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STORMWATER REPORT

For

3 Kendrick Road, LLC

3 Kendrick Road
Wareham, MA 02571

Prepared for

3 Kendrick Road, LLC

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Prepared by

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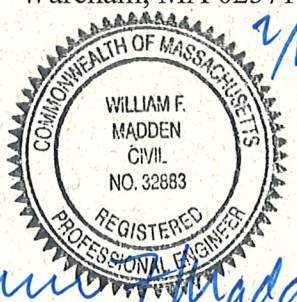

2/14/22

February 10, 2022
G.A.F. Job No.: 21-9731

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DRAINAGE NARRATIVE

General Description

The project site is a 2.76 Acre parcel of land located at the southeast corner of the intersection of Kendrick Road and Thacher Lane. The property was developed in 1983 and has been used by various industrial businesses since that time.

The applicant purchased the property in November 2021 and is proposing an expansion of the building and site access to utilize the facility for manufacturing crumpets and lease the remaining office space to a suitable tenant.

Due to the existing buildings and paved surfaces this project is considered a mixture of new development and redevelopment under the Massachusetts Stormwater Handbook. This project has been designed to fully comply with the standards for all of the new development and provides significant improvements with respect to stormwater runoff for downgradient properties.

A detailed description of the system design and performance is provided as follows.

Existing Conditions

The existing stormwater management system is very limited. There are only two catch basins on the property. One is off the end of the east side of the parking lot and one is at a low point near the loading dock. The parking lot catch basin is piped to the loading dock basin which discharges to a nearby catch basin in Thacher Lane. These two basins convey the majority of the runoff from the developed portion of the site.

The topography of the lot directs runoff which is not collected in all four directions in the form of overland flow. A portion of the front offices and access drive drains toward Kendrick Road. Other undeveloped areas consisting of woods and open space drain toward Thacher Lane and the abutters to the east and south.

There are two soil types shown for the property as mapped by the USDA Natural Resources Conservation Service. The east side of the property is mapped as Poquonock sand (323B), 3 to 8 percent slopes, very stony. This soil has a Hydrologic Soil Group Rating (HSG) A. The developed portion of the lot is shown as Udorthents – Urban land complex (656B), 0-8 percent slopes. This soil is assigned an HSG rating of B.

The existing conditions drainage analysis consists of five separate watersheds and three design points used for comparison with post-development runoff conditions.

Sub-catchment 1S is the developed portion of the site that drains to the catch basin at the east side of the existing parking lot.

Sub-catchment 2S is the area collected by the catch basin at the loading dock. Both of these areas send runoff to the piped system in Thacher Lane.

The open space portion of the lot adjacent to and upgradient from Thacher Lane is designated sub-catchment 3S.

All three of these areas are combined in the calculations using Link 1L which is the design point for Thacher Lane.

Sub-catchment 4S is the open space portion of the property in the southeast corner of the property that directs runoff onto abutting lot 1006.E. This is the second design point.

The final sub-catchment, 5S is the developed portion of the lot along the west side which directs runoff into Kendrick Road, the third design point.

Proposed Conditions

One of the goals of the drainage design for this project was to reduce and minimize the amount of runoff currently directed to Thacher Lane. This was achieved due to the pervious soils and low groundwater table along the south and east side of the property.

The stormwater management system design's primary component consists of an infiltration basin located along the east side and southeast corner of the lot. This basin receives runoff from more than half of the total lot area and a significant portion of the area considered new development. The runoff is pretreated prior to entering the basin by the installation of four proprietary RainGuardian Turret units. Testing has shown that these units provide in excess of the required 44% removal of total suspended solids prior to infiltration in high permeability soils. Refer to the relevant portions of the report provided in Appendix A.

An additional stormwater management control consists of the installation of a crushed stone infiltration trench located on the north side of the proposed building addition. These two systems result in the desired reduction in runoff to Thacher Lane.

Post-development runoff analysis has been formatted for ease of comparison with pre-development conditions, consisting of five watershed areas and the same three design points.

Sub-catchment 1S is the area of the lot considered to be new development which is collected in the infiltration basin, Pond 1P. This basin is large enough to store and infiltrate all storm events up to and including the 100 year storm.

Sub-catchment 2S is the area on the north side of the property which includes existing and proposed building roof runoff as well as lawn areas which drain toward the buildings. This runoff is collected and infiltrated in the crushed stone trench, modeled as Pond 2P in the calculations.

Sub-catchment 3S is the narrow strip of land along Thacher Lane which cannot be collected and flows unmitigated into the layout of Thacher Lane. This runoff is

combined with the overflow from Pond 2P through the Link 1L which is used for comparison with pre-development Link 1L.

Sub-catchment 4S is the reduced portion of the lot which drains toward abutting lot 1006.E and is compared with pre-development sub-catchment 4S.

Sub-catchment 5S is the portion of the lot which directs runoff to Kendrick Road. There are no alterations proposed within this area therefore the runoff characteristics remain the same.

The stormwater management design for this project provides for the treatment and retention of the majority of the runoff on the project site. In our opinion the successful development of this project in compliance with the design significantly reduces stormwater runoff rates and volumes to Thacher Lane and adjacent properties. Compliance with each of the standards listed within the Massachusetts Stormwater Management Handbook are included within this report.

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Drainage Summary

Pre-Development vs. Post-Development to Thacher Lane (1L/1L)

Storm Event	Pre		Post		Pre vs. Post changes	
	Peak Discharge (cfs)	Volume (ac-ft.)	Peak Discharge (cfs)	Volume (ac-ft.)	Peak Discharge (cfs)	Volume (ac-ft.)
2 yr	2.22	0.201	0.44	0.018	-1.78	-0.183
10 yr	4.17	0.376	1.15	0.054	-3.02	-0.322
25 yr	5.45	0.498	1.53	0.081	-3.92	-0.417
100 yr	7.54	0.698	2.10	0.128	-5.44	-0.570

Pre-Development vs. Post-Development to Lot 1006.E (4S/4S)

Storm Event	Pre		Post		Pre vs. Post changes	
	Peak Discharge (cfs)	Volume (ac-ft.)	Peak Discharge (cfs)	Volume (ac-ft.)	Peak Discharge (cfs)	Volume (ac-ft.)
2 yr	0.01	0.004	0	0	-0.01	-0.004
10 yr	0.15	0.018	0	0.001	-0.15	-0.017
25 yr	0.34	0.031	0.01	0.003	-0.33	-0.028
100 yr	0.71	0.055	0.04	0.009	-0.67	-0.046

Pre-Development vs. Post-Development to Kendrick Road (5S/5S)

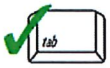
Storm Event	Pre		Post		Pre vs. Post changes	
	Peak Discharge (cfs)	Volume (ac-ft.)	Peak Discharge (cfs)	Volume (ac-ft.)	Peak Discharge (cfs)	Volume (ac-ft.)
2 yr	0.28	0.026	0.28	0.026	0	0
10 yr	0.71	0.058	0.71	0.058	0	0
25 yr	1.01	0.081	1.01	0.081	0	0
100 yr	1.52	0.120	1.52	0.120	0	0

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.

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

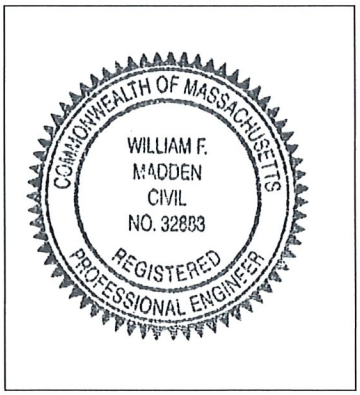
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



William F Madden 2/10/22
Signature and Date

Checklist

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

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

COMPLIANCE WITH THE STORMWATER MANAGEMENT STANDARDS

The Stormwater Management Standards

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

    - *This project significantly reduces runoff presently directed to Thacher Lane. There are no new outfalls associated with this project.*

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

    - *This project results in a reduction of peak discharge rates and volumes to downgradient properties.*

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

    - *Recharge volumes in excess of the standard are achieved within the proposed infiltration basin and crushed stone trench.*

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

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

- *This project includes proprietary treatment units and an infiltration basin which results in greater than 80% TSS removal.*

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

    - *This project is not considered a land use with higher potential pollutant loads.*

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

    - *This project is not located within a Zone II of a public water supply. There are no existing or proposed stormwater discharges.*

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

- *This project is considered a mix of new development and redevelopment. Full compliance with the standards is provided for this project.*

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

    - *Construction period erosion and sedimentation control measures are included on the design plans and in this report.*

9. A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

    - *A long-term operation and maintenance plan is listed on the design plans and is included in this report.*

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

    - *An illicit discharge compliance statement is included in the drainage report.*

Date: 2-9-2022

To whom it may concern:

I hereby certify that no illicit discharge connections to the town's drainage system presently exist nor will any be permitted in the future for the property located at 3 Kendrick Road in Wareham Massachusetts.

3 Kendrick Road, LLC

Long Term Operation and Maintenance Plan

Responsible Party: 3 Kendrick Road, LLC
P.O. Box 1135
Marion, MA 02738

The property owner is responsible for the inspection, operation and maintenance of the Stormwater Management System. The property manager and subsequent owners will be provided with copies of the approved site design and as-built plans to make them aware of the locations of system components. A copy of this Operation and Maintenance (O & M) Plan should also be provided.

System Description: The drainage system consists of an infiltration basin which receives runoff from the parking lot and loading dock areas. Four RainGuardian Turret units are specified at the inlets to the basin to provide pretreatment prior to infiltration in the basin.

Rain Guardian Turrets: Rain Guardian units shall be inspected after every rain event in excess of 0.25" for the first few months after installation to ensure proper function. Thereafter the units shall be inspected monthly and cleaned at least four times per year or whenever the sediment has accumulated to 75% of the storage capacity. Remove all sediment and debris from the top of the grate, from within the chamber, and from the face of the filter wall. Remove the filter, place in a disposable container, and brush off any sediment with a broom or rinse clean with pressurized water. All sediments and hydrocarbons should be handled properly and disposed of in accordance with local, state, and federal guidelines and regulations.

Infiltration Basins: The basin should be inspected monthly for bare spots and re-seeded if necessary. Add peastone to the basin bottom if needed. Any debris, trash, or sediment should be removed. Mowing of the basin side slopes will be infrequent, once or twice a year, primarily to prevent the growth of undesirable weeds, trees, and shrubs. Remove any sediment which has entered the basin. Dispose of any sediment in accordance with local, state, and federal guidelines and regulations.

Public Safety Features: The infiltration basin is designed with 3:1 side slopes. The maximum depth of stormwater in the basin is 2.65 feet. The maximum depth of runoff in the basin will drain dry in less than ten hours. The project is located within an industrial park. Retail sales will not occur at the site. Access will be limited to employees and delivery drivers.

Operation and Maintenance Budget: The estimated annual cost for inspection, mowing, and sediment removal associated with the maintenance of the Stormwater Management System is $1,000.

Construction Period Pollution Prevention and

Erosion & Sedimentation Control Plan

Narrative: This project consists of construction of a six thousand square foot building addition which will be utilized for manufacturing crumpets. The property will be further improved with the addition of an outdoor freezer, vestibule, two loading docks, and stormwater management system. A new site access drive will be created to allow access to Thacher Lane.

Responsible Parties: The site contractor and the owner.

Construction Period Operation / Maintenance Plan:

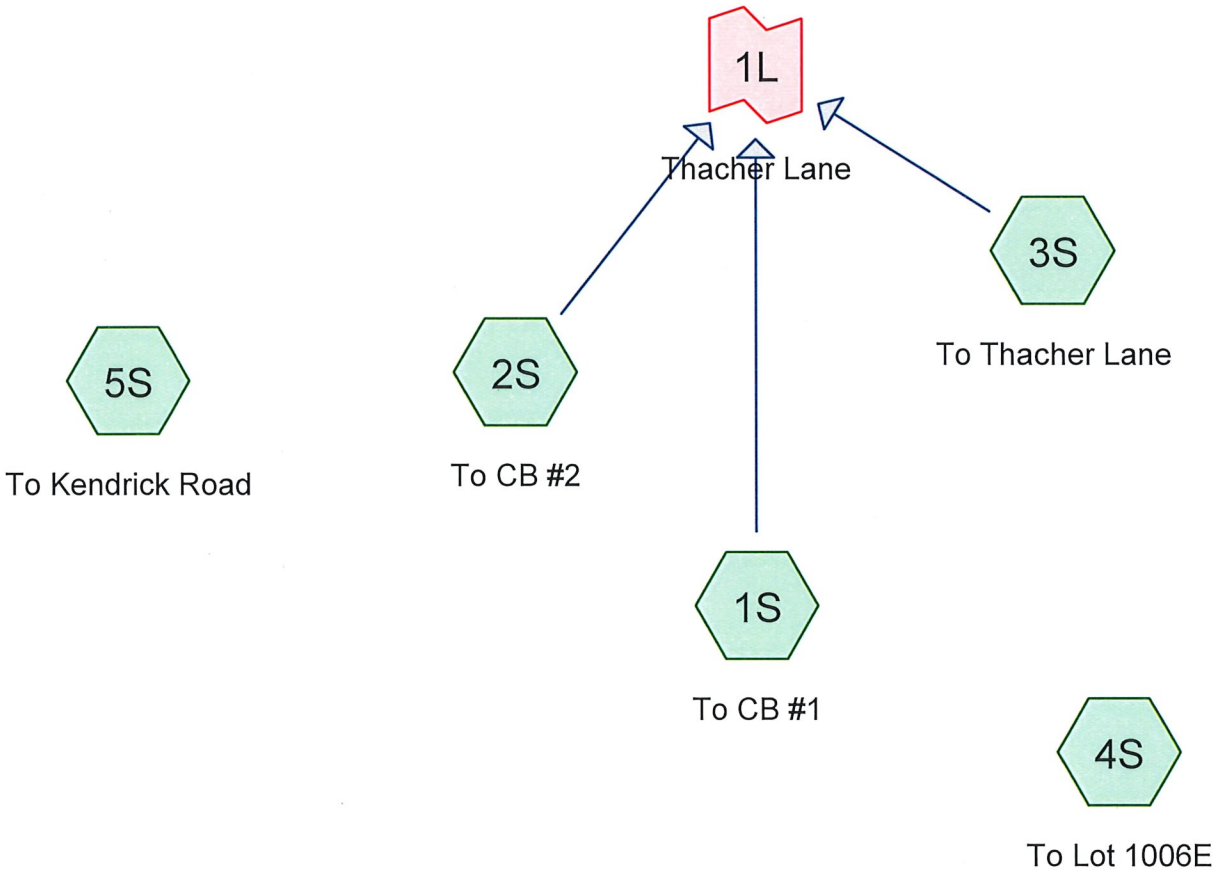
- Provide sufficient refuse containers and empty as needed.
- Inspect erosion controls daily. Repair or replace as needed.
- Police the area for safety hazards and trash on a daily basis.
- Store materials away from drainage and resource areas.
- Provide or receive only the materials which can be installed promptly.
- Inspect vehicles for leaks and repair or replace when necessary.
- Provide dust control with watering.
- Maintain truck runoff pads.
- Provide a contact person for complaints and to receive notification of problems.
- Direct dewatering to adequately sized containment areas.

Construction Sequence:

- Install erosion controls per the plans.
- Install silt sacks in existing catch basins.
- Clear the land, remove stumps, and rough grade.
- Demolish and remove existing buildings and foundations.
- Install building foundations, drainage structures and utilities.
- Install base course of pavement.
- Install top course pavement.
- Install landscaping. Loam & seed disturbed areas.
- Install permanent pavement markings.
- Remove erosion controls.

Maintenance Schedule:

- Erosion controls are to be inspected daily and repaired or replaced as needed.
- Trash is to be picked up daily.
- Water shall be used for dust control as needed.
- Silt sacks shall be emptied or replaced when full.
- Vehicles shall be inspected daily for any leaks and repaired or replaced as needed.



Subcat Reach Pond Link

Routing Diagram for 9731 Pre
Prepared by G.A.F. Engineering, Inc., Printed 2/14/2022

Project Notes

Rainfall events imported from "9731 Post.hcp"

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 Year Storm	Type III 24-hr		Default	24.00	1	3.44	2
2	10 Year Storm	Type III 24-hr		Default	24.00	1	5.04	2
3	25 Year Storm	Type III 24-hr		Default	24.00	1	6.04	2
4	100 Year Storm	Type III 24-hr		Default	24.00	1	7.59	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.286	39	>75% Grass cover, Good, HSG A (1S, 4S)
0.481	61	>75% Grass cover, Good, HSG B (1S, 2S, 4S, 5S)
0.668	98	Paved parking, HSG B (1S, 2S, 5S)
0.159	98	Roofs, HSG B (1S)
0.226	98	Unconnected roofs, HSG B (2S, 5S)
0.436	30	Woods, Good, HSG A (2S, 3S, 4S)
0.504	55	Woods, Good, HSG B (1S, 2S, 3S, 4S, 5S)
2.760	**67**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.721	HSG A	1S, 2S, 3S, 4S
2.039	HSG B	1S, 2S, 3S, 4S, 5S
0.000	HSG C	
0.000	HSG D	
0.000	Other	
2.760		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.286	0.481	0.000	0.000	0.000	0.767	>75% Grass cover, Good	1S, 2S, 4S, 5S
0.000	0.668	0.000	0.000	0.000	0.668	Paved parking	1S, 2S, 5S
0.000	0.159	0.000	0.000	0.000	0.159	Roofs	1S
0.000	0.226	0.000	0.000	0.000	0.226	Unconnected roofs	2S, 5S
0.436	0.504	0.000	0.000	0.000	0.939	Woods, Good	1S, 2S, 3S, 4S, 5S
0.721	**2.039**	**0.000**	**0.000**	**0.000**	**2.760**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To CB #1 Runoff Area=40,568 sf 67.67% Impervious Runoff Depth=1.73"
Flow Length=248' Tc=13.3 min CN=82 Runoff=1.49 cfs 0.135 af

Subcatchment 2S: To CB #2 Runoff Area=27,424 sf 49.58% Impervious Runoff Depth=1.26"
Flow Length=145' Tc=12.3 min CN=75 Runoff=0.73 cfs 0.066 af

Subcatchment 3S: To Thacher Lane Runoff Area=19,600 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=170' Tc=12.4 min CN=36 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: To Lot 1006E Runoff Area=16,000 sf 0.00% Impervious Runoff Depth=0.13"
Flow Length=145' Tc=4.7 min CN=48 Runoff=0.01 cfs 0.004 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=0.82"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=0.28 cfs 0.026 af

Link 1L: Thacher Lane Inflow=2.22 cfs 0.201 af
Primary=2.22 cfs 0.201 af

Total Runoff Area = 2.760 ac Runoff Volume = 0.231 af Average Runoff Depth = 1.00"
61.83% Pervious = 1.706 ac 38.17% Impervious = 1.054 ac

Summary for Subcatchment 1S: To CB #1

Runoff = 1.49 cfs @ 12.19 hrs, Volume= 0.135 af, Depth= 1.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Description
20,508	98	Paved parking, HSG B
6,944	98	Roofs, HSG B
5,556	39	>75% Grass cover, Good, HSG A
2,444	61	>75% Grass cover, Good, HSG B
5,116	55	Woods, Good, HSG B
40,568	82	Weighted Average
13,116		32.33% Pervious Area
27,452		67.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.7	158	0.0060	1.57		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.9	40	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.3	248	Total			

Summary for Subcatchment 2S: To CB #2

Runoff = 0.73 cfs @ 12.18 hrs, Volume= 0.066 af, Depth= 1.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Description
7,026	98	Paved parking, HSG B
6,570	98	Unconnected roofs, HSG B
7,692	61	>75% Grass cover, Good, HSG B
3,712	30	Woods, Good, HSG A
2,424	55	Woods, Good, HSG B
27,424	75	Weighted Average
13,828		50.42% Pervious Area
13,596		49.58% Impervious Area
6,570		48.32% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	95	0.0410	4.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.3	145	Total			

Summary for Subcatchment 3S: To Thacher Lane

[45] Hint: Runoff=Zero

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

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Description
14,760	30	Woods, Good, HSG A
4,840	55	Woods, Good, HSG B
19,600	36	Weighted Average
19,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	120	0.0720	4.32		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.4	170	Total			

Summary for Subcatchment 4S: To Lot 1006E

Runoff = 0.01 cfs @ 12.46 hrs, Volume= 0.004 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Description
6,890	39	>75% Grass cover, Good, HSG A
800	61	>75% Grass cover, Good, HSG B
500	30	Woods, Good, HSG A
7,810	55	Woods, Good, HSG B
16,000	48	Weighted Average
16,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	50	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.6	95	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.7	145	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 0.28 cfs @ 12.14 hrs, Volume= 0.026 af, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Link 1L: Thacher Lane

Inflow Area = 2.011 ac, 46.86% Impervious, Inflow Depth = 1.20" for 2 Year Storm event
Inflow = 2.22 cfs @ 12.18 hrs, Volume= 0.201 af
Primary = 2.22 cfs @ 12.18 hrs, Volume= 0.201 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To CB #1 Runoff Area=40,568 sf 67.67% Impervious Runoff Depth=3.11"
Flow Length=248' Tc=13.3 min CN=82 Runoff=2.69 cfs 0.242 af

Subcatchment 2S: To CB #2 Runoff Area=27,424 sf 49.58% Impervious Runoff Depth=2.48"
Flow Length=145' Tc=12.3 min CN=75 Runoff=1.49 cfs 0.130 af

Subcatchment 3S: To Thacher Lane Runoff Area=19,600 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=170' Tc=12.4 min CN=36 Runoff=0.01 cfs 0.004 af

Subcatchment 4S: To Lot 1006E Runoff Area=16,000 sf 0.00% Impervious Runoff Depth=0.60"
Flow Length=145' Tc=4.7 min CN=48 Runoff=0.15 cfs 0.018 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=1.83"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=0.71 cfs 0.058 af

Link 1L: Thacher Lane Inflow=4.17 cfs 0.376 af
Primary=4.17 cfs 0.376 af

Total Runoff Area = 2.760 ac Runoff Volume = 0.453 af Average Runoff Depth = 1.97"
61.83% Pervious = 1.706 ac 38.17% Impervious = 1.054 ac

Summary for Subcatchment 1S: To CB #1

Runoff = 2.69 cfs @ 12.18 hrs, Volume= 0.242 af, Depth= 3.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Description
20,508	98	Paved parking, HSG B
6,944	98	Roofs, HSG B
5,556	39	>75% Grass cover, Good, HSG A
2,444	61	>75% Grass cover, Good, HSG B
5,116	55	Woods, Good, HSG B
40,568	82	Weighted Average
13,116		32.33% Pervious Area
27,452		67.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.7	158	0.0060	1.57		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.9	40	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.3	248	Total			

Summary for Subcatchment 2S: To CB #2

Runoff = 1.49 cfs @ 12.17 hrs, Volume= 0.130 af, Depth= 2.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Description
7,026	98	Paved parking, HSG B
6,570	98	Unconnected roofs, HSG B
7,692	61	>75% Grass cover, Good, HSG B
3,712	30	Woods, Good, HSG A
2,424	55	Woods, Good, HSG B
27,424	75	Weighted Average
13,828		50.42% Pervious Area
13,596		49.58% Impervious Area
6,570		48.32% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	95	0.0410	4.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.3	145	Total			

Summary for Subcatchment 3S: To Thacher Lane

Runoff = 0.01 cfs @ 14.92 hrs, Volume= 0.004 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Description
14,760	30	Woods, Good, HSG A
4,840	55	Woods, Good, HSG B
19,600	36	Weighted Average
19,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	120	0.0720	4.32		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.4	170	Total			

Summary for Subcatchment 4S: To Lot 1006E

Runoff = 0.15 cfs @ 12.11 hrs, Volume= 0.018 af, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Description
6,890	39	>75% Grass cover, Good, HSG A
800	61	>75% Grass cover, Good, HSG B
500	30	Woods, Good, HSG A
7,810	55	Woods, Good, HSG B
16,000	48	Weighted Average
16,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	50	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.6	95	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.7	145	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 0.71 cfs @ 12.14 hrs, Volume= 0.058 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Link 1L: Thacher Lane

Inflow Area = 2.011 ac, 46.86% Impervious, Inflow Depth = 2.25" for 10 Year Storm event
Inflow = 4.17 cfs @ 12.18 hrs, Volume= 0.376 af
Primary = 4.17 cfs @ 12.18 hrs, Volume= 0.376 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To CB #1 Runoff Area=40,568 sf 67.67% Impervious Runoff Depth=4.02"
Flow Length=248' Tc=13.3 min CN=82 Runoff=3.46 cfs 0.312 af

Subcatchment 2S: To CB #2 Runoff Area=27,424 sf 49.58% Impervious Runoff Depth=3.32"
Flow Length=145' Tc=12.3 min CN=75 Runoff=1.99 cfs 0.174 af

Subcatchment 3S: To Thacher Lane Runoff Area=19,600 sf 0.00% Impervious Runoff Depth=0.30"
Flow Length=170' Tc=12.4 min CN=36 Runoff=0.03 cfs 0.011 af

Subcatchment 4S: To Lot 1006E Runoff Area=16,000 sf 0.00% Impervious Runoff Depth=1.02"
Flow Length=145' Tc=4.7 min CN=48 Runoff=0.34 cfs 0.031 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=2.56"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=1.01 cfs 0.081 af

Link 1L: Thacher Lane Inflow=5.45 cfs 0.498 af
Primary=5.45 cfs 0.498 af

Total Runoff Area = 2.760 ac Runoff Volume = 0.610 af Average Runoff Depth = 2.65"
61.83% Pervious = 1.706 ac 38.17% Impervious = 1.054 ac

Summary for Subcatchment 1S: To CB #1

Runoff = 3.46 cfs @ 12.18 hrs, Volume= 0.312 af, Depth= 4.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Description
20,508	98	Paved parking, HSG B
6,944	98	Roofs, HSG B
5,556	39	>75% Grass cover, Good, HSG A
2,444	61	>75% Grass cover, Good, HSG B
5,116	55	Woods, Good, HSG B
40,568	82	Weighted Average
13,116		32.33% Pervious Area
27,452		67.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.7	158	0.0060	1.57		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.9	40	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.3	248	Total			

Summary for Subcatchment 2S: To CB #2

Runoff = 1.99 cfs @ 12.17 hrs, Volume= 0.174 af, Depth= 3.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Description
7,026	98	Paved parking, HSG B
6,570	98	Unconnected roofs, HSG B
7,692	61	>75% Grass cover, Good, HSG B
3,712	30	Woods, Good, HSG A
2,424	55	Woods, Good, HSG B
27,424	75	Weighted Average
13,828		50.42% Pervious Area
13,596		49.58% Impervious Area
6,570		48.32% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	95	0.0410	4.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.3	145	Total			

Summary for Subcatchment 3S: To Thacher Lane

Runoff = 0.03 cfs @ 12.52 hrs, Volume= 0.011 af, Depth= 0.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Description
14,760	30	Woods, Good, HSG A
4,840	55	Woods, Good, HSG B
19,600	36	Weighted Average
19,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	120	0.0720	4.32		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.4	170	Total			

Summary for Subcatchment 4S: To Lot 1006E

Runoff = 0.34 cfs @ 12.09 hrs, Volume= 0.031 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Description
6,890	39	>75% Grass cover, Good, HSG A
800	61	>75% Grass cover, Good, HSG B
500	30	Woods, Good, HSG A
7,810	55	Woods, Good, HSG B
16,000	48	Weighted Average
16,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	50	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.6	95	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.7	145	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 1.01 cfs @ 12.13 hrs, Volume= 0.081 af, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Link 1L: Thacher Lane

Inflow Area = 2.011 ac, 46.86% Impervious, Inflow Depth = 2.97" for 25 Year Storm event
Inflow = 5.45 cfs @ 12.18 hrs, Volume= 0.498 af
Primary = 5.45 cfs @ 12.18 hrs, Volume= 0.498 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To CB #1 Runoff Area=40,568 sf 67.67% Impervious Runoff Depth=5.47"
Flow Length=248' Tc=13.3 min CN=82 Runoff=4.65 cfs 0.425 af

Subcatchment 2S: To CB #2 Runoff Area=27,424 sf 49.58% Impervious Runoff Depth=4.67"
Flow Length=145' Tc=12.3 min CN=75 Runoff=2.80 cfs 0.245 af

Subcatchment 3S: To Thacher Lane Runoff Area=19,600 sf 0.00% Impervious Runoff Depth=0.75"
Flow Length=170' Tc=12.4 min CN=36 Runoff=0.15 cfs 0.028 af

Subcatchment 4S: To Lot 1006E Runoff Area=16,000 sf 0.00% Impervious Runoff Depth=1.81"
Flow Length=145' Tc=4.7 min CN=48 Runoff=0.71 cfs 0.055 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=3.78"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=1.52 cfs 0.120 af

Link 1L: Thacher Lane Inflow=7.54 cfs 0.698 af
Primary=7.54 cfs 0.698 af

Total Runoff Area = 2.760 ac Runoff Volume = 0.874 af Average Runoff Depth = 3.80"
61.83% Pervious = 1.706 ac 38.17% Impervious = 1.054 ac

Summary for Subcatchment 1S: To CB #1

Runoff = 4.65 cfs @ 12.18 hrs, Volume= 0.425 af, Depth= 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

Area (sf)	CN	Description
20,508	98	Paved parking, HSG B
6,944	98	Roofs, HSG B
5,556	39	>75% Grass cover, Good, HSG A
2,444	61	>75% Grass cover, Good, HSG B
5,116	55	Woods, Good, HSG B
40,568	82	Weighted Average
13,116		32.33% Pervious Area
27,452		67.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0260	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.7	158	0.0060	1.57		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.9	40	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.3	248	Total			

Summary for Subcatchment 2S: To CB #2

Runoff = 2.80 cfs @ 12.17 hrs, Volume= 0.245 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

Area (sf)	CN	Description
7,026	98	Paved parking, HSG B
6,570	98	Unconnected roofs, HSG B
7,692	61	>75% Grass cover, Good, HSG B
3,712	30	Woods, Good, HSG A
2,424	55	Woods, Good, HSG B
27,424	75	Weighted Average
13,828		50.42% Pervious Area
13,596		49.58% Impervious Area
6,570		48.32% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	95	0.0410	4.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.3	145	Total			

Summary for Subcatchment 3S: To Thacher Lane

Runoff = 0.15 cfs @ 12.38 hrs, Volume= 0.028 af, Depth= 0.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

Area (sf)	CN	Description
14,760	30	Woods, Good, HSG A
4,840	55	Woods, Good, HSG B
19,600	36	Weighted Average
19,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	120	0.0720	4.32		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.4	170	Total			

Summary for Subcatchment 4S: To Lot 1006E

Runoff = 0.71 cfs @ 12.08 hrs, Volume= 0.055 af, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

Area (sf)	CN	Description
6,890	39	>75% Grass cover, Good, HSG A
800	61	>75% Grass cover, Good, HSG B
500	30	Woods, Good, HSG A
7,810	55	Woods, Good, HSG B
16,000	48	Weighted Average
16,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	50	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.6	95	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.7	145	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 1.52 cfs @ 12.13 hrs, Volume= 0.120 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

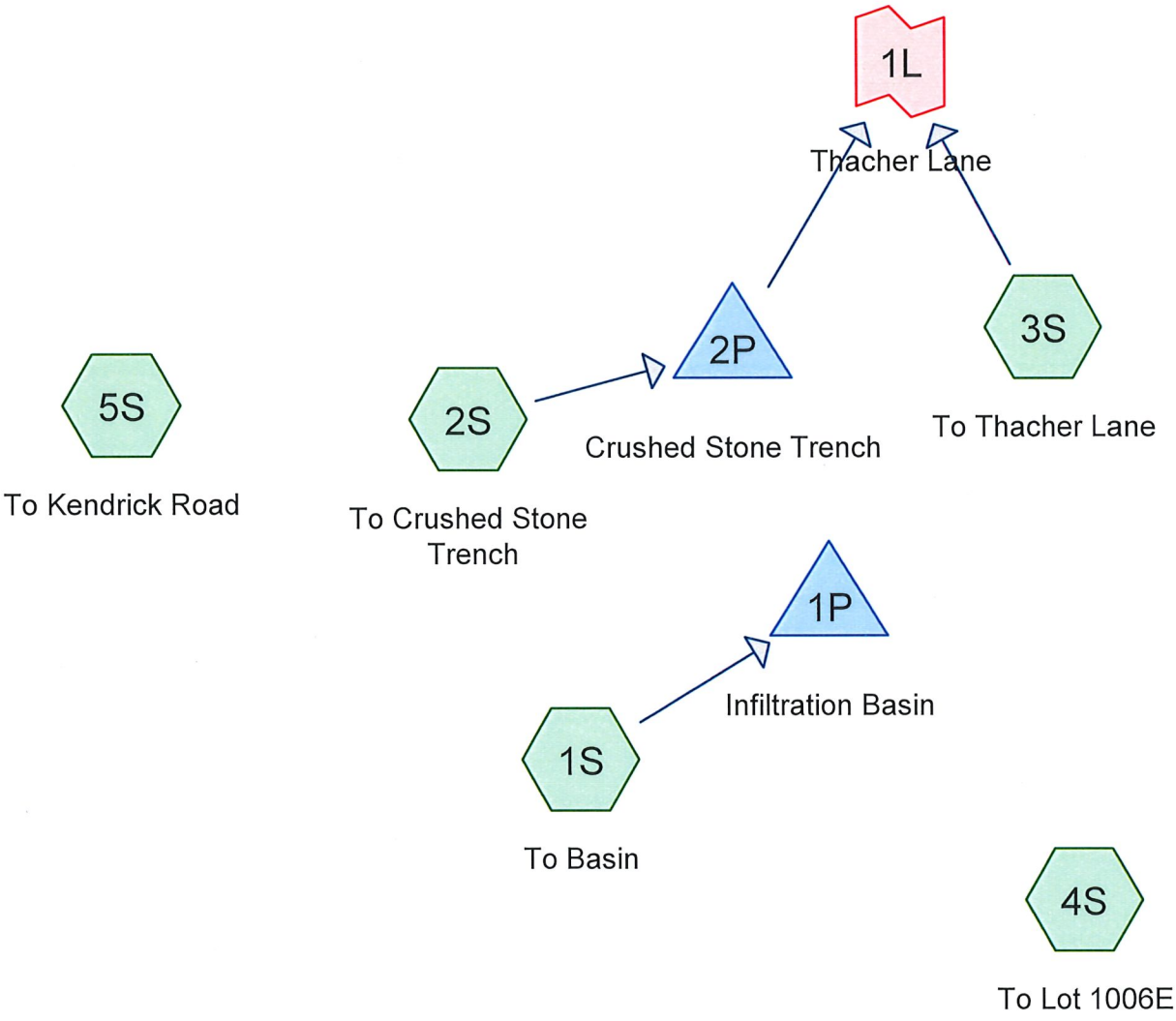
Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Link 1L: Thacher Lane

Inflow Area = 2.011 ac, 46.86% Impervious, Inflow Depth = 4.16" for 100 Year Storm event
Inflow = 7.54 cfs @ 12.18 hrs, Volume= 0.698 af
Primary = 7.54 cfs @ 12.18 hrs, Volume= 0.698 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs



Subcat Reach Pond Link

Routing Diagram for 9731 Post
Prepared by G.A.F. Engineering, Inc., Printed 2/14/2022

Project Notes

Rainfall events imported from "9731 Post.hcp"

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 Year Storm	Type III 24-hr		Default	24.00	1	3.44	2
2	10 Year Storm	Type III 24-hr		Default	24.00	1	5.04	2
3	25 Year Storm	Type III 24-hr		Default	24.00	1	6.04	2
4	100 Year Storm	Type III 24-hr		Default	24.00	1	7.59	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.629	39	>75% Grass cover, Good, HSG A (1S, 2S, 3S, 4S)
0.289	61	>75% Grass cover, Good, HSG B (1S, 2S, 5S)
0.008	98	Conc. pads and landings (2S)
1.000	98	Impervious pavement, roofs, conc. pads (1S)
0.044	98	Paved parking, HSG A (3S)
0.036	98	Paved parking, HSG B (5S)
0.138	98	Roofs, HSG A (2S)
0.151	98	Roofs, HSG B (2S)
0.075	98	Unconnected roofs, HSG B (5S)
0.120	30	Woods, Good, HSG A (4S)
0.270	55	Woods, Good, HSG B (1S, 2S, 3S, 4S, 5S)
2.760	**74**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.931	HSG A	1S, 2S, 3S, 4S
0.821	HSG B	1S, 2S, 3S, 4S, 5S
0.000	HSG C	
0.000	HSG D	
1.008	Other	1S, 2S
2.760		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Sub Num
0.629	0.289	0.000	0.000	0.000	0.918	>75% Grass cover, Good	
0.000	0.000	0.000	0.000	0.008	0.008	Conc. pads and landings	
0.000	0.000	0.000	0.000	1.000	1.000	Impervious pavement, roofs, conc. pads	
0.044	0.036	0.000	0.000	0.000	0.080	Paved parking	
0.138	0.151	0.000	0.000	0.000	0.289	Roofs	
0.000	0.075	0.000	0.000	0.000	0.075	Unconnected roofs	
0.120	0.270	0.000	0.000	0.000	0.390	Woods, Good	
0.931	**0.821**	**0.000**	**0.000**	**1.008**	**2.760**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	2P	46.00	43.00	45.0	0.0667	0.012	0.0	6.0	0.0

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Basin Runoff Area=68,200 sf 63.85% Impervious Runoff Depth=1.45"
Flow Length=130' Tc=10.6 min CN=78 Runoff=2.25 cfs 0.189 af

Subcatchment 2S: To Crushed Stone Runoff Area=19,990 sf 64.63% Impervious Runoff Depth=1.52"
Tc=6.0 min CN=79 Runoff=0.81 cfs 0.058 af

Subcatchment 3S: To Thacher Lane Runoff Area=7,802 sf 24.61% Impervious Runoff Depth=0.63"
Flow Length=320' Tc=13.4 min CN=63 Runoff=0.08 cfs 0.009 af

Subcatchment 4S: To Lot 1006E Runoff Area=7,600 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=105' Tc=9.4 min CN=34 Runoff=0.00 cfs 0.000 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=0.82"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=0.28 cfs 0.026 af

Pond 1P: Infiltration Basin Peak Elev=40.87' Storage=2,160 cf Inflow=2.25 cfs 0.189 af
Outflow=0.63 cfs 0.189 af

Pond 2P: Crushed Stone Trench Peak Elev=46.40' Storage=365 cf Inflow=0.81 cfs 0.058 af
Discarded=0.18 cfs 0.050 af Primary=0.37 cfs 0.008 af Outflow=0.55 cfs 0.058 af

Link 1L: Thacher Lane Inflow=0.44 cfs 0.018 af
Primary=0.44 cfs 0.018 af

Total Runoff Area = 2.760 ac Runoff Volume = 0.283 af Average Runoff Depth = 1.23"
47.41% Pervious = 1.308 ac 52.59% Impervious = 1.452 ac

Summary for Subcatchment 1S: To Basin

Runoff = 2.25 cfs @ 12.15 hrs, Volume= 0.189 af, Depth= 1.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

	Area (sf)	CN	Description
*	43,544	98	Impervious pavement, roofs, conc. pads
	2,008	61	>75% Grass cover, Good, HSG B
	3,392	55	Woods, Good, HSG B
	19,256	39	>75% Grass cover, Good, HSG A
	68,200	78	Weighted Average
	24,656		36.15% Pervious Area
	43,544		63.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	80	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	130	Total			

Summary for Subcatchment 2S: To Crushed Stone Trench

Runoff = 0.81 cfs @ 12.09 hrs, Volume= 0.058 af, Depth= 1.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

	Area (sf)	CN	Description
*	350	98	Conc. pads and landings
	6,000	98	Roofs, HSG A
	6,570	98	Roofs, HSG B
	562	61	>75% Grass cover, Good, HSG B
	1,150	55	Woods, Good, HSG B
	5,358	39	>75% Grass cover, Good, HSG A
	19,990	79	Weighted Average
	7,070		35.37% Pervious Area
	12,920		64.63% Impervious Area

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

Summary for Subcatchment 3S: To Thacher Lane

Runoff = 0.08 cfs @ 12.22 hrs, Volume= 0.009 af, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Description
1,920	98	Paved parking, HSG A
4,840	55	Woods, Good, HSG B
1,042	39	>75% Grass cover, Good, HSG A
7,802	63	Weighted Average
5,882		75.39% Pervious Area
1,920		24.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.5	270	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
13.4	320	Total			

Summary for Subcatchment 4S: To Lot 1006E

[45] Hint: Runoff=Zero

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

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Description
600	55	Woods, Good, HSG B
1,752	39	>75% Grass cover, Good, HSG A
5,248	30	Woods, Good, HSG A
7,600	34	Weighted Average
7,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.4	105	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 0.28 cfs @ 12.14 hrs, Volume= 0.026 af, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Year Storm Rainfall=3.44"

Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Pond 1P: Infiltration Basin

Inflow Area = 1.566 ac, 63.85% Impervious, Inflow Depth = 1.45" for 2 Year Storm event
Inflow = 2.25 cfs @ 12.15 hrs, Volume= 0.189 af
Outflow = 0.63 cfs @ 12.59 hrs, Volume= 0.189 af, Atten= 72%, Lag= 26.3 min
Discarded = 0.63 cfs @ 12.59 hrs, Volume= 0.189 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 40.87' @ 12.59 hrs Surf.Area= 3,296 sf Storage= 2,160 cf

Plug-Flow detention time= 31.6 min calculated for 0.189 af (100% of inflow)
Center-of-Mass det. time= 31.4 min (881.0 - 849.5)

Volume	Invert	Avail.Storage	Storage Description
#1	38.00'	80 cf	**2.00'W x 50.00'L x 2.00'H Prismatoid** 200 cf Overall x 40.0% Voids
#2	40.00'	21,274 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		21,354 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	1,600	0	0
41.00	3,440	2,520	2,520
42.00	5,288	4,364	6,884
43.00	7,124	6,206	13,090
44.00	9,244	8,184	21,274

Device	Routing	Invert	Outlet Devices
#1	Discarded	38.00'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.63 cfs @ 12.59 hrs HW=40.87' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.63 cfs)

Summary for Pond 2P: Crushed Stone Trench

Inflow Area = 0.459 ac, 64.63% Impervious, Inflow Depth = 1.52" for 2 Year Storm event
Inflow = 0.81 cfs @ 12.09 hrs, Volume= 0.058 af
Outflow = 0.55 cfs @ 12.18 hrs, Volume= 0.058 af, Atten= 32%, Lag= 5.4 min
Discarded = 0.18 cfs @ 12.18 hrs, Volume= 0.050 af
Primary = 0.37 cfs @ 12.18 hrs, Volume= 0.008 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 46.40' @ 12.18 hrs Surf.Area= 650 sf Storage= 365 cf

Plug-Flow detention time= 9.4 min calculated for 0.058 af (100% of inflow)
Center-of-Mass det. time= 9.4 min (851.6 - 842.2)

Volume	Invert	Avail.Storage	Storage Description
#1	45.00'	1,032 cf	**6.50'W x 100.00'L x 4.00'H Prismatoid** 2,600 cf Overall - 20 cf Embedded = 2,580 cf x 40.0% Voids
#2	46.50'	20 cf	**6.0" Round Pipe Storage** Inside #1 L= 100.0' S= 0.0050 '/'
		1,052 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	45.00'	**8.270 in/hr Exfiltration over Wetted area**
#2	Primary	46.00'	**6.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 46.00' / 43.00' S= 0.0667 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf

Discarded OutFlow Max=0.18 cfs @ 12.18 hrs HW=46.40' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.18 cfs)

Primary OutFlow Max=0.37 cfs @ 12.18 hrs HW=46.40' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.37 cfs @ 2.17 fps)

Summary for Link 1L: Thacher Lane

Inflow Area = 0.638 ac, 53.40% Impervious, Inflow Depth = 0.33" for 2 Year Storm event
Inflow = 0.44 cfs @ 12.18 hrs, Volume= 0.018 af
Primary = 0.44 cfs @ 12.18 hrs, Volume= 0.018 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Basin Runoff Area=68,200 sf 63.85% Impervious Runoff Depth=2.75"
Flow Length=130' Tc=10.6 min CN=78 Runoff=4.32 cfs 0.358 af

Subcatchment 2S: To Crushed Stone Runoff Area=19,990 sf 64.63% Impervious Runoff Depth=2.84"
Tc=6.0 min CN=79 Runoff=1.53 cfs 0.108 af

Subcatchment 3S: To Thacher Lane Runoff Area=7,802 sf 24.61% Impervious Runoff Depth=1.53"
Flow Length=320' Tc=13.4 min CN=63 Runoff=0.24 cfs 0.023 af

Subcatchment 4S: To Lot 1006E Runoff Area=7,600 sf 0.00% Impervious Runoff Depth=0.07"
Flow Length=105' Tc=9.4 min CN=34 Runoff=0.00 cfs 0.001 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=1.83"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=0.71 cfs 0.058 af

Pond 1P: Infiltration Basin Peak Elev=41.62' Storage=5,088 cf Inflow=4.32 cfs 0.358 af
Outflow=0.90 cfs 0.358 af

Pond 2P: Crushed Stone Trench Peak Elev=47.21' Storage=584 cf Inflow=1.53 cfs 0.108 af
Discarded=0.21 cfs 0.077 af Primary=0.93 cfs 0.031 af Outflow=1.14 cfs 0.108 af

Link 1L: Thacher Lane Inflow=1.15 cfs 0.054 af
Primary=1.15 cfs 0.054 af

Total Runoff Area = 2.760 ac Runoff Volume = 0.549 af Average Runoff Depth = 2.39"
47.41% Pervious = 1.308 ac 52.59% Impervious = 1.452 ac

Summary for Subcatchment 1S: To Basin

Runoff = 4.32 cfs @ 12.15 hrs, Volume= 0.358 af, Depth= 2.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

	Area (sf)	CN	Description
*	43,544	98	Impervious pavement, roofs, conc. pads
	2,008	61	>75% Grass cover, Good, HSG B
	3,392	55	Woods, Good, HSG B
	19,256	39	>75% Grass cover, Good, HSG A
	68,200	78	Weighted Average
	24,656		36.15% Pervious Area
	43,544		63.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	80	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	130	Total			

Summary for Subcatchment 2S: To Crushed Stone Trench

Runoff = 1.53 cfs @ 12.09 hrs, Volume= 0.108 af, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

	Area (sf)	CN	Description
*	350	98	Conc. pads and landings
	6,000	98	Roofs, HSG A
	6,570	98	Roofs, HSG B
	562	61	>75% Grass cover, Good, HSG B
	1,150	55	Woods, Good, HSG B
	5,358	39	>75% Grass cover, Good, HSG A
	19,990	79	Weighted Average
	7,070		35.37% Pervious Area
	12,920		64.63% Impervious Area

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

Summary for Subcatchment 3S: To Thacher Lane

Runoff = 0.24 cfs @ 12.20 hrs, Volume= 0.023 af, Depth= 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Description
1,920	98	Paved parking, HSG A
4,840	55	Woods, Good, HSG B
1,042	39	>75% Grass cover, Good, HSG A
7,802	63	Weighted Average
5,882		75.39% Pervious Area
1,920		24.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.5	270	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
13.4	320	Total			

Summary for Subcatchment 4S: To Lot 1006E

Runoff = 0.00 cfs @ 15.47 hrs, Volume= 0.001 af, Depth= 0.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Description
600	55	Woods, Good, HSG B
1,752	39	>75% Grass cover, Good, HSG A
5,248	30	Woods, Good, HSG A
7,600	34	Weighted Average
7,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.4	105	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 0.71 cfs @ 12.14 hrs, Volume= 0.058 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Year Storm Rainfall=5.04"

Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Pond 1P: Infiltration Basin

Inflow Area = 1.566 ac, 63.85% Impervious, Inflow Depth = 2.75" for 10 Year Storm event
Inflow = 4.32 cfs @ 12.15 hrs, Volume= 0.358 af
Outflow = 0.90 cfs @ 12.65 hrs, Volume= 0.358 af, Atten= 79%, Lag= 30.2 min
Discarded = 0.90 cfs @ 12.65 hrs, Volume= 0.358 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 41.62' @ 12.65 hrs Surf.Area= 4,686 sf Storage= 5,088 cf

Plug-Flow detention time= 52.2 min calculated for 0.358 af (100% of inflow)
Center-of-Mass det. time= 52.3 min (883.3 - 831.0)

Volume	Invert	Avail.Storage	Storage Description
#1	38.00'	80 cf	**2.00'W x 50.00'L x 2.00'H Prismatoid** 200 cf Overall x 40.0% Voids
#2	40.00'	21,274 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		21,354 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	1,600	0	0
41.00	3,440	2,520	2,520
42.00	5,288	4,364	6,884
43.00	7,124	6,206	13,090
44.00	9,244	8,184	21,274

Device	Routing	Invert	Outlet Devices
#1	Discarded	38.00'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.90 cfs @ 12.65 hrs HW=41.62' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.90 cfs)

Summary for Pond 2P: Crushed Stone Trench

Inflow Area = 0.459 ac, 64.63% Impervious, Inflow Depth = 2.84" for 10 Year Storm event
Inflow = 1.53 cfs @ 12.09 hrs, Volume= 0.108 af
Outflow = 1.14 cfs @ 12.16 hrs, Volume= 0.108 af, Atten= 25%, Lag= 4.3 min
Discarded = 0.21 cfs @ 12.16 hrs, Volume= 0.077 af
Primary = 0.93 cfs @ 12.16 hrs, Volume= 0.031 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 47.21' @ 12.16 hrs Surf.Area= 650 sf Storage= 584 cf

Plug-Flow detention time= 9.3 min calculated for 0.108 af (100% of inflow)
Center-of-Mass det. time= 9.3 min (833.4 - 824.1)

Volume	Invert	Avail.Storage	Storage Description
#1	45.00'	1,032 cf	**6.50'W x 100.00'L x 4.00'H Prismatoid** 2,600 cf Overall - 20 cf Embedded = 2,580 cf x 40.0% Voids
#2	46.50'	20 cf	**6.0" Round Pipe Storage** Inside #1 L= 100.0' S= 0.0050 '/'
		1,052 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	45.00'	**8.270 in/hr Exfiltration over Wetted area**
#2	Primary	46.00'	**6.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 46.00' / 43.00' S= 0.0667 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf

Discarded OutFlow Max=0.21 cfs @ 12.16 hrs HW=47.21' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=0.93 cfs @ 12.16 hrs HW=47.21' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.93 cfs @ 4.72 fps)

Summary for Link 1L: Thacher Lane

Inflow Area = 0.638 ac, 53.40% Impervious, Inflow Depth = 1.02" for 10 Year Storm event
Inflow = 1.15 cfs @ 12.17 hrs, Volume= 0.054 af
Primary = 1.15 cfs @ 12.17 hrs, Volume= 0.054 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Basin Runoff Area=68,200 sf 63.85% Impervious Runoff Depth=3.61"
Flow Length=130' Tc=10.6 min CN=78 Runoff=5.68 cfs 0.472 af

Subcatchment 2S: To Crushed Stone Runoff Area=19,990 sf 64.63% Impervious Runoff Depth=3.72"
Tc=6.0 min CN=79 Runoff=1.99 cfs 0.142 af

Subcatchment 3S: To Thacher Lane Runoff Area=7,802 sf 24.61% Impervious Runoff Depth=2.20"
Flow Length=320' Tc=13.4 min CN=63 Runoff=0.35 cfs 0.033 af

Subcatchment 4S: To Lot 1006E Runoff Area=7,600 sf 0.00% Impervious Runoff Depth=0.22"
Flow Length=105' Tc=9.4 min CN=34 Runoff=0.01 cfs 0.003 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=2.56"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=1.01 cfs 0.081 af

Pond 1P: Infiltration Basin Peak Elev=42.04' Storage=7,199 cf Inflow=5.68 cfs 0.472 af
Outflow=1.05 cfs 0.472 af

Pond 2P: Crushed Stone Trench Peak Elev=47.83' Storage=748 cf Inflow=1.99 cfs 0.142 af
Discarded=0.24 cfs 0.094 af Primary=1.19 cfs 0.048 af Outflow=1.43 cfs 0.142 af

Link 1L: Thacher Lane Inflow=1.53 cfs 0.081 af
Primary=1.53 cfs 0.081 af

Total Runoff Area = 2.760 ac Runoff Volume = 0.731 af Average Runoff Depth = 3.18"
47.41% Pervious = 1.308 ac 52.59% Impervious = 1.452 ac

Summary for Subcatchment 1S: To Basin

Runoff = 5.68 cfs @ 12.15 hrs, Volume= 0.472 af, Depth= 3.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

	Area (sf)	CN	Description
*	43,544	98	Impervious pavement, roofs, conc. pads
	2,008	61	>75% Grass cover, Good, HSG B
	3,392	55	Woods, Good, HSG B
	19,256	39	>75% Grass cover, Good, HSG A
	68,200	78	Weighted Average
	24,656		36.15% Pervious Area
	43,544		63.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	80	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	130	Total			

Summary for Subcatchment 2S: To Crushed Stone Trench

Runoff = 1.99 cfs @ 12.09 hrs, Volume= 0.142 af, Depth= 3.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

	Area (sf)	CN	Description
*	350	98	Conc. pads and landings
	6,000	98	Roofs, HSG A
	6,570	98	Roofs, HSG B
	562	61	>75% Grass cover, Good, HSG B
	1,150	55	Woods, Good, HSG B
	5,358	39	>75% Grass cover, Good, HSG A
	19,990	79	Weighted Average
	7,070		35.37% Pervious Area
	12,920		64.63% Impervious Area

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

Summary for Subcatchment 3S: To Thacher Lane

Runoff = 0.35 cfs @ 12.19 hrs, Volume= 0.033 af, Depth= 2.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Description
1,920	98	Paved parking, HSG A
4,840	55	Woods, Good, HSG B
1,042	39	>75% Grass cover, Good, HSG A
7,802	63	Weighted Average
5,882		75.39% Pervious Area
1,920		24.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.5	270	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
13.4	320	Total			

Summary for Subcatchment 4S: To Lot 1006E

Runoff = 0.01 cfs @ 13.67 hrs, Volume= 0.003 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Description
600	55	Woods, Good, HSG B
1,752	39	>75% Grass cover, Good, HSG A
5,248	30	Woods, Good, HSG A
7,600	34	Weighted Average
7,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.4	105	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 1.01 cfs @ 12.13 hrs, Volume= 0.081 af, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Storm Rainfall=6.04"

Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Pond 1P: Infiltration Basin

Inflow Area = 1.566 ac, 63.85% Impervious, Inflow Depth = 3.61" for 25 Year Storm event
Inflow = 5.68 cfs @ 12.15 hrs, Volume= 0.472 af
Outflow = 1.05 cfs @ 12.68 hrs, Volume= 0.472 af, Atten= 82%, Lag= 32.1 min
Discarded = 1.05 cfs @ 12.68 hrs, Volume= 0.472 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 42.04' @ 12.68 hrs Surf.Area= 5,469 sf Storage= 7,199 cf

Plug-Flow detention time= 65.1 min calculated for 0.471 af (100% of inflow)
Center-of-Mass det. time= 65.0 min (888.2 - 823.1)

Volume	Invert	Avail.Storage	Storage Description
#1	38.00'	80 cf	**2.00'W x 50.00'L x 2.00'H Prismatoid** 200 cf Overall x 40.0% Voids
#2	40.00'	21,274 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		21,354 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	1,600	0	0
41.00	3,440	2,520	2,520
42.00	5,288	4,364	6,884
43.00	7,124	6,206	13,090
44.00	9,244	8,184	21,274

Device	Routing	Invert	Outlet Devices
#1	Discarded	38.00'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=1.05 cfs @ 12.68 hrs HW=42.04' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 1.05 cfs)

Summary for Pond 2P: Crushed Stone Trench

Inflow Area = 0.459 ac, 64.63% Impervious, Inflow Depth = 3.72" for 25 Year Storm event
Inflow = 1.99 cfs @ 12.09 hrs, Volume= 0.142 af
Outflow = 1.43 cfs @ 12.16 hrs, Volume= 0.142 af, Atten= 28%, Lag= 4.6 min
Discarded = 0.24 cfs @ 12.16 hrs, Volume= 0.094 af
Primary = 1.19 cfs @ 12.16 hrs, Volume= 0.048 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 47.83' @ 12.16 hrs Surf.Area= 650 sf Storage= 748 cf

Plug-Flow detention time= 9.7 min calculated for 0.142 af (100% of inflow)
Center-of-Mass det. time= 9.7 min (826.1 - 816.4)

Volume	Invert	Avail.Storage	Storage Description
#1	45.00'	1,032 cf	**6.50'W x 100.00'L x 4.00'H Prismatoid** 2,600 cf Overall - 20 cf Embedded = 2,580 cf x 40.0% Voids
#2	46.50'	20 cf	**6.0" Round Pipe Storage** Inside #1 L= 100.0' S= 0.0050 '/'
		1,052 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	45.00'	**8.270 in/hr Exfiltration over Wetted area**
#2	Primary	46.00'	**6.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 46.00' / 43.00' S= 0.0667 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf

Discarded OutFlow Max=0.24 cfs @ 12.16 hrs HW=47.83' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.24 cfs)

Primary OutFlow Max=1.19 cfs @ 12.16 hrs HW=47.83' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 1.19 cfs @ 6.05 fps)

Summary for Link 1L: Thacher Lane

Inflow Area = 0.638 ac, 53.40% Impervious, Inflow Depth = 1.52" for 25 Year Storm event
Inflow = 1.53 cfs @ 12.17 hrs, Volume= 0.081 af
Primary = 1.53 cfs @ 12.17 hrs, Volume= 0.081 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Basin Runoff Area=68,200 sf 63.85% Impervious Runoff Depth=5.01"
Flow Length=130' Tc=10.6 min CN=78 Runoff=7.84 cfs 0.654 af

Subcatchment 2S: To Crushed Stone Runoff Area=19,990 sf 64.63% Impervious Runoff Depth=5.13"
Tc=6.0 min CN=79 Runoff=2.73 cfs 0.196 af

Subcatchment 3S: To Thacher Lane Runoff Area=7,802 sf 24.61% Impervious Runoff Depth=3.35"
Flow Length=320' Tc=13.4 min CN=63 Runoff=0.55 cfs 0.050 af

Subcatchment 4S: To Lot 1006E Runoff Area=7,600 sf 0.00% Impervious Runoff Depth=0.59"
Flow Length=105' Tc=9.4 min CN=34 Runoff=0.04 cfs 0.009 af

Subcatchment 5S: To Kendrick Road Runoff Area=16,633 sf 29.12% Impervious Runoff Depth=3.78"
Flow Length=64' Tc=9.1 min UI Adjusted CN=67 Runoff=1.52 cfs 0.120 af

Pond 1P: Infiltration Basin Peak Elev=42.65' Storage=10,781 cf Inflow=7.84 cfs 0.654 af
Outflow=1.26 cfs 0.654 af

Pond 2P: Crushed Stone Trench Peak Elev=48.94' Storage=1,036 cf Inflow=2.73 cfs 0.196 af
Discarded=0.29 cfs 0.118 af Primary=1.55 cfs 0.078 af Outflow=1.84 cfs 0.196 af

Link 1L: Thacher Lane Inflow=2.10 cfs 0.128 af
Primary=2.10 cfs 0.128 af

Total Runoff Area = 2.760 ac Runoff Volume = 1.029 af Average Runoff Depth = 4.47"
47.41% Pervious = 1.308 ac 52.59% Impervious = 1.452 ac

Summary for Subcatchment 1S: To Basin

Runoff = 7.84 cfs @ 12.14 hrs, Volume= 0.654 af, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

	Area (sf)	CN	Description
*	43,544	98	Impervious pavement, roofs, conc. pads
	2,008	61	>75% Grass cover, Good, HSG B
	3,392	55	Woods, Good, HSG B
	19,256	39	>75% Grass cover, Good, HSG A
	68,200	78	Weighted Average
	24,656		36.15% Pervious Area
	43,544		63.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.1	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.5	80	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	130	Total			

Summary for Subcatchment 2S: To Crushed Stone Trench

Runoff = 2.73 cfs @ 12.09 hrs, Volume= 0.196 af, Depth= 5.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

	Area (sf)	CN	Description
*	350	98	Conc. pads and landings
	6,000	98	Roofs, HSG A
	6,570	98	Roofs, HSG B
	562	61	>75% Grass cover, Good, HSG B
	1,150	55	Woods, Good, HSG B
	5,358	39	>75% Grass cover, Good, HSG A
	19,990	79	Weighted Average
	7,070		35.37% Pervious Area
	12,920		64.63% Impervious Area

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

Summary for Subcatchment 3S: To Thacher Lane

Runoff = 0.55 cfs @ 12.19 hrs, Volume= 0.050 af, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

Area (sf)	CN	Description
1,920	98	Paved parking, HSG A
4,840	55	Woods, Good, HSG B
1,042	39	>75% Grass cover, Good, HSG A
7,802	63	Weighted Average
5,882		75.39% Pervious Area
1,920		24.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.9	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.5	270	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
13.4	320	Total			

Summary for Subcatchment 4S: To Lot 1006E

Runoff = 0.04 cfs @ 12.38 hrs, Volume= 0.009 af, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

Area (sf)	CN	Description
600	55	Woods, Good, HSG B
1,752	39	>75% Grass cover, Good, HSG A
5,248	30	Woods, Good, HSG A
7,600	34	Weighted Average
7,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.4	105	Total			

Summary for Subcatchment 5S: To Kendrick Road

Runoff = 1.52 cfs @ 12.13 hrs, Volume= 0.120 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Year Storm Rainfall=7.59"

Area (sf)	CN	Adj	Description
1,556	98		Paved parking, HSG B
3,288	98		Unconnected roofs, HSG B
10,029	61		>75% Grass cover, Good, HSG B
1,760	55		Woods, Good, HSG B
16,633	71	67	Weighted Average, UI Adjusted
11,789			70.88% Pervious Area
4,844			29.12% Impervious Area
3,288			67.88% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0060	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.44"
0.3	14	0.0020	0.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	64	Total			

Summary for Pond 1P: Infiltration Basin

Inflow Area = 1.566 ac, 63.85% Impervious, Inflow Depth = 5.01" for 100 Year Storm event
Inflow = 7.84 cfs @ 12.14 hrs, Volume= 0.654 af
Outflow = 1.26 cfs @ 12.73 hrs, Volume= 0.654 af, Atten= 84%, Lag= 35.2 min
Discarded = 1.26 cfs @ 12.73 hrs, Volume= 0.654 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 42.65' @ 12.73 hrs Surf.Area= 6,579 sf Storage= 10,781 cf

Plug-Flow detention time= 83.9 min calculated for 0.654 af (100% of inflow)
Center-of-Mass det. time= 83.9 min (897.7 - 813.8)

Volume	Invert	Avail.Storage	Storage Description
#1	38.00'	80 cf	**2.00'W x 50.00'L x 2.00'H Prismatoid** 200 cf Overall x 40.0% Voids
#2	40.00'	21,274 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		21,354 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	1,600	0	0
41.00	3,440	2,520	2,520
42.00	5,288	4,364	6,884
43.00	7,124	6,206	13,090
44.00	9,244	8,184	21,274

Device	Routing	Invert	Outlet Devices
#1	Discarded	38.00'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=1.26 cfs @ 12.73 hrs HW=42.65' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 1.26 cfs)

Summary for Pond 2P: Crushed Stone Trench

Inflow Area = 0.459 ac, 64.63% Impervious, Inflow Depth = 5.13" for 100 Year Storm event
Inflow = 2.73 cfs @ 12.09 hrs, Volume= 0.196 af
Outflow = 1.84 cfs @ 12.17 hrs, Volume= 0.196 af, Atten= 33%, Lag= 5.2 min
Discarded = 0.29 cfs @ 12.17 hrs, Volume= 0.118 af
Primary = 1.55 cfs @ 12.17 hrs, Volume= 0.078 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 48.94' @ 12.17 hrs Surf.Area= 650 sf Storage= 1,036 cf

Plug-Flow detention time= 10.3 min calculated for 0.196 af (100% of inflow)
Center-of-Mass det. time= 10.2 min (817.5 - 807.2)

Volume	Invert	Avail.Storage	Storage Description
#1	45.00'	1,032 cf	**6.50'W x 100.00'L x 4.00'H Prismatoid** 2,600 cf Overall - 20 cf Embedded = 2,580 cf x 40.0% Voids
#2	46.50'	20 cf	**6.0" Round Pipe Storage** Inside #1 L= 100.0' S= 0.0050 '/'
		1,052 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	45.00'	**8.270 in/hr Exfiltration over Wetted area**
#2	Primary	46.00'	**6.0" Round Culvert** L= 45.0' Ke= 0.500 Inlet / Outlet Invert= 46.00' / 43.00' S= 0.0667 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf

Discarded OutFlow Max=0.28 cfs @ 12.17 hrs HW=48.94' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=1.55 cfs @ 12.17 hrs HW=48.94' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 1.55 cfs @ 7.89 fps)

Summary for Link 1L: Thacher Lane

Inflow Area = 0.638 ac, 53.40% Impervious, Inflow Depth = 2.41" for 100 Year Storm event
Inflow = 2.10 cfs @ 12.18 hrs, Volume= 0.128 af
Primary = 2.10 cfs @ 12.18 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: 3 Kendrick Road, Wareham, MA

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
RainGuardian Turret Units	0.70	1.00	0.70	0.30
Infiltration Basin	0.80	0.30	0.24	0.06

Total TSS Removal = 94 %

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

Project: 3 Kendrick Road, LLC

Prepared By: G.A.F. Engineering

Date: 2-10-22

*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

Recharge Volume Calculation

Required Recharge Depth = 0.60 inch volume from impervious surfaces (HSG A Soil)

The 1.00 inch water quality volume calculation confirms that the recharge volume is available in the infiltration basin. The following calculations confirm that the basin and infiltration trench meet the required system drawdown time of 72 hours maximum for the 100-year storm event.

Infiltration Basin:

Recharge System Drawdown time (72 hrs. max.)

$$\text{Time} = \frac{\text{Storage Volume}}{(\text{Rawls Rate})\,(\text{Bottom Area})}$$

$$\text{Time} = \frac{10{,}781 \text{ cf}}{(8.27 \text{ inches/hour})(1 \text{ ft}/12 \text{ inches})(1{,}600 \text{ sf})}$$

9.78 hours < 72 hours OK

Crushed Stone Trench:

$$\text{Time} = \frac{1{,}036 \text{ cf}}{(8.27 \text{ inches/hour})(1 \text{ ft}/12 \text{ inches})(650 \text{ sf})}$$

2.3 hours < 72 hours OK

Water Quality Volume Calculation

Area to Infiltration Basin

Design Water Quality Depth = 1-inch volume from impervious surfaces

Total Impervious Area = 43,544 sf

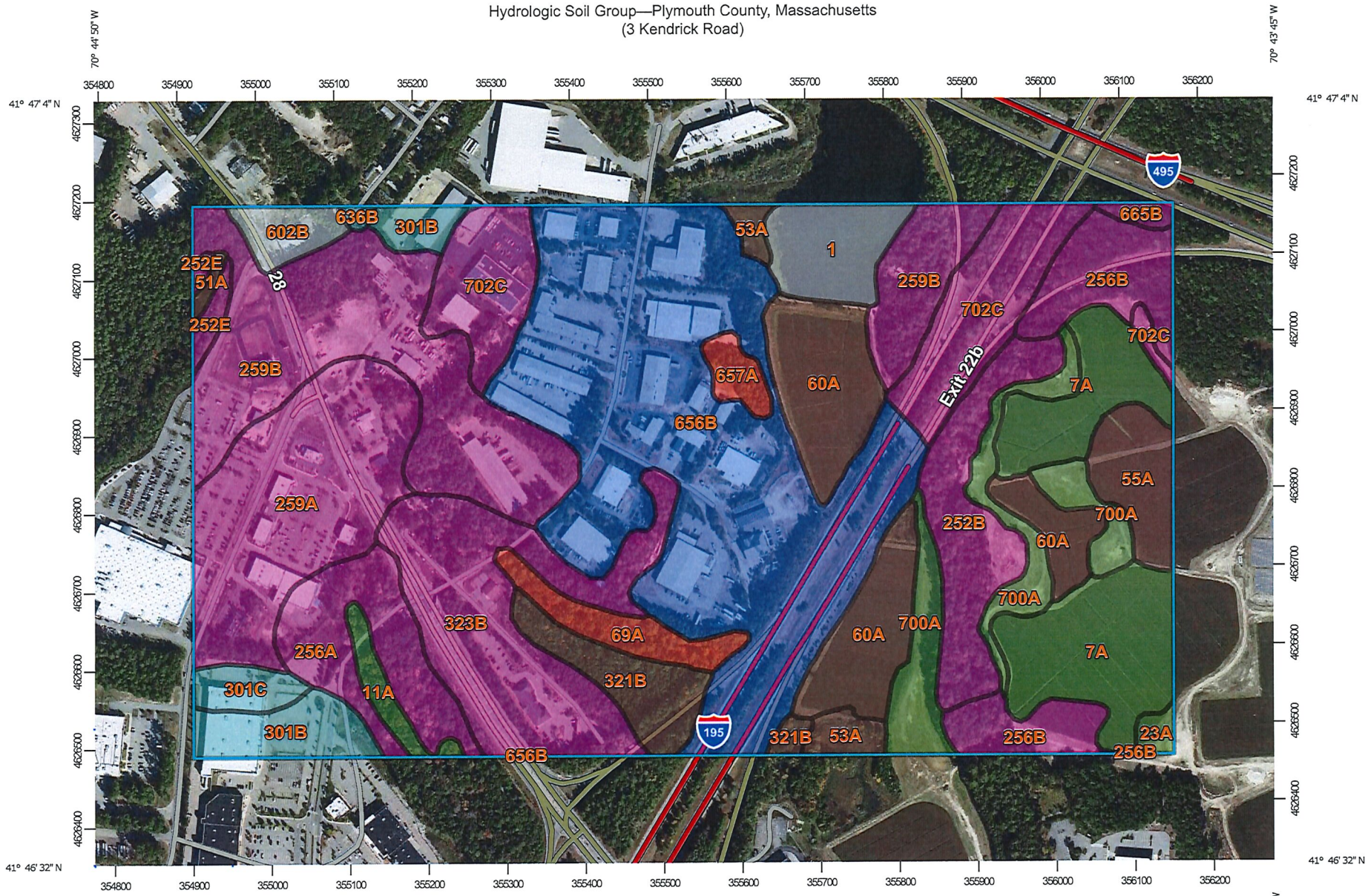
Water Quality Volume = 43,544 sf x 1.00"/12 = 3,628.7 cf

Total Storage in Basin up to 100-year elevation = 10,781 cf (HydroCAD)

10,781 cf > 3,628.7 cf - OK

G.A.F. Engineering, Inc.
February 10, 2022
G.A.F. Job No.: 21-9731

Hydrologic Soil Group—Plymouth County, Massachusetts
(3 Kendrick Road)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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

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

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

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

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 13, Jun 9, 2020

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

Date(s) aerial images were photographed: Sep 25, 2020—Oct 9, 2020

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		4.7	2.1%
7A	Rainberry coarse sand, 0 to 3 percent slopes, sanded surface	A/D	14.7	6.7%
11A	Rainberry coarse sand, 0 to 3 percent slopes	A/D	1.6	0.7%
23A	Tihonet coarse sand, 0 to 3 percent slopes	A/D	0.6	0.3%
51A	Swansea muck, 0 to 1 percent slopes	B/D	0.4	0.2%
53A	Freetown muck, ponded, 0 to 1 percent slopes	B/D	2.0	0.9%
55A	Freetown coarse sand, 0 to 3 percent slopes, sanded surface	B/D	4.1	1.9%
60A	Swansea coarse sand, 0 to 2 percent slopes	B/D	14.5	6.7%
69A	Mattapoisett loamy sand, 0 to 3 percent slopes, extremely stony	D	3.3	1.5%
252B	Carver coarse sand, 3 to 8 percent slopes	A	8.4	3.8%
252E	Carver coarse sand, 15 to 35 percent slopes	A	1.0	0.5%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	A	8.0	3.7%
256B	Deerfield loamy fine sand, 3 to 8 percent slopes	A	8.5	3.9%
259A	Carver loamy coarse sand, 0 to 3 percent slopes	A	17.5	8.0%
259B	Carver loamy coarse sand, 3 to 8 percent slopes	A	26.2	12.0%
301B	Montauk fine sandy loam, 0 to 8 percent slopes, very stony	C	5.2	2.4%
301C	Montauk fine sandy loam, 8 to 15 percent slopes, very stony	C	1.8	0.8%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
321B	Birchwood sand, 3 to 8 percent slopes, very stony	B/D	5.0	2.3%
323B	Poquonock sand, 3 to 8 percent slopes, very stony	A	16.5	7.5%
602B	Urban land, 0 to 8 percent slopes		2.1	1.0%
636B	Montauk-Urban land complex, 0 to 8 percent slopes	C	0.3	0.1%
656B	Udorthents - Urban land complex, 0 to 8 percent slopes	B	47.6	21.8%
657A	Aquepts, 0 to 3 percent slopes	D	1.4	0.7%
665B	Udipsamments, 0 to 8 percent slopes	A	0.6	0.3%
700A	Udipsamments, wet substratum, 0 to 3 percent slopes	A/D	8.9	4.1%
702C	Udipsamments, 8 to 15 percent slopes	A	13.6	6.2%
Totals for Area of Interest			**218.5**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix "A"

UNIVERSITY OF MINNESOTA

ST. ANTHONY FALLS LABORATORY

Engineering, Environmental and Geophysical Fluid Dynamics

Project Report No. 586

Capture of Gross Solids and Sediment by Pretreatment Practices for Bioretention

Final Report for the Project:
Field performance assessment of sediment and gross solids removal from surface inlet pretreatment practices for bioretention

by

Andrew J. Erickson and Matt A. Hernick

St. Anthony Falls Laboratory, University of Minnesota,
2 Third Avenue SE Minneapolis, MN 55455

Prepared for
University of Minnesota Water Resources Center,
Minnesota Stormwater Research Council
and
Anoka Conservation District

January 2019
Minneapolis, Minnesota

Table 2. Pretreatment practice, Unique identifier, storage and flow rate capacity, test flow rates and durations, and number of replicates. cfs = cubic feet per second.

Pretreatment Practice	ID	Flow rate and Storage Capacity	Test flow rate and duration (replicates)
Grass Lined Inlet	GLI	Storage capacity = minimal (depth of grass). Flow rate capacity = unknown.	0.25cfs for 40 minutes (2), 0.5cfs for 20 minutes (2)
Rain Guardian Bunker	RGB	Storage capacity = 2.85ft^3. Flow rate capacity = 6.11cfs.	0.25cfs for 40 minutes (2), 0.5cfs for 20 minutes (2)
Rain Guardian Turret	RGT	Storage capacity = 4.02ft^3. Flowr ate capacity = 3.45cfs.	0.25cfs for 40 minutes (2), 0.5cfs for 20 minutes (2)
Rock Lined Inlet	RLI	Storage capacity = minimal (pore space between rock). Flow rate capacity = unknown.	0.25cfs for 40 minutes (2), 0.5cfs for 20 minutes (2)
Shallow sump grit chamber (bypass)	BBP	Storage capacity = ~6ft^3. Flow rate capacity = unknown.	0.12cfs for 40 minutes (1), 0.25cfs for 20 minutes (1)
Shallow sump grit chamber (design volume)	BDV	Storage capacity = ~6ft^3. Flow rate capacity = unknown.	0.06cfs for 30 minutes (2), 0.12cfs for 15 minutes (2)

3.1 GRASS LINED INLET

A grass lined inlet (GLI) in a non-proprietary grassed conveyance that is sloped between the curb cut and the bottom of bioretention, as shown in Figure 7. It is also sometimes called a filter strip, buffer strip, or vegetative filter. GLIs capture sediment and gross solids by a combination of settling and vegetative filtration. As water, sediment and gross solids flow over the GLI, the vegetation both intercepts particles and gross solids (vegetative filtration) and reduces the flow velocity near the soil surface, which allows for settling of sediment. Sediment that settles on the soil within the vegetation is thus protected by the vegetation within a non-turbulent boundary layer.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 ANOKA SITE: GRASS LINED INLET, RAIN GUARDIAN BUNKER, RAIN GUARDIAN TURRET, AND ROCK LINED INLET

5.1.1 Sediment Capture

5.1.1.1 Low intensity (Q = 0.25cfs for 40 minutes)

Sediment capture for the tests designed to simulate the design storage volume of the bioretention practice (600 cubic feet for Anoka) for the low intensity flow conditions is shown in Figure 51. In general, all pretreatment practices captured at least 95% of the coarse sediment fraction (D_{50} = 1.17mm) mass and the medium sediment fraction (D_{50} = 0.41mm) mass. The pretreatment practices also captured 65 – 80% of the fine sediment fraction (D_{50} = 0.12mm).

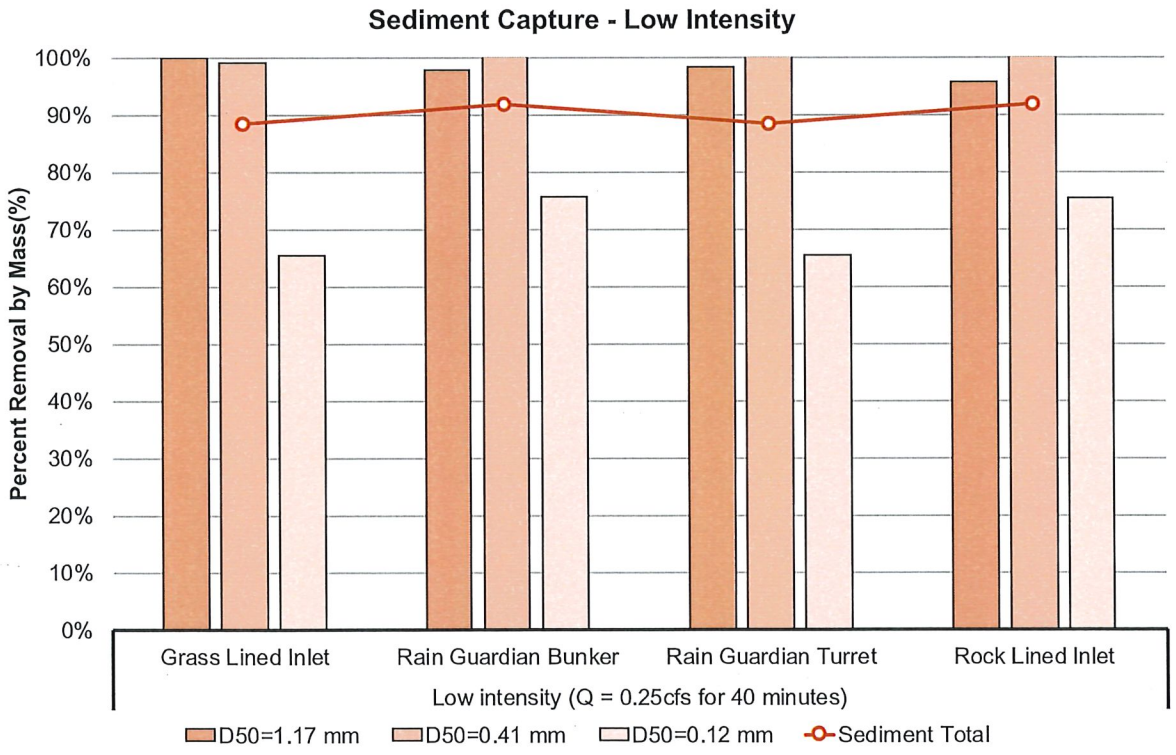


Figure 51: Sediment capture by percent for design volume low intensity tests (Q = 0.25cfs, duration = 40 minutes).

The purpose of pretreatment is to reduce the maintenance burden on primary treatment practices (i.e., bioretention) by capturing gross solids and 25% of the sediment > 100µm (MPCA 2017a). As shown in Figure 19, approximately 90% of the fine sediment fraction used in testing is between than 0.1mm (100 µm) and 0.2 mm. As shown in Figure 51, 65 – 80% of this fine sediment fraction was captured by all four pretreatment practices for low intensity tests. When all three sediment fractions are summed, 88 – 95% of the sediment mass was captured by the pretreatment practices.

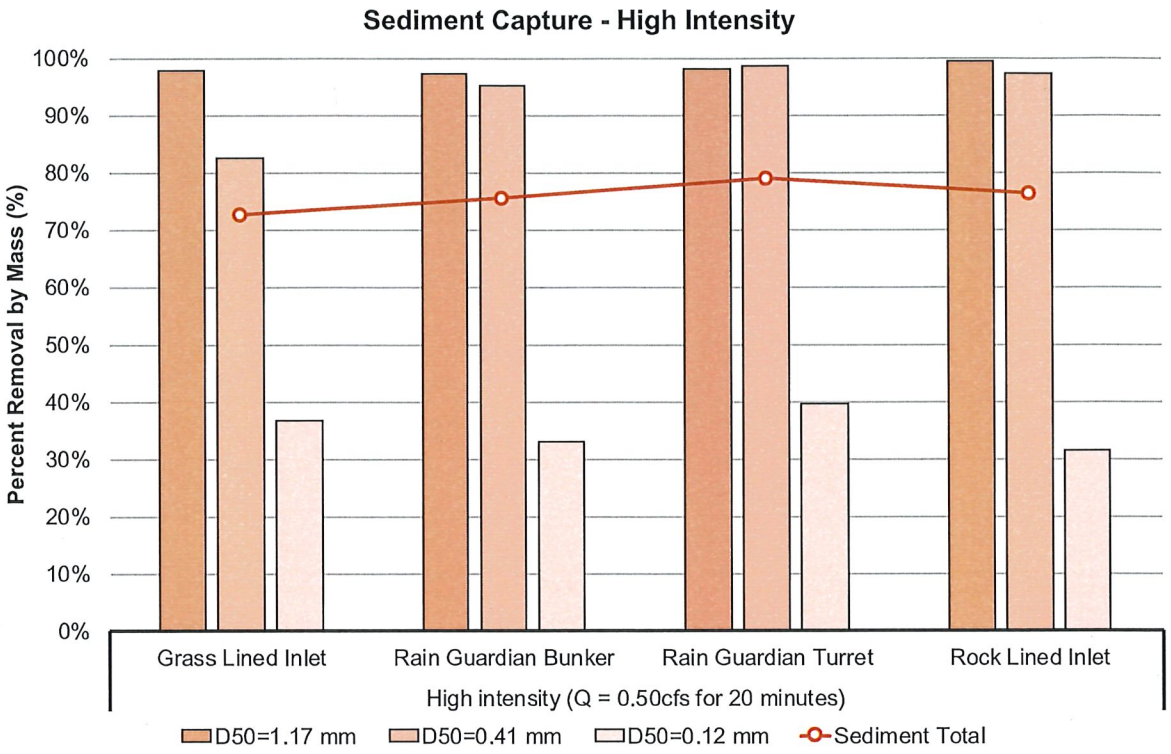


Figure 53: Sediment capture by percent for design volume high intensity tests (Q = 0.50cfs, duration = 20 minutes).

For all practices and all sediment fractions, less sediment was captured in the high intensity tests (Figure 53) compared to the low intensity tests (Figure 51). This is expected because higher flow creates more turbulence, more mixing, and shorter residence time within the pretreatment practice, and likely causes more overflow from the pretreatment practice into the primary practice (i.e., bioretention). All practices did, however, capture greater than 30% of the fine sediment fraction and at least 70% of the total sediment mass, which exceeds the goal of 25% capture of sediment > 100µm (MPCA 2017a).

5.1.2 Gross Solids Capture

5.1.2.1 Low Intensity (Q = 0.25cfs for 40 minutes)

Gross solids capture for the design volume low intensity test is shown in Figure 54. The RGB, RGT, and RLI captured over 98% of the mass of forks and leaves. The GLI, however, only captured 8% of the forks and 3% of the leaves. For the wood dowels, approximately 40% of the mass was captured by the GLI and the RGB; approximately 60% by the RGT; and over 80% captured by the RLI. Of the gross solids used in this testing, the wood dowels best represent floatables because they remained floating on the water surface throughout the duration of most tests. Overall, gross solids were captured at 20% (GLI), 80% (RGB), 85% (RGT), or 95% (RLI).

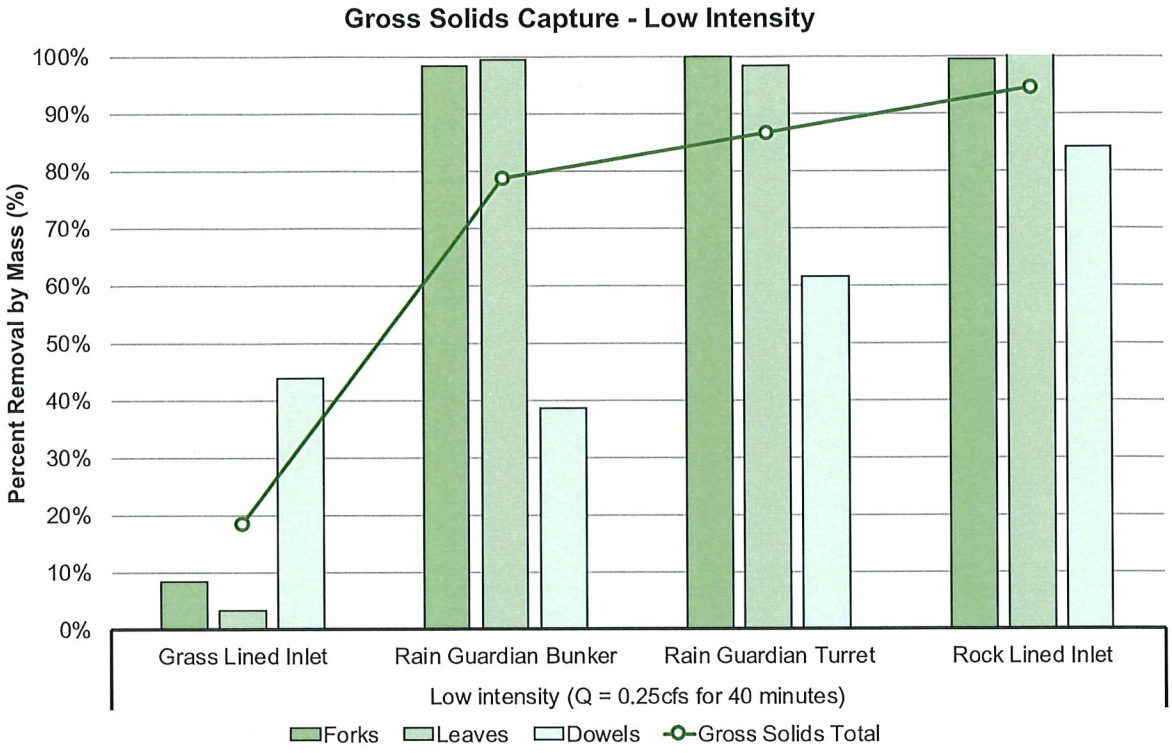


Figure 54: Gross solids capture by percent for design volume low intensity tests (Q = 0.25cfs, duration = 40 minutes).

While the GLI was shown to capture sediment (Figure 51 & Figure 53), it is evident from Figure 54 that GLIs are not effective at capturing gross solids. This is consistent with the design of GLIs in that there is no physical mechanism for gross solids to be captured. The short length and flexibility of lawn grass is not enough to capture and retain debris. While it appears from Figure 54 that the GLI captured over 40% of the wood dowels, field observations revealed that these dowels were floating on the water surface and deposited on the GLI as the water in the bioretention was drained (Figure 55). Without the corral, it is likely these dowels would have been dispersed throughout the bioretention and would not have been "captured" by the GLI.

The Rain Guardian Bunker and Turret captured 80% and 85% of the gross solids, respectively (Figure 54). Most of the gross solids were captured on the surface grate and nearly all of the remaining gross solids were captured within the chamber (data in Appendix A). A small fraction (2 – 4%) of gross solids were captured on the concrete pad downstream of the screen wall (data in Appendix A).

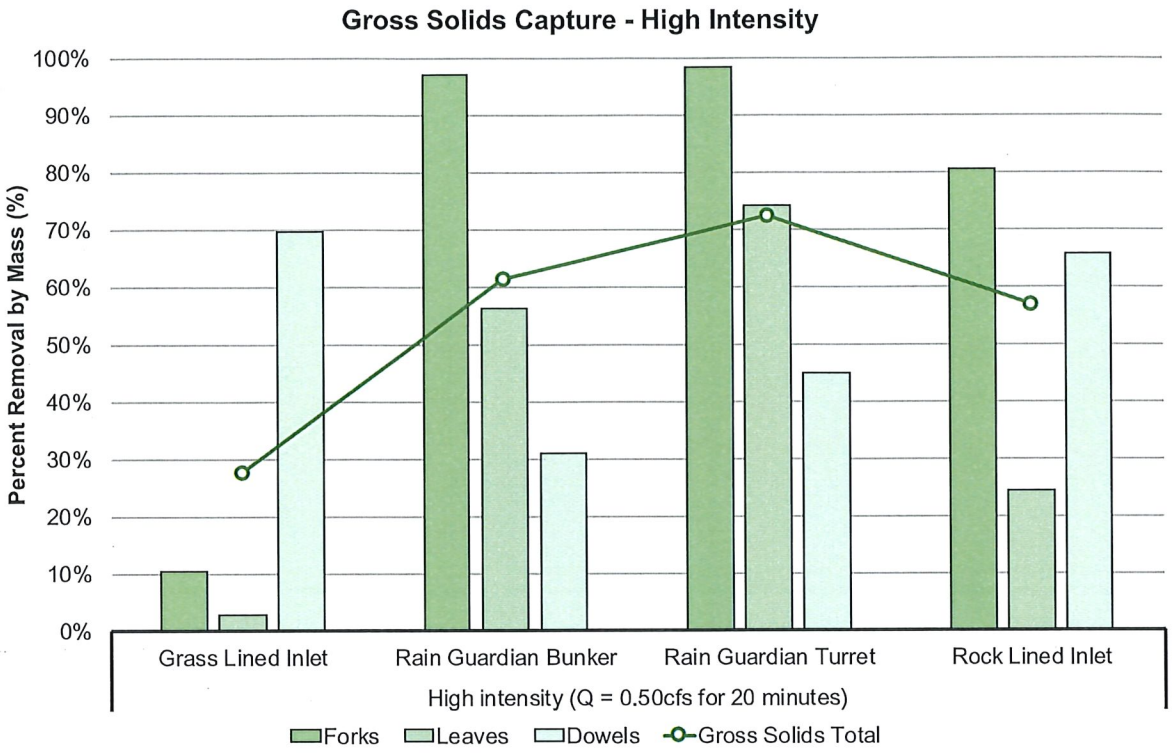
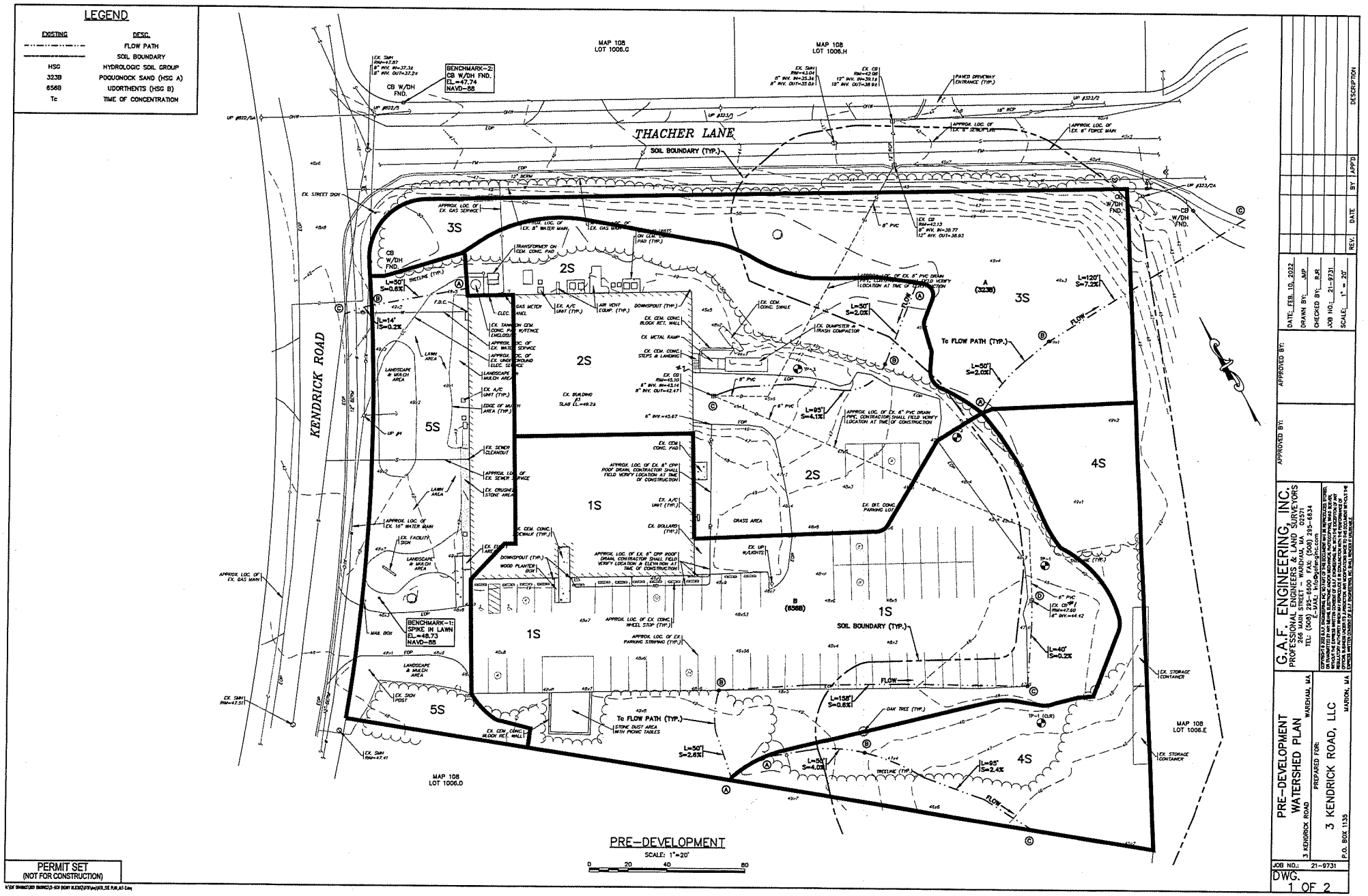


Figure 56: Gross solids capture by percent for design storage volume tests, Q = 0.50cfs, duration = 20 minutes.

In addition to the flow rate (and likely flow velocity), a primary difference between the low intensity and high intensity tests at the Anoka site (GLI, RGB, RGT, RLI) is the water depth within the bioretention cell, and subsequently the proportion of the pretreatment practice that was inundated by backwater. For the sloped practices (GLI, RLI), this meant that water, sediment, and gross solids that were carried into the practice by high velocity supercritical flow were intercepted by a standing pool at some point along the slope of the pretreatment practice. This point occurred near the bottom edge of the GLI and RLI for the low intensity tests, and near the upper edge during the high intensity tests. In other words, the GLI and RLI were mostly exposed during low intensity such that rocks and even some grass were emergent through the flow. Conversely, most of the rock and grass were fully submerged during high intensity flow. Thus, emergent rocks were able to intercept and capture gross solids during the low intensity tests but gross solids were carried further downstream during the high intensity tests, as shown in Figure 57. During the low intensity tests on the RLI, it was observed that the accumulation of gross solids (Figure 57) also created a "debris filter" that intercepted and captured sediment among the gross solids.



PERMIT SET
(NOT FOR CONSTRUCTION)

DATE: FEB. 10, 2022
DRAWN BY: MP
CHECKED BY: RJR
JOB NO.: 21-9731
SCALE: 1" = 20'

REV.	DATE	BY	APP'D	DESCRIPTION

APPROVED BY:

APPROVED BY:

G.A.F. ENGINEERING, INC.
PROFESSIONAL ENGINEERS & LAND SURVEYORS
266 MAIN STREET - WAREHAM, MA 02571
TEL: (508) 295-6800 FAX: (508) 295-6834
E-MAIL: info@gafengineering.com

PRE-DEVELOPMENT
WATERSHED PLAN
3 KENDRICK ROAD
WAREHAM, MA

PREPARED FOR:
3 KENDRICK ROAD, LLC
P.O. BOX 1135
MARION, MA

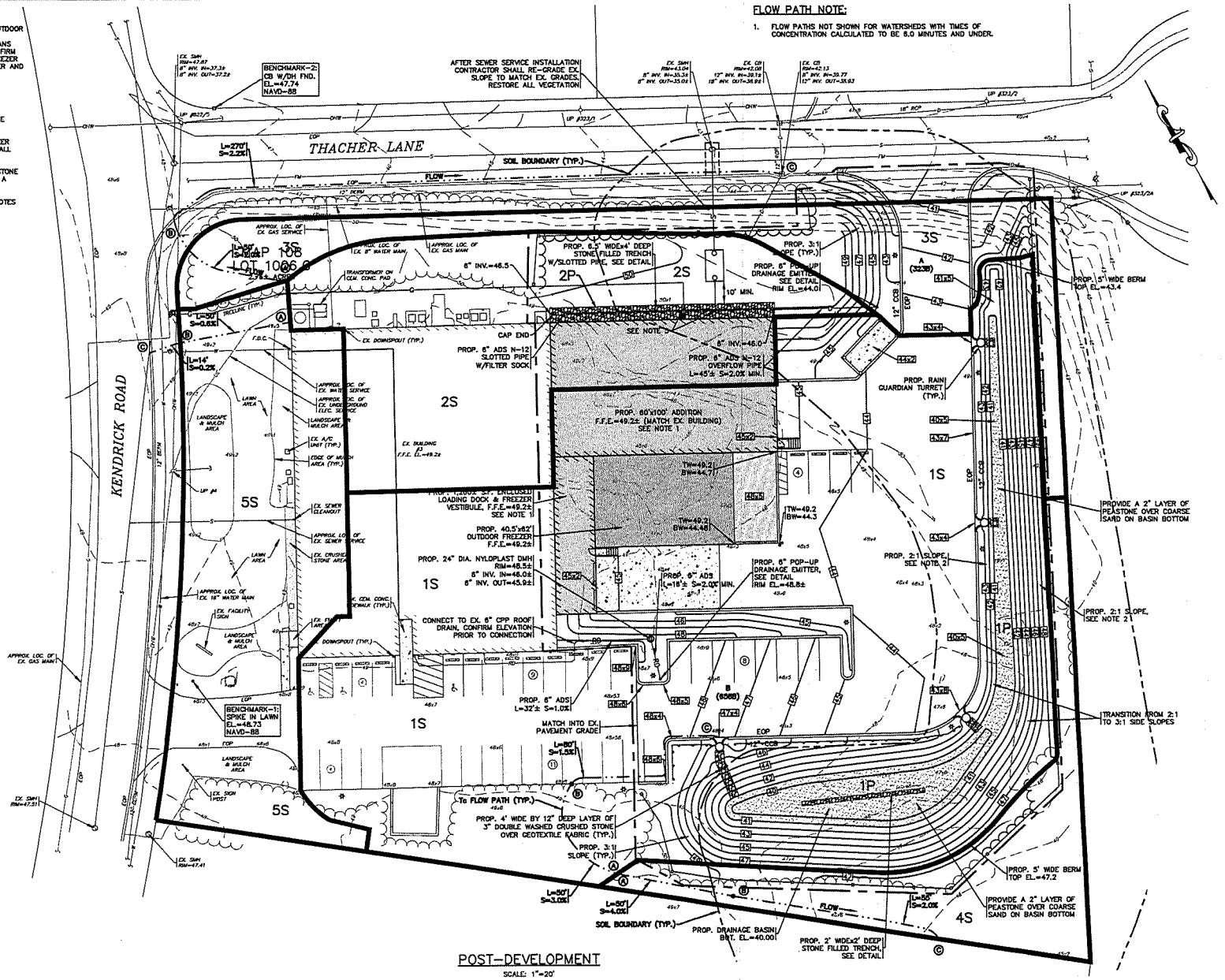
JOB NO.: 21-9731
DWG. 1 OF 2

NOTES:

1. FOR COMPLETE BUILDING ADDITION, FREEZER VESTIBULE, OUTDOOR FREEZER AND ENCLOSED LOADING DOCK DIMENSIONS, SPECIFICATIONS AND CONSTRUCTION DETAILS REFER TO PLANS BY CAPE BUILDING SYSTEMS, INC. CONTRACTOR SHALL CONFIRM THE BUILDING ADDITION, FREEZER VESTIBULE, OUTDOOR FREEZER AND ENCLOSED LOADING DOCK SLAB ELEVATION WITH OWNER AND ARCHITECT PRIOR TO CONSTRUCTION.
2. 2:1 SIDE SLOPES SHALL BE STABILIZED WITH AN EROSION CONTROL BLANKET OVER THE PLANTED SEED BED.
3. COVER ALL PROPOSED STONE FILLED TRENCHES WITH AN ADDITIONAL TEMPORARY LAYER OF FILTER FABRIC UNTIL THE ABOVE GRADIENT SLOPE IS STABILIZED.
4. CONTRACTOR SHALL COORDINATE WITH STRUCTURAL ENGINEER FOR CEMENT CONCRETE RETAINING WALL ELEVATIONS AND ALL DESIGN DETAILS, SEE NOTE 2 ON SHEET 4.
5. WHERE THE PROPOSED SEWER AND GAS LINE CROSS THE STONE FILLED TRENCH ENCASE BOTH PIPES IN CEMENT CONCRETE A MINIMUM OF 24" IN EACH DIRECTION.
6. FOR COMPLETE DRAINAGE OPERATION AND MAINTENANCE NOTES SEE SHEET 2.

FLOW PATH NOTE:

1. FLOW PATHS NOT SHOWN FOR WATERSHEDS WITH TIMES OF CONCENTRATION CALCULATED TO BE 6.0 MINUTES AND UNDER.



POST-DEVELOPMENT

SCALE: 1"=20'

0 20 40 80

LEGEND

EXISTING	DESC.
---·---·---	FLOW PATH
———	SOIL BOUNDARY
HSG	HYDROLOGIC SOIL GROUP
323B	PODUNOCK SAND (HSG A)
656B	UDORTHENTS (HSG B)
Tc	TIME OF CONCENTRATION

PERMIT SET
(NOT FOR CONSTRUCTION)

REV.	DATE	BY	APP'D	DESCRIPTION

DATE: FEB. 10, 2022
DRAWN BY: MP
CHECKED BY: RJR
JOB NO.: 21-9731
SCALE: 1" = 20'

APPROVED BY:
APPROVED BY:

G.A.F. ENGINEERING, INC.
PROFESSIONAL ENGINEERS & LAND SURVEYORS
265 MAIN STREET - WAREHAM, MA 02571
TEL: (508) 295-6600 FAX: (508) 295-6634
E-MAIL: info@gafinc.com

POST-DEVELOPMENT
WATERSHED PLAN
3 KENDRICK ROAD WAREHAM, MA

PREPARED FOR:
3 KENDRICK ROAD, LLC
P.O. BOX 1135
MARION, MA

JOB NO.: 21-9731
DWG. 2 OF 2