Nitsch Engineering

November 30, 2012

# STORMWATER REPORT
## FOR SITE PLAN REVIEW

For

**SOUTH HADLEY LIBRARY PROJECT**
2 Canal Street
South Hadley, Massachusetts 01075

Prepared for:

**Johnson Roberts Associates Inc.**
15 Properzi Way
Somerville, MA 02143

Prepared by:


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Nitsch Project #9165

Building better communities with you.

**South Hadley Library Project**
**2 Canal Street**
**South Hadley, MA 01075**
**Nitsch Engineering**
**Timothy J. McGivern, PE**

## 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.


11/21/2012

Signature, Date

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**APPENDICES**

## 1.0 INTRODUCTION

Nitsch Engineering prepared this Stormwater Memo for the Notice of Intent (NOI) associated with the proposed South Hadley Library project in South Hadley, Massachusetts. The proposed project includes the construction of a new library building with associated walkways, parking, and utilities.

## 2.0 EXISTING CONDITIONS

The South Hadley Library project site is located on Canal Street near the Connecticut River (Refer to USGS Locus Map). The existing site contains two 2-story buildings and associated parking and landscaped area. Access to the site is provided by Canal Street and West Main Street. Wetland resource areas surround the project site to the southwest, bordering on the limits of the existing disturbed area.

### 2.1 Existing Drainage Infrastructure

The majority of stormwater runoff generated by the existing buildings and other paved areas is either collected using catch basins or flows overland and is discharged to the Connecticut River. Stormwater runoff from a portion of the site is collected in catch basins which connect into the municipal closed drainage system. There is a 24-inch drain line in West Main Street.

### 2.2 NRSC Soil Designations

The soils underlying the site are classified by the Natural Resource Conservation Service (NRCS) Soil Survey maps as Paxton-Charlton-Urban land complex. Therefore, the on-site soil is classified as HSG C.

### 2.3 On-Site Soil Exploration

Two soil test pits were performed in the vicinity of the proposed infiltration basin. The test pits indicate varied disturbed soil material comprised of mostly sand with a high percentage of cobbles. The nature of the cobbles appears to be broken ledge. No groundwater or evidence of groundwater was observed. See Appendix B for additional information.

### 2.4 Wetland Resource Areas

The project site is bordered to the southwest by wetland resource areas. Epsilon Associates, Inc. conducted a site visit on April 14, 2012 to determine the extent of the wetlands resources adjacent to the project site, which include:

- 200-foot Riverfront Area
- Inland Bank
- 100-ft Buffer Zone
- 50-ft local No Disturbance Conservation Zone

Refer to the NOI project narrative and Wetland Resource Area Evaluation, prepared by Epsilon Associates, Inc., provided in Appendix A of the NOI, for a detailed summary of the on-site wetland resource areas and impacts from the proposed work.

### 2.5 Connecticut River Watershed

The project site discharges to a closed drainage system which eventually discharges into the Connecticut River. A Final Phosphorus Total Maximum Daily Load (TMDL) for the Connecticut River Watershed was issued by DEP and the Environmental Protection Agency (EPA) in December

2001. However, the TMDL only applies to selected lakes in the watershed; therefore, the TMDL is not applicable to this project.

## 3.0 PROPOSED CONDITIONS

### 3.1 Project Description

The proposed project includes the construction of a new library building with associated parking, walkways, utilities, and site features. A separate Notice of Intent has been submitted for the demolition of the two existing buildings on-site. The project results in a net decrease in impervious area on site.

**Table 1. Proposed land use change for South Hadley Library (in acres)**

| Land Use | Existing | Proposed | Change |
|---|---|---|---|
| **Impervious Area** | 1.30 | 1.15 | -0.15 |
| **Grass/Plantings** | 0.64 | 0.79 | +0.15 |
| **Total** | 1.94 | 1.94 | 0 |

### 3.2 Stormwater Management System

The proposed building project will include a new stormwater management system which will improve the water quality of stormwater runoff. The new system will also prevent water from directly discharging into the Connecticut River. The Best Management Practices (BMP's) included in the system include deep sump hooded catch basins in the parking lot, a bioretention area with a stone reservoir to promote recharge, a hydrodynamic proprietary treatment device, and a subsurface infiltration basin. The majority of stormwater runoff is collected and conveyed to the Connecticut River via a connection to the Town system located in West Main Street. A decrease in impervious area is proposed for the site; however, point source discharges directly to the Connecticut River are eliminated in the proposed condition resulting in more drainage area directed to the West Main Street system. The stormwater management system will meet the MassDEP Stormwater Management Standards.

## 4.0 STORMWATER MANAGEMENT ANALYSIS

### 4.1 Methodology

Nitsch Engineering completed a hydrologic analysis of the existing project site utilizing Soil Conservation Service (SCS) Runoff Curve Number (CN) methodology. The SCS method calculates the rate at which the runoff reaches the design point considering several factors: the slope and flow lengths of the subcatchment area, the soil type of the subcatchment area, and the type of surface cover in the subcatchment area. HydroCAD Version 10.00 computer modeling software was used in conjunction with the SCS method to determine the peak rates of runoff for the 2-year, 10-year, and 100-year 24-hour storm events. The proposed project site is being analyzed with the same methodology.

The project site was divided into multiple drainage areas, or subcatchments, which drain to the design points along the property boundary and within the site. For each subcatchment area, SCS Runoff Curve Numbers (CNs) were selected by using the cover type and hydrologic soil group of each area. The peak runoff rates for the 2-year, 10-year, and 100-year 24-hour storm events were then determined by inputting the drainage areas, CNs, and Tc paths into the HydroCAD.

## 4.2 HydroCAD Version 10.00

The HydroCAD computer program uses SCS and TR-20 methods to model drainage systems. TR-20 (Technical Release 20) was developed by the Soil Conservation Service to estimate runoff and peak discharges in small watersheds. TR-20 is generally accepted by engineers and reviewing authorities as the standard method for estimating runoff and peak discharges.

HydroCAD Version 10.00 uses up to four types of components to analyze the hydrology of a given site: subcatchments, reaches, basins, and links. Subcatchments are areas of land that produce surface runoff. The area, weighted CN, and $T_c$ characterize each individual subcatchment area. Reaches are generally uniform streams, channels, or pipes that convey water from one point to another. A basin is any impoundment that fills with water from one or more sources and empties via an outlet structure. Links are used to introduce hydrographs into a project from another source or to provide a junction for more than one hydrograph within a project.

## 4.3 Precipitation Data

Nitsch used Technical Paper 40 by the National Weather Service to estimate the rainfall for the 2-year, 10-year, and 100-year 24-hour storms. The rainfall values for Hampshire County that were used are as follows:

| Storm Event | 24–hour Rainfall |
|---|---|
| 2-year | 3.0 in. |
| 10-year | 4.5 in. |
| 100-year | 6.4 in. |

## 4.4 Existing Hydrologic Conditions

Nitsch delineated the existing watershed into two (2) subcatchment areas utilizing an existing conditions survey and on-site observations (Figure D1). Runoff from subcatchment E2 drains either overland or via point source discharge directly to the Connecticut River. Runoff from subcatchment E1 drains to Canal Street or West Main Street and collected via catch basins. The closed Town system in Canal and West Main Street ultimately discharges to the Connecticut River. The point discharge is located approximately 600 feet downstream from the site.

The Design Point selected for the project is the Connecticut River. Runoff that enters the Town closed system is discharged to the river in close proximity to the site. Removing direct discharges from the site to the river and minimizing overland flow directly to the river results in an increase in runoff rates to the Town system; however, the proposed infiltration basin and bioretention basin provide storage volume to minimize the increase in rate. The runoff rates and volumes for the Connecticut River design point are reduced for the 2-year, 10-year, and 100-year storm events.

## 4.5 Proposed Hydrologic Conditions

The proposed project will be designed to meet the goals of the design points as described above, in accordance with the Massachusetts Stormwater Management Policy, the South Hadley Wetlands Bylaw, and the South Hadley Stormwater Management Bylaw. The existing subcatchment areas were modified to reflect the proposed topography, drainage structures and roof areas. (Fig. D2). The drainage structures included in the hydrologic analysis are a bioretenion basin and infiltration basin. The following descriptions do not include BMP's such as water quality structures, deep sump hooded catch basins, or other BMP's with insignificant storage.

The majority of the west side of the proposed site is comprised of two (2) subcatchments. Runoff from subcatchment P1 travels overland directly to the Connecticut River, and runoff from subcatchment P2 is directed to the bioretention basin. Subcatchment P1 is comprised of wooded area, landscaped area, and pedestrian walkway. There is no water quality treatment proposed for Subcatchment P1; however, the weighted average of TSS removal for runoff leaving the site is greater than 80%. Subcatchment P2 is comprised of wooded area, landscaped area, pedestrian walkway, and roof. The roof runoff is directed to the surface of the bioretention basin, and the remaining runoff in the subcatchment is collected in the underlying stone volume. The bioretention basin includes a control orifice to take advantage of the storage volume provided by the underlying stone and minimize the increase in rate to the Town system.

The outlet from the bioretention area connects to the closed system which conveys runoff to the infiltration basin

The majority of the east side of the site is comprised of two (2) subcatchments. Runoff from subacatchment P3 travels overland directly to the Connecticut River, and runoff from subcatchment P4 is directed to the infiltration basin. Subcatchment P3 is comprised of landscaped area at the southern end of the property. There is no impervious area included in Subcatchment P3. Subcatchment P4 is comprised of parking lot, roof, landscaped islands, plaza, and pedestrian walkway. The infiltration basin provides peak rate attenuation, volume reduction through exfiltration, groundwater recharge, and water quality treatment.

The size of the infiltration basin was determined by the desired recharge volume and required water quality volume. The underlying soils in the parking lot is sand with a high percentage of cobbles, therefore the calculated recharge volume for the infiltration basin was determined using A soil, or 0.6 inches over the proposed impervious area directed to the basin. The simple dynamic method was used with the Rawls rate for sand.

### 4.6 Peak Flow Rates

The proposed stormwater management system is expected to reduce the post-development peak rates of runoff to at or below the pre-development rates for the 2-, and 10-year, 24-hour storm events. Flooding impacts from the 100-year, 24-hour storm were evaluated. The pre-development peak discharge rate calculations for the 2-, 10- and 100-year, 24-hour storm events are included with this report in Appendix C. The post-development HydroCAD routing diagram and summaries of proposed subcatchments are included in Appendix D.

**Table 1. Design Point Summary for Rates**

| Design Point | 2-yr rate (cfs) | | 10-yr rate (cfs) | | 100-yr rate (cfs) | |
|---|---|---|---|---|---|---|
| | PRE | POST | PRE | POST | PRE | POST |
| Connecticut River | 3.54 | 2.61 | 5.91 | 5.09 | 8.92 | 7.75 |

**Table 2. Design Point Summary for Volume**

| Design Point | 2-yr rate (cfs) | | 10-yr rate (cfs) | | 100-yr Vol (cf) | |
|---|---|---|---|---|---|---|
| | PRE | POST | PRE | POST | PRE | POST |
| Connecticut River | 14,205 | 6,395 | 24,133 | 14,312 | 37,083 | 25,391 |

**100-year 24-hour Storm Off-Site Flooding Evaluation**

The reduction in impervious area as well as the added infiltration reduces the 100-year storm runoff volume by approximately 32%. The flow path for site overflow will remain unchanged. In the existing and proposed conditions runoff produced from the 100-year storm event that surpasses the capaci of the closed drainage system travels overland towards the south to the Connecticut River.

## 5.0 MassDEP Stormwater Management Standards

The existing site is developed and the library building project will decrease the impervious area. Therefore, the project is considered a ***redevelopment*** under the DEP Stormwater Management System.

The proposed South Hadley Library was designed to meet the MassDEP Stormwater Management Standards as summarized below:

Since the project is a redevelopment project, it will be required to meet the following Stormwater Management Standards to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges will comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

### Standard 1: No New Untreated Discharges

The proposed design will comply with this Standard. There will be no untreated stormwater discharge. The DEP Stormwater Management Policy allows only discharges of treated water into the resource area.

Water quality treatment BMPs have been incorporated into the stormwater management system to provide increased TSS removal over the existing conditions. Deep sump hooded catch basins, hydrodynamic proprietarty treatment, and infiltration water quality BMPs have been incorporated into the design and sized to provide 92% TSS removal. The BMP sizing calculations are included with this report in Appendix F. The existing stormwater outfalls in the embankment will be taken offline to allow for water quality treatment with the proposed stormwater management system.

### Standard 2: Peak Rate Attenuation

Stormwater management systems shall be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

The South Hadley Library project will not create more impervious area on site and therefore the peak discharge rates on site will not be increased compared to pre-existing conditions. See Table 1 above for tabulated rates.

### Standard 3: Groundwater Recharge

Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater BMPs, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

The South Hadley Library project will not affect the groundwater recharge on site. The project will not create more impervious area on site and therefore no groundwater recharge is required for this project; however, groundwater recharge is provided to the maximum extent practical. The recharge volume calculation, BMP sizing calculations, and infiltration drawdown calculations are included in this report in the Appendices.

**Standard 4: Water Quality Treatment**

Stormwater management systems shall be designed to remove at least 80% of the average annual post-construction load of Total Suspended Solids (TSS). This standard is met when:

Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained; Structural stormwater BMPs are sized to capture the required water quality volume as determined in accordance with the Massachusetts Stormwater Handbook; and Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

All redevelopment projects must improve existing conditions and new stormwater controls must be incorporated into the design and result in a reduction in annual stormwater pollutant loads from the site. This project includes water quality treatment BMPs in the stormwater management system to provide increased TSS removal over existing conditions. Deep sump hooded catch basins, hydrodynamic proprietary treatment, and infiltration water quality BMPs have been incorporated into the design and sized to provide 92% TSS removal. The BMP sizing calculations are included with this report in Appendix F. Documentation supporting the use of Stormceptor and the proposed TSS removal rates achieved are included with this report in Appendix G. A Long-Term Operation and Maintenance (O&M) Plan for the storm drainage system has been included with this report in Appendix E.

**Standard 5: Land Uses with Higher Potential Pollutant Loads**

For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If, through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L.c. 21, §§ 26-53 and the regulations promulgated there under at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

The project is not associated with Higher Potential Pollutant Loads (per the Policy, Volume I, page 1-8). This project complies with this standard.

**Standard 6: Critical Areas**

Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or to any other critical area require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1. or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00.[1] Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of the public water supply.

The project does not contain areas of Sensitive Resources and will not discharge untreated stormwater to a sensitive resource area. This project complies with this standard.

**Standard 7: Redevelopments**

A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Since the South Hadley Library project is a redevelopment project, the following Stormwater Management Standards will be met to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6 (see compliance narrative for Standards 2, 3, 4, 5, and 6). Existing stormwater discharges will comply with Standard 1 only to the maximum extent practicable (see compliance narrative for Standard 1). This project will comply with all other requirements of the Stormwater Management Standards and improve existing conditions (see compliance narratives for Standards 8, 9, and 10).

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

A plan to control construction-related impacts, including erosion, sedimentation, and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

Since the project will disturb more than one (1) acre of land, South Hadley Library will be submitting a NOI to the Environmental Protection Agency (EPA) for coverage under the General Permit of the National Pollution Discharge Elimination System (NPDES). As part of this application the Applicant is required to prepare a Storm Water Pollution Prevention Plan (SWPPP) and implement the measures in the SWPPP. The SWPPP, which is to be kept on site, includes erosion and sediment controls (stabilization practices and structural practices), temporary and permanent stormwater management measures, Contractor inspection schedules and reporting of all SWPPP features, materials management, waste disposal, off-site vehicle tracking, spill prevention and response, sanitation, and non-stormwater discharges. The SWPPP will be submitted before land disturbance begins.

**Standard 9: Operation and Maintenance Plan**

A Long -Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

**Compliance:** An operations and maintenance plan (enclosed) including long-term BMP operation requirements has been prepared and will assure proper maintenance and functioning of the stormwater management system.

**Standard 10:** All illicit discharges to the stormwater management system are prohibited.

**Compliance:** There will be no illicit connections associated with this project. This project complies with this standard.

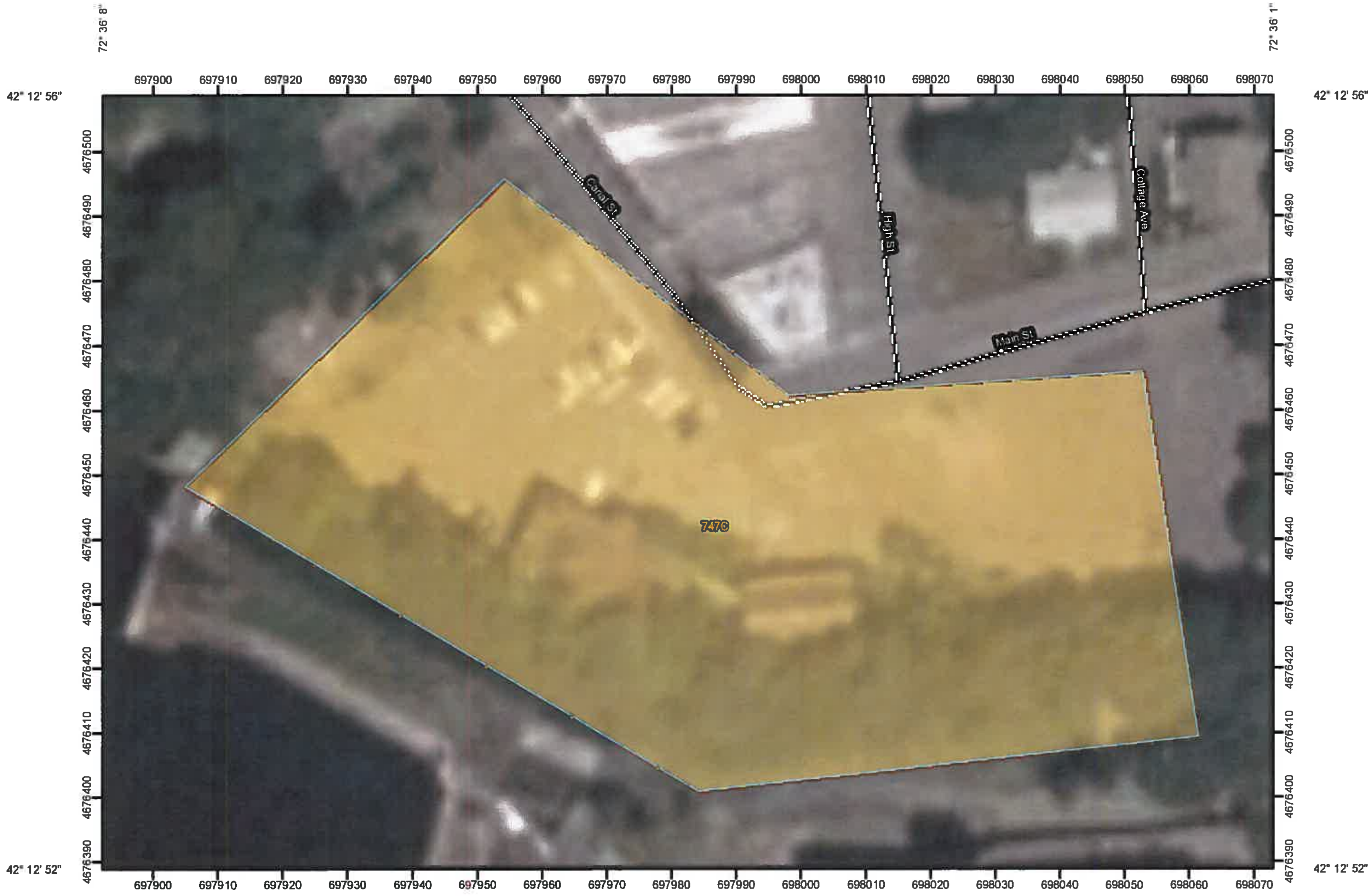
## 6.0 CONCLUSION

In conclusion, the proposed South Hadley Library stormwater management system will reduce peak runoff rates and improve the water quality of stormwater being discharged from the project site. The project is being designed in accordance with the MassDEP Stormwater Management Standards, the South Hadley Stormwater Management Bylaw, and the South Hadley Wetlands Bylaw.

## APPENDIX A

**Soils Information: NRCS Soils Map with Hydrologic Soil Group**

# Hydrologic Soil Group—Hampshire County, Massachusetts, Central Part




Map Scale: 1:858 if printed on A size (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 45 90 180 270

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

- Soil Map Units

**Soil Ratings**

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

**Political Features**

- Cities

**Water Features**

- Streams and Canals

**Transportation**

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

## MAP INFORMATION

Map Scale: 1:858 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:15,840.

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 18N NAD83

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

Soil Survey Area: Hampshire County, Massachusetts, Central Part
Survey Area Data: Version 6, Jun 11, 2008

Date(s) aerial images were photographed: 7/30/2003

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

# Hydrologic Soil Group

| Hydrologic Soil Group— Summary by Map Unit — Hampshire County, Massachusetts, Central Part (MA609) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| 747C | Paxton-Charlton-Urban land complex, 3 to 15 percent slopes | C | 2.1 | 100.0% |
| **Totals for Area of Interest** | | | **2.1** | **100.0%** |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

## APPENDIX B

## Soil Test Pit Logs and Geotechnical Report

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# Form S3-A: Standard 3 – Groundwater Recharge
# On-Site Soil Evaluation Log

| | |
|---|---|
| Project Name: **South Hadley Library** | Nitsch Project #: **9165** |
| Location: **South Hadley, MA** | |
| Prepared by: **Timothy McGivern** | Soil Evaluator No. **SE2833** |
| Date: **2012-9-27** | Sheet No. **1 OF 4** |

## Refer to instructions

## Section A: Site Information – Complete for Stage 1A, Stage 1B, and Stage 2:

NRCS Published Soil Survey Information

Soil Names: **Paxton-Charlton-Urban land complex**
Hydrologic Soil Groups (HSG): **Undefined, complex**
Soil Limitations if any:

Is there any portion of the site which does NOT have a HSG indicated in the NRCS?* YES X NO ☐

Are there any noticeable existing deviations from the NRCS Soil Survey on site? (i.e. bedrock outcrops, open gravel/sand areas, recent fills, etc.) YES ☐ NO X

Have the on-site soils been disturbed, filled, or altered in any way? YES X NO ☐

Do existing soil logs or borings conflict with the NRCS Soil Survey? YES ☐ NO X

If you have answered YES to any of the four questions above please continue to the Section B.

## Section B: Soil Logs – Complete for Stage 1B, and Stage 2:

Stage 1B: One test pit must be performed per acre with a minimum of four (4) test pits on-site. All test pits shall be at least 60-inches deep.

Stage 2: Soil tests must be conducted where recharge is proposed. Refer to BMP Specifications in Volume 2, Chapter 2 for the number of test locations required. If the Dynamic Field method is proposed, the Saturated Hydraulic Conductivity must be determined at the recharge location.

### Legend

S – Sand
LS – Loamy Sand
SL – Sandy Loam
L – Loam
SIL – Silt Loam
SICL – Silty Clay Loam
CL – Clay Loam
C – Clay

GR – Granular
CR – Crumb
P – Platy
PR – Prismatic
CPR – Columnar
SG – Single Grain
M – Massive
BL – Blocky

F – Friable
VF – Very Friable
FI – Firm
VFI – Very Firm
XF – Extremely Firm
R – Rigid

Co – Coarse
Med – Medium
Fi – Fine

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Test Pit No.: **TP-1** Date: **9/27/2012** Time: **10:30a-11:30a** Weather: **Sunny, 60's**

Land Use and Surface Description: **Parking Lot**

Vegetation: **None** Landform: **Unknown**

Parent Material: **Unknown** NRCS soil type: **Paxton-Charlton-Urban land complex**
HSG: **Undefined**

Groundwater Observed? **No**
Depth Weeping:
Depth Standing:

Estimated Depth to High Groundwater:

| Depth (in) | Soil Horizon/ Layer | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features (mottles) | | | Soil Texture (USDA) | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth | Color | Percent | | Gravel | Cobbles & Stones | | |
| 2 | F1 | - | - | - | - | - | - | - | - | - |
| 18 | F2 | Varied/un defined | - | - | - | S | 10 | - | - | - |
| 90 | F3 | Varied/un defined | - | - | - | LS/S | 10 | 25 | - | loose |
| | R | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Additional Notes: **F1 is pavement. No observable soil structure. F3 Appeared to be disturbed soil and broken ledge. Angular, sharp cobbles from 2" to 8" in size. Refusal was fractured ledge. F2 layer had no cobbles and was dark in color. F2 appeared to be pavement base. F2 has remnants of bituminous material throughout.**

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Test Pit No.: **TP-2** Date: **9/27/2012** Time: **10:30a-11:30a** Weather: **Sunny, 60's**

Land Use and Surface Description: **Parking Lot**

Vegetation: **None**

Landform: **Unknown**

Parent Material: **Unknown**

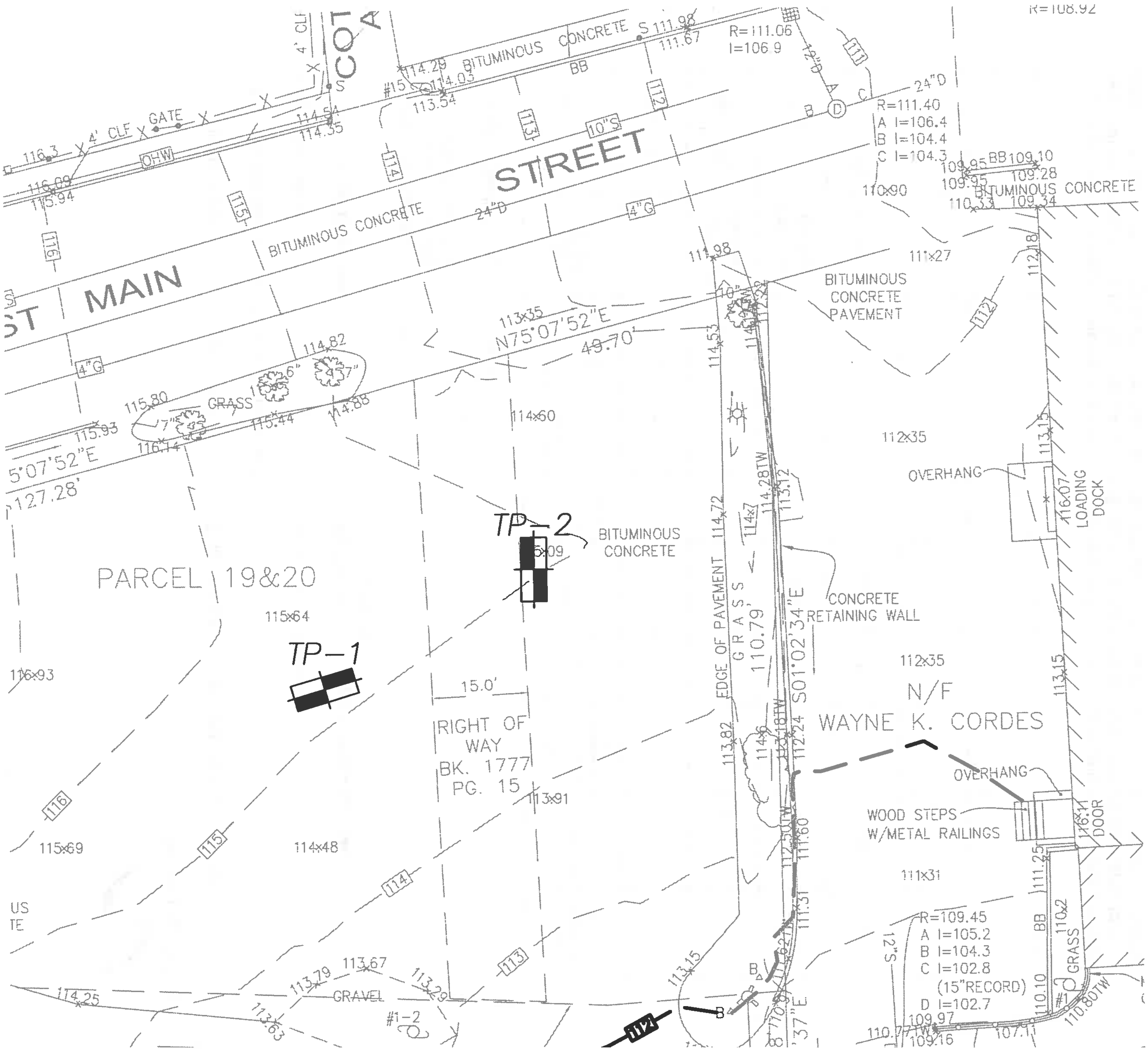
NRCS soil type: **Paxton-Charlton-Urban land complex**
HSG: **Undefined**

Groundwater Observed? **No**
Depth Weeping:
Depth Standing:

Estimated Depth to High Groundwater:

| Depth (in) | Soil Horizon/ Layer | Soil Matrix Color-Moist (Munsell) | Redoximorphic Features (mottles) | | | Soil Texture (USDA) | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth | Color | Percent | | Gravel | Cobbles & Stones | | |
| 2 | F1 | - | - | - | - | - | - | - | - | - |
| 18 | F2 | Varied/un defined | - | - | - | S | 10 | - | - | - |
| 72 | F3 | Varied/un defined | - | - | - | LS/S | 10 | 45 | - | Loose |
| 102 | C/F4 | 2.5Y6/3 | - | - | - | LS | 5 | - | M | F |
| | | | | | | | | | | |
| | | | | | | | | | | |

Additional Notes: **No refusal. No observable soil structure in F2 and F3. Appeared to be disturbed soil and broken ledge. Angular, sharp cobbles from 2" to 12" in size. F1 is pavement. F2 appeared to be pavement base. C/F4 may have been natural, although lacked structure and may have been disturbed. Cave-in prevented further exploration.**


MAIN STREET
PARCEL 19&20
TP-1
TP-2
BITUMINOUS CONCRETE
RIGHT OF WAY
BK. 1777
PG. 15
15.0'
N75°07'52"E
49.70'
127.28'
EDGE OF PAVEMENT
GRASS
110.79'
S01°02'34"E
CONCRETE RETAINING WALL
N/F
WAYNE K. CORDES
WOOD STEPS W/METAL RAILINGS
OVERHANG
LOADING DOCK
DOOR
BITUMINOUS CONCRETE PAVEMENT
4' CLF
GATE
GRAVEL
R=109.45
A I=105.2
B I=104.3
C I=102.8
(15"RECORD)
D I=102.7
R=111.40
A I=106.4
B I=104.4
C I=104.3
R=111.06
I=106.9
24"D
12"S
10"S
4"G

Environmental Safety Health Geotechnical

**O'Reilly, Talbot & Okun**
[ A S S O C I A T E S ]

ENGINEERING

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J0952-18-01
January 18, 2011

Mr. Joseph Rodio
South Hadley Public Library
27 Bardwell Street
South Hadley, Massachusetts 01075

Re: Preliminary Geotechnical Recommendations
Proposed South Hadley Library
Canal Street and West Main Street
South Hadley, Massachusetts

Dear Mr. Rodio:

We are pleased to provide this letter report summarizing our preliminary geotechnical engineering findings and recommendations for the proposed South Hadley Public Library, to be located at the corner of Canal Street and West Main Street in South Hadley, Massachusetts. A Site Locus is provided as Figure 1. A Site Plan is provided as Figure 2.

Our preliminary geotechnical study was based upon four soil borings. Our services consisted of the full-time observation of the borings, review of the boring logs and soil samples, engineering analyses, and preparation of this report. This report is subject to the attached limitations.

## PROJECT DESCRIPTION

The project Site is located at the corner of Canal Street and West Main Street in South Hadley, Massachusetts. The site is presently occupied by two abandoned buildings, a two-story concrete structure and a two-story wooden structure. Project plans call for the demolition of these existing structures, and for the construction of an approximately 8,000 to 10,000 square foot (approximate footprint) library building. The building is expected to be a two-story high, slab-on-grade structure. The proposed structure will likely be steel-framed, with brick masonry. Building live loads are expected to be on the order of 150 pounds per square foot.

In general, existing topography is relatively flat in the vicinity of the proposed building. We understand that the building will be constructed near existing grade. Therefore, cuts and fills to construct the new building pad will be less than five feet.

## SUBSURFACE EXPLORATIONS

Subsurface explorations consisted of four soil borings (SHL-1 through SHL-4). These were performed on January 4, 2011 by Seaboard Drilling of Chicopee, Massachusetts. The borings were located in paved areas surrounding the existing buildings. The borings were performed using a truck mounted rig, equipped with hollow stem augers. The borings were extended until drilling refusal was encountered at a depth of between 10 and 20 feet below ground surface. An O'Reilly, Talbot and Okun Associates, Inc. (OTO) field scientist observed and logged each boring. Boring locations are shown on Figure 2. Boring logs are attached.

Two borings (SHL-1 and SHL-3) were completed as groundwater monitoring wells upon drilling completion. Monitoring well locations are shown on Figure 2. Monitoring well construction data is indicated on the attached boring logs.

Soil samples were collected continuously from the ground surface to the completion depth of eight feet below ground surface. Soil samples were collected using a 2-inch diameter split spoon sampler driven 24-inches with a 140 pound hammer falling 30 inches (American Society for Testing and Materials Test Method D1586-99 "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils"). The number of blows required to drive the sampler each 6 inches was recorded. The standard penetration resistance, or N-value, is the number of blows required to drive the sampler the middle 12 inches. Soil properties, such as strength and density, are related to the SPT blow count. After drilling, the boreholes were backfilled with sand. Soil samples were screened in the field for the presence of volatile organic compounds (VOCs), using a photoionization detector (PID). Results of PID screening are shown on boring logs and are discussed under separate cover.

## SUBSURFACE CONDITIONS

Subsurface conditions were interpreted based upon the soil borings. In general, the subsurface conditions were similar between borings and varied little with depth. Borings SHL-1, SHL-2 and SHL-4 encountered approximately 2 inches of asphalt pavement at the ground surface. Boring SHL-3, which was performed in a grass covered area located to the east of the existing buildings, encountered approximately 12 inches of topsoil at the ground surface.

Soil conditions encountered below the topsoil/asphalt layer consisted primarily of five feet of dense to very dense, fine sand and gravel with some to little amounts of silt and little to trace amounts of coarse sand. This sand layer was underlain by either a medium dense, sandy silt or dense to very dense glacial till. Glacial till is a very dense, heterogeneous mixture of silt, clay, sand and gravel, and is generally present immediately above bedrock throughout New England.

The borings were terminated at drilling refusal at a depth of between 10 and 20 feet below ground surface. Refusal was most likely upon hard glacial till, boulders, or bedrock.

Groundwater was encountered at depths between 10 and 13 feet below ground surface. In addition, static groundwater level measurements were obtained on January 11, 2011 in the monitoring wells installed at locations SHL-1 and SHL-3. The depth to groundwater in borings SHL-1 and SHL-3 were 10.2 and 14.2 feet below ground surface, respectively.

Please note that based upon the soil conditions observed, perched water may be encountered during wet periods.

## ENVIRONMENTAL CONDITIONS

The soil samples collected from the borings were screened in the field for Volatile Organic Compounds (VOCs) using a TEI 580 B photoionization detector (PID). No staining, odors, or other indications of contamination were identified in the soil samples collected. No VOCs were detected by the PID screening. Additional environmental conditions are discussed in the Phase II Environmental Site Assessment, provided under separate cover.

## GEOTECHNICAL ISSUES

The significant geotechnical issues for the proposed construction addressed in this report are foundation bearing capacity and settlement, and the suitability of on-Site materials for use in engineered fills.

## PRELIMINARY DESIGN RECOMMENDATIONS

In general, subsurface conditions are favorable for the proposed construction. The proposed addition can be founded on normal spread footings bearing on the dense, native Site soils or compacted engineered fill. The following preliminary recommendations are provided for the assumed construction.

### Foundations

The proposed building can be founded on normal spread footing foundations bearing on the dense, native granular deposits or compacted sand and gravel fill. For preliminary design, we recommend that footings bearing on these materials be designed for a maximum allowable bearing pressure of 5,000 pounds per square foot. If wet, disturbed soils or debris, non-engineered fill, organic soils or other suitable materials are present within footing excavations, they should be removed and replaced with compacted Sand and Gravel fill or Crushed Stone.

Furthermore, we understand the existing Site buildings will be demolished prior to the start of construction. If any below grade structures or utilities, associated with the existing Site buildings are encountered, these should be removed and backfilled with engineered fill in accordance to recommendations provided below. The documentation of this fill placement should be reviewed by the geotechnical engineer. Any footings or foundation walls that are located within the footprint of the proposed building should be removed prior to construction of the new building.

We anticipate that settlements of footings and slabs bearing on the granular material or compacted engineered fill should be small and largely elastic in nature. We anticipate that maximum settlements would be on the order of 1/2 inch or less and would occur relatively quickly after load application (during construction).

We recommend that spread footings be embedded a minimum of 48 inches below the ground surface for frost protection. Conventional spread footings shall be at least 18 inches wide for continuous footings, and at least 24 inches wide for isolated footings. All other applicable requirements of the Massachusetts State Building Code (MSBC) should be followed.

If winter construction occurs, footings should not be placed on frozen soils. Footing excavations should be free of loose or disturbed materials. Any boulders or cobbles larger than 4 inches diameter should be removed from within one foot of the bottom of the footings and replaced with Sand and Gravel fill or Crushed Stone. If loose materials are present in the excavations, they shall be recompacted to form a firm, dense bearing surface.

Concrete Slabs

We recommend that concrete floor slabs bear on at least 12 inches of compacted Sand and Gravel fill, to provide uniform support and a capillary moisture break. The subgrade should also be free of large boulders, if encountered. The Sand and Gravel fill beneath the concrete slabs should meet the grain size distribution characteristics for Sand and Gravel as outlined in Table 1. Fill supporting slabs should be placed in accordance with the recommendations for gradation and compaction provided below.

Seismic Considerations

Earthquake loadings must be considered under requirements in Section 1615 and 1804 of the 7th Edition (September 2008) Massachusetts State Building Code (MSBC). Note that Section 1615.0 includes Sections with prefix of "9" which refer to the applicable section of ASCE 7.

Section 1615 covers lateral forces imposed on structures from earthquake shaking. Per Table 1604.10, the maximum considered earthquake spectral response acceleration at short periods ($S_s$) and at 1-sec ($S_1$) was determined to be 0.23 and 0.066, respectively, for South Hadley, Massachusetts. In addition, the Site Class was determined to be Class C based upon soil data collected. Furthermore, the Site coefficients $F_a$ and $F_v$ were determined according to Tables 9.4.1.2.4a and 9.4.1.2.4b, using both the $S_s$ and $S_v$ values and the Site Class. For this Site, $F_a$ and $F_v$ were determined to be 1.2 and 1.7, respectively.

Section 1804.6 relates to the liquefaction potential of the underlying soils. The liquefaction potential is evaluated for Site soils that are encountered below the water table, using Figure 18.4.6(B) of the MSBC. Based upon density and fines content, the soils at the Site are not likely to be susceptible to liquefaction.

Earthwork Recommendations

We anticipate that earthwork for this project will include cuts and fills for the building pad, excavations for footings, and subgrade preparation.

Three engineered fill types are recommended, Sand and Gravel and/or Crushed Stone for use within 12 inches beneath footings and floor slabs, and Granular Fill for use as miscellaneous fill. Grain size distribution requirements are presented in Table 1.

**Table 1**
**Grain Size Distribution Requirements**

| Size | Sand and Gravel | Crushed Stone | Granular Fill |
|---|---|---|---|
| | Percent Finer by Weight | | |
| 4 inch | 100 | --- | 100 |
| 1 inch | --- | 100 | --- |
| 3/4 inch | --- | 90-100 | --- |
| 1/2 inch | 50-85 | 10-50 | --- |
| 3/8 inch | --- | 1-20 | --- |
| No. 4 | 40-75 | 0-5 | --- |
| No. 10 | --- | --- | 30-90 |
| No. 40 | 10-35 | --- | 10-70 |
| No. 100 | --- | --- | --- |
| No. 200 | 0-8 | --- | 0-15 |

The near surface soils encountered at the time of drilling may meet the grain size distribution requirements for re-use as granular fill. We recommend that representative samples of near surface soils be collected during final design and analyzed for grain size distribution, to determine if Site soils can be re-used as engineered fill. It does not appear that on-site soils meet requirements for Sand and Gravel or Crushed Stone fill.

Any asphalt, concrete, topsoil, vegetation and organic soils should be stripped from beneath the proposed structures. Debris, topsoil, or organic soils stripped from the excavation should not be re-used as fill beneath structures. To avoid point loads, any cobbles or boulders larger than 4 inches in diameter encountered at the subgrade for footings and slabs-on-grade should be removed and replaced with compacted sand and gravel fill. Fill should be placed in lifts of no more than 12-inches thick and compacted with at least four passes with a vibrating drum roller (minimum of 6,000 pound weight). Compaction should achieve at least 95% of the Modified Proctor dry density as defined in ASTM D1557, Method C.

The contractor should note that the native silty soils at the Site are susceptible to moisture, due to the high percentage of fines within the soil mass. If these soils become wet during construction, they will become soft and easily disturbed. During winter construction periods, the fine grained soils will tend to remain wet and can not be easily dried or stabilized. It may be necessary to remove the disturbed soils and replace the materials with compacted Sand and Gravel or Crushed Stone. To avoid this potential issue, the contractor should establish and maintain proper drainage of soil surfaces.

Additional Services

Depending on final design and layout, we recommend additional geotechnical engineering services. These services and construction may include the following:

1. Additional soil borings within the footprint of the proposed building;
2. Laboratory analyses of soil samples, to evaluate their suitability for use as engineered fill and storm water disposal design;
3. Preparation of a final design report; and
4. Construction phase services.

We appreciated the opportunity to be of service on this project. If you have any questions, please call the undersigned.

Sincerely yours,
O'Reilly, Talbot & Okun Associates, Inc.

Ashley L. Mickiewicz, P.E.
Senior Project Manager

Michael J. Talbot, P.E.
Principal

Attachments: Limitations, Site Locus, Site Plan, Boring Logs

F:\J0900\952 J Stewart Roberts Architects\18-01 S Hadley Library S Hadley MA-Geotech & Environmental Svcs\Geotech Report\Geotech Report S Hadley Library 1-18-2011.doc

# LIMITATIONS

## LIMITATIONS

1. The observations presented in this report were made under the conditions described herein. The conclusions presented in this report were based solely upon the services described in the report and not on scientific tasks or procedures beyond the scope of the project or the time and budgetary constraints imposed by the client. The work described in this report was carried out in accordance with the Statement of Terms and Conditions attached to our proposal.

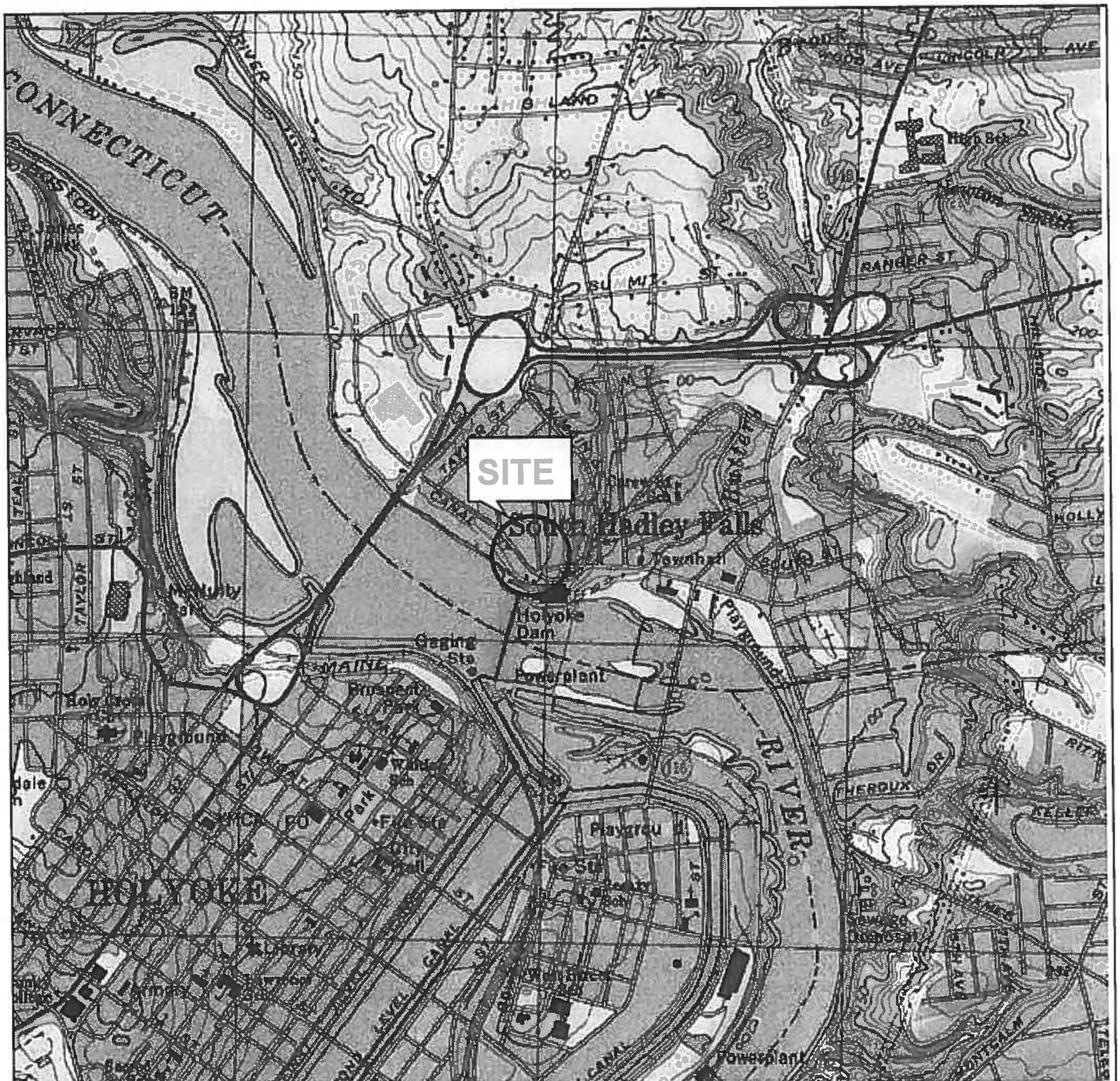
2. The analysis and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

3. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

4. In the event that any changes in the nature, design or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by O'Reilly, Talbot & Okun Associates Inc. It is recommended that we be retained to provide a general review of final plans and specifications.

5. Our report was prepared for the exclusive benefit of our client. Reliance upon the report and its conclusions is not made to third parties or future property owners.

# FIGURES
## (Site Locus and Site Plan)




N

Topographic Map Quadrant: Springfield North, MA
Map Version: 1975
Current as of: 1979



0 .5 1 MILES

1000 0 1000 2000 3000 4000 5000 FEET

1 .5 0 KILOMETERS 1

1000 0 METERS 1000

**O'Reilly, Talbot & Okun**
[ A S S O C I A T E S ]
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www.oto-env.com

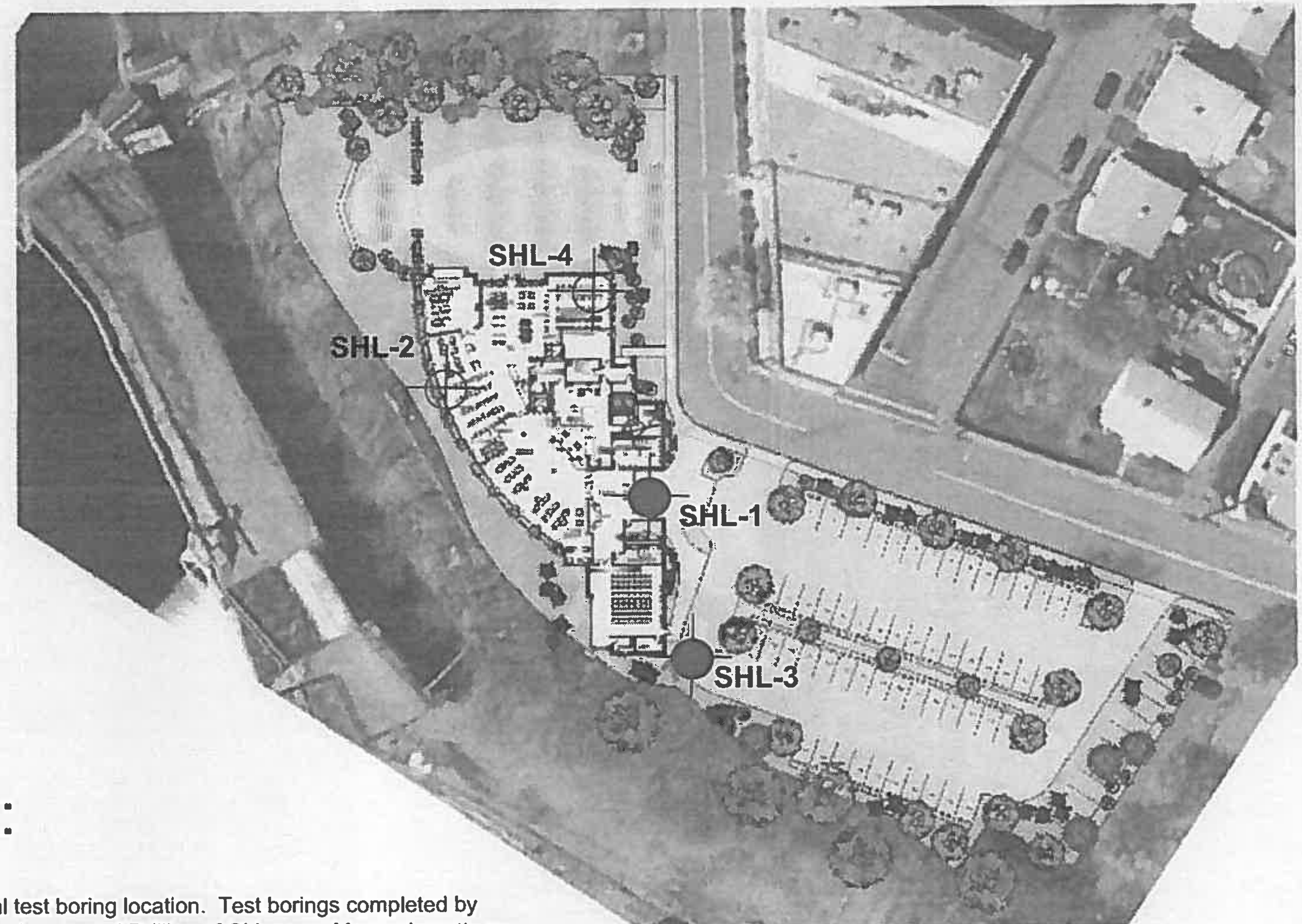
Proposed South Hadley Library
South Hadley, Massachusetts

## SITE LOCUS

January, 2011

Figure 1

# FIGURE 2 - SITE SKETCH




## Legend:

- Geotechnical test boring location. Test borings completed by Seaboard Environmental Drilling of Chicopee, Massachusetts on 01/04/2011, observed by OTO.
- Geotechnical test boring and monitoring well location. Test borings completed by Seaboard Environmental Drilling of Chicopee, Massachusetts on 01/04/2011, observed by OTO.

O'Reilly, Talbot and Okun Associates, Inc.

Job Number 0952-18-01
Proposed Public Library
Canal Street and West Main Street
South Hadley, Massachusetts

# BORING LOGS

# O'REILLY, TALBOT & OKUN ASSOCIATES, INC.
ENVIRONMENTAL AND GEOTECHNICAL ENGINEERING CONSULTANTS

## LOG OF BORING SHL-1



| | | | |
|---|---|---|---|
| PROJECT: South Hadley Library | | LOCATION: South Hadley, MA | PROJECT NO.: 0952-18-01 |
| DRILLING CONTRACTOR Seaboard Environmental Drilling | FOREMAN Jeff<br>HELPER Dave | DATE STARTED 01/04/2011 | DATE FINISHED 01/04/2011 |
| DRILLING EQUIPMENT B-53 Truck Mounted Rig | | COMPLETION DEPTH 20' | GROUND SURFACE ELEV.<br>DATUM |
| TYPE BIT Hollow Stem Auger | SIZE &TYPE OF CORE BARREL | No. Samples 8 | UNDIST. |
| CASING | | TIME | FIRST / COMPL. / HR. |
| CASING HAMM. | WEIGHT / DROP | WATER LEVEL (FT.) | 10' (FIRST) |
| SAMPLER: 2" O.D. Split Spoon | Rod A(1 5/8" O.D.) | BORING LOCATION | 52' north of northwestern corner of southaastern building<br>15' east of northwest corner of southeastern building |
| SAMPLER HAMMER Safety | WEIGHT 140 / DROP 30" (wire line) | ENGINEER/GEOLOGIST | Sabrina Moreau |

| DEPTH FT. | PENETR. RESIST. BL/6 IN. | REC. IN. | TYPE/ NO. | DESCRIPTION | FIELD MEASUREMENTS | SOIL DESCRIPTION | WELL CONSTRUCTION |
|---|---|---|---|---|---|---|---|
| 0 | | | S-1 (0-2) | Aproximately 2" ASPHALT<br>Red-brown, fine to medium SAND, trace (+) silt, trace (-) fine gravel, dry | 0 | ASPHALT<br>FINE TO MEDIUM SAND | |
| 2 | 15/16/19/20 | 18/24 | S-2 (2-4) | Densa, red-brown, fine to medium SAND, trace silt, trace (+) fine gravel, dry | 0 | | 4' |
| 4 | 12/26/25/22 | 10/24 | S-3 (4-6) | Very dense, red-brown, fine to medium SAND, trace silt, trace (+) fine gravel, dry | 0 | 7' | 6' |
| 6 | 37/17/19/19 | 14/24 | S-4 (6-8) | Top 8": Dense, red-brown, fine to medium SAND, trace silt, trace (+) fine gravel, moist<br>Bottom 6": Dense, red-brown, fine SAND, some silt, trace (-) fine gravel, moist | 0 | GLACIAL TILL | 8' |
| 8 | 22/43/ 50 for 3" | 14/18 | S-5 (8-10) | Very dense, red-brown, fine SAND, some silt, trace (-) fine gravel, tip appears wet (glacial till) | 0 | | |
| 10 | 50 for 1" | 1/1 | S-6 (10-12) | Very dense, grey, CRUSHED ROCK, dry | 0 | | |
| 15 | 3/6/27/ 50 for 2" | 12/20 | S-7 (15-17) | Dense, brown, fine SAND & SILT, little crushed rock, wet (glacial till) | 0 | | 18' |
| 20 | 50 for 2" | 2/24 | S-8 (20-22) | Very dense, brown, SILT, some crushed angular rock, wet (glacial till) | – | | |
| | | | | Auger refusal at 20', end of exploration | | | |

Remarks:
1. Soil screened in field using TEI Model 580B photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume. "ND" indicates none detected
2. Sample from 0-2' collected from auger due to frozen ground
3. Auger bouncing and grinding from 2'-3'
4. 2" PVC well set at 18' below ground surface, screen 18'-8', solid PVC riser 8'-0.5', curb box to grade cemented in place, sand pack 18'-6', bentonite clay seal 6'-4', soil cuttings to grade.

# O'REILLY, TALBOT & OKUN ASSOCIATES, INC.
ENVIRONMENTAL AND GEOTECHNICAL ENGINEERING CONSULTANTS

## LOG OF BORING SHL-2



| | |
|---|---|
| PROJECT: | South Hadley Library |
| LOCATION: | South Hadley, MA |
| PROJECT NO.: | 0952-18-01 |
| DRILLING CONTRACTOR | Seaboard Environmental Drilling |
| FOREMAN | Jeff |
| HELPER | Dave |
| DATE STARTED | 01/04/2011 |
| DATE FINISHED | 01/04/2011 |
| DRILLING EQUIPMENT | B-53 Truck Mounted Rig |
| COMPLETION DEPTH | 10' |
| GROUND SURFACE ELEV. | |
| DATUM | |
| TYPE BIT | Hollow Stem Auger |
| SIZE & TYPE OF CORE BARREL | |
| No. Samples | 2 |
| UNDIST. | |
| CASING | |
| TIME | |
| CASING HAMM. | WEIGHT / DROP |
| WATER LEVEL (FT.) | FIRST: – ; COMPL.: ; HR.: |
| SAMPLER: 2" O.D. Split Spoon | Rod A(1 5/8" O.D.) |
| BORING LOCATION | 10' northeast of southwestern corner of northwestern building; 13' northwest of southwestern corner of northwestern building |
| SAMPLER HAMMER | Safety; WEIGHT 140; DROP 30" (wire line) |
| ENGINEER/GEOLOGIST | Sabrina Moreau |

| DEPTH FT. | PENETR. RESIST. BL/6 IN. | REC. IN. | TYPE/NO. | DESCRIPTION | FIELD MEASUREMENTS | SOIL DESCRIPTION | REMARKS |
|---|---|---|---|---|---|---|---|
| 0 | | | | Approximately 2" ASPHALT | | ASPHALT | |
| 2-4 | 5/8/12/14 | 8/24 | S-1 (2-4) | Medium dense, brown, fine to medium SAND, trace (+) fine to medium gravel, dry | 0 | FINE TO MEDIUM SAND (to 5') | |
| 5-7 | 32/42/27/ 50 for 4" | 12/24 | S-2 (5-7) | Very dense, red-brown, fine to medium SAND, trace (+) fine to medium gravel/crushed rock, dry (glacial till) | 0 | GLACIAL TILL | |
| 10 | | | | Auger refusal at 10', end of exploration | | | |

Remarks:
1. Soil screened in field using TEI Model 580B photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume. "ND" indicates none detected
2. Auger grinding from 8'-10'

# O'REILLY, TALBOT & OKUN ASSOCIATES, INC.
ENVIRONMENTAL AND GEOTECHNICAL ENGINEERING CONSULTANTS

## LOG OF BORING SHL-3



| | | | |
|---|---|---|---|
| PROJECT : South Hadley Library | LOCATION: South Hadley, MA | PROJECT NO. : 0952-18-01 | |
| DRILLING CONTRACTOR Seaboard Environmental Drilling | FOREMAN Jeff / HELPER Dave | DATE STARTED 01/04/2011 | DATE FINISHED 01/04/2011 |
| DRILLING EQUIPMENT B-53 Truck Mounted Rig | | COMPLETION DEPTH 19.5 | GROUND SURFACE ELEV. DATUM |
| TYPE BIT Hollow Stem Auger | SIZE &TYPE OF CORE BARREL | No. Samples 5 | UNDIST. |
| CASING | | TIME | FIRST / COMPL. / HR. |
| CASING HAMM. | WEIGHT / DROP | WATER LEVEL (FT.) | 13' |
| SAMPLER: 2" O.D. Split Spoon | Rod A(1 5/8" O.D.) | BORING LOCATION | 12' east of southeast corner of former southern building; 3.5 ' northaast of southeast corner of former southern building |
| SAMPLER HAMMER Safety | WEIGHT 140 / DROP 30" (wire line) | ENGINEER/GEOLOGIST | Sabrina Moreau |

| SAMPLES | DEPTH FT. | PENETR. RESIST. BL/6 IN. | REC. IN. | TYPE/ NO. | DESCRIPTION | FIELD MEASUREMENTS | SOIL DESCRIPTION | WELL CONSTRUCTION |
|---|---|---|---|---|---|---|---|---|
| | | | | | Approximately 12" silty Topsoil | | TOPSOIL | |
| X | 2 | 2/4/7/23 | 18/24 | S-1 (2-4) | Medium dense, brown, fine to medium SAND, trace (+) fine to medium gravel, dry | 0 | FINE TO MEDIUM SAND (to 5') | |
| X | 5 | 22/32/32/20 | 14/24 | S-2 (5-7) | Very dense, red-brown, fine to medium SAND, trace (+) fine gravel, dry (glacial till) | 0 | Sandy SILT | 6', 8' |
| X | 10 | 12/10/13/37 | 18/24 | S-3 (10-12) | Medium dense, red-brown, SILT, some fine sand, trace (+) fine gravel, moist (glacial till) | 0 | | 10' |
| X | 15 | 12/5/8/12 | 16/24 | S-4 (15-17) | Medium dense, red-brown, SILT, some fine sand, trace (+) fine gravel, wet (glacial till) | 0 | | 19' |
| X | 20 | 50 for 1" | 0/24 | S-5 (19.5-21.5) | No recovery, small gray rock chip in spoon | - | | |
| | | | | | Auger refusal at 19.5', end of exploration | | | |
| | 25 | | | | | | | |

Remarks:
1. Soil screened in field using TEI Model 580B photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume. "ND" indicates none detected
2. 2" PVC well set at 19.5' below ground surface, screen 19.5'-10', solid PVC riser 10'-0.5', curb box to grade cemented in place, sand pack 19.5'-8', bentonite clay seal 8'-6', soil cuttings to grade.

# O'REILLY, TALBOT & OKUN ASSOCIATES, INC.
ENVIRONMENTAL AND GEOTECHNICAL ENGINEERING CONSULTANTS

## LOG OF BORING SHL-4



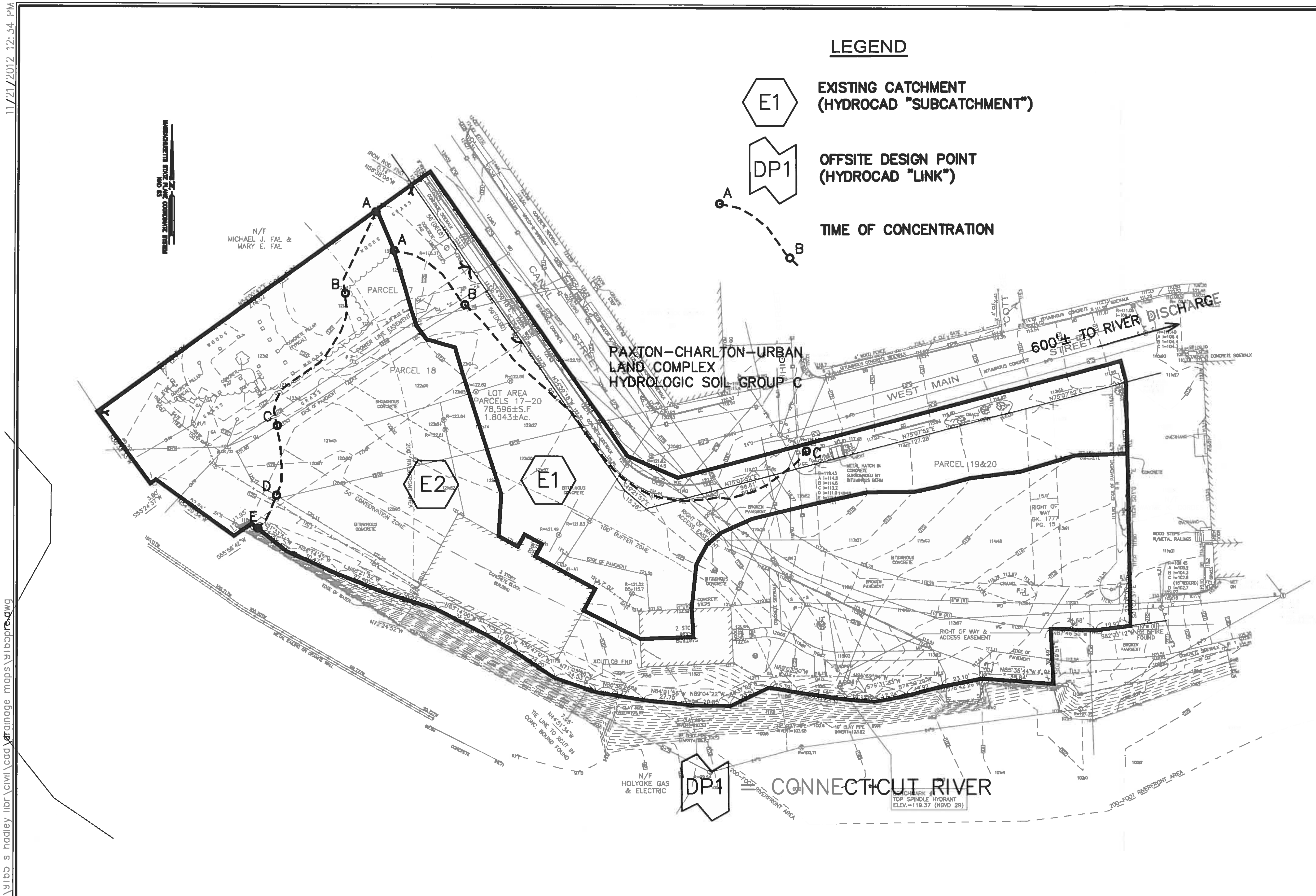
| | | | |
|---|---|---|---|
| PROJECT: South Hadley Library | | LOCATION: South Hadley, MA | PROJECT NO.: 0952-18-01 |
| DRILLING CONTRACTOR Seaboard Environmental Drilling | FOREMAN Jeff; HELPER Dave | DATE STARTED 01/04/2011 | DATE FINISHED 01/04/2011 |
| DRILLING EQUIPMENT B-53 Truck Mounted Rig | | COMPLETION DEPTH 15' | GROUND SURFACE ELEV. DATUM |
| TYPE BIT Hollow Stem Auger | SIZE & TYPE OF CORE BARREL | No. Samples 3 | UNDIST. |
| CASING | | TIME | FIRST 11'; COMPL.; HR. |
| CASING HAMM. WEIGHT DROP | | WATER LEVEL (FT.) | |
| SAMPLER: 2" O.D. Split Spoon | Rod A(1 5/8" O.D.) | BORING LOCATION 77' northeast of northeastern corner of northwestern building | |
| SAMPLER HAMMER Safety | WEIGHT 140; DROP 30" (wire line) | ENGINEER/GEOLOGIST Sabrina Moreau | |

| DEPTH FT. | PENETR. RESIST. BL/6 IN. | REC. IN. | TYPE/ NO. | DESCRIPTION | FIELD MEASUREMENTS | SOIL DESCRIPTION | REMARKS |
|---|---|---|---|---|---|---|---|
| 0 | | | | Approximately 2" ASPHALT | | ASPHALT | |
| 2-4 | 11/11/42/24 | 12/24 | S-1 (2-4) | Very dense, red-brown, fine to medium SAND, some silt, some fine to medium gravel (or crushed rock), dry (glacial till) | 0 | GLACIAL TILL | |
| 5-7 | 25/20/18/18 | 12/24 | S-3 (5-7) | Dense, red-brown, fine to medium SAND, some silt, little fine to medium gravel, dry (glacial till) | 0 | ↓ | |
| 10-12 | 16/23/30/37 | 20/24 | S-3 (10-12) | Dense, red-brown, fine to medium SAND, some silt, little fine to medium gravel, wet at 11' (glacial till) | 0 | ↓ | |
| 15 | | | | Auger refusal at 15', end of exploration | | | |

Remarks:
1. Soil screened in field using TEI Model 580B photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume. "ND" indicetes none detected

## APPENDIX C

**Pre-Development Conditions – HydroCAD Calculations**




**PRE-DEVELOPMENT DRAINAGE MAP**
SOUTH HADLEY LIBRARY
CANAL STREET, SOUTH HADLEY, MA

PREPARED FOR:
**JOHNSON ROBERS ASSOCIATES, INC**
15 PROPERZI WAY, SOMERVILLE, MA

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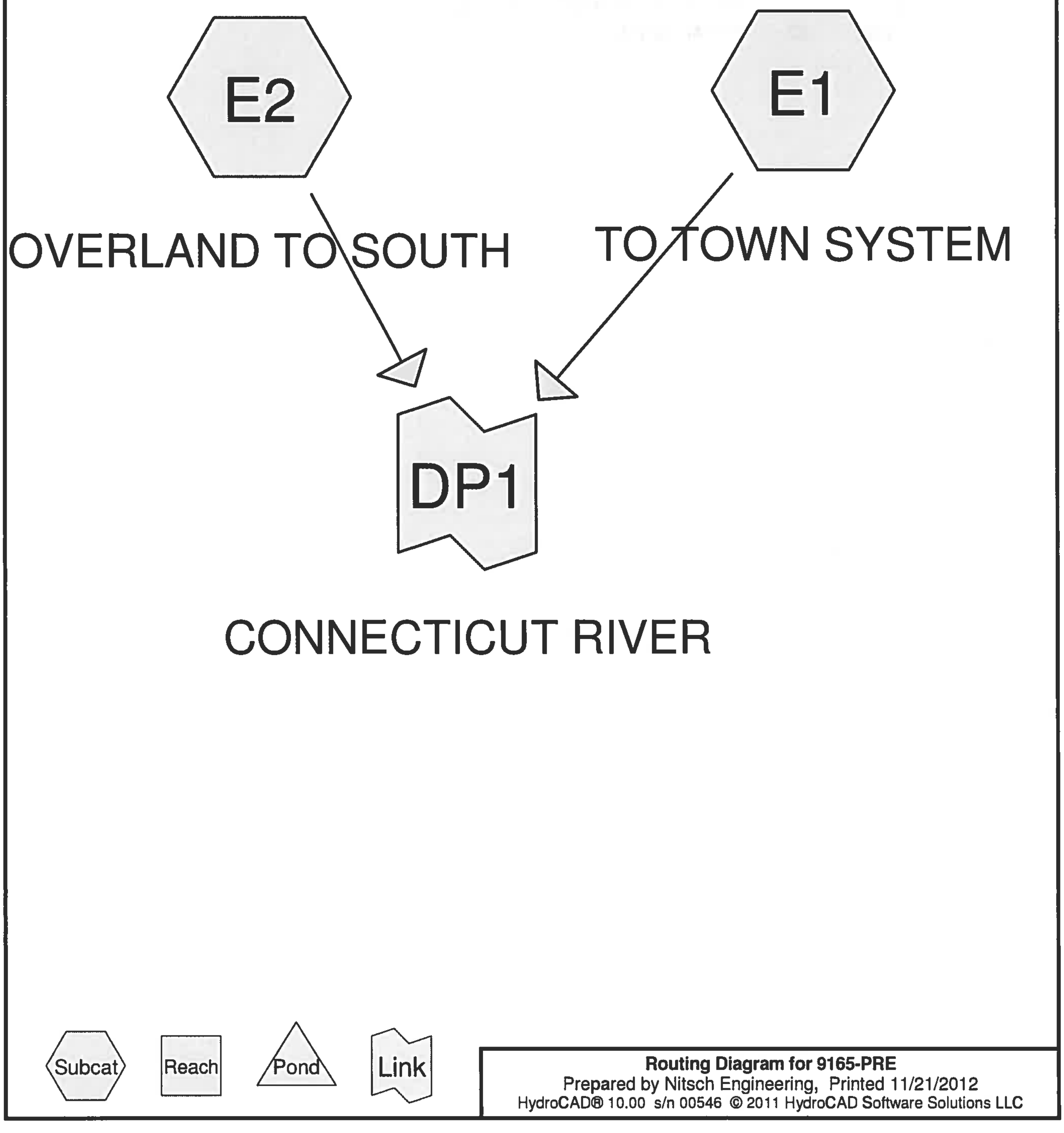
| | |
|---|---|
| PROJECT # | 9165 |
| FILE | 9165-PRE DWG |
| SCALE: | 1"=50' |
| DATE: | 11/09/2012 |
| PROJECT MGR: | DMC |
| SURVEYOR: | NITSCH |
| DRAFTED BY: | TJM |
| CHECKED BY: | DMC |

SHEET: 1

D1

OF 2 REV.




**Routing Diagram for 9165-PRE**
Prepared by Nitsch Engineering, Printed 11/21/2012
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## Area Listing (all nodes)

| Area (sq-ft) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 5,817 | 70 | Woods, Good, HSG C (E2) |
| 21,950 | 74 | >75% Grass cover, Good, HSG C (E1, E2) |
| 56,822 | 98 | Paved parking, HSG C (E1, E2) |
| **84,589** | **90** | **TOTAL AREA** |

## Summary for Subcatchment E1: TO TOWN SYSTEM

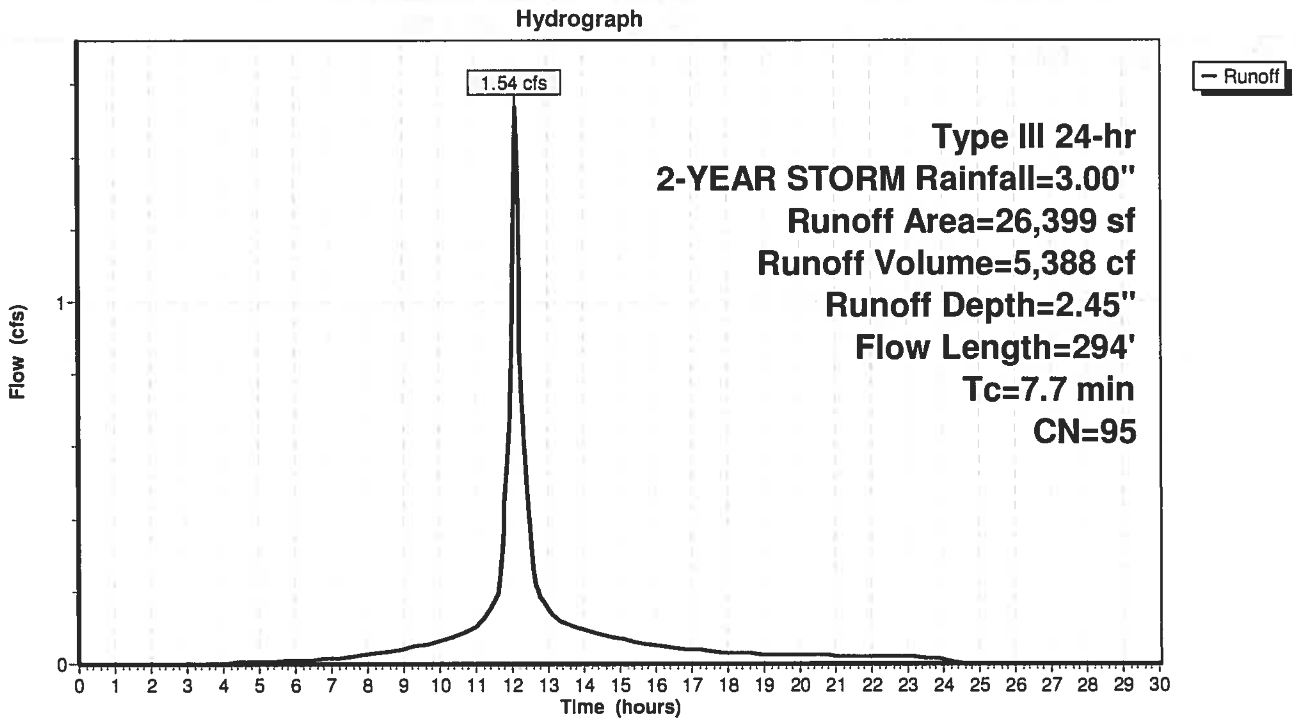
Runoff = 1.54 cfs @ 12.11 hrs, Volume= 5,388 cf, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YEAR STORM Rainfall=3.00"

| Area (sf) | CN | Description |
|---|---|---|
| 22,576 | 98 | Paved parking, HSG C |
| 3,823 | 74 | >75% Grass cover, Good, HSG C |
| 26,399 | 95 | Weighted Average |
| 3,823 | | 14.48% Pervious Area |
| 22,576 | | 85.52% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.2 | 50 | 0.0440 | 0.13 | | **Sheet Flow, A TO B** Grass: Dense n= 0.240 P2= 3.00" |
| 1.5 | 244 | 0.0180 | 2.72 | | **Shallow Concentrated Flow, B TO C** Paved Kv= 20.3 fps |
| 7.7 | 294 | Total | | | |

## Subcatchment E1: TO TOWN SYSTEM



## Summary for Subcatchment E2: OVERLAND TO SOUTH

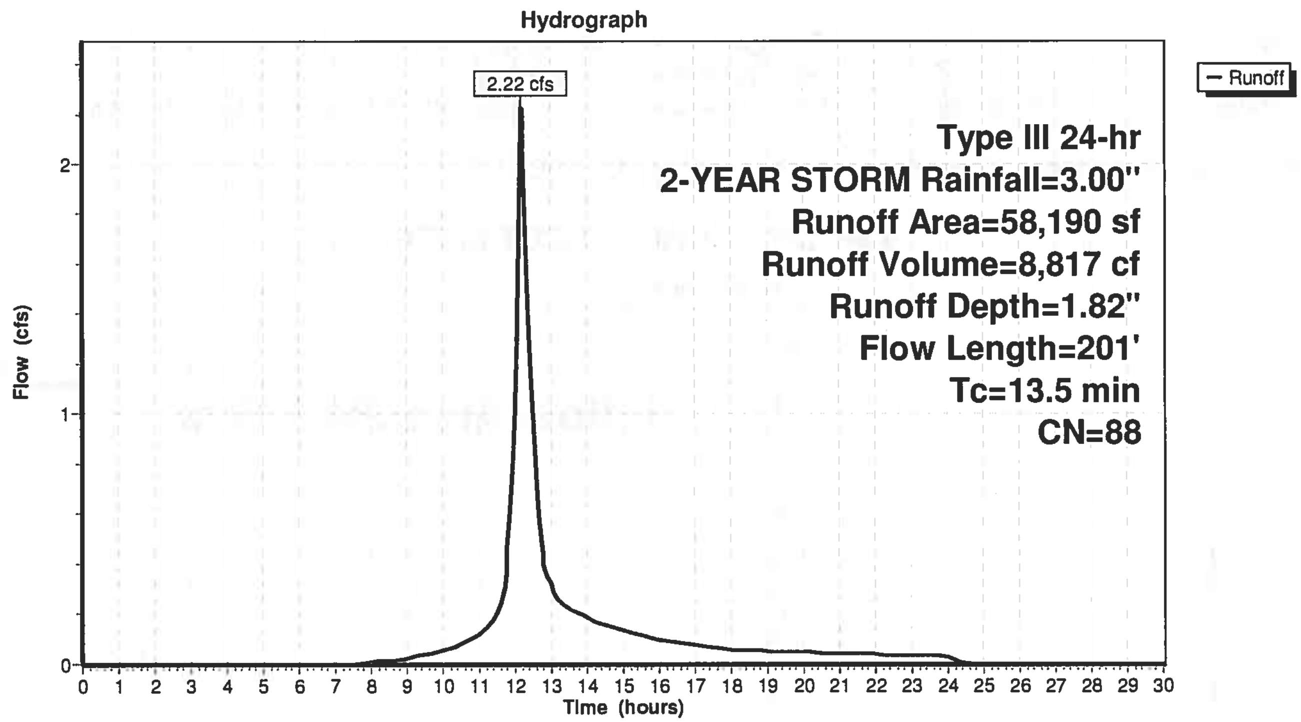
Runoff = 2.22 cfs @ 12.19 hrs, Volume= 8,817 cf, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YEAR STORM Rainfall=3.00"

| Area (sf) | CN | Description |
|---|---|---|
| 34,246 | 98 | Paved parking, HSG C |
| 18,127 | 74 | >75% Grass cover, Good, HSG C |
| 5,817 | 70 | Woods, Good, HSG C |
| 58,190 | 88 | Weighted Average |
| 23,944 | | 41.15% Pervious Area |
| 34,246 | | 58.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.7 | 50 | 0.0200 | 0.07 | | **Sheet Flow, A TO B**<br>Woods: Light underbrush n= 0.400 P2= 3.00" |
| 0.5 | 89 | 0.0400 | 3.22 | | **Shallow Concentrated Flow, B TO C**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 40 | 0.0230 | 3.08 | | **Shallow Concentrated Flow, C TO D**<br>Paved Kv= 20.3 fps |
| 0.1 | 22 | 0.1200 | 5.58 | | **Shallow Concentrated Flow, D TO E**<br>Unpaved Kv= 16.1 fps |
| 13.5 | 201 | Total | | | |

## Subcatchment E2: OVERLAND TO SOUTH

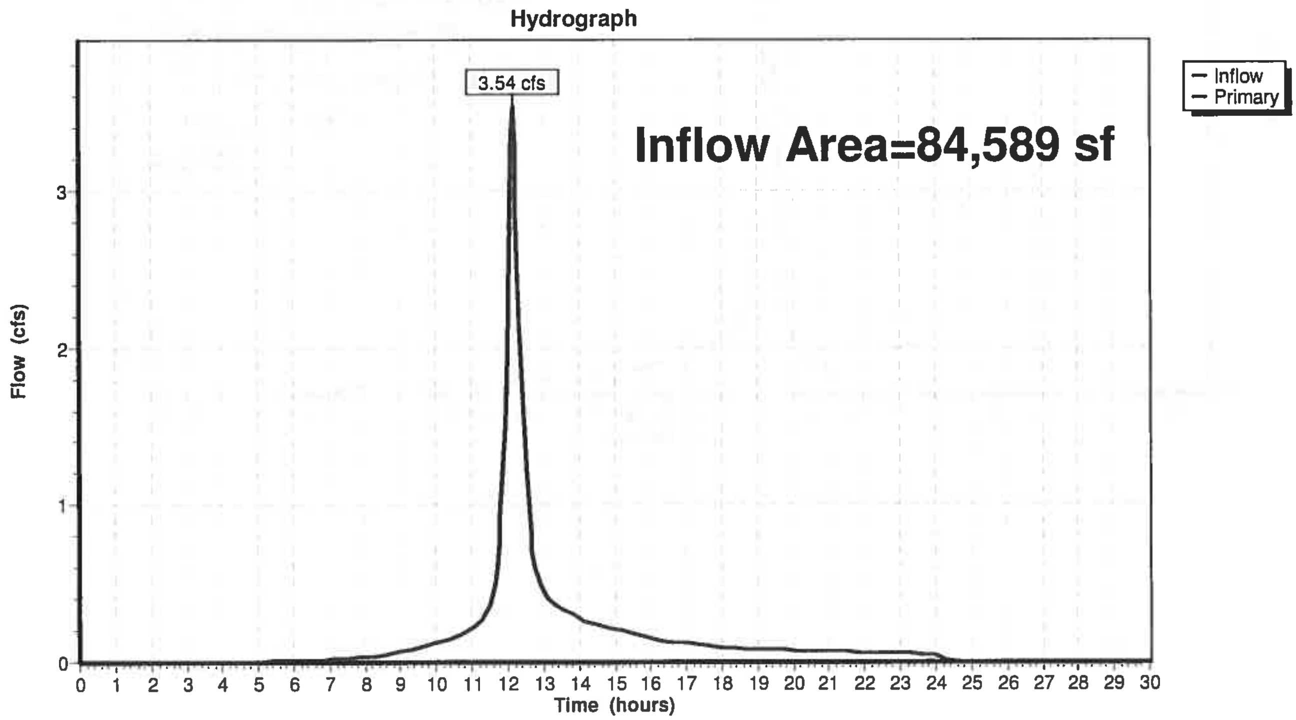


## Summary for Link DP1: CONNECTICUT RIVER

Inflow Area = 84,589 sf, 67.17% Impervious, Inflow Depth = 2.02" for 2-YEAR STORM event
Inflow = 3.54 cfs @ 12.15 hrs, Volume= 14,205 cf
Primary = 3.54 cfs @ 12.15 hrs, Volume= 14,205 cf, Atten= 0%, Lag= 0.0 min

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

## Link DP1: CONNECTICUT RIVER



## Summary for Subcatchment E1: TO TOWN SYSTEM

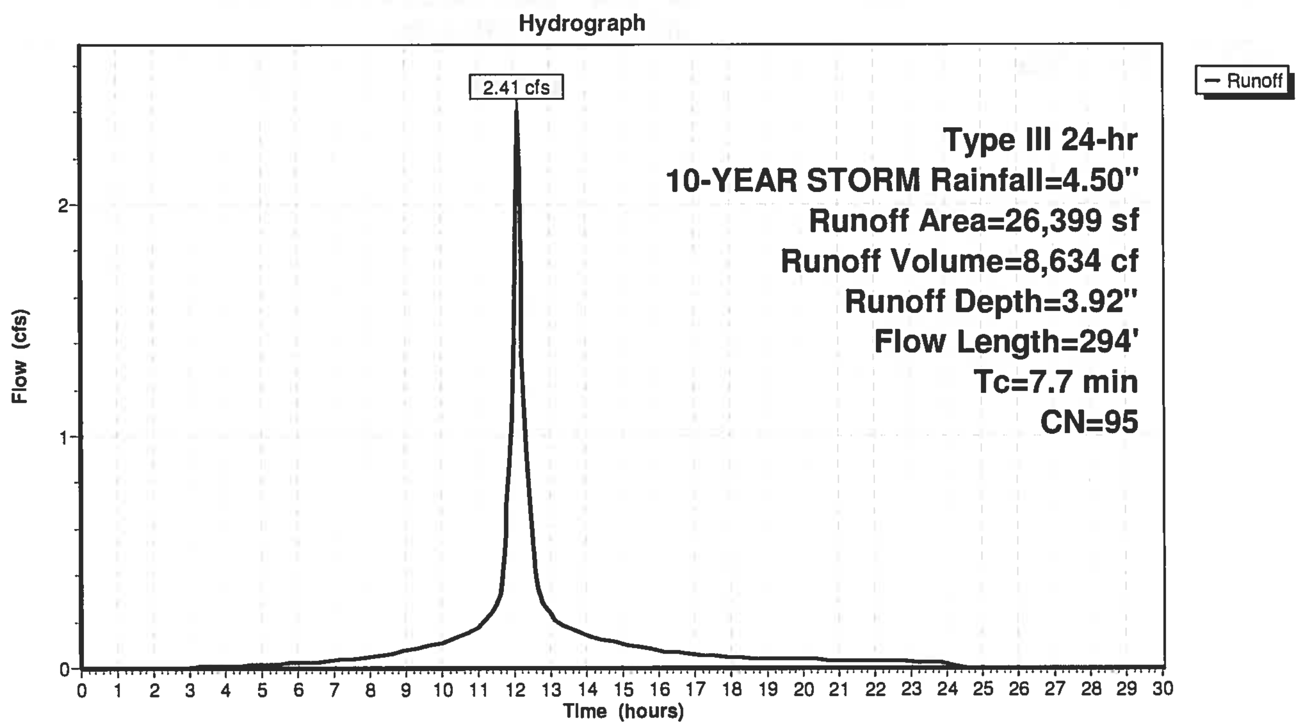
Runoff = 2.41 cfs @ 12.11 hrs, Volume= 8,634 cf, Depth= 3.92"

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

| Area (sf) | CN | Description |
|---|---|---|
| 22,576 | 98 | Paved parking, HSG C |
| 3,823 | 74 | >75% Grass cover, Good, HSG C |
| 26,399 | 95 | Weighted Average |
| 3,823 | | 14.48% Pervious Area |
| 22,576 | | 85.52% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.2 | 50 | 0.0440 | 0.13 | | **Sheet Flow, A TO B**<br>Grass: Dense n= 0.240 P2= 3.00" |
| 1.5 | 244 | 0.0180 | 2.72 | | **Shallow Concentrated Flow, B TO C**<br>Paved Kv= 20.3 fps |
| 7.7 | 294 | Total | | | |

## Subcatchment E1: TO TOWN SYSTEM



## Summary for Subcatchment E2: OVERLAND TO SOUTH

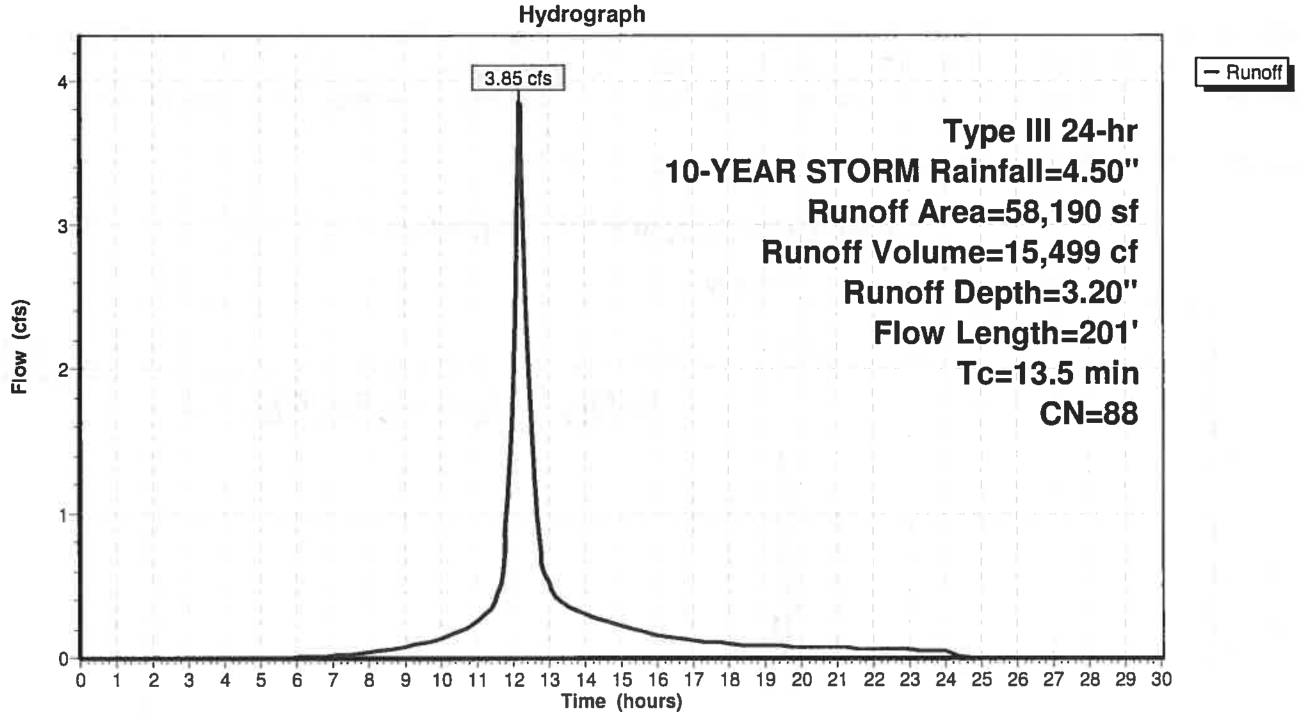
Runoff = 3.85 cfs @ 12.18 hrs, Volume= 15,499 cf, Depth= 3.20"

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

| Area (sf) | CN | Description |
|---|---|---|
| 34,246 | 98 | Paved parking, HSG C |
| 18,127 | 74 | >75% Grass cover, Good, HSG C |
| 5,817 | 70 | Woods, Good, HSG C |
| 58,190 | 88 | Weighted Average |
| 23,944 | | 41.15% Pervious Area |
| 34,246 | | 58.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.7 | 50 | 0.0200 | 0.07 | | **Sheet Flow, A TO B**<br>Woods: Light underbrush n= 0.400 P2= 3.00" |
| 0.5 | 89 | 0.0400 | 3.22 | | **Shallow Concentrated Flow, B TO C**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 40 | 0.0230 | 3.08 | | **Shallow Concentrated Flow, C TO D**<br>Paved Kv= 20.3 fps |
| 0.1 | 22 | 0.1200 | 5.58 | | **Shallow Concentrated Flow, D TO E**<br>Unpaved Kv= 16.1 fps |
| 13.5 | 201 | Total | | | |

## Subcatchment E2: OVERLAND TO SOUTH

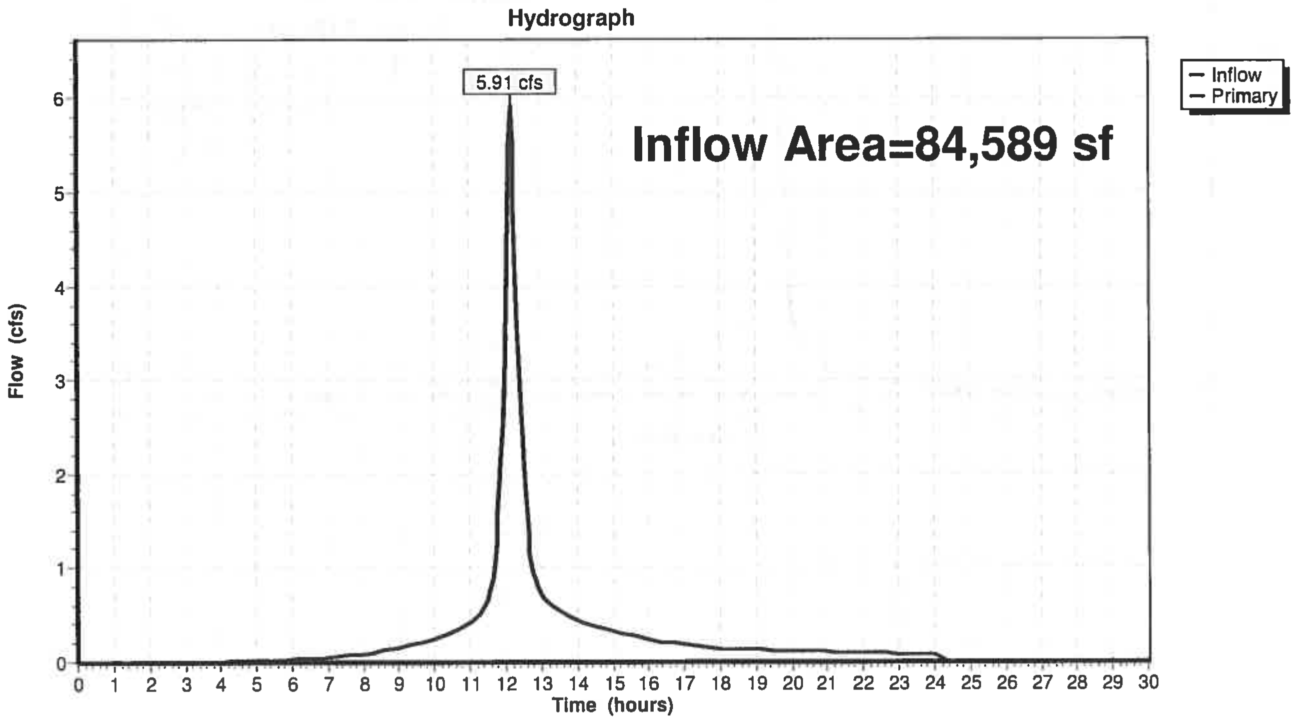


## Summary for Link DP1: CONNECTICUT RIVER

Inflow Area = 84,589 sf, 67.17% Impervious, Inflow Depth = 3.42" for 10-YEAR STORM event
Inflow = 5.91 cfs @ 12.15 hrs, Volume= 24,133 cf
Primary = 5.91 cfs @ 12.15 hrs, Volume= 24,133 cf, Atten= 0%, Lag= 0.0 min

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

### Link DP1: CONNECTICUT RIVER



## Summary for Subcatchment E1: TO TOWN SYSTEM

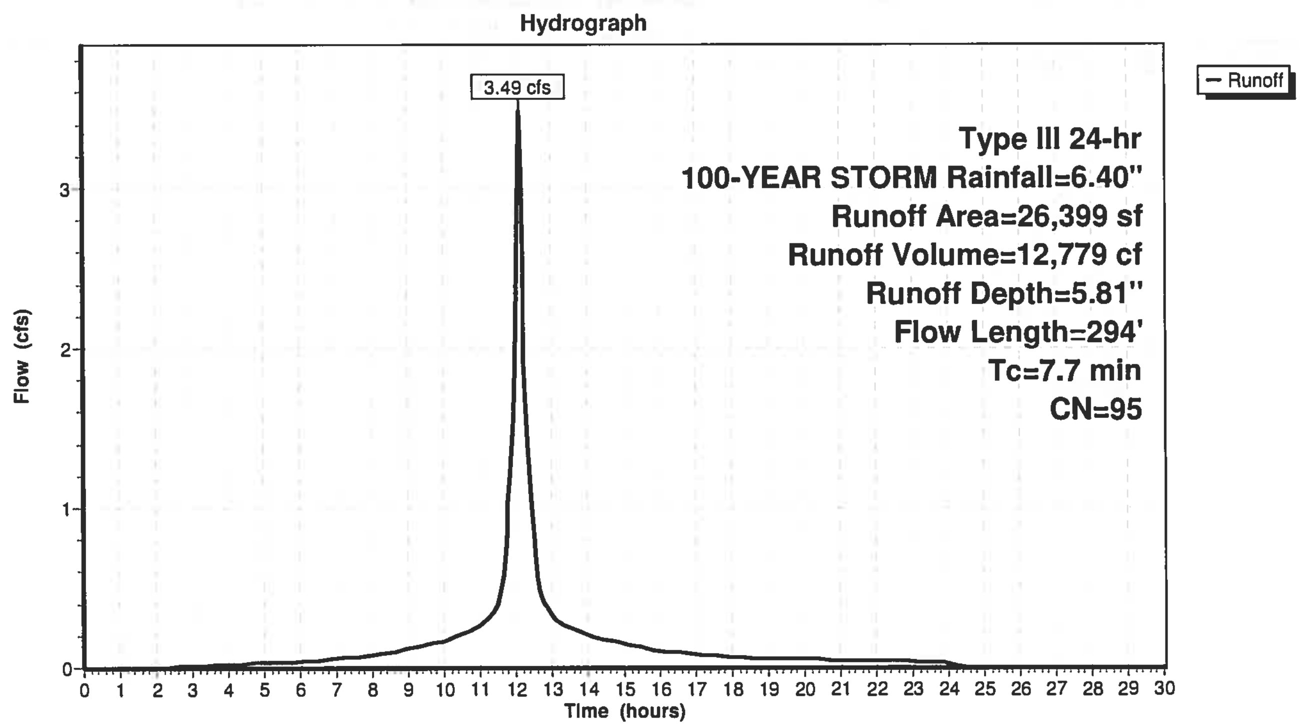
Runoff = 3.49 cfs @ 12.11 hrs, Volume= 12,779 cf, Depth= 5.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YEAR STORM Rainfall=6.40"

| Area (sf) | CN | Description |
|---|---|---|
| 22,576 | 98 | Paved parking, HSG C |
| 3,823 | 74 | >75% Grass cover, Good, HSG C |
| 26,399 | 95 | Weighted Average |
| 3,823 | | 14.48% Pervious Area |
| 22,576 | | 85.52% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.2 | 50 | 0.0440 | 0.13 | | **Sheet Flow, A TO B** Grass: Dense n= 0.240 P2= 3.00" |
| 1.5 | 244 | 0.0180 | 2.72 | | **Shallow Concentrated Flow, B TO C** Paved Kv= 20.3 fps |
| 7.7 | 294 | Total | | | |

## Subcatchment E1: TO TOWN SYSTEM



## Summary for Subcatchment E2: OVERLAND TO SOUTH

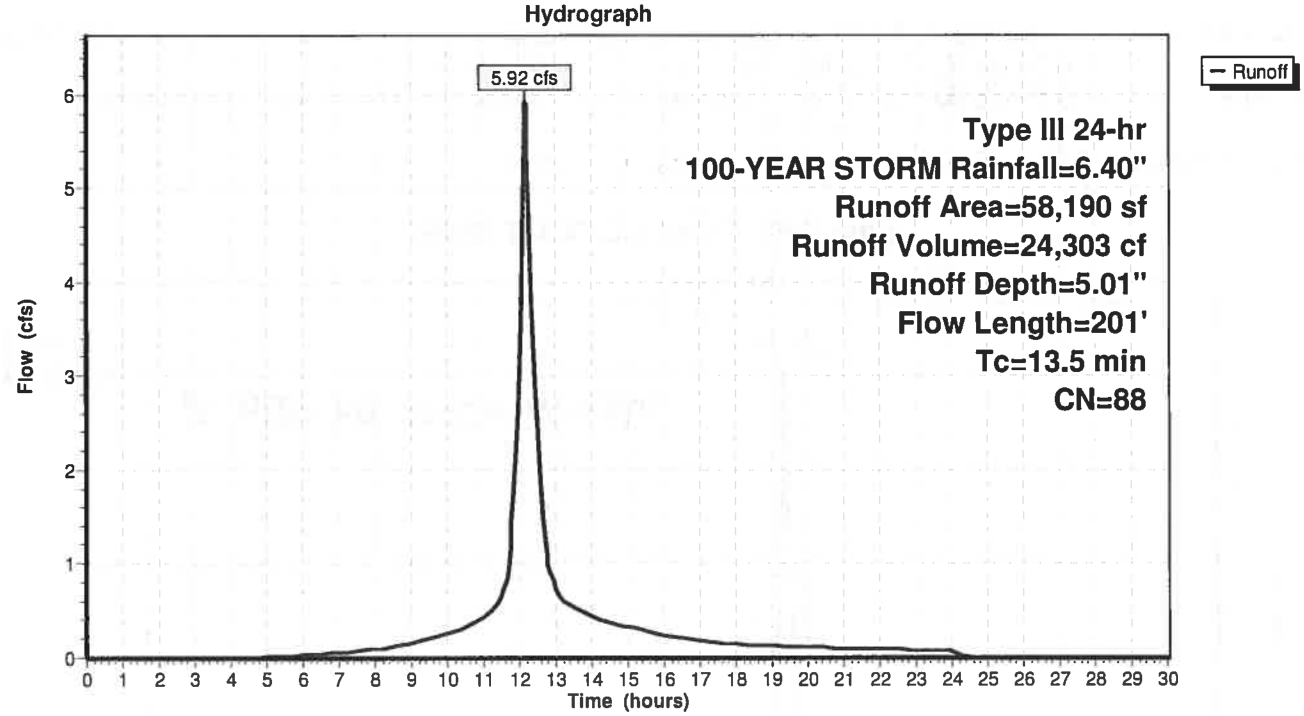
Runoff = 5.92 cfs @ 12.18 hrs, Volume= 24,303 cf, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YEAR STORM Rainfall=6.40"

| Area (sf) | CN | Description |
|---|---|---|
| 34,246 | 98 | Paved parking, HSG C |
| 18,127 | 74 | >75% Grass cover, Good, HSG C |
| 5,817 | 70 | Woods, Good, HSG C |
| 58,190 | 88 | Weighted Average |
| 23,944 | | 41.15% Pervious Area |
| 34,246 | | 58.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.7 | 50 | 0.0200 | 0.07 | | **Sheet Flow, A TO B**<br>Woods: Light underbrush n= 0.400 P2= 3.00" |
| 0.5 | 89 | 0.0400 | 3.22 | | **Shallow Concentrated Flow, B TO C**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 40 | 0.0230 | 3.08 | | **Shallow Concentrated Flow, C TO D**<br>Paved Kv= 20.3 fps |
| 0.1 | 22 | 0.1200 | 5.58 | | **Shallow Concentrated Flow, D TO E**<br>Unpaved Kv= 16.1 fps |
| 13.5 | 201 | Total | | | |

## Subcatchment E2: OVERLAND TO SOUTH

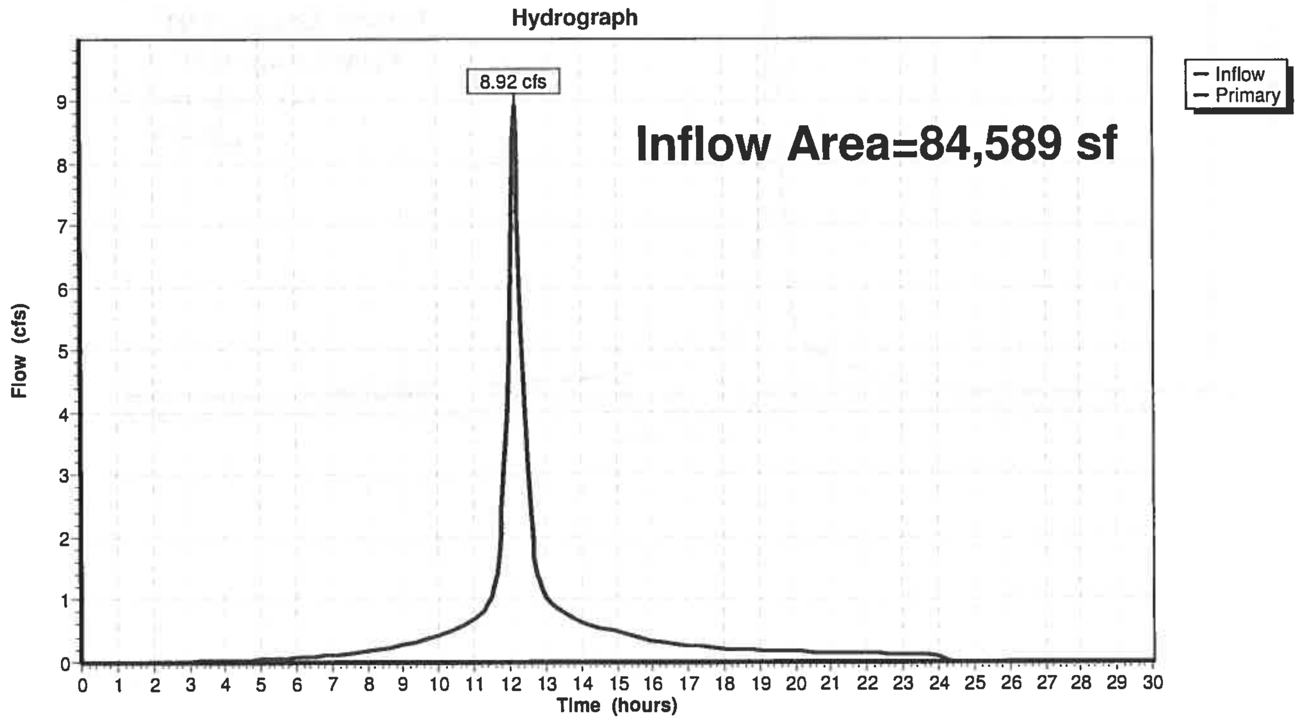


## Summary for Link DP1: CONNECTICUT RIVER

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 84,589 sf, | 67.17% Impervious, | Inflow Depth = 5.26" | for 100-YEAR STORM event |
| Inflow = | 8.92 cfs @ | 12.15 hrs, Volume= | 37,083 cf | |
| Primary = | 8.92 cfs @ | 12.15 hrs, Volume= | 37,083 cf, Atten= 0%, Lag= 0.0 min | |

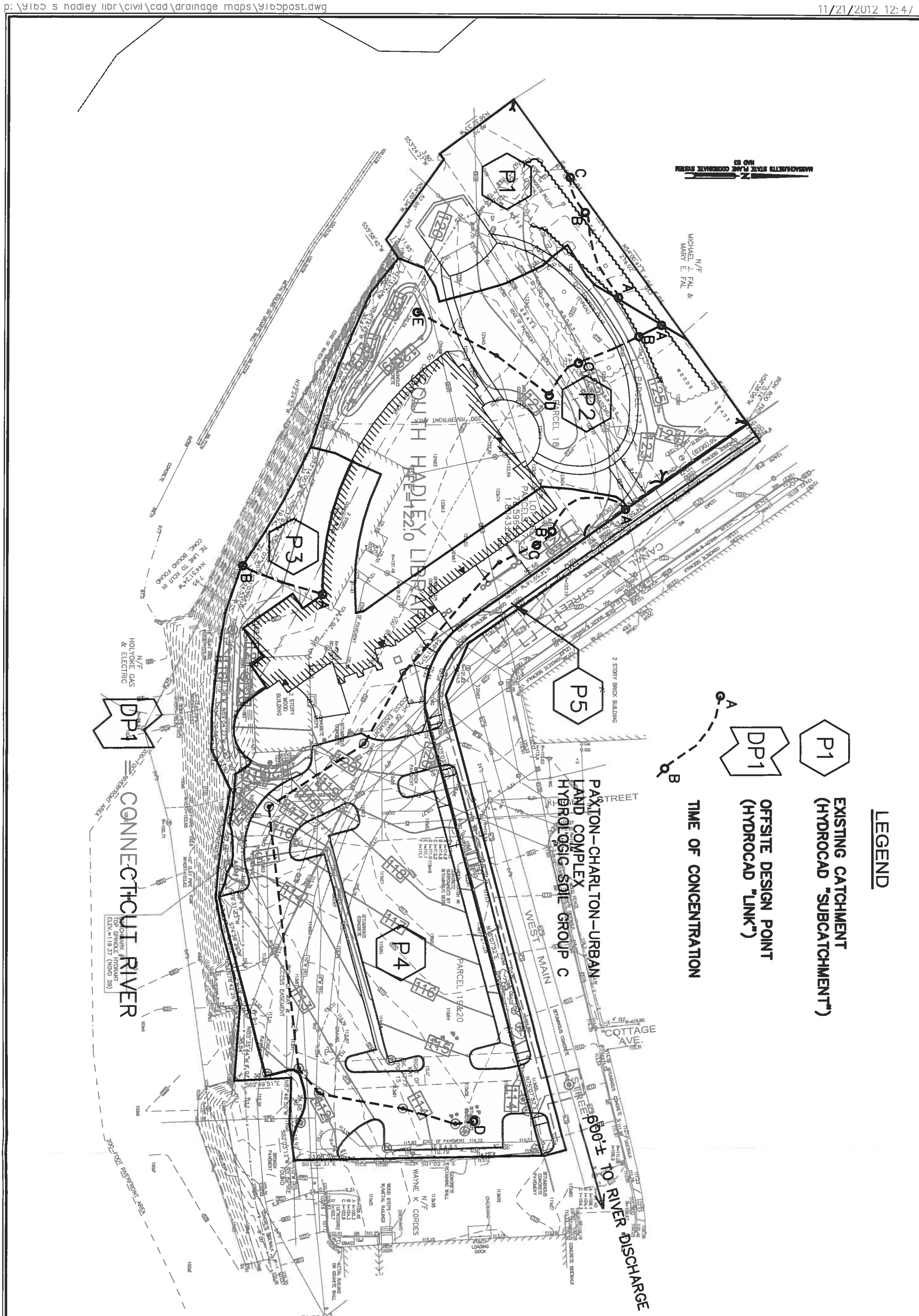
Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

### Link DP1: CONNECTICUT RIVER



## APPENDIX D

### Post-Development Conditions – HydroCAD Calculations

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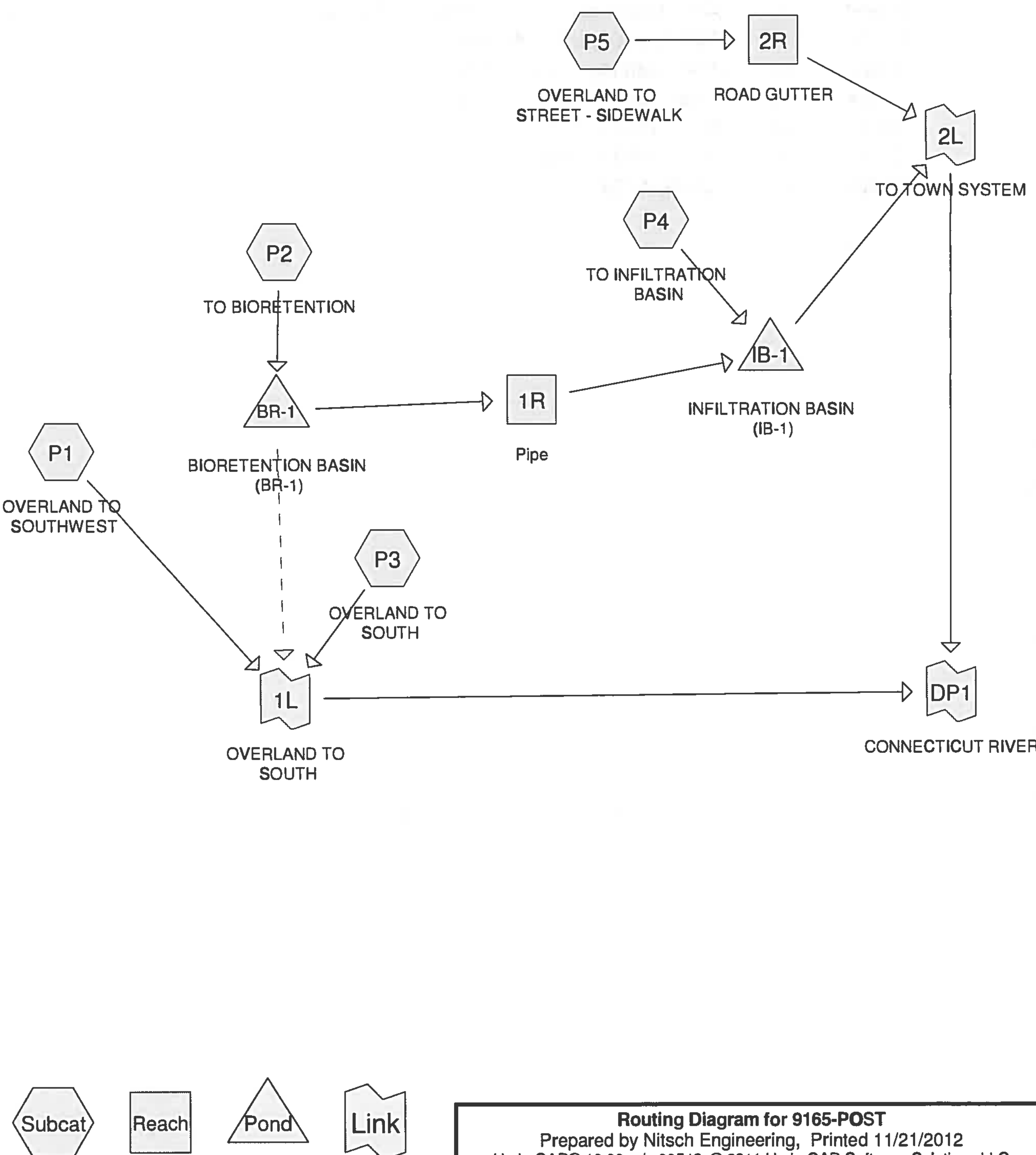
**POST-DEVELOPMENT DRAINAGE MAP**
SOUTH HADLEY LIBRARY
CANAL STREET, SOUTH HADLEY, MA

PREPARED FOR:
**JOHNSON ROBERTS ASSOCIATES, INC**
15 PROPERZI WAY, SOMERVILLE, MA

PROJECT #: 9165
FILE: 9165PRE.DWG
SCALE: 1"=50'
DATE: 11/13/2012
PROJECT MGR: DMC
SURVEYOR: NITSCH
DRAFTED BY: TJM
CHECKED BY: DMC

SHEET: 1 OF 2
D2
REV.




**Routing Diagram for 9165-POST**
Prepared by Nitsch Engineering, Printed 11/21/2012
HydroCAD® 10.00 s/n 00546 © 2011 HydroCAD Software Solutions LLC

## Area Listing (all nodes)

| Area (sq-ft) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 2,384 | 70 | Woods, Good, HSG C (P1, P2) |
| 31,959 | 74 | >75% Grass cover, Good, HSG C (P1, P2, P3, P4) |
| 27,755 | 98 | Paved parking, HSG A (P4) |
| 5,825 | 98 | Paved parking, HSG C (P5) |
| 3,224 | 98 | Paved path, HSG C (P1, P2) |
| 6,080 | 98 | Roofs, HSG A (P4) |
| 7,362 | 98 | Roofs, HSG C (P2) |
| **84,589** | **88** | **TOTAL AREA** |

## Summary for Subcatchment P1: OVERLAND TO SOUTHWEST

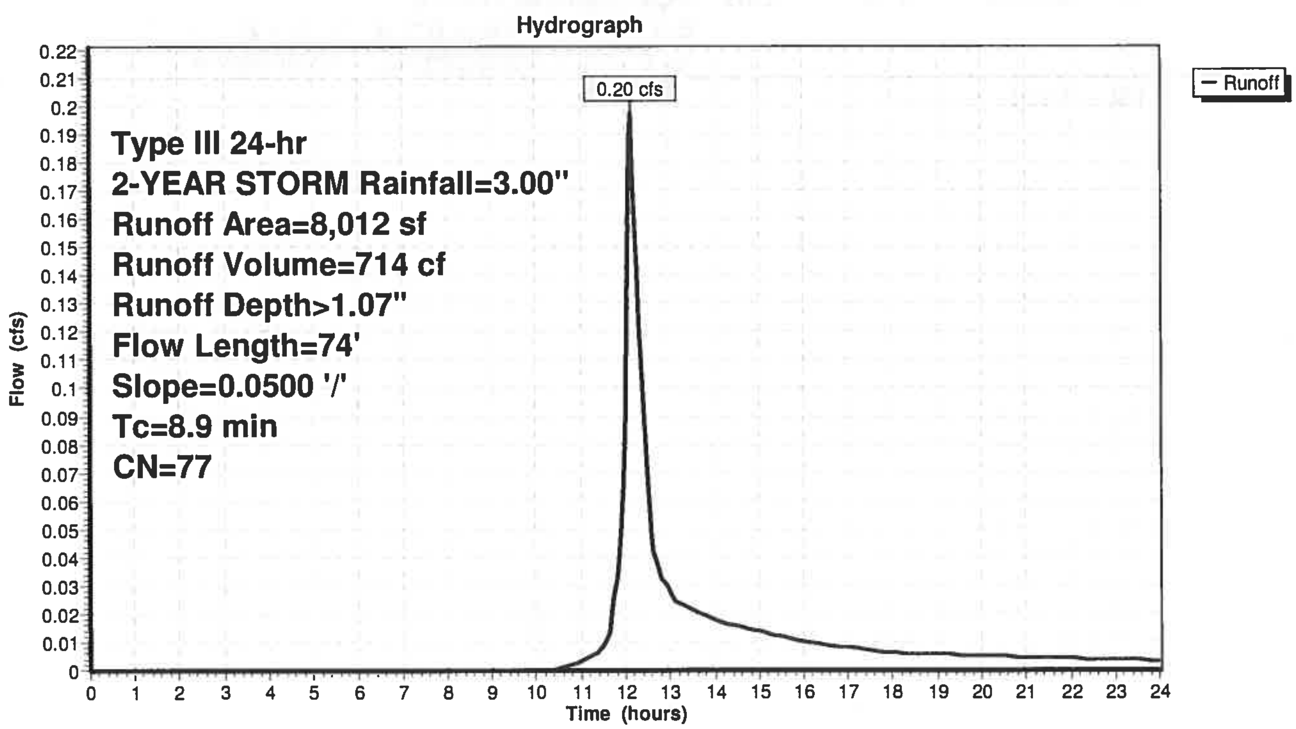
Runoff = 0.20 cfs @ 12.14 hrs, Volume= 714 cf, Depth> 1.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YEAR STORM Rainfall=3.00"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 1,347 | 98 | Paved path, HSG C |
| | 5,137 | 74 | >75% Grass cover, Good, HSG C |
| | 1,528 | 70 | Woods, Good, HSG C |
| | 8,012 | 77 | Weighted Average |
| | 6,665 | | 83.19% Pervious Area |
| | 1,347 | | 16.81% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.8 | 50 | 0.0500 | 0.09 | | **Sheet Flow, A TO B**<br>Woods: Light underbrush n= 0.400 P2= 3.00" |
| 0.1 | 24 | 0.0500 | 3.60 | | **Shallow Concentrated Flow, B TO C**<br>Unpaved Kv= 16.1 fps |
| 8.9 | 74 | Total | | | |

### Subcatchment P1: OVERLAND TO SOUTHWEST



## Summary for Subcatchment P2: TO BIORETENTION

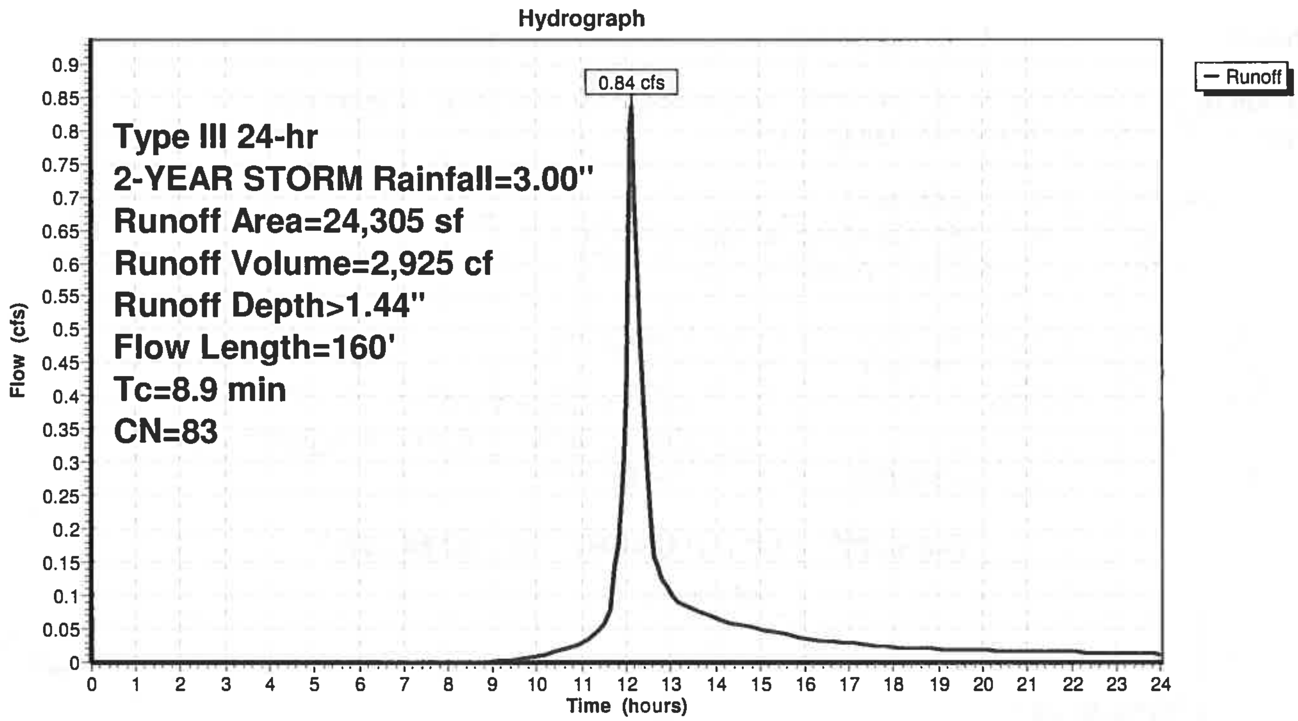
Runoff = 0.84 cfs @ 12.13 hrs, Volume= 2,925 cf, Depth> 1.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YEAR STORM Rainfall=3.00"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 1,877 | 98 | Paved path, HSG C |
| | 14,210 | 74 | >75% Grass cover, Good, HSG C |
| | 856 | 70 | Woods, Good, HSG C |
| * | 7,362 | 98 | Roofs, HSG C |
| | 24,305 | 83 | Weighted Average |
| | 15,066 | | 61.99% Pervious Area |
| | 9,239 | | 38.01% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.1 | 14 | 0.0100 | 0.04 | | **Sheet Flow, A TO B**<br>Woods: Light underbrush n= 0.400 P2= 3.00" |
| 2.5 | 36 | 0.0833 | 0.24 | | **Sheet Flow, B TO C**<br>Grass: Short n= 0.150 P2= 3.00" |
| 0.1 | 25 | 0.0600 | 3.94 | | **Shallow Concentrated Flow, C TO D**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 85 | 0.0300 | 6.00 | 2.09 | **Pipe Channel, D TO E**<br>8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17'<br>n= 0.013 Corrugated PE, smooth interior |
| 8.9 | 160 | Total | | | |

## Subcatchment P2: TO BIORETENTION



## Summary for Subcatchment P3: OVERLAND TO SOUTH

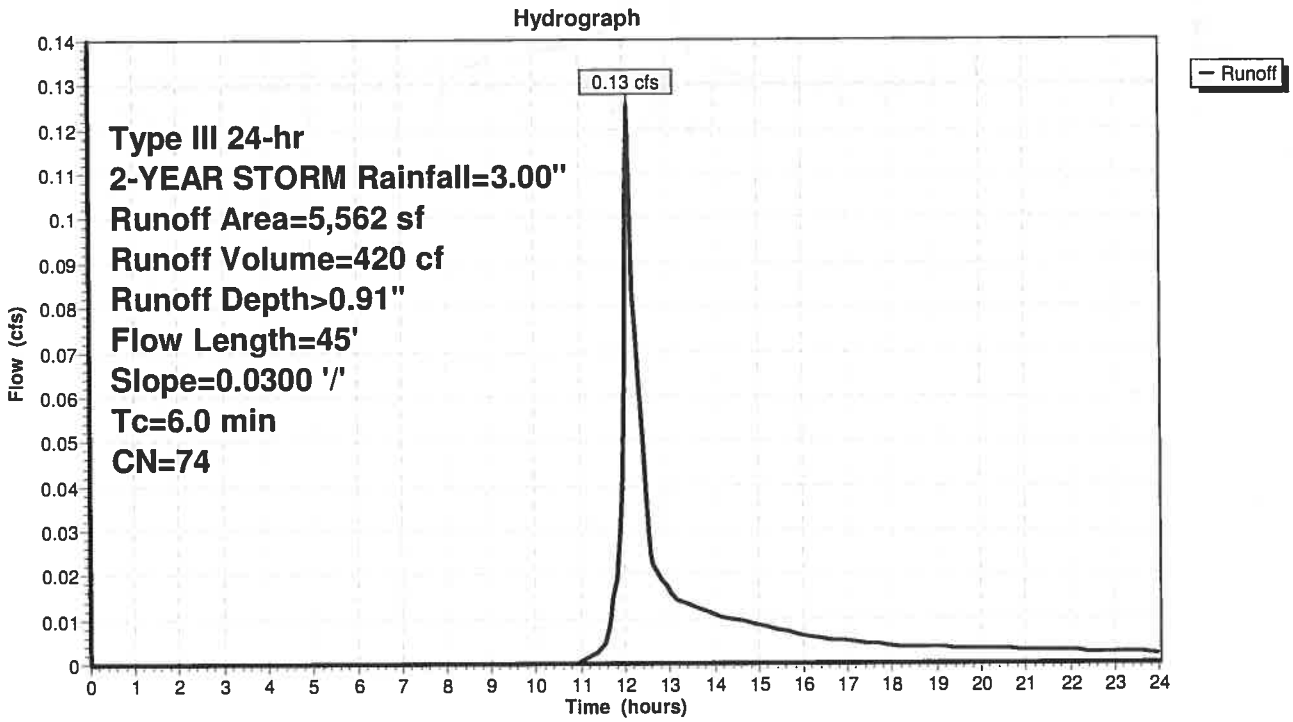
Runoff = 0.13 cfs @ 12.10 hrs, Volume= 420 cf, Depth> 0.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YEAR STORM Rainfall=3.00"

| Area (sf) | CN | Description |
|---|---|---|
| 5,562 | 74 | >75% Grass cover, Good, HSG C |
| 5,562 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.5 | 45 | 0.0300 | 0.17 | | **Sheet Flow, A TO B**<br>Grass: Short n= 0.150 P2= 3.00" |
| 4.5 | 45 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment P3: OVERLAND TO SOUTH



## Summary for Subcatchment P4: TO INFILTRATION BASIN

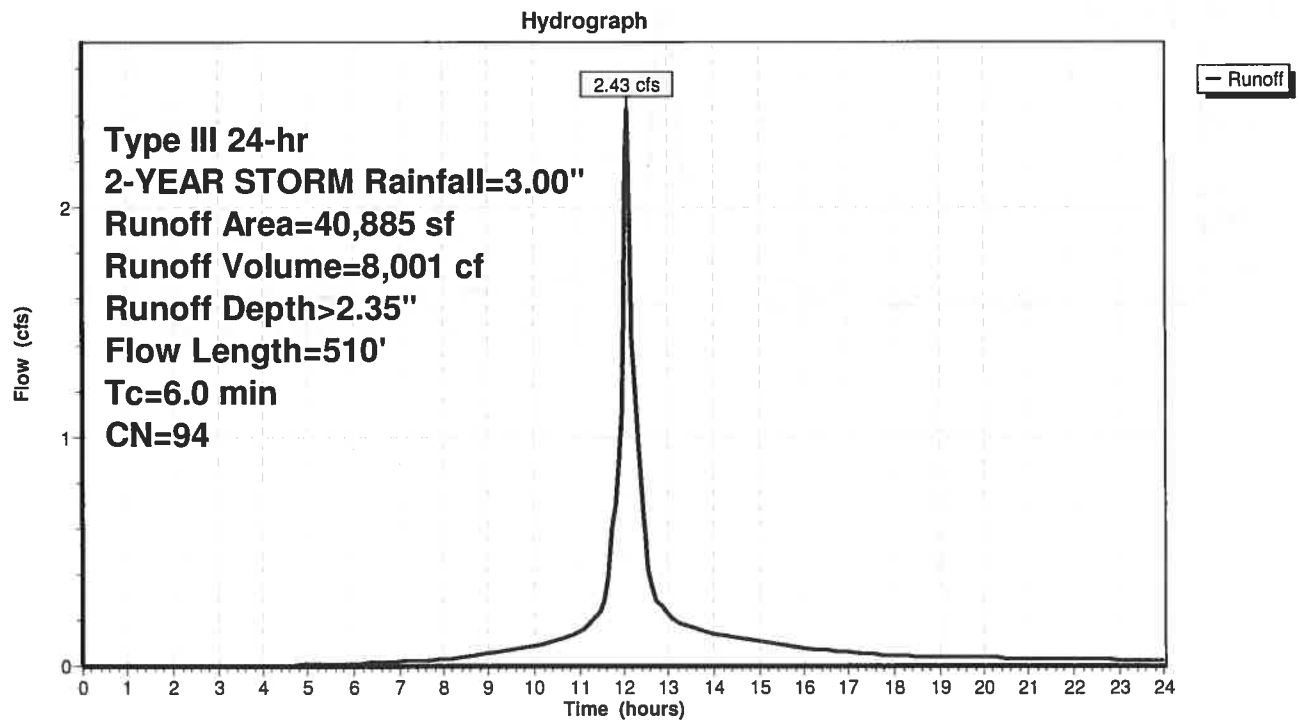
Runoff = 2.43 cfs @ 12.09 hrs, Volume= 8,001 cf, Depth> 2.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YEAR STORM Rainfall=3.00"

| Area (sf) | CN | Description |
|---|---|---|
| 6,080 | 98 | Roofs, HSG A |
| 27,755 | 98 | Paved parking, HSG A |
| 7,050 | 74 | >75% Grass cover, Good, HSG C |
| 40,885 | 94 | Weighted Average |
| 7,050 | | 17.24% Pervious Area |
| 33,835 | | 82.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.2 | 50 | 0.0450 | 0.20 | | **Sheet Flow, A TO B**<br>Grass: Short n= 0.150 P2= 3.00" |
| 0.1 | 11 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, B TO C**<br>Unpaved Kv= 16.1 fps |
| 1.0 | 449 | 0.0250 | 7.17 | 5.63 | **Pipe Channel, C TO D**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 |
| 5.3 | 510 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment P4: TO INFILTRATION BASIN



## Summary for Subcatchment P5: OVERLAND TO STREET - SIDEWALK

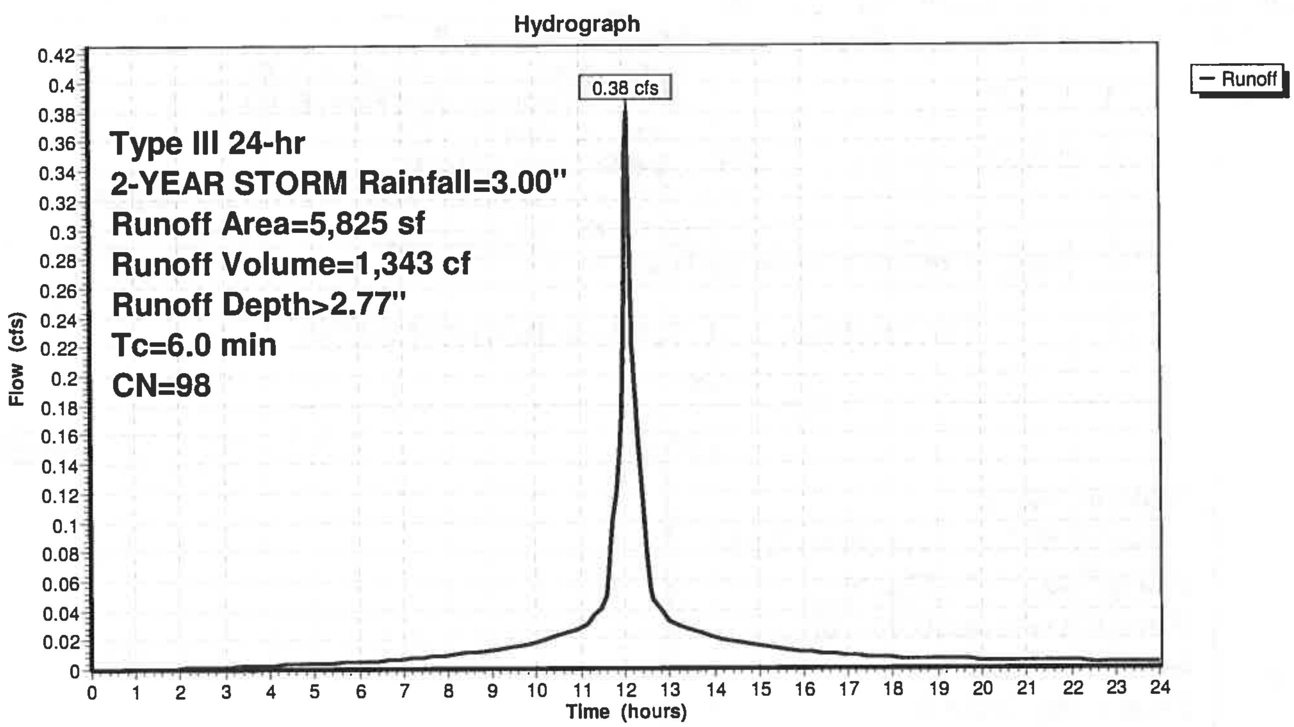
Runoff = 0.38 cfs @ 12.09 hrs, Volume= 1,343 cf, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-YEAR STORM Rainfall=3.00"

| Area (sf) | CN | Description |
|---|---|---|
| 5,825 | 98 | Paved parking, HSG C |
| 5,825 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Sidewalk** |

## Subcatchment P5: OVERLAND TO STREET - SIDEWALK



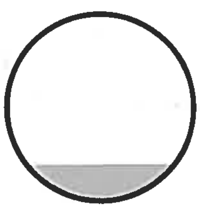
## Summary for Reach 1R: Pipe

Inflow Area = 24,305 sf, 38.01% Impervious, Inflow Depth > 1.20" for 2-YEAR STORM event
Inflow = 0.36 cfs @ 12.42 hrs, Volume= 2,434 cf
Outflow = 0.36 cfs @ 12.50 hrs, Volume= 2,428 cf, Atten= 0%, Lag= 4.8 min

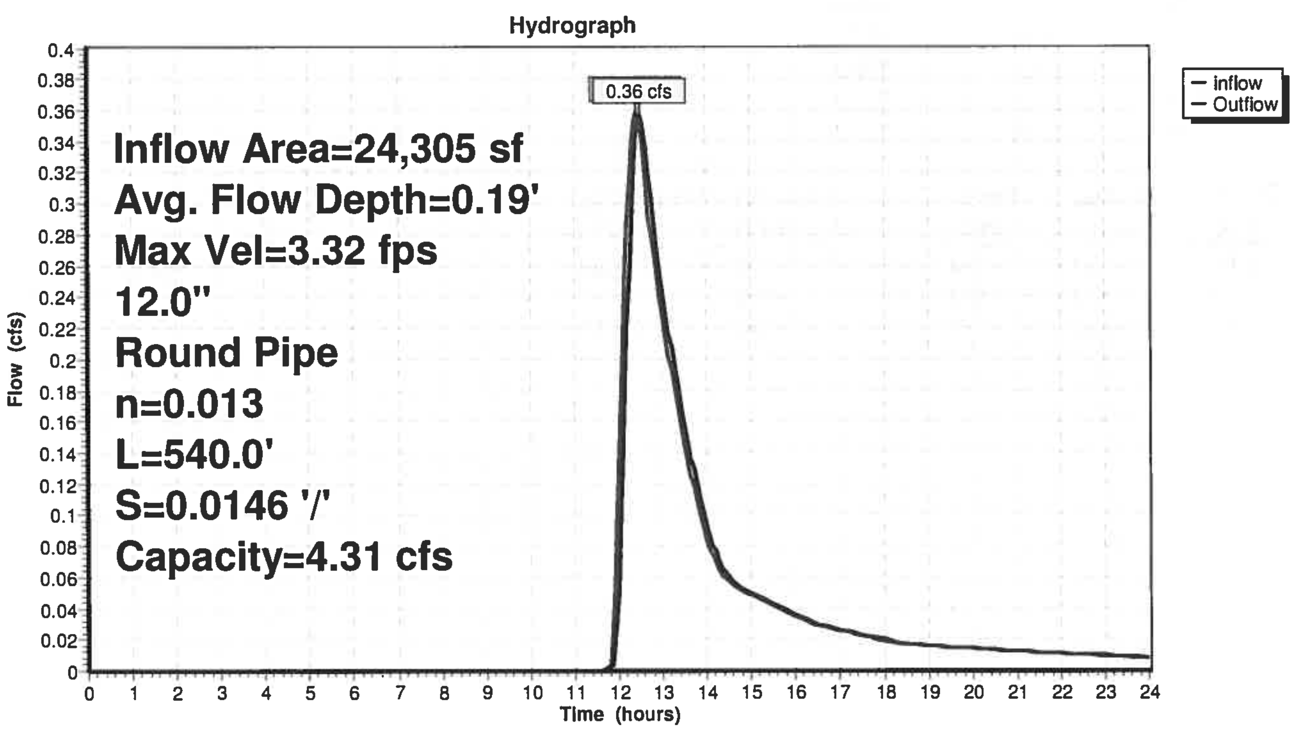
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.32 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 1.63 fps, Avg. Travel Time= 5.5 min

Peak Storage= 58 cf @ 12.45 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.31 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 540.0' Slope= 0.0146 '/'
Inlet Invert= 115.10', Outlet Invert= 107.19'



### Reach 1R: Pipe



## Summary for Reach 2R: ROAD GUTTER

Inflow Area = 5,825 sf,100.00% Impervious, Inflow Depth > 2.77" for 2-YEAR STORM event
Inflow = 0.38 cfs @ 12.09 hrs, Volume= 1,343 cf
Outflow = 0.35 cfs @ 12.16 hrs, Volume= 1,341 cf, Atten= 7%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.88 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 6.7 min

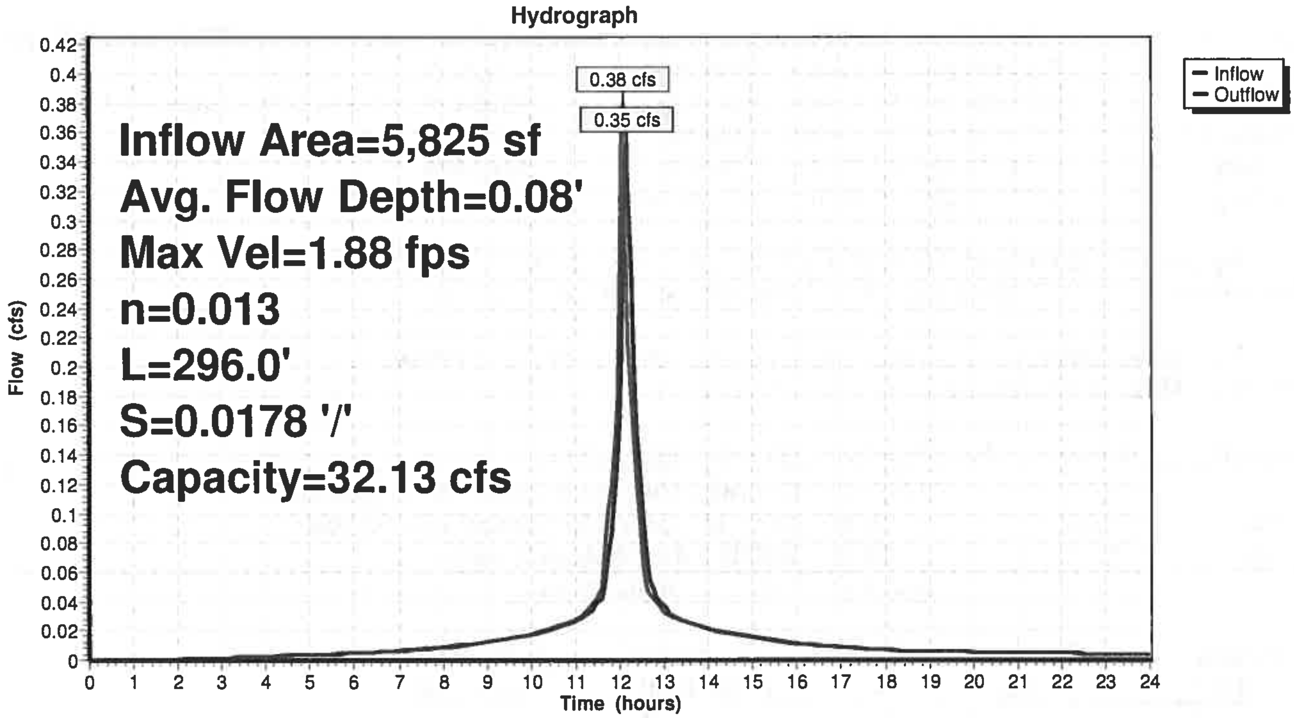
Peak Storage= 56 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 32.13 cfs

Custom cross-section, Length= 296.0' Slope= 0.0178 '/'
Constant n= 0.013 Asphalt, smooth
Inlet Invert= 123.80', Outlet Invert= 118.53'

| Offset (feet) | Elevation (feet) | Chan.Depth (feet) |
|---|---|---|
| 0.00 | 0.50 | 0.00 |
| 0.10 | 0.00 | 0.50 |
| 0.50 | 0.00 | 0.50 |
| 10.00 | 0.20 | 0.30 |
| 10.10 | 0.50 | 0.00 |

| Depth (feet) | End Area (sq-ft) | Perim. (feet) | Storage (cubic-feet) | Discharge (cfs) |
|---|---|---|---|---|
| 0.00 | 0.0 | 0.4 | 0 | 0.00 |
| 0.20 | 1.0 | 10.1 | 306 | 3.45 |
| 0.50 | 4.0 | 10.7 | 1,196 | 32.13 |

## Reach 2R: ROAD GUTTER



## Summary for Pond BR-1: BIORETENTION BASIN (BR-1)

Inflow Area = 24,305 sf, 38.01% Impervious, Inflow Depth > 1.44" for 2-YEAR STORM event
Inflow = 0.84 cfs @ 12.13 hrs, Volume= 2,925 cf
Outflow = 0.36 cfs @ 12.42 hrs, Volume= 2,664 cf, Atten= 57%, Lag= 17.1 min
Discarded = 0.00 cfs @ 13.34 hrs, Volume= 231 cf
Primary = 0.36 cfs @ 12.42 hrs, Volume= 2,434 cf
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 117.62' @ 12.42 hrs Surf.Area= 688 sf Storage= 848 cf

Plug-Flow detention time= 76.0 min calculated for 2,659 cf (91% of inflow)
Center-of-Mass det. time= 32.4 min ( 870.1 - 837.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.30' | 2,863 cf | **Overall (Prismatic)** Listed below (Recalc) |
| #2 | 115.20' | 46 cf | **12.0" D x 59.0'L Underdrain S= 0.0050 '/'** |
| #3 | 115.20' | 28 cf | **2.00'D x 4.47'H Area Drains** x 2 |
| | | 2,937 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Voids (%) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|---|
| 114.30 | 682 | 0.0 | 0 | 0 |
| 114.31 | 682 | 40.0 | 3 | 3 |
| 116.75 | 682 | 40.0 | 666 | 668 |
| 116.76 | 682 | 20.0 | 1 | 670 |
| 118.99 | 682 | 20.0 | 304 | 974 |
| 119.00 | 682 | 100.0 | 7 | 981 |
| 120.00 | 1,180 | 100.0 | 931 | 1,912 |
| 120.50 | 2,624 | 100.0 | 951 | 2,863 |

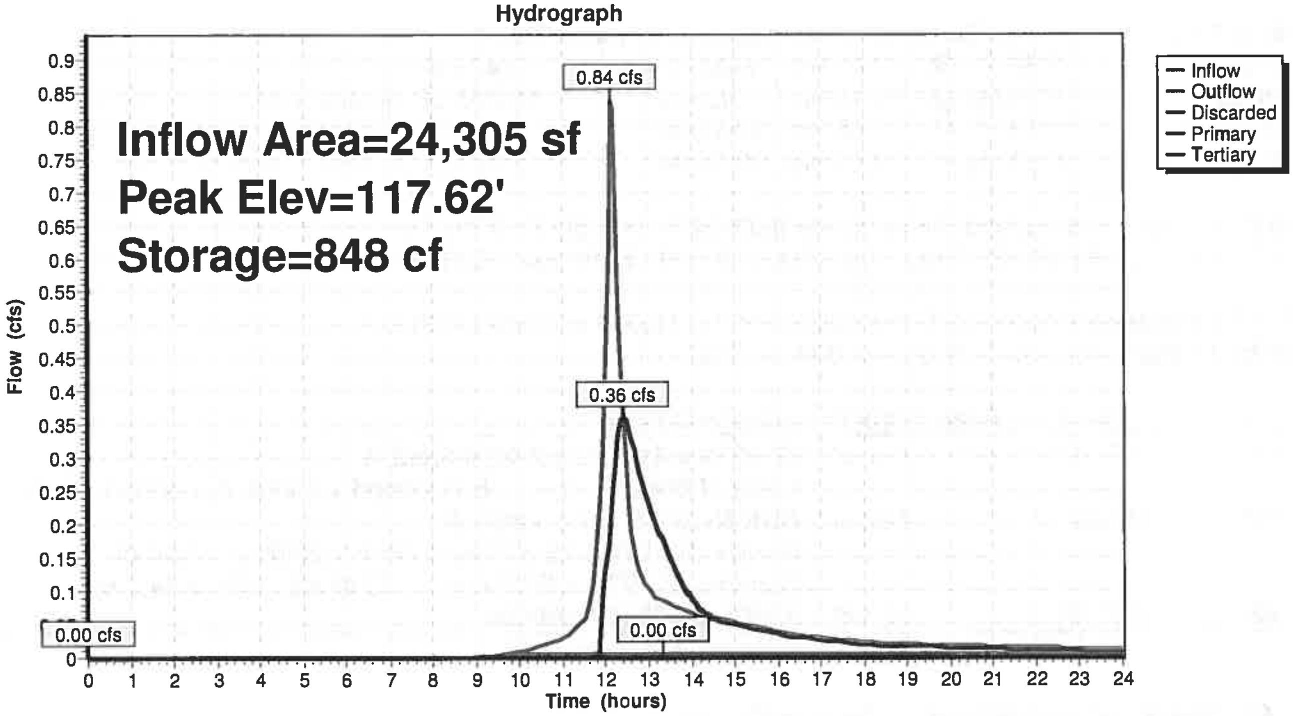
| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.20' | **3.0" Vert. Outlet Control** C= 0.600 |
| #2 | Discarded | 114.30' | **0.270 in/hr Exfiltration over Surface area** |
| #3 | Tertiary | 120.00' | **72.0' long x 2.0' breadth Broad-Crested Rectangular Weir**<br>Head (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<br>Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32 |

**Discarded OutFlow** Max=0.00 cfs @ 13.34 hrs HW=115.84' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.00 cfs)

**Primary OutFlow** Max=0.36 cfs @ 12.42 hrs HW=117.61' (Free Discharge)
↑—**1=Outlet Control** (Orifice Controls 0.36 cfs @ 7.28 fps)

**Tertiary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=114.30' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond BR-1: BIORETENTION BASIN (BR-1)



## Summary for Pond IB-1: INFILTRATION BASIN (IB-1)

Inflow Area = 65,190 sf, 66.07% Impervious, Inflow Depth > 1.92" for 2-YEAR STORM event
Inflow = 2.56 cfs @ 12.09 hrs, Volume= 10,429 cf
Outflow = 2.15 cfs @ 12.10 hrs, Volume= 10,065 cf, Atten= 16%, Lag= 0.6 min
Discarded = 0.15 cfs @ 11.05 hrs, Volume= 6,145 cf
Primary = 2.00 cfs @ 12.10 hrs, Volume= 3,921 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 110.34' @ 12.10 hrs Surf.Area= 765 sf Storage= 1,001 cf

Plug-Flow detention time= 58.5 min calculated for 10,044 cf (96% of inflow)
Center-of-Mass det. time= 38.8 min ( 844.9 - 806.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 107.19' | 507 cf | **17.96'W x 41.50'L x 2.42'H Field A** |
| | | | 1,802 cf Overall - 534 cf Embedded = 1,268 cf x 40.0% Voids |
| #2A | 107.52' | 432 cf | **ADS N-12 18** x 12 Inside #1 |
| | | | Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf |
| | | | Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf |
| #3 | 107.19' | 153 cf | **5.00'D x 7.81'H Manhole** |
| | | 1,092 cf | Total Available Storage |

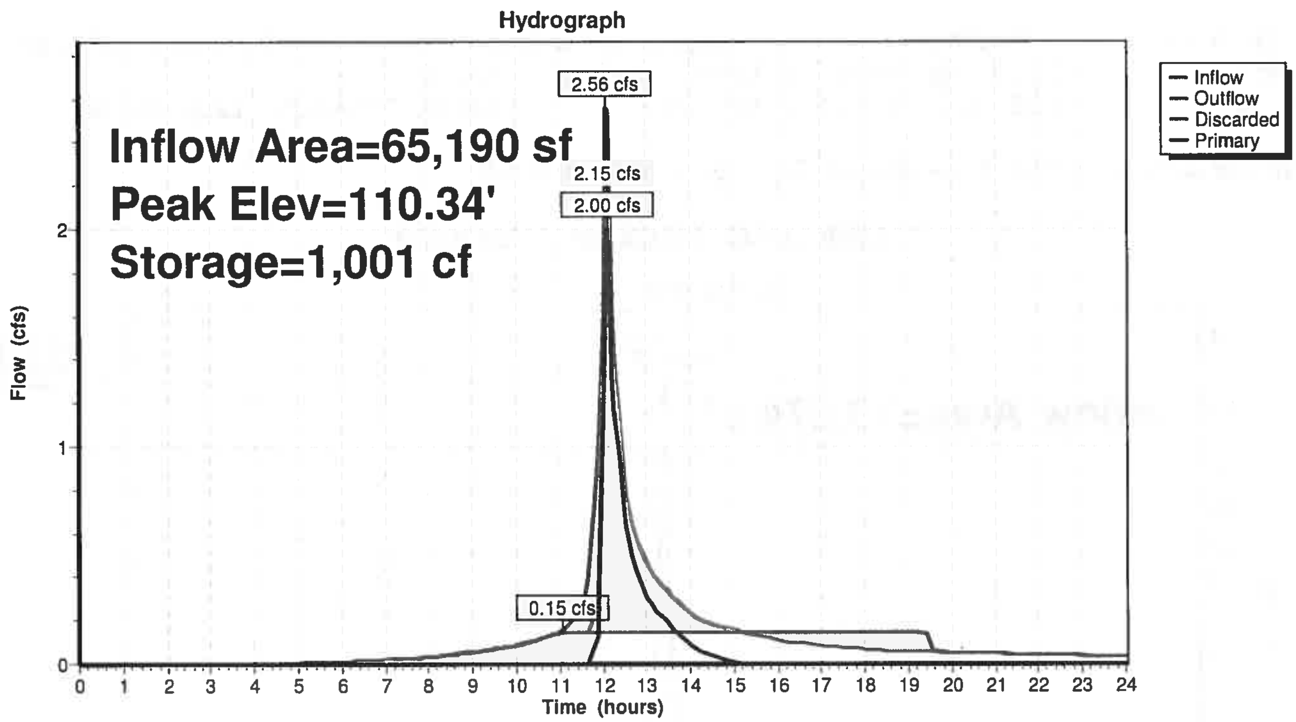
Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 109.60' | **18.0" Round Culvert** |
| | | | L= 29.0' CPP, projecting, no headwall, Ke= 0.900 |
| | | | Inlet / Outlet Invert= 109.60' / 107.51' S= 0.0721 '/' Cc= 0.900 |
| | | | n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |
| #2 | Discarded | 107.19' | **8.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.15 cfs @ 11.05 hrs HW=107.27' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.15 cfs)

**Primary OutFlow** Max=1.99 cfs @ 12.10 hrs HW=110.34' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 1.99 cfs @ 2.30 fps)

## Pond IB-1: INFILTRATION BASIN (IB-1)

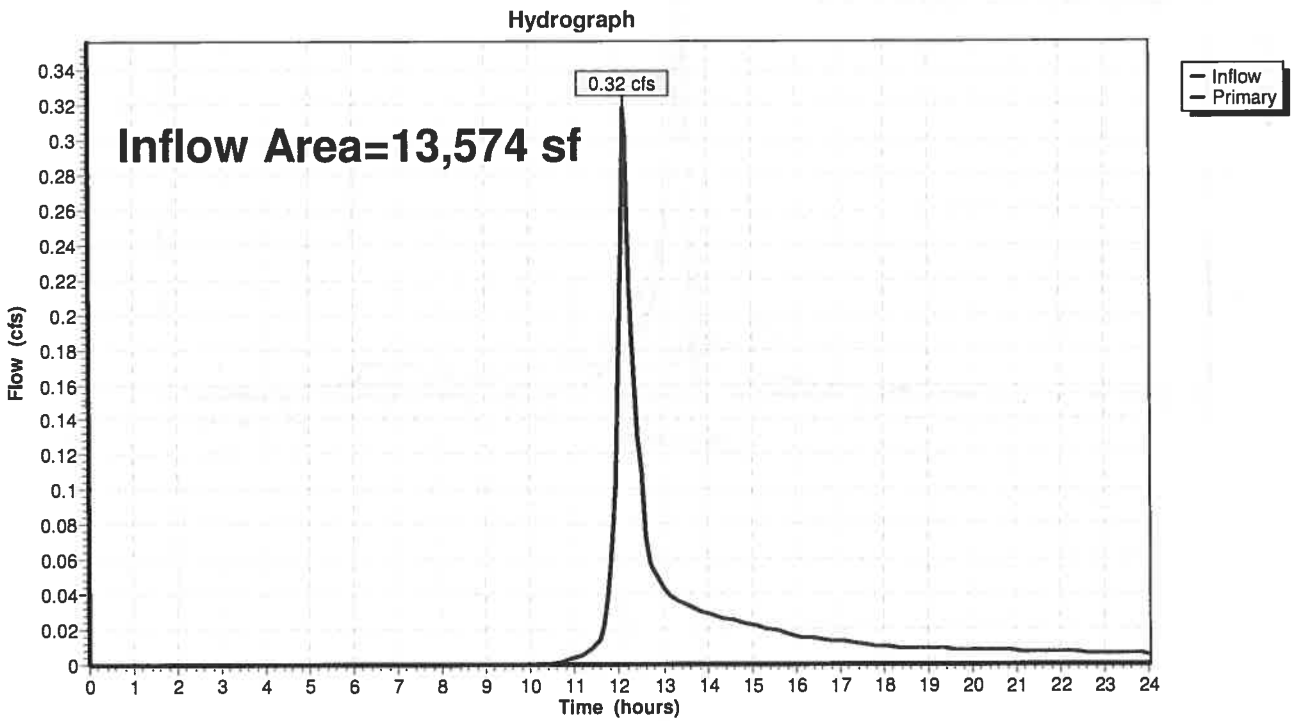


## Summary for Link 1L: OVERLAND TO SOUTH

Inflow Area = 13,574 sf, 9.92% Impervious, Inflow Depth > 1.00" for 2-YEAR STORM event
Inflow = 0.32 cfs @ 12.12 hrs, Volume= 1,134 cf
Primary = 0.32 cfs @ 12.12 hrs, Volume= 1,134 cf, Atten= 0%, Lag= 0.0 min

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

### Link 1L: OVERLAND TO SOUTH

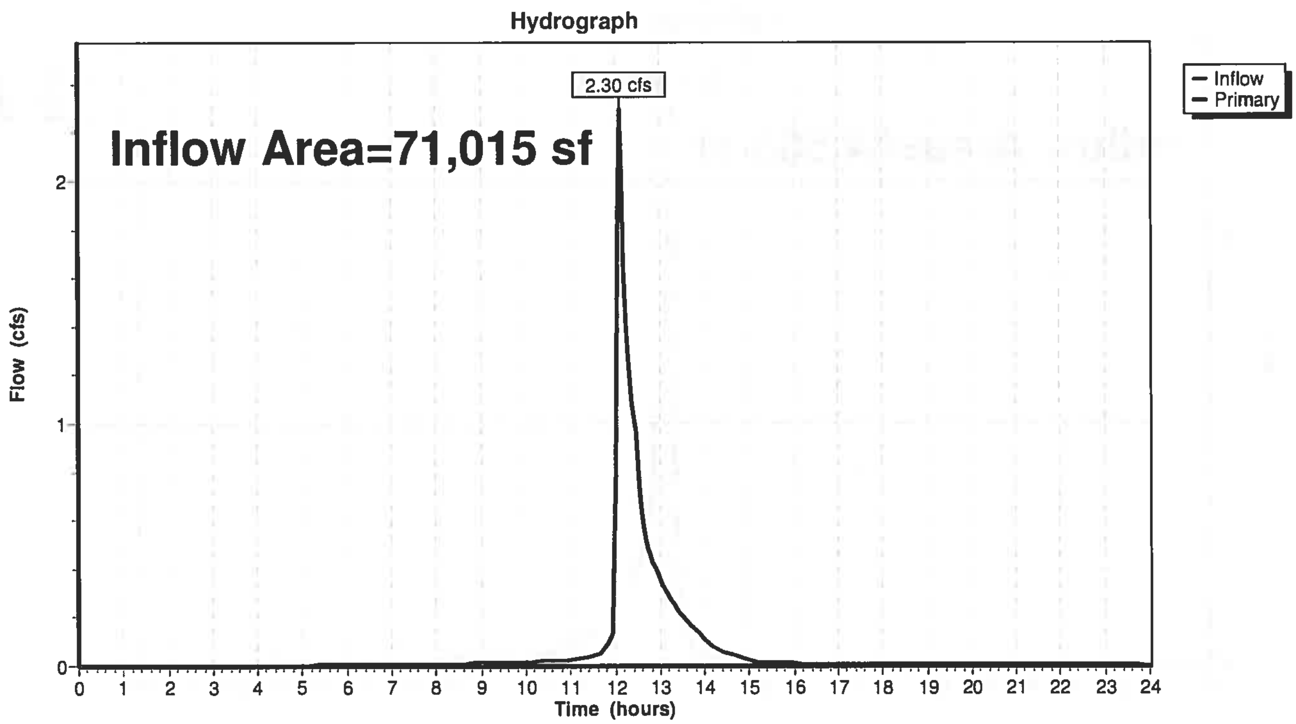


## Summary for Link 2L: TO TOWN SYSTEM

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 71,015 sf, | 68.86% Impervious, | Inflow Depth > 0.89" | for 2-YEAR STORM event |
| Inflow = | 2.30 cfs @ | 12.11 hrs, Volume= | 5,261 cf | |
| Primary = | 2.30 cfs @ | 12.11 hrs, Volume= | 5,261 cf, | Atten= 0%, Lag= 0.0 min |

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

### Link 2L: TO TOWN SYSTEM

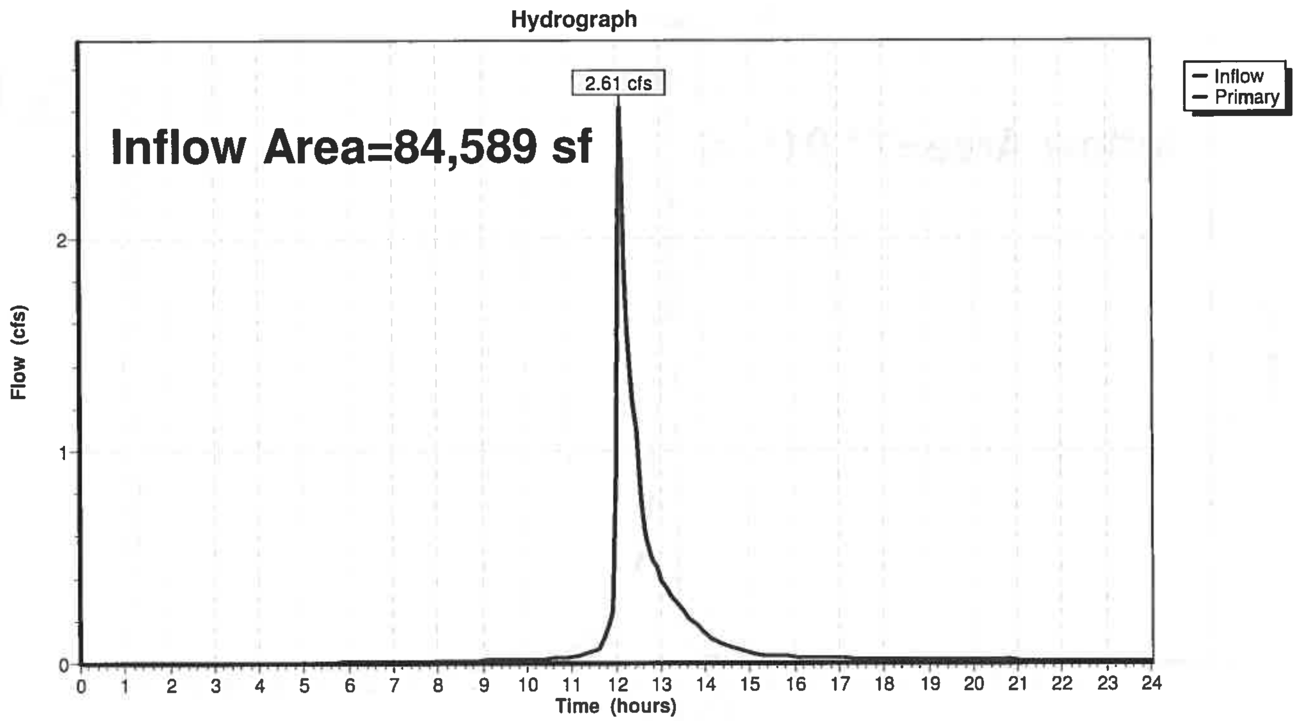


## Summary for Link DP1: CONNECTICUT RIVER

Inflow Area = 84,589 sf, 59.40% Impervious, Inflow Depth > 0.91" for 2-YEAR STORM event
Inflow = 2.61 cfs @ 12.11 hrs, Volume= 6,395 cf
Primary = 2.61 cfs @ 12.11 hrs, Volume= 6,395 cf, Atten= 0%, Lag= 0.0 min

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

## Link DP1: CONNECTICUT RIVER



## Summary for Subcatchment P1: OVERLAND TO SOUTHWEST

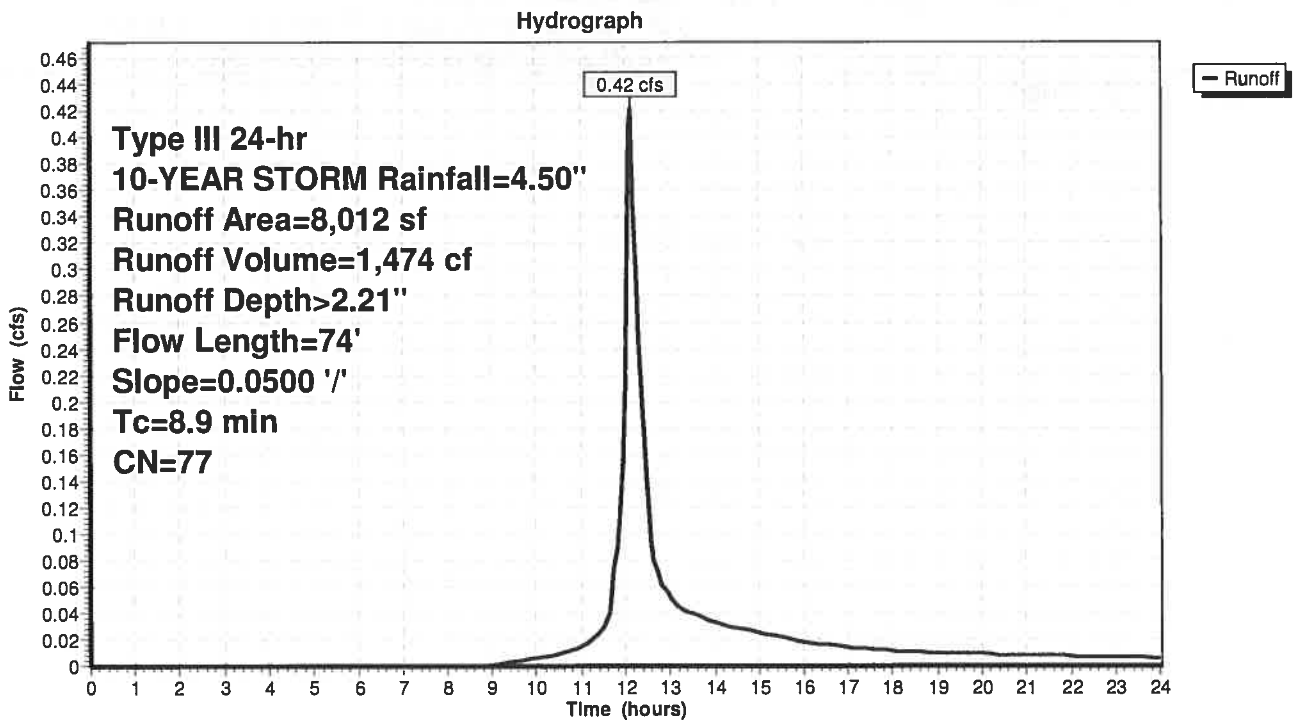
Runoff = 0.42 cfs @ 12.13 hrs, Volume= 1,474 cf, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YEAR STORM Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 1,347 | 98 | Paved path, HSG C |
| | 5,137 | 74 | >75% Grass cover, Good, HSG C |
| | 1,528 | 70 | Woods, Good, HSG C |
| | 8,012 | 77 | Weighted Average |
| | 6,665 | | 83.19% Pervious Area |
| | 1,347 | | 16.81% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.8 | 50 | 0.0500 | 0.09 | | **Sheet Flow, A TO B** |
| | | | | | Woods: Light underbrush n= 0.400 P2= 3.00" |
| 0.1 | 24 | 0.0500 | 3.60 | | **Shallow Concentrated Flow, B TO C** |
| | | | | | Unpaved Kv= 16.1 fps |
| 8.9 | 74 | Total | | | |

## Subcatchment P1: OVERLAND TO SOUTHWEST



## Summary for Subcatchment P2: TO BIORETENTION

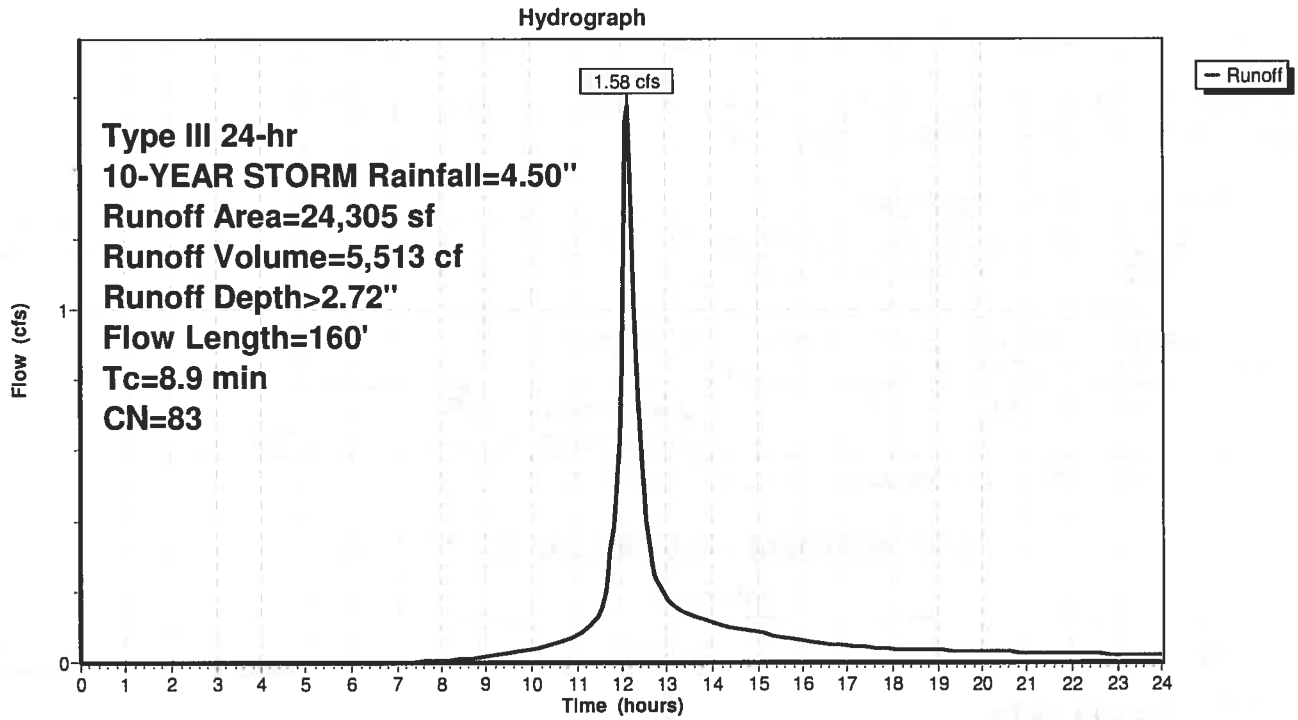
Runoff = 1.58 cfs @ 12.13 hrs, Volume= 5,513 cf, Depth> 2.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YEAR STORM Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 1,877 | 98 | Paved path, HSG C |
| | 14,210 | 74 | >75% Grass cover, Good, HSG C |
| | 856 | 70 | Woods, Good, HSG C |
| * | 7,362 | 98 | Roofs, HSG C |
| | 24,305 | 83 | Weighted Average |
| | 15,066 | | 61.99% Pervious Area |
| | 9,239 | | 38.01% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.1 | 14 | 0.0100 | 0.04 | | **Sheet Flow, A TO B**<br>Woods: Light underbrush n= 0.400 P2= 3.00" |
| 2.5 | 36 | 0.0833 | 0.24 | | **Sheet Flow, B TO C**<br>Grass: Short n= 0.150 P2= 3.00" |
| 0.1 | 25 | 0.0600 | 3.94 | | **Shallow Concentrated Flow, C TO D**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 85 | 0.0300 | 6.00 | 2.09 | **Pipe Channel, D TO E**<br>8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17'<br>n= 0.013 Corrugated PE, smooth interior |
| 8.9 | 160 | Total | | | |

## Subcatchment P2: TO BIORETENTION



## Summary for Subcatchment P3: OVERLAND TO SOUTH

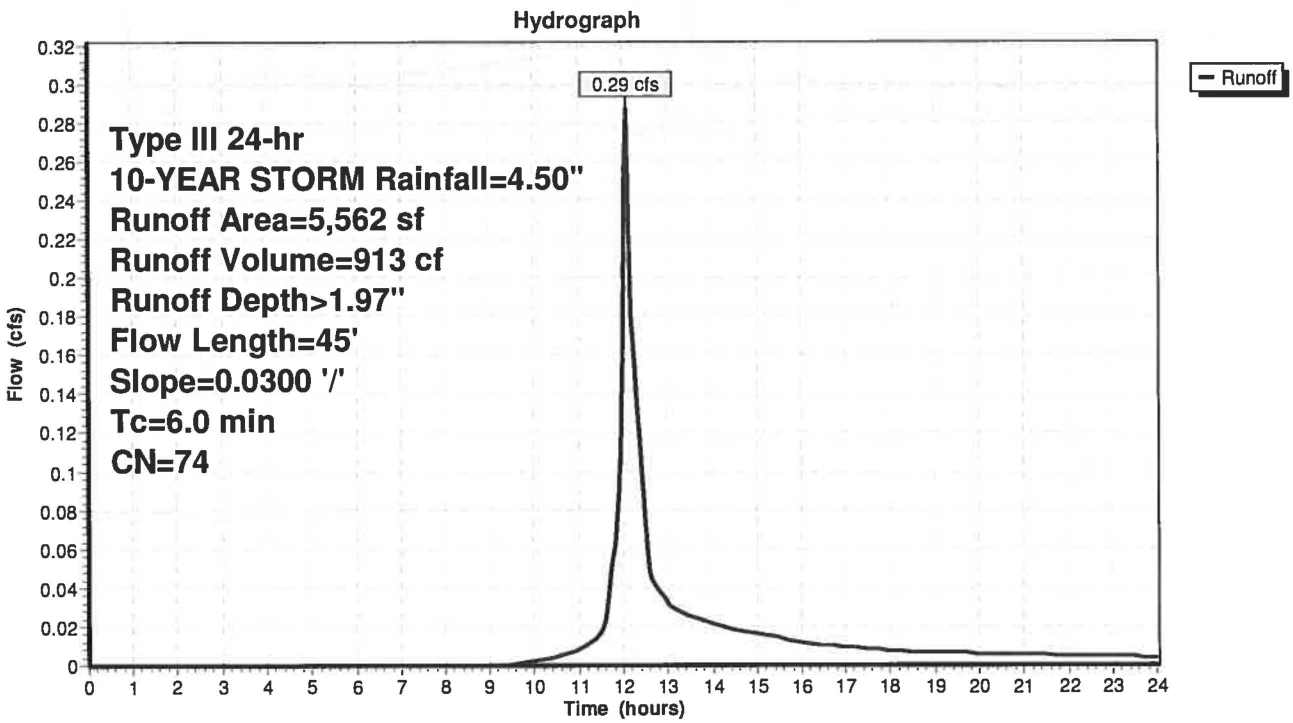
Runoff = 0.29 cfs @ 12.10 hrs, Volume= 913 cf, Depth> 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YEAR STORM Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 5,562 | 74 | >75% Grass cover, Good, HSG C |
| 5,562 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.5 | 45 | 0.0300 | 0.17 | | **Sheet Flow, A TO B** Grass: Short n= 0.150 P2= 3.00" |
| 4.5 | 45 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment P3: OVERLAND TO SOUTH



## Summary for Subcatchment P4: TO INFILTRATION BASIN

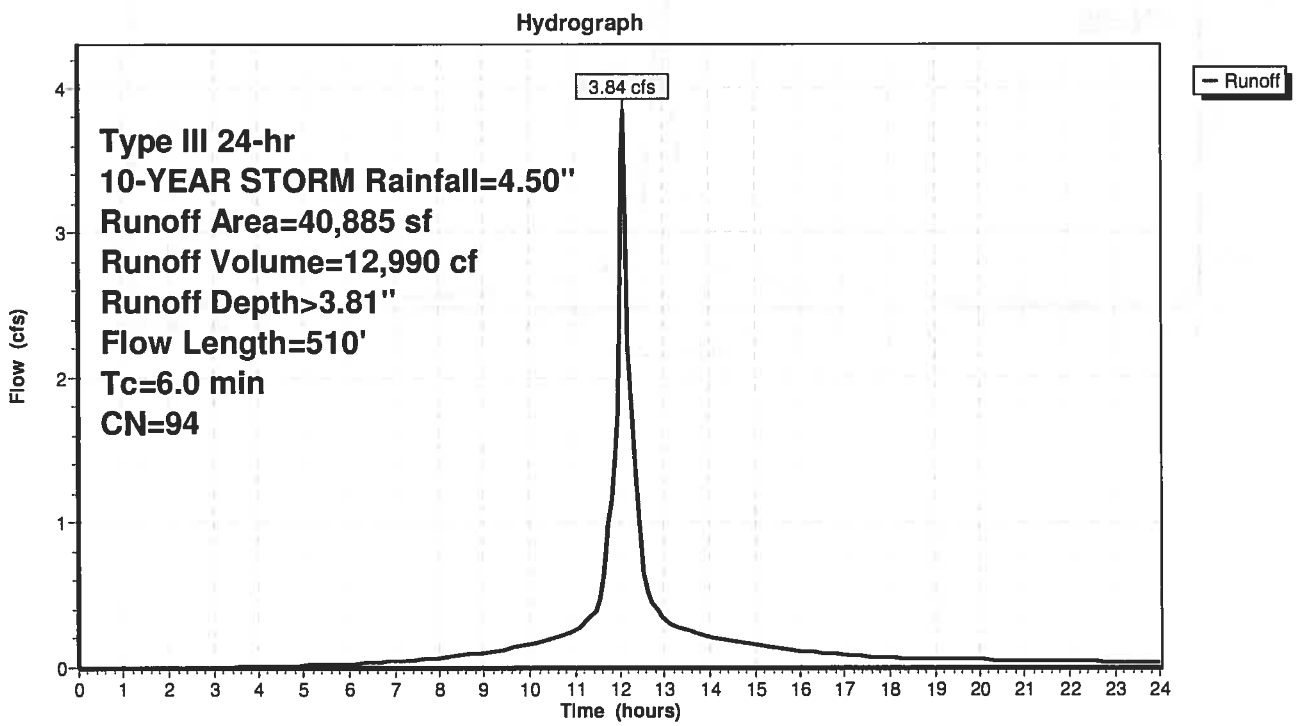
Runoff = 3.84 cfs @ 12.09 hrs, Volume= 12,990 cf, Depth> 3.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YEAR STORM Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 6,080 | 98 | Roofs, HSG A |
| 27,755 | 98 | Paved parking, HSG A |
| 7,050 | 74 | >75% Grass cover, Good, HSG C |
| 40,885 | 94 | Weighted Average |
| 7,050 | | 17.24% Pervious Area |
| 33,835 | | 82.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.2 | 50 | 0.0450 | 0.20 | | **Sheet Flow, A TO B**<br>Grass: Short n= 0.150 P2= 3.00" |
| 0.1 | 11 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, B TO C**<br>Unpaved Kv= 16.1 fps |
| 1.0 | 449 | 0.0250 | 7.17 | 5.63 | **Pipe Channel, C TO D**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 |
| 5.3 | 510 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment P4: TO INFILTRATION BASIN



## Summary for Subcatchment P5: OVERLAND TO STREET - SIDEWALK

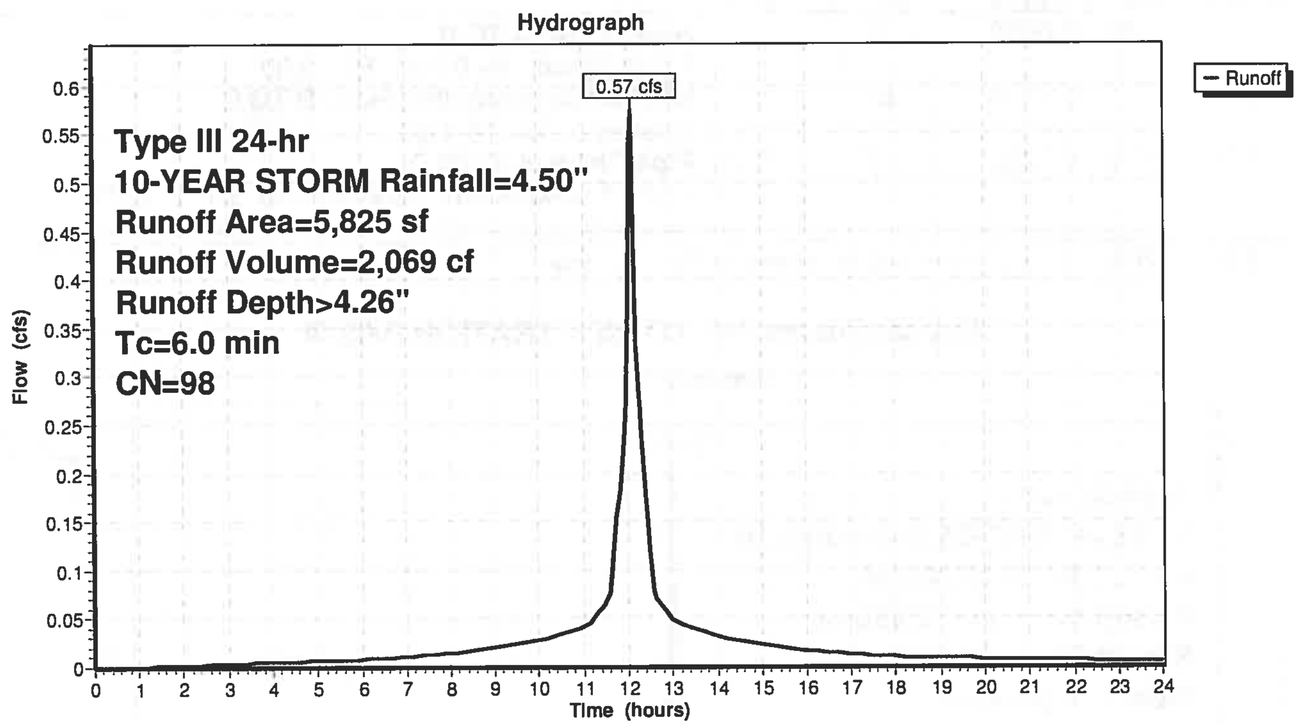
Runoff = 0.57 cfs @ 12.09 hrs, Volume= 2,069 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-YEAR STORM Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 5,825 | 98 | Paved parking, HSG C |
| 5,825 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Sidewalk** |

## Subcatchment P5: OVERLAND TO STREET - SIDEWALK



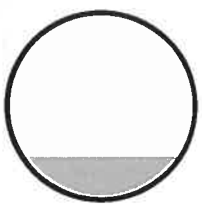
## Summary for Reach 1R: Pipe

Inflow Area = 24,305 sf, 38.01% Impervious, Inflow Depth > 2.46" for 10-YEAR STORM event
Inflow = 0.50 cfs @ 12.49 hrs, Volume= 4,979 cf
Outflow = 0.50 cfs @ 12.57 hrs, Volume= 4,970 cf, Atten= 0%, Lag= 4.3 min

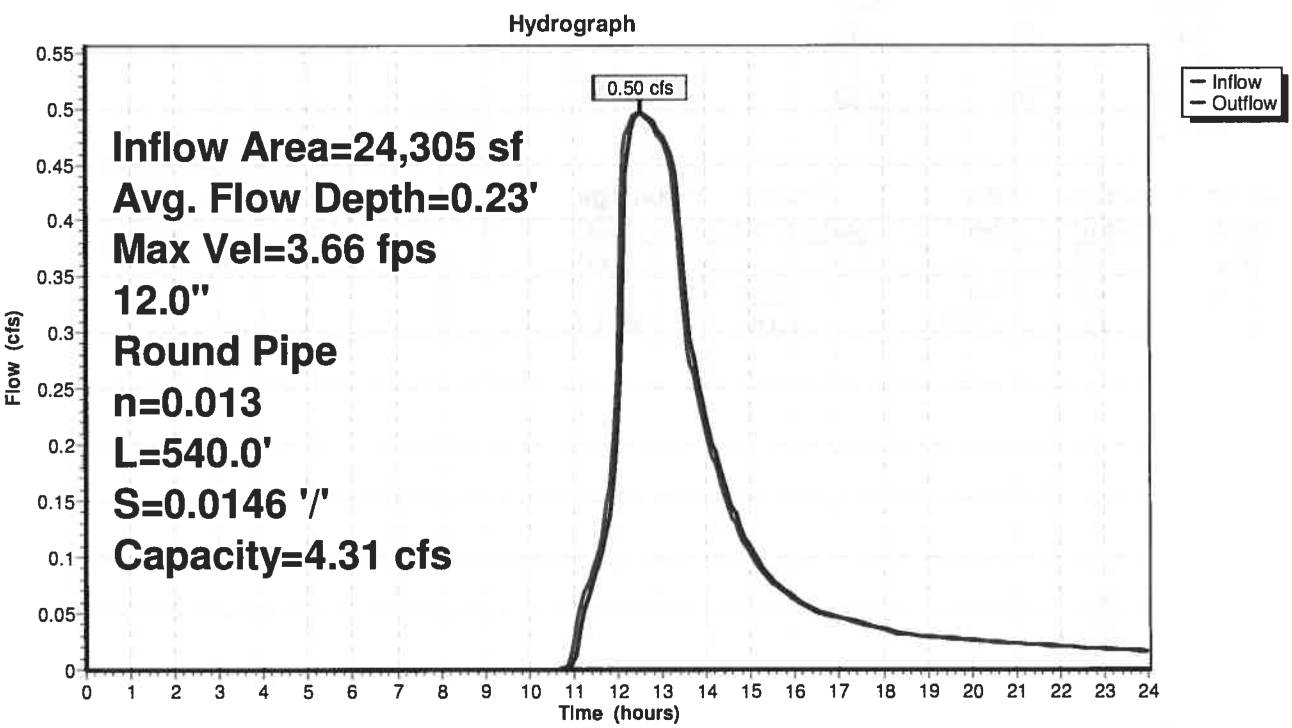
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.66 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 2.00 fps, Avg. Travel Time= 4.5 min

Peak Storage= 73 cf @ 12.52 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.31 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 540.0' Slope= 0.0146 '/'
Inlet Invert= 115.10', Outlet Invert= 107.19'



## Reach 1R: Pipe



## Summary for Reach 2R: ROAD GUTTER

Inflow Area = 5,825 sf,100.00% Impervious, Inflow Depth > 4.26" for 10-YEAR STORM event
Inflow = 0.57 cfs @ 12.09 hrs, Volume= 2,069 cf
Outflow = 0.53 cfs @ 12.16 hrs, Volume= 2,065 cf, Atten= 7%, Lag= 4.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.10 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.82 fps, Avg. Travel Time= 6.0 min

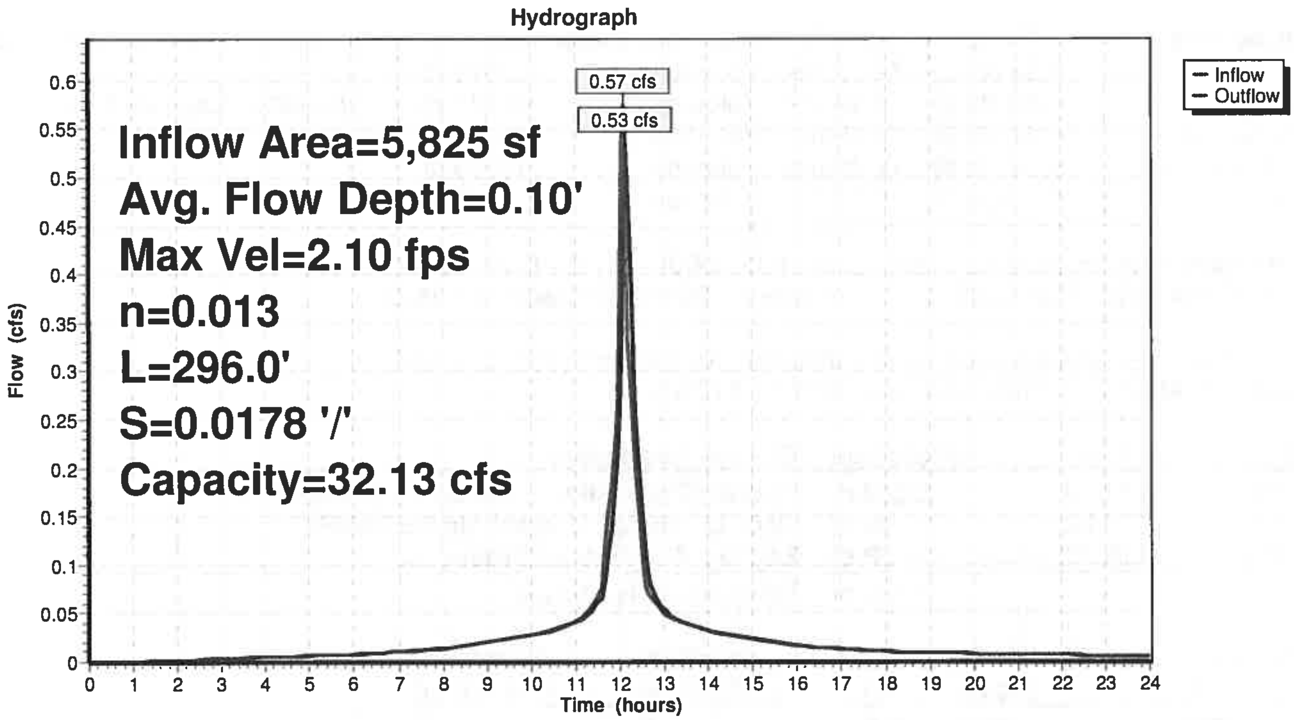
Peak Storage= 77 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 32.13 cfs

Custom cross-section, Length= 296.0' Slope= 0.0178 '/'
Constant n= 0.013 Asphalt, smooth
Inlet Invert= 123.80', Outlet Invert= 118.53'

| Offset (feet) | Elevation (feet) | Chan.Depth (feet) |
|---|---|---|
| 0.00 | 0.50 | 0.00 |
| 0.10 | 0.00 | 0.50 |
| 0.50 | 0.00 | 0.50 |
| 10.00 | 0.20 | 0.30 |
| 10.10 | 0.50 | 0.00 |

| Depth (feet) | End Area (sq-ft) | Perim. (feet) | Storage (cubic-feet) | Discharge (cfs) |
|---|---|---|---|---|
| 0.00 | 0.0 | 0.4 | 0 | 0.00 |
| 0.20 | 1.0 | 10.1 | 306 | 3.45 |
| 0.50 | 4.0 | 10.7 | 1,196 | 32.13 |

## Reach 2R: ROAD GUTTER



## Summary for Pond BR-1: BIORETENTION BASIN (BR-1)

| | | | |
|---|---|---|---|
| Inflow Area = | 24,305 sf, 38.01% Impervious, | Inflow Depth > 2.72" | for 10-YEAR STORM event |
| Inflow = | 1.58 cfs @ 12.13 hrs, | Volume= 5,513 cf | |
| Outflow = | 0.50 cfs @ 12.49 hrs, | Volume= 5,243 cf, | Atten= 68%, Lag= 22.1 min |
| Discarded = | 0.01 cfs @ 12.49 hrs, | Volume= 263 cf | |
| Primary = | 0.50 cfs @ 12.49 hrs, | Volume= 4,979 cf | |
| Tertiary = | 0.00 cfs @ 0.00 hrs, | Volume= 0 cf | |

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 119.73' @ 12.49 hrs Surf.Area= 1,053 sf Storage= 1,688 cf

Plug-Flow detention time= 61.6 min calculated for 5,232 cf (95% of inflow)
Center-of-Mass det. time= 35.1 min ( 854.7 - 819.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.30' | 2,863 cf | **Overall (Prismatic)** Listed below (Recalc) |
| #2 | 115.20' | 46 cf | **12.0" D x 59.0'L Underdrain S= 0.0050 '/'** |
| #3 | 115.20' | 28 cf | **2.00'D x 4.47'H Area Drains** x 2 |
| | | 2,937 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Voids (%) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|---|
| 114.30 | 682 | 0.0 | 0 | 0 |
| 114.31 | 682 | 40.0 | 3 | 3 |
| 116.75 | 682 | 40.0 | 666 | 668 |
| 116.76 | 682 | 20.0 | 1 | 670 |
| 118.99 | 682 | 20.0 | 304 | 974 |
| 119.00 | 682 | 100.0 | 7 | 981 |
| 120.00 | 1,180 | 100.0 | 931 | 1,912 |
| 120.50 | 2,624 | 100.0 | 951 | 2,863 |

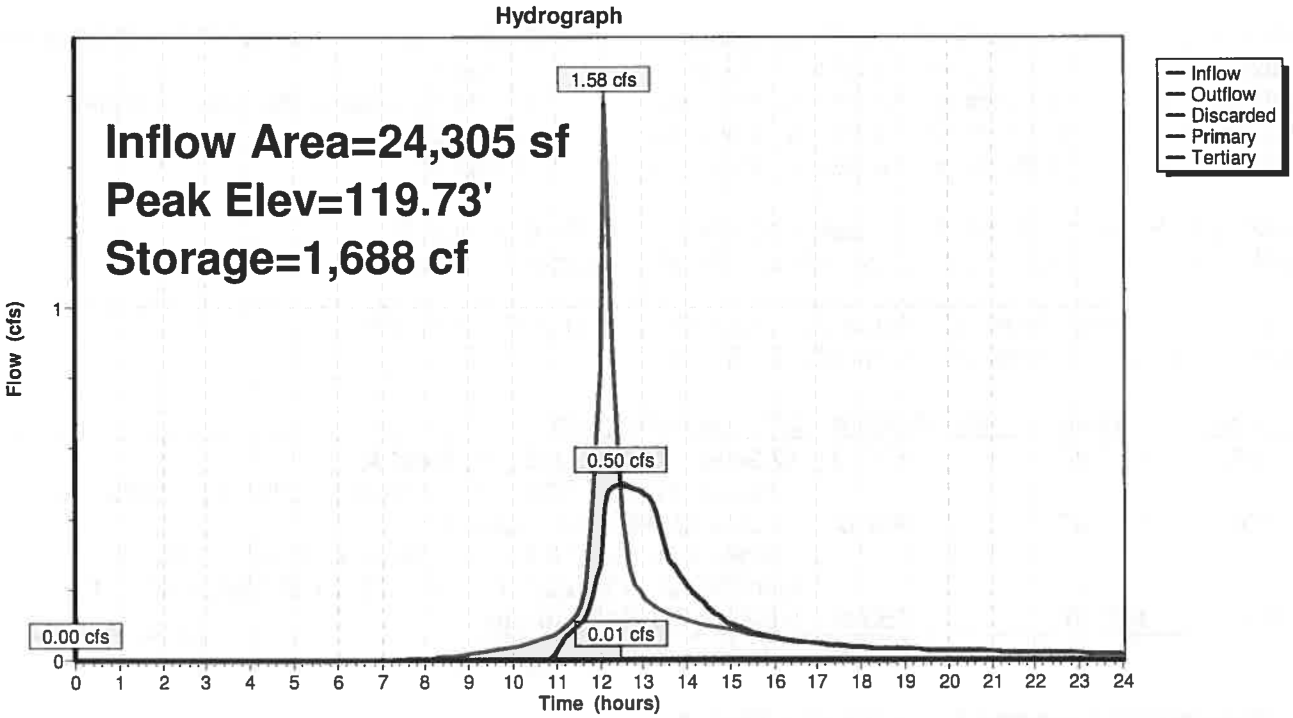
| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.20' | **3.0" Vert. Outlet Control** C= 0.600 |
| #2 | Discarded | 114.30' | **0.270 in/hr Exfiltration over Surface area** |
| #3 | Tertiary | 120.00' | **72.0' long x 2.0' breadth Broad-Crested Rectangular Weir**<br>Head (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<br>Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32 |

**Discarded OutFlow** Max=0.01 cfs @ 12.49 hrs HW=119.73' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

**Primary OutFlow** Max=0.50 cfs @ 12.49 hrs HW=119.73' (Free Discharge)
↑—**1=Outlet Control** (Orifice Controls 0.50 cfs @ 10.11 fps)

**Tertiary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=114.30' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond BR-1: BIORETENTION BASIN (BR-1)



## Summary for Pond IB-1: INFILTRATION BASIN (IB-1)

Inflow Area = 65,190 sf, 66.07% Impervious, Inflow Depth > 3.31" for 10-YEAR STORM event
Inflow = 4.13 cfs @ 12.09 hrs, Volume= 17,961 cf
Outflow = 4.10 cfs @ 12.09 hrs, Volume= 17,796 cf, Atten= 1%, Lag= 0.0 min
Discarded = 0.15 cfs @ 9.85 hrs, Volume= 7,936 cf
Primary = 3.96 cfs @ 12.09 hrs, Volume= 9,861 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 110.71' @ 12.09 hrs Surf.Area= 765 sf Storage= 1,008 cf

Plug-Flow detention time= 35.2 min calculated for 17,796 cf (99% of inflow)
Center-of-Mass det. time= 29.5 min ( 827.2 - 797.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 107.19' | 507 cf | **17.96'W x 41.50'L x 2.42'H Field A**<br>1,802 cf Overall - 534 cf Embedded = 1,268 cf x 40.0% Voids |
| #2A | 107.52' | 432 cf | **ADS N-12 18** x 12 Inside #1<br>Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf<br>Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf |
| #3 | 107.19' | 153 cf | **5.00'D x 7.81'H Manhole** |
| | | 1,092 cf | Total Available Storage |

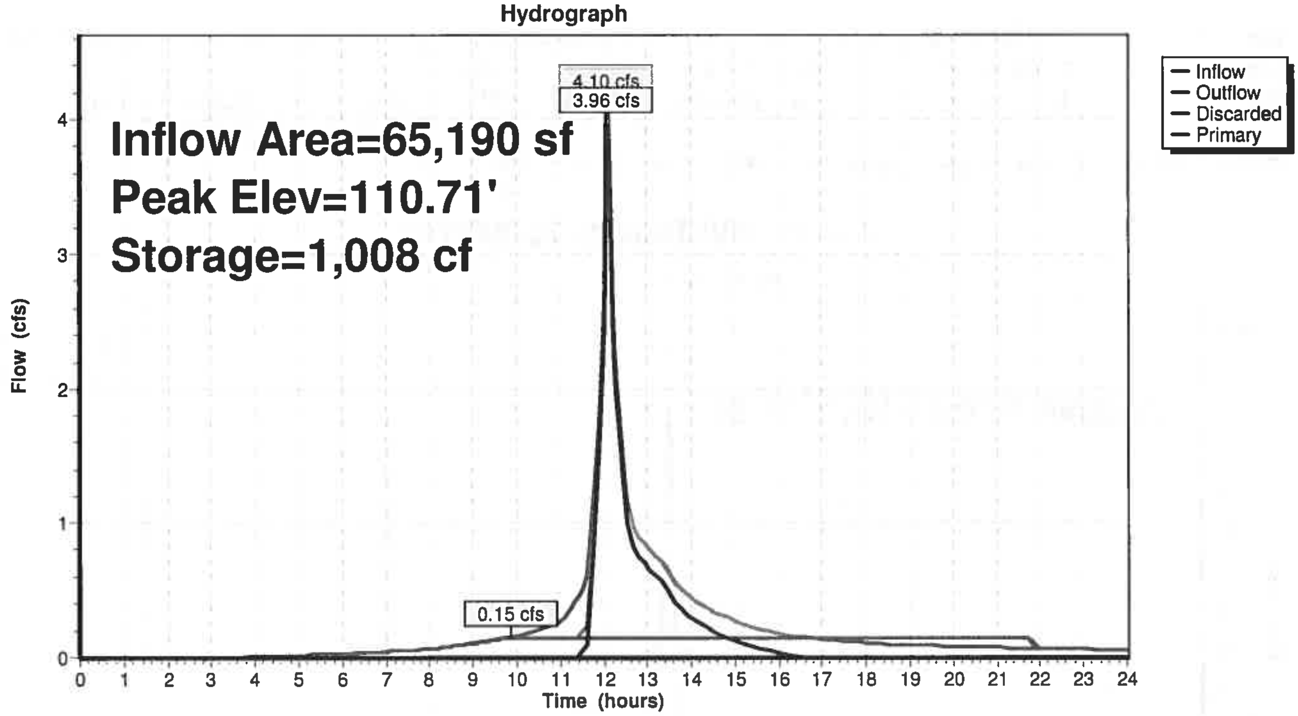
Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 109.60' | **18.0" Round Culvert**<br>L= 29.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 109.60' / 107.51' S= 0.0721 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |
| #2 | Discarded | 107.19' | **8.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.15 cfs @ 9.85 hrs HW=107.27' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.15 cfs)

**Primary OutFlow** Max=3.88 cfs @ 12.09 hrs HW=110.69' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 3.88 cfs @ 2.81 fps)

## Pond IB-1: INFILTRATION BASIN (IB-1)

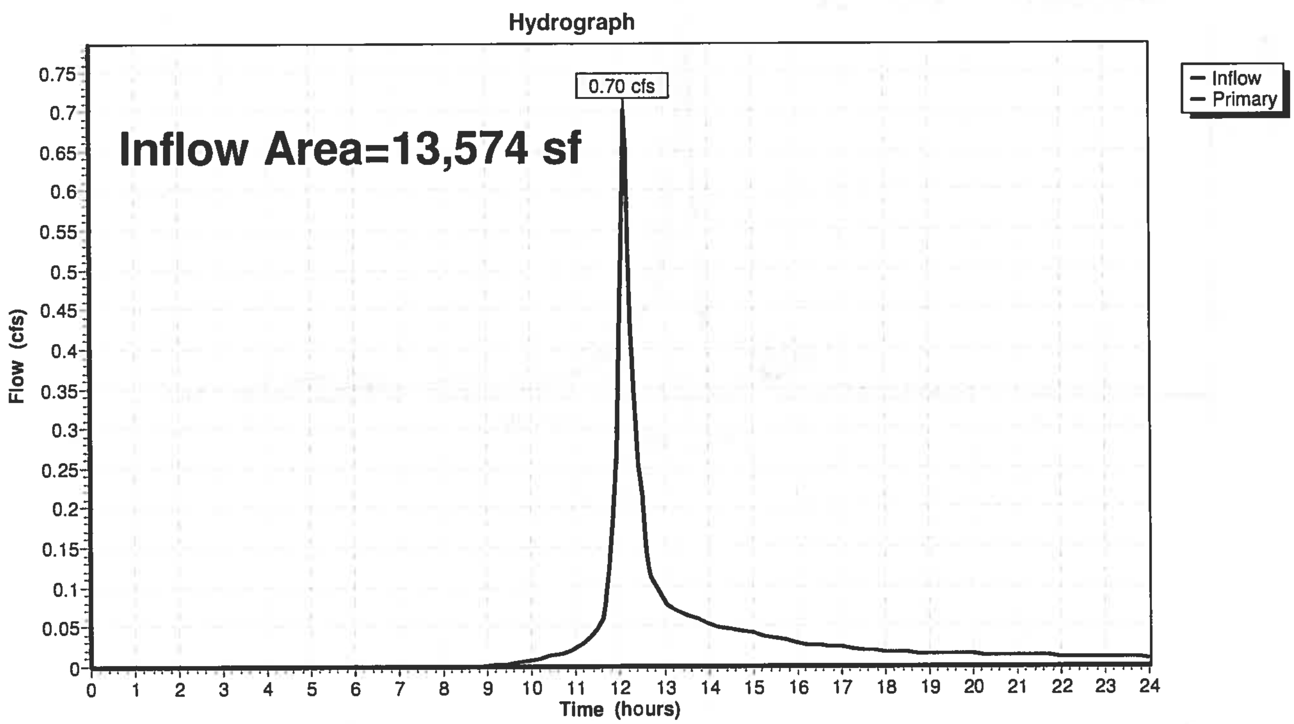


## Summary for Link 1L: OVERLAND TO SOUTH

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 13,574 sf, | 9.92% Impervious, | Inflow Depth > 2.11" | for 10-YEAR STORM event |
| Inflow = | 0.70 cfs @ | 12.11 hrs, Volume= | 2,387 cf | |
| Primary = | 0.70 cfs @ | 12.11 hrs, Volume= | 2,387 cf, | Atten= 0%, Lag= 0.0 min |

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

### Link 1L: OVERLAND TO SOUTH

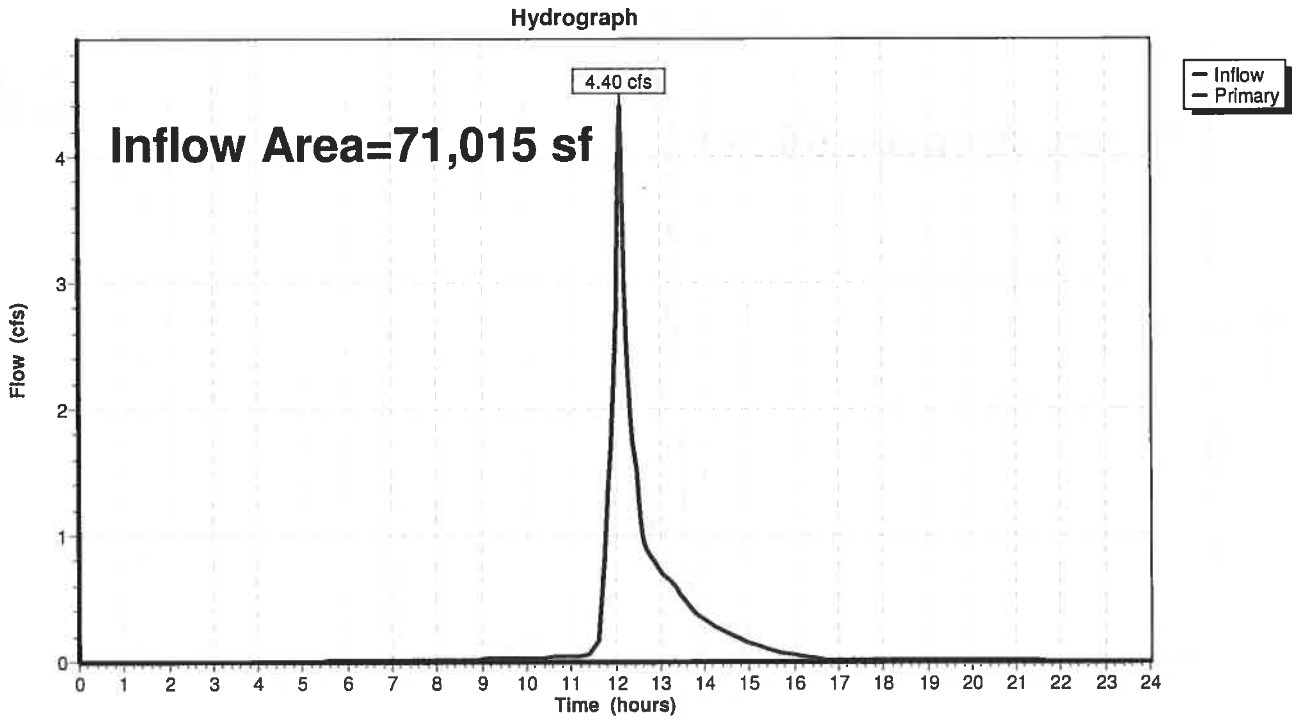


## Summary for Link 2L: TO TOWN SYSTEM

| | | | |
|---|---|---|---|
| Inflow Area = | 71,015 sf, 68.86% Impervious, | Inflow Depth > 2.02" | for 10-YEAR STORM event |
| Inflow = | 4.40 cfs @ 12.10 hrs, Volume= | 11,926 cf | |
| Primary = | 4.40 cfs @ 12.10 hrs, Volume= | 11,926 cf, Atten= 0%, Lag= 0.0 min | |

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

### Link 2L: TO TOWN SYSTEM

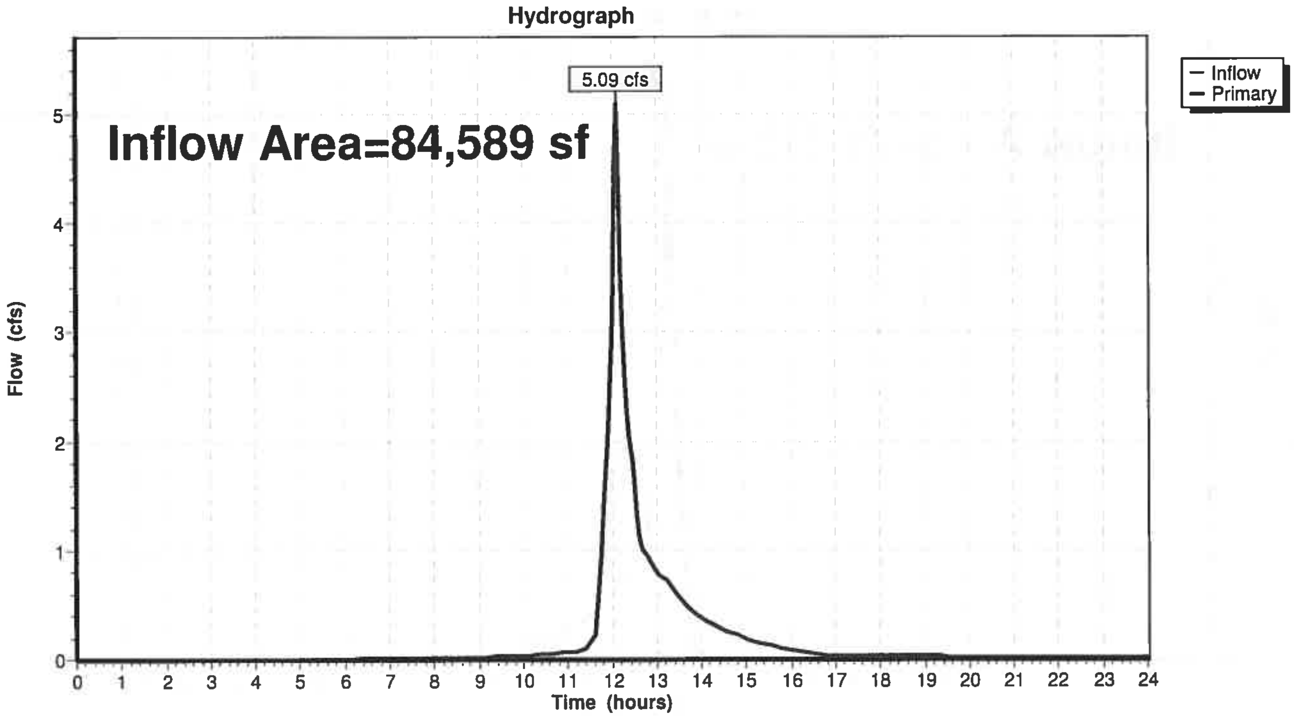


## Summary for Link DP1: CONNECTICUT RIVER

| | | | |
|---|---|---|---|
| Inflow Area = | 84,589 sf, 59.40% Impervious, | Inflow Depth > 2.03" | for 10-YEAR STORM event |
| Inflow = | 5.09 cfs @ 12.10 hrs, Volume= | 14,313 cf | |
| Primary = | 5.09 cfs @ 12.10 hrs, Volume= | 14,313 cf, Atten= 0%, Lag= 0.0 min | |

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

### Link DP1: CONNECTICUT RIVER



## Summary for Subcatchment P1: OVERLAND TO SOUTHWEST

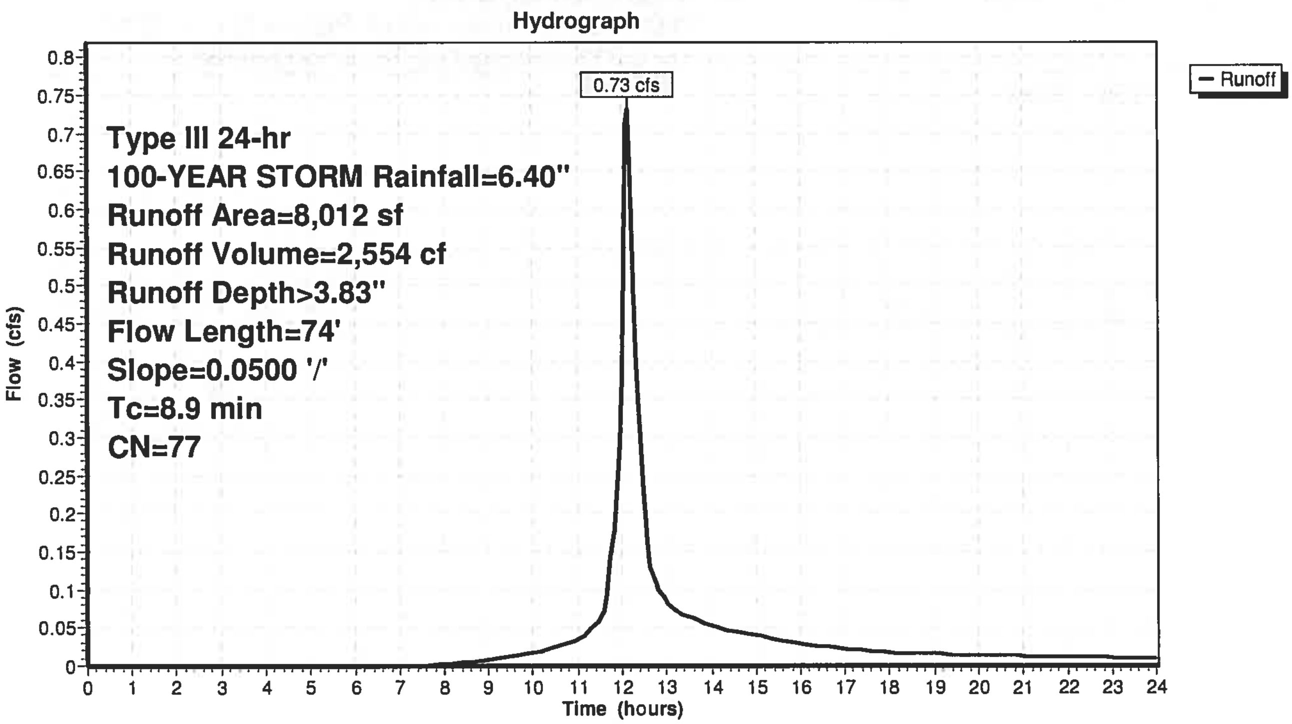
Runoff = 0.73 cfs @ 12.13 hrs, Volume= 2,554 cf, Depth> 3.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YEAR STORM Rainfall=6.40"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 1,347 | 98 | Paved path, HSG C |
| | 5,137 | 74 | >75% Grass cover, Good, HSG C |
| | 1,528 | 70 | Woods, Good, HSG C |
| | 8,012 | 77 | Weighted Average |
| | 6,665 | | 83.19% Pervious Area |
| | 1,347 | | 16.81% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.8 | 50 | 0.0500 | 0.09 | | **Sheet Flow, A TO B** Woods: Light underbrush n= 0.400 P2= 3.00" |
| 0.1 | 24 | 0.0500 | 3.60 | | **Shallow Concentrated Flow, B TO C** Unpaved Kv= 16.1 fps |
| 8.9 | 74 | Total | | | |

## Subcatchment P1: OVERLAND TO SOUTHWEST



## Summary for Subcatchment P2: TO BIORETENTION

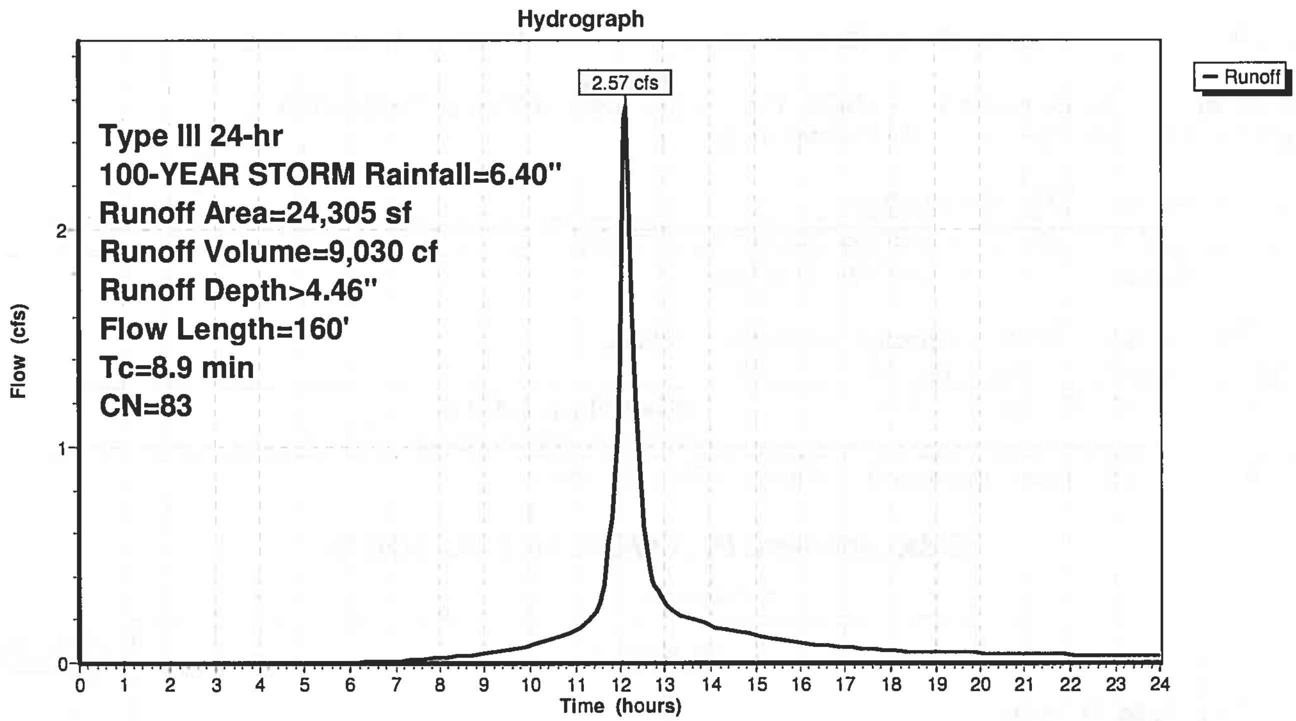
Runoff = 2.57 cfs @ 12.12 hrs, Volume= 9,030 cf, Depth> 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YEAR STORM Rainfall=6.40"

| | Area (sf) | CN | Description |
|---|---|---|---|
| * | 1,877 | 98 | Paved path, HSG C |
| | 14,210 | 74 | >75% Grass cover, Good, HSG C |
| | 856 | 70 | Woods, Good, HSG C |
| * | 7,362 | 98 | Roofs, HSG C |
| | 24,305 | 83 | Weighted Average |
| | 15,066 | | 61.99% Pervious Area |
| | 9,239 | | 38.01% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.1 | 14 | 0.0100 | 0.04 | | **Sheet Flow, A TO B**<br>Woods: Light underbrush n= 0.400 P2= 3.00" |
| 2.5 | 36 | 0.0833 | 0.24 | | **Sheet Flow, B TO C**<br>Grass: Short n= 0.150 P2= 3.00" |
| 0.1 | 25 | 0.0600 | 3.94 | | **Shallow Concentrated Flow, C TO D**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 85 | 0.0300 | 6.00 | 2.09 | **Pipe Channel, D TO E**<br>8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17'<br>n= 0.013 Corrugated PE, smooth interior |
| 8.9 | 160 | Total | | | |

## Subcatchment P2: TO BIORETENTION



## Summary for Subcatchment P3: OVERLAND TO SOUTH

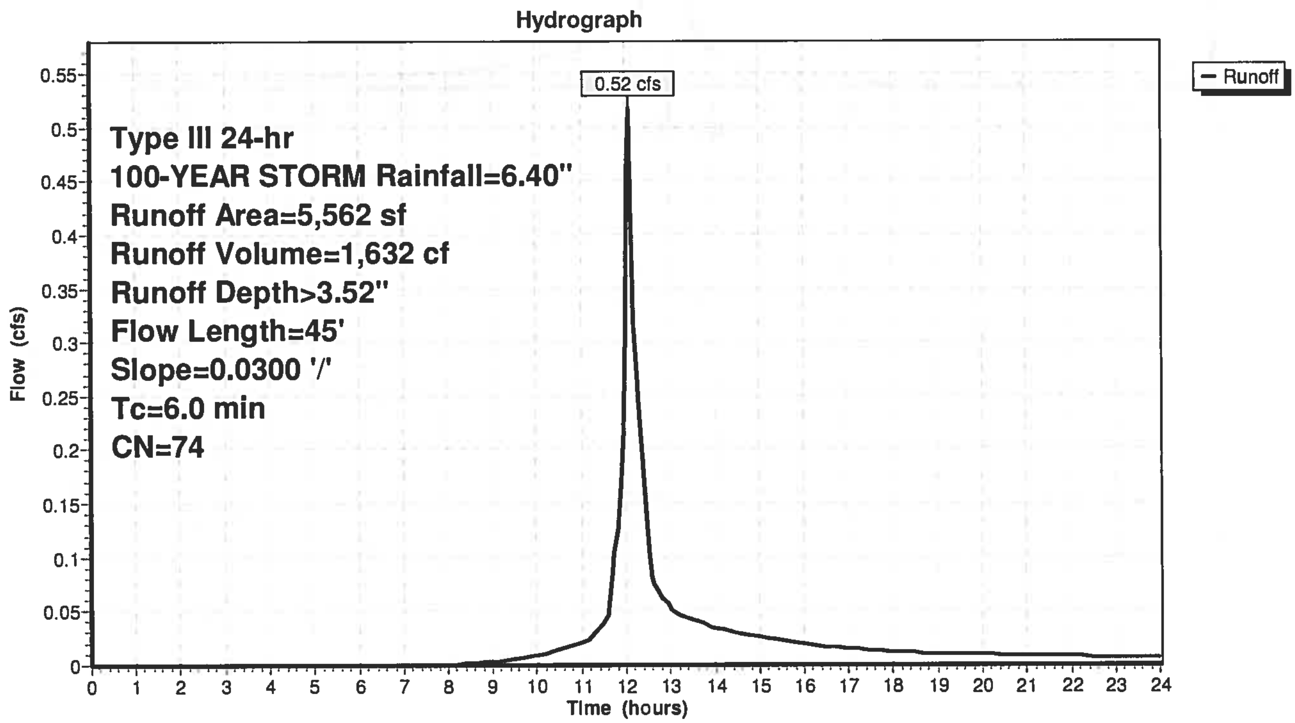
Runoff = 0.52 cfs @ 12.09 hrs, Volume= 1,632 cf, Depth> 3.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YEAR STORM Rainfall=6.40"

| Area (sf) | CN | Description |
|---|---|---|
| 5,562 | 74 | >75% Grass cover, Good, HSG C |
| 5,562 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.5 | 45 | 0.0300 | 0.17 | | **Sheet Flow, A TO B**<br>Grass: Short n= 0.150 P2= 3.00" |
| 4.5 | 45 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment P3: OVERLAND TO SOUTH



## Summary for Subcatchment P4: TO INFILTRATION BASIN

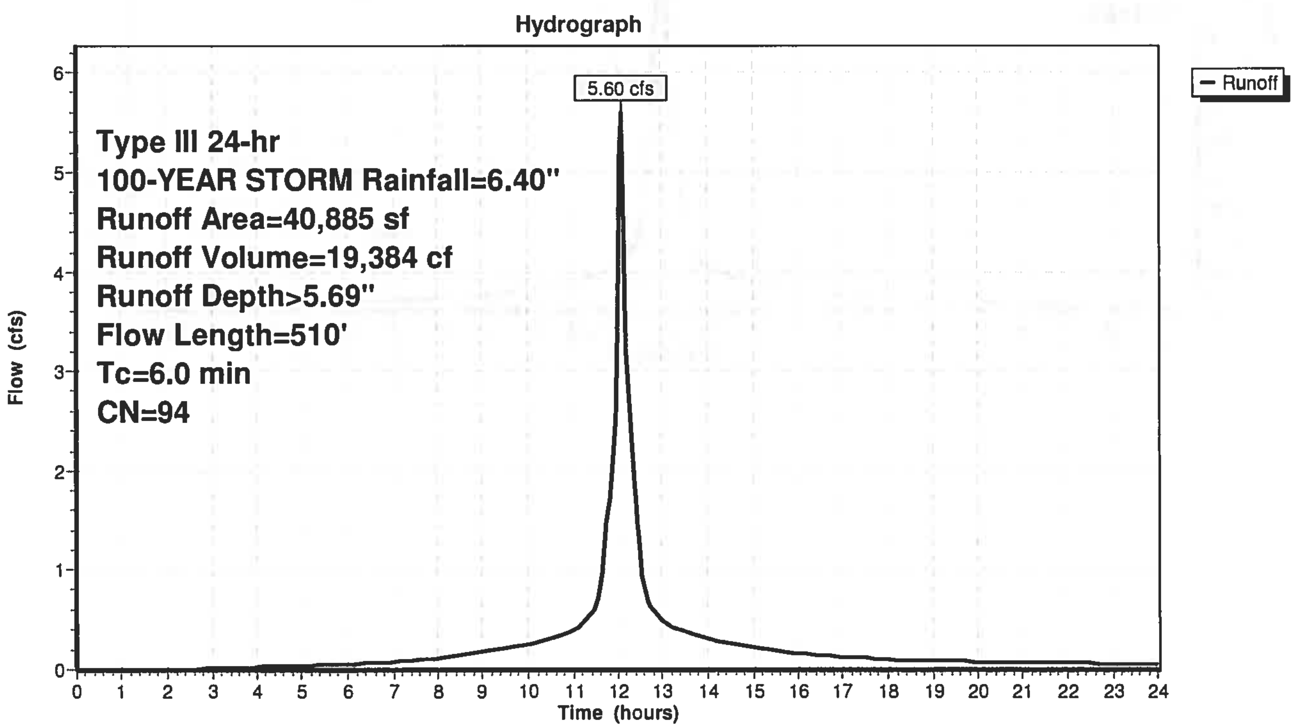
Runoff = 5.60 cfs @ 12.09 hrs, Volume= 19,384 cf, Depth> 5.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YEAR STORM Rainfall=6.40"

| Area (sf) | CN | Description |
|---|---|---|
| 6,080 | 98 | Roofs, HSG A |
| 27,755 | 98 | Paved parking, HSG A |
| 7,050 | 74 | >75% Grass cover, Good, HSG C |
| 40,885 | 94 | Weighted Average |
| 7,050 | | 17.24% Pervious Area |
| 33,835 | | 82.76% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.2 | 50 | 0.0450 | 0.20 | | **Sheet Flow, A TO B**<br>Grass: Short n= 0.150 P2= 3.00" |
| 0.1 | 11 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, B TO C**<br>Unpaved Kv= 16.1 fps |
| 1.0 | 449 | 0.0250 | 7.17 | 5.63 | **Pipe Channel, C TO D**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 |
| 5.3 | 510 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment P4: TO INFILTRATION BASIN



## Summary for Subcatchment P5: OVERLAND TO STREET - SIDEWALK

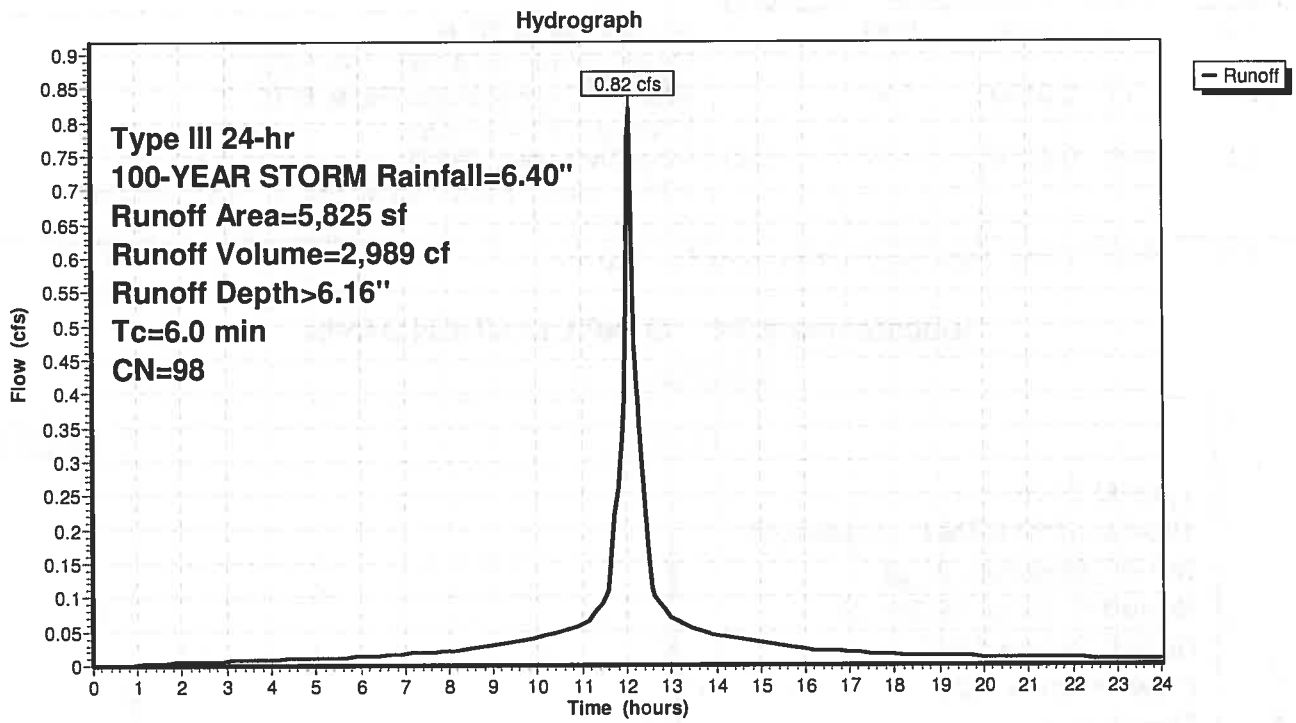
Runoff = 0.82 cfs @ 12.09 hrs, Volume= 2,989 cf, Depth> 6.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-YEAR STORM Rainfall=6.40"

| Area (sf) | CN | Description |
|---|---|---|
| 5,825 | 98 | Paved parking, HSG C |
| 5,825 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Sidewalk** |

## Subcatchment P5: OVERLAND TO STREET - SIDEWALK



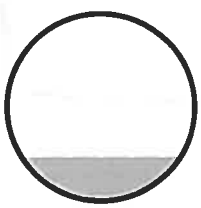
## Summary for Reach 1R: Pipe

Inflow Area = 24,305 sf, 38.01% Impervious, Inflow Depth > 3.61" for 100-YEAR STORM event
Inflow = 0.51 cfs @ 12.20 hrs, Volume= 7,306 cf
Outflow = 0.51 cfs @ 12.30 hrs, Volume= 7,293 cf, Atten= 0%, Lag= 6.0 min

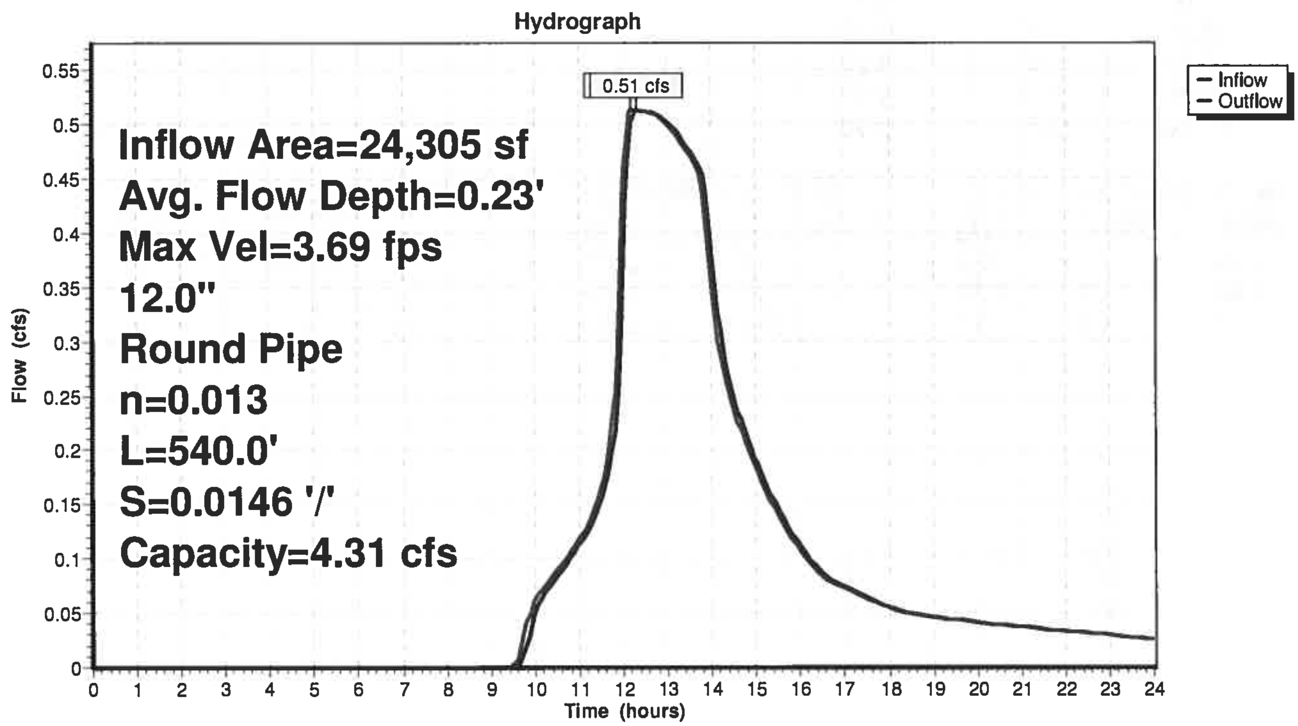
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.69 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 2.25 fps, Avg. Travel Time= 4.0 min

Peak Storage= 75 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.31 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 540.0' Slope= 0.0146 '/'
Inlet Invert= 115.10', Outlet Invert= 107.19'



### Reach 1R: Pipe



## Summary for Reach 2R: ROAD GUTTER

Inflow Area = 5,825 sf,100.00% Impervious, Inflow Depth > 6.16" for 100-YEAR STORM event
Inflow = 0.82 cfs @ 12.09 hrs, Volume= 2,989 cf
Outflow = 0.76 cfs @ 12.15 hrs, Volume= 2,985 cf, Atten= 7%, Lag= 3.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.30 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 0.91 fps, Avg. Travel Time= 5.4 min

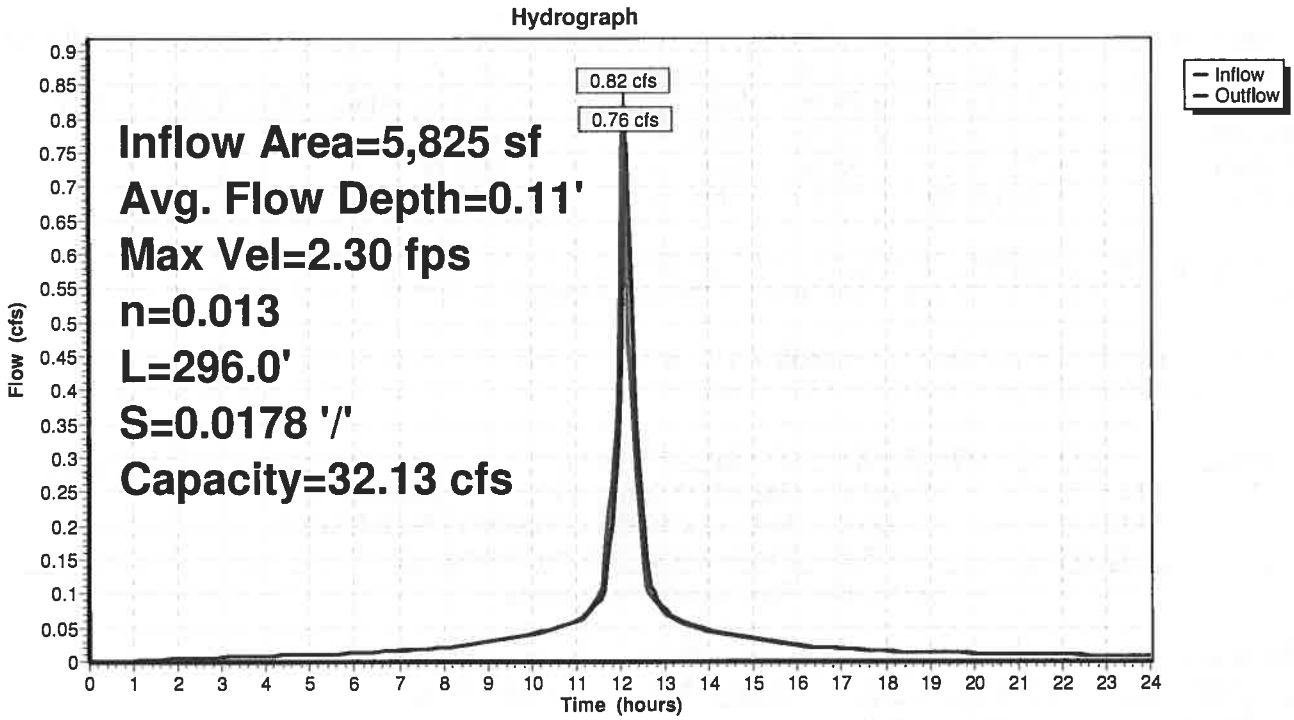
Peak Storage= 101 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 0.50' Flow Area= 4.0 sf, Capacity= 32.13 cfs

Custom cross-section, Length= 296.0' Slope= 0.0178 '/'
Constant n= 0.013 Asphalt, smooth
Inlet Invert= 123.80', Outlet Invert= 118.53'

| Offset (feet) | Elevation (feet) | Chan.Depth (feet) |
|---|---|---|
| 0.00 | 0.50 | 0.00 |
| 0.10 | 0.00 | 0.50 |
| 0.50 | 0.00 | 0.50 |
| 10.00 | 0.20 | 0.30 |
| 10.10 | 0.50 | 0.00 |

| Depth (feet) | End Area (sq-ft) | Perim. (feet) | Storage (cubic-feet) | Discharge (cfs) |
|---|---|---|---|---|
| 0.00 | 0.0 | 0.4 | 0 | 0.00 |
| 0.20 | 1.0 | 10.1 | 306 | 3.45 |
| 0.50 | 4.0 | 10.7 | 1,196 | 32.13 |

## Reach 2R: ROAD GUTTER



## Summary for Pond BR-1: BIORETENTION BASIN (BR-1)

Inflow Area = 24,305 sf, 38.01% Impervious, Inflow Depth > 4.46" for 100-YEAR STORM event
Inflow = 2.57 cfs @ 12.12 hrs, Volume= 9,030 cf
Outflow = 2.16 cfs @ 12.22 hrs, Volume= 8,639 cf, Atten= 16%, Lag= 5.5 min
Discarded = 0.01 cfs @ 12.22 hrs, Volume= 297 cf
Primary = 0.51 cfs @ 12.20 hrs, Volume= 7,306 cf
Tertiary = 1.64 cfs @ 12.22 hrs, Volume= 1,037 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 120.03' @ 12.20 hrs Surf.Area= 1,286 sf Storage= 2,028 cf

Plug-Flow detention time= 58.3 min calculated for 8,621 cf (95% of inflow)
Center-of-Mass det. time= 34.3 min ( 839.9 - 805.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.30' | 2,863 cf | **Overall (Prismatic)** Listed below (Recalc) |
| #2 | 115.20' | 46 cf | **12.0" D x 59.0'L Underdrain S= 0.0050 '/'** |
| #3 | 115.20' | 28 cf | **2.00'D x 4.47'H Area Drains** x 2 |
| | | 2,937 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Voids (%) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|---|
| 114.30 | 682 | 0.0 | 0 | 0 |
| 114.31 | 682 | 40.0 | 3 | 3 |
| 116.75 | 682 | 40.0 | 666 | 668 |
| 116.76 | 682 | 20.0 | 1 | 670 |
| 118.99 | 682 | 20.0 | 304 | 974 |
| 119.00 | 682 | 100.0 | 7 | 981 |
| 120.00 | 1,180 | 100.0 | 931 | 1,912 |
| 120.50 | 2,624 | 100.0 | 951 | 2,863 |

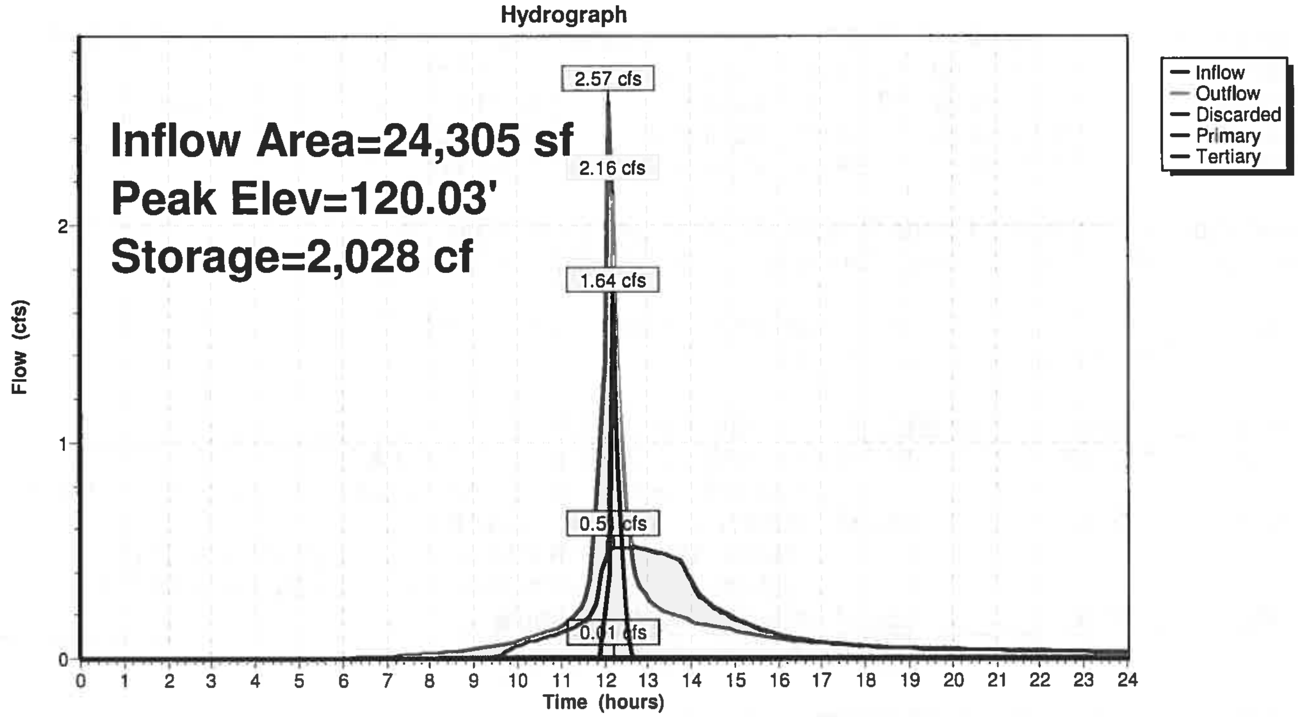
| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.20' | **3.0" Vert. Outlet Control** C= 0.600 |
| #2 | Discarded | 114.30' | **0.270 in/hr Exfiltration over Surface area** |
| #3 | Tertiary | 120.00' | **72.0' long x 2.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00<br>2.50 3.00 3.50<br>Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88<br>2.85 3.07 3.20 3.32 |

**Discarded OutFlow** Max=0.01 cfs @ 12.22 hrs HW=120.03' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

**Primary OutFlow** Max=0.51 cfs @ 12.20 hrs HW=120.03' (Free Discharge)
↑—**1=Outlet Control** (Orifice Controls 0.51 cfs @ 10.45 fps)

**Tertiary OutFlow** Max=1.06 cfs @ 12.22 hrs HW=120.03' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir** (Weir Controls 1.06 cfs @ 0.46 fps)

## Pond BR-1: BIORETENTION BASIN (BR-1)



## Summary for Pond IB-1: INFILTRATION BASIN (IB-1)

Inflow Area = 65,190 sf, 66.07% Impervious, Inflow Depth > 4.91" for 100-YEAR STORM event
Inflow = 6.06 cfs @ 12.09 hrs, Volume= 26,677 cf
Outflow = 6.04 cfs @ 12.09 hrs, Volume= 26,414 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.15 cfs @ 8.65 hrs, Volume= 9,345 cf
Primary = 5.89 cfs @ 12.09 hrs, Volume= 17,069 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 111.11' @ 12.09 hrs Surf.Area= 765 sf Storage= 1,016 cf

Plug-Flow detention time= 29.2 min calculated for 26,414 cf (99% of inflow)
Center-of-Mass det. time= 23.0 min ( 814.0 - 791.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 107.19' | 507 cf | **17.96'W x 41.50'L x 2.42'H Field A** |
| | | | 1,802 cf Overall - 534 cf Embedded = 1,268 cf x 40.0% Voids |
| #2A | 107.52' | 432 cf | **ADS N-12 18** x 12 Inside #1 |
| | | | Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf |
| | | | Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf |
| #3 | 107.19' | 153 cf | **5.00'D x 7.81'H Manhole** |
| | | 1,092 cf | Total Available Storage |

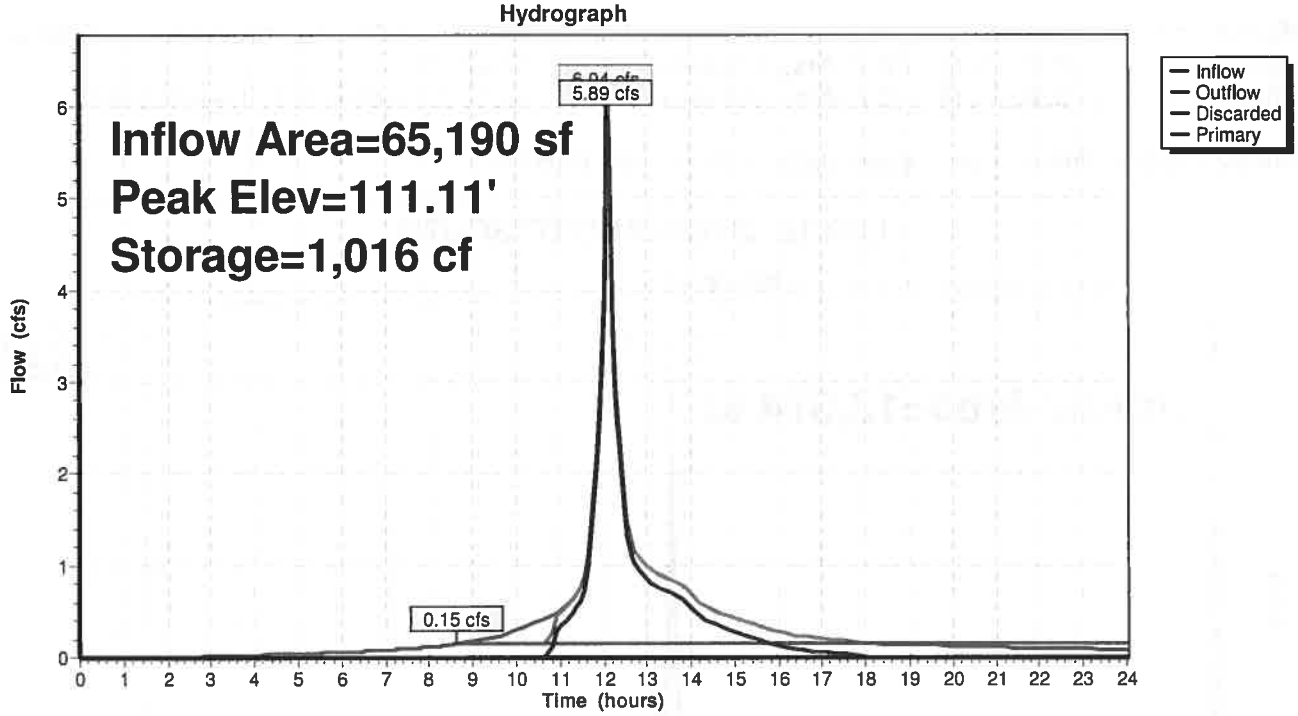
Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 109.60' | **18.0" Round Culvert** |
| | | | L= 29.0' CPP, projecting, no headwall, Ke= 0.900 |
| | | | Inlet / Outlet Invert= 109.60' / 107.51' S= 0.0721 '/' Cc= 0.900 |
| | | | n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |
| #2 | Discarded | 107.19' | **8.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.15 cfs @ 8.65 hrs HW=107.27' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.15 cfs)

**Primary OutFlow** Max=5.76 cfs @ 12.09 hrs HW=111.08' (Free Discharge)
└─**1=Culvert** (Inlet Controls 5.76 cfs @ 3.27 fps)

## Pond IB-1: INFILTRATION BASIN (IB-1)

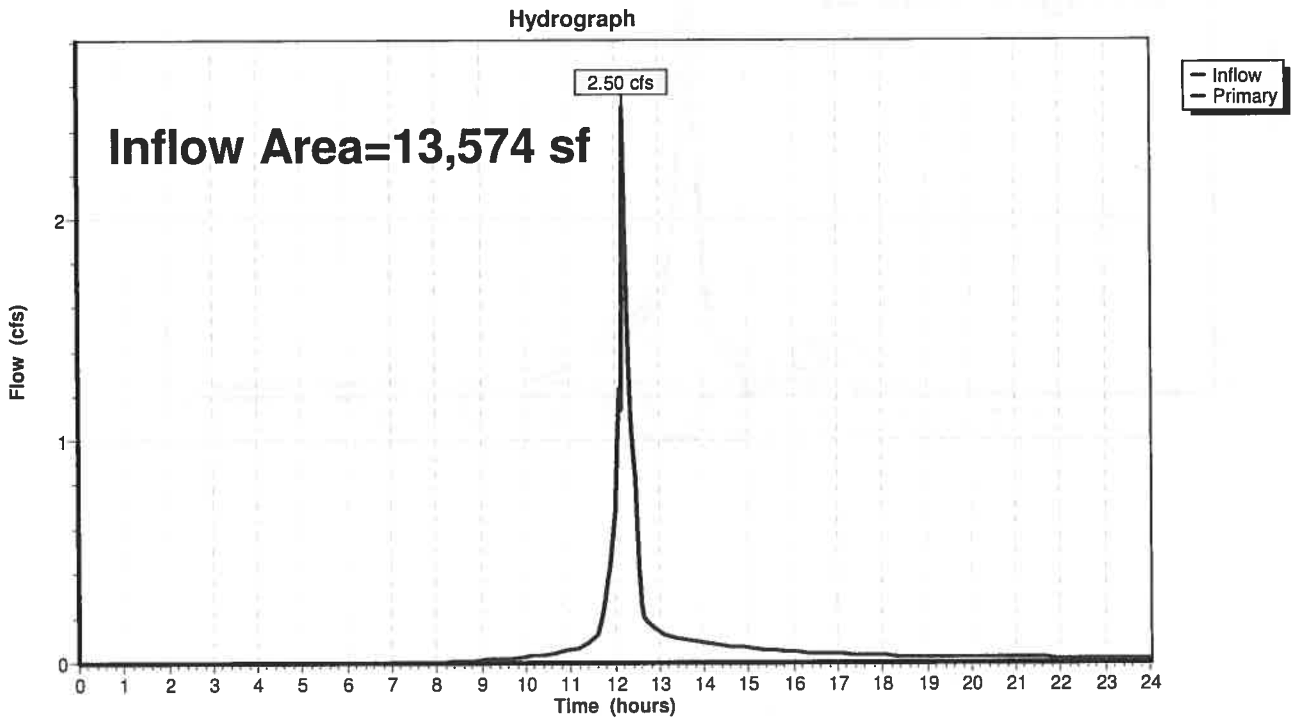


## Summary for Link 1L: OVERLAND TO SOUTH

Inflow Area = 13,574 sf, 9.92% Impervious, Inflow Depth > 4.62" for 100-YEAR STORM event
Inflow = 2.50 cfs @ 12.21 hrs, Volume= 5,222 cf
Primary = 2.50 cfs @ 12.21 hrs, Volume= 5,222 cf, Atten= 0%, Lag= 0.0 min

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

## Link 1L: OVERLAND TO SOUTH

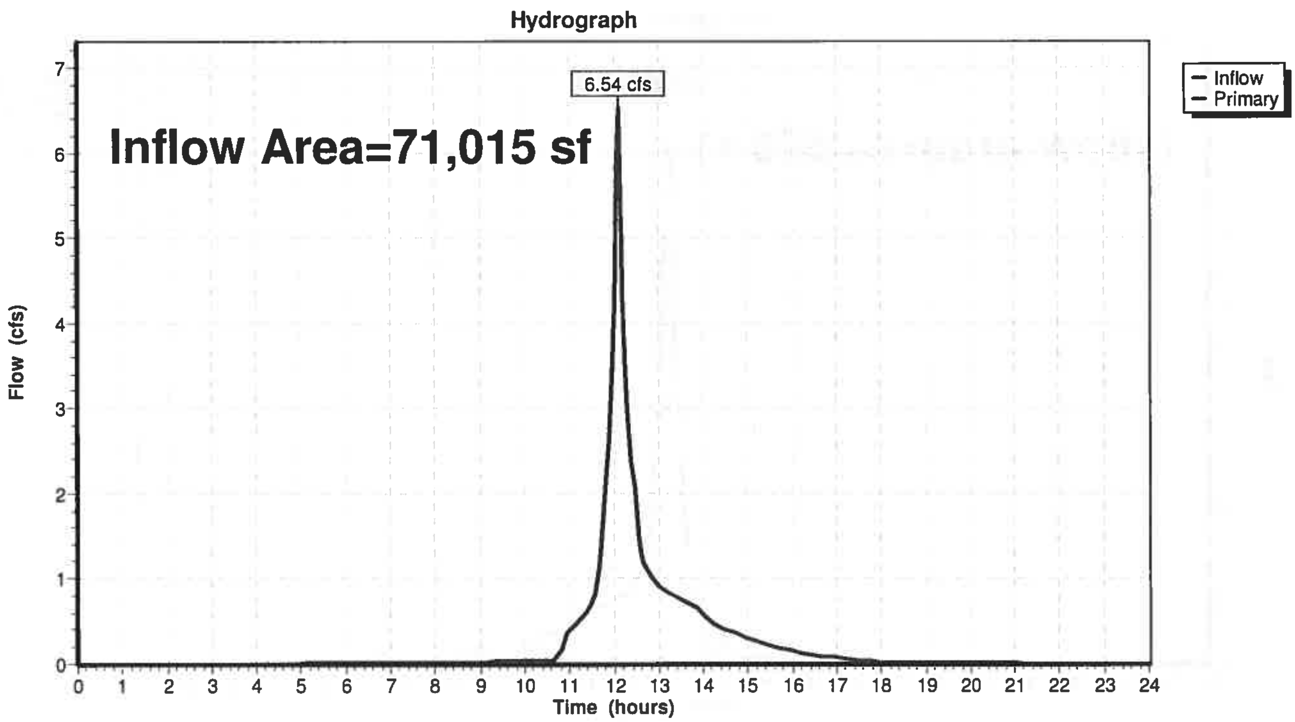


## Summary for Link 2L: TO TOWN SYSTEM

Inflow Area = 71,015 sf, 68.86% Impervious, Inflow Depth > 3.39" for 100-YEAR STORM event
Inflow = 6.54 cfs @ 12.09 hrs, Volume= 20,054 cf
Primary = 6.54 cfs @ 12.09 hrs, Volume= 20,054 cf, Atten= 0%, Lag= 0.0 min

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

### Link 2L: TO TOWN SYSTEM

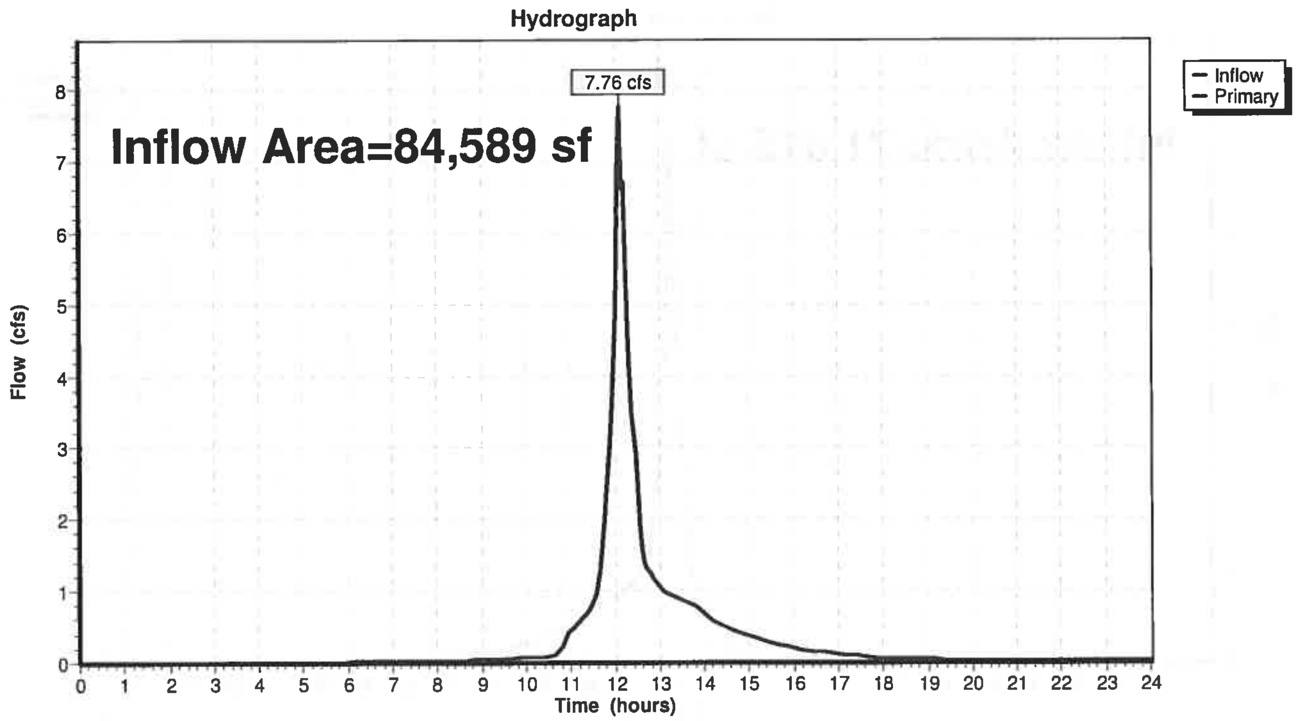


## Summary for Link DP1: CONNECTICUT RIVER

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 84,589 sf, | 59.40% Impervious, | Inflow Depth > 3.59" | for 100-YEAR STORM event |
| Inflow = | 7.76 cfs @ | 12.10 hrs, Volume= | 25,277 cf | |
| Primary = | 7.76 cfs @ | 12.10 hrs, Volume= | 25,277 cf, | Atten= 0%, Lag= 0.0 min |

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

### Link DP1: CONNECTICUT RIVER



## APPENDIX E

**Long-Term Pollution Prevention and Stormwater Operation and Maintenance Plan**

# APPENDIX E: LONG-TERM POLLUTION PREVENTION PLAN AND STORMWATER OPERATION AND MAINTENANCE PLAN

South Hadley Library

## Table of Contents

## 1.0 INTRODUCTION

The purpose of this document is to specify the pollution prevention measures and stormwater management system operation and maintenance for the South Hadley Library (The Library). The Owner shall implement the management practices outlined in this Manual and proactively conduct operations at the The Library campus in an environmentally responsible manner. Compliance with this Manual does not in any way dismiss the Owner, property manager, or occupants from compliance with other applicable Federal, State or local laws.

Owner: South Hadley Library
2 Canal Street
South Hadley, MA 01075

This Document has been prepared in compliance with Standards 4 and 9 of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards, which state:

Standard 4:
The Long Term Pollution Prevention Plan shall include the proper procedures for the following:

- Good housekeeping
- Storing materials and waste products inside or under cover
- Vehicle washing
- Routine inspections of stormwater best management practices
- Spill prevention and response
- Maintenance of lawns, gardens, and other landscaped areas
- Storage and used of fertilizers, herbicides, and pesticides
- Pet waste management
- Operation and management of septic systems
- Proper management of deicing chemicals and snow

Standard 9:
The Long-Term Operation and Maintenance Plan shall at a minimum include:

- Stormwater management system(s) owner(s)
- The party or parties responsible for operation and maintenance, including how future property owners shall be notified of the presence of the stormwater management system and the requirement for operation and maintenance
- The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks
- A plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along with the discharge point
- A description of public safety features
- An estimated operations and maintenance budget

## 2.0 LONG-TERM POLLUTION PREVENTION PLAN

### 2.1 Source Control Practices for Pollution Prevention

The Owner and occupants should follow good housekeeping procedures at the farmstead to reduce the possibility of accidental releases and to reduce safety hazards, which shall include but not be limited to the following:

- Proper handling, storage, disposal, and recycling of hazardous materials and waste products
- Proper handling, storage and inventory of household chemicals
- Prompt cleanup and removal of spills and releases

### 2.2 Storage of Hazardous Materials

To prevent leaks and spills, keep hazardous materials and waste products under cover or inside. Use drip pans or spill containment systems to prevent chemicals from entering the drainage system. Inspect storage areas for materials and waste products at least once per year to determine amount and type of the material on site, and if the material requires disposal.

Securely store liquid petroleum products and other liquid chemicals in federally- and state-approved containers. Restrict access to maintenance personnel and administrators.

Store fluid fertilizers in labeled containers and/or structures that prevent the discharge of fluid fertilizers and are resistant to corrosion, puncture, or cracking. Store and handle dry fertilizers in a manner to prevent pollution by minimizing losses to the air, surface water, ground water, or subsoil.

### 2.3 Storage of Waste Products

Collect and store all waste materials in securely lidded dumpster(s) or other secure containers as applicable to the material. Keep dumpster lids closed and the areas around them clean. Do not fill the dumpsters with liquid waste or hose them out. Sweep areas around the dumpster regularly and put the debris in the garbage, instead of sweeping or hosing it into the parking lot. Legally dispose of collected waste on a regular basis.

Segregate liquid wastes, including motor oil, antifreeze, solvents, and lubricants, from solid waste and recycle through hazardous waste disposal companies, whenever possible. Separate oil filters, batteries, tires, and metal filings from grinding and polishing metal parts from common trash items and recycle. These items are not trash and are illegal to dump. Contact a hazardous waste hauler for proper disposal of unwanted pesticides to a hazardous waste collection center.

### 2.4 Spill Prevention and Response

The Owner shall implement spill response procedures for releases of significant materials such as fuels, oils, or chemical materials onto the ground or other area that could reasonably be expected to discharge to surface or groundwater.

- The drainage system at the vehicle fueling station located at the maintenance garage on the farmstead has contains emergency shut-off valves that shall be closed in the event of a fuel spill.

- For minor spills, keep fifty (50) gallon spill control kits and Speedy Dry at all shop and work areas.
- Immediately contact applicable Federal, State, and local agencies for reportable quantities as required by law. For minor spills, keep fifty (50) gallon spill control kits and Speedy Dry at all shop and work areas.
- Immediately perform applicable containment and cleanup procedures following a spill release.
- Promptly remove and dispose of all material collected during the response in accordance with Federal, State and local requirements. A licensed emergency response contractor may be required to assist in cleanup of releases depending on the amount of the release, and the ability of the Contractor to perform the required response.
- Reportable quantities of chemicals, fuels, or oils are established under the Clean Water Act and enforced through Massachusetts Department of Environmental Protection (DEP).

### 2.5 Minimize Soil Erosion

Soil erosion facilitates mechanical transport of nutrients, pathogens, and organic matter to surface water bodies. Repair all areas where erosion is occurring throughout the farmstead, paddocks, and pastures. Stabilize bare soil with riprap, seed, mulch, or vegetation.

### 2.6 Vehicle Washing:

Vehicle washing shall not occur on the property.

### 2.7 Maintenance of Lawns, Gardens, and other Landscaped Areas

Pesticides and fertilizers shall not be used in the landscaped areas associated with the site. Grass clippings, pruned branches and any other landscaped waste should be disposed of or composted in an appropriate location.

### 2.8 Storage of Fertilizers, Herbicides, and Pesticides

No fertilizers, herbicides, or pesticides shall be applied in the landscaped areas associated with the site.

### 2.9 Pet Waste Management

Pet waste contributes to poor water quality that affects the drainage system and surrounding water bodies. The property owner shall implement a cleanup program where pet owners must put the pet waste into bags and dispose of the waste in the trash.

### 2.10 Management of Deicing Chemicals and Snow

The qualified contractor selected for snow plowing and deicing shall be made fully aware of the requirements of this section.

There will be no usage of salt-based deicing chemicals within buffer areas of the wetland resources areas. Deicing chemicals shall be stored in a locked room inside the building and shall be used at exterior stairs and walkways.

During typical snow plowing operations, snow shall be pushed to the designated snow removal areas noted on the The Plan. Snow shall not be stockpiled in wetland resource areas or drainage system components. In severe conditions where snow cannot be stockpiled on site, the snow shall be removed from the site and properly disposed of in accordance with DEP Guideline BRP601-01.

Before winter begins, the property owner and the contractor shall review snow plowing, deicing, and stockpiling procedures. Areas designated for stockpiling should be cleaned of any debris. Street and parking lot sweeping should be followed in accordance with the Operation and Maintenance Plan.

### 2.11 Coordination with other Permits and Requirements

Certain conditions of other approvals affecting the long term management of the property shall be considered part of this Long Term Pollution Prevention Plan. The Owner shall become familiar with those documents and comply with the guidelines set forth in those documents.

## 3.0 STORMWATER MANAGEMENT SYSTEM OPERATION AND MAINTENANCE PLAN

### 3.1 Introduction

This Operation and Maintenance Plan (O&M Plan) for South Hadley Library is required under Standard 9 of the 2008 MassDEP Stormwater Handbook to provide best management practices for implementing maintenance activities for the stormwater management system in a manner that minimizes impacts to wetland resource areas.

The Owner shall implement this O&M Plan and proactively conduct operations at the site in an environmentally responsible manner. Compliance with this O&M Plan does not in any way dismiss the Owner from compliance with other applicable Federal, State or local laws.

Routine maintenance during construction and post-development phases of the project, as defined in the Operation and Maintenance Plan, shall be permitted without amendment to the Order of Conditions. A continuing condition in the Certificate of Compliance shall ensure that maintenance can be performed without triggering further filings under the Wetlands Protection Act.

All stormwater best management practices (BMPs) shall be operated and maintained in accordance with the design plans and the Operation and Maintenance Plan approved by the issuing authority. The Owner shall:

a. Maintain an operation and maintenance log for the last three years, including inspections, repairs, replacement and disposal (for disposal the log shall indicate the type of material and the disposal location). This is a rolling log in which the responsible party records all operation and maintenance activities for the past three years.

b. Make this log available to MassDEP and the Conservation Commission upon request; and

c. Allow members and agents of the MassDEP and the Conservation Commission to enter and inspect the premises to evaluate and ensure that the Owner complies with the Operation and Maintenance requirements for each BMP.

### 3.2 Stormwater Operation and Maintenance Requirements

Inspect and maintain the stormwater management system as directed below. Repairs to any component of the system shall be made as soon as possible to prevent any potential pollutants (including silt) from entering the resource areas.

<u>Deep Sump and Hooded Catch Basins</u>

Inspect catch basins four times per year, including after the foliage season. Other inspection and maintenance requirements include:

- Remove organic material, sediment and hydrocarbons four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.
- Always clean out catch basins after street sweeping. If any evidence of hydrocarbons is found during inspection, the material immediately remove using absorbent pads or other suitable measures and dispose of legally. Remove other accumulated debris as necessary.

- Transport and disposal of accumulated sediment off-site shall be in accordance with applicable local, state and federal guidelines and regulations.

Area Drains

Inspect area drains at least once per month and remove debris from the grate. Clean out accumulated sediments at least once per year and more frequently as necessary.

Water Quality Units (Proprietary Separators)

Maintain water quality units according the recommendations set forth by the manufacturer. General inspection and maintenance procedures for proprietary devices are provided below:

- Inspect units following completion of construction, prior to being put into service.
- Inspect units at least twice per year following installation and no less than once per year thereafter.
- Inspect units immediately after any oil, fuel or chemical spill.
- All inspections shall include checking the oil level and sediment depth in the unit. Removal of sediments/oils shall occur per manufacturer recommendations.
- A licensed waste management company shall remove captured petroleum waste products from any oil, chemical or fuel spills and dispose.
- OSHA confined space entry protocols shall be followed if entry into the unit is required.

Bioretention Basin

Perform annual maintenance of all components of the bioretention area, including plants, soil, and mulch. Table 1, below, outlines required maintenance activities.

**Table 1. Rain garden maintenance recommendations**

| Location | Description | Frequency | Time of Year |
|---|---|---|---|
| Surface | Inspect and remove trash | Monthly | Year round |
| Soil | Inspect and repair erosion | Monthly | Year round |
| Organic Layer | Remulch void areas | Annually | Spring |
| | Remove previous mulch layer before applying new layer (optional) | Annually | Spring |
| Plants | Water vegetation at end of day for 14 consecutive days after planting | Immediately after planting | As needed |
| | Remove and replace all dead and diseased vegetation that cannot be treated | Annually | Spring |
| | Treat all diseased trees and shrubs | As needed | Variable |

During and after storm events, record the length of time standing water remains in the bioretention area. If the time is greater than 72 hours, thoroughly inspect the basin for signs of clogging and develop a corrective action plan. The corrective action plan, prepared by a qualified professional, will outline procedures to restore infiltrative function. The owners of the site shall take immediate action to implement these corrective measures.

Subsurface Detention/Infiltration Structures

Inspect subsurface detention/infiltration structures twice per year. Inspect the inlets and observation ports to determine if there is accumulated sediment within the system. Remove all debris and accumulated sediment that may clog the system.

### 3.3 Street Sweeping

Perform street sweeping at least twice per year and whenever there is significant debris present on roads and parking lots. Street sweeping shall occur in March (or before spring rains begin) and November (or before the first snow storm). Sweepings must be handled and disposed of properly according to the South Hadley Conservation Commission.

### 3.4 Repair of the Stormwater Management System

The stormwater management system shall be maintained. The repair of any component of the system shall be made as soon as possible to prevent any potential pollutants including silt from entering the resource areas or the existing closed drainage system.

### 3.5 Reporting

The Owner shall maintain a record of drainage system inspections and maintenance (per this Plan) and submit a yearly report to the South Hadley Conservation Commission.

## STORMWATER MANAGEMENT SYSTEM INSPECTION FORM

| | |
|---|---|
| **South Hadley Library**<br>**South Hadley, MA** | **Inspected by:**____________<br>**Date:**____________ |

| Component | Status/Inspection | Action Taken |
|---|---|---|
| Deep Sump Catch Basins, Area Drains and Drain Manholes | | |
| Bioretention Basin | | |
| Subsurface Detention/Infiltration System | | |
| Water Quality Inlet | | |
| General site conditions – evidence of erosion, etc. | | |

**SUBMIT COPIES OF STORMWATER MANAGEMENT SYSTEM INSPECTION FORM TO THE SOUTH HADLEY CONSERVATION COMMISSIONS WITH THE YEARLY REPORT.**

## APPENDIX F

**Calculations: Pipe Sizing (Hydraulic Calculations), TSS Removal, Water Quality Volume, Recharge, and Drawdown Calculations**

**AutoDesk® Storm and Sanitary Analysis: Understanding this Report**

Nitsch Engineering used AutoDesk® Storm and Sanitary Analysis Software ("SSA") to estimate storm system inflows by the Rational Method and to size the proposed closed drainage systems. SSA contains several hydraulic modeling capabilities which are used to simultaneously route calculated runoff through complicated drainage system networks. The software can support both free-flow and surcharged pipe conditions. The results of these analyses are automatically compiled into tabular reports by the program as described below. This document is intended to help explain the definition of terms and the interpretation in stormwater design.

The following includes definitions of the different reports, data, and terms as generated by the SSA model for this project.

**"Rainfall Details" Section:**

Return Period: The selected return period of the IDF curve chosen for the hydrologic model

**"Subbasin Summary" Section:**

This section contains a summary of the inputs and calculations of all subbasins, or drainage areas, within the hydrology model.

SN: The assigned subbasin number

Subbasin ID: The name assigned to the subbasin

Area: The area of the drainage subbasin used to calculate the Peak Runoff Rate

Weighted Runoff Coefficient: The dimensionless Rational *C* value for the drainage subbasin reflecting the subbasin's surface cover and ability to absorb rainfall

Peak Runoff: The calculated volumetric flow rate using the Rational Method

Time of Concentration: The length of time between the start of the analysis and the time when the Peak Flow Rate Q is achieved

**"Link Summary" Section:**

This section contains a summary of the calculations for the closed drainage pipe network.

From (Inlet) Node: The upstream structure, or node, of the pipe

Inlet Invert Elevation: The elevation of the upstream invert of the pipe used to calculate Pipe Slope

To (Outlet) Node: The downstream structure, or node, of the pipe

Outlet Invert Elevation: The elevation of the downstream invert of the pipe used to calculate Pipe Slope

| | |
|---|---|
| Length: | The length of the pipe used to calculate the Pipe Slope |
| Pipe Slope: | The slope of the pipe calculated by subtracting the Outlet Invert Elevation from the Inlet Invert Elevation and dividing by pipe Length |
| Pipe Diameter: | The interior diameter of the pipe used to calculate the Pipe Design Capacity, Peak Flow Velocity, and Peak Flow Depth |
| Manning's Roughness: | A dimensionless coefficient describing the relative roughness of the interior pipe surface as determined from the pipe material. This coefficient is used to calculate the Pipe Flow Velocity and Pipe Design Capacity |
| Peak Flow Q: | The peak volumetric flow rate through the pipe. This is calculated from the contributing subbasin hydrology. This is used to calculate Peak Flow Velocity, Q/Qf Ratio, and Peak Flow Depth |
| Peak Flow Velocity: | The average speed of the runoff moving through the pipe during Peak Flow |
| Pipe Design Capacity Qf: | The maximum capacity of the pipe as calculated using *Manning's Equation* |
| Q/Qf Ratio: | The ratio of the Peak Flow Q to Pipe Design Capacity Qf. Values of less than 1.00 indicate that the Peak Flow Rate Q does not exceed the capacity of the pipe. Values of greater than 1.00 indicate that the pipe is under capacity and flows under submerged conditions. |
| Peak Flow Depth: | The depth of the flow, in feet, as measured from the invert of the pipe at the point of maximum depth. For free flow conditions, this value is assumed to be uniform throughout the pipe. |

**"Junction Input" Sections:**

| | |
|---|---|
| Junction Name: | Indicates the name of the structure |
| Invert Elevation: | The lowest invert of the structure |
| Rim Elevation: | The rim elevation of the structure |

**The Rational Method for Closed Drainage System Design**

The Rational Method is a widely accepted rainfall-runoff model used for estimating peak design flows when modeling closed drainage system hydraulics. It is typically used when analyzing runoff rates from drainage areas to individual catch basins due to its simplicity and advantages on smaller scales over other models. Nitsch Engineering used the Rational Method for the project stormwater calculations to estimate the runoff into catch basins and the closed drainage system.

The general formula for the rational method is:

$$Q = C\,i\,A$$

where

- $Q$ = *volumetric rate of runoff, in cubic feet per second*
- $C$ = *dimensionless runoff coefficient*
- $i$ = *peak rainfall intensity, in inches per hour*
- $A$ = *contributing drainage area (subcatchment), in acres*

The volumetric flow rate $Q$ at which the runoff reaches a catch basin or other drainage inlet is determined by a number of factors: the slope and flow lengths of the subcatchment area, the soil type, the surface cover and size of the subcatchment area, and the chosen rainfall return period and associated intensity.

### Drainage Areas

A drainage area, or subcatchment, is a portion of land that contributes runoff to a catch basin, inlet or other design point. This design point is the focus of the runoff analysis for that individual subcatchment and is considered to be the outflow point for the subcatchment. Peak rates of runoff are calculated at this point and then used to model the receiving pipe network hydraulics to determine pipe sizes, rates of flow, and velocities.

### The Runoff Coefficient

The dimensionless runoff coefficient $C$ is determined from a number of factors which are generally related to the surface cover of each individual subcatchment. Surface cover on a site is defined as impervious or pervious and can take the form of lawn, roof, pavement, brush, woods, etc.

Certain types of cover create more opportunities for water to be absorbed into the ground. A site covered with impermeable surfaces, such as pavement, typically has a runoff coefficient of 0.90. This value implies that almost all of the rain that falls on pavement or other impermeable covers will be converted to runoff. A site covered by permeable surfaces, such as grass or other landscaping, will allow some of the water to be absorbed into the ground and can have coefficients which vary from 0.20-0.40 reflecting the associated reduction of runoff due to absorption. These different cover types within a drainage area are assigned a runoff coefficient and then weighted to determine an overall drainage area runoff coefficient $C$ for each subcatchment.

### Flow Length and Time of Concentration

As rainfall lands on a portion of the drainage area and produces runoff, this runoff must travel to across the surface to the point of discharge, such as a catch basin, before contributing to the closed drainage hydraulic model. To achieve a maximum flow rate from a subcatchment using the Rational Method, all portions of a drainage area must first contribute to the discharge point. This point in time is known as the *time of concentration*, and is determined by identifying the longest flow path of a watershed with respect to the time of travel. To do this, Nitsch Engineering reviewed several factors of each watershed, including slope, surface cover type, and length and types of flow. As is standard practice, the analysis assumes a minimum time of concentration of six minutes for any subcatchment.

The type of surface along the runoff flow path affects the time of concentration. In general, "smooth" surfaces such as roofs and pavements will offer less resistance to flow allowing for runoff to move more quickly. "Rough" surfaces such as lawns or woods offer more resistance to flow, and therefore runoff typically moves more slowly across these types of surfaces.

In addition, runoff travels across the surface of a drainage area in two types of flow geometry. "Sheet" flow occurs over short distances, typically up to a maximum of fifty feet. Sheet flow is generally very shallow and spreads out across a wide flow path. An example of sheet flow is the runoff between the crown of a roadway to the curb and gutter. Sheet flow eventually gathers together and channelizes into "shallow concentrated" flow which carries runoff more quickly. Flow in the gutter of a road is an example of shallow concentrated flow.

The slope of the shallow concentrated or sheet flow path also affects the travel time. A site with steep slopes will produce more runoff and transport it at a faster rate than a flat site. The slope of the site is easily determined by using an existing conditions survey, proposed grading plans, or by a field examination.

**Rainfall Intensity-Duration-Frequency Curves**

Rainfall Intensity-Duration-Frequency curves, or IDF curves, describe the probabilistic relationships between average rainfall peak intensities, the duration of the watershed analysis, and the frequency (in years) at which the peak intensity should be expected. *Intensity* of a storm refers to the average rate at which rainfall lands on the surface of a drainage area, typically measured in inches of rainfall per hour. A higher intensity will produce more runoff. For the rational method, *duration* refers to the length of time between the start of the analysis and the point of time when the entire watershed contributes to the discharge point and is equal to time of concentration. A longer duration lowers the intensity value and therefore the peak runoff rate. The *frequency*, or return period, refers to the average number of years between occurrences of a specified peak intensity. For example, if rainfall intensities of equal to or greater than six inches per hour were recorded ten times over a 100-year period, then the return period (frequency) of a 6-inch rainfall would be once every ten years. Put more simply, this is known as a "10-year" storm and has a 1/10, or 10%, statistical chance of occurring during any given year.

IDF curves are important to stormwater designers when developing closed drainage system models. They provide a meaningful basis for use when considering the cost-benefit relationships for new stormwater infrastructure and the flood risk associated with the chosen return period. Nitsch Engineering uses the Steel Formula to develop IDF curves. The Steel Formula is an empirical equation based in historic rainfall data and is used for defining the Intensity-Duration-Frequency relationships depending on the proposed return periods. For the project, Nitsch Engineering has determined that a 10-year Steel Formula Intensity-Duration-Frequency curve is appropriate for design.

**AutoDesk® Storm and Sanitary Analysis Software v. 6.4**

Nitsch Engineering used AutoDesk® Storm and Sanitary Analysis Software ("SSA") to estimate storm system inflows by the Rational Method and to size the proposed closed drainage systems. SSA contains several hydraulic modeling capabilities used to route calculated runoff through drainage system networks

**SSA & Free-Flow in Storm Pipes**

The closed drainage system has been designed to maintain free-flow conditions. Stormwater in drainage system pipes is considered to be "free-flowing" when the upstream and downstream ends of the pipes are not submerged and the flow within the pipe is below the capacity of the pipe. For these cases, SSA calculates the storm pipe capacity using *Manning's Equation* which considers pipe slope, material, and interior pipe diameter to estimate capacity. In general, when pipe diameters and slopes increase, capacities increase. Rougher pipe materials will create greater frictional forces which restrict flow when compared to smoother pipe materials. Using Manning's Equation, SSA also calculates the water surface elevation through pipes and at the pipe beginning and end. This elevation is more commonly known as the "Hydraulic Grade Line" or "HGL", and helps determine flow conditions and losses through pipe systems.

**SSA & Manning's Equation**

SSA software uses *Manning's Equation* to calculate the full flow capacity of pipes. *Manning's Equation* is a regularly used formula to calculate the flow within stormwater pipes for free flow conditions. It is commonly written as:

$$Q = {}^{1.49}/_{n}\, A\, R^{2/3}\, S^{1/2}$$

where

| | | | | | |
|---|---|---|---|---|---|
| $Q$ | = | *volumetric capacity of flow* | $n$ | = | *pipe roughness factor* |
| $A$ | = | *cross-sectional area of pipe at full flow* | $R$ | = | *hydraulic radius at full flow* |
| $S$ | = | *pipe slope* | | | |

It should be noted that the inclusion of the cross-sectional pipe flow area $A$ is a common modification to the standard *Manning's Equation*. The pipe flow area may be removed from the formula to calculate velocity $V$ of flow within the pipe. The addition of flow area allows stormwater designers to understand the distance at which a two-dimensional area $A$ can move through a pipe over a given time period, typically measured in one second. This enables the calculation of a volumetric flow rate $Q$. For example, if a pipe has a cross-sectional flow area $A$ of two square feet and the calculated velocity $V$ through the pipe is five feet per second, then the distance that this two square foot area "moves" in one second is five feet. This creates an imaginary cylinder of water that is five feet long. Therefore, the volume of water that flows through the pipe over this one second time period is equal to two square feet multiplied by five lineal feet, or ten cubic feet. This is important to engineers because it allows the design of stormwater systems to relate to the hydrology calculations which ar e similarly measured in volumetric flow rates.

A quick assessment of the equation reveals that the pipe geometry and material are significant factors in determining capacity of flow. The pipe roughness factor, $n$, is an experimentally derived value related to the chosen pipe material. Many elements affect this, including age and condition, material, and shape of the pipe wall (ie, corrugated interiors versus smooth-walled pipes). Generally, as roughness factor increases, the frictional resistance to flow through the pipe increases, thus lowering overall speed of flow and capacity.

When considering this frictional resistance, it is important to note that resistance only occurs along the surfaces of contact between the water flow area and the pipe wall. This contact surface is known as the wetted perimeter. For full flow in circular pipes, this is considered to be the perimeter of the interior pipe wall, and is equal to the diameter of the pipe multiplied by pi.

The wetted perimeter is a significant factor in determining actual flow through a pipe when the pipe is not flowing full, as the surface of the water in the pipe does not contact a pipe wall or contribute to the frictional resistance. The equation accounts for this by applying a ratio of the area of flow to the actual wetted perimeter, otherwise known as the hydraulic radius, or *R*. In the case of full circular pipe flow, the hydraulic radius is equal to the diameter of the pipe divided by four.

The pipe flow area, or *A*, defines the two-dimensional space within the pipe that can be used to pass stormwater flow. Logically, the larger the area and pipe diameter, the greater volume of water the pipe can transmit over a given time period.

**SSA & Modeling of Hydraulic Losses**

Hydraulic Losses through a closed storm drainage network refer to the actions of natural forces which work to restrict flow rates and velocities or otherwise alter the nature of flow in pipe systems. Losses are important to stormwater design because they change the depth of flow in pipes, sometimes significantly, and must be factored into flow systems to obtain accurate hydraulic grade lines and minimize the occurrence of street flooding.

Friction between the moving column of water and pipe wall is more commonly known as *major losses*. Flow through storm pipes is generally accomplished by the pull of gravity on the water in the pipe acting to accelerate it from the higher end of the pipe to the lower end. The force of friction between the water and the pipe acts to resist the pull of gravity, and this resistance increases with the velocity of flow. As such, the pull of gravity can either be greater than the pull of friction (*subcritical flow)* or the pull of friction can be greater than the pull of gravity (*supercritical flow).* Subcritical flow tends to be deeper and slower, and supercritical flow tends to be shallower and faster. SSA uses *Manning's Equation* to determine the relationships between flow depth and velocity in free-flow conditions. In addition, SSA is able to determine the point at which friction forces overcome gravitational forces causing a *hydraulic jump,* or a point in the flow regime where depth quickly increases and flow quickly decreases due to a rapid change in velocity. In submerged pipe flow, the pressure of the elevated water column within an upstream structure acts to push flow through the pipe. SSA uses the Saint Venant equations to estimate flow rates through these pipes, then applies the calculated velocity to a form of the *Manning's Equation* to determine the loss in the pipe due to friction. Major losses in submerged pipes tend to be larger than major losses in free-flowing pipes because of the increases in velocity required to push stormwater through the drain line.

Other types of losses include changes in the flow direction or flow cross-section, such as bends, expansions from smaller to larger pipes, or entrances to or exits from storm drainage structures like manholes. These are more commonly known as *minor losses*. For the calculation of minor losses, SSA uses scientifically derived formulas which are typical of the industry.

Losses are measured in units of length, typically in lineal feet for closed system design. This is easily understood when considering that the speed of water at the outfall of a pipe is directly calculated from the change in vertical distance over which gravity acts. Typically, the larger this change in height, the steeper the slope of the pipe, and the faster the column of water will travel through the pipe. In submerged flow assuming a constant velocity, the difference in real elevation between the downstream structure's HGL and the upstream structure's HGL is generally equal to the sum of the losses minus the change in height from the pipe beginning to end. Over long distances, these losses can become substantial, in the order of several feet. SSA uses this information and applies it to the height of vertical columns of water in closed drainage systems to determine actual HGLs relative to the rim grades of structures.

## Rainfall Details

Return Period........................................................................ 10 year(s)

## Subbasin Summary

| Subbasin Name | Area (ac) | Weighted Runoff Coefficient | Peak Runoff (cfs) | Time of Concentration (days hh:mm:ss) |
|---|---|---|---|---|
| ROOF TO AD-5 | 0.07 | 0.90 | 0.37 | 0 00:06:00 |
| ROOF TO AD-6 | 0.26 | 0.70 | 1.06 | 0 00:06:00 |
| TO AD-1 | 0.05 | 0.90 | 0.26 | 0 00:06:00 |
| TO AD-2 | 0.04 | 0.90 | 0.21 | 0 00:06:00 |
| TO AD-4 & AD-3 | 0.04 | 0.45 | 0.11 | 0 00:06:00 |
| TO AD-7 | 0.15 | 0.38 | 0.31 | 0 00:08:00 |
| TO AD-8 | 0.15 | 0.38 | 0.31 | 0 00:08:00 |
| TO AD-9 | 0.03 | 0.90 | 0.18 | 0 00:06:00 |
| TO CB-1 | 0.04 | 0.60 | 0.00 | 0 00:00:00 |
| TO CB-2 | 0.05 | 0.90 | 0.26 | 0 00:06:00 |
| TO CB-3 | 0.19 | 0.89 | 0.99 | 0 00:06:00 |
| TO CB-4 | 0.09 | 0.87 | 0.45 | 0 00:06:00 |
| TO CB-5 | 0.26 | 0.85 | 1.30 | 0 00:06:00 |
| TO CB-7 | 0.02 | 0.90 | 0.13 | 0 00:06:00 |

## Link Summary

| Pipe Name | From (Inlet) Node | Inlet Invert Elevation (ft) | To (Outlet) Node | Outlet Invert Elevation (ft) | Pipe Length (ft) | Pipe Slope (%) | Pipe Diameter (in) | Manning's Roughness | Peak Flow Q (cfs) | Peak Flow Velocity (ft/sec) | Pipe Design Capacity Qf (cfs) | Q/Qf Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A | AD-8 | 117.70 | AD-7 | 117.52 | 35 | 0.51 | 8 | 0.0120 | 0.31 | 2.54 | 0.93 | 0.33 |
| 1B | AD-7 | 117.52 | AD-6 | 115.60 | 49 | 3.95 | 8 | 0.0120 | 0.61 | 4.74 | 2.60 | 0.24 |
| 1C | AD-8 | 115.50 | AD-5 | 115.20 | 59 | 0.51 | 12 | 0.0120 | 1.48 | 3.14 | 2.75 | 0.54 |
| 1D | AD-5 | 115.10 | DMH-11 | 114.41 | 138 | 0.50 | 12 | 0.0120 | 1.81 | 3.39 | 2.73 | 0.66 |
| 1E | DMH-11 | 114.31 | DMH-10 | 114.18 | 26 | 0.50 | 12 | 0.0120 | 1.74 | 3.04 | 2.72 | 0.64 |
| 1F | AD-9 | 115.71 | AD-9 WYE | 113.82 | 6 | 31.69 | 12 | 0.0120 | 0.18 | 5.28 | 21.73 | 0.01 |
| 1G | DMH-10 | 114.08 | AD-9 WYE | 113.82 | 51 | 0.51 | 12 | 0.0120 | 1.72 | 2.50 | 2.75 | 0.63 |
| 1H | AD-9 WYE | 113.82 | DMH-8 | 113.72 | 20 | 0.51 | 12 | 0.0120 | 1.85 | 3.04 | 2.75 | 0.67 |
| 2A | AD-4 | 118.80 | AD-3 | 118.62 | 23 | 0.79 | 8 | 0.0120 | 0.10 | 1.94 | 1.16 | 0.09 |
| 2B | AD-3 | 118.52 | AD-2 | 118.43 | 27 | 0.34 | 8 | 0.0120 | 0.10 | 1.33 | 0.76 | 0.13 |
| 2C | AD-2 | 118.30 | AD-1 | 118.14 | 51 | 0.31 | 8 | 0.0120 | 0.29 | 2.05 | 0.73 | 0.40 |
| 2D | AD-1 | 118.04 | DMH-9 | 117.00 | 43 | 2.40 | 12 | 0.0120 | 0.54 | 4.67 | 5.98 | 0.09 |
| 2E | CB-7 | 117.20 | DMH-9 | 117.00 | 40 | 0.50 | 12 | 0.0120 | 0.12 | 1.46 | 2.72 | 0.05 |
| 2F | DMH-9 | 116.90 | DMH-8 | 113.72 | 61 | 5.20 | 12 | 0.0120 | 0.66 | 5.45 | 8.94 | 0.07 |
| 3A | CB-5 | 109.10 | DMH-7 | 108.95 | 17 | 0.87 | 12 | 0.0120 | 1.34 | 2.84 | 3.61 | 0.37 |
| 3B | CB-4 | 109.10 | DMH-7 | 108.95 | 29 | 0.51 | 12 | 0.0120 | 0.54 | 1.53 | 2.77 | 0.19 |
| 3C | DMH-8 | 113.62 | DMH-7 | 108.95 | 141 | 3.31 | 12 | 0.0120 | 2.42 | 4.11 | 7.02 | 0.34 |
| 3D | DMH-7 | 108.85 | DMH-6 | 108.77 | 17 | 0.47 | 15 | 0.0120 | 3.84 | 3.13 | 4.78 | 0.80 |
| 3E | CB-2 | 110.30 | DMH-5 | 108.43 | 23 | 8.14 | 12 | 0.0120 | 0.55 | 3.24 | 11.01 | 0.05 |
| 3F | CB-3 | 111.80 | DMH-5 | 108.43 | 27 | 12.68 | 12 | 0.0120 | 0.98 | 7.30 | 13.74 | 0.07 |
| 3G | DMH-6 | 108.67 | DMH-5 | 108.43 | 46 | 0.53 | 15 | 0.0120 | 4.00 | 3.26 | 5.07 | 0.79 |
| 3H | DMH-5 | 108.33 | DMH-4 | 108.18 | 29 | 0.51 | 18 | 0.0120 | 5.08 | 2.88 | 8.13 | 0.63 |
| 3I | DMH-4 | 108.44 | DMH-3 | 107.76 | 10 | 6.75 | 18 | 0.0120 | 5.10 | 4.08 | 29.56 | 0.17 |
| 3K | CB-1 | 109.50 | DMH-2 | 109.45 | 7 | 0.75 | 12 | 0.0120 | 0.00 | 0.00 | 3.35 | 0.00 |
| 3L | DMH-3 | 109.60 | DMH-2 | 107.51 | 29 | 7.22 | 18 | 0.0120 | 5.09 | 8.83 | 30.57 | 0.17 |
| 3M | DMH-2 | 107.41 | DMH-1 | 106.40 | 26 | 3.93 | 18 | 0.0120 | 5.16 | 8.07 | 22.55 | 0.23 |

## Junction Input

| Juntion Name | Invert Elevation (ft) | Rim Elevation (ft) |
|---|---|---|
| AD-1 | 118.04 | 120.80 |
| AD-2 | 118.30 | 121.84 |
| AD-3 | 118.52 | 121.83 |
| AD-4 | 118.80 | 120.80 |
| AD-5 | 115.10 | 119.67 |
| AD-6 | 115.50 | 119.67 |
| AD-7 | 117.52 | 120.70 |
| AD-8 | 117.70 | 120.70 |
| AD-9 | 115.71 | 119.71 |
| AD-9 WYE | 113.82 | 114.98 |
| CB-1 | 109.50 | 113.40 |
| CB-2 | 110.30 | 113.00 |
| CB-3 | 111.80 | 114.50 |
| CB-4 | 109.10 | 111.80 |
| CB-5 | 109.10 | 111.80 |
| CB-7 | 117.20 | 119.90 |
| DMH-10 | 114.08 | 120.00 |
| DMH-11 | 114.31 | 118.00 |
| DMH-2 | 107.41 | 113.60 |
| DMH-3 | 107.66 | 114.94 |
| DMH-4 | 108.08 | 114.50 |
| DMH-5 | 108.33 | 113.60 |
| DMH-6 | 108.67 | 112.50 |
| DMH-7 | 108.85 | 113.10 |
| DMH-8 | 113.62 | 116.20 |
| DMH-9 | 117.00 | 120.80 |

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## Form S3-B: Standard #3 – Recharge
## Required Recharge Volume

| | |
|---|---|
| Project Name: South Hadley Library | Nitsch Project #: 9165 |
| Location: South Hadley, MA | Checked by: DMC |
| Prepared by: TJM | Sheet No. **1** of **1** |
| Date: 10/26/2012 | |

INSTRUCTIONS:
1. Determine the increase in impervious area (in square feet) proposed above each Hydrologic Soil Group and input those areas in the appropriate blue cells.
2. The Required Recharge Volume (in cubic feet) will be calculated and displayed in the yellow cell.

**The South Hadley Library Project is a Redevelopment project that reduces the overall impervious area of the site. Recharge is required only to the maximum extent practical.**

**The NRCS Soil Survey indicates that the site is HSG C. A test pit at the Infiltration Basin (IB-1) indicates HSG A soil. The Recharge Volume for the area contributing to IB-1 is calculated using HSG A soil.**

| Step No. | | | |
|---|---|---|---|
| 1 | Impervious area located above: | | |
| | Hydrologic Soil Group "A" Soil = | 33,835 | sf |
| | Hydrologic Soil Group "B" Soil = | 0 | sf |
| | Hydrologic Soil Group "C" Soil = | 10,331 | sf |
| | Hydrologic Soil Group "D" Soil = | 0 | sf |
| 2 | Required Recharge Volume = | 1,906.98 | cf |

The recharge volume provided by the Bioretention Area is the static volume below the underdrain invert. The recharge volume provided by the Infiltration Basin is calculated using the Simple Dynamic Method using a Rawls Rate for Sand. See Simple Dynamic Calculations.

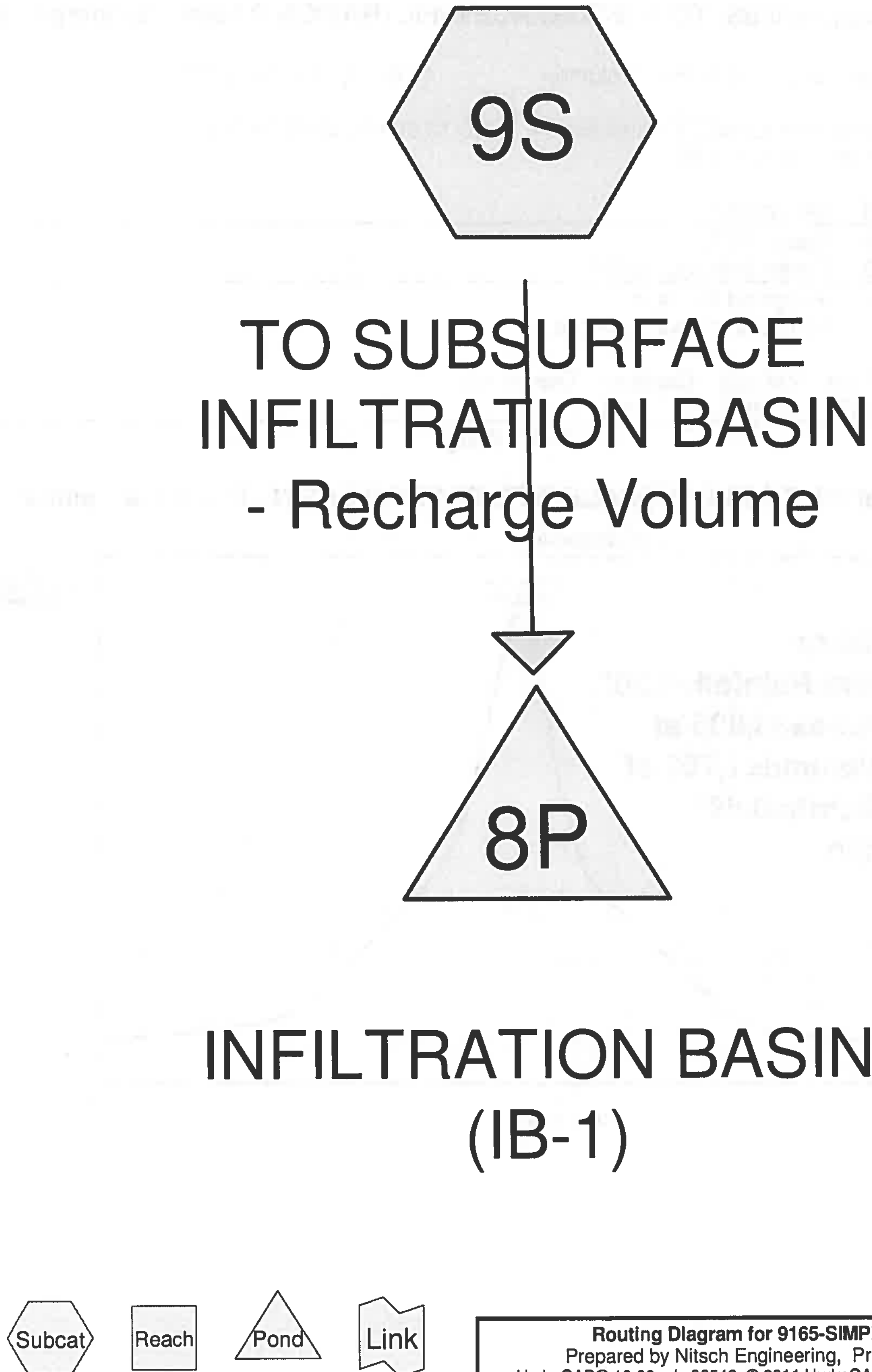
**Proposed Recharge Volume**

**Static**

| System ID | Description | Contributing Area | HSG | Static Volume (cf) |
|---|---|---|---|---|
| BR-1 | Bioretention Basin | 9239 | C | 246 |

**Simple Dynamic**

| System ID | Description | Contributing Area | HSG | Simple Dynamic Vol. (cf) |
|---|---|---|---|---|
| IB-1 | Infiltration Basin | 33835 | A | 1,702 |
| | TOTAL | | | **1,948** |




**Routing Diagram for 9165-SIMPLE-DYNAMIC**
Prepared by Nitsch Engineering, Printed 11/15/2012
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## Summary for Subcatchment 9S: TO SUBSURFACE INFILTRATION BASIN - Recharge Volume

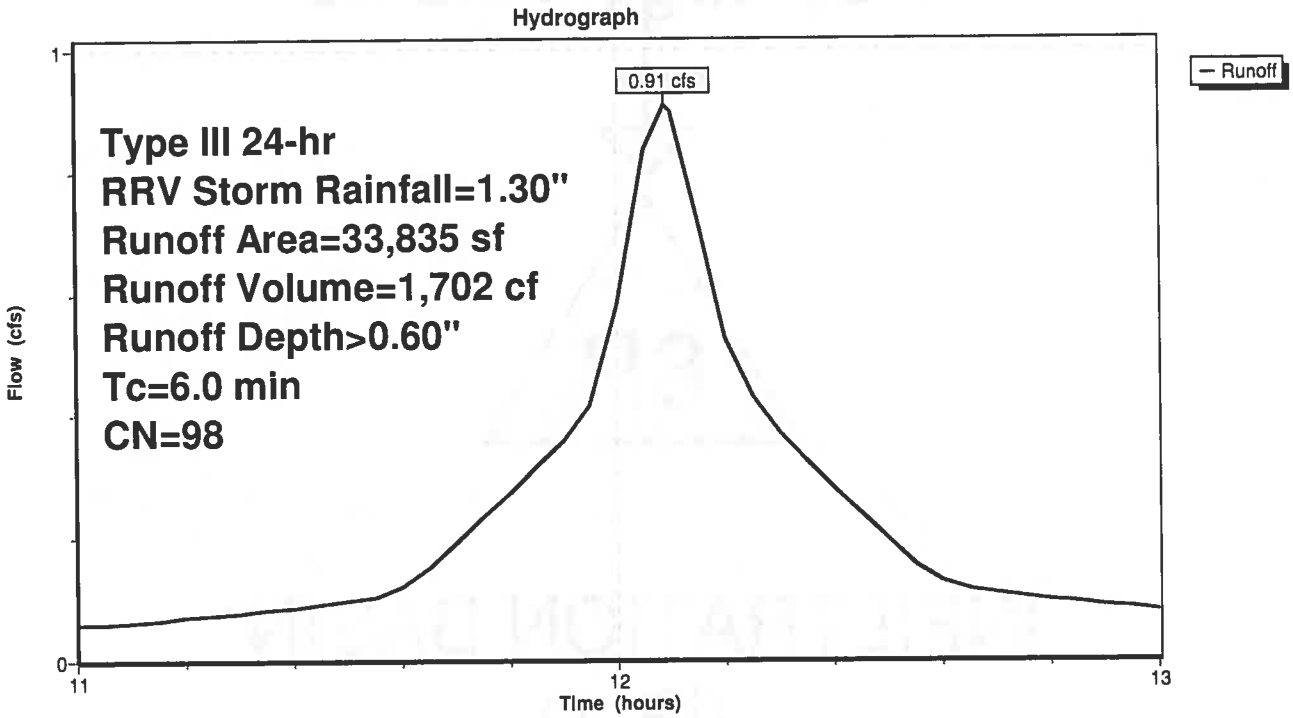
Runoff = 0.91 cfs @ 12.09 hrs, Volume= 1,702 cf, Depth> 0.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 11.00-13.00 hrs, dt= 0.05 hrs
Type III 24-hr RRV Storm Rainfall=1.30"

| Area (sf) | CN | Description |
|---|---|---|
| 6,080 | 98 | Roofs, HSG A |
| 27,755 | 98 | Paved parking, HSG A |
| 33,835 | 98 | Weighted Average |
| 33,835 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

### Subcatchment 9S: TO SUBSURFACE INFILTRATION BASIN - Recharge Volume



## Summary for Pond 8P: INFILTRATION BASIN (IB-1)

Inflow Area = 33,835 sf,100.00% Impervious, Inflow Depth > 0.60" for RRV Storm event
Inflow = 0.91 cfs @ 12.09 hrs, Volume= 1,702 cf
Outflow = 0.15 cfs @ 11.70 hrs, Volume= 903 cf, Atten= 84%, Lag= 0.0 min
Discarded = 0.15 cfs @ 11.70 hrs, Volume= 903 cf
Primary = 0.00 cfs @ 11.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 11.00-13.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 109.24' @ 12.57 hrs Surf.Area= 765 sf Storage= 871 cf

Plug-Flow detention time= 19.3 min calculated for 879 cf (52% of inflow)
Center-of-Mass det. time= 4.0 min ( 728.9 - 724.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 107.19' | 507 cf | **17.96'W x 41.50'L x 2.42'H Field A** |
| | | | 1,802 cf Overall - 534 cf Embedded = 1,268 cf x 40.0% Voids |
| #2A | 107.52' | 432 cf | **ADS N-12 18** x 12 Inside #1 |
| | | | Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf |
| | | | Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf |
| #3 | 107.19' | 153 cf | **5.00'D x 7.81'H Manhole** |
| | | 1,092 cf | Total Available Storage |

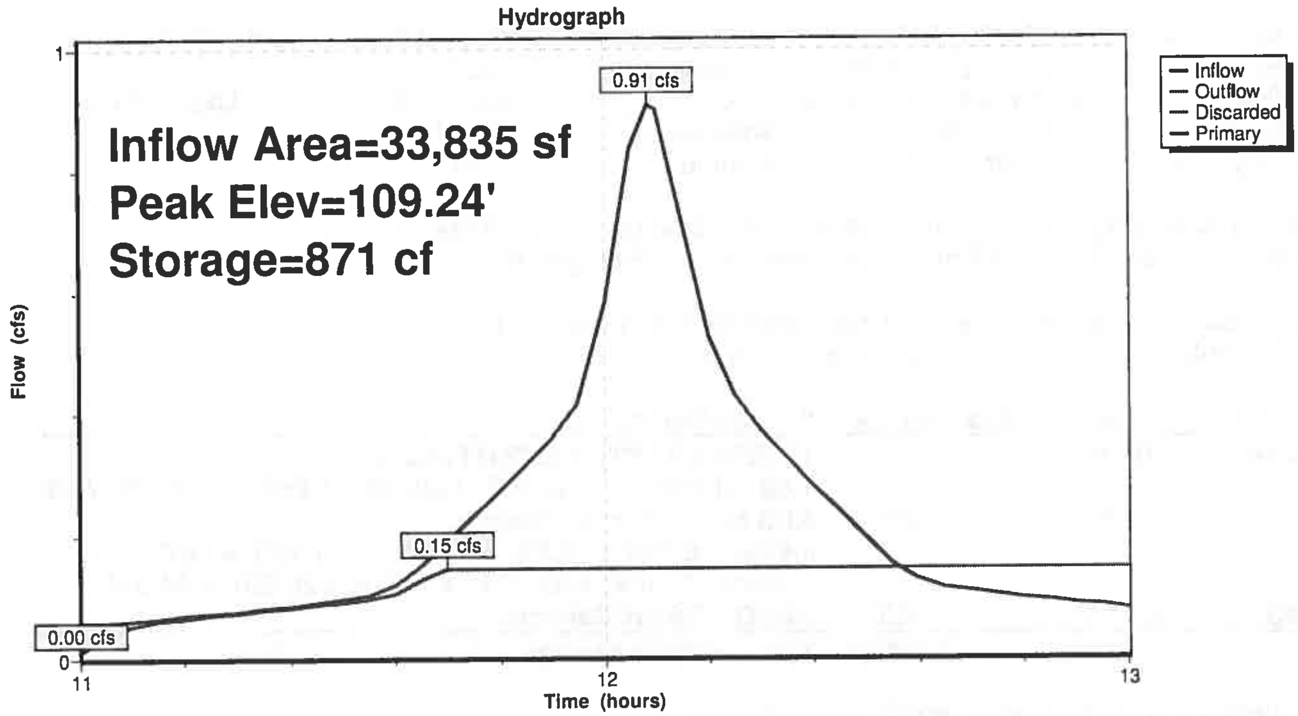
Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 109.60' | **18.0" Round Culvert** |
| | | | L= 29.0' CPP, projecting, no headwall, Ke= 0.900 |
| | | | Inlet / Outlet Invert= 109.60' / 107.51' S= 0.0721 '/' Cc= 0.900 |
| | | | n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |
| #2 | Discarded | 107.19' | **8.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.15 cfs @ 11.70 hrs HW=107.28' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.15 cfs)

**Primary OutFlow** Max=0.00 cfs @ 11.00 hrs HW=107.20' (Free Discharge)
↑**1=Culvert** ( Controls 0.00 cfs)

## Pond 8P: INFILTRATION BASIN (IB-1)



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## Form S3-B: Standard #3 – WQV
## Water Quality Volume

| | |
|---|---|
| Project Name: **South Hadley Library** | Nitsch Project #: **4036** |
| Location: **South Hadley, MA** | Checked by: DMC |
| Prepared by: **TJM** | Sheet No. **1 of 1** |
| Date: **10/26/2012** | |

| Step No. | | | |
|---|---|---|---|
| 1 | Impervious area: | 50,246 | sf |
| | Roof Area: | 13,442 | sf |
| | Sidewalk to Street | 5,825 | |
| | Overland to South (pedestrian walks) | 1,347 | |
| | Treated Impervious Area: | 29,632 | sf |
| | Water Quality Depth: | 0.5 | in |
| 2 | Water Quality Volume = | 1,235 | cf |

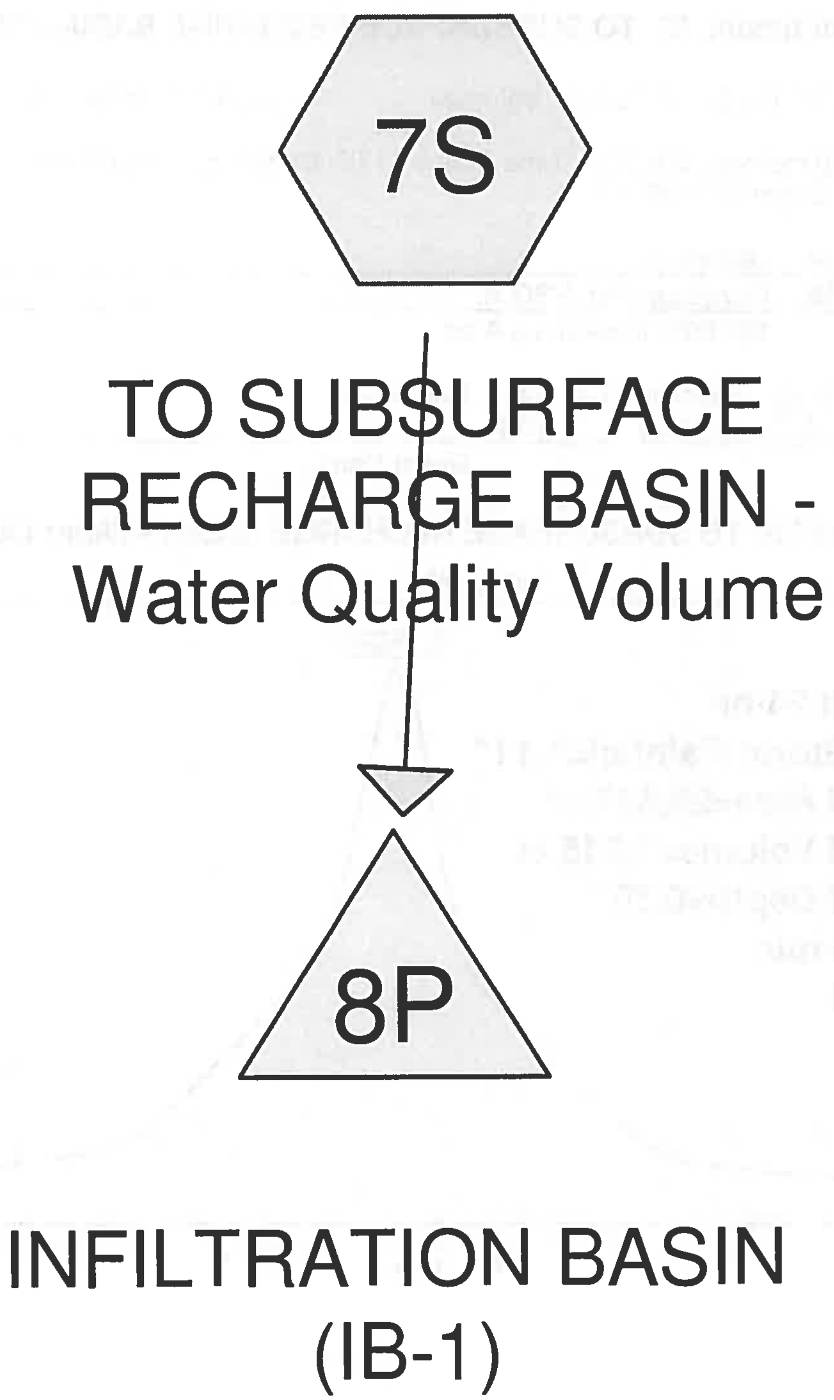
The sidewalk installed as part of this project is the public right of way and will drain to the South Hadley closed system as it does in the existing condition

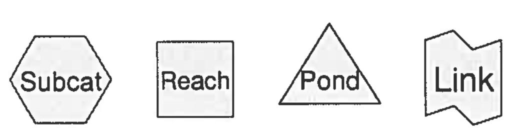
A relatively small amount of impervious associated with a walking path and overlook plaza will drain overland without treatment. The weighted Water Quality Volume for the entire site exceeds 80% TSS removal.

See Simple Dynamic Method for Treated Volume Calculation for the Infiltration Basin.

**Proposed Water Quality Volume - Weighted TSS Removal**

| BMP | Treated Volume (cf) | Non-roof Impervious area in watershed (sf) | Water Quality Depth (in) | Required Design Water Quality Volume (cf) | TSS Removal |
|---|---|---|---|---|---|
| Infiltration Basin | 1,245 | 29,632 | 0.5 | 1,235 | 96% |
| Overland to South | 0 | 1,347 | 0.5 | 56 | 0% |
| | total= | 30,979 | | | |
| | | | | Weighted TSS removal = | 92% |




**Routing Diagram for 9165-SIMPLE-DYNAMIC**
Prepared by Nitsch Engineering, Printed 11/15/2012
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## Summary for Subcatchment 7S: TO SUBSURFACE RECHARGE BASIN - Water Quality Volume

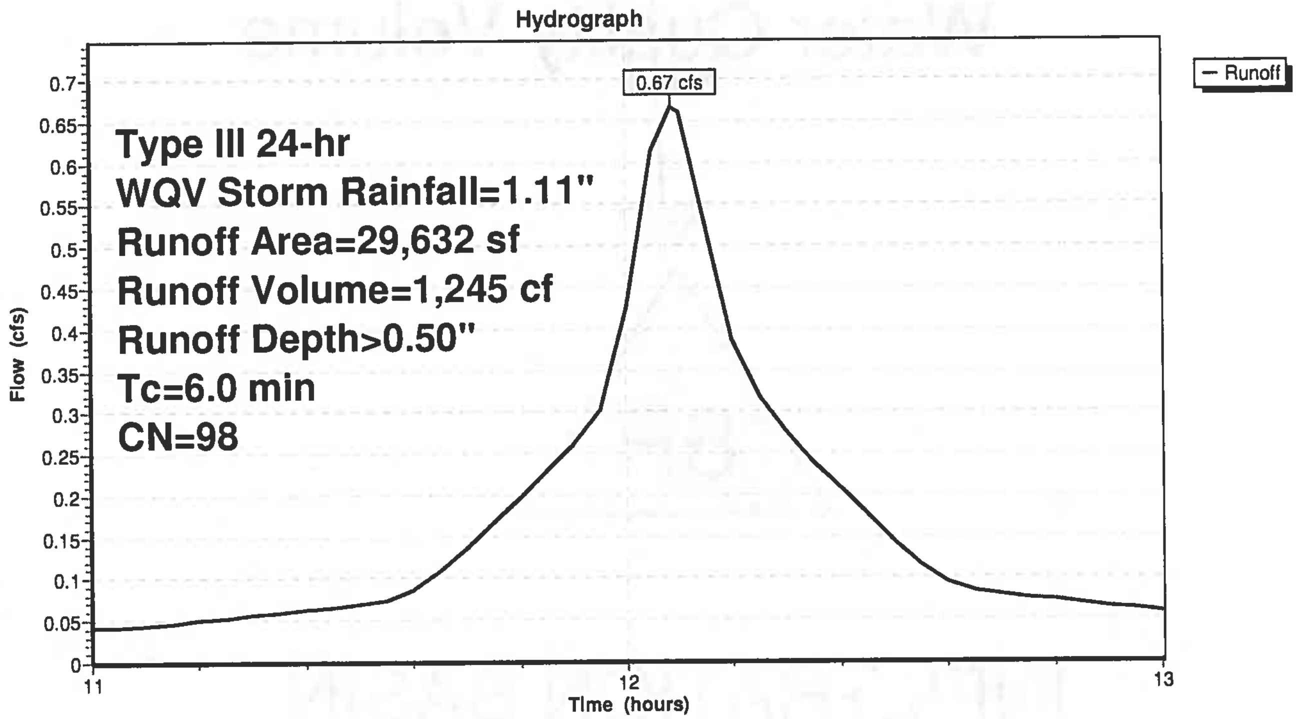
Runoff = 0.67 cfs @ 12.09 hrs, Volume= 1,245 cf, Depth> 0.50"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 11.00-13.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Storm Rainfall=1.11"

| Area (sf) | CN | Description |
|---|---|---|
| 29,632 | 98 | Paved parking, HSG A |
| 29,632 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

### Subcatchment 7S: TO SUBSURFACE RECHARGE BASIN - Water Quality Volume



## Summary for Pond 8P: INFILTRATION BASIN (IB-1)

Inflow Area = 29,632 sf,100.00% Impervious, Inflow Depth > 0.50" for WQV Storm event
Inflow = 0.67 cfs @ 12.09 hrs, Volume= 1,245 cf
Outflow = 0.15 cfs @ 11.80 hrs, Volume= 842 cf, Atten= 78%, Lag= 0.0 min
Discarded = 0.15 cfs @ 11.80 hrs, Volume= 842 cf
Primary = 0.00 cfs @ 11.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 11.00-13.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 108.46' @ 12.50 hrs Surf.Area= 765 sf Storage= 524 cf

Plug-Flow detention time= 18.6 min calculated for 840 cf (67% of inflow)
Center-of-Mass det. time= 6.9 min ( 732.0 - 725.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 107.19' | 507 cf | **17.96'W x 41.50'L x 2.42'H Field A**<br>1,802 cf Overall - 534 cf Embedded = 1,268 cf x 40.0% Voids |
| #2A | 107.52' | 432 cf | **ADS N-12 18** x 12 Inside #1<br>Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf<br>Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf |
| #3 | 107.19' | 153 cf | **5.00'D x 7.81'H Manhole** |
| | | 1,092 cf | Total Available Storage |

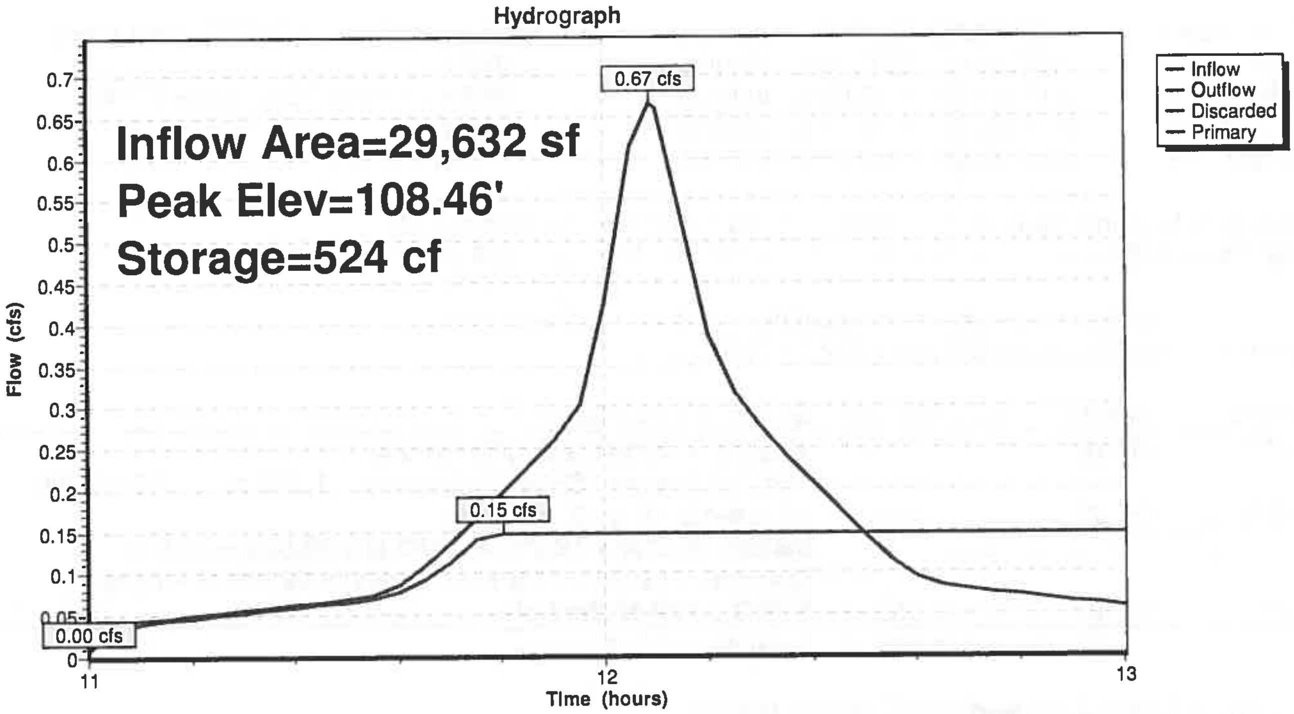
Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 109.60' | **18.0" Round Culvert**<br>L= 29.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 109.60' / 107.51' S= 0.0721 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |
| #2 | Discarded | 107.19' | **8.270 in/hr Exfiltration over Surface area** |

**Discarded OutFlow** Max=0.15 cfs @ 11.80 hrs HW=107.29' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.15 cfs)

**Primary OutFlow** Max=0.00 cfs @ 11.00 hrs HW=107.19' (Free Discharge)
└─**1=Culvert** ( Controls 0.00 cfs)

## Pond 8P: INFILTRATION BASIN (IB-1)



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## Form S4-C: Standard 4 – Water Quality
## TSS Worksheet

| | |
|---|---|
| Project Name: South Hadley Library | Nitsch Project #: 9165 |
| Location: South Hadley, MA | Checked by: DMC |
| Prepared by: TJM | Sheet No.1 of 1 |
| Date: **11-14-2012** | |

Stormwater runoff that is collected by the closed drainage system is treated with a Proprietary Treatment Practice (WQS-1) prior to infiltration. Prior to WQS-1 runoff from the parking lot is collected with deep sump hooded catch basins. Runoff from the landscaped areas and pedestrian walkways is collected with area drains. The collection structures have not been included in the TSS removal calculations for a conservative approach.

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

*Version 1, Automated: Mar. 4, 2008*

Location: IB-1

**TSS Removal Calculation Worksheet**

| B<br>BMP[1] | C<br>TSS Removal Rate[1] | D<br>Starting TSS Load* | E<br>Amount Removed (C*D) | F<br>Remaining Load (D-E) |
|---|---|---|---|---|
| Proprietary Treatment Practice | 0.80 | 1.00 | 0.80 | 0.20 |
| Infiltration Basin | 0.80 | 0.20 | 0.16 | 0.04 |
| | 0.00 | 0.04 | 0.00 | 0.04 |
| | 0.00 | 0.04 | 0.00 | 0.04 |
| | 0.00 | 0.04 | 0.00 | 0.04 |

**Total TSS Removal =** 96%

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

Project: S. Hadley Library
Prepared By: TJM
Date: 11/14/2012

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

***TSS WORKSHEET** from Volume 2, Chapter 3, Table 4, TSS Removal*

## APPENDIX G

**Stormceptor Sizing Calculations and Documentation**

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Amherst, MA 01003

**Massachusetts Stormwater Evaluation Project**

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**www.mastep.net**

# MASTEP Technology Review

**Technology Name:** Stormceptor

**Studies Reviewed:** Final NJCAT Technology Verification Stormceptor STC900 September 2004; Coventry University Study, 1996; Technology Assessment, University of Massachusetts, 1997; SeaTac Stormceptor Performance report 2001; SWAMP report Ontario 2004; Phoenix Group Edmonton report 1995; Stormceptor 1200 Field Evaluation report 2004; Applied Hydrology Associates Denver report 2003; Rinker Materials Como Park St. Paul MN report 2002; VA DOT / UVA "Testing of Ultra-Urban Stormwater Best Management Practices" report 2001.

**Date:** November 23, 2007

**Reviewer:** Jerry Schoen

**Rating:** 2

**Brief rationale for rating:** This rating is primarily based on the 2005 NJCAT Technology Verification study. In general, this was a well-conducted test, which in large part followed NJDEP test guidelines for laboratory studies, which MASTEP considers as the laboratory equivalent of TARP field protocols. Issues of concern: the study measured suspended sediment concentration (SSC) rather than total suspended solids (TSS). Although SSC is considered by many scientists to be the preferred method, it is at odds with Massachusetts stormwater regulations, which are based on TSS treatment. Comparing SSC and TSS results is considered an inexact science. The test was conducted with higher influent sediment concentrations than is preferred, but results were fairly consistent across all ranges studied. The particle size distribution also appears to be slightly higher than the target test range. There are additional field studies that in general support the results obtained in this laboratory studies. These studies do not satisfy TARP protocols, but they do not contradict results obtained in the NJCAT study.

**TARP Requirements Not Met*:**

- Measurements in TSS.
- Influent sediment concentration is 100 – 300 mg/l: actual was 153-460.
- No documentation of a Quality Assurance Project Plan
- Third party studies are preferred. This was conducted by Stormceptor personnel, with sample analyses conducted by an external laboratory.

* Criteria also based on NJDEP laboratory testing guidelines.

Stormceptor®

# Stormceptor Sizing Detailed Report

**PCSWMM for Stormceptor**

## Project Information

| | |
|---|---|
| Date | 11/14/2012 |
| Project Name | South Hadley Library |
| Project Number | 9165 |
| Location | South Hadley, MA |

## Stormwater Quality Objective

This report outlines how Stormceptor System can achieve a defined water quality objective through the removal of total suspended solids (TSS). Attached to this report is the Stormceptor Sizing Summary.

## Stormceptor System Recommendation

The Stormceptor System model STC 900 achieves the water quality objective removing 80% TSS for a NJDEP (clay, silt, sand) particle size distribution; providing continuous positive treatment for a stormwater quality flow rate of 0.67 cfs.

## The Stormceptor System

The Stormceptor oil and sediment separator is sized to treat stormwater runoff by removing pollutants through gravity separation and flotation. Stormceptor's patented design generates positive TSS removal for all rainfall events, including large storms. Significant levels of pollutants such as heavy metals, free oils and nutrients are prevented from entering natural water resources and the re-suspension of previously captured sediment (scour) does not occur.

Stormceptor provides a high level of TSS removal for small frequent storm events that represent the majority of annual rainfall volume and pollutant load. Positive treatment continues for large infrequent events, however, such events have little impact on the average annual TSS removal as they represent a small percentage of the total runoff volume and pollutant load.

Stormceptor is the only oil and sediment separator on the market sized to remove TSS for a wide range of particle sizes, including fine sediments (clays and silts), that are often overlooked in the design of other stormwater treatment devices.



Rinker MATERIALS™

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**Small storms dominate hydrologic activity, US EPA reports**

"*Early efforts in stormwater management focused on flood events ranging from the 2-yr to the 100-yr storm. Increasingly stormwater professionals have come to realize that small storms (i.e. < 1 in. rainfall) dominate watershed hydrologic parameters typically associated with water quality management issues and BMP design. These small storms are responsible for most annual urban runoff and groundwater recharge. Likewise, with the exception of eroded sediment, they are responsible for most pollutant washoff from urban surfaces. Therefore, the small storms are of most concern for the stormwater management objectives of ground water recharge, water quality resource protection and thermal impacts control.*"

"*Most rainfall events are much smaller than design storms used for urban drainage models. In any given area, most frequently recurrent rainfall events are small (less than 1 in. of daily rainfall).*"

"*Continuous simulation offers possibilities for designing and managing BMPs on an individual site-by-site basis that are not provided by other widely used simpler analysis methods. Therefore its application and use should be encouraged.*"

– US EPA Stormwater Best Management Practice Design Guide, Volume 1 – General Considerations, 2004

## Design Methodology

Each Stormceptor system is sized using PCSWMM for Stormceptor, a continuous simulation model based on US EPA SWMM. The program calculates hydrology from up-to-date local historical rainfall data and specified site parameters. With US EPA SWMM's precision, every Stormceptor unit is designed to achieve a defined water quality objective.

The TSS removal data presented follows US EPA guidelines to reduce the average annual TSS load. Stormceptor's unit process for TSS removal is settling. The settling model calculates TSS removal by analyzing (summary of analysis presented in Appendix 2):

- Site parameters
- Continuous historical rainfall, including duration, distribution, peaks (Figure 1)
- Interevent periods
- Particle size distribution
- Particle settling velocities (Stokes Law, corrected for drag)
- TSS load (Figure 2)
- Detention time of the system

The Stormceptor System maintains continuous positive TSS removal for all influent flow rates. Figure 3 illustrates the continuous treatment by Stormceptor throughout the full range of storm events analyzed. It is clear that large events do not significantly impact the average annual TSS removal. There is no decline in cumulative TSS removal, indicating scour does not occur as the flow rate increases.

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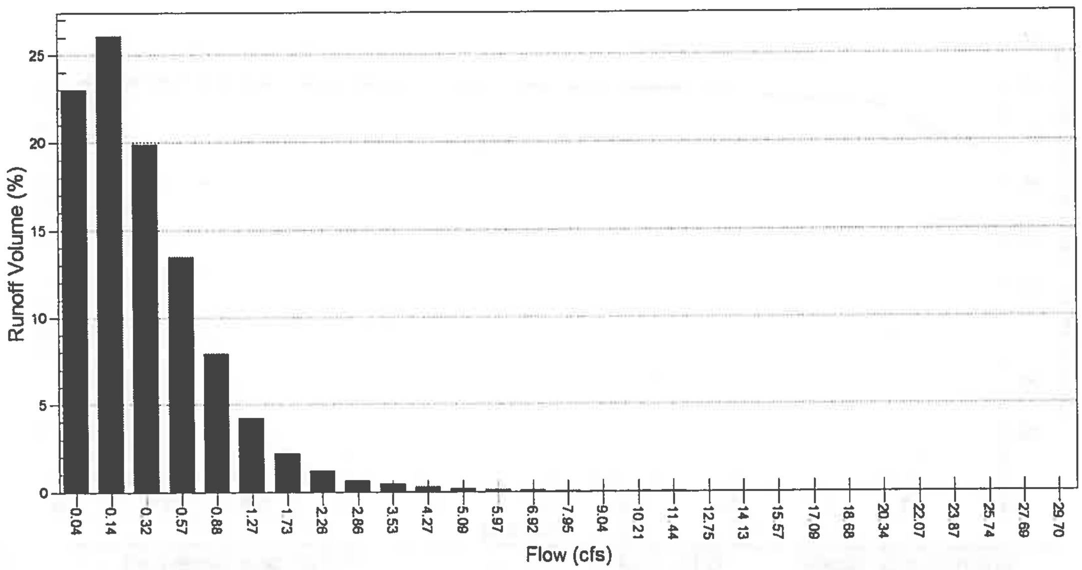


**Figure 1. Runoff Volume by Flow Rate for BOSTON WSFO AP – MA 770, 1948 to 2005 for 1.5 ac, 66% impervious.** Small frequent storm events represent the majority of annual rainfall volume. Large infrequent events have little impact on the average annual TSS removal, as they represent a small percentage of the total annual volume of runoff.

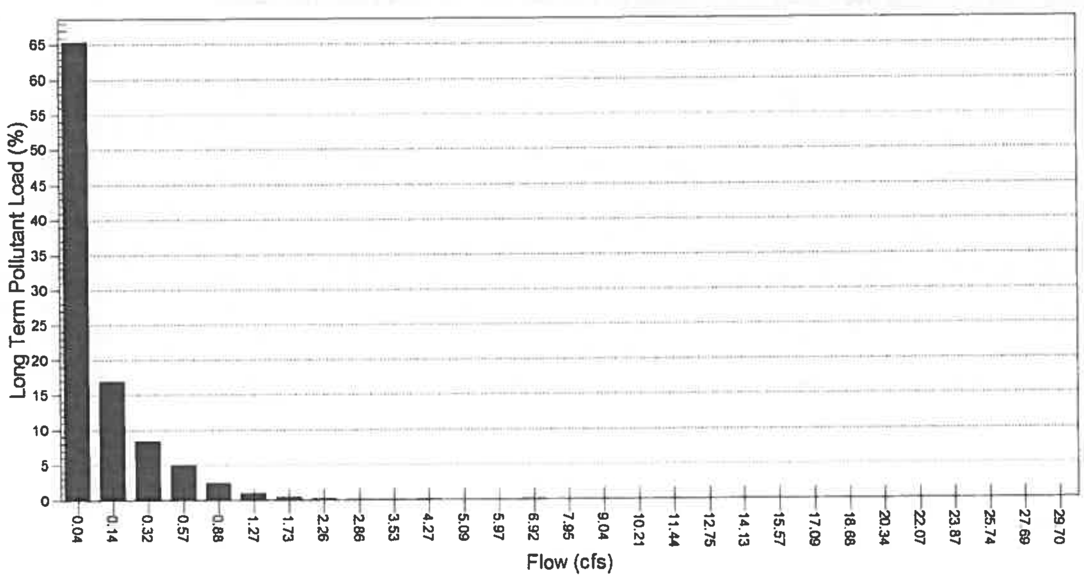


**Figure 2. Long Term Pollutant Load by Flow Rate for BOSTON WSFO AP – 770, 1948 to 2005 for 1.5 ac, 66% impervious.** The majority of the annual pollutant load is transported by small frequent storm



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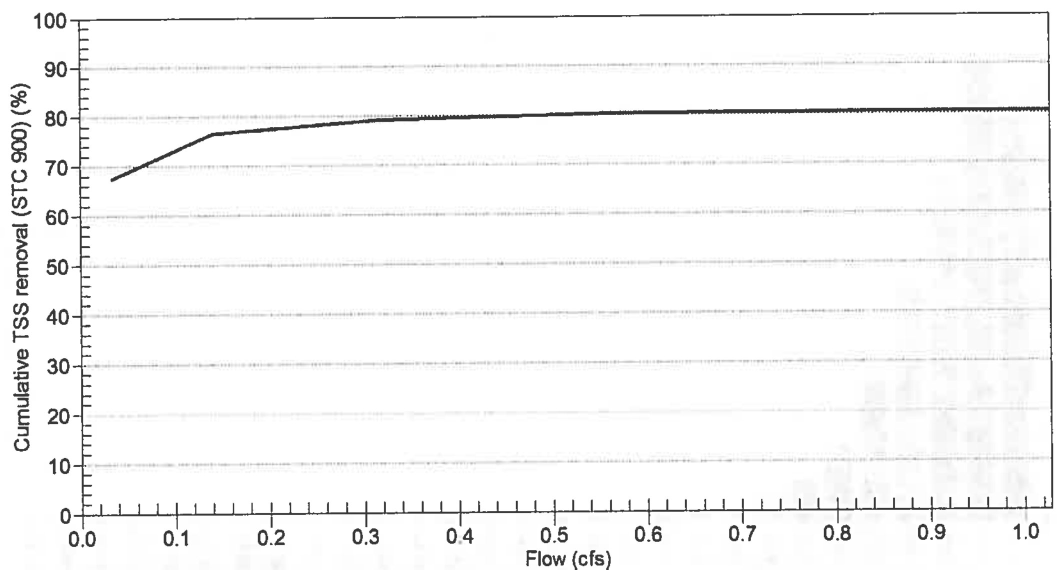
events. Conversely, large infrequent events carry an insignificant percentage of the total annual pollutant load.




| | | | |
|---|---|---|---|
| Stormceptor Model | STC 900 | Drainage Area (ac) | 1.5 |
| TSS Removal (%) | 80 | Impervious (%) | 66 |
| | | WQ Flow Rate (cfs) | 0.67 |

**Figure 3. Cumulative TSS Removal by Flow Rate for BOSTON WSFO AP – 770, 1948 to 2005.** Stormceptor continuously removes TSS throughout the full range of storm events analyzed. Note that large events do not significantly impact the average annual TSS removal. Therefore no decline in cumulative TSS removal indicates scour does not occur as the flow rate increases.

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## Appendix 1
## Stormceptor Design Summary

### Project Information

| | |
|---|---|
| Date | 11/14/2012 |
| Project Name | South Hadley Library |
| Project Number | 9165 |
| Location | South Hadley, MA |

### Designer Information

| | |
|---|---|
| Company | Nitsch Engineering |
| Contact | Tim McGivern, PE |

### Notes

N/A

### Drainage Area

| | |
|---|---|
| Total Area (ac) | 1.5 |
| Imperviousness (%) | 66 |

The Stormceptor System model STC 900 achieves the water quality objective removing 80% TSS for a NJDEP (clay, silt, sand) particle size distribution; providing continuous positive treatment for a stormwater quality flow rate of 0.67 cfs.

### Rainfall

| | |
|---|---|
| Name | BOSTON WSFO AP |
| State | MA |
| ID | 770 |
| Years of Records | 1948 to 2005 |
| Latitude | 42°21'38"N |
| Longitude | 71°0'38"W |

### Water Quality Objective

| | |
|---|---|
| TSS Removal (%) | 80 |
| WQ Flow Rate (cfs) | 0.67 |

### Upstream Storage

| Storage (ac-ft) | Discharge (cfs) |
|---|---|
| 0 | 0 |

### Stormceptor Sizing Summary

| Stormceptor Model | TSS Removal % |
|---|---|
| STC 450i | 72 |
| STC 900 | 80 |
| STC 1200 | 80 |
| STC 1800 | 81 |
| STC 2400 | 84 |
| STC 3600 | 85 |
| STC 4800 | 88 |
| STC 6000 | 88 |
| STC 7200 | 90 |
| STC 11000 | 93 |
| STC 13000 | 93 |
| STC 16000 | 94 |



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## Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

NJDEP (clay, silt, sand)

| Particle Size µm | Distribution % | Specific Gravity | Settling Velocity ft/s | | Particle Size µm | Distribution % | Specific Gravity | Settling Velocity ft/s |
|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 2.65 | 0.0012 | | | | | |
| 4 | 15 | 2.65 | 0.0012 | | | | | |
| 29 | 25 | 2.65 | 0.0025 | | | | | |
| 75 | 15 | 2.65 | 0.0133 | | | | | |
| 175 | 30 | 2.65 | 0.0619 | | | | | |
| 375 | 5 | 2.65 | 0.1953 | | | | | |
| 750 | 5 | 2.65 | 0.4266 | | | | | |

## Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

**Inlet and Outlet Pipe Invert Elevations Differences**

| Inlet Pipe Configuration | STC 450i | STC 900 to STC 7200 | STC 11000 to STC 16000 |
|---|---|---|---|
| Single inlet pipe | 3 in. | 1 in. | 3 in. |
| Multiple inlet pipes | 3 in. | 3 in. | Only one inlet pipe. |

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Rinker Materials 1 (800) 909-7763 www.rinkerstormceptor.com



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## Appendix 2
## Summary of Design Assumptions

# SITE DETAILS

### Site Drainage Area

| | | | |
|---|---|---|---|
| Total Area (ac) | 1.5 | Imperviousness (%) | 66 |

### Surface Characteristics

| | |
|---|---|
| Width (ft) | 511.2338 |
| Slope (%) | 2 |
| Impervious Depression Storage (in.) | 0.02 |
| Pervious Depression Storage (in.) | 0.2 |
| Impervious Manning's n | 0.015 |
| Pervious Manning's n | 0.25 |

### Infiltration Parameters

Horton's equation is used to estimate infiltration

| | |
|---|---|
| Max. Infiltration Rate (in/hr) | 2.44 |
| Min. Infiltration Rate (in/hr) | 0.4 |
| Decay Rate ($s^{-1}$) | 0.00055 |
| Regeneration Rate ($s^{-1}$) | 0.01 |

### Maintenance Frequency

Sediment build-up reduces the storage volume for sedimentation. Frequency of maintenance is assumed for TSS removal calculations.

| | |
|---|---|
| Maintenance Frequency (months) | 12 |

### Evaporation

| | |
|---|---|
| Daily Evaporation Rate (inches/day) | 0.1 |

### Dry Weather Flow

| | |
|---|---|
| Dry Weather Flow (cfs) | No |

### Upstream Attenuation

Stage-storage and stage-discharge relationship used to model attenuation upstream of the Stormceptor System is identified in the table below.

| Storage ac-ft | Discharge cfs |
|---|---|
| 0 | 0 |



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# PARTICLE SIZE DISTRIBUTION

## Particle Size Distribution

Removing fine particles from runoff ensures the majority of pollutants, such as heavy metals, hydrocarbons, free oils and nutrients are not discharged into natural water resources. The table below identifies the particle size distribution selected to define TSS removal for the design of the Stormceptor System.

NJDEP (clay, silt, sand)

| Particle Size µm | Distribution % | Specific Gravity | Settling Velocity ft/s | | Particle Size µm | Distribution % | Specific Gravity | Settling Velocity ft/s |
|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 2.65 | 0.0012 | | | | | |
| 4 | 15 | 2.65 | 0.0012 | | | | | |
| 29 | 25 | 2.65 | 0.0025 | | | | | |
| 75 | 15 | 2.65 | 0.0133 | | | | | |
| 175 | 30 | 2.65 | 0.0619 | | | | | |
| 375 | 5 | 2.65 | 0.1953 | | | | | |
| 750 | 5 | 2.65 | 0.4266 | | | | | |

PCSWMM for Stormceptor
Grain Size Distributions

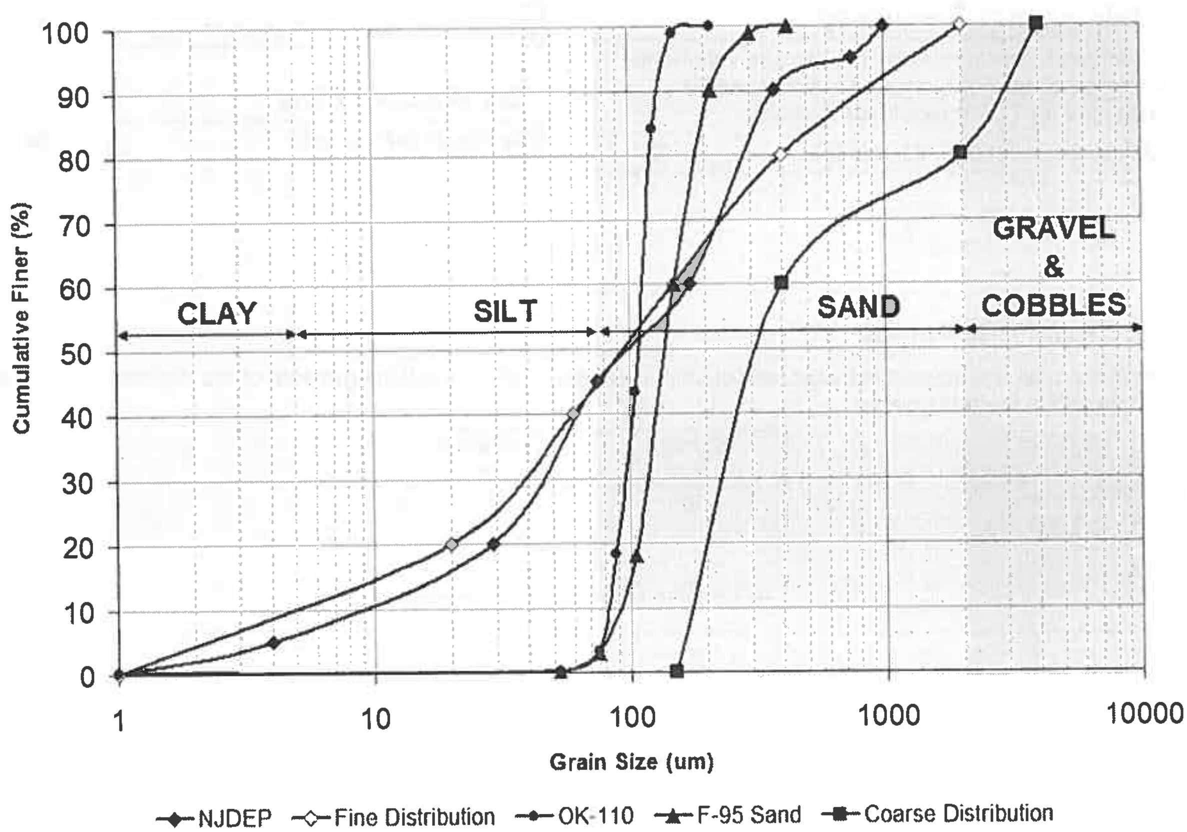


**Figure 1.** PCSWMM for Stormceptor standard design grain size distributions.



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## TSS LOADING

### TSS Loading Parameters

| | |
|---|---|
| TSS Loading Function | Buildup / Washoff |

### Parameters

| | |
|---|---|
| Target Event Mean Concentration (EMC) (mg/L) | 125 |
| Exponential Buildup Power | 0.4 |
| Exponential Washoff Exponential | 0.2 |

## HYDROLOGY ANALYSIS

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of the Stormceptor System are based on the average annual removal of TSS for the selected site parameters. The Stormceptor System is engineered to capture fine particles (silts and sands) by focusing on average annual runoff volume ensuring positive removal efficiency is maintained during all rainfall events, while preventing the opportunity for negative removal efficiency (scour).

Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

### Rainfall Station

| | | | |
|---|---|---|---|
| Rainfall Station | BOSTON WSFO AP | | |
| Rainfall File Name | MA770.NDC | Total Number of Events | 9245 |
| Latitude | 42°21'38"N | Total Rainfall (in.) | 2457.1 |
| Longitude | 71°0'38"W | Average Annual Rainfall (in.) | 42.4 |
| Elevation (ft) | 20 | Total Evaporation (in.) | 157.4 |
| Rainfall Period of Record (y) | 58 | Total Infiltration (in.) | 824.1 |
| Total Rainfall Period (y) | 58 | Percentage of Rainfall that is Runoff (%) | 62.2 |



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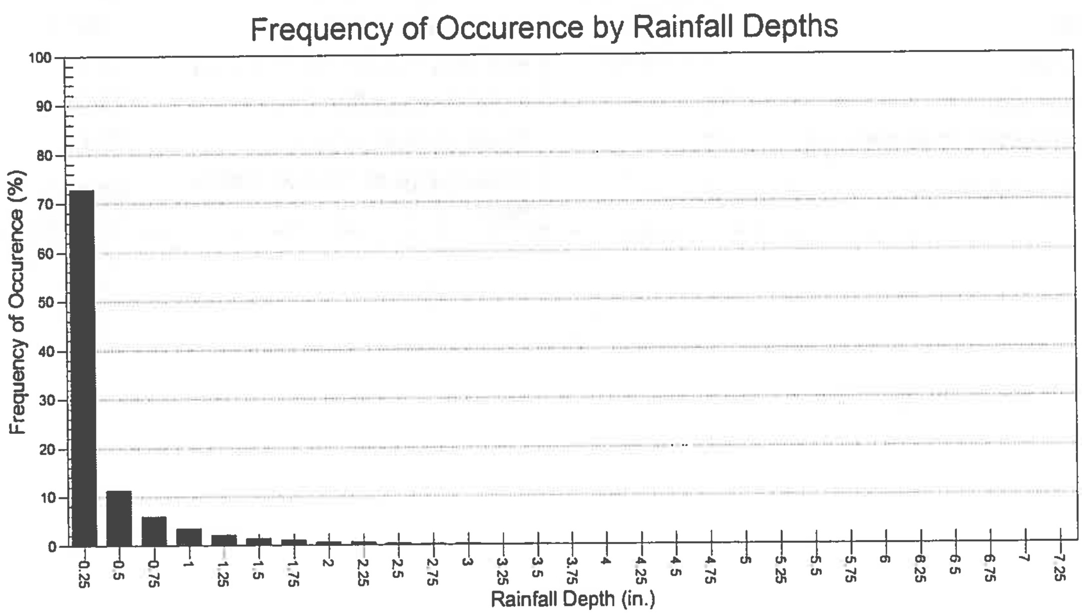
## Rainfall Event Analysis

| Rainfall Depth<br>in. | No. of Events | Percentage of Total Events<br>% | Total Volume<br>in. | Percentage of Annual Volume<br>% |
|---|---|---|---|---|
| 0.25 | 6728 | 72.8 | 423 | 17.2 |
| 0.50 | 1052 | 11.4 | 387 | 15.8 |
| 0.75 | 541 | 5.9 | 335 | 13.6 |
| 1.00 | 323 | 3.5 | 281 | 11.4 |
| 1.25 | 192 | 2.1 | 217 | 8.8 |
| 1.50 | 128 | 1.4 | 177 | 7.2 |
| 1.75 | 89 | 1.0 | 144 | 5.9 |
| 2.00 | 52 | 0.6 | 97 | 3.9 |
| 2.25 | 48 | 0.5 | 102 | 4.1 |
| 2.50 | 29 | 0.3 | 69 | 2.8 |
| 2.75 | 14 | 0.2 | 37 | 1.5 |
| 3.00 | 16 | 0.2 | 46 | 1.9 |
| 3.25 | 4 | 0.0 | 12 | 0.5 |
| 3.50 | 5 | 0.1 | 17 | 0.7 |
| 3.75 | 4 | 0.0 | 15 | 0.6 |
| 4.00 | 2 | 0.0 | 8 | 0.3 |
| 4.25 | 4 | 0.0 | 17 | 0.7 |
| 4.50 | 2 | 0.0 | 9 | 0.4 |
| 4.75 | 1 | 0.0 | 5 | 0.2 |
| 5.00 | 4 | 0.0 | 20 | 0.8 |
| 5.25 | 1 | 0.0 | 5 | 0.2 |
| 5.50 | 0 | 0.0 | 0 | 0.0 |
| 5.75 | 3 | 0.0 | 17 | 0.7 |
| 6.00 | 0 | 0.0 | 0 | 0.0 |
| 6.25 | 2 | 0.0 | 12 | 0.5 |
| 6.50 | 0 | 0.0 | 0 | 0.0 |
| 6.75 | 0 | 0.0 | 0 | 0.0 |
| 7.00 | 0 | 0.0 | 0 | 0.0 |
| 7.25 | 1 | 0.0 | 7 | 0.3 |
| 7.50 | 0 | 0.0 | 0 | 0.0 |
| 7.75 | 0 | 0.0 | 0 | 0.0 |
| 8.00 | 0 | 0.0 | 0 | 0.0 |
| 8.25 | 0 | 0.0 | 0 | 0.0 |
| >8.25 | 0 | 0.0 | 0 | 0.0 |



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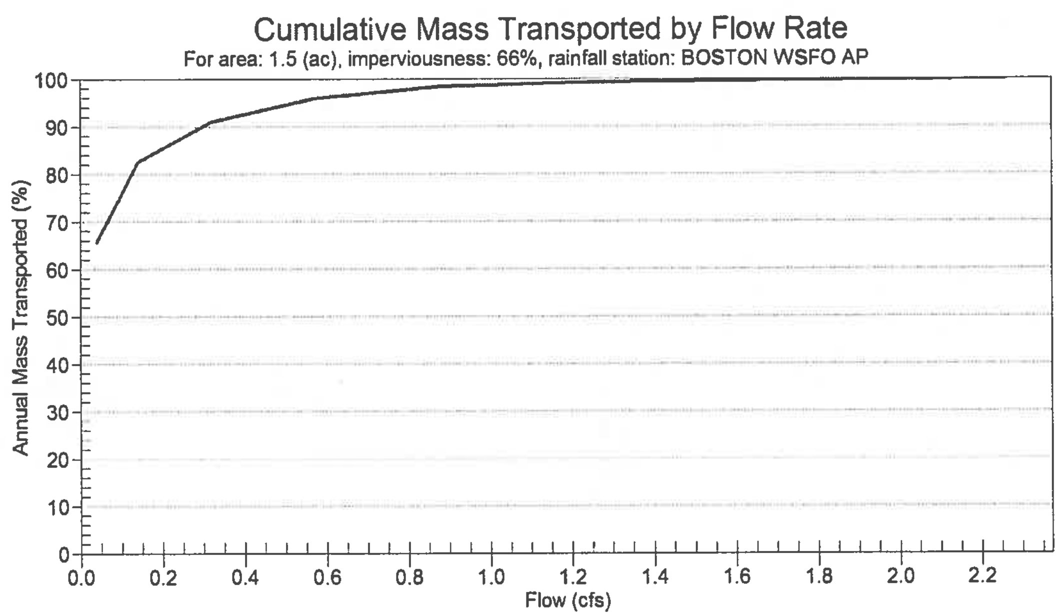
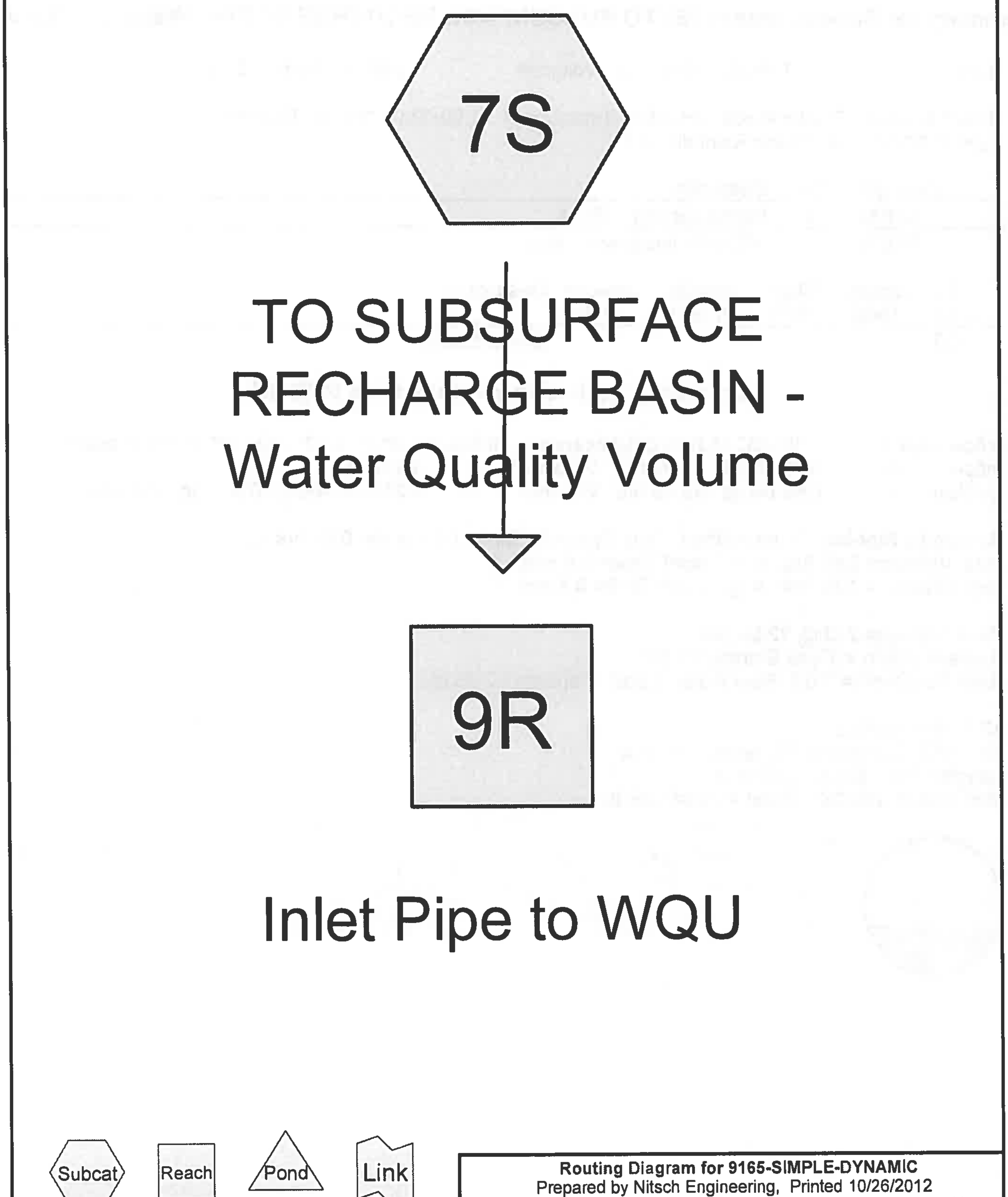
## Pollutograph

| Flow Rate cfs | Cumulative Mass % |
|---|---|
| 0.035 | 65.6 |
| 0.141 | 82.5 |
| 0.318 | 90.9 |
| 0.565 | 95.9 |
| 0.883 | 98.4 |
| 1.271 | 99.3 |
| 1.73 | 99.7 |
| 2.26 | 99.9 |
| 2.86 | 100.0 |
| 3.531 | 100.0 |
| 4.273 | 100.0 |
| 5.085 | 100.0 |
| 5.968 | 100.0 |
| 6.922 | 100.0 |
| 7.946 | 100.0 |
| 9.041 | 100.0 |
| 10.206 | 100.0 |
| 11.442 | 100.0 |
| 12.749 | 100.0 |
| 14.126 | 100.0 |
| 15.574 | 100.0 |
| 17.092 | 100.0 |
| 18.681 | 100.0 |
| 20.341 | 100.0 |
| 22.072 | 100.0 |
| 23.873 | 100.0 |
| 25.744 | 100.0 |
| 27.687 | 100.0 |
| 29.7 | 100.0 |
| 31.783 | 100.0 |






Routing Diagram for 9165-SIMPLE-DYNAMIC
Prepared by Nitsch Engineering, Printed 10/26/2012
HydroCAD® 10.00 s/n 00546 © 2011 HydroCAD Software Solutions LLC

## Summary for Subcatchment 7S: TO SUBSURFACE RECHARGE BASIN - Water Quality Volume

Runoff = 0.67 cfs @ 12.09 hrs, Volume= 1,245 cf, Depth> 0.50"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 11.00-13.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Storm Rainfall=1.11"

| Area (sf) | CN | Description |
|---|---|---|
| 29,632 | 98 | Paved parking, HSG A |
| 29,632 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

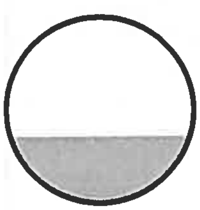
## Summary for Reach 9R: Inlet Pipe to WQU

Inflow Area = 29,632 sf,100.00% Impervious, Inflow Depth > 0.50" for WQV Storm event
Inflow = 0.67 cfs @ 12.09 hrs, Volume= 1,245 cf
Outflow = 0.66 cfs @ 12.09 hrs, Volume= 1,218 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 11.00-13.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.65 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.65 fps, Avg. Travel Time= 0.1 min

Peak Storage= 2 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.46 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 6.3' Slope= 0.0048 '/'
Inlet Invert= 108.08', Outlet Invert= 108.05'



## APPENDIX H

## MassDEP Checklist for Stormwater Report and Illicit Discharge Compliance Statement

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

# Checklist for Stormwater Report

## A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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

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

# 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
TIMOTHY J. McGIVERN
CIVIL
No. 47569
REGISTERED PROFESSIONAL ENGINEER

11/21/2012

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 for Stormwater Report

## Checklist (continued)

**Standard 4: Water Quality** (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

**Standard 6: Critical Areas**

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

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

# Checklist for Stormwater Report

## Checklist (continued)

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

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

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

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

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

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

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

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

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

# Checklist for Stormwater Report

## **Checklist** (continued)

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

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

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

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

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

**Standard 9: Operation and Maintenance Plan**

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

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

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

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

**Standard 10: Prohibition of Illicit Discharges**

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

☒ An Illicit Discharge Compliance Statement is attached;

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

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November 21, 2012

South Hadley Library
2 Canal Street
South Hadley, Massachusetts

**STANDARD 10: Illicit Discharge Compliance Statement**

**Standard 10 states: All illicit discharges to the stormwater management system are prohibited.**

This is to verify:

1. Based on the information available there are no know or suspected illicit discharges to the stormwater management system at the South Hadley Library project site as defined in the DEP Stormwater Handbook.
2. The design of the stormwater system includes no proposed illicit discharges and no proposed illicit discharges are proposed.

Timothy J. McGivern, P.E.

11/21/2012
Date