

8 LILLY POND ROAD

BOXFORD, MASSACHUSETTS

Calculations of Drainage System Components

Introduction

100-year storm – Rainfall for North Reading (NOAA Atlas 14):

(8.10" – Point Precipitation Frequency Estimates for Boxford, MA)

Corresponding runoff over impervious area, for curve number CN=98: $8.10" = 0.675'$

Corresponding runoff over existing wood / grass combination area with Hinkley Soil (HSG "A"), for curve number CN=32: $0.67" = 0.06'$

The Property Owner is planning to replace a dirt road on site with a paved one (6,500+/- s.f.) leading to the proposed house (3,383+/- s.f.) As of now, the proposed project area is a wood / grass combination, it does not have any storm drainage facility, and storm water runs off the site without any mitigation.

As shown on Proposed Plan of Land, the owner suggests mitigating the proposed roof (3,387 s.f.) runoff with 3 sets of Infiltration Chambers installed in the areas with original soil infiltration parameters. The site composed of Hinkley and Windsor loamy sands (HSG "A") and adjacent Merrimac sandy loam, and has the pre-development curve number CN=32 with corresponding runoff over wood / grass combination area $0.67" = 0.06'$

The Town of Boxford requires 0.8" of runoff over the roof to be retained and mitigated by infiltration. The remaining 8.02" (100-yr storm) will form the post-development runoff from the 3,387 s.f. building roof.

Estimated Existing Runoff:

Estimated Existing Runoff Volume from the Project Area for 100-year storm (Wood / Grass Combination, Weighted CN = 38) is 0.406 af = **17,685 c.f.** (Total Runoff Area = 4.246 ac = 184,956 s.f. Average Runoff Depth = 1.15" = 0.0958', 96.13% Pervious, and 3.87% Impervious Area)

Proposed Runoff:

Proposed Site Runoff Volume for 100-year storm (Wood / Grass Combination, Weighted CN = 40 - Outside of Proposed Building Roof Area) is 0.464 af = **20,212 c.f.** (Total Runoff Area = 4.168 ac = 181,558 s.f. Average Runoff Depth = 1.33" = 0.1108', 94.27% Pervious, and 5.73% Impervious Area)

20,212 c.f. - 17685 c.f. = 2,527 c.f. - runoff increase on site due to site development (1.86% increase of Impervious Area.)

Proposed Building Roof Runoff: $3,387 \text{ s.f.} * (8.10" / 12 \text{ in/ft}) = 3,387 \text{ s.f.} * 0.675' = \mathbf{2,286 \text{ c.f.}}$

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Calculations of Drainage System Components (continued)

As it was mentioned above, The Town of Boxford requires 0.8" of runoff over the roof to be mitigated by infiltration. This portion of the roof runoff will be collected with a gutter and downspouts and the volume of water to be mitigated is calculated as follows (For Designations see attached Post – Development Plan):

PRS-1	1,175 s.f. building * 0.8"/12"/ft. = 78.3 c.f.
PRS-2	1,400 s.f. building * 0.8"/12"/ft. = 93.3 c.f.
PRS-3	812 s.f. building * 0.8"/12"/ft. = 54.2 c.f.

In according to indicated roof segments, as for storm drainage facility, the project suggests to build 3 groups of infiltration chambers Cultec R-180 HD which will allow to accommodate the required portion of impervious area proposed stormwater runoff increase, and infiltrate it on site.

Infiltration Chambers Settings

Chamber: Cultec R-180 HD

Length: 6.33' (Assembled + 0.5' @ each end); Width: 3.0'; Height 1.71'; Volume: 21.8 c.f.

Depth: 1.71' + 6" crushed stone base = 2.21'; Void ratio: 0.40; Infiltration: 2.41 in./hr. = 4.82 ft. /day

The soil tests on site show an acceptable Infiltration Soil Depth of 2 feet as required separation from the bottom of infiltration system to ESHWT) at all of the proposed Infiltration System locations. (All infiltration occurs in Loamy Sand Stratum based on Results of Soil Tests)

Group PRS-1 (3 chambers):

Crushed stone area: 9'x 26' (3' stone around) = 234 s.f.

Chambers Capacity: 21.8 c.f. x 3 = 65.4 c.f.

Crushed Stone Storage: [234 s.f. * 2.21' - 65.4 c.f.] * 0.4 = 180.7 c.f.

Infiltration Capacity = 234 s.f. * 4.82' = 1,127.9 c.f.

Bulk storage Group PRS-1 (3 chambers): = Chambers Capacity + Crushed Stone Storage + Infiltration Capacity = 65.4 c.f. + 180.7 c.f. + 1,127.9 = 1,374 c.f.

Group PRS-2 (4 chambers)

Crushed stone area: 18'x 20' (3' stone around) = 360 s.f.

Chambers Capacity: 21.8 c.f. x 4 = 87.2 c.f.

Crushed Stone Storage: [360 s.f. * 2.21' - 87.2 c.f.] * 0.4 = 283.4 c.f.

Infiltration Capacity = 360 s.f. * 4.82' = 1,735.2 c.f.

Bulk storage Group PRS-2 (4 chambers): = Chambers Capacity + Crushed Stone Storage + Infiltration Capacity = 87.2 c.f. + 283.4 c.f. + 1,735.2 = 2,105.8 c.f.

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Group PRS-3 (3 chambers)

Crushed stone area: 9' x 26' (3' stone around) = 234 s.f.

Chambers Capacity: 21.8 c.f. x 3 = 65.4 c.f.

Crushed Stone Storage: [234 s.f. * 2.21' - 65.4 c.f.] * 0.4 = 180.7 c.f.

Infiltration Capacity = 234 s.f. * 4.82' = 1,127.9 c.f.

Bulk storage Group PRS-3 (3 chambers): = Chambers Capacity + Crushed Stone Storage + Infiltration Capacity = 65.4 c.f. + 180.7 c.f. + 1,127.9 = 1,374 c.f.

78.3 c.f. (Segment-1 Roof Runoff) << 1,374 c.f. (Infiltration System-1 Capacity) - OK

93.3 c.f. (Segment-2 Roof Runoff) << 2,105 c.f. (Infiltration System-2 Capacity) - OK

54.2 c.f. (Segment-3 Roof Runoff) << 1,374 c.f. (Infiltration System-3 Capacity) - OK

Total Storage & Infiltration System Capacity: 1,374 + 2,105.8 + 1,374 = **4,853 c.f.**

Total Runoff Increase due to Site Development:

2,527 c.f. (1.86% increase of Impervious Area) + **2,286 c.f.** (Prop. Building Roof Runoff) = **4,813 c.f.**

4,813 c.f. < 4,853 c.f. - O.K.

so 3 Groups of total 10 Infiltration Chambers Cultec R-180 HD with 828 s.f. of Crushed Stone area will accommodate an entire (100%) of the 100-yr Storm Runoff Increase from Site Development (1.86% increase of Impervious Area & Building Roof)

Standard 3. Infiltration System Drawdown Time.

The Soils on the site were classified as Hinckley & Windsor Loamy Sands (66.7%) - HSG A and Merrimac Sandy Loam (33.3%) - HSG B. The whole Infiltration System is located within Hinckley Loamy Sands area - HSG A.

Infiltration: 2.41 inches / hour, as suggested by Rawls Rates Chart (see below).
An infiltration structure is proposed to meet Standard 3.

The total calculated 0.8" runoff from the proposed building roof is (78.3 c.f. + 93.3 c.f. + 54.2 c.f. = 225.8 c.f. - say 226 c.f.), and distributed uniformly into 3 groups of 10 infiltration chambers with total (storage & infiltration) capacity of 4,853 c.f. The total infiltration area of proposed chamber groups is 828 s.f. Determine if the proposed infiltration system will draw down the 226 c.f. of water within 72 hours.

Drawdown rate = 2.41 inches per hour (Rawls Rate for Loamy Sand) * 1 ft. / 12 inches * 828 s.f. = 166.3 c.f. / hour (see chart below);

So Drawdown time = 226 c.f. / 166.3 c.f./ hour = 1.36 hours < 72 hours, so the result is satisfactory for design purposes.

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Calculations of Drainage System Components (continued)

1982 Rawls Rates

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate (Inches / Hour)
Sand	A	8.27
Loamy Sand	A	2.41
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	0.27
Sandy Clay Loam	C	0.17
Clay Loam	D	0.09
Silty Clay Loam	D	0.06
Sandy Clay	D	0.05
Silty Clay	D	0.04
Clay	D	0.02

Infiltration Trench Analysis:

Contributing Areas:

(Eastern Slope of Sub-Catchment PRW) – 24,970 s.f.
Average Runoff Depth = 1.10" (0.092') for Weighted CN = 38
Estimated Runoff: 24,970 s.f. * 0.092' = 2,297 c.f.

Access Road – 6,520 s.f.
Runoff Depth = 8.10" (0.675') for Impervious Area CN = 98
Estimated Runoff: 6,520 s.f. * 0.675' = 4,401 c.f.

Total Contributing Runoff into Infiltration Area: 2,297 c.f. + 4,401 c.f. = 6,698 c.f., say 6,700 c.f.

Infiltration Trench:

Length – 450' L
X-Section – 6.0 s.f. (3' W * 2' D)
Void Ratio – 0.4
Bottom Area – 450' L * 3' W = 1,350 s.f.

Crushed Stone Storage: 450' * 6.0 s.f. * 0.4 = 1,080 c.f.
Infiltration Capacity: 1,350 s.f. * 4.82' = 6,507 c.f.
Total Trench Crushed Stone Storage & Infiltration Capacity: 1,080 c.f. + 6,507 c.f. = 7,587 c.f.

6,700 c.f. < 7,587 c.f. – Proposed Infiltration Trench is adequate to accommodate 100-yr runoff from contributing areas.

