STORMWATER MANAGEMENT REPORT

Geoffrey Park
Off Indian Ridge Road South
Holliston, Massachusetts

May 14, 2020
Revised: July 10, 2020

Prepared for:

Indian Ridge Realty Trust
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Holliston, Massachusetts

Prepared by:

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7-15-2020
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Design Engineer

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Project Introduction:

The applicant, Indian Ridge Realty Trust, is proposing to develop a 24 Unit Residential development, located off Indian Ridge Road South, in Holliston Massachusetts. The proposed project was filed with Massachusetts Housing pursuant to Massachusetts General Laws Chapter 40B. The 24 Units will be single family and duplex style dwellings. The existing property is undeveloped wooded area and consists of 12.67 acres.
The proposal is to construct a roadway from the end of Indian Ridge Road South to provide access and egress. The Project will be serviced by Town water, available public utilities and a common onsite sewage disposal system. The stormwater generated from the Project will be captured, conveyed, treated and mitigated on-site utilizing Best Management Practices.

The purpose of these calculations is to demonstrate design compliance of the Project's stormwater management system for water quality and quantity, specifically post-development peak discharge rates per the DEP's Stormwater Management Policy, the Town of Holliston Land Subdivision Regulations. As designed, the system will mitigate peak rates of runoff for storms up to and including the 100-year event under post-construction conditions.

Methodology/Sources of Data:

The overall storm water management plan for the project is designed to maintain the peak rate of storm water runoff and runoff volumes from the site after development. The Soil Conservation Service Modified Soil Cover Complex Method, the computer program "HydroCAD" by Applied Microcomputer Systems, and the procedures specified in Urban Hydrology for storm Small Watersheds were used to determine pre-and post-developed peak flow rates of runoff from the site. The storm events have been compiled from the Soil Conservation Services Technical Report No. 55 and the U.S. Department of Commerce Technical Paper (TP 40). The 2-year, 10-year, 25-year and 100-year storm events have been utilized for hydrology calculations. The rainfall data for the Type III, 24-hour storm events follow:

24-Hour Storm	Rainfall (inches)
2	3.20
10	4.80
25	5.50
100	7.0

The storm water runoff will be controlled through the use of "Best Management Practices" and in conformance with the MADEP Stormwater Management Policy. The proposed Project will result in an improvement over the existing conditions, by constructing a storm water management system that will provide treatment, groundwater recharge and reduce the peak rates of runoff and offsite runoff volumes.

The piped drainage system has been designed utilizing the Rational Method for the 25 year storm event to size street drains.

Soils:

The Natural Resources Conservation Service (NRCS), Hydrologic Soils Group Map for Middlesex county, Massachusetts indicates that the on-site soils consist of Charlton Hollis Rock-103D, and Canton Fine sandy loam-424C. Soil testing was conducted onsite to confirm soil conditions. The results where consistent with sandy-loam and percolation rates of 15.0 minutes per inch. The test concluded large boulders in the test holes and surface boulders throughout the site. Based on the soil testing it is opinion that the soil throughout the site area is consistent with a “B” type hydrologic Rating. Therefore the design for pre- and post-development was performed using a “B” soil type.

Existing Conditions Overview:

The Project is located at the end of Indian Ridge Road South and identified as Assessor Map 14, Block 3, Lot 1 containing approximately 12.6 +/- acres. The site is currently undeveloped wooded land. There is a bordering vegetated wetland area located along the southerly and easterly boundaries. The site slopes from the northwest portion to the southeast.

The existing site is divided into five (5) existing watershed subcatchment areas. Three subcatchment areas converge at the southeast portion of the property. See the attached Pre-Development Subcatchment Area Plan for delineations. Subcatchment E1 flows overland towards the southern wetland to an intermittent stream. E2 is centrally located and flows to the south and E3 flows toward the westerly wetland. The three subcatchments flow via. overland and brooks to the southeast portion of the site and are combined with Link DP1.
Subcatchment E4 flows via overland northerly to a low lying area along the northerly boundary. Subcatchment E5 flows to the northwest abutting property where it flows via overland to the existing drainage basin at the end of Indian Ridge Road.

Proposed Conditions Overview:

The proposal is to contruct 24 Residential homes, both single family and duplex style. The proposed roadway is an extension of Indian Ridge Road South. The extension is a total length of 1,640 feet of roadway that loops around on itself within the site. The proposed stormwater drainage system is designed to capture the runoff utilizing catch basins, manholes and culverts to convey the stormwater to a drainage basin located at the beginning of the proposed roadway.

The proposed runoff areas have been divided into five (5) subcatchments. Subcatchment P1 discharges via overland flow towards southern wetland, Subcatchment P2 is centrally located and discharges to the drainage basin and Subcatchment P3 flows via overland to the westerly wetlands. The overall stormwater discharge from the site is combine in link DP2.

Subcatchment P4 flows via overland northerly to a low lying area along the northerly boundary. Subcatchment P5 flows to the northwest abutting property where it flows via overland to the existing drainage basin at the end of Indian Ridge Road.
The proposed systems will reduce all post-development flow rates of runoff up to and including the 100-year event to existing levels at all abutting areas. Existing uncaptured off-site runoff not associated with the Project will continue to flow overland without change.

The following is summary comparison of Pre- and Post-Developed Rates and Volumes of Runoff:

Summary of Peak Stormwater Runoff Rates:								
Design Point	**2-Yr Peak Flow (cfs)**		**10-Yr Peak Flow (cfs)**		**25-Yr Peak Flow (cfs)**		**100-Yr Peak Flow (cfs)**	
	Existing	***Proposed***	***Existing***	***Proposed***	***Existing***	***Proposed***	***Existing***	***Proposed***
DP1/ **DP2**	1.10	1.06	6.76	6.68	8.23	7.75	19.29	18.92
E4/P4	0.07	0.18	0.48	0.68	0.59	0.49	1.41	1.56
E5/P5	0.04	0.05	0.25	.026	0.31	0.30	0.73	0.64

The following is a summary of the Retention Basin:

Summary of Retention Basin								
Design Point	**2-Yr Volume (cu.ft.)**		**10-Yr Volume (ac-ft)**		**25-Yr Volume (ac-ft)**		**100-Yr Volume (ac-ft)**	
	Peak Elev.Ft.	***Outflow (cfs)***	***Peak Elev. Ft.***	***Outflow (cfs)***	***Peak Elev.Ft.***	***Outflow (cfs)***	***Peak Elev.Ft.***	***Outflow (cfs)***
1P	269.48	0.52	270.88	3.14	271.12	3.53	272.48	9.41

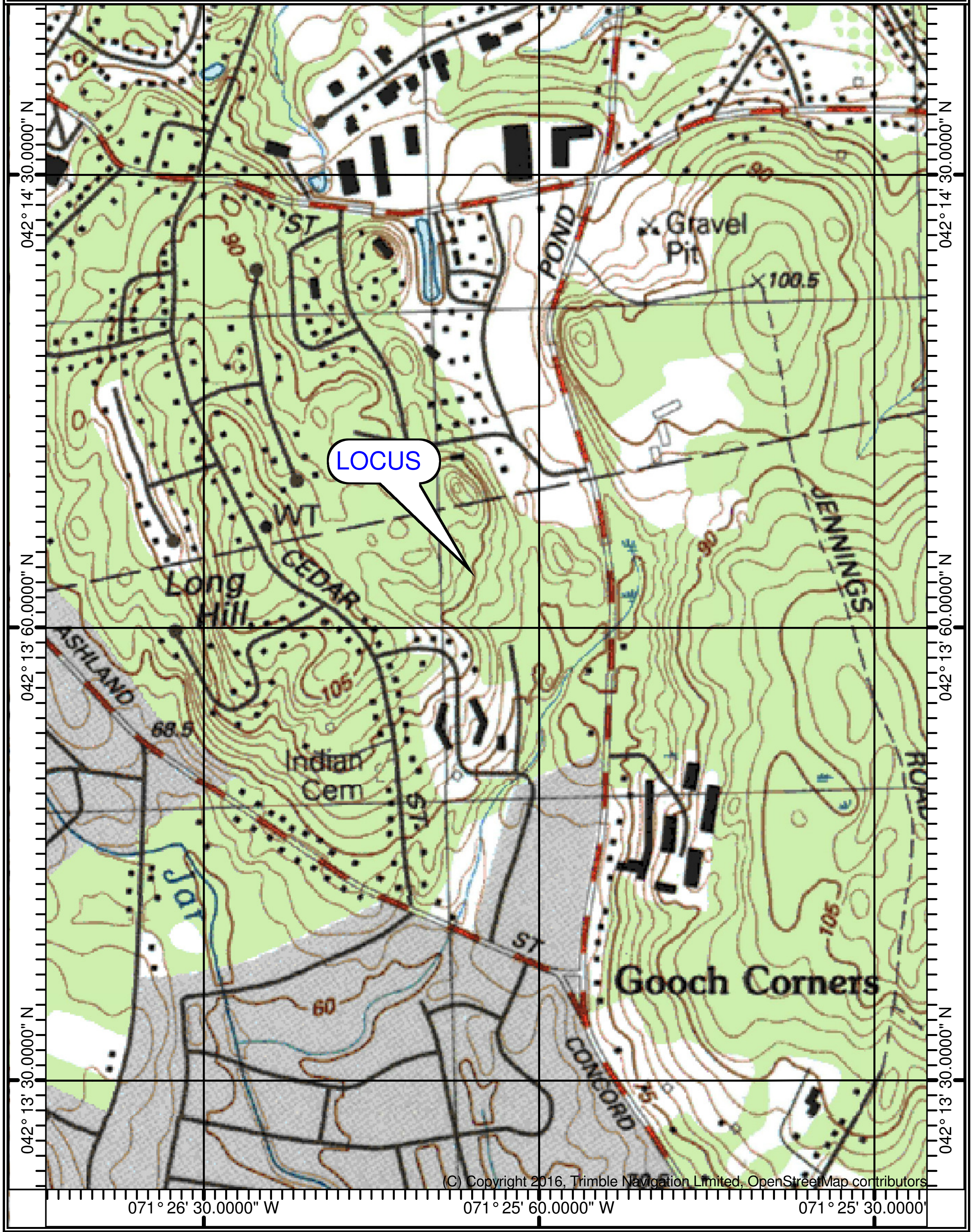
Summary:

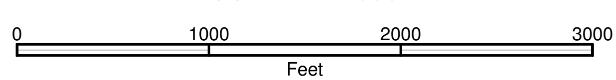
The calculations indicate a small increase in peak runoff along the northerly boundary. The runoff to the north is contained in a isolate low lying area primarily within the project boundaries.

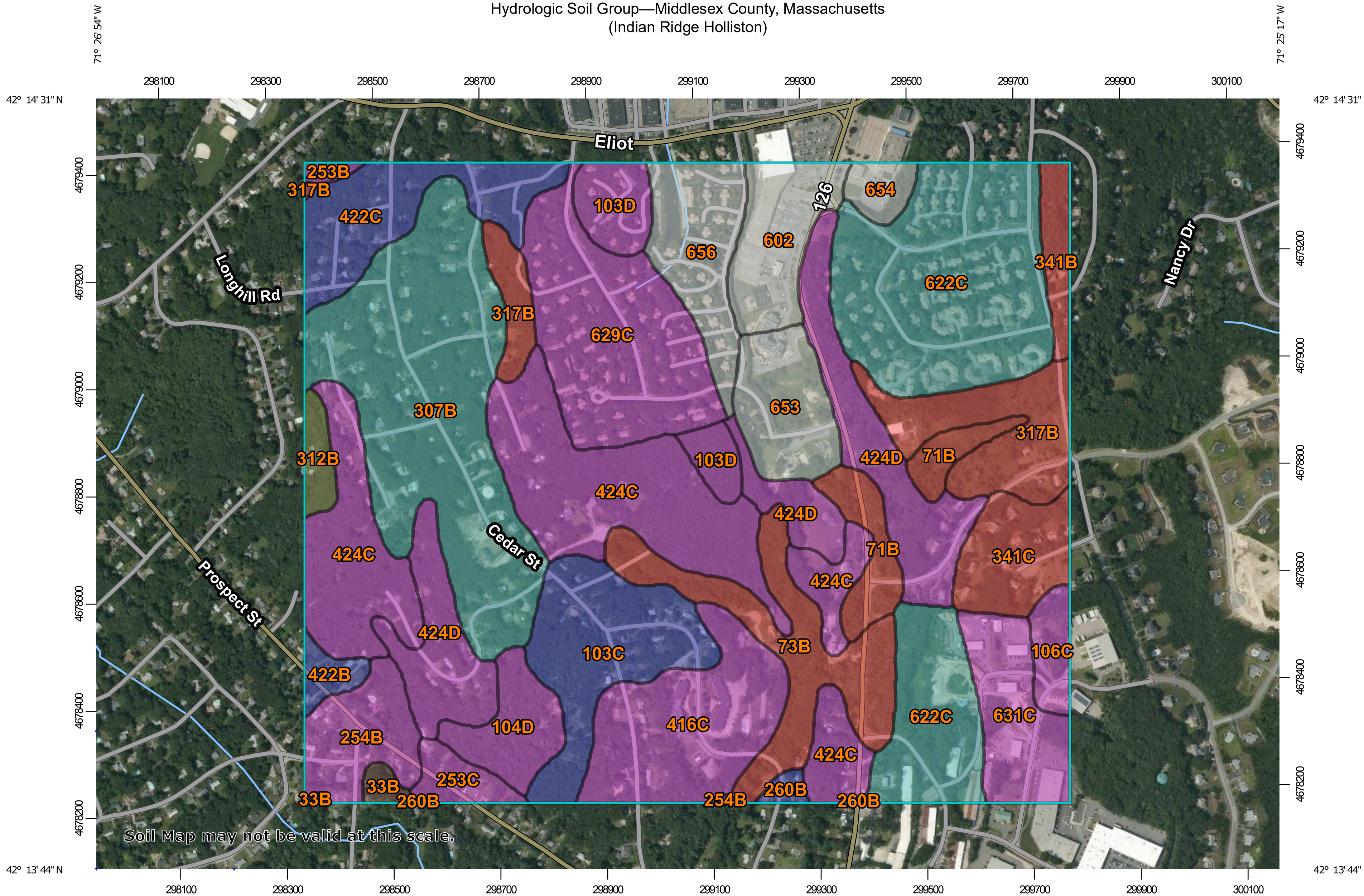
The calculations performed for all design storm events indicate that the total peak rates and volumes of runoff for the Project as proposed will not exceed those of existing conditions with the implementation of the stormwater management system.

With the implementation of the stormwater management system as designed, along with the Operation and Maintenance plan contained herein, all of the objectives of the DEP's Stormwater Management Regulations are satisfied.

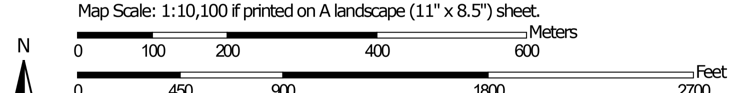
Map Name: MEDFIELD	Scale: 1 inch = 1,000 ft.	Horizontal Datum: NAD27
Print Date: 05/14/20	Map Center: 042° 14' 03.0487" N,	







Map Scale: 1:10,100 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

Streams and Canals

Transportation

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

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 19, Sep 12, 2019

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

Date(s) aerial images were photographed: Jul 28, 2019—Aug 15, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
33B	Raypol silt loam, 0 to 5 percent slopes	B/D	1.4	0.3%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	D	9.0	2.1%
73B	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	19.7	4.6%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	B	19.8	4.7%
103D	Charlton-Hollis-Rock outcrop complex, 15 to 25 percent slopes	A	8.3	1.9%
104D	Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes	A	8.0	1.9%
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes	A	3.9	0.9%
253B	Hinckley loamy sand, 3 to 8 percent slopes	A	0.8	0.2%
253C	Hinckley loamy sand, 8 to 15 percent slopes	A	3.7	0.9%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	10.2	2.4%
260B	Sudbury fine sandy loam, 3 to 8 percent slopes	B	1.2	0.3%
307B	Paxton fine sandy loam, 0 to 8 percent slopes, extremely stony	C	50.1	11.8%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	C/D	2.8	0.7%
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony	D	18.7	4.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
341B	Broadbrook very fine sandy loam, 3 to 8 percent slopes, very stony	D	4.3	1.0%
341C	Broadbrook very fine sandy loam, 8 to 15 percent slopes, very stony	D	10.0	2.4%
416C	Narragansett silt loam, 8 to 15 percent slopes, very stony	A	22.0	5.2%
422B	Canton fine sandy loam, 0 to 8 percent slopes, extremely stony	B	2.4	0.6%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	B	15.1	3.6%
424C	Canton fine sandy loam, 8 to 15 percent slopes, extremely bouldery	A	51.9	12.2%
424D	Canton fine sandy loam, 15 to 25 percent slopes, extremely bouldery	A	31.1	7.3%
602	Urban land		11.5	2.7%
622C	Paxton-Urban land complex, 3 to 15 percent slopes	C	51.9	12.2%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	A	28.1	6.6%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	A	12.2	2.9%
653	Udorthents, sandy		11.2	2.6%
654	Udorthents, loamy		3.1	0.7%
656	Udorthents-Urban land complex		13.0	3.0%
Totals for Area of Interest			**425.6**	**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

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.

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[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.

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

COMMONWEALTH OF MASSACHUSETTS
PAUL
E.
TRUAX
CIVIL
NO. 46527
REGISTERED
PROFESSIONAL ENGINEER

7-15-2020

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 (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 (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 (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 (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 (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 (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 – A

Hydrogeological Calculations for Pre & Post Development
Hydraulic Design (Manning's Equation)

Standard 2

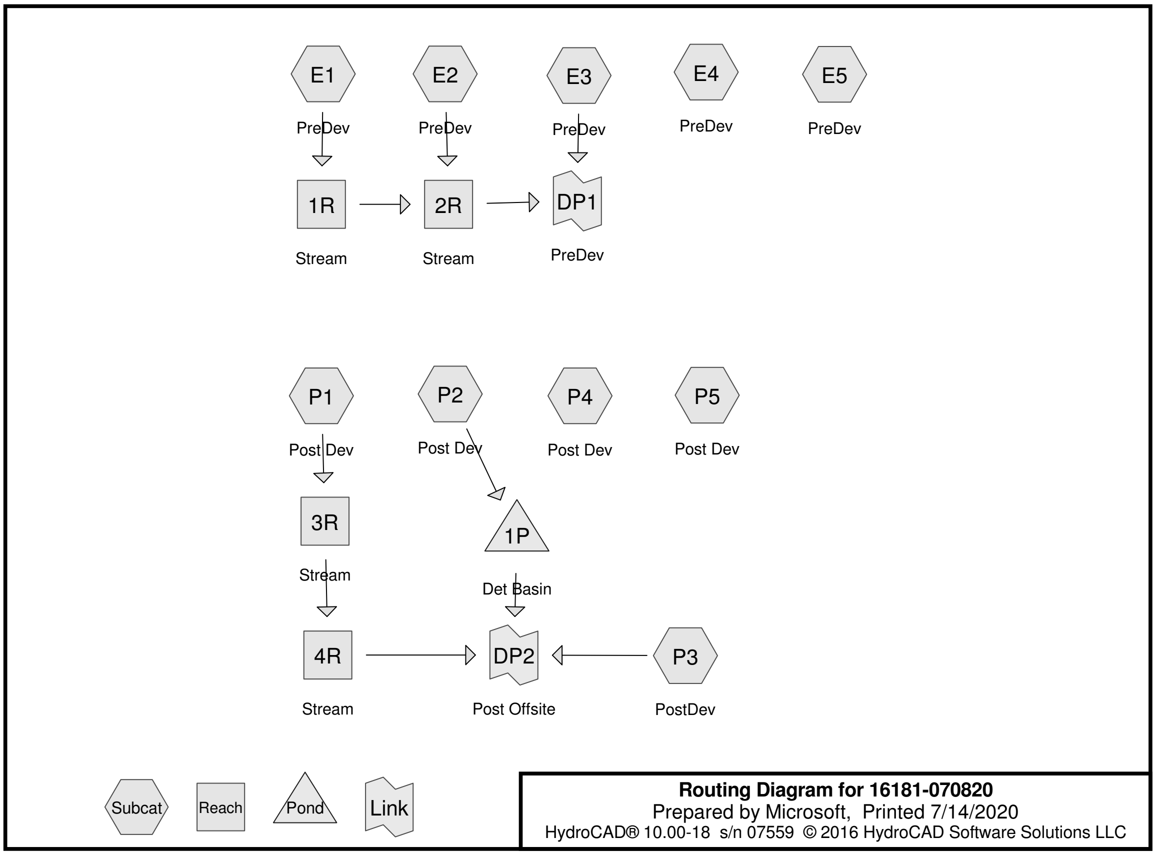
Runoff Area Summary:

Pre-Developed Runoff Areas:

Subcatchment	Area
E1	63,319 s.f.
E2	273,208 s.f.
E3	256,975 s.f.
E4	31,814 s.f.
E5	15,632 s.f.
Total	640,948 s.f.

Post-Developed Runoff Areas:

Subcatchment	Area
P1	54,609 s.f.
P2	322,008 s.f.
P3	229,845 s.f.
P4	23,657 s.f.
P5	10,829 s.f.
Total	640,948 s.f.



Routing Diagram for 16181-070820
Prepared by Microsoft, Printed 7/14/2020
HydroCAD® 10.00-18 s/n 07559 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment E1: PreDev

Runoff = 0.13 cfs @ 12.49 hrs, Volume= 1,313 cf, Depth> 0.25"

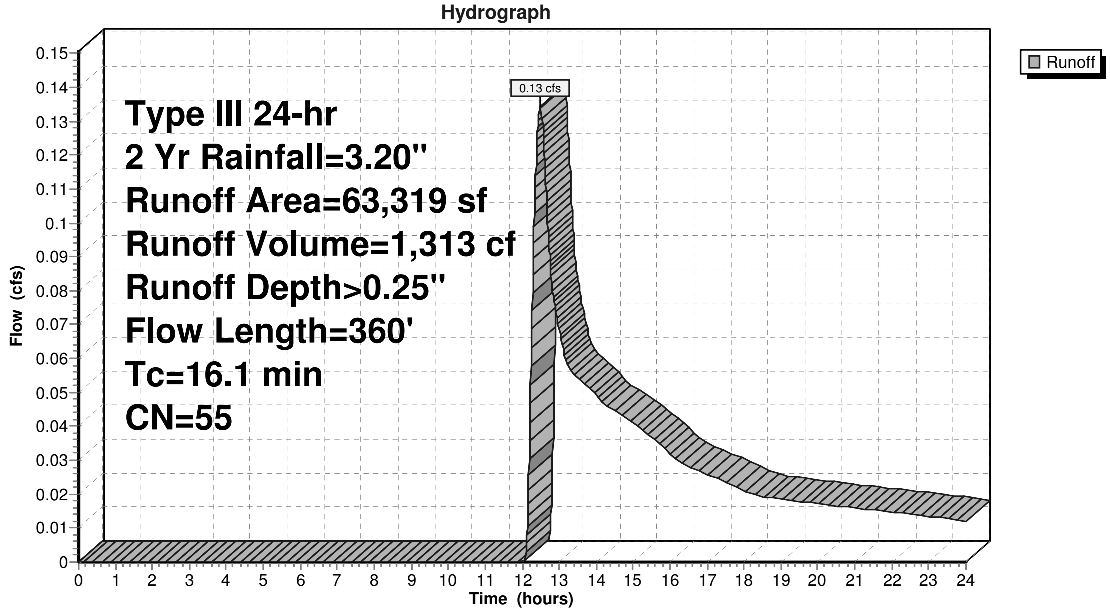
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
63,319	55	Woods, Good, HSG B
63,319		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
3.8	310	0.0750	1.37		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
16.1	360	Total			

Subcatchment E1: PreDev

Hydrograph



Summary for Subcatchment E2: PreDev

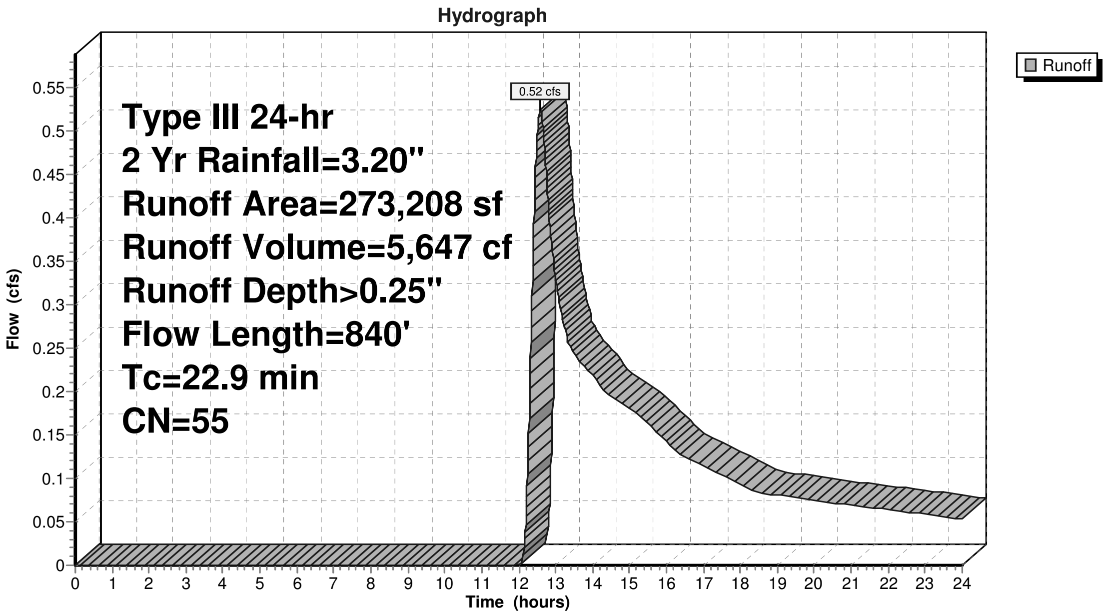
Runoff = 0.52 cfs @ 12.59 hrs, Volume= 5,647 cf, Depth> 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
273,208	55	Woods, Good, HSG B
273,208		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
12.4	790	0.0450	1.06		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
22.9	840	Total			

Subcatchment E2: PreDev



Summary for Subcatchment E3: PreDev

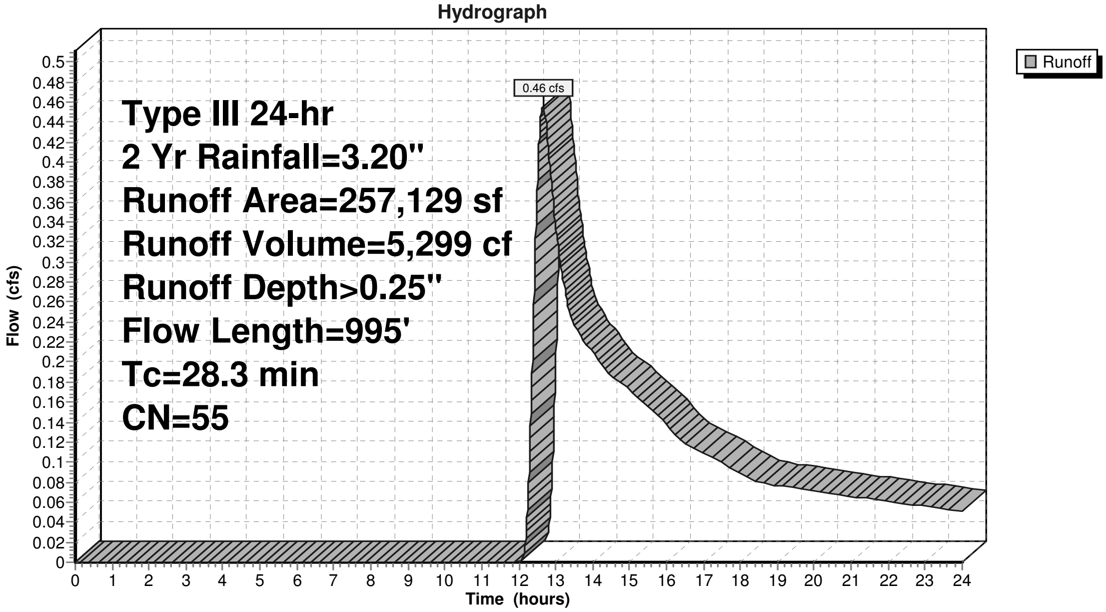
Runoff = 0.46 cfs @ 12.67 hrs, Volume= 5,299 cf, Depth> 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
257,129	55	Woods, Good, HSG B
257,129		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
5.3	450	0.0800	1.41		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
28.3	995	Total			

Subcatchment E3: PreDev



Summary for Subcatchment E4: PreDev

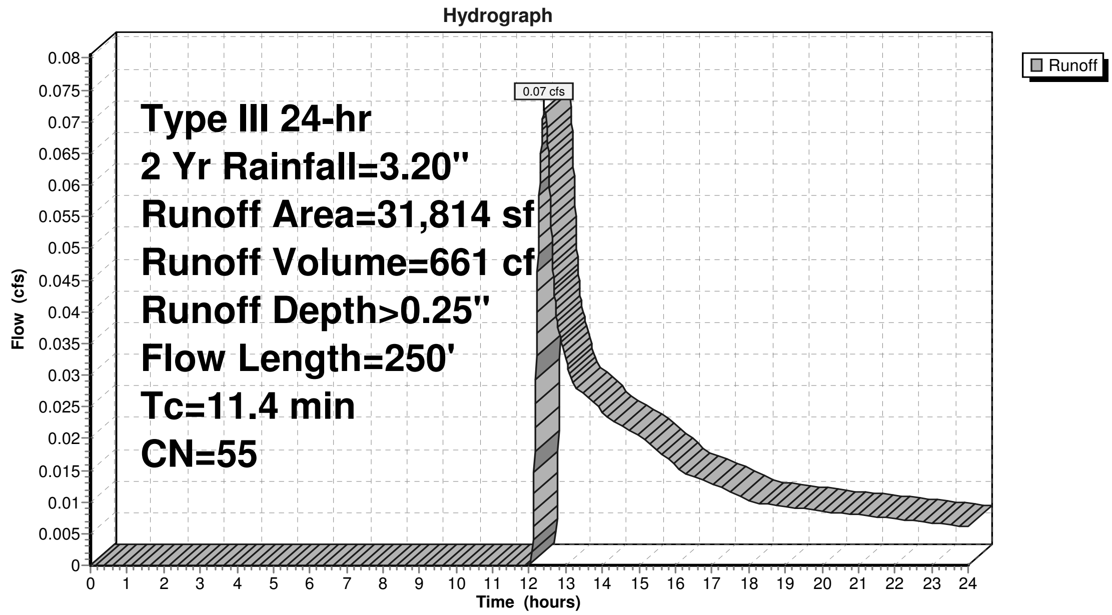
Runoff = 0.07 cfs @ 12.42 hrs, Volume= 661 cf, Depth> 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
31,814	55	Woods, Good, HSG B
31,814		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0400	0.09		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
2.1	200	0.1000	1.58		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.4	250	Total			

Subcatchment E4: PreDev



Summary for Subcatchment E5: PreDev

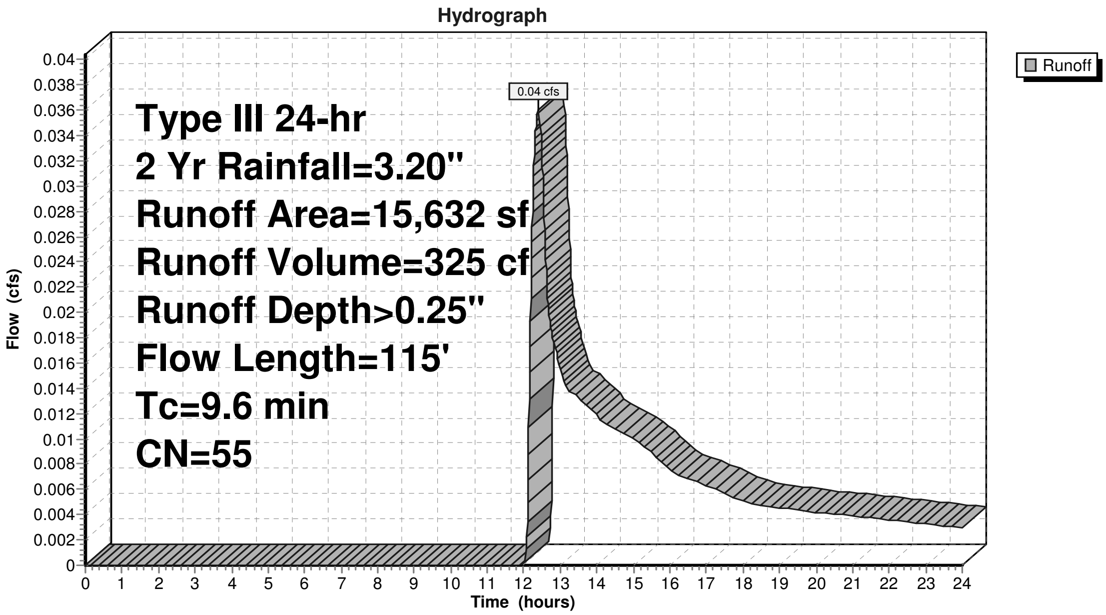
Runoff = 0.04 cfs @ 12.39 hrs, Volume= 325 cf, Depth> 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
15,632	55	Woods, Good, HSG B
15,632		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	65	0.0400	1.00		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
9.6	115	Total			

Subcatchment E5: PreDev



Summary for Subcatchment P1: Post Dev

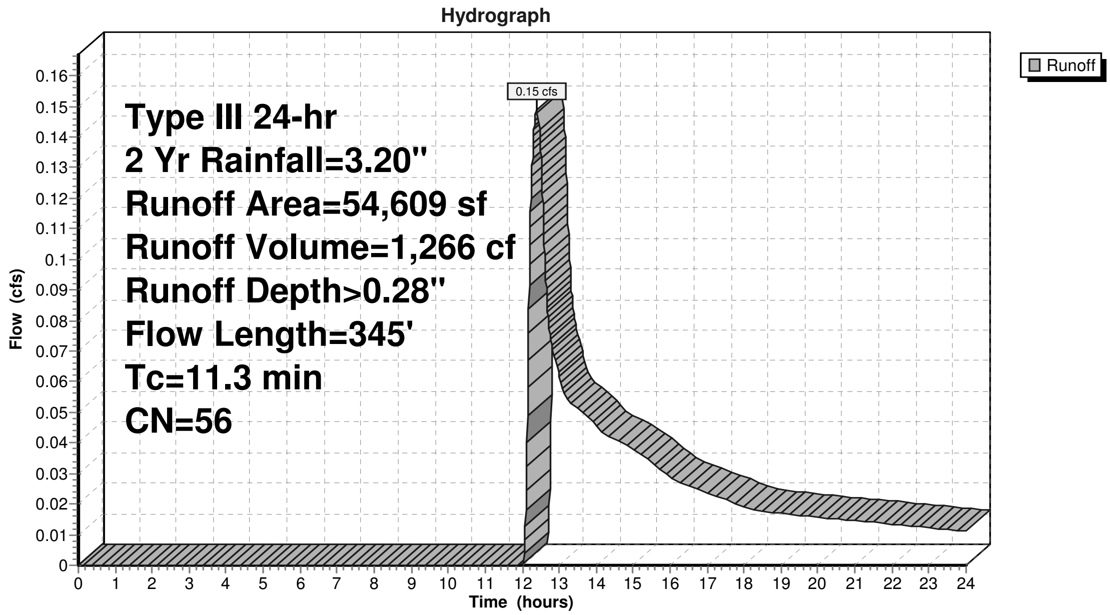
Runoff = 0.15 cfs @ 12.39 hrs, Volume= 1,266 cf, Depth> 0.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
848	98	Roofs, HSG B
4,300	61	>75% Grass cover, Good, HSG B
49,461	55	Woods, Good, HSG B
54,609	56	Weighted Average
53,761		98.45% Pervious Area
848		1.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.2	60	0.0800	4.55		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.9	235	0.0750	1.37		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
11.3	345	Total			

Subcatchment P1: Post Dev



Summary for Subcatchment P2: Post Dev

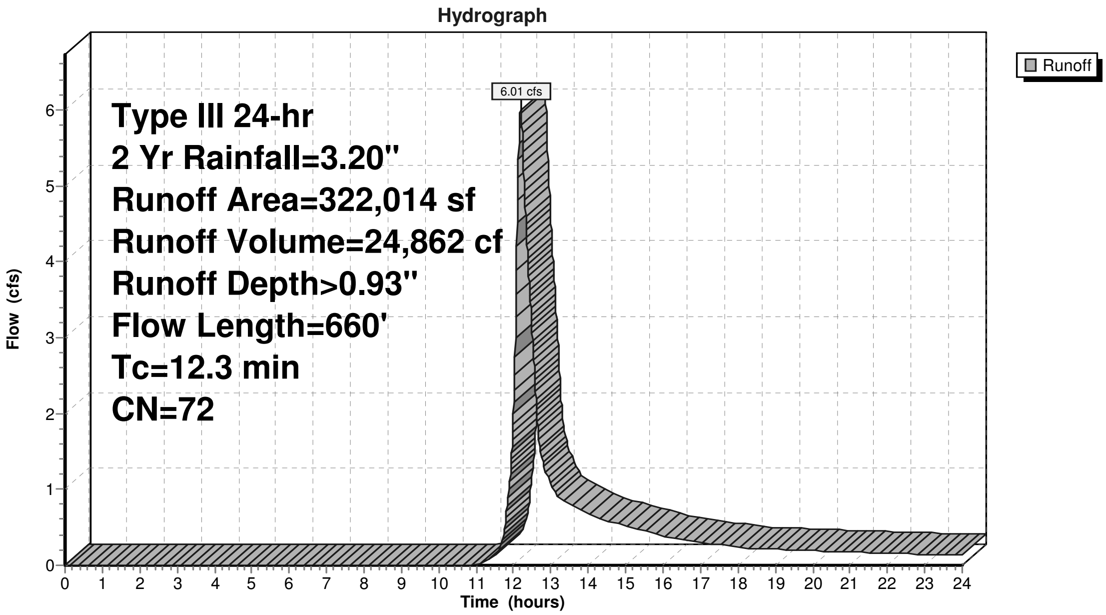
Runoff = 6.01 cfs @ 12.18 hrs, Volume= 24,862 cf, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

	Area (sf)	CN	Description
*	28,527	98	Paved Road, HSG B
*	7,666	98	Paved Sidewalk, HSG B
*	27,215	98	Paved Drives, HSG B
	30,966	98	Roofs, HSG B
	223,133	61	>75% Grass cover, Good, HSG B
	4,507	55	Woods, Good, HSG B
	322,014	72	Weighted Average
	227,640		70.69% Pervious Area
	94,374		29.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.7	220	0.0700	5.37		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
0.4	310	0.0800	12.83	10.08	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
12.3	660	Total			

Subcatchment P2: Post Dev



Summary for Subcatchment P3: PostDev

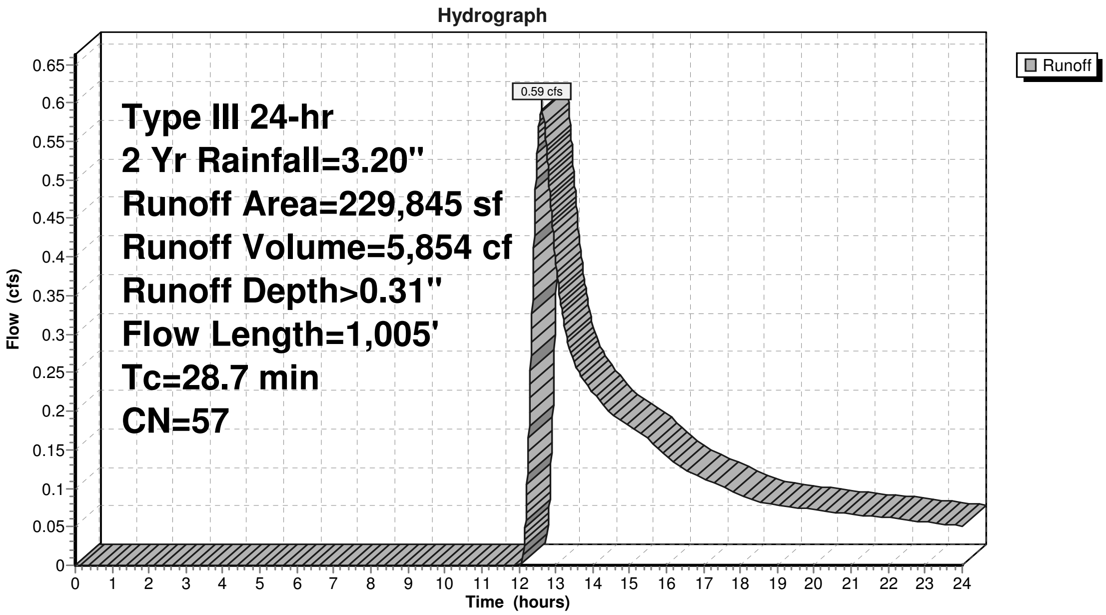
Runoff = 0.59 cfs @ 12.62 hrs, Volume= 5,854 cf, Depth> 0.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
4,976	98	Roofs, HSG B
54,253	61	>75% Grass cover, Good, HSG B
170,616	55	Woods, Good, HSG B
229,845	57	Weighted Average
224,869		97.84% Pervious Area
4,976		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
5.4	460	0.0800	1.41		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
28.7	1,005	Total			

Subcatchment P3: PostDev



Summary for Subcatchment P4: Post Dev

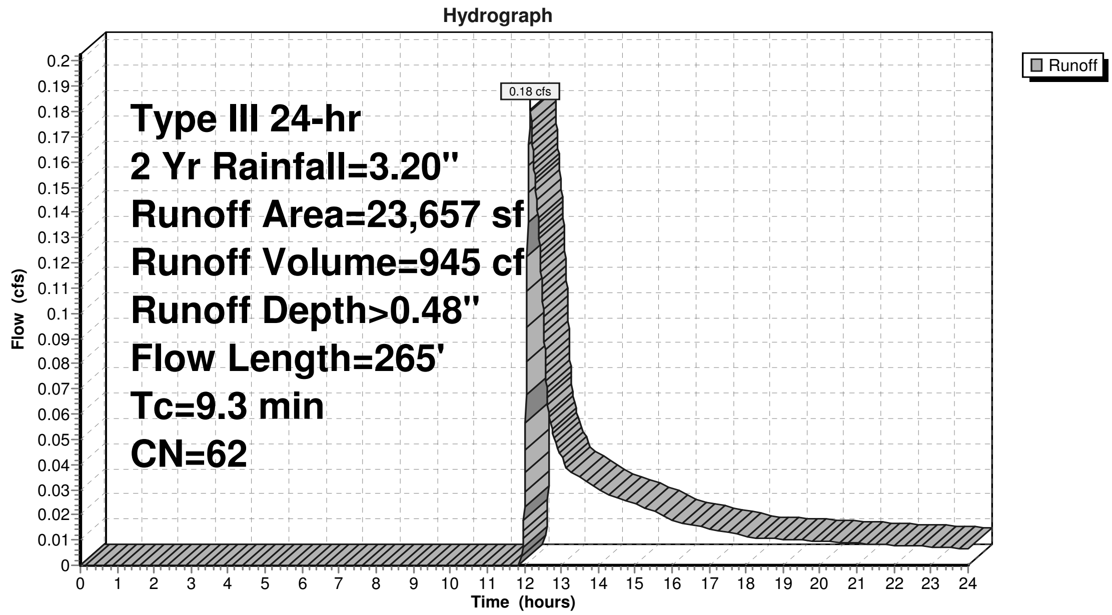
Runoff = 0.18 cfs @ 12.17 hrs, Volume= 945 cf, Depth> 0.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
1,592	98	Roofs, HSG B
15,676	61	>75% Grass cover, Good, HSG B
6,389	55	Woods, Good, HSG B
23,657	62	Weighted Average
22,065		93.27% Pervious Area
1,592		6.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.4	125	0.1000	5.09		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.3	265	Total			

Subcatchment P4: Post Dev



Summary for Subcatchment P5: Post Dev

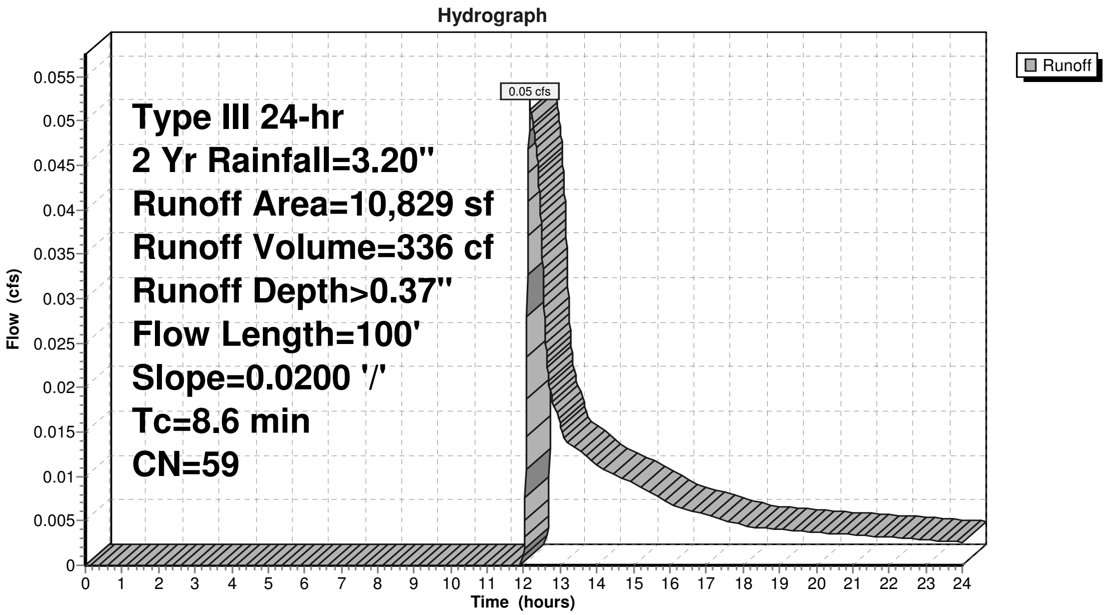
Runoff = 0.05 cfs @ 12.19 hrs, Volume= 336 cf, Depth> 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

Area (sf)	CN	Description
6,641	61	>75% Grass cover, Good, HSG B
4,188	55	Woods, Good, HSG B
10,829	59	Weighted Average
10,829		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	50	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
8.6	100	Total			

Subcatchment P5: Post Dev



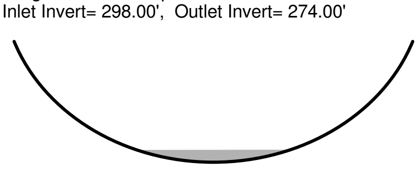
Summary for Reach 1R: Stream

Inflow Area = 63,319 sf, 0.00% Impervious, Inflow Depth > 0.25" for 2 Yr event
Inflow = 0.13 cfs @ 12.49 hrs, Volume= 1,313 cf
Outflow = 0.13 cfs @ 12.57 hrs, Volume= 1,307 cf, Atten= 1%, Lag= 4.8 min

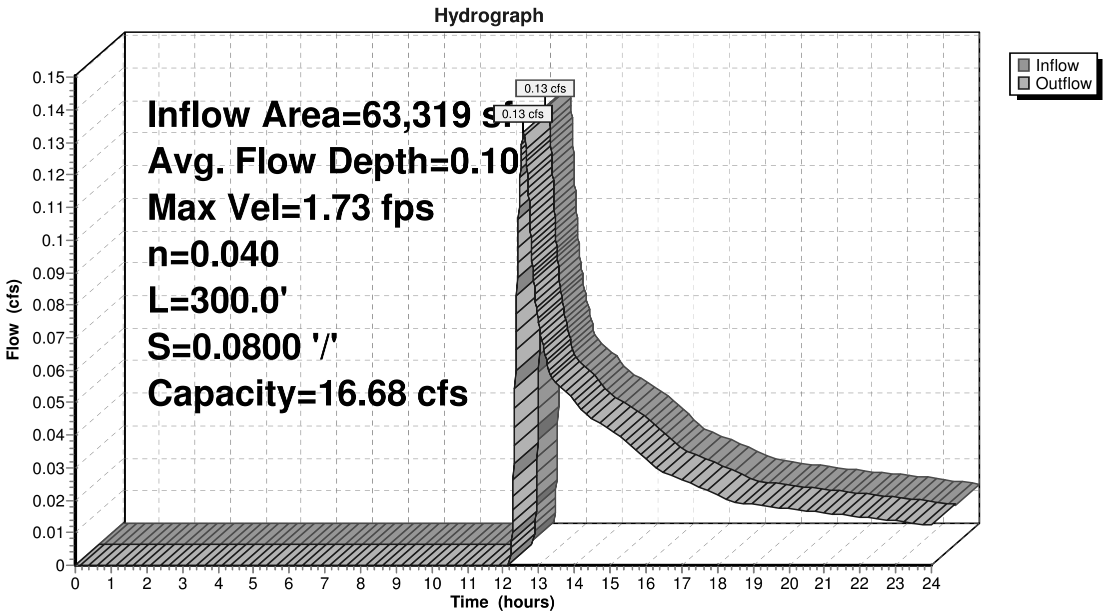
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.73 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 4.7 min

Peak Storage= 23 cf @ 12.52 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 1R: Stream



Summary for Reach 2R: Stream

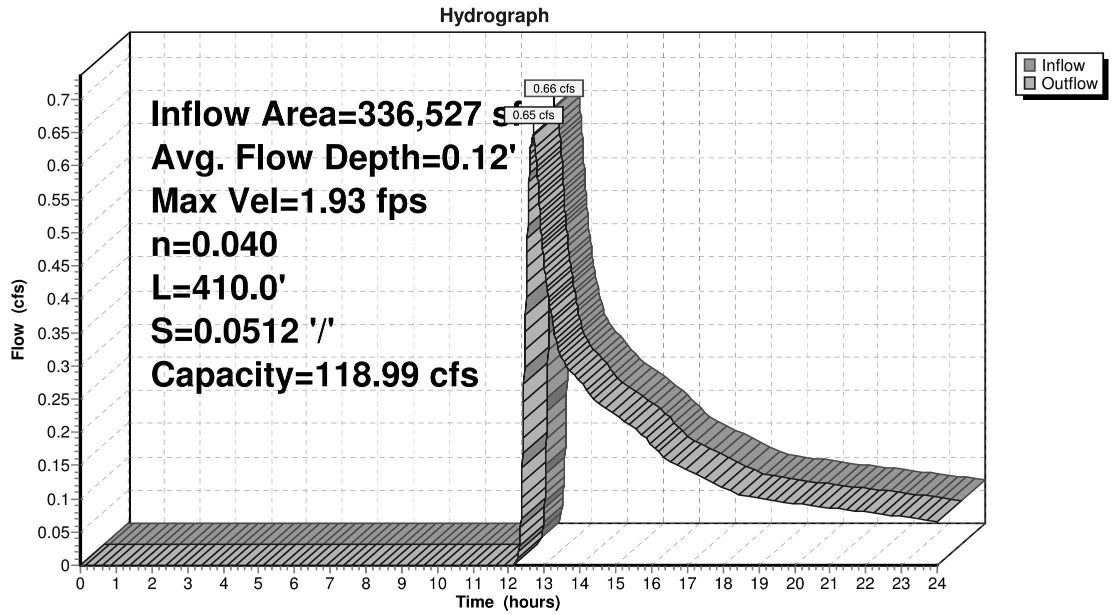
Inflow Area = 336,527 sf, 0.00% Impervious, Inflow Depth > 0.25" for 2 Yr event
Inflow = 0.66 cfs @ 12.59 hrs, Volume= 6,953 cf
Outflow = 0.65 cfs @ 12.68 hrs, Volume= 6,908 cf, Atten= 1%, Lag= 5.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.93 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 6.2 min

Peak Storage= 138 cf @ 12.62 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 2R: Stream



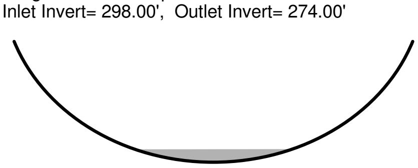
Summary for Reach 3R: Stream

Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 0.28" for 2 Yr event
Inflow = 0.15 cfs @ 12.39 hrs, Volume= 1,266 cf
Outflow = 0.15 cfs @ 12.47 hrs, Volume= 1,260 cf, Atten= 1%, Lag= 4.9 min

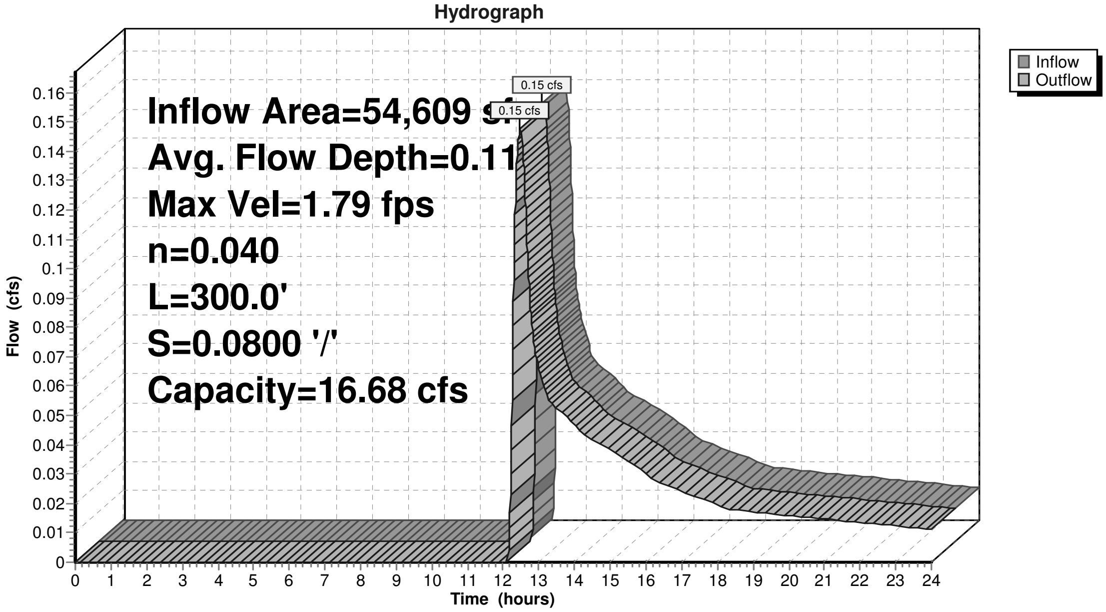
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.79 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 1.04 fps, Avg. Travel Time= 4.8 min

Peak Storage= 25 cf @ 12.43 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 3R: Stream



Summary for Reach 4R: Stream

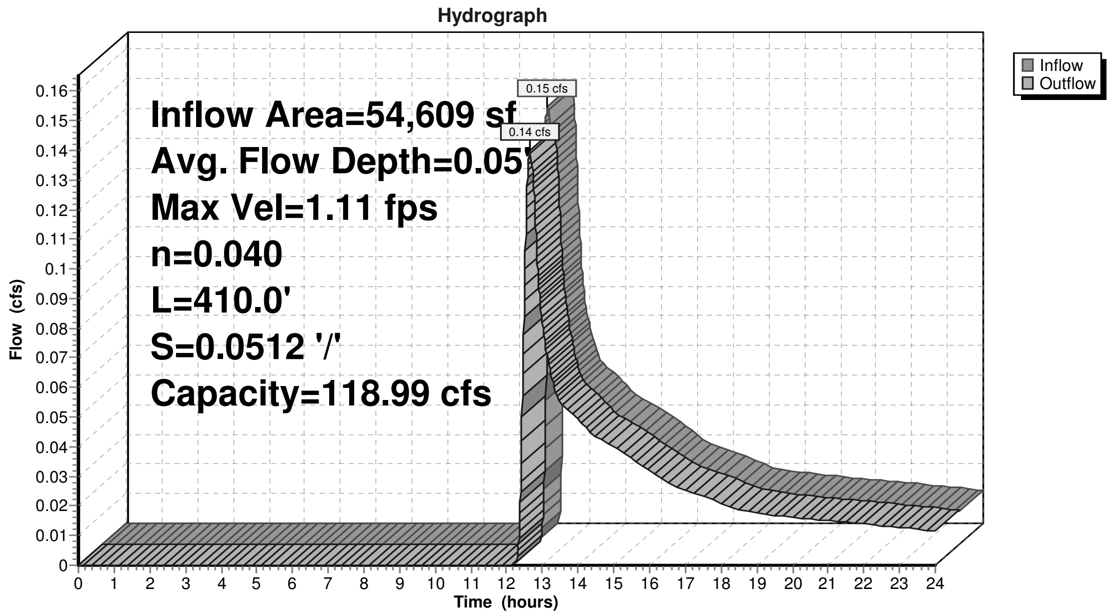
Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 0.28" for 2 Yr event
Inflow = 0.15 cfs @ 12.47 hrs, Volume= 1,260 cf
Outflow = 0.14 cfs @ 12.66 hrs, Volume= 1,248 cf, Atten= 5%, Lag= 10.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.11 fps, Min. Travel Time= 6.2 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 10.3 min

Peak Storage= 52 cf @ 12.55 hrs
Average Depth at Peak Storage= 0.05'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 4R: Stream



Summary for Pond 1P: Det Basin

Inflow Area = 322,014 sf, 29.31% Impervious, Inflow Depth > 0.93" for 2 Yr event
Inflow = 6.01 cfs @ 12.18 hrs, Volume= 24,862 cf
Outflow = 0.77 cfs @ 13.63 hrs, Volume= 18,901 cf, Atten= 87%, Lag= 86.5 min
Discarded = 0.23 cfs @ 13.63 hrs, Volume= 8,400 cf
Primary = 0.54 cfs @ 13.63 hrs, Volume= 10,501 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 269.48' @ 13.63 hrs Surf.Area= 6,372 sf Storage= 10,847 cf

Plug-Flow detention time= 223.9 min calculated for 18,901 cf (76% of inflow)
Center-of-Mass det. time= 132.7 min (1,005.3 - 872.6)

Volume	Invert	Avail.Storage	Storage Description
#1	266.50'	44,870 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

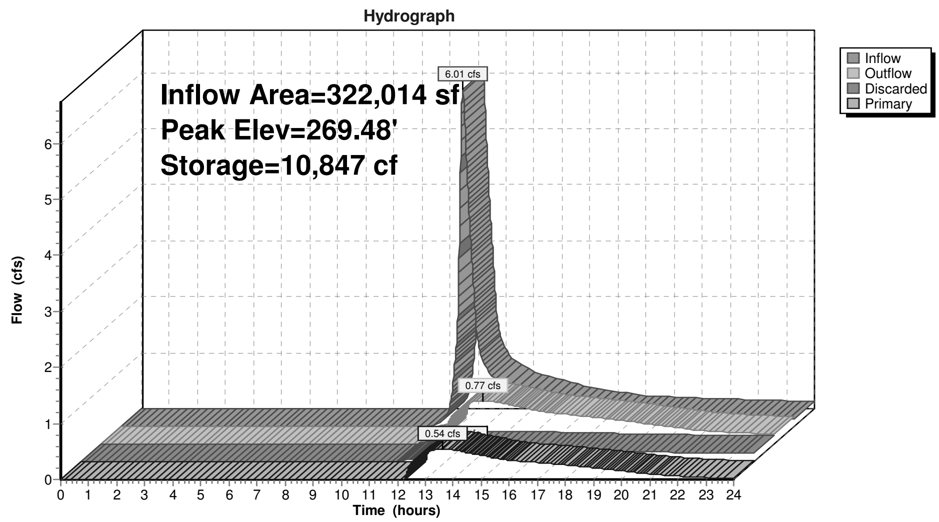
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
266.50	1,320	147.0	0	0	1,320
268.00	3,623	243.0	3,565	3,565	4,314
270.00	7,534	370.0	10,921	14,486	10,539
272.00	11,140	448.0	18,557	33,043	15,682
273.00	12,527	468.0	11,827	44,870	17,210

Device	Routing	Invert	Outlet Devices
#1	Discarded	266.50'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 264.00'
#2	Primary	265.00'	**24.0" Round Culvert** L= 52.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 265.00' / 259.50' S= 0.1058 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#3	Device 2	268.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#4	Device 2	269.30'	**0.7' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 4.5' Crest Height
#5	Device 2	272.30'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.23 cfs @ 13.63 hrs HW=269.48' (Free Discharge)
└─**1=Exfiltration** (Controls 0.23 cfs)

Primary OutFlow Max=0.54 cfs @ 13.63 hrs HW=269.48' (Free Discharge)
└─**2=Culvert** (Passes 0.54 cfs of 28.20 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.38 cfs @ 4.33 fps)
  ├─**4=Sharp-Crested Rectangular Weir** (Weir Controls 0.16 cfs @ 1.38 fps)
  └─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: Det Basin

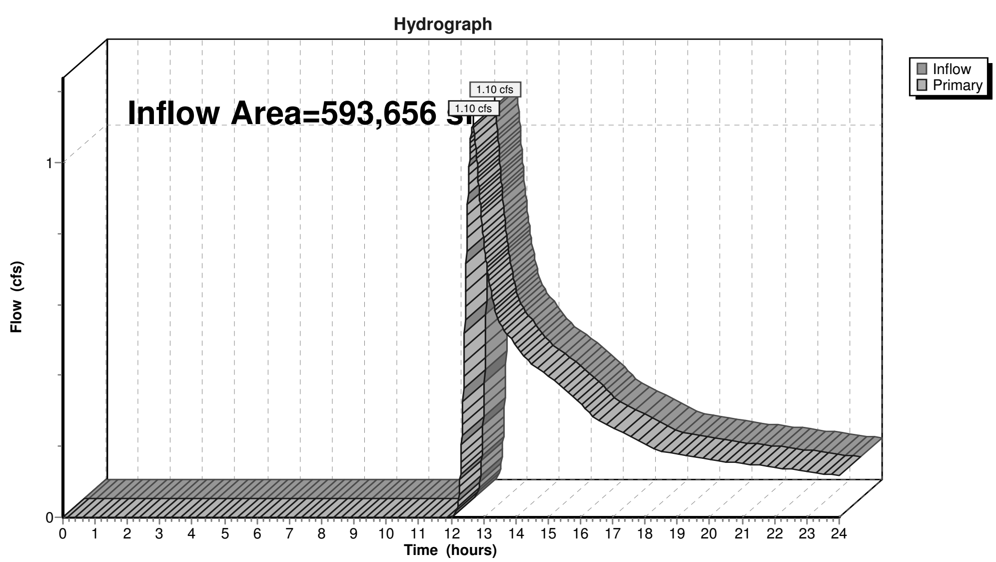


Summary for Link DP1: PreDev

Inflow Area =	593,656 sf,	0.00% Impervious,	Inflow Depth > 0.25"	for 2 Yr event
Inflow =	1.10 cfs @	12.67 hrs, Volume=	12,207 cf	
Primary =	1.10 cfs @	12.67 hrs, Volume=	12,207 cf, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: PreDev

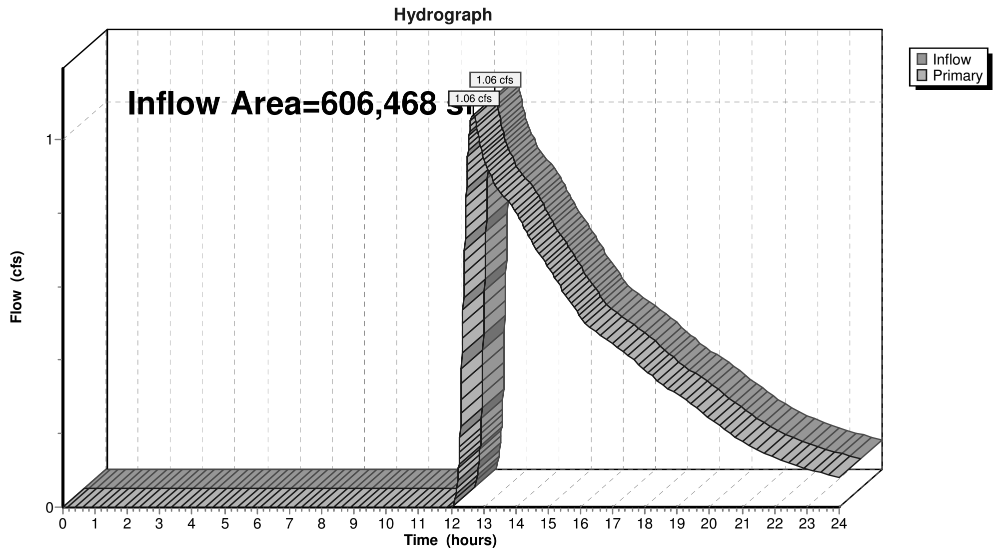


Summary for Link DP2: Post Offsite

Inflow Area = 606,468 sf, 16.52% Impervious, Inflow Depth > 0.35" for 2 Yr event
Inflow = 1.06 cfs @ 12.69 hrs, Volume= 17,602 cf
Primary = 1.06 cfs @ 12.69 hrs, Volume= 17,602 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Post Offsite



Summary for Subcatchment E1: PreDev

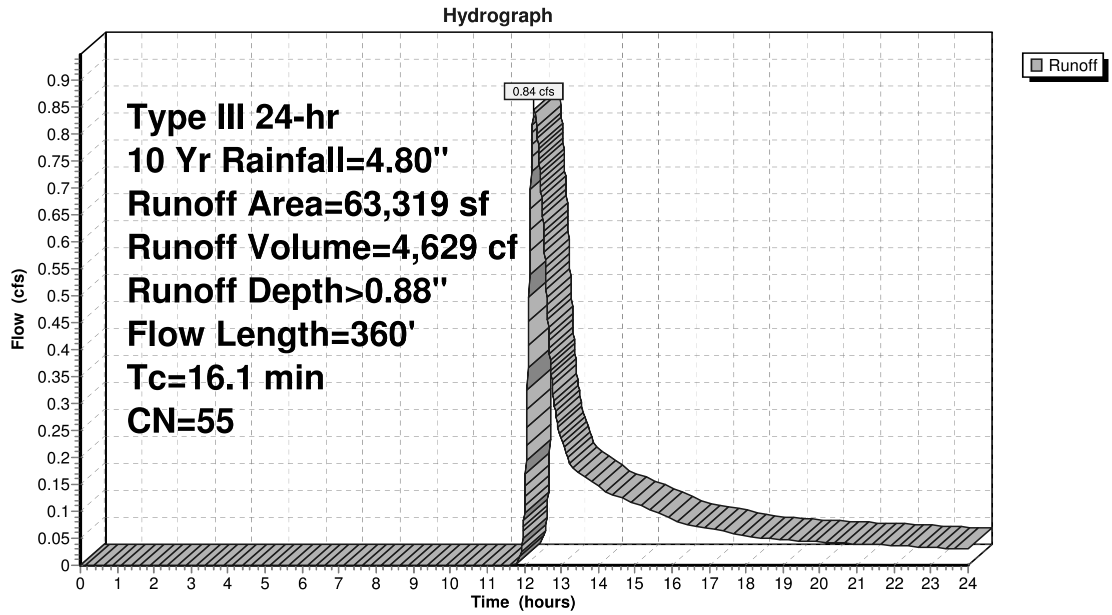
Runoff = 0.84 cfs @ 12.27 hrs, Volume= 4,629 cf, Depth> 0.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
63,319	55	Woods, Good, HSG B
63,319		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
3.8	310	0.0750	1.37		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
16.1	360	Total			

Subcatchment E1: PreDev



Summary for Subcatchment E2: PreDev

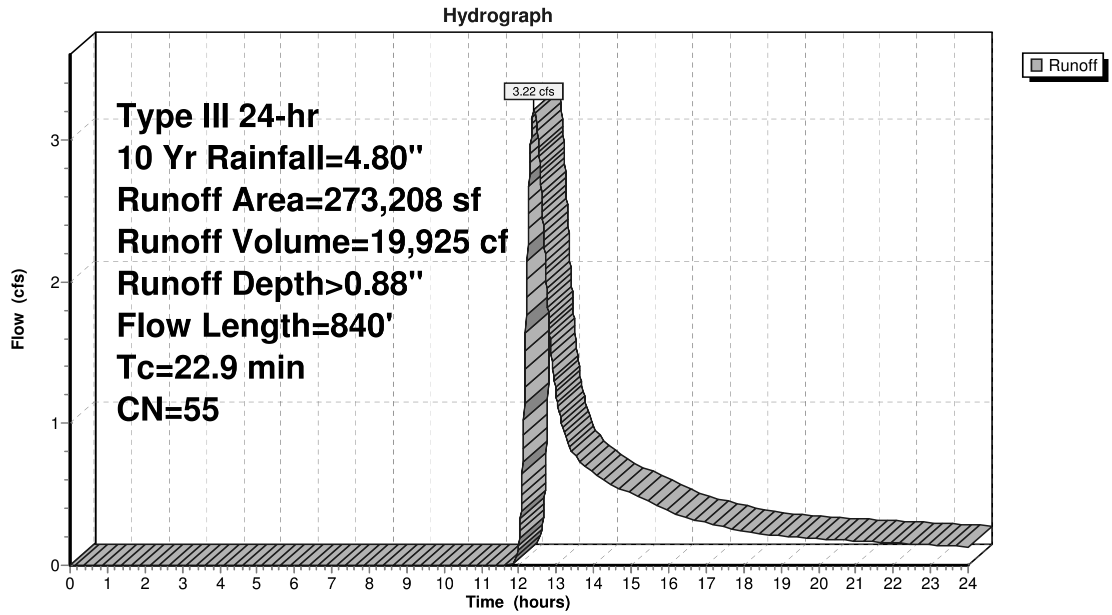
Runoff = 3.22 cfs @ 12.39 hrs, Volume= 19,925 cf, Depth> 0.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
273,208	55	Woods, Good, HSG B
273,208		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
12.4	790	0.0450	1.06		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
22.9	840	Total			

Subcatchment E2: PreDev



Summary for Subcatchment E3: PreDev

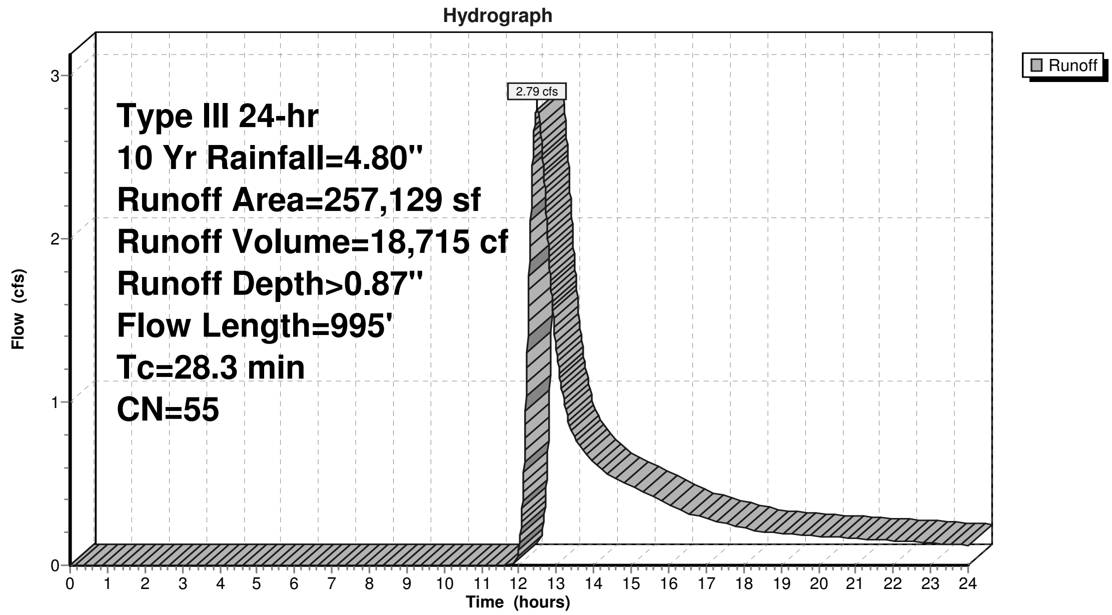
Runoff = 2.79 cfs @ 12.48 hrs, Volume= 18,715 cf, Depth> 0.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
257,129	55	Woods, Good, HSG B
257,129		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
5.3	450	0.0800	1.41		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
28.3	995	Total			

Subcatchment E3: PreDev



Summary for Subcatchment E4: PreDev

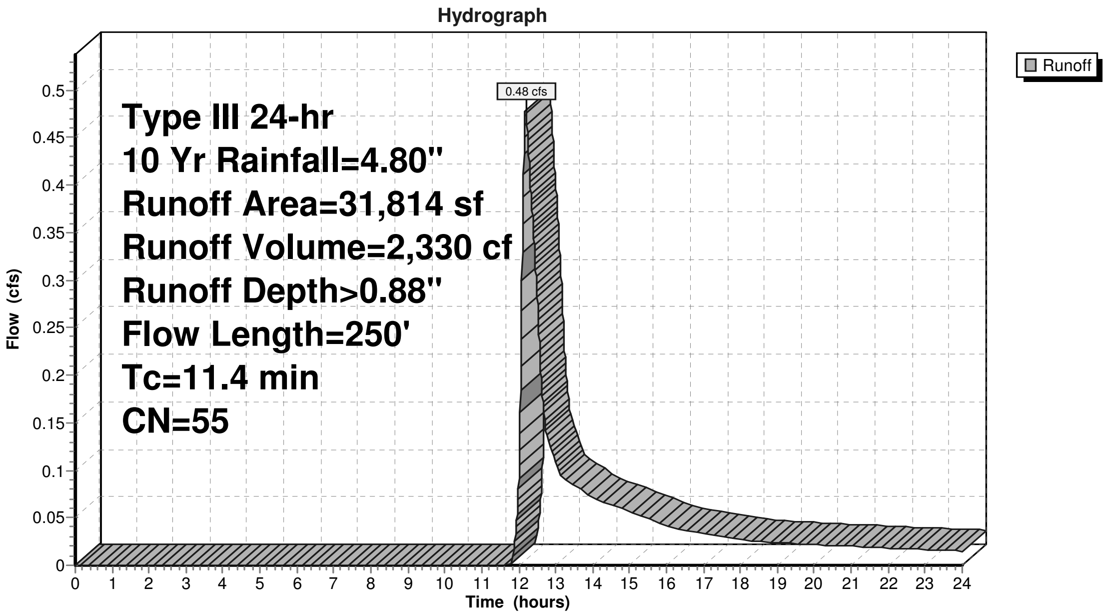
Runoff = 0.48 cfs @ 12.19 hrs, Volume= 2,330 cf, Depth> 0.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
31,814	55	Woods, Good, HSG B
31,814		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0400	0.09		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
2.1	200	0.1000	1.58		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.4	250	Total			

Subcatchment E4: PreDev



Summary for Subcatchment E5: PreDev

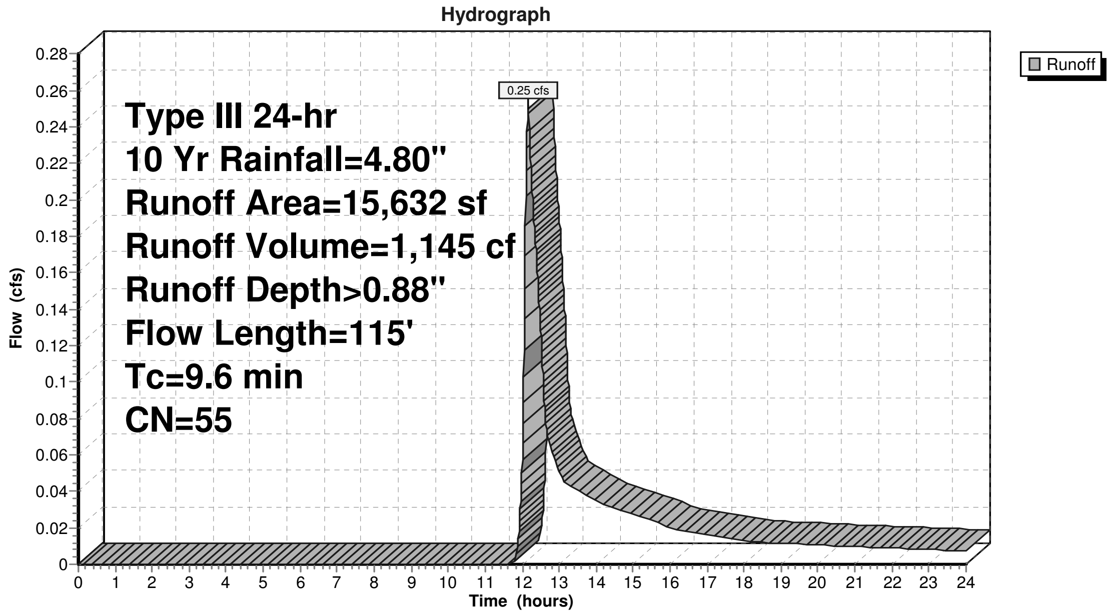
Runoff = 0.25 cfs @ 12.16 hrs, Volume= 1,145 cf, Depth> 0.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
15,632	55	Woods, Good, HSG B
15,632		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	65	0.0400	1.00		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
9.6	115	Total			

Subcatchment E5: PreDev



Summary for Subcatchment P1: Post Dev

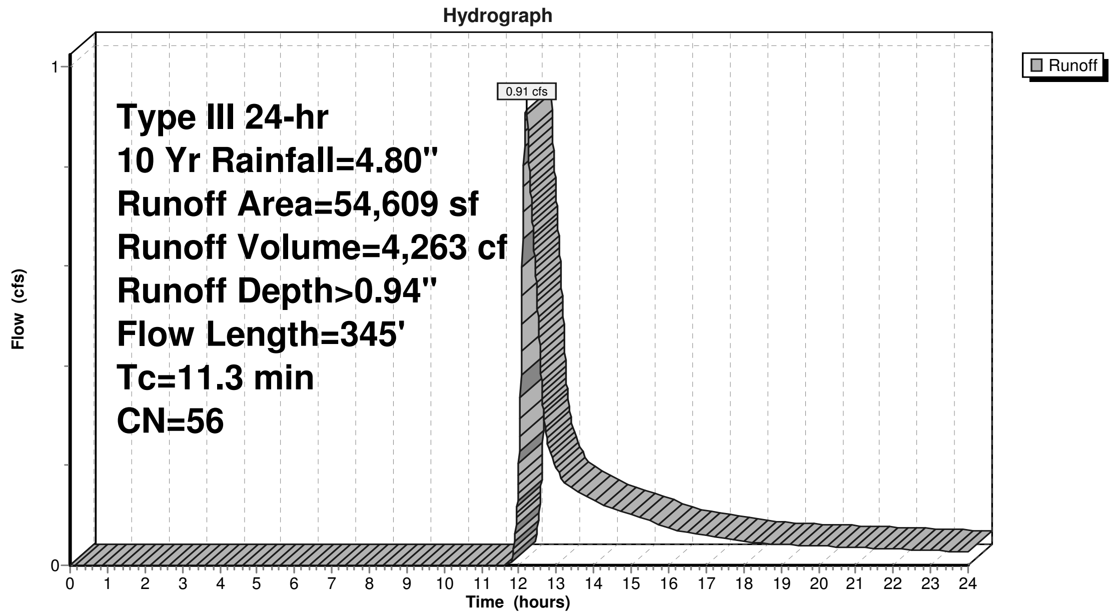
Runoff = 0.91 cfs @ 12.19 hrs, Volume= 4,263 cf, Depth> 0.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
848	98	Roofs, HSG B
4,300	61	>75% Grass cover, Good, HSG B
49,461	55	Woods, Good, HSG B
54,609	56	Weighted Average
53,761		98.45% Pervious Area
848		1.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.2	60	0.0800	4.55		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.9	235	0.0750	1.37		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
11.3	345	Total			

Subcatchment P1: Post Dev



Summary for Subcatchment P2: Post Dev

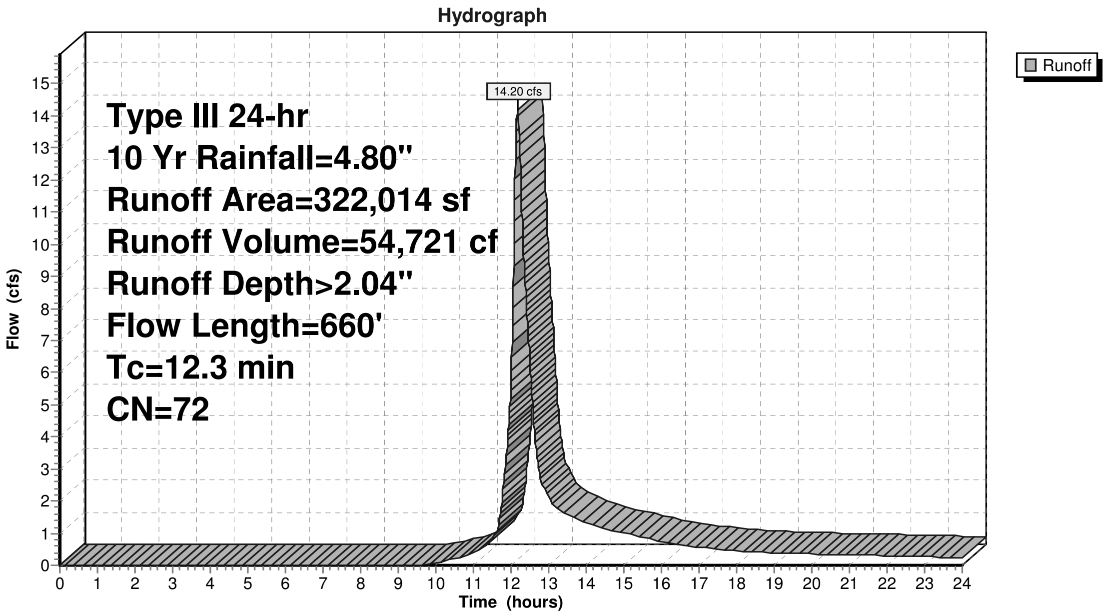
Runoff = 14.20 cfs @ 12.18 hrs, Volume= 54,721 cf, Depth> 2.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

	Area (sf)	CN	Description
*	28,527	98	Paved Road, HSG B
*	7,666	98	Paved Sidewalk, HSG B
*	27,215	98	Paved Drives, HSG B
	30,966	98	Roofs, HSG B
	223,133	61	>75% Grass cover, Good, HSG B
	4,507	55	Woods, Good, HSG B
	322,014	72	Weighted Average
	227,640		70.69% Pervious Area
	94,374		29.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.7	220	0.0700	5.37		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
0.4	310	0.0800	12.83	10.08	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
12.3	660	Total			

Subcatchment P2: Post Dev



Summary for Subcatchment P3: PostDev

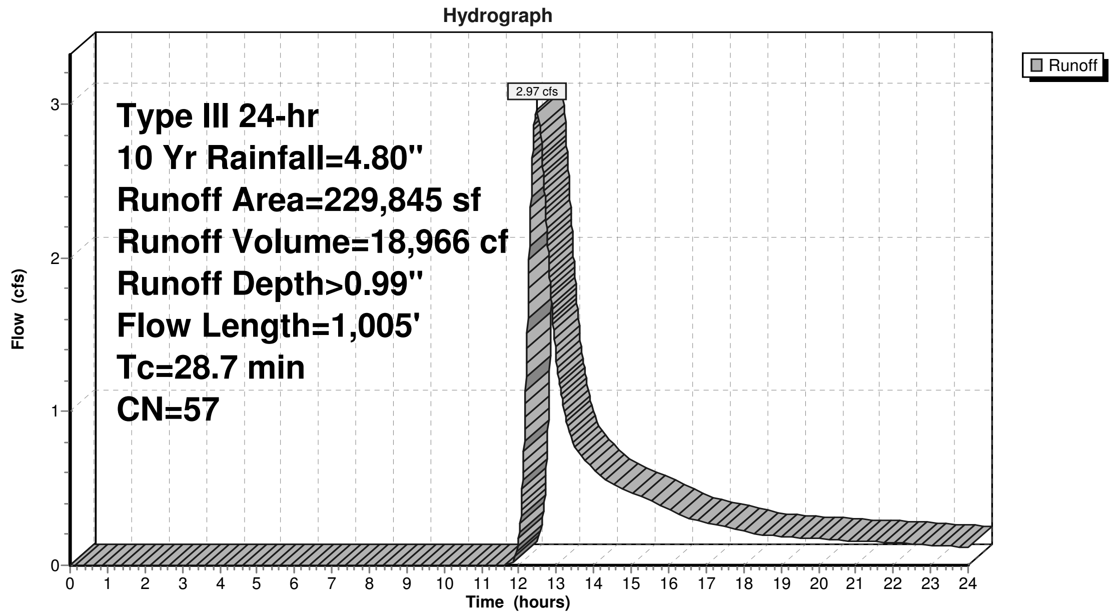
Runoff = 2.97 cfs @ 12.47 hrs, Volume= 18,966 cf, Depth> 0.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
4,976	98	Roofs, HSG B
54,253	61	>75% Grass cover, Good, HSG B
170,616	55	Woods, Good, HSG B
229,845	57	Weighted Average
224,869		97.84% Pervious Area
4,976		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
5.4	460	0.0800	1.41		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
28.7	1,005	Total			

Subcatchment P3: PostDev



Summary for Subcatchment P4: Post Dev

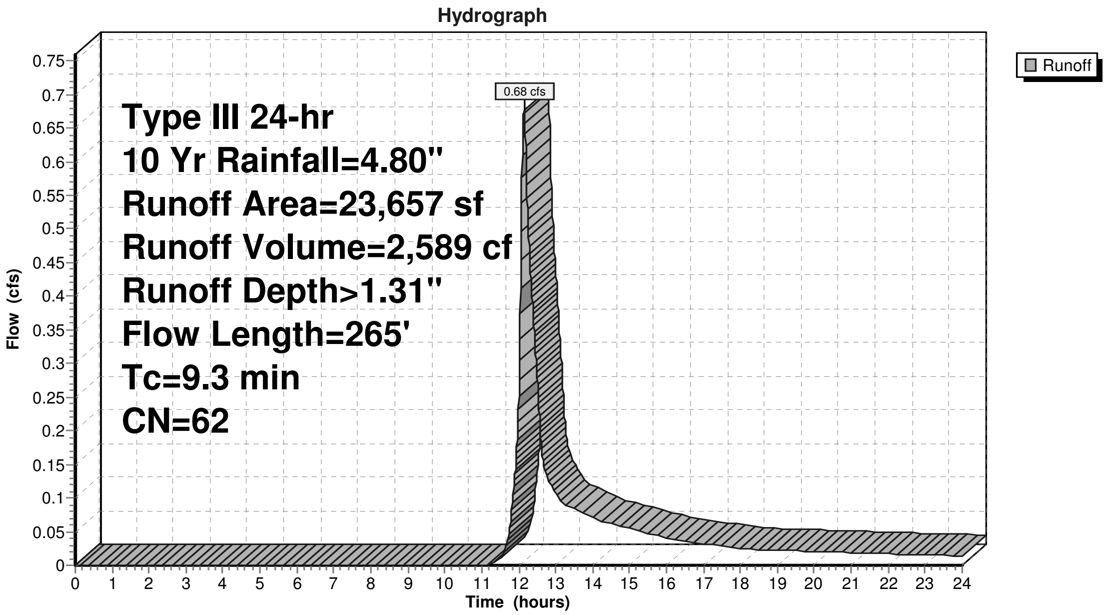
Runoff = 0.68 cfs @ 12.14 hrs, Volume= 2,589 cf, Depth> 1.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
1,592	98	Roofs, HSG B
15,676	61	>75% Grass cover, Good, HSG B
6,389	55	Woods, Good, HSG B
23,657	62	Weighted Average
22,065		93.27% Pervious Area
1,592		6.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.4	125	0.1000	5.09		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.3	265	Total			

Subcatchment P4: Post Dev



Summary for Subcatchment P5: Post Dev

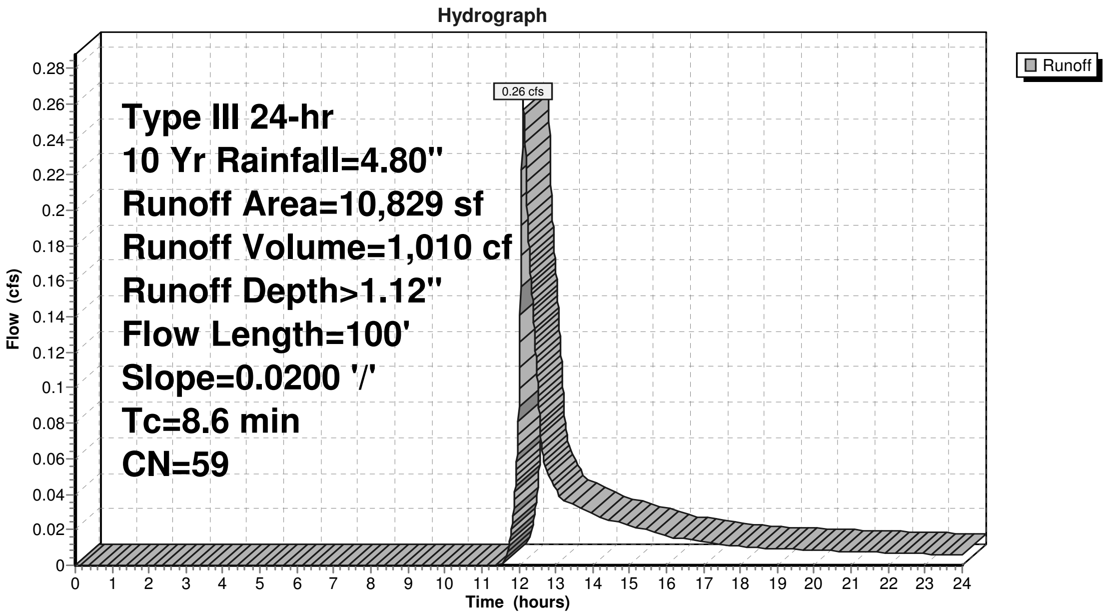
Runoff = 0.26 cfs @ 12.14 hrs, Volume= 1,010 cf, Depth> 1.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

Area (sf)	CN	Description
6,641	61	>75% Grass cover, Good, HSG B
4,188	55	Woods, Good, HSG B
10,829	59	Weighted Average
10,829		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	50	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
8.6	100	Total			

Subcatchment P5: Post Dev



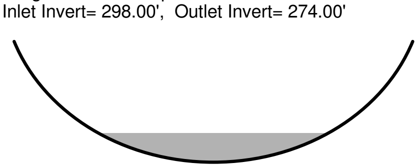
Summary for Reach 1R: Stream

Inflow Area = 63,319 sf, 0.00% Impervious, Inflow Depth > 0.88" for 10 Yr event
Inflow = 0.84 cfs @ 12.27 hrs, Volume= 4,629 cf
Outflow = 0.84 cfs @ 12.32 hrs, Volume= 4,618 cf, Atten= 1%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.02 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.47 fps, Avg. Travel Time= 3.4 min

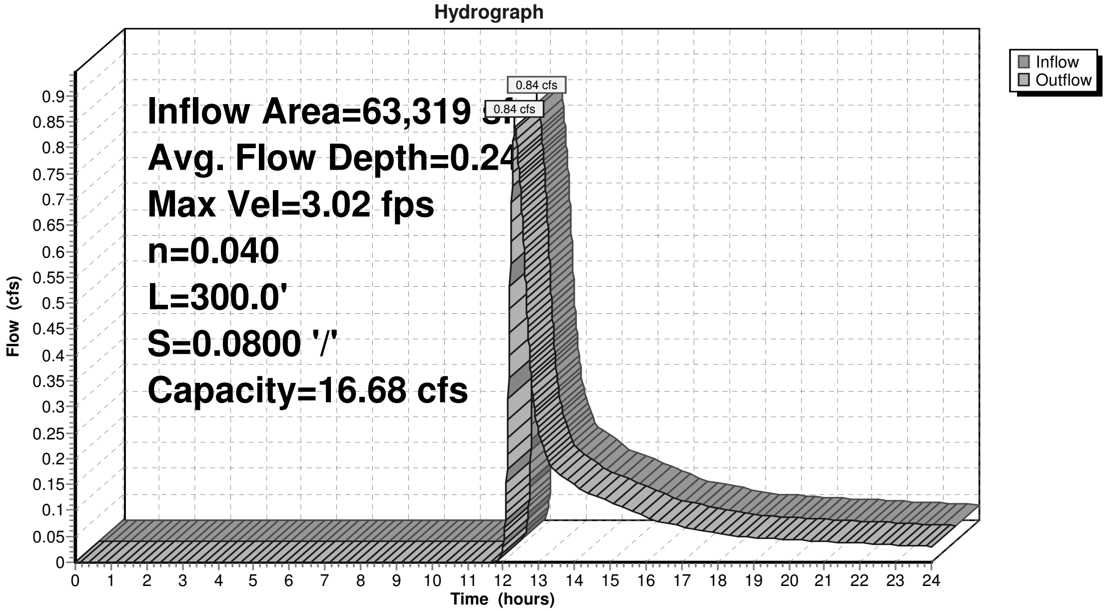
Peak Storage= 83 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 1R: Stream

Hydrograph



Summary for Reach 2R: Stream

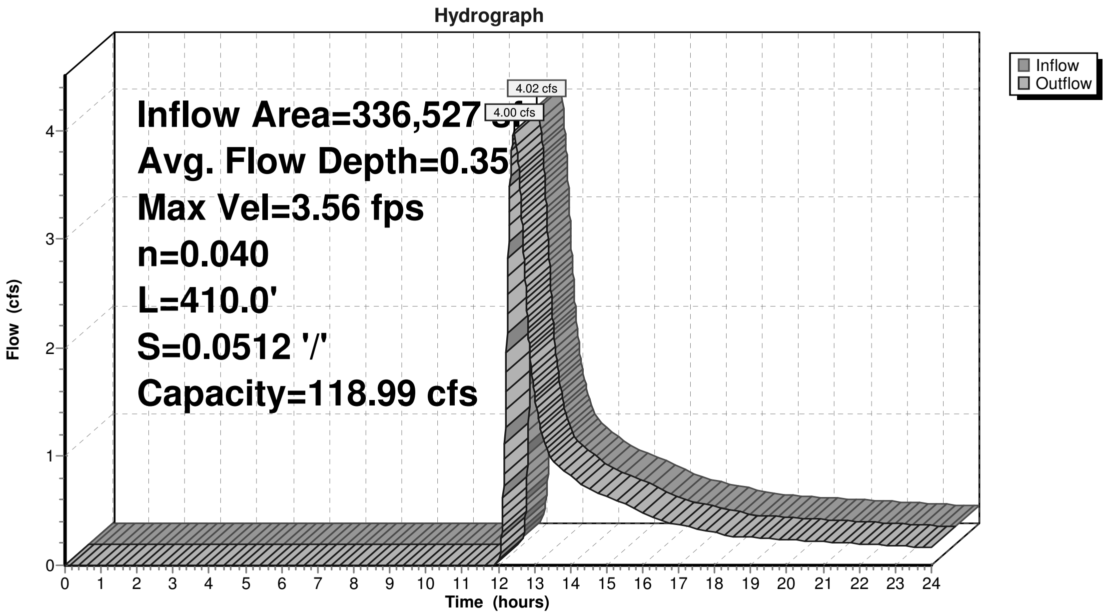
Inflow Area = 336,527 sf, 0.00% Impervious, Inflow Depth > 0.88" for 10 Yr event
Inflow = 4.02 cfs @ 12.39 hrs, Volume= 24,543 cf
Outflow = 4.00 cfs @ 12.44 hrs, Volume= 24,468 cf, Atten= 1%, Lag= 3.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.56 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.64 fps, Avg. Travel Time= 4.2 min

Peak Storage= 460 cf @ 12.41 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 2R: Stream



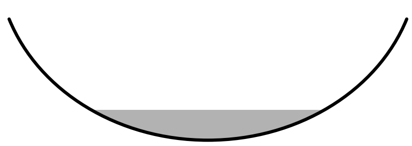
Summary for Reach 3R: Stream

Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 0.94" for 10 Yr event
Inflow = 0.91 cfs @ 12.19 hrs, Volume= 4,263 cf
Outflow = 0.90 cfs @ 12.23 hrs, Volume= 4,253 cf, Atten= 1%, Lag= 2.9 min

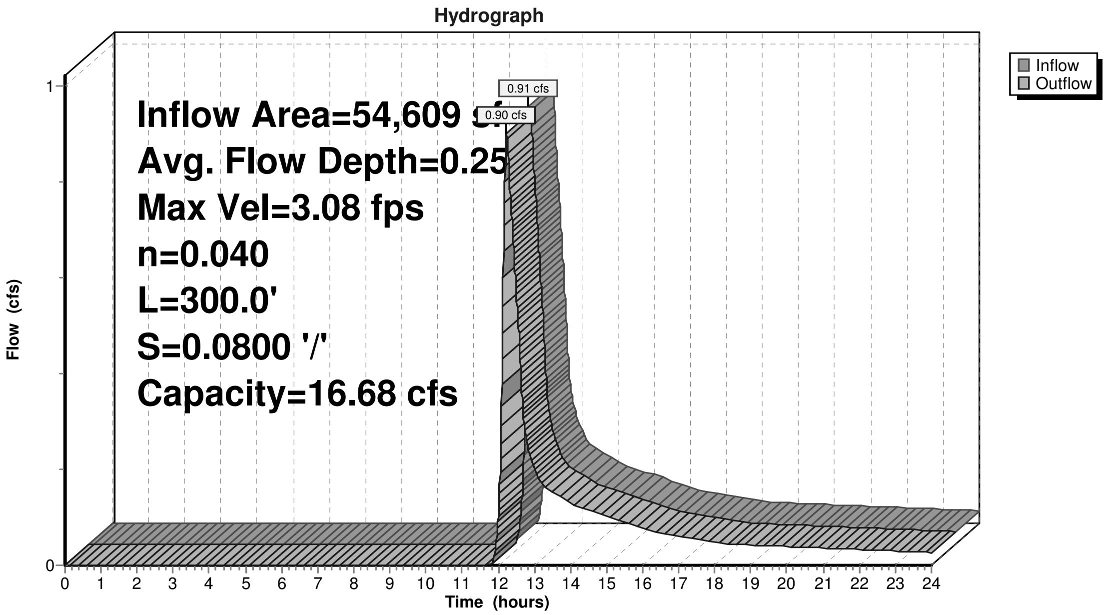
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.08 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 3.5 min

Peak Storage= 88 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 3R: Stream



Summary for Reach 4R: Stream

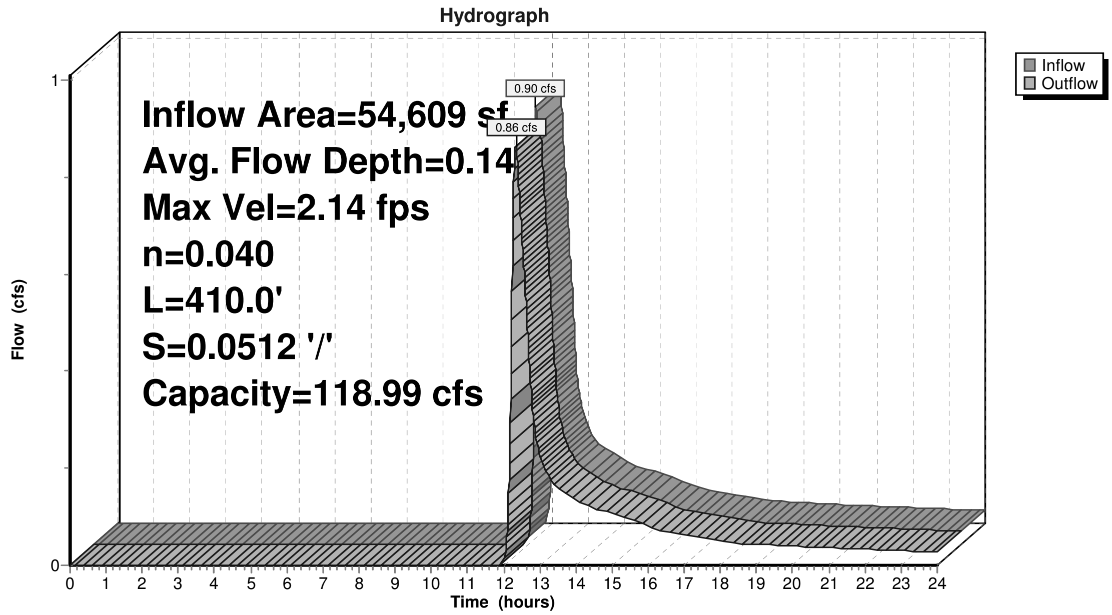
Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 0.93" for 10 Yr event
Inflow = 0.90 cfs @ 12.23 hrs, Volume= 4,253 cf
Outflow = 0.86 cfs @ 12.33 hrs, Volume= 4,230 cf, Atten= 4%, Lag= 5.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.14 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 7.9 min

Peak Storage= 165 cf @ 12.28 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 4R: Stream



Summary for Pond 1P: Det Basin

Inflow Area = 322,014 sf, 29.31% Impervious, Inflow Depth > 2.04" for 10 Yr event
Inflow = 14.20 cfs @ 12.18 hrs, Volume= 54,721 cf
Outflow = 3.54 cfs @ 12.67 hrs, Volume= 47,591 cf, Atten= 75%, Lag= 29.6 min
Discarded = 0.36 cfs @ 12.67 hrs, Volume= 10,688 cf
Primary = 3.18 cfs @ 12.67 hrs, Volume= 36,903 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 270.85' @ 12.67 hrs Surf.Area= 8,974 sf Storage= 21,464 cf

Plug-Flow detention time= 144.8 min calculated for 47,591 cf (87% of inflow)
Center-of-Mass det. time= 86.0 min (934.8 - 848.8)

Volume	Invert	Avail.Storage	Storage Description
#1	266.50'	44,870 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

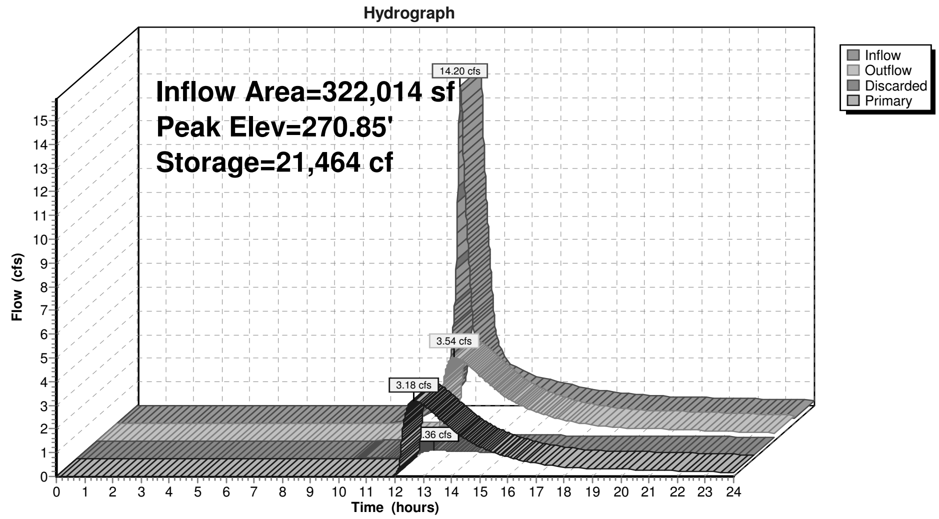
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
266.50	1,320	147.0	0	0	1,320
268.00	3,623	243.0	3,565	3,565	4,314
270.00	7,534	370.0	10,921	14,486	10,539
272.00	11,140	448.0	18,557	33,043	15,682
273.00	12,527	468.0	11,827	44,870	17,210

Device	Routing	Invert	Outlet Devices
#1	Discarded	266.50'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 264.00'
#2	Primary	265.00'	**24.0" Round Culvert** L= 52.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 265.00' / 259.50' S= 0.1058 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#3	Device 2	268.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#4	Device 2	269.30'	**0.7' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 4.5' Crest Height
#5	Device 2	272.30'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.36 cfs @ 12.67 hrs HW=270.85' (Free Discharge)
└─**1=Exfiltration** (Controls 0.36 cfs)

Primary OutFlow Max=3.18 cfs @ 12.67 hrs HW=270.85' (Free Discharge)
└─**2=Culvert** (Passes 3.18 cfs of 33.30 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.62 cfs @ 7.11 fps)
  ├─**4=Sharp-Crested Rectangular Weir** (Weir Controls 2.56 cfs @ 4.24 fps)
  └─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: Det Basin

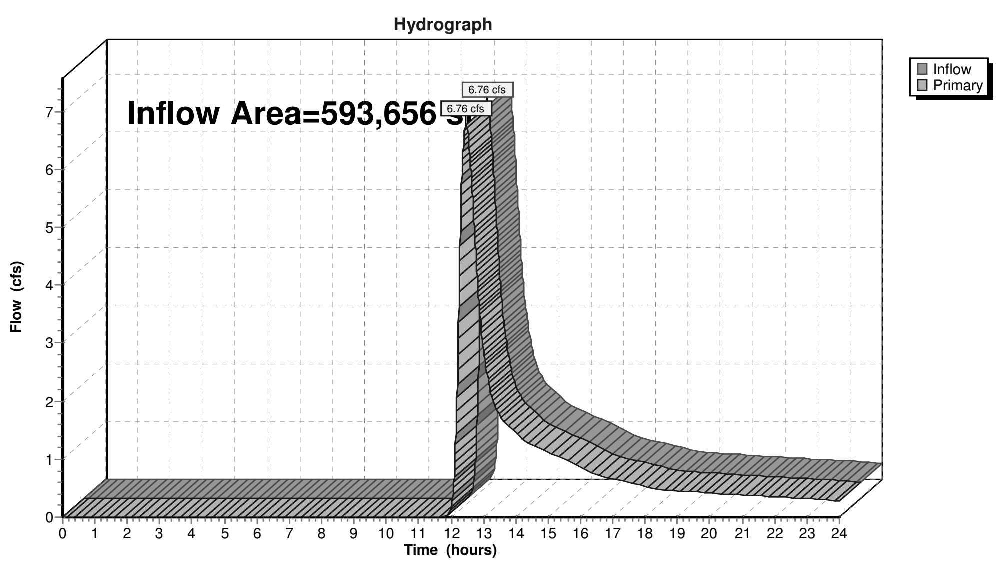


Summary for Link DP1: PreDev

Inflow Area =	593,656 sf, 0.00% Impervious, Inflow Depth > 0.87" for 10 Yr event	
Inflow =	6.76 cfs @ 12.46 hrs, Volume=	43,183 cf
Primary =	6.76 cfs @ 12.46 hrs, Volume=	43,183 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: PreDev

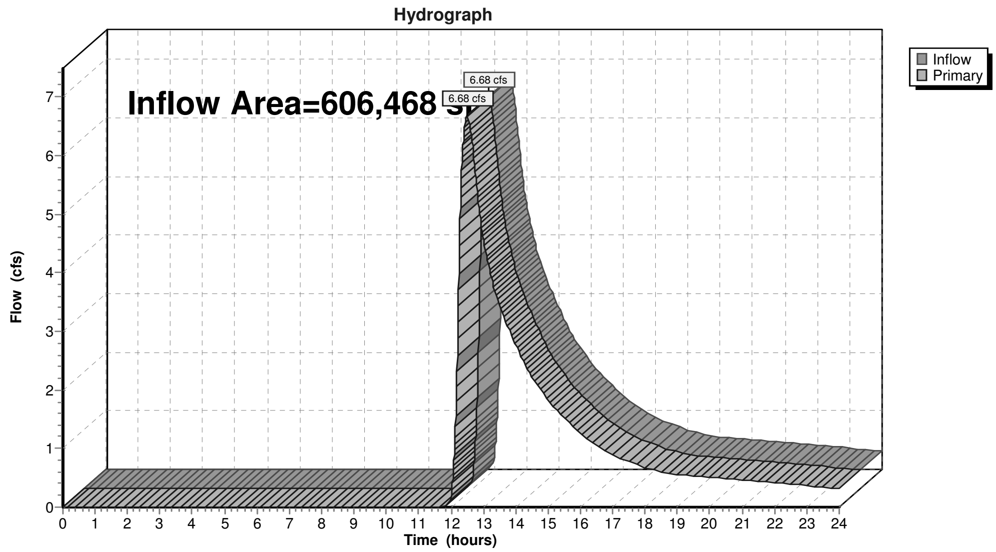


Summary for Link DP2: Post Offsite

Inflow Area = 606,468 sf, 16.52% Impervious, Inflow Depth > 1.19" for 10 Yr event
Inflow = 6.68 cfs @ 12.50 hrs, Volume= 60,099 cf
Primary = 6.68 cfs @ 12.50 hrs, Volume= 60,099 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Post Offsite



Summary for Subcatchment E1: PreDev

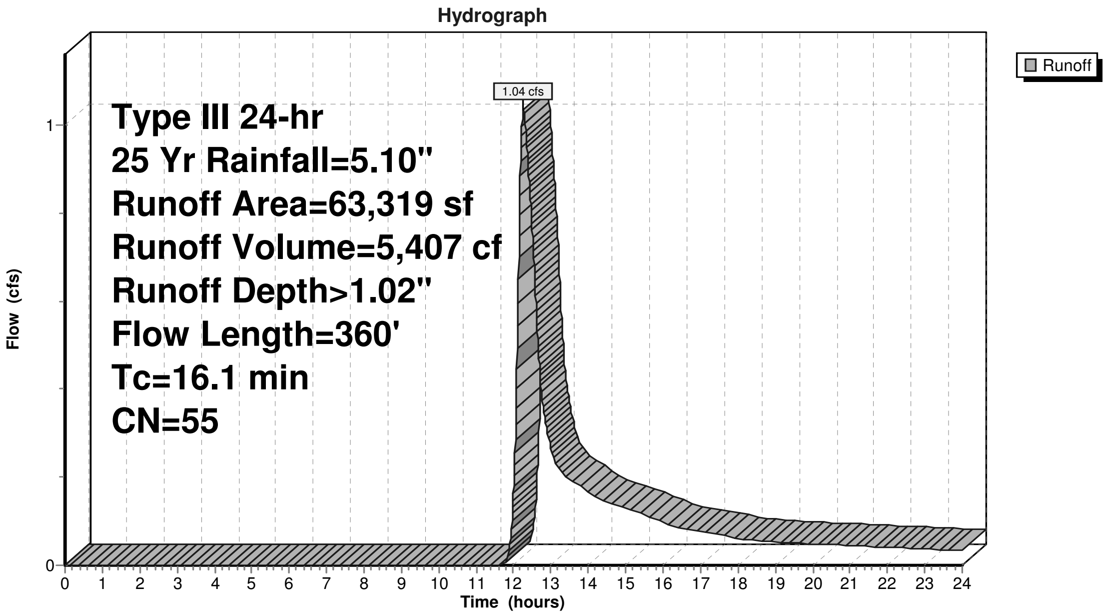
Runoff = 1.04 cfs @ 12.26 hrs, Volume= 5,407 cf, Depth> 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
63,319	55	Woods, Good, HSG B
63,319		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
3.8	310	0.0750	1.37		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
16.1	360	Total			

Subcatchment E1: PreDev



Summary for Subcatchment E2: PreDev

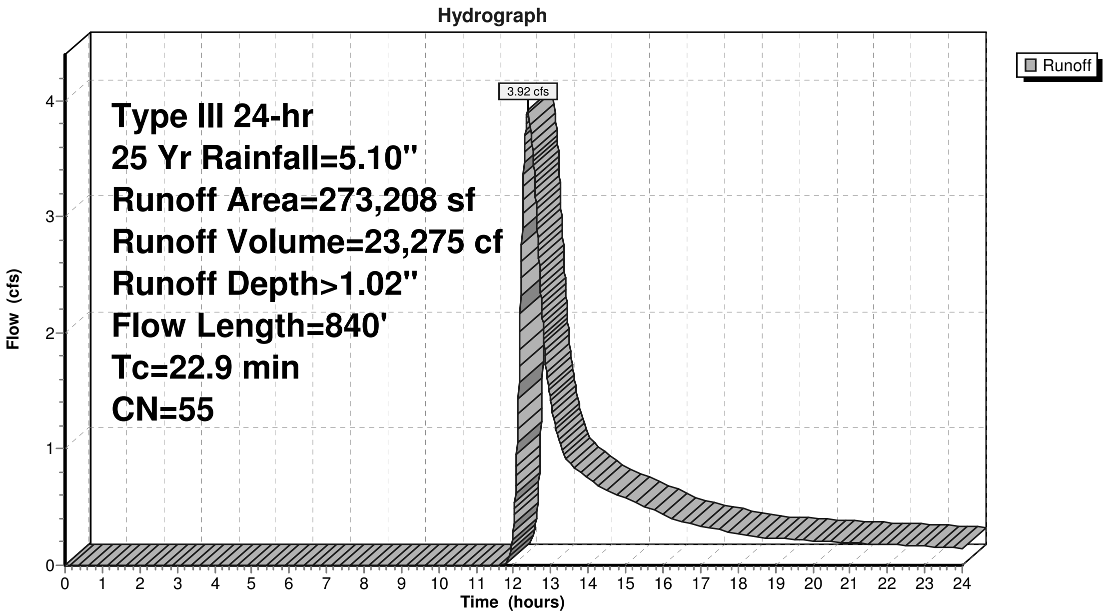
Runoff = 3.92 cfs @ 12.39 hrs, Volume= 23,275 cf, Depth> 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
273,208	55	Woods, Good, HSG B
273,208		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
12.4	790	0.0450	1.06		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
22.9	840	Total			

Subcatchment E2: PreDev



Summary for Subcatchment E3: PreDev

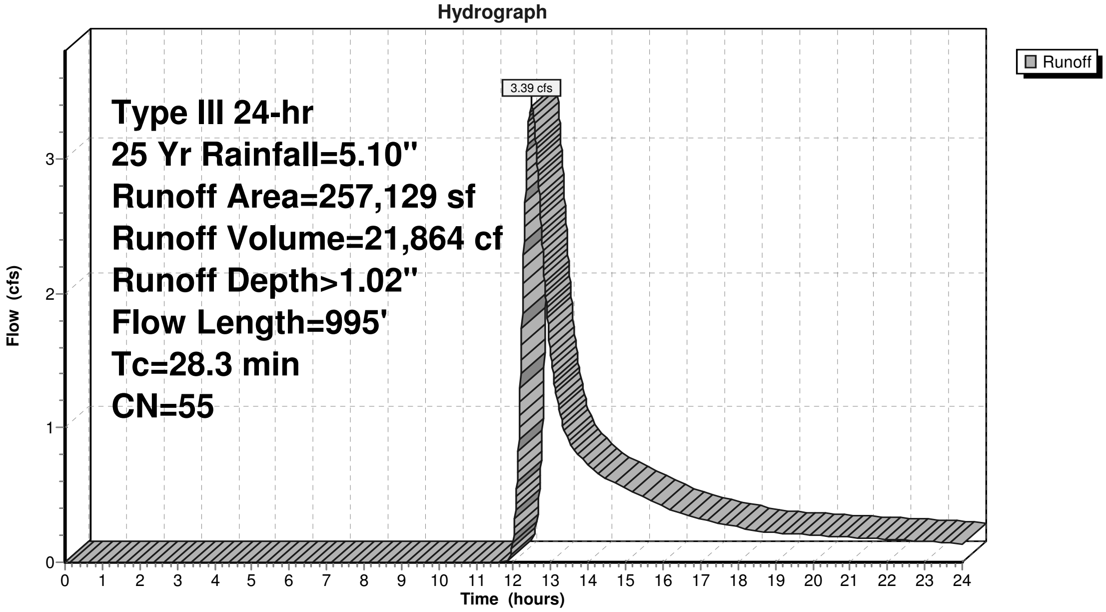
Runoff = 3.39 cfs @ 12.48 hrs, Volume= 21,864 cf, Depth> 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
257,129	55	Woods, Good, HSG B
257,129		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
5.3	450	0.0800	1.41		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
28.3	995	Total			

Subcatchment E3: PreDev



Summary for Subcatchment E4: PreDev

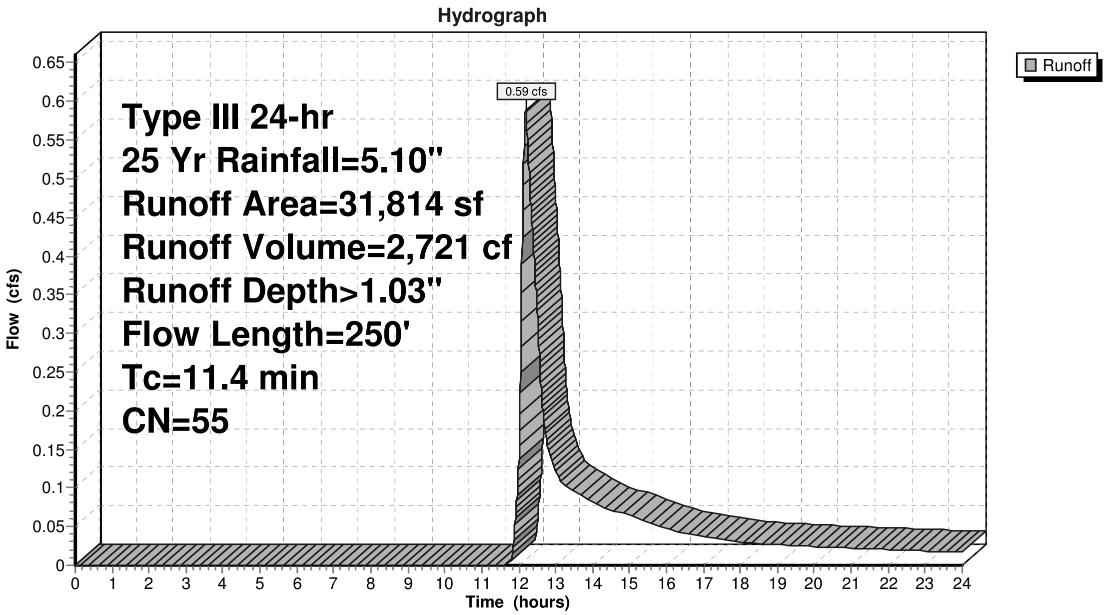
Runoff = 0.59 cfs @ 12.19 hrs, Volume= 2,721 cf, Depth> 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
31,814	55	Woods, Good, HSG B
31,814		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0400	0.09		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
2.1	200	0.1000	1.58		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.4	250	Total			

Subcatchment E4: PreDev



Summary for Subcatchment E5: PreDev

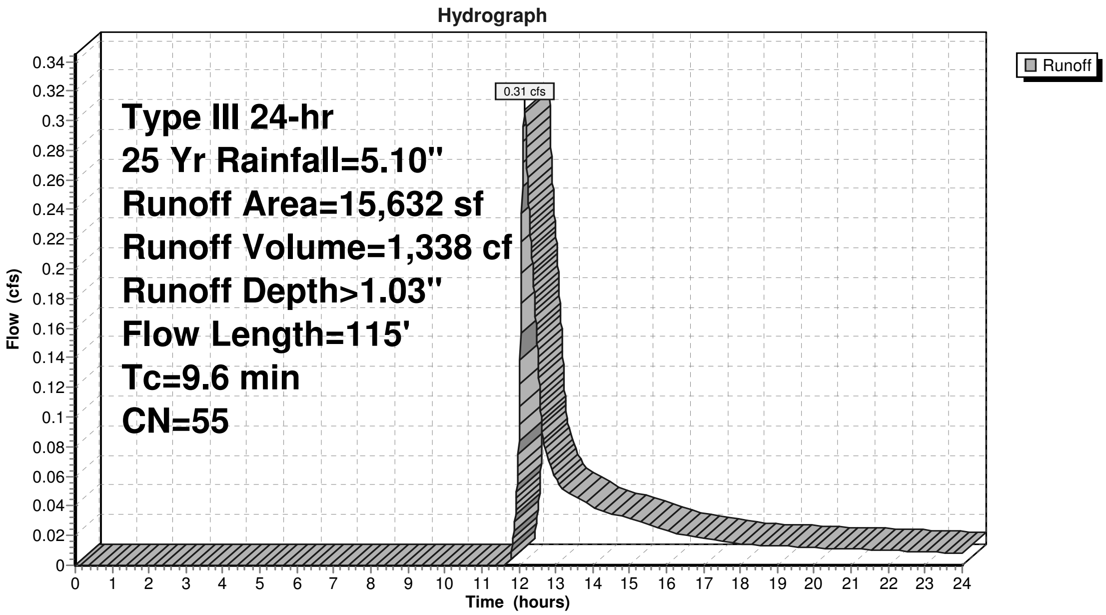
Runoff = 0.31 cfs @ 12.16 hrs, Volume= 1,338 cf, Depth> 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
15,632	55	Woods, Good, HSG B
15,632		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	65	0.0400	1.00		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
9.6	115	Total			

Subcatchment E5: PreDev



Summary for Subcatchment P1: Post Dev

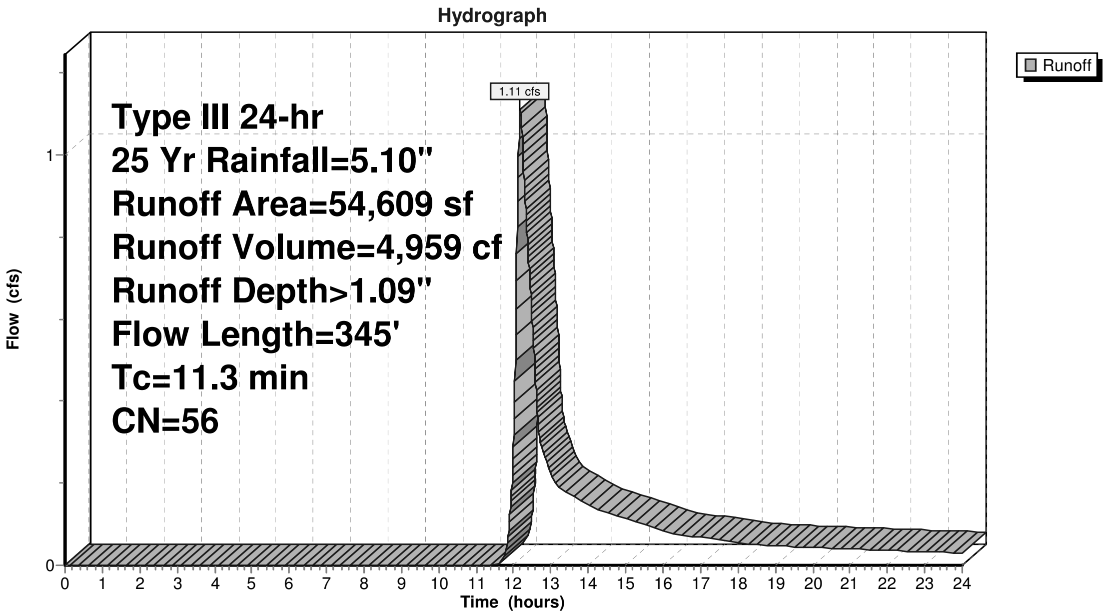
Runoff = 1.11 cfs @ 12.18 hrs, Volume= 4,959 cf, Depth> 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
848	98	Roofs, HSG B
4,300	61	>75% Grass cover, Good, HSG B
49,461	55	Woods, Good, HSG B
54,609	56	Weighted Average
53,761		98.45% Pervious Area
848		1.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.2	60	0.0800	4.55		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.9	235	0.0750	1.37		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
11.3	345	Total			

Subcatchment P1: Post Dev



Summary for Subcatchment P2: Post Dev

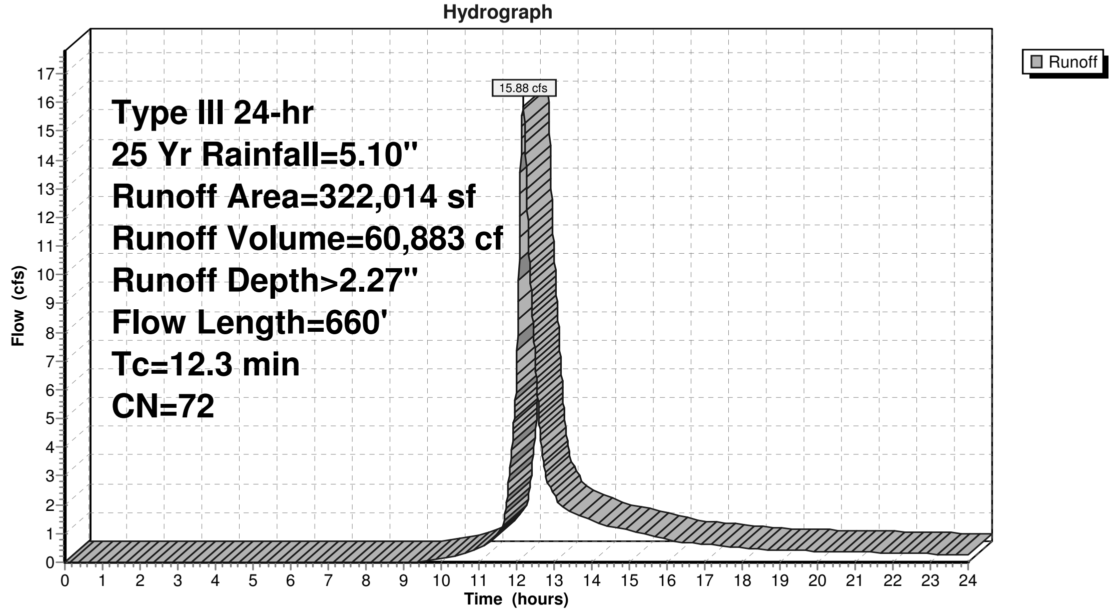
Runoff = 15.88 cfs @ 12.18 hrs, Volume= 60,883 cf, Depth> 2.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

	Area (sf)	CN	Description
*	28,527	98	Paved Road, HSG B
*	7,666	98	Paved Sidewalk, HSG B
*	27,215	98	Paved Drives, HSG B
	30,966	98	Roofs, HSG B
	223,133	61	>75% Grass cover, Good, HSG B
	4,507	55	Woods, Good, HSG B
	322,014	72	Weighted Average
	227,640		70.69% Pervious Area
	94,374		29.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.7	220	0.0700	5.37		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
0.4	310	0.0800	12.83	10.08	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
12.3	660	Total			

Subcatchment P2: Post Dev



Summary for Subcatchment P3: PostDev

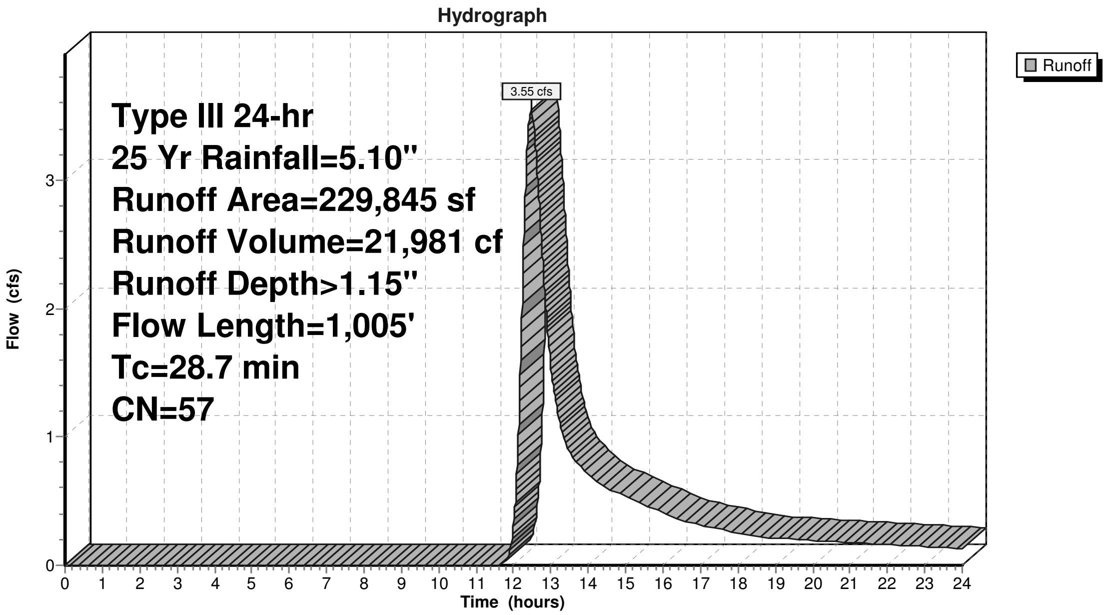
Runoff = 3.55 cfs @ 12.47 hrs, Volume= 21,981 cf, Depth> 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
4,976	98	Roofs, HSG B
54,253	61	>75% Grass cover, Good, HSG B
170,616	55	Woods, Good, HSG B
229,845	57	Weighted Average
224,869		97.84% Pervious Area
4,976		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
5.4	460	0.0800	1.41		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
28.7	1,005	Total			

Subcatchment P3: PostDev



Summary for Subcatchment P4: Post Dev

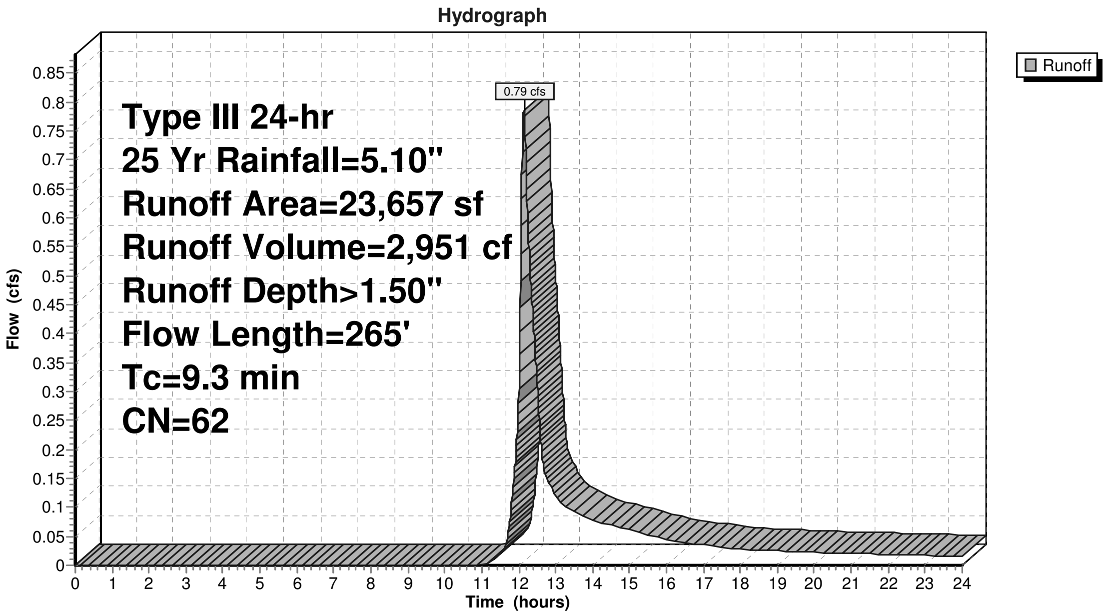
Runoff = 0.79 cfs @ 12.14 hrs, Volume= 2,951 cf, Depth> 1.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
1,592	98	Roofs, HSG B
15,676	61	>75% Grass cover, Good, HSG B
6,389	55	Woods, Good, HSG B
23,657	62	Weighted Average
22,065		93.27% Pervious Area
1,592		6.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.4	125	0.1000	5.09		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.3	265	Total			

Subcatchment P4: Post Dev



Summary for Subcatchment P5: Post Dev

Runoff = 0.30 cfs @ 12.14 hrs, Volume= 1,162 cf, Depth> 1.29"

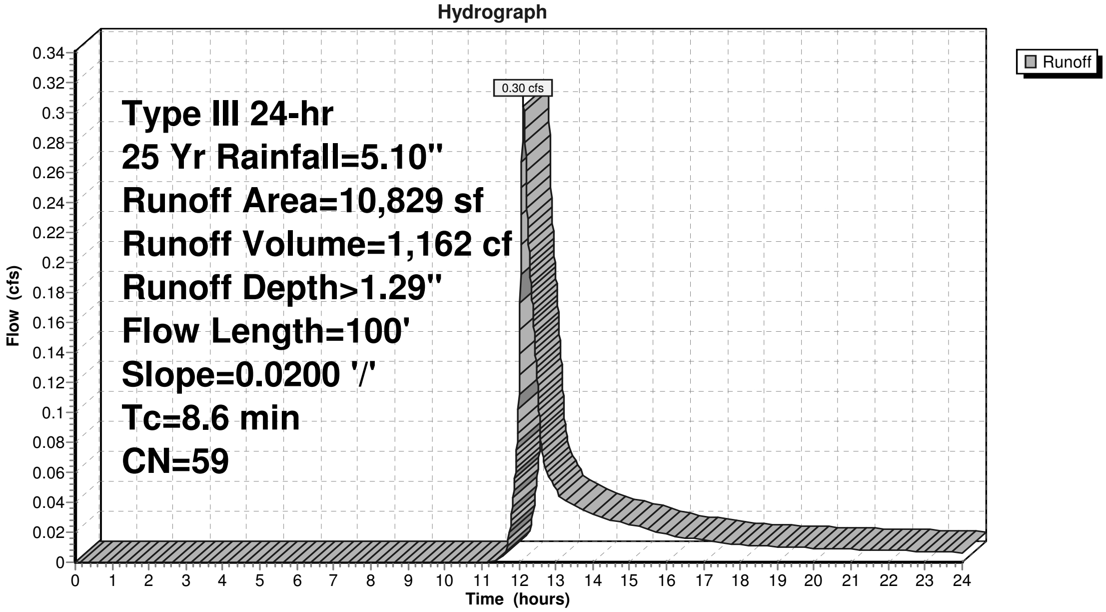
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

Area (sf)	CN	Description
6,641	61	>75% Grass cover, Good, HSG B
4,188	55	Woods, Good, HSG B
10,829	59	Weighted Average
10,829		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	50	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
8.6	100	Total			

Subcatchment P5: Post Dev

Hydrograph



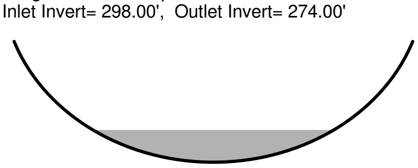
Summary for Reach 1R: Stream

Inflow Area = 63,319 sf, 0.00% Impervious, Inflow Depth > 1.02" for 25 Yr event
Inflow = 1.04 cfs @ 12.26 hrs, Volume= 5,407 cf
Outflow = 1.03 cfs @ 12.31 hrs, Volume= 5,395 cf, Atten= 1%, Lag= 3.0 min

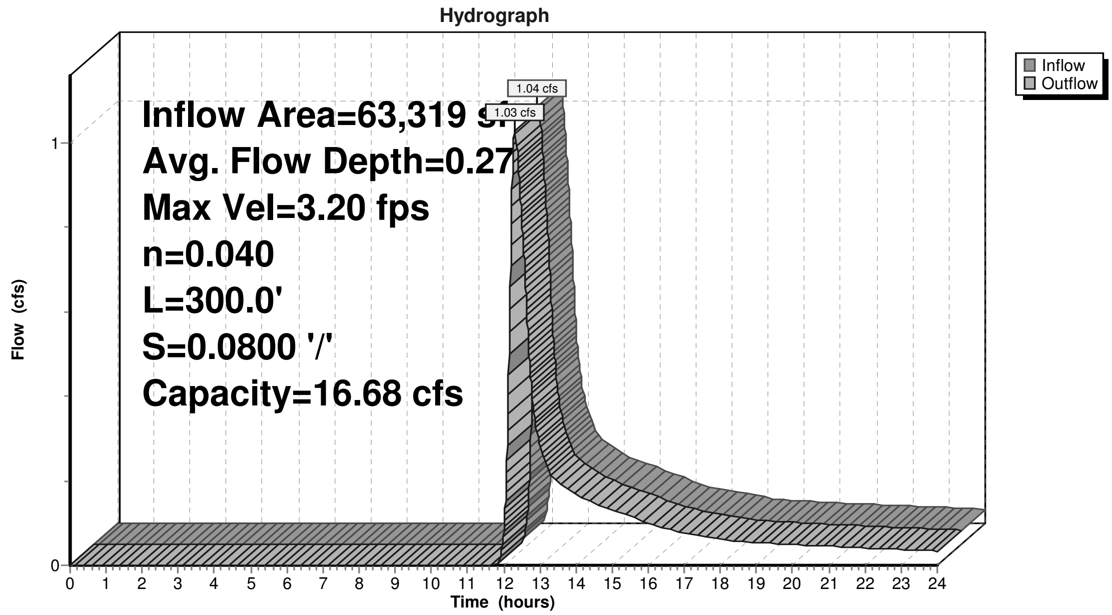
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.20 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 3.3 min

Peak Storage= 96 cf @ 12.29 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 1R: Stream



Summary for Reach 2R: Stream

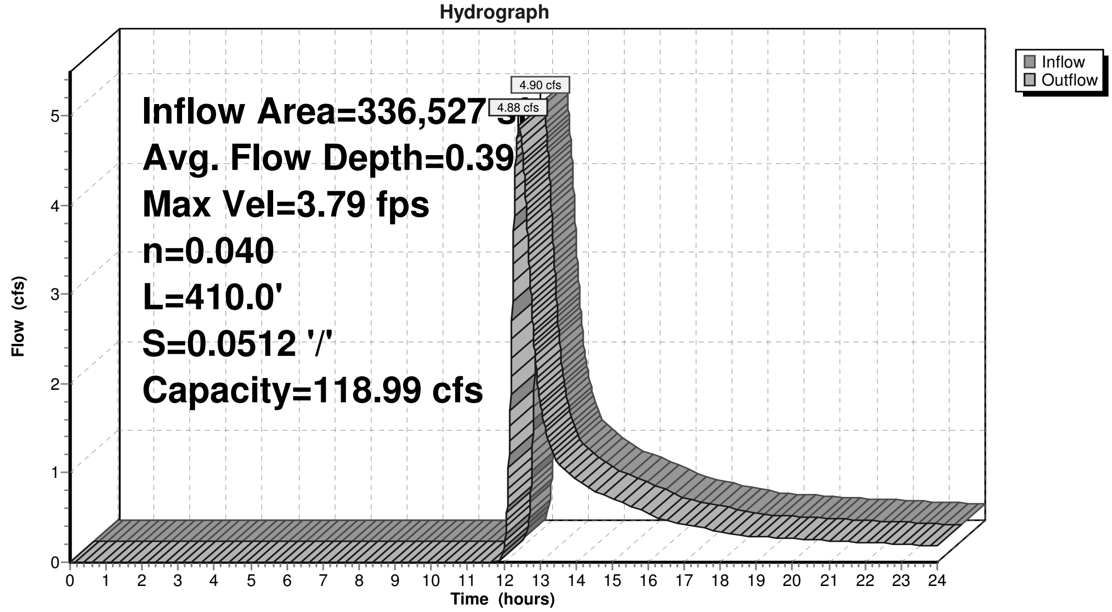
Inflow Area = 336,527 sf, 0.00% Impervious, Inflow Depth > 1.02" for 25 Yr event
Inflow = 4.90 cfs @ 12.37 hrs, Volume= 28,670 cf
Outflow = 4.88 cfs @ 12.42 hrs, Volume= 28,590 cf, Atten= 0%, Lag= 3.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.79 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.72 fps, Avg. Travel Time= 4.0 min

Peak Storage= 528 cf @ 12.39 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 2R: Stream



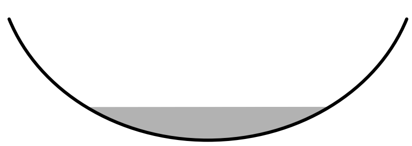
Summary for Reach 3R: Stream

Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 1.09" for 25 Yr event
Inflow = 1.11 cfs @ 12.18 hrs, Volume= 4,959 cf
Outflow = 1.10 cfs @ 12.23 hrs, Volume= 4,948 cf, Atten= 1%, Lag= 2.7 min

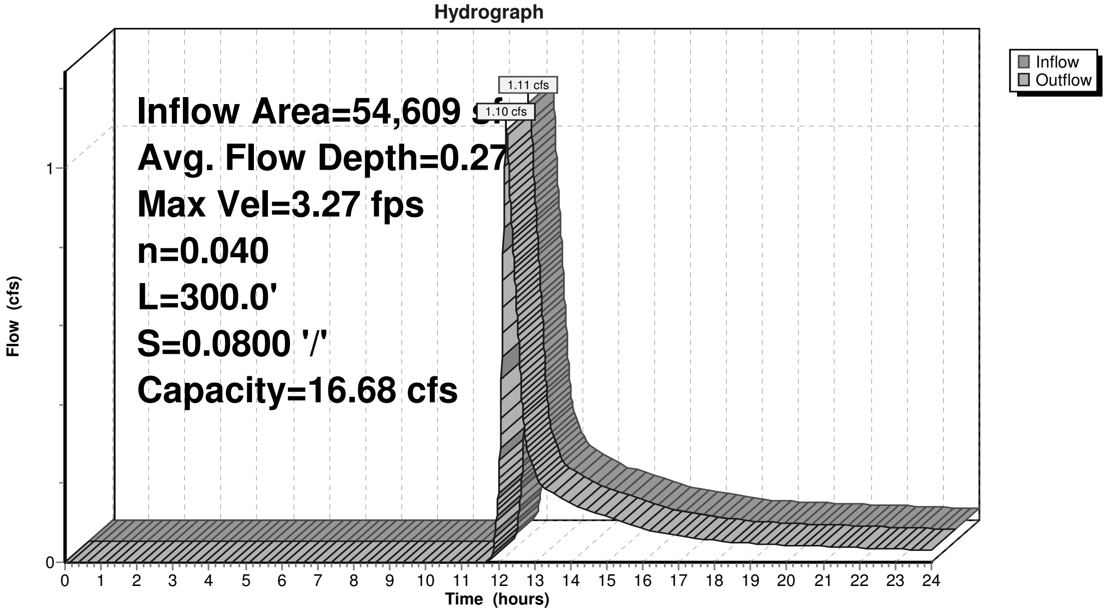
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.27 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.48 fps, Avg. Travel Time= 3.4 min

Peak Storage= 101 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 3R: Stream



Summary for Reach 4R: Stream

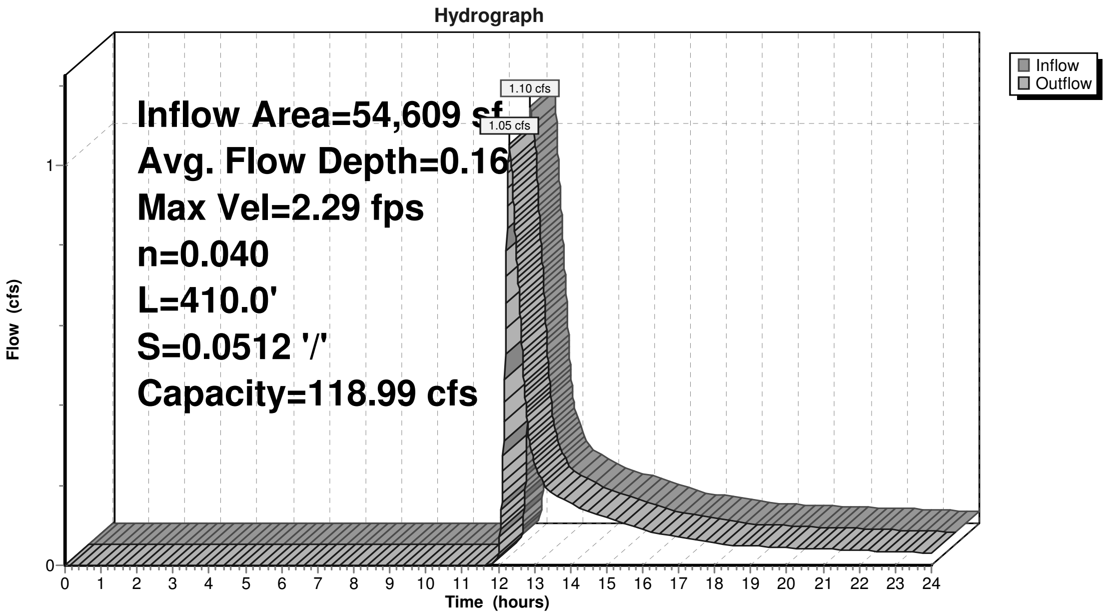
Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 1.09" for 25 Yr event
Inflow = 1.10 cfs @ 12.23 hrs, Volume= 4,948 cf
Outflow = 1.05 cfs @ 12.32 hrs, Volume= 4,922 cf, Atten= 4%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.29 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 0.91 fps, Avg. Travel Time= 7.5 min

Peak Storage= 188 cf @ 12.27 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 4R: Stream



Summary for Pond 1P: Det Basin

Inflow Area = 322,014 sf, 29.31% Impervious, Inflow Depth > 2.27" for 25 Yr event
Inflow = 15.88 cfs @ 12.18 hrs, Volume= 60,883 cf
Outflow = 4.00 cfs @ 12.66 hrs, Volume= 53,470 cf, Atten= 75%, Lag= 29.1 min
Discarded = 0.39 cfs @ 12.66 hrs, Volume= 11,136 cf
Primary = 3.61 cfs @ 12.66 hrs, Volume= 42,334 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 271.12' @ 12.66 hrs Surf.Area= 9,471 sf Storage= 24,008 cf

Plug-Flow detention time= 138.6 min calculated for 53,448 cf (88% of inflow)
Center-of-Mass det. time= 82.9 min (928.6 - 845.7)

Volume	Invert	Avail.Storage	Storage Description
#1	266.50'	44,870 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

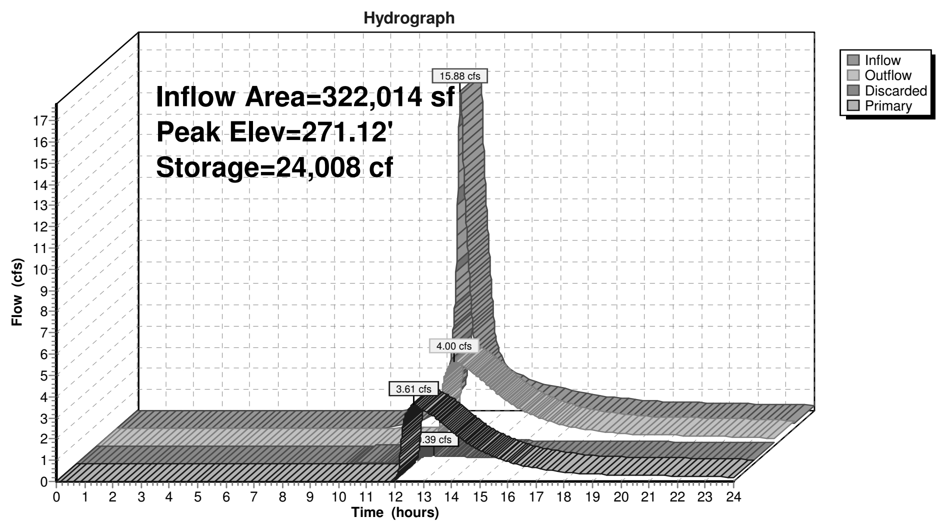
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
266.50	1,320	147.0	0	0	1,320
268.00	3,623	243.0	3,565	3,565	4,314
270.00	7,534	370.0	10,921	14,486	10,539
272.00	11,140	448.0	18,557	33,043	15,682
273.00	12,527	468.0	11,827	44,870	17,210

Device	Routing	Invert	Outlet Devices
#1	Discarded	266.50'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 264.00'
#2	Primary	265.00'	**24.0" Round Culvert** L= 52.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 265.00' / 259.50' S= 0.1058 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#3	Device 2	268.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#4	Device 2	269.30'	**0.7' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 4.5' Crest Height
#5	Device 2	272.30'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.39 cfs @ 12.66 hrs HW=271.12' (Free Discharge)
└─**1=Exfiltration** (Controls 0.39 cfs)

Primary OutFlow Max=3.61 cfs @ 12.66 hrs HW=271.12' (Free Discharge)
└─**2=Culvert** (Passes 3.61 cfs of 34.24 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.66 cfs @ 7.55 fps)
  ├─**4=Sharp-Crested Rectangular Weir** (Weir Controls 2.95 cfs @ 4.63 fps)
  └─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: Det Basin

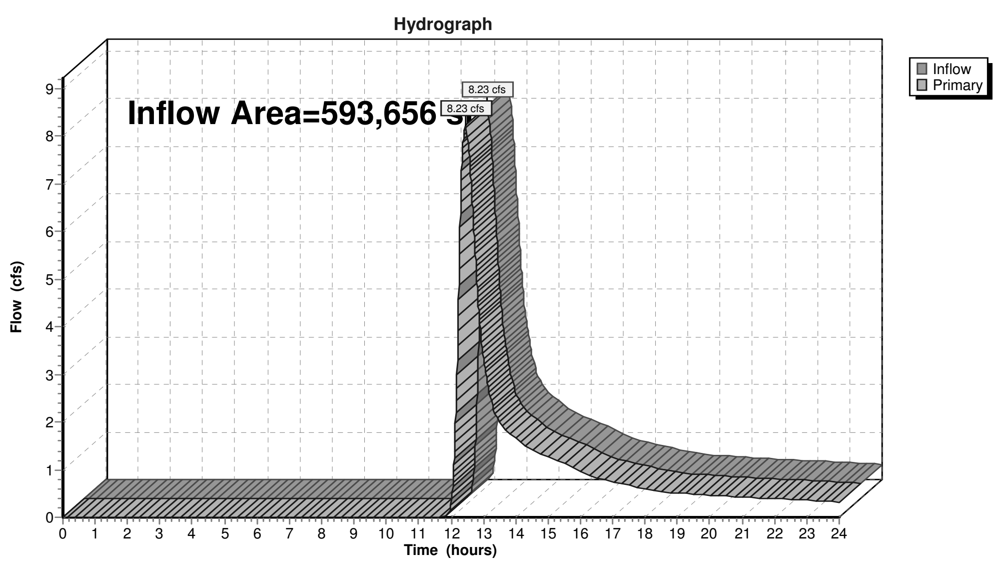


Summary for Link DP1: PreDev

Inflow Area =	593,656 sf,	0.00% Impervious,	Inflow Depth > 1.02"	for 25 Yr event
Inflow =	8.23 cfs @	12.44 hrs, Volume=	50,454 cf	
Primary =	8.23 cfs @	12.44 hrs, Volume=	50,454 cf, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: PreDev

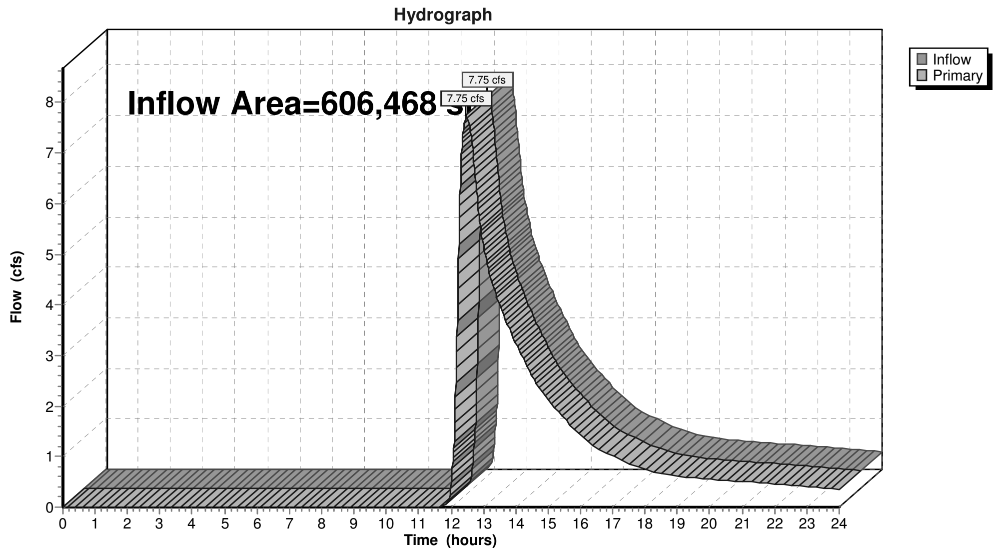


Summary for Link DP2: Post Offsite

Inflow Area =	606,468 sf, 16.52% Impervious, Inflow Depth > 1.37"	for 25 Yr event
Inflow =	7.75 cfs @ 12.47 hrs, Volume=	69,237 cf
Primary =	7.75 cfs @ 12.47 hrs, Volume=	69,237 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Post Offsite



Summary for Subcatchment E1: PreDev

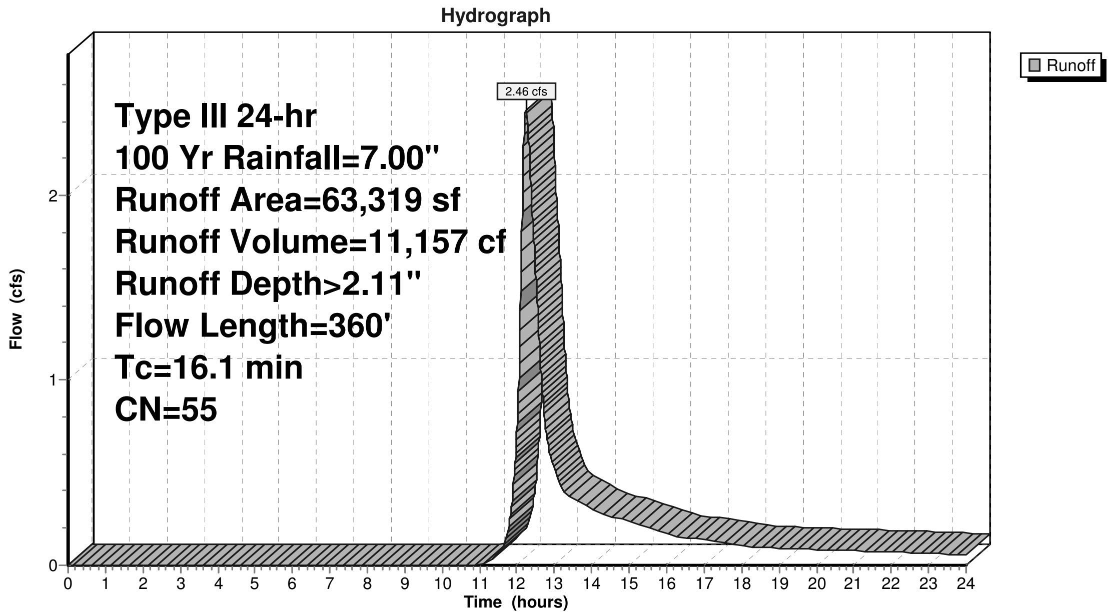
Runoff = 2.46 cfs @ 12.24 hrs, Volume= 11,157 cf, Depth> 2.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
63,319	55	Woods, Good, HSG B
63,319		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
3.8	310	0.0750	1.37		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
16.1	360	Total			

Subcatchment E1: PreDev



Summary for Subcatchment E2: PreDev

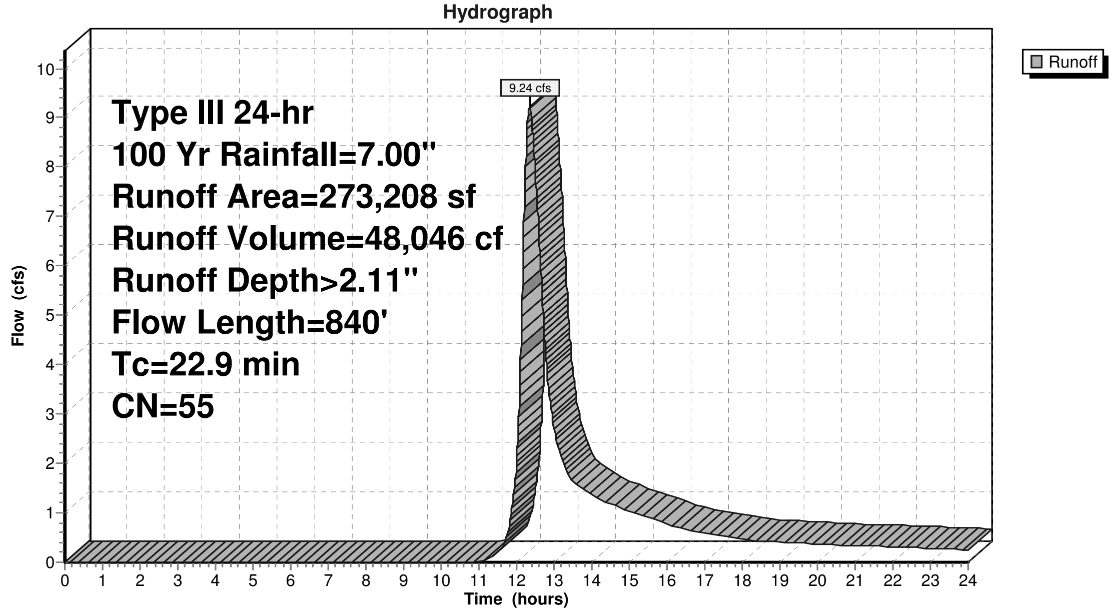
Runoff = 9.24 cfs @ 12.34 hrs, Volume= 48,046 cf, Depth> 2.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
273,208	55	Woods, Good, HSG B
273,208		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
12.4	790	0.0450	1.06		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
22.9	840	Total			

Subcatchment E2: PreDev



Summary for Subcatchment E3: PreDev

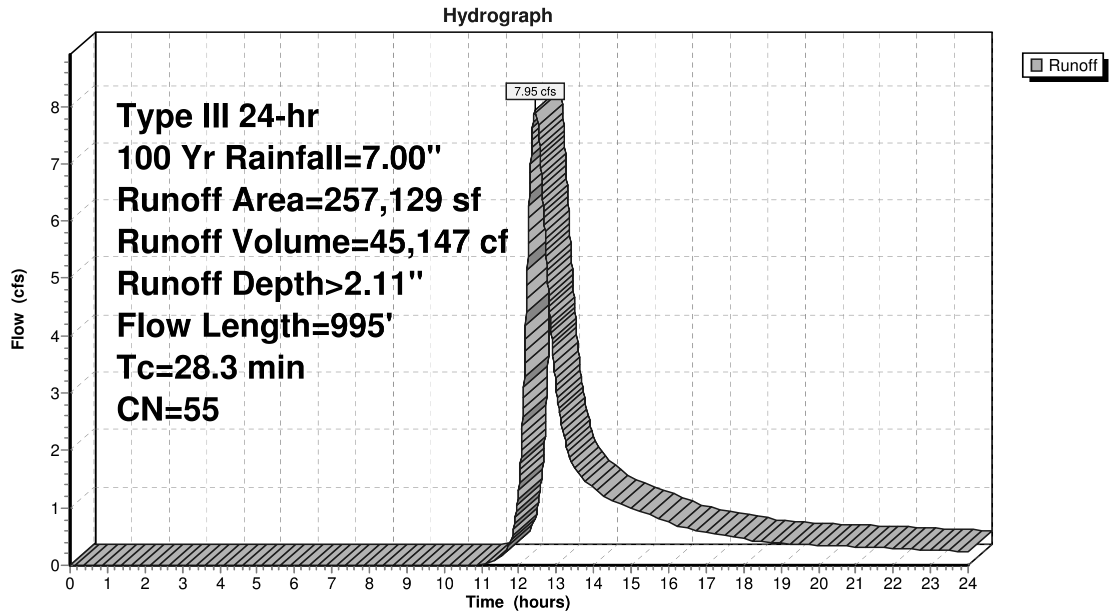
Runoff = 7.95 cfs @ 12.42 hrs, Volume= 45,147 cf, Depth> 2.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
257,129	55	Woods, Good, HSG B
257,129		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
5.3	450	0.0800	1.41		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
28.3	995	Total			

Subcatchment E3: PreDev



Summary for Subcatchment E4: PreDev

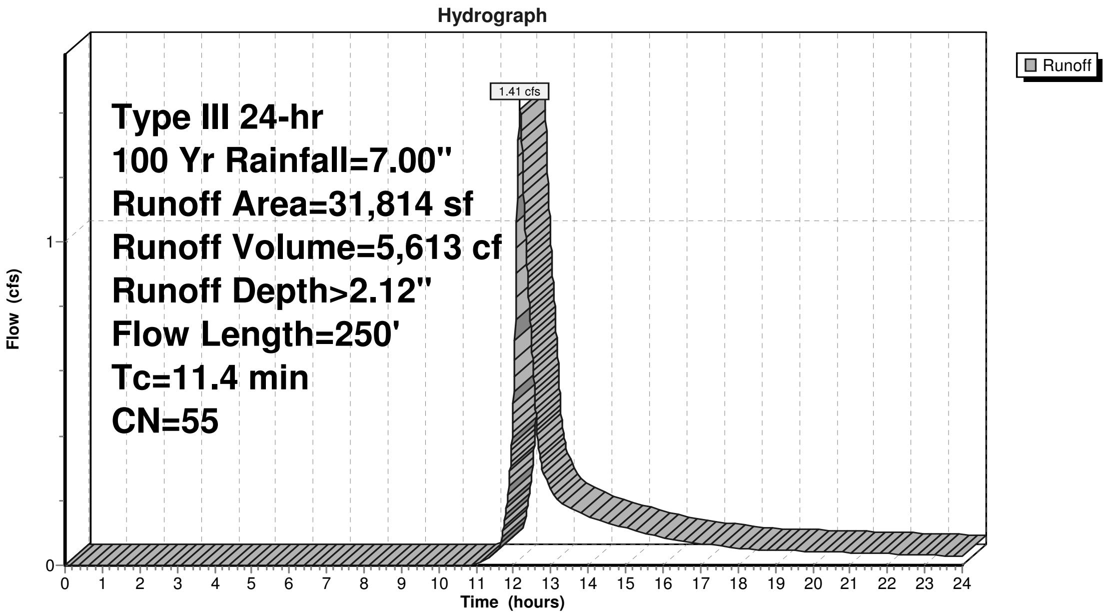
Runoff = 1.41 cfs @ 12.17 hrs, Volume= 5,613 cf, Depth> 2.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
31,814	55	Woods, Good, HSG B
31,814		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0400	0.09		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
2.1	200	0.1000	1.58		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.4	250	Total			

Subcatchment E4: PreDev



Summary for Subcatchment E5: PreDev

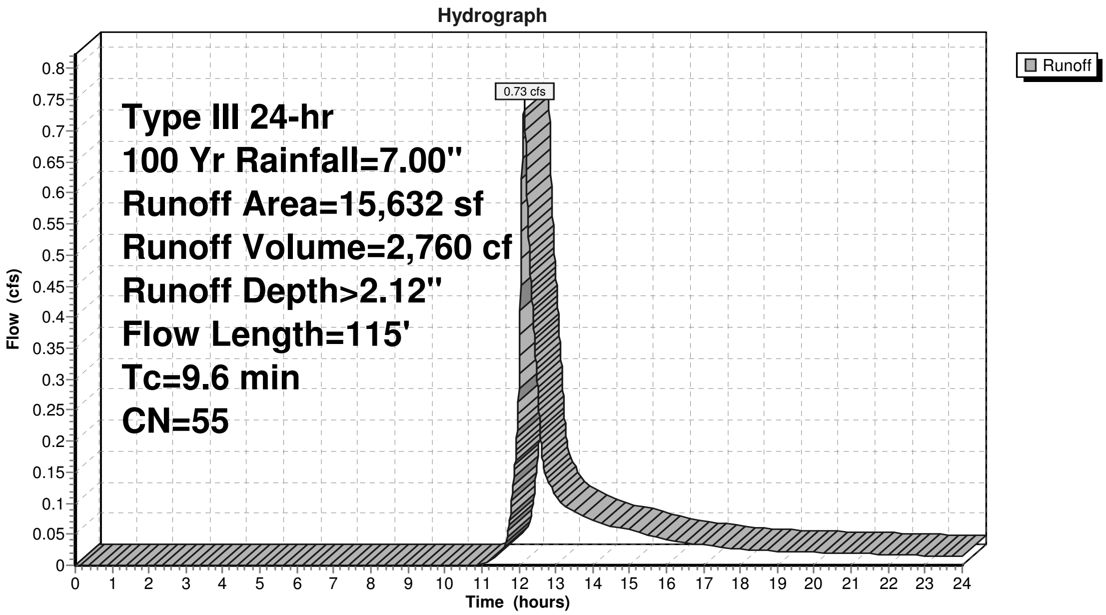
Runoff = 0.73 cfs @ 12.15 hrs, Volume= 2,760 cf, Depth> 2.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
15,632	55	Woods, Good, HSG B
15,632		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	65	0.0400	1.00		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
9.6	115	Total			

Subcatchment E5: PreDev



Summary for Subcatchment P1: Post Dev

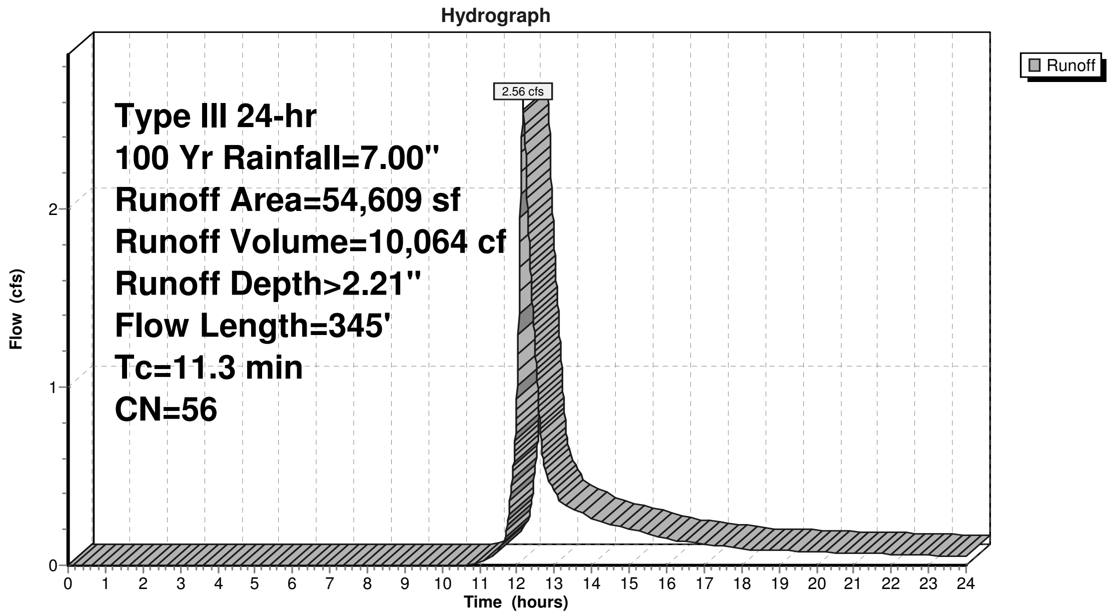
Runoff = 2.56 cfs @ 12.17 hrs, Volume= 10,064 cf, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
848	98	Roofs, HSG B
4,300	61	>75% Grass cover, Good, HSG B
49,461	55	Woods, Good, HSG B
54,609	56	Weighted Average
53,761		98.45% Pervious Area
848		1.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.2	60	0.0800	4.55		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
2.9	235	0.0750	1.37		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
11.3	345	Total			

Subcatchment P1: Post Dev



Summary for Subcatchment P2: Post Dev

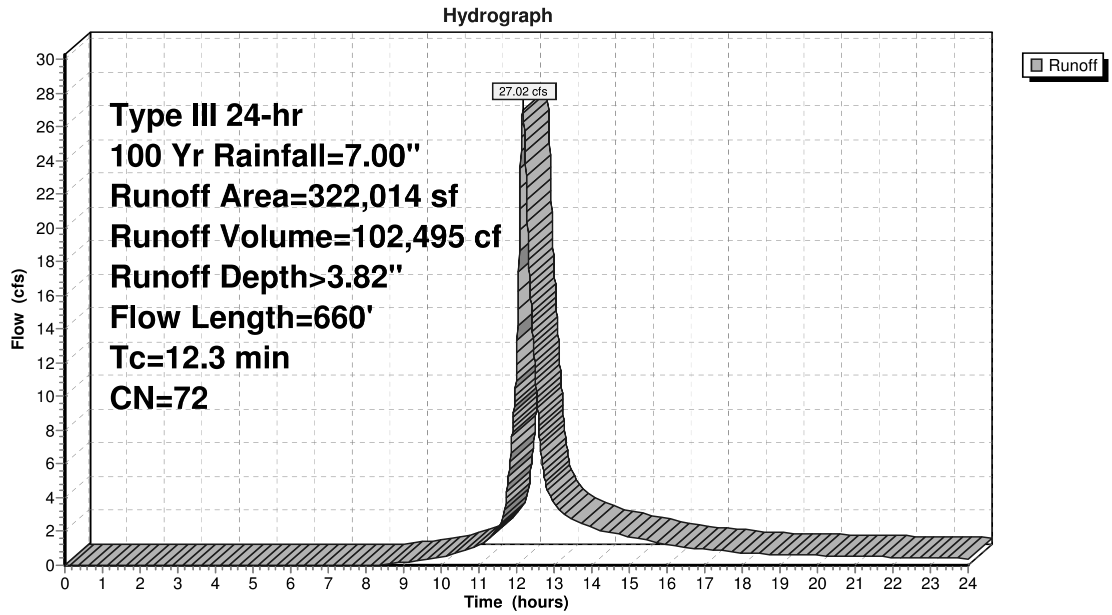
Runoff = 27.02 cfs @ 12.17 hrs, Volume= 102,495 cf, Depth> 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

	Area (sf)	CN	Description
*	28,527	98	Paved Road, HSG B
*	7,666	98	Paved Sidewalk, HSG B
*	27,215	98	Paved Drives, HSG B
	30,966	98	Roofs, HSG B
	223,133	61	>75% Grass cover, Good, HSG B
	4,507	55	Woods, Good, HSG B
	322,014	72	Weighted Average
	227,640		70.69% Pervious Area
	94,374		29.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.7	220	0.0700	5.37		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
0.4	310	0.0800	12.83	10.08	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
12.3	660	Total			

Subcatchment P2: Post Dev



Summary for Subcatchment P3: PostDev

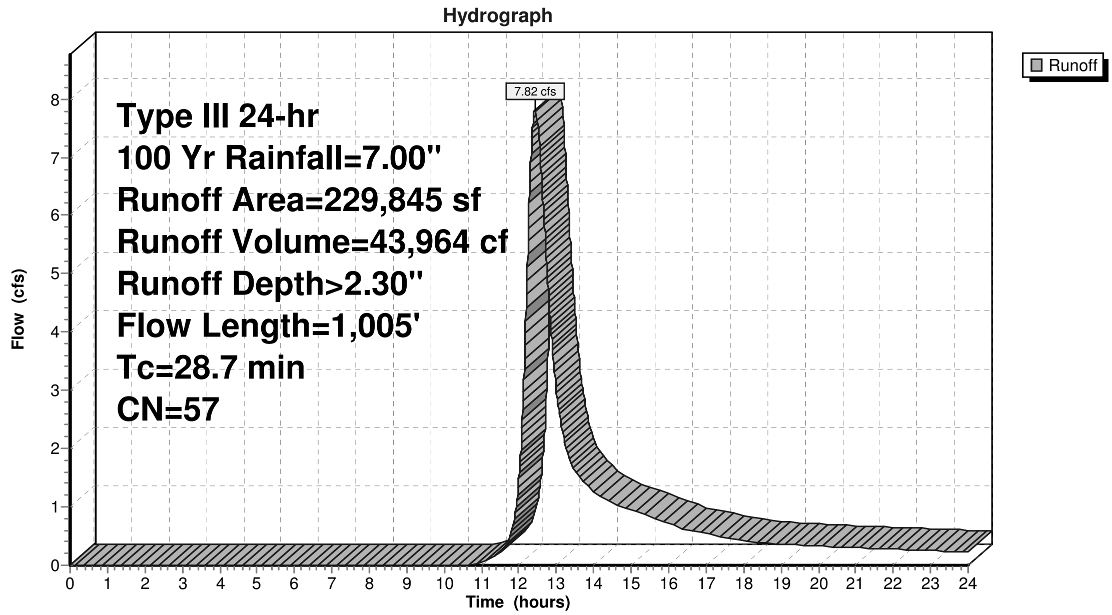
Runoff = 7.82 cfs @ 12.43 hrs, Volume= 43,964 cf, Depth> 2.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
4,976	98	Roofs, HSG B
54,253	61	>75% Grass cover, Good, HSG B
170,616	55	Woods, Good, HSG B
229,845	57	Weighted Average
224,869		97.84% Pervious Area
4,976		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B**
					Grass: Dense n= 0.240 P2= 3.20"
5.4	460	0.0800	1.41		**Shallow Concentrated Flow, B-C**
					Woodland Kv= 5.0 fps
15.1	495	0.0120	0.55		**Shallow Concentrated Flow, C-D**
					Woodland Kv= 5.0 fps
28.7	1,005	Total			

Subcatchment P3: PostDev



Summary for Subcatchment P4: Post Dev

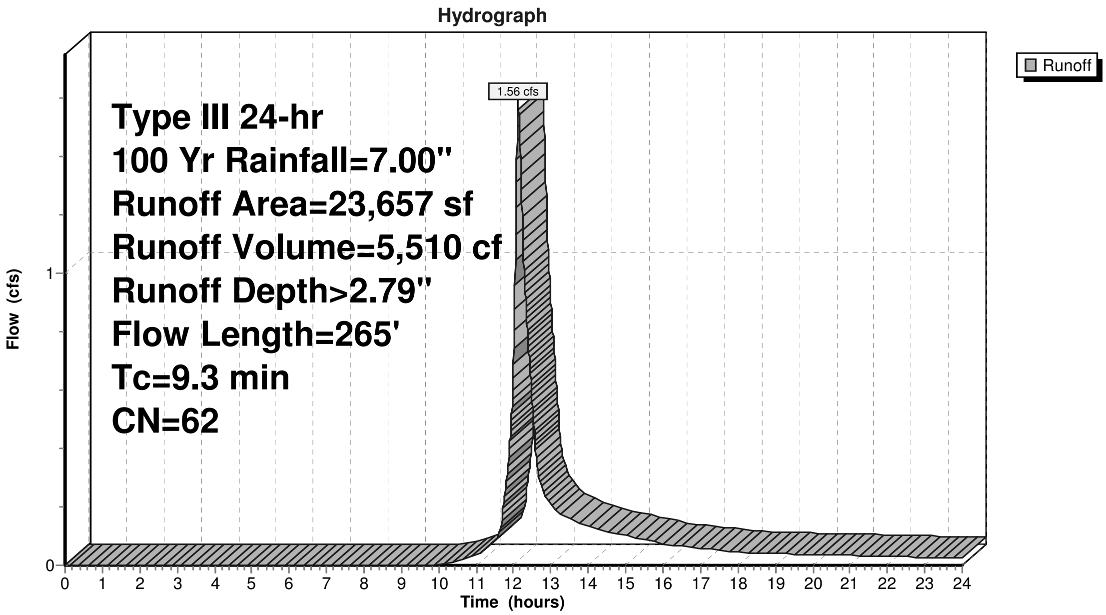
Runoff = 1.56 cfs @ 12.14 hrs, Volume= 5,510 cf, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
1,592	98	Roofs, HSG B
15,676	61	>75% Grass cover, Good, HSG B
6,389	55	Woods, Good, HSG B
23,657	62	Weighted Average
22,065		93.27% Pervious Area
1,592		6.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.4	125	0.1000	5.09		**Shallow Concentrated Flow, C-D** Unpaved Kv= 16.1 fps
9.3	265	Total			

Subcatchment P4: Post Dev



Summary for Subcatchment P5: Post Dev

Runoff = 0.64 cfs @ 12.13 hrs, Volume= 2,257 cf, Depth> 2.50"

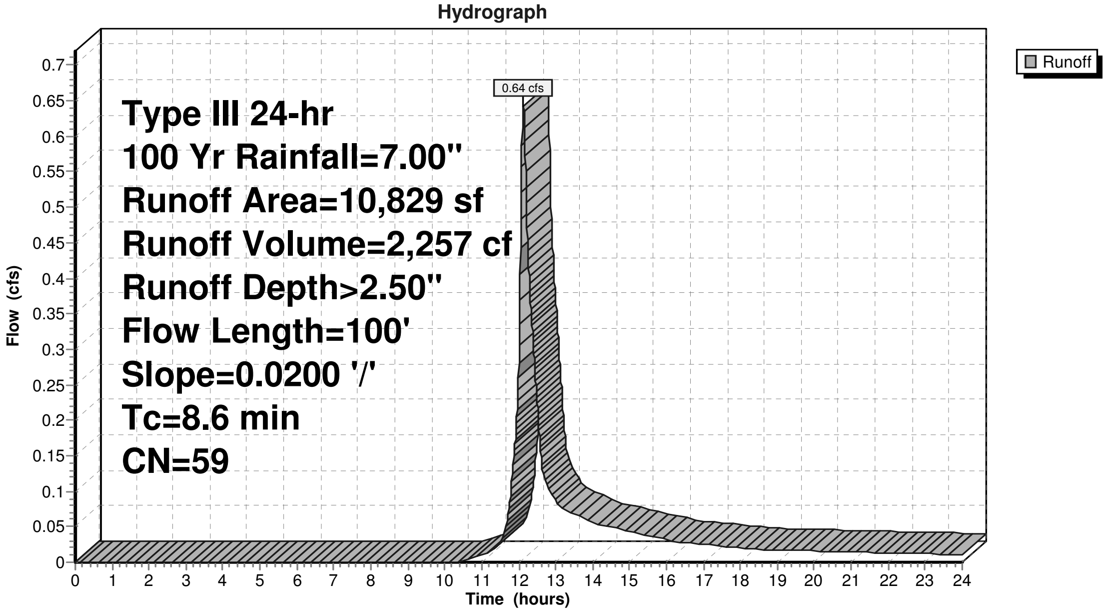
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

Area (sf)	CN	Description
6,641	61	>75% Grass cover, Good, HSG B
4,188	55	Woods, Good, HSG B
10,829	59	Weighted Average
10,829		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
0.4	50	0.0200	2.28		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
8.6	100	Total			

Subcatchment P5: Post Dev

Hydrograph



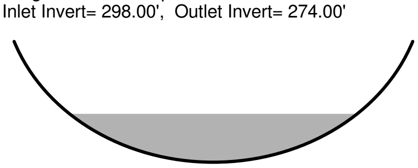
Summary for Reach 1R: Stream

Inflow Area = 63,319 sf, 0.00% Impervious, Inflow Depth > 2.11" for 100 Yr event
Inflow = 2.46 cfs @ 12.24 hrs, Volume= 11,157 cf
Outflow = 2.46 cfs @ 12.28 hrs, Volume= 11,140 cf, Atten= 0%, Lag= 2.0 min

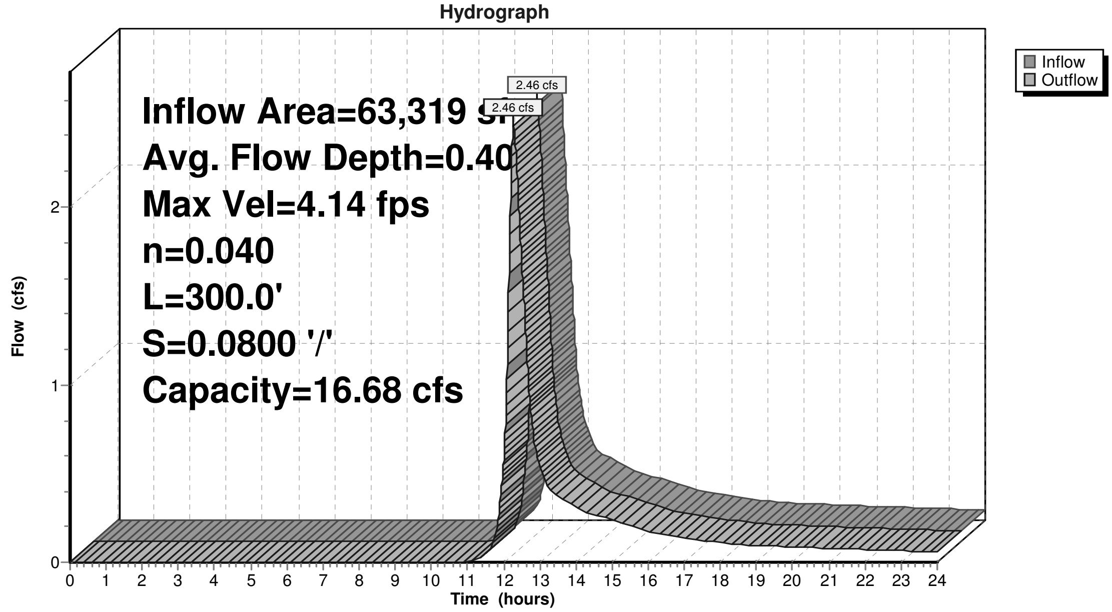
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.14 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.81 fps, Avg. Travel Time= 2.8 min

Peak Storage= 178 cf @ 12.26 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 1R: Stream



Summary for Reach 2R: Stream

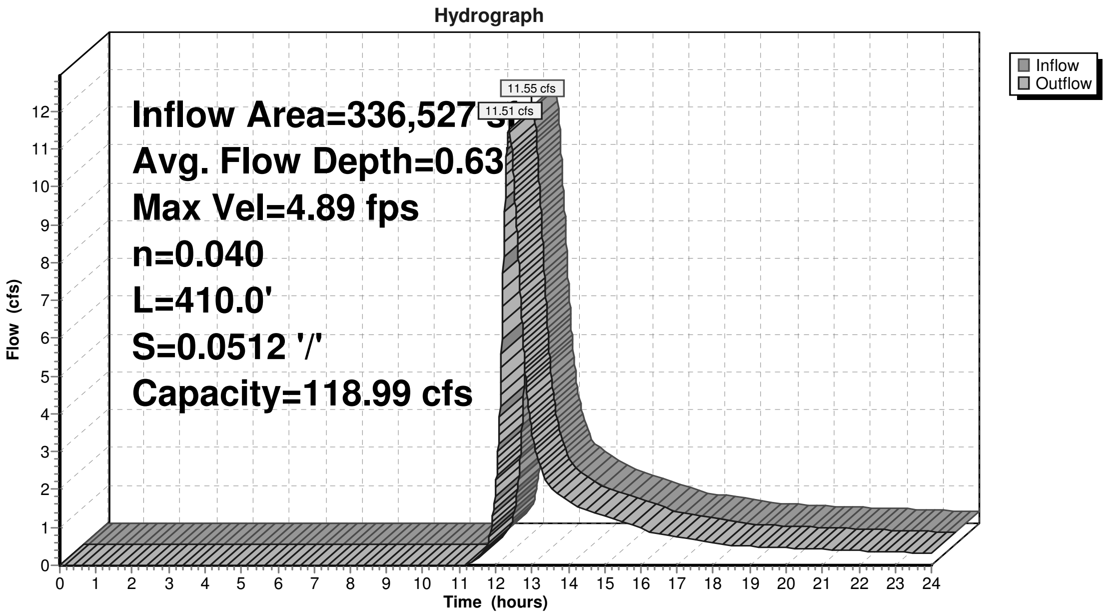
Inflow Area = 336,527 sf, 0.00% Impervious, Inflow Depth > 2.11" for 100 Yr event
Inflow = 11.55 cfs @ 12.34 hrs, Volume= 59,186 cf
Outflow = 11.51 cfs @ 12.37 hrs, Volume= 59,074 cf, Atten= 0%, Lag= 2.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.89 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 2.09 fps, Avg. Travel Time= 3.3 min

Peak Storage= 965 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 2R: Stream



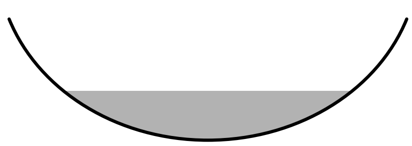
Summary for Reach 3R: Stream

Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 2.21" for 100 Yr event
Inflow = 2.56 cfs @ 12.17 hrs, Volume= 10,064 cf
Outflow = 2.54 cfs @ 12.20 hrs, Volume= 10,049 cf, Atten= 1%, Lag= 2.1 min

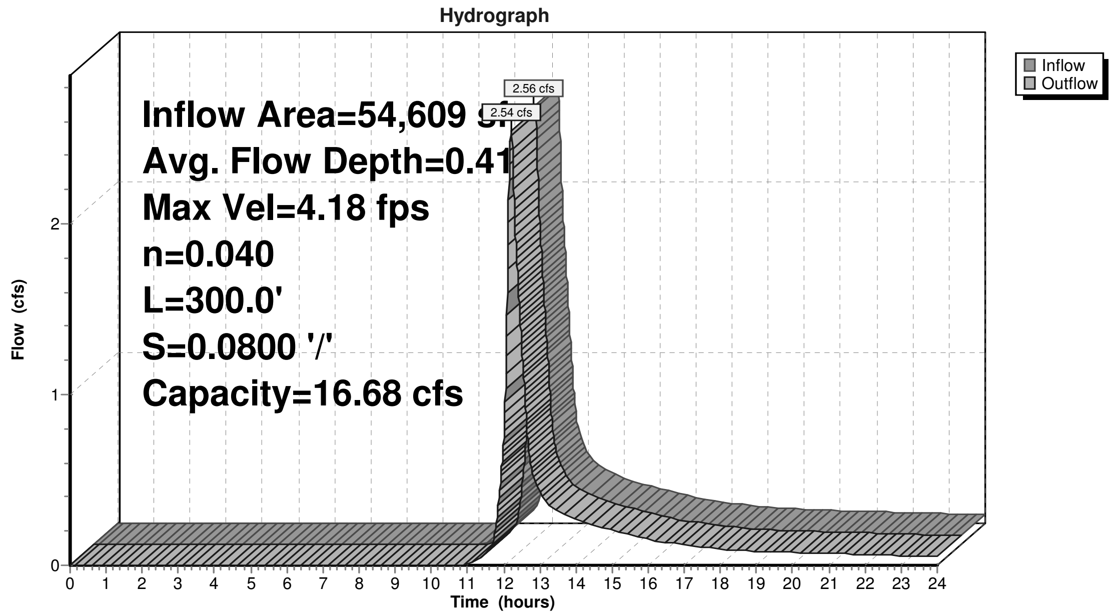
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.18 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.74 fps, Avg. Travel Time= 2.9 min

Peak Storage= 182 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



Reach 3R: Stream



Summary for Reach 4R: Stream

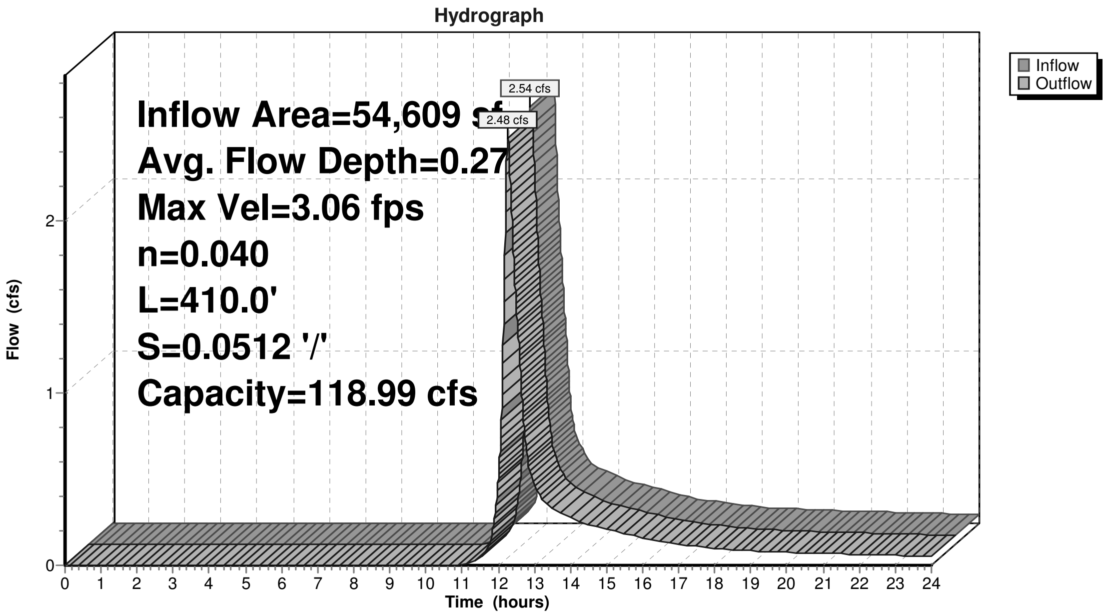
Inflow Area = 54,609 sf, 1.55% Impervious, Inflow Depth > 2.21" for 100 Yr event
Inflow = 2.54 cfs @ 12.20 hrs, Volume= 10,049 cf
Outflow = 2.48 cfs @ 12.27 hrs, Volume= 10,015 cf, Atten= 2%, Lag= 3.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.06 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 6.1 min

Peak Storage= 332 cf @ 12.23 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 2.00' Flow Area= 13.0 sf, Capacity= 118.99 cfs

2.50' x 2.00' deep channel, n= 0.040 Winding stream, pools & shoals
Side Slope Z-value= 2.0 '/' Top Width= 10.50'
Length= 410.0' Slope= 0.0512 '/'
Inlet Invert= 274.00', Outlet Invert= 253.00'

Reach 4R: Stream



Summary for Pond 1P: Det Basin

Inflow Area = 322,014 sf, 29.31% Impervious, Inflow Depth > 3.82" for 100 Yr event
Inflow = 27.02 cfs @ 12.17 hrs, Volume= 102,495 cf
Outflow = 10.38 cfs @ 12.53 hrs, Volume= 93,365 cf, Atten= 62%, Lag= 21.4 min
Discarded = 0.52 cfs @ 12.53 hrs, Volume= 13,596 cf
Primary = 9.85 cfs @ 12.53 hrs, Volume= 79,769 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 272.48' @ 12.53 hrs Surf.Area= 11,795 sf Storage= 38,537 cf

Plug-Flow detention time= 111.0 min calculated for 93,365 cf (91% of inflow)
Center-of-Mass det. time= 67.2 min (897.9 - 830.7)

Volume	Invert	Avail.Storage	Storage Description
#1	266.50'	44,870 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

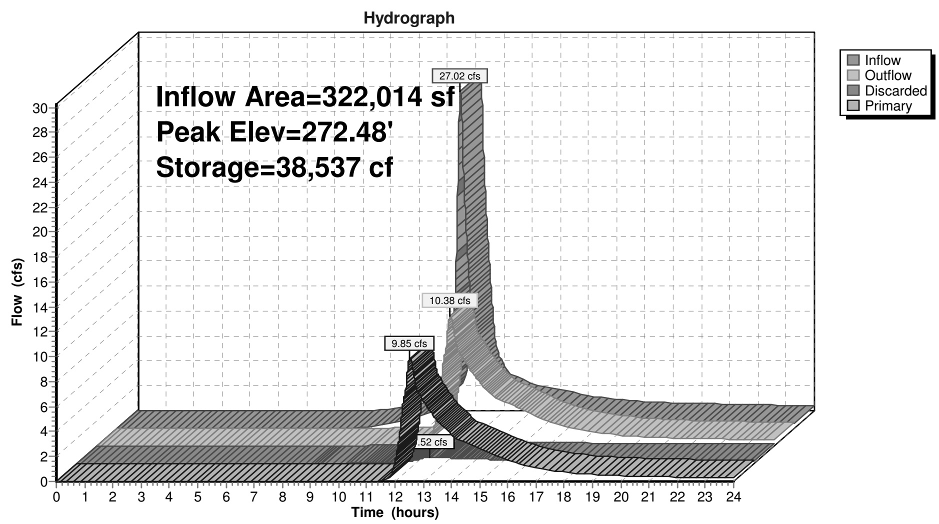
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
266.50	1,320	147.0	0	0	1,320
268.00	3,623	243.0	3,565	3,565	4,314
270.00	7,534	370.0	10,921	14,486	10,539
272.00	11,140	448.0	18,557	33,043	15,682
273.00	12,527	468.0	11,827	44,870	17,210

Device	Routing	Invert	Outlet Devices
#1	Discarded	266.50'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 264.00'
#2	Primary	265.00'	**24.0" Round Culvert** L= 52.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 265.00' / 259.50' S= 0.1058 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#3	Device 2	268.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#4	Device 2	269.30'	**0.7' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 4.5' Crest Height
#5	Device 2	272.30'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.52 cfs @ 12.53 hrs HW=272.48' (Free Discharge)
└─**1=Exfiltration** (Controls 0.52 cfs)

Primary OutFlow Max=9.85 cfs @ 12.53 hrs HW=272.48' (Free Discharge)
└─**2=Culvert** (Passes 9.85 cfs of 38.50 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.82 cfs @ 9.40 fps)
  ├─**4=Sharp-Crested Rectangular Weir** (Weir Controls 7.05 cfs @ 6.33 fps)
  └─**5=Orifice/Grate** (Weir Controls 1.98 cfs @ 1.38 fps)

Pond 1P: Det Basin

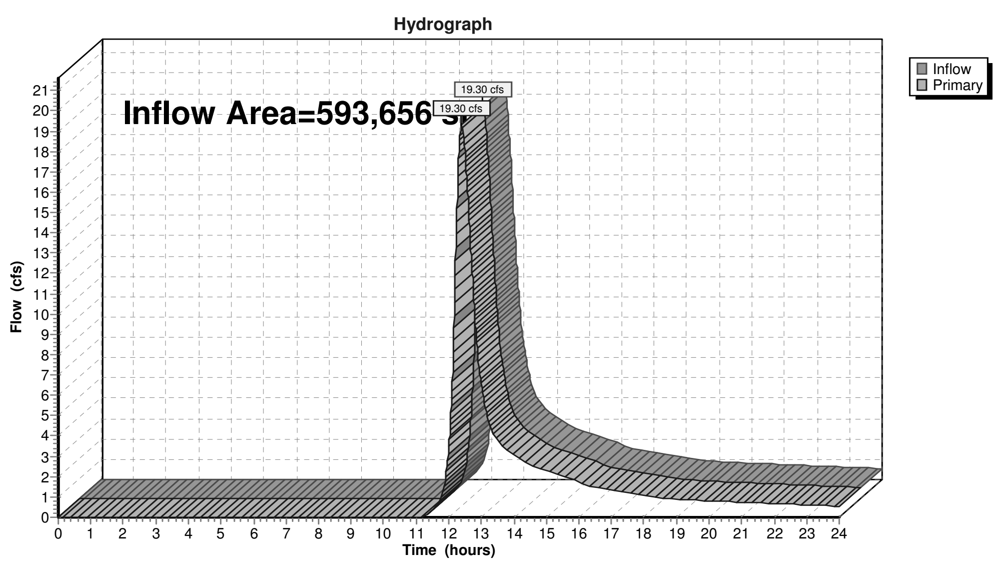


Summary for Link DP1: PreDev

Inflow Area = 593,656 sf, 0.00% Impervious, Inflow Depth > 2.11" for 100 Yr event
Inflow = 19.30 cfs @ 12.39 hrs, Volume= 104,221 cf
Primary = 19.30 cfs @ 12.39 hrs, Volume= 104,221 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: PreDev

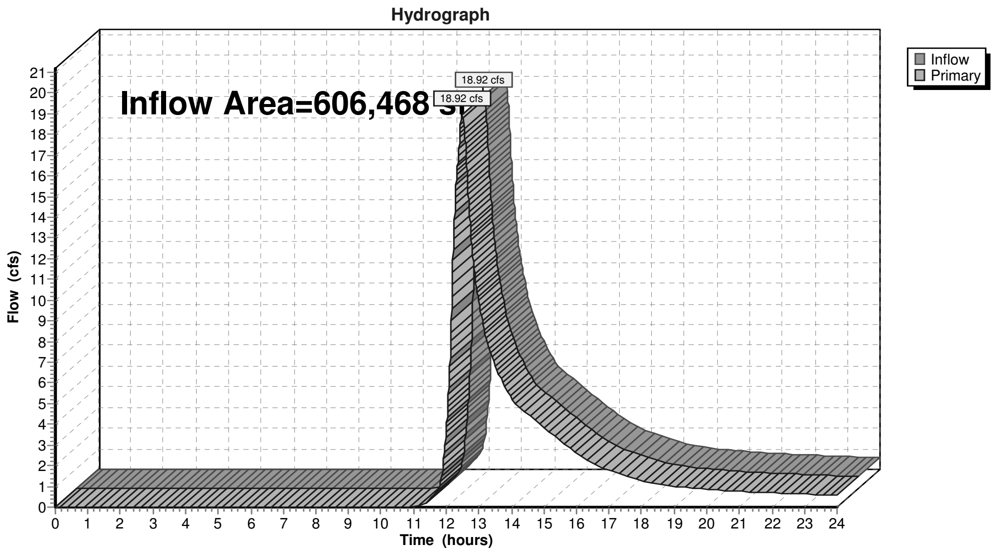


Summary for Link DP2: Post Offsite

Inflow Area = 606,468 sf, 16.52% Impervious, Inflow Depth > 2.65" for 100 Yr event
Inflow = 18.92 cfs @ 12.49 hrs, Volume= 133,748 cf
Primary = 18.92 cfs @ 12.49 hrs, Volume= 133,748 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Post Offsite



APPENDIX – B

Hydraulic Design (Manning's Equation)
Time of Flow, Average CN values
Groundwater Mounding Calculations

Standard 2

STORM DRAINAGE CALCULATIONS
Pipe Flow Calculations - Manning's Equation

i = Rainfall Intensity at 25 Year Storm

Date: 5/13/20
Revised:
Job No: 16,181
Calc. by: rst

Project: Geoffrey Park
Town: Holliston, MA

Line		Length	Drain Area	Total Area	Runoff	Time of Concentration (min.)			Rainfall i	Required Capacity Q(cfs)		Pipe Diameter	Slope	Design Conditions		Invert Elevation		Rim Elev.	
From	To	(Feet)	(Ac)	(Ac)	"C"	Upper End	In Pipe	Total	(in./hr.)	Inlet	Pipe	(in.)	(ft./ft.)	Depth (in.)	Velocity (f.p.s.)	Upper	Lower	Upper	n
CB 1	DMH 3	11	0.90		0.43	19.78	0.03	19.81	3.97	1.51		12	0.018	4.60	5.40	269.70	269.50	272.79	0.013
CB 2	DMH 3	5	0.19		0.49	9.95	0.02	9.97	5.19	0.49		12	0.040	2.10	5.20	269.70	269.50	272.79	0.013
DMH 3	DMH 4	56		1.09	0.44	19.81	0.21	20.02	3.96	1.89		12	0.009	6.40	4.40	269.40	268.90	273.50	0.013
DMH 4	HW 5	22		1.09	0.44	20.02	0.08	20.11	3.94		1.88	12	0.009	6.40	4.40	268.70	268.50	288.12	0.013
CB 20	DMH 19	15	0.26		0.46	13.59	0.04	13.64	4.63	0.55		12	0.033	2.10	5.80	305.30	304.80	309.39	0.013
CB 21	DMH 19	10	0.83		0.67	15.21	0.02	15.24	4.43	2.46		12	0.050	5.10	7.70	305.30	304.80	309.39	0.013
DMH 19	DMH 18	45		1.09	0.62	15.24	0.08	15.32	4.43		2.98	12	0.049	5.10	9.30	304.70	302.50	308.83	0.013
DMH 18	DMH 17	36		1.09	0.62	15.32	0.07	15.38	4.42		2.98	12	0.044	5.20	8.90	302.40	300.80	306.61	0.013
DMH 17	DMH 16	36		1.09	0.62	15.38	0.07	15.45	4.41		2.97	12	0.047	5.20	9.20	300.70	299.00	304.84	0.013
DMH 16	DMH 13	110		1.09	0.62	15.45	0.20	15.65	4.41		2.97	12	0.045	5.20	9.10	298.90	293.90	303.06	0.013
CB 14	DMH 13	11	0.37		0.50	16.04	0.02	16.06	4.34	0.81		12	0.091	2.20	8.10	294.90	293.90	298.31	0.013
CB 15	DMH 13	5	0.86		0.52	14.87	0.01	14.88	4.47	2.02		12	0.200	2.90	11.90	294.90	293.90	298.31	0.013
DMH 13	DMH 12	185		1.23	0.52	14.88	0.34	15.22	4.47		2.85	12	0.047	5.10	9.10	293.80	285.10	297.96	0.013
CB 27	DMH 26	11	0.31		0.59	11.87	0.03	11.89	4.88	0.90		12	0.045	2.80	6.50	299.50	299.00	305.10	0.013
CB 28	DMH 26	5	0.88		0.54	15.87	0.01	15.87	4.36	2.07		12	0.100	3.40	10.90	299.50	299.00	305.10	0.013
DMH 26	DMH 25	36		1.19	0.55	15.87	0.06	15.94	4.36		2.88	12	0.049	5.00	9.30	297.25	295.50	304.33	0.013
DMH 25	DMH 22	155		1.19	0.55	15.94	0.28	16.22	4.35		2.87	12	0.050	5.00	9.30	294.25	286.50	300.65	0.013
CB 23	DMH 22	11	0.35		0.51	13.64	0.03	13.67	4.63	0.83		12	0.027	3.10	5.30	286.80	286.50	291.17	0.013
CB 24	DMH 22	5	0.58		0.53	18.37	0.01	18.38	4.10	1.27		12	0.060	3.10	7.90	286.80	286.50	291.17	0.013
DMH 22	DMH 12	32		2.13	0.54	18.38	0.05	18.44	4.10		4.71	12	0.041	7.10	9.80	286.40	285.10	290.77	0.013
DMH 12	DMH 9	30		3.36	0.53	18.44	0.05	18.49	4.09		7.32	12	0.037	10.80	9.80	285.00	283.90	289.54	0.013
CB 10	DMH 9	11	0.82		0.46	18.19	0.03	18.22	4.11	1.56		12	0.027	4.20	6.30	284.20	283.90	288.33	0.013
CB 11	DMH 9	5	0.36		0.67	11.54	0.01	11.55	4.93	1.18		12	0.060	3.00	7.80	284.20	283.90	288.33	0.013
DMH 9	DMH 8	40		4.54	0.53	18.49	0.06	18.54	4.09		9.84	18	0.040	8.60	11.90	279.10	277.50	287.99	0.013
DMH 8	DMH 7	90		4.54	0.53	18.54	0.13	18.67	4.08		9.82	18	0.040	8.60	11.70	273.10	269.50	285.99	0.013
DMH 7	HW 6	5		4.54	0.53	18.67	0.01	18.68	4.07		9.79	18	0.040	8.60	11.70	269.20	269.00	273.50	0.013

Outlet Structure #6 (Headwall)

Outlet #6 (9.79 cfs)

$$D_{50} = 0.2D[Q/(g)^{1/2}D^{2.5}]^{4/3}[D/Tw]$$

D = Diameter, ft.
g = Accel. of gravity, 32.2 f.p.s.
Q = Discharge rate, c.f.s.
D50 = Riprap size, ft. (minimum)
Tw = Tailwater Depth, ft.(Unknown Tw = 0.4 x D)

Class	D_{50}(in.)	Apron Length	Apron Depth
1	5	4D	$3.5D_{50}$
2	6	4D	$3.3D_{50}$
3	10	5D	$2.4D_{50}$

Width(at apron end) = 3D+(2/3)L

Note: Formulas taken from HEC No. 14; Publication No. FHWA-NHI-06-086 July 2006

(1) **Headwall #6**

D =	1.50	ft.
Q =	9.79	c.f.s.
Tw =	0.60	ft.
D_{50} =	0.40	ft.
=	4.83	inches
RipRap Class =	1	
L=	6.00	ft. (min.)
Depth =	16.90	inches (min.)
W =	8.50	ft. (min)

Outlet Structure #5 (Headwall)
Outlet #5 (1.88 cfs)

$$D_{50} = 0.2D[Q/(g)^{1/2}D^{2.5}]^{4/3}[D/Tw]$$

D = Diameter, ft.
g = Accel. of gravity, 32.2 f.p.s.
Q = Discharge rate, c.f.s.
D50 = Riprap size, ft. (minimum)
Tw = Tailwater Depth, ft.(Unknown Tw = 0.4 x D)

Class	D_{50}(in.)	Apron Length	Apron Depth
1	5	4D	$3.5D_{50}$
2	6	4D	$3.3D_{50}$
3	10	5D	$2.4D_{50}$

Width(at apron end) = 3D+(2/3)L

Note: Formulas taken from HEC No. 14; Publication No. FHWA-NHI-06-086 July 2006

(1) **Headwall #5**

D =	**1.00**	ft.
Q =	**1.88**	c.f.s.
Tw =	**0.40**	ft.
D_{50} =	**0.12**	ft.
=	**1.38**	inches
RipRap Class =	**1**	
L=	**4.00**	ft. (min.)
Depth =	**4.83**	inches (min.)
W =	**5.67**	ft. (min)

AVERAGE 'c' VALUE FOR STRUCTURES

STORM RUNOFF DATA

Date: **5/13/20**
Revised:

Project: **Geoffrey Park**
Town: **Holliston, MA**

Job No: **16,181**
Calc. by: **RST**

Structure	**Total Area (SF)**	**Ground Cover**	**Area (SF)**	**c**	**Σ(Area*c)**	**Average c**	**Total Area (Ac)**
CB#1	39,042	imp	7,539	0.95	7,162.05	0.43	0.896
		lawn	31,503	0.30	9,450.90		
		wooded	0	0.20	0.00		
CB#2	8,359	imp	2,494	0.95	2,369.30	0.49	0.192
		lawn	5,865	0.30	1,759.50		
		wooded	0	0.20	0.00		
CB#10	35,825	imp	8,950	0.95	8,502.50	0.46	0.822
		lawn	26,875	0.30	8,062.50		
		wooded	0	0.20	0.00		
CB#11	15,656	imp	8,792	0.95	8,352.40	0.67	0.359
		lawn	6,864	0.30	2,059.20		
		wooded	0	0.20	0.00		
CB#14	16,127	imp	5,048	0.95	4,795.60	0.50	0.370
		lawn	11,079	0.30	3,323.70		
		wooded	0	0.20	0.00		
CB#15	37,649	imp	12,870	0.95	12,226.50	0.52	0.864
		lawn	24,779	0.30	7,433.70		
		wooded	0	0.20	0.00		
CB#20	11,208	imp	3,604	0.95	3,423.80	0.51	0.257
		lawn	7,604	0.30	2,281.20		
		wooded	0	0.20	0.00		
CB#21	36,311	imp	7,673	0.95	7,289.35	0.44	0.834
		lawn	28,638	0.30	8,591.40		
		wooded	0	0.20	0.00		
CB#27	13,608	imp	6,104	0.95	5,798.80	0.59	0.312
		lawn	7,504	0.30	2,251.20		
		wooded	0	0.20	0.00		
CB#28	38,293	imp	14,234	0.95	13,522.30	0.54	0.879
		lawn	24,059	0.30	7,217.70		
		wooded	0	0.20	0.00		
CB#23	15,412	imp	4,940	0.95	4,693.00	0.51	0.354
		lawn	10,472	0.30	3,141.60		
		wooded	0	0.20	0.00		
CB#24	25,304	imp	9,100	0.95	8,645.00	0.53	0.581
		lawn	16,204	0.30	4,861.20		
		wooded	0	0.20	0.00		

OVERLAND FLOW TRAVEL TIME

STORM RUNOFF DATA

Date: **5/7/20**
Revised:

Project: **Geoffrey Park** Job No: **16,181**
Town: **Holliston, MA** Calc. by: **rst**

Structure	Impervious			Lawn			Wooded			Total
	Length (ft)	Slope ('/')	Time (min.)	Length (ft)	Slope ('/')	Time (min.)	Length (ft)	Slope ('/')	Time (min.)	Travel Time (min.)
1	20	0.080	0.21	325	0.090	19.57				19.78
2	240	0.080	1.40	45	0.060	8.55				9.95
10	200	0.044	1.54	210	0.075	16.66				18.19
11	190	0.044	1.48	45	0.030	10.06				11.54
14	140	0.015	1.77	110	0.040	14.28				16.04
15	170	0.044	1.35	120	0.060	13.52				14.87
20	175	0.040	1.44	55	0.020	12.16				13.59
21	175	0.040	1.44	125	0.060	13.78				15.21
23	140	0.065	1.00	120	0.080	12.63				13.64
24	200	0.065	1.32	180	0.050	17.05				18.37
27	220	0.035	1.80	45	0.030	10.06				11.87
28	220	0.035	1.80	125	0.055	14.06				15.87

APPENDIX – C

Stormwater Recharge Calculations, Water Quality Volumes, TSS Removal & Infiltration BMP Drain Time
Groundwater Mounding Calculations

Standards 3 & 4:

APPENDIX – B
Stormwater Recharge, Water Quality & Forebay Calculations
Standard 3 & 4:

Project:
Geofrey Park
Holliston, Massachusetts
Date: May 14, 2020

Water Quality Volume (WQV): Based on 0.5 inch rainfall
Recharge Volume(Rv): Based on Soil Classification
    Rv = F * Impervious Area
    Rv = Required Recharge Volume
    F = Depth Factor
        Soil Type A – 0.60 inch
        Soil Type B – 0.35 inch
        Soil Type C – 0.25 inch
        Soil Type D – 0.00 inch

Total Impervious Area:

Roadway/Drives:	63,408 s.f. (To drainage basin)
Roof: (to basins)	30,966 s.f
Roof:(bypass basin)	5,824 s.f.
Total Imp. Area:	100,198 s.f.

Total Impervious to Recharge Basins: 94,374 s.f.
Total Impervious Area Uncaptured: 5,824 s.f.
Capture Adjustment:
94,374 s.f. / 100,198 s.f. = 94.2% > 65%
100,198 s.f. / 94,374 s.f. = 1.06 capture adjustment

Drainage Basin #1 :
Imp. Area Pavement: 63,408 s.f.
WQV = (63,408 sf * 0.5 in)/12 = 2642 c.f.

Recharge Volume Required: (Soil Type B – 0.35 inch)
Tot. Imp Area: 94,374 s.f.
Rv = (94,374 sf * 0.35 in)/12 = 2752 c.f. x Capture Adjustment (1.06) = 2,918 c.f.

Storage Volume below outlet
"Static" Storage Volume Provided:
Volume (Outlet 268.5) provided = 5,584 c.f.
5,584 > 2,918 c.f. **OK**

Time to drain:
Drawdown time = Volume/(K*Bottom Area)
Volume = 2918 cf
K=1.02 in/hr = 0.085 ft/hr
Bottom Area = 3620 sf (El.268.0)
Drawdown time = 2918/(0.085 ft/hr x 3620 sf)
Drawdown time = 9.5 hr < 72 hr ***ok***

Stage-Area-Storage for Pond 1P: Det Basin

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
266.50	1,320	0
266.60	1,438	138
266.70	1,561	288
266.80	1,690	450
266.90	1,823	626
267.00	1,961	815
267.10	2,105	1,018
267.20	2,253	1,236
267.30	2,407	1,469
267.40	2,565	1,718
267.50	2,729	1,982
267.60	2,898	2,264
267.70	3,071	2,562
267.80	3,250	2,878
267.90	3,434	3,212
268.00	3,623	3,565
268.10	3,785	3,935
268.20	3,950	4,322
268.30	4,119	4,725
268.40	4,292	5,146
268.50	4,468	5,584
268.60	4,648	6,040
268.70	4,831	6,514
268.80	5,017	7,006
268.90	5,208	7,517
269.00	5,402	8,048
269.10	5,599	8,598
269.20	5,800	9,168
269.30	6,004	9,758
269.40	6,212	10,369
269.50	6,424	11,000
269.60	6,639	11,653
269.70	6,857	12,328
269.80	7,079	13,025
269.90	7,305	13,744
270.00	7,534	14,486
270.10	7,698	15,248
270.20	7,863	16,026
270.30	8,030	16,820
270.40	8,199	17,632
270.50	8,370	18,460
270.60	8,542	19,306
270.70	8,716	20,168
270.80	8,892	21,049
270.90	9,070	21,947
271.00	9,249	22,863
271.10	9,430	23,797
271.20	9,613	24,749
271.30	9,798	25,720
271.40	9,984	26,709
271.50	10,173	27,716
271.60	10,363	28,743
271.70	10,554	29,789
271.80	10,748	30,854
271.90	10,943	31,939
272.00	11,140	33,043
272.10	11,275	34,164
272.20	11,411	35,298
272.30	11,548	36,446
272.40	11,685	37,607
272.50	11,823	38,783
272.60	11,962	39,972
272.70	12,102	41,175
272.80	12,243	42,393
272.90	12,385	43,624
273.00	**12,527**	**44,870**

INSTRUCTIONS:
1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: HEADWALL #4

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
DEEP Sump HOODED C.B.	0.25	1.00	0.25	0.75
CDS Treatment Unit #3	0.87	0.75	0.65	0.10
Infiltration BASIN	0.80	0.10	.08	.02

Total TSS Removal = 98%

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

Project: GEOFFREY Park
Prepared By: GLM
Date: 7/10/2020

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: HEADWALL #7

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
DEEP Sump HOODED CB	0.25	1.00	.25	0.75
CDS Treatment Unit #4	0.82	0.75	.61	.14
Infiltration Basin	0.80	.14	.11	.03

Total TSS Removal = 97 %

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

Project: GEOFFREY
Prepared By: GLM
Date: 7/10/2020

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

GEOFFREY PARK
HOLLISTON, MA

Area	**1.21 ac**	Unit Site Designation	**Treatment Unit #7**
Weighted C	**0.9**	Rainfall Station #	**68**
t_c	**6 min**		
CDS Model	**2015-4**	CDS Treatment Capacity	**1.4 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.02	0.02	9.3
0.04	9.5%	18.8%	0.04	0.04	9.3
0.06	8.7%	27.5%	0.07	0.07	8.5
0.08	10.1%	37.6%	0.09	0.09	9.7
0.10	7.2%	44.8%	0.11	0.11	6.8
0.12	6.0%	50.8%	0.13	0.13	5.7
0.14	6.3%	57.1%	0.15	0.15	5.9
0.16	5.6%	62.7%	0.17	0.17	5.2
0.18	4.7%	67.4%	0.20	0.20	4.3
0.20	3.6%	71.0%	0.22	0.22	3.3
0.25	8.2%	79.1%	0.27	0.27	7.1
0.50	14.9%	94.0%	0.54	0.54	11.1
0.75	3.2%	97.3%	0.82	0.82	2.0
1.00	1.2%	98.5%	1.09	1.09	0.6
1.50	0.7%	99.2%	1.63	1.40	0.2
2.00	0.8%	100.0%	2.18	1.40	0.2
					89.1
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.2%
				Predicted Net Annual Load Removal Efficiency =	**82.6%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

GEOFFREY PARK
HOLLISTON, MA

Area	**0.23 ac**	Unit Site Designation	**Treatment Unit #4**
Weighted C	**0.9**	Rainfall Station #	**68**
t_c	**6 min**		
CDS Model	**1515-3**	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.00	0.00	9.0
0.04	9.5%	18.8%	0.01	0.01	9.2
0.06	8.7%	27.5%	0.01	0.01	8.4
0.08	10.1%	37.6%	0.02	0.02	9.7
0.10	7.2%	44.8%	0.02	0.02	6.9
0.12	6.0%	50.8%	0.02	0.02	5.7
0.14	6.3%	57.1%	0.03	0.03	6.0
0.16	5.6%	62.7%	0.03	0.03	5.3
0.18	4.7%	67.4%	0.04	0.04	4.4
0.20	3.6%	71.0%	0.04	0.04	3.4
0.25	8.2%	79.1%	0.05	0.05	7.6
0.50	14.9%	94.0%	0.10	0.10	13.4
0.75	3.2%	97.3%	0.16	0.16	2.8
1.00	1.2%	98.5%	0.21	0.21	1.0
1.50	0.7%	99.2%	0.31	0.31	0.5
2.00	0.8%	100.0%	0.41	0.41	0.5
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					94.0

Removal Efficiency Adjustment[2] =	6.5%
Predicted % Annual Rainfall Treated =	93.5%
Predicted Net Annual Load Removal Efficiency =	**87.6%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Mound Calculation Basin
Geoffrey Park, Holliston, MA
Date: 05/14/2020

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
1.2100	***R***	**Recharge (infiltration) rate (feet/day)**
0.210	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
20.40	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
76.000	**x**	**1/2 length of basin (x direction, in feet)**
37.000	**y**	**1/2 width of basin (y direction, in feet)**
1.000	**t**	**duration of infiltration period (days)**
25.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	**feet/day**
0.67	1.33
2.00	4.00

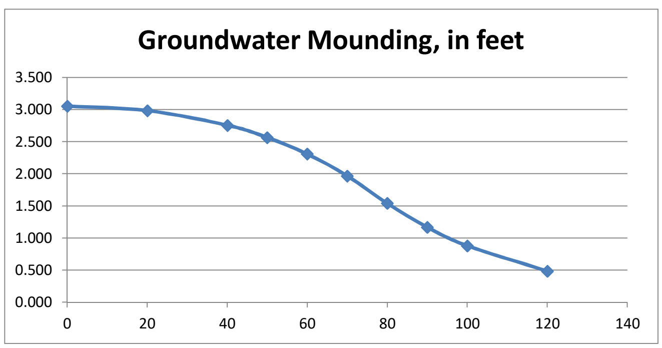
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

28.055	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
3.055	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
3.055	**0**
2.985	**20**
2.756	**40**
2.565	**50**
2.308	**60**
1.967	**70**
1.540	**80**
1.169	**90**
0.881	**100**
0.486	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

APPENDIX – D

Stormwater Operation and Maintenance Plan
and
Long Term Pollution Prevention Plan

Standard 9

Stormwater Management Operation and Maintenance Plan And Long Term Pollution Prevention Plan

Maintenance Agreement
Geoffrey Park
Holliston, Massachusetts

May 14, 2020
Revised: July 10, 2020

In accordance with Standard 9 of the Massachusetts Department of Environmental Protection Stormwater Handbook (February 2008), the attached on-site maintenance program for the proposed stormwater management system has been developed to ensure the Best Management Practices (BMP's) in place will remain functioning as designed. The landowner/operator, or its successors, of the Project Site, Geoffrey Park shall be responsible for financing maintenance and emergency repairs of the entire storm-water management system on the property. The Plan contains both construction period operations and maintenance as well as post construction responsibilities that shall "run" with the property if ownership is transferred.

Responsible Operator:

Indian Ridge Realty Trust
Attn: David Adams
223 Courtland Street
Holliston, MA 01746
Office: 508-561-4197

____________________________ ____________________________
David Adams Date

Estimated Maintenance Yearly Budget:

Annual Catch Basin and CDS Units Cleaning:	$ 1,500.00
Mowing, vegetation maintenance of Drainage Basin:	$ 480.00
Repairs:	$ 250.00
Total	$ 2,230.00

Construction Period Operation and Maintenance:

Good Housekeeping Practices:

- Remove all debris from site and dispose of in trash dumpsters
- Plan for adequate disposal of scrap, waste and surplus materials
- Keep work area clean
- Secure loose or light material that is stored on the site
- Store flammable materials apart from other materials
- Secure all materials at the end of each work day
- Maintain a clean neat and orderly site

Safety:

Keep safety considerations at the forefront of inspection procedures at all times. Likely hazards should be anticipated and avoided. Never enter a confined space (outlet structure, manhole, etc) without proper training or equipment. A confined space should never be entered without at least one additional person present. If a toxic or flammable substance is discovered, leave the immediate area and contact the local authorities at 911.

All cast iron storm water structure grates and covers shall be kept in good condition and kept closed at all times. Any damaged or broken structures will be replaced immediately upon discovery.

Construction Entrances:

The purpose of stabilizing entrances to a construction site is to minimize the amount of sediment leaving the area as mud and sediment attached to vehicles. The entrances shall be sized according to the Massachusetts DEP and US EPA guidelines and will be maintained on a weekly basis during construction. A Detail is included in the Site Plans prepared for the Project.

Dust Control:

Soils information for the site indicates that it is comprised of sandy soils. Therefore, Dust control BMPs to reduce surface activities and air movement that causes dust to be generated from disturbed soil surfaces will be required. The preferred measure for dust control is sprinkling/irrigation. This is an on-going/as-needed requirement until surfaces have been stabilized. There shall be a water truck on-site available as needed.

Catch Basin Protection:

Temporary inlet protection barriers consisting of Silt Sacks® will be placed within all constructed inlets to prevent inflow of sediments into the constructed drainage system. The barriers shall remain in place until a permanent cover is established or diversions away from the inlets are constructed. The barriers shall be observed and maintained as necessary on a weekly basis and after every rainfall of 0.5 inches or more.

Spill Control:

A contingency plan to address the spillage/release of petroleum products and any hazardous materials will be implemented for the site during construction. The plan will include the following measures:

- Equipment necessary to quickly attend to inadvertent spills or leaks shall be on-site in a secure but accessible location. Such equipment will include, but not be limited to, the following: urethane drain cover seals (mats), a spill containment kit which includes sand and shovels, suitable absorbent materials, storage containers, safety goggles, chemically resistant gloves and overshoe boots, water and chemical fire extinguishers, and first aid equipment.
- Spills or leaks will be treated properly according to material type, volume of spillage and location of spill. Mitigation will include preventing further spillage, containing the spilled material to the smallest practical area, removing spilled material in a safe and environmentally friendly manner, and remediating any damage to the environment.
- The contractor shall be familiar with the reporting requirements of the Massachusetts Contingency Plan (310 CMR 40.00) as issued by the Massachusetts Department of Environmental Protection (DEP); specifically Subpart C Notification of Releases and Threats of Release of Oil and Hazardous Materials and Subpart D Preliminary Response Activities and Risk Reduction Measures.
- For any large spills. The Massachusetts DEP Hazardous Waste Incident Response Group shall be notified immediately at 1-617-792-7653 and an emergency response contractor will be called in.

Post-Construction Period Operation and Maintenance:

Pavement Sweeping:

Sweeping has been shown to be an effective initial treatment for reducing contaminants in stormwater runoff. Sweeping is not required to meet TSS removal goals in this case but should be performed at least once per year, in the spring to remove winter accumulations or at other when warranted.

CDS Treatment Units:

Sediments, associated pollutants and trash are removed only when inlets or sumps are cleaned out, so regular maintenance is essential. Cleaning includes removal of accumulated oil and grease and sediment using a vacuum truck or other ordinary catch basin cleaning device. In areas of high sediment loading, inspect and clean inlets after every major storm. At a minimum, inspect oil grit separators and clean them out at least twice per year. Cleaning of a Stormceptor systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. (See attached manufacturer maintenance)

Stormceptor Treatment Units:

Activity	Inspection Frequency
Inspect Inlet and Outlet	2 times per yr. After a heavy rain event 1” storm or larger
Sediment buildup & Clean	2 times per yr. (minimum) Accumulated sediment buildup shall be Vacuumed cleaned as necessary

Retention Basin:

Vehicle access if necessary will be via the access around the top of the retention basin. The drainage easement shall be mowed twice a year and kept clear of any trees. The easement will be used for access to the basin.

Inspect it after every major storm for the first few months to ensure it is stabilized and functioning properly and if necessary to take corrective action. Also inspect the basin every time there is a discharge through the high outlet weir. A major storm is defined as a storm that is equal to or greater than the 2.5 inches in a 24-hour storm. Note how long the water remains standing after a storm. If longer than 72 hours, there may be clogging of the infiltrative surfaces. Inspect the basin and mow it as needed. When mowing keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Remove grass clippings, organic matter and trash. Use deep tilling to break up compacted or clogged surfaces.

Check for signs of gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by reseeding.

Retention Basin:

Activity	Inspection Frequency
Sediment Removal	Inspect Monthly Remove accumulated sediment buildup Grass Mowing during growing season (Keep grasses no greater than 6 inches & no lower than 3 to 4 inches)

Deep Sump Catch Basins:

Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. Inspect and clean sumps when sediments whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert to the lowest pipe in the basin, at least once (1) time per year, at the end of the foliage and snow removal seasons. Clamshell buckets or vacuum trucks shall be utilized.

Riprap Outlet Maintenance:

Maintenance needs are relatively low. Inspect outlet protection on a regular basis for erosion, sedimentation, scour or undercutting. Repair or replace riprap, geotextile or concrete structures as necessary to handle design flows.
Remove trash, debris, grass, sediment or burrowing animals as needed.

Snow Removal and De-icing:

Snow shall be stored in the designated areas shown on the site plans. If snow accumulation exceeds the limits of the storage areas, excess snow shall be removed from the site and disposed of in a proper manner.

The use of Sodium Chloride (“rock salt”) for de-icing of paved surfaces will be limited; except when found to be necessary for safety of the residents. Sand will be the primary icing control agent. Alternative de-icing products such as calcium chloride may be used as temperatures or other conditions warrant.

Fertilizer:

Slow release organic fertilizers will be used in landscape areas to limit nutrient transport to groundwater and wetland areas. Application will be limited to 3 lbs. per 1000 sf of lawn area.

Stormwater Construction Site Inspection Report

General Information			
Project Name	Geoffrey Park		
MA DEP File No.		**Location**	Holliston, MA
Date of Inspection		**Start/End Time**	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			
Inspector's Qualifications			
Describe present phase of construction			
Type of Inspection: ❑ Regular ❑ Pre-storm event ❑ During storm event ❑ Post-storm event			
Weather Information			
Has there been a storm event since the last inspection? ❑Yes ❑No **If yes, provide:** Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):			
Weather at time of this inspection? ❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snowing ❑ High Winds ❑ Other: Temperature:			
Have any discharges occurred since the last inspection? ❑Yes ❑No **If yes, describe:**			
Are there any discharges at the time of inspection? ❑Yes ❑No **If yes, describe:**			

Site-specific BMPs

- *Number the structural and non-structural BMPs identified in your SWPPP on your site map and list them below (add as many BMPs as necessary). Carry a copy of the numbered site map with you during your inspections. This list will ensure that you are inspecting all required BMPs at your site.*
- *Describe corrective actions initiated, date completed, and note the person that completed the work in the Corrective Action Log.*

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1		❑Yes ❑No	❑Yes ❑No	
2		❑Yes ❑No	❑Yes ❑No	
3		❑Yes ❑No	❑Yes ❑No	
4		❑Yes ❑No	❑Yes ❑No	
5		❑Yes ❑No	❑Yes ❑No	
6		❑Yes ❑No	❑Yes ❑No	
7		❑Yes ❑No	❑Yes ❑No	
8		❑Yes ❑No	❑Yes ❑No	
9		❑Yes ❑No	❑Yes ❑No	

Non-Compliance

Describe any incidents of non-compliance not described above:

CERTIFICATION STATEMENT

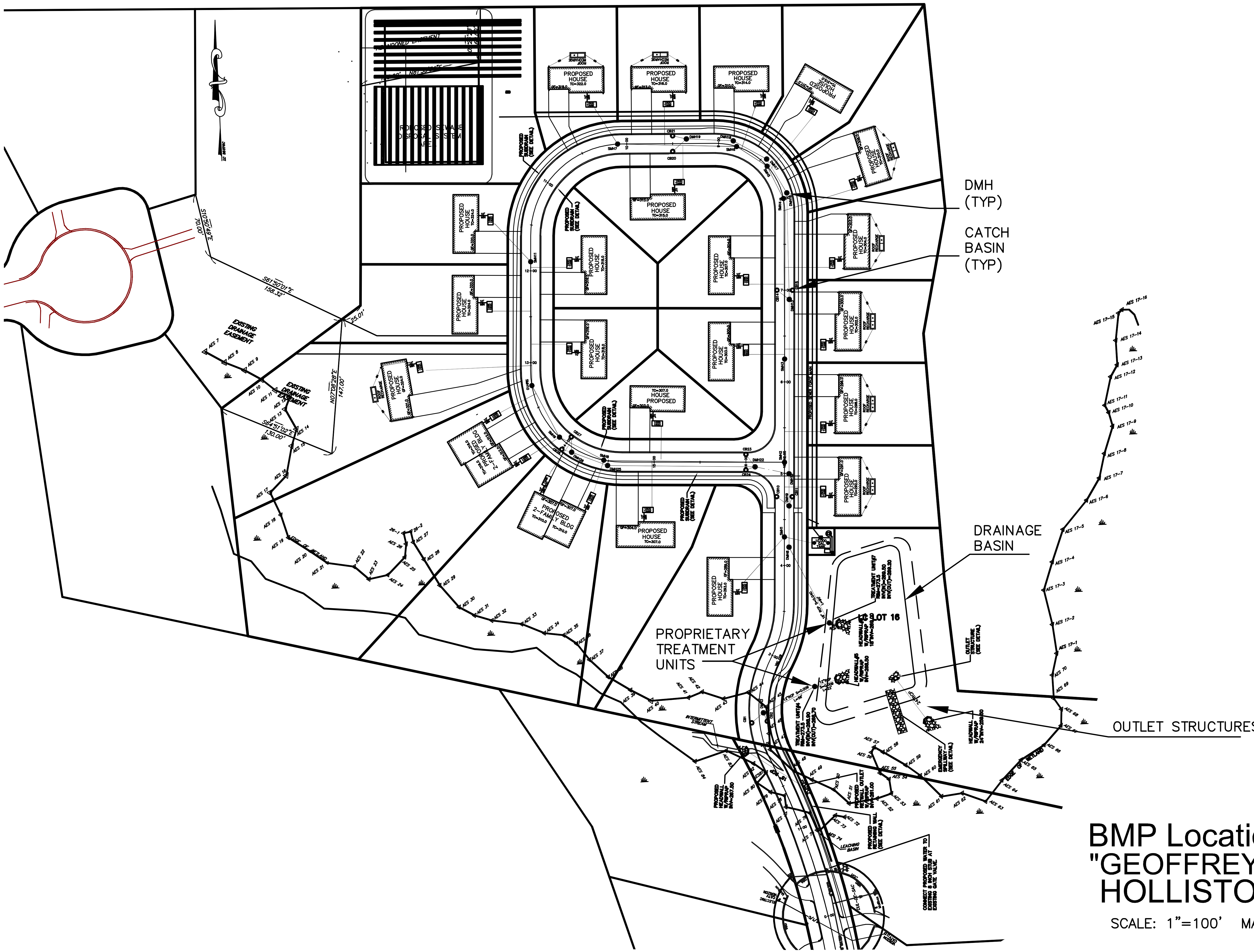
"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name and title: ____

Signature:____ **Date:**____________________

Appendix A

BMP Location Plan



BMP Location Plan
"GEOFFREY PARK"
HOLLISTON, MA

SCALE: 1"=100' MAY 14,2014

CONTECH
ENGINEERED SOLUTIONS

CDS® Inspection and Maintenance Guide

CDS TECHNOLOGIES

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y³	m³
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.3	3.0	0.9	1.3	1.0
CDS2020	5	1.3	3.5	1.1	1.3	1.0
CDS2025	5	1.3	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater, earth stabilization and wastewater treament products. For information, visit www.ContechES.com or call 800.338.1122

The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; 7,517,450 related foreign patents or other patents pending.

CONTECH®
ENGINEERED SOLUTIONS
800.925.5240
www.ContechES.com

CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

APPENDIX – E

Illicit Discharge Statement

Standard 10

Illicit Discharge Compliance Statement

Geoffrey Park
Holliston, Massachusetts

May 14, 2020

This statement is provided in accordance with the provisions of the Massachusetts Stormwater Management Standard #10.

To the best of the applicant's/owners knowledge there are no illicit discharges to the site's stormwater manangement system.

All proposed uses on the site will not generate, store or discharge any pollutants to the groundwater and/or wetland resource areas.

Any illicit discharges identified during or after construction will be terminated immediately.

Applicant/Owner:

Indian Ridge Realty Trust
Attn: David Adams
232 Courtland Street
Holliston, MA 01746
Phone: 508-561-4197

____________________________ ________________________
David Adams Date

APPENDIX – R

Culvert Crossing Sizing Calculations

Appendix – F

Culvert Crossing
Sta. 1+75

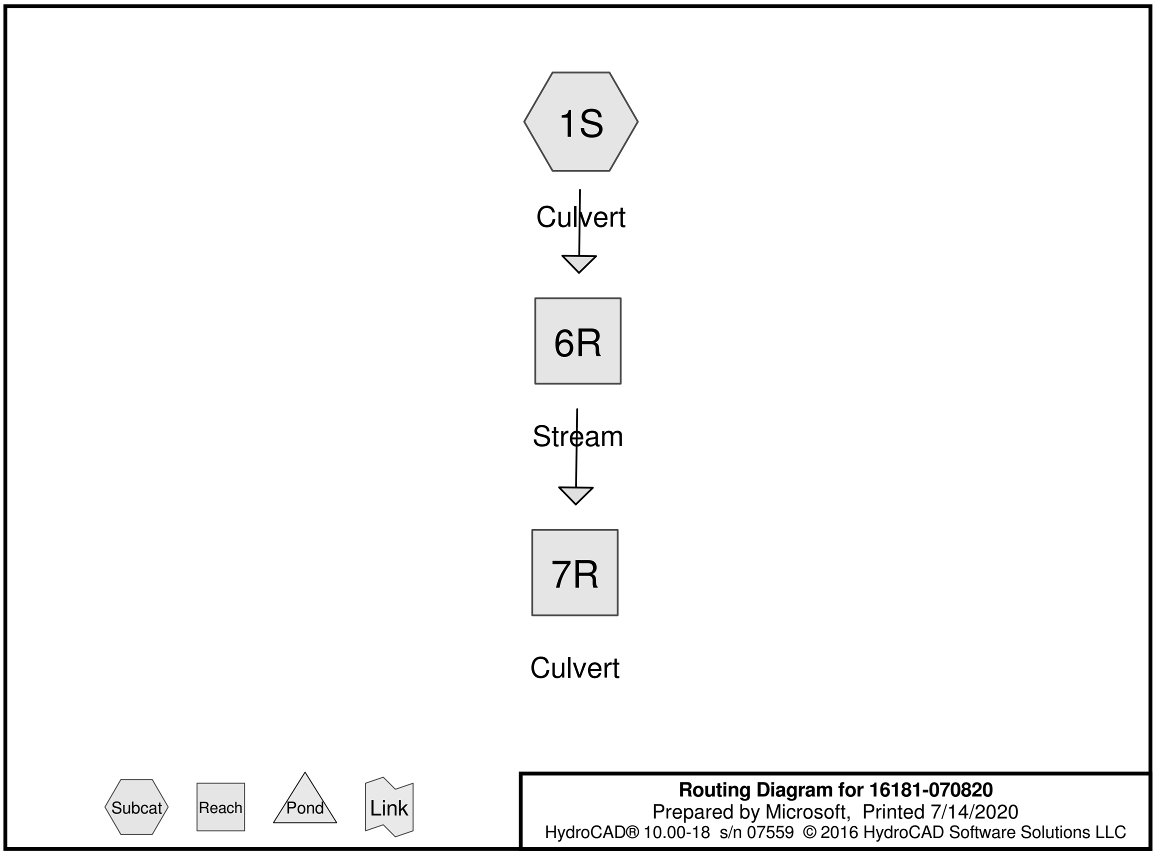
Project:
Geofrey Park
Holliston, Massachusetts
Date: July 9, 2020

Subcatchment 1S
Total Runoff Area:
11.4 Acres

Avg CN Values:

Wetlands:	42,500 s.f.
Woods:	100,400 s.f.
1 Ac Res.	353,000 s.f.
Total	495,900 s.f. or 11.4 ac

Time of Concentration:
50’ Grass S=0.020
270’ Grass S=0.050
250’ Paved S=0.040 (Road)
150’ Grass S=0.010 (Through detention basin at Cul-de-sac)
335’ Woods S=0.075 (To intermittent stream)
Reach 6R To Crossing (Same as 1R)
Culvert (Reach 7R)



Summary for Subcatchment 1S: Culvert

Runoff = 5.04 cfs @ 12.26 hrs, Volume= 26,430 cf, Depth> 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Yr Rainfall=3.20"

	Area (sf)	CN	Description
*	42,500	78	Wetlands
	100,400	55	Woods, Good, HSG B
	353,000	68	1 acre lots, 20% imp, HSG B
	495,900	66	Weighted Average
	425,300		85.76% Pervious Area
	70,600		14.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
1.2	270	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
1.0	250	0.0400	4.06		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
1.7	150	0.0100	1.50		**Shallow Concentrated Flow, D-E** Grassed Waterway Kv= 15.0 fps
4.1	335	0.0750	1.37		**Shallow Concentrated Flow, E-F** Woodland Kv= 5.0 fps
16.2	1,055	Total			

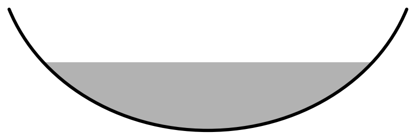
Summary for Reach 6R: Stream

Inflow Area = 495,900 sf, 14.24% Impervious, Inflow Depth > 0.64" for 2 Yr event
Inflow = 5.04 cfs @ 12.26 hrs, Volume= 26,430 cf
Outflow = 5.03 cfs @ 12.30 hrs, Volume= 26,394 cf, Atten= 0%, Lag= 1.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.10 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 2.46 fps, Avg. Travel Time= 2.0 min

Peak Storage= 296 cf @ 12.28 hrs
Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



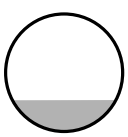
Summary for Reach 7R: Culvert

Inflow Area =	495,900 sf, 14.24% Impervious, Inflow Depth > 0.64"	for 2 Yr event
Inflow =	5.03 cfs @ 12.30 hrs, Volume=	26,394 cf
Outflow =	5.02 cfs @ 12.30 hrs, Volume=	26,391 cf, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.20 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.36 fps, Avg. Travel Time= 0.2 min

Peak Storage= 27 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 32.01 cfs

18.0" Round Pipe
n= 0.013
Length= 70.0' Slope= 0.0929 '/'
Inlet Invert= 267.50', Outlet Invert= 261.00'



Summary for Subcatchment 1S: Culvert

Runoff = 14.73 cfs @ 12.24 hrs, Volume= 65,546 cf, Depth> 1.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Yr Rainfall=4.80"

	Area (sf)	CN	Description
*	42,500	78	Wetlands
	100,400	55	Woods, Good, HSG B
	353,000	68	1 acre lots, 20% imp, HSG B
	495,900	66	Weighted Average
	425,300		85.76% Pervious Area
	70,600		14.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
1.2	270	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
1.0	250	0.0400	4.06		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
1.7	150	0.0100	1.50		**Shallow Concentrated Flow, D-E** Grassed Waterway Kv= 15.0 fps
4.1	335	0.0750	1.37		**Shallow Concentrated Flow, E-F** Woodland Kv= 5.0 fps
16.2	1,055	Total			

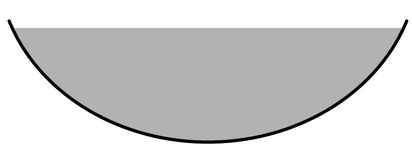
Summary for Reach 6R: Stream

Inflow Area = 495,900 sf, 14.24% Impervious, Inflow Depth > 1.59" for 10 Yr event
Inflow = 14.73 cfs @ 12.24 hrs, Volume= 65,546 cf
Outflow = 14.71 cfs @ 12.26 hrs, Volume= 65,489 cf, Atten= 0%, Lag= 1.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.91 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 3.02 fps, Avg. Travel Time= 1.7 min

Peak Storage= 639 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.94'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



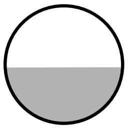
Summary for Reach 7R: Culvert

Inflow Area = 495,900 sf, 14.24% Impervious, Inflow Depth > 1.58" for 10 Yr event
Inflow = 14.71 cfs @ 12.26 hrs, Volume= 65,489 cf
Outflow = 14.71 cfs @ 12.26 hrs, Volume= 65,484 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 17.73 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 7.83 fps, Avg. Travel Time= 0.1 min

Peak Storage= 58 cf @ 12.26 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 32.01 cfs

18.0" Round Pipe
n= 0.013
Length= 70.0' Slope= 0.0929 '/'
Inlet Invert= 267.50', Outlet Invert= 261.00'



Summary for Subcatchment 1S: Culvert

Runoff = 16.81 cfs @ 12.23 hrs, Volume= 73,917 cf, Depth> 1.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr Rainfall=5.10"

	Area (sf)	CN	Description
*	42,500	78	Wetlands
	100,400	55	Woods, Good, HSG B
	353,000	68	1 acre lots, 20% imp, HSG B
	495,900	66	Weighted Average
	425,300		85.76% Pervious Area
	70,600		14.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
1.2	270	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
1.0	250	0.0400	4.06		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
1.7	150	0.0100	1.50		**Shallow Concentrated Flow, D-E** Grassed Waterway Kv= 15.0 fps
4.1	335	0.0750	1.37		**Shallow Concentrated Flow, E-F** Woodland Kv= 5.0 fps
16.2	1,055	Total			

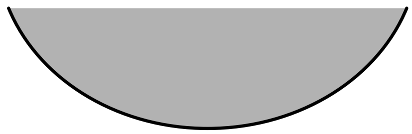
Summary for Reach 6R: Stream

Inflow Area = 495,900 sf, 14.24% Impervious, Inflow Depth > 1.79" for 25 Yr event
Inflow = 16.81 cfs @ 12.23 hrs, Volume= 73,917 cf
Outflow = 16.78 cfs @ 12.26 hrs, Volume= 73,856 cf, Atten= 0%, Lag= 1.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.16 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 3.11 fps, Avg. Travel Time= 1.6 min

Peak Storage= 703 cf @ 12.24 hrs
Average Depth at Peak Storage= 1.00'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



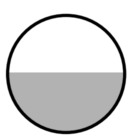
Summary for Reach 7R: Culvert

Inflow Area = 495,900 sf, 14.24% Impervious, Inflow Depth > 1.79" for 25 Yr event
Inflow = 16.78 cfs @ 12.26 hrs, Volume= 73,856 cf
Outflow = 16.78 cfs @ 12.26 hrs, Volume= 73,851 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 18.33 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 8.05 fps, Avg. Travel Time= 0.1 min

Peak Storage= 64 cf @ 12.26 hrs
Average Depth at Peak Storage= 0.77'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 32.01 cfs

18.0" Round Pipe
n= 0.013
Length= 70.0' Slope= 0.0929 '/'
Inlet Invert= 267.50', Outlet Invert= 261.00'



Summary for Subcatchment 1S: Culvert

Runoff = 31.12 cfs @ 12.22 hrs, Volume= 131,940 cf, Depth> 3.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Yr Rainfall=7.00"

	Area (sf)	CN	Description
*	42,500	78	Wetlands
	100,400	55	Woods, Good, HSG B
	353,000	68	1 acre lots, 20% imp, HSG B
	495,900	66	Weighted Average
	425,300		85.76% Pervious Area
	70,600		14.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.20"
1.2	270	0.0500	3.60		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
1.0	250	0.0400	4.06		**Shallow Concentrated Flow, C-D** Paved Kv= 20.3 fps
1.7	150	0.0100	1.50		**Shallow Concentrated Flow, D-E** Grassed Waterway Kv= 15.0 fps
4.1	335	0.0750	1.37		**Shallow Concentrated Flow, E-F** Woodland Kv= 5.0 fps
16.2	1,055	Total			

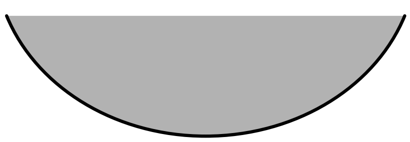
Summary for Reach 6R: Stream

Inflow Area = 495,900 sf, 14.24% Impervious, Inflow Depth > 3.19" for 100 Yr event
Inflow = 31.12 cfs @ 12.22 hrs, Volume= 131,940 cf
Outflow = 31.05 cfs @ 12.25 hrs, Volume= 131,858 cf, Atten= 0%, Lag= 1.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.19 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 3.53 fps, Avg. Travel Time= 1.4 min

Peak Storage= 1,137 cf @ 12.24 hrs
Average Depth at Peak Storage= 1.42'
Bank-Full Depth= 1.00' Flow Area= 2.3 sf, Capacity= 16.68 cfs

3.50' x 1.00' deep Parabolic Channel, n= 0.040 Winding stream, pools & shoals
Length= 300.0' Slope= 0.0800 '/'
Inlet Invert= 298.00', Outlet Invert= 274.00'



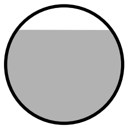
Summary for Reach 7R: Culvert

Inflow Area = 495,900 sf, 14.24% Impervious, Inflow Depth > 3.19" for 100 Yr event
Inflow = 31.05 cfs @ 12.25 hrs, Volume= 131,858 cf
Outflow = 31.04 cfs @ 12.25 hrs, Volume= 131,850 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.64 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 9.14 fps, Avg. Travel Time= 0.1 min

Peak Storage= 105 cf @ 12.25 hrs
Average Depth at Peak Storage= 1.19'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 32.01 cfs

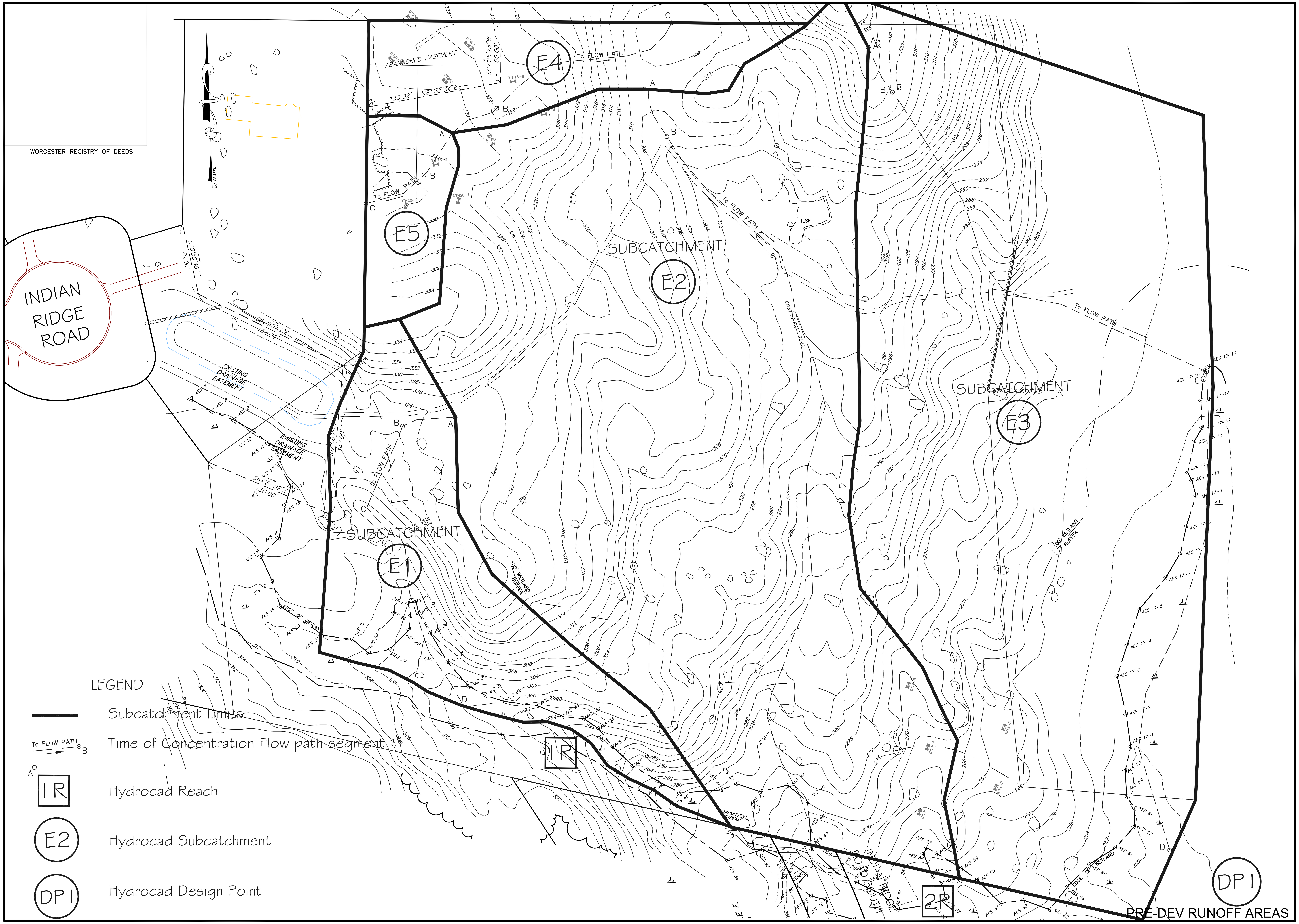
18.0" Round Pipe
n= 0.013
Length= 70.0' Slope= 0.0929 '/'
Inlet Invert= 267.50', Outlet Invert= 261.00'



APPENDIX – G

Supplemental Stormwater Plans

Pre-Development Subcatchment Areas
Post-Development Subcatchment Areas
Hydraulic Subcatchment Areas



REVISIONS

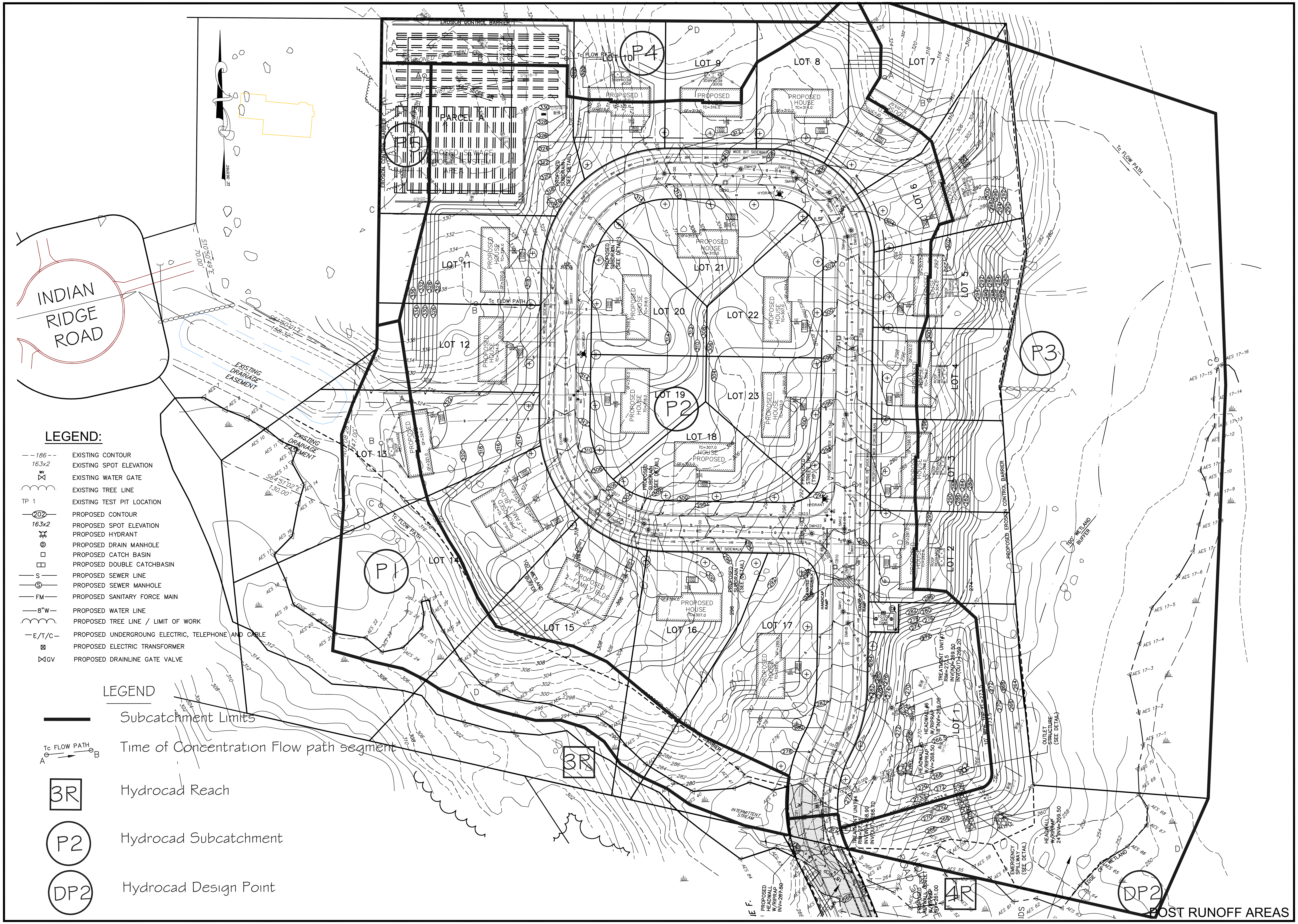
No.	DATE	DESCRIPTION
1	07/10/20	REVISED PER ZBA REVIEW COMMENTS

SITE DEVELOPMENT PLAN OF LAND
A 40B Comprehensive Permit Project
"GEOFFREY PARK"
HOLLISTON, MASSACHUSETTS

PREPARED FOR:
INDIAN RIDGE REALTY TRUST
223 COURTLAND STREET
HOLLISTON, MA 01746

GLM Engineering Consultants, Inc.
19 EXCHANGE STREET
HOLLISTON, MA 01746
P: 508-429-1100
F: 508-429-7160
www.GLMengineering.com

JOB No.	16,181
DATE:	FEB. 29, 2020
SCALE:	1"=40'
SHEET:	1 of 3
PLAN #:	27,337



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JOB No.	16,181
DATE:	FEB. 29, 2020
SCALE:	1"=40'
SHEET:	2 of 3
PLAN #:	27,337

LEGEND:

186	EXISTING CONTOUR
163x2	EXISTING SPOT ELEVATION
	EXISTING WATER GATE
	EXISTING TREE LINE
TP 1	EXISTING TEST PIT LOCATION
202	PROPOSED CONTOUR
163x2	PROPOSED SPOT ELEVATION
	PROPOSED HYDRANT
	PROPOSED DRAIN MANHOLE
	PROPOSED CATCH BASIN
	PROPOSED DOUBLE CATCHBASIN
S	PROPOSED SEWER LINE
S	PROPOSED SEWER MANHOLE
FM	PROPOSED SANITARY FORCE MAIN
8"W	PROPOSED WATER LINE
	PROPOSED TREE LINE / LIMIT OF WORK
E/T/C	PROPOSED UNDERGROUNG ELECTRIC, TELEPHONE AND CABLE
	PROPOSED ELECTRIC TRANSFORMER
GV	PROPOSED DRAINLINE GATE VALVE

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DATE: FEB. 29, 2020
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SHEET: 3 of 3
PLAN #: 27,337

REVISIONS

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1	07/10/20	REVISED PER ZBA REVIEW COMMENTS