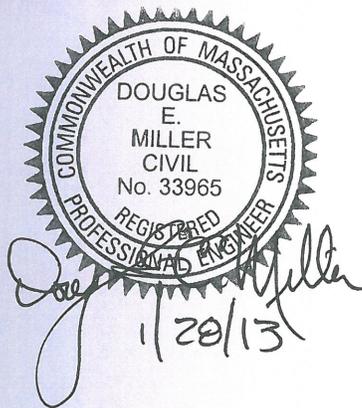


# Stormwater Management Report

**Acton Crossroads  
321 Main Street  
Acton, MA**

**January 2013**

**Submitted to:  
Acton Board of Selectmen and  
Conservation Commission  
Acton Town Hall  
472 Main Street  
Acton, MA 01720**



**Submitted by:  
Acton Crossroads, Inc.  
321 Main Street  
Acton, MA 01720**

**Prepared by:  
Goldsmith, Prest & Ringwall, Inc.  
39 Main Street, Suite 301  
Ayer, MA 01432**

**Project No:  
121072**



# Table of Contents

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<b>Section</b>	<b>Title</b>
<b>1</b>	<b>Introduction and Methodology</b>
<b>2</b>	<b>Hydrology Summary for 24-hour Storm</b>
<b>3</b>	<b>Mass DEP Stormwater Management Report Checklist</b>
<b>4</b>	<b>Appendix</b>
	Mapped Soil Survey Overlay
	Flood Insurance Rate Map - Map No. 25017C0352E
	Pre-Development Watershed Map - Existing Conditions Watershed Computations
	Post-Development Watershed Map - Developed Conditions Watershed Computations Stormwater Quality Computations Groundwater Recharge Infiltrating BMP Drawdown Time Infiltrating BMP Mounding Analysis Water Quality Retention Volume TSS Removal

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**Attachments**

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"Permit Plan, Acton Crossroads, 321 Main Street, Acton, MA" plan set (24"x36")

Long-Term Pollution Prevention Plan by GPR Inc, Dated January 2013

## **Section 1**

### **Introduction and Methodology**

## Introduction and Methodology

This Stormwater Management Report is intended to accompany plans for the proposed parking expansion at the Acton Medical Associates location at 321 Main Street, Acton, MA. Included in this report are calculations that support a final engineering design as required by the state's Wetlands Protection Act Regulations and the Town of Acton's ordinances and regulations. Site specific information is presented under two scenarios, "pre-development" and "post-development" conditions, so that potential impacts due to the project can be identified, quantified and, as necessary, mitigated.

The final design intent seeks to meet the following interrelated goals:

1. Limit stormwater runoff rates for the 2- and 10-year storm events to existing (pre-development) levels;
2. Evaluate potential on- and off-site flooding during the 100-year storm event due to proposed development;
3. Maintain or increase the volume of stormwater recharged per storm event to those of existing (pre-development) levels;
4. Prevent appreciable sediment and other suspended solids and contaminants transport by trapping them on site via Best Management Practices;
5. Provide adequate drainage for new surfaces;
6. Maintain existing drainage patterns while providing a cost-effective engineering solution that addresses regulatory as well as real-world constraints.

## Site Description

The proposed development is located at 321 Main Street, Acton, MA, nestled in the southwest corner of the intersection of Route 2 and Route 27 (Main Street), at exit interchange number 42. The project area consists of three parcels that contain the medical office building and parking areas, covering the majority of the property. The site generally slopes from its high point along Main Street, downward to the rear of the property to a wetland area in a stepped fashion. Grades within parking areas themselves are relatively flat, ranging between 2 and 3.5 percent. Landscape areas and the grades of the access driveway on the southern side of the building are much more sharply sloped with the paved areas averaging 8.5 percent and landscape areas sloped at a ratio averaging 2.5 feet vertical to 1 foot horizontal.

The total site area is 3.6± acres, with mapped soils consisting of a mix of Narragansett silt loam and the Udorthents-Urban land complex. The Narragansett soils are typically associated with hydraulic soil group B and no group designation being paired with the Udorthents-Urban complex

areas. Onsite soil evaluations done during pervious subsurface sewage designs available from the Acton Board of Health record files dating between 1971 and 1984, show the parent soil to be “rocky silty sandy gravel” and “packed sandy gravel and clay”. These soil descriptions, along with other listed characteristics in the logs, would most commonly be referred to as a cemented sandy loam by today’s current classification standards, which is also consistent with the mapped hydraulic soil group B designation.

Under the pre-development scenario, the site has been divided into 2 subcatchments, as shown on the plan entitled “WATERSHED MAP – EXISTING CONDITIONS”, included within the attached Appendix. These two subcatchments limit the watershed under study to the grass field area located east of the existing building, situated between the front and rear parking areas, where the proposed parking area will be located. The majority of this area is currently maintained grasses with mature trees, scrub growth and forest litter on the slope extending downward from the front parking area and extending to and along the property line to the east. A portion of the existing parking spaces in the eastern most portion of the rear parking area are also included, contributing to the total 27,538± square foot watershed being evaluated. The two subcatchments both outline runoff originating in the grass meadow area but subcatchment SC2 outlines runoff which flows directly into the wetland system and subcatchment SC1 describes flow onto the existing paved parking area. This runoff enters the current site’s drainage system via a double grated catch basin and ultimately discharging into the wetland system in the rear of the property.

### Project Description

The proposed development will include the construction of a paved parking area, concrete stairs along the existing building and associated grading on the eastern side of the existing building. The parking area will consist of 23 new parking spaces (10 of which are “double spaces”) that will be accessed from the lower parking area in the rear of the building. A total of 3 existing parking spaces and the dumpster / trash bin fenced area will be removed to provide access to the new parking spaces. The dumpster / trash bin enclosure, currently within the wetland areas buffer zone, will be reconstructed in the western corner of the project site, approximately 200± feet from the wetland edge. To accommodate stormwater runoff generated from the proposed pavement areas, the parking area has been designed to direct sheet flow into a bioretention area along the eastern property line.

Under the post-development scenario, the site has been divided into two drainage subcatchments, shown on the plan entitled “WATERSHED MAP – DEVELOPED CONDITIONS”, included in the attached Appendix. Stormwater runoff generated within the grass area between the proposed parking area and the existing building and the area of existing parking included within the watershed under study, is outlined within subcatchment SC1 which flows over the existing parking spaces to the south. This runoff enters the current site’s drainage system via a double grated catch basin and ultimately discharging into the wetland system in the rear of the property. No new Best Management Practice (BMP) is proposed within this existing drainage flow path. The impervious coverage within this subcatchment has been reduced by 415± sf from pre-developed conditions, qualifying it as a redevelopment area per the Mass Stormwater Handbook. Subcatchment SC2 describes surface runoff originating within the new parking area. This surface runoff will be directed into the proposed bioretention area prior to discharging to the wetland

system.

### Hydrologic and Hydraulic Computation Methodology

Runoff rates were computed using the Soil Conservation Service TR-20 Method entitled “Urban Hydrology for Small Watersheds”. The following 24-hour rainfall events were analyzed:

Frequency (years): 2, 10, and 100

Runoff from the site has been analyzed at one point under both the pre-development and post-development conditions. The PRE analysis point represents runoff to the wetland system under current pre-development conditions, while the POST analysis point reflects the same flows under the proposed conditions.

### **Summary of Results**

Peak discharge rates and volumes of the calculated runoff for both conditions analyzed are displayed in the HYDROLOGY SUMMARY that follows. As shown within the summary the discharge rates during the 2- and 10-year event under the developed conditions are equal to those of the pre-developed. A slight increase in discharge rate, less than 1 cfs, is expected during the 100-year event. Due to the lack of standing water and the sloping nature of the adjacent wetland system, coupled with the lack of existing flooding in the area, this increase will have little to no effect on the system nor increase flooding.

While pre-development runoff flow paths have been maintained, further review of the provided drainage model shows additional benefits to each evaluated discharge to the wetland system. Comparison of calculated runoff within the pre- and post-development SC1 subcatchment shows that discharge rates to the current site’s existing drainage system are equal or have been reduced under the developed condition. Further, while a similar review of expected runoff directly discharging to the wetland system (subcatchment SC2 in predevelopment conditions and pond BIO in post) he SC2 subcatchment, discharging directly into the wetland system, shows an increase in peak discharge for all storm events analyzed, this discharge has been “filtered” to a higher standard (90% TSS removal within the bioretention area) than that of the current site’s drainage system of old fashioned catch basin and detention basin system. Additionally, the bioretention area provides double the groundwater recharge over current conditions, providing 1,276± cubic feet of total recharge each storm event.

These design factors show that while a redistribution of calculated runoff to individual discharge points into the wetland is shown, the total discharge to the wetland is equal to existing conditions while being “cleaner” through a higher TSS removal and increasing the sites groundwater recharge volume.

## **Stormwater Quality**

The development meets the MADEP Stormwater Management Standards through the employment of Best Management Practices that address groundwater recharge, water quality (first flush) retention, and suspended solids removal within sustainable BMP's. See Appendix for computed solids quantities / removal process trains, and water quality runoff volumes.

## **Section 2**

### **Hydrology Summary for 24-hour Storm**

# HYDROLOGY SUMMARY FOR 24-HOUR STORM

Acton Crossroads, Inc.  
321 Main Street  
Project No. 121072

## PEAK DISCHARGE RATE

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### Pre-Development (cfs)

Analysis Point	2-YR	10-YR	100-YR
PRE	0.4	1.0	2.1

### Development (cfs)

Analysis Point	2-YR	10-YR	100-YR
POST	0.4	1.0	2.9

### Pre-Development vs. Developed (cfs)

Analysis Point	2-YR	10-YR	100-YR
PRE vs POST	<b>0.0</b>	<b>0.0</b>	<b>0.8</b>

## PEAK DISCHARGE VOLUME

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### Pre-Development (Cubic feet)

Analysis Point	2-YR	10-YR	100-YR
PRE	1,586	3,409	6,592

### Development (cubic feet)

Analysis Point	2-YR	10-YR	100-YR
POST	1,268	3,518	7,233

### Pre-Development vs. Developed (cubic feet)

Analysis Point	2-YR	10-YR	100-YR
PRE vs POST	<b>-318</b>	<b>109</b>	<b>641</b>

## **Section 3**

### **Mass DEP Stormwater Management Report Checklist**



# 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.

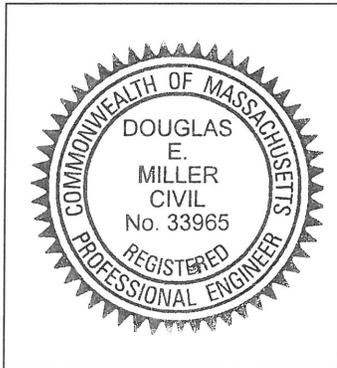
*Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that 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



*Douglas E. Miller* 1/28/13  
Signature and Date

### Checklist

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

- New development
- Redevelopment
- Mix of New Development and Redevelopment



# Checklist for Stormwater Report

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## Checklist (continued)

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

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

### Standard 1: No New Untreated Discharges

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



# Checklist for Stormwater Report

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## 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<sup>1</sup>
- 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.

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<sup>1</sup> 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



# Checklist for Stormwater Report

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## Checklist (continued)

### Standard 3: Recharge (continued)

- The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

### Standard 4: Water Quality

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

- Good housekeeping practices;
  - Provisions for storing materials and waste products inside or under cover;
  - Vehicle washing controls;
  - Requirements for routine inspections and maintenance of stormwater BMPs;
  - Spill prevention and response plans;
  - Provisions for maintenance of lawns, gardens, and other landscaped areas;
  - Requirements for storage and use of fertilizers, herbicides, and pesticides;
  - Pet waste management provisions;
  - Provisions for operation and management of septic systems;
  - Provisions for solid waste management;
  - Snow disposal and plowing plans relative to Wetland Resource Areas;
  - Winter Road Salt and/or Sand Use and Storage restrictions;
  - Street sweeping schedules;
  - Provisions for prevention of illicit discharges to the stormwater management system;
  - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
  - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
  - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
  - Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
    - is within the Zone II or Interim Wellhead Protection Area
    - is near or to other critical areas
    - is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
    - involves runoff from land uses with higher potential pollutant loads.
  - The Required Water Quality Volume is reduced through use of the LID site Design Credits.
  - Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.



# Checklist for Stormwater Report

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## Checklist (continued)

### Standard 4: Water Quality (continued)

- The BMP is sized (and calculations provided) based on:
  - The ½" or 1" Water Quality Volume or
  - The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

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

- The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted **prior to** the discharge of stormwater to the post-construction stormwater BMPs.
- The NPDES Multi-Sector General Permit does **not** cover the land use.
- LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- All exposure has been eliminated.
- All exposure has **not** been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

### Standard 6: Critical Areas

- The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- Critical areas and BMPs are identified in the Stormwater Report.



# Checklist for Stormwater Report

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## Checklist (continued)

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

- The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
  - Limited Project
  - Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
  - Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
  - Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
  - Bike Path and/or Foot Path
  - Redevelopment Project
  - Redevelopment portion of mix of new and redevelopment.
- Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

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

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

- Narrative;
  - Construction Period Operation and Maintenance Plan;
  - Names of Persons or Entity Responsible for Plan Compliance;
  - Construction Period Pollution Prevention Measures;
  - Erosion and Sedimentation Control Plan Drawings;
  - Detail drawings and specifications for erosion control BMPs, including sizing calculations;
  - Vegetation Planning;
  - Site Development Plan;
  - Construction Sequencing Plan;
  - Sequencing of Erosion and Sedimentation Controls;
  - Operation and Maintenance of Erosion and Sedimentation Controls;
  - Inspection Schedule;
  - Maintenance Schedule;
  - Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



# Checklist for Stormwater Report

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## 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.

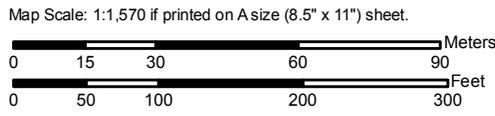
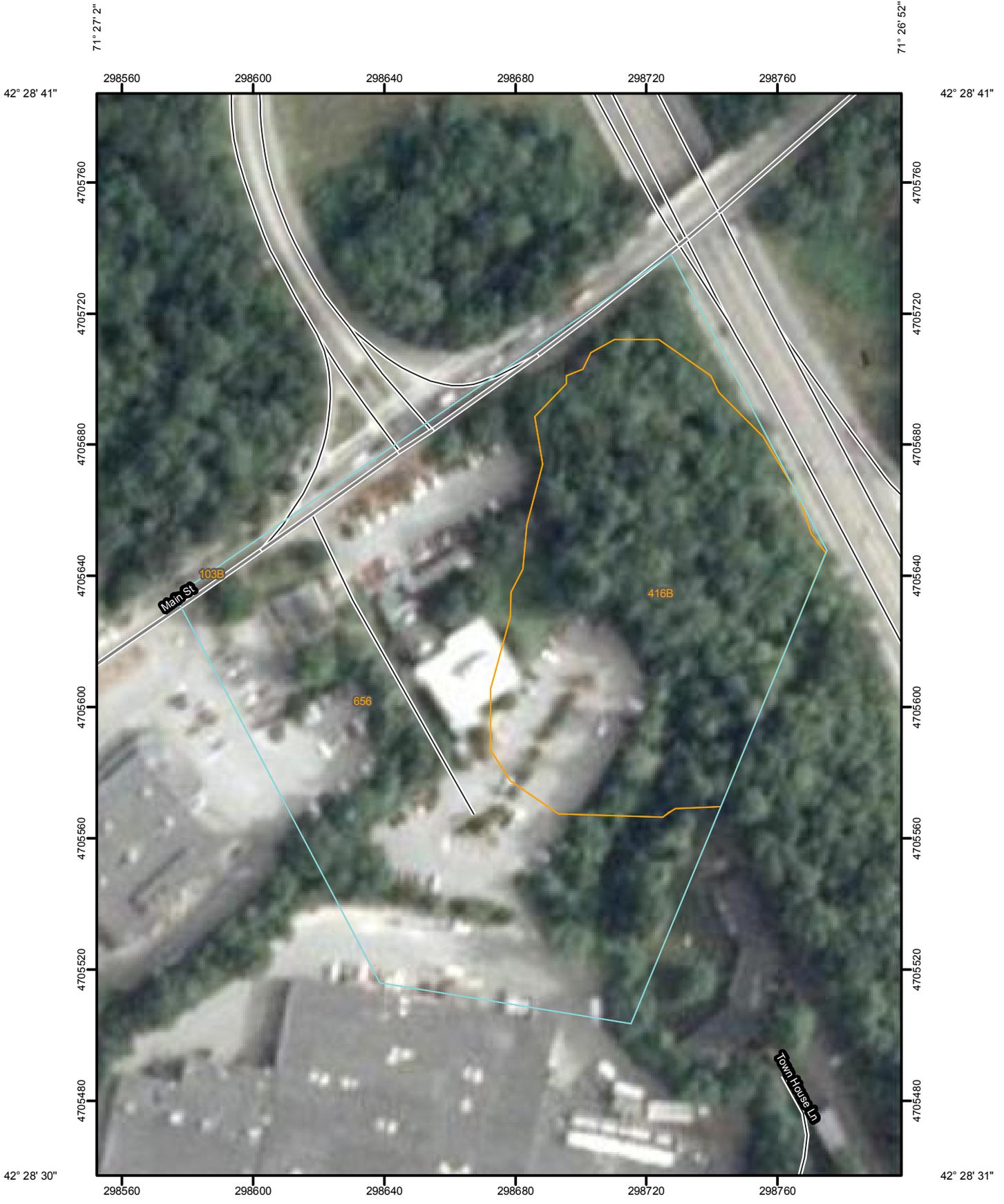
### Standard 10: Prohibition of Illicit Discharges

- 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.

## **Section 4**

### **Appendix**

Soil Map—Middlesex County, Massachusetts  
(121072 - Acton Crossroads)



## MAP LEGEND

 Area of Interest (AOI)	 Very Stony Spot
 Soils	 Wet Spot
 Area of Interest (AOI)	 Other
 Soil Map Units	<b>Special Line Features</b>
<b>Special Point Features</b>	 Gully
 Blowout	 Short Steep Slope
 Borrow Pit	 Other
 Clay Spot	<b>Political Features</b>
 Closed Depression	 Cities
 Gravel Pit	<b>Water Features</b>
 Gravelly Spot	 Streams and Canals
 Landfill	<b>Transportation</b>
 Lava Flow	 Rails
 Marsh or swamp	 Interstate Highways
 Mine or Quarry	 US Routes
 Miscellaneous Water	 Major Roads
 Perennial Water	 Local Roads
 Rock Outcrop	
 Saline Spot	
 Sandy Spot	
 Severely Eroded Spot	
 Sinkhole	
 Slide or Slip	
 Sodic Spot	
 Spoil Area	
 Stony Spot	

## MAP INFORMATION

Map Scale: 1:1,570 if printed on A size (8.5" x 11") sheet.  
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 accurate map measurements.

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

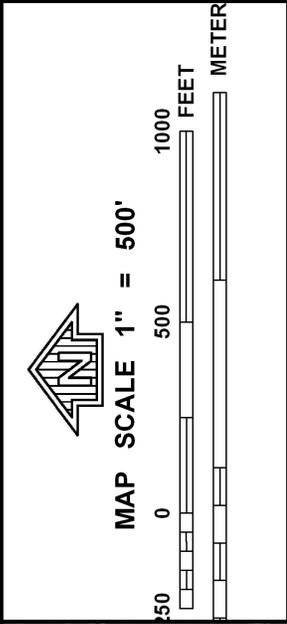
This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts  
Survey Area Data: Version 12, Feb 26, 2010  
Date(s) aerial images were photographed: 7/28/2003

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

## Map Unit Legend

Middlesex County, Massachusetts (MA017)				Hydrologic Soil Group (HSG)
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI	
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	0.0	0.0%	B
416B	Narragansett silt loam, 3 to 8 percent slopes, very stony	2.6	38.8%	B
656	Udorthents-Urban land complex	4.1	61.2%	---
<b>Totals for Area of Interest</b>		<b>6.8</b>	<b>100.0%</b>	



**NFIP** NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0352E

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

**PANEL 352 OF 656**  
 (SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:  
 COMMUNITY NUMBER 250176  
 ACTON, TOWN OF PREFIX 0352 E

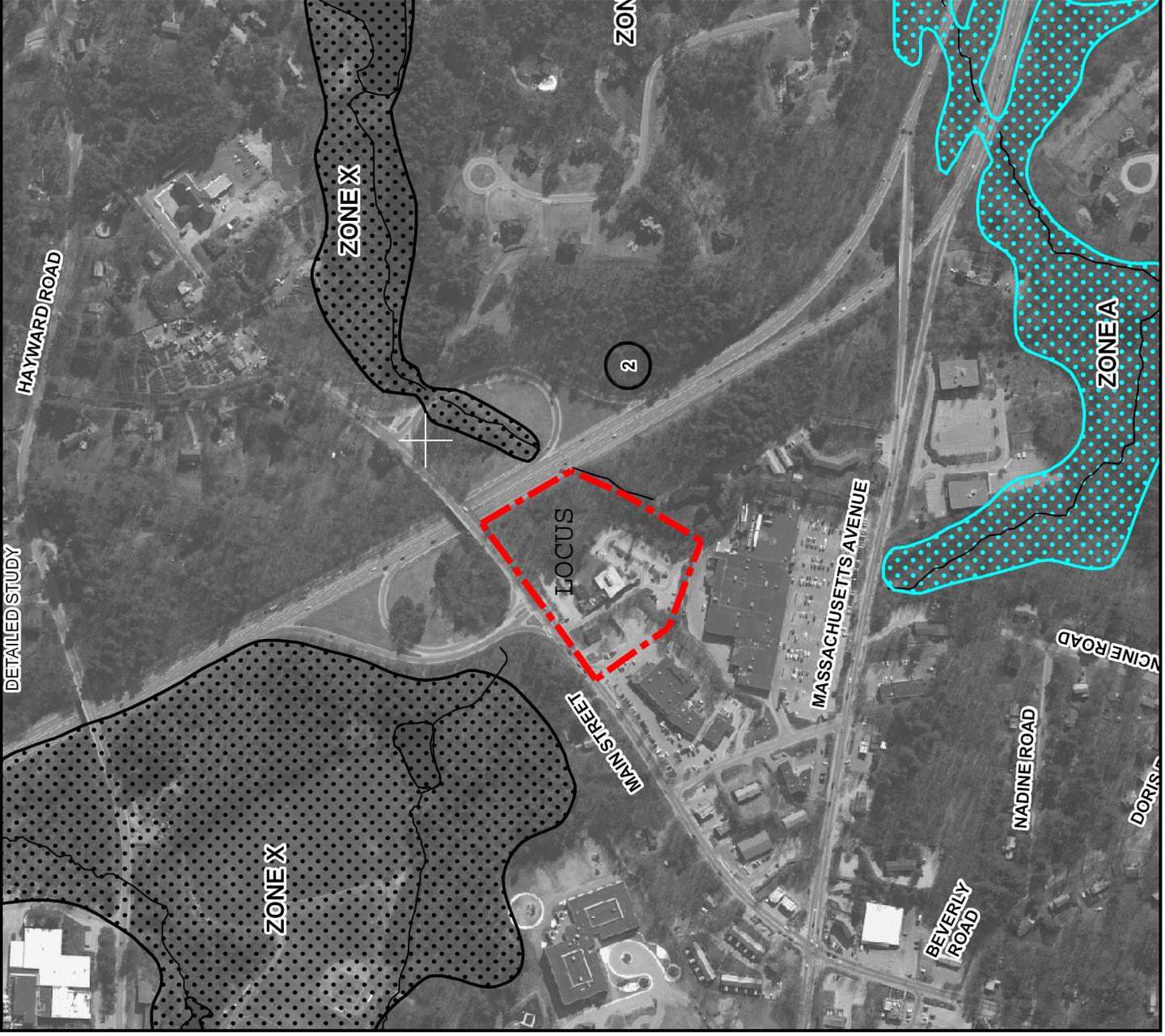
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

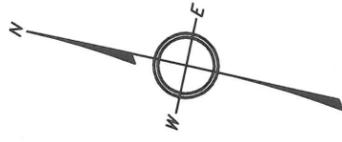
**MAP NUMBER**  
 25017C0352E

**EFFECTIVE DATE**  
 JUNE 4, 2010

  
 Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps, check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)

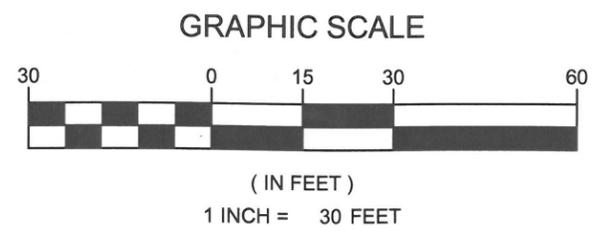




**ROUTE 2**  
SHEETS 9 & 10 OF LAYOUT No. 3713  
ACTON - 1950 - 500' WIDTH

**LEGEND:**

-  SUBCATCHMENT LIMIT
-  SUBCATCHMENT LABEL
-  TIME OF CONCENTRATION
-  DRAINAGE ANALYSIS POINT



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PREPARED FOR:  
ACTON CROSSROAD, INC.  
321 MAIN STREET  
ACTON, MA 01720

DES'D BY: NMP      CHK'D BY: BDR

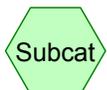
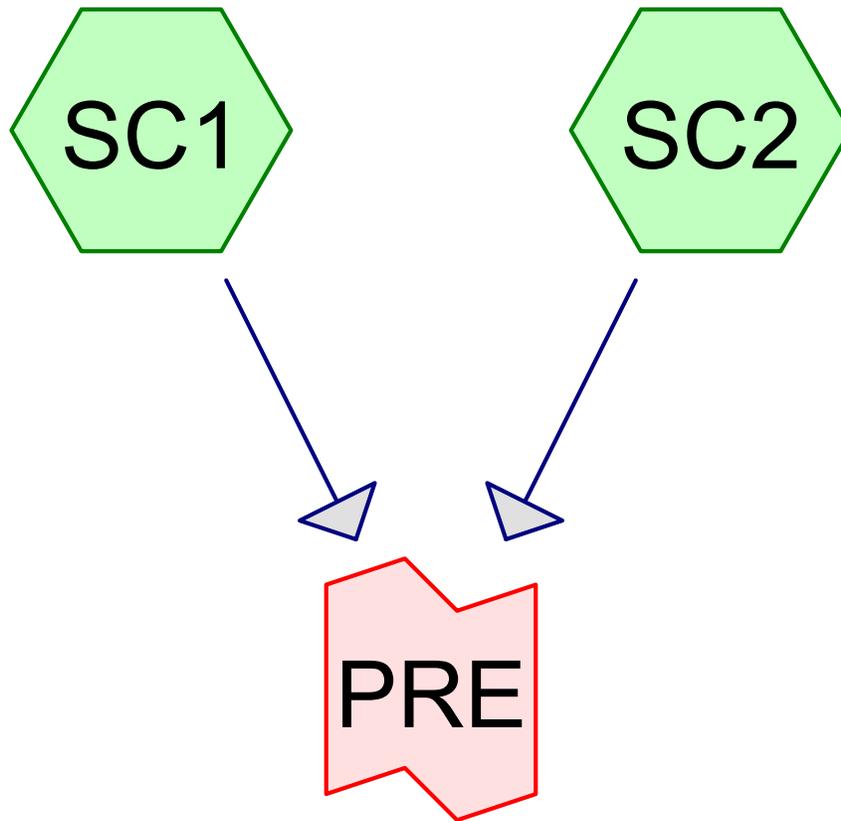
DATE: JANUARY 2013

**WATERSHED MAP  
EXISTING CONDITIONS**

321 MAIN STREET  
ACTON, MA 01720

PROJECT: 121072      PRE

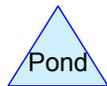
# Pre-Development



Subcat



Reach



Pond



Link

**Routing Diagram for Stormwater Management**  
Prepared by Goldsmith, Prest & Ringwall, Inc., Printed 12/14/2012  
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**Stormwater Management**

Prepared by Goldsmith, Prest &amp; Ringwall, Inc.

Printed 12/14/2012

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Page 2

**Area Listing (selected nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
0.330	61	>75% Grass cover, Good, HSG B (SC1, SC2)
0.161	48	Brush, Good, HSG B (SC2)
0.015	98	Other Impervious Surfaces, HSG B (SC1, SC2)
0.126	98	Paved parking, HSG B (SC1)

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121072 - Acton Crossroads

Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 3

## Summary for Subcatchment SC1:

flow continues in parking area prior to entering existing double grated catch basin and drainage system before outleting into wetland

Runoff = 0.4 cfs @ 12.08 hrs, Volume= 1,320 cf, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2-yr Event Rainfall=3.10"

Area (sf)	CN	Description
5,503	98	Paved parking, HSG B
* 587	98	Other Impervious Surfaces, HSG B
7,107	61	>75% Grass cover, Good, HSG B
13,197	78	Weighted Average
7,107		53.85% Pervious Area
6,090		46.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.23		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
0.8	69	0.0479	1.53		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.5	86	0.0228	3.07		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
4.9	205	Total			

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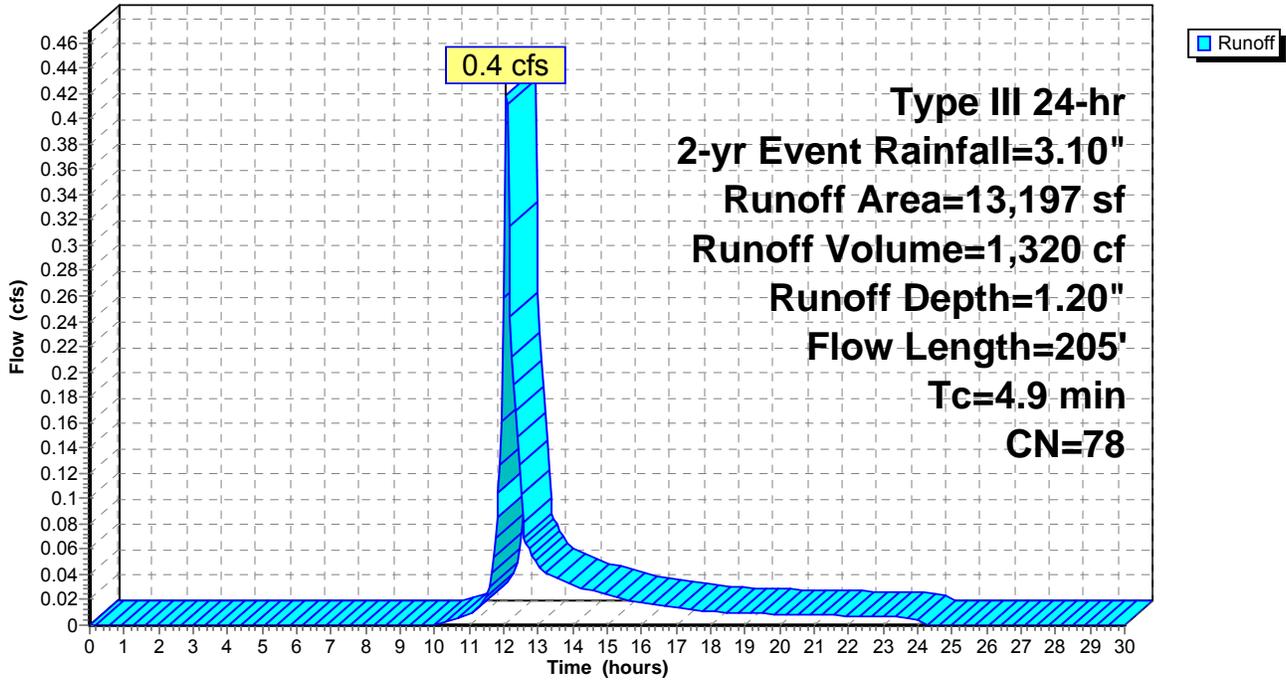
Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 4

## Subcatchment SC1:

Hydrograph



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Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 5

## Summary for Subcatchment SC2:

direct flow to wetland area

Runoff = 0.0 cfs @ 12.33 hrs, Volume= 265 cf, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2-yr Event Rainfall=3.10"

Area (sf)	CN	Description
* 57	98	Other Impervious Surfaces, HSG B
7,256	61	>75% Grass cover, Good, HSG B
7,028	48	Brush, Good, HSG B
14,341	55	Weighted Average
14,284		99.60% Pervious Area
57		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.2286	0.27		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
1.2	121	0.0533	1.62		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.4	50	0.1378	1.86		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
4.7	221	Total			

# Stormwater Management

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121072 - Acton Crossroads

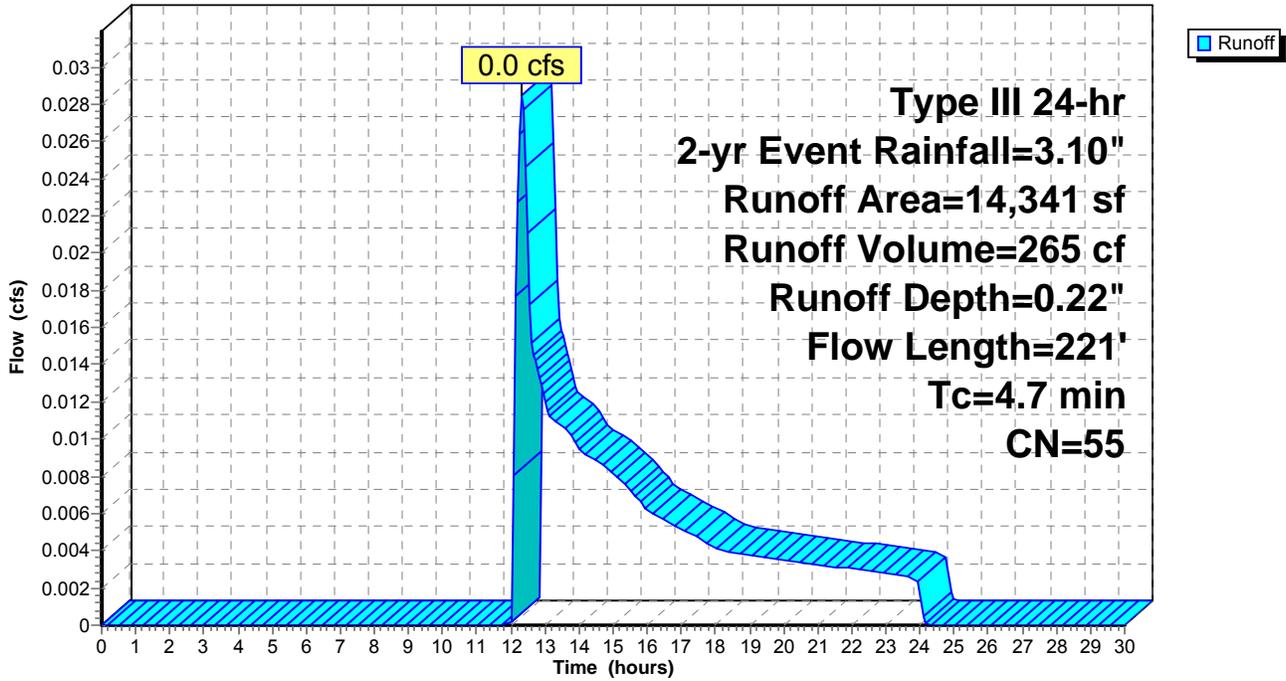
Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 6

## Subcatchment SC2:

Hydrograph



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Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 7

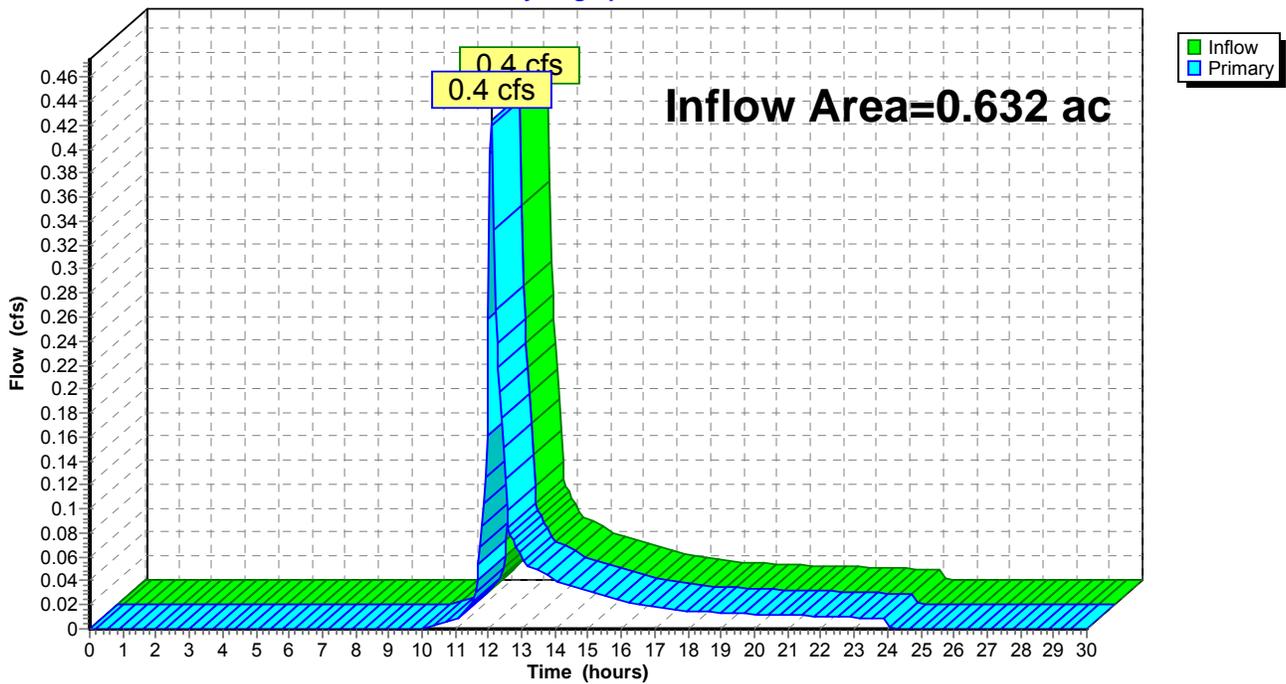
## Summary for Link PRE:

Inflow Area = 0.632 ac, 22.32% Impervious, Inflow Depth = 0.69" for 2-yr Event event  
Inflow = 0.4 cfs @ 12.09 hrs, Volume= 1,586 cf  
Primary = 0.4 cfs @ 12.09 hrs, Volume= 1,586 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

### Link PRE:

Hydrograph



# Stormwater Management

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121072 - Acton Crossroads

Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 8

## Summary for Subcatchment SC1:

flow continues in parking area prior to entering existing double grated catch basin and drainage system before outleting into wetland

Runoff = 0.8 cfs @ 12.08 hrs, Volume= 2,522 cf, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10-yr Event Rainfall=4.50"

Area (sf)	CN	Description
5,503	98	Paved parking, HSG B
* 587	98	Other Impervious Surfaces, HSG B
7,107	61	>75% Grass cover, Good, HSG B
13,197	78	Weighted Average
7,107		53.85% Pervious Area
6,090		46.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.23		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
0.8	69	0.0479	1.53		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.5	86	0.0228	3.07		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
4.9	205	Total			

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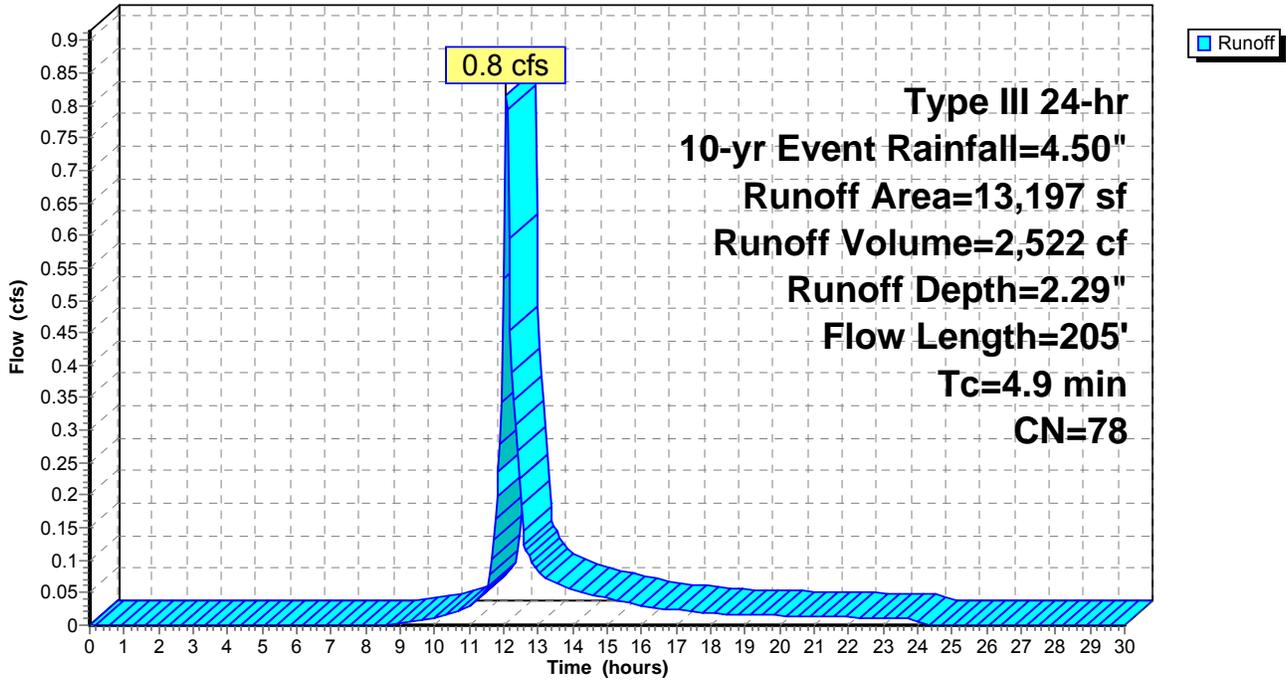
Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 9

## Subcatchment SC1:

Hydrograph



# Stormwater Management

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Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 10

## Summary for Subcatchment SC2:

direct flow to wetland area

Runoff = 0.2 cfs @ 12.10 hrs, Volume= 887 cf, Depth= 0.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10-yr Event Rainfall=4.50"

Area (sf)	CN	Description
* 57	98	Other Impervious Surfaces, HSG B
7,256	61	>75% Grass cover, Good, HSG B
7,028	48	Brush, Good, HSG B
14,341	55	Weighted Average
14,284		99.60% Pervious Area
57		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.2286	0.27		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
1.2	121	0.0533	1.62		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.4	50	0.1378	1.86		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
4.7	221	Total			

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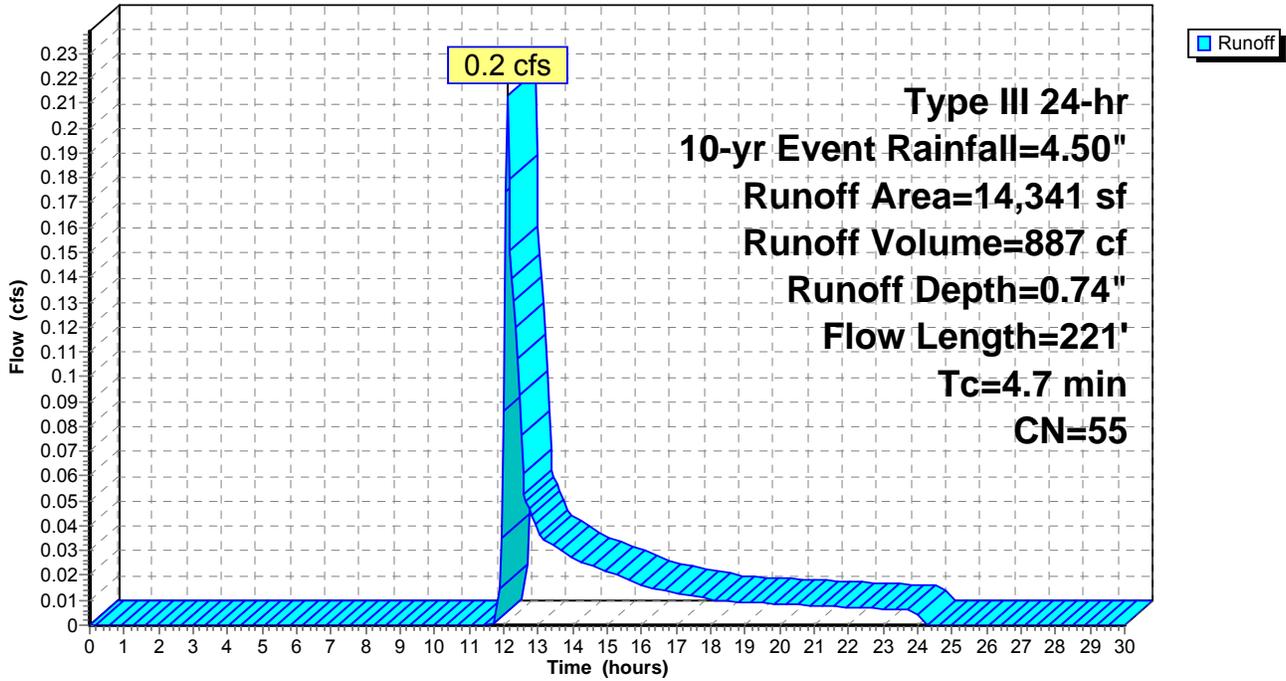
Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 11

## Subcatchment SC2:

Hydrograph



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Type III 24-hr 10-yr Event Rainfall=4.50"

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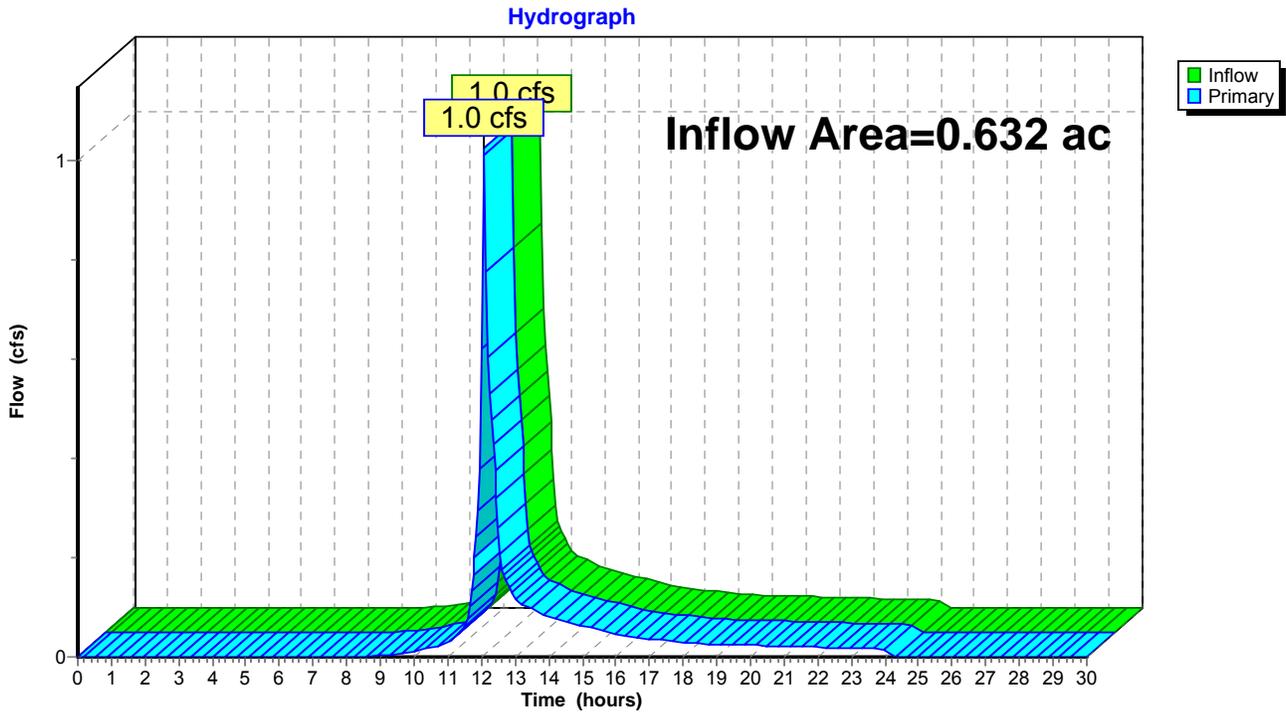
Page 12

## Summary for Link PRE:

Inflow Area = 0.632 ac, 22.32% Impervious, Inflow Depth = 1.49" for 10-yr Event event  
Inflow = 1.0 cfs @ 12.08 hrs, Volume= 3,409 cf  
Primary = 1.0 cfs @ 12.08 hrs, Volume= 3,409 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

### Link PRE:



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Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 13

## Summary for Subcatchment SC1:

flow continues in parking area prior to entering existing double grated catch basin and drainage system before outleting into wetland

Runoff = 1.4 cfs @ 12.07 hrs, Volume= 4,425 cf, Depth= 4.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100-yr Event Rainfall=6.50"

Area (sf)	CN	Description
5,503	98	Paved parking, HSG B
* 587	98	Other Impervious Surfaces, HSG B
7,107	61	>75% Grass cover, Good, HSG B
13,197	78	Weighted Average
7,107		53.85% Pervious Area
6,090		46.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.23		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
0.8	69	0.0479	1.53		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.5	86	0.0228	3.07		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
4.9	205	Total			

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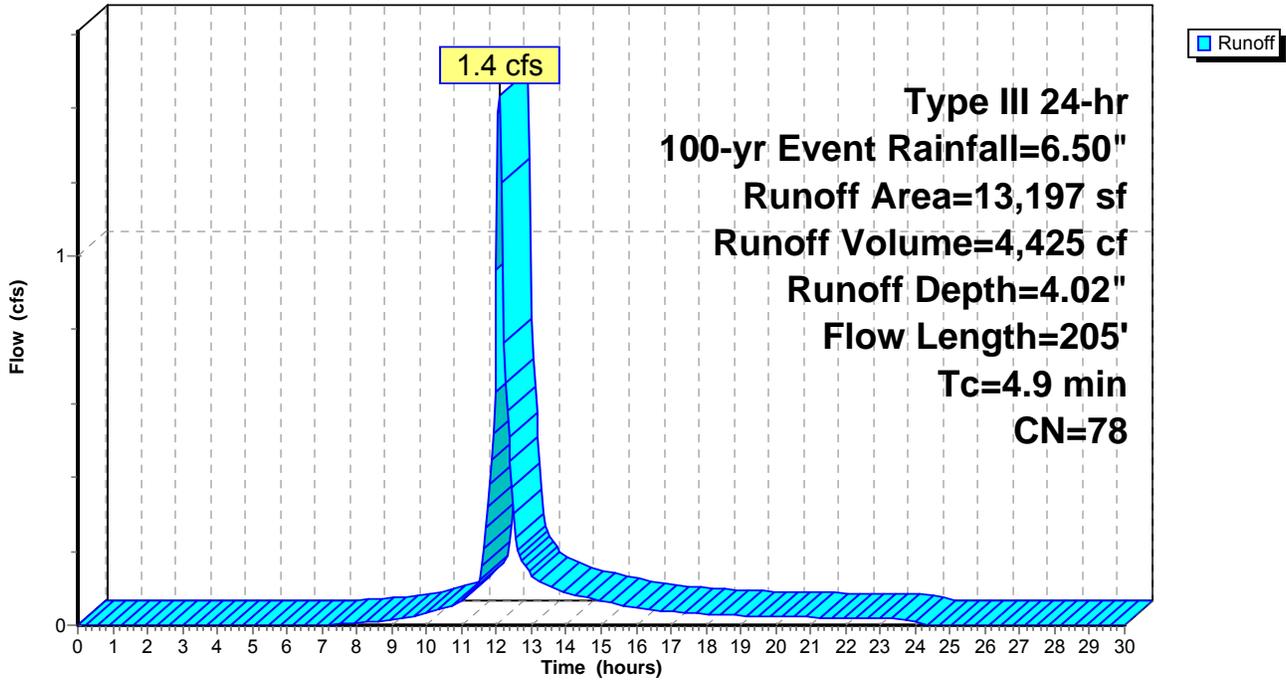
Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 14

**Subcatchment SC1:**

Hydrograph



# Stormwater Management

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Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 15

## Summary for Subcatchment SC2:

direct flow to wetland area

Runoff = 0.6 cfs @ 12.09 hrs, Volume= 2,167 cf, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100-yr Event Rainfall=6.50"

Area (sf)	CN	Description
* 57	98	Other Impervious Surfaces, HSG B
7,256	61	>75% Grass cover, Good, HSG B
7,028	48	Brush, Good, HSG B
14,341	55	Weighted Average
14,284		99.60% Pervious Area
57		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.2286	0.27		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
1.2	121	0.0533	1.62		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.4	50	0.1378	1.86		<b>Shallow Concentrated Flow,</b> Woodland Kv= 5.0 fps
4.7	221	Total			

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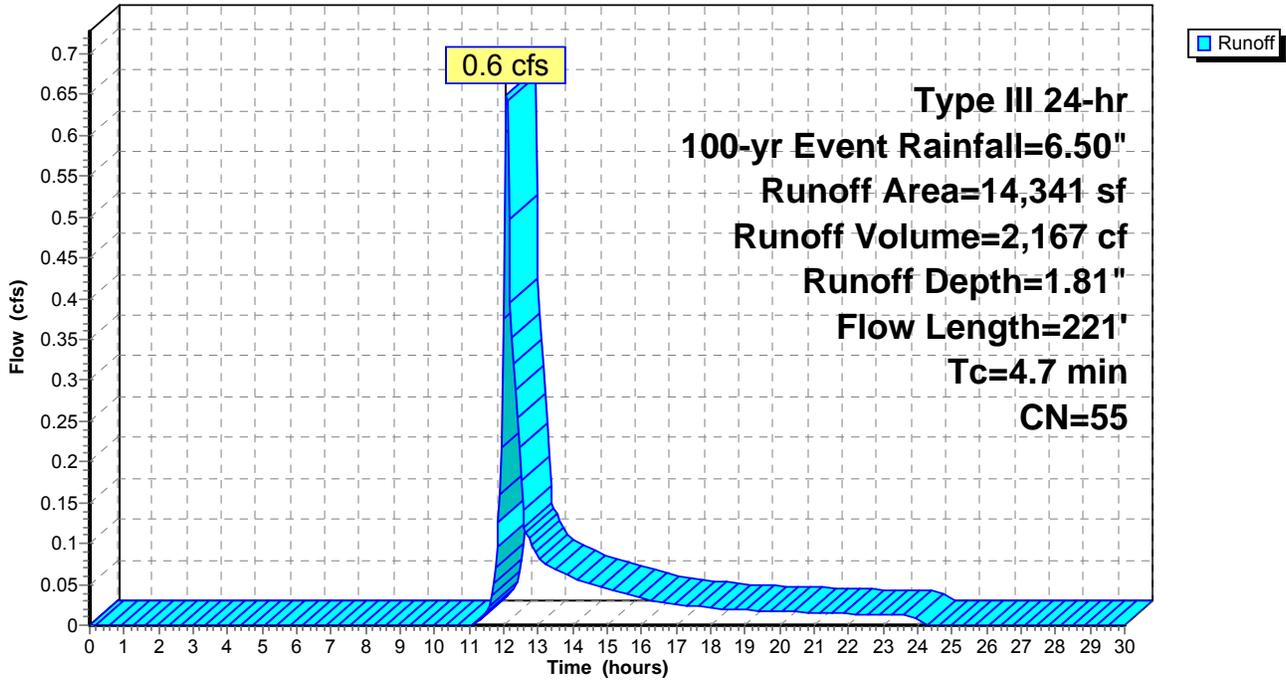
Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 16

**Subcatchment SC2:**

Hydrograph



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Type III 24-hr 100-yr Event Rainfall=6.50"

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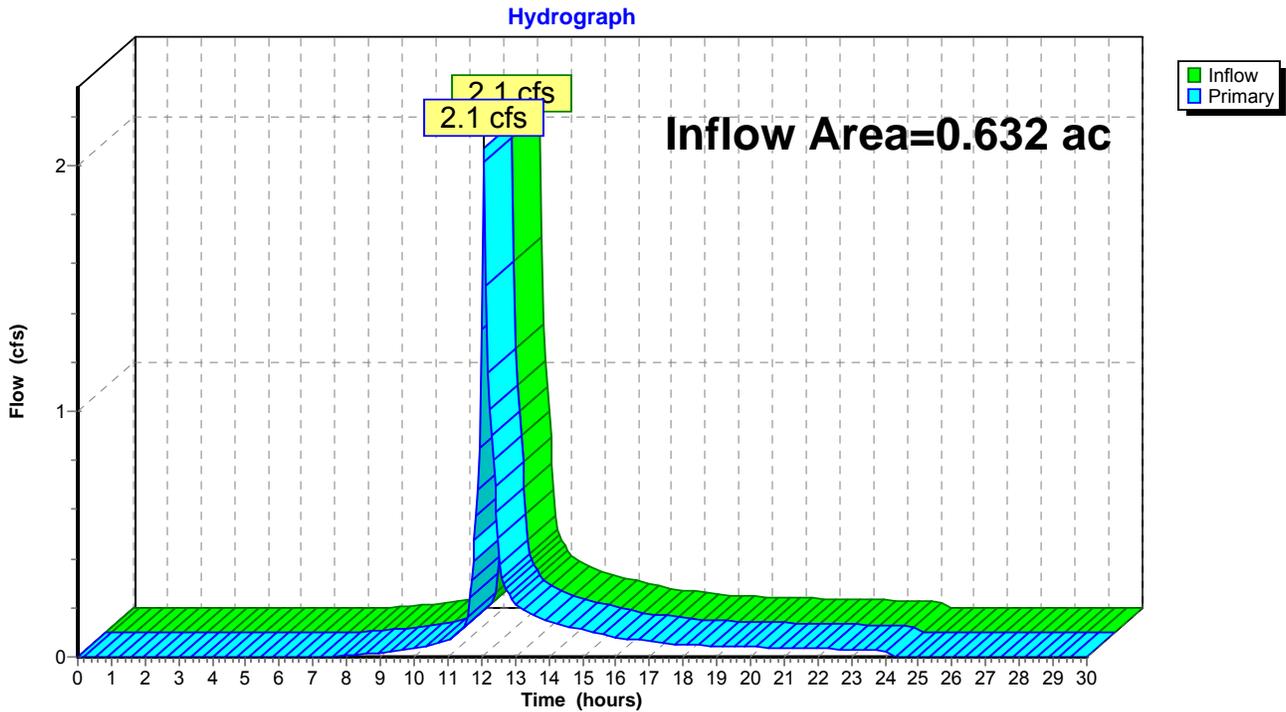
Page 17

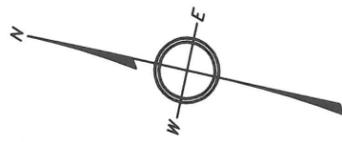
## Summary for Link PRE:

Inflow Area = 0.632 ac, 22.32% Impervious, Inflow Depth = 2.87" for 100-yr Event event  
Inflow = 2.1 cfs @ 12.08 hrs, Volume= 6,592 cf  
Primary = 2.1 cfs @ 12.08 hrs, Volume= 6,592 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

### Link PRE:

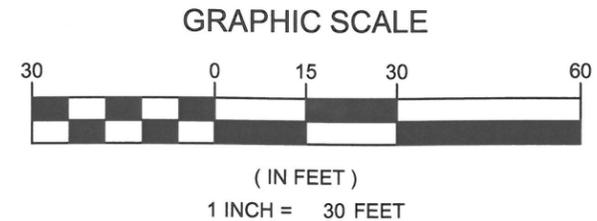




**ROUTE 2**  
SHEETS 9 & 10 OF LAYOUT No. 3713  
ACTON - 1990 - 500' WIDTH

**LEGEND:**

-  SUBCATCHMENT LIMIT
-  SUBCATCHMENT LABEL
-  TIME OF CONCENTRATION
-  DRAINAGE ANALYSIS POINT



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DES'D BY: NMP      CHK'D BY: BDR

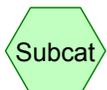
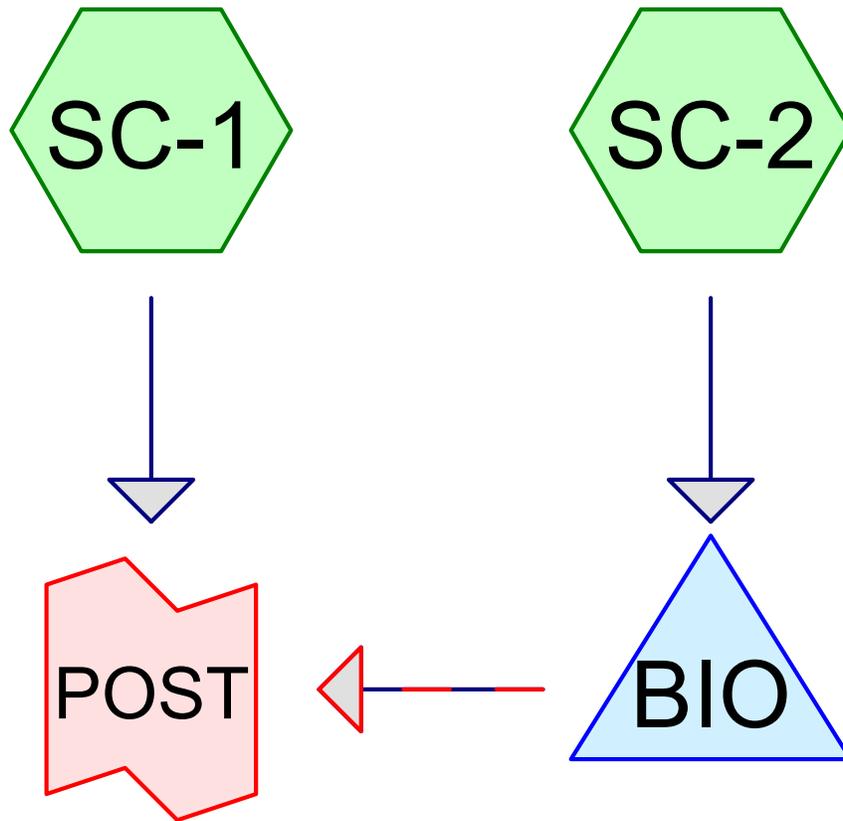
DATE: JANUARY 2013

**WATERSHED MAP  
DEVELOPED CONDITIONS**

321 MAIN STREET  
ACTON, MA 01720

PROJECT: 121072      POST

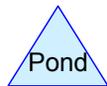
# Post development



Subcat



Reach



Pond



Link

**Stormwater Management**

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Page 2

**Area Listing (selected nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
0.248	61	>75% Grass cover, Good, HSG B (SC-1, SC-2)
0.055	48	Brush, Good, HSG B (SC-2)
0.020	98	Other Impervious Surfaces, HSG B (SC-1, SC-2)
0.309	98	Paved parking, HSG B (SC-1, SC-2)

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121072 - Acton Crossroads

Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 3

## Summary for Subcatchment SC-1:

Runoff = 0.4 cfs @ 12.08 hrs, Volume= 1,245 cf, Depth= 1.33"

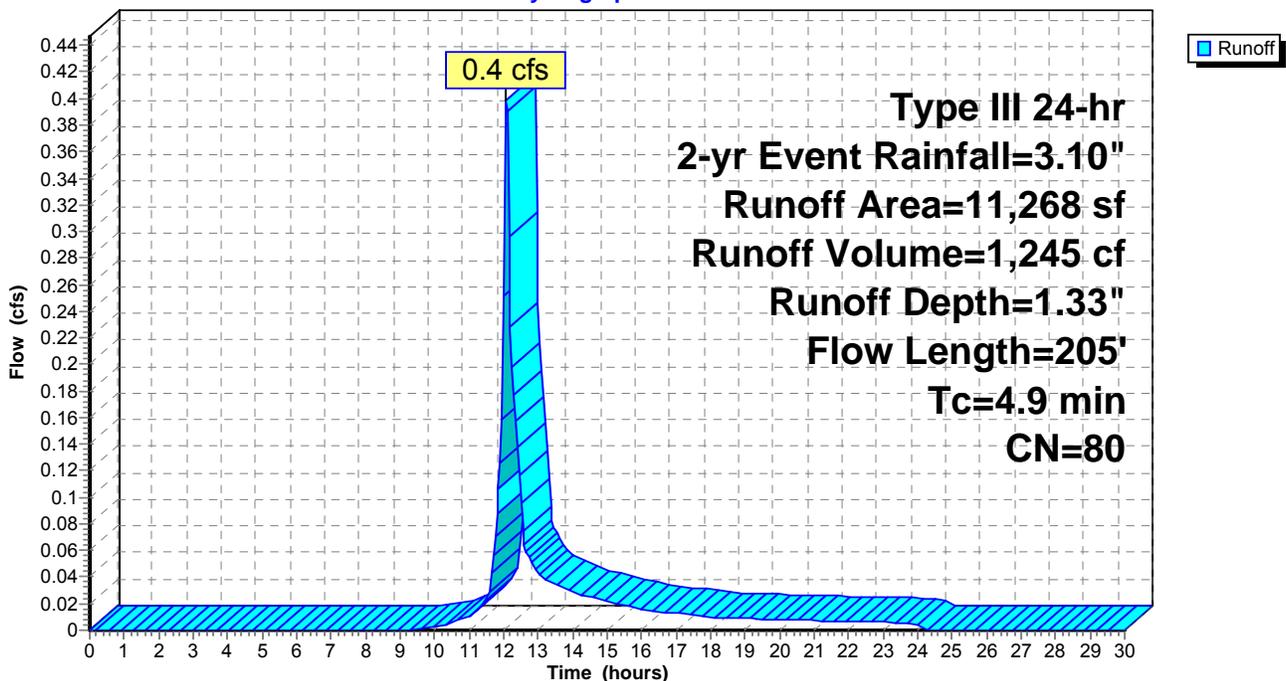
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2-yr Event Rainfall=3.10"

Area (sf)	CN	Description
5,561	98	Paved parking, HSG B
* 114	98	Other Impervious Surfaces, HSG B
5,593	61	>75% Grass cover, Good, HSG B
11,268	80	Weighted Average
5,593		49.64% Pervious Area
5,675		50.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.23		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
0.8	69	0.0479	1.53		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.5	86	0.0228	3.07		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
4.9	205	Total			

## Subcatchment SC-1:

Hydrograph



# Stormwater Management

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Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 4

## Summary for Subcatchment SC-2:

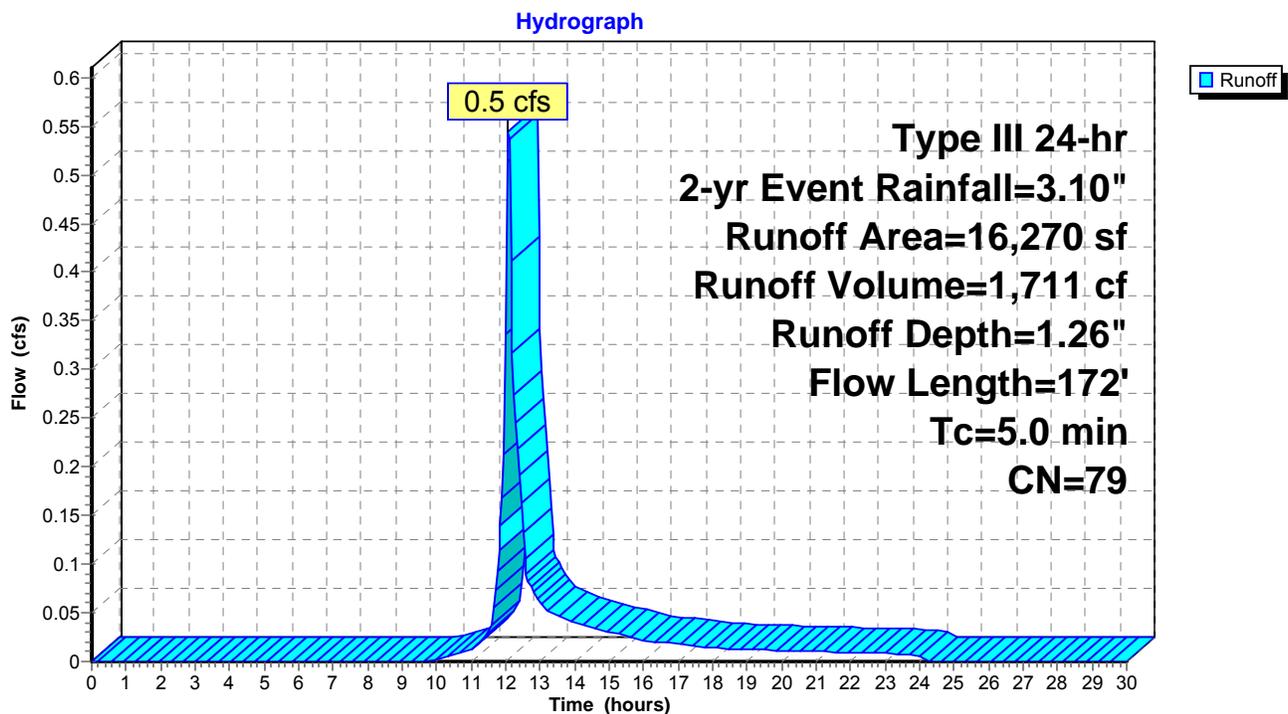
Runoff = 0.5 cfs @ 12.08 hrs, Volume= 1,711 cf, Depth= 1.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2-yr Event Rainfall=3.10"

Area (sf)	CN	Description
7,906	98	Paved parking, HSG B
* 778	98	Other Impervious Surfaces, HSG B
5,194	61	>75% Grass cover, Good, HSG B
2,392	48	Brush, Good, HSG B
16,270	79	Weighted Average
7,586		46.63% Pervious Area
8,684		53.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	172		0.57		Direct Entry, Calculated 1.8

## Subcatchment SC-2:



**Stormwater Management**

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Page 5

**Summary for Pond BIO:**

Inflow Area = 0.374 ac, 53.37% Impervious, Inflow Depth = 1.26" for 2-yr Event event  
 Inflow = 0.5 cfs @ 12.08 hrs, Volume= 1,711 cf  
 Outflow = 0.0 cfs @ 14.27 hrs, Volume= 1,626 cf, Atten= 93%, Lag= 131.3 min  
 Discarded = 0.0 cfs @ 14.27 hrs, Volume= 1,603 cf  
 Primary = 0.0 cfs @ 14.27 hrs, Volume= 23 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Peak Elev= 188.81' @ 14.27 hrs Surf.Area= 662 sf Storage= 899 cf

Plug-Flow detention time= 366.1 min calculated for 1,626 cf (95% of inflow)  
 Center-of-Mass det. time= 339.2 min ( 1,186.0 - 846.7 )

Volume	Invert	Avail.Storage	Storage Description			
#1	184.50'	1,457 cf	<b>Bioretention Area (Irregular)</b> Listed below (Recalc)			
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.50	162	141.5	0.0	0	0	162
185.00	208	146.2	40.0	37	37	291
185.25	232	147.3	40.0	22	59	336
185.50	257	150.9	30.0	18	77	429
186.00	306	154.3	30.0	42	119	542
186.50	257	157.7	30.0	42	162	657
187.00	409	161.2	30.0	50	211	776
187.50	461	163.2	30.0	65	276	872
187.75	488	164.2	30.0	36	312	921
188.00	515	165.3	100.0	125	437	971
188.25	542	166.3	100.0	132	569	1,020
188.50	569	167.3	100.0	139	708	1,070
188.80	658	173.8	100.0	184	892	1,253
189.00	751	181.4	100.0	141	1,033	1,471
189.50	951	196.6	100.0	425	1,457	1,938

Device	Routing	Invert	Outlet Devices
#1	Primary	188.80'	<b>3.0' long x 6.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#2	Discarded	184.50'	<b>1.020 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.0 cfs @ 14.27 hrs HW=188.81' (Free Discharge)  
 ↳ **2=Exfiltration** (Exfiltration Controls 0.0 cfs)

**Primary OutFlow** Max=0.0 cfs @ 14.27 hrs HW=188.81' TW=0.00' (Dynamic Tailwater)  
 ↳ **1=Broad-Crested Rectangular Weir** (Weir Controls 0.0 cfs @ 0.24 fps)

# Stormwater Management

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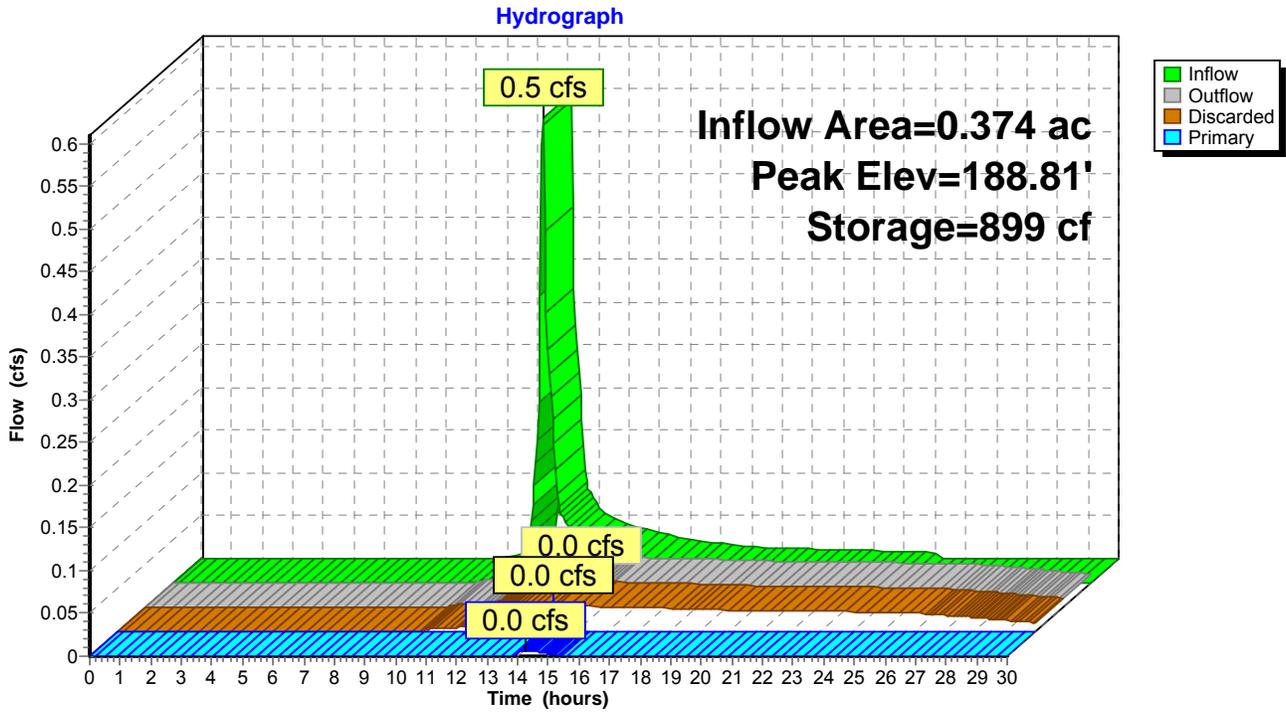
121072 - Acton Crossroads

Type III 24-hr 2-yr Event Rainfall=3.10"

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Page 6

## Pond BIO:



# Stormwater Management

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Page 7

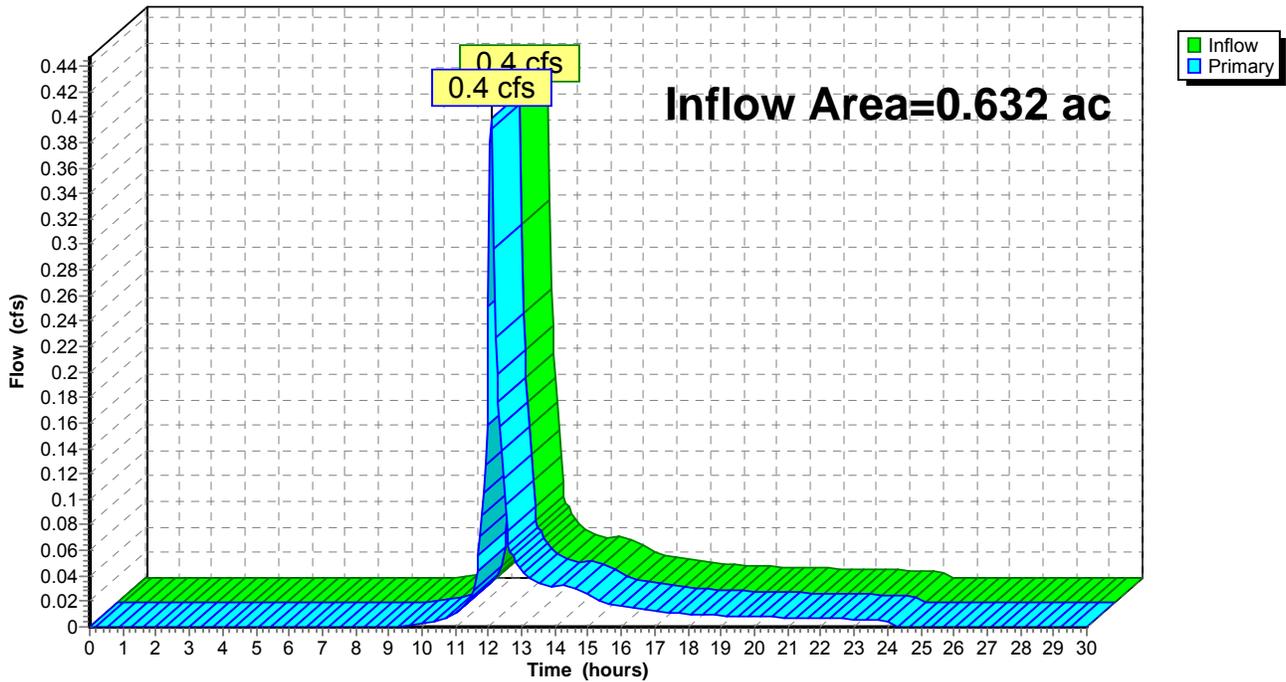
## Summary for Link POST:

Inflow Area = 0.632 ac, 52.14% Impervious, Inflow Depth = 0.55" for 2-yr Event event  
Inflow = 0.4 cfs @ 12.08 hrs, Volume= 1,268 cf  
Primary = 0.4 cfs @ 12.08 hrs, Volume= 1,268 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

## Link POST:

Hydrograph



# Stormwater Management

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121072 - Acton Crossroads

Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 8

## Summary for Subcatchment SC-1:

Runoff = 0.7 cfs @ 12.08 hrs, Volume= 2,311 cf, Depth= 2.46"

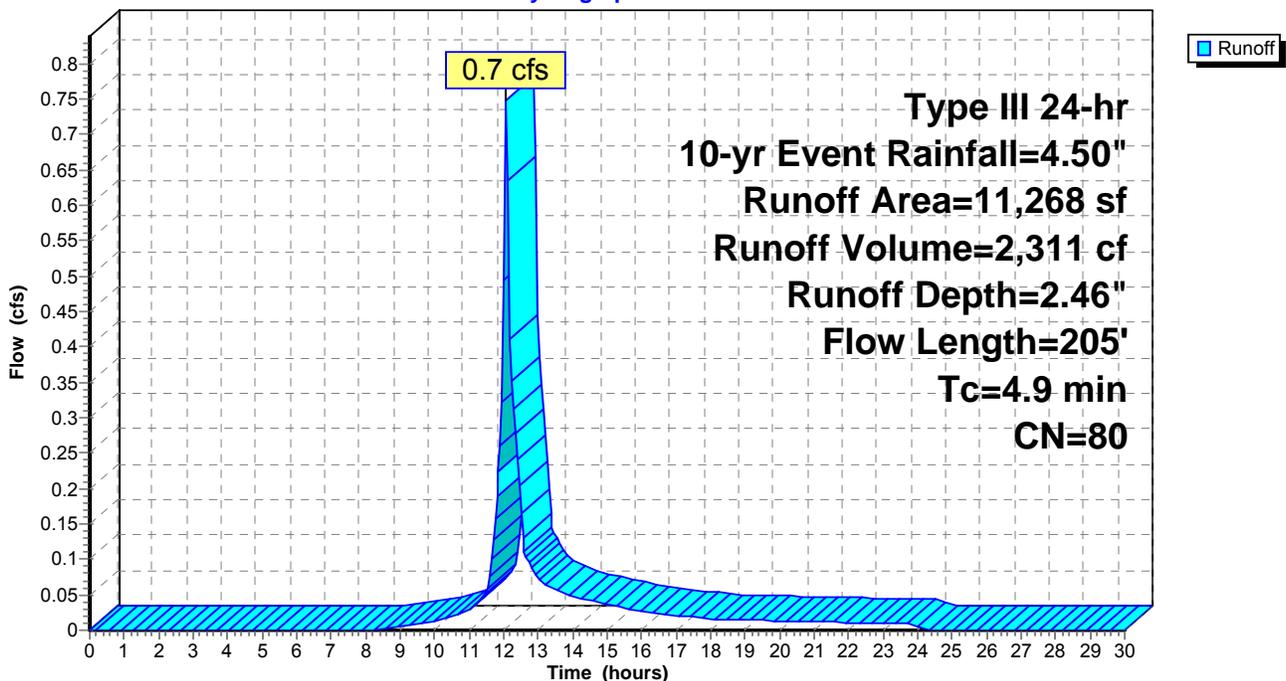
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10-yr Event Rainfall=4.50"

Area (sf)	CN	Description
5,561	98	Paved parking, HSG B
* 114	98	Other Impervious Surfaces, HSG B
5,593	61	>75% Grass cover, Good, HSG B
11,268	80	Weighted Average
5,593		49.64% Pervious Area
5,675		50.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.23		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
0.8	69	0.0479	1.53		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.5	86	0.0228	3.07		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
4.9	205	Total			

## Subcatchment SC-1:

Hydrograph



# Stormwater Management

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Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 9

## Summary for Subcatchment SC-2:

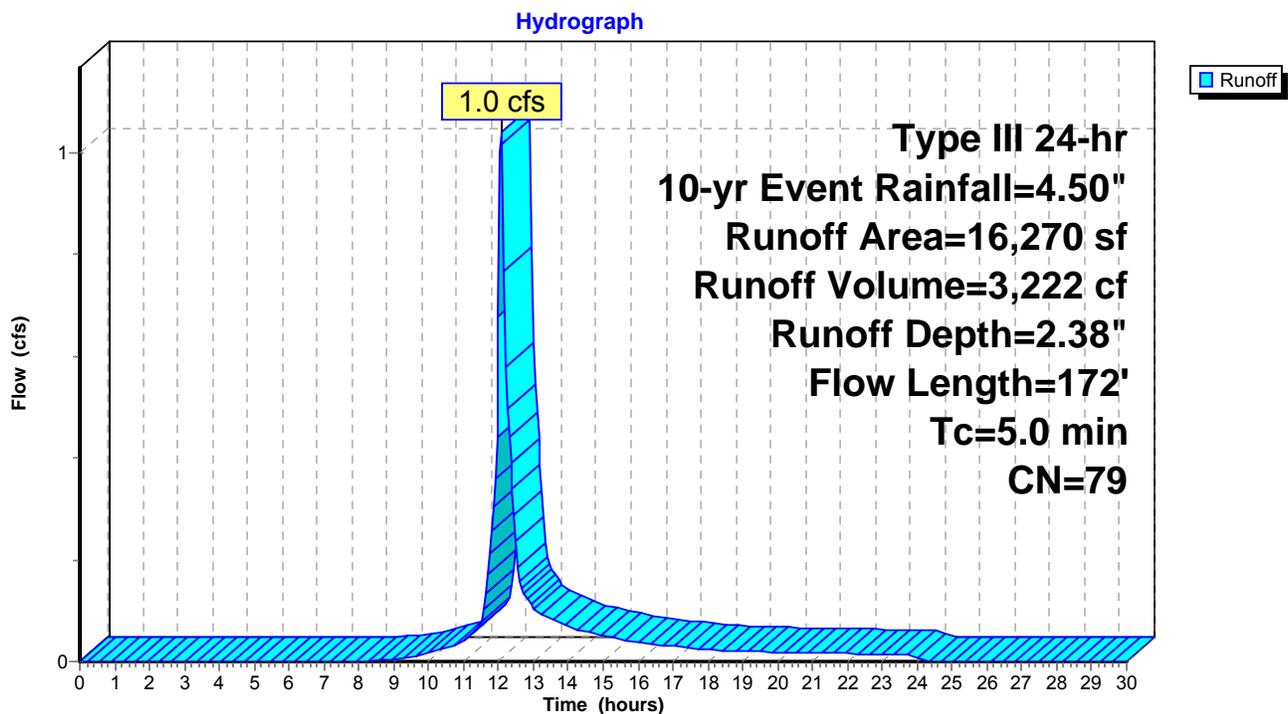
Runoff = 1.0 cfs @ 12.08 hrs, Volume= 3,222 cf, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10-yr Event Rainfall=4.50"

Area (sf)	CN	Description
7,906	98	Paved parking, HSG B
* 778	98	Other Impervious Surfaces, HSG B
5,194	61	>75% Grass cover, Good, HSG B
2,392	48	Brush, Good, HSG B
16,270	79	Weighted Average
7,586		46.63% Pervious Area
8,684		53.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	172		0.57		Direct Entry, Calculated 1.8

## Subcatchment SC-2:



# Stormwater Management

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Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 10

## Summary for Pond BIO:

Inflow Area = 0.374 ac, 53.37% Impervious, Inflow Depth = 2.38" for 10-yr Event event  
 Inflow = 1.0 cfs @ 12.08 hrs, Volume= 3,222 cf  
 Outflow = 0.6 cfs @ 12.21 hrs, Volume= 3,036 cf, Atten= 40%, Lag= 7.9 min  
 Discarded = 0.0 cfs @ 12.21 hrs, Volume= 1,829 cf  
 Primary = 0.6 cfs @ 12.21 hrs, Volume= 1,206 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Peak Elev= 188.99' @ 12.21 hrs Surf.Area= 746 sf Storage= 1,025 cf

Plug-Flow detention time= 226.5 min calculated for 3,036 cf (94% of inflow)  
 Center-of-Mass det. time= 195.5 min ( 1,023.8 - 828.3 )

Volume	Invert	Avail.Storage	Storage Description			
#1	184.50'	1,457 cf	<b>Bioretention Area (Irregular)</b> Listed below (Recalc)			
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.50	162	141.5	0.0	0	0	162
185.00	208	146.2	40.0	37	37	291
185.25	232	147.3	40.0	22	59	336
185.50	257	150.9	30.0	18	77	429
186.00	306	154.3	30.0	42	119	542
186.50	257	157.7	30.0	42	162	657
187.00	409	161.2	30.0	50	211	776
187.50	461	163.2	30.0	65	276	872
187.75	488	164.2	30.0	36	312	921
188.00	515	165.3	100.0	125	437	971
188.25	542	166.3	100.0	132	569	1,020
188.50	569	167.3	100.0	139	708	1,070
188.80	658	173.8	100.0	184	892	1,253
189.00	751	181.4	100.0	141	1,033	1,471
189.50	951	196.6	100.0	425	1,457	1,938

Device	Routing	Invert	Outlet Devices
#1	Primary	188.80'	<b>3.0' long x 6.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#2	Discarded	184.50'	<b>1.020 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.0 cfs @ 12.21 hrs HW=188.99' (Free Discharge)  
 ↑**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

**Primary OutFlow** Max=0.6 cfs @ 12.21 hrs HW=188.99' TW=0.00' (Dynamic Tailwater)  
 ↑**1=Broad-Crested Rectangular Weir** (Weir Controls 0.6 cfs @ 1.02 fps)

# Stormwater Management

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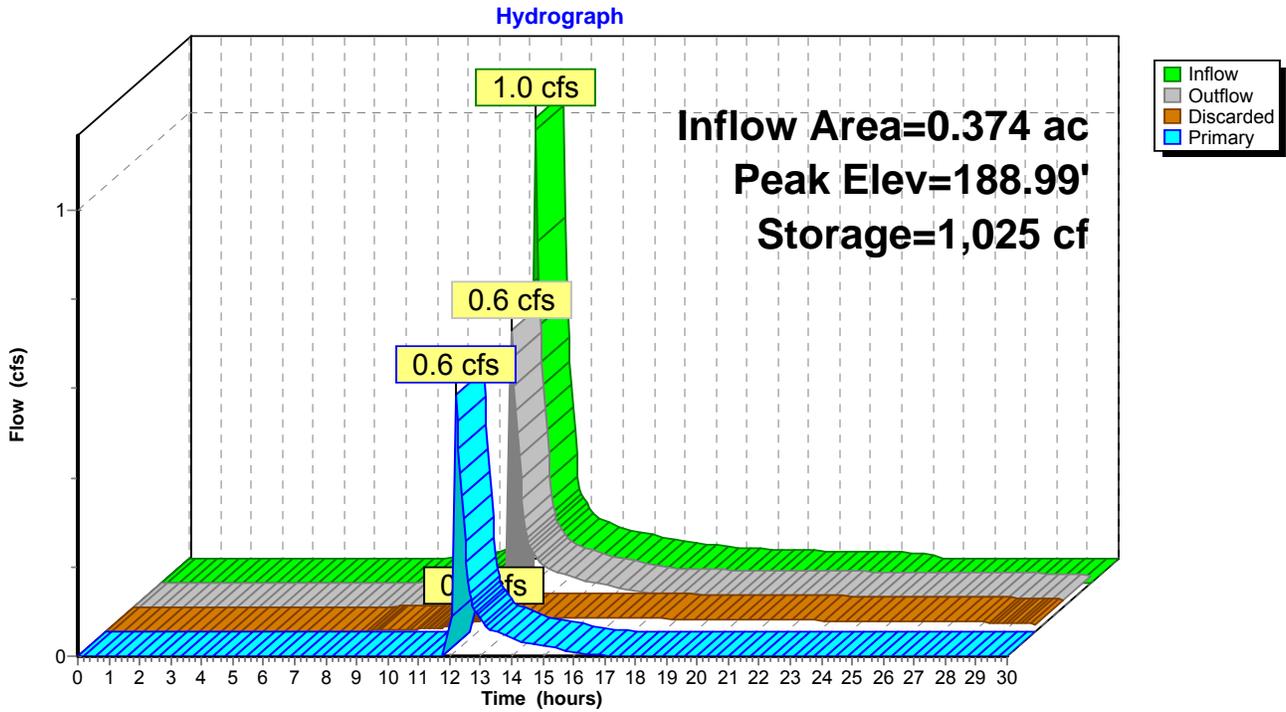
121072 - Acton Crossroads

Type III 24-hr 10-yr Event Rainfall=4.50"

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Page 11

## Pond BIO:



# Stormwater Management

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Type III 24-hr 10-yr Event Rainfall=4.50"

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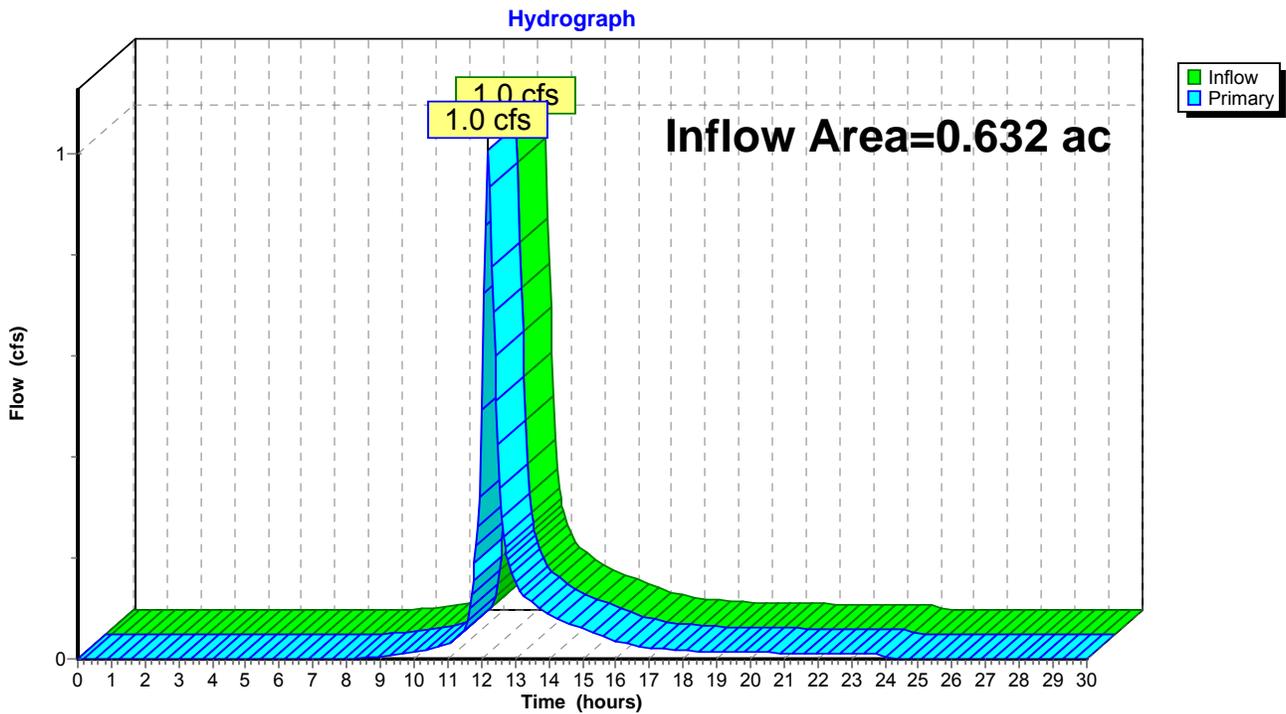
Page 12

## Summary for Link POST:

Inflow Area = 0.632 ac, 52.14% Impervious, Inflow Depth = 1.53" for 10-yr Event event  
Inflow = 1.0 cfs @ 12.18 hrs, Volume= 3,518 cf  
Primary = 1.0 cfs @ 12.18 hrs, Volume= 3,518 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

## Link POST:



# Stormwater Management

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Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 13

## Summary for Subcatchment SC-1:

Runoff = 1.3 cfs @ 12.07 hrs, Volume= 3,977 cf, Depth= 4.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100-yr Event Rainfall=6.50"

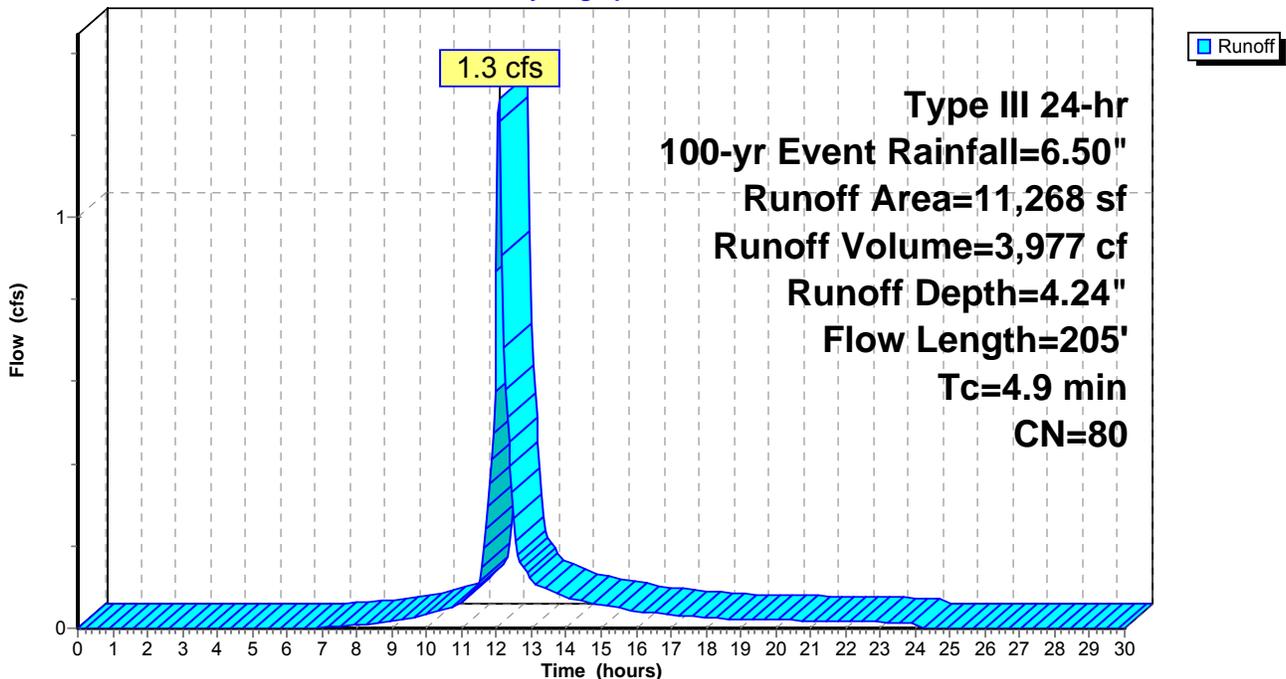
Area (sf)	CN	Description
5,561	98	Paved parking, HSG B
* 114	98	Other Impervious Surfaces, HSG B
5,593	61	>75% Grass cover, Good, HSG B
11,268	80	Weighted Average
5,593		49.64% Pervious Area
5,675		50.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.23		<b>Sheet Flow,</b> Grass: Dense n= 0.240 P2= 3.10"
0.8	69	0.0479	1.53		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
0.5	86	0.0228	3.07		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
4.9	205	Total			

## Subcatchment SC-1:

Hydrograph



# Stormwater Management

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Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 14

## Summary for Subcatchment SC-2:

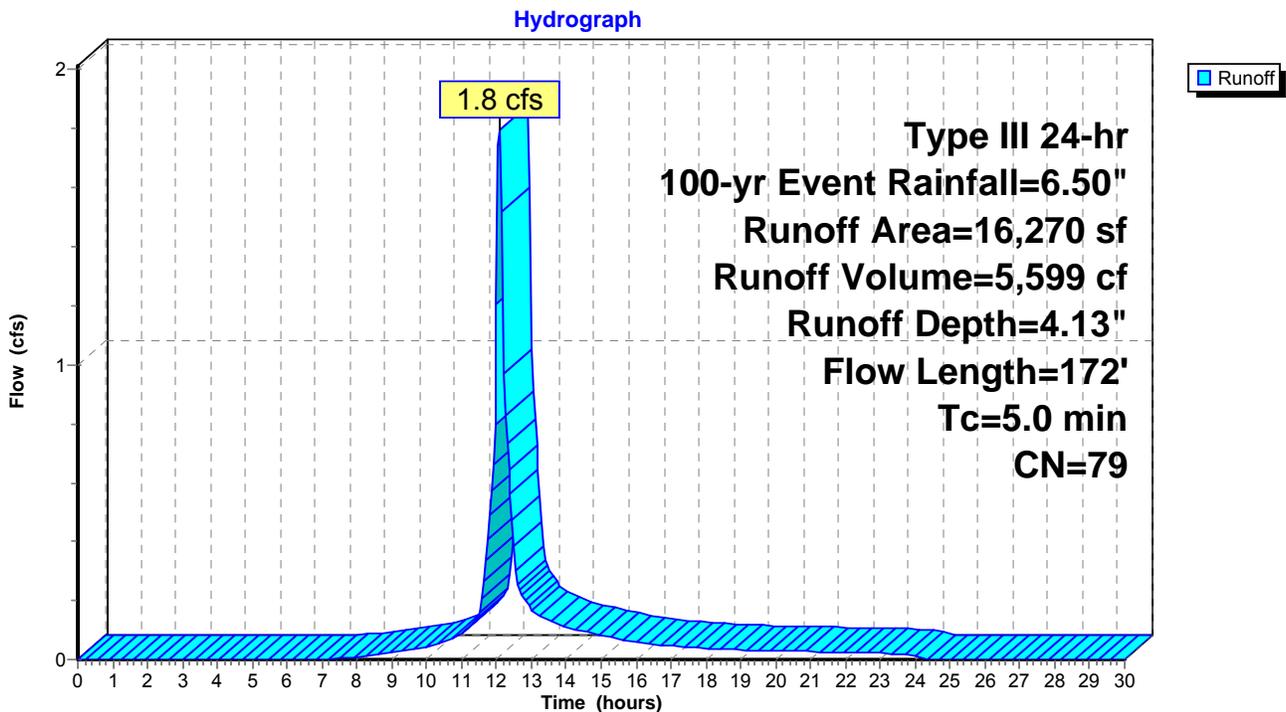
Runoff = 1.8 cfs @ 12.08 hrs, Volume= 5,599 cf, Depth= 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100-yr Event Rainfall=6.50"

Area (sf)	CN	Description
7,906	98	Paved parking, HSG B
* 778	98	Other Impervious Surfaces, HSG B
5,194	61	>75% Grass cover, Good, HSG B
2,392	48	Brush, Good, HSG B
16,270	79	Weighted Average
7,586		46.63% Pervious Area
8,684		53.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	172		0.57		Direct Entry, Calculated 1.8

## Subcatchment SC-2:



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Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 15

## Summary for Pond BIO:

Inflow Area = 0.374 ac, 53.37% Impervious, Inflow Depth = 4.13" for 100-yr Event event  
 Inflow = 1.8 cfs @ 12.08 hrs, Volume= 5,599 cf  
 Outflow = 1.7 cfs @ 12.11 hrs, Volume= 5,296 cf, Atten= 5%, Lag= 2.0 min  
 Discarded = 0.0 cfs @ 12.11 hrs, Volume= 2,040 cf  
 Primary = 1.7 cfs @ 12.11 hrs, Volume= 3,256 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Peak Elev= 189.17' @ 12.11 hrs Surf.Area= 816 sf Storage= 1,164 cf

Plug-Flow detention time= 142.2 min calculated for 5,288 cf (94% of inflow)  
 Center-of-Mass det. time= 113.4 min ( 925.9 - 812.4 )

Volume	Invert	Avail.Storage	Storage Description			
#1	184.50'	1,457 cf	<b>Bioretention Area (Irregular)</b> Listed below (Recalc)			
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.50	162	141.5	0.0	0	0	162
185.00	208	146.2	40.0	37	37	291
185.25	232	147.3	40.0	22	59	336
185.50	257	150.9	30.0	18	77	429
186.00	306	154.3	30.0	42	119	542
186.50	257	157.7	30.0	42	162	657
187.00	409	161.2	30.0	50	211	776
187.50	461	163.2	30.0	65	276	872
187.75	488	164.2	30.0	36	312	921
188.00	515	165.3	100.0	125	437	971
188.25	542	166.3	100.0	132	569	1,020
188.50	569	167.3	100.0	139	708	1,070
188.80	658	173.8	100.0	184	892	1,253
189.00	751	181.4	100.0	141	1,033	1,471
189.50	951	196.6	100.0	425	1,457	1,938

Device	Routing	Invert	Outlet Devices
#1	Primary	188.80'	<b>3.0' long x 6.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#2	Discarded	184.50'	<b>1.020 in/hr Exfiltration over Wetted area</b>

**Discarded OutFlow** Max=0.0 cfs @ 12.11 hrs HW=189.16' (Free Discharge)  
 ↑**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

**Primary OutFlow** Max=1.6 cfs @ 12.11 hrs HW=189.16' TW=0.00' (Dynamic Tailwater)  
 ↑**1=Broad-Crested Rectangular Weir** (Weir Controls 1.6 cfs @ 1.50 fps)

# Stormwater Management

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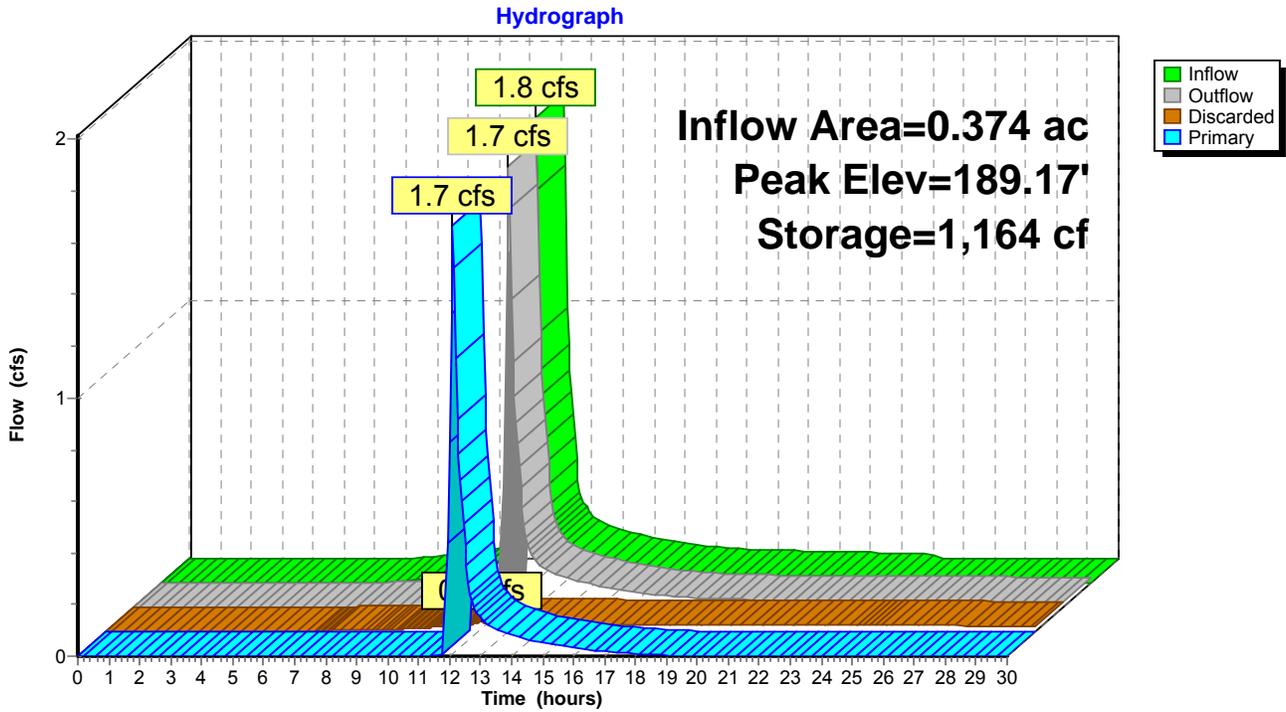
121072 - Acton Crossroads

Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 16

## Pond BIO:



# Stormwater Management

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Type III 24-hr 100-yr Event Rainfall=6.50"

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Page 17

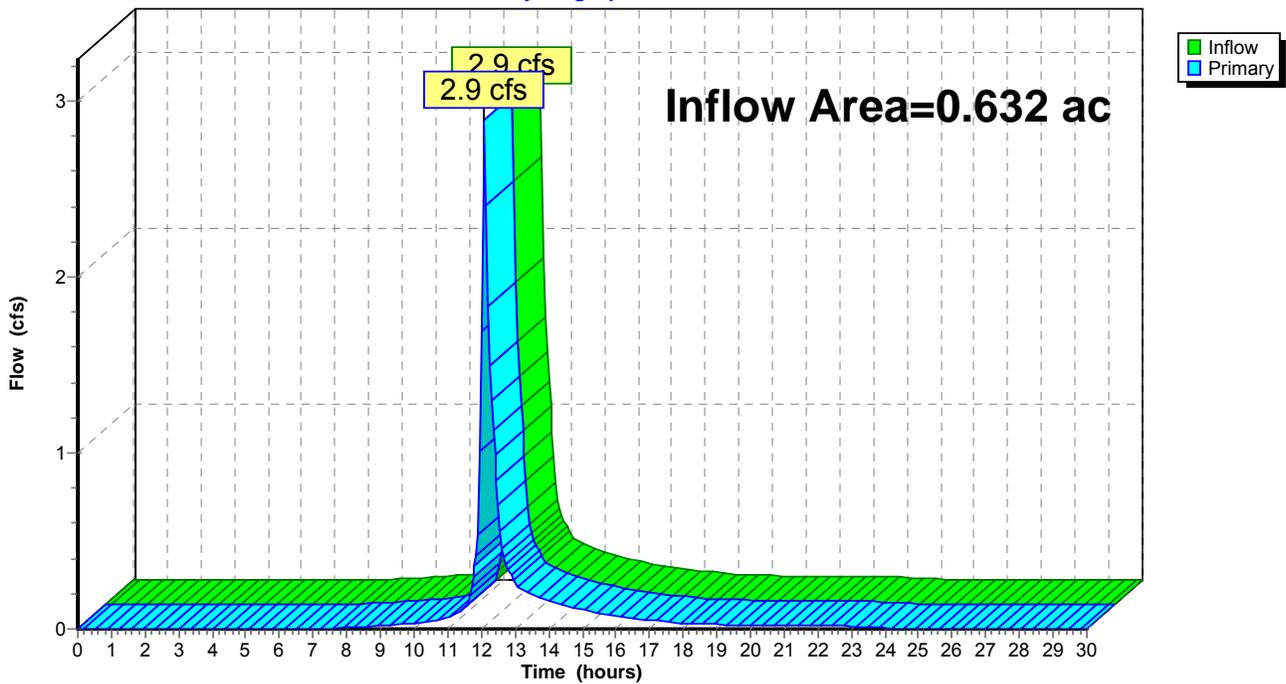
## Summary for Link POST:

Inflow Area = 0.632 ac, 52.14% Impervious, Inflow Depth = 3.15" for 100-yr Event event  
Inflow = 2.9 cfs @ 12.09 hrs, Volume= 7,233 cf  
Primary = 2.9 cfs @ 12.09 hrs, Volume= 7,233 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

## Link POST:

Hydrograph



**Stormwater Management Standard 3  
GROUNDWATER RECHARGE**

Acton Crossroads, Inc.  
321 Main Street  
Project No. 121072

**Pre-Development Conditions**

---

		<u>Area (sf)</u>	<u>Area (Ac)</u>
<b>Total Subcatchment Areas</b>		27,538	0.6
<b>Total Area of Hydrolic Soil Groups</b>	B	27,538	0.6
<b>Surface Type Areas</b>			
Paved & Other Impervious Areas	B	6,147	0.1
Grass / Landscape Area	B	14,363	0.3
Brush growth / Trees	B	7,028	0.2
<b>Total Impervious Area</b>	B	6,147	0.1

---

**Infiltration Volume**

Inches of Recharge per Storm Event      B      0.35

$$\text{Infiltration Volume} = \sum \{[(\text{Total Subcatchment Area within HSG}) - (\text{Total Impervious Area within HSG})] \times (\text{inches of Recharge Per Storm})\}$$

**Infiltration Volume**

<b>624</b>	<b>CF</b>
------------	-----------

**Stormwater Management Standard 3  
GROUNDWATER RECHARGE**

Acton Crossroads, Inc.  
321 Main Street  
Project No. 121072

**Post Development Conditions**

---

		<u>Area (sf)</u>	<u>Area (Ac)</u>
<b>Total Subcatchment Area (On-Site)</b>		27,538	0.6
<b>Total Area of Hydrolic Soil Groups</b>	B	27,538	0.6
<b>Surface Type Areas</b>			
Paved & Other Impervious Areas	B	14,359	0.3
Grass / Landscape Area	B	10,787	0.2
Brush growth / Trees	B	2,392	0.1
<b>Total Impervious Area</b>	B	14,359	0.3

---

**Infiltration Volume**

Inches of Recharge per Storm Event      B      0.35

$$\text{Infiltration Volume} = \sum \{[(\text{Total Subcatchment Area within HSG}) - (\text{Total Impervious Area within HSG})] \times (\text{inches of Recharge Per Storm})\}$$

Natural Infiltration Volume	384	CF
Pre-Development Infiltration Volume	624	CF
<b>Required Infiltration Volume</b>	<b>240</b>	<b>CF</b>

**Provided Infiltration Volume**

---

Bioretention Area	892	CF
<b>Total Provided Infiltration Volume</b>	<b>892</b>	<b>CF</b>

**Stormwater Management Standard 3  
GROUNDWATER RECHARGE**

Acton Crossroads, Inc.  
321 Main Street  
Project No. 121072

**Infiltration Area Requirements**

**Drawdown Time**

(Per Massachusetts Stormwater regulations, infiltration areas must completely drain within 72 hours)

**Rain Garden**

Infiltration Area Storage Volume	cf	892
Design infiltration Rate	in/hr	1.02
Infiltration Bottom Area	sf	162

Drawdown Time = Infiltration Area Storage Volume / [Design Infiltration Rate x Infiltration Area Bottom Area]

<b>Drawdown Time (Hrs)</b>	<b>65.0</b>
----------------------------	-------------

**Mounding Analysis**

Per the Massachusetts Stormwater Handbook, mounding analysis is required when "... The vertical separation from the bottom of an exfiltration system to seasonal high groundwater is less than four (4) feet and the recharge system is proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm." The mounding analysis "... must show that the REQUIRED RECHARGE VOLUME is fully dewatered within 72 hours..."

Rain Garden

Hydraulic Conductivity	ft/day	16	Standard Value for "Fine Sand" material
Specific Yield		0.23	Standard Value for "Fine Sand" material
Initial Saturated Thickness	ft	15	Depth to bedrock
Design Recharge Rate	ft/day	2.04	infiltration rate
Time	days	3	Minimum 72 hr evaluation period
Bottom Infiltrating Area	sf	162	
Length of Infiltration Area	ft	64	
Width of Infiltration Area	ft	2.5	
Time when Infiltration Stops	days	2.71	Calculated Drawdown Time (see Above)

Maximum Water table rise at 72 hours<sup>1</sup>

<b>ft</b>	<b>0.41</b>
<b>in</b>	<b>5</b>

**- Resulting mound will not interfere with the full draining of the infiltration area in accordance with Mass Stormwater Standards -**

<sup>1</sup> - mounding analysis calculated using the Hantush (1967) method. Automated calculator available online from the Aquifer Test Forum sponsored by HydroSOLVE, Inc.

**Stormwater Management Standard 4  
WATER QUALITY RETENTION VOLUME**

Acton Crossroads, Inc.  
321 Main Street  
Project No. 121072

Parameter	Unit	Quantity	Remarks
Watershed area	sf	27,538	
Predevelopment impervious area	sf	6,147	
Total impervious area added	sf	8,212	
Total impervious area	sf	14,359	
Total impervious area required for retention	sf	<u>8,212</u>	
Runoff depth over impervious area	IN	0.5	
<b>REQUIRED WATER QUALITY RETENTION VOLUME</b>			<b>VOLUME PROVIDED BY:</b>
	CF	342	
<b>DESIGN VOLUME PROVIDED</b>	CF	892	Bioretention Area

**Stormwater Management Standard 4  
TSS REMOVAL**

Acton Crossroads, Inc.  
321 Main Street  
Project No. 121072

Process Train No.	Impervious Area (SF)	BMP Type	TSS Removal Rate	TSS Remaining at Discharge	TSS Removed at Discharge
SC1 *	5,675	SS	5%	95%	5%
SC2	8,684	SS	5%	95%	5%
		BIO	90%	10%	<b>91%</b>

\* - Impervious areas within Subcatchments SC1 is limited to existing impervious areas untouched by the proposed development, flowing into the site's existing drainage system.

**ABBREVIATIONS:**

TSS=total suspended solids; SC=subcatchment; SS = Street Sweeping; GC=grassed channel; AP=analysis point; BMP=best management practices; TB = Tree Box Filter; BIO=bioretention area; CB=deep sump catch basin; FB = Sediment Forebay; CSW = Constructed Stormwater Wetland