Appendix D-3
Conceptual Stormwater Management Report:
Routes 140/24 Improvements – Option 4

DRAFT
CONCEPTUAL STORMWATER MANAGEMENT REPORT

First Light Casino Off-Site Mitigation
Routes 140/24 Improvements – Option 4
Taunton, Massachusetts

July 2013

Prepared for:

Prepared by:

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CONCEPTUAL STORMWATER MANAGEMENT REPORT

PROJECT DESCRIPTION:

On behalf of the *Project First Light-Destination Resort Casino,* Fay, Spofford & Thorndike, LLC, (FST) has prepared a Conceptual Stormwater Management Report for off-site mitigation on Route 140 at the interchange with Route 24 in the City of Taunton, Massachusetts. These improvements have been identified as Option 4 and are depicted on Figure No.1 entitled "Proposed Improvements-Routes 24 NB and SB Ramps/County Street (Route 140)". Limits of the project extend on County Street (Route 140) from a point approximately 800 feet west of the of the Route 24 SB ramps to a point approximately 600 feet east of the Route 24 NB Ramps.

With respect to stormwater management, this Conceptual Stormwater Management Report presents FST's evaluation of potential project impacts on the existing surface and closed drainage systems and identifies specific Best Management Practices (BMP's) for improving stormwater treatment and control stormwater discharges. The location and selection of stormwater BMPs are designed to improve existing conditions such as water quality, promote groundwater recharge and minimize impacts of stormwater runoff to the greatest extent practicable.

The existing stormwater management facilities located within the project limits are comprised of an open and closed drainage system consisting of overland flow, drainage swales, cross-culverts, catch basins, manholes, piping, and outfalls which ultimately discharge to the Cotley River. The selected stormwater best management practices (BMPs) will control runoff, provided groundwater recharge and retain contaminants. It is assumed existing cross culverts within the project limits will be retained. Proposed BMPs include where applicable, retrofitting of the existing closed drainage system by relocating or providing new pretreatment BMP's such as deep sump/hooded catch basins, piping, drainage manholes, flared end sections w/stone apron and sediment forebays. Anticipated stormwater treatment and infiltration BMPs include grass channels, extended dry detention basins and infiltration basins/trenches. Segments of the existing and proposed stormwater improvements are identified on Figure No.2 entitled "Conceptual Drainage Design".

COMPLIANCE WITH DEP STORMWATER MANAGEMENT STANDARDS:

To protect the wetlands and waters of the Commonwealth from the adverse impacts of stormwater runoff, the DEP issued a *Stormwater Management Policy* that established stormwater management standards in November 1996. In 1997, DEP published the

Massachusetts Stormwater Handbook as guidance on the *Stormwater Policy*. DEP revised the 1997 ***Handbook*** and associated stormwater management standards, which became effective on January 2, 2008. As such, the proposed project must comply with these revised standards.

As defined in Volume 1 Chapter 1 page 20 of the "Massachusetts Stormwater Handbook", issued February 2008, (a.k.a. the MA Stormwater Handbook) this project qualifies as a **REDEVELOPMENT** project. The handbook states that redevelopment projects are defined to include "maintenance and improvement of existing roadways, including widening less than a single lane, adding shoulders, correcting substandard intersections, improving existing drainage systems, and repaving." Proposed improvements associated with the Route 140/24 project are in accord with this definition.

Under the criteria outlined in the handbook "a redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice (BMP) requirements of Standards 4, 5, and 6." In contrast, the project must meet Standards 1, 8, 9 and 10 in full. As such, elements have been incorporated into the proposed project to improve existing conditions associated with stormwater runoff. The following summarizes the extent to which the proposed project complies with the new Stormwater Management Standards:

Standard No. 1 – No New Untreated Discharges: No new outfalls that discharge directly into the Cotley River will be created as part of the project. Stormwater improvements will include the construction of new deep sump/hooded catch basins, piping, manholes, flared end sections w/stone apron, sediment forebays, grass channels, extended dry detention basins and infiltration basins/trenches. The existing storm drainage culverts located within the project limits will be retained and utilized as part of the stormwater management system.

Standard No. 2 – Peak Rate Attenuation: Proposed improvements will result in an overall increase of approximately 0.71 acres of impervious surface area within the project limits. Existing drainage patterns will be maintained as part of the proposed stormwater management system. See attached hydrologic analysis ***(Appendix E)*** for calculations and other documentation regarding peak discharge rates.

A summary of the hydrologic calculations for the 2, 10, 25, 50 and 100-yr storm events for pre and post development conditions, within the project limits is presented below.

SUBCATCHMENT NAME		POINT OF INTEREST	PRE-DEVELOPMENT STORM EVENT					POST-DEVELOPMENT STORM EVENT				
EXISTING CONDITION	PROPOSED CONDITION		2-yr	10-yr	25-yr	50-yr	100-yr	2-yr	10-yr	25-yr	50-yr	100-yr
1S	10L	POI 1	3.66	5.37	6.46	7.18	8.02	3.00	4.06	5.14	6.25	7.56
2S	20L	POI 2	11.75	17.11	20.52	22.80	25.44	8.35	12.10	14.61	16.34	18.57

Standard No. 3 – Recharge: The intent of Standard 3 is to ensure that the infiltration volume of precipitation into the ground under post-development conditions is at least as much as the infiltration volume under pre-development conditions. The project improvements will result in an increase impervious surface area of approximately 0.71 acres, thereby, resulting in a decrease in the volume of rainfall recharging to the groundwater and improvement to existing conditions.

A review of the NRCS Soil Survey map classified soils within the project area as Udorthents/Urban Land (No Hydrologic Group) and Woodbridge/Fine Sandy Loam (Hydrologic Group C). A copy of the NRCS Soil Map is provided within *Appendix A.* As part of the drainage analysis, FST assumed a Hydrologic Group C within the project limits with the goal to coordinate with the project proponent to perform a field investigation at selected locations to further determine soil conditions within the project area.

Based on the above referenced soil conditions (i.e. Hydrologic Soil Group C) the required recharge volume is approximately 645.0 cubic feet. As such, the proposed stormwater infiltration BMP's will be design to recharge the required stormwater runoff volume.

Standard No. 4 – Water Quality: The proposed project meets the definition of redevelopment, thereby requiring the 80% TSS removal standard to be met only to the maximum extent practicable. Proposed BMP devices selected throughout the project area include the following:

BMP's:

Deep Sump/Hooded Catch Basins	25% TSS Removal Rate
Sediment Forebays	25% TSS Removal Rate
Grass Channel	50% TSS Removal Rate
Extended Dry Detention Basin	50% TSS Removal Rate
Infiltration Basin/Trench	80% TSS Removal Rate

The proposed BMP's meet the 80% TSS removal pretreatment requirement, as a redevelopment project, the BMP's will provide an improvement to existing conditions. TSS removal calculation worksheets for proposed treatment methods at each point of interest (POI 1 & 2) located within the project area are provided within *Appendix D.*

The Massachusetts Stormwater Handbook requires the computation of the water quality treatment volume for stormwater runoff. The required water quality treatment volume is based upon 0.5 inches (1.0-inch if within a Critical Areas, i.e. Zone II) times the total impervious area of the post development project site. For the Route 140/24 improvement project the required water quality volume is based on 0.5 inches of runoff times the total impervious area of the post development project site. The proposed stormwater treatment and infiltration BMPs will be ultimately sized to treat stormwater flows from the proposed impervious area and provide a water quality volume to the maximum extent practicable within the project area.

Standard No. 5 – Land Uses With Higher Potential Pollutant Loads (LUHPPLs):
This standard is not applicable due to the fact that the proposed use is not associated with higher potential pollutant loads.

Standard No. 6 - Critical Areas: This standard is not applicable. The stormwater discharges are not located within/or near a critical area.

Standard No. 7 – Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable: The proposed project is considered a redevelopment project per the Massachusetts Stormwater Handbook criteria. The applicable stormwater standards have been met to the maximum extent practicable

Standard No. 8 – Construction Period Pollution Prevention and Erosion and Sedimentation Control: A Construction Period Pollution Prevention/Soil Erosion and Sediment Control Plan will be developed to address activities associated with proposed roadway construction in a manner that minimizes erosion, sediment, debris, and other pollutants from contaminating the resource areas and receiving waters. The installation of soil erosion and sediment controls will comply with the *Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas* (Massachusetts Executive Office of Environmental Affairs et. al.; 2003), and all aspects of Standard No. 8.

As the proposed project will involve more than one (1) acre of earth disturbance, a National Pollutant Discharge Elimination System (NPDES) Stormwater General Permit for construction will be required. In conjunction with this permit, a project specific Stormwater Pollution Prevention Plan (SWPPP) will be generated for construction-related activities. The SWPPP, to be prepared by the contractor prior to construction, will incorporate the soil erosion and sediment controls indicated on the project plans provided under separate cover, and any other structural and non-structural controls that will or may be used, as appropriate, to control erosion/sedimentation within the construction zone.

These measures are anticipated to consist of straw/hay bales/compost filter sock, silt fencing, check dams, catch basin/storm drain inlet protection, and seeding/mulching, although not all of these BMPs necessarily will be implemented. The SWPPP also will document procedures associated with the inspection of erosion/sedimentation controls to ensure that all such controls are functioning properly.

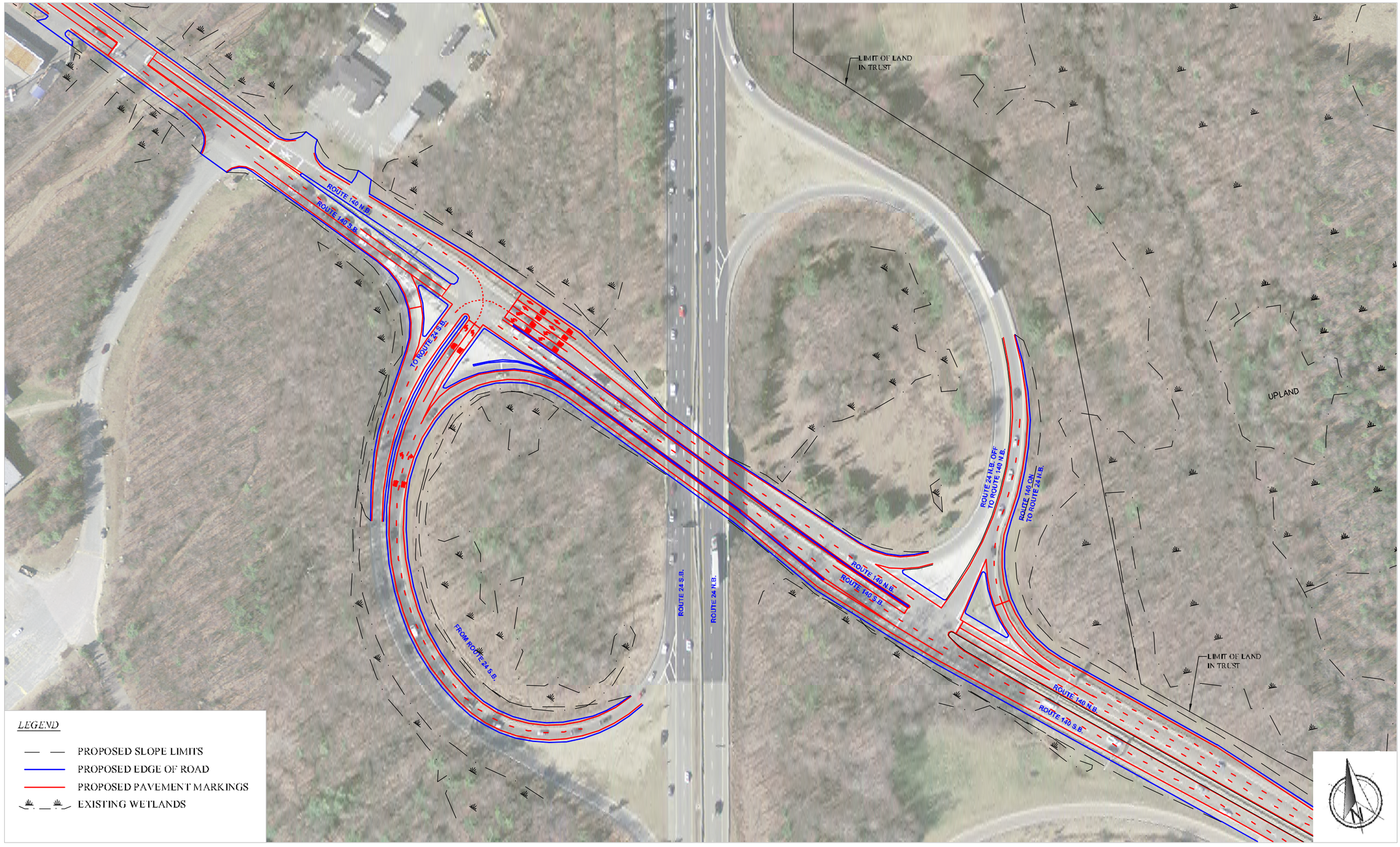
To apply for coverage under the EPA General Permit, a 'Notice of Intent for Stormwater Discharges Associated with Construction Activity under an NPDES General Permit' will be filed with the U.S. Environmental Protection Agency (EPA) prior to the commencement of construction. As required, the SWPPP also will be kept at the construction site for review by regulatory agency staff.

Standard No. 9 - Operation and Maintenance Plan: MassDOT is responsible for the operation and maintenance of the redevelopment project and proposed safety improvements. The schedule for inspection and maintenance will be according to MassDOT's annual maintenance program.

Standard No. 10 – Prohibition of Illicit Discharges: A 'No Illicit Discharge Compliance Statement' will be submitted prior to the discharge of any stormwater to post-construction BMP's.

FIGURES

ROUTES 140/24 IMPROVEMENTS

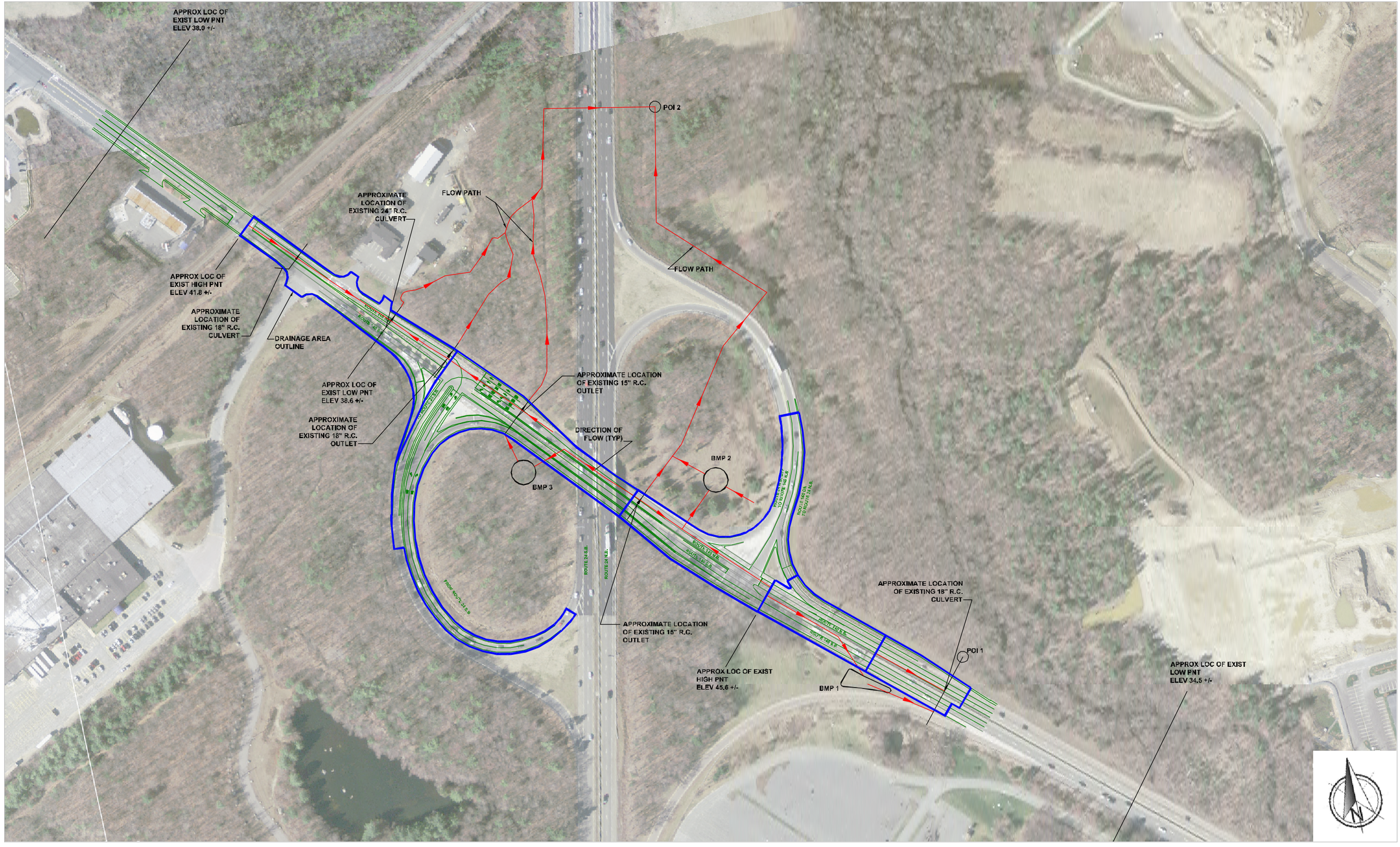


SOURCE: Fay, Spofford & Thorndike

Mashpee Wampanoag Tribe - Fee to Trust Acquisition - Draft EIS

Figure 1.0

Proposed Improvements - Route 24 NB and SB Ramps/County Street (Route 140)



SOURCE: Fay, Spofford & Thorndike

Mashpee Wampanoag Tribe - Fee to Trust Acquisition - Draft EIS

Figure 2.0

Conceptual Drainage Design - Route 24 NB and SB Ramps/County Street (Route 140)

APPENDIX A

ROUTES 140/24 IMPROVEMENTS
OPTION 4

NRCS SOIL SURVEY MAP

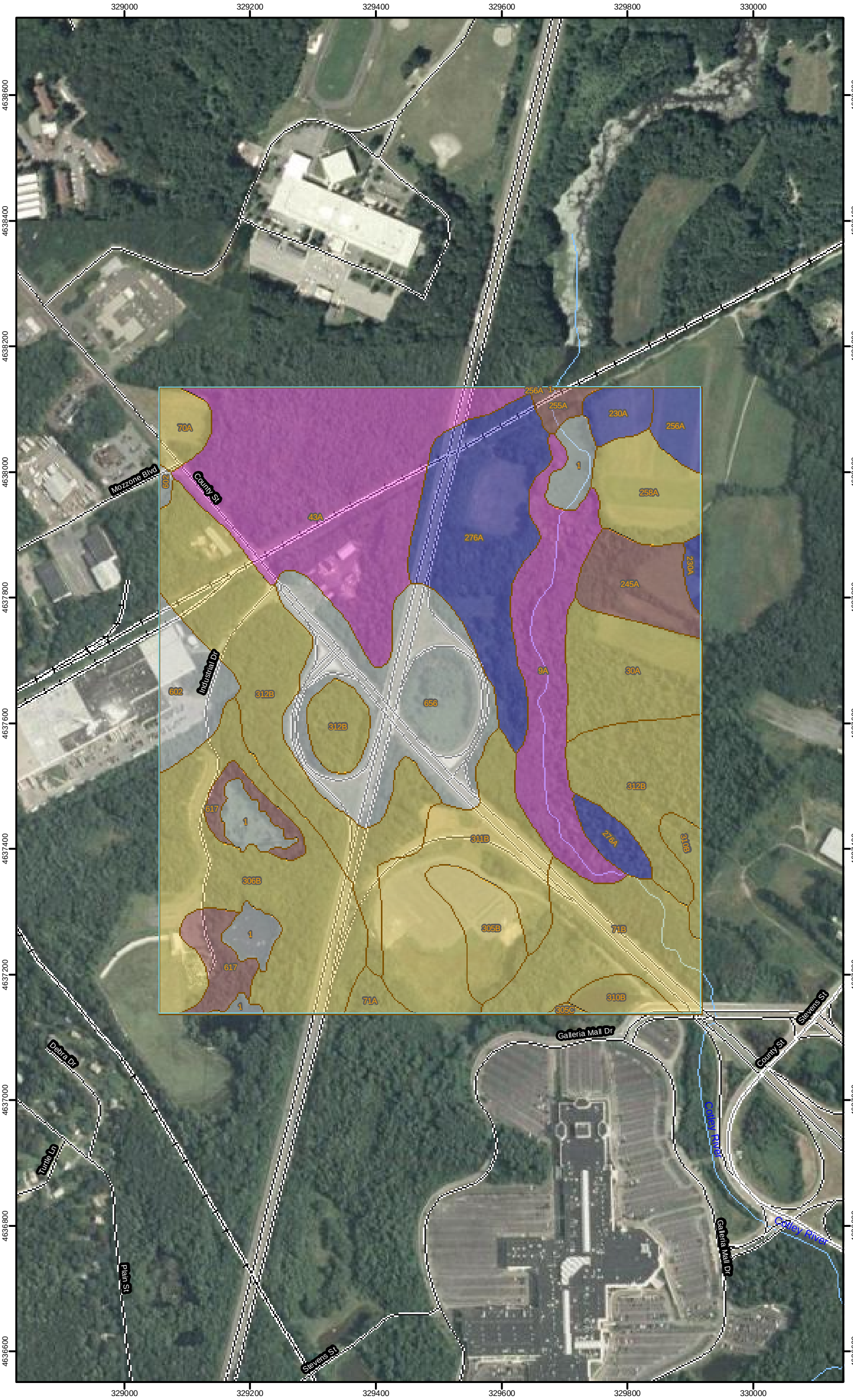
Hydrologic Soil Group—Bristol County, Massachusetts, Northern Part
(Taunton RTE 140)

71° 3' 46" 71° 2' 49"

41° 52' 54" 41° 52' 55"

329000 329200 329400 329600 329800 330000

4638600 4638400 4638200 4638000 4637800 4637600 4637400 4637200 4637000 4636800 4636600



41° 51' 44" 41° 51' 45"

329000 329200 329400 329600 329800 330000

71° 3' 44" 71° 2' 47"

Map Scale: 1:6,000 if printed on B size (11" x 17") sheet.

N

Meters
0 40 80 160 240

Feet
0 150 300 600 900

MAP LEGEND

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

Soils
- Soil Map Units

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

Political Features
- Cities

Water Features
- Streams and Canals

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

MAP INFORMATION

Map Scale: 1:6,000 if printed on B size (11" × 17") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 19N NAD83

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

Soil Survey Area: Bristol County, Massachusetts, Northern Part
Survey Area Data: Version 5, Jul 27, 2010

Date(s) aerial images were photographed: 8/15/2003; 8/14/2003; 7/31/2003

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Bristol County, Massachusetts, Northern Part (MA602)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Water		5.6	2.6%
9A	Birdsall silt loam, 0 to 3 percent slopes	D	13.0	6.1%
30A	Raynham silt loam, 0 to 3 percent slopes	C	8.7	4.1%
43A	Scarboro mucky loamy fine sand, 0 to 3 percent slopes	D	29.5	13.9%
70A	Ridgebury fine sandy loam, 0 to 3 percent slopes	C	2.1	1.0%
71A	Ridgebury fine sandy loam, 0 to 3 percent slopes, extremely stony	C	1.1	0.5%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	C	12.0	5.6%
230A	Unadilla very fine sandy loam, 0 to 3 percent slopes	B	2.7	1.3%
245A	Hinckley sandy loam, 0 to 3 percent slopes	A	5.5	2.6%
255A	Windsor loamy sand, 0 to 3 percent slopes	A	1.1	0.5%
256A	Deerfield loamy sand, 0 to 3 percent slopes	B	2.3	1.1%
258A	Amostown fine sandy loam, 0 to 5 percent slopes	C	6.0	2.8%
276A	Ninigret fine sandy loam, 0 to 3 percent slopes	B	18.2	8.6%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	4.6	2.2%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	C	0.2	0.1%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	20.6	9.7%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C	3.5	1.6%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C	14.9	7.0%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	C	31.3	14.8%
602	Urban land		5.4	2.5%
617	Pits - Udorthents complex, gravelly	A	4.5	2.1%
656	Udorthents - Urban land complex		19.4	9.1%
Totals for Area of Interest			**212.2**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

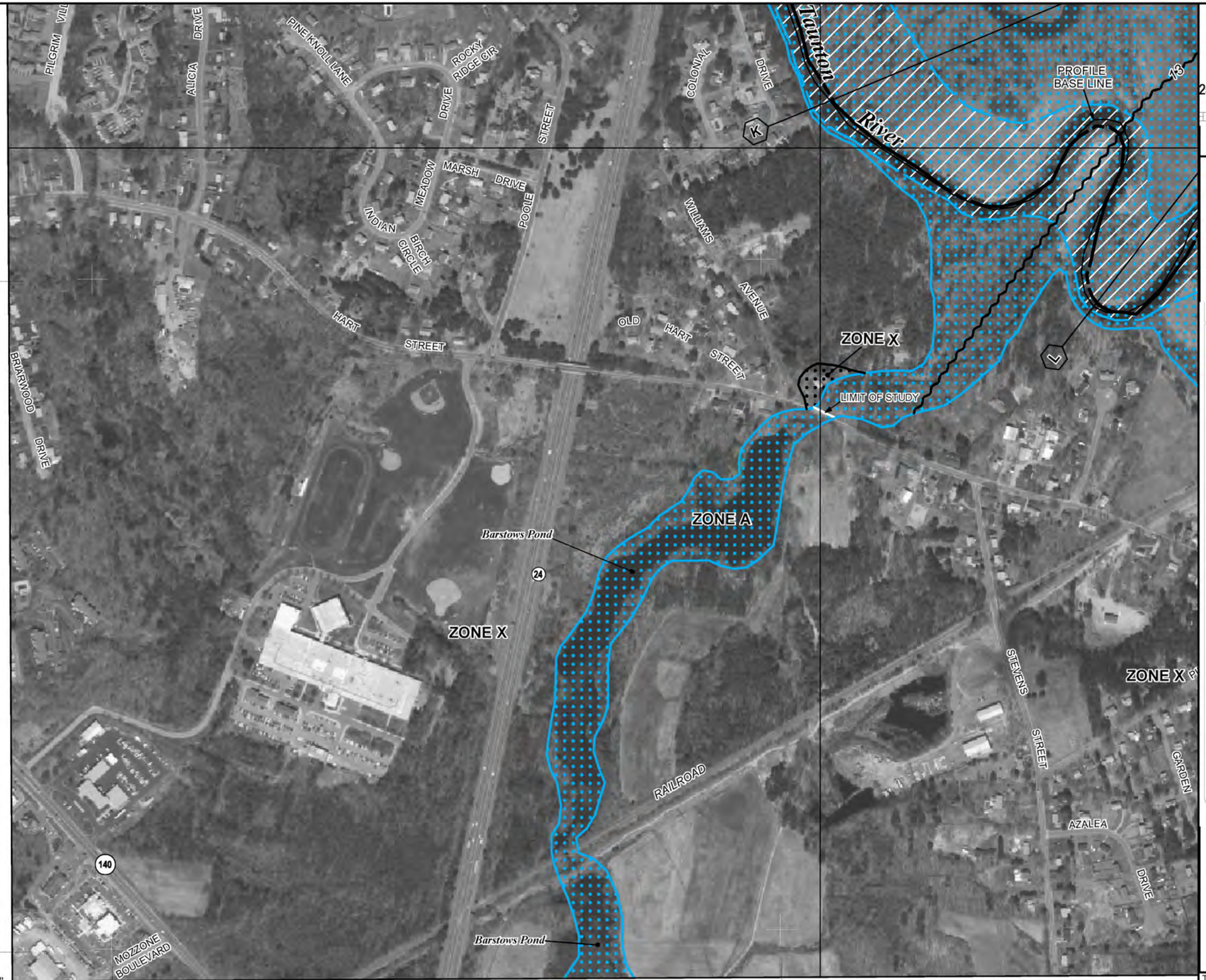
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX B

ROUTES 140/24 IMPROVEMENTS
OPTION 4

FEMA FIRM PANEL



MAP SCALE 1" = 500'

250 0 500 1000 FEET METE

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0168F

FIRM

FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, MASSACHUSETTS

(ALL JURISDICTIONS)

PANEL 168 OF 550

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
RAYNHAM, TOWN OF	250061	0168	F
TAUNTON, CITY OF	250066	0168	F

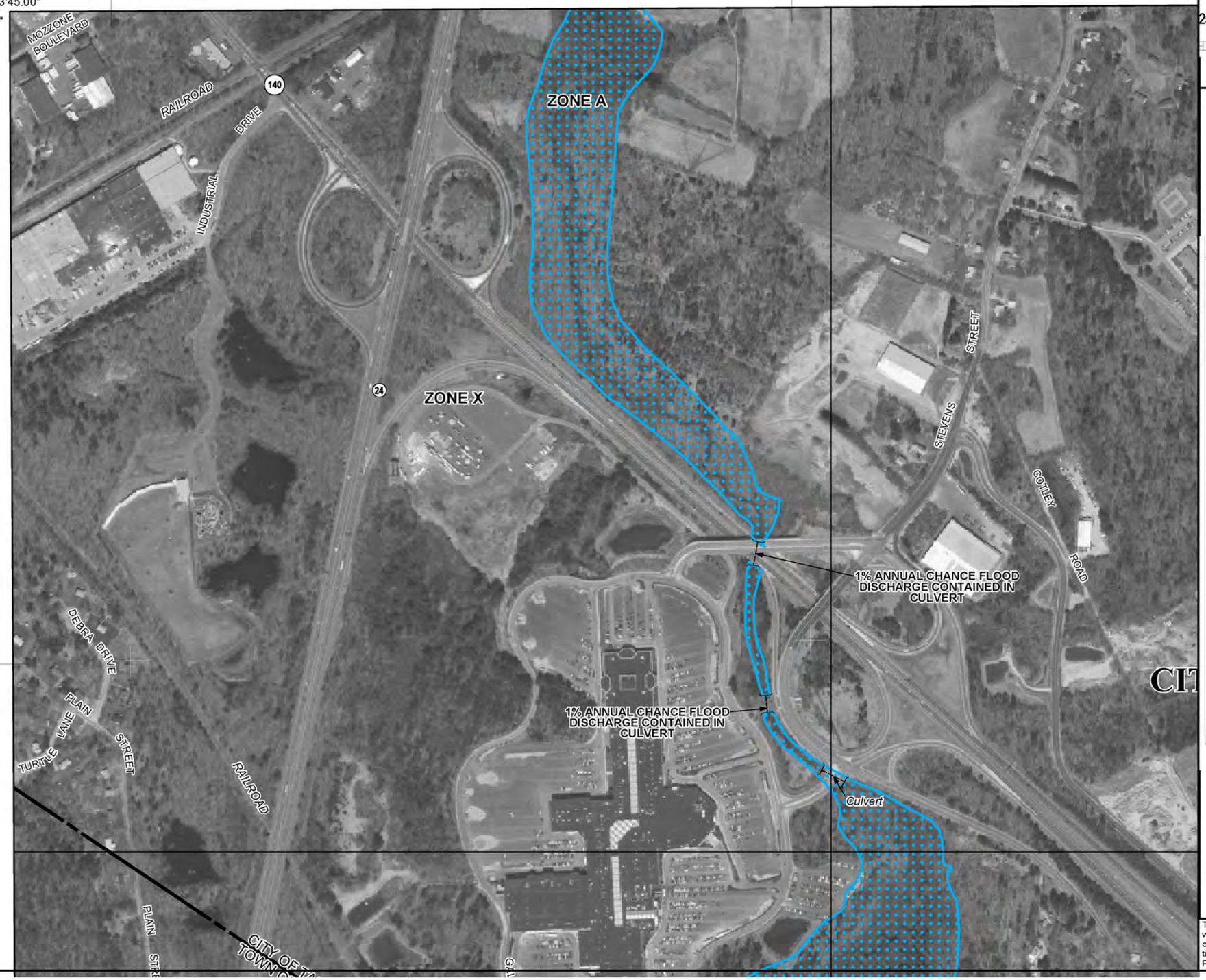
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25005C0168F

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

71°03'45.00"
41°52'30.00"
$^{3}29^{000m}$ E
$^{3}30^{000m}$ E
JOINS PANEL 0168
$^{46}37^{000m}$ N



MAP SCALE 1" = 500'
250 0 500 1000 FEET
METE

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0256F

FIRM
FLOOD INSURANCE RATE MAP
BRISTOL COUNTY, MASSACHUSETTS
(ALL JURISDICTIONS)

PANEL 256 OF 550
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BERKLEY, TOWN OF	250050	0256	F
TAUNTON, CITY OF	250066	0256	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25005C0256F

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

MAP SCALE 1" = 500'

250 0 500 1000 FEET METE

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0256F

FIRM

FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, MASSACHUSETTS

(ALL JURISDICTIONS)

PANEL 256 OF 550

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
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TAUNTON, CITY OF	250066	0256	F

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MAP NUMBER
25005C0256F

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A — A — Cross section line
- 23 - - - - - - - - 23 — Transect line
- 97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- $^{42}75^{000m}$N — 1000-meter Universal Transverse Mercator grid ticks, zone 19
- 6000000 M — 5000-foot grid values: Massachusetts State Plane coordinate system, mainland zone (FIPSZONE 2001), Lambert Conformal Conic
- DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES

Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

July 7, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

MAP SCALE 1" = 500'

250 0 500 1000 FEET

METE

PANEL 0256F

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, MASSACHUSETTS

(ALL JURISDICTIONS)

PANEL 256 OF 550

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
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MAP NUMBER
25005C0256F

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

APPENDIX C

ROUTES 140/24 IMPROVEMENTS
OPTION 4

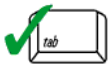
STORMWATER REPORT CHECKLIST

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☒ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): Stormwater Treatment and Infiltration BMPs

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☐ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is ***not*** discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume ***only*** to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☐ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☒ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☐ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☐ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☐ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX D

ROUTES 140/24 IMPROVEMENTS
OPTION 4

TSS REMOVAL WORKSHEETS

TSS Removal Calculator

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: POI 1 (RT 140 CULVERT)

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Extended Dry Detention Basin	**0.50**	**0.75**	**0.38**	**0.38**
Grass Channel	**0.50**	**0.38**	**0.19**	**0.19**
	0.00	**0.19**	**0.00**	**0.19**
	0.00	**0.19**	**0.00**	**0.19**

Total TSS Removal = **81%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **QM-172 First Light Casino Rt 140/24 Improvements**

Prepared By: **Fay, Spofford & Thorndike**

Date: **12/17/2012**

*Equals remaining load from previous BMP (E) which enters the BMP

TSS Removal Calculator

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: POI 2 (RT 24 CULVERT)

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Infiltration Basin	**0.80**	**0.75**	**0.60**	**0.15**
Grass Channel	**0.50**	**0.15**	**0.08**	**0.08**
	0.00	**0.08**	**0.00**	**0.08**
	0.00	**0.08**	**0.00**	**0.08**

Total TSS Removal = **93%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **QM-172 First Light Casino Rt 140/24 Improvements**

Prepared By: **Fay, Spofford & Thorndike**

Date: **12/17/2012**

*Equals remaining load from previous BMP (E) which enters the BMP

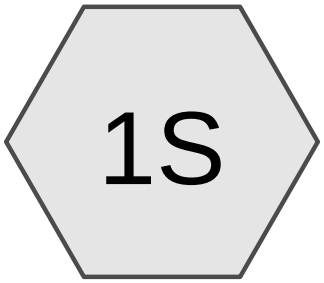
APPENDIX E

ROUTES 140/24 IMPROVEMENTS
OPTION 4

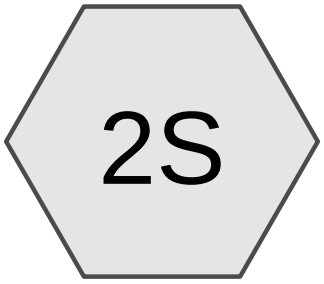
HYDROCADD ANALYSIS

EXISTING CONDITIONS

ROUTES 140/24 IMPROVEMENTS



POI 1 - OVERLAND
DIRECT DISCHARGE



POI 2 - OVERLAND
DIRECT DISCHARGE

Subcat Reach Pond Link

Routing Diagram for TAUNTON RTE 140 PRE DEVELOPMENT
Prepared by Fay, Spofford & Thorndike, Printed 12/13/2012

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: POI 1 - OVERLAND DIRECT Runoff Area=53,716 sf 84.50% Impervious Runoff Depth>2.74"
Tc=6.0 min CN=95 Runoff=3.66 cfs 12,270 cf

Subcatchment 2S: POI 2 - OVERLAND DIRECT Runoff Area=216,977 sf 88.67% Impervious Runoff Depth>2.84"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=96 Runoff=11.75 cfs 51,387 cf

Total Runoff Area = 270,693 sf Runoff Volume = 63,657 cf Average Runoff Depth = 2.82"
12.16% Pervious = 32,905 sf 87.84% Impervious = 237,788 sf

Summary for Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

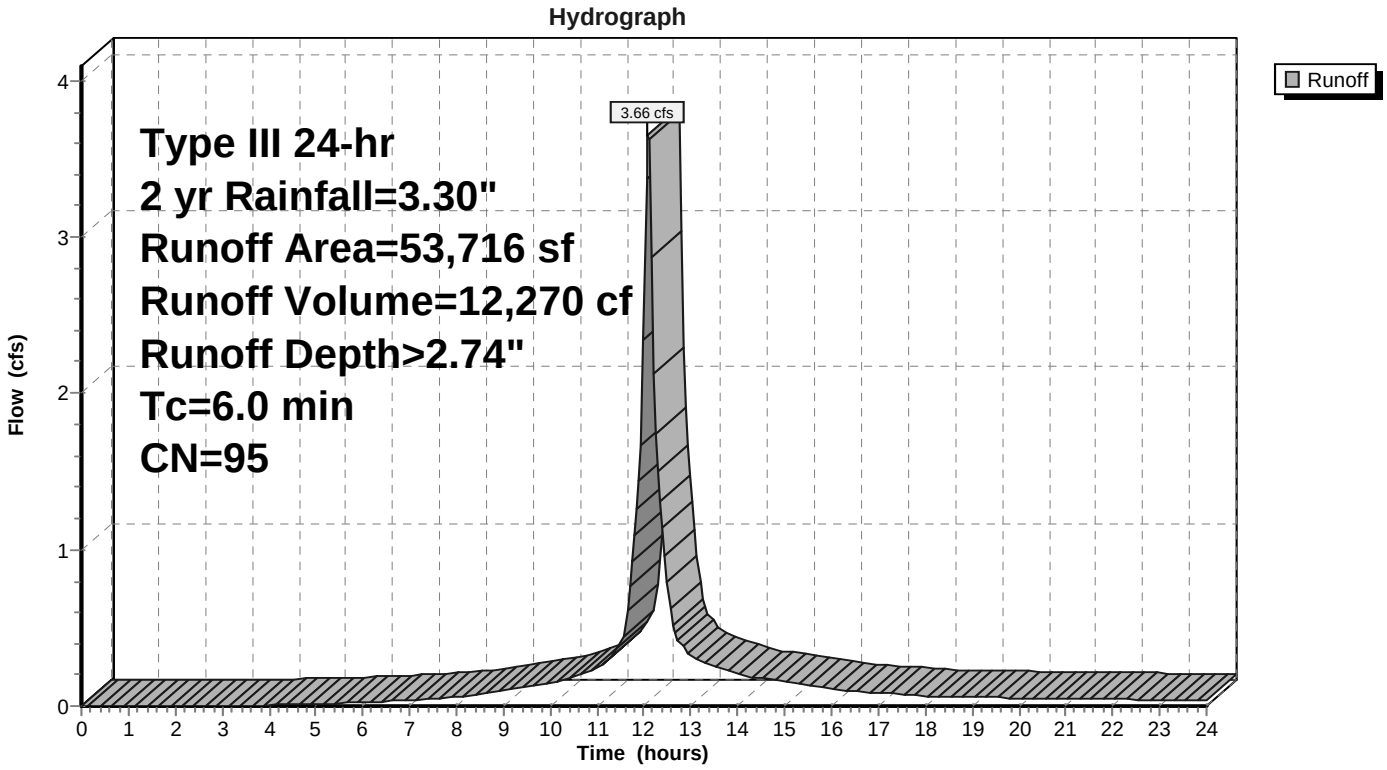
Runoff = 3.66 cfs @ 12.09 hrs, Volume= 12,270 cf, Depth> 2.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.30"

Area (sf)	CN	Description
45,392	98	Paved roads w/curbs & sewers, HSG C
8,324	79	50-75% Grass cover, Fair, HSG C
53,716	95	Weighted Average
8,324		15.50% Pervious Area
45,392		84.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.
2. For shallow flow, the high point elev is 32 ft and the low point elev is 23 ft.

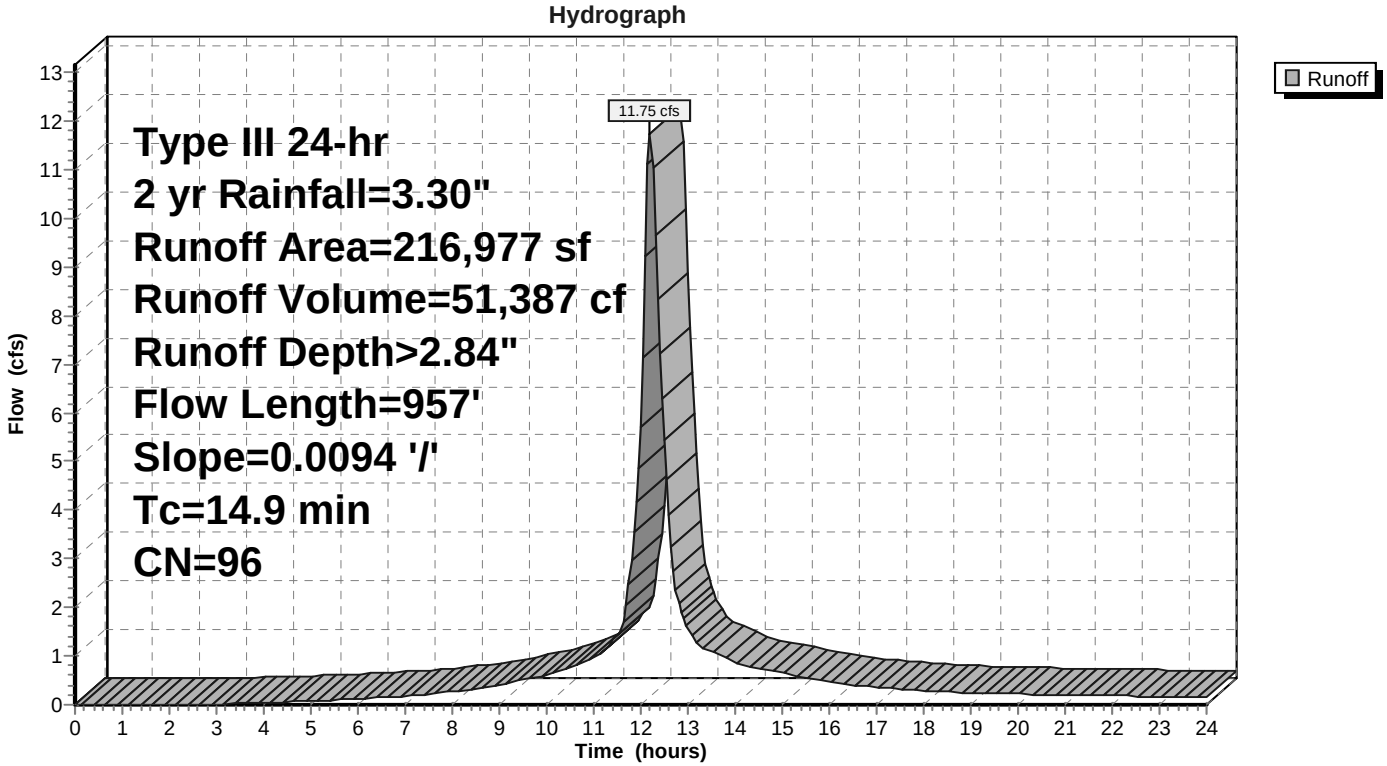
Runoff = 11.75 cfs @ 12.20 hrs, Volume= 51,387 cf, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.30"

Area (sf)	CN	Description
192,396	98	Paved roads w/curbs & sewers, HSG C
13,618	79	50-75% Grass cover, Fair, HSG C
10,963	84	50-75% Grass cover, Fair, HSG D
216,977	96	Weighted Average
24,581		11.33% Pervious Area
192,396		88.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: POI 1 - OVERLAND DIRECT Runoff Area=53,716 sf 84.50% Impervious Runoff Depth>4.12"
Tc=6.0 min CN=95 Runoff=5.37 cfs 18,442 cf

Subcatchment 2S: POI 2 - OVERLAND DIRECT Runoff Area=216,977 sf 88.67% Impervious Runoff Depth>4.23"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=96 Runoff=17.11 cfs 76,416 cf

Total Runoff Area = 270,693 sf Runoff Volume = 94,857 cf Average Runoff Depth = 4.21"
12.16% Pervious = 32,905 sf 87.84% Impervious = 237,788 sf

Summary for Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

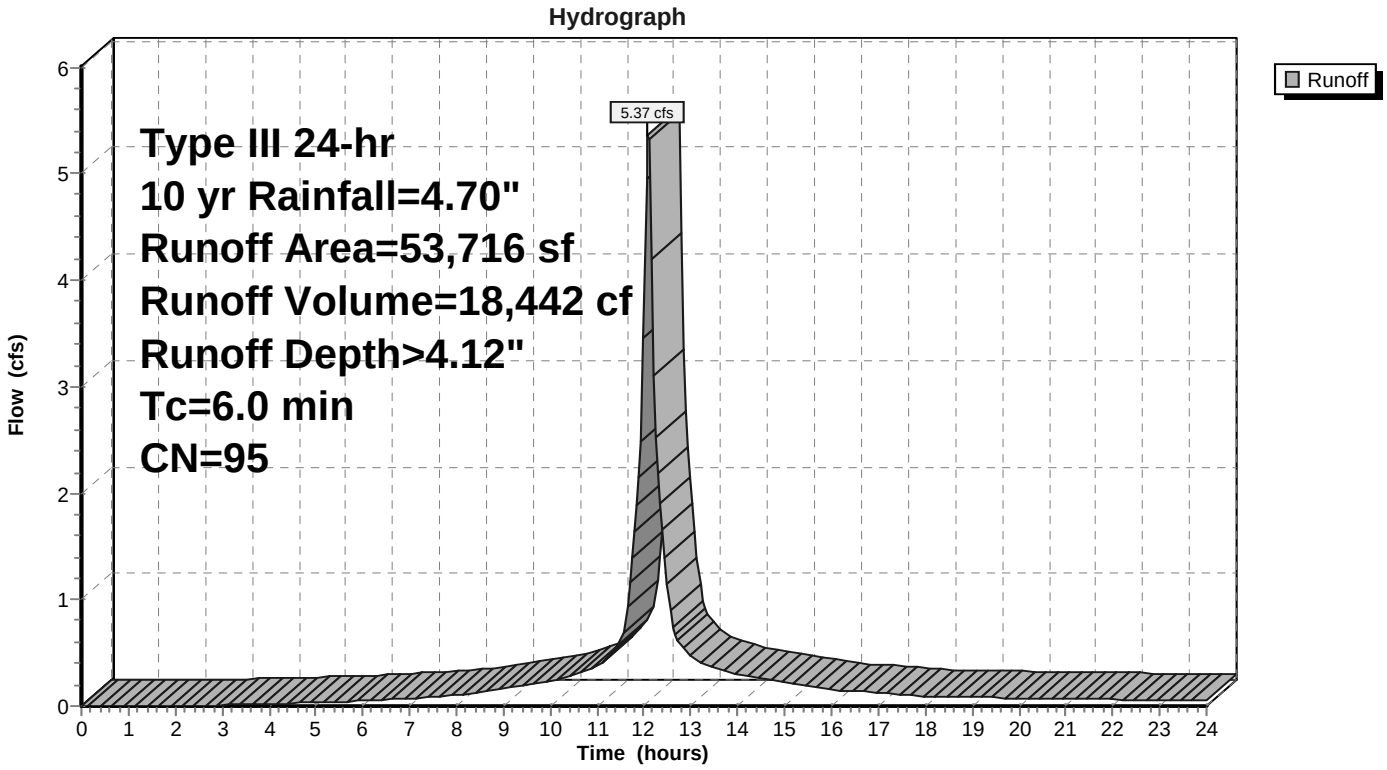
Runoff = 5.37 cfs @ 12.09 hrs, Volume= 18,442 cf, Depth> 4.12"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
45,392	98	Paved roads w/curbs & sewers, HSG C
8,324	79	50-75% Grass cover, Fair, HSG C
53,716	95	Weighted Average
8,324		15.50% Pervious Area
45,392		84.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.
2. For shallow flow, the high point elev is 32 ft and the low point elev is 23 ft.

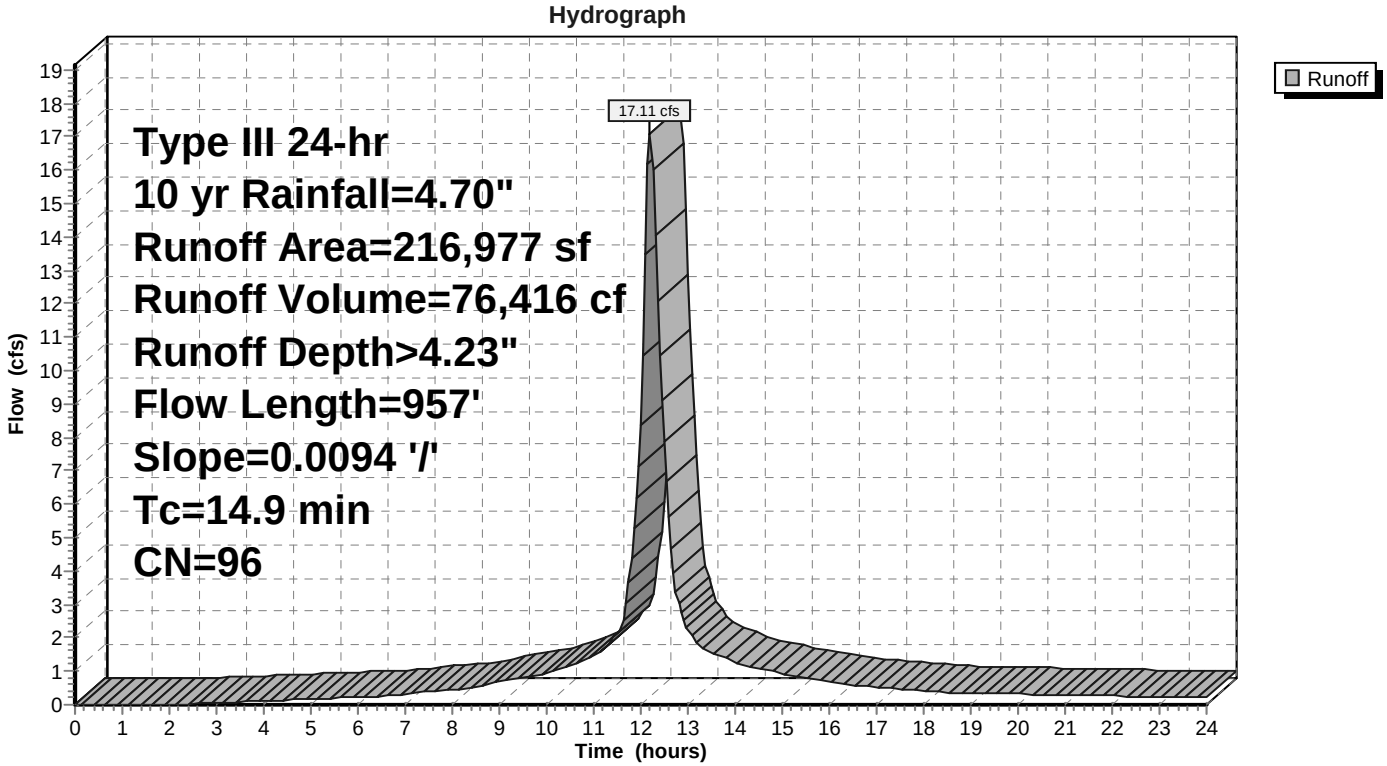
Runoff = 17.11 cfs @ 12.20 hrs, Volume= 76,416 cf, Depth> 4.23"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
192,396	98	Paved roads w/curbs & sewers, HSG C
13,618	79	50-75% Grass cover, Fair, HSG C
10,963	84	50-75% Grass cover, Fair, HSG D
216,977	96	Weighted Average
24,581		11.33% Pervious Area
192,396		88.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: POI 1 - OVERLAND DIRECT Runoff Area=53,716 sf 84.50% Impervious Runoff Depth>5.01"
Tc=6.0 min CN=95 Runoff=6.46 cfs 22,432 cf

Subcatchment 2S: POI 2 - OVERLAND DIRECT Runoff Area=216,977 sf 88.67% Impervious Runoff Depth>5.12"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=96 Runoff=20.52 cfs 92,565 cf

Total Runoff Area = 270,693 sf Runoff Volume = 114,997 cf Average Runoff Depth = 5.10"
12.16% Pervious = 32,905 sf 87.84% Impervious = 237,788 sf

Summary for Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

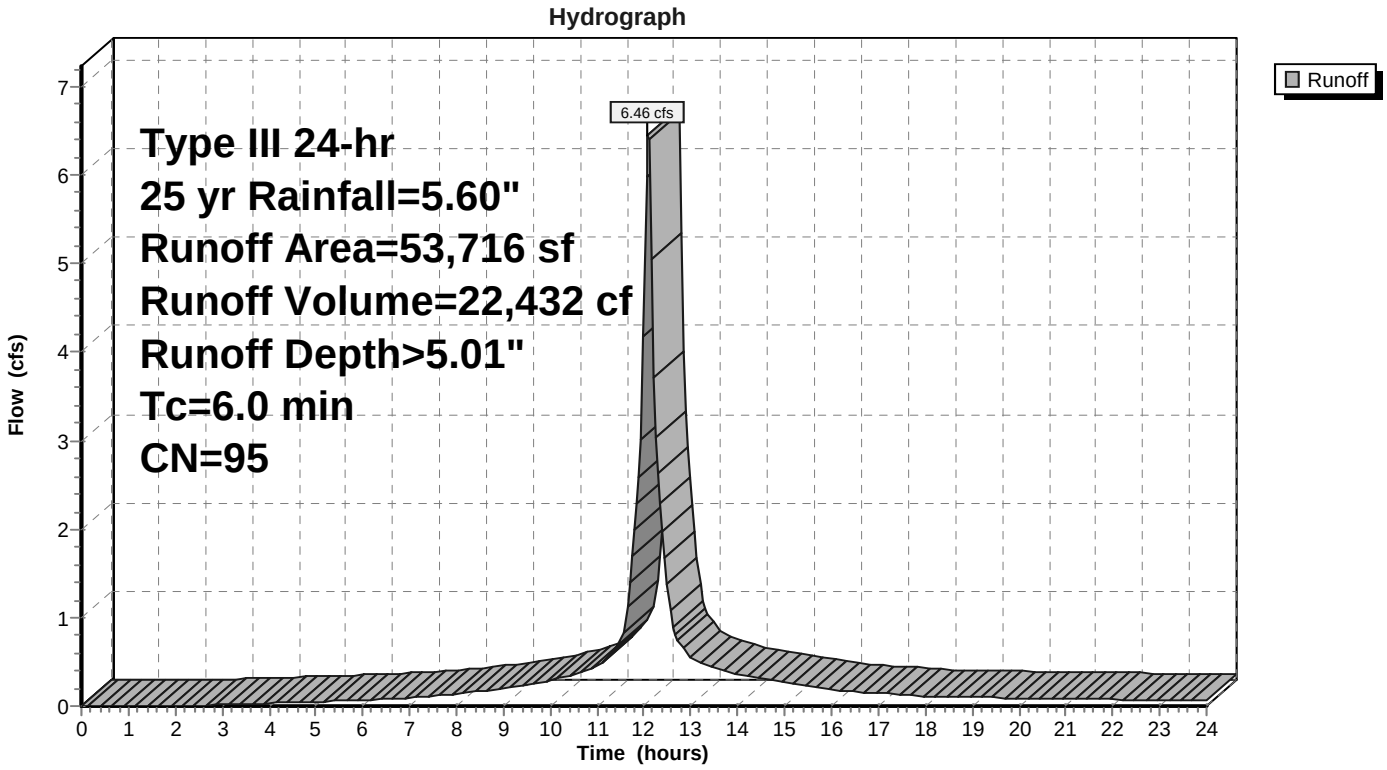
Runoff = 6.46 cfs @ 12.09 hrs, Volume= 22,432 cf, Depth> 5.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
45,392	98	Paved roads w/curbs & sewers, HSG C
8,324	79	50-75% Grass cover, Fair, HSG C
53,716	95	Weighted Average
8,324		15.50% Pervious Area
45,392		84.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.
2. For shallow flow, the high point elev is 32 ft and the low point elev is 23 ft.

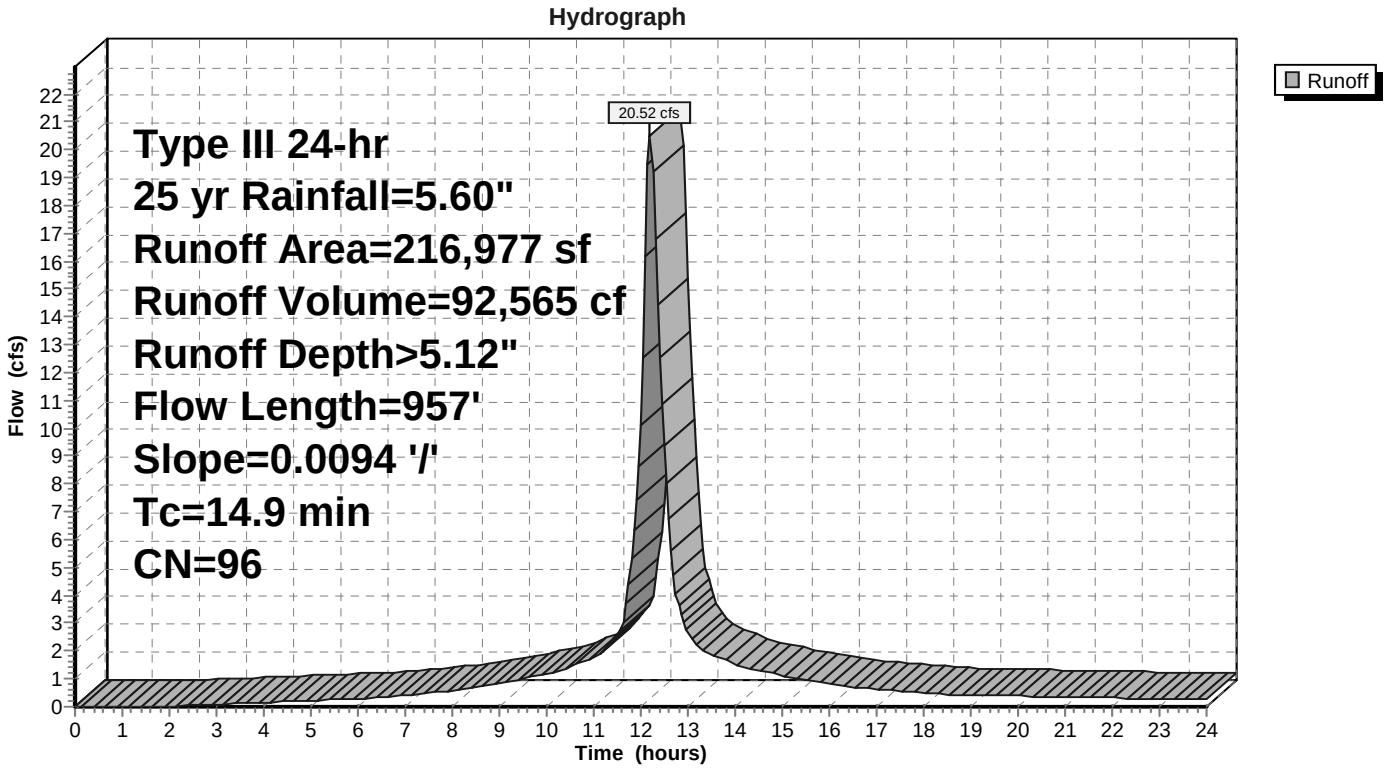
Runoff = 20.52 cfs @ 12.20 hrs, Volume= 92,565 cf, Depth> 5.12"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
192,396	98	Paved roads w/curbs & sewers, HSG C
13,618	79	50-75% Grass cover, Fair, HSG C
10,963	84	50-75% Grass cover, Fair, HSG D
216,977	96	Weighted Average
24,581		11.33% Pervious Area
192,396		88.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: POI 1 - OVERLAND DIRECT Runoff Area=53,716 sf 84.50% Impervious Runoff Depth>5.61"
Tc=6.0 min CN=95 Runoff=7.18 cfs 25,097 cf

Subcatchment 2S: POI 2 - OVERLAND DIRECT Runoff Area=216,977 sf 88.67% Impervious Runoff Depth>5.72"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=96 Runoff=22.80 cfs 103,346 cf

Total Runoff Area = 270,693 sf Runoff Volume = 128,444 cf Average Runoff Depth = 5.69"
12.16% Pervious = 32,905 sf 87.84% Impervious = 237,788 sf

Summary for Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

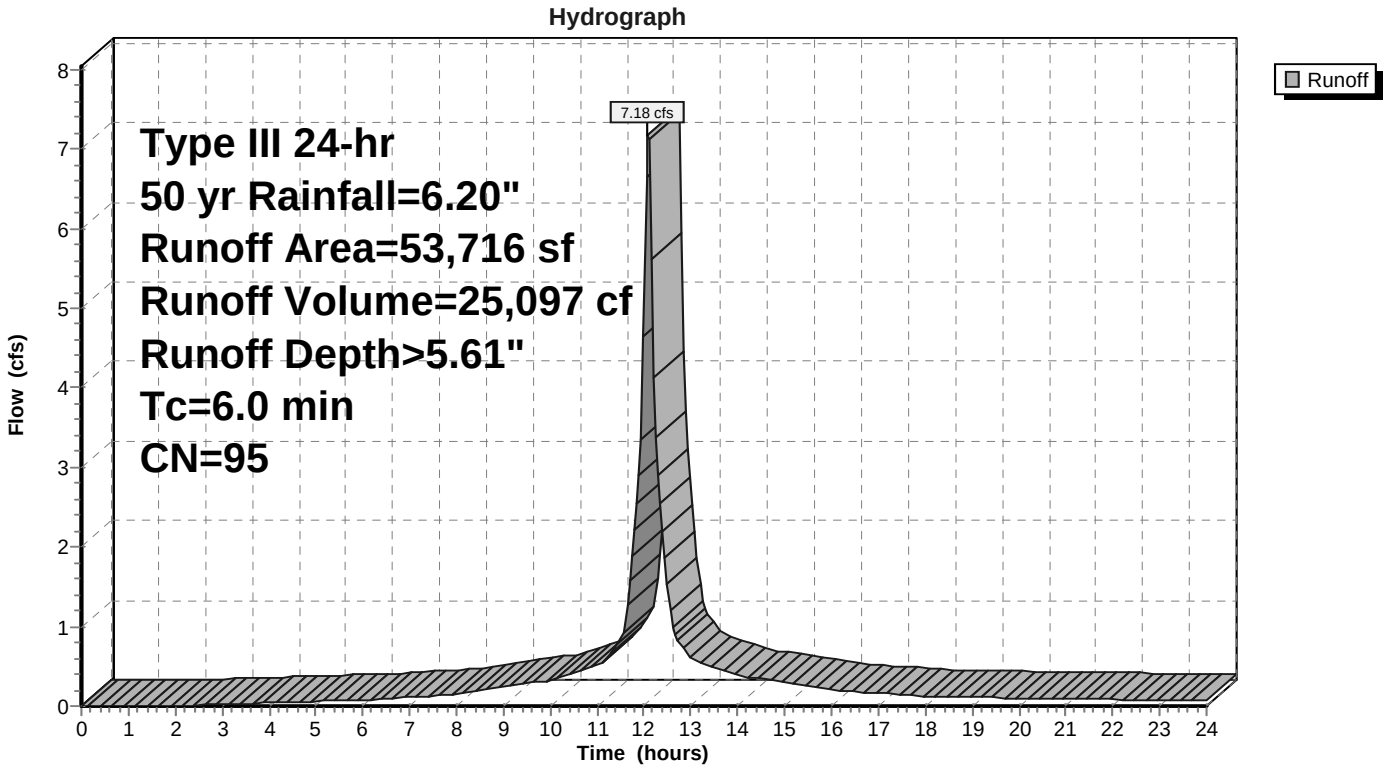
Runoff = 7.18 cfs @ 12.09 hrs, Volume= 25,097 cf, Depth> 5.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=6.20"

Area (sf)	CN	Description
45,392	98	Paved roads w/curbs & sewers, HSG C
8,324	79	50-75% Grass cover, Fair, HSG C
53,716	95	Weighted Average
8,324		15.50% Pervious Area
45,392		84.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.
2. For shallow flow, the high point elev is 32 ft and the low point elev is 23 ft.

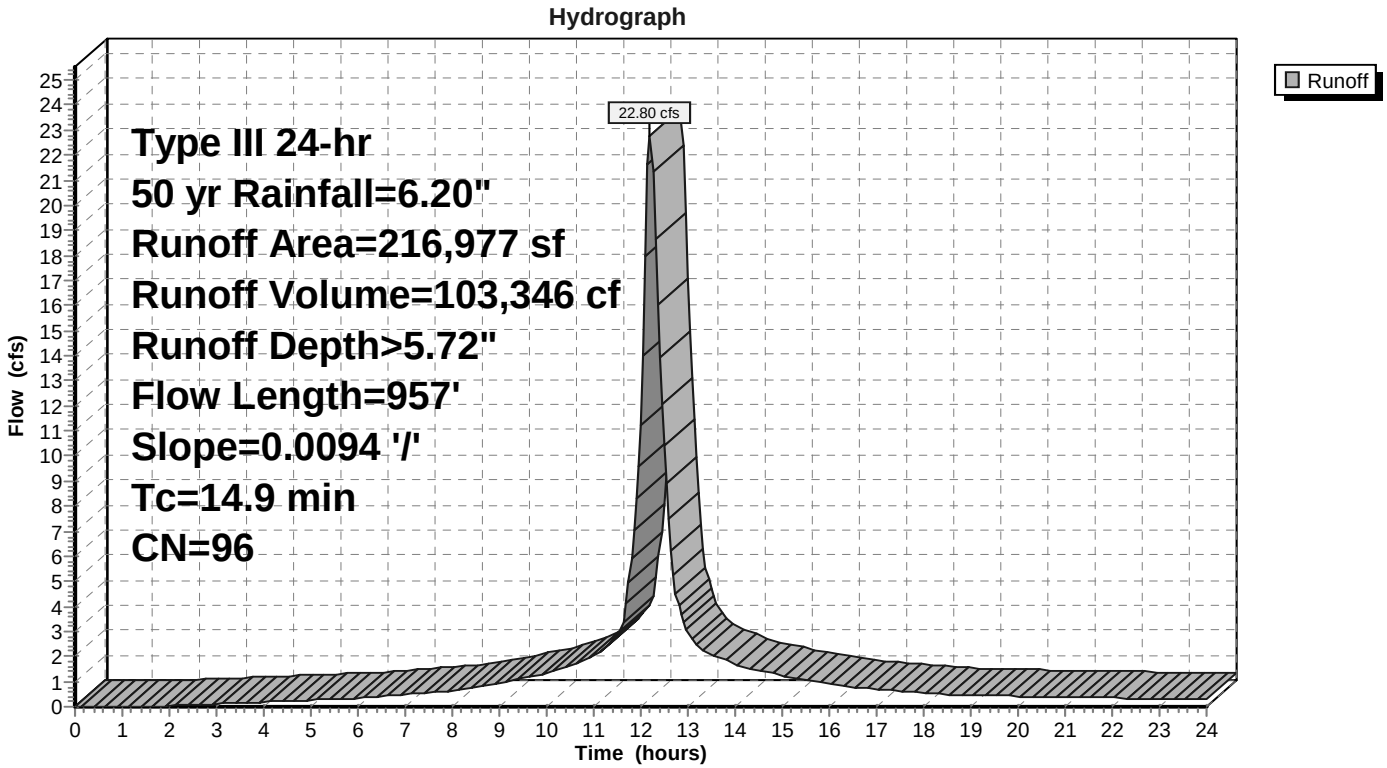
Runoff = 22.80 cfs @ 12.20 hrs, Volume= 103,346 cf, Depth> 5.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=6.20"

Area (sf)	CN	Description
192,396	98	Paved roads w/curbs & sewers, HSG C
13,618	79	50-75% Grass cover, Fair, HSG C
10,963	84	50-75% Grass cover, Fair, HSG D
216,977	96	Weighted Average
24,581		11.33% Pervious Area
192,396		88.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: POI 1 - OVERLAND DIRECT Runoff Area=53,716 sf 84.50% Impervious Runoff Depth>6.30"
Tc=6.0 min CN=95 Runoff=8.02 cfs 28,211 cf

Subcatchment 2S: POI 2 - OVERLAND DIRECT Runoff Area=216,977 sf 88.67% Impervious Runoff Depth>6.41"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=96 Runoff=25.44 cfs 115,934 cf

Total Runoff Area = 270,693 sf Runoff Volume = 144,145 cf Average Runoff Depth = 6.39"
12.16% Pervious = 32,905 sf 87.84% Impervious = 237,788 sf

Summary for Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

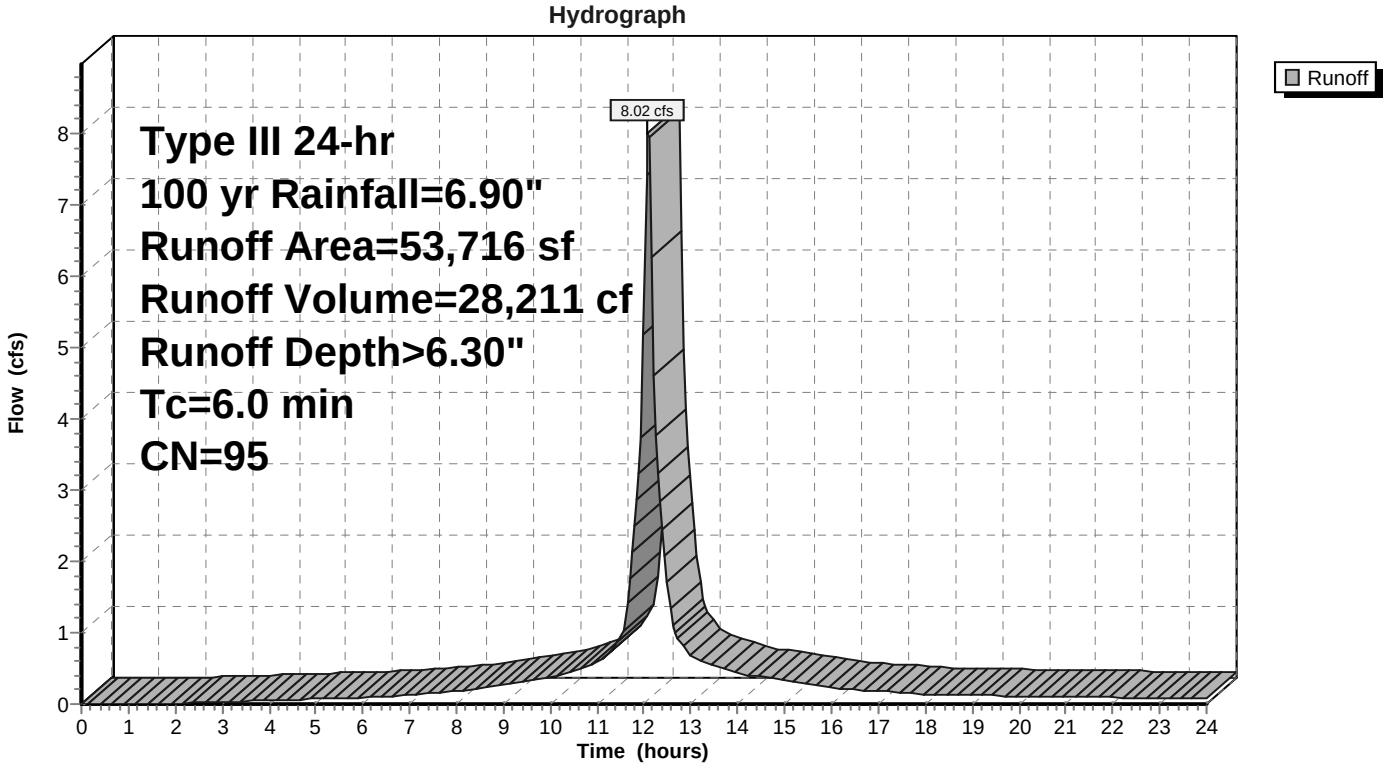
Runoff = 8.02 cfs @ 12.09 hrs, Volume= 28,211 cf, Depth> 6.30"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.90"

Area (sf)	CN	Description
45,392	98	Paved roads w/curbs & sewers, HSG C
8,324	79	50-75% Grass cover, Fair, HSG C
53,716	95	Weighted Average
8,324		15.50% Pervious Area
45,392		84.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1S: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.
2. For shallow flow, the high point elev is 32 ft and the low point elev is 23 ft.

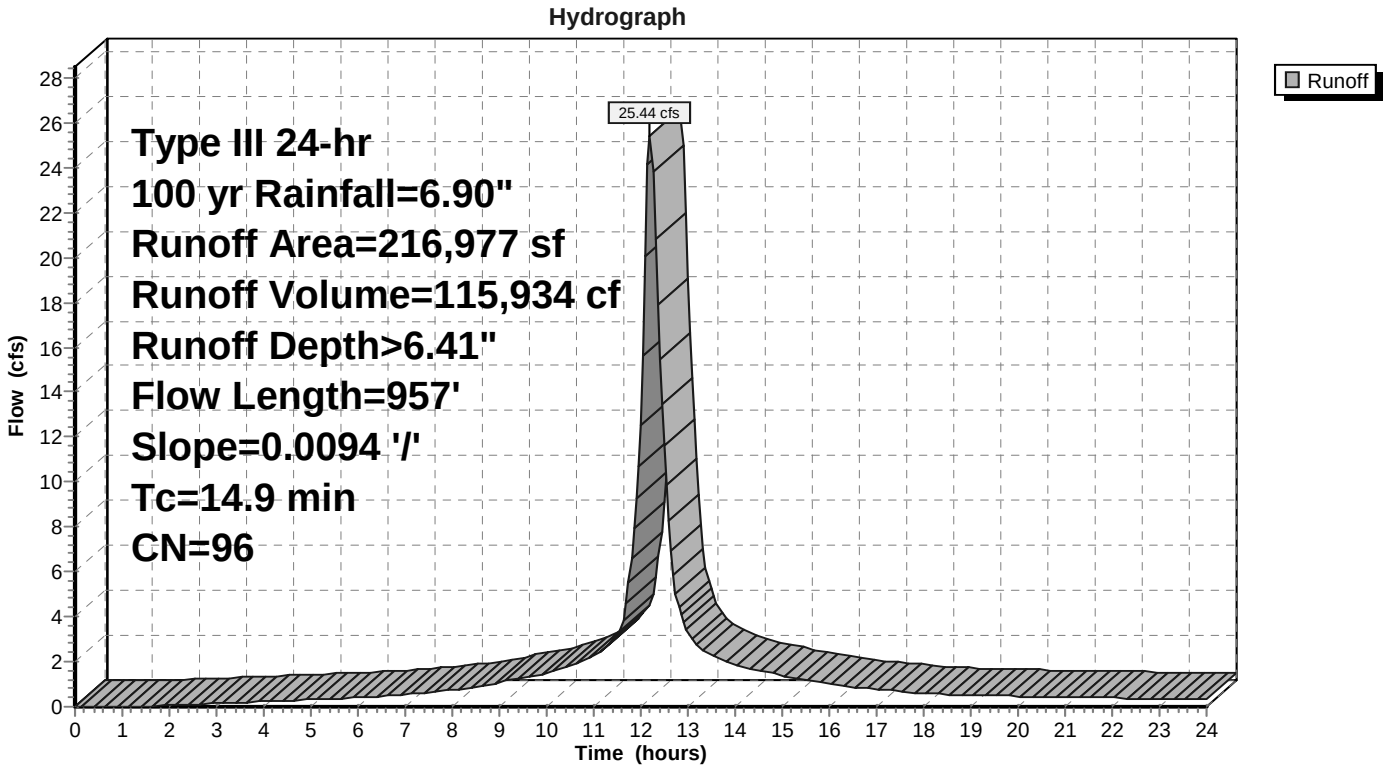
Runoff = 25.44 cfs @ 12.20 hrs, Volume= 115,934 cf, Depth> 6.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.90"

Area (sf)	CN	Description
192,396	98	Paved roads w/curbs & sewers, HSG C
13,618	79	50-75% Grass cover, Fair, HSG C
10,963	84	50-75% Grass cover, Fair, HSG D
216,977	96	Weighted Average
24,581		11.33% Pervious Area
192,396		88.67% Impervious Area

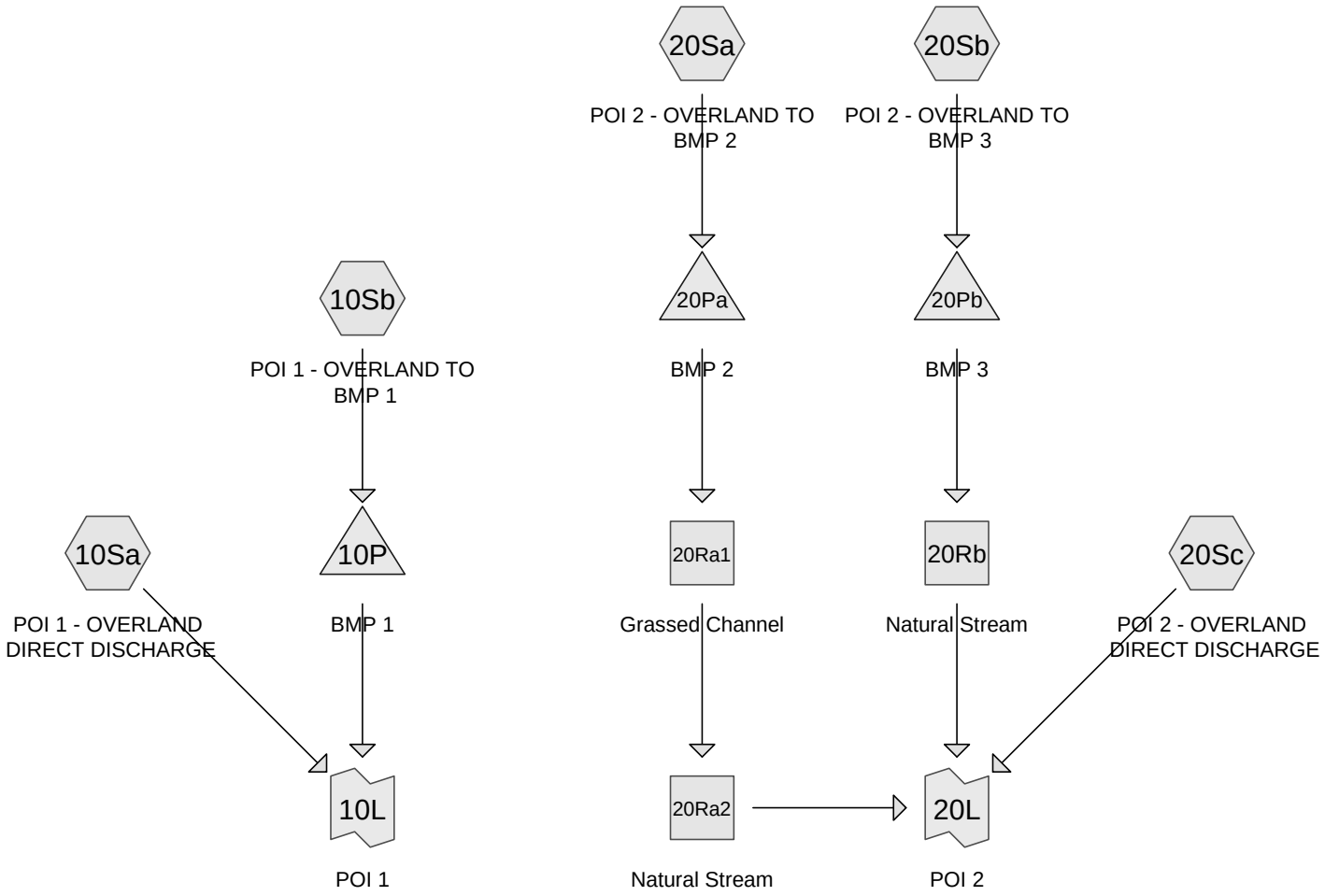
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 2S: POI 2 - OVERLAND DIRECT DISCHARGE



PROPOSED CONDITIONS

ROUTES 140/24 IMPROVEMENTS



Subcat Reach Pond Link

Routing Diagram for TAUNTON RTE 140 POST DEVELOPMENT
Prepared by Fay, Spofford & Thorndike, Printed 12/13/2012

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT Runoff Area=22,947 sf 100.00% Impervious Runoff Depth>3.07"
Tc=6.0 min CN=98 Runoff=1.65 cfs 5,861 cf

Subcatchment 10Sb: POI 1 - OVERLAND TO Runoff Area=30,768 sf 100.00% Impervious Runoff Depth>3.07"
Tc=6.0 min CN=98 Runoff=2.21 cfs 7,859 cf

Subcatchment 20Sa: POI 2 - OVERLAND TO Runoff Area=68,209 sf 100.00% Impervious Runoff Depth>3.07"
Tc=6.0 min CN=98 Runoff=4.90 cfs 17,423 cf

Subcatchment 20Sb: POI 2 - OVERLAND TO Runoff Area=19,523 sf 100.00% Impervious Runoff Depth>3.07"
Tc=6.0 min CN=98 Runoff=1.40 cfs 4,987 cf

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT Runoff Area=129,249 sf 98.50% Impervious Runoff Depth>3.06"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=98 Runoff=7.24 cfs 32,972 cf

Reach 20Ra1: Grassed Channel Avg. Flow Depth=0.19' Max Vel=2.38 fps Inflow=2.54 cfs 14,340 cf
n=0.022 L=436.0' S=0.0161 '/' Capacity=16.40 cfs Outflow=2.46 cfs 14,297 cf

Reach 20Ra2: Natural Stream Avg. Flow Depth=0.22' Max Vel=1.05 fps Inflow=2.46 cfs 14,297 cf
n=0.040 L=600.0' S=0.0100 '/' Capacity=12.48 cfs Outflow=2.15 cfs 14,174 cf

Reach 20Rb: Natural Stream Avg. Flow Depth=0.12' Max Vel=0.85 fps Inflow=1.04 cfs 4,314 cf
n=0.040 L=1,006.0' S=0.0129 '/' Capacity=14.18 cfs Outflow=0.75 cfs 4,231 cf

Pond 10P: BMP 1 Peak Elev=38.44' Storage=1,527 cf Inflow=2.21 cfs 7,859 cf
Outflow=1.48 cfs 7,105 cf

Pond 20Pa: BMP 2 Peak Elev=38.89' Storage=6,114 cf Inflow=4.90 cfs 17,423 cf
Outflow=2.54 cfs 14,340 cf

Pond 20Pb: BMP 3 Peak Elev=39.72' Storage=1,150 cf Inflow=1.40 cfs 4,987 cf
Outflow=1.04 cfs 4,314 cf

Link 10L: POI 1 Inflow=3.00 cfs 12,967 cf
Primary=3.00 cfs 12,967 cf

Link 20L: POI 2 Inflow=8.35 cfs 51,377 cf
Primary=8.35 cfs 51,377 cf

Total Runoff Area = 270,696 sf Runoff Volume = 69,103 cf Average Runoff Depth = 3.06"
0.72% Pervious = 1,937 sf 99.28% Impervious = 268,759 sf

Summary for Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

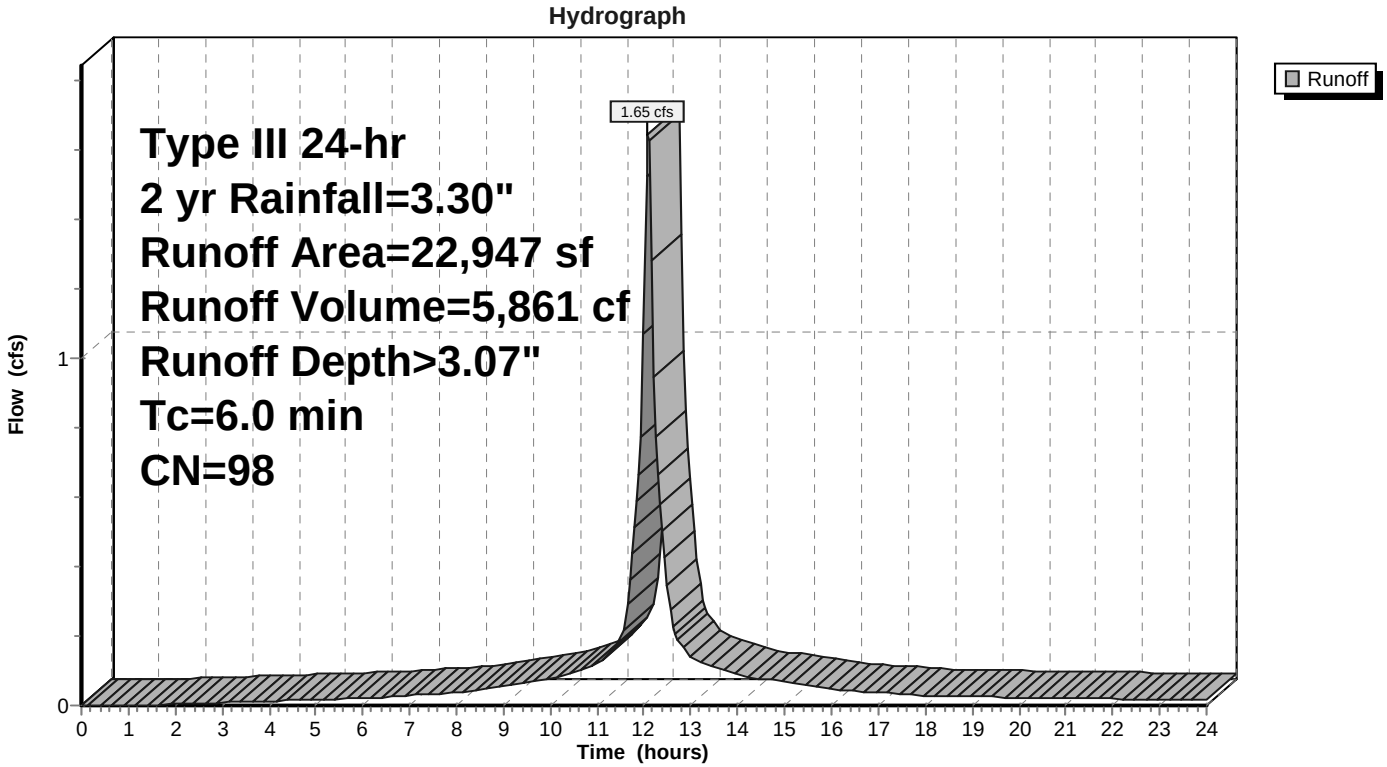
Runoff = 1.65 cfs @ 12.09 hrs, Volume= 5,861 cf, Depth> 3.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.30"

Area (sf)	CN	Description
22,947	98	Paved roads w/curbs & sewers, HSG C
22,947		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1

1. For pavements, Tc assumed to be 5 minutes.

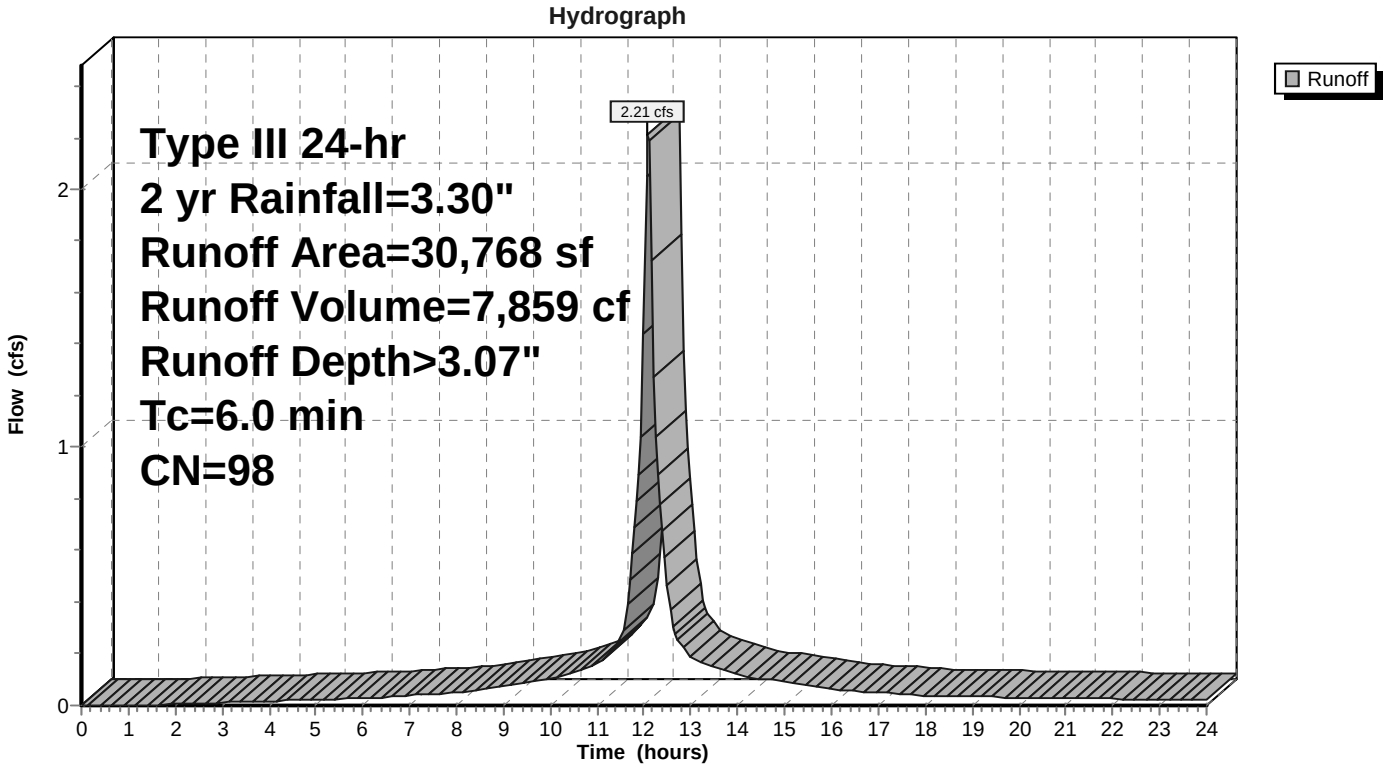
Runoff = 2.21 cfs @ 12.09 hrs, Volume= 7,859 cf, Depth> 3.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.30"

Area (sf)	CN	Description
30,768	98	Paved roads w/curbs & sewers, HSG C
30,768		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1



Summary for Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2

1. For pavements, Tc assumed to be 5 minutes.

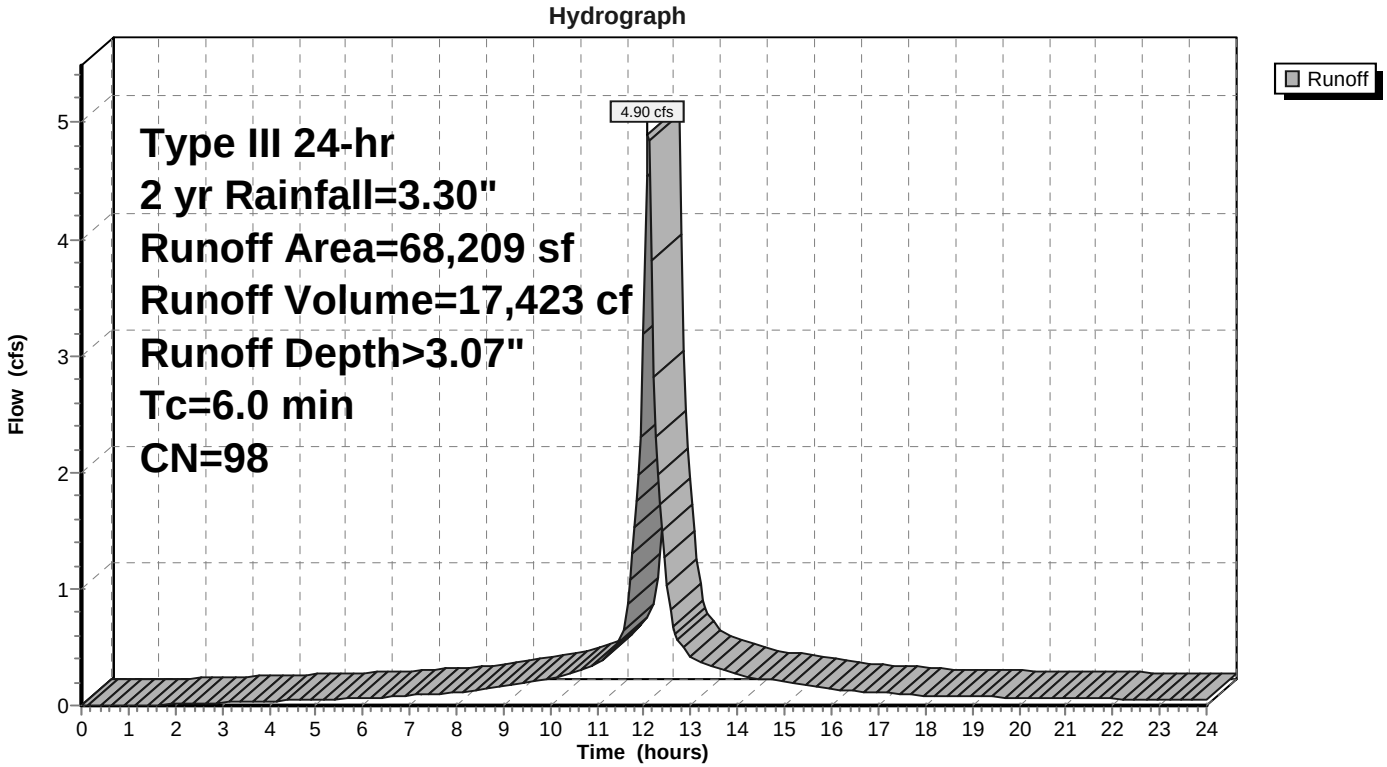
Runoff = 4.90 cfs @ 12.09 hrs, Volume= 17,423 cf, Depth> 3.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.30"

Area (sf)	CN	Description
68,209	98	Paved roads w/curbs & sewers, HSG C
68,209		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2



Summary for Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3

1. For pavements, Tc assumed to be 5 minutes.

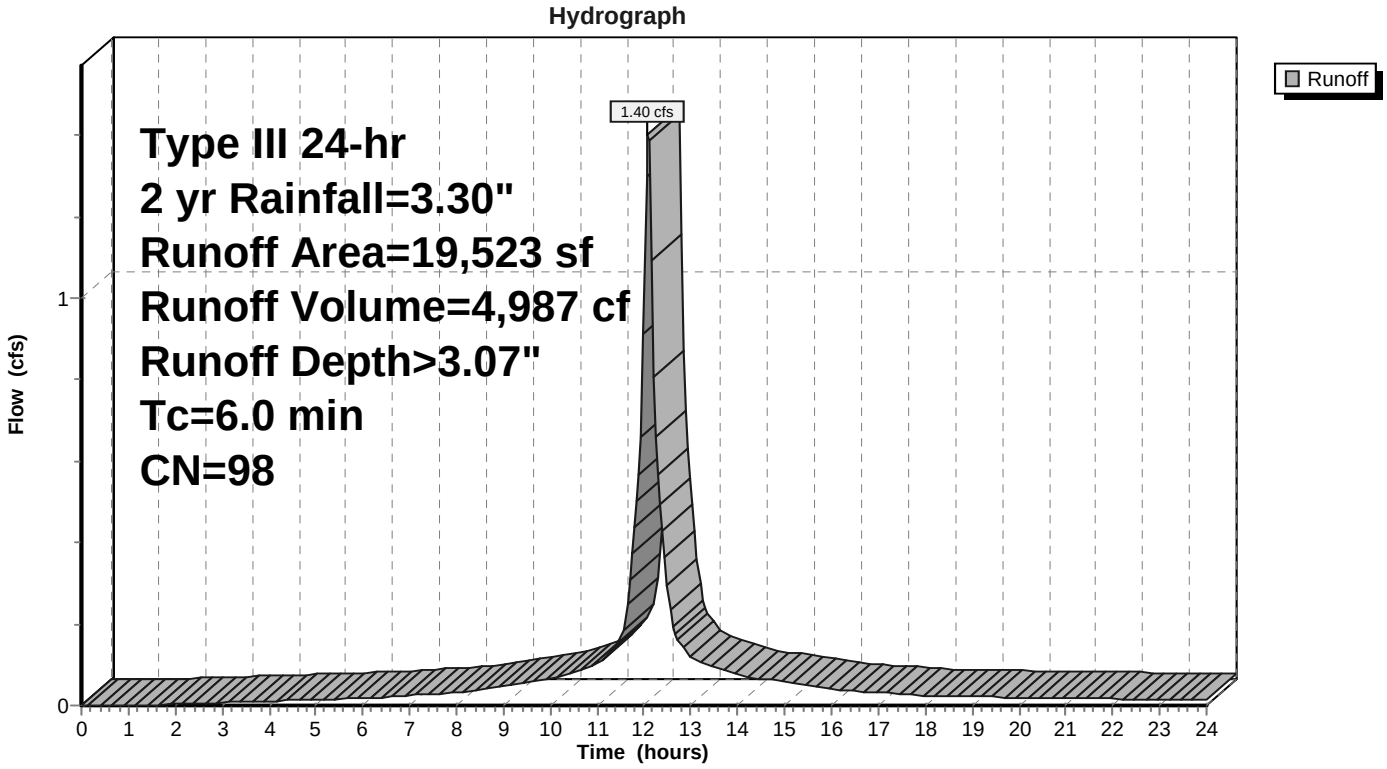
Runoff = 1.40 cfs @ 12.09 hrs, Volume= 4,987 cf, Depth> 3.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.30"

Area (sf)	CN	Description
19,523	98	Paved roads w/curbs & sewers, HSG C
19,523		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3



Summary for Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

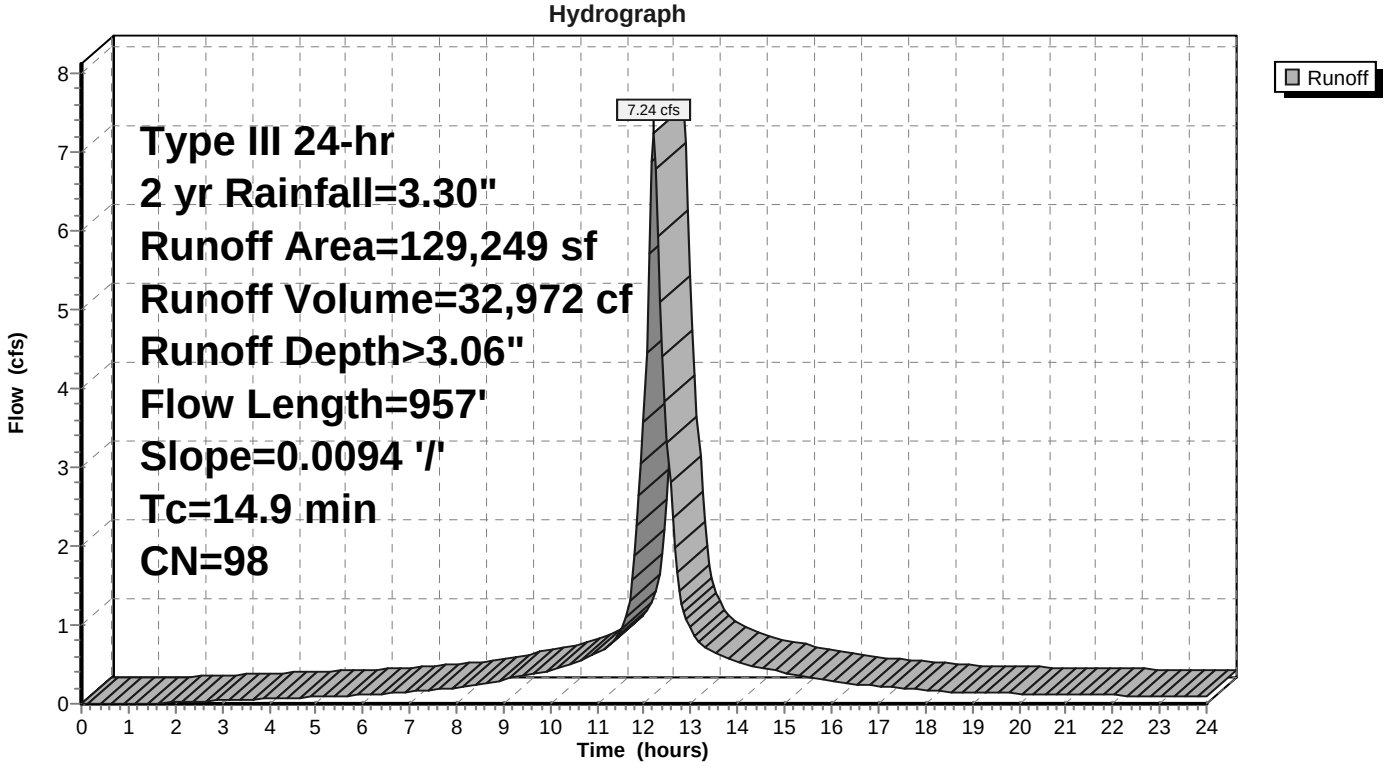
Runoff = 7.24 cfs @ 12.20 hrs, Volume= 32,972 cf, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.30"

Area (sf)	CN	Description
127,312	98	Paved roads w/curbs & sewers, HSG C
1,937	79	50-75% Grass cover, Fair, HSG C
129,249	98	Weighted Average
1,937		1.50% Pervious Area
127,312		98.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE



Summary for Reach 20Ra1: Grassed Channel

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 2.52" for 2 yr event
Inflow = 2.54 cfs @ 12.23 hrs, Volume= 14,340 cf
Outflow = 2.46 cfs @ 12.32 hrs, Volume= 14,297 cf, Atten= 3%, Lag= 5.2 min

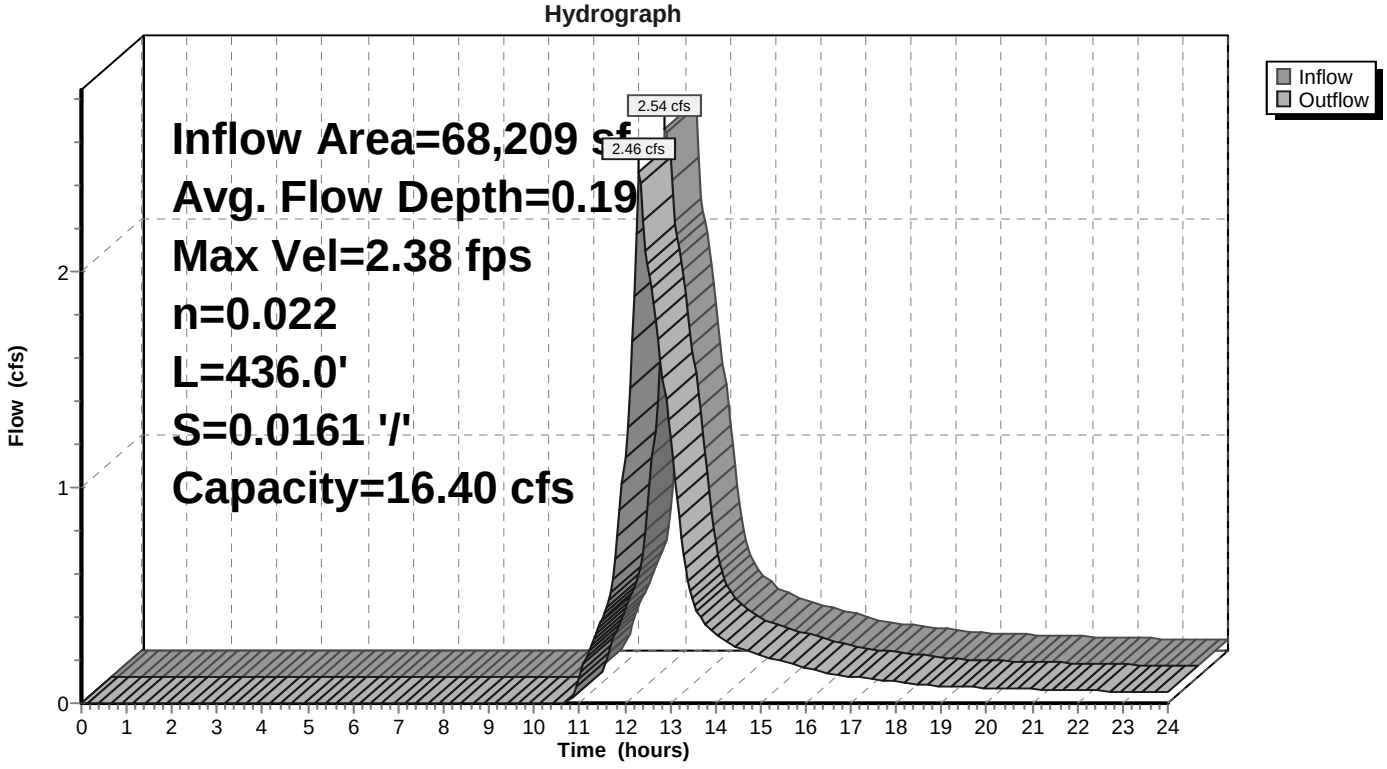
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.38 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 7.5 min

Peak Storage= 450 cf @ 12.27 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 16.40 cfs

4.00' x 0.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 8.0 '/' Top Width= 12.00'
Length= 436.0' Slope= 0.0161 '/'
Inlet Invert= 36.00', Outlet Invert= 29.00'

‡

Reach 20Ra1: Grassed Channel



Summary for Reach 20Ra2: Natural Stream

[62] Hint: Exceeded Reach 20Ra1 OUTLET depth by 0.06' @ 13.20 hrs

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 2.52" for 2 yr event
Inflow = 2.46 cfs @ 12.32 hrs, Volume= 14,297 cf
Outflow = 2.15 cfs @ 12.60 hrs, Volume= 14,174 cf, Atten= 13%, Lag= 16.8 min

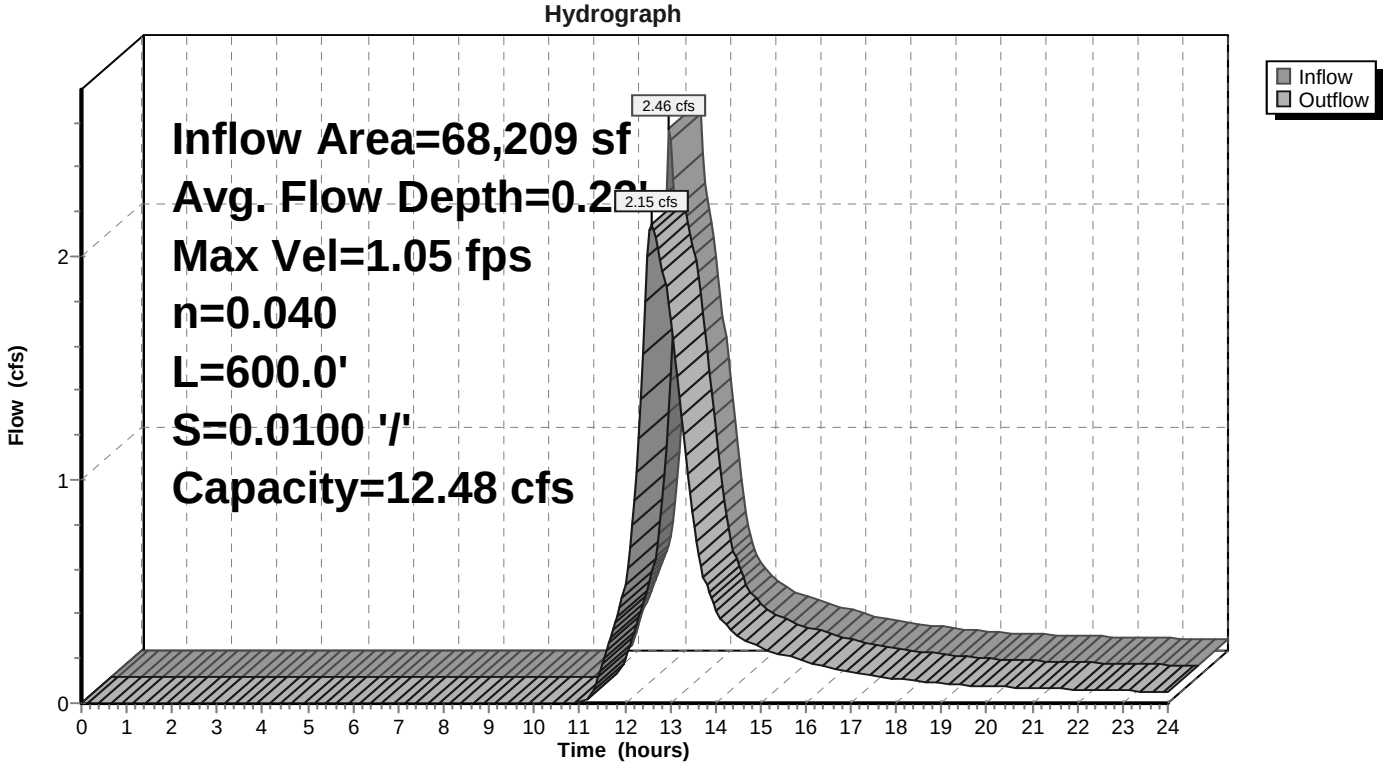
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.05 fps, Min. Travel Time= 9.6 min
Avg. Velocity = 0.49 fps, Avg. Travel Time= 20.6 min

Peak Storage= 1,234 cf @ 12.43 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 12.48 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 600.0' Slope= 0.0100 '/'
Inlet Invert= 29.00', Outlet Invert= 23.00'

‡

Reach 20Ra2: Natural Stream



Summary for Reach 20Rb: Natural Stream

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 2.65" for 2 yr event
Inflow = 1.04 cfs @ 12.16 hrs, Volume= 4,314 cf
Outflow = 0.75 cfs @ 12.67 hrs, Volume= 4,231 cf, Atten= 29%, Lag= 30.6 min

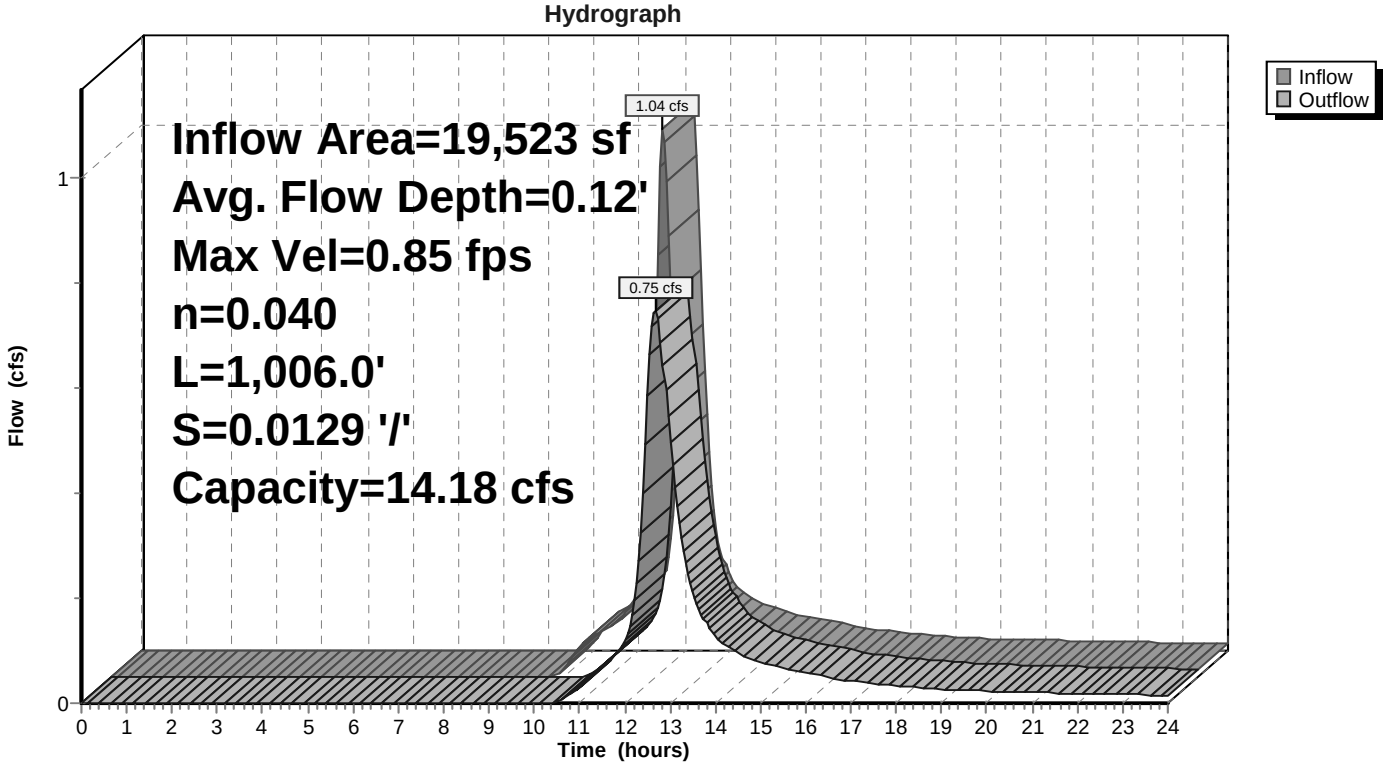
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.85 fps, Min. Travel Time= 19.8 min
Avg. Velocity = 0.35 fps, Avg. Travel Time= 48.1 min

Peak Storage= 887 cf @ 12.34 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 14.18 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 1,006.0' Slope= 0.0129 '/'
Inlet Invert= 36.00', Outlet Invert= 23.00'

‡

Reach 20Rb: Natural Stream



Summary for Pond 10P: BMP 1

Inflow Area = 30,768 sf,100.00% Impervious, Inflow Depth > 3.07" for 2 yr event
Inflow = 2.21 cfs @ 12.09 hrs, Volume= 7,859 cf
Outflow = 1.48 cfs @ 12.18 hrs, Volume= 7,105 cf, Atten= 33%, Lag= 5.5 min
Primary = 1.48 cfs @ 12.18 hrs, Volume= 7,105 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 38.44' @ 12.18 hrs Surf.Area= 922 sf Storage= 1,527 cf

Plug-Flow detention time= 92.9 min calculated for 7,105 cf (90% of inflow)
Center-of-Mass det. time= 45.4 min (800.7 - 755.3)

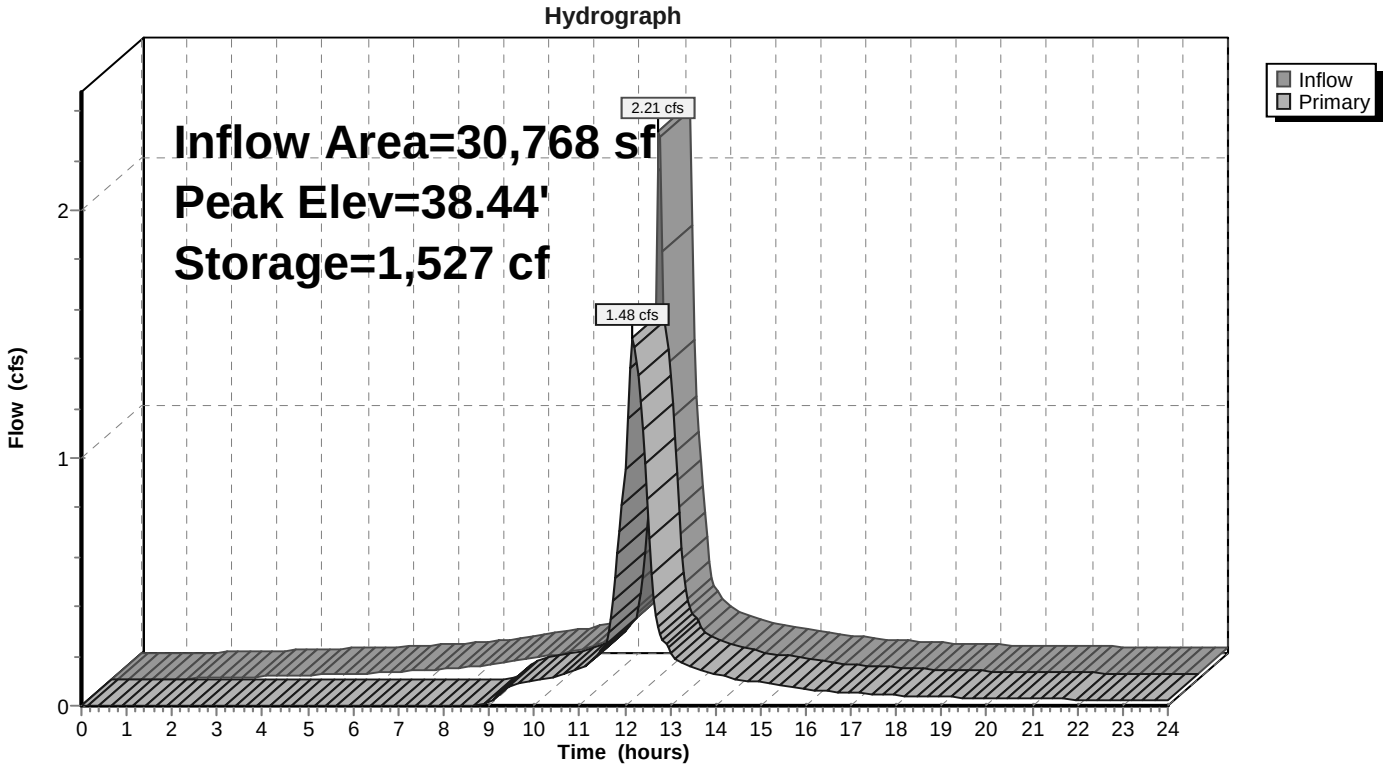
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	3,463 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
35.00	110	0	0	110
36.00	257	178	178	264
37.00	476	361	539	493
38.00	768	616	1,156	798
39.00	1,139	947	2,103	1,185
40.00	1,593	1,360	3,463	1,657

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 172.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 35.28' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.33'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	39.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.47 cfs @ 12.18 hrs HW=38.43' (Free Discharge)
└**1=RCP_Round 12"** (Passes 1.47 cfs of 3.65 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 1.47 cfs @ 4.22 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 10P: BMP 1



Summary for Pond 20Pa: BMP 2

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 3.07" for 2 yr event
Inflow = 4.90 cfs @ 12.09 hrs, Volume= 17,423 cf
Outflow = 2.54 cfs @ 12.23 hrs, Volume= 14,340 cf, Atten= 48%, Lag= 8.9 min
Primary = 2.54 cfs @ 12.23 hrs, Volume= 14,340 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 38.89' @ 12.23 hrs Surf.Area= 2,007 sf Storage= 6,114 cf

Plug-Flow detention time= 142.8 min calculated for 14,311 cf (82% of inflow)
Center-of-Mass det. time= 73.2 min (828.5 - 755.3)

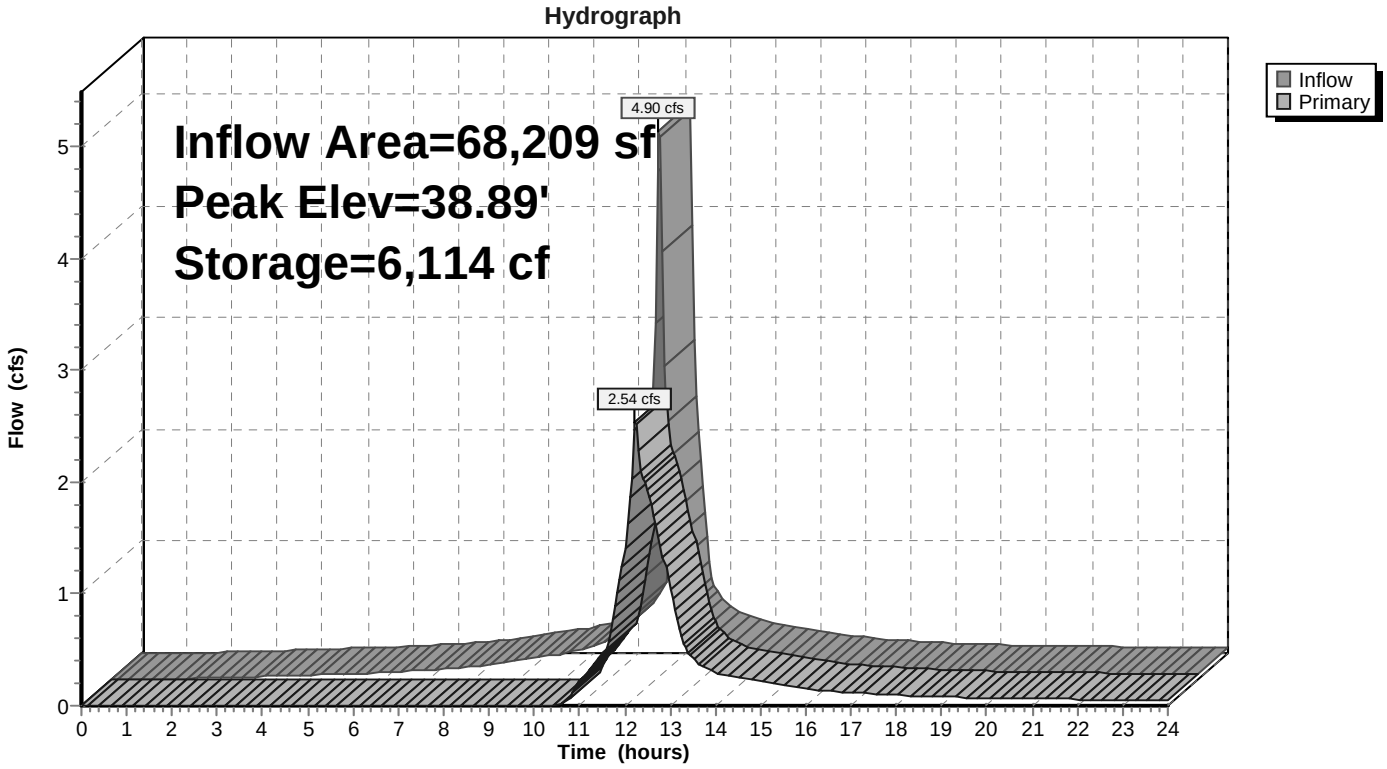
Volume	Invert	Avail.Storage	Storage Description
#1	34.00'	8,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
34.00	612	0	0	612
35.00	837	722	722	856
36.00	1,094	963	1,684	1,136
37.00	1,384	1,236	2,920	1,451
38.00	1,703	1,541	4,461	1,799
39.00	2,046	1,872	6,333	2,175
40.00	2,414	2,227	8,560	2,579

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 50.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 36.50' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	38.83'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	39.50'	**8.0' 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=2.47 cfs @ 12.23 hrs HW=38.89' (Free Discharge)
- **1=RCP_Round 12"** (Passes 2.47 cfs of 4.41 cfs potential flow)
  - **2=Orifice/Grate** (Orifice Controls 2.10 cfs @ 6.00 fps)
  - **3=Orifice/Grate** (Weir Controls 0.37 cfs @ 0.79 fps)
- **4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 20Pa: BMP 2



Summary for Pond 20Pb: BMP 3

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 3.07" for 2 yr event
Inflow = 1.40 cfs @ 12.09 hrs, Volume= 4,987 cf
Outflow = 1.04 cfs @ 12.16 hrs, Volume= 4,314 cf, Atten= 26%, Lag= 4.5 min
Primary = 1.04 cfs @ 12.16 hrs, Volume= 4,314 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.72' @ 12.16 hrs Surf.Area= 843 sf Storage= 1,150 cf

Plug-Flow detention time= 116.5 min calculated for 4,314 cf (87% of inflow)
Center-of-Mass det. time= 56.7 min (812.1 - 755.3)

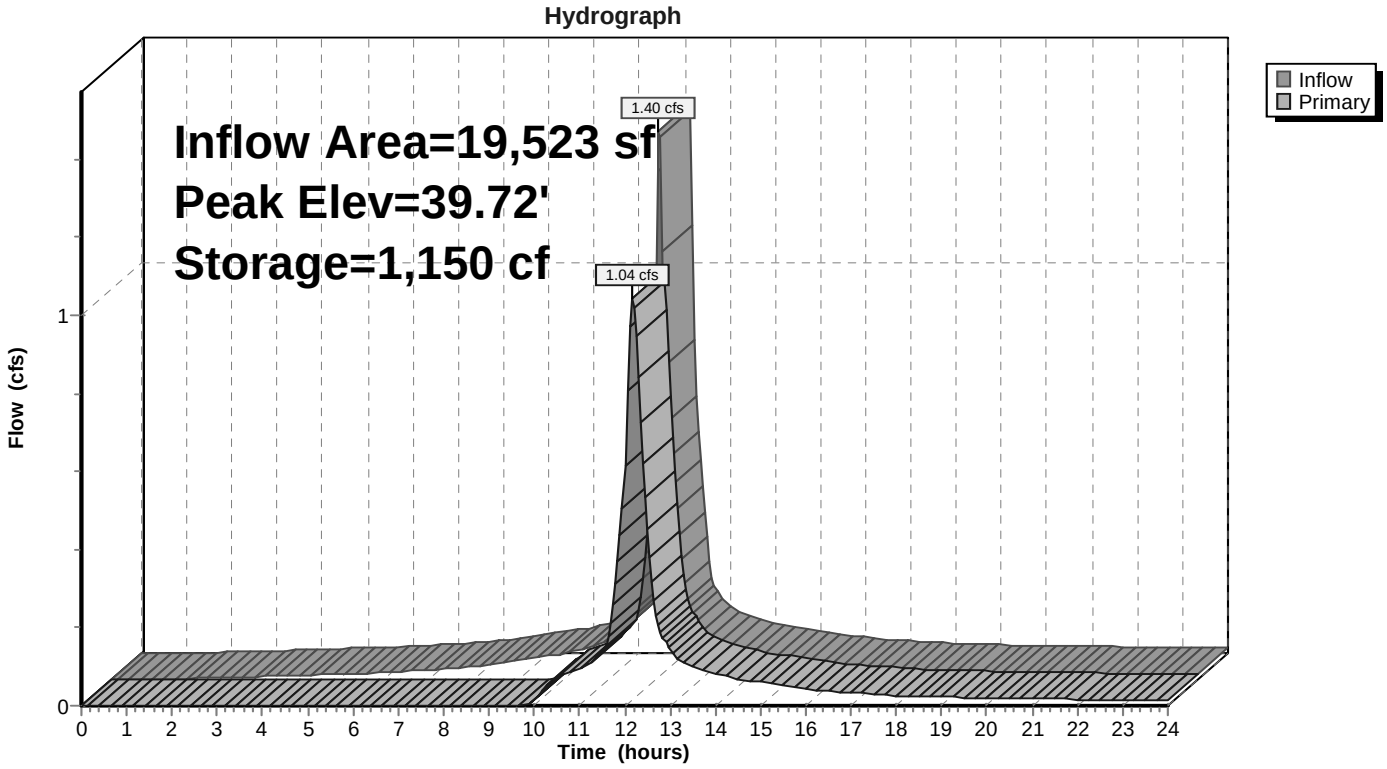
Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	2,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
37.00	111	0	0	111
38.00	303	199	199	309
39.00	590	439	638	606
40.00	954	765	1,402	983
41.00	1,373	1,157	2,560	1,419

Device	Routing	Invert	Outlet Devices
#1	Primary	39.00'	**12.0" Round RCP_Round 12"** L= 81.7' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 39.00' / 38.00' S= 0.0122 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	39.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	40.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.04 cfs @ 12.16 hrs HW=39.71' (Free Discharge)
└**1=RCP_Round 12"** (Passes 1.04 cfs of 1.72 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 1.04 cfs @ 2.97 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 20Pb: BMP 3

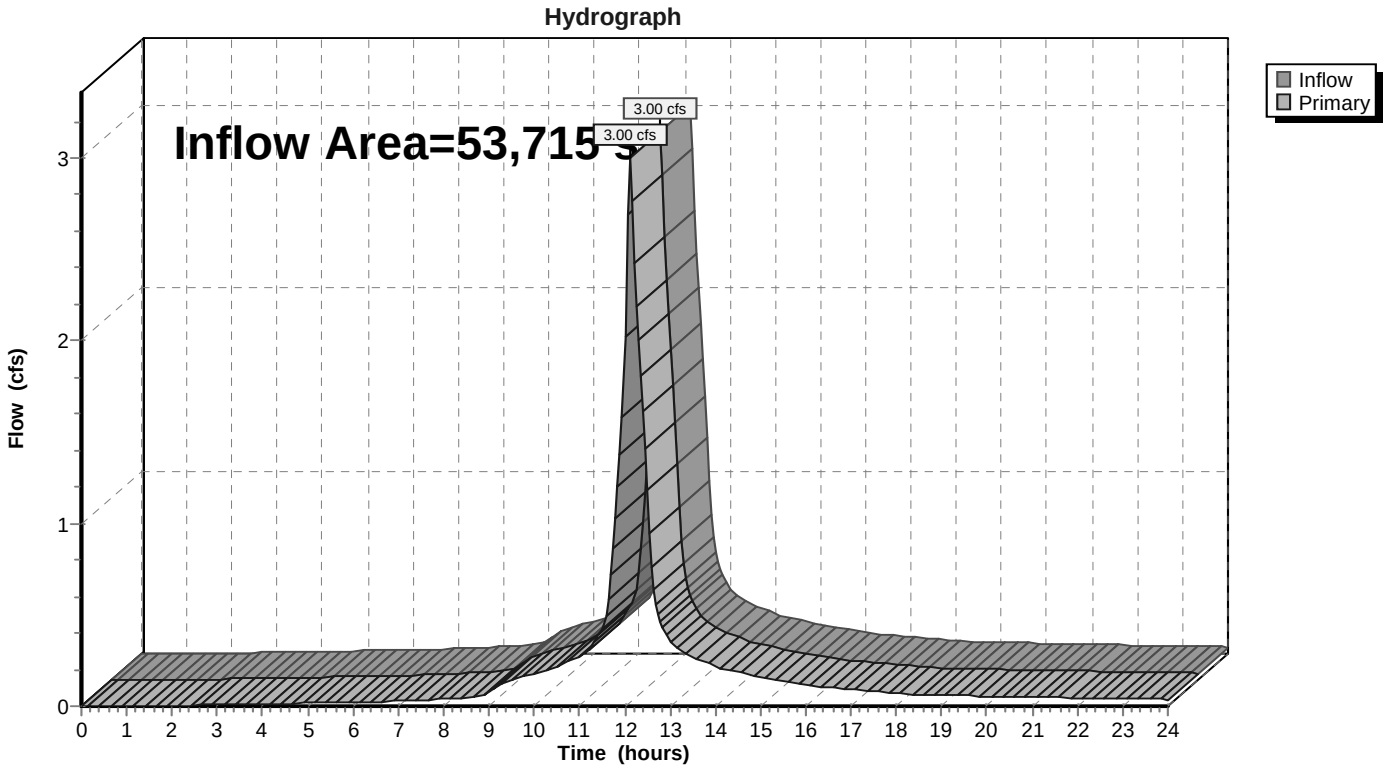


Summary for Link 10L: POI 1

Inflow Area = 53,715 sf,100.00% Impervious, Inflow Depth > 2.90" for 2 yr event
Inflow = 3.00 cfs @ 12.10 hrs, Volume= 12,967 cf
Primary = 3.00 cfs @ 12.10 hrs, Volume= 12,967 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 10L: POI 1

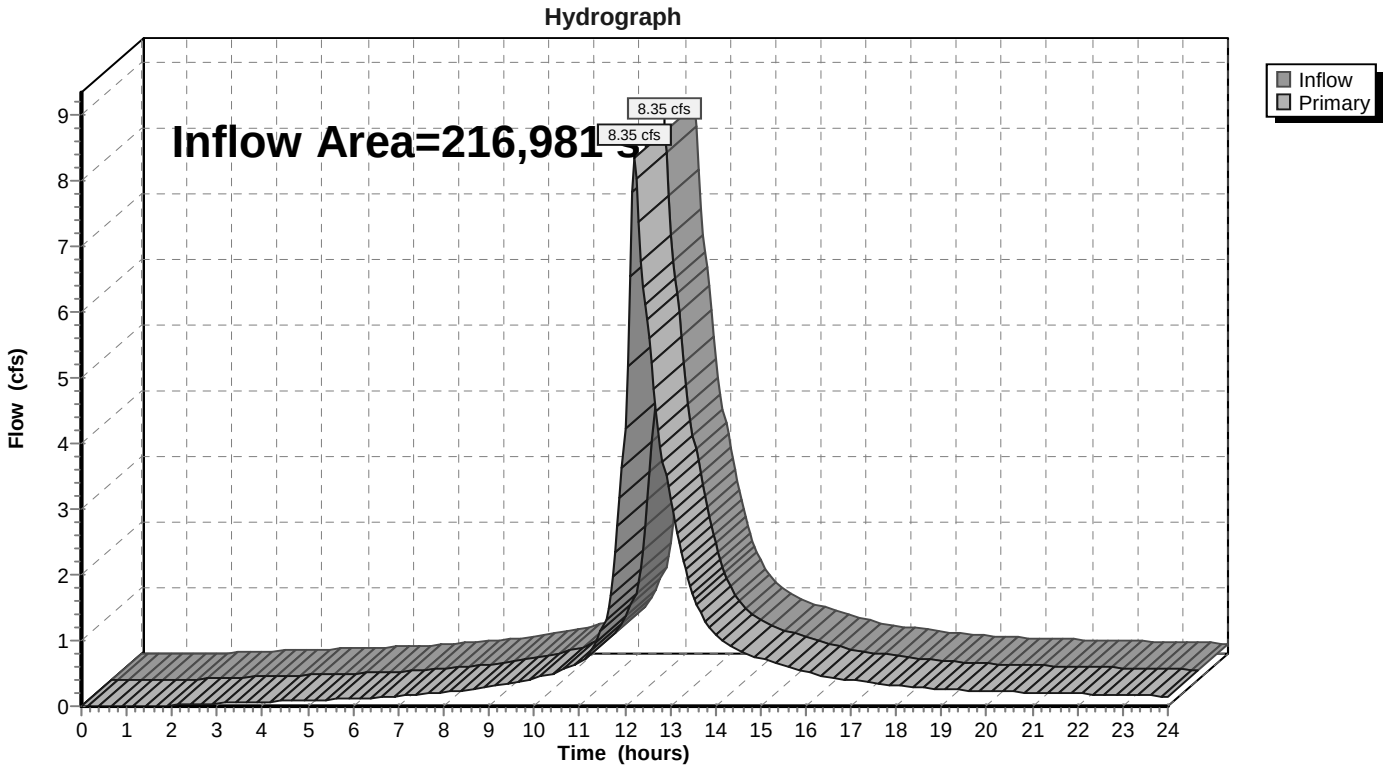


Summary for Link 20L: POI 2

Inflow Area = 216,981 sf, 99.11% Impervious, Inflow Depth > 2.84" for 2 yr event
Inflow = 8.35 cfs @ 12.21 hrs, Volume= 51,377 cf
Primary = 8.35 cfs @ 12.21 hrs, Volume= 51,377 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 20L: POI 2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT Runoff Area=22,947 sf 100.00% Impervious Runoff Depth>4.46"
Tc=6.0 min CN=98 Runoff=2.36 cfs 8,530 cf

Subcatchment 10Sb: POI 1 - OVERLAND TO Runoff Area=30,768 sf 100.00% Impervious Runoff Depth>4.46"
Tc=6.0 min CN=98 Runoff=3.17 cfs 11,438 cf

Subcatchment 20Sa: POI 2 - OVERLAND TO Runoff Area=68,209 sf 100.00% Impervious Runoff Depth>4.46"
Tc=6.0 min CN=98 Runoff=7.03 cfs 25,356 cf

Subcatchment 20Sb: POI 2 - OVERLAND TO Runoff Area=19,523 sf 100.00% Impervious Runoff Depth>4.46"
Tc=6.0 min CN=98 Runoff=2.01 cfs 7,258 cf

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT Runoff Area=129,249 sf 98.50% Impervious Runoff Depth>4.46"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=98 Runoff=10.38 cfs 47,987 cf

Reach 20Ra1: Grassed Channel Avg. Flow Depth=0.27' Max Vel=2.92 fps Inflow=4.92 cfs 22,244 cf
n=0.022 L=436.0' S=0.0161 '/' Capacity=16.40 cfs Outflow=4.87 cfs 22,191 cf

Reach 20Ra2: Natural Stream Avg. Flow Depth=0.30' Max Vel=1.25 fps Inflow=4.87 cfs 22,191 cf
n=0.040 L=600.0' S=0.0100 '/' Capacity=12.48 cfs Outflow=4.16 cfs 22,040 cf

Reach 20Rb: Natural Stream Avg. Flow Depth=0.14' Max Vel=0.94 fps Inflow=1.36 cfs 6,577 cf
n=0.040 L=1,006.0' S=0.0129 '/' Capacity=14.18 cfs Outflow=1.07 cfs 6,472 cf

Pond 10P: BMP 1 Peak Elev=38.93' Storage=2,022 cf Inflow=3.17 cfs 11,438 cf
Outflow=1.89 cfs 10,676 cf

Pond 20Pa: BMP 2 Peak Elev=39.23' Storage=6,817 cf Inflow=7.03 cfs 25,356 cf
Outflow=4.92 cfs 22,244 cf

Pond 20Pb: BMP 3 Peak Elev=39.99' Storage=1,394 cf Inflow=2.01 cfs 7,258 cf
Outflow=1.36 cfs 6,577 cf

Link 10L: POI 1 Inflow=4.06 cfs 19,206 cf
Primary=4.06 cfs 19,206 cf

Link 20L: POI 2 Inflow=12.10 cfs 76,500 cf
Primary=12.10 cfs 76,500 cf

Total Runoff Area = 270,696 sf Runoff Volume = 100,570 cf Average Runoff Depth = 4.46"
0.72% Pervious = 1,937 sf 99.28% Impervious = 268,759 sf

Summary for Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

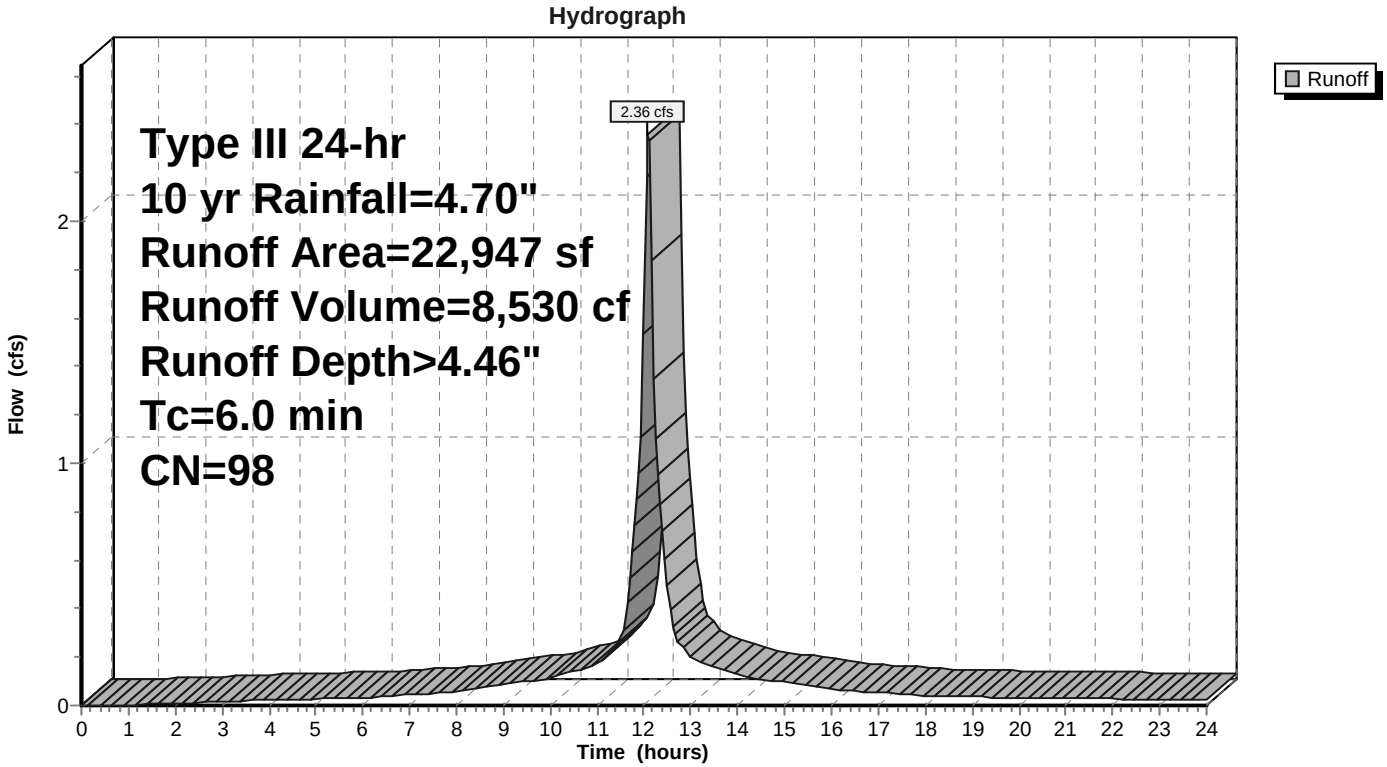
Runoff = 2.36 cfs @ 12.09 hrs, Volume= 8,530 cf, Depth> 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
22,947	98	Paved roads w/curbs & sewers, HSG C
22,947		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1

1. For pavements, Tc assumed to be 5 minutes.

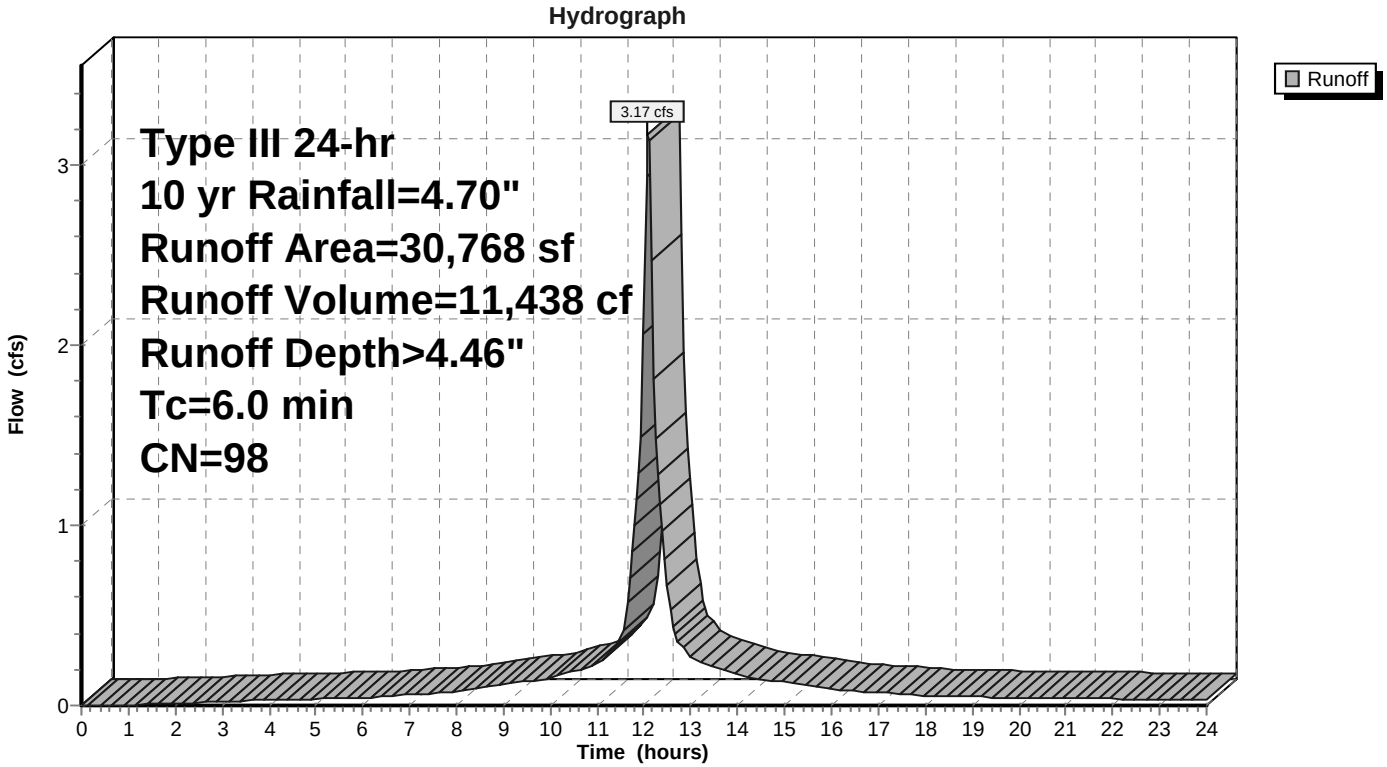
Runoff = 3.17 cfs @ 12.09 hrs, Volume= 11,438 cf, Depth> 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
30,768	98	Paved roads w/curbs & sewers, HSG C
30,768		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1



Summary for Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2

1. For pavements, Tc assumed to be 5 minutes.

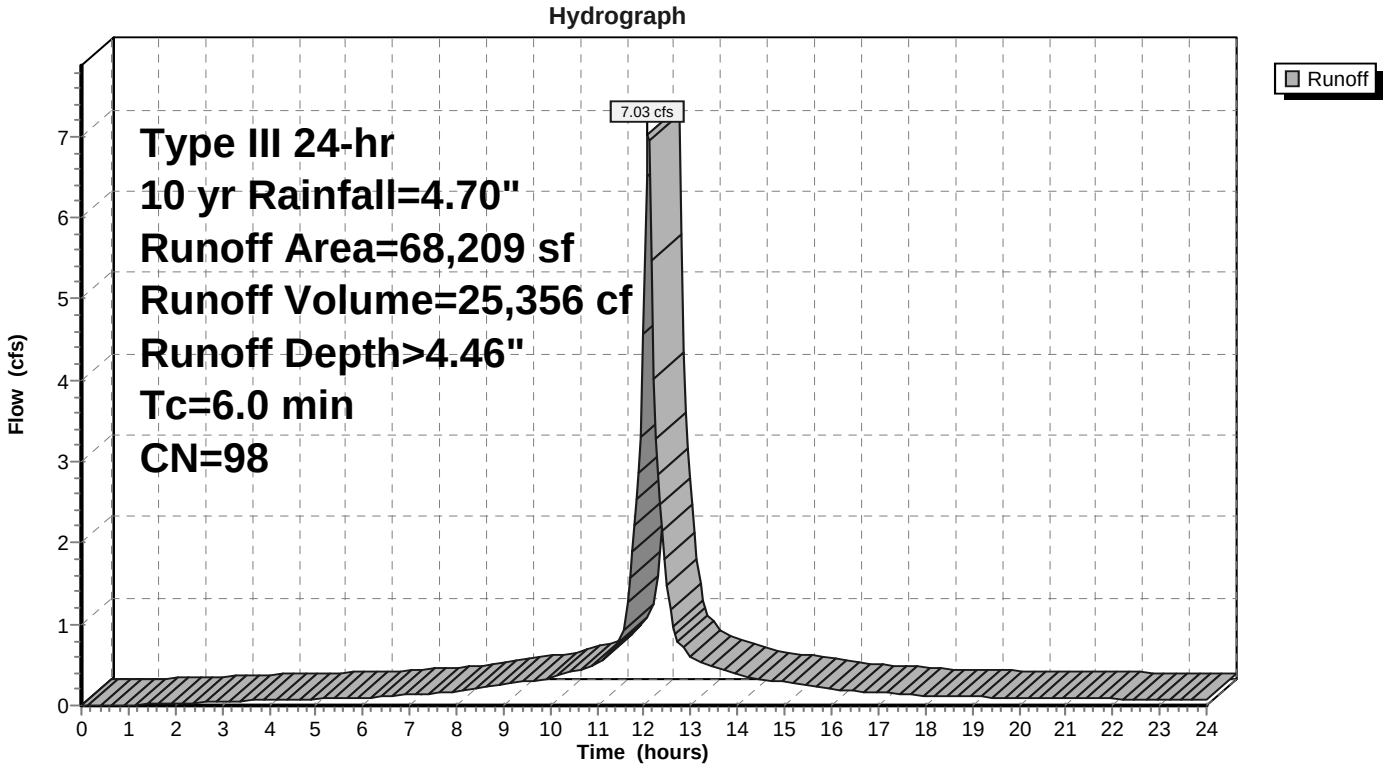
Runoff = 7.03 cfs @ 12.09 hrs, Volume= 25,356 cf, Depth> 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
68,209	98	Paved roads w/curbs & sewers, HSG C
68,209		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2



Summary for Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3

1. For pavements, Tc assumed to be 5 minutes.

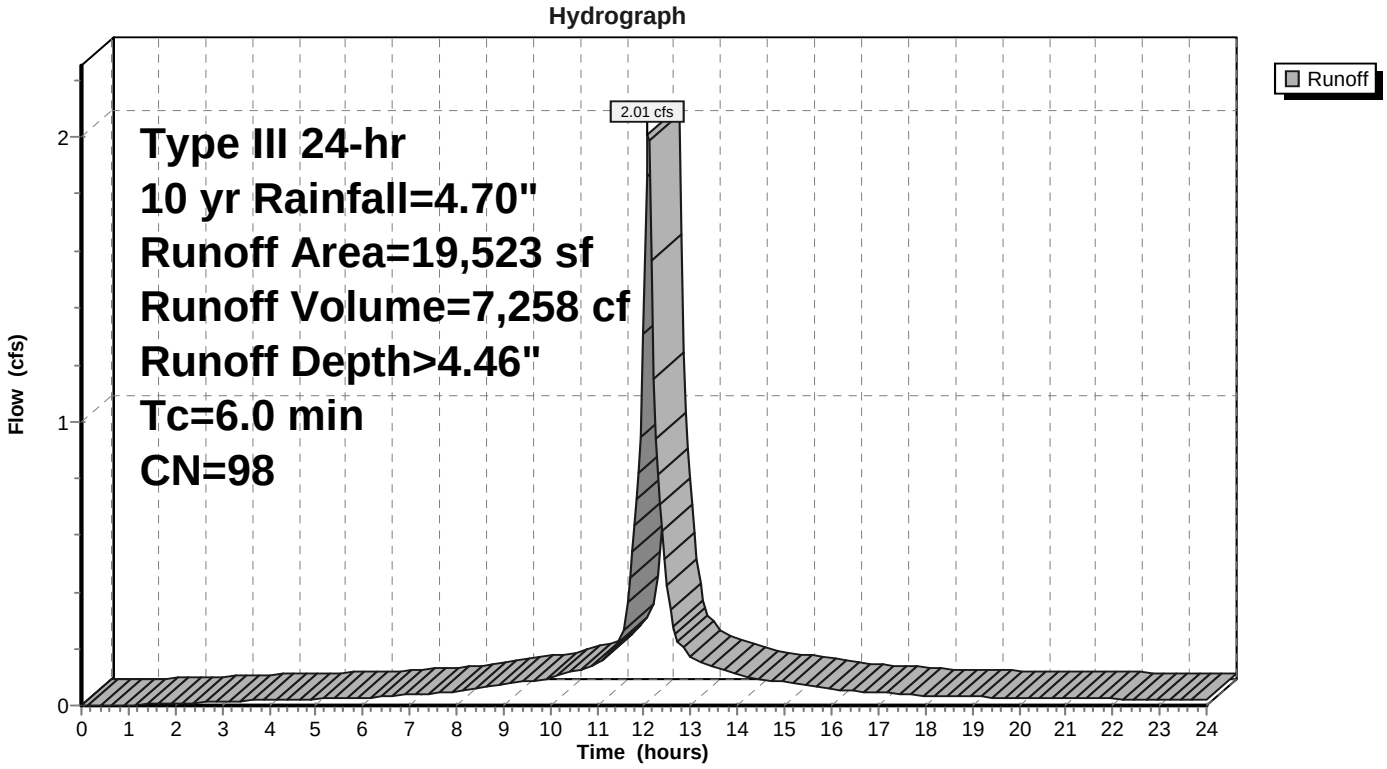
Runoff = 2.01 cfs @ 12.09 hrs, Volume= 7,258 cf, Depth> 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
19,523	98	Paved roads w/curbs & sewers, HSG C
19,523		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3



Summary for Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

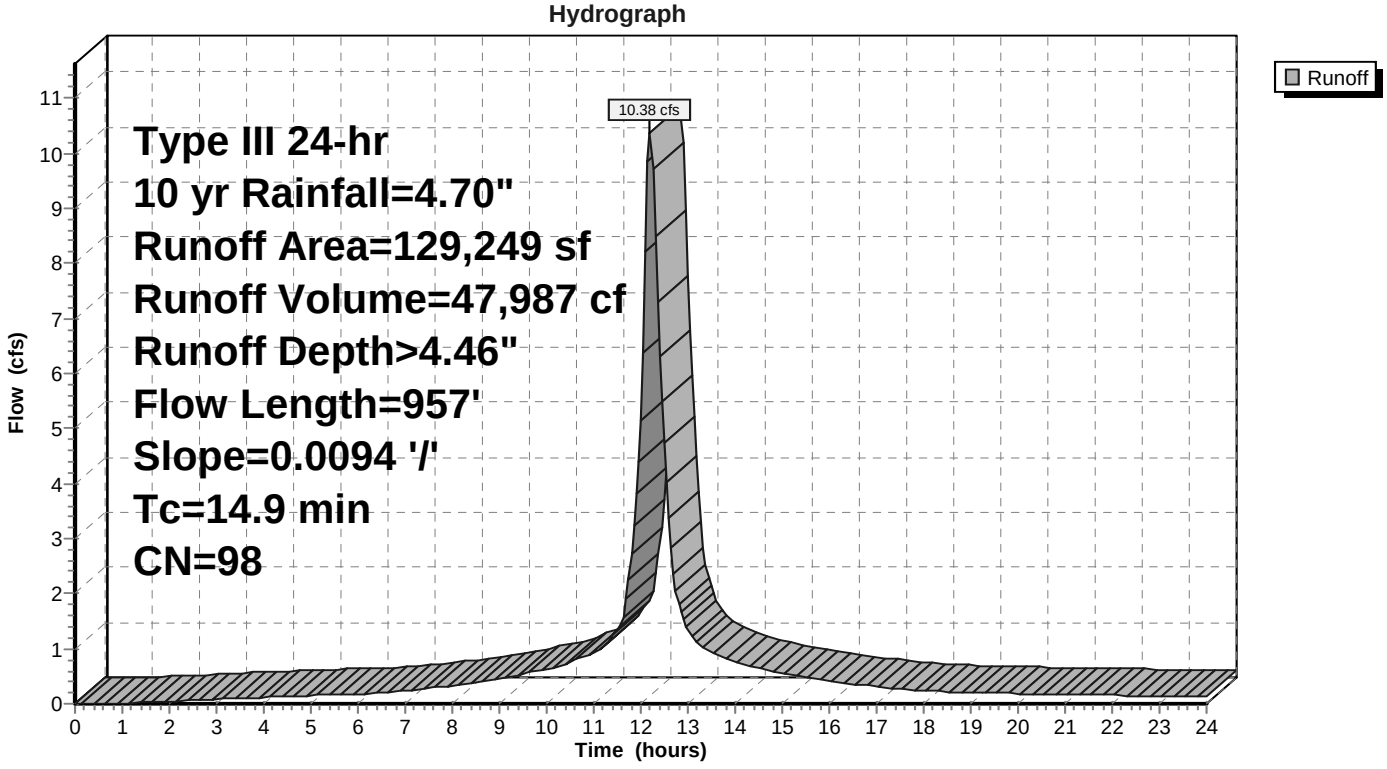
Runoff = 10.38 cfs @ 12.20 hrs, Volume= 47,987 cf, Depth> 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
127,312	98	Paved roads w/curbs & sewers, HSG C
1,937	79	50-75% Grass cover, Fair, HSG C
129,249	98	Weighted Average
1,937		1.50% Pervious Area
127,312		98.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE



Summary for Reach 20Ra1: Grassed Channel

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 3.91" for 10 yr event
Inflow = 4.92 cfs @ 12.17 hrs, Volume= 22,244 cf
Outflow = 4.87 cfs @ 12.26 hrs, Volume= 22,191 cf, Atten= 1%, Lag= 5.1 min

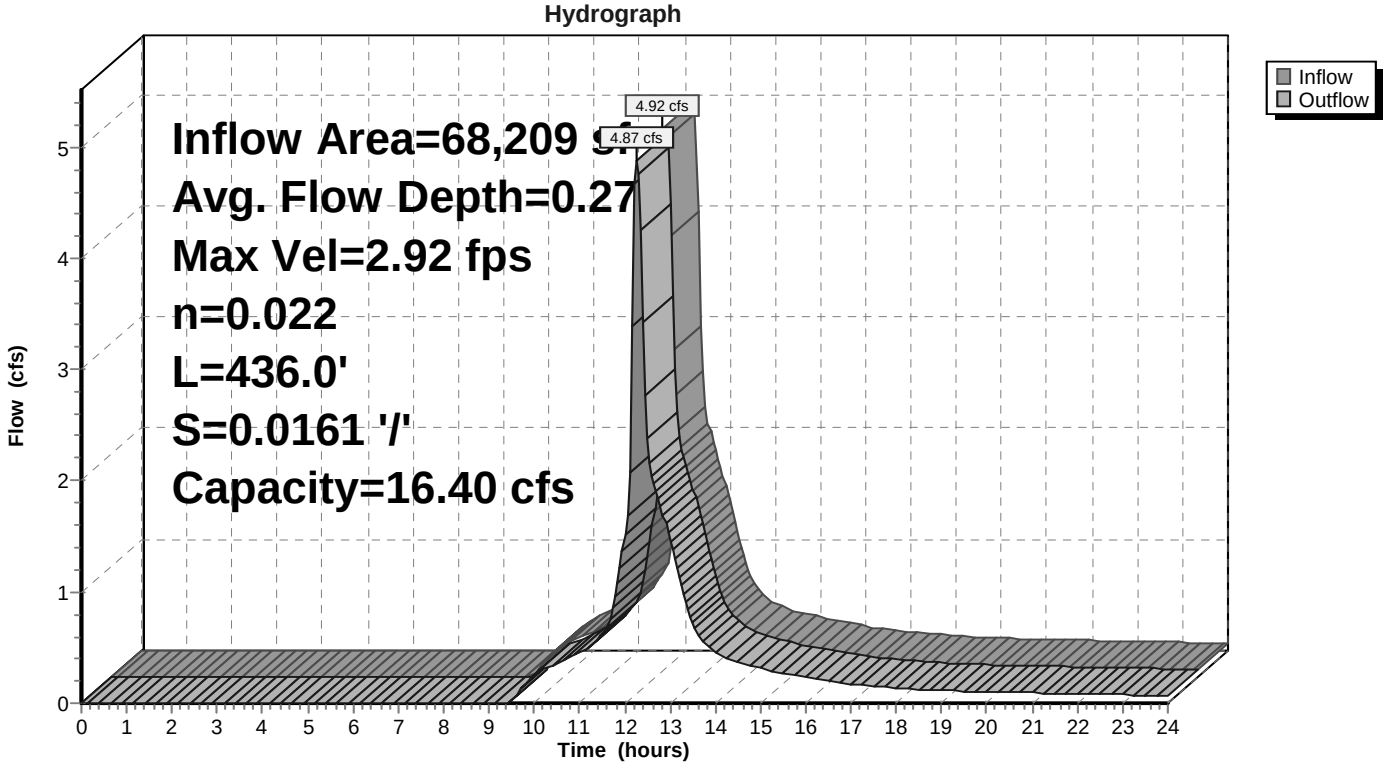
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.92 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 6.5 min

Peak Storage= 729 cf @ 12.22 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 16.40 cfs

4.00' x 0.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 8.0 '/' Top Width= 12.00'
Length= 436.0' Slope= 0.0161 '/'
Inlet Invert= 36.00', Outlet Invert= 29.00'

‡

Reach 20Ra1: Grassed Channel



Summary for Reach 20Ra2: Natural Stream

[62] Hint: Exceeded Reach 20Ra1 OUTLET depth by 0.10' @ 12.45 hrs

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 3.90" for 10 yr event
Inflow = 4.87 cfs @ 12.26 hrs, Volume= 22,191 cf
Outflow = 4.16 cfs @ 12.49 hrs, Volume= 22,040 cf, Atten= 15%, Lag= 13.9 min

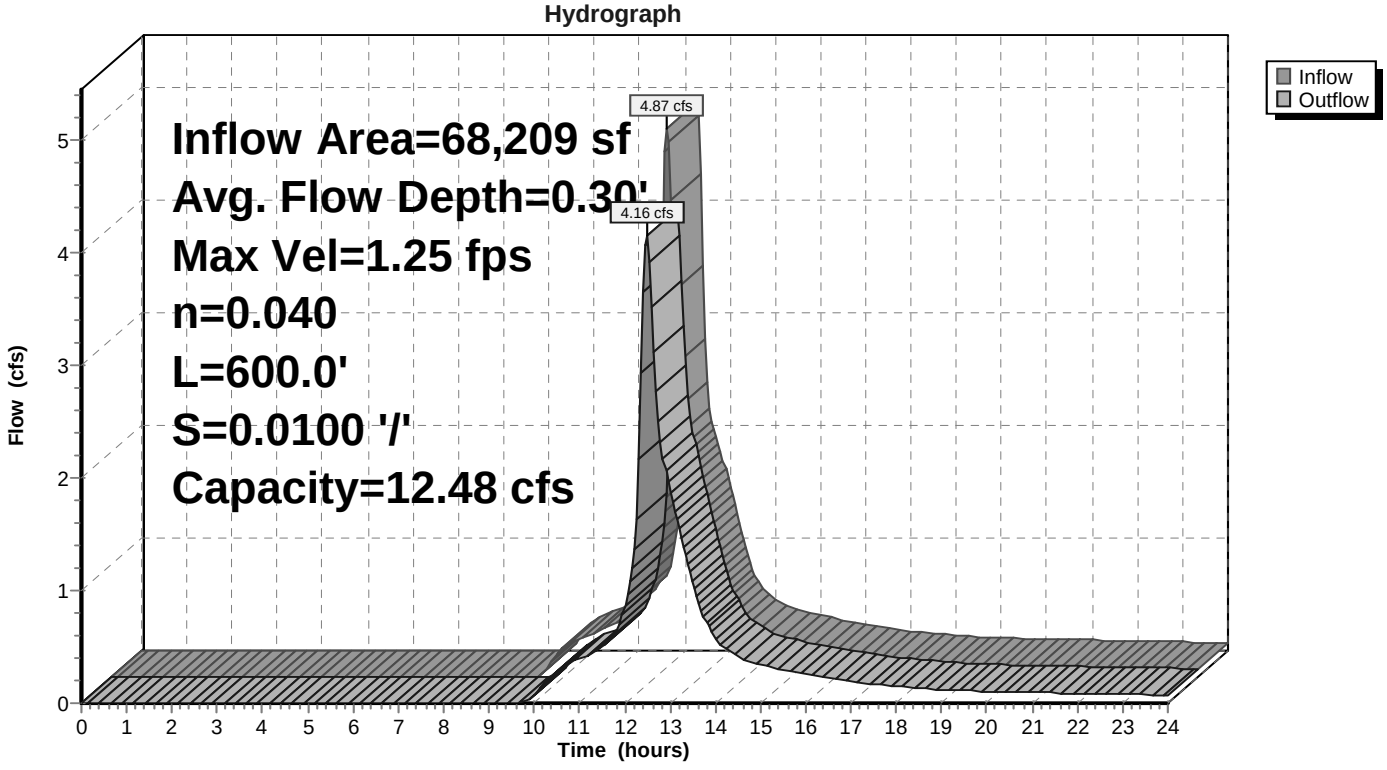
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.25 fps, Min. Travel Time= 8.0 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 18.3 min

Peak Storage= 2,014 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 12.48 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 600.0' Slope= 0.0100 '/'
Inlet Invert= 29.00', Outlet Invert= 23.00'

‡

Reach 20Ra2: Natural Stream



Summary for Reach 20Rb: Natural Stream

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 4.04" for 10 yr event
Inflow = 1.36 cfs @ 12.18 hrs, Volume= 6,577 cf
Outflow = 1.07 cfs @ 12.67 hrs, Volume= 6,472 cf, Atten= 21%, Lag= 29.5 min

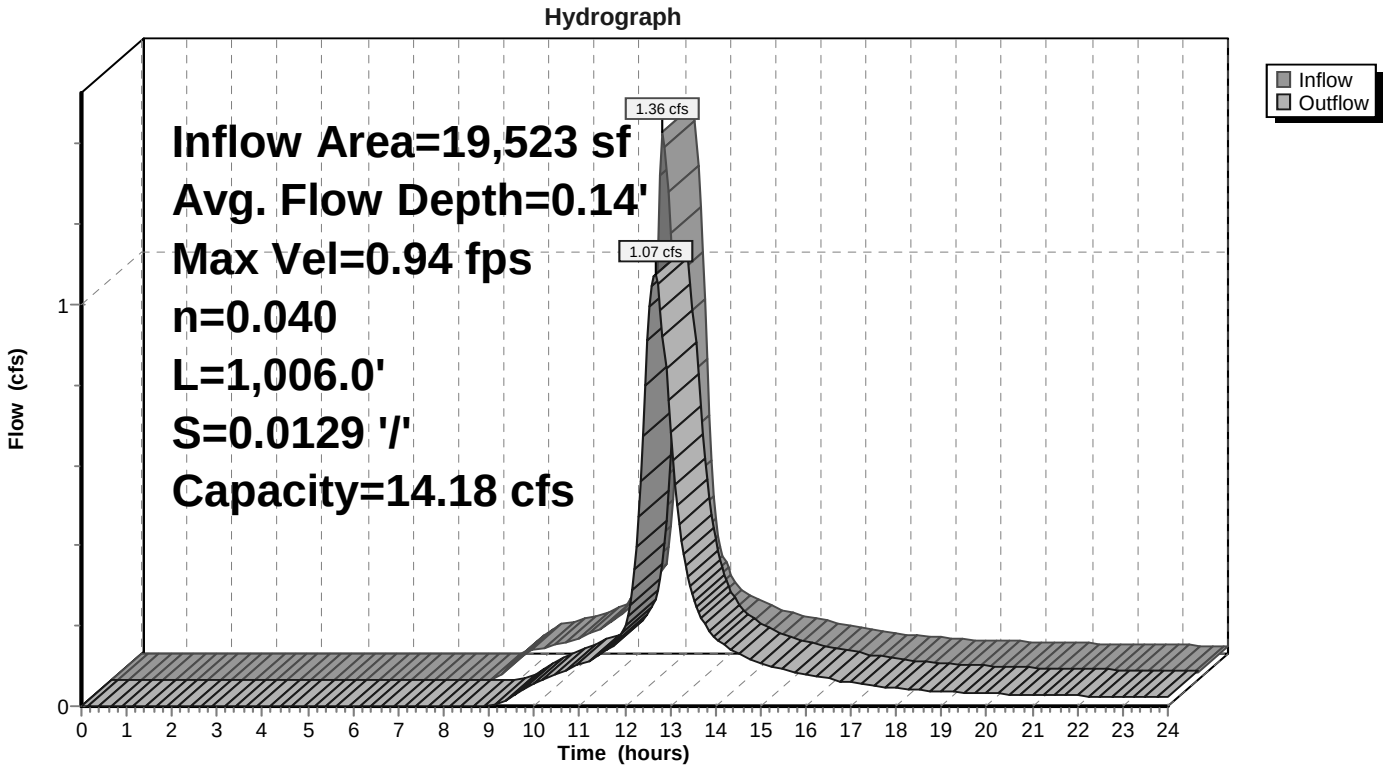
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.94 fps, Min. Travel Time= 17.8 min
Avg. Velocity = 0.39 fps, Avg. Travel Time= 42.6 min

Peak Storage= 1,145 cf @ 12.37 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 14.18 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 1,006.0' Slope= 0.0129 '/'
Inlet Invert= 36.00', Outlet Invert= 23.00'

‡

Reach 20Rb: Natural Stream



Summary for Pond 10P: BMP 1

Inflow Area = 30,768 sf,100.00% Impervious, Inflow Depth > 4.46" for 10 yr event
Inflow = 3.17 cfs @ 12.09 hrs, Volume= 11,438 cf
Outflow = 1.89 cfs @ 12.20 hrs, Volume= 10,676 cf, Atten= 40%, Lag= 6.9 min
Primary = 1.89 cfs @ 12.20 hrs, Volume= 10,676 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 38.93' @ 12.20 hrs Surf.Area= 1,110 sf Storage= 2,022 cf

Plug-Flow detention time= 74.4 min calculated for 10,654 cf (93% of inflow)
Center-of-Mass det. time= 38.5 min (787.2 - 748.6)

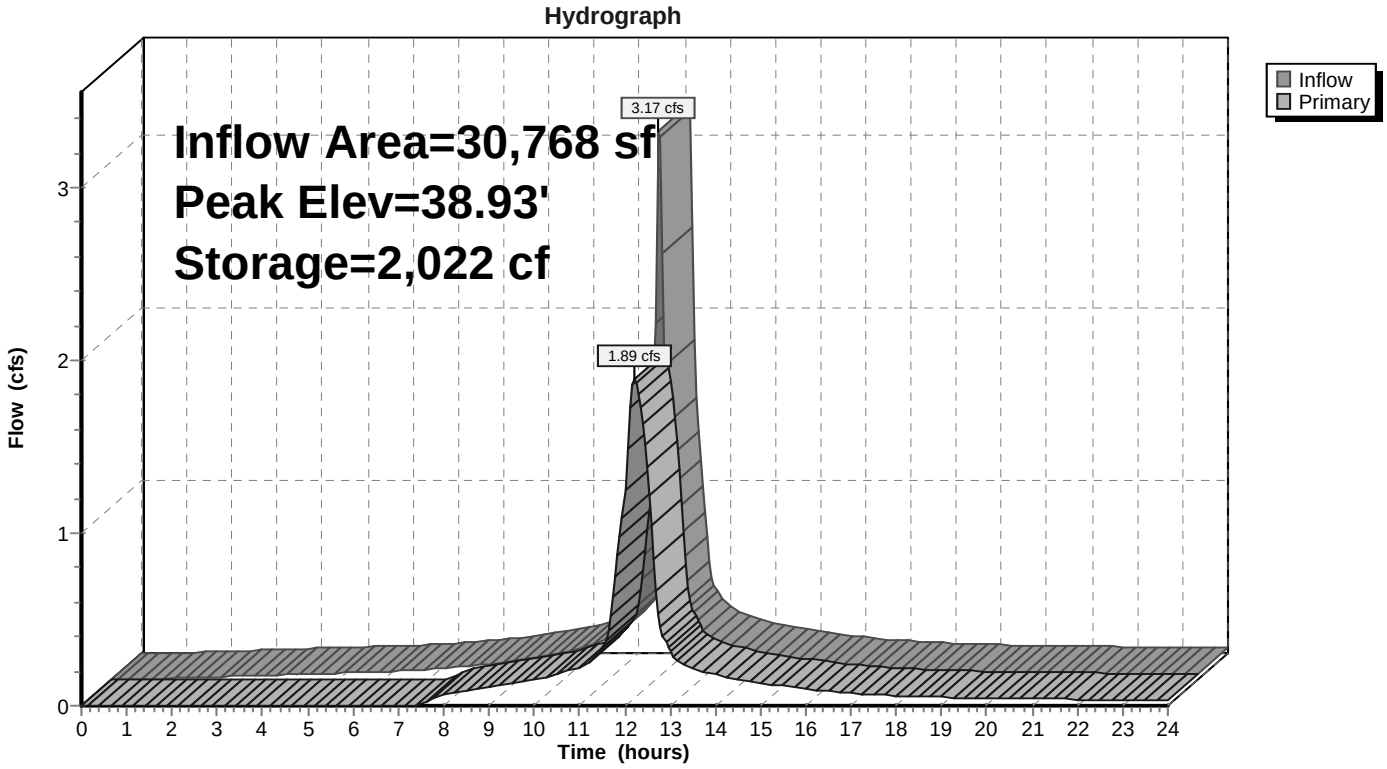
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	3,463 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
35.00	110	0	0	110
36.00	257	178	178	264
37.00	476	361	539	493
38.00	768	616	1,156	798
39.00	1,139	947	2,103	1,185
40.00	1,593	1,360	3,463	1,657

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 172.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 35.28' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.33'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	39.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.89 cfs @ 12.20 hrs HW=38.93' (Free Discharge)
└**1=RCP_Round 12"** (Passes 1.89 cfs of 4.15 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 1.89 cfs @ 5.41 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 10P: BMP 1



Summary for Pond 20Pa: BMP 2

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 4.46" for 10 yr event
Inflow = 7.03 cfs @ 12.09 hrs, Volume= 25,356 cf
Outflow = 4.92 cfs @ 12.17 hrs, Volume= 22,244 cf, Atten= 30%, Lag= 5.0 min
Primary = 4.92 cfs @ 12.17 hrs, Volume= 22,244 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.23' @ 12.17 hrs Surf.Area= 2,129 sf Storage= 6,817 cf

Plug-Flow detention time= 117.7 min calculated for 22,198 cf (88% of inflow)
Center-of-Mass det. time= 61.8 min (810.5 - 748.6)

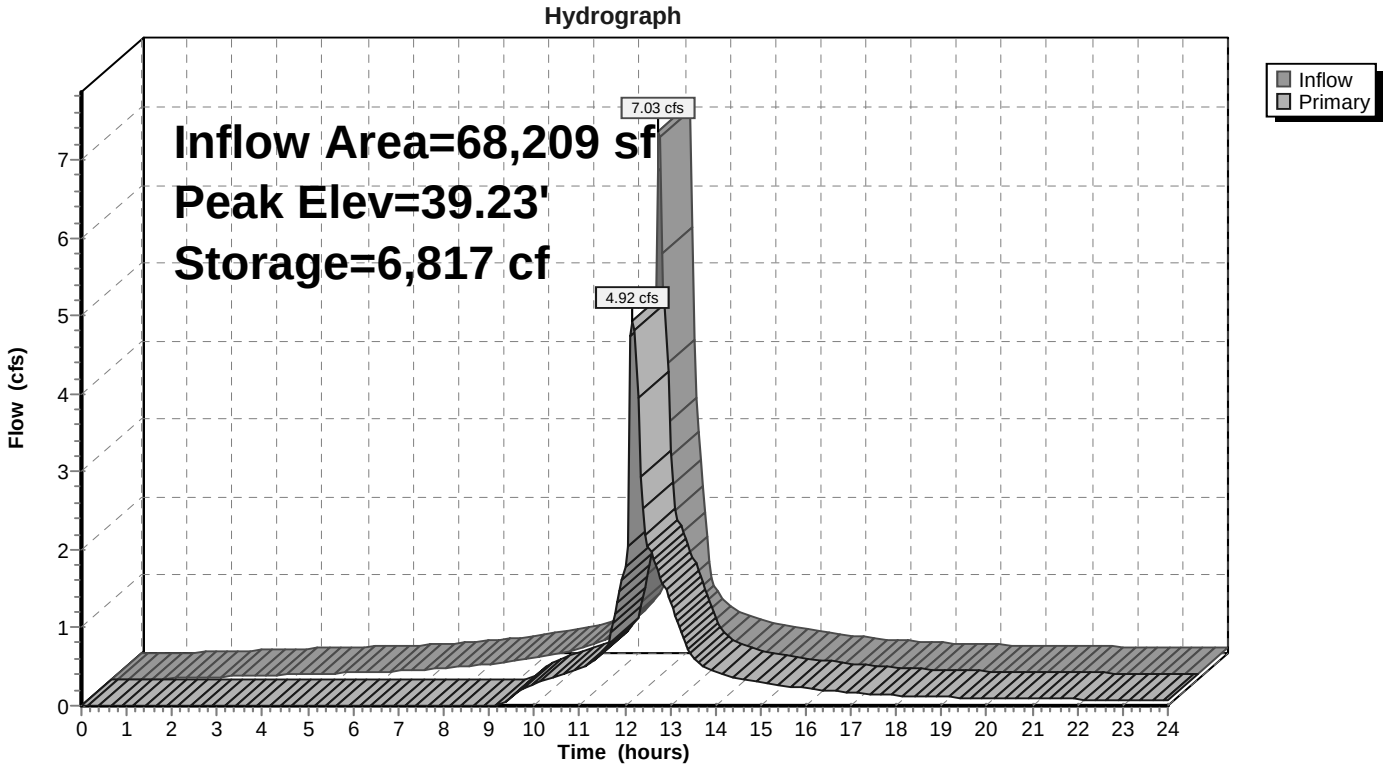
Volume	Invert	Avail.Storage	Storage Description
#1	34.00'	8,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
34.00	612	0	0	612
35.00	837	722	722	856
36.00	1,094	963	1,684	1,136
37.00	1,384	1,236	2,920	1,451
38.00	1,703	1,541	4,461	1,799
39.00	2,046	1,872	6,333	2,175
40.00	2,414	2,227	8,560	2,579

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 50.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 36.50' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	38.83'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	39.50'	**8.0' 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=4.90 cfs @ 12.17 hrs HW=39.22' (Free Discharge)
- **1=RCP_Round 12"** (Barrel Controls 4.90 cfs @ 6.24 fps)
  - **2=Orifice/Grate** (Passes < 2.31 cfs potential flow)
  - **3=Orifice/Grate** (Passes < 6.28 cfs potential flow)
- **4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 20Pa: BMP 2



Summary for Pond 20Pb: BMP 3

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 4.46" for 10 yr event
Inflow = 2.01 cfs @ 12.09 hrs, Volume= 7,258 cf
Outflow = 1.36 cfs @ 12.18 hrs, Volume= 6,577 cf, Atten= 32%, Lag= 5.3 min
Primary = 1.36 cfs @ 12.18 hrs, Volume= 6,577 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.99' @ 12.18 hrs Surf.Area= 950 sf Storage= 1,394 cf

Plug-Flow detention time= 94.9 min calculated for 6,577 cf (91% of inflow)
Center-of-Mass det. time= 47.8 min (796.5 - 748.6)

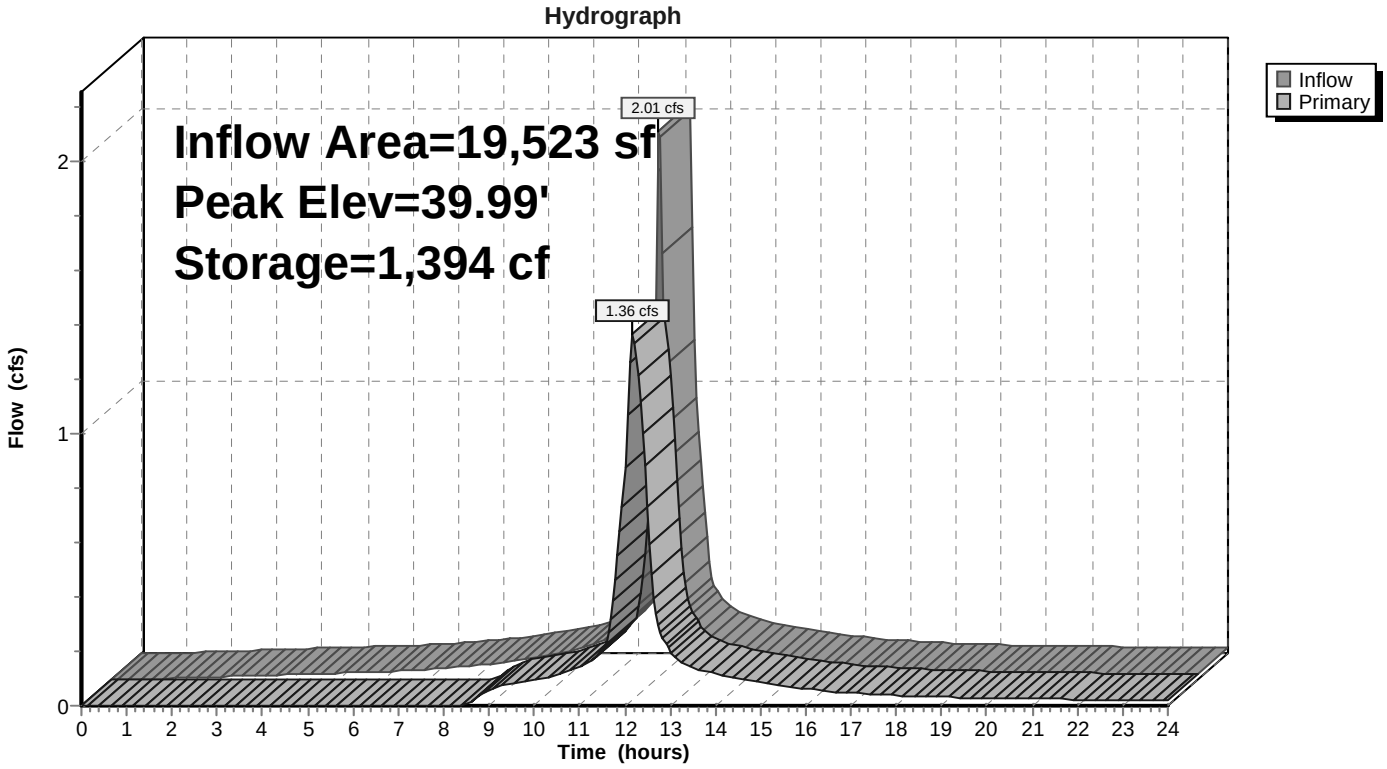
Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	2,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
37.00	111	0	0	111
38.00	303	199	199	309
39.00	590	439	638	606
40.00	954	765	1,402	983
41.00	1,373	1,157	2,560	1,419

Device	Routing	Invert	Outlet Devices
#1	Primary	39.00'	**12.0" Round RCP_Round 12"** L= 81.7' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 39.00' / 38.00' S= 0.0122 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	39.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	40.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.36 cfs @ 12.18 hrs HW=39.98' (Free Discharge)
└**1=RCP_Round 12"** (Passes 1.36 cfs of 2.64 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 1.36 cfs @ 3.89 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 20Pb: BMP 3

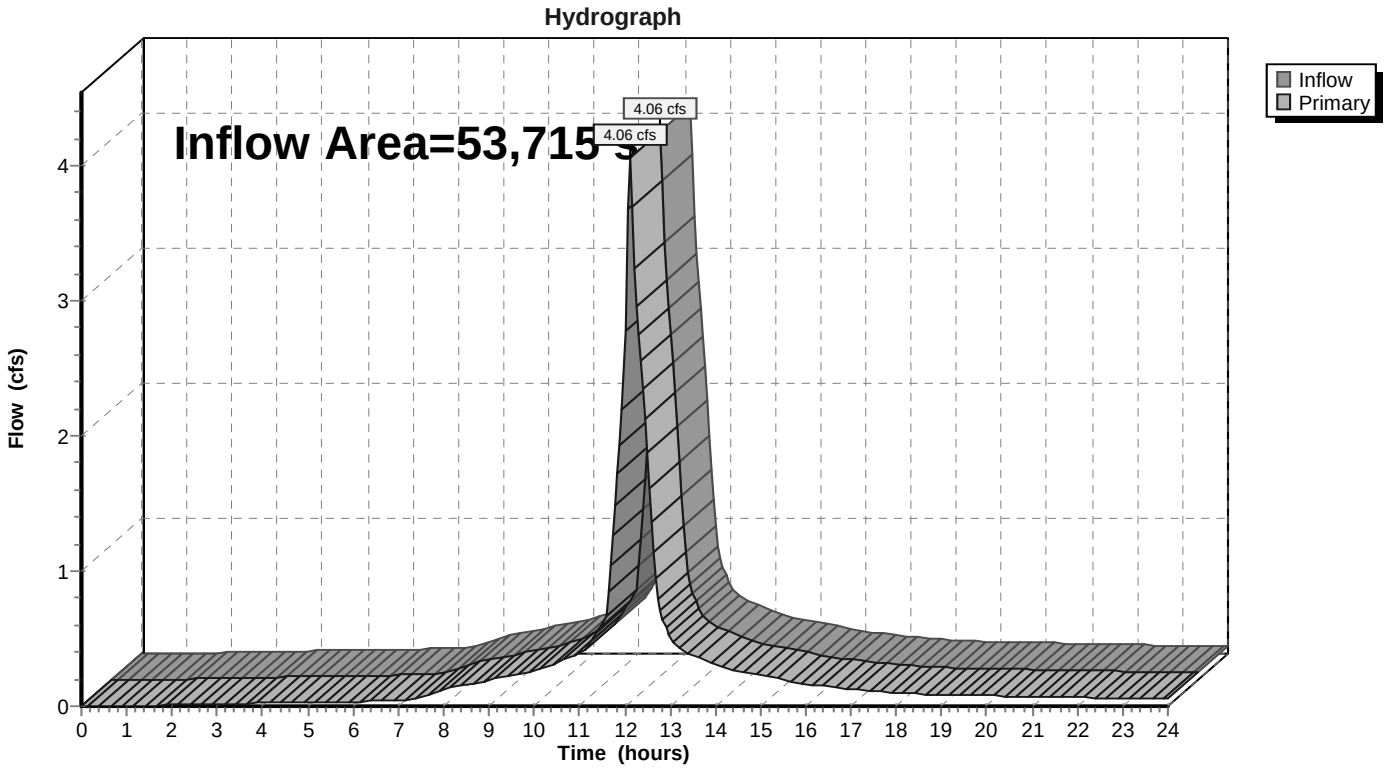


Summary for Link 10L: POI 1

Inflow Area = 53,715 sf,100.00% Impervious, Inflow Depth > 4.29" for 10 yr event
Inflow = 4.06 cfs @ 12.10 hrs, Volume= 19,206 cf
Primary = 4.06 cfs @ 12.10 hrs, Volume= 19,206 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 10L: POI 1

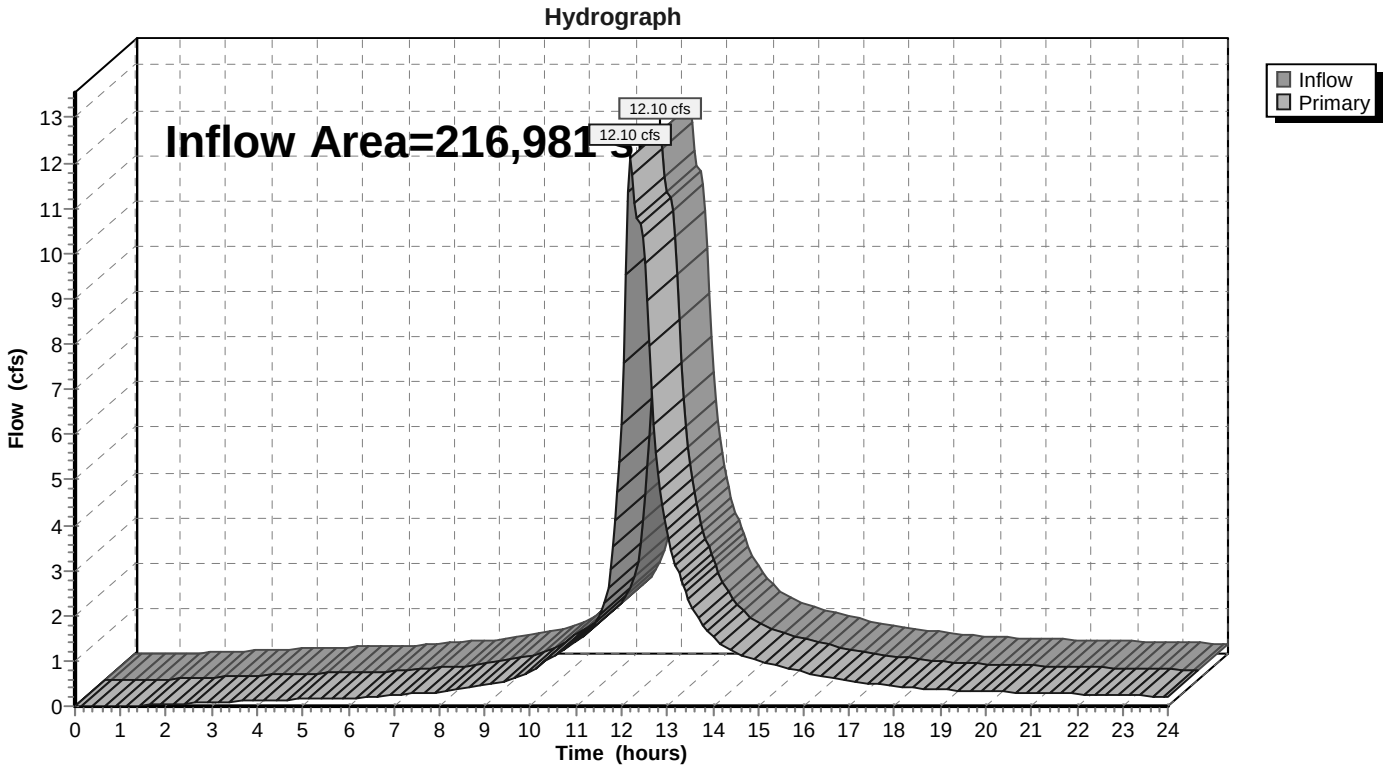


Summary for Link 20L: POI 2

Inflow Area = 216,981 sf, 99.11% Impervious, Inflow Depth > 4.23" for 10 yr event
Inflow = 12.10 cfs @ 12.21 hrs, Volume= 76,500 cf
Primary = 12.10 cfs @ 12.21 hrs, Volume= 76,500 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 20L: POI 2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT Runoff Area=22,947 sf 100.00% Impervious Runoff Depth>5.36"
Tc=6.0 min CN=98 Runoff=2.82 cfs 10,248 cf

Subcatchment 10Sb: POI 1 - OVERLAND TO Runoff Area=30,768 sf 100.00% Impervious Runoff Depth>5.36"
Tc=6.0 min CN=98 Runoff=3.78 cfs 13,741 cf

Subcatchment 20Sa: POI 2 - OVERLAND TO Runoff Area=68,209 sf 100.00% Impervious Runoff Depth>5.36"
Tc=6.0 min CN=98 Runoff=8.39 cfs 30,461 cf

Subcatchment 20Sb: POI 2 - OVERLAND TO Runoff Area=19,523 sf 100.00% Impervious Runoff Depth>5.36"
Tc=6.0 min CN=98 Runoff=2.40 cfs 8,719 cf

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT Runoff Area=129,249 sf 98.50% Impervious Runoff Depth>5.35"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=98 Runoff=12.40 cfs 57,649 cf

Reach 20Ra1: Grassed Channel Avg. Flow Depth=0.28' Max Vel=3.00 fps Inflow=5.41 cfs 27,331 cf
n=0.022 L=436.0' S=0.0161 '/' Capacity=16.40 cfs Outflow=5.34 cfs 27,271 cf

Reach 20Ra2: Natural Stream Avg. Flow Depth=0.33' Max Vel=1.31 fps Inflow=5.34 cfs 27,271 cf
n=0.040 L=600.0' S=0.0100 '/' Capacity=12.48 cfs Outflow=4.92 cfs 27,101 cf

Reach 20Rb: Natural Stream Avg. Flow Depth=0.16' Max Vel=0.99 fps Inflow=1.54 cfs 8,033 cf
n=0.040 L=1,006.0' S=0.0129 '/' Capacity=14.18 cfs Outflow=1.26 cfs 7,918 cf

Pond 10P: BMP 1 Peak Elev=39.11' Storage=2,237 cf Inflow=3.78 cfs 13,741 cf
Outflow=2.96 cfs 12,974 cf

Pond 20Pa: BMP 2 Peak Elev=39.53' Storage=7,461 cf Inflow=8.39 cfs 30,461 cf
Outflow=5.41 cfs 27,331 cf

Pond 20Pb: BMP 3 Peak Elev=40.18' Storage=1,579 cf Inflow=2.40 cfs 8,719 cf
Outflow=1.54 cfs 8,033 cf

Link 10L: POI 1 Inflow=5.14 cfs 23,222 cf
Primary=5.14 cfs 23,222 cf

Link 20L: POI 2 Inflow=14.61 cfs 92,668 cf
Primary=14.61 cfs 92,668 cf

Total Runoff Area = 270,696 sf Runoff Volume = 120,818 cf Average Runoff Depth = 5.36"
0.72% Pervious = 1,937 sf 99.28% Impervious = 268,759 sf

Summary for Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

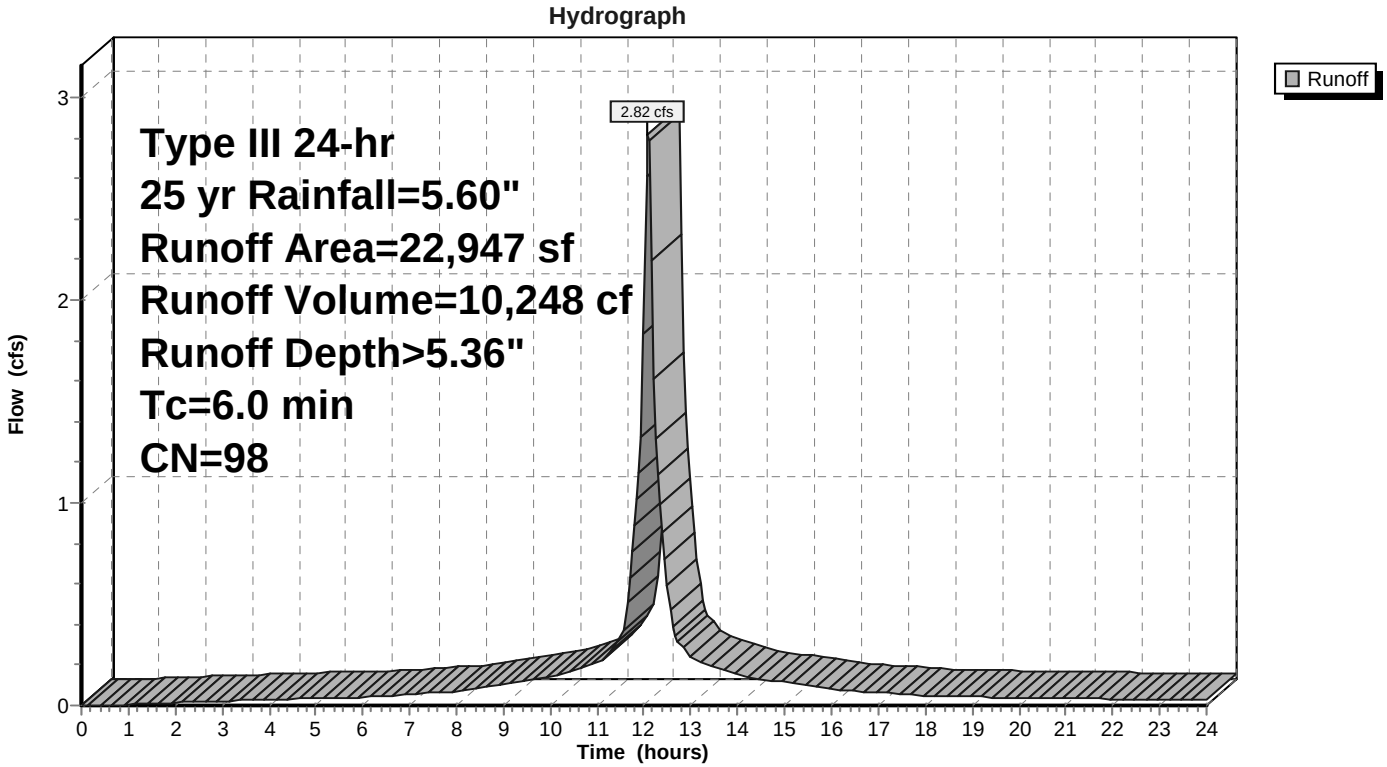
Runoff = 2.82 cfs @ 12.09 hrs, Volume= 10,248 cf, Depth> 5.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
22,947	98	Paved roads w/curbs & sewers, HSG C
22,947		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1

1. For pavements, Tc assumed to be 5 minutes.

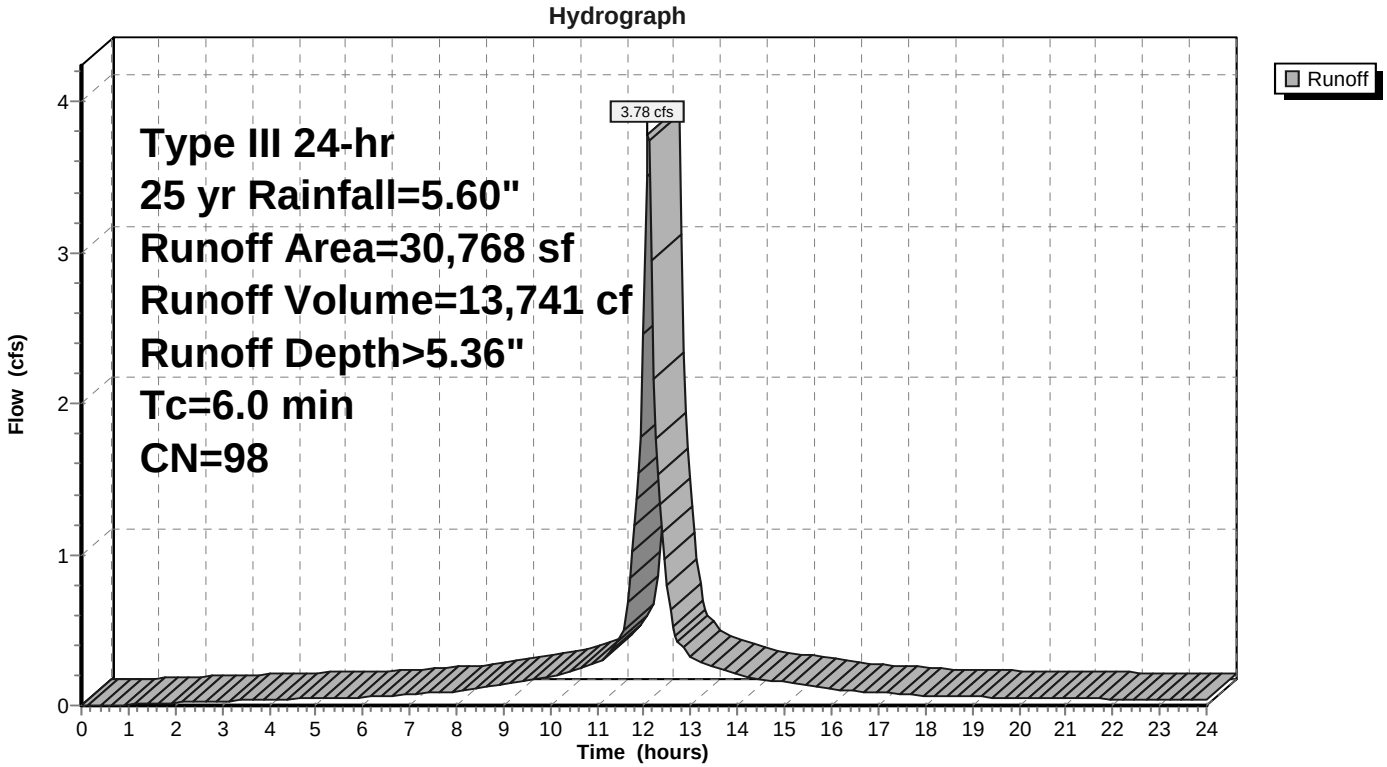
Runoff = 3.78 cfs @ 12.09 hrs, Volume= 13,741 cf, Depth> 5.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
30,768	98	Paved roads w/curbs & sewers, HSG C
30,768		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1



Summary for Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2

1. For pavements, Tc assumed to be 5 minutes.

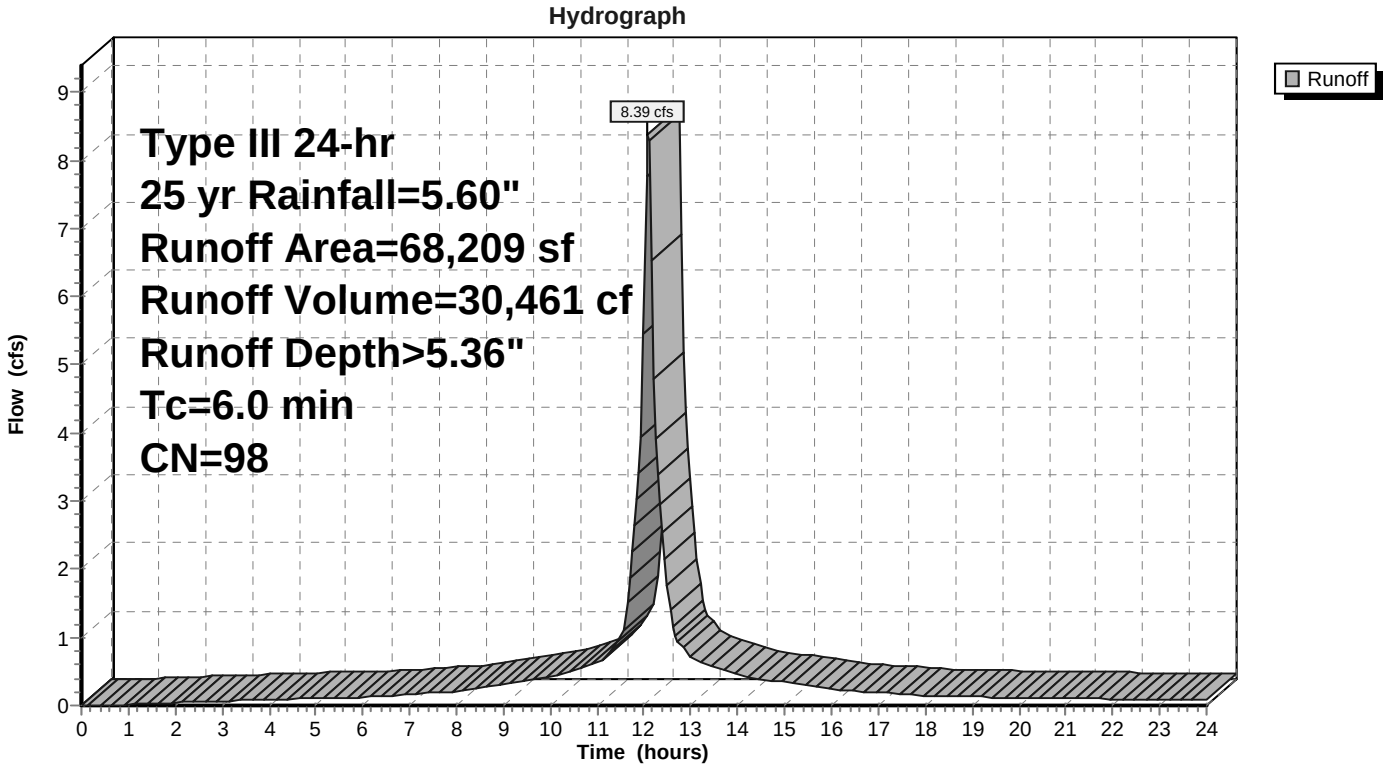
Runoff = 8.39 cfs @ 12.09 hrs, Volume= 30,461 cf, Depth> 5.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
68,209	98	Paved roads w/curbs & sewers, HSG C
68,209		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2



Summary for Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3

1. For pavements, Tc assumed to be 5 minutes.

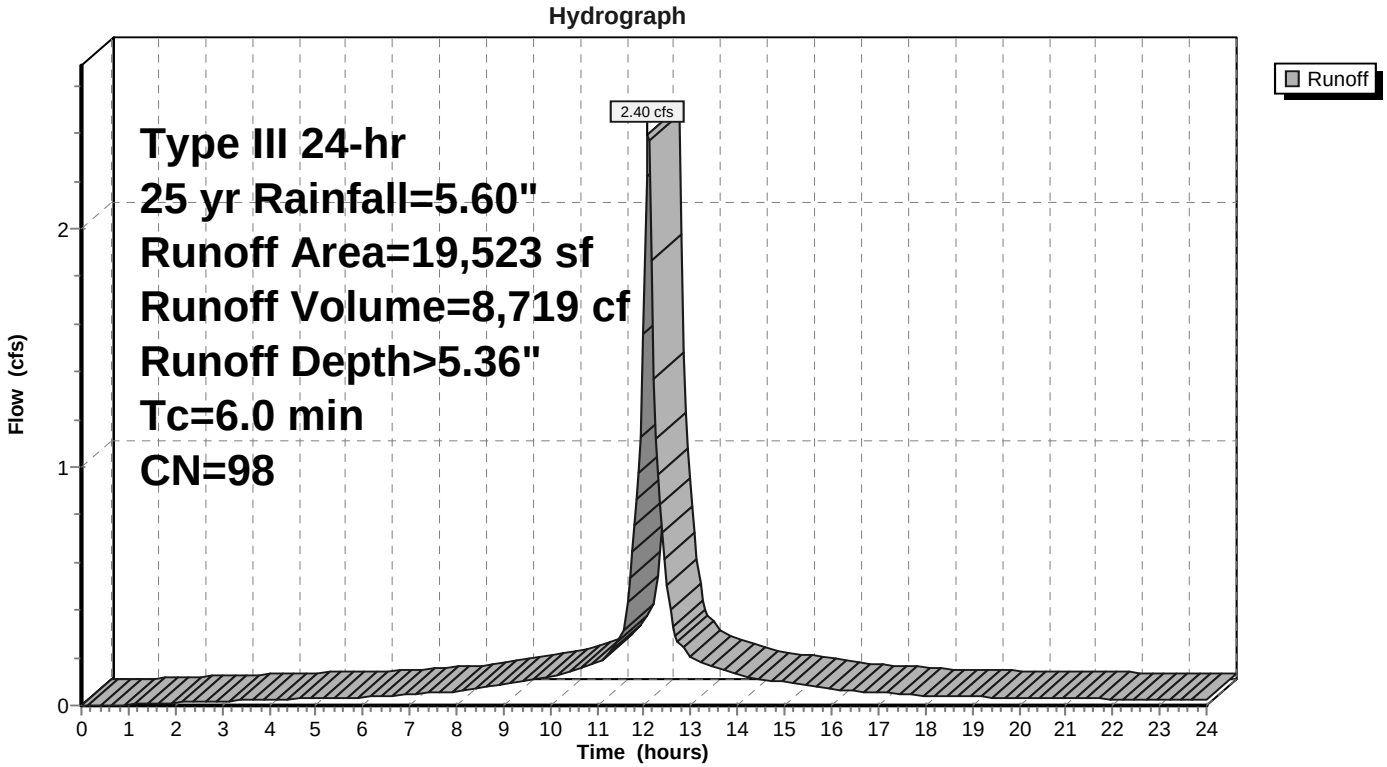
Runoff = 2.40 cfs @ 12.09 hrs, Volume= 8,719 cf, Depth> 5.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
19,523	98	Paved roads w/curbs & sewers, HSG C
19,523		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3



Summary for Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

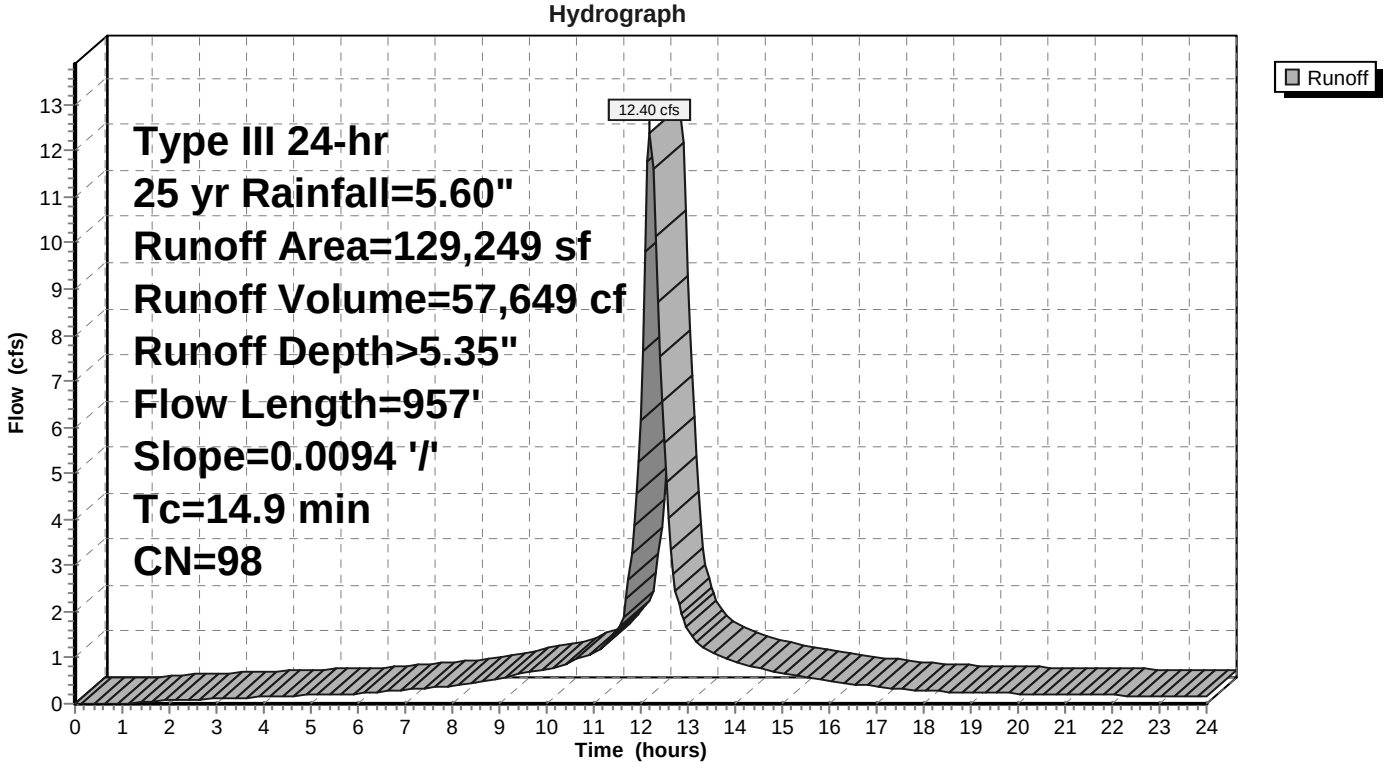
Runoff = 12.40 cfs @ 12.20 hrs, Volume= 57,649 cf, Depth> 5.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
127,312	98	Paved roads w/curbs & sewers, HSG C
1,937	79	50-75% Grass cover, Fair, HSG C
129,249	98	Weighted Average
1,937		1.50% Pervious Area
127,312		98.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE



Summary for Reach 20Ra1: Grassed Channel

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 4.81" for 25 yr event
Inflow = 5.41 cfs @ 12.19 hrs, Volume= 27,331 cf
Outflow = 5.34 cfs @ 12.26 hrs, Volume= 27,271 cf, Atten= 1%, Lag= 4.2 min

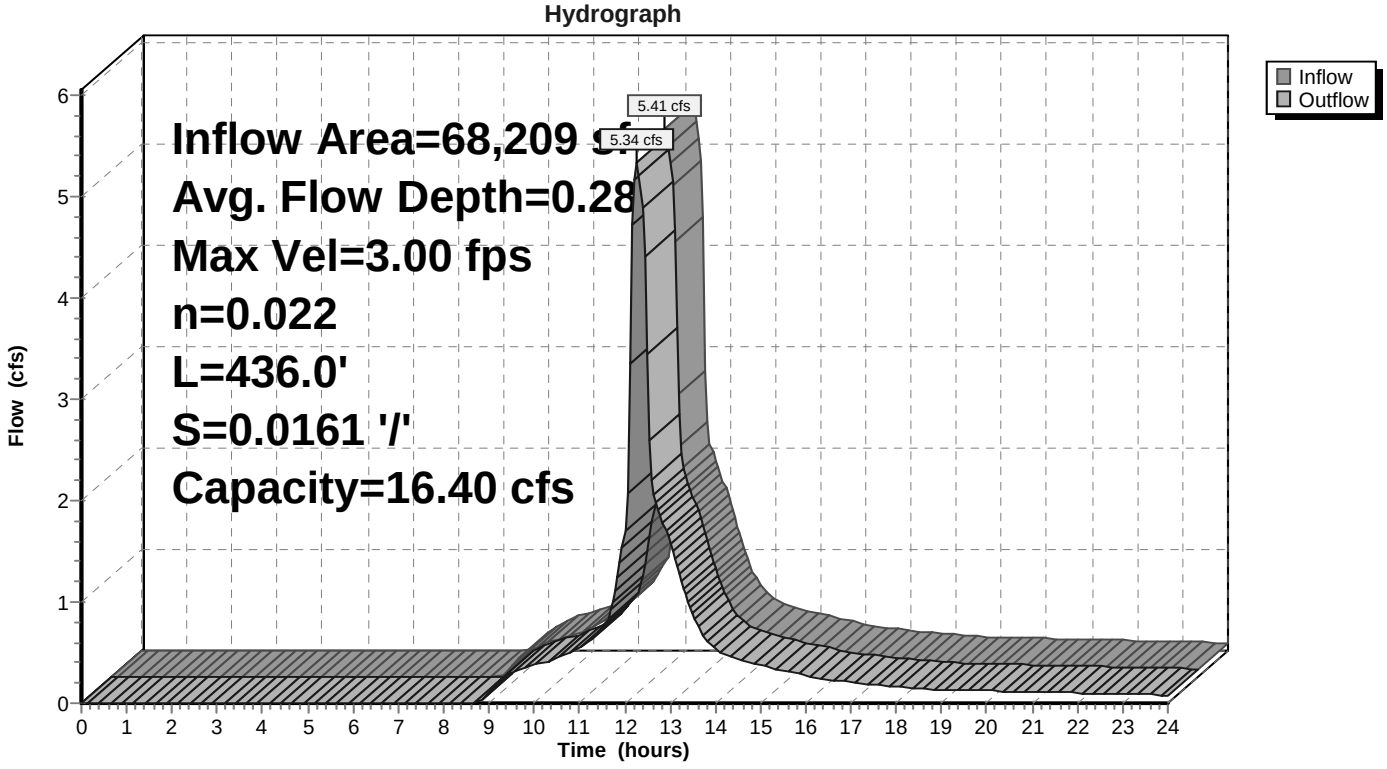
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.00 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.18 fps, Avg. Travel Time= 6.2 min

Peak Storage= 777 cf @ 12.22 hrs
Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 16.40 cfs

4.00' x 0.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 8.0 '/' Top Width= 12.00'
Length= 436.0' Slope= 0.0161 '/'
Inlet Invert= 36.00', Outlet Invert= 29.00'

‡

Reach 20Ra1: Grassed Channel



Summary for Reach 20Ra2: Natural Stream

[62] Hint: Exceeded Reach 20Ra1 OUTLET depth by 0.12' @ 12.50 hrs

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 4.80" for 25 yr event
Inflow = 5.34 cfs @ 12.26 hrs, Volume= 27,271 cf
Outflow = 4.92 cfs @ 12.52 hrs, Volume= 27,101 cf, Atten= 8%, Lag= 15.1 min

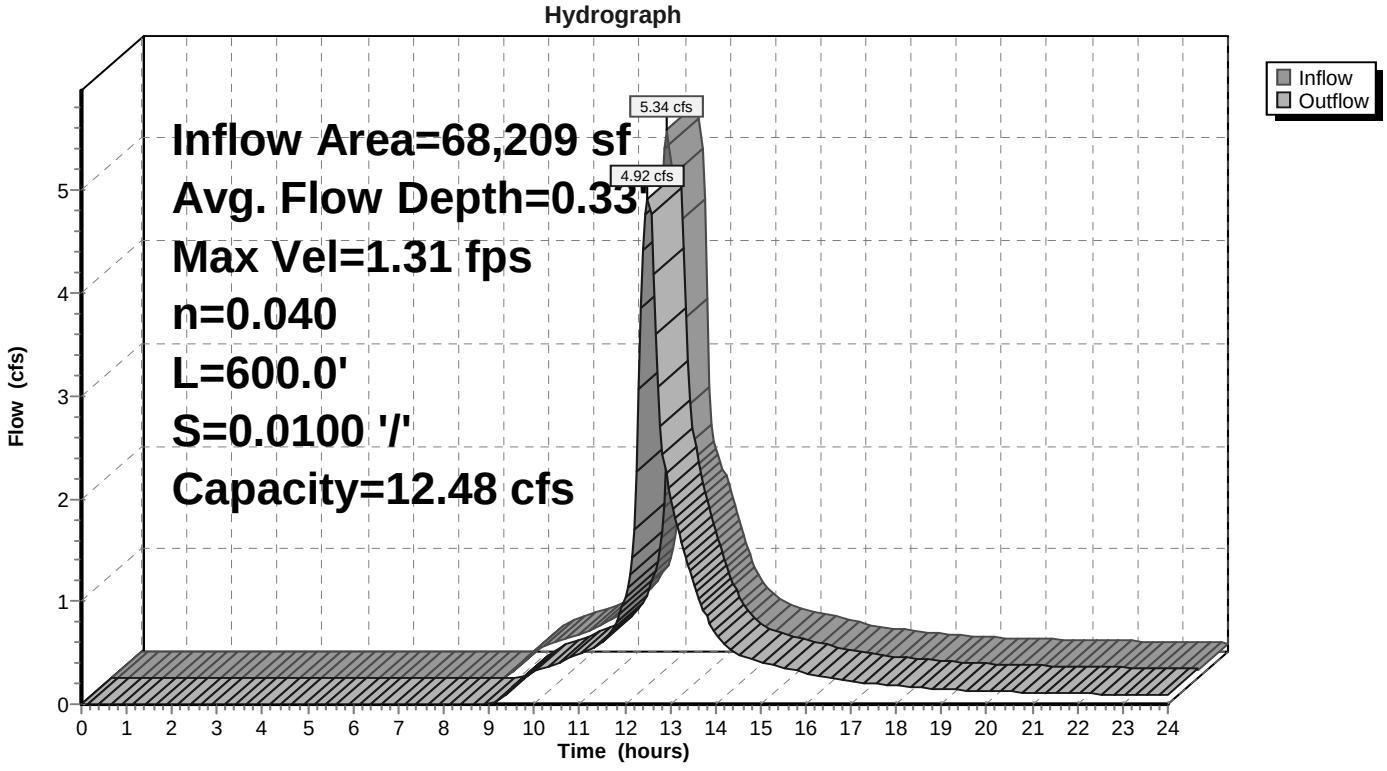
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.31 fps, Min. Travel Time= 7.7 min
Avg. Velocity = 0.58 fps, Avg. Travel Time= 17.3 min

Peak Storage= 2,269 cf @ 12.39 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 12.48 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 600.0' Slope= 0.0100 '/'
Inlet Invert= 29.00', Outlet Invert= 23.00'

‡

Reach 20Ra2: Natural Stream



Summary for Reach 20Rb: Natural Stream

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 4.94" for 25 yr event
Inflow = 1.54 cfs @ 12.19 hrs, Volume= 8,033 cf
Outflow = 1.26 cfs @ 12.67 hrs, Volume= 7,918 cf, Atten= 19%, Lag= 28.9 min

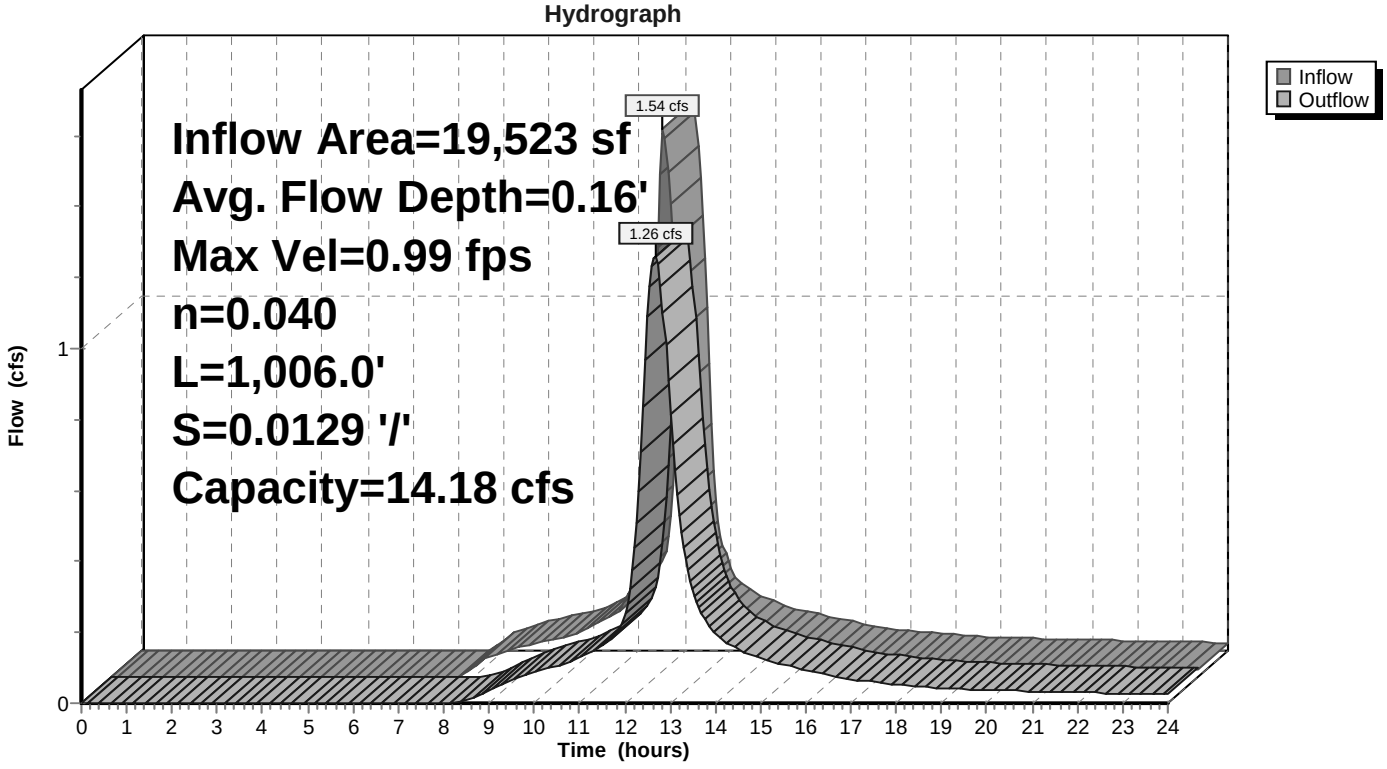
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.99 fps, Min. Travel Time= 17.0 min
Avg. Velocity = 0.42 fps, Avg. Travel Time= 40.3 min

Peak Storage= 1,284 cf @ 12.39 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 14.18 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 1,006.0' Slope= 0.0129 '/'
Inlet Invert= 36.00', Outlet Invert= 23.00'

‡

Reach 20Rb: Natural Stream



Summary for Pond 10P: BMP 1

Inflow Area = 30,768 sf,100.00% Impervious, Inflow Depth > 5.36" for 25 yr event
Inflow = 3.78 cfs @ 12.09 hrs, Volume= 13,741 cf
Outflow = 2.96 cfs @ 12.16 hrs, Volume= 12,974 cf, Atten= 22%, Lag= 4.5 min
Primary = 2.96 cfs @ 12.16 hrs, Volume= 12,974 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.11' @ 12.17 hrs Surf.Area= 1,187 sf Storage= 2,237 cf

Plug-Flow detention time= 66.4 min calculated for 12,947 cf (94% of inflow)
Center-of-Mass det. time= 35.1 min (780.9 - 745.8)

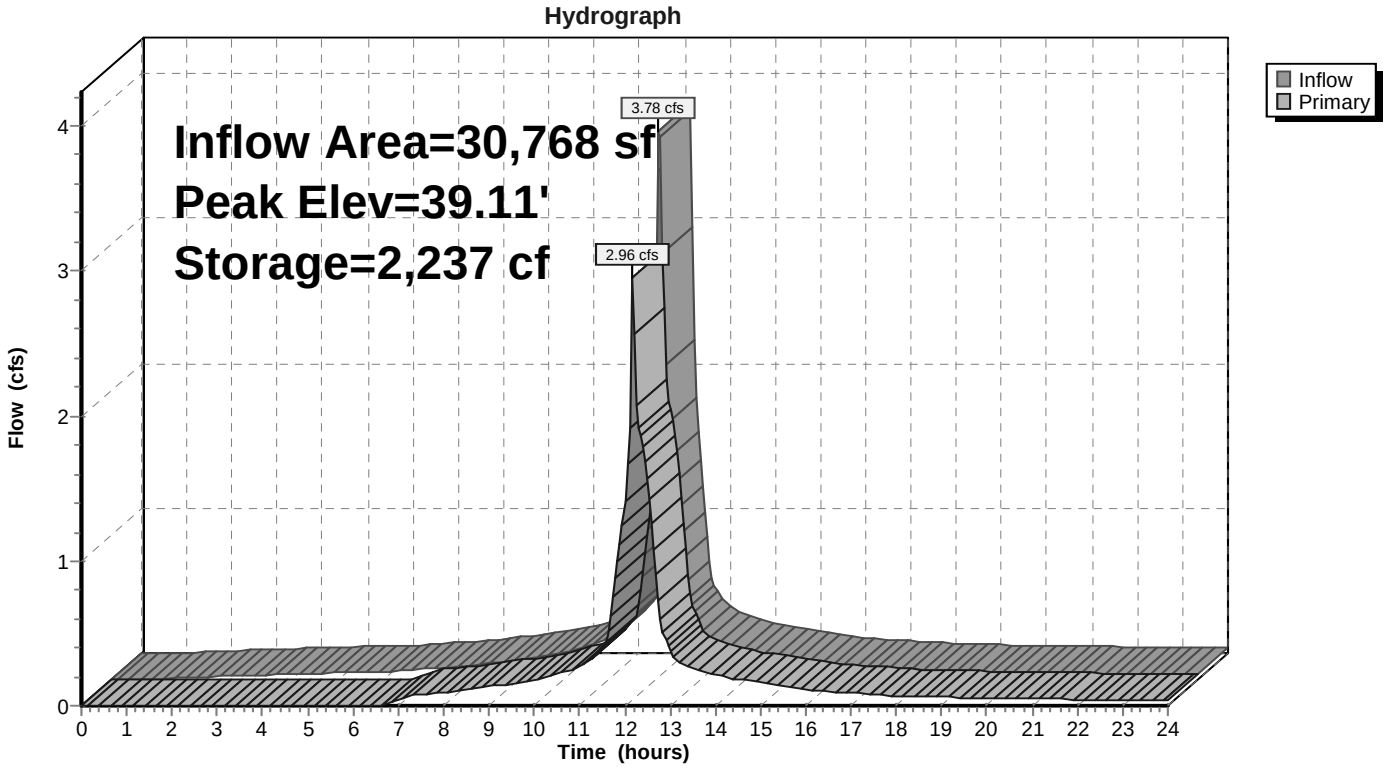
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	3,463 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
35.00	110	0	0	110
36.00	257	178	178	264
37.00	476	361	539	493
38.00	768	616	1,156	798
39.00	1,139	947	2,103	1,185
40.00	1,593	1,360	3,463	1,657

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 172.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 35.28' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.33'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	39.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.82 cfs @ 12.16 hrs HW=39.10' (Free Discharge)
└**1=RCP_Round 12"** (Passes 2.82 cfs of 4.28 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 2.01 cfs @ 5.77 fps)
  └**3=Orifice/Grate** (Weir Controls 0.80 cfs @ 1.02 fps)

Pond 10P: BMP 1



Summary for Pond 20Pa: BMP 2

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 5.36" for 25 yr event
Inflow = 8.39 cfs @ 12.09 hrs, Volume= 30,461 cf
Outflow = 5.41 cfs @ 12.19 hrs, Volume= 27,331 cf, Atten= 36%, Lag= 6.5 min
Primary = 5.41 cfs @ 12.19 hrs, Volume= 27,331 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.53' @ 12.19 hrs Surf.Area= 2,236 sf Storage= 7,461 cf

Plug-Flow detention time= 107.2 min calculated for 27,331 cf (90% of inflow)
Center-of-Mass det. time= 56.8 min (802.6 - 745.8)

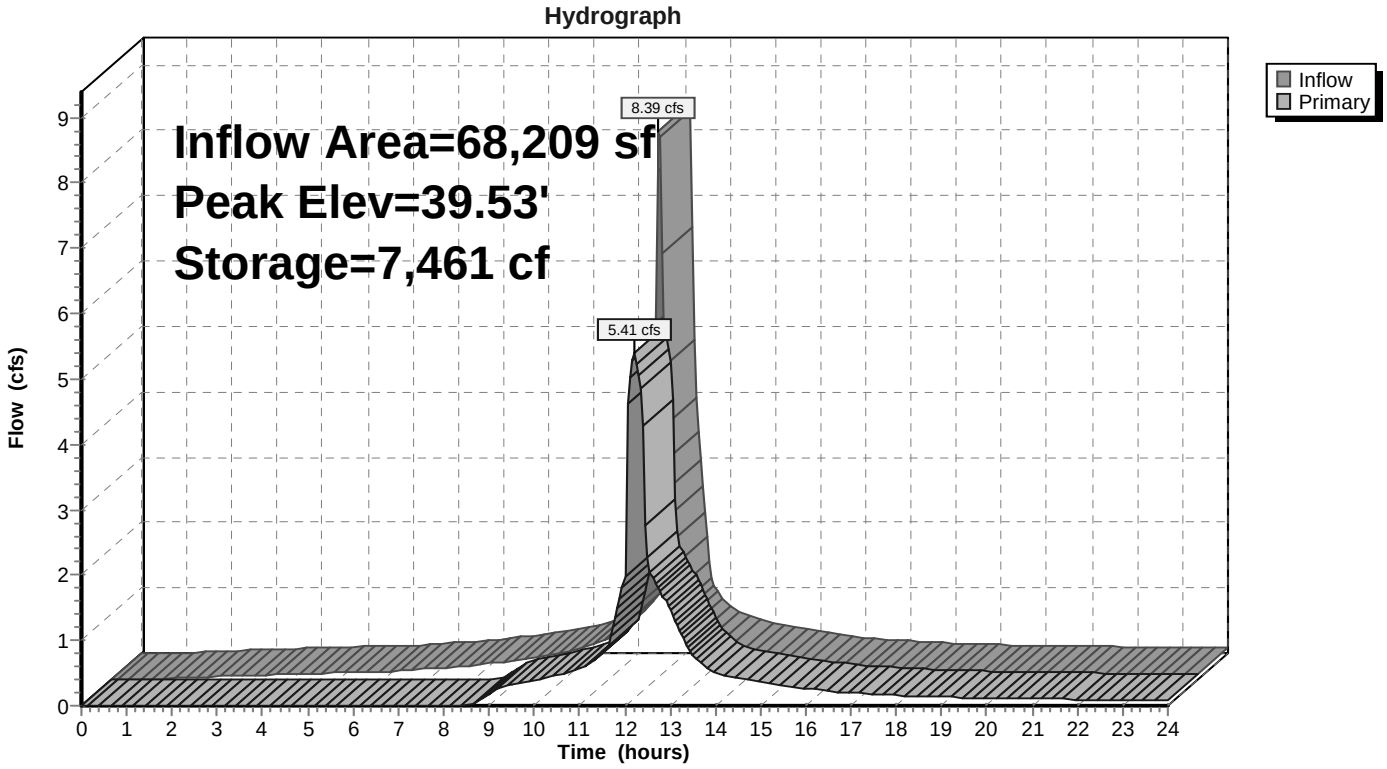
Volume	Invert	Avail.Storage	Storage Description
#1	34.00'	8,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
34.00	612	0	0	612
35.00	837	722	722	856
36.00	1,094	963	1,684	1,136
37.00	1,384	1,236	2,920	1,451
38.00	1,703	1,541	4,461	1,799
39.00	2,046	1,872	6,333	2,175
40.00	2,414	2,227	8,560	2,579

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 50.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 36.50' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	38.83'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	39.50'	**8.0' 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=5.38 cfs @ 12.19 hrs HW=39.52' (Free Discharge)
- **1=RCP_Round 12"** (Barrel Controls 5.32 cfs @ 6.77 fps)
  - **2=Orifice/Grate** (Passes < 2.49 cfs potential flow)
  - **3=Orifice/Grate** (Passes < 15.02 cfs potential flow)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 0.06 cfs @ 0.36 fps)

Pond 20Pa: BMP 2



Summary for Pond 20Pb: BMP 3

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 5.36" for 25 yr event
Inflow = 2.40 cfs @ 12.09 hrs, Volume= 8,719 cf
Outflow = 1.54 cfs @ 12.19 hrs, Volume= 8,033 cf, Atten= 36%, Lag= 6.0 min
Primary = 1.54 cfs @ 12.19 hrs, Volume= 8,033 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 40.18' @ 12.19 hrs Surf.Area= 1,023 sf Storage= 1,579 cf

Plug-Flow detention time= 84.7 min calculated for 8,017 cf (92% of inflow)
Center-of-Mass det. time= 43.8 min (789.6 - 745.8)

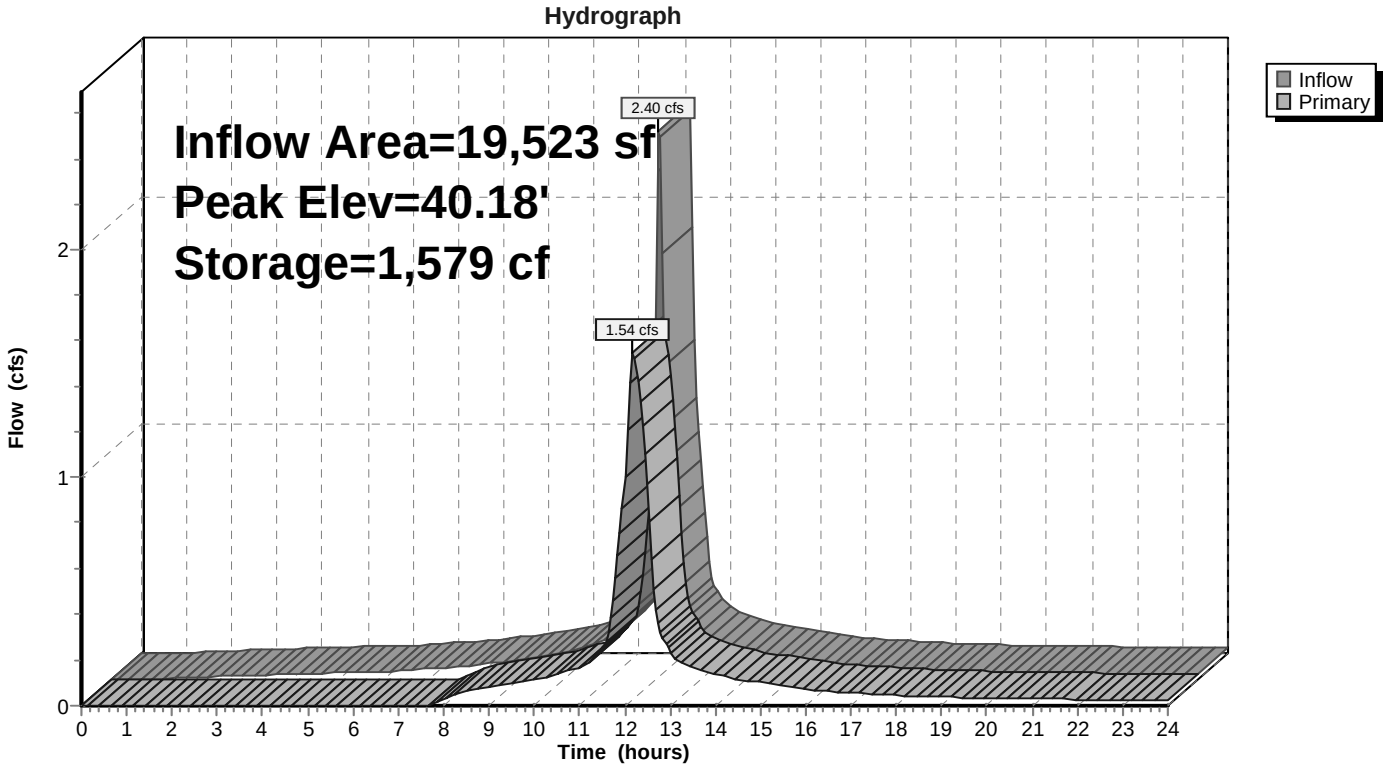
Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	2,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
37.00	111	0	0	111
38.00	303	199	199	309
39.00	590	439	638	606
40.00	954	765	1,402	983
41.00	1,373	1,157	2,560	1,419

Device	Routing	Invert	Outlet Devices
#1	Primary	39.00'	**12.0" Round RCP_Round 12"** L= 81.7' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 39.00' / 38.00' S= 0.0122 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	39.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	40.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.54 cfs @ 12.19 hrs HW=40.17' (Free Discharge)
└**1=RCP_Round 12"** (Passes 1.54 cfs of 3.10 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 1.54 cfs @ 4.41 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 20Pb: BMP 3

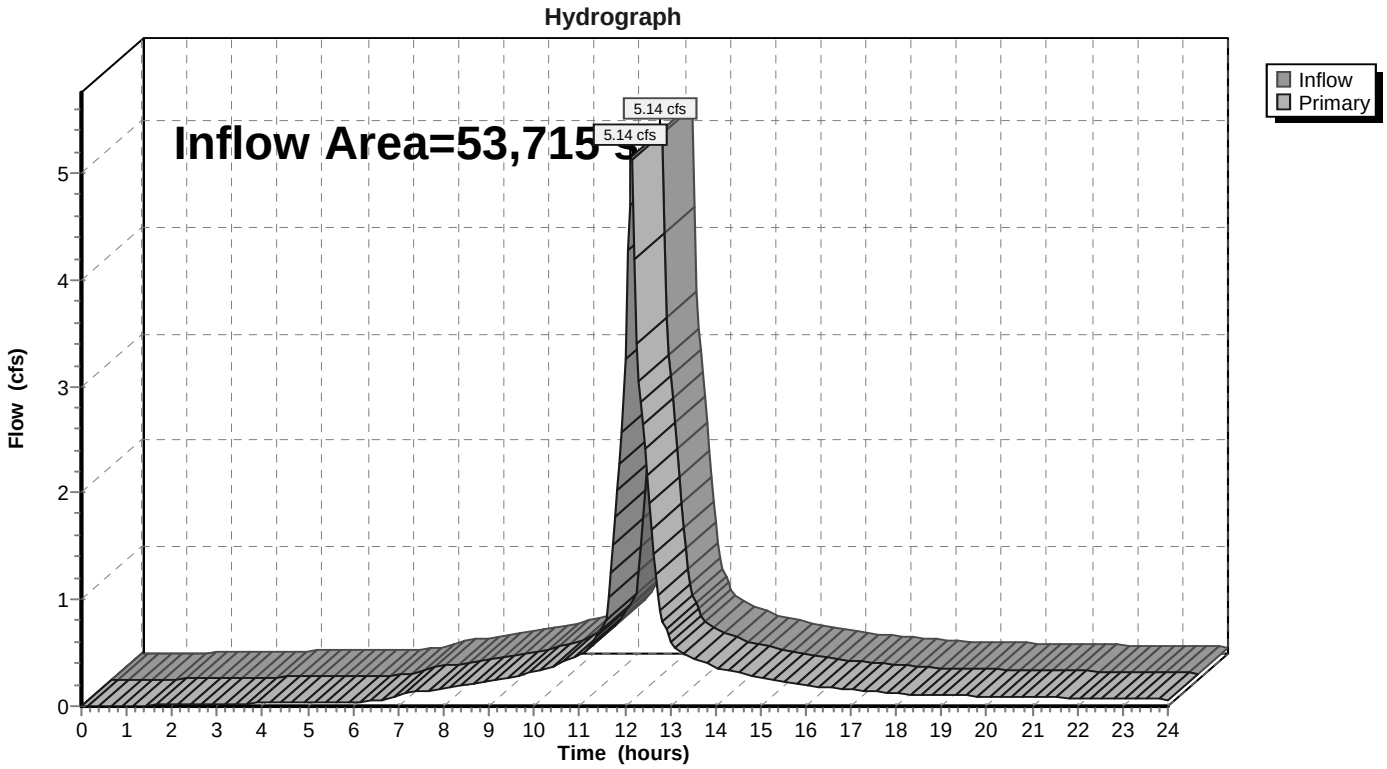


Summary for Link 10L: POI 1

Inflow Area = 53,715 sf,100.00% Impervious, Inflow Depth > 5.19" for 25 yr event
Inflow = 5.14 cfs @ 12.14 hrs, Volume= 23,222 cf
Primary = 5.14 cfs @ 12.14 hrs, Volume= 23,222 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 10L: POI 1

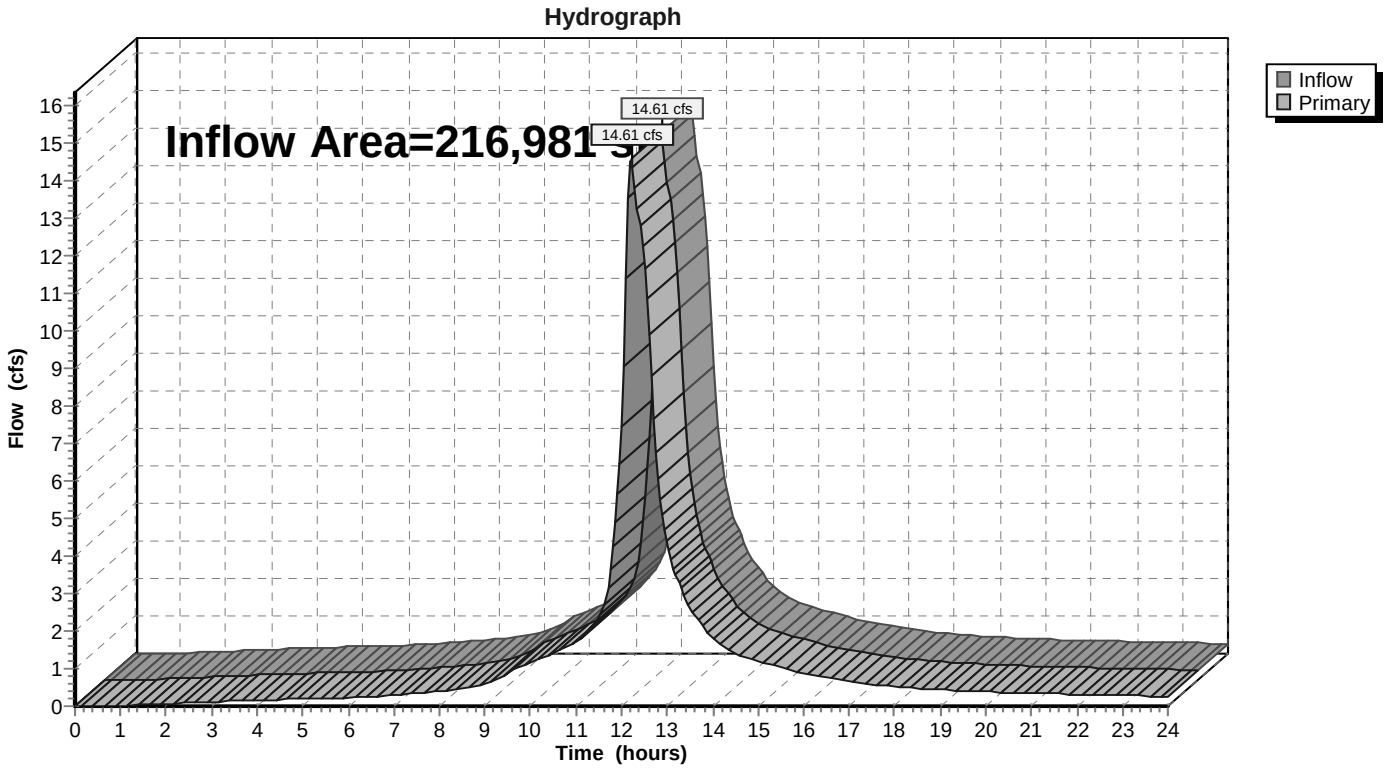


Summary for Link 20L: POI 2

Inflow Area = 216,981 sf, 99.11% Impervious, Inflow Depth > 5.12" for 25 yr event
Inflow = 14.61 cfs @ 12.22 hrs, Volume= 92,668 cf
Primary = 14.61 cfs @ 12.22 hrs, Volume= 92,668 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 20L: POI 2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT Runoff Area=22,947 sf 100.00% Impervious Runoff Depth>5.96"
Tc=6.0 min CN=98 Runoff=3.13 cfs 11,393 cf

Subcatchment 10Sb: POI 1 - OVERLAND TO Runoff Area=30,768 sf 100.00% Impervious Runoff Depth>5.96"
Tc=6.0 min CN=98 Runoff=4.19 cfs 15,276 cf

Subcatchment 20Sa: POI 2 - OVERLAND TO Runoff Area=68,209 sf 100.00% Impervious Runoff Depth>5.96"
Tc=6.0 min CN=98 Runoff=9.29 cfs 33,866 cf

Subcatchment 20Sb: POI 2 - OVERLAND TO Runoff Area=19,523 sf 100.00% Impervious Runoff Depth>5.96"
Tc=6.0 min CN=98 Runoff=2.66 cfs 9,693 cf

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT Runoff Area=129,249 sf 98.50% Impervious Runoff Depth>5.95"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=98 Runoff=13.74 cfs 64,093 cf

Reach 20Ra1: Grassed Channel Avg. Flow Depth=0.32' Max Vel=3.21 fps Inflow=7.15 cfs 30,723 cf
n=0.022 L=436.0' S=0.0161 '/' Capacity=16.40 cfs Outflow=6.62 cfs 30,659 cf

Reach 20Ra2: Natural Stream Avg. Flow Depth=0.35' Max Vel=1.35 fps Inflow=6.62 cfs 30,659 cf
n=0.040 L=600.0' S=0.0100 '/' Capacity=12.48 cfs Outflow=5.62 cfs 30,479 cf

Reach 20Rb: Natural Stream Avg. Flow Depth=0.16' Max Vel=1.01 fps Inflow=1.66 cfs 9,006 cf
n=0.040 L=1,006.0' S=0.0129 '/' Capacity=14.18 cfs Outflow=1.38 cfs 8,882 cf

Pond 10P: BMP 1 Peak Elev=39.16' Storage=2,291 cf Inflow=4.19 cfs 15,276 cf
Outflow=3.74 cfs 14,506 cf

Pond 20Pa: BMP 2 Peak Elev=39.69' Storage=7,830 cf Inflow=9.29 cfs 33,866 cf
Outflow=7.15 cfs 30,723 cf

Pond 20Pb: BMP 3 Peak Elev=40.31' Storage=1,712 cf Inflow=2.66 cfs 9,693 cf
Outflow=1.66 cfs 9,006 cf

Link 10L: POI 1 Inflow=6.25 cfs 25,899 cf
Primary=6.25 cfs 25,899 cf

Link 20L: POI 2 Inflow=16.34 cfs 103,454 cf
Primary=16.34 cfs 103,454 cf

Total Runoff Area = 270,696 sf Runoff Volume = 134,322 cf Average Runoff Depth = 5.95"
0.72% Pervious = 1,937 sf 99.28% Impervious = 268,759 sf

Summary for Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

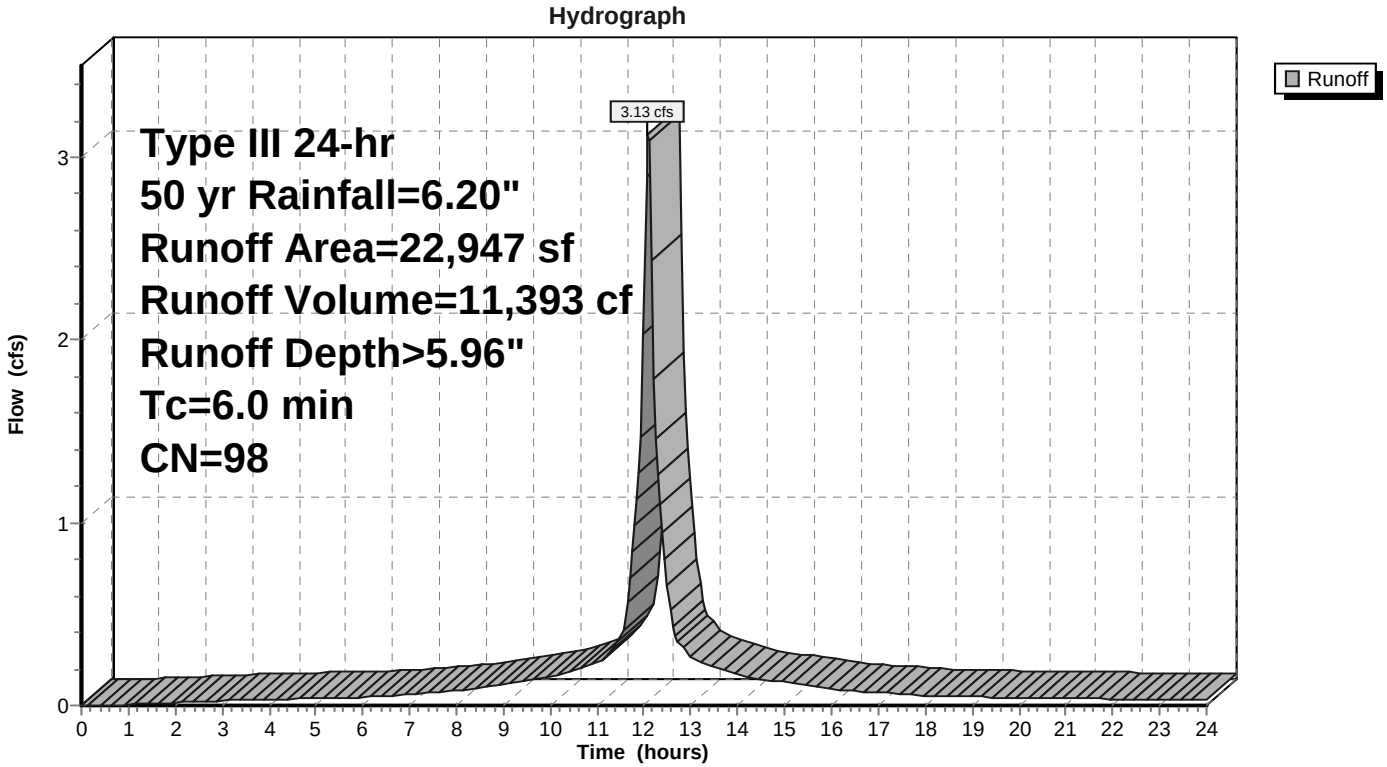
Runoff = 3.13 cfs @ 12.09 hrs, Volume= 11,393 cf, Depth> 5.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=6.20"

Area (sf)	CN	Description
22,947	98	Paved roads w/curbs & sewers, HSG C
22,947		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1

1. For pavements, Tc assumed to be 5 minutes.

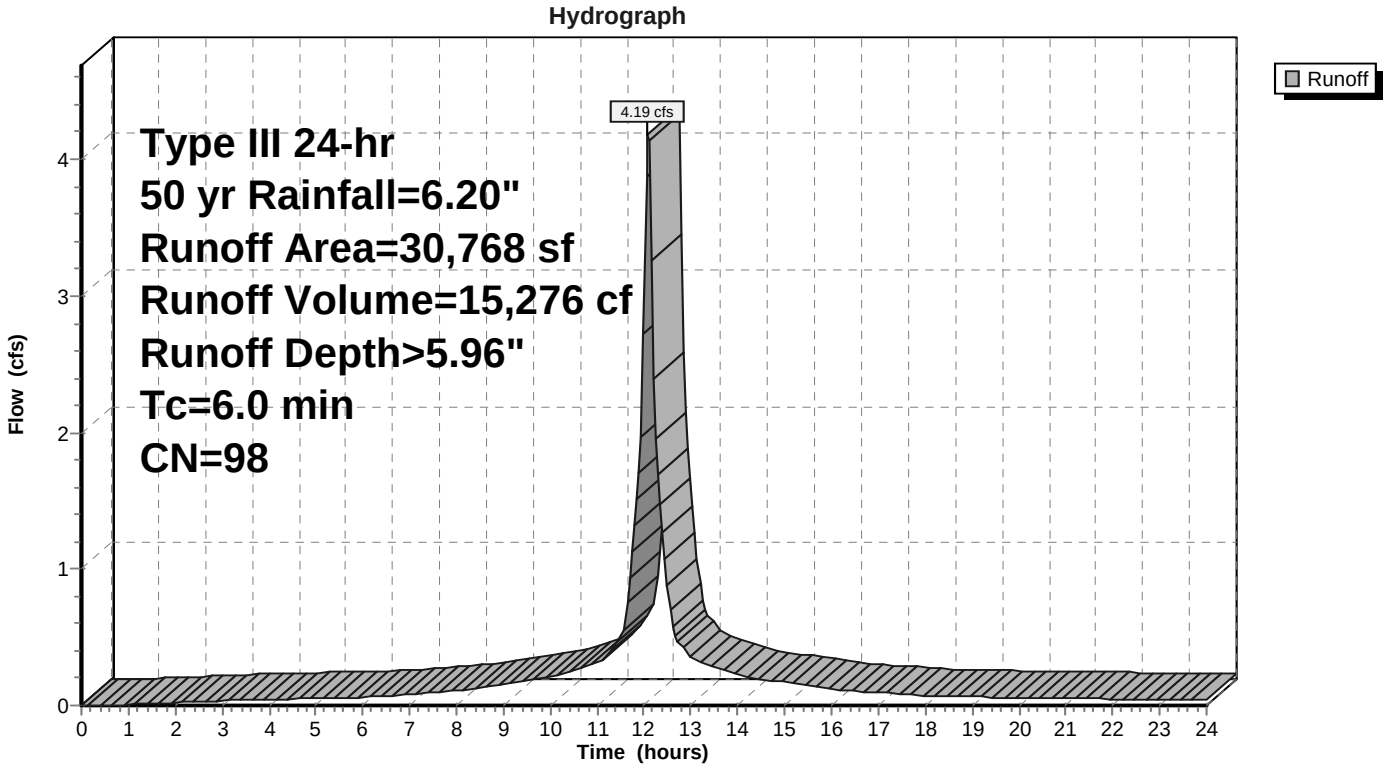
Runoff = 4.19 cfs @ 12.09 hrs, Volume= 15,276 cf, Depth> 5.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=6.20"

Area (sf)	CN	Description
30,768	98	Paved roads w/curbs & sewers, HSG C
30,768		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1



Summary for Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2

1. For pavements, Tc assumed to be 5 minutes.

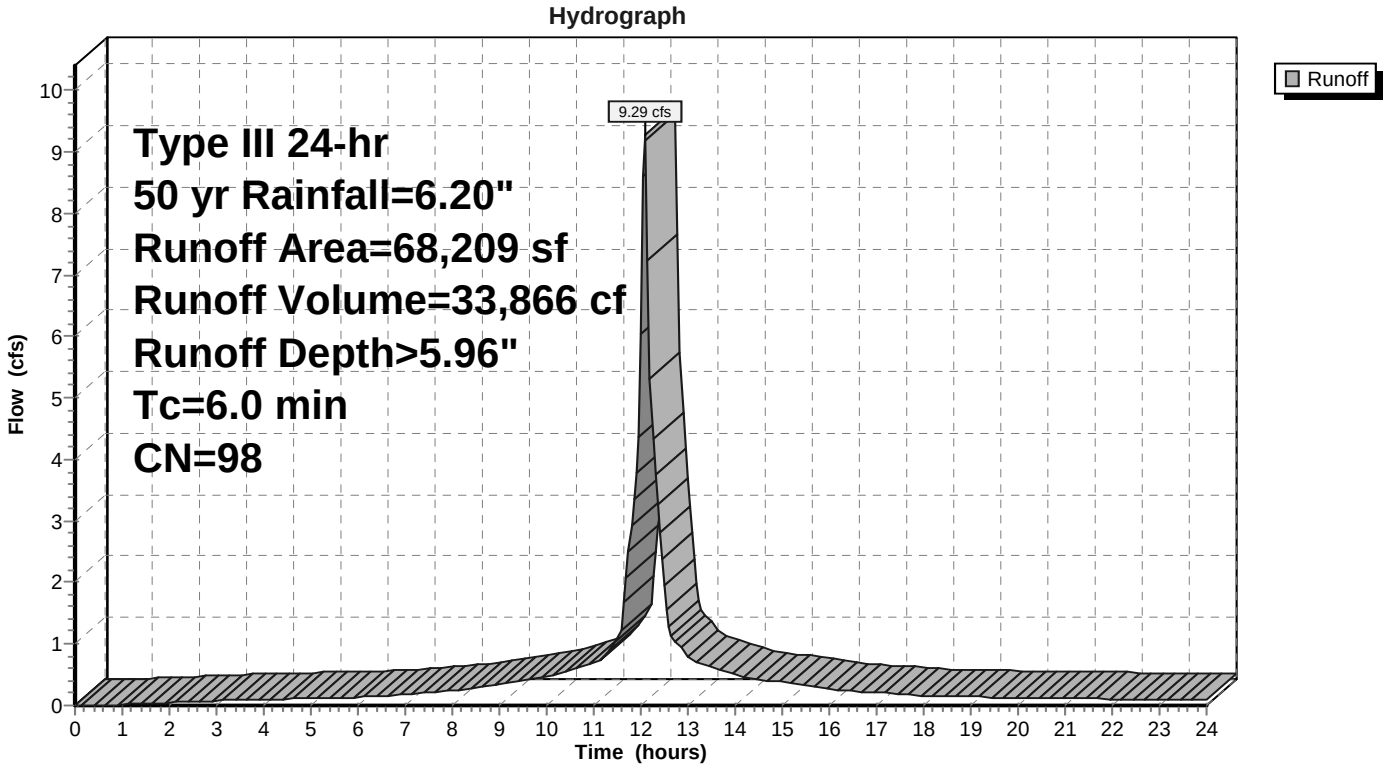
Runoff = 9.29 cfs @ 12.09 hrs, Volume= 33,866 cf, Depth> 5.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=6.20"

Area (sf)	CN	Description
68,209	98	Paved roads w/curbs & sewers, HSG C
68,209		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2



Summary for Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3

1. For pavements, Tc assumed to be 5 minutes.

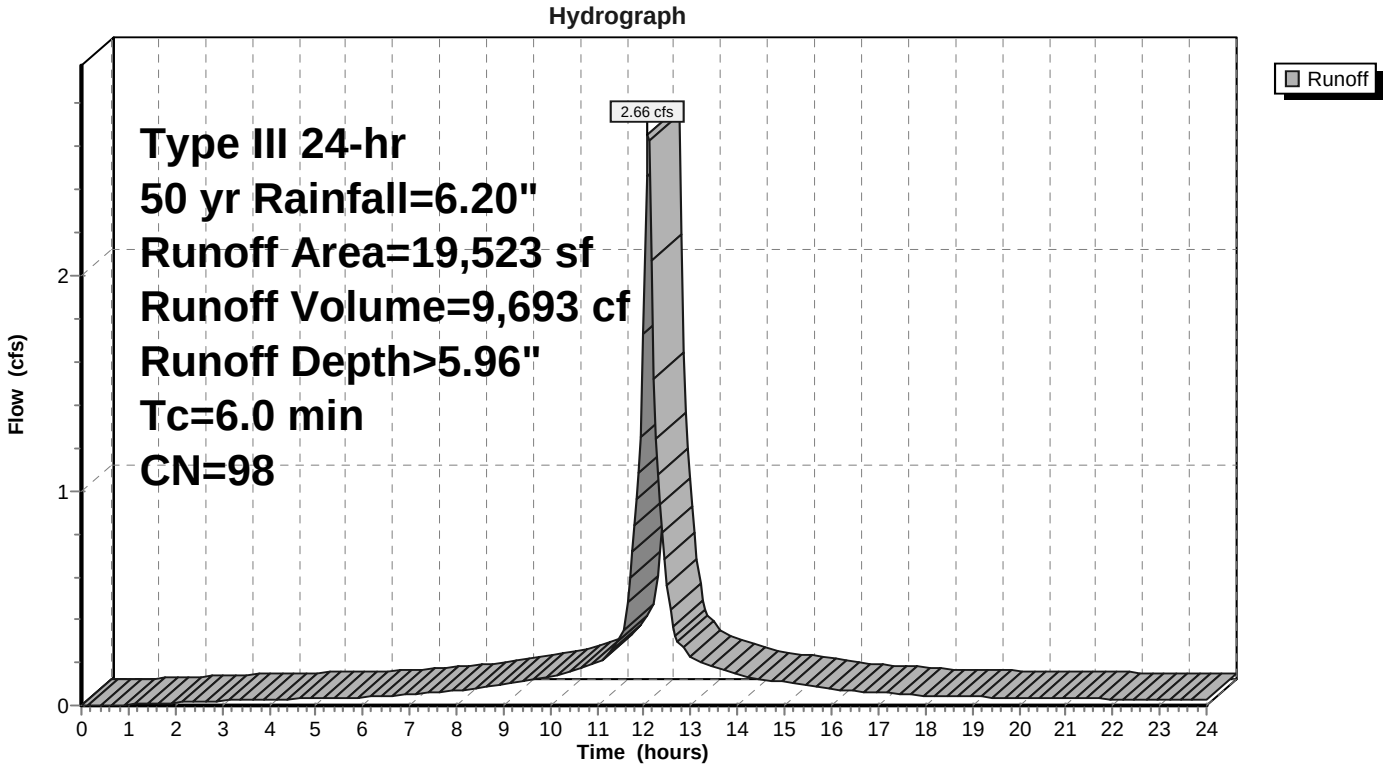
Runoff = 2.66 cfs @ 12.09 hrs, Volume= 9,693 cf, Depth> 5.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=6.20"

Area (sf)	CN	Description
19,523	98	Paved roads w/curbs & sewers, HSG C
19,523		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3



Summary for Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

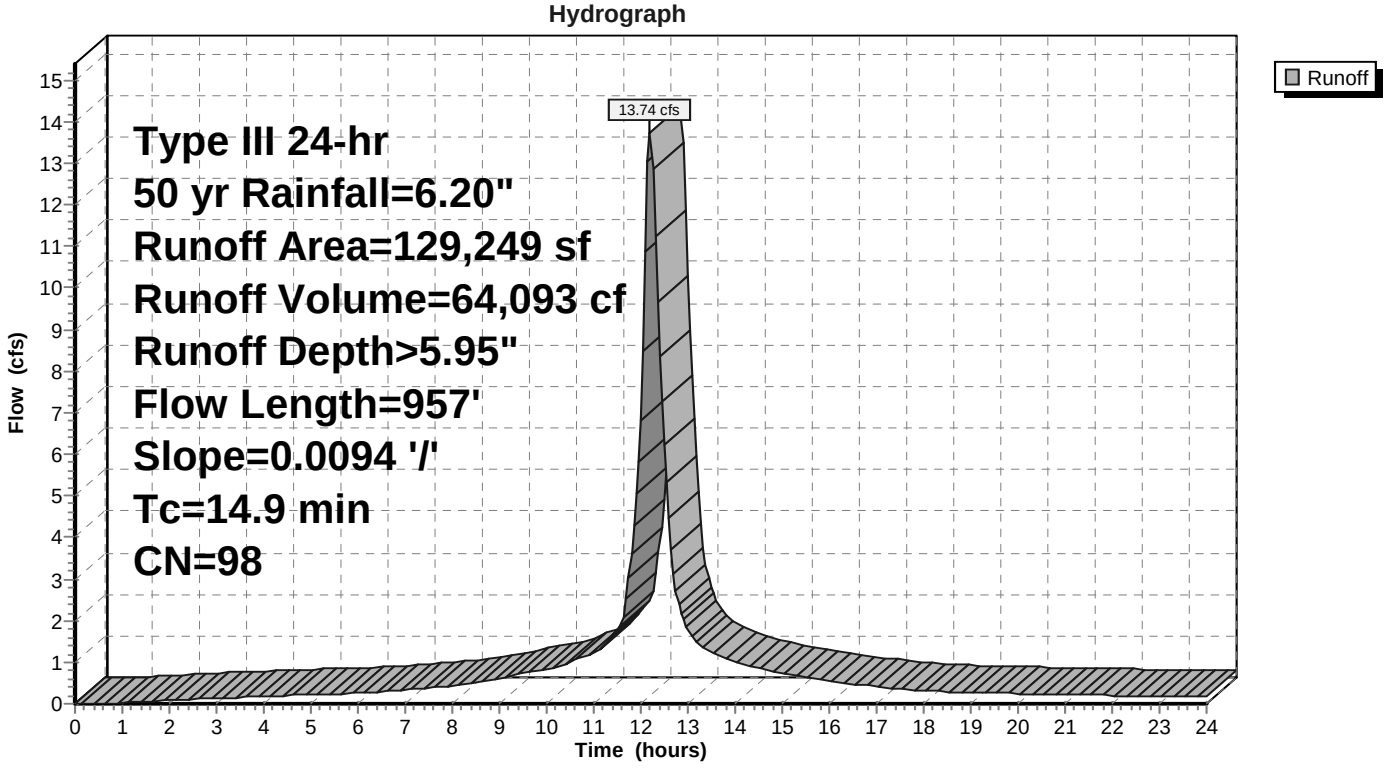
Runoff = 13.74 cfs @ 12.20 hrs, Volume= 64,093 cf, Depth> 5.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=6.20"

Area (sf)	CN	Description
127,312	98	Paved roads w/curbs & sewers, HSG C
1,937	79	50-75% Grass cover, Fair, HSG C
129,249	98	Weighted Average
1,937		1.50% Pervious Area
127,312		98.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE



Summary for Reach 20Ra1: Grassed Channel

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 5.41" for 50 yr event
Inflow = 7.15 cfs @ 12.16 hrs, Volume= 30,723 cf
Outflow = 6.62 cfs @ 12.24 hrs, Volume= 30,659 cf, Atten= 7%, Lag= 4.6 min

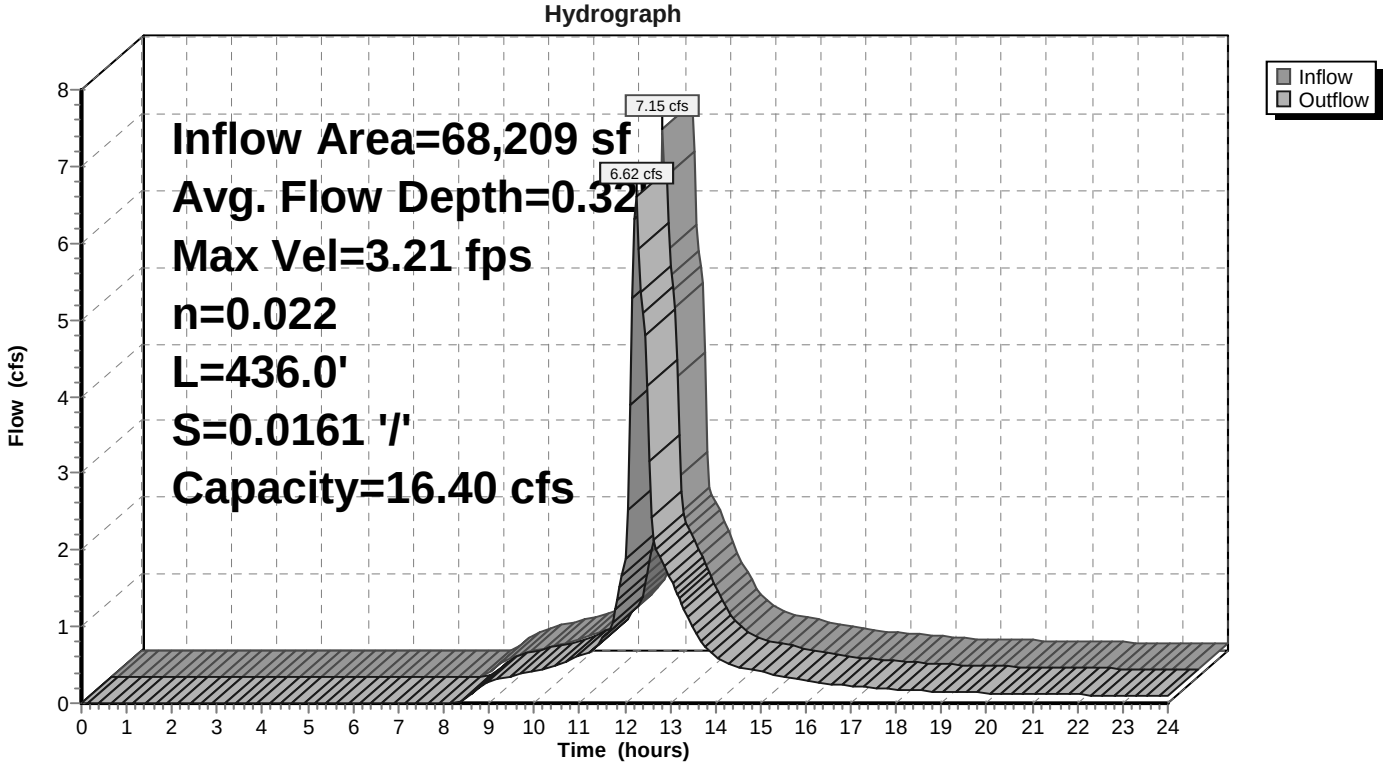
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.21 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 6.0 min

Peak Storage= 919 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 16.40 cfs

4.00' x 0.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 8.0 '/' Top Width= 12.00'
Length= 436.0' Slope= 0.0161 '/'
Inlet Invert= 36.00', Outlet Invert= 29.00'

‡

Reach 20Ra1: Grassed Channel



Summary for Reach 20Ra2: Natural Stream

[62] Hint: Exceeded Reach 20Ra1 OUTLET depth by 0.12' @ 12.55 hrs

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 5.39" for 50 yr event
Inflow = 6.62 cfs @ 12.24 hrs, Volume= 30,659 cf
Outflow = 5.62 cfs @ 12.46 hrs, Volume= 30,479 cf, Atten= 15%, Lag= 13.3 min

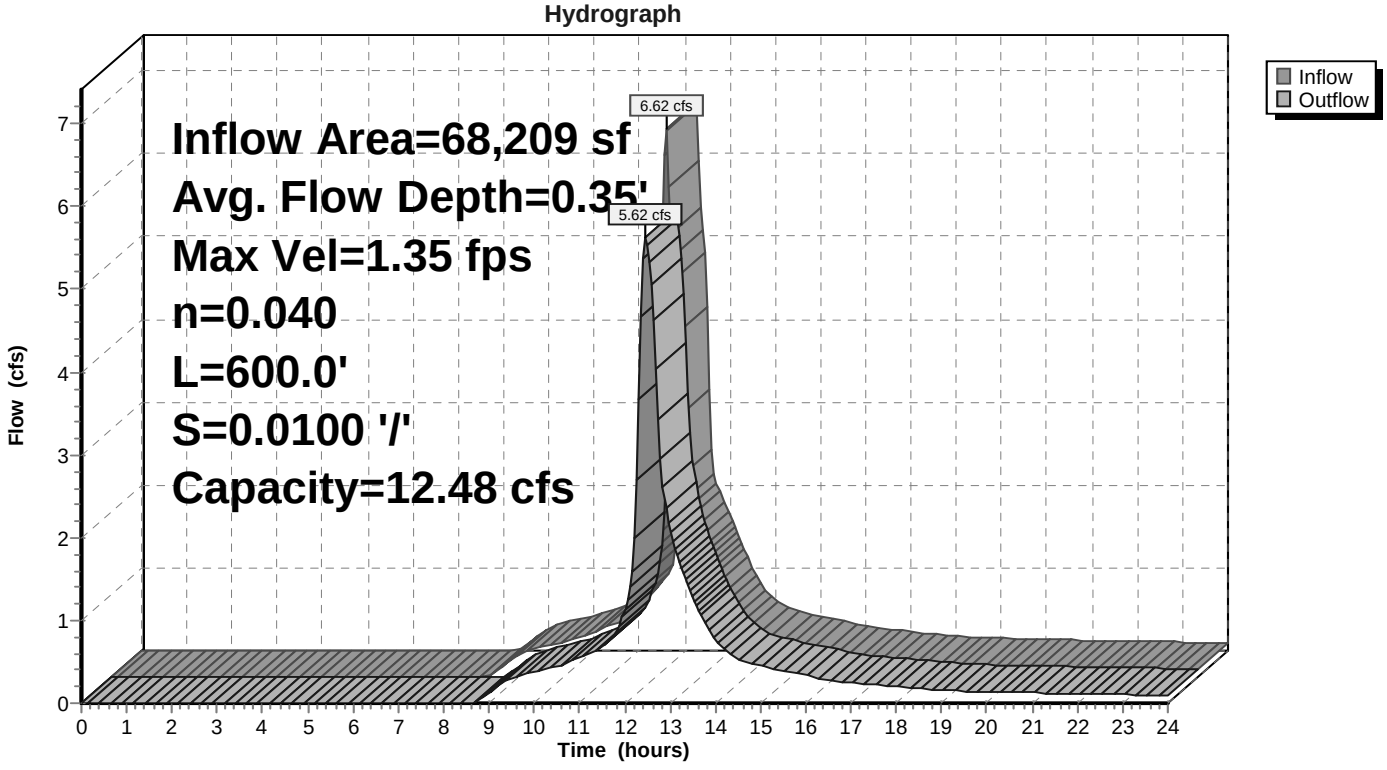
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.35 fps, Min. Travel Time= 7.4 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 16.8 min

Peak Storage= 2,498 cf @ 12.33 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 12.48 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 600.0' Slope= 0.0100 '/'
Inlet Invert= 29.00', Outlet Invert= 23.00'

‡

Reach 20Ra2: Natural Stream



Summary for Reach 20Rb: Natural Stream

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 5.54" for 50 yr event
Inflow = 1.66 cfs @ 12.19 hrs, Volume= 9,006 cf
Outflow = 1.38 cfs @ 12.67 hrs, Volume= 8,882 cf, Atten= 17%, Lag= 28.7 min

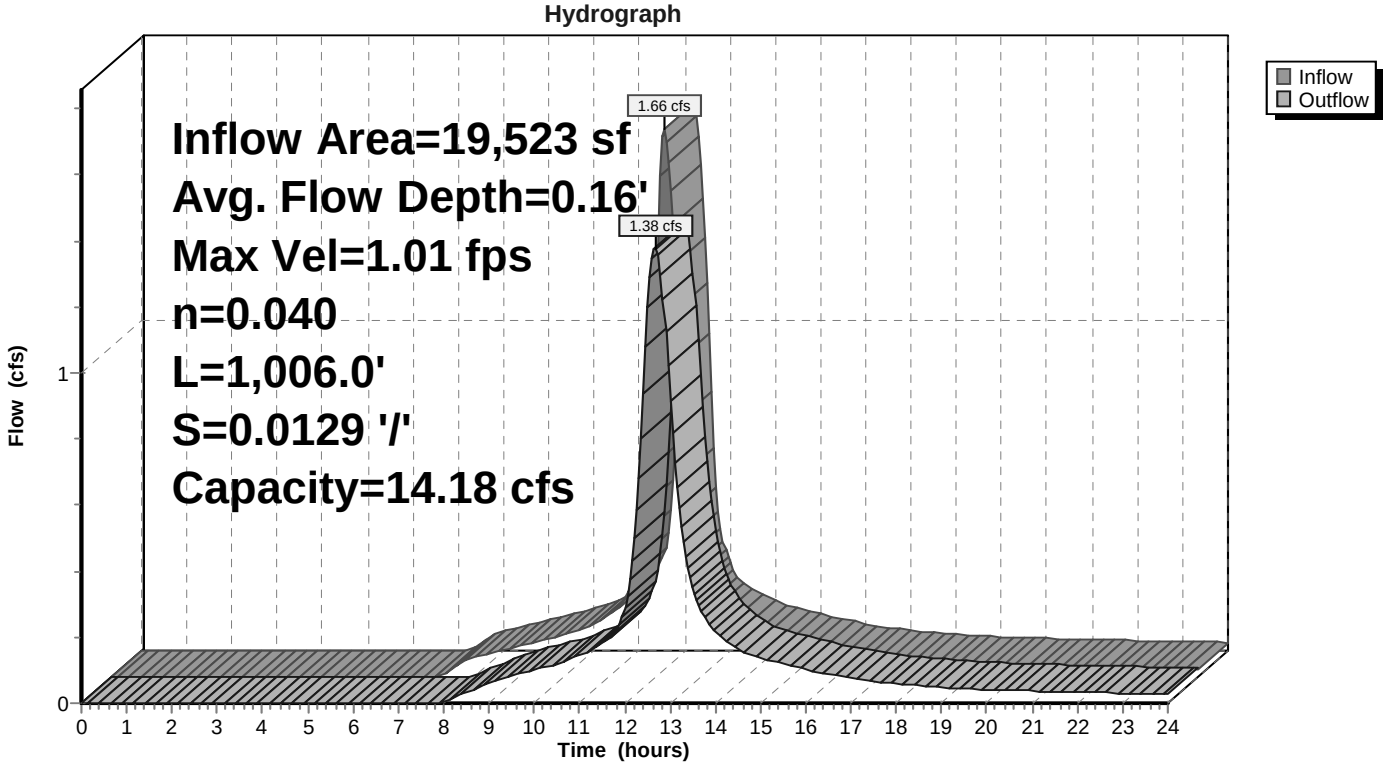
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.01 fps, Min. Travel Time= 16.5 min
Avg. Velocity = 0.43 fps, Avg. Travel Time= 39.1 min

Peak Storage= 1,369 cf @ 12.40 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 14.18 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 1,006.0' Slope= 0.0129 '/'
Inlet Invert= 36.00', Outlet Invert= 23.00'

‡

Reach 20Rb: Natural Stream



Summary for Pond 10P: BMP 1

Inflow Area = 30,768 sf,100.00% Impervious, Inflow Depth > 5.96" for 50 yr event
Inflow = 4.19 cfs @ 12.09 hrs, Volume= 15,276 cf
Outflow = 3.74 cfs @ 12.15 hrs, Volume= 14,506 cf, Atten= 11%, Lag= 4.0 min
Primary = 3.74 cfs @ 12.15 hrs, Volume= 14,506 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.16' @ 12.15 hrs Surf.Area= 1,207 sf Storage= 2,291 cf

Plug-Flow detention time= 62.3 min calculated for 14,506 cf (95% of inflow)
Center-of-Mass det. time= 33.1 min (777.3 - 744.2)

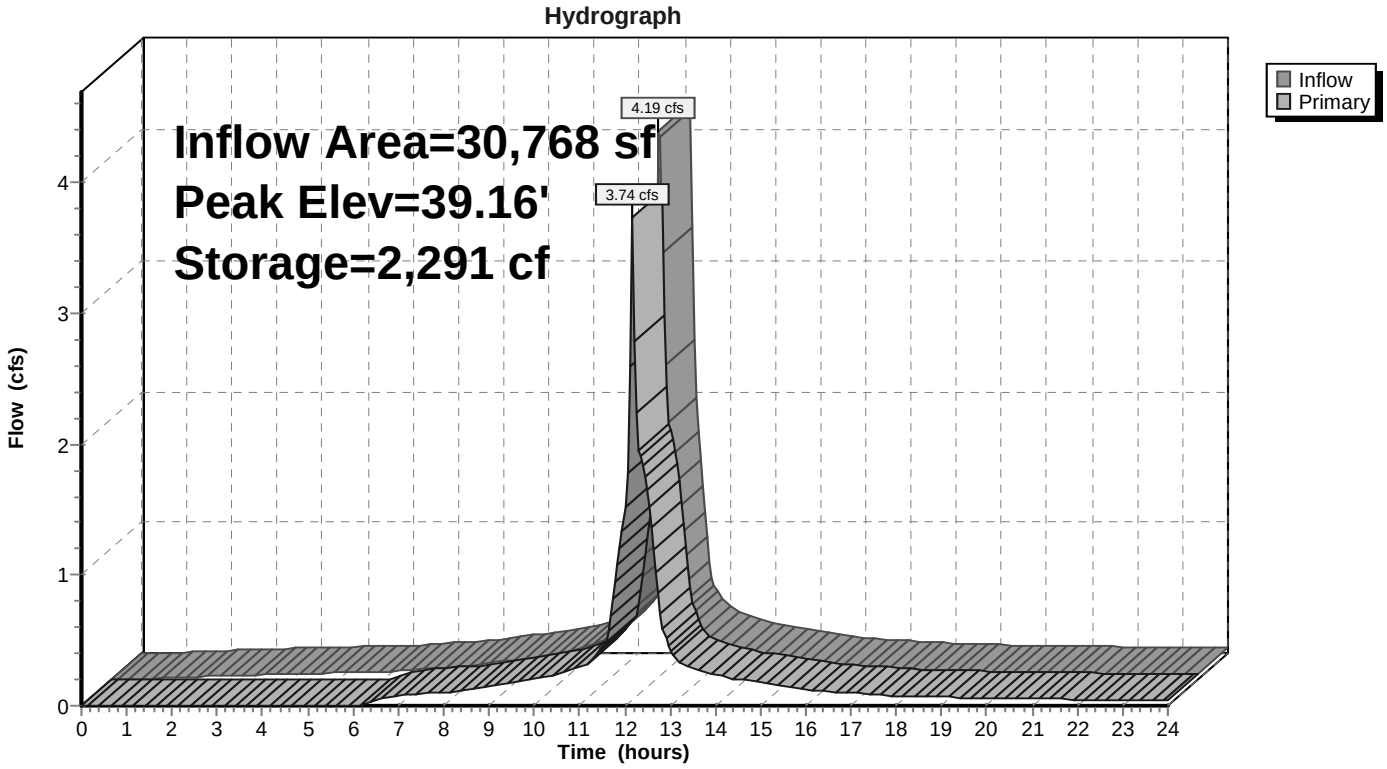
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	3,463 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
35.00	110	0	0	110
36.00	257	178	178	264
37.00	476	361	539	493
38.00	768	616	1,156	798
39.00	1,139	947	2,103	1,185
40.00	1,593	1,360	3,463	1,657

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 172.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 35.28' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.33'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	39.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.69 cfs @ 12.15 hrs HW=39.16' (Free Discharge)
└**1=RCP_Round 12"** (Passes 3.69 cfs of 4.33 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 2.05 cfs @ 5.89 fps)
  └**3=Orifice/Grate** (Weir Controls 1.64 cfs @ 1.30 fps)

Pond 10P: BMP 1



Summary for Pond 20Pa: BMP 2

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 5.96" for 50 yr event
Inflow = 9.29 cfs @ 12.09 hrs, Volume= 33,866 cf
Outflow = 7.15 cfs @ 12.16 hrs, Volume= 30,723 cf, Atten= 23%, Lag= 4.6 min
Primary = 7.15 cfs @ 12.16 hrs, Volume= 30,723 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.69' @ 12.16 hrs Surf.Area= 2,297 sf Storage= 7,830 cf

Plug-Flow detention time= 100.9 min calculated for 30,723 cf (91% of inflow)
Center-of-Mass det. time= 54.0 min (798.2 - 744.2)

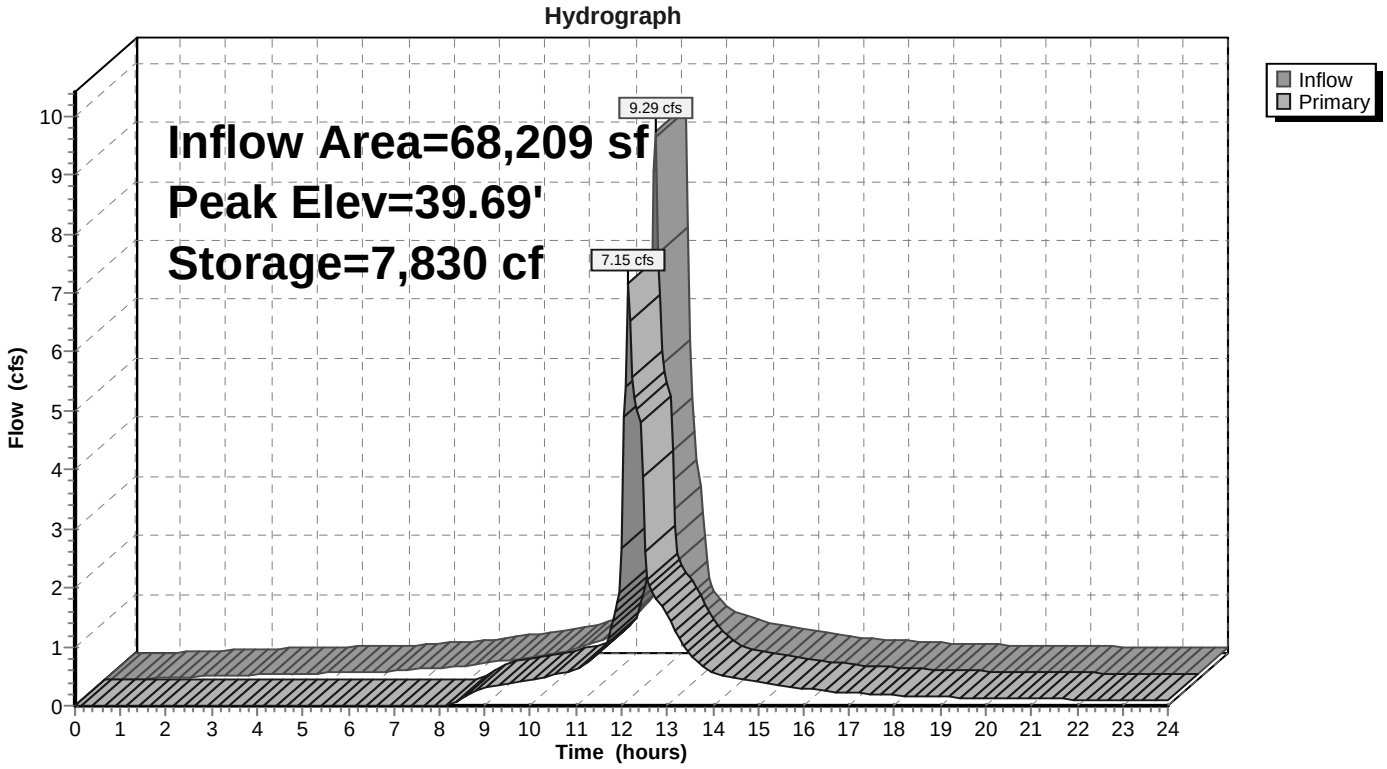
Volume	Invert	Avail.Storage	Storage Description
#1	34.00'	8,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
34.00	612	0	0	612
35.00	837	722	722	856
36.00	1,094	963	1,684	1,136
37.00	1,384	1,236	2,920	1,451
38.00	1,703	1,541	4,461	1,799
39.00	2,046	1,872	6,333	2,175
40.00	2,414	2,227	8,560	2,579

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 50.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 36.50' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	38.83'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	39.50'	**8.0' 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 @ 12.16 hrs HW=39.67' (Free Discharge)
- **1=RCP_Round 12"** (Barrel Controls 5.51 cfs @ 7.02 fps)
  - **2=Orifice/Grate** (Passes < 2.57 cfs potential flow)
  - **3=Orifice/Grate** (Passes < 17.66 cfs potential flow)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 1.41 cfs @ 1.03 fps)

Pond 20Pa: BMP 2



Summary for Pond 20Pb: BMP 3

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 5.96" for 50 yr event
Inflow = 2.66 cfs @ 12.09 hrs, Volume= 9,693 cf
Outflow = 1.66 cfs @ 12.19 hrs, Volume= 9,006 cf, Atten= 38%, Lag= 6.4 min
Primary = 1.66 cfs @ 12.19 hrs, Volume= 9,006 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 40.31' @ 12.19 hrs Surf.Area= 1,074 sf Storage= 1,712 cf

Plug-Flow detention time= 79.6 min calculated for 8,987 cf (93% of inflow)
Center-of-Mass det. time= 41.7 min (785.9 - 744.2)

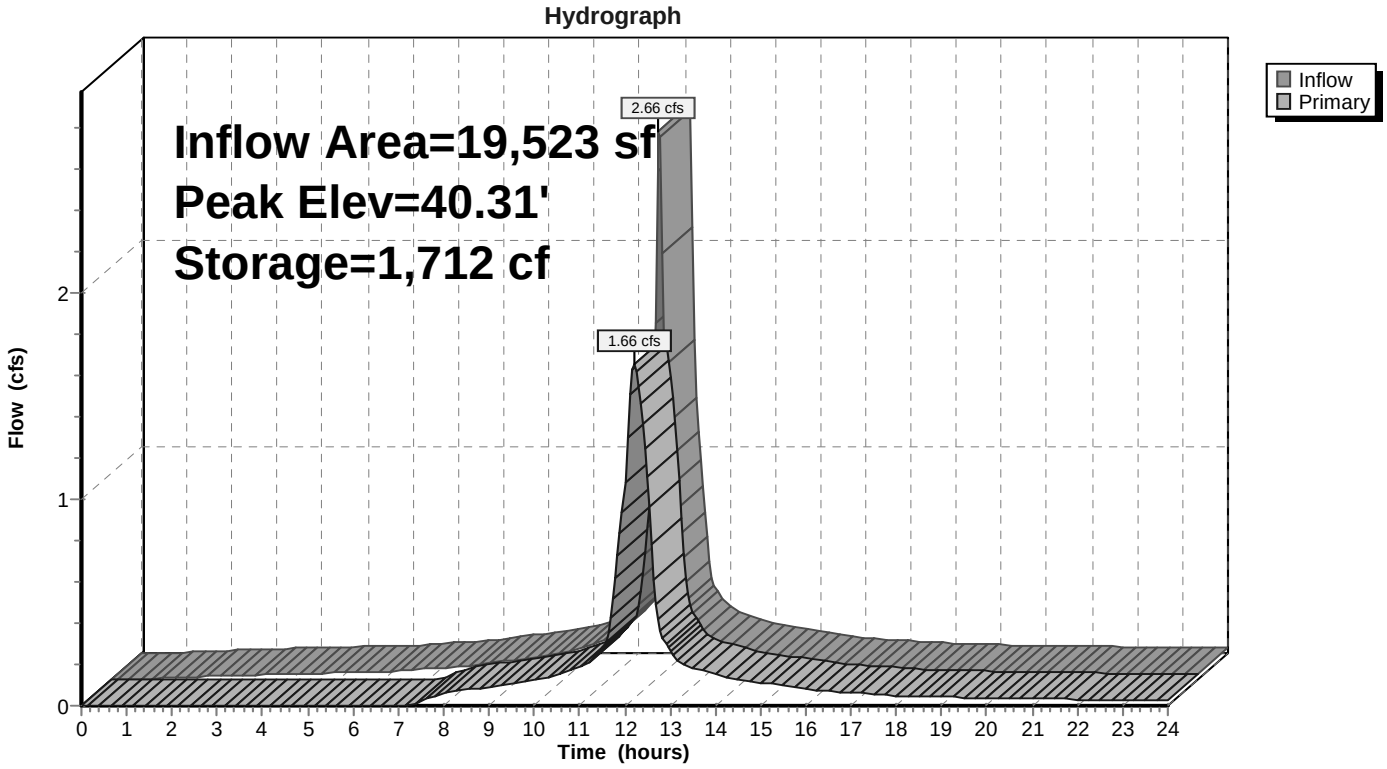
Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	2,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
37.00	111	0	0	111
38.00	303	199	199	309
39.00	590	439	638	606
40.00	954	765	1,402	983
41.00	1,373	1,157	2,560	1,419

Device	Routing	Invert	Outlet Devices
#1	Primary	39.00'	**12.0" Round RCP_Round 12"** L= 81.7' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 39.00' / 38.00' S= 0.0122 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	39.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	40.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.65 cfs @ 12.19 hrs HW=40.30' (Free Discharge)
└**1=RCP_Round 12"** (Passes 1.65 cfs of 3.39 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 1.65 cfs @ 4.74 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 20Pb: BMP 3

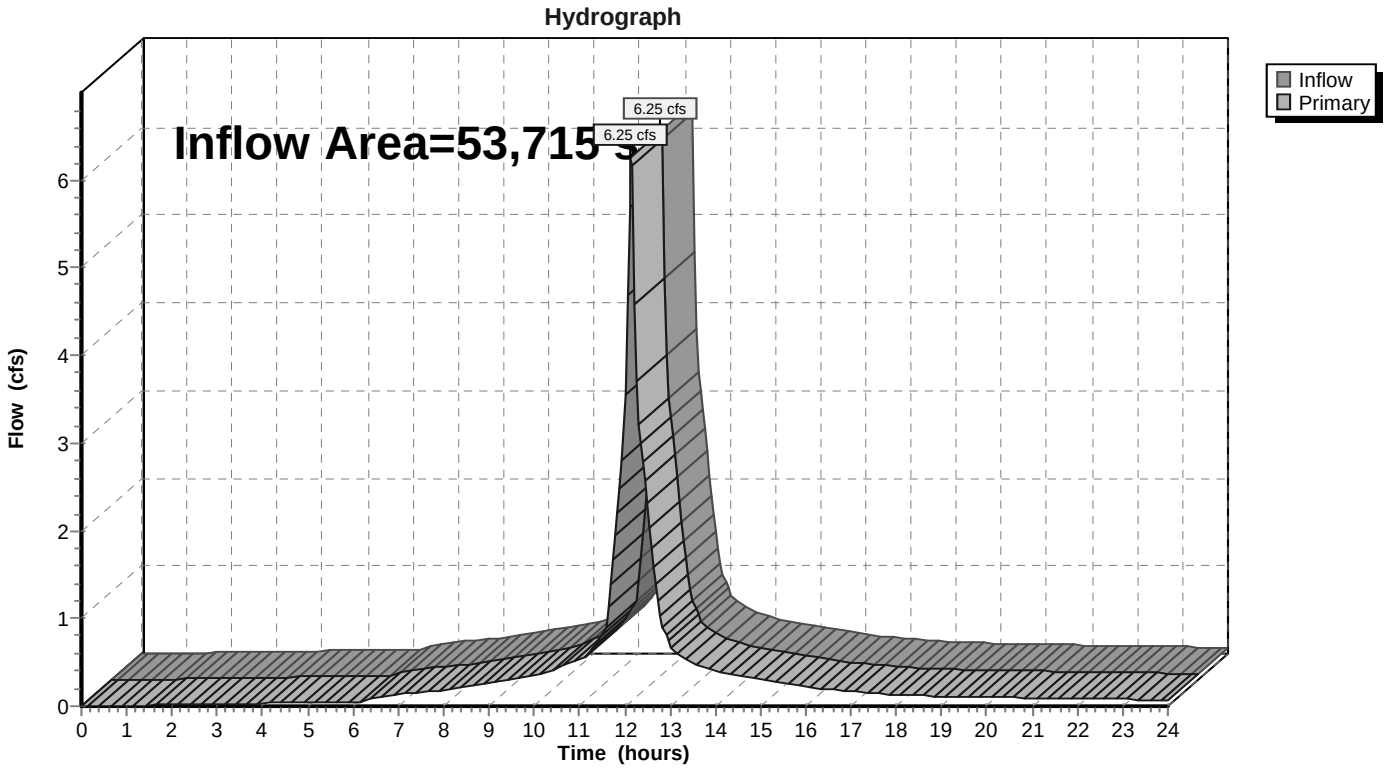


Summary for Link 10L: POI 1

Inflow Area = 53,715 sf,100.00% Impervious, Inflow Depth > 5.79" for 50 yr event
Inflow = 6.25 cfs @ 12.14 hrs, Volume= 25,899 cf
Primary = 6.25 cfs @ 12.14 hrs, Volume= 25,899 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 10L: POI 1

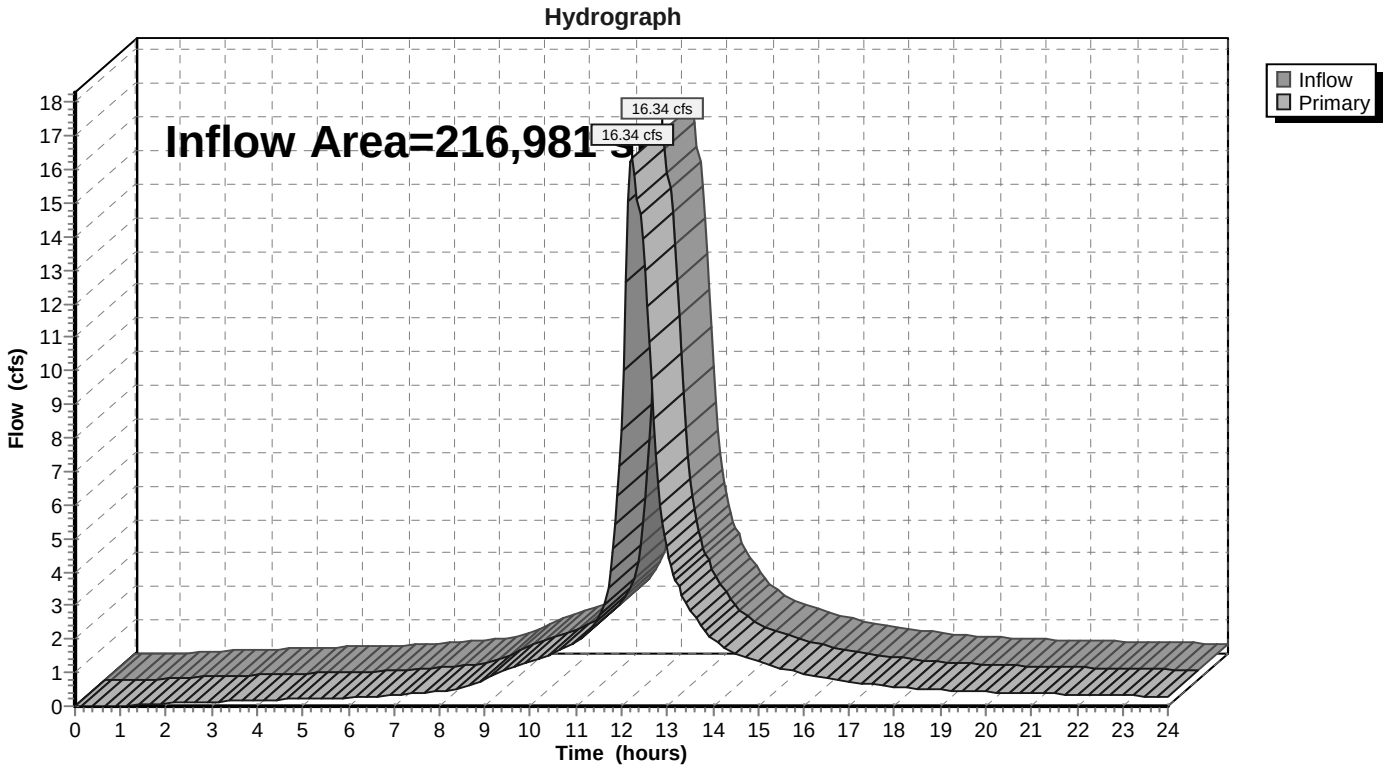


Summary for Link 20L: POI 2

Inflow Area = 216,981 sf, 99.11% Impervious, Inflow Depth > 5.72" for 50 yr event
Inflow = 16.34 cfs @ 12.22 hrs, Volume= 103,454 cf
Primary = 16.34 cfs @ 12.22 hrs, Volume= 103,454 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 20L: POI 2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT Runoff Area=22,947 sf 100.00% Impervious Runoff Depth>6.66"
Tc=6.0 min CN=98 Runoff=3.48 cfs 12,730 cf

Subcatchment 10Sb: POI 1 - OVERLAND TO Runoff Area=30,768 sf 100.00% Impervious Runoff Depth>6.66"
Tc=6.0 min CN=98 Runoff=4.67 cfs 17,069 cf

Subcatchment 20Sa: POI 2 - OVERLAND TO Runoff Area=68,209 sf 100.00% Impervious Runoff Depth>6.66"
Tc=6.0 min CN=98 Runoff=10.35 cfs 37,839 cf

Subcatchment 20Sb: POI 2 - OVERLAND TO Runoff Area=19,523 sf 100.00% Impervious Runoff Depth>6.66"
Tc=6.0 min CN=98 Runoff=2.96 cfs 10,830 cf

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT Runoff Area=129,249 sf 98.50% Impervious Runoff Depth>6.65"
Flow Length=957' Slope=0.0094 '/' Tc=14.9 min CN=98 Runoff=15.30 cfs 71,612 cf

Reach 20Ra1: Grassed Channel Avg. Flow Depth=0.35' Max Vel=3.36 fps Inflow=8.54 cfs 34,681 cf
n=0.022 L=436.0' S=0.0161 '/' Capacity=16.40 cfs Outflow=7.79 cfs 34,614 cf

Reach 20Ra2: Natural Stream Avg. Flow Depth=0.37' Max Vel=1.41 fps Inflow=7.79 cfs 34,614 cf
n=0.040 L=600.0' S=0.0100 '/' Capacity=12.48 cfs Outflow=6.52 cfs 34,421 cf

Reach 20Rb: Natural Stream Avg. Flow Depth=0.17' Max Vel=1.04 fps Inflow=1.78 cfs 10,140 cf
n=0.040 L=1,006.0' S=0.0129 '/' Capacity=14.18 cfs Outflow=1.51 cfs 10,008 cf

Pond 10P: BMP 1 Peak Elev=39.19' Storage=2,329 cf Inflow=4.67 cfs 17,069 cf
Outflow=4.22 cfs 16,294 cf

Pond 20Pa: BMP 2 Peak Elev=39.77' Storage=8,026 cf Inflow=10.35 cfs 37,839 cf
Outflow=8.54 cfs 34,681 cf

Pond 20Pb: BMP 3 Peak Elev=40.45' Storage=1,877 cf Inflow=2.96 cfs 10,830 cf
Outflow=1.78 cfs 10,140 cf

Link 10L: POI 1 Inflow=7.56 cfs 29,024 cf
Primary=7.56 cfs 29,024 cf

Link 20L: POI 2 Inflow=18.57 cfs 116,040 cf
Primary=18.57 cfs 116,040 cf

Total Runoff Area = 270,696 sf Runoff Volume = 150,080 cf Average Runoff Depth = 6.65"
0.72% Pervious = 1,937 sf 99.28% Impervious = 268,759 sf

Summary for Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

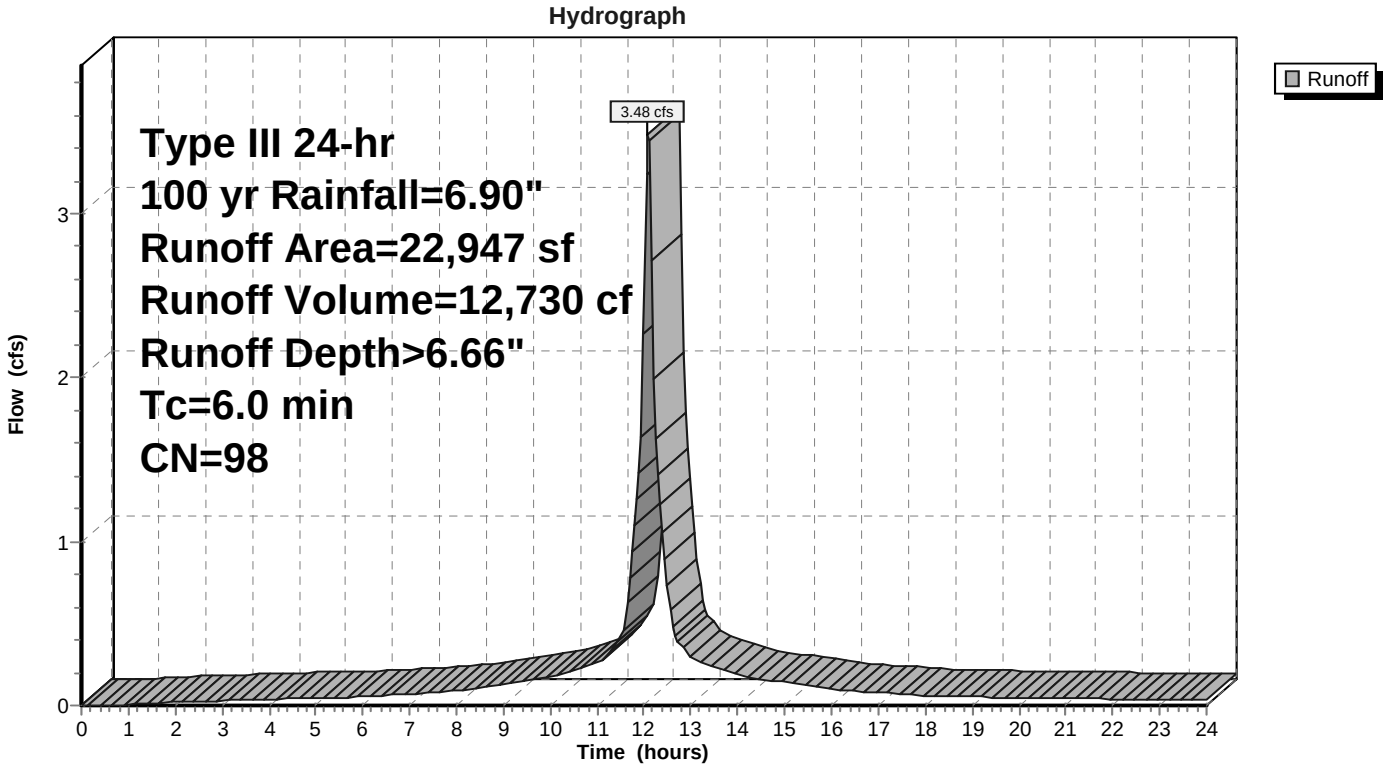
Runoff = 3.48 cfs @ 12.09 hrs, Volume= 12,730 cf, Depth> 6.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.90"

Area (sf)	CN	Description
22,947	98	Paved roads w/curbs & sewers, HSG C
22,947		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sa: POI 1 - OVERLAND DIRECT DISCHARGE



Summary for Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1

1. For pavements, Tc assumed to be 5 minutes.

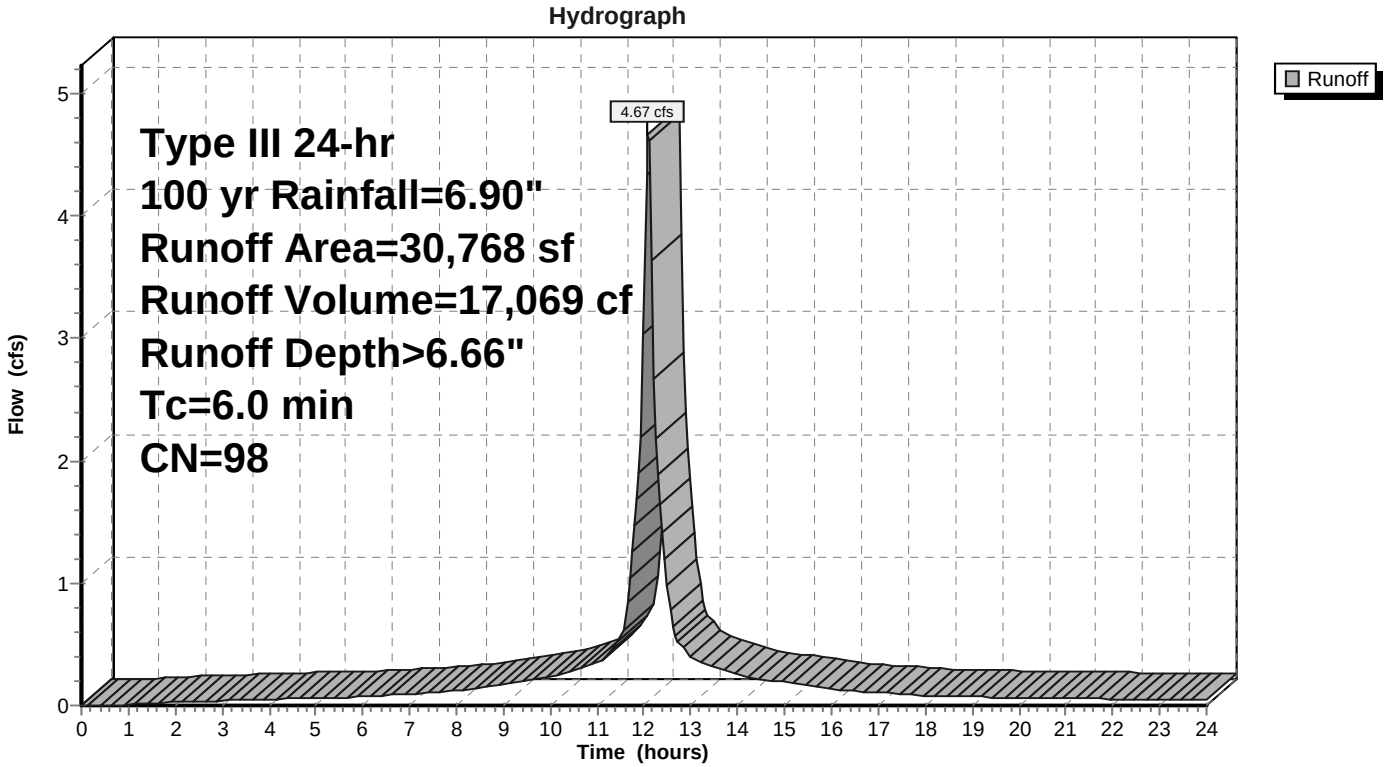
Runoff = 4.67 cfs @ 12.09 hrs, Volume= 17,069 cf, Depth> 6.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.90"

Area (sf)	CN	Description
30,768	98	Paved roads w/curbs & sewers, HSG C
30,768		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 10Sb: POI 1 - OVERLAND TO BMP 1



Summary for Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2

1. For pavements, Tc assumed to be 5 minutes.

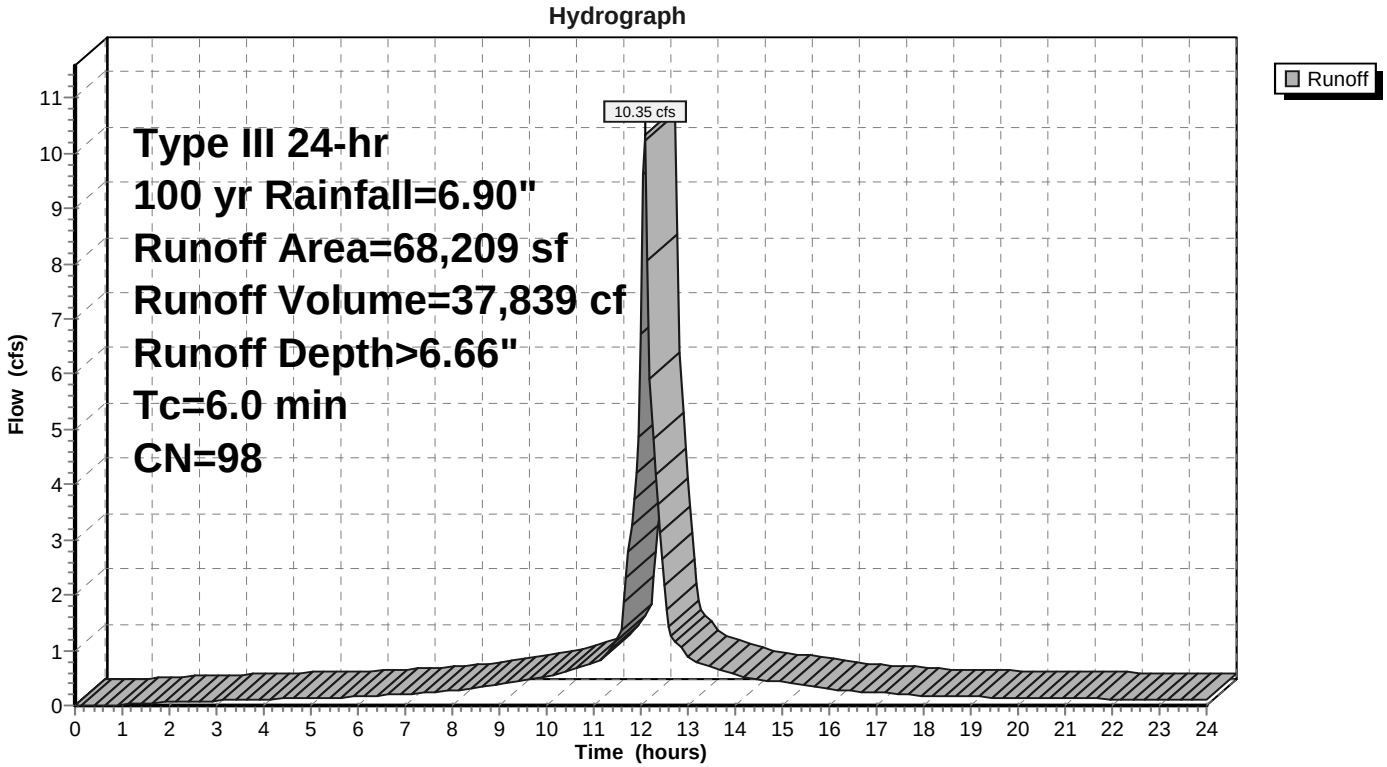
Runoff = 10.35 cfs @ 12.09 hrs, Volume= 37,839 cf, Depth> 6.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.90"

Area (sf)	CN	Description
68,209	98	Paved roads w/curbs & sewers, HSG C
68,209		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sa: POI 2 - OVERLAND TO BMP 2



Summary for Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3

1. For pavements, Tc assumed to be 5 minutes.

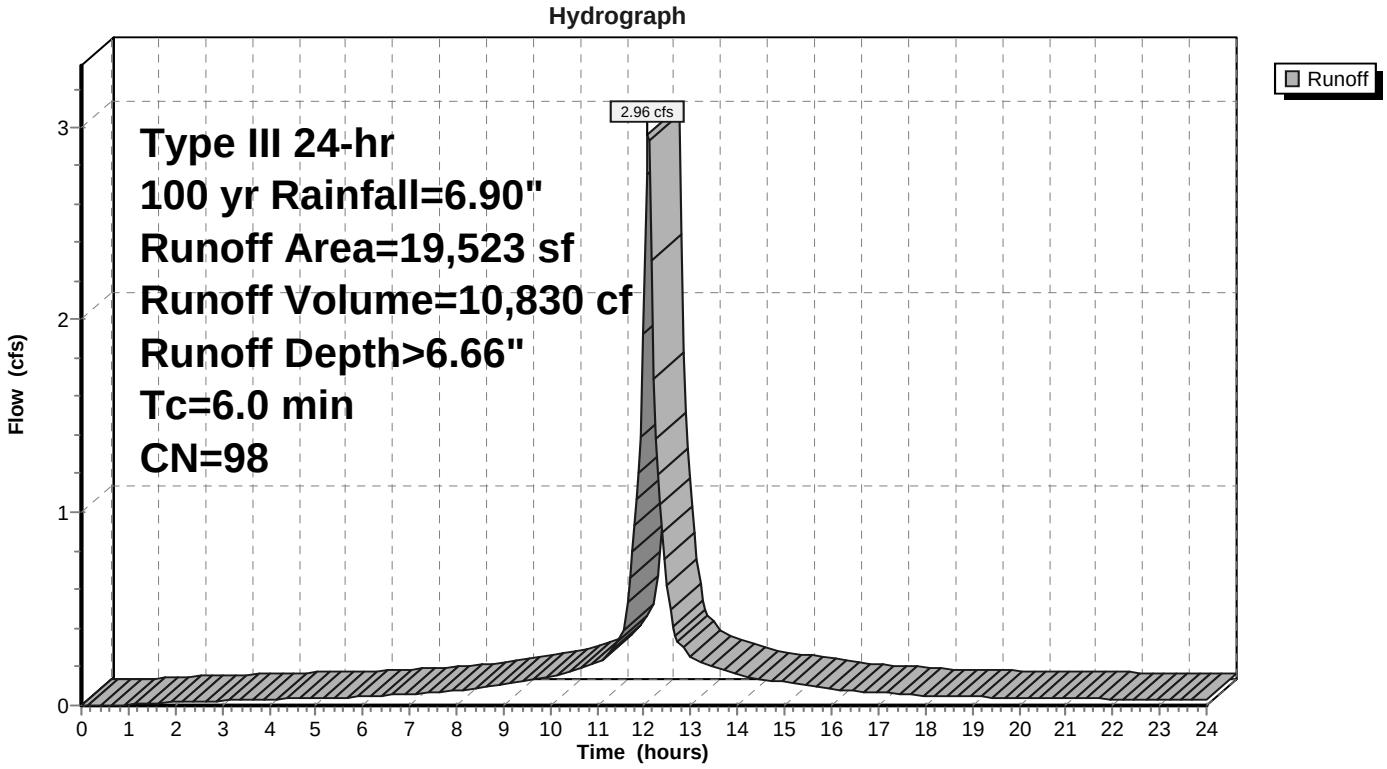
Runoff = 2.96 cfs @ 12.09 hrs, Volume= 10,830 cf, Depth> 6.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.90"

Area (sf)	CN	Description
19,523	98	Paved roads w/curbs & sewers, HSG C
19,523		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 20Sb: POI 2 - OVERLAND TO BMP 3



Summary for Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE

1. For pavements, Tc assumed to be 5 minutes.

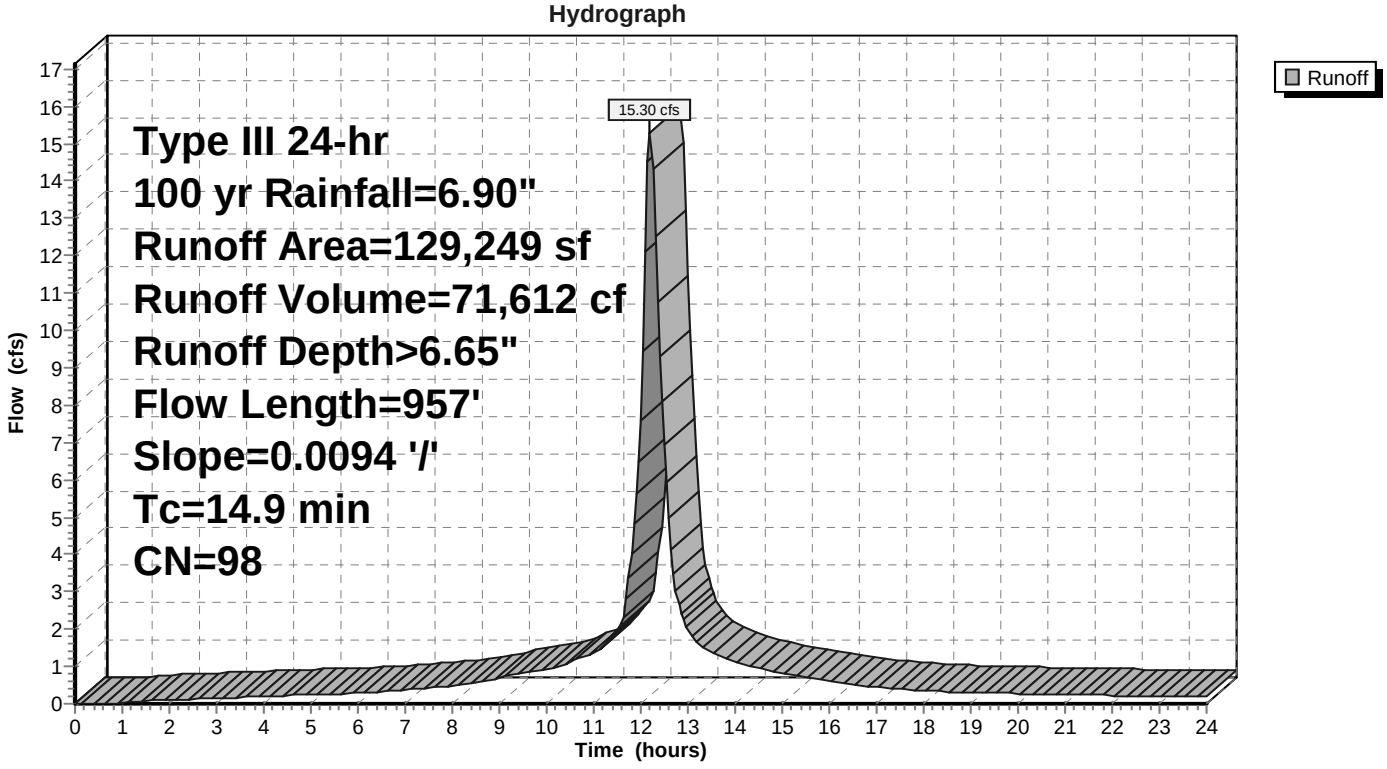
Runoff = 15.30 cfs @ 12.20 hrs, Volume= 71,612 cf, Depth> 6.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.90"

Area (sf)	CN	Description
127,312	98	Paved roads w/curbs & sewers, HSG C
1,937	79	50-75% Grass cover, Fair, HSG C
129,249	98	Weighted Average
1,937		1.50% Pervious Area
127,312		98.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**
9.9	957	0.0094	1.61	12.11	**Channel Flow, Natural Stream** Area= 7.5 sf Perim= 25.0' r= 0.30' n= 0.040 Winding stream
14.9	957	Total			

Subcatchment 20Sc: POI 2 - OVERLAND DIRECT DISCHARGE



Summary for Reach 20Ra1: Grassed Channel

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 6.10" for 100 yr event
Inflow = 8.54 cfs @ 12.16 hrs, Volume= 34,681 cf
Outflow = 7.79 cfs @ 12.22 hrs, Volume= 34,614 cf, Atten= 9%, Lag= 4.1 min

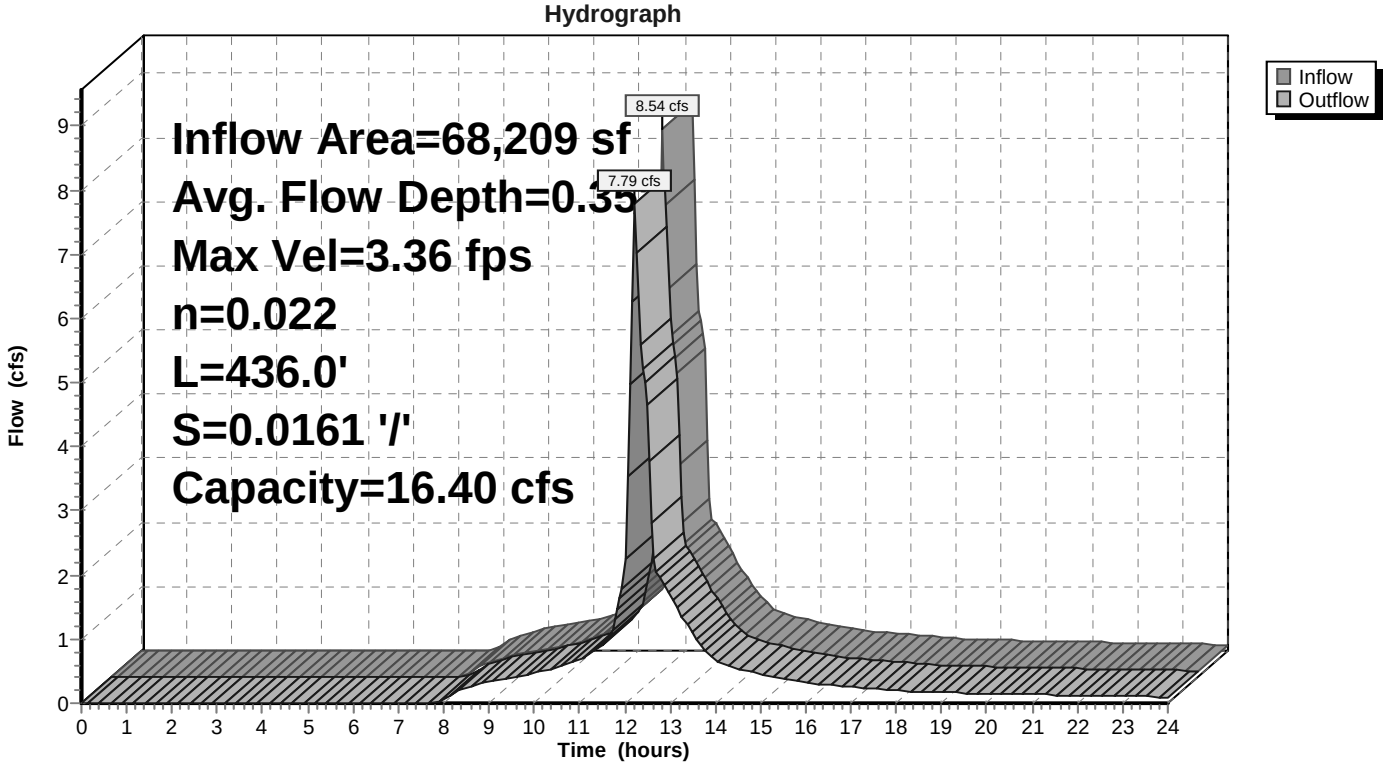
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.36 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 5.8 min

Peak Storage= 1,034 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 16.40 cfs

4.00' x 0.50' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 8.0 '/' Top Width= 12.00'
Length= 436.0' Slope= 0.0161 '/'
Inlet Invert= 36.00', Outlet Invert= 29.00'

‡

Reach 20Ra1: Grassed Channel



Summary for Reach 20Ra2: Natural Stream

[62] Hint: Exceeded Reach 20Ra1 OUTLET depth by 0.12' @ 12.60 hrs

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 6.09" for 100 yr event
Inflow = 7.79 cfs @ 12.22 hrs, Volume= 34,614 cf
Outflow = 6.52 cfs @ 12.42 hrs, Volume= 34,421 cf, Atten= 16%, Lag= 12.0 min

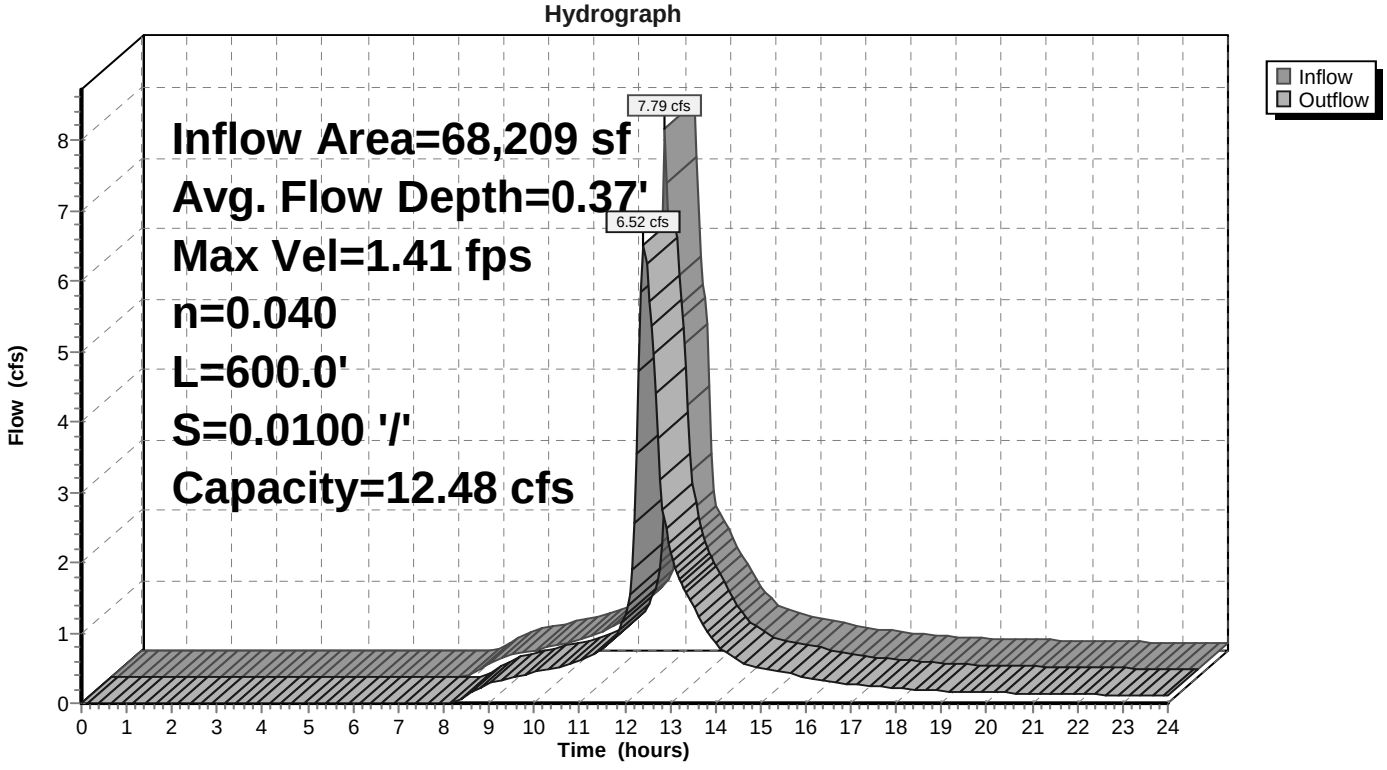
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.41 fps, Min. Travel Time= 7.1 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 16.3 min

Peak Storage= 2,802 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 12.48 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 600.0' Slope= 0.0100 '/'
Inlet Invert= 29.00', Outlet Invert= 23.00'

‡

Reach 20Ra2: Natural Stream



Summary for Reach 20Rb: Natural Stream

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 6.23" for 100 yr event
Inflow = 1.78 cfs @ 12.20 hrs, Volume= 10,140 cf
Outflow = 1.51 cfs @ 12.68 hrs, Volume= 10,008 cf, Atten= 15%, Lag= 28.5 min

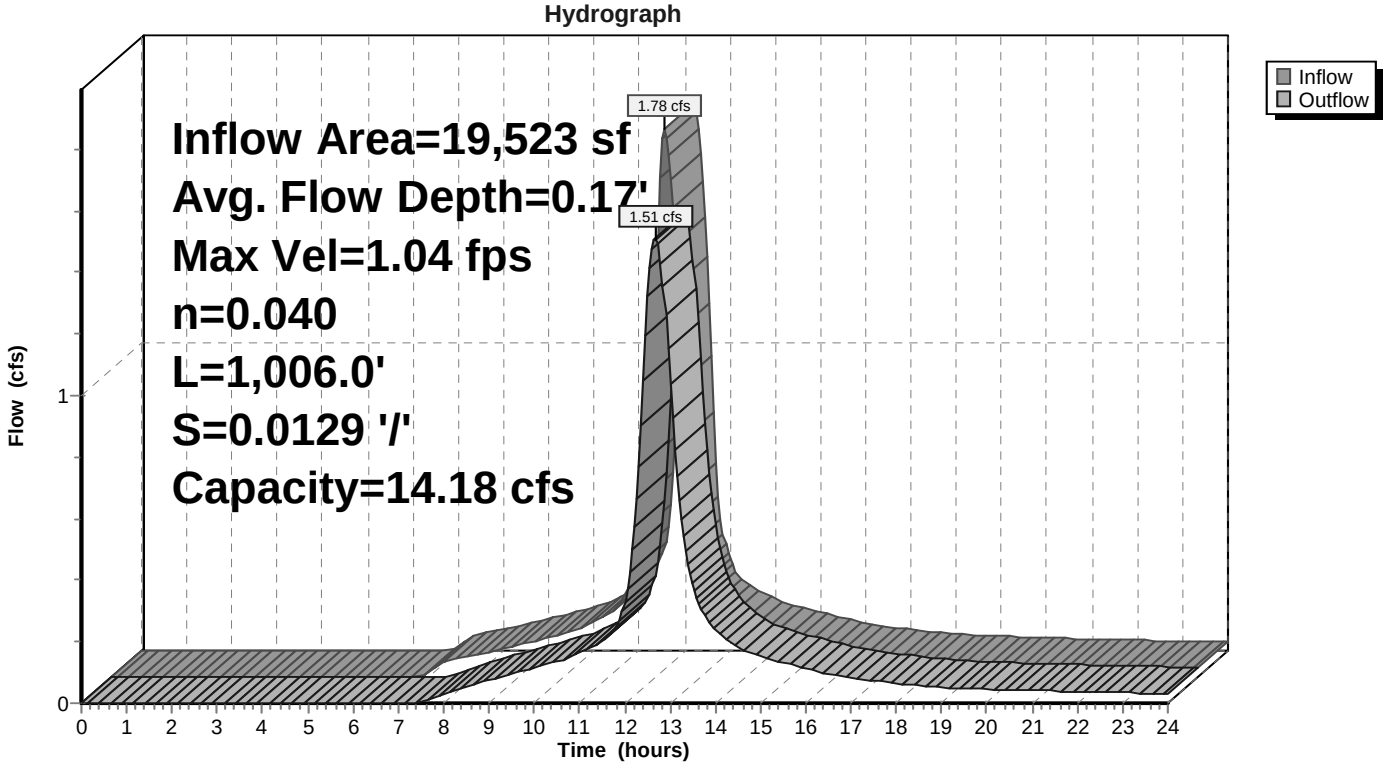
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.04 fps, Min. Travel Time= 16.1 min
Avg. Velocity = 0.44 fps, Avg. Travel Time= 37.9 min

Peak Storage= 1,461 cf @ 12.41 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 0.50' Flow Area= 7.5 sf, Capacity= 14.18 cfs

5.00' x 0.50' deep channel, n= 0.040 Winding stream
Side Slope Z-value= 20.0 '/' Top Width= 25.00'
Length= 1,006.0' Slope= 0.0129 '/'
Inlet Invert= 36.00', Outlet Invert= 23.00'

‡

Reach 20Rb: Natural Stream



Summary for Pond 10P: BMP 1

Inflow Area = 30,768 sf,100.00% Impervious, Inflow Depth > 6.66" for 100 yr event
Inflow = 4.67 cfs @ 12.09 hrs, Volume= 17,069 cf
Outflow = 4.22 cfs @ 12.13 hrs, Volume= 16,294 cf, Atten= 10%, Lag= 2.7 min
Primary = 4.22 cfs @ 12.13 hrs, Volume= 16,294 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.19' @ 12.13 hrs Surf.Area= 1,220 sf Storage= 2,329 cf

Plug-Flow detention time= 57.4 min calculated for 16,260 cf (95% of inflow)
Center-of-Mass det. time= 31.0 min (773.7 - 742.7)

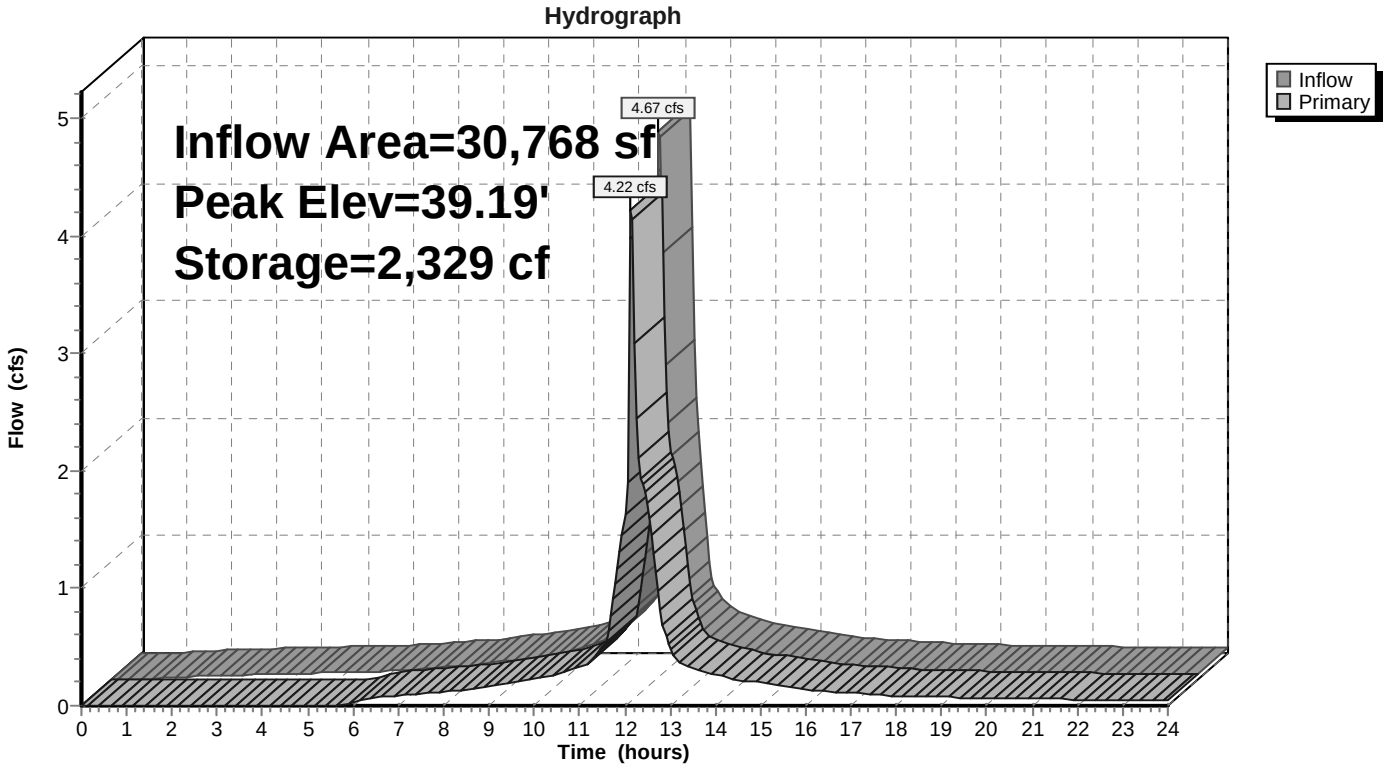
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	3,463 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
35.00	110	0	0	110
36.00	257	178	178	264
37.00	476	361	539	493
38.00	768	616	1,156	798
39.00	1,139	947	2,103	1,185
40.00	1,593	1,360	3,463	1,657

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 172.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 35.28' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.33'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	39.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.11 cfs @ 12.13 hrs HW=39.18' (Free Discharge)
└**1=RCP_Round 12"** (Passes 4.11 cfs of 4.35 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 2.07 cfs @ 5.93 fps)
  └**3=Orifice/Grate** (Weir Controls 2.04 cfs @ 1.40 fps)

Pond 10P: BMP 1



Summary for Pond 20Pa: BMP 2

Inflow Area = 68,209 sf,100.00% Impervious, Inflow Depth > 6.66" for 100 yr event
Inflow = 10.35 cfs @ 12.09 hrs, Volume= 37,839 cf
Outflow = 8.54 cfs @ 12.16 hrs, Volume= 34,681 cf, Atten= 17%, Lag= 4.1 min
Primary = 8.54 cfs @ 12.16 hrs, Volume= 34,681 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 39.77' @ 12.16 hrs Surf.Area= 2,328 sf Storage= 8,026 cf

Plug-Flow detention time= 93.9 min calculated for 34,609 cf (91% of inflow)
Center-of-Mass det. time= 51.0 min (793.7 - 742.7)

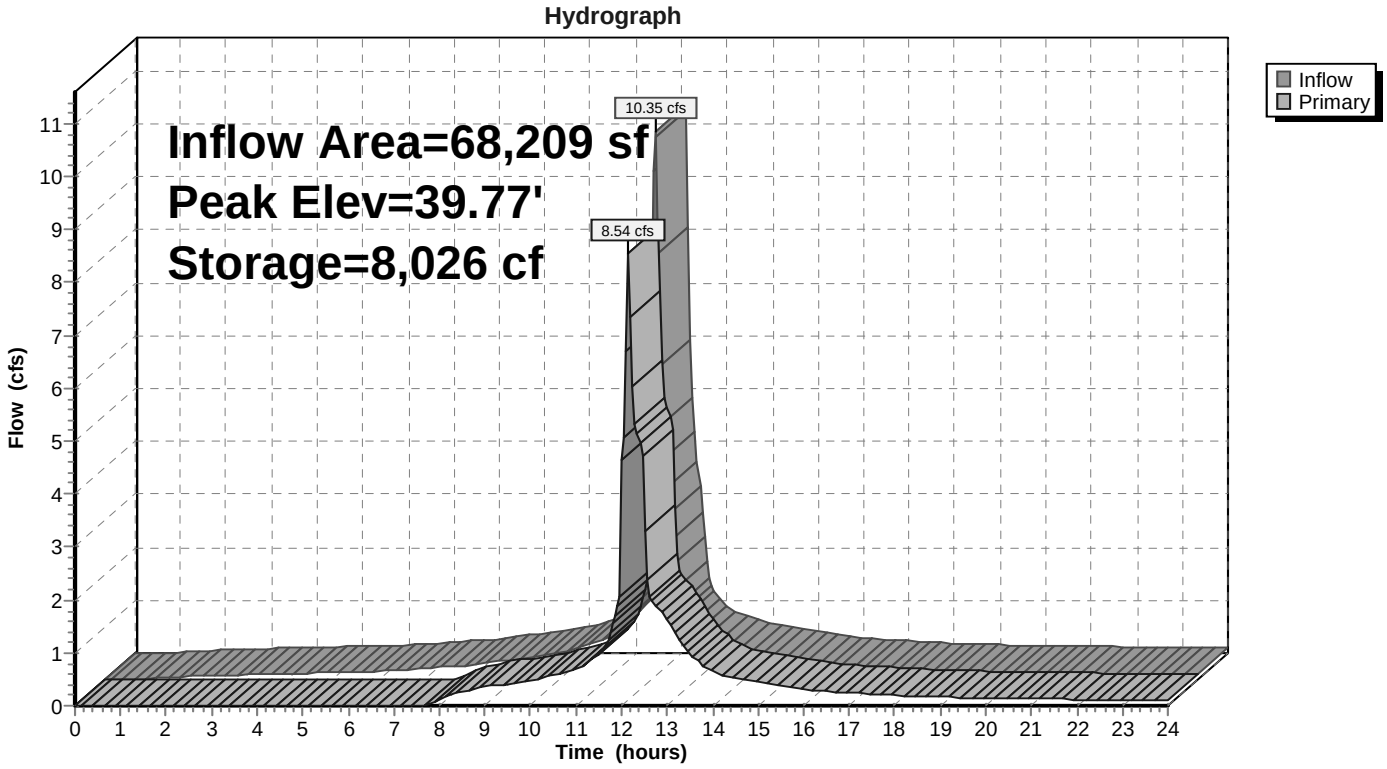
Volume	Invert	Avail.Storage	Storage Description
#1	34.00'	8,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
34.00	612	0	0	612
35.00	837	722	722	856
36.00	1,094	963	1,684	1,136
37.00	1,384	1,236	2,920	1,451
38.00	1,703	1,541	4,461	1,799
39.00	2,046	1,872	6,333	2,175
40.00	2,414	2,227	8,560	2,579

Device	Routing	Invert	Outlet Devices
#1	Primary	37.00'	**12.0" Round RCP_Round 12"** L= 50.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 37.00' / 36.50' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	37.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	38.83'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	39.50'	**8.0' 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=8.38 cfs @ 12.16 hrs HW=39.77' (Free Discharge)
- **1=RCP_Round 12"** (Barrel Controls 5.63 cfs @ 7.17 fps)
  - **2=Orifice/Grate** (Passes < 2.62 cfs potential flow)
  - **3=Orifice/Grate** (Passes < 18.63 cfs potential flow)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 2.75 cfs @ 1.29 fps)

Pond 20Pa: BMP 2



Summary for Pond 20Pb: BMP 3

Inflow Area = 19,523 sf,100.00% Impervious, Inflow Depth > 6.66" for 100 yr event
Inflow = 2.96 cfs @ 12.09 hrs, Volume= 10,830 cf
Outflow = 1.78 cfs @ 12.20 hrs, Volume= 10,140 cf, Atten= 40%, Lag= 6.9 min
Primary = 1.78 cfs @ 12.20 hrs, Volume= 10,140 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 40.45' @ 12.20 hrs Surf.Area= 1,135 sf Storage= 1,877 cf

Plug-Flow detention time= 74.9 min calculated for 10,140 cf (94% of inflow)
Center-of-Mass det. time= 39.5 min (782.2 - 742.7)

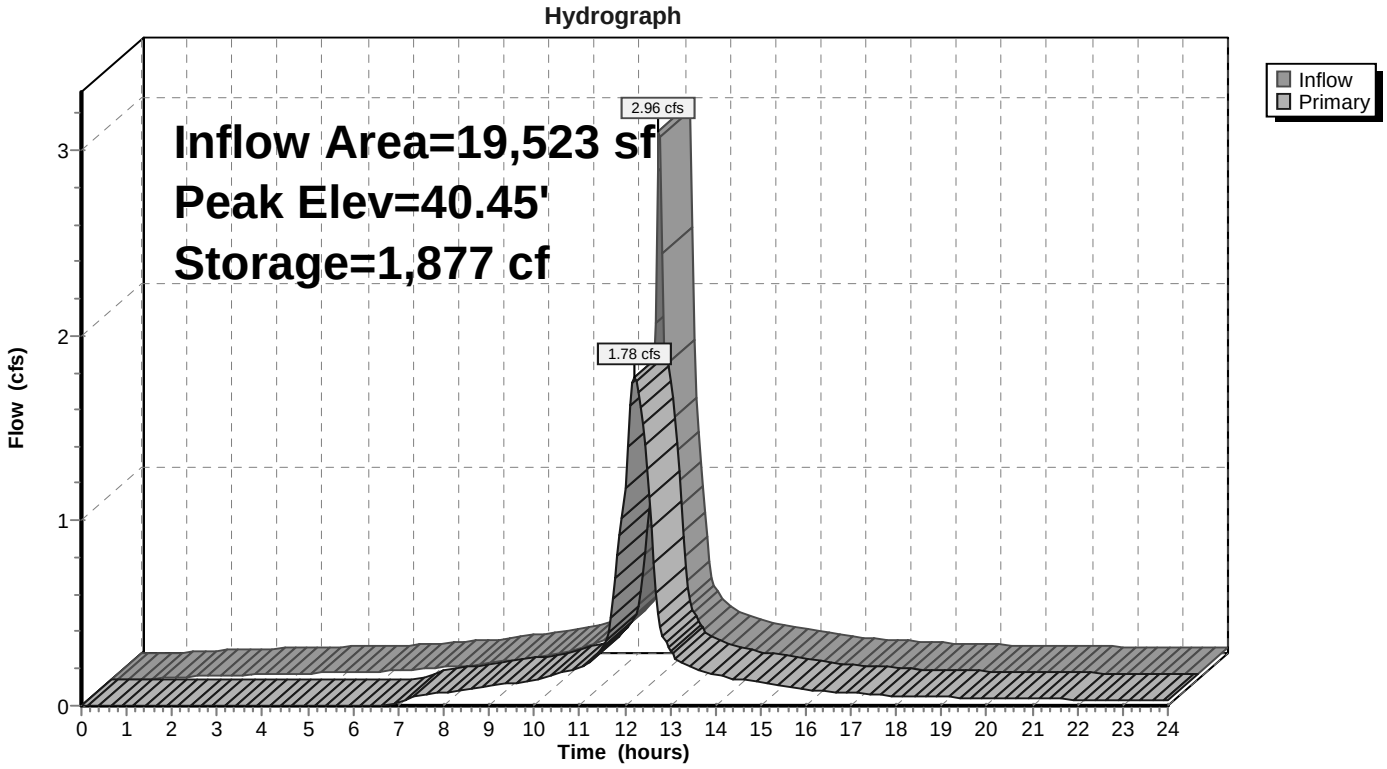
Volume	Invert	Avail.Storage	Storage Description
#1	37.00'	2,560 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
37.00	111	0	0	111
38.00	303	199	199	309
39.00	590	439	638	606
40.00	954	765	1,402	983
41.00	1,373	1,157	2,560	1,419

Device	Routing	Invert	Outlet Devices
#1	Primary	39.00'	**12.0" Round RCP_Round 12"** L= 81.7' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 39.00' / 38.00' S= 0.0122 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	39.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	40.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.78 cfs @ 12.20 hrs HW=40.45' (Free Discharge)
└─**1=RCP_Round 12"** (Passes 1.78 cfs of 3.69 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.78 cfs @ 5.10 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 20Pb: BMP 3

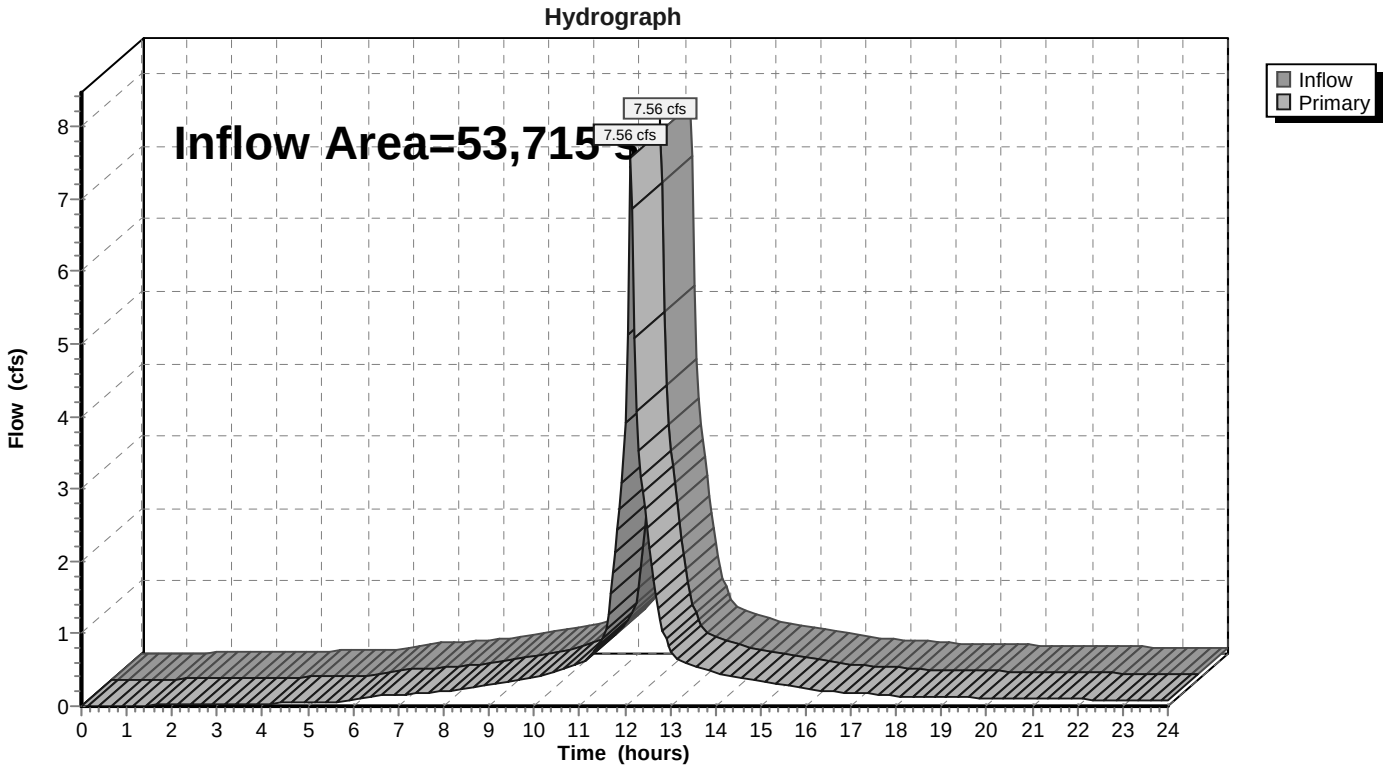


Summary for Link 10L: POI 1

Inflow Area = 53,715 sf,100.00% Impervious, Inflow Depth > 6.48" for 100 yr event
Inflow = 7.56 cfs @ 12.11 hrs, Volume= 29,024 cf
Primary = 7.56 cfs @ 12.11 hrs, Volume= 29,024 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 10L: POI 1

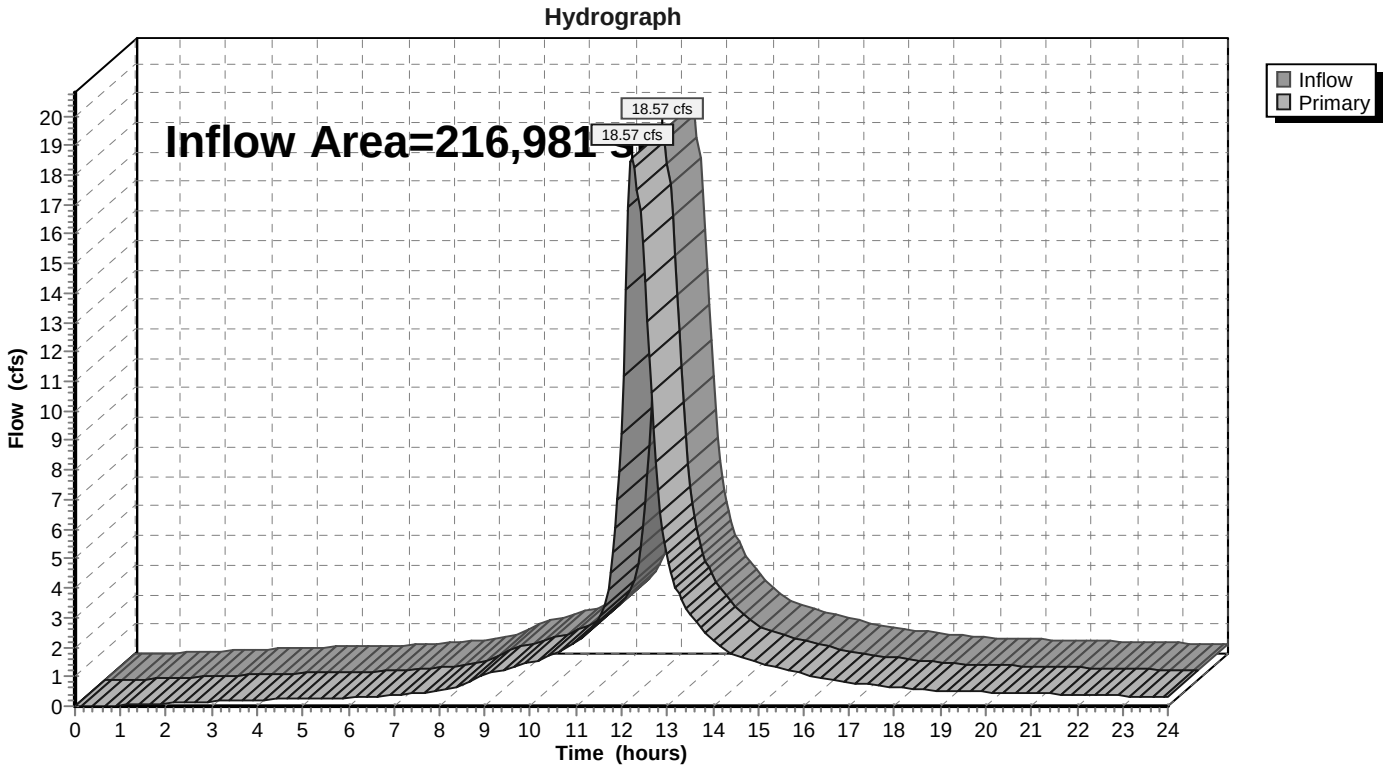


Summary for Link 20L: POI 2

Inflow Area = 216,981 sf, 99.11% Impervious, Inflow Depth > 6.42" for 100 yr event
Inflow = 18.57 cfs @ 12.23 hrs, Volume= 116,040 cf
Primary = 18.57 cfs @ 12.23 hrs, Volume= 116,040 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

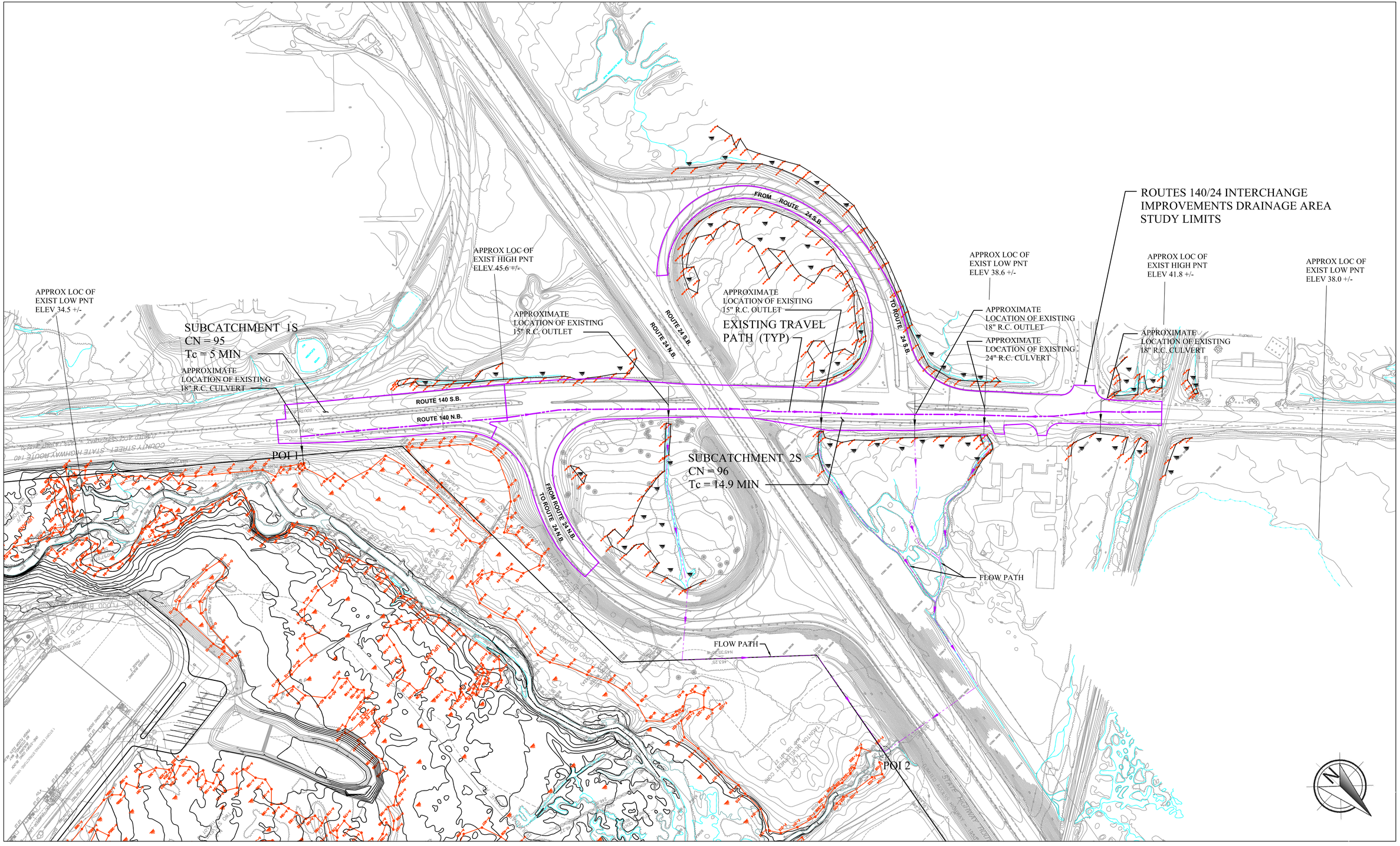
Link 20L: POI 2



APPENDIX F

ROUTES 140/24 IMPROVEMENTS
OPTION 4

DRAINAGE AREA MAPS

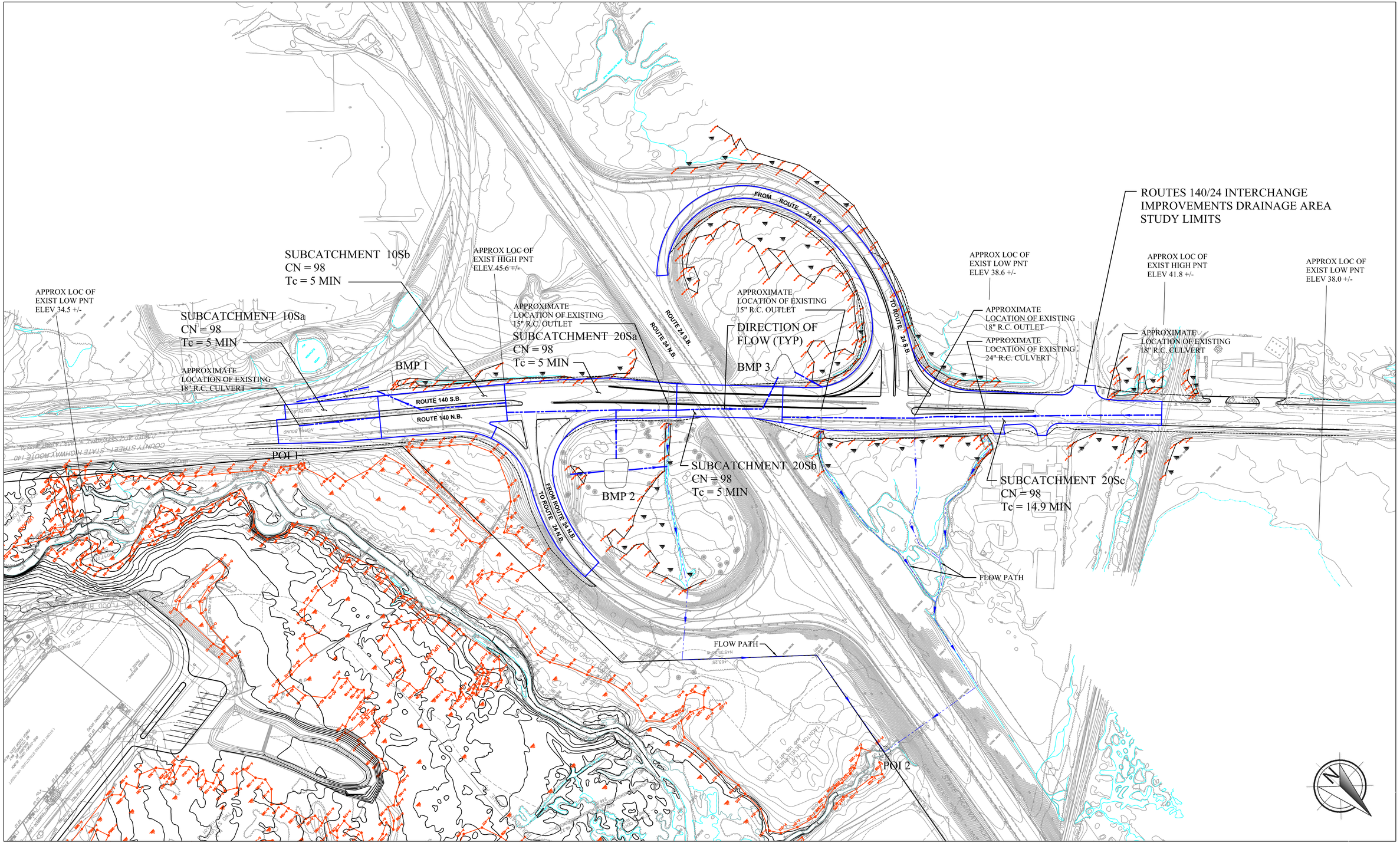


Mashpee Wampanoag Tribe - Fee to Trust Acquisition - Draft EIS

SOURCE: Fay, Spofford & Thorndike

Proposed Improvements - Route 24 NB and SB Ramps/County Street (Route 140)
Pre-Development Condition Drainage Area Map

DATE: DEC. 2012



SOURCE: Fay, Spofford & Thorndike

Mashpee Wampanoag Tribe - Fee to Trust Acquisition - Draft EIS

Proposed Improvements - Route 24 NB and SB Ramps/County Street (Route 140)
Post-Development Condition Drainage Area Map

DATE: DEC. 2012

Appendix D-4
Conceptual Stormwater Management Report:
Route 140 at Stevens Street Northbound On-ramp (Option 1)

CONCEPTUAL STORMWATER MANAGEMENT REPORT

First Light Casino Off-Site Mitigation

Route 140 at Stevens Street
Northbound On-ramp

TAUNTON, MASSACHUSETTS

February 2013

Prepared by:

Howard/Stein-Hudson Associates, Inc.
CREATIVE SOLUTIONS • EFFECTIVE PARTNERING ®

Existing Conditions

In the area of the intersection of Stevens Street and Route 140 as it existing today, a closed drainage system consisting of catch basins and reinforced concrete pipe (RCP) collect and convey stormwater runoff directly to an adjacent wetland north of the intersection. The proposed on ramp from Stevens Street to Route 140 northbound will incorporate an updated and improved drainage system which will treat and infiltrate stormwater.

Methodology

HSH will conduct pre- and post-hydrology study using HydroCAD, a stormwater modeling program. The Runoff Curve Numbers were selected from the tables listed within the Soil Conservation Service Technical Release 55. The terminology used by StormNET is summarized below.

1. ***Subcatchment*** – refers to a relatively homogenous area of land that drains into a single reach or pond.

2. ***Reach*** – refers to a uniform stream, channel, or pipe that conveys water from one point to another reach or pond.

3. ***Pond*** – refers to a pond, swamp, dam, or other impoundment that fills with water from 1 or more sources and empties in a manner determined by a weir, culvert, exfiltration, or device(s) at its outlet.

Proposed Conditions

The overall Stormwater Management Plan, which will be designed and implemented as part of this proposed on-ramp, will play a supporting role to the design and function of this project. With the added site trips to and from Route 140, Option A proposes a new Route 140 NB ramp to remove the conflict between the northbound through traffic and southbound left-turns at the intersection of the Overpass Connector/Route 104 NB Ramp/Stevens Street. A right-entering on-ramp is proposed to connect Stevens Street southbound to Route 140 northbound prior to the signal prior to the Overpass Connector/Route 104 NB Ramp/Stevens Street.

This will remove the need for the double southbound left-turn onto Route 140 NB ramp at this intersection, requiring only a single shared through/right-turn lane for the Stevens Street southbound approach. The northbound Stevens Street Overpass Approach will have three through lanes including a channelized right-turn to the existing Route 140 NB on-ramp. Both the northbound and eastbound approaches will continue to access Route 140 NB as they currently do. The proposed ramp for Option A is shown in Figure 8.1-80. After considerable investigation, the proposed ramp location is proximate to environmentally sensitive areas and will also require a

bridged crossing of the Cotley River. This alternative has benefits of eliminating intersection conflicts but the balance is impacts to wetlands. Because of the impacts, Option B is also considered as a potential solution to servicing exiting traffic from the site and Steven's Street onto Route 140 NB.

When the final design is complete, existing and proposed drainage systems will be analyzed using HydroCAD, a SCS TR-20 based program, to calculate existing and proposed peak discharge rates. This method takes into account all existing and proposed pervious and impervious areas including soil types and hydrologic classifications.

Stormwater Compliance

The "Regulatory Compliance" portion of this report addresses the ten Massachusetts Department of Environmental Protection (DEP) Stormwater Management Performance Standards under the Wetlands Protection Act. The proposed project will be designed in accordance with these standards for the area of new development. Compliance with the Standards is outlined below.

1. *No new stormwater conveyances may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth*.

This project will propose no new untreated stormwater discharges into the adjacent wetland or stream.

2. *Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates*.

The addition of the new on-ramp will create additional impervious area, however a subsurface detention/infiltration system will be designed into the proposed drainage system to detain stormwater and prevent any increase in peak discharge rates.

3. *Loss of annual recharge to groundwater should be minimized through the use of infiltration measures where feasible.*

As stated above, a subsurface detention/infiltration system is being planned for the proposed storwamter management system to provide groundwater infiltration. The existing close drainage system provides no additional groundwater recharge. The proposed system will be designed to provide a recharge volume that correlates to the additional impervious area and the hydrologic soil group of the existing land.

4. *For new development, stormwater management systems must be designed to remove 80 percent of Total Suspended Solids (TSS).*

Prior to entering the proposed subsurface detention/infiltration system, the storwmater runoff will be passed through a water quality unit designed to remove at least 80% TSS. Deep sump hooded

catch basins will also be proposed to increase the TSS removal rate. The existing closed drainage system provides no treatment for stormwater.

5. *Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs.*

The present land use does not fall under the requirements of higher pollution loads.

6. *Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters, shell fish beds, swimming beaches, cold water fisheries and recharge areas for public water supplies.*

There will be no stormwater discharges to critical areas.

7. *Redevelopment of previously developed areas must meet the Stormwater Management Standards to the maximum extent practicable.*

The addition of the new on ramp will be considered new development and required to meet all the Stormwater Management Standards. If the proposed drainage system ends up intercepting stormwater from the existing closed drainage system on the adjacent roadways, the stormwater from this area would only be required to meet the Standards to the maximum extent practical.

8. *Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities.*

The project will be designed to include erosion and sedimentation controls to prevent impacts to downgradient resource areas. Construction activities will be isolated from downgradient resource areas by creating an erosion control barrier with hay bales and silt fence, compost filter tubes, or a similar product as agreed upon by the City of Taunton Conservation Commission and MassDEP.

9. *All stormwater management systems must have an operation and maintenance plan to ensure that systems function as designed.*

This project will include a long-term Operation and Maintenance Plan to provide efficient operation of the features of the proposed drainage system. After the final design is complete, the O&M plan will clearly define the maintenance required for all proposed Best Management Practices (BMPs) used in the project to ensure the new drainage system is running efficiently and effectively to convey, treat, infiltrate, and discharge the storm water runoff.

10. *Illicit Discharges*

All illicit discharges will be prohibited.

DEP Checklist

See checklist at the end of the document

Operation and Maintenance

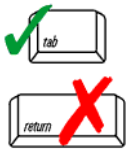
The proposed Route 140 entrance ramp will be owned and maintained by MassDOT Highway Section. The new ramp will become part of the Route 140 state highway system, specifics related to regular maintenance will be detailed during the Access Permit approval process.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☒ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

☐ Site is comprised solely of C and D soils and/or bedrock at the land surface

☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

☒ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☐ The BMP is sized (and calculations provided) based on:

- ☐ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

☐ Limited Project

☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.

☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area

☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff

☐ Bike Path and/or Foot Path

☒ Redevelopment Project

☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☒ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.