

STORMWATER MANAGEMENT REPORT

FOR

82 HIGHLAND AVENUE

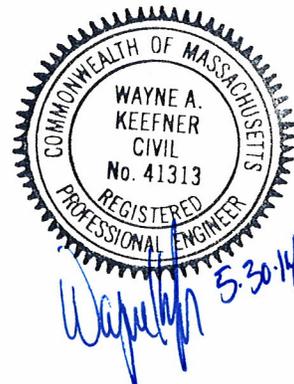
**6 Residential Units
82 Highland Avenue
Somerville, MA**

Prepared for:
LaRosa Development Corp.
850 Pleasant Street
Norwood, MA 02143

Prepared by:
Design Consultants, Inc.
120 Middlesex Avenue, Suite 20
Somerville, Massachusetts 02145-1104

Project 2013-134
May 16, 2014

Revised May 30, 2014



Design Consultants, Inc.

CIVIL ENGINEERS and LAND SURVEYORS

120 Middlesex Avenue, Suite 20

Somerville, MA 02145

617-776-3350p 617-776-7710f

Table of Contents

Introduction.....	1
Existing Condition	1
Soils.....	1
Proposed Condition.....	1
Hydrologic Model.....	2
Table 1- Stormwater Runoff Summary	2
Conclusion	3

Appendix

- A. FEMA Flood Insurance Rate Map
- B. Soils Map – NRCS Web Soil Survey
- C. Figure 1 – Existing Catchment Areas
- D. Figure 2 – Proposed Catchment Areas
- E. Drainage Calculations
- F. Sanitary Sewer Calculations
- G. Domestic Water Demand Calculations and Pipe Sizing

INTRODUCTION

LaRosa Development Corp proposes the development of the property at 82 Highland Avenue in Somerville, MA. The site is zoned Residential C (RC). The existing parcel covers 5,444 square feet (0.128 acres). There is currently a two and a half story, wood framed, mixed used building on the subject site. There is an existing curb cut on Prescott Street that provides access to a paved parking area.

STORM WATER MANAGEMENT POLICY

The reference document used for developing the proposed stormwater management system for the proposed project is the City of Somerville's Zoning Ordinance, Version June 25, 2009. Section 5.4.6.4 of the document describes the stormwater management standards that control quality, quantity and groundwater recharge.

EXISTING CONDITION

The runoff from the lot is one drainage area (subcatchment). (See Appendix C, Figure 1) The site imperviousness is approximately 89% impervious and slopes gently from the northwest to the southeast. Roof runoff is collected by gutters and discharged at grade through several downspouts. There is no other onsite stormwater management. All stormwater from the site is tributary to the combined sewer in Putnam Street.

According to FEMA Flood Insurance Rate Map Number 25017C0438E, with an effective date of June 4, 2010, the site is located in Zone X, areas of 0-2% annual chance of flood; areas of 1% annual chance of flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance of flood. (See Appendix A).

SOILS

The NRCS Web Soil Survey characterizes the soil at the site as entirely Newport-Urban Land Complex, 3 to 15 percent slopes, with a Hydrologic Soil Group (HSG) rating of C. (See Appendix B)

Per the Massachusetts Stormwater Handbook, Table 2.3.3 1982 Rawls Rates, an infiltration rate of 0.17 in/hr is recommended for HSG C soils and is used in the hydrologic model. A planned soil test will determine the groundwater elevation. The proposed storage and infiltration fields, described below, have been designed for minimal cover. If necessary, shallower storage chambers can be substituted to provide additional separation to groundwater.

PROPOSED CONDITION

The proposed development includes the demolition of the existing building to accommodate a three-story building with 6 residential units, built within approximately the same footprint as the existing building. Parking is provided at grade and under the

building. The site is accessed by modifying the existing curb cut on Prescott Street. Increased landscape area is proposed for the site, reducing site imperviousness. The proposed site is approximately 82% impervious.

The catchments in the proposed condition are very similar to the catchments in the existing condition. (See Appendix D, *Figure 2*)

Drainage:

Stormwater runoff calculations were conducted to evaluate peak discharges from the project site under the pre-development and post-development conditions (See Appendix E). As required under the City of Somerville's Stormwater Management Policy, peak discharges under post development conditions will not exceed the pre-development conditions

The proposed development reduces offsite runoff by decreasing imperviousness and providing a subsurface stormwater storage and infiltration system. Groundwater recharge is naturally increased through the reduction of imperviousness and the subsurface infiltration system. Runoff quality is improved by capturing stormwater runoff from the paved area with a deep sump and hooded catch basin that discharges to the subsurface storage/infiltration system. If the subsurface system's storage capacity is exhausted, excess stormwater will sheetflow into catch basins in Prescott Street. Stormwater falling on the building's roof will be collected by gutters. Downspouts will discharge to landscape areas.

4:1 Infiltration/Inflow Removal:

This project does not meet the threshold of 2,000gpd sewage discharge that requires 4:1 I/I removal, therefore 4:1 I/I removal is not provided. (See Appendix F for sewer calculations)

HYDROLOGIC MODEL

The hydrologic model used for this analysis is based upon the SCS Method. Both existing and proposed conditions are modeled for the 2-year, 10-year, 25-year and 100-year storm events. The SCS Method allows for variable rainfall intensity throughout the storm duration, peaking near the middle of the Type III, 24-hour storm. The drainage area's time of concentration (t_c) is assumed to be six minutes for this site.

Table 1

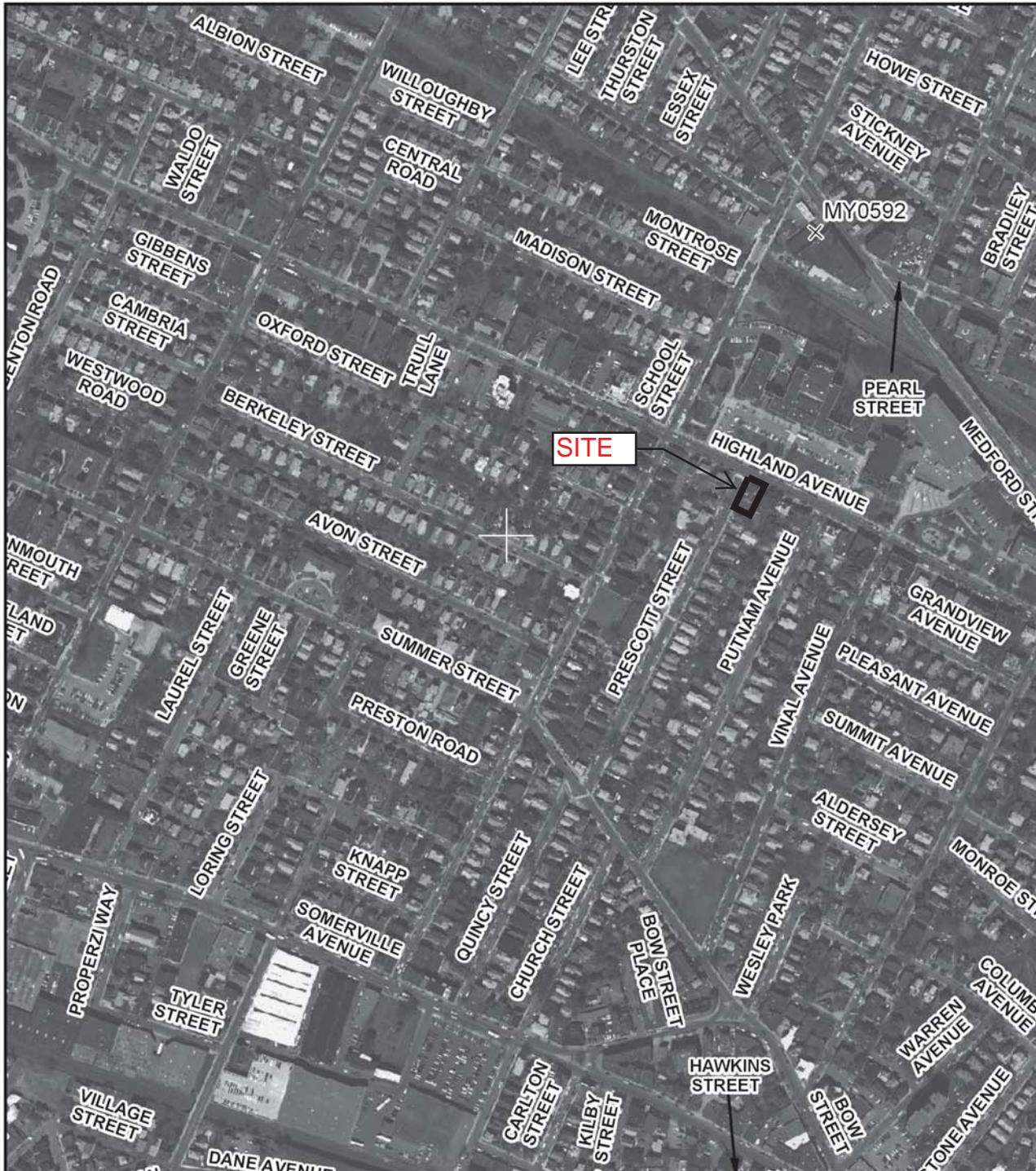
Total Offsite Runoff
Peak Discharges (cubic feet per second, CFS) and Volumes cubic feet (CF)

Description	Existing Conditions		Proposed Conditions	
Drainage Area	0.128 Acres		0.128 Acres	
Storm Event (Years)	Offsite Peak Runoff (CFS)	Offsite Runoff Volume (CF)	Offsite Peak Runoff (CFS)	Offsite Runoff Volume (CF)
2	0.24	1,202	0.12	675
10	0.36	1,831	0.18	1,140
25	0.43	2,192	0.25	1,485
100	0.53	2,734	0.37	1,847

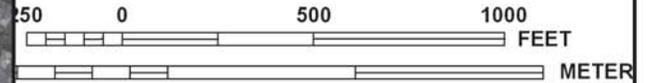
CONCLUSION

Based on DCI's analysis of the existing and proposed conditions, the proposed site condition meets the criteria set forth in the City of Somerville's Zoning Ordinance. Overall site imperviousness is decreased, therefore off-site runoff volume and peak flow rate for the 2, 10, 25 and 100-year storm events is decreased. If an illicit stormwater connection to the sanitary sewer is found, it will be eliminated and a new connection will be made to the appropriate storm sewer. The 4:1 I/I requirement does not apply to this project. DCI concludes that the proposed development at 82 Highland Avenue, Somerville, MA adheres to all applicable stormwater management policies.

Appendix A



MAP SCALE 1" = 500'



NFIP

PANEL 0438E

FIRM

FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY,
MASSACHUSETTS
(ALL JURISDICTIONS)

PANEL 438 OF 656

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CAMBRIDGE, CITY OF	250186	0438	E
MEDFORD, CITY OF	250205	0438	E
SOMERVILLE, CITY OF	250214	0438	E

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



MAP NUMBER
25017C0438E

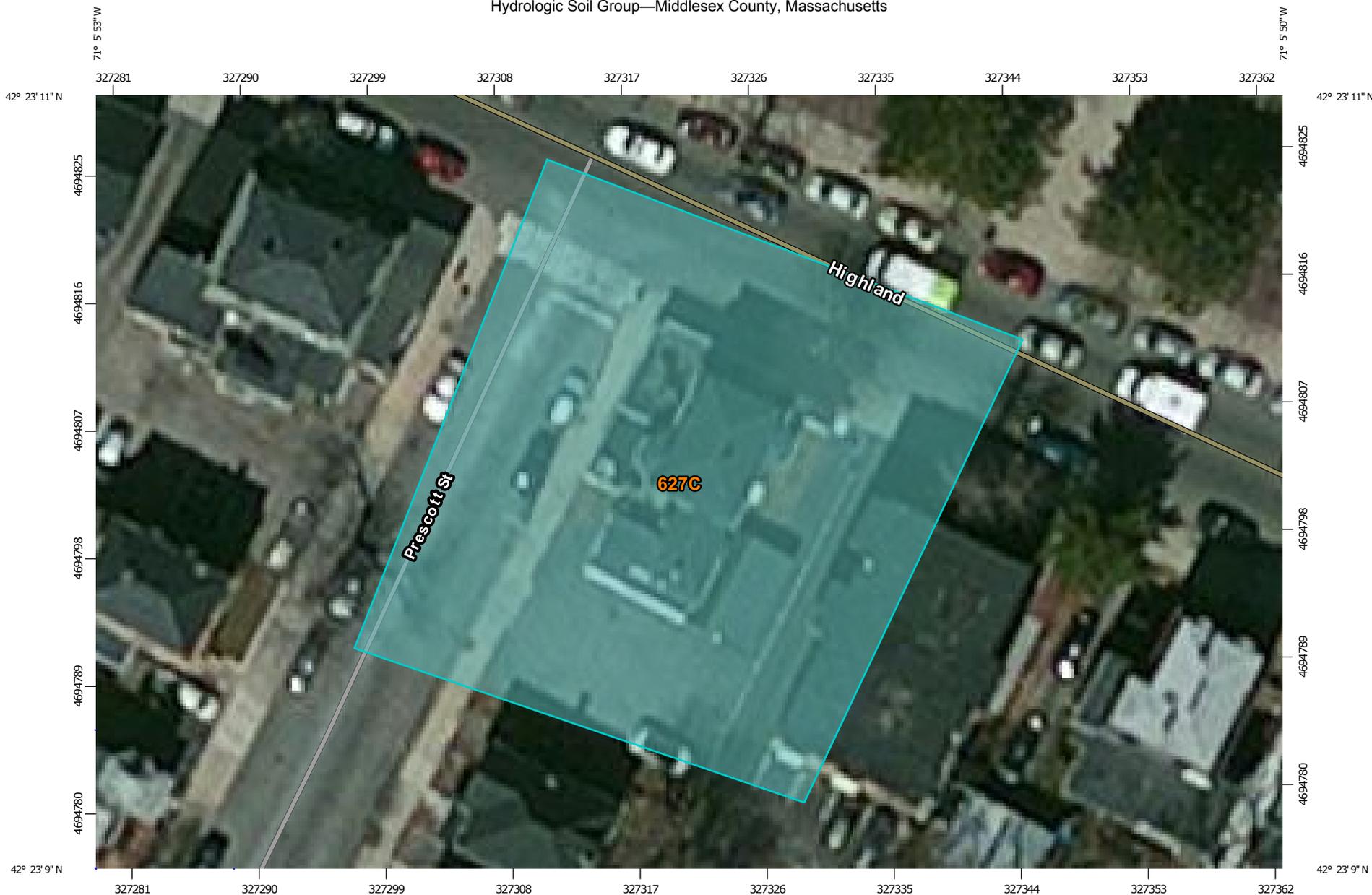
EFFECTIVE DATE
JUNE 4, 2010

Federal Emergency Management Agency

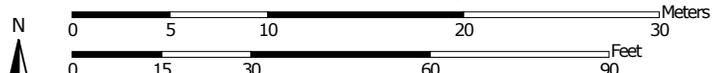
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix B

Hydrologic Soil Group—Middlesex County, Massachusetts



Map Scale: 1:384 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

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 map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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 13, Dec 17, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

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.

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
627C	Newport-Urban land complex, 3 to 15 percent slopes	C	0.3	100.0%
Totals for Area of Interest			0.3	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.

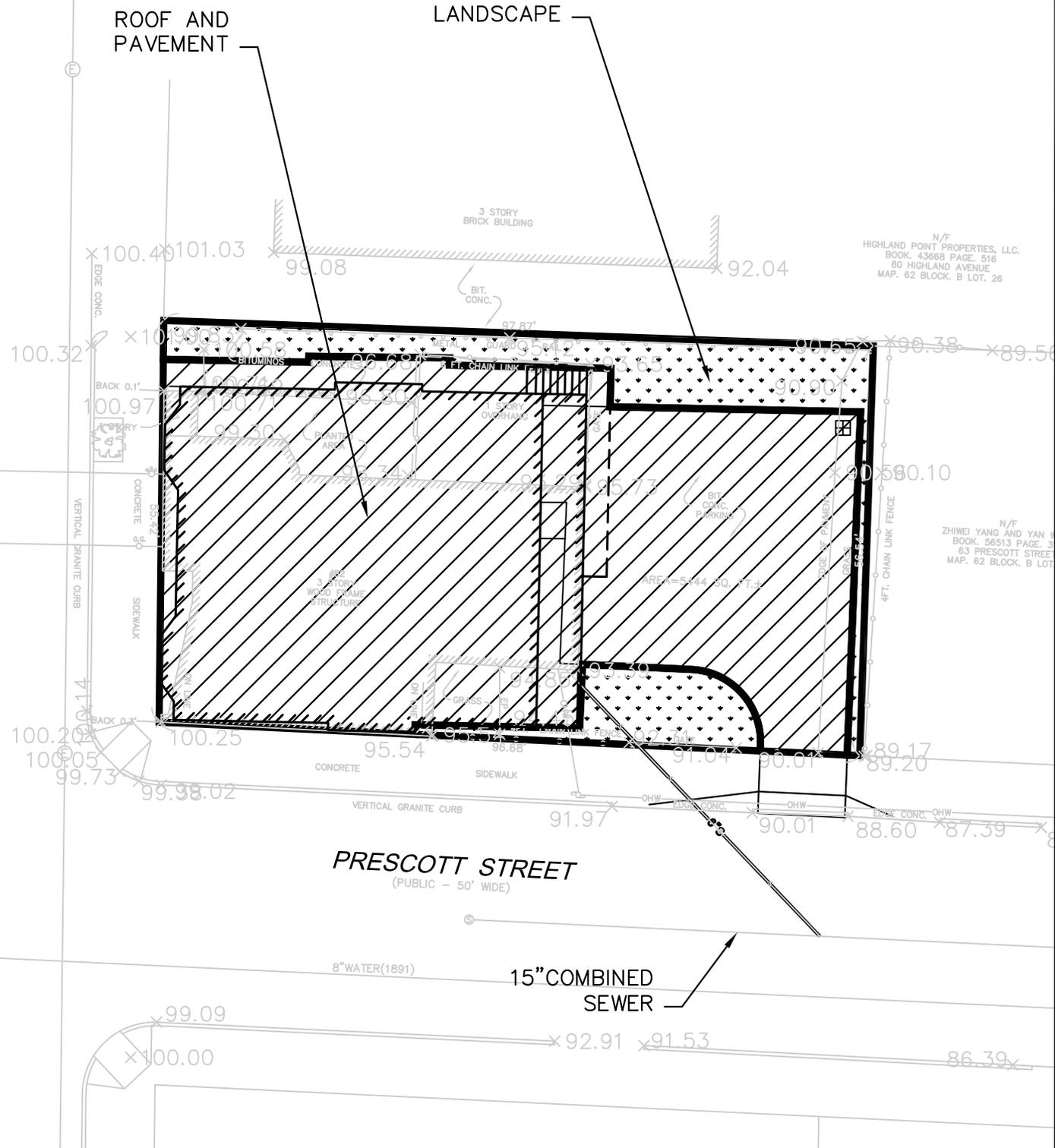
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Appendix C

Appendix D



Design Consultants, Inc.
 Consulting Engineers and Surveyors

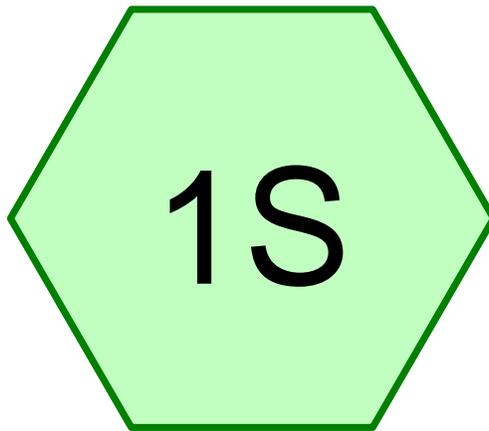
120 MIDDLESEX AVENUE
 SOMERVILLE, MA 02145
 617-776-3350

**82 HIGHLAND AVENUE
 SOMERVILLE, MA**

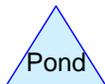
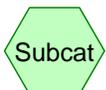
**FIGURE 2
 PROPOSED
 CATCHMENT
 AREAS**

SCALE: 1" = 20' 2013-134

Appendix E



Existing



Drainage Diagram for 13-134 EX
Prepared by Microsoft, Printed 3/27/2014
HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

13-134 EX

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland
Type III 24-hr 2-Year Rainfall=3.10"

Printed 3/27/2014

Page 2

Summary for Subcatchment 1S: Existing

Runoff = 0.24 cfs @ 12.05 hrs, Volume= 1,202 cf, Depth= 2.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
4,825	98	Paved parking, HSG C
619	79	50-75% Grass cover, Fair, HSG C
5,444	96	Weighted Average
619		11.37% Pervious Area
4,825		88.63% Impervious Area

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

13-134 EX

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland
Type III 24-hr 10-Year Rainfall=4.50"

Printed 3/27/2014

Page 3

Summary for Subcatchment 1S: Existing

Runoff = 0.36 cfs @ 12.05 hrs, Volume= 1,831 cf, Depth= 4.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
4,825	98	Paved parking, HSG C
619	79	50-75% Grass cover, Fair, HSG C
5,444	96	Weighted Average
619		11.37% Pervious Area
4,825		88.63% Impervious Area

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

13-134 EX

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland
Type III 24-hr 25-Year Rainfall=5.30"

Printed 3/27/2014

Page 4

Summary for Subcatchment 1S: Existing

Runoff = 0.43 cfs @ 12.05 hrs, Volume= 2,192 cf, Depth= 4.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (sf)	CN	Description
4,825	98	Paved parking, HSG C
619	79	50-75% Grass cover, Fair, HSG C
5,444	96	Weighted Average
619		11.37% Pervious Area
4,825		88.63% Impervious Area

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

13-134 EX

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland
Type III 24-hr 100-Year Rainfall=6.50"

Printed 3/27/2014

Page 5

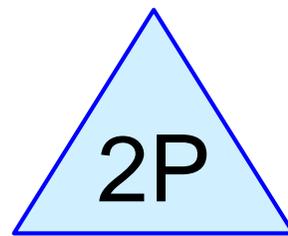
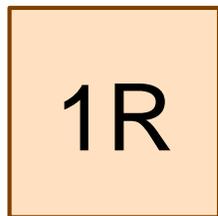
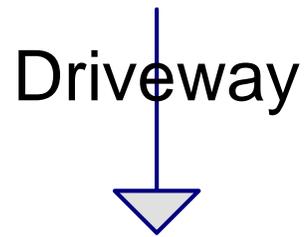
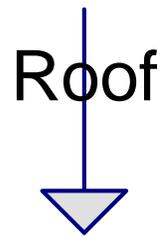
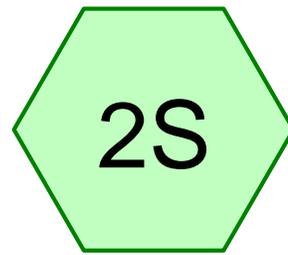
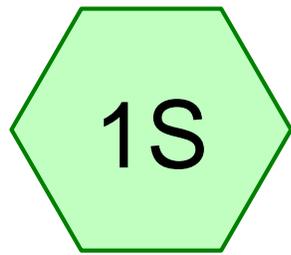
Summary for Subcatchment 1S: Existing

Runoff = 0.53 cfs @ 12.04 hrs, Volume= 2,734 cf, Depth= 6.03"

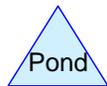
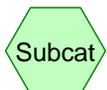
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
4,825	98	Paved parking, HSG C
619	79	50-75% Grass cover, Fair, HSG C
5,444	96	Weighted Average
619		11.37% Pervious Area
4,825		88.63% Impervious Area

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



Detention



Drainage Diagram for 13-134 PR
Prepared by Microsoft, Printed 5/30/2014
HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

13-134 PR

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland

Type III 24-hr 2-Year Rainfall=3.10"

Printed 5/30/2014

Page 2

Summary for Subcatchment 1S: Roof

Runoff = 0.12 cfs @ 12.05 hrs, Volume= 630 cf, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
2,636	98	Roofs, HSG C
2,636		100.00% Impervious Area

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

Summary for Subcatchment 2S: Driveway

Runoff = 0.08 cfs @ 12.05 hrs, Volume= 391 cf, Depth= 2.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
1,630	98	Paved parking, HSG C
* 70	82	Permeable Apron
1,700	97	Weighted Average
70		4.12% Pervious Area
1,630		95.88% Impervious Area

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

Summary for Reach 1R:

Inflow Area = 4,336 sf, 98.39% Impervious, Inflow Depth = 1.87" for 2-Year event
 Inflow = 0.12 cfs @ 12.05 hrs, Volume= 675 cf
 Outflow = 0.12 cfs @ 12.05 hrs, Volume= 675 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs

Summary for Pond 2P: Detention

Inflow Area = 1,700 sf, 95.88% Impervious, Inflow Depth = 2.76" for 2-Year event
 Inflow = 0.08 cfs @ 12.05 hrs, Volume= 391 cf
 Outflow = 0.01 cfs @ 15.98 hrs, Volume= 80 cf, Atten= 93%, Lag= 235.9 min
 Discarded = 0.00 cfs @ 4.80 hrs, Volume= 35 cf
 Primary = 0.00 cfs @ 15.98 hrs, Volume= 45 cf

13-134 PR

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland
Type III 24-hr 2-Year Rainfall=3.10"

Printed 5/30/2014

Page 3

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs / 2
Peak Elev= 89.90' @ 15.90 hrs Surf.Area= 95 sf Storage= 321 cf

Plug-Flow detention time= 528.5 min calculated for 80 cf (21% of inflow)
Center-of-Mass det. time= 310.8 min (1,077.4 - 766.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.00'	66 cf	5.92'W x 16.00'L x 3.21'H Field A 304 cf Overall - 85 cf Embedded = 219 cf x 30.0% Voids
#2A	83.50'	85 cf	Cultec R-280 x 2 Inside #1 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
#3	86.21'	190 cf	Surface (Prismatic) Listed below (Recalc) -Impervious
		340 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.21	13	0	0
88.50	13	30	30
90.00	200	160	190

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	89.90'	5.0' long x 2.0' breadth Overflow to Street Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Discarded OutFlow Max=0.00 cfs @ 4.80 hrs HW=83.07' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 15.98 hrs HW=89.90' (Free Discharge)
↑**2=Overflow to Street** (Weir Controls 0.00 cfs @ 0.11 fps)

13-134 PR

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland

Type III 24-hr 10-Year Rainfall=4.50"

Printed 5/30/2014

Page 4

Summary for Subcatchment 1S: Roof

Runoff = 0.18 cfs @ 12.04 hrs, Volume= 937 cf, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
2,636	98	Roofs, HSG C
2,636		100.00% Impervious Area

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

Summary for Subcatchment 2S: Driveway

Runoff = 0.11 cfs @ 12.05 hrs, Volume= 588 cf, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
1,630	98	Paved parking, HSG C
* 70	82	Permeable Apron
1,700	97	Weighted Average
70		4.12% Pervious Area
1,630		95.88% Impervious Area

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

Summary for Reach 1R:

Inflow Area = 4,336 sf, 98.39% Impervious, Inflow Depth = 3.16" for 10-Year event

Inflow = 0.18 cfs @ 12.08 hrs, Volume= 1,140 cf

Outflow = 0.18 cfs @ 12.08 hrs, Volume= 1,140 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs

Summary for Pond 2P: Detention

Inflow Area = 1,700 sf, 95.88% Impervious, Inflow Depth = 4.15" for 10-Year event

Inflow = 0.11 cfs @ 12.05 hrs, Volume= 588 cf

Outflow = 0.03 cfs @ 12.35 hrs, Volume= 240 cf, Atten= 76%, Lag= 18.4 min

Discarded = 0.00 cfs @ 3.60 hrs, Volume= 37 cf

Primary = 0.03 cfs @ 12.35 hrs, Volume= 203 cf

13-134 PR

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland
Type III 24-hr 10-Year Rainfall=4.50"

Printed 5/30/2014

Page 5

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs / 2
Peak Elev= 89.91' @ 12.30 hrs Surf.Area= 95 sf Storage= 323 cf

Plug-Flow detention time= 316.2 min calculated for 240 cf (41% of inflow)
Center-of-Mass det. time= 171.2 min (929.0 - 757.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.00'	66 cf	5.92'W x 16.00'L x 3.21'H Field A 304 cf Overall - 85 cf Embedded = 219 cf x 30.0% Voids
#2A	83.50'	85 cf	Cultec R-280 x 2 Inside #1 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
#3	86.21'	190 cf	Surface (Prismatic) Listed below (Recalc) -Impervious
		340 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.21	13	0	0
88.50	13	30	30
90.00	200	160	190

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	89.90'	5.0' long x 2.0' breadth Overflow to Street Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Discarded OutFlow Max=0.00 cfs @ 3.60 hrs HW=83.09' (Free Discharge)
↑1=Exfiltration (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.01 cfs @ 12.35 hrs HW=89.91' (Free Discharge)
↑2=Overflow to Street (Weir Controls 0.01 cfs @ 0.27 fps)

13-134 PR

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland

Type III 24-hr 25-Year Rainfall=5.30"

Printed 5/30/2014

Page 6

Summary for Subcatchment 1S: Roof

Runoff = 0.21 cfs @ 12.04 hrs, Volume= 1,112 cf, Depth= 5.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (sf)	CN	Description
2,636	98	Roofs, HSG C
2,636		100.00% Impervious Area

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

Summary for Subcatchment 2S: Driveway

Runoff = 0.13 cfs @ 12.04 hrs, Volume= 701 cf, Depth= 4.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (sf)	CN	Description
1,630	98	Paved parking, HSG C
* 70	82	Permeable Apron
1,700	97	Weighted Average
70		4.12% Pervious Area
1,630		95.88% Impervious Area

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

Summary for Reach 1R:

Inflow Area = 4,336 sf, 98.39% Impervious, Inflow Depth = 4.11" for 25-Year event
 Inflow = 0.25 cfs @ 12.21 hrs, Volume= 1,485 cf
 Outflow = 0.25 cfs @ 12.21 hrs, Volume= 1,485 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs

Summary for Pond 2P: Detention

Inflow Area = 1,700 sf, 95.88% Impervious, Inflow Depth = 4.95" for 25-Year event
 Inflow = 0.13 cfs @ 12.04 hrs, Volume= 701 cf
 Outflow = 0.12 cfs @ 12.34 hrs, Volume= 410 cf, Atten= 14%, Lag= 17.5 min
 Discarded = 0.00 cfs @ 3.00 hrs, Volume= 37 cf
 Primary = 0.12 cfs @ 12.34 hrs, Volume= 373 cf

13-134 PR

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland
Type III 24-hr 25-Year Rainfall=5.30"

Printed 5/30/2014

Page 7

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs / 2
Peak Elev= 89.94' @ 12.30 hrs Surf.Area= 95 sf Storage= 328 cf

Plug-Flow detention time= 227.0 min calculated for 410 cf (59% of inflow)
Center-of-Mass det. time= 115.7 min (870.1 - 754.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.00'	66 cf	5.92'W x 16.00'L x 3.21'H Field A 304 cf Overall - 85 cf Embedded = 219 cf x 30.0% Voids
#2A	83.50'	85 cf	Cultec R-280 x 2 Inside #1 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
#3	86.21'	190 cf	Surface (Prismatic) Listed below (Recalc) -Impervious
		340 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.21	13	0	0
88.50	13	30	30
90.00	200	160	190

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	89.90'	5.0' long x 2.0' breadth Overflow to Street Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Discarded OutFlow Max=0.00 cfs @ 3.00 hrs HW=83.08' (Free Discharge)
↑1=Exfiltration (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.09 cfs @ 12.34 hrs HW=89.94' (Free Discharge)
↑2=Overflow to Street (Weir Controls 0.09 cfs @ 0.49 fps)

13-134 PR

Prepared by Microsoft

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Highland

Type III 24-hr 100-Year Rainfall=6.50"

Printed 5/30/2014

Page 8

Summary for Subcatchment 1S: Roof

Runoff = 0.26 cfs @ 12.04 hrs, Volume= 1,375 cf, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
2,636	98	Roofs, HSG C
2,636		100.00% Impervious Area

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

Summary for Subcatchment 2S: Driveway

Runoff = 0.17 cfs @ 12.04 hrs, Volume= 870 cf, Depth= 6.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
1,630	98	Paved parking, HSG C
* 70	82	Permeable Apron
1,700	97	Weighted Average
70		4.12% Pervious Area
1,630		95.88% Impervious Area

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

Summary for Reach 1R:Inflow Area = 4,336 sf, 98.39% Impervious, Inflow Depth = 5.11" for 100-Year event
Inflow = 0.37 cfs @ 12.06 hrs, Volume= 1,847 cf
Outflow = 0.37 cfs @ 12.06 hrs, Volume= 1,847 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs

Summary for Pond 2P: DetentionInflow Area = 1,700 sf, 95.88% Impervious, Inflow Depth = 6.14" for 100-Year event
Inflow = 0.17 cfs @ 12.04 hrs, Volume= 870 cf
Outflow = 0.11 cfs @ 12.08 hrs, Volume= 509 cf, Atten= 31%, Lag= 2.1 min
Discarded = 0.00 cfs @ 2.40 hrs, Volume= 38 cf
Primary = 0.11 cfs @ 12.08 hrs, Volume= 471 cf

13-134 PR

Prepared by Microsoft

Printed 5/30/2014

HydroCAD® 9.10 s/n 00884 © 2010 HydroCAD Software Solutions LLC

Page 9

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.30 hrs / 2

Peak Elev= 89.94' @ 12.00 hrs Surf.Area= 95 sf Storage= 328 cf

Plug-Flow detention time= 223.1 min calculated for 509 cf (58% of inflow)

Center-of-Mass det. time= 110.2 min (860.7 - 750.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.00'	66 cf	5.92'W x 16.00'L x 3.21'H Field A 304 cf Overall - 85 cf Embedded = 219 cf x 30.0% Voids
#2A	83.50'	85 cf	Cultec R-280 x 2 Inside #1 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
#3	86.21'	190 cf	Surface (Prismatic) Listed below (Recalc) -Impervious
		340 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.21	13	0	0
88.50	13	30	30
90.00	200	160	190

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	89.90'	5.0' long x 2.0' breadth Overflow to Street Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32

Discarded OutFlow Max=0.00 cfs @ 2.40 hrs HW=83.07' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.09 cfs @ 12.08 hrs HW=89.94' (Free Discharge)

↑**2=Overflow to Street** (Weir Controls 0.09 cfs @ 0.49 fps)

Appendix F

I. INTRODUCTION

The following sewerage calculations are based upon 310 CMR 15.203, 314 CMR 7.15 and architectural floor plans provided by Christopher-Roche Architects.

II. CALCULATIONS

Number of Bedrooms	12
Average Daily Flow (110 gal/day/bedroom)	1,320 gpd
Peaking Factor	5.5
Total Peak Flow	5.04 gal/min
Slope	0.020
Pipe Size	6"

III. DESIGN

PVC pipe (Manning's roughness coefficient = 0.011) at the calculated slope and diameter is adequate for flows of 385 gal/min and less (see attached nomograph). The proposed design falls within acceptable limits.

IV. CONCLUSION

Six-inch (6") PVC, SDR 35, ASTM D3034 is proposed for the sewer line.

Appendix G

