

113 – 115 Boston Post Road
Wayland, Massachusetts

November 14, 2022

POST CONSTRUCTION STORMWATER MANAGEMENT REPORT

Prepared For:

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1. INTRODUCTION

The proposed project includes a stormwater management system designed to mitigate potential impacts the proposed project could have on the existing watershed. Stormwater controls have been proposed to mitigate peak runoff rates, provide water quality, promote groundwater recharge and provide sediment removal. The proposed system has been designed to comply with:

- The 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Management Handbook, and
- The Massachusetts Wetland Protection Act (310 CMR 10.00)

The pre- and post-development hydrologic conditions were modeled using HydroCAD version 10.00 to demonstrate that post-development stormwater runoff rates will be less than or equal to the pre-development rates. Watershed maps with soil types as well as detailed analyses of the model results are also included. The following tables summarize the peak runoff rates and volumes for the pre- and post-development conditions.

Table 1: Pre- & Post-development Peak Runoff Rate Comparison, units are in cubic feet per second (cfs).

Storm Event	2 Year		10 Year		100 Year	
	Pre	Post	Pre	Post	Pre	Post
DP-1	4.97	0.54	9.12	7.39	18.20	17.33
DP-2	2.52	0.03	4.57	0.16	8.38	0.49

Table 2: Pre- & Post-development Runoff Volumes Comparison, units are in acre feet (af).

Storm Event	2 Year		10 Year		100 Year	
	Pre	Post	Pre	Post	Pre	Post
DP-1	0.674	0.095	1.220	0.711	2.318	1.498
DP-2	0.183	0.005	0.331	0.014	0.618	0.037

2. PRE-DEVELOPMENT CONDITIONS

2.1 Site Conditions

The Property consists of a ±6.5-acre site, comprised of two separate parcels which can be further identified as Assessors Map 30, Lots 70 and 71. The parcel at 115 Boston Post Road is currently occupied by a garden center and contains buildings, parking lots, greenhouses, and appurtenances associated with the business. The parcel at 113 Boston Post Road contains a single-family dwelling and carriage house. The Site is surrounded by a combination of residential dwellings and retail and commercial development.

Runoff from the site currently drains, unmitigated and untreated, to a stream (Pine Brook) on the southern side of the property. This stream, which flows from east to west, is classified as a cold-water fishery and therefore the site discharges to a critical area. The stream and associated wetland to the south have been identified as Design Point 1 (DP-1) accordingly in the hydrologic analyses. A portion of the onsite runoff flows to the western abutter prior to ultimately discharging to the stream. Accordingly, the property line shared with the western abutter has been identified as Design Point 2 (DP-2).

2.2 Soil Description

According to the United States Department of Agricultural (USDA) soil survey for Middlesex County and the Natural Resources Conservation Service (NRCS) Web Soil Survey, dominant soils within upland portions of the site are mapped as Haven-Urban land complex, with slopes ranging from 0 to 8 percent. These are generally classified as well drained soils of excavated or filled land. Dominant soils within the wetland areas are classified as Scarboro Mucky fine sandy loam with 0 to 3 percent slopes. These are classified as very poorly drained depressions, outwash terraces, or drainage ways. These map designations are generally consistent with field observations.

Topographically, the Site is relatively flat and slopes gently towards the wetland systems to the south and west of the existing development and towards Pine Brook. NRCS classifies these types of soils as hydrologic class A/D and A soils. While the USDA classifies these types of soils as hydrologic class B and D soils.

Competent Soils Individuals conducted site visits on 12/13/2016 & 1/12/17 and subsequently on 11/14/17, & 12/22/17 to verify the NRCS classification. Test pits logs indicated that the on-site soils are generally sandy loam, loamy sand, sand and gravel. Based on the data present in the test pit logs, the soils were modeled as a Class B soils for the hydrology analysis. Wetland soils were modeled as a Class D soils for the hydrology analysis.

The estimated seasonal high groundwater elevation varied throughout the site. Mottling and redox features were found as shallow as 2.6-feet and as deep as 9.3-feet below surface grade.

2.3 Hydrologic Analysis

Sub-catchment areas were delineated based on existing runoff patterns and topographic information. This information is shown on the *Pre-Development Conditions Hydrologic Areas Map* included in Appendix B. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results also in Appendix B.

3. POST-DEVELOPMENT CONDITIONS

3.1 Design Strategy

During the design phase of the site layout, consideration was given to conserving environmentally sensitive features and improving impact on the existing hydrology. Through careful site planning the proposed impervious surfaces have been minimized, reducing the impact the project may have on the existing watershed. Specifically, the majority of the parking areas have been located in a subsurface parking garage to reduce paved parking impervious surfaces.

A stormwater management system has been designed to provide treatment for stormwater runoff associated with the proposed impervious surfaces on site. All stormwater BMPs were designed to treat a minimum of the first 1.0 inch of runoff generated by the on-site impervious areas. Proprietary stormwater treatment systems were designed to treat the runoff rate associated with the water quality volume in accordance with the requirements of the DEP Stormwater Handbook. Stormwater BMP sizing worksheets and water quality sizing calculations are included in Appendix E of this report. The resulting stormwater runoff water quality will be significantly improved from existing conditions.

To mitigate increased stormwater flow rates associated with the proposed impervious area, an infiltration basin proposed. Based on the data presented in the soil borings, the infiltration basin is located at the western perimeter of the site. The infiltration basin will discharge to the wetland system, consistent with the existing hydrology of the site.

In addition to the collection, conveyance and treatment of stormwater generated from the project site, the drainage system has been designed to treat the stormwater from the Boston Post Road municipal drainage system that is located within Boston Post Road and that discharges through the project property directly to the Pine Brook with no treatment or other mitigation measures. The system has been designed to divert stormwater from the Boston Post Road system via a forebay at the roadway edge, where stormwater runoff will be conveyed to the larger extended retention basin and then through the weirs and overflows will travel to the Pine Brook at generally the same location it does today.

3.2 Hydrologic Analysis

The established design point used in the pre-development conditions analysis was used in the post-development analysis for direct comparison. The tributary areas and flow paths were modified to reflect post-development conditions. See Appendix C for the *Post-Development Conditions Hydrologic Areas Map*. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results in Appendix C.

3.3 Stormwater Management Controls Sizing

Infiltration Basin

The proposed infiltration basin has been designed to provide groundwater recharge and reduce post-development runoff up to the 100-year storm event. The infiltration basin has been designed with an outlet to provide control for a variety of storm events which would otherwise send stormwater towards the Bordering Vegetated Wetlands (BVW). In the event of overtopping an emergency spillway has been provided to direct the excess flow towards the BVW, consistent with the existing drainage pattern.

The infiltration system was sized using the Simple Dynamic Method, as described in Chapter 3 of the Massachusetts Stormwater Handbook. A permeability rate of 1.07 inches per hour was calculated based on field testing though a Rawl's exfiltration rate of 1.02 inches per hour was utilized for design. The system has been designed to meet the required recharge volume, and will fully dewater within 72 hours.

4. Compliance with DEP Stormwater Management Standards

The proposed stormwater management system was designed in compliance with the ten (10) DEP Stormwater Management Standards. The following summary provides key information related to the proposed stormwater management system, its design elements, and mitigation measures for potential impacts.

STANDARD 1: No new stormwater conveyance (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

There will be no direct discharge of untreated stormwater to nearby wetlands or waters of the Commonwealth. Runoff from all impervious areas of the site will be conveyed to stormwater

management controls for infiltration, water quality treatment, and runoff rate attenuation prior to discharge to adjacent wetlands.

STANDARD 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

The stormwater management design will control post-development peak discharge rates for the 2-, 10-, and 100-year, 24-hour storms so as to maintain or reduce pre-development peak discharge rates. Refer to Section 1.0 Introduction for a summary of the peak runoff rates.

STANDARD 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater management practices 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 types. 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 stormwater management system includes an infiltration basin which will effectively recharge groundwater on-site. The Infiltration BMP was sized using the simple dynamic method based on the required recharge volume for the post-development site. As a result, annual recharge from the post-development site will approximate the annual recharge from the site under pre-development conditions. See Appendix E for stormwater BMP design worksheets and Groundwater Recharge Calculation.

The existing site includes various buildings, a large heavily compacted gravel lot, and a wooded area. The existing buildings and the gravel lot are functioning as impervious surfaces. Currently there is no stormwater recharge infrastructure at the site. There is an overall significant decrease in impervious surfaces from pre- to post- development conditions, 3.60 acres of impervious buildings and gravel areas under pre-development conditions, versus 1.58 acres under post development conditions. For the purposes of calculating required recharge volume, we have not included the existing gravel areas in the total impervious area. Under post-development conditions, the required recharge volume is approximately 0.028 acre-feet. The infiltration basin will provide 0.032 acre-feet of recharge volume.

STANDARD 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

The proposed project will meet the water quality requirements of Standard 4 using several on site treatment trains that achieve 80% TSS removal. Refer to Appendix E for the TSS removal worksheets. Structural BMPs designed for water quality treatment, include a Contech® water quality treatment unit, sized to capture and treat the flow rate associated with the first 1.0-inch of runoff from proposed impervious surfaces. All proposed stormwater management BMPs will be operated and maintained to ensure continued water quality treatment of runoff. The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

STANDARD 5: For land uses with higher potential pollutant loads (LUHPPLs), 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.

The proposed project is not associated with stormwater discharges from land uses with higher potential pollutant loads.

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

The proposed BMPs are consistent with the Stormwater Management Handbook for use within critical areas. The stormwater management system has been designed to capture and treat the first 1.0-inch of runoff as stipulated in the Stormwater Management Handbook. The infiltration basin, and Contech® water quality treatment unit is proposed to remove pollutants from the first 1.0-inch of runoff from all new impervious areas. Adequate pretreatment will be provided before discharge.

STANDARD 7: Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.

The proposed project qualifies as a redevelopment. However, it fully complies with all standards of the Stormwater Management Handbook. Therefore, this standard does not apply.

STANDARD 8: A plan to control construction-related impacts during 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.

A Stormwater Pollution Prevention Plan (SWPPP) has been developed to comply with Section 3 of the NPDES Construction General Permit for Stormwater Discharges, and a draft version of the SWPPP has been included in the Appendices of this report; therefore, the requirements of Standard 8 are fulfilled.

STANDARD 9: A Long-Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of the stormwater best management practices (BMPs) associated with the proposed development.

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

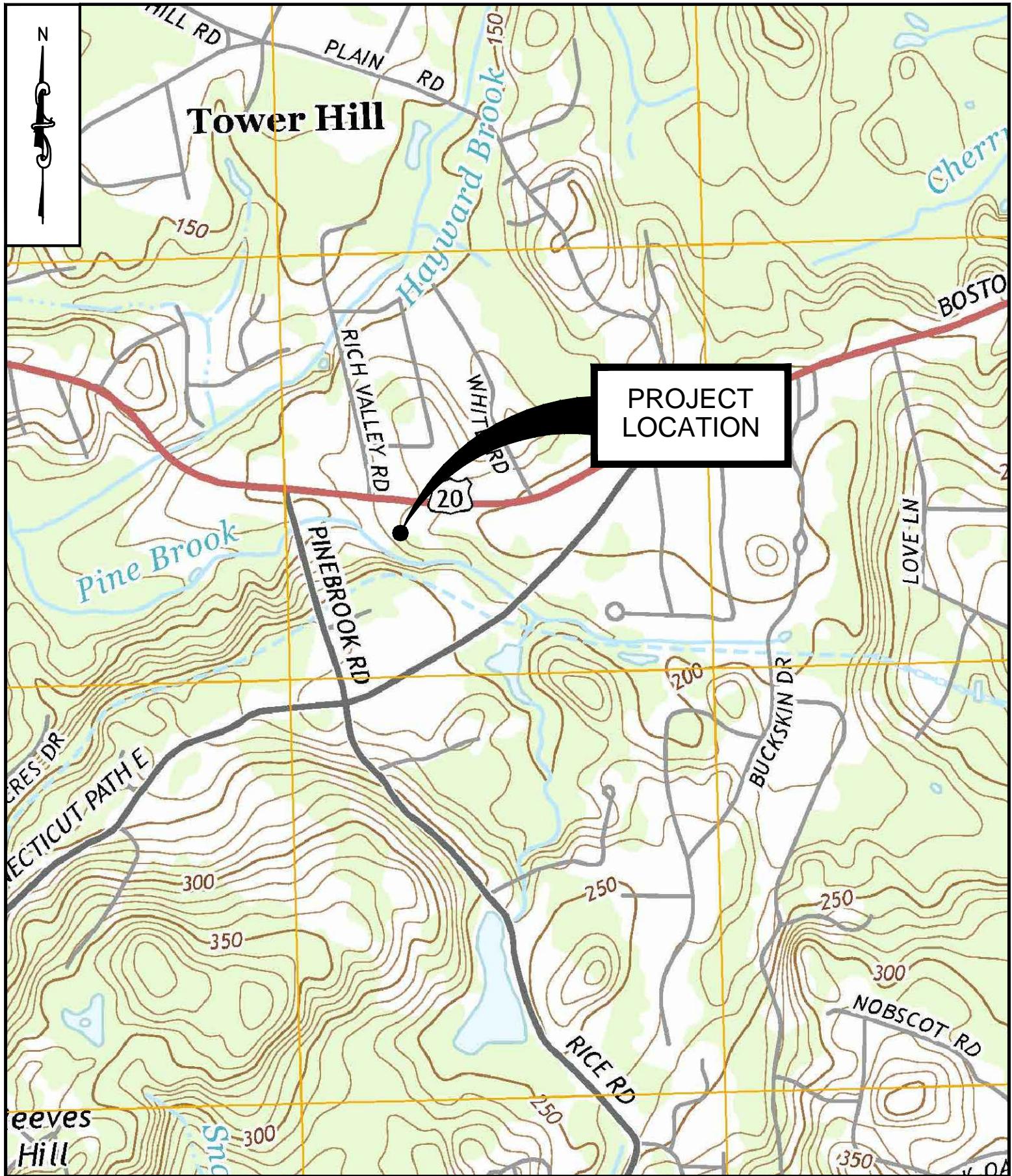
There will be no illicit discharges to the proposed stormwater management system associated with the proposed project. An Illicit Discharge Compliance Statement is provided below.

4.1 Illicit Discharge Compliance Statement

An illicit discharge is any discharge to a municipal separate storm sewer that is not comprised entirely of stormwater, discharges from fire-fighting activities, and certain non-designated non-stormwater discharges.

To the best of my knowledge, no detectable illicit discharge exists on site. The site plans included with this report detail the storm sewers that convey stormwater on the site and demonstrate that these systems do not include the entry of an illicit discharge. A Site Owner's Manual is also included, which contains the Long-Term Pollution Plan that outlines measures to prevent future illicit discharges. As the Site Owner, I will ultimately be responsible for implementing the Long-Term Pollution Prevention Plan.

Signature: _____
Menemsha Capital Strategies, LLC



C1.0

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No.	Description	Date
DWG ISSUE & REVISION HISTORY		

Stamp:

Drawing Title:

**LOCUS MAP
CASCADE
WAYLAND, MA**

Project No. 160012

Scale: 1" = 1,000'

Drawn By: GMD

Checked By: GMD

Approved By: WAD

Date: NOVEMBER 14, 2022

Drawing No.

FIG 1

APPENDIX A

Soils Information

Map Unit Name—Middlesex County, Massachusetts
(2841.01)



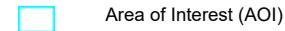
Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

1/16/2018
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MAP LEGEND

Area of Interest (AOI)



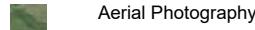
US Routes

Soils

Soil Rating Polygons

- Haven-Urban land complex, 0 to 8 percent slopes
- Scarboro mucky fine sandy loam, 0 to 3 percent slopes
- Not rated or not available

Background



Aerial Photography

Soil Rating Lines

- Haven-Urban land complex, 0 to 8 percent slopes
- Scarboro mucky fine sandy loam, 0 to 3 percent slopes
- Not rated or not available

Soil Rating Points

- Haven-Urban land complex, 0 to 8 percent slopes
- Scarboro mucky fine sandy loam, 0 to 3 percent slopes
- Not rated or not available

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Middlesex County, Massachusetts

Survey Area Data: Version 17, Oct 6, 2017

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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

Map Unit Name

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	4.2	26.9%
624B	Haven-Urban land complex, 0 to 8 percent slopes	Haven-Urban land complex, 0 to 8 percent slopes	11.3	73.1%
Totals for Area of Interest			15.5	100.0%

Description

A soil map unit is a collection of soil areas or nonsoil areas (miscellaneous areas) delineated in a soil survey. Each map unit is given a name that uniquely identifies the unit in a particular soil survey area.

Rating Options

Aggregation Method: No Aggregation Necessary

Tie-break Rule: Lower



Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

Middlesex County, Massachusetts

6A—Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svky

Elevation: 0 to 1,320 feet



Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Scarboro and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scarboro

Setting

Landform: Depressions, outwash terraces, drainageways, outwash deltas
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy glaciofluvial deposits derived from schist and/or sandy glaciofluvial deposits derived from gneiss and/or sandy glaciofluvial deposits derived from granite

Typical profile

Oe - 0 to 3 inches: mucky peat
A - 3 to 11 inches: mucky fine sandy loam
Cg1 - 11 to 21 inches: sand
Cg2 - 21 to 65 inches: gravelly coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat):
Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: About 0 to 2 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Hydric soil rating: Yes

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs, swamps



Landform position (three-dimensional): Dip

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: Yes

Walpole

Percent of map unit: 5 percent

Landform: Deltas, depressions, depressions, outwash plains, outwash terraces

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Tread, talus, dip

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: Yes

Wareham

Percent of map unit: 5 percent

Landform: Depressions

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: Yes

624B—Haven-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 9956

Elevation: 0 to 1,000 feet

Mean annual precipitation: 45 to 54 inches

Mean annual air temperature: 43 to 54 degrees F

Frost-free period: 145 to 240 days

Farmland classification: Not prime farmland

Map Unit Composition

Haven and similar soils: 40 percent

Urban land: 40 percent

Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Haven

Setting

Landform: Terraces, plains

Landform position (two-dimensional): Foothills

Landform position (three-dimensional): Tread, rise

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Friable loamy eolian deposits over loose sandy glacioluvial deposits

Typical profile

H1 - 0 to 2 inches: silt loam

H2 - 2 to 20 inches: silt loam



H3 - 20 to 32 inches: very fine sandy loam

H4 - 32 to 65 inches: stratified coarse sand to sand to fine sand

Properties and qualities

Slope: 0 to 8 percent

Depth to restrictive feature: 18 to 36 inches to strongly contrasting textural stratification

Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2e

Hydrologic Soil Group: A

Hydric soil rating: No

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Excavated and filled land

Minor Components

Tisbury

Percent of map unit: 10 percent

Landform: Terraces, plains

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Tread, dip

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent

Landform: Eskers, ridges, terraces

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Convex

Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent

Landform: Terraces, plains

Landform position (two-dimensional): Shoulder



Landform position (three-dimensional): Tread, rise

Down-slope shape: Convex

Across-slope shape: Convex

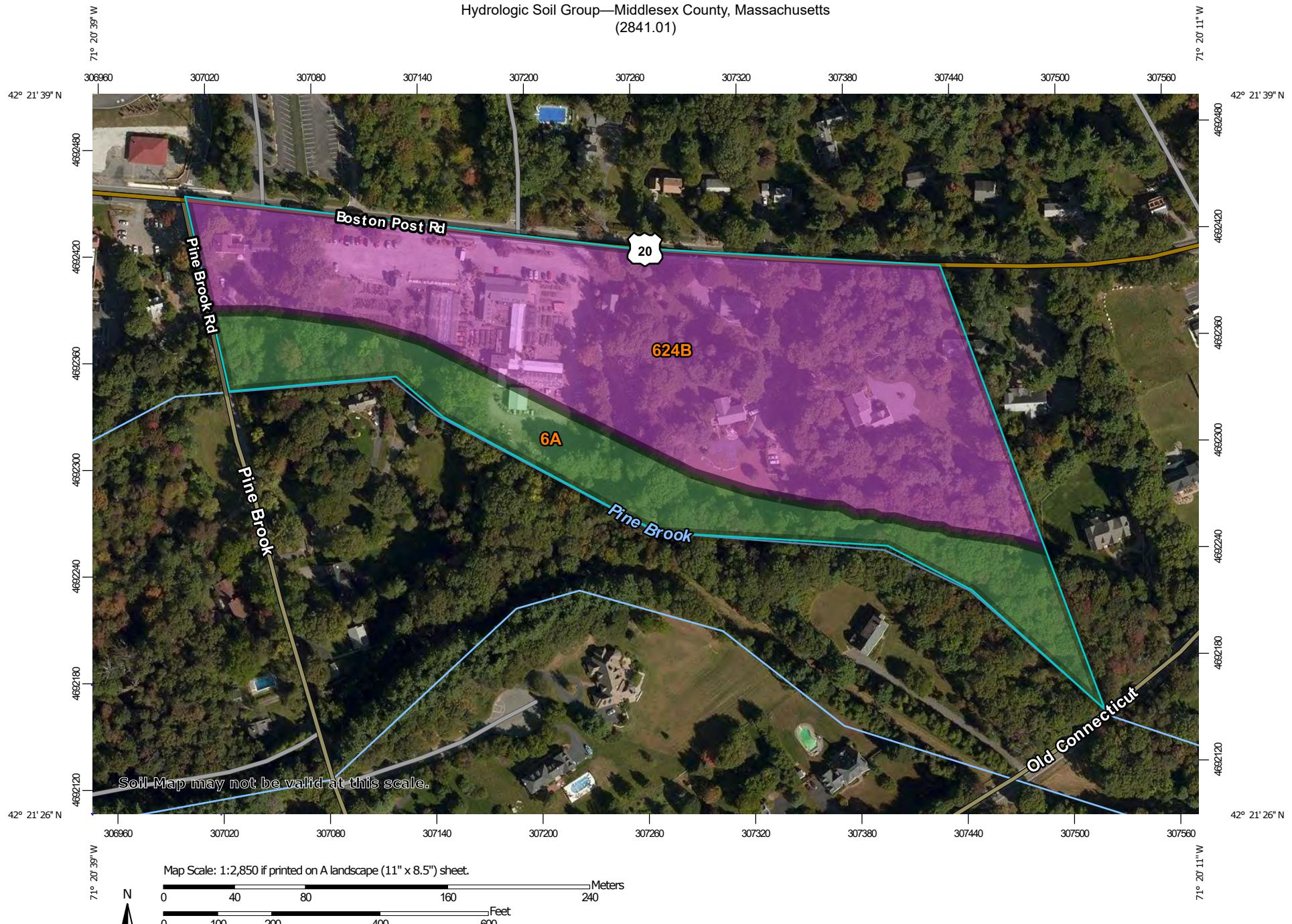
Hydric soil rating: No

Data Source Information

Soil Survey Area: Middlesex County, Massachusetts

Survey Area Data: Version 17, Oct 6, 2017

Hydrologic Soil Group—Middlesex County, Massachusetts
(2841.01)



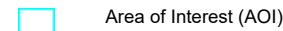
Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

1/16/2018
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MAP LEGEND

Area of Interest (AOI)



Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

	A
	A/D
	B
	B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Middlesex County, Massachusetts

Survey Area Data: Version 17, Oct 6, 2017

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	4.2	26.9%
624B	Haven-Urban land complex, 0 to 8 percent slopes	A	11.3	73.1%
Totals for Area of Interest			15.5	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



MIDDLESEX COUNTY
MASSACHUSETTS

INTERIM
SOIL SURVEY REPORT

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

Published by the
MIDDLESEX CONSERVATION DISTRICT

July, 1995

FOURTH EDITION

All programs of the Middlesex Conservation District and Natural Resources Conservation Service are offered on a non-discriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

HAVEN-URBAN LAND COMPLEX consists of nearly level and undulating and very deep, well drained Haven soils and areas of Urban land. Although urban land development has altered the soils and landscapes in these areas, the soil can be identified at widely separated points, and the general nature of the area can be determined. Broad delineations are made on the map. This map unit consists of about 75 percent Haven and similar soils and at least 25 percent Urban land and other disturbed areas. Urban land consists of streets, parking lots, buildings and other impermeable structures. For information on Haven soils see "Haven" series description.

HINCKLEY series consists of nearly level to very steep, deep (5+ ft.), excessively drained soils on glacial outwash plain, terraces, kames, and eskers. They formed in gravelly and cobbly coarse textured glacial outwash. Hinckley soils have friable or loose, gravelly and very gravelly sandy loam to loamy coarse sand surface soil and subsoil with rapid permeability, with loose stratified sands and gravels in the substratum at 12 to 30 inches which have very rapid permeability. Major limitations are related to slope and droughtiness.

HOLLIS series consists of gently sloping to very steep, shallow (<20"), somewhat excessively drained soils on bedrock controlled uplands. They formed in a thin mantle of glacial till or residuum from local bedrock. Hollis soils have friable fine sandy loam surface soil and subsoil with moderate or moderately rapid permeability. Depth to bedrock is 10 to 20 inches. Rock outcrops are common, and many areas have stones and boulders on the surface. Major limitations are related to depth to bedrock, rockiness and slope.

HOLLIS-ROCK OUTCROP CHARLTON COMPLEX consists of undulating and rolling shallow soils, areas of exposed bedrock and very deep soils on hills and ridges where relief is highly affected by underlying bedrock. The components of this complex occur in such intricate patterns it is not practical to separate them. The complex is approximately 30 percent Hollis soils, 30 percent Rock outcrop and 25 percent Charlton and 15 percent other soils. Major limitations are related to rockiness, slope and depth to bedrock in the Hollis soil. See "Charlton" and "Hollis" series descriptions for more information.

LANDFILL consists of areas used for residential or industrial solid waste disposal. They commonly contain waste paper, metal, plastic, glass, rubble, cinders, and organic debris. Characteristics of each area are highly variable. Most areas are subject to subsidence.

ROCK OUTCROP-HOLLIS COMPLEX is on ridges and hills. It consists of exposed bedrock, and somewhat excessively drained, shallow, nearly level to very steep Hollis soils. They exist in such intricate patterns that it was not practical to separate them at the scale of mapping. Generally these areas are made up of about 55 percent rock outcrop, 40 percent Hollis and 5 percent other soils. Major limitations are related to depth to bedrock, rockiness, and slope. For information on Hollis soils, see "Hollis" series description.

SACO series consist of nearly level, deep (5+ ft.), very poorly drained soils on floodplains. They formed in recent silty alluvium that is high in organic matter. Saco soils have mucky silt loam or silt loam surface soil with moderate permeability, over a silt loam or very fine sandy loam substratum with moderate permeability, underlain at 40 to 60 inches by stratified sand and gravel with rapid permeability. These soils have a high water table that is at or near the surface most of the year and are frequently flooded. Major limitations are related to flooding and wetness.

→ SCARBORO series consists of nearly level, deep (5+ ft.), very poorly drained soils in depressions of glacial outwash plains and terraces. They formed in sandy glacial outwash. Scarboro soils have muck, mucky sandy loam or mucky loamy sand surface soil, over stratified sand and gravel at 3 to 16 inches. Permeability is rapid or very rapid. They have a high water table which is at or near the surface most of the year. Major limitations are related to wetness.

SCIO series consists of nearly level and gently sloping, deep (5+ ft.), moderately well drained soils on glacial outwash terraces, alluvial fans and lake beds. They formed in glacial outwash, lacustrine and aeolian deposits. Scio soils have silt loam or very fine sandy loam surface soil, subsoil and substratum with moderate permeability. The substratum is underlain at 40 to 60 inches with stratified sand and gravel. They have a seasonal high water table at 18 to 24 inches. Major limitations are related to wetness.

SCIO-URBAN LAND COMPLEX consists of very deep, nearly level to gently sloping, moderately well drained Scio soils and areas of Urban land. Although urban land development has altered the soils and landscape these areas, the soil can be identified at widely separated points, and the general nature of the area can be determined. Broad delineations are made on the map. This map consists of about 75 percent Scio and similar soils and at least 25 percent Urban land and other disturbed areas. Urban land consists of streets, parking lots, buildings and other impermeable structures. For information on Scio soils see "Scio" series description.

SOIL SURVEY MIDDLESEX COUNTY, MASSACHUSETTS

TABLE C.—SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Frequency	Duration	Months	Depth	Kind	Months	Depth	Potential frost action	Erosion of surface	Erosion of foundations
									Unprotected		
27B, 27C, 28B, 28C— Scituate	C	None	—	—	—	Perched	Nov-May	>60	Moderate	Low	High
32B— Ridgebury	C	None	—	—	—	0-1.5 Apparent	Nov-Jun	>60	High	High	High
34— Whitman	D	None	—	—	+1-0.5	Parched	Sep-Jun	>60	High	High	High
35A, 35B, 35C, 35D, 35E— Hancock	A	None	—	—	>6.0	—	—	>60	Low	Low	High
37A, 37B, 37C— Merrimac	A	None	—	—	>6.0	—	—	>60	Low	Low	High
38B— Sudbury	B	None	—	—	—	11.5-3.0 Apparent	Dec-Apr	>60	Moderate	Low	High
40— Scarboro	D	None	—	—	—	+1-1.0 Apparent	Jan-Dec	>60	High	High	High
42— Pootatuck	B	Occasional	Brief	—	—	—	—	>60	Moderate	Low	High
43— Ripponam	C	Frequent	Brief	Oct-May	0-1.5 Apparent	Sep-Jun	—	>60	Moderate	Moderate	Moderate
44— Saco	D	Frequent	Brief	Oct-May	0-0.5 Apparent	Sep-Jun	—	>60	High	Low	Moderate
45— Swanson	D	None	—	—	—	—	—	>60	High	High	High
46— Freetown	D	None	—	—	—	0-1.0 Apparent	Jan-Dec	>60	High	High	High

See footnote at end of table.

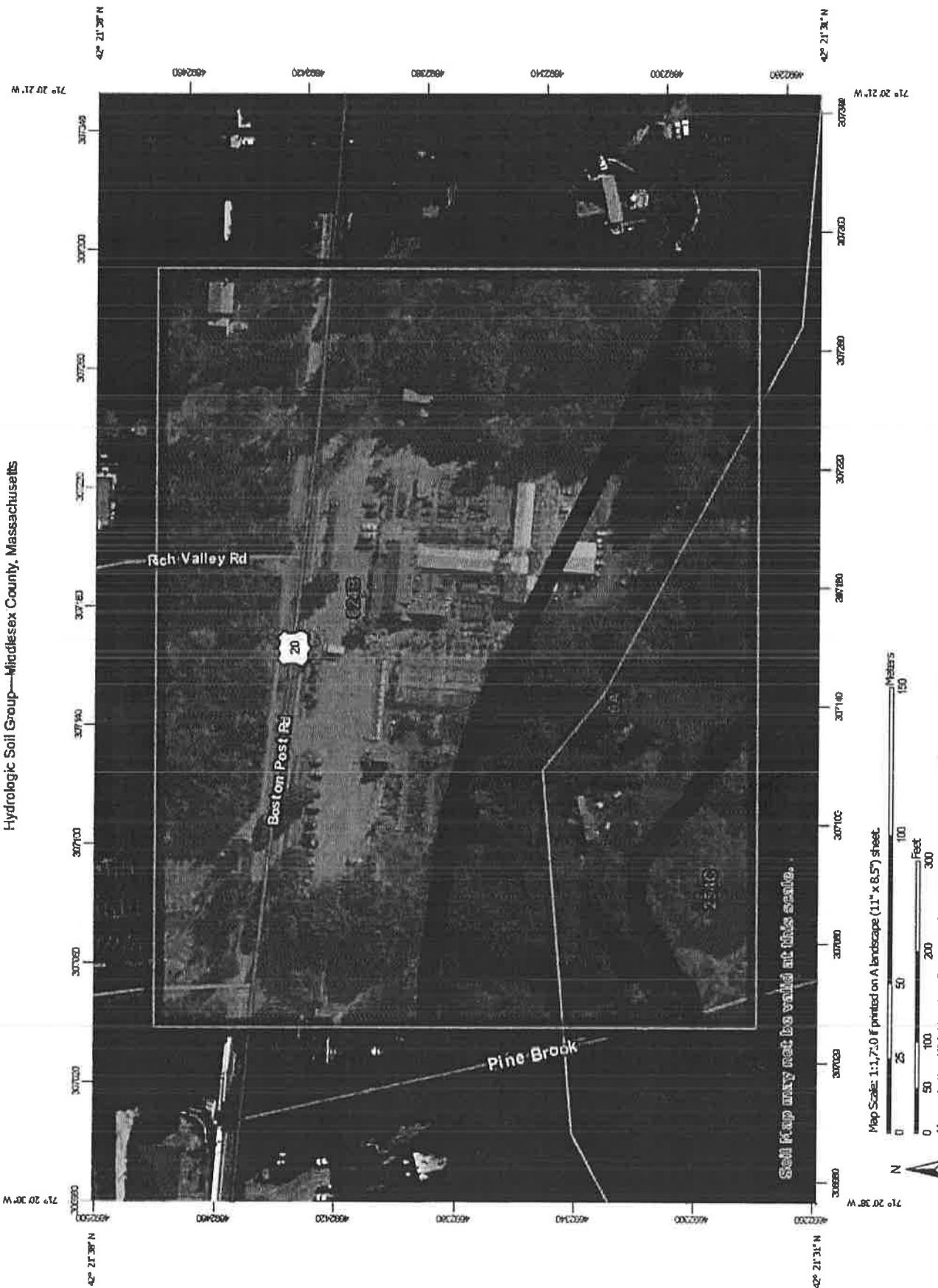
SOIL SURVEY MIDDLESEX COUNTY, MASSACHUSETTS

TABLE C--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Elevation			High-water-table			Bedrock			Rain or Leaching		
		Frequency	Duration	Months	Depth	Kind	Months	Depth	In	frost action	Uncotted	Concrete	steel
65e. Udorthents	B.	None	---	---	---	---	---	260	Moderate	Low	---	High	---
63A; 63B- Haven	B.	---	---	---	26.0	---	---	260	Low	---	---	High	---
67A; 67B; 67C- Windsor	A	None	---	---	26.0	---	---	260	Low	---	---	High	---
76A; 75B; 75C- Carver	A	None	---	---	26.0	---	---	260	Low	---	---	High	---
81A; 81B; 81C; 82B; 82C; 83B; Woodbridge	C	None	---	---	11.5-2.5	Perched	Nov-May	260	High	Low	---	Moderate	---
69A; 82B- Sunkook	A	Frequent	Br-leaf	Mar-May	13.0-6.0	Apparent	Jan-Apr	260	Low	---	Low	High	---
92- Winoski	B	Frequent	Br-leaf	Feb-April	5-3.0	Apparent	Mar-Apr	260	High	---	Moderate	Moderate	---
93- Limerick	C	Frequent	Br-leaf	Nov-May	0-1.5	Apparent	Nov-May	260	High	High	Low	---	---
99- Freetown	D	None	---	---	+3-0	Apparent	Jan-Dec	260	High	High	High	High	---
100A; 100B- Tisbury	B	None	---	---	11.5-2.5	Apparent	Nov-Apr	260	High	---	---	Moderate	---
113B; 114C; 113D; 114B; 114C; 114D; 115B; 115C; 115D- Canton	B	None	---	---	26.0	---	---	260	Low	---	---	High	---

See footnote at end of table.

Hydrologic Soil Group—Middlesex County, Massachusetts



USDA Natural Resources Conservation Service

Web Soil Survey
National Cooperative Soil Survey

BROOKSIDE
113-119 BOSTON POST ROAD
WAYLAND, MASSACHUSETTS

NEW TEST PIT LOCATIONS
AND SOIL INFORMATION




FIG 1

REV DATE DESCRIPTION

PROJECT NO.: 00000
DATE: JANUARY 2017
SCALE: 1"=40'
SHEET: 1 of 1


DRAWN BY: RLW DESIGN BY: RLW
CHECKED BY: DCF APPROVED BY: DCF

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CLIENT. COPYING OR MODIFYING WITHOUT WRITTEN PERMISSION IS
PROHIBITED.

40 0 20 40 80
SCALE: 1 INCH = 40 FEET

BROOKSIDE
113-119 BOSTON POST ROAD
WAYLAND, MASSACHUSETTS

COMPILED PLAN OF EXISTING
SOIL TEST PIT DATA



**PROGRESS
PRINT**

REV DATE DESCRIPTION

PROJECT NO.: 00000
DATE: JANUARY 2017
SCALE: 1"=40'
SHEET: 1 of 1

DRAWN BY: RLW DESIGN BY: RLW
CHECKED BY: DCF APPROVED BY: DCF

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FIG 1



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

DEP has provided this form for use by on-site professionals and local Boards of Health. Other forms may be used, but the information must be substantially the same as provided here. Before using this form, check with your local Board of Health to determine the form they use.

A. Facility Information

1. Facility Information

Mahoney's Garden Center, LLC

Owner Name

115 Boston Post Road

Map/Lot: Map 30, Lot 071

Street Address

Wayland

MA

City/Town

01778

Zip Code

B. Site Information

1. (Check one) New Construction Upgrade Repair

2. Published Soil Survey available? Yes No If yes: Year Published Publication Scale Soil Map Unit

Haven Urban Land Complex (MassGIS)

Soil Name

Soil limitations

3. Surficial Geological Report available? Yes No If yes: Year Published Publication Scale Map Unit

Geologic Material

Landform

4. Flood Rate Insurance Map:

Above the 500 year flood boundary? Yes No Within the 100 year flood boundary? Yes No

Within the 500 year flood boundary? Yes No Within a Velocity Zone? Yes No

5. Wetland Area: National Wetland Inventory Map

Map Unit

Name

Wetlands Conservancy Program Map

Map Unit

Name



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

6. Current Water Resource Conditions (USGS) December 2016 Month/Year Range: Above Normal Normal Below Normal

7. Other references reviewed: _____

C. On-Site Review *(minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number:

December 13, 2016

Date

AM

Time

Sunny 30s F

Weather

1. Location

Ground Elevation at Surface of Hole Varies

Location (Identify on Plan) See Plan

2. Land Use: Nursery

(e.g. woodland, agricultural field, vacant lot, etc.)

None

Surface Stones

3-8%

Slope (%)

Disturbed
Vegetation

Moraine
Landform

Position on landscape (attach sheet)

3. Distances from: Open Water Body > 100

feet Drainage Way > 100

feet Possible Wet Area > 100

feet
Property Line > 10

feet Drinking Water Well > 100

feet Other _____

4. Parent Material: Ice Contact Outwash

Unsuitable Materials Present: Yes No

If Yes: Disturbed Soil Fill Material Impervious Layer(s) Weathered/Fractured Rock Bedrock

5. Groundwater Observed: Yes No

If Yes: Depth Weeping from Pit Varies Depth Standing Water in Hole Varies

Estimated Depth to High Groundwater: Varies (see Testpits) inches elevation



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-1

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			

Additional Notes

Excavation within buried foundation



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-2

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-42	Fill		38"								
42-60	C ₁	2.5 Y 7/6				Very Fine Sand			Single Grain	Loose	
60-108	C ₂	2.5 Y 6/6				Sandy Loam			Massive	Friable	

Additional Notes

Water Weeping @ 78", ESHGW = 38"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-3

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-22	Fill										
22-33	A	10 YR 3/2				Sandy Loam			Massive	Friable	
33-105	C ₁	2.5 Y 6/6	58"			Loamy Sand			Single Grain	Loose	

Additional Notes

Water Weeping @ 74", ESHGW=58"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-4

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-50	Fill										
50-57	A	10 YR 3/2	55"			Sandy Loam			Massive	Friable	
57-72	C ₁	2.5 Y 6/3				Coarse Sand			Single Grain	Loose	
72-106	C ₂	2.5 Y 6/3				Very Fine Loamy Sand			Single Grain	Loose	

Additional Notes

Water Weeping @ 72", ESHGW=55"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-5

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-90	Fill										
90-101	A	10 YR 3/2	90"			Sandy Loam			Massive	Friable	
101- 132	C	2.5 Y 5/6				Very Fine Loamy Sand			Single Grain	Loose	

Additional Notes

Water Standing @ 112", ESHGW=90"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-6

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-13	Fill										
13-24	A	10 YR 3/2				Sandy Loam			Massive	Friable	
24-48	Bw	10 YR 5/6	39"			Sandy Loam			Massive	Friable	
48-108	C ₁	2.5 Y 6/6				Sandy Loam			Massive	Friable	

Additional Notes

ESHGW=39"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

2. Index Well Number _____ Reading Date _____ Index Well Level _____
Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

- a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes No

b. If yes, at what depth was it observed? Upper boundary: _____ Varies _____ inches Lower boundary: _____ Varies _____ inches

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator

Date _____

Signature of Self-Evaluator:
Raymond Willis, P.E. for Onsite Engineering, Inc.

May 1996

Raymond Wills, P.E. for Onsite Engineer
Typed or Printed Name of Soil Evaluator/ license Number

*Date of Soil Evaluator Exam

Darren MacCaughey
Name of Board of Health Witness

Town of Wayland
Board of Health



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Use this sheet for field diagrams:

See Attached Plans



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

DEP has provided this form for use by on-site professionals and local Boards of Health. Other forms may be used, but the information must be substantially the same as provided here. Before using this form, check with your local Board of Health to determine the form they use.

A. Facility Information

1. Facility Information

Mahoney's Garden Center, LLC

Owner Name

115 Boston Post Road

Street Address

Wayland

City/Town

Map/Lot: Map 30, Lot 071

MA
State

01778
Zip Code

B. Site Information

1. (Check one) New Construction Upgrade Repair

2. Published Soil Survey available? Yes No If yes: _____ Year Published _____ Publication Scale _____ Soil Map Unit

Haven Urban Land Complex (MassGIS)
Soil Name

Soil limitations

3. Surficial Geological Report available? Yes No If yes: _____ Year Published _____ Publication Scale _____ Map Unit

Geologic Material

Landform

4. Flood Rate Insurance Map:

Above the 500 year flood boundary? Yes

No

Within the 100 year flood boundary? Yes

No

Within the 500 year flood boundary? Yes

No

Within a Velocity Zone? Yes

No

5. Wetland Area: National Wetland Inventory Map

Map Unit

Name

Wetlands Conservancy Program Map

Map Unit

Name



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

6. Current Water Resource Conditions (USGS) January 2017 Range: Above Normal Normal Below Normal
Month/Year

7. Other references reviewed: _____

C. On-Site Review *(minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number:

January 12, 2017
Date

AM
Time

Overcast-Sunny 50s F
Weather

1. Location

Ground Elevation at Surface of Hole Varies

Location (Identify on Plan) See Plan

2. Land Use:

Nursery
(e.g. woodland, agricultural field, vacant lot, etc.)

None
Surface Stones

3-8%
Slope (%)

Disturbed
Vegetation

Moraine
Landform

Position on landscape (attach sheet)

3. Distances from:

Open Water Body > 100
feet

Drainage Way > 100
feet

Possible Wet Area > 100
feet

Property Line > 10
feet

Drinking Water Well > 100
feet

Other
feet

4. Parent Material:

Ice Contact Outwash

Unsuitable Materials Present: Yes No

If Yes: Disturbed Soil Fill Material Impervious Layer(s) Weathered/Fractured Rock Bedrock

5. Groundwater Observed:

Yes No

If Yes: Depth Weeping from Pit Varies Depth Standing Water in Hole Varies

Estimated Depth to High Groundwater: Varies (see Testpits)
inches elevation



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-7

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-24	Fill										
24-36	C ₁	2.5 Y 7/6				Coarse Sand & Gravel		>5%	Single Grain	Loose	Gravel
36-156	C ₂	2.5 Y 7/4	42"			Coarse Sand & Gravel		>5%	Single Grain	Loose	Gravel

Additional Notes

Water Standing @ 53", ESHGW @ 42"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-8

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-44	Fill		34"								
44-66	C ₁	2.5 Y 7/4				Coarse Sand & Gravel		>5%	Single Grain	Loose	Gravel
66-120	C ₂	2.5 Y 6/4				Medium Sand			Single Grain	Loose	

Additional Notes

Water Standing @ 54", ESHGW = 34"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-9

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12	Fill					Medium Sand					
12-24	C ₁	2.5 Y 7/6				Coarse Sand & Gravel		>5%	Single Grain	Loose	
24-120	C ₂	2.5 Y 7/4	31"						Single Grain	Loose	Gravel

Additional Notes

Water Standing @ 53", ESHGW=31"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-10

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-25	Fill										
25-45	C ₁	2.5 Y 7/4				Coarse Sand & Gravel			Single Grain	Loose	
45	R										

Additional Notes

No Water, No Mottles



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-11

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-15	Fill										
15-55	C ₁	10 YR 5/6	36"			Loamy Sand			Single Grain	Loose	
55-101	C ₂	2.5 Y 6/4				Coarse Sand & Gravel		>5%	Single Grain	Loose	Gravel
101- 132	C ₃	2.5 Y 6/4				Medium Sand			Single Grain	Loose	

Additional Notes

Water Standing @ 60", ESHGW=36"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-12

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-32	Fill										
32-82	C ₁	2.5 Y 6/6	57"			Sandy Loam			Single Grain	Loose	
82-144	C ₂	2.5 Y 6/6				Sandy Loam		>5%	Single Grain	Loose	Gravel
144	R										Rock or Large Boulder

Additional Notes

Water Weeping @ 77", ESHGW=57"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-13

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-34	Fill										
34-54	C ₁	2.5 Y 7/4	54"			Very Fine Loamy Sand			Single Grain	Loose	
54-125	C ₂	2.5 Y 6/6				Sandy Loam			Massive	Friable	
125	R										

Additional Notes

Water Weeping @ 96", ESHGW=54"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-14

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-30	Fill										
30-120	C ₁	2.5 Y 7/4	36"			Very Fine Loamy Sand			Single Grain	Loose	

Additional Notes

Water Standing @ 58", ESHGW=36"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-15

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-65	Fill		60"			Very Fine Loamy Sand					
65-72	C ₁	2.5 Y 7/4				Coarse Sand & Gravel		>5%	Single Grain	Loose	
72-120	C ₂	2.5 Y 6/4							Single Grain	Loose	Gravel

Additional Notes

Water Standing @ 65", ESHGW=60"



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-16

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)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-39	Fill										
39-98	C ₁	2.5 Y 6/6				Sandy Loam			Massive	Friable	

Additional Notes

No water, west side of hold has 57" of fill.



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method used:
 - Depth observed standing water in observation hole A. Varies B. inches
 - Depth weeping from side of observation hole A. Varies B. inches
 - Depth to soil redoximorphic features (mottles) A. Varies B. inches
 - Groundwater adjustment (USGS methodology) A. B. inches
2. Index Well Number _____ Reading Date _____ Index Well Level _____
Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material
 - a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes No
 - b. If yes, at what depth was it observed? Upper boundary: Varies inches Lower boundary: Varies inches

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator _____

Date _____

Raymond Willis, P.E. for Onsite Engineering, Inc. _____

May 1996 _____

Typed or Printed Name of Soil Evaluator/License Number _____

*Date of Soil Evaluator Exam _____

Name of Board of Health Witness _____

Town of Wayland _____
Board of Health _____



Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Use this sheet for field diagrams:

See Attached Plans

DRAFT



BEALS + THOMAS

Soil Test Pit Log

2841.00 – Wayland, Massachusetts

Date: November 14, 2017

Deep Observation Hole Number: TP-1A

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap1	10YR2.5/1				SL	50%	50%*			Fill
6-15	Ap2	10YR2.5/1				SL	50%				Fill
15-28	B?	7.5YR3/3				SL					Fill?
28-40	C1	10YR3/2				SL					
40-120	C2	10YR3/2	42±		10%	LS	50%	25%			

Additional Notes:

Ground surface elevation, 157.5'±. Groundwater observed at 51"±.

*Peastone



BEALS + THOMAS

Soil Test Pit Log

2841.00 – Wayland, Massachusetts

Date: November 14, 2017

Deep Observation Hole Number: TP-1B

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap1	10YR2.5/1				-	50%	50%*			Fill
6-16	B?	10YR2.5/1				SL	50%				Fill?
16-27	C1	10YR3/4				LS		25%			
27-42	C2	10YR3/4				LS		25%			
42-120	C3	10YR4/2	42±		10%	SL		25%			

Additional Notes:

Ground surface elevation, 159.5'±. Groundwater observed at 42"±.

*Peastone



BEALS + THOMAS

Soil Test Pit Log

2841.00 – Wayland, Massachusetts

Date: November 14, 2017

Deep Observation Hole Number:

TP-2

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-10	Parking	-				-	-				Lot/Gravel
10-26	Fill					LS					Fill
26-42	Fill					LS					Fill
42-46	A					-					Roots
46-66	B					SL					
66-100	C					FSL				Firm	

Additional Notes:

Ground surface elevation, 160.1'. No groundwater observed.



BEALS + THOMAS

Soil Test Pit Log

2841.00 – Wayland, Massachusetts

Date: November 14, 2017

Deep Observation Hole Number:

TP-3

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-8	Gravel					-					Lot
8-12	B					LS		25%			
12-33	C1	7.5YR4/4	39±		10%	SL					
33-84	C2	7.5YR3/2				SL					

Additional Notes:

Ground surface elevation, 163.2'±. Groundwater observed between 80"± to 83"±.



BEALS + THOMAS

Soil Test Pit Log

2841.00 – Wayland, Massachusetts

Date: November 14, 2017

Deep Observation Hole Number:

TP-4

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Gravel	-				-					Lot
6-30	B	7.5YR3/4				LS	25%				Fill?
30-58	C1	10YR6/2	39±		10%	LS				Firm	
58-96	C2	10YR6/2				LS					Till?

Additional Notes:

Ground surface elevation, 166.2'±. Groundwater observed at 92"±.



BEALS + THOMAS

Soil Test Pit Log

2841.00 – Wayland, Massachusetts

Date: November 14, 2017

Deep Observation Hole Number: TP-5

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Gravel										
6-28	B?										Fill?
28-120	C										

Additional Notes:

Ground surface elevation, 168.8'±. Groundwater observed at 84"±. TP for groundwater/refusal.



BEALS + THOMAS

Soil Test Pit Log

2841.01 – Wayland, MA

Date: 12/22/2017
TJS

Observation Hole Number: # / _____

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)		Redoximorphic Features		Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistency (Moist)	Other
		Depth	Color	Percent	Gravel					
0 - 4	-	-	-	-	-	-	90%	10%	MED "COARSE PEBBLES"	-
4 - 12	-	10 YR 5/6	-	-	SAND	10%	5%	SAND w/ SPECKLES	-	Gravel/ FILL

Additional Notes:

water + electric utilities observed running under the man-made
drainage ditches within the Green house,
Cobbles + Boulders (rocks larger than >10.1") observed @ 12"



BEEALS + THOMAS

Soil Test Pit Log

2841.01 – Wayland, MA

Date: 12/22/2017
TJS

Deep Observation Hole Number:

2

Additional Notes:

additional Notes:
Layer of Bennett Potting Soil / Sandy Loam in upper 3" w/ grass growing
at surface, underlaid by Fill / Gravel.



2841.01 - Wayland, MA

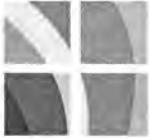
Soil Test Pit Log

Date: 12/22/2017
TJSObservation Hole Number: #3

Depth (in.)	Soil Horizon/ Layer	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistency (Moist)	Other
		Depth	Color	Percent					
0 - 4	-	7.5 YR 2.5/1	-	-	-	10%	LOAMY SAND	-	INHIBITED POTENTIAL
4 - 9	-	-	-	-	-	100%	MED-FINE PEBBLES	-	FILL

Additional Notes:

Layer of Remnant Potting Soil / Sandy Loam in upper 4" w/ grass growing at surface, underlaid by 5-11" Gravel.
Resistance @ 9" Due to Compacted Cobble + Large Rocks.



BEALS + THOMAS

Soil Test Pit Log

2841.01 - Wayland, MA

Date: 12/22/2017 TJS

4

Deep Observation Hole Number:

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Consistence (Moist)	Other
			Depth	Color	Percent					
0 - 2	-	7.5YR 2.5/1	-	-	-	-	10%	Loamy Sand	-	Intra bedded Wet soil
2 - 9	-	-	-	-	-	-	10%	MED-COARSE PEBBLES	-	FILL

Additional Notes:

Layer of Remnant Savanah Loam in Upper 2' with Grass at Surface, Compacted Fill Pebbles/Gravel

**BEALS + THOMAS**

Soil Test Pit Log

2841.01 – Wayland, MA

Date: 12/22/2017
JJSDeep Observation Hole Number: #5

Depth (in.)	Soil Horizon/ Layer	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
		Depth	Color	Percent					
0-8	-	-	-	-	-	10%	MED-COARSE PEBBLES	-	Fill
8-13	-	2.5 Y 4/4	-	-	-	25%	COARSE-MED FINE SAND	-	PEBBLES MIXED IN

Additional Notes:

SANDY GRavel + Fill



Soil Test Pit Log

2841.01 - Wayland, MA

Date: 12/22/2017

Deep Observation Hole Number: #6

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)		Redoximorphic Features		Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure Cobbles & Stones	Soil Consistency (Moist)	Other
		Depth	Color	Percent	Gravel					
1/4 - 0	O	-	-	-	-	-	5%	-	-	Organic/DUFF
0 - 5	A	10 YR 3/3	-	-	-	-	5%	-	-	MED-COMM Loamy Sand
5 - 14	B	10 YR 4/6	-	-	-	-	-	-	-	MED Sand

Additional Notes:

OBSERVATION West of a Hemlock tree, + south of gravel driveway, in a
Grassy Area.



BEALS + THOMAS

Soil Test Pit Log

2841.01 – Wayland, MA

Date: 12/22/2017
#75

Bore Observation Hole Number: 7

Depth (in.)	Soil Horizon/ Layer	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure Cobbles & Stones	Soil Consistency (Moist)	Other
		Depth	Color	Percent		Gravel	Cobbles			
0 - 9	-	2.5 Y 4/3	-	-	-	75%	SANDY GRAVEL	-	-	COARSE- PEBBLES

Additional Notes:

GRAVEL, PEBBLES mixed with SAND + some COBBLES.



BEALS + THOMASS

Soil Test Pit Log

2841.01 - Wayland, MA

Date: 12/22/2017
TJS

Deep Observation Hole Number: # 8

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)		Redoximorphic Features			Soil Texture (USDA)		Coarse Fragments % by Volume		Soil Structure Cobbles & Stones	Soil Consistency (Moist)	Other
		Depth	Color	Percent	Gravel	Cobbles	Stones						
0 - 9	-	-	-	-	-	-	-	90%	10%	VERY COARSE PIBBLES	-	<i>COBBLERS + GRAVEL</i>	
9 - 12	-	10 YR 3/3	-	-	-	-	-	50%	50%	MED - SANDY PEBBLES	-	<i>FILL -</i>	

Additional Notes:

GRAVEL, PEBBLES + SANDY FILL.



Soil Test Pit Log

2841.01 – Wayland, MA

Date: 12/22/2017
TJS

Boop Observation Hole Number: #9

Depth (in.)	Soil Horizon/ Soil Matrix: Color-Moist (Munsell)		Redoximorphic Features		Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
	Layer	Color	Depth	Percent					
0 - 2	-	-	-	-	-	10%	COARSE- MEDIUM PEBBLES	-	COMPRESSED PEBBLES
2 - 6	-	2.5YR 5/6	-	-	-	50%	VERY COARSE HEAVY SAND	-	DEB-FINE PEBBLES SAND
6 - 12	-	10YR 3/2	-	-	-	10%	LOAMY, BROWN SAND	-	BURNED OR MIXED FIN

Additional Notes:

DISTURBED FILL AREA TAPPED with GRAVEL + PEbbLES.



2841.01 – Wayland, MA

Date: 12/22/2017
TJS

Observation Hole Number: # 10

Depth (in.)	Soil Horizon/ Layer	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Consistence (Moist)	Other
		Depth	Color	Percent					
0 - 2"	-	-	-	-	-	100%	COARCE-PED PEBBLES	-	COMPRESSED FILL + PEBBLES
2 - 14"	-	10YR 4/4	-	-	-	50%	MED-FINE PEBBLES + MEDIUM SAND	-	SMALL COBBLES + SANDY GRAVEL FILL

Additional Notes:

GRAVEL + SANDY FILL



BEALS + THOMAS

Soil Test Pit Log

2841.01 - Wayland, MA

Date: 12/22/2017

一一

Deep Observation Hole Number:

Additional Notes:

GRAVEL + SANDY FILL



Soil Test Pit Log

2841.01 – Wayland, MA

Date: 12/22/2017
TJS

Drop Observation Hole Number:

12

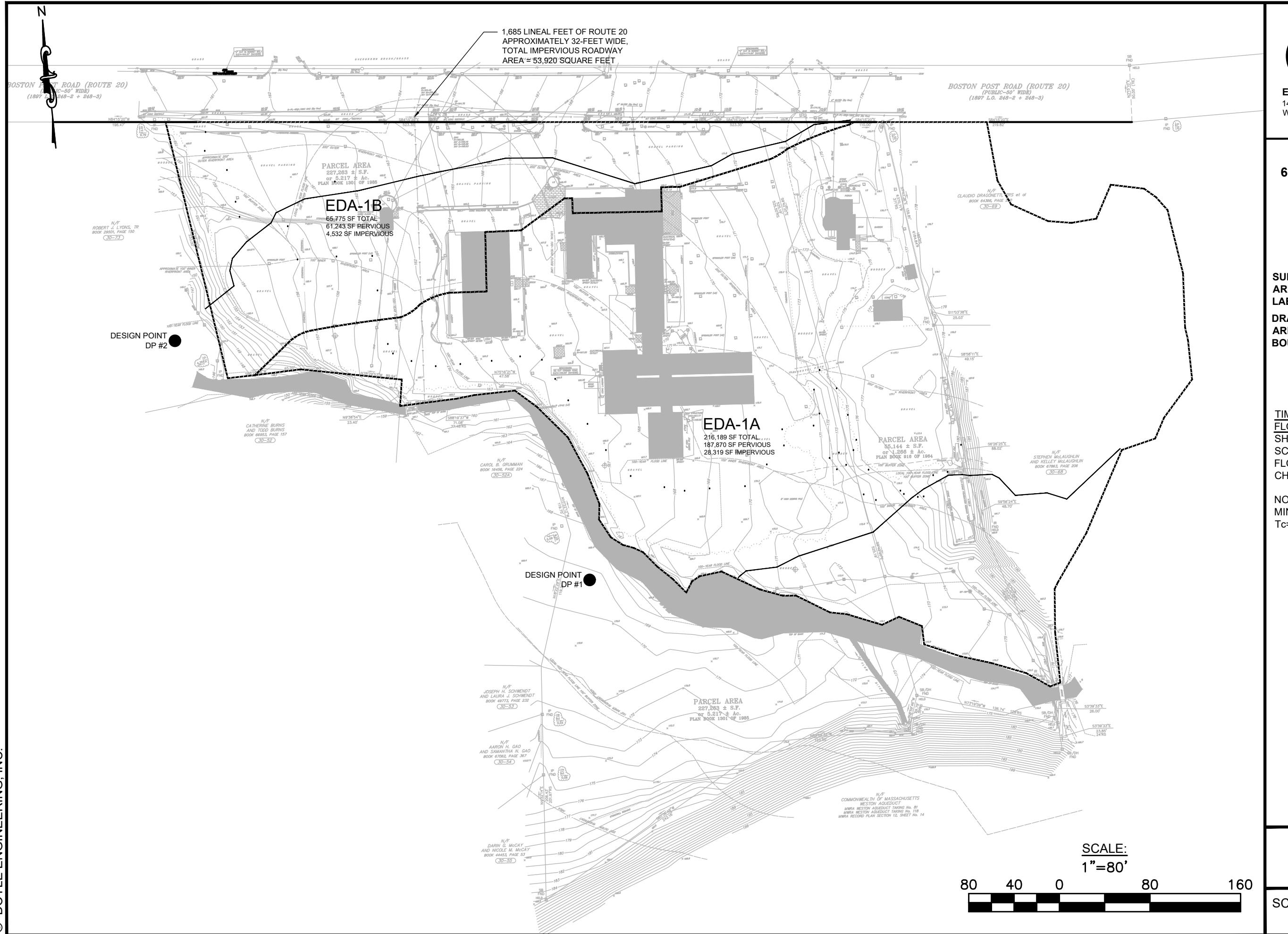
Depth (in.)	Soil Horizon/ Layer	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
		Depth	Color	Percent					
1-0	O	~	~	~	-	-	-	-	DUSTY mud
0-9	A	10 YR 3/3	~	~	-	-	-	LOAMY SAND	Roots
9-13	B	25 YR 4/6	~	~	-	-	-	SAND	-

Additional Notes:

OBSERVATION Within tree line, southeastern portion of property.

APPENDIX B

Pre-Development Hydrologic Analysis



C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

**667 WELLESLEY STREET
WESTON, MA**

Watershed Plan

**SUB
AREA
LABEL**

**DRAINAGE
AREA
BOUNDARY**



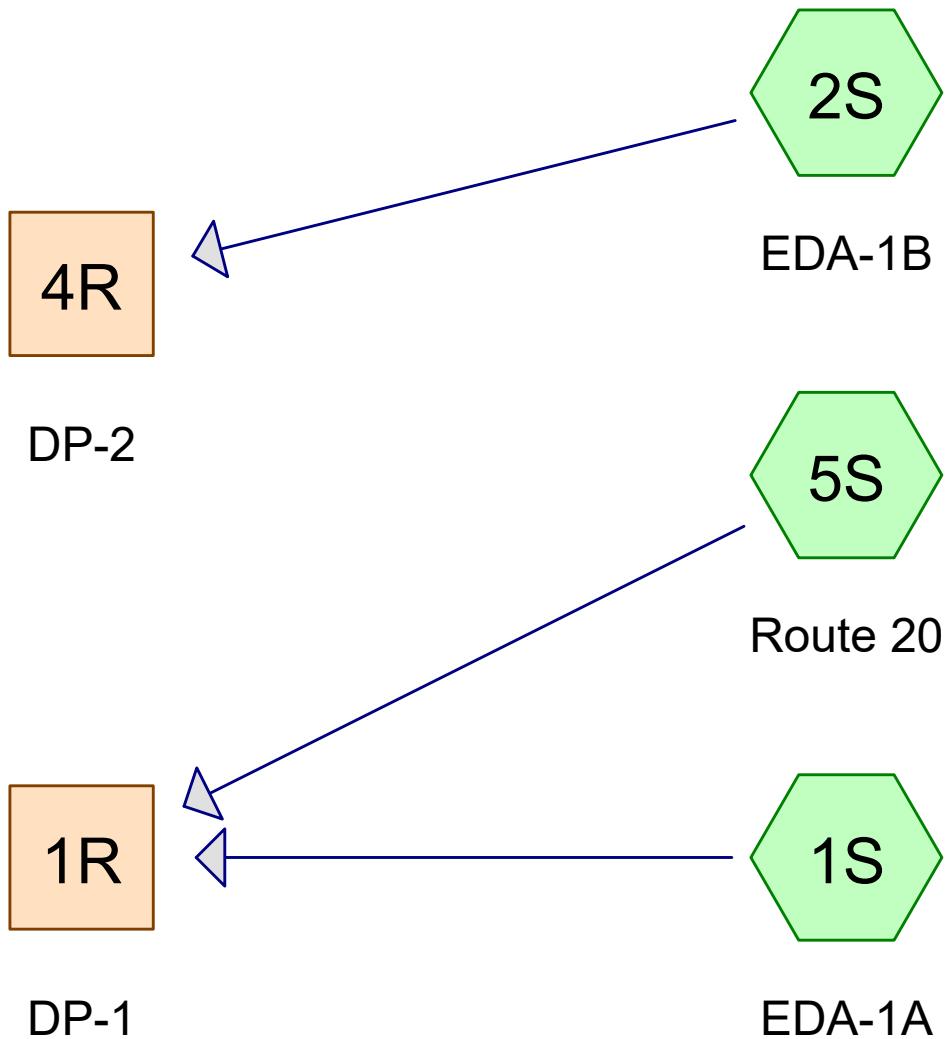
EX-1

TIME OF CONCENTRATION
LOW TYPES:
HEET - SHEET FLOW
C - SHALLOW CONCENTRATED
LOW
CHANNEL - CHANNEL FLOW

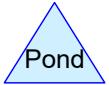
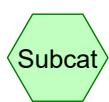
NOTE: IF Tc IS LESS THAN 5
MINUTES, USE 5 MINUTES (MIN.
 $T_c = 5$ MINUTES)

EXISTING

SCALE: 1"=80' FIG. 2



Pre-Development Conditions



Routing Diagram for Existing
Prepared by {enter your company name here}, Printed 5/15/2021
HydroCAD® 10.00-25 s/n 07330 © 2019 HydroCAD Software Solutions LLC

Existing

Prepared by {enter your company name here}
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Printed 5/15/2021

Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.427	61	>75% Grass cover, Good, HSG B (1S, 2S)
3.292	85	Gravel roads, HSG B (1S, 2S)
1.238	98	Paved parking, HSG B (5S)
0.059	98	Unconnected pavement, HSG B (2S)
0.655	98	Unconnected roofs, HSG B (1S, 2S)
0.040	98	Walkway, HSG B (1S)
1.798	55	Woods, Good, HSG B (1S, 2S)
0.203	77	Woods, Good, HSG D (1S)
7.711	80	TOTAL AREA

Existing

Prepared by {enter your company name here}

HydroCAD® 10.00-25 s/n 07330 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr Middlesex-002yr Rainfall=3.10"

Printed 5/15/2021

Page 3

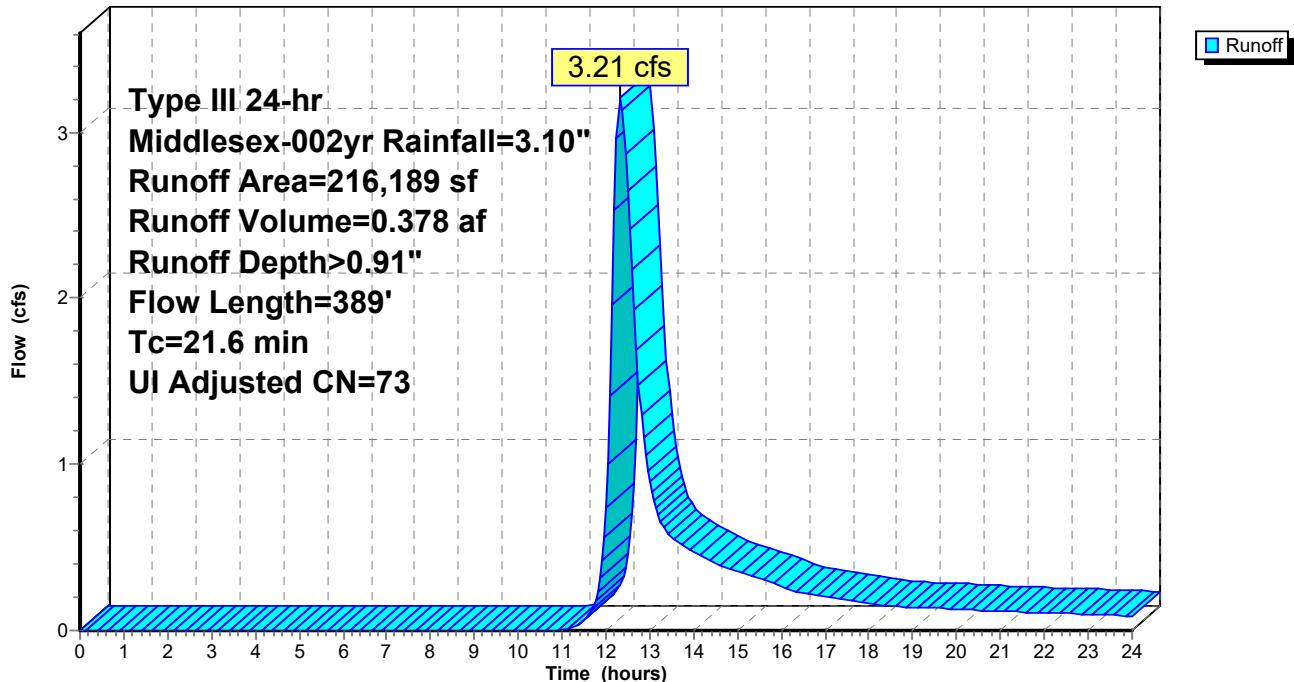
Summary for Subcatchment 1S: EDA-1A

Runoff = 3.21 cfs @ 12.33 hrs, Volume= 0.378 af, Depth> 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Adj	Description
*			
1,741	98		Walkway, HSG B
90,478	85		Gravel roads, HSG B
14,899	61		>75% Grass cover, Good, HSG B
73,671	55		Woods, Good, HSG B
8,822	77		Woods, Good, HSG D
26,578	98		Unconnected roofs, HSG B
216,189	74	73	Weighted Average, UI Adjusted
187,870			86.90% Pervious Area
28,319			13.10% Impervious Area
26,578			93.85% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.3	50	0.0350	0.05		Sheet Flow, sf1 Woods: Dense underbrush n= 0.800 P2= 3.15"
0.7	56	0.0625	1.25		Shallow Concentrated Flow, scf1 Woodland Kv= 5.0 fps
0.3	55	0.2400	3.43		Shallow Concentrated Flow, scf2 Short Grass Pasture Kv= 7.0 fps
3.3	228	0.0530	1.15		Shallow Concentrated Flow, scf3 Woodland Kv= 5.0 fps
21.6	389	Total			

Subcatchment 1S: EDA-1A**Hydrograph**

Existing

Prepared by {enter your company name here}

HydroCAD® 10.00-25 s/n 07330 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr Middlesex-002yr Rainfall=3.10"

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Page 5

Summary for Subcatchment 2S: EDA-1B

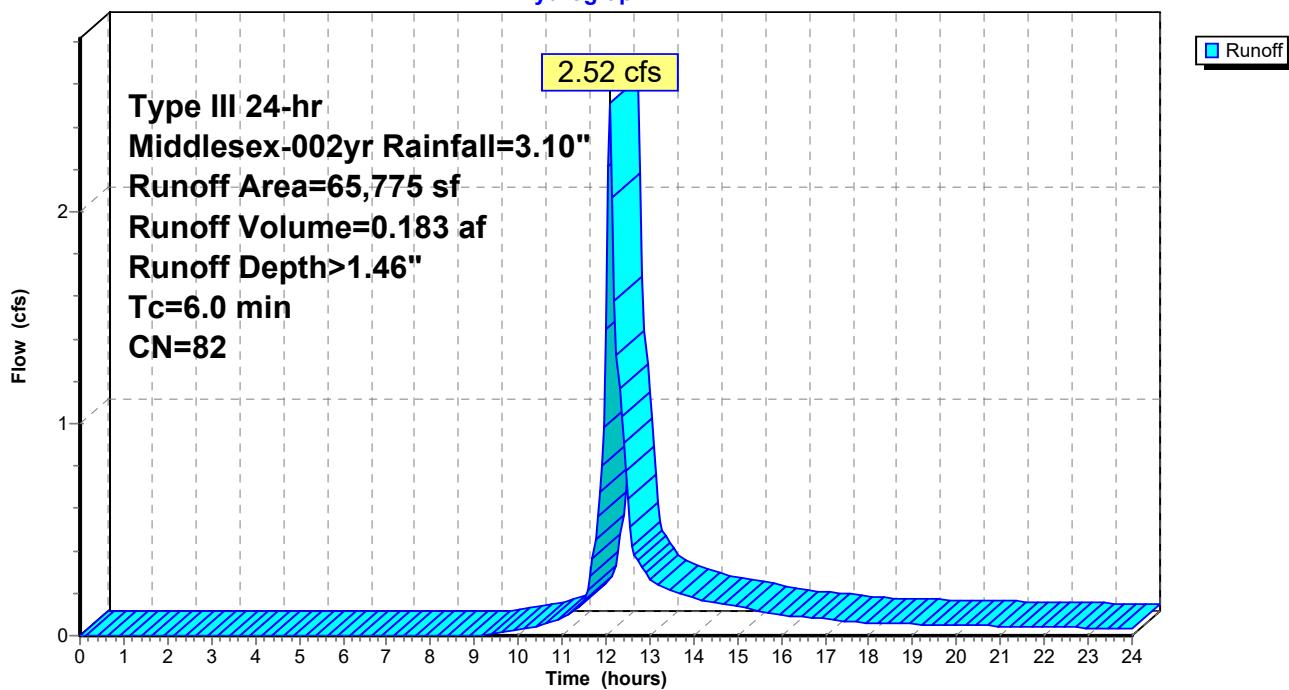
Runoff = 2.52 cfs @ 12.09 hrs, Volume= 0.183 af, Depth> 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description			
3,687	61	>75% Grass cover, Good, HSG B			
2,564	98	Unconnected pavement, HSG B			
1,968	98	Unconnected roofs, HSG B			
52,925	85	Gravel roads, HSG B			
4,631	55	Woods, Good, HSG B			
65,775	82	Weighted Average			
61,243		93.11% Pervious Area			
4,532		6.89% Impervious Area			
4,532		100.00% Unconnected			
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, min

Subcatchment 2S: EDA-1B

Hydrograph



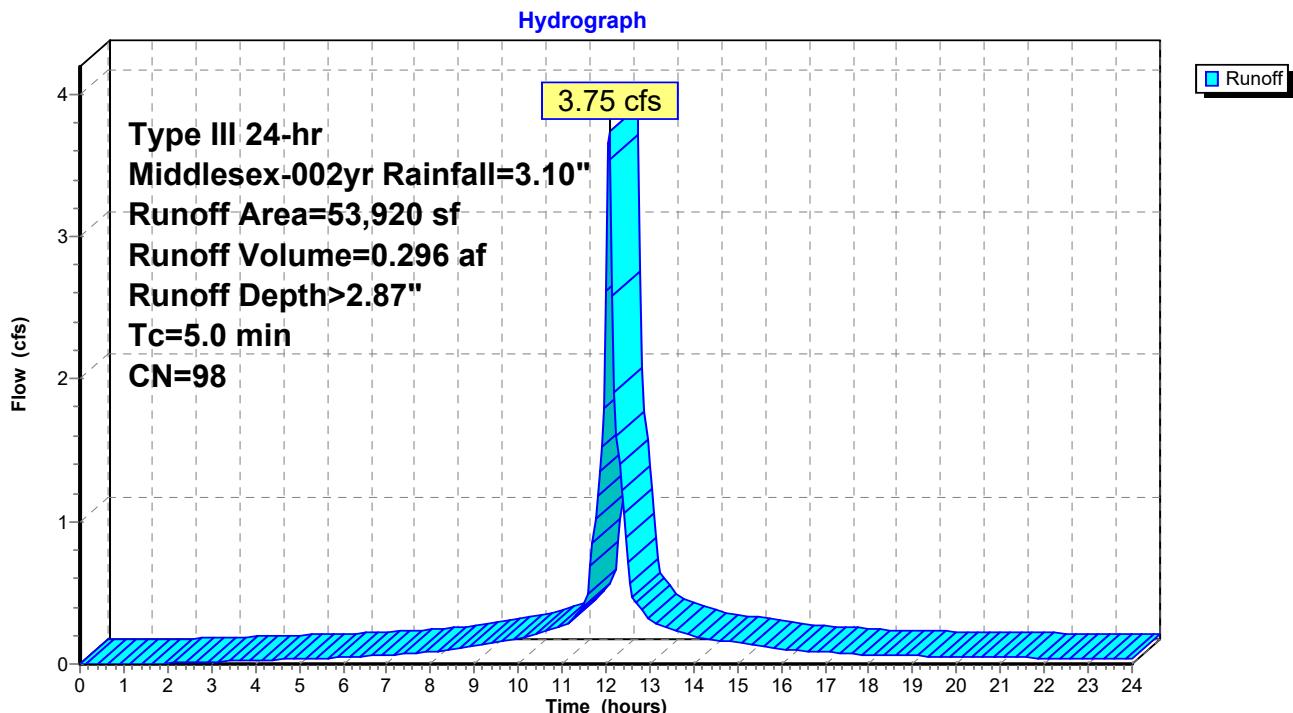
Summary for Subcatchment 5S: Route 20

Runoff = 3.75 cfs @ 12.07 hrs, Volume= 0.296 af, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
53,920	98	Paved parking, HSG B
53,920		100.00% Impervious Area

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

Subcatchment 5S: Route 20

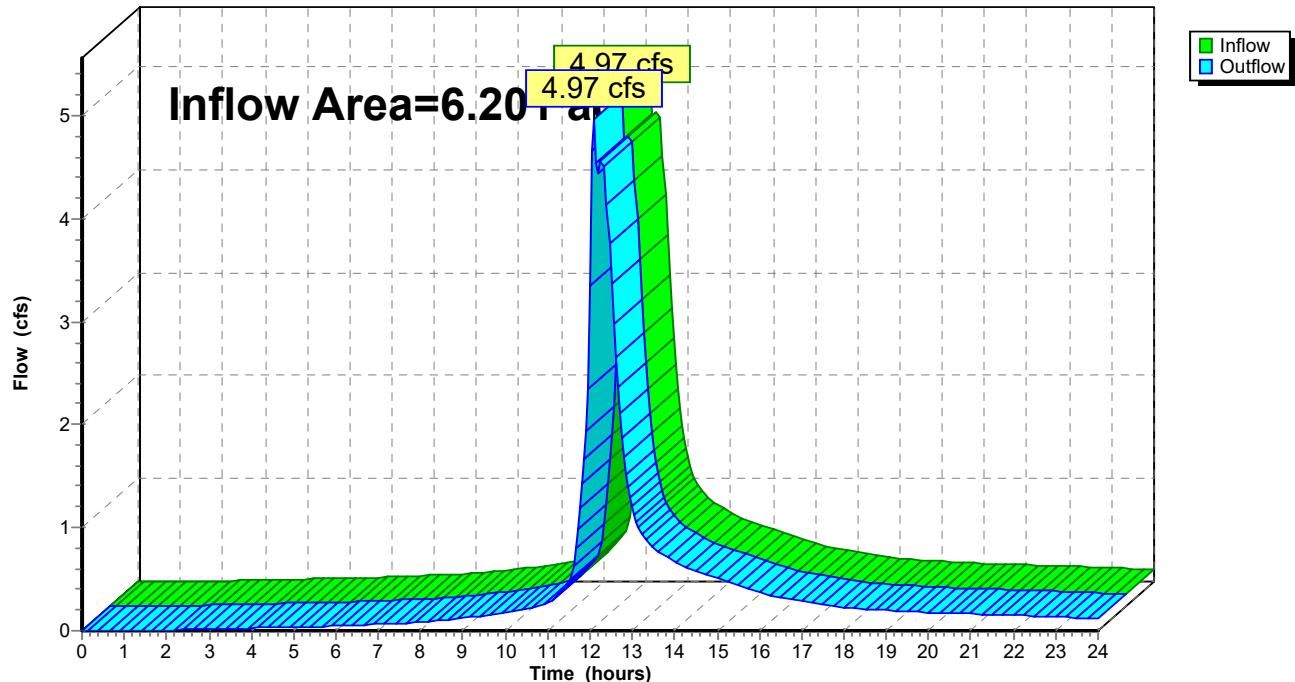
Summary for Reach 1R: DP-1

Inflow Area = 6.201 ac, 30.45% Impervious, Inflow Depth > 1.30" for Middlesex-002yr event

Inflow = 4.97 cfs @ 12.10 hrs, Volume= 0.674 af

Outflow = 4.97 cfs @ 12.10 hrs, Volume= 0.674 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 1R: DP-1**Hydrograph**

Summary for Reach 4R: DP-2

Inflow Area = 1.510 ac, 6.89% Impervious, Inflow Depth > 1.46" for Middlesex-002yr event

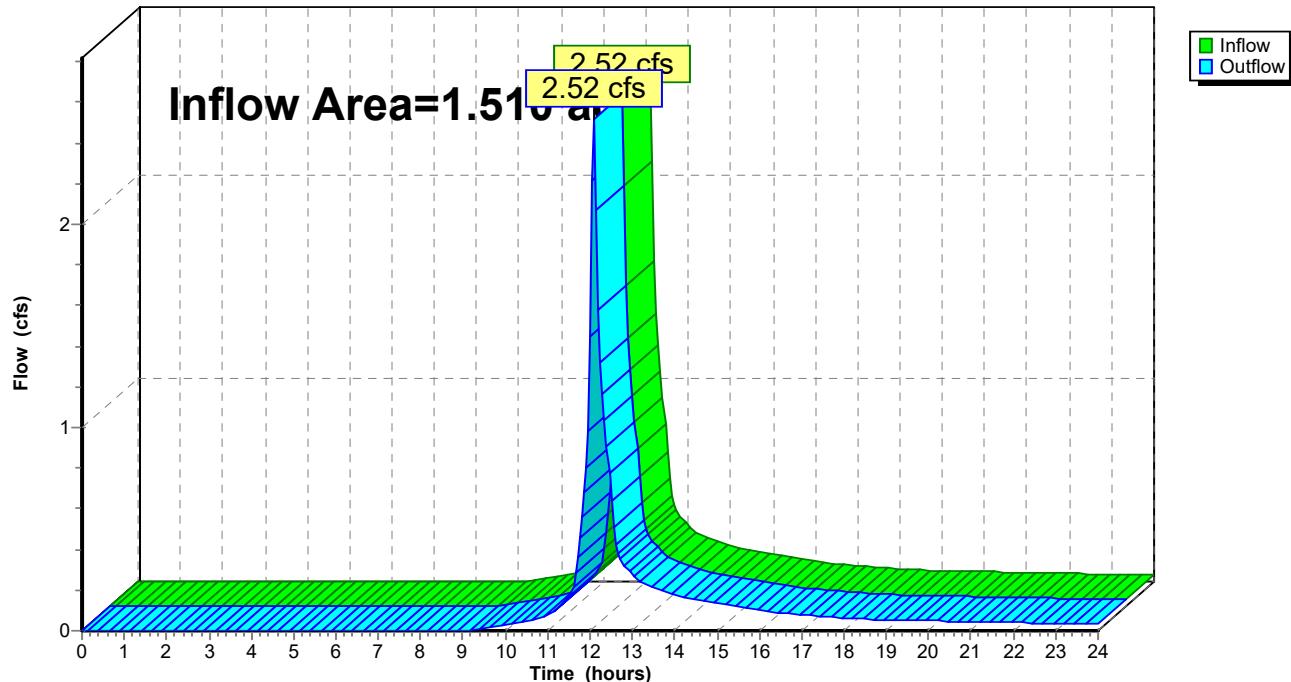
Inflow = 2.52 cfs @ 12.09 hrs, Volume= 0.183 af

Outflow = 2.52 cfs @ 12.09 hrs, Volume= 0.183 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 4R: DP-2

Hydrograph



Existing

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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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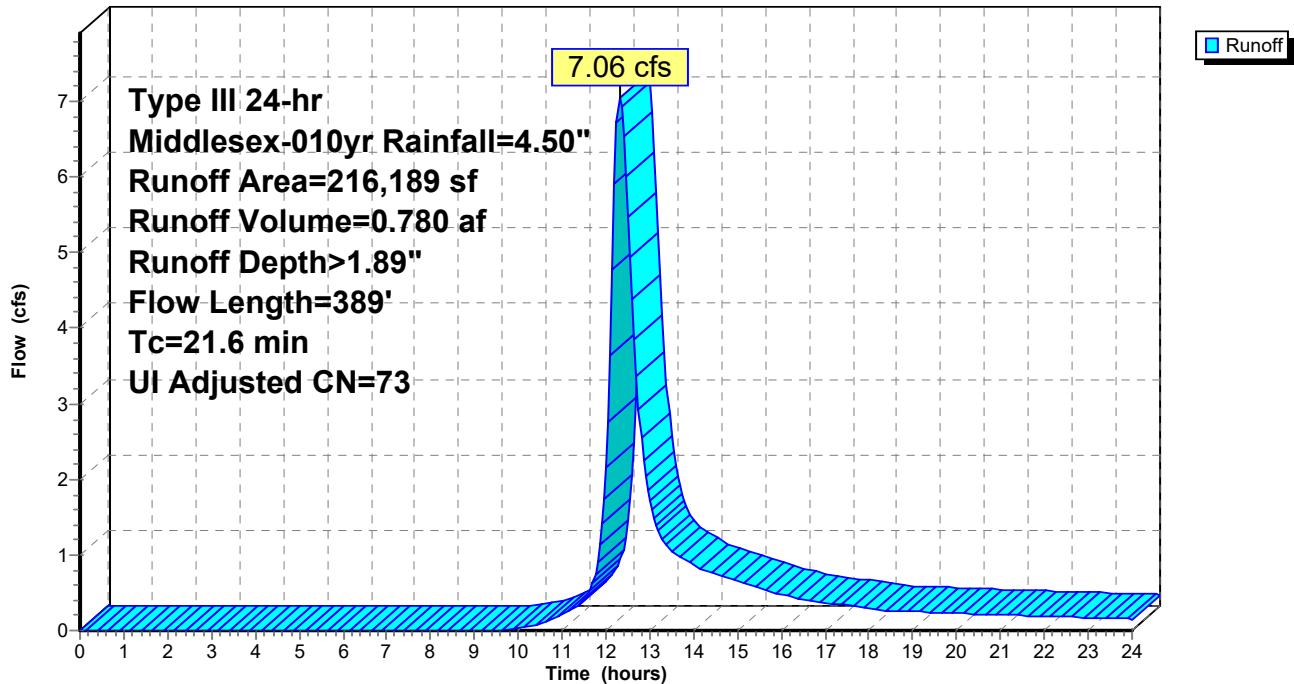
Summary for Subcatchment 1S: EDA-1A

Runoff = 7.06 cfs @ 12.31 hrs, Volume= 0.780 af, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Adj	Description
*			
1,741	98		Walkway, HSG B
90,478	85		Gravel roads, HSG B
14,899	61		>75% Grass cover, Good, HSG B
73,671	55		Woods, Good, HSG B
8,822	77		Woods, Good, HSG D
26,578	98		Unconnected roofs, HSG B
216,189	74	73	Weighted Average, UI Adjusted
187,870			86.90% Pervious Area
28,319			13.10% Impervious Area
26,578			93.85% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.3	50	0.0350	0.05		Sheet Flow, sf1 Woods: Dense underbrush n= 0.800 P2= 3.15"
0.7	56	0.0625	1.25		Shallow Concentrated Flow, scf1 Woodland Kv= 5.0 fps
0.3	55	0.2400	3.43		Shallow Concentrated Flow, scf2 Short Grass Pasture Kv= 7.0 fps
3.3	228	0.0530	1.15		Shallow Concentrated Flow, scf3 Woodland Kv= 5.0 fps
21.6	389	Total			

Subcatchment 1S: EDA-1A**Hydrograph**

Existing

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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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Summary for Subcatchment 2S: EDA-1B

Runoff = 4.57 cfs @ 12.09 hrs, Volume= 0.331 af, Depth> 2.63"

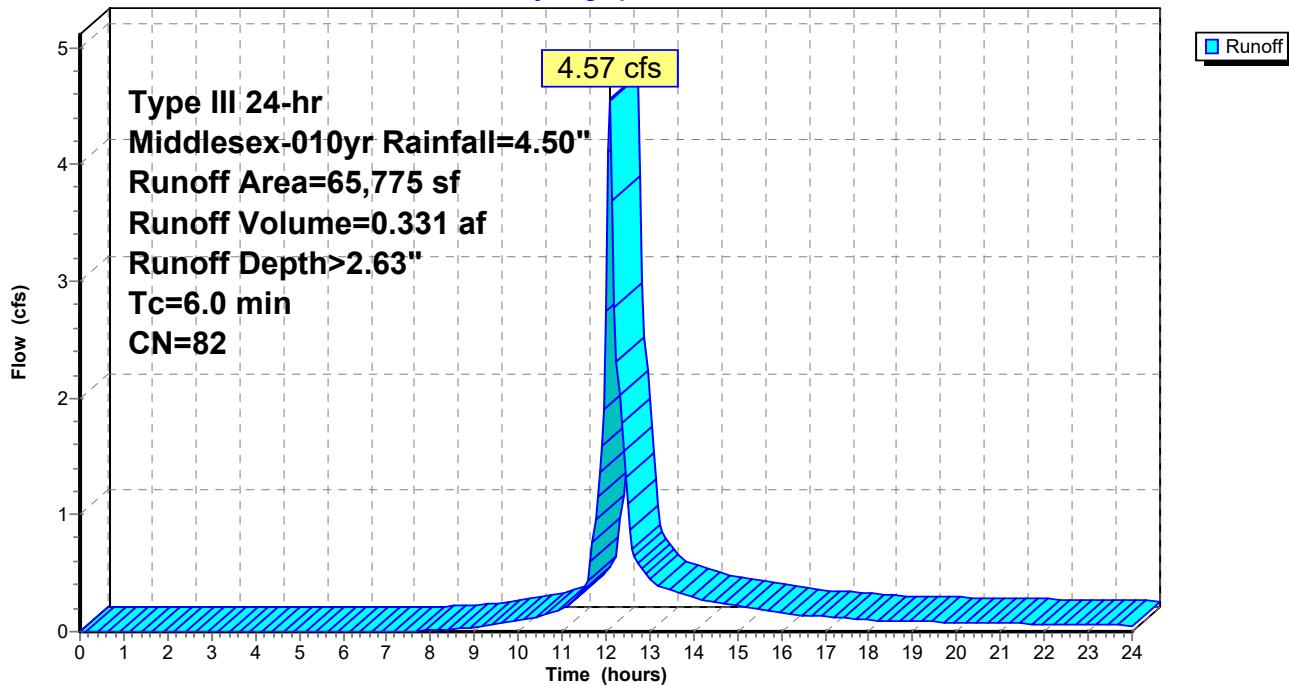
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
3,687	61	>75% Grass cover, Good, HSG B
2,564	98	Unconnected pavement, HSG B
1,968	98	Unconnected roofs, HSG B
52,925	85	Gravel roads, HSG B
4,631	55	Woods, Good, HSG B
65,775	82	Weighted Average
61,243		93.11% Pervious Area
4,532		6.89% Impervious Area
4,532		100.00% Unconnected

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

Subcatchment 2S: EDA-1B

Hydrograph



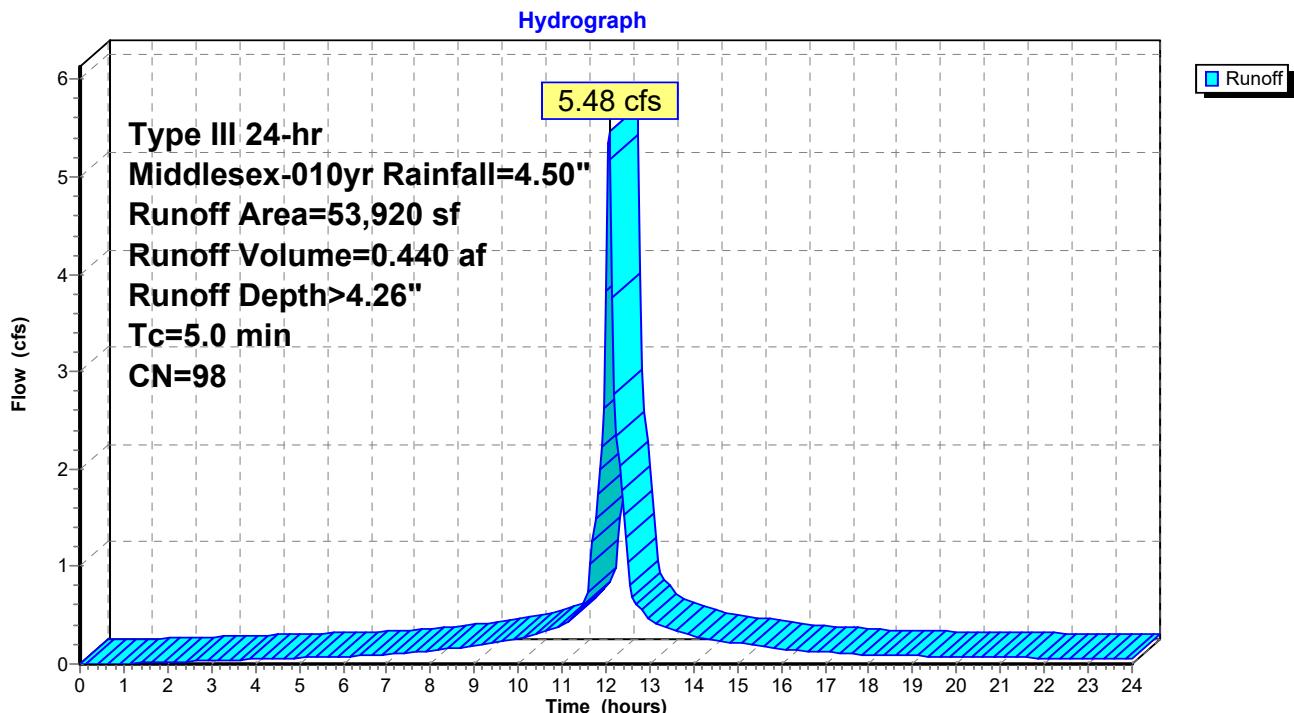
Summary for Subcatchment 5S: Route 20

Runoff = 5.48 cfs @ 12.07 hrs, Volume= 0.440 af, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
53,920	98	Paved parking, HSG B
53,920		100.00% Impervious Area

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

Subcatchment 5S: Route 20

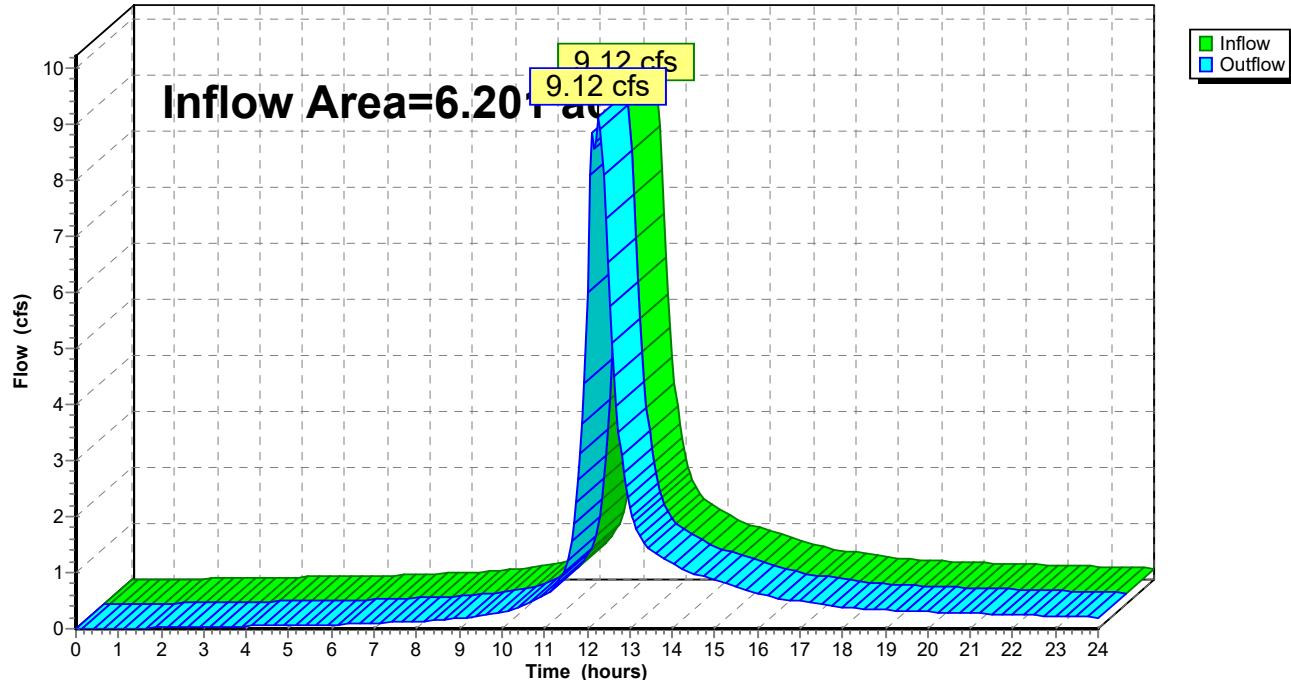
Summary for Reach 1R: DP-1

Inflow Area = 6.201 ac, 30.45% Impervious, Inflow Depth > 2.36" for Middlesex-010yr event

Inflow = 9.12 cfs @ 12.28 hrs, Volume= 1.220 af

Outflow = 9.12 cfs @ 12.28 hrs, Volume= 1.220 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 1R: DP-1**Hydrograph**

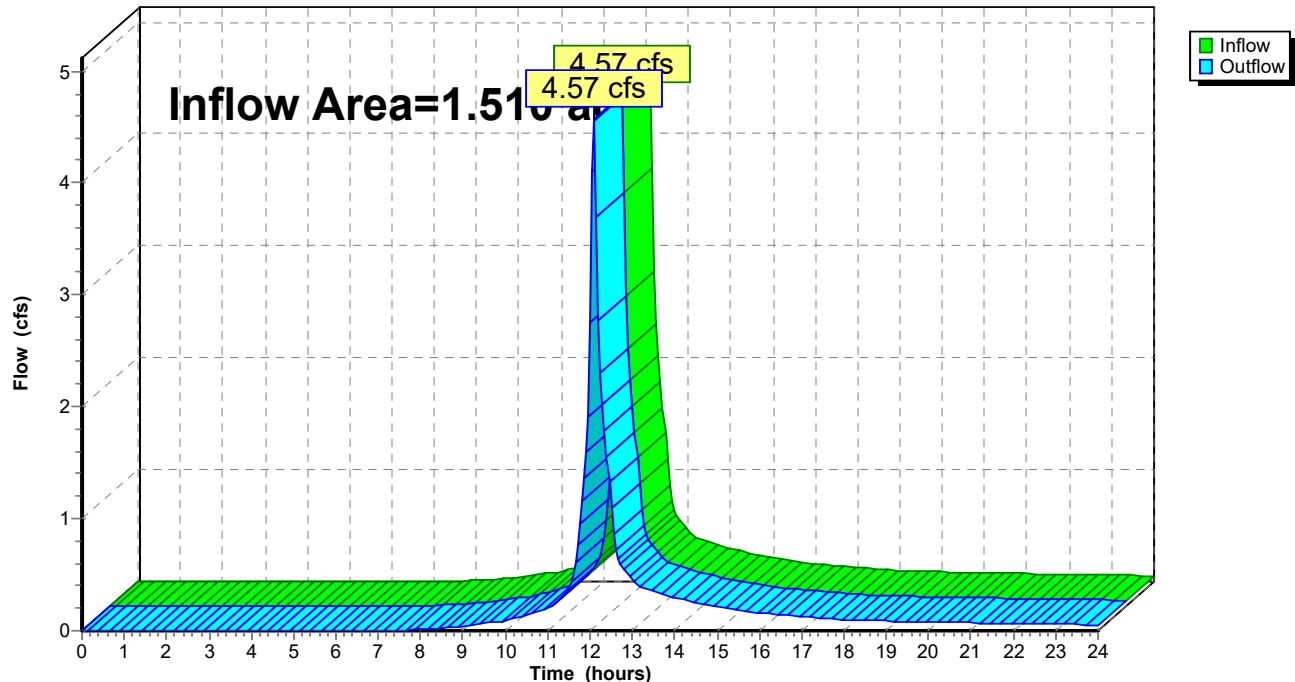
Summary for Reach 4R: DP-2

Inflow Area = 1.510 ac, 6.89% Impervious, Inflow Depth > 2.63" for Middlesex-010yr event

Inflow = 4.57 cfs @ 12.09 hrs, Volume= 0.331 af

Outflow = 4.57 cfs @ 12.09 hrs, Volume= 0.331 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 4R: DP-2**Hydrograph**

Existing

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Type III 24-hr Middlesex-100yr Rainfall=7.00"

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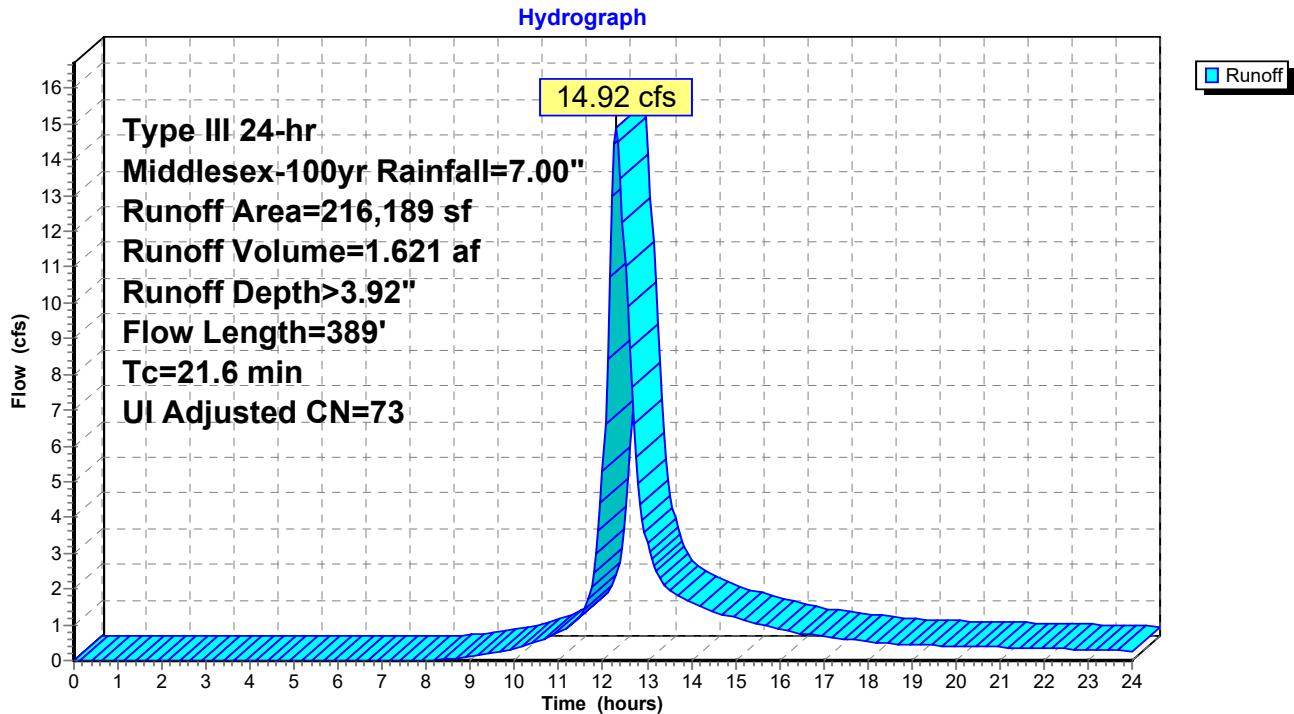
Summary for Subcatchment 1S: EDA-1A

Runoff = 14.92 cfs @ 12.30 hrs, Volume= 1.621 af, Depth> 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Adj	Description
*			
1,741	98		Walkway, HSG B
90,478	85		Gravel roads, HSG B
14,899	61		>75% Grass cover, Good, HSG B
73,671	55		Woods, Good, HSG B
8,822	77		Woods, Good, HSG D
26,578	98		Unconnected roofs, HSG B
216,189	74	73	Weighted Average, UI Adjusted
187,870			86.90% Pervious Area
28,319			13.10% Impervious Area
26,578			93.85% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.3	50	0.0350	0.05		Sheet Flow, sf1 Woods: Dense underbrush n= 0.800 P2= 3.15"
0.7	56	0.0625	1.25		Shallow Concentrated Flow, scf1 Woodland Kv= 5.0 fps
0.3	55	0.2400	3.43		Shallow Concentrated Flow, scf2 Short Grass Pasture Kv= 7.0 fps
3.3	228	0.0530	1.15		Shallow Concentrated Flow, scf3 Woodland Kv= 5.0 fps
21.6	389	Total			

Subcatchment 1S: EDA-1A

Existing

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Type III 24-hr Middlesex-100yr Rainfall=7.00"

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Summary for Subcatchment 2S: EDA-1B

Runoff = 8.38 cfs @ 12.09 hrs, Volume= 0.618 af, Depth> 4.91"

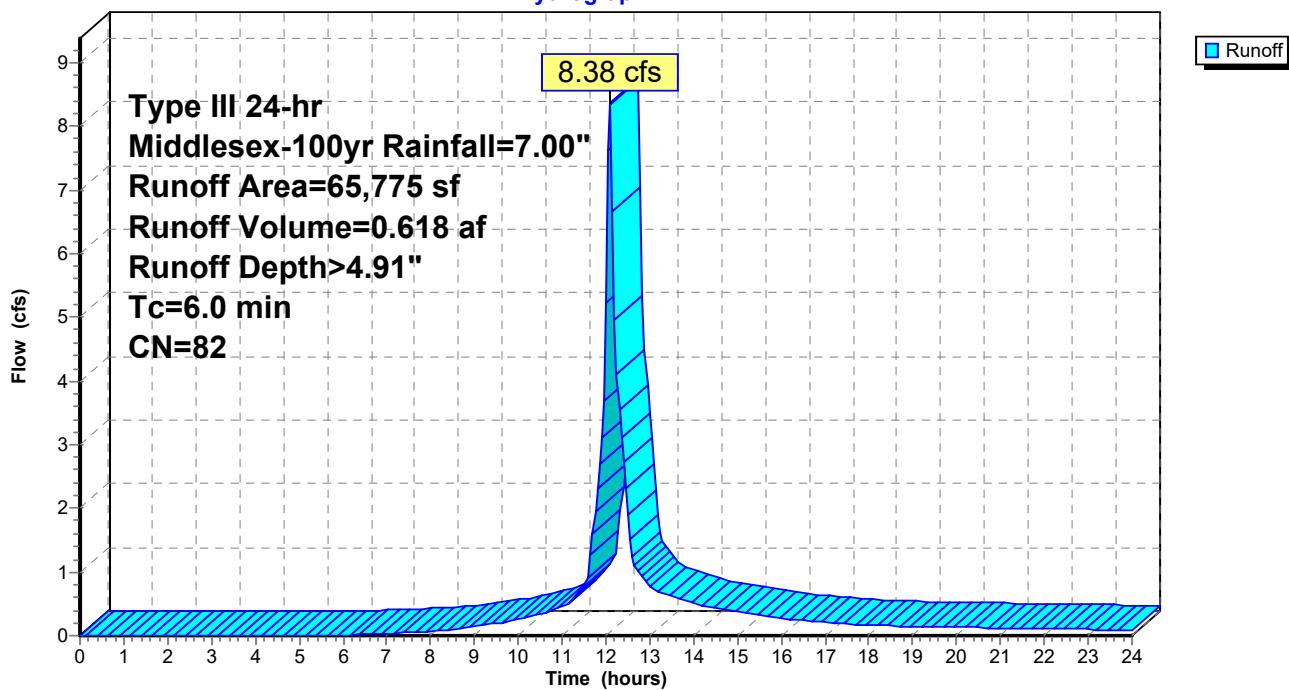
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
3,687	61	>75% Grass cover, Good, HSG B
2,564	98	Unconnected pavement, HSG B
1,968	98	Unconnected roofs, HSG B
52,925	85	Gravel roads, HSG B
4,631	55	Woods, Good, HSG B
65,775	82	Weighted Average
61,243		93.11% Pervious Area
4,532		6.89% Impervious Area
4,532		100.00% Unconnected

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

Subcatchment 2S: EDA-1B

Hydrograph



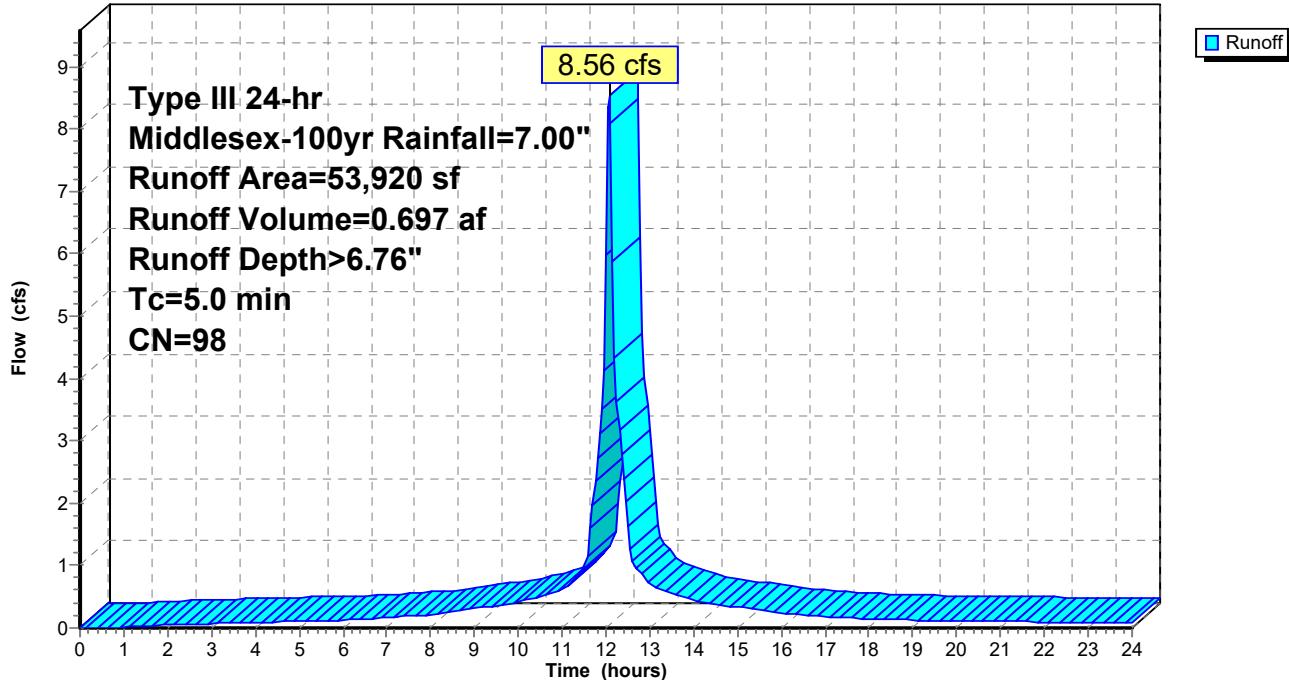
Summary for Subcatchment 5S: Route 20

Runoff = 8.56 cfs @ 12.07 hrs, Volume= 0.697 af, Depth> 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
53,920	98	Paved parking, HSG B
53,920		100.00% Impervious Area

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

Subcatchment 5S: Route 20**Hydrograph**

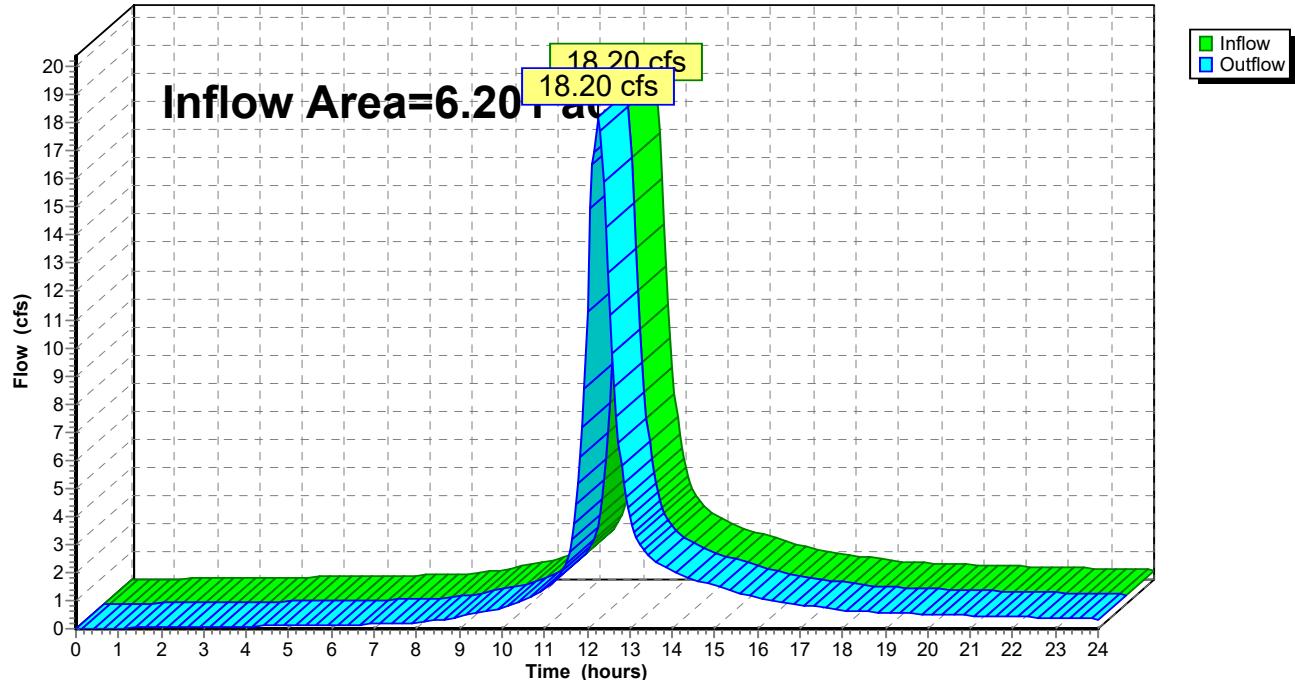
Summary for Reach 1R: DP-1

Inflow Area = 6.201 ac, 30.45% Impervious, Inflow Depth > 4.49" for Middlesex-100yr event

Inflow = 18.20 cfs @ 12.27 hrs, Volume= 2.318 af

Outflow = 18.20 cfs @ 12.27 hrs, Volume= 2.318 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 1R: DP-1**Hydrograph**

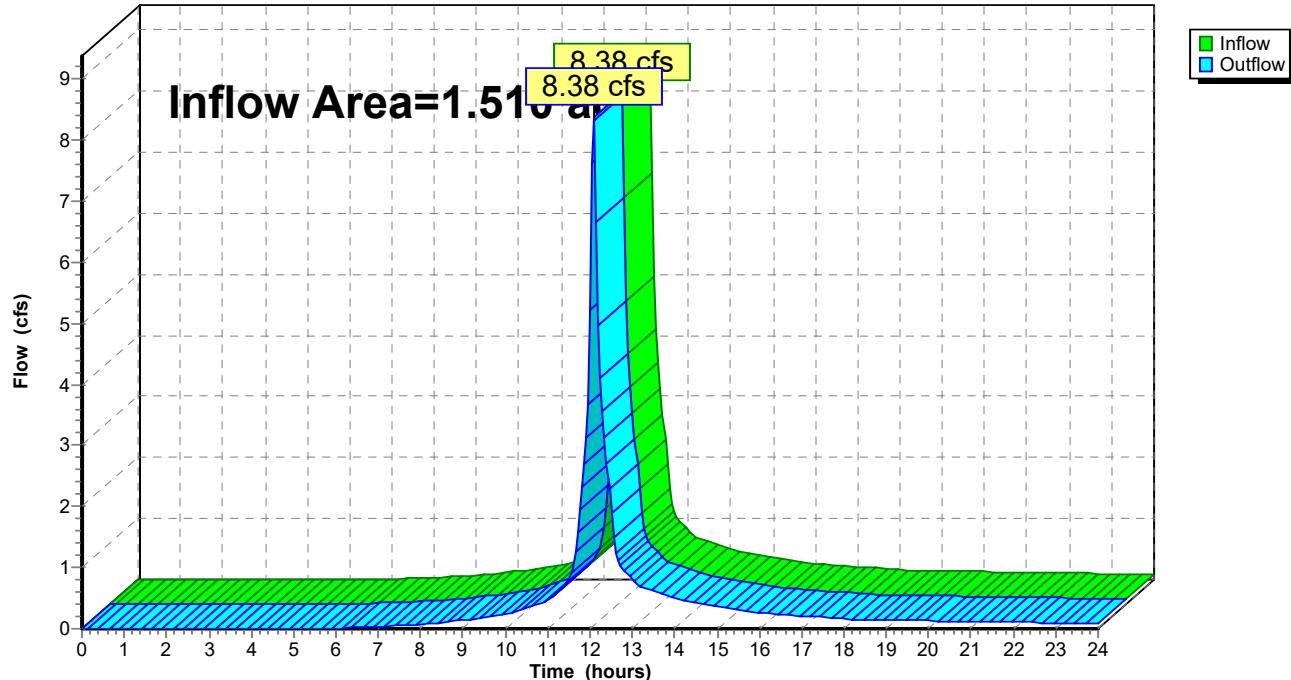
Summary for Reach 4R: DP-2

Inflow Area = 1.510 ac, 6.89% Impervious, Inflow Depth > 4.91" for Middlesex-100yr event

Inflow = 8.38 cfs @ 12.09 hrs, Volume= 0.618 af

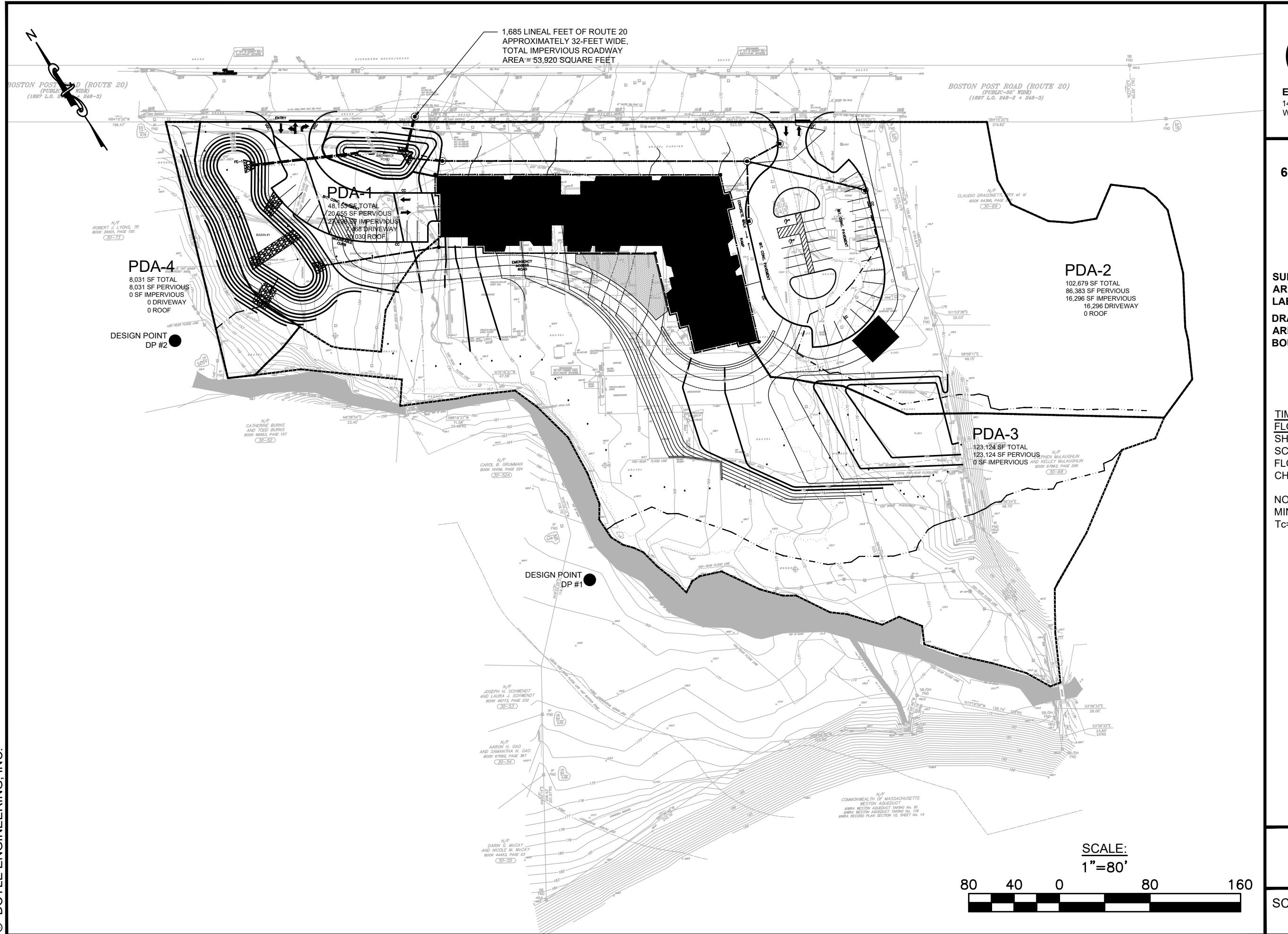
Outflow = 8.38 cfs @ 12.09 hrs, Volume= 0.618 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 4R: DP-2**Hydrograph**

APPENDIX C

Post-Development Hydrologic Analysis



C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

**667 WELLESLEY STREET
WESTON, MA**

Watershed Plan

**SUB
AREA
LABEL**

**DRAINAGE
AREA
BOUNDARY**



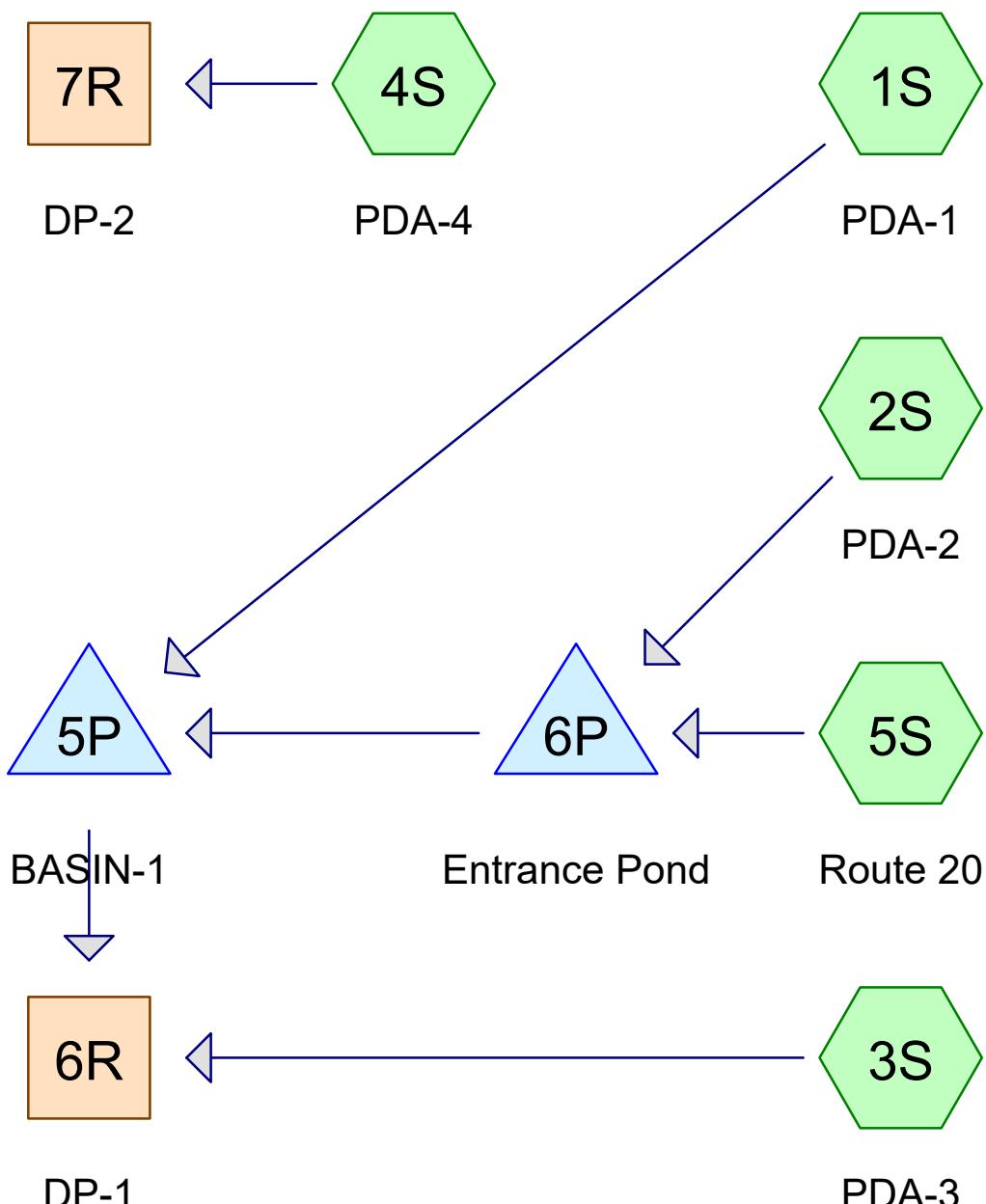
PR-1

TIME OF CONCENTRATION
FLOW TYPES:
SHEET - SHEET FLOW
SC - SHALLOW CONCENTRATED
FLOW
CHANNEL - CHANNEL FLOW

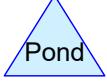
NOTE: IF Tc IS LESS THAN 5
MINUTES, USE 5 MINUTES (MIN.
 $T_c = 5$ MINUTES)

PROPOSED

SCALE: 1"=30' **FIG. 3**



Post-Development Conditions



Routing Diagram for Proposed
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Proposed

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Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
4.499	61	>75% Grass cover, Good, HSG B (1S, 2S, 3S, 4S)
1.409	98	Paved parking, HSG B (1S, 5S)
0.466	98	Roofs, HSG B (1S, 3S)
0.374	98	Unconnected pavement, HSG B (2S)
0.760	55	Woods, Good, HSG B (3S, 4S)
0.203	77	Woods, Good, HSG D (3S)
7.711	72	TOTAL AREA

Proposed

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Type III 24-hr Middlesex-002yr Rainfall=3.10"

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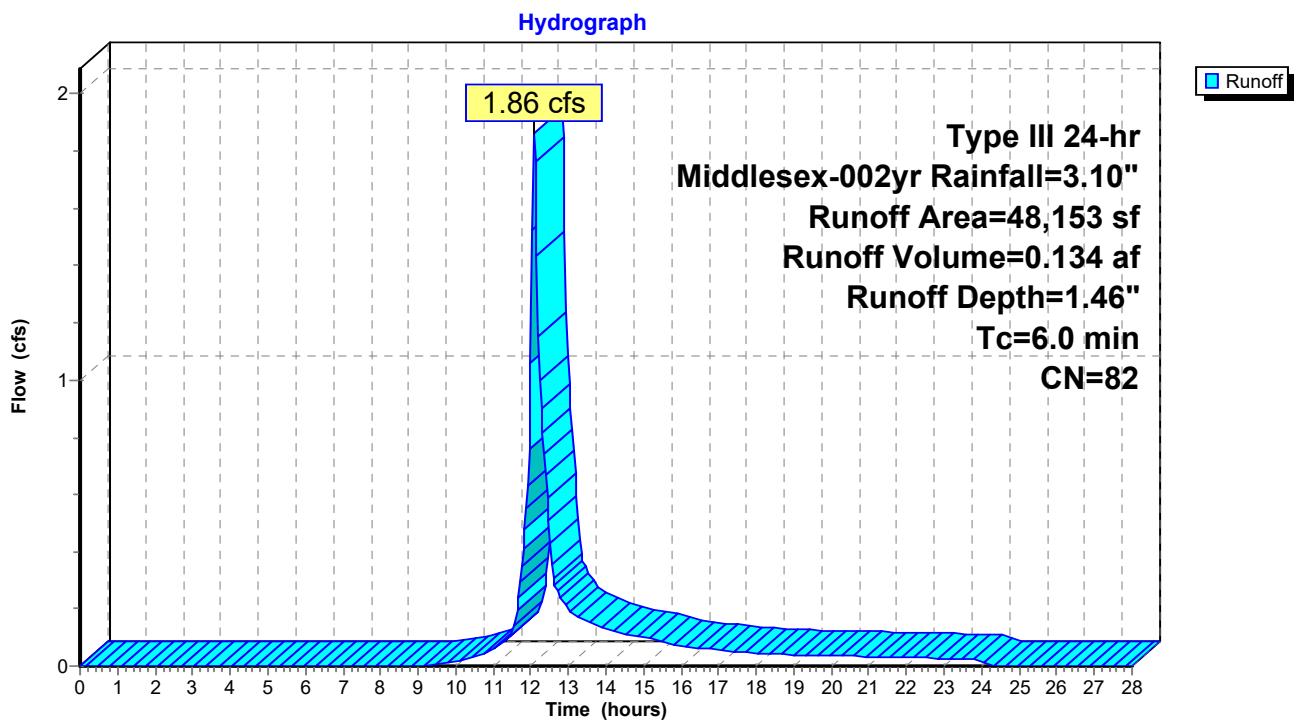
Summary for Subcatchment 1S: PDA-1

Runoff = 1.86 cfs @ 12.09 hrs, Volume= 0.134 af, Depth= 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
20,030	98	Roofs, HSG B
20,655	61	>75% Grass cover, Good, HSG B
7,468	98	Paved parking, HSG B
48,153	82	Weighted Average
20,655		42.89% Pervious Area
27,498		57.11% Impervious Area

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

Subcatchment 1S: PDA-1

Proposed

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Type III 24-hr Middlesex-002yr Rainfall=3.10"

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Page 4

Summary for Subcatchment 2S: PDA-2

Runoff = 1.01 cfs @ 12.12 hrs, Volume= 0.101 af, Depth= 0.51"

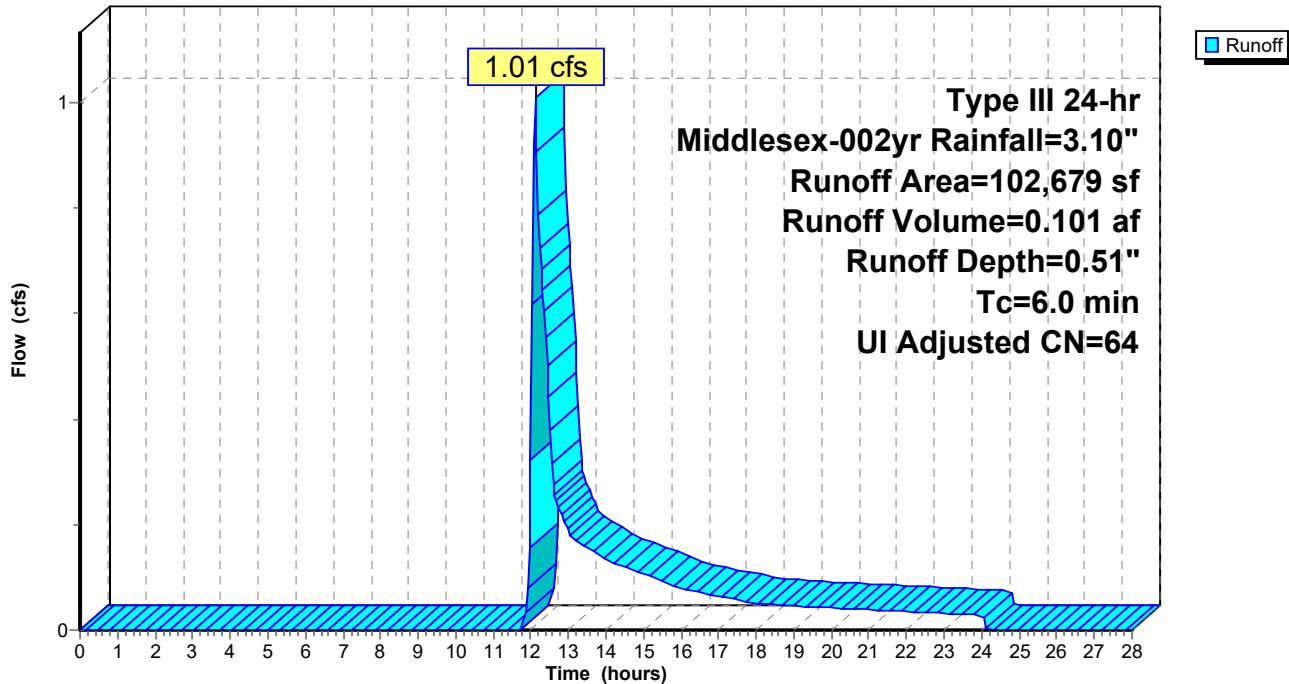
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Adj	Description
86,383	61		>75% Grass cover, Good, HSG B
16,296	98		Unconnected pavement, HSG B
102,679	67	64	Weighted Average, UI Adjusted
86,383			84.13% Pervious Area
16,296			15.87% Impervious Area
16,296			100.00% Unconnected

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

Subcatchment 2S: PDA-2

Hydrograph



Proposed

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Type III 24-hr Middlesex-002yr Rainfall=3.10"

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Summary for Subcatchment 3S: PDA-3

Runoff = 0.54 cfs @ 12.48 hrs, Volume= 0.095 af, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
85,154	61	>75% Grass cover, Good, HSG B
283	98	Roofs, HSG B
28,865	55	Woods, Good, HSG B
8,822	77	Woods, Good, HSG D
123,124	61	Weighted Average
122,841		99.77% Pervious Area
283		0.23% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		Sheet Flow, SF Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		Shallow Concentrated Flow, SCF1 Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		Shallow Concentrated Flow, SCF2 Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		Shallow Concentrated Flow, SCF3 Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		Shallow Concentrated Flow, SCF4 Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		Shallow Concentrated Flow, SCF5 Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		Shallow Concentrated Flow, SCF6 Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		Shallow Concentrated Flow, SCF7 Woodland Kv= 5.0 fps
23.7	504	Total			

Proposed

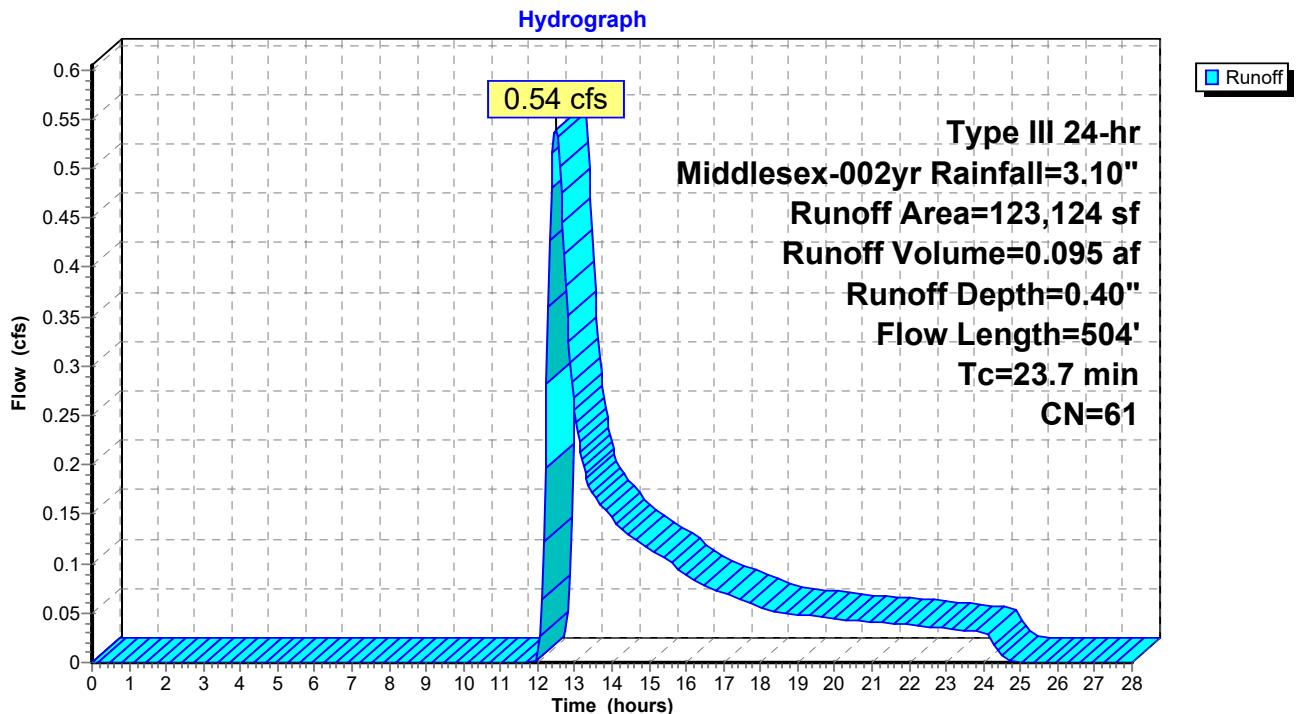
Prepared by {enter your company name here}

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Type III 24-hr Middlesex-002yr Rainfall=3.10"

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Subcatchment 3S: PDA-3

Proposed

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Type III 24-hr Middlesex-002yr Rainfall=3.10"

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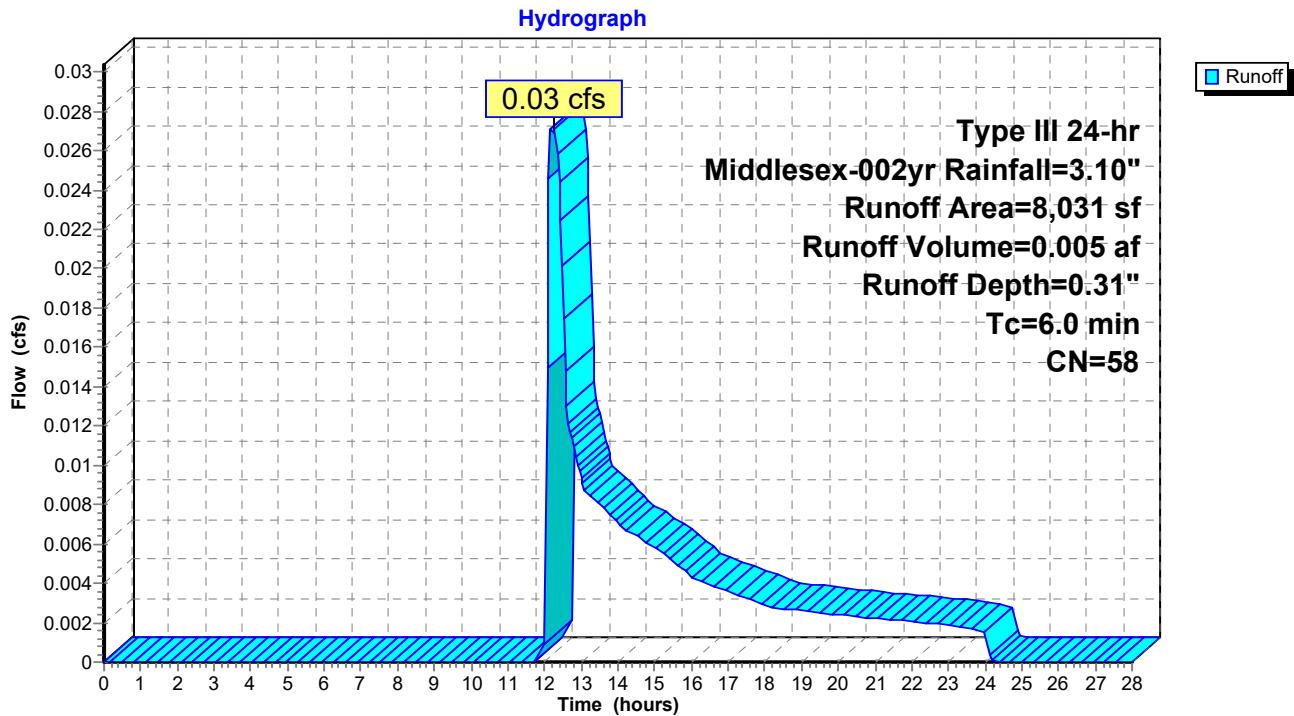
Summary for Subcatchment 4S: PDA-4

Runoff = 0.03 cfs @ 12.27 hrs, Volume= 0.005 af, Depth= 0.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
3,777	61	>75% Grass cover, Good, HSG B
4,254	55	Woods, Good, HSG B
8,031	58	Weighted Average
8,031		100.00% Pervious Area

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

Subcatchment 4S: PDA-4

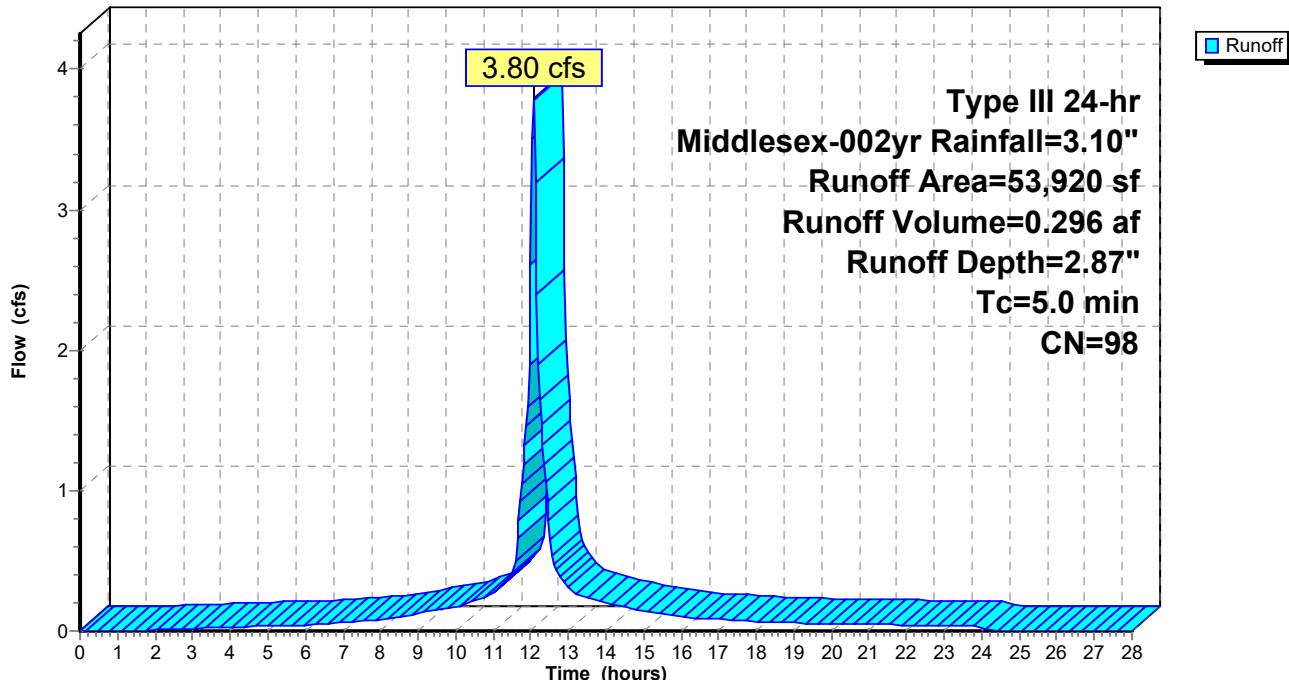
Summary for Subcatchment 5S: Route 20

Runoff = 3.80 cfs @ 12.07 hrs, Volume= 0.296 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
53,920	98	Paved parking, HSG B
53,920		100.00% Impervious Area

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

Subcatchment 5S: Route 20**Hydrograph**

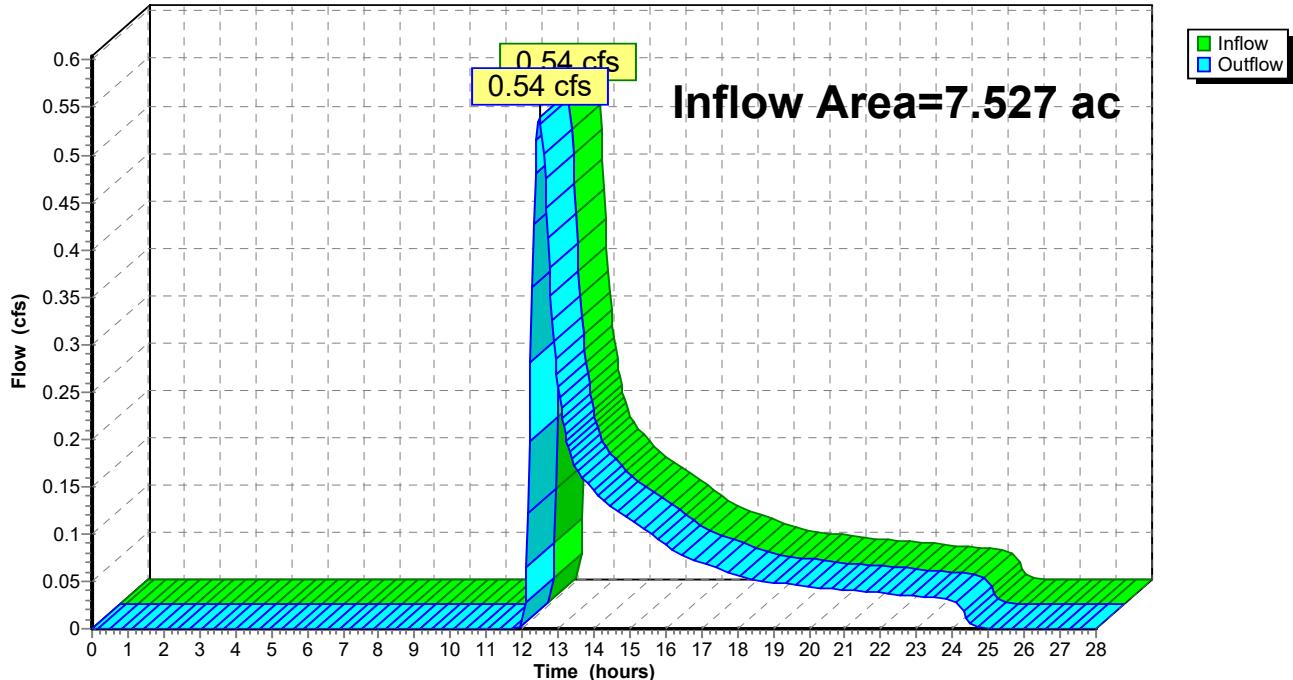
Summary for Reach 6R: DP-1

Inflow Area = 7.527 ac, 29.89% Impervious, Inflow Depth = 0.15" for Middlesex-002yr event

Inflow = 0.54 cfs @ 12.48 hrs, Volume= 0.095 af

Outflow = 0.54 cfs @ 12.48 hrs, Volume= 0.095 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 6R: DP-1**Hydrograph**

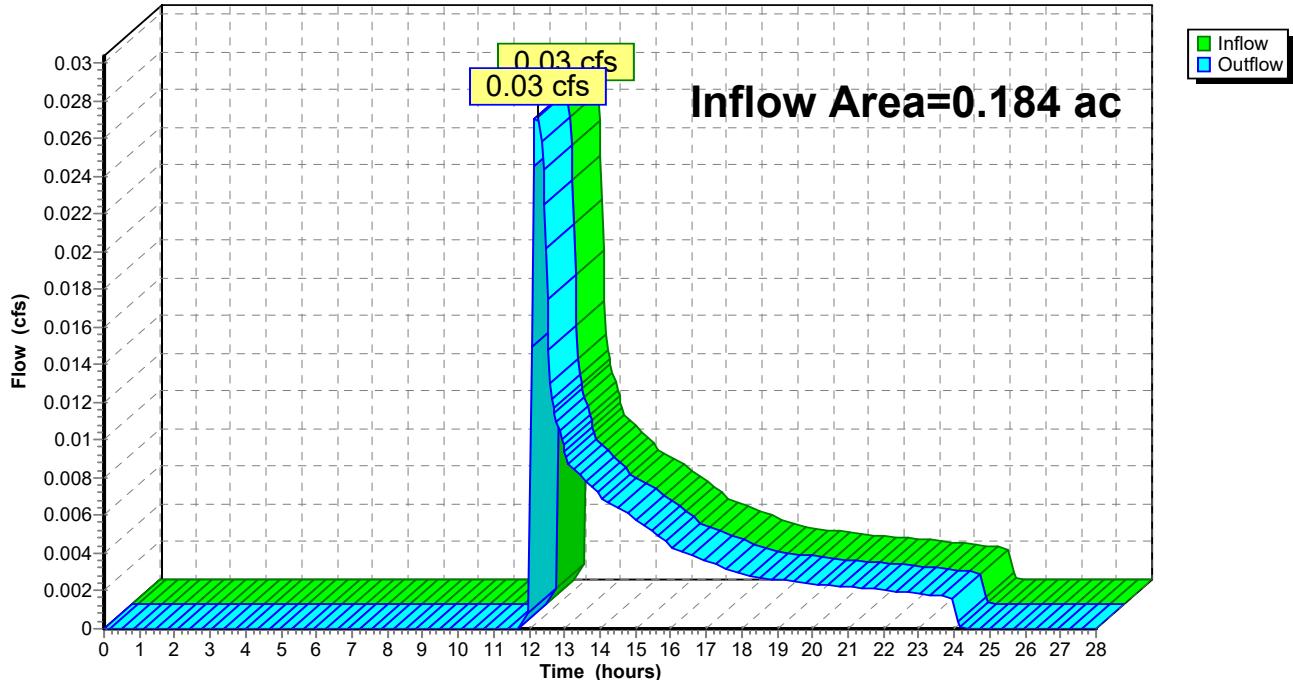
Summary for Reach 7R: DP-2

Inflow Area = 0.184 ac, 0.00% Impervious, Inflow Depth = 0.31" for Middlesex-002yr event

Inflow = 0.03 cfs @ 12.27 hrs, Volume= 0.005 af

Outflow = 0.03 cfs @ 12.27 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 7R: DP-2**Hydrograph**

Proposed

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Type III 24-hr Middlesex-002yr Rainfall=3.10"

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Summary for Pond 5P: BASIN-1

Inflow Area = 4.700 ac, 47.72% Impervious, Inflow Depth = 1.35" for Middlesex-002yr event
 Inflow = 6.30 cfs @ 12.10 hrs, Volume= 0.530 af
 Outflow = 0.28 cfs @ 15.83 hrs, Volume= 0.380 af, Atten= 96%, Lag= 223.8 min
 Discarded = 0.28 cfs @ 15.83 hrs, Volume= 0.380 af
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
 Peak Elev= 157.14' @ 15.83 hrs Surf.Area= 7,542 sf Storage= 13,025 cf

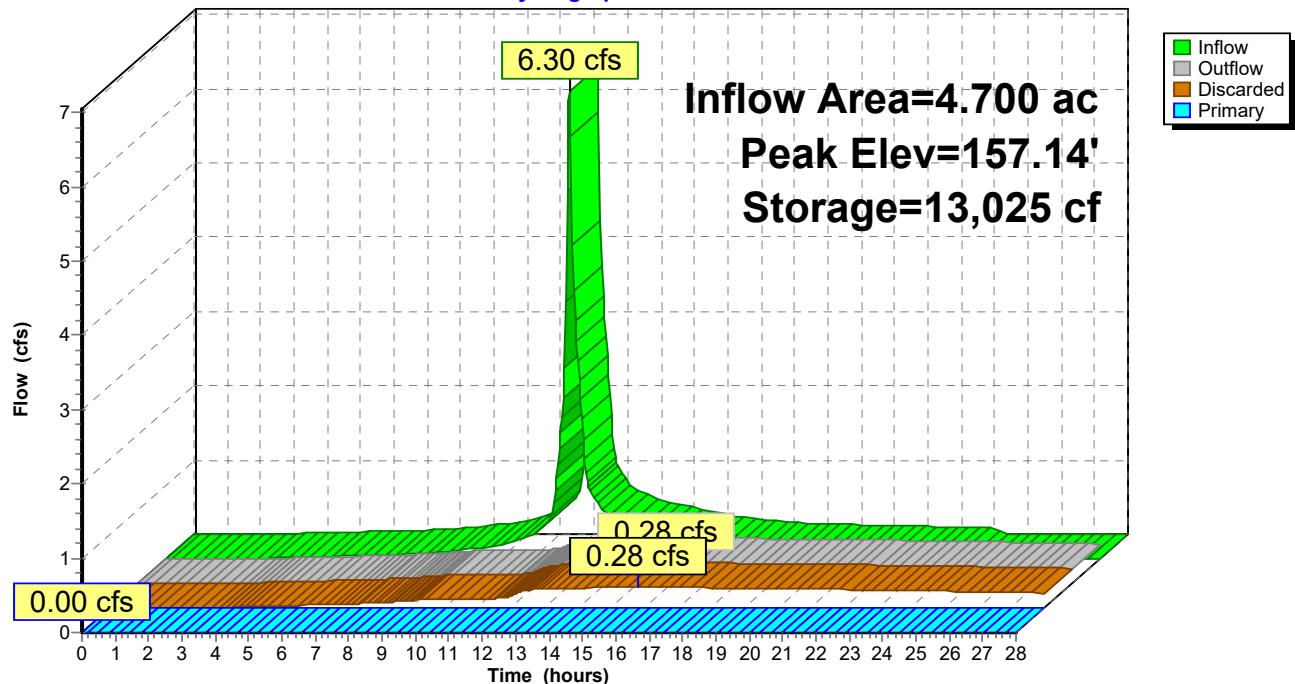
Plug-Flow detention time= 389.4 min calculated for 0.380 af (72% of inflow)
 Center-of-Mass det. time= 288.0 min (1,097.8 - 809.8)

Volume	Invert	Avail.Storage	Storage Description
#1	155.00'	40,568 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
155.00	4,691	0	0
156.00	5,992	5,342	5,342
157.00	7,350	6,671	12,013
158.00	8,764	8,057	20,070
159.00	10,235	9,500	29,569
160.00	11,762	10,999	40,568

Device	Routing	Invert	Outlet Devices
#1	Primary	159.00'	14.0' long x 15.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Primary	158.00'	12.0" Round Culvert L= 30.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 158.00' / 157.50' S= 0.0167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Discarded	155.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 152.00'

Discarded OutFlow Max=0.28 cfs @ 15.83 hrs HW=157.14' (Free Discharge)
 ↑ 3=Exfiltration (Controls 0.28 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=155.00' (Free Discharge)
 ↑ 1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)
 ↓ 2=Culvert (Controls 0.00 cfs)

Pond 5P: BASIN-1**Hydrograph**

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Type III 24-hr Middlesex-002yr Rainfall=3.10"

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Summary for Pond 6P: Entrance Pond

Inflow Area = 3.595 ac, 44.84% Impervious, Inflow Depth = 1.32" for Middlesex-002yr event
 Inflow = 4.71 cfs @ 12.08 hrs, Volume= 0.397 af
 Outflow = 4.44 cfs @ 12.10 hrs, Volume= 0.396 af, Atten= 6%, Lag= 1.4 min
 Primary = 4.44 cfs @ 12.10 hrs, Volume= 0.396 af

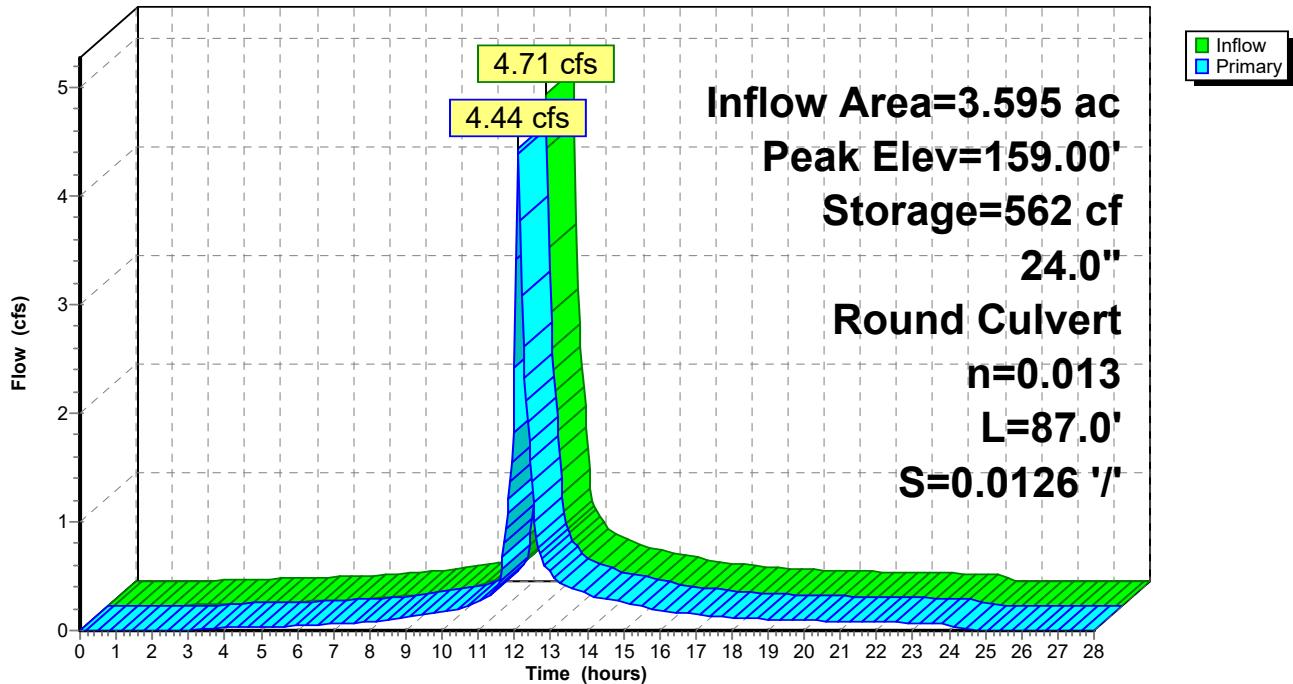
Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs / 2
 Peak Elev= 159.00' @ 12.10 hrs Surf.Area= 758 sf Storage= 562 cf

Plug-Flow detention time= 8.2 min calculated for 0.396 af (100% of inflow)
 Center-of-Mass det. time= 6.7 min (800.3 - 793.5)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	5,058 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
158.00	364	0	0
159.00	758	561	561
160.00	1,193	976	1,537
161.00	1,685	1,439	2,976
162.00	2,480	2,083	5,058

Device	Routing	Invert	Outlet Devices
#1	Primary	158.10'	24.0" Round Culvert L= 87.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 158.10' / 157.00' S= 0.0126 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=4.35 cfs @ 12.10 hrs HW=158.99' (Free Discharge)
 ↑1=Culvert (Inlet Controls 4.35 cfs @ 3.21 fps)

Pond 6P: Entrance Pond**Hydrograph**

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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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Summary for Subcatchment 1S: PDA-1

Runoff = 3.38 cfs @ 12.09 hrs, Volume= 0.243 af, Depth= 2.64"

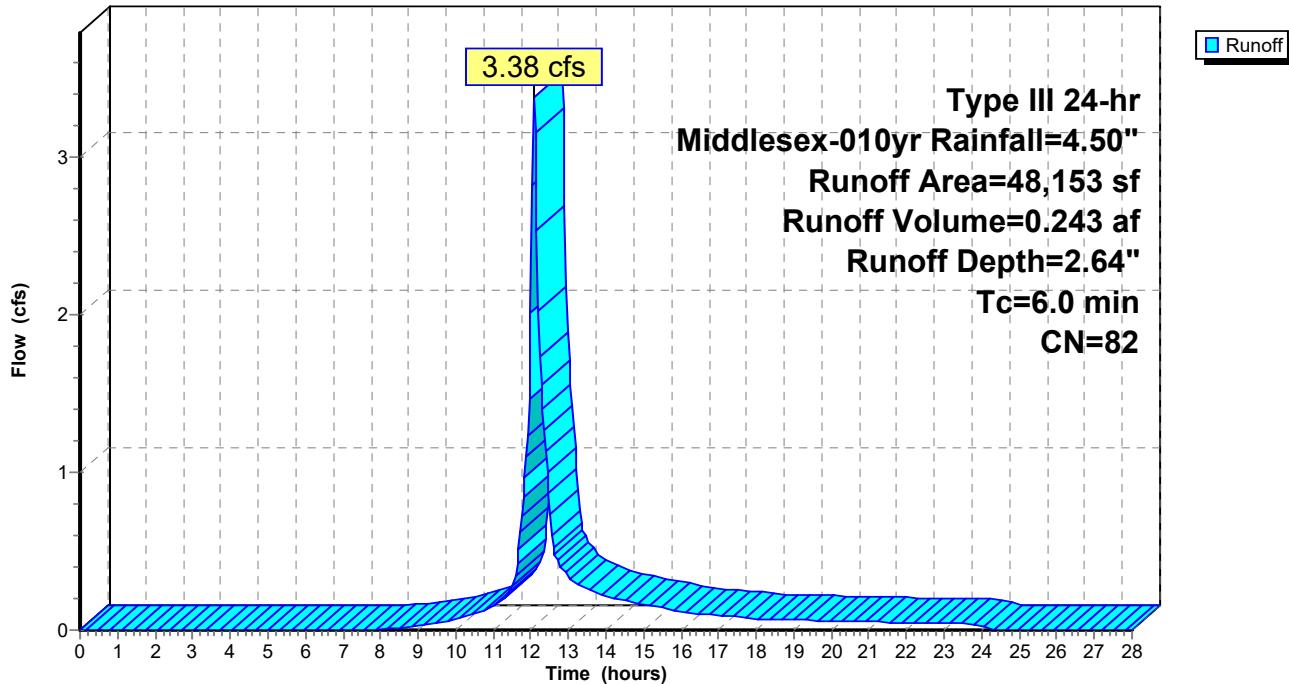
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
20,030	98	Roofs, HSG B
20,655	61	>75% Grass cover, Good, HSG B
7,468	98	Paved parking, HSG B
48,153	82	Weighted Average
20,655		42.89% Pervious Area
27,498		57.11% Impervious Area

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

Subcatchment 1S: PDA-1

Hydrograph



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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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Summary for Subcatchment 2S: PDA-2

Runoff = 3.17 cfs @ 12.10 hrs, Volume= 0.249 af, Depth= 1.27"

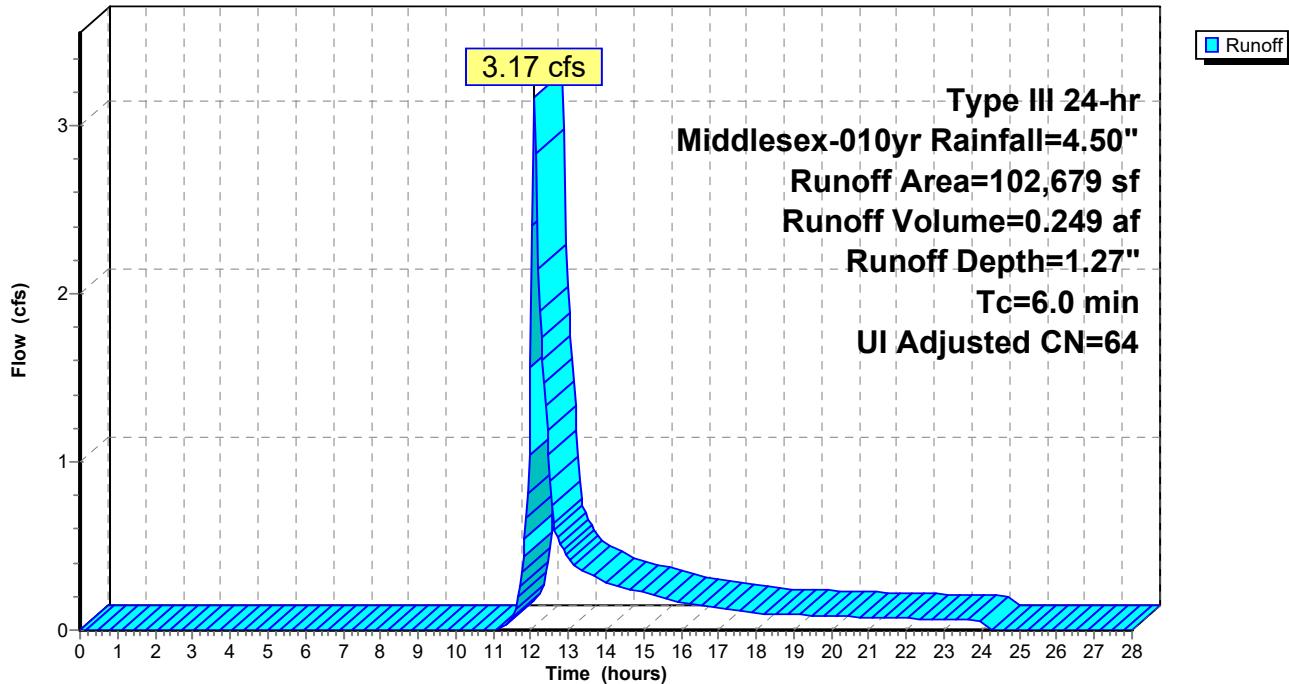
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Adj	Description
86,383	61		>75% Grass cover, Good, HSG B
16,296	98		Unconnected pavement, HSG B
102,679	67	64	Weighted Average, UI Adjusted
86,383			84.13% Pervious Area
16,296			15.87% Impervious Area
16,296			100.00% Unconnected

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

Subcatchment 2S: PDA-2

Hydrograph



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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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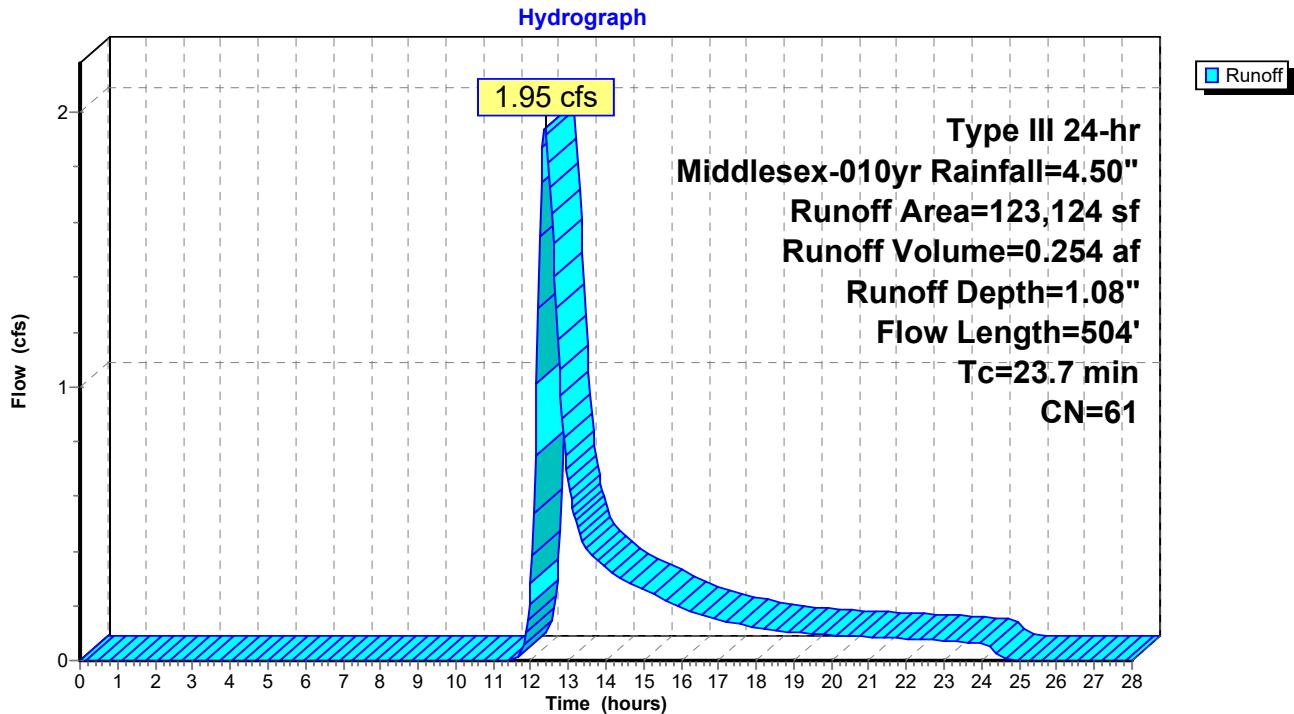
Summary for Subcatchment 3S: PDA-3

Runoff = 1.95 cfs @ 12.38 hrs, Volume= 0.254 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
85,154	61	>75% Grass cover, Good, HSG B
283	98	Roofs, HSG B
28,865	55	Woods, Good, HSG B
8,822	77	Woods, Good, HSG D
123,124	61	Weighted Average
122,841		99.77% Pervious Area
283		0.23% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		Sheet Flow, SF Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		Shallow Concentrated Flow, SCF1 Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		Shallow Concentrated Flow, SCF2 Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		Shallow Concentrated Flow, SCF3 Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		Shallow Concentrated Flow, SCF4 Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		Shallow Concentrated Flow, SCF5 Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		Shallow Concentrated Flow, SCF6 Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		Shallow Concentrated Flow, SCF7 Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 3S: PDA-3

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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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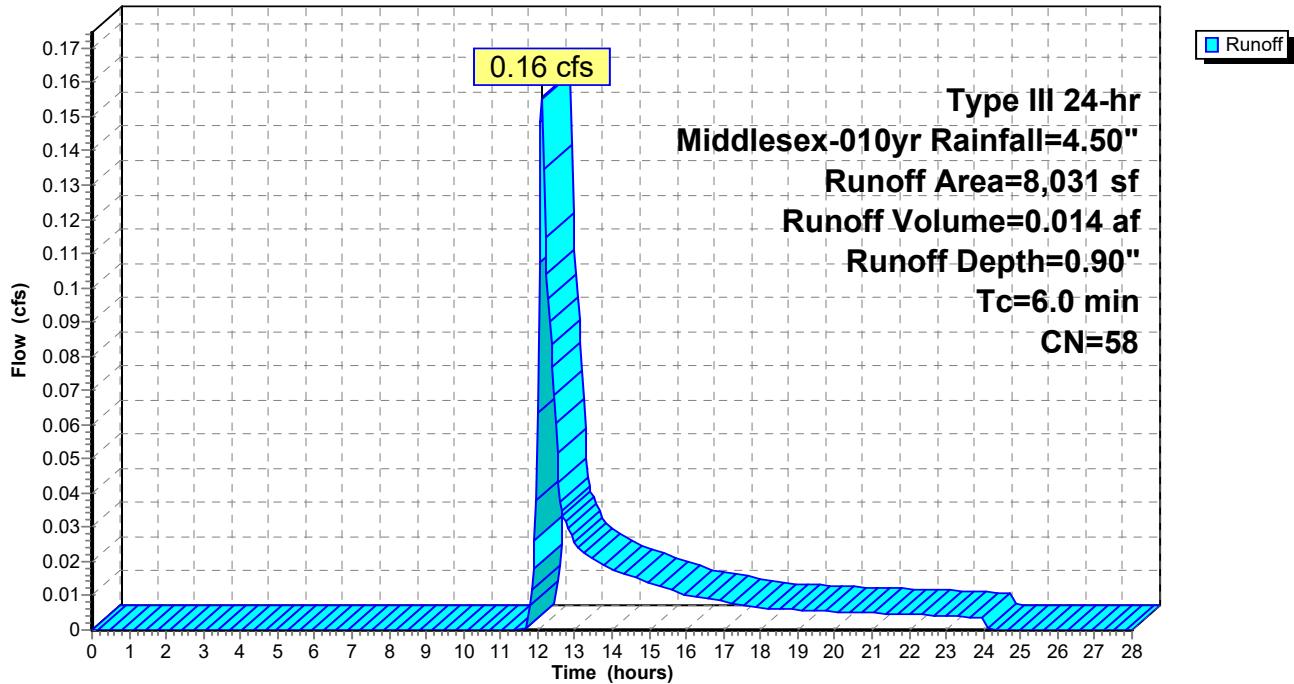
Summary for Subcatchment 4S: PDA-4

Runoff = 0.16 cfs @ 12.11 hrs, Volume= 0.014 af, Depth= 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
3,777	61	>75% Grass cover, Good, HSG B
4,254	55	Woods, Good, HSG B
8,031	58	Weighted Average
8,031		100.00% Pervious Area

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

Subcatchment 4S: PDA-4**Hydrograph**

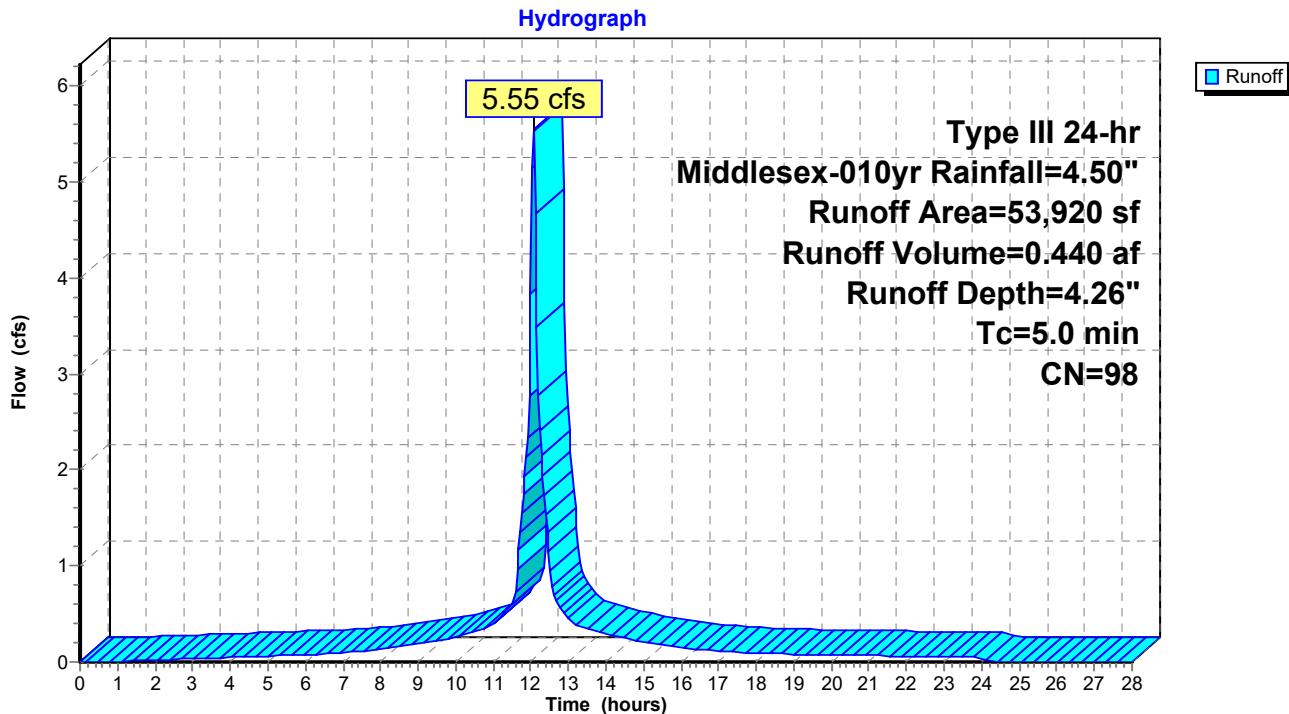
Summary for Subcatchment 5S: Route 20

Runoff = 5.55 cfs @ 12.07 hrs, Volume= 0.440 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
53,920	98	Paved parking, HSG B
53,920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0				5.55	Direct Entry,

Subcatchment 5S: Route 20

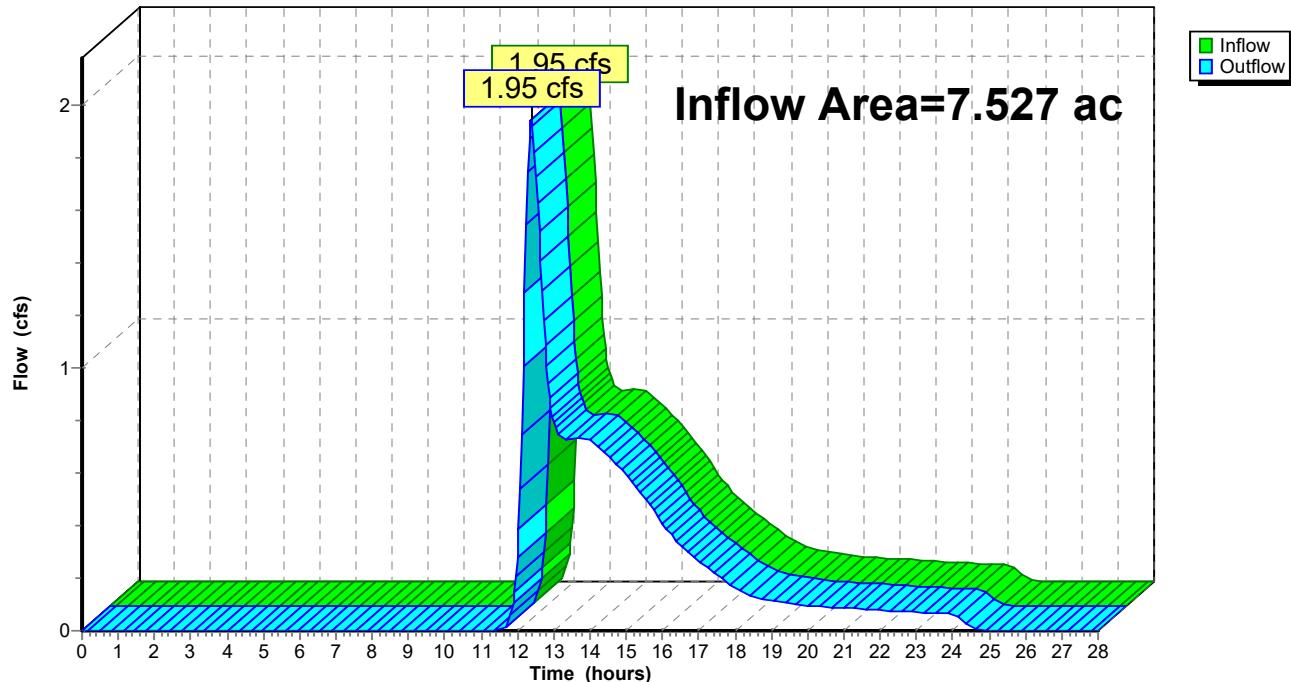
Summary for Reach 6R: DP-1

Inflow Area = 7.527 ac, 29.89% Impervious, Inflow Depth = 0.57" for Middlesex-010yr event

Inflow = 1.95 cfs @ 12.38 hrs, Volume= 0.356 af

Outflow = 1.95 cfs @ 12.38 hrs, Volume= 0.356 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 6R: DP-1**Hydrograph**

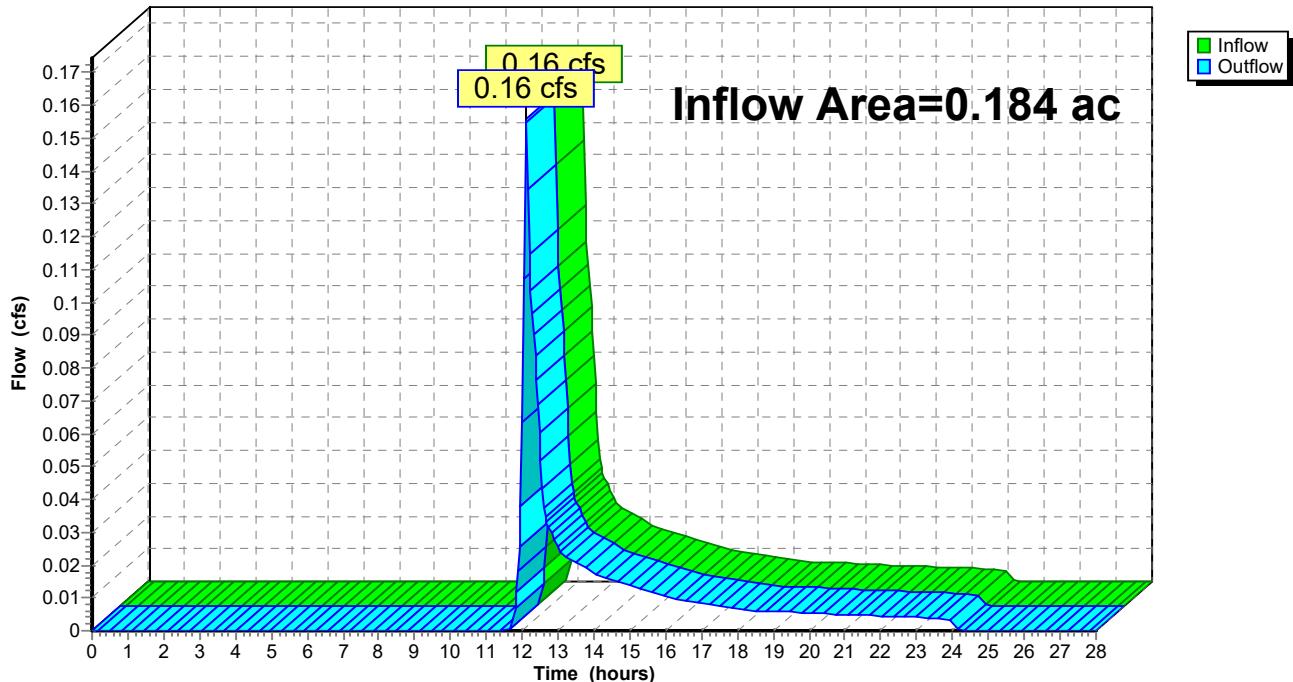
Summary for Reach 7R: DP-2

Inflow Area = 0.184 ac, 0.00% Impervious, Inflow Depth = 0.90" for Middlesex-010yr event

Inflow = 0.16 cfs @ 12.11 hrs, Volume= 0.014 af

Outflow = 0.16 cfs @ 12.11 hrs, Volume= 0.014 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 7R: DP-2**Hydrograph**

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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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Summary for Pond 5P: BASIN-1

Inflow Area = 4.700 ac, 47.72% Impervious, Inflow Depth = 2.38" for Middlesex-010yr event
 Inflow = 11.50 cfs @ 12.10 hrs, Volume= 0.930 af
 Outflow = 0.77 cfs @ 14.07 hrs, Volume= 0.624 af, Atten= 93%, Lag= 118.3 min
 Discarded = 0.38 cfs @ 14.07 hrs, Volume= 0.522 af
 Primary = 0.39 cfs @ 14.07 hrs, Volume= 0.102 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
 Peak Elev= 158.28' @ 14.07 hrs Surf.Area= 9,175 sf Storage= 22,574 cf

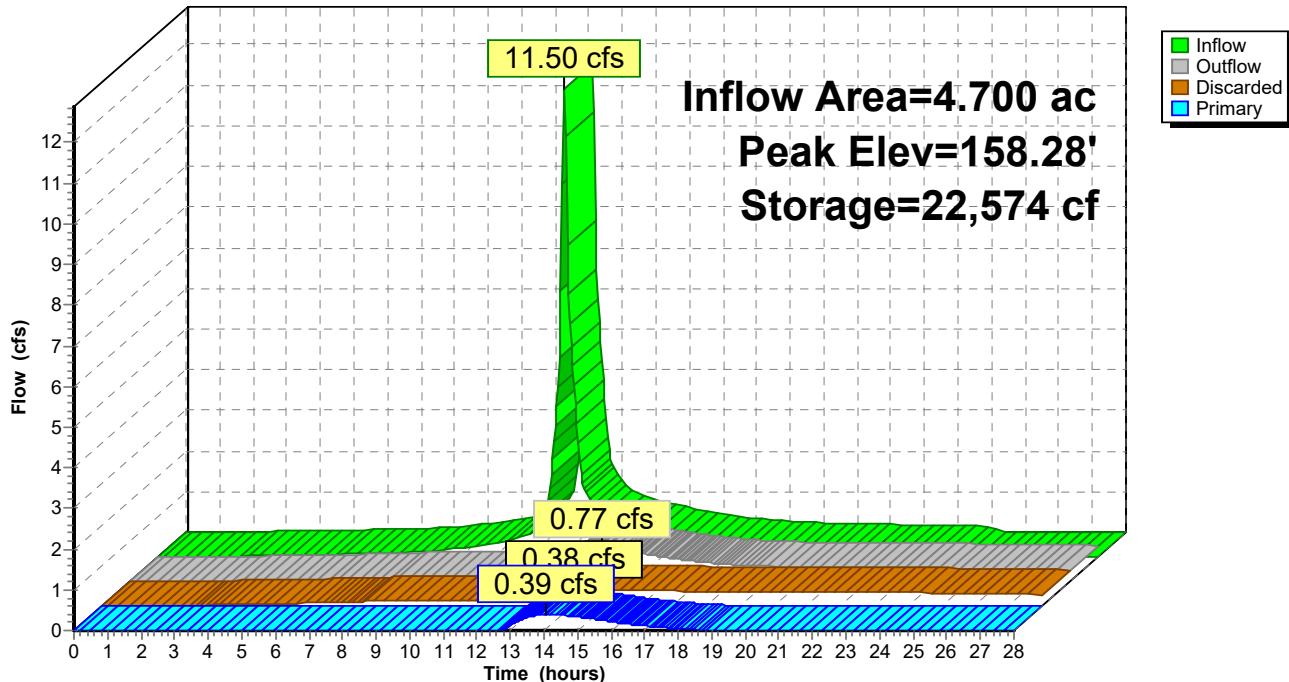
Plug-Flow detention time= 364.5 min calculated for 0.623 af (67% of inflow)
 Center-of-Mass det. time= 258.4 min (1,062.3 - 803.9)

Volume	Invert	Avail.Storage	Storage Description
#1	155.00'	40,568 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
155.00	4,691	0	0
156.00	5,992	5,342	5,342
157.00	7,350	6,671	12,013
158.00	8,764	8,057	20,070
159.00	10,235	9,500	29,569
160.00	11,762	10,999	40,568

Device	Routing	Invert	Outlet Devices
#1	Primary	159.00'	14.0' long x 15.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Primary	158.00'	12.0" Round Culvert L= 30.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 158.00' / 157.50' S= 0.0167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Discarded	155.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 152.00'

Discarded OutFlow Max=0.38 cfs @ 14.07 hrs HW=158.28' (Free Discharge)
 ↑ 3=Exfiltration (Controls 0.38 cfs)

Primary OutFlow Max=0.39 cfs @ 14.07 hrs HW=158.28' (Free Discharge)
 ↑ 1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)
 2=Culvert (Barrel Controls 0.39 cfs @ 3.26 fps)

Pond 5P: BASIN-1**Hydrograph**

Proposed

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Type III 24-hr Middlesex-010yr Rainfall=4.50"

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Summary for Pond 6P: Entrance Pond

Inflow Area = 3.595 ac, 44.84% Impervious, Inflow Depth = 2.30" for Middlesex-010yr event
 Inflow = 8.63 cfs @ 12.08 hrs, Volume= 0.688 af
 Outflow = 8.14 cfs @ 12.11 hrs, Volume= 0.688 af, Atten= 6%, Lag= 1.4 min
 Primary = 8.14 cfs @ 12.11 hrs, Volume= 0.688 af

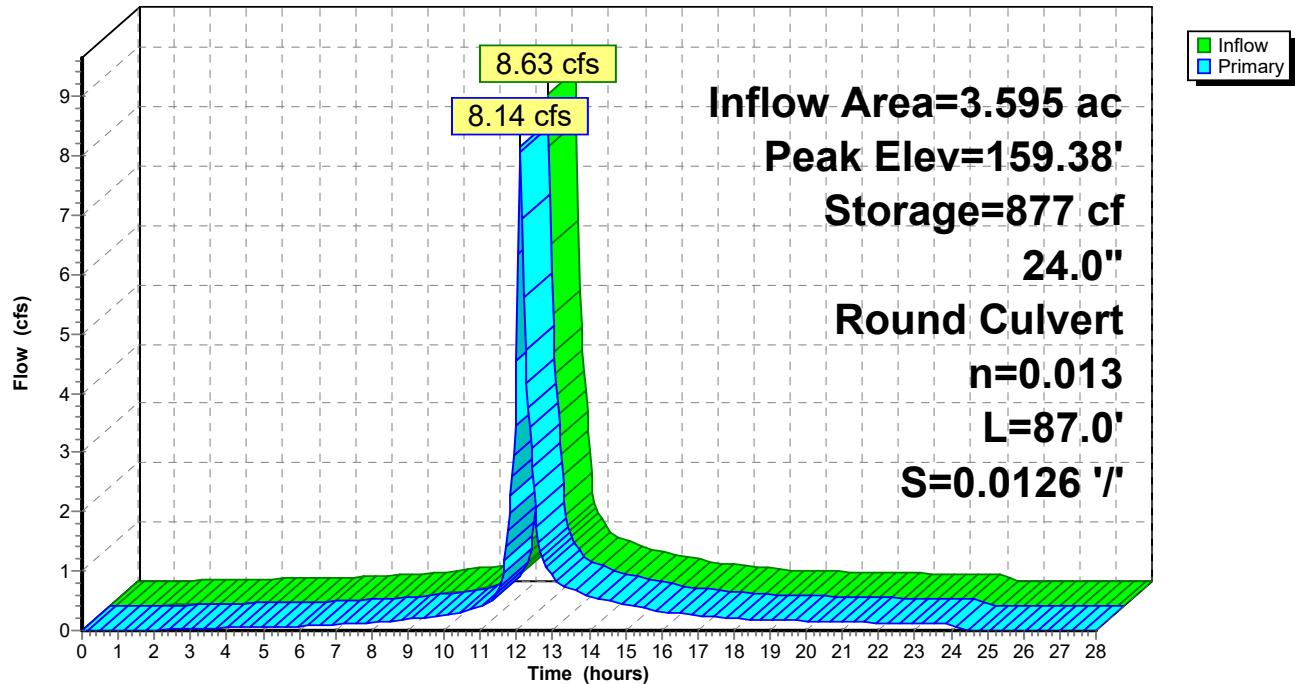
Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs / 2
 Peak Elev= 159.38' @ 12.11 hrs Surf.Area= 922 sf Storage= 877 cf

Plug-Flow detention time= 6.0 min calculated for 0.688 af (100% of inflow)
 Center-of-Mass det. time= 5.1 min (798.0 - 792.9)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	5,058 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
158.00	364	0	0
159.00	758	561	561
160.00	1,193	976	1,537
161.00	1,685	1,439	2,976
162.00	2,480	2,083	5,058

Device	Routing	Invert	Outlet Devices
#1	Primary	158.10'	24.0" Round Culvert L= 87.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 158.10' / 157.00' S= 0.0126 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=8.00 cfs @ 12.11 hrs HW=159.36' (Free Discharge)
 ↑ 1=Culvert (Inlet Controls 8.00 cfs @ 3.83 fps)

Pond 6P: Entrance Pond**Hydrograph**

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Type III 24-hr Middlesex-100yr Rainfall=7.00"

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Summary for Subcatchment 1S: PDA-1

Runoff = 6.22 cfs @ 12.09 hrs, Volume= 0.453 af, Depth= 4.92"

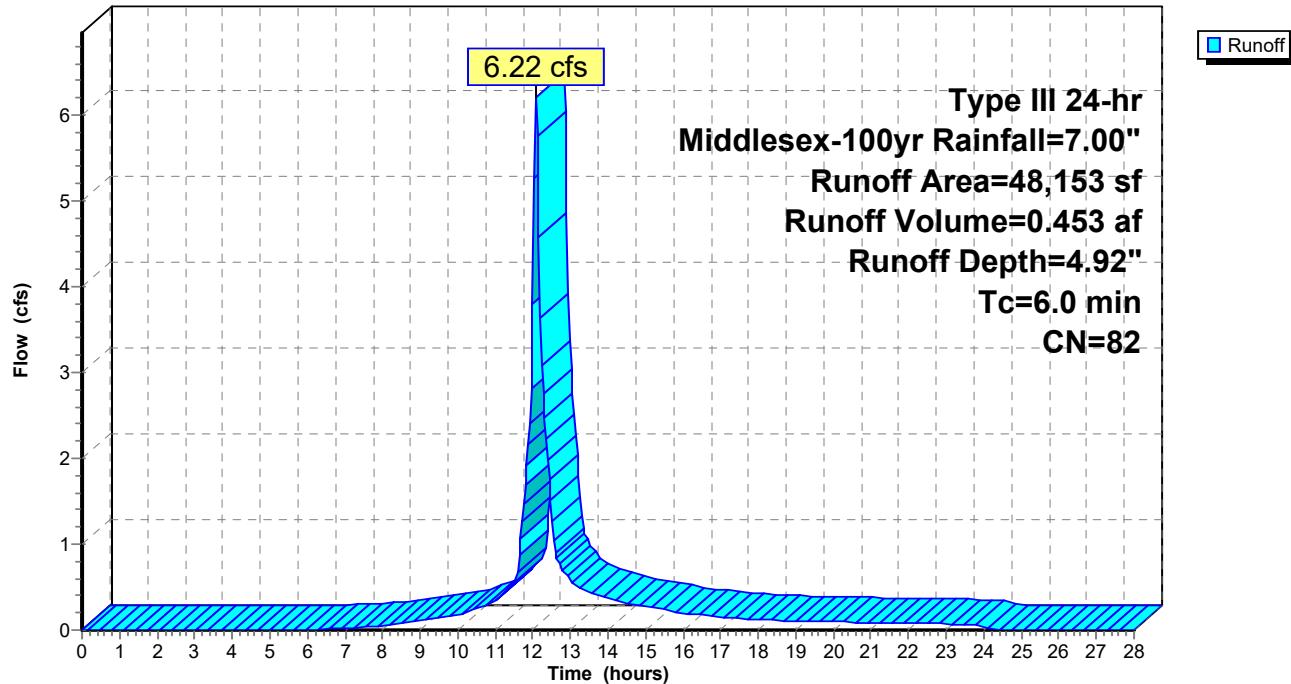
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
20,030	98	Roofs, HSG B
20,655	61	>75% Grass cover, Good, HSG B
7,468	98	Paved parking, HSG B
48,153	82	Weighted Average
20,655		42.89% Pervious Area
27,498		57.11% Impervious Area

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

Subcatchment 1S: PDA-1

Hydrograph



Proposed

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Type III 24-hr Middlesex-100yr Rainfall=7.00"

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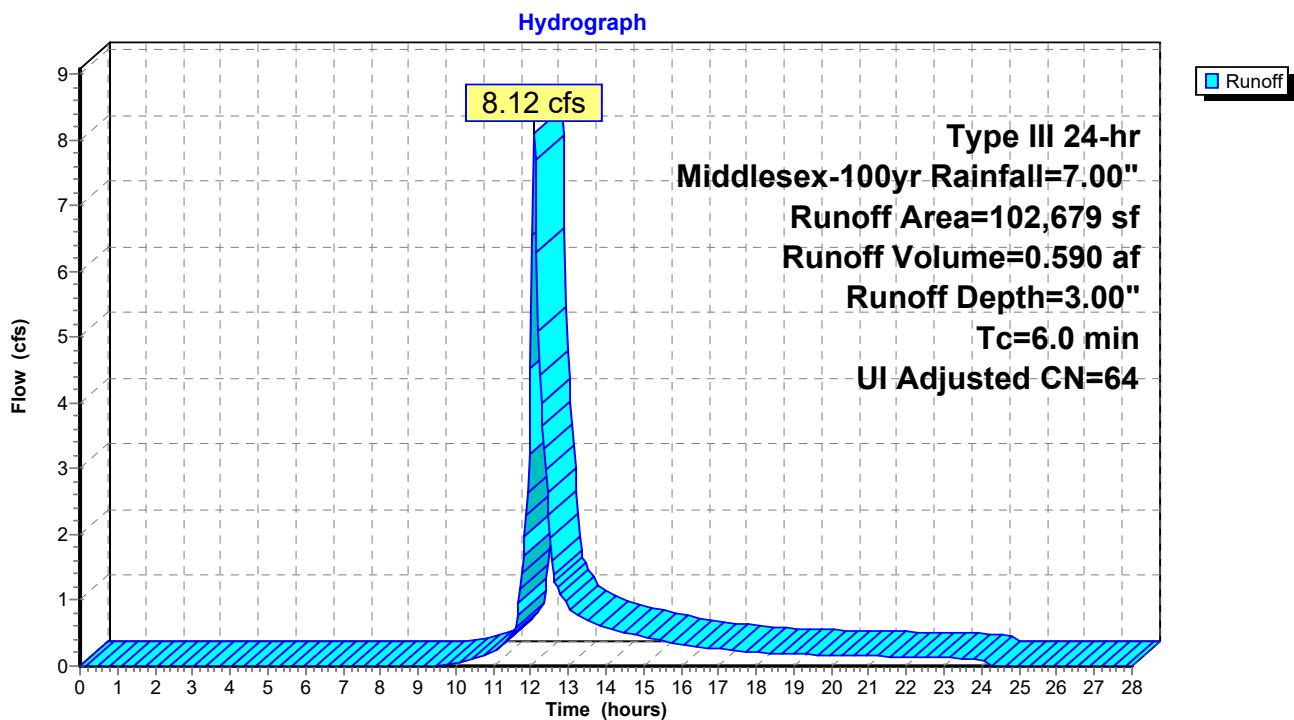
Summary for Subcatchment 2S: PDA-2

Runoff = 8.12 cfs @ 12.09 hrs, Volume= 0.590 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Adj	Description
86,383	61		>75% Grass cover, Good, HSG B
16,296	98		Unconnected pavement, HSG B
102,679	67	64	Weighted Average, UI Adjusted
86,383			84.13% Pervious Area
16,296			15.87% Impervious Area
16,296			100.00% Unconnected

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

Subcatchment 2S: PDA-2

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Type III 24-hr Middlesex-100yr Rainfall=7.00"

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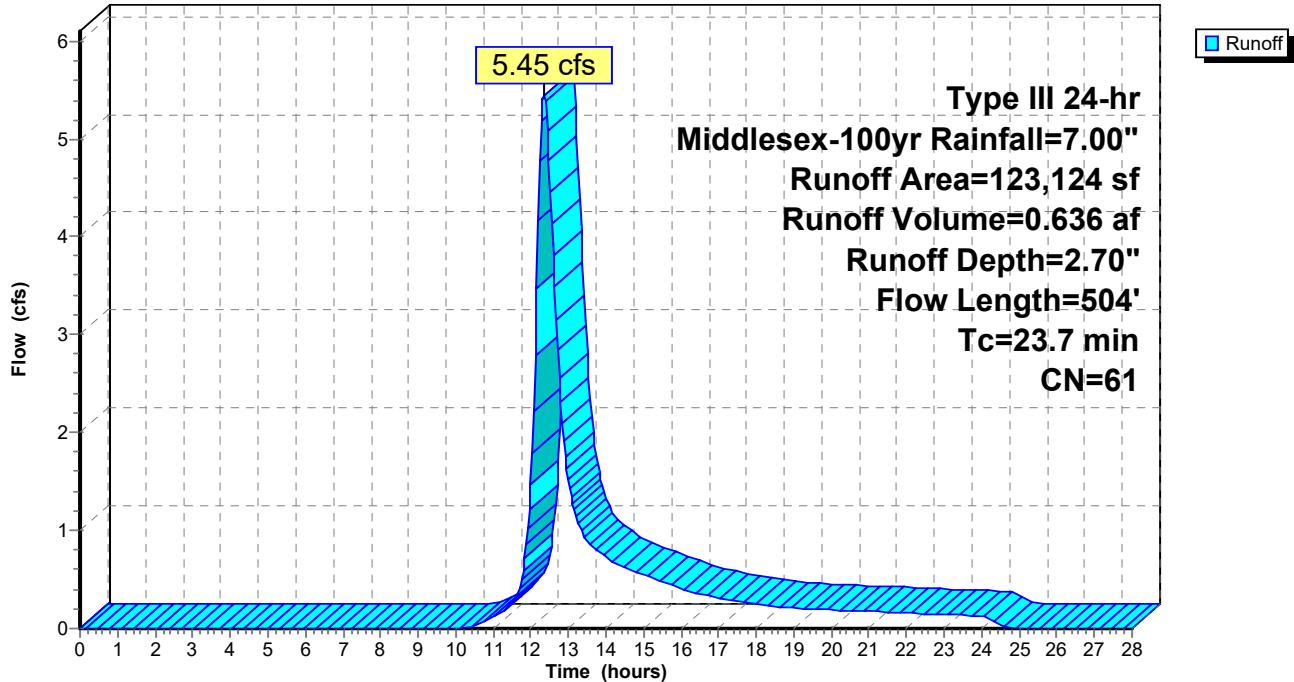
Summary for Subcatchment 3S: PDA-3

Runoff = 5.45 cfs @ 12.35 hrs, Volume= 0.636 af, Depth= 2.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
85,154	61	>75% Grass cover, Good, HSG B
283	98	Roofs, HSG B
28,865	55	Woods, Good, HSG B
8,822	77	Woods, Good, HSG D
123,124	61	Weighted Average
122,841		99.77% Pervious Area
283		0.23% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		Sheet Flow, SF Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		Shallow Concentrated Flow, SCF1 Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		Shallow Concentrated Flow, SCF2 Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		Shallow Concentrated Flow, SCF3 Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		Shallow Concentrated Flow, SCF4 Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		Shallow Concentrated Flow, SCF5 Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		Shallow Concentrated Flow, SCF6 Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		Shallow Concentrated Flow, SCF7 Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 3S: PDA-3**Hydrograph**

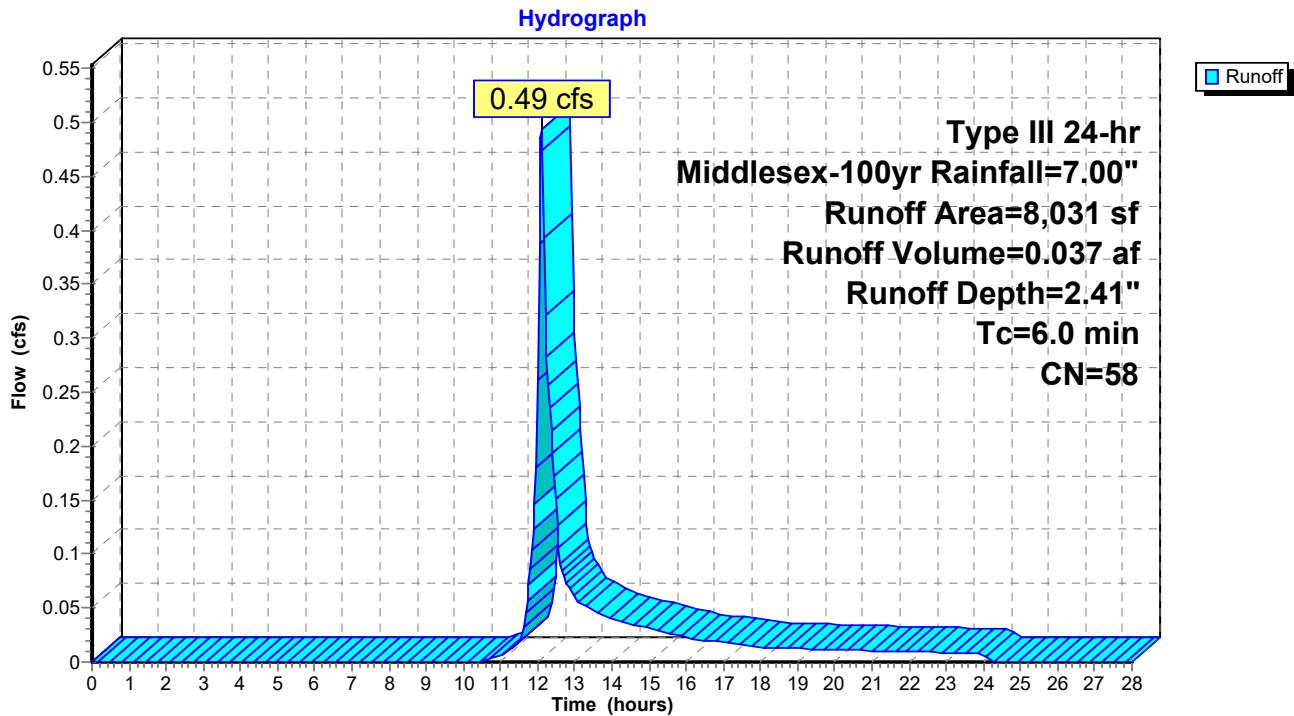
Summary for Subcatchment 4S: PDA-4

Runoff = 0.49 cfs @ 12.10 hrs, Volume= 0.037 af, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
3,777	61	>75% Grass cover, Good, HSG B
4,254	55	Woods, Good, HSG B
8,031	58	Weighted Average
8,031		100.00% Pervious Area

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

Subcatchment 4S: PDA-4

Proposed

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Type III 24-hr Middlesex-100yr Rainfall=7.00"

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Summary for Subcatchment 5S: Route 20

Runoff = 8.68 cfs @ 12.07 hrs, Volume= 0.697 af, Depth= 6.76"

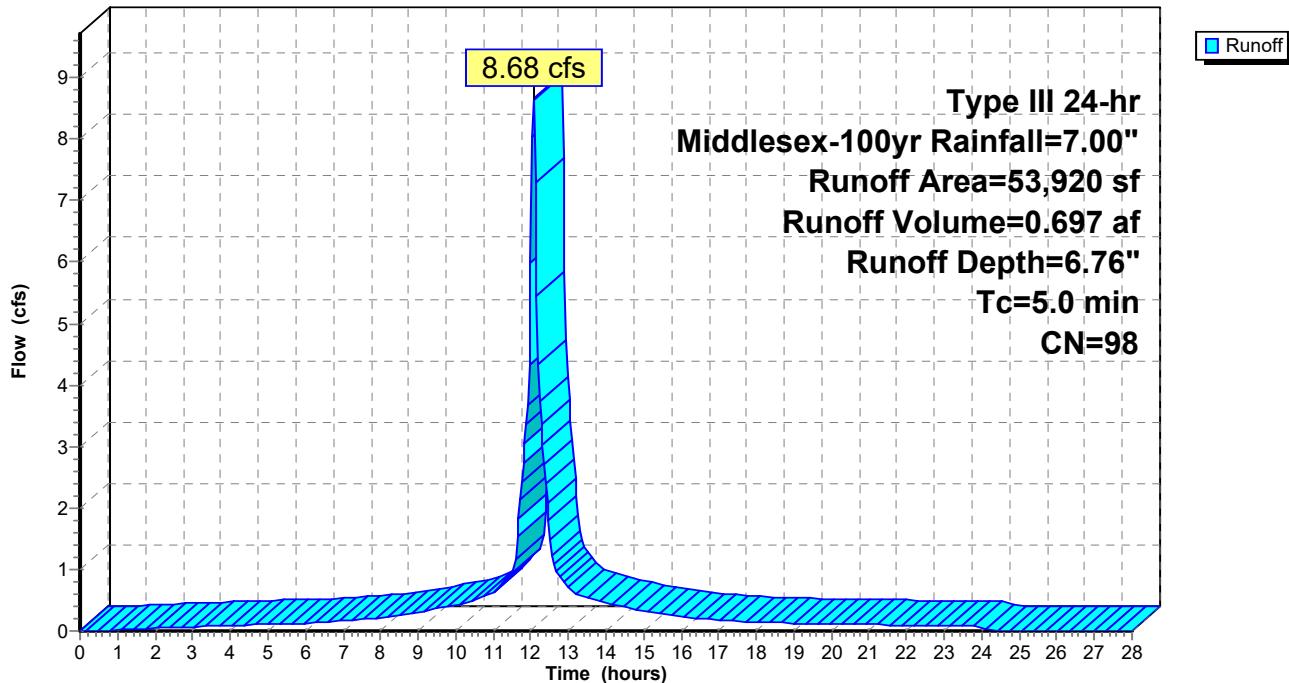
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
53,920	98	Paved parking, HSG B
53,920		100.00% Impervious Area

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

Subcatchment 5S: Route 20

Hydrograph



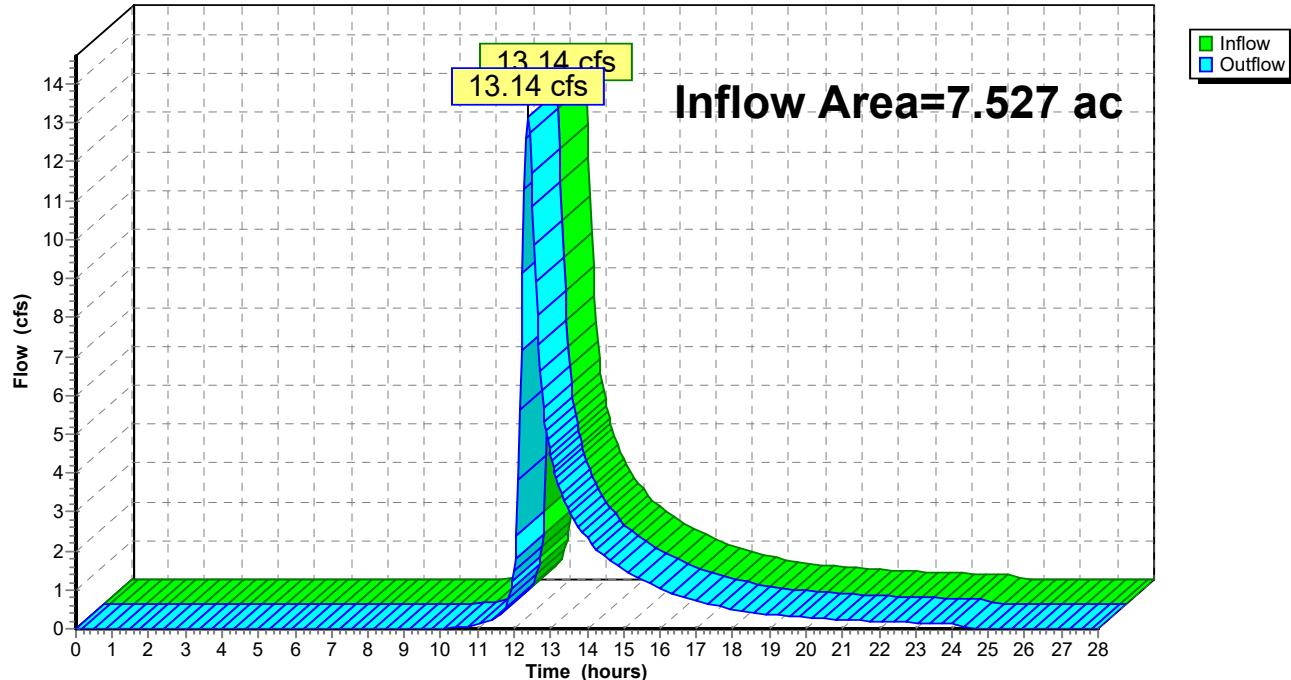
Summary for Reach 6R: DP-1

Inflow Area = 7.527 ac, 29.89% Impervious, Inflow Depth = 2.28" for Middlesex-100yr event

Inflow = 13.14 cfs @ 12.37 hrs, Volume= 1.433 af

Outflow = 13.14 cfs @ 12.37 hrs, Volume= 1.433 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 6R: DP-1**Hydrograph**

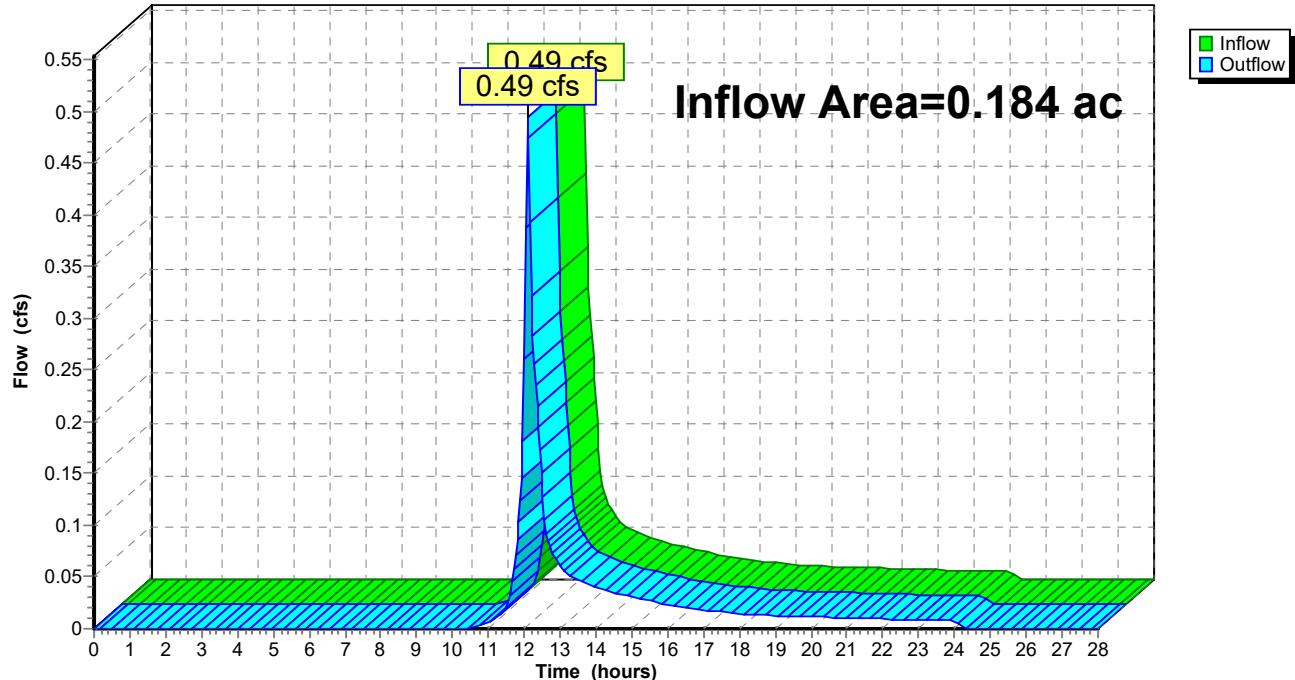
Summary for Reach 7R: DP-2

Inflow Area = 0.184 ac, 0.00% Impervious, Inflow Depth = 2.41" for Middlesex-100yr event

Inflow = 0.49 cfs @ 12.10 hrs, Volume= 0.037 af

Outflow = 0.49 cfs @ 12.10 hrs, Volume= 0.037 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 7R: DP-2**Hydrograph**

Proposed

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Type III 24-hr Middlesex-100yr Rainfall=7.00"

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Summary for Pond 5P: BASIN-1

Inflow Area = 4.700 ac, 47.72% Impervious, Inflow Depth = 4.44" for Middlesex-100yr event
 Inflow = 21.23 cfs @ 12.10 hrs, Volume= 1.739 af
 Outflow = 8.19 cfs @ 12.38 hrs, Volume= 1.384 af, Atten= 61%, Lag= 16.7 min
 Discarded = 0.47 cfs @ 12.38 hrs, Volume= 0.587 af
 Primary = 7.72 cfs @ 12.38 hrs, Volume= 0.797 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
 Peak Elev= 159.21' @ 12.38 hrs Surf.Area= 10,563 sf Storage= 31,802 cf

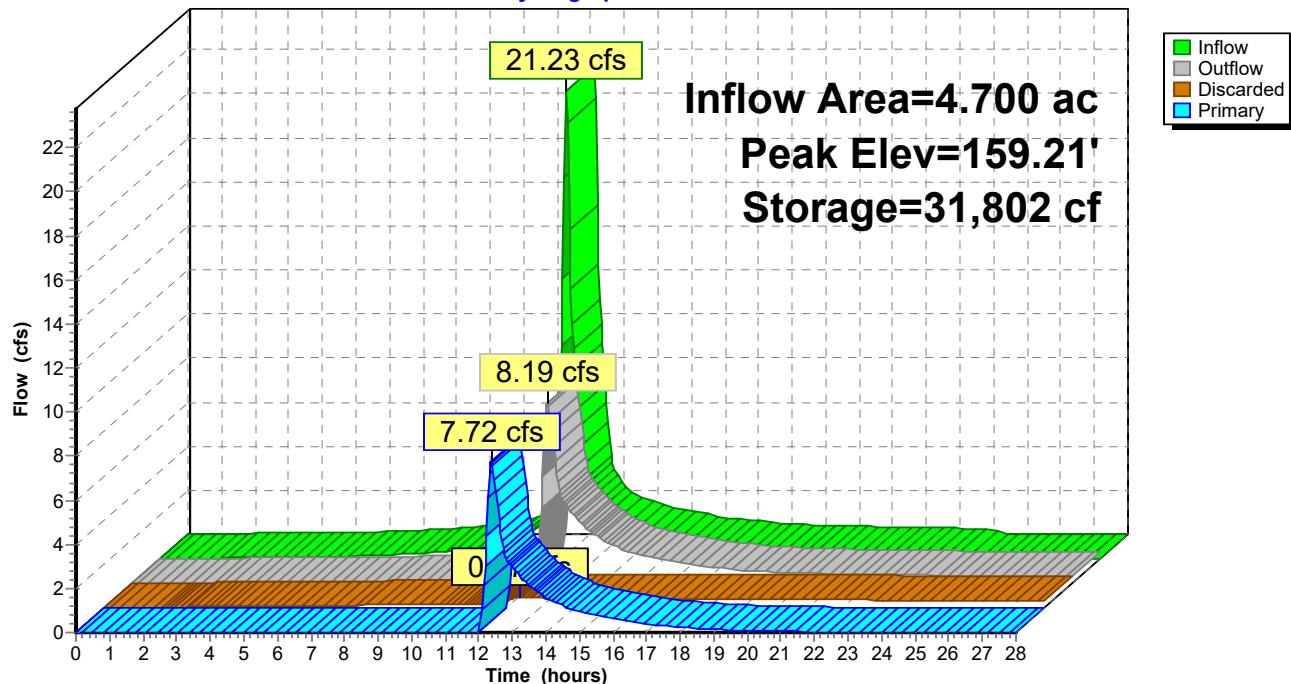
Plug-Flow detention time= 215.4 min calculated for 1.382 af (79% of inflow)
 Center-of-Mass det. time= 135.6 min (930.9 - 795.3)

Volume	Invert	Avail.Storage	Storage Description
#1	155.00'	40,568 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
155.00	4,691	0	0
156.00	5,992	5,342	5,342
157.00	7,350	6,671	12,013
158.00	8,764	8,057	20,070
159.00	10,235	9,500	29,569
160.00	11,762	10,999	40,568

Device	Routing	Invert	Outlet Devices
#1	Primary	159.00'	14.0' long x 15.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Primary	158.00'	12.0" Round Culvert L= 30.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 158.00' / 157.50' S= 0.0167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Discarded	155.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 152.00'

Discarded OutFlow Max=0.47 cfs @ 12.38 hrs HW=159.21' (Free Discharge)
 ↑ 3=Exfiltration (Controls 0.47 cfs)

Primary OutFlow Max=7.67 cfs @ 12.38 hrs HW=159.21' (Free Discharge)
 ↑ 1=Broad-Crested Rectangular Weir (Weir Controls 3.70 cfs @ 1.24 fps)
 2=Culvert (Barrel Controls 3.97 cfs @ 5.29 fps)

Pond 5P: BASIN-1**Hydrograph**

Proposed

Type III 24-hr Middlesex-100yr Rainfall=7.00"

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Summary for Pond 6P: Entrance Pond

Inflow Area = 3.595 ac, 44.84% Impervious, Inflow Depth = 4.30" for Middlesex-100yr event

Inflow = 16.67 cfs @ 12.08 hrs, Volume= 1.287 af

Outflow = 15.26 cfs @ 12.11 hrs, Volume= 1.286 af, Atten= 8%, Lag= 1.9 min

Primary = 15.26 cfs @ 12.11 hrs, Volume= 1.286 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs / 2

Peak Elev= 160.12' @ 12.11 hrs Surf.Area= 1,250 sf Storage= 1,678 cf

Plug-Flow detention time= 4.3 min calculated for 1.286 af (100% of inflow)

Center-of-Mass det. time= 3.8 min (792.6 - 788.8)

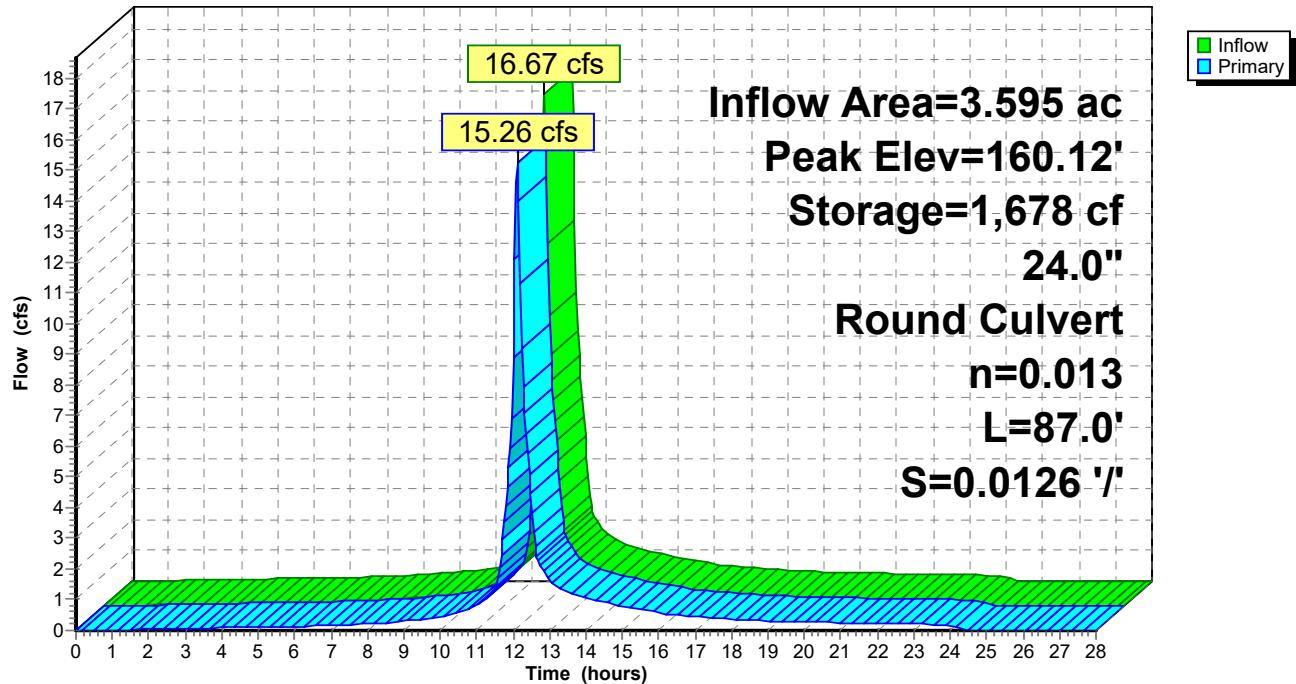
Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	5,058 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
158.00	364	0	0
159.00	758	561	561
160.00	1,193	976	1,537
161.00	1,685	1,439	2,976
162.00	2,480	2,083	5,058

Device	Routing	Invert	Outlet Devices
#1	Primary	158.10'	24.0" Round Culvert L= 87.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 158.10' / 157.00' S= 0.0126 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=15.12 cfs @ 12.11 hrs HW=160.10' (Free Discharge)

↑=Culvert (Inlet Controls 15.12 cfs @ 4.81 fps)

Pond 6P: Entrance Pond**Hydrograph**

APPENDIX D

TSS Removal, Water Quality Volume and Recharge Calculations

Groundwater Recharge Volume Required:

Rv = F x Impervious Area, where:

Rv = Required Recharge Volume [Ac-ft]

F = Target Depth Factor associated with each Hydrologic Soil Group (HSG) [in]

Impervious Area = Total Increase in Pavement and Rooftop Area under Post development Conditions [Ac]

		Impervious Area [Acres]	Required Recharge Volume [Ac-ft]
HSG "A", use F	= 0.6 in	0.000	0.000
HSG "B", use F	= 0.35 in	1.085	0.032
HSG "C", use F	= 0.25 in	0.000	0.000
HSG "D", use F	= 0.1 in	0.000	0.000
Total Required Recharge Volume (Rv) =			0.032 Ac-ft

Capture Area Adjustment: (Ref: DEP Handbook V.3 Ch.1 P.27-28)

Total Increase in Site Impervious Area (Total)= 1.085 Acres

Impervious Area Draining to Infiltrative BMPs (infil) = 1.06

Percent of Increase in Imp. Area Draining to Infiltrative BMPs = 97.4%

Capture Area Adjustment Factor = (Total)/(Infil) = Ca = 1.03

Adjusted Required Recharge Volume = Ca x Rv **0.032 Ac-ft**

Groundwater Recharge Volume Provided:

BMP	Provided Recharge Volume [Ac-ft]
Infiltration Basin	0.034
Total Provided Recharge Volume =	0.034 Ac-ft

Provided groundwater recharge volume is greater than or equal to the required recharge volume, therefore proposed stormwater management design is in compliance with Standard 3.

$$\text{Drawdown Time} = \frac{Rv}{(K) (\text{Bottom Area})}$$

where:

Rv = Storage Volume Below Outlet [Ac-ft]

K= Infiltration Rate [in/hr]

Bottom Area= Area of Recharge [Ac]

Infiltration Basin

Rv =	0.034 Ac-ft
K =	1.02 in/hr (<1.07 in/hr calculated from field testing)
Bottom Area =	0.039 Acres
Drawdown Time =	10.231 Hours

$$\text{Drawdown Time} = \frac{0.034 \text{ Ac-ft}}{(1.02 \text{ in/hr}) (0.039 \text{ ac})} = 10.231$$

10.231 < 72 Hours, therefore design is in compliance with Standard #3

Note:

1. The infiltration BMPs have been designed to fully drain within 72 hours, therefore the proposed stormwater management design is in compliance with Standard 3.
2. Infiltration Rate based on Volume 3, Chapter 1, Table 2.3.3 Rawls Rates from the 2008 MADEP Stormwater Management Handbook.

$$V_{WQ} = (DWQ / 12 \text{ in/ft}) \times (A_{IMP} \times 43,560 \text{ SF/Ac})$$

Where:

VWQ = Required Water Quality Volume [CF]

DWQ = Water Quality Depth: 1-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near critical areas, runoff from LUHPPL, or exfiltration to soil with infiltration rate 2.4 in/hr or greater; ½-inch for discharges to other areas.

AIMP = Post-development Increase in Impervious Area; may exclude roof top areas [Ac]

Required Water Quality Volume:

Drainage Area/ Treatment Train	AIMP (ac)	DWQ (in)	VWQ Required (cf)
PDA-2	0.595	1	2,161
Total Required Water Quality Volume:			2,161

Provided Water Quality Volume:

Drainage Area/ Treatment Train	BMP	Water Quality Volume Provided (cf)
PDA-2	Water Quality Unit	2,161
PDA-2	Infiltration Basin	0
Total Required Water Quality Volume:		2,161

Water quality volume provided is greater than or equal to the required water quality volume, therefore proposed stormwater management design is in compliance with Standard #4.

APPENDIX E

Site Owner's Manual

113 – 115 Boston Post Road
Wayland, Massachusetts

November 14, 2022

**PROJECT SITE
OWNER'S MANUAL**

Prepared For:

Cascade Development Associates, LLC
831 Beacon Street, Suite #268
Newton Center, MA 02459

Prepared By:

C1.0
**ENGINEERING &
DEVELOPMENT**

14 Spring Street
2nd Floor
Waltham, MA 02451

C1.0 #160012

1.0 INTRODUCTION

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Handbook. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

2.0 SITE OWNER'S AGREEMENT

2.1 Operation and Maintenance Compliance Statement

Site Owner: Cascade Development Associates, LLC
831 Beacon Street, Suite #268
Newton Center, MA 02459

Responsible Party: Cascade Development Associates, LLC

Eden Management, Inc. or their successors shall maintain ownership of the on-site stormwater management system as well as the responsibility for operation and maintenance during the post-development stages of the project. The site has been inspected for erosion and appropriate measures have been taken to permanently stabilize any eroded areas. All aspects of stormwater best management practices (BMPs) have been inspected for damage, wear and malfunction, and appropriate steps have been taken to repair or replace the system or portions of the system so that the stormwater at the site may be managed in accordance with the Stormwater Management Standards. Future responsible parties shall be notified of their continuing legal responsibility to operate and maintain the BMPs. The operation and maintenance plan for the stormwater BMPs is being implemented.

Responsible Party Signature Date

2.2 Stormwater Maintenance Easements

There are no off-site areas utilized for stormwater control, therefore no stormwater management easements are required. The Site Owner will have access to all stormwater practices for inspection and maintenance, including direct maintenance access by heavy equipment to structures requiring regular maintenance.

2.3 Record Keeping

The Site Owner shall maintain a rolling log in which all inspections and maintenance activities for the past three years shall be recorded. The Operation and Maintenance Log includes information pertaining to inspections, repairs, and disposal relevant to the project's stormwater management system. The Log is located in Appendix A. The Operation and Maintenance Log shall be made available to the Conservation Commission and the DEP upon request. The Conservation Commission and the DEP

shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the maintenance requirements for each BMP.

2.4 Training

Employees involved in grounds maintenance and emergency response will be educated on the general concepts of stormwater management and groundwater protection. The Site Owner's Manual will be reviewed with the maintenance staff. The staff will be trained on the proper course of action for specific events expected to be incurred during routine maintenance or emergency situations.

3.0 LONG-TERM POLLUTION PREVENTION PLAN

In compliance with Standard 4 of the 2008 DEP Stormwater Management Handbook, this section outlines source control and pollution prevention measures to be employed on-site after construction.

3.1 Storage of Materials and Waste

The site shall be kept clear of trash and debris at all times. Certain materials and waste products shall be stored inside or outside upon an impervious surface and covered, as required by local and state regulations.

3.2 Vehicle Washing

No commercial vehicle washing shall take place on site.

3.3 Routine Inspections and Maintenance of Stormwater BMPs

See Section 4.0 Long-Term Operation and Maintenance Plan, for routine inspection and maintenance requirements for all proposed stormwater BMPs.

3.4 Spill Prevention and Response

A contingency plan shall be implemented to address the spill or release of petroleum products and hazardous materials and will include the following measures:

- 3.4.1 Equipment necessary to quickly attend to inadvertent spills or leaks shall be stored on-site in a secure but accessible location. Such equipment shall include but not be limited to the following: safety goggles, chemically resistant gloves and overshoe boots, water and chemical fire extinguishers, sand and shovels, suitable absorbent materials, storage containers and first aid equipment (i.e. Indian Valley Industries, Inc. 55-gallon Spill Containment kit or approved equivalent).
- 3.4.2 Spills or leaks shall be treated properly according to material type, volume of spillage and location of spill. Mitigation shall include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally-friendly manner, and remediation of any damage to the environment.
- 3.4.3 For large spills, Massachusetts DEP Hazardous Waste Incident Response Group shall be notified immediately at (617) 792-7653 and an emergency response contractor shall be consulted.

3.5 Maintenance of Lawns, Gardens, and other Landscaped Areas

Lawns, gardens, and other landscaped areas shall be maintained regularly by the site owner. Vegetated and landscaped BMPs will be maintained as outlined in Section 4.0.

3.6 Storage and Use of Fertilizers, Herbicides, and Pesticides

All fertilizers, herbicides, and pesticides shall be stored in accordance with local, state, and federal regulations. The application rate and use of fertilizers, herbicides, and pesticides on the site shall at no time exceed local, state, or federal specifications.

3.7 Pet Waste Management

Pet owners shall be required to pick up after their animals and dispose of waste in the trash.

3.8 Operation and Management of Septic Systems

The proposed development includes a septic system to treat wastewater. The septic system shall be operated and maintained in accordance with local and state regulations.

3.9 Snow and Deicing Chemical Management

Snow removal and use of deicing chemicals at the proposed development shall comply with the following requirements:

- Plowed snow shall be placed in the areas designated on the site plans and/or outside of wetland boundaries and stormwater best management practices. The following maintenance measures shall be undertaken at all snow disposal sites:
 - Debris shall be cleared from an area prior to using it for snow disposal.
 - Debris and accumulated sediments shall be cleared from the site and properly disposed of at the end of the snow season and no later than May 15.
- In accordance with the Massachusetts General Laws, Chapter 85, Section 7A, salt and other de-icing chemicals will be stored at an indoor location. Salt and other deicing chemicals shall be stored in accordance with Massachusetts General Law.
- Sand piles shall be contained and stabilized to prevent the discharge of sand to wetlands or water bodies, and, where feasible, covered.
- Salt storage piles shall be located outside of the 100-year floodplain.
- The application of salt on the proposed parking areas and driveway shall at no time exceed state or local requirements.

3.10 Nutrient Management Plan

There are no TMDLs issued for the waterbodies downstream of the proposed project.

4.0 LONG-TERM OPERATION AND MAINTENANCE PLAN

This section outlines the stormwater best management practices (BMPs) associated with the proposed stormwater management system and identifies the long-term inspection and maintenance requirements for each BMP.

4.1 Stormwater Management System Components

The following table outlines the type and quantity of the BMPs and their general location. Please reference the site plan(s) provided in the Figures section for exact location. All basins are accessible for maintenance from either the development driveway or parking areas.

BMP	Quantity	Location
Catch Basins	3	Throughout paved parking area.
Proprietary Separator	1	In the western parking area, upgradient of the infiltration basin.
Infiltration Basin	1	Along the western perimeter of the

		property
--	--	----------

4.2 Inspection and Maintenance Schedules

4.2.1 General Maintenance for Mosquito Control

If necessary to minimize mosquito breeding, a licensed pesticide applicator shall apply larvicides, such as Bacillus sphaericus (Bs) to all catch basins sumps, and water quality inlets. Larvicides shall be applied in compliance with all pesticide label requirements, and will be applied during or immediately after wet weather, unless the product used can withstand extended dry periods. Ensure all manhole covers, and inspection ports are secure to reduce the likelihood of mosquitoes laying eggs in standing water.

4.2.2 Area Drains and Drop Inlets

Area drains and drop inlets shall be inspected and/or cleaned at least once per year.

4.2.3 Proprietary Separators

Maintenance of proprietary separators shall be performed according the recommendations set forth by the manufacturer (see Appendix C. Proprietary Separator Technical Manual for complete installation, operation, and maintenance procedures). Inspection and maintenance procedures for proprietary devices are provided below:

- Units shall be inspected post-construction, prior to being put into service.
- Units shall be inspected not less than twice per year following installation and no less than once per year thereafter.
- Units shall be inspected 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.

4.2.4 Infiltration Basins

Infiltration basins shall be inspected and maintained after major storm events (rainfall totals greater than 2.5 inches in 24 hours) during the first three months of operation and twice a year and when there are discharges through the outlet control structure thereafter. Additionally, all pretreatment BMPs shall be inspected in accordance with the minimal requirements specified for those practices and after all major storm events. Inspections shall include the following measures:

- During and after major storm events, the length of time standing water remains in the basin shall be recorded.
 - If the time is greater than 72 hours, thoroughly inspect the basin for signs of clogging. A corrective action plan should then be developed by a qualified professional to restore infiltrative function. The Site Owner shall take immediate action to implement these corrective measures.

- Examine the outlet structure for evidence of clogging or outflow release velocities that are greater than the design velocity.
- Identify areas of sediment accumulation, differential settlement, cracking, and erosion within the basin.
- Inspect embankments for leakage and tree growth.
- Examine the health of the vegetation within the basin and on the embankments.

Corrective measures shall be taken immediately as warranted by the inspections. If any evidence of hydrocarbons is found during inspection, the material shall be immediately removed using absorbent pads or other suitable measures and legally disposed.

Preventative maintenance shall include the following activities:

- Mow the buffer area and basin bottom and side slopes, if vegetated.
- Remove trash, debris, and accumulated organic matter.
- Remove clippings after mowing.

4.2.5 Stormwater Outfalls

Flared end sections and associated riprap spillways shall be inspected at least once per year and after major storm events (rainfall totals greater than 2.5 inches in 24 hours) to ensure that the stability of the outlet area is maintained. The outfall area shall be kept clear of debris such as trash, branches, and sediment. Repairs shall be made immediately if riprap displacement or downstream channel scour is observed.

4.3 Estimated Operation and Maintenance Budget

An operations and maintenance budget was prepared to approximate the annual cost of the inspections required in compliance with the DEP Stormwater Management Policy. The table below estimates the annual cost to inspect and maintain each proposed BMP, based on the requirements in Section 4.2.

BMP Type	# of BMPS	Annual O&M Cost (per BMP)	Total Cost
Catch Basin	3	\$200-\$400	\$600-\$1,200
Area Drain	1	\$50-\$100	\$50-\$100
Water Quality Unit	1	\$100-\$300	\$100-\$300
Infiltration Basin	1	\$200 - \$400	\$200-\$400
Riprap Spillway	3	\$50-\$100	\$150-\$300
		Total	\$1,100-\$2,300

4.4 Public Safety Features

Multiple safety measures are proposed to protect the public and prevent pollutant contamination of the stormwater management system and other water resources. Curbing and vegetation along the driveway will prevent cars from inadvertently detouring down steep side slopes and into adjacent wetlands or stormwater basins. The site was designed to ensure protection to the public and prevent pollutant contamination of the stormwater management system and the municipal drainage system.

Parameter Brief

Removal of Suspended Solids using the CDS® System – Laboratory Evaluations

The CDS® system is a hydrodynamic separator which uses patented continuous deflective separation (CDS) technology to separate and capture trash, debris, sediment and oil and grease from stormwater runoff. Indirect screening allows for 100% removal of floatables and neutrally buoyant material without blinding the screen. Flow and screening controls separate captured solids and minimize resuspension of previously captured pollutants.

The CDS system can effectively capture 100% of particulate material, including trash and debris, greater than screen aperture size (2400 or 4700 microns). In addition, the CDS can remove medium and coarse sediments. A full-scale laboratory evaluation of the CDS system using test materials with various particle size distributions is summarized here.

Laboratory Study – Full-Scale Evaluation at University of Florida

A full-scale CDS unit (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This full-scale CDS unit was evaluated under controlled laboratory conditions of pumped influent and the controlled addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSD) of the test materials were analyzed using standard method "Gradation ASTM D-422 with Hydrometer" by a certified laboratory. UF Sediment is a mixture of three different U.S. Silica Sand products referred as: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d_{50} = 20 to 30 µm) covering a wide size range (uniform coefficient C_u averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d_{50} (d_{50} for NJDEP is approximately 50 µm) (NJDEP, 2003). The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d_{50}) of 106 microns. The PSDs for the test material are shown in Figure 1.

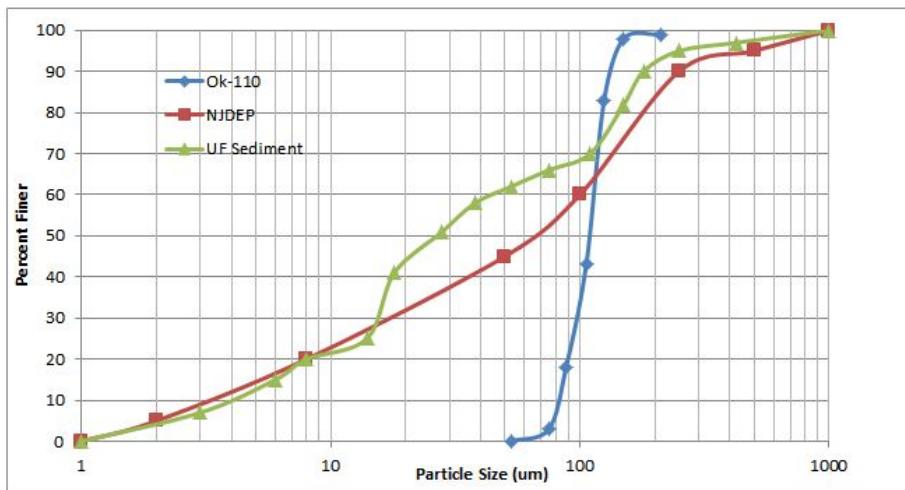


Figure 1. Particle size distributions for the test materials, as compared to the NJCAT/NJDEP theoretical distribution.

Tests were conducted to quantify the CDS unit (1.1 cfs design capacity) performance at various flow rates, ranging from 1% up to 125% of the design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC – ASTM Standard Method D3977-97) and particle size distribution analysis.

Results and Modeling

Based on the testing data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve for the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation assuming sandy-silt type of inorganic components of SSC. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand).

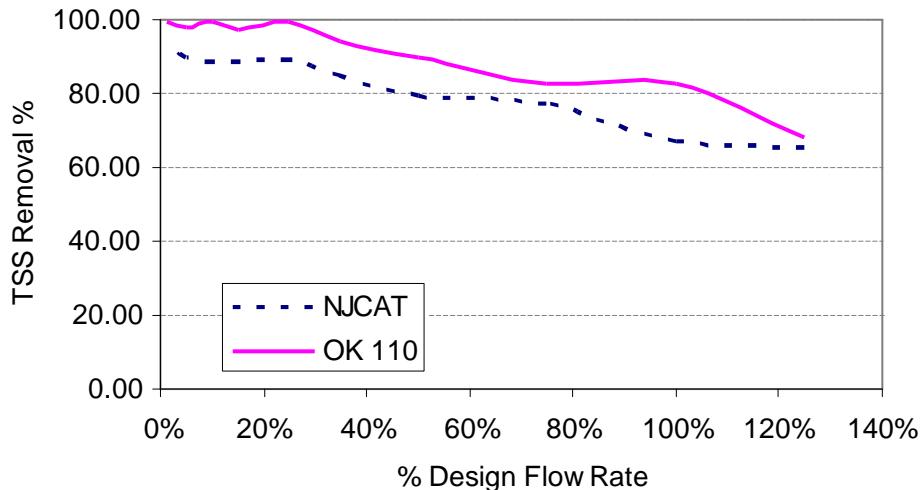


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d_{50}) of 125 microns (WADOE, 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). Supported by the laboratory data, the model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at 100% of design flow rate, for this particle size distribution ($d_{50} = 125 \mu\text{m}$).

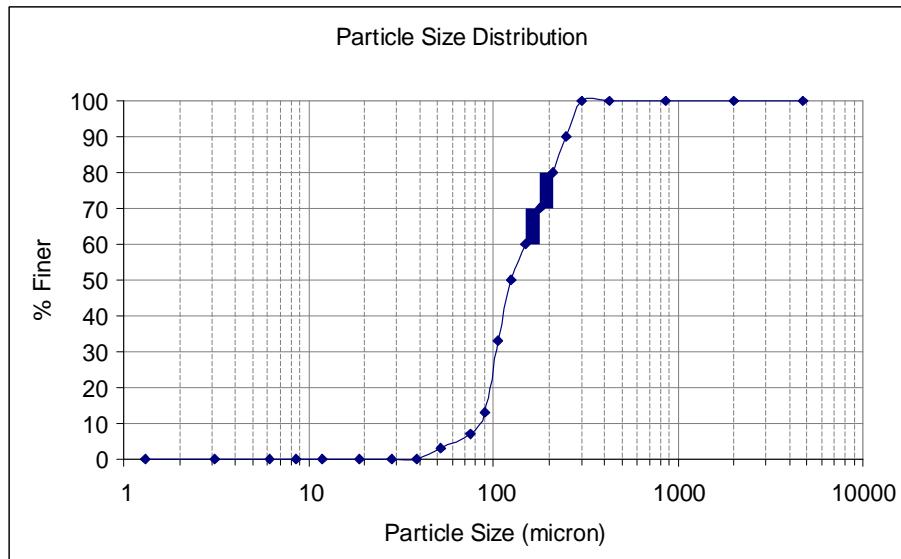


Figure 3. PSD with $d_{50} = 125$ microns, used to model performance for Ecology submittal.

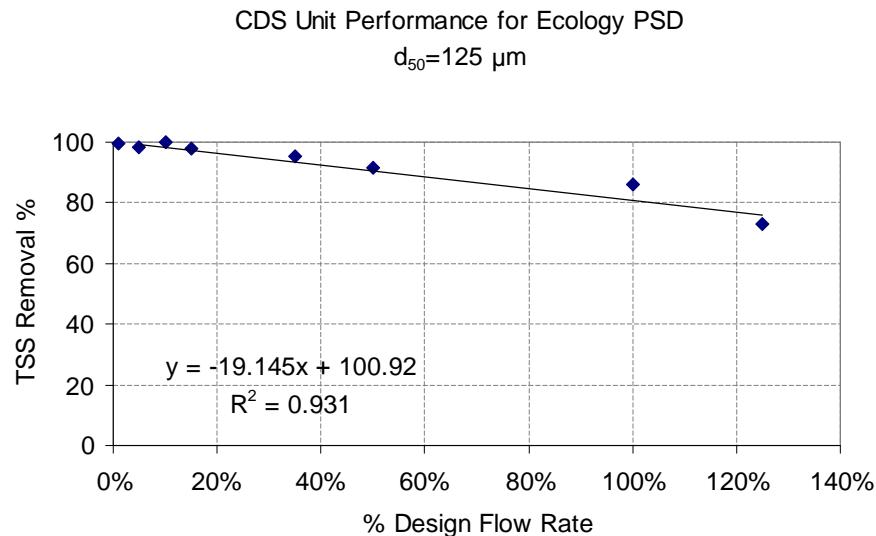


Figure 4. Modeled performance for CDS unit with 2400 microns screen, using Ecology PSD.

References:

- New Jersey Department of Environmental Protection (NJDEP). (2003). Total Suspended Solids Laboratory Testing Procedures (December 23, 2003).
- Washington State Department of Ecology (WADOE). (2008). Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol—Ecology (TAPE) (Publication Number 02-10-037). Olympia, Washington: Author. Available Online: www.ecy.wa.gov/biblio/0210037.html

The CDS® Unit for Removal of Oil and Grease

The CDS system is a hydrodynamic separator which uses patented continuous deflective separation (CDS) technology to separate and trap debris, sediment and oil and grease from stormwater runoff. Indirect screening allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls separate captured solids and minimize resuspension of previously captured pollutants.

Oil and grease (O&G) are commonly found in stormwater runoff from automobiles and associated anthropogenic activities. O&G appear in many different forms in stormwater runoff: free, dissolved, emulsified, and attached to sediments. Total Petroleum Hydrocarbons (TPH) is the usual analytical measure of fuels, oil and grease (O&G) for stormwater. Typically the concentrations of TPH associated with runoff from streets and parking lots range from 2.7 to 27 mg/l (FHWA, 1996). The Oregon Association of Clean Water Agencies (ACWA) reports O&G levels for runoff from different land uses for the period of 1991 – 1996, as shown in Table 1.

Table 1. O&G levels from different land uses.

Land Use	Median (mg/L)	Range (mg/L)
Residential	1.2	ND - 12.6
Commercial	2.4	ND – 18
Industrial	2.0	ND – 107.6 (12 mg/l next highest)
Mixed	1.0	ND –28

CDS units can be equipped with a conventional oil baffle to capture and retain oil, grease, and other TPH pollutant as they are transported through the storm drain system during wet weather (stormwater) and dry weather (spills) flows. In addition, CDS units with the addition of oil sorbents can ensure the permanent removal of the free oil and grease from stormwater runoff. Laboratory investigations into the CDS unit's removal of oils and greases are summarized below.

Laboratory Studies – CDS Unit at Portland State University, 2003

In 2003, Slominski and Wells at Portland State University conducted tests on a CDS Model 20_20 unit equipped with a 2400 micron screen and oil baffle. Tests were conducted at 25, 50 and 75 percent of the unit's hydraulic capacity (500 gpm) for the removal of used motor oil with influent concentrations of 10, 25 and 50 mg/L. A summary of the test is shown in Table 2 (Slominski and Wells, 2003).



UNIVERSITY OF MASSACHUSETTS AT AMHERST

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Massachusetts Stormwater
Evaluation Project

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www.mastep.net

MASTEP Technology Review

Technology Name: CDS (Continuous Deflective Separator) - Contech Stormwater Solutions, Inc.

Studies Reviewed:

- Independent Review of CDS 2015 Product Evaluation, FB Environmental Associates, 2009.
- NJCAT Technology Verification Addendum Report High Efficiency Continuous Deflective Separators CDS Technologies Inc. December 2004
- Continuous Deflection Separation (CDS) Unit For Sediment Control In Brevard County, Florida January, 2000

Date: 12/16/2009

Reviewer: Jerry Schoen

Rating: 2

Brief rationale for rating: MASTEP rating is based primarily on FB Environmental 2009 laboratory study. This study generally followed NJDEP-recommended laboratory test protocols, with some exceptions: no evidence of a Quality Assurance Project Plan, little discussion of quality control, higher than recommended particle size distribution, limited range of influent sediment concentration, sediments analyzed by SSC method but not TSS.

The Florida field study monitored 5 storm events and encountered sampling/equipment problems in four of them. The NJCAT lab study was conducted on a unit that was specially modified for testing in New Jersey, and is now being sold in NJ and NY.

Other Comments:

FB Environmental Associates study:

- OK-110 sediment mix used. This is recommended by Maine DEP, but produces sediments somewhat larger than those recommended by New Jersey DEP.
- Sediment analysis conducted with whole sample; essentially SSC method. SSC is generally regarded as more accurate than TSS method, but comparisons with other studies or products that use TSS data are problematic.
- Full range of flows were tested.
- Only one target sediment concentration was tested; average influent SSC was 313 mg/l, slightly outside of recommended 100-300 mg/l range.
- Scour test was performed; system produced no scour at flows up to 137% of capacity.

NJCAT Study

- Expectations of sediment removal performance comparable to this study should be confined to units that contain the sediment weir and a 2400 micron screen.
- The study did not include a scour test.
- A particularly fine sediment mix (Sil-Col-Sil 106, pre-washed to remove all particles > 100 microns), which makes sediment removal more difficult. Higher removal efficiencies may be obtained if sediment particle size range is larger.

- A narrow range of influent sediment (164 – 203 mg/l, average 184), was tested but this is within the NJDEP-recommended 100-300 mg/l range.
- TSS analysis appears to have been performed by a non- standardized method.
- No discussion of quality control.

Brevard County FL study

- This study was performed before release of the TARP Tier II Protocols and does not conform to them.
- The study states that “testing under higher flow conditions would be desirable.”
- TSS, BOD, COD, pH, total phosphorus, and turbidity were monitored.

Table 2. Summary of oil and grease tests (Slominski and Wells, 2003).

Flow Rate (gpm)	Influent Conc. (mg/L)	Average Effluent Conc. (mg/L)	Removal Efficiency (%)
125	7.2	3.5	51
125	18.3	1.5	92
125	46.2	3.5	92
250	9.9	2	80
250	22.8	5	78
250	45.6	7.5	84
375	10.5	7.5	29
375	21.9	16	27
375	46.9	27	42

Laboratory Studies – CDS Unit Oil Spill Test at Portland State University, 2003

In addition to the regular capture test performed to measure the removal of free oil and grease from stormwater, Slominski and Wells (2003) also performed an oil spill test. The unit performed extremely well in the oil spill test, with the peak oil concentration in the effluent occurring right as the addition of oil to the unit stopped. This showed a capture rate of more than 99.75% of the oil dumped into the unit (82,000 mg/L). This demonstrates that a CDS unit would be a very effective means of containing an oil spill. An oil storage capacity chart for the CDS unit is available on request.

Laboratory Study – CDS Unit with Sorbents at University of California, Los Angeles (UCLA)

Studies by Stenstrom and Lau (1998) at UCLA demonstrated that the CDS unit with sorbents can achieve 80 to 90 percent removal of oil and grease at influent concentrations ranging from 13.6 mg/L to 41.1 mg/L. Test results showed that the effluent oil and grease concentrations were less than 10 mg/L.

A series of nine laboratory experiments were performed on a CDS unit (Model PMSU20_15) to determine its ability to remove free oil and grease using sorbents (Stenstrom and Lau, 1998). One control experiment was performed without sorbents. The focus of this study was to evaluate the effectiveness of various sorbent materials to control the typically low concentrations of free oil and grease found in urban stormwater runoff when applied within the separation chamber of a CDS unit. The conventional oil baffle was not installed within the CDS unit during this evaluation. The sorbents were allowed to float on the surface of the separation chamber of the CDS device. Different amounts of each sorbent were used because of the varying properties of the sorbents (density and surface area).

Tests were performed using a 2400-micron screen over 30 minutes at 125 gpm (approximately 40% of the CDS unit's nominal flow capacity). Used motor oil (Specific Gravity = 0.86) was introduced into the feed of the CDS at approximately 25 mg/L, which is generally the upper limit of oil and grease concentrations found in stormwater runoff. Oil and grease were measured at various times (influent/effluent) to determine the

removal efficiency. Background oil and grease was measured as well as oil and grease released from the sorbents after the influent oil and grease was reduced to zero.

Five commercially available sorbents were evaluated. Two sorbents were found particularly effective and they are:

- OARS™ (AbTech Industries, 4110N. Scottsdale Rd., Suite 235, Scottsdale, AZ 85251)
- Rubberizer™ (Haz-Mat Response Technologies, Inc., 4626 Santa Fe Street, San Diego, CA 92109)

Results from the sorbent laboratory study (Stenstrom and Lau, 1998) are shown in Table 3.

Table 3. Performance of Oil and Grease Removal of CDS Units.

Test No.	Sorbent Type	Sorbent Mass (g)	Influent (mg/L)	Effluent (mg/L)	Percent Removal	Flow (gpm)
2	OARS	2600	19.6	2.7	86	125
3	OARS	2600	24.0	4.3	82	190
4	OARS	2600	30.7	1.7	94	75
5	OARS	2600	21.0	3.5	83	125
6	Rubberizer	1030	27.2	3.9	86	125

Effluent concentration of oil using the OARS™ sorbent was less than 1.0 mg/L. Effluent concentration of oil using the Rubberizer™ sorbent was 1.96 mg/L.

References:

- Federal Highway Association. (1996). Evaluation and Management of Highway Runoff Water Quality. Publication No. FHWA-PD-96-032.
- Slominski and Wells. (2003). Oil and Grease Removal using Continuous Deflection Separation with an Oil Baffle. Portland, Oregon: Author.
- Stenstrom, M. K. and Sim-Lin Lau. (1998). Oil and Grease Removal by Floating Sorbent in a CDS Device. Los Angeles.

APPENDIX F

Stormwater Checklist



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 8²
- 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.

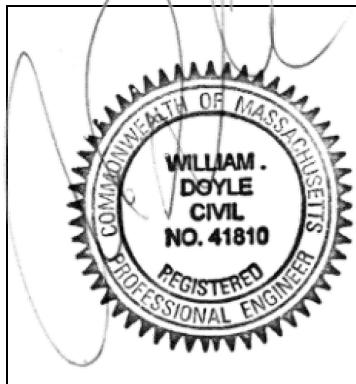
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Signature and Date

Checklist

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

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



Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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



Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

- Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

- Soil Analysis provided.
- Required Recharge Volume calculation provided.
- Required Recharge volume reduced through use of the LID site Design Credits.
- Sizing the infiltration, BMPs is based on the following method: Check the method used.
 - Static
 - Simple Dynamic
 - Dynamic Field¹
- Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
 - Site is comprised solely of C and D soils and/or bedrock at the land surface
 - M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
 - Solid Waste Landfill pursuant to 310 CMR 19.000
 - Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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



Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

Standard 4: Water Quality

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

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



Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

- The BMP is sized (and calculations provided) based on:
 - The ½" or 1" Water Quality Volume or
 - The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the proprietary 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.