STORM DRAIN AND SWALE CAPACITY
for
HERRING BROOK MEADOWS
SCITUATE, MA

Calculate Peak Discharges for Subcatchment Areas using Rational Method (25-Year Design Flood Frequency):

$$Q = C\ i\ A$$

where:

Q = Peak Discharge Flowrate (ft.^{3} / second)
C = Runoff Coefficient
i = Average Rainfall Intensity (in. / hr.) for a Storm Duration Equal to the Time of Concentration, T_c
A = Drainage Area (acres)

Calculate Storm Drain Diameter Assuming Full Flow Conditions using Manning Equation:

$$D = 1.335\left(\frac{n\,Q}{\sqrt{S}}\right)^{\frac{3}{8}}$$

where:

D = Storm Drain Diameter (ft.)
n = Manning Roughness Coefficient
Q = Flowrate (ft.^{3} / sec.)
S = Slope of Storm Drain (ft. / ft.)

Calculate Stone Lined Channel Capacity Assuming Full Flow Conditions using Manning Equation:

$$V = \frac{Q}{A} = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

where:

Q = Flowrate (ft.^{3} / sec.)
V=Velocity (ft/sec)
A = Cross Sectional Area of Swale (ft^2)
r =Hydraulic Radius $= \frac{a}{p_w} = \frac{Area(ft^2)}{WettedPerimeter(ft)}$
n = Manning Roughness Coefficient
s = Slope of Storm Drain (ft. / ft.)

FLOWS FROM CATCH BASIN 1:

CRITERIA:

A = 59,147 ft.^{2} = **1.358 Acres**
Impervious Areas = 1.122 Acres
Pervious Areas = 0.237 Acres
T_c = Assumed to be less than 5 minutes
i = 5.3 in / hr. (See attached Intensity – Duration – Frequency Curve for Barnstable, MA)

$C_{impervious}$ = 0.90 (Paved Parking Area)
$C_{pervious}$ = 0.20

ANALYSIS:

$$C_{avg} = \frac{(1.122\ acres)(0.9) + (0.237\ acres)(0.2)}{1.358\ acres} = 0.778$$

$$Q = (0.778)\left(5.3\frac{in.}{hr.}\right)(1.358\ acres) = 5.60\frac{ft.^3}{\text{sec}.}$$

$$D = 1.335\left(\frac{n\,Q}{\sqrt{S}}\right)^{\frac{3}{8}} = 1.335\left(\frac{0.011\,(5.60)}{\sqrt{0.006}}\right)^{\frac{3}{8}} = 1.23\ ft. = 14.84\ inches$$

USE 15" HDPE Storm Drain with S = 0.006 ft / ft
(When Q = 5.60 ft.^{3} / sec., velocity 5.51 ft. / sec.)
Maximum Capacity = 5.92 ft.^{3} / sec.

FLOWS FROM CATCH BASIN 2:

CRITERIA:

A = 33,308 ft.^{2} = **0.765 Acres**

Impervious Areas = 0.293 Acres

Pervious Areas = 0.472 Acres

T_c = Assumed to be less than 5 minutes

i = 5.3 in / hr. (See attached Intensity – Duration – Frequency Curve for Barnstable, MA)

$C_{impervious}$ = 0.90 (Paved Parking Area)

$C_{pervious}$ = 0.20

ANALYSIS:

$$C_{avg} = \frac{(0.263\ acres)(0.9) + (0.472\ acres)(0.2)}{0.765\ acres} = 0.43$$

$$Q = (0.43)\left(5.3\frac{in.}{hr.}\right)(0.765\ acres) = 1.74\frac{ft.^3}{\text{sec.}}$$

$$D = 1.335\left(\frac{n\,Q}{\sqrt{S}}\right)^{\frac{3}{8}} = 1.335\left(\frac{0.011\,(1.74)}{\sqrt{0.006}}\right)^{\frac{3}{8}} = 0.79\ ft. = 9.48\ inches$$

USE 12" HDPE Storm Drain with S = 0.006 ft / ft
(When Q = 1.74 ft.^{3} / sec., velocity = 4.07 ft. / sec.)
Maximum Capacity = 3.27 ft.^{3} / sec.

FLOWS FROM CATCH BASIN 3:

CRITERIA:

A = 27,423 ft.^{2} = **0.630 Acres**
Impervious Areas = 0.342 Acres
Pervious Areas = 0.287 Acres
T_c = Assumed to be less than 5 minutes
i = 5.3 in / hr. (See attached Intensity – Duration – Frequency Curve for Barnstable, MA)

$C_{impervious}$ = 0.90 (Paved Parking Area)
$C_{pervious}$ = 0.20

ANALYSIS:

$$C_{avg} = \frac{(0.342\ acres)(0.9) + (0.287\ acres)(0.2)}{0.604\ acres} = 0.605$$

$$Q = (0.605)\left(5.3\frac{in.}{hr.}\right)(0.604\ acres) = 1.94\frac{ft.^3}{\sec.}$$

$$D = 1.335\left(\frac{n\,Q}{\sqrt{S}}\right)^{\frac{3}{8}} = 1.335\left(\frac{0.011\,(1.94)}{\sqrt{0.0065}}\right)^{\frac{3}{8}} = 0.81\ ft. = 9.72\ inches$$

USE 12" HDPE Storm Drain with S = 0.0065 ft / ft
(When Q = 1.94 ft.^{3} / sec., velocity = 4.29 ft. / sec.)
Maximum Capacity = 3.40 ft.^{3} / sec.

COMBINED FLOWS:

Flows from CB1, CB2 and CB3

5.60cfs + 1.74cfs + 1.94cfs = **9.28 cfs**

ANALYSIS:

$$D = 1.335\left(\frac{n\,Q}{\sqrt{S}}\right)^{\frac{3}{8}} = 1.335\left(\frac{0.011\,(9.28)}{\sqrt{0.006}}\right)^{\frac{3}{8}} = 1.48\ ft. = 17.78\ inches$$

USE 18" HDPE Storm Drain with S = 0.006 ft / ft
(When Q = 9.28 ft.^{3} / sec., velocity = 6.21 ft. / sec.)
Maximum Capacity = 9.64 ft.^{3} / sec.

GRASSED STORMWATER QUALITY SWALE CAPACITY CALCUALTIONS:

CRITERIA:

Minimum channel dimensions:
- 10 ft Channel Bottom
- 0.5 ft. Minimum Channel Depth
- 3:1 channel side slope
- Minimum slope of 0.005 ft /ft
- Manning's Roughness Coefficient = 0.030
- r =Hydraulic Radius $= \frac{a}{p_w} = \frac{13 ft^2}{16.32 ft} = 0.796 ft$

ANALYSIS:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} = \frac{1.49(0.79 ft)^{\frac{2}{3}}(0.005 ft / ft)^{\frac{1}{2}}}{0.06} = 1.50 \frac{ft}{s}$$

$$Q = VA = 1.50 \frac{ft}{s} \times 13 ft^2 = 19.51 \frac{ft^3}{s}$$

This channel provides a capacity of 19.51 ft^3/s at a slope of 0.005 ft / ft assuming the minimum channel dimensions specified. This channel will provide sufficient capacity for a maximum peak discharge of 9.28 ft^3/s.

ATTACHMENT C

Revised Total Suspended Solids Removal Calculation Worksheet

TSS Removal Calculation Worksheet

Total Suspended Solid Removal Calculation Worksheet 1

Location: ***126 - 132 Chief Justice Cushing Highway***
Scituate, Massachusetts 02066

A BMP	B TSS Removal Rate	C Starting TSS Load*	D Amount Removed (BxC)	E Remaining Load (C-D)
Pavement Sweeping	10%	1.00*	0.10	0.90
Deep Sump Catch Basin	25%	0.90	0.23	0.68
CDS Stormwater Treatment Unit	80%	0.68	0.54	0.14
Stormwater Quality Swale	70%	0.14	0.10	0.04

Total TSS Removal= 97%

Project: Herring Brook Meadow

Prepared By: AJM

Date: 9/17/2007

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

(Refer to Stormwater Management Plan, Sheet 5 of 11)

ATTACHMENT D

Revised Operation and Maintenance Plan

STORMWATER MANAGEMENT SYSTEM
OPERATION AND MAINTENANCE PLAN

September 17, 2007

HERRING BROOK MEADOW
RESIDENTIAL COMMUNITY

126 – 132 Chief Justice Cushing Highway
Scituate, Massachusetts 02066

An important element of the overall stormwater management system is the regular maintenance of the control components. Specifically, the effectiveness of the sediment control components (silt/erosion fencing) is dependent upon their continued maintenance and repair. These components are particularly important in locations where upgradient areas are not fully stabilized and may be subject to erosion. As natural deterioration of these barriers occurs, replacement and/or repair efforts must be coordinated by removing the accumulated sediment and extending the barrier laterally, as required.

Extreme weather conditions can serve to highlight the need for a vigorous maintenance program as well as a need to fine-tune and improve upon the system's design. The following section outlines a recommended plan for long term maintenance and immediate repair and improvement of the sediment controls.

The performance of the proposed maintenance program shall include the following responsibilities and authorities:

During Construction:

Silt/erosion fencing installed along the perimeter of the project site shall be inspected frequently by the supervising engineer and/or the contractor during construction. Should there be indications of damage or deterioration of these devices, they shall be removed and replaced immediately.

Supplemental haybale check dams shall be placed around all catch basin inlets, including the CDS stormwater treatment unit inlet, as well as the rip rap area adjacent to the storm drain outfall at the proposed concrete headwall. These will prevent the transmission of sediments into stormwater controls while vegetation is being established. Any accumulated sediments within these controls shall be manually removed.

In order for the owner to respond to the performance requirements outlined above, the owner shall be required to maintain a small supply of haybales on-site for emergency stabilization and repair work. The implementation of the recommended repair work and maintenance program will improve the long-term effectiveness of the stormwater control structures.

Routine System Maintenance:

After the completion of construction, the roadways and stormwater management system shall be inspected and maintained by the owner or homeowners association. Routine inspections and maintenance shall be conducted on the catch basins including the stormwater treatment unit, drainage manholes, the grassed water quality swale and rip rap areas. Accumulated sediment shall be removed in these stormwater controls a minimum of four (4) times a year or if accumulated sediment affects the performance of the stormwater management system. Disposal of the accumulated sediment must be in accordance with applicable local, state and federal guidelines and regulations. Refer to the Operation & Maintenance Guidelines for the CDS Stormwater Treatment Unit attached to this Operation & Maintenance Plan.

Sweeping of the pavement shall be conducted on the site bi-annually, once in the spring and once in the fall, unless more frequent sweeping is required. This will further limit sediment accumulation in the catch basins and adjacent down-gradient areas.