Memorandum

To: Mr. Barney Heath, Director
City of Newton Planning & Development
1000 Commonwealth Avenue
Room 202
Newton, Massachusetts 02459

Date: July 23, 2021

Project #: 10865.03

From: Peter Mara, PE
Richard Hollworth, PE

Re: Riverside Supplemental Stormwater Memo for Revised Stormwater Management Design

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The following memorandum summarizes the revisions to the stormwater management system for the proposed Riverside Station Redevelopment (the "Project") located on a 13.05-acre parcel of land on Grove Street in Newton, MA, (the "Site") originally presented in the Riverside Station Special Permit submitted to the City of Newton on December 9, 2019, as amended through May 12, 2021, and as described in the Riverside Station Stormwater Report. The proposed revisions to the stormwater management system remain consistent with the stormwater management plan outlined in the previous site plan filings with the City of Newton and provide similar water quality and improvements to the Site.

As shown in the site plans titled "Riverside Station", dated December 9, 2019 with revisions through July 23, 2021, the proposed drainage patterns are essentially unchanged from the previously submitted site plans, dated May 12, 2021. The modifications to the stormwater management system include relocating the subsurface infiltration system, P101, from the MBTA garage to Main Street and associated re-routing of drain line connections to and from infiltration system P101. The relocated infiltration system provides an increase in storage capacity and provides the same water quality and high recharge volume compared to the previous stormwater management design. The modifications also include a new connection to the City of Newton 60-inch drain culvert at the intersection of Main Street and Road C. This new drainage connection replaces the previous 60-inch drain culvert connection between Buildings 8 and the MBTA Garage in Road C. New Water Quality Units (WQU) have been located and sized to accommodate the new location of subsurface infiltration system P101. The changes to the stormwater management system improve the stormwater design by increasing storage capacity, reducing the overall depth of the drainage infrastructure, and reducing peak flows.

Other changes to the Site include Buildings 1 and 2 footprints resizing, and reconfigurations to the Research Green open space area by Road A between Buildings 2, 3, and 4, as shown on the Project's Site Plans dated May 12, 2021, previously submitted to the City of Newton. Utilities have been re-routed throughout the Site to provide space for the subsurface infiltration systems in Main Street. These utility changes can be found in the revised Special Permit Site Plans, dated July 23, 2021.

With these drainage modifications, the overall stormwater management system for the entire Site will continue to maintain peak flows at or below existing peak flows, provide the required total phosphorous (TP) and total suspended

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solids (TSS) removal, and provide the capacity to infiltrate the required recharge volume. Supporting revised drainage area maps, water quality calculations, and hydrologic results are attached at the end of this memorandum. Updated soil condition information performed by Sanborn Head at the revised location of system P101 are included in the attachments.

Hydrologic Analysis

Proposed Conditions

The stormwater runoff generated from the Site will be routed through a series of catch basins with deep sumps and oil/debris traps, proprietary separators, and a closed pipe network to two subsurface infiltration systems, P101 and P102, prior to discharging to the 60-inch culvert that runs east to west through the Site. The 60-inch City of Newton drain culvert eventually outfalls to the Charles River, which has associated Total Maximum Daily Load (TMDL) criteria established by the Environmental Protection Agency (EPA) Municipal Separate Storm Sewer System (MS4) Storm Water Management Program (SWMP) for the Upper/Middle Charles River Basin, with which the Project's revised stormwater management system has been designed to comply. The runoff pattern is generally unchanged from the previously presented design. Sanborn Head performed more recent subsurface investigations within the limits of the proposed subsurface infiltration system, P101, and has provided revised infiltration rates based on Rawls Rates, estimated seasonal high groundwater (ESHGW), and soil conditions at the revised location of system P101. The proposed infiltration rates established by Sanborn Head are used for the design of subsurface infiltration system P101.

As the proposed MBTA garage design advanced, it was determined that a subsurface infiltration system was no longer feasible to be located with the garage footprint without conflicting with the garage's foundation, thus the system was relocated to be within the pavement limits of Main Street. This allowed the garage to be designed without a subsurface infiltration system restricting space and locating the system within the roadway limits impact to the proposed landscaping along Main Street. Relocating the infiltration system allowed for a system with more chambers and a greater storage capacity. System P101 is split into two fields, Field A and Field B, connected by a 48" HDPE pipe. Field A is located between Buildings 5 and 10, where the existing soil conditions allow a high infiltration rate. Field B is located between Buildings 6 and 9, where the existing soil conditions have a low infiltration rate. Field B will provide additional storage for the stormwater runoff to be collected and retained prior to recharging through Field A or discharging to the existing City of Newton 60-inch culvert for larger storm events. The system is comprised of StormTrap Doubletrap units that are approximately 6.0-feet tall and allows the stormwater to be recharged. A weir is

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located at the northern end of Field B, which mitigates the collected runoff to allow the water quality storm volume to fully infiltrate. Sanborn Head determined the infiltration rate to be 8.27 in/hr, based on Sanborn Head' test pit SH-205 underneath Field A. The bottom of system P101 at elevation 53.0 is greater than four-feet above the ESHGW. Based on Sanborn Head's analysis, ESHGW is at elevation 45 and elevation 46, thus a mounding analysis is not required. Stormwater runoff conveyed to the StormTrap Doubletrap system is pretreated using three WQUs, located at the inlets to the system. Subsurface infiltration system P102 has remained unchanged.

Figure 3, *Proposed Drainage Conditions*, illustrates the proposed drainage conditions for the Project, including the revised building footprints, Road A layout, and relocation of subsurface infiltration system P101, is attached to this memorandum. A revised version of the previously presented in Table 2 provides a summary of the updated proposed conditions hydrologic data.

Table 2
Proposed Conditions Hydrologic Data

Drainage Area	*Discharge Location*	*Design Point*	*Area (acres)*	*Curve Number*	*Time of Concentration (min)*
100	Charles River Marsh	DP-1	2.3	52	8.8
101	Charles River Marsh	DP-1	13.2	87	5
116	Charles River Marsh	DP-1	1.2	93	5
117	Charles River Marsh	DP-1	0.3	91	5
1S	Charles River Marsh	DP-1	9.2	94	7.8
2S	Charles River Marsh	DP-1	0.7	79	5
3S	Charles River Marsh	DP-1	0.3	98	5.7
4S	Charles River Marsh	DP-1	1.1	98	5
200	Recreation Road	DP-2	1.4	73	5

A revised hydrologic analysis was conducted for the Site based on the input parameters in Table 2 above. The existing conditions have remained unchanged from the previous analyses. The detailed existing and proposed hydrologic analyses are attached.

Water Quality

The revised stormwater management system provides the required treatment for the 1-inch water quality volume as required. The previously proposed treatment trains for all design points have been maintained. Water quality calculations, including TSS removal, phosphorous removal, WQU sizing, recharge volume, and best management practices (BMP) sizing calculations are included in the attachments.

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Water quality treatment for Riverside runoff consists of an operation and maintenance ("O&M") program for water quality measures, a construction phase spill prevention plan, WQUs, and subsurface infiltration basins. A revised detailed stormwater O&M program has been included in the attachments.

Regulatory Compliance

The revised stormwater management system has been designed to comply with local and state regulations. As noted in the previously submitted Stormwater Report, the following stormwater regulations and guidelines apply to the Project:

- Two Total Maximum Daily Loads (TMDLs) enforced by the U.S. Environmental Protection Agency
- Massachusetts Department of Environmental Protection Stormwater Management Standards
- City of Newton Requirements for On-Site Drainage revised in October 2018 as part of the City of Newton's MS4 SWMP.

The Project complies with the regulations listed above and as described below.

Charles River Watershed - TMDL

The TMDL associated with the Charles River Watershed requires a 65-percent reduction in annual phosphorous loading. As previously reported in Tables 3-1, 3-2, and 3-3, the Project reduces more than the required 65-percent TP removal. Revised version of Tables 3-1, 3-2, and 3-3 are provided below reflecting the revised stormwater management design.

Table 3.1: Existing Conditions Phosphorus Loading

Site Use	*Land Cover within Use*	*Phosphorus Load Export Rate (lbs/ac/year)**	*Area (acres)***	*Existing Phosphorus Load Export (lb/yr)*
Commercial and Industrial	Directly Connected Impervious	1.78	12.77	22.73
	Pervious (HSG A)	0.03	2.68	0.08
Totals			**15.45**	**22.81**

* Per MA MS4 General Permit, Table 3-1 - Average annual distinct phosphorus load (P Load) export rates for use in estimating phosphorus load reduction credits the MA MS4 Permit.

**Site Area includes only the proposed area of redevelopment and excludes the MBTA Rail Yard.

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Table 3.2: Proposed Conditions Phosphorus Loading

Drainage Area ID	*Site Use*	*Land Cover within Use*	*Phosphorus Load Export Rate (lbs/ac/year)*	*Area (acres)*	*Proposed Phosphorus Load Export (lb/yr)*
1S	High Density Residential	Directly Connected Impervious	2.32	9.90	22.96
		Pervious (HSG A)	0.03	0.61	0.02
2S	High Density Residential	Directly Connected Impervious	2.32	0.49	1.13
		Pervious (HSG A)	0.03	0.22	0.01
3S	Commercial	Directly Connected Impervious	1.78	0.26	0.46
		Pervious (HSG A)	0.03	0.00	0.00
4S	Commercial	Directly Connected Impervious	1.78	1.08	1.92
		Pervious (HSG A)	0.03	0.00	0.00
116	Commercial	Directly Connected Impervious	1.78	1.14	2.02
		Pervious (HSG A)	0.03	0.10	0.00
117	Commercial	Directly Connected Impervious	1.78	0.22	0.40
		Pervious (HSG A)	0.03	0.03	0.00
200	Commercial	Directly Connected Impervious	1.78	0.81	1.44
		Pervious (HSG A)	0.03	0.60	0.02
	Totals			**15.45**	**30.38**

Table 3.3: Proposed Conditions Phosphorus Reduction*

Drainage Area ID	*Drainage Area BMP Type*	*Phosphorus Load to BMP (lbs/yr)*	*BMP Removal %***	*Proposed Phosphorus Load after BMP (lbs/yr)*
1S	Subsurface Infiltration	22.98	98%	0.46
2S	Subsurface Infiltration	1.14	97%	0.04
3S	N/A	0.46	0%	0.46
4S	N/A	1.92	0%	1.92
116	Existing	2.02	0%	2.02
117	Existing	0.40	0%	0.40
200	Existing	1.46	0%	1.46
Totals		**30.38**		**6.76**

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*Detailed calculations for the analysis of phosphorus reduction is included in Appendix C - *Weighted Phosphorous Removal Calculation*.

**Per MA MS4 General Permit Appendix F Attachment 3, Table 3-15.

From Table 3.1 above, the total phosphorous load for the Site under existing conditions is 22.81 lbs/yr. From Table 3.2 above, the total phosphorous load directed to the BMPs under proposed conditions is equal to 30.38 lbs/yr. The use of the BMPs on the Site provide a dramatic decrease of loading with a removal rate of 23.62 lbs/yr for a final total of 6.76 lbs/yr. This removal equates to an 78% phosphorous removal under proposed conditions, which exceeds the required 65%.

Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated below, the proposed Project's stormwater improvements comply with the DEP Stormwater Management Standards.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1.

Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2. As in the previous submission, the rainfall-runoff response of the Site under existing and proposed conditions was evaluated for the storm events with recurrence intervals of 2, 10, 25, and 100-years. Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm and NOAAA Atlas 14 precipitation depths for the Site: 3.26, 4.77, 6.03, and 8.78 inches, respectively. The peak discharge rates for the Project, previously presented in Table 4, have been revised and, consistent with the previous design, decrease the peak discharge rates for each storm event. A revised Table 4 has been included below to demonstrate the revised peak discharge rates.

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Table 4
Peak Discharge Rates (cfs*)

Design Point	*2-year*	*10-year*	*25-year*	*100-year*
Design Point 1: Charles River Marsh				
Existing	58.8	103.6	139.8	219.0
Proposed	37.8	75.14	124.3	197.9
Design Point 2: Recreation Road				
Existing	6.0	10.5	14.1	22.0
Proposed	2.3	4.8	6.9	11.6

Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3. As previously established, the predominant soil is HSG 'A'. In accordance with the Stormwater Handbook and based upon HSG Type 'A', the Required Recharge Volume for the Project is 8,276 cubic feet.

As previously reported, the recharge of stormwater has been provided using structured subsurface infiltration systems which have been sized using the Simple Dynamic Method. A majority of the Site is directed through Infiltration System P101, now located in Main Street. The bottom of the system is at elevation 53.00. The system is proposed for the stormwater to be recharged in an area with an infiltration rate of 8.27 inches per hour. The remainder of the Site is directed through System P102, which consists of SC-740 Chambers and is infiltrated at a rate of 1.02 in/hr. The tributary area contributing stormwater runoff to System P102 and the design of System P102 have remained unchanged. Each infiltration system has been designed to drain completely within 72 hours. The provided recharge volume, previously presented in Table 5, have been revised and, consistent with the previous design, the Project provides more than required recharge volume via systems P101 and P102. A revised Table 5 has been included below.

Table 5
Summary of Recharge Calculations

Infiltration BMP	*Provided Recharge Volume (cubic feet)*
P101 – Doubletrap	30,286
P102 – SC-740	1,797
Total Provided Recharge	**32,083**
Total Required Recharge	**8,276**

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Standard 4: Water Quality

The Project has been designed to comply with Standard 4. The proposed treatment train for the Project has remained unchanged and provides greater than 80% TSS Removal of stormwater runoff from all proposed impervious surface as well as 44% pretreatment prior to the infiltration BMPs. The required water quality volume, based on 1-inch of runoff over the impervious area, for systems P101 and P102 are 35,926 CF and 1,771 CF, respectively. Using Simple Dynamic Method, system P101 provides 37,264 CF and system P102 provides 1,964 CF of volume to treat the required 1-inch water quality volume. Revised water quality volume calculations are attached.

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

Consistent with the previously submitted stormwater management design, the stormwater management system is designed to provide 44% pretreatment as well as treat the 1-inch water quality volume.

Standard 6: Critical Areas

The Project does not discharge to or near a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

Consistent with the previously submitted stormwater management design, the proposed stormwater management system has been designed to consider plaza and sidewalk areas as impervious. In reality, these areas will include a variety of pervious cover types including planters and permeable pavers, therefore causing no increase in impervious area from existing to proposed conditions. As such, the Project is considered a redevelopment under MassDEP Standards. Notwithstanding, the stormwater management system has been designed to comply with the Stormwater Management Standards similar to a new development.

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

The Project will disturb more than one acre of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction

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General Permit (CGP). As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins.

Standard 9: Operation and Maintenance Plan

The Project complies with Standard 9. A revised O&M plan is attached to this memorandum, reflecting the revised stormwater management design.

Standard 10: Prohibition of Illicit Discharges

Sanitary sewer and storm drainage structures remaining from previous development which are part of the redevelopment area will be removed or will be incorporated into updated sanitary sewer and separate stormwater sewer systems. The design plans submitted have been design so that the components included therein are in full compliance with current standards. No statement is made with regard to the drainage system in portions of the Site not included in the redevelopment project area. The previously submitted Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges.

Conclusion

The Revised Stormwater Management Plan presented herein and as shown on the revised Special Permit Site Plans provides functionality for the Project while maintaining previously submitted design elements and intent. The proposed modifications include Best Management Practices for maintaining stormwater runoff quality both during and after construction and are designed to protect downstream receiving waters from stormwater related impacts.

Attachment 1 – Figures

Figure 2: Existing Drainage Conditions

Figure 3: Proposed Drainage Conditions

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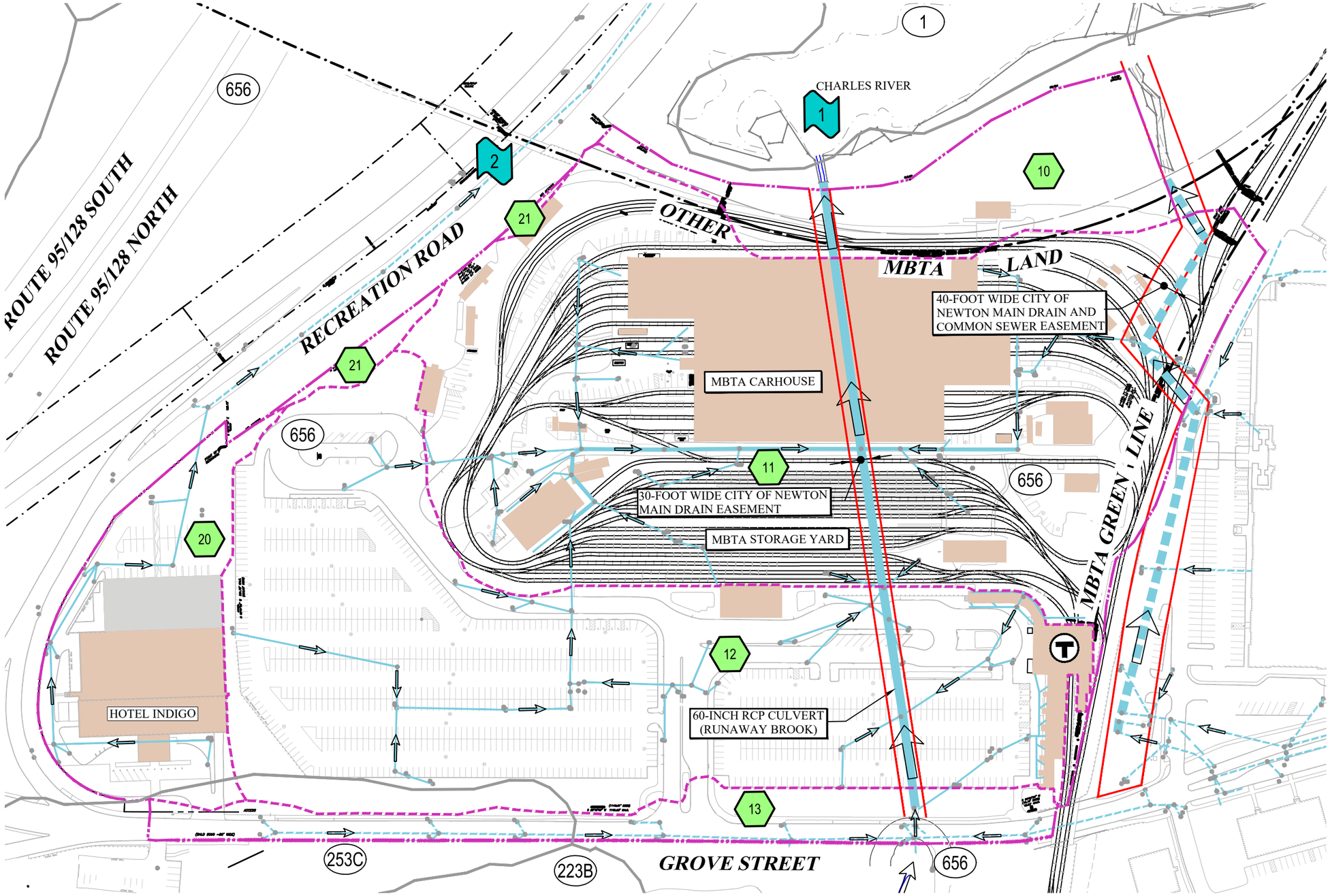

1 SUBCATCHMENT DRAINAGE AREA DESIGNATION

1 DESIGN POINT

MAJOR DRAINGE AREA BOUNDARY

SUB–DRAINAGE AREA BOUNDARY

LIMIT OF REGULATED RESOURCE

TRIBUTARY TO DESIGN POINT 1

CHARLES RIVER

10 11 12 13

TRIBUTARY TO DESIGN POINT 2

RECREATION ROAD

20 21

SCS SOIL CLASSIFICATIONS

223B SCIO VERY FINE SANDY LOAM, 3 TO 8 PERCENT SLOPES, HSG B/D

253C HINCKLEY LOAMY SAND, 8 TO 15 PERCENT SLOPES, HSG A

656 UDORTHENTS-URBAN LAND COMPLEX

Drainage Utility Easement

Existing Drain Infrastructure (On-Site)

Existing Drain Infrastructure (Off-Site)

Drainage Flow Direction

0 75 150 Feet

vhb

Existing Drainage Conditions
Riverside Station
Grove Street
Newton, Massachusetts

Figure 2

12/09/19

CHARLES RIVER

DP-1

DP-2

ROUTE 95/128 SOUTH

ROUTE 95/128 NORTH

RECREATION ROAD

100

40-FOOT WIDE CITY OF NEWTON MAIN DRAIN AND COMMON SEWER EASEMENT

60-INCH RCP CULVERT (RUNAWAY BROOK)

MBTA CARHOUSE

101

4S

3S

MBTA GREEN LINE

30-FOOT WIDE CITY OF NEWTON MAIN DRAIN EASEMENT

MBTA STORAGE YARD

200

BUILDING 1 LAB/RESEARCH/OFFICE

BUILDING 2 LAB/RESEARCH/OFFICE

MBTA GARAGE

BUILDING 8 RETAIL/ RESIDENTIAL

1S

BUILDING 10 RESIDENTIAL

BUILDING 9 RETAIL

RIVERSIDE STATION

BUILDING 7 RETAIL/ RESIDENTIAL

BUILDING 3 RESIDENTIAL

BUILDING 4 RESIDENTIAL

P101

P101

BUILDING 5 RESIDENTIAL

BUILDING 6 RETAIL/ RESIDENTIAL

P102

2S

116

117

GROVE STREET

LEGEND

1 — SUBCATCHMENT DRAINAGE AREA DESIGNATION

1 — STORMWATER STORAGE BMP

1 — DESIGN POINT

MAJOR DRAINGE AREA BOUNDARY

SUB–DRAINAGE AREA BOUNDARY

LIMIT OF REGULATED RESOURCE

TRIBUTARY TO DESIGN POINT 1
CHARLES RIVER

1S 2S 4S 100 101 116 117

TRIBUTARY TO DESIGN POINT 2
RECREATION ROAD

200 3S

Proprietary Device

Subsurface Infiltration Structure

Drainage Utility Easement

Existing Drain Infrastructure (On-Site)

Proposed Drain Infrastructure

0 75 150 Feet

vhb

Proposed Drainage Conditions
Riverside Station
Grove Street
Newton, Massachusetts

Figure 3

12/9/19
Rev 7/23/21

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Attachment 2 – Water Quality and Recharge Worksheets

BMP Sizing (Includes Drawdown & Isolator Row Sizing Calculations)

Required and Provided Recharge Volumes

TSS Removal Worksheets

Stormceptor Sizing

Weighted Phosphorous Removal Calculation

On-Site Subsurface Investigation and Infiltration Rates

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Best Management Practice (BMP) Sizing

Project Name:	**Riverside Station**	**Proj. No.:**	10865.03
Project Location:	**Newton, MA**	**Date:**	July 2021
		Calculated by:	PTM
		Checked by:	KSS

Per Massachusetts Stormwater Handbook (2008) Vol. 3 Ch. 1 pg 37, where infiltration BMPs are sized to provide both water quality treatment and recharge, the infiltration BMP has been sized to treat the larger of the Required Water Quality Volume and the Required Recharge Volume.

Where the Volume needed to treat Total Phosphorus exceeds the sizing requirements of the Massachusetts Stormwater Handbook (2008), BMPs have been sized per the EPA's "Stormwater Best Management Practices (BMP) Performance Analysis" (March 2010).

The sizing requirements for project BMPs have been provided below. The minimum required treatment volume per the above standards has been listed for each BMP as "Sizing Based On."

BMP P101

Runoff from Subcatchment Area 1S

Total Impervious Area = 9.897 ac.

BMP Type: Subsurface Infiltration Structure

Sizing Based On: Water Quality Volume

Required

Depth to be Treated (in.): **1.0 ***

*Within an area with a Rapid Infiltration Rate

Required Volume (c.f.): **35,926**

Assumptions

StormTrap ST2 DoubleTrap

Stone Foundation Depth (in.): 0

Freeboard (in.): 6

Values

Soil Infiltration Rate (K) (in./hr): 8.27

Best Management Practice (BMP) Sizing

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Provided

Number of Chambers (C_{1S}): 36
Chamber Storage, inlcuding border (c.f.): 1,577.4 (Chamber Storage/# of Chambers)
Border Volume Storage (c.f.) = 31,297.0 (Taken from HydroCAD)

Provided Static Storage Volume (V_S) (c.f.) — Below Weir Elevation 56.70, taken from HydroCAD Storage Table, see table at end of calculations.

V_S = 30,286 c.f.

Field A Bed Size (S) (s.f.)* = Base Length x Base Width

S = 5,063 s.f.

*Within an area with a Rapid Infiltration Rate

Infiltration Volume (V_I) per Simple Dynamic Method** = Bed Size (S) x Soil Infiltration Rate (K) x 2(hr)

V_I = 6,979 c.f.

Total Treatment Volume (V_T) = $V_S + V_I$

V_T = 37,264 c.f.

Note: Based on EPA "Stormwater Best Management Practices (BMP) Performance Analysis" and assuming commercial and high density land uses, the BMP is expected to achieve an approximate 98 percent total phosphorus reduction.

Drawdown Analysis

$$Time_{drawdown}\ (hr) = \frac{\text{Total Treatment Volume } (V_T)}{\text{Bed Size (S) x Soil Infiltration Rate (K)}}$$

$Time_{drawdown}$ = 10.68 hr <72 hr OK

Best Management Practice (BMP) Sizing

Project Name:	**Riverside Station**	**Proj. No.:**	10865.03
Project Location:	**Newton, MA**	**Date:**	July 2021
		Calculated by:	PTM
		Checked by:	KSS

BMP P102

Runoff from Subcatchment Area 2S — Total Impervious Area = 0.488 ac.

BMP Type: Subsurface Infiltration Structure

Sizing Based On: Water Quality Volume

Required

Depth to be Treated (in.): **1.0 ***

*Within an area with a Rapid Infiltration Rate

Required Volume (c.f.): **1,771**

Pretreatment: Isolator Row Sizing

Depth to be Treated (in.): **0.1**

Required Volume (c.f.): **177**

Provided Volume (5 chambers with 45.9 c.f. storage each) (c.f.): **230**

Assumptions

Stormtech SC-740 (see sizing table at end of calculations)

Number of Chambers (C_{2S}): 24
Stone Foundation Depth (in.): 6
Freeboard (in.): 12

Values

Soil Infiltration Rate (K) (in./hr): 1.02

Provided

Provided Static Storage Volume (V_S) (c.f.) — Below Weir Elevation 57.00, taken from HydroCAD Storage Table, see table at end of calculations.

V_S = 1,797 c.f.

Bed Size (S) (s.f.) = Base Length x Base Width

S = 980 s.f.

Infiltration Volume (V_I) per Simple Dynamic Method = Bed Size (S) x Soil Infiltration Rate (K) x 2(hr)

V_I = 167 c.f.

Total Treatment Volume (V_T) = $V_S + V_I$

V_T = 1,964 c.f.

Note: Based on EPA "Stormwater Best Management Practices (BMP) Performance Analysis" and assuming commercial and high density land uses, the BMP is expected to achieve an approximate 96 percent total phosphorus reduction.

Drawdown Analysis

$$Time_{drawdown}\ (hr) = \frac{\text{Total Treatment Volume } (V_T)}{\text{Bed Size (S) x Soil Infiltration Rate (K)}}$$

$Time_{drawdown}$ = 23.57 hr <72 hr OK

Best Management Practice (BMP) Sizing

Project Name:	**Riverside Station**	**Proj. No.:**	10865.03
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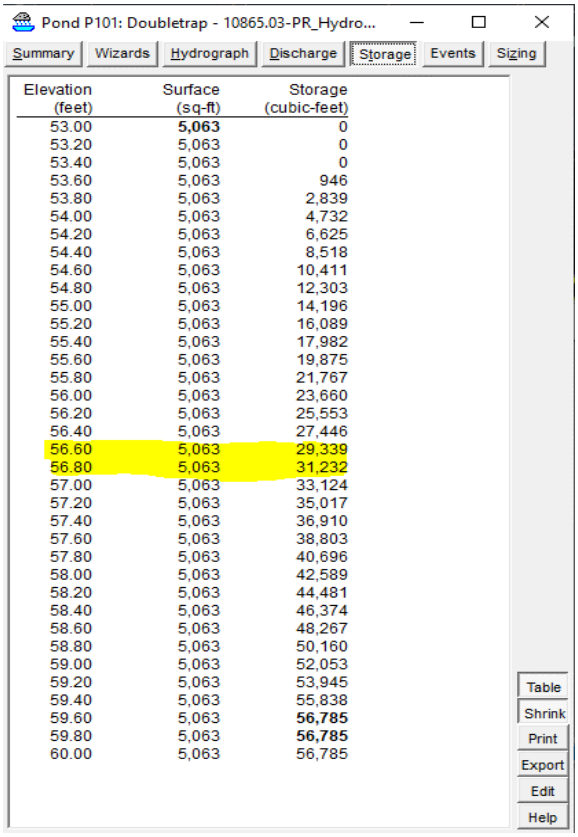
		Calculated by:	PTM
		Checked by:	KSS



Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
53.00	**5,063**	0
53.20	5,063	0
53.40	5,063	0
53.60	5,063	946
53.80	5,063	2,839
54.00	5,063	4,732
54.20	5,063	6,625
54.40	5,063	8,518
54.60	5,063	10,411
54.80	5,063	12,303
55.00	5,063	14,196
55.20	5,063	16,089
55.40	5,063	17,982
55.60	5,063	19,875
55.80	5,063	21,767
56.00	5,063	23,660
56.20	5,063	25,553
56.40	5,063	27,446
56.60	5,063	29,339
56.80	5,063	31,232
57.00	5,063	33,124
57.20	5,063	35,017
57.40	5,063	36,910
57.60	5,063	38,803
57.80	5,063	40,696
58.00	5,063	42,589
58.20	5,063	44,481
58.40	5,063	46,374
58.60	5,063	48,267
58.80	5,063	50,160
59.00	5,063	52,053
59.20	5,063	53,945
59.40	5,063	55,838
59.60	5,063	**56,785**
59.80	5,063	**56,785**
60.00	5,063	56,785

Best Management Practice (BMP) Sizing

Project Name:	**Riverside Station**	**Proj. No.:**	10865.03
Project Location:	**Newton, MA**	**Date:**	July 2021
		Calculated by:	PTM
		Checked by:	KSS

Pond P102: SC-740 - 10865.03-PR_HydroCAD-REV - concept rapid infil

Summary | Wizards | Hydrograph | Discharge | Storage | Events | Sizing

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
54.10	**980**	0
54.20	980	39
54.30	980	78
54.40	980	118
54.50	980	157
54.60	980	196
54.70	980	273
54.80	980	350
54.90	980	427
55.00	980	503
55.10	980	579
55.20	980	654
55.30	980	728
55.40	980	801
55.50	980	874
55.60	980	946
55.70	980	1,017
55.80	980	1,087
55.90	980	1,156
56.00	980	1,224
56.10	980	1,291
56.20	980	1,356
56.30	980	1,420
56.40	980	1,482
56.50	980	1,542
56.60	980	1,600
56.70	980	1,655
56.80	980	1,707
56.90	980	1,754
57.00	980	1,797
57.10	980	1,837
57.20	980	1,876
57.30	980	1,915
57.40	980	1,955
57.50	980	1,994
57.60	980	**2,033**

Recharge Calculations

Project Name: Riverside | **Proj. No.:** 10856.03

Project Location: Newton, MA | **Date:** July 2021

Calculated by: PTM

Checked by: KSS

Proposed Impervious Surface Summary

Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
1S	1.69	0.0	0.0	0.0	1.7
2S	0.49	0.0	0.0	0.0	0.5
3S	0.26	0.0	0.0	0.0	0.3
4S	1.08	0.0	0.0	0.0	1.1
100	0.00	0.0	0.0	0.0	0.0
101	0.06	0.0	0.0	0.0	0.1
116	0.00	0.0	0.0	0.0	0.0
117	0.22	0.0	0.0	0.0	0.2
200	0.00	0.0	0.0	0.0	0.0
TOTAL	**3.8**	**0.0**	**0.0**	**0.0**	**3.8**

Required Recharge Volume (Cubic Feet)

HSG	Area (acres)	Recharge Depth * (in.)	Volume (c.f.)
A	3.8	0.60	8,276
B	0.0	0.35	0
C	0.0	0.25	0
D	0.0	0.10	0
TOTAL			**8,276**

* Per 2008 Massachusetts DEP Recharge Requirement

Provided Recharge Volume (Cubic Feet)

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet - see HydroCAD report)

P101	30,286	
P102	1,797	
Total	**32,083**	c.f.

TSS Removal Calculation Worksheet

101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name:	**Riverside Redevelopment**	Sheet:	**1 of 2**
Project Number:	**10856.03**	Date:	**July 2020**
Location:	**Newton, MA**	Computed by:	**PTM**
Discharge Point:	**DP-1**	Checked by:	**KSS**
Drainage Area(s):	**1S**		

1. Pre-Treatment prior to Infiltration

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**100%**	**25%**	**75%**
Proprietary Separator	**44%**	**75%**	**33%**	**42%**
	0%	**42%**	**0%**	**42%**

Pre-Treatment TSS Removal = **58%**

2. Total TSS Removal including Pretreatment 1.

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**100%**	**25%**	**75%**
Proprietary Separator	**44%**	**75%**	**33%**	**42%**
StormTrap Infiltration System	**80%**	**42%**	**34%**	**8%**
	0%	**8%**	**0%**	**8%**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. The proprietary separator has been sized to treat 56% per manufacturer's sizing calculations. A TSS Removal Rate for Proprietary Separator of 44% is used instead.

** Equals remaining load from previous BMP (E)

Treatment Train TSS Removal = **92%**

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TSS Removal Calculation Worksheet

Project Name:	**Riverside Redevelopment**	Sheet:	**2 of 2**
Project Number:	**10865.03**	Date:	**July 2020**
Location:	**Newton, MA**	Computed by:	**PTM**
Discharge Point:	**DP-1**	Checked by:	**KSS**
Drainage Area(s):	**2S**		

1. Pre-Treatment prior to Infiltration

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**100%**	**25%**	**75%**
Isolator Row* **	**66%**	**75%**	**50%**	**26%**
	0%	**26%**	**0%**	**26%**
		Pre-Treatment TSS Removal =		**75%**

2. Total TSS Removal including Pretreatment 1.

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**100%**	**25%**	**75%**
Isolator Row* **	**66%**	**75%**	**50%**	**26%**
Subsurface Infiltration Structure	**80%**	**26%**	**20%**	**5%**
	0%	**5%**	**0%**	**5%**
			Treatment Train TSS Removal =	**95%**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
** Equals remaining load from previous BMP (E)
*** TSS removal for Isolator Row is based on Manufacturer's removal efficiency per MA STEP Performance Evaluation

Brief Stormceptor Sizing Report - Riverside WQU 1

Project Information & Location			
Project Name	Riverside Station	**Project Number**	10865.03
City	Newton	**State/ Province**	Massachusetts
Country	United States of America	**Date**	5/19/2021
Designer Information		**EOR Information (optional)**	
Name	Max Hogewind	**Name**	
Company	Vanasse Hangen Brustlin, Inc	**Company**	
Phone #	617-320-0057	**Phone #**	
Email	mhogewind@vhb.com	**Email**	

Stormwater Treatment Recommendation
The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Riverside WQU 1
Target TSS Removal (%)	44
TSS Removal (%) Provided	59
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	59
STC 900	69
STC 1200	69
STC 1800	69
STC 2400	74
STC 3600	74
STC 4800	79
STC 6000	79
STC 7200	82
STC 11000	86
STC 13000	86
STC 16000	89

Sizing Details

Drainage Area

Total Area (acres)	4.16
Imperviousness %	100.0

Rainfall

Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective

TSS Removal (%)	44.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	

Up Stream Storage

Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion

Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal

Fine Distribution

Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Notes

• Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
• Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
• For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Brief Stormceptor Sizing Report - Riverside WQU 2

Project Information & Location			
Project Name	Riverside Station	**Project Number**	10865.03
City	Newton	**State/ Province**	Massachusetts
Country	United States of America	**Date**	5/19/2021
Designer Information		**EOR Information (optional)**	
Name	Max Hogewind	**Name**	
Company	Vanasse Hangen Brustlin, Inc	**Company**	
Phone #	617-320-0057	**Phone #**	
Email	mhogewind@vhb.com	**Email**	

Stormwater Treatment Recommendation
The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Riverside WQU 2
Target TSS Removal (%)	44
TSS Removal (%) Provided	91
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	91
STC 900	95
STC 1200	95
STC 1800	95
STC 2400	96
STC 3600	97
STC 4800	97
STC 6000	98
STC 7200	98
STC 11000	99
STC 13000	99
STC 16000	99

Stormceptor®

CONTECH ENGINEERED SOLUTIONS
A FORTERRA COMPANY

Sizing Details

Drainage Area

Total Area (acres)	0.18
Imperviousness %	100.0

Rainfall

Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective

TSS Removal (%)	44.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	

Up Stream Storage

Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion

Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal

Fine Distribution

Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Notes

• Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
• Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
• For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Brief Stormceptor Sizing Report - Riverside WQU 3

Project Information & Location			
Project Name	Riverside Station	**Project Number**	10865.03
City	Newton	**State/ Province**	Massachusetts
Country	United States of America	**Date**	5/19/2021
Designer Information		**EOR Information (optional)**	
Name	Max Hogewind	**Name**	
Company	Vanasse Hangen Brustlin, Inc	**Company**	
Phone #	617-320-0057	**Phone #**	
Email	mhogewind@vhb.com	**Email**	

Stormwater Treatment Recommendation
The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Riverside WQU 3
Target TSS Removal (%)	44
TSS Removal (%) Provided	71
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	71
STC 900	79
STC 1200	79
STC 1800	79
STC 2400	83
STC 3600	84
STC 4800	87
STC 6000	88
STC 7200	90
STC 11000	92
STC 13000	92
STC 16000	94

Sizing Details

Drainage Area

Total Area (acres)	1.63
Imperviousness %	100.0

Rainfall

Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective

TSS Removal (%)	44.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	

Up Stream Storage

Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion

Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal

Fine Distribution

Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Notes

• Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
• Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
• For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Phosphorus Loading - Existing Conditions

Project Name: Riverside Station
Project Location: Newton, MA

Proj. No.: 10865.03
Date: July 2021
Calculated by: PTM
Checked by: KSS

Subcatchment Number	Land Cover within Use	Phosphorus Load Export Rate (lbs/ac/year)*	Area** (acre)	Phosphorous Loading to BMP per Area (lb/yr)	Total Phosphorus Loading to BMP (lb/yr)
Commercial (Indigo Hotel)	Directly Connected Impervious	1.78	2.20	3.92	3.94
	Pervious (HGS A)	0.03	0.72	0.02	
Industrial (MBTA Parking Lot)	Directly Connected Impervious	1.78	10.57	18.81	18.87
	Pervious (HGS A)	0.03	1.96	0.06	
Totals =			15.45	---	22.81

* Per MA MS4 General Permit, Table 3-1, Average Annual Disttinct Phosphorus Load (P Load) export rates for use in exstimating phosphorus load reduction credits the MA MS4 Permit.
** Site Area includes only the proposed area of redevelopment and excludes the MBTA Rail Yard

Phosphorus Loading to BMPs - Proposed Conditions

Project Name: Riverside Station
Project Location: Newton, MA

Proj. No.: 10865.03
Date: July 2021
Calculated by: PTM
Checked by: KSS

Subcatchment Number	Land Cover within Use	Phosphorus Load Export Rate (lbs/ac/year)*	Area (acre)	Phosphorous Loading to BMP per Area (lb/yr)	Total Phosphorus Loading to BMP (lb/yr)	Phosphorous Removal	Total Phosphorus Removal (lb/yr)
1S	Impervious (High-Density Residential)	2.32	9.90	22.96	22.98	98%	22.52
	Pervious (HGS A)	0.03	0.61	0.02			
2S	Impervious (High-Density Residential)	2.32	0.49	1.13	1.14	97%	1.10
	Pervious (HGS A)	0.03	0.22	0.01			
3S	Impervious (Commercial)	1.78	0.26	0.46	0.46	0%	0.00
	Pervious (HGS A)	0.03	0.00	0.00			
4S	Impervious (Commercial)	1.78	1.08	1.92	1.92	0%	0.00
	Pervious (HGS A)	0.03	0.00	0.00			
116	Impervious (Commercial)	1.78	1.14	2.02	2.03	0%	0.00
	Pervious (HGS A)	0.03	0.10	0.00			
117	Impervious (Commercial)	1.78	0.22	0.40	0.40	0%	0.00
	Pervious (HGS A)	0.03	0.03	0.00			
200	Impervious (Commercial)	1.78	0.81	1.44	1.46	0%	0.00
	Pervious (HGS A)	0.03	0.60	0.02			
Totals =			15.45	---	30.38	---	23.62

Existing Phosphorus Load	22.81
Proposed Phosphorus Load	30.38
Total Phosphorus Removed	***23.62***
	78%

* Per MA MS4 General Permit, Table 3-1, Average Annual Distinct Phosphorus Load (P Load) export rates for use in exstimating phosphorus load reduction credits the MA MS4 Permit.

Weighted Phosphorous Removal Calculation

Project Name: Riverside Station
Project Location: Newton, MA

Proj. No.: 10865.03
Date: July 2021
Calculated by: PTM
Checked by: KSS

Subcatchment Number	Impervious Area (ac)	Infiltration Rate (in/hr)	Phosphorous Removal	A x PR
1S	9.90	8.27	98%	9.70
2S	0.49	1.02	97%	0.47
3S	0.26	N/A	0%	0.00
4S	1.08	N/A	0%	0.00
116	1.14	N/A	0%	0.00
117	0.22	N/A	0%	0.00
200	0.81	N/A	0%	0.00
Totals =	13.89		---	10.17

Weighted Phosphorous Removal:	**S(AxPR) / SA =**	**73.2%**

Note: Phosphorous removal based on EPA "Stormwater Best Management Practices (BMP) Performance Analysis" assuming commercial and high density land uses. Phosphorous removal rate based on 1.0 inch Depth of Runoff Treated.

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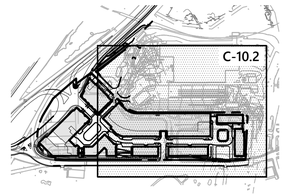


Key

Not To Scale

NOTES:
1. DRAIN LINES ARE TO BE 12" IN DIAMETER AND HDPE IN MATERIAL, UNLESS OTHERWISE SHOWN HEREON.
2. UTILITY CONNECTIONS TO PROPOSED BUILDINGS SHOWN GRAPHICALLY ONLY. FINAL CONNECTION LOCATIONS TO BE DETERMINED AS BUILDINGS ARE FURTHER DESIGNED AND DEVELOPED.

MBTA MAINTENANCE FACILITY

LOT AREA = 984,348 SQ. FT. 22.598 ACRES

MATCHLINE

APPROXIMATE DISPOSAL SITE BOUNDARY FOR RTN 3-18501

APPROXIMATE DISPOSAL SITE BOUNDARY FOR RTN 3-10565

INFILTRATION SYSTEM 103

INFILTRATION SYSTEM 101

INFILTRATION SYSTEM 102

INFILTRATION SYSTEM 101
1 ROW x 20 CHAMBERS
STORMTRAP 8' TALL DOUBLETRAP
BOTTOM OF SYSTEM = 51.00
ESHGW = 44.00
CONTRACTOR TO OVEREXCAVATE DOWN TO SAND AND FILL WITH ___

INFILTRATION SYSTEM 102
2 ROWS x 12 SC-740 CHAMBERS
BOTTOM OF STONE = 54.10
ESHGW = 49.20

BUILDING 11
RESEARCH/OFFICE

BUILDING 10
RESIDENTIAL/GARAGE

BUILDING 9
RETAIL (BELOW) GARAGE

BUILDING 8
RETAIL/RESIDENTIAL

BUILDING 7
RETAIL/RESIDENTIAL

BUILDING 6
RETAIL/RESIDENTIAL

BUILDING 5
RESIDENTIAL

BUILDING 4
RESIDENTIAL

RIVERSIDE STATION

Road A

Road B

Road C

Main Street

Grove Street

SH-105 SH-106 SH-107 SH-108 SH-109 SH-110 SH-111 SH-201 SH-202 SH-203 SH-204 SH-205 SH-206 SH-207

TP-3 TP-4 TP-5 HA09-2 RIZ-3 HA09-4 HA09-14(OW) HA09-9 HA09-13(OW) HA09-10(OW) HA09-8 HA09-12 HA09-11 HA09-6(OW)

CUT & CAP 12" DRAIN LINE

EXISTING 15' WIDE MWRA EASEMENT
CONNECT TO EXISTING 48" MWRA WATER LINE
PROPOSED 15' WIDE EASEMENT FOR MWRA WATER LINE

12" TO 6" REDUCER

CONNECT TO EXISTING 8" WATER LINE

EXISTING HYDRANT TO REMAIN

UTILITY SERVICE CONNECTIONS SHOWN GRAPHICALLY ONLY. FINAL LOCATIONS TO BE DETERMINED AS BUILDING DESIGN PROGRESSES

SEWER BUILDING CONNECTION (TYP)

ROOF DRAIN CONNECTION (TYP)

CUT & CAP 24" DRAIN LINE

CONTRACTOR TO VIDEO EXIST CULVERT PRIOR TO CONSTRUCTION TO CHECK FOR DEBRIS AND BLOCKAGE. CONTRACTOR TO REMOVE DEBRIS AS NEEDED.

ADJUST EXISTING MANHOLE TO GRADE

CONNECT TO EXIST 6" WATER LINE

CONNECT TO EXIST 6 INCH DRAIN LINE. CONTRACTOR TO CONFIRM INVERT PRIOR TO CONSTRUCTION

CONNECT TO EXIST ROOF DRAIN. CONTRACTOR TO CONFIRM INVERT PRIOR TO CONSTRUCTION

MAINTAIN EXIST ROOF DRAINS. CONTRACTOR TO CONFIRM INVERTS PRIOR TO CONSTRUCTION

CONNECT TO EXIST ROOF DRAIN. CONTRACTOR TO CONFIRM INVERT PRIOR TO CONSTRUCTION

RECONSTRUCT EXIST ROOF DRAINS. CONTRACTOR TO CONFIRM INVERTS PRIOR TO CONSTRUCTION

8" HDPE

CONNECT TO EXIST UP. BRING TELECOM UNDERGROUND AT UP.

EXIST HYDRANT DECOMMISSIONED. COORDINATE REPLACEMENT OF HYDRANT WITH CITY OF NEWTON

CONNECT TO EXIST CULVERT AT INVERT 53.00
EXIST CULVERT
INVERT = 50.15±
CROWN = 55.15±

EXISTING CULVERT TO REMAIN
CONNECT TO EXIST CULVERT AT INVERT 54.50;
EXIST CULVERT
INVERT = 50.58±
CROWN = 55.58±
TOP SECTION OF STRUCTURE TO BE RECONSTRUCTED WITH RISERS AND DMH F&C FLUSH WITH FINISHED GRADE. SEE DETAIL

OIL GAS SEPARATOR
RIM = 59.50
INV IN = 55.50±
INV OUT = 55.40±

R&R EXIST UP AND RECONNECT EXIST OHW. BRING ELEC UNDERGROUND AT UP.

APPROXIMATE 25' NVB

CUT, PLUG, AND REMOVE EXIST DRAINS

EXIST HEADWALL TO REMAIN
CONNECT TO EXIST CB (INV=57.75)
APPROXIMATE EDGE OF STREAM
CONNECT TO EXISTING 12" WATER LINE

CONNECT TO EXISTING 12" WATER LINE

APPROXIMATE 100' BZ
APPROXIMATE 50' BZ

CUT & CAP 6" WATER LINE

EXIST GAS TO REMAIN

CUT AND CAP 4" GAS LINE

CONNECT TO EXISTING 8" GAS LINE

CUT & CAP 8" WATER LINE

PROPOSED UTILITY LAYOUT SUBJECT TO REVIEW AND APPROVAL BY MASSDOT & CITY OF NEWTON

COORDINATE REPLACEMENT OF HYDRANT AND GATE VALVE OR WATER LINE CONNECTION TO MAIN WITH CITY OF NEWTON

MAINTAIN EXIST GAS

IG 12" WATER STREET

0 20 40 80 Feet

Riverside Station

Grove Street
Newton, Massachusetts

No.	Revision	Date	Appvd.
1	RESPONSE TO COMMENTS	04/28/2020	RSH
2	RESPONSE TO COMMENTS	07/07/2020	RSH
3	SPECIAL PERMIT SUBMISSION	03/05/2021	RSH

Designed by: PTM
Checked by: KSS

Issued for: Special Permit
Date: Dec. 9, 2019

Not Approved for Construction

Drawing Title: Utility Plan

Drawing Number: C-10.2

Sheet 20 of 25

Project Number: 10865.03

COMMONWEALTH OF MASSACHUSETTS
RICHARD S. HOLLWORTH
CIVIL
No. 38535
REGISTERED PROFESSIONAL ENGINEER

3/5/2021

Riverside Infiltration Rates from SHA

Below is a table summarizing groundwater levels, soil classification, and corresponding Rawl's rates based on the Massachusetts Stormwater Handbook from our most recent drilling program. The locations of the test borings are shown on the attached exploration location plan. SH-204 and SH-206 were finished as groundwater monitoring wells.

Test Borings	Test Strata	Elevations (ft) (+/-)			Design Infiltration Rate (in/hr)
		Existing Ground Surface	Grain Size Elevation	Stabilized Groundwater Reading	
SH-204	Loamy Sand	63.5	54.5 to 41.5	44.1	2.41
SH-205	Sand	65	49 to 44	N/A	8.27
SH-206	Silt Loam	66	58 to 45	45.4	0.27
SH-207	Silt Loam	63.5	48.5 to 38.5	N/A	0.27

No redoxomorphic features indicating estimated seasonal high groundwater were observed during drilling. As such, assume ESHGW to be 1 foot above the observed groundwater levels noted above.

Memorandum

Attachment 3 – Long Term Pollution Prevention and Stormwater Operation and Maintenance Measures

Long Term O&M Plan

Maintenance Checklist

101 Walnut Street
PO Box 9151
Watertown, MA 02472-4026
P 617.924.1770

Long-Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Pollutant Control Approach

Maintenance of Pavement Systems

Standard Asphalt Pavement

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- Sweep or vacuum asphalt pavement areas semi-annually with a commercial cleaning unit and dispose of removed material.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary
- Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Permeable Asphalt Pavement

Regular maintenance of the porous pavement will prevent premature failure of the drainage and water quality treatment benefits of the stormwater management system. Any areas that drain to the porous pavement must be free from erosion. Heavy sediment loads in these areas can clog the pavement surface and result in premature failure.

Preventing Clogging of Permeable Pavement Surfaces

- Vacuum pavement at least four times per year with a commercial cleaning unit and properly dispose of removed material.

- The use of pavement washing systems or compressed air units is not recommended as it may result in diminished permeability.
- Maintain vegetated areas adjacent to permeable asphalt pavement to prevent washout of soil onto surface.
- Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface. If necessary, place tarp or other impermeable material beneath the stockpiled materials and do not allow to runoff onto pavement.
- Do not apply any type of sealant to porous asphalt pavement.

Inspecting the System

- Inspect areas paved with permeable asphalt pavement monthly during the first three months following installation and annually thereafter.
- Inspect the porous pavement surface annually for deterioration or spalling. Annual inspections should take place after large storms, when puddles will make any clogging obvious.

Permeable Pavers

The primary maintenance requirement for permeable pavers is to clean the surface drainage voids. Fine debris and dirt accumulate in the drainage openings and reduce the pavement's flow capacity. Even though some irreplaceable loss in permeability should be expected over the paver's lifetime, one can increase the longevity of the system by following the maintenance schedule for vacuum sweeping and high-pressure washing, restricting the area's use by heavy vehicles, limiting the use of de-icing chemicals and sand, and implementing a stringent sediment control plan.

Preventing Clogging of Permeable Paver Surface Areas

- Patio areas and/or other areas with permeable pavers shall be cleaned annually with vacuums or washed with high pressure washers.
- Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface.
- Maintain vegetated areas adjacent to areas with permeable pavers to prevent washout of soil onto surface.
- Do not apply any type of sealant to permeable pavers.

Inspecting the System

- Inspect areas paved with permeable pavers monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect areas paved with permeable pavers annually after initial three month period. Annual inspections should take place after large storms, when puddles will make any clogging obvious.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should be cut to a height between three and four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.
- Pet waste provision if applicable.

Management of Snow and Ice

Storage and Disposal

As much as possible, stored snow will be allowed to melt on pavement where debris and sand may be deposited and swept up for disposal. Snow melt will enter the stormwater management system where it will receive proper treatment.

When snowfall amounts exceed the functional capacity of the Project Site, it shall be removed to an approved off-site location as necessary by the developer.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.

- Specific environmentally sensitive areas, including the 100' buffer zone, should be designated as no and/or reduced salt areas.
- Alternate materials such as sand should be used in place of standard salt and deicing chemicals in specific environmentally sensitive areas, including within the 100' buffer zone.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Spill prevention equipment and training will be provided by the property management company.

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

FACILITY MANAGER

Name: _____ Home Phone: _____

Phone: _____ E-mail: _____

CONSTRUCTION MANAGER

Name: _____ Home Phone: _____

Phone: _____ E-mail: _____

The supervisor will first contact the Fire Department and then notify the Police Department, the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts Department of Environmental Protection (MassDEP) and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the main construction/facility office and readily accessible to all employees. A hazardous waste spill report shall be completed as necessary using the attached form.

Emergency Notification Phone Numbers

1. FACILITY MANAGER

Name: _____ Home Phone: _____

Phone: _____ E-mail: _____

ALTERENATE

Name: _____ Home Phone: _____

Phone: _____ E-mail: _____

2. FIRE DEPARTMENT

Emergency: **911**

Business: (781) 270-1925

POLICE DEPARTMENT

Emergency: **911**

Business: 617-796-2107

3. CLEANUP CONTRACTOR:

Address: _____

Phone: _____

4. MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

Emergency: _____

Northeast Region – Wilmington Office: 978-694-3200

5. NATIONAL RESPONSE CENTER

Phone: (800) 424-8802

ALTERNATE: U.S. ENVIRONMENTAL PROTECTION AGENCY

Emergency: _____

Business: _____

6. CONSERVATION COMMISSION

Contact: Jennifer Steel

Phone: 617-796-1134

BOARD OF HEALTH

Contact: Deborah Youngblood, PhD

Phone: 617-796-1420

Hazardous Waste / Oil Spill Report

Date _____ Time _____ AM / PM

Exact location (Transformer #) _____

Type of equipment _____ Make _____ Size _____

S / N _____ Weather Conditions _____

On or near Water ☐ Yes If Yes, name of body of Water _____

☐ No

Type of chemical/oil spilled _____

Amount of chemical/oil spilled _____

Cause of Spill _____

Measures taken to contain or clean up spill _____

Amount of chemical/oil recovered _____ Method _____

Material collected as a result of cleanup:

_____ Drums containing _____

_____ Drums containing _____

_____ Drums containing _____

Location and method of debris disposal

_____

Name and address of any person, firm, or corporation suffering damages:

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring:

_____

Spill reported to General Office by _____ Time _____ AM / PM

Spill reported to DEP / National Response Center by _____

DEP Date _____ Time _____ AM / PM Inspector _____

NRC Date _____ Time _____ AM / PM Inspector _____

Additional comments: _____

Assessment - Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department	911
Municipality Health Department	617-796-1420
Municipality Conservation Commission:	617-796-1134

Emergency Response Equipment

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

Supplies		Recommended Suppliers
SORBENT PILLOWS/"PIGS"	**2**	http://www.newpig.com
SORBENT BOOM/SOCK	**25 FEET**	Item # KIT276 — mobile container with two pigs,
SORBENT PADS	**50**	26 feet of sock, 50 pads, and five pounds of
LITE-DRI® ABSORBENT	**5**	absorbent (or equivalent)
POUNDS		http://www.forestry-suppliers.com
SHOVEL	**1**	Item # 43210 — Manhole cover pick (or
PRY BAR	**1**	equivalent)
GOGGLES	**1 PAIR**	Item # 33934 — Shovel (or equivalent)
GLOVES – HEAVY	**1 PAIR**	Item # 90926 — Gloves (or equivalent)

Stormwater Operation and Maintenance Plan

Project Information

Site

Riverside Station Redevelopment

Leasee

Mark Development LLC
275 Grove Street, Suite 2-150
Newton, MA 02466

Site Supervisor - TBD

Site Manager Name
Site Manager Address
Site Manager City, State Zip
Site Manager Phone Number

Name: _____

Telephone: _____

Cell phone: _____

Email: _____

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long term operation and maintenance of the stormwater management system.

Catch Basins

- All catch basins shall be inspected and cleaned a minimum of four times per year.
- Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

Subsurface Infiltration System

- The subsurface infiltration systems will be inspected at least once each year by removing the manhole/access port covers and determining the thickness of sediment that has accumulated in the sediment removal row.
- If sediment is more than six inches deep, it must be suspended via flushing with clean water and removed using a vactor truck.
- Manufacturer's specifications and instructions for cleaning the sediment removal row is provided as an attachment to this section.
- Emergency overflow pipes will be examined at least once each year and verified that no blockage has occurred.
- System will be observed after rainfalls to see if it is properly draining.

Structural Water Quality Devices

- Inspect devices monthly for the first three months after construction.
- After initial three month period, all water quality units are to be inspected at least four times per year and cleaned a minimum of at least once per year or when sediment reaches 8" in depth.
- Follow manufacturer instructions for inspection and cleaning and contact manufacturer if system is malfunctioning.

Roof Drain Leaders

- Perform routine roof inspections monthly.
- Keep roofs clean and free of debris.
- Keep roof drainage systems clear.
- Keep roof access limited to authorized personnel.
- Clean inlets draining to the subsurface bed twice per year as necessary.

Biofiltration Islands (for Reference Only)

Biofiltration swales require routine maintenance (similar to conventional landscaping maintenance) to ensure that the system both functions well as a stormwater management practice while also maintaining an aesthetic quality compatible with the surrounding land uses.

Inspections and Cleaning:

- Biofiltration swales shall be inspected twice during for the first year and annually thereafter for sediment buildup, erosion, vegetative conditions, etc. If sediment build-up is found, core aeration or cultivating of un-vegetated areas may be required to ensure adequate filtration.
- The inflow location should be inspected annually for clogging. Sediment build up is a common problem where runoff leaves an impervious surface and enters a vegetative or earthen surface. Any built-up sediment should be removed to prevent runoff from bypassing the facility.
- The overflow structure should be inspected annually to ensure that it is properly functioning.
- Inspect biofiltration swales after a large storm event to ensure that proper drainage is occurring. Water that remains ponded on the surface of the swale after 72 hours of dry weather could indicate a problem with the infiltrative capacity of the swale, and maintenance should be scheduled.

Field Observation Date: ____/____/____ Observation Performed By: _____

Catch Basins / Trench Drains – 4 times per year, clean when sediment depth >6 inches or at least once per year					
Catch Basin	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damaged)
AD 1				/ /	
CB 1				/ /	
CB 2				/ /	
CB 3				/ /	
CB 4				/ /	
CB 6				/ /	
CB 8				/ /	
CB 9				/ /	
CB 10				/ /	
CB 11				/ /	
CB 12				/ /	
CB 13				/ /	
CB 14				/ /	
CB 15				/ /	
CB 17				/ /	
CB 21				/ /	
CB 22				/ /	
CB 23				/ /	
CB 24				/ /	
CB 26				/ /	
CB 27				/ /	
OCS 102				/ /	
TD 1				/ /	

Field Observation Date: ___/___/___ Observation Performed By: _____

Water Quality Units – Monthly for first three months after construction, 4 times per year after that, clean at least once per year or when sediment reaches a depth of 8 inches

Outfall	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damage)
WQU 1				/ /	
WQU 2				/ /	
WQU 3				/ /	

Infiltration Basins – Once per year, remove sediment if more than 6 inches has accumulated in sediment collection row

Basin	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Sediment, Damage)
P101				/ /	
P102				/ /	

Roof Runoff Downspouts – Roof Drains Monthly, Clean inlets draining to the subsurface bed twice per year.

Bldg #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Sediment, Damage)
Bldg 1				/ /	
Bldg 2				/ /	
Bldg 3				/ /	
Bldg 4				/ /	
Bldg 5				/ /	
Bldg 6				/ /	
Bldg 7				/ /	
Bldg 8				/ /	
Bldg 9				/ /	
Bldg 10				/ /	

Memorandum

Attachment 4 – Hydraulic Analysis (StormCAD)

101 Walnut Street
PO Box 9151
Watertown, MA 02472-4026
P 617.924.1770

Scenario: Base
Current Time Step: 0.000 h
FlexTable: Conduit Table

Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Diameter (in)	Slope (Calculated) (ft/ft)	Manning's n	System Intensity (in/h)	Upstream Inlet Area (ft²)	Upstream Inlet C	System CA (ft²)	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)
WQU 2	57.50	IS P101	57.00	42.4	18.0	0.012	0.011	7.838	(N/A)	(N/A)	7,308.000	1.33	13.48	4.85	67.39	57.93	66.00	57.32
CB 9	64.20	DMH 7	63.80	17.8	12.0	0.023	0.011	8.306	2,986.000	0.900	2,687.400	0.52	6.32	4.85	68.39	64.50	68.10	64.17
CB 10	64.00	DMH 7	63.80	19.0	12.0	0.011	0.011	8.306	3,001.000	0.900	2,700.900	0.52	4.32	3.71	67.99	64.30	68.10	64.17
EX 60"	50.60	EX MH	49.20	321.7	60.0	0.004	0.011	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	203.03	(N/A)	3.15	(N/A)	62.38	(N/A)
BLDG 10 Runoff	58.00	IS P101	57.00	22.5	16.0	0.044	0.011	8.306	65,808.000	0.900	59,227.201	11.38	19.12	14.29	66.92	59.25	0.00	57.90
CB 11	63.00	DMH 6	62.80	14.2	12.0	0.014	0.011	8.306	888.000	0.900	799.200	0.15	5.00	2.87	67.04	63.16	67.27	62.98
CB 12	63.00	DMH 6	62.80	14.0	12.0	0.014	0.011	8.306	1,007.000	0.900	906.300	0.17	5.03	3.00	67.04	63.17	67.27	62.98
DMH 6	62.70	DMH 27	62.00	29.9	12.0	0.023	0.011	8.264	(N/A)	(N/A)	1,705.500	0.33	6.44	4.29	67.27	62.94	67.38	62.15
DMH 7	63.70	DMH 27	63.00	39.7	12.0	0.018	0.011	7.924	(N/A)	(N/A)	5,602.500	1.03	5.59	5.42	68.10	64.13	67.38	63.29
DMH 3	60.70	DMH 2	58.60	164.6	30.0	0.013	0.011	8.023	(N/A)	(N/A)	158,581.980	29.44	54.75	11.36	67.20	62.55	65.90	60.95
BLDG 4 runoff	61.05	DMH 2	60.30	31.1	12.0	0.024	0.011	8.306	21,855.000	0.900	19,669.500	3.78	6.52	8.61	66.50	61.88	65.90	60.89
DMH 2	58.50	DMH 5	57.60	72.7	30.0	0.012	0.011	7.899	(N/A)	(N/A)	178,251.488	32.58	53.93	11.50	65.90	60.44	65.90	59.86
DMH 5	57.50	WQU 1	57.10	34.2	36.0	0.012	0.011	7.845	(N/A)	(N/A)	218,545.431	39.67	85.24	11.84	65.90	59.55	66.08	59.35
WQU 1	57.00	IS P101	56.50	48.2	36.0	0.010	0.011	7.820	(N/A)	(N/A)	218,545.431	39.55	80.28	11.31	66.08	59.05	59.00	58.15
BLDG 5 runoff	58.00	IS P101	57.00	19.5	12.0	0.051	0.011	8.306	11,786.000	0.900	10,607.400	2.04	9.53	9.66	66.83	58.61	0.00	57.35
BLDG 6 runoff	58.00	IS P101	57.00	17.5	12.0	0.057	0.011	8.306	18,004.000	0.900	16,203.600	3.11	10.06	11.30	68.30	58.76	0.00	57.45
BLDG 1 RUNOFF	62.50	DMH 20	62.25	17.1	12.0	0.015	0.011	8.306	26,995.000	0.900	24,295.501	4.67	5.09	5.95	62.90	64.00	66.44	63.79
CB 8	63.30	DMH 20	63.10	23.4	12.0	0.009	0.011	8.306	8,070.000	0.900	7,263.000	1.40	3.89	4.55	66.55	63.80	66.44	63.79
CB 2	60.60	DMH 5	60.50	15.6	12.0	0.006	0.011	8.306	19,773.000	(N/A)	17,795.700	3.42	3.37	4.88	65.66	61.43	65.90	61.29
CB 4	60.66	DMH 5	60.50	16.6	12.0	0.009	0.011	8.306	31,039.000	(N/A)	22,498.249	4.32	4.08	5.87	65.66	61.54	65.90	61.37
CB-14	58.60	DMH 10	58.30	18.4	12.0	0.016	0.011	8.306	11,268.000	0.900	10,141.200	1.95	5.38	6.31	62.20	59.20	62.48	58.75
CB-13	57.00	DMH 10	56.50	11.9	12.0	0.042	0.011	8.306	11,175.000	0.900	10,057.500	1.93	8.64	2.46	62.20	58.79	62.48	58.76
DMH 21	58.95	DMH 10	57.40	131.4	24.0	0.012	0.011	7.743	(N/A)	(N/A)	44,131.022	7.91	29.03	7.87	61.69	59.95	62.48	58.76
CB 15	59.10	DMH 21	58.95	23.5	12.0	0.006	0.011	8.306	7,677.000	0.880	6,755.760	1.30	3.36	1.65	61.40	60.19	61.69	60.17
BLDG 7 Runoff	59.40	DMH 21	59.05	63.1	12.0	0.006	0.011	8.306	12,315.000	0.900	11,083.500	2.13	3.14	4.29	62.23	60.32	61.69	60.17
CB 6	59.15	DMH 21	58.95	38.5	15.0	0.005	0.011	8.306	10,984.000	0.630	6,919.920	1.33	5.50	3.69	61.40	60.17	61.69	60.17
BLDG 8 Runoff	59.70	DMH 24	59.45	48.5	12.0	0.005	0.011	8.306	10,556.000	0.900	9,500.400	1.83	3.02	2.32	63.05	60.89	62.39	60.79
CB 3	63.40	DMH 23	62.55	79.6	15.0	0.011	0.011	8.306	14,466.000	0.650	9,402.900	1.81	7.89	5.22	66.33	64.26	66.49	64.25
CB 1	63.25	DMH 23	63.00	20.0	18.0	0.013	0.011	8.306	14,255.000	0.740	10,548.700	2.03	13.88	5.61	66.25	64.24	66.49	64.25
DMH 23	62.45	DMH 3	61.80	79.8	24.0	0.008	0.011	8.109	(N/A)	(N/A)	74,674.302	14.01	24.12	7.97	66.49	63.80	67.20	62.91
CB 21	59.75	DMH 24	59.45	54.3	12.0	0.006	0.011	8.306	6,798.000	0.680	4,622.640	0.89	3.13	1.13	62.28	60.82	62.39	60.79
DMH 24	59.35	DMH 21	58.95	79.5	12.0	0.005	0.011	7.895	(N/A)	(N/A)	19,371.840	3.54	2.99	4.51	62.39	60.73	61.69	60.17
CB 22	59.65	DMH 24	59.45	34.8	12.0	0.006	0.011	8.306	6,480.000	0.810	5,248.800	1.01	3.19	1.28	62.25	60.81	62.39	60.79
CB-23	63.00	DMH-14	62.70	23.0	12.0	0.013	0.011	8.306	6,176.000	0.800	4,940.800	0.95	4.81	4.76	66.70	63.41	67.10	63.27
DMH-14	62.60	DMH 3	62.20	46.1	12.0	0.009	0.011	8.265	(N/A)	(N/A)	10,346.680	1.98	3.92	5.01	67.10	63.20	67.20	63.05
CB-24	63.00	DMH-14	62.70	12.0	12.0	0.025	0.011	8.306	7,113.000	0.760	5,405.880	1.04	6.66	6.17	66.95	63.43	67.10	63.27
DMH 20	62.00	DMH-15	61.20	120.7	24.0	0.007	0.011	8.262	50,000.000	0.800	71,558.497	13.68	21.76	7.32	66.44	63.33	66.78	63.21
DMH-15	61.10	DMH 3	60.80	51.0	30.0	0.006	0.011	8.121	(N/A)	(N/A)	73,561.001	13.82	37.18	7.01	66.78	63.05	67.20	63.05
CB-26	62.70	DMH-15	62.60	6.9	12.0	0.015	0.011	8.306	1,095.000	0.900	985.500	0.19	5.08	3.09	66.64	63.21	66.78	63.21
CB-27	62.70	DMH-15	62.60	15.1	12.0	0.007	0.011	8.306	1,130.000	0.900	1,017.000	0.20	3.43	2.37	66.64	63.21	66.78	63.21
BLDG 2 RUNOFF	62.50	DMH 23	61.90	24.0	12.0	0.025	0.011	8.306	30,350.000	0.900	27,315.001	5.25	6.66	6.68	67.24	64.62	66.49	64.25
BLDG 9 runoff	58.00	IS P101	57.00	32.6	12.0	0.031	0.011	8.306	52,157.000	0.900	46,941.300	9.02	7.37	11.49	67.80	59.49	0.00	57.99
BLDG 3 Runoff	63.50	DMH 23	62.55	154.2	12.0	0.006	0.011	8.306	30,453.000	0.900	27,407.699	5.27	3.30	6.71	68.00	66.66	66.49	64.25
DMH 26	55.40	DMH 12	55.25	28.2	12.0	0.005	0.011	8.212	(N/A)	(N/A)	5,208.720	0.99	3.07	3.48	58.10	56.37	58.94	56.35
DMH 12	55.15	IS P102	55.10	5.0	12.0	0.010	0.011	8.142	(N/A)	(N/A)	21,035.500	3.96	4.21	6.10	58.94	55.99	0.00	55.90
OCS 102	53.20	Existing Culvert	53.00	16.5	12.0	0.012	0.011	11.382	(N/A)	(N/A)	0.000	3.22	4.64	6.37	61.88	53.97	0.00	53.65
EX CB 2	55.65	DMH 26	55.50	21.0	12.0	0.007	0.011	8.306	3,859.000	0.780	3,010.020	0.58	3.56	3.34	57.32	56.37	58.10	56.37
EX CB 1	55.75	DMH 26	55.55	32.0	12.0	0.006	0.011	8.306	2,443.000	0.900	2,198.700	0.42	3.33	2.91	57.92	56.37	58.10	56.37
CB 17	56.10	DMH 12	56.00	22.0	12.0	0.005	0.011	8.306	10,415.000	0.830	8,644.450	1.66	2.84	3.76	58.40	56.65	58.94	56.55
TD 1	58.42	DMH 12	57.00	50.9	12.0	0.028	0.011	8.306	14,083.000	0.510	7,182.330	1.38	7.03	6.95	59.50	58.92	58.94	57.30
DMH 27	58.00	WQU 2	57.60	16.7	18.0	0.024	0.011	7.861	(N/A)	(N/A)	7,308.000	1.33	19.20	6.24	67.38	58.43	67.39	57.89
AD 1	67.00	DMH 25	66.00	48.3	6.0	0.021	0.011	8.306	238.000	0.900	214.200	0.04	0.95	2.42	71.00	67.10	69.97	66.07
DMH 25	66.00	DMH 7	64.00	67.4	6.0	0.030	0.011	8.135	(N/A)	(N/A)	214.200	0.04	1.14	2.74	69.97	66.10	68.10	64.17
IS P101 OutFlow	53.10	Existing Culvert	52.60	94.6	48.0	0.005	0.011	8.306	(N/A)	(N/A)	0.000	51.24	123.41	9.36	66.50	55.25	60.00	54.45
IS P102 OutFlow	54.70	OCS 102	54.60	6.2	24.0	0.016	0.011	8.306	(N/A)	(N/A)	0.000	3.22	34.07	6.82	61.88	55.33	61.88	55.11
DMH 10	57.30	WQU-3	57.20	9.9	24.0	0.010	0.011	7.600	(N/A)	(N/A)	64,329.718	11.31	26.87	8.19	62.48	58.51	62.60	58.45
WQU-3	57.10	IS P101	57.00	10.0	24.0	0.010	0.011	7.590	(N/A)	(N/A)	64,329.718	11.30	26.73	8.15	62.60	58.31	66.00	58.05

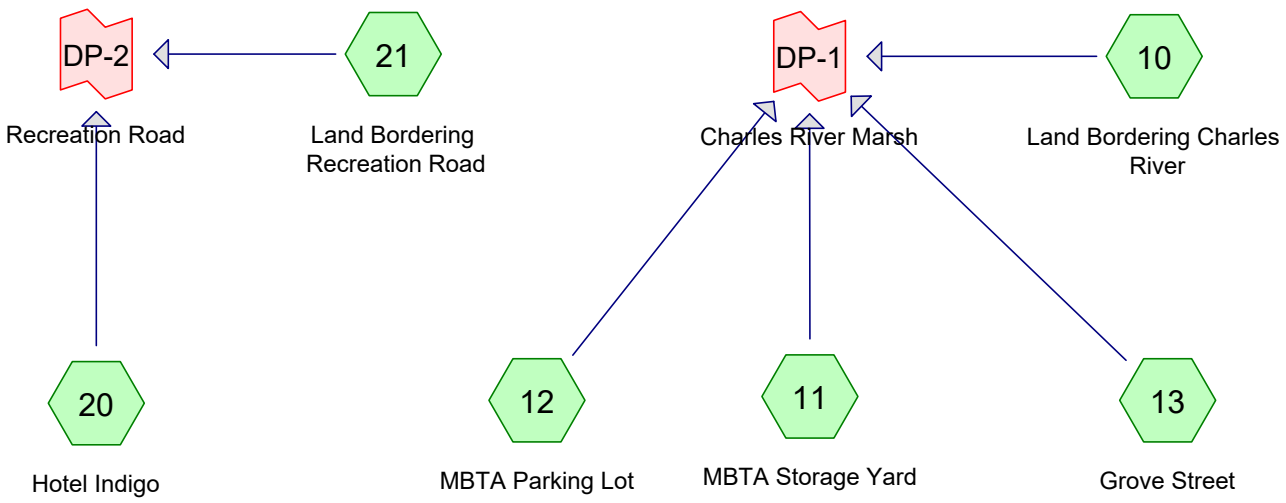
Memorandum

Attachment 5 – Hydrologic Analysis (HydroCAD)

HydroCAD Analysis: Existing Conditions

HydroCAD Analysis: Proposed Conditions

101 Walnut Street
PO Box 9151
Watertown, MA 02472-4026
P 617.924.1770



Subcat Reach Pond Link

Routing Diagram for 10865.03-EX_HydroCAD-REV
Prepared by VHB, Printed 12/5/2019

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

Subcatchment10: Land Bordering Charles Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=0.16"
Flow Length=270' Tc=8.8 min CN=52 Runoff=0.10 cfs 1,361 cf

Subcatchment11: MBTA Storage Yard Runoff Area=13.474 ac 51.00% Impervious Runoff Depth=1.80"
Flow Length=1,197' Tc=5.0 min CN=86 Runoff=29.49 cfs 88,058 cf

Subcatchment12: MBTA Parking Lot Runoff Area=10.581 ac 87.43% Impervious Runoff Depth=2.13"
Flow Length=862' Tc=5.0 min CN=90 Runoff=27.13 cfs 81,872 cf

Subcatchment13: Grove Street Runoff Area=1.790 ac 63.41% Impervious Runoff Depth=1.07"
Flow Length=1,162' Tc=5.0 min CN=75 Runoff=2.22 cfs 6,933 cf

Subcatchment20: Hotel Indigo Runoff Area=2.622 ac 81.96% Impervious Runoff Depth=1.88"
Flow Length=972' Tc=5.0 min CN=87 Runoff=5.98 cfs 17,889 cf

Subcatchment21: Land Bordering Runoff Area=0.197 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=40' Slope=0.1233 '/' Tc=5.0 min CN=37 Runoff=0.00 cfs 0 cf

Link DP-1: Charles River Marsh Inflow=58.83 cfs 178,224 cf
Primary=58.83 cfs 178,224 cf

Link DP-2: Recreation Road Inflow=5.98 cfs 17,889 cf
Primary=5.98 cfs 17,889 cf

Total Runoff Area = 1,348,356 sf Runoff Volume = 196,113 cf Average Runoff Depth = 1.75"
35.98% Pervious = 485,171 sf 64.02% Impervious = 863,185 sf

Summary for Subcatchment 10: Land Bordering Charles River

Runoff = 0.10 cfs @ 12.46 hrs, Volume= 1,361 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
*	0.381	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.028	98	Rooftop, HSG A
*	0.428	76	Gravel (Rail Yard), HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 11: MBTA Storage Yard

Runoff = 29.49 cfs @ 12.07 hrs, Volume= 88,058 cf, Depth= 1.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
*	3.612	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	3.260	98	Rooftop, HSG A
*	6.352	76	Gravel (Rail Yard), HSG A
	0.147	39	>75% Grass cover, Good, HSG A
	0.103	30	Woods, Good, HSG A
	13.474	86	Weighted Average
	6.602		49.00% Pervious Area
	6.872		51.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 12: MBTA Parking Lot

Runoff = 27.13 cfs @ 12.07 hrs, Volume= 81,872 cf, Depth= 2.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
*	8.833	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.418	98	Rooftop, HSG A
*	0.020	76	Gravel (Rail Yard), HSG A
	0.658	39	>75% Grass cover, Good, HSG A
	0.652	30	Woods, Good, HSG A
	10.581	90	Weighted Average
	1.330		12.57% Pervious Area
	9.251		87.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.4	340	0.0135	2.36		**Shallow Concentrated Flow, pavement** Paved Kv= 20.3 fps
0.6	217	0.0110	6.23	11.02	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	255	0.0060	5.58	17.52	**Pipe Channel, 24" D** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
4.7	862	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 13: Grove Street

Runoff = 2.22 cfs @ 12.08 hrs, Volume= 6,933 cf, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
*	1.135	98	Paved (Road, Walkway, Plaza, Parking), HSG A
	0.425	39	>75% Grass cover, Good, HSG A
	0.230	30	Woods, Good, HSG A
	1.790	75	Weighted Average
	0.655		36.59% Pervious Area
	1.135		63.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 20: Hotel Indigo

Runoff = 5.98 cfs @ 12.07 hrs, Volume= 17,889 cf, Depth= 1.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
*	1.062	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	1.087	98	Rooftop, HSG A
	0.396	39	>75% Grass cover, Good, HSG A
	0.077	30	Woods, Good, HSG A
	2.622	87	Weighted Average
	0.473		18.04% Pervious Area
	2.149		81.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.1	27	0.0466	4.38		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
1.1	550	0.0450	8.52	4.65	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
0.7	345	0.0360	8.61	6.76	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
2.8	972	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 21: Land Bordering Recreation Road

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
*	0.029	76	Gravel (Rail Yard), HSG A
	0.168	30	Woods, Good, HSG A
	0.197	37	Weighted Average
	0.197		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	40	0.1233	0.13		**Sheet Flow, Wooded** Woods: Light underbrush n= 0.400 P2= 3.20"

Summary for Link DP-1: Charles River Marsh

Inflow Area = 1,225,561 sf, 62.79% Impervious, Inflow Depth = 1.75" for 2-Year event
Inflow = 58.83 cfs @ 12.07 hrs, Volume= 178,224 cf
Primary = 58.83 cfs @ 12.07 hrs, Volume= 178,224 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 122,796 sf, 76.23% Impervious, Inflow Depth = 1.75" for 2-Year event
Inflow = 5.98 cfs @ 12.07 hrs, Volume= 17,889 cf
Primary = 5.98 cfs @ 12.07 hrs, Volume= 17,889 cf, Atten= 0%, Lag= 0.0 min

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

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

Subcatchment10: Land Bordering Charles Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=0.70"
Flow Length=270' Tc=8.8 min CN=52 Runoff=1.12 cfs 5,847 cf

Subcatchment11: MBTA Storage Yard Runoff Area=13.474 ac 51.00% Impervious Runoff Depth=3.25"
Flow Length=1,197' Tc=5.0 min CN=86 Runoff=52.64 cfs 159,103 cf

Subcatchment12: MBTA Parking Lot Runoff Area=10.581 ac 87.43% Impervious Runoff Depth=3.65"
Flow Length=862' Tc=5.0 min CN=90 Runoff=45.46 cfs 140,379 cf

Subcatchment13: Grove Street Runoff Area=1.790 ac 63.41% Impervious Runoff Depth=2.26"
Flow Length=1,162' Tc=5.0 min CN=75 Runoff=4.91 cfs 14,711 cf

Subcatchment20: Hotel Indigo Runoff Area=2.622 ac 81.96% Impervious Runoff Depth=3.35"
Flow Length=972' Tc=5.0 min CN=87 Runoff=10.51 cfs 31,896 cf

Subcatchment21: Land Bordering Runoff Area=0.197 ac 0.00% Impervious Runoff Depth=0.10"
Flow Length=40' Slope=0.1233 '/' Tc=5.0 min CN=37 Runoff=0.00 cfs 72 cf

Link DP-1: Charles River Marsh Inflow=103.64 cfs 320,040 cf
Primary=103.64 cfs 320,040 cf

Link DP-2: Recreation Road Inflow=10.51 cfs 31,969 cf
Primary=10.51 cfs 31,969 cf

Total Runoff Area = 1,348,356 sf Runoff Volume = 352,008 cf Average Runoff Depth = 3.13"
35.98% Pervious = 485,171 sf 64.02% Impervious = 863,185 sf

Summary for Subcatchment 10: Land Bordering Charles River

Runoff = 1.12 cfs @ 12.16 hrs, Volume= 5,847 cf, Depth= 0.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
*	0.381	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.028	98	Rooftop, HSG A
*	0.428	76	Gravel (Rail Yard), HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 11: MBTA Storage Yard

Runoff = 52.64 cfs @ 12.07 hrs, Volume= 159,103 cf, Depth= 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
*	3.612	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	3.260	98	Rooftop, HSG A
*	6.352	76	Gravel (Rail Yard), HSG A
	0.147	39	>75% Grass cover, Good, HSG A
	0.103	30	Woods, Good, HSG A
	13.474	86	Weighted Average
	6.602		49.00% Pervious Area
	6.872		51.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 12: MBTA Parking Lot

Runoff = 45.46 cfs @ 12.07 hrs, Volume= 140,379 cf, Depth= 3.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
*	8.833	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.418	98	Rooftop, HSG A
*	0.020	76	Gravel (Rail Yard), HSG A
	0.658	39	>75% Grass cover, Good, HSG A
	0.652	30	Woods, Good, HSG A
	10.581	90	Weighted Average
	1.330		12.57% Pervious Area
	9.251		87.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.4	340	0.0135	2.36		**Shallow Concentrated Flow, pavement** Paved Kv= 20.3 fps
0.6	217	0.0110	6.23	11.02	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	255	0.0060	5.58	17.52	**Pipe Channel, 24" D** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
4.7	862	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 13: Grove Street

Runoff = 4.91 cfs @ 12.08 hrs, Volume= 14,711 cf, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
*	1.135	98	Paved (Road, Walkway, Plaza, Parking), HSG A
	0.425	39	>75% Grass cover, Good, HSG A
	0.230	30	Woods, Good, HSG A
	1.790	75	Weighted Average
	0.655		36.59% Pervious Area
	1.135		63.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 20: Hotel Indigo

Runoff = 10.51 cfs @ 12.07 hrs, Volume= 31,896 cf, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
*	1.062	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	1.087	98	Rooftop, HSG A
	0.396	39	>75% Grass cover, Good, HSG A
	0.077	30	Woods, Good, HSG A
	2.622	87	Weighted Average
	0.473		18.04% Pervious Area
	2.149		81.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.1	27	0.0466	4.38		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
1.1	550	0.0450	8.52	4.65	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
0.7	345	0.0360	8.61	6.76	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
2.8	972	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 21: Land Bordering Recreation Road

Runoff = 0.00 cfs @ 14.85 hrs, Volume= 72 cf, Depth= 0.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
*	0.029	76	Gravel (Rail Yard), HSG A
	0.168	30	Woods, Good, HSG A
	0.197	37	Weighted Average
	0.197		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	40	0.1233	0.13		**Sheet Flow, Wooded** Woods: Light underbrush n= 0.400 P2= 3.20"

Summary for Link DP-1: Charles River Marsh

Inflow Area = 1,225,561 sf, 62.79% Impervious, Inflow Depth = 3.13" for 10-Year event
Inflow = 103.64 cfs @ 12.07 hrs, Volume= 320,040 cf
Primary = 103.64 cfs @ 12.07 hrs, Volume= 320,040 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 122,796 sf, 76.23% Impervious, Inflow Depth = 3.12" for 10-Year event
Inflow = 10.51 cfs @ 12.07 hrs, Volume= 31,969 cf
Primary = 10.51 cfs @ 12.07 hrs, Volume= 31,969 cf, Atten= 0%, Lag= 0.0 min

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

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

Subcatchment10: Land Bordering Charles Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=1.30"
Flow Length=270' Tc=8.8 min CN=52 Runoff=2.64 cfs 10,847 cf

Subcatchment11: MBTA Storage Yard Runoff Area=13.474 ac 51.00% Impervious Runoff Depth=4.44"
Flow Length=1,197' Tc=5.0 min CN=86 Runoff=70.93 cfs 217,062 cf

Subcatchment12: MBTA Parking Lot Runoff Area=10.581 ac 87.43% Impervious Runoff Depth=4.88"
Flow Length=862' Tc=5.0 min CN=90 Runoff=59.71 cfs 187,248 cf

Subcatchment13: Grove Street Runoff Area=1.790 ac 63.41% Impervious Runoff Depth=3.31"
Flow Length=1,162' Tc=5.0 min CN=75 Runoff=7.20 cfs 21,492 cf

Subcatchment20: Hotel Indigo Runoff Area=2.622 ac 81.96% Impervious Runoff Depth=4.55"
Flow Length=972' Tc=5.0 min CN=87 Runoff=14.07 cfs 43,267 cf

Subcatchment21: Land Bordering Runoff Area=0.197 ac 0.00% Impervious Runoff Depth=0.35"
Flow Length=40' Slope=0.1233 '/' Tc=5.0 min CN=37 Runoff=0.02 cfs 251 cf

Link DP-1: Charles River Marsh Inflow=139.76 cfs 436,649 cf
Primary=139.76 cfs 436,649 cf

Link DP-2: Recreation Road Inflow=14.07 cfs 43,518 cf
Primary=14.07 cfs 43,518 cf

Total Runoff Area = 1,348,356 sf Runoff Volume = 480,167 cf Average Runoff Depth = 4.27"
35.98% Pervious = 485,171 sf 64.02% Impervious = 863,185 sf

Summary for Subcatchment 10: Land Bordering Charles River

Runoff = 2.64 cfs @ 12.14 hrs, Volume= 10,847 cf, Depth= 1.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
*	0.381	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.028	98	Rooftop, HSG A
*	0.428	76	Gravel (Rail Yard), HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 11: MBTA Storage Yard

Runoff = 70.93 cfs @ 12.07 hrs, Volume= 217,062 cf, Depth= 4.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
*	3.612	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	3.260	98	Rooftop, HSG A
*	6.352	76	Gravel (Rail Yard), HSG A
	0.147	39	>75% Grass cover, Good, HSG A
	0.103	30	Woods, Good, HSG A
	13.474	86	Weighted Average
	6.602		49.00% Pervious Area
	6.872		51.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 12: MBTA Parking Lot

Runoff = 59.71 cfs @ 12.07 hrs, Volume= 187,248 cf, Depth= 4.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
*	8.833	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.418	98	Rooftop, HSG A
*	0.020	76	Gravel (Rail Yard), HSG A
	0.658	39	>75% Grass cover, Good, HSG A
	0.652	30	Woods, Good, HSG A
	10.581	90	Weighted Average
	1.330		12.57% Pervious Area
	9.251		87.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.4	340	0.0135	2.36		**Shallow Concentrated Flow, pavement** Paved Kv= 20.3 fps
0.6	217	0.0110	6.23	11.02	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	255	0.0060	5.58	17.52	**Pipe Channel, 24" D** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
4.7	862	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 13: Grove Street

Runoff = 7.20 cfs @ 12.08 hrs, Volume= 21,492 cf, Depth= 3.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
*	1.135	98	Paved (Road, Walkway, Plaza, Parking), HSG A
	0.425	39	>75% Grass cover, Good, HSG A
	0.230	30	Woods, Good, HSG A
	1.790	75	Weighted Average
	0.655		36.59% Pervious Area
	1.135		63.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 20: Hotel Indigo

Runoff = 14.07 cfs @ 12.07 hrs, Volume= 43,267 cf, Depth= 4.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
*	1.062	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	1.087	98	Rooftop, HSG A
	0.396	39	>75% Grass cover, Good, HSG A
	0.077	30	Woods, Good, HSG A
	2.622	87	Weighted Average
	0.473		18.04% Pervious Area
	2.149		81.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.1	27	0.0466	4.38		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
1.1	550	0.0450	8.52	4.65	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
0.7	345	0.0360	8.61	6.76	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
2.8	972	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 21: Land Bordering Recreation Road

Runoff = 0.02 cfs @ 12.38 hrs, Volume= 251 cf, Depth= 0.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
*	0.029	76	Gravel (Rail Yard), HSG A
	0.168	30	Woods, Good, HSG A
	0.197	37	Weighted Average
	0.197		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	40	0.1233	0.13		**Sheet Flow, Wooded** Woods: Light underbrush n= 0.400 P2= 3.20"

Summary for Link DP-1: Charles River Marsh

Inflow Area = 1,225,561 sf, 62.79% Impervious, Inflow Depth = 4.28" for 25-Year event
Inflow = 139.76 cfs @ 12.07 hrs, Volume= 436,649 cf
Primary = 139.76 cfs @ 12.07 hrs, Volume= 436,649 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 122,796 sf, 76.23% Impervious, Inflow Depth = 4.25" for 25-Year event
Inflow = 14.07 cfs @ 12.07 hrs, Volume= 43,518 cf
Primary = 14.07 cfs @ 12.07 hrs, Volume= 43,518 cf, Atten= 0%, Lag= 0.0 min

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

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

Subcatchment10: Land Bordering Charles Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=2.97"
Flow Length=270' Tc=8.8 min CN=52 Runoff=6.91 cfs 24,724 cf

Subcatchment11: MBTA Storage Yard Runoff Area=13.474 ac 51.00% Impervious Runoff Depth=7.09"
Flow Length=1,197' Tc=5.0 min CN=86 Runoff=110.61 cfs 346,745 cf

Subcatchment12: MBTA Parking Lot Runoff Area=10.581 ac 87.43% Impervious Runoff Depth=7.57"
Flow Length=862' Tc=5.0 min CN=90 Runoff=90.45 cfs 290,923 cf

Subcatchment13: Grove Street Runoff Area=1.790 ac 63.41% Impervious Runoff Depth=5.75"
Flow Length=1,162' Tc=5.0 min CN=75 Runoff=12.42 cfs 37,366 cf

Subcatchment20: Hotel Indigo Runoff Area=2.622 ac 81.96% Impervious Runoff Depth=7.21"
Flow Length=972' Tc=5.0 min CN=87 Runoff=21.77 cfs 68,631 cf

Subcatchment21: Land Bordering Runoff Area=0.197 ac 0.00% Impervious Runoff Depth=1.29"
Flow Length=40' Slope=0.1233 '/' Tc=5.0 min CN=37 Runoff=0.20 cfs 922 cf

Link DP-1: Charles River Marsh Inflow=219.02 cfs 699,759 cf
Primary=219.02 cfs 699,759 cf

Link DP-2: Recreation Road Inflow=21.95 cfs 69,553 cf
Primary=21.95 cfs 69,553 cf

Total Runoff Area = 1,348,356 sf Runoff Volume = 769,312 cf Average Runoff Depth = 6.85"
35.98% Pervious = 485,171 sf 64.02% Impervious = 863,185 sf

Summary for Subcatchment 10: Land Bordering Charles River

Runoff = 6.91 cfs @ 12.13 hrs, Volume= 24,724 cf, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
*	0.381	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.028	98	Rooftop, HSG A
*	0.428	76	Gravel (Rail Yard), HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 11: MBTA Storage Yard

Runoff = 110.61 cfs @ 12.07 hrs, Volume= 346,745 cf, Depth= 7.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
*	3.612	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	3.260	98	Rooftop, HSG A
*	6.352	76	Gravel (Rail Yard), HSG A
	0.147	39	>75% Grass cover, Good, HSG A
	0.103	30	Woods, Good, HSG A
	13.474	86	Weighted Average
	6.602		49.00% Pervious Area
	6.872		51.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 12: MBTA Parking Lot

Runoff = 90.45 cfs @ 12.07 hrs, Volume= 290,923 cf, Depth= 7.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
*	8.833	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	0.418	98	Rooftop, HSG A
*	0.020	76	Gravel (Rail Yard), HSG A
	0.658	39	>75% Grass cover, Good, HSG A
	0.652	30	Woods, Good, HSG A
	10.581	90	Weighted Average
	1.330		12.57% Pervious Area
	9.251		87.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.4	340	0.0135	2.36		**Shallow Concentrated Flow, pavement** Paved Kv= 20.3 fps
0.6	217	0.0110	6.23	11.02	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	255	0.0060	5.58	17.52	**Pipe Channel, 24" D** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
4.7	862	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 13: Grove Street

Runoff = 12.42 cfs @ 12.07 hrs, Volume= 37,366 cf, Depth= 5.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
*	1.135	98	Paved (Road, Walkway, Plaza, Parking), HSG A
	0.425	39	>75% Grass cover, Good, HSG A
	0.230	30	Woods, Good, HSG A
	1.790	75	Weighted Average
	0.655		36.59% Pervious Area
	1.135		63.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 20: Hotel Indigo

Runoff = 21.77 cfs @ 12.07 hrs, Volume= 68,631 cf, Depth= 7.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
*	1.062	98	Paved (Road, Walkway, Plaza, Parking), HSG A
*	1.087	98	Rooftop, HSG A
	0.396	39	>75% Grass cover, Good, HSG A
	0.077	30	Woods, Good, HSG A
	2.622	87	Weighted Average
	0.473		18.04% Pervious Area
	2.149		81.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.1	27	0.0466	4.38		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
1.1	550	0.0450	8.52	4.65	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
0.7	345	0.0360	8.61	6.76	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
2.8	972	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 21: Land Bordering Recreation Road

Runoff = 0.20 cfs @ 12.10 hrs, Volume= 922 cf, Depth= 1.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
*	0.029	76	Gravel (Rail Yard), HSG A
	0.168	30	Woods, Good, HSG A
	0.197	37	Weighted Average
	0.197		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	40	0.1233	0.13		**Sheet Flow, Wooded** Woods: Light underbrush n= 0.400 P2= 3.20"

Summary for Link DP-1: Charles River Marsh

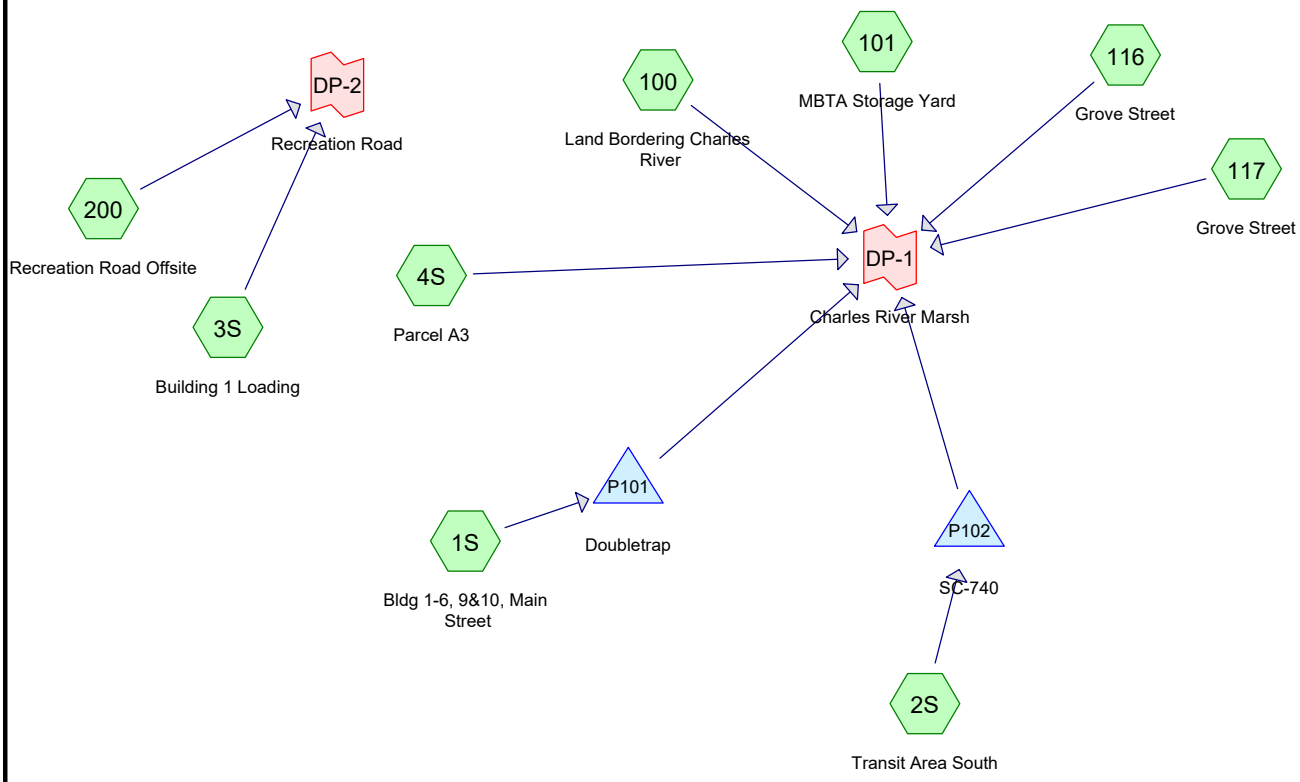
Inflow Area = 1,225,561 sf, 62.79% Impervious, Inflow Depth = 6.85" for 100-Year event
Inflow = 219.02 cfs @ 12.07 hrs, Volume= 699,759 cf
Primary = 219.02 cfs @ 12.07 hrs, Volume= 699,759 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 122,796 sf, 76.23% Impervious, Inflow Depth = 6.80" for 100-Year event
Inflow = 21.95 cfs @ 12.07 hrs, Volume= 69,553 cf
Primary = 21.95 cfs @ 12.07 hrs, Volume= 69,553 cf, Atten= 0%, Lag= 0.0 min

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



Subcat Reach Pond Link

Routing Diagram for 10865.03-PR_HydroCAD
Prepared by VHB, Printed 7/29/2021

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.16	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.77	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.03	2
4	100-Year	Type III 24-hr		Default	24.00	1	8.78	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
80,427	39	>75% Grass cover, Good, HSG A (1S, 2S, 100, 101, 116, 117, 200)
293,072	76	Gravel roads, HSG A (100, 101)
491,829	98	Paved roads w/curbs & sewers, HSG A (1S, 2S, 3S, 4S, 100, 101, 116, 117, 200)
150,369	98	Rooftop, HSG A (100, 101)
223,585	98	Unconnected roofs, HSG A (1S, 2S, 3S)
52,795	30	Woods, Good, HSG A (100)
1,292,076	**87**	**TOTAL AREA**

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

Subcatchment1S: Bldg 1-6, 9&10, Main Runoff Area=9.215 ac 93.40% Impervious Runoff Depth=2.51"
Flow Length=370' Tc=7.8 min CN=94 Runoff=24.41 cfs 83,795 cf

Subcatchment2S: Transit Area South Runoff Area=0.711 ac 68.68% Impervious Runoff Depth=1.37"
Flow Length=342' Tc=5.0 min CN=80 Runoff=1.17 cfs 3,537 cf

Subcatchment3S: Building 1 Loading Runoff Area=0.260 ac 100.00% Impervious Runoff Depth=2.93"
Flow Length=225' Tc=5.7 min CN=98 Runoff=0.81 cfs 2,763 cf

Subcatchment4S: Parcel A3 Runoff Area=1.076 ac 100.00% Impervious Runoff Depth=2.93"
Tc=5.0 min CN=98 Runoff=3.42 cfs 11,436 cf

Subcatchment100: Land Bordering Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=0.16"
Flow Length=270' Tc=8.8 min CN=52 Runoff=0.10 cfs 1,361 cf

Subcatchment101: MBTA Storage Yard Runoff Area=13.219 ac 51.96% Impervious Runoff Depth=1.88"
Flow Length=1,197' Tc=5.0 min CN=87 Runoff=30.17 cfs 90,190 cf

Subcatchment116: Grove Street Runoff Area=1.236 ac 92.04% Impervious Runoff Depth=2.41"
Flow Length=1,162' Tc=5.0 min CN=93 Runoff=3.50 cfs 10,799 cf

Subcatchment117: Grove Street Runoff Area=0.254 ac 88.42% Impervious Runoff Depth=2.22"
Tc=5.0 min CN=91 Runoff=0.67 cfs 2,044 cf

Subcatchment200: Recreation Road Offsite Runoff Area=1.402 ac 57.49% Impervious Runoff Depth=0.96"
Tc=5.0 min CN=73 Runoff=1.52 cfs 4,872 cf

Pond P101: Doubletrap Peak Elev=56.93' Storage=32,504 cf Inflow=24.41 cfs 83,795 cf
Discarded=1.83 cfs 76,423 cf Primary=4.41 cfs 6,948 cf Outflow=6.23 cfs 83,371 cf

Pond P102: SC-740 Peak Elev=57.03' Storage=1,807 cf Inflow=1.17 cfs 3,537 cf
Discarded=0.04 cfs 3,154 cf Primary=0.07 cfs 384 cf Outflow=0.11 cfs 3,537 cf

Link DP-1: Charles River Marsh Inflow=37.76 cfs 123,161 cf
Primary=37.76 cfs 123,161 cf

Link DP-2: Recreation Road Inflow=2.33 cfs 7,635 cf
Primary=2.33 cfs 7,635 cf

Total Runoff Area = 1,292,076 sf Runoff Volume = 210,796 cf Average Runoff Depth = 1.96"
32.99% Pervious = 426,293 sf 67.01% Impervious = 865,783 sf

Summary for Subcatchment 1S: Bldg 1-6, 9&10, Main Street

Runoff = 24.41 cfs @ 12.11 hrs, Volume= 83,795 cf, Depth= 2.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (ac)	CN	Description
0.608	39	>75% Grass cover, Good, HSG A
3.484	98	Paved roads w/curbs & sewers, HSG A
5.123	98	Unconnected roofs, HSG A
9.215	94	Weighted Average
0.608		6.60% Pervious Area
8.607		93.40% Impervious Area
5.123		59.52% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, Bldg to CB** Grass: Short n= 0.150 P2= 3.20"
0.2	165	0.0128	12.62	89.18	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	73	0.0179	14.92	105.46	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.0	34	0.0205	15.97	112.86	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	48	0.0142	13.29	93.93	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
7.8	370	Total			

Summary for Subcatchment 2S: Transit Area South

Runoff = 1.17 cfs @ 12.08 hrs, Volume= 3,537 cf, Depth= 1.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (ac)	CN	Description
0.223	39	>75% Grass cover, Good, HSG A
0.487	98	Paved roads w/curbs & sewers, HSG A
0.001	98	Unconnected roofs, HSG A
0.711	80	Weighted Average
0.223		31.32% Pervious Area
0.488		68.68% Impervious Area
0.001		0.22% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement - first 50 feet** Smooth surfaces n= 0.011 P2= 3.20"
1.8	276	0.0167	2.62		**Shallow Concentrated Flow, Pavement to CB** Paved Kv= 20.3 fps
0.0	16	0.0121	8.58	26.96	**Pipe Channel, 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
2.7	342	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 3S: Building 1 Loading

Runoff = 0.81 cfs @ 12.08 hrs, Volume= 2,763 cf, Depth= 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (ac)	CN	Description
0.251	98	Paved roads w/curbs & sewers, HSG A
0.009	98	Unconnected roofs, HSG A
0.260	98	Weighted Average
0.260		100.00% Impervious Area
0.009		3.37% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.2	50	0.0300	3.52		**Shallow Concentrated Flow, Grass** Paved Kv= 20.3 fps
0.7	125	0.0200	2.87		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.7	225	Total			

Summary for Subcatchment 4S: Parcel A3

Runoff = 3.42 cfs @ 12.07 hrs, Volume= 11,436 cf, Depth= 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (ac)	CN	Description
1.076	98	Paved roads w/curbs & sewers, HSG A
1.076		100.00% Impervious Area

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

Summary for Subcatchment 100: Land Bordering Charles River

Runoff = 0.10 cfs @ 12.46 hrs, Volume= 1,361 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
	0.381	98	Paved roads w/curbs & sewers, HSG A
*	0.028	98	Rooftop, HSG A
	0.428	76	Gravel roads, HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 101: MBTA Storage Yard

[47] Hint: Peak is 467% of capacity of segment #3
[47] Hint: Peak is 287% of capacity of segment #4

Runoff = 30.17 cfs @ 12.07 hrs, Volume= 90,190 cf, Depth= 1.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (ac)	CN	Description
	0.051	39	>75% Grass cover, Good, HSG A
	6.300	76	Gravel roads, HSG A
	3.444	98	Paved roads w/curbs & sewers, HSG A
*	3.424	98	Rooftop, HSG A
	13.219	87	Weighted Average
	6.351		48.04% Pervious Area
	6.868		51.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 116: Grove Street

Runoff = 3.50 cfs @ 12.07 hrs, Volume= 10,799 cf, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (ac)	CN	Description
0.098	39	>75% Grass cover, Good, HSG A
1.137	98	Paved roads w/curbs & sewers, HSG A
1.236	93	Weighted Average
0.098		7.96% Pervious Area
1.137		92.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 117: Grove Street

Runoff = 0.67 cfs @ 12.07 hrs, Volume= 2,044 cf, Depth= 2.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (ac)	CN	Description
0.029	39	>75% Grass cover, Good, HSG A
0.224	98	Paved roads w/curbs & sewers, HSG A
0.254	91	Weighted Average
0.029		11.58% Pervious Area
0.224		88.42% Impervious Area

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

Summary for Subcatchment 200: Recreation Road Offsite

Runoff = 1.52 cfs @ 12.08 hrs, Volume= 4,872 cf, Depth= 0.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (ac)	CN	Description
0.596	39	>75% Grass cover, Good, HSG A
0.806	98	Paved roads w/curbs & sewers, HSG A
1.402	73	Weighted Average
0.596		42.51% Pervious Area
0.806		57.49% Impervious Area

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

Summary for Pond P101: Doubletrap

Inflow Area = 401,405 sf, 93.40% Impervious, Inflow Depth = 2.51" for 2-Year event
Inflow = 24.41 cfs @ 12.11 hrs, Volume= 83,795 cf
Outflow = 6.23 cfs @ 12.50 hrs, Volume= 83,371 cf, Atten= 74%, Lag= 23.5 min
Discarded = 1.83 cfs @ 12.50 hrs, Volume= 76,423 cf
Primary = 4.41 cfs @ 12.50 hrs, Volume= 6,948 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 56.93' @ 12.50 hrs Surf.Area= 5,063 sf Storage= 32,504 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 149.5 min (938.7 - 789.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	53.00'	0 cf	**30.27'W x 167.27'L x 7.00'H Field A** 35,444 cf Overall - 35,444 cf Embedded = 0 cf x 40.0% Voids
#2A	53.00'	26,906 cf	**StormTrap ST2 DoubleTrap 6-0** x 20 Inside #1 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 20 Chambers in 2 Rows 16.96' x 153.96' Core + 6.66' Border = 30.27' x 167.27' System
#3B	53.00'	0 cf	**21.79'W x 259.65'L x 7.00'H Field B** Impervious 39,607 cf Overall - 39,607 cf Embedded = 0 cf x 40.0% Voids
#4B	53.00'	29,879 cf	**StormTrap ST2 DoubleTrap 6-0** x 16 Inside #3 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 8.48' x 246.33' Core + 6.66' Border = 21.79' x 259.65' System
		56,785 cf	Total Available Storage

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

Device	Routing	Invert	Outlet Devices
#1	Discarded	53.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.55'
#2	Primary	53.10'	**48.0" Round Culvert** L= 94.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 53.10' / 52.60' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 12.57 sf
#3	Device 2	56.70'	**11.8' long x 2.30' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.7' Crest Height

Discarded OutFlow Max=1.83 cfs @ 12.50 hrs HW=56.93' (Free Discharge)
└**1=Exfiltration** (Controls 1.83 cfs)

Primary OutFlow Max=4.38 cfs @ 12.50 hrs HW=56.93' TW=55.50' (Fixed TW Elev= 55.50')
└**2=Culvert** (Passes 4.38 cfs of 69.98 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 4.38 cfs @ 1.59 fps)

Summary for Pond P102: SC-740

previously had infiltration rate of 0.52 in/hr

Inflow Area = 30,955 sf, 68.68% Impervious, Inflow Depth = 1.37" for 2-Year event
Inflow = 1.17 cfs @ 12.08 hrs, Volume= 3,537 cf
Outflow = 0.11 cfs @ 13.23 hrs, Volume= 3,537 cf, Atten= 91%, Lag= 69.3 min
Discarded = 0.04 cfs @ 13.23 hrs, Volume= 3,154 cf
Primary = 0.07 cfs @ 13.23 hrs, Volume= 384 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 57.03' @ 13.23 hrs Surf.Area= 980 sf Storage= 1,807 cf

Plug-Flow detention time= 511.9 min calculated for 3,537 cf (100% of inflow)
Center-of-Mass det. time= 511.9 min (1,354.4 - 842.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.10'	930 cf	**11.00'W x 89.06'L x 3.50'H Field A** 3,429 cf Overall - 1,103 cf Embedded = 2,326 cf x 40.0% Voids
#2A	54.60'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 2 Rows
		2,033 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	54.10'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 49.20'
#2	Primary	53.20'	**24.0" Round Culvert** L= 14.0' Ke= 0.900 Inlet / Outlet Invert= 53.20' / 53.00' S= 0.0143 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#3	Device 2	57.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 3	54.70'	**24.0" Round Culvert** L= 5.0' Ke= 0.900 Inlet / Outlet Invert= 54.70' / 54.60' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Discarded OutFlow Max=0.04 cfs @ 13.23 hrs HW=57.03' (Free Discharge)
└**1=Exfiltration** (Controls 0.04 cfs)

Primary OutFlow Max=0.06 cfs @ 13.23 hrs HW=57.03' (Free Discharge)
└**2=Culvert** (Passes 0.06 cfs of 20.07 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.06 cfs @ 0.52 fps)
└**4=Culvert** (Passes 0.06 cfs of 1.89 cfs potential flow)

Summary for Link DP-1: Charles River Marsh

Inflow Area = 1,219,682 sf, 67.18% Impervious, Inflow Depth = 1.21" for 2-Year event
Inflow = 37.76 cfs @ 12.07 hrs, Volume= 123,161 cf
Primary = 37.76 cfs @ 12.07 hrs, Volume= 123,161 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 72,394 sf, 64.14% Impervious, Inflow Depth = 1.27" for 2-Year event
Inflow = 2.33 cfs @ 12.08 hrs, Volume= 7,635 cf
Primary = 2.33 cfs @ 12.08 hrs, Volume= 7,635 cf, Atten= 0%, Lag= 0.0 min

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

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

Subcatchment1S: Bldg 1-6, 9&10, Main Runoff Area=9.215 ac 93.40% Impervious Runoff Depth=4.08"
Flow Length=370' Tc=7.8 min CN=94 Runoff=38.70 cfs 136,518 cf

Subcatchment2S: Transit Area South Runoff Area=0.711 ac 68.68% Impervious Runoff Depth=2.69"
Flow Length=342' Tc=5.0 min CN=80 Runoff=2.33 cfs 6,947 cf

Subcatchment3S: Building 1 Loading Runoff Area=0.260 ac 100.00% Impervious Runoff Depth=4.53"
Flow Length=225' Tc=5.7 min CN=98 Runoff=1.23 cfs 4,278 cf

Subcatchment4S: Parcel A3 Runoff Area=1.076 ac 100.00% Impervious Runoff Depth=4.53"
Tc=5.0 min CN=98 Runoff=5.20 cfs 17,709 cf

Subcatchment100: Land Bordering Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=0.70"
Flow Length=270' Tc=8.8 min CN=52 Runoff=1.12 cfs 5,847 cf

Subcatchment101: MBTA Storage Yard Runoff Area=13.219 ac 51.96% Impervious Runoff Depth=3.35"
Flow Length=1,197' Tc=5.0 min CN=87 Runoff=52.98 cfs 160,807 cf

Subcatchment116: Grove Street Runoff Area=1.236 ac 92.04% Impervious Runoff Depth=3.97"
Flow Length=1,162' Tc=5.0 min CN=93 Runoff=5.62 cfs 17,819 cf

Subcatchment117: Grove Street Runoff Area=0.254 ac 88.42% Impervious Runoff Depth=3.76"
Tc=5.0 min CN=91 Runoff=1.11 cfs 3,460 cf

Subcatchment200: Recreation Road Offsite Runoff Area=1.402 ac 57.49% Impervious Runoff Depth=2.10"
Tc=5.0 min CN=73 Runoff=3.55 cfs 10,696 cf

Pond P101: Doubletrap Peak Elev=57.49' Storage=37,753 cf Inflow=38.70 cfs 136,518 cf
Discarded=1.95 cfs 94,656 cf Primary=27.14 cfs 41,874 cf Outflow=29.09 cfs 136,530 cf

Pond P102: SC-740 Peak Elev=57.26' Storage=1,898 cf Inflow=2.33 cfs 6,947 cf
Discarded=0.04 cfs 3,608 cf Primary=2.09 cfs 3,339 cf Outflow=2.13 cfs 6,947 cf

Link DP-1: Charles River Marsh Inflow=75.14 cfs 250,854 cf
Primary=75.14 cfs 250,854 cf

Link DP-2: Recreation Road Inflow=4.77 cfs 14,974 cf
Primary=4.77 cfs 14,974 cf

Total Runoff Area = 1,292,076 sf Runoff Volume = 364,080 cf Average Runoff Depth = 3.38"
32.99% Pervious = 426,293 sf 67.01% Impervious = 865,783 sf

Summary for Subcatchment 1S: Bldg 1-6, 9&10, Main Street

Runoff = 38.70 cfs @ 12.11 hrs, Volume= 136,518 cf, Depth= 4.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (ac)	CN	Description
0.608	39	>75% Grass cover, Good, HSG A
3.484	98	Paved roads w/curbs & sewers, HSG A
5.123	98	Unconnected roofs, HSG A
9.215	94	Weighted Average
0.608		6.60% Pervious Area
8.607		93.40% Impervious Area
5.123		59.52% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, Bldg to CB** Grass: Short n= 0.150 P2= 3.20"
0.2	165	0.0128	12.62	89.18	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	73	0.0179	14.92	105.46	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.0	34	0.0205	15.97	112.86	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	48	0.0142	13.29	93.93	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
7.8	370	Total			

Summary for Subcatchment 2S: Transit Area South

Runoff = 2.33 cfs @ 12.07 hrs, Volume= 6,947 cf, Depth= 2.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (ac)	CN	Description
0.223	39	>75% Grass cover, Good, HSG A
0.487	98	Paved roads w/curbs & sewers, HSG A
0.001	98	Unconnected roofs, HSG A
0.711	80	Weighted Average
0.223		31.32% Pervious Area
0.488		68.68% Impervious Area
0.001		0.22% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement - first 50 feet** Smooth surfaces n= 0.011 P2= 3.20"
1.8	276	0.0167	2.62		**Shallow Concentrated Flow, Pavement to CB** Paved Kv= 20.3 fps
0.0	16	0.0121	8.58	26.96	**Pipe Channel, 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
2.7	342	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 3S: Building 1 Loading

Runoff = 1.23 cfs @ 12.08 hrs, Volume= 4,278 cf, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (ac)	CN	Description
0.251	98	Paved roads w/curbs & sewers, HSG A
0.009	98	Unconnected roofs, HSG A
0.260	98	Weighted Average
0.260		100.00% Impervious Area
0.009		3.37% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.2	50	0.0300	3.52		**Shallow Concentrated Flow, Grass** Paved Kv= 20.3 fps
0.7	125	0.0200	2.87		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.7	225	Total			

Summary for Subcatchment 4S: Parcel A3

Runoff = 5.20 cfs @ 12.07 hrs, Volume= 17,709 cf, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (ac)	CN	Description
1.076	98	Paved roads w/curbs & sewers, HSG A
1.076		100.00% Impervious Area

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

Summary for Subcatchment 100: Land Bordering Charles River

Runoff = 1.12 cfs @ 12.16 hrs, Volume= 5,847 cf, Depth= 0.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
	0.381	98	Paved roads w/curbs & sewers, HSG A
*	0.028	98	Rooftop, HSG A
	0.428	76	Gravel roads, HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 101: MBTA Storage Yard

[47] Hint: Peak is 820% of capacity of segment #3
[47] Hint: Peak is 504% of capacity of segment #4
[47] Hint: Peak is 129% of capacity of segment #5

Runoff = 52.98 cfs @ 12.07 hrs, Volume= 160,807 cf, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (ac)	CN	Description
	0.051	39	>75% Grass cover, Good, HSG A
	6.300	76	Gravel roads, HSG A
	3.444	98	Paved roads w/curbs & sewers, HSG A
*	3.424	98	Rooftop, HSG A
	13.219	87	Weighted Average
	6.351		48.04% Pervious Area
	6.868		51.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 116: Grove Street

Runoff = 5.62 cfs @ 12.07 hrs, Volume= 17,819 cf, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (ac)	CN	Description
0.098	39	>75% Grass cover, Good, HSG A
1.137	98	Paved roads w/curbs & sewers, HSG A
1.236	93	Weighted Average
0.098		7.96% Pervious Area
1.137		92.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 117: Grove Street

Runoff = 1.11 cfs @ 12.07 hrs, Volume= 3,460 cf, Depth= 3.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (ac)	CN	Description
0.029	39	>75% Grass cover, Good, HSG A
0.224	98	Paved roads w/curbs & sewers, HSG A
0.254	91	Weighted Average
0.029		11.58% Pervious Area
0.224		88.42% Impervious Area

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

Summary for Subcatchment 200: Recreation Road Offsite

Runoff = 3.55 cfs @ 12.08 hrs, Volume= 10,696 cf, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (ac)	CN	Description
0.596	39	>75% Grass cover, Good, HSG A
0.806	98	Paved roads w/curbs & sewers, HSG A
1.402	73	Weighted Average
0.596		42.51% Pervious Area
0.806		57.49% Impervious Area

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

Summary for Pond P101: Doubletrap

Inflow Area = 401,405 sf, 93.40% Impervious, Inflow Depth = 4.08" for 10-Year event
Inflow = 38.70 cfs @ 12.11 hrs, Volume= 136,518 cf
Outflow = 29.09 cfs @ 12.19 hrs, Volume= 136,530 cf, Atten= 25%, Lag= 4.7 min
Discarded = 1.95 cfs @ 12.19 hrs, Volume= 94,656 cf
Primary = 27.14 cfs @ 12.19 hrs, Volume= 41,874 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 57.49' @ 12.19 hrs Surf.Area= 5,063 sf Storage= 37,753 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 123.0 min (899.5 - 776.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	53.00'	0 cf	**30.27'W x 167.27'L x 7.00'H Field A** 35,444 cf Overall - 35,444 cf Embedded = 0 cf x 40.0% Voids
#2A	53.00'	26,906 cf	**StormTrap ST2 DoubleTrap 6-0** x 20 Inside #1 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 20 Chambers in 2 Rows 16.96' x 153.96' Core + 6.66' Border = 30.27' x 167.27' System
#3B	53.00'	0 cf	**21.79'W x 259.65'L x 7.00'H Field B** Impervious 39,607 cf Overall - 39,607 cf Embedded = 0 cf x 40.0% Voids
#4B	53.00'	29,879 cf	**StormTrap ST2 DoubleTrap 6-0** x 16 Inside #3 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 8.48' x 246.33' Core + 6.66' Border = 21.79' x 259.65' System
		56,785 cf	Total Available Storage

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

Device	Routing	Invert	Outlet Devices
#1	Discarded	53.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.55'
#2	Primary	53.10'	**48.0" Round Culvert** L= 94.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 53.10' / 52.60' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 12.57 sf
#3	Device 2	56.70'	**11.8' long x 2.30' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.7' Crest Height

Discarded OutFlow Max=1.95 cfs @ 12.19 hrs HW=57.49' (Free Discharge)
└**1=Exfiltration** (Controls 1.95 cfs)

Primary OutFlow Max=27.10 cfs @ 12.19 hrs HW=57.49' TW=55.50' (Fixed TW Elev= 55.50')
└**2=Culvert** (Passes 27.10 cfs of 84.62 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 27.10 cfs @ 2.95 fps)

Summary for Pond P102: SC-740

previously had infiltration rate of 0.52 in/hr

Inflow Area = 30,955 sf, 68.68% Impervious, Inflow Depth = 2.69" for 10-Year event
Inflow = 2.33 cfs @ 12.07 hrs, Volume= 6,947 cf
Outflow = 2.13 cfs @ 12.11 hrs, Volume= 6,947 cf, Atten= 9%, Lag= 2.2 min
Discarded = 0.04 cfs @ 12.11 hrs, Volume= 3,608 cf
Primary = 2.09 cfs @ 12.11 hrs, Volume= 3,339 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 57.26' @ 12.11 hrs Surf.Area= 980 sf Storage= 1,898 cf

Plug-Flow detention time= 305.4 min calculated for 6,946 cf (100% of inflow)
Center-of-Mass det. time= 305.5 min (1,128.4 - 822.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.10'	930 cf	**11.00'W x 89.06'L x 3.50'H Field A** 3,429 cf Overall - 1,103 cf Embedded = 2,326 cf x 40.0% Voids
#2A	54.60'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 2 Rows
		2,033 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	54.10'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 49.20'
#2	Primary	53.20'	**24.0" Round Culvert** L= 14.0' Ke= 0.900 Inlet / Outlet Invert= 53.20' / 53.00' S= 0.0143 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#3	Device 2	57.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 3	54.70'	**24.0" Round Culvert** L= 5.0' Ke= 0.900 Inlet / Outlet Invert= 54.70' / 54.60' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Discarded OutFlow Max=0.04 cfs @ 12.11 hrs HW=57.25' (Free Discharge)
└**1=Exfiltration** (Controls 0.04 cfs)

Primary OutFlow Max=2.08 cfs @ 12.11 hrs HW=57.25' (Free Discharge)
└**2=Culvert** (Passes 2.08 cfs of 20.87 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.08 cfs @ 1.65 fps)
└**4=Culvert** (Passes 2.08 cfs of 6.02 cfs potential flow)

Summary for Link DP-1: Charles River Marsh

Inflow Area = 1,219,682 sf, 67.18% Impervious, Inflow Depth = 2.47" for 10-Year event
Inflow = 75.14 cfs @ 12.12 hrs, Volume= 250,854 cf
Primary = 75.14 cfs @ 12.12 hrs, Volume= 250,854 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 72,394 sf, 64.14% Impervious, Inflow Depth = 2.48" for 10-Year event
Inflow = 4.77 cfs @ 12.08 hrs, Volume= 14,974 cf
Primary = 4.77 cfs @ 12.08 hrs, Volume= 14,974 cf, Atten= 0%, Lag= 0.0 min

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

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

Subcatchment1S: Bldg 1-6, 9&10, Main Runoff Area=9.215 ac 93.40% Impervious Runoff Depth=5.33"
Flow Length=370' Tc=7.8 min CN=94 Runoff=49.76 cfs 178,168 cf

Subcatchment2S: Transit Area South Runoff Area=0.711 ac 68.68% Impervious Runoff Depth=3.81"
Flow Length=342' Tc=5.0 min CN=80 Runoff=3.28 cfs 9,824 cf

Subcatchment3S: Building 1 Loading Runoff Area=0.260 ac 100.00% Impervious Runoff Depth=5.79"
Flow Length=225' Tc=5.7 min CN=98 Runoff=1.55 cfs 5,465 cf

Subcatchment4S: Parcel A3 Runoff Area=1.076 ac 100.00% Impervious Runoff Depth=5.79"
Tc=5.0 min CN=98 Runoff=6.59 cfs 22,624 cf

Subcatchment100: Land Bordering Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=1.30"
Flow Length=270' Tc=8.8 min CN=52 Runoff=2.64 cfs 10,847 cf

Subcatchment101: MBTA Storage Yard Runoff Area=13.219 ac 51.96% Impervious Runoff Depth=4.55"
Flow Length=1,197' Tc=5.0 min CN=87 Runoff=70.92 cfs 218,136 cf

Subcatchment116: Grove Street Runoff Area=1.236 ac 92.04% Impervious Runoff Depth=5.21"
Flow Length=1,162' Tc=5.0 min CN=93 Runoff=7.26 cfs 23,381 cf

Subcatchment117: Grove Street Runoff Area=0.254 ac 88.42% Impervious Runoff Depth=4.99"
Tc=5.0 min CN=91 Runoff=1.45 cfs 4,589 cf

Subcatchment200: Recreation Road Offsite Runoff Area=1.402 ac 57.49% Impervious Runoff Depth=3.11"
Tc=5.0 min CN=73 Runoff=5.30 cfs 15,845 cf

Pond P101: Doubletrap Peak Elev=57.77' Storage=40,434 cf Inflow=49.76 cfs 178,168 cf
Discarded=2.01 cfs 105,664 cf Primary=43.05 cfs 72,508 cf Outflow=45.06 cfs 178,172 cf

Pond P102: SC-740 Peak Elev=57.34' Storage=1,932 cf Inflow=3.28 cfs 9,824 cf
Discarded=0.04 cfs 3,778 cf Primary=3.22 cfs 6,046 cf Outflow=3.26 cfs 9,824 cf

Link DP-1: Charles River Marsh Inflow=124.26 cfs 358,132 cf
Primary=124.26 cfs 358,132 cf

Link DP-2: Recreation Road Inflow=6.85 cfs 21,311 cf
Primary=6.85 cfs 21,311 cf

Total Runoff Area = 1,292,076 sf Runoff Volume = 488,880 cf Average Runoff Depth = 4.54"
32.99% Pervious = 426,293 sf 67.01% Impervious = 865,783 sf

Summary for Subcatchment 1S: Bldg 1-6, 9&10, Main Street

Runoff = 49.76 cfs @ 12.11 hrs, Volume= 178,168 cf, Depth= 5.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

Area (ac)	CN	Description
0.608	39	>75% Grass cover, Good, HSG A
3.484	98	Paved roads w/curbs & sewers, HSG A
5.123	98	Unconnected roofs, HSG A
9.215	94	Weighted Average
0.608		6.60% Pervious Area
8.607		93.40% Impervious Area
5.123		59.52% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, Bldg to CB** Grass: Short n= 0.150 P2= 3.20"
0.2	165	0.0128	12.62	89.18	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	73	0.0179	14.92	105.46	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.0	34	0.0205	15.97	112.86	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	48	0.0142	13.29	93.93	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
7.8	370	Total			

Summary for Subcatchment 2S: Transit Area South

Runoff = 3.28 cfs @ 12.07 hrs, Volume= 9,824 cf, Depth= 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

Area (ac)	CN	Description
0.223	39	>75% Grass cover, Good, HSG A
0.487	98	Paved roads w/curbs & sewers, HSG A
0.001	98	Unconnected roofs, HSG A
0.711	80	Weighted Average
0.223		31.32% Pervious Area
0.488		68.68% Impervious Area
0.001		0.22% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement - first 50 feet** Smooth surfaces n= 0.011 P2= 3.20"
1.8	276	0.0167	2.62		**Shallow Concentrated Flow, Pavement to CB** Paved Kv= 20.3 fps
0.0	16	0.0121	8.58	26.96	**Pipe Channel, 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
2.7	342	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 3S: Building 1 Loading

Runoff = 1.55 cfs @ 12.08 hrs, Volume= 5,465 cf, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

Area (ac)	CN	Description
0.251	98	Paved roads w/curbs & sewers, HSG A
0.009	98	Unconnected roofs, HSG A
0.260	98	Weighted Average
0.260		100.00% Impervious Area
0.009		3.37% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.2	50	0.0300	3.52		**Shallow Concentrated Flow, Grass** Paved Kv= 20.3 fps
0.7	125	0.0200	2.87		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.7	225	Total			

Summary for Subcatchment 4S: Parcel A3

Runoff = 6.59 cfs @ 12.07 hrs, Volume= 22,624 cf, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

Area (ac)	CN	Description
1.076	98	Paved roads w/curbs & sewers, HSG A
1.076		100.00% Impervious Area

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

Summary for Subcatchment 100: Land Bordering Charles River

Runoff = 2.64 cfs @ 12.14 hrs, Volume= 10,847 cf, Depth= 1.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
	0.381	98	Paved roads w/curbs & sewers, HSG A
*	0.028	98	Rooftop, HSG A
	0.428	76	Gravel roads, HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 101: MBTA Storage Yard

[47] Hint: Peak is 1098% of capacity of segment #3
[47] Hint: Peak is 675% of capacity of segment #4
[47] Hint: Peak is 173% of capacity of segment #5

Runoff = 70.92 cfs @ 12.07 hrs, Volume= 218,136 cf, Depth= 4.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

	Area (ac)	CN	Description
	0.051	39	>75% Grass cover, Good, HSG A
	6.300	76	Gravel roads, HSG A
	3.444	98	Paved roads w/curbs & sewers, HSG A
*	3.424	98	Rooftop, HSG A
	13.219	87	Weighted Average
	6.351		48.04% Pervious Area
	6.868		51.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 116: Grove Street

[47] Hint: Peak is 114% of capacity of segment #3
[47] Hint: Peak is 102% of capacity of segment #4

Runoff = 7.26 cfs @ 12.07 hrs, Volume= 23,381 cf, Depth= 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

Area (ac)	CN	Description
0.098	39	>75% Grass cover, Good, HSG A
1.137	98	Paved roads w/curbs & sewers, HSG A
1.236	93	Weighted Average
0.098		7.96% Pervious Area
1.137		92.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 117: Grove Street

Runoff = 1.45 cfs @ 12.07 hrs, Volume= 4,589 cf, Depth= 4.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

Area (ac)	CN	Description
0.029	39	>75% Grass cover, Good, HSG A
0.224	98	Paved roads w/curbs & sewers, HSG A
0.254	91	Weighted Average
0.029		11.58% Pervious Area
0.224		88.42% Impervious Area

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

Summary for Subcatchment 200: Recreation Road Offsite

Runoff = 5.30 cfs @ 12.08 hrs, Volume= 15,845 cf, Depth= 3.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.03"

Area (ac)	CN	Description
0.596	39	>75% Grass cover, Good, HSG A
0.806	98	Paved roads w/curbs & sewers, HSG A
1.402	73	Weighted Average
0.596		42.51% Pervious Area
0.806		57.49% Impervious Area

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

Summary for Pond P101: Doubletrap

Inflow Area = 401,405 sf, 93.40% Impervious, Inflow Depth = 5.33" for 25-Year event
Inflow = 49.76 cfs @ 12.11 hrs, Volume= 178,168 cf
Outflow = 45.06 cfs @ 12.15 hrs, Volume= 178,172 cf, Atten= 9%, Lag= 2.5 min
Discarded = 2.01 cfs @ 12.15 hrs, Volume= 105,664 cf
Primary = 43.05 cfs @ 12.15 hrs, Volume= 72,508 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 57.77' @ 12.15 hrs Surf.Area= 5,063 sf Storage= 40,434 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 109.7 min (879.8 - 770.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	53.00'	0 cf	**30.27'W x 167.27'L x 7.00'H Field A** 35,444 cf Overall - 35,444 cf Embedded = 0 cf x 40.0% Voids
#2A	53.00'	26,906 cf	**StormTrap ST2 DoubleTrap 6-0** x 20 Inside #1 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 20 Chambers in 2 Rows 16.96' x 153.96' Core + 6.66' Border = 30.27' x 167.27' System
#3B	53.00'	0 cf	**21.79'W x 259.65'L x 7.00'H Field B** Impervious 39,607 cf Overall - 39,607 cf Embedded = 0 cf x 40.0% Voids
#4B	53.00'	29,879 cf	**StormTrap ST2 DoubleTrap 6-0** x 16 Inside #3 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 8.48' x 246.33' Core + 6.66' Border = 21.79' x 259.65' System
		56,785 cf	Total Available Storage

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

Device	Routing	Invert	Outlet Devices
#1	Discarded	53.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.55'
#2	Primary	53.10'	**48.0" Round Culvert** L= 94.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 53.10' / 52.60' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 12.57 sf
#3	Device 2	56.70'	**11.8' long x 2.30' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.7' Crest Height

Discarded OutFlow Max=2.01 cfs @ 12.15 hrs HW=57.77' (Free Discharge)
└**1=Exfiltration** (Controls 2.01 cfs)

Primary OutFlow Max=43.02 cfs @ 12.15 hrs HW=57.77' TW=55.50' (Fixed TW Elev= 55.50')
└**2=Culvert** (Passes 43.02 cfs of 91.14 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 43.02 cfs @ 3.46 fps)

Summary for Pond P102: SC-740

previously had infiltration rate of 0.52 in/hr

Inflow Area =	30,955 sf,	68.68% Impervious,	Inflow Depth =	3.81"	for 25-Year event
Inflow =	3.28 cfs @	12.07 hrs, Volume=	9,824 cf		
Outflow =	3.26 cfs @	12.08 hrs, Volume=	9,824 cf,	Atten= 1%,	Lag= 0.5 min
Discarded =	0.04 cfs @	12.08 hrs, Volume=	3,778 cf		
Primary =	3.22 cfs @	12.08 hrs, Volume=	6,046 cf		

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 57.34' @ 12.08 hrs Surf.Area= 980 sf Storage= 1,932 cf

Plug-Flow detention time= 226.5 min calculated for 9,823 cf (100% of inflow)
Center-of-Mass det. time= 226.6 min (1,039.6 - 813.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.10'	930 cf	**11.00'W x 89.06'L x 3.50'H Field A** 3,429 cf Overall - 1,103 cf Embedded = 2,326 cf x 40.0% Voids
#2A	54.60'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 2 Rows
		2,033 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	54.10'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 49.20'
#2	Primary	53.20'	**24.0" Round Culvert** L= 14.0' Ke= 0.900 Inlet / Outlet Invert= 53.20' / 53.00' S= 0.0143 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#3	Device 2	57.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 3	54.70'	**24.0" Round Culvert** L= 5.0' Ke= 0.900 Inlet / Outlet Invert= 54.70' / 54.60' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Discarded OutFlow Max=0.04 cfs @ 12.08 hrs HW=57.34' (Free Discharge)
└**1=Exfiltration** (Controls 0.04 cfs)

Primary OutFlow Max=3.21 cfs @ 12.08 hrs HW=57.34' (Free Discharge)
└**2=Culvert** (Passes 3.21 cfs of 21.17 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 3.21 cfs @ 1.91 fps)
└**4=Culvert** (Passes 3.21 cfs of 6.97 cfs potential flow)

Summary for Link DP-1: Charles River Marsh

Inflow Area = 1,219,682 sf, 67.18% Impervious, Inflow Depth = 3.52" for 25-Year event
Inflow = 124.26 cfs @ 12.09 hrs, Volume= 358,132 cf
Primary = 124.26 cfs @ 12.09 hrs, Volume= 358,132 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 72,394 sf, 64.14% Impervious, Inflow Depth = 3.53" for 25-Year event
Inflow = 6.85 cfs @ 12.08 hrs, Volume= 21,311 cf
Primary = 6.85 cfs @ 12.08 hrs, Volume= 21,311 cf, Atten= 0%, Lag= 0.0 min

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

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

Subcatchment1S: Bldg 1-6, 9&10, Main Runoff Area=9.215 ac 93.40% Impervious Runoff Depth=8.06"
Flow Length=370' Tc=7.8 min CN=94 Runoff=73.67 cfs 269,540 cf

Subcatchment2S: Transit Area South Runoff Area=0.711 ac 68.68% Impervious Runoff Depth=6.36"
Flow Length=342' Tc=5.0 min CN=80 Runoff=5.38 cfs 16,406 cf

Subcatchment3S: Building 1 Loading Runoff Area=0.260 ac 100.00% Impervious Runoff Depth=8.54"
Flow Length=225' Tc=5.7 min CN=98 Runoff=2.27 cfs 8,058 cf

Subcatchment4S: Parcel A3 Runoff Area=1.076 ac 100.00% Impervious Runoff Depth=8.54"
Tc=5.0 min CN=98 Runoff=9.61 cfs 33,358 cf

Subcatchment100: Land Bordering Runoff Area=2.290 ac 17.86% Impervious Runoff Depth=2.97"
Flow Length=270' Tc=8.8 min CN=52 Runoff=6.91 cfs 24,724 cf

Subcatchment101: MBTA Storage Yard Runoff Area=13.219 ac 51.96% Impervious Runoff Depth=7.21"
Flow Length=1,197' Tc=5.0 min CN=87 Runoff=109.74 cfs 346,006 cf

Subcatchment116: Grove Street Runoff Area=1.236 ac 92.04% Impervious Runoff Depth=7.94"
Flow Length=1,162' Tc=5.0 min CN=93 Runoff=10.81 cfs 35,605 cf

Subcatchment117: Grove Street Runoff Area=0.254 ac 88.42% Impervious Runoff Depth=7.70"
Tc=5.0 min CN=91 Runoff=2.19 cfs 7,082 cf

Subcatchment200: Recreation Road Offsite Runoff Area=1.402 ac 57.49% Impervious Runoff Depth=5.51"
Tc=5.0 min CN=73 Runoff=9.35 cfs 28,026 cf

Pond P101: Doubletrap Peak Elev=58.13' Storage=43,862 cf Inflow=73.67 cfs 269,540 cf
Discarded=2.09 cfs 125,369 cf Primary=66.69 cfs 144,165 cf Outflow=68.78 cfs 269,534 cf

Pond P102: SC-740 Peak Elev=57.48' Storage=1,986 cf Inflow=5.38 cfs 16,406 cf
Discarded=0.04 cfs 3,976 cf Primary=5.32 cfs 12,429 cf Outflow=5.36 cfs 16,406 cf

Link DP-1: Charles River Marsh Inflow=197.91 cfs 603,371 cf
Primary=197.91 cfs 603,371 cf

Link DP-2: Recreation Road Inflow=11.61 cfs 36,085 cf
Primary=11.61 cfs 36,085 cf

Total Runoff Area = 1,292,076 sf Runoff Volume = 768,807 cf Average Runoff Depth = 7.14"
32.99% Pervious = 426,293 sf 67.01% Impervious = 865,783 sf

Summary for Subcatchment 1S: Bldg 1-6, 9&10, Main Street

Runoff = 73.67 cfs @ 12.11 hrs, Volume= 269,540 cf, Depth= 8.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (ac)	CN	Description
0.608	39	>75% Grass cover, Good, HSG A
3.484	98	Paved roads w/curbs & sewers, HSG A
5.123	98	Unconnected roofs, HSG A
9.215	94	Weighted Average
0.608		6.60% Pervious Area
8.607		93.40% Impervious Area
5.123		59.52% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, Bldg to CB** Grass: Short n= 0.150 P2= 3.20"
0.2	165	0.0128	12.62	89.18	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	73	0.0179	14.92	105.46	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.0	34	0.0205	15.97	112.86	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
0.1	48	0.0142	13.29	93.93	**Pipe Channel, 36"D** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.011
7.8	370	Total			

Summary for Subcatchment 2S: Transit Area South

Runoff = 5.38 cfs @ 12.07 hrs, Volume= 16,406 cf, Depth= 6.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (ac)	CN	Description
0.223	39	>75% Grass cover, Good, HSG A
0.487	98	Paved roads w/curbs & sewers, HSG A
0.001	98	Unconnected roofs, HSG A
0.711	80	Weighted Average
0.223		31.32% Pervious Area
0.488		68.68% Impervious Area
0.001		0.22% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement - first 50 feet** Smooth surfaces n= 0.011 P2= 3.20"
1.8	276	0.0167	2.62		**Shallow Concentrated Flow, Pavement to CB** Paved Kv= 20.3 fps
0.0	16	0.0121	8.58	26.96	**Pipe Channel, 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
2.7	342	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 3S: Building 1 Loading

Runoff = 2.27 cfs @ 12.08 hrs, Volume= 8,058 cf, Depth= 8.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (ac)	CN	Description
0.251	98	Paved roads w/curbs & sewers, HSG A
0.009	98	Unconnected roofs, HSG A
0.260	98	Weighted Average
0.260		100.00% Impervious Area
0.009		3.37% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.2	50	0.0300	3.52		**Shallow Concentrated Flow, Grass** Paved Kv= 20.3 fps
0.7	125	0.0200	2.87		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.7	225	Total			

Summary for Subcatchment 4S: Parcel A3

Runoff = 9.61 cfs @ 12.07 hrs, Volume= 33,358 cf, Depth= 8.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (ac)	CN	Description
1.076	98	Paved roads w/curbs & sewers, HSG A
1.076		100.00% Impervious Area

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

Summary for Subcatchment 100: Land Bordering Charles River

Runoff = 6.91 cfs @ 12.13 hrs, Volume= 24,724 cf, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
	0.381	98	Paved roads w/curbs & sewers, HSG A
*	0.028	98	Rooftop, HSG A
	0.428	76	Gravel roads, HSG A
	0.241	39	>75% Grass cover, Good, HSG A
	1.212	30	Woods, Good, HSG A
	2.290	52	Weighted Average
	1.881		82.14% Pervious Area
	0.409		17.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.20"
0.3	30	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
3.8	170	0.0225	0.75		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
0.4	20	0.0300	0.87		**Shallow Concentrated Flow, Woods** Woodland Kv= 5.0 fps
8.8	270	Total			

Summary for Subcatchment 101: MBTA Storage Yard

[47] Hint: Peak is 1699% of capacity of segment #3
[47] Hint: Peak is 1045% of capacity of segment #4
[47] Hint: Peak is 268% of capacity of segment #5

Runoff = 109.74 cfs @ 12.07 hrs, Volume= 346,006 cf, Depth= 7.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

	Area (ac)	CN	Description
	0.051	39	>75% Grass cover, Good, HSG A
	6.300	76	Gravel roads, HSG A
	3.444	98	Paved roads w/curbs & sewers, HSG A
*	3.424	98	Rooftop, HSG A
	13.219	87	Weighted Average
	6.351		48.04% Pervious Area
	6.868		51.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	0.99		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.6	75	0.0125	2.27		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	125	0.0100	5.26	6.46	**Pipe Channel, 15" D** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013
0.4	150	0.0100	5.94	10.50	**Pipe Channel, 18" D** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
0.8	407	0.0100	8.36	41.02	**Pipe Channel, 30" D** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.013
0.5	390	0.0090	12.58	247.08	**Pipe Channel, 60" D** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.013
3.5	1,197	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 116: Grove Street

[47] Hint: Peak is 170% of capacity of segment #3
[47] Hint: Peak is 152% of capacity of segment #4

Runoff = 10.81 cfs @ 12.07 hrs, Volume= 35,605 cf, Depth= 7.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (ac)	CN	Description
0.098	39	>75% Grass cover, Good, HSG A
1.137	98	Paved roads w/curbs & sewers, HSG A
1.236	93	Weighted Average
0.098		7.96% Pervious Area
1.137		92.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0180	1.15		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.20"
0.7	117	0.0180	2.72		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.0	25	0.0840	11.64	6.35	**Pipe Channel, 10" D** 10.0" Round Area= 0.5 sf Perim= 2.6' r= 0.21' n= 0.013
1.8	970	0.0400	9.07	7.13	**Pipe Channel, 12" D** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
3.2	1,162	Total, Increased to minimum Tc = 5.0 min			

Summary for Subcatchment 117: Grove Street

Runoff = 2.19 cfs @ 12.07 hrs, Volume= 7,082 cf, Depth= 7.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (ac)	CN	Description
0.029	39	>75% Grass cover, Good, HSG A
0.224	98	Paved roads w/curbs & sewers, HSG A
0.254	91	Weighted Average
0.029		11.58% Pervious Area
0.224		88.42% Impervious Area

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

Summary for Subcatchment 200: Recreation Road Offsite

Runoff = 9.35 cfs @ 12.07 hrs, Volume= 28,026 cf, Depth= 5.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (ac)	CN	Description
0.596	39	>75% Grass cover, Good, HSG A
0.806	98	Paved roads w/curbs & sewers, HSG A
1.402	73	Weighted Average
0.596		42.51% Pervious Area
0.806		57.49% Impervious Area

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

Summary for Pond P101: Doubletrap

Inflow Area = 401,405 sf, 93.40% Impervious, Inflow Depth = 8.06" for 100-Year event
Inflow = 73.67 cfs @ 12.11 hrs, Volume= 269,540 cf
Outflow = 68.78 cfs @ 12.14 hrs, Volume= 269,534 cf, Atten= 7%, Lag= 2.1 min
Discarded = 2.09 cfs @ 12.14 hrs, Volume= 125,369 cf
Primary = 66.69 cfs @ 12.14 hrs, Volume= 144,165 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 58.13' @ 12.14 hrs Surf.Area= 5,063 sf Storage= 43,862 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 93.1 min (854.0 - 760.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	53.00'	0 cf	**30.27'W x 167.27'L x 7.00'H Field A** 35,444 cf Overall - 35,444 cf Embedded = 0 cf x 40.0% Voids
#2A	53.00'	26,906 cf	**StormTrap ST2 DoubleTrap 6-0** x 20 Inside #1 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 20 Chambers in 2 Rows 16.96' x 153.96' Core + 6.66' Border = 30.27' x 167.27' System
#3B	53.00'	0 cf	**21.79'W x 259.65'L x 7.00'H Field B** Impervious 39,607 cf Overall - 39,607 cf Embedded = 0 cf x 40.0% Voids
#4B	53.00'	29,879 cf	**StormTrap ST2 DoubleTrap 6-0** x 16 Inside #3 Inside= 101.7"W x 72.0"H => 45.99 sf x 15.40'L = 708.0 cf Outside= 101.7"W x 84.0"H => 59.35 sf x 15.40'L = 913.8 cf 8.48' x 246.33' Core + 6.66' Border = 21.79' x 259.65' System
		56,785 cf	Total Available Storage

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

Device	Routing	Invert	Outlet Devices
#1	Discarded	53.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.55'
#2	Primary	53.10'	**48.0" Round Culvert** L= 94.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 53.10' / 52.60' S= 0.0053 '/' Cc= 0.900 n= 0.011, Flow Area= 12.57 sf
#3	Device 2	56.70'	**11.8' long x 2.30' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 5.7' Crest Height

Discarded OutFlow Max=2.09 cfs @ 12.14 hrs HW=58.13' (Free Discharge)
└**1=Exfiltration** (Controls 2.09 cfs)

Primary OutFlow Max=66.65 cfs @ 12.14 hrs HW=58.13' TW=55.50' (Fixed TW Elev= 55.50')
└**2=Culvert** (Passes 66.65 cfs of 98.09 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 66.65 cfs @ 4.04 fps)

Summary for Pond P102: SC-740

previously had infiltration rate of 0.52 in/hr

Inflow Area = 30,955 sf, 68.68% Impervious, Inflow Depth = 6.36" for 100-Year event
Inflow = 5.38 cfs @ 12.07 hrs, Volume= 16,406 cf
Outflow = 5.36 cfs @ 12.08 hrs, Volume= 16,406 cf, Atten= 0%, Lag= 0.4 min
Discarded = 0.04 cfs @ 12.08 hrs, Volume= 3,976 cf
Primary = 5.32 cfs @ 12.08 hrs, Volume= 12,429 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 57.48' @ 12.08 hrs Surf.Area= 980 sf Storage= 1,986 cf

Plug-Flow detention time= 143.2 min calculated for 16,403 cf (100% of inflow)
Center-of-Mass det. time= 143.3 min (941.8 - 798.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.10'	930 cf	**11.00'W x 89.06'L x 3.50'H Field A** 3,429 cf Overall - 1,103 cf Embedded = 2,326 cf x 40.0% Voids
#2A	54.60'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 2 Rows
		2,033 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	54.10'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 49.20'
#2	Primary	53.20'	**24.0" Round Culvert** L= 14.0' Ke= 0.900 Inlet / Outlet Invert= 53.20' / 53.00' S= 0.0143 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#3	Device 2	57.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 3	54.70'	**24.0" Round Culvert** L= 5.0' Ke= 0.900 Inlet / Outlet Invert= 54.70' / 54.60' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Discarded OutFlow Max=0.04 cfs @ 12.08 hrs HW=57.48' (Free Discharge)
└**1=Exfiltration** (Controls 0.04 cfs)

Primary OutFlow Max=5.31 cfs @ 12.08 hrs HW=57.48' (Free Discharge)
└**2=Culvert** (Passes 5.31 cfs of 21.62 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 5.31 cfs @ 2.26 fps)
└**4=Culvert** (Passes 5.31 cfs of 8.26 cfs potential flow)

Summary for Link DP-1: Charles River Marsh

Inflow Area = 1,219,682 sf, 67.18% Impervious, Inflow Depth = 5.94" for 100-Year event
Inflow = 197.91 cfs @ 12.09 hrs, Volume= 603,371 cf
Primary = 197.91 cfs @ 12.09 hrs, Volume= 603,371 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link DP-2: Recreation Road

Inflow Area = 72,394 sf, 64.14% Impervious, Inflow Depth = 5.98" for 100-Year event
Inflow = 11.61 cfs @ 12.07 hrs, Volume= 36,085 cf
Primary = 11.61 cfs @ 12.07 hrs, Volume= 36,085 cf, Atten= 0%, Lag= 0.0 min

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