Applicant:
Artis Senior Living LLC
1651 Old Meadow Road
Mclean, VA 22102

Hayes Engineering, Inc

Stormwater Report
1090-1100 Main St
Reading, Massachusetts

May 29, 2013

MITIGATIVE DRAINAGE ANALYSIS AND STORMWATER REPORT
ARTIS SENIOR HOUSING
MAIN STREET
READING, MASSACHUSETTS

May 29, 2013

In conjunction with designing the drainage system for the Artis Senior Living project at 1090-1100 Main Street in Reading, Massachusetts, the following Stormwater Report has been prepared.

Project Description

The scope of the project is to remove the existing buildings and paved areas, and construct a new 21,000 square-foot building with a parking area for thirty six (36) cars and associated walks and fire lanes, as shown on the plans.

Standard 1: No New Untreated Discharges

The new discharges will consist of only treated stormwater from the parking lot, and overflow from the recharge structure which is clean roof runoff and runoff from the courtyard area which will be landscaped area and walks. The three discharges are to be onto six-foot long level spreaders. Velocity calculations are included in the BMP section of this report. The discharge velocities for the 10-year storm are suitable for discharge onto a grass surface.

Standard 2: Peak Rate Attenuation

This project is a redevelopment of an existing garden center with buildings, greenhouses and large paved areas. Much of the area that is not paved is hard-packed gravel. The proposed use of the site will result in a substantial reduction in impervious area and removal of the hard-packed gravel area which is nearly impervious. This reduction in impervious area results in the decrease in rate and volume of runoff that is reflected in the summary table.

The subject site is divided into two major watersheds. One watershed drains into the on-site pond and the other watershed drains into the northerly wetland area downstream of the on-site pond. The watersheds are both depicted on the existing and proposed watershed maps which are included in this report.

The runoff computations for this project were all conducted utilizing the HydroCAD Stormwater Modeling System by HydroCAD Software Solutions, LLC. The methodology used is based on TR-55 and TR-20 as developed by the Soil Conservation Service of the USDA.

Runoff curve numbers and concentration times were calculated for each sub-watershed in the existing and proposed condition. A computer model for both conditions was then created using the software program. Schematics of the models are included at the beginning of the respective (existing vs. proposed) sections of this report.

Included in the proposed design is the creation of a man-made subsurface stormwater management basin through which the runoff from the roof is routed.

To comply with the DEP Stormwater Management Policy and local regulations, the 2, 10, 25 and 100-year, Type III, 24-hour storms have been studied.

There are two (2) sets of calculations: the existing and the proposed. Each calculation set includes: 1) summary sheets for each watershed and link; and 2) detailed summary sheets including flood routing for the stormwater management basin for the 2-year design storm. For the 10, 25 and 100-year storms, a summary of each watershed, link, and pond is included.

The results of the calculations indicate that there is a decrease in peak rate and volume of runoff from the site for all storms studied.

Standard 3: Recharge

The Massachusetts Department of Environmental Protection Stormwater Management Policy also requires projects to be designed such that the annual groundwater recharge after development approximates pre-development recharge.

This standard is presumed met when a specific volume of runoff from the proposed impervious areas is infiltrated into the ground. Hydrologic group "B" soils require 0.35 inches of runoff (over the proposed impervious area) to be infiltrated every storm.

The soil types and hydrologic soil groups were determined using the Web Soil Survey from the National Cooperative Soil Survey for Middlesex County. The majority of the site consists of Udorthents-Urban Land Complex. Since that soil type is not rated for a hydrologic soil group, we looked at the surrounding soil types, which were all rated "B".

Since there is a reduction in impervious area, there would be an increase in on-site recharge so that no artificial recharge would be necessary. The design does, however, propose recharging a portion of the runoff from the roof. Because of grading restrictions, it was impossible to maintain the required two-foot separation from groundwater. Since the runoff is from the roof and is presumed clean, the separation really is not an issue.

The infiltration basin was designed using the "static" method, sizing the basin to store the entire recharge volume with no allowances for exfiltration. The time required to drain was calculated based on the Rawls rate for sandy loam of 1.02 inch/hour. The required calculations are included in the BMP section of this report.

Standard 4: Water Quality

In order to address the issue of water quality, the drainage system has been designed to conform to the Department of Environmental Protection's Stormwater Management Policy. The system includes deep sump catch basins with gas traps and a Stormceptor STP 450i.

The DEP has assigned presumed total suspended solids (TSS) removal rates for each of these types of Best Management Practices (BMPs). The catch basins are rated to remove 25%. The Stormceptor is rated by the manufacturer's software to remove 80%, for a total of 85%.

The subsurface infiltration structure is treating rooftop runoff which is already presumed clean.

The water quality volume calculations are included in the BMP section of this report.

Standard 5: Land Use with Higher Potential Pollutant Loads

The project does not include any "Land Use with Higher Potential Pollutant Loads".

Standard 6: Critical Areas

The stormwater system does not discharge into a critical area.

Standard 7: Redevelopment

The project does meet the definition of a Redevelopment, although every attempt has still been made to comply with relevant Stormwater Standards.

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

Included in report.

Standard 9: Operation and Maintenance Plan

Included in report.

Standard 10: Prohibition of Illicit Discharges

Included in report.

CONTENTS

- Summary Table
- Existing HydroCAD Calcs
- Proposed HydroCAD Calcs
- BMP Data
- Soils Data
- Checklist for Stormwater Report
- Checklist for Redevelopment
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- Construction Period Pollution Prevention & Erosion and Sedimentation Control Plan
- Watershed Maps

SUMMARY TABLE

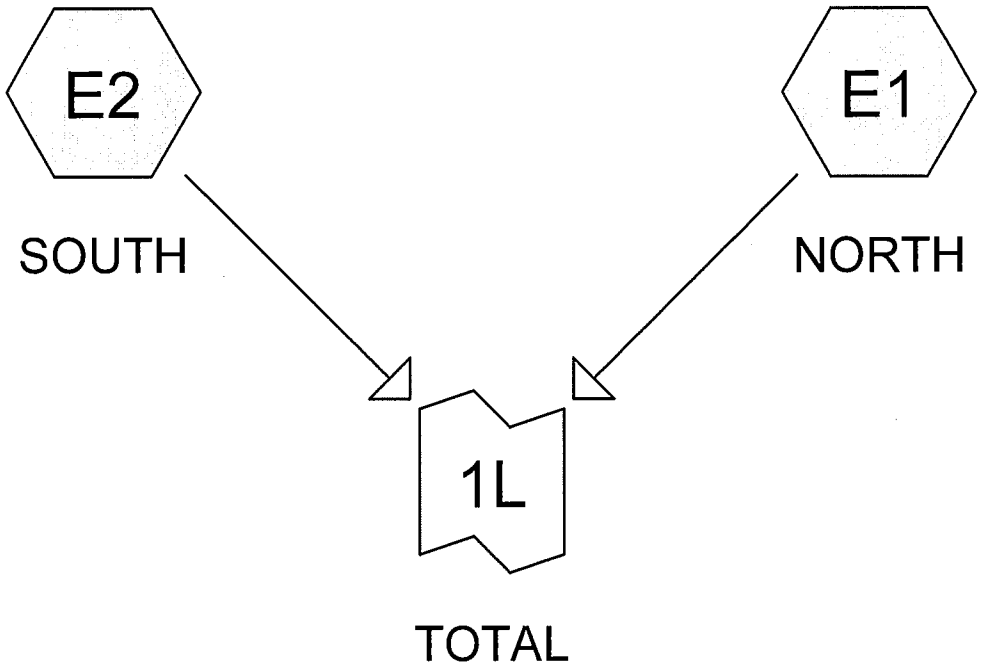
RUNOFF COMPARISON

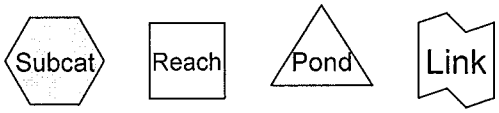
		EXISTING		PROPOSED	
W.S.	STORM	Q	VOL	Q	VOL
NORTH	2YR	0.93	3,071	0.42	2,167
	10YR	1.71	5,627	1.24	5,109
	25YR	2.18	7,181	1.78	7,082
	100YR	2.88	9,589	2.65	10,315
SOUTH	2YR	4.57	16,759	2.90	11,030
	10YR	7.92	29,149	5.27	20,128
	25YR	9.87	36,536	6.70	25,740
	100YR	12.80	47,855	8.88	34,527
TOTAL	2YR	5.47	19,831	3.32	13,197
	10YR	9.58	34,776	6.49	25,237
	25YR	11.98	43,718	8.46	32,823
	100YR	15.60	57,444	11.52	44,842

HydroCAD Calculations

EXISTING CONDITIONS

EXISTING RUNOFF





Routing Diagram for REA387E
Prepared by Hayes Engineering, Inc., Printed 5/28/2013
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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
39,510	61	>75% Grass cover, Good, HSG B (E1, E2)
26,300	96	Gravel surface, HSG B (E1, E2)
3,860	98	O.S. Paved parking, HSG B (E2)
800	98	O.S. Roofs, HSG B (E2)
1,040	98	O.S. WALKS, HSG B (E2)
49,220	98	Paved parking, HSG B (E1, E2)
14,410	98	Roofs, HSG B (E1, E2)
11,600	55	Woods, Good, HSG B (E1, E2)
146,740	**84**	**TOTAL AREA**

Summary for Subcatchment E1: NORTH

Runoff = 0.93 cfs @ 12.10 hrs, Volume= 3,071 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

Area (sf)	CN	Description
7,050	98	Roofs, HSG B
4,100	98	Paved parking, HSG B
3,350	96	Gravel surface, HSG B
10,000	61	>75% Grass cover, Good, HSG B
2,000	55	Woods, Good, HSG B
26,500	81	Weighted Average
15,350		57.92% Pervious Area
11,150		42.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.4	50	0.1000	0.19		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
0.1	25	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	65	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	25	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	25	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.6	190	Total			

Summary for Subcatchment E2: SOUTH

Runoff = 4.57 cfs @ 12.13 hrs, Volume= 16,759 cf, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

	Area (sf)	CN	Description
	7,360	98	Roofs, HSG B
*	800	98	O.S. Roofs, HSG B
	45,120	98	Paved parking, HSG B
*	3,860	98	O.S. Paved parking, HSG B
*	1,040	98	O.S. WALKS, HSG B
	22,950	96	Gravel surface, HSG B
	29,510	61	>75% Grass cover, Good, HSG B
	9,600	55	Woods, Good, HSG B
	120,240	85	Weighted Average
	62,060		51.61% Pervious Area
	58,180		48.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	100	0.1000	0.22		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
0.3	110	0.0800	5.74		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	40	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	80	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	160	0.0120	5.38	4.23	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
9.2	490	Total			

Summary for Link 1L: TOTAL

Inflow Area = 146,740 sf, 47.25% Impervious, Inflow Depth = 1.62" for 2 Year event
Inflow = 5.47 cfs @ 12.13 hrs, Volume= 19,831 cf
Primary = 5.47 cfs @ 12.13 hrs, Volume= 19,831 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentE1: NORTH Runoff Area=26,500 sf 42.08% Impervious Runoff Depth=2.55"
Flow Length=190' Tc=5.6 min CN=81 Runoff=1.71 cfs 5,627 cf

SubcatchmentE2: SOUTH Runoff Area=120,240 sf 48.39% Impervious Runoff Depth=2.91"
Flow Length=490' Tc=9.2 min CN=85 Runoff=7.92 cfs 29,149 cf

Link 1L: TOTAL Inflow=9.58 cfs 34,776 cf
Primary=9.58 cfs 34,776 cf

Total Runoff Area = 146,740 sf Runoff Volume = 34,776 cf Average Runoff Depth = 2.84"
52.75% Pervious = 77,410 sf 47.25% Impervious = 69,330 sf

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentE1: NORTH Runoff Area=26,500 sf 42.08% Impervious Runoff Depth=3.25"
Flow Length=190' Tc=5.6 min CN=81 Runoff=2.18 cfs 7,181 cf

SubcatchmentE2: SOUTH Runoff Area=120,240 sf 48.39% Impervious Runoff Depth=3.65"
Flow Length=490' Tc=9.2 min CN=85 Runoff=9.87 cfs 36,536 cf

Link 1L: TOTAL Inflow=11.98 cfs 43,718 cf
Primary=11.98 cfs 43,718 cf

Total Runoff Area = 146,740 sf Runoff Volume = 43,718 cf Average Runoff Depth = 3.58"
52.75% Pervious = 77,410 sf 47.25% Impervious = 69,330 sf

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentE1: NORTH Runoff Area=26,500 sf 42.08% Impervious Runoff Depth=4.34"
Flow Length=190' Tc=5.6 min CN=81 Runoff=2.88 cfs 9,589 cf

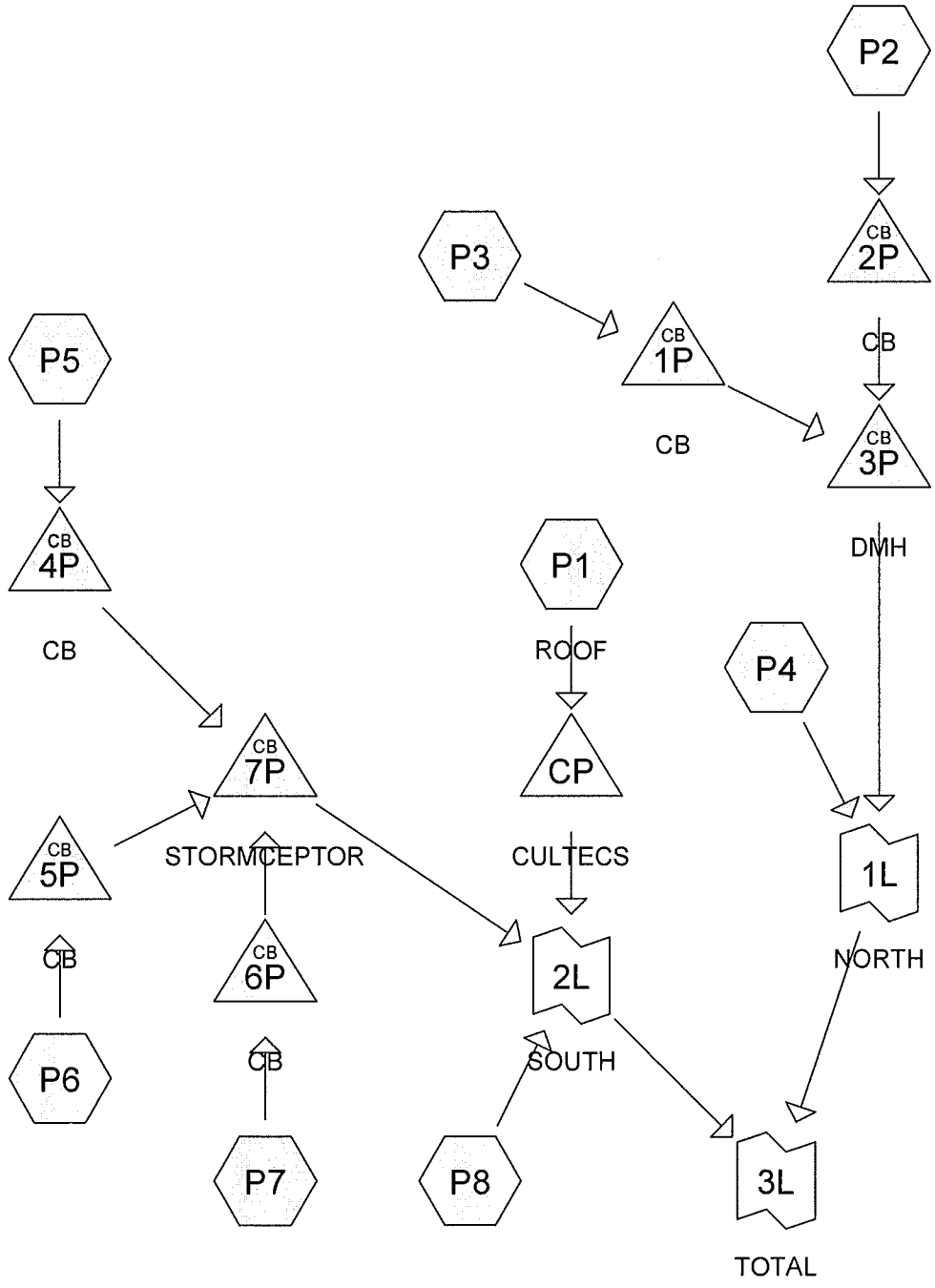
SubcatchmentE2: SOUTH Runoff Area=120,240 sf 48.39% Impervious Runoff Depth=4.78"
Flow Length=490' Tc=9.2 min CN=85 Runoff=12.80 cfs 47,855 cf

Link 1L: TOTAL Inflow=15.60 cfs 57,444 cf
Primary=15.60 cfs 57,444 cf

Total Runoff Area = 146,740 sf Runoff Volume = 57,444 cf Average Runoff Depth = 4.70"
52.75% Pervious = 77,410 sf 47.25% Impervious = 69,330 sf

PROPOSED CONDITIONS

PROPOSED RUNOFF



Subcat Reach Pond Link

Routing Diagram for REA387P
Prepared by Hayes Engineering, Inc., Printed 5/28/2013
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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
80,230	61	>75% Grass cover, Good, HSG B (P2, P3, P4, P5, P6, P7, P8)
3,860	98	O.S. Paved parking, HSG B (P5)
800	98	O.S. Roofs, HSG B (P5)
1,040	98	O.S. WALKS, HSG B (P2, P5)
520	98	PADS, HSG B (P6)
17,190	98	Paved parking, HSG B (P4, P6, P7)
21,590	98	Roofs, HSG B (P1, P2, P7, P8)
11,510	98	WALKS, HSG B (P2, P3, P5, P6, P7, P8)
10,000	55	Woods, Good, HSG B (P4, P8)
146,740	**75**	**TOTAL AREA**

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	1P	106.70	106.48	25.0	0.0088	0.012	8.0	0.0	0.0
2	2P	107.00	106.48	172.0	0.0030	0.012	8.0	0.0	0.0
3	3P	106.48	106.25	76.0	0.0030	0.012	10.0	0.0	0.0
4	4P	107.00	106.25	166.0	0.0045	0.012	10.0	0.0	0.0
5	5P	106.40	106.25	28.0	0.0054	0.012	12.0	0.0	0.0
6	6P	106.40	106.25	13.0	0.0115	0.012	12.0	0.0	0.0
7	7P	106.00	105.79	60.0	0.0035	0.012	15.0	0.0	0.0

Summary for Subcatchment P1: ROOF

Runoff = 1.24 cfs @ 12.09 hrs, Volume= 4,601 cf, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

Area (sf)	CN	Description
19,250	98	Roofs, HSG B
19,250		100.00% Impervious Area

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

Summary for Subcatchment P2:

Runoff = 0.21 cfs @ 12.23 hrs, Volume= 1,041 cf, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

	Area (sf)	CN	Description
	700	98	Roofs, HSG B
*	1,580	98	WALKS, HSG B
*	520	98	O.S. WALKS, HSG B
	18,260	61	>75% Grass cover, Good, HSG B
	21,060	66	Weighted Average
	18,260		86.70% Pervious Area
	2,800		13.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.0	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.8	75	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.8	125	Total			

Summary for Subcatchment P3:

Runoff = 0.13 cfs @ 12.12 hrs, Volume= 515 cf, Depth= 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

	Area (sf)	CN	Description
*	1,500	98	WALKS, HSG B
	8,220	61	>75% Grass cover, Good, HSG B
	9,720	67	Weighted Average
	8,220		84.57% Pervious Area
	1,500		15.43% Impervious Area

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

Summary for Subcatchment P4:

Runoff = 0.14 cfs @ 12.13 hrs, Volume= 611 cf, Depth= 0.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

Area (sf)	CN	Description
1,620	98	Paved parking, HSG B
9,660	61	>75% Grass cover, Good, HSG B
2,000	55	Woods, Good, HSG B
13,280	65	Weighted Average
11,660		87.80% Pervious Area
1,620		12.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	80	0.1000	0.21		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"

Summary for Subcatchment P5:

Runoff = 0.39 cfs @ 12.14 hrs, Volume= 1,549 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

	Area (sf)	CN	Description
*	800	98	O.S. Roofs, HSG B
*	3,860	98	O.S. Paved parking, HSG B
*	900	98	WALKS, HSG B
*	520	98	O.S. WALKS, HSG B
	18,040	61	>75% Grass cover, Good, HSG B
	24,120	70	Weighted Average
	18,040		74.79% Pervious Area
	6,080		25.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	100	0.1000	0.22		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
0.3	110	0.0800	5.74		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	35	0.2000	3.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.1	245	Total			

Summary for Subcatchment P6:

Runoff = 0.64 cfs @ 12.11 hrs, Volume= 2,130 cf, Depth= 1.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

	Area (sf)	CN	Description
*	1,340	98	WALKS, HSG B
*	520	98	PADS, HSG B
	8,190	98	Paved parking, HSG B
	10,200	61	>75% Grass cover, Good, HSG B
	20,250	79	Weighted Average
	10,200		50.37% Pervious Area
	10,050		49.63% Impervious Area

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

Summary for Subcatchment P7:

Runoff = 0.82 cfs @ 12.10 hrs, Volume= 2,704 cf, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

	Area (sf)	CN	Description
	820	98	Roofs, HSG B
*	4,390	98	WALKS, HSG B
	7,380	98	Paved parking, HSG B
	4,420	61	>75% Grass cover, Good, HSG B
	17,010	88	Weighted Average
	4,420		25.98% Pervious Area
	12,590		74.02% Impervious Area

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

Summary for Subcatchment P8:

Runoff = 0.16 cfs @ 12.24 hrs, Volume= 873 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Type III 24-hr 2 Year Rainfall=3.10"

	Area (sf)	CN	Description
	820	98	Roofs, HSG B
*	1,800	98	WALKS, HSG B
	11,430	61	>75% Grass cover, Good, HSG B
	8,000	55	Woods, Good, HSG B
	22,050	63	Weighted Average
	19,430		88.12% Pervious Area
	2,620		11.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0300	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"

Summary for Pond 1P: CB

Inflow Area = 9,720 sf, 15.43% Impervious, Inflow Depth = 0.64" for 2 Year event
Inflow = 0.13 cfs @ 12.12 hrs, Volume= 515 cf
Outflow = 0.13 cfs @ 12.12 hrs, Volume= 515 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.13 cfs @ 12.12 hrs, Volume= 515 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 106.93' @ 12.22 hrs
Flood Elev= 108.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	106.70'	**8.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 106.70' / 106.48' S= 0.0088 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf

Primary OutFlow Max=0.09 cfs @ 12.12 hrs HW=106.92' TW=106.82' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.09 cfs @ 1.28 fps)

Summary for Pond 2P: CB

Inflow Area = 21,060 sf, 13.30% Impervious, Inflow Depth = 0.59" for 2 Year event
Inflow = 0.21 cfs @ 12.23 hrs, Volume= 1,041 cf
Outflow = 0.21 cfs @ 12.23 hrs, Volume= 1,041 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.21 cfs @ 12.23 hrs, Volume= 1,041 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 107.34' @ 12.24 hrs
Flood Elev= 108.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	107.00'	**8.0" Round Culvert** L= 172.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 107.00' / 106.48' S= 0.0030 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf

Primary OutFlow Max=0.20 cfs @ 12.23 hrs HW=107.33' TW=106.84' (Dynamic Tailwater)
↑—**1=Culvert** (Outlet Controls 0.20 cfs @ 1.64 fps)

Summary for Pond 3P: DMH

Inflow Area = 30,780 sf, 13.97% Impervious, Inflow Depth = 0.61" for 2 Year event
Inflow = 0.30 cfs @ 12.21 hrs, Volume= 1,556 cf
Outflow = 0.30 cfs @ 12.21 hrs, Volume= 1,556 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.30 cfs @ 12.21 hrs, Volume= 1,556 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 106.84' @ 12.21 hrs
Flood Elev= 110.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	106.48'	**10.0" Round Culvert** L= 76.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 106.48' / 106.25' S= 0.0030 '/' Cc= 0.900 n= 0.012, Flow Area= 0.55 sf

Primary OutFlow Max=0.30 cfs @ 12.21 hrs HW=106.84' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.30 cfs @ 1.95 fps)

Summary for Pond 4P: CB

Inflow Area = 24,120 sf, 25.21% Impervious, Inflow Depth = 0.77" for 2 Year event
Inflow = 0.39 cfs @ 12.14 hrs, Volume= 1,549 cf
Outflow = 0.39 cfs @ 12.14 hrs, Volume= 1,549 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.39 cfs @ 12.14 hrs, Volume= 1,549 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 107.39' @ 12.17 hrs
Flood Elev= 108.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	107.00'	**10.0" Round Culvert** L= 166.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 107.00' / 106.25' S= 0.0045 '/' Cc= 0.900 n= 0.012, Flow Area= 0.55 sf

Primary OutFlow Max=0.34 cfs @ 12.14 hrs HW=107.38' TW=106.75' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.34 cfs @ 2.06 fps)

Summary for Pond 5P: CB

Inflow Area =	20,250 sf, 49.63% Impervious, Inflow Depth = 1.26" for 2 Year event				
Inflow =	0.64 cfs @	12.11 hrs, Volume=	2,130 cf		
Outflow =	0.64 cfs @	12.11 hrs, Volume=	2,130 cf, Atten= 0%, Lag= 0.0 min		
Primary =	0.64 cfs @	12.11 hrs, Volume=	2,130 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 106.91' @ 12.17 hrs
Flood Elev= 108.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	106.40'	**12.0" Round Culvert** L= 28.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 106.40' / 106.25' S= 0.0054 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.34 cfs @ 12.11 hrs HW=106.87' TW=106.80' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.34 cfs @ 1.37 fps)

Summary for Pond 6P: CB

Inflow Area =	17,010 sf, 74.02% Impervious, Inflow Depth = 1.91" for 2 Year event				
Inflow =	0.82 cfs @	12.10 hrs, Volume=	2,704 cf		
Outflow =	0.82 cfs @	12.10 hrs, Volume=	2,704 cf, Atten= 0%, Lag= 0.0 min		
Primary =	0.82 cfs @	12.10 hrs, Volume=	2,704 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 106.92' @ 12.16 hrs
Flood Elev= 108.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	106.40'	**12.0" Round Culvert** L= 13.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 106.40' / 106.25' S= 0.0115 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.49 cfs @ 12.10 hrs HW=106.90' TW=106.80' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.49 cfs @ 1.82 fps)

Summary for Pond 7P: STORMCEPTOR

Inflow Area = 61,380 sf, 46.79% Impervious, Inflow Depth = 1.25" for 2 Year event
Inflow = 1.83 cfs @ 12.11 hrs, Volume= 6,382 cf
Outflow = 1.83 cfs @ 12.11 hrs, Volume= 6,382 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.83 cfs @ 12.11 hrs, Volume= 6,382 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 106.80' @ 12.11 hrs
Flood Elev= 108.70'

Device	Routing	Invert	Outlet Devices
#1	Primary	106.00'	**15.0" Round Culvert** L= 60.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 106.00' / 105.79' S= 0.0035 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=1.77 cfs @ 12.11 hrs HW=106.79' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.77 cfs @ 3.09 fps)

Summary for Pond CP: CULTECS

Inflow Area = 19,250 sf,100.00% Impervious, Inflow Depth = 2.87" for 2 Year event
Inflow = 1.24 cfs @ 12.09 hrs, Volume= 4,601 cf
Outflow = 1.01 cfs @ 12.16 hrs, Volume= 3,774 cf, Atten= 18%, Lag= 4.0 min
Primary = 1.01 cfs @ 12.16 hrs, Volume= 3,774 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 108.40' @ 12.16 hrs Surf.Area= 1,406 sf Storage= 1,184 cf

Plug-Flow detention time= 140.8 min calculated for 3,765 cf (82% of inflow)
Center-of-Mass det. time= 71.3 min (828.4 - 757.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	107.00'	972 cf	**22.50'W x 62.50'L x 2.21'H Field A** 3,105 cf Overall - 676 cf Embedded = 2,430 cf x 40.0% Voids
#2A	107.50'	676 cf	**Cultec C-100** x 48 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 6 rows
		1,648 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	108.00'	**4.0" Vert. Orifice/Grate X 5.00** C= 0.600

Primary OutFlow Max=0.98 cfs @ 12.16 hrs HW=108.38' TW=0.00' (Dynamic Tailwater)
└**1=Orifice/Grate** (Orifice Controls 0.98 cfs @ 2.24 fps)

Summary for Link 1L: NORTH

Inflow Area = 44,060 sf, 13.44% Impervious, Inflow Depth = 0.59" for 2 Year event
Inflow = 0.42 cfs @ 12.18 hrs, Volume= 2,167 cf
Primary = 0.42 cfs @ 12.18 hrs, Volume= 2,167 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs

Summary for Link 2L: SOUTH

Inflow Area = 102,680 sf, 49.27% Impervious, Inflow Depth = 1.29" for 2 Year event
Inflow = 2.90 cfs @ 12.12 hrs, Volume= 11,030 cf
Primary = 2.90 cfs @ 12.12 hrs, Volume= 11,030 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs

Summary for Link 3L: TOTAL

Inflow Area = 146,740 sf, 38.51% Impervious, Inflow Depth = 1.08" for 2 Year event
Inflow = 3.32 cfs @ 12.13 hrs, Volume= 13,197 cf
Primary = 3.32 cfs @ 12.13 hrs, Volume= 13,197 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentP1: ROOF Runoff Area=19,250 sf 100.00% Impervious Runoff Depth=4.26"
Tc=6.0 min CN=98 Runoff=1.81 cfs 6,840 cf

SubcatchmentP2: Runoff Area=21,060 sf 13.30% Impervious Runoff Depth=1.40"
Flow Length=125' Slope=0.0100 '/' Tc=12.8 min CN=66 Runoff=0.58 cfs 2,451 cf

SubcatchmentP3: Runoff Area=9,720 sf 15.43% Impervious Runoff Depth=1.46"
Tc=6.0 min CN=67 Runoff=0.34 cfs 1,186 cf

SubcatchmentP4: Runoff Area=13,280 sf 12.20% Impervious Runoff Depth=1.33"
Flow Length=80' Slope=0.1000 '/' Tc=6.4 min CN=65 Runoff=0.41 cfs 1,472 cf

SubcatchmentP5: Runoff Area=24,120 sf 25.21% Impervious Runoff Depth=1.67"
Flow Length=245' Tc=8.1 min CN=70 Runoff=0.93 cfs 3,364 cf

SubcatchmentP6: Runoff Area=20,250 sf 49.63% Impervious Runoff Depth=2.38"
Tc=6.0 min CN=79 Runoff=1.22 cfs 4,010 cf

SubcatchmentP7: Runoff Area=17,010 sf 74.02% Impervious Runoff Depth=3.20"
Tc=6.0 min CN=88 Runoff=1.34 cfs 4,531 cf

SubcatchmentP8: Runoff Area=22,050 sf 11.88% Impervious Runoff Depth=1.20"
Flow Length=100' Slope=0.0300 '/' Tc=12.3 min CN=63 Runoff=0.51 cfs 2,209 cf

Pond 1P: CB Peak Elev=107.17' Inflow=0.34 cfs 1,186 cf
8.0" Round Culvert n=0.012 L=25.0' S=0.0088 '/' Outflow=0.34 cfs 1,186 cf

Pond 2P: CB Peak Elev=107.65' Inflow=0.58 cfs 2,451 cf
8.0" Round Culvert n=0.012 L=172.0' S=0.0030 '/' Outflow=0.58 cfs 2,451 cf

Pond 3P: DMH Peak Elev=107.12' Inflow=0.83 cfs 3,636 cf
10.0" Round Culvert n=0.012 L=76.0' S=0.0030 '/' Outflow=0.83 cfs 3,636 cf

Pond 4P: CB Peak Elev=107.69' Inflow=0.93 cfs 3,364 cf
10.0" Round Culvert n=0.012 L=166.0' S=0.0045 '/' Outflow=0.93 cfs 3,364 cf

Pond 5P: CB Peak Elev=107.27' Inflow=1.22 cfs 4,010 cf
12.0" Round Culvert n=0.012 L=28.0' S=0.0054 '/' Outflow=1.22 cfs 4,010 cf

Pond 6P: CB Peak Elev=107.27' Inflow=1.34 cfs 4,531 cf
12.0" Round Culvert n=0.012 L=13.0' S=0.0115 '/' Outflow=1.34 cfs 4,531 cf

Pond 7P: STORMCEPTOR Peak Elev=107.20' Inflow=3.47 cfs 11,905 cf
15.0" Round Culvert n=0.012 L=60.0' S=0.0035 '/' Outflow=3.47 cfs 11,905 cf

Pond CP: CULTECS Peak Elev=108.64' Storage=1,330 cf Inflow=1.81 cfs 6,840 cf
Outflow=1.45 cfs 6,014 cf

Link 1L: NORTH

Inflow=1.24 cfs 5,109 cf
Primary=1.24 cfs 5,109 cf

Link 2L: SOUTH

Inflow=5.27 cfs 20,128 cf
Primary=5.27 cfs 20,128 cf

Link 3L: TOTAL

Inflow=6.49 cfs 25,237 cf
Primary=6.49 cfs 25,237 cf

Total Runoff Area = 146,740 sf Runoff Volume = 26,063 cf Average Runoff Depth = 2.13"
61.49% Pervious = 90,230 sf 38.51% Impervious = 56,510 sf

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentP1: ROOF Runoff Area=19,250 sf 100.00% Impervious Runoff Depth=5.06"
Tc=6.0 min CN=98 Runoff=2.14 cfs 8,121 cf

SubcatchmentP2: Runoff Area=21,060 sf 13.30% Impervious Runoff Depth=1.94"
Flow Length=125' Slope=0.0100 '/' Tc=12.8 min CN=66 Runoff=0.83 cfs 3,396 cf

SubcatchmentP3: Runoff Area=9,720 sf 15.43% Impervious Runoff Depth=2.01"
Tc=6.0 min CN=67 Runoff=0.48 cfs 1,632 cf

SubcatchmentP4: Runoff Area=13,280 sf 12.20% Impervious Runoff Depth=1.86"
Flow Length=80' Slope=0.1000 '/' Tc=6.4 min CN=65 Runoff=0.60 cfs 2,054 cf

SubcatchmentP5: Runoff Area=24,120 sf 25.21% Impervious Runoff Depth=2.26"
Flow Length=245' Tc=8.1 min CN=70 Runoff=1.28 cfs 4,545 cf

SubcatchmentP6: Runoff Area=20,250 sf 49.63% Impervious Runoff Depth=3.06"
Tc=6.0 min CN=79 Runoff=1.56 cfs 5,166 cf

SubcatchmentP7: Runoff Area=17,010 sf 74.02% Impervious Runoff Depth=3.95"
Tc=6.0 min CN=88 Runoff=1.65 cfs 5,606 cf

SubcatchmentP8: Runoff Area=22,050 sf 11.88% Impervious Runoff Depth=1.70"
Flow Length=100' Slope=0.0300 '/' Tc=12.3 min CN=63 Runoff=0.75 cfs 3,128 cf

Pond 1P: CB Peak Elev=107.33' Inflow=0.48 cfs 1,632 cf
8.0" Round Culvert n=0.012 L=25.0' S=0.0088 '/' Outflow=0.48 cfs 1,632 cf

Pond 2P: CB Peak Elev=108.07' Inflow=0.83 cfs 3,396 cf
8.0" Round Culvert n=0.012 L=172.0' S=0.0030 '/' Outflow=0.83 cfs 3,396 cf

Pond 3P: DMH Peak Elev=107.28' Inflow=1.18 cfs 5,028 cf
10.0" Round Culvert n=0.012 L=76.0' S=0.0030 '/' Outflow=1.18 cfs 5,028 cf

Pond 4P: CB Peak Elev=107.92' Inflow=1.28 cfs 4,545 cf
10.0" Round Culvert n=0.012 L=166.0' S=0.0045 '/' Outflow=1.28 cfs 4,545 cf

Pond 5P: CB Peak Elev=107.54' Inflow=1.56 cfs 5,166 cf
12.0" Round Culvert n=0.012 L=28.0' S=0.0054 '/' Outflow=1.56 cfs 5,166 cf

Pond 6P: CB Peak Elev=107.54' Inflow=1.65 cfs 5,606 cf
12.0" Round Culvert n=0.012 L=13.0' S=0.0115 '/' Outflow=1.65 cfs 5,606 cf

Pond 7P: STORMCEPTOR Peak Elev=107.47' Inflow=4.47 cfs 15,318 cf
15.0" Round Culvert n=0.012 L=60.0' S=0.0035 '/' Outflow=4.47 cfs 15,318 cf

Pond CP: CULTECS Peak Elev=108.81' Storage=1,424 cf Inflow=2.14 cfs 8,121 cf
Outflow=1.69 cfs 7,295 cf

Link 1L: NORTH

Inflow=1.78 cfs 7,082 cf
Primary=1.78 cfs 7,082 cf

Link 2L: SOUTH

Inflow=6.70 cfs 25,740 cf
Primary=6.70 cfs 25,740 cf

Link 3L: TOTAL

Inflow=8.46 cfs 32,823 cf
Primary=8.46 cfs 32,823 cf

Total Runoff Area = 146,740 sf Runoff Volume = 33,649 cf Average Runoff Depth = 2.75"
61.49% Pervious = 90,230 sf 38.51% Impervious = 56,510 sf

Time span=0.00-40.00 hrs, dt=0.10 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentP1: ROOF Runoff Area=19,250 sf 100.00% Impervious Runoff Depth=6.26"
Tc=6.0 min CN=98 Runoff=2.62 cfs 10,044 cf

SubcatchmentP2: Runoff Area=21,060 sf 13.30% Impervious Runoff Depth=2.82"
Flow Length=125' Slope=0.0100 '/' Tc=12.8 min CN=66 Runoff=1.22 cfs 4,943 cf

SubcatchmentP3: Runoff Area=9,720 sf 15.43% Impervious Runoff Depth=2.91"
Tc=6.0 min CN=67 Runoff=0.71 cfs 2,360 cf

SubcatchmentP4: Runoff Area=13,280 sf 12.20% Impervious Runoff Depth=2.72"
Flow Length=80' Slope=0.1000 '/' Tc=6.4 min CN=65 Runoff=0.89 cfs 3,011 cf

SubcatchmentP5: Runoff Area=24,120 sf 25.21% Impervious Runoff Depth=3.21"
Flow Length=245' Tc=8.1 min CN=70 Runoff=1.83 cfs 6,446 cf

SubcatchmentP6: Runoff Area=20,250 sf 49.63% Impervious Runoff Depth=4.13"
Tc=6.0 min CN=79 Runoff=2.10 cfs 6,968 cf

SubcatchmentP7: Runoff Area=17,010 sf 74.02% Impervious Runoff Depth=5.11"
Tc=6.0 min CN=88 Runoff=2.10 cfs 7,241 cf

SubcatchmentP8: Runoff Area=22,050 sf 11.88% Impervious Runoff Depth=2.53"
Flow Length=100' Slope=0.0300 '/' Tc=12.3 min CN=63 Runoff=1.15 cfs 4,653 cf

Pond 1P: CB Peak Elev=107.81' Inflow=0.71 cfs 2,360 cf
8.0" Round Culvert n=0.012 L=25.0' S=0.0088 '/' Outflow=0.71 cfs 2,360 cf

Pond 2P: CB Peak Elev=109.51' Inflow=1.22 cfs 4,943 cf
8.0" Round Culvert n=0.012 L=172.0' S=0.0030 '/' Outflow=1.22 cfs 4,943 cf

Pond 3P: DMH Peak Elev=107.74' Inflow=1.74 cfs 7,303 cf
10.0" Round Culvert n=0.012 L=76.0' S=0.0030 '/' Outflow=1.74 cfs 7,303 cf

Pond 4P: CB Peak Elev=108.90' Inflow=1.83 cfs 6,446 cf
10.0" Round Culvert n=0.012 L=166.0' S=0.0045 '/' Outflow=1.83 cfs 6,446 cf

Pond 5P: CB Peak Elev=108.17' Inflow=2.10 cfs 6,968 cf
12.0" Round Culvert n=0.012 L=28.0' S=0.0054 '/' Outflow=2.10 cfs 6,968 cf

Pond 6P: CB Peak Elev=108.16' Inflow=2.10 cfs 7,241 cf
12.0" Round Culvert n=0.012 L=13.0' S=0.0115 '/' Outflow=2.10 cfs 7,241 cf

Pond 7P: STORMCEPTOR Peak Elev=108.04' Inflow=6.00 cfs 20,656 cf
15.0" Round Culvert n=0.012 L=60.0' S=0.0035 '/' Outflow=6.00 cfs 20,656 cf

Pond CP: CULTECS Peak Elev=109.09' Storage=1,580 cf Inflow=2.62 cfs 10,044 cf
Outflow=2.02 cfs 9,218 cf

Link 1L: NORTH

Inflow=2.65 cfs 10,315 cf
Primary=2.65 cfs 10,315 cf

Link 2L: SOUTH

Inflow=8.88 cfs 34,527 cf
Primary=8.88 cfs 34,527 cf

Link 3L: TOTAL

Inflow=11.52 cfs 44,842 cf
Primary=11.52 cfs 44,842 cf

Total Runoff Area = 146,740 sf Runoff Volume = 45,668 cf Average Runoff Depth = 3.73"
61.49% Pervious = 90,230 sf 38.51% Impervious = 56,510 sf

BMP DATA

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REFER TO FILE # REA-0387
NAME ARTIS
DATE 5-28-13

MADE BY

☐ MEMO

☐ CALCULATION

IMPERVIOUS AREA TO STORMCEPTOR

A = 61380 SF x 46.79% = 28720 SF

RECHARGE VOLUME FROM ROOF

VOL = 21590 SF x 0.35" = 630 CF
VOL BETWEEN 107.0 & 108.0 = 825 CF

Summary for Pond CP: CULTECS

Inflow Area =	19,250 sf,	100.00% Impervious,	Inflow Depth =	6.26"	for 100 Year event
Inflow =	2.62 cfs @	12.09 hrs,	Volume=	10,044 cf	
Outflow =	2.02 cfs @	12.18 hrs,	Volume=	9,218 cf,	Atten= 23%, Lag= 4.9 min
Primary =	2.02 cfs @	12.18 hrs,	Volume=	9,218 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.10 hrs
Peak Elev= 109.09' @ 12.18 hrs Surf.Area= 1,406 sf Storage= 1,580 cf

Plug-Flow detention time= 92.7 min calculated for 9,218 cf (92% of inflow)
Center-of-Mass det. time= 48.7 min (792.7 - 744.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	107.00'	972 cf	**22.50'W x 62.50'L x 2.21'H Field A** 3,105 cf Overall - 676 cf Embedded = 2,430 cf x 40.0% Voids
#2A	107.50'	676 cf	**Cultec C-100** x 48 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 6 rows
		1,648 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	108.00'	**4.0" Vert. Orifice/Grate X 5.00** C= 0.600

Primary OutFlow Max=1.97 cfs @ 12.18 hrs HW=109.05' TW=0.00' (Dynamic Tailwater)
└─**1=Orifice/Grate** (Orifice Controls 1.97 cfs @ 4.53 fps)

Pond CP: CULTECS - Chamber Wizard Field A

Chamber Model = Cultec C-100
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 6 rows

36.0" Wide + 6.0" Spacing = 42.0" C-C Row Spacing

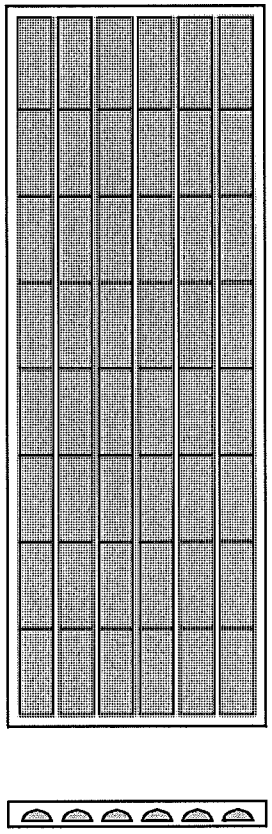
8 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 60.50' Row Length +12.0" End Stone x 2 = 62.50' Base Length
6 Rows x 36.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 22.50' Base Width
6.0" Base + 12.5" Chamber Height + 8.0" Cover = 2.21' Field Height

48 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 6 Rows = 675.7 cf Chamber Storage

3,105.5 cf Field - 675.7 cf Chambers = 2,429.7 cf Stone x 40.0% Voids = 971.9 cf Stone Storage

Chamber Storage + Stone Storage = 1,647.6 cf = 0.038 af
Overall Storage Efficiency = 53.1%

48 Chambers
115.0 cy Field
90.0 cy Stone



Stage-Area-Storage for Pond CP: CULTECS

Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)
107.00	0	108.04	866	109.08	1,575
107.02	11	108.06	886	109.10	1,587
107.04	23	108.08	906	109.12	1,598
107.06	34	108.10	926	109.14	1,609
107.08	45	108.12	946	109.16	1,620
107.10	56	108.14	965	109.18	1,632
107.12	68	108.16	984	109.20	**1,643**
107.14	79	108.18	1,003		
107.16	90	108.20	1,022		
107.18	101	108.22	1,040		
107.20	113	108.24	1,059		
107.22	124	108.26	1,076		
107.24	135	108.28	1,094		
107.26	146	108.30	1,110		
107.28	158	108.32	1,127		
107.30	169	108.34	1,143		
107.32	180	108.36	1,158		
107.34	191	108.38	1,173		
107.36	202	108.40	1,187		
107.38	214	108.42	1,200		
107.40	225	108.44	1,213		
107.42	236	108.46	1,226		
107.44	247	108.48	1,238		
107.46	259	108.50	1,249		
107.48	270	108.52	1,260		
107.50	281	108.54	1,272		
107.52	304	108.56	1,283		
107.54	327	108.58	1,294		
107.56	349	108.60	1,305		
107.58	372	108.62	1,317		
107.60	394	108.64	1,328		
107.62	416	108.66	1,339		
107.64	439	108.68	1,350		
107.66	460	108.70	1,362		
107.68	482	108.72	1,373		
107.70	504	108.74	1,384		
107.72	526	108.76	1,395		
107.74	548	108.78	1,407		
107.76	570	108.80	1,418		
107.78	592	108.82	1,429		
107.80	613	108.84	1,440		
107.82	635	108.86	1,452		
107.84	657	108.88	1,463		
107.86	678	108.90	1,474		
107.88	699	108.92	1,485		
107.90	721	108.94	1,497		
107.92	742	108.96	1,508		
107.94	763	108.98	1,519		
107.96	784	109.00	1,530		
107.98	804	109.02	1,542		
108.00	825	109.04	1,553		
108.02	846	109.06	1,564		

CULTEC CHAMBERS

STORM	Qin	Qout	WL
2YR	1.24	1.01	108.40
10YR	1.81	1.45	108.64
25YR	2.14	1.69	108.81
100 YR	2.62	2.02	109.09

NOTES: BOT STONE @ 107.0, BOT CHAMBER @ 107.5,
TOP CHAMBER @ 108.54, TOP STONE @ 109.20
OUTLET: 5 - 4" @ 108.0
INFILTRATION RATE=NONE

TIME TO DRAIN (FROM 108.0):
T=825 CF / (1406 SF X 0.087 FT/HR) =6.7 HOURS

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

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

Location: ARTIS SENIOR HOUSING

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
DEEP SUMP CB W/GT	.25	1.00	.25	.75
STORMCEPTOR STC 450i	.80	.75	.60	.15

Total TSS Removal = .85

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

Project: REA - 0387

Prepared By: EES

Date: 5-28-13

*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

Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	5/28/2013
Project Name	ARTIS SENIOR LIVING
Project Number	REA-0387
Location	1090-1100 MAIN ST, READING, MA

Designer Information

Company	HAYES ENGINEERING, INC
Contact	P.J. OGREN

Notes

N/A

Drainage Area

Total Area (ac)	1.41
Imperviousness (%)	47

The Stormceptor System model STC 450i achieves the water quality objective removing 80% TSS for a Fine (organics, silts and sand) particle size distribution.

Rainfall

Name	BOSTON WSFO AP
State	MA
ID	770
Years of Records	1948 to 2005
Latitude	42°21'38"N
Longitude	71°0'38"W

Water Quality Objective

TSS Removal (%)	80

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	**80**
STC 900	87
STC 1200	88
STC 1800	88
STC 2400	90
STC 3600	91
STC 4800	93
STC 6000	93
STC 7200	94
STC 11000	96
STC 13000	96
STC 16000	97

Rinker MATERIALS™

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
20	20	1.3	0.0013					
60	20	1.8	0.0051					
150	20	2.2	0.0354					
400	20	2.65	0.2123					
2000	20	2.65	0.9417					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in.	1 in.	3 in.
Multiple inlet pipes	3 in.	3 in.	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Rinker Materials 1 (800) 909-7763 www.rinkerstormceptor.com

Rinker MATERIALS™

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
TEL.: (781) 246-2800
FAX: (781) 246-7596

JOB FILE #: REA-0387
NAME: ARTIS
DATE: 5-28-13
MADE BY:

☐ MEMO
☐ CALCULATION

LEVEL SPREADER ANALYSIS

1) 10" OUTLET FROM COURTYARD

10 YR Q = 0.83 CFS

V = .8 CFS / (.12' × 6') = 1.1 FPS

2) 12" OUTLET FROM CULTECS

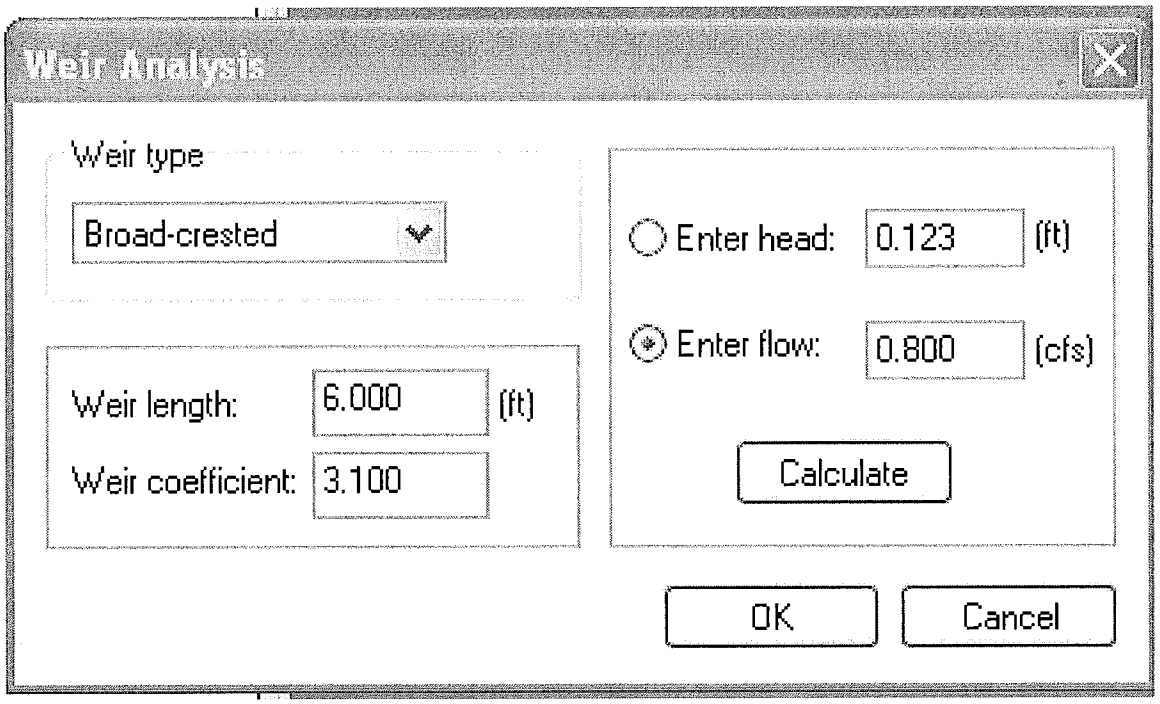
10 YR Q = 1.4 CFS

V = 1.4 CFS / (.18' × 6') = 1.3 FPS

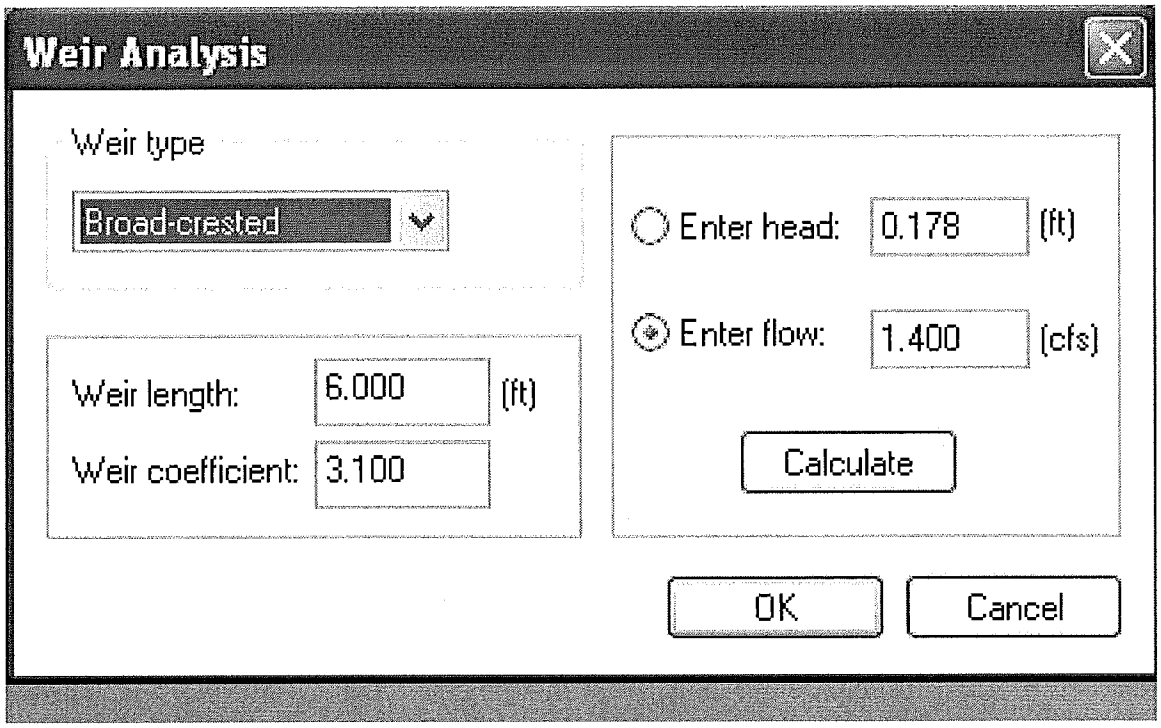
3) 15" OUTLET FROM STORMCEPTOR

10 YR Q = 3.5 CFS

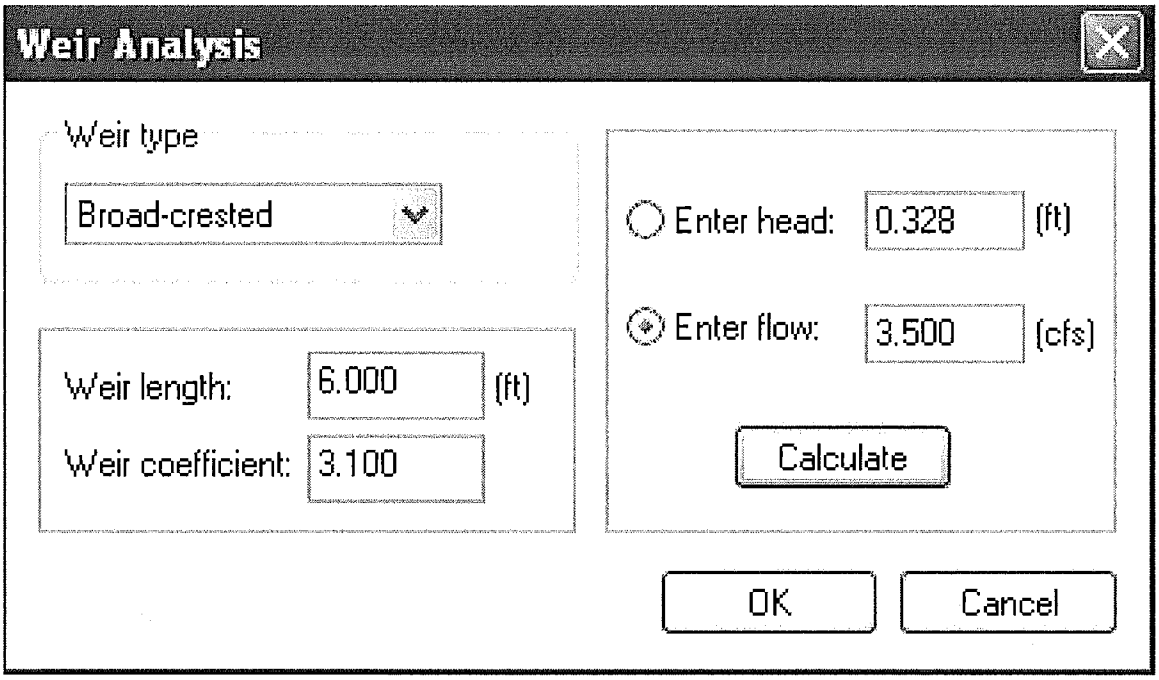
V = 3.5 CFS / (.33' × 6') = 1.8 FPS



10" OUTLET FROM COURTYARD



12" OUTLET FROM CULTECS



15" OUTLET FROM STORMCEPTOR

SOILS DATA

USDA Natural Resources Conservation Service

Web Soil Survey
National Cooperative Soil Survey

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

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

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

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

MAP INFORMATION

Map Scale: 1:2,100 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 19N NAD83

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 12, Feb 26, 2010

Date(s) aerial images were photographed: 7/7/2003

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

Map Unit Legend

Middlesex County, Massachusetts (MA017)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
422B	Canton fine sandy loam, 3 to 8 percent slopes, extremely stony	4.8	29.8%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	1.6	10.0%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	1.8	11.3%
656	Udorthents-Urban land complex	7.8	48.9%
Totals for Area of Interest		**16.0**	**100.0%**

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
422B	Canton fine sandy loam, 3 to 8 percent slopes, extremely stony	B	4.8	29.8%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	B	1.6	10.0%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	B	1.8	11.3%
656	Udorthents-Urban land complex		7.8	48.9%
Totals for Area of Interest			**16.0**	**100.0%**

Description

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

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

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

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

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

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

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

Middlesex County, Massachusetts

631C—Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky

Map Unit Setting

Landscape: Hills, uplands
Elevation: 0 to 1,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days

Map Unit Composition

Urban land: 40 percent
Charlton and similar soils: 40 percent
Hollis and similar soils: 10 percent
Minor components: 10 percent

Description of Charlton

Setting

Landform: Drumlins, ground moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 3e
Hydrologic Soil Group: B

Typical profile

0 to 5 inches: Fine sandy loam
5 to 22 inches: Sandy loam
22 to 65 inches: Gravelly sandy loam

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Description of Hollis

Setting

Landform: Ridges, hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till over granite and gneiss

Properties and qualities

Slope: 3 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 6s
Hydrologic Soil Group: D

Typical profile

0 to 2 inches: Fine sandy loam
2 to 14 inches: Fine sandy loam
14 to 18 inches: Unweathered bedrock

Minor Components

Canton

Percent of map unit: 4 percent
Landform: Hills
Landform position (two-dimensional): Toeslope, backslope
Landform position (three-dimensional): Base slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex

Udorthents, loamy

Percent of map unit: 2 percent

Rock outcrop

Percent of map unit: 2 percent
Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope

Down-slope shape: Concave
Across-slope shape: Concave

Scituate
Percent of map unit: 1 percent
Landform: Depressions, hillslopes
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Linear
Across-slope shape: Concave

Montauk
Percent of map unit: 1 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Nose slope, head slope
Down-slope shape: Convex
Across-slope shape: Convex

Data Source Information

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 12, Feb 26, 2010

Middlesex County, Massachusetts

422B—Canton fine sandy loam, 3 to 8 percent slopes, extremely stony

Map Unit Setting

Landscape: Hills, uplands
Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Canton and similar soils: 85 percent
Minor components: 15 percent

Description of Canton

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Head slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable sandy basal till derived from granite and gneiss

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 7s
Hydrologic Soil Group: B

Typical profile

0 to 8 inches: Fine sandy loam
8 to 21 inches: Fine sandy loam
21 to 65 inches: Gravelly loamy sand

Minor Components

Montauk

Percent of map unit: 5 percent
Landform: Hillslopes

Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Nose slope, head slope
Down-slope shape: Convex
Across-slope shape: Convex

Charlton

Percent of map unit: 5 percent
Landform: Drumlins, ground moraines
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex
Across-slope shape: Convex

Scituate

Percent of map unit: 5 percent
Landform: Hillslopes, depressions
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear
Across-slope shape: Concave

Data Source Information

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 12, Feb 26, 2010

Middlesex County, Massachusetts

629C—Canton-Charlton-Urban land complex, 3 to 15 percent slopes

Map Unit Setting

Landscape: Hills, uplands
Elevation: 0 to 1,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days

Map Unit Composition

Canton and similar soils: 40 percent
Charlton and similar soils: 30 percent
Urban land: 25 percent
Minor components: 5 percent

Description of Canton

Setting

Landform: Hills
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Base slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable sandy basal till derived from granite and gneiss

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 3e
Hydrologic Soil Group: B

Typical profile

0 to 8 inches: Fine sandy loam
8 to 21 inches: Fine sandy loam
21 to 65 inches: Gravelly loamy sand

Description of Charlton

Setting

Landform: Drumlins, ground moraines

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 3e
Hydrologic Soil Group: B

Typical profile

0 to 5 inches: Fine sandy loam
5 to 22 inches: Sandy loam
22 to 65 inches: Gravelly sandy loam

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Scituate

Percent of map unit: 2 percent
Landform: Depressions, hillslopes
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Linear
Across-slope shape: Concave

Montauk

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Nose slope, head slope
Down-slope shape: Convex
Across-slope shape: Convex

Udorthents, loamy
Percent of map unit: 1 percent

Data Source Information

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 12, Feb 26, 2010

Middlesex County, Massachusetts

656—Udorthents-Urban land complex

Map Unit Setting

Landscape: Hills, outwash plains, uplands, valleys
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days

Map Unit Composition

Urban land: 40 percent
Udorthents and similar soils: 40 percent
Minor components: 20 percent

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Description of Udorthents

Setting

Parent material: Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Minor Components

Canton

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex

Merrimac

Percent of map unit: 5 percent
Landform: Plains, terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise

Down-slope shape: Convex
Across-slope shape: Convex

Paxton
Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex

Data Source Information

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 12, Feb 26, 2010

Commonwealth of Massachusetts
City/Town of READING

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Hayes Engineering, Inc.
603 Salem Stree
Wakefield, MA 0188
T: (781) 246-280
F: (781) 246-759
Nantucket: (508) 228-780

JOB FILE

A. Facility Information

Owner Name: GODDARD FAMILY HOUSE

Street Address: 1090-1100 MAIN ST.

City: READING | State: MA | Map/Lot # | Zip Code: 01867

B. Site Information

1. (Check one) ☑ New Construction ☐ Upgrade ☐ Repair

2. Published Soil Survey Available? ☐ Yes ☐ No If yes: Year Published | Publication Scale | Soil Map Unit
   Soil Name | Soil Limitations

3. Surficial Geological Report Available? ☐ Yes ☐ No If yes: Year Published | Publication Scale | Map Unit
   Geologic Material | Landform

4. Flood Rate Insurance Map
   Above the 500-year flood boundary? ☐ Yes ☐ No
   Within the 500-year flood boundary? ☐ Yes ☐ No
   Within the 100-year flood boundary? ☐ Yes ☐ No
   Within a velocity zone? ☐ Yes ☐ No

5. Wetland Area:
   National Wetland Inventory Map — Map Unit | Name
   Wetlands Conservancy Program Map — Map Unit | Name

6. Current Water Resource Conditions (USGS): Month/Year Range: ☐ Above Normal ☐ Normal ☐ Below Normal

7. Other references reviewed:

Commonwealth of Massachusetts
City/Town of READING

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserved disposal area*)

Deep Observation Hole Number: DOH-1 Date: 5-24-13 Time: _____ Weather: _____

1. Location 1100 MAIN ST

Ground Elevation at Surface of Hole: 109.5 Location (identify on plan): BEHIND EAST HOUSE

2. Land Use YARD (e.g., woodland, agricultural field, vacant lot, etc.) Surface Stones: NONE Slope (%): A

Vegetation: NONE Landform: _____ Position on Landscape (attach sheet): _____

3. Distances from: Open Water Body _____ feet Drainage Way _____ feet Possible Wet Area _____ feet

Property Line Glacial till feet Drinking Water Well _____ feet Other _____ feet

4. Parent Material: _____ Unsuitable Materials Present: ☐ Yes ☐ No

If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If yes: Depth Weeping from Pit: NO Depth Standing Water in Hole: NO

Estimated Depth to High Groundwater: 36 inches 109.5 elevation

Commonwealth of Massachusetts
City/Town of READING

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: DOH-1

Depth (in.)	Soil Horizon/ Layer	Soil Matric Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12	Ap	10YR 3/3				fsl	0	0%	gr	mfr	
12-32	Bw	10YR 4/6				fsl	0	0%	gr	mfr	
32-96	C	2.5Y 6/4	36	10YR 6/8 5Y 7/1		gr sl	15	5%	m	mfr	

Additional Notes:

Commonwealth of Massachusetts
City/Town of READING

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserved disposal area*)

Deep Observation Hole Number: DOH-2 5-23-13 (Date) _____ (Time) Cldy-Rain-60° (Weather)

1. Location 1100 MAIN ST.

Ground Elevation at Surface of Hole: 109.0 Location (identify on plan): BEHIND EXISTING HOUSE

2. Land Use YARD (e.g., woodland, agricultural field, vacant lot, etc.) NONE (Surface Stones) A (Slope (%))

NONE (Vegetation) _____ (Landform) _____ (Position on Landscape (attach sheet))

3. Distances from: Open Water Body ____ feet; Drainage Way ____ feet; Possible Wet Area ____ feet

Property Line ____ feet; Drinking Water Well ____ feet; Other ____ feet

4. Parent Material: Glacial till

Unsuitable Materials Present: ☐ Yes ☐ No

If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If yes: 48 (Depth Weeping from Pit) 48 (Depth Standing Water in Hole)

Estimated Depth to High Groundwater: 30 inches 106.5 elevation

Commonwealth of Massachusetts
City/Town of READING

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: DOH-2

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-15	Ap	10YR 3/3				fsl	0	0/0	gr	mfr	
15-22	Bw	10YR 4/6				fsl	0	0/0	gr	mfr	
22-48	C1	2.5Y 7/3	30"			fs	0	0/0	m	mvfr	
48-78	C2	2.5Y 6/4				grsl	15	10/0/0	m	mfr	

Additional Notes:

Commonwealth of Massachusetts
City/Town of READING
Form 11 - Soil Suitability Assessment for On-Site ~~Sewage~~ Disposal

D. Determination of High Groundwater Elevation

1. Method Used:

☐ Depth observed standing water in observation hole	A. — inches	B. 48 inches
☐ Depth weeping from side of observation hole	A. — inches	B. 48 inches
☐ Depth to soil redoximorphic features (mottles)	A. 36 inches	B. 30 inches
☐ Groundwater adjustment (USGS methodology)	A. inches	B. inches

2. Index Well Number _____ Reading Date _____ Index Well Level _____

Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

   ☐ Yes ☐ No

   b. If yes, at what depth was it observed? Upper boundary: _____ inches Lower boundary: _____ inches

Commonwealth of Massachusetts
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Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator	May 23, 2013 Date
Gordon Rogerson SE2074 Typed or Printed Name of Soil Evaluator / License #	Nov. 1994 Date of Soil Evaluator Exam
Name of Board of Health Witness	Board of Health

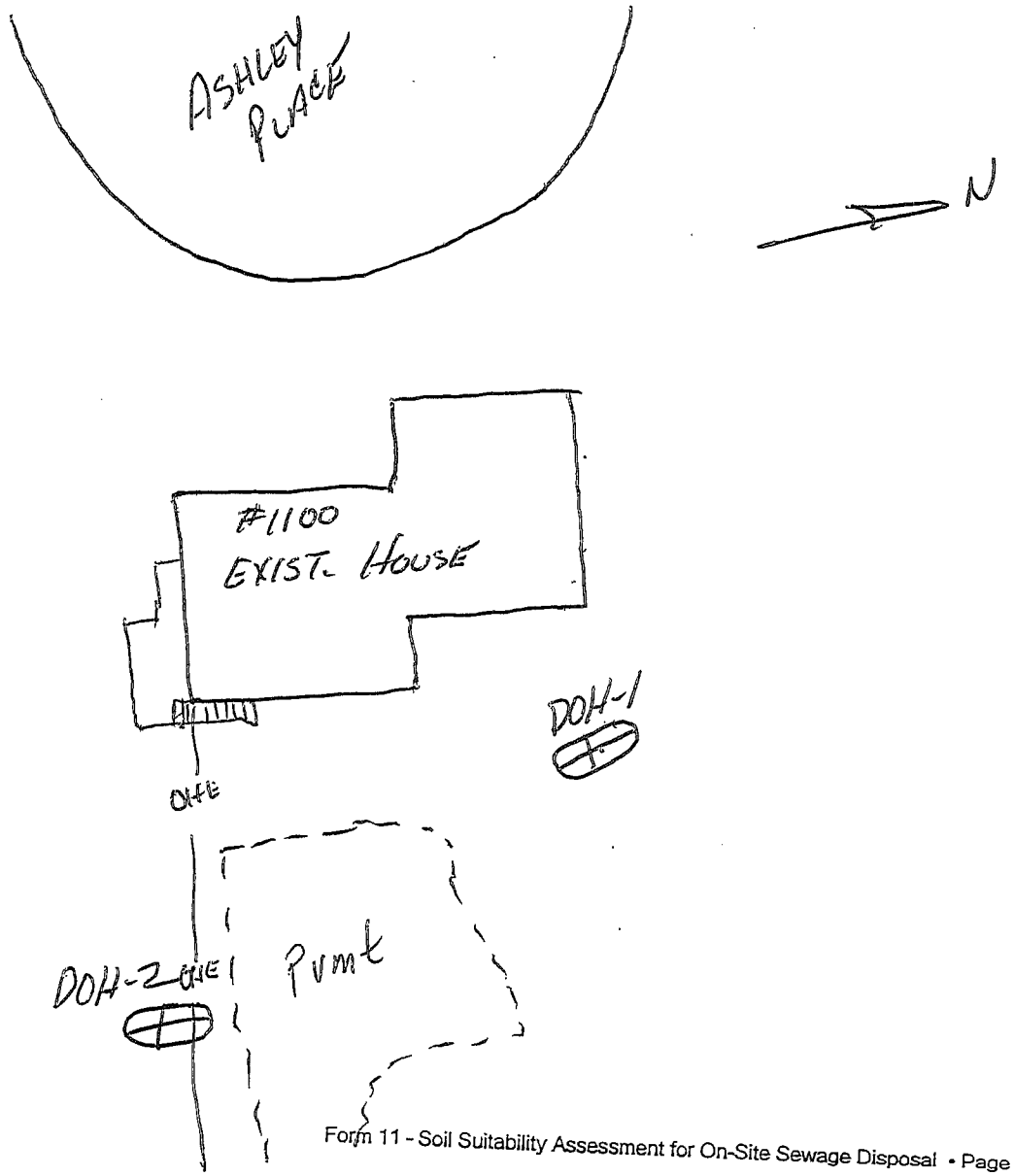
Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Commonwealth of Massachusetts
City/Town of READING

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Field Diagrams

Use this sheet for field diagrams:



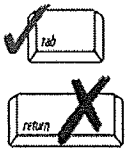
STORMWATER CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

PE May. 29, 2013

Signature and Date

Checklist

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

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs) *N/A*

☐ 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 *N/A*

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

REDEVELOPMENT CHECKLIST

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
- Increase in impervious surface

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?
- What BMPs are proposed to ensure that no new discharges cause erosion in wetlands or waters of the Commonwealth?
- 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?

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?
- 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".)
- What BMPs have been considered to prevent erosion from existing stormwater discharges?

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?
- 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.)
- 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.)
- 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)?
- 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.)

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?
- 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?
- 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]
- Is the stormwater runoff from a land use with a higher potential pollutant load?
- Is the discharge to the ground located within the Zone II or Interim Wellhead Protection Area of a public water supply?
- Does the site have an infiltration rate greater than 2.4 inches per hour?

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?
- 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.)
- Has the applicant evaluated measures for reducing site runoff? (See Menu.)

<u>Standard 4: (80% TSS Removal)</u>

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.

- Has the proponent developed a long-term pollution plan that fully meets the requirements of Standard 4?
- Does the pollution prevention plan include the following source control measures?
    - Street sweeping

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

- 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?
- Have the proposed stormwater BMPs been properly sized to capture the prescribed runoff volume?
  - 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?
  - 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?
- Have any of the best management practices in the Retrofit Section been considered?
- Have any of the following pollution prevention measures been considered?
  - 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.

<u>Standard 5 (Higher Potential Pollutant Loads (HPPL)</u>

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)
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?

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?

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?
- Has an illicit connection detection program been implemented using visual screening, dye or smoke testing?
- 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?

Improvements to Existing Conditions:

- Once all illicit discharges are removed, has the proponent implemented any measures to prevent additional illicit discharges?

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.

OPERATION & MAINTENANCE PLAN / LTPPP

OPERATION AND MAINTENANCE PLAN
AND LONG-TERM POLLUTION PREVENTION PLAN
ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MASSACHUSETTS

May 28, 2013

GENERAL

The management plan incorporates a combination of the following chain of structural best management practices to improve water quality of the stormwater runoff from the proposed roadway and other impervious surfaces, and control runoff to downgradient areas.

1. Deep Sump Catch Basin with Hoods, Oil and Gas Traps
2. Cultec Contactor 100HD Subsurface Infiltration Chambers
3. STC 450i Stormceptor Chamber.
4. Granite Curb Level Spreader
5. Yard Drains

These stormwater management facilities have unique characteristics, uses, planning considerations and maintenance requirements. The maintenance requirements, as suggested by the DEP in "Volume 2, Chapter 2: Structural BMP Specifications for the Massachusetts Stormwater Handbook", and the suggested schedules are summarized in the following sections. It is suggested that the following guidelines be adhered to following completion of the project and then adjusted, as necessary, based on the results of the required inspections and based on evidence of maintenance history. The owner can submit a revised maintenance schedule to the Engineering Division for review and approval. The maintenance and repair reports will be submitted to the Engineering Division and the Conservation Commission annually by January 15th. There will be an inspection conducted for all components of the stormwater management system for major storm events equal to or exceeding 2 inches.

Deep Sump Catch Basin with Hood, Oil and Gas Traps

The catch basins must be inspected four (4) times a year including at the end of foliage and snow removal season. Inspections shall consist of two tasks: measuring and recording depth of sediment deposits contained within the basin, and inspecting structural basin, hood, "Snout" and sump components for damage. The inspection frequency may need to be increased if catch basins are regularly found to contain a significant amount of trash and sediment.

- Basins shall be cleaned at least annually using a vacuum truck or when they are found to contain a significant amount of deposits (whenever the deposit depth is greater than or equal to one-half the depth from the bottom of the lowest invert) and there is a significant amount of trash, as specified in the MADEP Stormwater Handbook, Volume 2, Chapter 2, pages 3 through 5.

- Damaged basin components shall be repaired as soon after discovery as possible to ensure that the catch basin functions properly.

- Removed basin deposits must be handled as specified in the attached page (Structural BMPs – Volume 2, Chapter 2, page 5) from the MADEP Stormwater Handbook.

Yard Drains

Yard drain grates and pipe inverts shall to be inspected at the same time as the deep sump catch basins. Inspections shall consist of two tasks: inspecting structural components for damage or clogging, and removal of sediment accumulations, leaves and other debris from the yard drain, if present. Debris and sediment accumulations shall be removed either by hand or by using a vacuum truck, as deemed necessary.

Cultec 100HD Subsurface Chambers

Recharge systems are prone to failure due to clogging. Adherence to this aggressive maintenance plan and schedule preserves effectiveness of the system.

- The subsurface system will be inspected after every major storm for the first few months after construction to ensure that proper function has been achieved. Thereafter, the area will be inspected at least four times a year. Water levels in the chambers should be recorded over several days to check drainage.

- The inspection ports for the recharger system will be inspected after every major storm and the collected debris removed.

- Any required cleaning or other action will be documented and completed within seven business days.

- Ponded water inside the chambers (as visible from the inspection ports) after 24 hours or several days most likely indicates that the bottoms of the pipes are clogged.

- The inspection, cleaning and maintenance responsibility for the site drainage system shall belong to the owner.

- If inspection indicates that replacement or major repair is required, a work plan will be submitted within 7 days to the Engineering Division for review and repair.

Stormceptor STC 450i Water Quality Chambers

Regulating the sediment and petroleum product input to the proposed water quality system is the priority maintenance activity. Sediments and any oil spillage should be trapped and removed before they reach the chambers.

- Stormceptor chamber maintenance shall be performed on a regular basis as recommended by the manufacturer (described in the attached O & M specifications from the Stormceptor Maintenance Brochure obtained from the Stormceptor website (www.stormceptor.com) and as summarized herein. All inspections and all necessary sediment cleaning repair actions shall be documented in a maintenance log kept by the property owner.

- Conduct initial inspection after construction. Remove any debris, sediments and/or pollutants accumulations as necessary using a vacuum truck.

- Inspect every 6 months the first year of operation. . Remove any debris, sediments or pollutants as needed.

- Inspect at least annually thereafter (frequency of inspection to be adjusted based on observed accumulation rates). The units are designed to accept 15% of their capacity in solids annually based on maximum drainage area loading. Removal of sediment, oils and grease from the system will depend on rates of accumulation.

- Inspect after oil, fuel or chemical spill to detect any intrusion of such materials into the chambers.

- Sediment removal is recommended annually, but is likely to vary widely based on site conditions and loadings. Typical maintenance cleaning can be done with a vacuum truck. Inspection for each of the Stormceptor units will include a quantification of the sediment load and oil and grease volumes. This is easily made from the surface with a tube dipstick with ball valve inserted through the cleanout pipe or other access port. Depths of sediment indicating maintenance are presented in the following table for the various models. Inspection of the internal structure should be part of the routine inspection plan.

  All sediment and oil waste materials shall be disposed of in accordance with all Federal, State and Local regulations.

REQUIRED MAINTENANCE *

Model	Sediment Depth (in.)
STC 450i	*8

* based on 15% of the interceptor's sediment storage.

Granite Curb Level Spreader

The granite curb level spreader should be checked periodically after every major storm to determine if the berm has been damaged and to determine that the design conditions have not changed. Any detrimental sediment accumulation should be removed. If riling has taken place on the berm or adjacent to the level spreader, then the damage should be repaired as soon as possible. Leaf litter shall be removed from the level spreader area. The vegetation in the vicinity down gradient of the spreader will be periodically inspected and fertilized to maintain healthy dense growth.

Removal of Siltation Controls

All siltation controls, including, but not limited to, hay bales and silt fence, shall be removed, with the approval of the Reading Town Engineering Department, as soon as practical after paving, re-vegetation and total stabilization of the site. Unvegetated areas remaining in the area of the siltation controls shall be loamed and seeded with the appropriate groundcover to insure re-vegetation as rapidly as possible after the removal of the siltation controls. In the case of all proposed stormwater management facilities, during construction of the proposed stormwater management system the developer shall be the owner and party responsible for maintenance.

Splil Emergency Response and Shutoff Plan

In the event of an accidental spill of gasoline or oil, there shall provided, and kept on site, two 36" x 60" "Drain Protector II" rectangular catch basin covers and one 10-foot long "Spill berm" to provide protection for the drainage system. Both items are available from "Supply Line Direct". These items will be stored on site in an easily accessible location and personnel will be instructed in their proper use.

Ownership / Maintenance Responsibility

The developer / future owner, Artis Senior Living, LLC, shall be the owner and party responsible for maintenance of the stormwater management facilities during development construction and post construction long-term maintenance.

Standard #4: Water Quality

The Long-Term Pollution Prevention Plan

- Good housekeeping practices: Prevent or reduce pollutant runoff from the project development through the use of street sweeping, erosion and catch basin cleaning. It should be noted that we are seeking credit for TSS removal with street sweeping for this project.

- Provisions for storing materials and waste products inside or under cover: All materials stored on site shall be stored in a neat and orderly fashion in their appropriate containers and under a roof or other secure enclosure. Waste products should be placed in secure receptacles until they are emptied by a licensed solid waste management company in Massachusetts.

- Requirements for routine inspections and maintenance of stormwater BMPs: Follow the guidelines outlined above.

- Spill prevention and response plans:

    - Prevention: All materials stored on site shall be stored in a neat and orderly fashion in their appropriate containers and under a roof or other secure enclosure. Products will be kept in their original containers with the original manufacturer's label. Products should not be mixed with one another unless recommended by the manufacturer. If possible, all of the product should be used up before disposing of the container. The manufacturer's recommendations for proper use and disposal should be followed.

    - Response: Manufacturer's recommended methods for cleanup shall be followed. Spills should be cleaned up immediately after discovery. The spill area shall be kept well ventilated and personnel shall wear appropriate protective clothing to prevent injury from contact with a hazardous substance. Spills of toxic or hazardous material shall be reported to the appropriate State and/or local authority in accordance with local and/or State regulations.

- Provisions for maintenance of lawns, gardens, and other landscaped areas: Maintenance of the landscaped areas shall be scheduled and supervised by the developer/future owner and their designated property manager (of any).

- Requirements for storage and use of fertilizers, herbicides and pesticides will be in compliance with all applied laws:

    - Fertilizers: Fertilizers shall be applied in the minimum amounts recommended by the manufacturer. Once applied, fertilizers shall be worked into the soil to limit exposure to stormwater. Storage shall be under a roof or other secure enclosure. The contents of any partially-used bags of fertilizer shall be transferred to a sealable plastic bag or bin to avoid spills.

    - Herbicides and Pesticides: Store herbicides and pesticides in original containers that are closed and labeled, in a secure area out of reach of children and pets. Avoid storing in damp areas where containers may become moist or rusty. Herbicides and pesticides shall not be stored near food. Follow the label instructions strictly about where and how much to apply. Do not put herbicides and pesticides in the trash or down the drain. Use rubber gloves when handling, and use an appropriate cartridge mask if using products extensively.

- Provisions for solid waste management: Waste products shall be placed in secure receptacles until they are emptied by a licensed solid waste management company in Massachusetts.

- Pet waste management provisions: The responsibility of managing pet waste lies with the individual residents who own pets to perform the clean up and disposal of their pet waste.

- Provisions for operation and management of septic systems: Not applicable. This project will have sewer service.

- Snow disposal and plowing plans relative to Wetland Resource Areas: Snow disposal will be in accordance with the Department of Environmental Protection, Bureau of Resource Protection, Snow Disposal Guidelines, Guideline No. BRPG01-01, effective March 8, 2001. In general, snow will be plowed in accordance with standard operating procedures. During construction, snow will be plowed and stored in designated areas adjacent to the parking lots and roadways.

- Winter road salt and/or sand use and storage restrictions:

    - Salt/Sand: Whenever possible, use of environmentally friendly alternatives, i.e. calcium chloride and sand instead of salt for melting ice, will be considered.

- Street sweeping schedules: In order to minimize the Total Suspended Solids (TSS) load to the deep-sump catch basins and those BMPs down gradient, street sweeping will be performed at least four (4) times per year, primarily in spring and fall.

Standard #10: Illicit Discharge Statement

Provisions for prevention of illicit discharges to the stormwater management systems: **There are no proposed illicit discharges to the proposed stormwater management systems**. However, by definition, an illicit discharge does not include discharges from the following activities or facilities: firefighting, water-line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, water used for street washing and water used to clean buildings without detergents. See the information presented in the "Atris Senior Living" plan set for the proposed locations of the drainage system, stormwater management BMPs, and utilities. Upon review of said plans, it is evident that there are no entries of illicit discharges into the stormwater management system. The owner shall be responsible for verifying that there are no illicit discharges to the stormwater management system (discharges of water into the system other than stormwater) after the system has been constructed.

- 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 land uses with higher potential pollutant loads (LUHPPL): The project does not discharge to or near critical areas and is not a LUHPPL.

- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan: The responsibility lies with Artis Senior Living, LLC (the developer/future owner), and any designated Facility Manager.

- List of emergency contacts for implementing Long-Term Pollution Prevention Plan for the assisted living facility: The responsibility lies with Artis Senior Living, LLC (the developer/future owner) and any designated Facility Manager during construction and post construction pollution control

Current Owner:

The Goddard Family Trust
#1090 Main Street
Reading, MA 01887

Applicant/Devloper Contact Info:

Artis Senior Living, LLC
c/o Jason Erb or Jay Hicks
1651 Old \Meadow Road
McLean, VA 22102
(410) 259-1736

LONG TERM INSPECTION AND MAINTENANCE REPORT FORM

ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MASSACHUSETTS

INSPECTIONS TO BE CONDUCTED AT THE FREQUENCY SPECIFIED IN THE FACILITY OPERATION AND MAINTENANCE PLAN AND ORDER OF CONDITIONS
Maintenance and repair reports must be submitted to the Engineering Division and Conservation Commission annually by January 15th.

Date: _____

Inspected By: _____

Days Since Last Rainfall: _____ Amount of Last Rainfall: _____

BMP	BMP Installed as designed? (circle one)		BMP Maintenance Required? (circle one)		Depth Sediment Build-Up	Corrective Action Needed And Notes
2 Catch Basins at Parking Lot (Inspect Grates, Basin structure, ,Hood, Snout Oil Trap, and Gas trap)	Yes	No	Yes	No		

Remarks:

_____

_____

_____

LONG TERM INSPECTION AND MAINTENANCE REPORT FORM

ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MASSACHUSETTS

INSPECTIONS TO BE CONDUCTED AT THE FREQUENCY SPECIFIED IN THE FACILITY OPERATION AND MAINTENANCE PLAN AND ORDER OF CONDITIONS
Maintenance and repair reports must be submitted to the Engineering Division and Conservation Commission annually by January 15th.

Date: _____

Inspected By: _____

Days Since Last Rainfall: _____ Amount of Last Rainfall: _____

Yard Drains (Inspect Grates, Basin structure and inverts; remove accumulated leaves and sediment)				
Yard Drain Location and Conditions	BMP Maintenance Required? (circle one)		Depth Sediment Build-Up	Corrective Action Needed And Notes
	Yes	No		

Remarks:

_____

_____

_____

LONG TERM INSPECTION AND MAINTENANCE REPORT FORM

ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MASSACHUSETTS

INSPECTIONS TO BE CONDUCTED AT THE FREQUENCY SPECIFIED IN THE FACILITY OPERATION AND MAINTENANCE PLAN AND ORDER OF CONDITIONS
Maintenance and repair reports must be submitted to the Engineering Division and Conservation Commission annually by January 15th

Date: _____

Inspected By: _____

Days Since Last Rainfall: _____ Amount of Last Rainfall: _____

Stormceptor STC 450i (STC)		
Pipe Conditions	Sediment Depth	Maintenance Performed

Remarks:

_____

_____

_____

LONG TERM INSPECTION AND MAINTENANCE REPORT FORM

ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MASSACHUSETTS

INSPECTIONS TO BE CONDUCTED AT THE FREQUENCY SPECIFIED IN THE FACILITY OPERATION AND MAINTENANCE PLAN AND ORDER OF CONDITIONS
Maintenance and repair reports must be submitted to the Engineering Division and Conservation Commission annually by January 15th

Date: _____

Inspected By: _____

Days Since Last Rainfall: _____ Amount of Last Rainfall: _____

Cultec Stormwater Management Area **Refer to Cultec O. & M. Manual For Maintenance Requirements and Sample Log**		
Chamber Conditions	Maintenance Performed	Sediment Depth

Remarks:

_____

_____

_____

LONG TERM INSPECTION AND MAINTENANCE REPORT FORM

ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MASSACHUSETTS

INSPECTIONS TO BE CONDUCTED AT THE FREQUENCY SPECIFIED IN THE FACILITY OPERATION AND MAINTENANCE PLAN AND ORDER OF CONDITIONS
Maintenance and repair reports must be submitted to the Engineering Division and Conservation Commission annually by January 15th

Date: _____

Inspected By: _____

Days Since Last Rainfall: _____ Amount of Last Rainfall: _____

Granite Curb Level Spreader		
Curb and Riprap Conditions	Maintenance Performed	Sediment Depth

Remarks:

_____

_____

_____

UNIVERSITY OF MASSACHUSETTS
AT AMHERST
Water Resources Research Center
Blaisdell House, UMass
310 Hicks Way
Amherst, MA 01003

Massachusetts Stormwater Evaluation Project

(413) 545-5532
(413) 545-2304 FAX
www.mastep.net

MASTEP Technology Review

Technology Name: Stormceptor 450i.

Studies Reviewed: Multi-Phase Physical Model Testing of a Stormceptor STC450i

Date: March 14, 2009

Reviewers: Jerry Schoen

Rating: 2

Brief rationale for rating:

This laboratory study is generally well conducted and documented. No documentation of a quality assurance project, plan but quality control data was reported. Sediment analysis was done by the SSC method, but not the TSS method. Although SSC is considered by many scientists to be the preferred method, it is at odds with Massachusetts stormwater regulations, which are based on TSS treatment. Comparing SSC and TSS results is considered an inexact science.

TARP Requirements Not Met*:

- No documentation of a Quality Assurance Project Plan
- TSS analysis was not performed.

Other Comments

- SSC removal efficiency, calculated according to the NJDEP weighted formula, was 59.5 – 63.6%.
- SSC removal evaluated using event mean concentration and modified mass balance method, the latter considered to be a particularly accurate method of evaluating sediment removal in a laboratory setting.
- Particle Size Distribution (with d50 of 67 microns) closely matched the 55% sand, 40% silt, 5% clay mix recommended by NJDEP.
- A full range of flows (2% - 125%) was tested.
- Scour test was performed at 500% of design flow. This is more rigorous than the 125% recommended for scour tests. Effluent concentrations for the scour tests ranged from 5.9 – 6.1mg/l, not considered a significant level of scour.

* Laboratory testing was based on the NJDEP TARP laboratory testing guidelines.

Pollution Removal Performance Comparison Table

This table presents the range of pollution removal rates for particular pollutants claimed by manufacturers of stormwater BMP systems. Claims are presented along with removal rates obtained in one or more performance evaluation studies. All studies presented in this table were awarded a MASTEP rating of 1 or 2, indicating the studies possess strong scientific merit. When a range is displayed (e.g. 50-80%) rather than a single number, this means either different studies obtained different rates for a pollutant, or several individual constituents are lumped together in a class of pollutants - e.g .lead and copper are displayed under 'Metals removal.'

n/a = not applicable. This was not quantitatively tested in the associated studies.

Product Name	BMP Type	Removal Claimed by Manufacturer	TSS removal, third party verified	Nutrient removal, third party verified	Bacteria removal, third party verified	Petroleum Product removal, third party verified	Metals removal, third party verified	Infiltration (i.e. groundwater recharge)	Link to MASTEP Website	Comments
ecoSep - Royal Environmental Systems	Oil/Water Separator	Oil < 5 PPM, hydrocarbons < 10 PPM	n/a	n/a	n/a	Oil, < 5 PPM (99+%)	n/a	n/a	http://www.mastep.net/admin/d_eval.cfm?recID=639&vID=6	Laboratory study. Results reported as < 5 PPM, which equates to > 99% removal.
Oil Grit Separator	Oil/sediment Separator	no claim - non proprietary	28 - 35% as SSC	n/a	n/a	n/a	n/a	n/a	http://www.mastep.net/database/d_eval.cfm?recID=734&vID=6	
Stormceptor OSR	Oil/sediment Separator	69% TSS as SSC	69%	n/a	n/a	n/a	n/a	n/a	http://www.mastep.net/database/d_eval.cfm?recID=533&vID=412	
Stormceptor STC	Oil/sediment Separator	TSS/SSC 50-80%, Metals 0-80%, Petroleum Products 0-98%	50-83%	n/a	n/a	n/a	n/a	n/a	http://www.mastep.net/database/d_eval.cfm?recID=527&vID=43	
Stormceptor STC 450i	Oil/sediment Separator	Oil & Grease, 0-90%. SSC 54-87%	59.5% - 63.6% as SSC	n/a	n/a	n/a	n/a	n/a	http://www.mastep.net/admin/d_eval.cfm?recID=684&vID=6	This unit can be deployed in either an inlet or an inline configuration.
Stormvault	Oil/sediment Separator	77-87% as TSS	77-86%	23%	n/a	BDL	35.80%	n/a	http://www.mastep.net/database/sections_display.cfm?RecID=626&vID=41	
PermaPave Permeable Pavers	Porous Pavement	76-100% TSS, 17-52% TN, 29-82% TP	76-99%	17-52% TN, 29-82% TP	n/a	n/a	n/a	not quantified, but benefits were evident	http://www.mastep.net/database/d_eval.cfm?recID=773&vID=6	study, running simulated stormwater through pavement system
			100%							

CONSTRUCTION PERIOD POLLUTION PREVENTION & EROSION AND SEDIMETATION CONTROL PLAN

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control – May 28, 2013

SITE DESCRIPTION

Project Name and Location: (Latitude, Longitude, or Address)
Artis Assisted Living Facility
#1090 and 1100 Main Street
Reading, MA 01887
Note that a portion of the project locus is presently occupied by a nursery known as "Eric's Greenhouse".

Proponent Name and Address
Artis Senior Living, LLC
c/o Jason Erb
1651 Old Meadow Road
Mclean, VA 22102

Owner Name and Address
The Goddard Family Trust
Thomas Goddard, Trustee
#1090 Main Street
Reading, MA 01887

Description: (Purpose and Types of Soil Disturbing Activities)
The overall project is the redevelopment of two adjacent properties to accommodate the construction of a two-story, 65 bed, assisted living facility (nursing home), including associated building, walkways, utilities, parking lot and fire lane, drainage system, stormwater management and landscaping.

Soil disturbing activities include: installation of erosion and sediment control devices; removal of pavement; structures and other existing materials; vegetation clearing; excavation; installation of drainage structure and stormwater management BMPs; building construction; paving; walkway and fire lane construction; and final loaming, seeding and landscaping.

Sequence of Major Activities

The order of activities shall be as follows:

1. Prior to the start of earthwork, the Contractor shall arrange an on-site meeting with the Conservation Commission, Owner and Engineer for the purpose of establishing Contractor's schedule of operation and scheduling inspection procedures and requirements.

2. Install erosion and sediment control devices.

3. Establish equipment, material and soil staging areas. Soil piles to be surrounded by sedimentation controls.

4. Remove existing structures and materials as necessary (e.g. pavement, buildings, and remaining landscape materials)

5. Install retaining wall.

6. Commence site grading.

7. Install stormwater management, BMPs, drainage systems and, other utilities.

8. Install foundation and construct building structure.

9. Install walkways and fire lane.

10. Install binder coat of pavement, including curbing.

11. Loam and seed all disturbed areas.

12. Install final pavement course and final inspection of stormwater management BMPs.

CONTROLS

Erosion and Sediment Control Stabilization Practices

The Developer, Site Contractor, and/or designated Project Manager ("Manager") are responsible for ensuring that erosion and sedimentation control practices and controls are monitored and followed upon commencement of, and during project construction.

A. Protecting and Minimizing Exposed Areas

The project will temporarily leave bare earth open to erosion. Steps shall be taken to minimize this area of exposure by preserving existing vegetation and providing soil stabilization. Equipment and trucks shall be routed only over the existing pavement or areas of proposed work and workers shall minimize foot traffic in vegetated areas adjacent to the work area as much as possible. During site work, utilization of stabilization techniques is necessary for controlling erosion on exposed areas, including grading, seeding and otherwise stabilizing the areas.

B. Sediment And Erosion Control / Soil Stabilization

i) Prior to any construction occurring adjacent to identified resource areas (shown on the plan and/or marked in the field), proper erosion and siltation barriers shall be installed so that throughout and until completion of

construction, those areas will be afforded maximum protection. Temporary stockpiles of soil shall be surrounded with an erosion control barrier to prevent sediments from exiting the subject property. All erosion control barriers must be maintained in functioning condition and periodically inspected until areas of bare soil are stabilized to ensure that they are in functioning condition. Any accumulations of sediments present along erosion control barriers shall be removed as soon as possible after deposition in order to ensure the effectiveness of all sedimentation controls.

ii) On sites where grading or other work will occur on moderately steep slopes (3:1 and greater) located immediately upgradient of wetlands, the contractor shall work on one portion of the slope at a time, ensuring the stability of the disturbed soil by immediately loaming and seeding the slope, or otherwise vegetating the slope as desired, and installing erosion control mats (straw or cocoanut fiber designed for the slope steepness). If work is interrupted and the slope is to be left bare or otherwise unstabilized for duration of a day or more, a series of erosion control fences oriented parallel to the slope.

C. Vegetational Covers

1. Temporary Vegetational Cover

Any area proposed for removal of vegetation where soil will be exposed for more than 10 days shall be mulched, netted or otherwise treated to prevent erosion. On sediment-producing areas in the buffer zone, where the period of exposure will be more than 30 days, the following procedures should be followed for a cover of annual rye. When bare soils are not completely graded and vegetated by September 30 of any year, winter rye shall be planted as specified in table and mulched with three (3) inches of hay or straw. If soil conditions are inappropriate for planting, exposed areas shall be stabilized with jute netting, or mulched with at least 3" of straw mulch or other Natural Resource Conservation Service approved methods

a. Install needed surface water control measures.

b. Perform all cultural operations at right angles to the slope.

c. Establish grass or other ground cover species as recommended in the attached excerpt (pgs 144 -146) from Massachusetts Erosion and Sedimentation Guidelines for Urban and Suburban Areas, 2003.

2. Permanent Vegetational Cover

To reduce damages from the potential incidence of sedimentation and runoff to other properties, and to avoid erosion on the site itself, a permanent type cover shall be established in disturbed areas located adjacent to resource areas immediately upon completion of grading. Seeding herbaceous cover is usually the most economical and

practical way to stabilize any large area. For this site, all disturbed areas where lawns are desired will be seeded in fall during the period of August 1 to October 1; or in spring by May 15 with a commercial lawn mixture utilizing standard landscape methods and as recommended by the seed manufacturer. Grass sod or landscape plantings may be used instead of seed, if preferred.

In upland/ buffer zone areas, outside of lawn locations, where an erosion control - wildlife seed mixture is desired, prepare soil and use one of grass seed mixes #1 through #6 as recommended in the attached excerpts (pgs 136 -139) from Massachusetts Erosion and Sedimentation Guidelines for Urban and Suburban Areas 2003, to establish a stable, permanent cover.

REFERENCES

Department of Environmental Protection, Bureau of Resource Protection and U.S. Environmental Protection Agency, Massachusetts Erosion and Sedimentation Guidelines for Urban and Suburban Areas: A Guide for Planners, Designers and Municipal Officials. Massachusetts Executive Office of Environmental Affairs, Boston, Massachusetts, Reprint: May 2003.

Seeding Dates

Seeding operations should be performed as an early spring seeding (April 1-May 15) with the use of cold treated seed. A late fall early winter dormant seeding (November 1 - December 15) can also be made, however the seeding rate will need to be increased by 50%.

Seeding Methods

Seeding should be performed by one of the following methods:

- Drill seedings (de-awned or de-bearded seed should be used unless the drill is equipped with special features to accept awned seed).
- Broadcast seeding with subsequent rolling, cultipacking or tracking the seeding with small track construction equipment. Tracking should be oriented up and down the slope.
- Hydroseeding with subsequent tracking. If wood fiber mulch is used, it should be applied as a separate operation after seeding and tracking to assure good seed to soil contact.

Mulch

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.

Seed Mixtures for Permanent Cover

Recommended mixtures for permanent seeding are provided on the following pages. Select plant species which are suited to the site conditions and planned use. Soil moisture conditions, often the major limiting site factor, are usually classified as follows:

Dry - Sands and gravels to sandy loams. No effective moisture supply from seepage or a high water table.

Moist - Well drained to moderately well drained sandy loams, loams, and finer; or coarser textured material with moderate influence on root zone from seepage or a high water table.

Wet - All textures with a water table at or very near the soil surface, or with enduring seepage.

When other factors strongly influence site conditions, the plants selected must also be tolerant of these conditions.

Permanent Seeding Mixtures

Mix	Site	Seed Mixture	Seed, Pounds per: Acre	1,000 sf	Remarks
1	Dry	Little Bluestem or Broomsedge	10	0.25	* Use Warm Season planting procedure. * Roadsides
		Tumble Lovegrass*	1	0.10	* Sand and Gravel Stabilization
		Switchgrass	10	0.25	* Clover requires inoculation with nitrogen-fixing bacteria
		Bush Clover*	2	0.10	
		Red Top	1	0.10	* Rates for this mix are for PLS.
2	Dry	Deertongue	15	0.35	* Use Warm Season planting procedures.
		Broomsedge	10	0.25	* Acid sites/Mine spoil
		Bush Clover*	2	0.10	* Clover requires inoculation with nitrogen-fixing bacteria.
		Red Top	1	0.10	*Rates for this mix are for PLS.
3	Dry	Big Bluestem	10	0.25	* Use Warm Season planting procedures.
		Indian Grass	10	0.25	* Eastern Prairie appearance
		Switchgrass	10	0.25	* Sand and Gravel pits.
		Little Bluestem	10	0.25	* Golf Course Wild Areas
		Red Top or	1	0.10	* Sanitary Landfill Cover seeding
		Perennial Ryegrass	10	0.25	* Wildlife Areas *OK to substitute Poverty Dropseed in place of Red Top/Ryegrass. *Rates for this mix are for PLS.
4	Dry	Flat Pea	25	0.60	* Use Cool Season planting procedures
		Red Top or	2	0.10	* Utility Rights-of-Ways (tends to suppress woody growth)
		Perennial Ryegrass	15	0.35	
5	Dry	Little Bluestem	5	0.10	* Use Warm Season planting procedures.
		Switchgrass	10	0.25	* Coastal sites
		Beach Pea*	20	0.45	* Rates for Bluestem and Switchgrass are for PLS.
		Perennial Ryegrass	10	0.25	
6	Dry - Moist	Red Fescue	10	0.25	* Use Cool Season planting procedure.
		Canada Bluegrass	10	0.25	* Provides quick cover but is non-aggressive; will tend to allow indigenous plant colonization.
		Perennial Ryegrass	10	0.25	
		Red Top	1	0.10	* General erosion control on variety of sites, including forest roads, skid trails and landings.
7	Moist-Wet	Switchgrass	10	0.25	* Use Warm Season planting procedure.
		Virginia Wild Rye	5	0.10	* Coastal plain/flood plain
		Big Bluestem	15	0.35	* Rates for Bluestem and Switchgrass are for PLS.
		Red Top	1	0.10	

Permanent Seeding Mixtures

Mix	Site	Seed Mixture	Seed, Pounds per: Acre	1,000 sf	Remarks
8	Moist Wet	Creeping Bentgrass	5	0.10	* Use Cool Season planting procedures.
		Fringed Bromegrass	5	0.10	* Pond Banks
		Fowl Meadowgrass	5	0.10	* Waterways/ditch banks
		Bluejoint Reedgrass or Rice Cutgrass	2	0.10	
		Perennial Ryegrass	10	0.25	
9	Moist Wet	Red Fescue	5	0.10	*Salt Tolerant
		Creeping Bentgrass	2	0.10	* Fescue and Bentgrass provide low growing appearance, while Switchgrass provides tall cover for wildlife.
		Switchgrass	8	0.20	
		Perennial Ryegrass	10	0.25	
10	Moist Wet	Red Fescue	5	0.10	* Use Cool Season planting procedure.
		Creeping Bentgrass	5	0.10	* Trefoil requires inoculation with nitrogen fixing bacteria.
		Virginia Wild Rye	8	0.20	
		Wood Reed Grass*	1	0.10	* Suitable for forest access roads, skid trails and other partial shade situations.
		Showy Tick Trefoil*	1	0.10	
11	Moist Wet	Creeping Bentgrass	5	0.10	* Use Cool Season planting procedure.
		Bluejoint Reed Grass	1	0.10	* Suitable for waterways, pond or ditch banks.
		Virginia Wild Rye	3	0.10	* Trefoil requires inoculation with nitrogen fixing bacteria.
		Fowl Meadow Grass	10	0.25	
		Showy Tick Trefoil*	1	0.10	
		Red Top	1	0.10	
12	Wet	Blue Joint Reed Grass	1	0.10	* Use Cool Season planting procedure.
		Canada Manna Grass	1	0.10	* OK to seed in saturated soil conditions, but not in standing water.
		Rice Cut Grass	1	0.10	
		Creeping Bent Grass	5	0.10	* Suitable as stabilization seeding for created wetland.
		Fowl Meadow Grass	5	0.10	* All species in this mix are native to Massachusetts.
13	Dry - Moist	American Beachgrass	18"	18' centers	*Vegetative planting with dormant culms, 3-5 culms per planting centers
14	Inter-Tidal	Smooth Cordgrass Saltmeadow Cordgrass	12-18"	12-18" centers	* Vegetative planting with transplants. centers

Notes:

* Species such as Tumble Lovegrass, Fringed Bromegrass, Wood Reedgrass, Bush Clover and Beach Pea, while known to be commercially available from specific seed suppliers, may not always be available from your particular seed suppliers. The local Natural Resources Conservation Service office may be able to help with a source of supply. In the event a particular species listed in a mix can not be obtained, however, it may be possible to substitute another species.

Seed mixtures by courtesy of Natural Resources Conservation Service, Amherst, MA.

(PLS) Pure Live Seed

Warm Season grass seed is sold and planted on the basis of pure live seed. An adjustment is made to the bulk rate of the seed to compensate for inert material and non-viable seed. Percent of pure live seed is calculated by multiplying the percent purity by the percent germination; (% purity) x (% germination) = percent PLS.

For example, if the seeding rate calls for 10 lbs./acre PLS and the seed lot has a purity of 70% and germination of 75%, the PLS factor is:

(.70 x .75) =.53

10 lbs. divided by .53 = approx. 19 lbs.

Therefore, 19 lbs of seed from the particular lot will need to be applied to obtain 10 lbs. of pure live seed.

Special Note

Tall Fescue, Reed Canary Grass, Crownvetch and Birdsfoot Trefoil are no longer recommended for general erosion control use in Massachusetts due to the invasive characteristics of each. If these species are used, it is recommended that the ecosystem of the site be analyzed for the effects species invasiveness may impose. The mixes listed in the above mixtures include either species native to Massachusetts or non-native species that are not perceived to be invasive, as per the Massachusetts Native Plant Advisory Committee.

Wetlands Seed Mixtures

For newly created wetlands, a wetlands specialist should design plantings to provide the best chance of success. Do not use introduced, invasive plants like reed canarygrass (Phalaris arundinacea) or purple loosestrife (Lythrum salicaria). Using plants such as these will cause many more problems than they will solve.

The following grasses all thrive in wetland situations:

- Fresh Water Cordgrass (*Spartina pectinata*)
- Marsh/Creeping Bentgrass (*Agrostis stolonifera, var. Palustric*)
- Broomsedge (*Andropogon virginicus*)
- Fringed Bromegrass (*Bromus ciliatus*)
- Blue Joint Reed Grass (*Calamagrostis cavedensis*)
- Fowl Meadow Grass (*Glyceria striata*)
- Riverbank Wild Rye (*Elymus riparius*)
- Rice Cutgrass (*Leersia oryzoides*)
- Stout Wood Reed (*Cinna arundinacea*)
- Canada Manna Grass (*Glyceria canadensis*)

A sample wetlands seed mix developed by The New England Environmental Wetland Plant Nursery is shown on the following page.

Wetland Seed Mixture

The New England Environmental Wetland Plant Nursery has developed a seed mixture which is specifically designed to be used in wetland replication projects and stormwater detention basins. It is composed of seeds from a variety of indigenous wetland species. Establishing a native wetland plant understory in these areas provides quick erosion control, wildlife food and cover, and helps to reduce the establishment of undesirable invasive species such as Phragmites and purple loosestrife (Lythrum salicaria). The species have been selected to represent varying degrees of drought tolerance, and will establish themselves based upon microtopography and the resulting variation in soil moisture.

Common Name (*Scientific Name*)	% in Mix	Comments
Lurid Sedge (*Carex lurida*)	30	A low ground cover that tolerates mesic sites in addition to saturated areas; prolific seeder in second growing season.
Fowl Meadow Grass (*Glyceria Canadensis*)	25	Prolific seed producer that is a valuable wildlife food source.
Fringed Sedge (*Carex crinita*)	10	A medium to large sedge that tolerates saturated areas; good seed producer.
Joe-Pye Weed (*Eupatoriadelphus maculatus*)	10	Flowering plant that is valuable for wildlife cover. Grows to 4 feet.
Brook Sedge (*Carex spp., Ovales group*)	10	Tolerates a wide range of hydrologic conditions.
Woolgrass (*Scirpus cyperinus*)	5	Tolerates fluctuating hydrology.
Boneset (*Eupatorium perfoliatum*)	5	Flowering Plant that is valuable for wildlife cover. Grows to 3 feet.
Tussock Sedge (*Carex stricta*)	<5	Grows in elevated hummocks on wet sites, may grow rhizomonously on drier sites.
Blue Vervain (*Verbena hastata*)	<5	A native plant that bears attractive, blue flowers.

The recommended application rate is one pound per 5,000 square feet when used as an understory cover. This rate should be increased to one pound per 2,500 square feet for detention basins and other sites which require a very dense cover. For best results, a late fall application is recommended. This mix is not recommended for standing water.

Maintenance

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.

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

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.

Seeded areas should be fertilized during the second growing season. Lime and fertilize thereafter at periodic intervals, as needed.

References

North Carolina Department of Environment, Health, and Natural Resources, ***Erosion and Sediment Control Field Manual***, Raleigh, NC, February 1991.

Personal communication, Richard J. DeVergilio, USDA, Natural Resources Conservation Service, Amherst, MA.

U.S. Environmental Protection Agency, ***Storm Water Management For Construction Activities***, EPA-832-R- 92-005, Washington, DC, September, 1992.

Washington State Department of Ecology, ***Stormwater Management Manual for the Puget Sound Basin***, Olympia, WA, February, 1992.

Seeding, Temporary

Planting rapid-growing annual grasses, small grains, or legumes to provide initial, temporary cover for erosion control on disturbed areas.

Purpose

To temporarily stabilize areas that will not be brought to final grade for a period of more than 30 working days.

To stabilize disturbed areas before final grading or in a season not suitable for permanent seeding.

Temporary seeding controls runoff and erosion until permanent vegetation or other erosion control measures can be established.

Root systems hold down the soils so that they are less apt to be carried offsite by storm water runoff or wind.

Temporary seeding also reduces the problems associated with mud and dust from bare soil surfaces during construction.

Where Practice Applies

On any cleared, unvegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than one year. Applications of this practice include diversions, dams, temporary sediment basins, temporary road banks, and topsoil stockpiles.

Where permanent structures are to be installed or extensive re-grading of the area will occur prior to the establishment of permanent vegetation.

Areas which will not be subjected to heavy wear by construction traffic.

Areas sloping up to 10% for 100 feet or less, where temporary seeding is the only practice used.

Advantages

This is a relatively inexpensive form of erosion control but should only be used on sites awaiting permanent planting or grading. Those sites should have permanent measures used.

Vegetation will not only prevent erosion from occurring, but will also trap sediment in runoff from other parts of the site.

Temporary seeding offers fairly rapid protection to exposed areas.

Disadvantages/Problems

Temporary seeding is only viable when there is a sufficient window in time for plants to grow and establish cover. It depends heavily on the season and rainfall rate for success.

If sown on subsoil, growth will be poor unless heavily fertilized and limed. Because overfertilization can cause pollution of stormwater runoff, other practices such as mulching alone may be more appropriate. The potential for over-fertilization is an even worse problem in or near aquatic systems.

Once seeded, areas should not be travelled over.

Irrigation may be needed for successful growth. Regular irrigation is not encouraged because of the expense and the potential for erosion in areas that are not regularly inspected.

Planning Considerations

Temporary seedings provide protective cover for less than one year. Areas must be reseeded annual or planted with perennial vegetation.

Temporary seeding is used to protect earthen sediment control practices and to stabilize denuded areas that will not be brought into final grade for several weeks or months. Temporary seeding can provide a nurse crop for permanent vegetation, provide residue for soil protection and seedbed preparation, and help prevent dust production during construction.

Use low-maintenance native species wherever possible.

Planting should be timed to minimize the need for irrigation.

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, the soil surface itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Annual plants which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Temporary seeding is effective when combined with construction phasing so bare areas of the site are minimized at all times.

Temporary seeding may prevent costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of the basin is seeded where grading and construction are not taking place. Perimeter dikes will be more effective if not choked with sediment.

Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Soil that has been compacted by heavy traffic or machinery may need to be loosened. Successful growth usually requires that the soil be tilled before the seed is applied. Topsoiling is not necessary for temporary seeding; however, it may improve the chances of establishing temporary vegetation in an area.

Planting Procedures

Time of Planting

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

Site Preparation

Before seeding, install needed surface runoff control measures such as gradient terraces, interceptor dike/swales, level spreaders, and sediment basins.

Seedbed Preparation

The seedbed should be firm with a fairly fine surface.

Perform all cultural operations across or at right angles to the slope. See **Topsoiling** and **Surface Roughening** for more information on seedbed preparation. A minimum of 2 to 4 inches of tilled topsoil is required.

Liming and Fertilization

Apply uniformly 2 tons of ground limestone per acre (100 lbs. per 1,000 Sq. Ft.) or according to soil test.

Apply uniformly 10-10-10 analysis fertilizer at the rate of 400 lbs. per acre (14 lbs. per 1,000 Sq. Ft.) or as indicated by soil test. Forty percent of the nitrogen should be in organic form.

Work in lime and fertilizer to a depth of 4 inches using any suitable equipment.

Seedings for Temporary Cover

Species	*Seeding Rates lbs/sq.ft.* 1,000 Sq.Ft.	Acre	*Recommended* Seeding Dates
Annual Ryegrass	1	40	April 1 to June 1 Aug. 15 to Sept. 15
Foxtail Millet	0.7	30	May 1 to June 30
Oats	2	80	April 1 to July 1 August 15 to Sept. 15
Winter Rye	3	120	Aug. 15 to Oct. 15

"Hydro-seeding" applications with appropriate seed-mulch-fertilizer mixtures may also be used.

Seeding

Select adapted species from the accompanying table.

Apply seed uniformly according to the rate indicated in the table by broadcasting, drilling or hydraulic application.

Cover seeds with suitable equipment as follows:

- Rye grass — ¼ inch
- Millet — ½ to ¾ inch
- Oats — 1 to 1-1/2 inches
- Winter rye — 1 to 1-1/2 inches.

Mulch

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

Common Trouble Points

Lime and fertilizer not incorporated to at least 4 inches

May be lost to runoff or remain concentrated near the surface where they may inhibit germination.

Mulch rate inadequate or straw mulch not tacked down

Results in poor germination or failure, and erosion damage. Repair damaged areas, reseed and mulch.

Annual ryegrass used for temporary seeding
Ryegrass reseeds itself and makes it difficult to establish a good cover of permanent vegetation.
Seed not broadcast evenly or rate too low
Results in patchy growth and erosion.

Maintenance

Inspect within 6 weeks of planting to see if stands are adequate. Check for damage after heavy rains. Stands should be uniform and dense. Fertilize, reseed, and mulch damaged and sparse areas immediately. Tack or tie down mulch as necessary.

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

References

Massachusetts Department of Environmental Protection, Office of Watershed Management, Nonpoint Source Program, Massachusetts ***Nonpoint Source Management Manual***, Boston, Massachusetts, June, 1993.

North Carolina Department of Environment, Health, and Natural Resources, ***Erosion and Sediment Control Field Manual***, Raleigh, NC, February 1991.

U.S. Environmental Protection Agency, ***Storm Water Management For Construction Activities***, EPA-832-R- 92-005, Washington, DC, September, 1992.

Washington State Department of Ecology, ***Stormwater Management Manual for the Puget Sound Basin***, Olympia, WA, February, 1992.

Silt Curtain

A temporary sediment barrier installed parallel to the bank of a stream or lake. Used to contain the sediment produced by construction operations on the bank of a stream or lake and allow for its removal.

Where Practice Applies

The silt curtain is used along the banks of streams or lakes where sediment could pollute or degrade the stream or lake.

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Structural Practices

Silt Fencing/StrawBales– shall be installed as shown on the approved plans to help prevent erosion and sedimentation to the downstream wetland resources on the project. . The applicant shall maintain a minimum of 25 additional haybales with stakes as well as one-hundred (100) linear feet of silt fence with stakes on site for use as needed.

Deep Sump Catch Basins/ "Silt Sack" – shall be fitted with filter fabric or "Silt Sack" sediment control devices (or equivalent product) during construction to prevent the accumulation of sediments in the sumps. Catch basin structures are to be cleaned as needed during construction using a truck-mounted vacuum device

Stormwater Management

The proposed stormwater management plan in the drainage analysis outlines the impacts of stormwater runoff for the project as it related to the downstream areas of comparison. Elements incorporated in the design of the stormwater management plan include the following best management practices (BMPs):

1. Deep Sump Catch Basin with "Snout" Oil and Grit Separator and Gas Trap
2. Stormceptor STC 450i Water Quality Chambers
3. Cultec 100HD Roof Infiltration Chambers

Utilization of these BMPs as part of the overall watershed management plan will be instrumental in reducing the peak rate of runoff as well as the volume of runoff from the site into the wetland.

OTHER CONTROLS

Dust Control:

Minimizing wind erosion and controlling dust will be accomplished by one or more of he following methods.

A. Covering 30% or more of the soil surface with a non-erodible material.
B. Roughening the soil to produce ridges perpendicular to the prevailing wind
C. Frequent watering of locations where demolition, excavation, and fill activity.
D. Installation of a gravel tracking pad at parking lot entrance/exit.
E. Removal of any accumulated sediments present in the on-site paved parking lot or Main Street by street sweeping, as required.

Waste Disposal:

Waste Materials: all waste material shall be collected and stored in secure metal dumpsters rented from a licensed solid waste management company in Massachusetts. The dumpsters shall meet all local and State solid waste management regulations as outlined in 310 CMR 19.00. All trash and construction debris generated on site shall be disposed of in the dumpsters. The dumpsters shall be emptied as often as necessary during construction and transferred to an approved solid waste facility licensed to accept

municipal solid waste and/or construction and demolition debris. No construction waste shall be buried on site. All personnel shall be instructed regarding the correct procedure for waste disposal.

Hazardous Waste: All hazardous waste materials shall be disposed of in a manner specified by local or State regulation or by the manufacturer. Site personnel shall be instructed in these practices.

Sanitary Waste: All sanitary waste shall be collected from portable units, as needed, by a septage hauler licensed in Massachusetts, in accordance with the requirements of the local Board of Health.

TIMING OF CONTROLS/MEASURES

As indicated in the Sequence of Major Activities, the installation of erosion and sediment control devices shall be in place prior to major earth excavation activities. Areas where construction activities are exposed more than two months, but less than 12 months shall be stabilized with the temporary stabilization practices referred to above. Once construction activity is completed in an area, that area shall be stabilized with permanent seed and mulch.

MAINTENANCE/INSPECTION PROCEDURES

The Developer, Site Contractor, and/or designated Project Manager ("Manager") are responsible for ensuring that erosion and sedimentation control practices and controls are monitored, maintained, and followed upon commencement of, and during project construction.

Erosion and Sediment Control Inspection and Maintenance Practices

The following items represent the inspection and maintenance practices that shall be used to maintain sediment and erosion control for the project.

1. All control measures shall be inspected at least once every seven (7) days and following any storm event of 0.25 inches or greater.
2. All measures shall be maintained in good working order; if a repair is necessary, it shall be initiated within 24 hours of the report.
3. Built up sediment shall be removed from erosion control when it has reached one-third the height of the fence.
4. Siltation Control shall be inspected for depth of sediment and tears.
5. The deep sump catch basin shall be inspected for inlet elevation relative to current surface condition; condition of "Silt Sack", and degree to which sediment has accumulated at the inlet and in the sump of the structure.

6. Temporary and permanent seeding and any plantings shall be inspected for bare spots, washouts, and healthy growth.
7. A maintenance inspection report shall be prepared following each inspection. A copy of the report form to be completed by the inspector is attached with this document.
8. The Site Contractor/ Project Manager ("Manager") shall select three individuals who will be responsible for inspections, maintenance and repair activities. The "Manager" shall be responsible for filling out the inspection and maintenance report.
9. Personnel selected for inspections and maintenance responsibilities shall receive training from the "Manager". They will be trained in all the inspection and maintenance practices necessary for keeping the erosion and sediment control devices used on site in good working order.

Non-Stormwater Discharges

It is expected that the following non-stormwater discharges will occur from the site during the construction period:

1. Pavement wash waters which shall not be directed to unstabilized earth surfaces.

INVENTORY FOR POLLUTION PREVENTION PLAN

The materials or substances listed below are expected to be present on site during construction:

- Concrete
- Fertilizers
- Petroleum Based Products
- Tar
- Waterproofing Materials

SPILL PREVENTION

The following are the material management practices that shall be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff.

Equipment fueling and Storage:

Equipment shall be stored in locations outside of the buffer zone at the end of the day. Fuels and lubricants shall not be temporarily or permanently stored on site.

Good Housekeeping:

The following good housekeeping practices must be followed on site during the construction project.

1. A concerted effort shall be made to store only enough product required to complete a particular task

2. All materials stored on site shall be stored in a neat and orderly fashion in their appropriate containers and, if possible, under a roof or other secure enclosure
3. Products shall be kept in their original containers with the original manufacture's label
4. Substances shall not be mixed with one another unless recommended by the manufacturer
5. Whenever possible, all of a product shall be used up before disposing of the container
6. Manufacture's recommendations for proper use and disposal shall be followed
7. The site superintendent shall inspect daily to ensure proper use and disposal of materials on site.

Hazardous Products:

Then following practices are intended to reduce the risks associated with hazardous materials.

1. Products shall be kept in original containers unless they are not re-sealable
2. Where feasible, the original labels and material safety data shall be retained, whereas they contain important product information
3. If surplus product must be disposed, follow manufacturer's or local and State recommended methods for proper disposal.

PRODUCT SPECIFIC PRACTICES

The following product specific practices shall be followed on site:

Petroleum Products:

All on site vehicles shall be monitored for leaks and receive regular preventative maintenance to reduce the risk of leakage. Any refueling shall take place outside of the buffer zone. Petroleum products shall be stored outside the buffer zone in tightly sealed containers which are clearly labeled. Any bituminous concrete or asphalt substances used on site shall be applied according to the manufacturer's recommendations. All equipment shall be parked outside of the 100' Buffer Zone at the end of the day and no temporary storage of fuels or lubricants shall be allowed.

Fertilizers:

Fertilizers shall be applied in the minimum amounts recommended by the manufacturer. Once applied, fertilizers shall be worked into the soil to limit exposure to stormwater. Storage shall be in a covered shed or trailer. The contents of any partially used bags of fertilizers shall be transferred to a sealable plastic bag or bin to avoid spills.

Paints:

All containers shall be tightly sealed and stored when not required for use. Excess paint shall not be discharged into any catch basin, drain manhole or any portion of the

stormwater management system. Excess paint shall be properly disposed of according to manufacturer's recommendations or State and local regulations.

Concrete Trucks:

Concrete trucks shall not be allowed to wash out or discharge surplus concrete or drum wash water on site.

SPILL CONTROL PRACTICES

The Site Contractor / Project Manager ("Manager") is responsible for ensuring that spill control practices are followed upon commencement of, and during project construction.

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

1. Manufacturer's recommended methods for cleanup for on-site materials must be readily available at the Dealership offices, and site personnel shall be made aware of the procedures and the location of the information.
2. Materials and equipment necessary for spill cleanup shall be kept in the material storage area on site. Equipment and materials shall include, but not be limited to sediment barrier in front of inlet, brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand sawdust, and plastic and metal trash containers specifically for this purpose. Oil absorbent socks shall be available to protect catch basin inlets. All spills shall be cleaned up immediately after discovery.
3. The spill area shall be kept well ventilated and personnel shall wear appropriate protective clothing to prevent injury from contact with hazardous substance.
4. Spills of toxic or hazardous material shall be reported to the appropriate State and/or local authority in accordance with local and/or State regulations.
5. The spill prevention plan shall be adjusted to include measures to prevent a particular type of spill from reoccurring and how to clean up the spill if there is another occurrence. A description of the spill, what caused it, and the clean up measures shall also be included.
6. The "Manager" shall be the spill preventions and cleanup coordinator. The "Manager" shall designate at least three other site personnel who will be trained in the spill control practices identified above.

ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MA
CONSTRUCTION POLLUTION PREVENTION PLAN
INSPECTION AND MAINTENANCE REPORT FORM

INSPECTION TO BE COMPLETED EVERY 14 DAYS AND WITHIN 24 HOURS OF A RAINFALL EVENT OF 0.25 INCHES OR GREATER DURING CONSTRUCTION PERIOD

Inspector: _____ Date: _____

Inspector's Title: _____

Days Since Last Rainfall: _____ Amount of Last Rainfall: _____

Structural Controls: Siltation Control			
Description	Avg. Depth of Sediment (inches)	Tears (yes/no) Circle one	Overall Condition and Function Circle one
Silt fence/ haybales (At limit of work)		yes – no	Poor Fair Good
"Silt Sack" Sediment control device (at CB's)		yes – no	Poor Fair Good

Maintenance Required: _____

_____

To Be Performed By: _____ On or Before: _____

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control – May 28, 2013

ARTIS ASSISTED LIVING FACILITY
#1090 AND 1100 MAIN STREET
READING, MA
CONSTRUCTION POLLUTION PREVENTION PLAN
INSPECTION AND MAINTENANCE REPORT FORM

INSPECTION TO BE COMPLETED EVERY 14 DAYS AND WITHIN 24 HOURS OF A RAINFALL EVENT OF 0.25 INCHES OR GREATER DURING CONSTRUCTION PERIOD

Inspector: _____ Date: _____

Inspector's Title: _____

Days Since Last Rainfall: _____ Amount of Last Rainfall: _____

	BMP	BMP Installed at Grade? (circle one)		BMP Maintenance Required? (circle one)		Corrective Action Needed And Notes
3	Cultec 100HD Chambers	Yes	No	Yes	No	
4	Catch basins and Yard Drains	Yes	No	Yes	No	
5	Granite Curb Level Spreader	Yes	No	Yes	No	
6	Stormceptor STC 450i Chambers	Yes	No	Yes	No	

WATERSHED MAPS

EXISTING CONDITIONS WATERSHED MAP

READING, MASS.

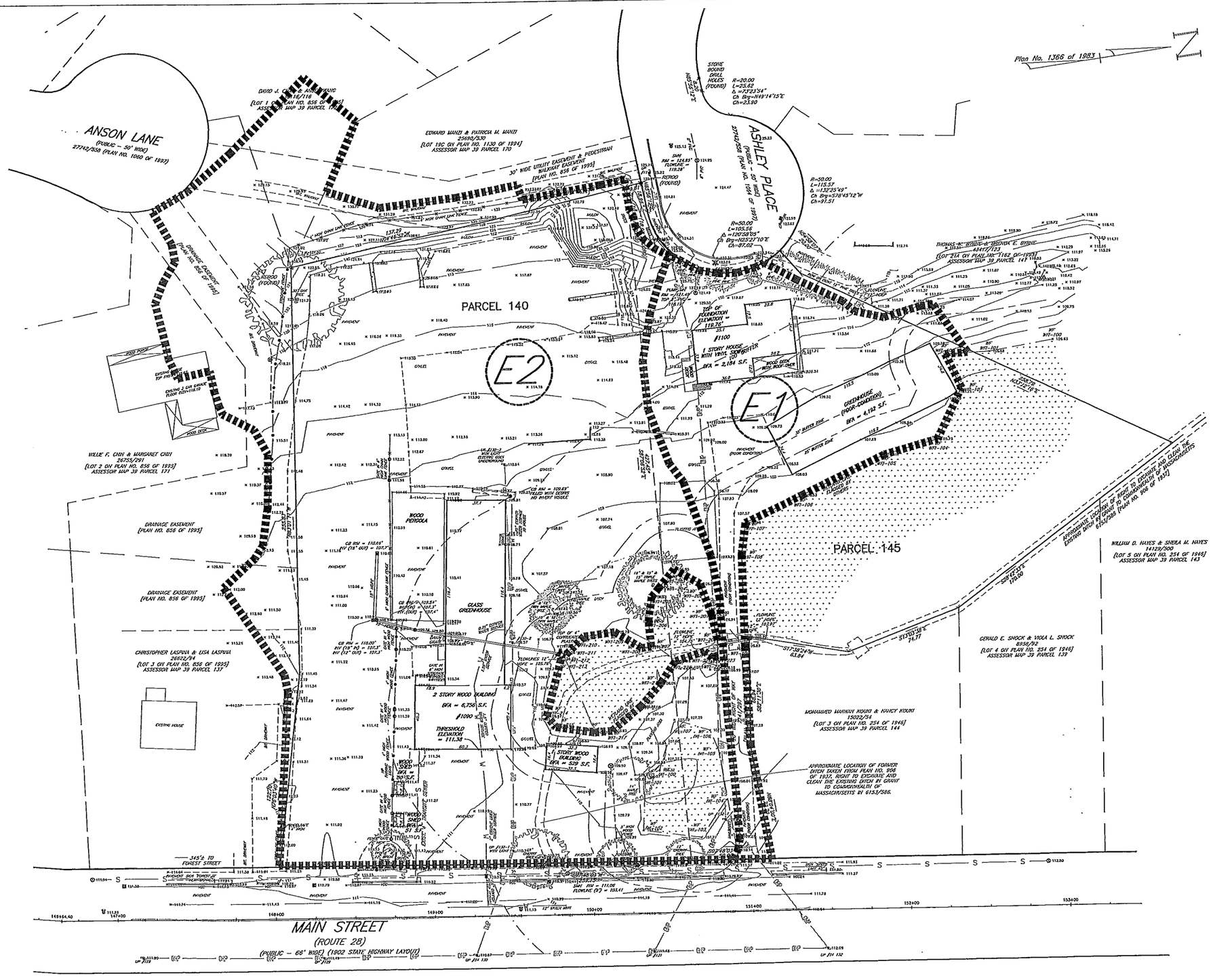
Hayes Engineering, Inc.
Civil Engineers & Land Surveyors
603 Salem Street
Wakefield, MA 01880

Telephone: 781.246.2800
Facsimile: 781.246.7596
www.hayeseng.com

Scale: 1" = 30' 0' 15' 30' 60'

May 29, 2013

#1090 & #1010 MAIN STREET



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PROPOSED CONDITIONS WATERSHED MAP

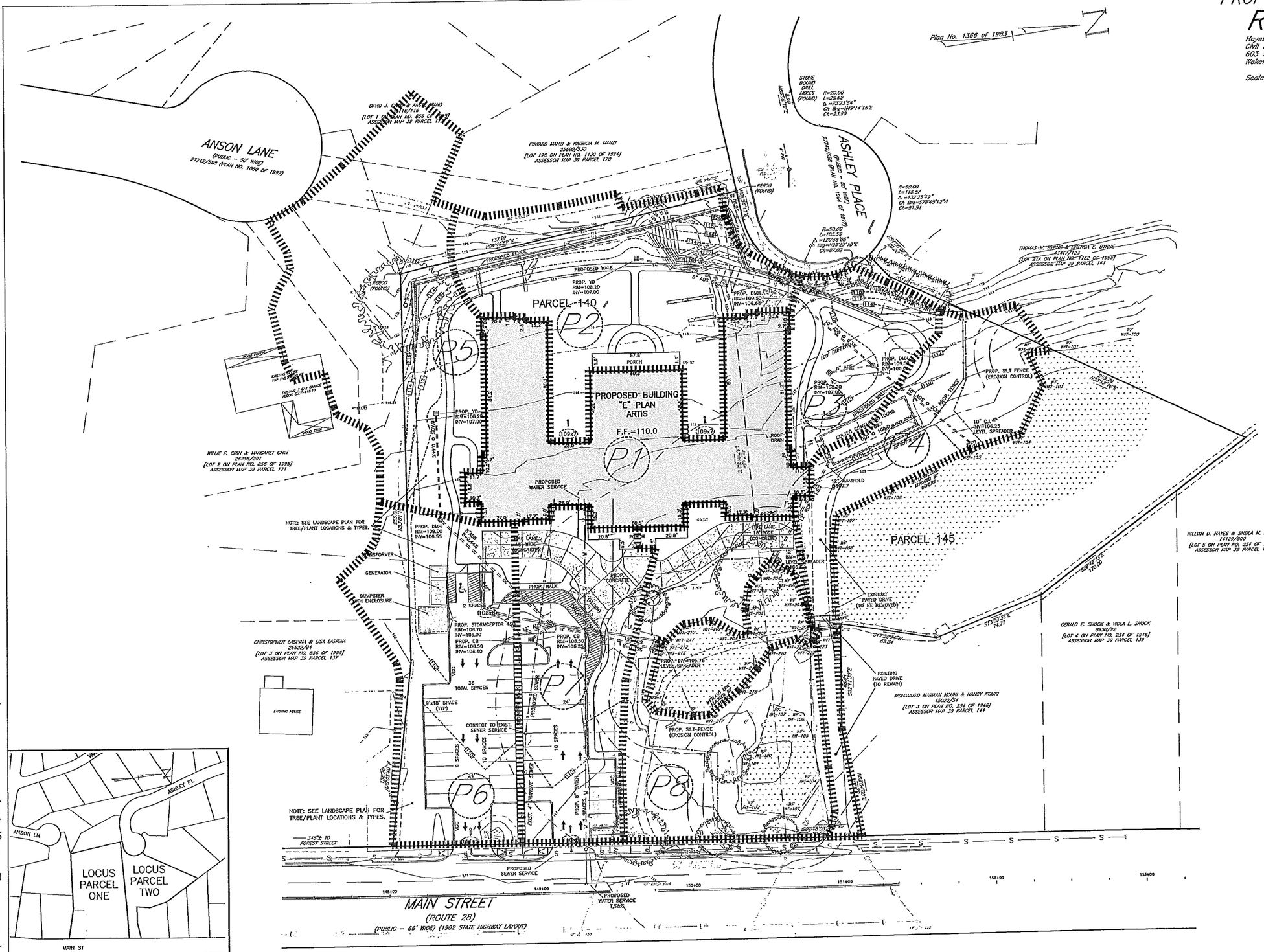
READING, MASS.

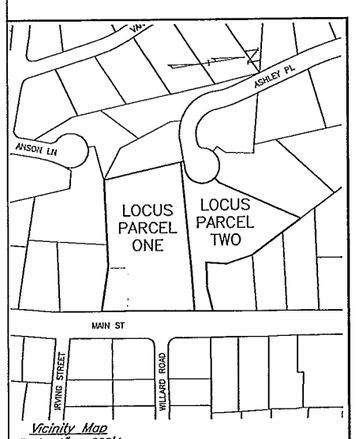
Hayes Engineering, Inc.
Civil Engineers & Land Surveyors
603 Salem Street
Wakefield, MA 01880

Telephone: 781.246.2800
Facsimile: 781.246.7596
www.hayeseng.com

Scale: 1" = 30' 0' 15' 30' 60' May 29, 2013

#1090 & #1010 MAIN STREET





Vicinity Map
Scale: 1" = 200'±

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