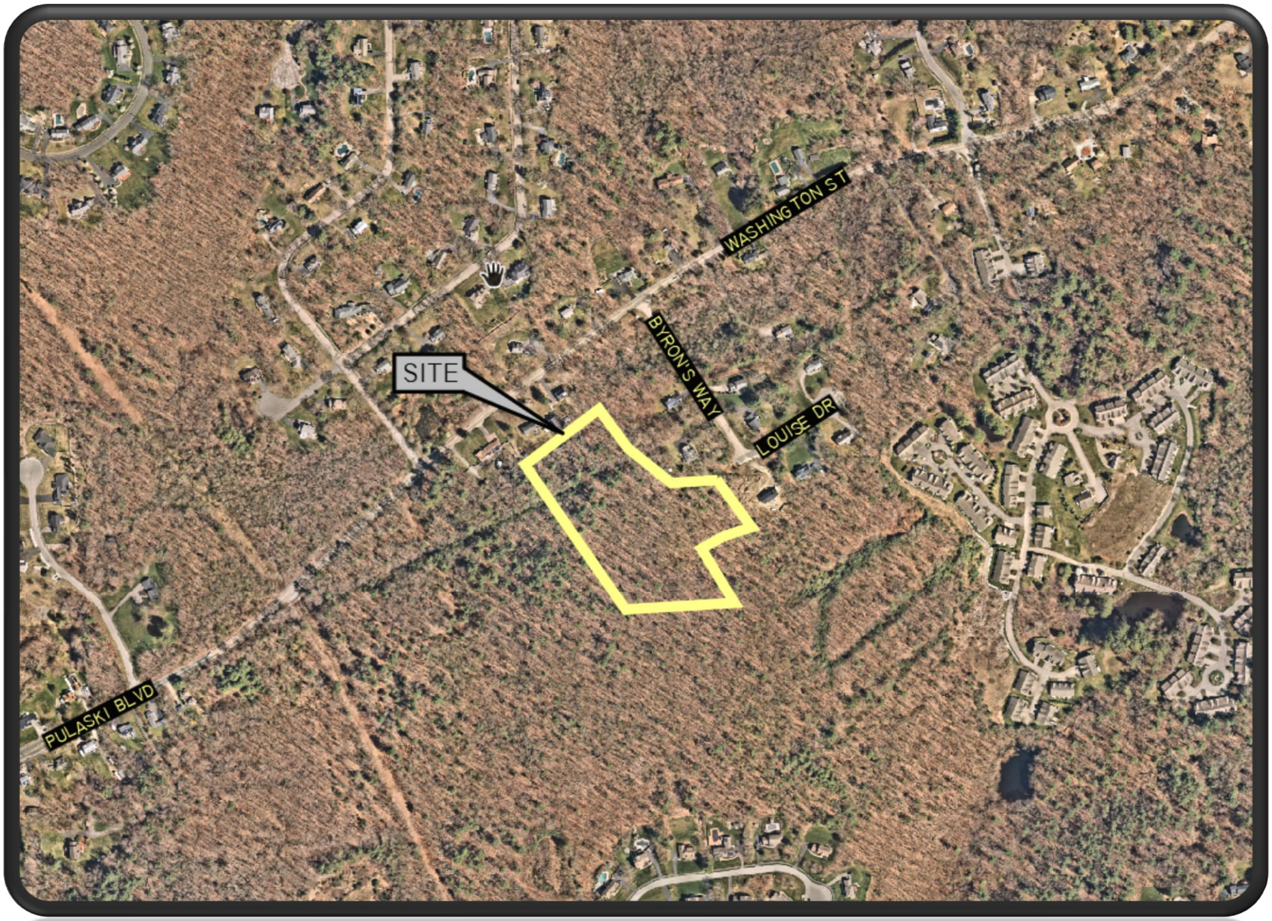
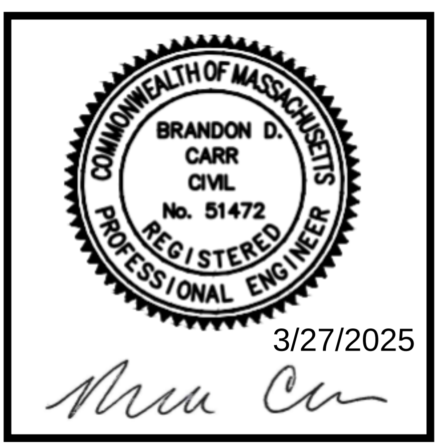
DiPrete Engineering

Stormwater Management Report





Louise Drive

Located in Franklin, MA

Applicant: Paul Longobardi

9-18-2024

Revised 1-22-2025

Revised 3-27-2025

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Executive Summary

On behalf of the Client, we are submitting drainage calculations for the proposed development on Louise Drive. The site is located on Assessors' Plat 339 Lots 13-16 & Assessors' Plat 349 Lot 2. The site exists today as almost entirely wooded area. The client proposes to construct a new roadway for four new homes and associated parking that will extend from the current Louise Drive. The post development stormwater will be treated for water quality using Best Management Practices (BMPs). The Site has been designed to the Massachusetts Stormwater Management Standards (MASWMS). Site constraints included a high groundwater table and crossing of a wetland.

To treat and mitigate post development flows on site, a proprietary treatment device, a series of catch basins, a sediment forebay, a sand filter, and a detention pond are utilized. The treatment train will remove TSS (total suspended solids) in accordance with the MASWMS. The infiltration / detention systems are designed to control runoff for the 2 through 100-year storm events.

This report details how the site will show no net increase in stormwater runoff from pre development to post development conditions, and how the proposed BMPs will meet the Massachusetts Stormwater Management Standards (MASWMS) and the Town of Frankin Stormwater Management Bylaw.

Pre development Conditions versus Post Development Conditions are summarized below:

Pre Development vs. Post Development Mitigated

Watershed 1: (DP-1)

Conditions – Peak Flow	2-Year	10-Year	25-Year	100-Year
Pre Dev Summation	5.64	17.78	29.37	56.17
Post Dev Summation	4.99	14.05	27.71	58.93
Net Change	-0.65	-3.73	-1.66	2.76

All flows in cubic feet per second (cfs)

Conditions – Volume	2-Year	10-Year	25-Year	100-Year
Pre Dev Summation	0.665	1.714	2.717	5.070
Post Dev Summation	0.702	1.780	2.768	5.030
Net Change	0.037	0.066	0.049	-0.040

All volumes in acre-feet (ac-ft)

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.

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
BRANDON D.
CARR
CIVIL
No. 51472
REGISTERED
PROFESSIONAL ENGINEER
01/22/2025

1/22/25

Signature and Date

Checklist

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

☑ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

Standard 3: Recharge

- ☑ Soil Analysis provided.
- ☐ Required Recharge Volume calculation provided.
- ☐ Required Recharge volume reduced through use of the LID site Design Credits.
- ☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.

  ☐ Static ☑ Simple Dynamic ☐ Dynamic Field[1]

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

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

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☑ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

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

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☑ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☑ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Standard 4: Water Quality (continued)

- [x] The BMP is sized (and calculations provided) based on:
  - [x] 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.
- [x] 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.

N/A **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 (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 (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.

1.0 Project Description

The purpose of this report is to specify a Storm Water Management System for the proposed development at 0 Louise Drive. A Stormwater System Operations and Maintenance Plan (O&M) has been prepared by DiPrete Engineering as a separate document.

The proposed development is located on Assessors' Plat 339 Lots 13-16 & Assessors' Plat 349 Lot 2 in Franklin, Massachusetts. The site is located on Louise Drive starting where it intersects with Byron's Way. The first watercourse that receives stormwater runoff downstream of the site is the Miscoe Brook.

The proposed development will include a paved roadway with provision for a future four new home subdivision and associated driveways. The future site will be serviced by private wells and private septic tanks.

Stormwater treatment and mitigation will be provided by utilizing Best Management Practices (BMPs) as established by the Massachusetts Stormwater Handbook. BMPs will consist of a proprietary treatment device, a series of catch basins, a sediment forebay, a sand filter, and a detention pond. The system has been designed to meet the MADEP Stormwater Handbook, otherwise known as the Massachusetts Stormwater Management Standards (MASWMS), and the Town of Frankin Stormwater Management Bylaws.

2.0 Site Conditions

2.1 SOILS

There are the following soil types within the analyzed area of the Site as mapped by the NRCS USDA Soil Conservation service:

Soil Symbol	Description	Hydrologic Group
103D	Charlton-Hollis-Rock outcrop complex, 15 to 20 percent slopes	B
104C	Hollis-Rock outcrop-Charlton complex, 3 to 15 percent slopes	D
302C	Montauk fine sandy loam, 8 to 15 percent slopes, extremely stony	C

The onsite soil includes 103D - Charlton-Hollis-Rock outcrop complex which is Hydrologic Group B soil due to the depth achieved in the test pits and lack of ledge shown on site in areas containing 103D soils. Other soils in and around the site include 104C – Hollis-Rock outcrop-Charlton complex, which is Hydrologic Group D soil, and 302C – Montauk fine sandy loam, which is Hydrologic Group C soil. Therefore, Hydrologic Group D has been used for modeling the 103D soil.

Site specific soil evaluations can be found in Appendix A2.1.

2.2 EXISTING SITE CONDITIONS

Currently the site is wooded. Stormwater runoff from the majority of the site flows overland and discharges to the existing wetland complex to the northeast of the site.

Stormwater from the site ultimately discharges to the Miscoe Brook. None of the stormwater discharging from the site is currently treated or detained before ultimately discharging to Miscoe Brook.

Design Point 1 (DP-1) represents the existing northeast wetland complex.

2.3 POST SITE CONDITIONS

The proposed drainage analysis uses stormwater management systems to control and treat runoff from the proposed development. The following BMP's are proposed and have been designed to include the following elements:

- Proprietary Separator (Downstream Defender)
    - Phosphorus removal capabilities
    - 3rd party testing demonstrates over 80% removal efficiency of TSS
    - 3rd party testing demonstrates over 80% removal efficiency of oils
- Sediment Forebay
    - Pretreatment of impervious areas.
    - 2.0'-4.0' forebay depth with proposed 2:1 reinforced slopes.
    - Acts as a stormwater bypass system. The water quality storm is directed to the water quality device while other storms are bypassed.
        - Equipped with Water quality stormwater event by-pass to the water quality BMP.
    - Sandy-loam or other slower infiltrating soil to be placed under the sediment forebays to inhibit infiltration within sediment forebay in areas with high in situ infiltration rates.
- Sand Filter
    - Fully infiltrates the water quality stormwater event.
    - 2.0' of sand media mix including 6" of top soil and 1.5' of filter sand for stormwater infiltration.
- Conveyance Swale
    - Diverts water around the pond complex to not impede on the abutters
- Detention pond
    - Provides a subdrain for high water table

The above elements will be used to meet the MASWMS.

3.0 Minimum Standards

The site has been designed to meet the MASWMS. The following sections outline how the site meets or exceeds the minimum required standards.

3.1 Minimum Standard 1: No New Untreated Discharges

There are no new untreated discharges from the proposed development.

3.2 Minimum Standard 2: Peak Rate Attenuation

3.2.1 Method of Analysis

USDA Soil Conservation Service Method as defined by Technical Release No. 20 (TR-20) determines Stormwater runoff rate and volume. Type III rainfall distribution is utilized. Time of concentration is determined using Technical Release No 55 (TR-55) methodology, through the computer program *HydroCAD ver. 10* by HydroCAD Software Solutions LLC.
Infiltration rates have been determined based on onsite soil evaluations. The soil evaluations were used to develop a texture class. Infiltration rates are based on Rawl's Rates. See table 2.3.3 of the Massachusetts Stormwater Handbook.

Based on the sandy loamy soil at the surface of the existing natural depression on site, an infiltration rate of 1.02 in/hr would have been used under existing conditions. Under proposed conditions, the A and B soil horizons are to be removed for the Sand filter so that the pond bottom can be set within the C soil horizon. An infiltration rate of 2.00 in/hr is used in the sand filter as proposed conditions per the MA Stormwater Handbook, V2C2 Page 59.

The 'bottom of pond' areas for open air infiltration BMPs have been modeled as CN 98, since the direct rainfall that hits the pond bottom enters the pond instantaneously without any appreciable losses.

The drainage system has been designed to mitigate all stormwater flows for the 2 through 100 year storm events. The outlets have been sized to handle the 100-year storm event and minimize potential erosion.

Drainage Network Design Parameters:

A. PIPES

- All drainage pipes are HDPE or equivalent unless otherwise noted.
- Manning's coefficient = 0.012 for HDPE Pipe
- Diameters & lengths as specified
- The 50-year design storm is utilized for the drainage pipe design and overland flow design to ensure that the drainage system contains and channels water to the BMP areas as shown on the plans.
- The rational method has been used for the closed drainage system.

B. STRUCTURES

- Catch basins – Pre-cast concrete with 4' sump unless otherwise noted, with inverts as specified
- Manholes – Pre-cast concrete with inverts as specified.

C. OPEN CHANNELS SYSTEMS (SWALES)

- All open channels systems shall be grassed channels unless otherwise noted.
- Manning's coefficient = 0.030 for grass
- Width, depth, slope and side slopes as noted on plans.
- The 100-year design storm is utilized for the open channel design to ensure that the drainage system contains and channels water to the BMP areas as shown on the plans.
- HydroCAD has been used to model the open channels/ swales. See Appendix A5.1.

3.2.2 Design Storm

Analysis of 2-year, 10-year, 25-year and 100-year frequency storms are included. The following 24-hour rainfall intensities are obtained from the Cornell Extreme Precipitation in New York & New England (http://precip.eas.cornell.edu/). Note: For design storms where the Hydrology Handbook for Conservation Commissioners (Table F-1) lists a higher intensity than the Cornell data, that intensity has been adopted in lieu of the Cornell figure.

Norfolk County.

2 year =	3.27 inches
10 year =	4.94 inches
25 year =	6.26 inches
100 year=	8.99 inches

3.2.3 Design Point Breakdown

The site is analyzed as 1 watershed area. In the pre development stage there are 2 sub-catchments. In the post development stage, there are 7 sub-catchments. Each watershed will demonstrate zero increase of runoff due to the proposed development. A description of each watershed and associated sub-catchments are summarized as follows, for cover types see color watershed maps located in back of this report. Numbers in parentheses ( ) indicate the HydroCAD Node Number.

Design Point 1:

Watershed #1 flows to Design Point 1 (DP-1)(12/119). This watershed consists of the entire site, plus upstream run on as shown on the Watershed Maps at the back of this report. The design point is the existing northeast wetland complex (12/119).

In pre development conditions there are 2 sub-catchments tributary to Design Point 1.

Pre-01 (10) collects stormwater runoff from the southeast section of the site. Water flows overland and discharges onto the neighboring abutter, which ultimately continues downstream to the existing MassDOT drainage network.

Pre-02 (11) collects stormwater runoff from the majority of the site flows overland and discharges to the existing wetland complex to the northeast of the site.

In post development conditions there are 7 sub-catchments tributary to Design Point 1.

Post-01 (100) collects runoff from the existing upland in the western central southern portion of the site, through a series of pipe network drainage structures (101, 104, 110, 111) which directs the stormwater to Pond Complex A (113, 114, 115) before being discharged to DP-1 (119) via overland flow.

Post-02 (102) collects runoff from a proposed home site and portion of the proposed roadway, through a series of pipe network drainage structures (103, 104, 110, 111) which directs the stormwater to Pond Complex A (113, 114, 115) before being discharged to DP-1 (119) via overland flow.

Post-03 (105) collects runoff from the existing upland in the western southern portion of the site, a proposed home site and southern portion of the proposed cul-de-sac through a series of pipe network drainage structures (106, 109, 110, 111) which directs the stormwater to Pond Complex A (113, 114, 115) before being discharged to DP-1 (119) via overland flow.

Post-04 (107) collects runoff from a proposed home and northern portion of the proposed cul-de-sac, through a series of pipe network drainage structures (108, 109, 110, 111) which directs the stormwater to Pond Complex A (113, 114, 115) before being discharged to DP-1 (119) via overland flow.

Post-05 (112) contains Pond Complex A. It collects runoff from a northern portion of the site and directs it via overland flow to Pond Complex A (113, 114, 115) before being discharged to DP-1 (119) via overland flow.

Post-06 (116) collects runoff from the existing upland in the eastern central southern portion of the site and directs via overland flow it through a Box Arch Culvert (117) into DP-1 (119).

Post-06A (116A) collects runoff from the existing upland in the eastern central southern portion of the site and directs via overland flow it through a Box Arch Culvert (117) into DP-1 (119).

Post-07 (118) contains the undetained area downgradient of Box Arch Culvert (113P). Stormwater discharges to DP-1 (119) via overland flow.

Post-08 (120) collects runoff from the existing upland in the eastern central southern portion of the site and directs via overland flow to a proprietary device (121) before reaching the existing detention pond off of Byron's Way (122).

Below is a summary of the hydrologic parameters for the pre and post development sub-catchments in Design Point-1 (119).

*Flowing to existing detention basin

	Area (acres)	CN	Tc (min)
Pre-01	1.145	55	10.9
Pre-02	12.075	65	13.5
Pre-03	1.240	55	13.3
Post-01	0.123	84	6.0
Post-02	0.431	75	6.0
Post-03	1.516	77	10.2
Post-04	0.350	84	6.0
Post-05	0.826	65	7.6
Post-06	1.646	59	12.8
Post-06A	4.283	70	12.2

Post-07	2.886	65	8.3
Post-08*	2.398	61	11.1

3.2.4 Outlet Protection

The proposed BMPs and drainage systems have been designed to minimize erosion from the proposed development. Outlet structures include rip rap where specified, to encourage non erosive velocities. Per the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas (Part III), design criteria for outlet protection should address peak runoff from the 10 year storm. Exit velocities equal to or less than 3.0 ft/s are considered non erosive.

Pipe Outlet Protection Calculations

In the absence of specific design data in the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas (Part III), the design equation listed in both the Rhode Island and Connecticut SESC manuals has been used to estimate exit velocity from the riprap pads, as follows:

$$L_a = \frac{1.7Q}{D_O^{3/2}} + 8D_O$$

Where:

La = required length of riprap apron (ft)

Q = outlet pipe discharge (cfs)

Do = outlet pipe diameter (ft)

For discharges where tailwater (TW) is > 0.5 Do, the width of distant end of riprap is:

W = 3*Do + 0.4*La

For stone size, d_{50} is determined by the following formula:

$$d_{50} = \left(\frac{0.02}{TW}\right)\left(\frac{Q}{D_o}\right)^{4/3}$$

Source: Rhode Island Soil Erosion and Sediment Control Handbook; Connecticut Guidelines for Soil Erosion and Sediment Control Handbook

The above equations are used to generate outlet protection parameters to promote non-erosive discharge. The table below shows a summary of the required and provided riprap pads. Note the 100 year discharges have been used, instead of the 10 year discharge. Therefore, the outlet protection pads are conservative:

Outlet Protection

Outlet	Do (ft)	100 Year Q (cfs)	La (ft) Required	W (ft) Required	d-50 (in)
FES-11	1.50	7.55	19	24	3

It should be noted that the 10-year storm is typically used for determining the above parameters, however the 100-year flow data has been used in this instance to be conservative.

Based on the equations, all proposed stone pad lengths will adequately reduce the exit velocities.

3.2.5 Standard 2 Conclusion

The tables below present a summary of the pre-development flows vs. the mitigated post development flows. The tables show a decrease in the rate of runoff and volume for all storms included in the analysis.

Pre Development vs. Post Development Mitigated

Watershed 1: (DP-1)

Conditions – Peak Flow	2-Year	10-Year	25-Year	100-Year
Pre Dev Summation	5.64	17.78	29.37	56.17
Post Dev Summation	4.99	14.05	27.71	58.93
Net Change	-0.65	-3.73	-1.66	2.76

All flows in cubic feet per second (cfs)

Conditions – Volume	2-Year	10-Year	25-Year	100-Year
Pre Dev Summation	0.665	1.714	2.717	5.070
Post Dev Summation	0.702	1.780	2.768	5.030
Net Change	0.037	0.066	0.049	-0.040

All volumes in acre-feet (ac-ft)

As shown in the tables above, there will be no increase in stormwater runoff flow for the 2 through 25 year storm events. The 100 year storm flow has a slight increase, however the volume for the 100 year storm decreases from pre to post development. The stormwater system has been designed to provide appropriate peak rate attenuation for the 2 through 25 year storm events and reduce the volume of the 100 year storm.

3.3 Minimum Standard 3: Recharge

Recharge is analyzed per watershed based on impervious area coverage in accordance with Standard 3. Groundwater recharge is determined from the following equation:

Rv=F*impervious area

Where: Rv=Required Recharge Volume (ac-ft)
F= Target Depth Factor based on Hydrologic Soil Group Recharge (see table below)
I=Impervious Area (acres)

HSG	Target Depth Factor (F) (inch)
A	0.60
B	0.35
C	0.25
D	0.10

Due to the presence of Hydraulic Group D soils, the Target Depth Factor for this project is 0.10 inches for the Recharge Volume.

For each treatment system, one practice is being used to meet both Standards 3 & 4. Town requirements specify a water quality/ recharge volume of 1”, which is equal to or larger than both the recharge and water quality volumes required by the MASWMS. Therefore, the town requirements overrule and 1” has been used for both recharge and water quality volumes in this analysis.

Recharge requirements will be met through the use of a sand filter(infiltrating).

Recharge has been analyzed using the Simple Dynamic (Computer Model) Method per the Massachusetts Stormwater Handbook Volume 3 Chapter 1, using HydroCAD.

The table below summarizes the required Recharge Volume for each BMP:

BMP	HSG	F (inch)	I (Acres)	R_v Required (ac-ft)
A	C	1	0.669	0.0558

A hydrocad model was created for each applicable BMP system using contributing impervious area (only) and calibrating the rainfall data to produce a runoff volume equal to the Required Recharge (Rv) volume per the table above, during the peak 2 hours of the storm. Exfiltration was set to apply to “horizontal area only”.

As shown in the reported results, all stormwater is recharged without exiting the pond.

See Appendix 3.3 for all HydroCAD results.

Drawdown

All infiltration BMPs are required to drain down the required recharge volume completely within 72 hours, using the following formula:

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:

Rv = Required Storage Volume

K = Saturated Hydraulic Conductivity for “Static” and “Simple Dynamic” Methods (Rawls Rate)

Bottom Area = Bottom Area of Recharge Structure

The table below summarizes the drawdown results for each BMP:

BMP	R_v (cu-ft)	K (in/hr)	Bottom Area (sf)	Drawdown (hr)
SF-A	2428	2.0	1,407	10.3

3.4 Minimum Standard 4: Water Quality

The proposed treatment train has been designed to meet or exceed water quality requirements per Standard 4.

The stormwater management system is required to provide a minimum of 80% TSS removal per Standard 4. See Appendix A3.4 for TSS Removal Calculation Worksheets.

For water quality volume requirements, per the Massachusetts Stormwater Handbook:

The required water quality volume equals 1.0 inch of runoff times the total impervious area of the post development project site for a discharge –

- From a land use with a higher potential pollutant load
- Within an area with a rapid infiltration rate (greater than 2.4 inches per hour)
- Within a Zone II or Interim Wellhead Protection Area
- Near or to the following critical areas:
    - Outstanding Resource Waters
    - Special Resource Waters
    - Bathing beaches
    - Shellfish growing areas
    - Cold-water fisheries

For all other discharges the required water quality volume equals 0.5 inches of runoff times the total impervious area of the post development site.

However, Town/ City requirements specify a water quality/ recharge volume of 1", which is equal to or larger than both the recharge and water quality volumes required by the MASWMS. Therefore, the Town/ City requirements overrule and 1" has been adopted.

For each treatment system, one practice is being used to meet both Standards 3 & 4. Therefore, the BMPs have been sized for the larger of the Recharge/ Water Quality Volume. See Section 3.3 for more details.

The stormwater management system is also required to provide a minimum of 80% TSS removal per Standard 4.

See Appendix 3.4 for TSS & TP removal worksheets.

3.4.1 Individual BMP Water Quality Requirements

Each BMP has been designed per the Massachusetts Stormwater Handbook to provide water quality treatment to the maximum extent practical.

Downstream Defender™ (121)

The Downstream Defender™ is a proprietary device which removes stormwater runoff sediment before stormwater is then discharged. The device also provides TP removal and was sized per the manufacturer's requirements.

3.4.2 TMDL

The proposed development site ultimately discharges stormwater to the Miscoe Brook (USGS-01103220), which has no listed impairments. Therefore, no TMDL applies to this site.

3.5 Minimum Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The site is not considered a LUHPPL.

3.6 Minimum Standard 6: Critical Areas

The site is not located within a critical resource area.

3.7 Minimum Standard 7: Redevelopments

The site is not classified as a redevelopment site.

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

See the plan set and Stormwater Pollution Prevention Plan (SWPPP) for this development prepared by DiPrete Engineering.

3.9 Minimum Standard 9: Operation and Maintenance Plan

See the Stormwater System Operations and Maintenance Plan prepared by DiPrete Engineering.

3.10 Minimum Standard 10: Prohibition of Illicit Discharges

There are no existing or proposed illicit discharges on site. As this project is within Wetlands jurisdiction, an Illicit Discharge Compliance Statement will be submitted to the issuing authority prior to the discharge of any stormwater to post-construction BMPs.

4.0 Town of Franklin Stormwater Management Ordinance

This section is intended to address any additional requirements of the Town of Franklin Stormwater Management and Erosion Control Bylaw and Town of Franklin Rules and Regulations Governing the Subdivision of Land that were not covered by the MASWMS. The following sections outline how the site meets or exceeds the minimum required standards.

4.1 Stormwater Conveyance System

Drainage Network Design Parameters:

A. PIPES

- *All Drainpipes shall be reinforced concrete pipe (RCP) having a minimum diameter of 12 inches.*
    - DiPrete Engineering is requesting a waiver to use HDPE in lieu of RCP.
    - All proposed pipes have a diameter of 12 inches or greater.
- *The designed culverts shall be of adequate capacity to accommodate flows from a fifty (50) year storm at a minimum. The closed storm drain system shall be of adequate capacity to accommodate flows from a twenty five (25) year storm at a minimum.*
    - The 100-year design storm has been utilized for the drainage pipe design to ensure that the drainage system captures and conveys stormwater to the BMP areas as shown on the plans.

B. STRUCTURES

- *All catch basins are to be constructed with sumps having a minimum depth of four (4) feet.*
    - Proposed catch basins have sumps of 4 foot depth.

C. STANDARDS

For new development sites

- *Retain the volume of runoff equivalent to, or greater than, 1.0 inch multiplied by the total post construction impervious surface area on the site.*
- *Remove 90% of the average annual load of total suspended solids (TSS) generated from the total post-construction impervious area on the site and 60% of the average annual load of total phosphorus (TP) generated from the total post-construction impervious surface area on the site.*

See Plan Set prepared by DiPrete Engineering and HydroCAD™ calculations to follow for Drainage Network Calculations.

Appendix A

A2.1 Soil Evaluations

DiPrete Engineering

Massachusetts Soil Evaluation Form

DE Project Number 3343-001

Property Owner: Pam Longobardi
Property Location: Louise Drive, Franklin
Date of Test Hole: 05/23/2024
Soil Evaluator: Tim Twohig   License Number: SE14783
Weather: Sunny to thunderstorms   Time: 8:00

TH dth 24-1 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Coarse Fragment % by Vol. Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Soil Colors - Moist (Munsell) Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-4"	-	-	10YR 2/1	-	-	fsl	1 Gr	Fr	
Bw	4-36"	-	-	10YR 5/4	7.5YR 5/6	22", 5%	fsl	1 SBK	Fr	
Cd1	36-48"	5	5	2.5Y 5/2	7.5YR 5/8	36", 10%	lfs	1 Pl	Fi	
Cd2	48-96"	15	15	Gley 1 5/10GY	-	-	Cb Gr lfs	1 Pl	Fi	

TH dth 24-2 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Coarse Fragment % by Vol. Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Soil Colors - Moist (Munsell) Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-6"	-	-	10YR 2/1	-	-	fsl	1 Gr	Fr	
Bw1	6-25"	-	-	10YR 5/4	-	-	fsl	1 SBK	Fr	
Bw2	25-32"	5	-	10YR 5/4	7.5YR 5/8	28", 5%	fsl	1 SBK	Fr	
Cd1	32-60"	5	-	2.5Y 5/2	7.5YR 5/8	32", 10%	lfs	1 Pl	Fi	
Cd2	60-96"	15	15	2.5Y 5/2	-	-	Cb Gr lfs	1 Pl	Fi	

TH dth 24-1 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 26" SHWT 22"

TH dth 24-2 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 36" SHWT 28"

Comments:

Massachusetts Soil Evaluation Form

DE Project Number 3343-001

Property Owner: Pam Longobardi
Property Location: Louise Drive, Franklin
Date of Test Hole: 05/23/2024
Soil Evaluator: Tim Twohig License Number: SE14783
Weather: Sunny to thunderstorms Time: 8:00

TH dth 24-3 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-5"	-	-	10YR 2/1	-	-	fsl	1 Gr	Fr	
Bw	5-28"	-	-	10YR 4/4	7.5YR 5/6	22", 15%	fsl	1 SBK	Fr	
Cd1	28-35"	-	-	2.5Y 5/3	7.5YR 5/8	28", 15%	lfs	1 Pl	Fi	
Cd2	35-96"	15	15	5Y 4/3	-	-	Cb Gr fsl	1 Pl	Fi	

TH dth 24-4 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-8"	-	-	10YR 2/2	-	-	fsl	1 Gr	Fr	
Bw	8-32"	-	-	10YR 4/4	7.5YR 5/6	25", 5%	fsl	1 SBK	Fr	
Cd1	32-60"	5	-	2.5Y 5/3	7.5YR 5/8	32", 10%	fsl	1 Pl	Fi	
Cd2	60-96"	15	15	2.5Y 5/3	7.5YR 5/8	60", 10%	Cb Gr lfs	1 Pl	Fi	

TH dth 24-3 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 28" SHWT 22"

TH dth 24-4 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 28" SHWT 25"

Comments: dth 24-4: Both Cd horizons have pockets of lfs and fsl

DiPrete Engineering

Massachusetts Soil Evaluation Form

DE Project Number 3343-001

Property Owner: Pam Longobardi
Property Location: Louise Drive, Franklin
Date of Test Hole: 05/23/2024
Soil Evaluator: Tim Twohig License Number: SE14783
Weather: Sunny to thunderstorms Time: 8:00

TH dth 24-5 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Coarse Fragment % by Vol. Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Soil Colors - Moist (Munsell) Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-10"	-	-	10YR 2/2	-	-	fsl	1 Gr	Fr	
Bw	10-24"	-	-	10YR 4/4	-	-	fsl	1 SBK	Fr	
Cd	24-96"	15	15	2.5Y 5/3	7.5YR 5/6	27", 5%	fsl	1 Pl	Fi	

TH dth 24-6 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Coarse Fragment % by Vol. Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Soil Colors - Moist (Munsell) Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-2"	-	-	10YR 2/2	-	-	fsl	1 Gr	Fr	
AB	2-8"	-	-	10YR 3/3	-	-	fsl	1 SBK	Fr	
Bw	8-31"	-	-	10YR 5/4	-	-	fsl	1 SBK	Fr	
Cd1	31-60"	-	-	10YR 5/3	7.5YR 5/6	31", 5%	lfs	1 Pl	Fi	
Cd2	60-84"	20	20	10YR 5/3	-	-	Cb Gr lfs	1 Pl	Fi	
2C	84-96"	15	-	2.5Y 5/3	-	-	Gr cos	0 SGR	Lo	

TH dth 24-5 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 36" SHWT 27"

TH dth 24-6 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 77" SHWT 31"

Comments:

DiPrete Engineering

Massachusetts Soil Evaluation Form

DE Project Number 3343-001

Property Owner: Pam Longobardi
Property Location: Louise Drive, Franklin
Date of Test Hole: 05/23/2024
Soil Evaluator: Tim Twohig License Number: SE14783
Weather: Sunny to thunderstorms Time: 8:00

TH dth 24-7 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Coarse Fragment % by Vol. Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Soil Colors - Moist (Munsell) Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-10"	-	-	10YR 2/2	-	-	fsl	1 Gr	Fr	
Bw	10-34"	-	-	10YR 5/4	-	-	fsl	1 SBK	Fr	
Cd	34-96"	10	10	2.5Y 5/3	7.5YR 5/6	34", 5%	lfs	0 M	Fi	

TH dth 24-8 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Coarse Fragment % by Vol. Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Soil Colors - Moist (Munsell) Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-8"	-	-	10YR 2/2	-	-	fsl	1 Gr	Fr	
Bw	8-24"	-	-	10YR 5/4	-	-	fsl	1 SBK	Fr	
Cd	24-72"	-	-	2.5Y 5/3	7.5YR 5/6	24", 5%	lfs	0 M	Fi	
2C	72-96"	-	-	2.5Y 4/3	7.5YR 5/6	-	s	0 SGR	Lo	

TH dth 24-7 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 41" SHWT 34"

TH dth 24-8 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 48" SHWT 24"

Comments:

DiPrete Engineering

Massachusetts Soil Evaluation Form

DE Project Number 3343-001

Property Owner: Pam Longobardi
Property Location: Louise Drive, Franklin
Date of Test Hole: 05/23/2024
Soil Evaluator: Tim Twohig   License Number: SE14783
Weather: Sunny to thunderstorms   Time: 8:00

TH dth 24-9 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-7"	-	-	10YR 2/2	-	-	fsl	1 Gr	Fr	
Bw	7-32"	-	-	10YR 5/4	7.5YR 5/6	28", 5%	fsl	1 SBK	Fr	
Cd	32-69"	10	10	2.5Y 5/3	2.5Y 5/2	32", 5%	fsl	0 M	Fr --> Fi	
2C	69-96"			2.5Y 5/3	-	-	ls	0 M	Fr	

TH dth 24-10 Horizon	Depth	Coarse Fragment % by Vol. Gravel	Cobbles & Stones	Soil Colors - Moist (Munsell) Matrix	Re-Dox Features	Re-Dox Depth, Percent	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
A	0-6"	-	-	10YR 2/2	-	-	fsl	1 Gr	Fr	
Bw	6-27"	-	-	10YR 5/4	-	-	fsl	1 SBK	Fr	
Cd1	27-67"	-	-	2.5Y 5/3	7.5YR 5/8	29", 5%	fsl	0 M	Fi	
Cd2	67-96"	15	15	2.5Y 5/3	-	-	Cb Gr fsl	0 M	Fi	

TH dth 24-9 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth - SHWT 28"

TH dth 24-10 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth 34" SHWT 29"

Comments:

Massachusetts Soil Evaluation Form

DE Project Number 3343-001

Property Owner: Pam Longobardi
Property Location: Louise Drive, Franklin
Date of Test Hole: 05/23/2024
Soil Evaluator: Tim Twohig License Number: SE14783
Weather: Sunny to thunderstorms Time: 8:00

TH dth 24-11 Horizon	Depth	Coarse Fragment % by Vol.		Soil Colors - Moist (Munsell)		Re-Dox	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
		Gravel	Cobbles & Stones	Matrix	Re-Dox Features	Depth, Percent				
A	0-5"	-	-	10YR 3/2	-	-	fsl	1 Gr	Fr	
Bw	5-27"	-	-	10YR 5/4	-	-	fsl	1 SBK	Fr	
Cd1	27-48"	-		2.5Y 5/3	7.5YR 5/6	27", 5%	fsl	0 M	Fi	
Cd2	48-96"	10	10	5Y 4/1	-	-	fsl	1 Pl	Fi	

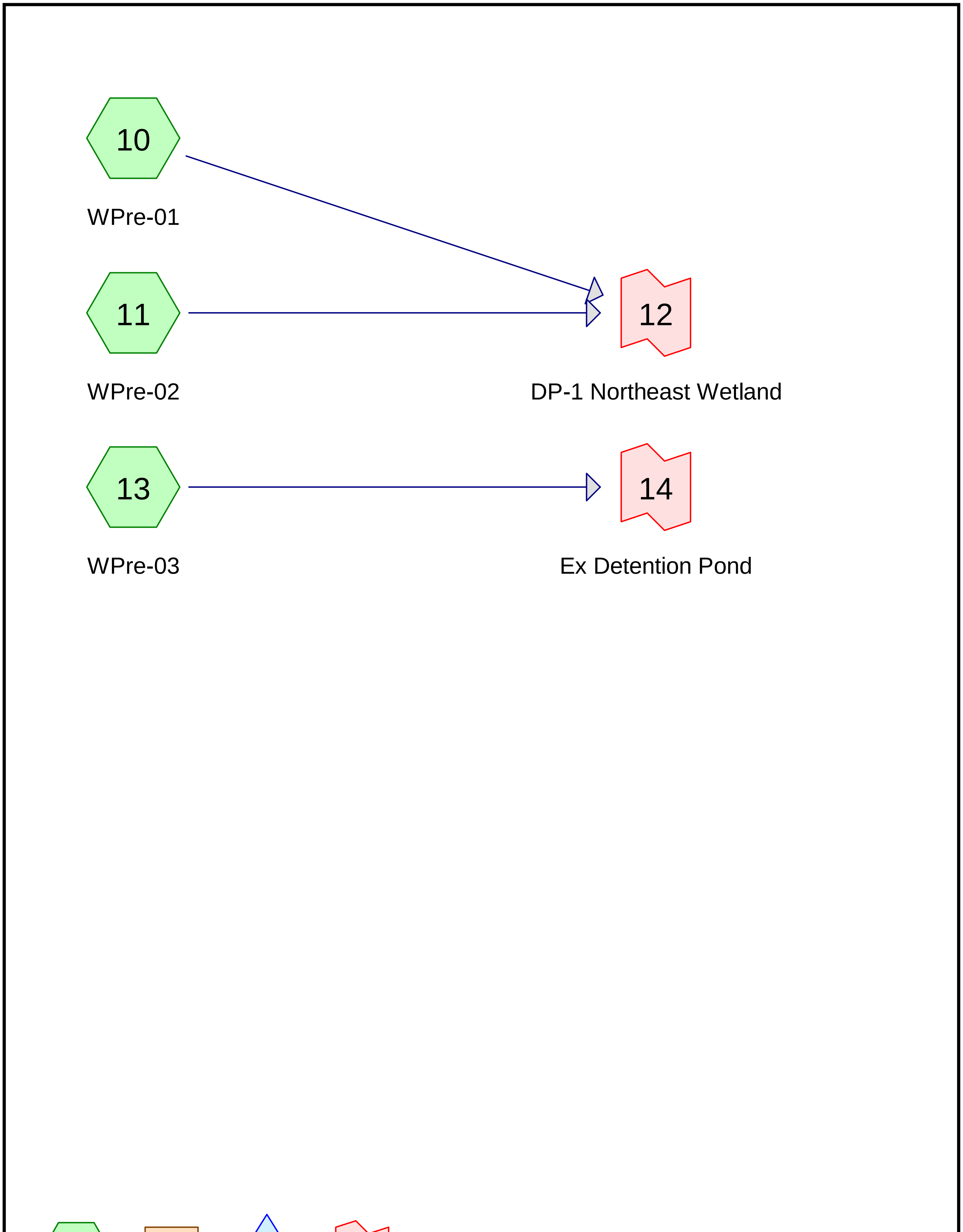
TH____ Horizon	Depth	Coarse Fragment % by Vol.		Soil Colors - Moist (Munsell)		Re-Dox	Soil Texture (USDA)	Soil Structure	Soil Consistence (Moist)	Other
		Gravel	Cobbles & Stones	Matrix	Re-Dox Features	Depth, Percent				

TH dth 24-11 Fill Depth - Total Depth 96" Impervious/Limiting Layer Depth - GW Seepage Depth - SHWT 27"

TH ______ Fill Depth ______ Total Depth ______ Impervious/Limiting Layer Depth ______ GW Seepage Depth ______ SHWT ______

Comments:

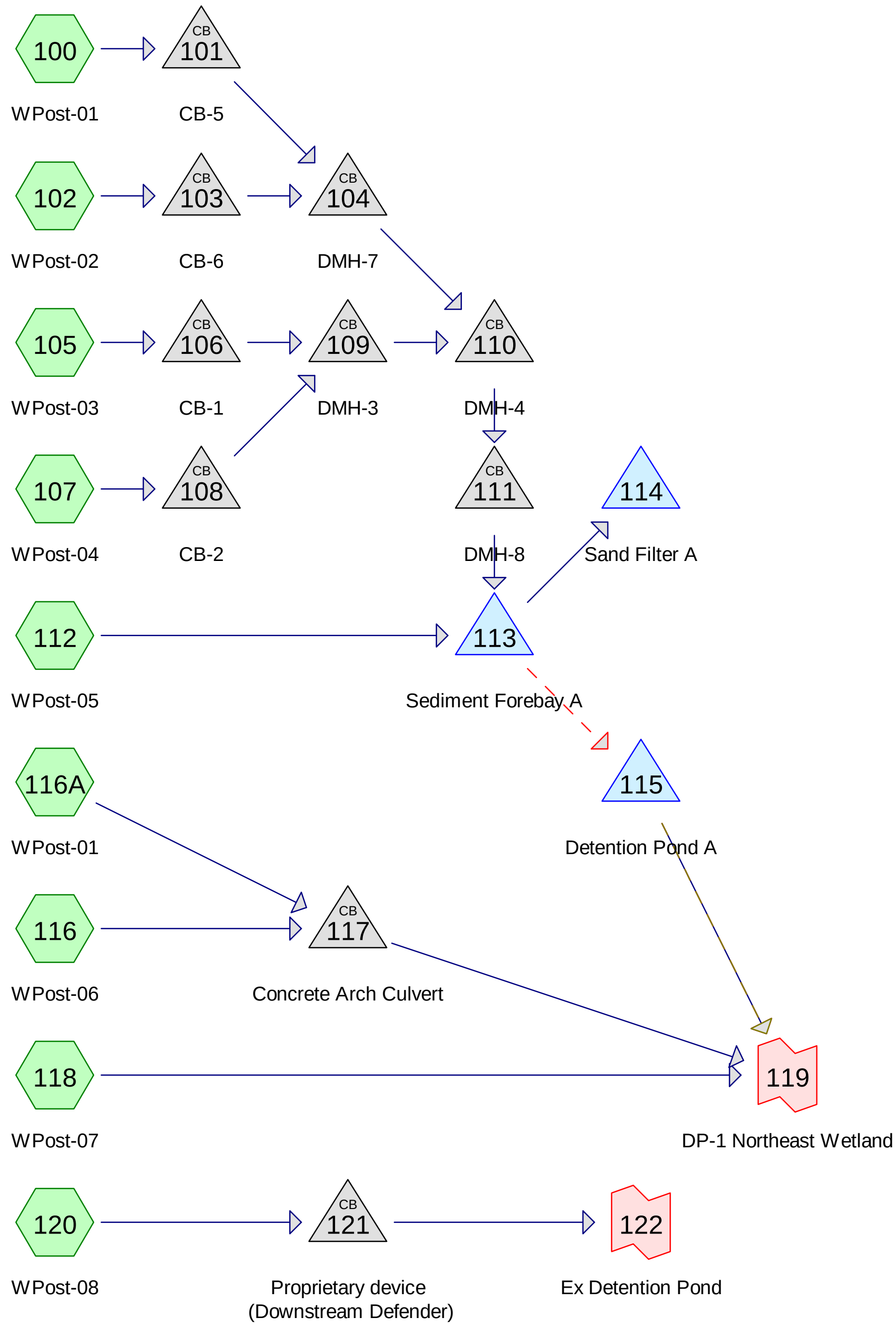
A3.2.1 HydroCAD Node Diagram

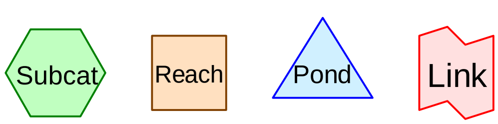


Routing Diagram for 3343-001-ALLS-EHCD-INHS-wApproved
Prepared by DiPrete Engineering, Printed 3/13/2025

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.015	61	>75% Grass cover, Good, HSG B (13)
0.143	74	>75% Grass cover, Good, HSG C (11)
8.371	55	Woods, Good, HSG B (10, 11, 13)
1.601	70	Woods, Good, HSG C (11)
4.330	77	Woods, Good, HSG D (10, 11)
14.460	**63**	**TOTAL AREA**





Routing Diagram for 3343-001-ALLS-PHCD-INHS-20250312
Prepared by DiPrete Engineering, Printed 3/13/2025
HydroCAD® 10.20-6a s/n 01125 © 2024 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.902	61	>75% Grass cover, Good, HSG B (100, 102, 105, 107, 112, 116, 118, 120)
0.726	74	>75% Grass cover, Good, HSG C (112, 118)
0.043	80	>75% Grass cover, Good, HSG D (100, 102, 105, 116, 118)
0.677	98	Impervious, HSG B (100, 102, 105, 107, 118, 120)
0.016	98	Impervious, HSG D (100, 102, 118, 120)
0.220	98	Roofs, HSG B (102, 105, 107, 118, 120)
0.000	98	Water Surface, 0% imp, HSG B (112)
0.022	98	Water Surface, 0% imp, HSG C (112)
5.586	55	Woods, Good, HSG B (100, 105, 107, 112, 116, 118, 120)
0.996	70	Woods, Good, HSG C (112, 118)
4.272	77	Woods, Good, HSG D (100, 105, 116, 118, 120)
14.460	**67**	**TOTAL AREA**

A3.2.2 HydroCAD 2-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10: WPre-01 Runoff Area=1.145 ac 0.00% Impervious Runoff Depth=0.27"
Flow Length=1,047' Tc=10.9 min CN=55 Runoff=0.13 cfs 0.026 af

Subcatchment 11: WPre-02 Runoff Area=12.075 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=1,701' Tc=13.5 min CN=65 Runoff=5.54 cfs 0.639 af

Subcatchment 13: WPre-03 Runoff Area=1.240 ac 0.00% Impervious Runoff Depth=0.27"
Flow Length=1,011' Tc=13.3 min CN=55 Runoff=0.14 cfs 0.028 af

Link 12: DP-1 Northeast Wetland Inflow=5.64 cfs 0.665 af
Primary=5.64 cfs 0.665 af

Link 14: Ex Detention Pond Inflow=0.14 cfs 0.028 af
Primary=0.14 cfs 0.028 af

Total Runoff Area = 14.460 ac Runoff Volume = 0.693 af Average Runoff Depth = 0.57"
100.00% Pervious = 14.460 ac 0.00% Impervious = 0.000 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100: WPost-01 Runoff Area=0.123 ac 60.16% Impervious Runoff Depth=1.74"
Tc=6.0 min CN=84 Runoff=0.25 cfs 0.018 af

Subcatchment 102: WPost-02 Runoff Area=0.431 ac 38.14% Impervious Runoff Depth=1.14"
Tc=6.0 min CN=75 Runoff=0.55 cfs 0.041 af

Subcatchment 105: WPost-03 Runoff Area=1.516 ac 14.18% Impervious Runoff Depth=1.26"
Flow Length=688' Tc=10.2 min CN=77 Runoff=1.89 cfs 0.159 af

Subcatchment 107: WPost-04 Runoff Area=0.350 ac 61.18% Impervious Runoff Depth=1.74"
Tc=6.0 min CN=84 Runoff=0.72 cfs 0.051 af

Subcatchment 112: WPost-05 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=161' Tc=7.6 min CN=65 Runoff=0.46 cfs 0.044 af

Subcatchment 116: WPost-06 Runoff Area=1.646 ac 0.00% Impervious Runoff Depth=0.40"
Flow Length=786' Tc=12.8 min CN=59 Runoff=0.35 cfs 0.055 af

Subcatchment 116A: WPost-01 Runoff Area=4.283 ac 0.00% Impervious Runoff Depth=0.87"
Flow Length=1,281' Tc=12.2 min CN=70 Runoff=3.18 cfs 0.310 af

Subcatchment 118: WPost-07 Runoff Area=2.886 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=435' Tc=8.3 min CN=65 Runoff=1.56 cfs 0.153 af

Subcatchment 120: WPost-08 Runoff Area=2.398 ac 10.22% Impervious Runoff Depth=0.47"
Flow Length=1,156' Tc=11.1 min CN=61 Runoff=0.72 cfs 0.095 af

Subcatchment 200: WPost-07 Node Runoff Area=2.896 ac 0.00% Impervious Runoff Depth=1.08"
Flow Length=434' Tc=12.6 min CN=74 Runoff=2.81 cfs 0.262 af

Reach 201: swale north of pond Avg. Flow Depth=0.45' Max Vel=2.63 fps Inflow=2.81 cfs 0.262 af
n=0.058 L=238.0' S=0.0588 '/' Capacity=16.61 cfs Outflow=2.78 cfs 0.262 af

Pond 101: CB-5 Peak Elev=375.24' Inflow=0.25 cfs 0.018 af
18.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=0.25 cfs 0.018 af

Pond 103: CB-6 Peak Elev=375.65' Inflow=0.55 cfs 0.041 af
15.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=0.55 cfs 0.041 af

Pond 104: DMH-7 Peak Elev=374.79' Inflow=0.81 cfs 0.059 af
24.00" Round Culvert n=0.012 L=48.0' S=0.0100 '/' Outflow=0.81 cfs 0.059 af

Pond 106: CB-1 Peak Elev=375.92' Inflow=1.89 cfs 0.159 af
24.00" Round Culvert n=0.012 L=21.0' S=0.0100 '/' Outflow=1.89 cfs 0.159 af

Pond 108: CB-2 Peak Elev=377.05' Inflow=0.72 cfs 0.051 af
10.00" Round Culvert n=0.012 L=201.0' S=0.0010 '/' Outflow=0.72 cfs 0.051 af

Pond 109: DMH-3 Peak Elev=375.69' Inflow=2.50 cfs 0.210 af
24.00" Round Culvert n=0.012 L=52.0' S=0.0200 '/' Outflow=2.50 cfs 0.210 af

Pond 110: DMH-4 Peak Elev=373.61' Inflow=3.25 cfs 0.269 af
36.00" Round Culvert n=0.013 L=227.0' S=0.0758 '/' Outflow=3.25 cfs 0.269 af

Pond 111: DMH-8 Peak Elev=359.70' Inflow=3.25 cfs 0.269 af
36.00" Round Culvert n=0.013 L=17.6' S=0.0114 '/' Outflow=3.25 cfs 0.269 af

Pond 113: Sediment Forebay A Peak Elev=359.69' Storage=1,500 cf Inflow=3.71 cfs 0.313 af
Primary=0.81 cfs 0.104 af Secondary=2.88 cfs 0.185 af Outflow=3.69 cfs 0.289 af

Pond 114: Sand Filter A Peak Elev=359.53' Storage=1,514 cf Inflow=0.81 cfs 0.104 af
Outflow=0.07 cfs 0.104 af

Pond 115: Detention Pond A Peak Elev=351.58' Storage=5,792 cf Inflow=2.88 cfs 0.185 af
Primary=0.09 cfs 0.185 af Secondary=0.00 cfs 0.000 af Outflow=0.09 cfs 0.185 af

Pond 117: Concrete Arch Culvert Peak Elev=377.90' Inflow=3.48 cfs 0.365 af
174.00" x 36.00", R=150.00" Arch Culvert n=0.012 L=40.5' S=0.0968 '/' Outflow=3.48 cfs 0.365 af

Pond 121: Proprietary device (Downstream Defender) Peak Elev=362.42' Inflow=0.72 cfs 0.095 af
15.00" Round Culvert n=0.012 L=100.0' S=0.1200 '/' Outflow=0.72 cfs 0.095 af

Link 119: DP-1 Northeast Wetland Inflow=4.99 cfs 0.702 af
Primary=4.99 cfs 0.702 af

Link 122: Ex Detention Pond Inflow=0.72 cfs 0.095 af
Primary=0.72 cfs 0.095 af

Total Runoff Area = 17.356 ac Runoff Volume = 1.187 af Average Runoff Depth = 0.82"
94.74% Pervious = 16.443 ac 5.26% Impervious = 0.913 ac

Summary for Pond 115: Detention Pond A

Inflow = 2.88 cfs @ 12.13 hrs, Volume= 0.185 af
Outflow = 0.09 cfs @ 17.00 hrs, Volume= 0.185 af, Atten= 97%, Lag= 292.2 min
Primary = 0.09 cfs @ 17.00 hrs, Volume= 0.185 af
Routed to Link 119 : DP-1 Northeast Wetland
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 119 : DP-1 Northeast Wetland

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 351.58' @ 17.00 hrs Surf.Area= 3,139 sf Storage= 5,792 cf

Plug-Flow detention time= 717.8 min calculated for 0.185 af (100% of inflow)
Center-of-Mass det. time= 717.9 min (1,545.6 - 827.7)

Volume	Invert	Avail.Storage	Storage Description
#1	348.00'	16,248 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

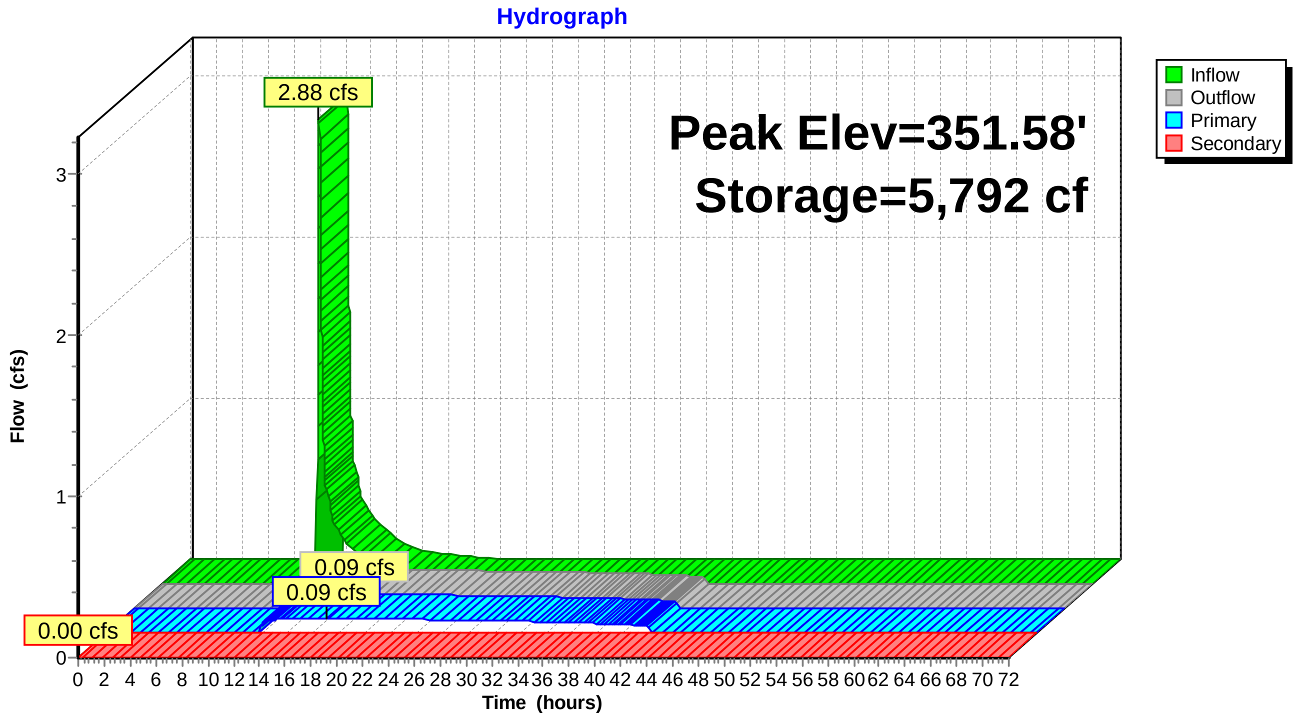
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
348.00	237	0	0
350.00	1,717	1,954	1,954
352.00	3,516	5,233	7,187
354.00	5,545	9,061	16,248

Device	Routing	Invert	Outlet Devices
#1	Primary	342.50'	**18.00" Round Culvert** L= 68.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 342.50' / 338.00' S= 0.0662 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	347.00'	**1.25" Vert. Low Flow 6"** C= 0.600 Limited to weir flow at low heads
#3	Device 1	351.60'	**30.00" W x 8.00" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	353.00'	**30.0' 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

Primary OutFlow Max=0.09 cfs @ 17.00 hrs HW=351.58' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.09 cfs of 21.67 cfs potential flow)
  ├─**2=Low Flow 6"** (Orifice Controls 0.09 cfs @ 10.25 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=348.00' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 115: Detention Pond A



Hydrograph for Pond 115: Detention Pond A

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0	348.00	0.00	0.00	**0.00**
2.00	0.00	0	348.00	0.00	0.00	0.00
4.00	0.00	0	348.00	0.00	0.00	0.00
6.00	0.00	0	348.00	0.00	0.00	0.00
8.00	0.00	0	348.00	0.00	0.00	0.00
10.00	0.00	0	348.00	0.00	0.00	0.00
12.00	**0.77**	37	348.13	0.04	0.04	0.00
14.00	**0.28**	4,919	351.29	0.08	0.08	0.00
16.00	0.13	**5,731**	**351.56**	**0.09**	**0.09**	0.00
18.00	0.06	**5,734**	**351.56**	**0.09**	**0.09**	0.00
20.00	0.03	5,398	351.45	0.09	0.09	0.00
22.00	0.01	4,941	351.30	0.08	0.08	0.00
24.00	0.00	4,391	351.10	0.08	0.08	0.00
26.00	0.00	3,805	350.88	0.08	0.08	0.00
28.00	0.00	3,236	350.64	0.08	0.08	0.00
30.00	0.00	2,686	350.39	0.07	0.07	0.00
32.00	0.00	2,158	350.12	0.07	0.07	0.00
34.00	0.00	1,653	349.82	0.07	0.07	0.00
36.00	0.00	1,177	349.49	0.06	0.06	0.00
38.00	0.00	733	349.12	0.06	0.06	0.00
40.00	0.00	330	348.68	0.05	0.05	0.00
42.00	0.00	0	348.00	0.00	0.00	0.00
44.00	0.00	0	348.00	0.00	0.00	0.00
46.00	0.00	0	348.00	0.00	0.00	0.00
48.00	0.00	0	348.00	0.00	0.00	0.00
50.00	0.00	0	348.00	0.00	0.00	0.00
52.00	0.00	0	348.00	0.00	0.00	0.00
54.00	0.00	0	348.00	0.00	0.00	0.00
56.00	0.00	0	348.00	0.00	0.00	0.00
58.00	0.00	0	348.00	0.00	0.00	0.00
60.00	0.00	0	348.00	0.00	0.00	0.00
62.00	0.00	0	348.00	0.00	0.00	0.00
64.00	0.00	0	348.00	0.00	0.00	0.00
66.00	0.00	0	348.00	0.00	0.00	0.00
68.00	0.00	0	348.00	0.00	0.00	0.00
70.00	0.00	0	348.00	0.00	0.00	0.00
72.00	0.00	0	348.00	0.00	0.00	0.00

A3.2.3 HydroCAD 10-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10: WPre-01 Runoff Area=1.145 ac 0.00% Impervious Runoff Depth=0.95"
Flow Length=1,047' Tc=10.9 min CN=55 Runoff=0.84 cfs 0.091 af

Subcatchment 11: WPre-02 Runoff Area=12.075 ac 0.00% Impervious Runoff Depth=1.61"
Flow Length=1,701' Tc=13.5 min CN=65 Runoff=16.94 cfs 1.624 af

Subcatchment 13: WPre-03 Runoff Area=1.240 ac 0.00% Impervious Runoff Depth=0.95"
Flow Length=1,011' Tc=13.3 min CN=55 Runoff=0.85 cfs 0.098 af

Link 12: DP-1 Northeast Wetland Inflow=17.78 cfs 1.714 af
Primary=17.78 cfs 1.714 af

Link 14: Ex Detention Pond Inflow=0.85 cfs 0.098 af
Primary=0.85 cfs 0.098 af

Total Runoff Area = 14.460 ac Runoff Volume = 1.813 af Average Runoff Depth = 1.50"
100.00% Pervious = 14.460 ac 0.00% Impervious = 0.000 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100: WPost-01 Runoff Area=0.123 ac 60.16% Impervious Runoff Depth=3.22"
Tc=6.0 min CN=84 Runoff=0.46 cfs 0.033 af

Subcatchment 102: WPost-02 Runoff Area=0.431 ac 38.14% Impervious Runoff Depth=2.40"
Tc=6.0 min CN=75 Runoff=1.21 cfs 0.086 af

Subcatchment 105: WPost-03 Runoff Area=1.516 ac 14.18% Impervious Runoff Depth=2.57"
Flow Length=688' Tc=10.2 min CN=77 Runoff=3.97 cfs 0.325 af

Subcatchment 107: WPost-04 Runoff Area=0.350 ac 61.18% Impervious Runoff Depth=3.22"
Tc=6.0 min CN=84 Runoff=1.31 cfs 0.094 af

Subcatchment 112: WPost-05 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=1.61"
Flow Length=161' Tc=7.6 min CN=65 Runoff=1.40 cfs 0.111 af

Subcatchment 116: WPost-06 Runoff Area=1.646 ac 0.00% Impervious Runoff Depth=1.20"
Flow Length=786' Tc=12.8 min CN=59 Runoff=1.61 cfs 0.165 af

Subcatchment 116A: WPost-01 Runoff Area=4.283 ac 0.00% Impervious Runoff Depth=1.99"
Flow Length=1,281' Tc=12.2 min CN=70 Runoff=7.98 cfs 0.711 af

Subcatchment 118: WPost-07 Runoff Area=2.886 ac 0.00% Impervious Runoff Depth=1.61"
Flow Length=435' Tc=8.3 min CN=65 Runoff=4.77 cfs 0.388 af

Subcatchment 120: WPost-08 Runoff Area=2.398 ac 10.22% Impervious Runoff Depth=1.33"
Flow Length=1,156' Tc=11.1 min CN=61 Runoff=2.84 cfs 0.266 af

Subcatchment 200: WPost-07 Node Runoff Area=2.896 ac 0.00% Impervious Runoff Depth=2.32"
Flow Length=434' Tc=12.6 min CN=74 Runoff=6.30 cfs 0.559 af

Reach 201: swale north of pond Avg. Flow Depth=0.65' Max Vel=3.24 fps Inflow=6.30 cfs 0.559 af
n=0.058 L=238.0' S=0.0588 '/' Capacity=16.61 cfs Outflow=6.25 cfs 0.559 af

Pond 101: CB-5 Peak Elev=375.34' Inflow=0.46 cfs 0.033 af
18.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=0.46 cfs 0.033 af

Pond 103: CB-6 Peak Elev=375.88' Inflow=1.21 cfs 0.086 af
15.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=1.21 cfs 0.086 af

Pond 104: DMH-7 Peak Elev=374.98' Inflow=1.67 cfs 0.119 af
24.00" Round Culvert n=0.012 L=48.0' S=0.0100 '/' Outflow=1.67 cfs 0.119 af

Pond 106: CB-1 Peak Elev=376.34' Inflow=3.97 cfs 0.325 af
24.00" Round Culvert n=0.012 L=21.0' S=0.0100 '/' Outflow=3.97 cfs 0.325 af

Pond 108: CB-2 Peak Elev=377.72' Inflow=1.31 cfs 0.094 af
10.00" Round Culvert n=0.012 L=201.0' S=0.0010 '/' Outflow=1.31 cfs 0.094 af

Pond 109: DMH-3 Peak Elev=376.05' Inflow=5.09 cfs 0.419 af
24.00" Round Culvert n=0.012 L=52.0' S=0.0200 '/' Outflow=5.09 cfs 0.419 af

Pond 110: DMH-4 Peak Elev=373.94' Inflow=6.64 cfs 0.538 af
36.00" Round Culvert n=0.013 L=227.0' S=0.0758 '/' Outflow=6.64 cfs 0.538 af

Pond 111: DMH-8 Peak Elev=359.92' Inflow=6.64 cfs 0.538 af
36.00" Round Culvert n=0.013 L=17.6' S=0.0114 '/' Outflow=6.65 cfs 0.538 af

Pond 113: Sediment Forebay A Peak Elev=359.88' Storage=1,626 cf Inflow=8.05 cfs 0.649 af
Primary=0.94 cfs 0.109 af Secondary=7.16 cfs 0.516 af Outflow=8.00 cfs 0.625 af

Pond 114: Sand Filter A Peak Elev=359.80' Storage=1,987 cf Inflow=0.94 cfs 0.109 af
Outflow=0.07 cfs 0.109 af

Pond 115: Detention Pond A Peak Elev=352.15' Storage=7,720 cf Inflow=7.16 cfs 0.516 af
Primary=3.35 cfs 0.516 af Secondary=0.00 cfs 0.000 af Outflow=3.35 cfs 0.516 af

Pond 117: Concrete Arch Culvert Peak Elev=378.07' Inflow=9.57 cfs 0.876 af
174.00" x 36.00", R=150.00" Arch Culvert n=0.012 L=40.5' S=0.0968 '/' Outflow=9.57 cfs 0.876 af

Pond 121: Proprietary device (Downstream Defender) Peak Elev=362.93' Inflow=2.84 cfs 0.266 af
15.00" Round Culvert n=0.012 L=100.0' S=0.1200 '/' Outflow=2.84 cfs 0.266 af

Link 119: DP-1 Northeast Wetland Inflow=14.05 cfs 1.780 af
Primary=14.05 cfs 1.780 af

Link 122: Ex Detention Pond Inflow=2.84 cfs 0.266 af
Primary=2.84 cfs 0.266 af

Total Runoff Area = 17.356 ac Runoff Volume = 2.738 af Average Runoff Depth = 1.89"
94.74% Pervious = 16.443 ac 5.26% Impervious = 0.913 ac

A3.2.4 HydroCAD 25-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10: WPre-01 Runoff Area=1.145 ac 0.00% Impervious Runoff Depth=1.67"
Flow Length=1,047' Tc=10.9 min CN=55 Runoff=1.70 cfs 0.159 af

Subcatchment 11: WPre-02 Runoff Area=12.075 ac 0.00% Impervious Runoff Depth=2.54"
Flow Length=1,701' Tc=13.5 min CN=65 Runoff=27.71 cfs 2.558 af

Subcatchment 13: WPre-03 Runoff Area=1.240 ac 0.00% Impervious Runoff Depth=1.67"
Flow Length=1,011' Tc=13.3 min CN=55 Runoff=1.72 cfs 0.173 af

Link 12: DP-1 Northeast Wetland Inflow=29.37 cfs 2.717 af
Primary=29.37 cfs 2.717 af

Link 14: Ex Detention Pond Inflow=1.72 cfs 0.173 af
Primary=1.72 cfs 0.173 af

Total Runoff Area = 14.460 ac Runoff Volume = 2.890 af Average Runoff Depth = 2.40"
100.00% Pervious = 14.460 ac 0.00% Impervious = 0.000 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100: WPost-01 Runoff Area=0.123 ac 60.16% Impervious Runoff Depth=4.44"
Tc=6.0 min CN=84 Runoff=0.63 cfs 0.046 af

Subcatchment 102: WPost-02 Runoff Area=0.431 ac 38.14% Impervious Runoff Depth=3.50"
Tc=6.0 min CN=75 Runoff=1.77 cfs 0.126 af

Subcatchment 105: WPost-03 Runoff Area=1.516 ac 14.18% Impervious Runoff Depth=3.71"
Flow Length=688' Tc=10.2 min CN=77 Runoff=5.72 cfs 0.468 af

Subcatchment 107: WPost-04 Runoff Area=0.350 ac 61.18% Impervious Runoff Depth=4.44"
Tc=6.0 min CN=84 Runoff=1.79 cfs 0.130 af

Subcatchment 112: WPost-05 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=2.54"
Flow Length=161' Tc=7.6 min CN=65 Runoff=2.28 cfs 0.175 af

Subcatchment 116: WPost-06 Runoff Area=1.646 ac 0.00% Impervious Runoff Depth=2.01"
Flow Length=786' Tc=12.8 min CN=59 Runoff=2.92 cfs 0.275 af

Subcatchment 116A: WPost-01 Runoff Area=4.283 ac 0.00% Impervious Runoff Depth=3.01"
Flow Length=1,281' Tc=12.2 min CN=70 Runoff=12.28 cfs 1.075 af

Subcatchment 118: WPost-07 Runoff Area=2.886 ac 0.00% Impervious Runoff Depth=2.54"
Flow Length=435' Tc=8.3 min CN=65 Runoff=7.79 cfs 0.611 af

Subcatchment 120: WPost-08 Runoff Area=2.398 ac 10.22% Impervious Runoff Depth=2.18"
Flow Length=1,156' Tc=11.1 min CN=61 Runoff=4.94 cfs 0.436 af

Subcatchment 200: WPost-07 Node Runoff Area=2.896 ac 0.00% Impervious Runoff Depth=3.40"
Flow Length=434' Tc=12.6 min CN=74 Runoff=9.34 cfs 0.822 af

Reach 201: swale north of pond Avg. Flow Depth=0.78' Max Vel=3.58 fps Inflow=9.34 cfs 0.822 af
n=0.058 L=238.0' S=0.0588 '/' Capacity=16.61 cfs Outflow=9.27 cfs 0.822 af

Pond 101: CB-5 Peak Elev=375.40' Inflow=0.63 cfs 0.046 af
18.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=0.63 cfs 0.046 af

Pond 103: CB-6 Peak Elev=376.05' Inflow=1.77 cfs 0.126 af
15.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=1.77 cfs 0.126 af

Pond 104: DMH-7 Peak Elev=375.11' Inflow=2.40 cfs 0.171 af
24.00" Round Culvert n=0.012 L=48.0' S=0.0100 '/' Outflow=2.40 cfs 0.171 af

Pond 106: CB-1 Peak Elev=376.66' Inflow=5.72 cfs 0.468 af
24.00" Round Culvert n=0.012 L=21.0' S=0.0100 '/' Outflow=5.72 cfs 0.468 af

Pond 108: CB-2 Peak Elev=378.40' Inflow=1.79 cfs 0.130 af
10.00" Round Culvert n=0.012 L=201.0' S=0.0010 '/' Outflow=1.79 cfs 0.130 af

Pond 109: DMH-3 Peak Elev=376.31' Inflow=7.25 cfs 0.598 af
24.00" Round Culvert n=0.012 L=52.0' S=0.0200 '/' Outflow=7.25 cfs 0.598 af

Pond 110: DMH-4 Peak Elev=374.16' Inflow=9.49 cfs 0.769 af
36.00" Round Culvert n=0.013 L=227.0' S=0.0758 '/' Outflow=9.49 cfs 0.769 af

Pond 111: DMH-8 Peak Elev=360.10' Inflow=9.49 cfs 0.769 af
36.00" Round Culvert n=0.013 L=17.6' S=0.0114 '/' Outflow=9.53 cfs 0.769 af

Pond 113: Sediment Forebay A Peak Elev=360.01' Storage=1,714 cf Inflow=11.81 cfs 0.944 af
Primary=0.72 cfs 0.114 af Secondary=11.07 cfs 0.806 af Outflow=11.73 cfs 0.920 af

Pond 114: Sand Filter A Peak Elev=359.95' Storage=2,258 cf Inflow=0.72 cfs 0.114 af
Outflow=0.07 cfs 0.114 af

Pond 115: Detention Pond A Peak Elev=352.63' Storage=9,609 cf Inflow=11.07 cfs 0.806 af
Primary=6.74 cfs 0.806 af Secondary=0.00 cfs 0.000 af Outflow=6.74 cfs 0.806 af

Pond 117: Concrete Arch Culvert Peak Elev=378.19' Inflow=15.18 cfs 1.351 af
174.00" x 36.00", R=150.00" Arch Culvert n=0.012 L=40.5' S=0.0968 '/' Outflow=15.18 cfs 1.351 af

Pond 121: Proprietary device (Downstream Defender) Peak Elev=363.52' Inflow=4.94 cfs 0.436 af
15.00" Round Culvert n=0.012 L=100.0' S=0.1200 '/' Outflow=4.94 cfs 0.436 af

Link 119: DP-1 Northeast Wetland Inflow=27.71 cfs 2.768 af
Primary=27.71 cfs 2.768 af

Link 122: Ex Detention Pond Inflow=4.94 cfs 0.436 af
Primary=4.94 cfs 0.436 af

Total Runoff Area = 17.356 ac Runoff Volume = 4.164 af Average Runoff Depth = 2.88"
94.74% Pervious = 16.443 ac 5.26% Impervious = 0.913 ac

A3.2.5 HydroCAD 100-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10: WPre-01 Runoff Area=1.145 ac 0.00% Impervious Runoff Depth=3.48"
Flow Length=1,047' Tc=10.9 min CN=55 Runoff=3.86 cfs 0.332 af

Subcatchment 11: WPre-02 Runoff Area=12.075 ac 0.00% Impervious Runoff Depth=4.71"
Flow Length=1,701' Tc=13.5 min CN=65 Runoff=52.43 cfs 4.738 af

Subcatchment 13: WPre-03 Runoff Area=1.240 ac 0.00% Impervious Runoff Depth=3.48"
Flow Length=1,011' Tc=13.3 min CN=55 Runoff=3.89 cfs 0.360 af

Link 12: DP-1 Northeast Wetland Inflow=56.17 cfs 5.070 af
Primary=56.17 cfs 5.070 af

Link 14: Ex Detention Pond Inflow=3.89 cfs 0.360 af
Primary=3.89 cfs 0.360 af

Total Runoff Area = 14.460 ac Runoff Volume = 5.430 af Average Runoff Depth = 4.51"
100.00% Pervious = 14.460 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 10: WPre-01

Runoff = 3.86 cfs @ 12.16 hrs, Volume= 0.332 af, Depth= 3.48"
Routed to Link 12 : DP-1 Northeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
1.143	55	Woods, Good, HSG B
0.002	77	Woods, Good, HSG D
1.145	55	Weighted Average
1.145		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.0720	0.11		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
3.6	997	0.0843	4.67		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
10.9	1,047	Total			

Summary for Subcatchment 11: WPre-02

Runoff = 52.43 cfs @ 12.19 hrs, Volume= 4.738 af, Depth= 4.71"
Routed to Link 12 : DP-1 Northeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.143	74	>75% Grass cover, Good, HSG C
6.003	55	Woods, Good, HSG B
1.601	70	Woods, Good, HSG C
4.328	77	Woods, Good, HSG D
12.075	65	Weighted Average
12.075		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0760	0.12		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
6.3	1,651	0.0731	4.35		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
13.5	1,701	Total			

Summary for Subcatchment 13: WPre-03

Runoff = 3.89 cfs @ 12.19 hrs, Volume= 0.360 af, Depth= 3.48"
Routed to Link 14 : Ex Detention Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

	Area (ac)	CN	Description
*	1.225	55	Woods, Good, HSG B
*	0.015	61	>75% Grass cover, Good, HSG B
	1.240	55	Weighted Average
	1.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	50	0.0320	0.08		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
3.2	961	0.0961	4.99		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
13.3	1,011	Total			

Summary for Link 12: DP-1 Northeast Wetland

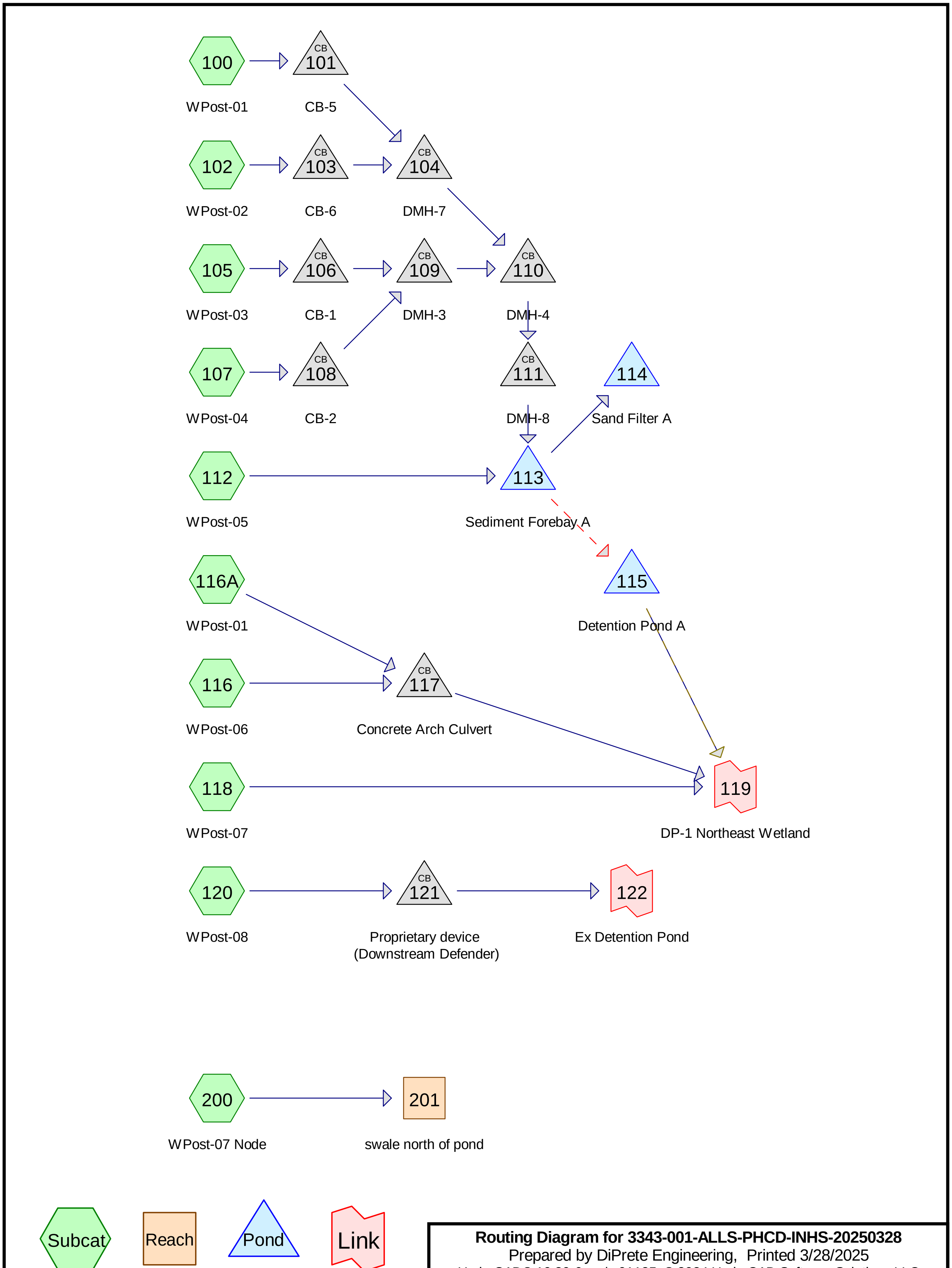
Inflow Area = 13.220 ac, 0.00% Impervious, Inflow Depth = 4.60" for 100-Year event
Inflow = 56.17 cfs @ 12.19 hrs, Volume= 5.070 af
Primary = 56.17 cfs @ 12.19 hrs, Volume= 5.070 af, Atten= 0%, Lag= 0.0 min
Routed to nonexistent node 17

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 14: Ex Detention Pond

Inflow Area = 1.240 ac, 0.00% Impervious, Inflow Depth = 3.48" for 100-Year event
Inflow = 3.89 cfs @ 12.19 hrs, Volume= 0.360 af
Primary = 3.89 cfs @ 12.19 hrs, Volume= 0.360 af, Atten= 0%, Lag= 0.0 min
Routed to nonexistent node 17

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



Routing Diagram for 3343-001-ALLS-PHCD-INHS-20250328
Prepared by DiPrete Engineering, Printed 3/28/2025
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Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100: WPost-01 Runoff Area=0.123 ac 60.16% Impervious Runoff Depth=7.05"
Tc=6.0 min CN=84 Runoff=0.98 cfs 0.072 af

Subcatchment 102: WPost-02 Runoff Area=0.431 ac 38.14% Impervious Runoff Depth=5.94"
Tc=6.0 min CN=75 Runoff=2.98 cfs 0.214 af

Subcatchment 105: WPost-03 Runoff Area=1.516 ac 14.18% Impervious Runoff Depth=6.19"
Flow Length=688' Tc=10.2 min CN=77 Runoff=9.45 cfs 0.782 af

Subcatchment 107: WPost-04 Runoff Area=0.350 ac 61.18% Impervious Runoff Depth=7.05"
Tc=6.0 min CN=84 Runoff=2.78 cfs 0.206 af

Subcatchment 112: WPost-05 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=4.71"
Flow Length=161' Tc=7.6 min CN=65 Runoff=4.31 cfs 0.324 af

Subcatchment 116: WPost-06 Runoff Area=1.646 ac 0.00% Impervious Runoff Depth=3.97"
Flow Length=786' Tc=12.8 min CN=59 Runoff=6.07 cfs 0.545 af

Subcatchment 116A: WPost-01 Runoff Area=4.283 ac 0.00% Impervious Runoff Depth=5.33"
Flow Length=1,281' Tc=12.2 min CN=70 Runoff=21.84 cfs 1.901 af

Subcatchment 118: WPost-07 Runoff Area=2.886 ac 0.00% Impervious Runoff Depth=4.71"
Flow Length=435' Tc=8.3 min CN=65 Runoff=14.70 cfs 1.132 af

Subcatchment 120: WPost-08 Runoff Area=2.398 ac 10.22% Impervious Runoff Depth=4.22"
Flow Length=1,156' Tc=11.1 min CN=61 Runoff=9.93 cfs 0.842 af

Subcatchment 200: WPost-07 Node Runoff Area=2.896 ac 0.00% Impervious Runoff Depth=5.82"
Flow Length=434' Tc=12.6 min CN=74 Runoff=15.90 cfs 1.405 af

Reach 201: swale north of pond Avg. Flow Depth=0.98' Max Vel=4.10 fps Inflow=15.90 cfs 1.405 af
n=0.058 L=238.0' S=0.0588 '/' Capacity=16.61 cfs Outflow=15.81 cfs 1.405 af

Pond 101: CB-5 Peak Elev=375.54' Inflow=0.98 cfs 0.072 af
18.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=0.98 cfs 0.072 af

Pond 103: CB-6 Peak Elev=376.36' Inflow=2.98 cfs 0.214 af
15.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=2.98 cfs 0.214 af

Pond 104: DMH-7 Peak Elev=375.34' Inflow=3.96 cfs 0.286 af
24.00" Round Culvert n=0.012 L=48.0' S=0.0100 '/' Outflow=3.96 cfs 0.286 af

Pond 106: CB-1 Peak Elev=377.54' Inflow=9.45 cfs 0.782 af
24.00" Round Culvert n=0.012 L=21.0' S=0.0100 '/' Outflow=9.45 cfs 0.782 af

Pond 108: CB-2 Peak Elev=380.48' Inflow=2.78 cfs 0.206 af
10.00" Round Culvert n=0.012 L=201.0' S=0.0010 '/' Outflow=2.78 cfs 0.206 af

Pond 109: DMH-3 Peak Elev=376.92' Inflow=11.84 cfs 0.988 af
24.00" Round Culvert n=0.012 L=52.0' S=0.0200 '/' Outflow=11.84 cfs 0.988 af

Pond 110: DMH-4 Peak Elev=374.56' Inflow=15.52 cfs 1.274 af
36.00" Round Culvert n=0.013 L=227.0' S=0.0758 '/' Outflow=15.52 cfs 1.274 af

Pond 111: DMH-8 Peak Elev=360.50' Inflow=15.52 cfs 1.274 af
36.00" Round Culvert n=0.013 L=17.6' S=0.0114 '/' Outflow=15.53 cfs 1.274 af

Pond 113: Sediment Forebay A Peak Elev=360.24' Storage=1,914 cf Inflow=19.84 cfs 1.598 af
Primary=0.89 cfs 0.122 af Secondary=18.92 cfs 1.452 af Outflow=19.77 cfs 1.574 af

Pond 114: Sand Filter A Peak Elev=360.13' Storage=2,608 cf Inflow=0.89 cfs 0.122 af
Outflow=0.07 cfs 0.122 af

Pond 115: Detention Pond A Peak Elev=353.23' Storage=12,301 cf Inflow=18.92 cfs 1.452 af
Primary=9.23 cfs 1.337 af Secondary=8.34 cfs 0.115 af Outflow=17.57 cfs 1.452 af

Pond 117: Concrete Arch Culvert Peak Elev=378.43' Inflow=27.87 cfs 2.446 af
174.00" x 36.00", R=150.00" Arch Culvert n=0.012 L=40.5' S=0.0968 '/' Outflow=27.87 cfs 2.446 af

Pond 121: Proprietary device (Downstream Defender) Peak Elev=366.25' Inflow=9.93 cfs 0.842 af
15.00" Round Culvert n=0.012 L=100.0' S=0.1200 '/' Outflow=9.93 cfs 0.842 af

Link 119: DP-1 Northeast Wetland Inflow=58.93 cfs 5.030 af
Primary=58.93 cfs 5.030 af

Link 122: Ex Detention Pond Inflow=9.93 cfs 0.842 af
Primary=9.93 cfs 0.842 af

Total Runoff Area = 17.356 ac Runoff Volume = 7.423 af Average Runoff Depth = 5.13"
94.74% Pervious = 16.443 ac 5.26% Impervious = 0.913 ac

Summary for Subcatchment 100: WPost-01

Runoff = 0.98 cfs @ 12.08 hrs, Volume= 0.072 af, Depth= 7.05"
Routed to Pond 101 : CB-5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.047	61	>75% Grass cover, Good, HSG B
0.002	80	>75% Grass cover, Good, HSG D
0.069	98	Impervious, HSG B
0.005	98	Impervious, HSG D
0.123	84	Weighted Average
0.049	62	39.84% Pervious Area
0.074	98	60.16% Impervious Area

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

Summary for Subcatchment 102: WPost-02

Runoff = 2.98 cfs @ 12.09 hrs, Volume= 0.214 af, Depth= 5.94"
Routed to Pond 103 : CB-6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.266	61	>75% Grass cover, Good, HSG B
0.001	80	>75% Grass cover, Good, HSG D
0.100	98	Impervious, HSG B
0.004	98	Impervious, HSG D
0.060	98	Roofs, HSG B
0.431	75	Weighted Average
0.267	61	61.86% Pervious Area
0.164	98	38.14% Impervious Area

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

Summary for Subcatchment 105: WPost-03

Runoff = 9.45 cfs @ 12.14 hrs, Volume= 0.782 af, Depth= 6.19"
Routed to Pond 106 : CB-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.283	61	>75% Grass cover, Good, HSG B
0.021	80	>75% Grass cover, Good, HSG D
0.165	98	Impervious, HSG B
0.050	98	Roofs, HSG B
0.023	55	Woods, Good, HSG B
0.974	77	Woods, Good, HSG D
1.516	77	Weighted Average
1.301	73	85.82% Pervious Area
0.215	98	14.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
1.6	399	0.0700	4.26		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
0.8	239	0.0623	5.07		**Shallow Concentrated Flow, C - Paved** Paved Kv= 20.3 fps
10.2	688	Total			

Summary for Subcatchment 107: WPost-04

Runoff = 2.78 cfs @ 12.08 hrs, Volume= 0.206 af, Depth= 7.05"
Routed to Pond 108 : CB-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.135	61	>75% Grass cover, Good, HSG B
0.154	98	Impervious, HSG B
0.060	98	Roofs, HSG B
0.001	55	Woods, Good, HSG B
0.350	84	Weighted Average
0.136	61	38.82% Pervious Area
0.214	98	61.18% Impervious Area

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

Summary for Subcatchment 112: WPost-05

Runoff = 4.31 cfs @ 12.11 hrs, Volume= 0.324 af, Depth= 4.71"
Routed to Pond 113 : Sediment Forebay A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.298	61	>75% Grass cover, Good, HSG B
0.271	74	>75% Grass cover, Good, HSG C
0.000	98	Water Surface, 0% imp, HSG B
0.022	98	Water Surface, 0% imp, HSG C
0.230	55	Woods, Good, HSG B
0.005	70	Woods, Good, HSG C
0.826	65	Weighted Average
0.826	65	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	30	0.0670	0.15		**Sheet Flow, A** Grass: Dense n= 0.240 P2= 3.27"
3.9	20	0.0550	0.09		**Sheet Flow, B** Woods: Light underbrush n= 0.400 P2= 3.27"
0.4	111	0.0847	4.69		**Shallow Concentrated Flow, C** Unpaved Kv= 16.1 fps
7.6	161	Total			

Summary for Subcatchment 116: WPost-06

Runoff = 6.07 cfs @ 12.18 hrs, Volume= 0.545 af, Depth= 3.97"
Routed to Pond 117 : Concrete Arch Culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.014	61	>75% Grass cover, Good, HSG B
0.013	80	>75% Grass cover, Good, HSG D
1.319	55	Woods, Good, HSG B
0.301	77	Woods, Good, HSG D
1.646	59	Weighted Average
1.646	59	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	100	0.1230	0.16		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
2.5	686	0.0833	4.65		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
12.8	786	Total			

Summary for Subcatchment 116A: WPost-01

Runoff = 21.84 cfs @ 12.17 hrs, Volume= 1.901 af, Depth= 5.33"
Routed to Pond 117 : Concrete Arch Culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.116	61	>75% Grass cover, Good, HSG B
1.287	55	Woods, Good, HSG B
2.880	77	Woods, Good, HSG D
4.283	70	Weighted Average
4.283	70	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	50	0.0760	0.12		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
5.0	1,231	0.0654	4.12		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
12.2	1,281	Total			

Summary for Subcatchment 118: WPost-07

Runoff = 14.70 cfs @ 12.12 hrs, Volume= 1.132 af, Depth= 4.71"
Routed to Link 119 : DP-1 Northeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.261	61	>75% Grass cover, Good, HSG B
0.456	74	>75% Grass cover, Good, HSG C
0.006	80	>75% Grass cover, Good, HSG D
0.000	98	Impervious, HSG B
0.000	98	Impervious, HSG D
0.000	98	Roofs, HSG B
1.058	55	Woods, Good, HSG B
0.991	70	Woods, Good, HSG C
0.114	77	Woods, Good, HSG D
2.886	65	Weighted Average
2.886	65	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	50	0.0780	0.12		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
1.2	385	0.1094	5.33		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
8.3	435	Total			

Summary for Subcatchment 120: WPost-08

Runoff = 9.93 cfs @ 12.16 hrs, Volume= 0.842 af, Depth= 4.22"
Routed to Pond 121 : Proprietary device (Downstream Defender)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.483	61	>75% Grass cover, Good, HSG B
0.189	98	Impervious, HSG B
0.006	98	Impervious, HSG D
0.050	98	Roofs, HSG B
1.668	55	Woods, Good, HSG B
0.002	77	Woods, Good, HSG D
2.398	61	Weighted Average
2.153	56	89.78% Pervious Area
0.245	98	10.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	50	0.0720	0.11		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
3.1	874	0.0833	4.65		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
0.7	232	0.0849	5.91		**Shallow Concentrated Flow, C** Paved Kv= 20.3 fps
11.1	1,156	Total			

Summary for Subcatchment 200: WPost-07 Node

Runoff = 15.90 cfs @ 12.17 hrs, Volume= 1.405 af, Depth= 5.82"
Routed to Reach 201 : swale north of pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.298	74	>75% Grass cover, Good, HSG C
0.244	80	>75% Grass cover, Good, HSG D
0.000	98	Impervious, HSG D
0.000	98	Roofs, HSG D
1.260	70	Woods, Good, HSG C
1.094	77	Woods, Good, HSG D
2.896	74	Weighted Average
2.896	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	100	0.0900	0.14		**Sheet Flow, A** Woods: Light underbrush n= 0.400 P2= 3.27"
1.0	334	0.1107	5.36		**Shallow Concentrated Flow, B** Unpaved Kv= 16.1 fps
12.6	434	Total			

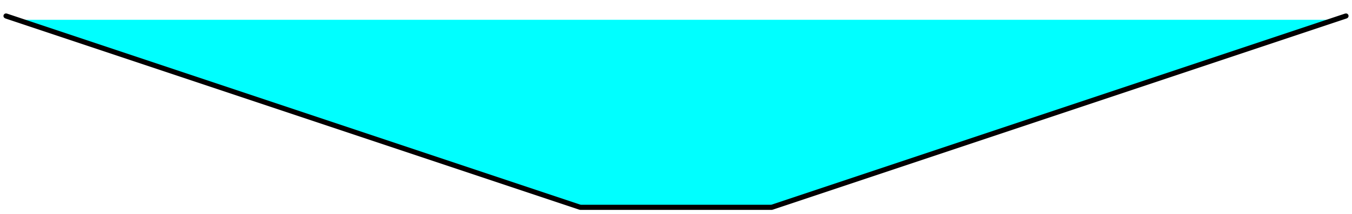
Summary for Reach 201: swale north of pond

Inflow Area = 2.896 ac, 0.00% Impervious, Inflow Depth = 5.82" for 100-Year event
Inflow = 15.90 cfs @ 12.17 hrs, Volume= 1.405 af
Outflow = 15.81 cfs @ 12.18 hrs, Volume= 1.405 af, Atten= 1%, Lag= 0.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.10 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 2.6 min

Peak Storage= 918 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.98' , Surface Width= 6.88'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 16.61 cfs

1.00' x 1.00' deep channel, n= 0.058
Side Slope Z-value= 3.0 '/' Top Width= 7.00'
Length= 238.0' Slope= 0.0588 '/'
Inlet Invert= 352.00', Outlet Invert= 338.00'



Summary for Pond 101: CB-5

Inflow Area = 0.123 ac, 60.16% Impervious, Inflow Depth = 7.05" for 100-Year event
Inflow = 0.98 cfs @ 12.08 hrs, Volume= 0.072 af
Outflow = 0.98 cfs @ 12.08 hrs, Volume= 0.072 af, Atten= 0%, Lag= 0.0 min
Primary = 0.98 cfs @ 12.08 hrs, Volume= 0.072 af
Routed to Pond 104 : DMH-7

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 375.54' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	374.97'	**18.00" Round Pipe** L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 374.97' / 374.88' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.96 cfs @ 12.08 hrs HW=375.54' TW=375.34' (Dynamic Tailwater)
↑—**1=Pipe** (Outlet Controls 0.96 cfs @ 2.31 fps)

Summary for Pond 103: CB-6

Inflow Area = 0.431 ac, 38.14% Impervious, Inflow Depth = 5.94" for 100-Year event
Inflow = 2.98 cfs @ 12.09 hrs, Volume= 0.214 af
Outflow = 2.98 cfs @ 12.09 hrs, Volume= 0.214 af, Atten= 0%, Lag= 0.0 min
Primary = 2.98 cfs @ 12.09 hrs, Volume= 0.214 af
Routed to Pond 104 : DMH-7

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 376.36' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	375.22'	**15.00" Round Pipe** L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 375.22' / 375.13' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=2.98 cfs @ 12.09 hrs HW=376.36' TW=375.34' (Dynamic Tailwater)
↑—**1=Pipe** (Barrel Controls 2.98 cfs @ 3.32 fps)

Summary for Pond 104: DMH-7

Inflow Area = 0.554 ac, 43.03% Impervious, Inflow Depth = 6.19" for 100-Year event
Inflow = 3.96 cfs @ 12.09 hrs, Volume= 0.286 af
Outflow = 3.96 cfs @ 12.09 hrs, Volume= 0.286 af, Atten= 0%, Lag= 0.0 min
Primary = 3.96 cfs @ 12.09 hrs, Volume= 0.286 af
Routed to Pond 110 : DMH-4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 375.34' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	374.38'	**24.00" Round Pipe** L= 48.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 374.38' / 373.90' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=3.95 cfs @ 12.09 hrs HW=375.34' TW=374.52' (Dynamic Tailwater)
↑—**1=Pipe** (Inlet Controls 3.95 cfs @ 2.64 fps)

Summary for Pond 106: CB-1

Inflow Area = 1.516 ac, 14.18% Impervious, Inflow Depth = 6.19" for 100-Year event
Inflow = 9.45 cfs @ 12.14 hrs, Volume= 0.782 af
Outflow = 9.45 cfs @ 12.14 hrs, Volume= 0.782 af, Atten= 0%, Lag= 0.0 min
Primary = 9.45 cfs @ 12.14 hrs, Volume= 0.782 af
Routed to Pond 109 : DMH-3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 377.54' @ 12.14 hrs
Flood Elev= 381.95'

Device	Routing	Invert	Outlet Devices
#1	Primary	375.15'	**24.00" Round Pipe** L= 21.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 375.15' / 374.94' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=9.58 cfs @ 12.14 hrs HW=377.54' TW=376.89' (Dynamic Tailwater)
↑—**1=Pipe** (Inlet Controls 9.58 cfs @ 3.05 fps)

Summary for Pond 108: CB-2

Inflow Area = 0.350 ac, 61.18% Impervious, Inflow Depth = 7.05" for 100-Year event
Inflow = 2.78 cfs @ 12.08 hrs, Volume= 0.206 af
Outflow = 2.78 cfs @ 12.08 hrs, Volume= 0.206 af, Atten= 0%, Lag= 0.0 min
Primary = 2.78 cfs @ 12.08 hrs, Volume= 0.206 af
Routed to Pond 109 : DMH-3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 380.48' @ 12.08 hrs
Flood Elev= 381.86'

Device	Routing	Invert	Outlet Devices
#1	Primary	376.31'	**10.00" Round Pipe** L= 201.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 376.31' / 376.10' S= 0.0010 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.55 sf

Primary OutFlow Max=2.78 cfs @ 12.08 hrs HW=380.46' TW=376.77' (Dynamic Tailwater)
↑—**1=Pipe** (Barrel Controls 2.78 cfs @ 5.10 fps)

Summary for Pond 109: DMH-3

Inflow Area = 1.866 ac, 23.00% Impervious, Inflow Depth = 6.35" for 100-Year event
Inflow = 11.84 cfs @ 12.12 hrs, Volume= 0.988 af
Outflow = 11.84 cfs @ 12.12 hrs, Volume= 0.988 af, Atten= 0%, Lag= 0.0 min
Primary = 11.84 cfs @ 12.12 hrs, Volume= 0.988 af
Routed to Pond 110 : DMH-4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 376.92' @ 12.12 hrs
Flood Elev= 381.55'

Device	Routing	Invert	Outlet Devices
#1	Primary	374.94'	**24.00" Round Pipe** L= 52.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 374.94' / 373.90' S= 0.0200 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=11.83 cfs @ 12.12 hrs HW=376.91' TW=374.55' (Dynamic Tailwater)
↑**1=Pipe** (Inlet Controls 11.83 cfs @ 3.77 fps)

Summary for Pond 110: DMH-4

Inflow Area = 2.421 ac, 27.59% Impervious, Inflow Depth = 6.31" for 100-Year event
Inflow = 15.52 cfs @ 12.11 hrs, Volume= 1.274 af
Outflow = 15.52 cfs @ 12.11 hrs, Volume= 1.274 af, Atten= 0%, Lag= 0.0 min
Primary = 15.52 cfs @ 12.11 hrs, Volume= 1.274 af
Routed to Pond 111 : DMH-8

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 374.56' @ 12.11 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	372.90'	**36.00" Round Culvert** L= 227.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 372.90' / 355.70' S= 0.0758 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 7.07 sf

Primary OutFlow Max=15.51 cfs @ 12.11 hrs HW=374.56' TW=360.50' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 15.51 cfs @ 3.87 fps)

Summary for Pond 111: DMH-8

Inflow Area = 2.421 ac, 27.59% Impervious, Inflow Depth = 6.31" for 100-Year event
Inflow = 15.52 cfs @ 12.11 hrs, Volume= 1.274 af
Outflow = 15.53 cfs @ 12.11 hrs, Volume= 1.274 af, Atten= 0%, Lag= 0.0 min
Primary = 15.53 cfs @ 12.11 hrs, Volume= 1.274 af
Routed to Pond 113 : Sediment Forebay A

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 360.50' @ 12.12 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	355.70'	**36.00" Round Culvert** L= 17.6' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 355.70' / 355.50' S= 0.0114 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 7.07 sf

Primary OutFlow Max=15.30 cfs @ 12.11 hrs HW=360.50' TW=360.24' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 15.30 cfs @ 2.17 fps)

Summary for Pond 113: Sediment Forebay A

Inflow Area = 3.247 ac, 20.57% Impervious, Inflow Depth = 5.91" for 100-Year event
Inflow = 19.84 cfs @ 12.11 hrs, Volume= 1.598 af
Outflow = 19.77 cfs @ 12.12 hrs, Volume= 1.574 af, Atten= 0%, Lag= 0.4 min
Primary = 0.89 cfs @ 12.09 hrs, Volume= 0.122 af
Routed to Pond 114 : Sand Filter A
Secondary = 18.92 cfs @ 12.12 hrs, Volume= 1.452 af
Routed to Pond 115 : Detention Pond A

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 360.24' @ 12.12 hrs Surf.Area= 800 sf Storage= 1,914 cf

Plug-Flow detention time= 19.9 min calculated for 1.573 af (98% of inflow)
Center-of-Mass det. time= 10.8 min (821.0 - 810.2)

Volume	Invert	Avail.Storage	Storage Description
#1	356.00'	3,071 cf	**Ponding Storage (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
356.00	162	0	0
358.00	405	567	567
359.00	565	485	1,052
359.10	582	57	1,109
360.00	750	599	1,709
361.00	959	855	2,563
361.50	1,071	508	3,071

Device	Routing	Invert	Outlet Devices
#1	Primary	359.00'	**6.00" Round Culvert X 2.00** L= 24.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 359.00' / 359.00' S= 0.0000 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf
#2	Secondary	359.45'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.86 cfs @ 12.09 hrs HW=360.22' TW=360.01' (Dynamic Tailwater)
↑—**1=Culvert** (Outlet Controls 0.86 cfs @ 2.19 fps)

Secondary OutFlow Max=18.92 cfs @ 12.12 hrs HW=360.24' TW=353.17' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 18.92 cfs @ 2.39 fps)

Summary for Pond 114: Sand Filter A

Inflow Area = 3.247 ac, 20.57% Impervious, Inflow Depth = 0.45" for 100-Year event
Inflow = 0.89 cfs @ 12.09 hrs, Volume= 0.122 af
Outflow = 0.07 cfs @ 8.94 hrs, Volume= 0.122 af, Atten= 93%, Lag= 0.0 min
Discarded = 0.07 cfs @ 8.94 hrs, Volume= 0.122 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 360.13' @ 12.21 hrs Surf.Area= 1,407 sf Storage= 2,608 cf

Plug-Flow detention time= 339.7 min calculated for 0.122 af (100% of inflow)
Center-of-Mass det. time= 339.6 min (1,209.6 - 869.9)

Volume	Invert	Avail.Storage	Storage Description
#1	359.00'	3,855 cf	**Ponding Storage (Prismatic)** Listed below (Recalc) -Impervious
#2	357.00'	696 cf	**Sand/Loam (Prismatic)** Listed below (Recalc) 2,111 cf Overall x 33.0% Voids
		4,551 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
359.00	1,407	0	0
359.10	1,455	143	143
359.45	1,629	540	683
360.00	1,915	975	1,657
361.00	2,480	2,198	3,855

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
357.00	1,407	0	0
358.50	1,407	2,111	2,111

Device	Routing	Invert	Outlet Devices
#1	Discarded	357.00'	**2.000 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.07 cfs @ 8.94 hrs HW=357.04' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.07 cfs)

Summary for Pond 115: Detention Pond A

Inflow	=	18.92 cfs @	12.12 hrs, Volume=	1.452 af
Outflow	=	17.57 cfs @	12.16 hrs, Volume=	1.452 af, Atten= 7%, Lag= 2.5 min
Primary	=	9.23 cfs @	12.16 hrs, Volume=	1.337 af
Routed to Link 119 : DP-1 Northeast Wetland				
Secondary	=	8.34 cfs @	12.16 hrs, Volume=	0.115 af
Routed to Link 119 : DP-1 Northeast Wetland				

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 353.23' @ 12.16 hrs Surf.Area= 4,768 sf Storage= 12,301 cf

Plug-Flow detention time= 140.9 min calculated for 1.452 af (100% of inflow)
Center-of-Mass det. time= 141.1 min (958.0 - 816.9)

Volume	Invert	Avail.Storage	Storage Description
#1	348.00'	16,248 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
348.00	237	0	0
350.00	1,717	1,954	1,954
352.00	3,516	5,233	7,187
354.00	5,545	9,061	16,248

Device	Routing	Invert	Outlet Devices
#1	Primary	342.50'	**18.00" Round Culvert** L= 68.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 342.50' / 338.00' S= 0.0662 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	347.00'	**1.25" Vert. Low Flow 6"** C= 0.600 Limited to weir flow at low heads
#3	Device 1	351.60'	**30.00" W x 8.00" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	353.00'	**30.0' 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

Primary OutFlow Max=9.23 cfs @ 12.16 hrs HW=353.23' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 9.23 cfs of 23.72 cfs potential flow)
  ├─**2=Low Flow 6"** (Orifice Controls 0.10 cfs @ 11.97 fps)
  └─**3=Orifice/Grate** (Orifice Controls 9.13 cfs @ 5.48 fps)

Secondary OutFlow Max=8.32 cfs @ 12.16 hrs HW=353.23' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Weir Controls 8.32 cfs @ 1.18 fps)

Summary for Pond 117: Concrete Arch Culvert

Inflow Area = 5.929 ac, 0.00% Impervious, Inflow Depth = 4.95" for 100-Year event
Inflow = 27.87 cfs @ 12.17 hrs, Volume= 2.446 af
Outflow = 27.87 cfs @ 12.17 hrs, Volume= 2.446 af, Atten= 0%, Lag= 0.0 min
Primary = 27.87 cfs @ 12.17 hrs, Volume= 2.446 af
Routed to Link 119 : DP-1 Northeast Wetland

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 378.43' @ 12.17 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	377.72'	**174.00" W x 36.00" H, R=150.00" Arch Culvert** L= 40.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 377.72' / 373.80' S= 0.0968 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 32.75 sf

Primary OutFlow Max=27.87 cfs @ 12.17 hrs HW=378.43' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 27.87 cfs @ 2.71 fps)

Summary for Pond 121: Proprietary device (Downstream Defender)

Inflow Area = 2.398 ac, 10.22% Impervious, Inflow Depth = 4.22" for 100-Year event
Inflow = 9.93 cfs @ 12.16 hrs, Volume= 0.842 af
Outflow = 9.93 cfs @ 12.16 hrs, Volume= 0.842 af, Atten= 0%, Lag= 0.0 min
Primary = 9.93 cfs @ 12.16 hrs, Volume= 0.842 af
Routed to Link 122 : Ex Detention Pond

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 366.25' @ 12.16 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	362.00'	**15.00" Round Culvert** L= 100.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 362.00' / 350.00' S= 0.1200 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.23 sf

Primary OutFlow Max=9.92 cfs @ 12.16 hrs HW=366.25' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 9.92 cfs @ 8.09 fps)

Summary for Link 119: DP-1 Northeast Wetland

Inflow Area = 8.815 ac, 0.00% Impervious, Inflow Depth = 6.85" for 100-Year event
Inflow = 58.93 cfs @ 12.16 hrs, Volume= 5.030 af
Primary = 58.93 cfs @ 12.16 hrs, Volume= 5.030 af, Atten= 0%, Lag= 0.0 min
Routed to nonexistent node 123L

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 122: Ex Detention Pond

Inflow Area = 2.398 ac, 10.22% Impervious, Inflow Depth = 4.22" for 100-Year event
Inflow = 9.93 cfs @ 12.16 hrs, Volume= 0.842 af
Primary = 9.93 cfs @ 12.16 hrs, Volume= 0.842 af, Atten= 0%, Lag= 0.0 min
Routed to nonexistent node 123L

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

A3.3 Water Quality Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10: WPre-01 Runoff Area=1.145 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=1,047' Tc=10.9 min CN=55/0 Runoff=0.00 cfs 0.000 af

Subcatchment 11: WPre-02 Runoff Area=12.075 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=1,701' Tc=13.5 min CN=65/0 Runoff=0.01 cfs 0.003 af

Subcatchment 13: WPre-03 Runoff Area=1.240 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=1,011' Tc=13.3 min CN=55/0 Runoff=0.00 cfs 0.000 af

Link 12: DP-1 Northeast Wetland Inflow=0.01 cfs 0.003 af
Primary=0.01 cfs 0.003 af

Link 14: Ex Detention Pond Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 14.460 ac Runoff Volume = 0.003 af Average Runoff Depth = 0.00"
100.00% Pervious = 14.460 ac 0.00% Impervious = 0.000 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100: WPost-01 Runoff Area=0.123 ac 60.16% Impervious Runoff Depth=0.25"
Tc=6.0 min CN=84 Runoff=0.03 cfs 0.003 af

Subcatchment 102: WPost-02 Runoff Area=0.431 ac 38.14% Impervious Runoff Depth=0.07"
Tc=6.0 min CN=75 Runoff=0.01 cfs 0.003 af

Subcatchment 105: WPost-03 Runoff Area=1.516 ac 14.18% Impervious Runoff Depth=0.10"
Flow Length=688' Tc=10.2 min CN=77 Runoff=0.06 cfs 0.013 af

Subcatchment 107: WPost-04 Runoff Area=0.350 ac 61.18% Impervious Runoff Depth=0.25"
Tc=6.0 min CN=84 Runoff=0.08 cfs 0.007 af

Subcatchment 112: WPost-05 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=161' Tc=7.6 min CN=65 Runoff=0.00 cfs 0.000 af

Subcatchment 116: WPost-06 Runoff Area=1.646 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=786' Tc=12.8 min CN=59 Runoff=0.00 cfs 0.000 af

Subcatchment 116A: WPost-01 Runoff Area=4.283 ac 0.00% Impervious Runoff Depth=0.03"
Flow Length=1,281' Tc=12.2 min CN=70 Runoff=0.01 cfs 0.009 af

Subcatchment 118: WPost-07 Runoff Area=2.886 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=435' Tc=8.3 min CN=65 Runoff=0.00 cfs 0.001 af

Subcatchment 120: WPost-08 Runoff Area=2.398 ac 10.22% Impervious Runoff Depth=0.00"
Flow Length=1,156' Tc=11.1 min CN=61 Runoff=0.00 cfs 0.000 af

Subcatchment 200: WPost-07 Node Runoff Area=2.896 ac 0.00% Impervious Runoff Depth=0.06"
Flow Length=434' Tc=12.6 min CN=74 Runoff=0.04 cfs 0.015 af

Reach 201: swale north of pond Avg. Flow Depth=0.05' Max Vel=0.76 fps Inflow=0.04 cfs 0.015 af
n=0.058 L=238.0' S=0.0588 '/' Capacity=16.61 cfs Outflow=0.04 cfs 0.015 af

Pond 101: CB-5 Peak Elev=375.06' Inflow=0.03 cfs 0.003 af
18.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=0.03 cfs 0.003 af

Pond 103: CB-6 Peak Elev=375.28' Inflow=0.01 cfs 0.003 af
15.00" Round Culvert n=0.012 L=18.0' S=0.0050 '/' Outflow=0.01 cfs 0.003 af

Pond 104: DMH-7 Peak Elev=374.46' Inflow=0.03 cfs 0.005 af
24.00" Round Culvert n=0.012 L=48.0' S=0.0100 '/' Outflow=0.03 cfs 0.005 af

Pond 106: CB-1 Peak Elev=375.26' Inflow=0.06 cfs 0.013 af
24.00" Round Culvert n=0.012 L=21.0' S=0.0100 '/' Outflow=0.06 cfs 0.013 af

Pond 108: CB-2 Peak Elev=376.55' Inflow=0.08 cfs 0.007 af
10.00" Round Culvert n=0.012 L=201.0' S=0.0010 '/' Outflow=0.08 cfs 0.007 af

Pond 109: DMH-3 Peak Elev=375.09' Inflow=0.11 cfs 0.020 af
24.00" Round Culvert n=0.012 L=52.0' S=0.0200 '/' Outflow=0.11 cfs 0.020 af

Pond 110: DMH-4 Peak Elev=373.04' Inflow=0.14 cfs 0.025 af
36.00" Round Culvert n=0.013 L=227.0' S=0.0758 '/' Outflow=0.14 cfs 0.025 af

Pond 111: DMH-8 Peak Elev=359.06' Inflow=0.14 cfs 0.025 af
36.00" Round Culvert n=0.013 L=17.6' S=0.0114 '/' Outflow=0.14 cfs 0.025 af

Pond 113: Sediment Forebay A Peak Elev=359.06' Storage=1,088 cf Inflow=0.14 cfs 0.025 af
Primary=0.01 cfs 0.001 af Secondary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.001 af

Pond 114: Sand Filter A Peak Elev=357.00' Storage=0 cf Inflow=0.01 cfs 0.001 af
Outflow=0.01 cfs 0.001 af

Pond 115: Detention Pond A Peak Elev=348.00' Storage=0 cf Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.000 af

Pond 117: Concrete Arch Culvert Peak Elev=377.72' Inflow=0.01 cfs 0.009 af
174.00" x 36.00", R=150.00" Arch Culvert n=0.012 L=40.5' S=0.0968 '/' Outflow=0.01 cfs 0.009 af

Pond 121: Proprietary device (Downstream Defender) Peak Elev=362.00' Inflow=0.00 cfs 0.000 af
15.00" Round Culvert n=0.012 L=100.0' S=0.1200 '/' Outflow=0.00 cfs 0.000 af

Link 119: DP-1 Northeast Wetland Inflow=0.01 cfs 0.010 af
Primary=0.01 cfs 0.010 af

Link 122: Ex Detention Pond Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 17.356 ac Runoff Volume = 0.050 af Average Runoff Depth = 0.03"
94.74% Pervious = 16.443 ac 5.26% Impervious = 0.913 ac

Summary for Pond 113: Sediment Forebay A

Inflow Area = 3.247 ac, 20.57% Impervious, Inflow Depth = 0.09" for WQ Storm event
Inflow = 0.14 cfs @ 12.30 hrs, Volume= 0.025 af
Outflow = 0.01 cfs @ 24.10 hrs, Volume= 0.001 af, Atten= 96%, Lag= 707.7 min
Primary = 0.01 cfs @ 24.10 hrs, Volume= 0.001 af
Routed to Pond 114 : Sand Filter A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 115 : Detention Pond A

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 359.06' @ 24.10 hrs Surf.Area= 576 sf Storage= 1,088 cf

Plug-Flow detention time= 957.0 min calculated for 0.001 af (4% of inflow)
Center-of-Mass det. time= 744.4 min (1,677.8 - 933.5)

Volume	Invert	Avail.Storage	Storage Description
#1	356.00'	3,071 cf	**Ponding Storage (Prismatic)** Listed below

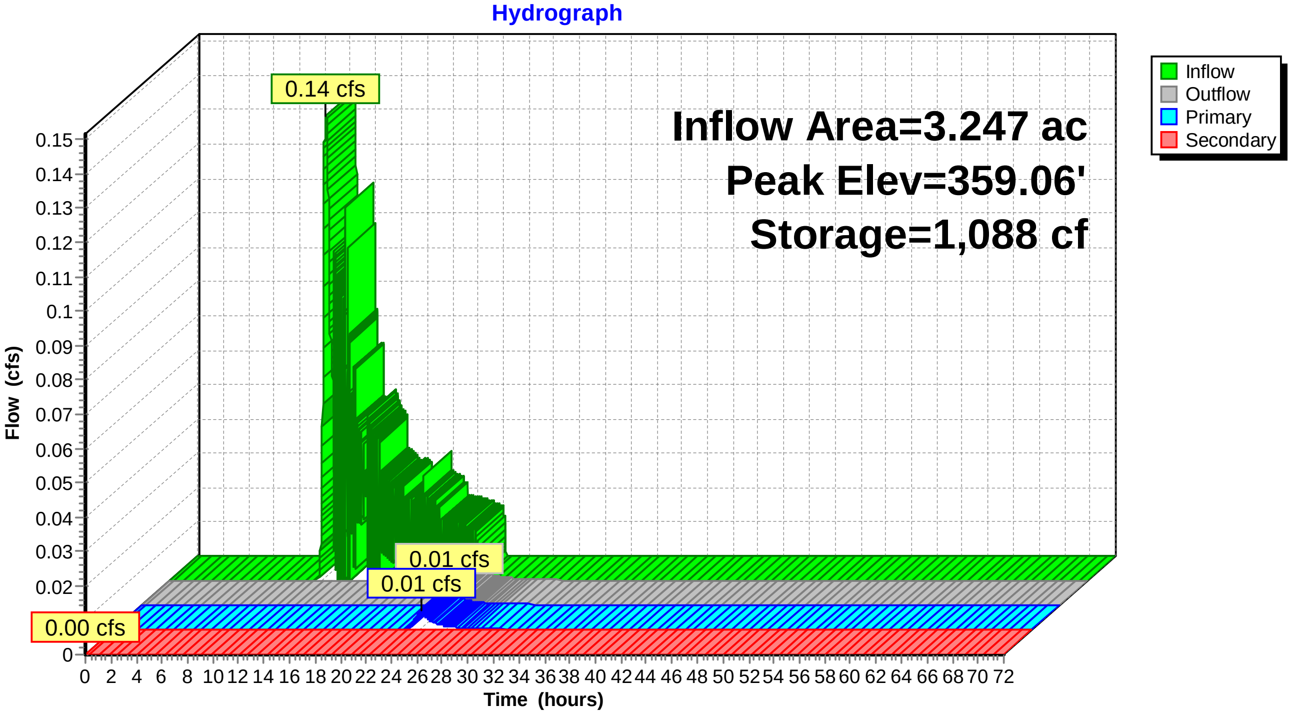
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
356.00	162	0	0
358.00	405	567	567
359.00	565	485	1,052
359.10	582	57	1,109
360.00	750	599	1,709
361.00	959	855	2,563
361.50	1,071	508	3,071

Device	Routing	Invert	Outlet Devices
#1	Primary	359.00'	**6.00" Round Culvert X 2.00** L= 24.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 359.00' / 359.00' S= 0.0000 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf
#2	Secondary	359.45'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.01 cfs @ 24.10 hrs HW=359.06' TW=357.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.01 cfs @ 0.29 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=356.00' TW=348.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 113: Sediment Forebay A



Hydrograph for Pond 113: Sediment Forebay A

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0	356.00	0.00	0.00	**0.00**
2.00	0.00	0	356.00	0.00	0.00	0.00
4.00	0.00	0	356.00	0.00	0.00	0.00
6.00	0.00	0	356.00	0.00	0.00	0.00
8.00	0.00	0	356.00	0.00	0.00	0.00
10.00	0.00	0	356.00	0.00	0.00	0.00
12.00	**0.04**	14	356.05	0.00	0.00	0.00
14.00	**0.06**	496	357.75	0.00	0.00	0.00
16.00	0.04	709	358.29	0.00	0.00	0.00
18.00	0.00	843	358.57	0.00	0.00	0.00
20.00	0.00	940	358.77	0.00	0.00	0.00
22.00	0.02	1,025	358.94	0.00	0.00	0.00
24.00	0.00	**1,087**	**359.06**	**0.01**	**0.01**	0.00
26.00	0.00	**1,072**	**359.03**	**0.00**	**0.00**	0.00
28.00	0.00	1,066	359.03	0.00	0.00	0.00
30.00	0.00	1,064	359.02	0.00	0.00	0.00
32.00	0.00	1,062	359.02	0.00	0.00	0.00
34.00	0.00	1,061	359.02	0.00	0.00	0.00
36.00	0.00	1,060	359.01	0.00	0.00	0.00
38.00	0.00	1,059	359.01	0.00	0.00	0.00
40.00	0.00	1,059	359.01	0.00	0.00	0.00
42.00	0.00	1,058	359.01	0.00	0.00	0.00
44.00	0.00	1,058	359.01	0.00	0.00	0.00
46.00	0.00	1,058	359.01	0.00	0.00	0.00
48.00	0.00	1,057	359.01	0.00	0.00	0.00
50.00	0.00	1,057	359.01	0.00	0.00	0.00
52.00	0.00	1,057	359.01	0.00	0.00	0.00
54.00	0.00	1,057	359.01	0.00	0.00	0.00
56.00	0.00	1,056	359.01	0.00	0.00	0.00
58.00	0.00	1,056	359.01	0.00	0.00	0.00
60.00	0.00	1,056	359.01	0.00	0.00	0.00
62.00	0.00	1,056	359.01	0.00	0.00	0.00
64.00	0.00	1,056	359.01	0.00	0.00	0.00
66.00	0.00	1,056	359.01	0.00	0.00	0.00
68.00	0.00	1,056	359.01	0.00	0.00	0.00
70.00	0.00	1,056	359.01	0.00	0.00	0.00
72.00	0.00	1,056	359.01	0.00	0.00	0.00

Summary for Pond 114: Sand Filter A

Inflow Area = 3.247 ac, 20.57% Impervious, Inflow Depth > 0.00" for WQ Storm event
Inflow = 0.01 cfs @ 24.10 hrs, Volume= 0.001 af
Outflow = 0.01 cfs @ 24.12 hrs, Volume= 0.001 af, Atten= 0%, Lag= 1.2 min
Discarded = 0.01 cfs @ 24.12 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 357.00' @ 24.12 hrs Surf.Area= 1,407 sf Storage= 0 cf

Plug-Flow detention time= 1.2 min calculated for 0.001 af (100% of inflow)
Center-of-Mass det. time= 1.1 min (1,679.0 - 1,677.8)

Volume	Invert	Avail.Storage	Storage Description
#1	359.00'	3,855 cf	**Ponding Storage (Prismatic)** Listed below (Recalc) -Impervious
#2	357.00'	696 cf	**Sand/Loam (Prismatic)** Listed below (Recalc) 2,111 cf Overall x 33.0% Voids
		4,551 cf	Total Available Storage

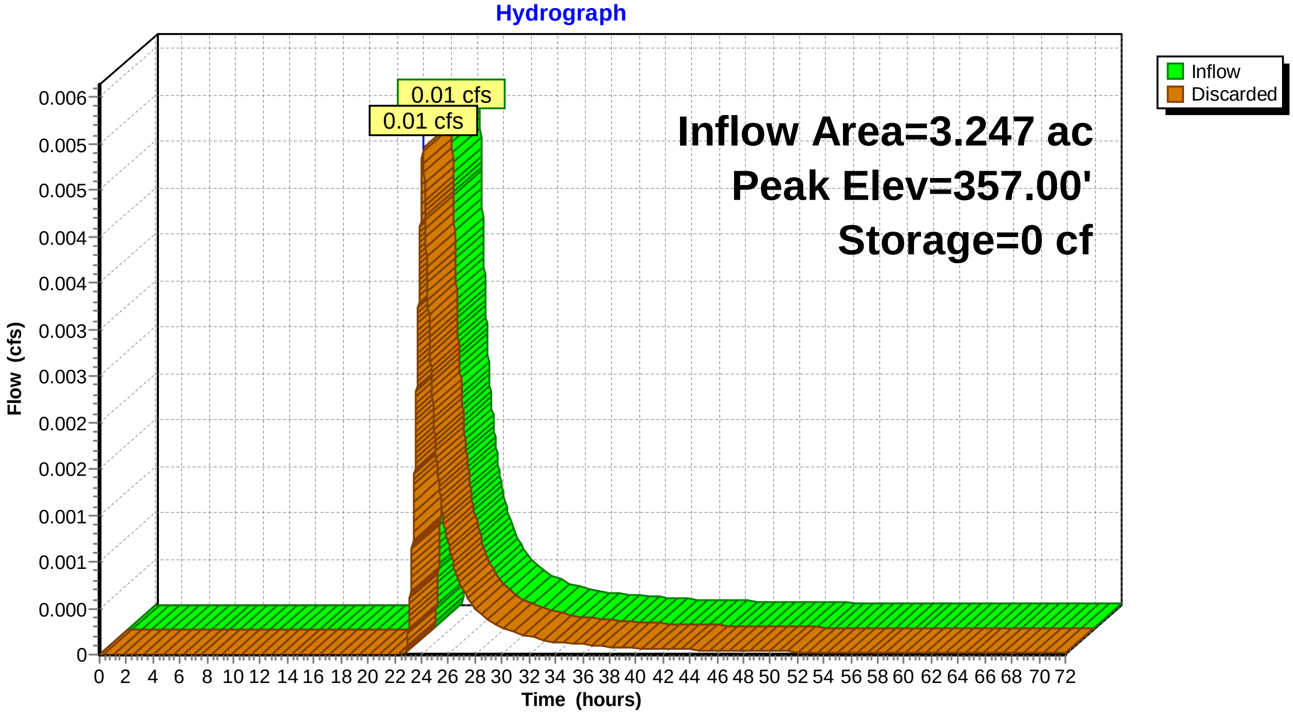
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
359.00	1,407	0	0
359.10	1,455	143	143
359.45	1,629	540	683
360.00	1,915	975	1,657
361.00	2,480	2,198	3,855

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
357.00	1,407	0	0
358.50	1,407	2,111	2,111

Device	Routing	Invert	Outlet Devices
#1	Discarded	357.00'	**2.000 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 24.12 hrs HW=357.00' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Pond 114: Sand Filter A



Hydrograph for Pond 114: Sand Filter A

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Discarded (cfs)
0.00	0.00	0	357.00	0.00
2.00	0.00	0	357.00	0.00
4.00	0.00	0	357.00	0.00
6.00	0.00	0	357.00	0.00
8.00	0.00	0	357.00	0.00
10.00	0.00	0	357.00	0.00
12.00	0.00	0	357.00	0.00
14.00	0.00	0	357.00	0.00
16.00	0.00	0	357.00	0.00
18.00	0.00	0	357.00	0.00
20.00	0.00	0	357.00	0.00
22.00	0.00	0	357.00	0.00
24.00	**0.01**	**0**	**357.00**	**0.01**
26.00	**0.00**	**0**	**357.00**	**0.00**
28.00	0.00	0	357.00	0.00
30.00	0.00	0	357.00	0.00
32.00	0.00	0	357.00	0.00
34.00	0.00	0	357.00	0.00
36.00	0.00	0	357.00	0.00
38.00	0.00	0	357.00	0.00
40.00	0.00	0	357.00	0.00
42.00	0.00	0	357.00	0.00
44.00	0.00	0	357.00	0.00
46.00	0.00	0	357.00	0.00
48.00	0.00	0	357.00	0.00
50.00	0.00	0	357.00	0.00
52.00	0.00	0	357.00	0.00
54.00	0.00	0	357.00	0.00
56.00	0.00	0	357.00	0.00
58.00	0.00	0	357.00	0.00
60.00	0.00	0	357.00	0.00
62.00	0.00	0	357.00	0.00
64.00	0.00	0	357.00	0.00
66.00	0.00	0	357.00	0.00
68.00	0.00	0	357.00	0.00
70.00	0.00	0	357.00	0.00
72.00	0.00	0	357.00	0.00

A3.4 TSS & TP Removal Calculations Worksheets and Downstream Defender Details

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

Version 1, Automated: Mar. 4, 2008

Location: Louise Dr, Franklin, MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Sand Filter	0.80	0.75	0.60	0.15
Extended Dry Detention Basin	0.50	0.15	0.08	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

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

Project: 3343-001
Prepared By: BEG
Date: 1/7/2024

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

Louise Drive
Pollutant Loading Calculations - Pre-Development - Total Phosphorus
Annual RainFall

Watershed	Land Use	Area (acres)	Loading (lb/ac/yr)	Total Loading lbs/year
Site	Open Land/Agriculture	13.22	1.52	20.1
				20.1

Louise Drive
Pollutant Loading Calculations - Post Development -Total Phosphorus
Annual RainFall

						Pollutant Removal Efficiencies						Loading
Watershed	Land Use	Area	Impervious	Runoff Coef., Rv	Concentration	Catch Basins	Sand Filter	Downstream Defender	Ext Dry Detention Basin	Overall Efficiency	Resultant Conc.	Total Loading
		(acres)	(%)		(lb/ac/yr)	0%	50%	30%	68%	(%)	(mg/l)	lbs/year
North Watershed	Highway	1.45	58.2%	0.57	1.34	0%	50%		68%	84%	0.21	0.3
	Medium Density Res (MDR)	11.77	2.8%	0.08	1.96	0%	50%		68%	84%	0.31	3.7
											Total Loading	**4.0**
										Pre Loading		20.09
										Difference		(16.09)
											%	**80%**

Stormwater Best Management Practice

Dry Detention Ponds

Minimum Measure: Post Construction Stormwater Management in New Development and Redevelopment
Subcategory: Retention/Detention

Description

Dry detention ponds (also called dry ponds, extended detention basins, detention ponds and extended detention ponds) are basins that detain stormwater for some minimum time (e.g., 24 hours) to allow particles and pollutants to settle and reduce peak flow rates. They do not have large permanent pools of water—unlike wet ponds—though they often have small pools at the inlet and outlet of the basin. Although dry detention ponds were once popular for flood control, they are less so now, given their limited ability to provide water quality treatment.

Dry detention pond with security fencing.
Credit: Jared Richardson for USEPA, 2012

Applicability

Dry detention ponds have traditionally been one of the most widely used stormwater controls. They are appropriate for detaining stormwater from large drainage areas (typically 10 or more acres). They require a large area to construct, so other stormwater controls are more appropriate for smaller sites (see Grassed Swales, Infiltration Basin, Infiltration Trench, Bioretention (Rain Gardens), Permeable Pavements, or Green Roofs). If pollutant removal efficiency is an important consideration, dry detention ponds may not be the most appropriate choice.

Common Terms

Stormwater hot spots are areas where land use or activities generate highly contaminated stormwater discharges, with pollutant concentrations exceeding those typically found in stormwater. Examples include gas stations, vehicle repair areas and waste storage areas.

A **stormwater retrofit** is a stormwater management practice (usually structural) put into place after development or construction of a stormwater control to improve water quality, protect downstream channels, reduce flooding or meet other specific objectives that did not exist at the time of original construction.

Regional Applicability

Dry detention ponds can work in all regions of the United States. Design engineers might need to make minor changes in cold or arid climates or in regions with karst (i.e., limestone) topography.

Stormwater Hot Spots

Dry detention ponds can accept flow from stormwater hot spots, but to do so need a liner or significant separation from groundwater.

Stormwater Retrofit

As noted above, dry detention ponds were common stormwater controls in the past but have become less popular given their limited ability to address water quality concerns (see “Limitations” below). They can be useful stormwater retrofit options, though, given their existing prevalence and the fact that they already offer certain stormwater management benefits such as flood control. In retrofit scenarios, it is possible to modify these facilities to incorporate features that address additional objectives such as water quality treatment and channel protection. This could be a more cost-effective option than constructing an entirely new stormwater control—as could combining a dry detention basin with other stormwater treatment options to address water quality impacts.

Cold Water (Trout) Streams

Dry detention ponds can increase the temperature of stormwater they receive (UNHSC, 2011). Generally, the only way to mitigate this effect is to decrease the detention time. Alternative stormwater controls may therefore be more appropriate in areas discharging to cold water streams.

Siting Considerations

Designers need to ensure that the dry detention pond is feasible at the site in question. This section provides basic guidelines for siting dry detention ponds.

Drainage Area

In general, dry detention ponds are appropriate for sites with a minimum area of 10 acres. On smaller sites, it can be challenging to provide proper discharge control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging (City of Portland, 2016). For smaller sites, green infrastructure practices and on-lot treatment controls are better options given their smaller footprint and effectiveness.

Slope

Dry detention ponds can operate at sites with slopes up to about 15 percent. The local slope needs to be relatively flat: this allows the pond's side slopes to be reasonably flat, which keeps safety risks low.

There is no minimum slope requirement, though there needs to be enough elevation drop from the pond inlet to the pond outlet to ensure that flow can move through the system.

Soils

Dry detention ponds can function with almost all soils and geology, with minor design adjustments for karst areas or in rapidly percolating soils such as sand. In such areas, extended detention ponds need impermeable liners to prevent groundwater contamination or sinkhole formation.

Standing Water

To limit standing water, the base of the extended detention facility should not intersect the groundwater table. The persistence of standing water for more than 3 days in dry detention facilities makes them ideal breeding grounds for mosquitoes (Metzger et al., 2002).

Design Considerations

Specific designs may vary considerably, depending on site constraints, preferences of the designer or community, or local regulations. Common recommended features fall into five basic categories: pretreatment, treatment, conveyance, maintenance reduction and landscaping. For any project, design engineers should follow local requirements.

Pretreatment

Removing coarse sediment particles from stormwater before they reach the large permanent pool reduces a pond's maintenance burden. Pretreatment features help settle out these particles. For a pond, the appropriate pretreatment feature is a sediment forebay, a small pool at the entrance to the pond (typically about 10 percent of the volume of water that the pond will treat for pollutant removal).

Treatment

Treatment design features enhance a stormwater control's ability to remove pollutants. To allow for enough settling time, the pond should be large enough to detain the volume of stormwater it treats for between 12 and 48 hours. Designing dry ponds with a high length-to-width ratio (i.e., at least 1.5:1) and incorporating other design features to maximize the flow path effectively increases the detention time in the system by keeping flow from short-circuiting the pond. Designing ponds with relatively flat side slopes can also help to lengthen the effective flow path. Last, as dry detention ponds alone do not provide a high degree of pollutant removal, adding filtration at the outlet improves water quality before discharging to receiving waters.

Conveyance

The conveyance system should carry stormwater to and from dry ponds safely, in a manner that minimizes erosion potential. It is also important to stabilize the outfall of pond systems to prevent scouring. To convey low flows through the system, designers should incorporate a small, shallow pilot channel, as well as an emergency spillway to safely convey water from large floods. To help mitigate the warming of water at the outlet channel, designers should provide shade around the channel at the pond outlet, if possible.

Maintenance Reduction

Stormwater controls need regular maintenance. Design features can ease this maintenance burden. In a dry detention pond, a micropool at the outlet can prevent resuspension of sediment and outlet clogging. A good design includes maintenance access to the forebay and micropool.

Another design feature that can reduce maintenance needs is a non-clogging outlet. Typical examples include a reverse-slope pipe or a weir outlet with a trash rack. A reverse-slope pipe draws from below the permanent pool, extending in a reverse angle up to the riser, and determines the water elevation of the micropool. Because these outlets draw water from below the level of the permanent pool, floating debris is less likely to clog them.

Landscaping

Designers should maintain a vegetated buffer around the dry detention pond and should select plants within the detention zone (i.e., the portion of the pond up to the elevation where it detains stormwater) that can withstand both wet and dry periods.

Storage Pipes and Tanks

Another variation of the dry detention pond design is the use of storage tanks, storage pipes or underground vaults. This approach is most common in urban environments on small sites with limited opportunity to provide flood control—where underground storage for a large drainage area would generally be costly. Because the drainage area contributing to tank or pipe storage is typically small, the outlet diameter needed to reduce the flow from very small storms would be very small. A very small outlet diameter, along with the underground location of the tanks or pipes, creates the chance that debris will build up in the outlet and cause maintenance problems.

Arid or Semiarid Climates

In arid and semiarid regions, design engineers might need to make changes to conserve scarce water resources. Any landscaping plans should prescribe drought-tolerant vegetation wherever possible. In addition, the design engineer can replace the wet forebay with an alternative dry pretreatment, such as a detention cell. In regions with distinct wet and dry seasons—as in many arid regions—detention ponds can have recreation uses in the dry season (e.g., as ball fields).

Cold Climates

In cold climates, some additional design features can help to treat spring snowmelt. One such modification is to increase the volume available for detention to help treat this relatively large flow event. As well, it may be necessary to remove sediment from the forebay more often than in warmer climates (see “Maintenance Considerations” below for guidelines) to account for sedimentation due to road sanding.

Maintenance Considerations

In addition to incorporating features into the dry detention pond design to minimize maintenance, site operators will need to carry out some regular maintenance and inspection practices. Table 1 outlines some of these practices.

Table 1. Typical maintenance activities for dry ponds

Activity	Schedule
▪ Note erosion of pond banks or bottom	Semiannual inspection
▪ Inspect for damage to the embankment ▪ Monitor for sediment accumulation in the facility and forebay ▪ Examine to ensure that inlet and outlet devices are free of debris and operational	Annual inspection
▪ Repair undercut or eroded areas ▪ Mow side slopes ▪ Manage pesticide and nutrients ▪ Remove litter and debris	Standard maintenance
▪ Seed or sod to restore dead or damaged ground cover	Annual maintenance (as needed)
▪ Monitor sediment accumulations in the forebay; remove sediment when the forebay capacity has been reduced by 50 percent	2- to 7-year maintenance
▪ Monitor sediment accumulations; remove sediment when the pond volume has been reduced by 25 percent	25- to 50-year maintenance

Source: Modified from MPCA, 2017

Limitations

Although dry detention ponds are widely applicable, they have some limitations that might make other stormwater controls preferable:

- Dry detention ponds have limited water quality treatment capacity compared to other structural stormwater controls and are ineffective at removing soluble pollutants (see “Effectiveness”).
- Dry extended detention ponds may become a nuisance due to mosquito breeding if improperly maintained or if shallow pools of water form for more than 3 days.
- Dry ponds may detract from the value of a home (see “Cost Considerations”).

Dry detention ponds on their own only provide peak flow reduction and do little to control stormwater volume, which could result in adverse downstream impacts.

Effectiveness

Structural stormwater controls can achieve four broad resource protection goals: flood control, channel protection, groundwater recharge and pollutant removal. Dry detention basins can provide flood control and channel protection, as well as some limited pollutant removal. They are not typically designed to provide groundwater recharge (for a similar control that does provide groundwater recharge, see Infiltration Basin). However, some infiltration to surrounding soils may occur, particularly in soils with high infiltration rates.

Flood Control

One objective of stormwater controls can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. One of the main purposes of dry detention basins is to slow stormwater and reduce peak flow rates. Dry detention ponds therefore provide effective flood control, especially in conjunction with other peak flow reduction controls throughout a watershed.

Channel Protection

One result of urbanization is the geomorphic changes that occur in response to modified hydrology. Traditionally, dry detention basins have provided control of the 2-year storm for channel protection. However, it appears that this control has been relatively ineffective for channel protection. Research suggests that control of a smaller storm, such as the 1-year storm, might be more appropriate (MacRae, 1996; Tillinghast et al., 2011). Most current channel protection standards are based on the 1-year storm event (e.g., MDE, 2009).

Pollutant Removal

Dry detention basins provide some pollutant removal, provided that the design features described in the “Siting Considerations” and “Design Considerations” sections are incorporated. Although they are effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Pollutant loading information for dry detention basins provided by the New Hampshire Department of Environmental Services allows for an assumed removal efficiency of 80 percent for total suspended solids, 55 percent for total nitrogen removal and 68 percent for total phosphorus removal (NHDES, 2011).

Cost Considerations[1]

The construction costs associated with dry detention ponds can range considerably depending on the type of construction and size. Adjusted for inflation, a reported range for dry detention ponds and dry extended detention ponds is $45,000 to $80,000 per acre of impervious surface treated (King & Hagan, 2011). As with most other stormwater controls, economies of scale suggest that larger systems are at the lower end of this range.

Maintenance costs can be slightly higher than comparable wet ponds, mostly due to the greater area needing regular mowing. For ponds, the annual cost of routine maintenance is typically about 2 to 6 percent of the construction cost (King & Hagan, 2011). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section.

Another economic concern associated with dry ponds is that they can detract from the value of adjacent properties, especially compared to wet ponds and mixed recreational use stormwater facilities (Lee & Li, 2009). One study found that dry ponds detract from the perceived value of adjacent homes by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA’s National Menu of Best Management Practices (BMPs) for Stormwater website

[1] Prices updated to 2019 dollars. Inflation rates obtained from the Bureau of Labor Statistics CPI Inflation Calculator website: https://data.bls.gov/cgi-bin/cpicalc.pl.

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Disclaimer

This fact sheet is intended to be used for informational purposes only. These examples and references are not intended to be comprehensive and do not preclude the use of other technically sound practices. State or local requirements may apply.

Downstream Defender®

High-Level Treatment in a Small Footprint

Product Profile

The Downstream Defender® is an advanced vortex separator used to treat stormwater runoff in pretreatment or stand-alone applications. Its unique flow-modifying internal components distinguish the Downstream Defender® from conventional and simple swirl separators that typically bypass untreated peak flows to prevent washout of captured pollutants. Its wide treatment flow range, low headloss, small footprint and low-profile make it a compact and economical solution for capturing nonpoint source pollution.

Components

1. Inlet to Precast Vortex Chamber
2. Cylindrical Baffle
3. Center Shaft
4. Outlet Pipe
5. Sediment Storage Sump
6. Access Lid

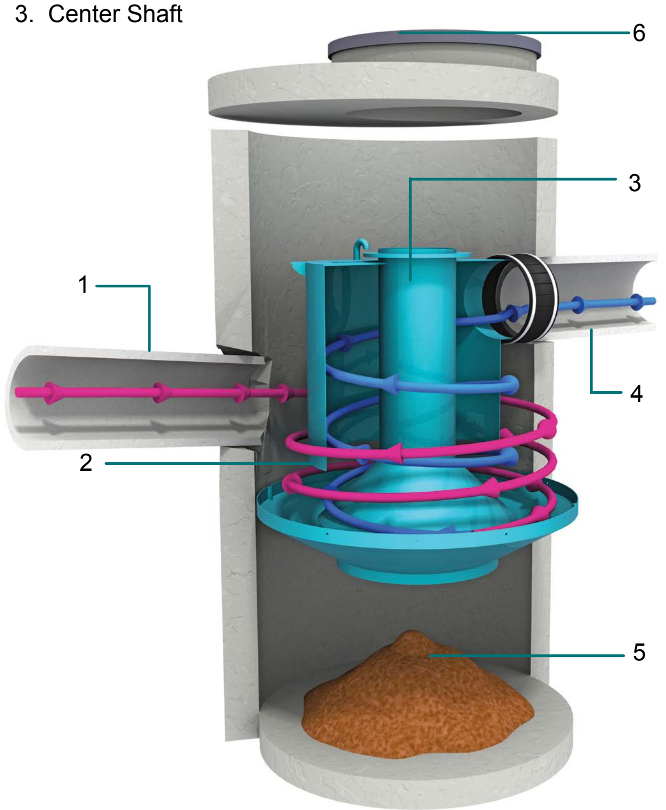

Fig.1 The Downstream Defender® has internal components designed to maximize pollutant capture and minimize pollutant washout.

Applications

- Removal of total suspended solids (TSS), floatable trash and petroleum products from stormwater runoff
- New construction or redevelopment of commercial and residential sites
- Pollutant hotspots such as maintenance yards, parking lots, gas stations, streets, highways, airports and transportation hubs
- Site constrained LID or green infrastructure based developments
- LEED® development projects

Advantages

- Special internal components maximize pollutant capture and minimize footprint, headloss and washout
- Captures and retains a wide range of TSS particles
- High peak treatment flow rates
- Treats the entire storm with no washout or untreated bypass flows
- Low maintenance requirements - no dredging required, and no screens or media to block
- Variable inlet/outlet angles for ease of site layout

How it Works

Advanced hydrodynamic vortex separation is a complex hydraulic process that augments gravity separation with low-energy rotary forces. The flow modifying internal components used in the Downstream Defender® harness the energy from vortex flow and maximize the time for separation to occur while deflecting high scour velocities (**Fig.1**).

Polluted stormwater is introduced tangentially into the side of the precast vortex chamber to establish rotational flow. A cylindrical baffle with an inner center shaft creates an outer (magenta arrow) and inner (blue arrow) spiraling column of flow and ensures maximum residence time for pollutant travel between the inlet and outlet.

Oil, trash and other floating pollutants are captured and stored on the surface of the outer spiraling column. Low energy vortex motion directs sediment into the protected sump region. Only after following a long three-dimensional flow path is the treated stormwater discharged from the outlet pipe. Maintenance ports at ground level provide access for easy inspection and clean-out.

Downstream Defender®

Drainage Profile

The Downstream Defender® is designed with a submerged tangential inlet to minimize turbulence within the device. Turbulence increases system headlosses and reduces performance by keeping pollutant particles in suspension.

The inlet elevation of the Downstream Defender® is located one inlet pipe diameter lower than the elevation of the outlet invert (**Fig.2**). This arrangement ensures that influent flows are introduced to the treatment chamber quiescently below the water surface elevation, minimizing turbulence.

The unique flow-modifying internal components also minimize hydraulic losses. There are no internal weirs or orifices; large clear openings ensure low headloss at peak flow rates with little risk of blockages that cause upstream flooding.

Inspection and Maintenance

Nobody maintains our systems better than we do. To ensure optimal, ongoing device performance, be sure to recommend Hydro International as a preferred service and maintenance provider to your clients.

Call **1 (800) 848-2706** to schedule an inspection and cleanout or learn more at **hydro-int.com/service**

Sizing & Design

The Downstream Defender® can be used to meet a wide range of stormwater treatment objectives. It is available in 5 precast models that fit easily into the drainage network (**Table 1**). Selection and layout of the appropriate Downstream Defender® model depends on site hydraulics, site constraints and local regulations. Both online (**Fig.3a)** and offline (**Fig.3b**) configurations are common.

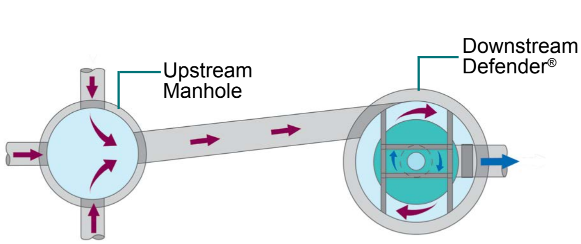

Fig.3a The Downstream Defender® in an online configuration.

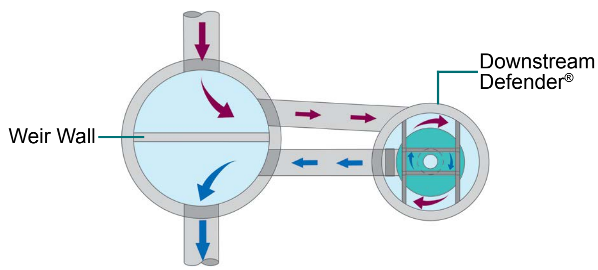

Fig.3b The Downstream Defender® in an offline configuration.

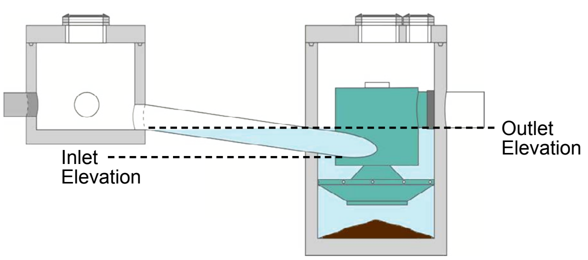

Fig.2 The Downstream Defender® has a submerged inlet that reduces headloss and improves efficiency of pollutant capture.

Free *Stormwater Sizing Tool*

This simple online tool will recommend the best separator, model size and online/offline arrangement based on site-specific data entered by the user.

Go to hydro-int.com/sizing to access the tool.

Table 1. Downstream Defender® Design Chart.

Model Number and Diameter		Peak Treatment Flow Rate		Maximum Pipe Diameter		Oil Storage Capacity		Sediment Storage Capacity		Minimum Distance from Outlet Invert to Top of Rim		Standard Height from Outlet Invert to Sump Floor	
(ft)	(m)	(cfs)	(L/s)	(in)	(mm)	(gal)	(L)	(yd³)	(m³)	(ft)	(m)	(ft)	(m)
4	1.2	3.0	85	12	300	70	265	0.70	0.53	2.8	0.85	4.1	1.25
6	1.8	8.0	227	18	450	216	818	2.10	1.61	3.2	0.98	5.9	1.80
8	2.4	15.0	425	24	600	540	2,044	4.65	3.56	4.2	1.28	7.7	2.35
10	3.0	25.0	708	30	750	1,050	3,975	8.70	6.65	5.0	1.52	9.4	2.85
12*	3.7	38.0	1,076	36	900	1,770	6,700	14.70	11.24	5.6	1.71	11.2	3.41

*Not available in all areas. Contact Hydro International for details.

July 7, 2020

To Whom It May Concern:

RE: Downstream Defender® Removal Efficiency

Regarding Downstream Defenders operating under submerged condition, I offer the following comments: A tail water condition in a detention system or pond will not adversely impact the operation of a Downstream Defender. An online Downstream Defender does not contain internal flow control devices (weirs or orifices) that will be bypassed by a rising tail water; consequently, any flow that passes through the Downstream Defender will be treated. In cases where there is the potential for a large reverse flow, such as a tidal condition in a large diameter main line pipe, we would recommend a back-flow preventer. In situations where the Downstream Defender is discharging to a submerged condition such as underground storage or a detention pond a backflow preventer is not required. This is because the water level in downstream storage tends to rise slowly and gradually submerge the upstream pipe network rather than generate large reverse flow rates.

For offline systems, we set the weir in the diversion structure to divert the first flush to an offline treatment unit under the assumption that the downstream storage is empty and available to accept the first flush. Alternatively, we can set the weir relative to a design tail water condition as required. In most cases, downstream storage is assumed to be empty and available to accept the first flush flow. After the first flush is diverted to downstream storage and as water levels start to rise and submerge the weir, the differential head across the treatment unit typically starts to decrease diverting less flow to an offline unit. The same thing occurs in treatment devices that may be placed online but have an internal bypass. Typically, by the time the weir is fully submerged the storage system is full and the first flush flow has already been adequately treated.

If you have any questions please do not hesitate to call us. We would be happy to assist you.

Signature,
Hydro International

John Larson III
Senior Project Engineer

Hydro International, 94 Hutchins Drive, Portland ME04102
Tel: +1 (207) 756 6200 Fax: +1 (207) 756 6212 Web: hydro-int.com

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Nonpoint Pollution Control
Division of Water Quality
401-02B
Post Office Box 420
Trenton, New Jersey 08625-0420
609-633-7021 Fax: 609-777-0432
http://www.state.nj.us/dep/dwq/bnpc_home.htm

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

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HYDRO INTERNATIONAL

August 18, 2015

Lisa Lemont, CPSWQ
Business Development Manager
Hydro International (Stormwater)
94 Hutchins Drive
Portland, ME 04102

Re: Revised MTD Lab Certification for the Downstream Defender Stormwater Treatment Device By Hydro International

TSS Removal Rate 50%

Dear Ms. Lemont:

This letter supersedes the previous certification letter dated January 21, 2015. Hydro International requested a new verification for the Downstream Defender Stormwater Treatment Device from the New Jersey Corporation for Advanced Technology (NJCAT) based on enhanced Maximum Treatment Flow Rate (MTFR).

The Stormwater Management rules under N.J.A.C. 7:8-5.5(b) and 5.7(c) allow the use of manufactured treatment devices (MTDs) for compliance with the design and performance standards at N.J.A.C. 7:8-5 if the pollutant removal rates have been verified by the New Jersey Corporation for Advanced Technology (NJCAT) and have been certified by the New Jersey Department of Environmental Protection (NJDEP). Hydro International has requested a Laboratory Certification for the Downstream Defender Stormwater Treatment Device.

The projects falls under the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advance Technology" dated January 25, 2013. The applicable protocol is the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" dated January 25, 2013.

NJCAT verification documents submitted to the NJDEP indicate that the requirements of the aforementioned protocol have been met or exceeded. The NJCAT letter also included a recommended certification TSS removal rate and the required maintenance plan. The NJCAT Verification Report with the Verification Appendix for this device is published online at http://www.njcat.org/verification-process/technology-verification-database.html.

The NJDEP certifies the use of the Downstream Defender Stormwater Treatment Device by Hydro International at a TSS removal rate of 50% when designed, operated and maintained in accordance with the information provided in the Verification Appendix.

Be advised a detailed maintenance plan is mandatory for any project with a Stormwater BMP subject to the Stormwater Management Rules, N.J.A.C. 7:8. The plan must include all of the items identified in the Stormwater Management Rules, N.J.A.C. 7:8-5.8. Such items include, but are not limited to, the list of inspection and maintenance equipment and tools, specific corrective and preventative maintenance tasks, indication of problems in the system, and training of maintenance personnel. Additional information can be found in Chapter 8: Maintenance of the New Jersey Stormwater Best Management Practices Manual.

If you have any questions regarding the above information, please contact Mr. Titus Magnanao of my office at (609) 633-7021.

Sincerely,

James J. Murphy, Chief
Bureau of Nonpoint Pollution Control

C: Chron File
Richard Magee, NJCAT
Madhu Guru, DLUR
Ravi Patraju, NJDEP
Titus Magnanao, BNPC

A 4.1 Drainage Network Hydraulic Calculations

DiPrete Engineering
Engineers • Planners • Surveyors

Project Name: Louise Drive Extension
Project Number: 3343-001

10-Year Storm
Date: 1/13/2025

Structure	Area	Inlet Time	Intensity	Runoff C	Q=Cia	Q Carry over	Q Captured	Q Bypassed	Bypass Structure	Inlet Type	Curb Opening	Curb Opening	Grate Length	Grate Width	Depth	Spread
	(sf)	(min)	(in/hr)	(C)	(cfs)	(cfs)	(cfs)	(cfs)			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
1	131,009	17.7	3.48	0.25	2.64	0	1.43	1.20	5	Grate inlet	---	---	2	2	0.168	8.421
2	15,261	6	6.287	0.65	1.44	0	0.92	0.52	6	Grate inlet	---	---	2	2	0.134	6.72
5	126,994	13.32	4.142	0.22	2.68	1.204	3.88	0.00	---	Grate inlet	---	---	4	2	0.317	15.846
6	18,787	6	6.287	0.5	1.37	0.521	1.89	0.00	---	Grate inlet	---	---	4	2	0.204	10.179
15	6,542	6	6.287	0.58	0.55	0	0.46	0.10	---	Grate inlet	---	---	2	2	0.087	4.344
20	99,129	17.52	3.487	0.26	2.08	0	1.26	0.82	---	Grate inlet	---	---	2	2	0.143	7.143

DiPrete Engineering Engineers • Planners • Surveyors	Project Name: Louise Drive Extension Project Number: 3343-001	25-Year Storm Date: 1/13/2025

Pipe Analysis

Pipe ID	Pipe Length	Pipe Size	Pipe Slope	Flow Rate	Capacity Full	Velocity	Invert Down	Invert Up
	(ft)	(in)	(%)	(cfs)	(cfs)	(ft/s)	(Ft)	(ft)
8 - 9	17.61	36	1.14%	7.9	77.09	7.0	356.00	356.20
4 - 8	227.91	36	7.35%	8.0	196.04	13.6	356.20	372.90
3 - 4	51.84	24	2.00%	4.3	34.69	7.5	373.90	374.94
1 - 3	20.85	24	1.00%	3.3	24.53	5.4	374.94	375.15
2 - 3	20.65	15	1.00%	1.8	7.01	4.8	375.69	375.89
7 - 4	48.34	24	1.00%	4.4	24.53	5.9	373.90	374.38
5 - 7	17.98	18	0.50%	3.3	8.05	4.3	374.88	374.97
6 - 7	17.98	15	0.50%	1.7	4.95	3.7	375.13	375.22
17 - 18	27.80	15	1.50%	1.2	8.58	4.9	360.93	361.35
15 - 17	22.23	12	1.50%	0.3	4.73	3.3	362.17	362.50
20 - 17	10.29	12	1.50%	1.0	4.73	4.8	361.35	361.50

DiPrete Engineering
Engineers • Planners • Surveyors

Project Name: Louise Drive Extension — 100-Year Storm
Project Number: 3343-001 — Date: 1/13/2025

Pipe Analysis

Pipe ID	Pipe Length	Pipe Size	Pipe Slope	Flow Rate	Capacity Full	Velocity	Invert Down	Invert Up
	(ft)	(in)	(%)	(cfs)	(cfs)	(ft/s)	(Ft)	(ft)
8 - 9	17.61	36	1.14%	10.7	77.09	7.7	356.00	356.20
4 - 8	227.91	36	7.35%	10.8	196.04	14.9	356.20	372.90
3 - 4	51.84	24	2.00%	5.8	34.69	8.2	373.90	374.94
1 - 3	20.85	24	1.00%	4.4	24.53	5.9	374.94	375.15
2 - 3	20.65	15	1.00%	2.3	7.01	5.1	375.69	375.89
7 - 4	48.34	24	1.00%	6.0	24.53	6.4	373.90	374.38
5 - 7	17.98	18	0.50%	4.5	8.05	4.7	374.88	374.97
6 - 7	17.98	15	0.50%	2.2	4.95	3.9	375.13	375.22
17 - 18	27.80	15	1.50%	1.2	8.58	4.9	360.93	361.35
15 - 17	22.23	12	1.50%	0.3	4.73	3.3	362.17	362.50
20 - 17	10.29	12	1.50%	1.0	4.73	4.8	361.35	361.50

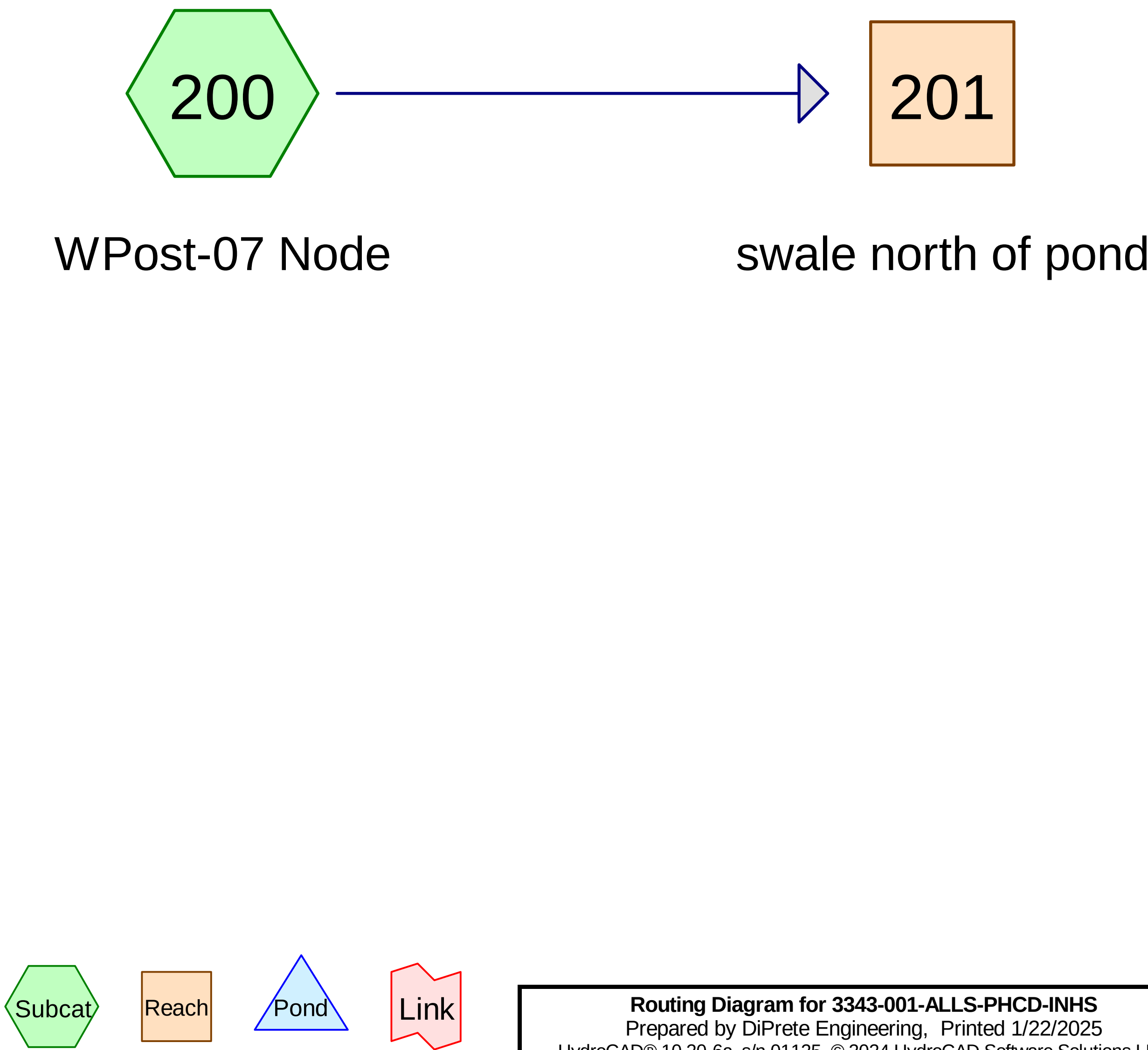
DiPrete Engineering
Engineers • Planners • Surveyors

Project Name: Louise Drive Extension — 100-Year Storm
Project Number: 3343-001 — Date: 1/13/2025

HGL at Structure

Structure	Rim Elevation	HGL Elevation	Rim-HGL
	(ft)	(ft)	(ft)
9	359.42	0.00	N/A
8	361.08	359.67	1.41
4	380.91	373.38	7.54
3	381.95	376.81	5.14
1	382.03	376.36	5.68
2	382.06	376.50	5.56
7	380.26	376.81	3.45
5	379.96	376.86	3.10
6	379.96	376.88	3.08
19	6.99	0.00	N/A
17	6.03	0.00	N/A
21	6.03	0.00	N/A

A 5.1 Open Channel Calculations HydroCAD 100-Year Storm Analysis



Routing Diagram for 3343-001-ALLS-PHCD-INHS
Prepared by DiPrete Engineering, Printed 1/22/2025
HydroCAD® 10.20-6a s/n 01125 © 2024 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.298	74	>75% Grass cover, Good, HSG C (200)
0.244	80	>75% Grass cover, Good, HSG D (200)
1.260	70	Woods, Good, HSG C (200)
1.094	77	Woods, Good, HSG D (200)

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 200: WPost-07 Node Runoff Area=2.896 ac 0.00% Impervious Runoff Depth=5.82"
Flow Length=434' Tc=12.6 min CN=74 Runoff=15.90 cfs 1.405 af

Reach 201: swale north of pond Avg. Flow Depth=0.98' Max Vel=4.10 fps Inflow=15.90 cfs 1.405 af
n=0.058 L=238.0' S=0.0588 '/' Capacity=16.61 cfs Outflow=15.81 cfs 1.405 af

Summary for Subcatchment 200: WPost-07 Node

Runoff = 15.90 cfs @ 12.17 hrs, Volume= 1.405 af, Depth= 5.82"
Routed to Reach 201 : swale north of pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.99"

Area (ac)	CN	Description
0.298	74	>75% Grass cover, Good, HSG C
0.244	80	>75% Grass cover, Good, HSG D
0.000	98	Impervious, HSG D
0.000	98	Roofs, HSG D
1.260	70	Woods, Good, HSG C
1.094	77	Woods, Good, HSG D
2.896	74	Weighted Average
2.896	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	100	0.0900	0.14		**Sheet Flow, A**
					Woods: Light underbrush n= 0.400 P2= 3.27"
1.0	334	0.1107	5.36		**Shallow Concentrated Flow, B**
					Unpaved Kv= 16.1 fps
12.6	434	Total			

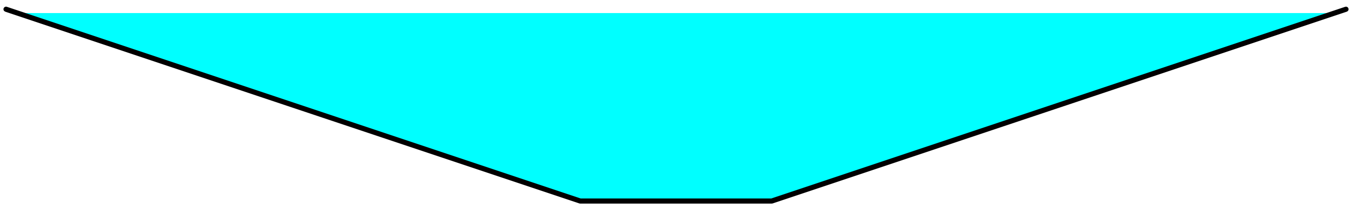
Summary for Reach 201: swale north of pond

Inflow Area = 2.896 ac, 0.00% Impervious, Inflow Depth = 5.82" for 100-Year event
Inflow = 15.90 cfs @ 12.17 hrs, Volume= 1.405 af
Outflow = 15.81 cfs @ 12.18 hrs, Volume= 1.405 af, Atten= 1%, Lag= 0.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.10 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 2.6 min

Peak Storage= 918 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.98' , Surface Width= 6.88'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 16.61 cfs

1.00' x 1.00' deep channel, n= 0.058
Side Slope Z-value= 3.0 '/' Top Width= 7.00'
Length= 238.0' Slope= 0.0588 '/'
Inlet Invert= 352.00', Outlet Invert= 338.00'



A 6.1 Groundwater Mounding Calculation

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

4.0000	***R***	Recharge (infiltration) rate (feet/day)
0.330	Sy	Specific yield, Sy (dimensionless, between 0 and 1)
165.40	K	Horizontal hydraulic conductivity, Kh (feet/day)*
11.500	x	1/2 length of basin (x direction, in feet)
31.500	y	1/2 width of basin (y direction, in feet)
1.000	t	duration of infiltration period (days)
6.200	hi(0)	initial thickness of saturated zone (feet)

Conversion Table

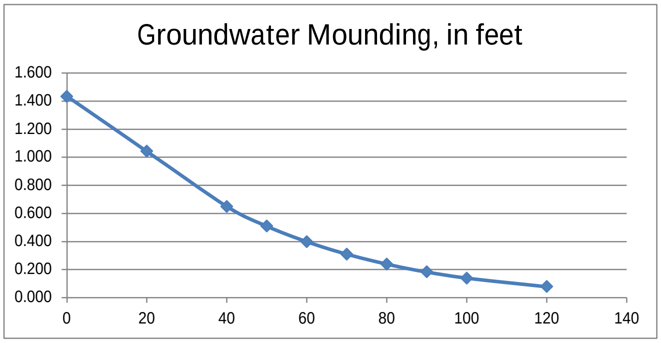
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

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

7.634	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
1.434	**Δ**h(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
1.434	0
1.043	20
0.649	40
0.510	50
0.398	60
0.309	70
0.239	80
0.183	90
0.139	100
0.079	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.

Pre-Development Watershed Map

Louise Drive

DiPrete Engineering

Two Stafford Court Cranston, RI 02920
tel 401-943-1000 fax 401-464-6006 www.diprete-eng.com

POST-DEVELOPMENT WATERSHED MAP

LOUISE DRIVE

DiPrete Engineering

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tel 401-943-1000 fax 401-464-6006 www.diprete-eng.com

DE JOB NO: 3343-001