

DRAINAGE REPORT

For

Town of Shrewsbury

PROPOSED

“CENTECH PARK NORTH”

***384-386 South Street
Shrewsbury, Massachusetts
Worcester County***

Prepared by:

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I. EXECUTIVE SUMMARY

This report examines the changes in drainage that can be expected as the result of the development of a proposed dead-ended subdivision road (“Road A”) of approximately 1,000± feet in length on the former Allen Farm property. Construction of the road will also include associated utility infrastructure, stormwater management components, a sidewalk, landscaping and lighting. The road will extend from South Street in the northern portion of the Site.

The subject property (the “Site”), which contains approximately 66.5± acres of land, is currently developed with three (3) vacant buildings and a paved/gravel parking area associated with the prior agricultural use of the property. The remaining and majority portion of the Site consists of undeveloped woodlands with mature tree growth, areas covered by scrub vegetation and secondary tree growth within the former farm fields, and wetland resource areas. The Site has undeveloped frontage along South Street and Route 20, and is separated into two distinct developable areas by a large wetland resource area that generally extends from the southwest edge of the Site to the northeast.

This report addresses a comparative analysis of the pre- and post-development site runoff conditions. Additionally, this report provides calculations documenting the design of the proposed stormwater conveyance/management system as illustrated within the accompanying Site Development Plans prepared by Bohler Engineering. The project will also provide erosion and sedimentation controls during the demolition and construction periods, as well as long term stabilization of the site.

On-Site Soil Information

The majority of the soils at the site are mapped as Paxton fine sandy loam which are classified by the Natural Resource Conservation Service (NRCS) with Hydrologic Soil Group (HSG) “C”. The central portion of the site and small portion of the site to the north are mapped as Ridgebury fine sandy loam and Whiteman loam, which are classified as HSG “D”, and Woodbridge fine sandy loam, which is classified as HSG “C/D”. Refer to **Appendix C** for additional information.

Design Point Descriptions

For the purposes of this analysis the pre- and post-development drainage conditions were analyzed at three (3) design points (DP1N, DP1S, & DP2) which are identified as onsite wetlands where stormwater runoff currently drains to under existing conditions. The central and largest wetland system is considered (2) design points, north (DP1N) and south (DP1S), to reflect Sub-Districts A and B which are located to the north and south of the wetland. The third design point (DP2) is associated with the wetland located in the northwest corner of the Site. The project proposes to develop the areas within DP1N and reduce the area flowing to DP2N. The sub-catchments associated with DP1N and DP2N are described in further detail in Sections 2 and 3 below.

A summary of the existing and proposed conditions peak runoff rates for the 2-, 10-, 25-, and 100-year storms can be found in **Table 1** below. Refer to the Drainage Area Maps in **Appendices D & E** for a graphical representation of the drainage areas.

Table 1: Design Point Peak Runoff Rate Summary*

Point of Analysis	2-Year Storm			10-Year Storm			25-Year Storm			100-Year Storm		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
DP1N	27.36	27.34	-0.02	55.98	55.52	-0.46	72.20	71.40	-0.80	97.10	95.38	-1.72
DP1S	25.79	25.79	0	49.76	49.76	0	63.06	63.06	0	83.26	83.26	0
DP2N	4.14	3.96	-0.18	8.31	7.95	-0.36	10.65	10.19	-0.46	14.24	13.63	-0.61

**Flows are represented in cubic feet per second (cfs)*

II. EXISTING SITE CONDITIONS

Existing Site Description

The Site consists of approximately 66.5± acres of land located on the west side of South Street, and contains three (3) vacant buildings and a paved/gravel parking area. The site is bounded by Charles River Laboratories to the north, South Street to the east, commercial properties to the east and south, a solar field to the southwest, and residential properties to the west.

Existing Collection and Conveyance

Stormwater generated onsite flows overland to one of two (2) onsite wetland systems. The small wetland system to the north flows offsite to the northwest and is associated with the Blackstone Watershed. The larger centrally located wetland flows to the east crossing beneath Route 20, and is associated with the Concord (SuAsCo) Watershed. A portion of the runoff in the northern portion of South Street is collected in a series of catch basins and conveyed to the centrally located wetland onsite. Runoff in the southern portion of South Street is collected in a series of catch basins and conveyed to a headwall located at the property line and flows to the central wetland onsite. Elevations onsite range from a maximum of 564 feet in the west to 496 feet adjacent to wetlands in the east. Slopes onsite range from approximately 20% to 0.5%.

The existing site is mapped as three (3) sub-catchments as further described below.

Sub-catchment E1N consists of 36.62 acres with existing paved/gravel parking areas, building roofs, and undeveloped woods and wetlands. Runoff from this area flows overland from north to south to a large wetland system centrally located onsite. This area has a calculated curve number of 79 and a calculated time of concentration of 31.9 minutes.

Sub-catchment E2N consists of 5.09 acres with undeveloped woods and wetlands. Runoff from this area flows overland from south to north to a wetland system in the northwest corner of the Site. This area has a calculated curve number of 80 and a calculated time of concentration of 29.9 minutes.

Sub-catchment E1S consists of 24.77 acres with undeveloped woods and wetlands. Runoff from this area flows overland from south to north to a large wetland system centrally located onsite.

This area has a calculated curve number of 82 and a calculated time of concentration of 21.7 minutes.

III. PROPOSED SITE CONDITIONS

Proposed Development Site Conditions

The proposed project consists of the construction of a new 1,000± LF subdivision road on the former Allen Farm property located at 384-386 South Street, along with a new pedestrian sidewalk, storm water management components, off grading, lighting and associated utilities. Due to existing site grades, a retaining wall of varying height is proposed within the south side of the proposed right-of-way.

Proposed Development Collection and Conveyance

The proposed subdivision road is designed to drain to three (3) underground stormwater conveyance systems. Runoff generated from the western and central portions of the roadway is proposed to be collected in a series of deep-sump, hooded catch basins associated with two (2) separate drainage systems. Flows will be directed to water quality units for additional pretreatment prior to discharge to forebays and surface infiltration systems located on the south side of the subdivision road (Basins #1 and #2). Pretreatment will be provided by deep -sump, hooded catch basins, proprietary water quality units, and forebays. The infiltration basins will provide peak rate attenuation, stormwater recharge and water quality treatment. Overflow from the basins will discharge to the large wetland system centrally located onsite.

Runoff generated from the eastern portion of the roadway is proposed to be collected in a series of deep-sump, hooded catch basins. Flows will be directed to a proprietary water quality unit prior to discharge to the large wetland system centrally located onsite.

A 4.4± acre area of woodland up gradient of the proposed subdivision road is proposed to be cleared and utilized as an area of cut to provide fill material for the construction of the proposed road. A series of grass swales are proposed at the foot of the clearing on the northern side of the subdivision road to intercept flows from this area and the remaining woodland area located upgradient of the proposed road. Drainage inlets located within the swales will collect and direct

flows through a culvert proposed beneath the subdivision road which ultimately discharges to the central wetland system.

Pipes have been designed for the 25-year storm using the Rational Method and pipe sizing calculations are included in **Appendix F**.

The best management practices (BMPs) incorporated into the proposed stormwater management system have been designed to meet the Stormwater Standards for new development and redevelopment, as applicable. Refer to **Appendix F** for calculations. In addition, a Stormwater Operation and Maintenance (O&M) Plan, attached in **Appendix G**, has been developed which includes scheduled maintenance and periodic inspections of stormwater management systems.

The project has been designed to maintain existing drainage watersheds to the greatest extent possible and with the same design points as described in **Section II** above. The project proposes to impact design points DP1N and DP2N, and design point DP1S will be maintained. DP1N was subdivided into five (5) sub-catchments, and DP2N maintains one (1) sub-catchment for the proposed conditions, as further described below.

Sub-catchment P1N(a) consists of 0.57 acres with roadway and landscaping. Runoff from this area flows overland from west to east to a series of catch basins and a proprietary water quality unit prior to discharge to a forebay and Basin #1. Overflow from the basin discharges to the central wetland. This area has a calculated curve number of 89 and a calculated time of concentration of 6 minutes.

Sub-catchment P1N(b) consists of 0.87 acres with roadway and landscaping. Runoff from this area flows overland toward the center of the proposed subdivision road to a series of catch basins and a proprietary water quality unit prior to discharge to a forebay and Basin #2. Overflow from the basin discharges to the central wetland. This area has a calculated curve number of 90 and a calculated time of concentration of 6 minutes.

Sub-catchment P1N(c) consists of 0.33 acres with roadway and landscaping. Runoff from this area flows overland to a series of catch basins and a proprietary water quality unit prior to discharge to the central wetland. This area has a calculated curve number of 94 and a calculated time of concentration of 6 minutes.

Sub-catchment P1N(d) consists of 4.37 acres of cleared vegetation located upgradient of the proposed subdivision road. Runoff generated within this sub-catchment flows overland to a series of grass swales with drainage inlets. These inlets collect and direct runoff through culverts extending beneath the roadway and ultimately discharge to the central wetland. This area has a calculated curve number of 74 and a calculated time of concentration of 14.6 minutes.

Sub-catchment P1N(e) consists of 30.70 acres of woodland, landscaping and wetlands. Runoff generated north of the proposed subdivision road flow overland to swales proposed along the north side of the road, and is collected in drainage inlets that direct runoff through culverts extending beneath the proposed road that ultimately discharge to the central wetland. Runoff from the remaining area flows overland to the wetland. This area has a calculated curve number of 81 and a calculated time of concentration of 33.4 minutes.

Sub-catchment P2N consists of 4.87 acres of woodland and wetlands. Runoff from this area flows overland from south to north to a wetland system in the northwest corner of the Site. This area has a calculated curve number of 80 and a calculated time of concentration of 29.9 minutes.

Refer to **Table 1** for proposed conditions peak rates of runoff. For additional hydrologic information, refer to **Appendix E**. Refer to the Drainage Area Maps in the appendices of this report for a graphical representation of the existing and proposed drainage areas.

IV. METHODOLOGY

Peak Flow Calculations

Methodology utilized to design the proposed stormwater management system includes compliance with the guidelines set forth in the latest edition of the Massachusetts DEP Stormwater Handbook. The pre- and post-development runoff rates being discharged from the site were computed using the HydroCAD computer program. The drainage area and outlet information were entered into the program, which routes storm flows based on NRCS TR-20 and TR-55 methods. The other components of the model were determined following standard NRCS procedures for Curve Numbers (CNs) and times of concentrations documented in the appendices of this report. The rainfall data utilized and listed below in **Table 2** below for stormwater calculations is based on Technical Paper-40. Refer to **Appendix F** for more information.

Table 2: Rainfall Intensities

Frequency	2 year	10 year	25 year	100 year
Rainfall* (inches)	3.00	4.50	5.30	6.50

*Values derived from Hydrology Handbook for Conservation Commissioners prepared by Mass DEP (TP-40 Maps)

The proposed stormwater management as designed will provide a decrease in peak rates of runoff from the proposed facility for the 2-, 10-, 25- and 100-year design storm events. Additionally, the proposed project meets the MADEP Stormwater Management standards as described further below.

V. STORMWATER MANAGEMENT STANDARDS

The site is considered a mix of new development and redevelopment and is designed in accordance with the Massachusetts Stormwater Management Standards as outlined below.

Standard #1: No New Untreated Discharges

The project has been designed so that proposed impervious areas shall be collected and passed through the proposed drainage system for treatment prior to discharge. Therefore, there are no new untreated discharges proposed as part of the project.

Standard #2: Peak Rate Attenuation

As outlined in **Table 1**, the development of the site and the proposed stormwater management system have been designed so that post-development peak rates of runoff are below pre-development conditions for the 2-, 10-, 25- and 100-year storm events at all design points.

Standard #3: Recharge

Stormwater runoff from majority of the subdivision road will be collected and diverted to two (2) proposed infiltration basins. The project as proposed will involve the creation of 0.43 acres of new impervious area and is required to infiltrate 520 cubic feet of stormwater as defined in Stormwater Standard 3. The proposed infiltration basins will provide a total of 5,336 cubic feet of volume below the lowest outlet for groundwater recharge. Refer to **Appendix F** of this report for calculations documenting required and provided recharge volumes.

The DEP Stormwater Standards require that the infiltration BMP drains completely within 72 hours of the end of the storm event. Drawdown calculations are included in **Appendix F** of this report.

A four (4) foot separation to estimated seasonal high groundwater is provided and a groundwater mounding analysis is not required.

Standard #4: Water Quality

Water quality treatment is provided via deep sump catch basins, proprietary water quality units, forebays and infiltration basins. TSS removal calculations are included in **Appendix F** of this report. The project as proposed will include 1.12 acres impervious area in total, and is required to treat 4,066 cubic feet of water quality volume as defined in Stormwater Standard 4. The proposed infiltration basin provides 5,336 cubic feet of water quality volume below the lowest outlet for water quality treatment. Refer to **Appendix F** of this report for calculations documenting required and provided water quality volumes.

Standard #5: Land Use with Higher Potential Pollutant Loads

The proposed project involves “Land Uses with Higher Potential Pollutant Loads”. Accordingly, the project will provide 44% TSS removal prior to infiltration, and proprietary treatment units (oil grit separators) are proposed within each treatment train, as further illustrated in **Appendix E** of this report.

Standard #6: Critical Areas

Not Applicable for this project.

Standard #7: Redevelopment

This project is considered a mix of new development and redevelopment; however, the site has been designed as if it is a new development. The project has been designed to meet the Stormwater Standards.

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

The proposed project will provide construction period erosion and sedimentation controls as indicated within the site plan set provided for this project. This includes a proposed construction exit, protection for stormwater inlets, protection around temporary material stock piles and various other techniques as outlined on the erosion and sediment control sheets. Additionally, the project is required to file a Notice of Intent with the US EPA and implement a Stormwater Pollution Prevention Plan (SWPPP) during the construction period. The SWPPP will be prepared prior to the start of construction and will be implemented by the site contractor under the guidance and responsibility of the project's proponent.

Standard #9: Operation and Maintenance Plan (O&M Plan)

An Operation and Maintenance (O&M) Plan for this site has been prepared and is included in **Appendix G** of this report. The O&M Plan outlines procedures and time tables for the long-term operation and maintenance of the proposed site stormwater management system, including initial inspections upon completion of construction, and periodic monitoring of the system components, in accordance with established practices and the manufacturer's recommendations. The O&M Plan includes a list of responsible parties for inspections and maintenance.

Standard #10: Prohibition of Illicit Discharges

The proposed stormwater system will only convey allowable non-stormwater discharges (firefighting waters, irrigation, air conditioning condensates, etc.) and will not contain any illicit discharges from prohibited sources. An Illicit Discharge Statement is included in **Appendix G** of this report.

VI. SUMMARY

In summary, the proposed stormwater management system illustrated on the drawings prepared by Bohler Engineering results in a reduction in peak rates of runoff from the Site when compared to pre-development conditions for the 2-, 10-, 25- and 100-year storm frequencies. The project will improve the quality of stormwater discharge from the site compared to the existing condition, and meets the MADEP Stormwater Management Standards as described herein. The pre-

development versus post-development peak discharge rates comparisons are contained in **Table 3** below:

Table 3: Design Point Peak Runoff Rate Summary*

Point of Analysis	2-Year Storm			10-Year Storm			25-Year Storm			100-Year Storm		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
DP1N	27.36	27.34	-0.02	55.98	55.52	-0.46	72.20	71.40	-0.80	97.10	95.38	-1.72
DP1S	25.79	25.79	0	49.76	49.76	0	63.06	63.06	0	83.26	83.26	0
DP2N	4.14	3.96	-0.18	8.31	7.95	-0.36	10.65	10.19	-0.46	14.24	13.63	-0.61

**Flows are represented in cubic feet per second (cfs)*

APPENDIX A: MASSACHUSETTS STORMWATER MANAGEMENT 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



3.28.19

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): Surface Infiltration Basins

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 propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

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

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

Standard 6: Critical Areas

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



Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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



Checklist for Stormwater Report

Checklist (continued)

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

- The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has **not** been included in the Stormwater Report but will be submitted **before** land disturbance begins.
- The project is **not** covered by a NPDES Construction General Permit.
- The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

- The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
 - Name of the stormwater management system owners;
 - Party responsible for operation and maintenance;
 - Schedule for implementation of routine and non-routine maintenance tasks;
 - Plan showing the location of all stormwater BMPs maintenance access areas;
 - Description and delineation of public safety features;
 - Estimated operation and maintenance budget; and
 - Operation and Maintenance Log Form.
- The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
 - A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
 - A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

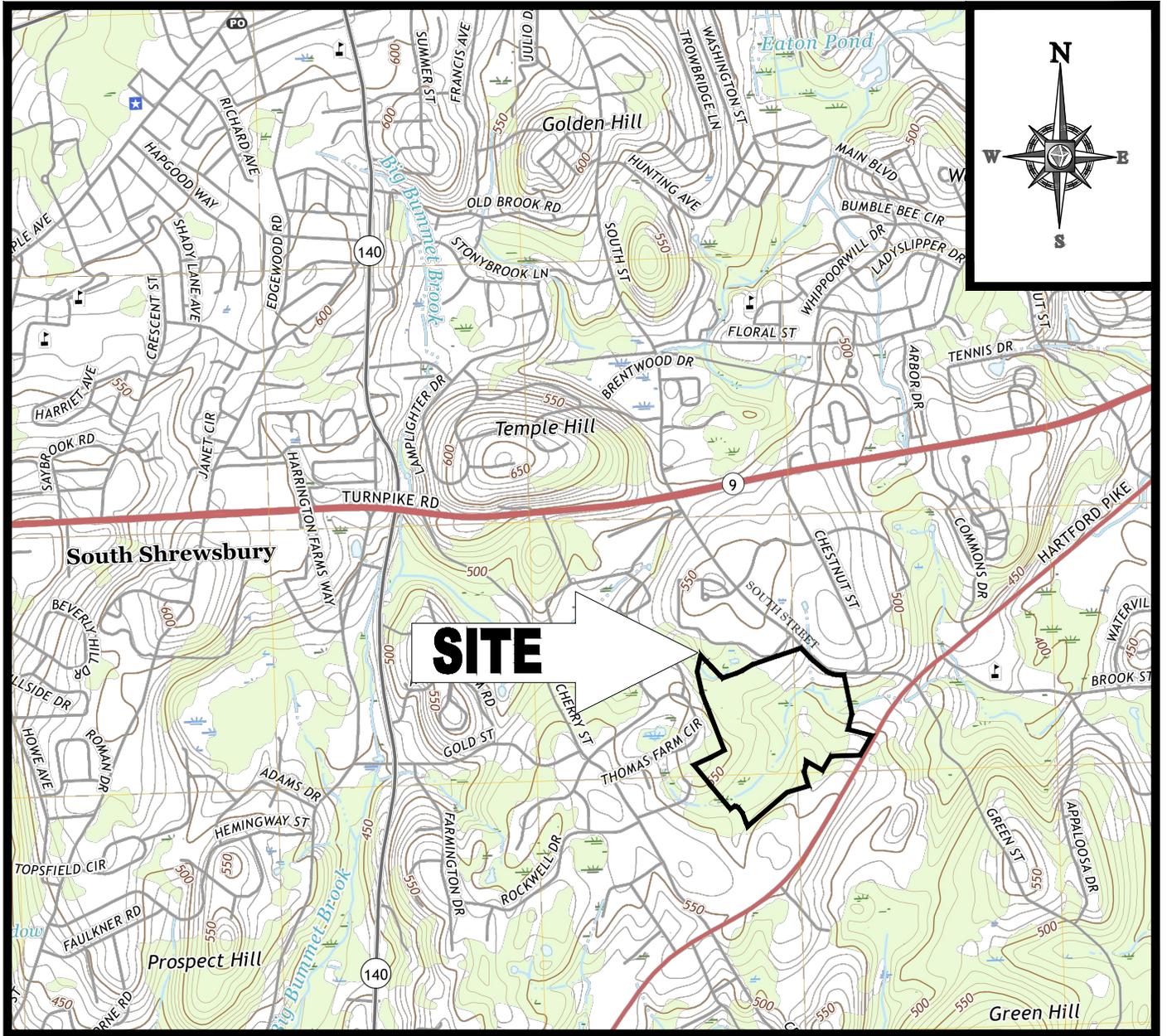
Standard 10: Prohibition of Illicit Discharges

- The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- An Illicit Discharge Compliance Statement is attached;
- NO Illicit Discharge Compliance Statement is attached but will be submitted **prior to** the discharge of any stormwater to post-construction BMPs.

APPENDIX B: PROJECT LOCATION MAPS

➤ *USGS MAP*

➤ *FEMA FIRMETTE*



LOCATION MAP

SCALE: 1"=2000'
PLAN REFERENCE: SHREWSBURY USGS QUADRANGLE

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Massachusetts State Plane Mainland Zone (FIPS zone 2001). The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIRM was derived from digital ortho-photography. Basemap files were provided in digital form by Massachusetts Geographic Information System (MassGIS). Ortho imagery was produced at a scale of 1:5000 and is dated April 2008. The projection used in the preparation of this map is Massachusetts State Plane Mainland (FIPSZONE2001). The horizontal datum is NAD 83, GRS1980 spheroid.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

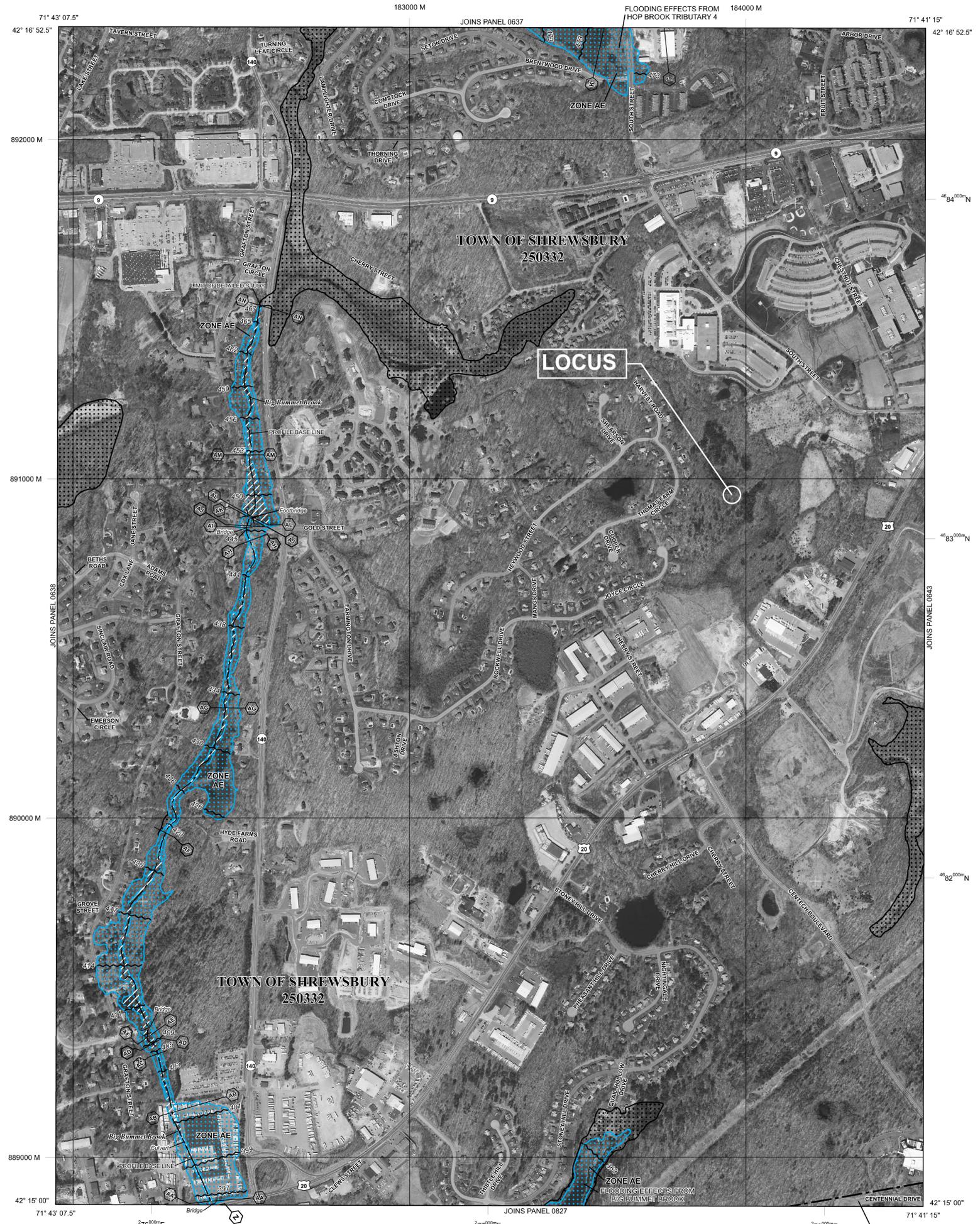
Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unreviewed streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/nfp>.



LEGEND

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

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

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

OTHER FLOOD AREAS

- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, and areas protected by levees from 1% annual chance flood.
- OTHER AREAS**
- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
- OTHERWISE PROTECTED AREAS (OPAs)**

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

- 1% Annual Chance Floodplain Boundary
- 0.2% Annual Chance Floodplain Boundary
- Floodway boundary
- Zone D boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- Cross section line
- Transect line
- Culvert
- Bridge

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

- 4989000 M
- 1000-meter grid values: Massachusetts State Plane Mainland Zone (FIPS Zone 2001), Lambert Conformal Conic projection
- 1000-meter Universal Transverse Mercator grid ticks, Zone 19N
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M 1.5

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
July 4, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
July 16, 2014, to change Base Flood Elevations and Special Flood Hazard Areas, to change zone designations, to update corporate limits and to add roads and road names.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0639F

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

PANEL 639 OF 1075
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRAFTON, TOWN OF	250336	0639	F
SHREWSBURY, TOWN OF	250332	0639	F

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

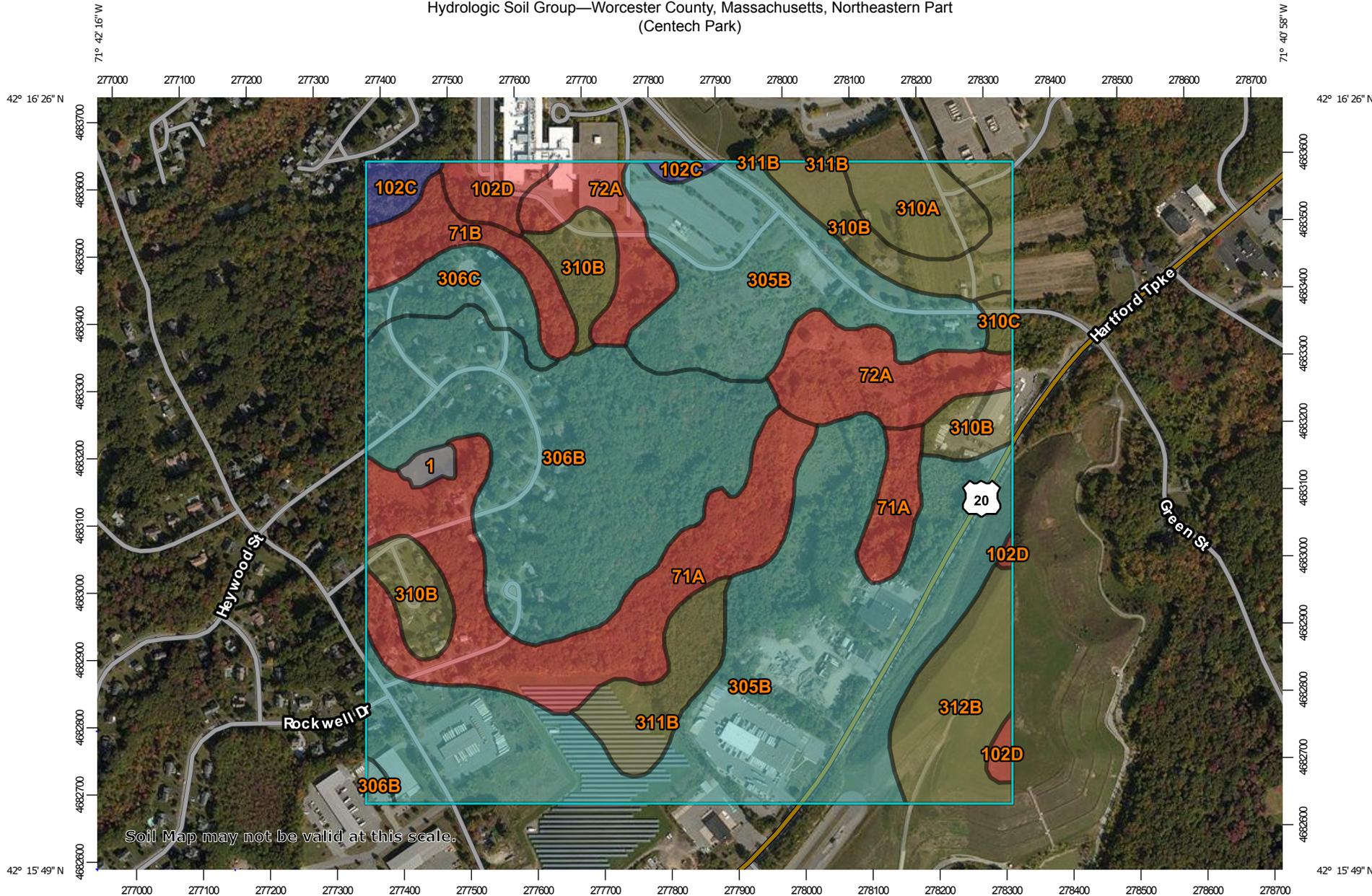
MAP NUMBER
25027C0639F
MAP REVISED
JULY 16, 2014

Federal Emergency Management Agency

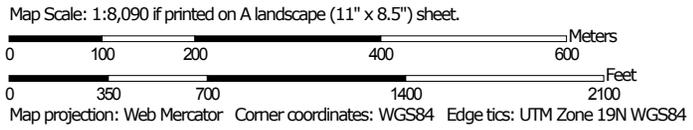
APPENDIX C: SOIL AND WETLAND INFORMATION

- *NCRS CUSTOM SOIL RESOURCE REPORT*
- *SOIL TESTING MAP & LOGS*

Hydrologic Soil Group—Worcester County, Massachusetts, Northeastern Part
(Centech Park)



Soil Map may not be valid at this scale.



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

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

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

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

Please rely on the bar scale on each map sheet for 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: Worcester County, Massachusetts,
 Northeastern Part
 Survey Area Data: Version 13, Sep 11, 2018

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
1	Water		0.9	0.4%
71A	Ridgebury fine sandy loam, 0 to 3 percent slopes, extremely stony	D	28.3	12.4%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	D	6.1	2.7%
72A	Whitman loam, 0 to 3 percent slopes	D	16.0	7.0%
102C	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	B	2.5	1.1%
102D	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	D	3.9	1.7%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	80.3	35.1%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	43.0	18.8%
306C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	5.7	2.5%
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C/D	5.8	2.5%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	17.9	7.8%
310C	Woodbridge fine sandy loam, 8 to 15 percent slopes	C/D	0.9	0.4%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	6.9	3.0%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	C/D	10.7	4.7%
Totals for Area of Interest			228.7	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

SOUTH STREET
(PUBLIC - VARIABLE WIDTH)

THOMAS FARM
CIRCLE

HARTFORD TURNPIKE
(P.A. ROAD #2)
(PUBLIC - 80' WIDE)
(1981 STATE HIGHWAY LAYOUT)
(LAYOUT NO. 2564)



TEST PIT PLAN
BOHLER ENGINEERING
10/19/18

TEST PIT SCHEDULE	
SW#	EXIST. SURFACE EL.
1	522'
2	519'
3	525'
4	505'
5	502'
6	514'
7	511'
8	515'
9	513'
10	518'



Site Location or lot #	Centech Park North				DEEP HOLE # SW-1		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP: 27 °			
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft.		Possible Wet Area:	>100 ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	40'+/- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-16"	FILL	Fill	-	-			
16-27"	A	Sandy Loam	10YR4/4	Massive, Friable, < 5% Cobbles			
27-48"	B	Sandy Loam	7.5YR4/6	Massive, Friable, 10% Cobbles			
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		36"				
	Weeping From Pit Face:		36"				
	Estimated Seasonal High Groundwater:			36"			
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:						
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-2		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	80'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-9"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
9-22"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
	-	-					
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		11"				
	Weeping From Pit Face:		-				
	Estimated Seasonal High Groundwater:			11"			
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:						
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	Ledge encountered at 22" For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-3		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	100'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-6"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
6-22"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
	-	-					
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		20"				
	Weeping From Pit Face:		-				
	Estimated Seasonal High Groundwater:			6"			
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:		6"				
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	Ledge encountered at 22" For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-4		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP: 27 °			
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	50'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-10"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
10-22"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
22-74"	C1	Sandy Loam	10YR6/2	Massive, Friable			
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:						
	Weeping From Pit Face:		45"				
	Estimated Seasonal High Groundwater:		15"				
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:		15"				
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-5		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	50'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-12"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
12-33"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
	-	-					
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:						
	Weeping From Pit Face:		33"				
	Estimated Seasonal High Groundwater:		12"				
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:		12"				
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	Ledge encountered @ 33" For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-6		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	50'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-10"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
10-24"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
24-33"	C	Sandy Loam	10YR6/2	Massive, Friable			
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		32"				
	Weeping From Pit Face:						
	Estimated Seasonal High Groundwater:			14"			
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:		14"				
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	Ledge encountered @ 33" For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-7		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	50'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-10"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
10-28"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
28-64"	C	Sandy Loam	10YR6/2	Massive, Friable			
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		52"				
	Weeping From Pit Face:						
	Estimated Seasonal High Groundwater:			32"			
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:		32"				
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-8		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft ft.		Possible Wet Area:	50'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-8"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
8-24"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
	-	-					
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		13"				
	Weeping From Pit Face:						
	Estimated Seasonal High Groundwater:						
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:			13"			
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:						
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-9		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	50'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-8"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
8-28"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
28-48"	C	Sandy Loam	10YR7/1	Massive, Friable			
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		32'''				
	Weeping From Pit Face:						
	Estimated Seasonal High Groundwater:						
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:			32'''			
	Depth to weeping from side of obs. hole:						
	Depth to soil mottles, description:						
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	Per conversation with Brad Stone, refer to adjacent Wetland area to confirm/revise ESHGW as necessary For drainage only.						

Site Location or lot #	Centech Park North				DEEP HOLE # SW-10		
Applicant/owner:	Town of Shrewsbury						
DATE:	November 15,2018	WEATHER:	Cloudy	TEMP:	27 °		
LOCATION: (Refer to sketch attached)	Refer to Attached Sketch						
PERFORMED BY:	Brandon Barry, EIT (MADEP Soil Evaluator #14024)						
WITNESSED BY:	Brad Stone						
Land Use:	Agricultural			Landform:			
Vegetation:	Overgrown			Slope:	3-4%		
Stone Walls:	<input type="checkbox"/> Y <input checked="" type="checkbox"/> N			Surface Stones:	<input checked="" type="checkbox"/> Y <input type="checkbox"/> N		
Distance From:							
Open Water Bodies:	>100 ft. ft.		Possible Wet Area:	50'+/- ft.			
Drinking Water Well:	N/A ft.		Drainageway:	N/A ft.			
Property Line:	>100'- ft.		Other:				
DEEP OBSERVATION HOLE LOG							
Depth	Soil Horizon	Soil Texture	Soil Color	Other: Structures; Stones; Boulders; Consistency; % gravel			
0-6"	Ap	Sandy Loam	10YR4/4	Massive, Friable			
6-26"	Bw	Sandy Loam	7.5YR4/6	Massive, Friable			
26-38"	C	Sandy Loam	10YR7/1	Massive, Friable			
	-	-					
Parent Material (geologic):	Glacial Till		Depth to Bedrock:	None			
Depth to Groundwater:	Standing Water in Hole:		19"				
	Weeping From Pit Face:		15"				
	Estimated Seasonal High Groundwater:						
DETERMINATION FOR SEASONAL HIGH WATER TABLE							
Method used:	Depth observed standing in obs. hole:						
	Depth to weeping from side of obs. hole:			15"			
	Depth to soil mottles, description:						
	Groundwater adjustment:						
Index Well #:	NA	Reading Date:	NA	Index Well Level:	NA	Adj. Factor:	NA
Adj. ground water level:	NA						
Notes:	Per conversation with Brad Stone, refer to adjacent Wetland area to confirm/revise ESHGW as necessary For drainage only.						

APPENDIX D: EXISTING CONDITIONS HYDROLOGIC ANALYSIS

- *EXISTING CONDITIONS DRAINAGE MAP*
- *EXISTING CONDITIONS HYDROCAD COMPUTATIONS*



DP2

E2N

E1N

DP1N

DP1S

E1S

SOUTH STREET
(PUBLIC - VARIABLE WIDTH)

THOMAS FARM
CIRCLE

HARTFORD TURNPIKE
(A.K.A. ROUTE 20)
(PUBLIC - 80' WIDE)
(1931 STATE HIGHWAY LAYOUT)
(LAYOUT NO. 2784)

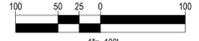
EXISTING DRAINAGE TRIBUTARY MAP

PREPARED BY



BOHLER
ENGINEERING

1" = 100'
DATE: 3/28/19



MAP 35, LOT 39
NF LANDS OF
CHARLES RIVER LABORATORIES, INC.
BK. 36908, PG. 281

MAP 42, LOT 2-20
NF LANDS OF
JENNIFER J. PADULA
BK. 56523, PG. 63

MAP 42, LOT 2-21
NF LANDS OF
KAREN M. JENKINSON
BK. 22732, PG. 314

MAP 42, LOT 2-22
NF LANDS OF
WILLIAM J. &
KIMBERLY C.
HITCHCOCK
BK. 18280, PG. 165

MAP 42, LOT 2-23
NF LANDS OF
SARA P. &
WILLIAM J. RUSSELL
BK. 41311, PG. 176

MAP 42, LOT 2-24
NF LANDS OF
JOHN A. MCCOY &
TERI L. MCCOY
BK. 15122, PG. 233

MAP 42, LOT 2-25
NF LANDS OF
MICHAEL D. &
TRACEY A. PORCARO
BK. 15114, PG. 66

MAP 42, LOT 2-26
NF LANDS OF
DONALD R. &
SUZANNE G. MCALASTER
BK. 18373, PG. 380

MAP 42, LOT 2-28
NF LANDS OF
SYED NAVEED ABBAS ZAIDI
& MARYUM KAZMI
BK. 46096, PG. 88

MAP 42, LOT 2-28
NF LANDS OF
RICHARD W. &
CYNTHIA A. HARRIS
BK. 38727, PG. 376

MAP 42, LOT 8-8
NF LANDS OF
DAVID & FLORA TRACIA
BK. 21442, PG. 187

MAP 42, LOT 8-7
NF LANDS OF
PAUL G. &
EMILY Y.M. MACDONALD
BK. 16014, PG. 398

MAP 42, LOT 8-6
NF LANDS OF
HILLS FARM
DEVELOPMENT, LLC
BK. 31198, PG. 49

MAP 42, LOT 11
NF LANDS OF
TOWN OF SHREWSBURY
BK. 28672, PG. 173

MAP 42, LOT 24
NF LANDS OF
JOSEPH J. &
PHYLLIS J. DEFALCO
BK. 6365, PG. 224

MAP 42, LOT 24
NF LANDS OF
JOSEPH J. &
PHYLLIS J. DEFALCO
BK. 6365, PG. 224

MAP 42, LOT 23
NF LANDS OF
HARTFORD TURNPIKE, LLC
BK. 48030, PG. 251

MAP 42, LOT 22
NF LANDS OF
TUCKER FARM, LLC
BK. 56186, PG. 162

MAP 42, LOT 22
NF LANDS OF
TUCKER FARM, LLC
BK. 56186, PG. 162

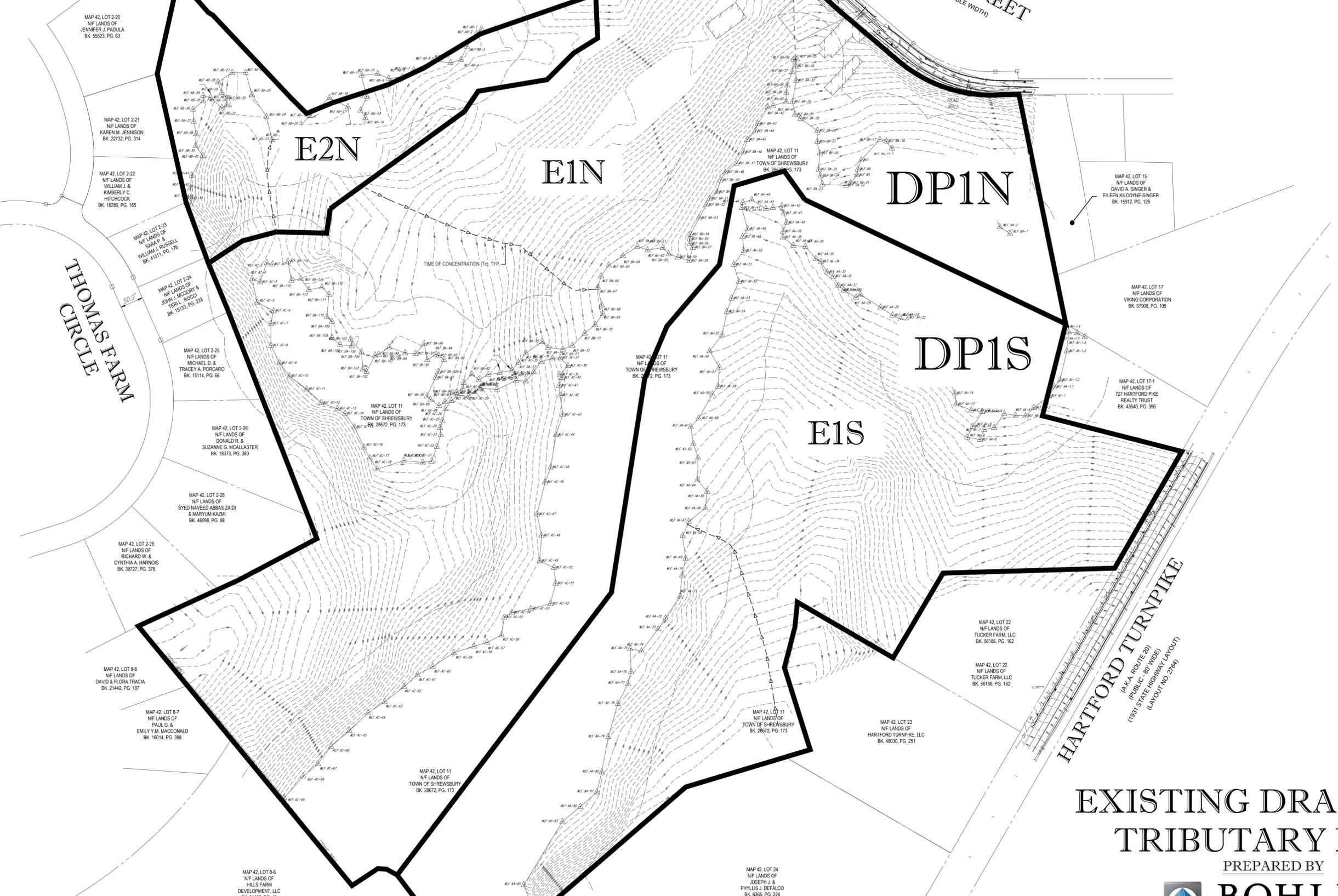
MAP 42, LOT 11
NF LANDS OF
TOWN OF SHREWSBURY
BK. 28672, PG. 173

MAP 42, LOT 15
NF LANDS OF
DAVID A. SINGER &
EILEEN KILCOYNE-SINGER
BK. 15912, PG. 126

MAP 42, LOT 17
NF LANDS OF
VIRING CORPORATION
BK. 57908, PG. 105

MAP 42, LOT 17-1
NF LANDS OF
727 HARTFORD PIKE
REALTY TRUST
BK. 43640, PG. 396

TIME OF CONCENTRATION (T_C), TYP.





North



Central Wetland



South



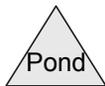
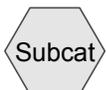
Central Wetland



North



North Wetland



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Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.48	98	Paved parking, HSG C (E1N)
0.21	98	Roofs, HSG C (E1N)
5.24	98	Water Surface, 0% imp, HSG C (E1N, E1S)
16.42	98	Water Surface, 0% imp, HSG D (E1N, E1S, E2N)
35.29	70	Woods, Good, HSG C (E1N, E1S, E2N)
8.84	77	Woods, Good, HSG D (E1N, E1S, E2N)
66.48	80	TOTAL AREA

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Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.00	HSG A	
0.00	HSG B	
41.22	HSG C	E1N, E1S, E2N
25.26	HSG D	E1N, E1S, E2N
0.00	Other	
66.48		TOTAL AREA

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Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.00	0.00	0.48	0.00	0.00	0.48	Paved parking	E1N
0.00	0.00	0.21	0.00	0.00	0.21	Roofs	E1N
0.00	0.00	5.24	16.42	0.00	21.66	Water Surface, 0% imp	E1N, E1S, E2N
0.00	0.00	35.29	8.84	0.00	44.13	Woods, Good	E1N, E1S, E2N
0.00	0.00	41.22	25.26	0.00	66.48	TOTAL AREA	

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Existing HydroCAD
Type III 24-hr 2 yr Rainfall=3.00"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentE1N: North

Runoff Area=36.62 ac 1.88% Impervious Runoff Depth=1.19"
Flow Length=559' Tc=31.9 min CN=79 Runoff=27.36 cfs 3.627 af

SubcatchmentE1S: South

Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=1.38"
Flow Length=503' Tc=21.7 min CN=82 Runoff=25.79 cfs 2.846 af

SubcatchmentE2N: North

Runoff Area=5.09 ac 0.00% Impervious Runoff Depth=1.25"
Flow Length=202' Tc=29.9 min CN=80 Runoff=4.14 cfs 0.530 af

Reach DP1N: Central Wetland

Inflow=27.36 cfs 3.627 af
Outflow=27.36 cfs 3.627 af

Reach DP1S: Central Wetland

Inflow=25.79 cfs 2.846 af
Outflow=25.79 cfs 2.846 af

Reach DP2N: North Wetland

Inflow=4.14 cfs 0.530 af
Outflow=4.14 cfs 0.530 af

Total Runoff Area = 66.48 ac Runoff Volume = 7.003 af Average Runoff Depth = 1.26"
98.96% Pervious = 65.79 ac 1.04% Impervious = 0.69 ac

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Existing HydroCAD
Type III 24-hr 2 yr Rainfall=3.00"

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Summary for Subcatchment E1N: North

Runoff = 27.36 cfs @ 12.47 hrs, Volume= 3.627 af, Depth= 1.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
0.21	98	Roofs, HSG C
0.48	98	Paved parking, HSG C
23.34	70	Woods, Good, HSG C
4.76	98	Water Surface, 0% imp, HSG C
1.21	77	Woods, Good, HSG D
6.62	98	Water Surface, 0% imp, HSG D
36.62	79	Weighted Average
35.93		98.12% Pervious Area
0.69		1.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.7	509	0.0480	1.10		Shallow Concentrated Flow, 535.25-511
					Woodland Kv= 5.0 fps
31.9	559	Total			

Summary for Subcatchment E1S: South

Runoff = 25.79 cfs @ 12.31 hrs, Volume= 2.846 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520
					Woodland Kv= 5.0 fps
21.7	503	Total			

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Existing HydroCAD
Type III 24-hr 2 yr Rainfall=3.00"

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Summary for Subcatchment E2N: North

Runoff = 4.14 cfs @ 12.44 hrs, Volume= 0.530 af, Depth= 1.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
1.97	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
5.09	80	Weighted Average
5.09		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7
					Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5
					Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach DP1N: Central Wetland

Inflow Area = 36.62 ac, 1.88% Impervious, Inflow Depth = 1.19" for 2 yr event
 Inflow = 27.36 cfs @ 12.47 hrs, Volume= 3.627 af
 Outflow = 27.36 cfs @ 12.47 hrs, Volume= 3.627 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 1.38" for 2 yr event
 Inflow = 25.79 cfs @ 12.31 hrs, Volume= 2.846 af
 Outflow = 25.79 cfs @ 12.31 hrs, Volume= 2.846 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP2N: North Wetland

Inflow Area = 5.09 ac, 0.00% Impervious, Inflow Depth = 1.25" for 2 yr event
 Inflow = 4.14 cfs @ 12.44 hrs, Volume= 0.530 af
 Outflow = 4.14 cfs @ 12.44 hrs, Volume= 0.530 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Existing HydroCAD
Type III 24-hr 10 yr Rainfall=4.50"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentE1N: North

Runoff Area=36.62 ac 1.88% Impervious Runoff Depth=2.38"
Flow Length=559' Tc=31.9 min CN=79 Runoff=55.98 cfs 7.252 af

SubcatchmentE1S: South

Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=2.64"
Flow Length=503' Tc=21.7 min CN=82 Runoff=49.76 cfs 5.441 af

SubcatchmentE2N: North

Runoff Area=5.09 ac 0.00% Impervious Runoff Depth=2.46"
Flow Length=202' Tc=29.9 min CN=80 Runoff=8.31 cfs 1.044 af

Reach DP1N: Central Wetland

Inflow=55.98 cfs 7.252 af
Outflow=55.98 cfs 7.252 af

Reach DP1S: Central Wetland

Inflow=49.76 cfs 5.441 af
Outflow=49.76 cfs 5.441 af

Reach DP2N: North Wetland

Inflow=8.31 cfs 1.044 af
Outflow=8.31 cfs 1.044 af

Total Runoff Area = 66.48 ac Runoff Volume = 13.738 af Average Runoff Depth = 2.48"
98.96% Pervious = 65.79 ac 1.04% Impervious = 0.69 ac

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Existing HydroCAD
Type III 24-hr 10 yr Rainfall=4.50"

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Summary for Subcatchment E1N: North

Runoff = 55.98 cfs @ 12.45 hrs, Volume= 7.252 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.21	98	Roofs, HSG C
0.48	98	Paved parking, HSG C
23.34	70	Woods, Good, HSG C
4.76	98	Water Surface, 0% imp, HSG C
1.21	77	Woods, Good, HSG D
6.62	98	Water Surface, 0% imp, HSG D
36.62	79	Weighted Average
35.93		98.12% Pervious Area
0.69		1.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.7	509	0.0480	1.10		Shallow Concentrated Flow, 535.25-511
					Woodland Kv= 5.0 fps
31.9	559	Total			

Summary for Subcatchment E1S: South

Runoff = 49.76 cfs @ 12.30 hrs, Volume= 5.441 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520
					Woodland Kv= 5.0 fps
21.7	503	Total			

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Existing HydroCAD

Type III 24-hr 10 yr Rainfall=4.50"

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Summary for Subcatchment E2N: North

Runoff = 8.31 cfs @ 12.42 hrs, Volume= 1.044 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
1.97	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
5.09	80	Weighted Average
5.09		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7
					Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5
					Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach DP1N: Central Wetland

Inflow Area = 36.62 ac, 1.88% Impervious, Inflow Depth = 2.38" for 10 yr event
 Inflow = 55.98 cfs @ 12.45 hrs, Volume= 7.252 af
 Outflow = 55.98 cfs @ 12.45 hrs, Volume= 7.252 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 2.64" for 10 yr event
 Inflow = 49.76 cfs @ 12.30 hrs, Volume= 5.441 af
 Outflow = 49.76 cfs @ 12.30 hrs, Volume= 5.441 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP2N: North Wetland

Inflow Area = 5.09 ac, 0.00% Impervious, Inflow Depth = 2.46" for 10 yr event
 Inflow = 8.31 cfs @ 12.42 hrs, Volume= 1.044 af
 Outflow = 8.31 cfs @ 12.42 hrs, Volume= 1.044 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 25 yr Rainfall=5.30"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentE1N: North

Runoff Area=36.62 ac 1.88% Impervious Runoff Depth=3.06"
 Flow Length=559' Tc=31.9 min CN=79 Runoff=72.20 cfs 9.343 af

SubcatchmentE1S: South

Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=3.35"
 Flow Length=503' Tc=21.7 min CN=82 Runoff=63.06 cfs 6.912 af

SubcatchmentE2N: North

Runoff Area=5.09 ac 0.00% Impervious Runoff Depth=3.16"
 Flow Length=202' Tc=29.9 min CN=80 Runoff=10.65 cfs 1.339 af

Reach DP1N: Central Wetland

Inflow=72.20 cfs 9.343 af
 Outflow=72.20 cfs 9.343 af

Reach DP1S: Central Wetland

Inflow=63.06 cfs 6.912 af
 Outflow=63.06 cfs 6.912 af

Reach DP2N: North Wetland

Inflow=10.65 cfs 1.339 af
 Outflow=10.65 cfs 1.339 af

Total Runoff Area = 66.48 ac Runoff Volume = 17.594 af Average Runoff Depth = 3.18"
98.96% Pervious = 65.79 ac 1.04% Impervious = 0.69 ac

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Existing HydroCAD
Type III 24-hr 25 yr Rainfall=5.30"

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Summary for Subcatchment E1N: North

Runoff = 72.20 cfs @ 12.45 hrs, Volume= 9.343 af, Depth= 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
0.21	98	Roofs, HSG C
0.48	98	Paved parking, HSG C
23.34	70	Woods, Good, HSG C
4.76	98	Water Surface, 0% imp, HSG C
1.21	77	Woods, Good, HSG D
6.62	98	Water Surface, 0% imp, HSG D
36.62	79	Weighted Average
35.93		98.12% Pervious Area
0.69		1.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.7	509	0.0480	1.10		Shallow Concentrated Flow, 535.25-511
					Woodland Kv= 5.0 fps
31.9	559	Total			

Summary for Subcatchment E1S: South

Runoff = 63.06 cfs @ 12.30 hrs, Volume= 6.912 af, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520
					Woodland Kv= 5.0 fps
21.7	503	Total			

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Type III 24-hr 25 yr Rainfall=5.30"

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Summary for Subcatchment E2N: North

Runoff = 10.65 cfs @ 12.41 hrs, Volume= 1.339 af, Depth= 3.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
1.97	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
5.09	80	Weighted Average
5.09		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7
					Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5
					Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach DP1N: Central Wetland

Inflow Area = 36.62 ac, 1.88% Impervious, Inflow Depth = 3.06" for 25 yr event
 Inflow = 72.20 cfs @ 12.45 hrs, Volume= 9.343 af
 Outflow = 72.20 cfs @ 12.45 hrs, Volume= 9.343 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 3.35" for 25 yr event
 Inflow = 63.06 cfs @ 12.30 hrs, Volume= 6.912 af
 Outflow = 63.06 cfs @ 12.30 hrs, Volume= 6.912 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP2N: North Wetland

Inflow Area = 5.09 ac, 0.00% Impervious, Inflow Depth = 3.16" for 25 yr event
 Inflow = 10.65 cfs @ 12.41 hrs, Volume= 1.339 af
 Outflow = 10.65 cfs @ 12.41 hrs, Volume= 1.339 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 100 yr Rainfall=6.50"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentE1N: North

Runoff Area=36.62 ac 1.88% Impervious Runoff Depth=4.13"
Flow Length=559' Tc=31.9 min CN=79 Runoff=97.10 cfs 12.601 af

SubcatchmentE1S: South

Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=4.45"
Flow Length=503' Tc=21.7 min CN=82 Runoff=83.26 cfs 9.184 af

SubcatchmentE2N: North

Runoff Area=5.09 ac 0.00% Impervious Runoff Depth=4.24"
Flow Length=202' Tc=29.9 min CN=80 Runoff=14.24 cfs 1.796 af

Reach DP1N: Central Wetland

Inflow=97.10 cfs 12.601 af
Outflow=97.10 cfs 12.601 af

Reach DP1S: Central Wetland

Inflow=83.26 cfs 9.184 af
Outflow=83.26 cfs 9.184 af

Reach DP2N: North Wetland

Inflow=14.24 cfs 1.796 af
Outflow=14.24 cfs 1.796 af

Total Runoff Area = 66.48 ac Runoff Volume = 23.582 af Average Runoff Depth = 4.26"
98.96% Pervious = 65.79 ac 1.04% Impervious = 0.69 ac

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Type III 24-hr 100 yr Rainfall=6.50"

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Summary for Subcatchment E1N: North

Runoff = 97.10 cfs @ 12.44 hrs, Volume= 12.601 af, Depth= 4.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
0.21	98	Roofs, HSG C
0.48	98	Paved parking, HSG C
23.34	70	Woods, Good, HSG C
4.76	98	Water Surface, 0% imp, HSG C
1.21	77	Woods, Good, HSG D
6.62	98	Water Surface, 0% imp, HSG D
36.62	79	Weighted Average
35.93		98.12% Pervious Area
0.69		1.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.7	509	0.0480	1.10		Shallow Concentrated Flow, 535.25-511
					Woodland Kv= 5.0 fps
31.9	559	Total			

Summary for Subcatchment E1S: South

Runoff = 83.26 cfs @ 12.29 hrs, Volume= 9.184 af, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520
					Woodland Kv= 5.0 fps
21.7	503	Total			

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Type III 24-hr 100 yr Rainfall=6.50"

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Summary for Subcatchment E2N: North

Runoff = 14.24 cfs @ 12.41 hrs, Volume= 1.796 af, Depth= 4.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
1.97	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
5.09	80	Weighted Average
5.09		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7
					Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5
					Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach DP1N: Central Wetland

Inflow Area = 36.62 ac, 1.88% Impervious, Inflow Depth = 4.13" for 100 yr event
 Inflow = 97.10 cfs @ 12.44 hrs, Volume= 12.601 af
 Outflow = 97.10 cfs @ 12.44 hrs, Volume= 12.601 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 4.45" for 100 yr event
 Inflow = 83.26 cfs @ 12.29 hrs, Volume= 9.184 af
 Outflow = 83.26 cfs @ 12.29 hrs, Volume= 9.184 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach DP2N: North Wetland

Inflow Area = 5.09 ac, 0.00% Impervious, Inflow Depth = 4.24" for 100 yr event
 Inflow = 14.24 cfs @ 12.41 hrs, Volume= 1.796 af
 Outflow = 14.24 cfs @ 12.41 hrs, Volume= 1.796 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

APPENDIX E: PROPOSED CONDITIONS HYDROLOGIC ANALYSIS

- *PROPOSED CONDITIONS DRAINAGE MAP*
- *PROPOSED CONDITIONS HYRDOCAD CALCULATIONS*



DP2

MAP 35, LOT 39
NF LANDS OF
CHARLES RIVER LABORATORIES, INC.
BK. 36908, PG. 281

SOUTH STREET
(PUBLIC - VARIABLE WIDTH)

MAP 42, LOT 2-20
NF LANDS OF
JENNIFER J. PADULA
BK. 55523, PG. 63

MAP 42, LOT 2-21
NF LANDS OF
KAREN M. JENNISON
BK. 22732, PG. 314

MAP 42, LOT 2-22
NF LANDS OF
WILLIAM J. &
KIMBERLY C.
HITCHCOCK
BK. 18280, PG. 165

MAP 42, LOT 2-23
NF LANDS OF
SARA A. &
WILLIAM J. RUSSELL
BK. 41311, PG. 176

MAP 42, LOT 2-24
NF LANDS OF
JOHN J. MCCOY &
TERI L. ROCCI
BK. 15182, PG. 230

MAP 42, LOT 2-25
NF LANDS OF
MICHAEL D. &
TRACY A. PORCARO
BK. 15114, PG. 66

MAP 42, LOT 2-26
NF LANDS OF
DONALD R. &
SUZANNE G. MCALLASTER
BK. 18373, PG. 380

MAP 42, LOT 2-28
NF LANDS OF
SYED NAVEED ABBAS ZAIDI
& MARYUM KAZMI
BK. 40098, PG. 88

MAP 42, LOT 2-28
NF LANDS OF
RICHARD W. &
CYNTHIA A. HARRIS
BK. 38727, PG. 378

MAP 42, LOT 8-6
NF LANDS OF
DAVID & FLORA TRACIA
BK. 21442, PG. 187

MAP 42, LOT 8-7
NF LANDS OF
PAUL G. &
EMILY Y.M. MACDONALD
BK. 16014, PG. 398

MAP 42, LOT 8-6
NF LANDS OF
HILLS FARM
DEVELOPMENT, LLC
BK. 31198, PG. 49

MAP 42, LOT 11
NF LANDS OF
TOWN OF SHREWSBURY
BK. 28672, PG. 173

MAP 42, LOT 24
NF LANDS OF
JOSEPH J. &
PHYLLIS J. DEFALCO
BK. 6365, PG. 224

MAP 42, LOT 24
NF LANDS OF
JOSEPH J. &
PHYLLIS J. DEFALCO
BK. 6365, PG. 224

MAP 42, LOT 23
NF LANDS OF
HARTFORD TURNPIKE, LLC
BK. 48030, PG. 251

MAP 42, LOT 22
NF LANDS OF
TUCKER FARM, LLC
BK. 55186, PG. 162

MAP 42, LOT 22
NF LANDS OF
TUCKER FARM, LLC
BK. 55186, PG. 162

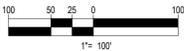
PROPOSED DRAINAGE TRIBUTARY MAP

PREPARED BY



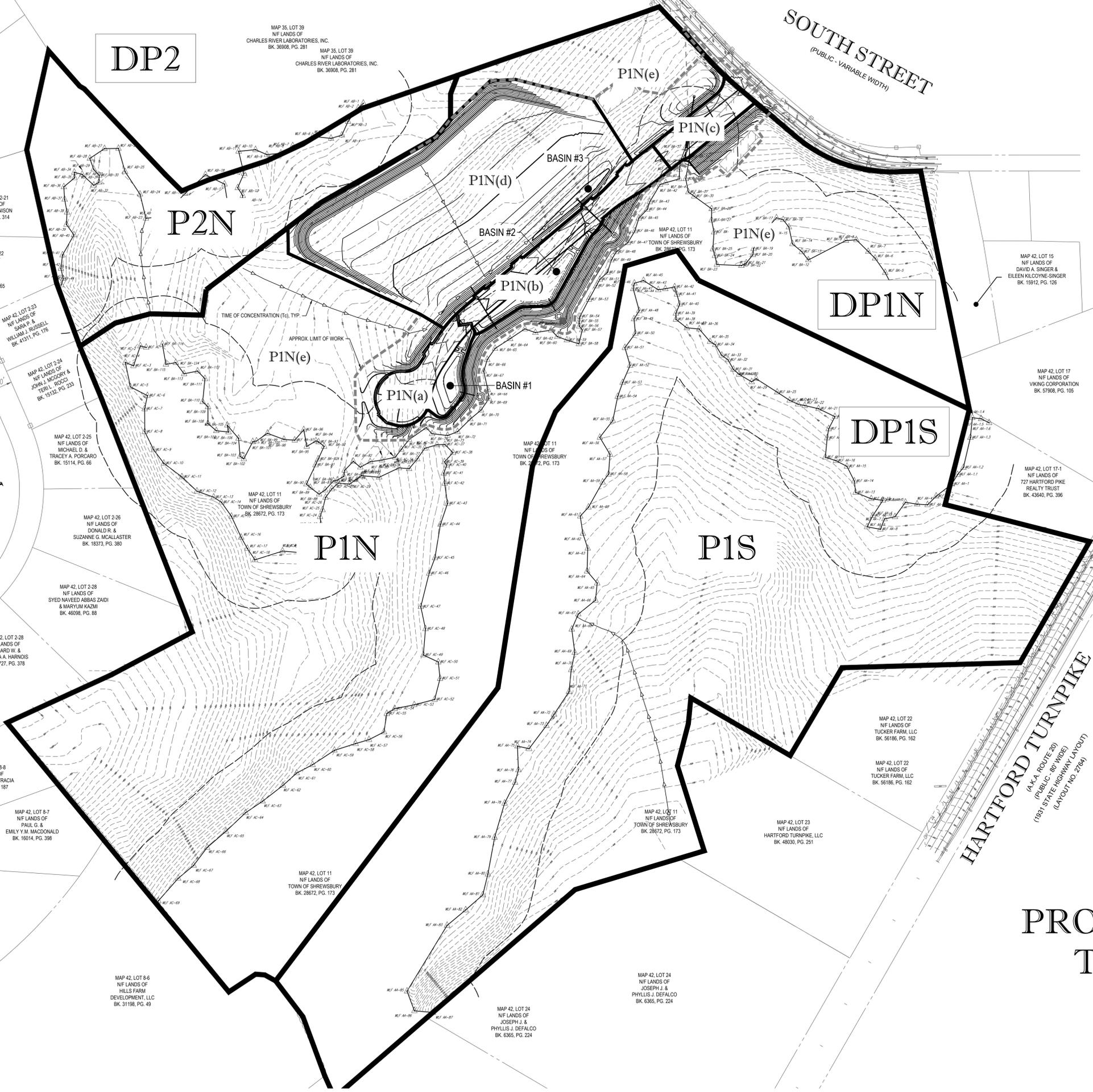
BOHLER ENGINEERING

1" = 100'
DATE: 3/28/19

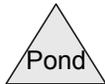
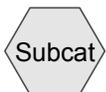
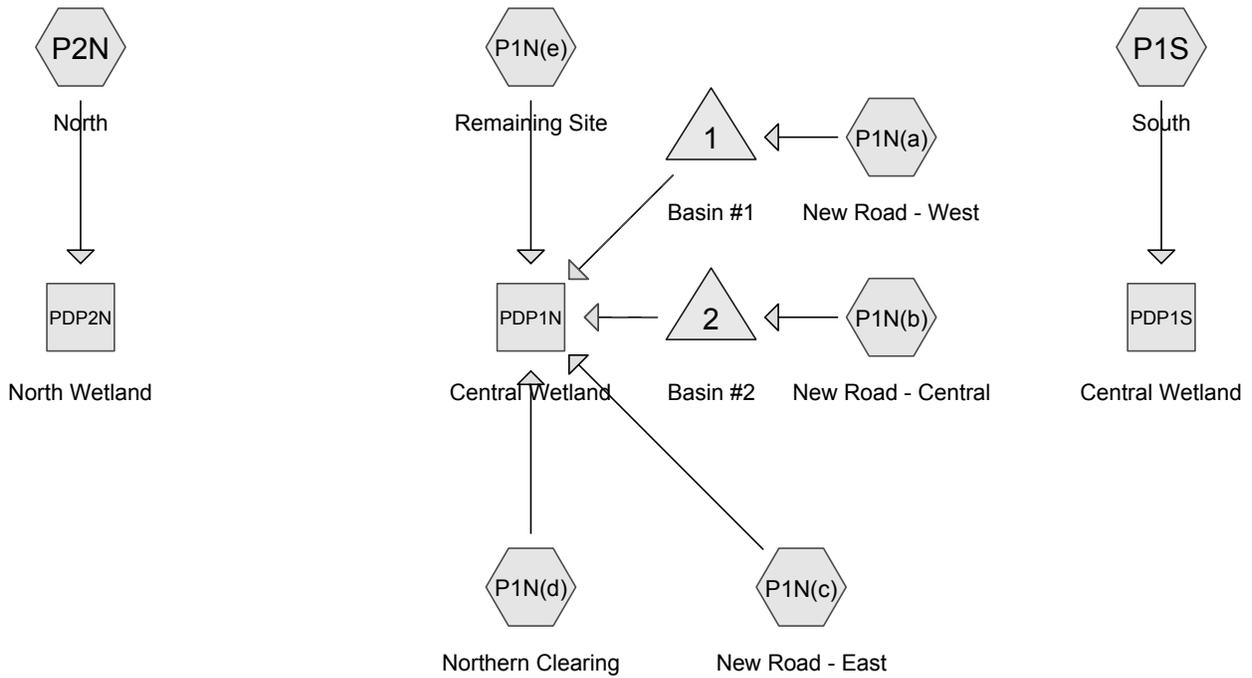


THOMAS FARM
CIRCLE

HARTFORD TURNPIKE
(A.K.A. ROUTE 80)
(PUBLIC - 80' WIDE)
(1991 STATE HIGHWAY LAYOUT)
(LAYOUT NO. 2784)



1" = 100'
DATE: 3/28/19



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Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.90	74	>75% Grass cover, Good, HSG C (P1N(a), P1N(b), P1N(c), P1N(d), P1N(e))
0.09	98	Basin, 0% imp, HSG C (P1N(a), P1N(b))
1.12	98	Paved parking, HSG C (P1N(a), P1N(b), P1N(c))
5.22	98	Water Surface, 0% imp, HSG C (P1N(e), P1S)
16.42	98	Water Surface, 0% imp, HSG D (P1N(e), P1S, P2N)
27.89	70	Woods, Good, HSG C (P1N(e), P1S, P2N)
8.84	77	Woods, Good, HSG D (P1N(e), P1S, P2N)
66.48	81	TOTAL AREA

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Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.00	HSG A	
0.00	HSG B	
41.22	HSG C	P1N(a), P1N(b), P1N(c), P1N(d), P1N(e), P1S, P2N
25.26	HSG D	P1N(e), P1S, P2N
0.00	Other	
66.48		TOTAL AREA

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Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.00	0.00	6.90	0.00	0.00	6.90	>75% Grass cover, Good	P1N(a), P1N(b), P1N(c), P1N(d), P1N(e)
0.00	0.00	0.09	0.00	0.00	0.09	Basin, 0% imp	P1N(a), P1N(b)
0.00	0.00	1.12	0.00	0.00	1.12	Paved parking	P1N(a), P1N(b), P1N(c)
0.00	0.00	5.22	16.42	0.00	21.64	Water Surface, 0% imp	P1N(e), P1S, P2N
0.00	0.00	27.89	8.84	0.00	36.73	Woods, Good	P1N(e), P1S, P2N
0.00	0.00	41.22	25.26	0.00	66.48	TOTAL AREA	

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Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	P1N(d)	0.00	0.00	100.0	0.0100	0.012	18.0	0.0	0.0
2	P1N(e)	0.00	0.00	100.0	0.0100	0.013	24.0	0.0	0.0
3	1	515.25	513.00	35.5	0.0634	0.012	12.0	0.0	0.0
4	2	515.00	513.00	34.0	0.0588	0.012	12.0	0.0	0.0

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Type III 24-hr 2 yr Rainfall=3.00"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentP1N(a): New Road - West Runoff Area=0.57 ac 59.65% Impervious Runoff Depth=1.90"
 Tc=6.0 min CN=89 Runoff=1.24 cfs 0.090 af

SubcatchmentP1N(b): New Road - Central Runoff Area=0.87 ac 57.47% Impervious Runoff Depth=1.98"
 Tc=6.0 min CN=90 Runoff=1.96 cfs 0.144 af

SubcatchmentP1N(c): New Road - East Runoff Area=0.33 ac 84.85% Impervious Runoff Depth=2.35"
 Tc=6.0 min CN=94 Runoff=0.85 cfs 0.065 af

SubcatchmentP1N(d): Northern Clearing Runoff Area=4.37 ac 0.00% Impervious Runoff Depth=0.91"
 Flow Length=616' Tc=14.6 min CN=74 Runoff=3.28 cfs 0.331 af

SubcatchmentP1N(e): Remaining Site Runoff Area=30.70 ac 0.00% Impervious Runoff Depth=1.31"
 Flow Length=635' Tc=33.4 min CN=81 Runoff=25.06 cfs 3.360 af

SubcatchmentP1S: South Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=1.38"
 Flow Length=503' Tc=21.7 min CN=82 Runoff=25.79 cfs 2.846 af

SubcatchmentP2N: North Runoff Area=4.87 ac 0.00% Impervious Runoff Depth=1.25"
 Flow Length=202' Tc=29.9 min CN=80 Runoff=3.96 cfs 0.507 af

Reach PDP1N: Central Wetland Inflow=27.34 cfs 3.818 af
 Outflow=27.34 cfs 3.818 af

Reach PDP1S: Central Wetland Inflow=25.79 cfs 2.846 af
 Outflow=25.79 cfs 2.846 af

Reach PDP2N: North Wetland Inflow=3.96 cfs 0.507 af
 Outflow=3.96 cfs 0.507 af

Pond 1: Basin #1 Peak Elev=518.87' Storage=2,505 cf Inflow=1.24 cfs 0.090 af
 Discarded=0.01 cfs 0.042 af Primary=0.05 cfs 0.026 af Secondary=0.00 cfs 0.000 af Outflow=0.06 cfs 0.067 af

Pond 2: Basin #2 Peak Elev=518.23' Storage=3,623 cf Inflow=1.96 cfs 0.144 af
 Discarded=0.02 cfs 0.072 af Primary=0.15 cfs 0.037 af Secondary=0.00 cfs 0.000 af Outflow=0.18 cfs 0.109 af

Total Runoff Area = 66.48 ac Runoff Volume = 7.344 af Average Runoff Depth = 1.33"
98.32% Pervious = 65.36 ac 1.68% Impervious = 1.12 ac

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Type III 24-hr 2 yr Rainfall=3.00"

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Summary for Subcatchment P1N(a): New Road - West

Runoff = 1.24 cfs @ 12.09 hrs, Volume= 0.090 af, Depth= 1.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
0.34	98	Paved parking, HSG C
* 0.02	98	Basin, 0% imp, HSG C
0.21	74	>75% Grass cover, Good, HSG C
0.57	89	Weighted Average
0.23		40.35% Pervious Area
0.34		59.65% Impervious Area

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

Summary for Subcatchment P1N(b): New Road - Central

Runoff = 1.96 cfs @ 12.09 hrs, Volume= 0.144 af, Depth= 1.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
0.50	98	Paved parking, HSG C
* 0.07	98	Basin, 0% imp, HSG C
0.30	74	>75% Grass cover, Good, HSG C
0.87	90	Weighted Average
0.37		42.53% Pervious Area
0.50		57.47% Impervious Area

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

Summary for Subcatchment P1N(c): New Road - East

Runoff = 0.85 cfs @ 12.09 hrs, Volume= 0.065 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

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Type III 24-hr 2 yr Rainfall=3.00"

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Area (ac)	CN	Description
0.28	98	Paved parking, HSG C
0.05	74	>75% Grass cover, Good, HSG C
0.33	94	Weighted Average
0.05		15.15% Pervious Area
0.28		84.85% Impervious Area

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

Summary for Subcatchment P1N(d): Northern Clearing

Runoff = 3.28 cfs @ 12.22 hrs, Volume= 0.331 af, Depth= 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
4.37	74	>75% Grass cover, Good, HSG C
4.37		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		Sheet Flow, 528-527 Grass: Short n= 0.150 P2= 3.00"
8.5	466	0.0170	0.91		Shallow Concentrated Flow, 527-519 Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.44	11.38	Pipe Channel, 513-512 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Corrugated PP, smooth interior
14.6	616	Total			

Summary for Subcatchment P1N(e): Remaining Site

Runoff = 25.06 cfs @ 12.48 hrs, Volume= 3.360 af, Depth= 1.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
1.97	74	>75% Grass cover, Good, HSG C
4.74	98	Water Surface, 0% imp, HSG C
6.62	98	Water Surface, 0% imp, HSG D
16.16	70	Woods, Good, HSG C
1.21	77	Woods, Good, HSG D
30.70	81	Weighted Average
30.70		100.00% Pervious Area

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Type III 24-hr 2 yr Rainfall=3.00"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25 Woods: Light underbrush n= 0.400 P2= 3.00"
5.5	322	0.0380	0.97		Shallow Concentrated Flow, 535.25-523 Woodland Kv= 5.0 fps
3.5	163	0.0120	0.77		Shallow Concentrated Flow, 523-521 Short Grass Pasture Kv= 7.0 fps
0.2	100	0.0100	7.20	22.62	Pipe Channel, pipe at 1% 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
33.4	635	Total			

Summary for Subcatchment P1S: South

Runoff = 25.79 cfs @ 12.31 hrs, Volume= 2.846 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90 Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520 Woodland Kv= 5.0 fps
21.7	503	Total			

Summary for Subcatchment P2N: North

Runoff = 3.96 cfs @ 12.44 hrs, Volume= 0.507 af, Depth= 1.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.00"

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Type III 24-hr 2 yr Rainfall=3.00"

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Area (ac)	CN	Description
1.75	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
4.87	80	Weighted Average
4.87		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7 Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5 Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach PDP1N: Central Wetland

Inflow Area = 36.84 ac, 3.04% Impervious, Inflow Depth = 1.24" for 2 yr event
 Inflow = 27.34 cfs @ 12.46 hrs, Volume= 3.818 af
 Outflow = 27.34 cfs @ 12.46 hrs, Volume= 3.818 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 1.38" for 2 yr event
 Inflow = 25.79 cfs @ 12.31 hrs, Volume= 2.846 af
 Outflow = 25.79 cfs @ 12.31 hrs, Volume= 2.846 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP2N: North Wetland

Inflow Area = 4.87 ac, 0.00% Impervious, Inflow Depth = 1.25" for 2 yr event
 Inflow = 3.96 cfs @ 12.44 hrs, Volume= 0.507 af
 Outflow = 3.96 cfs @ 12.44 hrs, Volume= 0.507 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Pond 1: Basin #1

Inflow Area = 0.57 ac, 59.65% Impervious, Inflow Depth = 1.90" for 2 yr event
 Inflow = 1.24 cfs @ 12.09 hrs, Volume= 0.090 af
 Outflow = 0.06 cfs @ 14.76 hrs, Volume= 0.067 af, Atten= 95%, Lag= 159.9 min
 Discarded = 0.01 cfs @ 14.76 hrs, Volume= 0.042 af
 Primary = 0.05 cfs @ 14.76 hrs, Volume= 0.026 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 2 yr Rainfall=3.00"

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Peak Elev= 518.87' @ 14.76 hrs Surf.Area= 3,748 sf Storage= 2,505 cf

Plug-Flow detention time= 703.7 min calculated for 0.067 af (74% of inflow)

Center-of-Mass det. time= 617.7 min (1,431.4 - 813.7)

Volume	Invert	Avail.Storage	Storage Description
#1	518.00'	9,246 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
518.00	2,040	0	0
519.00	4,014	3,027	3,027
520.25	5,936	6,219	9,246

Device	Routing	Invert	Outlet Devices
#1	Discarded	518.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.25'	12.0" Round Culvert L= 35.5' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.25' / 513.00' S= 0.0634 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.70'	3.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	519.25'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	519.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.01 cfs @ 14.76 hrs HW=518.87' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.05 cfs @ 14.76 hrs HW=518.87' (Free Discharge)

↑**2=Culvert** (Passes 0.05 cfs of 5.27 cfs potential flow)

↑**3=Orifice/Grate** (Orifice Controls 0.05 cfs @ 1.38 fps)

↑**4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=518.00' (Free Discharge)

↑**5=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Summary for Pond 2: Basin #2

Inflow Area = 0.87 ac, 57.47% Impervious, Inflow Depth = 1.98" for 2 yr event
 Inflow = 1.96 cfs @ 12.09 hrs, Volume= 0.144 af
 Outflow = 0.18 cfs @ 13.05 hrs, Volume= 0.109 af, Atten= 91%, Lag= 57.5 min
 Discarded = 0.02 cfs @ 13.05 hrs, Volume= 0.072 af
 Primary = 0.15 cfs @ 13.05 hrs, Volume= 0.037 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Peak Elev= 518.23' @ 13.05 hrs Surf.Area= 6,187 sf Storage= 3,623 cf

Plug-Flow detention time= 695.6 min calculated for 0.109 af (75% of inflow)

Center-of-Mass det. time= 611.8 min (1,421.2 - 809.4)

Volume	Invert	Avail.Storage	Storage Description
#1	517.50'	11,456 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
517.50	3,564	0	0
518.00	5,498	2,266	2,266
519.25	9,207	9,191	11,456

Device	Routing	Invert	Outlet Devices
#1	Discarded	517.50'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.00'	12.0" Round Culvert L= 34.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.00' / 513.00' S= 0.0588 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.20'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Secondary	518.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.02 cfs @ 13.05 hrs HW=518.23' (Free Discharge)

↑1=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.15 cfs @ 13.05 hrs HW=518.23' (Free Discharge)

↑2=Culvert (Passes 0.15 cfs of 4.93 cfs potential flow)

↑3=Orifice/Grate (Weir Controls 0.15 cfs @ 0.59 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=517.50' (Free Discharge)

↑4=Broad-Crested Rectangular Weir(Controls 0.00 cfs)

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Type III 24-hr 10 yr Rainfall=4.50"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentP1N(a): New Road - West Runoff Area=0.57 ac 59.65% Impervious Runoff Depth=3.30"
 Tc=6.0 min CN=89 Runoff=2.10 cfs 0.157 af

SubcatchmentP1N(b): New Road - Central Runoff Area=0.87 ac 57.47% Impervious Runoff Depth=3.40"
 Tc=6.0 min CN=90 Runoff=3.29 cfs 0.246 af

SubcatchmentP1N(c): New Road - East Runoff Area=0.33 ac 84.85% Impervious Runoff Depth=3.82"
 Tc=6.0 min CN=94 Runoff=1.35 cfs 0.105 af

SubcatchmentP1N(d): Northern Clearing Runoff Area=4.37 ac 0.00% Impervious Runoff Depth=1.97"
 Flow Length=616' Tc=14.6 min CN=74 Runoff=7.59 cfs 0.718 af

SubcatchmentP1N(e): Remaining Site Runoff Area=30.70 ac 0.00% Impervious Runoff Depth=2.55"
 Flow Length=635' Tc=33.4 min CN=81 Runoff=49.29 cfs 6.519 af

SubcatchmentP1S: South Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=2.64"
 Flow Length=503' Tc=21.7 min CN=82 Runoff=49.76 cfs 5.441 af

SubcatchmentP2N: North Runoff Area=4.87 ac 0.00% Impervious Runoff Depth=2.46"
 Flow Length=202' Tc=29.9 min CN=80 Runoff=7.95 cfs 0.999 af

Reach PDP1N: Central Wetland Inflow=55.52 cfs 7.565 af
 Outflow=55.52 cfs 7.565 af

Reach PDP1S: Central Wetland Inflow=49.76 cfs 5.441 af
 Outflow=49.76 cfs 5.441 af

Reach PDP2N: North Wetland Inflow=7.95 cfs 0.999 af
 Outflow=7.95 cfs 0.999 af

Pond 1: Basin #1 Peak Elev=519.22' Storage=3,932 cf Inflow=2.10 cfs 0.157 af
 Discarded=0.02 cfs 0.045 af Primary=0.15 cfs 0.087 af Secondary=0.00 cfs 0.000 af Outflow=0.16 cfs 0.132 af

Pond 2: Basin #2 Peak Elev=518.36' Storage=4,416 cf Inflow=3.29 cfs 0.246 af
 Discarded=0.03 cfs 0.075 af Primary=1.63 cfs 0.136 af Secondary=0.00 cfs 0.000 af Outflow=1.65 cfs 0.211 af

Total Runoff Area = 66.48 ac Runoff Volume = 14.185 af Average Runoff Depth = 2.56"
98.32% Pervious = 65.36 ac 1.68% Impervious = 1.12 ac

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Summary for Subcatchment P1N(a): New Road - West

Runoff = 2.10 cfs @ 12.09 hrs, Volume= 0.157 af, Depth= 3.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.34	98	Paved parking, HSG C
* 0.02	98	Basin, 0% imp, HSG C
0.21	74	>75% Grass cover, Good, HSG C
0.57	89	Weighted Average
0.23		40.35% Pervious Area
0.34		59.65% Impervious Area

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

Summary for Subcatchment P1N(b): New Road - Central

Runoff = 3.29 cfs @ 12.09 hrs, Volume= 0.246 af, Depth= 3.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.50	98	Paved parking, HSG C
* 0.07	98	Basin, 0% imp, HSG C
0.30	74	>75% Grass cover, Good, HSG C
0.87	90	Weighted Average
0.37		42.53% Pervious Area
0.50		57.47% Impervious Area

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

Summary for Subcatchment P1N(c): New Road - East

Runoff = 1.35 cfs @ 12.09 hrs, Volume= 0.105 af, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

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Type III 24-hr 10 yr Rainfall=4.50"

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Area (ac)	CN	Description
0.28	98	Paved parking, HSG C
0.05	74	>75% Grass cover, Good, HSG C
0.33	94	Weighted Average
0.05		15.15% Pervious Area
0.28		84.85% Impervious Area

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

Summary for Subcatchment P1N(d): Northern Clearing

Runoff = 7.59 cfs @ 12.21 hrs, Volume= 0.718 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
4.37	74	>75% Grass cover, Good, HSG C
4.37		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		Sheet Flow, 528-527 Grass: Short n= 0.150 P2= 3.00"
8.5	466	0.0170	0.91		Shallow Concentrated Flow, 527-519 Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.44	11.38	Pipe Channel, 513-512 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Corrugated PP, smooth interior
14.6	616	Total			

Summary for Subcatchment P1N(e): Remaining Site

Runoff = 49.29 cfs @ 12.47 hrs, Volume= 6.519 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
1.97	74	>75% Grass cover, Good, HSG C
4.74	98	Water Surface, 0% imp, HSG C
6.62	98	Water Surface, 0% imp, HSG D
16.16	70	Woods, Good, HSG C
1.21	77	Woods, Good, HSG D
30.70	81	Weighted Average
30.70		100.00% Pervious Area

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Type III 24-hr 10 yr Rainfall=4.50"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25 Woods: Light underbrush n= 0.400 P2= 3.00"
5.5	322	0.0380	0.97		Shallow Concentrated Flow, 535.25-523 Woodland Kv= 5.0 fps
3.5	163	0.0120	0.77		Shallow Concentrated Flow, 523-521 Short Grass Pasture Kv= 7.0 fps
0.2	100	0.0100	7.20	22.62	Pipe Channel, pipe at 1% 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
33.4	635	Total			

Summary for Subcatchment P1S: South

Runoff = 49.76 cfs @ 12.30 hrs, Volume= 5.441 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90 Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520 Woodland Kv= 5.0 fps
21.7	503	Total			

Summary for Subcatchment P2N: North

Runoff = 7.95 cfs @ 12.42 hrs, Volume= 0.999 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

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Type III 24-hr 10 yr Rainfall=4.50"

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Area (ac)	CN	Description
1.75	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
4.87	80	Weighted Average
4.87		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7 Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5 Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach PDP1N: Central Wetland

Inflow Area = 36.84 ac, 3.04% Impervious, Inflow Depth = 2.46" for 10 yr event
 Inflow = 55.52 cfs @ 12.44 hrs, Volume= 7.565 af
 Outflow = 55.52 cfs @ 12.44 hrs, Volume= 7.565 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 2.64" for 10 yr event
 Inflow = 49.76 cfs @ 12.30 hrs, Volume= 5.441 af
 Outflow = 49.76 cfs @ 12.30 hrs, Volume= 5.441 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP2N: North Wetland

Inflow Area = 4.87 ac, 0.00% Impervious, Inflow Depth = 2.46" for 10 yr event
 Inflow = 7.95 cfs @ 12.42 hrs, Volume= 0.999 af
 Outflow = 7.95 cfs @ 12.42 hrs, Volume= 0.999 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Pond 1: Basin #1

Inflow Area = 0.57 ac, 59.65% Impervious, Inflow Depth = 3.30" for 10 yr event
 Inflow = 2.10 cfs @ 12.09 hrs, Volume= 0.157 af
 Outflow = 0.16 cfs @ 13.25 hrs, Volume= 0.132 af, Atten= 92%, Lag= 69.7 min
 Discarded = 0.02 cfs @ 13.25 hrs, Volume= 0.045 af
 Primary = 0.15 cfs @ 13.25 hrs, Volume= 0.087 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Peak Elev= 519.22' @ 13.25 hrs Surf.Area= 4,347 sf Storage= 3,932 cf

Plug-Flow detention time= 474.5 min calculated for 0.132 af (84% of inflow)

Center-of-Mass det. time= 409.1 min (1,207.2 - 798.1)

Volume	Invert	Avail.Storage	Storage Description
#1	518.00'	9,246 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
518.00	2,040	0	0
519.00	4,014	3,027	3,027
520.25	5,936	6,219	9,246

Device	Routing	Invert	Outlet Devices
#1	Discarded	518.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.25'	12.0" Round Culvert L= 35.5' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.25' / 513.00' S= 0.0634 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.70'	3.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	519.25'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	519.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.02 cfs @ 13.25 hrs HW=519.22' (Free Discharge)

↑1=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.15 cfs @ 13.25 hrs HW=519.22' (Free Discharge)

↑2=Culvert (Passes 0.15 cfs of 5.56 cfs potential flow)

↑3=Orifice/Grate (Orifice Controls 0.15 cfs @ 3.01 fps)

↑4=Orifice/Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=518.00' (Free Discharge)

↑5=Broad-Crested Rectangular Weir(Controls 0.00 cfs)

Summary for Pond 2: Basin #2

Inflow Area = 0.87 ac, 57.47% Impervious, Inflow Depth = 3.40" for 10 yr event
 Inflow = 3.29 cfs @ 12.09 hrs, Volume= 0.246 af
 Outflow = 1.65 cfs @ 12.25 hrs, Volume= 0.211 af, Atten= 50%, Lag= 9.6 min
 Discarded = 0.03 cfs @ 12.25 hrs, Volume= 0.075 af
 Primary = 1.63 cfs @ 12.25 hrs, Volume= 0.136 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 10 yr Rainfall=4.50"

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Peak Elev= 518.36' @ 12.25 hrs Surf.Area= 6,557 sf Storage= 4,416 cf

Plug-Flow detention time= 395.7 min calculated for 0.211 af (86% of inflow)

Center-of-Mass det. time= 333.4 min (1,127.7 - 794.4)

Volume	Invert	Avail.Storage	Storage Description
#1	517.50'	11,456 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
517.50	3,564	0	0
518.00	5,498	2,266	2,266
519.25	9,207	9,191	11,456

Device	Routing	Invert	Outlet Devices
#1	Discarded	517.50'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.00'	12.0" Round Culvert L= 34.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.00' / 513.00' S= 0.0588 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.20'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Secondary	518.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.03 cfs @ 12.25 hrs HW=518.36' (Free Discharge)

↑1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=1.62 cfs @ 12.25 hrs HW=518.36' (Free Discharge)

↑2=Culvert (Passes 1.62 cfs of 5.05 cfs potential flow)

↑3=Orifice/Grate (Weir Controls 1.62 cfs @ 1.29 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=517.50' (Free Discharge)

↑4=Broad-Crested Rectangular Weir(Controls 0.00 cfs)

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentP1N(a): New Road - West Runoff Area=0.57 ac 59.65% Impervious Runoff Depth=4.06"
 Tc=6.0 min CN=89 Runoff=2.57 cfs 0.193 af

SubcatchmentP1N(b): New Road - Central Runoff Area=0.87 ac 57.47% Impervious Runoff Depth=4.17"
 Tc=6.0 min CN=90 Runoff=3.99 cfs 0.302 af

SubcatchmentP1N(c): New Road - East Runoff Area=0.33 ac 84.85% Impervious Runoff Depth=4.60"
 Tc=6.0 min CN=94 Runoff=1.61 cfs 0.127 af

SubcatchmentP1N(d): Northern Clearing Runoff Area=4.37 ac 0.00% Impervious Runoff Depth=2.61"
 Flow Length=616' Tc=14.6 min CN=74 Runoff=10.12 cfs 0.949 af

SubcatchmentP1N(e): Remaining Site Runoff Area=30.70 ac 0.00% Impervious Runoff Depth=3.25"
 Flow Length=635' Tc=33.4 min CN=81 Runoff=62.83 cfs 8.319 af

SubcatchmentP1S: South Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=3.35"
 Flow Length=503' Tc=21.7 min CN=82 Runoff=63.06 cfs 6.912 af

SubcatchmentP2N: North Runoff Area=4.87 ac 0.00% Impervious Runoff Depth=3.16"
 Flow Length=202' Tc=29.9 min CN=80 Runoff=10.19 cfs 1.281 af

Reach PDP1N: Central Wetland Inflow=71.40 cfs 9.707 af
 Outflow=71.40 cfs 9.707 af

Reach PDP1S: Central Wetland Inflow=63.06 cfs 6.912 af
 Outflow=63.06 cfs 6.912 af

Reach PDP2N: North Wetland Inflow=10.19 cfs 1.281 af
 Outflow=10.19 cfs 1.281 af

Pond 1: Basin #1 Peak Elev=519.32' Storage=4,386 cf Inflow=2.57 cfs 0.193 af
 Discarded=0.02 cfs 0.046 af Primary=0.65 cfs 0.122 af Secondary=0.00 cfs 0.000 af Outflow=0.66 cfs 0.168 af

Pond 2: Basin #2 Peak Elev=518.42' Storage=4,820 cf Inflow=3.99 cfs 0.302 af
 Discarded=0.03 cfs 0.076 af Primary=2.65 cfs 0.190 af Secondary=0.00 cfs 0.000 af Outflow=2.68 cfs 0.266 af

Total Runoff Area = 66.48 ac Runoff Volume = 18.083 af Average Runoff Depth = 3.26"
98.32% Pervious = 65.36 ac 1.68% Impervious = 1.12 ac

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Summary for Subcatchment P1N(a): New Road - West

Runoff = 2.57 cfs @ 12.09 hrs, Volume= 0.193 af, Depth= 4.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
0.34	98	Paved parking, HSG C
* 0.02	98	Basin, 0% imp, HSG C
0.21	74	>75% Grass cover, Good, HSG C
0.57	89	Weighted Average
0.23		40.35% Pervious Area
0.34		59.65% Impervious Area

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

Summary for Subcatchment P1N(b): New Road - Central

Runoff = 3.99 cfs @ 12.09 hrs, Volume= 0.302 af, Depth= 4.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
0.50	98	Paved parking, HSG C
* 0.07	98	Basin, 0% imp, HSG C
0.30	74	>75% Grass cover, Good, HSG C
0.87	90	Weighted Average
0.37		42.53% Pervious Area
0.50		57.47% Impervious Area

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

Summary for Subcatchment P1N(c): New Road - East

Runoff = 1.61 cfs @ 12.09 hrs, Volume= 0.127 af, Depth= 4.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

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Type III 24-hr 25 yr Rainfall=5.30"

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Area (ac)	CN	Description
0.28	98	Paved parking, HSG C
0.05	74	>75% Grass cover, Good, HSG C
0.33	94	Weighted Average
0.05		15.15% Pervious Area
0.28		84.85% Impervious Area

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

Summary for Subcatchment P1N(d): Northern Clearing

Runoff = 10.12 cfs @ 12.21 hrs, Volume= 0.949 af, Depth= 2.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
4.37	74	>75% Grass cover, Good, HSG C
4.37		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		Sheet Flow, 528-527 Grass: Short n= 0.150 P2= 3.00"
8.5	466	0.0170	0.91		Shallow Concentrated Flow, 527-519 Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.44	11.38	Pipe Channel, 513-512 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Corrugated PP, smooth interior
14.6	616	Total			

Summary for Subcatchment P1N(e): Remaining Site

Runoff = 62.83 cfs @ 12.46 hrs, Volume= 8.319 af, Depth= 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
1.97	74	>75% Grass cover, Good, HSG C
4.74	98	Water Surface, 0% imp, HSG C
6.62	98	Water Surface, 0% imp, HSG D
16.16	70	Woods, Good, HSG C
1.21	77	Woods, Good, HSG D
30.70	81	Weighted Average
30.70		100.00% Pervious Area

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Type III 24-hr 25 yr Rainfall=5.30"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25
					Woods: Light underbrush n= 0.400 P2= 3.00"
5.5	322	0.0380	0.97		Shallow Concentrated Flow, 535.25-523
					Woodland Kv= 5.0 fps
3.5	163	0.0120	0.77		Shallow Concentrated Flow, 523-521
					Short Grass Pasture Kv= 7.0 fps
0.2	100	0.0100	7.20	22.62	Pipe Channel, pipe at 1%
					24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
33.4	635	Total			

Summary for Subcatchment P1S: South

Runoff = 63.06 cfs @ 12.30 hrs, Volume= 6.912 af, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90
					Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520
					Woodland Kv= 5.0 fps
21.7	503	Total			

Summary for Subcatchment P2N: North

Runoff = 10.19 cfs @ 12.41 hrs, Volume= 1.281 af, Depth= 3.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.30"

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Type III 24-hr 25 yr Rainfall=5.30"

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Area (ac)	CN	Description
1.75	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
4.87	80	Weighted Average
4.87		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7 Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5 Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach PDP1N: Central Wetland

Inflow Area = 36.84 ac, 3.04% Impervious, Inflow Depth = 3.16" for 25 yr event
Inflow = 71.40 cfs @ 12.43 hrs, Volume= 9.707 af
Outflow = 71.40 cfs @ 12.43 hrs, Volume= 9.707 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 3.35" for 25 yr event
Inflow = 63.06 cfs @ 12.30 hrs, Volume= 6.912 af
Outflow = 63.06 cfs @ 12.30 hrs, Volume= 6.912 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP2N: North Wetland

Inflow Area = 4.87 ac, 0.00% Impervious, Inflow Depth = 3.16" for 25 yr event
Inflow = 10.19 cfs @ 12.41 hrs, Volume= 1.281 af
Outflow = 10.19 cfs @ 12.41 hrs, Volume= 1.281 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Pond 1: Basin #1

Inflow Area = 0.57 ac, 59.65% Impervious, Inflow Depth = 4.06" for 25 yr event
Inflow = 2.57 cfs @ 12.09 hrs, Volume= 0.193 af
Outflow = 0.66 cfs @ 12.47 hrs, Volume= 0.168 af, Atten= 74%, Lag= 22.6 min
Discarded = 0.02 cfs @ 12.47 hrs, Volume= 0.046 af
Primary = 0.65 cfs @ 12.47 hrs, Volume= 0.122 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 25 yr Rainfall=5.30"

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Peak Elev= 519.32' @ 12.47 hrs Surf.Area= 4,505 sf Storage= 4,386 cf

Plug-Flow detention time= 403.3 min calculated for 0.168 af (87% of inflow)

Center-of-Mass det. time= 346.9 min (1,139.3 - 792.4)

Volume	Invert	Avail.Storage	Storage Description
#1	518.00'	9,246 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
518.00	2,040	0	0
519.00	4,014	3,027	3,027
520.25	5,936	6,219	9,246

Device	Routing	Invert	Outlet Devices
#1	Discarded	518.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.25'	12.0" Round Culvert L= 35.5' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.25' / 513.00' S= 0.0634 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.70'	3.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	519.25'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	519.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.02 cfs @ 12.47 hrs HW=519.32' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.02 cfs)**Primary OutFlow** Max=0.63 cfs @ 12.47 hrs HW=519.32' (Free Discharge)↑**2=Culvert** (Passes 0.63 cfs of 5.64 cfs potential flow)↑**3=Orifice/Grate** (Orifice Controls 0.17 cfs @ 3.38 fps)↑**4=Orifice/Grate** (Weir Controls 0.47 cfs @ 0.86 fps)**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=518.00' (Free Discharge)↑**5=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)**Summary for Pond 2: Basin #2**

Inflow Area =	0.87 ac, 57.47% Impervious, Inflow Depth = 4.17" for 25 yr event
Inflow =	3.99 cfs @ 12.09 hrs, Volume= 0.302 af
Outflow =	2.68 cfs @ 12.18 hrs, Volume= 0.266 af, Atten= 33%, Lag= 5.7 min
Discarded =	0.03 cfs @ 12.18 hrs, Volume= 0.076 af
Primary =	2.65 cfs @ 12.18 hrs, Volume= 0.190 af
Secondary =	0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 25 yr Rainfall=5.30"

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Peak Elev= 518.42' @ 12.18 hrs Surf.Area= 6,737 sf Storage= 4,820 cf

Plug-Flow detention time= 326.2 min calculated for 0.266 af (88% of inflow)

Center-of-Mass det. time= 271.5 min (1,060.2 - 788.8)

Volume	Invert	Avail.Storage	Storage Description
#1	517.50'	11,456 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
517.50	3,564	0	0
518.00	5,498	2,266	2,266
519.25	9,207	9,191	11,456

Device	Routing	Invert	Outlet Devices
#1	Discarded	517.50'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.00'	12.0" Round Culvert L= 34.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.00' / 513.00' S= 0.0588 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.20'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Secondary	518.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.03 cfs @ 12.18 hrs HW=518.42' (Free Discharge)

↑1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=2.63 cfs @ 12.18 hrs HW=518.42' (Free Discharge)

↑2=Culvert (Passes 2.63 cfs of 5.10 cfs potential flow)

↑3=Orifice/Grate (Weir Controls 2.63 cfs @ 1.52 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=517.50' (Free Discharge)

↑4=Broad-Crested Rectangular Weir(Controls 0.00 cfs)

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentP1N(a): New Road - West Runoff Area=0.57 ac 59.65% Impervious Runoff Depth=5.22"
 Tc=6.0 min CN=89 Runoff=3.26 cfs 0.248 af

SubcatchmentP1N(b): New Road - Central Runoff Area=0.87 ac 57.47% Impervious Runoff Depth=5.33"
 Tc=6.0 min CN=90 Runoff=5.04 cfs 0.387 af

SubcatchmentP1N(c): New Road - East Runoff Area=0.33 ac 84.85% Impervious Runoff Depth=5.79"
 Tc=6.0 min CN=94 Runoff=2.00 cfs 0.159 af

SubcatchmentP1N(d): Northern Clearing Runoff Area=4.37 ac 0.00% Impervious Runoff Depth=3.61"
 Flow Length=616' Tc=14.6 min CN=74 Runoff=14.08 cfs 1.315 af

SubcatchmentP1N(e): Remaining Site Runoff Area=30.70 ac 0.00% Impervious Runoff Depth=4.34"
 Flow Length=635' Tc=33.4 min CN=81 Runoff=83.48 cfs 11.108 af

SubcatchmentP1S: South Runoff Area=24.77 ac 0.00% Impervious Runoff Depth=4.45"
 Flow Length=503' Tc=21.7 min CN=82 Runoff=83.26 cfs 9.184 af

SubcatchmentP2N: North Runoff Area=4.87 ac 0.00% Impervious Runoff Depth=4.24"
 Flow Length=202' Tc=29.9 min CN=80 Runoff=13.63 cfs 1.719 af

Reach PDP1N: Central Wetland Inflow=95.38 cfs 13.031 af
 Outflow=95.38 cfs 13.031 af

Reach PDP1S: Central Wetland Inflow=83.26 cfs 9.184 af
 Outflow=83.26 cfs 9.184 af

Reach PDP2N: North Wetland Inflow=13.63 cfs 1.719 af
 Outflow=13.63 cfs 1.719 af

Pond 1: Basin #1 Peak Elev=519.40' Storage=4,735 cf Inflow=3.26 cfs 0.248 af
 Discarded=0.02 cfs 0.047 af Primary=1.63 cfs 0.176 af Secondary=0.00 cfs 0.000 af Outflow=1.65 cfs 0.223 af

Pond 2: Basin #2 Peak Elev=518.48' Storage=5,252 cf Inflow=5.04 cfs 0.387 af
 Discarded=0.03 cfs 0.078 af Primary=3.89 cfs 0.273 af Secondary=0.00 cfs 0.000 af Outflow=3.92 cfs 0.351 af

Total Runoff Area = 66.48 ac Runoff Volume = 24.120 af Average Runoff Depth = 4.35"
98.32% Pervious = 65.36 ac 1.68% Impervious = 1.12 ac

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Summary for Subcatchment P1N(a): New Road - West

Runoff = 3.26 cfs @ 12.09 hrs, Volume= 0.248 af, Depth= 5.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
0.34	98	Paved parking, HSG C
* 0.02	98	Basin, 0% imp, HSG C
0.21	74	>75% Grass cover, Good, HSG C
0.57	89	Weighted Average
0.23		40.35% Pervious Area
0.34		59.65% Impervious Area

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

Summary for Subcatchment P1N(b): New Road - Central

Runoff = 5.04 cfs @ 12.09 hrs, Volume= 0.387 af, Depth= 5.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
0.50	98	Paved parking, HSG C
* 0.07	98	Basin, 0% imp, HSG C
0.30	74	>75% Grass cover, Good, HSG C
0.87	90	Weighted Average
0.37		42.53% Pervious Area
0.50		57.47% Impervious Area

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

Summary for Subcatchment P1N(c): New Road - East

Runoff = 2.00 cfs @ 12.09 hrs, Volume= 0.159 af, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

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Type III 24-hr 100 yr Rainfall=6.50"

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Area (ac)	CN	Description
0.28	98	Paved parking, HSG C
0.05	74	>75% Grass cover, Good, HSG C
0.33	94	Weighted Average
0.05		15.15% Pervious Area
0.28		84.85% Impervious Area

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

Summary for Subcatchment P1N(d): Northern Clearing

Runoff = 14.08 cfs @ 12.20 hrs, Volume= 1.315 af, Depth= 3.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
4.37	74	>75% Grass cover, Good, HSG C
4.37		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		Sheet Flow, 528-527 Grass: Short n= 0.150 P2= 3.00"
8.5	466	0.0170	0.91		Shallow Concentrated Flow, 527-519 Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.44	11.38	Pipe Channel, 513-512 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Corrugated PP, smooth interior
14.6	616	Total			

Summary for Subcatchment P1N(e): Remaining Site

Runoff = 83.48 cfs @ 12.46 hrs, Volume= 11.108 af, Depth= 4.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
1.97	74	>75% Grass cover, Good, HSG C
4.74	98	Water Surface, 0% imp, HSG C
6.62	98	Water Surface, 0% imp, HSG D
16.16	70	Woods, Good, HSG C
1.21	77	Woods, Good, HSG D
30.70	81	Weighted Average
30.70		100.00% Pervious Area

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Type III 24-hr 100 yr Rainfall=6.50"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 535.46-535.25 Woods: Light underbrush n= 0.400 P2= 3.00"
5.5	322	0.0380	0.97		Shallow Concentrated Flow, 535.25-523 Woodland Kv= 5.0 fps
3.5	163	0.0120	0.77		Shallow Concentrated Flow, 523-521 Short Grass Pasture Kv= 7.0 fps
0.2	100	0.0100	7.20	22.62	Pipe Channel, pipe at 1% 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
33.4	635	Total			

Summary for Subcatchment P1S: South

Runoff = 83.26 cfs @ 12.29 hrs, Volume= 9.184 af, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (ac)	CN	Description
9.98	70	Woods, Good, HSG C
0.48	98	Water Surface, 0% imp, HSG C
5.78	77	Woods, Good, HSG D
8.53	98	Water Surface, 0% imp, HSG D
24.77	82	Weighted Average
24.77		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	50	0.0140	0.06		Sheet Flow, 541.60-540.90 Woods: Light underbrush n= 0.400 P2= 3.00"
7.0	453	0.0460	1.07		Shallow Concentrated Flow, 540.9-520 Woodland Kv= 5.0 fps
21.7	503	Total			

Summary for Subcatchment P2N: North

Runoff = 13.63 cfs @ 12.41 hrs, Volume= 1.719 af, Depth= 4.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=6.50"

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Type III 24-hr 100 yr Rainfall=6.50"

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Area (ac)	CN	Description
1.75	70	Woods, Good, HSG C
1.85	77	Woods, Good, HSG D
1.27	98	Water Surface, 0% imp, HSG D
4.87	80	Weighted Average
4.87		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.2	50	0.0040	0.03		Sheet Flow, 532.9-532.7 Woods: Light underbrush n= 0.400 P2= 3.00"
5.7	152	0.0080	0.45		Shallow Concentrated Flow, 532.7-531.5 Woodland Kv= 5.0 fps
29.9	202	Total			

Summary for Reach PDP1N: Central Wetland

Inflow Area = 36.84 ac, 3.04% Impervious, Inflow Depth = 4.24" for 100 yr event
 Inflow = 95.38 cfs @ 12.42 hrs, Volume= 13.031 af
 Outflow = 95.38 cfs @ 12.42 hrs, Volume= 13.031 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP1S: Central Wetland

Inflow Area = 24.77 ac, 0.00% Impervious, Inflow Depth = 4.45" for 100 yr event
 Inflow = 83.26 cfs @ 12.29 hrs, Volume= 9.184 af
 Outflow = 83.26 cfs @ 12.29 hrs, Volume= 9.184 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Reach PDP2N: North Wetland

Inflow Area = 4.87 ac, 0.00% Impervious, Inflow Depth = 4.24" for 100 yr event
 Inflow = 13.63 cfs @ 12.41 hrs, Volume= 1.719 af
 Outflow = 13.63 cfs @ 12.41 hrs, Volume= 1.719 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Summary for Pond 1: Basin #1

Inflow Area = 0.57 ac, 59.65% Impervious, Inflow Depth = 5.22" for 100 yr event
 Inflow = 3.26 cfs @ 12.09 hrs, Volume= 0.248 af
 Outflow = 1.65 cfs @ 12.25 hrs, Volume= 0.223 af, Atten= 49%, Lag= 9.4 min
 Discarded = 0.02 cfs @ 12.25 hrs, Volume= 0.047 af
 Primary = 1.63 cfs @ 12.25 hrs, Volume= 0.176 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 100 yr Rainfall=6.50"

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Peak Elev= 519.40' @ 12.25 hrs Surf.Area= 4,622 sf Storage= 4,735 cf

Plug-Flow detention time= 328.2 min calculated for 0.222 af (90% of inflow)

Center-of-Mass det. time= 280.4 min (1,065.9 - 785.6)

Volume	Invert	Avail.Storage	Storage Description
#1	518.00'	9,246 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
518.00	2,040	0	0
519.00	4,014	3,027	3,027
520.25	5,936	6,219	9,246

Device	Routing	Invert	Outlet Devices
#1	Discarded	518.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.25'	12.0" Round Culvert L= 35.5' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.25' / 513.00' S= 0.0634 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.70'	3.0" Vert. Orifice/Grate C= 0.600
#4	Device 2	519.25'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#5	Secondary	519.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.02 cfs @ 12.25 hrs HW=519.40' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.02 cfs)**Primary OutFlow** Max=1.62 cfs @ 12.25 hrs HW=519.40' (Free Discharge)↑**2=Culvert** (Passes 1.62 cfs of 5.70 cfs potential flow)↑**3=Orifice/Grate** (Orifice Controls 0.18 cfs @ 3.64 fps)↑**4=Orifice/Grate** (Weir Controls 1.45 cfs @ 1.25 fps)**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=518.00' (Free Discharge)↑**5=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)**Summary for Pond 2: Basin #2**

Inflow Area =	0.87 ac, 57.47% Impervious, Inflow Depth = 5.33" for 100 yr event
Inflow =	5.04 cfs @ 12.09 hrs, Volume= 0.387 af
Outflow =	3.92 cfs @ 12.16 hrs, Volume= 0.351 af, Atten= 22%, Lag= 4.3 min
Discarded =	0.03 cfs @ 12.16 hrs, Volume= 0.078 af
Primary =	3.89 cfs @ 12.16 hrs, Volume= 0.273 af
Secondary =	0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

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Type III 24-hr 100 yr Rainfall=6.50"

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Peak Elev= 518.48' @ 12.16 hrs Surf.Area= 6,925 sf Storage= 5,252 cf

Plug-Flow detention time= 261.8 min calculated for 0.351 af (91% of inflow)

Center-of-Mass det. time= 215.6 min (997.8 - 782.2)

Volume	Invert	Avail.Storage	Storage Description
#1	517.50'	11,456 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
517.50	3,564	0	0
518.00	5,498	2,266	2,266
519.25	9,207	9,191	11,456

Device	Routing	Invert	Outlet Devices
#1	Discarded	517.50'	0.170 in/hr Exfiltration over Surface area
#2	Primary	515.00'	12.0" Round Culvert L= 34.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 515.00' / 513.00' S= 0.0588 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#3	Device 2	518.20'	24.0" x 24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Secondary	518.50'	20.0' long x 10.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.03 cfs @ 12.16 hrs HW=518.48' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=3.85 cfs @ 12.16 hrs HW=518.48' (Free Discharge)

↑**2=Culvert** (Passes 3.85 cfs of 5.15 cfs potential flow)

↑**3=Orifice/Grate** (Weir Controls 3.85 cfs @ 1.73 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=517.50' (Free Discharge)

↑**4=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

APPENDIX F: STORMWATER CALCULATIONS

- *MA STANDARD #3 – RECHARGE AND DRAWDOWN TIME*
- *MA STANDARD #4 – WATER QUALITY*
- *STAGE STORAGE TABLE*
- *RAINFALL DATA*
- *PIPE SIZING*
- *CATCH BASIN INLET MAP*
- *OUTLET PROTECTION SIZING*

Centech Park North
 384-386 South Street
 Shrewsbury, MA
 Bohler Job Number: W181144
 March 28, 2019

MA DEP Standard 3: Recharge Volume Calculations

Required Recharge Volume - A Soils (0.60 in.)	
Existing Site Impervious Area (ac)	0.000
Proposed Site Impervious Area (ac)	0.000
Proposed Increase in Site Impervious Area (ac)	0.000
Recharge Volume Required (cf)	0
Required Recharge Volume - B Soils (0.35 in.)	
Existing Site Impervious Area (ac)	0.000
Proposed Site Impervious Area (ac)	0.000
Proposed Increase in Site Impervious Area (ac)	0.000
Recharge Volume Required (cf)	0
Required Recharge Volume - C Soils (0.25 in.)	
Existing Site Impervious Area (ac)	0.690
Proposed Site Impervious Area (ac)	1.120
Proposed Increase in Site Impervious Area (ac)	0.430
Recharge Volume Required (cf)	390
Required Recharge Volume - D Soils (0.10 in.)	
Existing Site Impervious Area (ac)	0.000
Proposed Site Impervious Area (ac)	0.000
Proposed Increase in Site Impervious Area (ac)	0.000
Recharge Volume Required (cf)	0
Total Recharge Volume Required (cf)	
390	
Recharge Volume Adjustment Factor	
Impervious Area Directed to Infiltration BMP (ac)	0.840
%Impervious Directed to Infiltration BMP	75%
Adjustment Factor	1.33
Adjusted Total Recharge Volume Required (cf)	520
Provided Recharge Volume*	
Basin #1	1,912
Basin #2	3,424
Total Recharge Volume Provided (cf)	5,336

Provided greater than or Equal to Required

*Volume provided below lowest outlet in cubic feet (cf)

Centech Park North
384-386 South Street
Shrewsbury, MA
Bohler Job Number: W181144
March 28, 2019

MA DEP Standard 3: Drawdown Time Calculations

Drawdown Time - Basin #1	
Volume below outlet pipe (Rv) (cf)	1,912
Soil Type	Sandy Clay Loam - C
Infiltration rate (K)*	0.17
Bottom Area (sf)	2,040
Drawdown time (Hours)*	66.2
Drawdown Time - Basin #2	
Volume below outlet pipe (Rv) (cf)	3,424
Soil Type	Sandy Clay Loam - C
Infiltration rate (K)*	0.17
Bottom Area (sf)	3,564
Drawdown time (Hours)**	67.8

*Infiltration Rates taken from Rawls Table
 **Drawdown time = $R_v / (K) \times (\text{bottom area})$

**Centech Park North
384-386 South Street
Shrewsbury, MA
Bohler Job Number: W181144**

Forebay Sizing Calculations

Forebay #1

Total Post Development Impervious Area (acres)	0.34
Forebay Volume Required (cf)	123.42
Forebay Volume Provided (cf)*	169

Forebay #2

Total Post Development Impervious Area (acres)	0.5
Forebay Volume Required (cf)	181.5
Forebay Volume Provided (cf)*	199

*Volume provided below lowest outlet of forebay, refer to attached storage tables

Centech Park North
384-386 South Street
Shrewsbury, MA
Bohler Job Number: W181144
March 28, 2019

MA DEP Standard 4: Water Quality Volume Calculations

Water Quality Volume Required	
Water Quality Volume runoff (in.)*	1.0
Total Post Development Impervious Area (sf)	48,787
Required Water Quality Volume (cf)	
*Water Quality volume runoff is equal to 1.0 inches of runoff times the total impervious area of the post development project site	
Water Quality Volume Provided*	
Basin #1	1,912
Basin #2	3,424
Total Provided Water Quality Volume (cf)	
5,336	
<u>Provided greater than or Equal to Required</u>	
*Volume provided below lowest outlet pipe in cubic feet (cf)	

Bohler Job # W181144
 Calc: CMC
 Date: 3/28/2019

1" Water Quality Volume to Flow Rate Calculation Sheet

This spreadsheet should be used to convert water quality volume to an equivalent water quality peak flow rate as outlined in the new MA DEP guidelines that take effect on October 15, 2013.

Glossary

Water Quality Flow Rate = WQF
 Water Quality Volume = WQV*
 Unit peak discharge (csm/in) = qu**
 Impervious Area in watershed (square miles) = Ai

*WQV is expressed in watershed inches (you must use 1.0-inches in all cases with this method and not 0.5-inches)

** calculate the qu based on the time of concentration (see 1" - qu Table)

Compute Water Quality Flow with the following Equation

$WQF = (qu)(A)(WQV)$

Input Information (in colored cells only)

Site Plan Callout	=	Enter qu (from 1" - qu Table)	Enter Impervious Area (SF)	Ai (sq/mi)	WQV (inches)	=	WQF (cfs)
WQS400	=	774	12197	0.000438	1	=	0.34
WQS401	=	774	21780	0.000781	1	=	0.60
WQS402	=	774	14810	0.000531	1	=	0.41

Location: 44% Pretreatment to Infiltration Basins

TSS Removal Calculation Worksheet

A BMP ¹	B TSS Removal Rate ¹	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump Hooded Catch Basin	0.25	1.00	0.25	0.75
Proprietary Treatment Unit	0.80	0.75	0.60	0.15
Forebay	0.25	0.15	0.04	0.11

Total TSS Removal = 89%

Project: Centech Park North
 Prepared By: Bohler Engineering
 Date: 28-Mar-19

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

Location: Treatment - CB to WQU to Infiltration Basin

TSS Removal Calculation Worksheet

A BMP ¹	B TSS Removal Rate ¹	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump Hooded Catch Basin	0.25	1.00	0.25	0.75
Proprietary Treatment Unit	0.80	0.75	0.60	0.15
Infiltration Basin with Forebay	0.80	0.15	0.12	0.03

Total TSS Removal = 97%

Project: Centech Park North
 Prepared By: Bohler Engineering
 Date: 28-Mar-19

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

Location: Treatment - CB to WQU

TSS Removal Calculation Worksheet

A BMP ¹	B TSS Removal Rate ¹	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump Hooded Catch Basin	0.25	1.00	0.25	0.75
Proprietary Treatment Unit	0.80	0.75	0.60	0.15

Total TSS Removal = 85%

Project: Centech Park North
 Prepared By: Bohler Engineering
 Date: 28-Mar-19

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

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Basin Stage Storage

Type III 24-hr 2 yr Rainfall=3.00"

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Stage-Area-Storage for Pond 1: Basin #1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
518.00	2,040	0	518.51	3,047	1,297
518.01	2,060	20	518.52	3,066	1,328
518.02	2,079	41	518.53	3,086	1,358
518.03	2,099	62	518.54	3,106	1,389
518.04	2,119	83	518.55	3,126	1,421
518.05	2,139	104	518.56	3,145	1,452
518.06	2,158	126	518.57	3,165	1,483
518.07	2,178	148	518.58	3,185	1,515
518.08	2,198	170	518.59	3,205	1,547
518.09	2,218	192	518.60	3,224	1,579
518.10	2,237	214	518.61	3,244	1,612
518.11	2,257	236	518.62	3,264	1,644
518.12	2,277	259	518.63	3,284	1,677
518.13	2,297	282	518.64	3,303	1,710
518.14	2,316	305	518.65	3,323	1,743
518.15	2,336	328	518.66	3,343	1,776
518.16	2,356	352	518.67	3,363	1,810
518.17	2,376	375	518.68	3,382	1,844
518.18	2,395	399	518.69	3,402	1,878
518.19	2,415	423	518.70	3,422	1,912
518.20	2,435	447	518.71	3,442	1,946
518.21	2,455	472	518.72	3,461	1,980
518.22	2,474	497	518.73	3,481	2,015
518.23	2,494	521	518.74	3,501	2,050
518.24	2,514	546	518.75	3,521	2,085
518.25	2,534	572	518.76	3,540	2,120
518.26	2,553	597	518.77	3,560	2,156
518.27	2,573	623	518.78	3,580	2,192
518.28	2,593	649	518.79	3,599	2,228
518.29	2,612	675	518.80	3,619	2,264
518.30	2,632	701	518.81	3,639	2,300
518.31	2,652	727	518.82	3,659	2,336
518.32	2,672	754	518.83	3,678	2,373
518.33	2,691	781	518.84	3,698	2,410
518.34	2,711	808	518.85	3,718	2,447
518.35	2,731	835	518.86	3,738	2,484
518.36	2,751	862	518.87	3,757	2,522
518.37	2,770	890	518.88	3,777	2,560
518.38	2,790	918	518.89	3,797	2,597
518.39	2,810	946	518.90	3,817	2,635
518.40	2,830	974	518.91	3,836	2,674
518.41	2,849	1,002	518.92	3,856	2,712
518.42	2,869	1,031	518.93	3,876	2,751
518.43	2,889	1,060	518.94	3,896	2,790
518.44	2,909	1,089	518.95	3,915	2,829
518.45	2,928	1,118	518.96	3,935	2,868
518.46	2,948	1,147	518.97	3,955	2,907
518.47	2,968	1,177	518.98	3,975	2,947
518.48	2,988	1,207	518.99	3,994	2,987
518.49	3,007	1,237	519.00	4,014	3,027
518.50	3,027	1,267	519.01	4,029	3,067

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Basin Stage Storage

Type III 24-hr 2 yr Rainfall=3.00"

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Stage-Area-Storage for Pond 2: Basin #2

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
517.50	3,564	0	518.01	5,528	2,321
517.51	3,603	36	518.02	5,557	2,376
517.52	3,641	72	518.03	5,587	2,432
517.53	3,680	109	518.04	5,617	2,488
517.54	3,719	146	518.05	5,646	2,544
517.55	3,757	183	518.06	5,676	2,601
517.56	3,796	221	518.07	5,706	2,658
517.57	3,835	259	518.08	5,735	2,715
517.58	3,873	297	518.09	5,765	2,772
517.59	3,912	336	518.10	5,795	2,830
517.60	3,951	376	518.11	5,824	2,888
517.61	3,989	415	518.12	5,854	2,947
517.62	4,028	456	518.13	5,884	3,005
517.63	4,067	496	518.14	5,913	3,064
517.64	4,106	537	518.15	5,943	3,124
517.65	4,144	578	518.16	5,973	3,183
517.66	4,183	620	518.17	6,002	3,243
517.67	4,222	662	518.18	6,032	3,303
517.68	4,260	704	518.19	6,062	3,364
517.69	4,299	747	518.20	6,091	3,424
517.70	4,338	790	518.21	6,121	3,486
517.71	4,376	834	518.22	6,151	3,547
517.72	4,415	878	518.23	6,180	3,609
517.73	4,454	922	518.24	6,210	3,670
517.74	4,492	967	518.25	6,240	3,733
517.75	4,531	1,012	518.26	6,269	3,795
517.76	4,570	1,057	518.27	6,299	3,858
517.77	4,608	1,103	518.28	6,329	3,921
517.78	4,647	1,150	518.29	6,358	3,985
517.79	4,686	1,196	518.30	6,388	4,048
517.80	4,724	1,243	518.31	6,418	4,112
517.81	4,763	1,291	518.32	6,448	4,177
517.82	4,802	1,339	518.33	6,477	4,241
517.83	4,840	1,387	518.34	6,507	4,306
517.84	4,879	1,435	518.35	6,537	4,372
517.85	4,918	1,484	518.36	6,566	4,437
517.86	4,956	1,534	518.37	6,596	4,503
517.87	4,995	1,583	518.38	6,626	4,569
517.88	5,034	1,634	518.39	6,655	4,635
517.89	5,073	1,684	518.40	6,685	4,702
517.90	5,111	1,735	518.41	6,715	4,769
517.91	5,150	1,786	518.42	6,744	4,836
517.92	5,189	1,838	518.43	6,774	4,904
517.93	5,227	1,890	518.44	6,804	4,972
517.94	5,266	1,943	518.45	6,833	5,040
517.95	5,305	1,995	518.46	6,863	5,109
517.96	5,343	2,049	518.47	6,893	5,177
517.97	5,382	2,102	518.48	6,922	5,246
517.98	5,421	2,156	518.49	6,952	5,316
517.99	5,459	2,211	518.50	6,982	5,385
518.00	5,498	2,266	518.51	7,011	5,455

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Forebay Stage Storage
Type III 24-hr 2 yr Rainfall=3.00"

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Stage-Area-Storage for Pond F1: Forebay

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
519.00	280	0	519.51	398	173
519.01	282	3	519.52	400	177
519.02	285	6	519.53	402	181
519.03	287	9	519.54	405	185
519.04	289	11	519.55	407	189
519.05	292	14	519.56	409	193
519.06	294	17	519.57	412	197
519.07	296	20	519.58	414	201
519.08	298	23	519.59	416	205
519.09	301	26	519.60	419	210
519.10	303	29	519.61	421	214
519.11	305	32	519.62	423	218
519.12	308	35	519.63	426	222
519.13	310	38	519.64	428	227
519.14	312	41	519.65	430	231
519.15	315	45	519.66	432	235
519.16	317	48	519.67	435	239
519.17	319	51	519.68	437	244
519.18	322	54	519.69	439	248
519.19	324	57	519.70	442	253
519.20	326	61	519.71	444	257
519.21	329	64	519.72	446	261
519.22	331	67	519.73	449	266
519.23	333	71	519.74	451	270
519.24	335	74	519.75	453	275
519.25	338	77	519.76	456	280
519.26	340	81	519.77	458	284
519.27	342	84	519.78	460	289
519.28	345	87	519.79	462	293
519.29	347	91	519.80	465	298
519.30	349	94	519.81	467	303
519.31	352	98	519.82	469	307
519.32	354	101	519.83	472	312
519.33	356	105	519.84	474	317
519.34	359	109	519.85	476	321
519.35	361	112	519.86	479	326
519.36	363	116	519.87	481	331
519.37	365	119	519.88	483	336
519.38	368	123	519.89	486	341
519.39	370	127	519.90	488	346
519.40	372	130	519.91	490	350
519.41	375	134	519.92	493	355
519.42	377	138	519.93	495	360
519.43	379	142	519.94	497	365
519.44	382	146	519.95	499	370
519.45	384	149	519.96	502	375
519.46	386	153	519.97	504	380
519.47	389	157	519.98	506	385
519.48	391	161	519.99	509	390
519.49	393	165	520.00	511	396
519.50	396	169			

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Forebay Stage Storage
Type III 24-hr 2 yr Rainfall=3.00"

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Stage-Area-Storage for Pond F2: Forebay

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
518.00	353	0	518.51	446	204
518.01	355	4	518.52	448	208
518.02	357	7	518.53	449	213
518.03	358	11	518.54	451	217
518.04	360	14	518.55	453	222
518.05	362	18	518.56	455	226
518.06	364	22	518.57	457	231
518.07	366	25	518.58	459	235
518.08	368	29	518.59	460	240
518.09	369	33	518.60	462	245
518.10	371	36	518.61	464	249
518.11	373	40	518.62	466	254
518.12	375	44	518.63	468	259
518.13	377	47	518.64	469	263
518.14	378	51	518.65	471	268
518.15	380	55	518.66	473	273
518.16	382	59	518.67	475	277
518.17	384	63	518.68	477	282
518.18	386	66	518.69	479	287
518.19	388	70	518.70	480	292
518.20	389	74	518.71	482	297
518.21	391	78	518.72	484	301
518.22	393	82	518.73	486	306
518.23	395	86	518.74	488	311
518.24	397	90	518.75	490	316
518.25	399	94	518.76	491	321
518.26	400	98	518.77	493	326
518.27	402	102	518.78	495	331
518.28	404	106	518.79	497	336
518.29	406	110	518.80	499	341
518.30	408	114	518.81	500	346
518.31	409	118	518.82	502	351
518.32	411	122	518.83	504	356
518.33	413	126	518.84	506	361
518.34	415	131	518.85	508	366
518.35	417	135	518.86	510	371
518.36	419	139	518.87	511	376
518.37	420	143	518.88	513	381
518.38	422	147	518.89	515	386
518.39	424	152	518.90	517	391
518.40	426	156	518.91	519	397
518.41	428	160	518.92	520	402
518.42	429	164	518.93	522	407
518.43	431	169	518.94	524	412
518.44	433	173	518.95	526	417
518.45	435	177	518.96	528	423
518.46	437	182	518.97	530	428
518.47	439	186	518.98	531	433
518.48	440	190	518.99	533	439
518.49	442	195	519.00	535	444
518.50	444	199			

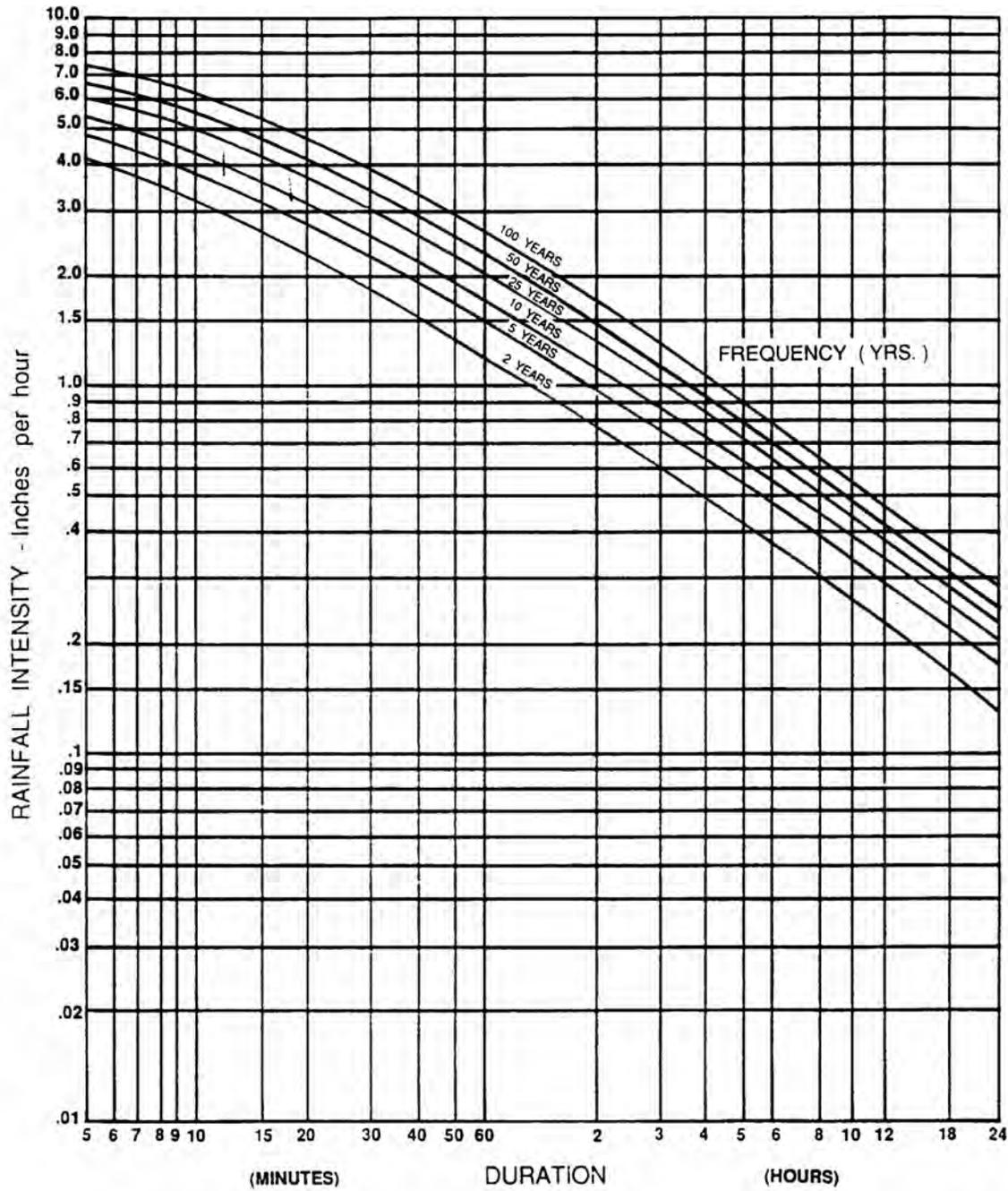
F-1. Rainfall Data for Massachusetts from *Rainfall Frequency Atlas of the United States (TP-40)*

- Users of this Handbook should note that current MA DEP written guidance (see DEP Waterlines newsletter -- Fall 2000) requires the use of TP-40 Rainfall Data for calculations under the Wetlands Protection Regulations and the Stormwater Management Policy. More stringent design storms may be used under a local bylaw or ordinance. However, DEP will continue to require the use of TP-40 in any case it reviews under the Wetlands Protection Act and Stormwater Management Policy.

Adjusted Technical Paper 40 Design Storms for 24-hour Event by County

County Name	1-yr 24-hr	2-yr 24-hr	5-yr 24-hr	10-yr 24-hr	25-yr 24-hr	50-yr 24-hr	100-yr 24-hr
Barnstable	2.5	3.6	4.5	4.8	5.7	6.4	7.1
Berkshire	2.5	2.9	3.8	4.4	5.1	5.9	6.4
Bristol	2.5	3.4	4.3	4.8	5.6	6.3	7.0
Dukes	2.5	3.6	4.6	4.9	5.8	6.5	7.2
Essex	2.5	3.1	3.9	4.5	5.4	5.9	6.5
Franklin	2.5	2.9	3.8	4.3	5.1	5.8	6.2
Hampden	2.5	3.0	4.0	4.6	5.3	6.0	6.5
Hampshire	2.5	3.0	3.9	4.5	5.2	5.9	6.4
Middlesex	2.5	3.1	4.0	4.5	5.3	5.9	6.5
Nantucket	2.5	3.6	4.6	4.9	5.8	6.5	7.2
Norfolk	2.5	3.2	4.1	4.7	5.5	6.1	6.7
Plymouth	2.5	3.4	4.3	4.7	5.6	6.2	7.0
Suffolk	2.5	3.2	4.0	4.6	5.5	6.0	6.6
Worcester	2.5	3.0	4.0	4.5	5.3	5.9	6.5

Exhibit 8-12
Intensity - Duration - Frequency Curve for Boston, MA



Source: TR55 - Urban Hydrology for Small Wetlands, NRCS

Centech Park North
384-386 South Street
Shrewsbury, MA
Bohler Job Number: W181144
March 28, 2019

Rational Pipe Sizing Calculations

Design Period Storm:		25 Year		Design Period Intensity*				5.9 in/hr										
LOCATION		IMPERVIOUS			OTHER				SUM CA	Tc (min)	I (in/hr)	Q (cfs)	D (in)	S (ft/ft)	Material	n	Q Full (cfs)	V Full (fps)
FROM	TO	A	C	CA	A	C	CA											
EX-DMH	DMH201	See Note#1 & calculation below for flow rate								6	5.9	16.03	18	0.020	HDPE	0.012	16.09	9.11
DMH201	DMH202	See Note#1 & calculation below for flow rate								6	5.9	16.03	18	0.020	HDPE	0.012	16.09	9.11
DMH202	DMH203	See Note#1 & calculation below for flow rate								6	5.9	16.03	18	0.020	HDPE	0.012	16.09	9.11
DI01	DMH203	0.00	0.95	0.00	1.11	0.30	0.33	0.33	6	5.9	1.96	18	0.010	HDPE	0.012	11.38	6.44	
DMH203	DMH204	DMH202 + DI01								6	5.9	18.00	24	0.016	HDPE	0.012	31.00	9.87
CB100	WQS400	0.15	0.95	0.14	0.00	0.30	0.00	0.14	6	5.9	0.84	12	0.010	HDPE	0.012	3.86	4.91	
CB101	WQS400	0.18	0.95	0.17	0.05	0.30	0.02	0.19	6	5.9	1.10	12	0.010	HDPE	0.012	3.86	4.91	
WQS400	DMH204	0.33	0.95	0.31	0.05	0.30	0.02	0.33	6	5.9	1.94	12	0.010	HDPE	0.012	3.86	4.91	
DMH204	FES01	DMH203 + WQS400								6	5.9	19.94	24	0.011	HDPE	0.012	25.70	8.18
DI02	FES02	0.00	0.95	0.00	3.02	0.30	0.91	0.91	6	5.9	5.35	18	0.010	HDPE	0.012	11.38	6.44	
DI03	FES05	0.00	0.95	0.00	4.31	0.30	1.29	1.29	6	5.9	7.63	18	0.009	HDPE	0.012	10.92	6.18	
CB104	DMH206	0.07	0.95	0.07	0.00	0.30	0.00	0.07	6	5.9	0.39	12	0.006	HDPE	0.012	3.01	3.84	
CB105	DMH206	0.05	0.95	0.05	0.03	0.30	0.01	0.06	6	5.9	0.33	12	0.008	HDPE	0.012	3.45	4.40	
DMH206	DMH205	0.12	0.95	0.11	0.03	0.30	0.01	0.12	6	5.9	0.73	12	0.006	HDPE	0.012	2.89	3.68	
CB102	DMH205	0.22	0.95	0.21	0.00	0.30	0.00	0.21	6	5.9	1.23	12	0.005	HDPE	0.012	2.73	3.47	
CB103	DMH205	0.15	0.95	0.14	0.08	0.30	0.02	0.17	6	5.9	0.98	12	0.011	HDPE	0.012	4.10	5.22	
DMH205	WQS401	0.49	0.95	0.47	0.11	0.30	0.03	0.50	6	5.9	2.94	12	0.015	HDPE	0.012	4.65	5.92	
WQS401	FES03	0.49	0.95	0.47	0.11	0.30	0.03	0.50	6	5.9	2.94	12	0.024	HDPE	0.012	5.98	7.61	
CB106	WQS402	0.18	0.95	0.17	0.00	0.30	0.00	0.17	6	5.9	1.01	12	0.015	HDPE	0.012	4.73	6.02	
CB107	WQS402	0.16	0.95	0.15	0.06	0.30	0.02	0.17	6	5.9	1.00	12	0.010	HDPE	0.012	3.86	4.91	
WQS402	FES06	0.34	0.95	0.32	0.06	0.30	0.02	0.34	6	5.9	2.01	12	0.024	HDPE	0.012	5.92	7.53	

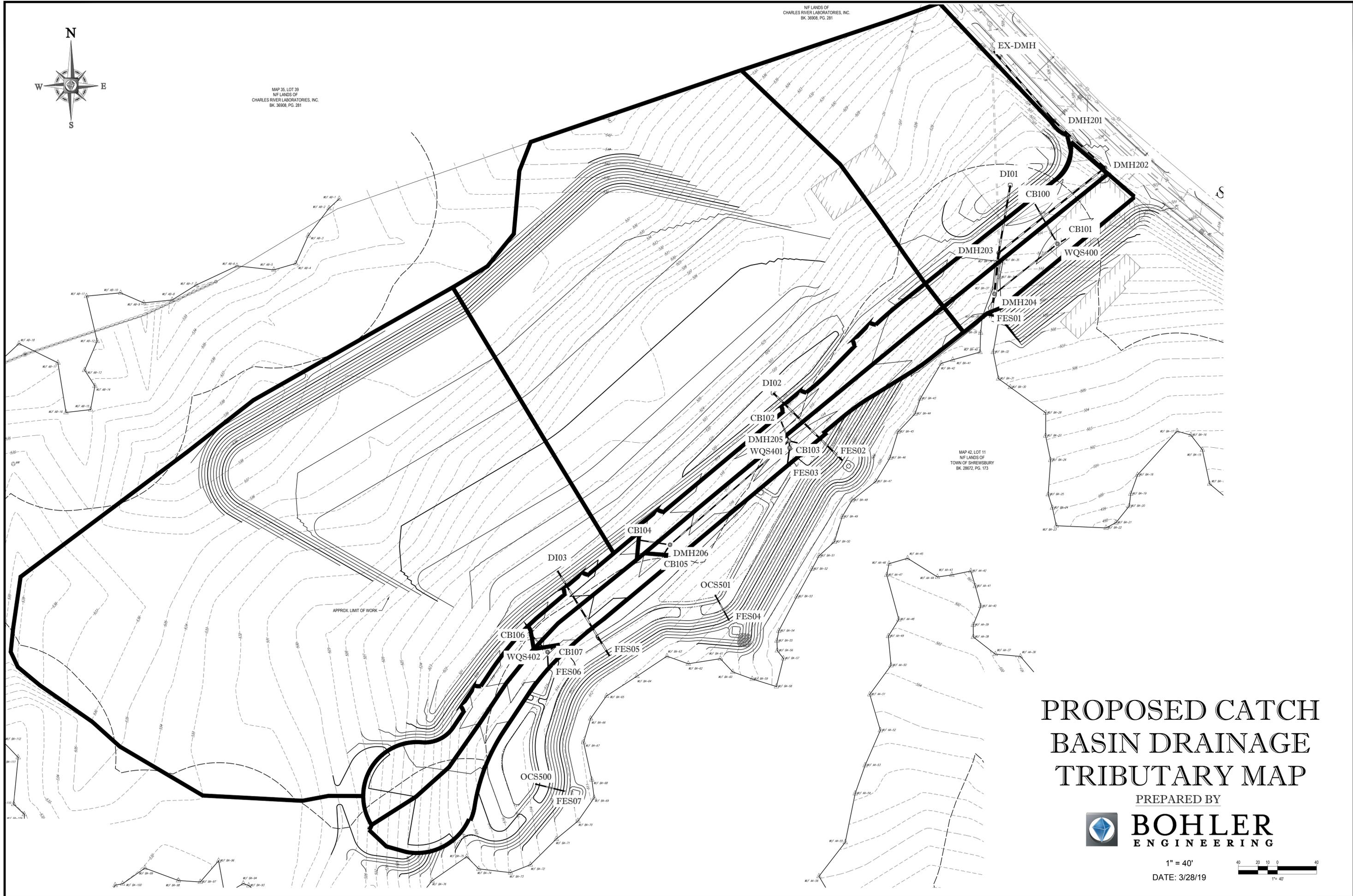
*Rainfall intensity provided MassDOT IDF Curve for Boston, MA, 2006 (Source: TR55)

FROM	TO	A	C	CA	A	C	CA	SUM CA	Tc (min)	I (in/hr)	Q (cfs)	D (in)	S (ft/ft)	Material	n	Q Full (cfs)	V Full (fps)
Note#1: Existing 15" RCP pipe to be diverted around subject property. Existing maximum pipe flow rate (flowing full):																	
EX-DMH	DMH201											15	0.053	RCP	0.012	16.03	13.07

N/L LANDS OF
CHARLES RIVER LABORATORIES, INC.
BK. 36908, PG. 281

MAP 35, LOT 39
N/L LANDS OF
CHARLES RIVER LABORATORIES, INC.
BK. 36908, PG. 281

MAP 42, LOT 11
N/L LANDS OF
TOWN OF SHREWSBURY
BK. 28672, PG. 173



PROPOSED CATCH BASIN DRAINAGE TRIBUTARY MAP

PREPARED BY



BOHLER ENGINEERING

1" = 40'
DATE: 3/28/19



OUTLET PROTECTION - OUTLET VELOCITY \leq 14 feet/sec

DISCHARGE (cfs)	OUTLET PIPE DIAMETER OR SPAN (in)										
	12	15	18	24	30	36	42	48	54	60	
0-5	10	10		<i>USE</i>							
6	12	11									
7		13	12								
8		14	13	12		MINIMUM					
9			14	13							
10			15	13							
11			16	14				LENGTH			
12				14							
14				16	14						
16				17	15	14			OUTLINED		
18				18	16	15					
20					17	15	14				
22		<i>USE</i>			18	16	15				
24						17	15	14			
26						17	16	15			
28						18	16	15			
30						19	17	16			
35						20	18	17	16		
40			PREFORMED					20	18	17	16
45							21	19	18	16	
50							22	20	18	17	
55								21	19	18	
60								22	20	19	
65								24	21	20	
70					SCOUR				25	22	20
75								26	23	21	
80									24	22	
90									26	24	
100									28	25	
110										27	
125							HOLE			29	
130										30	

Table 11-12.1 - Length - L_a (feet)

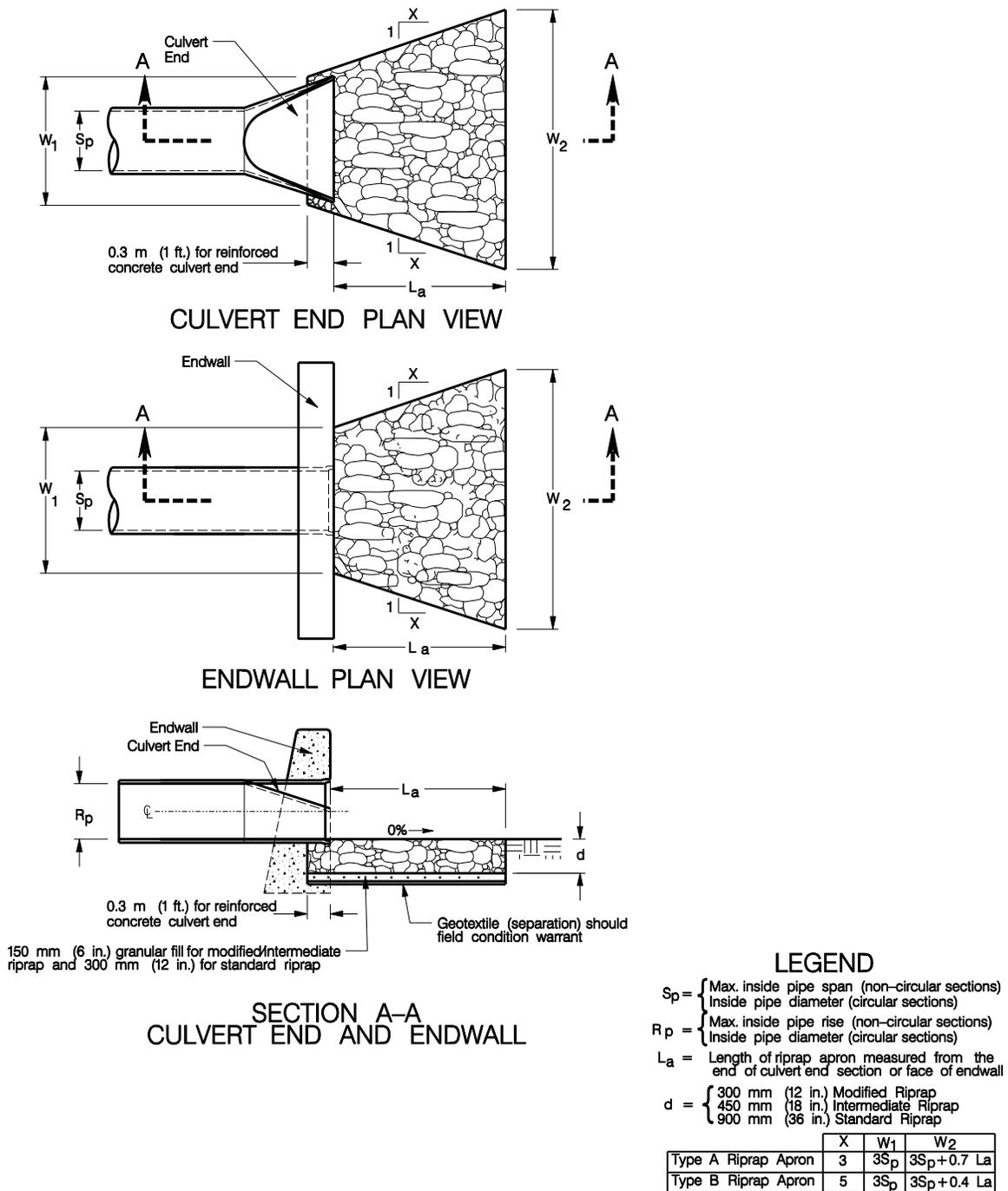
Type A Riprap Apron

- Notes: 1. Bold face outlined boxes indicate minimum L_a to be used for a given pipe diameter or span.
 2. Rounding and interpolating are acceptable.

OUTLET PROTECTION
OUTLET VELOCITY > 14 feet/sec or Length of Apron exceeds limits shown on
Tables 11-12.1 and 11-13.1

Preformed Scour Hole										
(See Figure 11-15)	PIPE DIAMETER OR SPAN (in)									
	12	15	18	24	30	36	42	48	54	60
Type 1										
B	5	6	8	10	13	15	18	20	23	25
C	6	8	9	12	15	18	21	24	27	30
d	Depends on riprap type(see Figure 11-15)									
2S_p	2.0	2.6	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
3S_p	3.0	3.9	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
F = 0.5 S_p	0.5	0.625	0.75	1	1.25	1.5	1.75	2	2.25	2.5
Type 2										
B	8	10	12	16	20	24	28	32	36	40
C	9	11	14	18	23	27	32	36	41	45
d	Depends on riprap size (see Figure 11-15)									
2S_p	2.0	2.6	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
3S_p	3.0	3.9	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
F = S_p	1.0	1.3	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0

Table 11-14.1 - Dimensions of Preformed Scour Hole (Feet)



**Figure 11-13 Type A and B Riprap Apron
(to be used where there is no defined channel downstream of the outlet)**

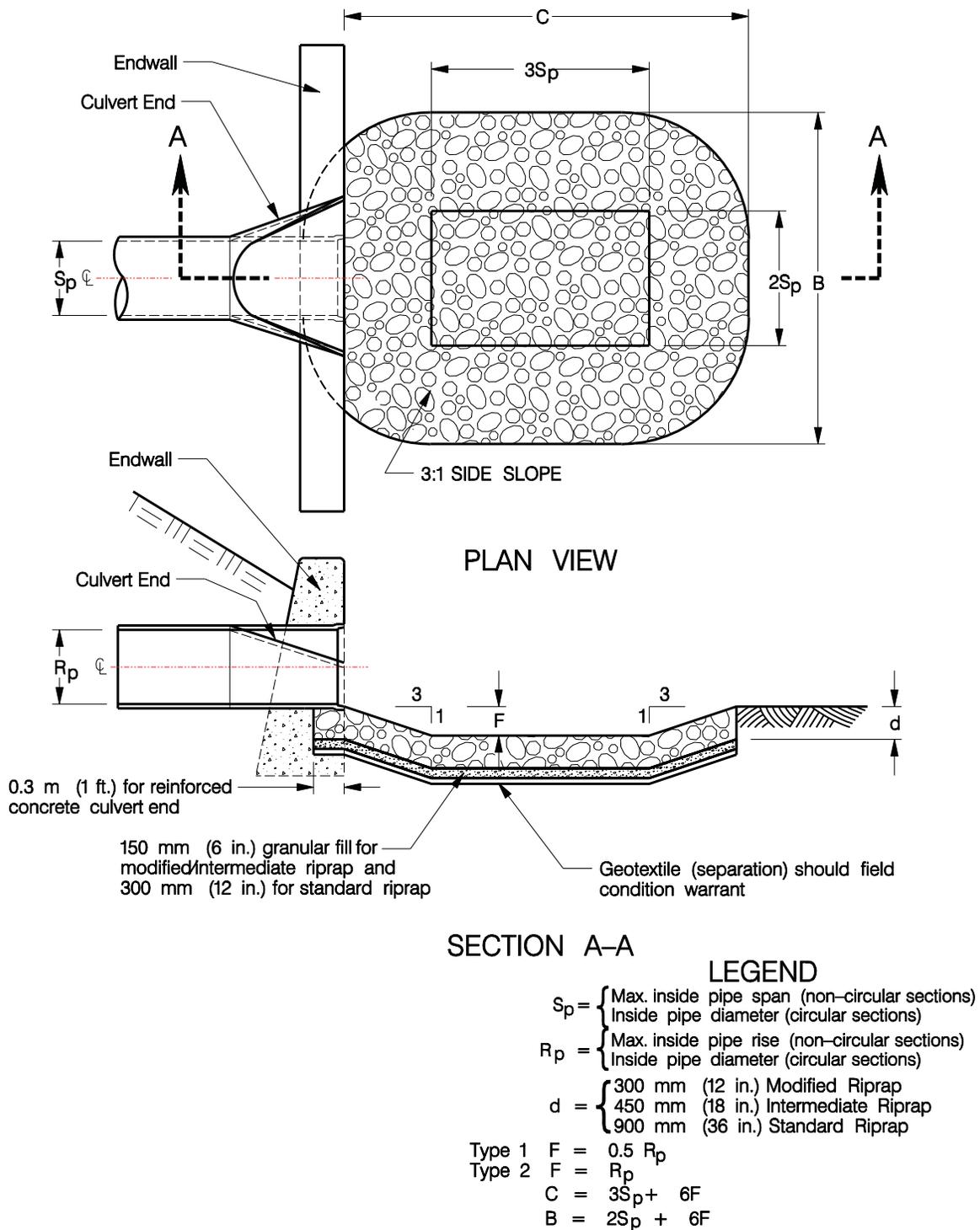


Figure 11-15 Preformed Scour Hole Type 1 and Type 2

**Centech Park North
384-386 South Street
Shrewsbury, MA
Bohler Job Number: W181144**

Rip Rap Sizing Calculations

Rip Rap Sizing Calculations						
Design Period Storm: 25 Year						
Location	Pipe Size (in)	Pipe Size (ft)	Q (cfs)	TW* (ft)	D ₅₀ (ft)	D ₅₀ ** (in)
FES01	24	2.0	19.94	0.3	0.89	12
FES02	18	1.5	5.35	0.3	0.23	6
FES03	12	1.0	2.94	0.3	0.17	6
FES04	12	1.0	2.65	0.3	0.15	6
FES05	18	1.5	7.63	0.3	0.36	6
FES06	12	1.0	2.01	0.3	0.11	6
FES07	12	1.0	0.65	0.3	0.02	6

Based on Eq. 11.35 of ConnDOT Drainage Manual

* Assume tailwater = 0.3

** Q<10 cfs - min. 6" stone size, Q>10 cfs - min. 12" stone size

Outlet Protection Sizing Calculations						
Design Period Storm: 25 Year						
Location	Pipe Size (in)	Pipe Size (ft)	Q (cfs)	W1 (ft)	La (ft)	W2 (ft)
FES01	24	2.0	19.94	6.00	Use Scour Hole	
FES02	18	1.5	5.35	4.50	Use Scour Hole	
FES03	12	1.0	2.94	3.00	10	16
FES04	12	1.0	2.65	3.00	Use Scour Hole	
FES05	18	1.5	7.63	4.50	13	32
FES06	12	1.0	2.01	3.00	10	13
FES07	12	1.0	0.65	3.00	Use Scour Hole	

Based ConnDOT Drainage Manual - Type A Riprap Apron

**Centech Park North
384-386 South Street
Shrewsbury, MA**

Scour Hole Sizing Calculations						
Design Period Storm:		25		Year		
Location	Pipe Size (in)	Pipe Size (ft)	Q (cfs)	F (ft)	C (ft)	B (ft)
FES01	24	2.0	19.94	1.00	12	10
FES02	18	1.5	5.35	0.75	10	10
FES04	12	1.0	2.65	0.50	10	10
FES07	12	1.0	0.65	0.50	10	10

Based on ConnDOT Drainage Manual - Type 1 Scour Hole

APPENDIX G: OPERATION AND MAINTENANCE

- *STORMWATER OPERATION AND MAINTENANCE PLAN*
- *INSPECTION REPORT*
- *INSPECTION AND MAINTENANCE LOG FORM*
- *LONG-TERM POLLUTION PREVENTION PLAN*
- *ILLICIT DISCHARGE STATEMENT*
- *SPILL PREVENTION*
- *PROPRIETARY WATER QUALITY UNIT INSPECTION AND MAINTENANCE GUIDE BY MANUFACTURER*

STORMWATER OPERATION AND MAINTENANCE PLAN

*Centech Park North
384-386 South Street
Shrewsbury, Massachusetts*

RESPONSIBLE PARTY DURING CONSTRUCTION:

*Town of Shrewsbury
100 Maple Avenue
Shrewsbury, MA 01545*

RESPONSIBLE PARTY POST CONSTRUCTION:

*Town of Shrewsbury
100 Maple Avenue
Shrewsbury, MA 01545*

Construction Phase

During the construction phase, all erosion control devices and measures shall be maintained in accordance with the final record plans, local/state approvals and conditions, the EPA Construction General Permit and the Stormwater Pollution Prevention Plan (SWPPP) if applicable. Additionally, the maintenance of all erosion / siltation control measures during construction shall be the responsibility of the general contractor. Contact information of the OWNER and CONTRACTOR shall be listed in the SWPPP for this site. The SWPPP also includes information regarding construction period allowable and illicit discharges, housekeeping and emergency response procedures. Upon proper notice to the property owner, the Town/City or its authorized designee shall be allowed to enter the property at a reasonable time and in a reasonable manner for the purposes of inspection.

Post Development Controls

Once construction is completed, the post development stormwater controls are to be operated and maintained in compliance with the following permanent procedures (note that the continued implementation of these procedures shall be the responsibility of the Owner or its assignee):

1. Parking lots and on-site driveways: Sweep at least two (2) times per year and on a more frequent basis depending on sanding operations. All resulting sweepings shall be collected and properly disposed of off site in accordance with MADEP and other applicable requirements.
2. Catch basins, yard drains, trench drains, manholes and piping: Inspect two (2) times per year and at the end of foliage and snow-removal seasons. These features shall be cleaned two (2) times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the catch basin or underground system. Accumulated sediment and hydrocarbons present must be removed and properly disposed of off site in accordance with MADEP and other applicable requirements.

3. Water Quality Unit (Proprietary Separator): Follow manufacturer's recommendations (attached).
4. Infiltration Basin: Preventative maintenance after every major storm event during the first three (3) months of operation and at least twice per year thereafter. Inspect structure and pretreatment BMP to ensure proper operation after every major storm event (generally equal or greater to 3.0 inches in 24 hours) for the first three months. Mow the buffer area, side slopes and basin bottom if grassed floor, rake if stone or sand bottom, remove trash and debris, remove grass clippings and accumulated organic matter. Any sediment removed shall be disposed of in accordance with MADEP and other applicable requirements.
5. Forebays: The sediment forebay areas shall be inspected once per month to ensure they are operating as intended and that all components are stable and in working order. Inspections shall be by qualified personnel. During the growing season, the forebay shall be mowed at least twice, with additional cuttings performed as needed. All vegetation (i.e. tree saplings) will be removed from embankments and the forebay bottom. The inlet to the forebay shall be inspected for erosion and sedimentation, and rip-rap shall be promptly repaired as needed. Sediment forebays shall be cleaned twice per year and when sediment depth reaches half the height of the stone weir, or three to six feet, whichever is less. After sediment is removed, replace any vegetation damaged during the clean out by either reseeding or re-sodding. Any sediment removed shall be disposed of in accordance with MADEP and other applicable requirements.

STORMWATER MANAGEMENT SYSTEM
POST-CONSTRUCTION INSPECTION REPORT

LOCATION:

*Centech Park North
384-386 South Street
Shrewsbury, Massachusetts*

RESPONSIBLE PARTY:

*Town of Shrewsbury
100 Maple Avenue
Shrewsbury, MA 01545*

NAME OF INSPECTOR:	INSPECTION DATE:
Note Condition of the Following (sediment depth, debris, standing water, damage, etc.):	
Catch Basins:	
Discharge Points/ Flared End Sections / Rip Rap:	
Infiltration Basin:	
Water Quality Units:	
Forebay:	
Other:	

Note Recommended Actions to be taken on the Following (sediment and/or debris removal, repairs, etc.):

Catch Basins:

Discharge Points / Flared End Sections / Rip Rap:

Infiltration Basin:

Water Quality Units:

Forebay:

Other:

Comments:

LONG-TERM POLLUTION PREVENTION PLAN

*Centech Park North
384-386 South Street
Shrewsbury, Massachusetts*

RESPONSIBLE PARTY DURING CONSTRUCTION:

*Town of Shrewsbury
100 Maple Avenue
Shrewsbury, MA 01545*

RESPONSIBLE PARTY POST CONSTRUCTION:

*Town of Shrewsbury
100 Maple Avenue
Shrewsbury, MA 01545*

For this site, the Long-Term Pollution Prevention Plan will consist of the following:

- No outdoor maintenance or washing of vehicles allowed.
- The property owner shall be responsible for “good housekeeping” including proper periodic maintenance of building and pavement areas, curbing, landscaping, etc.
- Proper storage and removal of solid waste (dumpsters).
- Sweeping of driveways a minimum of twice per year with a commercial cleaning unit. Any sediment removed shall be disposed of in accordance with applicable local and state requirements.
- Regular inspections and maintenance of Stormwater Management System as noted in the “O&M Plan”.
- Snow removal shall be the responsibility of the property owner. Snow shall not be plowed, dumped and/or placed in forebays, infiltration basins or similar stormwater controls. Salting and/or sanding of pavement / walkway areas during winter conditions shall only be done in accordance with all state/local requirements and approvals.

OPERATON AND MAINTENANCE TRAINING PROGRAM

The Owner will coordinate an annual in-house training session to discuss the Operations and Maintenance Plan, the Long-Term Pollution Prevention Plan, and the Spill Prevention Plan and response procedures. Annual training will include the following:

Discuss the Operations and Maintenance Plan

- Explain the general operations of the stormwater management system and its BMPs
- Identify potential sources of stormwater pollution and measures / methods of reducing or eliminating that pollution
- Emphasize good housekeeping measures

Discuss the Spill Prevention and Response Procedures

- Explain the process in the event of a spill
- Identify potential sources of spills and procedures for cleanup and /or reporting and notification
- Complete a yearly inventory or Materials Safety Data sheets of all tenants and confirm that no potentially harmful chemicals are in use.
- In no case shall snow be disposed of or stored in the infiltration basins.

ILLICIT DISCHARGE STATEMENT

Certain types of non-stormwater discharges are allowed under the U.S. Environmental Protection Agency Construction General Permit. These types of discharges will be allowed under the conditions that no pollutants will be allowed to come in contact with the water prior to or after its discharge. The control measures which have been outlined previously in this LTPPP will be strictly followed to ensure that no contamination of these non-storm water discharges takes place. Any existing illicit discharges, if discovered during the course of the work, will be reported to MassDEP and the local DPW, as applicable, to be addressed in accordance with their respective policies. No illicit discharges will be allowed in conjunction with the proposed improvements.

SPILL PREVENTION AND RESPONSE PROCEDURES **(POST CONSTRUCTION)**

In order to prevent or minimize the potential for a spill of Hazardous Substances or Oil or come into contact with stormwater, the following steps will be implemented:

1. All Hazardous Substances or Oil (such as pesticides, petroleum products, fertilizers, detergents, acids, paints, paint solvents, cleaning solvents, etc.) will be stored in a secure location, with their lids on, preferably under cover, when not in use.
2. The minimum practical quantity of all such materials will be kept on site.
3. A spill control and containment kit (containing, for example, absorbent materials, acid neutralizing powder, brooms, dust pans, mops, rags, gloves, goggles, plastic and metal trash containers, etc.) will be provided on site.
4. Manufacturer's recommended methods for spill cleanup will be clearly posted and site personnel will be trained regarding these procedures and the location of the information and cleanup supplies.
5. It is the OWNER's responsibility to ensure that all Hazardous Waste on site is disposed of properly by a licensed hazardous material disposal company. The OWNER is responsible for not exceeding Hazardous Waste storage requirements mandated by the EPA or state and local authorities.

In the event of a spill of Hazardous Substances or Oil, the following procedures should be followed:

1. All measures should be taken to contain and abate the spill and to prevent the discharge of the Hazardous Substance or Oil to stormwater or off-site. (The spill area should be kept well ventilated and personnel should wear appropriate protective clothing to prevent injury from contact with the Hazardous Substances.)
2. For spills of less than five (5) gallons of material, proceed with source control and containment, clean-up with absorbent materials or other applicable means unless an imminent hazard or other circumstances dictate that the spill should be treated by a professional emergency response contractor.
3. For spills greater than five (5) gallons of material immediately contact the MADEP at the toll-free 24-hour statewide emergency number: **1-888-304-1133**, the local fire department (**9-1-1**) and an approved emergency response contractor. Provide information on the type of material spilled, the location of the spill, the quantity spilled, and the time of the spill to the emergency response contractor or coordinator, and proceed with prevention, containment and/or clean-up if so desired. (Use the form provided, or similar).
4. If there is a Reportable Quantity (RQ) release, then the National Response Center should be notified immediately at (800) 424-8802; within 14 days a report should be submitted to the EPA regional office describing the release, the date and circumstances of the release and the steps taken to prevent another release. This Pollution Prevention Plan should be updated to reflect any such steps or actions taken and measures to prevent the same from reoccurring.

Cause of Spill: _____

Measures Taken to Clean up Spill: _____

Type of equipment: _____ Make: _____ Size: _____

License or S/N: _____

Location and Method of Disposal _____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: _____

Additional Contact Numbers:

- DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP) EMERGENCY PHONE: 1-888-304-1133
- NATIONAL RESPONSE CENTER PHONE: (800) 424-8802
- U.S. ENVIRONMENTAL PROTECTION AGENCYPHONE: (888) 372-7341

CDS[®] Inspection and Maintenance Guide



Maintenance

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

Inspection

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

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

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

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

Cleaning

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

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

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



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

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities



Support

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

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