TOWN OF PLYMOUTH CAPITAL IMPROVEMENT PLAN REQUEST
FY26 SPRING ANNUAL TOWN MEETING

Department:	Energy and Environment	**Priority #:**	1 - Special
Project Title and Description:	Jenney Pond Dam Repairs/Bypass Channel	**Total Project Cost:**	6,738,500

Department/Division Head: David Gould, Director

Check if project is: New ☐ Resubmitted ☒ **Cost estimate was developed**: Internally ☐ Externally ☒

For project re-submittals, list prior year(s): FY25

List any funding sources and amounts already granted:

$10,021,000 in NOAA BIL funding for bypass channel and associated improvements. $1,500,000 in CPA funds for trail/walking path reconstruction.

Basis of Estimated Costs (attach additional information if available)

Capital:	Cost	Comments
Planning and Design		
Labor and Materials	$6,738,500	
Administration		
Land Acquisition		
Equipment		
Other		
Contingency		
Total Capital	$6,738,500	

If project has impact on 5 Year Plan and future operating budgets, insert estimated amounts.

Fiscal Year:	Capital	Operations & Maintenance
FY27		
FY28		
FY29		
FY30		
FY31		

Project Justification and Objective:

Jenney Pond Dam needs to be brought up to MA Office of Dam Safety standards based upon recent inspections. The proposed bypass improves both fish passage and helps to increase spillway capacity. Trail improvements result in ADA compliance and an enhanced public space.

For Capital Project Requests:

Will this project be phased over more than one fiscal year? If yes, enter it on the 5 Year Plan Yes ☐ No ☒
Can this project be phased over more than one fiscal year? Yes ☐ No ☒

For Capital Equipment Requests:

☐ Check if equipment requested is replacement and enter the year, make & model, VIN and present condition of existing equipment

What is the expected lifespan of this new/replacement equipment: ______________________

Attach backup information, estimates, or justification to support this request.

MEMO

To: Derek Brindisi, Town Manager
Lynne Barrett, Finance Director

From: David Gould, Director of Energy and Environment

Re: **Capital Request – Jenney Pond Dam Repairs**

Date: November 6, 2024

The proposed dam repairs at Jenney Pond would bring the structure into compliance with the Massachusetts Office of Dam Safety (ODS) standards. The Town has been working with ODS over the last several years as we have progressed through engineering, permitting and fund raising for this project so that they were aware we were moving ahead with the necessary repairs. The proposed nature-like fishway/bypass which will be funded by NOAA provides not only fish passage but allows an increase in spillway capacity thereby allowing the dam to pass the 100-year storm event which it cannot currently do. Work within the bypass footprint can be covered by NOAA funding so some road, sidewalk and landscaping work will be covered by the federal funding but the capital request for $6,738,500 will go only towards dam repair work.

It is important to realize that the Jenney Pond Dam consists of the upstream and downstream slopes of the structure along with Spring Lane as the roadway is the crest of the dam. As detailed in the cost breakdown backup materials submitted with this project the dam repair work includes removal of most of the road, curb, sidewalk, signage, trees, light poles and the set up of erosion controls and water control systems including cofferdams, pumps and bypasses and temporary road access for vehicular traffic.

In addition, there is considerable work to regrade the road, replace the water main, and reset the road, curbing, sidewalks and other features that are disturbed during the repairs including fences, signage, benches, lighting, conduit, and plantings.

Lasty, there are significant structural repairs including a cutoff wall, retaining walls, headwall repairs, masonry and culvert repairs and the necessary temporary shoring and supports to complete this work.

In conclusion, while the dam repair costs are significant it would be even more expensive without the NOAA grant funding that will not only result in conveyance of the 100-year storm but also offset costs within its footprint.

Should you have any questions regarding this work please contact me at your earliest convenience. Thanks.

Opinion of Estimated Construction Costs
Jenney Grist Mill Bypass - Dam Repairs, Grist Mill & Spring Lane Improvements
Plymouth, Massachusetts
Preliminary Design
11982.00018
Prepared on: 9/23/2024 by SLR

ITEM NO.	ITEM/DESCRIPTION	UNIT	QTY	UNIT COST	AMOUNT IN FIGURES
1.0	**Site Preparation, Removals & Mobilization**				
	Mobilization & Bonding (10%)	LS	1	$ 444,800	$444,800
	Construction Staking	LS	1	$ 43,200	$43,200
	Test Pits	EA	15	$ 2,700	$40,500
	Chainlink Safety Fence	LF	300	$ 13	$3,888
	Temporary Signage and Vehicular and Pedestrian Traffic Control	LS	1	$ 486,000	$486,000
	Removal of Concrete	SF	200	$ 27	$5,400
	Removal of Brick Pavers	SF	200	$ 11	$2,160
	Removal of Bituminous Paving	SF	11,500	$ 5	$62,100
	Removal of Granite Curb	LF	650	$ 43	$28,080
	Removal of Wood Guardrail	LF	150	$ 54	$8,100
	Removals of Existing Stone Pavers	SF	40	$ 27	$1,093
	Grind Existing Stump	EA	1	$ 1,080	$1,080
	Removal of Existing Deck, Hatches, and Hinges	SF	500	$ 11	$5,400
	Removal of Portion of Stone Wall (adjacent to deck)	LF	90	$ 92	$8,262
	Removal of Portion of Buried Concrete Wall (at Spring Lane sidewalk)	LF	50	$ 216	$10,800
	Removal of Existing Wood Picket Fence	LF	200	$ 32	$6,415
	Removal of Existing Light Poles and Foundations	EA	9	$ 864	$7,776
	Removal of Existing Signage	EA	4	$ 540	$2,160
	Removal of Existing Trees	EA	5	$ 1,296	$6,480
	Tree Protection	EA	3	$ 702	$2,106
	Topsoil-strip and Stockpile (6" Depth)	CY	20	$ 27	$540
	Clearing and Grubbing	LS	1	$ 17,820	$17,820
					$1,195,000
2.0	**Sediment and Erosion Controls & Water Control**				
	Construction Entrance Pad	EA	2	$ 2,700	$5,400
	Temporary Road & E&S Measures	LS	1	$ 48,600	$48,600
	Silt Fence & Haybales	LF	650	$ 11	$7,020
	Turbidity Curtains	LS	1	$ 16,200	$16,200
	Water Control (Cofferdamming, Bypass, Pumping, Etc.)	LS	1	$ 140,400	$140,400
					$218,000
3.0	**Earthwork and Grading**				
	Formation of Subgrade for Paving	SY	1,800	$ 81	$145,800
	Subgrade Material to be Excavated/Reused	CY	150	$ 49	$7,290
	Subgrade Material to be Imported	CY	100	$ 97	$9,720
	Subgrade Material to be Exported	CY	1,060	$ 103	$108,756
					$272,000

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ITEM NO.	ITEM/DESCRIPTION	UNIT	QTY	UNIT COST	AMOUNT IN FIGURES
4.0	Site Features				
	Reset Existing Granite Curbing	LF	700	$ 70	$49,140
	Bituminous Concrete Paving (3" Depth)	TON	167	$ 265	$44,188
	Processed Aggregate Base for Bituminous Concrete Paving (6" depth)	CY	170	$ 70	$11,934
	Gravel Subbase for Bituminous Concrete Paving (8" depth)	CY	230	$ 97	$22,356
	Colored Concrete Paving (4" depth)	SY	100	$ 103	$10,260
	Gravel Subbase for concrete (6" depth)	CY	20	$ 97	$1,944
	Brick (Sidewalks)	SF	3,100	$ 43	$133,920
	Concrete Slab Below Brick Sidewalks	CY	60	$ 1,080	$64,800
	Granite Curb Edger	LF	30	$ 162	$4,860
	Granite Paver Banding	SF	1,000	$ 38	$37,800
	Wood Decking	SF	500	$ 27	$13,500
	Recycled Brick (setting only)	SY	40	$ 130	$5,184
	Concrete Slab for Recycled Brick and Granite Paver Banding	CY	7	$ 1,620	$11,340
	Stop Sign	EA	1	$ 540	$540
	Pedestrian Crossing Sign	EA	2	$ 540	$1,080
	Downward Diagonal Arrow Sign	EA	2	$ 540	$1,080
	Jenney Pond - Rip Rap for Dam Repairs	TN	500	$ 130	$64,800
	Granite Bollards	EA	7	$ 1,080	$7,560
	Safety Railing on Wall	LF	50	$ 151	$7,560
	Granite Block Steps to Existing Headwall	LS	1	$ 5,940	$5,940
	4'-0" Wood Gates at Headwall	EA	2	$ 1,026	$2,052
	Decorative Granite Post and Wood Picket Fence	LF	300	$ 1,188	$356,400
	Relocate Existing Wood Guardrail	LF	150	$ 119	$17,820
	Dumpster Enclosure	LS	1	$ 27,000	$27,000
	Epoxy Parking Re-striping, Double Yellow Line, Stop Bar, and Crosswalk	LS	1	$ 5,940	$5,940
	Detectable Warning Strip	EA	1	$ 1,080	$1,080
					$911,000
5.0	Park-Site Furniture				
	New Granite Block Benches (Product & Install)	EA	6	$ 2,700	$16,200
	Salvaged Granite Block Benches (setting only)	EA	12	$ 594	$7,128
	Traditional Colonial Hinges (Product & Install	EA	5	$ 432	$2,160
	Informational Sign (Sign Design, Fabrication, and Installation)	EA	1	$ 7,128	$7,128
	Relocate Existing Informational Sign	EA	2	$ 378	$756
	Relocate and Mount Existing Signs on Wood Posts	EA	2	$ 594	$1,188
	Reinstall Existing Bus Signage	EA	3	$ 216	$648
	Relocate Existing Sculpture and Memorial Bench	EA	2	$ 1,080	$2,160
	Pole Mounted Site Light (Product & Install)	EA	5	$ 14,580	$72,900
	Light Bollard	EA	13	$ 3,780	$49,140
	Wall Mounted Lighting	EA	6	$ 2,376	$14,256
					$174,000
6.0	Topsoil				
	Furnish and Place Topsoil (Planting Areas) 12" Depth	CY	75	$ 59	$4,455
					$5,000
7.0	Plantings				
	Trees	EA	4	$ 1,620	$6,480
	Shrubs	EA	50	$ 97	$4,860
	Perennials	EA	350	$ 43	$15,120
	Pine Bark Mulch (4" Depth)	SY	200	$ 11	$2,160
	Temporary Irrigation	SF	4000	$ 1	$2,376
					$31,000

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8.0	**Structural**				
	Spring Lane Cutoff Wall	LS	1	$ 86,400	$86,400
	Spring Lane Retaining Wall & Railing	LS	1	$ 302,400	$302,400
	Dam Headwall Repairs	LS	1	$ 27,000	$27,000
	Grist Mill Deck Repairs and Reconstruction	LS	1	$ 216,000	$216,000
	Platform for AC Units and Utilities	LS	1	$ 43,200	$43,200
	Masonry Repairs under Grist Mill and Within Culvert	LS	1	$ 54,000	$54,000
	Miscellaneous Structural Items	LS	1	$ 64,800	$64,800
	Temporary Shoring, Supports and Specialty Equipment	LS	1	$ 86,400	$86,400
					$881,000
9.0	**Utilities**				
	Water Main Replacement	LS	1	$ 529,200	$529,200
	Drainage Improvements	LS	1	$ 124,200	$124,200
	Electrical Improvements	LS	1	$ 172,800	$172,800
	Eversource Pole & Duct Bank Relocation Coordination	LS	1	$ 86,400	$86,400
	Electric and Com Service Reconnections	LS	1	$ 151,200	$151,200
	HVAC, Misc. Utility Relocation, & Utility Coordination	LS	1	$ 140,400	$140,400
					$1,205,000
10.0	**Construction Incidentals (±5%)**				$ 222,400
11.0	**Project Closeout (±2%)**				$ 89,000

CONTRACT ITEMS SUBTOTAL =	**$5,203,400**
12.0 CONTINGENCY (±17.5%)	**$910,600**
TOTAL CONSTRUCTION	**$6,114,000**
13.0 CONSTRUCTION PHASE ENGINEERING AND CONSULTING (±12%)	**$624,500**
TOTAL CONSTRUCTION PHASE	**$6,738,500**

MEMORANDUM

TO:	Massachusetts Office of Dam Safety
FROM:	Milone & MacBroom, Inc., now part of SLR International Corporation
RE:	Hydrologic Analysis of Jenney (Arms House) Pond Dam
DATE:	December 1, 2020
MMI #:	1982-08-25

1.0 PROJECT DESCRIPTION

Milone & MacBroom, Inc. (MMI) was retained by the Town of Plymouth to conduct a Phase II Inspection of Jenney (aka Arms House) Pond Dam, which is located along Town Brook in Plymouth, Massachusetts. As part of the inspection, MMI developed a hydrologic model for the dam, its impoundment (Jenney Pond), and the Town Brook watershed (see Figure 1-1). The model was used to determine the discharge capacity of the dam, assess whether it meets state requirements for spillway capacity and freeboard, and evaluate how much a proposed fish passage culvert at the dam will improve its capacity.

As part of this analysis, the Massachusetts Office of Dam Safety (ODS) requested that MMI perform a dam breach analysis for Jenney Pond Dam to determine if the current hazard classification is appropriate based on the risk to downstream areas posed by a potential dam breach. Currently, Jenney Pond Dam is classified as an Intermediate size, Significant (Class II) Hazard Potential. According to the Massachusetts dam safety guidelines provided in 302 CMR 10, failure of a significant hazard dam may cause "loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use and service of relatively important facilities." If loss of life and severe damage to downstream properties and infrastructure appear to be "likely" based on the results of the dam breach analysis, the dam classification would need to be upgraded to a High (Class I) Hazard Potential.

The flood hazard potential for the area downstream of the dam was assessed based on the resulting flooding extents, water surface elevations, and flow velocities for various dam breach scenarios, which were simulated using a two-dimensional (2D) hydraulic model developed with the Hydrologic Engineering Center – *River Analysis System* (HEC-RAS) computer software. The dam breach analysis for Jenney Pond Dam was performed according to the procedures described in the Federal Guidelines for Inundation Mapping of Flood Risks Associated with Dam Incidents and Failures (FEMA P-946, 2013).

Jenney Pond Dam (State ID #7-12-239-4, National ID #MA00907) is an intermediate size, earthen structure with a maximum storage capacity of approximately 27.6 acre-feet and a structural height of 12 feet. The dam has two outlets: a concrete arch culvert, which discharges to the water wheel at the restored grist mill immediately downstream of the dam, and a concrete pipe culvert, which discharges to a Denil fish ladder. Outflows from the pond are controlled by stoplogs installed along the inlets of the culverts. Spring Lane, a paved roadway, forms the crest of the dam.

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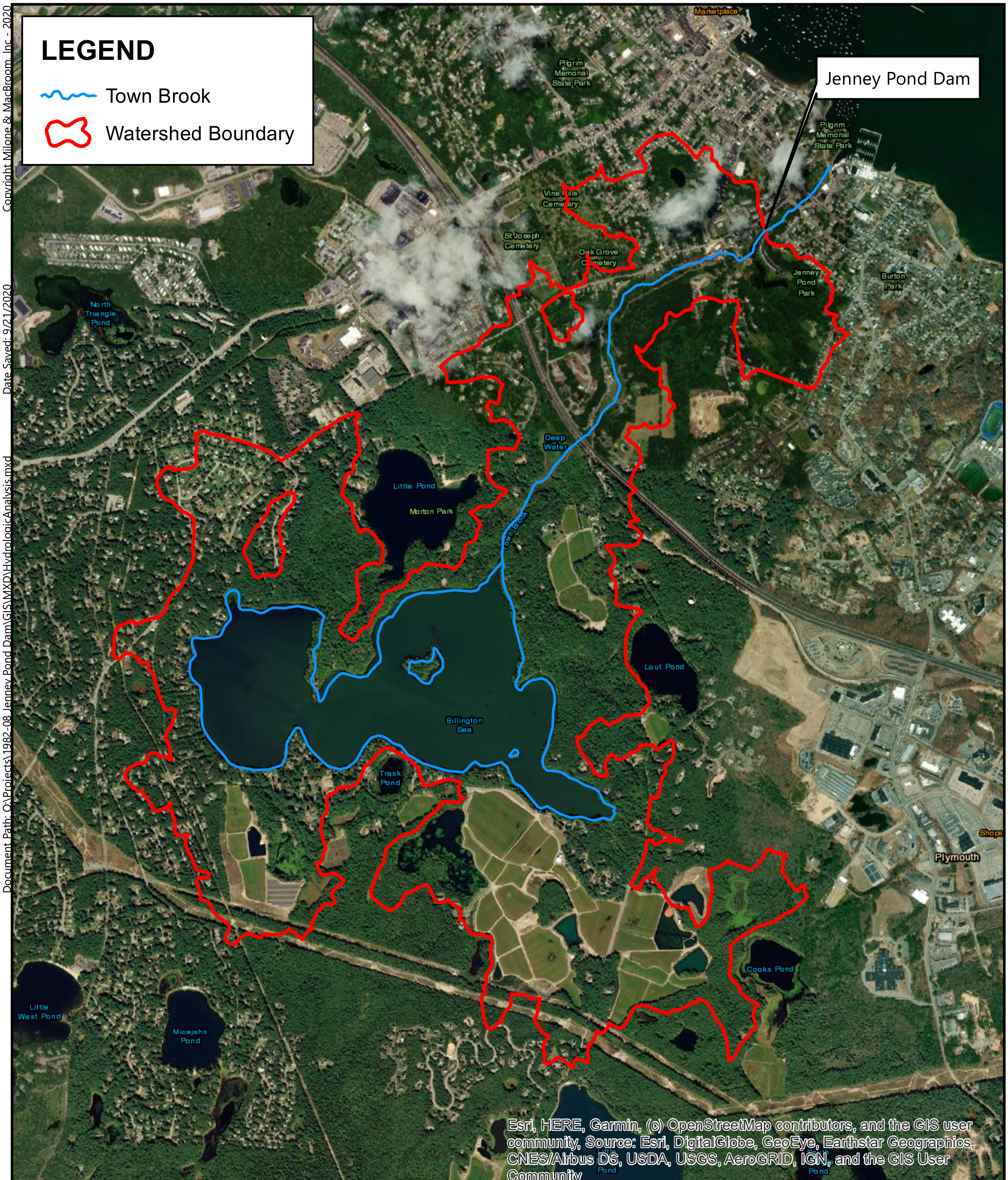
The Town Brook watershed, which drains to Jenney Pond, has an area of 2.32 square miles and includes the Billington Sea, numerous kettle ponds and wetlands, and a network of cranberry bogs. The water level in each of the bogs and flow between bogs is loosely controlled with an assortment of culverts, pumps, and stoplogs. The rest of the watershed consists of forest, wetlands, and some developed areas near the downstream end. Due to the sandy soils within the watershed, infiltration rates are high, and flows along Town Brook are primarily controlled by groundwater. Due to these characteristics, the region regression equations for peak flood flows which were developed for Massachusetts do not apply to Plymouth or the Town Brook watershed (Wandle 1983).

Currently, the only flood flow estimates for Town Brook were those developed for the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS #25023CV001C). These peak flows, which are presented in Table 1-1, were estimated using the United States Army Corps of Engineers (USACE) HEC-1 flood hydrograph computer model. The model was calibrated using the discharge data from United States Geological Survey (USGS) Gauge #01105870, which is on the Jones River in the town of Kingston. For the FIS, the Town Brook watershed was estimated to be 3.9 square miles at the Sandwich Street bridge, approximately 600 feet downstream of Jenney Pond Dam. The watershed area differs from the new delineation due to changes in the watershed and a more detailed field investigation of the watershed boundaries and noncontributing area.



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TOWN BROOK WATERSHED

JENNEY POND DAM - HYDROLOGIC ANALYSIS
TOWN OF PLYMOUTH
Spring Lane
Plymouth, MA

N

0 500 1,000
Feet

SCALE	1 " = 2,000 '
DATE	9/21/2020
PROJ. NO.	1982-08

FIG. 1-1

TABLE 1-1
FEMA FIS Peak Discharges for Town Brook at Sandwich Street in Plymouth

Flood Event	Peak Discharge (CFS)
10-Year	132
50-Year	174
100-Year	202
500-Year	255

CFS = cubic feet per second

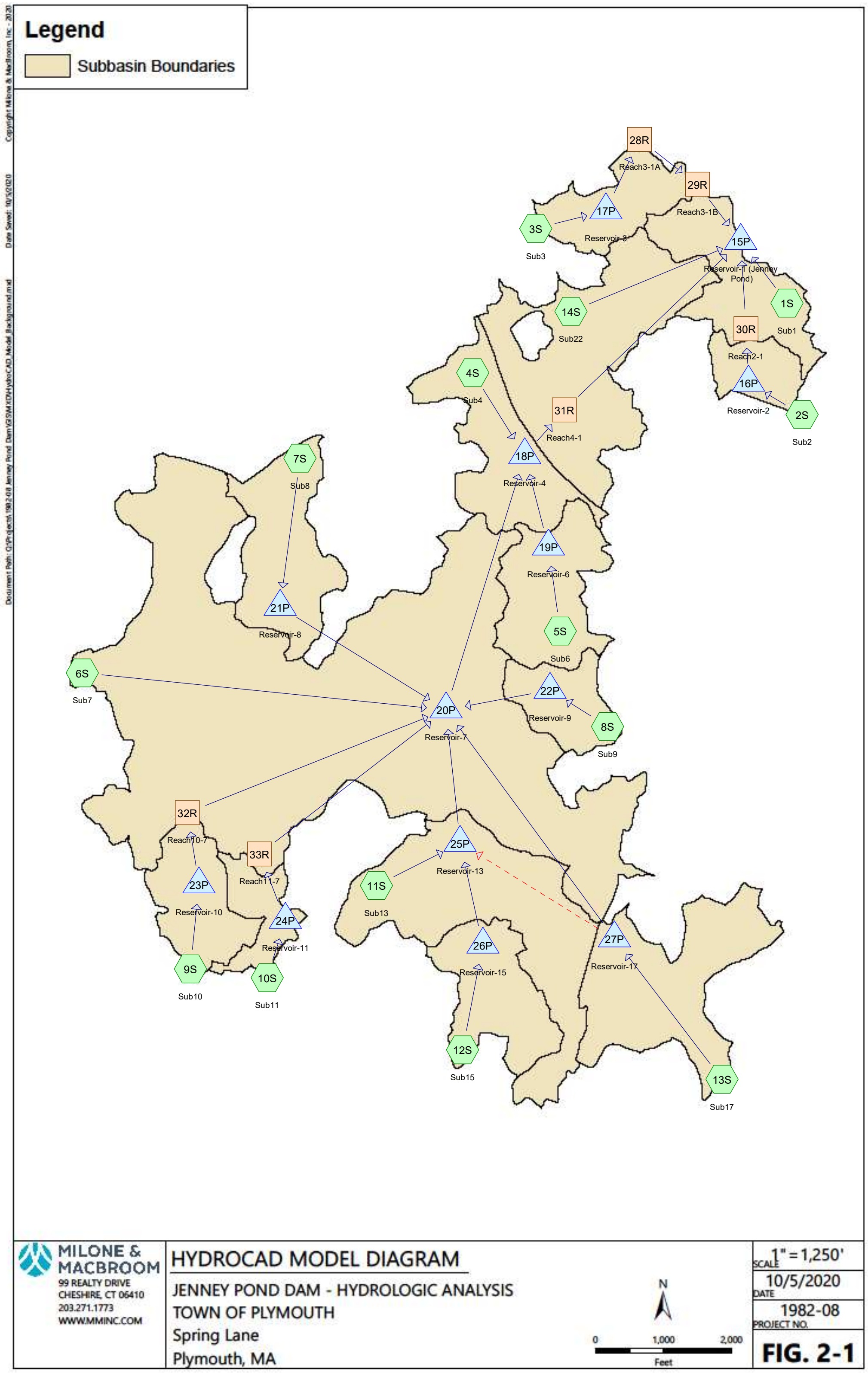
2.0 MODELING INPUT PARAMETERS

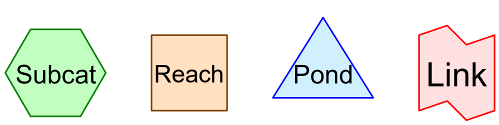
2.1 Hydrologic Model

The hydrologic model for Town Brook and Jenney Pond Dam was developed using the *HydroCAD Stormwater Modeling* program (version 10.0). The model is a TR-20 type rainfall-runoff model (SCS 1992), which calculates surface runoff according to the Soil Conservation Service (SCS) Curve Number (CN) method and routes flows downstream to a point of interest. There are three basic components to the model: subbasin nodes, reach nodes, and pond/reservoir nodes. The Town Brook watershed area was divided up into 14 subbasin nodes, 13 pond/reservoir nodes, and 6 reach nodes. A diagram of the model, showing the components and how they are linked, is presented in Figure 2-1. The HydroCAD model report, containing the results from the 100-year flood simulation, is presented in Appendix A.

2.1.1 Subbasin Nodes

The subbasin nodes represent various sections of the watershed area. Runoff calculations were performed for each subbasin using the SCS-CN method, which utilizes the SCS Unit Hydrograph. The method requires various input parameters, including the watershed area, CN value, and time of concentration (T_c). The subbasins were delineated in *ArcGIS* using contours developed from 3-meter resolution Light Detection and Ranging (LiDAR) data and updated based on field observations. CN values were primarily obtained from Table 2-2 in *Technical Release 55* (TR-55) (USDA-NRCS 1986) and are based on mapped hydrologic soil groups (HSGs) and landcover data. For landcover types that do not appear in TR-55, such as wetlands and cranberry bogs, CN values were chosen based on recommendations from the draft publication *Hydrologic Soil-Cover Complexes in the National Engineering Handbook* (NRCS-USDA 2017). CN values for wetlands and cranberry bogs may vary significantly depending on the water levels in these areas at the time of a storm event. A single, area-weighted CN value was then calculated for each of the subbasins. The T_c for each subbasin was calculated using the velocity method (NRCS-USDA 2010). Various input parameters for the subbasin model nodes are presented in Table 2-1.





Routing Diagram for TownBrookHydrology_1982-08_ExCon
Prepared by Milone & MacBroom, Inc., Printed 10/5/2020
HydroCAD® 10.00-25 s/n 11053 © 2019 HydroCAD Software Solutions LLC

TABLE 2-1
Subbasin Nodes – Model Input Parameters

Subbasin Node	Drainage Area (acres)	Weighted CN	Time of Concentration (min)
Sub1	64.8	57	13.9
Sub2	25.1	45	15.7
Sub3	43.2	60	25.6
Sub4	72.2	59	42.1
Sub6	65.1	53	20.1
Sub7	579.7	73	39.0
Sub8	73.1	50	58.8
Sub9	36.6	44	21.6
Sub10	50.5	54	20.2
Sub11	26.9	55	20.1
Sub13	137.3	65	28.1
Sub15	59.4	58	30.9
Sub17	101.7	53	37.3
Sub22	137.4	54	31.7

2.1.2 Pond/Reservoir nodes

The Town Brook watershed includes many different waterbodies, including kettle ponds, wetlands, cranberry bogs, and ponds. Some of these waterbodies, such as Little Pond which is immediately north of Billington Sea, are hydrologically isolated and do not drain downstream to Town Brook. Others are highly interconnected due to a network of man-made channels and culverts used to control water levels. Additionally, flows between cranberry bogs and some ponds are controlled by pumping water from one waterbody to another. In order to incorporate the waterbodies into the *HydroCAD* model, a variety of simplifying assumptions were made. Hydrologically connected waterbodies within the Town Brook watershed were modeled using 13 reservoir nodes. Groups of waterbodies that were highly interconnected and could be assumed to maintain a similar water level were incorporated into individual nodes. This helped to significantly reduce the number of reservoir nodes and the data requirements for the model.

Input parameters for each node include storage volumes and outlet information (see Table 2-2). Volumes were calculated from elevation-area curves, which were primarily calculated using LiDAR-based contours. No bathymetric information was available for the waterbodies except for Billington Sea and Jenney Pond, for which average depths were obtained from local officials. Because LiDAR is ineffective at penetrating water, elevation-area curves primarily begin at water surface elevations at the time the LiDAR was collected. Assumptions about the depth of various waterbodies were only made if outlets could not be incorporated into a node without lowering the initial elevation of storage. For example, if a pond has a 3-foot-diameter outlet culvert and the elevation-area curve for the pond starts 2 feet below the top elevation of the road, the depth of the pond was assumed to be 1 foot so that the minimum pond elevation is at or below the inlet elevation of the outlet.

TABLE 2-2
Reservoir Nodes – Model Input Parameters

Reservoir Node	Name/Description	Primary Outlet	Emergency Spillway
Reservoir-1	Jenney Pond	5.5' by 7' concrete arch culvert and 24" reinforced concrete pipe culvert	Top of Dam/Roadway (Elev. = 25.3')
Reservoir-2	Unnamed Pond	Channel outlet modeled as weir	N/A
Reservoir-3	Unnamed Pond	36" corrugated metal pipe culvert	Top of Roadway (Elev. = 47.6')
Reservoir-4	Morton Pond	14.1' by 9.5' concrete box culvert	Top of Roadway (Elev. = 89.0')
Reservoir-6	Cranberry Bogs	4.3' by 3.4' concrete box culvert	Top of Roadway (Elev. = 82.6')
Reservoir-7	Billington Sea	6.9' by 6.0' concrete box culvert	Top of Roadway (Elev. = 84.5')
Reservoir-8	Wetland	24" corrugated metal pipe culvert	Top of Roadway (Elev. = 84.2')
Reservoir-9	Wetland/Abandoned Cranberry Bog	24" corrugated metal pipe culvert	Top of Roadway (Elev. = 82.5')
Reservoir-10	Cranberry Bogs	24" reinforced concrete pipe culvert	Top of Roadway (Elev. = 90.8')
Reservoir-11	Unnamed Pond and Wetland	24" corrugated metal pipe culvert	Top of Roadway (Elev. = 89.2')
Reservoir-13	Briggs Reservoir and Cranberry Bogs	4.0' by 3.0' elliptical corrugated metal pipe culvert	Top of Roadway (Elev. = 86.4')
Reservoir-15	Cranberry Bogs	24" corrugated plastic pipe culvert	Top of Roadway (Elev. = 89.3')
Reservoir-17	Cranberry Bogs and Unnamed Pond	36" corrugated metal pipe culvert	Top of Roadway (Elev. = 85.6')

Outlet information for each reservoir node was obtained from 3-meter resolution LiDAR data, field measurements, and the hydraulic model used in development of the FEMA effective FIS (FIS #25023CV001C) for Town Brook. If outlet invert elevations could not be measured in the field or were not available in the flood insurance model, the values were estimated based on LiDAR data. Additionally, outlet dimensions for Reservoir-2, -3, -8, and -9 were inaccessible during fieldwork and were therefore estimated based on photographs. Reservoir routing calculations were performed using the dynamic storage-indication method.

2.1.3 Reach Nodes

A total of six reach nodes were used to model the flow of runoff through the various channels connecting waterbodies within the Town Brook watershed. Each reach node was labeled based on the reservoir nodes that it links. For example, Reach 4-1 represents the section of Town Brook that connects Reservoir-4 (Billington Sea) to Reservoir-1 (Jenney Pond). Reach input parameters, including channel length and slope, were calculated using LiDAR data and are presented in Table 2-3. Channel dimensions for all reaches were also estimated using LiDAR data except Reach 4-1, for which channel dimensions were available from as-built drawings from several dam removal projects that have been performed along Town Brook since 2002. Reach routing calculations were performed using the dynamic storage-indication method.

TABLE 2-3
Reach Nodes – Model Input Parameters

Reach Node	Channel Length (ft)	Channel Slope (ft/ft)	Manning's n Value
Reach 2-1	636	0.030	0.045
Reach 3-1A	365	0.010	0.045
Reach 3-1B	590	0.028	0.013
Reach 4-1	4,473	0.012	0.045
Reach 10-7	370	0.024	0.045
Reach 11-7	1,244	0.007	0.045

2.1.4 Rainfall Data

Rainfall data for the Town Brook hydrologic model was obtained from the precipitation frequency data from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (Station ID: 19-6486). For Plymouth, Massachusetts, the estimated rainfall depth for the 24-hour duration, 100-year return period event is 7.49 inches. This event was selected because Jenney Pond Dam is required to pass the 100-year flood event with 1 foot of freeboard according to regulations for Significant Hazard dams. Rainfall depths for the 10-, 50-, and 500-year return period events, presented in Table 2-4, were also modeled for comparison purposes. The rainfall distribution for each event was modeled according to the SCS Type III rainfall distribution described in TR-55 (USDA-NRCS 1986).

TABLE 2-4
Precipitation Frequency Estimates for Plymouth-Kingston, Massachusetts
NOAA Atlas 14

Return Period	24-Hr Rainfall Depth
10-Year	5.00
50-Year	6.72
100-Year	7.49
500-Year	9.56

2.1.5 Baseflow and Initial Conditions

Baseflow conditions within the Town Brook watershed are controlled by groundwater levels and can vary seasonally based on infiltration. Due to the complexity of the Town Brook watershed and lack of available groundwater and/or USGS gauge data, baseflow conditions could not be estimated for each of the subbasins and reservoirs within the watershed. However, several flow measurements were taken downstream of Jenney Pond Dam between June and August 2020. These flow values provide a measure of the total baseflow for Town Brook during this period but could not be used to determine baseflows for individual subbasins and reservoirs upstream of Jenney Pond. The average of the flow measurements, which was approximately 25 cubic feet per second (CFS), was used as the constant baseflow for Reservoir-7 (i.e., Billington Sea). This waterbody is most likely the primary contributor of baseflow to Town Brook due to its size and because the majority of the watershed drains into it. All other subbasin and reservoir nodes were assumed to have zero baseflow.

Initial water surface elevations (WSEs) for most of the reservoirs, except Reservoir-1, -4, and -7, were set at the invert elevations of their primary outlets unless the tailwater elevation was estimated to be higher. This produced a baseline condition to which various alternative conditions could be compared. The actual water level in each waterbody could be significantly different depending on the groundwater level, if stoplogs are being used to increase the WSE, or if water is being pumped from one waterbody to another. The initial WSEs in Reservoir-1, -4, and -7 were adjusted to maintain the baseflow condition along Town Brook. For example, the initial WSE for Reservoir-7 was set to 80.27 feet so that the baseflow entering the reservoir is equal to the outflow. The same was done for Reservoir-1 (Jenney Pond) and Reservoir-4.

2.1.6 Dam Breach Modeling

Three different flooding scenarios were evaluated as part of the Jenney Pond dam breach analysis: (1) a "fair-weather" dam breach scenario, (2) a "rainy-day" dam breach scenario, and (3) a "rainy-day" scenario without a dam breach. For the fair-weather breach scenario, the dam breach is assumed to occur spontaneously under normal baseflow conditions without the influence of a storm event. Under these conditions, breaches of earthen dams usually occur as piping failures where seepage through the dam leads to destabilization of the fill material, internal erosion, and the eventual failure of the structure. Rainy-day dam breaches occur during storm events and are usually modeled as overtopping failures where flood flows exceed the capacity of a dam's outlets and spillways, overtop the dam, and cause erosion of the dam crest and/or downstream face of the structure, eventually leading to a head cut and complete structural failure. The spillway design flood (SDF) is modeled as the associated storm event for the rainy-day breach scenario because Massachusetts dam safety regulations require dams to have the capacity to pass the SDF with a specific amount of freeboard. As an intermediate size, significant hazard structure, Jenney Pond Dam has an SDF equal to the peak discharge from the 100-year storm event for the Town Brook watershed (302 CMR 10).

The third scenario, which simulates the rainy-day storm event without a dam breach, was modeled for comparison purposes. When performing a dam breach analysis, the flooding resulting from the rainy-day breach is compared to that which results from the rainy-day, no-breach scenario in order to evaluate the incremental increase in flooding related to the dam breach. Under certain conditions, the flooding caused by a breach may be insignificant compared to the flooding caused by the rainy-day storm event or vice versa.

The discharge hydrograph for each flood scenario was developed using the hydrologic model described previously. Dam breach parameters, including the type, dimensions, and timing of a breach, were used to define the characteristics of the breach in the model. Initial estimates for the parameters were calculated using empirical formulas that relate the parameters to various dimensions of the dam and its impoundment. These values, which are presented in Table 2-5, were then modified to better present site-specific characteristics of Jenney Pond Dam.

TABLE 2-5
Dam Breach Parameters for Jenney Pond Dam

Breach Parameters	Fair-Weather Scenario	Rainy-Day Scenario
Initial Reservoir Water Surface Elevations (ft)	21.9	26.0
Failure Mode	Piping	Overtopping
Breach Bottom Elevation (ft)	15.0	15.0
Breach Height (ft)	10.3	10.3
Side Slopes (H:V)	1:1	1:1
Mean Width (ft)	30.9	30.9
Bottom Width (ft)	20.6	20.6
Formation Time (hr)	1.0	1.0

2.2 Hydraulic Model

Downstream flooding caused by the potential failure of Jenney Pond Dam was modeled using a 2D, unsteady-state hydraulic model that was developed using HEC-RAS. The model encompasses both Town Brook and its surrounding floodplain, extending approximately 2,000 feet downstream of the dam to where Town Brook flows into Plymouth Harbor. Unlike the more commonly used one-dimensional models, the 2D model simulates the flow of water through a gridded mesh of cells rather than linearly between cross sections. The water surface elevation in each cell and the flow between adjacent cells are calculated iteratively for each time step of a flood hydrograph. Flow is computed based on the St. Venant shallow water approximations of the Navier-Stokes equations for fluid flow in three dimensions as numerically discretized by HEC. Two-dimensional modeling can be advantageous for flood simulations, especially when modeling complex, nonlinear flow paths, because it allows water surface elevations to vary spatially and allows for a more detailed assessment of flooding. Additionally, unsteady-state models allow for simulation of an entire flood hydrograph rather than a single peak discharge. Diagrams showing the hydraulic model extent, 2D mesh, model terrain, and flood hydrographs are presented in Appendix B.

Various structures downstream of the dam, including the Plimoth Grist Mill building, downstream spillway, and four stream crossings were incorporated into the hydraulic model in order to determine how the structures influence flooding. Input parameters for each of the structures are presented in Tables 2-6 and 2-7. During a dam failure, the location of the grist mill building immediately downstream of the dam has a significant impact on how the flood wave travels downstream. Flows must either pass through the opening underneath the building, around the sides of the building, or through the building, if the flooding depths are significant. In the hydraulic model, the grist mill was simulated as a solid obstruction with a culvert at its base.

TABLE 2-6
Bridge and Culvert Input Parameters for the Jenney Pond Dam Hydraulic Model

Input Parameters	Opening Under the Grist Mill	Market St Bridge	Main St Ext Bridge	Pedestrian Bridge	Water St Bridge
Opening Type	Box Culvert	Arch Culvert	Arch Culvert	Box Culvert	Box Culvert
Span (ft)	20.0	30.0	38.2	24.1	15.0
Rise (ft)	2.5	19.0	21.0	3.0	4.3
Culvert Length (ft)	15.0	30.0	36.0	9.0	39.2
Entrance Loss Coefficient	0.5	0.5	0.5	0.4	0.5
Exit Loss Coefficient	1.0	1.0	1.0	1.0	1.0
Inlet Invert Elevation (ft)	11.5	8.3	5.85	4.2	3.7
Outlet Invert Elevation (ft)	11.5	8.3	5.7	4.2	1.1
Manning's n for Bottom	0.04	0.05	0.05	0.04	0.04
Manning's n for Top	0.02	0.013	0.013	0.024	0.024

TABLE 2-7
Bridge Deck and Spillway Input Parameters for the Jenney Pond Dam Hydraulic Model

Input Parameters	Spillway Downstream of Grist Mill	Market St Bridge	Main St Ext Bridge	Pedestrian Bridge	Water St Bridge
Weir Coefficient	2.6	2.6	2.6	2.9	2.6
Bridge Deck/Weir Width (ft)	1.5	50.0	55.0	9.0	38.0
Crest Elevation (ft)	12.43	Varies	Varies	Varies	Varies

In order to assess the flooding under worst-case conditions, the downstream boundary condition was configured to represent the water surface elevation of Plymouth Harbor during high tide. The hydrographs for the three flooding scenarios from the hydrologic model were used as input for the hydraulic model. The resulting flooding extents, water surface elevations, and flow velocities produced by the hydraulic model were evaluated to determine the potential consequences of the various dam breach scenarios.

3.0 HYDROLOGIC MODEL RESULTS AND ANALYSIS

For the 24-hour duration, 100-year return period storm event, the model produces a peak discharge of 245 CFS at Jenney Pond Dam. This results in a peak water surface elevation of 22.4 feet in Jenney Pond, which is approximately 2.9 feet below the top of the dam elevation of 25.3 feet. The capacity of the dam outlets is approximately 410 CFS when there are no stoplogs in place. When considering this result, one should remember that the initial water surface in Jenney Pond was set based on the assumption that the stoplogs at the outlets were removed and the pond had drained down prior to the storm event. In the past, when a large storm event has been forecasted, the Town of Plymouth has removed the logs to drain the pond and prevent the structure from being overtopped. When the stoplogs are in place, the capacity of the outlet is significantly reduced. For the same storm event, the dam would be overtopped by approximately 0.7 feet if the stoplogs were installed as they are currently (i.e., set to a top elevation of approximately 21 feet or 1.0 foot below the top of the culvert). The stoplogs reduce the discharge capacity of the dam's outlets to approximately 70 CFS.

The top elevation of the stoplogs at the primary outlet was varied in the model in order to determine what configuration would allow Jenney Pond Dam to pass the 100-year flood. Table 3-1 presents the resulting peak discharges and pond water surface elevations when the stoplogs are set at different elevations. If the stoplogs were lowered from an elevation of 21.0 feet to 19.7 feet, the dam can just barely pass the 100-year flood without being overtopped. By lowering the stoplogs by another 0.9 feet to a top elevation of 18.8 feet, the dam passes the 100-year flood with at least a foot of freeboard. The model results show that the stoplogs' elevation significantly affects the capacity of the dam but could be lowered to pass the 100-year flood with a foot of freeboard.

TABLE 3-1
Peak Discharge and Water Surface Elevation for Jenney Pond Dam
Depending on Stoplog Configuration

Stoplog Top Elevation (ft)	Discharge (CFS)	Water Surface Elevation (ft)
16.6 (No Stoplogs)	244	22.4
21.0	188	26.0
19.7	155	25.3
18.8	189	24.3

CFS = cubic feet per second

In order to validate the results, the model was run for a large storm event that occurred on July 12, 2019, and produced approximately 5.33 inches of rain in less than 24 hours according to the rain gauge data from the Plymouth Municipal Airport. Even though the stoplogs were in place at the Jenney Pond Dam outlet, the water level in the pond only reached an elevation of approximately 24.5 feet (about 1 foot below the top of dam) based on a photo taken the day of the event (see Figure 3-1). If a SCS Type-III rainfall distribution is used to model the July 12 rain event, the resulting water surface elevation in Jenney Pond is approximately 24.8 feet. The minor discrepancy between these values suggests that the model is effectively estimating runoff flows from the Town Brook watershed.

FIGURE 3-1
Photo of Jenney Pond Dam during a Large Rainstorm
Taken at 8:03 a.m. on July 12, 2019

In comparison to the estimated peak flows from the FEMA FIS, the modeled 50-, 100-, and 500-year peak flows are all slightly higher while the 10-year peak flow is lower (see Table 3-2). The variation between the model and FEMA FIS may be due to several differences between FEMA's model and the model used for this study, including watershed area, changes in landcover, and the inclusion of the stoplogs at the outlet of Jenney Pond. One should note that the watershed area defined in the FEMA FIS is approximately 1.6 square miles larger than the modeled watershed area in this study.

TABLE 3-2
Peak Flow Comparison – Jenney Pond Dam

Flood Event	FEMA FIS Flows (CFS)	Town Brook Model Flows (CFS)
10-Year	132	114
50-Year	174	205
100-Year	202	244
500-Year	255	341

CFS = cubic feet per second

Another way to assess the accuracy of the model is to compare the flow per unit area, calculated by dividing a flow by the watershed area, for the modeled watershed to a gauging station along a nearby waterway. USGS Gauge 01105870 along the Jones River in Kingston, Massachusetts, was selected for this comparison because it is the closest stream gauge to Jenney Pond Dam and has similar watershed characteristics, including high infiltration rates and a large storage capacity, to the Town Brook watershed. A *Bulletin-17C* gauge analysis was performed for the gauge to determine peak flood flows. For the 100-year return period event, the Jones River produces a flow per unit area of 33 cubic feet per second per square mile (CFSM) (see Table 3-2). This means that 33 CFS is produced for each square mile of the Jones River watershed on average.

TABLE 3-3
Comparison of Flow per Unit Area

Source	Flow per Unit Area (CFSM)
Town Brook Model (No Stoplogs)	105
Town Brook Model (Stoplogs in Place)	81
FEMA FIS	52
Jones River – USGS Gauge Analysis	33

CFSM = Cubic Feet per Second per Square Mile

For the FEMA FIS, the flow per unit area was approximately 52 CFSM for the 100-year flood, which is fairly close to the estimate for the Jones River watershed. In contrast, the Town Brook model produces a flow per unit area of 105 CFSM for the 100-year event, which is significantly higher. However, the peak discharge from Jenney Pond is highly dependent on the elevation of the stoplogs at the primary outlet. If the stoplogs are in place, as they are currently, the peak discharge for Jenney Pond Dam decreases to approximately 188 CFS and the flow per unit area decreases to 81 CFSM. The flow per unit area comparison may not be a reasonable comparison due to the effects of stoplogs at the Jenney Pond Dam outlets and the presence of other flow control structures throughout the Town Brook Watershed.

4.0 DAM BREACH RESULTS AND ANALYSIS

As outlined in Section 2.1.6, three dam breach scenarios were modeled: a fair-weather breach, which assumes that Jenney Pond Dam fails during normal baseflow conditions independent of a storm event; a rainy-day breach, which assumes that the dam fails when the pond reaches its maximum elevation during the spillway design flood (i.e., the 100-year storm event); and a rainy-day no-breach scenario, which is used for comparison as a baseline of the expected downstream flooding during the spillway design flood. One should note that during all three scenarios the stoplogs that control the water surface elevation in Jenney Pond were assumed to be installed to a top elevation of 21.0 feet. Inundation maps were developed from the results of the 2D hydraulic model to evaluate potential hazards and assess the consequences of a breach. The depth of flooding, flow velocities, and number of affected properties were considered when quantifying downstream hazards.

The peak discharge and water surface elevation for Jenney Pond during each flooding scenario are presented in Table 4-1. At 808 CFS, the peak discharge for the rainy-day dam breach scenario is over two and half times larger than the peak discharge for the fair-weather breach and over four times larger than that of the rainy-day, no-breach scenario. This is primarily due to volume of water within the reservoir prior to dam failure. Many years of accumulated sediment within the reservoir have significantly reduced storage volume within the reservoir to only 7.3 acre-feet under baseflow conditions, limiting the amount of water that can be discharged downstream during a fair-weather breach. During the 100-year storm event, the reservoir storage increases to 33.6 acre-feet, creating a much higher peak discharge for the rainy-day dam breach scenario.

TABLE 4-1
Peak Discharge and Water Surface Elevation for Jenney Pond Dam Depending on Stoplog Configuration

Flooding Scenario	Discharge (CFS)	Water Surface Elevation (ft)
Fair-Weather Breach	294	21.9
Rainy-Day (SDF) – No Breach	188	26.0
Rainy-Day Dam Breach	808	26.0

CFS = cubic feet per second

During the fair-weather dam breach scenario (see Figure 4-1), the extent and severity of flooding along Town Brook are relatively minimal. The only building that experiences flooding is the Plimoth Grist Mill, which crosses over Town Brook immediately downstream of Jenney Pond Dam. During the dam breach, the flood flows are constricted by the opening underneath the mill building causing the water surface to rise to a peak elevation of approximately 16.1 feet. With a first-floor elevation of approximately 15.2 feet, the building has just under a foot of flooding. Downstream of the mill, the breach leads to some minor flooding of the pedestrian bridge and foot paths in the Brewster Gardens park but does not impact any other structures.

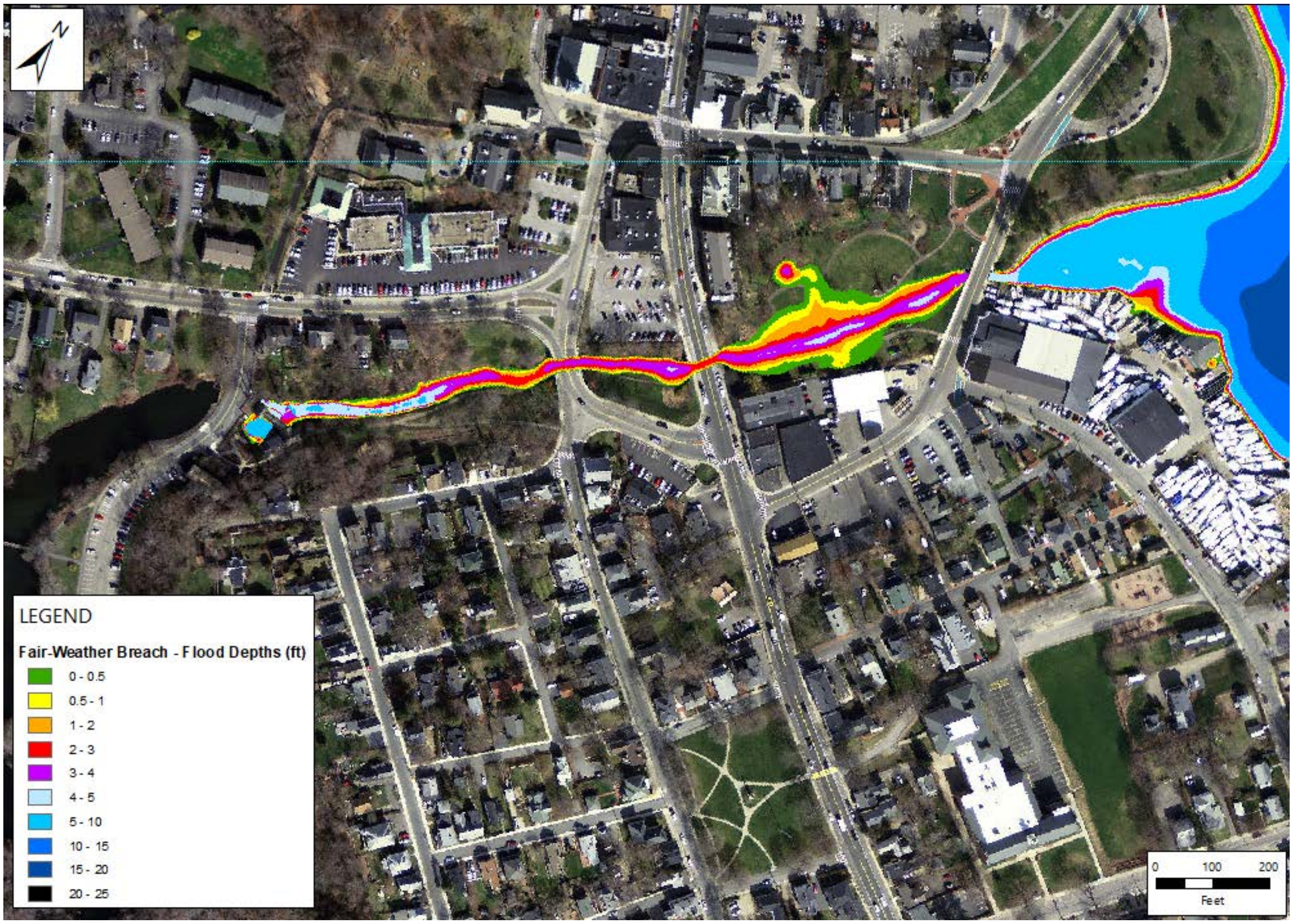


FIGURE 4-1
Fair-Weather Dam Breach Scenario – Flooding Depths

The rainy-day dam breach causes significantly more flooding than the fair-weather breach. Approximately 10 buildings experience minor flooding due to the breach, with the majority of the flooding occurring along Water Street, Union Street, Watercure Street, and Freedom Street due to the channel constriction created by the Water Street culvert (see Figure 4-2). The Plimoth Grist Mill experiences severe flooding due to the breach with flood depths as high as 6.6 feet above the first-floor elevation. As in the fair-weather breach scenario, the pedestrian bridge and foot paths in the Brewster Gardens park are also inundated. Figure 4-3 presents the flood depth grid map for the rainy-day, no breach scenario and the inundation extent of the rainy-day dam breach scenario for comparison. Without the dam breach, the 100-year storm event does not cause any significant flooding downstream of Jenney Pond Dam. However, as described in the previous section, Jenney Pond Dam does not have the capacity to pass the 100-year flood if the stoplogs are installed to a top elevation of 21.0 feet at its primary outlet. The dam would be overtopped by approximately 0.7 feet, which could lead to erosion of the dam crest and the downstream face of the structure and damage Spring Lane, which runs along its crest. For comparison, Table 4-2 provides the peak water surface elevations for each flooding scenario at the stream crossings downstream of Jenney Pond Dam.

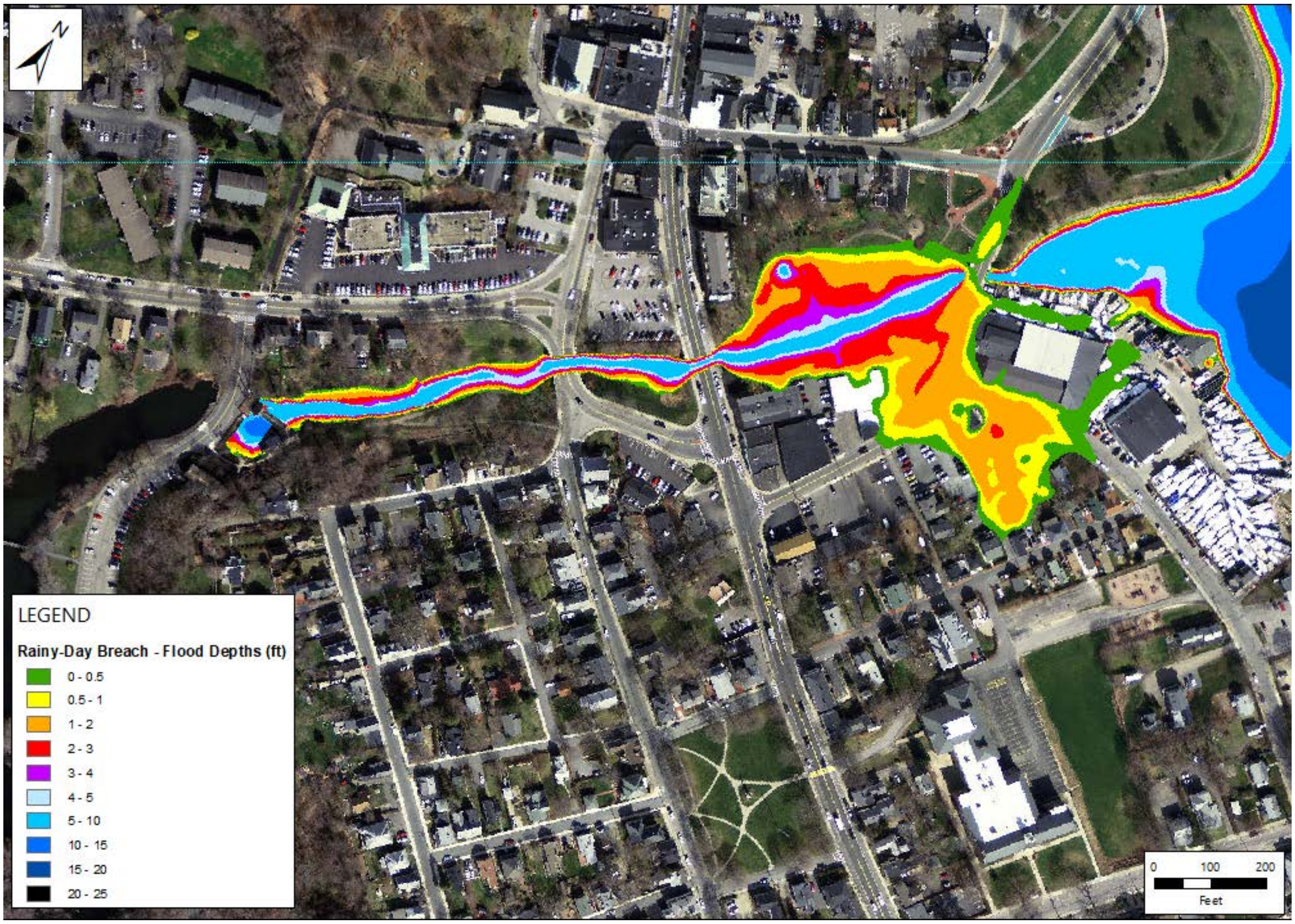


FIGURE 4-2
Rainy-Day Dam Breach Scenario – Flooding Depths

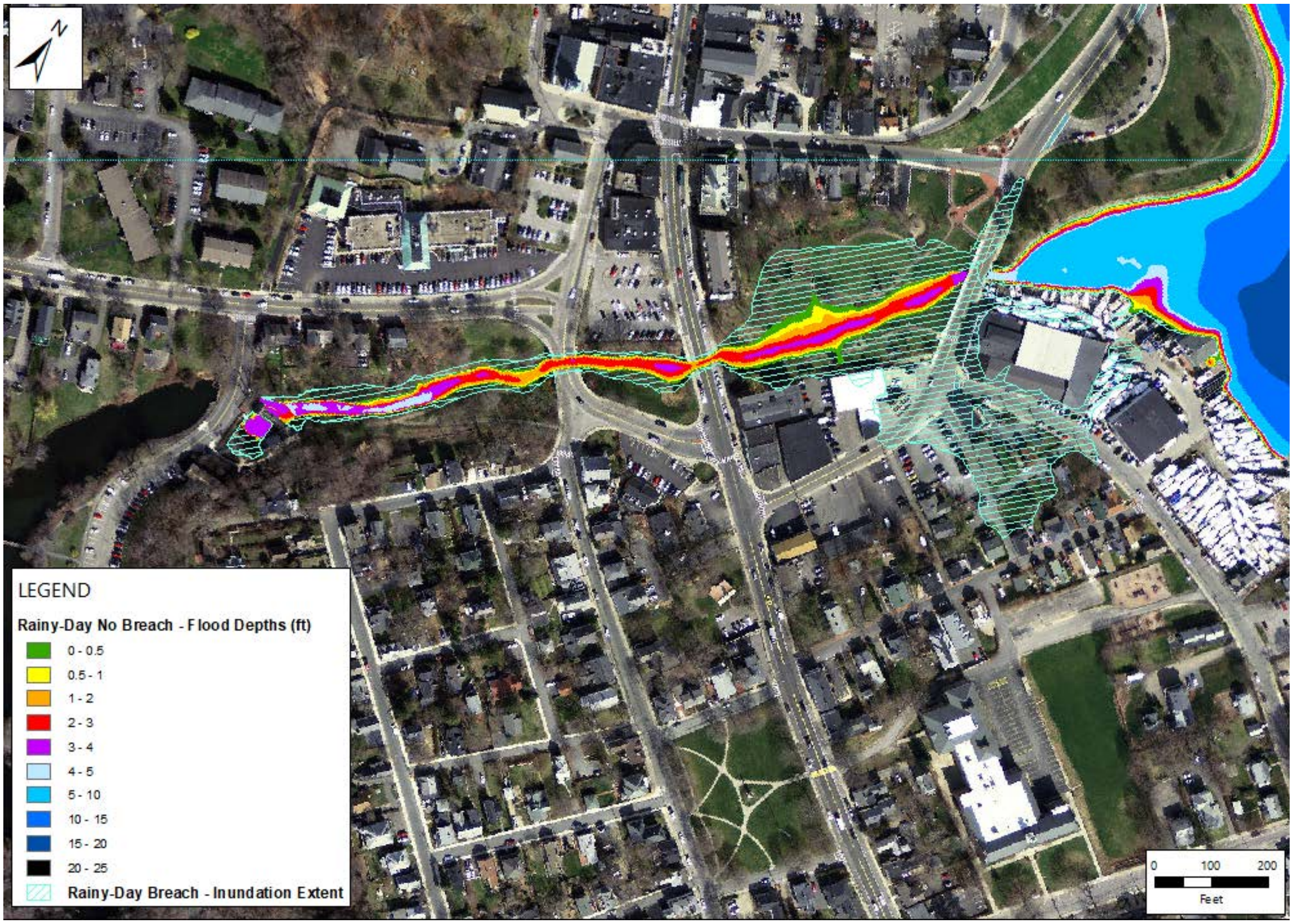


FIGURE 4-3
Rainy-Day No-Breach Scenario – Flooding Depths

TABLE 4-2
Peak Water Surface Elevations at
Stream Crossings Downstream of Jenney Pond Dam

Structure	Roadway Elevation (ft)	Water Surface Elevation (ft)		
		Rainy-Day Dam Breach	Rainy-Day - No Breach	Fair-Weather Dam Breach
Grist Mill Building	15.2 (First-floor elev.)	21.8	14.8	16.1
Market Street Bridge	30	14.2	11	11.7
Main Street Ext. Bridge	24.6	11.6	8.4	9.1
Pedestrian Bridge	8.8	10.5	7.4	8.3
Water Street Bridge	8.9	10	6.7	7.5

Downstream flooding hazards due to high-flow velocities were also assessed as part of the dam breach analysis. Depending on the depth of flooding, high flow velocities could be dangerous for people sheltering inside buildings. *Technical Memorandum No. 11* (1988), a publication of the U.S. Bureau of Reclamation, provides guidelines for classifying downstream dam breach hazards according to the relationship between flood depth and flow velocity. The guidelines describe three danger zones, which are defined based on the likelihood that potentially fatal conditions may result. If flooding depths and velocities at a specific home are relatively low, the home is considered to be within the low-danger zone because it is unlikely that lives are in jeopardy. When flooding depths and velocities are high, there is a much higher likelihood that conditions could lead to a fatality, and the home is classified as being in the high-danger zone. The third zone is referred to as the judgement zone because one must consider other factors when determining whether there is the potential for fatalities. For example, it is less likely that a flood will cause loss of life if the home being flooded has two floors and the living quarters are on the second floor. However, residents of a one-story home may have more difficulty escaping the floodwaters.

For the fair-weather breach scenario, the Plimoth Grist Mill is flooded by approximately 0.9 feet of water and is subjected to peak flow velocities of approximately 1.5 feet per second. Under these conditions, the mill building is within the low-danger zone, and loss of life is considered unlikely. For the rainy-day dam breach scenario, the peak flooding depth of 6.6 feet and peak flow velocity of 1.7 feet per second puts the mill building in the high danger zone. All of the other buildings that are impacted, including four businesses, four single-family homes, and one apartment complex, are within the low-danger zone due to minor flooding depths and low flow velocities. The results of the depth-velocity hazard analysis for the rainy-day dam breach scenario are presented in Figure 4-4.

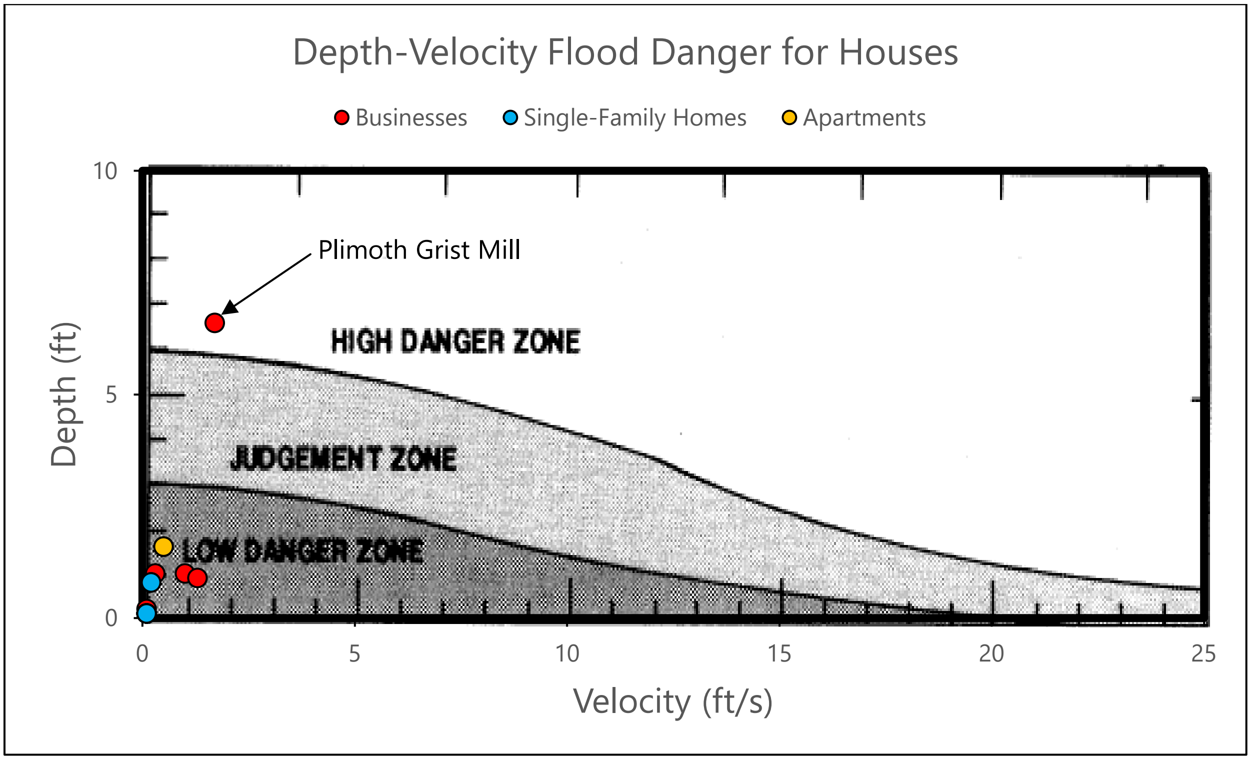


FIGURE 4-4
Flooding Depth and Flow Velocities for Buildings during the Rainy-Day Dam Breach Scenario Plotted on Figure 2 from ACER Technical Memorandum No. 11

Overall, Jenney Pond Dam appears to satisfy the definition for a significant hazard dam in that it is unlikely to cause loss of life due to a breach event but may cause some damage to homes, industrial/commercial facilities, and public infrastructure. During a fair-weather breach, the Plimoth Grist Mill experiences only minor flooding of less than 1 foot above the first-floor elevation. This is unlikely to cause loss of life even if the breach were to happen without significant warning time. No other buildings are flooded during the fair-weather breach scenario. During a rainy-day dam breach scenario, the flooding of the grist mill building is more severe and is classified within the high danger zone based on water depth and flow velocity. However, people would most likely not be in the building during a significant flood event, such as the 100-year storm, and would most likely have enough time to leave the mill building and seek shelter before the dam fails. The nine other buildings that are impacted during the rainy-day breach scenario experience only minor flooding. The only major stream crossing that is impacted is the Water Street culvert, which would be overtopped during the rainy-day breach scenario. If this were to occur and the stream crossing were to be damaged, there are numerous potential detour routes available. Based on the results of this analysis, MMI recommends that Jenney Pond Dam remains classified as a Significant (Class II) Hazard dam.

It is recommended that the operation and maintenance manual (OMM) for Jenny Pond Dam be modified to require staged evacuation of the Plimoth Grist Mill and the pedestrian bridge and foot paths in the Brewster Gardens park when water first begins to discharge over Spring Lane.

The revised OMM will provide for adequate time to evacuate these downstream structures prior to a potential breach and any loss of life.

5.0 PROPOSED IMPROVEMENTS

An additional outlet is currently being proposed for Jenney Pond Dam to improve fish passage. The structure would have the added benefit of increasing the discharge capacity of the dam. The proposed outlet consists of a 2-foot by 5-foot box culvert which discharges to a constructed, natural-bottom channel that will reconnect with Town Brook approximately 50 feet downstream of the dam. Based on the results of the hydrologic model, installing the proposed fish passage culvert would increase the dam's discharge capacity from 410 CFS to around 510 CFS when stoplogs are not in place. Under these conditions, the dam could pass the 100-year flood event with a peak water surface elevation in Jenney Pond of 22.2 feet, providing 3.1 feet of freeboard.

When the flashboards are in place and set to a top elevation of 21.0 feet, the proposed fish passage culvert increases the discharge capacity of the dam to approximately 170 CFS, which reduces the peak water surface elevation to 25.2 feet so that the dam has approximately 0.1 feet of freeboard during the 100-year flood event. To get a foot of freeboard, the stoplogs would need to be lowered to an elevation of 19.9 feet or less.

Under current conditions, Jenney Pond Dam can only satisfy the discharge and freeboard requirements for a significant hazard dam if the stoplogs are removed or lowered by at least 2.2 feet. With the addition of the proposed fish passage culvert, the model shows that the stoplogs would only have to be lowered by 1.1 foot to allow for the passage of the 100-year flood with a foot of freeboard.

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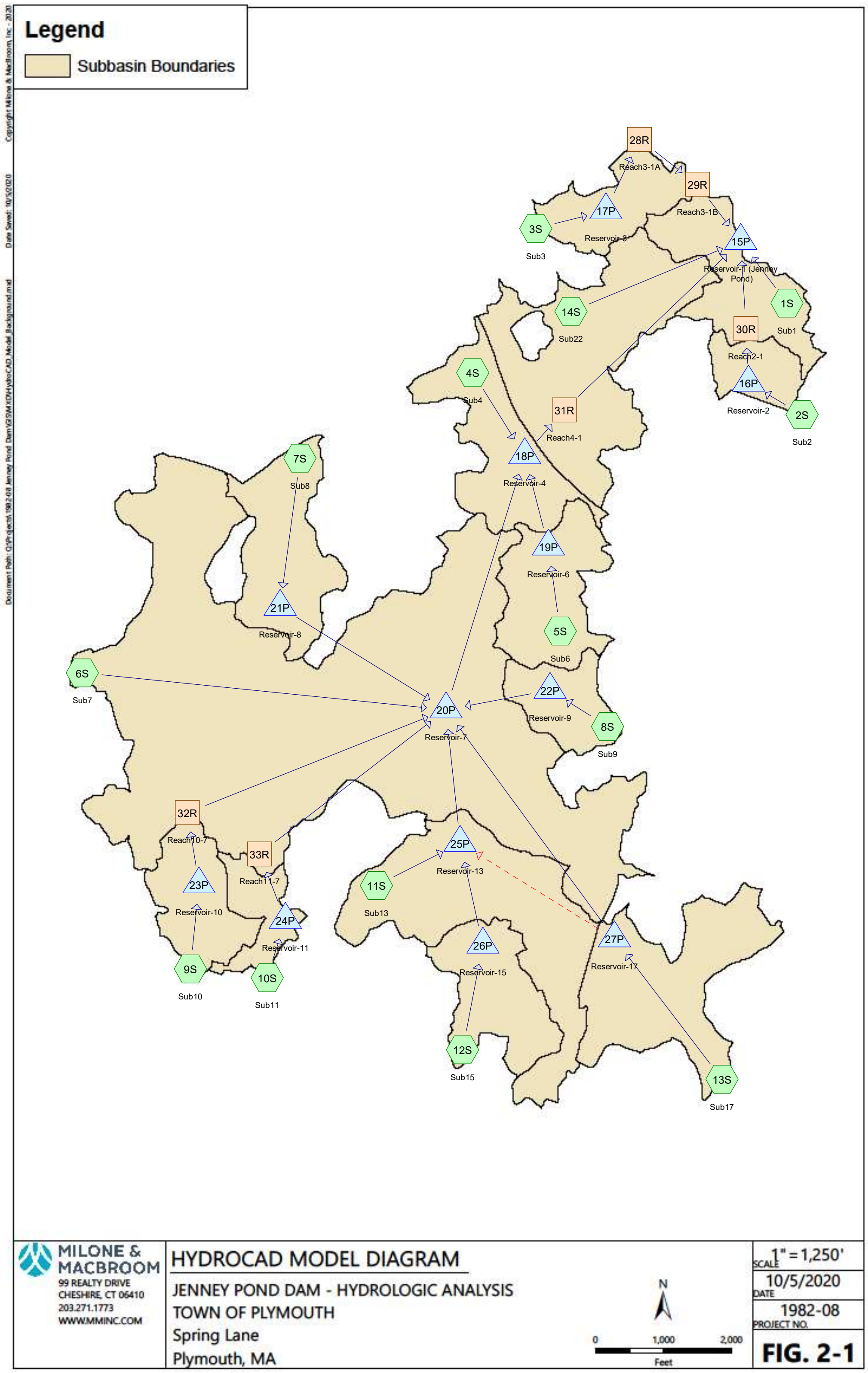
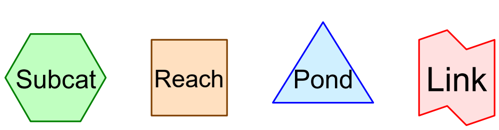
APPENDIX A

Hydrologic Model Report – 100-Yr Flood Event





Routing Diagram for TownBrookHydrology_1982-08_ExCon
Prepared by {enter your company name here}, Printed 12/1/2020
HydroCAD® 10.00-25 s/n 11053 © 2019 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Sub1

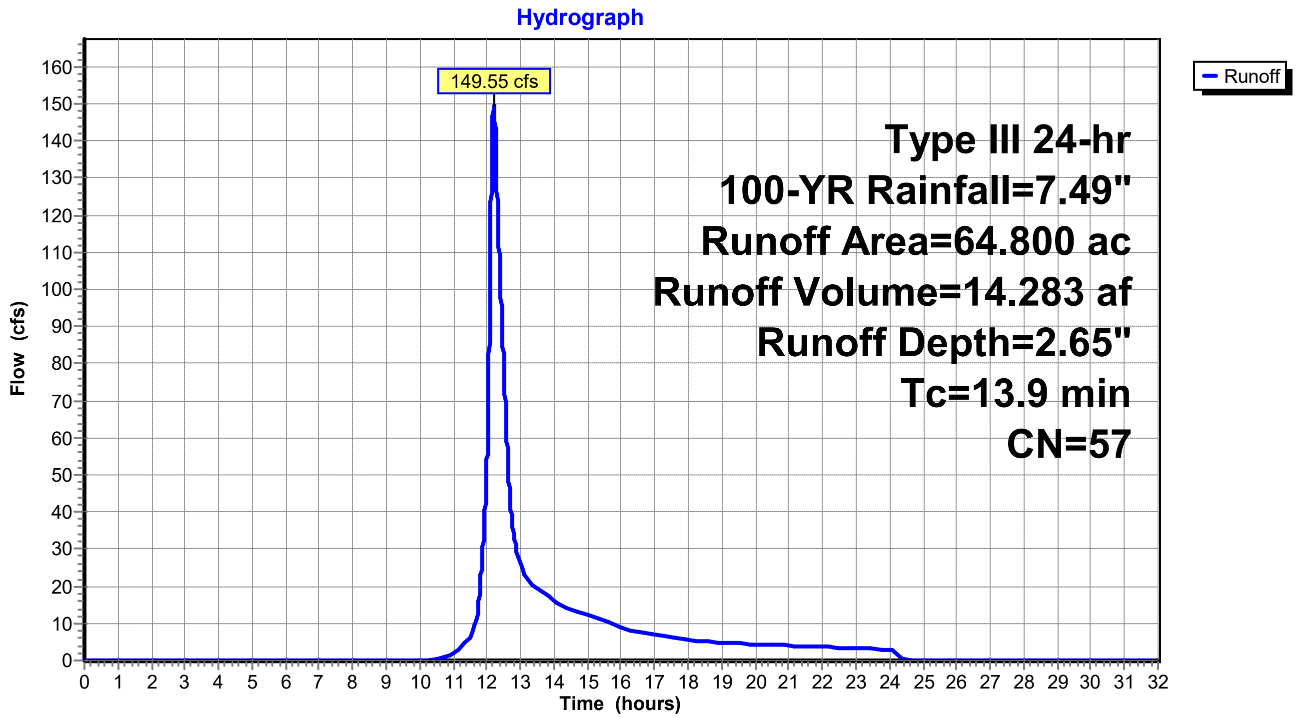
Runoff = 149.55 cfs @ 12.20 hrs, Volume= 14.283 af, Depth= 2.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	64.800	57	Weighted CN value
	64.800		100.00% Pervious Area

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

Subcatchment 1S: Sub1



Summary for Subcatchment 2S: Sub2

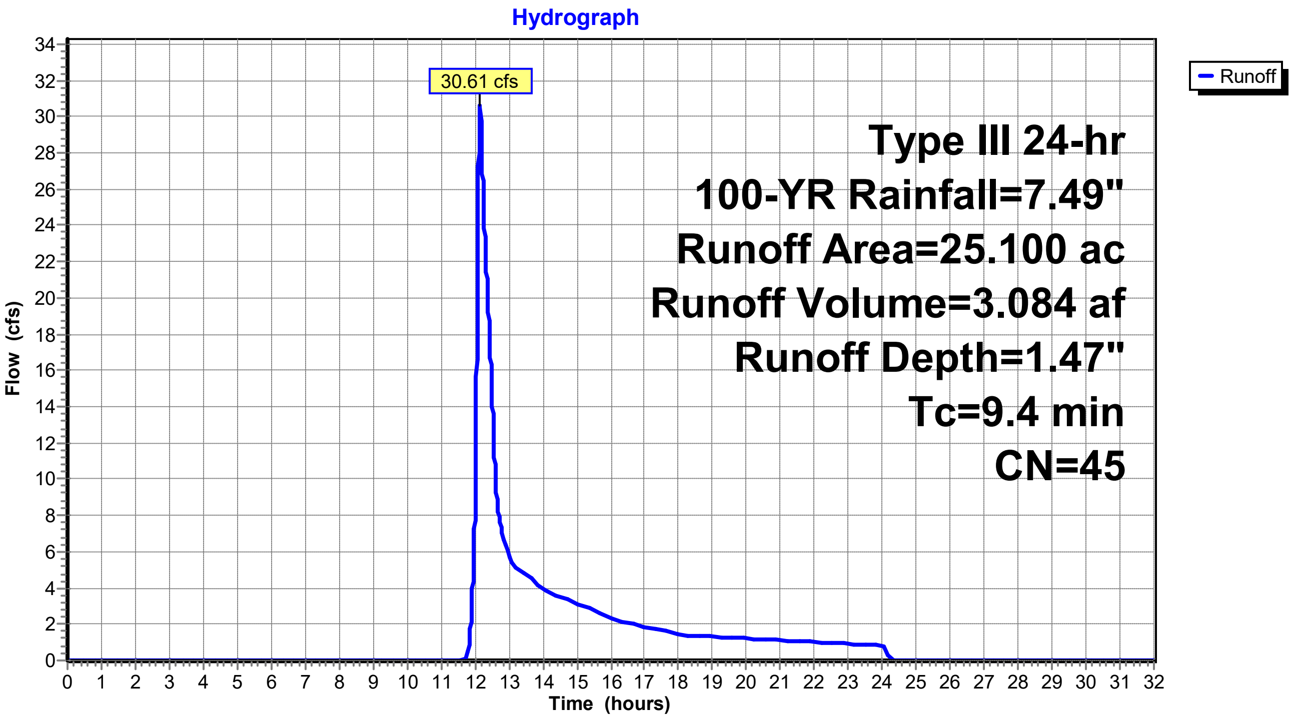
Runoff = 30.61 cfs @ 12.15 hrs, Volume= 3.084 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	25.100	45	Weighted CN value
	25.100		100.00% Pervious Area

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

Subcatchment 2S: Sub2



Summary for Subcatchment 3S: Sub3

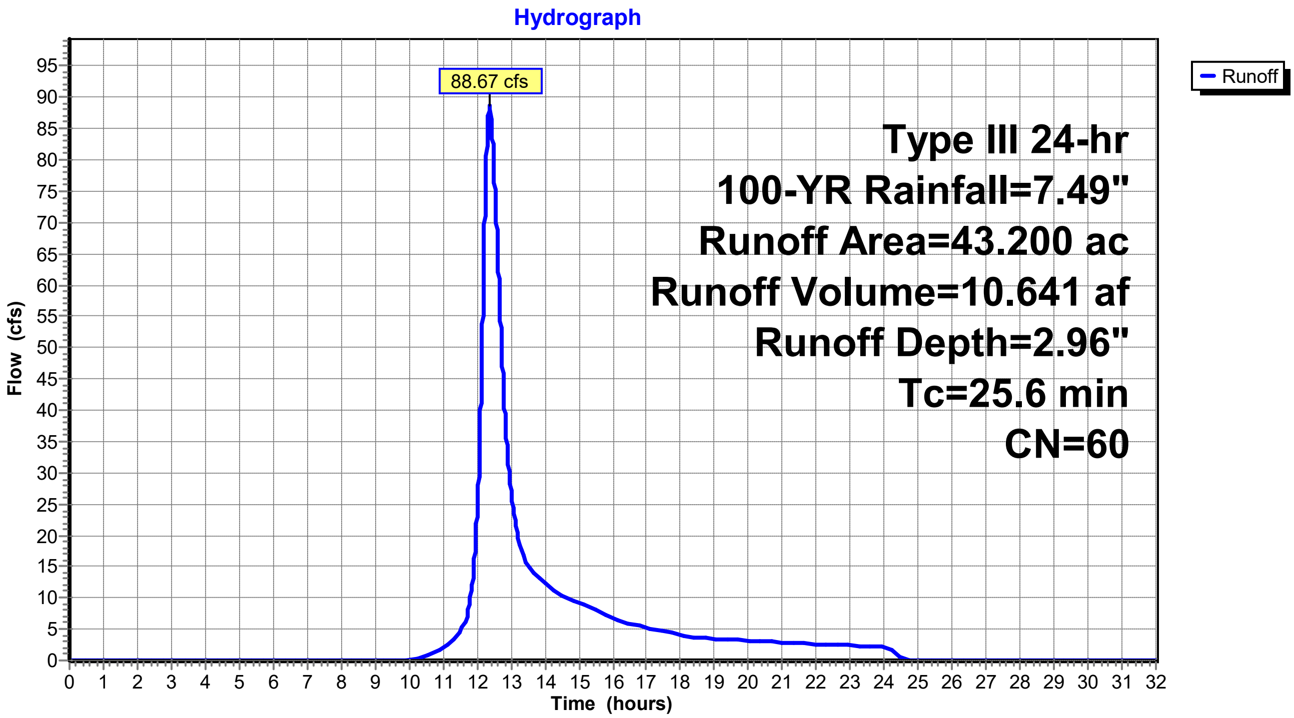
Runoff = 88.67 cfs @ 12.37 hrs, Volume= 10.641 af, Depth= 2.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	43.200	60	Weighted CN value
	43.200		100.00% Pervious Area

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

Subcatchment 3S: Sub3



Summary for Subcatchment 4S: Sub4

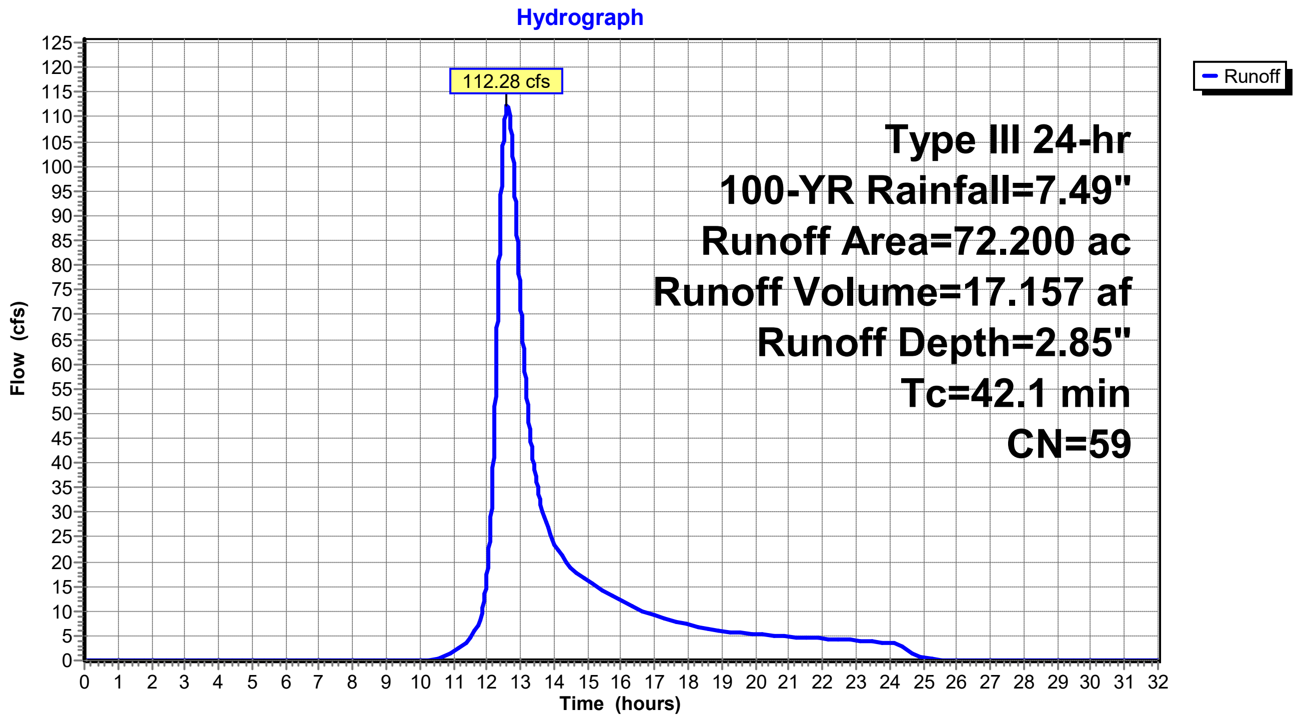
Runoff = 112.28 cfs @ 12.59 hrs, Volume= 17.157 af, Depth= 2.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	72.200	59	Weighted CN value
	72.200		100.00% Pervious Area

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

Subcatchment 4S: Sub4



Summary for Subcatchment 5S: Sub6

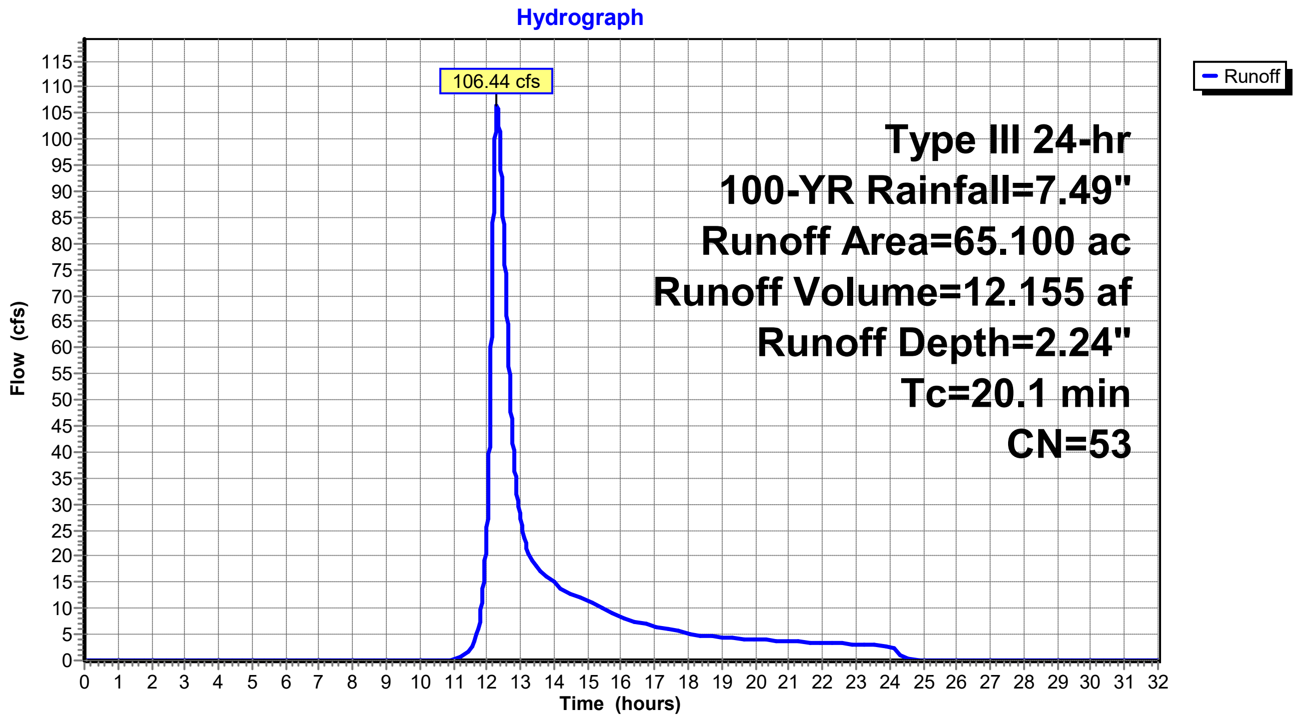
Runoff = 106.44 cfs @ 12.31 hrs, Volume= 12.155 af, Depth= 2.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	65.100	53	Weighted CN value
	65.100		100.00% Pervious Area

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

Subcatchment 5S: Sub6



Summary for Subcatchment 6S: Sub7

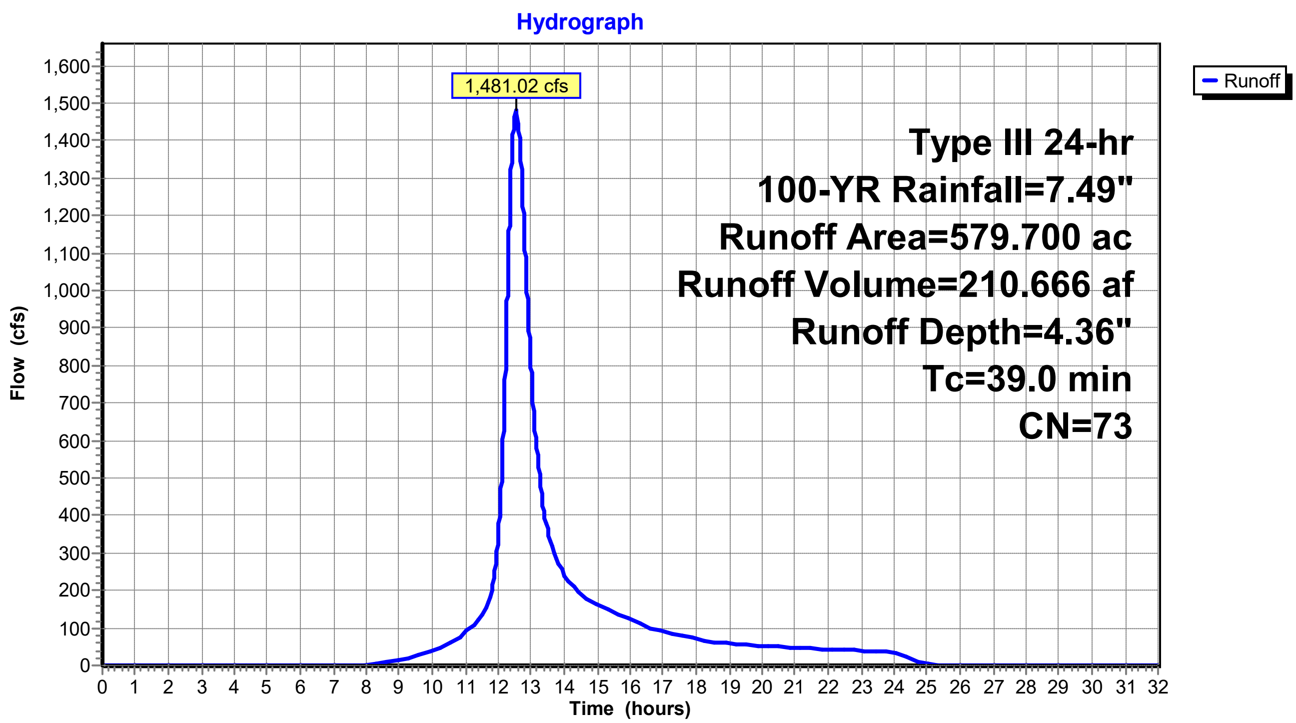
Runoff = 1,481.02 cfs @ 12.53 hrs, Volume= 210.666 af, Depth= 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	579.700	73	Weighted CN value
	579.700		100.00% Pervious Area

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

Subcatchment 6S: Sub7



Summary for Subcatchment 7S: Sub8

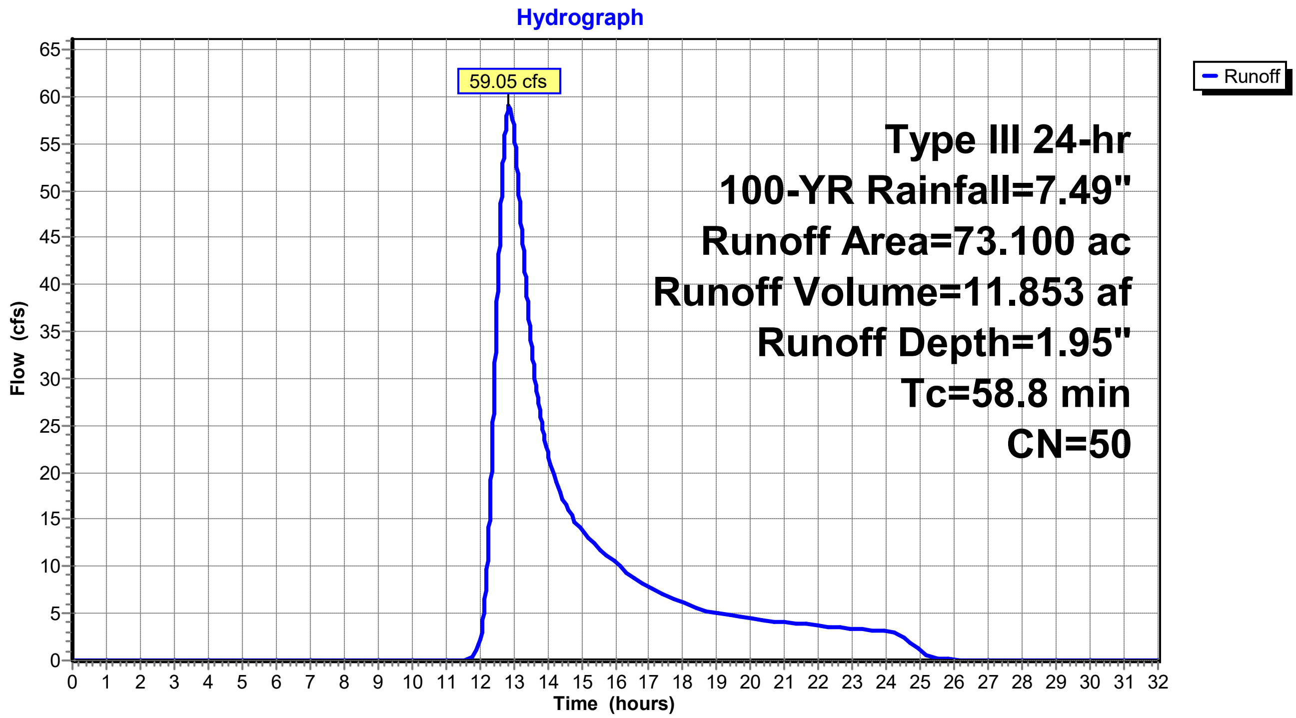
Runoff = 59.05 cfs @ 12.87 hrs, Volume= 11.853 af, Depth= 1.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	73.100	50	Weighted CN value
	73.100		100.00% Pervious Area

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

Subcatchment 7S: Sub8



Summary for Subcatchment 8S: Sub9

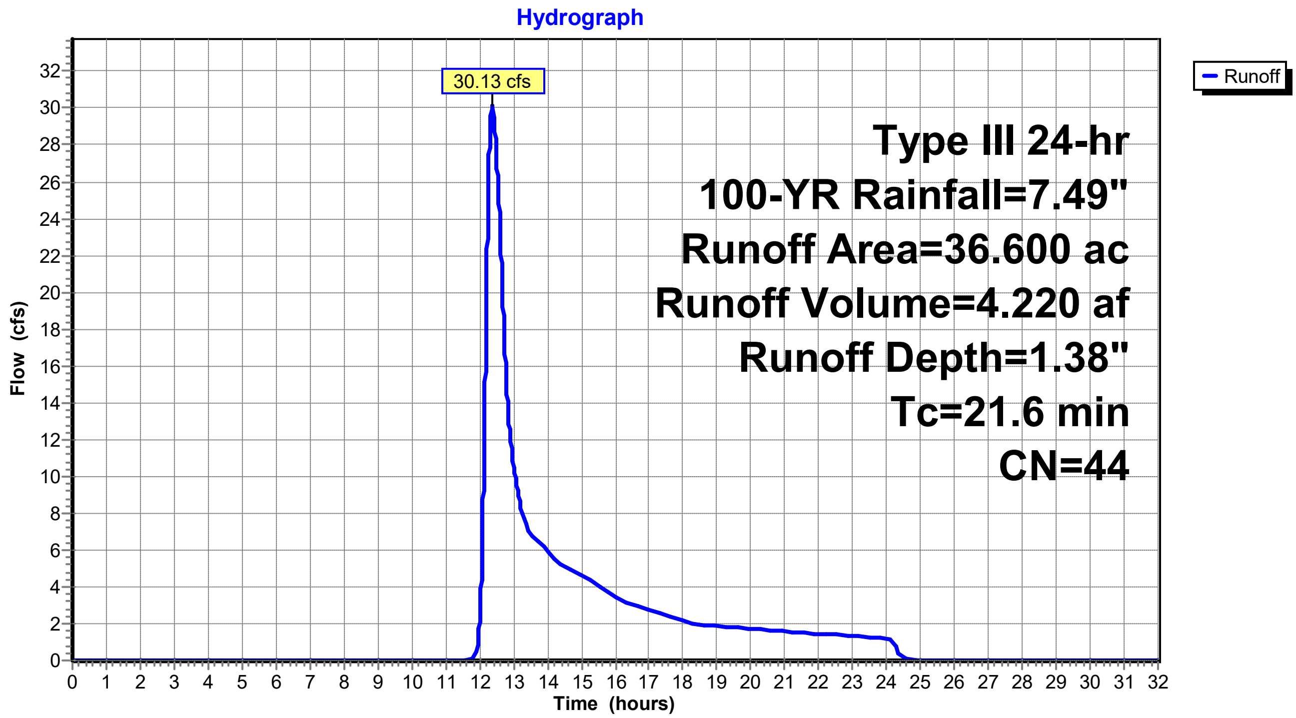
Runoff = 30.13 cfs @ 12.36 hrs, Volume= 4.220 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	36.600	44	Weighted CN value
	36.600		100.00% Pervious Area

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

Subcatchment 8S: Sub9



Summary for Subcatchment 9S: Sub10

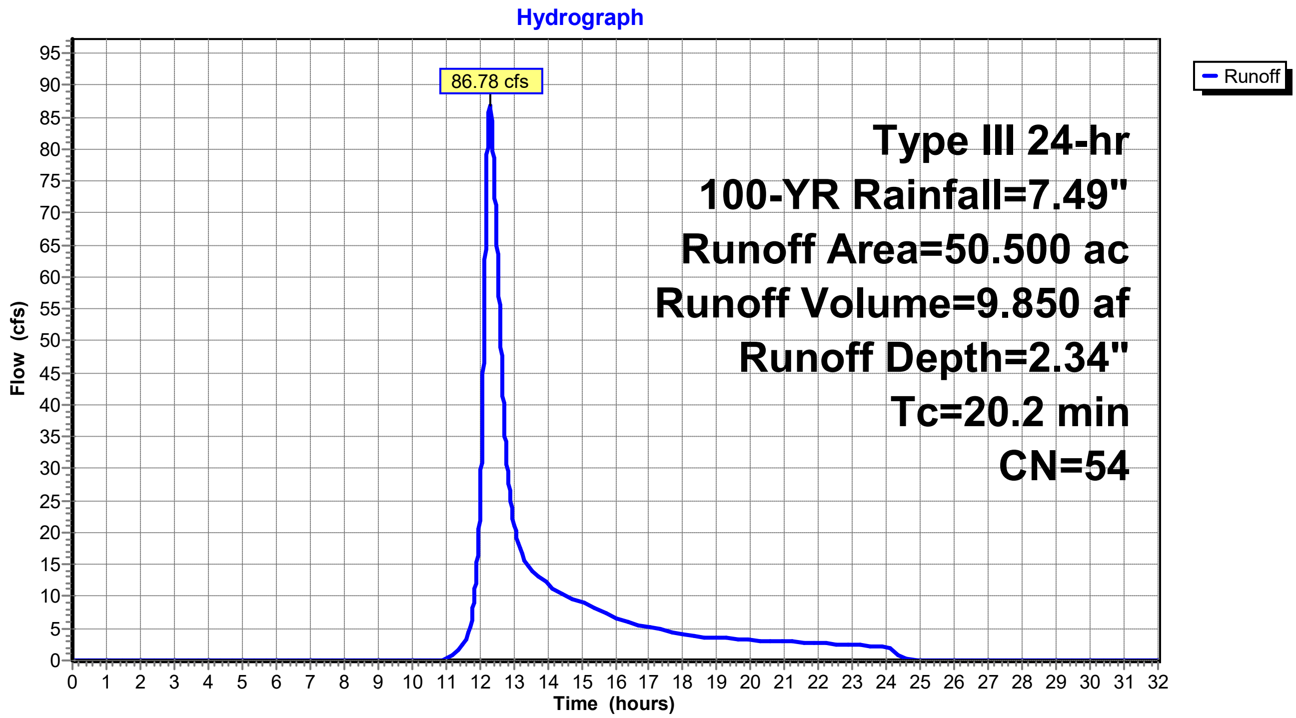
Runoff = 86.78 cfs @ 12.30 hrs, Volume= 9.850 af, Depth= 2.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	50.500	54	Weighted CN value
	50.500		100.00% Pervious Area

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

Subcatchment 9S: Sub10



Summary for Subcatchment 10S: Sub11

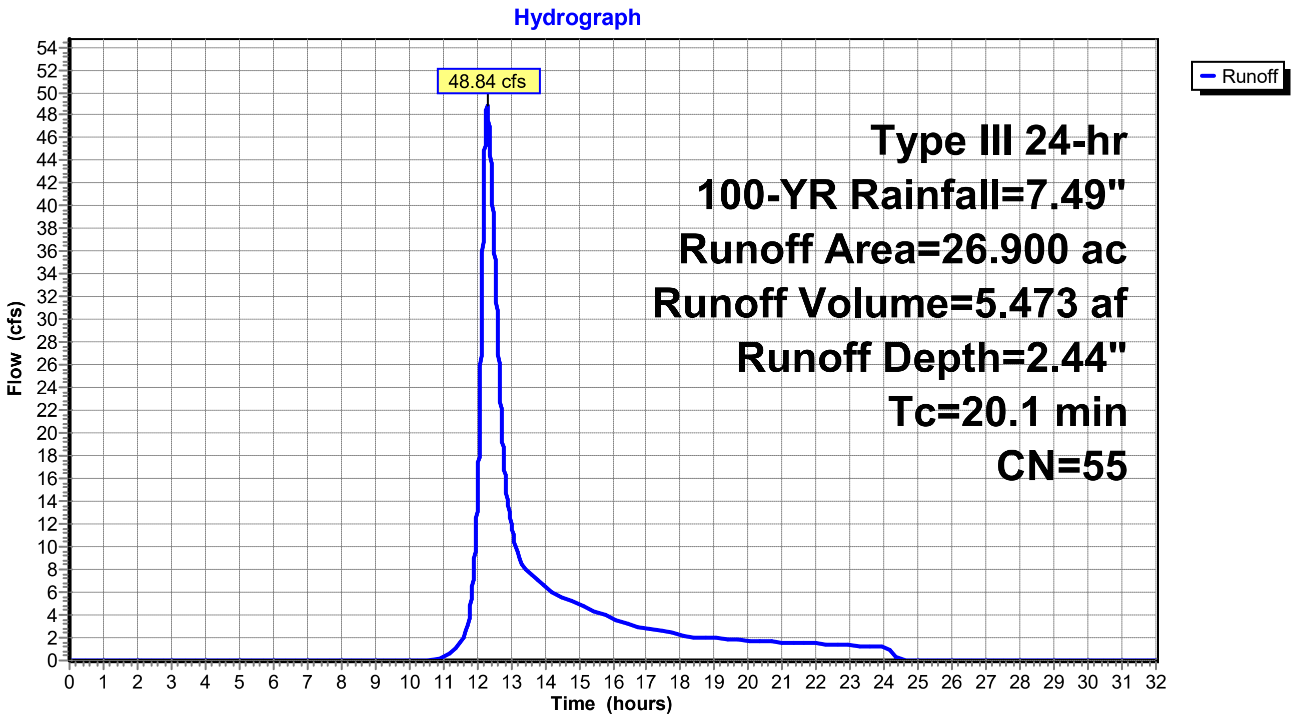
Runoff = 48.84 cfs @ 12.30 hrs, Volume= 5.473 af, Depth= 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	26.900	55	Weighted CN value
	26.900		100.00% Pervious Area

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

Subcatchment 10S: Sub11



Summary for Subcatchment 11S: Sub13

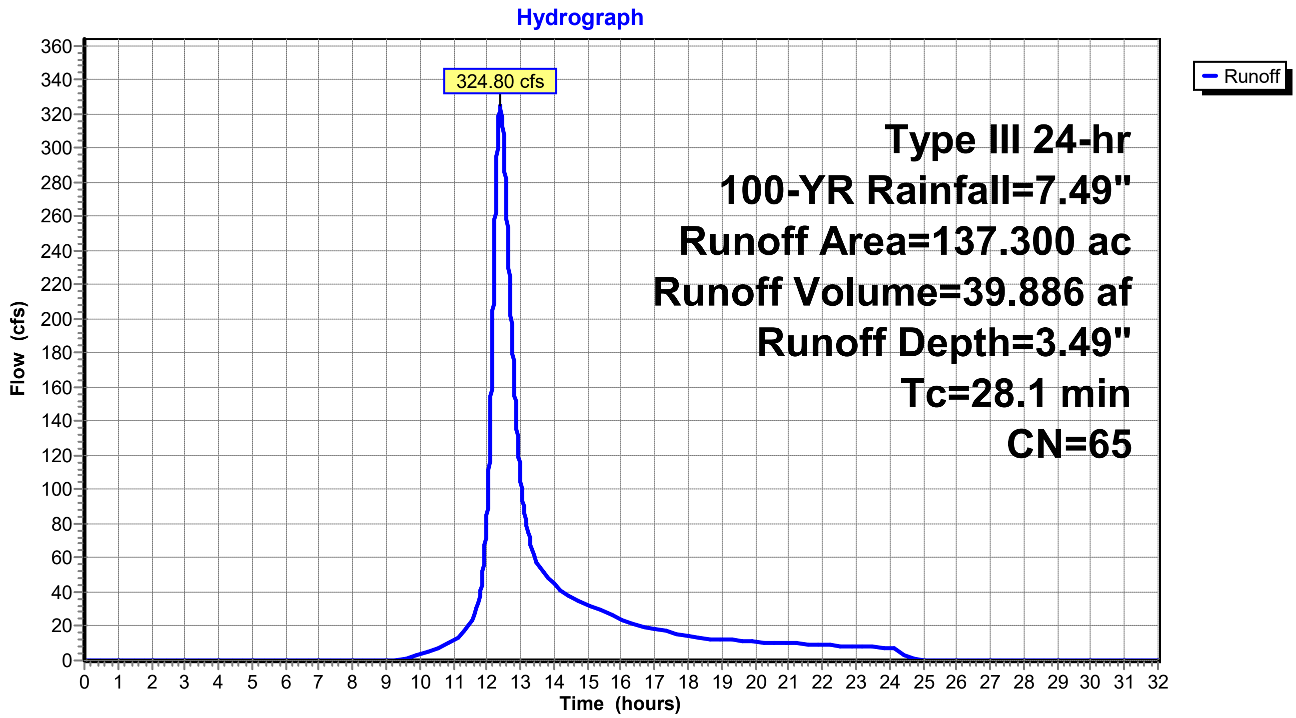
Runoff = 324.80 cfs @ 12.40 hrs, Volume= 39.886 af, Depth= 3.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	137.300	65	Weighted CN value
	137.300		100.00% Pervious Area

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

Subcatchment 11S: Sub13



Summary for Subcatchment 12S: Sub15

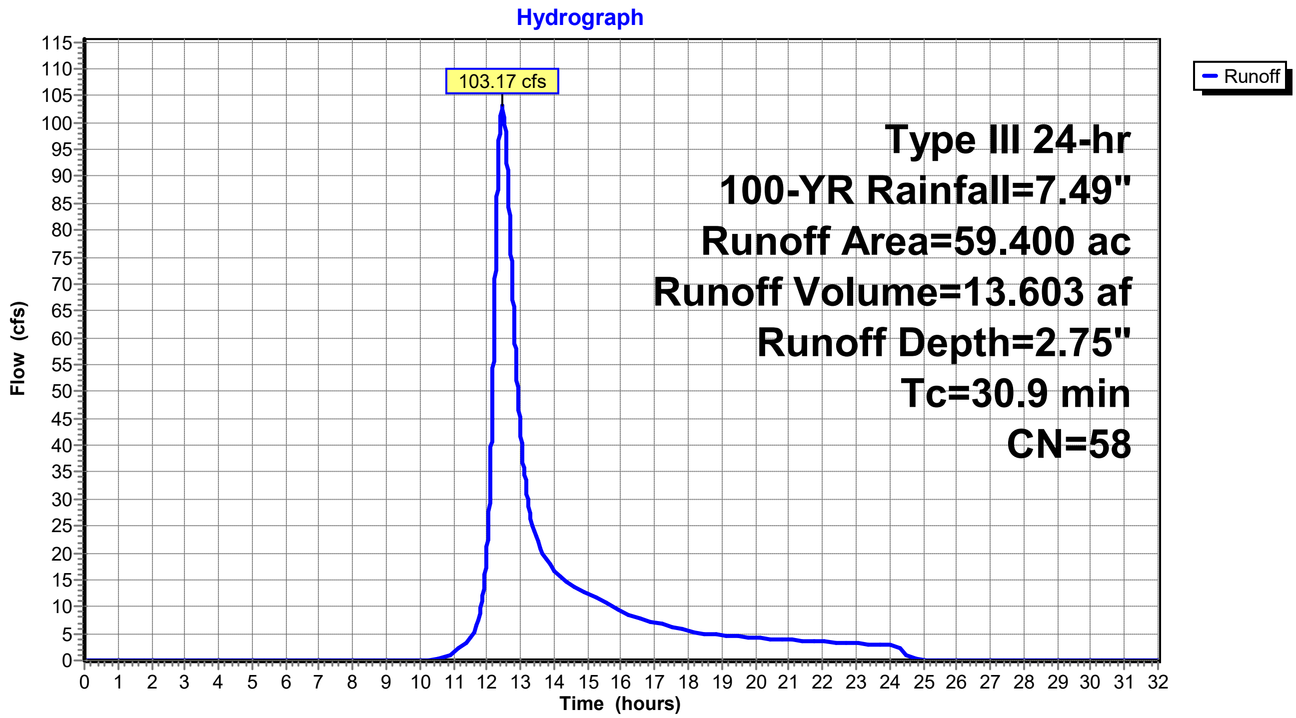
Runoff = 103.17 cfs @ 12.46 hrs, Volume= 13.603 af, Depth= 2.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	59.400	58	Weighted CN value
	59.400		100.00% Pervious Area

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

Subcatchment 12S: Sub15



Summary for Subcatchment 13S: Sub17

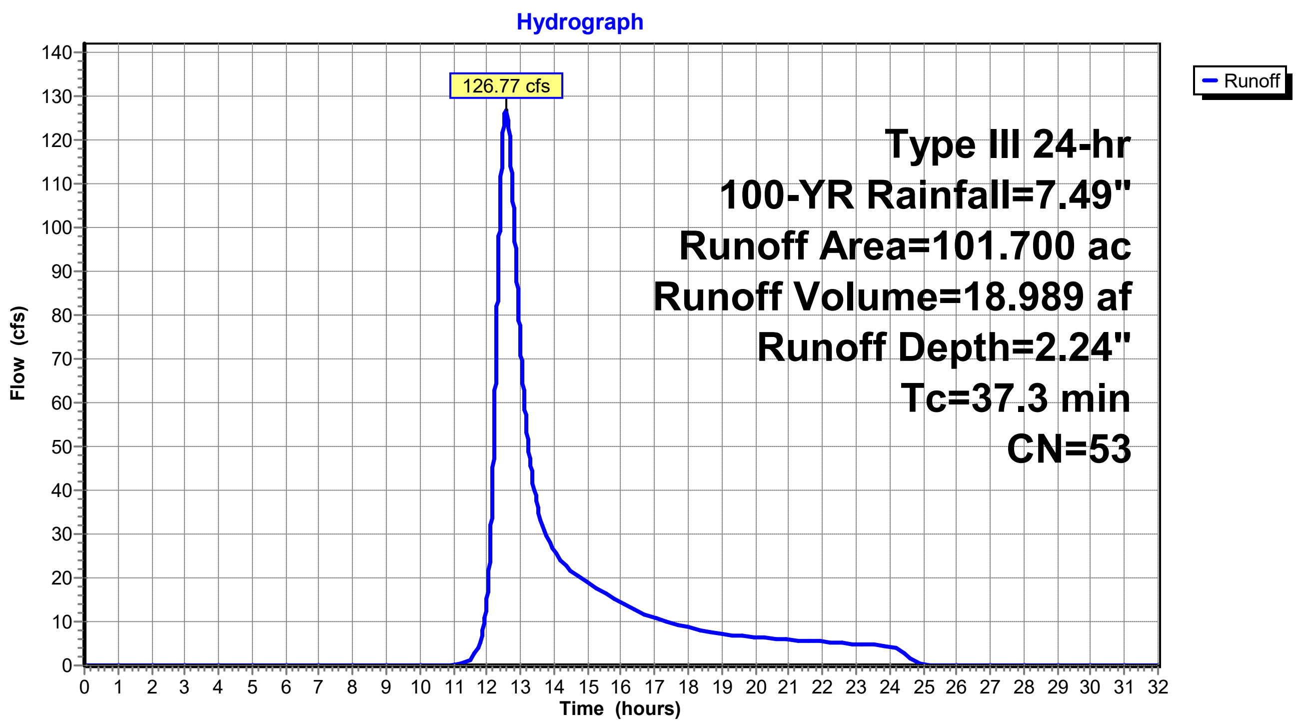
Runoff = 126.77 cfs @ 12.56 hrs, Volume= 18.989 af, Depth= 2.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	101.700	53	Weighted CN value
	101.700		100.00% Pervious Area

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

Subcatchment 13S: Sub17



Summary for Subcatchment 14S: Sub22

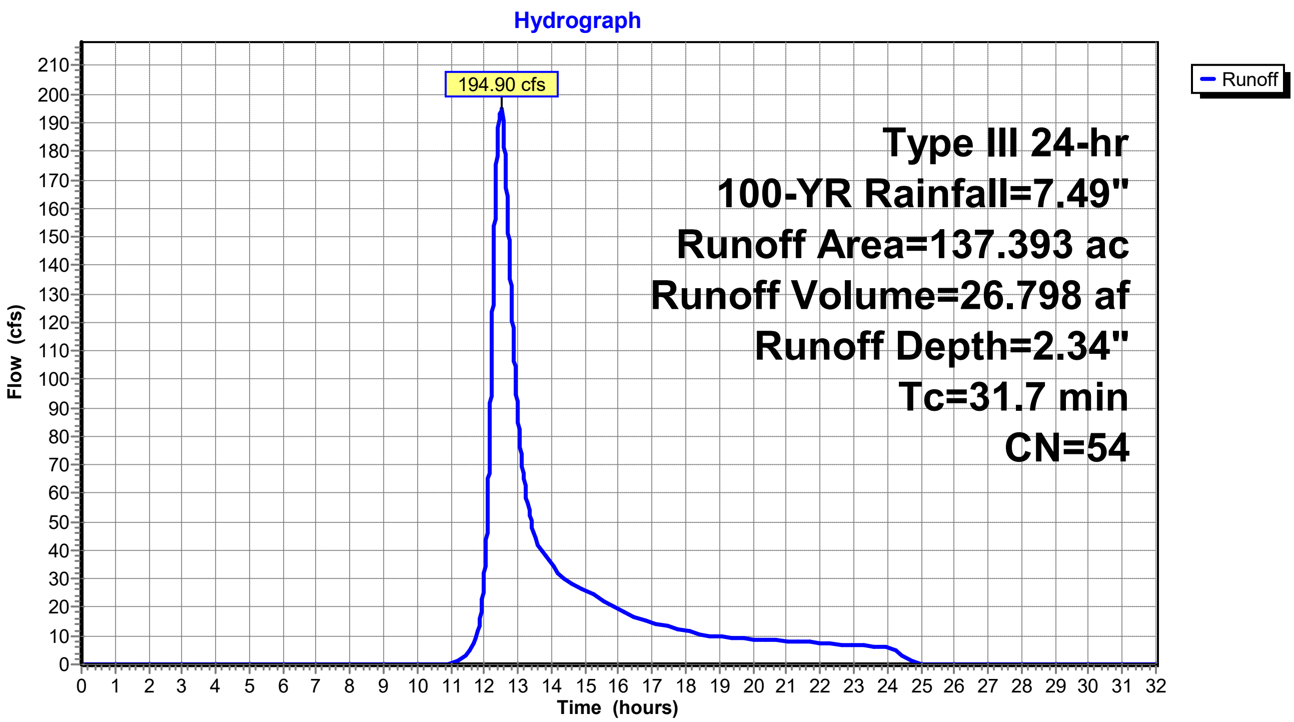
Runoff = 194.90 cfs @ 12.50 hrs, Volume= 26.798 af, Depth= 2.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs
Type III 24-hr 100-YR Rainfall=7.49"

	Area (ac)	CN	Description
*	137.393	54	Weighted CN value
	137.393		100.00% Pervious Area

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

Subcatchment 14S: Sub22



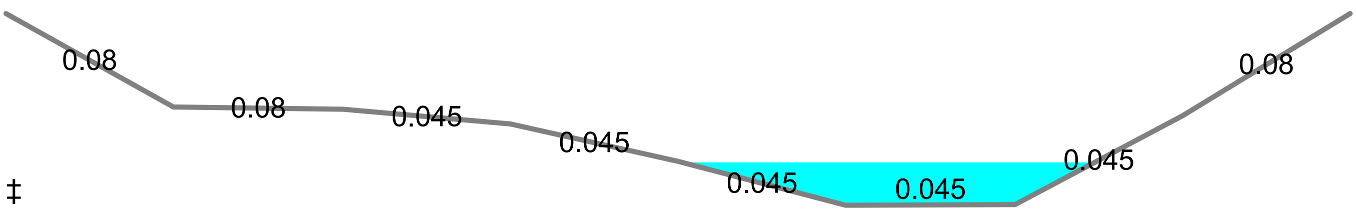
Summary for Reach 28R: Reach3-1A

Inflow Area = 43.200 ac, 0.00% Impervious, Inflow Depth > 2.72" for 100-YR event
Inflow = 15.05 cfs @ 13.53 hrs, Volume= 9.796 af
Outflow = 15.04 cfs @ 13.57 hrs, Volume= 9.787 af, Atten= 0%, Lag= 2.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Max. Velocity= 1.77 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 1.18 fps, Avg. Travel Time= 5.2 min

Peak Storage= 3,094 cf @ 13.57 hrs
Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 2.50' Flow Area= 107.4 sf, Capacity= 475.63 cfs

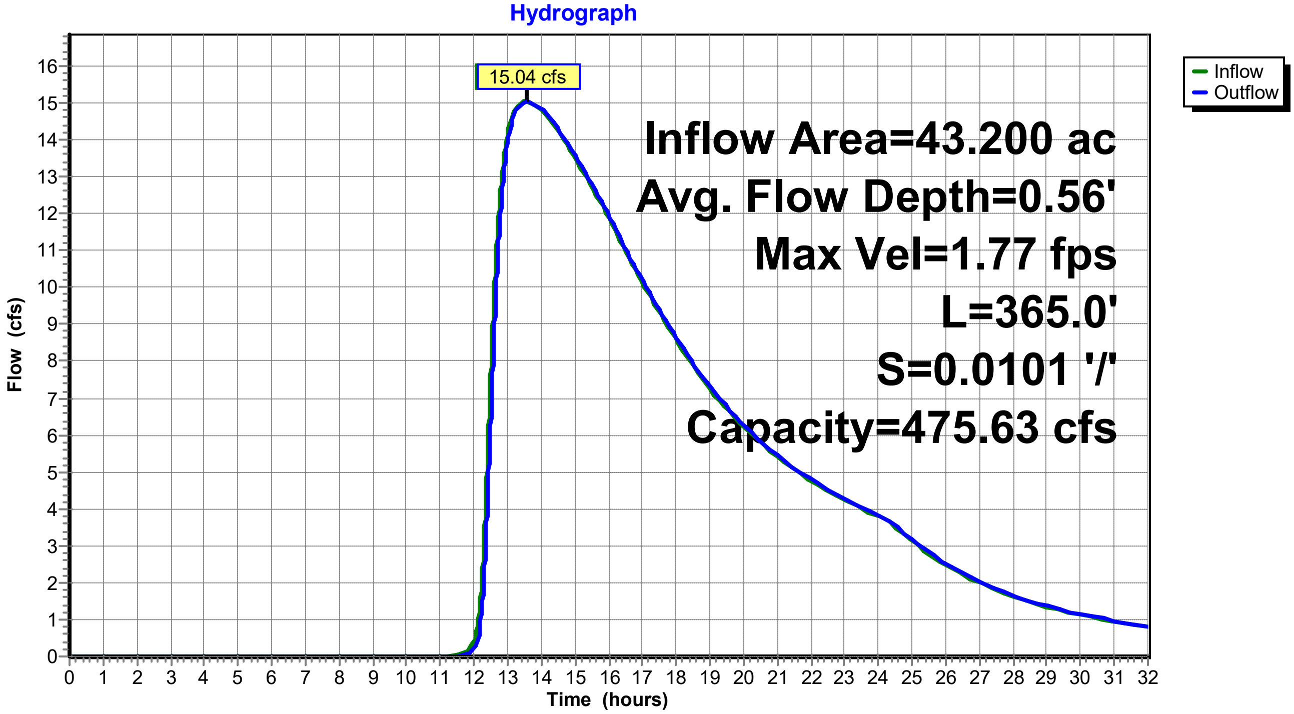
Custom cross-section, Length= 365.0' Slope= 0.0101 '/' (104 Elevation Intervals)
Flow calculated by Manning's Subdivision method
Inlet Invert= 44.00', Outlet Invert= 40.30'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
0.00	2.50	0.00		
8.80	1.28	1.22	0.080	
17.70	1.25	1.25	0.080	
26.50	1.06	1.44	0.045	
35.30	0.57	1.93	0.045	
44.10	0.00	2.50	0.045	
53.00	0.01	2.49	0.045	
61.80	1.17	1.33	0.045	
70.60	2.50	0.00	0.080	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.01	0.0	9.1	17	0.00
0.57	8.7	22.0	3,185	15.66
1.06	22.5	34.6	8,230	56.38
1.17	26.7	40.5	9,733	67.09
1.25	30.1	44.7	10,974	77.22
1.28	31.5	53.8	11,514	83.00
2.50	107.4	70.9	39,194	475.63

Reach 28R: Reach3-1A



Summary for Reach 29R: Reach3-1B

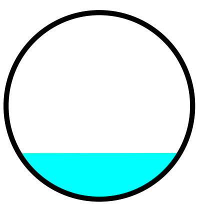
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach 28R OUTLET depth by 0.19' @ 13.62 hrs

Inflow Area = 43.200 ac, 0.00% Impervious, Inflow Depth > 2.72" for 100-YR event
Inflow = 15.04 cfs @ 13.57 hrs, Volume= 9.787 af
Outflow = 15.04 cfs @ 13.58 hrs, Volume= 9.784 af, Atten= 0%, Lag= 0.7 min

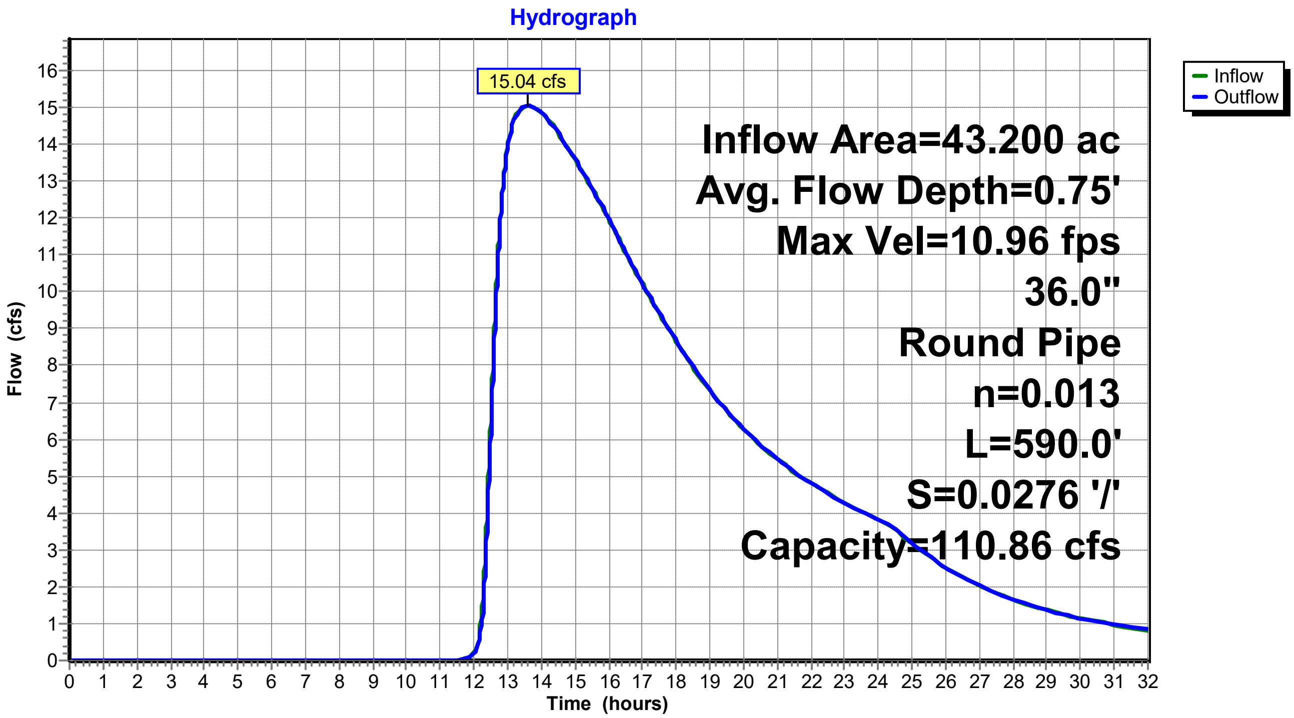
Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Max. Velocity= 10.96 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 7.43 fps, Avg. Travel Time= 1.3 min

Peak Storage= 810 cf @ 13.58 hrs
Average Depth at Peak Storage= 0.75'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 110.86 cfs

36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 590.0' Slope= 0.0276 '/'
Inlet Invert= 40.30', Outlet Invert= 24.00'



Reach 29R: Reach3-1B



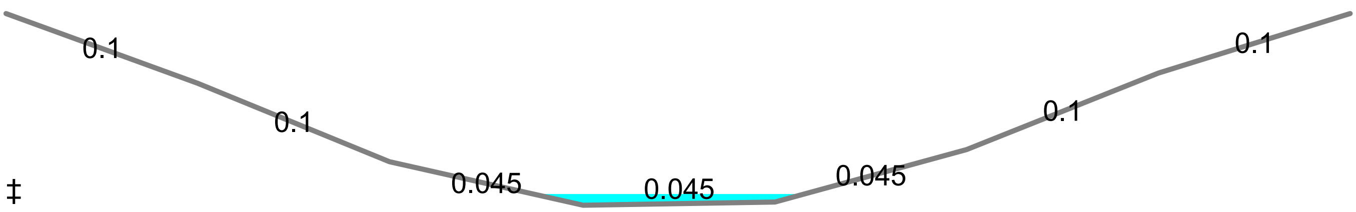
Summary for Reach 30R: Reach2-1

Inflow Area = 25.100 ac, 0.00% Impervious, Inflow Depth > 1.45" for 100-YR event
Inflow = 15.18 cfs @ 12.49 hrs, Volume= 3.042 af
Outflow = 15.02 cfs @ 12.54 hrs, Volume= 3.041 af, Atten= 1%, Lag= 2.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Max. Velocity= 2.98 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 8.6 min

Peak Storage= 3,201 cf @ 12.54 hrs
Average Depth at Peak Storage= 0.51'
Bank-Full Depth= 8.70' Flow Area= 339.4 sf, Capacity= 5,622.83 cfs

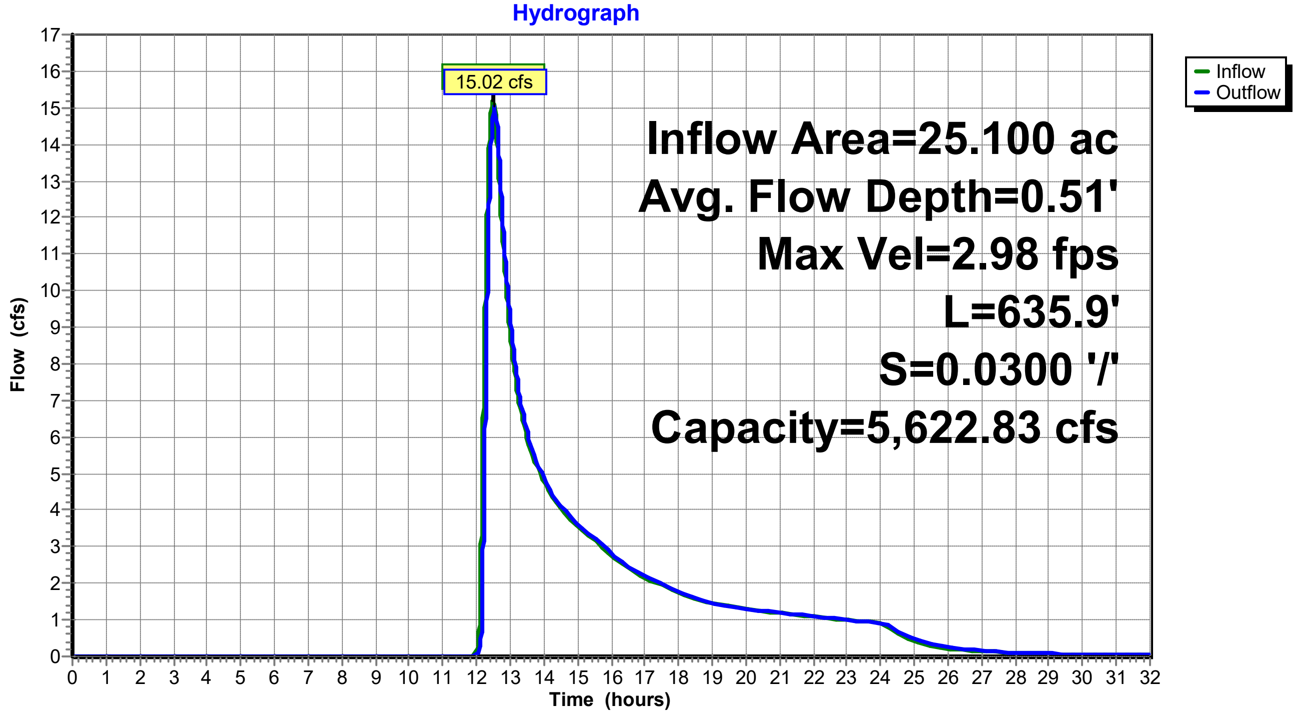
Custom cross-section, Length= 635.9' Slope= 0.0300 '/' (104 Elevation Intervals)
Flow calculated by Manning's Subdivision method
Inlet Invert= 40.50', Outlet Invert= 21.42'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
0.00	8.70	0.00		
9.40	5.53	3.17	0.100	
18.80	1.98	6.72	0.100	
28.30	0.00	8.70	0.045	
37.70	0.14	8.56	0.045	
47.10	2.53	6.17	0.045	
56.50	6.00	2.70	0.100	
65.90	8.70	0.00	0.100	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.14	0.7	10.1	448	0.68
1.98	34.0	26.6	21,631	229.41
2.53	49.4	30.4	31,406	399.65
5.53	162.8	47.5	103,500	2,232.64
6.00	184.9	50.3	117,596	2,639.30
8.70	339.4	68.6	215,798	5,622.83

Reach 30R: Reach2-1



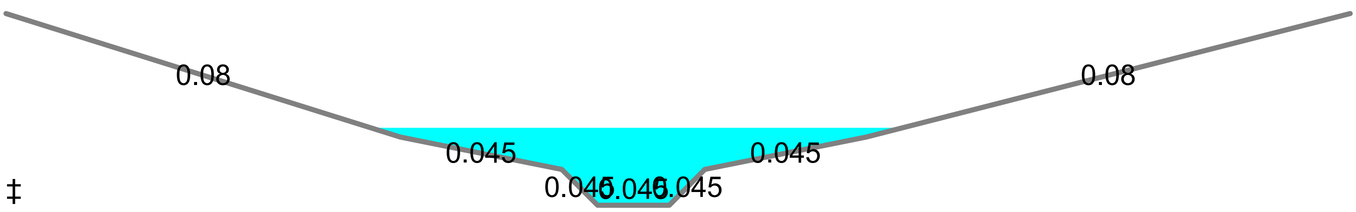
Summary for Reach 31R: Reach4-1

Inflow Area = 1,202.500 ac, 0.00% Impervious, Inflow Depth > 1.33" for 100-YR event
Inflow = 128.33 cfs @ 13.19 hrs, Volume= 133.465 af
Outflow = 125.82 cfs @ 13.44 hrs, Volume= 131.727 af, Atten= 2%, Lag= 15.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Max. Velocity= 3.99 fps, Min. Travel Time= 18.7 min
Avg. Velocity = 3.11 fps, Avg. Travel Time= 23.9 min

Peak Storage= 141,201 cf @ 13.44 hrs
Average Depth at Peak Storage= 2.39'
Bank-Full Depth= 5.90' Flow Area= 215.5 sf, Capacity= 1,526.64 cfs

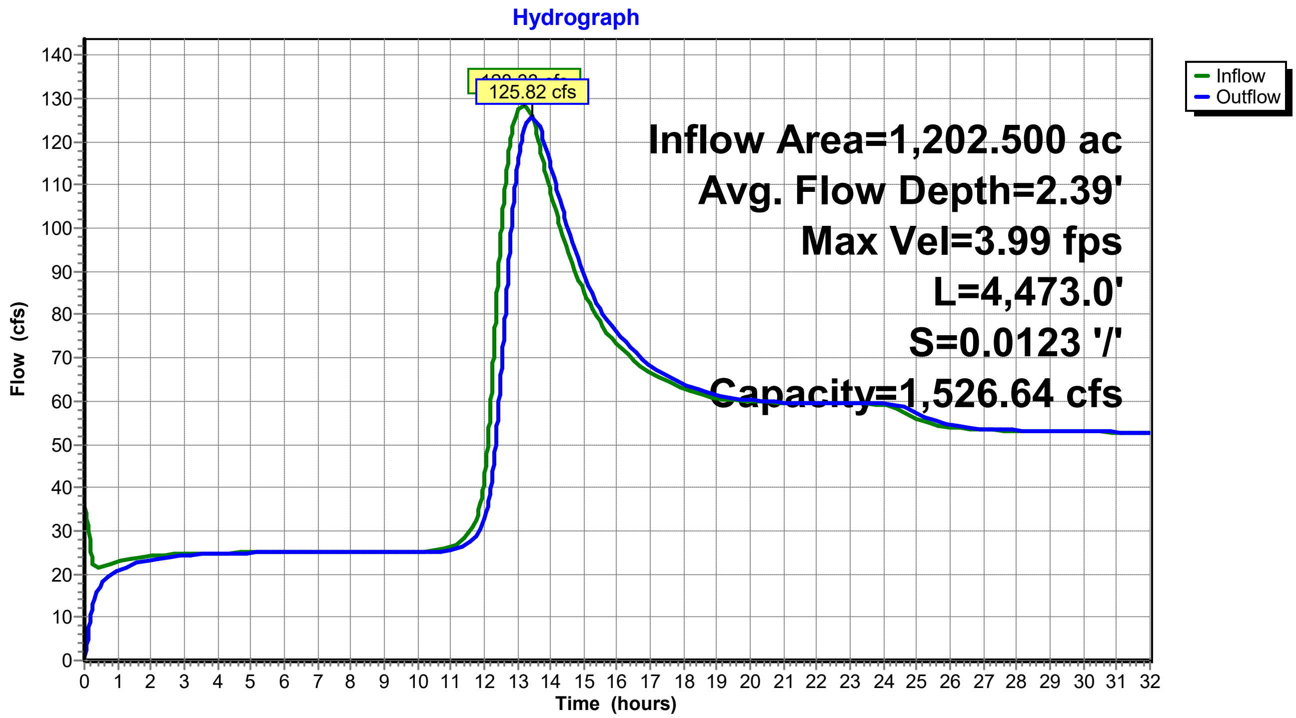
Custom cross-section, Length= 4,473.0' Slope= 0.0123 '/' (102 Elevation Intervals)
Flow calculated by Manning's Subdivision method
Inlet Invert= 75.80', Outlet Invert= 21.00'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
0.00	5.90	0.00		
22.00	2.10	3.80	0.080	
31.00	1.10	4.80	0.045	
33.00	0.00	5.90	0.045	
37.00	0.00	5.90	0.045	
39.00	1.10	4.80	0.045	
48.00	2.10	3.80	0.045	
75.00	5.90	0.00	0.080	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	4.0	0	0.00
1.10	6.6	8.6	29,522	20.28
2.10	23.6	26.7	105,563	79.49
5.90	215.5	76.3	963,932	1,526.64

Reach 31R: Reach4-1



Summary for Reach 32R: Reach10-7

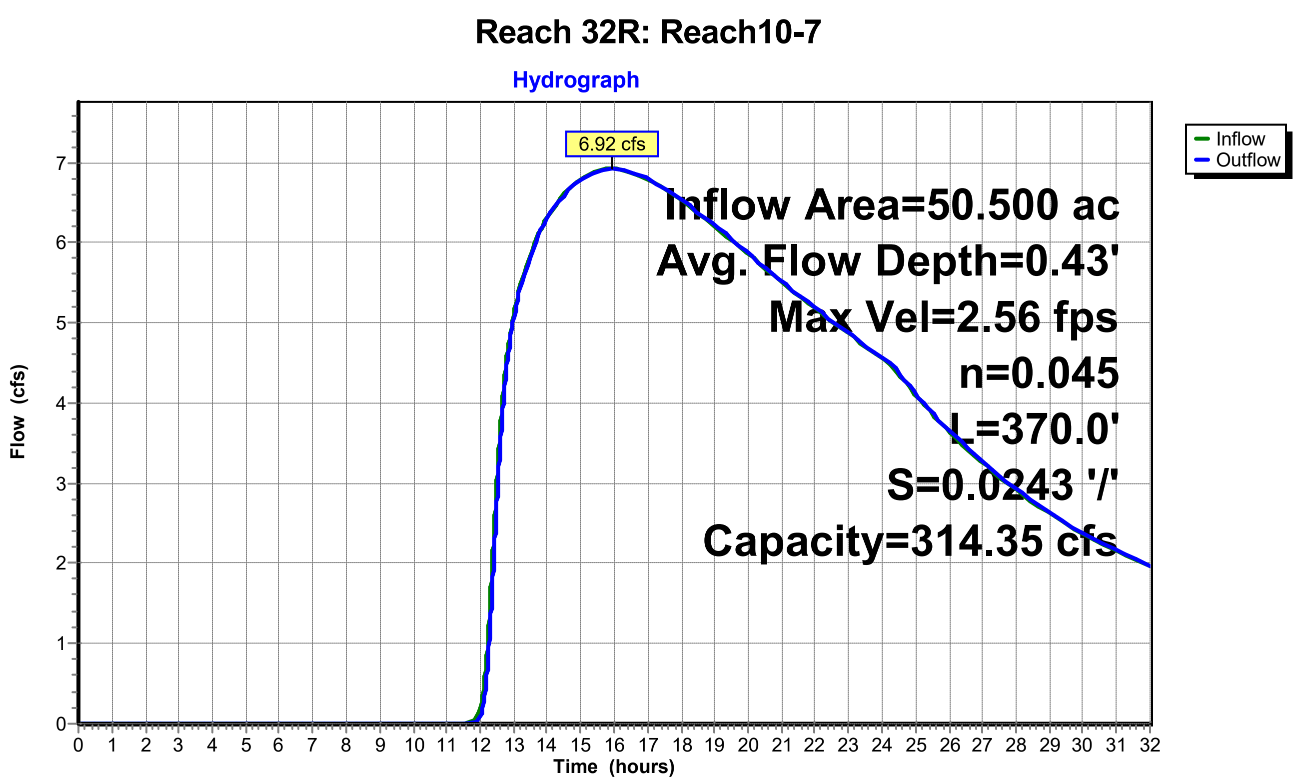
Inflow Area = 50.500 ac, 0.00% Impervious, Inflow Depth > 1.83" for 100-YR event
Inflow = 6.92 cfs @ 15.92 hrs, Volume= 7.697 af
Outflow = 6.92 cfs @ 15.94 hrs, Volume= 7.687 af, Atten= 0%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Max. Velocity= 2.56 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 2.14 fps, Avg. Travel Time= 2.9 min

Peak Storage= 1,000 cf @ 15.94 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 3.00' Flow Area= 42.0 sf, Capacity= 314.35 cfs

5.00' x 3.00' deep channel, n= 0.045
Side Slope Z-value= 3.0 '/' Top Width= 23.00'
Length= 370.0' Slope= 0.0243 '/'
Inlet Invert= 87.00', Outlet Invert= 78.00'

‡



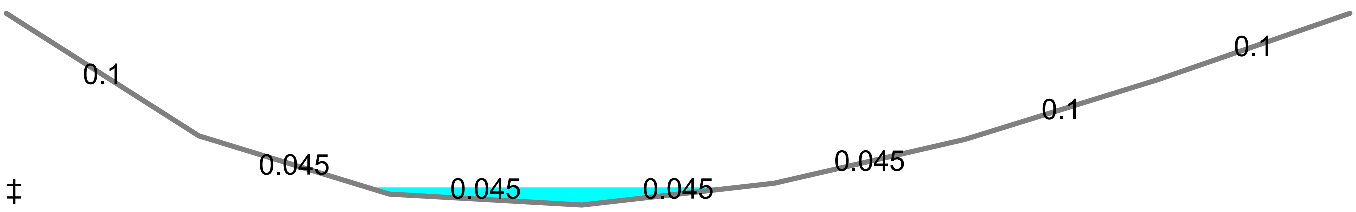
Summary for Reach 33R: Reach11-7

Inflow Area = 26.900 ac, 0.00% Impervious, Inflow Depth > 1.21" for 100-YR event
Inflow = 2.07 cfs @ 18.35 hrs, Volume= 2.716 af
Outflow = 2.07 cfs @ 18.76 hrs, Volume= 2.665 af, Atten= 0%, Lag= 24.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Max. Velocity= 0.77 fps, Min. Travel Time= 26.9 min
Avg. Velocity = 0.69 fps, Avg. Travel Time= 30.0 min

Peak Storage= 3,330 cf @ 18.76 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 2.80' Flow Area= 117.3 sf, Capacity= 482.65 cfs

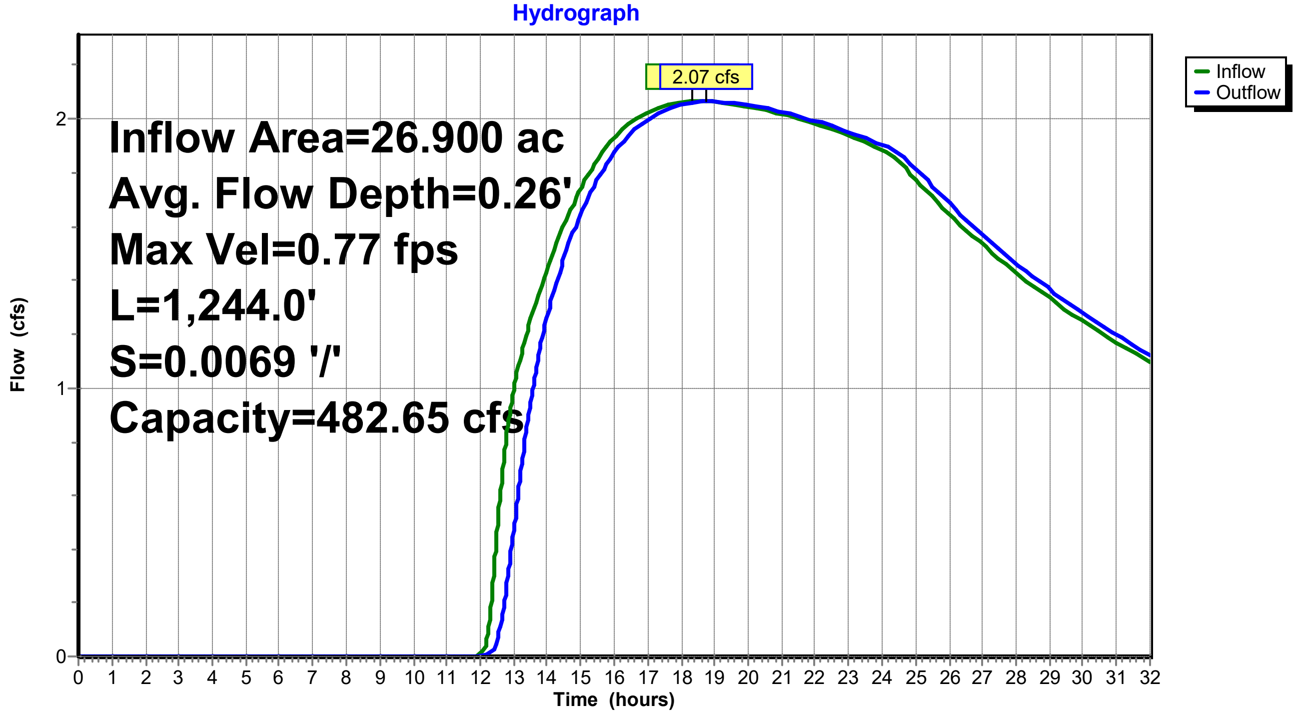
Custom cross-section, Length= 1,244.0' Slope= 0.0069 '/' (104 Elevation Intervals)
Flow calculated by Manning's Subdivision method
Inlet Invert= 86.60', Outlet Invert= 78.00'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
0.00	2.80	0.00		
9.40	1.01	1.79	0.100	
18.70	0.16	2.64	0.045	
28.10	0.00	2.80	0.045	
37.50	0.32	2.48	0.045	
46.80	0.96	1.84	0.045	
56.20	1.83	0.97	0.100	
65.60	2.80	0.00	0.100	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.16	1.1	14.1	1,403	0.57
0.32	3.9	20.6	4,852	3.53
0.96	22.3	36.9	27,703	43.65
1.01	24.1	38.0	30,029	49.42
1.83	60.6	51.3	75,446	197.91
2.80	117.3	65.9	145,860	482.65

Reach 33R: Reach11-7



Summary for Pond 15P: Reservoir-1 (Jenney Pond)

[62] Hint: Exceeded Reach 29R OUTLET depth by 1.24' @ 14.00 hrs
[62] Hint: Exceeded Reach 30R OUTLET depth by 4.27' @ 14.08 hrs
[62] Hint: Exceeded Reach 31R OUTLET depth by 2.71' @ 15.01 hrs

Inflow Area = 1,472.993 ac, 0.00% Impervious, Inflow Depth > 1.51" for 100-YR event
Inflow = 363.10 cfs @ 12.44 hrs, Volume= 185.634 af
Outflow = 187.57 cfs @ 13.95 hrs, Volume= 172.614 af, Atten= 48%, Lag= 91.0 min
Primary = 74.37 cfs @ 13.95 hrs, Volume= 138.739 af
Secondary = 113.19 cfs @ 13.95 hrs, Volume= 33.875 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 22.20' Surf.Area= 4.465 ac Storage= 8.700 af
Peak Elev= 25.98' @ 13.95 hrs Surf.Area= 9.267 ac Storage= 33.575 af (24.875 af above start)

Plug-Flow detention time= 209.2 min calculated for 163.914 af (88% of inflow)
Center-of-Mass det. time= 60.2 min (1,104.8 - 1,044.6)

Volume	Invert	Avail.Storage	Storage Description
#1	15.00'	54.701 af	**Custom Stage Data (Conic)** Listed below (Recalc)

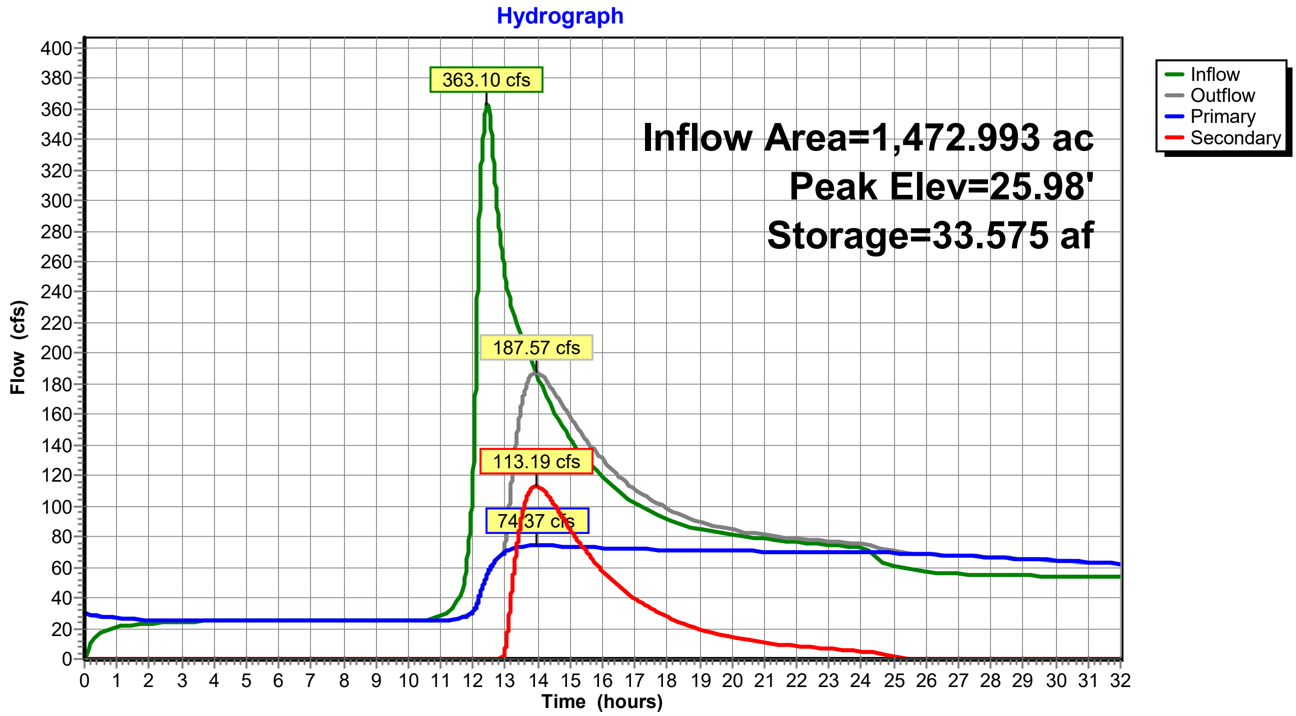
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
15.00	0.000	0.000	0.000	0.000
18.00	0.007	0.007	0.007	0.007
19.00	0.707	0.261	0.268	0.707
20.00	2.105	1.344	1.612	2.105
21.00	3.028	2.553	4.165	3.029
22.00	4.323	3.656	7.821	4.324
23.00	5.054	4.684	12.505	5.056
24.00	6.177	5.606	18.111	6.180
25.00	7.928	7.034	25.145	7.932
26.00	9.293	8.601	33.747	9.297
27.00	10.326	9.805	43.552	10.332
28.00	11.992	11.149	54.701	11.999

Device	Routing	Invert	Outlet Devices
#1	Primary	21.00'	**84.0" W x 66.0" H, R=42.0" Arch Culvert w/ 53.0" inside fill** L= 45.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.58' / 16.58' S= 0.0000 '/' Cc= 0.900 n= 0.012, Flow Area= 3.79 sf
#2	Primary	19.47'	**24.0" Round RCP_Round 24"** L= 45.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 19.47' / 19.00' S= 0.0104 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Secondary	25.30'	**Asymmetrical Weir, C= 2.67** Offset (feet) 0.00 19.50 38.80 58.00 77.10 85.80 112.00 138.10 147.00 164.90 183.00 201.50 219.90 238.40 256.80 275.20 Height (feet) 4.50 2.92 1.74 0.79 0.13 0.00 0.00 0.00 0.19 0.76 1.56 2.40 3.04 3.77 4.08 4.50

Primary OutFlow Max=74.37 cfs @ 13.95 hrs HW=25.98' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 38.86 cfs @ 10.26 fps)
└—**2=RCP_Round 24"** (Inlet Controls 35.51 cfs @ 11.30 fps)

Secondary OutFlow Max=113.19 cfs @ 13.95 hrs HW=25.98' (Free Discharge)
↑—**3=Asymmetrical Weir** (Weir Controls 113.19 cfs @ 1.77 fps)

Pond 15P: Reservoir-1 (Jenney Pond)



Summary for Pond 16P: Reservoir-2

Inflow Area = 25.100 ac, 0.00% Impervious, Inflow Depth = 1.47" for 100-YR event
Inflow = 30.61 cfs @ 12.15 hrs, Volume= 3.084 af
Outflow = 15.18 cfs @ 12.49 hrs, Volume= 3.042 af, Atten= 50%, Lag= 20.3 min
Primary = 15.18 cfs @ 12.49 hrs, Volume= 3.042 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 41.20' Surf.Area= 1.306 ac Storage= 1.326 af
Peak Elev= 41.64' @ 12.49 hrs Surf.Area= 1.453 ac Storage= 1.939 af (0.613 af above start)

Plug-Flow detention time= 330.9 min calculated for 1.716 af (56% of inflow)
Center-of-Mass det. time= 55.7 min (951.2 - 895.5)

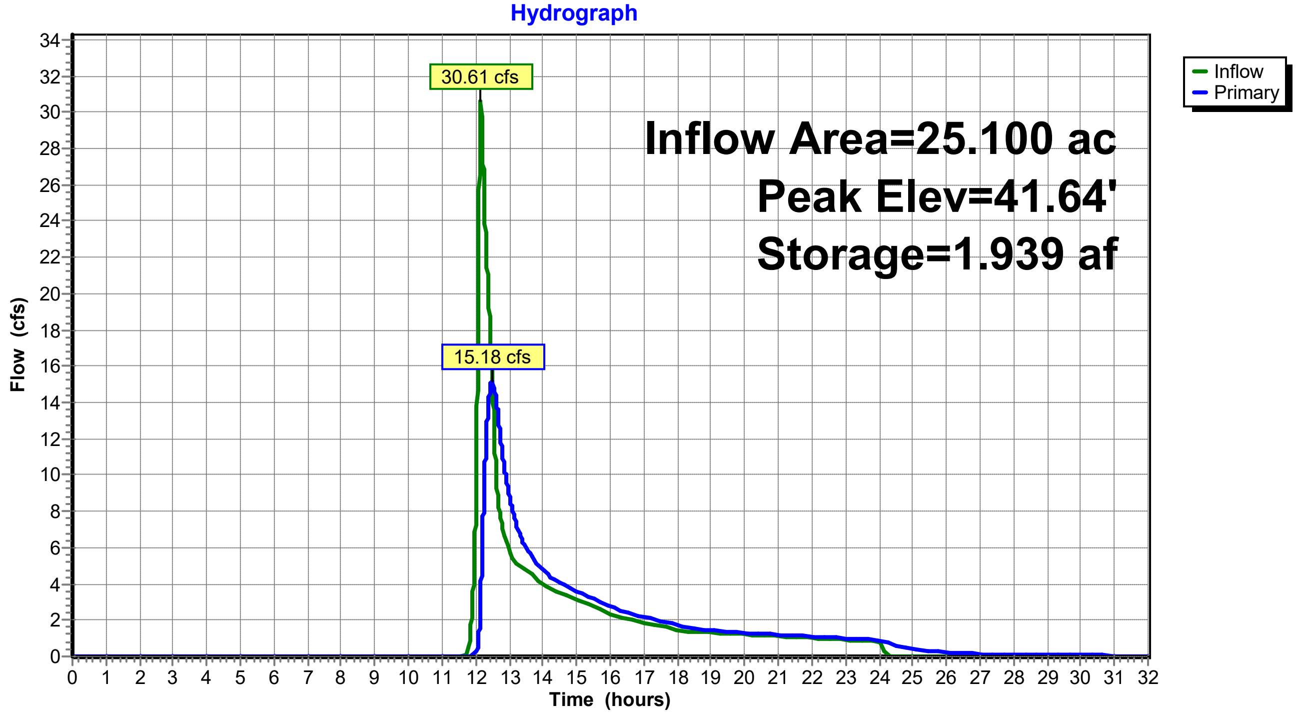
Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	6.062 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
40.00	0.909	0.000	0.000	0.909
41.00	1.242	1.071	1.071	1.242
42.00	1.576	1.406	2.477	1.577
43.00	1.806	1.690	4.167	1.808
44.00	1.987	1.896	6.062	1.991

Device	Routing	Invert	Outlet Devices
#1	Primary	41.20'	**Asymmetrical Weir, C= 2.67** Offset (feet) 0.00 8.30 16.60 24.90 33.20 41.90 50.60 59.20 67.90 76.60 84.40 92.60 Height (feet) 3.20 2.21 1.41 0.69 0.28 0.20 0.31 0.64 0.83 1.25 2.07 3.20

Primary OutFlow Max=15.18 cfs @ 12.49 hrs HW=41.64' TW=41.01' (Dynamic Tailwater)
└─**1=Asymmetrical Weir** (Weir Controls 15.18 cfs @ 1.14 fps)

Pond 16P: Reservoir-2



Summary for Pond 17P: Reservoir-3

Inflow Area = 43.200 ac, 0.00% Impervious, Inflow Depth = 2.96" for 100-YR event
Inflow = 88.67 cfs @ 12.37 hrs, Volume= 10.641 af
Outflow = 15.05 cfs @ 13.53 hrs, Volume= 9.796 af, Atten= 83%, Lag= 69.3 min
Primary = 15.05 cfs @ 13.53 hrs, Volume= 9.796 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 45.00' Surf.Area= 1.691 ac Storage= 1.217 af
Peak Elev= 47.01' @ 13.53 hrs Surf.Area= 2.976 ac Storage= 6.135 af (4.918 af above start)

Plug-Flow detention time= 340.9 min calculated for 8.578 af (81% of inflow)
Center-of-Mass det. time= 218.3 min (1,086.2 - 867.9)

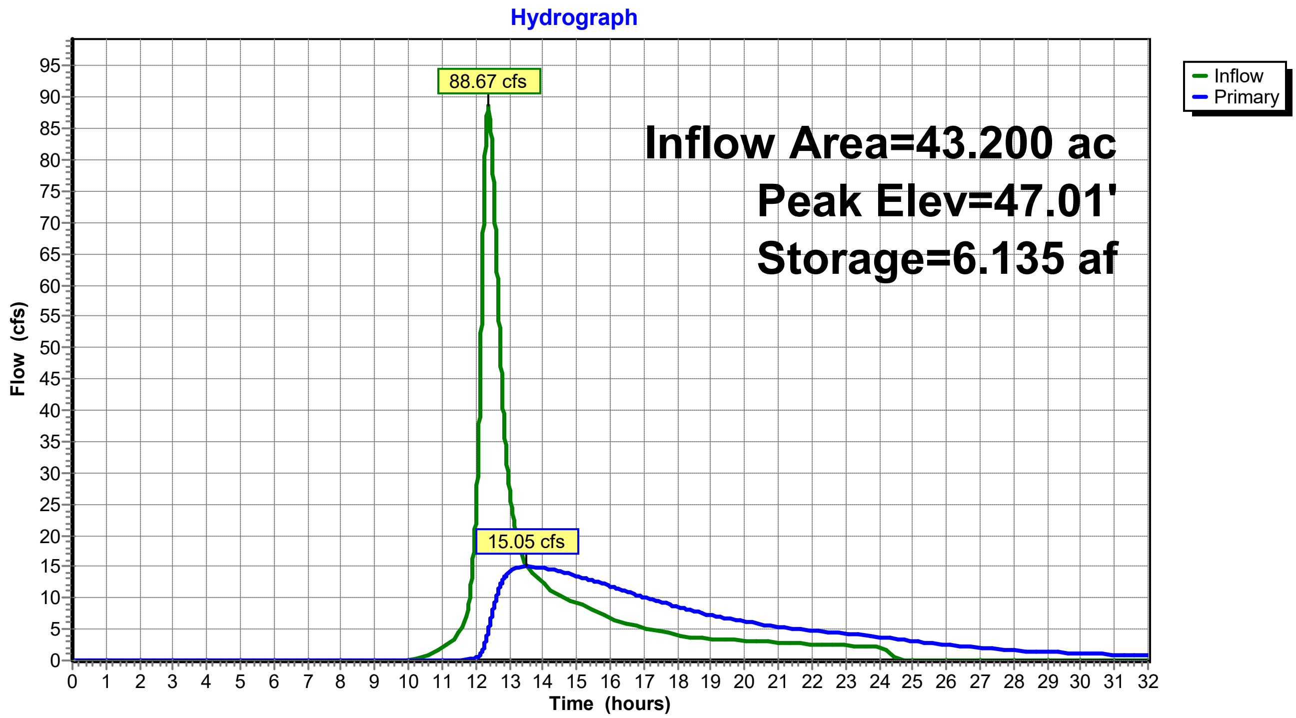
Volume	Invert	Avail.Storage	Storage Description
#1	44.00'	12.801 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
44.00	0.798	0.000	0.000	0.798
45.00	1.691	1.217	1.217	1.691
46.00	2.584	2.122	3.339	2.585
47.00	2.973	2.776	6.115	2.975
48.00	3.397	3.183	9.298	3.400
49.00	3.612	3.504	12.801	3.617

Device	Routing	Invert	Outlet Devices
#1	Primary	45.00'	**36.0" Round Culvert** L= 130.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 45.00' / 44.00' S= 0.0077 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 7.07 sf
#2	Primary	47.60'	**60.0' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=15.05 cfs @ 13.53 hrs HW=47.01' TW=44.56' (Dynamic Tailwater)
1=Culvert (Barrel Controls 15.05 cfs @ 4.24 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 17P: Reservoir-3



Summary for Pond 18P: Reservoir-4

[80] Warning: Exceeded Pond 19P by 0.06' @ 10.94 hrs (0.19 cfs 0.061 af)

Inflow Area = 1,202.500 ac, 0.00% Impervious, Inflow Depth > 1.35" for 100-YR event
Inflow = 202.54 cfs @ 12.63 hrs, Volume= 135.177 af
Outflow = 128.33 cfs @ 13.19 hrs, Volume= 133.465 af, Atten= 37%, Lag= 33.9 min
Primary = 128.33 cfs @ 13.19 hrs, Volume= 133.465 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 77.00' Surf.Area= 0.993 ac Storage= 0.331 af
Peak Elev= 78.72' @ 13.31 hrs Surf.Area= 9.203 ac Storage= 7.254 af (6.923 af above start)

Plug-Flow detention time= 28.7 min calculated for 133.108 af (98% of inflow)
Center-of-Mass det. time= 13.1 min (1,082.5 - 1,069.4)

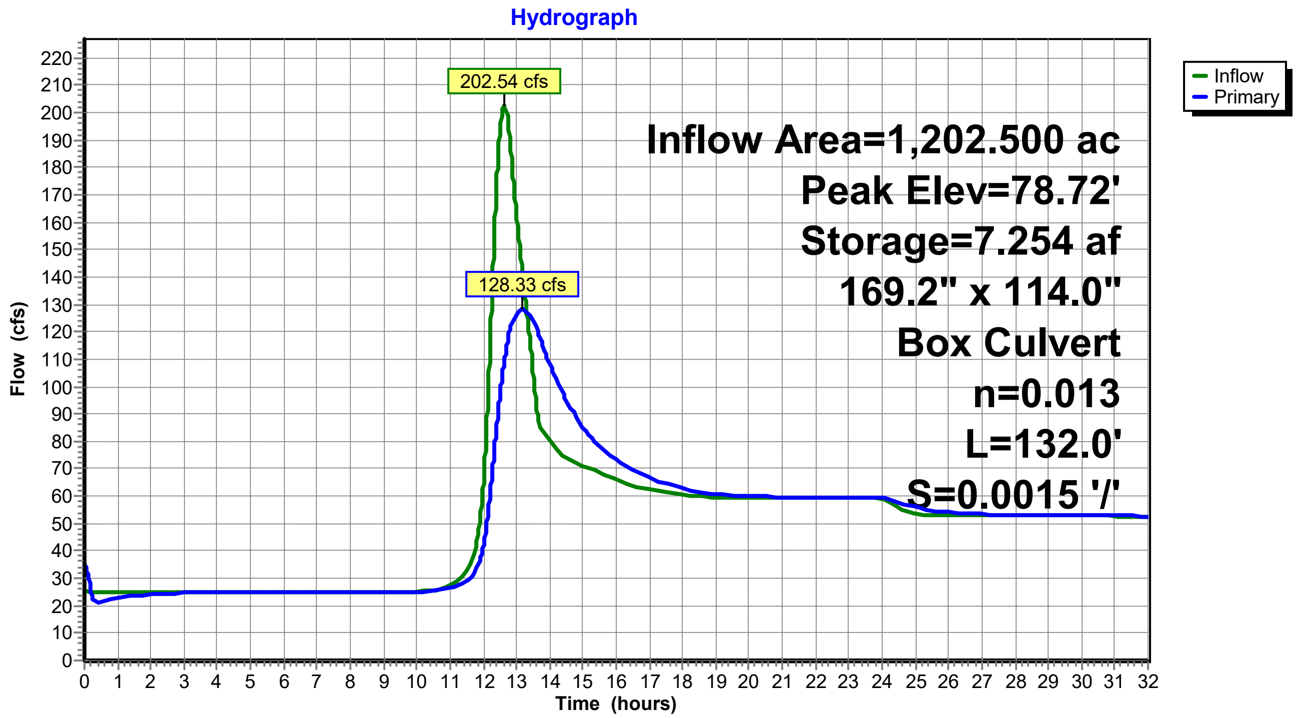
Volume	Invert	Avail.Storage	Storage Description
#1	76.00'	107.316 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
76.00	0.000	0.000	0.000	0.000
78.00	3.972	2.648	2.648	3.972
79.00	11.838	7.556	10.204	11.838
80.00	18.579	15.082	25.286	18.580
81.00	19.496	19.036	44.322	19.500
82.00	20.499	19.995	64.317	20.505
83.00	21.789	21.141	85.458	21.798
84.00	21.927	21.858	107.316	21.957

Device	Routing	Invert	Outlet Devices
#1	Primary	76.00'	**169.2" W x 114.0" H Box Culvert** L= 132.0' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 76.00' / 75.80' S= 0.0015 '/' Cc= 0.900 n= 0.013 Concrete, trowel finish, Flow Area= 133.95 sf

Primary OutFlow Max=128.33 cfs @ 13.19 hrs HW=78.71' TW=78.17' (Dynamic Tailwater)
↑—**1=Culvert** (Outlet Controls 128.33 cfs @ 4.47 fps)

Pond 18P: Reservoir-4



Summary for Pond 19P: Reservoir-6

Inflow Area = 65.100 ac, 0.00% Impervious, Inflow Depth = 2.24" for 100-YR event
Inflow = 106.44 cfs @ 12.31 hrs, Volume= 12.155 af
Outflow = 57.62 cfs @ 12.65 hrs, Volume= 12.141 af, Atten= 46%, Lag= 20.9 min
Primary = 57.62 cfs @ 12.65 hrs, Volume= 12.141 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 77.30' Surf.Area= 0.014 ac Storage= 0.004 af
Peak Elev= 80.38' @ 12.65 hrs Surf.Area= 4.721 ac Storage= 1.732 af (1.728 af above start)

Plug-Flow detention time= 9.5 min calculated for 12.136 af (100% of inflow)
Center-of-Mass det. time= 8.4 min (888.5 - 880.1)

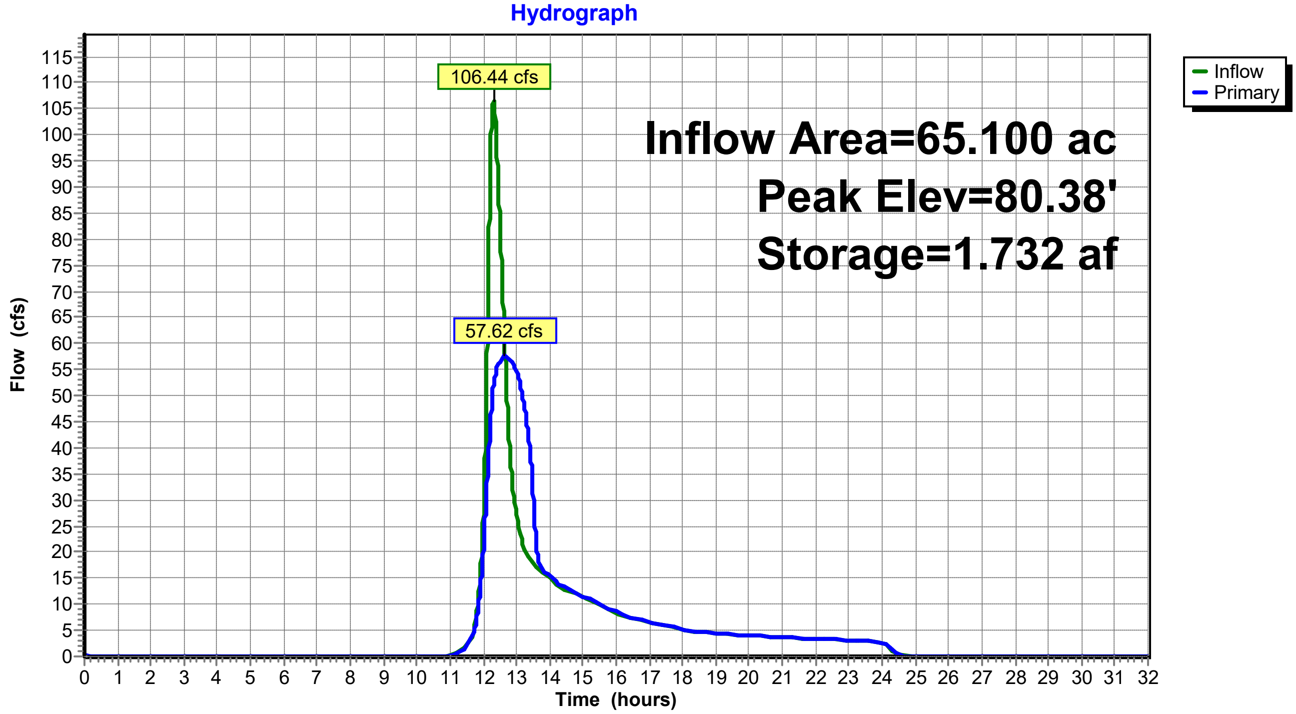
Volume	Invert	Avail.Storage	Storage Description
#1	76.50'	42.654 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
76.50	0.000	0.000	0.000	0.000
79.00	0.139	0.116	0.116	0.139
80.00	1.172	0.572	0.687	1.172
81.00	15.621	7.024	7.711	15.621
82.00	17.437	16.521	24.232	17.439
83.00	19.424	18.422	42.654	19.427

Device	Routing	Invert	Outlet Devices
#1	Primary	77.20'	**51.6" W x 40.8" H Box Culvert** L= 27.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 76.60' / 77.20' S= -0.0222 '/' Cc= 0.900 n= 0.045, Flow Area= 14.62 sf
#2	Primary	82.60'	**60.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=57.62 cfs @ 12.65 hrs HW=80.38' TW=78.43' (Dynamic Tailwater)
├─**1=Culvert** (Barrel Controls 57.62 cfs @ 4.73 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 19P: Reservoir-6



Summary for Pond 20P: Reservoir-7

[62] Hint: Exceeded Reach 32R OUTLET depth by 2.90' @ 32.00 hrs
[62] Hint: Exceeded Reach 33R OUTLET depth by 2.91' @ 32.00 hrs

Inflow Area = 1,065.200 ac, 0.00% Impervious, Inflow Depth > 3.97" for 100-YR event
Inflow = 1,541.52 cfs @ 12.53 hrs, Volume= 352.528 af, Incl. 24.00 cfs Base Flow
Outflow = 53.10 cfs @ 25.90 hrs, Volume= 105.878 af, Atten= 97%, Lag= 802.6 min
Primary = 53.10 cfs @ 25.90 hrs, Volume= 105.878 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 80.27' Surf.Area= 286.579 ac Storage= 2,835.526 af
Peak Elev= 81.12' @ 25.90 hrs Surf.Area= 300.842 ac Storage= 3,086.403 af (250.877 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 178.9 min (1,119.9 - 941.1)

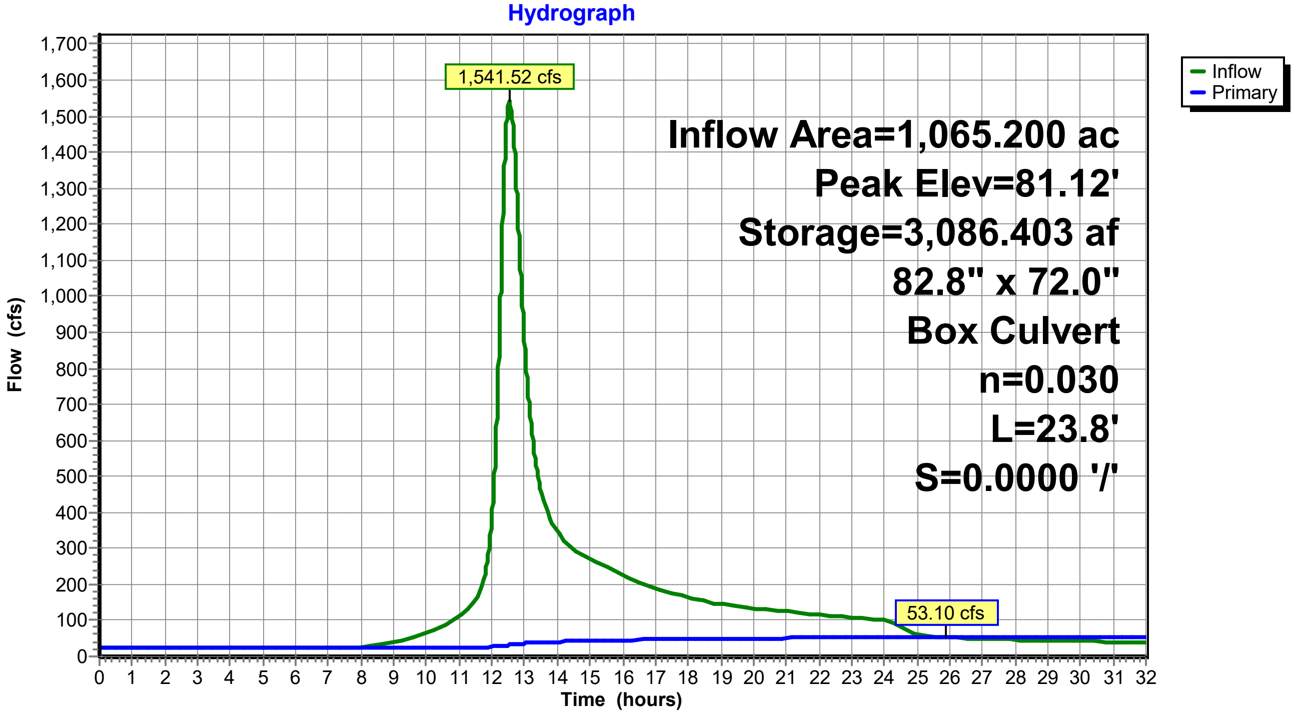
Volume	Invert	Avail.Storage	Storage Description
#1	69.00'	3,353.418 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
69.00	220.799	0.000	0.000	220.799
79.00	276.201	2,479.837	2,479.837	276.265
80.00	281.741	278.966	2,758.804	281.813
81.00	299.866	290.756	3,049.560	299.940
82.00	307.867	303.858	3,353.418	307.947

Device	Routing	Invert	Outlet Devices
#1	Primary	78.80'	**82.8" W x 72.0" H Box Culvert** L= 23.8' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 78.80' / 78.80' S= 0.0000 '/' Cc= 0.900 n= 0.030, Flow Area= 41.40 sf

Primary OutFlow Max=53.10 cfs @ 25.90 hrs HW=81.12' TW=77.86' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 53.10 cfs @ 4.42 fps)

Pond 20P: Reservoir-7



Summary for Pond 21P: Reservoir-8

Inflow Area = 73.100 ac, 0.00% Impervious, Inflow Depth = 1.95" for 100-YR event
Inflow = 59.05 cfs @ 12.87 hrs, Volume= 11.853 af
Outflow = 21.42 cfs @ 14.06 hrs, Volume= 11.673 af, Atten= 64%, Lag= 71.6 min
Primary = 21.42 cfs @ 14.06 hrs, Volume= 11.673 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Peak Elev= 84.46' @ 14.06 hrs Surf.Area= 10.023 ac Storage= 4.144 af

Plug-Flow detention time= 183.2 min calculated for 11.673 af (98% of inflow)
Center-of-Mass det. time= 174.7 min (1,099.1 - 924.5)

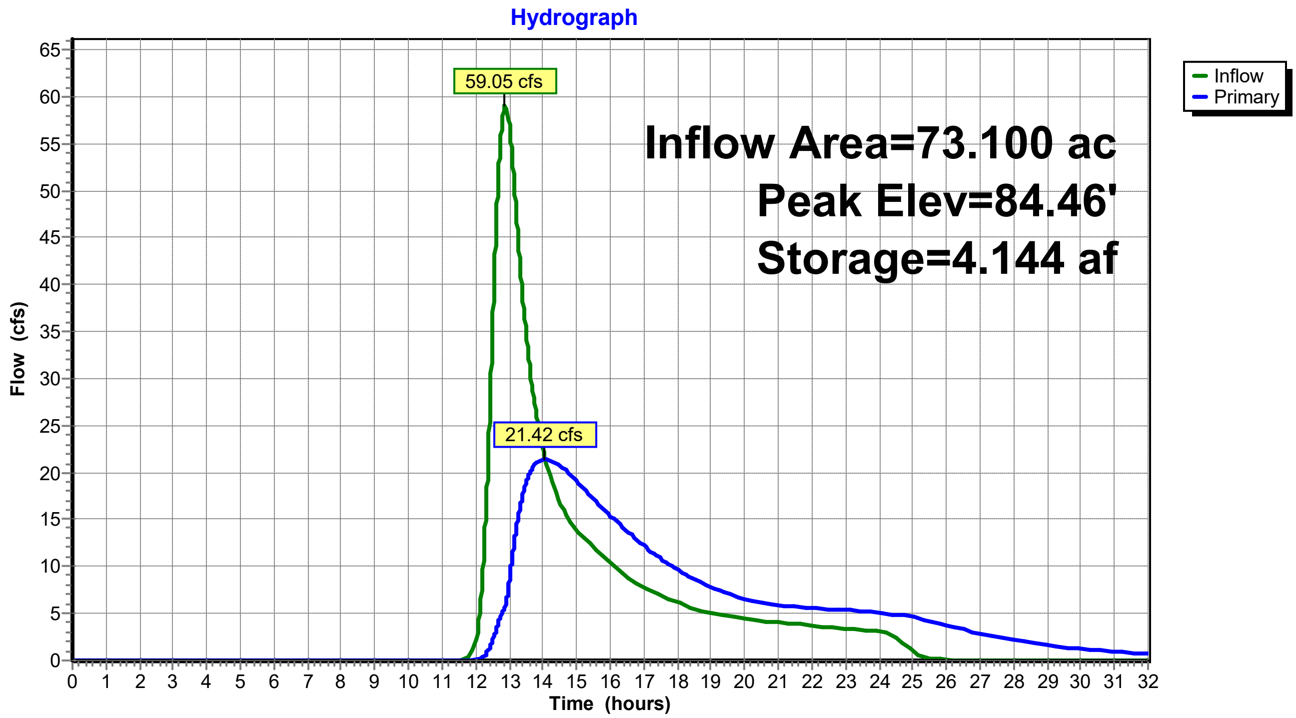
Volume	Invert	Avail.Storage	Storage Description
#1	83.00'	31.523 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
83.00	0.000	0.000	0.000
84.00	2.507	1.253	1.253
85.00	18.795	10.651	11.904
86.00	20.441	19.618	31.523

Device	Routing	Invert	Outlet Devices
#1	Primary	83.00'	**24.0" Round CMP_Round 24"** L= 30.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 83.00' / 82.00' S= 0.0333 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 3.14 sf
#2	Primary	84.20'	**40.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=21.42 cfs @ 14.06 hrs HW=84.46' TW=80.79' (Dynamic Tailwater)
├─**1=CMP_Round 24"** (Inlet Controls 7.99 cfs @ 3.25 fps)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 13.43 cfs @ 1.28 fps)

Pond 21P: Reservoir-8



Summary for Pond 22P: Reservoir-9

Inflow Area = 36.600 ac, 0.00% Impervious, Inflow Depth = 1.38" for 100-YR event
Inflow = 30.13 cfs @ 12.36 hrs, Volume= 4.220 af
Outflow = 1.55 cfs @ 13.03 hrs, Volume= 2.067 af, Atten= 95%, Lag= 39.7 min
Primary = 1.55 cfs @ 13.03 hrs, Volume= 2.067 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 80.80' Surf.Area= 6.673 ac Storage= 4.862 af
Peak Elev= 81.12' @ 25.21 hrs Surf.Area= 7.154 ac Storage= 7.072 af (2.211 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

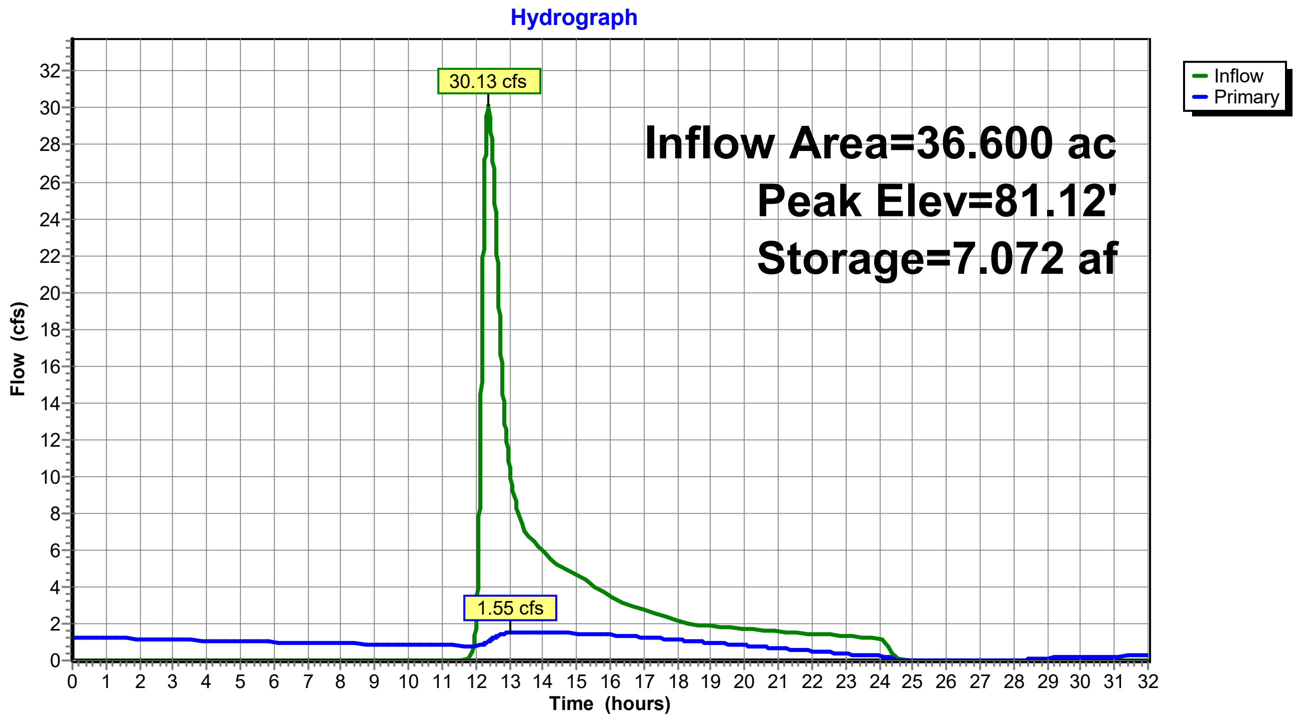
Volume	Invert	Avail.Storage	Storage Description
#1	80.00'	33.039 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
80.00	5.500	0.000	0.000	5.500
81.00	6.984	6.227	6.227	6.985
82.00	8.467	7.714	13.941	8.468
83.00	9.600	9.028	22.968	9.603
84.00	10.548	10.070	33.039	10.552

Device	Routing	Invert	Outlet Devices
#1	Primary	80.00'	**24.0" Round CMP_Round 24"** L= 40.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 80.00' / 80.00' S= 0.0000 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 3.14 sf
#2	Primary	82.50'	**80.0' long x 82.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.55 cfs @ 13.03 hrs HW=80.87' TW=80.66' (Dynamic Tailwater)
├─**1=CMP_Round 24"** (Outlet Controls 1.55 cfs @ 1.73 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 22P: Reservoir-9



Summary for Pond 23P: Reservoir-10

Inflow Area = 50.500 ac, 0.00% Impervious, Inflow Depth = 2.34" for 100-YR event
Inflow = 86.78 cfs @ 12.30 hrs, Volume= 9.850 af
Outflow = 6.92 cfs @ 15.92 hrs, Volume= 7.697 af, Atten= 92%, Lag= 216.8 min
Primary = 6.92 cfs @ 15.92 hrs, Volume= 7.697 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 89.50' Surf.Area= 1.528 ac Storage= 0.273 af
Peak Elev= 90.67' @ 15.92 hrs Surf.Area= 6.048 ac Storage= 5.891 af (5.618 af above start)

Plug-Flow detention time= 459.7 min calculated for 7.424 af (75% of inflow)
Center-of-Mass det. time= 349.1 min (1,226.6 - 877.5)

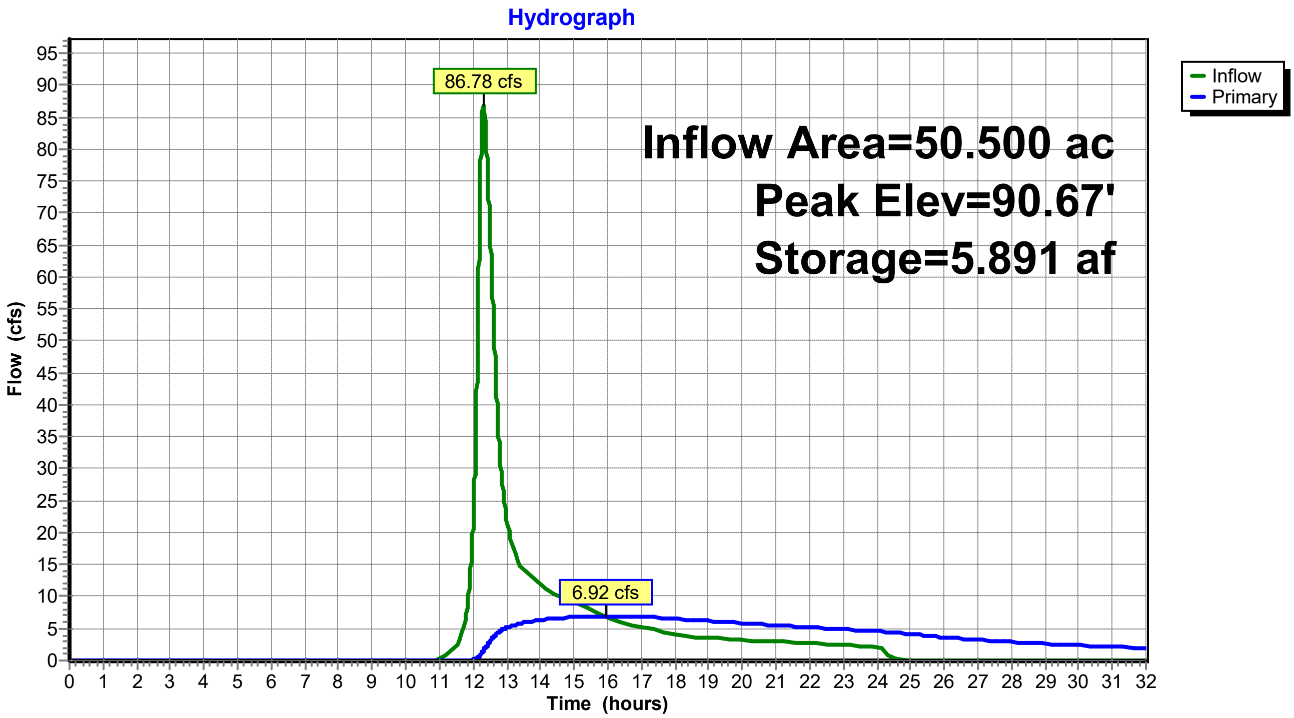
Volume	Invert	Avail.Storage	Storage Description
#1	89.00'	56.465 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
89.00	0.007	0.000	0.000	0.007
90.00	5.707	1.971	1.971	5.707
91.00	6.222	5.963	7.934	6.224
92.00	8.875	7.509	15.443	8.877
93.00	9.670	9.270	24.713	9.674
94.00	10.441	10.053	34.766	10.447
95.00	10.824	10.632	45.398	10.834
96.00	11.312	11.067	56.465	11.325

Device	Routing	Invert	Outlet Devices
#1	Primary	89.50'	**24.0" Round RCP_Round 24"** L= 30.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 89.50' / 89.00' S= 0.0167 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Primary	90.80'	**30.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=6.92 cfs @ 15.92 hrs HW=90.67' TW=87.43' (Dynamic Tailwater)
↑—**1=RCP_Round 24"** (Barrel Controls 6.92 cfs @ 5.24 fps)
└—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 23P: Reservoir-10



Summary for Pond 24P: Reservoir-11

Inflow Area = 26.900 ac, 0.00% Impervious, Inflow Depth = 2.44" for 100-YR event
Inflow = 48.84 cfs @ 12.30 hrs, Volume= 5.473 af
Outflow = 2.07 cfs @ 18.35 hrs, Volume= 2.716 af, Atten= 96%, Lag= 362.7 min
Primary = 2.07 cfs @ 18.35 hrs, Volume= 2.716 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Peak Elev= 87.72' @ 18.35 hrs Surf.Area= 5.557 ac Storage= 3.878 af

Plug-Flow detention time= 565.6 min calculated for 2.716 af (50% of inflow)
Center-of-Mass det. time= 434.2 min (1,309.1 - 874.8)

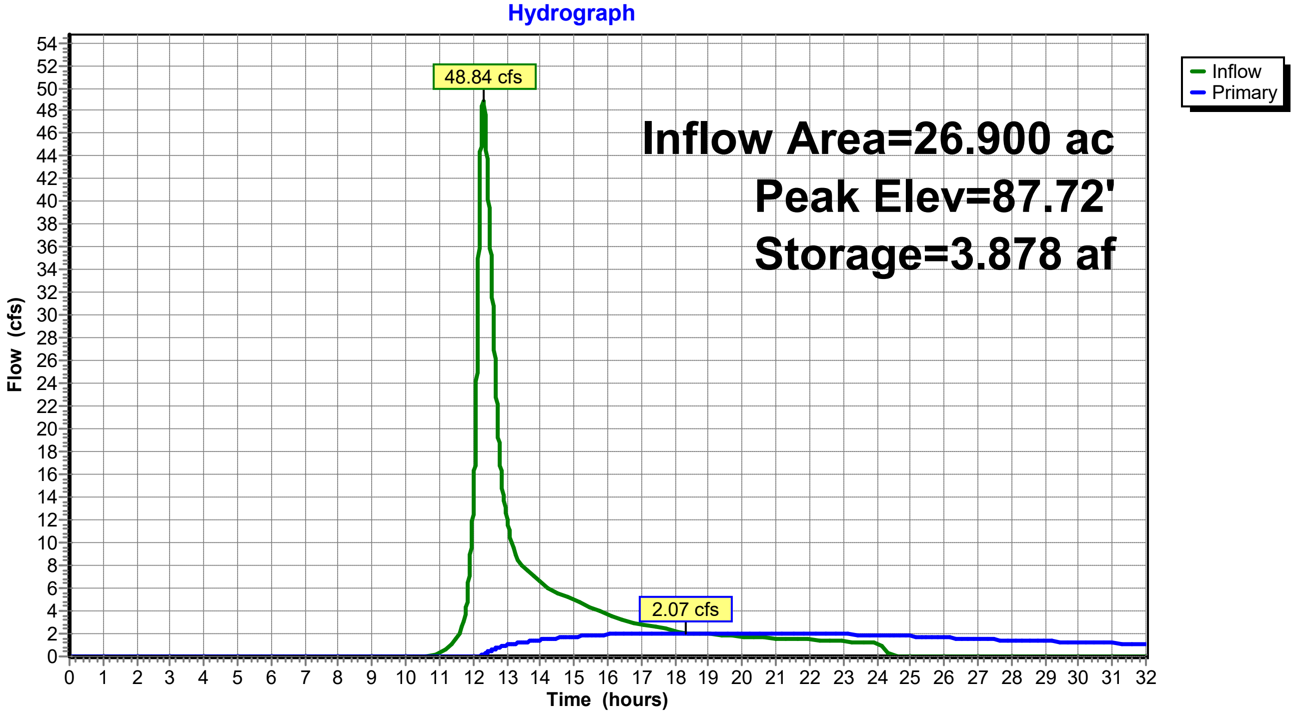
Volume	Invert	Avail.Storage	Storage Description
#1	87.00'	67.471 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
87.00	5.151	0.000	0.000	5.151
88.00	5.716	5.431	5.431	5.717
89.00	6.280	5.996	11.427	6.283
90.00	7.124	6.698	18.124	7.128
91.00	7.911	7.514	25.638	7.916
92.00	8.367	8.138	33.776	8.375
93.00	9.714	9.032	42.809	9.723
94.00	12.862	11.251	54.060	12.871
95.00	13.968	13.411	67.471	13.979

Device	Routing	Invert	Outlet Devices
#1	Primary	87.00'	**24.0" Round CMP_Round 24"** L= 35.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 87.00' / 86.50' S= 0.0143 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 3.14 sf
#2	Primary	89.20'	**60.0' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.07 cfs @ 18.35 hrs HW=87.72' TW=86.86' (Dynamic Tailwater)
—**1=CMP_Round 24"** (Barrel Controls 2.07 cfs @ 3.00 fps)
—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 24P: Reservoir-11



Summary for Pond 25P: Reservoir-13

Inflow Area = 196.700 ac, 0.00% Impervious, Inflow Depth > 3.00" for 100-YR event
Inflow = 325.62 cfs @ 12.40 hrs, Volume= 49.185 af
Outflow = 29.68 cfs @ 16.21 hrs, Volume= 35.266 af, Atten= 91%, Lag= 228.9 min
Primary = 29.68 cfs @ 16.21 hrs, Volume= 35.266 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 80.50' Surf.Area= 2.180 ac Storage= 0.363 af
Peak Elev= 82.55' @ 16.66 hrs Surf.Area= 22.567 ac Storage= 27.710 af (27.347 af above start)

Plug-Flow detention time= 469.1 min calculated for 34.898 af (71% of inflow)
Center-of-Mass det. time= 336.5 min (1,249.8 - 913.3)

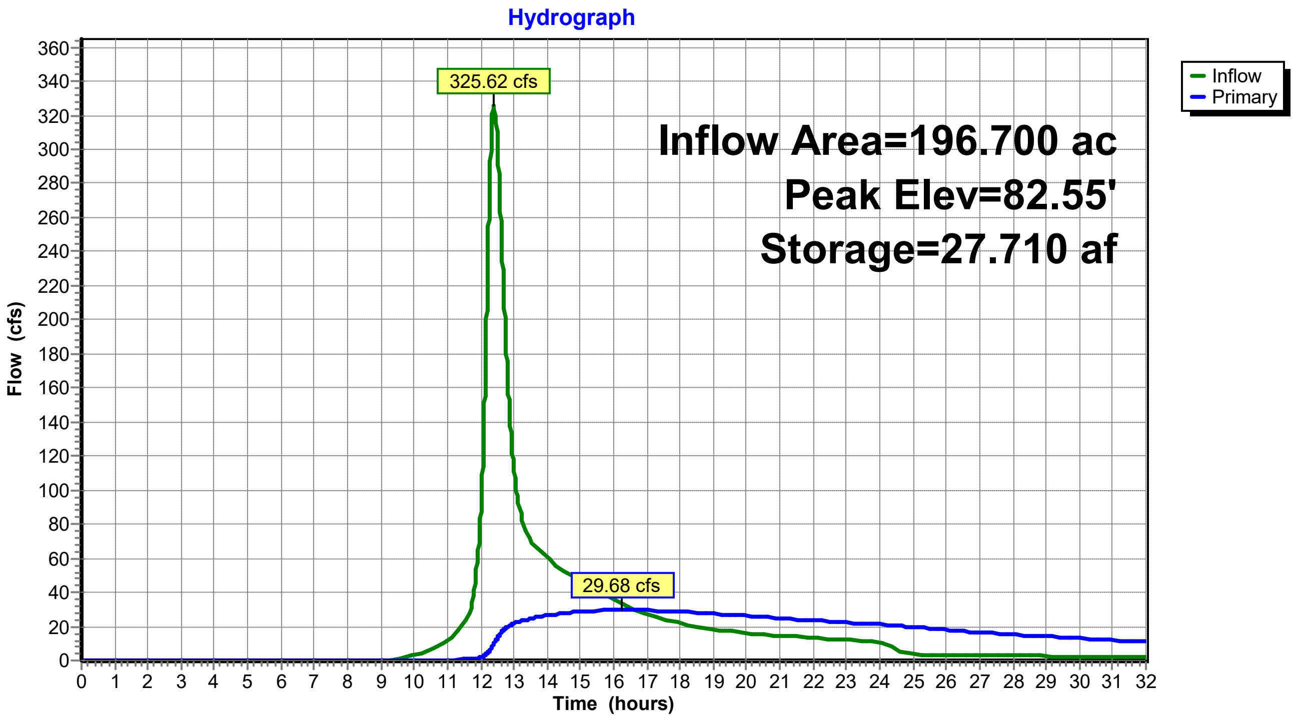
Volume	Invert	Avail.Storage	Storage Description
#1	80.00'	293.577 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
80.00	0.000	0.000	0.000	0.000
81.00	8.720	2.907	2.907	8.720
82.00	18.890	13.481	16.388	18.890
83.00	25.860	22.284	38.672	25.861
84.00	30.520	28.158	66.830	30.522
85.00	35.220	32.842	99.672	35.223
86.00	40.690	37.922	137.594	40.694
87.00	50.460	45.487	183.081	50.464
88.00	56.520	53.461	236.543	56.526
89.00	57.550	57.034	293.577	57.563

Device	Routing	Invert	Outlet Devices
#1	Primary	80.50'	**48.0" W x 36.0" H, R=35.0" Elliptical Culvert** L= 65.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 80.50' / 79.00' S= 0.0231 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 9.65 sf
#2	Primary	86.40'	**40.0' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=29.68 cfs @ 16.21 hrs HW=82.54' TW=80.92' (Dynamic Tailwater)
├─**1=Culvert** (Outlet Controls 29.68 cfs @ 5.99 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 25P: Reservoir-13



Summary for Pond 26P: Reservoir-15

Inflow Area = 59.400 ac, 0.00% Impervious, Inflow Depth = 2.75" for 100-YR event
Inflow = 103.17 cfs @ 12.46 hrs, Volume= 13.603 af
Outflow = 16.02 cfs @ 14.12 hrs, Volume= 9.299 af, Atten= 84%, Lag= 99.5 min
Primary = 16.02 cfs @ 14.12 hrs, Volume= 9.299 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 88.50' Surf.Area= 6.013 ac Storage= 4.461 af
Peak Elev= 89.42' @ 14.12 hrs Surf.Area= 9.589 ac Storage= 11.626 af (7.164 af above start)

Plug-Flow detention time= 638.1 min calculated for 4.837 af (36% of inflow)
Center-of-Mass det. time= 268.5 min (1,146.0 - 877.5)

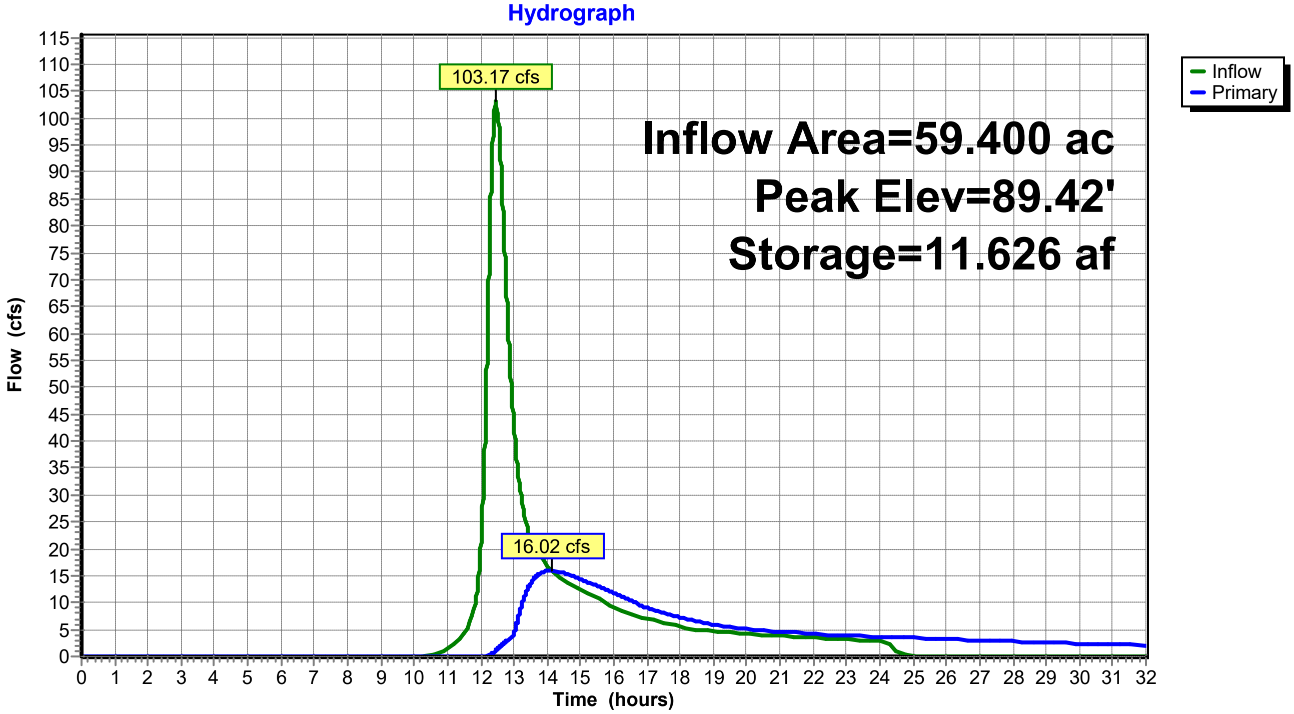
Volume	Invert	Avail.Storage	Storage Description
#1	86.00'	91.535 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
86.00	0.000	0.000	0.000	0.000
87.00	0.187	0.062	0.062	0.187
88.00	4.360	1.817	1.879	4.360
89.00	7.931	6.057	7.936	7.931
90.00	12.117	9.950	17.886	12.118
91.00	22.197	16.905	34.791	22.198
92.00	29.577	25.799	60.590	29.578
93.00	32.334	30.945	91.535	32.337

Device	Routing	Invert	Outlet Devices
#1	Primary	88.50'	**24.0" Round CMP_Round 24"** L= 95.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 88.50' / 86.50' S= 0.0211 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf
#2	Primary	89.30'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=16.02 cfs @ 14.12 hrs HW=89.42' TW=82.41' (Dynamic Tailwater)
├─**1=CMP_Round 24"** (Inlet Controls 4.62 cfs @ 3.27 fps)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 11.39 cfs @ 0.94 fps)

Pond 26P: Reservoir-15



Summary for Pond 27P: Reservoir-17

Inflow Area = 101.700 ac, 0.00% Impervious, Inflow Depth = 2.24" for 100-YR event
Inflow = 126.77 cfs @ 12.56 hrs, Volume= 18.989 af
Outflow = 25.26 cfs @ 14.10 hrs, Volume= 19.022 af, Atten= 80%, Lag= 92.2 min
Primary = 25.26 cfs @ 14.10 hrs, Volume= 19.022 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-32.00 hrs, dt= 0.005 hrs / 3
Starting Elev= 81.50' Surf.Area= 0.200 ac Storage= 0.033 af
Peak Elev= 83.49' @ 14.10 hrs Surf.Area= 9.418 ac Storage= 7.446 af (7.413 af above start)

Plug-Flow detention time= 158.2 min calculated for 18.989 af (100% of inflow)
Center-of-Mass det. time= 156.3 min (1,052.3 - 896.0)

Volume	Invert	Avail.Storage	Storage Description
#1	81.00'	264.118 af	**Custom Stage Data (Conic)** Listed below (Recalc)

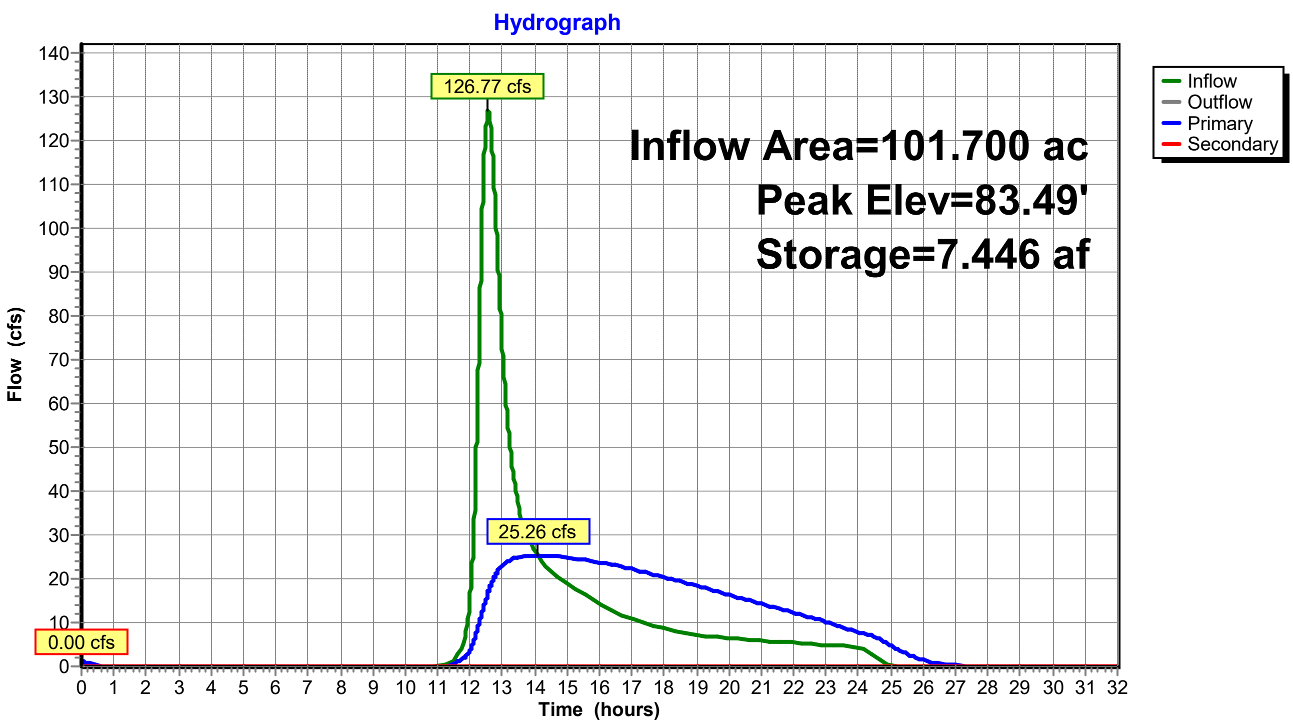
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
81.00	0.000	0.000	0.000	0.000
82.00	0.800	0.267	0.267	0.800
83.00	6.623	3.242	3.508	6.623
84.00	12.798	9.543	13.051	12.798
85.00	25.231	18.666	31.717	25.232
86.00	30.123	27.641	59.358	30.124
87.00	33.641	31.866	91.224	33.644
88.00	37.810	35.705	126.929	37.814
89.00	44.775	41.243	168.172	44.780
90.00	48.907	46.826	214.998	48.913
91.00	49.332	49.119	264.118	49.355

Device	Routing	Invert	Outlet Devices
#1	Primary	81.00'	**36.0" Round Culvert** L= 71.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 81.00' / 80.00' S= 0.0141 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 7.07 sf
#2	Secondary	85.60'	**140.0' long x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=25.26 cfs @ 14.10 hrs HW=83.49' TW=80.79' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 25.26 cfs @ 5.45 fps)

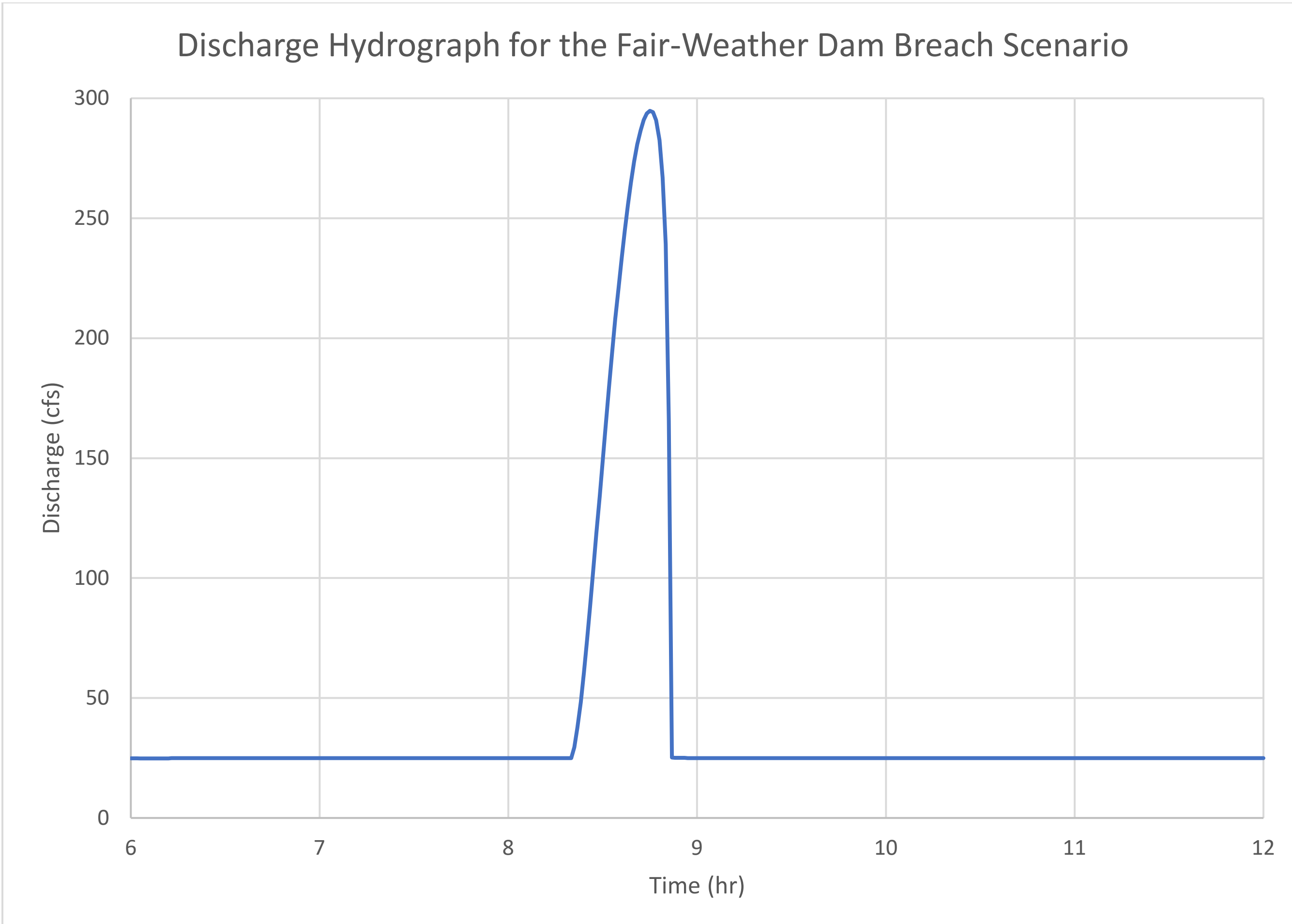
Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=81.50' TW=80.50' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

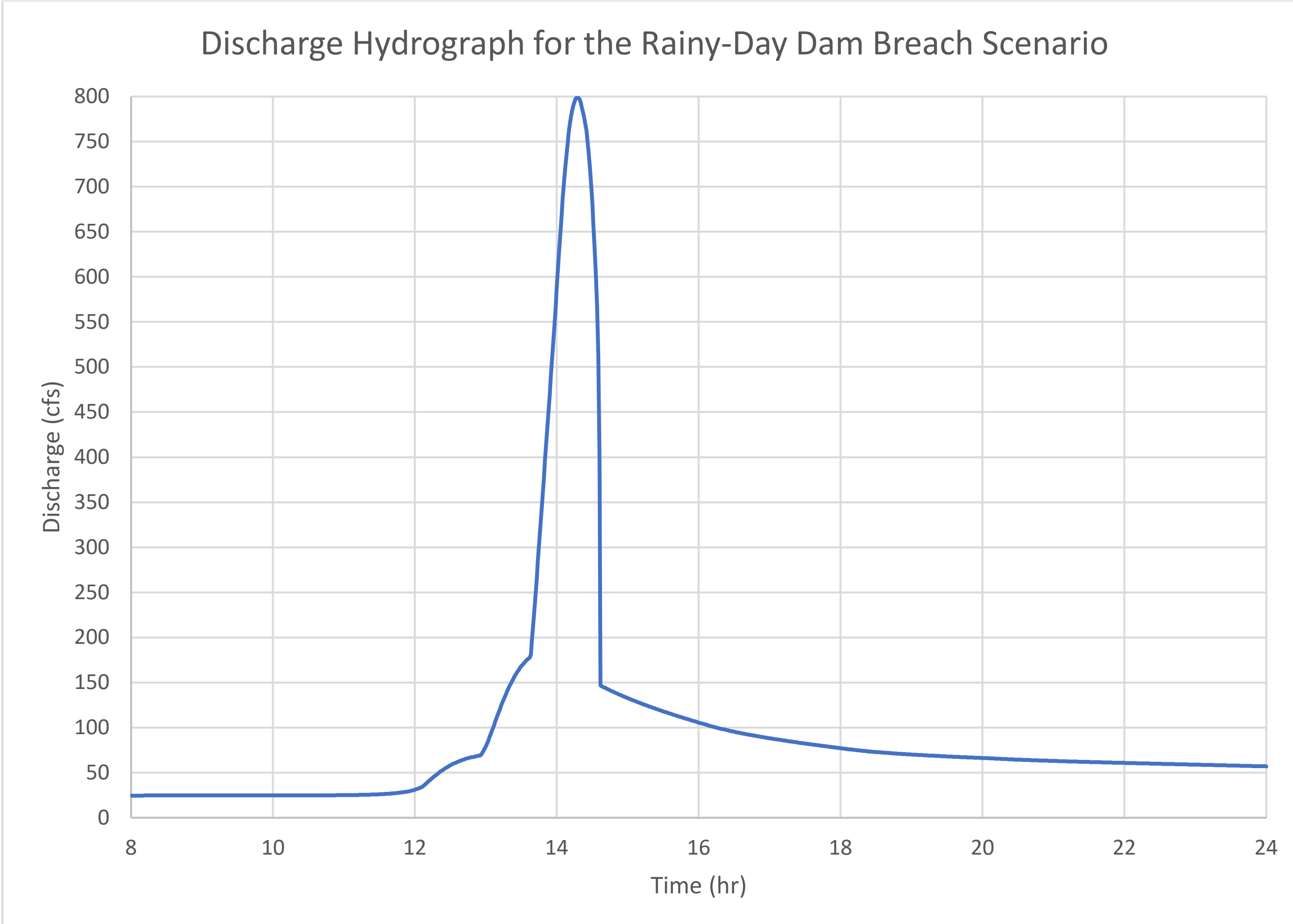
Pond 27P: Reservoir-17



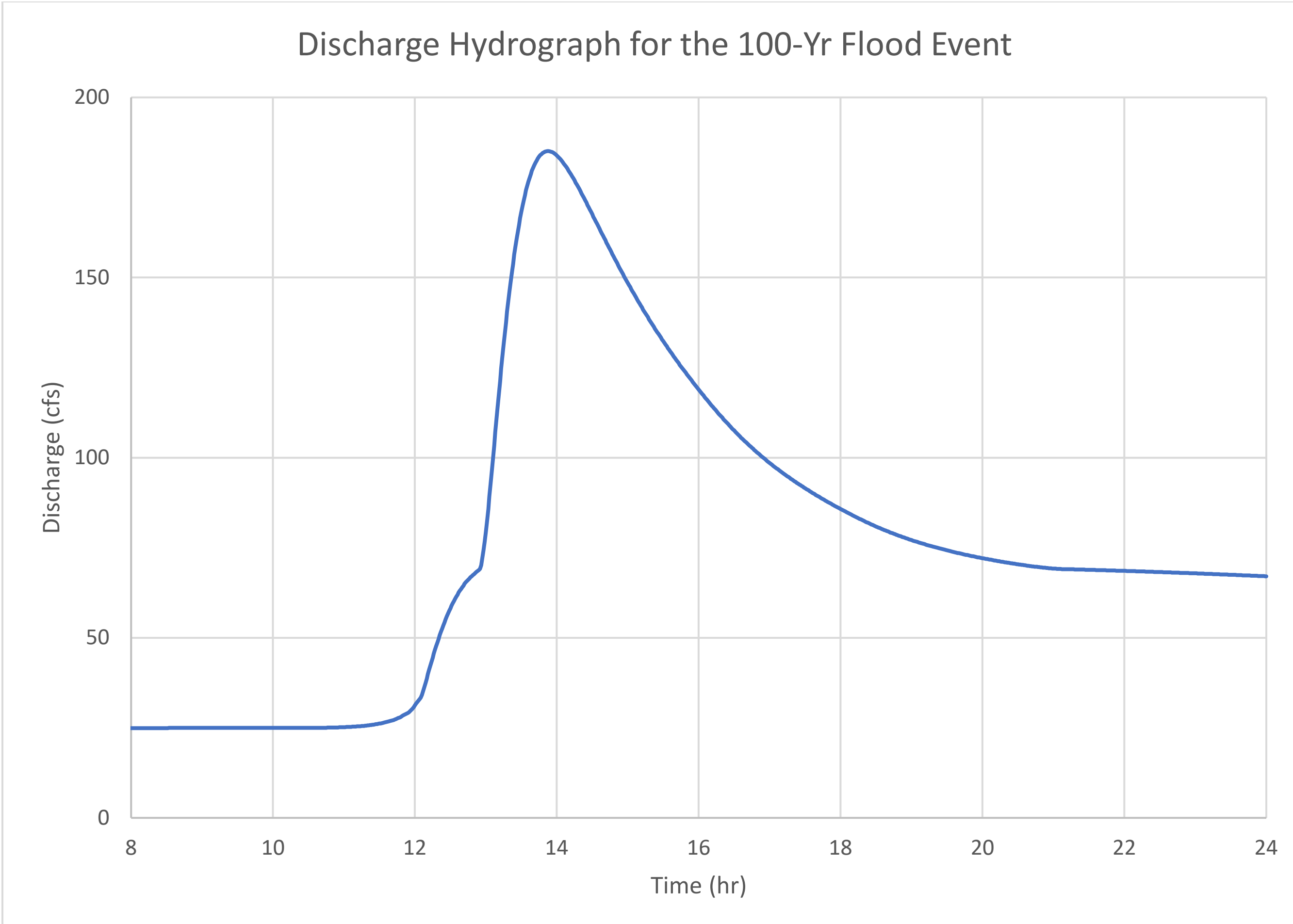
APPENDIX B

Hydraulic Model Diagrams

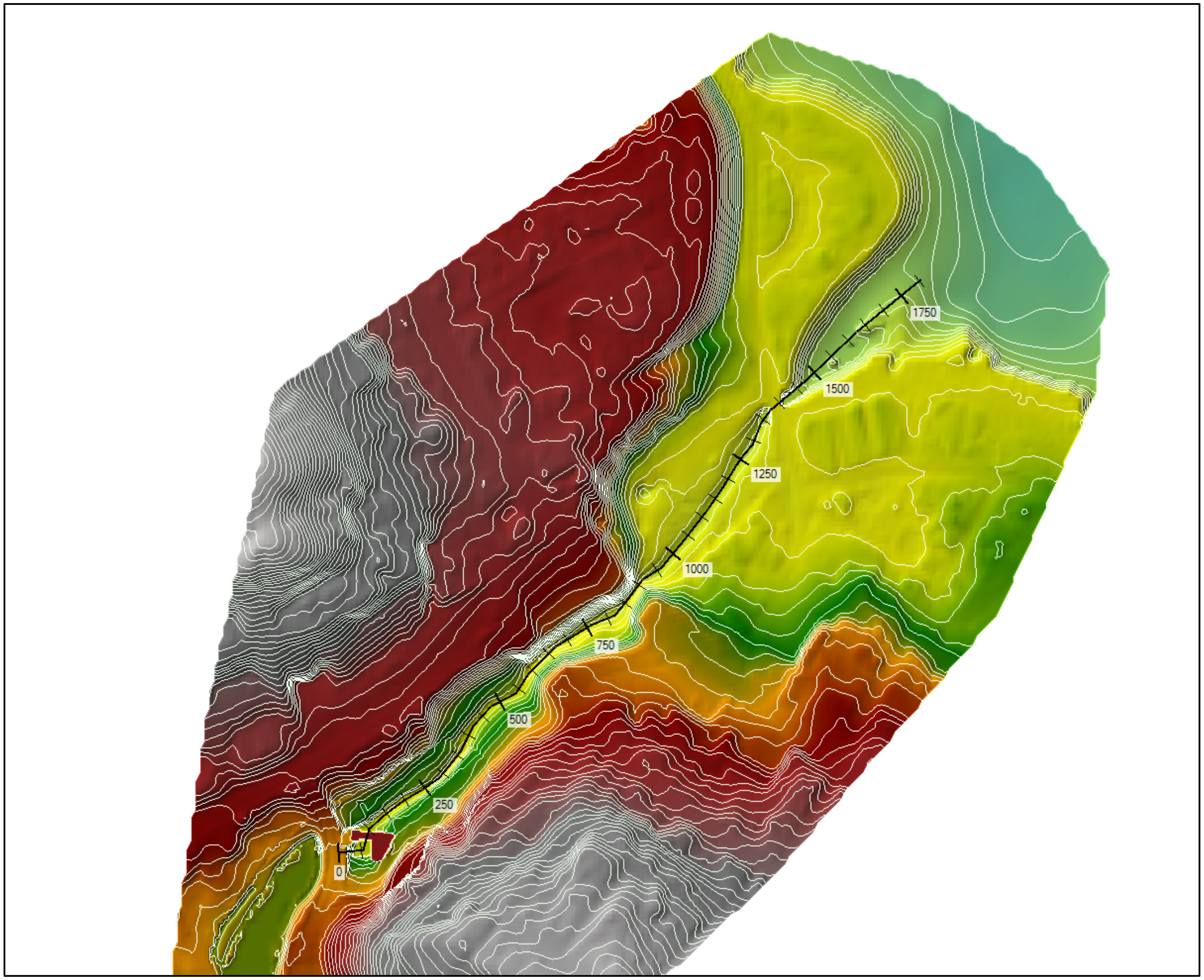

Discharge Hydrograph for the Fair-Weather Dam Breach Scenario
Discharge (cfs)
300
250
200
150
100
50
0
6
7
8
9
10
11
12
Time (hr)



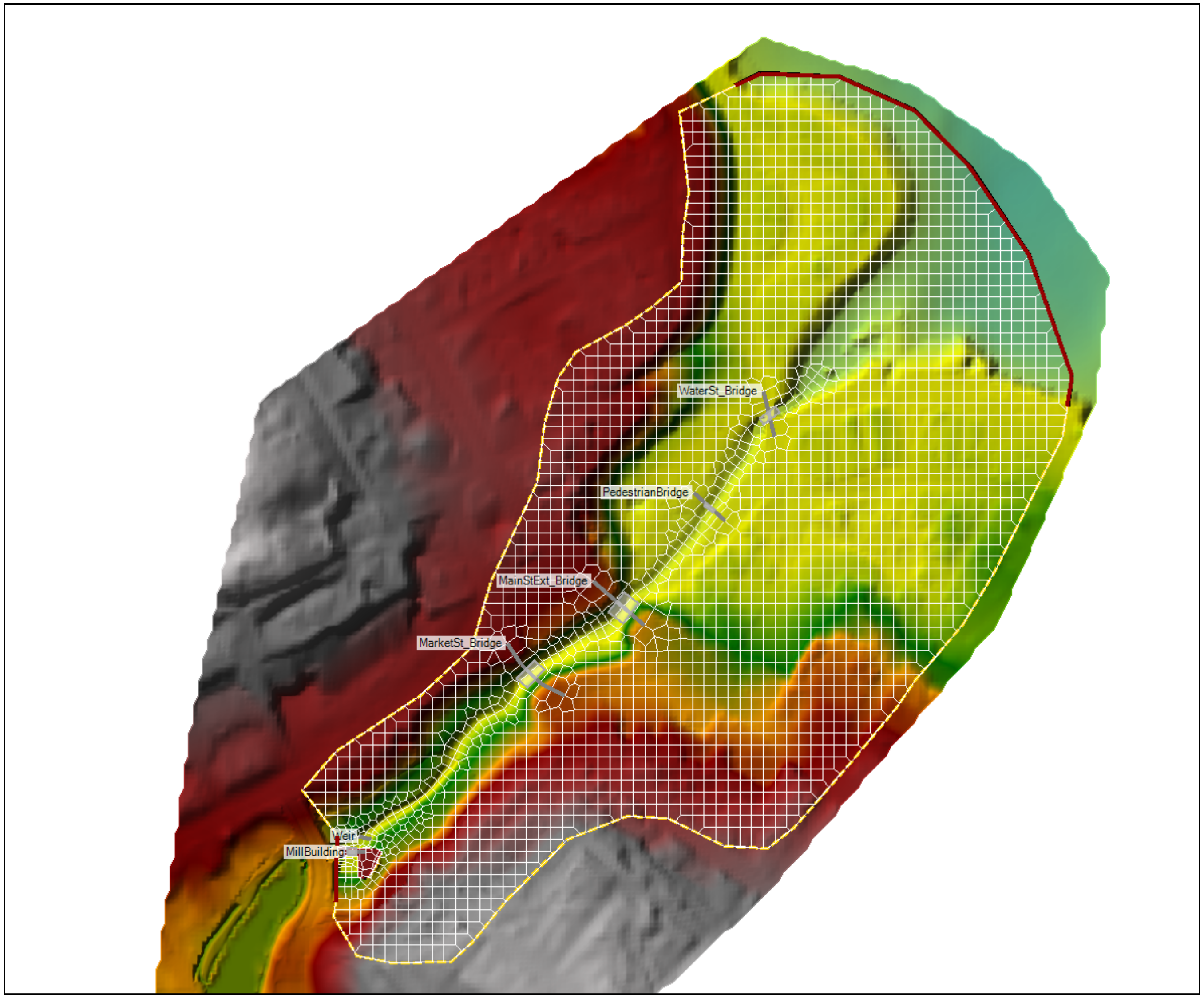
Discharge Hydrograph for the Rainy-Day Dam Breach Scenario
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Discharge (cfs)
8
10
12
14
16
18
20
22
24
Time (hr)


Discharge Hydrograph for the 100-Yr Flood Event
Discharge (cfs)
200
150
100
50
0
8
10
12
14
16
18
20
22
24
Time (hr)

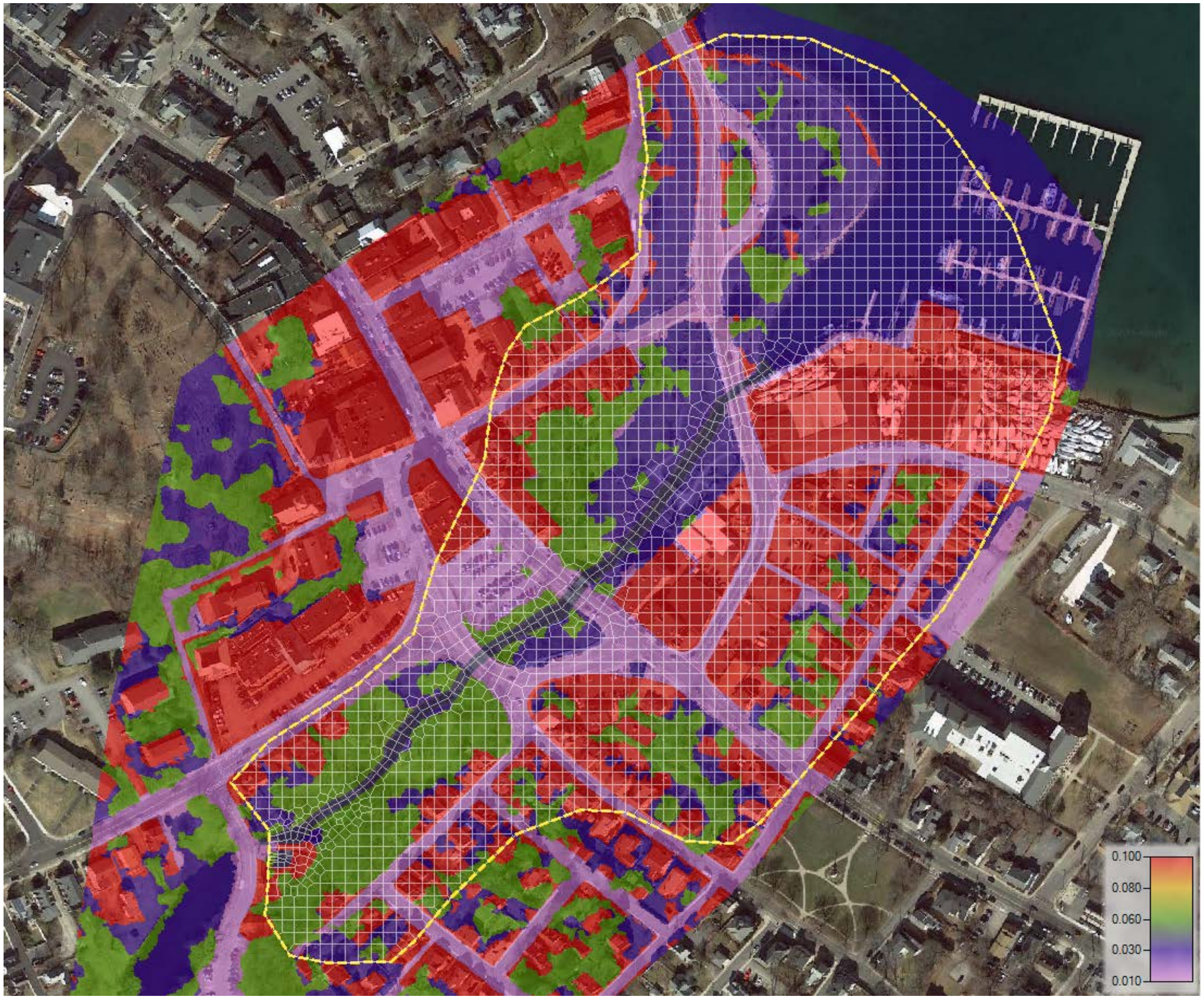
Perimeter of Two-Dimensional Hydraulic Model



Model Terrain Developed from 3-Meter Resolution LiDAR and Topographic Survey



Two-Dimensional Model Mesh with Boundary Conditions and In-Stream Structures



Manning's Roughness Coefficient Based on Landcover