SITE LOCUS: N.T.S.

101 KINGSTON COLLECTION WAY  
KINGSTON, MASSACHUSETTS  
DRAINAGE REPORT

DATE PREPARED: JANUARY 24, 2020

APPLICANT:
TRAMMELL CROW RESIDENTIAL  
2276 WASHINGTON STREET, SUITE 100  
NEWTON LOWER FALLS, MA 02462

PREPARED BY:  
ALLEN & MAJOR ASSOCIATES, INC.  
100 COMMERCE WAY, SUITE 5  
WOBURN, MASSACHUSETTS 01801

A&M PROJECT NO.: 2280-05
DRAINAGE REPORT

101 KINGSTON COLLECTION WAY
KINGSTON, MA

PROPOSED BY:
TRAMMELL CROW RESIDENTIAL
2276 WASHINGTON STREET, SUITE 100
NEWTON LOWER FALLS, MA 02462

PREPARED BY:
ALLEN & MAJOR ASSOCIATES, INC.
100 COMMERCE WAY, SUITE 5
WOBURN, MA 01801

DATE ISSUED: JANUARY 24, 2020

A&M PROJECT #2280-05
# Table of Contents

## 1. Drainage Report

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>1-1</td>
</tr>
<tr>
<td>Introduction</td>
<td>1-2</td>
</tr>
<tr>
<td>Site Categorization for Stormwater Regulations</td>
<td>1-2</td>
</tr>
<tr>
<td>Site Location and Access</td>
<td>1-2</td>
</tr>
<tr>
<td>Existing Site Conditions</td>
<td>1-3</td>
</tr>
<tr>
<td>Existing Soil Conditions</td>
<td>1-3</td>
</tr>
<tr>
<td>FEMA Floodplain</td>
<td>1-3</td>
</tr>
<tr>
<td>Drainage Analysis Methodology</td>
<td>1-3</td>
</tr>
<tr>
<td>Peak Rate of Runoff</td>
<td>1-4</td>
</tr>
<tr>
<td>MA DEP Stormwater Performance Standards</td>
<td>1-4</td>
</tr>
</tbody>
</table>

## 2. Operation & Maintenance Plan

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>2-1</td>
</tr>
<tr>
<td>Introduction</td>
<td>2-2</td>
</tr>
<tr>
<td>Notification Procedures for Change of Responsibility for O&amp;M</td>
<td>2-2</td>
</tr>
<tr>
<td>Contact Information</td>
<td>2-2</td>
</tr>
<tr>
<td>Construction Period</td>
<td>2-3</td>
</tr>
<tr>
<td>Long Term Pollution Prevention Plan</td>
<td>2-4</td>
</tr>
<tr>
<td>Housekeeping</td>
<td>2-4</td>
</tr>
<tr>
<td>Storing of Materials and Waste Products</td>
<td>2-4</td>
</tr>
<tr>
<td>Vehicle Washing</td>
<td>2-4</td>
</tr>
<tr>
<td>Spill Prevention and Response</td>
<td>2-4</td>
</tr>
<tr>
<td>Maintenance of Lawns, Gardens and Other Landscaped Areas</td>
<td>2-5</td>
</tr>
<tr>
<td>Storage and Use of Herbicides and Pesticides</td>
<td>2-6</td>
</tr>
<tr>
<td>Pet Waste Management</td>
<td>2-7</td>
</tr>
<tr>
<td>Operations and Management of Septic Systems</td>
<td>2-8</td>
</tr>
<tr>
<td>Management of Deicing Chemicals and Snow</td>
<td>2-8</td>
</tr>
<tr>
<td>Long Term Maintenance Plan – Facilities Description</td>
<td>2-8</td>
</tr>
<tr>
<td>Stormwater Collection System – On Site</td>
<td>2-8</td>
</tr>
<tr>
<td>Proprietary Separators</td>
<td>2-8</td>
</tr>
<tr>
<td>Inspection and Maintenance Frequency and Corrective Measures</td>
<td>2-10</td>
</tr>
<tr>
<td>Supplemental Information</td>
<td>2-10</td>
</tr>
</tbody>
</table>

## 3. HydroCAD Worksheets

### Existing Conditions

## 4. HydroCAD Worksheets

### Proposed Conditions

## 5. Appendix

### Rainfall Data

### Manning Number Tables

### Soils Map

### FEMA Flood Map

### ConTech Water Quality Flow Calculation

### ConTech WQU Sizing Spreadsheets

## 7. Watershed Plans

### EWS

### Existing Watershed Plan
8. **Plan Set (Under Separate Cover)**
Section 1.0  Drainage Report

Table of Contents

SECTION 1.0  DRAINAGE REPORT .......................................................................................... 1-1

TABLE OF CONTENTS .................................................................................................................. 1-1

- INTRODUCTION .................................................................................................................. 1-2
- SITE CATEGORIZATION FOR STORMWATER REGULATIONS ........................................ 1-2
- SITE LOCATION AND ACCESS ......................................................................................... 1-2
- EXISTING SITE CONDITIONS .......................................................................................... 1-3
- EXISTING SOIL CONDITIONS .......................................................................................... 1-3
- FEMA FLOODPLAIN ......................................................................................................... 1-3
- DRAINAGE ANALYSIS METHODOLOGY ........................................................................ 1-3
- PEAK RATE OF RUNOFF ................................................................................................... 1-4
- MA DEP STORMWATER PERFORMANCE STANDARDS ................................................ 1-4
INTRODUCTION
The purpose of this drainage report is to provide an overview of the proposed stormwater management system for the proposed site redevelopment at 101 Kingston Collection Way, Kingston MA. The report will show by means of narrative, calculations and exhibits that the project meets DEP and the Town of Kingston’s Stormwater Management Regulations.

The proposed site improvements include the removal of the existing Sears building and parking lot within the limits of the proposed property line. The existing pavement within Independence Mall Way will remain. Additional site preparations include removing the majority of existing drainage lines and structures on site. A portion of the existing 54” and 24” RCP drains shall remain and be connected to proposed manhole structures along with several existing catch basins, see Demolition and Grading & Drainage Plan.

The existing 54” CMP handles surface runoff from the existing site and discharges to the offsite Stormwater Retention Basin #1. This 54” CMP will be utilized under proposed conditions as an outlet for all surface runoff from the proposed site improvements. The existing 24” RCP handles only roof runoff from the existing Sears building and discharges to an offsite Stormwater Retention Basin (not shown on Existing Conditions Plan). Under proposed conditions, the majority of roof runoff from the proposed building will be connected to this 24” RCP; the contributing roof surface area will not be increased under proposed conditions.

The proposed stormwater management system (SMS) incorporates structural and non-structural BMPs to provide stormwater quality treatment and conveyance. The SMS includes roof drains, drain manholes, underground piping, deep sump catch basins with outlet hoods, area drains, and water quality units (proprietary separators).

The primary mechanisms to address the peak rate and volume of runoff from the site redevelopment is from the reduction in the total impervious area. The proposed redevelopment plan will reduce the impervious area by approximately 3 acres with the installation of new landscaped areas. The result is a reduction in the rate and volume of stormwater runoff to the offsite retention ponds.

SITE CATEGORIZATION FOR STORMWATER REGULATIONS
Due to the reduction in impervious area the proposed project is considered a redevelopment under the Massachusetts Stormwater Handbook. A “redevelopment” project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions. See the discussion of Stormwater Management Standards that follows.

SITE LOCATION AND ACCESS
The site is a single lot with proposed frontage along Kingston Collection Way, entirely within the Town of Kingston. Access to the site will be provided off of Independence Mall Way. Independence Mall Way also provides access to the existing mall building which will be maintained under proposed conditions.
EXISTING SITE CONDITIONS
The existing Sears building is located at the southwest end of the proposed property. All surrounding topography slopes away from the building towards Independence Mall Way at the perimeter of the site dropping approximately 4’ in elevation. The majority of the site is an existing parking lot and comprised of impervious cover with some small landscaped islands.

The majority of the site is connected to the underground drainage system through a series of catch basins and manholes that outlet into a 54” CMP that discharges directly to Stormwater Retention Basin #1 located offsite to the northwest. Roof runoff from the existing Sears Building outlet to a 24” RCP that discharges directly to an offsite retention basin (not shown on Existing conditions Plan) located southeast of the proposed development.

The surface drainage flows have been analyzed at two (2) Study Points. Study Point #1 is the summation of onsite surface and roof runoff to the existing 54” CMP at the northwest corner of the site. Study Point #2 is the summation of roof runoff from the site to the 24” RCP.

EXISTING SOIL CONDITIONS
The on-site soils have been identified utilizing the USDA Natural Resources Conservation Services (NRCS) Soil Survey for Middlesex County. The site is primarily soil type 602 – Urban Land. Urban Land building and pavement cover 75 percent or more of the surface area. A copy of the soil map is included in the appendix of this report.

The proposed stormwater management system does not propose any new surface or subsurface infiltration basins and the proposed condition of the site will introduce approximately 3 acres of pervious surfaces. Therefore, classifying the hydrologic soil type is not critical for the design so long as it remains consistent between existing and proposed conditions when analyzing peak rate and volume of runoff. For purposes of this design, a Hydrologic Soil Group “B” designation has been used throughout.

FEMA FLOODPLAIN
The site is located within the FEMA Zone “X” Area of Minimal Flood Hazard. Zone “X” is the area determined to be outside the 500-year flood. The official Flood Insurance Rate Map (FIRM) is dated November 4, 2016, community panel 25023C0352K. A copy of this map is provided in the appendix of this report.

DRAINAGE ANALYSIS METHODOLOGY
A peak rate of runoff has been determined using techniques and data found in the following:

1. Urban Hydrology for Small Watersheds – Technical Release 55 by the United States Department of Agriculture Soils Conservation Service, June 1986. Runoff curve numbers and 24-hour precipitation values were obtained from this reference.

2. HydroCAD® Stormwater Modeling System by HydroCAD Software Solutions LLC, version 10.00, 2018. The HydroCAD program was used to generate the runoff hydrographs for the watershed areas, to determine discharge/stage/storage characteristics for the stormwater BMPs, to perform drainage routing and to combine the results of the runoff hydrographs. HydroCAD uses the TR-20 methodology of the SCS Unit Hydrograph procedure (SCS-UH).

3. Soil Survey of Middlesex County Massachusetts by United States Department of Agriculture, NRCS. Soil types and boundaries were obtained from this reference.
DRAINAGE REPORT
101 Kingston Collection Way  A&M Project # 2280-05
Kingston, MA

- **PEAK RATE OF RUNOFF**
  A storm water runoff analysis has been prepared for both the existing and proposed conditions and includes an estimate of the peak rate of runoff and total runoff volume from various rainfall events. Peak runoff rates have been developed using TR-55 Urban Hydrology for Small Watersheds, developed by the U.S. Department of Commerce, Engineering Division and the HydroCAD 10.00 computer program. The peak rate and volume of runoff will be estimated for each watershed during the 2, 10, and 100-year storm events.

The stormwater runoff model indicates that the proposed site redevelopment reduces the rate and volume of runoff during all storm events at the identified points of analysis. The following tables provide a summary of the estimated peak rate, in Cubic Feet per Second (CFS) and total runoff volume, in acre-feet (AF) at each of the two (2) Study Points for each of the design storm events. The HydroCAD worksheets are included in Section 3 and 4 of this report.

**STUDY POINT #1 (Flow to Existing 54” CMP)**

<table>
<thead>
<tr>
<th></th>
<th>2-Year</th>
<th>10-Year</th>
<th>100-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Runoff (CFS)</td>
<td>23.03</td>
<td>32.72</td>
<td>49.67</td>
</tr>
<tr>
<td>Redeveloped Runoff (CFS)</td>
<td>14.86</td>
<td>24.47</td>
<td>42.03</td>
</tr>
<tr>
<td><strong>DECREASE</strong></td>
<td>8.17</td>
<td>8.25</td>
<td>7.64</td>
</tr>
<tr>
<td>Existing Volume (AF)</td>
<td>1.897</td>
<td>2.746</td>
<td>4.245</td>
</tr>
<tr>
<td>Redeveloped Volume (AF)</td>
<td>1.142</td>
<td>1.891</td>
<td>3.313</td>
</tr>
<tr>
<td><strong>DECREASE</strong></td>
<td>0.755</td>
<td>0.855</td>
<td>0.932</td>
</tr>
</tbody>
</table>

**STUDY POINT #2 (Flow to 24” RCP)**

<table>
<thead>
<tr>
<th></th>
<th>2-Year</th>
<th>10-Year</th>
<th>100-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Runoff (CFS)</td>
<td>5.22</td>
<td>7.26</td>
<td>10.85</td>
</tr>
<tr>
<td>Redeveloped Runoff (CFS)</td>
<td>5.08</td>
<td>7.07</td>
<td>10.56</td>
</tr>
<tr>
<td><strong>DECREASE</strong></td>
<td>0.14</td>
<td>0.19</td>
<td>0.29</td>
</tr>
<tr>
<td>Existing Volume (AF)</td>
<td>0.450</td>
<td>0.630</td>
<td>0.948</td>
</tr>
<tr>
<td>Redeveloped Volume (AF)</td>
<td>0.438</td>
<td>0.614</td>
<td>0.924</td>
</tr>
<tr>
<td><strong>DECREASE</strong></td>
<td>0.012</td>
<td>0.016</td>
<td>0.024</td>
</tr>
</tbody>
</table>

- **MA DEP STORMWATER PERFORMANCE STANDARDS**
  The MA DEP Stormwater Management Policy was developed to improve water quality by implementing performance standards for storm water management. The following section outlines how the proposed Stormwater Management System meets the standards set forth by the Policy.

BMP’s implemented in the design include:
- Deep sump Catch Basins
- Hydro-dynamic (Proprietary) Separators

Stormwater Best Management Practices have been incorporated into the design of the project to mitigate the anticipated pollutant loading. The stormwater management system incorporates structural and non-structural BMP’s to provide stormwater quality treatment and conveyance.

Temporary erosion and sedimentation controls will be incorporated into the construction phase of the project. These temporary controls may include straw bale and/or silt fence barriers, inlet sediment traps, diversion channels, slope stabilization, and stabilized construction entrances.
The Massachusetts Department of Environmental Protection has established ten (10) Stormwater Management Standards. A project that meets or exceeds the standards is presumed to satisfy the regulatory requirements regarding stormwater management. The Standards are enumerated below as well as a description as to how the Project will comply with the 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 proposed redevelopment will not introduce any new outfalls with direct discharge to a wetland area or waters of the Commonwealth of Massachusetts. All discharges will be treated for water quality and the rate will not be increased over existing conditions.

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

   The proposed development has been designed so that the post-development peak discharge rates do not exceed the predevelopment peak discharge rates. A summary of the existing and proposed discharge rates is included within this document.

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

   No subsurface infiltration systems are proposed as part of the redevelopment. The proposed site improvements are classified as a “redevelopment” under the MA DEP Stormwater Management Standards. Consequently, compliance with Standard #3 is to the maximum extent practicable. However, the pre-development annual recharge has been approximated in the post-developed condition. This is accomplished by the reduction of the impervious area.

   \[
   \begin{align*}
   \text{Existing impervious area} & \quad = 9.653\pm \text{acres} \\
   \text{Proposed impervious area} & \quad = 6.634\pm \text{acres} \\
   \text{Change in impervious area} & \quad = 3.019\pm \text{acres}
   \end{align*}
   \]

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

   \[
   \begin{align*}
   a. & \quad \text{Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;} \\
   b. & \quad \text{Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and} \\
   c. & \quad \text{Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.}
   \end{align*}
   \]
The site is classified as a “redevelopment” under the MA DEP Stormwater Management Standards. Consequently, compliance with Standard #4 is to the maximum extent practicable. Standard #4 is met when structural stormwater best management practices are sized to capture and treat the required water quality volume and pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

The water quality volume for the site redevelopment is captured and treated using deep sump catch basins (with hoods) and a hydro-dynamic (proprietary) separator. The water quality volume (WQV) for runoff discharging to the existing 54” CMP is captured in deep sump catch basins (with hoods) and routed through an offline proprietary separator. Consequently, there is a conversion of WQV to a peak water quality flow (WQF) rate. The MA DEP has adopted a computational method for this conversion. The proposed proprietary separator has been sized to meet the water quality flow rate for the 1” storm event. Supporting calculations by Contech are provided in the Appendix of this report.

The TSS removal efficiencies for the proprietary separator are based on the values assigned under the Technology Acceptance and Reciprocity Partnership (TARP) testing protocol. The TARP is a workgroup of the Environmental Council of States that was originally comprised of California, Illinois, Maryland, Massachusetts, New Jersey, New York, Pennsylvania and Virginia. TARP is recognized in the MA DEP Stormwater Management Handbook as a valid source for assigning TSS removal efficiencies for proprietary separators.

### FLOW TO EXISTING 54” CMP OUTLET PIPE

<table>
<thead>
<tr>
<th>BMP</th>
<th>TSS Removal Rate</th>
<th>Starting TSS Load</th>
<th>Amount Removed</th>
<th>Remaining TSS Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Sump Catch Basin</td>
<td>0.25</td>
<td>1.00</td>
<td>0.25</td>
<td>0.75</td>
</tr>
<tr>
<td>Proprietary Separator</td>
<td>0.80</td>
<td>0.75</td>
<td>0.60</td>
<td>0.15</td>
</tr>
</tbody>
</table>

TOTAL TSS REMOVAL 0.85 or 85.00%

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

The site is considered a source of higher potential pollutant loads because it is anticipated that the project will generate greater than 1,000 vehicle trips per day. Pretreatment and Source reduction is provided to the maximum extent practicable. The drainage system will be designed to treat 1” water quality volume.

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

The project site does discharge a portion of stormwater within a Zone II or Interim Wellhead Protection Area or near a critical area. Critical Areas are Outstanding Resource Waters as designated in 314 CMR 4.00, Special Resource Waters as designated in 314 CMR 4.00, recharge areas for public water supplies as defined in 310 CMR 22.02, bathing beaches as defined in 105 CMR 445.000, cold-water fisheries as defined in 314 CMR 9.02 and 310 CMR 10.04, and shellfish growing areas as defined in 314 CMR 9.02 and 310 CMR 10.04.

All surface runoff (excluding roof) from the proposed site will be captured and discharged outside the Zone II. The existing roof of the Sears building is collected and routed through a 24” RCP pipe that discharges into an existing retention basin located within the Zone II. Under proposed conditions, roof runoff from the proposed building will continue to be collected and routed through this same 24” RCP. Roof runoff is considered “clean” under the MA Stormwater Regulations.

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

The proposed project is considered a redevelopment under the MA DEP Stormwater Management Standards as there is a decrease in the amount of total impervious area.

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.

A plan to control construction-related impacts, including erosion, sedimentation and other pollutant sources during construction and land disturbance activities has been developed. A detailed Erosion and Sedimentation Control Plan is included in the Permit Drawings. The proponent will prepare and submit a Stormwater Pollution Prevention Plan (SWPPP) prior to commencement of construction activities that will result in the disturbance of one acre of land or more.

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

A Long-Term Operation and Maintenance (O&M) Plan has been developed for the proposed stormwater management system and can be found within this drainage report.
10. *All illicit discharges to the stormwater management system are prohibited.*

There are no expected illicit discharges to the stormwater management system. The applicant will submit the Illicit Discharge Compliance Statement prior to the discharge of stormwater runoff to the post-construction stormwater best management practices and prior to the issuance of a Certificate of Compliance.
# Section 2.0 Operation & Maintenance Plan

## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Table of Contents</td>
<td>2-1</td>
</tr>
<tr>
<td>2.2</td>
<td>INTRODUCTION</td>
<td>2-2</td>
</tr>
<tr>
<td>2.3</td>
<td>NOTIFICATION PROCEDURES FOR CHANGE OF RESPONSIBILITY FOR O&amp;M</td>
<td>2-2</td>
</tr>
<tr>
<td>2.4</td>
<td>CONTACT INFORMATION</td>
<td>2-2</td>
</tr>
<tr>
<td>2.5</td>
<td>CONSTRUCTION PERIOD</td>
<td>2-3</td>
</tr>
<tr>
<td>2.6</td>
<td>LONG TERM POLLUTION PREVENTION PLAN</td>
<td>2-4</td>
</tr>
<tr>
<td></td>
<td>HOUSEKEEPING</td>
<td>2-4</td>
</tr>
<tr>
<td></td>
<td>STORING OF MATERIALS AND WASTE PRODUCTS</td>
<td>2-4</td>
</tr>
<tr>
<td></td>
<td>VEHICLE WASHING</td>
<td>2-4</td>
</tr>
<tr>
<td></td>
<td>SPILL PREVENTION AND RESPONSE</td>
<td>2-4</td>
</tr>
<tr>
<td></td>
<td>MAINTENANCE OF LAWNS, GARDENS, AND OTHER LANDSCAPED AREAS</td>
<td>2-5</td>
</tr>
<tr>
<td></td>
<td>STORAGE AND USE OF HERBICIDES AND PESTICIDES</td>
<td>2-6</td>
</tr>
<tr>
<td></td>
<td>PET WASTE MANAGEMENT</td>
<td>2-7</td>
</tr>
<tr>
<td></td>
<td>OPERATIONS AND MANAGEMENT OF SEPTIC SYSTEMS</td>
<td>2-8</td>
</tr>
<tr>
<td></td>
<td>MANAGEMENT OF DEICING CHEMICALS AND SNOW</td>
<td>2-8</td>
</tr>
<tr>
<td>2.7</td>
<td>LONG TERM MAINTENANCE PLAN – FACILITIES DESCRIPTION</td>
<td>2-8</td>
</tr>
<tr>
<td></td>
<td>STORMWATER COLLECTION SYSTEM – ON SITE</td>
<td>2-8</td>
</tr>
<tr>
<td></td>
<td>PROPRIETARY SEPARATORS</td>
<td>2-8</td>
</tr>
<tr>
<td>2.8</td>
<td>INSPECTION AND MAINTENANCE FREQUENCY AND CORRECTIVE MEASURES</td>
<td>2-8</td>
</tr>
<tr>
<td>2.9</td>
<td>SUPPLEMENTAL INFORMATION</td>
<td>2-10</td>
</tr>
<tr>
<td>2.10</td>
<td>PROPOSED OPERATIONS AND MAINTENANCE LOG FORM</td>
<td>2-10</td>
</tr>
</tbody>
</table>
**INTRODUCTION**

In accordance with the standards set forth by the Stormwater Management Policy issued by the Department of Environmental Protection (DEP), Allen & Major Associates, Inc. has prepared the following Operation and Maintenance Plan for the redevelopment project located at 101 Kingston Collection Way, Kingston, MA.

The plan is broken down into three major sections. The first section describes construction-related erosion and sedimentation controls (Construction Period). The second section describes the long-term pollution prevention measures (Long Term Pollution Prevention Plan). The third section is a post-construction operation and maintenance plan designed to address the long-term maintenance needs of the stormwater management system (Long Term Maintenance Plan).

**NOTIFICATION PROCEDURES FOR CHANGE OF RESPONSIBILITY FOR O&M**

The Stormwater Management System (SMS) for this project is owned by Trammell Crow Residential (owner). The owner shall be legally responsible for the long-term operation and maintenance of this SMS as outlined in this Operation and Maintenance (O&M) Plan.

The project owner shall submit an annual summary report and the completed Operation & Maintenance Schedule & Checklist to the Conservation Commission (via email or print copy), highlighting inspection and maintenance activities including performances of BMPs. Should ownership of the SMS change, the owner will continue to be responsible until the succeeding owner shall notify the Commission that the succeeding owner has assumed such responsibility. Upon subsequent transfers, the responsibility shall continue to be that of transferring owner until the transferee owner notifies the Commission of its assumption of responsibility.

In the event the SMS will serve multiple lots/owners, such as the subdivision of the existing parcel or creation of lease areas, the owner(s) shall establish an association on other legally enforceable arrangements under which the association or a single party shall have legal responsibility for the operation and maintenance of the entire SMS. The legal instrument creating such responsibility shall be recorded with the Registry of Deeds and promptly following its recording, a copy thereof shall be furnished to the Commission.

**CONTACT INFORMATION**

Stormwater Management System Owner: Trammell Crow Residential
2276 Washington Street, Suite 100
Newton Lower Falls, MA 02462
Phone: 781-489-3229

Emergency Contact Information:

- Trammell Crow Residential (owner/operator) Phone (781) 489-3229
- Allen & Major Associates, Inc. (Site Civil Engineer) Phone (781) 935-6889
- Kingston Public Works Phone (781) 585-0500
- Kingston Fire Department (non-emergency line) Phone (781) 585-0532
- DEP Emergency Response (Mass DEP) Phone (888) 304-1133
CONSTRUCTION PERIOD

1. Prior to the commencement of any site work, the Applicant and general contractor shall meet with the Town Planner, Building Inspector, and the Board’s Consulting Engineer in order to establish a construction phasing schedule and designated construction route.

2. Install Erosion Control measures as shown on the Erosion Control Plan prepared by A&M. The Kingston Conservation agent shall approve the installation of tubular barriers prior to the start of any site demolition work. Install Construction fencing if determined to be necessary at the commencement of construction.

3. Install construction entrances and tubular barriers at the locations shown on the Erosion Control Plan prepared by A&M.

4. Site access shall be achieved only from the designated construction entrances.

5. Stockpiles of materials subject to erosion shall be stabilized with erosion control matting or temporary seeding whenever practicable, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased.

6. Install silt sacks and hay bales around each drain inlet prior to any demolition and or construction activities.

7. All erosion control measures shall be inspected weekly and after every rainfall event. Records of these inspections shall be kept on site for review by the Town of Kingston.

8. All erosion control measures shall be maintained, repaired or replaced as required or at the direction of the owner’s engineer, the Town Engineer, or the Town Conservation Agent.

9. Sediment accumulation up-gradient of the hay bales, silt fence, and stone check dams greater than 6” in depth shall be removed and disposed of in accordance with all applicable regulations.

10. If it appears that sediment is exiting the site, silt sacks shall be installed in all catch basins adjacent to the site. Sediment accumulation on all adjacent catch basin inlets shall be removed and the silt sack replaced if torn or damaged.

11. Install stone check dams on site during construction as needed. Temporary sediment basins combined with stone check dams shall be installed on site during construction to control and collect runoff from upland areas of this site during demolition and construction activities.

12. The contractor shall comply with the Sedimentation and Erosion Control Notes as shown on the Site Development Plans and Specifications.

13. The stabilized construction entrances shall be inspected weekly and records of inspections kept. The entrances shall be maintained by adding additional clean, angular, durable stone to remove the soil from the construction vehicle’s tires when exiting the site. If soil is still leaving the site via the construction vehicle tires, adjacent roadways shall be kept clean by street sweeping.

14. Dust pollution shall be controlled using on-site water trucks and or an approved soil stabilization product.
15. During demolition and construction activities Status Reports on compliance with this O&M Document shall be submitted weekly to the Conservation agent. The report shall document any deficiencies and corrective actions taken by the applicant.

- **LONG TERM POLLUTION PREVENTION PLAN**

  Standard #4 from the MA DEP Stormwater Management Handbook requires that a Long-Term Pollution Prevention Plan (LTPPP) be prepared and incorporated as part of the Operation and Maintenance of the Stormwater Management System. The purpose of the LTPPP is to identify potential sources of pollution that may affect the quality of stormwater discharges, and to describe the implementation of practices to reduce the pollutants in stormwater discharges. The following items describe the source control and proper procedures for the LTPPP.

  o **HOUSEKEEPING**

     The proposed site development will be designed to maintain a high level of water quality treatment for all stormwater discharge to the resource areas. An Operation and Maintenance (O&M) plan has been prepared and is included in this section of the report. The owner (or its designee) is responsible for adherence to the O&M plan in a strict and complete manner.

  o **STORING OF MATERIALS AND WASTE PRODUCTS**

     There are proposed fenced-in exterior dumpster storage areas. The trash and waste program for the site includes interior trash chutes and exterior dumpsters. There will be a trash contractor used to pick up the waste material in the dumpsters. The stormwater drainage system has water quality inlets designed to capture trash and debris.

  o **VEHICLE WASHING**

     Outdoor vehicle washing has the potential to result in high loads of nutrients, metals, and hydrocarbons during dry weather conditions, as the detergent-rich water used to wash the grime off the vehicle enters the stormwater drainage system. The proposed project does not include any designated vehicle washing areas, nor is it expected that any vehicle washing will take place on-site.

  o **SPILL PREVENTION AND RESPONSE**

     Sources of potential spill hazards include vehicle fluids, liquid fuels, pesticides, paints, solvents, and liquid cleaning products. The majority of the spill hazards would likely occur within the building and would not enter the stormwater drainage system. However, there are spill hazards from vehicle fluids or liquid fuels located outside of the buildings. These exterior spill hazards have the potential to enter the stormwater drainage system and are to be addressed as follows:

     1. Spill Hazards of pesticides, paints, and solvents shall be remediated using the Manufacturers’ recommended spill cleanup protocol.
     2. Vehicle fluids and liquid fuel spill shall be remediated according to the local and state regulations governing fuel spills.
     3. The owner shall have the following equipment and materials on hand to address a spill clean-up: brooms, dust pans, mops, rags, gloves, absorptive material, sand, sawdust, plastic and metal trash containers.
     4. All spills shall be cleaned up immediately after discovery
     5. Spills of toxic or hazardous material shall be reported, regardless of size, to the Massachusetts Department of Environmental Protection at 888-304-1133.
     6. Should a spill occur, the pollution prevention plan will be adjusted to include measures to prevent another spill of a similar nature. A description of the spill, along with the causes and cleanup measures will be included in the updated pollution prevention plan.
MAINTENANCE OF LAWNS, GARDENS, AND OTHER LANDSCAPED AREAS

It should be recognized that this is a general guideline towards achieving high quality and well-groomed landscaped areas. The grounds staff / landscape contractor must recognize the shortcomings of a general maintenance plan such as this, and modify and/or augment it based on weekly, monthly, and yearly observations. In order to assure the highest quality conditions, the staff must also recognize and appreciate the need to be aware of the constantly changing conditions of the landscaping and be able to respond to them on a proactive basis. No trees shall be planted over the drain lines or infiltration trenches, and that only shallow rooted plants and shrubs will be allowed.

- Fertilizer

Maintenance practices should be aimed at reducing environmental, mechanical and pest stresses to promote healthy and vigorous growth. When necessary, pest outbreaks should be treated with the most sensitive control measure available. Synthetic chemical controls should be used only as a last resort to organic and biological control methods. Fertilizer, synthetic chemical controls and pest management applications (when necessary) shall be performed only by licensed applicators in accordance with the manufacturer’s label instructions when environmental conditions are conducive to controlled product application.

Only slow-release organic fertilizers should be used in the planting and mulch areas to limit the amount of nutrients that could enter downstream resource areas. Fertilization of the planting and mulch areas will be performed within manufacturers labeling instructions and shall not exceed an NPK ratio of 1:1:1 (i.e. Triple 10 fertilizer mix), considered a low nitrogen mixture. Fertilizers approved for the use under this O&M Plan are as follows:

Type: LESCO® 28-0-12 (Lawn Fertilizer)
MERIT® 0.2 Plus Turf Fertilizer
MOMENTUM™ Force Weed & Feed

- Suggested Aeration Program

In-season aeration of lawn areas is good cultural practice, and is recommended whenever feasible. It should be accomplished with a solid thin tine aeration method to reduce disruption to the use of the area. The depth of solid tine aeration is similar to core type, but should be performed when the soil is somewhat drier for a greater overall effect.

Depending on the intensity of use, it can be expected that all landscaped lawn areas will need aeration to reduce compaction at least once per year. The first operation should occur in late May following the spring season. Methods of reducing compaction will vary based on the nature of the compaction. Compaction on newly established landscaped areas is generally limited to the top 2-3" and can be alleviated using hollow core or thin tine aeration methods.

The spring aeration should consist of two passes at opposite directions with 1/4" hollow core tines penetrating 3-5" into the soil profile. Aeration should occur when the soil is moist but not saturated. The soil cores should be shattered in place and dragged or swept back into the turf to control thatch. If desired the cores may also be removed and the area top-dressed with sand or sandy loam. If the area drains on average too slowly, the topdressing should contain a higher percentage of sand. If it is draining on average too quickly, the top dressing should contain a higher percentage of soil and organic matter.

- Landscape Maintenance Program Practices:
  - Lawn
1. Mow a minimum of once a week in spring, to a height of 2” to 2 1/2” high. Mowing should be frequent enough so that no more than 1/3 of grass blade is removed at each mowing. The top growth supports the roots; the shorter the grass is cut, the less the roots will grow. Short cutting also dries out the soil and encourages weeds to germinate.

2. Mow approximately once every two weeks from July 1st to August 15th depending on lawn growth.

3. Mow on a ten-day cycle in fall, when growth is stimulated by cooler nights and increased moisture.

4. Do not remove grass clippings after mowing.

5. Keep mower blades sharp to prevent ragged cuts on grass leaves, which cause a brownish appearance and increase the chance for disease to enter a leaf.

♦ **Shrubs**

1. Mulch not more than 3” depth with shredded pine or fir bark.

2. Hand prune annually, immediately after blooming, to remove 1/3 of the above-ground biomass (older stems). Stem removals to occur within 6” of the ground to open up shrub and maintain two-year wood (the blooming wood).

3. Hand prune evergreen shrubs only as needed to remove dead and damaged wood and to maintain the naturalistic form of the shrub. Never mechanically shear evergreen shrubs.

♦ **Trees**

1. Provide aftercare for new tree plantings for the first three years.

2. Do not fertilize trees, it artificially stimulates them (unless tree health warrants).

3. Water once a week for the first year; twice a month the second, once a month the third year.

4. Prune trees on a four-year cycle.

♦ **Invasive Species**

1. Inform the Conservation Commission Agent prior to the removal of invasive species proposed either through hand work or through chemical removal.

**Storage and Use of Herbicides and Pesticides**

Integrated Pest Management is the combination of all methods (of pest control) which may prevent, reduce, suppress, eliminate, or repel an insect population. The main requirements necessary to support any pest population are food, shelter and water, and any upset of the balance of these will assist in controlling a pest population. Scientific pest management is the knowledgeable use of all pest control methods (sanitation, mechanical, chemical) to benefit mankind's health, welfare, comfort, property and food. A Pest Management Professional (PMP) will be retained who is licensed with the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, Department of Agricultural Resources

The site manager will be provided with approved bulletin before entering into or renewing an agreement to apply pesticides for the control of indoor household or structural pests. 333 CMR 13.08.

Before beginning each application, the applicator must post a Department approved notice on all of the entrances to the treated room or area. The applicator must leave such notices posted after the application. The notice will be posted at conspicuous point(s) of access to the area treated. The location and number of signs will be determined by the configuration of the area to be treated based on the applicator’s best judgment. It is intended to give sufficient notice that no one comes into an area being treated unaware that the applicator is working and
pesticides are being applied. However, if the contracting entity does not want the signs posted, he/she may sign a Department approved waiver indicating this.

The applicator or employer will provide to any person upon their request the following information on previously conducted applications:

1. Name and phone number of pest control company
2. Date and time of the application;
3. Name and license number of the applicator
4. Target pests
5. Name and EPA Registration Number of pesticide products applied

Public Buildings - Applicators or their employers will provide pre-notification to any person upon their request. Pre-notification will include:

1. Name and phone number of the company making the application
2. Proposed date of application
3. Locations to be treated; and
4. Name, EPA Registration Number, and active ingredients of the products being used.

The applicator or their employers shall pre-notify the occupants of residential units between seven (7) days and forty-eight (48) hours prior to any application. The notification must include the following:

1. Name and phone number of company making the application
2. Proposed date and time of application
3. Locations to be treated
4. Product names, EPA Registration Numbers, and active ingredients for the pesticide products that may be used
5. Purpose of application
6. Preparation procedures required by the pesticide label to protect items such as food, utensils, and pests; and
7. Department approved Consumer Information Bulletin

The notification must be made in writing. The intent is so that individuals, who wish to avoid exposure or want to avoid encountering the applicator, can make necessary arrangements. Applicators are required by law to follow all directions on the pesticide label and must take all steps necessary to avoid applications with people present in a room or area to be treated. Individuals occupying a room or area to be treated at the time of application shall be informed of the procedure. Whenever possible, the applicator should not apply pesticides with anyone present. That may mean treating other areas and returning when occupants have left, asking people to leave the area while the work is being done, or treating before or after people occupy the room. If people do not leave, the applicator must make it clear that he is there to apply pesticides. The applicator will be prepared to provide whatever information possible about the pesticides and techniques used.

PET WASTE MANAGEMENT

The Town of Kingston has a dog control by-law and anti-littering by-law that requires all persons to remove waste material from within any way within the Town. The owner’s landscape crew (or
designee) shall remove any obvious pet waste that has been left behind by pet owners within the project area. The pet waste shall be disposed of in accordance with local and state regulations.

- **OPERATIONS AND MANAGEMENT OF SEPTIC SYSTEMS**
  There are no septic systems currently being proposed within the limits of the project.

- **MANAGEMENT OF DEICING CHEMICALS AND SNOW**
  Snow will be stockpiled on site until the accumulated snow becomes a hazard to the daily operations of the site. It will be the responsibility of the snow removal contractor to properly dispose of transported snow according to Massachusetts DEP, Bureau of Resource Protection – Snow Disposal Guideline #BRPG01-01, governing the proper disposal of snow. It will be the responsibility of the snow removal contractor to follow these guidelines and all applicable laws and regulations.

  The owner’s maintenance staff (or its designee) will be responsible for the clearing of the sidewalk and building entrances. The owner may be required to use a de-icing agent such as potassium chloride to maintain a safe walking surface. The de-icing agent for the walkways and building entrances will be kept within the storage rooms located within the building. De-icing agents will not be stored outside. The owner’s maintenance staff will limit the application of sand and salt.

- **LONG TERM MAINTENANCE PLAN – FACILITIES DESCRIPTION**
  The SMS shall be inspected immediately after construction. A maintenance log will be kept (i.e. report) summarizing inspections, maintenance, and any corrective actions taken. The log will include the date on which each inspection or maintenance task was performed, a description of the inspection findings or maintenance completed, and the name of the inspector or maintenance personnel performing the task. If a maintenance task requires the clean-out of any sediments or debris, the location where the sediment and debris was disposed after removal will be indicated. The log will be made accessible to department staff and a copy provided to the department upon request.

  The following is a description of the stormwater management system for the project site.

  - **STORMWATER COLLECTION SYSTEM – ON SITE**
    The stormwater collection system is a series of inlets located at low points within the limits of the paved area. A 54” CMP in the northwestern section of the site will remain undisturbed. All of the proposed on-site catch basins incorporate a deep sump and hooded outlet. The catch basins are connected by a closed gravity pipe network that pass through a proprietary separator prior to discharge into the 54” CMP.

  - **PROPRIETARY SEPARATORS**
    There is a proprietary separator prior to the 54” CMP. These devices are able to remove free oil and suspended solids, heavy particles and hydrocarbons and provide TSS removal. The maintenance needs of the separators are described further in the following section.

- **INSPECTION AND MAINTENANCE FREQUENCY AND CORRECTIVE MEASURES**
  In accordance with MA DEP Stormwater Handbook: Volume 2, Chapter 2; the following areas, facilities, and measures will be inspected and the identified deficiencies will be corrected. Clean-out must include the removal and legal disposal of any accumulated sediments, trash, and debris. In any and all cases, operations, inspections, and maintenance activities shall utilize best practical measures to avoid and minimize impacts to wetland resource areas outside the footprint of the SMS.
Structural Pretreatment BMPs: Regular maintenance of these BMPs is especially critical because they typically receive the highest concentration of suspended solids during the first flush of a storm event.

Deep Sump Catch Basins:
Inspect catch basins 2 times per year (specifically after foliage and snow season) to ensure that the catch basins are working in their intended fashion and that they are free of debris. Structures will be skimmed of floatable debris at each inspection and sediment will be removed when or before sump is determined to be 50% full. If the basin outlet is designed with a hood to trap floatable materials (i.e. Snout), check to ensure watertight seal is working.

Proprietary Separators:
Proprietary Separators will be inspected and cleaned out at least twice per year. Sediments and debris removed should be disposed of in accordance with all applicable local, state and federal laws and regulations including M.G.L.c. 21C and 310 CMR 30.00.

Other BMPs and Accessories:

Vegetated Areas:
Inspect slopes and embankments early in the growing season to identify active or potential erosion problems. Replant bare areas or areas with sparse growth. Where rill erosion is evident, armor the area with an appropriate lining or divert the erosive flows to on-site areas able to withstand the concentrated flows.

Roadways and Parking Surfaces:
Clear accumulations of winter sand in parking lots and along roadways at least once a year, preferably in the spring. Accumulations on pavement may be removed by pavement sweeping. Accumulations of sand along road shoulders may be removed by grading excess sand to the pavement edge and removing it manually or by a front-end loader.

Level Spreaders, Check Dams, Rip-Rap:
These accessories will be inspected twice per year for erosion, debris accumulation, and unwanted vegetation. Erosion will be stabilized and sediment, debris, and woody vegetation will be removed.

Catch Basin Inserts (silt bags, oil boom, etc):
Inserts will be maintained in strict accordance with manufactures recommendations but at a minimum inspected and cleaned out or replaced quarterly. All materials removed during maintenance will be disposed of according to all Federal, State and Local regulations.

Mosquito Control Plan:

MA Stormwater Handbook; Volume 2, Chapter 5 (Attached)
Both aboveground and underground stormwater BMPs have the potential to serve as mosquito breeding areas. Good design, proper operation and maintenance, and treatment with larvicides can minimize this potential.

The 2008 technical specifications for BMPs set forth in Volume 2, Chapter 2 of the Massachusetts Stormwater Handbook also concur with this practice by requiring that all stormwater practices designed to drain do so within 72 hours.
• SUPPLEMENTAL INFORMATION

PROPOSED OPERATIONS AND MAINTENANCE LOG FORM
Based on site specific stormwater management system asset list. At a minimum, fields should be provided for:
  o Date of inspection
  o Name of inspector
  o Condition of each BMP, including components such as:
    • Pretreatment devices
    • Vegetation or filter media
    • Fences or other safety devices
    • Spillways, valves, or other control structures
    • Embankments, slopes, and safety benches
    • Reservoir or treatment areas
    • Inlet and outlet channels and structures
    • Underground drainage
    • Sediment and debris accumulation in storage and forebay areas (including catch basins)
    • Any nonstructural practices
    • Any other item that could affect the proper function of the stormwater management system
<table>
<thead>
<tr>
<th>Structure or Task</th>
<th>Maintenance Activity</th>
<th>Schedule/Notes</th>
<th>Maintenance Cost/Unit</th>
<th>Estimated Maintenance Cost</th>
<th>Inspection Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Sweeping</td>
<td>Sweep, power broom or vacuum paved areas.</td>
<td>Perform roadway sweeping following the spring thaw to remove any traction sand applied during the winter months. Perform roadway sweeping in the late fall to remove any leaf litter or debris. Maintain information that confirms that all street sweepings have been disposed in accordance with state and local requirements</td>
<td>$1,500/Sweeping</td>
<td>Semi-annually (Spring &amp; Fall)</td>
<td></td>
</tr>
<tr>
<td>Water Quality Units and CB’s</td>
<td>vacuum sumps</td>
<td>Inspect at least 4x per year using Owner’s Manual. Clean when sediment is 6” deep, but never allow sediment to exceed 50% of sump volume. Clean once per year at a minimum. Maintain information that confirms that all sediments have been disposed in accordance with state and local requirements</td>
<td>$500/WQ</td>
<td>4 Water Quality Units - Cleaned Annually</td>
<td></td>
</tr>
<tr>
<td>Proprietary Separator</td>
<td>Cleaning and removal of debris after major storm events</td>
<td>Inspect monthly as well as following storms exceeding 1” of rainfall. Clean when sediment is 8” Deep; minimum twice a year. Submit information that confirms that all water quality inlets sediments have been disposed in accordance with state and local requirements</td>
<td>$4,000</td>
<td>Annually</td>
<td></td>
</tr>
<tr>
<td>Outfall locations</td>
<td>Inspect for sign of erosion or displaced stone. Replace outlet protection stone if needed. Inspect flap valves or Tideflex valves at outfall locations for proper operation.</td>
<td>Inspect twice a year for the first three years of construction and once per year thereafter. Check sediment build-up on a yearly basis and clean as needed using hand methods</td>
<td>$500 allowance</td>
<td>Annually</td>
<td></td>
</tr>
<tr>
<td>Mosquito Control</td>
<td>CB management targeted larviciding treatment to CB’s and all storm drains including proprietary separators to control mosquitoes in their aquatic stages.</td>
<td>Surveillance is a non chemical inspection method that involves classification of mosquito breeding sites, larval presence, and survey. Apply larvicide if larva growth is detected.</td>
<td>$500 allowance</td>
<td>CBs - quarterly</td>
<td></td>
</tr>
<tr>
<td>Snow Storage</td>
<td>Debris from melted snow shall be cleared from the site and properly disposed of at the end of the snow season, but shall be cleared no later than May 15.</td>
<td>Avoid dumping snow removal over catch basins. Use areas designated on the approved layout plan for snow storage. Snow shall not be stockpiled within the Wet Water Quality Swale.</td>
<td>$500 allowance</td>
<td>Annually</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 5
Miscellaneous Stormwater Topics

Mosquito Control in Stormwater Management Practices

Both aboveground and underground stormwater BMPs have the potential to serve as mosquito breeding areas. Good design, proper operation and maintenance and treatment with larvicides can minimize this potential.

EPA recommends that stormwater treatment practices dewater within 3 days (72 hours) to reduce the number of mosquitoes that mature to adults, since the aquatic stage of many mosquito species is 7 to 10 days. Massachusetts has had a 72-hour dewatering rule in its Stormwater Management Standards since 1996. The 2008 technical specifications for BMPs set forth in Volume 2, Chapter 2 of the Massachusetts Stormwater Handbook also concur with this practice by requiring that all stormwater practices designed to drain do so within 72 hours.

Some stormwater practices are designed to include permanent wet pools. These practices – if maintained properly – can limit mosquito breeding by providing habitat for mosquito predators. Additional measures that can be taken to reduce mosquito populations include increasing water circulation, attracting mosquito predators by adding suitable habitat, and applying larvicides.

The Massachusetts State Reclamation and Mosquito Control Board (SRMCB), through the Massachusetts Mosquito Control Districts, can undertake further mosquito control actions specifically for the purpose of mosquito control pursuant to Massachusetts General Law Chapter 252. The Mosquito Control Board, http://www.mass.gov/agr/mosquito/, describes mosquito control methods and is in the process of developing guidance documents that describe Best Management Practices for mosquito control projects.

The SRMCB and Mosquito Control Districts are not responsible for operating and maintaining stormwater BMPs to reduce mosquito populations. The owners of property that construct the stormwater BMPs or municipalities that “accept” them through local subdivision approval are responsible for their maintenance. The SRMCB is composed of officials from MassDEP, Department of Agricultural Resources, and Department of Conservation and Recreation. The nine (9) Mosquito Control Districts overseen by the SRMCB are located throughout Massachusetts, covering 176 municipalities.

Construction Period Best Management Practices for Mosquito Control

To minimize mosquito breeding during construction, it is essential that the following actions be taken to minimize the creation of standing pools by taking the following actions:

- **Minimize Land Disturbance:** Minimizing land disturbance reduces the likelihood of mosquito breeding by reducing silt in runoff that will cause construction period controls to clog and retain standing pools of water for more than 72 hours.
- **Catch Basin inlets:** Inspect and refresh filter fabric, hay bales, filter socks or stone dams on a regular basis to ensure that any stormwater ponded at the inlet drains within 8 hours after precipitation stops. Shorter periods may be necessary to avoid hydroplaning in roads

---

1 MassDEP and MassHighway understand that the numerous stormwater BMPs along state highways pose a unique challenge. To address this challenge, the 2004 MassHighway Stormwater Handbook will provide additional information on appropriate operation and maintenance practices for mosquito control when the Handbook is revised to reflect the 2008 changes to the Stormwater Management Standards.
Caused by water ponded at the catch basin inlet. Treat catch basin sumps with larvicides such as *Bacillus sphaericus (Bs)* using a licensed pesticide applicator.

- **Check Dams:** If temporary check dams are used during the construction period to lag peak rate of runoff or pond runoff for exfiltration, inspect and repair the check dams on a regular basis to ensure that any stormwater ponded behind the check dam drains within 72 hours.

- **Design construction period sediment traps** to dewater within 72 hours after precipitation. Because these traps are subject to high silt loads and tend to clog, treat them with the larvicide *Bs* after it rains from June through October, until the first frost occurs.

- **Construction period open conveyances:** When temporary manmade ditches are used for channelizing construction period runoff, inspect them on a regular basis to remove any accumulated sediment to restore flow capacity to the temporary ditch.

- **Revegetating Disturbed Surfaces:** Revegetating disturbed surfaces reduces sediment in runoff that will cause construction period controls to clog and retain standing pools of water for greater than 72 hours.

- **Sediment fences/hay bale barriers:** When inspections find standing pools of water beyond the 24-hour period after a storm, take action to restore barrier to its normal function.

**Post-Construction Stormwater Treatment Practices**

- Mosquito control begins with the environmentally sensitive site design. Environmentally sensitive site design that minimizes impervious surfaces reduces the amount of stormwater runoff. Disconnecting runoff using the LID Site Design credits outlined in the Massachusetts Stormwater Handbook reduces the amount of stormwater that must be conveyed to a treatment practice. Utilizing green roofs minimizes runoff from smaller storms. Storage media must be designed to dewater within 72 hours after precipitation.

- Mosquito control continues with the selection of structural stormwater BMPs that are unlikely to become breeding grounds for mosquitoes, such as:
  - **Bioretention Areas/Rain Gardens/Sand Filter:** These practices tend not to result in mosquito breeding. If any level spreaders, weirs or sediment forebays are used as part of the design, inspect them and correct them as necessary to prevent standing pools of water for more than 72 hours.
  - **Infiltration Trenches:** This practice tends not to result in mosquito breeding. If any level spreaders, weirs, or sediment forebays are used as part of the design, inspect them and correct them as necessary to prevent standing pools of water for more than 72 hours.

- Another mosquito control strategy is to select BMPs that can become habitats for mosquito predators, such as:
  - **Constructed Stormwater Wetlands:** Habitat features can be incorporated in constructed stormwater wetlands to attract dragonflies, amphibians, turtles, birds, bats, and other natural predators of mosquitoes.
  - **Wet Basins:** Wet basins can be designed to incorporate fish habitat features, such as deep pools. Introduce fish in consultation with Massachusetts Division of Fisheries and Wildlife. Vegetation within wet basins designed as fish habitat must be properly managed to ensure that vegetation does not overtake the habitat. Proper design to ensure that no low circulation or “dead” zones are created may reduce the potential for mosquito breeding. Introducing bubblers may increase water circulation in the wet basin.
Effective mosquito controls require proponents to design structural BMPs to prevent ponding and facilitate maintenance and, if necessary, the application of larvicides. Examples of such design practices include the following:

- **Basins:** Provide perimeter access around wet basins, extended dry detention basins and dry detention basins for both larviciding and routine maintenance. Control vegetation to ensure that access pathways stay open.

- **BMPs without a permanent pool of water:** All structural BMPs that do not rely on a permanent pool of water must drain and completely dewater within 72 hours after precipitation. This includes dry detention basins, extended dry detention basins, infiltration basins, and dry water quality swales. Use underdrains at extended dry detention basins to drain the small pools that form due to accumulation of silts. Wallace indicates that extended dry detention basins may breed more mosquitoes than wet basins. It is, therefore, imperative to design outlets from extended dry detention basins to completely dewater within the 72-hour period.

- **Energy Dissipators and Flow Spreaders:** Currier and Moeller, 2000 indicate that shallow recesses in energy dissipators and flow spreaders trap water where mosquitoes breed. Set the riprap in grout to reduce the shallow recesses and minimize mosquito breeding.

- **Outlet control structures:** Debris trapped in small orifices or on trash racks of outlet control structures such as multiple stage outlet risers may clog the orifices or the trash rack, causing a standing pool of water. Optimize the orifice size or trash rack mesh size to provide required peak rate attenuation/water quality detention/retention time while minimizing clogging.

- **Rain Barrels and Cisterns:** Seal lids to reduce the likelihood of mosquitoes laying eggs in standing water. Install mosquito netting over inlets. The cistern system should be designed to ensure that all collected water is drained into it within 72 hours.

- **Subsurface Structures, Deep Sump Catch Basins, Oil Grit Separators, and Leaching Catch Basins:** Seal all manhole covers to reduce the likelihood of mosquitoes laying eggs in standing water. Install mosquito netting over the outlet (CALTRANS 2004).

The Operation and Maintenance Plan should provide for mosquito prevention and control.

- **Check dams:** Inspect permanent check dams on the schedule set forth in the O&M Plan. Inspect check dams 72 hours after storms for standing water ponding behind the dam. Take corrective action if standing water is found.

- **Cisterns:** Apply Bs larvicide in the cistern if any evidence of mosquitoes is found. The Operation and Maintenance Plan shall specify how often larvicides should be applied to waters in the cistern.

- **Water quality swales:** Remove and properly dispose of any accumulated sediment as scheduled in the Operation and Maintenance Plan.

- **Larvicide Treatment:** The Operation and Maintenance Plan must include measures to minimize mosquito breeding, including larviciding.

The party identified in the Operation and Maintenance Plan as responsible for maintenance shall see that larvicides are applied as necessary to the following stormwater treatment practices: catch basins, oil/grit separators, wet basins, wet water quality swales, dry extended detention basins, infiltration basins, and constructed stormwater wetlands. The Operation and Maintenance Plan must ensure that all larvicides are applied by a licensed pesticide applicator and in compliance with all pesticide label requirements.

The Operation and Maintenance Plan should identify the appropriate larvicide and the time and method of application. For example, *Bacillus sphaericus (Bs)*, the preferred...
larvicide for stormwater BMPs, should be hand-broadcast. Alternatively, Altosid, a Methopren product, may be used. Because some practices are designed to dewater between storms, such as dry extended detention and infiltration basins, the Operation and Maintenance Plan should provide that larviciding must be conducted during or immediately after wet weather, when the detention or infiltration basin has a standing pool of water, unless a product is used that can withstand extended dry periods.

REFERENCES


O’Meara, G.F., 2003, Mosquitoes Associated With Stormwater Detention/Retention Areas, ENY627, University of Florida, Institute of Food and Agricultural Sciences Extension, http://edis.ifas.ufl.edu/mg338


---

2 *Bacillus thuringiensis israelensis* or *Bti* is usually applied by helicopter to wetlands and floodplains
Roads and Stormwater BMPs

In general, the stormwater BMPs used for land development projects can also be used for new roadways and roadway improvement projects. However, for improvement of existing roads, there are often constraints that limit the choice of BMP. These constraints derive from the linear configuration of the road, the limited area within the existing right-of-way, the structural and safety requirements attendant to good roadway design, and the long-term maintainability of the roadway drainage systems. The MassHighway Handbook provides strategies for dealing with the constraints associated with providing stormwater BMPs for roadway redevelopment projects.

Roadway design can minimize impacts caused by stormwater. Reducing roadway width reduces the total and peak volume of runoff. Designing a road with country drainage (no road shoulders or curbs) disconnects roadway runoff. Disconnection of roadway runoff is eligible for the Low Impact Site Design Credit provided the drainage is disconnected in accordance with specifications outlined in Volume 3.

Like other parties, municipalities that work within wetlands jurisdictional areas and adjacent buffer zones must design and implement structural stormwater best management practices in accordance with the Stormwater Management Standards and the Stormwater Management Handbook. In addition, in municipalities and areas where state agencies operate stormwater systems, the DPWs (or other town or state agencies) must meet the “good housekeeping” requirement of the municipality’s or agency’s MS4 permit.

MassHighway has taken stormwater management one step further by working with MassDEP to develop the MassHighway Storm Water Handbook for Highways and Bridges. The purpose of the MassHighway Handbook is to provide guidance for persons involved in the design, permitting, review and implementation of state highway projects, especially those involving existing roadways where physical constraints often limit the stormwater management options available. These constraints, like those common to redevelopment sites, may make it difficult to comply precisely with the requirements of the Stormwater Management Standards and the Massachusetts Stormwater Handbook. In response to these constraints, MassDEP and MHD developed specific design, permitting, review and implementation practices that meet the unique challenges of providing environmental protection for existing state roads. The information in the MassHighway Handbook may also aid in the planning and design of projects to build new highways and to add lanes to existing highways, since they may face similar difficulties in meeting the requirements of the Stormwater Management Standards.

Although it is very useful, the MassHighway Handbook does not allow MassHighway projects to proceed without individual review and approval by the issuing authority when subject to the Wetlands Protection Act Regulations, 310 CMR 10.00, or the 401 Water Quality Certification Regulations, 314 CMR 9.00. For example, MassHighway must provide a Conservation Commission with a project-specific Operation and Maintenance Plan in accordance with Standard 9 that documents how the project’s post-construction BMPs will be operated and maintained.

3 The 2004 MassHighway Handbook outlines standardized methods for dealing with these constraints as they apply to highway redevelopment projects. MassDEP and MassHighway intend to work together to provide guidance for add a lane projects when the 2004 Handbook is revised to reflect the 2008 changes to the Stormwater Management Standards.

4 The general permit for municipal separate storm sewer systems (the MS4 Permit) requires MassHighway to develop and implement procedures for the proper operation and maintenance of stormwater BMPs. To
Some municipalities have asked if the MassHighway Handbook governs municipal road projects. The answer is no. The MassHighway Handbook was developed in response to the unique problems and challenges arising out of the management of the state highway system. Like other project proponents, cities and towns planning road or other projects in areas subject to jurisdiction under the Wetlands Protection Act must design and implement LID, non-structural and structural best management practices in accordance with the Stormwater Management Standards and the Massachusetts Stormwater Handbook.

avoid duplication of effort, MassHighway may be able rely on the same procedures to fulfill the operation and maintenance requirements of Standard 9 and the MS 4 Permit.

Although the MassHighway Handbook does not govern municipal road projects, cities and towns may find some of the information presented in the Handbook useful.
**Summary for Subcatchment E1: EXISTING SURFACE RUNOFF TO EX. 54" CMP**

Runoff = 23.03 cfs @ 12.14 hrs, Volume= 1.897 af, Depth> 2.68"

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=3.40"**

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28,771</td>
<td>61</td>
<td>&gt;75% Grass cover, Good, HSG B</td>
</tr>
<tr>
<td>340,992</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>369,763</td>
<td>95</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>28,771</td>
<td></td>
<td>7.78% Pervious Area</td>
</tr>
<tr>
<td>340,992</td>
<td></td>
<td>92.22% Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>0</td>
<td></td>
<td></td>
<td>23.03</td>
<td>Total, Increased to minimum Tc = 10.0 min</td>
</tr>
</tbody>
</table>

**Subcatchment E1: EXISTING SURFACE RUNOFF TO EX. 54" CMP**

**Hydrograph**

- **Type III 24-hr 2-Year Rainfall=3.40"**
- **Runoff Area=369,763 sf**
- **Runoff Volume=1.897 af**
- **Runoff Depth>2.68"**
- **Tc=10.0 min**
- **CN=95**
Summary for Subcatchment R1: ROOF TO EX. 24" RCP

Runoff = 5.22 cfs @ 12.14 hrs, Volume = 0.450 af, Depth > 2.96"

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 = 3.40"

Area (sf) CN Description
79,486 98 Roofs, HSG B
79,486 100.00% Impervious Area

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs) Direct Entry, Min. Tc
6.0 0 Total, Increased to minimum Tc = 10.0 min

Summary for Link SP1: STUDY POINT #1 FLOW TO EX. 54" CMP

Inflow Area = 8.489 ac, 92.22% Impervious, Inflow Depth > 2.68" for 2-Year event
Inflow = 23.03 cfs @ 12.14 hrs, Volume = 1.897 af
Primary = 23.03 cfs @ 12.14 hrs, Volume = 1.897 af, Attent = 0%, Lag = 0.0 min
Primary outflow = Inflow, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

Inflow Area = 8.489 ac

Hydrograph

Type III 24-hr 2-Year Rainfall = 3.40"
Runoff Area = 79,486 sf
Runoff Volume = 0.450 af
Runoff Depth > 2.96"
Tc = 10.0 min
CN = 98
Summary for Link SP2: STUDY POINT #2 FLOW TO EX. 24" RCP

Inflow Area = 1.825 ac, 100.00% Impervious, Inflow Depth > 2.96" for 2-Year event
Inflow = 5.22 cfs @ 12.14 hrs, Volume= 0.450 af
Primary = 5.22 cfs @ 12.14 hrs, Volume= 0.450 af, Attenu= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Subcatchment E1: EXISTING SURFACE RUNOFF TO EX. 54" CMP

Runoff = 32.72 cfs @ 12.14 hrs, Volume= 2.746 af, Depth> 3.88"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28,771</td>
<td>61</td>
<td>&gt;75% Grass cover, Good, HSG B</td>
</tr>
<tr>
<td>340,992</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>369,763</td>
<td>95</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>28,771</td>
<td>7.78% Pervious Area</td>
<td></td>
</tr>
<tr>
<td>340,992</td>
<td>92.22% Impervious Area</td>
<td></td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
6.0 0 Total, Increased to minimum Tc = 10.0 min

Subcatchment E1: EXISTING SURFACE RUNOFF TO EX. 54" CMP

Type III 24-hr 10-Year Rainfall=4.70"
Runoff Area=369,763 sf
Runoff Volume=2.746 af
Runoff Depth>3.88"
Tc=10.0 min
CN=95
Summary for Subcatchment R1: ROOF TO EX. 24" RCP

Runoff = 7.26 cfs @ 12.14 hrs, Volume = 0.630 af, Depth > 4.14"

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=4.70"

Area (sf) CN Description
79,486 98 Roofs, HSG B
79,486 100.00% Impervious Area

Tc Length Slope Velocity Capacity Description
6.0 (min) (feet) (ft/ft) (ft/sec) (cfs)
Direct Entry, Min. Tc
6.0 0 Total, Increased to minimum Tc = 10.0 min

Subcatchment R1: ROOF TO EX. 24" RCP

Hydrograph

Type III 24-hr 10-Year Rainfall=4.70"
Runoff Area=79,486 sf
Runoff Volume=0.630 af
Runoff Depth>4.14"
Tc=10.0 min
CN=98
Summary for Link SP2: STUDY POINT #2 FLOW TO EX. 24" RCP

- **Inflow Area**: 1.825 ac, 100.00% Impervious, Inflow Depth > 4.14" for 10-Year event
- **Inflow**: 7.26 cfs @ 12.14 hrs, Volume = 0.630 af
- **Primary**: 7.26 cfs @ 12.14 hrs, Volume = 0.630 af, Atten = 0%, Lag = 0.0 min
- **Primary outflow** = Inflow, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

**Summary for Subcatchment E1: EXISTING SURFACE RUNOFF TO EX. 54" CMP**

- **Runoff**: 49.67 cfs @ 12.14 hrs, Volume = 4.245 af, Depth > 6.00"
- **Runoff by SCS TR-20 method**, UH = SCS, Weighted-CN, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

**Area (sf) CN Description**

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28,771</td>
<td>61</td>
<td>&gt;75% Grass cover, Good, HSG B</td>
</tr>
<tr>
<td>340,992</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>28,771</td>
<td>95</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>369,763</td>
<td>92.22%</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

**Tc Length Slope Velocity Capacity Description**

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Direct Entry, Min. Tc</td>
</tr>
</tbody>
</table>

**Subcatchment E1**: EXISTING SURFACE RUNOFF TO EX. 54" CMP

Type III 24-hr 100-Year Rainfall = 7.00"
- 100-Year Area = 369,763 sf
- Runoff Volume = 4.245 af
- Runoff Depth > 6.00"
- Tc = 10.0 min
- CN = 95
### Summary for Subcatchment R1: ROOF TO EX. 24" RCP

Runoff = 10.85 cfs @ 12.14 hrs, Volume = 0.948 af, Depth > 6.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

<table>
<thead>
<tr>
<th>Type III 24-hr 100-Year Rainfall=7.00&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff Area = 79,486 sf</td>
</tr>
<tr>
<td>Runoff Volume = 0.948 af</td>
</tr>
<tr>
<td>Runoff Depth &gt; 6.24&quot;</td>
</tr>
<tr>
<td>Tc = 10.0 min</td>
</tr>
<tr>
<td>CN = 98</td>
</tr>
</tbody>
</table>

### Summary for Link SP1: STUDY POINT #1 FLOW TO EX. 54" CMP

Inflow Area = 8.489 ac, 92.22% Impervious, Inflow Depth > 6.00" for 100-Year event

Inflow = 49.67 cfs @ 12.14 hrs, Volume = 4.245 af

Primary = 49.67 cfs @ 12.14 hrs, Volume = 4.245 af, Atten = 0%, Lag = 0.0 min

Primary outflow = Inflow, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

### Inflow Area = 8.489 ac
Summary for Link SP2: STUDY POINT #2 FLOW TO EX. 24" RCP

Inflow Area = 1.825 ac, 100.00% Impervious, Inflow Depth > 6.24" for 100-Year event
Primary = 10.85 cfs @ 12.14 hrs, Volume = 0.948 af, Attenuation = 0%, Lag = 0.0 min

Primary outflow = Inflow, Time Span = 5:00-20:00 hrs, dt = 0.05 hrs

Inflow Area = 1.825 ac

**Hydrograph**

**Time (hours)**

0 4 8 12 16 20

**Flow (cfs)**

0 2 4 6 8 10 12 14 16 18 20

10.85 cfs (Inflow)
10.85 cfs (Primary)
Routing Diagram for 2280-05_Proposed
Prepared by Microsoft  Printed 1/21/2020
HydroCAD® 10.00-24  s/n 02881  © 2018 HydroCAD Software Solutions LLC

Summary for Subcatchment P1: PROPOSED SURFACE RUNOFF TO EX. 54" CMP

Runoff = 14.36 cfs @ 12.15 hrs, Volume = 1.099 af, Depth > 1.58"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 5.00-20.00 hrs, dh= 0.05 hrs

Type III 24-hr 2-Year Rainfall=3.40"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>160,248</td>
<td>61</td>
<td>&gt;75% Grass cover, Good, HSG B</td>
</tr>
<tr>
<td>203,930</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>364,178</td>
<td>82</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>160,248</td>
<td></td>
<td>44.00% Pervious Area</td>
</tr>
<tr>
<td>203,930</td>
<td></td>
<td>56.00% Impervious Area</td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs)
6.0 0 Total, increased to minimum Tc = 10.0 min

Subcatchment P1: PROPOSED SURFACE RUNOFF TO EX. 54" CMP

Type III 24-hr 2-Year Rainfall=3.40"
Runoff Area = 364,178 sf
Runoff Volume = 1.099 af
Runoff Depth > 1.58"
Tc = 10.0 min
CN = 82
Summary for Subcatchment R1: ROOF TO EX. 54" CMP

Runoff = 0.50 cfs @ 12.14 hrs, Volume= 0.043 af, Depth> 2.96"
Run off by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Area (sf) CN Description
7,668 98 Roofs, HSG B
7,668 100.00% Impervious Area

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Min. Tc</td>
</tr>
</tbody>
</table>

Subcatchment R1: ROOF TO EX. 54" CMP

Type III 24-hr 2-Year Rainfall=3.40"
Runoff Area=7,668 sf
Runoff Volume=0.043 af
Runoff Depth>2.96"
Tc=10.0 min
CN=98

Summary for Subcatchment R2: ROOF TO EX. 24" RCP

Runoff = 1.86 cfs @ 12.14 hrs, Volume= 0.160 af, Depth> 2.96"
Run off by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Area (sf) CN Description
28,284 98 Roofs, HSG B
28,284 100.00% Impervious Area

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Min. Tc</td>
</tr>
</tbody>
</table>

Subcatchment R2: ROOF TO EX. 24" RCP

Type III 24-hr 2-Year Rainfall=3.40"
Runoff Area=28,284 sf
Runoff Volume=0.160 af
Runoff Depth>2.96"
Tc=10.0 min
CN=98
Summary for Subcatchment R3: ROOF TO EX. 24” RCP

Runoff = 3.23 cfs @ 12.14 hrs, Volume= 0.278 af, Depth> 2.96"

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=3.40"

Area (sf) CN Description
49,120 98 Roofs, HSG B
49,120 100.00% Impervious Area

Tc Length Slope Velocity Capacity Description
6.0 0 Direct Entry, Min. Tc

Total, Increased to minimum Tc = 10.0 min

Subcatchment R3: ROOF TO EX. 24” RCP

Inflow Area=8.536 ac, 56.90% Impervious, Inflow Depth > 1.61" for 2-Year event

Inflow = 14.86 cfs @ 12.15 hrs, Volume= 1.142 af

Primary = 14.86 cfs @ 12.15 hrs, Volume= 1.142 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Inflow Area=8.536 ac
Summary for Link SP2: STUDY POINT #2 FLOW TO EX. 24" RCP

Inflow Area = 1.777 ac, 100.00% Impervious, Inflow Depth > 2.96" for 2-Year event
Inflow = 5.08 cfs @ 12.14 hrs, Volume = 0.438 af
Primary = 5.08 cfs @ 12.14 hrs, Volume = 0.438 af, Atten = 0%, Lag = 0.0 min
Primary outflow = Inflow, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

Runoff Area = 364,178 sf
Runoff Volume = 1.830 af
Runoff Depth > 2.63"
Tc = 10.0 min
CN = 82

Subcatchment P1: PROPOSED SURFACE RUNOFF TO EX. 54" CMP

Runoff = 23.77 cfs @ 12.14 hrs, Volume = 1.830 af, Depth > 2.63"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

Area (sf) | CN | Description
---|---|---
160,248 | 61 | >75% Grass cover, Good, HSG B
203,930 | 98 | Paved parking, HSG B
364,178 | 82 | Weighted Average

Tc Length Slope Velocity Capacity Description
---|---|---|---|---|---
6.0 | Direct Entry, Min. Tc
6.0 | 0 Total, Increased to minimum Tc = 10.0 min

23.77 cfs
Summary for Subcatchment R1: ROOF TO EX. 54" CMP

Runoff = 0.70 cfs @ 12.14 hrs, Volume = 0.061 af, Depth > 4.14"

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=4.70"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,668</td>
<td>98</td>
<td>Roofs, HSG B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>6.0</td>
<td>0</td>
<td>Total, Increased to minimum Tc = 10.0 min</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subcatchment R1: ROOF TO EX. 54" CMP

Type III 24-hr 10-Year Rainfall=4.70"
Runoff Area=7,668 sf
Runoff Volume=0.061 af
Runoff Depth > 4.14"
Tc=10.0 min
CN=98

Summary for Subcatchment R2: ROOF TO EX. 24" RCP

Runoff = 2.58 cfs @ 12.14 hrs, Volume = 0.224 af, Depth > 4.14"

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=4.70"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28,284</td>
<td>98</td>
<td>Roofs, HSG B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>6.0</td>
<td>0</td>
<td>Total, Increased to minimum Tc = 10.0 min</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subcatchment R2: ROOF TO EX. 24" RCP

Type III 24-hr 10-Year Rainfall=4.70"
Runoff Area=28,284 sf
Runoff Volume=0.224 af
Runoff Depth > 4.14"
Tc=10.0 min
CN=98
Summary for Subcatchment R3: ROOF TO EX. 24" RCP

Runoff = 4.48 cfs @ 12.14 hrs, Volume = 0.389 af, Depth > 4.14"  

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 = 4.70"  
Area (sf) CN Description  
49,120 98 Roofs, HSG B  
49,120 100.00% Impervious Area  
Tc Length Slope Velocity Capacity Description  
(min) (feet) (ft/ft) (ft/sec) (cfs)  
6.0 Direct Entry, Min. Tc  
6.0 0 Total, Increased to minimum Tc = 10.0 min  

Subcatchment R3: ROOF TO EX. 24" RCP

Runoff Area = 49,120 sf  
Runoff Volume = 0.389 af  
Runoff Depth > 4.14"  
Tc = 10.0 min  
CN = 98

type III 24-hr 10-Year Rainfall = 4.70"
Summary for Link SP2: STUDY POINT #2 FLOW TO EX. 24" RCP

Inflow Area = 1.777 ac, 100.00% Impervious, Inflow Depth > 4.14" for 10-Year event
Inflow = 7.07 cfs @ 12.14 hrs, Volume= 0.614 af
Primary = 7.07 cfs @ 12.14 hrs, Volume= 0.614 af, Atten= 0%, Lag= 0.0 min
Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Runoff Area=364,178 sf
Runoff Volume=3.221 af
Runoff Depth>4.62"

Summary for Subcatchment P1: PROPOSED SURFACE RUNOFF TO EX. 54" CMP

Runoff = 40.98 cfs @ 12.14 hrs, Volume= 3.221 af, Depth> 4.62"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>160,248</td>
<td>61</td>
<td>&gt;75% Grass cover, Good, HSG B</td>
</tr>
<tr>
<td>203,930</td>
<td>98</td>
<td>Paved parking, HSG B</td>
</tr>
<tr>
<td>364,178</td>
<td>82</td>
<td>Weighted Average</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry, Min. Tc</td>
</tr>
<tr>
<td>6.0</td>
<td>0 Total, Increased to minimum Tc = 10.0 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subcatchment P1: PROPOSED SURFACE RUNOFF TO EX. 54" CMP

Type III 24-hr 100-Year Rainfall=7.00"
Runoff Area=364,178 sf
Runoff Volume=3.221 af
Runoff Depth>4.62"
Tc=10.0 min
CN=82
Summary for Subcatchment R1: ROOF TO EX. 54" CMP

Runoff = 1.05 cfs @ 12.14 hrs, Volume = 0.091 af, Depth > 6.24"

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=7.00"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,668</td>
<td>98</td>
<td>Roofs, HSG B</td>
</tr>
<tr>
<td>7,668</td>
<td>100.00% Impervious Area</td>
<td></td>
</tr>
</tbody>
</table>

| Tc Length Slope Velocity Capacity Description |
|------|-------|---------|-------|-----------------|
| min  | (feet) | (ft/ft) | (ft/sec) | (cfs) | Direct Entry, Min. Tc |
| 6.0  | 0         | Total, Increased to minimum Tc = 10.0 min |

Subcatchment R1: ROOF TO EX. 54" CMP

Type III 24-hr 100-Year Rainfall=7.00"
Runoff Area=7,668 sf
Runoff Volume=0.091 af
Runoff Depth>6.24"
Tc=10.0 min
CN=98

Summary for Subcatchment R2: ROOF TO EX. 24" RCP

Runoff = 3.86 cfs @ 12.14 hrs, Volume = 0.337 af, Depth > 6.24"

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=7.00"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28,284</td>
<td>98</td>
<td>Roofs, HSG B</td>
</tr>
<tr>
<td>28,284</td>
<td>100.00% Impervious Area</td>
<td></td>
</tr>
</tbody>
</table>

| Tc Length Slope Velocity Capacity Description |
|------|-------|---------|-------|-----------------|
| min  | (feet) | (ft/ft) | (ft/sec) | (cfs) | Direct Entry, Min. Tc |
| 6.0  | 0         | Total, Increased to minimum Tc = 10.0 min |

Subcatchment R2: ROOF TO EX. 24" RCP

Type III 24-hr 100-Year Rainfall=7.00"
Runoff Area=28,284 sf
Runoff Volume=0.337 af
Runoff Depth>6.24"
Tc=10.0 min
CN=98
Summary for Subcatchment R3: ROOF TO EX. 24" RCP

Runoff = 6.70 cfs @ 12.14 hrs, Volume = 0.586 af, Depth > 6.24"

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 = 7.00”

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>49,120</td>
<td>98</td>
<td>Roofs, HSG B</td>
</tr>
<tr>
<td>49,120</td>
<td>100.00%</td>
<td>Impervious Area</td>
</tr>
</tbody>
</table>

Tc | Length | Slope | Velocity | Capacity | Description
---|--------|-------|----------|----------|----------------
6.0 | 0      | 0     | 0        | 6.70 cfs | Direct Entry, Min. Tc
6.0 | 0      | 0     | 0        | 6.0      | Total, Increased to minimum Tc = 10.0 min

Subcatchment R3: ROOF TO EX. 24" RCP

Type III 24-hr 100-Year Rainfall = 7.00”
Runoff Area = 49,120 sf
Runoff Volume = 0.586 af
Runoff Depth > 6.24"
Tc = 10.0 min
CN = 98

Summary for Link SP1: STUDY POINT #1 FLOW TO EX. 54" CMP

Inflow Area = 8.536 ac, 56.90% Impervious, Inflow Depth > 4.66” for 100-Year event
Inflow = 42.03 cfs @ 12.14 hrs, Volume = 3.313 af
Primary = 42.03 cfs @ 12.14 hrs, Volume = 3.313 af, Attenuation = 0%, Lag = 0.0 min

Primary outflow = Inflow, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

Link SP1: STUDY POINT #1 FLOW TO EX. 54" CMP

Inflow Area = 8.536 ac
Summary for Link SP2: STUDY POINT #2 FLOW TO EX. 24" RCP

Inflow Area = 1.777 ac, 100.00% Impervious, Inflow Depth > 6.24" for 100-Year event
Inflow = 10.56 cfs @ 12.14 hrs, Volume = 0.924 af
Primary = 10.56 cfs @ 12.14 hrs, Volume = 0.924 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span = 5.00-20.00 hrs, dt = 0.05 hrs

Inflow Area = 1.777 ac
F-1. Rainfall Data for Massachusetts from *Rainfall Frequency Atlas of the United States* (TP-40)

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

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

<table>
<thead>
<tr>
<th>County Name</th>
<th>1-yr 24-hr</th>
<th>2-yr 24-hr</th>
<th>5-yr 24-hr</th>
<th>10-yr 24-hr</th>
<th>25-yr 24-hr</th>
<th>50-yr 24-hr</th>
<th>100-yr 24-hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnstable</td>
<td>2.5 3.6</td>
<td>4.5 4.8</td>
<td>5.7 6.4</td>
<td>7.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berkshire</td>
<td>2.5 2.9</td>
<td>3.8 4.4</td>
<td>5.1 5.9</td>
<td>6.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bristol</td>
<td>2.5 3.4</td>
<td>4.3 4.8</td>
<td>5.6 6.3</td>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dukes</td>
<td>2.5 3.6</td>
<td>4.6 4.9</td>
<td>5.8 6.5</td>
<td>7.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Essex</td>
<td>2.5 3.1</td>
<td>3.9 4.5</td>
<td>5.4 5.9</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Franklin</td>
<td>2.5 2.9</td>
<td>3.8 4.3</td>
<td>5.1 5.8</td>
<td>6.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hampden</td>
<td>2.5 3.0</td>
<td>4.0 4.6</td>
<td>5.3 6.0</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hampshire</td>
<td>2.5 3.0</td>
<td>3.9 4.5</td>
<td>5.2 5.9</td>
<td>6.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middlesex</td>
<td>2.5 3.1</td>
<td>4.0 4.5</td>
<td>5.3 5.9</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nantucket</td>
<td>2.5 3.6</td>
<td>4.6 4.9</td>
<td>5.8 6.5</td>
<td>7.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norfolk</td>
<td>2.5 3.2</td>
<td>4.1 4.7</td>
<td>5.5 6.1</td>
<td>6.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plymouth</td>
<td>2.5 3.4</td>
<td>4.3 4.7</td>
<td>5.6 6.2</td>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suffolk</td>
<td>2.5 3.2</td>
<td>4.0 4.6</td>
<td>5.5 6.0</td>
<td>6.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worcester</td>
<td>2.5 3.0</td>
<td>4.0 4.5</td>
<td>5.3 5.9</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Manning's Roughness Coefficients ("n")

<table>
<thead>
<tr>
<th>Conduit</th>
<th>Manning's Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Closed Conduits</strong></td>
<td></td>
</tr>
<tr>
<td>Asbestos-Cement Pipe</td>
<td>0.011 to 0.015</td>
</tr>
<tr>
<td>Brick</td>
<td>0.013 to 0.017</td>
</tr>
<tr>
<td>Cast Iron Pipe</td>
<td></td>
</tr>
<tr>
<td>Cement-lined and seal-coated</td>
<td>0.011 to 0.015</td>
</tr>
<tr>
<td>Concrete (Monolithic)</td>
<td></td>
</tr>
<tr>
<td>Smooth forms</td>
<td>0.012 to 0.014</td>
</tr>
<tr>
<td>Rough forms</td>
<td>0.015 to 0.017</td>
</tr>
<tr>
<td>Concrete Pipe</td>
<td>0.011 to 0.015</td>
</tr>
<tr>
<td>Corrugated-Metal Pipe (1/2 - STUL 34470 2 1/2-inch corrfgtn.)</td>
<td></td>
</tr>
<tr>
<td>Plain</td>
<td>0.022 to 0.026</td>
</tr>
<tr>
<td>Paved invert</td>
<td>0.018 to 0.022</td>
</tr>
<tr>
<td>Spun asphalt-lined</td>
<td>0.011 to 0.015</td>
</tr>
<tr>
<td>Plastic Pipe (Smooth)</td>
<td>0.011 to 0.015</td>
</tr>
<tr>
<td>Vitrified Clay</td>
<td></td>
</tr>
<tr>
<td>Pipes</td>
<td>0.011 to 0.015</td>
</tr>
<tr>
<td>Liner channels</td>
<td>0.013 to 0.017</td>
</tr>
<tr>
<td><strong>Open Channels</strong></td>
<td></td>
</tr>
<tr>
<td>Lined Channels</td>
<td></td>
</tr>
<tr>
<td>Asphalt</td>
<td>0.013 to 0.017</td>
</tr>
<tr>
<td>Brick</td>
<td>0.012 to 0.018</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.011 to 0.020</td>
</tr>
<tr>
<td>Rubble or riprap</td>
<td>0.020 to 0.035</td>
</tr>
<tr>
<td>Vegetal</td>
<td>0.030 to 0.040</td>
</tr>
<tr>
<td>Excavated or Dredged</td>
<td></td>
</tr>
<tr>
<td>Earth, straight and uniform</td>
<td>0.020 to 0.030</td>
</tr>
<tr>
<td>Earth, winding, fairly uniform</td>
<td>0.025 to 0.040</td>
</tr>
<tr>
<td>Rock</td>
<td>0.030 to 0.045</td>
</tr>
<tr>
<td>Unmaintained</td>
<td>0.050 to 0.140</td>
</tr>
<tr>
<td>Natural Channels (minor streams, top width at flood stage &lt; 100 feet)</td>
<td></td>
</tr>
<tr>
<td>Fairly regular section</td>
<td>0.030 to 0.070</td>
</tr>
<tr>
<td>Irregular section with pools</td>
<td>0.040 to 0.100</td>
</tr>
</tbody>
</table>

**Source:** *Design and Construction of Sanitary and Storm Sewers*, American Society of Civil Engineers and the Water Pollution Control Federation, 1969.
The soil surveys that comprise your AOI were mapped at 1:12,000.

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

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

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

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

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

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

Date(s) aerial images were photographed: Dec 31, 2009—Jul 3, 2017

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.
# Map Unit Legend

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water</td>
<td>9.0</td>
<td>4.1%</td>
</tr>
<tr>
<td>52A</td>
<td>Freetown muck, 0 to 1 percent slopes</td>
<td>0.7</td>
<td>0.3%</td>
</tr>
<tr>
<td>53A</td>
<td>Freetown muck, ponded, 0 to 1 percent slopes</td>
<td>3.3</td>
<td>1.5%</td>
</tr>
<tr>
<td>55A</td>
<td>Freetown coarse sand, 0 to 3 percent slopes, sanded surface</td>
<td>8.6</td>
<td>3.9%</td>
</tr>
<tr>
<td>252C</td>
<td>Carver coarse sand, 8 to 15 percent slopes</td>
<td>1.7</td>
<td>0.8%</td>
</tr>
<tr>
<td>253B</td>
<td>Hinckley loamy sand, 3 to 8 percent slopes</td>
<td>0.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>256B</td>
<td>Deerfield loamy fine sand, 3 to 8 percent slopes</td>
<td>1.0</td>
<td>0.5%</td>
</tr>
<tr>
<td>259B</td>
<td>Carver loamy coarse sand, 3 to 8 percent slopes</td>
<td>2.0</td>
<td>0.9%</td>
</tr>
<tr>
<td>276B</td>
<td>Ninigret fine sandy loam, 3 to 8 percent slopes</td>
<td>1.7</td>
<td>0.8%</td>
</tr>
<tr>
<td>437C</td>
<td>Plymouth loamy coarse sand, 8 to 15 percent slopes, bouldery</td>
<td>4.7</td>
<td>2.1%</td>
</tr>
<tr>
<td>480B</td>
<td>Plymouth - Carver complex, 3 to 8 percent slopes</td>
<td>3.0</td>
<td>1.4%</td>
</tr>
<tr>
<td>480C</td>
<td>Plymouth - Carver complex, 8 to 15 percent slopes</td>
<td>16.1</td>
<td>7.4%</td>
</tr>
<tr>
<td>480E</td>
<td>Plymouth - Carver complex, 15 to 35 percent slopes</td>
<td>32.5</td>
<td>14.9%</td>
</tr>
<tr>
<td>483C</td>
<td>Barnstable - Plymouth complex, 8 to 15 percent slopes, very bouldery</td>
<td>5.6</td>
<td>2.6%</td>
</tr>
<tr>
<td>483E</td>
<td>Barnstable - Plymouth complex, 15 to 35 percent slopes, very bouldery</td>
<td>8.0</td>
<td>3.7%</td>
</tr>
<tr>
<td>600</td>
<td>Pits, gravel</td>
<td>4.8</td>
<td>2.2%</td>
</tr>
<tr>
<td>602B</td>
<td>Urban land, 0 to 8 percent slopes</td>
<td>83.2</td>
<td>38.1%</td>
</tr>
<tr>
<td>656B</td>
<td>Udorthents - Urban land complex, 0 to 8 percent slopes</td>
<td>0.4</td>
<td>0.2%</td>
</tr>
<tr>
<td>659B</td>
<td>Udorthents, 0 to 8 percent slopes, gravelly</td>
<td>0.8</td>
<td>0.4%</td>
</tr>
<tr>
<td>660C</td>
<td>Udorthents, 8 to 15 percent slopes, gravelly</td>
<td>31.1</td>
<td>14.2%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>218.1</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>
**Purpose:** To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

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

**Procedure:** Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi²/watershed inches (csm/in).

Compute Q Rate using the following equation:

\[
Q = (qu) (A) (WQV)
\]

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

<table>
<thead>
<tr>
<th>Structure Name</th>
<th>Impv. (acres)</th>
<th>A (miles²)</th>
<th>tc (min)</th>
<th>tc (hr)</th>
<th>WQV (in)</th>
<th>qu (csm/in.)</th>
<th>Q (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WQU</td>
<td>4.84</td>
<td>0.0075625</td>
<td>6.0</td>
<td>0.100</td>
<td>1.00</td>
<td>774.00</td>
<td>5.85</td>
</tr>
</tbody>
</table>
## CDS Estimated Net Annual Solids Load Reduction

**Based on the Rational Rainfall Method**

### TCR Kingston

**Kingston, MA**

<table>
<thead>
<tr>
<th>Area</th>
<th>Weighted C</th>
<th>$t_c$</th>
<th>CDS Model</th>
<th>Unit Site Designation</th>
<th>Rainfall Station #</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.84 ac</td>
<td>0.9</td>
<td>6 min</td>
<td>3035-6</td>
<td>WQU</td>
<td>69</td>
</tr>
</tbody>
</table>

### CDS Treatment Capacity

<table>
<thead>
<tr>
<th>Rainfall Intensity (in/hr)</th>
<th>Percent Rainfall Volume</th>
<th>Cumulative Rainfall Volume</th>
<th>Total Flowrate (cfs)</th>
<th>Treated Flowrate (cfs)</th>
<th>Incremental Removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02</td>
<td>10.2%</td>
<td>10.2%</td>
<td>0.09</td>
<td>0.09</td>
<td>9.8</td>
</tr>
<tr>
<td>0.04</td>
<td>9.6%</td>
<td>19.8%</td>
<td>0.17</td>
<td>0.17</td>
<td>9.2</td>
</tr>
<tr>
<td>0.06</td>
<td>9.4%</td>
<td>29.3%</td>
<td>0.26</td>
<td>0.26</td>
<td>9.0</td>
</tr>
<tr>
<td>0.08</td>
<td>7.7%</td>
<td>37.0%</td>
<td>0.35</td>
<td>0.35</td>
<td>7.3</td>
</tr>
<tr>
<td>0.10</td>
<td>8.6%</td>
<td>45.6%</td>
<td>0.44</td>
<td>0.44</td>
<td>8.0</td>
</tr>
<tr>
<td>0.12</td>
<td>6.3%</td>
<td>51.9%</td>
<td>0.52</td>
<td>0.52</td>
<td>5.8</td>
</tr>
<tr>
<td>0.14</td>
<td>4.7%</td>
<td>56.5%</td>
<td>0.61</td>
<td>0.61</td>
<td>4.3</td>
</tr>
<tr>
<td>0.16</td>
<td>4.6%</td>
<td>61.2%</td>
<td>0.70</td>
<td>0.70</td>
<td>4.2</td>
</tr>
<tr>
<td>0.18</td>
<td>3.5%</td>
<td>64.7%</td>
<td>0.78</td>
<td>0.78</td>
<td>3.2</td>
</tr>
<tr>
<td>0.20</td>
<td>4.3%</td>
<td>69.1%</td>
<td>0.87</td>
<td>0.87</td>
<td>3.9</td>
</tr>
<tr>
<td>0.25</td>
<td>8.0%</td>
<td>77.1%</td>
<td>1.09</td>
<td>1.09</td>
<td>7.0</td>
</tr>
<tr>
<td>0.30</td>
<td>5.6%</td>
<td>82.7%</td>
<td>1.31</td>
<td>1.31</td>
<td>4.8</td>
</tr>
<tr>
<td>0.35</td>
<td>4.4%</td>
<td>87.0%</td>
<td>1.52</td>
<td>1.52</td>
<td>3.6</td>
</tr>
<tr>
<td>0.40</td>
<td>2.5%</td>
<td>89.5%</td>
<td>1.74</td>
<td>1.74</td>
<td>2.1</td>
</tr>
<tr>
<td>0.45</td>
<td>2.5%</td>
<td>92.1%</td>
<td>1.96</td>
<td>1.96</td>
<td>2.0</td>
</tr>
<tr>
<td>0.50</td>
<td>1.4%</td>
<td>93.5%</td>
<td>2.18</td>
<td>2.18</td>
<td>1.1</td>
</tr>
<tr>
<td>0.75</td>
<td>5.0%</td>
<td>98.5%</td>
<td>3.27</td>
<td>3.27</td>
<td>3.4</td>
</tr>
<tr>
<td>1.00</td>
<td>1.0%</td>
<td>99.5%</td>
<td>4.36</td>
<td>4.36</td>
<td>0.6</td>
</tr>
<tr>
<td>1.50</td>
<td>0.0%</td>
<td>99.5%</td>
<td>6.53</td>
<td>6.50</td>
<td>0.0</td>
</tr>
<tr>
<td>2.00</td>
<td>0.0%</td>
<td>99.5%</td>
<td>8.71</td>
<td>6.50</td>
<td>0.0</td>
</tr>
<tr>
<td>3.00</td>
<td>0.5%</td>
<td>100.0%</td>
<td>13.07</td>
<td>6.50</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**Removal Efficiency Adjustment**

**Predicted % Annual Rainfall Treated**

**Predicted Net Annual Load Removal Efficiency**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.