DRAINAGE REPORT

For

KS Partners owned& managed

PROPOSED

"GMP LAB FACILITY"

298 Concord Road
Billerica, Massachusetts
Middlesex 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 Good Manufacturing Practice (GMP) lab facility building located at 298 Concord Road in the Town of Billerica, Massachusetts. The overall Property, which contains approximately 31.2 acres of land, currently contains three (3) existing buildings, paved impervious parking areas, utilities, and landscape amenities. The analysis area, herein referred to as the "Site", consists of the western parking area adjacent to Concord Road including the existing 298 building area, associated parking and portions of the existing landscape and stormwater basin totaling approximately 6.05 acres.

The proposed Project includes the construction of a new ± 121,630 SF Good Manufacturing Practice (GMP) lab facility building, modifications to existing parking areas and utilities to accommodate the proposed building, and installation of new stormwater management features. The Project will also include additional landscaping and outdoor amenity space. The Project will result in an overall increase in impervious area. 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. The project will also provide erosion and sedimentation controls during the demolition and construction periods, as well as long term stabilization of the site.

For the purposes of this analysis the pre- and post-development drainage conditions were analyzed at one (1) "design point" where stormwater runoff currently drains to under existing conditions. The design point is described in further detail in **Section II** 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 1.1** below. In addition, the project has been designed to meet or exceed the Stormwater Management Standards as detailed herein.

Table 1.1: 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
DP1	4.86	3.19	**-1.67**	8.42	5.50	**-2.92**	11.30	7.99	**-3.31**	17.17	14.64	**-2.53**

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

Table 1.2: Design Point Volume 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
DP1	1.180	0.822	**-0.358**	2.129	1.694	**-0.435**	2.923	2.499	**-0.424**	4.595	4.247	**-0.348**

**Volumes are represented in acre feet (ac-ft)*

II. EXISTING SITE CONDITIONS

Existing Site Description

The limit of work on Site consists of approximately 6.05 acres of land located along the easterly side of Concord Road in the Town of Billerica, Massachusetts. The Site area consists of an existing building and paved impervious parking lot along with an existing stormwater basin. The Site analysis area is limited to the limit of work and does not include the existing buildings and parking facilities to remain on the Property.

On-Site Soil Information

The majority of the soils at the Site are mapped as Charlton-Urban Land – Hollis complex which are classified by the Natural Resource Conservation Service (NRCS) as Hydrologic Soil Group (HSG) “A”. Based upon on-site soil testing performed on December 21, 2022 by a licensed soil evaluator in the State of Massachusetts, the soils on Site at the depths of the proposed infiltration depth were observed to be loamy sand which is generally consistent with the HSG “A”. As such, the drainage analysis has utilized an infiltration rate of 2.41 in/hr which corresponds to the Rawl’s rate for loamy sand, HSG “A”.

During the soil testing performed on Site as described above, groundwater was observed on the Site between 3.2 and 5.3 feet below the surface elevation. In 2 of the 4 test pits, weeping from the side of the pit was observed 3.2 feet from the ground surface. Standing water in the pit was observed 6.8 – 8.9 feet below the ground surface. Based on the observed groundwater elevations, the Site is constrained relative to infiltration or other subsurface stormwater management features.

Refer to **Appendix C** for Test Pit Logs and additional information.

Existing Collection and Conveyance

The Site generally slopes from northeast to southwest to the existing wetland that borders the southern and western sides of the Site. The northern portion of the Site drains to several catch basins within the existing pavement areas and is conveyed via underground piping to an existing drain basin. The existing basin is located south of the #300 Concord Road and is broken into two portions connected with two 12” RCP pipes. The existing basin outlets through a riser structure

over to the existing wetland area underneath the access road. Located on the southwest corner of the basin is a rip rap emergency spillway, adjacent to the access road.

The existing parking lot to the southwest of the #298 building flows overland to existing catch basins and is conveyed via underground pipes to the wetlands. There does not appear to be any best management practices for this area. In addition, the northwestern portion of the Site to the rear of the #298 building flows via overland flow to existing drainage infrastructure.

Slopes on the site range from 1%-25% (in drainage basin areas) with on-site elevations ranging from 194 in the northern corner of the Site to 180 at the southwesterly portion of the property.

Existing Watersheds and Design Point Information

For the purposes of this analysis, the pre- and post-development drainage conditions were analyzed at one (1) “design point” as described below where stormwater runoff currently drains to under existing conditions. The existing site was subdivided into five (5) separate sub catchments, as described below, to analyze existing and proposed flow rates at the design point. The drainage analysis includes areas that are considered “off-site” drainage as they are not within the proposed limit of work but do contribute stormwater flows to the existing and proposed infrastructure.

Subcatchment EX-1 in total is 0.67 acres of mostly grassed areas with some paved areas. The area flows overland and is collected in an existing basin onsite. The existing basin provides some infiltration and attenuation before discharging into the larger basin in Subcatchment EX-2.

Subcatchment EX-2 in total is 3.55 acres of mostly grassed areas and building footprint. The building footprint runoff is collected via roof drains and conveyed via underground drainage infrastructure into the large stormwater basin on site. Overflow from the basin in larger storm events goes to the wetlands, DP1. The existing basin provides some infiltration and attenuation before discharging into the larger basin.

Subcatchment EX-3 in total is 0.22 acres of grassed area flows overland and is conveyed via underground drainage infrastructure to the existing wetland. The stormwater runoff from this Subcatchment is not treated or attenuated.

Subcatchment EX-4 in total is 1.98 acres of mostly paved areas and a building footprint with some landscape areas. The area flows overland and is conveyed via underground drainage

infrastructure to the large stormwater basin on site. Overflow from the basin in larger storm events goes to the wetlands, DP1. The existing basin provides some infiltration and attenuation before discharging into the larger basin in Subcatchment EX-2.

Subcatchment EX-5 in total is 4.05 acres of mostly paved parking areas and some landscape areas. The area flows overland and is conveyed via underground drainage infrastructure to the existing wetland. The stormwater runoff from the Subcatchment is not treated or attenuated.

Design Point #1 (DP1) is the existing wetland along the southwest property line. Under existing conditions, this design point receives stormwater flows from approximately 10.5 acres of land from the Site area, designated as subcatchment EX-1, EX-2, EX-3, EX-4 and EX-5.

Refer to **Table 1.1, 1.2, 6.1, and 6.2** for the existing conditions peak rates of runoff and volume of runoff. Refer to **Appendix D** and the Drainage Area Maps in the appendices of this report for a graphical representation of the existing drainage areas.

III. PROPOSED SITE CONDITIONS

Proposed Development Description

The proposed Project will include the construction of a ±121,630 SF Good Manufacturing Practice (GMP) lab facility building, modifications to existing parking areas and utilities to accommodate the proposed building, additional landscaping, and installation of new stormwater management features. The project involves an overall increase in impervious area through the introduction of a larger building footprint. The paved portions of the Site have been designed to drain to proprietary water quality inlets. The inlets will capture and convey stormwater runoff, via an underground pipe system to the subsurface infiltration system. All impervious area within the parking area are conveyed to a subsurface infiltration chamber system and eventually outfall to the existing wetland. Rooftop runoff has been designed to flow through the subsurface infiltration system as well.

Proposed Development Collection and Conveyance

Water Quality Inlets are proposed to collect and route runoff from the paved parking areas to the proposed infiltration system. Roof drains are proposed to collect runoff from the proposed building and are routed to the proposed infiltration system. Pipes have been designed for the 25-year storm using the Rational Method. Pipe sizing calculations are included in **Appendix F.**

The best management practices (BMPs) incorporated into the proposed stormwater management system have been designed to meets, or exceed, the standards set forth in the Massachusetts Department of Environmental Protection Stormwater Handbook standards as well as the Town of Billerica Board of Health Stormwater Management Bylaw. Refer to **Section V** for additional information.

Proposed Watersheds and Design Point Information

The project has been designed to maintain existing drainage watersheds to the greatest extent possible, with the same design points described in **Section II** above. The site was subdivided into five (5) separate sub catchments for the proposed conditions as described below. The minimum time of concentration for all proposed areas is calculated as 6 minutes (0.1 hr).

Under proposed conditions DP#1 receives stormwater flows from approximately 10.5 acres of land, designated as watershed “PR-1” and “PR-2”, “PR-3”, “PR-4” and “PR-5”.

Subcatchment PR-1 in total is 2.79 acres of building footprint area. The area flows through the proposed roof drain collection pipes and into the proposed subsurface infiltration system prior to discharging into to the existing wetland area.

Subcatchment PR-2 in total is 2.11 acres of pavement area and woods and grass areas of the existing drainage basin. The area flows overland and is collected in the existing basin onsite to the existing wetland area.

Subcatchment PR-3 in total is 1.38 acres of paved parking lot area and woods and grass. This area drains to proposed deep sump hooded catch basins and subsequently is routed through water quality inlets for water quality prior to flowing into the proposed subsurface infiltration system which outlets to the existing wetland area.

Subcatchment PR-4 in total is 0.15 of woods and grass area. The area flows overland to the existing wetland area.

Subcatchment PR-5 in total is 4.05 acres of mostly existing paved parking areas and some landscape areas. The area flows overland and is conveyed via underground drainage infrastructure to the existing basin onsite, prior to discharge to the wetlands.

Refer to **Table 1.1, 1.2, 6.1 and 6.2** for the calculated proposed conditions peak rates of runoff and volumes. For additional hydrologic information, refer to **Appendix D** and the Drainage Area Maps in the appendices of this report for a graphical representation of the 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 4.1 below for stormwater calculations is based on Cornell University Rainfall Data. Refer to **Appendix F** for more information.

Table 4.1: Cornell University Rainfall Intensities

Frequency	2 year	10 year	25 year	100 year
Rainfall* (inches)	3.13	4.73	6.00	8.59

*Values derived from Cornell University Atlas of Precipitation Extremes for the Northeastern United States and Southern Canada

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, or exceeds, the MADEP Stormwater Management standards as well as the Town of Billerica Stormwater Management By-law. Compliance with these standards is described further below.

V. STORMWATER MANAGEMENT STANDARDS

Standard #1: No New Untreated Discharges

The project has been designed so that proposed impervious areas including the building roof and paved parking/driveway areas shall be collected and passed through the proposed drainage system for treatment prior to discharge.

Standard #2: Peak Rate Attenuation

As outlined in **Table 1.1** and **Table 6.1**, 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

The stormwater runoff from the project will be collected and diverted to a proposed subsurface infiltration basin. The project as proposed will result in a net increase in impervious area of 0.94 acres and is required to infiltrate 2,048 cubic feet of stormwater as defined in Stormwater Standard 3. The proposed subsurface infiltration basin will provide 14,672 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. Calculations showing that the proposed infiltration basin will drain within 13 hours are included in **Appendix F** of this report.

A groundwater mounding analysis has been provided in **Appendix F** of this report. The analysis shows that the groundwater mound will have no effect on the proposed system.

Standard #4: Water Quality

Water quality treatment is provided via deep sump catch basins, CDS water quality inlets, CDS water quality unit, and a subsurface infiltration system. TSS removal calculations are included in **Appendix F** of this report. As a LUHPPL, the project is required to provide 1” water quality volume over the post-development impervious area. The project as proposed will produce a total post-construction impervious area within the site of 4.0 acres and is required to treat 14,525 cubic feet of water quality volume as defined in Stormwater Standard 4. The proposed subsurface infiltration

basin provides 28,399 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 Project will provide 44% TSS removal prior to infiltration and treat the 1.0 in water quality depth, as further illustrated in Appendix F of this report.

Standard #6: Critical Areas

Not Applicable for this project.

Standard #7: Redevelopment

Not Applicable for this project.

Standard #8: Construction Period Pollution Prevention and 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.

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 results in a reduction in peak rates of runoff from the subject site when compared to pre-development conditions for the 2-, 10-, 25- and 100-year storm frequencies. In addition, the proposed best management practices will result in an effective removal of total suspended solids from the post-development runoff. Also, the existing basin located on site will have the same storage volume in existing and proposed conditions due to the proposed detention system and the contributing area going to this basin will be significantly less in proposed conditions. The pre-development versus post-development stormwater discharge and volume comparisons are contained in **Table 6.1 and Table 6.2** below:

Table 6.1: 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
DP1	4.60	2.70	**-1.90**	8.06	4.91	**-3.15**	10.89	7.34	**-3.55**	16.71	14.03	**-2.68**

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

Table 6.2: Design Point Volume 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
DP1	0.916	0.652	**-0.246**	1.671	1.283	**-0.388**	2.334	1.918	**-416**	3.790	3.360	**-0.43**

**Volumes are represented in acre feet (ac-ft)*

As outlined in the table above, the proposed stormwater management system as designed will provide a decrease in peak rates of runoff from the proposed facility for the 2-, 10-, 25- and 100-year storm events. Additionally, the project meets or exceeds the MADEP Stormwater Management Standards as described further herein.

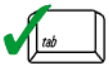
APPENDIX A: MASSACHUSETTS STORMWATER MANAGEMENT CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

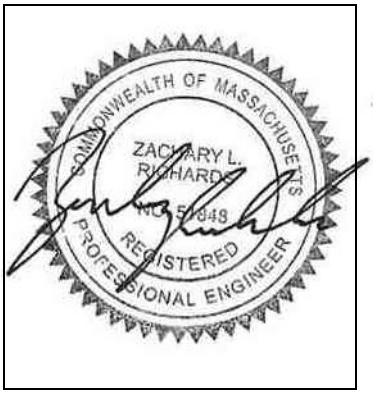
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Signature and Date

Checklist

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

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

☒ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☒ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☐ Use of "country drainage" versus curb and gutter conveyance and pipe

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Water Quality Structures, subsurface infiltration

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 Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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

Checklist 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

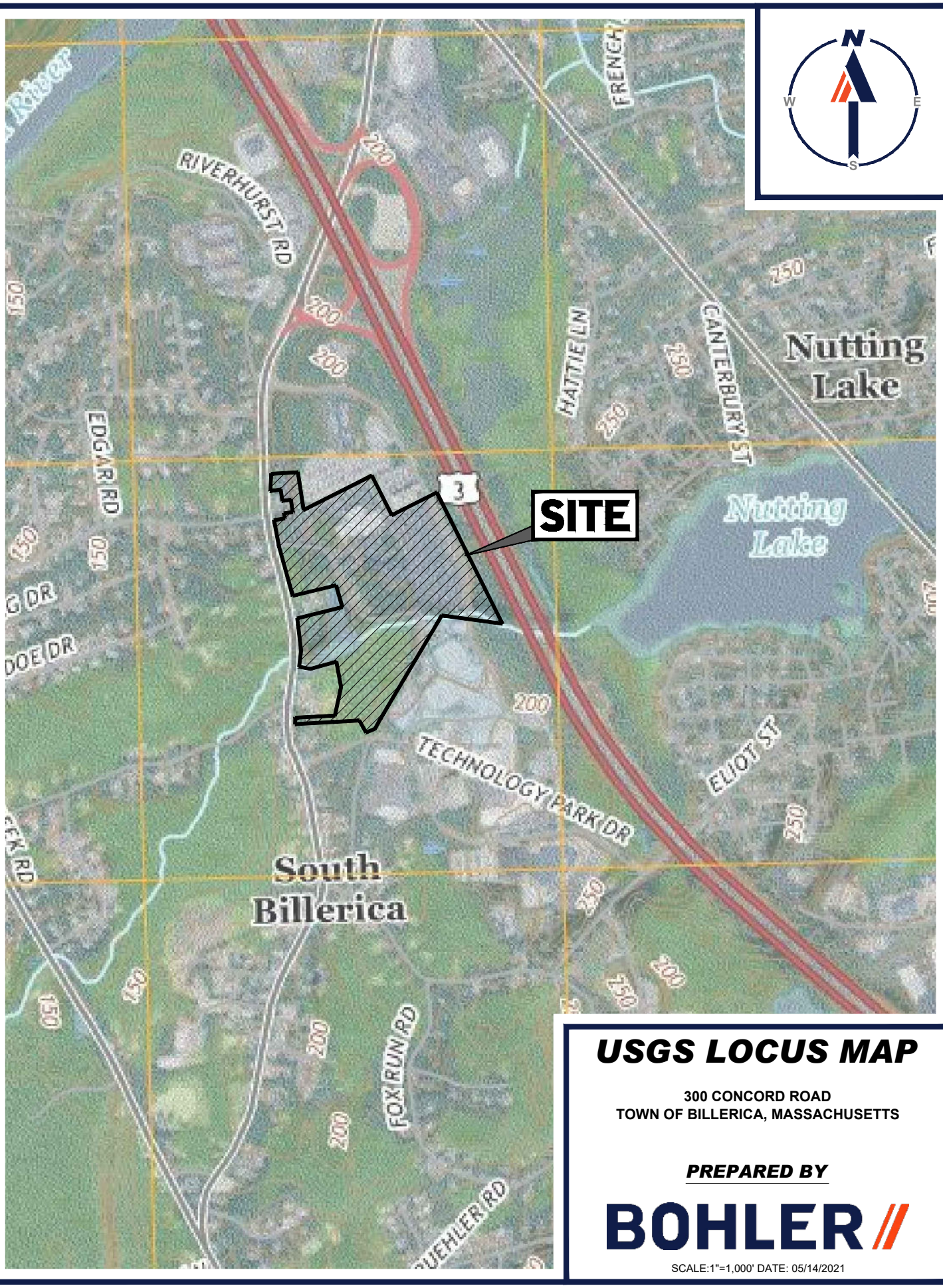
☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ 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*
- *SITE AERIAL*



USGS LOCUS MAP

300 CONCORD ROAD
TOWN OF BILLERICA, MASSACHUSETTS

PREPARED BY

BOHLER

SCALE:1"=1,000' DATE: 05/14/2021

National Flood Hazard Layer FIRMette

FEMA

71°17'14"W 42°32'20"N

71°16'36"W 42°31'53"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

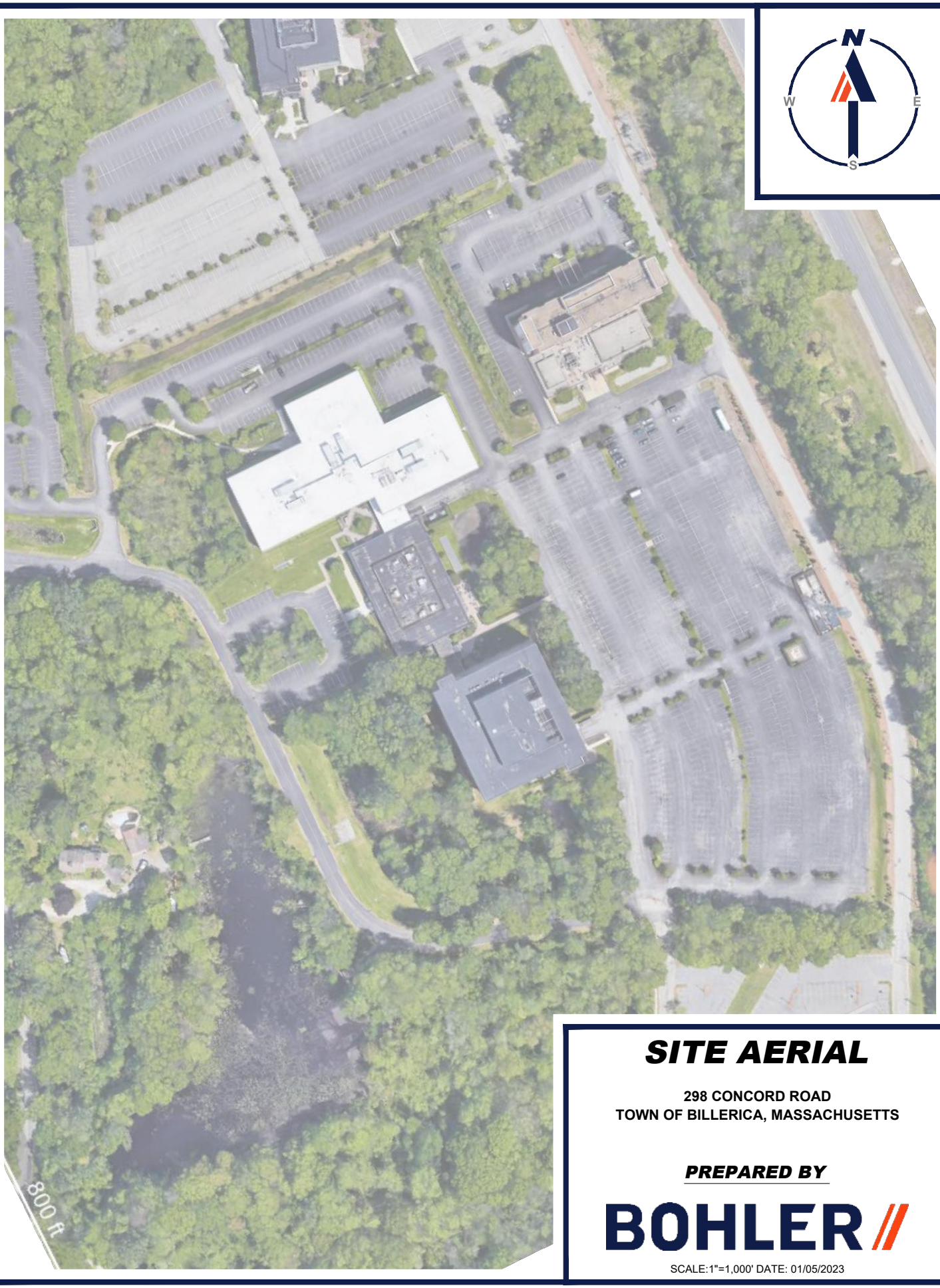
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/12/2021 at 4:07 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



SITE AERIAL

298 CONCORD ROAD
TOWN OF BILLERICA, MASSACHUSETTS

PREPARED BY

BOHLER

SCALE:1"=1,000' DATE: 01/05/2023

APPENDIX C: SOIL AND WETLAND INFORMATION

- *NCRS CUSTOM SOIL RESOURCE REPORT*
- *TEST PIT LOGS AND TEST PIT MAP*

Map Scale: 1:902 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 10 20 40 60

Feet
0 40 80 160 240

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 22, Sep 9, 2022

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	0.4	13.9%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	A	2.7	86.1%
Totals for Area of Interest			**3.1**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Commonwealth of Massachusetts
City/Town of

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

A. Facility Information

KS Partners, LLC
Owner Name

296-300 Concord Road
Street Address

Map 86, Block 108, Lot 5
Map/Lot #

Billerica
City

MA
State

01821
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade

2. Soil Survey — Web Soil Survey (Source); 631C (Soil Map Unit); Charlton-Urban land-Hollis complex (Soil Series)

Ground moraines, drumlins
Landform

Possible 8-20" to lithic bedrock; >80" to water table
Soil Limitations

Friable loamy eolian deposits over friable loamy basal till dervices from granite and gneiss; Friable, shallow loamy basal till over granite and gneiss
Soil Parent material

3. Surficial Geological Report — 2007 - Stone and Stone (Year Published/Source); Thin till; Swamp deposits (Map Unit)

Nonsorted, nonstratified matrix of sand, some silt, and little clay containing scatter gravel clasts and few large boulders; in areas where till is generally 10-15 ft thick; Organic muck and peat that contain minor amounts of sand, silt, and clay stratified and poorly sorted, in kettle depressions of poorly drained areas.
Description of Geologic Map Unit:

4. Flood Rate Insurance Map — Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No — If yes, MassGIS Wetland Data Layer: N/A (Wetland Type)

7. Current Water Resource Conditions (USGS): 12/19/2022 (MA-XMW 78) (Month/Day/ Year) Range: ☐ Above Normal ☐ Normal ☒ Below Normal

8. Other references reviewed: (Zone II, IWPA, Zone A, EEA Data Portal, etc.)
Site is not within Zone I, Zone II, IWPA, or Zone A; No NHESP habitat areas on-site; No domestic drinking water wells of record located near the site per EEA data portal.

Commonwealth of Massachusetts
City/Town of

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

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

Deep Observation Hole Number: TP1 (Hole #) | 12/21/2022 (Date) | 8:10 AM (Time) | Sunny; 23 degrees (Weather) | 42.536280 (Latitude) | -71.282870 (Longitude)

1. Land Use: Office parking lot grassed landscape area (e.g., woodland, agricultural field, vacant lot, etc.) | Short grass (Vegetation) | None observed (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: Edge of parking field (refer to attached map)

2. Soil Parent Material: Ablation till | Ground moraine (Landform) | BS (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body >200 feet | Drainage Way >100 feet | Wetlands >100 feet | Property Line >100 feet | Drinking Water Well >1,000 feet | Other N/A feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☒ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 38" Depth to Weeping in Hole | 81" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-8	Ap	Loamy sand	10YR3/2	-	Cnc : - Dpl: -	-	-	-	Granular	Friable	Vegetation roots observed down to 6"
8-19	HTM	Gravelly medium sand	10YR5/4	-	Cnc : - Dpl: -	-	-	-	Single grain	Loose	
19-31	HTM	Gravelly loamy sand	10YR3/3	-	Cnc : - Dpl: -	-	-	-	Massive	Friable	
31-81+	BC	Sandy loam	10YR5/6	42"	Cnc : 7.5YR5/8 Dpl:	10-15%	5-10%	-	Massive	Very friable	
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:
Test pitting observations for stormwater applications only. No refusal in pit.

Commonwealth of Massachusetts
City/Town of

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

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

Deep Observation Hole Number: TP2 (Hole #) | 12/21/2022 (Date) | 9:00 AM (Time) | Sunny; 25 degrees (Weather) | 42.536280 (Latitude) | -71.282870 (Longitude)

1. Land Use: Office parking lot grassed landscape area (e.g., woodland, agricultural field, vacant lot, etc.) | Short grass (Vegetation) | None observed (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: Edge of parking field (refer to attached map)

2. Soil Parent Material: Ablation till | Ground moraine (Landform) | BS (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body >100 feet | Drainage Way >100 feet | Wetlands 40 feet | Property Line >100 feet | Drinking Water Well >1,000 feet | Other N/A feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 107" Depth to Weeping in Hole | 107" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	Sandy loam	10YR3/4	-	Cnc : - Dpl: -	-	-	-	Granular	Friable	
12-24	Bw	Fine sandy loam	10YR4/4	-	Cnc : - Dpl: -	-	-	-	Massive	Friable	
24-42	C	Sandy loam	10YR5/3	-	Cnc : - Dpl: -	-	5-10%	-	Massive	Very friable	
42-48	2C	Fine sandy loam	2.5Y5/2	-	Cnc : - Dpl: -	-	-	-	Massive	Very friable	
48-107+	3C	Loamy sand	10YR5/6	53"	Cnc : 7.5YR5/8 Dpl:	10-15%	10-20%	10-15%	Massive	Friable	Large stones observed in digging bottom of pit
					Cnc : Dpl:						

Additional Notes:
Test pitting observations for stormwater applications only. No refusal in pit. No weeping in side wall of pit above standing water observed.

Commonwealth of Massachusetts
City/Town of

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

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

Deep Observation Hole Number: TP3 (Hole #) | 12/21/2022 (Date) | 10:45 AM (Time) | Sunny; 30 degrees (Weather) | 42.536280 (Latitude) | -71.282870 (Longitude)

1. Land Use: Office parking lot grassed landscape area (e.g., woodland, agricultural field, vacant lot, etc.) | Short grass (Vegetation) | Stone wall about 30 feet from pit (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: Edge of parking field (refer to attached map)

2. Soil Parent Material: Ablation till | Ground moraine (Landform) | BS (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body >200 ft feet | Drainage Way >100 ft feet | Wetlands >100 ft feet | Property Line >100 ft feet | Drinking Water Well >100 ft feet | Other N/A feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☒ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: N/A Depth to Weeping in Hole | 88" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-11	Ap	Loamy sand	10YR2/2	-	Cnc : - Dpl: -	-	-	-	Granular	Friable	
11-18	HTM	Fine sand	10YR5/4	-	Cnc : - Dpl: -	-	5%	-	Single grain	Loose	
18-25	HTM	Loamy sand	10YR4/4	-	Cnc : - Dpl: -	-	-	-	Massive	Friable	
25-78	BC	Gravelly loamy sand	10YR5/6	38"	Cnc : 7.5YR5/8 Dpl:	10-15%	-	-	Massive	Very friable	
78-88+	C	Gravelly loamy sand	10YR5/4	-	Cnc : - Dpl: -	-	-	-	Massive	Very friable	
					Cnc : Dpl:						

Additional Notes:
Test pitting observations for stormwater applications only. No refusal in pit.

Commonwealth of Massachusetts
City/Town of

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

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

Deep Observation Hole Number: TP4 (Hole #) | 12/21/2022 (Date) | 10:00 AM (Time) | Sunny; 27 degrees (Weather) | 42.536280 (Latitude) | -71.282870 (Longitude)

1. Land Use: Office parking lot grassed landscape area (e.g., woodland, agricultural field, vacant lot, etc.) | Short grass (Vegetation) | Stone wall about 15 feet from pit (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: Edge of parking field (refer to attached map)

2. Soil Parent Material: Ablation till | Ground moraine (Landform) | BS (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body >100 feet | Drainage Way 50 feet | Wetlands 35 feet | Property Line >100 feet | Drinking Water Well >1,000 feet | Other N/A feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 37" Depth to Weeping in Hole | 93" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-16	Ap	Sandy loam	10YR3/4	-	Cnc : - Dpl: -	-	-	-	Granular	Friable	
16-39	Bw	Fine sandy loam	10YR4/4	-	Cnc : - Dpl: -	-	-	-	Massive	Friable	
39-55	C	Sandy loam	10YR5/3	-	Cnc : - Dpl: -	-	10%	-	Massive	Very friable	
55-61	2C	Fine sandy loam	2.5Y5/2	-	Cnc : - Dpl: -	-	-	-	Massive	Very friable	
61-93+	3C	Loamy sand	10YR5/6	64"	Cnc : 7.5YR5/8 Dpl:	10%	10-15%	-	Massive	Friable	
					Cnc : Dpl:						

Additional Notes:
Test pitting observations for stormwater applications only. No refusal in pit.

Commonwealth of Massachusetts
City/Town of

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

D. Determination of High Groundwater Elevation

1. Method Used (Choose one):	Obs. Hole #1-4	Obs. Hole #1-4
☒ Depth to soil redoximorphic features	See logs inches	See logs inches
☒ Depth to observed standing water in observation hole	See logs inches	See logs inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

_____ Index Well Number _____ Reading Date

$S_h = S_c – [S_r \times (OW_c – OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

E. Depth of Pervious Material *

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

      ☐ Yes ☐ No

   b. If yes, at what depth was it observed (exclude O, A, and E Horizons)? Upper boundary: _____ inches Lower boundary: _____ inches

   c. If no, at what depth was impervious material observed? Upper boundary: _____ inches Lower boundary: _____ inches

*N/A - Test pitting observations for stormwater applications only.

Commonwealth of Massachusetts
City/Town of

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

F. Certification

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

Jared Walsh

Signature of Soil Evaluator

12/21/2022

Date

Jared Walsh, E.I.T. / License #14670

Typed or Printed Name of Soil Evaluator / License #

11/01/2025

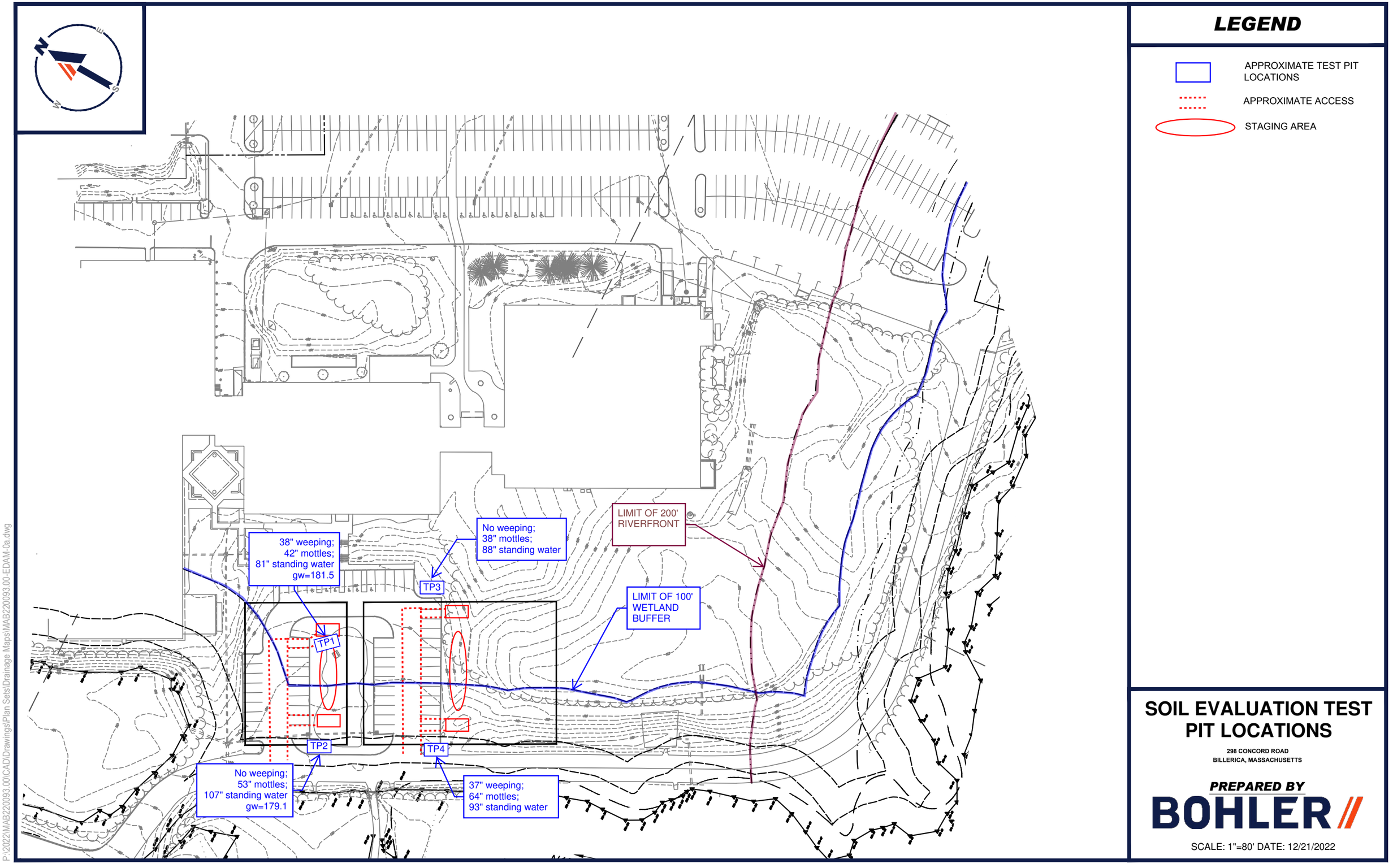
Expiration Date of License

Name of Approving Authority Witness

Approving Authority

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

Field Diagrams: Use this area for field diagrams:



LEGEND

- APPROXIMATE TEST PIT LOCATIONS
- APPROXIMATE ACCESS
- STAGING AREA

SOIL EVALUATION TEST PIT LOCATIONS

298 CONCORD ROAD
BILLERICA, MASSACHUSETTS

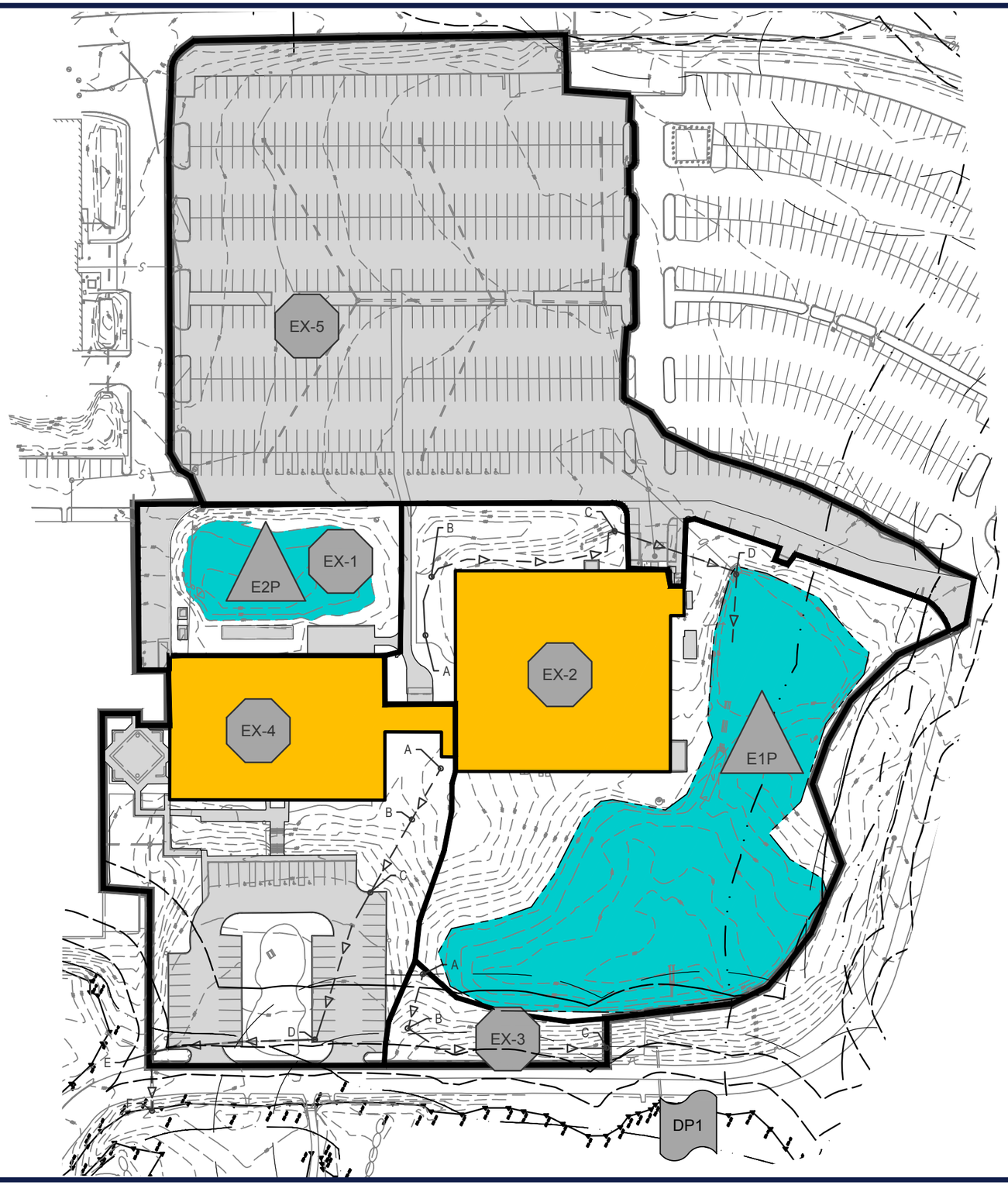
PREPARED BY
BOHLER

SCALE: 1"=80' DATE: 12/21/2022

P:\2022\MAB220093.00\CAD\Drawings\Plan Sets\Drainage Maps\MAB220093.00-EDAM-0a.dwg

APPENDIX D: EXISTING CONDITIONS HYDROLOGIC ANALYSIS

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



LEGEND

- DP# — DESIGN POINT
- EX-# — EXISTING SUBCATCHMENT
- XX# — BASIN OR MODELED DRAINAGE STRUCTURE
- OVERALL ANALYSIS BOUNDARY
- SUBCATCHMENT BOUNDARY
- TIME OF CONCENTRATION
- CONCRETE OR PAVEMENT
- ROOF
- SURFACE WATER (IMPERVIOUS)

EXISTING CONDITIONS DRAINAGE AREA MAP

298 CONCORD ROAD
BILLERICA, MA 01821

PREPARED BY

BOHLER

SCALE:1"=80' DATE: 01/24/2023

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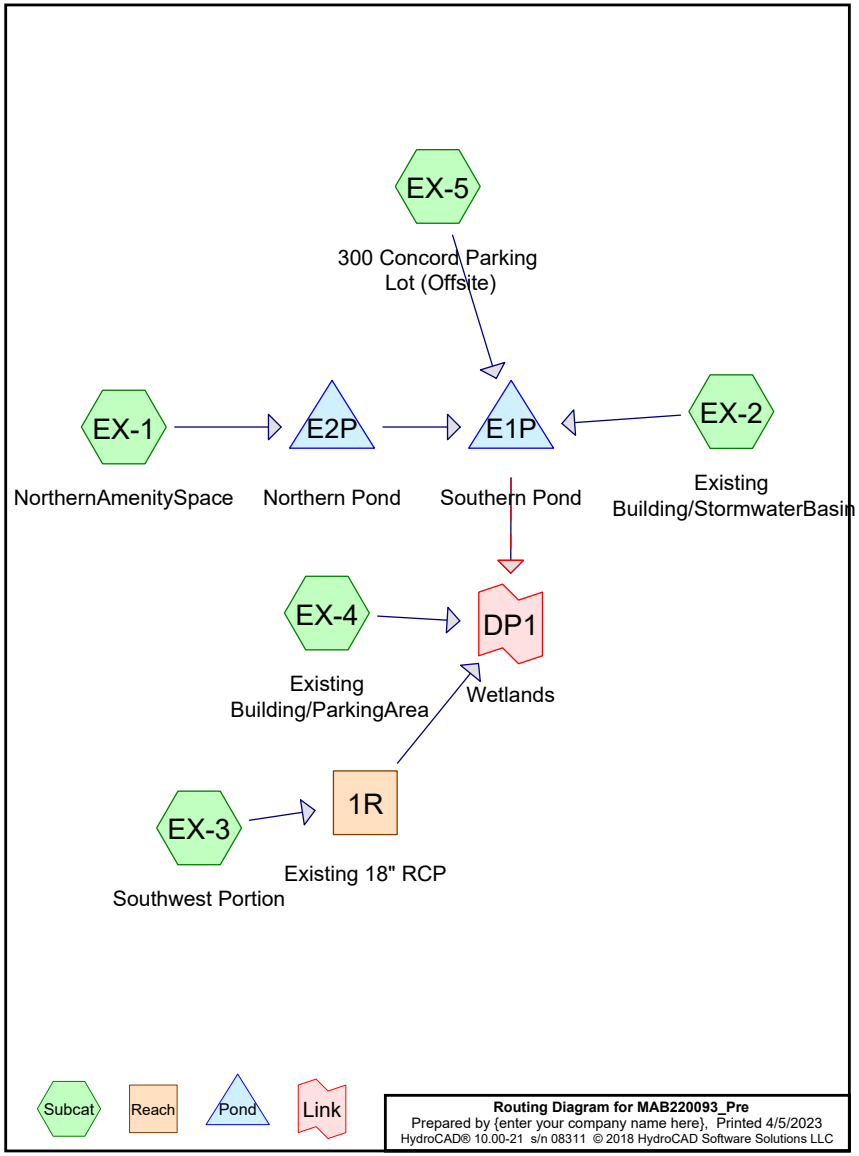


Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.228	39	>75% Grass cover, Good, HSG A (EX-1, EX-4, EX-5)
0.272	61	>75% Grass cover, Good, HSG B (EX-5)
3.636	98	Paved parking (EX-5)
0.954	98	Paved parking, HSG A (EX-1, EX-2, EX-4, EX-5)
1.282	98	Roofs, HSG A (EX-2, EX-4)
1.685	98	Water Surface, HSG A (EX-1, EX-2)
1.415	32	Woods/grass comb., Good, HSG A (EX-2, EX-3)
10.472	**81**	**TOTAL AREA**

Summary for Subcatchment EX-1: NorthernAmenitySpace

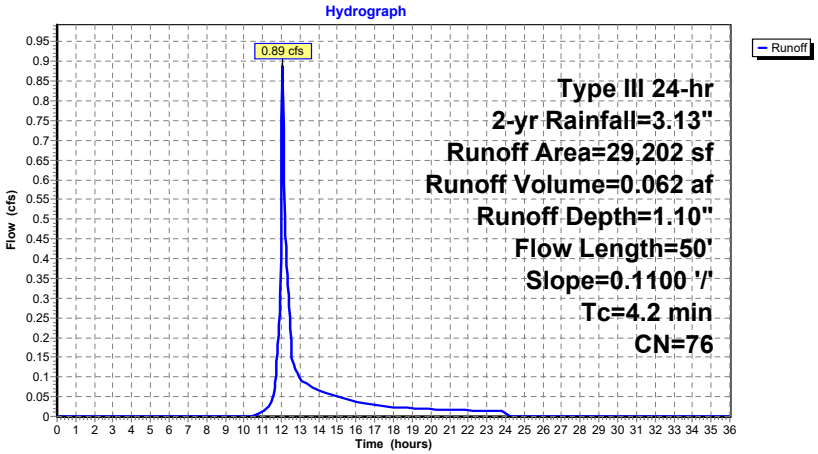
Runoff = 0.89 cfs @ 12.07 hrs, Volume= 0.062 af, Depth= 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
6,712	98	Paved parking, HSG A
10,796	39	>75% Grass cover, Good, HSG A
11,694	98	Water Surface, HSG A
29,202	76	Weighted Average
10,796		36.97% Pervious Area
18,406		63.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.1100	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"

Subcatchment EX-1: NorthernAmenitySpace



Summary for Subcatchment EX-2: Existing Building/StormwaterBasin

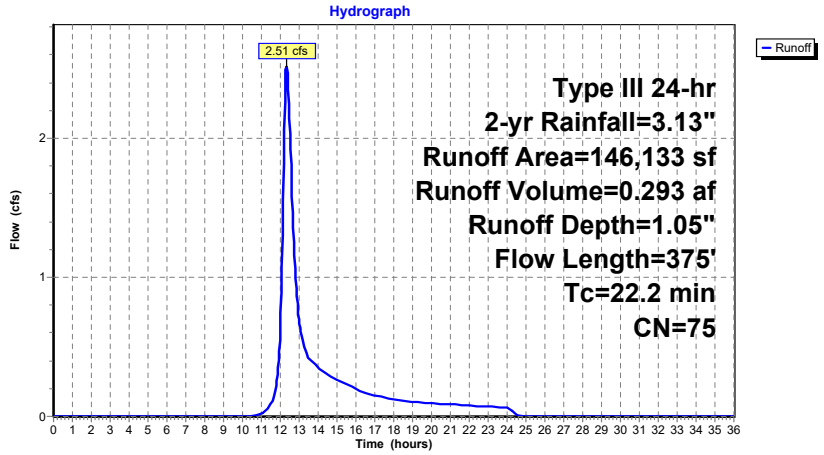
Runoff = 2.51 cfs @ 12.33 hrs, Volume= 0.293 af, Depth= 1.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
31,607	98	Roofs, HSG A
824	98	Paved parking, HSG A
51,995	32	Woods/grass comb., Good, HSG A
61,707	98	Water Surface, HSG A
146,133	75	Weighted Average
51,995		35.58% Pervious Area
94,138		64.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3	50	0.0020	0.06		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
3.4	160	0.0129	0.80		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
0.3	109	0.0129	6.70	5.26	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
4.2	56	0.0020	0.22		**Shallow Concentrated Flow, Pipe to bottom of pond** Woodland Kv= 5.0 fps
22.2	375	Total			

Subcatchment EX-2: Existing Building/StormwaterBasin



Summary for Subcatchment EX-3: Southwest Portion

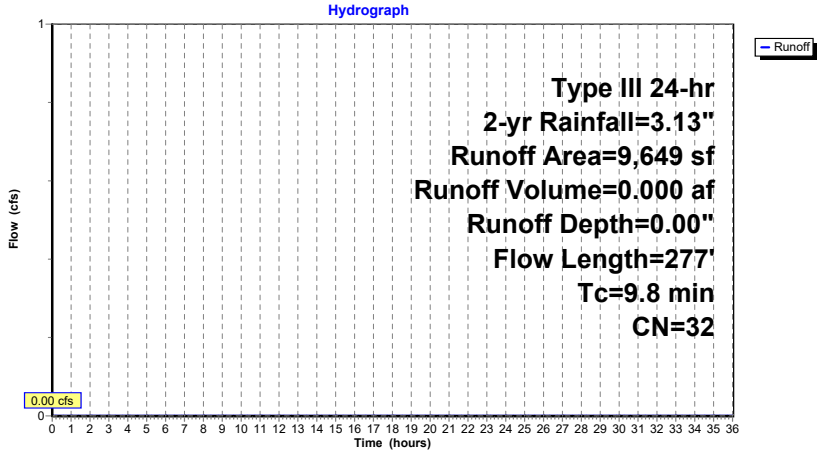
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
9,649	32	Woods/grass comb., Good, HSG A
9,649		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	59	0.1000	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"
4.8	218	0.0116	0.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.8	277	Total			

Subcatchment EX-3: Southwest Portion



Summary for Subcatchment EX-4: Existing Building/ParkingArea

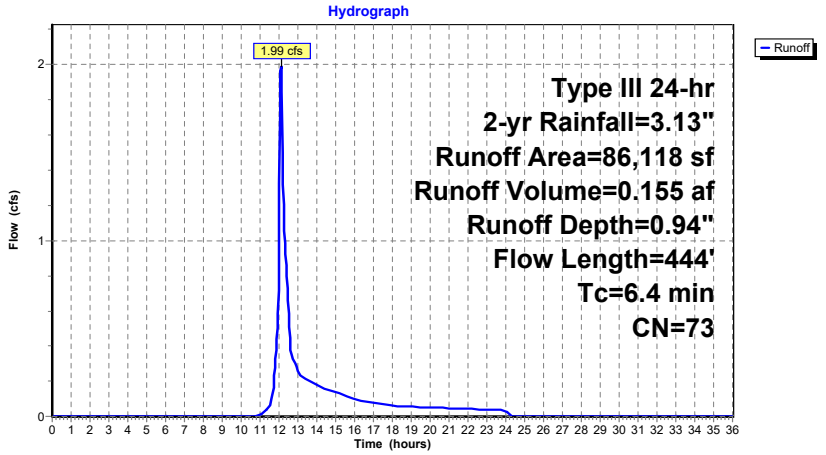
Runoff = 1.99 cfs @ 12.10 hrs, Volume= 0.155 af, Depth= 0.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
24,221	98	Roofs, HSG A
25,378	98	Paved parking, HSG A
36,519	39	>75% Grass cover, Good, HSG A
86,118	73	Weighted Average
36,519		42.41% Pervious Area
49,599		57.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.13"
0.6	70	0.0850	2.04		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	134	0.0246	3.18		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	139	0.0140	5.81	4.57	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Corrugated PP, smooth interior
0.4	51	0.0009	2.34	7.35	**Pipe Channel, RCP_Round 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Corrugated PP, smooth interior
6.4	444	Total			

Subcatchment EX-4: Existing Building/ParkingArea



Summary for Subcatchment EX-5: 300 Concord Parking Lot (Offsite)

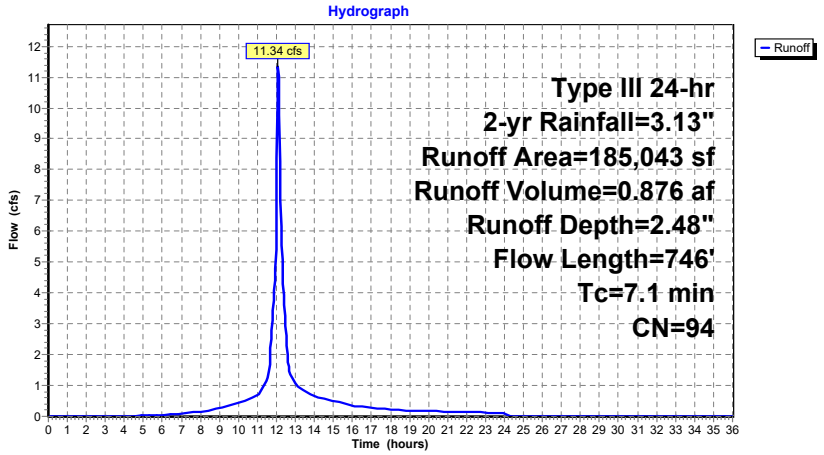
Runoff = 11.34 cfs @ 12.10 hrs, Volume= 0.876 af, Depth= 2.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

	Area (sf)	CN	Description
	11,848	61	>75% Grass cover, Good, HSG B
*	158,384	98	Paved parking
	6,186	39	>75% Grass cover, Good, HSG A
	8,625	98	Paved parking, HSG A
	185,043	94	Weighted Average
	18,034		9.75% Pervious Area
	167,009		90.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment EX-5: 300 Concord Parking Lot (Offsite)



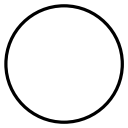
Summary for Reach 1R: Existing 18" RCP

Inflow Area = 0.222 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

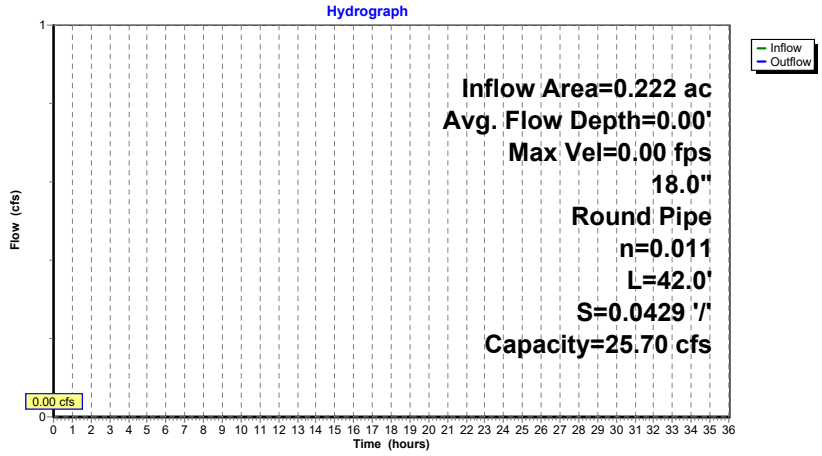
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 25.70 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 42.0' Slope= 0.0429 '/'
Inlet Invert= 178.80', Outlet Invert= 177.00'



Reach 1R: Existing 18" RCP



Summary for Pond E1P: Southern Pond

Inflow Area = 8.273 ac, 77.57% Impervious, Inflow Depth = 1.77" for 2-yr event
Inflow = 13.24 cfs @ 12.10 hrs, Volume= 1.223 af
Outflow = 4.58 cfs @ 12.53 hrs, Volume= 1.223 af, Atten= 65%, Lag= 25.4 min
Discarded = 0.87 cfs @ 12.53 hrs, Volume= 0.198 af
Primary = 3.72 cfs @ 12.53 hrs, Volume= 1.025 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 183.19' @ 12.53 hrs Surf.Area= 15,517 sf Storage= 11,531 cf

Plug-Flow detention time= 18.3 min calculated for 1.222 af (100% of inflow)
Center-of-Mass det. time= 18.3 min (830.8 - 812.5)

Volume	Invert	Avail.Storage	Storage Description
#1	182.00'	125,224 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,062	0	0
183.00	13,585	8,824	8,824
184.00	23,965	18,775	27,599
185.00	32,014	27,990	55,588
186.00	39,111	35,563	91,151
186.20	4,802	4,391	95,542
187.00	9,192	5,598	101,139
188.00	12,047	10,620	111,759
189.00	14,884	13,466	125,224

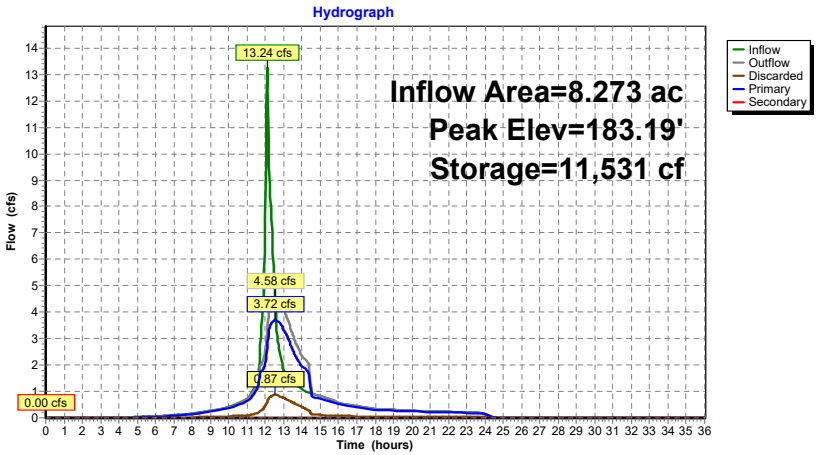
Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.87 cfs @ 12.53 hrs HW=183.19' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.87 cfs)

Primary OutFlow Max=3.71 cfs @ 12.53 hrs HW=183.19' (Free Discharge)
└**3=Culvert** (Passes 3.71 cfs of 9.99 cfs potential flow)
└**4=Orifice/Grate** (Orifice Controls 1.25 cfs @ 3.58 fps)
└**5=Orifice/Grate** (Orifice Controls 2.47 cfs @ 7.06 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Southern Pond



Summary for Pond E2P: Northern Pond

Inflow Area = 0.670 ac, 63.03% Impervious, Inflow Depth = 1.10" for 2-yr event
Inflow = 0.89 cfs @ 12.07 hrs, Volume= 0.062 af
Outflow = 0.85 cfs @ 12.09 hrs, Volume= 0.062 af, Atten= 4%, Lag= 1.4 min
Discarded = 0.10 cfs @ 12.09 hrs, Volume= 0.007 af
Primary = 0.75 cfs @ 12.09 hrs, Volume= 0.054 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 189.03' @ 12.09 hrs Surf.Area= 2,338 sf Storage= 69 cf

Plug-Flow detention time= 1.4 min calculated for 0.062 af (100% of inflow)
Center-of-Mass det. time= 1.4 min (856.6 - 855.2)

Volume	Invert	Avail.Storage	Storage Description
#1	189.00'	45,190 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

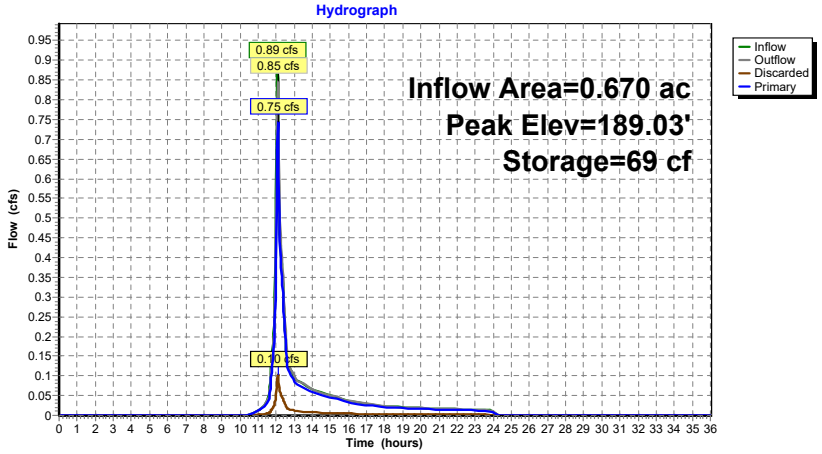
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
189.00	2,162	0	0
190.00	7,890	5,026	5,026
191.00	11,694	9,792	14,818
192.00	14,847	13,271	28,089
193.00	19,355	17,101	45,190

Device	Routing	Invert	Outlet Devices
#1	Discarded	189.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	189.00'	**50.0' long x 8.0' breadth Sidewalk** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74

Discarded OutFlow Max=0.13 cfs @ 12.09 hrs HW=189.03' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.13 cfs)

Primary OutFlow Max=0.65 cfs @ 12.09 hrs HW=189.03' (Free Discharge)
└**2=Sidewalk** (Weir Controls 0.65 cfs @ 0.42 fps)

Pond E2P: Northern Pond

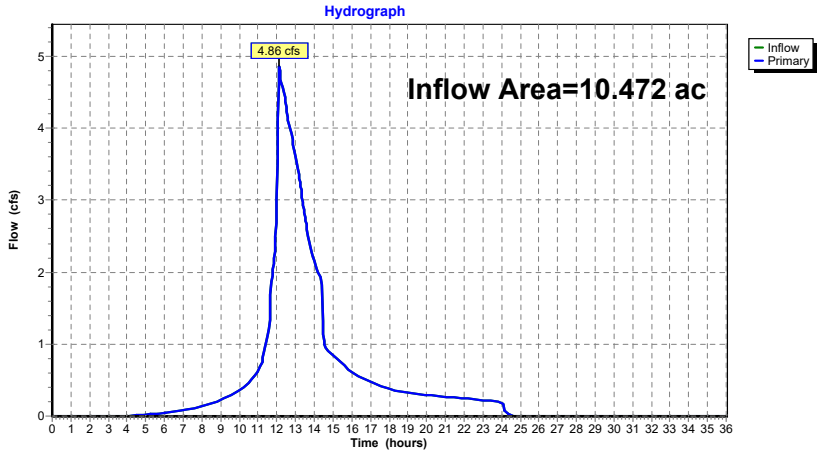


Summary for Link DP1: Wetlands

Inflow Area = 10.472 ac, 72.16% Impervious, Inflow Depth = 1.35" for 2-yr event
Inflow = 4.86 cfs @ 12.14 hrs, Volume= 1.180 af
Primary = 4.86 cfs @ 12.14 hrs, Volume= 1.180 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



Summary for Subcatchment EX-1: NorthernAmenitySpace

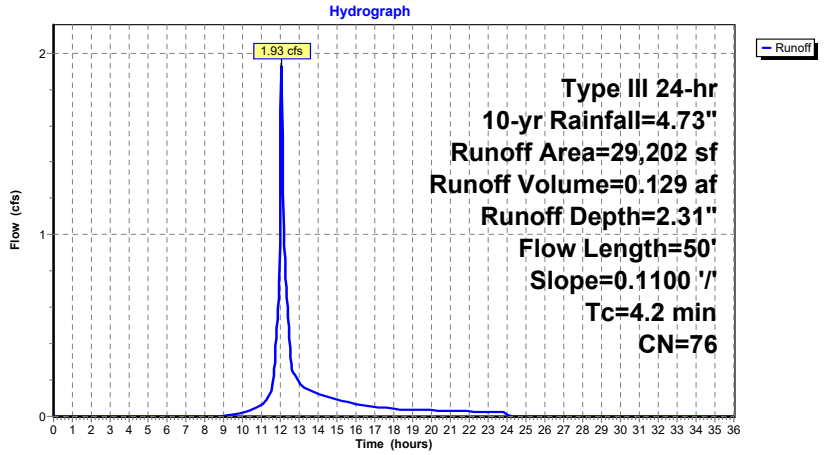
Runoff = 1.93 cfs @ 12.07 hrs, Volume= 0.129 af, Depth= 2.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
6,712	98	Paved parking, HSG A
10,796	39	>75% Grass cover, Good, HSG A
11,694	98	Water Surface, HSG A
29,202	76	Weighted Average
10,796		36.97% Pervious Area
18,406		63.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.1100	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"

Subcatchment EX-1: NorthernAmenitySpace



Summary for Subcatchment EX-2: Existing Building/StormwaterBasin

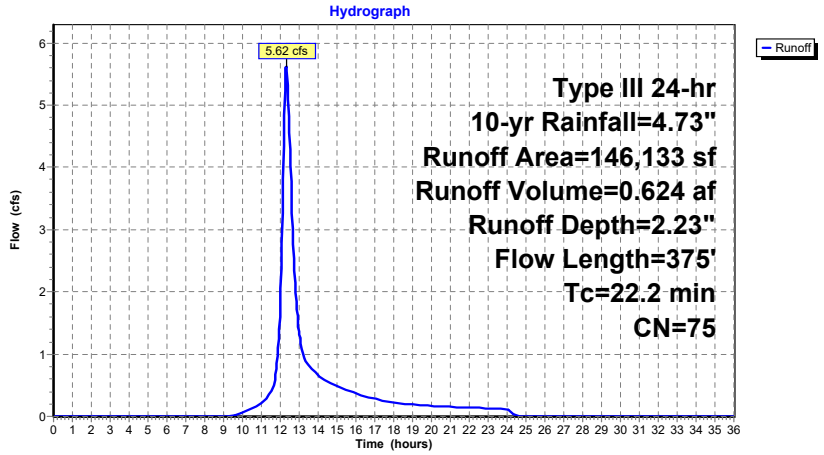
Runoff = 5.62 cfs @ 12.31 hrs, Volume= 0.624 af, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
31,607	98	Roofs, HSG A
824	98	Paved parking, HSG A
51,995	32	Woods/grass comb., Good, HSG A
61,707	98	Water Surface, HSG A
146,133	75	Weighted Average
51,995		35.58% Pervious Area
94,138		64.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3	50	0.0020	0.06		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
3.4	160	0.0129	0.80		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
0.3	109	0.0129	6.70	5.26	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
4.2	56	0.0020	0.22		**Shallow Concentrated Flow, Pipe to bottom of pond** Woodland Kv= 5.0 fps
22.2	375	Total			

Subcatchment EX-2: Existing Building/StormwaterBasin



Summary for Subcatchment EX-3: Southwest Portion

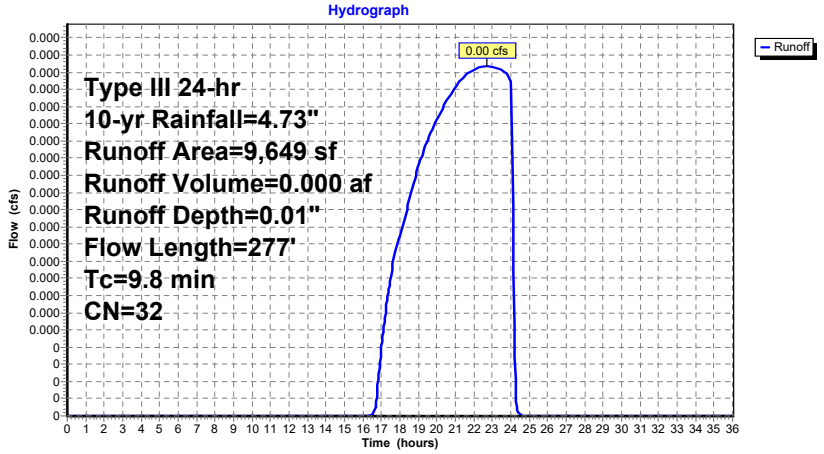
Runoff = 0.00 cfs @ 22.73 hrs, Volume= 0.000 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
9,649	32	Woods/grass comb., Good, HSG A
9,649		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	59	0.1000	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"
4.8	218	0.0116	0.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.8	277	Total			

Subcatchment EX-3: Southwest Portion



Summary for Subcatchment EX-4: Existing Building/ParkingArea

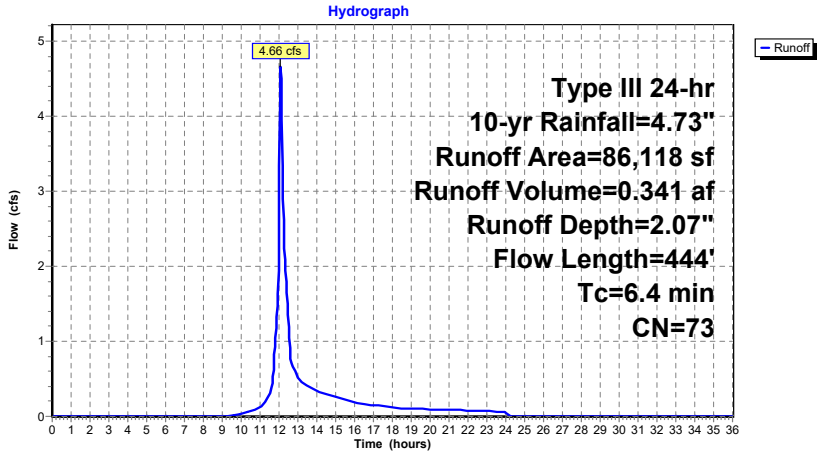
Runoff = 4.66 cfs @ 12.10 hrs, Volume= 0.341 af, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
24,221	98	Roofs, HSG A
25,378	98	Paved parking, HSG A
36,519	39	>75% Grass cover, Good, HSG A
86,118	73	Weighted Average
36,519		42.41% Pervious Area
49,599		57.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.13"
0.6	70	0.0850	2.04		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	134	0.0246	3.18		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	139	0.0140	5.81	4.57	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Corrugated PP, smooth interior
0.4	51	0.0009	2.34	7.35	**Pipe Channel, RCP_Round 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Corrugated PP, smooth interior
6.4	444	Total			

Subcatchment EX-4: Existing Building/ParkingArea



Summary for Subcatchment EX-5: 300 Concord Parking Lot (Offsite)

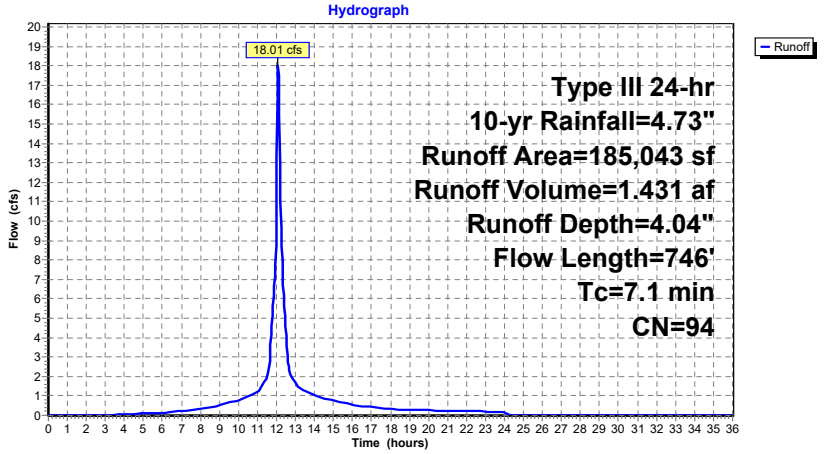
Runoff = 18.01 cfs @ 12.10 hrs, Volume= 1.431 af, Depth= 4.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

	Area (sf)	CN	Description
	11,848	61	>75% Grass cover, Good, HSG B
*	158,384	98	Paved parking
	6,186	39	>75% Grass cover, Good, HSG A
	8,625	98	Paved parking, HSG A
	185,043	94	Weighted Average
	18,034		9.75% Pervious Area
	167,009		90.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment EX-5: 300 Concord Parking Lot (Offsite)



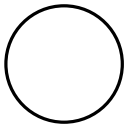
Summary for Reach 1R: Existing 18" RCP

Inflow Area = 0.222 ac, 0.00% Impervious, Inflow Depth = 0.01" for 10-yr event
Inflow = 0.00 cfs @ 22.73 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 22.74 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.9 min

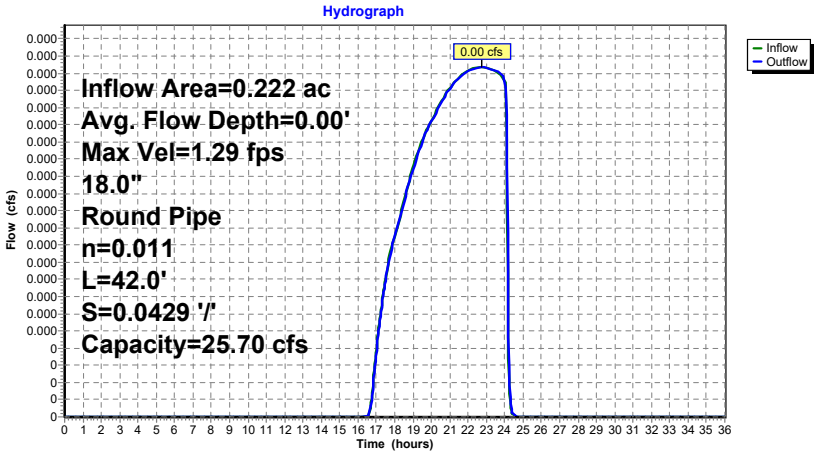
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Max. Velocity= 1.29 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 0.5 min

Peak Storage= 0 cf @ 22.74 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 25.70 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 42.0' Slope= 0.0429 '/'
Inlet Invert= 178.80', Outlet Invert= 177.00'



Reach 1R: Existing 18" RCP



Summary for Pond E1P: Southern Pond

Inflow Area = 8.273 ac, 77.57% Impervious, Inflow Depth = 3.15" for 10-yr event
Inflow = 22.66 cfs @ 12.10 hrs, Volume= 2.169 af
Outflow = 6.07 cfs @ 12.63 hrs, Volume= 2.169 af, Atten= 73%, Lag= 31.5 min
Discarded = 1.29 cfs @ 12.63 hrs, Volume= 0.381 af
Primary = 4.77 cfs @ 12.63 hrs, Volume= 1.788 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 183.93' @ 12.63 hrs Surf.Area= 23,212 sf Storage= 25,887 cf

Plug-Flow detention time= 33.0 min calculated for 2.169 af (100% of inflow)
Center-of-Mass det. time= 33.0 min (834.1 - 801.1)

Volume	Invert	Avail.Storage	Storage Description
#1	182.00'	125,224 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,062	0	0
183.00	13,585	8,824	8,824
184.00	23,965	18,775	27,599
185.00	32,014	27,990	55,588
186.00	39,111	35,563	91,151
186.20	4,802	4,391	95,542
187.00	9,192	5,598	101,139
188.00	12,047	10,620	111,759
189.00	14,884	13,466	125,224

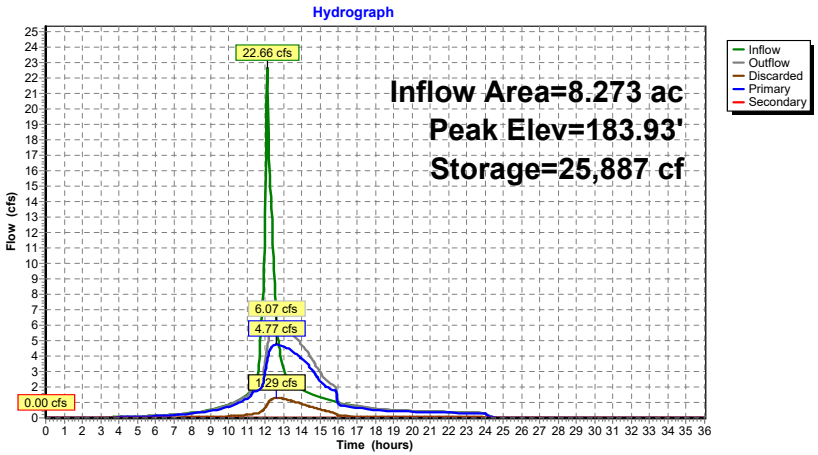
Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=1.29 cfs @ 12.63 hrs HW=183.93' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 1.29 cfs)

Primary OutFlow Max=4.77 cfs @ 12.63 hrs HW=183.93' (Free Discharge)
└**3=Culvert** (Passes 4.77 cfs of 11.21 cfs potential flow)
  └**4=Orifice/Grate** (Orifice Controls 1.91 cfs @ 5.48 fps)
  └**5=Orifice/Grate** (Orifice Controls 2.86 cfs @ 8.19 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Southern Pond



Summary for Pond E2P: Northern Pond

Inflow Area = 0.670 ac, 63.03% Impervious, Inflow Depth = 2.31" for 10-yr event
Inflow = 1.93 cfs @ 12.07 hrs, Volume= 0.129 af
Outflow = 1.88 cfs @ 12.08 hrs, Volume= 0.129 af, Atten= 3%, Lag= 1.0 min
Discarded = 0.14 cfs @ 12.08 hrs, Volume= 0.015 af
Primary = 1.74 cfs @ 12.08 hrs, Volume= 0.114 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 189.06' @ 12.08 hrs Surf.Area= 2,490 sf Storage= 133 cf

Plug-Flow detention time= 1.3 min calculated for 0.129 af (100% of inflow)
Center-of-Mass det. time= 1.4 min (834.6 - 833.3)

Volume	Invert	Avail.Storage	Storage Description
#1	189.00'	45,190 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

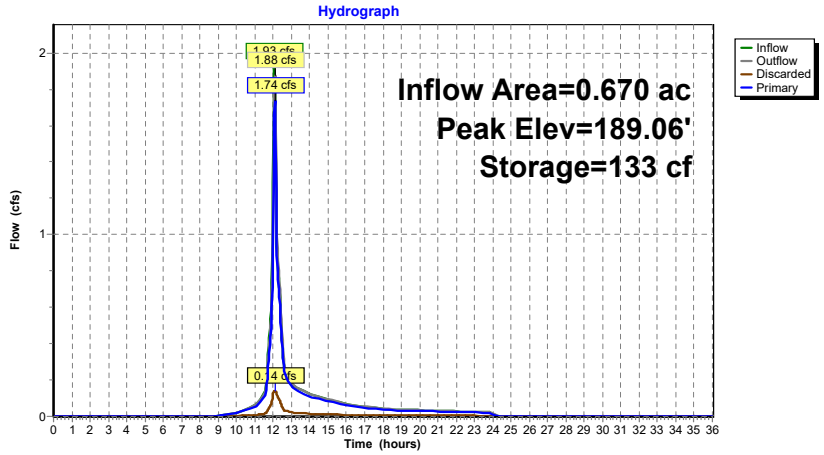
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
189.00	2,162	0	0
190.00	7,890	5,026	5,026
191.00	11,694	9,792	14,818
192.00	14,847	13,271	28,089
193.00	19,355	17,101	45,190

Device	Routing	Invert	Outlet Devices
#1	Discarded	189.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	189.00'	**50.0' long x 8.0' breadth Sidewalk** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74

Discarded OutFlow Max=0.14 cfs @ 12.08 hrs HW=189.06' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=1.64 cfs @ 12.08 hrs HW=189.06' (Free Discharge)
└**2=Sidewalk** (Weir Controls 1.64 cfs @ 0.58 fps)

Pond E2P: Northern Pond

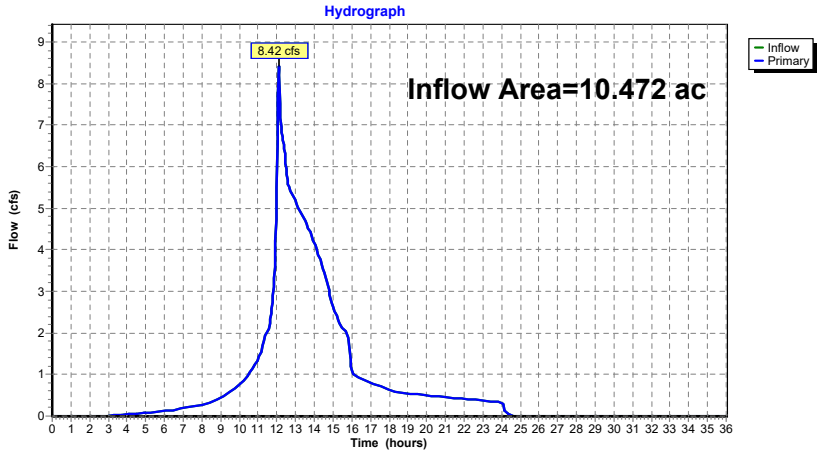


Summary for Link DP1: Wetlands

Inflow Area = 10.472 ac, 72.16% Impervious, Inflow Depth = 2.44" for 10-yr event
Inflow = 8.42 cfs @ 12.11 hrs, Volume= 2.130 af
Primary = 8.42 cfs @ 12.11 hrs, Volume= 2.130 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



Summary for Subcatchment EX-1: NorthernAmenitySpace

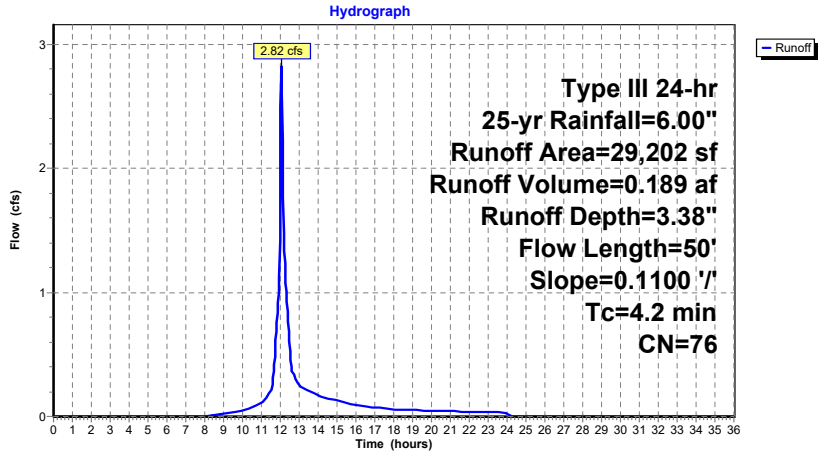
Runoff = 2.82 cfs @ 12.07 hrs, Volume= 0.189 af, Depth= 3.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
6,712	98	Paved parking, HSG A
10,796	39	>75% Grass cover, Good, HSG A
11,694	98	Water Surface, HSG A
29,202	76	Weighted Average
10,796		36.97% Pervious Area
18,406		63.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.1100	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"

Subcatchment EX-1: NorthernAmenitySpace



Summary for Subcatchment EX-2: Existing Building/StormwaterBasin

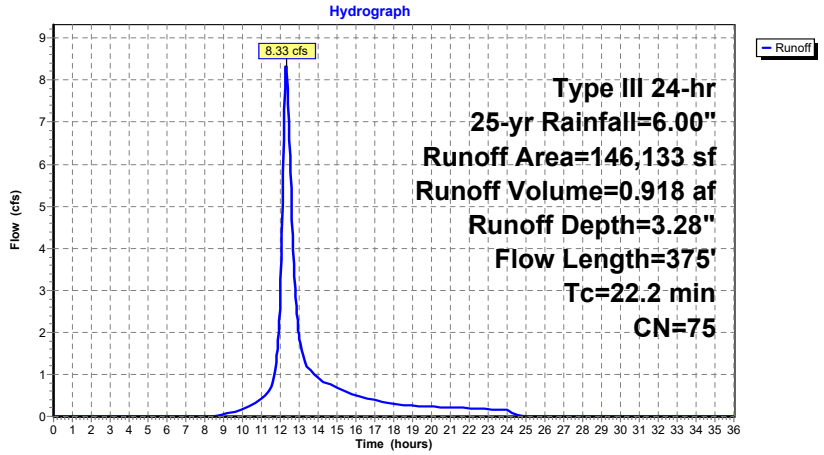
Runoff = 8.33 cfs @ 12.31 hrs, Volume= 0.918 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
31,607	98	Roofs, HSG A
824	98	Paved parking, HSG A
51,995	32	Woods/grass comb., Good, HSG A
61,707	98	Water Surface, HSG A
146,133	75	Weighted Average
51,995		35.58% Pervious Area
94,138		64.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3	50	0.0020	0.06		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
3.4	160	0.0129	0.80		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
0.3	109	0.0129	6.70	5.26	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
4.2	56	0.0020	0.22		**Shallow Concentrated Flow, Pipe to bottom of pond** Woodland Kv= 5.0 fps
22.2	375	Total			

Subcatchment EX-2: Existing Building/StormwaterBasin



Summary for Subcatchment EX-3: Southwest Portion

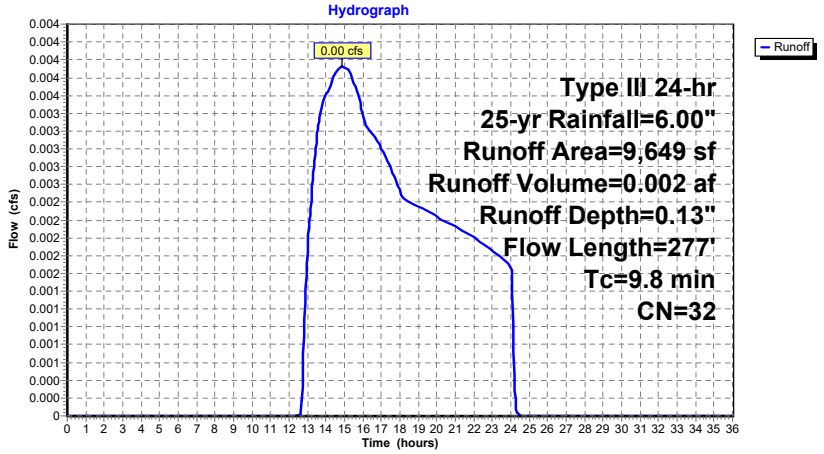
Runoff = 0.00 cfs @ 14.87 hrs, Volume= 0.002 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
9,649	32	Woods/grass comb., Good, HSG A
9,649		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	59	0.1000	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"
4.8	218	0.0116	0.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.8	277	Total			

Subcatchment EX-3: Southwest Portion



Summary for Subcatchment EX-4: Existing Building/ParkingArea

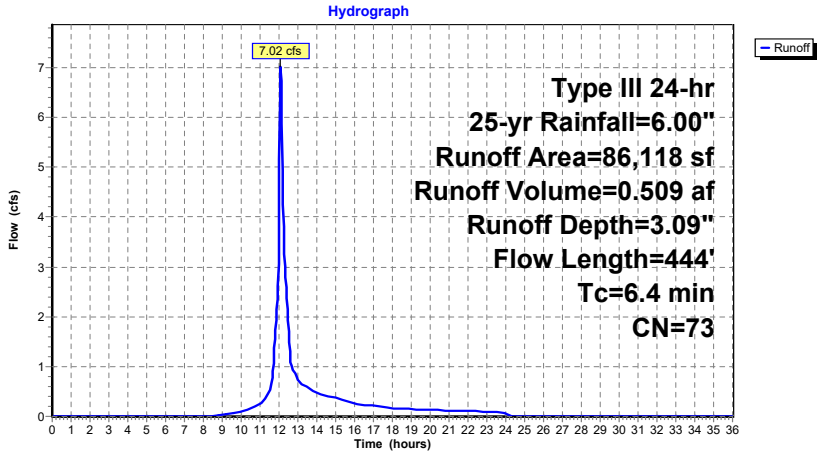
Runoff = 7.02 cfs @ 12.10 hrs, Volume= 0.509 af, Depth= 3.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
24,221	98	Roofs, HSG A
25,378	98	Paved parking, HSG A
36,519	39	>75% Grass cover, Good, HSG A
86,118	73	Weighted Average
36,519		42.41% Pervious Area
49,599		57.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.13"
0.6	70	0.0850	2.04		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	134	0.0246	3.18		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	139	0.0140	5.81	4.57	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Corrugated PP, smooth interior
0.4	51	0.0009	2.34	7.35	**Pipe Channel, RCP_Round 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Corrugated PP, smooth interior
6.4	444	Total			

Subcatchment EX-4: Existing Building/ParkingArea



Summary for Subcatchment EX-5: 300 Concord Parking Lot (Offsite)

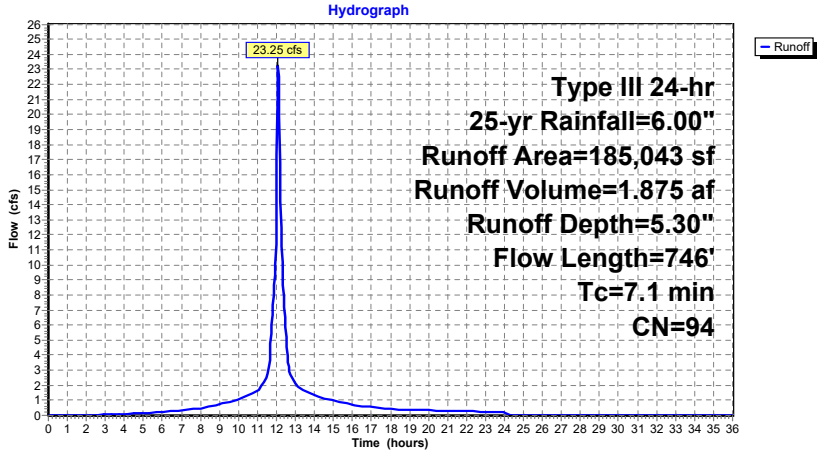
Runoff = 23.25 cfs @ 12.10 hrs, Volume= 1.875 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

	Area (sf)	CN	Description
	11,848	61	>75% Grass cover, Good, HSG B
*	158,384	98	Paved parking
	6,186	39	>75% Grass cover, Good, HSG A
	8,625	98	Paved parking, HSG A
	185,043	94	Weighted Average
	18,034		9.75% Pervious Area
	167,009		90.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment EX-5: 300 Concord Parking Lot (Offsite)



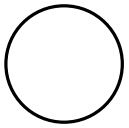
Summary for Reach 1R: Existing 18" RCP

Inflow Area = 0.222 ac, 0.00% Impervious, Inflow Depth = 0.13" for 25-yr event
Inflow = 0.00 cfs @ 14.87 hrs, Volume= 0.002 af
Outflow = 0.00 cfs @ 14.89 hrs, Volume= 0.002 af, Atten= 0%, Lag= 1.2 min

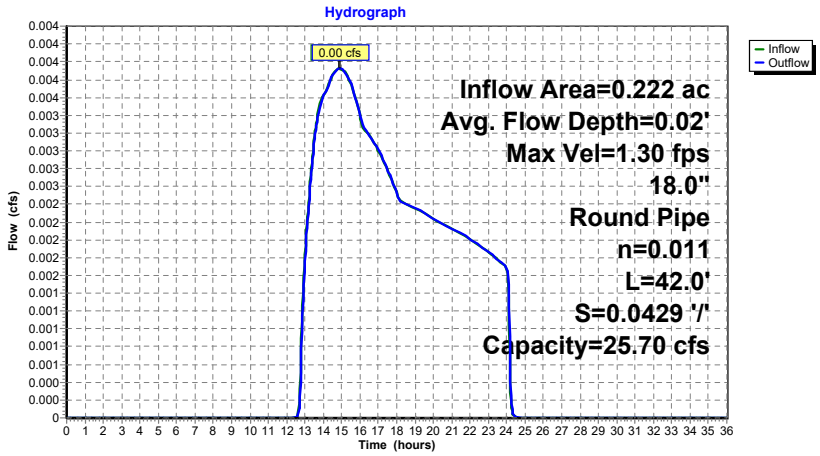
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Max. Velocity= 1.30 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 0.5 min

Peak Storage= 0 cf @ 14.88 hrs
Average Depth at Peak Storage= 0.02'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 25.70 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 42.0' Slope= 0.0429 '/'
Inlet Invert= 178.80', Outlet Invert= 177.00'



Reach 1R: Existing 18" RCP



Summary for Pond E1P: Southern Pond

Inflow Area = 8.273 ac, 77.57% Impervious, Inflow Depth = 4.29" for 25-yr event
Inflow = 30.34 cfs @ 12.10 hrs, Volume= 2.961 af
Outflow = 6.93 cfs @ 12.71 hrs, Volume= 2.961 af, Atten= 77%, Lag= 36.1 min
Discarded = 1.54 cfs @ 12.71 hrs, Volume= 0.548 af
Primary = 5.39 cfs @ 12.71 hrs, Volume= 2.412 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 184.46' @ 12.71 hrs Surf.Area= 27,694 sf Storage= 39,565 cf

Plug-Flow detention time= 45.8 min calculated for 2.958 af (100% of inflow)
Center-of-Mass det. time= 45.8 min (840.6 - 794.8)

Volume	Invert	Avail.Storage	Storage Description
#1	182.00'	125,224 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,062	0	0
183.00	13,585	8,824	8,824
184.00	23,965	18,775	27,599
185.00	32,014	27,990	55,588
186.00	39,111	35,563	91,151
186.20	4,802	4,391	95,542
187.00	9,192	5,598	101,139
188.00	12,047	10,620	111,759
189.00	14,884	13,466	125,224

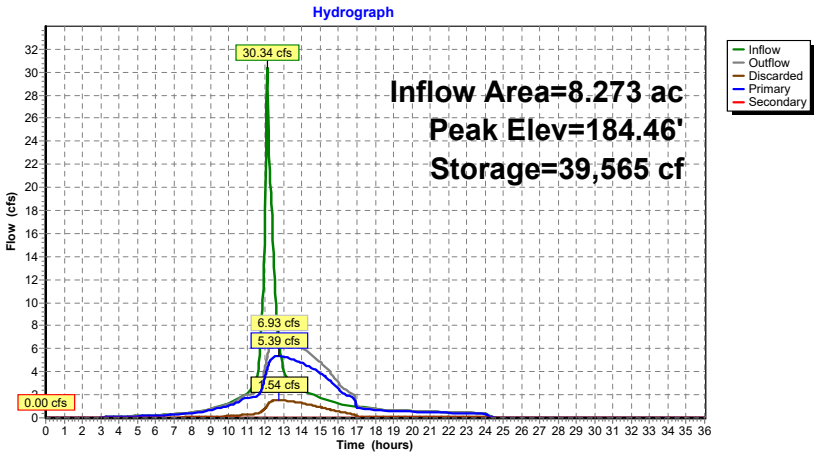
Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=1.54 cfs @ 12.71 hrs HW=184.46' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 1.54 cfs)

Primary OutFlow Max=5.39 cfs @ 12.71 hrs HW=184.46' (Free Discharge)
└**3=Culvert** (Passes 5.39 cfs of 12.02 cfs potential flow)
└**4=Orifice/Grate** (Orifice Controls 2.27 cfs @ 6.51 fps)
└**5=Orifice/Grate** (Orifice Controls 3.11 cfs @ 8.92 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Southern Pond



Summary for Pond E2P: Northern Pond

Inflow Area = 0.670 ac, 63.03% Impervious, Inflow Depth = 3.38" for 25-yr event
Inflow = 2.82 cfs @ 12.07 hrs, Volume= 0.189 af
Outflow = 2.75 cfs @ 12.08 hrs, Volume= 0.189 af, Atten= 3%, Lag= 1.0 min
Discarded = 0.15 cfs @ 12.08 hrs, Volume= 0.020 af
Primary = 2.60 cfs @ 12.08 hrs, Volume= 0.168 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 189.08' @ 12.08 hrs Surf.Area= 2,601 sf Storage= 183 cf

Plug-Flow detention time= 1.3 min calculated for 0.189 af (100% of inflow)
Center-of-Mass det. time= 1.3 min (823.7 - 822.4)

Volume	Invert	Avail.Storage	Storage Description
#1	189.00'	45,190 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

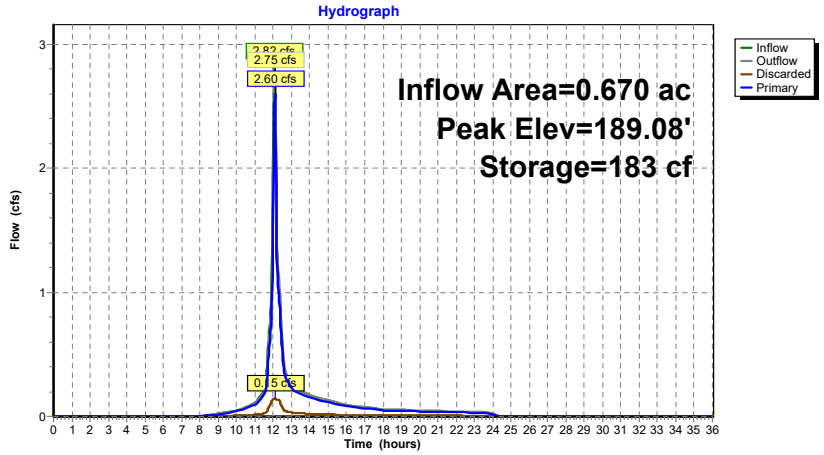
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
189.00	2,162	0	0
190.00	7,890	5,026	5,026
191.00	11,694	9,792	14,818
192.00	14,847	13,271	28,089
193.00	19,355	17,101	45,190

Device	Routing	Invert	Outlet Devices
#1	Discarded	189.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	189.00'	**50.0' long x 8.0' breadth Sidewalk** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74

Discarded OutFlow Max=0.14 cfs @ 12.08 hrs HW=189.08' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=2.54 cfs @ 12.08 hrs HW=189.08' (Free Discharge)
└**2=Sidewalk** (Weir Controls 2.54 cfs @ 0.67 fps)

Pond E2P: Northern Pond

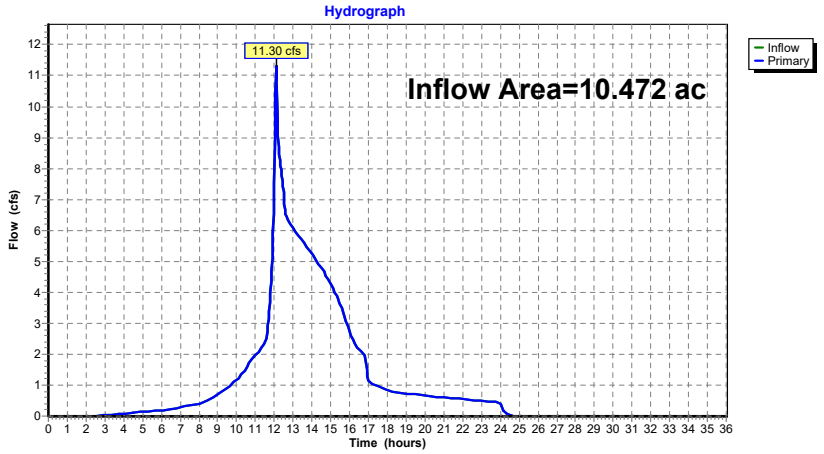


Summary for Link DP1: Wetlands

Inflow Area = 10.472 ac, 72.16% Impervious, Inflow Depth = 3.35" for 25-yr event
Inflow = 11.30 cfs @ 12.10 hrs, Volume= 2.924 af
Primary = 11.30 cfs @ 12.10 hrs, Volume= 2.924 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



Summary for Subcatchment EX-1: NorthernAmenitySpace

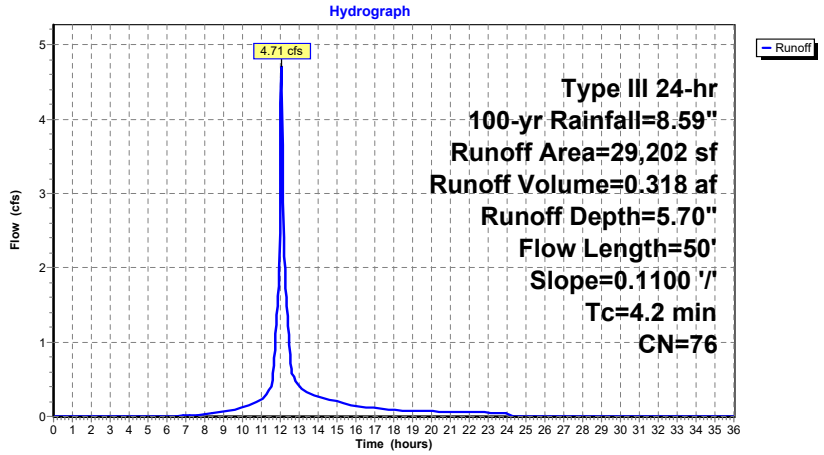
Runoff = 4.71 cfs @ 12.06 hrs, Volume= 0.318 af, Depth= 5.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
6,712	98	Paved parking, HSG A
10,796	39	>75% Grass cover, Good, HSG A
11,694	98	Water Surface, HSG A
29,202	76	Weighted Average
10,796		36.97% Pervious Area
18,406		63.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.1100	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"

Subcatchment EX-1: NorthernAmenitySpace



Summary for Subcatchment EX-2: Existing Building/StormwaterBasin

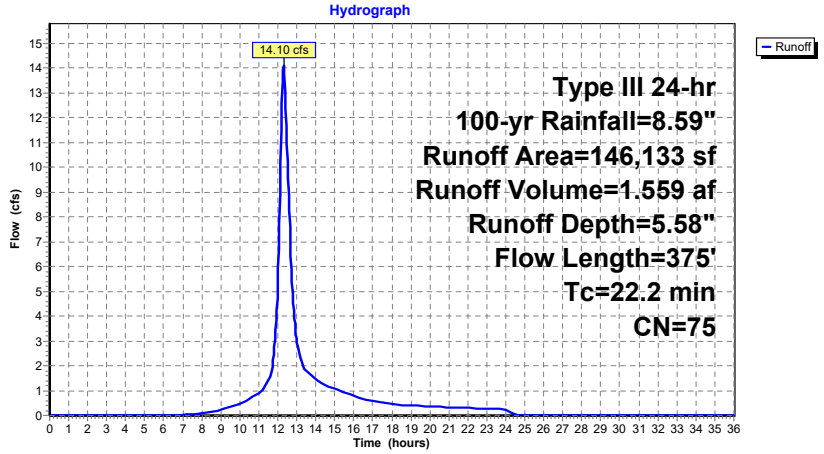
Runoff = 14.10 cfs @ 12.30 hrs, Volume= 1.559 af, Depth= 5.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
31,607	98	Roofs, HSG A
824	98	Paved parking, HSG A
51,995	32	Woods/grass comb., Good, HSG A
61,707	98	Water Surface, HSG A
146,133	75	Weighted Average
51,995		35.58% Pervious Area
94,138		64.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3	50	0.0020	0.06		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
3.4	160	0.0129	0.80		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
0.3	109	0.0129	6.70	5.26	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
4.2	56	0.0020	0.22		**Shallow Concentrated Flow, Pipe to bottom of pond** Woodland Kv= 5.0 fps
22.2	375	Total			

Subcatchment EX-2: Existing Building/StormwaterBasin



Summary for Subcatchment EX-3: Southwest Portion

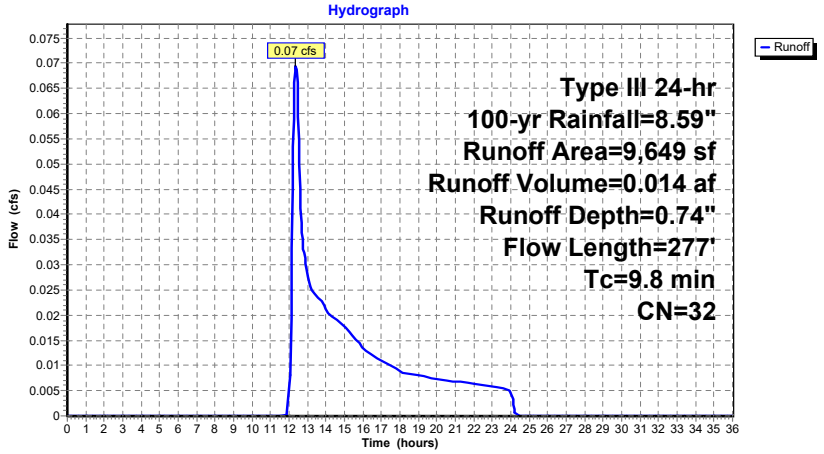
Runoff = 0.07 cfs @ 12.37 hrs, Volume= 0.014 af, Depth= 0.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
9,649	32	Woods/grass comb., Good, HSG A
9,649		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	59	0.1000	0.20		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.13"
4.8	218	0.0116	0.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.8	277	Total			

Subcatchment EX-3: Southwest Portion



Summary for Subcatchment EX-4: Existing Building/ParkingArea

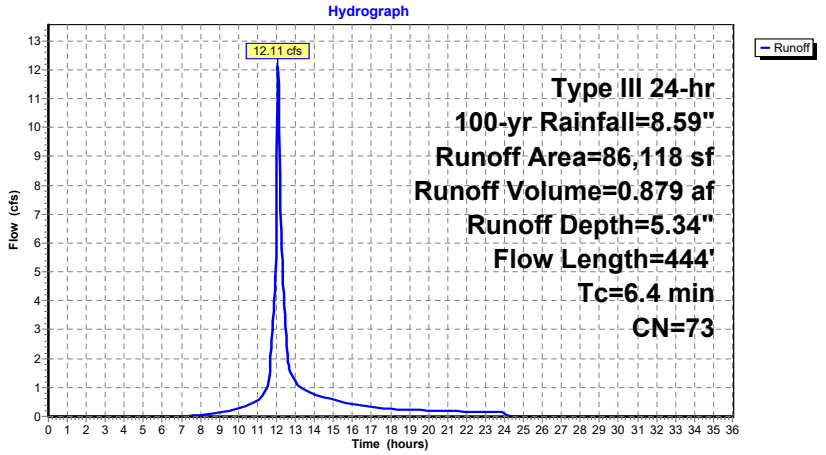
Runoff = 12.11 cfs @ 12.09 hrs, Volume= 0.879 af, Depth= 5.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
24,221	98	Roofs, HSG A
25,378	98	Paved parking, HSG A
36,519	39	>75% Grass cover, Good, HSG A
86,118	73	Weighted Average
36,519		42.41% Pervious Area
49,599		57.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.13"
0.6	70	0.0850	2.04		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	134	0.0246	3.18		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	139	0.0140	5.81	4.57	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Corrugated PP, smooth interior
0.4	51	0.0009	2.34	7.35	**Pipe Channel, RCP_Round 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Corrugated PP, smooth interior
6.4	444	Total			

Subcatchment EX-4: Existing Building/ParkingArea



Summary for Subcatchment EX-5: 300 Concord Parking Lot (Offsite)

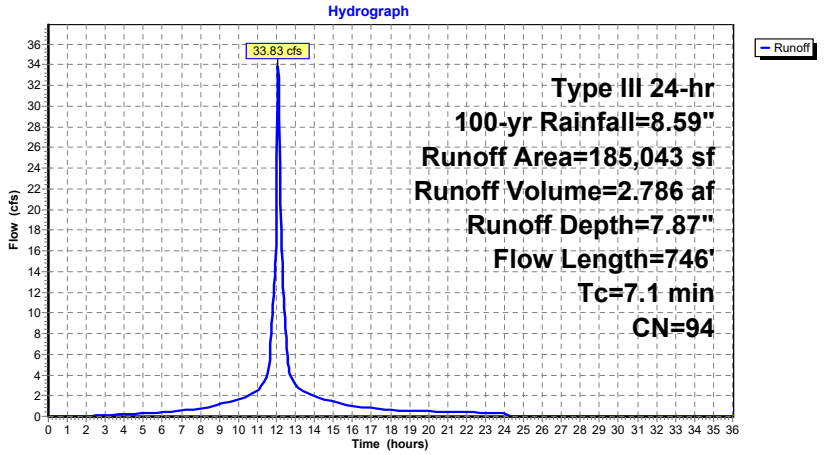
Runoff = 33.83 cfs @ 12.10 hrs, Volume= 2.786 af, Depth= 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

	Area (sf)	CN	Description
	11,848	61	>75% Grass cover, Good, HSG B
*	158,384	98	Paved parking
	6,186	39	>75% Grass cover, Good, HSG A
	8,625	98	Paved parking, HSG A
	185,043	94	Weighted Average
	18,034		9.75% Pervious Area
	167,009		90.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment EX-5: 300 Concord Parking Lot (Offsite)



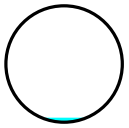
Summary for Reach 1R: Existing 18" RCP

Inflow Area = 0.222 ac, 0.00% Impervious, Inflow Depth = 0.74" for 100-yr event
Inflow = 0.07 cfs @ 12.37 hrs, Volume= 0.014 af
Outflow = 0.07 cfs @ 12.38 hrs, Volume= 0.014 af, Atten= 0%, Lag= 0.4 min

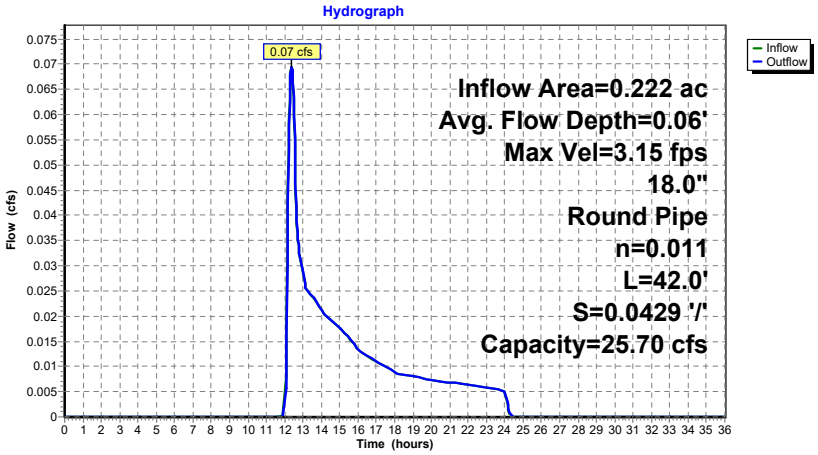
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Max. Velocity= 3.15 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.86 fps, Avg. Travel Time= 0.4 min

Peak Storage= 1 cf @ 12.38 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 25.70 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 42.0' Slope= 0.0429 '/'
Inlet Invert= 178.80', Outlet Invert= 177.00'



Reach 1R: Existing 18" RCP



Summary for Pond E1P: Southern Pond

Inflow Area = 8.273 ac, 77.57% Impervious, Inflow Depth = 6.72" for 100-yr event
Inflow = 46.21 cfs @ 12.10 hrs, Volume= 4.632 af
Outflow = 8.34 cfs @ 12.83 hrs, Volume= 4.632 af, Atten= 82%, Lag= 43.7 min
Discarded = 1.97 cfs @ 12.83 hrs, Volume= 0.929 af
Primary = 6.37 cfs @ 12.83 hrs, Volume= 3.703 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 185.47' @ 12.83 hrs Surf.Area= 35,359 sf Storage= 71,466 cf

Plug-Flow detention time= 73.5 min calculated for 4.628 af (100% of inflow)
Center-of-Mass det. time= 73.4 min (859.1 - 785.7)

Volume	Invert	Avail.Storage	Storage Description
#1	182.00'	125,224 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,062	0	0
183.00	13,585	8,824	8,824
184.00	23,965	18,775	27,599
185.00	32,014	27,990	55,588
186.00	39,111	35,563	91,151
186.20	4,802	4,391	95,542
187.00	9,192	5,598	101,139
188.00	12,047	10,620	111,759
189.00	14,884	13,466	125,224

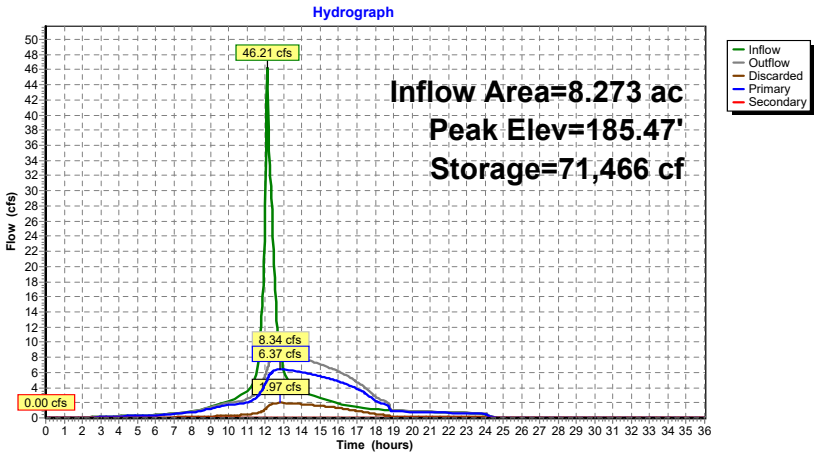
Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=1.97 cfs @ 12.83 hrs HW=185.47' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 1.97 cfs)

Primary OutFlow Max=6.37 cfs @ 12.83 hrs HW=185.47' (Free Discharge)
└**3=Culvert** (Passes 6.37 cfs of 13.40 cfs potential flow)
└**4=Orifice/Grate** (Orifice Controls 2.83 cfs @ 8.11 fps)
└**5=Orifice/Grate** (Orifice Controls 3.54 cfs @ 10.14 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Southern Pond



Summary for Pond E2P: Northern Pond

Inflow Area = 0.670 ac, 63.03% Impervious, Inflow Depth = 5.70" for 100-yr event
Inflow = 4.71 cfs @ 12.06 hrs, Volume= 0.318 af
Outflow = 4.61 cfs @ 12.08 hrs, Volume= 0.318 af, Atten= 2%, Lag= 0.8 min
Discarded = 0.16 cfs @ 12.08 hrs, Volume= 0.031 af
Primary = 4.45 cfs @ 12.08 hrs, Volume= 0.287 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 189.11' @ 12.08 hrs Surf.Area= 2,790 sf Storage= 271 cf

Plug-Flow detention time= 1.3 min calculated for 0.318 af (100% of inflow)
Center-of-Mass det. time= 1.3 min (808.7 - 807.5)

Volume	Invert	Avail.Storage	Storage Description
#1	189.00'	45,190 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

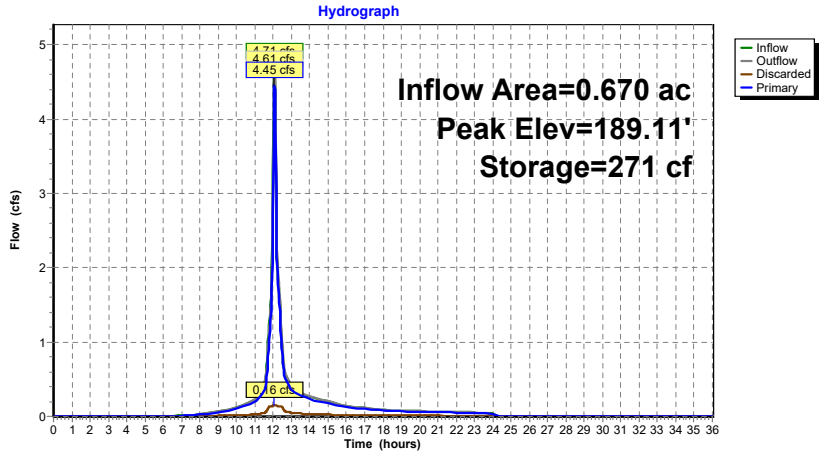
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
189.00	2,162	0	0
190.00	7,890	5,026	5,026
191.00	11,694	9,792	14,818
192.00	14,847	13,271	28,089
193.00	19,355	17,101	45,190

Device	Routing	Invert	Outlet Devices
#1	Discarded	189.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	189.00'	**50.0' long x 8.0' breadth Sidewalk** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74

Discarded OutFlow Max=0.16 cfs @ 12.08 hrs HW=189.11' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=4.33 cfs @ 12.08 hrs HW=189.11' (Free Discharge)
└**2=Sidewalk** (Weir Controls 4.33 cfs @ 0.80 fps)

Pond E2P: Northern Pond

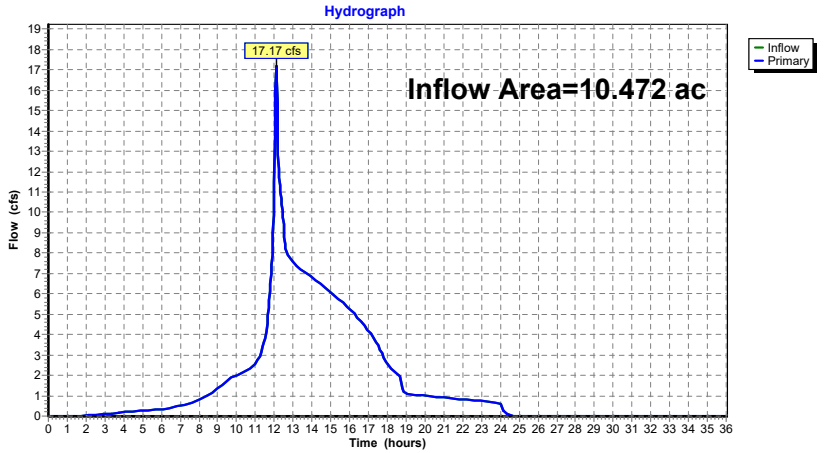


Summary for Link DP1: Wetlands

Inflow Area = 10.472 ac, 72.16% Impervious, Inflow Depth = 5.27" for 100-yr event
Inflow = 17.17 cfs @ 12.10 hrs, Volume= 4.596 af
Primary = 17.17 cfs @ 12.10 hrs, Volume= 4.596 af, Atten= 0%, Lag= 0.0 min

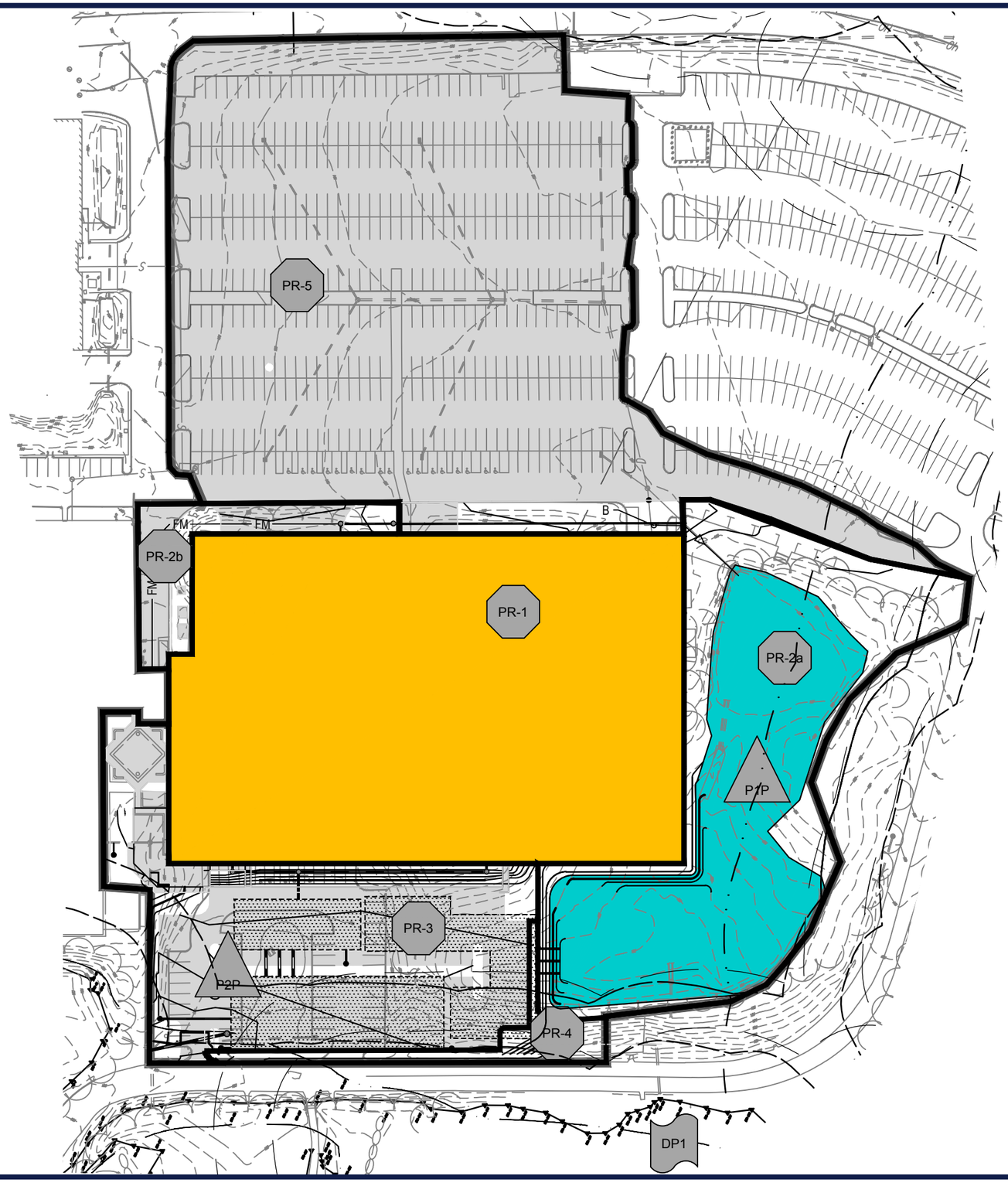
Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



APPENDIX E: PROPOSED CONDITIONS HYDROLOGIC ANALYSIS

- *PROPOSED CONDITIONS DRAINAGE MAP*
- *PROPOSED CONDITIONS HYDROCAD CALCULATIONS*



LEGEND

- DP# — DESIGN POINT
- PR-# — PROPOSED SUBCATCHMENT
- XX# — BASIN OR MODELED DRAINAGE STRUCTURE
- OVERALL ANALYSIS BOUNDARY
- SUBCATCHMENT BOUNDARY
- NRCS SOIL BOUNDARY
- CONCRETE OR PAVEMENT
- ROOF
- SURFACE WATER (IMPERVIOUS)

PROPOSED CONDITIONS DRAINAGE AREA MAP

298 CONCORD ROAD
BILLERICA, MA 01821

PREPARED BY

BOHLER

SCALE:1"=80' DATE: 04/04/2023

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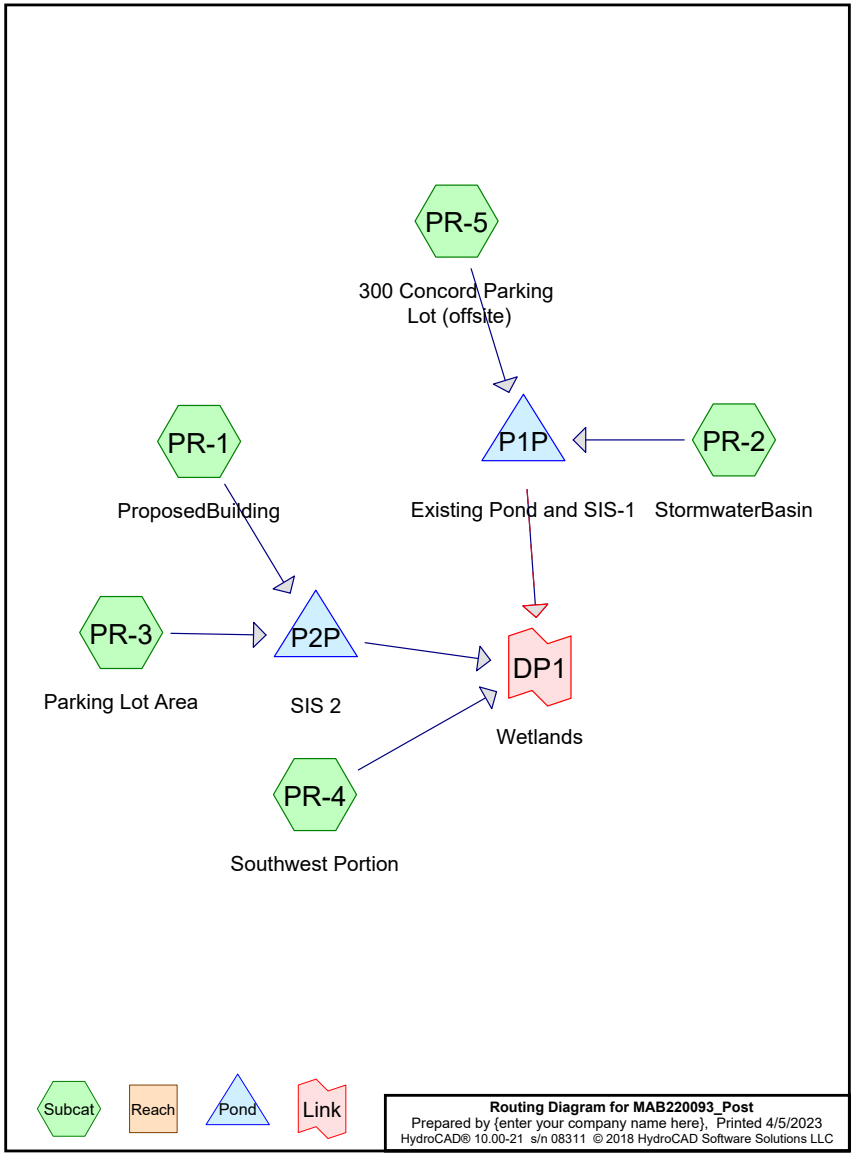


Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.142	39	>75% Grass cover, Good, HSG A (PR-5)
0.272	61	>75% Grass cover, Good, HSG B (PR-5)
3.636	98	Paved parking (PR-5)
1.260	98	Paved parking, HSG A (PR-2, PR-3)
2.792	98	Roofs, HSG A (PR-1)
1.089	98	Water Surface, HSG A (PR-2)
1.281	32	Woods/grass comb., Good, HSG A (PR-2, PR-3, PR-4)
10.471	**88**	**TOTAL AREA**

Summary for Subcatchment PR-1: ProposedBuilding

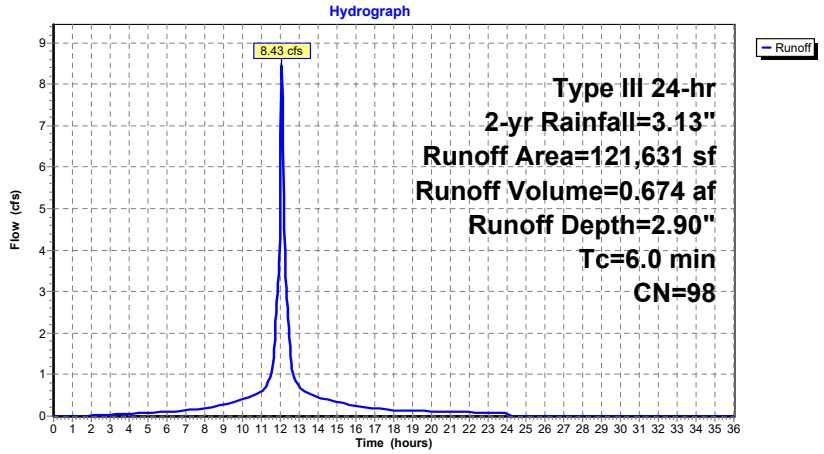
Runoff = 8.43 cfs @ 12.08 hrs, Volume= 0.674 af, Depth= 2.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
121,631	98	Roofs, HSG A
121,631		100.00% Impervious Area

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

Subcatchment PR-1: ProposedBuilding



Summary for Subcatchment PR-2: StormwaterBasin

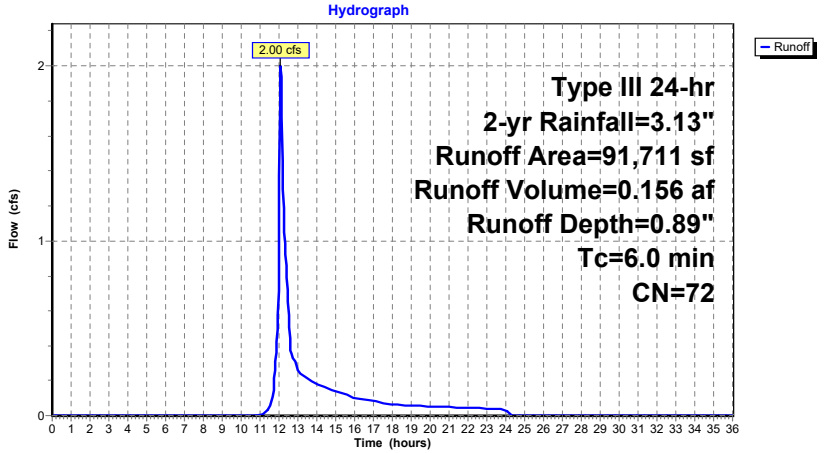
Runoff = 2.00 cfs @ 12.10 hrs, Volume= 0.156 af, Depth= 0.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
7,635	98	Paved parking, HSG A
36,660	32	Woods/grass comb., Good, HSG A
47,416	98	Water Surface, HSG A
91,711	72	Weighted Average
36,660		39.97% Pervious Area
55,051		60.03% Impervious Area

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

Subcatchment PR-2: StormwaterBasin



Summary for Subcatchment PR-3: Parking Lot Area

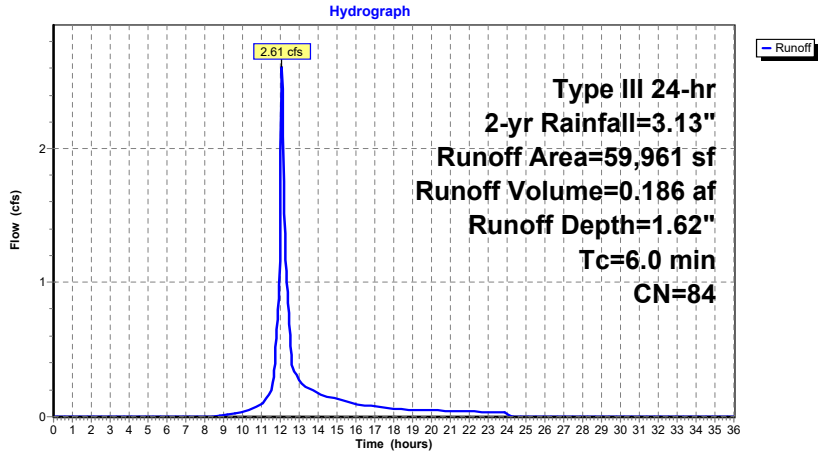
Runoff = 2.61 cfs @ 12.09 hrs, Volume= 0.186 af, Depth= 1.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
47,239	98	Paved parking, HSG A
12,722	32	Woods/grass comb., Good, HSG A
59,961	84	Weighted Average
12,722		21.22% Pervious Area
47,239		78.78% Impervious Area

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

Subcatchment PR-3: Parking Lot Area



Summary for Subcatchment PR-4: Southwest Portion

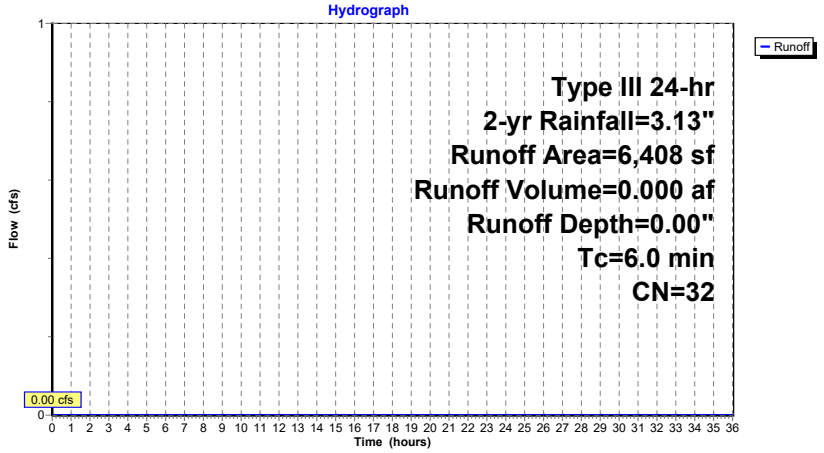
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

Area (sf)	CN	Description
6,408	32	Woods/grass comb., Good, HSG A
6,408		100.00% Pervious Area

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

Subcatchment PR-4: Southwest Portion



Summary for Subcatchment PR-5: 300 Concord Parking Lot (offsite)

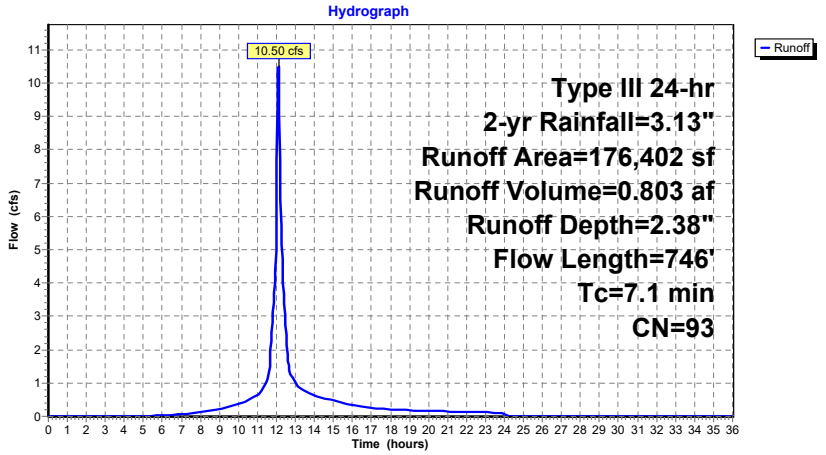
Runoff = 10.50 cfs @ 12.10 hrs, Volume= 0.803 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 2-yr Rainfall=3.13"

	Area (sf)	CN	Description
	11,835	61	>75% Grass cover, Good, HSG B
*	158,372	98	Paved parking
	6,195	39	>75% Grass cover, Good, HSG A
	176,402	93	Weighted Average
	18,030		10.22% Pervious Area
	158,372		89.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment PR-5: 300 Concord Parking Lot (offsite)



Summary for Pond P1P: Existing Pond and SIS-1

Inflow Area = 6.155 ac, 79.60% Impervious, Inflow Depth = 1.87" for 2-yr event
Inflow = 12.50 cfs @ 12.10 hrs, Volume= 0.958 af
Outflow = 3.76 cfs @ 12.45 hrs, Volume= 0.958 af, Atten= 70%, Lag= 21.1 min
Discarded = 0.57 cfs @ 12.45 hrs, Volume= 0.136 af
Primary = 3.19 cfs @ 12.45 hrs, Volume= 0.822 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 182.91' @ 12.45 hrs Surf.Area= 10,260 sf Storage= 9,259 cf

Plug-Flow detention time= 16.2 min calculated for 0.957 af (100% of inflow)
Center-of-Mass det. time= 16.2 min (823.0 - 806.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	182.60'	0 cf	**72.67'W x 136.48'L x 3.50'H Field A**-Impervious 34,711 cf Overall - 34,711 cf Embedded = 0 cf x 40.0% Voids
#2A	182.60'	26,599 cf	**StormTrap ST2 SingleTrap 3-0** x 56 Inside #1 Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf 7 Rows of 8 Chambers 59.35' x 123.17' Core + 6.66' Border = 72.67' x 136.48' System
#3	182.00'	84,892 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
		111,490 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,063	0	0
183.00	10,876	7,470	7,470
184.00	17,200	14,038	21,508
185.00	22,041	19,621	41,128
186.00	26,743	24,392	65,520
186.20	4,802	3,154	68,674
187.00	9,192	5,598	74,272
188.00	12,047	10,620	84,892

Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.57 cfs @ 12.45 hrs HW=182.91' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 0.57 cfs)

Primary OutFlow Max=3.19 cfs @ 12.45 hrs HW=182.91' (Free Discharge)
↑└**3=Culvert** (Passes 3.19 cfs of 9.50 cfs potential flow)
↑└**4=Orifice/Grate** (Orifice Controls 0.89 cfs @ 2.66 fps)
└**5=Orifice/Grate** (Orifice Controls 2.30 cfs @ 6.60 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
↑└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1P: Existing Pond and SIS-1 - Chamber Wizard Field A

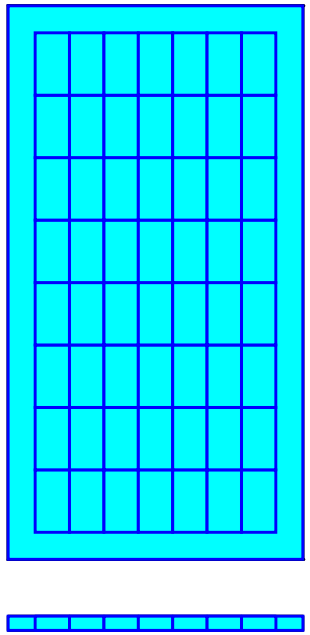
Chamber Model = StormTrap ST2 SingleTrap 3-0 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf
Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
42.0" Chamber Height = 3.50' Field Height

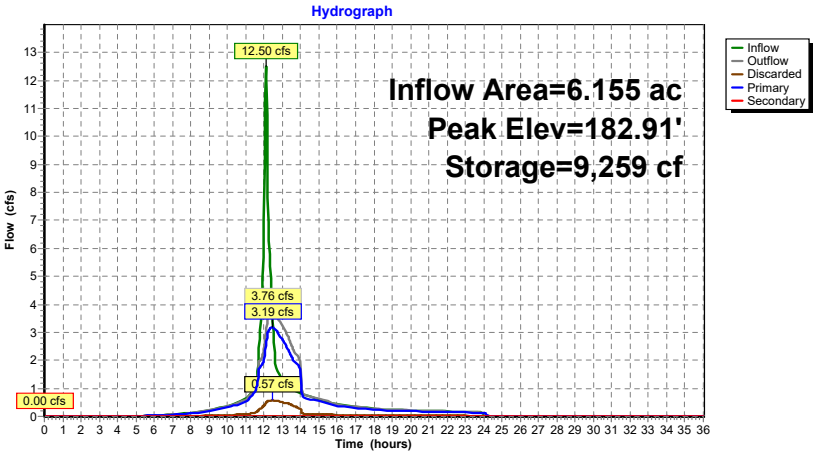
56 Chambers x 354.0 cf + 6,775.3 cf Border = 26,598.9 cf Chamber Storage
56 Chambers x 456.9 cf + 9,124.6 cf Border = 34,711.2 cf Displacement

Chamber Storage = 26,598.9 cf = 0.611 af
Overall Storage Efficiency = 76.6%
Overall System Size = 136.48' x 72.67' x 3.50'

56 Chambers (plus border)
1,285.6 cy Field



Pond P1P: Existing Pond and SIS-1



Summary for Pond P2P: SIS 2

Inflow Area = 4.169 ac, 92.99% Impervious, Inflow Depth = 2.48" for 2-yr event
Inflow = 11.03 cfs @ 12.09 hrs, Volume= 0.861 af
Outflow = 0.80 cfs @ 11.43 hrs, Volume= 0.861 af, Atten= 93%, Lag= 0.0 min
Discarded = 0.80 cfs @ 11.43 hrs, Volume= 0.861 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 181.93' @ 13.37 hrs Surf.Area= 14,393 sf Storage= 15,252 cf

Plug-Flow detention time= 157.2 min calculated for 0.861 af (100% of inflow)
Center-of-Mass det. time= 157.0 min (929.8 - 772.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	181.10'	0 cf	**72.67'W x 198.06'L x 3.00'H Field A** 43,178 cf Overall - 43,178 cf Embedded = 0 cf x 40.0% Voids
#2A	181.10'	31,676 cf	**StormTrap ST2 SingleTrap 2-6** x 84 Inside #1 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 7 Rows of 12 Chambers 59.35' x 184.75' Core + 6.66' Border = 72.67' x 198.06' System
#3B	181.10'	0 cf	**47.23'W x 136.48'L x 3.00'H Field B**-Impervious 19,337 cf Overall - 19,337 cf Embedded = 0 cf x 40.0% Voids
#4B	181.10'	14,128 cf	**StormTrap ST2 SingleTrap 2-6** x 32 Inside #3 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 4 Rows of 8 Chambers 33.92' x 123.17' Core + 6.66' Border = 47.23' x 136.48' System
#5	183.00'	136 cf	**4.00'D x 2.70'H Catch Basins** x 4 -Impervious
		45,940 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	181.10'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	181.60'	**24.0" Round Culvert** L= 100.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 181.60' / 180.00' S= 0.0160 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf
#3	Device 2	183.20'	**4.0' long x 0.5' breadth Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 2	182.50'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 2	181.97'	**4.0" Vert. Orifice/Grate X 6.00** C= 0.600

Discarded OutFlow Max=0.80 cfs @ 11.43 hrs HW=181.15' (Free Discharge)
↑└─**1=Exfiltration** (Exfiltration Controls 0.80 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=181.10' (Free Discharge)
↑└─**2=Culvert** (Controls 0.00 cfs)
↑ ├─**3=Weir** (Controls 0.00 cfs)
 ├─**4=Orifice/Grate** (Controls 0.00 cfs)
 └─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond P2P: SIS 2 - Chamber Wizard Field A

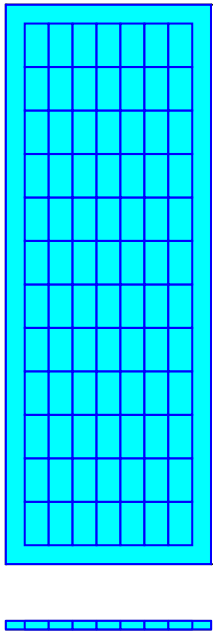
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

12 Chambers/Row x 15.40' Long = 184.75' Row Length +79.9" Border x 2 = 198.06' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
36.0" Chamber Height = 3.00' Field Height

84 Chambers x 289.8 cf + 7,332.3 cf Border = 31,676.4 cf Chamber Storage
84 Chambers x 391.6 cf + 10,280.6 cf Border = 43,177.6 cf Displacement

Chamber Storage = 31,676.4 cf = 0.727 af
Overall Storage Efficiency = 73.4%
Overall System Size = 198.06' x 72.67' x 3.00'

84 Chambers (plus border)
1,599.2 cy Field



Pond P2P: SIS 2 - Chamber Wizard Field B

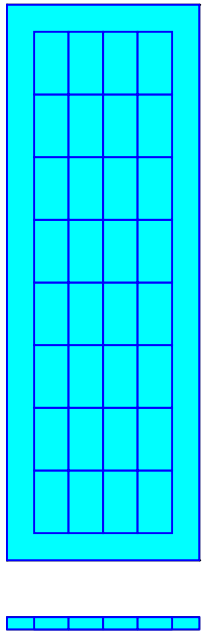
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
4 Rows x 101.7" Wide + 79.9" Side Border x 2 = 47.23' Base Width
36.0" Chamber Height = 3.00' Field Height

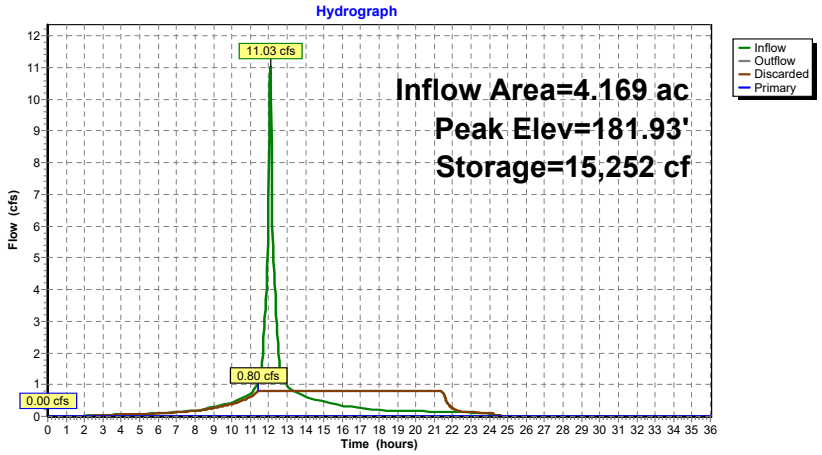
32 Chambers x 289.8 cf + 4,853.6 cf Border = 14,127.5 cf Chamber Storage
32 Chambers x 391.6 cf + 6,805.2 cf Border = 19,337.4 cf Displacement

Chamber Storage = 14,127.5 cf = 0.324 af
Overall Storage Efficiency = 73.1%
Overall System Size = 136.48' x 47.23' x 3.00'

32 Chambers (plus border)
716.2 cy Field



Pond P2P: SIS 2

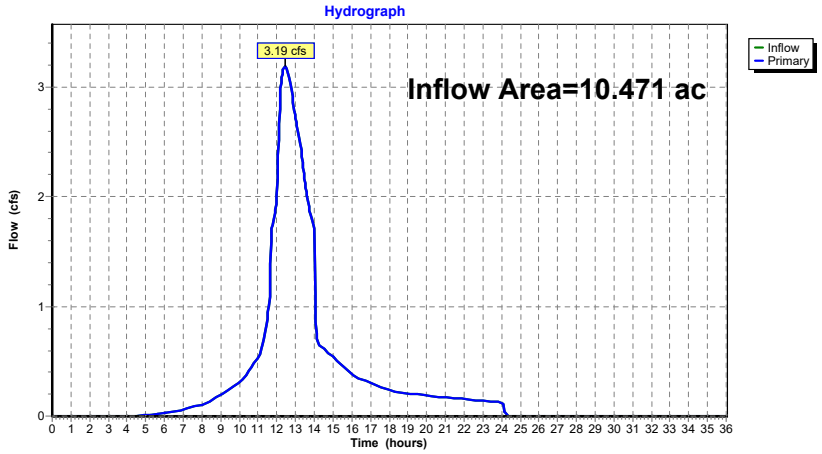


Summary for Link DP1: Wetlands

Inflow Area = 10.471 ac, 83.82% Impervious, Inflow Depth = 0.94" for 2-yr event
Inflow = 3.19 cfs @ 12.45 hrs, Volume= 0.822 af
Primary = 3.19 cfs @ 12.45 hrs, Volume= 0.822 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



Summary for Subcatchment PR-1: ProposedBuilding

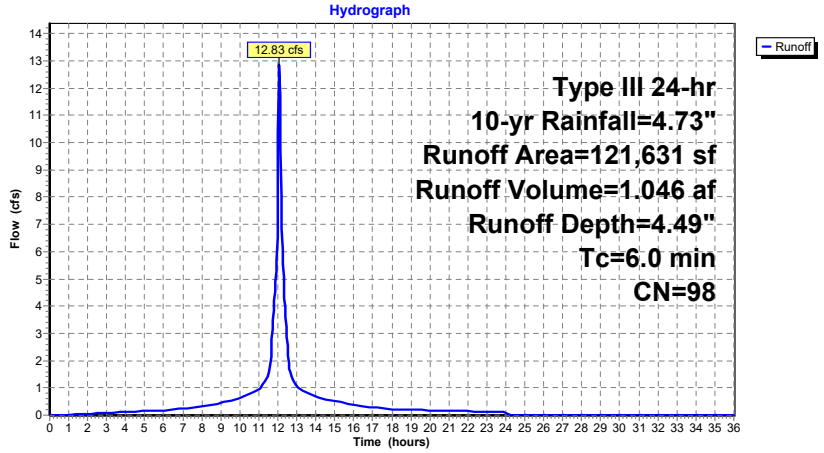
Runoff = 12.83 cfs @ 12.08 hrs, Volume= 1.046 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
121,631	98	Roofs, HSG A
121,631		100.00% Impervious Area

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

Subcatchment PR-1: ProposedBuilding



Summary for Subcatchment PR-2: StormwaterBasin

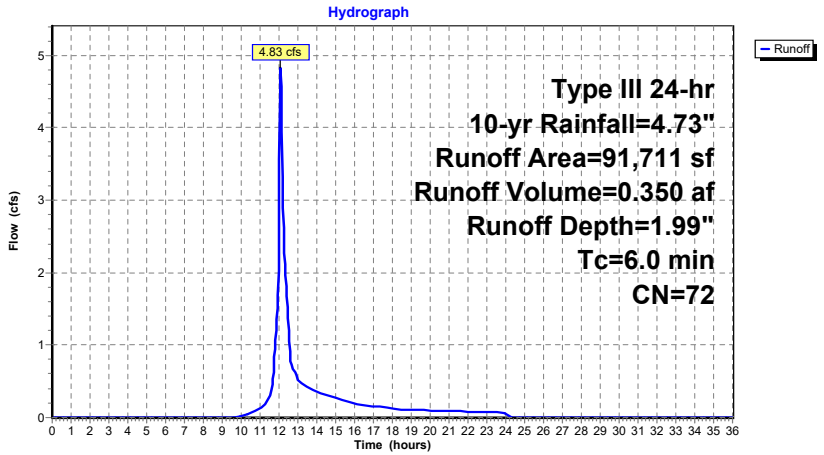
Runoff = 4.83 cfs @ 12.09 hrs, Volume= 0.350 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
7,635	98	Paved parking, HSG A
36,660	32	Woods/grass comb., Good, HSG A
47,416	98	Water Surface, HSG A
91,711	72	Weighted Average
36,660		39.97% Pervious Area
55,051		60.03% Impervious Area

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

Subcatchment PR-2: StormwaterBasin



Summary for Subcatchment PR-3: Parking Lot Area

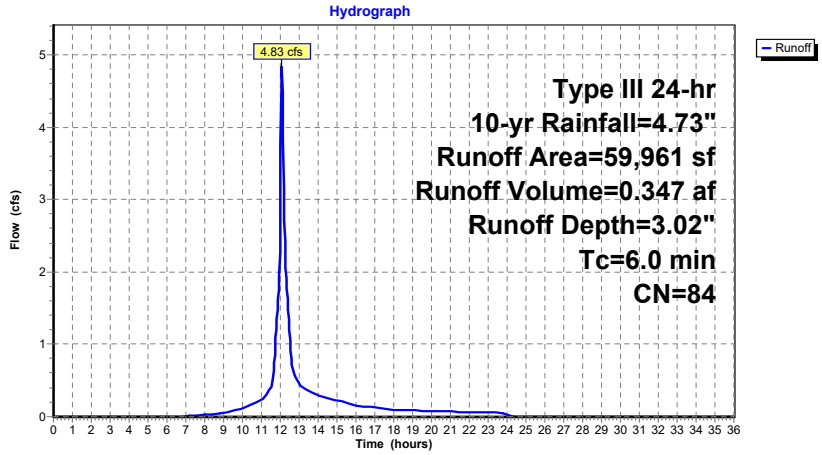
Runoff = 4.83 cfs @ 12.09 hrs, Volume= 0.347 af, Depth= 3.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
47,239	98	Paved parking, HSG A
12,722	32	Woods/grass comb., Good, HSG A
59,961	84	Weighted Average
12,722		21.22% Pervious Area
47,239		78.78% Impervious Area

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

Subcatchment PR-3: Parking Lot Area



Summary for Subcatchment PR-4: Southwest Portion

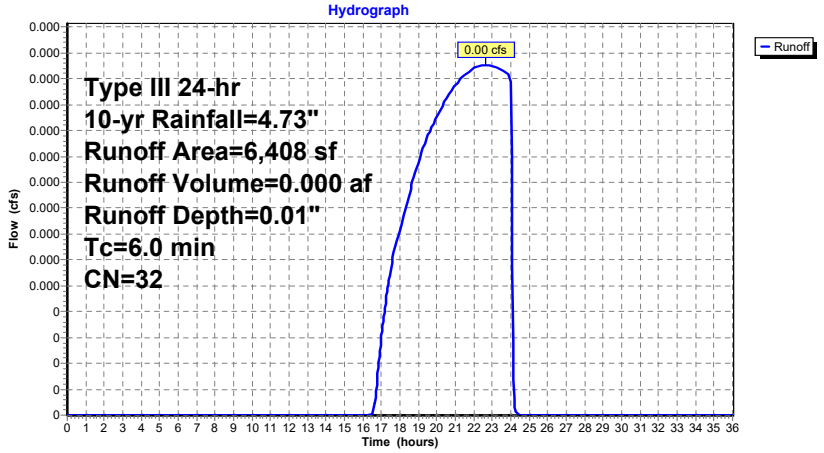
Runoff = 0.00 cfs @ 22.63 hrs, Volume= 0.000 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

Area (sf)	CN	Description
6,408	32	Woods/grass comb., Good, HSG A
6,408		100.00% Pervious Area

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

Subcatchment PR-4: Southwest Portion



Summary for Subcatchment PR-5: 300 Concord Parking Lot (offsite)

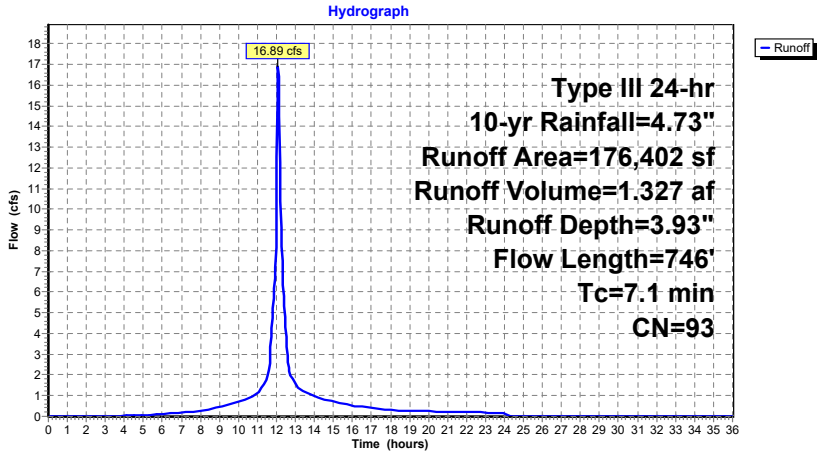
Runoff = 16.89 cfs @ 12.10 hrs, Volume= 1.327 af, Depth= 3.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 10-yr Rainfall=4.73"

	Area (sf)	CN	Description
	11,835	61	>75% Grass cover, Good, HSG B
*	158,372	98	Paved parking
	6,195	39	>75% Grass cover, Good, HSG A
	176,402	93	Weighted Average
	18,030		10.22% Pervious Area
	158,372		89.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment PR-5: 300 Concord Parking Lot (offsite)



Summary for Pond P1P: Existing Pond and SIS-1

Inflow Area = 6.155 ac, 79.60% Impervious, Inflow Depth = 3.27" for 10-yr event
Inflow = 21.71 cfs @ 12.10 hrs, Volume= 1.677 af
Outflow = 4.88 cfs @ 12.52 hrs, Volume= 1.677 af, Atten= 78%, Lag= 25.2 min
Discarded = 0.76 cfs @ 12.52 hrs, Volume= 0.243 af
Primary = 4.12 cfs @ 12.52 hrs, Volume= 1.434 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 183.44' @ 12.52 hrs Surf.Area= 13,673 sf Storage= 20,367 cf

Plug-Flow detention time= 29.9 min calculated for 1.675 af (100% of inflow)
Center-of-Mass det. time= 29.9 min (824.3 - 794.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	182.60'	0 cf	**72.67'W x 136.48'L x 3.50'H Field A**-Impervious 34,711 cf Overall - 34,711 cf Embedded = 0 cf x 40.0% Voids
#2A	182.60'	26,599 cf	**StormTrap ST2 SingleTrap 3-0** x 56 Inside #1 Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf 7 Rows of 8 Chambers 59.35' x 123.17' Core + 6.66' Border = 72.67' x 136.48' System
#3	182.00'	84,892 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
		111,490 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,063	0	0
183.00	10,876	7,470	7,470
184.00	17,200	14,038	21,508
185.00	22,041	19,621	41,128
186.00	26,743	24,392	65,520
186.20	4,802	3,154	68,674
187.00	9,192	5,598	74,272
188.00	12,047	10,620	84,892

Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.76 cfs @ 12.52 hrs HW=183.44' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 0.76 cfs)

Primary OutFlow Max=4.12 cfs @ 12.52 hrs HW=183.44' (Free Discharge)
↑└**3=Culvert** (Passes 4.12 cfs of 10.43 cfs potential flow)
↑└**4=Orifice/Grate** (Orifice Controls 1.51 cfs @ 4.33 fps)
└**5=Orifice/Grate** (Orifice Controls 2.61 cfs @ 7.47 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
↑└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1P: Existing Pond and SIS-1 - Chamber Wizard Field A

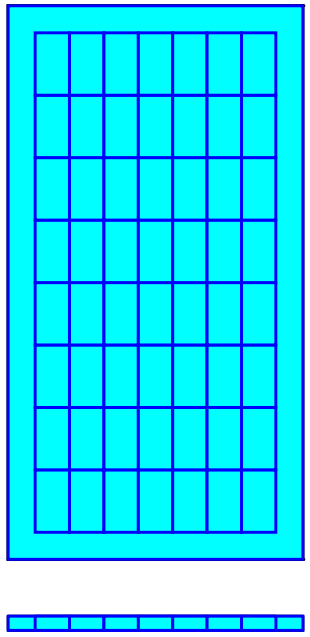
Chamber Model = StormTrap ST2 SingleTrap 3-0 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf
Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
42.0" Chamber Height = 3.50' Field Height

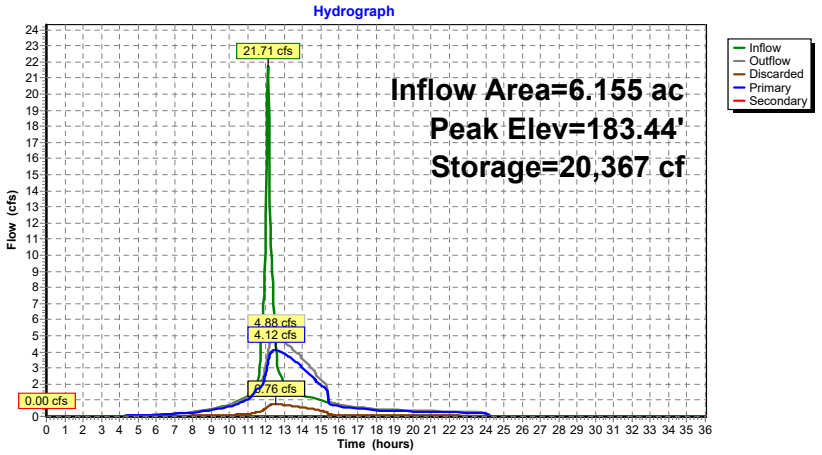
56 Chambers x 354.0 cf + 6,775.3 cf Border = 26,598.9 cf Chamber Storage
56 Chambers x 456.9 cf + 9,124.6 cf Border = 34,711.2 cf Displacement

Chamber Storage = 26,598.9 cf = 0.611 af
Overall Storage Efficiency = 76.6%
Overall System Size = 136.48' x 72.67' x 3.50'

56 Chambers (plus border)
1,285.6 cy Field



Pond P1P: Existing Pond and SIS-1



Summary for Pond P2P: SIS 2

Inflow Area = 4.169 ac, 92.99% Impervious, Inflow Depth = 4.01" for 10-yr event
Inflow = 17.66 cfs @ 12.09 hrs, Volume= 1.393 af
Outflow = 2.20 cfs @ 12.65 hrs, Volume= 1.393 af, Atten= 88%, Lag= 34.1 min
Discarded = 0.80 cfs @ 10.47 hrs, Volume= 1.132 af
Primary = 1.39 cfs @ 12.65 hrs, Volume= 0.261 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 182.44' @ 12.65 hrs Surf.Area= 14,393 sf Storage= 24,593 cf

Plug-Flow detention time= 173.7 min calculated for 1.391 af (100% of inflow)
Center-of-Mass det. time= 173.7 min (938.5 - 764.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	181.10'	0 cf	**72.67'W x 198.06'L x 3.00'H Field A** 43,178 cf Overall - 43,178 cf Embedded = 0 cf x 40.0% Voids
#2A	181.10'	31,676 cf	**StormTrap ST2 SingleTrap 2-6** x 84 Inside #1 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 7 Rows of 12 Chambers 59.35' x 184.75' Core + 6.66' Border = 72.67' x 198.06' System
#3B	181.10'	0 cf	**47.23'W x 136.48'L x 3.00'H Field B**-Impervious 19,337 cf Overall - 19,337 cf Embedded = 0 cf x 40.0% Voids
#4B	181.10'	14,128 cf	**StormTrap ST2 SingleTrap 2-6** x 32 Inside #3 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 4 Rows of 8 Chambers 33.92' x 123.17' Core + 6.66' Border = 47.23' x 136.48' System
#5	183.00'	136 cf	**4.00'D x 2.70'H Catch Basins** x 4 -Impervious
		45,940 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	181.10'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	181.60'	**24.0" Round Culvert** L= 100.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 181.60' / 180.00' S= 0.0160 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf
#3	Device 2	183.20'	**4.0' long x 0.5' breadth Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 2	182.50'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 2	181.97'	**4.0" Vert. Orifice/Grate X 6.00** C= 0.600

Discarded OutFlow Max=0.80 cfs @ 10.47 hrs HW=181.15' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 0.80 cfs)

Primary OutFlow Max=1.39 cfs @ 12.65 hrs HW=182.44' (Free Discharge)
↑└**2=Culvert** (Passes 1.39 cfs of 3.93 cfs potential flow)
↑ ├**3=Weir** (Controls 0.00 cfs)
 ├**4=Orifice/Grate** (Controls 0.00 cfs)
 └**5=Orifice/Grate** (Orifice Controls 1.39 cfs @ 2.66 fps)

Pond P2P: SIS 2 - Chamber Wizard Field A

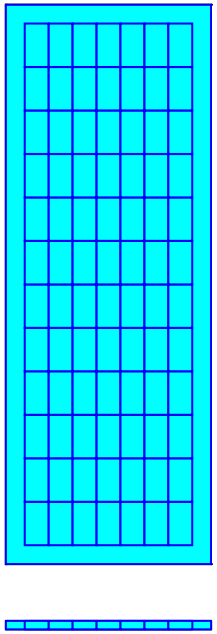
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

12 Chambers/Row x 15.40' Long = 184.75' Row Length +79.9" Border x 2 = 198.06' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
36.0" Chamber Height = 3.00' Field Height

84 Chambers x 289.8 cf + 7,332.3 cf Border = 31,676.4 cf Chamber Storage
84 Chambers x 391.6 cf + 10,280.6 cf Border = 43,177.6 cf Displacement

Chamber Storage = 31,676.4 cf = 0.727 af
Overall Storage Efficiency = 73.4%
Overall System Size = 198.06' x 72.67' x 3.00'

84 Chambers (plus border)
1,599.2 cy Field



Pond P2P: SIS 2 - Chamber Wizard Field B

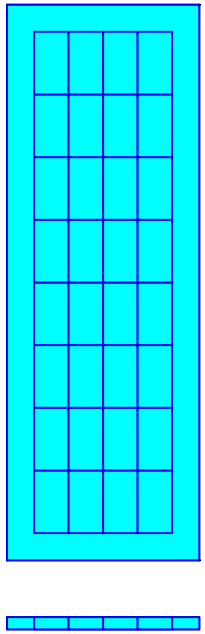
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
4 Rows x 101.7" Wide + 79.9" Side Border x 2 = 47.23' Base Width
36.0" Chamber Height = 3.00' Field Height

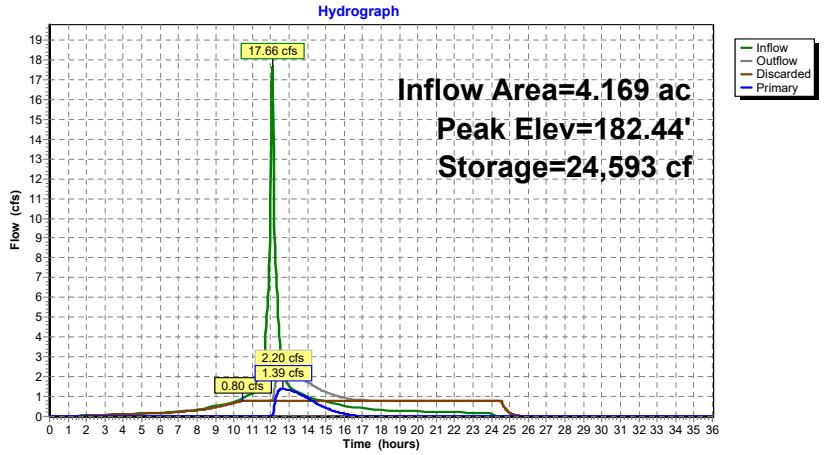
32 Chambers x 289.8 cf + 4,853.6 cf Border = 14,127.5 cf Chamber Storage
32 Chambers x 391.6 cf + 6,805.2 cf Border = 19,337.4 cf Displacement

Chamber Storage = 14,127.5 cf = 0.324 af
Overall Storage Efficiency = 73.1%
Overall System Size = 136.48' x 47.23' x 3.00'

32 Chambers (plus border)
716.2 cy Field



Pond P2P: SIS 2

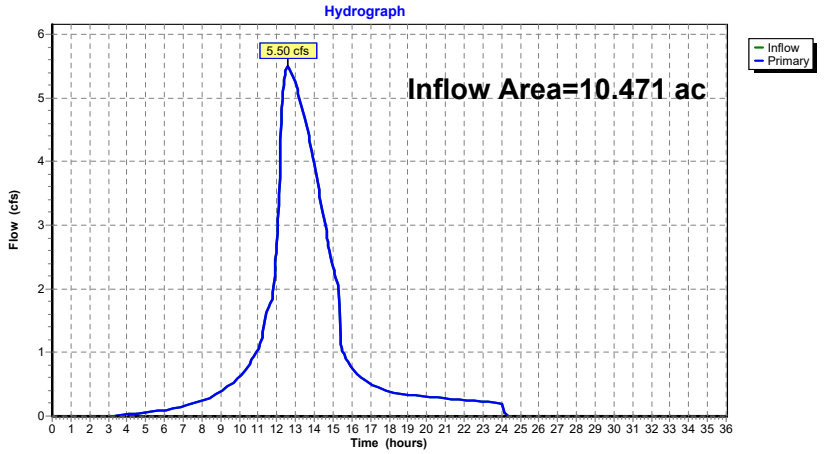


Summary for Link DP1: Wetlands

Inflow Area = 10.471 ac, 83.82% Impervious, Inflow Depth = 1.94" for 10-yr event
Inflow = 5.50 cfs @ 12.57 hrs, Volume= 1.694 af
Primary = 5.50 cfs @ 12.57 hrs, Volume= 1.694 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



Summary for Subcatchment PR-1: ProposedBuilding

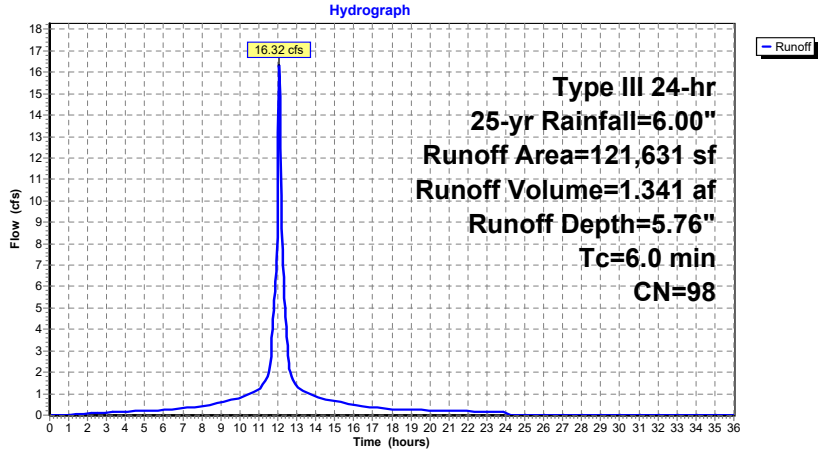
Runoff = 16.32 cfs @ 12.08 hrs, Volume= 1.341 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
121,631	98	Roofs, HSG A
121,631		100.00% Impervious Area

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

Subcatchment PR-1: ProposedBuilding



Summary for Subcatchment PR-2: StormwaterBasin

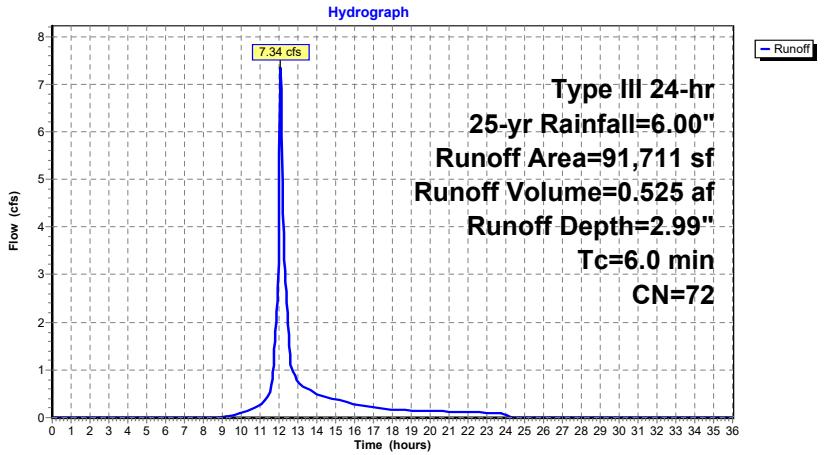
Runoff = 7.34 cfs @ 12.09 hrs, Volume= 0.525 af, Depth= 2.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
7,635	98	Paved parking, HSG A
36,660	32	Woods/grass comb., Good, HSG A
47,416	98	Water Surface, HSG A
91,711	72	Weighted Average
36,660		39.97% Pervious Area
55,051		60.03% Impervious Area

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

Subcatchment PR-2: StormwaterBasin



Summary for Subcatchment PR-3: Parking Lot Area

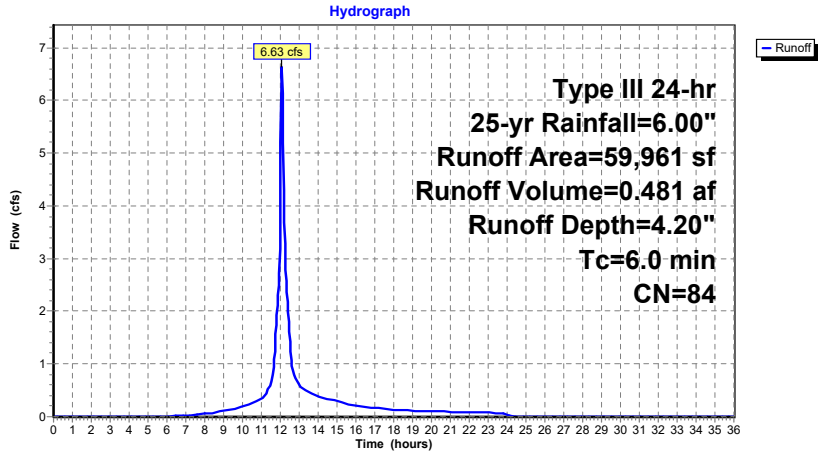
Runoff = 6.63 cfs @ 12.09 hrs, Volume= 0.481 af, Depth= 4.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
47,239	98	Paved parking, HSG A
12,722	32	Woods/grass comb., Good, HSG A
59,961	84	Weighted Average
12,722		21.22% Pervious Area
47,239		78.78% Impervious Area

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

Subcatchment PR-3: Parking Lot Area



Summary for Subcatchment PR-4: Southwest Portion

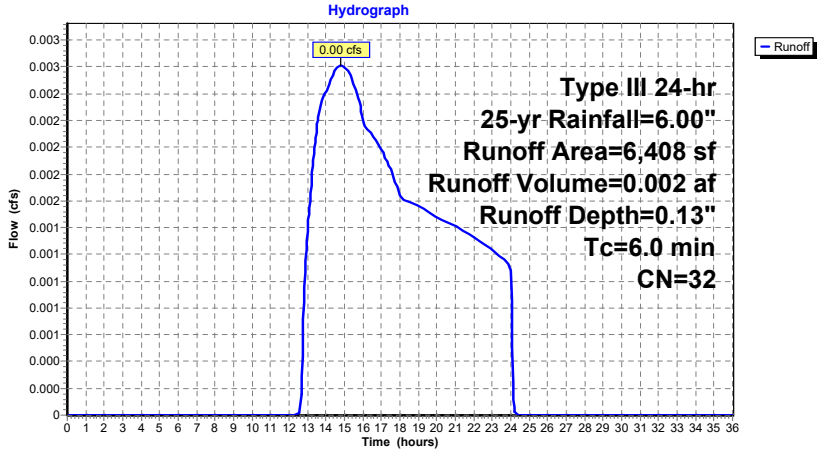
Runoff = 0.00 cfs @ 14.82 hrs, Volume= 0.002 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

Area (sf)	CN	Description
6,408	32	Woods/grass comb., Good, HSG A
6,408		100.00% Pervious Area

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

Subcatchment PR-4: Southwest Portion



Summary for Subcatchment PR-5: 300 Concord Parking Lot (offsite)

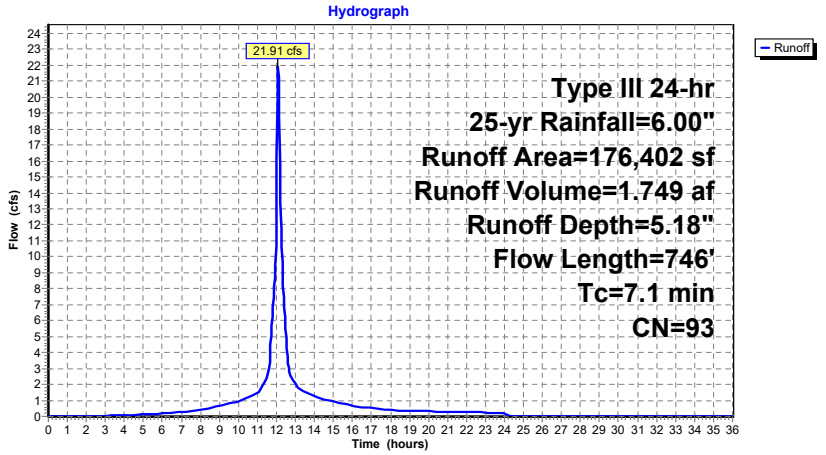
Runoff = 21.91 cfs @ 12.10 hrs, Volume= 1.749 af, Depth= 5.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 25-yr Rainfall=6.00"

	Area (sf)	CN	Description
	11,835	61	>75% Grass cover, Good, HSG B
*	158,372	98	Paved parking
	6,195	39	>75% Grass cover, Good, HSG A
	176,402	93	Weighted Average
	18,030		10.22% Pervious Area
	158,372		89.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment PR-5: 300 Concord Parking Lot (offsite)



Summary for Pond P1P: Existing Pond and SIS-1

Inflow Area = 6.155 ac, 79.60% Impervious, Inflow Depth = 4.43" for 25-yr event
Inflow = 29.24 cfs @ 12.10 hrs, Volume= 2.274 af
Outflow = 5.61 cfs @ 12.55 hrs, Volume= 2.274 af, Atten= 81%, Lag= 27.2 min
Discarded = 0.91 cfs @ 12.55 hrs, Volume= 0.336 af
Primary = 4.70 cfs @ 12.55 hrs, Volume= 1.938 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 183.87' @ 12.55 hrs Surf.Area= 16,357 sf Storage= 30,501 cf

Plug-Flow detention time= 41.3 min calculated for 2.272 af (100% of inflow)
Center-of-Mass det. time= 41.3 min (829.0 - 787.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	182.60'	0 cf	**72.67'W x 136.48'L x 3.50'H Field A**-Impervious 34,711 cf Overall - 34,711 cf Embedded = 0 cf x 40.0% Voids
#2A	182.60'	26,599 cf	**StormTrap ST2 SingleTrap 3-0** x 56 Inside #1 Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf 7 Rows of 8 Chambers 59.35' x 123.17' Core + 6.66' Border = 72.67' x 136.48' System
#3	182.00'	84,892 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
		111,490 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,063	0	0
183.00	10,876	7,470	7,470
184.00	17,200	14,038	21,508
185.00	22,041	19,621	41,128
186.00	26,743	24,392	65,520
186.20	4,802	3,154	68,674
187.00	9,192	5,598	74,272
188.00	12,047	10,620	84,892

Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.91 cfs @ 12.55 hrs HW=183.87' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 0.91 cfs)

Primary OutFlow Max=4.70 cfs @ 12.55 hrs HW=183.87' (Free Discharge)
↑└**3=Culvert** (Passes 4.70 cfs of 11.12 cfs potential flow)
↑└**4=Orifice/Grate** (Orifice Controls 1.87 cfs @ 5.35 fps)
└**5=Orifice/Grate** (Orifice Controls 2.83 cfs @ 8.10 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
↑└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1P: Existing Pond and SIS-1 - Chamber Wizard Field A

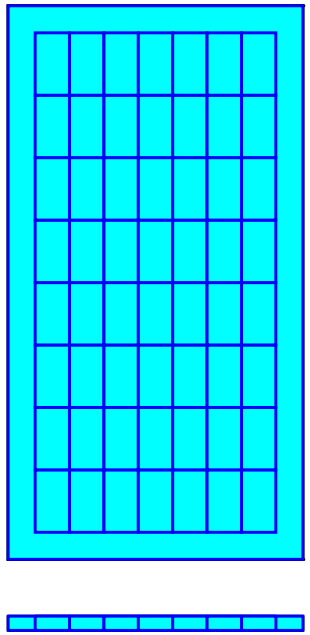
Chamber Model = StormTrap ST2 SingleTrap 3-0 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf
Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
42.0" Chamber Height = 3.50' Field Height

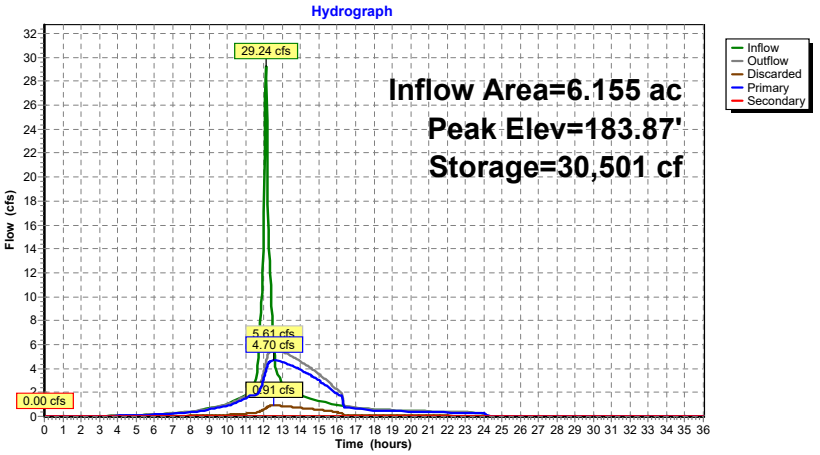
56 Chambers x 354.0 cf + 6,775.3 cf Border = 26,598.9 cf Chamber Storage
56 Chambers x 456.9 cf + 9,124.6 cf Border = 34,711.2 cf Displacement

Chamber Storage = 26,598.9 cf = 0.611 af
Overall Storage Efficiency = 76.6%
Overall System Size = 136.48' x 72.67' x 3.50'

56 Chambers (plus border)
1,285.6 cy Field



Pond P1P: Existing Pond and SIS-1



Summary for Pond P2P: SIS 2

Inflow Area = 4.169 ac, 92.99% Impervious, Inflow Depth = 5.24" for 25-yr event
Inflow = 22.95 cfs @ 12.09 hrs, Volume= 1.822 af
Outflow = 4.10 cfs @ 12.54 hrs, Volume= 1.822 af, Atten= 82%, Lag= 27.2 min
Discarded = 0.80 cfs @ 9.69 hrs, Volume= 1.262 af
Primary = 3.30 cfs @ 12.54 hrs, Volume= 0.560 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 182.85' @ 12.54 hrs Surf.Area= 14,393 sf Storage= 32,017 cf

Plug-Flow detention time= 165.3 min calculated for 1.821 af (100% of inflow)
Center-of-Mass det. time= 165.2 min (925.8 - 760.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	181.10'	0 cf	**72.67'W x 198.06'L x 3.00'H Field A** 43,178 cf Overall - 43,178 cf Embedded = 0 cf x 40.0% Voids
#2A	181.10'	31,676 cf	**StormTrap ST2 SingleTrap 2-6** x 84 Inside #1 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 7 Rows of 12 Chambers 59.35' x 184.75' Core + 6.66' Border = 72.67' x 198.06' System
#3B	181.10'	0 cf	**47.23'W x 136.48'L x 3.00'H Field B**-Impervious 19,337 cf Overall - 19,337 cf Embedded = 0 cf x 40.0% Voids
#4B	181.10'	14,128 cf	**StormTrap ST2 SingleTrap 2-6** x 32 Inside #3 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 4 Rows of 8 Chambers 33.92' x 123.17' Core + 6.66' Border = 47.23' x 136.48' System
#5	183.00'	136 cf	**4.00'D x 2.70'H Catch Basins** x 4 -Impervious
		45,940 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	181.10'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	181.60'	**24.0" Round Culvert** L= 100.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 181.60' / 180.00' S= 0.0160 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf
#3	Device 2	183.20'	**4.0' long x 0.5' breadth Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 2	182.50'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 2	181.97'	**4.0" Vert. Orifice/Grate X 6.00** C= 0.600

Discarded OutFlow Max=0.80 cfs @ 9.69 hrs HW=181.15' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 0.80 cfs)

Primary OutFlow Max=3.29 cfs @ 12.54 hrs HW=182.85' (Free Discharge)
↑└**2=Culvert** (Passes 3.29 cfs of 7.84 cfs potential flow)
↑ ├**3=Weir** (Controls 0.00 cfs)
 ├**4=Orifice/Grate** (Orifice Controls 1.17 cfs @ 2.01 fps)
 └**5=Orifice/Grate** (Orifice Controls 2.13 cfs @ 4.06 fps)

Pond P2P: SIS 2 - Chamber Wizard Field A

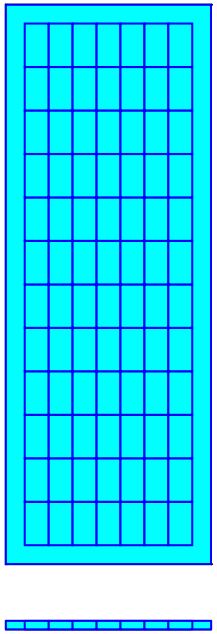
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

12 Chambers/Row x 15.40' Long = 184.75' Row Length +79.9" Border x 2 = 198.06' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
36.0" Chamber Height = 3.00' Field Height

84 Chambers x 289.8 cf + 7,332.3 cf Border = 31,676.4 cf Chamber Storage
84 Chambers x 391.6 cf + 10,280.6 cf Border = 43,177.6 cf Displacement

Chamber Storage = 31,676.4 cf = 0.727 af
Overall Storage Efficiency = 73.4%
Overall System Size = 198.06' x 72.67' x 3.00'

84 Chambers (plus border)
1,599.2 cy Field



Pond P2P: SIS 2 - Chamber Wizard Field B

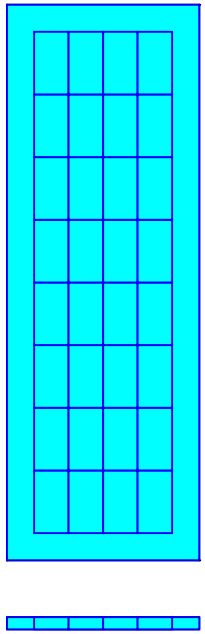
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
4 Rows x 101.7" Wide + 79.9" Side Border x 2 = 47.23' Base Width
36.0" Chamber Height = 3.00' Field Height

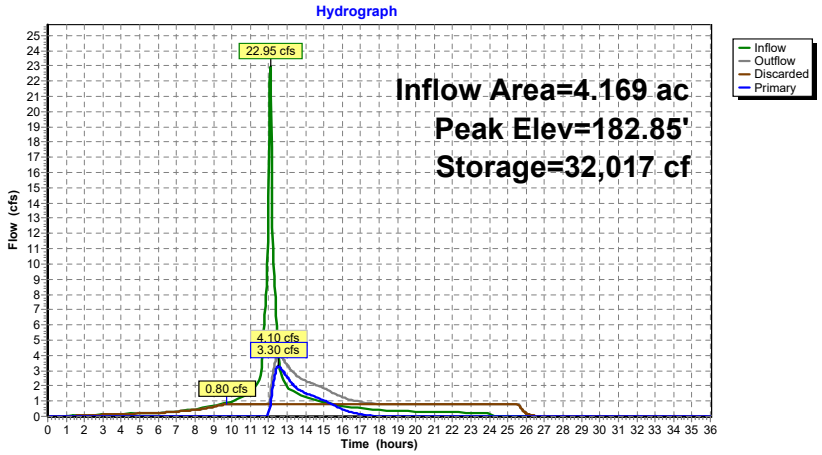
32 Chambers x 289.8 cf + 4,853.6 cf Border = 14,127.5 cf Chamber Storage
32 Chambers x 391.6 cf + 6,805.2 cf Border = 19,337.4 cf Displacement

Chamber Storage = 14,127.5 cf = 0.324 af
Overall Storage Efficiency = 73.1%
Overall System Size = 136.48' x 47.23' x 3.00'

32 Chambers (plus border)
716.2 cy Field



Pond P2P: SIS 2

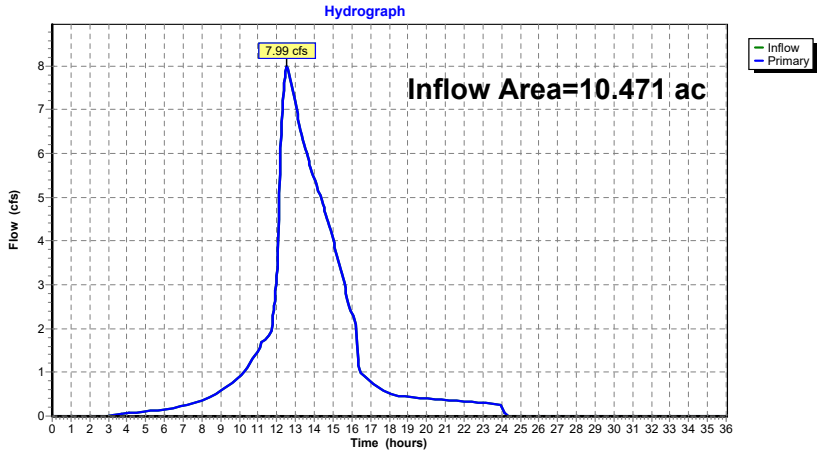


Summary for Link DP1: Wetlands

Inflow Area = 10.471 ac, 83.82% Impervious, Inflow Depth = 2.86" for 25-yr event
Inflow = 7.99 cfs @ 12.54 hrs, Volume= 2.499 af
Primary = 7.99 cfs @ 12.54 hrs, Volume= 2.499 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



Summary for Subcatchment PR-1: ProposedBuilding

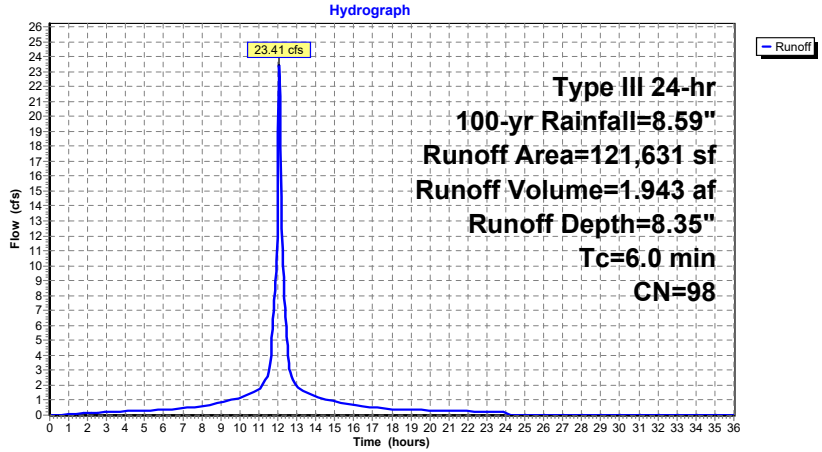
Runoff = 23.41 cfs @ 12.08 hrs, Volume= 1.943 af, Depth= 8.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
121,631	98	Roofs, HSG A
121,631		100.00% Impervious Area

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

Subcatchment PR-1: ProposedBuilding



Summary for Subcatchment PR-2: StormwaterBasin

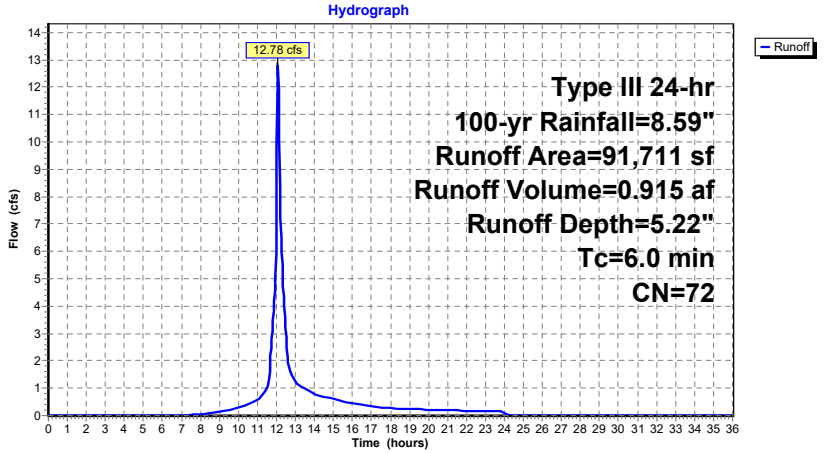
Runoff = 12.78 cfs @ 12.09 hrs, Volume= 0.915 af, Depth= 5.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
7,635	98	Paved parking, HSG A
36,660	32	Woods/grass comb., Good, HSG A
47,416	98	Water Surface, HSG A
91,711	72	Weighted Average
36,660		39.97% Pervious Area
55,051		60.03% Impervious Area

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

Subcatchment PR-2: StormwaterBasin



Summary for Subcatchment PR-3: Parking Lot Area

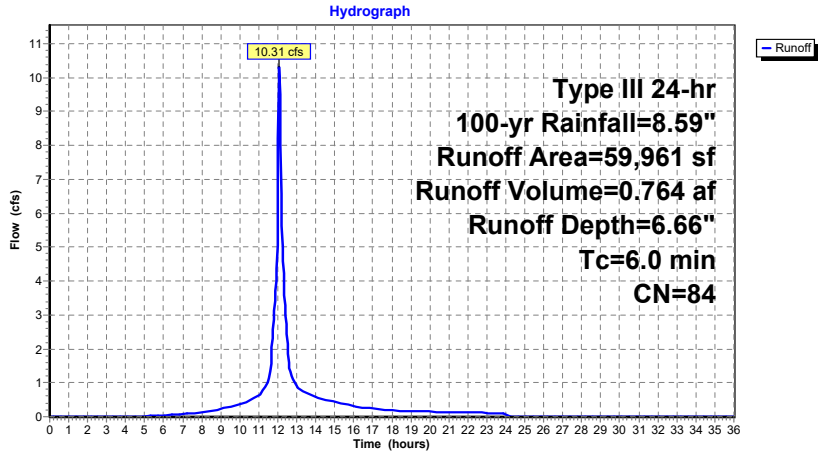
Runoff = 10.31 cfs @ 12.09 hrs, Volume= 0.764 af, Depth= 6.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
47,239	98	Paved parking, HSG A
12,722	32	Woods/grass comb., Good, HSG A
59,961	84	Weighted Average
12,722		21.22% Pervious Area
47,239		78.78% Impervious Area

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

Subcatchment PR-3: Parking Lot Area



Summary for Subcatchment PR-4: Southwest Portion

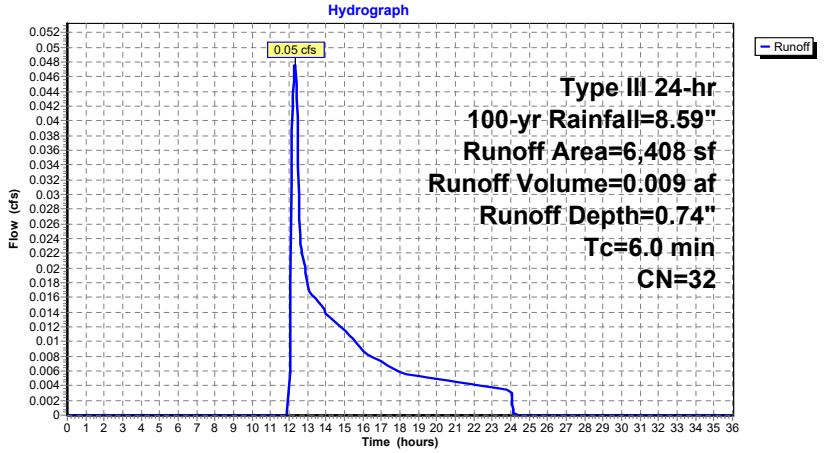
Runoff = 0.05 cfs @ 12.31 hrs, Volume= 0.009 af, Depth= 0.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

Area (sf)	CN	Description
6,408	32	Woods/grass comb., Good, HSG A
6,408		100.00% Pervious Area

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

Subcatchment PR-4: Southwest Portion



Summary for Subcatchment PR-5: 300 Concord Parking Lot (offsite)

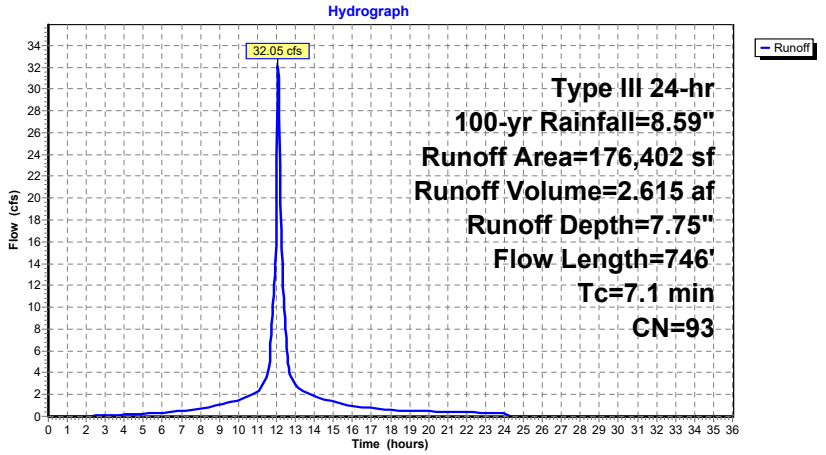
Runoff = 32.05 cfs @ 12.10 hrs, Volume= 2.615 af, Depth= 7.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Type III 24-hr 100-yr Rainfall=8.59"

	Area (sf)	CN	Description
	11,835	61	>75% Grass cover, Good, HSG B
*	158,372	98	Paved parking
	6,195	39	>75% Grass cover, Good, HSG A
	176,402	93	Weighted Average
	18,030		10.22% Pervious Area
	158,372		89.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	39	0.0610	0.22		**Sheet Flow, A-B** Grass: Short n= 0.150 P2= 3.13"
2.0	199	0.0227	1.64		**Sheet Flow, B-C** Smooth surfaces n= 0.011 P2= 3.13"
0.7	149	0.0047	3.37	2.65	**Pipe Channel, C-D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	95	0.0095	6.28	11.09	**Pipe Channel, D-E** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.8	163	0.0018	3.31	10.40	**Pipe Channel, E-F** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
0.3	101	0.0059	5.99	18.82	**Pipe Channel, F-G** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012 Concrete pipe, finished
7.1	746	Total			

Subcatchment PR-5: 300 Concord Parking Lot (offsite)



Summary for Pond P1P: Existing Pond and SIS-1

Inflow Area = 6.155 ac, 79.60% Impervious, Inflow Depth = 6.88" for 100-yr event
Inflow = 44.78 cfs @ 12.10 hrs, Volume= 3.530 af
Outflow = 6.79 cfs @ 12.60 hrs, Volume= 3.530 af, Atten= 85%, Lag= 30.4 min
Discarded = 1.15 cfs @ 12.60 hrs, Volume= 0.544 af
Primary = 5.64 cfs @ 12.60 hrs, Volume= 2.986 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 184.71' @ 12.60 hrs Surf.Area= 20,629 sf Storage= 53,596 cf

Plug-Flow detention time= 65.0 min calculated for 3.527 af (100% of inflow)
Center-of-Mass det. time= 64.9 min (843.2 - 778.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	182.60'	0 cf	**72.67'W x 136.48'L x 3.50'H Field A**-Impervious 34,711 cf Overall - 34,711 cf Embedded = 0 cf x 40.0% Voids
#2A	182.60'	26,599 cf	**StormTrap ST2 SingleTrap 3-0** x 56 Inside #1 Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf 7 Rows of 8 Chambers 59.35' x 123.17' Core + 6.66' Border = 72.67' x 136.48' System
#3	182.00'	84,892 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
		111,490 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
182.00	4,063	0	0
183.00	10,876	7,470	7,470
184.00	17,200	14,038	21,508
185.00	22,041	19,621	41,128
186.00	26,743	24,392	65,520
186.20	4,802	3,154	68,674
187.00	9,192	5,598	74,272
188.00	12,047	10,620	84,892

Device	Routing	Invert	Outlet Devices
#1	Discarded	182.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Secondary	186.00'	**35.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#3	Primary	179.70'	**15.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 179.70' / 178.50' S= 0.0126 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 1.23 sf
#4	Device 3	182.30'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 3	180.70'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=1.15 cfs @ 12.60 hrs HW=184.71' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 1.15 cfs)

Primary OutFlow Max=5.64 cfs @ 12.60 hrs HW=184.71' (Free Discharge)
↑└**3=Culvert** (Passes 5.64 cfs of 12.37 cfs potential flow)
↑└**4=Orifice/Grate** (Orifice Controls 2.42 cfs @ 6.94 fps)
└**5=Orifice/Grate** (Orifice Controls 3.22 cfs @ 9.23 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=182.00' (Free Discharge)
↑└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1P: Existing Pond and SIS-1 - Chamber Wizard Field A

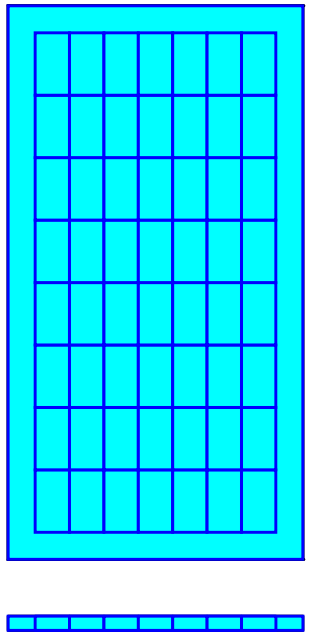
Chamber Model = StormTrap ST2 SingleTrap 3-0 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf
Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
42.0" Chamber Height = 3.50' Field Height

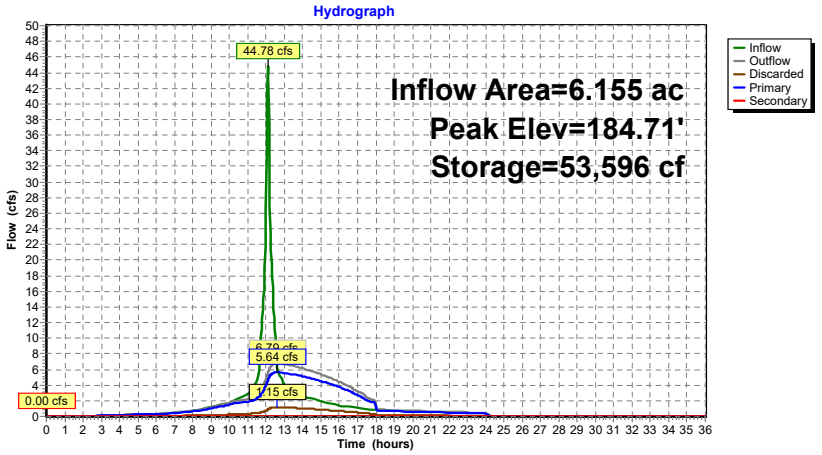
56 Chambers x 354.0 cf + 6,775.3 cf Border = 26,598.9 cf Chamber Storage
56 Chambers x 456.9 cf + 9,124.6 cf Border = 34,711.2 cf Displacement

Chamber Storage = 26,598.9 cf = 0.611 af
Overall Storage Efficiency = 76.6%
Overall System Size = 136.48' x 72.67' x 3.50'

56 Chambers (plus border)
1,285.6 cy Field



Pond P1P: Existing Pond and SIS-1



Summary for Pond P2P: SIS 2

Inflow Area = 4.169 ac, 92.99% Impervious, Inflow Depth = 7.79" for 100-yr event
Inflow = 33.72 cfs @ 12.08 hrs, Volume= 2.707 af
Outflow = 9.84 cfs @ 12.41 hrs, Volume= 2.707 af, Atten= 71%, Lag= 19.6 min
Discarded = 0.80 cfs @ 8.52 hrs, Volume= 1.456 af
Primary = 9.04 cfs @ 12.41 hrs, Volume= 1.251 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs
Peak Elev= 183.57' @ 12.41 hrs Surf.Area= 14,393 sf Storage= 45,252 cf

Plug-Flow detention time= 147.4 min calculated for 2.707 af (100% of inflow)
Center-of-Mass det. time= 147.3 min (901.8 - 754.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	181.10'	0 cf	**72.67'W x 198.06'L x 3.00'H Field A** 43,178 cf Overall - 43,178 cf Embedded = 0 cf x 40.0% Voids
#2A	181.10'	31,676 cf	**StormTrap ST2 SingleTrap 2-6** x 84 Inside #1 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 7 Rows of 12 Chambers 59.35' x 184.75' Core + 6.66' Border = 72.67' x 198.06' System
#3B	181.10'	0 cf	**47.23'W x 136.48'L x 3.00'H Field B**-Impervious 19,337 cf Overall - 19,337 cf Embedded = 0 cf x 40.0% Voids
#4B	181.10'	14,128 cf	**StormTrap ST2 SingleTrap 2-6** x 32 Inside #3 Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf 4 Rows of 8 Chambers 33.92' x 123.17' Core + 6.66' Border = 47.23' x 136.48' System
#5	183.00'	136 cf	**4.00'D x 2.70'H Catch Basins** x 4 -Impervious
		45,940 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	181.10'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	181.60'	**24.0" Round Culvert** L= 100.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 181.60' / 180.00' S= 0.0160 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf
#3	Device 2	183.20'	**4.0' long x 0.5' breadth Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 2	182.50'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 2	181.97'	**4.0" Vert. Orifice/Grate X 6.00** C= 0.600

Discarded OutFlow Max=0.80 cfs @ 8.52 hrs HW=181.15' (Free Discharge)
↑└**1=Exfiltration** (Exfiltration Controls 0.80 cfs)

Primary OutFlow Max=9.02 cfs @ 12.41 hrs HW=183.57' (Free Discharge)
↑└**2=Culvert** (Passes 9.02 cfs of 14.95 cfs potential flow)
↑ ├**3=Weir** (Weir Controls 2.59 cfs @ 1.76 fps)
 ├**4=Orifice/Grate** (Orifice Controls 3.42 cfs @ 4.35 fps)
 └**5=Orifice/Grate** (Orifice Controls 3.02 cfs @ 5.76 fps)

Pond P2P: SIS 2 - Chamber Wizard Field A

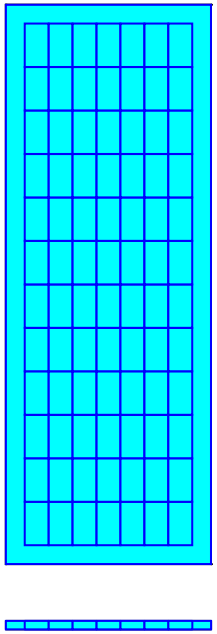
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

12 Chambers/Row x 15.40' Long = 184.75' Row Length +79.9" Border x 2 = 198.06' Base Length
7 Rows x 101.7" Wide + 79.9" Side Border x 2 = 72.67' Base Width
36.0" Chamber Height = 3.00' Field Height

84 Chambers x 289.8 cf + 7,332.3 cf Border = 31,676.4 cf Chamber Storage
84 Chambers x 391.6 cf + 10,280.6 cf Border = 43,177.6 cf Displacement

Chamber Storage = 31,676.4 cf = 0.727 af
Overall Storage Efficiency = 73.4%
Overall System Size = 198.06' x 72.67' x 3.00'

84 Chambers (plus border)
1,599.2 cy Field



Pond P2P: SIS 2 - Chamber Wizard Field B

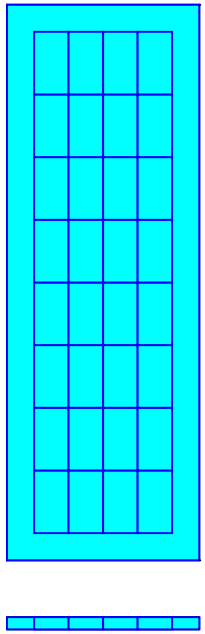
Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

8 Chambers/Row x 15.40' Long = 123.17' Row Length +79.9" Border x 2 = 136.48' Base Length
4 Rows x 101.7" Wide + 79.9" Side Border x 2 = 47.23' Base Width
36.0" Chamber Height = 3.00' Field Height

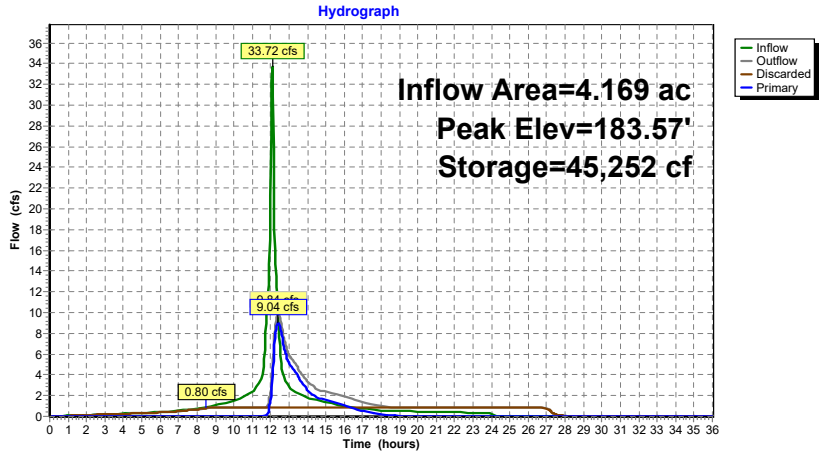
32 Chambers x 289.8 cf + 4,853.6 cf Border = 14,127.5 cf Chamber Storage
32 Chambers x 391.6 cf + 6,805.2 cf Border = 19,337.4 cf Displacement

Chamber Storage = 14,127.5 cf = 0.324 af
Overall Storage Efficiency = 73.1%
Overall System Size = 136.48' x 47.23' x 3.00'

32 Chambers (plus border)
716.2 cy Field



Pond P2P: SIS 2

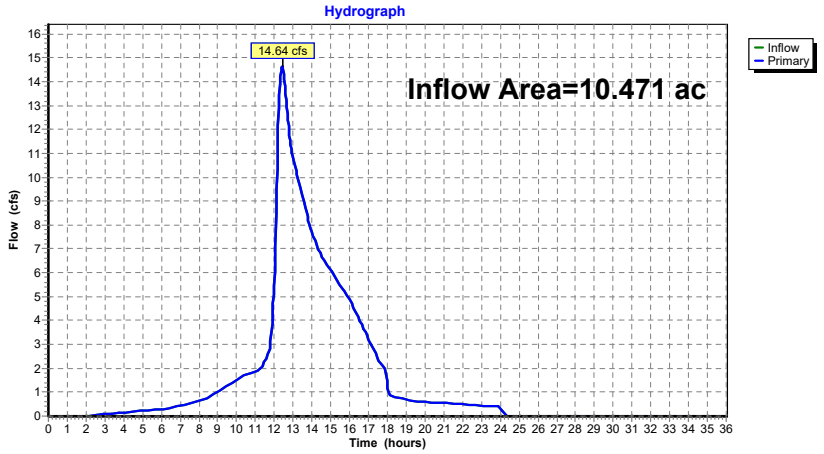


Summary for Link DP1: Wetlands

Inflow Area = 10.471 ac, 83.82% Impervious, Inflow Depth = 4.87" for 100-yr event
Inflow = 14.64 cfs @ 12.42 hrs, Volume= 4.247 af
Primary = 14.64 cfs @ 12.42 hrs, Volume= 4.247 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.03 hrs

Link DP1: Wetlands



APPENDIX F: STORMWATER CALCULATIONS

- *MA STANDARD #3 – RECHARGE AND DRAWDOWN TIME*
- *MA STANDARD #4 – WATER QUALITY AND TSS REMOVAL*
- *CORNELL RAINFALL DATA*
- *PIPE SIZING*
- *MOUNDING ANALYSIS AND NARRATIVE*
- *PHOSPHORUS AND NITROGEN CALCULATIONS*

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MA DEP Standard 3: Recharge Volume Calculations

Required Recharge Volume - A Soils (0.60 in.)	
Existing Site Impervious Area (ac)	3.308
Proposed Site Impervious Area (ac)	4.248
Proposed Increase in Site Impervious Area (ac)	0.940
Recharge Volume Required (cf)	**2,048**

Recharge Volume Adjustment Factor	
Impervious Area Directed to Infiltration BMP (ac)	**3.827**
%Impervious Directed to Infiltration BMP	90%
Adjustment Factor	1.11
Adjusted Total Recharge Volume Required (cf)	**2,273**

Provided Recharge Volume*	
P2P	29,399
Total Recharge Volume Provided (cf)	**29,399**

Provided greater than or Equal to Required

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

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MA DEP Standard 3: Drawdown Time Calculations

Drawdown Time - P2P	
Volume below outlet pipe (Rv) (cf)	29,399
Soil Type	Loamy Sand - A
Infiltration rate (K)*	2.41
Bottom Area (sf)	11,271
Drawdown time (Hours)*	**13.0**

*Infiltration Rates taken from Rawls Table
**Drawdown time = Rv / (K) x (bottom area)

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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)	185,043
Required Water Quality Volume (cf)	**15,420**

*Water Quality volume runoff is equal to 0.5 to 1.0 inches of runoff times the total impervious area of the post development project site.

Water Quality Volume Provided*	
P2P	29,399
0	0
0	0
0	0
0	0
Total Provided Water Quality Volume (cf)	**29,399**

Required Recharge Provided

*Volume provided below lowest outlet pipe in cubic feet (cf)
**Assuming the existing pond will handle the existing impervious area and the proposed pond will handle the i

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MA DEP Standard 4: TSS Removal Calculation Worksheet

BMP Treatment Train: WQI-1,2,3,4,&5

A BMP	B TSS Removal Rate	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
CDS Water Quality Unit	**0.60**	**1.00**	**0.60**	**0.40**
Subsurface Infiltration System	**0.80**	**0.40**	**0.32**	**0.08**
		Total TSS Removal =	**92%**	

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

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MA DEP Standard 4: Weighted TSS Removal Rate

Design Point - Treatment Train Description(s)	TSS Removal (%)	Treated Imp. Area* (ac)
DP-1 -WQI-1,2,3,4,&5	92%	1.190
DP-1 - Untreated (Driveway Apron)	0%	0.019
Weighted TSS Removal Rate	**91%**	

*Excludes roof runoff

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Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	Massachusetts
Location	
Longitude	71.282 degrees West
Latitude	42.535 degrees North
Elevation	0 feet
Date/Time	Wed, 28 Apr 2021 09:24:49 -0400

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.28	0.43	0.53	0.69	0.87	1.09	**1yr**	0.75	1.03	1.27	1.61	2.04	2.61	2.82	**1yr**	2.31	2.72	3.17	3.86	4.50	**1yr**
2yr	0.34	0.53	0.65	0.86	1.08	1.37	**2yr**	0.94	1.25	1.58	1.98	2.49	3.13	3.45	**2yr**	2.77	3.31	3.82	4.55	5.19	**2yr**
5yr	0.40	0.63	0.79	1.06	1.35	1.72	**5yr**	1.17	1.57	2.00	2.52	3.16	3.96	4.39	**5yr**	3.51	4.22	4.84	5.76	6.49	**5yr**
10yr	0.46	0.72	0.90	1.23	1.60	2.06	**10yr**	1.38	1.86	2.40	3.02	3.79	4.73	5.27	**10yr**	4.19	5.07	5.79	6.89	7.70	**10yr**
25yr	0.54	0.86	1.09	1.51	2.00	2.59	**25yr**	1.72	2.33	3.03	3.84	4.81	6.00	6.73	**25yr**	5.31	6.47	7.34	8.74	9.65	**25yr**
50yr	0.61	0.98	1.25	1.76	2.37	3.10	**50yr**	2.05	2.76	3.65	4.62	5.78	7.18	8.10	**50yr**	6.35	7.78	8.79	10.46	11.45	**50yr**
100yr	0.70	1.13	1.46	2.07	2.81	3.70	**100yr**	2.43	3.28	4.36	5.53	6.93	8.59	9.74	**100yr**	7.60	9.37	10.52	12.52	13.60	**100yr**
200yr	0.80	1.30	1.69	2.42	3.34	4.43	**200yr**	2.88	3.89	5.23	6.64	8.31	10.28	11.73	**200yr**	9.10	11.28	12.60	15.00	16.15	**200yr**
500yr	0.96	1.58	2.06	2.99	4.19	5.60	**500yr**	3.62	4.89	6.63	8.45	10.57	13.06	15.00	**500yr**	11.56	14.42	16.00	19.06	20.28	**500yr**

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.36	0.45	0.60	0.74	0.83	**1yr**	0.64	0.81	1.11	1.39	1.73	2.32	2.45	**1yr**	2.06	2.35	2.79	3.39	3.97	**1yr**
2yr	0.32	0.50	0.61	0.83	1.03	1.23	**2yr**	0.89	1.21	1.41	1.86	2.39	3.02	3.33	**2yr**	2.68	3.20	3.69	4.39	5.01	**2yr**
5yr	0.38	0.58	0.72	0.99	1.26	1.46	**5yr**	1.08	1.43	1.68	2.19	2.80	3.63	4.01	**5yr**	3.21	3.85	4.45	5.27	5.98	**5yr**
10yr	0.42	0.64	0.79	1.11	1.43	1.67	**10yr**	1.24	1.63	1.88	2.47	3.15	4.16	4.60	**10yr**	3.68	4.42	5.11	6.01	6.85	**10yr**
25yr	0.48	0.73	0.90	1.29	1.70	1.96	**25yr**	1.46	1.92	2.21	2.90	3.67	4.98	5.52	**25yr**	4.41	5.31	6.15	7.14	8.18	**25yr**
50yr	0.52	0.80	0.99	1.43	1.92	2.23	**50yr**	1.66	2.18	2.49	3.28	4.12	5.70	6.33	**50yr**	5.04	6.08	7.08	8.07	9.35	**50yr**
100yr	0.58	0.88	1.10	1.59	2.17	2.53	**100yr**	1.88	2.47	2.81	3.52	4.64	6.53	7.23	**100yr**	5.78	6.95	8.15	9.11	10.71	**100yr**
200yr	0.64	0.97	1.23	1.78	2.48	2.87	**200yr**	2.14	2.81	3.16	3.94	5.25	7.47	8.27	**200yr**	6.62	7.95	9.40	10.24	12.27	**200yr**
500yr	0.74	1.10	1.42	2.07	2.94	3.40	**500yr**	2.53	3.32	3.70	4.59	6.18	8.92	9.82	**500yr**	7.90	9.45	11.35	11.93	14.68	**500yr**

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.31	0.48	0.59	0.79	0.97	1.13	**1yr**	0.84	1.11	1.31	1.72	2.19	2.81	3.07	**1yr**	2.49	2.96	3.41	4.23	4.91	**1yr**
2yr	0.36	0.55	0.68	0.92	1.14	1.34	**2yr**	0.98	1.31	1.54	2.01	2.59	3.26	3.60	**2yr**	2.88	3.46	3.98	4.74	5.38	**2yr**
5yr	0.44	0.68	0.85	1.16	1.48	1.74	**5yr**	1.28	1.70	1.99	2.56	3.23	4.31	4.82	**5yr**	3.82	4.63	5.29	6.26	7.02	**5yr**
10yr	0.53	0.82	1.02	1.42	1.84	2.14	**10yr**	1.59	2.09	2.45	3.09	3.87	5.35	6.01	**10yr**	4.73	5.78	6.56	7.76	8.59	**10yr**
25yr	0.69	1.05	1.31	1.87	2.46	2.79	**25yr**	2.12	2.73	3.23	3.96	4.89	7.10	8.07	**25yr**	6.28	7.76	8.72	10.35	11.23	**25yr**
50yr	0.84	1.27	1.58	2.28	3.06	3.44	**50yr**	2.64	3.36	3.97	4.78	5.84	8.80	10.12	**50yr**	7.79	9.73	10.81	12.88	13.76	**50yr**
100yr	1.02	1.54	1.93	2.79	3.82	4.22	**100yr**	3.30	4.12	4.89	6.05	6.99	10.92	12.70	**100yr**	9.67	12.21	13.42	16.07	16.85	**100yr**
200yr	1.24	1.86	2.36	3.42	4.77	5.19	**200yr**	4.11	5.07	6.03	7.35	8.35	13.58	15.95	**200yr**	12.02	15.34	16.65	20.01	20.66	**200yr**
500yr	1.61	2.40	3.09	4.49	6.38	6.80	**500yr**	5.50	6.64	7.96	9.54	10.57	18.12	21.58	**500yr**	16.03	20.75	22.14	26.82	27.02	**500yr**

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Bohler Job Number: MAB220093
April 5, 2023

Rational Pipe Sizing Calculations

Design Period Storm:		25	Year	Design Period Intensity*			6	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										
WQI-01	P2P	0.16	0.95	0.15	0.14	0.30	0.04	0.19	6	6	1.16	12	0.010	HDPE	0.012	3.86	4.91
WQI-02	P2P	0.16	0.95	0.15	0.11	0.30	0.03	0.19	6	6	1.11	12	0.010	HDPE	0.012	3.86	4.91
WQI-03	P2P	0.31	0.95	0.29	0.05	0.30	0.02	0.31	6	6	1.86	12	0.010	HDPE	0.012	3.86	4.91
WQI-04	P2P	0.35	0.95	0.33	0.10	0.30	0.03	0.36	6	6	2.18	12	0.010	HDPE	0.012	3.86	4.91
RD-01	DMH-02	1.60	0.95	1.52	0.00	0.30	0.00	1.52	6	6	9.12	15	0.020	HDPE	0.012	9.90	8.06
DMH-02	DMH-03	1.60	0.95	1.52	0.00	0.30	0.00	1.52	6	6	9.12	15	0.030	HDPE	0.012	12.12	9.88
RD-02	DMH-01	1.20	0.95	1.14	0.00	0.30	0.00	1.14	6	6	6.84	15	0.020	HDPE	0.012	9.90	8.06
DMH-01	DMH-03	1.20	0.95	1.14	0.00	0.30	0.00	1.14	6	6	6.84	15	0.010	HDPE	0.012	7.00	5.70
DMH-03	P2P	2.80	0.95	2.66	0.00	0.30	0.00	2.66	6	6	15.96	18	0.020	HDPE	0.012	16.09	9.11

*Rainfall intensity provided by Cornell University's NRCC Atlas of Precipitation Extremes for the North Eastern United States and Canada

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GROUNDWATER MOUNDING CALCULATIONS

"298 Concord Road"
Billerica, MA
Project #MAB220093.00

Methodology

The infiltration basin identified as P2P this project is designed with less than 4 feet of groundwater separation. It is also designed to attenuate the 10-year storm event or larger. Therefore, groundwater mounding calculations are required according to MA DEP Stormwater Management Guidelines. The purpose of the calculations is to ensure that the mound will not prevent the full draining of the basin. The mounding analysis must show that the recharge volume will exfiltrate within seventy-two (72) hours. Additionally, it should be verified that the mounding effect will not cause stormwater to surge above the lowest discharge point out of a basin (during the 24-hour storm event) or raise the water elevation in a nearby resource area.

The groundwater mounding analysis was performed by a proprietary program using the Hantush Method with Glover's Solution. Input parameters are site specific and determined based on existing and proposed conditions. The required input parameters are the following: application rate; duration of application; fillable porosity; hydraulic conductivity; initial saturated thickness; length of application area; width of application area; and distance to closest resource area (constant head boundary).

Calculations using the Hantush Method are considered conservative due to the fact that the unsaturated soil zone is not incorporated. In practice, this zone will have a significant positive effect on reducing the groundwater mounding under an infiltration basin by allowing horizontal migration. A minimum of a 2-foot unsaturated zone has been provided in the basin and the mounding (Δh) falls below the lowest outlet in the basin ensuring that stormwater will not bypass the basin floor and discharge though the outlet device. Please refer to the table below:

Stormwater Basin	Unsaturated Zone (FT)	Depth Below Lowest Outlet (FT)	Mounding Storage Provided (FT)	Groundwater Mounding - Δh (FT)
2P2	**2.0**	**0.37**	**2.37**	**1.16**

The application rate used for each pond is determined by the rate at which the volume of runoff below the lowest outlet will draw down in the requisite 72 hours. The duration of application used for the analysis is the 24-hour based duration of the storm event. The fillable porosity, hydraulic conductivity, and initial saturated thickness used for the analysis are based on the existing soil conditions.

Results

Based on the criteria mentioned above, the analysis (see attached) indicates the mound in the stormwater basin falls below the mounding storage provided. Given these results, we feel as though the basins recharge the stormwater volume within 72 hours as required.

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

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

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

Input Values		
0.4340	***R***	**Recharge (infiltration) rate (feet/day)**
0.350	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
4.34	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
92.400	**x**	**1/2 length of basin (x direction, in feet)**
30.000	**y**	**1/2 width of basin (y direction, in feet)**
1.000	**t**	**duration of infiltration period (days)**
20.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

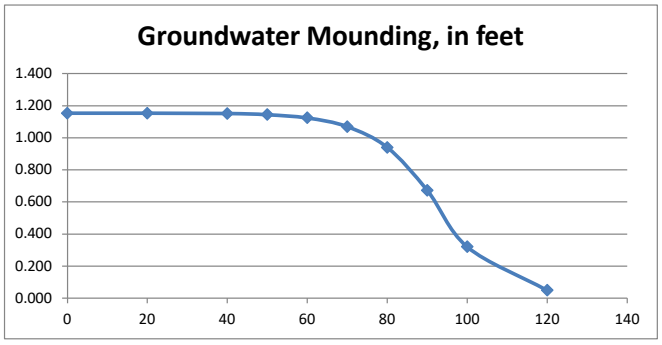
hours	days
36	1.50

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

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

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
1.153	0
1.153	20
1.151	40
1.144	50
1.124	60
1.069	70
0.940	80
0.672	90
0.320	100
0.048	120

Re-Calculate Now



Disclaimer

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

Proposed GMP Lab Facility Development
298 Concord Road
Billerica, MA
Bohler Job Number: MAB220093.00
January 25, 2023

Weighted Total Phosphorus Removal Rate

Structural BMP Phosphorus Removal

Subcatchment	Design Point	Phosphorus Loading (lbs/year)	Total Phosphorus Treatment Train	TP Removal (%)	TP Removal (lbs/year)
PR-01	DP1	4.97	Subsurface Infiltration System	98%	4.87
PR-02	DP1	0.06	Wet Basin	53%	0.03
PR-03	DP1	2.45	Subsurface Infiltration System	98%	2.40
PR-04	DP1	0.00	Subsurface Infiltration System	98%	0.00
PR-05	DP1	7.21	Wet Basin	53%	3.82
Total	-	**14.70**	-	-	**11.13**

Weighted Total Phosphorus Removal Rate (%)	**75.7%**

Prepared By:
BOHLER
45 Franklin Street, 5th Floor
Boston, MA 02110
(617) 849-8040

Phosphorus Loading Calculation Proposed Conditions					
Subcatchment	**Design Point**	**Land Use**	**Area (sf)**	**Phosphorus Load Export (lbs/acre/year)**	**Phosphorus Load (lbs/year)**
PR-01	DP1	Industrial	121,631	1.78	4.97
PR-02	DP1	Developed Land - HSG A	91,711	0.03	0.06
PR-03	DP1	Industrial	59,961	1.78	2.45
PR-04	DP1	Developed Land - HSG A	6,392	0.03	0.00
PR-05	DP1	Indistrial	176,402	1.78	7.21

DP Summary Table - Proposed Conditions	
Design Point	**Phosphorus Load Export (lbs/year)**
DP1	**14.70**

Subcatchment Summary Table - Proposed Conditions	
Subcatchment	**Phosphorus Load Export (lbs/year)**
PR-01	4.97
PR-02	0.06
PR-03	2.45
PR-04	0.00
PR-05	7.21
TOTAL	**14.70**

Phosphorus Loading By Use Table	
Land Use	**Phosphorus Load Export (lbs/acre/year)**
Commercial	1.78
Industrial	1.78
Multi-Family Residential	2.32
High-Density Residential	2.32
Medium-Density Residential	1.96
Low-Density Residential	1.52
Highway	1.34
Forest - Impervious	1.52
Forest - Pervious	0.13
Open Land	1.52
Agriculture - Impervious	1.52
Agriculture - Pervious	0.45
Developed Land - HSG A	0.03
Developed Land - HSG B	0.12
Developed Land - HSG C	0.21
Developed Land - HSG C/D	0.29
Developed Land - HSG D	0.37

Prepared By:
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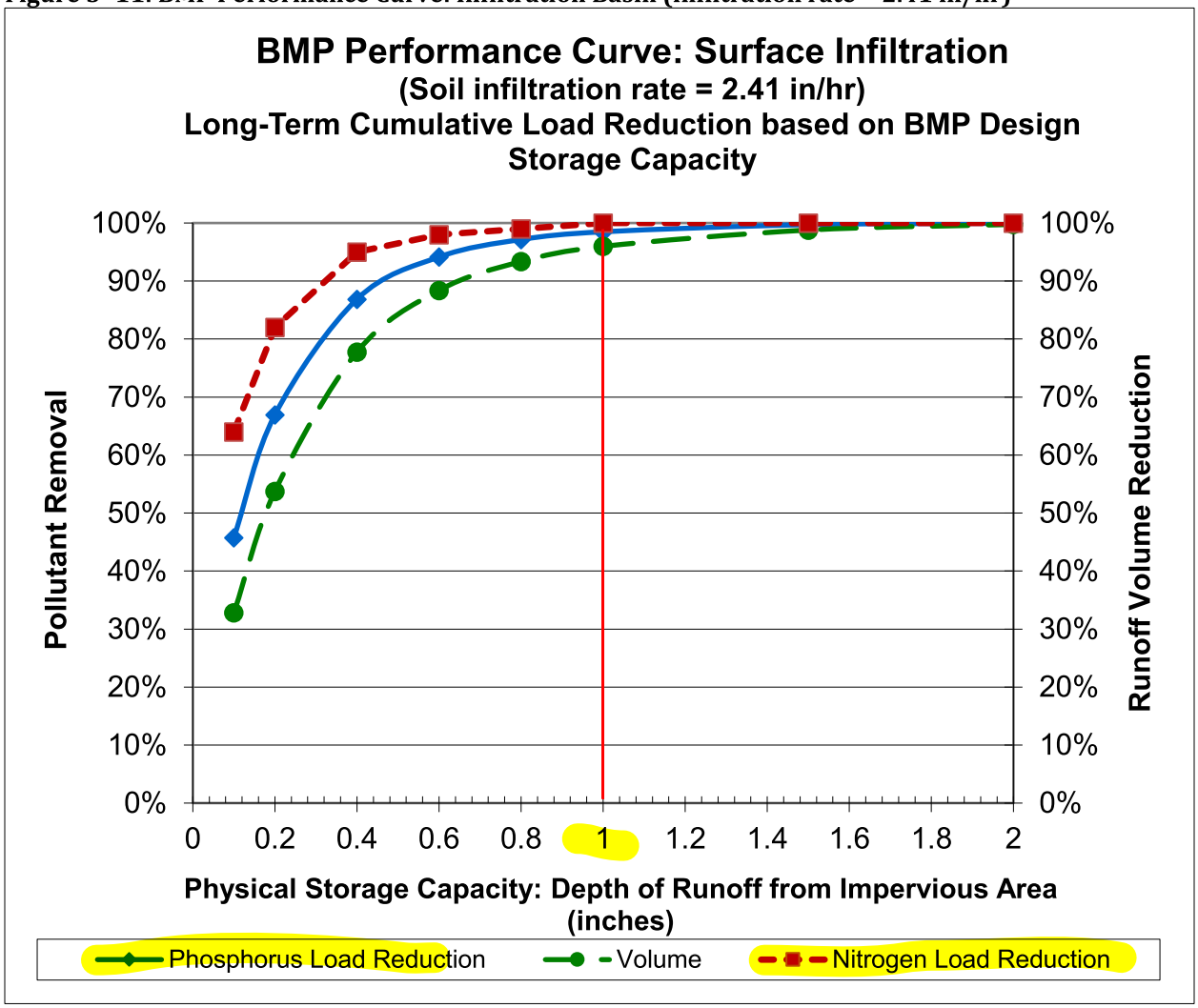
Table 3- 16: Surface Infiltration (2.41 in/hr) BMP Performance Table

Surface Infiltration (2.41 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	32.8%	53.8%	77.8%	88.4%	93.4%	96.0%	98.8%	99.8%
Cumulative Phosphorus Load Reduction	46%	67%	87%	94%	97%	98%	100%	100%
Cumulative Nitrogen Load Reduction	64%	82%	95%	98%	99%	100%	100%	100%

Figure 3- 11: BMP Performance Curve: Infiltration Basin (infiltration rate = 2.41 in/hr)



BMP Capacity: Depth of Runoff from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	14%	25%	37%	44%	48%	53%	58%	63%
Cumulative Nitrogen Load Reduction	9%	16%	23%	28%	31%	32%	37%	40%

Figure 3-18: BMP Performance Curve: Wet Pond

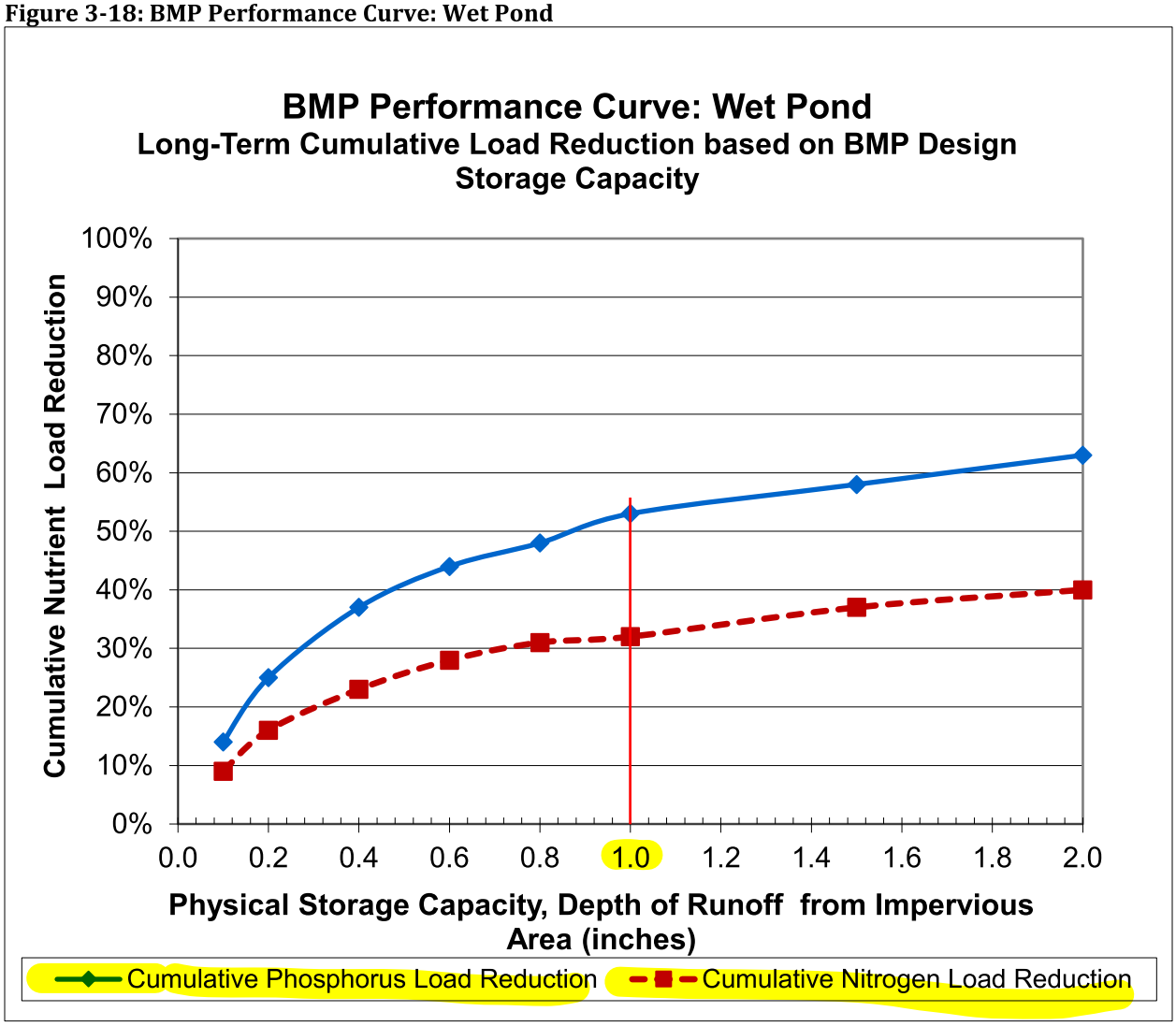


Table 3-24: Dry Pond BMP Performance Table

Extended Dry Pond BMP Performance Table: Long-Term Phosphorus & Nitrogen Load Reduction

Nitrogen Loading Calculation Proposed Conditions					
Subcatchment	**Design Point**	**Land Use**	**Area (sf)**	**Nitrogen Load Export (lbs/acre/year)**	**Nitrogen Load (lbs/year)**
PR-01	DP1	Industrial	121,631	15.00	41.88
PR-02	DP1	Developed Land - HSG A	91,711	0.30	0.63
PR-03	DP1	Industrial	59,961	15.00	20.65
PR-04	DP1	Developed Land - HSG A	6,392	0.30	0.04
PR-05	DP1	Indistrial	176,402	15.00	60.74

DP Summary Table - Proposed Conditions	
Design Point	**Nitrogen Load Export (lbs/year)**
DP1	**123.95**

Subcatchment Summary Table - Proposed Conditions	
Subcatchment	**Nitrogen Load Export (lbs/year)**
PR-01	41.88
PR-02	0.63
PR-03	20.65
PR-04	0.04
PR-05	60.74
TOTAL	**123.95**

Nitrogen Loading By Use Table	
Land Use	**Nitrogen Load Export (lbs/acre/year)**
Commercial	15.0
Industrial	15.0
All Residential	14.1
Highway	10.5
Forest - Impervious	11.3
Forest - Pervious	0.5
Open Land	11.3
Agriculture - Impervious	11.3
Agriculture - Pervious	2.6
Developed Land - HSG A	0.3
Developed Land - HSG B	1.2
Developed Land - HSG C	2.4
Developed Land - HSG C/D	3.1
Developed Land - HSG D	3.6

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Proposed GMP Lab Facility Development
298 Concord Road
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January 25, 2023

Weighted Total Nitrogen Removal Rate

Structural BMP Nitrogen Removal

Subcatchment	Design Point	Nitrogen Loading (lbs/year)	Total NitrogenTreatment Train	TN Removal (%)	TN Removal (lbs/year)
PR-01	DP1	41.88	Subsurface Infiltration System	100%	41.88
PR-02	DP1	0.63	Wet Basin	32%	0.20
PR-03	DP1	20.65	Subsurface Infiltration System	100%	20.65
PR-04	DP1	0.04	Subsurface Infiltration System	100%	0.04
PR-05	DP1	60.74	Wet Basin	32%	19.44
Total	-	**123.95**	-	-	**82.22**

Weighted Total Nitrogen Removal Rate (%)	**66.3%**

Prepared By:
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45 Franklin Street, 5th Floor
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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*
- *PROPOSED OPERATION AND MAINTENANCE MAP*
- *MANUFACTURER'S INSPECTION AND MAINTENANCE MANUALS*

STORMWATER OPERATION AND MAINTENANCE PLAN

GMP Lab Facility
298 Concord Road
Billerica, MA

RESPONSIBLE PARTY DURING CONSTRUCTION:

KS Partners
130 New Boston Street – Suite 303
Woburn, MA 01801

RESPONSIBLE PARTY POST CONSTRUCTION:

KS Partners
130 New Boston Street – Suite 303
Woburn, MA 01801

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). 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: Sweep at least two (2) times per year (March and late November) and on a more frequent basis depending on sanding operations. All resulting sweepings shall be collected and properly disposed of offsite in accordance with MADEP and other applicable requirements.

   Approximate Maintenance Budget: $1,000/year

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.

Approximate Maintenance Budget: $500/year per structure.

3. Water Quality Unit (Proprietary Separator): Follow manufacturer's recommendations (attached).

   Approximate Maintenance Budget: $1,000/year per unit.

4. Underground Infiltration/Detention Basins: 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. The outlet of the basin, if any, shall be inspected for erosion and sedimentation, and rip-rap shall be promptly repaired in the case of erosion. Sediment collecting in the bottom of the basin shall be inspected twice annually, and removal shall commence any time the sediment reaches a depth of six inches anywhere in the basin. Any sediment removed shall be disposed of in accordance with MADEP and other applicable requirements.

   Approximate Maintenance Budget: Cleaning - $1,000/year, Inspection - $200/year

All components of the stormwater system will be accessible by the owner or their assignee.

STORMWATER MANAGEMENT SYSTEM

POST-CONSTRUCTION INSPECTION REPORT

LOCATION:

GMP Lab Facility
298 Concord Road
Billerica, MA

RESPONSIBLE PARTY:

KS Partners
130 New Boston Street – Suite 303
Woburn, MA 01801

NAME OF INSPECTOR:	INSPECTION DATE:
Note Condition of the Following (sediment depth, debris, standing water, damage, etc.):	
Catch Basins:	
Infiltration System:	
Detention Systems:	
Trench Drains:	

Water Quality Units:
Other:
Note Recommended Actions to be taken on the Following (sediment and/or debris removal, repairs, etc.):
Catch Basins:
Infiltration System:
Detention System:
Trench Drains:

Water Quality Units:
Other:
Comments:

STORMWATER INSPECTION AND MAINTENANCE LOG FORM

GMP Lab Facility
298 Concord Road - Billerica, MA
**** To be submitted to DPW prior to May 30 annually***

Stormwater Management Practice	Responsible Party	Date	Maintenance Activity Performed

LONG-TERM POLLUTION PREVENTION PLAN

GMP Lab Facility
298 Concord Road
Billerica, MA

RESPONSIBLE PARTY DURING CONSTRUCTION:

KS Partners
130 New Boston Street – Suite 303
Woburn, MA 01801

RESPONSIBLE PARTY POST CONSTRUCTION:

KS Partners
130 New Boston Street – Suite 303
Woburn, MA 01801

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

- 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 parking lots, drive aisles and access aisles 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.
- Grass shall be maintained at a minimum blade height of two to three inches and only 1/3 of the plant height shall be removed at a time. Clippings shall not be disposed of within stormwater management areas or adjacent resource areas.
- Plants shall be pruned as necessary.

- Snow piles shall be located adjacent to or on pervious surfaces in upland areas. This will allow snow melt water to filter into the soil, leaving behind sand and debris which can be removed in the springtime.

- In no case shall snow be disposed of or stored in resource areas (wetlands, floodplain, streams, or other water bodies).

- In no case shall snow be disposed of or stored in the detention basins, infiltration basins or bioretention areas.

- If necessary, stockpiled snow will be removed from the Site and disposed of at an off-site location in accordance with all local, state and federal regulations.

- The amount of sand and deicing chemicals shall be kept at the minimum amount required to provide safe pedestrian and vehicle travel.

- The primary agents used for deicing at parking lots, sidewalks and the access roads shall consist of salt alternatives such as calcium carbonate (CaCO3) or potassium chloride (KCl) or sodium chloride.

- Deliveries shall be monitored by owner or owner's representative to ensure proper delivery and in the event that a spillage occurs it shall be contained and cleaned up immediately in accordance with the spill prevention program for the project.

- Recycle materials whenever possible. Provide separate containers for recycle materials. Recycling products will be removed by a certified waste hauler.

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.

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.

Duly Acknowledged:

KS PARTNERS

Signature 

Name 

Date 3/30/2023

Name & Title Date

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.

SPILL PREVENTION CONTROL AND COUNTERMEASURE FORM

GMP Lab Facility
298 Concord Road
Billerica, Massachusetts

Where a release containing a hazardous substance occurs, the following steps shall be taken by the facility manager and/or supervisor:

1. Immediately notify Billerica Fire Department (at **9-1-1**)

2. All measures must be taken to contain and abate the spill and to prevent the discharge of the pollutant(s) to off-site locations, receiving waters, wetlands and/or resource areas.

3. Notify the Billerica Health Department at (978) 671-0931 and the Town Conservation Commission at (978) 671-0966.

4. Provide documentation from licensed contractor showing disposal and cleanup procedures were completed as well as details on chemicals that were spilled to the Billerica Health Department and Conservation Commission.

Date of spill:_____ Time:_____ Reported By:_____

Weather Conditions:_____

Material Spilled	**Location of Spill**	**Approximate Quantity of Spill (in gallons)**	**Agency(s) Notified**	**Date of Notification**

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 AGENCY PHONE: (888) 372-7341

Project: 298 Concord Road
Location: Billerica, MA
Prepared For: Bohler Eng / Alex Horgan

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

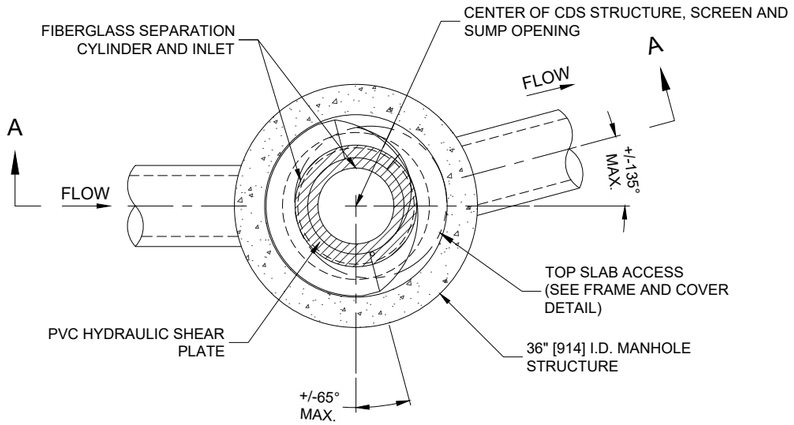
Compute Q Rate using the following equation:

$$Q = (qu)\ (A)\ (WQV)$$

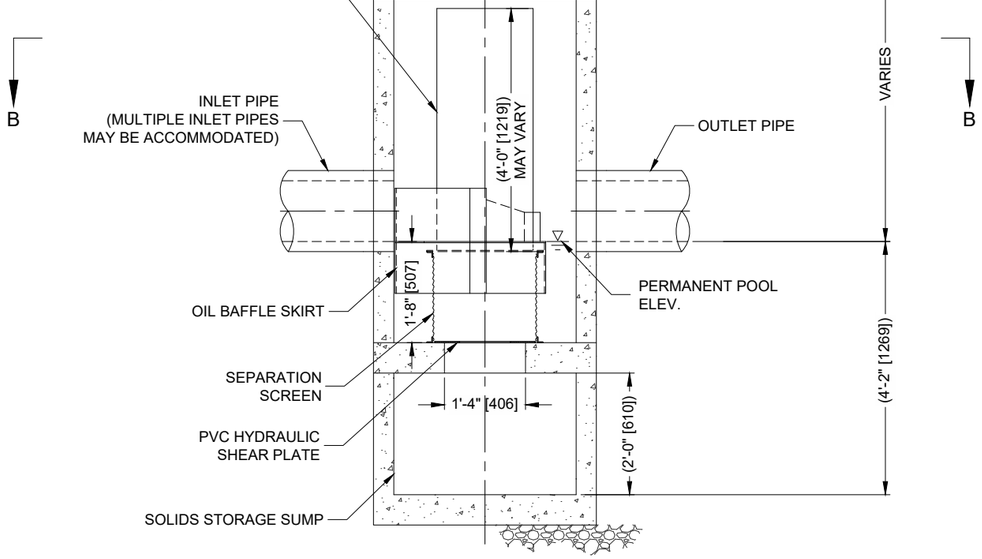
where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
WQO-01	0.16	0.0002500	5.0	0.083	1.00	795.00	0.20
WQI-01	0.35	0.0005469	5.0	0.083	1.00	795.00	0.43
WQI-02	0.15	0.0002344	5.0	0.083	1.00	795.00	0.19



PLAN VIEW B-B
N.T.S.

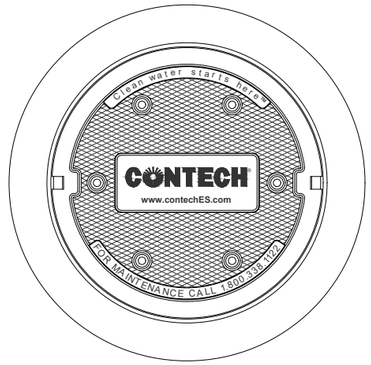


ELEVATION A-A
N.T.S.

CDS1515-3-C DESIGN NOTES

CDS1515-3-C RATED TREATMENT CAPACITY IS 1.0 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS1515-3-C CONFIGURATION IS SHOWN.



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS OR L/s)			*
PEAK FLOW RATE (CFS OR L/s)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*

NOTES/SPECIAL REQUIREMENTS:

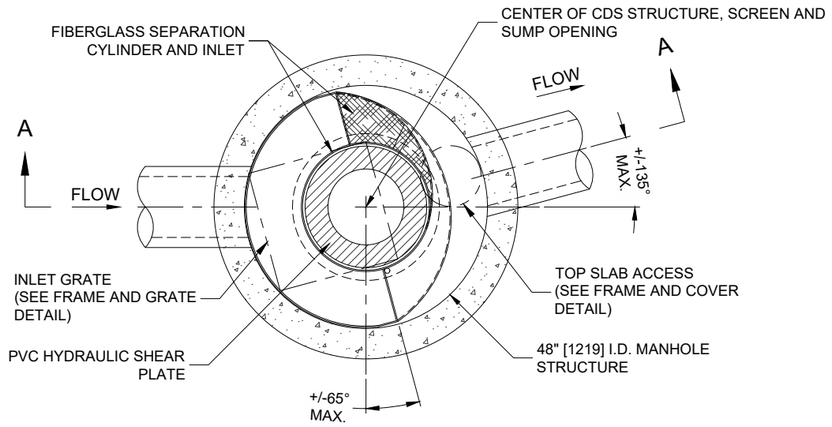
* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

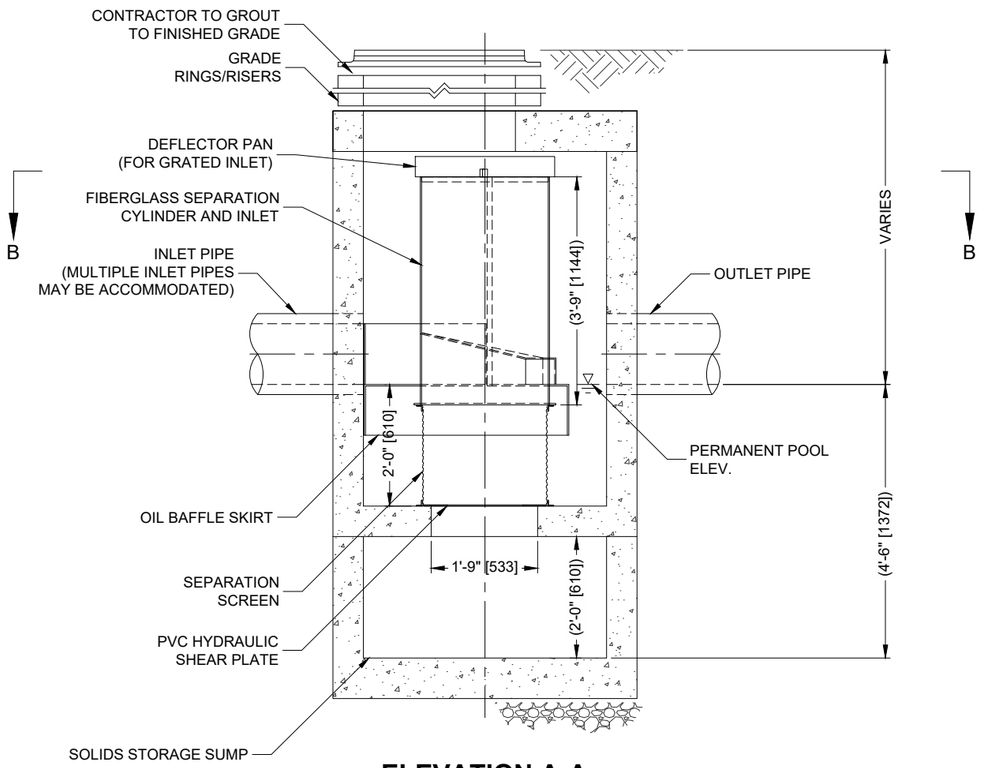
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS1515-3-C
ONLINE CDS
STANDARD DETAIL



PLAN VIEW B-B
N.T.S.



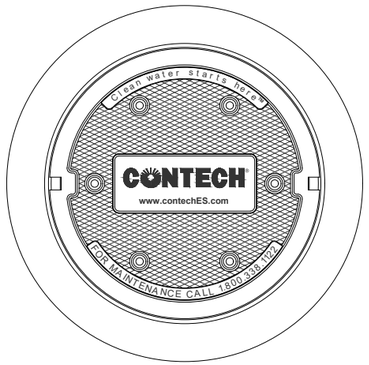
ELEVATION A-A
N.T.S.

CDS2015-4G DESIGN NOTES

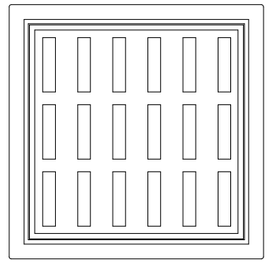
CDS2015-4G RATED TREATMENT CAPACITY IS 1.4 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS2015-4G CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.



FRAME AND GRATE
(24" SQUARE)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS2015-4G
ONLINE CDS
STANDARD DETAIL

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

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

298 CONCORD ROAD
BILLERICA, MA

Area	0.35 ac	Unit Site Designation	WQI-01
Weighted C	0.9	Rainfall Station #	146
t_c	5 min		
CDS Model	1515-3	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.1%	9.1%	0.01	0.01	9.1
0.04	8.9%	18.0%	0.01	0.01	8.9
0.06	9.8%	27.7%	0.02	0.02	9.8
0.08	8.2%	35.9%	0.03	0.03	8.2
0.10	7.7%	43.6%	0.03	0.03	7.7
0.12	5.5%	49.1%	0.04	0.04	5.5
0.14	5.0%	54.2%	0.04	0.04	5.0
0.16	4.9%	59.1%	0.05	0.05	4.9
0.18	4.3%	63.4%	0.06	0.06	4.2
0.20	4.8%	68.2%	0.06	0.06	4.7
0.25	7.4%	75.6%	0.08	0.08	7.3
0.30	5.8%	81.5%	0.09	0.09	5.6
0.35	4.5%	85.9%	0.11	0.11	4.3
0.40	2.4%	88.3%	0.13	0.13	2.3
0.45	2.0%	90.3%	0.14	0.14	1.9
0.50	1.9%	92.1%	0.16	0.16	1.7
0.75	5.0%	97.1%	0.24	0.24	4.5
1.00	1.6%	98.7%	0.32	0.32	1.4
1.50	0.8%	99.5%	0.47	0.47	0.7
2.00	0.0%	99.5%	0.63	0.63	0.0
2.50	0.5%	100.0%	0.79	0.79	0.3
					97.8
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**91.4%**

1 - Based on 10 years of hourly precipitation data from NCDC 6698, Providence WSO Airport, Kent County, RI
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

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

298 CONCORD ROAD
BILLERICA, MA

Area	0.16 ac	Unit Site Designation	WQO-01
Weighted C	0.9	Rainfall Station #	146
t_c	5 min		
CDS Model	1515-3	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.1%	9.1%	0.00	0.00	9.1
0.04	8.9%	18.0%	0.01	0.01	8.9
0.06	9.8%	27.7%	0.01	0.01	9.8
0.08	8.2%	35.9%	0.01	0.01	8.2
0.10	7.7%	43.6%	0.01	0.01	7.7
0.12	5.5%	49.1%	0.02	0.02	5.5
0.14	5.0%	54.2%	0.02	0.02	5.0
0.16	4.9%	59.1%	0.02	0.02	4.9
0.18	4.3%	63.4%	0.03	0.03	4.3
0.20	4.8%	68.2%	0.03	0.03	4.8
0.25	7.4%	75.6%	0.04	0.04	7.4
0.30	5.8%	81.5%	0.04	0.04	5.8
0.35	4.5%	85.9%	0.05	0.05	4.4
0.40	2.4%	88.3%	0.06	0.06	2.4
0.45	2.0%	90.3%	0.06	0.06	1.9
0.50	1.9%	92.1%	0.07	0.07	1.8
0.75	5.0%	97.1%	0.11	0.11	4.8
1.00	1.6%	98.7%	0.14	0.14	1.5
1.50	0.8%	99.5%	0.22	0.22	0.8
2.00	0.0%	99.5%	0.29	0.29	0.0
2.50	0.5%	100.0%	0.36	0.36	0.4
					99.4
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**92.9%**

1 - Based on 10 years of hourly precipitation data from NCDC 6698, Providence WSO Airport, Kent County, RI
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH®
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance

CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

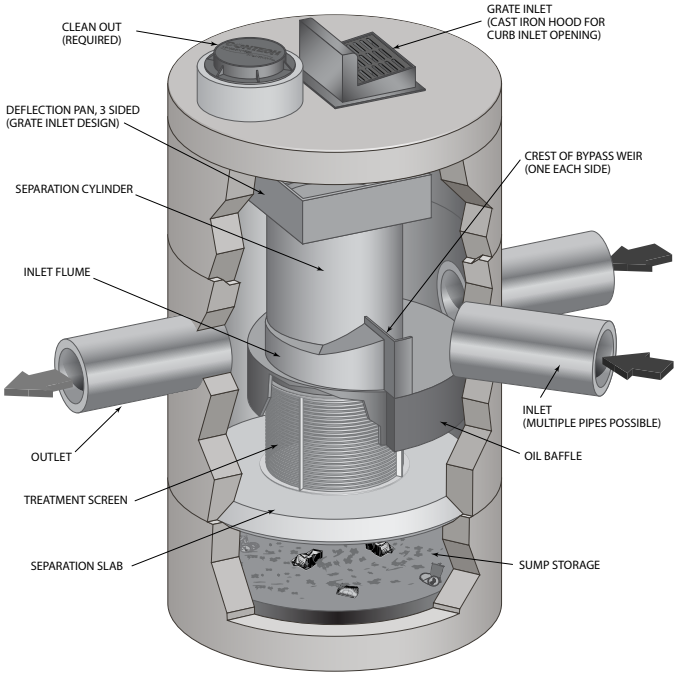
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are

determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

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

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

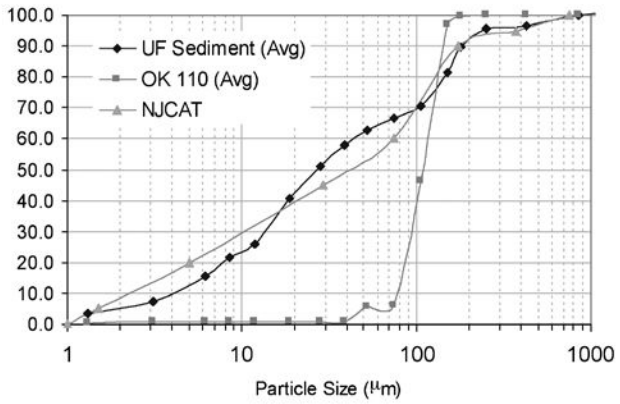


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect

to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

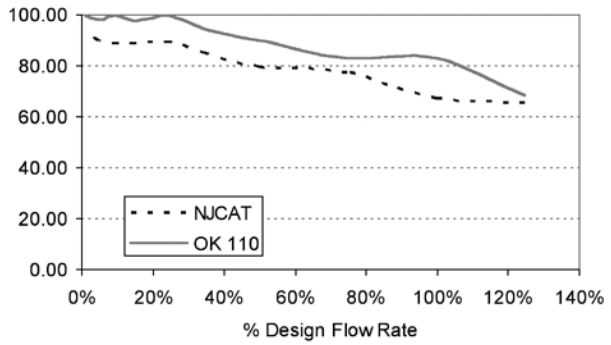


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

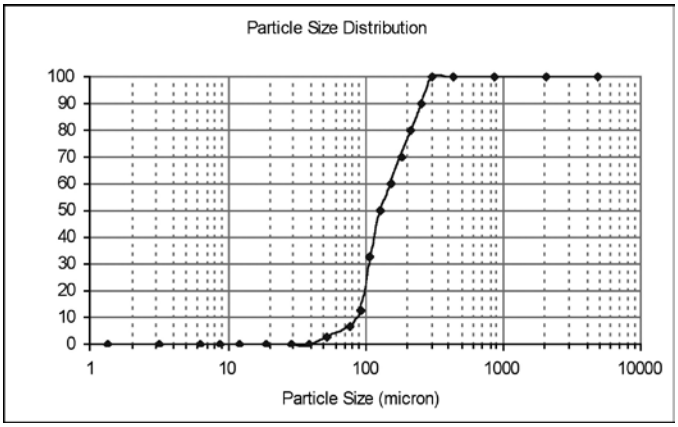


Figure 3. WASDOE PSD

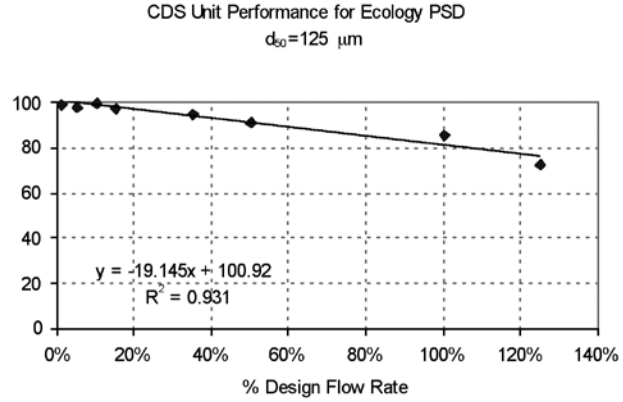


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

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

Inspection

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

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

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

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

Cleaning

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

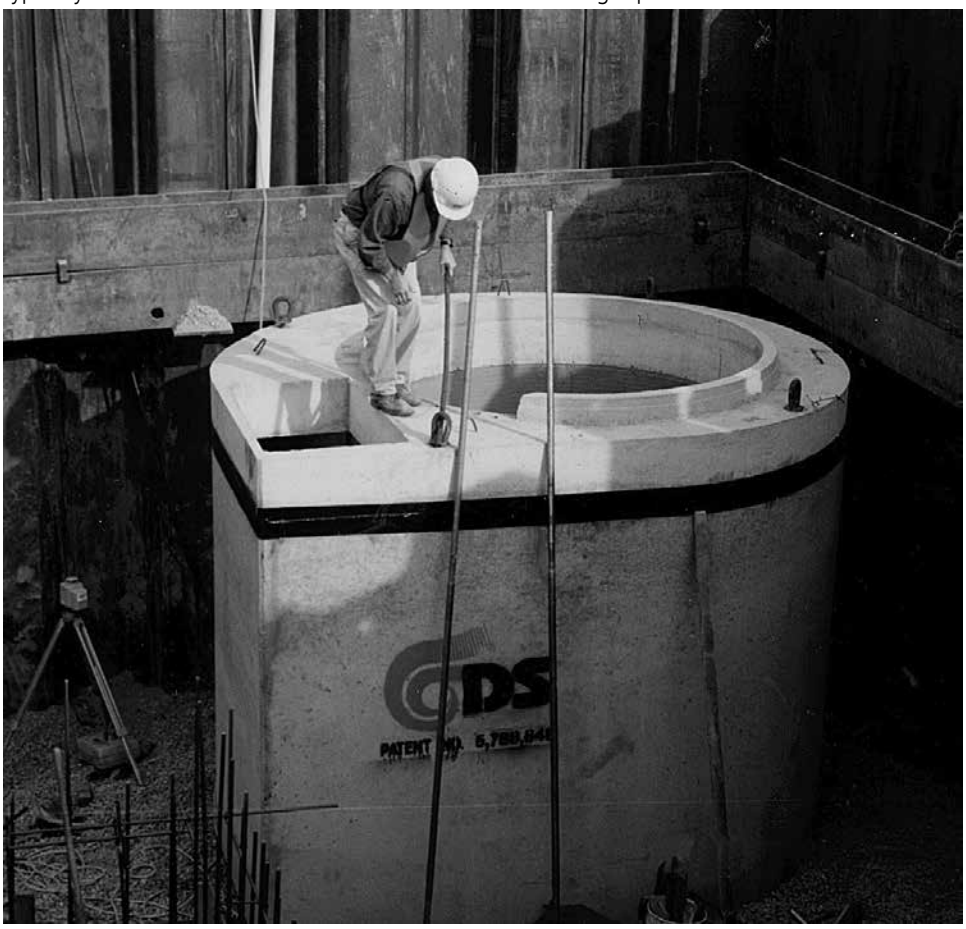
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should 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 cleaned 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. Check your local regulations for specific requirements on disposal.

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	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	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

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

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

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

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

SUPPORT

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

CONTECH®
ENGINEERED SOLUTIONS
800-338-1122
www.ContechES.com

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

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

cds_manual 3/17 PDF

LOADING AREA ONLY

TRENCH DRAIN

WQU

DMH

DMH

114.3'

FM

FM

FM

FM

FM

EN/EXT

EXIST. #296 BUILDING (TO REMAIN)

EXIST. BUILDING LOADING DOCK SERVICE AREA (TO REMAIN)

EXIST. COURTYARD AREA (TO REMAIN)

PROP. GMP FACILITY BUILDING
±121,630 SF (FOOTPRINT)
W/ 2ND-STORY MEZZANINE (±45,000 SF)
FFE=193.7±

SUBSURFACE DETENTION CHAMBER SYSTEM (TYP.)

AREA DRAIN

TRENCH DRAIN

DMH

DMH

DMH

SNOW STORAGE

SNOW STORAGE

WQI

SUBSURFACE DETENTION CHAMBER SYSTEM (TYP.)

OCS

WQI

WQI

WQI

WQI

SUBSURFACE INFILTRATION CHAMBER SYSTEM (TYP.)

APPROX. LOC. OF 24' WIDE ACCESS EASEMENT (REF. REF 7/10)

LOCATION MAHW/INLA
ON SITE VISITS COND
03/12/21, 03/15/21, 03/3
LUCAS ENVIRONMENT

LOCATION OF BORDERING VEGETATED WETLANDS BASED ON SITE VISITS CONDUCTED ON 03/08/21, 03/12/21, 03/15/21, 03/31/21 AND 10/07/22 BY LUCAS ENVIRONMENTAL, LLC.

PROPOSED BMP MAP

298 CONCORD ROAD
BILLERICA, MASSACHUSETTS

PREPARED BY

BOHLER

SCALE:1"=60' DATE: 03/28/2023

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