HYDROLOGY & STORMWATER MANAGEMENT REPORT

0 Farrington Street, Worcester, MA

PREPARED FOR:

Assad Challab
3 Farrington Street
Worcester, MA
July 24, 2024
Revised August 16, 2024

COMMONWEALTH OF MASSACHUSETTS
HOSSEIN HAGHANIZADEH
CIVIL
NO. 42529
REGISTERED
PROFESSIONAL ENGINEER

PREPARED BY:

H. S. & T. Group, Inc.

75 Hammond Street
Worcester, MA 01610

PROJECT SUMMARY

The property is located at 0 Farrington Street Worcester, Massachusetts. It is in the Residential RG-5 zoning district and was previously vacant. The site contains approximately 0.38. The surrounding properties are generally single and multy-family dwellings.

The lot slopes generally from the northern portion of the site towards the southern portion of the site. The property is not located within the limits of the 100-year floodplain as indicated on the Federal Emergency Management Agency Flood Insurance Rate Map, included as Appendix F.

Soils in the area of the site have been identified referencing the USDA NRCS Soil Survey for Worcester County Massachusetts, Southern Part (Soil Survey), included as Appendix D. The Soil Survey mapping indicates the soils on-site and abutting the site are classified as Hinckley loamy sand, 3 to 8 percent slopes (Map Unit 245B). The Hinckley loamy sand soils are located throughout the entire site. Paxton fine sandy loam is classified as Hydrologic Soil Group (HSG) A.

Hydrologic Analysis

A hydrologic analysis has been conducted for the site using SCS-TR 20 methodology. The 2-, 10-, 25-and 100-year storm events have been evaluated using a 24-hour, Type III rainfall distribution. Pre-development and post-development net peak stormwater discharge rates were estimated.

Under existing conditions, the project site generally drains towards the east of the site. The existing conditions watershed was broken into one subcatchment draining to the southeast of the site. An analysis point is provided to analyze the total runoff from the subcatchment.

Under proposed conditions the analysis area has been divided into three subcatchments. The subcatchments are divided into areas that flow to the northwestern portion of the site with a small area from P1 flowing to the east. P2 consists of the parking lot and P3 is the building roof. An underground pipe network is proposed including catch basins, manholes and a stormceptor to collect stormwater runoff from the parking lot and roof and directs it to a subsurface infiltration system. The stormceptor water quality unit treats the runoff prior to entering the system. The rooftop area is being connected directly to the subsurface infiltration system.

H. S. & T. Group, Inc. used HydroCAD software, to conduct hydrologic analyses. The analysis point has been evaluated under the pre-development and post-development conditions to estimate the stormwater runoff rates under the 2-year, 10-year, 25-year and 100-year, Type III, 24-hour storm events. Rainfall values for each of these return periods have been obtained from the National Weather Service NOAA Atlas 14 Point Precipitation Frequency Estimates. The HydroCAD input and output data generated in the analysis for each storm event is included in the appendices to this report.

Storm Event		
	Existing	Proposed
2-year	0.91	0.76
10-year	1.86	1.29
25-year	2.65	1.74
100-year	3.95	2.43

Table 1: Pre-development and Post-development Runoff Rates

The Stormwater management system has been designed to effectively control the design storm events, provide water quality treatment and stormwater recharge.

Massachusetts Stormwater Management Policy 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.*

   The standard is met. No new stormwater conveyances discharge untreated stormwater directly to or cause erosion to wetlands or waters of the Commonwealth.

2. *Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.*

   The standard is met. Post-development net peak discharge rates do not exceed the pre-development rates for the design storm events.

3. *Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge rate from the pre-development or existing site conditions, based on soil types.*

   On-site soils are described as Hydrologic Soil Groups C/D by the USDA Soil Conservation Service soil report. The annual recharge rate is calculated based on the impervious areas covering each soil type. The required storage volume is met using subsurface infiltration system at building to collect rooftop and parking lot runoff and provide detention prior to being routed to the existing drainage system in Farrington Street. Soil testing was conducted by EcoTec and is attached as an appendix to this report. The depth to groundwater does not allow for a four foot separation but does allow for a 2' separation. The standard is met to the maximum extent practicable given the existing on-site conditions. Due to the less than 4' separation groundwater mounding calculations were done and are included as an appendix to this report.

   Total Proposed Impervious areas HSG C= 10,584 square feet (sf)
   HSG C = 0.25" of runoff x (impervious area)
   = 0.25" x (10,584 sf) x 1ft/12"
   = 220.50 cf required for recharge

   Total Proposed Impervious areas HSG D= 181 square feet (sf)
   HSG D = 0.10" of runoff x (impervious area)
   = 0.10" x (181 sf) x 1ft/12"
   = 1.5 cf required for recharge

   Total required recharge is 223 cf

   Capture Area Adjustment:
   Required Recharge Volume = 223 cf
   Site Area (impervious) Draining to Recharge Facilities = 0.25 acres
   Total Site Area = 0.38 acres
   Total Site to Site Area Drainage Ratio = 1.52
   =Adjusted Minimum Required Recharge Volume = 339 cf

   545.7 cf of storage is provided

Drawdown Calculations

Cultec

545.7	Rv = Storage Volume (cf)
0.27	K = Saturated Hydraulic Conductivity (Rawls rate, Table 2.3.3, inches/hour)
495.83	Bottom Area = Bottom Area of Recharge Structure (sf)

$$\text{Time} = \frac{Rv}{(K)(\text{Bottom Area})} = \mathbf{48.91}$$

Hours < 72 hrs

4. *For new development, stormwater management systems must be designed to remove 80% of the average annual load (post development conditions) of Total Suspended Solids (TSS).*

   The standard is met. The Stormceptor water quality unit designed for the site provides 80% total suspended solids removal. The documentation for TSS Removal is provided in the appendices.

5. *Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs (see Stormwater Management Volume I: Stormwater Policy Handbook). The use of infiltration practices without pretreatment is prohibited.*

   The standard is met. The site is not an area with higher pollutant loads.

6. *Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas (see Stormwater Management Volume I: Stormwater Policy Handbook). Critical areas are Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold water fisheries and recharge areas for public water supplies.*

   The standard is met. The site does not discharge to a Critical Area.

7. *Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is no practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.*

   The standard is met. On-site soils are described as Hydrologic Soil Groups C/D by the USDA Soil Conservation Service soil report. Soil testing was conducted by EcoTec and is attached as an appendix to this report. The depth to groundwater does not allow for a four foot separation but does allow for a 2' separation. The standard is met to the maximum extent practicable given the existing on-site conditions.

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.*

   The standard is met. We have proposed an erosion and sedimentation control plan during construction.

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

   The standard is met. We have included an operation and maintenance plan to protect the quality of storm water runoff.

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

    The standard is met. We have included an operation and maintenance plan to protect the quality of storm water runoff.

APPENDICIES: Supporting Information Summary

APPENDIX A:
DEP Stormwater Checklist

APPENDIX B:
Drainage System Operation and Maintenance Plan

APPENDIX C:
NOAA Atlas 14 Volume 10, Version 3

APPENDIX D:
USDA NRCS Web Soil Survey (WSS)
Various USDA Soil Tables

APPENDIX E:
NFIP Firm Community Panel 25027C0620E

APPENDIX F:
TSS Removal Calculations and Stormceptor design information.

APPENDIX G:
CULTEC Design information

APPENDIX H:
Pre-development catchment locations
Post-development catchment locations

APPENDIX I:
Pre-Development Hydrology
- Type III, 2-Year 24 Hour Storm
- Type III, 10-Year 24 Hour Storm
- Type III, 25-Year 24 Hour Storm
- Type III, 100-Year 24 Hour Storm

APPENDIX J:
Post-Development Hydrology
- Type III, 2-Year 24 Hour Storm
- Type III, 10-Year 24 Hour Storm
- Type III, 25-Year 24 Hour Storm
- Type III, 100-Year 24 Hour Storm

APPENDIX K:
Soil Reports from Ecotec, Inc.

APPENDIX L:
Groundwater Mounding Calculations

APPENDIX M:
USGS Map

APPENDIX A:

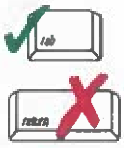
DEP Stormwater Checklist

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
HOSSEIN HAGHANIZADEH
CIVIL
NO. 42529
REGISTERED
PROFESSIONAL ENGINEER

H. Haghanizadeh 7/25/24

Signature and Date

Checklist

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

- [x] New development
- [ ] Redevelopment
- [ ] Mix of New Development and Redevelopment

Checklist (continued)

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

☒ No disturbance to any Wetland Resource Areas

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

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

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

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

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☐ Other (describe): ______________________

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist (continued)

Standard 4: Water Quality (continued)

☒ 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 (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.

Illicit Discharge Compliance Statement

This statement is to document that there are no and will be no Illicit Discharges for the Proposed site located at 0 Farrington Street, Worcester MA

Lesley Wilson, Senior Project Engineer

7-24-2024

Date

APPENDIX B:

Drainage System Operation and Maintenance Plan

OPERATION AND MAINTENANCE PLAN

This long-term Operation and Maintenance Plan outlines the efforts necessary to ensure that the stormwater collection and treatment system of this site operates in accordance with Massachusetts Department of Environmental Protection Stormwater Management Policy (MSMP) and as designed and approved. In the event that the system performance becomes inadequate, adjustments in the Plan may become necessary to improve the performance.

It is noted that the following restrictions on the use of this property are recommended, for the protection of groundwater:

- Use of salt on pavement is to be minimized. Under any conditions where sand or other non-toxic materials are suitable, they are to be used.
- Use of pesticides, herbicides and fertilizers should be restricted
- Pet waste should be collected by the owner and disposed of properly.
- Proper storage, use, and disposal of household hazardous chemicals, tires, yard waste, paint and solvents, automobile fluids, and propane tanks is encouraged.

STORMWATER OWNERSHIP AND OPERATION RESPONSIBILITIES

During Construction:
Construction, maintenance, oversight, and proper operation of the infiltration system and the appurtenant stormwater management system, and construction period erosion and sedimentation controls throughout the construction period shall be the responsibility of the contractor. The developer shall provide the Planning Board with a written report of inspections performed.

SCHEDULE OF INSPECTIONAND MAINTENANCE TASKS

Onsite Drainage Areas. Areas that drain into the collection system from onsite must be inspected to verify that soil surfaces are stable and that erosion of soils into the collection system is not occurring. In the event that erosion of onsite soils is occurring, the soils must be stabilized against further erosion. Permanently finish the surface against erosion, by placing stable vegetation such as loam and grass seed, or by armoring the surface against erosion with rip-rap placed on a filter fabric blanket.

Asphalt Surfaces. Inspect asphalt surfaces for accumulation of sand, litter, eroded soils or other deleterious materials. Verify that no hazardous materials, such as fuel oil, motor oils or other material has occurred. Pick up all litter, junk, trash, or any other deleterious materials left on the surface. Upon detecting accumulation of sand, sediment or other materials, the asphalt surface must be swept to remove all such materials. All sweepings collected must be disposed of in accordance with current Massachusetts Department of Environmental Protection standards for such waste disposal. Any material deposits deemed to be hazardous must be removed and disposed of by a licensed contractor.

CULTEC. See attached

Stormceptor. Inspect the unit monthly and within 24 hours after a storm with rainfall of 0.1" or greater. Sediment and oil shall be removed when the storage volume is reduced by one half, or at least every 6 months (refer to the manufacturers recommendations for maintenance requirements)

RECORDKEEPING

It is necessary that record of each inspection and maintenance activity be kept. The record keeping shall be kept on the O&M Maintenance Log for issued by DEP. Such information should include the following:

- Person Performing the activity
- The date of the activity, and the weather conditions
- The preceding weather conditions
- The site conditions (dry, heavy snow cover, saturated conditions, etc.)
- The specific activity (inspection, cleaning, etc)
- The facility inspected
- The conditions of the facility
- The results of the activity

Long-Term Pollution Prevention Plan

This is a Long-term Pollution Prevention Plan for the above-mentioned site.

Good Housekeeping:

Good housekeeping practices, outlined below, will be used on site:

- An effort will be made to store only enough products that will be needed.
- All materials stored on site will be stored neatly, in their appropriate containers, and, if possible, under a roof or other enclosure.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, all of a product will be used up before disposing of the container.
- The manufacturer's recommendations for proper use and disposal will be followed.

Routine Inspections:

Routine inspections and procedures are outlined in the Stormwater Operation & Maintenance Plan.

Waste Materials:

All waste materials will be collected and stored in a metal dumpster. All trash and debris from the site will be deposited in the dumpsters. Dumpsters will be emptied weekly or more often if necessary, and the trash will be hauled off-site to an approved waste facility. No construction waste materials will be buried on site. All personnel will be instructed regarding the correct procedures for waste disposal. Individual(s) managing day-to-day operations will be responsible for seeing that these procedures are followed.

Hazardous Waste:

All hazardous waste materials will be disposed of in the manner specified by local or state regulation or by the manufacturer. Site personnel will be instructed in these practices and the individual managing day-to-day operations will be responsible for implementing these practices.

Hazardous Materials:

These practices will be used to reduce the risks associated with hazardous materials.

Products will be kept in original containers unless they are not re-sealable.
Original labels and material safety data sheets (MSDS) will be retained; they contain important product information.

Manufacturers' and local and/or state recommended methods for proper disposal of excess materials will be followed.

Spill Control Practices:

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be used for spill prevention and cleanup:

Manufacturers' recommended methods for spill cleanup will be clearly posted and site personnel will be familiar with the procedures and location of the information and cleanup supplies.

Materials and equipment necessary for spill cleanup will be kept in the material storage area on site. Equipment and materials will include, but not be limited to, brooms, dustpans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.

All spills will be cleaned up immediately upon discovery.

Spill areas will be kept well ventilated, and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.

Spills of toxic or hazardous material will be reported to the appropriate state or local government agency, regardless of the size of the spill.

The spill prevention plan will be adjusted to include measures to prevent this type of spill from re-occurring and how to clean up the spill if there is another one. A description of the spill, what caused it, and the cleanup measures will also be included.

Snow and Ice Management:

Any deicing materials will be stored indoors and used per manufacturer's recommendations. Site personnel will be instructed in these practices and the individual managing day-to-day operations will be responsible for implementing these practices.

Grass Cutting:

The grass shall be cut to a depth of no less than 6 inches and should be cut not more than twice per growing season.

Supporting Plans & Analyses:

Proposed Site Plan and Detail Drawings

Stormwater Operation and Maintenance Plan, Stormwater Drainage Analysis

APPENDIX C:
NOAA Atlas 14 Volume 10, Version 3

Location name: Worcester, Massachusetts, USA*
Latitude: 42.2558°, Longitude: -71.7728°
Elevation: 507 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.342 (0.272-0.426)	0.403 (0.320-0.502)	0.503 (0.397-0.629)	0.585 (0.460-0.737)	0.699 (0.529-0.921)	0.785 (0.581-1.06)	0.874 (0.625-1.23)	0.970 (0.657-1.40)	1.10 (0.717-1.66)	1.21 (0.766-1.86)
10-min	0.485 (0.385-0.603)	0.571 (0.453-0.712)	0.712 (0.563-0.891)	0.829 (0.651-1.04)	0.990 (0.750-1.30)	1.11 (0.823-1.50)	1.24 (0.885-1.74)	1.38 (0.933-1.99)	1.56 (1.02-2.36)	1.72 (1.09-2.64)
15-min	0.570 (0.453-0.710)	0.672 (0.533-0.837)	0.838 (0.662-1.05)	0.976 (0.767-1.23)	1.16 (0.882-1.54)	1.31 (0.968-1.76)	1.46 (1.04-2.04)	1.62 (1.10-2.34)	1.84 (1.20-2.77)	2.02 (1.28-3.11)
30-min	0.773 (0.614-0.962)	0.911 (0.723-1.14)	1.14 (0.899-1.42)	1.32 (1.04-1.67)	1.58 (1.20-2.09)	1.78 (1.32-2.40)	1.98 (1.42-2.78)	2.20 (1.49-3.18)	2.50 (1.63-3.77)	2.74 (1.74-4.23)
60-min	0.975 (0.775-1.21)	1.15 (0.913-1.43)	1.44 (1.14-1.80)	1.67 (1.32-2.11)	2.00 (1.52-2.64)	2.25 (1.66-3.03)	2.50 (1.79-3.51)	2.78 (1.88-4.03)	3.17 (2.06-4.76)	3.47 (2.20-5.35)
2-hr	1.23 (0.985-1.52)	1.46 (1.17-1.81)	1.84 (1.47-2.29)	2.16 (1.71-2.70)	2.59 (1.98-3.41)	2.92 (2.18-3.93)	3.26 (2.36-4.59)	3.66 (2.49-5.27)	4.24 (2.76-6.34)	4.72 (3.00-7.22)
3-hr	1.41 (1.13-1.74)	1.68 (1.35-2.08)	2.13 (1.70-2.64)	2.50 (1.99-3.12)	3.02 (2.31-3.96)	3.40 (2.55-4.57)	3.80 (2.77-5.35)	4.28 (2.92-6.15)	5.00 (3.26-7.46)	5.61 (3.57-8.55)
6-hr	1.77 (1.43-2.17)	2.13 (1.72-2.61)	2.72 (2.19-3.35)	3.21 (2.56-3.98)	3.89 (3.00-5.08)	4.39 (3.31-5.88)	4.93 (3.61-6.91)	5.58 (3.81-7.96)	6.56 (4.30-9.72)	7.40 (4.72-11.2)
12-hr	2.19 (1.78-2.67)	2.66 (2.16-3.25)	3.43 (2.77-4.20)	4.07 (3.27-5.01)	4.94 (3.83-6.42)	5.59 (4.24-7.45)	6.29 (4.63-8.77)	7.13 (4.89-10.1)	8.41 (5.52-12.4)	9.49 (6.07-14.3)
24-hr	2.61 (2.13-3.15)	3.19 (2.60-3.86)	4.14 (3.36-5.03)	4.92 (3.98-6.02)	6.01 (4.69-7.76)	6.81 (5.20-9.02)	7.68 (5.68-10.6)	8.73 (6.01-12.3)	10.3 (6.80-15.1)	11.7 (7.50-17.5)
2-day	2.96 (2.44-3.56)	3.64 (2.99-4.38)	4.75 (3.89-5.74)	5.68 (4.62-6.90)	6.94 (5.46-8.93)	7.88 (6.06-10.4)	8.90 (6.64-12.3)	10.2 (7.02-14.2)	12.1 (8.00-17.6)	13.8 (8.87-20.5)
3-day	3.22 (2.66-3.85)	3.95 (3.26-4.74)	5.15 (4.23-6.20)	6.14 (5.01-7.44)	7.51 (5.92-9.61)	8.51 (6.56-11.2)	9.61 (7.19-13.2)	11.0 (7.60-15.3)	13.1 (8.66-18.9)	14.9 (9.61-22.0)
4-day	3.45 (2.86-4.12)	4.22 (3.49-5.05)	5.47 (4.51-6.57)	6.52 (5.33-7.87)	7.95 (6.28-10.1)	9.00 (6.96-11.8)	10.2 (7.61-13.9)	11.6 (8.03-16.1)	13.8 (9.14-19.9)	15.7 (10.1-23.1)
7-day	4.12 (3.43-4.90)	4.95 (4.12-5.90)	6.32 (5.23-7.55)	7.45 (6.13-8.95)	9.00 (7.14-11.4)	10.2 (7.86-13.2)	11.4 (8.55-15.5)	12.9 (8.99-17.8)	15.2 (10.1-21.8)	17.1 (11.1-25.1)
10-day	4.78 (4.00-5.67)	5.65 (4.72-6.70)	7.07 (5.88-8.42)	8.25 (6.82-9.89)	9.88 (7.85-12.4)	11.1 (8.60-14.3)	12.4 (9.27-16.7)	13.9 (9.71-19.1)	16.2 (10.8-23.1)	18.1 (11.7-26.4)
20-day	6.82 (5.74-8.03)	7.75 (6.51-9.13)	9.26 (7.75-11.0)	10.5 (8.73-12.5)	12.2 (9.75-15.2)	13.5 (10.5-17.2)	14.9 (11.1-19.6)	16.3 (11.5-22.3)	18.3 (12.3-26.0)	19.9 (12.9-28.9)
30-day	8.53 (7.21-10.0)	9.49 (8.00-11.1)	11.0 (9.28-13.0)	12.3 (10.3-14.6)	14.1 (11.3-17.4)	15.5 (12.0-19.5)	16.9 (12.5-22.0)	18.2 (12.9-24.7)	20.0 (13.4-28.2)	21.3 (13.9-30.8)
45-day	10.7 (9.04-12.5)	11.6 (9.87-13.6)	13.3 (11.2-15.6)	14.6 (12.2-17.3)	16.4 (13.2-20.1)	17.9 (13.9-22.4)	19.3 (14.3-24.9)	20.6 (14.6-27.8)	22.1 (14.9-31.0)	23.2 (15.1-33.4)
60-day	12.4 (10.6-14.5)	13.5 (11.4-15.7)	15.1 (12.8-17.7)	16.5 (13.9-19.5)	18.4 (14.8-22.5)	19.9 (15.5-24.8)	21.4 (15.9-27.4)	22.6 (16.0-30.4)	24.0 (16.2-33.6)	24.9 (16.3-35.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

APPENDIX D:

USDA NCRS Web Soil Survey
Various USDA Soil Tables

Map Scale: 1:1,350 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

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

Soils

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 18, Sep 10, 2023

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
72A	Whitman fine sandy loam, 0 to 3 percent slopes	D	1.1	12.6%
602	Urban land		0.1	1.4%
622C	Paxton-Urban land complex, 8 to 15 percent slopes	C	7.5	86.0%
Totals for Area of Interest			**8.8**	**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.

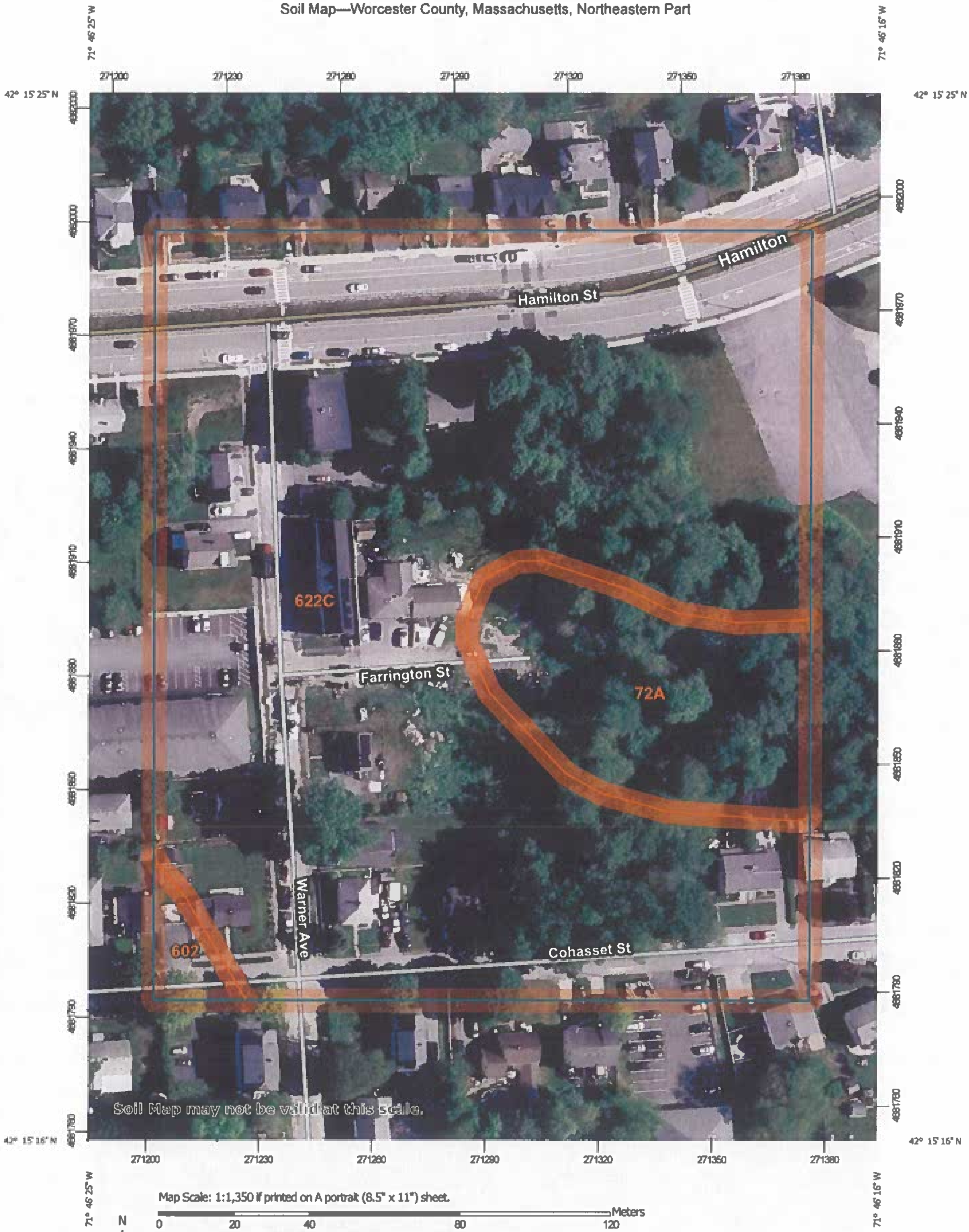
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



Map Scale: 1:1,350 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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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)

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Survey Area Data: Version 18, Sep 10, 2023

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Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
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602	Urban land	0.1	1.4%
622C	Paxton-Urban land complex, 8 to 15 percent slopes	7.5	86.0%
Totals for Area of Interest		**8.8**	**100.0%**

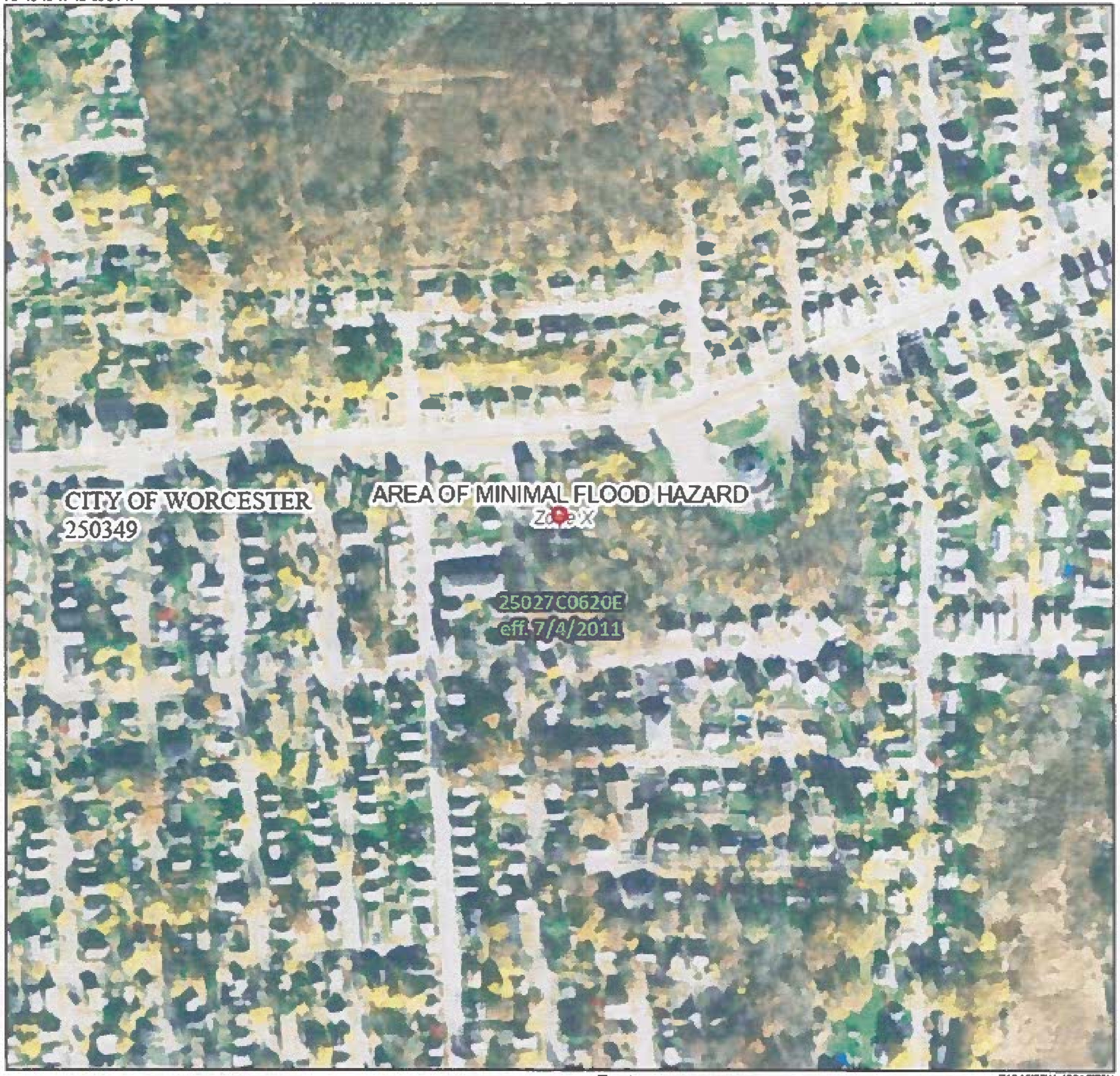
APPENDIX E:

NFIP Firm Community Panel 25027C0620E

National Flood Hazard Layer FIRMette

FEMA

71°46'41"W 42°15'34"N



Feet

1:6,000

71°46'3"W 42°15'7"N

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/22/2023 at 11:27 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

APPENDIX F:

TSS Removal Calculations and Stormceptor design information.

v

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

Version 1, Automated: Mar. 4, 2008

Location: O Farrington St. Worcester MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Proprietary Treatment Practice	0.80	0.75	0.60	0.15
Subsurface Infiltration Structure	0.80	0.15	0.12	0.03
	0.00	0.03	0.00	0.03
	0.00	0.03	0.00	0.03

Total TSS Removal = 97%

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

Project: 7172
Prepared By: Lesley Wilson
Date: 7-24-2024

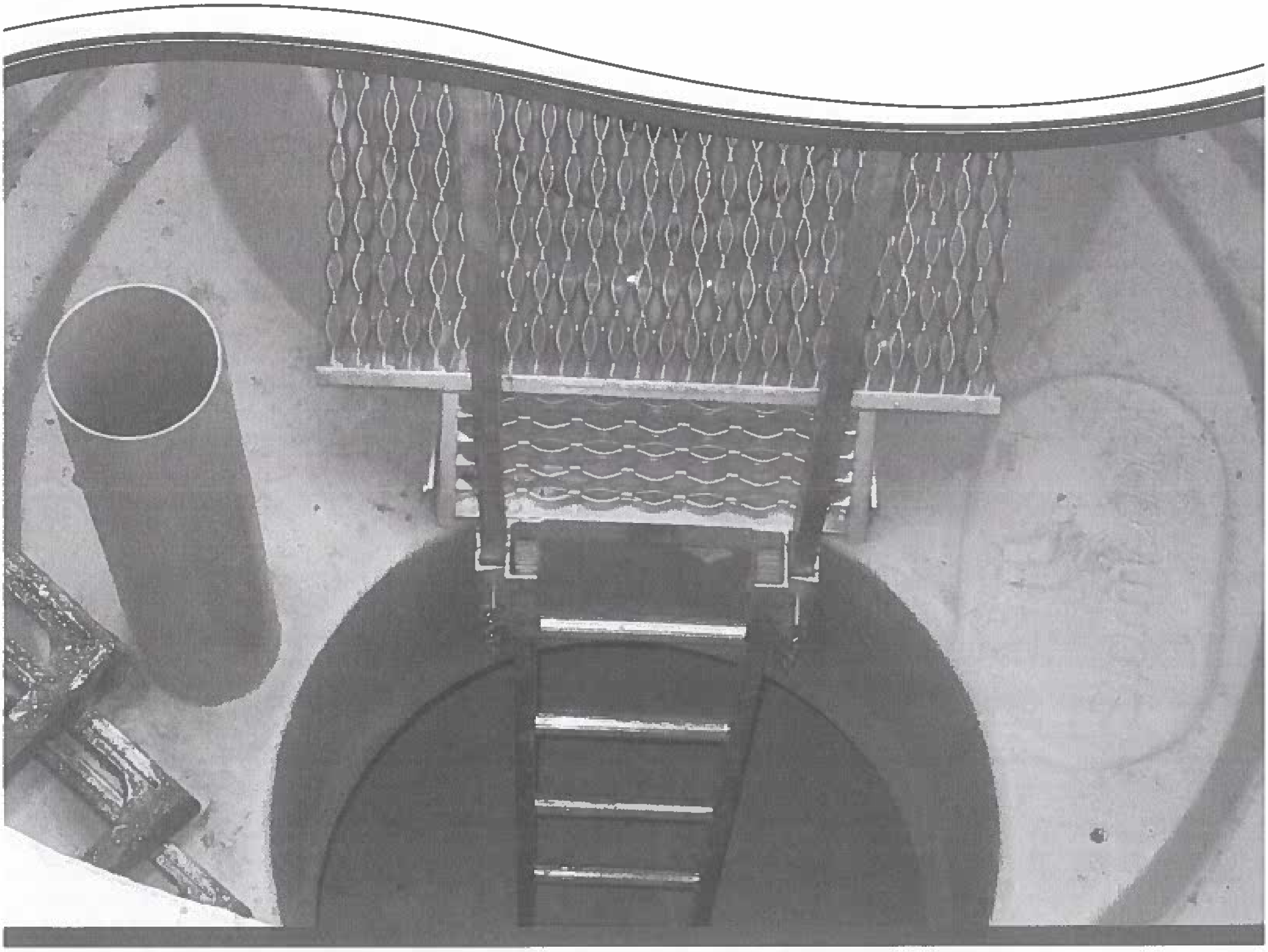
*Equals remaining load from previous BMP (E) which enters the BMP

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

Mass. Dept. of Environmental Protection

CONTECH
ENGINEERED SOLUTIONS

Stormceptor® STC
Operation and Maintenance Guide



Stormceptor® STC

Stormceptor Design Notes

- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.

Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences			
Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in. (75 mm)	1 in. (25 mm)	3 in. (75 mm)
Multiple inlet pipes	3 in. (75 mm)	3 in. (75 mm)	Only one inlet pipe.

Maximum inlet and outlet pipe diameters:

Inlet/Outlet Configuration	Inlet Unit STC 450i	In-Line Unit STC 900 to STC 7200	Series* STC 11000 to STC 16000
Straight Through	24 inch (600 mm)	42 inch (1050 mm)	60 inch (1500 mm)
Bend (90 degrees)	18 inch (450 mm)	33 inch (825 mm)	33 inch (825 mm)

- The inlet and in-line Stormceptor units can accommodate turns to a maximum of 90 degrees.
- Minimum distance from top of grade to crown is 2 feet (0.6 m)
- Submerged conditions. A unit is submerged when the standing water elevation at the proposed location of the Stormceptor unit is greater than the outlet invert elevation during zero flow conditions. In these cases, please contact your local Stormceptor representative and provide the following information:
- Top of grade elevation
- Stormceptor inlet and outlet pipe diameters and invert elevations
- Standing water elevation
- Stormceptor head loss, K = 1.3 (for submerged condition, K = 4)

Stormceptor® STC

OPERATION AND MAINTENANCE GUIDE

Table of Content

1. About Stormceptor

The Stormceptor® STC (Standard Treatment Cell) was developed by Imbrium™ Systems to address the growing need to remove and isolate pollution from the storm drain system before it enters the environment. The Stormceptor STC targets hydrocarbons and total suspended solids (TSS) in stormwater runoff. It improves water quality by removing contaminants through the gravitational settling of fine sediments and floatation of hydrocarbons while preventing the re-suspension or scour of previously captured pollutants.

The development of the Stormceptor STC revolutionized stormwater treatment, and created an entirely new category of environmental technology. Protecting thousands of waterways around the world, the Stormceptor System has set the standard for effective stormwater treatment.

1.1. Patent Information

The Stormceptor technology is protected by the following patents:

- Australia Patent No. 693,164 • 693,164 • 707,133 • 729,096 • 779401
- Austrian Patent No. 289647
- Canadian Patent No 2,009,208 •2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 (Pending)
- China Patent No 1168439
- Denmark DK 711879
- German DE 69534021
- Indonesian Patent No 16688
- Japan Patent No 9-11476 (Pending)
- Korea 10-2000-0026101 (Pending)
- Malaysia Patent No PI9701737 (Pending)
- New Zealand Patent No 314646
- United States Patent No 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690
- Stormceptor OSR Patent Pending • Stormceptor LCS Patent Pending

2. Stormceptor Design Overview

2.1. Design Philosophy

The patented Stormceptor System has been designed to focus on the environmental objective of providing long-term pollution control. The unique and innovative Stormceptor design allows for continuous positive treatment of runoff during all rainfall events, while ensuring that all captured pollutants are retained within the system, even during intense storm events.

An integral part of the Stormceptor design is PCSWMM for Stormceptor - sizing software developed in conjunction with Computational Hydraulics Inc. (CHI) and internationally acclaimed expert, Dr. Bill James. Using local historical rainfall data and continuous simulation modeling, this software allows a Stormceptor unit to be designed for each individual site and the corresponding water quality objectives.

By using PCSWMM for Stormceptor, the Stormceptor System can be designed to remove a wide range of particles (typically from 20 to 2,000 microns), and can also be customized to remove a specific particle size distribution (PSD). The specified PSD should accurately reflect what is in the stormwater runoff to ensure the device is achieving the desired water quality objective. Since stormwater runoff contains small particles (less than 75 microns), it is important to design a treatment system to remove smaller particles in addition to coarse particles.

2.2. Benefits

The Stormceptor System removes free oil and suspended solids from stormwater, preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits, capabilities and applications of the Stormceptor System are as follows:

- Provides continuous positive treatment during all rainfall events
- Can be designed to remove over 80% of the annual sediment load
- Removes a wide range of particles
- Can be designed to remove a specific particle size distribution (PSD)
- Captures free oil from stormwater
- Prevents scouring or re-suspension of trapped pollutants
- Pre-treatment to reduce maintenance costs for downstream treatment measures (ponds, swales, detention basins, filters)
- Groundwater recharge protection
- Spills capture and mitigation
- Simple to design and specify
- Designed to your local watershed conditions
- Small footprint to allow for easy retrofit installations
- Easy to maintain (vacuum truck)
- Multiple inlets can connect to a single unit
- Suitable as a bend structure
- Pre-engineered for traffic loading (minimum AASHTO HS-20)
- Minimal elevation drop between inlet and outlet pipes
- Small head loss
- Additional protection provided by an 18" (457 mm) fiberglass skirt below the top of the insert, for the containment of hydrocarbons in the event of a spill.

2.3. Environmental Benefit

Freshwater resources are vital to the health and welfare of their surrounding communities. There is increasing public awareness, government regulations and corporate commitment to reducing the pollution entering our waterways. A major source of this pollution originates from stormwater runoff from urban areas. Rainfall runoff carries oils, sediment and other contaminants from roads and parking lots discharging directly into our streams, lakes and coastal waterways.

The Stormceptor System is designed to isolate contaminants from getting into the natural environment. The Stormceptor technology provides protection for the environment from spills that occur at service stations and vehicle accident sites, while also removing contaminated sediment in runoff that washes from roads and parking lots.

3. Key Operation Features

3.1. Scour Prevention

A key feature of the Stormceptor System is its patented scour prevention technology. This innovation ensures pollutants are captured and retained during all rainfall events, even extreme storms. The Stormceptor System provides continuous positive treatment for all rainfall events, including intense storms. Stormceptor slows incoming runoff, controlling and reducing velocities in the lower chamber to create a non-turbulent environment that promotes free oils and floatable debris to rise and sediment to settle.

The patented scour prevention technology, the fiberglass insert, regulates flows into the lower chamber through a combination of a weir and orifice while diverting high energy flows away through the upper chamber to prevent scouring. Laboratory testing demonstrated no scouring when tested up to 125% of the unit's operating rate, with the unit loaded to 100% sediment capacity (NJDEP, 2005). Second, the depth of the lower chamber ensures the sediment storage zone is adequately separated from the path of flow in the lower chamber to prevent scouring.

3.2. Operational Hydraulic Loading Rate

Designers and regulators need to evaluate the treatment capacity and performance of manufactured stormwater treatment systems. A commonly used parameter is the "operational hydraulic loading rate" which originated as a design methodology for wastewater treatment devices.

Operational hydraulic loading rate may be calculated by dividing the flow rate into a device by its settling area. This represents the critical settling velocity that is the prime determinant to quantify the influent particle size and density captured by the device. PCSWMM for Stormceptor uses a similar parameter that is calculated by dividing the hydraulic detention time in the device by the fall distance of the sediment.

$$v_{SC} = \frac{H}{6_H} = \frac{Q}{A_S}$$

Where:

v_{SC} = critical settling velocity, ft/s (m/s)

H = tank depth, ft (m)

$Ø_H$ = hydraulic detention time, ft/s (m/s)

Q = volumetric flow rate, ft3/s (m3/s)

A_S = surface area, ft^2 (m^2)

(Tchobanoglous, G. and Schroeder, E.D. 1987. Water Quality. Addison Wesley.)

Unlike designing typical wastewater devices, stormwater systems are designed for highly variable flow rates including intense peak flows. PCSWMM for Stormceptor incorporates all of the flows into its calculations, ensuring that the operational hydraulic loading rate is considered not only for one flow rate, but for all flows including extreme events.

3.3. Double Wall Containment

The Stormceptor System was conceived as a pollution identifier to assist with identifying illicit discharges. The fiberglass insert has a continuous skirt that lines the concrete barrel wall for a depth of 18 inches (457 mm) that provides double wall containment for hydrocarbons storage. This protective barrier ensures that toxic floatables do not migrate through the concrete wall into the surrounding soils.

4. Stormceptor Product Line

4.1. Stormceptor Models

A summary of Stormceptor models and capacities are listed in Table 1.

Table 1. Stormceptor Models

Stormceptor Model	Total Storage Volume U.S. Gal (L)	Hydrocarbon Storage Capacity U.S. Gal (L)	Maximum Sediment Capacity ft³ (L)
STC 450i	470 (1,780)	86 (330)	46 (1,302)
STC 900	952 (3,600)	251 (950)	89 (2,520)
STC 1200	1,234 (4,670)	251 (950)	127 (3,596)
STC 1800	1,833 (6,940)	251 (950)	207 (5,861)
STC 2400	2,462 (9,320)	840 (3,180)	205 (5,805)
STC 3600	3,715 (1,406)	840 (3,180)	373 (10,562)
STC 4800	5,059 (1,950)	909 (3,440)	543 (15,376)
STC 6000	6,136 (23,230)	909 (3,440)	687 (19,453)
STC 7200	7,420 (28,090)	1,059 (4,010)	839 (23,757)
STC 11000	11,194 (42,370)	2,797 (10, 590)	1,086 (30,752)
STC 13000	13,348 (50,530)	2,797 (10, 590)	1,374 (38,907)
STC 16000	15,918 (60,260)	3,055 (11, 560)	1,677 (47,487)

NOTE: Storage volumes may vary slightly from region to region. For detailed information, contact your local Stormceptor representative.

4.2. Inline Stormceptor

The Inline Stormceptor, Figure 1, is the standard design for most stormwater treatment applications. The patented Stormceptor design allows the Inline unit to maintain continuous positive treatment of total suspended solids (TSS) year-round, regardless of flow rate. The Inline Stormceptor is composed of a precast concrete tank with a fiberglass insert situated at the invert of the storm sewer pipe, creating an upper chamber above the insert and a lower chamber below the insert.

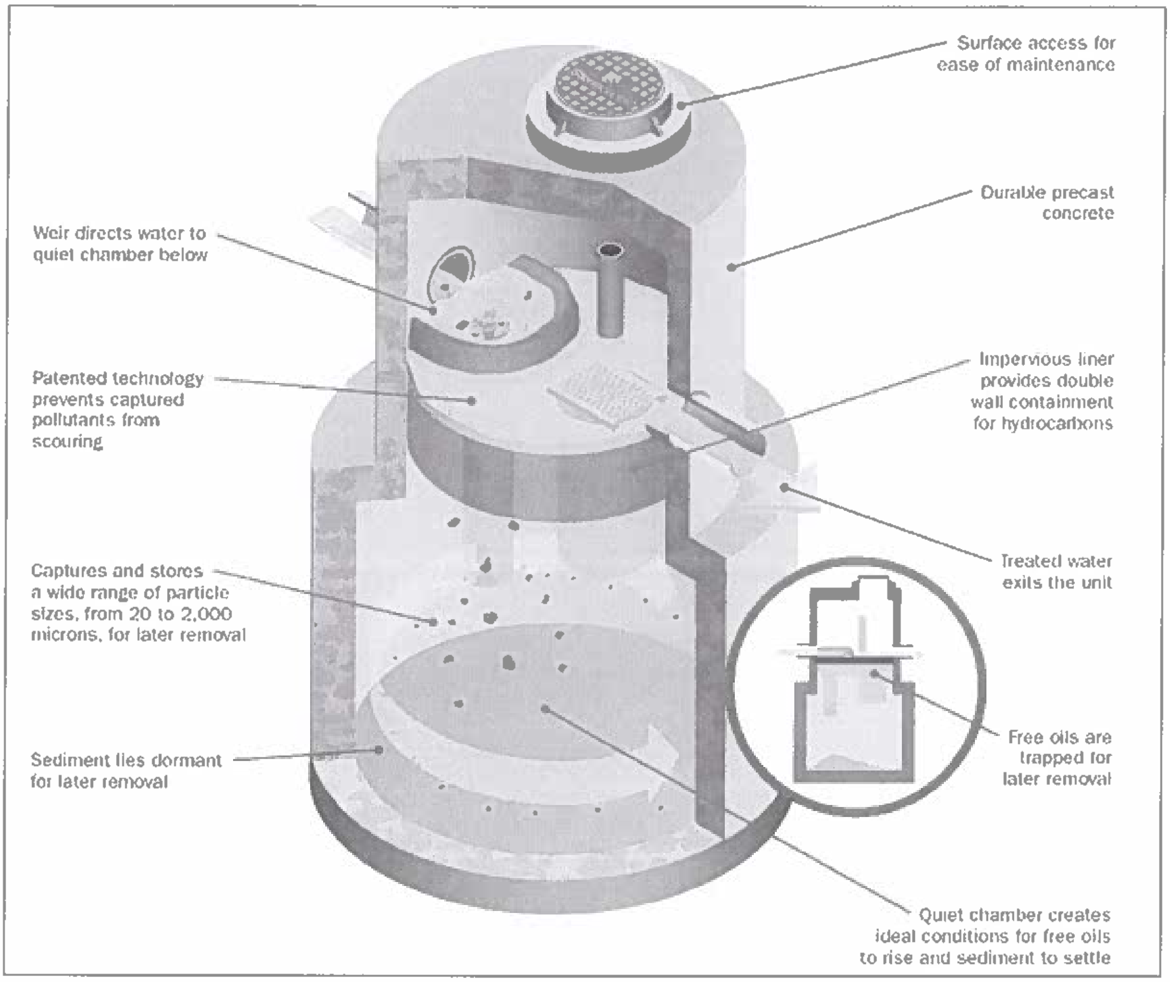


Figure 1. Inline Stormceptor

Operation

As water flows into the Stormceptor unit, it is slowed and directed to the lower chamber by a weir and drop tee. The stormwater enters the lower chamber, a non-turbulent environment, allowing free oils to rise and sediment to settle. The oil is captured underneath the fiberglass insert and shielded from exposure to the concrete walls by a fiberglass skirt. After the pollutants separate, treated water continues up a riser pipe, and exits the lower chamber on the downstream side of the weir before leaving the unit. During high flow events, the Stormceptor System's patented scour prevention technology ensures continuous pollutant removal and prevents re-suspension of previously captured pollutants.

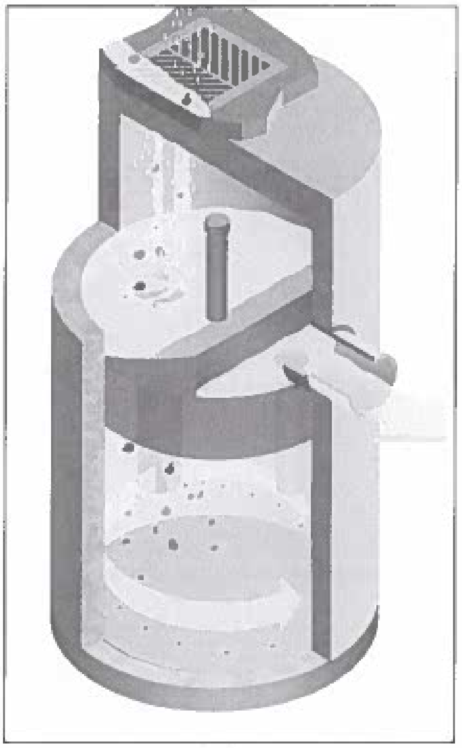


Figure 2. Inlet Stormceptor

4.3. Inlet Stormceptor

The Inlet Stormceptor System, Figure 2, was designed to provide protection for parking lots, loading bays, gas stations and other spill-prone areas. The Inlet Stormceptor is designed to remove sediment from stormwater introduced through a grated inlet, a storm sewer pipe, or both.

The Inlet Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

4.4. Series Stormceptor

Designed to treat larger drainage areas, the Series Stormceptor System, Figure 3, consists of two adjacent Stormceptor models that function in parallel. This design eliminates the need for additional structures and piping to reduce installation costs.

Figure 3. Series System

The Series Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

5. Sizing the Stormceptor System

The Stormceptor System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the Stormceptor model to meet the demands of each individual site in an efficient and cost-effective manner.

PCSWMM for Stormceptor is the support tool used for identifying the appropriate Stormceptor model. In order to size a unit, it is recommended the user follow the seven design steps in the program. The steps are as follows:

STEP 1 – Project Details

The first step prior to sizing the Stormceptor System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution.

STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

STEP 3 – Upstream Attenuation

The Stormceptor System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control devices such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a Stormceptor unit upstream of a detention facility. By placing the Stormceptor unit upstream of a detention structure, a benefit of less maintenance of the detention facility is realized.

STEP 4 – Particle Size Distribution

It is critical that the PSD be defined as part of the water quality objective. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for Stormceptor. The default particle size distribution is the Fine Distribution, Table 2, option.

Table 2. Fine Distribution

Particle Size	Distribution	Specific Gravity
20	20%	1.3
60	20%	1.8
150	20%	2.2
400	20%	2.65
2000	20%	2.65

If the objective is the long-term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site.

Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the U.S. National Oceanic and Atmospheric Administration, Environment Canada and regulatory agencies across North America. The rainfall data provided with PCSMM for Stormceptor provides an accurate estimation of small storm hydrology by modeling actual historical storm events including duration, intensities and peaks.

STEP 6 – Summary

At this point, the program may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each Stormceptor unit.

STEP 7 – Sizing Summary

Performance estimates of all Stormceptor units for the given site parameters will be displayed in a tabular format. The unit that meets the water quality objective, identified in Step 1, will be highlighted.

5.1. PCSWMM for Stormceptor

The Stormceptor System has been developed in conjunction with PCSWMM for Stormceptor as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal.

PCSWMM for Stormceptor is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from Stormceptor units that have been monitored in North America. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the Stormceptor (settling and discharge). The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:
   - The hydrology of the local area is properly and accurately incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back-to-back storms, inter-event times)
   - The distribution of TSS with the hydrology is properly and accurately considered in the sizing
   - Particle size distribution is properly considered in the sizing
   - The sizing can be optimized for TSS removal
   - The cost benefit of alternate TSS removal criteria can be easily assessed
   - The program assesses the performance of all Stormceptor models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding PCSWMM for Stormceptor, contact your local Stormceptor representative, or visit www.imbriumsystems.com to download a free copy of the program.

5.2. Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time and wash off with the next rainfall. When rainfall patterns are examined, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device.

Typical Sites

For standard site design of the Stormceptor System, PCSWMM for Stormceptor is utilized to accurately assess the unit's performance. As an integral part of the product's design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non – erodible surfaces.

Unstable Sites

While standard sites consist of stable concrete or asphalt surfaces, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are highly erodible and exhibit atypical sediment loading characteristics and must therefore be sized more carefully. Contact your local Stormceptor representative for assistance in selecting a proper unit sized for such unstable sites.

6. Spill Controls

When considering the removal of total petroleum hydrocarbons (TPH) from a storm sewer system there are two functions of the system: oil removal, and spill capture.

'Oil Removal' describes the capture of the minute volumes of free oil mobilized from impervious surfaces. In this instance relatively low concentrations, volumes and flow rates are considered. While the Stormceptor unit will still provide an appreciable oil removal function during higher flow events and/or with higher TPH concentrations, desired effluent limits may be exceeded under these conditions.

'Spill Capture' describes a manner of TPH removal more appropriate to recovery of a relatively high volume of a single phase deleterious liquid that is introduced to the storm sewer system over a relatively short duration. The two design criteria involved when considering this manner of introduction are overall volume and the specific gravity of the material. A standard Stormceptor unit will be able to capture and retain a maximum spill volume and a minimum specific gravity.

For spill characteristics that fall outside these limits, unit modifications are required. Contact your local Stormceptor Representative for more information.

One of the key features of the Stormceptor technology is its ability to capture and retain spills. While the standard Stormceptor System provides excellent protection for spill control, there are additional options to enhance spill protection if desired.

6.1. Oil Level Alarm

The oil level alarm is an electronic monitoring system designed to trigger a visual and audible alarm when a pre-set level of oil is reached within the lower chamber. As a standard, the oil

level alarm is designed to trigger at approximately 85% of the unit's available depth level for oil capture. The feature acts as a safeguard against spills caused by exceeding the oil storage capacity of the separator and eliminates the need for manual oil level inspection.

The oil level alarm installed on the Stormceptor insert is illustrated in Figure 4.

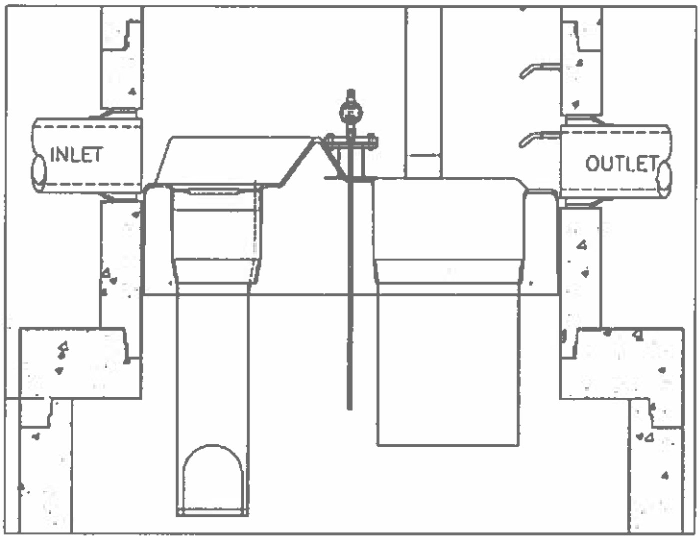


Figure 4. Oil level alarm

6.2. Increased Volume Storage Capacity

The Stormceptor unit may be modified to store a greater spill volume than is typically available. Under such a scenario, instead of installing a larger than required unit, modifications can be made to the recommended Stormceptor model to accommodate larger volumes. Contact your local Stormceptor representative for additional information and assistance for modifications.

7. Stormceptor Options

The Stormceptor System allows flexibility to incorporate to existing and new storm drainage infrastructure. The following section identifies considerations that should be reviewed when installing the system into a drainage network. For conditions that fall outside of the recommendations in this section, please contact your local Stormceptor representative for further guidance.

7.1. Installation Depth Minimum Cover

The minimum distance from the top of grade to the crown of the inlet pipe is 24 inches (600 mm). For situations that have a lower minimum distance, contact your local Stormceptor representative.

7.2. Maximum Inlet and Outlet Pipe Diameters

Maximum inlet and outlet pipe diameters are illustrated in Figure 5. Contact your local Stormceptor representative for larger pipe diameters

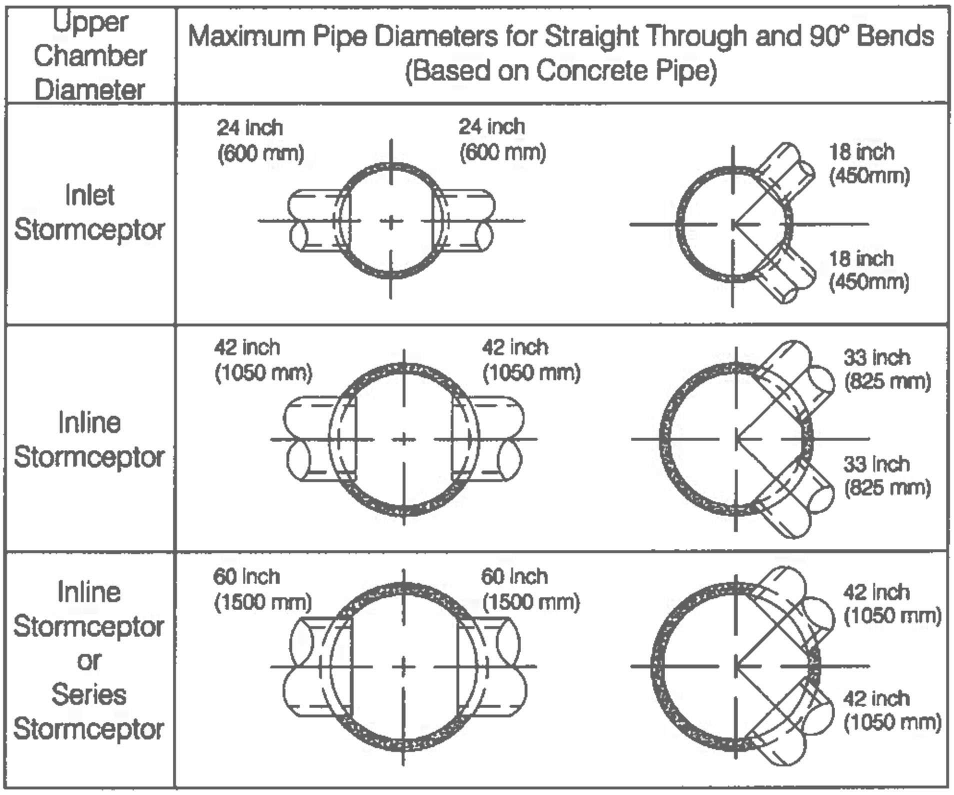


Figure 5. Maximum pipe diameters for straight through and bend applications

*The bend should only be incorporated into the second structure (downstream structure) of the Series Stormceptor System

7.3. Bends

The Stormceptor System can be used to change horizontal alignment in the storm drain network up to a maximum of 90 degrees. Figure 6 illustrates the typical bend situations of the Stormceptor System. Bends should only be applied to the second structure (downstream structure) of the Series Stormceptor System.

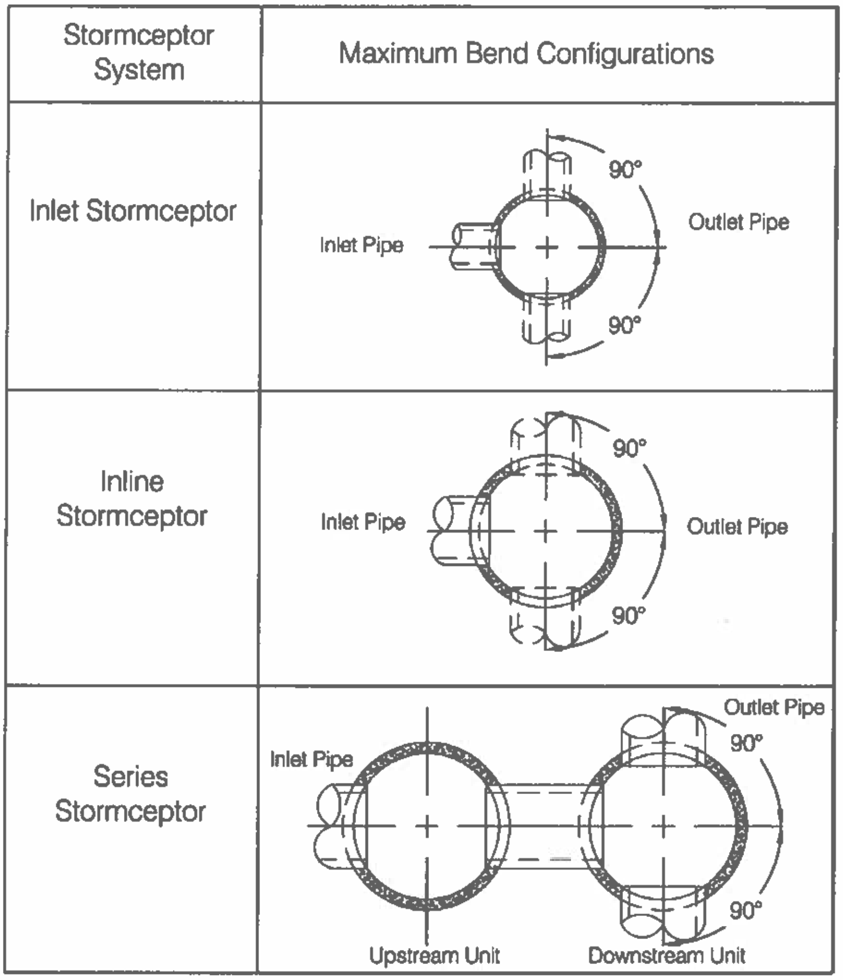


Figure 6. Maximum bend angles

7.4. Multiple Inlet Pipes

The Inlet and Inline Stormceptor System can accommodate two or more inlet pipes. The maximum number of inlet pipes that can be accommodated into a Stormceptor unit is a function of the number, alignment and diameter of the pipes and its effects on the structural integrity of the precast concrete. When multiple inlet pipes are used for new developments, each inlet pipe shall have an invert elevation 3 inches (75 mm) higher than the outlet pipe invert elevation.

7.5. Inlet/Outlet Pipe Invert Elevations

Recommended inlet and outlet pipe invert differences are listed in Table 3.

Table 3. Recommended Drops Between Inlet and Outlet Pipe Inverts

Number of Inlet Pipes	Inlet System	In-Line System	Series System
1	3 inches (75 mm)	1 inch (25 mm)	3 inches (75 mm)
>1	3 inches (75 mm)	3 inches (75 mm)	Not Applicable

7.6. Shallow Stormceptor

In cases where there may be restrictions to the depth of burial of storm sewer systems. In this situation, for selected Stormceptor models, the lower chamber components may be increased in diameter to reduce the overall depth of excavation required.

7.7. Customized Live Load

The Stormceptor system is typically designed for local highway truck loading (AASHTO HS- 20). When the project requires live loads greater than HS-20, the Stormceptor System may be customized structurally for a pre-specified live load. Contact your local Stormceptor representative for customized loading conditions.

7.8. Pre-treatment

The Stormceptor System may be sized to remove sediment and for spills control in conjunction with other stormwater BMPs to meet the water quality objective. For pretreatment applications, the Stormceptor System should be the first unit in a treatment train. The benefits of pre-treatment include the extension of the operational life (extension of maintenance frequency) of large stormwater management facilities, prevention of spills and lower total life- cycle maintenance cost.

7.9. Head loss

The head loss through the Stormceptor System is similar to a 60 degree bend at a manhole. The K value for calculating minor losses is approximately 1.3 (minor loss = k*1.3v2/2g).

However, when a Submerged modification is applied to a Stormceptor unit, the corresponding K value is 4.

7.10. Submerged

The Submerged modification, Figure 7, allows the Stormceptor System to operate in submerged or partially submerged storm sewers. This configuration can be installed on all models of the Stormceptor System by modifying the fiberglass insert. A customized weir height and a secondary drop tee are added.

Submerged instances are defined as standing water in the storm drain system during zero flow conditions. In these instances, the following information is necessary for the proper design and application of submerged modifications:

- Stormceptor top of grade elevation
- Stormceptor outlet pipe invert elevation
- Standing water elevation

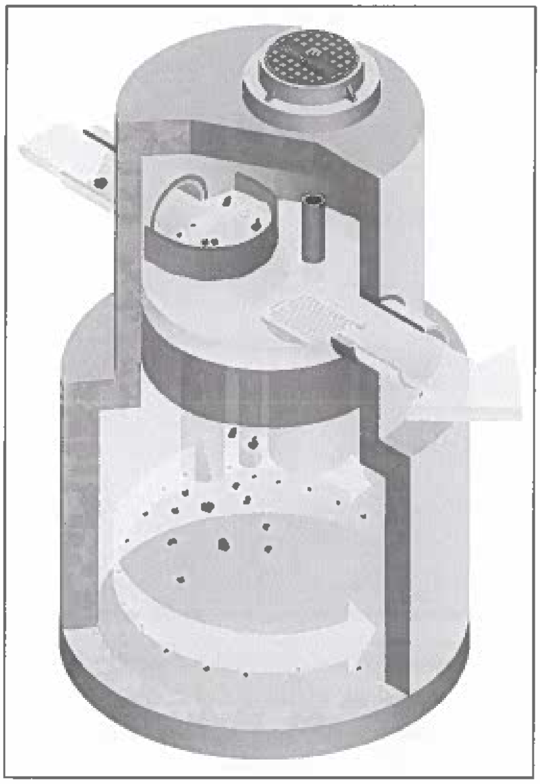


Figure 7. Submerged Stormceptor

8. Comparing Technologies

Designers have many choices available to achieve water quality goals in the treatment of stormwater runoff. Since many alternatives are available for use in stormwater quality treatment it is important to consider how to make an appropriate comparison between "approved alternatives". The following is a guide to assist with the accurate comparison of differing technologies and performance claims.

8.1. Particle Size Distribution (PSD)

The most sensitive parameter to the design of a stormwater quality device is the selection of the design particle size. While it is recommended that the actual particle size distribution (PSD) for sites be measured prior to sizing, alternative values for particle size should be selected to represent what is likely to occur naturally on the site. A reasonable estimate of a particle size distribution likely to be found on parking lots or other impervious surfaces should consist of a wide range of particles such as 20 microns to 2,000 microns (Ontario MOE, 1994).

There is no absolute right particle size distribution or specific gravity and the user is cautioned to review the site location, characteristics, material handling practices and regulatory requirements when selecting a particle size distribution. When comparing technologies, designs using different PSDs will result in incomparable TSS removal efficiencies. The PSD of the TSS removed needs to be standard between two products to allow for an accurate comparison.

8.2. Scour Prevention

In order to accurately predict the performance of a manufactured treatment device, there must be confidence that it will perform under all conditions. Since rainfall patterns cannot be predicted, stormwater quality devices placed in storm sewer systems must be able to withstand extreme events, and ensure that all pollutants previously captured are retained in the system.

In order to have confidence in a system's performance under extreme conditions, independent validation of scour prevention is essential when examining different technologies. Lack of independent verification of scour prevention should make a designer wary of accepting any product's performance claims.

8.3. Hydraulics

Full scale laboratory testing has been used to confirm the hydraulics of the Stormceptor System. Results of lab testing have been used to physically design the Stormceptor System and the sewer pipes entering and leaving the unit. Key benefits of Stormceptor are:

- Low head loss (typical k value of 1.3)
- Minimal inlet/outlet invert elevation drop across the structure
- Use as a bend structure
- Accommodates multiple inlets

The adaptability of the treatment device to the storm sewer design infrastructure can affect the overall performance and cost of the site.

8.4. Hydrology

Stormwater quality treatment technologies need to perform under varying climatic conditions. These can vary from long low intensity rainfall to short duration, high intensity storms. Since a treatment device is expected to perform under all these conditions, it makes sense that any system's design should accommodate those conditions as well.

Long-term continuous simulation evaluates the performance of a technology under the varying conditions expected in the climate of the subject site. Single, peak event design does not provide this information and is not equivalent to long-term simulation. Designers should request long-term simulation performance to ensure the technology can meet the long-term water quality objective.

9. Testing

The Stormceptor System has been the most widely monitored stormwater treatment technology in the world. Performance verification and monitoring programs are completed to the strictest standards and integrity. Since its introduction in 1990, numerous independent field tests and studies detailing the effectiveness of the Stormceptor System have been completed.

- Coventry University, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- National Water Research Institute, Canada, - scaled testing for the development of the Stormceptor System identifying both TSS removal and scour prevention.
- New Jersey TARP Program – full scale testing of an STC 900 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The New Jersey Department of Environmental Protection was followed.
- City of Indianapolis – full scale testing of an STC 900 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour.
- Westwood Massachusetts (1997), demonstrated >80% TSS removal
- Como Park (1997), demonstrated 76% TSS removal
- Ontario MOE SWAMP Program – 57% removal of 1 to 25 micron particles
- Laval Quebec – 50% removal of 1 to 25 micron particles

10. Installation

The installation of the concrete Stormceptor should conform in general to state highway, or local specifications for the installation of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

10.1. Excavation

Excavation for the installation of the Stormceptor should conform to state highway, or local specifications. Topsoil removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials.

Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12 inches (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

10.2. Backfilling

Backfill material should conform to state highway or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300mm) in depth and compacted to state highway or local specifications.

11. Stormceptor Construction Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. Aggregate base
2. Base slab
3. Lower chamber sections
4. Upper chamber section with fiberglass insert
5. Connect inlet and outlet pipes
6. Assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate
7. Remainder of upper chamber
8. Frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary. Once the Stormceptor has been constructed, any lift holes must be plugged with mortar.

12. Maintenance

12.1. Health and Safety

The Stormceptor System has been designed considering safety first. It is recommended that confined space entry protocols be followed if entry to the unit is required. In addition, the fiberglass insert has the following health and safety features:

- Designed to withstand the weight of personnel
- A safety grate is located over the 24 inch (600 mm) riser pipe opening
- Ladder rungs can be provided for entry into the unit, if required

12.2. Maintenance Procedures

Maintenance of the Stormceptor system is performed using vacuum trucks. No entry into the unit is required for maintenance (in most cases). The vacuum service industry is a well- established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean a Stormceptor will vary based on the size of unit and transportation distances.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the unit can be determined by inserting a dipstick in the oil inspection/cleanout port.

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor via a dipstick tube equipped with a ball valve. This tube would be inserted through the riser pipe. Maintenance should be performed once the sediment depth exceeds the guideline values provided in the Table 4.

Table 4. Sediment Depths Indicating Required Servicing*

Particle Size	Specific Gravity
Model	Sediment Depth inches (mm)
450i	8 (200)
900	8 (200)
1200	10 (250)
1800	15 (381)
2400	12 (300)
3600	17 (430)
4800	15 (380)
6000	18 (460)
7200	15 (381)
11000	17 (380)
13000	20 (500)
16000	17 (380)
* based on 15% of the Stormceptor unit's total storage	

Although annual servicing is recommended, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilized maintenance may only be required every two or three years).

Oil is removed through the oil inspection/cleanout port and sediment is removed through the riser pipe. Alternatively oil could be removed from the 24 inches (600 mm) opening if water is removed from the lower chamber to lower the oil level below the drop pipes.

The following procedures should be taken when cleaning out Stormceptor:

1. Check for oil through the oil cleanout port
2. Remove any oil separately using a small portable pump
3. Decant the water from the unit to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank
4. Remove the sludge from the bottom of the unit using the vacuum truck
5. Re-fill Stormceptor with water where required by the local jurisdiction

12.3. Submerged Stormceptor

Careful attention should be paid to maintenance of the Submerged Stormceptor System. In cases where the storm drain system is submerged, there is a requirement to plug both the inlet and outlet pipes to economically clean out the unit.

12.4. Hydrocarbon Spills

The Stormceptor is often installed in areas where the potential for spills is great. The Stormceptor System should be cleaned immediately after a spill occurs by a licensed liquid waste hauler.

12.5. Disposal

Requirements for the disposal of material from the Stormceptor System are similar to that of any other stormwater Best Management Practice (BMP) where permitted. Disposal options for the sediment may range from disposal in a sanitary trunk sewer upstream of a sewage treatment plant, to disposal in a sanitary landfill site. Petroleum waste products collected in the Stormceptor (free oil/chemical/fuel spills) should be removed by a licensed waste management company.

12.6. Oil Sheens

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a rainbow or sheen can be seen at very small oil concentrations (<10 mg/L). Stormceptor will remove over 98% of all free oil spills from storm sewer systems for dry weather or frequently occurring runoff events.

The appearance of a sheen at the outlet with high influent oil concentrations does not mean the unit is not working to this level of removal. In addition, if the influent oil is emulsified the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified conditions.

SUPPORT

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

CONTECH ENGINEERED SOLUTIONS
800-925-5240
www.ContechES.com

APPENDIX G:

CULTEC Design & Operation and Maintenance information

CULTEC StormGenie

USER INPUTS

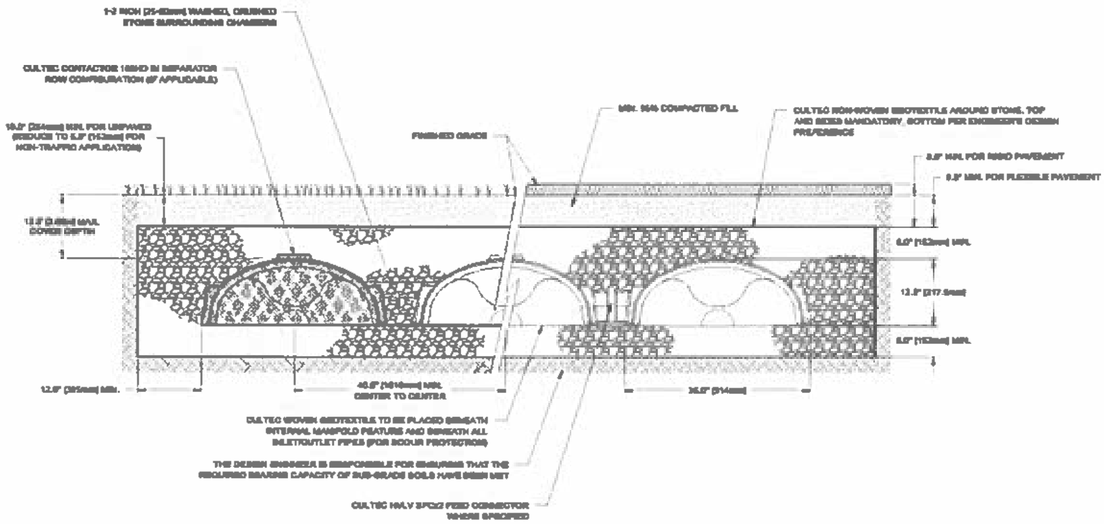
Project Name:	0 Farrington Street
Engineer:	Lesley Wilson
Project Location:	Massachusetts
Measurement Type:	Imperial
Chamber Model:	Contactor 100HD
Required Storage Volume:	375 cf
Available Length:	30 ft
Available Width:	30 ft
Stone Above Chambers:	6 in
Stone Below Chambers:	6 in
Base Stone Elevation:	507.29 ft
Stone Porosity:	40%
Maximum Allowable Finished Grade	520.83 ft
Minimum Allowable Finished Grade	510 ft
Outlet Control Structure:	Yes

RESULTS

Installed Storage Volume:	380.49 cf
Storage Volume Per Chamber:	14 cf
Chamber Rows:	4
Maximum Length:	25 ft
Maximum Width:	15 ft
Approx. Bed Area Required:	350.00 sf

SYSTEM COMPONENTS - NOT FOR CONSTRUCTION

Number of Chambers Required:	11
Number of End Caps Required:	8
Number of Feed Connectors Required:	4
Amount of Stone Required:	21 cy
Volume of Excavation (Not Including Fill):	27 cy
Non-woven Geotextile Required:	146 sy
Woven Geotextile Required (Beneath Internal Manifold):	33 ft
Woven Geotextile Required (Separator Row):	28 ft
Total Woven Geotextile Required:	61 ft



CULTEC
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Brookfield, CT 06804 USA

Phone: 203-775-4416
www.cultec.com
StormGenie@cultec.com

CULTEC StormGenie DESIGN TOOL

Click for Metric

Date:	07/24/2024
PROJECT INFORMATION	
Project Name:	0 Farrington Street
City:	Worcester
State / Province:	MA
Country:	USA

Chamber Model:	Contactor 100HD	
Number of Rows:	4	units
Total Number of Chambers:	11	units
Stone Void:	40	%
Stone Base:	6	inches
Stone Above Units:	6	inches
Area:	350.00	ft^2
Base of Stone Elevation:	507.29	ft

346.56 Min. Area Required

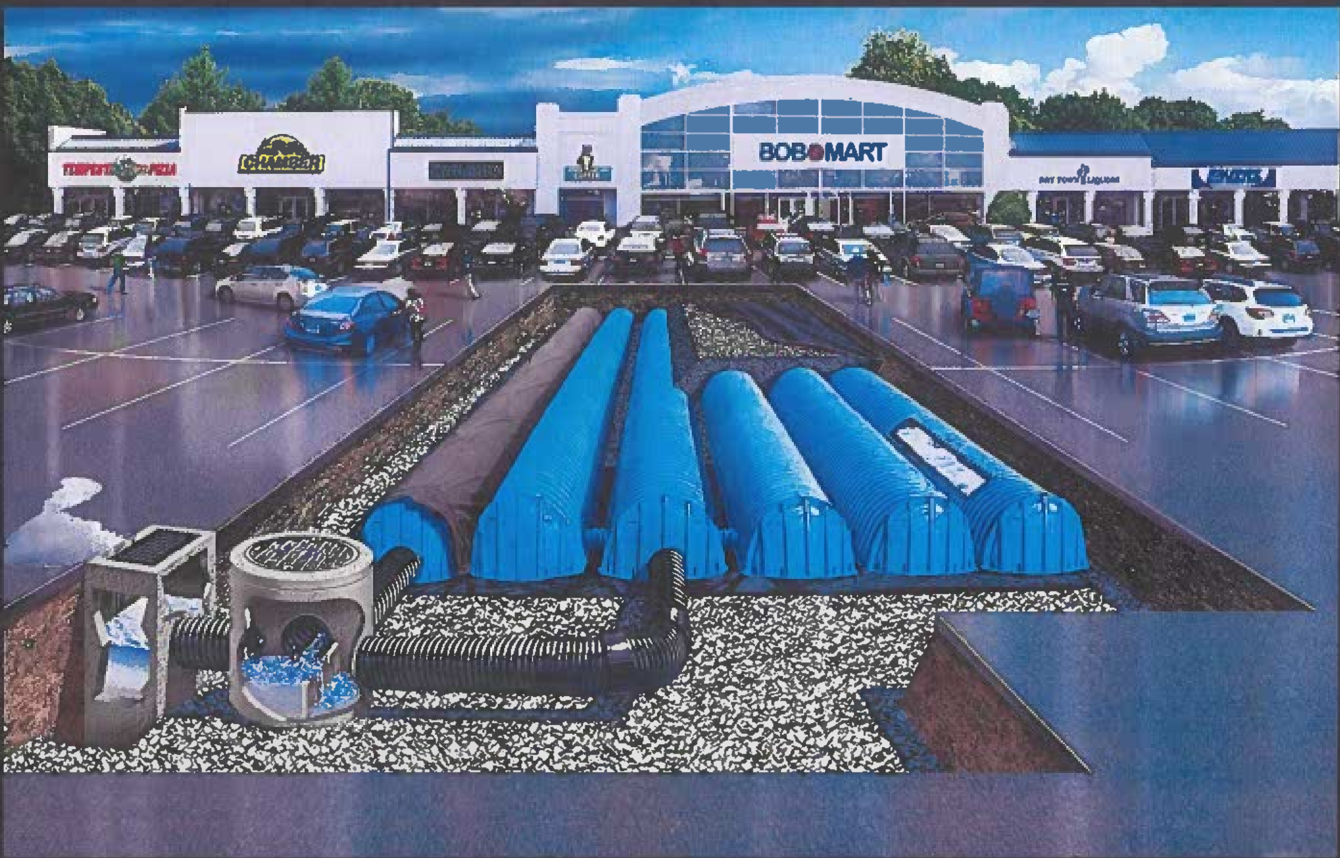
Note: Min. Area Required is based on 12" around the system and typ. spacing

0 Farrington Street
Contactor 100HD Incremental Storage Volumes

Height of System	Chamber Volume	Stone Volume	Cumulative Storage Volume	Total Cumulative Storage Volume	Elevation
in	ft^3	ft^3	ft^3	ft^3	ft
24.5	0.00	11.67	11.67	381.21	509.33
23.5	0.00	11.67	11.67	369.54	509.25
22.5	0.00	11.67	11.67	357.87	509.17
21.5	0.00	11.67	11.67	346.21	509.08
20.5	0.00	11.67	11.67	334.54	509.00
19.5	0.00	11.67	11.67	322.87	508.92
18.5	0.01	5.83	5.84	311.21	508.83
18	2.03	10.86	12.88	305.37	508.79
17	5.66	9.40	15.06	292.48	508.71
16	9.30	7.95	17.24	277.42	508.62
15	11.75	6.97	18.71	260.18	508.54
14	13.44	6.29	19.73	241.46	508.46
13	14.70	5.79	20.49	221.73	508.37
12	15.55	5.45	21.00	201.25	508.29
11	16.22	5.18	21.40	180.25	508.21
10	17.15	4.81	21.96	158.85	508.12
9	17.15	4.81	21.96	136.89	508.04
8	17.15	4.81	21.96	114.93	507.96
7	18.84	4.13	22.97	92.97	507.87
6	0.00	11.67	11.67	70.00	507.79
5	0.00	11.67	11.67	58.33	507.71
4	0.00	11.67	11.67	46.67	507.62
3	0.00	11.67	11.67	35.00	507.54
2	0.00	11.67	11.67	23.33	507.46
1	0.00	11.67	11.67	11.67	507.37
0	0.00	0.00	0.00	0.00	507.29

CONTACTOR® & RECHARGER®

STORMWATER MANAGEMENT SOLUTIONS



OPERATION & MAINTENANCE GUIDELINES

FOR CULTEC STORMWATER MANAGEMENT SYSTEMS

STORMWATER MANAGEMENT SOLUTIONS

CULTEC

Published by
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Contact Information:
For general information on our other products and services, please contact our offices within the United States at (800)428-5832, (203)775-4416 ext. 202, or e-mail us at custservice@cultec.com.

For technical support, please call (203)775-4416 ext. 203 or e-mail tech@cultec.com.

Visit www.cultec.com/downloads.html for Product Downloads and CAD details.

Doc ID: CLT057 01-20
January 2020

These instructions are for single-layer traffic applications only. For multi-layer applications, contact CULTEC.
All illustrations and photos shown herein are examples of typical situations. Be sure to follow the engineer's drawings.
Actual designs may vary.

This manual contains guidelines recommended by CULTEC, Inc. and may be used in conjunction with, but not to supersede, local regulations or regulatory authorities. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Introduction

The CULTEC Subsurface Stormwater Management System is a high-density polyethylene (HDPE) chamber system arranged in parallel rows surrounded by washed stone. The CULTEC chambers create arch-shaped voids within the washed stone to provide stormwater detention, retention, infiltration, and reclamation. Filter fabric is placed between the native soil and stone interface to prevent the intrusion of fines into the system. In order to minimize the amount of sediment which may enter the CULTEC system, a sediment collection device (stormwater pretreatment device) is recommended upstream from the CULTEC chamber system. Examples of pretreatment devices include, but are not limited to, an appropriately sized catch basin with sump, pretreatment catchment device, oil grit separator, or baffled distribution box. Manufactured pretreatment devices may also be used in accordance with CULTEC chambers. Installation, operation, and maintenance of these devices shall be in accordance with manufacturer's recommendations. Almost all of the sediment entering the stormwater management system will be collected within the pretreatment device.

Best Management Practices allow for the maintenance of the preliminary collection systems prior to feeding the CULTEC chambers. The pretreatment structures shall be inspected for any debris that will restrict inlet flow rates. Outfall structures, if any, such as outlet control must also be inspected for any obstructions that would restrict outlet flow rates. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Operation and Maintenance Requirements

I. Operation

CULTEC stormwater management systems shall be operated to receive only stormwater run-off in accordance with applicable local regulations. CULTEC subsurface stormwater management chambers operate at peak performance when installed in series with pretreatment. Pretreatment of suspended solids is superior to treatment of solids once they have been introduced into the system. The use of pretreatment is adequate as long as the structure is maintained and the site remains stable with finished impervious surfaces such as parking lots, walkways, and pervious areas are properly maintained. If there is to be an unstable condition, such as improvements to buildings or parking areas, all proper silt control measures shall be implemented according to local regulations.

II. Inspection and Maintenance Options

A. The CULTEC system may be equipped with an inspection port located on the inlet row. The inspection port is a circular cast box placed in a rectangular concrete collar. When the lid is removed, a 6-inch (150 mm) pipe with a screw-in plug will be exposed. Remove the plug. This will provide access to the CULTEC Chamber row below. From the surface, through this access, the sediment may be measured at this location. A stadia rod may be used to measure the depth of sediment if any in this row. If the depth of sediment is in excess of 3 inches (76 mm), then this row should be cleaned with high pressure water through a culvert cleaning nozzle. This would be carried out through an upstream manhole or through the CULTEC StormFilter Unit (or other pre-treatment device). CCTV inspection of this row can be deployed through this access port to deter mine if any sediment has accumulated in the inlet row.

B. If the CULTEC bed is not equipped with an inspection port, then access to the inlet row will be through an upstream manhole or the CULTEC StormFilter.

1. Manhole Access
This inspection should only be carried out by persons trained in confined space entry and sewer inspection services. After the manhole cover has been removed a gas detector must be lowered into the manhole to ensure that there are not high concentrations of toxic gases present. The inspector should be lowered into the manhole with the proper safety equipment as per OSHA requirements. The inspector may be able to observe sediment from this location. If this is not possible, the inspector will need to deploy a CCTV robot to permit viewing of the sediment.

2. **StormFilter Access**
Remove the manhole cover to allow access to the unit. Typically a 30-inch (750 mm) pipe is used as a riser from the StormFilter to the surface. As in the case with manhole access, this access point requires a technician trained in confined space entry with proper gas detection equipment. This individual must be equipped with the proper safety equipment for entry into the StormFilter. The technician will be lowered onto the StormFilter unit. The hatch on the unit must be removed. Inside the unit are two filters which may be removed according to StormFilter maintenance guidelines. Once these filters are removed the inspector can enter the StormFilter unit to launch the CCTV camera robot.

C. The inlet row of the CULTEC system is placed on a polyethylene liner to prevent scouring of the washed stone beneath this row. This also facilitates the flushing of this row with high pressure water through a culvert cleaning nozzle. The nozzle is deployed through a manhole or the StormFilter and extended to the end of the row. The water is turned on and the inlet row is back-flushed into the manhole or StormFilter. This water is to be removed from the manhole or StormFilter using a vacuum truck.

III. Maintenance Guidelines

The following guidelines shall be adhered to for the operation and maintenance of the CULTEC stormwater management system:

A. The owner shall keep a maintenance log which shall include details of any events which would have an effect on the system's operational capacity.

B. The operation and maintenance procedure shall be reviewed periodically and changed to meet site conditions.

C. Maintenance of the stormwater management system shall be performed by qualified workers and shall follow applicable occupational health and safety requirements.

D. Debris removed from the stormwater management system shall be disposed of in accordance with applicable laws and regulations.

IV. Suggested Maintenance Schedules

A. **Minor Maintenance**
The following suggested schedule shall be followed for routine maintenance during the regular operation of the stormwater system:

Frequency	Action
Monthly in first year	Check inlets and outlets for clogging and remove any debris, as required.
Spring and Fall	Check inlets and outlets for clogging and remove any debris, as required.
One year after commissioning and every third year following	Check inlets and outlets for clogging and remove any debris, as required.

B. **Major Maintenance**
The following suggested maintenance schedule shall be followed to maintain the performance of the CULTEC stormwater management chambers. Additional work may be necessary due to insufficient performance and other issues that might be found during the inspection of the stormwater management chambers. (See table on next page)

	Frequency	Action
Inlets and Outlets	Every 3 years	• Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
	Spring and Fall	• Check inlet and outlets for clogging and remove any debris as required.
CULTEC Stormwater Chambers	2 years after commissioning	• Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
	9 years after commissioning every 9 years following	• Clean stormwater management chambers and feed connectors of any debris. • Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
	45 years after commissioning	• Clean stormwater management chambers and feed connectors of any debris. • Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. • Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. • Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. • Attain the appropriate approvals as required. • Establish a new operation and maintenance schedule.
Surrounding Site	Monthly in 1st year	• Check for depressions in areas over and surrounding the stormwater management system.
	Spring and Fall	• Check for depressions in areas over and surrounding the stormwater management system.
	Yearly	• Confirm that no unauthorized modifications have been performed to the site.

For additional information concerning the maintenance of CULTEC Subsurface Stormwater Management Chambers, please contact CULTEC, Inc. at 1-800-428-5832.

WQMP
Operation & Maintenance (O&M) Plan

Project Name:____

Prepared for:

Project Name: ____

Address:____

City, State Zip:____

Prepared on:

Date:____

This O&M Plan describes the designated responsible party for implementation of this WQMP, including: operation and maintenance of all the structural BMP(s), conducting the training/educational program and duties, and any other necessary activities. The O&M Plan includes detailed inspection and maintenance requirements for all structural BMPs, including copies of any maintenance contract agreements, manufacturer's maintenance requirements, permits, etc.

8.1.1 Project Information

Project name	
Address	
City, State Zip	
Site size	
List of structural BMPs, number of each	
Other notes	

8.1.2 Responsible Party

The responsible party for implementation of this WQMP is:

Name of Person or HOA Property Manager	
Address	
City, State Zip	
Phone number	
24-Hour Emergency Contact number	
Email	

8.1.3 Record Keeping

Parties responsible for the O&M plan shall retain records for at least 5 years.

All training and educational activities and BMP operation and maintenance shall be documented to verify compliance with this O&M Plan. A sample Training Log and Inspection and Maintenance Log are included in this document.

8.1.4 Electronic Data Submittal

This document along with the Site Plan and Attachments shall be provided in PDF format. AutoCAD files and/or GIS coordinates of BMPs shall also be submitted to the City.

Appendix ___

BMP SITE PLAN

Site plan is preferred on minimum 11" by 17" colored sheets, as long as legible.

BMP OPERATION & MAINTENANCE LOG

Project Name: ____

Today's Date: ____

Name of Person Performing Activity (Printed): ______________________________

Signature: ____

BMP Name (As Shown in O&M Plan)	Brief Description of Implementation, Maintenance, and Inspection Activity Performed

Minor Maintenance

Frequency		Action
Monthly in first year		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
◻ Month 1	Date:	
◻ Month 2	Date:	
◻ Month 3	Date:	
◻ Month 4	Date	
◻ Month 5	Date:	
◻ Month 6	Date:	
◻ Month 7	Date:	
◻ Month 8	Date:	
◻ Month 9	Date:	
◻ Month 10	Date:	
◻ Month 11	Date:	
◻ Month 12	Date:	
Spring and Fall		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
◻ Spring	Date:	
◻ Fall	Date:	
◻ Spring	Date:	
◻ Fall	Date:	
◻ Spring	Date:	
◻ Fall	Date:	
◻ Spring	Date:	
◻ Fall	Date:	
◻ Spring	Date:	
◻ Fall	Date:	
◻ Spring	Date:	
◻ Fall	Date:	
One year after commissioning and every third year following		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
◻ Year 1	Date:	
◻ Year 4	Date:	
◻ Year 7	Date:	
◻ Year 10	Date:	
◻ Year 13	Date:	
◻ Year 16	Date:	
◻ Year 19	Date:	
◻ Year 22	Date:	

Major Maintenance

	Frequency		Action
Inlets and Outlets	**Every 3 years**		Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
			Notes
	☐ Year 1	Date:	
	☐ Year 4	Date:	
	☐ Year 7	Date:	
	☐ Year 10	Date:	
	☐ Year 13	Date:	
	☐ Year 16	Date:	
	☐ Year 19	Date:	
	☐ Year 22	Date:	
	Spring and Fall		Check inlet and outlets for clogging and remove any debris, as required.
			Notes
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
CULTEC Stormwater Chambers	**2 years after commissioning**		☐ Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. ☐ Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
			Notes
	☐ Year 2	Date:	

For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

Major Maintenance

	Frequency		Action
CULTEC Stormwater Chambers	**9 years after commissioning every 9 years following**		☐ Clean stormwater management chambers and feed connectors of any debris. ☐ Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. ☐ Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
			Notes
	☐ Year 9	Date:	
	☐ Year 18	Date:	
	☐ Year 27	Date:	
	☐ Year 36	Date:	
	45 years after commissioning		☐ Clean stormwater management chambers and feed connectors of any debris. ☐ Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. ☐ Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. ☐ Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. ☐ Attain the appropriate approvals as required. ☐ Establish a new operation and maintenance schedule.
			Notes
	☐ Year 45	Date:	

For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

Major Maintenance

	Frequency		Action
Surrounding Site	**Monthly in 1st year**		☐ Check for depressions in areas over and surrounding the stormwater management system.
			Notes
	☐ Month 1	Date:	
	☐ Month 2	Date:	
	☐ Month 3	Date:	
	☐ Month 4	Date:	
	☐ Month 5	Date:	
	☐ Month 6	Date:	
	☐ Month 7	Date:	
	☐ Month 8	Date:	
	☐ Month 9	Date:	
	☐ Month 10	Date:	
	☐ Month 11	Date:	
	☐ Month 12	Date:	
	Spring and Fall		☐ Check for depressions in areas over and surrounding the stormwater management system.
			Notes
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	☐ Spring	Date:	
	☐ Fall	Date:	
	Yearly		☐ Confirm that no unauthorized modifications have been performed to the site.
			Notes
	☐ Year 1	Date:	
	☐ Year 2	Date:	
	☐ Year 3	Date:	
	☐ Year 4	Date:	
	☐ Year 5	Date:	
	☐ Year 6	Date:	
	☐ Year 7	Date:	

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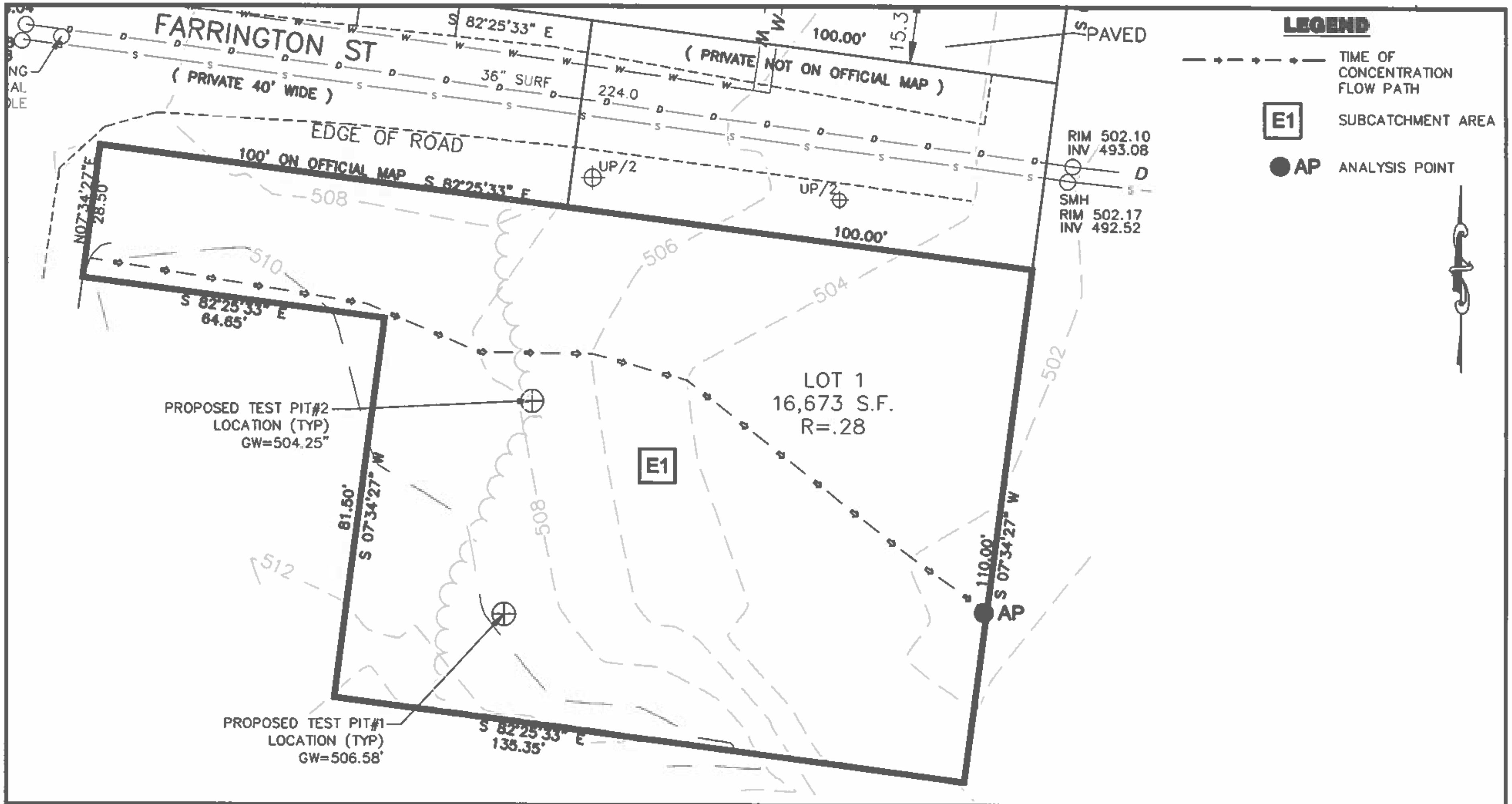
RETENTION • DETENTION • INFILTRATION • WATER QUALITY

APPENDIX H:

Pre-development catchment locations
Post-development catchment locations



EXISTING WATERSHED PLAN

0 FARRINGTON ST
WORCESTER MA

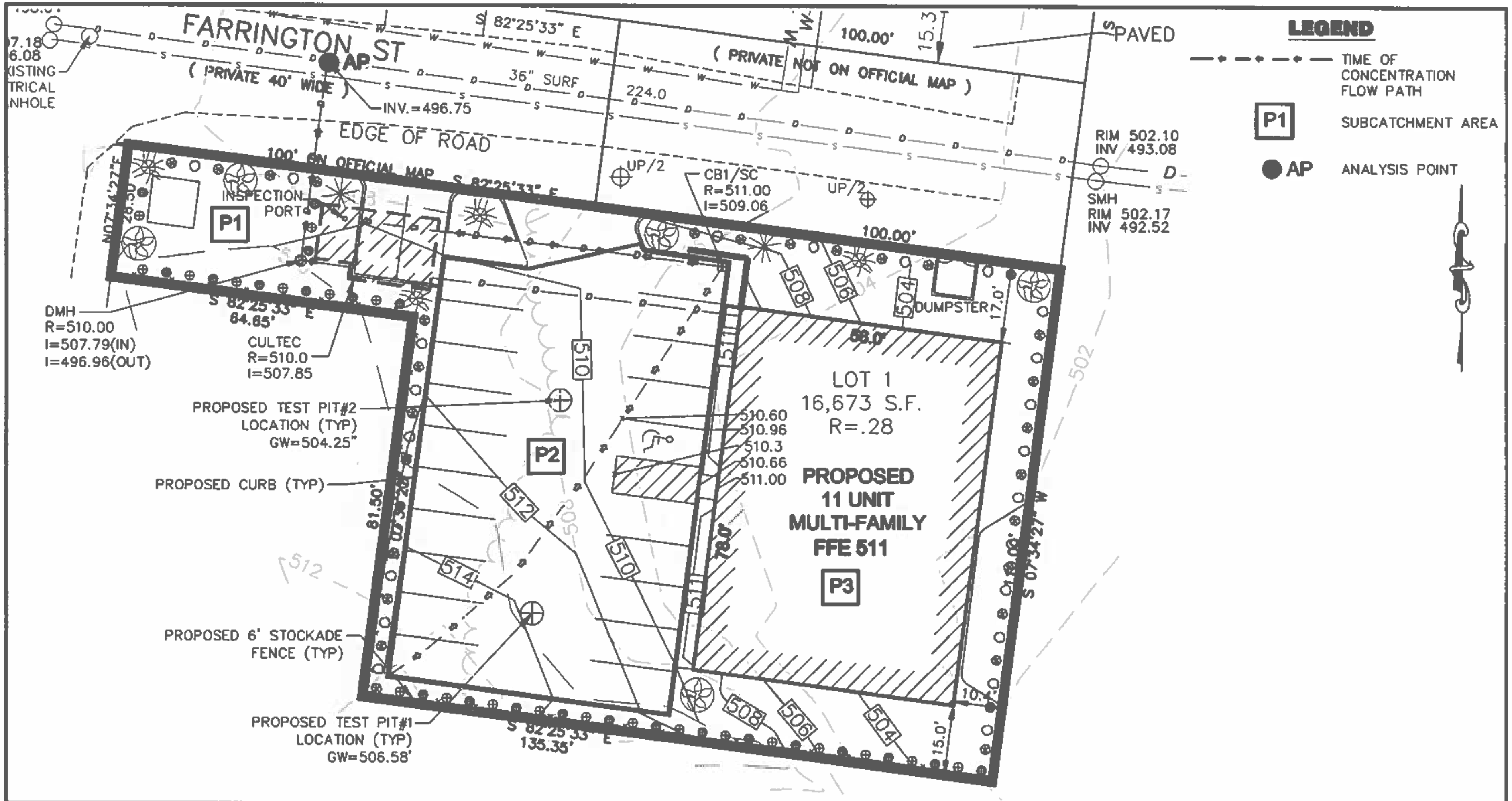
20 0 20 40 60

SCALE 1"=20'

DWG FILE: FARRINGTONPROP 2

DATE 7-24-2024

H. S. & T. GROUP, INC.
PROFESSIONAL CIVIL ENGINEERS & LAND SURVEYORS
75 HAMMOND STREET – 2ND FLOOR
WORCESTER, MASSACHUSETTS 01610-1723
PHONE: (508) 757-4944 FAX: (508) 752-8895
EMAIL: INFO@HSTGROUP.NET WWW.HSTGROUP.NET



PROPOSED WATERSHED PLAN

0 FARRINGTON ST
WORCESTER MA

SCALE 1"=20'

DWG FILE: FARRINGTONPROP 2

DATE 7-24-2024

H. S. & T. GROUP, INC.
PROFESSIONAL CIVIL ENGINEERS & LAND SURVEYORS
75 HAMMOND STREET – 2ND FLOOR
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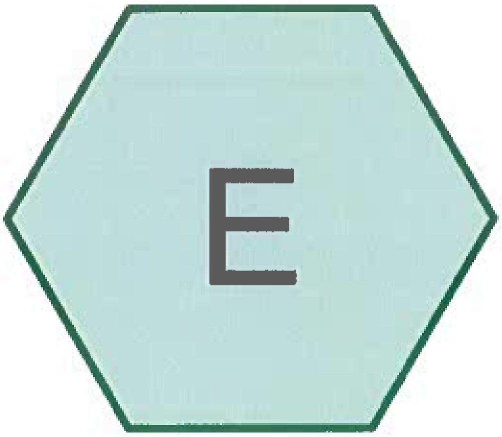
PHONE: (508) 757-4944 FAX: (508) 752-8895
EMAIL: INFO@HSTGROUP.NET WWW.HSTGROUP.NET

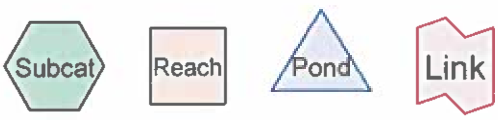
APPENDIX I:

Pre-Development Hydrology for POI

Type III, 2-Year 24 Hour Storm
Type III, 10-Year 24 Hour Storm
Type III, 25-Year 24 Hour Storm
Type III, 100-Year 24 Hour Storm



EXISTING



Routing Diagram for exist - hydro
Prepared by HS&T Group, Printed 8/16/2024
HydroCAD® 10.00-15 s/n 04131 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment E: EXISTING

Runoff = 0.91 cfs @ 12.01 hrs, Volume= 0.053 af, Depth> 1.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.86"

Area (sf)	CN	Description
10,608	70	Woods, Good, HSG C
1,309	77	Woods, Good, HSG D
4,814	96	Gravel surface, HSG C
16,731	78	Weighted Average
16,731		100.00% Pervious Area

Summary for Subcatchment E: EXISTING

Runoff = 1.86 cfs @ 12.00 hrs, Volume= 0.108 af, Depth> 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=6.02"

Area (sf)	CN	Description
10,608	70	Woods, Good, HSG C
1,309	77	Woods, Good, HSG D
4,814	96	Gravel surface, HSG C
16,731	78	Weighted Average
16,731		100.00% Pervious Area

Summary for Subcatchment E: EXISTING

Runoff = 2.65 cfs @ 12.00 hrs, Volume= 0.156 af, Depth> 4.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 year Rainfall=7.76"

Area (sf)	CN	Description
10,608	70	Woods, Good, HSG C
1,309	77	Woods, Good, HSG D
4,814	96	Gravel surface, HSG C
16,731	78	Weighted Average
16,731		100.00% Pervious Area

Summary for Subcatchment E: EXISTING

Runoff = 3.95 cfs @ 12.00 hrs, Volume= 0.237 af, Depth> 7.40"

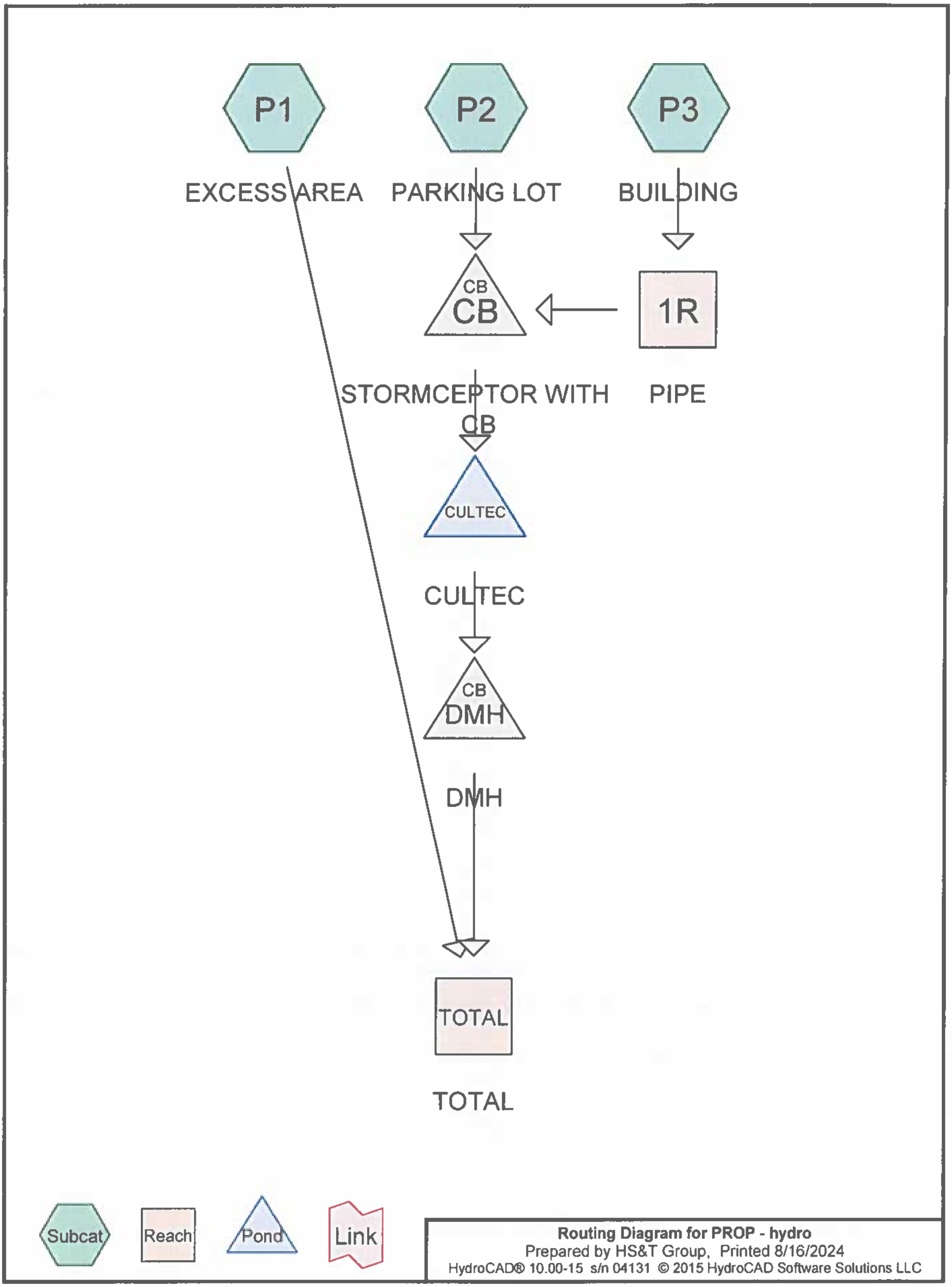
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=10.60"

Area (sf)	CN	Description
10,608	70	Woods, Good, HSG C
1,309	77	Woods, Good, HSG D
4,814	96	Gravel surface, HSG C
16,731	78	Weighted Average
16,731		100.00% Pervious Area

APPENDIX J:

Post-Development Hydrology for POI

Type III, 2-Year 24 Hour Storm
Type III, 10-Year 24 Hour Storm
Type III, 25-Year 24 Hour Storm
Type III, 100-Year 24 Hour Storm



Routing Diagram for PROP - hydro
Prepared by HS&T Group, Printed 8/16/2024
HydroCAD® 10.00-15 s/n 04131 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment P1: EXCESS AREA

Runoff = 0.20 cfs @ 12.10 hrs, Volume= 0.022 af, Depth> 1.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 2 year Rainfall=3.86"

	Area (sf)	CN	Description
	4,834	74	>75% Grass cover, Good, HSG C
	927	80	>75% Grass cover, Good, HSG D
*	765	98	Pavement
	6,526	78	Weighted Average
	5,761		88.28% Pervious Area
	765		11.72% Impervious Area

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

Summary for Subcatchment P2: PARKING LOT

Runoff = 0.35 cfs @ 12.05 hrs, Volume= 0.041 af, Depth> 3.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 2 year Rainfall=3.86"

	Area (sf)	CN	Description
*	5,903	98	Pavement to stormceptor
	5,903		100.00% Impervious Area

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

Summary for Subcatchment P3: BUILDING

Runoff = 0.26 cfs @ 12.05 hrs, Volume= 0.030 af, Depth> 3.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 2 year Rainfall=3.86"

	Area (sf)	CN	Description
*	4,368	98	Building
	4,368		100.00% Impervious Area

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

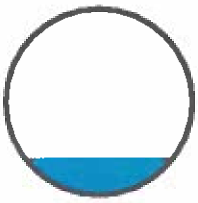
Summary for Reach 1R: PIPE

Inflow Area = 0.100 ac,100.00% Impervious, Inflow Depth > 3.63" for 2 year event
Inflow = 0.26 cfs @ 12.05 hrs, Volume= 0.030 af
Outflow = 0.26 cfs @ 12.06 hrs, Volume= 0.030 af, Atten= 1%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Max. Velocity= 2.30 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 1.3 min

Peak Storage= 7 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.97 cfs

12.0" Round Pipe
n= 0.011
Length= 66.2' Slope= 0.0050 '/'
Inlet Invert= 508.18', Outlet Invert= 507.85'



Summary for Reach TOTAL: TOTAL

Inflow Area = 0.386 ac, 65.70% Impervious, Inflow Depth > 2.81" for 2 year event
Inflow = 0.76 cfs @ 12.14 hrs, Volume= 0.090 af
Outflow = 0.76 cfs @ 12.14 hrs, Volume= 0.090 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs

Summary for Pond CB: STORMCEPTOR WITH CB

Inflow Area = 0.236 ac,100.00% Impervious, Inflow Depth > 3.62" for 2 year event
Inflow = 0.61 cfs @ 12.06 hrs, Volume= 0.071 af
Outflow = 0.61 cfs @ 12.06 hrs, Volume= 0.071 af, Atten= 0%, Lag= 0.0 min
Primary = 0.61 cfs @ 12.06 hrs, Volume= 0.071 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 509.57' @ 12.06 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	509.06'	**8.0" Round Stormceptor** L= 62.2' Ke= 0.200 Inlet / Outlet Invert= 509.06' / 508.75' S= 0.0050 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=0.56 cfs @ 12.06 hrs HW=509.55' TW=508.32' (Dynamic Tailwater)
↑—**1=Stormceptor** (Barrel Controls 0.56 cfs @ 2.85 fps)

Summary for Pond CULTEC: CULTEC

Inflow Area = 0.236 ac,100.00% Impervious, Inflow Depth > 3.62" for 2 year event
Inflow = 0.61 cfs @ 12.06 hrs, Volume= 0.071 af
Outflow = 0.57 cfs @ 12.16 hrs, Volume= 0.068 af, Atten= 6%, Lag= 6.0 min
Primary = 0.57 cfs @ 12.16 hrs, Volume= 0.068 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 508.36' @ 12.16 hrs Surf.Area= 458 sf Storage= 289 cf

Plug-Flow detention time= 52.5 min calculated for 0.068 af (96% of inflow)
Center-of-Mass det. time= 28.3 min (781.1 - 752.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	507.29'	289 cf	**18.33'W x 25.00'L x 2.04'H Field A** 936 cf Overall - 214 cf Embedded = 722 cf x 40.0% Voids
#2A	507.79'	214 cf	**Cultec C-100HD** x 15 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 5 rows
		503 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	507.85'	**8.0" Round Culvert** L= 11.4' Ke= 0.200 Inlet / Outlet Invert= 507.85' / 507.79' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=0.53 cfs @ 12.16 hrs HW=508.34' TW=508.07' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.53 cfs @ 2.70 fps)

Summary for Pond DMH: DMH

Inflow Area = 0.236 ac,100.00% Impervious, Inflow Depth > 3.47" for 2 year event
Inflow = 0.57 cfs @ 12.16 hrs, Volume= 0.068 af
Outflow = 0.57 cfs @ 12.16 hrs, Volume= 0.068 af, Atten= 0%, Lag= 0.0 min
Primary = 0.57 cfs @ 12.16 hrs, Volume= 0.068 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 508.09' @ 12.16 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	507.59'	**8.0" Round Culvert** L= 42.7' Ke= 0.200 Inlet / Outlet Invert= 507.59' / 507.38' S= 0.0049 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=0.53 cfs @ 12.16 hrs HW=508.07' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.53 cfs @ 2.77 fps)

Summary for Subcatchment P1: EXCESS AREA

Runoff = 0.42 cfs @ 12.08 hrs, Volume= 0.045 af, Depth> 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 10 year Rainfall=6.02"

	Area (sf)	CN	Description
	4,834	74	>75% Grass cover, Good, HSG C
	927	80	>75% Grass cover, Good, HSG D
*	765	98	Pavement
	6,526	78	Weighted Average
	5,761		88.28% Pervious Area
	765		11.72% Impervious Area

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

Summary for Subcatchment P2: PARKING LOT

Runoff = 0.55 cfs @ 12.05 hrs, Volume= 0.065 af, Depth> 5.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 10 year Rainfall=6.02"

	Area (sf)	CN	Description
*	5,903	98	Pavement to stormceptor
	5,903		100.00% Impervious Area

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

Summary for Subcatchment P3: BUILDING

Runoff = 0.41 cfs @ 12.05 hrs, Volume= 0.048 af, Depth> 5.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 10 year Rainfall=6.02"

	Area (sf)	CN	Description
*	4,368	98	Building
	4,368		100.00% Impervious Area

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

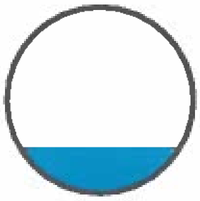
Summary for Reach 1R: PIPE

Inflow Area = 0.100 ac,100.00% Impervious, Inflow Depth > 5.78" for 10 year event
Inflow = 0.41 cfs @ 12.05 hrs, Volume= 0.048 af
Outflow = 0.40 cfs @ 12.06 hrs, Volume= 0.048 af, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Max. Velocity= 2.62 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 1.1 min

Peak Storage= 10 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.97 cfs

12.0" Round Pipe
n= 0.011
Length= 66.2' Slope= 0.0050 '/'
Inlet Invert= 508.18', Outlet Invert= 507.85'



Summary for Reach TOTAL: TOTAL

Inflow Area = 0.386 ac, 65.70% Impervious, Inflow Depth > 4.83" for 10 year event
Inflow = 1.29 cfs @ 12.12 hrs, Volume= 0.155 af
Outflow = 1.29 cfs @ 12.12 hrs, Volume= 0.155 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs

Summary for Pond CB: STORMCEPTOR WITH CB

Inflow Area = 0.236 ac,100.00% Impervious, Inflow Depth > 5.78" for 10 year event
Inflow = 0.95 cfs @ 12.06 hrs, Volume= 0.114 af
Outflow = 0.95 cfs @ 12.06 hrs, Volume= 0.114 af, Atten= 0%, Lag= 0.0 min
Primary = 0.95 cfs @ 12.06 hrs, Volume= 0.114 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 509.76' @ 12.06 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	509.06'	**8.0" Round Stormceptor** L= 62.2' Ke= 0.200 Inlet / Outlet Invert= 509.06' / 508.75' S= 0.0050 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=0.89 cfs @ 12.06 hrs HW=509.73' TW=508.49' (Dynamic Tailwater)
↑**1=Stormceptor** (Barrel Controls 0.89 cfs @ 3.16 fps)

Summary for Pond CULTEC: CULTEC

Inflow Area =	0.236 ac,100.00% Impervious,	Inflow Depth > 5.78"	for 10 year event	
Inflow =	0.95 cfs @ 12.06 hrs,	Volume=	0.114 af	
Outflow =	0.90 cfs @ 12.14 hrs,	Volume=	0.110 af,	Atten= 6%, Lag= 5.1 min
Primary =	0.90 cfs @ 12.14 hrs,	Volume=	0.110 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 508.52' @ 12.15 hrs Surf.Area= 458 sf Storage= 340 cf

Plug-Flow detention time= 37.0 min calculated for 0.109 af (96% of inflow)
Center-of-Mass det. time= 21.6 min (766.8 - 745.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	507.29'	289 cf	**18.33'W x 25.00'L x 2.04'H Field A** 936 cf Overall - 214 cf Embedded = 722 cf x 40.0% Voids
#2A	507.79'	214 cf	**Cultec C-100HD** x 15 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 5 rows
		503 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	507.85'	**8.0" Round Culvert** L= 11.4' Ke= 0.200 Inlet / Outlet Invert= 507.85' / 507.79' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=0.83 cfs @ 12.14 hrs HW=508.50' TW=508.23' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.83 cfs @ 3.04 fps)

Summary for Pond DMH: DMH

Inflow Area =	0.236 ac,100.00% Impervious,	Inflow Depth > 5.62"	for 10 year event	
Inflow =	0.90 cfs @ 12.14 hrs,	Volume=	0.110 af	
Outflow =	0.90 cfs @ 12.14 hrs,	Volume=	0.110 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.90 cfs @ 12.14 hrs,	Volume=	0.110 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 508.27' @ 12.14 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	507.59'	**8.0" Round Culvert** L= 42.7' Ke= 0.200 Inlet / Outlet Invert= 507.59' / 507.38' S= 0.0049 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=0.83 cfs @ 12.14 hrs HW=508.23' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.83 cfs @ 3.09 fps)

Summary for Subcatchment P1: EXCESS AREA

Runoff = 0.61 cfs @ 12.07 hrs, Volume= 0.065 af, Depth> 5.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 25 year Rainfall=7.76"

	Area (sf)	CN	Description
	4,834	74	>75% Grass cover, Good, HSG C
	927	80	>75% Grass cover, Good, HSG D
*	765	98	Pavement
	6,526	78	Weighted Average
	5,761		88.28% Pervious Area
	765		11.72% Impervious Area

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

Summary for Subcatchment P2: PARKING LOT

Runoff = 0.71 cfs @ 12.05 hrs, Volume= 0.085 af, Depth> 7.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 25 year Rainfall=7.76"

	Area (sf)	CN	Description
*	5,903	98	Pavement to stormceptor
	5,903		100.00% Impervious Area

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

Summary for Subcatchment P3: BUILDING

Runoff = 0.53 cfs @ 12.05 hrs, Volume= 0.063 af, Depth> 7.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 25 year Rainfall=7.76"

	Area (sf)	CN	Description
*	4,368	98	Building
	4,368		100.00% Impervious Area

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

Summary for Reach 1R: PIPE

Inflow Area = 0.100 ac,100.00% Impervious, Inflow Depth > 7.52" for 25 year event
Inflow = 0.53 cfs @ 12.05 hrs, Volume= 0.063 af
Outflow = 0.52 cfs @ 12.06 hrs, Volume= 0.063 af, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Max. Velocity= 2.83 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 1.0 min

Peak Storage= 12 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.97 cfs

12.0" Round Pipe
n= 0.011
Length= 66.2' Slope= 0.0050 '/'
Inlet Invert= 508.18', Outlet Invert= 507.85'

Summary for Reach TOTAL: TOTAL

Inflow Area = 0.386 ac, 65.70% Impervious, Inflow Depth > 6.51" for 25 year event
Inflow = 1.74 cfs @ 12.11 hrs, Volume= 0.209 af
Outflow = 1.74 cfs @ 12.11 hrs, Volume= 0.209 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs

Summary for Pond CB: STORMCEPTOR WITH CB

Inflow Area = 0.236 ac,100.00% Impervious, Inflow Depth > 7.52" for 25 year event
Inflow = 1.23 cfs @ 12.06 hrs, Volume= 0.148 af
Outflow = 1.23 cfs @ 12.06 hrs, Volume= 0.148 af, Atten= 0%, Lag= 0.0 min
Primary = 1.23 cfs @ 12.06 hrs, Volume= 0.148 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 510.09' @ 12.03 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	509.06'	**8.0" Round Stormceptor** L= 62.2' Ke= 0.200 Inlet / Outlet Invert= 509.06' / 508.75' S= 0.0050 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=1.13 cfs @ 12.06 hrs HW=510.01' TW=508.63' (Dynamic Tailwater)
↑**1=Stormceptor** (Barrel Controls 1.13 cfs @ 3.25 fps)

Summary for Pond CULTEC: CULTEC

Inflow Area =	0.236 ac,100.00% Impervious,	Inflow Depth > 7.52"	for 25 year event
Inflow =	1.23 cfs @ 12.06 hrs,	Volume=	0.148 af
Outflow =	1.16 cfs @ 12.14 hrs,	Volume=	0.145 af, Atten= 6%, Lag= 4.8 min
Primary =	1.16 cfs @ 12.14 hrs,	Volume=	0.145 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 508.67' @ 12.16 hrs Surf.Area= 458 sf Storage= 378 cf

Plug-Flow detention time= 30.8 min calculated for 0.143 af (97% of inflow)
Center-of-Mass det. time= 18.4 min (760.1 - 741.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	507.29'	289 cf	**18.33'W x 25.00'L x 2.04'H Field A** 936 cf Overall - 214 cf Embedded = 722 cf x 40.0% Voids
#2A	507.79'	214 cf	**Cultec C-100HD** x 15 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 5 rows
		503 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	507.85'	**8.0" Round Culvert** L= 11.4' Ke= 0.200 Inlet / Outlet Invert= 507.85' / 507.79' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=1.05 cfs @ 12.14 hrs HW=508.64' TW=508.39' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.05 cfs @ 3.01 fps)

Summary for Pond DMH: DMH

Inflow Area =	0.236 ac,100.00% Impervious,	Inflow Depth > 7.36"	for 25 year event
Inflow =	1.16 cfs @ 12.14 hrs,	Volume=	0.145 af
Outflow =	1.16 cfs @ 12.14 hrs,	Volume=	0.145 af, Atten= 0%, Lag= 0.0 min
Primary =	1.16 cfs @ 12.14 hrs,	Volume=	0.145 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 508.45' @ 12.14 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	507.59'	**8.0" Round Culvert** L= 42.7' Ke= 0.200 Inlet / Outlet Invert= 507.59' / 507.38' S= 0.0049 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=1.07 cfs @ 12.14 hrs HW=508.39' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 1.07 cfs @ 3.25 fps)

Summary for Subcatchment P1: EXCESS AREA

Runoff = 0.91 cfs @ 12.07 hrs, Volume= 0.098 af, Depth> 7.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 100 year Rainfall=10.60"

	Area (sf)	CN	Description
	4,834	74	>75% Grass cover, Good, HSG C
	927	80	>75% Grass cover, Good, HSG D
*	765	98	Pavement
	6,526	78	Weighted Average
	5,761		88.28% Pervious Area
	765		11.72% Impervious Area

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

Summary for Subcatchment P2: PARKING LOT

Runoff = 0.97 cfs @ 12.05 hrs, Volume= 0.117 af, Depth>10.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 100 year Rainfall=10.60"

	Area (sf)	CN	Description
*	5,903	98	Pavement to stormceptor
	5,903		100.00% Impervious Area

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

Summary for Subcatchment P3: BUILDING

Runoff = 0.72 cfs @ 12.05 hrs, Volume= 0.087 af, Depth>10.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Type III 24-hr 100 year Rainfall=10.60"

	Area (sf)	CN	Description
*	4,368	98	Building
	4,368		100.00% Impervious Area

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

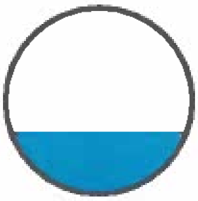
Summary for Reach 1R: PIPE

Inflow Area =	0.100 ac,100.00% Impervious,	Inflow Depth > 10.36"	for 100 year event	
Inflow =	0.72 cfs @ 12.05 hrs,	Volume=	0.087 af	
Outflow =	0.71 cfs @ 12.06 hrs,	Volume=	0.087 af,	Atten= 1%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Max. Velocity= 3.09 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.17 fps, Avg. Travel Time= 0.9 min

Peak Storage= 15 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.97 cfs

12.0" Round Pipe
n= 0.011
Length= 66.2' Slope= 0.0050 '/'
Inlet Invert= 508.18', Outlet Invert= 507.85'



Summary for Reach TOTAL: TOTAL

Inflow Area =	0.386 ac, 65.70% Impervious,	Inflow Depth > 9.27"	for 100 year event	
Inflow =	2.43 cfs @ 12.09 hrs,	Volume=	0.298 af	
Outflow =	2.43 cfs @ 12.09 hrs,	Volume=	0.298 af,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs

Summary for Pond CB: STORMCEPTOR WITH CB

Inflow Area =	0.236 ac,100.00% Impervious,	Inflow Depth > 10.36"	for 100 year event	
Inflow =	1.69 cfs @ 12.06 hrs,	Volume=	0.204 af	
Outflow =	1.69 cfs @ 12.06 hrs,	Volume=	0.204 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.69 cfs @ 12.06 hrs,	Volume=	0.204 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 510.69' @ 12.05 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	509.06'	**8.0" Round Stormceptor** L= 62.2' Ke= 0.200 Inlet / Outlet Invert= 509.06' / 508.75' S= 0.0050 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=1.57 cfs @ 12.06 hrs HW=510.55' TW=508.97' (Dynamic Tailwater)
↑**1=Stormceptor** (Barrel Controls 1.57 cfs @ 4.50 fps)

Summary for Pond CULTEC: CULTEC

Inflow Area = 0.236 ac,100.00% Impervious, Inflow Depth > 10.36" for 100 year event
Inflow = 1.69 cfs @ 12.06 hrs, Volume= 0.204 af
Outflow = 1.53 cfs @ 12.10 hrs, Volume= 0.200 af, Atten= 9%, Lag= 2.6 min
Primary = 1.53 cfs @ 12.10 hrs, Volume= 0.200 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 509.22' @ 12.23 hrs Surf.Area= 458 sf Storage= 483 cf

Plug-Flow detention time= 25.4 min calculated for 0.200 af (98% of inflow)
Center-of-Mass det. time= 15.1 min (753.3 - 738.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	507.29'	289 cf	**18.33'W x 25.00'L x 2.04'H Field A** 936 cf Overall - 214 cf Embedded = 722 cf x 40.0% Voids
#2A	507.79'	214 cf	**Cultec C-100HD** x 15 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 5 rows
		503 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	507.85'	**8.0" Round Culvert** L= 11.4' Ke= 0.200 Inlet / Outlet Invert= 507.85' / 507.79' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=1.07 cfs @ 12.10 hrs HW=509.03' TW=508.77' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.07 cfs @ 3.08 fps)

Summary for Pond DMH: DMH

Inflow Area = 0.236 ac,100.00% Impervious, Inflow Depth > 10.19" for 100 year event
Inflow = 1.53 cfs @ 12.10 hrs, Volume= 0.200 af
Outflow = 1.53 cfs @ 12.10 hrs, Volume= 0.200 af, Atten= 0%, Lag= 0.0 min
Primary = 1.53 cfs @ 12.10 hrs, Volume= 0.200 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.24 hrs
Peak Elev= 508.87' @ 12.10 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	507.59'	**8.0" Round Culvert** L= 42.7' Ke= 0.200 Inlet / Outlet Invert= 507.59' / 507.38' S= 0.0049 '/' Cc= 0.900 n= 0.011, Flow Area= 0.35 sf

Primary OutFlow Max=1.41 cfs @ 12.10 hrs HW=508.77' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 1.41 cfs @ 4.04 fps)

APPENDIX K:

SOIL REPORT FROM ECOTEC, INC

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 / Fax: 508-752-9494

July 21, 2023

Asaad Challab
3 Farrington Street
Worcester, MA

Re: 3 Farrington Street, Worcester, MA

Subject: Soil Evaluations

Dear Asaad:

On May 25, 2023 I evaluated soils, in two deep hole test pits, at the above-referenced property. Attached are logs of the soil profile descriptions as well as photos of the test pit locations and the soil profiles, plus a site plan section showing the location of the soil pits that were evaluated. I am a Certified Professional Soil Scientist and a Massachusetts Approved Soil Evaluator (see qualifications attached).

USDA-NRCS soil mapping for the project site indicates Paxton Fine Sandy Loams in the vicinity of the test pits. The Paxton soils formed in well drained, loamy till with a restrictive layer at depth. Paxton soils are typically found on the upper part of glacial drumlins.

Soils in test pit TP-1 consisted of relatively undisturbed, stony and friable sandy loams in the upper part over a dense glacial hardpan at 72-inches. The hardpan is restrictive to water infiltration and a seasonally saturated Cg horizon is found above the hardpan. Estimated seasonal high groundwater in TP-1, based on redoximorphic features, was noted at 41-inches (see soil logs). Soils in test pit TP-2 consisted of relatively undisturbed, stony and friable sandy loams in the upper part over a dense glacial hardpan at 45-inches. The hardpan is restrictive to water infiltration. Estimated seasonal high groundwater in TP-2, based on redoximorphic features, was noted at 45-inches (see soil logs).

Please do not hesitate to contact me if you have any questions concerning this or other matters.

Sincerely,

Arthur Allen, CPSS, CWS, Approved Soil Evaluator #13764
Vice President

Attachments: 3 (1-qualfication page, 1-soil log page, 2-photo pages)

AA/Soil/Worcester 3 Farrington Soil Report 7_21_2023

QUALIFICATIONS

Arthur Allen is the Vice President of EcoTec, Inc. and has been a senior environmental scientist there since 1995. His work with EcoTec has involved wetland delineation, wildlife habitat evaluation, environmental permitting (federal, state and local), environmental monitoring, expert testimony, peer reviews, contaminated site assessment and the description, mapping and interpretation of soils. His clients have included private landowners, developers, major corporations and regulatory agencies. Prior to joining EcoTec, Mr. Allen mapped and interpreted soils in Franklin County, MA for the U.S.D.A. Natural Resources Conservation Service (formerly Soil Conservation Service) and was a research soil scientist at Harvard University's Harvard Forest. Since 1994, Mr. Allen has assisted the Massachusetts Department of Environmental Protection and the Massachusetts Association of Conservation Commissions as an instructor in the interpretation of soils for wetland delineation and for the Title V Soil Evaluator program.

Mr. Allen has a civil service rating as a soil scientist, an undergraduate degree in Natural Resource Studies and a graduate certificate in Soil Studies. His work on the Franklin County soil survey involved interpretation of landscape-soil-water relationships, classifying soils and drainage, and determining use and limitation of the soil units that he delineated. As a soil scientist at the Harvard Forest, Mr. Allen was involved in identifying the legacies of historical land-use in modern soil and vegetation at a number of study sites across southern New England. He has a working knowledge of the chemical and physical properties of soil and water and how these properties interact with the plants that grow on a given site. While at Harvard Forest he authored and presented several papers describing his research results which were later published. In addition to his aforementioned experience, Mr. Allen was previously employed by the Trustees of Reservations as a land manager and by the Town of North Andover, MA as a conservation commission intern.

Education:
1993-Graduate Certificate in Soil Studies, University of New Hampshire
1982-Bachelor of Science in Natural Resource Studies, University of Massachusetts

Professional Affiliations:
Certified Professional Soil Scientist (ARCPACS CPSS #22529)
New Hampshire Certified Wetland Scientist (#19)
Registered Professional Soil Scientist – Society of Soil Scientists of SNE [Board Member (2000-2006)]
Certified Erosion, Sediment & Stormwater Inspector (#965)
Massachusetts Approved Soil Evaluator (#13764)
Massachusetts Arborists Association-Certified Arborist (1982 – 1998)
New England Hydric Soils Technical Committee member
Massachusetts Association of Conservation Commissions member
Society of Wetland Scientists member

Refereed Publications:
Soil Science and Survey at Harvard Forest. A.Allen. *In*: Soil Survey Horizons. Vol. 36, No. 4, 1995, pp. 133-142.
Controlling Site to Evaluate History: Vegetation Patterns of a New England Sand Plain. G.Motzkin, D.Foster, A.Allen, J.Harrod, & R.Boone. *In*: Ecological Monographs 66(3), 1996, pp. 345-365.
Vegetation Patterns in Heterogeneous Landscapes: The Importance of History and Environment. G.Motzkin, P.Wilson, D.R.Foster & A.Allen. In: Journal of Vegetation Science 10, 1999, pp. 903-920.

SITE: 3 Farrington St., Worcester, MA
TP-1 BY: Arthur Allen, SE 13764
DATE OF DESCRIPTION: 5/25/2023

HORIZON	DEPTH (in.)	MATRIX COLOR	REDOXIMORPHIC FEATURES color, abundance, size, contrast	USDA texture; nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.
A	0-10	10YR 3/2	none	Fine sandy loam Weak fine granular, very friable
Bw	10-41	10YR 5/6	None	Fine sandy loam Massive, Friable 2% gravel
Cg	41-72	2.5Y 5/2	5% 7.5YR 5/4	Stony fine sandy loam Massive, Friable 15% stone, 10% gravel, 5% cobbles
Cdg	72-84	2.5Y 4/2	20% 7.5YR 4/6	Stony fine sandy loam Sub-angular blocky, Firm 15% stone, 10% gravel, 10% cobbles

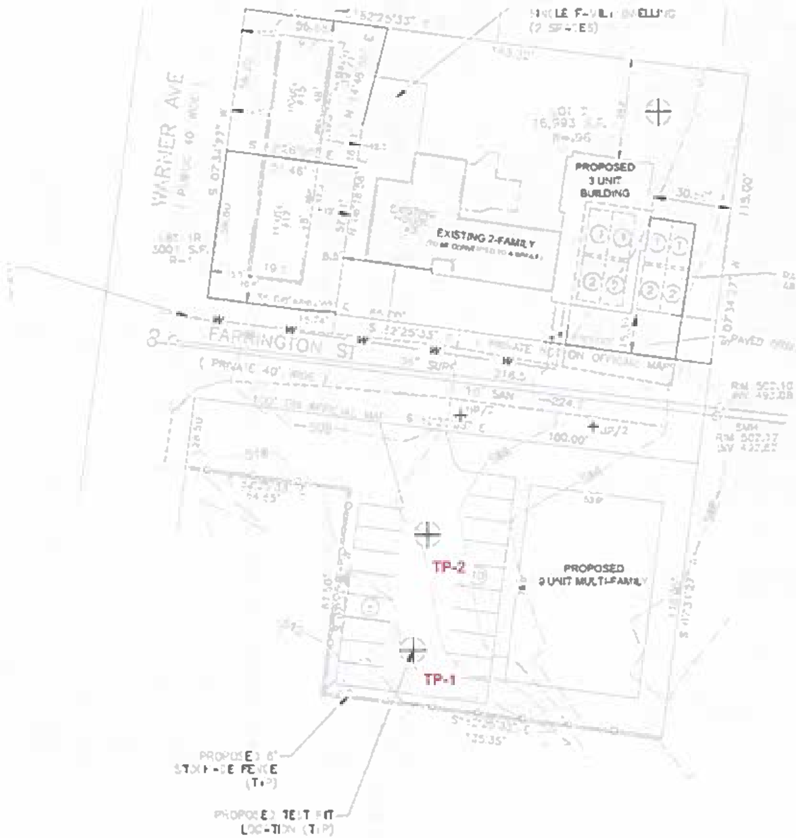
NOTES: Refusal at 84-inches due to hardpan. Estimated seasonal high groundwater at 41 inches.

SITE: 3 Farrington St., Worcester, MA
TP-2 BY: Arthur Allen, SE 13764
DATE OF DESCRIPTION: 5/25/2023

HORIZON	DEPTH (in.)	MATRIX COLOR	REDOXIMORPHIC FEATURES color, abundance, size, contrast	USDA texture; nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.
A	0-23	10YR 3/2	none	Fine sandy loam Weak fine granular, very friable
Bw	23-36	10YR 4/6	none	Fine sandy loam Massive, Friable 5% gravel
C	36-45	2.5Y 5/3	none	Fine sandy loam Massive, Very Friable 10% stone, 10% gravel, 5% cobbles
Cd	45-84	10YR 5/4	10% 7.5YR 5/6	Fine sandy loam Sub-angular blocky, Firm 10% stone, 5% gravel, 5% cobbles

NOTES: Hardpan (Cd) is restrictive to water infiltration. Estimated seasonal high groundwater at 45 inches.

SOIL EVALUATION PHOTOS TAKEN AT 3 FARRINGTON ST., WORCESTER, MA



1. Site plan section with test pits indicated

2. Test pit location overview

SOIL EVALUATION PHOTOS TAKEN AT 3 FARRINGTON ST., WORCESTER, MA

3 Test Pit TP-1

4 Test Pit TP-2

APPENDIX L:

Groundwater Mounding Calculations

The equation representing the groundwater mound beneath a rectangular recharge area is given by:

$$h_m^2 - h_i^2 = (2w/K)vtS^*((0.5L/(\sqrt{4vt})),(0.5W/(\sqrt{4vt})))$$

where:

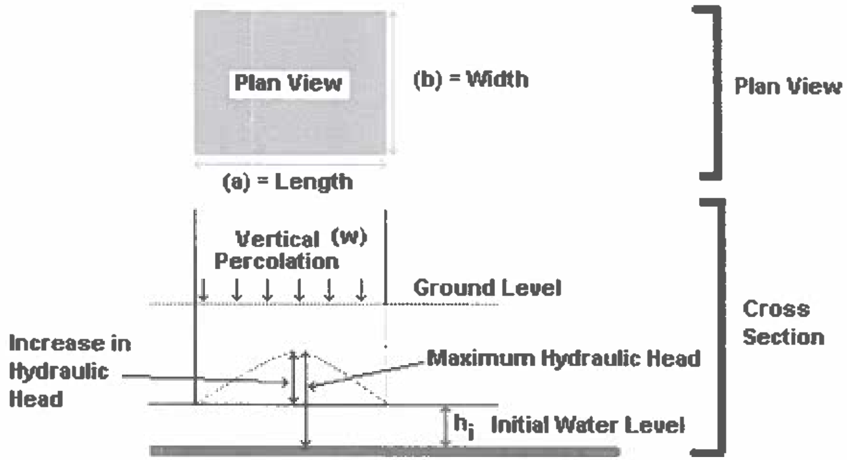
$$v = K\bar{b}/\varepsilon$$

$$\bar{b} = 0.5(h_i(0) + h(t))$$

where h_m is the maximum height of the mound; h_i is the initial height of the water table; w is the recharge or percolation rate; K is the hydraulic conductivity; t is the time of interest; L and W are the length and width of the rectangular recharge area, and ε is the specific yield of the aquifer. S* is an integral equation given by:

$$S^*(\alpha,\beta) = \int_0^1 \operatorname{erf}\left(\frac{\alpha}{\sqrt{\tau}}\right) \bullet \operatorname{erf}\left(\frac{\beta}{\sqrt{\tau}}\right) d\tau$$

This equation is estimated in the calculator by using a table of values given by Hantush (1967).



GROUNDWATER MOUND UNDER A RECTANGULAR RECHARGE AREA Using the Hantush (1967) Derivation

Inputs

w* (*Percolation Rate*):** .91 **[L/T]*K* (*Hydraulic Conductivity*):** .54 **[L/T]*S

(Specific Yield): .25 **[-]*t*(Time):** 1 **[T]h_i**

(Initial Saturated Thickness): 3.75 **[L]*a* (*Length of Recharge Area*):** 25 **[L]*b***

(Width of Recharge Area): 15 **[L]**

****KEEP UNITS CONSISTENT****

Calculate

Results

****Note that because of estimations of an integral function, this is an estimate****

Maximum hydraulic head: 7.18204291 **[L]Increase in hydraulic head:** 3.43204291 **[L]**

APPENDIX M:

USGS Map

USGS

Property Tax Parcels
USGS Topographic Maps