The Morin-Cameron GROUP, INC.

DRAINAGE REPORT

FOR THE

MULTIFAMILY RESIDENTIAL DEVELOPMENT

LOCATED AT

3 BOSTON WAY
NEWBURYPORT, MASSACHUSETTS

October 23, 2019

Revised: January 23, 2020

CIVIL ENGINEERS • LAND SURVEYORS • ENVIRONMENTAL CONSULTANTS • LAND USE PLANNERS

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Revised: January 23, 2020

SUBMITTED TO:

CITY OF NEWBURYPORT
PLANNING BOARD
60 PLEASANT STREET
P.O. BOX 550
NEWBURYPORT, MA 01950

APPLICANT:

THREE BOSTON WAY, LLC
231 SUTTON STREET
NORTH ANDOVER, MA 01845

PREPARED BY:

THE MORIN-CAMERON GROUP, INC.
66 ELM STREET
DANVERS, MA 01923

COMMONWEALTH OF MASSACHUSETTS
SCOTT P. CAMERON
CIVIL
No. 47601
REGISTERED
PROFESSIONAL ENGINEER

1-23-2020

DRAINAGE REPORT NARRATIVE

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DRAINAGE REPORT NARRATIVE
3 Boston Way Multi-Family Site Development

I. Executive Summary

Three Boston Way, LLC, the applicant, proposes to construct a multi-family residential building at 3 Boston Way in Newburyport, Massachusetts ("site"). The project will include 84 residential units with surface and underground parking, landscaping improvements, stormwater management system and new utility infrastructure. The subject parcels are shown on the City of Newburyport Assessor's Map 78, Lot 1-I which is situated in the Industrial (1B) Zoning District. Additionally, the site is located within the Smart Growth Overlay District Subdistrict "A" and is within 250 feet of the MBTA right-of-way.

The project will require Site Plan Approval through the Newburyport Planning Board and a Notice of Intent will be filed concurrently with the Newburyport Conservation Commission. As part of the project permitting, the proponent must demonstrate compliance with applicable stormwater best management practices and regulations. The following drainage narrative contains a description of existing and proposed site conditions, stormwater management design methodology and results summaries and other supplemental information in support of the stormwater best management system design.

II. Existing Site Description

The site consists of a total land area of 91,489 square feet (2.1± acres) and is currently developed with two existing commercial buildings with associated parking, drainage, and utility infrastructure. The property is used by an ambulance service company and by a landscape contractor with exterior material storage. The south and east edges of the property consist of a bordering vegetated wetland, mowed lawn areas and wooded areas. The site includes two vegetated drainage swales and is subject to both a drainage easement and an electric easement as shown on the Existing Conditions Plan. The site is bordered to the east by the MBTA right-of-way and railroad, to the south by the Newburyport Commuter Train Station parking and a restaurant, west by Boston Way, and to the north by 1 Boston Way which is currently under construction by the applicant for 76 units of apartment housing. Refer to Figure 1: Ortho Map and Figure 2: USGS Locus Map for illustrations of the site and surrounding features.

Grades on the site vary, with slopes ranging from 1% to 25%. The site has a high elevation of approximately 20.0 (northeast and southeast corners of the site) and low elevation of approximately 11.0 (southwest corner of the site). Stormwater from most of the parking area flows overland to drainage swales to the east and west of the paved area. The large existing building and part of the paved area is captured in an existing catch basin between the two buildings, which leads to the drainage swale along the western edge of the property. These two swales flow to a 30" reinforced concrete pipe ("RCP") under Boston Way. The runoff from the small existing building, remaining pavement, and gravel/storage area flows overland in a southwesterly direction towards the existing wetland along the south edge of the property and the 15" RCP at the southwestern corner of the property.

Soils on site are Buxton, 3-8% slopes, Hydrologic Soil Group (HSG) D (228B); and Scantic Silt Loam, 0-3% slopes, Hydrologic Soil Group (HSG) C/D (16A) (See Figure 3: SCS Soils Map). The entire site is shown to be outside of Zone X on the FEMA Federal Insurance Rate Map (FIRM) #25009C0117G, dated July 16, 2014 (See Figure 4: FEMA Flood Map).

III. Proposed Site Description

The applicant proposes to construct an 84-unit multifamily residential building with associated parking, landscaping, stormwater management system and new utility connections. The building footprint area totals approximately 18,400± sf. The proposed building, which is situated in the eastern portion of the site along Boston Way, will have an underground garage with the entrance in the southern end of the building. A surface parking lot and drive aisle is proposed, with the entrance located at the southwestern portion of the property off Boston Way. The drive aisle and surface parking will wrap around the southern and eastern edges of the new building and will connect to 1 Boston Way in the northeastern corner of the property. The wetland located along the eastern and southern edges of the property will be protected. There is minimal work proposed within the 25' wetland buffer, which primarily consists of restoration activities, grading and vegetated stormwater wetland construction. All such work will occur on previously disturbed or degraded land.

Infrastructure associated with the development of the site will include the removal and replacement of the existing water, drainage, overhead-electrical and sewer services and construction of stormwater management infrastructure with other associated utilities including domestic water and fire protection services, natural gas, electrical, communications and fiber optic services. Since the elevation of the developed area will need to be raised to accommodate the parking areas and drive aisle, fill will need to be used. Cut material from the foundation construction and 1 Boston Way construction will be used to achieve the necessary grades.

The proposed stormwater management system for the project will consist of various Best Management Practices ("BMP's") in both mitigating and renovating stormwater runoff. The entire stormwater system was designed in accordance with the City of Newburyport's Stormwater Management and Erosion Control Regulations and the Massachusetts Stormwater Management Handbook ("Handbook"), which the City of Newburyport references in its regulations. The measures to be implemented at the site includes a subsurface detention system utilizing concrete chambers, Vortsentry water quality inlets, vegetated swales and constructed stormwater wetlands. Refer to the Grading & Drainage Plan and associated construction details for more information. The existing watershed characteristics, flow paths and drainage patterns were matched to the extent practicable in the proposed condition to demonstrate that there are no adverse impacts to adjacent properties at the design points.

IV. Stormwater Management

A. Existing Watershed Characteristics

Stormwater runoff exits the site in the existing condition at two (2) distinct locations. The location where stormwater runoff leaves the site boundary is called the design point ("DP"). DP1 is the existing constructed stormwater wetland and 30" RCP to the northwest corner of the site adjacent to Boston Way. DP2 is the 15" culvert in the southwest corner of the site adjacent to Boston Way. The design points and the tributary watersheds (or subcatchments) are illustrated on Figure 5: Existing Site Development Watershed Plan and Figure 7: Offsite Watershed Plan, included herein. The table below lists the total area associated with each subcatchment area.

Summary of Existing Subcatchments

Proposed Drainage Area (E)	Total Area (SF)	% Impervious	Composite Curve Number
E1	176,682	69.1%	92
E2	61,958	13.2%	86
Total	**238,640 (5.5 acres)**	**54.6%**	**91**

Description of Existing Subcatchments

The subcatchments analyzed in the existing condition can be described as follows:

- **Subcatchment E1:** Consists of the northwesterly portion of the property, 1 Boston Way site, and offsite areas on Boston Way and the MBTA property. This area includes the larger of the two existing buildings, a majority of the existing on-site pavement and off-site roadway pavement, on-site and off-site concrete walkways, and pervious surfaces to the northwest and northeast of the property. These areas flow to the constructed stormwater wetland near the southwest corner of the property on the 1 Boston Way property (DP1).
- **Subcatchment E2:** This area consists of the southeasterly portion of the site. This area includes some pavement, the smaller of the two existing buildings, a large gravel area, storage areas as well as a wetland area. Off-site wooded, concrete sidewalks and other vegetated areas are also included in the subcatchment. This area flows along the eastern property line, towards the southern property line, then proceeds along the southern property line to a 15" culvert at the southwestern corner of the property adjacent to Boston Way (DP2).

B. Proposed Watershed Characteristics

The proposed development of the site will maintain the design points identified in the existing watershed analysis. In order to understand and analyze the proposed development, smaller subcatchments were delineated to analyze stormwater impacts on more detailed scale. The table below provides the total drainage area and the percentage that will be impervious in the post-development condition. The design points and the tributary watersheds (or subcatchments) are illustrated on Figure 6: Proposed Site Development Watershed Plan and Figure 7: Offsite Watershed Plan, included herein. The table below lists the total area associated with each subcatchment area.

Summary of Proposed Subcatchments

Proposed Drainage Area (P)	Total Area (SF)	% Impervious	Composite Curve Number
P1A	46,298	69.2%	92
P1B	105,744	70.3%	93
P2A	44,503	6.1%	81
P2B	24,166	97.3%	98
P2C	17,929	46.7%	88
Totals	**238,640 (5.5 acres)**	**59.1%**	**91**

Description of Proposed Subcatchments

- **Subcatchment P1A:** Includes the northeastern portion of the proposed parking lot, as well as some concrete sidewalk area. It also includes a portion of the MBTA parcel and eastern portion of 1 Boston Way. Runoff from this area is captured by catch basins, which discharge to the existing 15" pipe located in the drainage easement running along the northern property line leading to the existing constructed stormwater wetland near the northwest property corner at 1 Boston Way (DP1).

- **Subcatchment P1B:** Wraps around the proposed building: from the south of the building and around the west part of the building. Includes some pavement and concrete sidewalk south of the building, the sidewalk west of the building, as well as a drainage swale west of the building. The offsite area includes the tributary roadway and majority of 1 Boston Way site, which includes the proposed building. Runoff from this subcatchment flows to both overland and through the proposed drainage system to the existing constructed stormwater wetland near the northwest property corner at 1 Boston Way (DP1).
- **Subcatchment P2A:** Is a subcatchment located along the eastern property lines and southern property line. This area is comprised of grass, woods, and wetlands. It also includes a portion of the walkway for the train station. This area flows from the northeastern portion of the property along the eastern property line and then along the southern property line; leading to a 15" culvert at the southwestern corner of the property (DP2).
- **Subcatchment P2B:** Includes the roof area and a portion of the parking lot east of the building, as well as some concrete sidewalk area and patches of pervious surfaces. Runoff discharges into a concrete subsurface detention system (3P) underneath the proposed parking lot. This system discharges to the constructed stormwater wetland prior to DP1.
- **Subcatchment P2C:** This subcatchment is located on the southern portion of the property. It consists of pavement and sidewalk to the south and east of the building as well as a grass swale that will operate as a constructed stormwater wetland to the south of the building. This constructed pocket wetland will treat the runoff and will discharge to the 15" culvert at the southwestern corner of the property (DP2).

C. Hydrologic Analysis:

The purpose of the stormwater analysis is to demonstrate that the proposed development will not adversely impact the land or surrounding land. The industry standard for stormwater management design in Massachusetts is governed by the Massachusetts Stormwater Management Handbook ("Handbook") published by the Mass Department of Environmental Protection, January 2008. The City of Newburyport Stormwater Management and Erosion Control Bylaw and associated Regulations provide additional requirements including analyzing the 2, 10, and 100-year storm events.

The Handbook lists 10 standards covering both mitigation and renovation of stormwater runoff. A full discussion on compliance with the standards can be found at the end of this report. However, the following section will summarize the projects compliance with the mitigation standards 1 and 2 of the Handbook relating to reducing peak rates of runoff and creating no adverse down gradient impacts.

In order to demonstrate that there will be no downstream impacts as a result of the proposed project, a stormwater analysis was performed using the U.S. Soil Conservation Service (S.C.S) method of analysis contained in Technical Release #20 (TR-20) published by the U.S. Conservation Service. The software application HydroCAD was used to analyze the existing and proposed development watershed conditions. This application is widely used in the civil engineering industry and an accepted means of performing a TR-20 analysis. It is a computer aided design program for analyzing the hydrology and hydraulics of storm water runoff. It utilizes the latest techniques of both fields to accurately predict the consequences of any given storm event. This analysis allows the engineer to verify that a given drainage system is adequate for the area under consideration and further allows the engineer to predict where flooding or erosion are most likely to occur. This model was used to analyze the storm drainage system designed for the development to demonstrate that the drainage system is in compliance with the City's Stormwater Management Standards.

The HydroCAD analysis was performed by examining the two design points that were previously referenced. The following is a listing of the total existing and proposed development rates of stormwater runoff for the proposed development for the 2, 10, and 100-year rainfall events:

DP1 Peak Discharge Rates (CFS)				
Storm Event		Existing Conditions	Proposed Conditions	Change in Peak
2-yr	*Inflow*	***8.55***	***8.09***	***-0.46***
	Outflow	7.92	7.16	-0.76
10-yr	*Inflow*	***17.82***	***16.81***	***-1.01***
	Outflow	15.31	14.52	-0.79
100-yr	**Inflow*	***34.79***	***32.63***	***-2.16***
	Outflow	25.02	25.73	+0.71

Peak Water Surface Elevation @ **DP1** (Constructed Wetland)			
Storm Event	Existing Conditions	Proposed Conditions	Change in Peak Water Surface
2-yr	9.88	9.82	-0.06
10-yr	10.47	10.41	-0.06
100-yr	11.44	11.52	+0.08

Note: The 100-year storm HydroCAD model includes a tailwater elevation of 10.0 to approximate the effects of floodwater as depicted on the FEMA Flood Map (Zone AE). The minor increase in peak rate and peak water surface elevation during the 100-year storm is due to the proposed re-grading of the constructed stormwater wetland shown on the *Grading & Drainage Plan*. These minor increases will not impact the subject property, Boston Way or any adjacent properties and will not cause erosion or scour in wetlands or waterways of the Commonwealth because the land would be flooded in this condition regardless of developed conditions. The 100-year flood elevation is generated by coastal floodwater backing up the Little River, therefore the minor increases represented above will have no impact on off-site flooding.

The HydroCAD model was limited to the tributary areas from 1 and 3 Boston Way only, and does not include other off-site areas that drain toward DP1. Due to several unknown factors of the off-site watershed (e.g.: size, groundcover, time of concentration), the resulting model would not have an acceptable degree of accuracy. As such, the numbers listed above are not indicative of actual flow characteristics through the 30" culvert, but instead they are intended to understand the impacts of the proposed projects on 1 and 3 Boston Way, including re-grading the existing stormwater wetland.

DP2 Peak Discharge Rates (CFS)				
Storm Event		Existing Conditions	Proposed Conditions	Change in Peak
2-yr	*Inflow*	***1.87***	***1.65***	***-0.22***
	Outflow	1.72	1.47	-0.25
10-yr	*Inflow*	***4.56***	***4.34***	***-0.22***
	Outflow	3.82	3.46	-0.36
100-yr	*Inflow*	***9.65***	***9.59***	***-0.06***
	Outflow	9.53	8.96	-0.57

D. Review of Stormwater Management Standards

The proposed development project is comprised of a mix of new development and redevelopment. Standard 4 is met to the maximum extent practicable due to site constraints on Boston Way, which is a fixed roadway that cannot be altered other than minor adjustments to ensure proper drainage. The drainage system has been designed to attenuate peak rates of stormwater for all storm events up to and including the 100-year event. Measures will also be implemented to provide the required total suspended solids (TSS) removal where practicable, to ensure the stormwater runoff is renovated prior to discharge. The following is an assessment of each Standard as it relates to the proposed multi-family residential development project:

1. No stormwater conveyance system discharges untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. The project includes a variety of BMPs to provide treatment of runoff prior to discharge.
   The proposed development meets this standard.
2. The stormwater management system has been designed such that proposed peak rates of runoff do not exceed existing rates for all storm events considered.
   The proposed development meets this standard.
3. Loss of annual recharge to groundwater is required only to the maximum extent practicable since soils present on site are considered to be HSG-D soils. While unaccounted for in the design, some infiltration will occur in the detention system, landscaped areas, water quality swale, and constructed pocket wetland.
   The proposed development meets this standard to the maximum extent practicable.
4. The proposed stormwater management system has been designed to remove a minimum of 80% of the average annual post-construction load of Total Suspended Solids (TSS). The best management practices treatment train utilizes CDS and Stormceptor water quality units, filter strips, a water quality swale, a constructed pocket wetland, and an underground detention system to achieve TSS removal. However, due to the poorly drained soils and topographic constraints, 80% TSS removal is not practicable for runoff from Boston Way at the location of the proposed parallel parking spaces.
   The proposed development meets this standard to the maximum extent practicable.
5. Land Uses with Higher Potential Pollutant Load.
   This standard does not apply.

6. Discharges to critical areas.
   This standard does not apply.

7. Redevelopment Projects: the project consists of a mix of new development and redevelopment.
   The project includes a mix of new development and redevelopment. All standards are fully met with the exception of Standard 3 and Standard 4 as described above.

8. A Construction Phase Operation and Maintenance Plan in included herewith. A Stormwater Pollution Prevention Plan following the EPA guidelines under the National Pollutant Discharge Elimination System will be prepared prior to construction.
   The proposed development meets this standard.

9. A long-term operation and maintenance plan: A long-term O&M has been prepared to provide guidance for current and future owners to inspect and maintain the stormwater management systems in perpetuity. A copy of this O&M plan is included herein.
   The proposed development meets this standard.

10. Illicit discharges: To the best of our knowledge and belief there are no illicit discharges to the stormwater management system on this site. A certification is included herein.
    The proposed development meets this standard.

V. Flood Resiliency Summary

A small portion of the subject property in the northwest corner is located within the 100-year FEMA flood plain (elevation 10.0) by virtue of the hydraulic connection through the culvert below Boston Way. As currently mapped by FEMA, there will be no impacts to pedestrian or vehicular access or safety during the 100-year flood event, because floodwaters will remain beneath the level of all sidewalks, parking lots and the Boston Way roadway surface. However, in the interest of coastal resiliency in the face of uncertain effects caused by climate change, the applicant would like to address how the subject property and 1 Boston Way will function during extreme flood events.

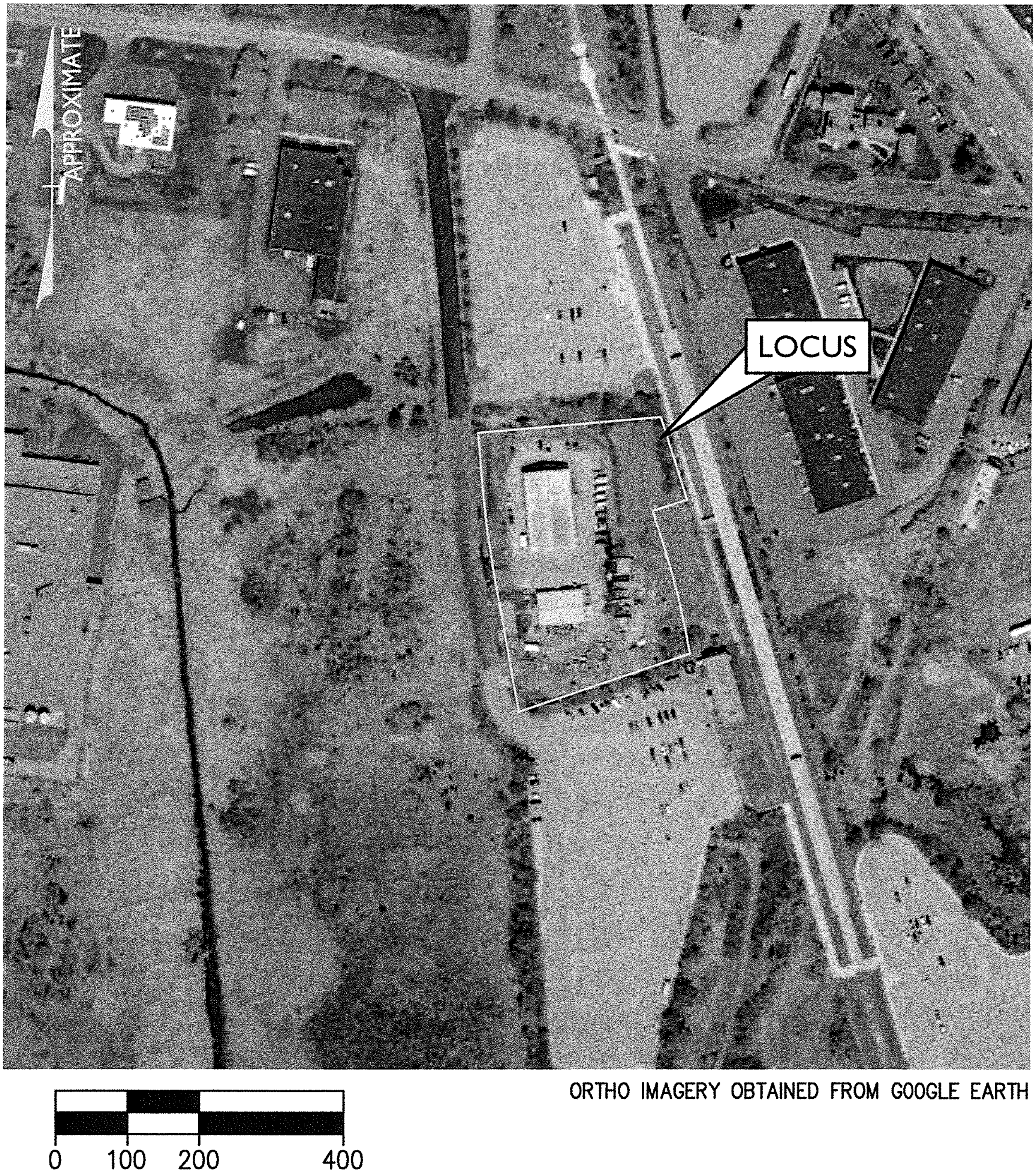
Although the science is still evolving on the extent of sea level rise, the numbers being reported for Boston area are in the range of one to three feet within 50 years. If this is the case, then it is possible that part of Boston Way will be under water during a 100 year flood, which will limit access by both pedestrians and vehicles. Since the low point of the road is around elevation 11.5, the depth of floodwater based on the most extreme projections would be approximately 18 inches at the deepest point. Under existing conditions, Boston Way is the only way to access the properties, and there is no second means of egress. However, under proposed conditions there will be a new access point from Parker Street to One Boston Way, which is well above the flood elevation. Since the development of Three Boston Way includes a connection to One Boston Way, the Parker Street entrance point can be used by vehicles and pedestrians to provide a safe means of egress from both properties. Additionally, the garage slab elevation is set three feet above the current 100 year flood elevation and all utility systems will be constructed in accordance with the Massachusetts State Building Code.

VI. Conclusion

The project at 3 Boston Way, as proposed, is in compliance with the MassDEP Stormwater Management Handbook to the maximum extent practicable as a project involving both new development and redevelopment. The project is also in compliance with the Newburyport Stormwater Management Rules and Regulations, which reference the MA Stormwater Standards. The project will involve the restoration and protection of wetland buffer zone land that was used as a landscape materials storage area by the previous owner, and will utilize naturally vegetated stormwater management systems to treat and attenuate stormwater runoff.

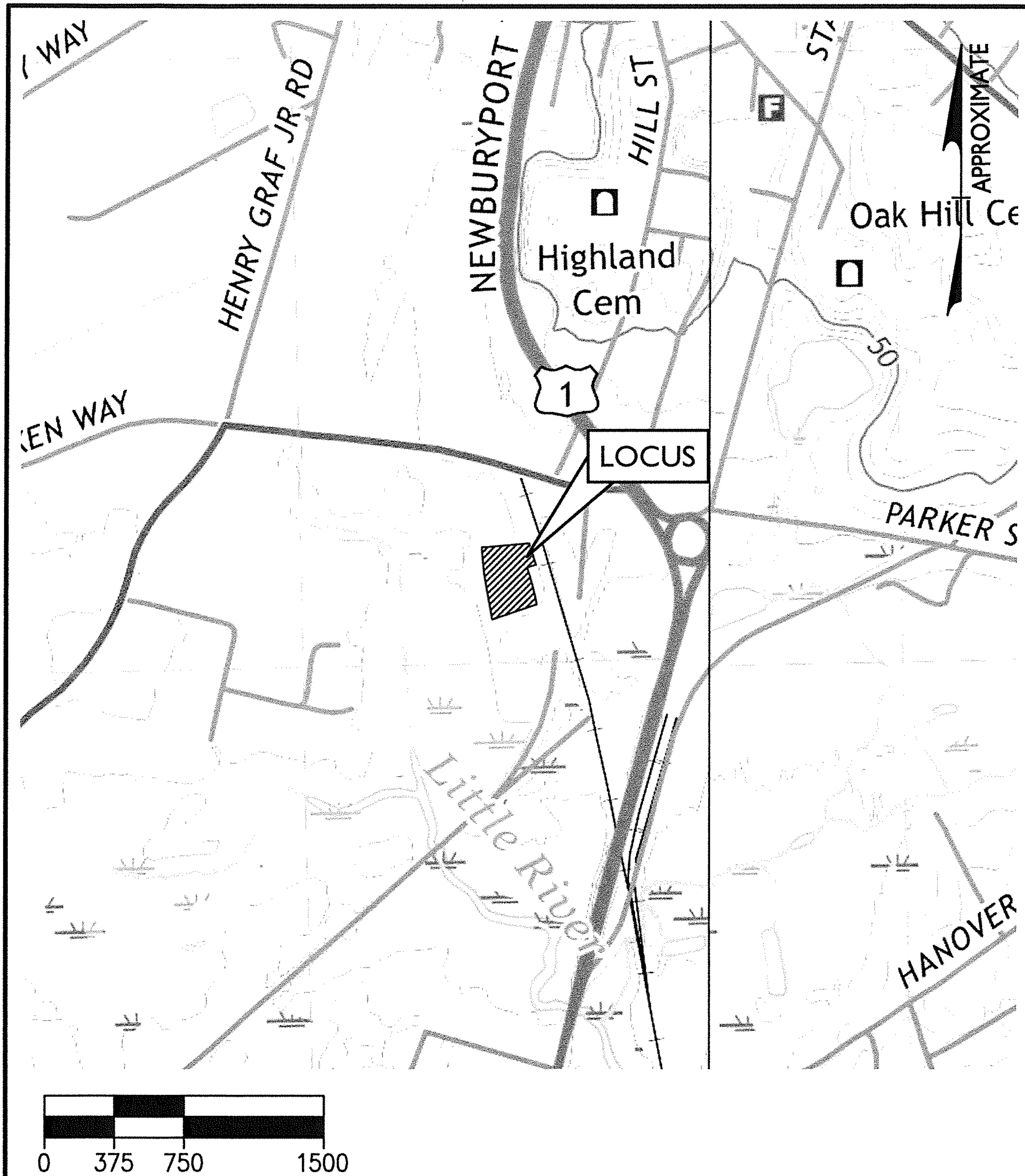
For questions regarding this Drainage Report, please contact The Morin-Cameron Group, Inc. between the hours of 8:30am to 4:30pm at (978) 777-8586.

FIGURES



ORTHO IMAGERY OBTAINED FROM GOOGLE EARTH

THE MORIN-CAMERON GROUP, INC. 66 ELM STREET, DANVERS, MA 01923 **P | 978.777.8586 F | 978.774.3488** WWW.MORINCAMERON.COM	ORTHO MAP 3 BOSTON WAY IN NEWBURYPORT, MA
DATE: JANUARY 23, 2020 | Scale: 1" = 200'	**FIGURE #1**



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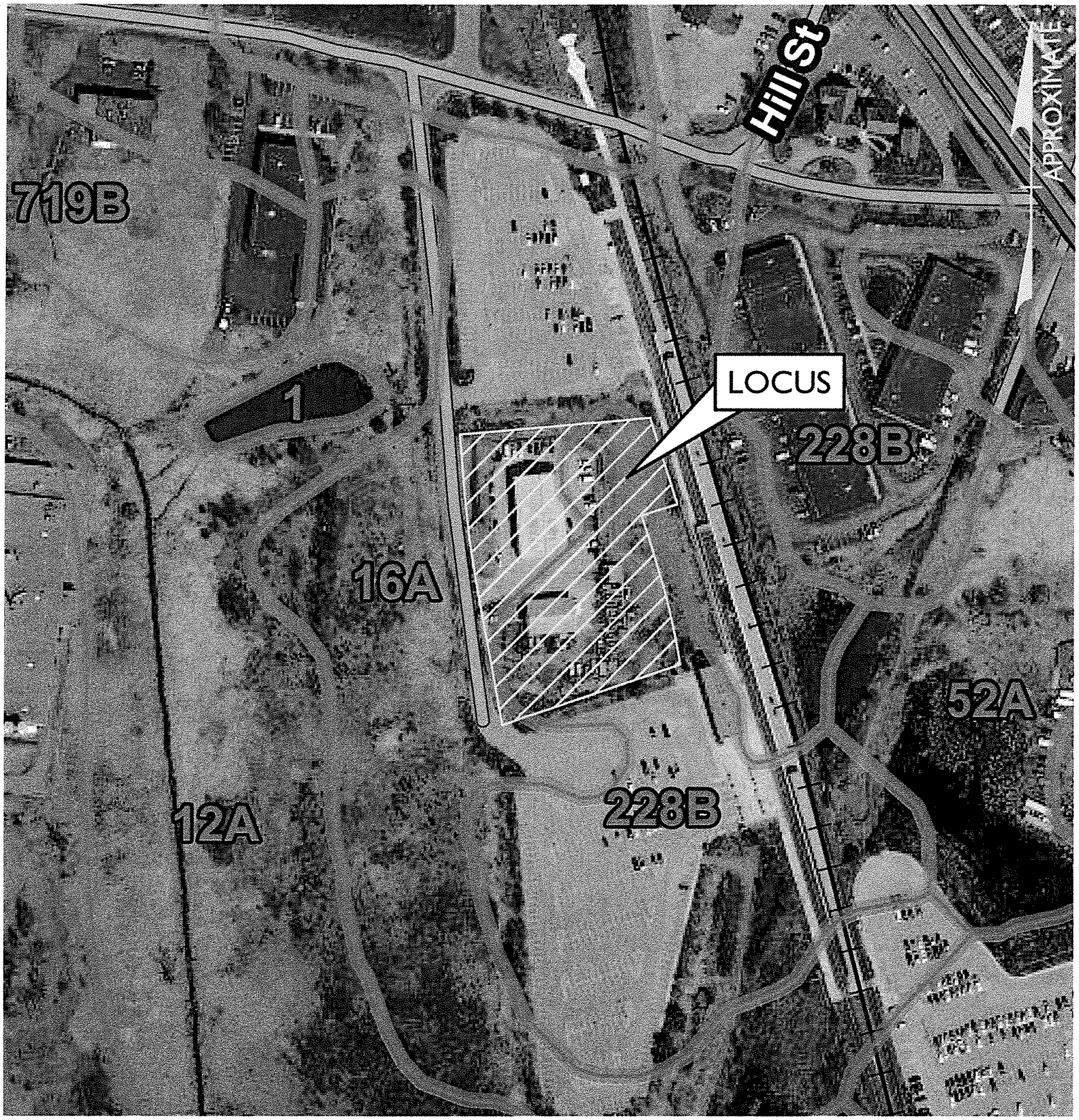
USGS LOCUS MAP
3 BOSTON WAY
IN
NEWBURYPORT, MA

DATE: JANUARY 23, 2020

Scale: 1" = 750'

FIGURE #2



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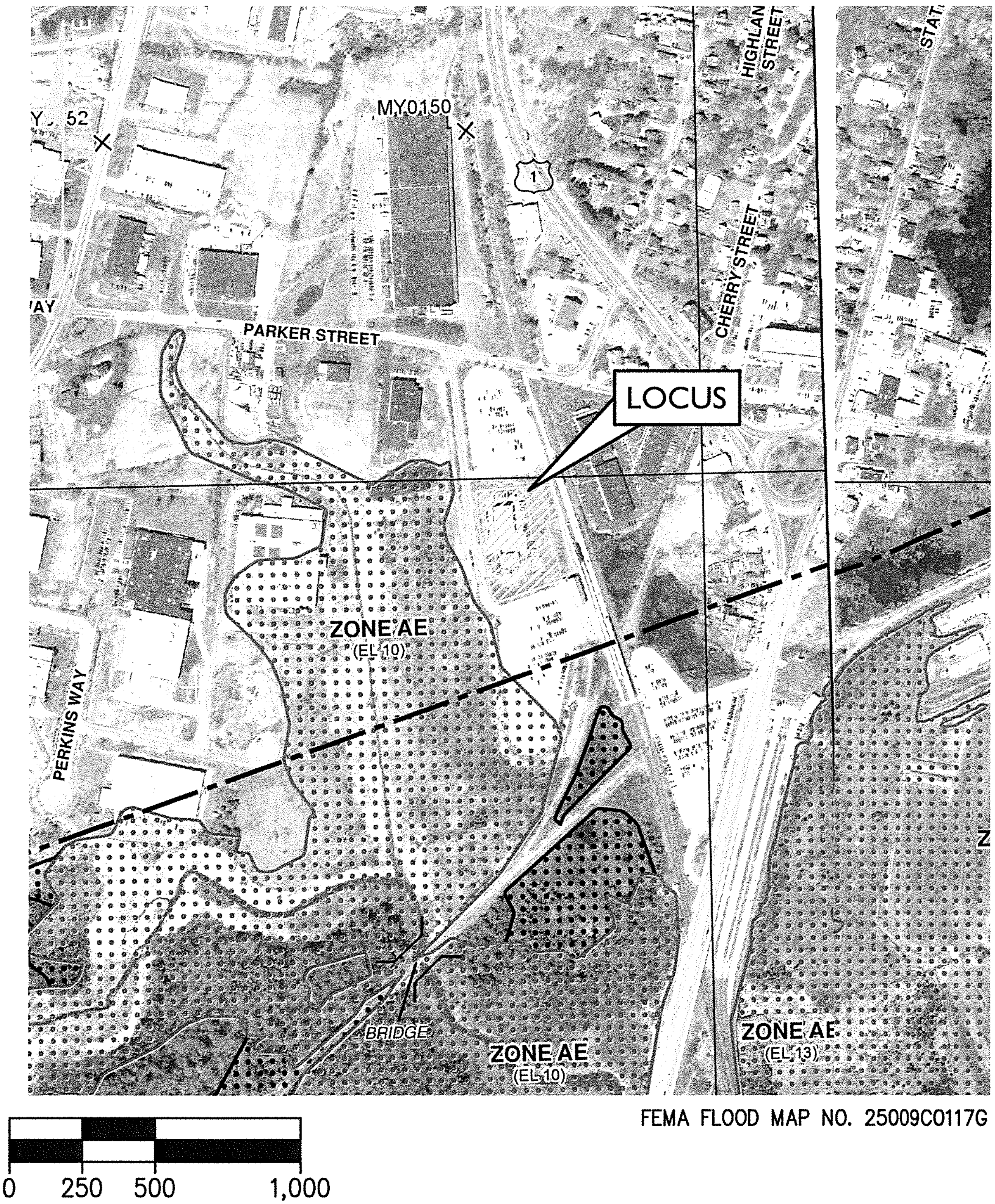
SCS SOILS MAP
3 BOSTON WAY
IN
NEWBURYPORT, MA

DATE: JANUARY 23, 2020

Scale: 1" = 200'

FIGURE #3



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FEMA FLOOD MAP
3 BOSTON WAY
IN
NEWBURYPORT, MA

DATE: JANUARY 23, 2020	Scale: 1" = 500'	**FIGURE #4**

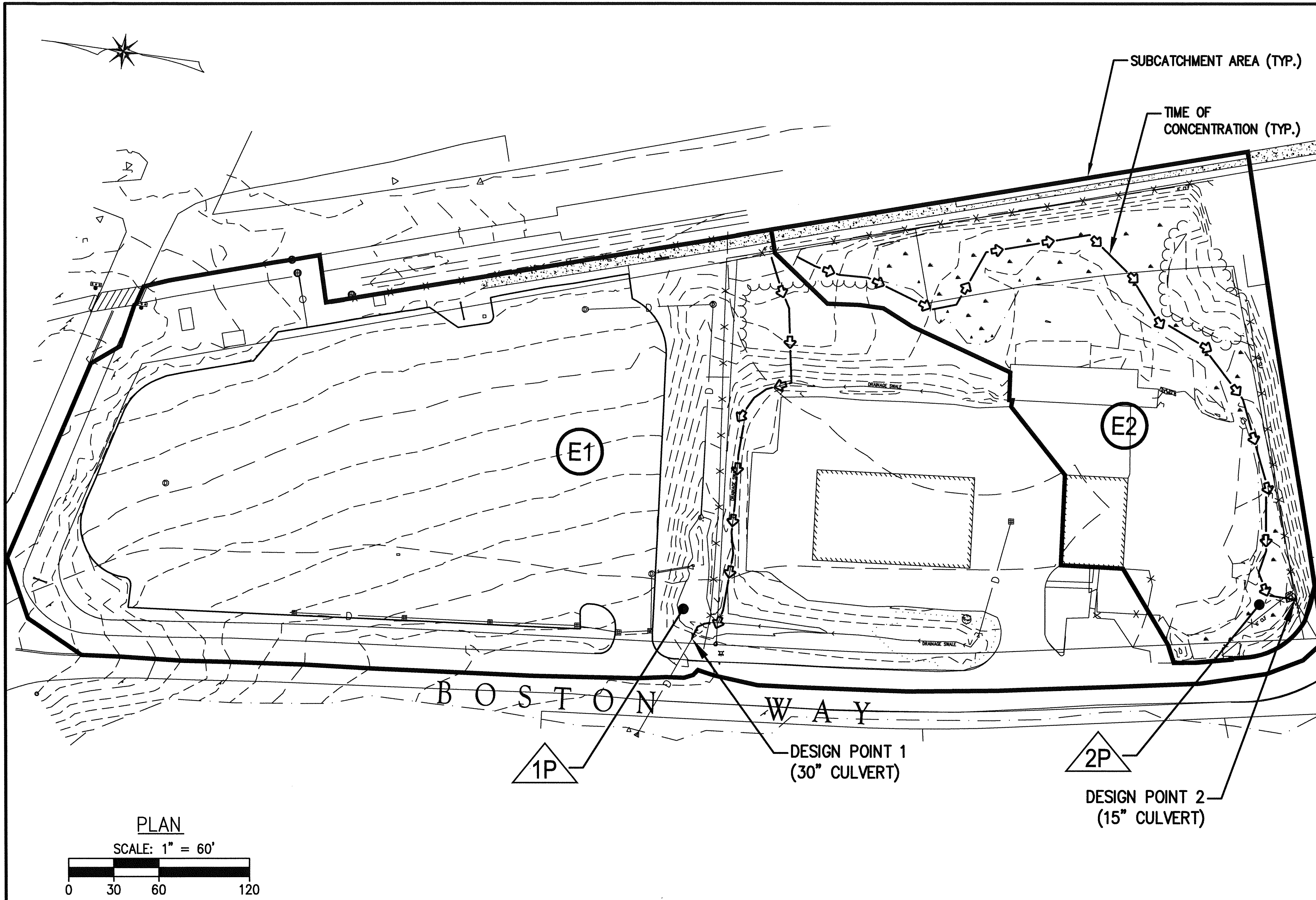

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FIGURE 5
DATE: 1/23/20
SCALE: 1" = 60'

EXISTING SITE DEVELOPMENT
WATERSHED PLAN
AT:
3 BOSTON WAY
NEWBURYPORT, MASSACHUSETTS

PROJ. #3856

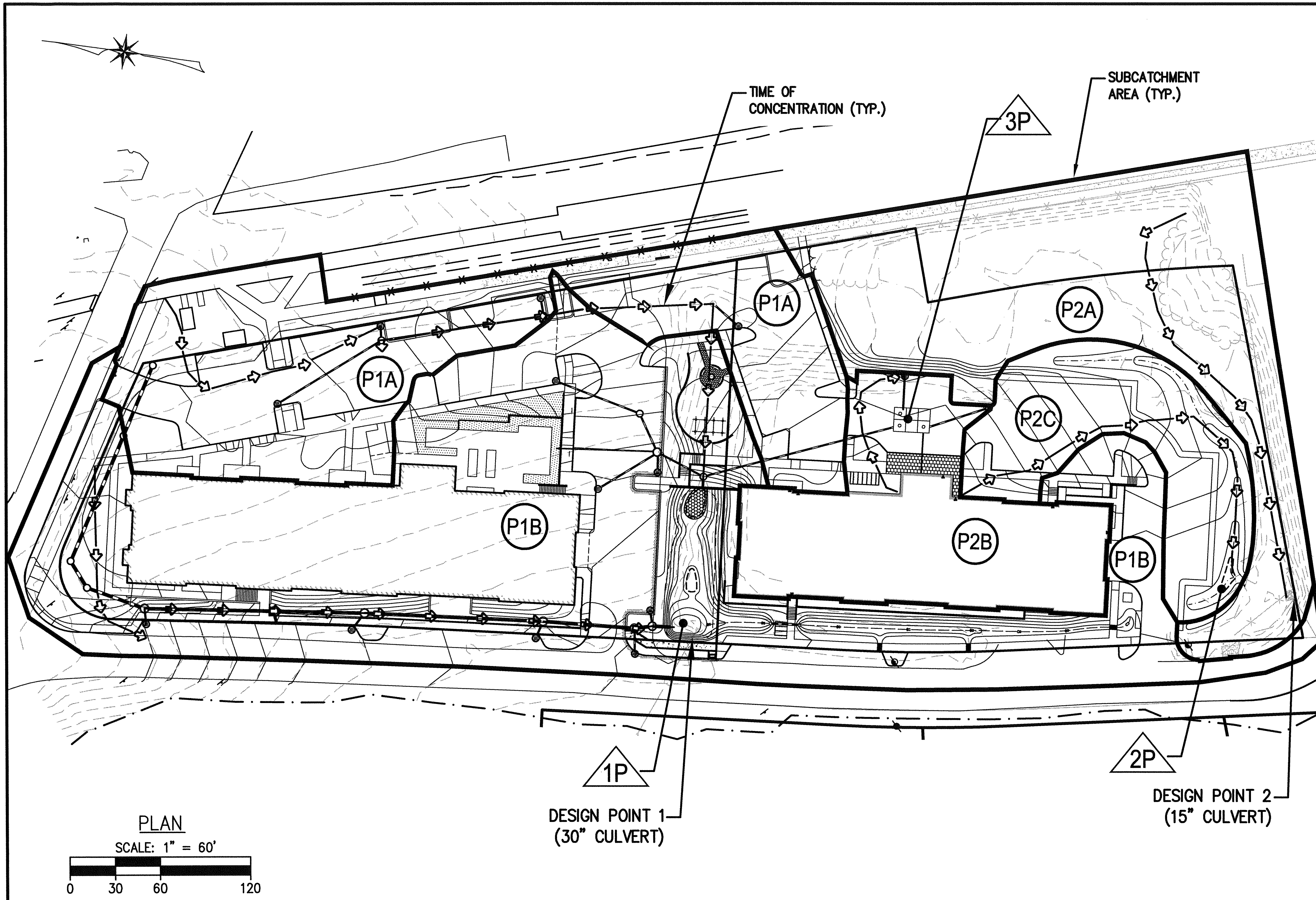

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FIGURE 6

DATE: 1/23/20

SCALE: 1" = 60'

PROPOSED SITE DEVELOPMENT
WATERSHED PLAN
AT:
3 BOSTON WAY
NEWBURYPORT, MASSACHUSETTS

PROJ. #3856

APPENDIX A:

MASSDEP STORMWATER MANAGEMENT REPORT CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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

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

B. Stormwater Checklist and Certification

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

Checklist for Stormwater Report

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
SCOTT P. CAMERON
CIVIL
No. 47601
REGISTERED
PROFESSIONAL ENGINEER

1-23-2020
Signature and Date

Checklist

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

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist (continued)

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

☒ No disturbance to any Wetland Resource Areas

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

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

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

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

☐ Bioretention Cells (includes Rain Gardens)

☒ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☒ Water Quality Swale

☒ Grass Channel

☐ Green Roof

☐ Other (describe): ____________________

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

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

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

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☐ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

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

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

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

☐ is within the Zone II or Interim Wellhead Protection Area

☐ is near or to other critical areas

☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

☐ involves runoff from land uses with higher potential pollutant loads.

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

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

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist (continued)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

Chapter 3

Checklist for Redevelopment Projects

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

Redevelopment is defined to include

- Maintenance and improvement of existing roadways, including widening less than a single lane, adding shoulders, correcting substandard intersections, improving existing drainage systems, and repaving;
- ***Development rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area***; and
- Remedial projects specifically designed to provide improved stormwater management, such as projects to separate storm drains and sanitary sewers, and stormwater retrofit projects.

Components of redevelopment projects that include development of previously undeveloped sites do not meet this definition. The portion of the project located in a previously developed area must meet Standard 7, but project components within undeveloped areas must meet all the Standards.

MassDEP recognizes that site constraints often make it difficult to comply with all the Standards at a redevelopment site. These constraints are as follows:

Lack of space. Because of the presence of existing structures, on-site subsurface sewage disposal systems, stormwater best management practices, and water bodies and wetlands, and easements, the space available for the installation of additional stormwater BMPs may be quite limited. On many suites it may be difficult or impossible to use space-intensive BMPs such as wet detention basins.

Soils: ***The presence of bedrock or clay can limit the effectiveness of infiltration or detention BMPs. Often soils at redevelopment sites have been compacted by buildings and heavy traffic, impairing their ability to infiltrate stormwater into the ground.***

Underground utilities. The presence of underground utilities including gas and water mains, sewer pipes and electric cable conduits can greatly reduce the amount of land available for BMPs.

This chapter provides specific guidance and checklists to ensure that the applicant has met his/her obligations under Standard 7. Because it may be difficult for a redevelopment project to comply with all the Stormwater Management Standards, Standard 7 provides that a redevelopment project is required to comply with the following Standards only "to the maximum extent practicable": Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing outfalls shall be brought into compliance with Standard 1 only to the maximum extent practicable.

As set forth in Standard 7, the phrase "to the maximum extent practicable" means that:

(1) Proponents of redevelopment projects have made all reasonable efforts to meet the requirements of Standards 2 and 3 and the pretreatment and structural stormwater best management practices requirements of Standards 4, 5, and 6 and to bring existing outfalls into compliance with Standard 1.

(2) They have made a complete evaluation of possible stormwater management measures, including environmentally sensitive site design that minimizes land disturbance and impervious surfaces, low impact development techniques and structural stormwater BMPs; and

(3) If not in full compliance with Standard 1 for existing outfalls, Standards 2 and 3 and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6, they are implementing the highest practicable level of stormwater management.

Generally, an alternative is practicable if it can be implemented within the site being redeveloped, taking into consideration cost, land area requirements, soils and other site constraints. However, offsite alternatives may also be practicable. Proponents must document the evaluation of practicable alternatives with sufficient information to support the conclusions of the analysis.

At the same time, stormwater runoff from redevelopment projects must be properly managed. To this end, Standard 7 provides that redevelopment projects shall comply with all other requirements of the Stormwater Management Standards, including, without limitation, the pollution prevention requirements of Standards 4, 5, and 6, the erosion and sedimentation control requirements of Standard 8, the operation and maintenance requirements of Standard 9, and the prohibition of illicit discharge set forth in Standard 10. Proponents must also improve existing conditions.

Proponents of redevelopment projects shall document their compliance with these requirements. To assist proponents and reviewers in determining whether a redevelopment project complies with Standard 7, MassDEP has prepared the following redevelopment checklist.

[*Proponents of MassHighway redevelopment projects and Conservation Commissions reviewing such projects may follow the guidelines for redevelopment provided in the MassHighway Stormwater Handbook for Highways and Bridges (May 2004 or latest version) in lieu of the guidance set forth in this chapter.*[1] *The MassHighway Stormwater Handbook was developed by the Massachusetts Highway Department and issued by joint correspondence of May 7, 2004 by MassHighway and MassDEP. It provides detailed guidance on the evaluation and implementation of stormwater management practices for MassHighway road and bridge redevelopment projects, including a methodology for screening and selecting Best Management Practices (BMPs). Proponents and reviewers of other public roadway redevelopment projects may find useful information in the MassHighway Stormwater Handbook.*]

[1] The MassHighway Handbook published in 2004 must be revised to make it consistent with this Handbook.

Redevelopment Checklist

Existing Conditions

- On-site: For all redevelopment projects, proponents should document existing conditions, including a description of extent of impervious surfaces, soil types, existing land uses with higher potential pollutant loads, and current onsite stormwater management practices.
- Watershed: Proponents should determine whether the project is located in a watershed or subwatershed, where flooding, low streamflow or poor water quality is an issue.

The Project

Is the project a redevelopment project?

- Maintenance and improvement of existing roadways
- ***Development of rehabilitation, expansion or phased project on redeveloped site***, or
- Remedial stormwater project

For non-roadway projects, is any portion of the project outside the definition of redevelopment?

- Development of previously undeveloped area - ***Yes***
- Increase in impervious surface - ***Yes***

If a component of the project is not a redevelopment project, the proponent shall use the checklist set forth below to document that at a minimum the proposed stormwater management system fully meets each Standard for that component. The proponent shall also document that the proposed stormwater management system meets the requirements of Standard 7 for the remainder of the project.

The Stormwater Management Standards

The redevelopment checklist reviews compliance with each of the Stormwater Management Standards in order.

Standard 1: (Untreated discharges)
No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.
Same rule applies for new developments and redevelopments.

Full compliance with Standard 1 is required for new outfalls.

- What BMPs are proposed to ensure that all new discharges associated with the discharge are adequately treated? – ***Hydrodynamic separators, constructed wetlands***
- What BMPs are proposed to ensure that no new discharges cause erosion in wetlands or waters of the Commonwealth? – ***Detention system, constructed wetlands***
- Will the proposed discharge comply with all applicable requirements of the Massachusetts Clean Waters Act and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00? – ***No new untreated discharges***

Existing outfalls shall be brought into compliance with Standard 1 to the maximum extent practicable.

- Are there any existing discharges associated with the redevelopment project for which new treatment could be provided? - ***Yes***
- If so, the proponent shall specify the stormwater BMP retrofit measures that have been considered to ensure that the discharges are adequately treated and indicate the reasons for adopting or rejecting those measures. (See Section entitled "Retrofit of Existing BMPs".) – ***Constructed wetlands***
- What BMPs have been considered to prevent erosion from existing stormwater discharges? – ***Detention system, constructed wetlands***

Standard 2: (Peak rate control and flood prevention)
Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for land subject to coastal storm flowage.
Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 2, comparing post-development to pre-development conditions? - ***Yes***
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard. (See Menu of Strategies to Reduce Runoff and Peak Flows and/or Increase Recharge Menu included at the end of this chapter.)

Improvement of existing conditions:

- Does the project reduce the volume and/or rate of runoff to less than current estimated conditions? Has the applicant considered all the alternatives for reducing the volume and/or rate of runoff from the site? (See Menu.) - ***Yes***
- Is the project located within a watershed subject to damage by flooding during the 2-year or 10-year 24-hour storm event? If so, does the project design provide for attenuation of the 2-year and 10-year 24-hour storm event to less than current estimated conditions? Have measures been implemented to reduce the volume of runoff from the site resulting from the 2 year or 10 year 24 hour storm event? (See Menu.) - ***Yes***
- Is the project located adjacent to a water body or watercourse subject to adverse impacts from flooding during the 100-year 24-hour storm event? If so, are portions of the site available to increase flood storage adjacent to existing Bordering Land Subject to Flooding (BLSF)? - ***Yes***
- Have measures been implemented to attenuate peak rates of discharge during the 100-year 24-hour storm event to less than the peak rates under current estimated conditions? Have measures been implemented to reduce the volume of runoff from the site resulting from the 100-year 24-hour storm event? (See Menu.) – ***The discharge point affected in the 100-year 24-hour storm event is subject to coastal flooding.***

Standard 3: (Recharge to Ground water)
Loss of annual recharge to ground water shall be eliminated or minimized through the use of infiltration measures, including environmentally sensitive site design, low impact development techniques, best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from the pre-development conditions based on soil type. This Standard is met when the stormwater management

system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusettss Stormwater Handbook.
Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 3, comparing post-development to pre-development conditions? *- No*
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard?
- What soil types are present on the site? Is the site is comprised solely of C and D soils and bedrock at the land surface? *- Silt Loams, HSG-D*
- Does the project include sites where recharge is proposed at or adjacent to an area classified as contaminated, sites where contamination has been capped in place, sites that have an Activity and Use Limitation (AUL) that precludes inducing runoff to the groundwater, pursuant to MGL Chapter 21E and the Massachusetts Contingency Plan 310 CMR 40.0000; sites that are the location of a solid waste landfill as defined in 310 CMR 19.000; or sites where groundwater from the recharge location flows directly toward a solid waste landfill or 21E site?[2] *- No*
- Is the stormwater runoff from a land use with a higher potential pollutant load? *- No*
- Is the discharge to the ground located within the Zone II or Interim Wellhead Protection Area of a public water supply? *- No*
- Does the site have an infiltration rate greater than 2.4 inches per hour? *- No*

Improvements to Existing Conditions:

- Does the project increase the required recharge volume over existing (developed) conditions? If so, can the project be redesigned to reduce the required recharge volume by decreasing impervious surfaces (make building higher, put parking under the building, narrower roads, sidewalks on only one side of street, etc.) or using low impact development techniques such as porous pavement? – ***While impervious area is increased, well-drained fill materials will be imported as part of the project.***
- Is the project located within a basin or sub-basin that has been categorized as under high or medium stress by the Massachusetts Water Resources Commission, or where there is other evidence that there are rivers and streams experiencing low flow problems? If so, have measures been considered to replace the natural recharge lost as a result of the prior development? (See Menu.) *- No*
- Has the applicant evaluated measures for reducing site runoff? (See Menu.) *- Yes*

Standard 4: (80% TSS Removal)

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

a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan and thereafter are implemented and maintained;

b. Stormwater BMPs are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and

c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

Full compliance for any component that is not a redevelopment
Full compliance with the long-term pollution plan requirement for new developments and redevelopments.

[2] A mounding analysis is needed if a site falls within this category. See Volume 3.

- Has the proponent developed a long-term pollution plan that fully meets the requirements of Standard 4? - ***Yes***
- Does the pollution prevention plan include the following source control measures? - ***Yes***
  - Street sweeping
  - Proper management of snow, salt, sand and other deicing chemicals
  - Proper management of fertilizers, herbicides and pesticides
  - Stabilization of existing eroding surfaces

Compliance to the Maximum Extent Practicable for the other requirements:

- Does the redevelopment design provide for treatment of all runoff from existing (as well as new) impervious areas to achieve 80% TSS removal? If 80% TSS removal is not achieved, has the stormwater management system been designed to remove TSS to the maximum extent practicable? - ***Yes***
- Have the proposed stormwater BMPs been properly sized to capture the prescribed runoff volume? - ***Yes***
  - One inch rule applies for discharge
    - within a Zone II or Interim Wellhead Protection Area,
    - near or to another critical area,
    - from a land use with a higher potential pollutant load
    - to the ground where the infiltration rate is greater than 2.4 inches per hour
- Has adequate pretreatment been proposed? - ***Yes***
  - 44% TSS Removal Pretreatment Requirement applies if:
    - Stormwater runoff is from a land use with a higher potential pollutant load
    - Stormwater is discharged
      - To the ground within the Zone II or Interim Wellhead Protection Area of a Public Water Supply
      - To the ground with an infiltration rate greater than 2.4 inches per hour
      - Near or to an Outstanding Resource Water, Special Resource Water, Cold-Water Fishery, Shellfish Growing Area, or Bathing Beach.

- If the stormwater BMPs do not meet all the requirements set forth above, the applicant shall document an analysis of alternative approaches for meeting the these requirements. (See Section on Retrofitting Existing BMPs (the "Retrofit Section").

Improvements to Existing Conditions:

- Have measures been provided to achieve at least partial compliance with the TSS removal standard? - ***Yes***
- Have any of the best management practices in the Retrofit Section been considered? - ***Yes***
- Have any of the following pollution prevention measures been considered? - ***Yes***
  - Reduction or elimination of winter sanding, where safe and prudent to do so
  - Tighter controls over the application of fertilizers, herbicides, and pesticides
  - Landscaping that reduces the need for fertilizer, herbicides and pesticides
  - High frequency sweeping of paved surfaces using vacuum sweepers
  - Improved catch basin cleaning
  - Waterfowl control programs
- Are there any discharges (new or existing) to impaired waters? If so, see TMDL section. - ***No***

Standard 5 (Higher Potential Pollutant Loads (HPPL) ***(STANDARD DOES NOT APPLY)***
For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt and stormwater runoff, the proponent shall use the specific stormwater BMPs determined by the Department to be suitable for such use as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53, and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.
Full compliance for any component that is not a redevelopment.
Full compliance with pollution prevention requirements for new developments and redevelopments.

Pollution Prevention

- Has the proponent considered any of the following operational source control measures?
  - Formation of a pollution prevention team,
  - Good housekeeping practices,
  - Preventive maintenance procedures,
  - Spill prevention and clean up,
  - Employee training, and
  - Regular inspection of pollutant sources.

- Has the proponent considered implementation of any of the following operational changes to reduce the quantity of pollutants on site?
  - Process changes,
  - Raw material changes,
  - Product changes, or
  - Recycling.

- Has the proponent considered making capital improvements to protect the land uses with higher potential pollutant loads from exposure to rain, snow, snow melt, and stormwater runoff?

  - Enclosing and/or covering pollutant sources (e.g. placing pollutant sources within a building or other enclosure, placing a roof over storage and working areas, placing tarps under pollutant source)

  - Installing a containment system with an emergency shutoff to contain spills?

  - Physically segregating the pollutant source to prevent run-on of uncontaminated stormwater?

Treatment

- If applicable, compliance with the treatment and pretreatment requirements of Standard 5 only to the Maximum Extent Practicable by directing the stormwater runoff from land uses with higher potential pollutant loads to appropriate stormwater BMPs?

  - Are the BMPs selected capable of removing the pollutants associated with the higher potential pollutant load land ("LUHPPL") use?

- Is the land use likely to generate stormwater with high concentrations of oil and grease? If so has an oil grit separator, sand filter, filtering bioretention area or equivalent been proposed for pretreatment?

Improvement of Existing Conditions.

- If the redevelopment converts a site from a non-LUHPPL use to a LUHPPL use, the applicant shall document how the stormwater BMPs shall be modified or replaced to come into compliance with Standard 5.

- What specific measures have been considered to offset the anticipated impacts of land uses with higher potential pollutant loads?

- If the redevelopment proposal is a brownfield project, the applicant shall demonstrate how the stormwater management measures have been designed to prevent mobilization or remobilization of soil and groundwater contamination. (See Brownfield section)

Other Requirements

- Does the discharge comply with all applicable requirements of the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00?

Standard 6 (Critical Areas) ***(STANDARD DOES NOT APPLY)***
Stormwater discharges to a Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or any other critical area require the use of the specific source control and pollution prevention measures and the specific stormwater best management practices determined by the Department to be suitable for managing discharges to such area, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters or Special Resource Waters shall be set back from the receiving water and receive the highest and best practical method of treatment. A "stormwater discharge," as defined in 314 CMR 3.04(2)(a)1. or (b), to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of the public water supply.
Full compliance for component of project that is not a redevelopment
Full compliance with pollution prevention requirements for new developments and redevelopments.

If applicable, compliance to the Maximum Extent Practicable with the pretreatment and treatment requirements of Standard 6:

- Does the redevelopment project utilize the pretreatment, treatment and infiltration BMPs approved for discharges near or to critical areas?
- If the redevelopment project does not comply with Standard 6, the applicant shall document an analysis of alternative measures for meeting Standard 6. (See Section on Specific Redevelopment Projects.)

Improvements to Existing Conditions:
- Have measures to protect critical areas been considered, including additional pollution prevention measures and structural and non-structural BMPs?

Other Requirements

- Does the discharge comply with the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00, and 314 CMR 5.00?

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

All redevelopment projects shall fully comply with Standard 8.

- Has the proponent submitted a construction period erosion, sedimentation and pollution prevention plan that meets the requirements of Standard 8? *- Yes*

Standard 9: (Operation and Maintenance)
A long-term operation and maintenance plan must be developed and implemented to ensure that stormwater management systems function as designed.
All redevelopment projects shall fully comply with Standard 9.

- Has the proponent submitted a long-term Operation and Maintenance plan that meets the requirements of Standard 9? - ***Yes***

Standard 10 (Illicit Discharges)
All illicit discharges to the stormwater management system are prohibited.
All redevelopment projects shall fully comply with Standard 10.

- Are there any known or suspected illicit discharges to the stormwater management system at the redevelopment project site? - *No*
- Has an illicit connection detection program been implemented using visual screening, dye or smoke testing? - *No*
- Have an Illicit Discharge Compliance Statement and associated site map been submitted verifying that there are no illicit discharges to the stormwater management system at the site? - ***Yes***

Improvements to Existing Conditions:
- Once all illicit discharges are removed, has the proponent implemented any measures to prevent additional illicit discharges? - ***Yes***

Figure 5-1

Menu of Strategies to Reduce Runoff or Peak Flows and/or Increase Recharge

- Rehabilitate the soils
- Plant trees and other vegetation
- Install a green roof
- Maximize naturally vegetated areas
- Reduce impervious surfaces
- Disconnect roof runoff from direct discharge to the drainage system
- Disconnect other existing paved areas from direct discharge to the drainage system, allowing controlled flow over pervious areas or through BMPs providing at least partial recharge
- Install porous pavement and/or other recharge measures (where sustainable and maintainable for promoting infiltration)
- Apply LID techniques for runoff reduction
- Install additional structural BMPs that are appropriate for redevelopment sites including infiltration trenches, subsurface structures, oil-grit separators, proprietary BMPs
- Retrofit existing BMPs

Retrofitting Existing BMPs

Many BMPs can be effectively retrofitted depending on site conditions and the water quantity or quality objectives trying to be achieved.[3] The objective of stormwater retrofitting is to remedy problems associated with, and improve water quality mitigation functions of, older, poorly designed, or poorly maintained stormwater management systems. Prior to the development of the stormwater standards, site drainage design did not require stormwater detention for controlling post-development peak flows. As a result, drainage, flooding, and erosion problems can be common in many older developed areas of the state. Furthermore, a majority of the dry detention basins throughout the state have been designed to control peak flows, without regard to water quality mitigation. Therefore, many existing dry detention basins provide only minimal water quality benefit. Incorporating stormwater retrofits into existing developed sites or into redevelopment projects can reduce the adverse impacts of uncontrolled stormwater runoff.

Bioretention Area Retrofits - can be used as a stormwater retrofit, by modifying existing landscaped areas, or if a parking lot is being resurfaced. In highly urban watersheds, they are one of the few practical retrofit options.

Catch Basin Retrofits or Reconstruction - Older catch basins without sumps can be replaced with catch basins having four foot-deep sumps. Sumps provide storage volume for coarse sediments, assuming that accumulated sediment is removed on a regular basis. Hooded outlets, which are covers over the catch basin outlets that extend below the standing water line, can also be used to trap litter and other floatable materials. Leaching catch basins can be installed adjacent to deep sump catch basins to achieve 80% TSS removal. Be aware, however, that many products are being touted as catch basin inserts, but the effectiveness of these devices can vary significantly.

Dry Detention Basin Retrofits - Traditional dry detention basins can be modified to become extended dry detention basins, wet basins, or constructed stormwater wetlands for enhanced pollutant removal. This is one of the most commonly and easily implemented retrofits, since it typically requires little or no additional land area, capitalizes on an existing facility for which there is already some resident acceptance of stormwater management, and involves minimal impacts to environmental resources (Claytor, Center for Watershed Protection, 2000).

There are numerous retrofit options that will enhance the removal of pollutants in detention basins:

- Excavate the basin bottom to create more permanent pool storage.
- Raise the basin embankment to obtain additional storage for extended detention.
- Modify the outfall structure to create a two-stage release to better control small storms while not significantly compromising flood control detention for large storms.
- Increase the flow path from inflow to outflow and eliminate short-circuiting by using baffles, earthen berms or micro-pond topography to increase residence time.
- Incorporate stilling basins at inlets and outlets.
- Regrade the basin bottom to create a wetland area near the basin outlet or revegetate parts of the basin bottom with wetland vegetation to enhance pollutant removal, reduce mowing, and improve aesthetics.
- Create a wetland shelf along the perimeter of a wet basin to improve shoreline stabilization, enhance pollutant filtering, and enhance aesthetic and habitat functions.
- Create a low maintenance "no-mow" wildflower ecosystem in the drier portions of the basin.

[3] Additional information on retrofitting stormwater BMPs can be found in the Urban Stormwater Retrofit Practices Manual. See http://www.cwp.org/Downloads/ELC_USRM3app.pdf.

- Provide a high flow bypass to avoid resuspension of captured sediments/pollutants during high flows.
- Eliminate low-flow bypasses.

Drainage Channel Retrofits - Existing channelized streams and drainage conveyances such as drainage channels can be modified to reduce flow velocities and enhance pollutant removal. Weir walls or riprap check dams placed across a channel create opportunities for ponding, infiltration, and establishment of wetland vegetation upstream of the retrofit. In-stream retrofit practices include stream bank stabilization of eroded areas and placement of habitat improvement structures (i.e., flow deflectors, boulders, pools/riffles, and low-flow channels) in natural streams and along stream banks. In-stream retrofits may require an evaluation of potential flooding and floodplain impacts resulting from altered channel conveyance, as well as requirements for local, state, or federal approval for work in wetlands and watercourses.

Parking Lots and Roadways- Parking lots offer ideal opportunities for a wide range of stormwater retrofits:

1. Incorporate bioretention areas into parking lot islands and landscaped areas; tree planter boxes can be converted into functional bioretention areas, rain gardens, or treebox filters to reduce and treat stormwater runoff.
2. Remove curbing and add slotted curb stops. Curbs along the edges of parking lots can sometimes be removed or slotted to re-route runoff to vegetated filter strips, water quality swales, grass channels, or bioretention facilities. The capacity of existing swales may need to be evaluated and expanded as part of this retrofit option.
3. Incorporate new treatment practices such as bioretention areas, sand filters, and constructed stormwater wetlands at the edges of parking lots.
4. In overflow parking or other low-traffic areas, asphalt can be replaced with porous pavement.

Sand Filter Retrofits - are suitable where space is limited, because they consume little surface space and have few site restrictions. Since sand filters cannot treat large drainage areas, retrofitting many small individual sites may be the only option. This option may be expensive.

Storm Drain Outfalls - New stormwater treatment practices can be constructed at the outfalls of existing drainage systems. The new stormwater treatment practices are commonly designed as *off-line devices* to treat the first flush volume and bypass larger storms. Water quality swales, bioretention areas, sand filters, constructed stormwater wetlands, and wet basins are commonly used for this type of retrofit. Other stormwater treatment practices may also be used if there is enough space for construction and maintenance.

Specific Redevelopment Projects

Redevelopment projects present unique challenges for controlling stormwater. It is possible that site constraints may prevent a redevelopment project from complying with one or more of the Stormwater Management Standards. Even if a redevelopment project cannot meet all of the Standards, there may be ample opportunity to improve existing site conditions depending on the other water quality or quantity issues in the watershed. The following special considerations provide unique opportunities for identifying how existing conditions may be improved:

A. Groundwater Recharge Areas - Redevelopment projects located within these areas (Zone II, Interim Wellhead Protection Areas (IWPA), aquifer protection districts, etc.) should place a high priority on ground water recharge BMPs.
   1) Disconnecting Rooftop Runoff – In some instances, building roof drains connected to the stormwater drainage system can be disconnected and re-directed to vegetated filter strips, bioretention facilities, or infiltration structures (dry wells or infiltration trenches).
   2) Use of Porous Paving Materials - Existing impermeable pavement in overflow parking or other low-traffic areas can sometimes be replaced with alternative permeable materials such as modular concrete paving blocks, modular concrete or plastic lattice, or cast-in-place concrete grids. Site-specific factors including traffic volumes, soil permeability, maintenance, sediment loads, and land use must be carefully considered prior to selection.

B. Cold-Water Fisheries - Redevelopment projects adjacent to these areas should place a high priority on mitigating potential thermal impacts. Techniques to consider include:

   1) Maintain Time of Concentration - Time of concentration (Tc) is based on the flow path and length, ground cover, slope and channel shape. When development occurs, Tc is often shortened due to the impervious area, causing greater flows to occur over a shorter period of time. Increasing the Tc will help to reduce the thermal impact of stormwater runoff from warm surface areas. Options to consider include:
      - Increasing the length of the runoff flow path
      - Increasing the surface roughness of the flow path
      - Detaining flows on site
      - Minimizing land disturbance
      - Creating flatter slopes.
   2) Disconnecting impervious areas – Breaking up large impervious expanses with vegetated zones will reduce the potential temperature increases of stormwater flowing across hot pavement.

C. Brownfield Redevelopment – Redeveloping urban and non-urban brownfield sites (which in Massachusetts includes most "disposal sites" under the Massachusetts Contingency Plan [MCP]) are a Commonwealth priority, with ramifications for urban sprawl as well as the remediation of historically contaminated properties. Proponents of brownfield redevelopment projects should evaluate BMPs that will prevent the significant uncontrolled mobilization or remobilization of soil or ground water contamination. BMP considerations at these sites should consider such factors as:
   - The location of stormwater infiltration units with respect to contaminated areas
   - Ground water mounding effects on the rate and direction of migration of ground water contaminants
   - The location of outfalls
   - Water quality BMPs.

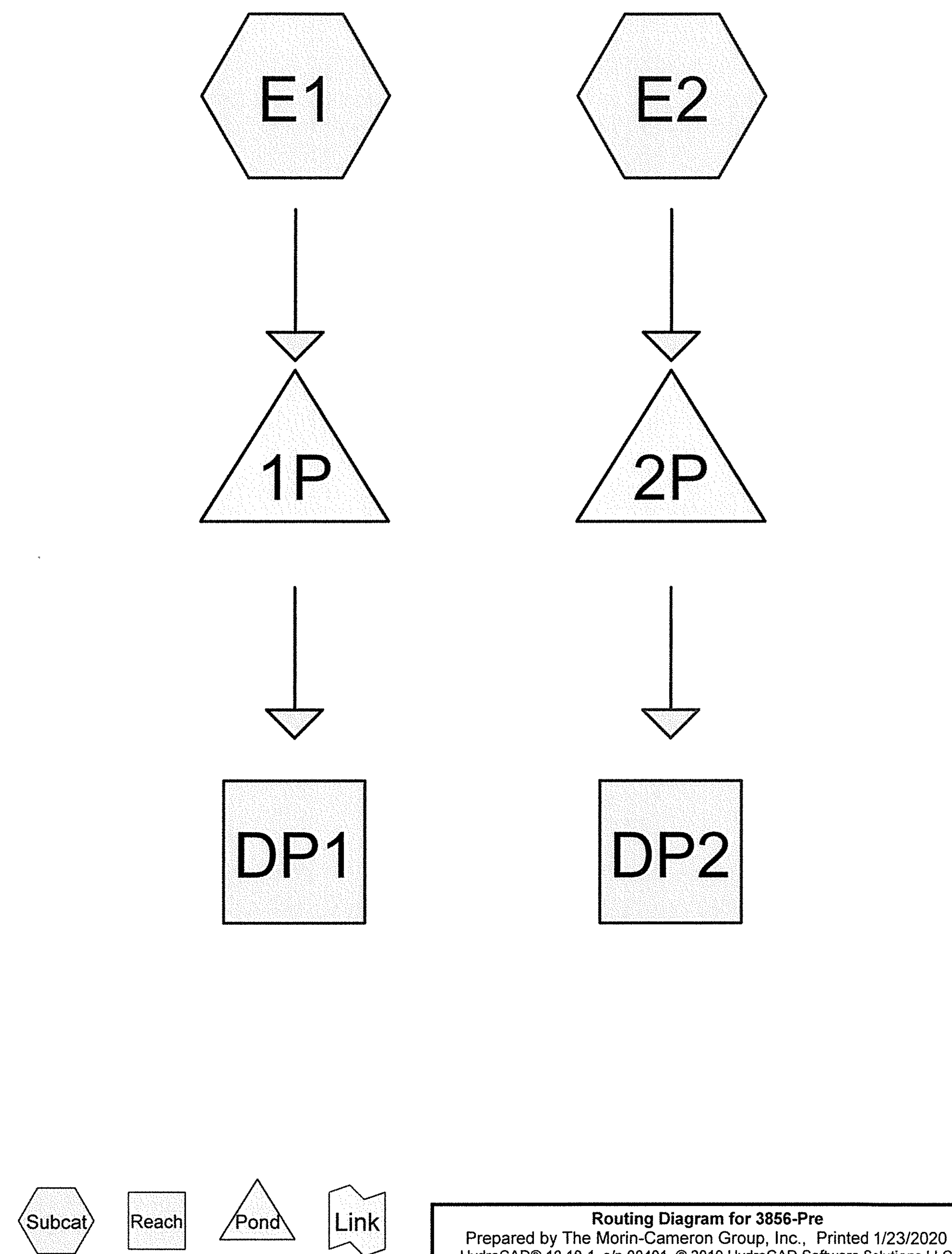
D. Runoff to Impaired Water Bodies – If MassDEP has issued a Total Maximum Daily Load (TMDL) that establishes a waste load allocation for stormwater discharge and/or a TMDL Implementation Plan that identifies remedies aimed at reducing the amount of pollutants from stormwater discharges, proponents may be required to install stormwater BMPs that are consistent with the TMDL.

E. Runoff to Areas of Localized Flooding – Project proponents must also understand the potential impacts of stormwater runoff in areas prone to localized flooding. When completing the checklist, proponents should consider the capacity of the receiving water and/or storm drainage system. When evaluating discharges to areas subject to localized flooding, the proponent should evaluate the ability to maintain and/or improve existing site cover and reduce runoff volume.

APPENDIX B:

EXISTING CONDITIONS

HYDROLOGIC ANALYSIS REPORT



Routing Diagram for 3856-Pre
Prepared by The Morin-Cameron Group, Inc., Printed 1/23/2020

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
86,141	80	>75% Grass cover, Good, HSG D (E1, E2)
9,556	98	Concrete, HSG D (E1, E2)
5,957	89	Dirt roads, HSG D (E2)
10,314	96	Gravel surface, HSG D (E1, E2)
108,514	98	Paved parking, HSG D (E1)
3,016	98	Paved roads w/curbs & sewers, HSG D (E2)
9,098	98	Roofs, HSG D (E1, E2)
6,044	77	Woods, Good, HSG D (E1, E2)
238,640	**91**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
238,640	HSG D	E1, E2
0	Other	
238,640		**TOTAL AREA**

Summary for Subcatchment E1:

Runoff = 8.55 cfs @ 12.08 hrs, Volume= 26,707 cf, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=2.63"

	Area (sf)	CN	Description
	6,581	98	Roofs, HSG D
	108,514	98	Paved parking, HSG D
*	6,939	98	Concrete, HSG D
	53,043	80	>75% Grass cover, Good, HSG D
	1,341	77	Woods, Good, HSG D
	264	96	Gravel surface, HSG D
	176,682	92	Weighted Average
	54,648		30.93% Pervious Area
	122,034		69.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.0	240	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.9	290	Total			

Summary for Subcatchment E2:

Runoff = 1.87 cfs @ 12.16 hrs, Volume= 6,973 cf, Depth= 1.35"

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 2-Year Rainfall=2.63"

	Area (sf)	CN	Description
	2,517	98	Roofs, HSG D
	3,016	98	Paved roads w/curbs & sewers, HSG D
	10,050	96	Gravel surface, HSG D
	33,098	80	>75% Grass cover, Good, HSG D
	4,703	77	Woods, Good, HSG D
	5,957	89	Dirt roads, HSG D
*	2,617	98	Concrete, HSG D
	61,958	86	Weighted Average
	53,808		86.85% Pervious Area
	8,150		13.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.5	475	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.5	525	Total			

Summary for Reach DP1:

Inflow Area =	176,682 sf,	69.07% Impervious,	Inflow Depth = 1.81"	for 2-Year event
Inflow =	7.92 cfs @	12.12 hrs, Volume=	26,707 cf	
Outflow =	7.92 cfs @	12.12 hrs, Volume=	26,707 cf,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2:

Inflow Area =	61,958 sf, 13.15% Impervious,	Inflow Depth = 1.35"	for 2-Year event
Inflow =	1.72 cfs @ 12.21 hrs, Volume=	6,961 cf	
Outflow =	1.72 cfs @ 12.21 hrs, Volume=	6,961 cf, Atten= 0%, Lag= 0.0 min	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 176,682 sf, 69.07% Impervious, Inflow Depth = 1.81" for 2-Year event
Inflow = 8.55 cfs @ 12.08 hrs, Volume= 26,707 cf
Outflow = 7.92 cfs @ 12.12 hrs, Volume= 26,707 cf, Atten= 7%, Lag= 2.0 min
Primary = 7.92 cfs @ 12.12 hrs, Volume= 26,707 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 9.88' @ 12.12 hrs Surf.Area= 1,672 sf Storage= 803 cf

Plug-Flow detention time= 0.8 min calculated for 26,699 cf (100% of inflow)
Center-of-Mass det. time= 0.8 min (805.7 - 804.9)

Volume	Invert	Avail.Storage	Storage Description
#1	8.66'	9,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.66	0	0	0
9.00	108	18	18
10.00	1,882	995	1,013
11.00	6,216	4,049	5,062
11.30	8,732	2,242	7,305
11.50	12,077	2,081	9,385

Device	Routing	Invert	Outlet Devices
#1	Primary	8.66'	**30.0" Round Culvert** L= 71.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.66' / 7.87' S= 0.0111 '/' Cc= 0.900 n= 0.015, Flow Area= 4.91 sf

Primary OutFlow Max=7.91 cfs @ 12.12 hrs HW=9.88' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 7.91 cfs @ 3.32 fps)

Summary for Pond 2P:

Inflow Area = 61,958 sf, 13.15% Impervious, Inflow Depth = 1.35" for 2-Year event
Inflow = 1.87 cfs @ 12.16 hrs, Volume= 6,973 cf
Outflow = 1.72 cfs @ 12.21 hrs, Volume= 6,961 cf, Atten= 8%, Lag= 3.2 min
Primary = 1.72 cfs @ 12.21 hrs, Volume= 6,961 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 11.44' @ 12.21 hrs Surf.Area= 937 sf Storage= 251 cf

Plug-Flow detention time= 3.2 min calculated for 6,961 cf (100% of inflow)
Center-of-Mass det. time= 2.1 min (838.6 - 836.5)

Volume	Invert	Avail.Storage	Storage Description
#1	10.20'	2,162 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.20	0	0	0
11.00	71	28	28
12.00	2,029	1,050	1,078
12.50	2,306	1,084	2,162

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**15.0" Round Culvert** L= 72.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 10.70' / 10.20' S= 0.0069 '/' Cc= 0.900 n= 0.015, Flow Area= 1.23 sf
#2	Secondary	12.20'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=1.72 cfs @ 12.21 hrs HW=11.44' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.72 cfs @ 3.25 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.20' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment E1:

Runoff = 17.82 cfs @ 12.08 hrs, Volume= 57,766 cf, Depth= 3.92"

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=4.83"

	Area (sf)	CN	Description
	6,581	98	Roofs, HSG D
	108,514	98	Paved parking, HSG D
*	6,939	98	Concrete, HSG D
	53,043	80	>75% Grass cover, Good, HSG D
	1,341	77	Woods, Good, HSG D
	264	96	Gravel surface, HSG D
	176,682	92	Weighted Average
	54,648		30.93% Pervious Area
	122,034		69.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.0	240	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.9	290	Total			

Summary for Subcatchment E2:

Runoff = 4.56 cfs @ 12.15 hrs, Volume= 17,083 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 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	2,517	98	Roofs, HSG D
	3,016	98	Paved roads w/curbs & sewers, HSG D
	10,050	96	Gravel surface, HSG D
	33,098	80	>75% Grass cover, Good, HSG D
	4,703	77	Woods, Good, HSG D
	5,957	89	Dirt roads, HSG D
*	2,617	98	Concrete, HSG D
	61,958	86	Weighted Average
	53,808		86.85% Pervious Area
	8,150		13.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.5	475	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.5	525	Total			

Summary for Reach DP1:

Inflow Area =	176,682 sf,	69.07% Impervious,	Inflow Depth = 3.92"	for 10-Year event	
Inflow =	15.31 cfs @	12.13 hrs,	Volume=	57,766 cf	
Outflow =	15.31 cfs @	12.13 hrs,	Volume=	57,766 cf,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2:

Inflow Area =	61,958 sf,	13.15% Impervious,	Inflow Depth = 3.31"	for 10-Year event
Inflow =	3.82 cfs @	12.23 hrs, Volume=	17,072 cf	
Outflow =	3.82 cfs @	12.23 hrs, Volume=	17,072 cf,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 176,682 sf, 69.07% Impervious, Inflow Depth = 3.92" for 10-Year event
Inflow = 17.82 cfs @ 12.08 hrs, Volume= 57,766 cf
Outflow = 15.31 cfs @ 12.13 hrs, Volume= 57,766 cf, Atten= 14%, Lag= 2.8 min
Primary = 15.31 cfs @ 12.13 hrs, Volume= 57,766 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 10.47' @ 12.13 hrs Surf.Area= 3,905 sf Storage= 2,364 cf

Plug-Flow detention time= 1.1 min calculated for 57,750 cf (100% of inflow)
Center-of-Mass det. time= 1.1 min (784.8 - 783.7)

Volume	Invert	Avail.Storage	Storage Description
#1	8.66'	9,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.66	0	0	0
9.00	108	18	18
10.00	1,882	995	1,013
11.00	6,216	4,049	5,062
11.30	8,732	2,242	7,305
11.50	12,077	2,081	9,385

Device	Routing	Invert	Outlet Devices
#1	Primary	8.66'	**30.0" Round Culvert** L= 71.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.66' / 7.87' S= 0.0111 '/' Cc= 0.900 n= 0.015, Flow Area= 4.91 sf

Primary OutFlow Max=15.31 cfs @ 12.13 hrs HW=10.47' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 15.31 cfs @ 5.63 fps)

Summary for Pond 2P:

Inflow Area = 61,958 sf, 13.15% Impervious, Inflow Depth = 3.31" for 10-Year event
Inflow = 4.56 cfs @ 12.15 hrs, Volume= 17,083 cf
Outflow = 3.82 cfs @ 12.23 hrs, Volume= 17,072 cf, Atten= 16%, Lag= 4.8 min
Primary = 3.82 cfs @ 12.23 hrs, Volume= 17,072 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 11.94' @ 12.23 hrs Surf.Area= 1,915 sf Storage= 964 cf

Plug-Flow detention time= 2.8 min calculated for 17,067 cf (100% of inflow)
Center-of-Mass det. time= 2.4 min (813.2 - 810.9)

Volume	Invert	Avail.Storage	Storage Description
#1	10.20'	2,162 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.20	0	0	0
11.00	71	28	28
12.00	2,029	1,050	1,078
12.50	2,306	1,084	2,162

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**15.0" Round Culvert** L= 72.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 10.70' / 10.20' S= 0.0069 '/' Cc= 0.900 n= 0.015, Flow Area= 1.23 sf
#2	Secondary	12.20'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.82 cfs @ 12.23 hrs HW=11.94' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 3.82 cfs @ 3.89 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.20' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment E1:

Runoff = 34.79 cfs @ 12.08 hrs, Volume= 117,420 cf, Depth= 7.97"

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=8.94"

	Area (sf)	CN	Description
	6,581	98	Roofs, HSG D
	108,514	98	Paved parking, HSG D
*	6,939	98	Concrete, HSG D
	53,043	80	>75% Grass cover, Good, HSG D
	1,341	77	Woods, Good, HSG D
	264	96	Gravel surface, HSG D
	176,682	92	Weighted Average
	54,648		30.93% Pervious Area
	122,034		69.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
2.0	240	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.9	290	Total			

Summary for Subcatchment E2:

Runoff = 9.65 cfs @ 12.15 hrs, Volume= 37,408 cf, Depth= 7.25"

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 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	2,517	98	Roofs, HSG D
	3,016	98	Paved roads w/curbs & sewers, HSG D
	10,050	96	Gravel surface, HSG D
	33,098	80	>75% Grass cover, Good, HSG D
	4,703	77	Woods, Good, HSG D
	5,957	89	Dirt roads, HSG D
*	2,617	98	Concrete, HSG D
	61,958	86	Weighted Average
	53,808		86.85% Pervious Area
	8,150		13.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.5	475	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.5	525	Total			

Summary for Reach DP1:

Inflow Area =	176,682 sf,	69.07% Impervious,	Inflow Depth = 7.91"	for 100-Year event
Inflow =	25.02 cfs @	12.16 hrs, Volume=	116,406 cf	
Outflow =	25.02 cfs @	12.16 hrs, Volume=	116,406 cf,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2:

Inflow Area =	61,958 sf,	13.15% Impervious,	Inflow Depth = 7.24" for 100-Year event
Inflow =	9.53 cfs @	12.17 hrs, Volume=	37,397 cf
Outflow =	9.53 cfs @	12.17 hrs, Volume=	37,397 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 176,682 sf, 69.07% Impervious, Inflow Depth = 7.97" for 100-Year event
Inflow = 34.79 cfs @ 12.08 hrs, Volume= 117,420 cf
Outflow = 25.02 cfs @ 12.16 hrs, Volume= 116,406 cf, Atten= 28%, Lag= 4.5 min
Primary = 25.02 cfs @ 12.16 hrs, Volume= 116,406 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 11.44' @ 12.16 hrs Surf.Area= 11,071 sf Storage= 8,689 cf

Plug-Flow detention time= 12.3 min calculated for 116,406 cf (99% of inflow)
Center-of-Mass det. time= 6.6 min (772.7 - 766.1)

Volume	Invert	Avail.Storage	Storage Description
#1	8.66'	9,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.66	0	0	0
9.00	108	18	18
10.00	1,882	995	1,013
11.00	6,216	4,049	5,062
11.30	8,732	2,242	7,305
11.50	12,077	2,081	9,385

Device	Routing	Invert	Outlet Devices
#1	Primary	8.66'	**30.0" Round Culvert** L= 71.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.66' / 7.87' S= 0.0111 '/' Cc= 0.900 n= 0.015, Flow Area= 4.91 sf

Primary OutFlow Max=25.02 cfs @ 12.16 hrs HW=11.44' TW=10.00' (Fixed TW Elev= 10.00')
↑—**1=Culvert** (Inlet Controls 25.02 cfs @ 5.10 fps)

Summary for Pond 2P:

Inflow Area = 61,958 sf, 13.15% Impervious, Inflow Depth = 7.25" for 100-Year event
Inflow = 9.65 cfs @ 12.15 hrs, Volume= 37,408 cf
Outflow = 9.53 cfs @ 12.17 hrs, Volume= 37,397 cf, Atten= 1%, Lag= 1.1 min
Primary = 4.87 cfs @ 12.26 hrs, Volume= 34,419 cf
Secondary = 4.72 cfs @ 12.17 hrs, Volume= 2,978 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 12.37' @ 12.17 hrs Surf.Area= 2,234 sf Storage= 1,867 cf

Plug-Flow detention time= 2.8 min calculated for 37,387 cf (100% of inflow)
Center-of-Mass det. time= 2.6 min (791.9 - 789.3)

Volume	Invert	Avail.Storage	Storage Description
#1	10.20'	2,162 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.20	0	0	0
11.00	71	28	28
12.00	2,029	1,050	1,078
12.50	2,306	1,084	2,162

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**15.0" Round Culvert** L= 72.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 10.70' / 10.20' S= 0.0069 '/' Cc= 0.900 n= 0.015, Flow Area= 1.23 sf
#2	Secondary	12.20'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

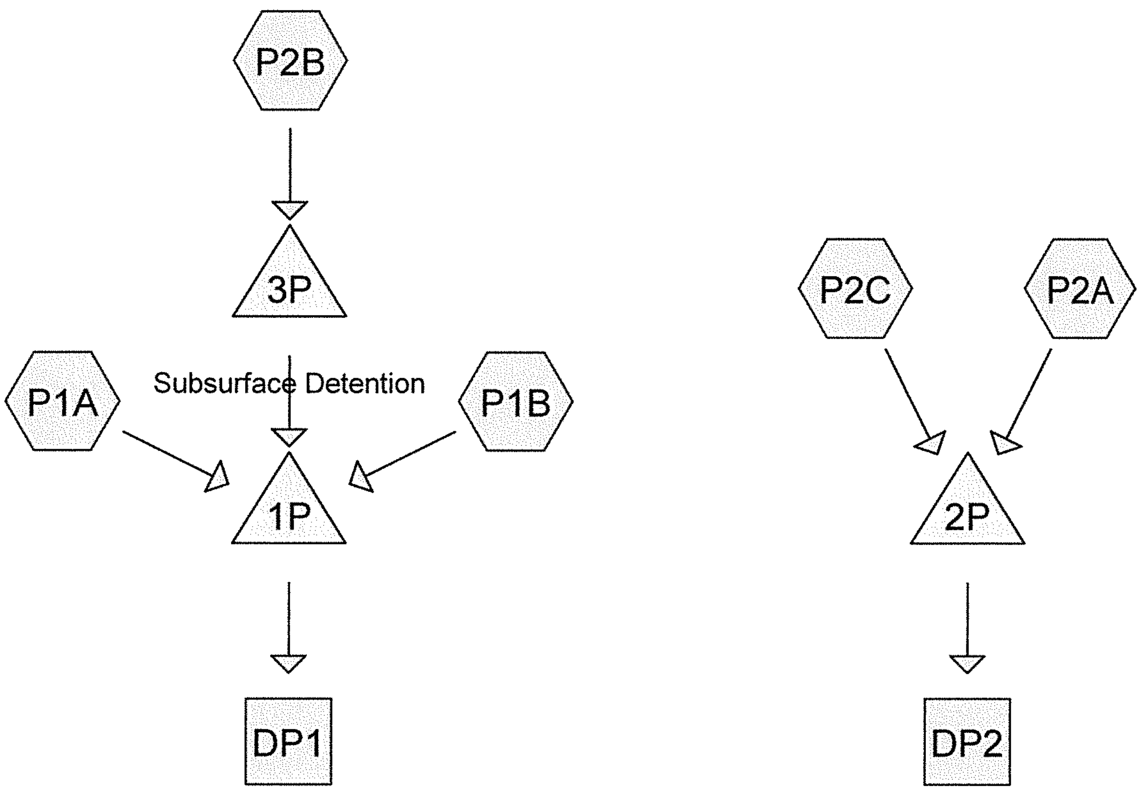
Primary OutFlow Max=4.87 cfs @ 12.26 hrs HW=12.32' TW=10.00' (Fixed TW Elev= 10.00')
└—**1=Culvert** (Barrel Controls 4.87 cfs @ 4.00 fps)

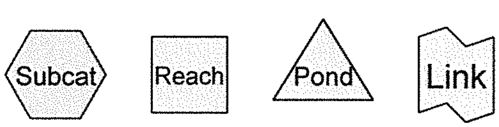
Secondary OutFlow Max=4.71 cfs @ 12.17 hrs HW=12.37' TW=10.00' (Fixed TW Elev= 10.00')
└—**2=Broad-Crested Rectangular Weir** (Weir Controls 4.71 cfs @ 1.11 fps)

APPENDIX C:

PROPOSED CONDITIONS

HYDROLOGIC ANALYSIS REPORT





Routing Diagram for 3856-Post
Prepared by The Morin-Cameron Group, Inc., Printed 1/23/2020

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
93,678	80	>75% Grass cover, Good, HSG D (P1A, P1B, P2A, P2B, P2C)
72,146	98	Paved parking, HSG D (P1A, P1B, P2B, P2C)
40,601	98	Roofs, HSG D (P1A, P1B, P2B)
28,213	98	Sidewalks, HSG D (P1A, P1B, P2A, P2B, P2C)
4,002	77	Woods, Good, HSG D (P2A)
238,640	**91**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
238,640	HSG D	P1A, P1B, P2A, P2B, P2C
0	Other	
238,640		**TOTAL AREA**

Summary for Subcatchment P1A:

Runoff = 2.25 cfs @ 12.08 hrs, Volume= 6,998 cf, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=2.63"

	Area (sf)	CN	Description
	22,532	98	Paved parking, HSG D
*	9,377	98	Sidewalks, HSG D
	14,274	80	>75% Grass cover, Good, HSG D
	115	98	Roofs, HSG D
	46,298	92	Weighted Average
	14,274		30.83% Pervious Area
	32,024		69.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.8	140	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.7	350	0.0260	7.92	6.22	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
5.8	540	Total			

Summary for Subcatchment P1B:

Runoff = 5.05 cfs @ 12.10 hrs, Volume= 16,761 cf, Depth= 1.90"

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=2.63"

	Area (sf)	CN	Description
	37,753	98	Paved parking, HSG D
*	14,517	98	Sidewalks, HSG D
	31,398	80	>75% Grass cover, Good, HSG D
	22,076	98	Roofs, HSG D
	105,744	93	Weighted Average
	31,398		29.69% Pervious Area
	74,346		70.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.3	60	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	23	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	362	0.0170	10.17	31.95	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
7.4	495	Total			

Summary for Subcatchment P2A:

Runoff = 1.05 cfs @ 12.15 hrs, Volume= 3,843 cf, Depth= 1.04"

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=2.63"

	Area (sf)	CN	Description
	37,783	80	>75% Grass cover, Good, HSG D
	4,002	77	Woods, Good, HSG D
*	2,718	98	Sidewalks, HSG D
	44,503	81	Weighted Average
	41,785		93.89% Pervious Area
	2,718		6.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0070	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.6	250	0.0250	2.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	300	Total			

Summary for Subcatchment P2B:

Runoff = 1.38 cfs @ 12.09 hrs, Volume= 4,833 cf, Depth= 2.40"

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=2.63"

	Area (sf)	CN	Description
	18,410	98	Roofs, HSG D
*	1,227	98	Sidewalks, HSG D
	3,871	98	Paved parking, HSG D
	658	80	>75% Grass cover, Good, HSG D
	24,166	98	Weighted Average
	658		2.72% Pervious Area
	23,508		97.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	11	0.0200	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.2	9	0.0200	0.84		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
2.5	18	0.0200	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8	12	0.0200	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.3	50	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	20	0.0200	6.95	5.46	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
6.5	120	Total			

Summary for Subcatchment P2C:

Runoff = 0.75 cfs @ 12.07 hrs, Volume= 2,231 cf, Depth= 1.49"

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=2.63"

	Area (sf)	CN	Description
*	374	98	Sidewalks, HSG D
	7,990	98	Paved parking, HSG D
	9,565	80	>75% Grass cover, Good, HSG D
	17,929	88	Weighted Average
	9,565		53.35% Pervious Area
	8,364		46.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	23	0.0150	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.4	27	0.0300	1.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.3	90	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	140	0.0320	2.88		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.9	280	Total			

Summary for Reach DP1:

Inflow Area =	176,208 sf,	73.71% Impervious,	Inflow Depth = 1.95"	for 2-Year event	
Inflow =	7.16 cfs @	12.15 hrs,	Volume=	28,589 cf	
Outflow =	7.16 cfs @	12.15 hrs,	Volume=	28,589 cf,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2:

Inflow Area =	62,432 sf,	17.75% Impervious,	Inflow Depth = 1.17"	for 2-Year event
Inflow =	1.47 cfs @	12.17 hrs, Volume=	6,063 cf	
Outflow =	1.47 cfs @	12.17 hrs, Volume=	6,063 cf,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area =	176,208 sf,	73.71% Impervious,	Inflow Depth = 1.95"	for 2-Year event	
Inflow =	8.09 cfs @	12.10 hrs, Volume=	28,592 cf		
Outflow =	7.16 cfs @	12.15 hrs, Volume=	28,589 cf,	Atten= 11%,	Lag= 2.9 min
Primary =	7.16 cfs @	12.15 hrs, Volume=	28,589 cf		
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 9.82' @ 12.15 hrs Surf.Area= 2,494 sf Storage= 1,573 cf

Plug-Flow detention time= 6.5 min calculated for 28,581 cf (100% of inflow)
Center-of-Mass det. time= 6.5 min (804.2 - 797.7)

Volume	Invert	Avail.Storage	Storage Description
#1	8.66'	15,170 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.66	637	0	0
9.00	775	240	240
10.00	2,884	1,830	2,070
11.00	4,469	3,677	5,746
11.50	6,639	2,777	8,523
12.00	19,949	6,647	15,170

Device	Routing	Invert	Outlet Devices
#1	Primary	8.66'	**30.0" Round Culvert** L= 71.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.66' / 7.87' S= 0.0111 '/' Cc= 0.900 n= 0.015, Flow Area= 4.91 sf
#2	Secondary	11.60'	**Asymmetrical Weir, C= 3.27** Offset (feet) 0.00 0.00 70.00 130.00 200.00 Height (feet) 0.40 0.20 0.00 0.00 0.40

Primary OutFlow Max=7.16 cfs @ 12.15 hrs HW=9.81' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 7.16 cfs @ 3.23 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=8.66' TW=0.00' (Dynamic Tailwater)
└─**2=Asymmetrical Weir** (Controls 0.00 cfs)

Summary for Pond 2P:

Inflow Area = 62,432 sf, 17.75% Impervious, Inflow Depth = 1.17" for 2-Year event
Inflow = 1.65 cfs @ 12.11 hrs, Volume= 6,074 cf
Outflow = 1.47 cfs @ 12.17 hrs, Volume= 6,063 cf, Atten= 11%, Lag= 3.7 min
Primary = 1.47 cfs @ 12.17 hrs, Volume= 6,063 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 11.38' @ 12.17 hrs Surf.Area= 1,075 sf Storage= 245 cf

Plug-Flow detention time= 3.6 min calculated for 6,063 cf (100% of inflow)
Center-of-Mass det. time= 2.4 min (844.6 - 842.2)

Volume	Invert	Avail.Storage	Storage Description
#1	10.20'	2,759 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.20	0	0	0
11.00	71	28	28
12.00	2,726	1,399	1,427
12.40	3,936	1,332	2,759

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**15.0" Round Culvert** L= 72.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 10.70' / 10.20' S= 0.0069 '/' Cc= 0.900 n= 0.015, Flow Area= 1.23 sf
#2	Secondary	12.20'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=1.47 cfs @ 12.17 hrs HW=11.38' TW=0.00' (Dynamic Tailwater)
└—**1=Culvert** (Barrel Controls 1.47 cfs @ 3.13 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.20' TW=0.00' (Dynamic Tailwater)
└—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 3P: Subsurface Detention

Inflow Area = 24,166 sf, 97.28% Impervious, Inflow Depth = 2.40" for 2-Year event
Inflow = 1.38 cfs @ 12.09 hrs, Volume= 4,833 cf
Outflow = 0.94 cfs @ 12.18 hrs, Volume= 4,832 cf, Atten= 32%, Lag= 5.2 min
Primary = 0.94 cfs @ 12.18 hrs, Volume= 4,832 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 15.80' @ 12.18 hrs Surf.Area= 384 sf Storage= 591 cf

Plug-Flow detention time= 14.9 min calculated for 4,832 cf (100% of inflow)
Center-of-Mass det. time= 14.7 min (775.9 - 761.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	14.00'	0 cf	**16.00'W x 24.00'L x 5.17'H Field A** 1,984 cf Overall - 1,984 cf Embedded = 0 cf x 40.0% Voids
#2A	14.00'	1,477 cf	**retain_it retain_it 4.5'** x 6 Inside #1 Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf 2 Rows adjusted for 89.7 cf perimeter wall
		1,477 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.00' / 13.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	14.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	14.75'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	15.75'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	17.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	18.20'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.94 cfs @ 12.18 hrs HW=15.80' TW=9.80' (Dynamic Tailwater)
└1=Culvert (Passes 0.94 cfs of 4.14 cfs potential flow)
  ├2=Orifice/Grate (Orifice Controls 0.54 cfs @ 6.16 fps)
  ├3=Orifice/Grate (Orifice Controls 0.40 cfs @ 4.53 fps)
  ├4=Orifice/Grate (Orifice Controls 0.01 cfs @ 0.77 fps)
  ├5=Orifice/Grate (Controls 0.00 cfs)
  └6=Orifice/Grate (Controls 0.00 cfs)

Pond 3P: Subsurface Detention - Chamber Wizard Field A

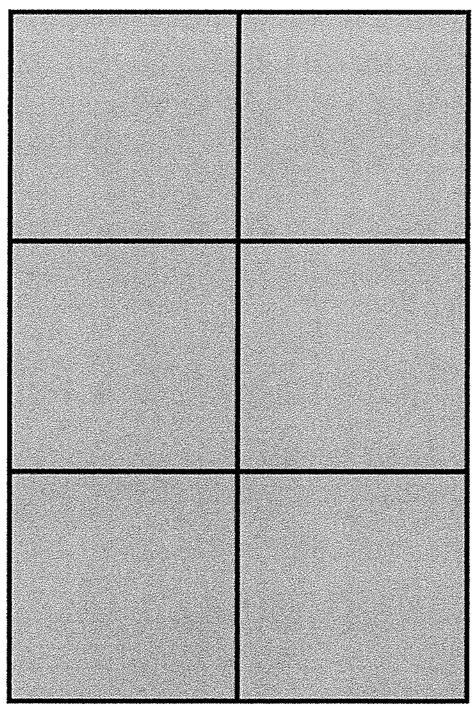
Chamber Model = retain_it retain_it 4.5' (retain-it®)
Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf
Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf
2 Rows adjusted for 89.7 cf perimeter wall

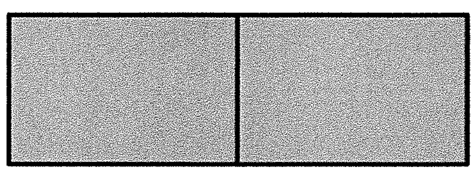
3 Chambers/Row x 8.00' Long = 24.00' Row Length
2 Rows x 96.0" Wide = 16.00' Base Width
62.0" Chamber Height = 5.17' Field Height

9.0 cf Sidewall x 3 x 2 + 9.0 cf Endwall x 2 x 2 = 89.7 cf Perimeter Wall
6 Chambers x 261.1 cf - 89.7 cf Perimeter wall = 1,477.0 cf Chamber Storage
6 Chambers x 330.7 cf = 1,984.0 cf Displacement

Chamber Storage = 1,477.0 cf = 0.034 af
Overall Storage Efficiency = 74.4%
Overall System Size = 24.00' x 16.00' x 5.17'

6 Chambers
73.5 cy Field





Summary for Subcatchment P1A:

Runoff = 4.68 cfs @ 12.08 hrs, Volume= 15,137 cf, Depth= 3.92"

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=4.83"

	Area (sf)	CN	Description
	22,532	98	Paved parking, HSG D
*	9,377	98	Sidewalks, HSG D
	14,274	80	>75% Grass cover, Good, HSG D
	115	98	Roofs, HSG D
	46,298	92	Weighted Average
	14,274		30.83% Pervious Area
	32,024		69.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.8	140	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.7	350	0.0260	7.92	6.22	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
5.8	540	Total			

Summary for Subcatchment P1B:

Runoff = 10.31 cfs @ 12.10 hrs, Volume= 35,522 cf, Depth= 4.03"

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=4.83"

	Area (sf)	CN	Description
	37,753	98	Paved parking, HSG D
*	14,517	98	Sidewalks, HSG D
	31,398	80	>75% Grass cover, Good, HSG D
	22,076	98	Roofs, HSG D
	105,744	93	Weighted Average
	31,398		29.69% Pervious Area
	74,346		70.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.3	60	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	23	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	362	0.0170	10.17	31.95	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
7.4	495	Total			

Summary for Subcatchment P2A:

Runoff = 2.95 cfs @ 12.14 hrs, Volume= 10,516 cf, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	37,783	80	>75% Grass cover, Good, HSG D
	4,002	77	Woods, Good, HSG D
*	2,718	98	Sidewalks, HSG D
	44,503	81	Weighted Average
	41,785		93.89% Pervious Area
	2,718		6.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0070	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.6	250	0.0250	2.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	300	Total			

Summary for Subcatchment P2B:

Runoff = 2.58 cfs @ 12.09 hrs, Volume= 9,250 cf, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	18,410	98	Roofs, HSG D
*	1,227	98	Sidewalks, HSG D
	3,871	98	Paved parking, HSG D
	658	80	>75% Grass cover, Good, HSG D
	24,166	98	Weighted Average
	658		2.72% Pervious Area
	23,508		97.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	11	0.0200	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.2	9	0.0200	0.84		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
2.5	18	0.0200	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8	12	0.0200	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.3	50	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	20	0.0200	6.95	5.46	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
6.5	120	Total			

Summary for Subcatchment P2C:

Runoff = 1.72 cfs @ 12.07 hrs, Volume= 5,241 cf, Depth= 3.51"

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=4.83"

	Area (sf)	CN	Description
*	374	98	Sidewalks, HSG D
	7,990	98	Paved parking, HSG D
	9,565	80	>75% Grass cover, Good, HSG D
	17,929	88	Weighted Average
	9,565		53.35% Pervious Area
	8,364		46.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	23	0.0150	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.4	27	0.0300	1.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.3	90	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	140	0.0320	2.88		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.9	280	Total			

Summary for Reach DP1:

Inflow Area =	176,208 sf,	73.71% Impervious,	Inflow Depth = 4.08"	for 10-Year event	
Inflow =	14.52 cfs @	12.15 hrs,	Volume=	59,905 cf	
Outflow =	14.52 cfs @	12.15 hrs,	Volume=	59,905 cf,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2:

Inflow Area =	62,432 sf, 17.75% Impervious,	Inflow Depth = 3.03"	for 10-Year event
Inflow =	3.46 cfs @ 12.20 hrs, Volume=	15,746 cf	
Outflow =	3.46 cfs @ 12.20 hrs, Volume=	15,746 cf, Atten= 0%, Lag= 0.0 min	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 176,208 sf, 73.71% Impervious, Inflow Depth = 4.08" for 10-Year event
Inflow = 16.81 cfs @ 12.10 hrs, Volume= 59,908 cf
Outflow = 14.52 cfs @ 12.15 hrs, Volume= 59,905 cf, Atten= 14%, Lag= 3.2 min
Primary = 14.52 cfs @ 12.15 hrs, Volume= 59,905 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 10.41' @ 12.15 hrs Surf.Area= 3,529 sf Storage= 3,374 cf

Plug-Flow detention time= 5.3 min calculated for 59,889 cf (100% of inflow)
Center-of-Mass det. time= 5.3 min (783.6 - 778.4)

Volume	Invert	Avail.Storage	Storage Description
#1	8.66'	15,170 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.66	637	0	0
9.00	775	240	240
10.00	2,884	1,830	2,070
11.00	4,469	3,677	5,746
11.50	6,639	2,777	8,523
12.00	19,949	6,647	15,170

Device	Routing	Invert	Outlet Devices
#1	Primary	8.66'	**30.0" Round Culvert** L= 71.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.66' / 7.87' S= 0.0111 '/' Cc= 0.900 n= 0.015, Flow Area= 4.91 sf
#2	Secondary	11.60'	**Asymmetrical Weir, C= 3.27** Offset (feet) 0.00 0.00 70.00 130.00 200.00 Height (feet) 0.40 0.20 0.00 0.00 0.40

Primary OutFlow Max=14.51 cfs @ 12.15 hrs HW=10.41' TW=0.00' (Dynamic Tailwater)
└—**1=Culvert** (Barrel Controls 14.51 cfs @ 5.57 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=8.66' TW=0.00' (Dynamic Tailwater)
└—**2=Asymmetrical Weir** (Controls 0.00 cfs)

Summary for Pond 2P:

Inflow Area = 62,432 sf, 17.75% Impervious, Inflow Depth = 3.03" for 10-Year event
Inflow = 4.34 cfs @ 12.11 hrs, Volume= 15,757 cf
Outflow = 3.46 cfs @ 12.20 hrs, Volume= 15,746 cf, Atten= 20%, Lag= 5.4 min
Primary = 3.46 cfs @ 12.20 hrs, Volume= 15,746 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 11.85' @ 12.20 hrs Surf.Area= 2,337 sf Storage= 1,056 cf

Plug-Flow detention time= 3.3 min calculated for 15,746 cf (100% of inflow)
Center-of-Mass det. time= 2.8 min (818.4 - 815.7)

Volume	Invert	Avail.Storage	Storage Description
#1	10.20'	2,759 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.20	0	0	0
11.00	71	28	28
12.00	2,726	1,399	1,427
12.40	3,936	1,332	2,759

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**15.0" Round Culvert** L= 72.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 10.70' / 10.20' S= 0.0069 '/' Cc= 0.900 n= 0.015, Flow Area= 1.23 sf
#2	Secondary	12.20'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=3.46 cfs @ 12.20 hrs HW=11.85' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 3.46 cfs @ 3.81 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=10.20' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 3P: Subsurface Detention

Inflow Area = 24,166 sf, 97.28% Impervious, Inflow Depth = 4.59" for 10-Year event
Inflow = 2.58 cfs @ 12.09 hrs, Volume= 9,250 cf
Outflow = 2.09 cfs @ 12.15 hrs, Volume= 9,249 cf, Atten= 19%, Lag= 3.6 min
Primary = 2.09 cfs @ 12.15 hrs, Volume= 9,249 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 16.78' @ 12.15 hrs Surf.Area= 384 sf Storage= 912 cf

Plug-Flow detention time= 12.2 min calculated for 9,249 cf (100% of inflow)
Center-of-Mass det. time= 12.1 min (761.1 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	14.00'	0 cf	**16.00'W x 24.00'L x 5.17'H Field A** 1,984 cf Overall - 1,984 cf Embedded = 0 cf x 40.0% Voids
#2A	14.00'	1,477 cf	**retain_it retain_it 4.5'** x 6 Inside #1 Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf 2 Rows adjusted for 89.7 cf perimeter wall
		1,477 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.00' / 13.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	14.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	14.75'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	15.75'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	17.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	18.20'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.09 cfs @ 12.15 hrs HW=16.78' TW=10.41' (Dynamic Tailwater)
└─**1=Culvert** (Passes 2.09 cfs of 5.14 cfs potential flow)
 ├─**2=Orifice/Grate** (Orifice Controls 0.68 cfs @ 7.78 fps)
 ├─**3=Orifice/Grate** (Orifice Controls 0.57 cfs @ 6.57 fps)
 ├─**4=Orifice/Grate** (Orifice Controls 0.83 cfs @ 4.24 fps)
 ├─**5=Orifice/Grate** (Controls 0.00 cfs)
 └─**6=Orifice/Grate** (Controls 0.00 cfs)

Pond 3P: Subsurface Detention - Chamber Wizard Field A

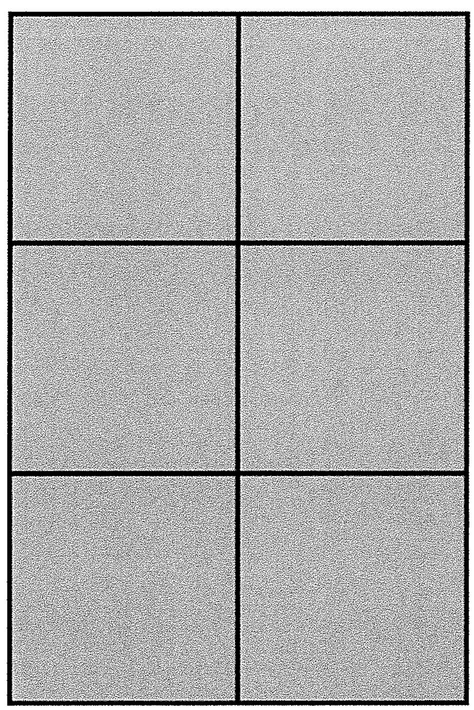
Chamber Model = retain_it retain_it 4.5' (retain-it®)
Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf
Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf
2 Rows adjusted for 89.7 cf perimeter wall

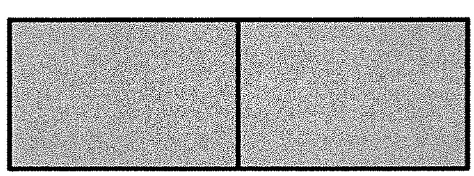
3 Chambers/Row x 8.00' Long = 24.00' Row Length
2 Rows x 96.0" Wide = 16.00' Base Width
62.0" Chamber Height = 5.17' Field Height

9.0 cf Sidewall x 3 x 2 + 9.0 cf Endwall x 2 x 2 = 89.7 cf Perimeter Wall
6 Chambers x 261.1 cf - 89.7 cf Perimeter wall = 1,477.0 cf Chamber Storage
6 Chambers x 330.7 cf = 1,984.0 cf Displacement

Chamber Storage = 1,477.0 cf = 0.034 af
Overall Storage Efficiency = 74.4%
Overall System Size = 24.00' x 16.00' x 5.17'

6 Chambers
73.5 cy Field





Summary for Subcatchment P1A:

Runoff = 9.15 cfs @ 12.08 hrs, Volume= 30,769 cf, Depth= 7.97"

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=8.94"

	Area (sf)	CN	Description
	22,532	98	Paved parking, HSG D
*	9,377	98	Sidewalks, HSG D
	14,274	80	>75% Grass cover, Good, HSG D
	115	98	Roofs, HSG D
	46,298	92	Weighted Average
	14,274		30.83% Pervious Area
	32,024		69.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.8	140	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.7	350	0.0260	7.92	6.22	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
5.8	540	Total			

Summary for Subcatchment P1B:

Runoff = 19.91 cfs @ 12.10 hrs, Volume= 71,343 cf, Depth= 8.10"

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 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	37,753	98	Paved parking, HSG D
*	14,517	98	Sidewalks, HSG D
	31,398	80	>75% Grass cover, Good, HSG D
	22,076	98	Roofs, HSG D
	105,744	93	Weighted Average
	31,398		29.69% Pervious Area
	74,346		70.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.3	60	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	23	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.6	362	0.0170	10.17	31.95	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
7.4	495	Total			

Summary for Subcatchment P2A:

Runoff = 6.74 cfs @ 12.14 hrs, Volume= 24,602 cf, Depth= 6.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	37,783	80	>75% Grass cover, Good, HSG D
	4,002	77	Woods, Good, HSG D
*	2,718	98	Sidewalks, HSG D
	44,503	81	Weighted Average
	41,785		93.89% Pervious Area
	2,718		6.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0070	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.6	250	0.0250	2.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	300	Total			

Summary for Subcatchment P2B:

Runoff = 4.79 cfs @ 12.09 hrs, Volume= 17,520 cf, Depth= 8.70"

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 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	18,410	98	Roofs, HSG D
*	1,227	98	Sidewalks, HSG D
	3,871	98	Paved parking, HSG D
	658	80	>75% Grass cover, Good, HSG D
	24,166	98	Weighted Average
	658		2.72% Pervious Area
	23,508		97.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	11	0.0200	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.2	9	0.0200	0.84		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
2.5	18	0.0200	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
1.8	12	0.0200	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.3	50	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	20	0.0200	6.95	5.46	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
6.5	120	Total			

Summary for Subcatchment P2C:

Runoff = 3.54 cfs @ 12.07 hrs, Volume= 11,189 cf, Depth= 7.49"

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=8.94"

	Area (sf)	CN	Description
*	374	98	Sidewalks, HSG D
	7,990	98	Paved parking, HSG D
	9,565	80	>75% Grass cover, Good, HSG D
	17,929	88	Weighted Average
	9,565		53.35% Pervious Area
	8,364		46.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	23	0.0150	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.4	27	0.0300	1.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.3	90	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	140	0.0320	2.88		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.9	280	Total			

Summary for Reach DP1:

Inflow Area =	176,208 sf,	73.71% Impervious,	Inflow Depth = 8.01"	for 100-Year event	
Inflow =	25.73 cfs @	12.17 hrs, Volume=	117,561 cf		
Outflow =	25.73 cfs @	12.17 hrs, Volume=	117,561 cf,	Atten= 0%,	Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2:

Inflow Area =	62,432 sf, 17.75% Impervious,	Inflow Depth = 6.88" for 100-Year event
Inflow =	8.96 cfs @ 12.15 hrs, Volume=	35,780 cf
Outflow =	8.96 cfs @ 12.15 hrs, Volume=	35,780 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 176,208 sf, 73.71% Impervious, Inflow Depth = 8.15" for 100-Year event
Inflow = 32.63 cfs @ 12.10 hrs, Volume= 119,632 cf
Outflow = 25.73 cfs @ 12.17 hrs, Volume= 117,561 cf, Atten= 21%, Lag= 4.2 min
Primary = 25.73 cfs @ 12.17 hrs, Volume= 117,561 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 11.52' @ 12.17 hrs Surf.Area= 7,237 sf Storage= 8,679 cf

Plug-Flow detention time= 22.6 min calculated for 117,561 cf (98% of inflow)
Center-of-Mass det. time= 11.3 min (773.9 - 762.5)

Volume	Invert	Avail.Storage	Storage Description
#1	8.66'	15,170 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.66	637	0	0
9.00	775	240	240
10.00	2,884	1,830	2,070
11.00	4,469	3,677	5,746
11.50	6,639	2,777	8,523
12.00	19,949	6,647	15,170

Device	Routing	Invert	Outlet Devices
#1	Primary	8.66'	**30.0" Round Culvert** L= 71.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.66' / 7.87' S= 0.0111 '/' Cc= 0.900 n= 0.015, Flow Area= 4.91 sf
#2	Secondary	11.60'	**Asymmetrical Weir, C= 3.27** Offset (feet) 0.00 0.00 70.00 130.00 200.00 Height (feet) 0.40 0.20 0.00 0.00 0.40

Primary OutFlow Max=25.73 cfs @ 12.17 hrs HW=11.52' TW=10.00' (Fixed TW Elev= 10.00')
↑—**1=Culvert** (Inlet Controls 25.73 cfs @ 5.24 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=8.66' TW=10.00' (Fixed TW Elev= 10.00')
↑—**2=Asymmetrical Weir** (Controls 0.00 cfs)

Summary for Pond 2P:

Inflow Area = 62,432 sf, 17.75% Impervious, Inflow Depth = 6.88" for 100-Year event
Inflow = 9.59 cfs @ 12.11 hrs, Volume= 35,791 cf
Outflow = 8.96 cfs @ 12.15 hrs, Volume= 35,780 cf, Atten= 7%, Lag= 2.6 min
Primary = 4.87 cfs @ 12.23 hrs, Volume= 33,394 cf
Secondary = 4.13 cfs @ 12.15 hrs, Volume= 2,386 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 12.36' @ 12.15 hrs Surf.Area= 3,802 sf Storage= 2,588 cf

Plug-Flow detention time= 3.7 min calculated for 35,780 cf (100% of inflow)
Center-of-Mass det. time= 3.4 min (796.7 - 793.3)

Volume	Invert	Avail.Storage	Storage Description
#1	10.20'	2,759 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.20	0	0	0
11.00	71	28	28
12.00	2,726	1,399	1,427
12.40	3,936	1,332	2,759

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**15.0" Round Culvert** L= 72.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 10.70' / 10.20' S= 0.0069 '/' Cc= 0.900 n= 0.015, Flow Area= 1.23 sf
#2	Secondary	12.20'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=4.87 cfs @ 12.23 hrs HW=12.32' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 4.87 cfs @ 4.00 fps)

Secondary OutFlow Max=4.12 cfs @ 12.15 hrs HW=12.36' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 4.12 cfs @ 1.06 fps)

Summary for Pond 3P: Subsurface Detention

Inflow Area = 24,166 sf, 97.28% Impervious, Inflow Depth = 8.70" for 100-Year event
Inflow = 4.79 cfs @ 12.09 hrs, Volume= 17,520 cf
Outflow = 4.22 cfs @ 12.13 hrs, Volume= 17,520 cf, Atten= 12%, Lag= 2.7 min
Primary = 4.22 cfs @ 12.13 hrs, Volume= 17,520 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 18.27' @ 12.13 hrs Surf.Area= 384 sf Storage= 1,403 cf

Plug-Flow detention time= 10.4 min calculated for 17,520 cf (100% of inflow)
Center-of-Mass det. time= 10.3 min (750.7 - 740.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	14.00'	0 cf	**16.00'W x 24.00'L x 5.17'H Field A** 1,984 cf Overall - 1,984 cf Embedded = 0 cf x 40.0% Voids
#2A	14.00'	1,477 cf	**retain_it retain_it 4.5'** x 6 Inside #1 Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf 2 Rows adjusted for 89.7 cf perimeter wall
		1,477 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.00' / 13.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	14.00'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	14.75'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	15.75'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	17.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	18.20'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.19 cfs @ 12.13 hrs HW=18.27' (Free Discharge)
↑—**1=Culvert** (Passes 4.19 cfs of 6.37 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 0.85 cfs @ 9.75 fps)
  —**3=Orifice/Grate** (Orifice Controls 0.77 cfs @ 8.82 fps)
  —**4=Orifice/Grate** (Orifice Controls 1.42 cfs @ 7.26 fps)
  —**5=Orifice/Grate** (Orifice Controls 0.96 cfs @ 4.86 fps)
  └—**6=Orifice/Grate** (Weir Controls 0.19 cfs @ 0.87 fps)

Pond 3P: Subsurface Detention - Chamber Wizard Field A

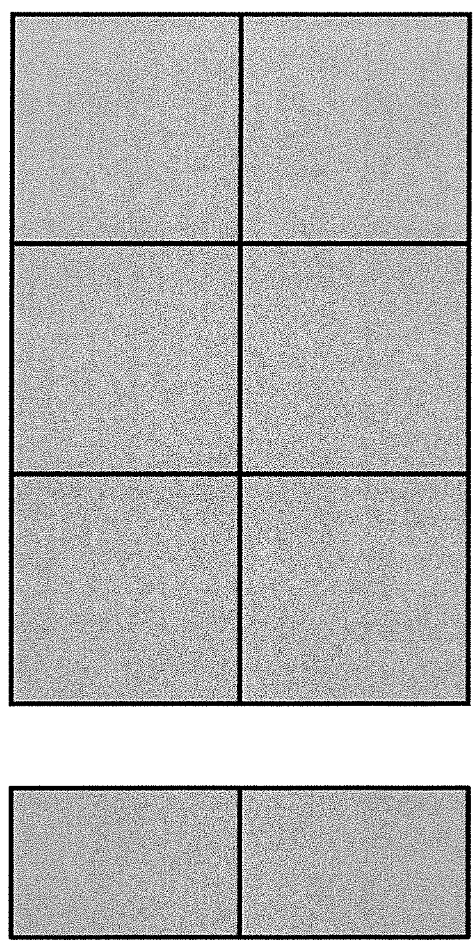
Chamber Model = retain_it retain_it 4.5' (retain-it®)
Inside= 84.0"W x 54.0"H => 32.64 sf x 8.00'L = 261.1 cf
Outside= 96.0"W x 62.0"H => 41.33 sf x 8.00'L = 330.7 cf
2 Rows adjusted for 89.7 cf perimeter wall

3 Chambers/Row x 8.00' Long = 24.00' Row Length
2 Rows x 96.0" Wide = 16.00' Base Width
62.0" Chamber Height = 5.17' Field Height

9.0 cf Sidewall x 3 x 2 + 9.0 cf Endwall x 2 x 2 = 89.7 cf Perimeter Wall
6 Chambers x 261.1 cf - 89.7 cf Perimeter wall = 1,477.0 cf Chamber Storage
6 Chambers x 330.7 cf = 1,984.0 cf Displacement

Chamber Storage = 1,477.0 cf = 0.034 af
Overall Storage Efficiency = 74.4%
Overall System Size = 24.00' x 16.00' x 5.17'

6 Chambers
73.5 cy Field



APPENDIX D:

CONSTRUCTION PHASE

BEST MANAGEMENT PRACTICES PLAN

Construction Phase Best Management Practices (BMP's)

Erosion and Sedimentation will be controlled at the site by utilizing structural practices, stabilization practices, and dust control. These practices correspond with the site development plans entitled "3 Boston Way in Newburyport, Massachusetts" prepared by The Morin-Cameron Group, Inc. dated October 23, 2019 as revised and approved by the Newburyport Planning Board, hereinafter referred to as the Site Plans.

Responsible Party Contact Information:

Stormwater Management System Owner:	Three Boston Way, LLC 231 Sutton Street North Andover, MA 01845 P: (978) 688-5422
General Contractor:	TBD
Site Contractor:	TBD

Town Contact Information:

Newburyport Engineering Department:	Department of Public Services 16C Perry Way Newburyport, MA 01950 P: (978) 465-4464
Newburyport Planning Board:	Planning Board 60 Pleasant Street P.O. Box 550 Newburyport, MA 01950 P: (978) 465-4400

Site Design Engineer Information:	The Morin-Cameron Group, Inc. 66 Elm Street Danvers, MA 01923 Phone: (978) 777-8586
Other Contacts:	TBD

Structural Practices:

1) **Silt Fence** –siltation fence shall be installed in accordance with the approved plans where high rates of stormwater runoff are anticipated.
   a) Installation Schedule: Prior to Start of land disturbance

   b) Maintenance and Inspection: The site supervisor shall inspect the silt fence at least once per week and shall repair any damaged or affected areas of the fence at the time they are noted.

2) **Mulch Sock** – Mulch sock shall be installed in accordance with the approved plans where high rates of stormwater runoff are anticipated.
   c) Installation Schedule: Prior to Start of land disturbance

   d) Maintenance and Inspection: The site supervisor shall inspect the mulch sock at least once per week and shall repair any damaged or affected areas of the sock at the time they are noted.

3) **Hay-Bales/Silt Fence** – Hay-bales and siltation fence shall be installed in accordance with the approved plans where high rates of stormwater runoff are anticipated.
   e) Installation Schedule: Prior to Start of land disturbance

   f) Maintenance and Inspection: The site supervisor shall inspect the silt fence at least once per week and shall repair any damaged or affected areas of the fence at the time they are noted.

4) **Inlet Protection** – Inlet Protection will be utilized around the catch basin grates in the street layout along the frontage of the property. The inlet protection will allow the storm drain inlets to be used before final stabilization. This structural practice will allow early use of the drainage system. Siltsack or equivalent will be utilized for the inlet protection. Siltsack is manufactured by ACF Environmental. The telephone number is 800-448-3636. Regular flow siltsack will be utilized, and if it does not allow enough storm water flow, hi-flow siltsack will be utilized.

Silt Sack (or equivalent) Inlet Protection Inspection/Maintenance Requirements *

a) The silt sack trapping device and the catch basin should be inspected after every rain storm and repairs made as necessary.

b) Sediment should be removed from the silt sack after the sediment has reached a maximum depth of one-half the depth of the trap.

c) Sediment should be disposed of in a suitable area and protected from erosion by either structural or vegetative means. Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

d) The silt sack must be replaced if it is ripped or torn in any way.

e) Temporary traps should be removed and the area repaired as soon as the contributing drainage area to the inlet has been completely stabilized.

5) **Sediment Track-Out:** Stabilized Construction Exit: Prior to the commencement of site work, crushed stone anti-tracking pads will be installed at the entrance to the site. This will prevent trucks from tracking material onto the road from the construction site. If, at any point during the project, the tracking pad becomes ineffective due to accumulation of soil, the crushed stone shall be replaced. Details for construction of the stabilized entrance can be found in the Erosion Control Details sheet that is part of the comprehensive permit plan set associated with the project. The site supervisor will inspect the tracking pads weekly to ensure that they are properly limiting the tracking of soil onto the road. If tracking onto the roadway is noted, it shall be removed immediately via a mechanical street sweeper.

Stabilization Practices:

Stabilization measures shall be implemented as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased, with the following exceptions.

- Where the initiation of stabilization measures by the 14th day after construction activity temporary or permanently cease is precluded by snow cover, stabilization measures shall be initiated as soon as practicable.

- Where construction activity will resume on a portion of the site within 21 days from when activities ceased, (e.g. the total time period that construction activity is temporarily ceased is less than 21 days) then stabilization measures do not have to be initiated on that portion of the site by the 14th day after construction activity temporarily ceased.

1) **Temporary Seeding** – Temporary seeding will allow a short-term vegetative cover on disturbed site areas that may be in danger of erosion. Temporary seeding will be done at stock piles and disturbed portions of the site where construction activity will temporarily cease for at least 21 days. The temporary seeding will stabilize cleared and unvegetated areas that will not be brought into final grade for several weeks or months.

Temporary Seeding Planting Procedures *

a) Planting should preferably be done between April 1st and June 30th, and September 1st through September 31st. If planting is done in the months of July and August, irrigation may be required. If planting is done between October 1st and March 31st, mulching should be applied immediately after planting. If seeding is done during the summer months, irrigation of some sort will probably be necessary.

b) Before seeding, install structural practice controls. Utilize Amoco supergro or equivalent.

c) Select the appropriate seed species for temporary cover from the following table.

Species	Seeding Rate (lbs./1,000 sq.)	Seeding Rate (lbs./acre)	Recommended Seeding Dates	Seed Cover required
Annual Ryegrass	1	40	April 1st to June 1st August 15th to Sept. 15th	¼ inch
Foxtail Millet	0.7	30	May 1st to June 30th	½ to ¾ inch
Oats	2	80	April 1st to July 1st August 15th to Sept. 15th	1 to 1-½ inch
Winter Rye	3	120	August 15th to Oct. 15th	1 to 1-½ inch

Apply the seed uniformly by hydroseeding, broadcasting, or by hand.

d) Use effective mulch, such as clean grain straw; tacked and/or tied with netting to protect seedbed and encourage plant growth.

Temporary Seeding Inspection/Maintenance *

a) Inspect within 6 weeks of planting to see if stands are adequate. Check for damage within 24 hours of the end to a heavy rainfall, defined as a 2-year storm event (i.e., 3.2 inches of rainfall within a twenty-four-hour period). Stands should be uniform and dense. Reseed and mulch damaged and sparse areas immediately. Tack or tie down mulch as necessary.

b) Seeds should be supplied with adequate moisture. Furnish water as needed, especially in abnormally hot or dry weather. Water application rates should be controlled to prevent runoff.

2) **Geotextiles** - Geotextiles such as jute netting will be used in combination with other practices such as mulching to stabilize slopes. The following geotextile materials or equivalent are to be utilized for structural and nonstructural controls as shown in the following table.

Practice	Manufacturer	Product	Remarks
Sediment Fence	Amoco	Woven polypropylene 1198 or equivalent	0.425 mm opening
Construction Entrance	Amoco	Woven polypropylene 2002 or equivalent	0.300 mm opening
Outlet Protection	Amoco	Nonwoven polypropylene 4551 or equivalent	0.150 mm opening
Erosion Control (slope stability)	Amoco	Supergro or equivalent	Erosion control revegetation mix, open polypropylene fiber on degradable

			polypropylene net scrim

Amoco may be reached at (800) 445-7732

Geotextile Installation

a) Netting and matting require firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material.

Geotextile Inspection/Maintenance *

a) In the field, regular inspections should be made to check for cracks, tears, or breaches in the fabric. The appropriate repairs should be made.

3) **Mulching and Netting** – Mulching will provide immediate protection to exposed soils during the period of short construction delays, or over winter months through the application of plant residues, or other suitable materials, to exposed soil areas. In areas, which have been seeded either for temporary or permanent cover, mulching should immediately follow seeding. On steep slopes, mulch must be supplemented with netting. The preferred mulching material is straw.

Mulch (Hay or Straw) Materials and Installation

a) Straw has been found to be one of the most effective organic mulch materials. The specifications for straw are described below, but other material may be appropriate. The straw should be air-dried; free of undesirable seeds & coarse materials. The application rate per 1,000 sq. is 90-100 lbs. (2-3 bales) and the application rate per acre is 2 tons (100-120 bales). The application should cover about 90% of the surface. The use of straw mulch is appropriate where mulch is maintained for more than three months. Straw mulch is subject to wind blowing unless anchored, is the most commonly used mulching material, and has the best microenvironment for germinating seeds.

Mulch Maintenance *

a) Inspect after rainstorms to check for movement of mulch or erosion. If washout, breakage, or erosion occurs, repair surface, reseed, remulch, and install new netting.

b) Straw or grass mulches that blow or wash away should be repaired promptly.

c) If plastic netting is used to anchor mulch, care should be taken during initial mowing to keep the mower height high. Otherwise, the netting can wrap up on the mower blade shafts. After a period of time, the netting degrades and becomes less of a problem.

d) Continue inspections until vegetation is well established.

4) **Land Grading** – Grading on fill slopes, cut slopes, and stockpile areas will be done with full siltation controls in place.

Land Grading Design/Installation Requirements

a) Areas to be graded should be cleared and grubbed of all timber, logs, brush, rubbish, and vegetated matter that will interfere with the grading operation. Topsoil should be stripped and stockpiled for use on critical disturbed areas for establishment of vegetation. Cut slopes to be topsoiled should be thoroughly scarified to a minimum depth of 3-inches prior to placement of topsoil.

b) Fill materials should be generally free of brush, rubbish, rocks, and stumps. Frozen materials or soft and easily compressible materials should not be used in fills intended to support buildings, parking lots, roads, conduits, or other structures.

c) Earth fill intended to support structural measures should be compacted to a minimum of 90 percent of Standard Proctor Test density with proper moisture control, or as otherwise specified by the engineer responsible for the design. Compaction of other fills should be to the density required to control sloughing, erosion or excessive moisture content. Maximum thickness of fill layers prior to compaction should not exceed 9 inches.

d) The uppermost one foot of fill slopes should be compacted to at least 85 percent of the maximum unit weight (based on the modified AASHTO compaction test). This is usually accomplished by running heavy equipment over the fill.

e) Fill should consist of material from borrow areas and excess cut will be stockpiled in areas shown on the Site Plans. All disturbed areas should be free draining, left with a neat and finished appearance, and should be protected from erosion.

Land Grading Stabilization Inspection/Maintenance *

a) All slopes should be checked periodically to see that vegetation is in good condition. Any rills or damage from erosion and animal burrowing should be repaired immediately to avoid further damage.

b) If seeps develop on the slopes, the area should be evaluated to determine if the seep will cause an unstable condition. Subsurface drains or a gravel mulch may be required to solve seep problems. However, no seeps are anticipated.

c) Areas requiring revegetation should be repaired immediately. Control undesirable vegetation such as weeds and woody growth to avoid bank stability problems in the future.

5) **Topsoiling *** – Topsoiling will help establish vegetation on all disturbed areas throughout the site during the seeding process. The soil texture of the topsoil to be used will be a sandy loam to a silt loam texture with 15% to 20% organic content.

Topsoiling Placement

a) Topsoil should not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed seeding.

b) Do not place topsoil on slopes steeper than 2.5:1, as it will tend to erode.

c) If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method is to actually work the topsoil into the layer below for a depth of at least 6 inches.

6) **Permanent Seeding** – Permanent Seeding should be done immediately after the final design grades are achieved. Native species of plants should be used to establish perennial vegetative cover on disturbed areas. The revegetation should be done early enough in the fall so that a good cover is established before cold weather comes and growth stops until the spring. A good cover is defined as vegetation covering 75 percent or more of the ground surface.

Permanent Seeding Seedbed Preparation

a) In infertile or coarse-textured subsoil, it is best to stockpile topsoil and re-spread it over the finished slope at a minimum 2 to 6-inch depth and roll it to provide a firm seedbed. The topsoil must have a sandy loam to silt loam texture with 15% to 20% organic content. If construction fill operations have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll.

b) Loosen the soil to a depth of 3-5 inches with suitable agricultural or construction equipment.

c) Areas not to receive topsoil shall be treated to firm the seedbed after incorporation of the lime and fertilizer so that it is depressed no more than ½ - 1 inch when stepped on with a shoe. Areas to receive topsoil shall not be firmed until after topsoiling and lime and fertilizer is applied and incorporated, at which time it shall be treated to firm the seedbed as described above.

Permanent Seeding Grass Selection/Application

a) Select an appropriate cool or warm season grass based on site conditions and seeding date. Apply the seed uniformly by hydro-seeding, broadcasting, or by hand. Uniform seed distribution is essential. On steep slopes, hydroseeding may be the most effective seeding method. Surface roughening is particularly important when preparing slopes for hydroseeding.

b) Lime and fertilize. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

c) Mulch the seedings with straw applied at the rate of ½ tons per acre. Anchor the mulch with erosion control netting or fabric on sloping areas. Amoco supergro or equivalent should be utilized.

Permanent Seeding Inspection/Maintenance *

a) Frequently inspect seeded areas for failure and make necessary repairs and reseed immediately. Conduct or follow-up survey after one year and replace failed plants where necessary.

b) If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.

c) If a stand has less than 40% cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand following seedbed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results. If the season prevents resowing, mulch or jute netting is an effective temporary cover.

d) Seeded areas should be fertilized during the second growing season. Lime and fertilize thereafter at periodic intervals, as needed. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

Dust Control:

Dust control will be utilized throughout the entire construction process of the site. For example, keeping disturbed surfaces moist during windy periods will be an effective control measure, especially for construction access roads. The use of dust control will prevent the movement of soil to offsite areas. However, care must be taken to not create runoff from excessive use of water to control dust. The following are methods of Dust Control that may be used on-site:

- Vegetative Cover – The most practical method for disturbed areas not subject to traffic.
- Calcium Chloride – Calcium chloride may be applied by mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.
- Sprinkling – The site may be sprinkled until the surface is wet. Sprinkling will be effective for dust control on haul roads and other traffic routes.
- Stone – Stone will be used to stabilize construction roads; will also be effective for dust control.

The general contractor shall employ an on-site water vehicle for the control of dust as necessary.

Non-Stormwater Discharges:

The construction de-watering and all non-stormwater discharges will be directed into a sediment dirt bag (or equivalent inlet protection) or a sediment basin. Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

The developer and site general contractor will comply with the E.P.A.'s Final General Permit for Construction De-watering Discharges, (N.P.D.E.S., Section 402 and 40 C.F.R. 122.26(b) (14) (x).

Inspection/Maintenance:

Operator personnel must inspect the construction site at least once every 14 calendar days and within 24 hours of a storm event of ½-inch or greater. The applicant shall be responsible to secure the services of a design professional or similar professional (inspector) on an on-going basis throughout all phases of the project. Refer to the Inspection/Maintenance Requirements presented earlier in the "Structural and Stabilization Practices." The inspector should review the erosion and sediment controls with respect to the following:

- Whether or not the measure was installed/performed correctly.
- Whether or not there has been damage to the measure since it was installed or performed.
- What should be done to correct any problems with the measure.

The inspector should complete a Stormwater Management Construction Phase BMP Inspection Schedule and Evaluation Checklist for documenting the findings and should request the required maintenance or repair for the pollution prevention measures when the inspector finds that it is necessary for the measure to be effective. The inspector should notify the appropriate person to make the changes and submit copies of the form to the Newburyport Engineering Department.

It is essential that the inspector document the inspection of the pollution prevention measures. These records will be used to request maintenance and repair and to prove that the inspection and maintenance were performed. The forms list each of the measures to be inspected on the site, the inspector's name, the date of the inspection, the condition of the measure/area inspected, maintenance or repair performed and any changes which should be made to the Operation and Maintenance Plan to control or eliminate unforeseen pollution of storm water.

APPENDIX E:

LONG TERM BEST MANAGEMENT PRACTICES O&M PLAN

Long Term Stormwater Best Management Practices Operation and Maintenance Plan

for

3 Boston Way Newburyport, Massachusetts

October 23, 2019
Revised: January 23, 2020

The following operation and maintenance plan has been provided to satisfy the requirements of Standard 9 of the Mass DEP Stormwater Management Handbook associated with development of the site and associated infrastructure. The success of the Stormwater Management Plan depends on the proper implementation, operation and maintenance of several management components. The following procedures shall be implemented to ensure success of the Stormwater Management Plan:

1. The contractor shall comply with the details of construction of the site as shown on the approved plans.
2. The vegetated stormwater management areas, subsurface detention system and water quality units shall be inspected and maintained as indicated below.
3. Effective erosion control measurers during and after construction shall be maintained until a stable turf is established on all altered areas.

Basic Information

Stormwater Management System Owner:	Three Boston Way, LLC 231 Sutton Street North Andover, MA 01845 P: (978) 687-5422
Newburyport Engineering Department:	Department of Public Services 16C Perry Way Newburyport, MA 01950 P: (978) 465-4464
Newburyport Planning Board:	Planning Board 60 Pleasant Street P.O. Box 550 Newburyport, MA 01950 P: (978) 465-4400

Erosion and Sedimentation Controls during Construction:
The site and drainage construction contractor shall be responsible for maintaining the stormwater system during construction. Routine maintenance of all items shall be performed to ensure adequate runoff and pollution control during construction.

A proposed silt fence will be placed downgradient of the work area prior to the commencement of any clearing, grubbing, and earth removal or construction activity. The integrity of the erosion control barrier will be maintained by periodic inspection and replacement as necessary. The erosion control barrier will remain in place until the first course of pavement has been placed and all side slopes have been loamed and seeded and vegetation has been established. A silt sack will also be placed over the new catch basins once constructed.

Operations and maintenance plans for the Stormwater Management construction phase and long term operation of the system have been attached to this report.

General Conditions

1. The developer shall be responsible for scheduling regular inspections and maintenance of the stormwater BMP's. The BMP maintenance shall be conducted as detailed in the following long-term pollution prevention plan and illustrated on the approved design plans:
   "3 Boston Way in Newburyport, Massachusetts", prepared by The Morin-Cameron Group, Inc. dated October 23, 2019 as revised and approved by the Newburyport Planning Board.
2. All Stormwater BMP's shall be operated and maintained in accordance with the design plans and the following Long-Term Pollution Prevention Plan.
3. The owner shall:
   a. Maintain an Operation and Maintenance Log for the last three years. The Log shall include all BMP inspections, repairs, replacement activities and disposal activities (disposal material and disposal location shall be included in the Log);
   b. Make the log available to the Newburyport Engineering Department and Planning Board upon request;
   c. Allow members and agents of the Newburyport Engineering Department and Planning Board to enter the premises and ensure that the Owner has complied with the Operation and Maintenance Plan requirements for each BMP.
4. A recommended inspection and maintenance schedule is outlined below based on statewide averages. This inspection and maintenance schedule shall be adhered to at a minimum for the first year of service of all BMP's referenced in this document. At the commencement of the first year of service, a more accurate inspection/maintenance schedule shall be determined based on the level of service for this site.

Long-Term Pollution Prevention Plan (LTPPP)

Vegetated Areas:

Immediately after construction, monitoring of the erosion control systems shall occur until establishment of natural vegetation. Afterwards, vegetated areas shall be maintained as such. Vegetation shall be replaced as necessary to ensure proper stabilization of the site.

Cost: Included with annual landscaping budget. Consult with local landscape contractors.

Paved Areas:

Sweepers shall sweep paved areas periodically during dry weather to remove excess sediments and to reduce the amount of sediments that the drainage system shall have to remove from the runoff. The sweeping shall be conducted primarily between March 15^{th} and November 15^{th}. Special attention should be made to sweeping paved surfaces in March and April before spring rains wash residual sand into the drainage system.

Cost: $100 - $150 per sweeping

Salt used for de-icing on the driveway during winter months shall be limited as much as possible as this will reduce the need for removal and treatment. Sand containing the minimum amount of calcium chloride (or approved equivalent) needed for handling may be applied as part of the routine winter maintenance activities.

CDS Water Quality Units:

The CDS Water Quality Units shall be inspected after every major storm event for the first 3 months after construction; a major storm event is 3.9 inches of rainfall in a 24-hour period (5 year storm). Thereafter, the system shall be inspected twice per year in April and October. The units shall be cleaned per manufacturer's instructions included herein.

Cost: $50 - $100 per cleaning per unit as needed. The owner shall consult local vacuum cleaning contractors for detailed cost estimates.

Public Safety Concerns: The manhole covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately.

Stormceptor Water Quality Units:

The Stormceptor Water Quality Units shall be inspected after every major storm event for the first 3 months after construction; a major storm event is 3.9 inches of rainfall in a 24-hour period (5 year storm). Thereafter, the system shall be inspected twice per year in April and October. The units shall be cleaned per manufacturer's instructions included herein.

Cost: $50 - $100 per cleaning per unit as needed. The owner shall consult local vacuum cleaning contractors for detailed cost estimates.

Public Safety Concerns: The manhole covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately.

Subsurface Detention System:

The subsurface detention system shall be monitored annually to ensure it is draining properly. The outlet structure shall be checked for debris accumulation twice per year, in the spring and fall. In the case that water remains in the detention system for greater than three (3) days after a storm event, an inspection is warranted and maintenance or repairs should be addressed as necessary. Confirm that the low flow outlet in the outlet structure is not obstructed by debris. The inspections shall be conducted by qualified personnel.

Cost: $500-$5,000 per cleaning depending on the volume of material/liquids that need to be removed.

Public Safety Concerns: Manhole covers or inspection port covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately. At no time shall any person enter the subsurface structure unless measures have been taken to ensure safe access in accordance with OSHA enclosed space regulations.

Grass & Gravel Filter Strip:
The filter strip shall be checked regularly to ensure that the surface is free of debris such as leaves, sticks and trash. Remove and dispose of any debris. If surface ponding is visible, remove top course of stone and accumulated sediment and replace with clean stone. Material removed shall be disposed of in accordance with all applicable local, state, and federal regulations

Cost: $500-$2,500 per cleaning depending on the volume of material/liquids that need to be removed.

Constructed Wetland:
The constructed wetland shall remain free from foreign objects and contamination. During the first growing season, vegetation should be inspected every 2 to 3 weeks. During the first 2 years, the constructed wetland should be inspected at least 4 times per year and after major storms (greater than 2 inches in 24 hours). Inspections should access the vegetation, erosion, flow channelization, bank stability, outlet conditions, and sediment/debris accumulation. Problems should be corrected as soon as possible. Wetland and buffer vegetation may require support – watering, weeding, mulching, replanting, etc. – during the first 3 years. Undesirable species should be removed, and desirable replacements planted, if necessary. Once established, the constructed wetland should require little maintenance aside from regular inspections and removal of litter and debris.

Sediment dredging within the constructed wetland may be required every 10-years depending on use.

Cost: $100-$200 per cleaning of sediment forebay. Consult local pumping companies for costs associated with cleaning of basin if necessary to remove sediment.

Overall Site Grading and Stormwater Management:
After construction, and during the initial vegetation establishment period, the site should be inspected after every rainfall. Mowing, litter removal, and spot vegetation repair should be performed on a regular basis.

Debris & Litter:
All debris and litter shall be removed from the driveway/parking area as necessary to prevent migration into the drainage system.

Pesticides, Herbicides, and Fertilizers:
Pesticides and herbicides shall be used sparingly. Fertilizers shall be restricted to the use of organic, slow release nitrogen fertilizers only. All fertilizers, herbicides, pesticides, sand and salt for deicing and the like shall be stored in dry area that is protected from weather.

Cost: Included in the routine landscaping maintenance schedule. The Owner shall consult local landscaping contractors for details.

Public Safety Concerns: Chemicals shall be stored in a secure area to prevent children from obtaining access to them. Any major spills shall be reported to municipal officials.

Prevention of Illicit Discharges:
Illicit discharges to the stormwater management system are not allowed. Illicit discharges are discharges that are not comprised entirely of stormwater. Pursuant to Mass DEP Stormwater Standards the following activities or facilities are not considered illicit discharges: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, DE chlorinated water from swimming pools, water used for street washing and water used to clean residential building without detergents.

To prevent illicit discharges to the stormwater management system the following policies should be implemented:

1. Provisions For Storing Materials And Waste Products Inside Or Under Cover
2. Vehicle Maintenance And Washing Controls
3. Requirements for Routine Inspections of the Stormwater Management System (i.e.: sediment forebays, constructed stormwater wetland, swales, constructed pocket weltand, CDS & Sotrmceptor water quality units & subsurface and detention systems.)
4. Spill Prevention and Response Plans.

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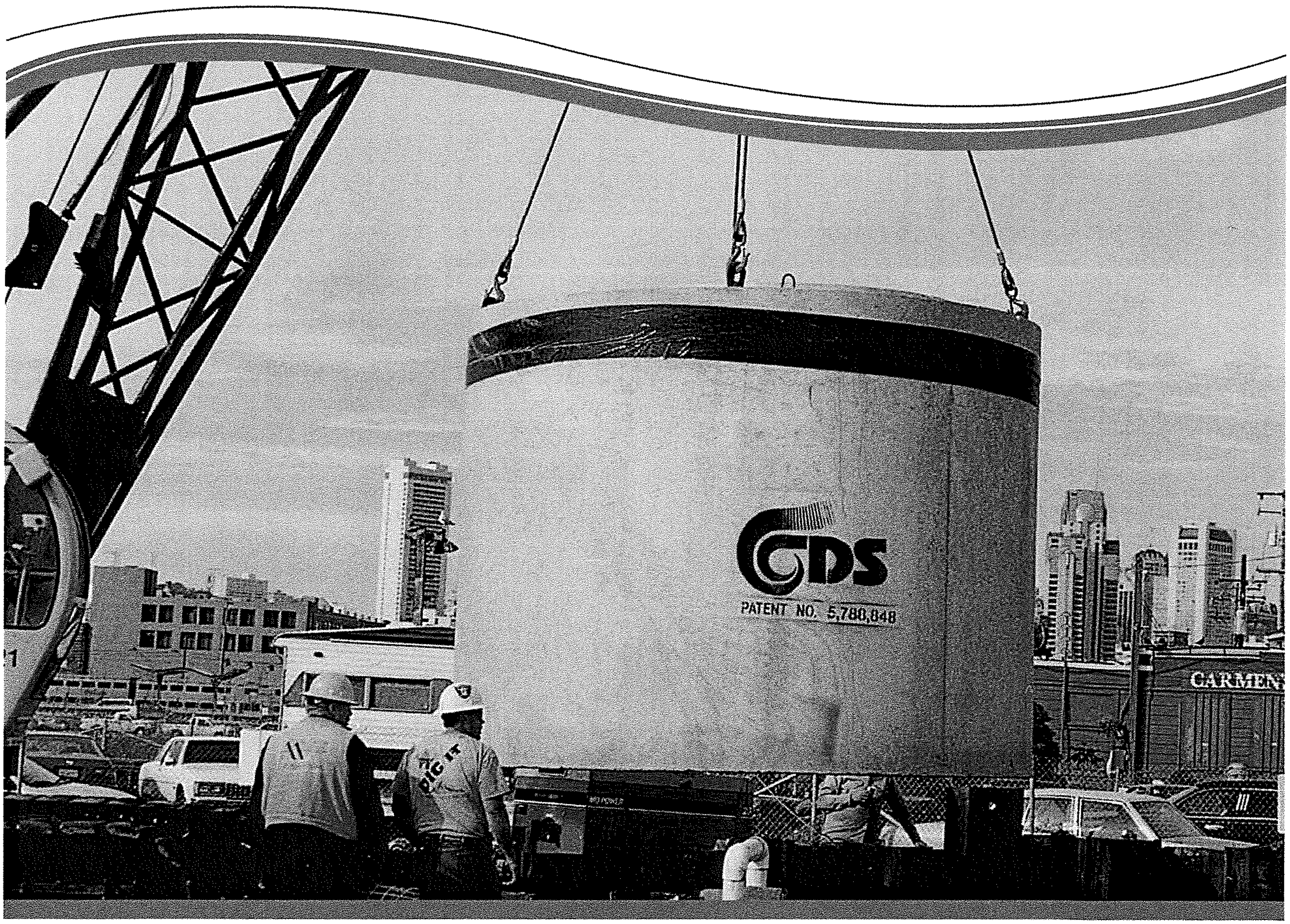
CDS Guide
Operation, Design, Performance and Maintenance



CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

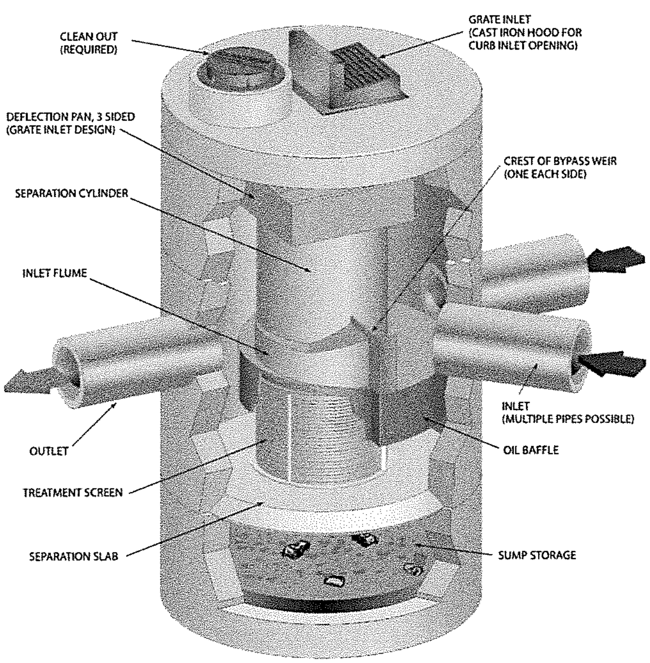
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

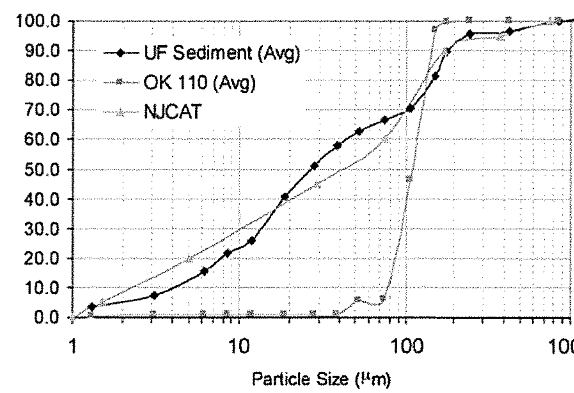


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

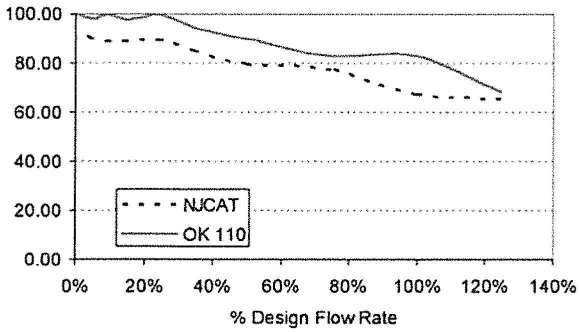


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

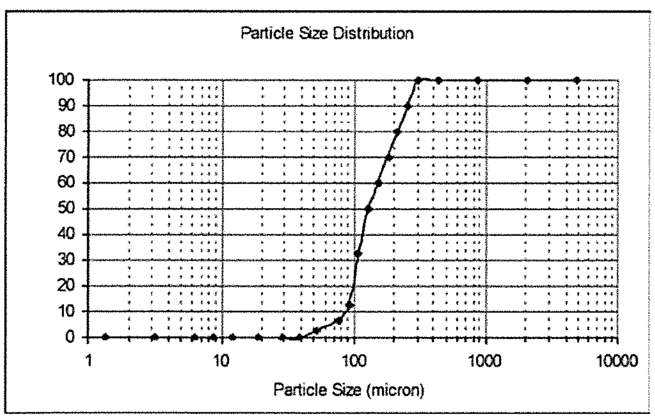


Figure 3. WASDOE PSD

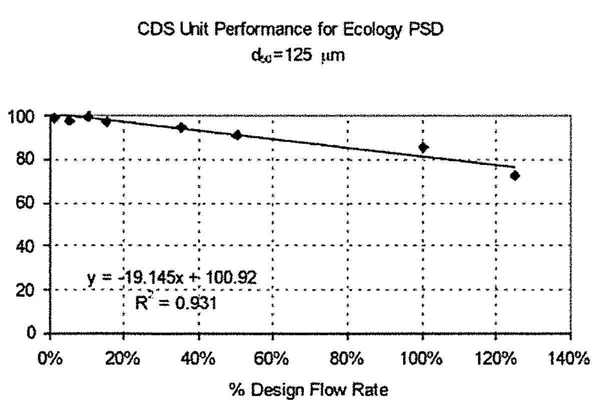


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

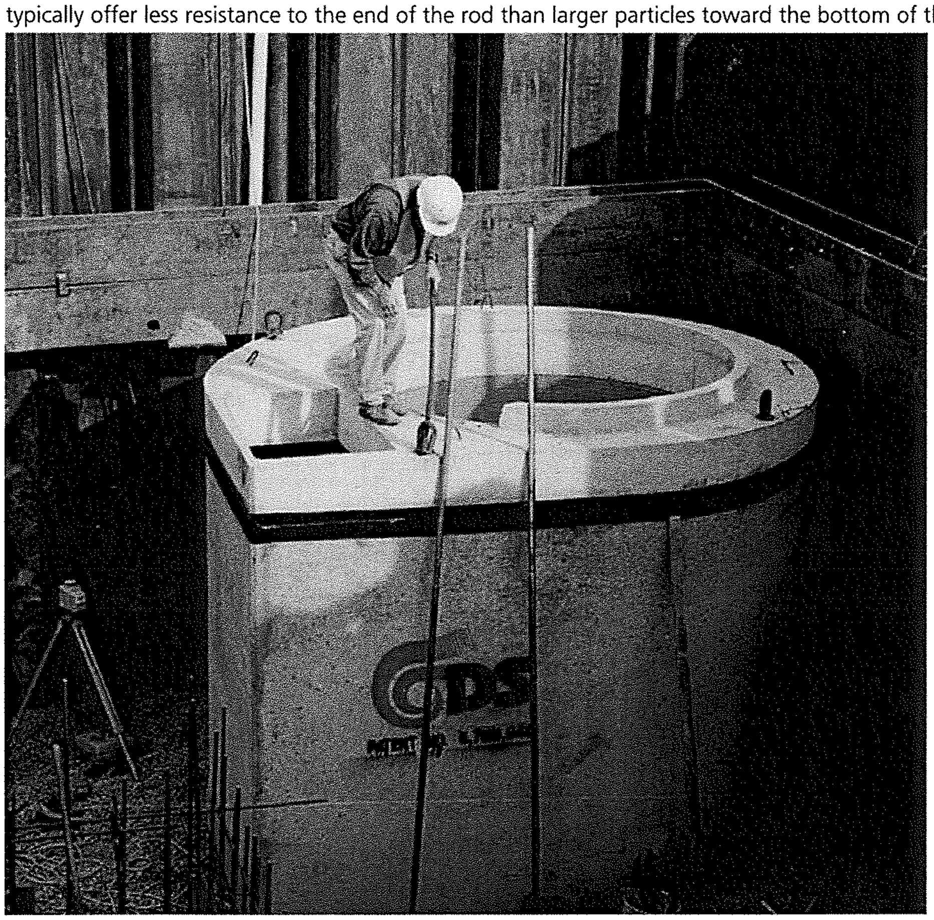
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

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

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Contech Engineered Solutions provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, earth stabilization and stormwater treatment products. For information on other Contech division offerings, visit www.ContechES.com or call 800.338.1122

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CONTECH®
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Stormceptor® STC Owner's Manual

Stormceptor® STC

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For patent information, go to www.ContechES.com/ip.

Your selection of a Stormceptor® means that you have chosen the most recognized and efficient stormwater oil/sediment separator available for protecting the environment. Stormceptor is a pollution control device often referred to as a "Hydrodynamic Separator (HDS)" or an "Oil Grit Separator (OGS)", engineered to remove and retain pollutants from stormwater runoff to protect our lakes, rivers and streams from the harmful effects of non-point source pollution.

1 – Stormceptor Overview

Stormceptor is a patented stormwater quality structure most often utilized as a treatment component of the underground storm drain network for stormwater pollution prevention. Stormceptor is designed to remove sediment, total suspended solids (TSS), other pollutants attached to sediment, hydrocarbons and free oil from stormwater runoff. Collectively the Stormceptor provides spill protection and prevents non-point source pollution from entering downstream waterways.

Key benefits of Stormceptor include:

- Removes sediment, suspended solids, debris, nutrients, heavy metals, and hydrocarbons (oil and grease) from runoff and snowmelt.
- Will not scour or re-suspend trapped pollutants.
- Provides sediment and oil storage.
- Provides spill control for accidents, commercial and industrial developments.
- Easy to inspect and maintain (vacuum truck).
- "STORMCEPTOR" is clearly marked on the access cover (excluding inlet designs).
- Relatively small footprint.
- 3rd Party tested and independently verified.
- Dedicated team of experts available to provide support.

Model Types:

- STC (Standard)
- EOS (Extended Oil Storage)
- OSR (Oil and Sand Removal)
- MAX (Custom designed unit, specific to site)

Configuration Types:

- Inlet unit (accommodates inlet flow entry, and multi-pipe entry)
- In-Line (accommodates multi-pipe entry)
- Submerged Unit (accommodates the site's tailwater conditions)
- Series Unit (combines treatment in two systems)

PLEASE MAINTAIN YOUR STORMCEPTOR

To ensure long-term environmental protection through continued performance as originally designed for your site, Stormceptor must be maintained, as any stormwater treatment practice does. The need for maintenance is determined through inspection of the Stormceptor. Procedures for inspection are provided within this document. Maintenance of the Stormceptor is performed from the surface via vacuum truck.

If you require information about Stormceptor, or assistance in finding resources to facilitate inspections or maintenance of your Stormceptor please call Contech at 1-800-338-1122.

2 – Stormceptor Operation and Components

Stormceptor is a flexibly designed underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention using patented flow separation technology. Stormceptor creates a non-turbulent treatment environment below the insert platform within the system. The insert diverts water into the lower chamber, allowing free oils and debris to rise, and sediment to settle under relatively low velocity conditions. These pollutants are trapped and stored below the insert and protected from large runoff events for later removal during the maintenance procedure.

With thousands of units operating worldwide, Stormceptor delivers reliable protection every day, in every storm. The patented Stormceptor design prohibits the scour and release of captured pollutants, ensuring superior water quality treatment and protection during even the most extreme storm events. Stormceptor's proven performance is backed by the longest record of lab and field verification in the industry.

Stormceptor Schematic and Component Functions

Below are schematics of two common Stormceptor configurations with key components identified and their functions briefly described.

- **Manhole access cover** – provides access to the subsurface components
- **Precast reinforced concrete structure** – provides the vessel's watertight structural support
- **Fiberglass insert** – separates vessel into upper and lower chambers
- **Weir** – directs incoming stormwater and oil spills into the lower chamber
- **Orifice plate** – prevents scour of accumulated pollutants
- **Inlet drop tee** – conveys stormwater into the lower chamber
- **Fiberglass skirt** – provides double-wall containment of hydrocarbons
- **Outlet riser pipe** – conveys treated water to the upper chamber; primary vacuum line access port for sediment removal
- **Oil inspection port** – primary access for measuring oil depth and oil removal
- **Safety grate** – safety measure to cover riser pipe in the event of manned entry into vessel

Figure 1.

Inline Stormceptor

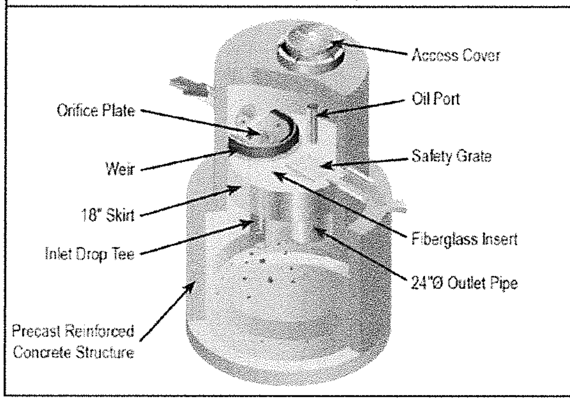
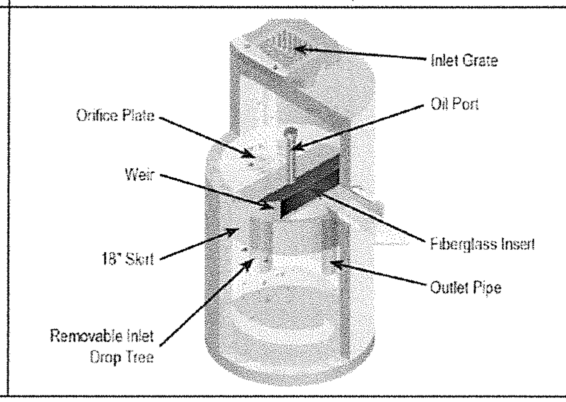


Figure 2.

Inlet Stormceptor



3 – Stormceptor Identification

Stormceptor is available in both precast concrete and fiberglass vessels, with precast concrete often being the dominant material of construction.

In the Stormceptor, a patented, engineered fiberglass insert separates the structure into an upper chamber and lower chamber. The lower chamber will remain full of water, as this is where the pollutants are sequestered for later removal. Multiple Stormceptor model (STC, OSR, EOS and MAX) configurations exist, each to be inspected and maintained in a similar fashion.

Each unit is easily identifiable as a Stormceptor by the trade name "Stormceptor" embossed on each access cover at the surface. To determine the location of "inlet" Stormceptor units with horizontal catch basin inlet, look down into the grate as the Stormceptor insert will be visible. The name "Stormceptor" is not embossed on inlet models due to the variability of inlet grates used/approved across North America.

Once the location of the Stormceptor is determined, the model number may be identified by comparing the measured depth from the fiberglass insert level at the outlet pipe's invert (water level) to the bottom of the tank using Table 1.

In addition, starting in 1996 a metal serial number tag containing the model number has been affixed to the inside of the unit, on the fiberglass insert. If the unit does not have a serial number, or if there is any uncertainty regarding the size of the unit using depth measurements, please contact your local Contech Representative for assistance.

Sizes/Models

Typical general dimensions and capacities of the standard precast STC, EOS and OSR Stormceptor models are provided in Tables 1 and 2. Typical rim to invert measurements are provided later in this document. The total depth for cleaning will be the sum of the depth from outlet pipe invert (generally the water level) to rim (grade) and the depth from outlet pipe invert to the precast bottom of the unit. Note that depths and capacities may vary slightly between regions.

Table 1. Stormceptor Dimensions - Insert to Base of Structure

STC Model	Insert to Base (in.)
450	60
900	55
1200	71
1800	105
2400	94
3600	134
4800	128
6000	150
7200	134
11000*	128
13000*	150
16000*	134

Notes:
1. Depth Below Pipe Inlet Invert to the Inside Top Base Slab can vary slightly by manufacturing facility, and can be modified to accommodate specific site designs, pollutant loads or site conditions. Contact your local representative for assistance.
**Consist of two chamber structures in series.*

Table 2. Storage Capacities

STC Model	Hydrocarbon Storage Capacity (gal)	Sediment Capacity (ft³)
450	86	46
900	251	89
1200	251	127
1800	251	207
2400	840	205
3600	840	373
4800	909	543
6000	909	687
7200	1059	839
11000*	2797	1089
13000*	2797	1374
16000*	3055	1677

Notes:
1. Hydrocarbon and Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.
**Consist of two chamber structures in series*

4 – Stormceptor Inspection and Maintenance

Regular inspection and maintenance is a proven, cost-effective way to maximize water resource protection for all stormwater pollution control practices, and is required to insure proper functioning of the Stormceptor. Both inspection and maintenance of the Stormceptor is easily performed from the surface. Stormceptor's patented technology has no moving parts, simplifying the inspection and maintenance process.

Please refer to the following information and guidelines before conducting inspection and maintenance activities.

When is inspection needed?

- Post-construction inspection is required prior to putting the Stormceptor into service.
- Routine inspections are recommended during the first year of operation to accurately assess the sediment accumulation.
- Inspection frequency in subsequent years is based on the maintenance plan developed in the first year.
- Inspections should also be performed immediately after oil, fuel, or other chemical spills.

When is maintenance cleaning needed?

- For optimum performance, the unit should be cleaned out once the sediment depth reaches the recommended maintenance sediment depth, which is approximately 15% of the unit's total storage capacity (see Table 3). The frequency should be adjusted based on historical inspection results due to variable site pollutant loading.
- Sediment removal is easier when removed on a regular basis at or prior to the recommended maintenance sediment depths, as sediment build-up can compact making removal more difficult.
- The unit should be cleaned out immediately after an oil, fuel or chemical spill.

What conditions can compromise Stormceptor performance?

- If construction sediment and debris is not removed prior to activating the Stormceptor unit, maintenance frequency may be reduced.
- If the system is not maintained regularly and fills with sediment and debris beyond the capacity as indicated in Table 2, pollutant removal efficiency may be reduced.
- If an oil spill(s) exceeds the oil capacity of the system, subsequent spills may not be captured.
- If debris clogs the inlet of the system, removal efficiency of sediment and hydrocarbons may be reduced.
- If a downstream blockage occurs, a backwater condition may occur for the Stormceptor and removal efficiency of sediment and hydrocarbons may be reduced.

What training is required?

The Stormceptor is to be inspected and maintained by professional vacuum cleaning service providers with experience in the maintenance of underground tanks, sewers and catch basins.

For typical inspection and maintenance activities, no specific supplemental training is required

Recommended Stormceptor Inspection Procedure:

- Stormceptor is to be inspected from grade through a standard surface manhole access cover.
- Sediment and oil depth inspections are performed with a sediment probe and oil dipstick.
- Oil depth is measured through the oil inspection port, either a 4-inch or 6-inch diameter port.
- Sediment depth can be measured through the oil inspection port or the 24-inch diameter outlet riser pipe.
- Inspections also involve a visual inspection of the internal components of the system.

What equipment is typically required for maintenance?

- Vacuum truck equipped with water hose and jet nozzle
- Small pump and tubing for oil removal
- Manhole access cover lifting tool
- Oil dipstick / Sediment probe with ball valve (typically ¾-inch to 1-inch diameter)
- Flashlight
- Camera
- Data log / Inspection Report
- Safety cones
- Hard hats, safety shoes, safety glasses, chemical-resistant gloves, and hearing protection for service providers
- Gas analyzer, respiratory gear, hoist and safety harness for specially trained personnel if confined space entry is required

Figure 3.

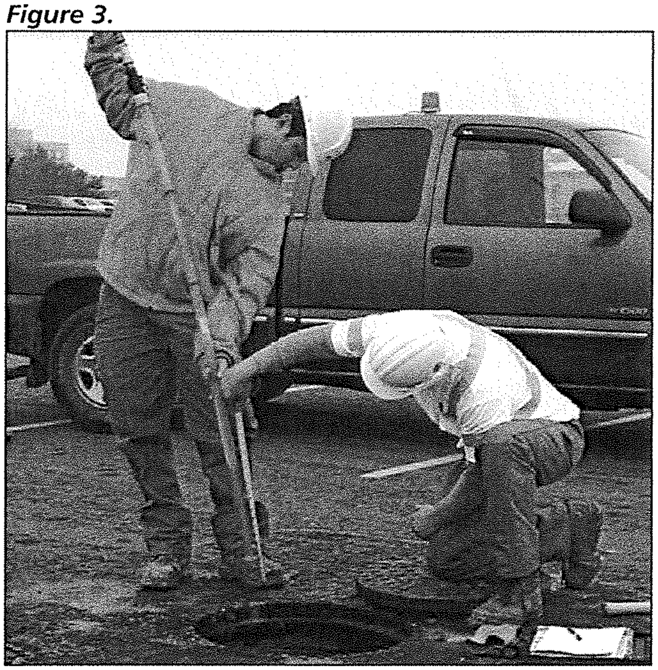
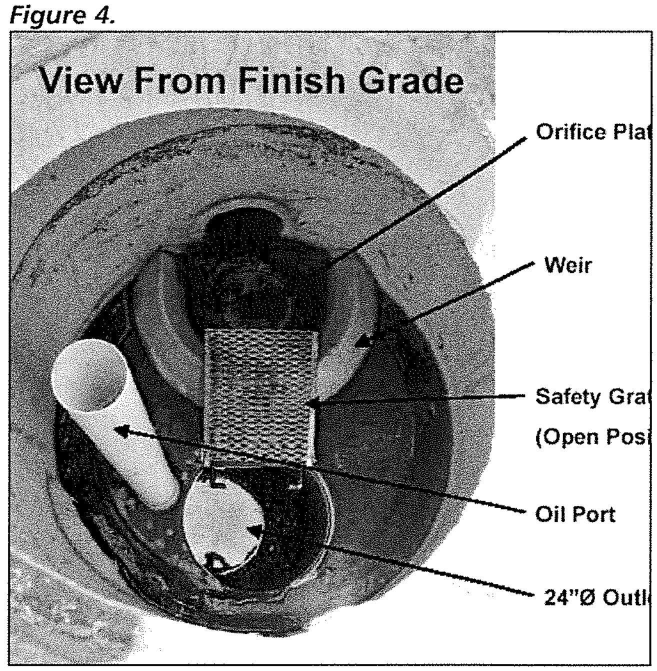


Figure 4.



Recommended Stormceptor Maintenance Procedure

Maintenance of Stormceptor is performed using a vacuum truck. No entry into the unit is required for maintenance. DO NOT ENTER THE STORMCEPTOR CHAMBER unless you have the proper personal safety equipment, have been trained and are qualified to enter a confined space, as identified by local Occupational Safety and Health Regulations (e.g. 29 CFR 1910.146). Without the proper equipment, training and permit, entry into confined spaces can result in serious bodily harm and potentially death. Consult local and/or state regulations to determine the requirements for confined space entry. Be aware, and take precaution that the Stormceptor fiberglass insert may be slippery. In addition, be aware that some units do not have a safety grate to cover the outlet riser pipe that leads to the submerged, lower chamber.

- Ideally maintenance should be conducted during dry weather conditions when no flow is entering the unit.
- Stormceptor is to be maintained through a standard surface manhole access cover.
- Insert the oil dipstick into the oil inspection port. If oil is present, pump off the oil layer into separate containment using a small pump and tubing.
- Maintenance cleaning of accumulated sediment is performed with a vacuum truck.
  - » For 6-ft diameter models and larger, the vacuum hose is inserted into the lower chamber via the 24-inch outlet riser pipe (See Fig. 5).
  - » For 4-ft diameter model, the removable drop tee is lifted out, and the vacuum hose is inserted into the lower chamber via the 12-inch drop tee hole (See Fig. 6).

Figure 5.

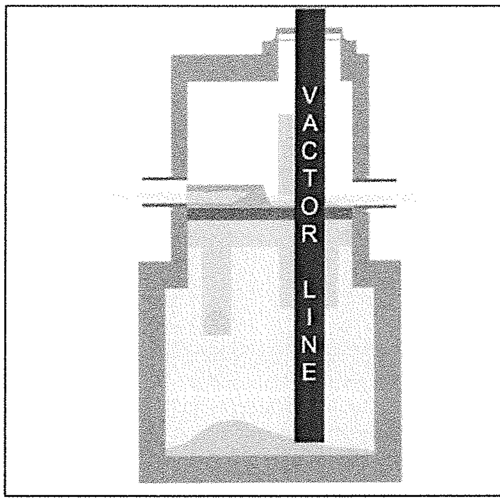
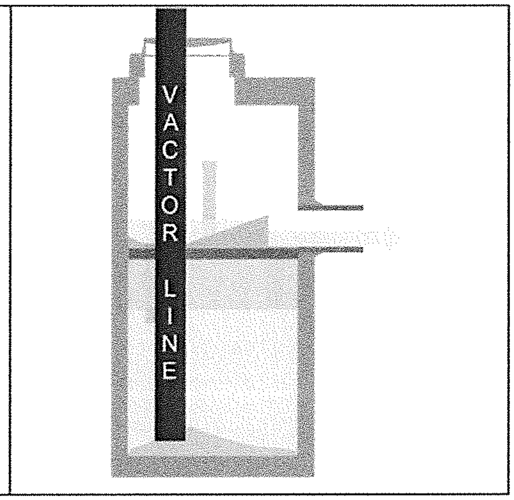


Figure 6.



- Using the vacuum hose, decant the water from the lower chamber into a separate containment tank or to the sanitary sewer, if permitted by the local regulating authority.
- Remove the sediment sludge from the bottom of the unit using the vacuum hose. For large Stormceptor units, a flexible hose is often connected to the primary vacuum line for ease of movement in the lower chamber.
- Units that have not been maintained regularly, have surpassed the maximum recommended sediment capacity, or contain damaged components may require manned entry by trained personnel using safe and proper confined space entry procedures.

What is required for proper disposal?

The requirements for the disposal of material removed from Stormceptor units are similar to that of any other stormwater treatment Best Management Practices (BMP). Local guidelines should be consulted prior to disposal of the separator contents. In most areas the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste. This could be site and pollutant dependent. In some cases, approval from the disposal facility operator/agency may be required.

What about oil spills?

Stormceptor is often implemented in areas where there is high potential for oil, fuel or other hydrocarbon or chemical spills. Stormceptor units should be cleaned immediately after a spill occurs by a licensed liquid waste hauler. You should also notify the appropriate regulatory agencies as required in the event of a spill.

What if I see an oil rainbow or sheen at the Stormceptor outlet?

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a hydrocarbon rainbow or sheen can be seen at very small oil concentrations (< 10 ppm). Stormceptor is effective at removing 95% of free oil, and the appearance of a sheen at the outlet with high influent oil concentrations does not mean unit is not working to this level of removal. In addition, if the influent oil is emulsified, the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified or dissolved oil conditions.

What factors affect the costs involved with inspection/maintenance?

The Vacuum Service Industry for stormwater drainage and sewer systems is a well-established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean Stormceptor units will vary. Inspection and maintenance costs are most often based on unit size, the number of units on a site, sediment/oil/hazardous material loads, transportation distances, tipping fees, disposal requirements and other local regulations.

What factors predict maintenance frequency?

Maintenance frequency will vary with the amount of pollution on your site (number of hydrocarbon spills, amount of sediment, site activity and use, etc.). It is recommended that the frequency of maintenance be increased or reduced based on local conditions. If the sediment load is high from an unstable site or sediment loads transported from upstream catchments, maintenance may be required semi-annually. Conversely once a site has stabilized, maintenance may be required less frequently (for example: two to seven year, site and situation dependent). Maintenance should be performed immediately after an oil spill or once the sediment depth in Stormceptor reaches the value specified in Table 3 based on the unit size.

Table 3. Recommended Sediment Depths Indicating Maintenance

STC Model	Maintenance Sediment Depth (in)
450	8
900	8
1200	10
1800	15
2400	12
3600	17
4800	15
6000	18
7200	15
11000*	17
13000*	20
16000*	17

Notes:
1. The values above are for typical standard units.
** Per structure.*

Replacement parts

Since there are no moving parts during operation in a Stormceptor, broken, damaged, or worn parts are not typically encountered. Therefore, inspection and maintenance activities are generally focused on pollutant removal. However, if replacements parts are necessary, they may be purchased by contacting your local Contech Representative or call 800-338-1122.

The benefits of regular inspection and maintenance are many – from ensuring maximum operation efficiency, to keeping maintenance costs low, to the continued protection of natural waterways – and provide the key to Stormceptor's long and effective service life.

Stormceptor Inspection and Maintenance Log

Stormceptor Model No: ______________________________

Allowable Sediment Depth: ______________________________

Serial Number: ______________________________

Installation Date: ______________________________

Location Description of Unit: ______________________________

Other Comments: ______________________________

5 – Contact Information

Questions regarding the Stormceptor can be addressed by contacting your local Contech representative or by calling 800-338-1122.

SUPPORT

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

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater, and earth stabilization products. For information, visit www.ContechES.com or call 800.338.1122

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

APPENDIX F:

ILLICIT DISCHARGE

COMPLIANCE STATEMENT

Illicit Discharge Compliance Statement

I, Scott P. Cameron, P.E., hereby notify the Newburyport Planning Board that I have not witnessed, nor am aware of any existing illicit discharges at the site known as 3 Boston Way in Newburyport, Massachusetts. I also hereby certify that the development of said property as illustrated on the final plans entitled "Multifamily Site Development Plans in Newburyport, Massachusetts, 3 Boston Way," prepared by The Morin-Cameron Group, Inc. dated October 23, 2019 and as revised and approved by the Newburyport Planning Board and maintenance thereof in accordance with the "Construction Period Pollution Prevention Plan" and "Long-Term Pollution Prevention Plan" prepared by The Morin-Cameron Group, Inc dated October 23, 2019 and as revised and approved by the Newburyport Planning Board will not create any new illicit discharges. There is no warranty implied regarding future illicit discharges that may occur as a result of improper construction or maintenance of the stormwater management system or unforeseen accidents.

Name: Scott P. Cameron, P.E.

Company: The Morin-Cameron Group, Inc.

Title: Owner's Representative

Signature:

Date: 1-23-2020

APPENDIX G:

TSS REMOVAL

CALCULATIONS

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for P1A

Name: 3 Boston Way
Location: 3 Boston Way
Newburyport, MA
County: Essex County
Applicant: Turnpike Redevelopment, LLC

Proj. No.: 3856
Date: 10/23/2019
Revised: 1/23/2020
Computed by: Daniel Powers
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Proprietary Treatment Practice	0.94	1.00	0.94	0.06
Constructed Stormwater Wetland	0.80	0.06	0.05	0.01
	0.00	0.01	0.00	0.01
	0.00	0.01	0.00	0.01
	0.00	0.01	0.00	0.01

Total TSS Removal = 99%

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

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

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for P2B

Name: 3 Boston Way
Location: 3 Boston Way
Newburyport, MA
County: Essex County
Applicant: Turnpike Redevelopment, LLC

Proj. No.: 3856
Date: 10/23/2019
Revised: 1/23/2020
Computed by: Daniel Powers
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Proprietary Treatment Practice	0.96	1.00	0.96	0.04
Constructed Stormwater Wetland	0.80	0.04	0.03	0.01
	0.00	0.01	0.00	0.01
	0.00	0.01	0.00	0.01
	0.00	0.01	0.00	0.01

Total TSS Removal = 99%

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

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

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for P1B

Name: 3 Boston Way
Location: 3 Boston Way
Newburyport, MA
County: Essex County
Applicant: Turnpike Redevelopment, LLC

Proj. No.: 3856
Date: 10/23/2019
Revised: 1/23/2020
Computed by: Daniel Powers
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Constructed Stormwater Wetland	0.80	0.50	0.40	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = 90%

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

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

Mass. Dept. of Environmental Protection

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for P2C

Name: 3 Boston Way
Location: 3 Boston Way
Newburyport, MA
County: Essex County
Applicant: Turnpike Redevelopment, LLC

Proj. No.: 3856
Date: 10/23/2019
Revised: 1/23/2020
Computed by: Daniel Powers
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Vegetated Filter Strip >25 feet	0.10	1.00	0.10	0.90
Drainage Channel	0.00	0.90	0.00	0.90
Constructed Stormwater Wetland	0.80	0.90	0.72	0.18
	0.00	0.18	0.00	0.18
	0.00	0.18	0.00	0.18

Total TSS Removal = 82%

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

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

Project:	**3 Boston Way**	
Location:	**Newburyport, MA**	**CONTECH ENGINEERED SOLUTIONS**
Prepared For:	**Morin-Cameron Group**	

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

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

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

Compute Q Rate using the following equation:

Q = (qu) (A) (WQV)

where:

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

Structure Name	Impv. (acres)	A ($miles^2$)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
WQS-1	0.31	0.0004886	3.1	0.052	1.00	831.00	0.41
WQS-2	0.09	0.0001441	2.4	0.040	1.00	835.00	0.12
WQS-3	0.02	0.0000388	1.0	0.017	1.00	835.00	0.03

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

3 BOSTON WAY
NEWBURYPORT, MA

Area	0.31 ac	Unit Site Designation	WQS-1
Weighted C	0.9	Rainfall Station #	67
t_c	3 min		
CDS Model	2015-4	CDS Treatment Capacity	**1.4 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.08	41.0%	41.0%	0.02	0.02	39.5
0.16	23.9%	64.9%	0.05	0.05	22.7
0.24	11.5%	76.5%	0.07	0.07	10.8
0.32	7.4%	83.9%	0.09	0.09	6.9
0.40	4.4%	88.3%	0.11	0.11	4.1
0.48	2.9%	91.2%	0.14	0.14	2.6
0.56	1.8%	93.0%	0.16	0.16	1.6
0.64	1.2%	94.2%	0.18	0.18	1.0
0.72	1.6%	95.8%	0.20	0.20	1.4
0.80	0.8%	96.6%	0.23	0.23	0.7
1.00	0.6%	97.1%	0.28	0.28	0.5
1.40	1.4%	98.6%	0.39	0.39	1.1
1.80	0.9%	99.5%	0.51	0.51	0.7
2.20	0.5%	100.0%	0.62	0.62	0.3
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					93.9

Removal Efficiency Adjustment[2] = 0.0%

Predicted % Annual Rainfall Treated = 100.0%

Predicted Net Annual Load Removal Efficiency = 93.9%

1 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA

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

Stormceptor®

CONTECH
ENGINEERED SOLUTIONS
A QUIKRETE COMPANY

Brief Stormceptor Sizing Report - WQS-2

Project Information & Location			
Project Name	3 Boston Way	Project Number	637025
City	Newburyport	State/ Province	Massachusetts
Country	United States of America	Date	1/6/2020
Designer Information		EOR Information (optional)	
Name	David Adams	Name	
Company	Contech	Company	Morin-Cameron
Phone #	207-885-6191	Phone #	
Email	dadams@conteches.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	WQS-2
Target TSS Removal (%)	80
TSS Removal (%) Provided	96
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	96
STC 900	98
STC 1200	98
STC 1800	98
STC 2400	99
STC 3600	99
STC 4800	99
STC 6000	99
STC 7200	100
STC 11000	100
STC 13000	100
STC 16000	100
StormceptorMAX	Custom

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A QUIKRETE® COMPANY

Sizing Details

Drainage Area	
Total Area (acres)	0.09
Imperviousness %	100.0

Rainfall	
Station Name	ROCKPORT 1 ESE
State/Province	Massachusetts
Station ID #	6977
Years of Records	36
Latitude	42°39'0"N
Longitude	70°36'0"W

Water Quality Objective	
TSS Removal (%)	80.0
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)	0.00000

Particle Size Distribution (PSD) The selected PSD defines TSS removal		
OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	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

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A QUIKRETE® COMPANY

Brief Stormceptor Sizing Report - WQS-3

Project Information & Location			
Project Name	3 Boston Way	Project Number	637025
City	Newburyport	State/ Province	Massachusetts
Country	United States of America	Date	1/6/2020
Designer Information		EOR Information (optional)	
Name	David Adams	Name	
Company	Contech	Company	Morin-Cameron
Phone #	207-885-6191	Phone #	
Email	dadams@conteches.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	WQS-3
Target TSS Removal (%)	80
TSS Removal (%) Provided	99
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	99
STC 900	99
STC 1200	99
STC 1800	100
STC 2400	100
STC 3600	100
STC 4800	100
STC 6000	100
STC 7200	100
STC 11000	100
STC 13000	100
STC 16000	100
StormceptorMAX	Custom

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A QUIKRETE COMPANY

Sizing Details

Drainage Area	
Total Area (acres)	0.02
Imperviousness %	100.0

Rainfall	
Station Name	ROCKPORT 1 ESE
State/Province	Massachusetts
Station ID #	6977
Years of Records	36
Latitude	42°39'0"N
Longitude	70°36'0"W

Water Quality Objective	
TSS Removal (%)	80.0
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		
OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	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