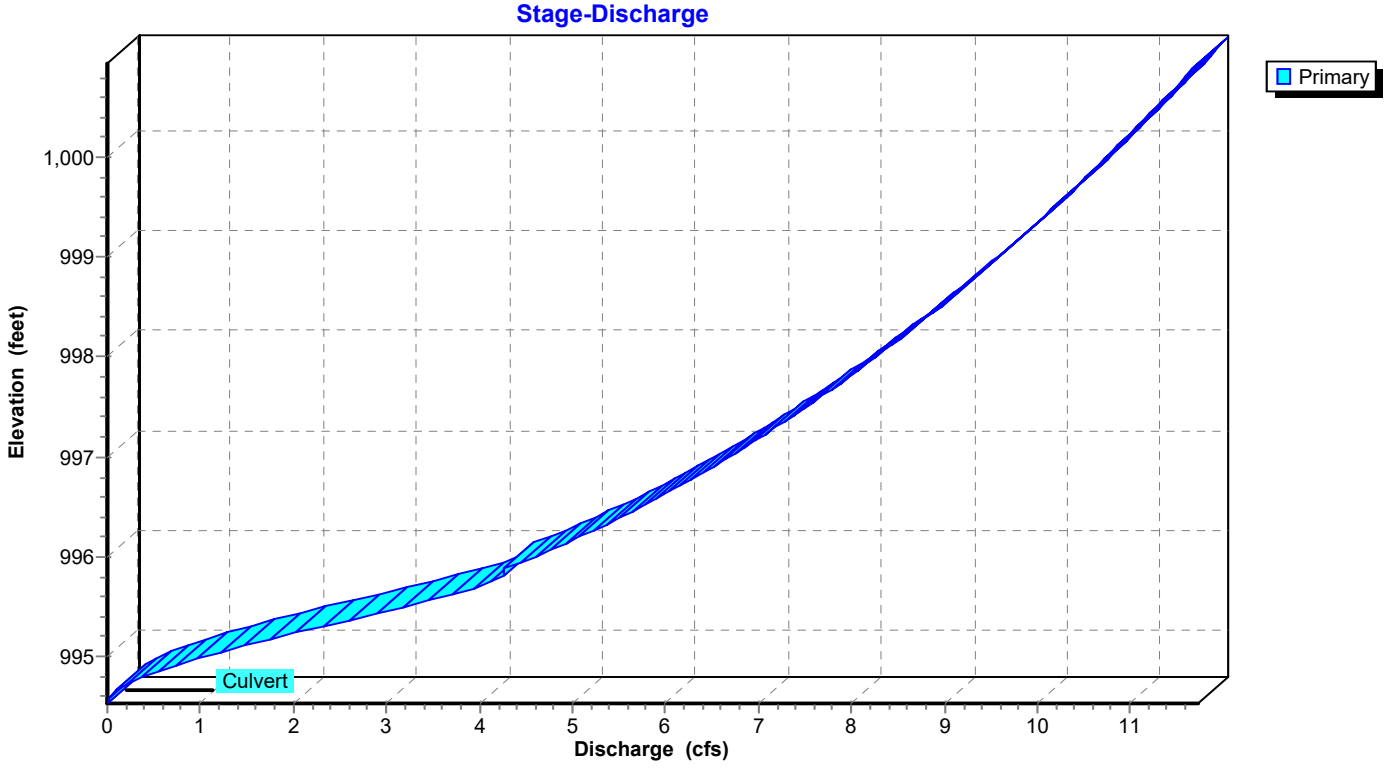
Pond 50P: BASIN REACH



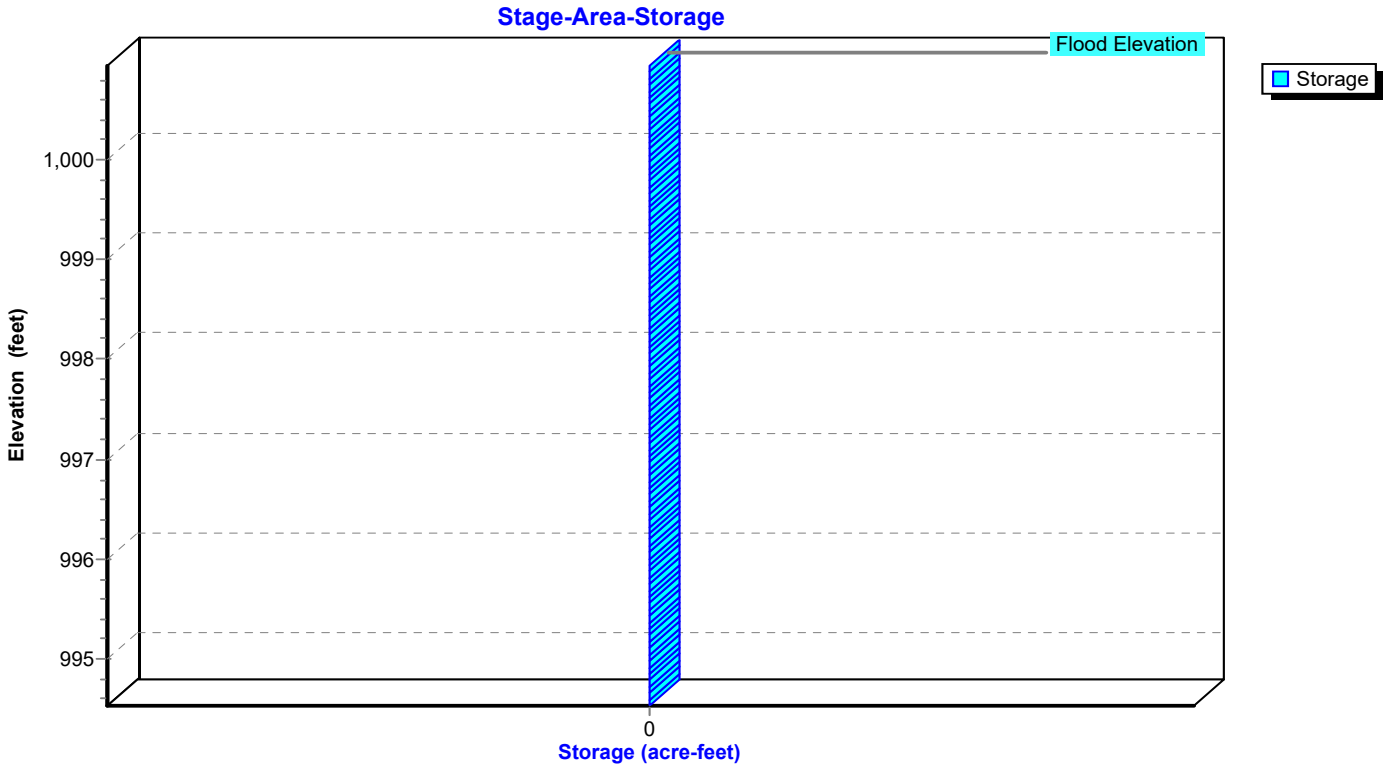
Pond 51P: ROOF DRAINS TO BASIN



Pond 51P: ROOF DRAINS TO BASIN

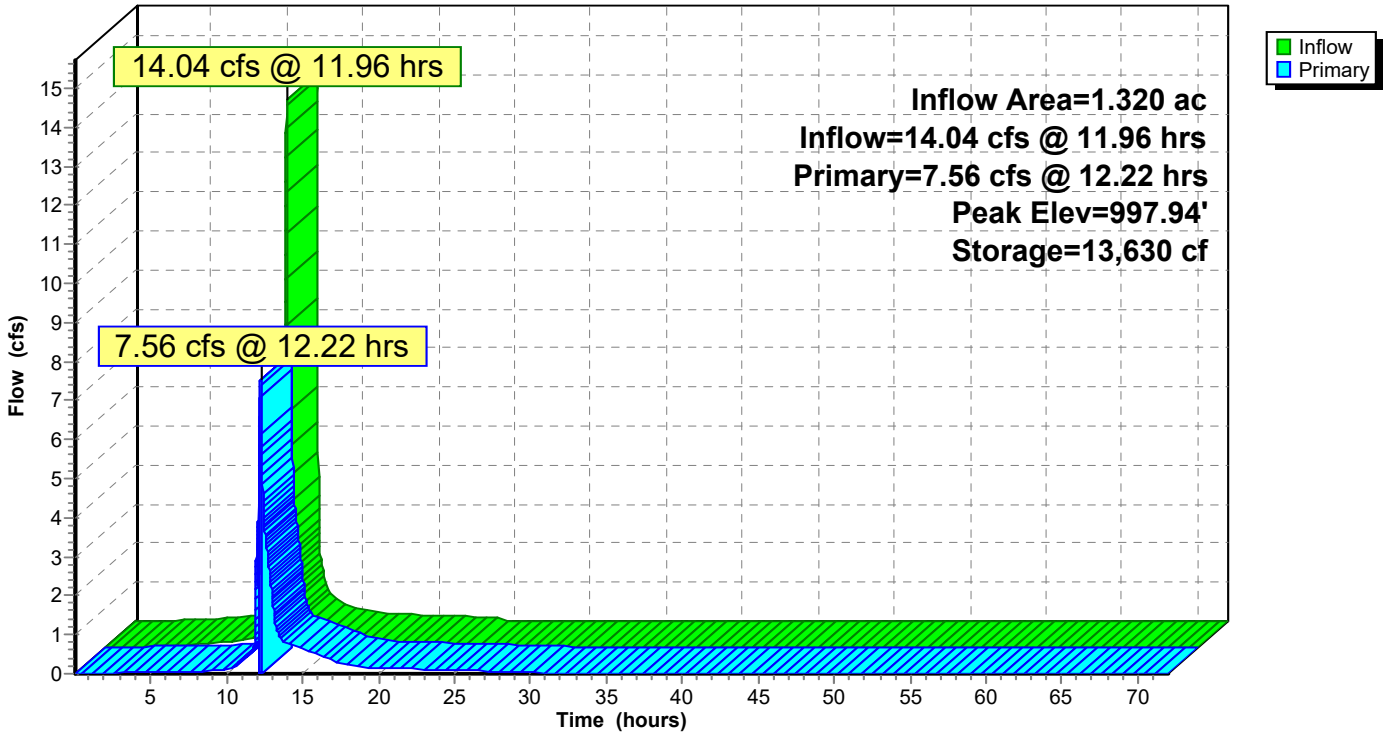


Pond 51P: ROOF DRAINS TO BASIN



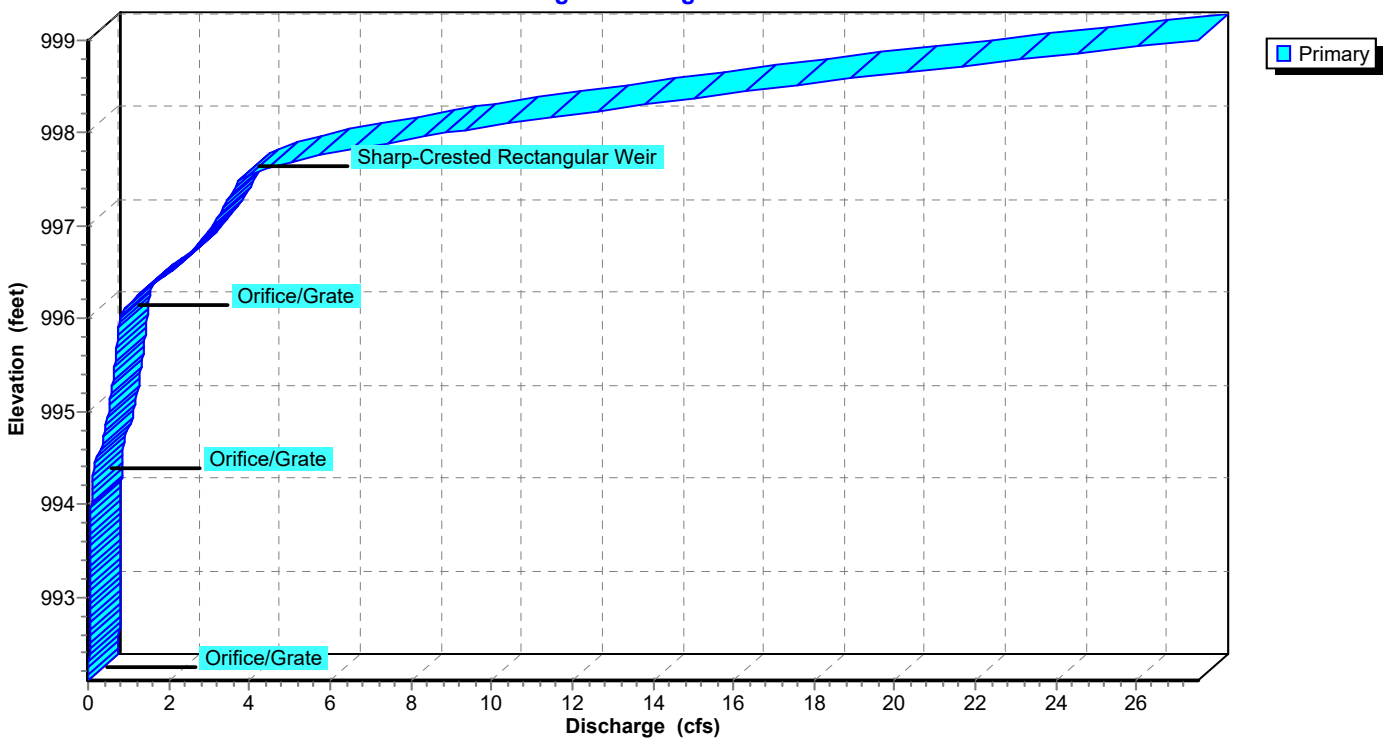
Pond 52P: DETENTION BASIN

Hydrograph

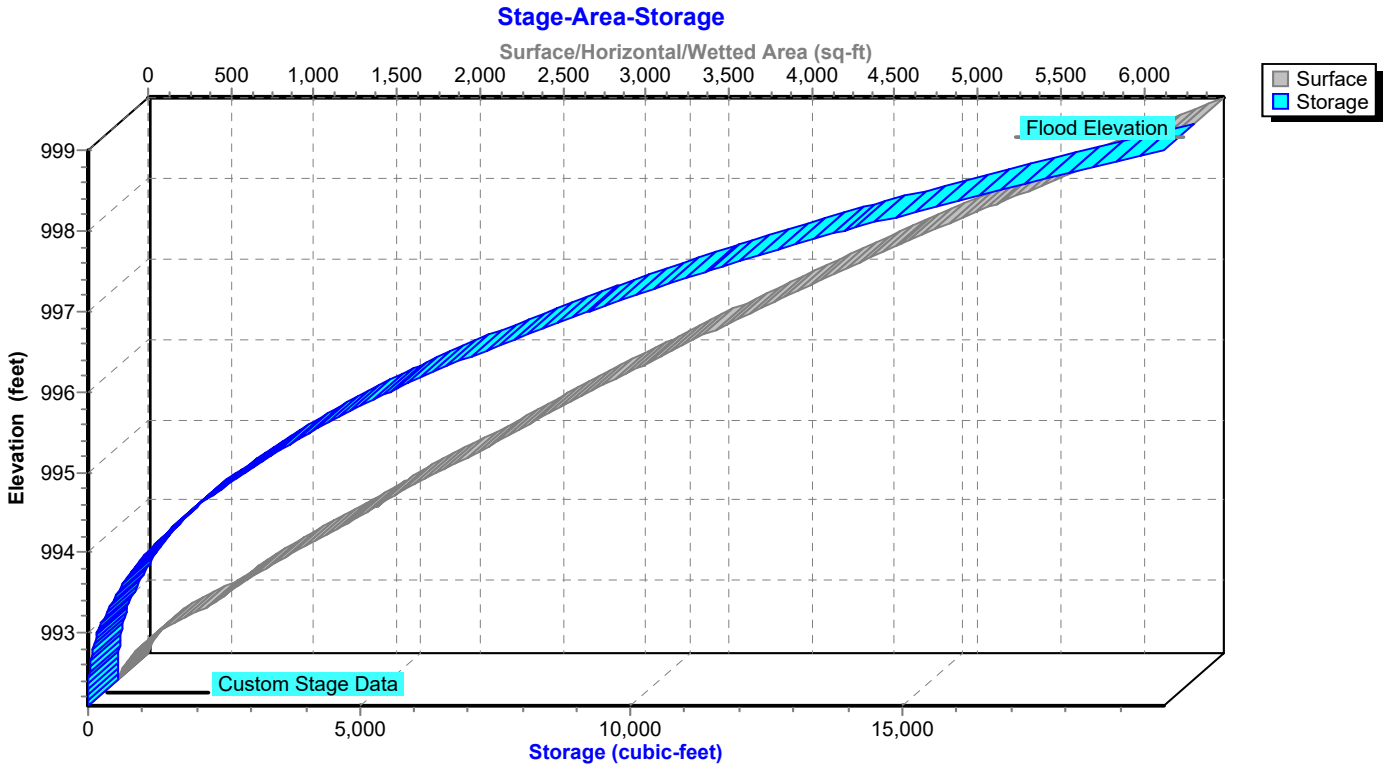


Pond 52P: DETENTION BASIN

Stage-Discharge

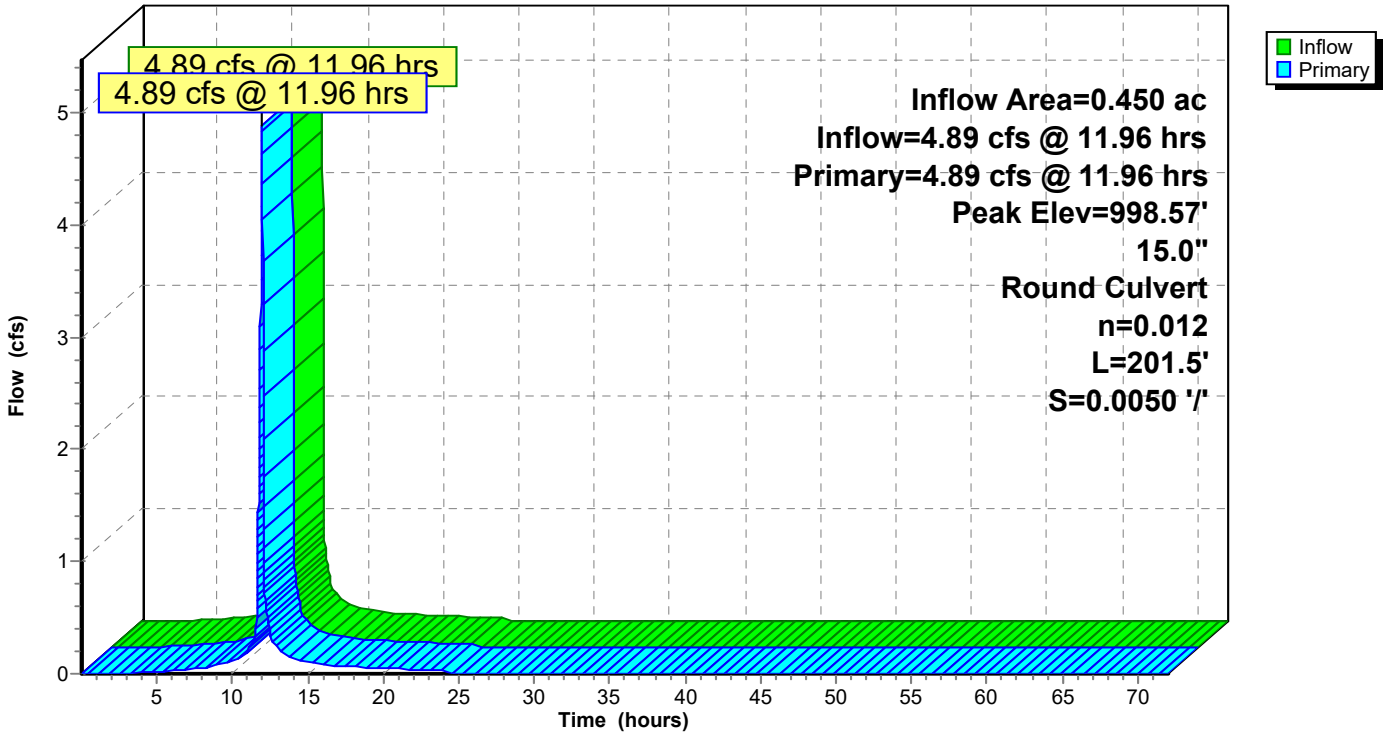


Pond 52P: DETENTION BASIN



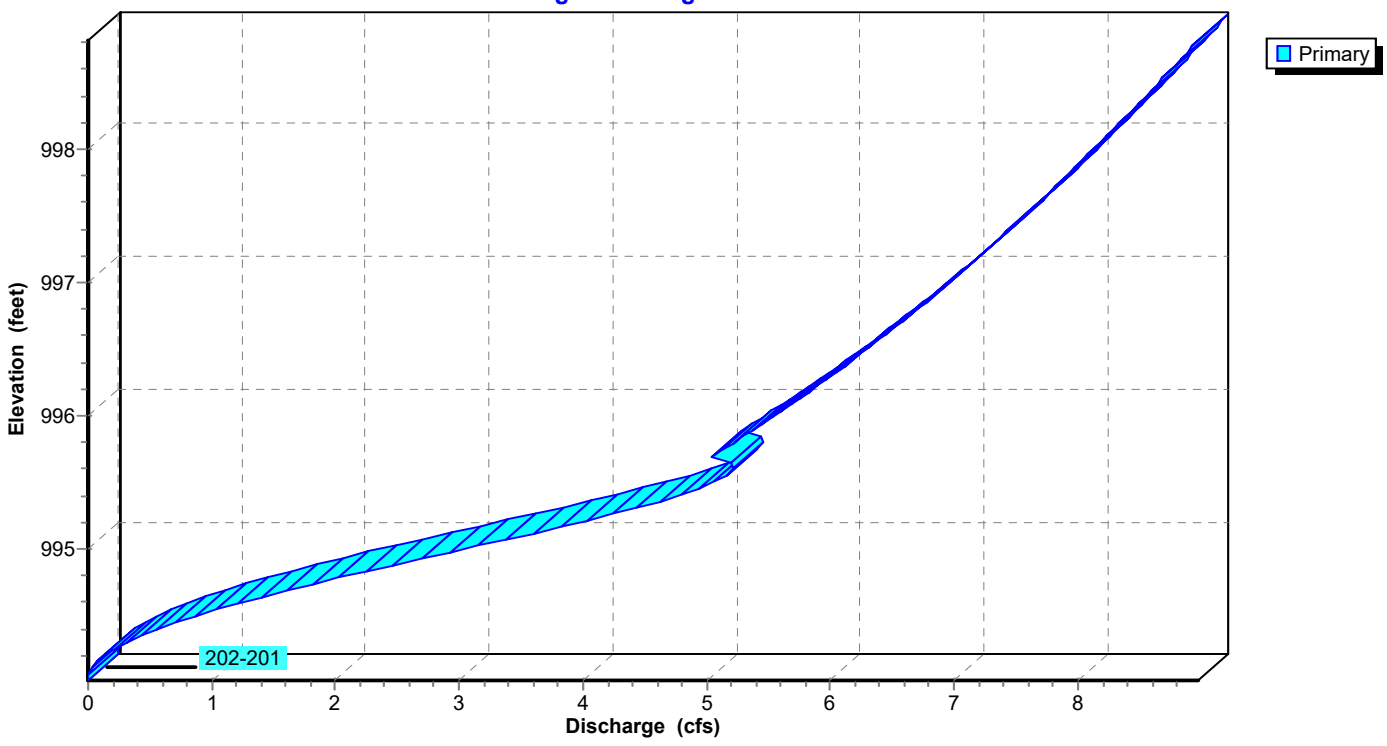
Pond 53P: 301-300

Hydrograph

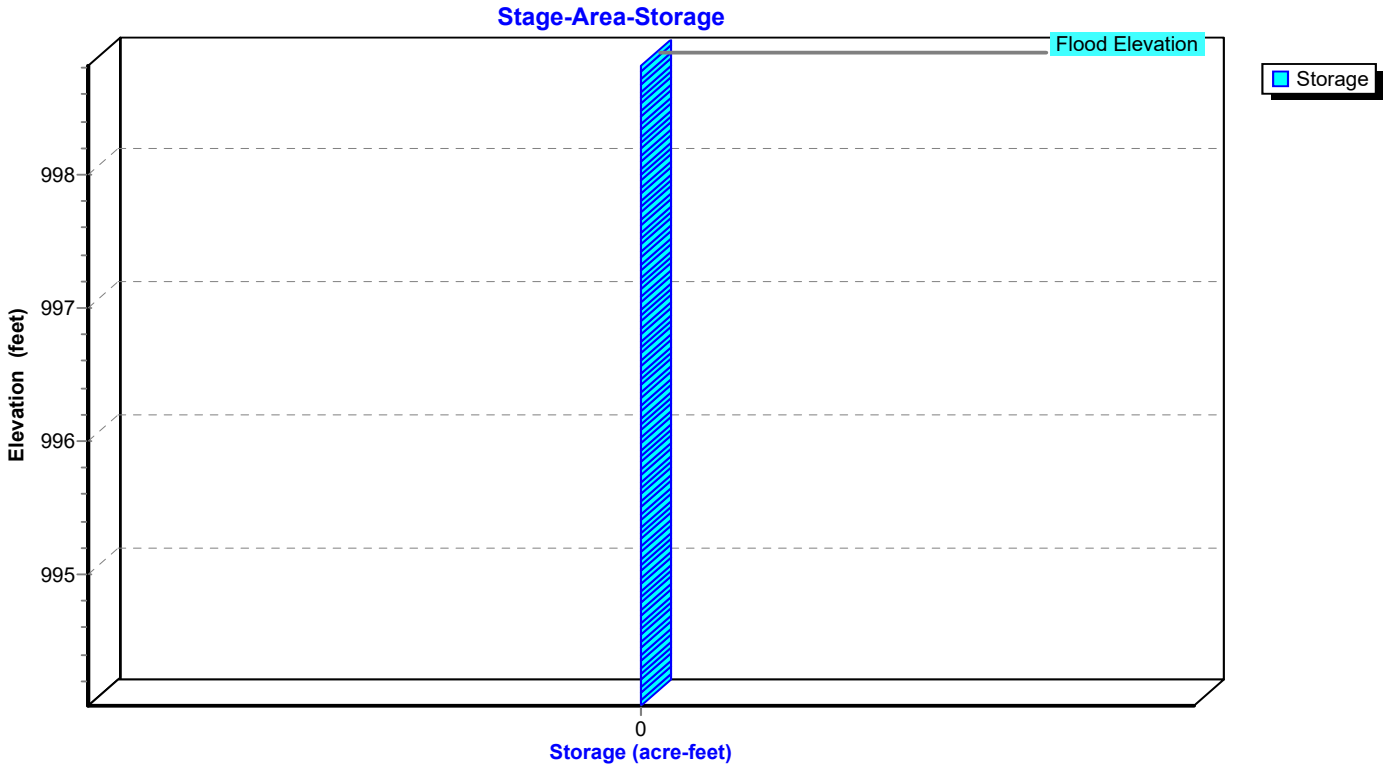


Pond 53P: 301-300

Stage-Discharge

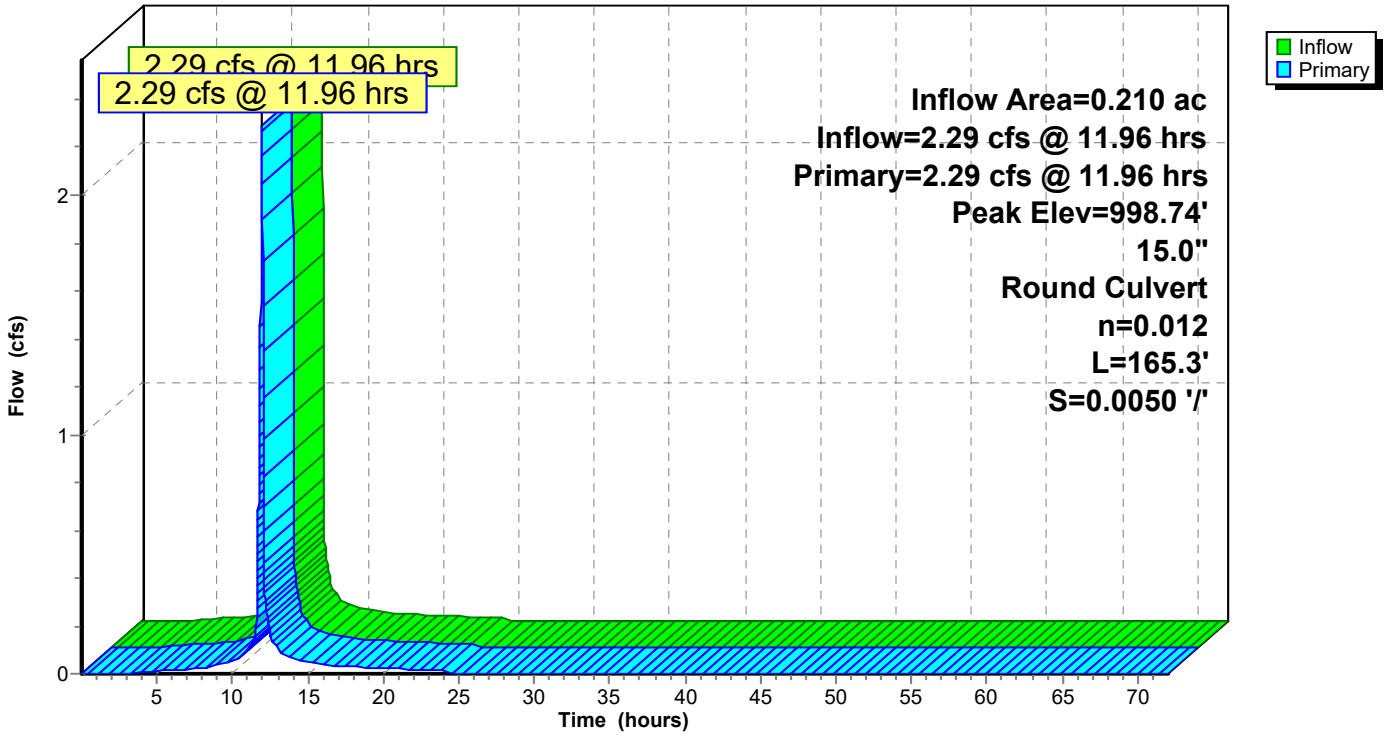


Pond 53P: 301-300



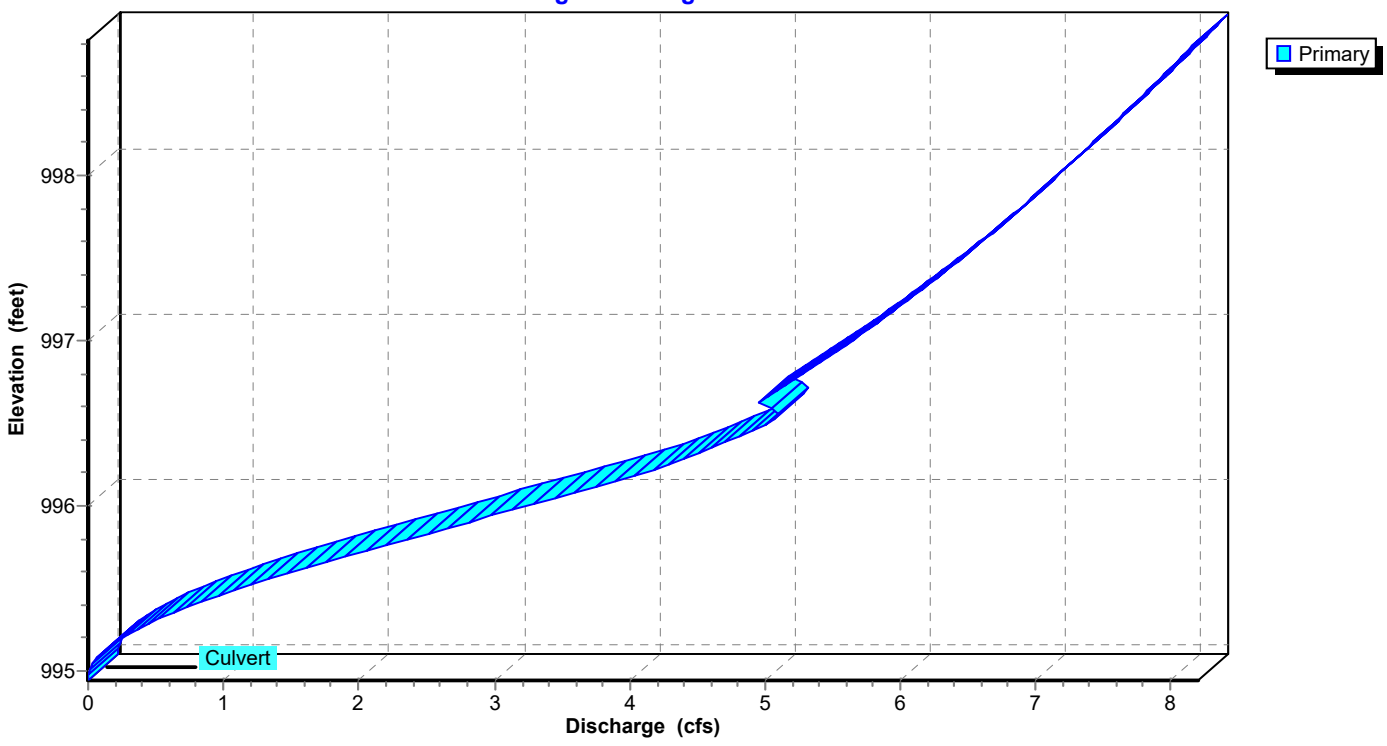
Pond 54P: 302-301

Hydrograph

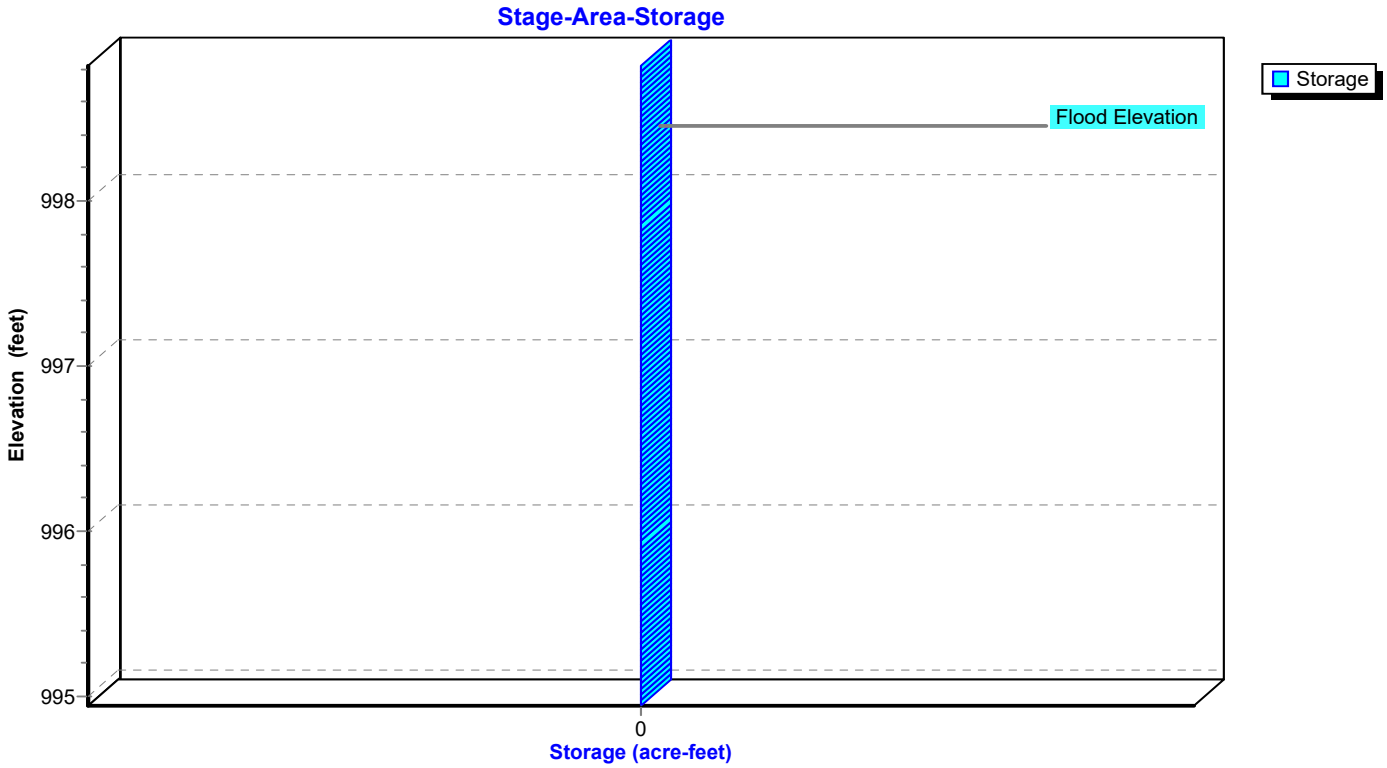


Pond 54P: 302-301

Stage-Discharge

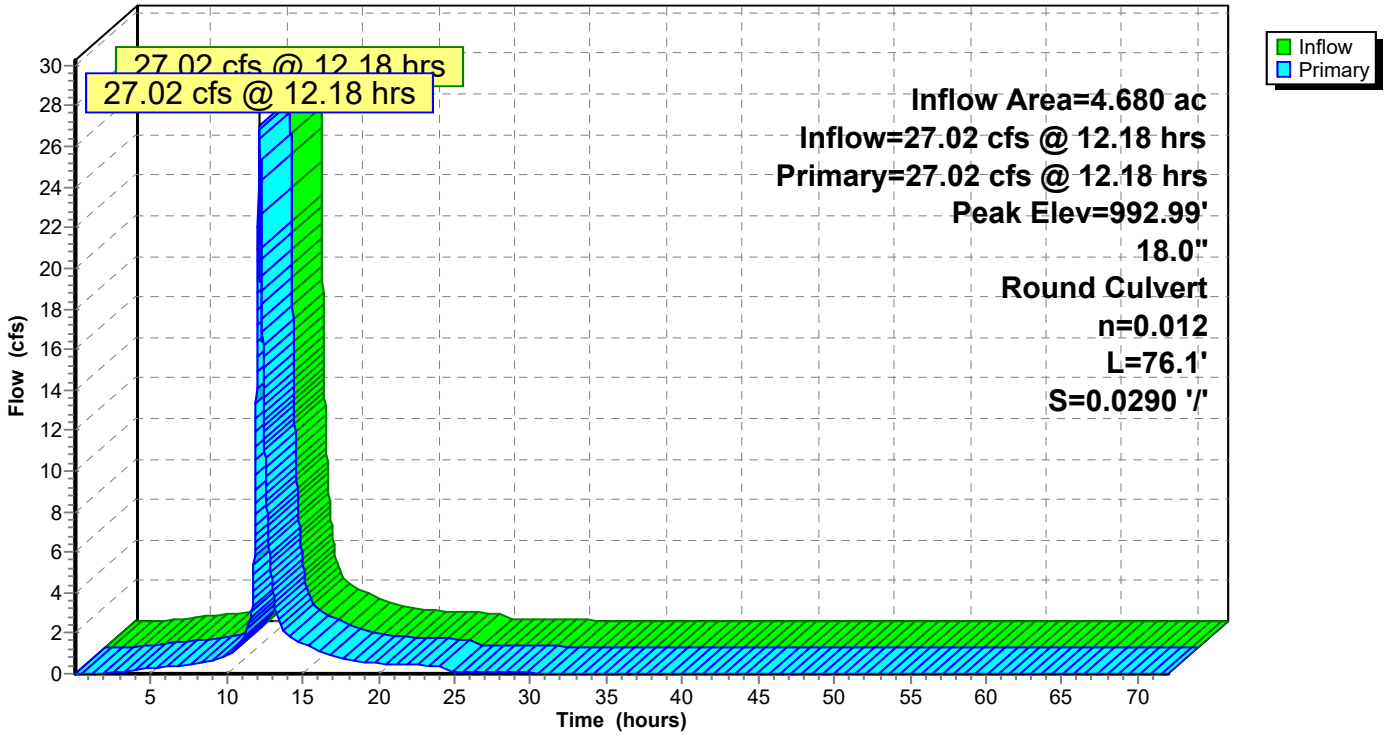


Pond 54P: 302-301



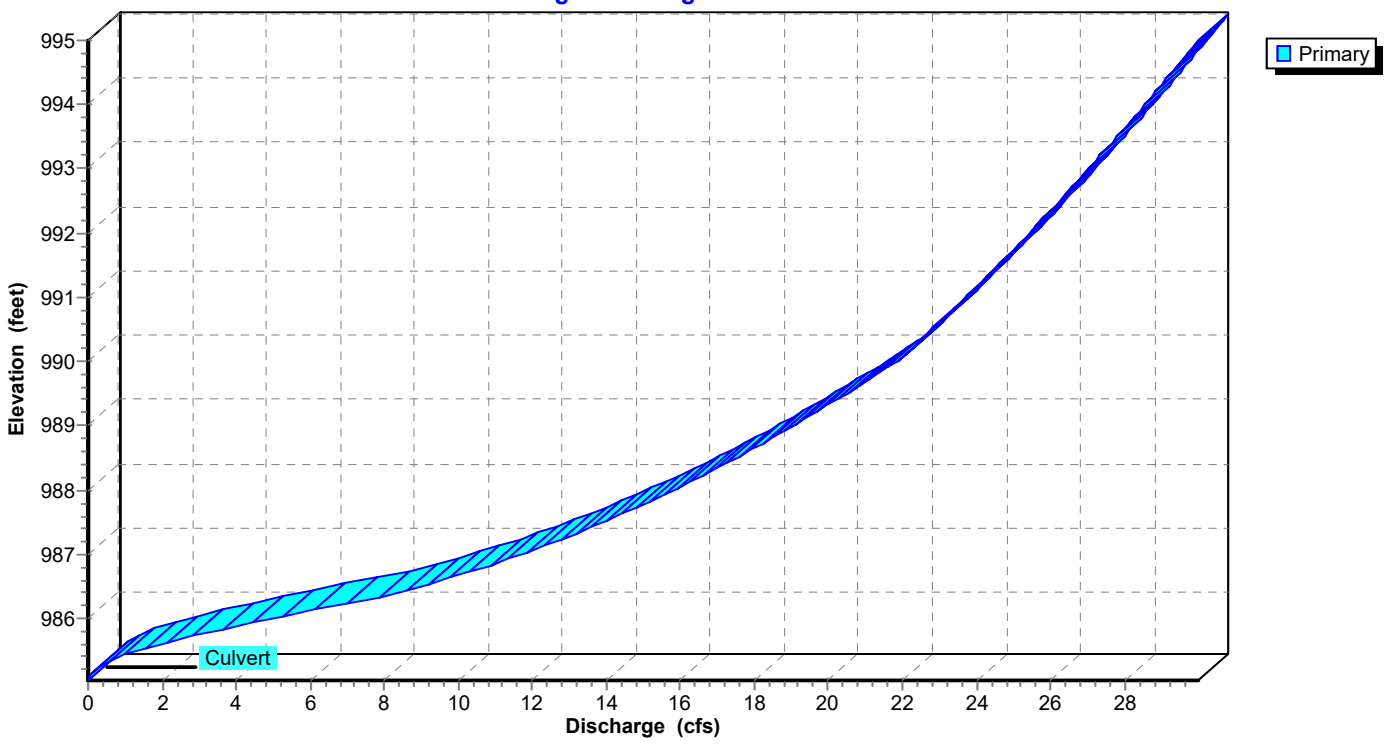
Pond 55P: 11-10

Hydrograph

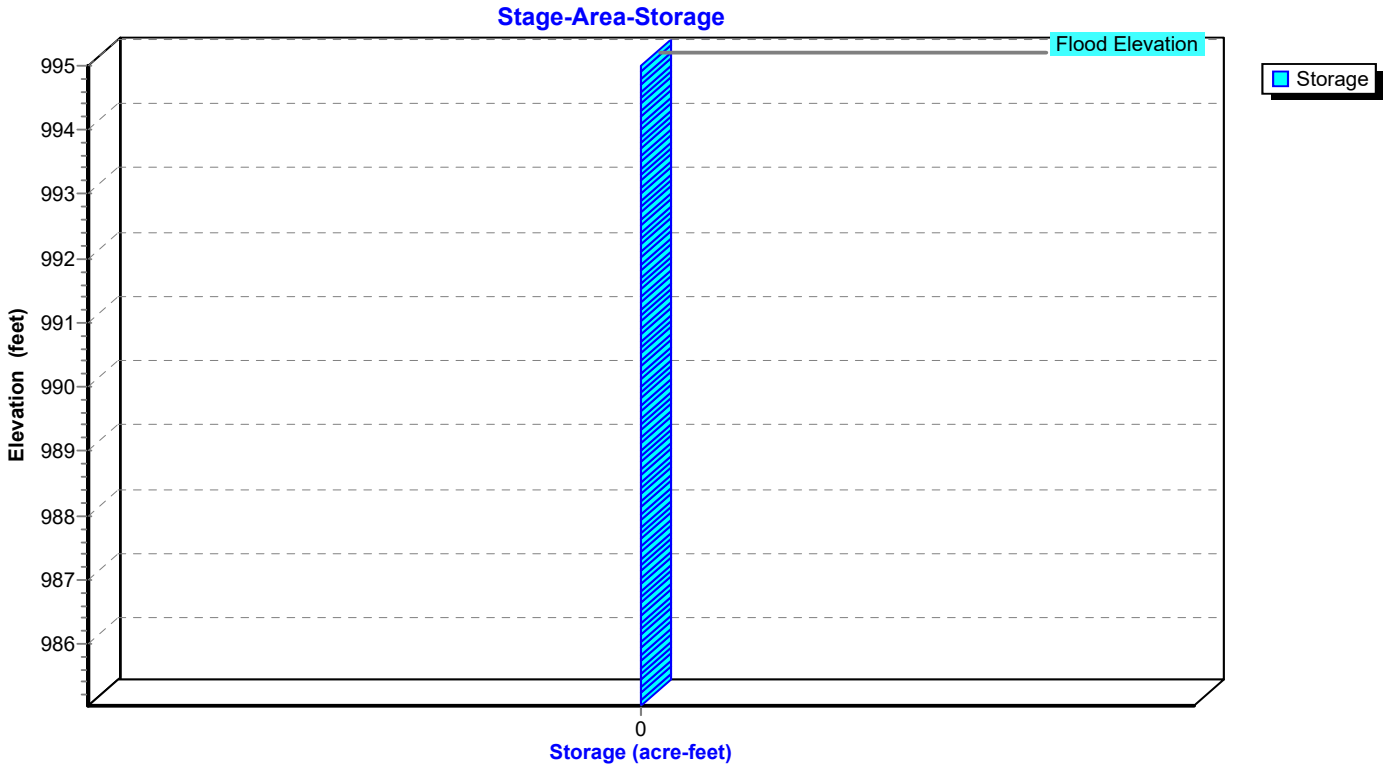


Pond 55P: 11-10

Stage-Discharge

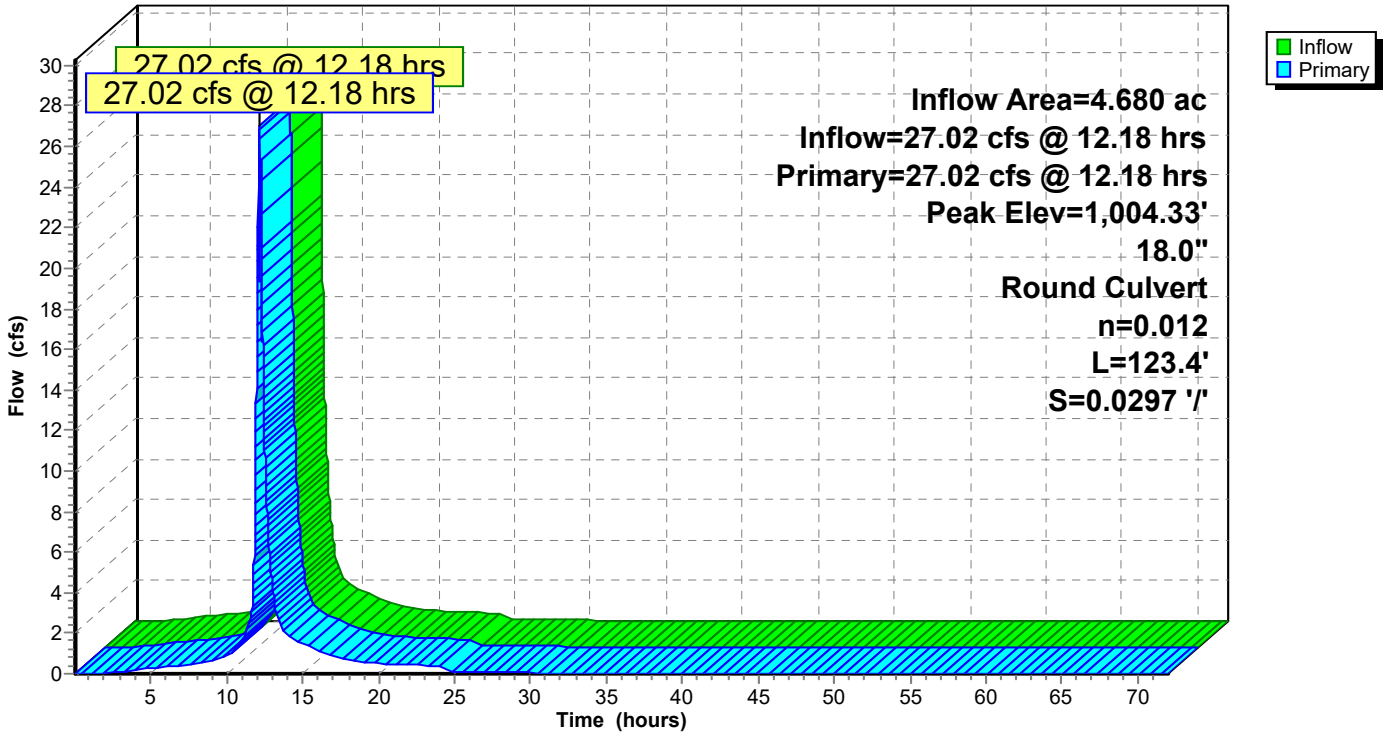


Pond 55P: 11-10



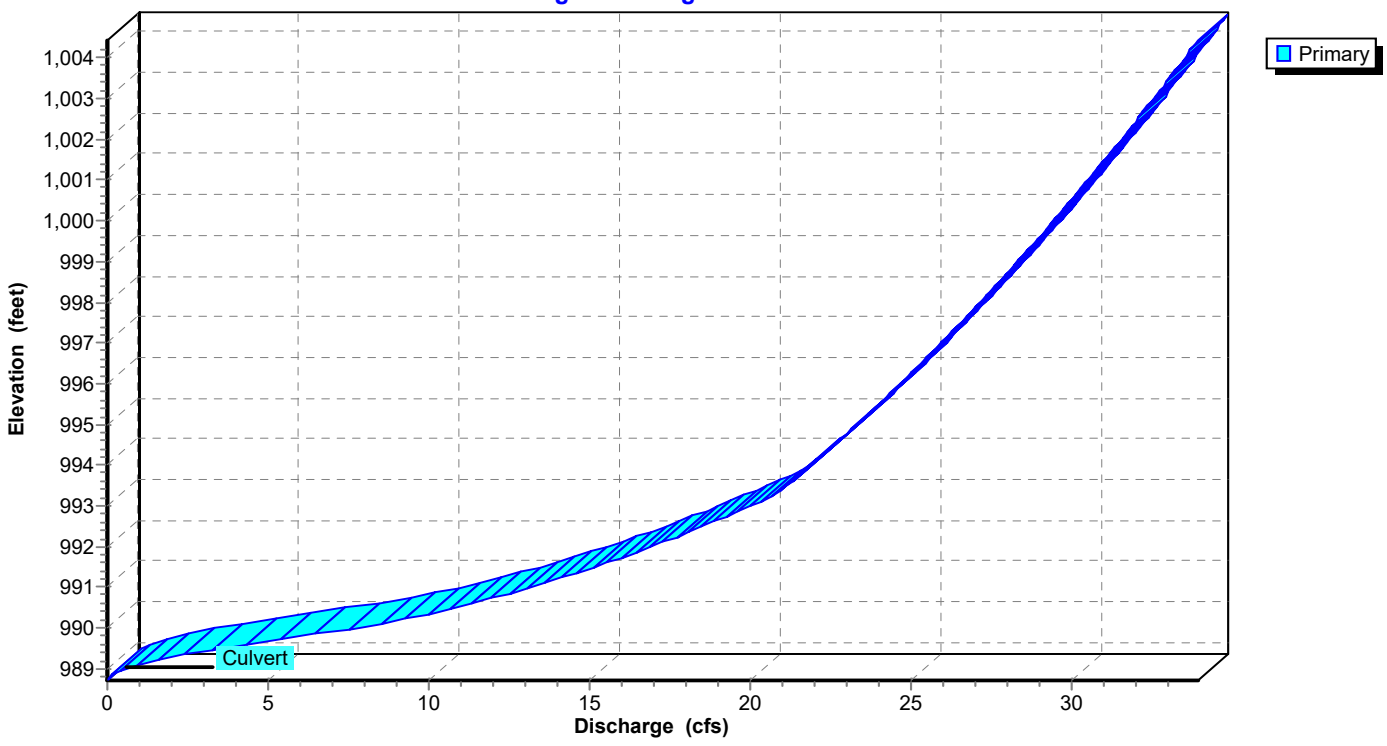
Pond 56P: 11 - 100 MH

Hydrograph

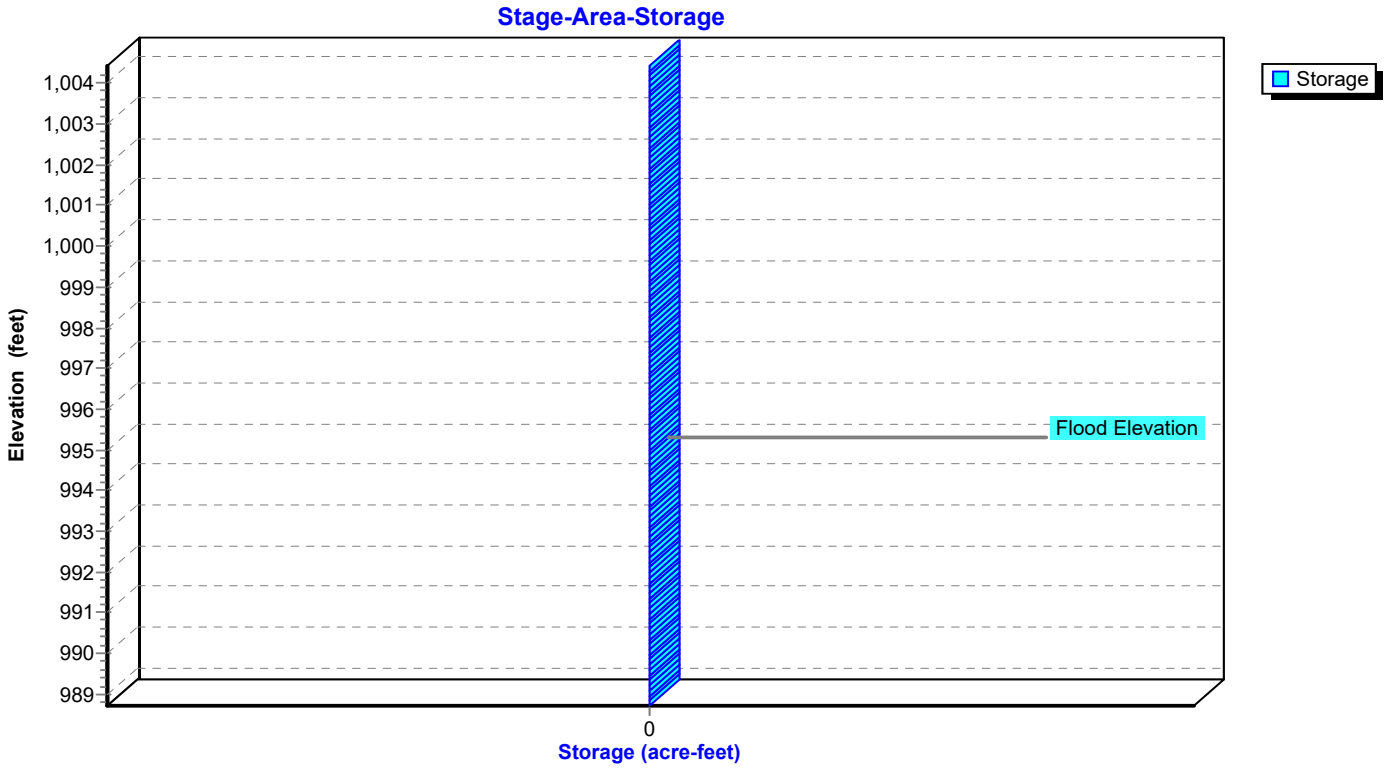


Pond 56P: 11 - 100 MH

Stage-Discharge

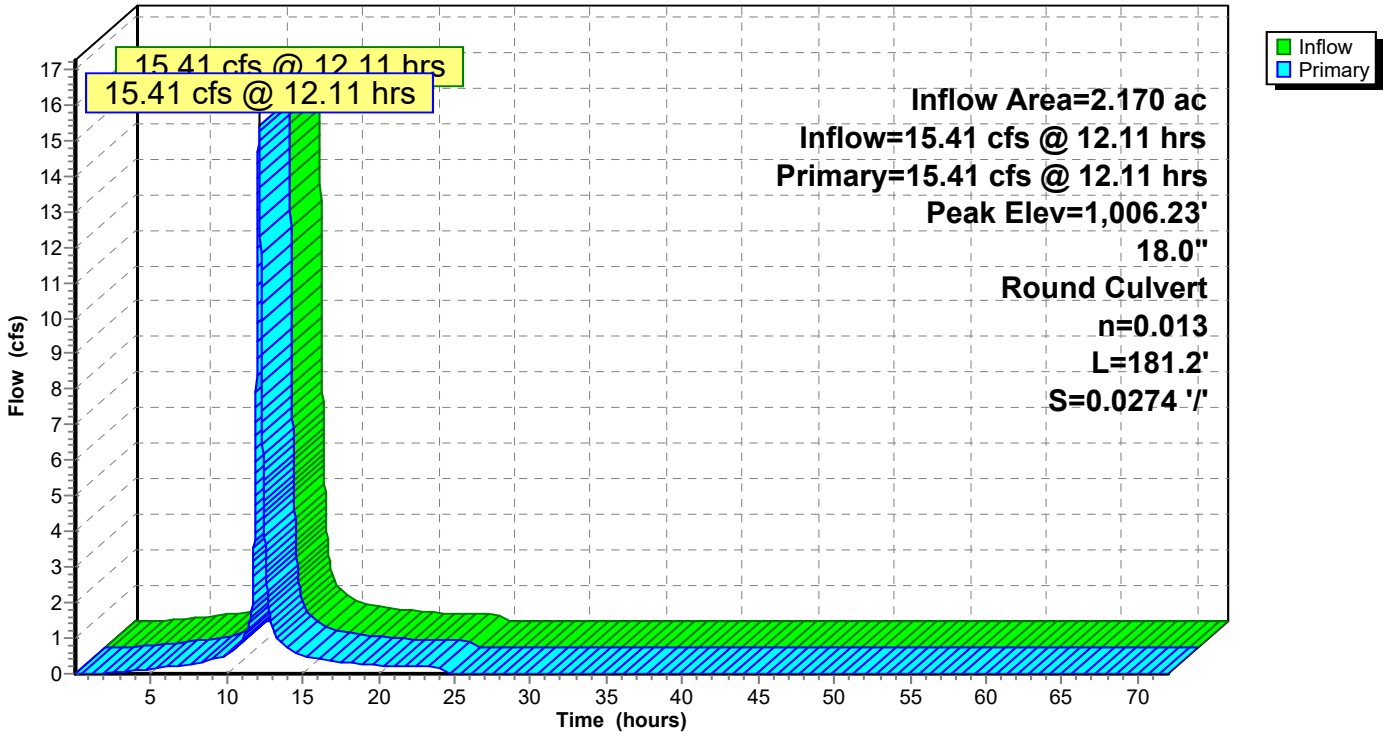


Pond 56P: 11 - 100 MH



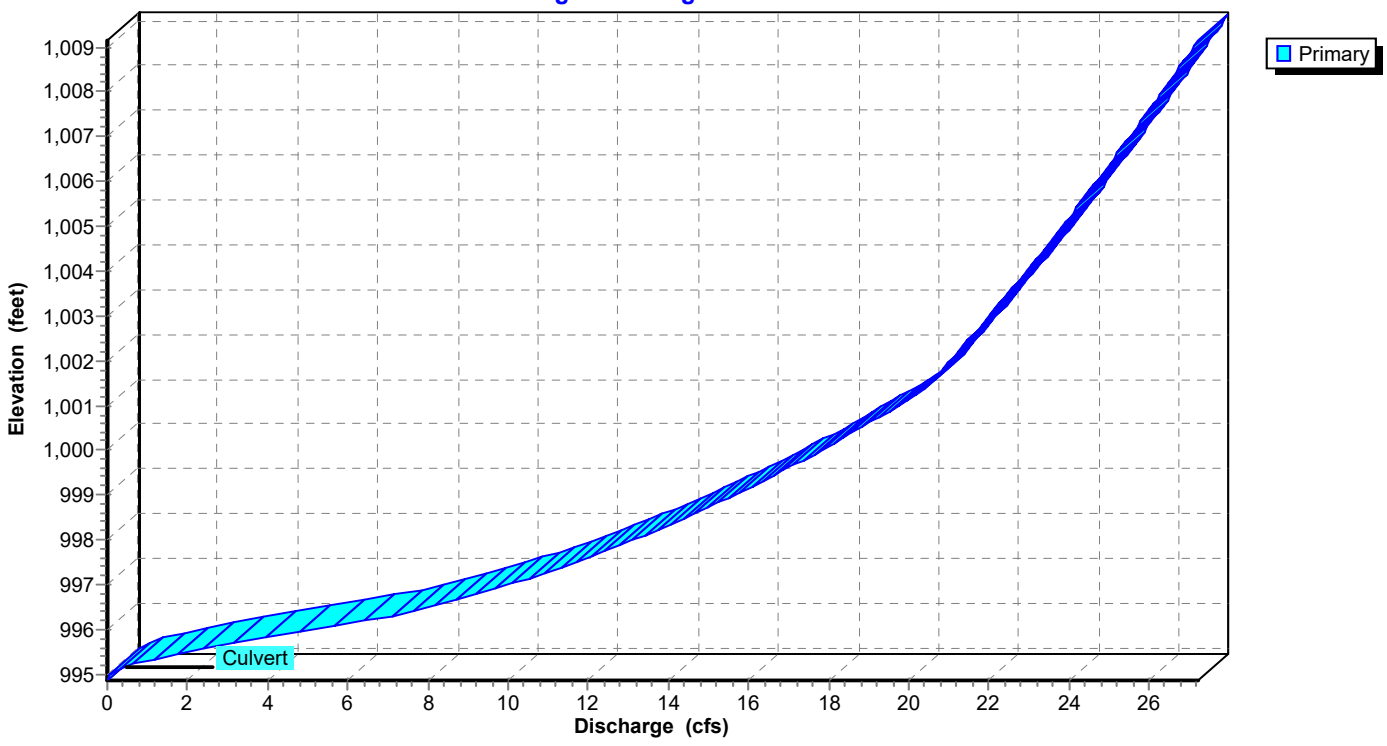
Pond 57P: 12-11

Hydrograph

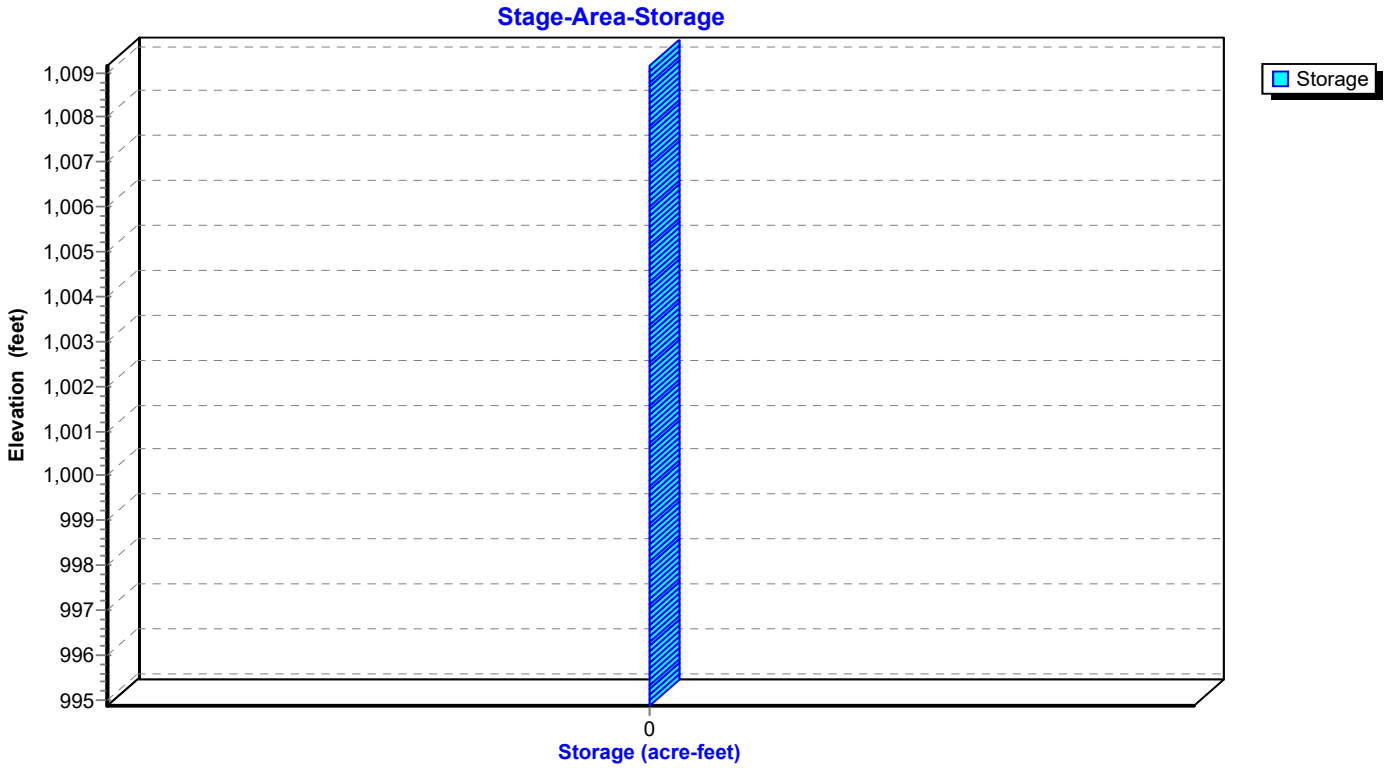


Pond 57P: 12-11

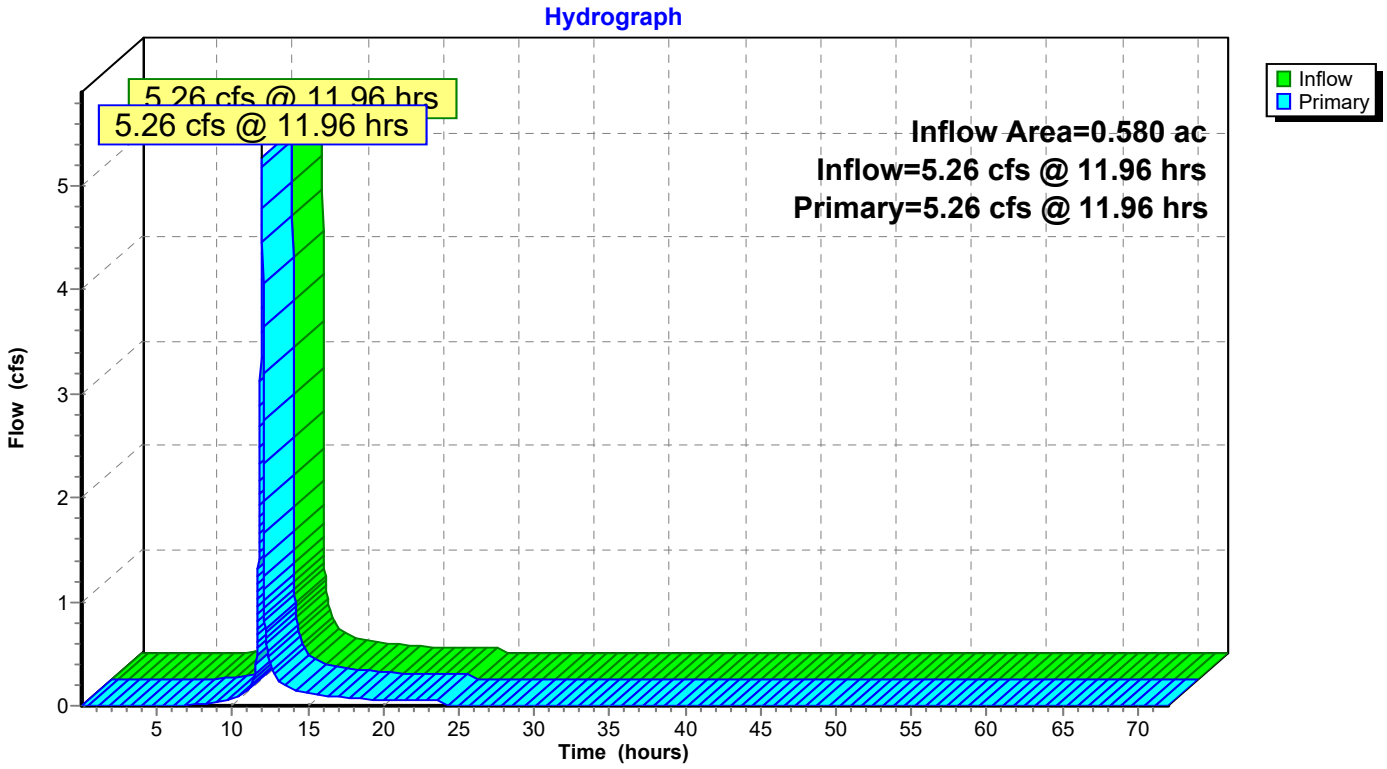
Stage-Discharge



Pond 57P: 12-11



Link 90L: BYPASS AREAS



Events for Subcatchment 1S: EXISTING CONDITIONS

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	3.98	0.218	1.24
10-Year	5.30	8.48	0.458	2.61
100-Year	**7.70**	**15.01**	**0.819**	**4.66**

Events for Subcatchment 2S: AREA A

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	2.79	0.276	2.84
10-Year	5.30	4.43	0.449	4.60
100-Year	**7.70**	**6.58**	**0.681**	**6.98**

Events for Subcatchment 3S: AREA B

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.12	0.005	1.24
10-Year	5.30	0.24	0.011	2.61
100-Year	**7.70**	**0.42**	**0.019**	**4.66**

Events for Subcatchment 4S: AREA C

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.35	0.015	1.24
10-Year	5.30	0.73	0.033	2.61
100-Year	**7.70**	**1.27**	**0.058**	**4.66**

Events for Subcatchment 5S: AREA D

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.14	0.006	1.24
10-Year	5.30	0.29	0.013	2.61
100-Year	**7.70**	**0.51**	**0.023**	**4.66**

Events for Subcatchment 6S: AREA E

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	6.56	0.513	2.84
10-Year	5.30	10.38	0.833	4.60
100-Year	**7.70**	**15.41**	**1.263**	**6.98**

Events for Subcatchment 7S: AREA F

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	3.57	0.195	1.24
10-Year	5.30	7.60	0.410	2.61
100-Year	**7.70**	**13.44**	**0.734**	**4.66**

Events for Subcatchment 8S: AREA G

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.04	0.002	1.24
10-Year	5.30	0.08	0.004	2.61
100-Year	**7.70**	**0.14**	**0.008**	**4.66**

Events for Subcatchment 9S: AREA H

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.02	0.001	1.24
10-Year	5.30	0.04	0.002	2.61
100-Year	**7.70**	**0.07**	**0.004**	**4.66**

Events for Subcatchment 10S: PROPOSED CONDITIONS

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	6.96	0.313	1.78
10-Year	5.30	12.78	0.589	3.35
100-Year	**7.70**	**20.67**	**0.980**	**5.58**

Events for Subcatchment 60S: AREA 6

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	1.36	0.061	1.43
10-Year	5.30	2.70	0.122	2.88
100-Year	**7.70**	**4.59**	**0.212**	**5.00**

Events for Subcatchment 61S: AREA 7

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.22	0.010	1.71
10-Year	5.30	0.41	0.019	3.25
100-Year	**7.70**	**0.68**	**0.032**	**5.46**

Events for Subcatchment 62S: AREA 1

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.94	0.044	2.54
10-Year	5.30	1.52	0.075	4.27
100-Year	**7.70**	**2.29**	**0.116**	**6.63**

Events for Subcatchment 63S: AREA 2

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	1.04	0.049	2.45
10-Year	5.30	1.71	0.083	4.17
100-Year	**7.70**	**2.60**	**0.130**	**6.51**

Events for Subcatchment 64S: AREA 3

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	1.51	0.068	1.86
10-Year	5.30	2.73	0.126	3.45
100-Year	**7.70**	**4.37**	**0.209**	**5.69**

Events for Subcatchment 65S: AREA 4

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	1.69	0.090	3.27
10-Year	5.30	2.57	0.139	5.06
100-Year	**7.70**	**3.74**	**0.205**	**7.46**

Events for Subcatchment 66S: AREA 5

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.38	0.017	2.10
10-Year	5.30	0.66	0.031	3.75
100-Year	**7.70**	**1.04**	**0.050**	**6.04**

Events for Subcatchment 67S: OFFSITE TO CI 12

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	6.56	0.513	2.84
10-Year	5.30	10.38	0.833	4.60
100-Year	**7.70**	**15.41**	**1.263**	**6.98**

Events for Subcatchment 68S: AREA TO AI 11

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	0.05	0.002	1.24
10-Year	5.30	0.10	0.004	2.61
100-Year	**7.70**	**0.17**	**0.008**	**4.66**

Events for Subcatchment 69S: OFFSITE TO BMP

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2-Year	3.50	2.79	0.276	2.84
10-Year	5.30	4.43	0.449	4.60
100-Year	**7.70**	**6.58**	**0.681**	**6.98**

Events for Pond 10P: 12-11

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	6.59	6.59	998.69	**0.000**
10-Year	10.44	10.44	998.87	0.000
100-Year	**15.51**	**15.51**	**1,000.28**	0.000

Events for Pond 11P: 11-10

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	9.08	9.08	992.69	**0.000**
10-Year	14.44	14.44	993.30	0.000
100-Year	**21.49**	**21.49**	**994.55**	0.000

Events for Pond 50P: BASIN REACH

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	2.07	2.07	995.85	**0.000**
10-Year	3.23	3.23	996.95	0.000
100-Year	**4.78**	**4.78**	**998.33**	0.000

Events for Pond 51P: ROOF DRAINS TO BASIN

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	2.07	2.07	995.86	**0.000**
10-Year	3.23	3.23	997.26	0.000
100-Year	**4.78**	**4.78**	**999.17**	0.000

Events for Pond 52P: DETENTION BASIN

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (cubic-feet)
2-Year	5.56	0.75	995.85	5,098
10-Year	9.19	2.67	996.77	8,285
100-Year	**14.04**	**7.56**	**997.94**	**13,630**

Events for Pond 53P: 301-300

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	1.98	1.98	995.85	**0.000**
10-Year	3.23	3.23	997.02	0.000
100-Year	**4.89**	**4.89**	**998.57**	0.000

Events for Pond 54P: 302-301

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	0.94	0.94	995.86	**0.000**
10-Year	1.52	1.52	997.06	0.000
100-Year	**2.29**	**2.29**	**998.74**	0.000

Events for Pond 55P: 11-10

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	9.74	9.74	986.63	**0.000**
10-Year	16.82	16.82	988.29	0.000
100-Year	**27.02**	**27.02**	**992.99**	0.000

Events for Pond 56P: 11 - 100 MH

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	9.74	9.74	990.30	**0.000**
10-Year	16.82	16.82	992.68	0.000
100-Year	**27.02**	**27.02**	**1,004.33**	0.000

Events for Pond 57P: 12-11

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
2-Year	6.56	6.56	996.21	**0.000**
10-Year	10.38	10.38	997.11	0.000
100-Year	**15.41**	**15.41**	**1,006.23**	0.000

Events for Link 90L: BYPASS AREAS

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)
2-Year	1.58	1.58	**0.00**
10-Year	3.12	3.12	0.00
100-Year	**5.26**	**5.26**	0.00