CIVIL ENGINEERS • LAND SURVEYORS • ENVIRONMENTAL CONSULTANTS

FORESITE ENGINEERING

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# STORMWATER REPORT AND CALCULATIONS

**FOR**

# "Hayward Farm"
## A Proposed Residential Subdivision

At 121 Hayward Road, Acton, Massachusetts
Assessors Map E-2 Parcels 261-2, 261-3, 262, 272 & 273

August 29, 2014

**Prepared for:**
Acton Management, Inc.
P.O. Box 2350
Acton, Massachusetts 01720

**Prepared by:**
FORESITE Engineering Associates, Inc.
16 Gleasondale Road, Suite 1-1
Stow, Massachusetts 01775

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## I. Introduction

Hayward Farm subdivision is a proposed 4-lot Residential Compound subdivision located at 121 Hayward Road in Acton. The site is located on the northerly side of Hayward Road opposite the intersection of Joseph Reed Lane and Hayward Road, approximately 1,000 feet east of the intersection of Hayward Road and Arlington Street. The site is currently utilized for a single family dwelling and, with the exception of the existing dwelling and driveway is predominantly undeveloped woodland. Existing drainage is northerly from Hayward Road overland toward Kennedy Drive with an intermittent stream bed which conveys intermittent surface drainage north to the Kennedy Drive drainage system.

Soils on site are identified by the U.S. Natural Resource Conservation Service (NRCS) as Paxton and Paxton Urban Land Complex, which are typically well drained upland soils. On site deep observation tests and percolation tests were performed in June of 2014 to field verify on site soil conditions for sewage disposal system and drainage system design.

Under current conditions surface drainage flows over land northerly to the Kennedy Drive drainage system via an intermittent stream that bisects the locus tract that is ultimately tributary to Grassy Pond Brook via the Kenned Drive drainage system. Existing street drainage sheet flows off the road crown to the shoulders of Hayward Road. The grade of Hayward Road is minor and the only infrastructure along the site frontage is a culvert under Hayward Road that conveys drainage from the southerly side of Hayward Road to the on-site intermittent stream to the south.

The development proposal for the site involves clearing and grubbing of approximately 2 acres of land, more or less, constructing a 350-ft subdivision roadway and associated infrastructure, and constructing six (6) new single family dwellings (4 subdivision lots and 2 Approval Not Require (ANR) lots). The change in surface cover from existing predominantly wooded surface cover to proposed less pervious surface covers of

pavement, rooftops and lawns will increase the rate and volume of runoff from the site if unmitigated.

Increase in off-site runoff rate and volume is proposed to be mitigated by (1) limiting site disturbance to the extent necessary for site development, (2) utilizing a Stormceptor (proprietary oil/grit separator) for treatment of drainage from paved surfaces prior to attenuation and infiltration, (3) utilizing an on-site retention basin for attenuation, infiltration and controlled release of major storm events to the down-gradient intermittent stream.

Increases in the rate and volume of runoff will be managed with the selected BMP's. The hydrologic analysis was performed on the pre-development and post-development site areas for the 2-yr, 10-yr, and 100-yr design storms as required by the Massachusetts Department of Environmental Protection Stormwater Management Standards.

## II. Methodology & References

*Methodology:*

SCS TR-55 & SCS TR-20 utilizing HydroCAD (v 10.0) software.

*References:*

A Guide to Hydrologic Analysis Using SCS Methods, Richard McCuen, copyright 1982, Prentice Hall, Inc.

Natural Resources Conservation Service (NRCS), Web Soil Survey

USGS Quadrangle Map, Maynard, Massachusetts, 1987

## III. Results

The proposed subdivision drainage study area was evaluated as the area east of the intermittent stream that flows northerly toward Kennedy Lane. Table 1 below shows the key of each off-site area analyzed as it is referenced in the HydroCAD calculations in Appendix I, and also shows which pre-development areas are compared to which post-development areas for evaluation of the effectiveness of the proposed storm water system.

**TABLE 1**

**Pre-development & Post-development Comparison Areas**

| PRE | POST |
|---|---|
| 1S | REACH 50 |

The off-site areas were analyzed for rate and volume of runoff under existing conditions for the 2-yr, 10-yr, and 100-yr, 24-hr design storms and the results are shown in Table 2. Under post-development conditions increases in runoff from development activities are controlled with the implementation of stormwater detention and recharge Best Management Practices (BMP's). Comparison of the off site rates and volumes of runoff under pre-development conditions to the off site runoff to the same areas under post-development conditions illustrates the effectiveness of the proposed stormwater controls. The results in Table 2 show that runoff rates and volumes are effectively maintained at similar or lesser values by the proposed drainage system.

## TABLE 2

## Pre-development & Post-development Runoff Rates and Volumes

| 2-YR STORM | PRE-DEVELOPMENT | | POST-DEVELOPMENT | |
|---|---|---|---|---|
| | Q (cfs) | V (cu-ft) | Q (cfs) | V (cu-ft) |
| Off-site North (1S/50R) | 1.98 | 8,394 | 1.91 | 6,481 |

| 10-YR STORM | PRE-DEVELOPMENT | | POST-DEVELOPMENT | |
|---|---|---|---|---|
| | Q (cfs) | V (cu-ft) | Q (cfs) | V (cu-ft) |
| Off-site North (1S/50R) | 4.14 | 16,445 | 3.64 | 15,208 |

| 100-YR STORM | PRE-DEVELOPMENT | | POST-DEVELOPMENT | |
|---|---|---|---|---|
| | Q (cfs) | V (cu-ft) | Q (cfs) | V (cu-ft) |
| Off-site North (1S/50R) | 8.11 | 31,548 | 7.26 | 31,245 |

**Stormwater Management Standards Compliance:**

**Standard 1:** No new untreated stormwater discharges; no erosion or scour to wetland resource areas is proposed by construction activities.

**Standard 2:** Peak rate attention. Stormwater calculations performed for the 2-yr, 10-yr, and 100-yr 24-hr design storms; no increase in peak rate runoff rates or volumes; no increase in off-site flooding during the 100-yr storm.

**Standard 3:** Recharge. Required recharge volume = Target Depth Factor, F x Total Post Development Impervious Area = 0.25"/12"/ft x 24,000 s.f. = **500 cubic feet.**

Capture Area of **Infiltration Basin** (2S): 44,972 s.f. total, 14,729 s.f. impervious
Volume to recharge = 500 cubic ft over basin surface area at this volume (at elevation 234.4) = 1,418 s.f.
Exfiltration rate of basin is 1.02"/hr or 0.085'/hr, so time to drain is:
500 cu.ft/1,418 s.f. / 0.085'/hr = 4.4 hrs to drain the recharge volume

Next calculate time to drain basin when full,
Volume of basin full (to elevation 237.0) is 6,073 cubic feet over a surface area of 2,910 s.f.
Time to drain = 6,073 cu.ft./2,910 s.f / 0.085'/hr = 24.6 hrs < 72 hrs, OK

**Standard 4:** Water Quality. Required water quality volume is 1" of runoff over tributary area:

To Infiltration Basin: 44,972 s.f. x 1"/12"/ft = 3,748 cubic feet < 6,073 cubic feet capacity

80% or greater TSS removal provided for all BMP's treating runoff from paved surfaces prior to infiltration or discharge (see Appendix G).

**Standard 5:** Land Uses With Higher Potential Pollutant Loads. (Not Applicable)

**Standard 6:** Critical Areas. (Not Applicable)

**Standard 7:** Redevelopment and Other Projects Subject to the Standards to the maximum extent practicable. (Not Applicable)

**Standard 8:** Construction Period Pollution Prevention and Erosion and Sedimentation Control. Provided in Erosion & Sediment Control Plan (2 sheets).

**Standard 9:** Stormwater Operation & Maintenance Plan. Provided in Appendix E: 'Stormwater Operation & Maintenance Plan'.

**Standard 10:** Prohibition of Illicit Discharges. Provided in Appendix E: 'Stormwater Operation & Maintenance Plan'.

## IV. Conclusions

The proposed drainage system adequately controls both the rate and volume of runoff from proposed site improvements at the proposed Hayward Farm Subdivision. There is no increase in runoff rate or volume from the site above predevelopment rates and volumes. The storm water management controls proposed sufficiently detain and recharge the increase in runoff generated by development to similar or lesser rates and volumes as under predevelopment conditions. All storm water controls have been sized to properly manage storm events up to and including the 100-year, 24 hour design storm. Runoff rates and volumes from the site will be reduced or maintained following development and runoff quality will be improved or maintained through implementation of the proposed stormwater BMP's. The proposed drainage system has been designed in compliance with the Massachusetts Stormwater Management Policy and Standards.

# Appendix A

Portion of USGS Quadrangle Map, Maynard, Massachusetts, 1987
(Scale: 1:25,000)

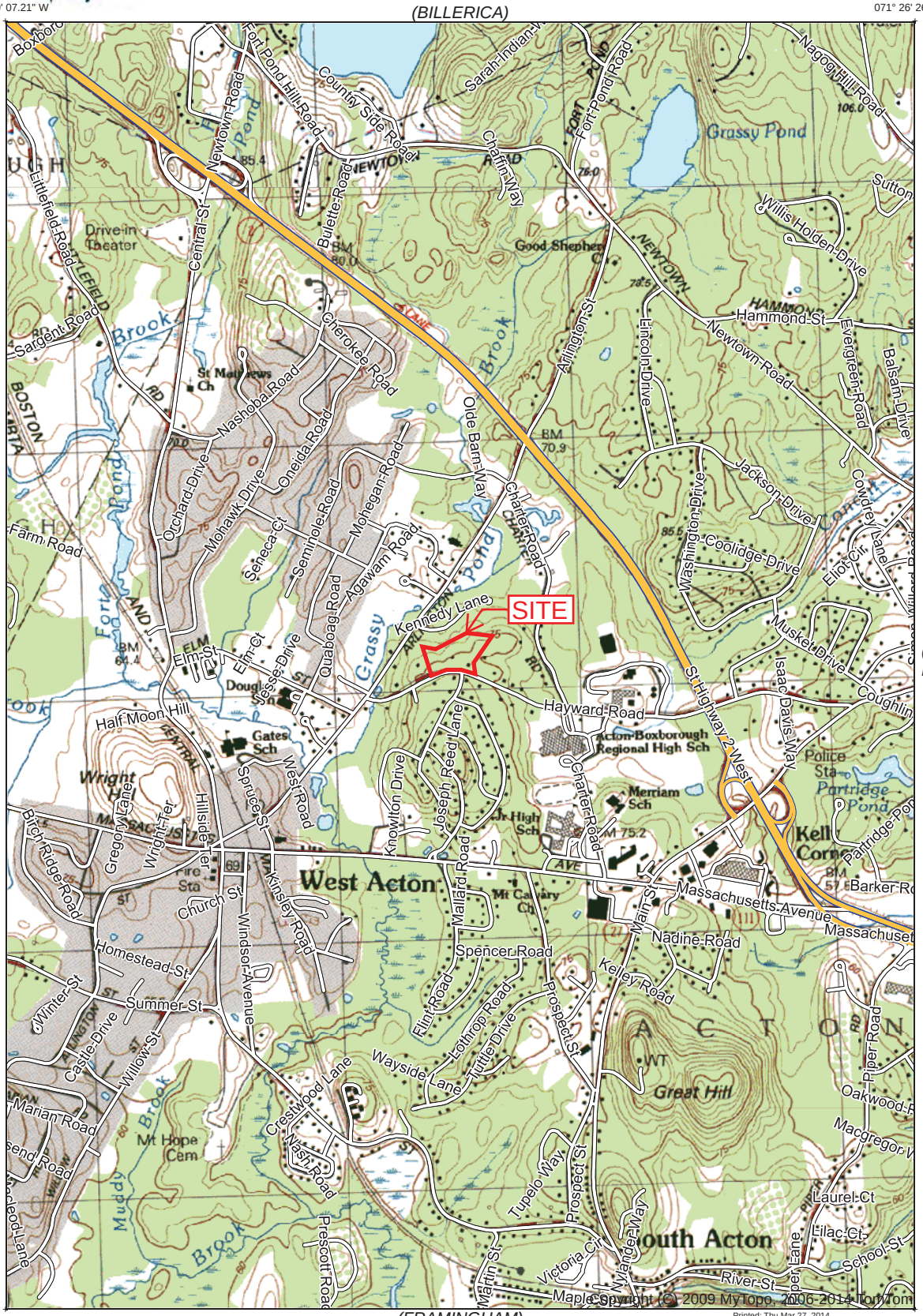
MAYNARD QUADRANGLE
MASSACHUSETTS
TOPOGRAPHIC SERIES

(AYER) (READING)

071° 29' 07.21" W
042° 30' 21.91" N

(BILLERICA)

071° 26' 82.82" W
042° 30' 21.91" N




(HUDSON) (BOSTON NORTH)

042° 27' 34.34" N
071° 29' 07.21" W

(FRAMINGHAM)

Copyright (C) 2009 MyTopo, 2006-2014 TomTom

Printed: Thu Mar 27, 2014

042° 27' 34.34" N
071° 26' 82.82" W

(MARLBOROUGH) (BOSTON SOUTH)

Declination

MN GN

GN 1.66° W
MN 14.78° W

SCALE 1:24000

0 1
MILE

0 1000
YARDS

0 1
KILOMETER

CONTOUR INTERVAL 3 METERS
NATIONAL GEODETIC VERTICAL DATUM 1929

Produced by MyTopo Terrain Navigator
Topography based on USGS 1:24,000 Maps

North American 1983 Datum (NAD83)
Universal Transverse Mercator Projection

To place on the predicted North American 1927 move the projection lines 10M N and 40M E

MAYNARD, MA
1987

# Appendix B

Soil map overlay from Natural Resources Conservation Service (NRCS) web soil survey map, and soil description

Soil Map—Middlesex County, Massachusetts
(Hayward Farm NRCS Soils)

Map Scale: 1:3,020 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

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 Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

**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

**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

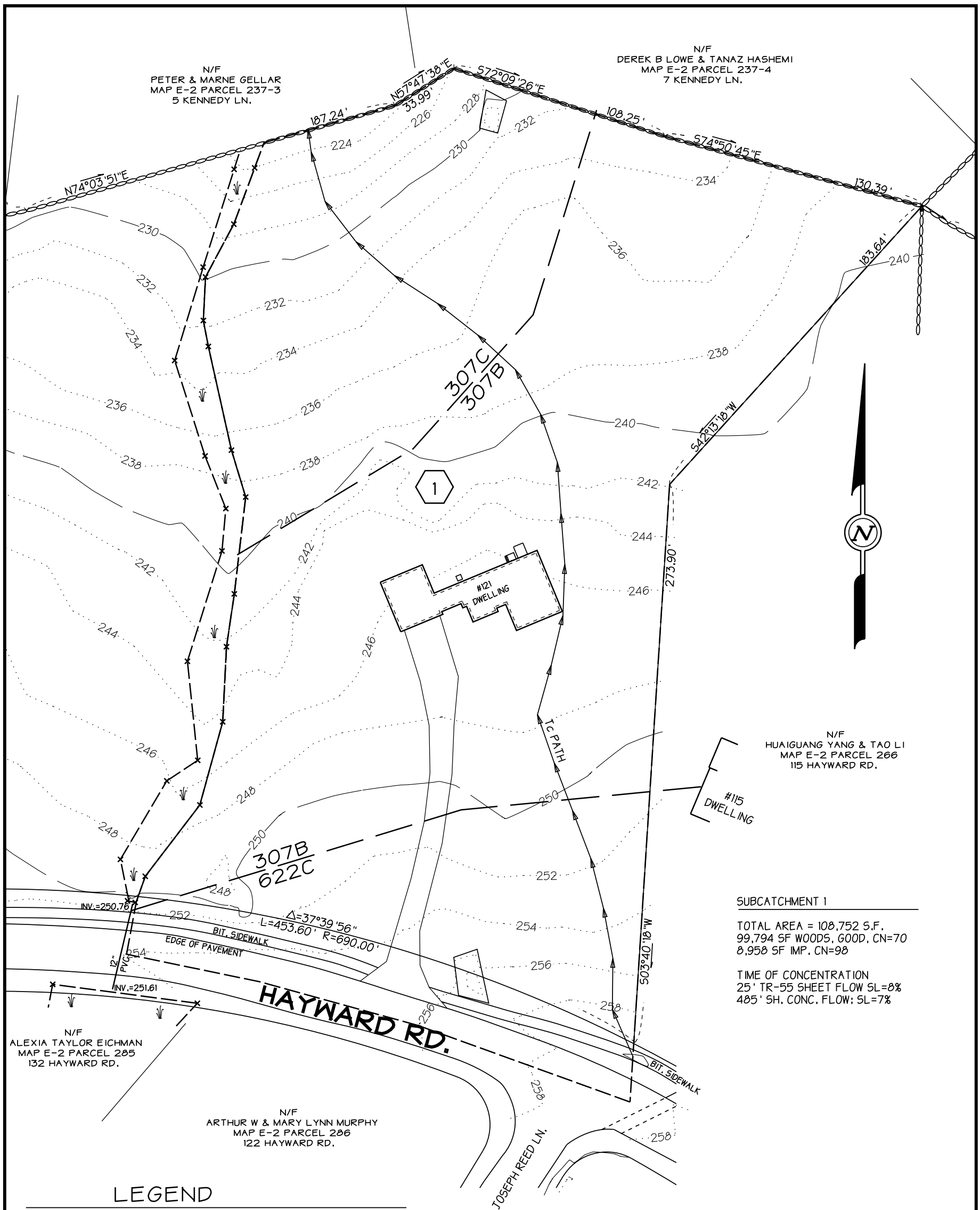
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

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.

# Map Unit Legend

| Middlesex County, Massachusetts (MA017) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| 52A | Freetown muck, 0 to 1 percent slopes | 0.8 | 2.1% |
| 307B | Paxton fine sandy loam, 3 to 8 percent slopes, extremely stony | 10.1 | 26.9% |
| 307C | Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony | 14.7 | 39.1% |
| 622C | Paxton-Urban land complex, 3 to 15 percent slopes | 12.0 | 31.9% |
| **Totals for Area of Interest** | | **37.6** | **100.0%** |




SUBCATCHMENT 1

TOTAL AREA = 108,752 S.F.
99,794 SF WOODS, GOOD, CN=70
8,958 SF IMP. CN=98

TIME OF CONCENTRATION
25' TR-55 SHEET FLOW SL=8%
485' SH. CONC. FLOW; SL=7%

## LEGEND

⟨X⟩ = SUBCATCHMENT AREA LABEL (TYP.)

– – – = SUBCATCHMENT AREA BOUNDARY

⟶ = TIME OF CONCENTRATION PATH

NOTE: ALL SOILS ARE NRCS HYDROLOGIC SOIL GROUP C, PAXTON & PAXTON URBAN LAND COMPLEX

# APPENDIX C
# PRE-DEVELOPMENT DRAINAGE PLAN

SCALE: 1 INCH = 50 FEET

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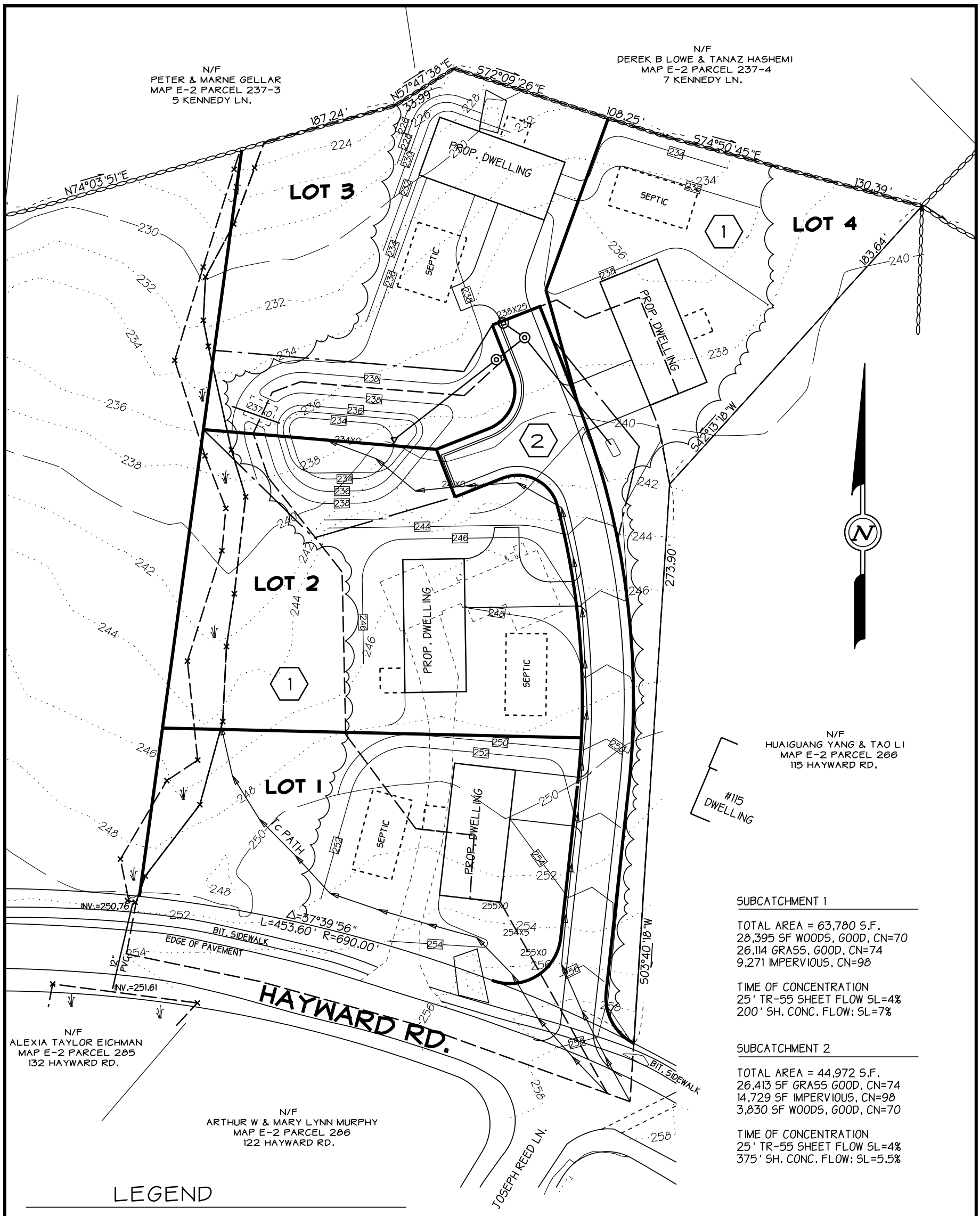
1821PRE.2D




SUBCATCHMENT 1

TOTAL AREA = 63,780 S.F.
28,395 SF WOODS, GOOD, CN=70
26,114 GRASS, GOOD, CN=74
9,271 IMPERVIOUS, CN=98

TIME OF CONCENTRATION
25' TR-55 SHEET FLOW SL=4%
200' SH. CONC. FLOW; SL=7%

SUBCATCHMENT 2

TOTAL AREA = 44,972 S.F.
26,413 SF GRASS GOOD, CN=74
14,729 SF IMPERVIOUS, CN=98
3,830 SF WOODS, GOOD, CN=70

TIME OF CONCENTRATION
25' TR-55 SHEET FLOW SL=4%
375' SH. CONC. FLOW; SL=5.5%

## LEGEND

(X) = SUBCATCHMENT AREA LABEL (TYP.)

— — — = SUBCATCHMENT AREA BOUNDARY

→ = TIME OF CONCENTRATION PATH

NOTE: ALL SOILS ARE NRCS HYDROLOGIC SOIL GROUP C, PAXTON & PAXTON URBAN LAND COMPLEX

# APPENDIX D
# POST-DEVELOPMENT DRAINAGE PLAN

SCALE: 1 INCH = 50 FEET

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1921POST.2D

# Appendix E

Stormwater Operation & Maintenance Plan

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# STORMWATER OPERATION & MAINTENANCE PLAN FOR

# "Hayward Farm"

## Acton, Massachusetts

August 29, 2014

**Prepared for:**
Acton Management, Inc.
P.O. Box 2350
Acton, MA 01720

**Prepared By:**
FORESITE Engineering Associates, Inc.
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2 Planned Erosion & Sedimentation Controls During Construction

3 Long Term Inspection & Maintenance Measures After Construction

4 Illicit Discharge Compliance Statement

## 1. Project Description

Hayward Farm subdivision is a proposed 4-lot Residential Compound subdivision located at 121 Hayward Road in Acton. The site is located on the northerly side of Hayward Road opposite the intersection of Joseph Reed Lane and Hayward Road, approximately 1,000 feet east of the intersection of Hayward Road and Arlington Street. The site is currently utilized for a single family dwelling and, with the exception of the existing dwelling and driveway is predominantly undeveloped woodland. Existing drainage is northerly from Hayward Road overland toward Kennedy Drive with an intermittent stream bed which conveys intermittent surface drainage north to the Kennedy Drive drainage system.

Soils on site are identified by the U.S. Natural Resource Conservation Service (NRCS) as Paxton and Paxton Urban Land Complex, which are typically well drained upland soils. On site deep observation tests and percolation tests were performed in June of 2014 to field verify on site soil conditions for sewage disposal system and drainage system design.

Under current conditions surface drainage flows over land northerly to the Kennedy Drive drainage system via an intermittent stream that bisects the locus tract that is ultimately tributary to Grassy Pond Brook via the Kenned Drive drainage system. Existing street drainage sheet flows off the road crown to the shoulders of Hayward Road. The grade of Hayward Road is minor and the only infrastructure along the site frontage is a culvert under Hayward Road that conveys drainage from the southerly side of Hayward Road to the on-site intermittent stream to the south.

The development proposal for the site involves clearing and grubbing of approximately 2 acres of land, more or less, constructing a 350-ft subdivision roadway and associated infrastructure, and constructing six (6) new single family dwellings (4 subdivision lots and 2 Approval Not Require (ANR) lots). The change in surface cover from existing predominantly wooded surface cover to proposed less pervious surface covers of pavement, rooftops and lawns will increase the rate and volume of runoff from the site if unmitigated.

Increase in off-site runoff rate and volume is proposed to be mitigated by (1) limiting site disturbance to the extent necessary for site development, (2) utilizing a Stormceptor (proprietary oil/grit separator) for treatment of drainage from paved surfaces prior to attenuation and infiltration, (3) utilizing an on-site retention basin for attenuation, infiltration and controlled release of major storm events to the down-gradient intermittent stream.

## 2. Planned Erosion and Sedimentation Control Measures During Construction

### Haybales/Siltation Fence

Staked hay bales with are proposed to be installed, as shown on the site plan, around the perimeter and up gradient of the bordering vegetated wetlands. The siltation barrier will be installed prior to the commencement of any work on-site and in accordance with the design plans. An additional supply of hay bales shall be on-site to replace and/or repair hay bale fencing that is disturbed. The lines of hay bales shall be inspected and maintained on a weekly basis during construction.

### Storm Drain Inlet Protection

Temporary storm inlet protection filter or hay bales will be placed around all catch basin units and drainage system inlets during construction. The purpose of the filter is to prevent the inflow of sediments into the closed drainage system. The filter or hay bales shall remain in place until a permanent vegetative cover is established and the transport of sediment is no longer a potential hazard. The filter shall be inspected and maintained on a weekly basis and after every storm event during construction. Storm drain inlet protection shall be removed upon completion of site improvements and stabilization of site.

### Surface Stabilization

The surface of all disturbed areas shall be stabilized during and after construction. Temporary measures shall be taken during construction to prevent erosion and siltation. All disturbed slopes will be stabilized with a permanent vegetative cover. Some or all of the following measures will be utilized on this project as conditions may warrant.

a. Temporary Seeding
b. Temporary Mulching
c. Permanent Seeding
d. Placement of Sod
e. Hydroseeding

f. Placement of Hay
g. Placement of Jute Netting

**Inspection and Maintenance of Stormceptor 450i Catch Basin**

The performance of the Stormceptor 450i catch basin will be limited during construction by filter fabric and hay bale inlet protection proposed to keep sediments out of the system. The Stormceptor shall be inspected after every rainfall event during construction and cleaned of sediments and debris as necessary (typically when sediment depth in the sump reaches 8" or greater).

**3. Long-Term Inspection and Maintenance Measures After Construction**

**Stormwater Management System Owners & Party Responsible for Maintenance:**

Acton Management, Inc.
P.O. Box 2350
Acton, MA 01720

**Erosion Control**

Eroded sediments can adversely affect the performance of the stormwater management system. Eroding or barren areas should be re-vegetated immediately.

**Debris and Litter Removal**

Trash may collect in the BMP's, potentially causing clogging of the facilities. All debris and litter shall be removed from the site as soon as possible upon discovery, and after each storm event.

**Inspection and Maintenance of Catch Basin**

The catch basin shall be inspected four (4) times per year in the first year following construction, and if necessary, maintenance shall be performed so that it functions as designed. The catch basin shall be cleaned annually thereafter, and when sediment depth reaches 24 inches or greater. Outlet pipe should be checked for clogging. At a minimum, inspection of the catch basin shall be performed during the last week of April and the first week of October each calendar year.

The Stormceptor 450i catch basin shall be inspected four (4) times per year in the first year following construction, and if necessary, maintenance shall be performed so that it functions as designed in accordance with the attached inspection and maintenance procedures. Inlet and outlet pipes should be checked for clogging. The Stormceptor shall be inspected once per year thereafter, and cleaned with a vacuum truck when sediment depth reaches 8 inches or greater.

**Retention Basin**

Retention basin should be inspected at least semi-annually, and maintenance and repairs made as necessary. Additional inspections should be scheduled regularly during the first few months to make sure the covering vegetation is adequately established. Repairs and reseeding should be done as required. Basins slopes should be mowed at least once per year. Grass clippings should be removed. The grass must not be cut too often or shorter than four inches, in order to maintain the effectiveness of the basin. Sediment and debris should be removed from the basin manually (by hand), at least once per year, before vegetation is adversely impacted.

## 4. Illicit Discharge Compliance Statement

(1) Prohibition of Illicit Discharges.

(a) Prohibition. No person shall throw, drain, discharge, cause to be discharged, or allow others under their control to discharge into the storm sewer system or watercourse any materials other than stormwater, including but not limited to pollutants or waters containing pollutants.

(b) Exemptions. The following non-stormwater discharges are excluded from (a) above:

(1) waterline flushing or other potable water sources;

(2) landscape irrigation or lawn watering;

(3) diverted, natural riparian habitat and/or wetland flows;

(4) rising ground water, ground water infiltration to storm drains, and/or uncontaminated pumped groundwater;

(5) foundation or footing drains (not including active ground water dewatering systems) and crawl space pumps;

(6) air conditioning condensation;

(7) springs;

(8) other water sources determined by the Massachusetts Department of Environmental Protection, in writing, as not containing pollutants that cause or contribute to waterway degradation, including but not limited to a violation of applicable water quality standards and/or degradation of the biotic integrity of surface water bodies and their floodplains.

# Stormceptor® STC
# Inspection and Maintenance Information

## Stormceptor® Inspection and Maintenance

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

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

***When is inspection needed?***

- Post-construction inspection is required prior to putting the Stormceptor System into service.
- Routine inspections are recommended during the first year of operation to accurately assess the sediment accumulation.
- Specifically for New Jersey installations, regulations require all BMPs to be inspected a minimum four times per year and after every storm with greater than one inch of rainfall.
- Inspection frequency in subsequent years is based on the maintenance plan developed in the first year.
- Inspections should also be performed immediately after an oil, fuel or other chemical spill.

***When is maintenance cleaning needed?***

- For optimum performance, the unit should be cleaned out once the sediment depth reaches 15% of the unit's total storage capacity (see Table 1). Generally, the minimum cleaning frequency is once annually, although the frequency can be based on historical inspection results.
- The unit should be cleaned out immediately after an oil, fuel or chemical spill.

Table 1

| **Sediment Maintenance Depth* and Oil Capacity** | | |
|---|---|---|
| **STC Model** | **Sediment Depth*** (inches) | **Oil Capacity** (gallons) |
| 450i | 8 | 86 |
| 900 | 8 | 251 |
| 1200 | 10 | 251 |
| 1800 | 15 | 251 |
| 2400 | 12 | 840 |

| | | |
|---|---|---|
| 3600 | 17 | 840 |
| 4800 | 15 | 909 |
| 6000 | 18 | 909 |
| 7200 | 15 | 1059 |
| 11000 | 17 | 2797 |
| 13000 | 20 | 2797 |
| 16000 | 17 | 3055 |
| * based on 15% of the lower chamber volume | | |

***What conditions can compromise the Stormceptor System performance?***

- If the system is not maintained regularly and fills with sediment and debris beyond the capacity indicated in Table 1, sediment removal efficiency may be reduced.
- If an oil spill(s) exceeds the oil capacity of the system, subsequent spills may not be captured.
- If debris clogs the inlet of the system, removal efficiency of sediment and hydrocarbons may be reduced.
- If a downstream blockage occurs, a backwater condition may occur in the system and removal efficiency of sediment and hydrocarbons may be reduced.

***What training is required?***

The Stormceptor System is inspected and maintained by professional vacuum cleaning service providers with experience in the maintenance of underground tanks, sewers and catch basins. For typical inspection and maintenance activities, no specific supplemental training is required for the Stormceptor System. Information provided in this document or the Stormceptor Operation and Maintenance Manual (provided to the system owner) contains sufficient guidance to maintain the system properly.

In unusual circumstances, such as if a damaged component needs replacement or some other condition requires manned entry into the vessel, confined space entry procedures must be followed. Only professional maintenance service providers trained in these procedures should enter the vessel. Service provider companies typically have personnel who are trained and certified in confined space entry procedures according to local, state, and federal standards.

***What equipment is typically required for inspection?***

- Manhole access cover lifting tool
- Oil dipstick
- Sediment probe
- Flashlight
- Camera
- Data log
- Safety cones and caution tape
- Hard hat, safety shoes, safety glasses, and chemical-resistant gloves

***How is the Stormceptor System inspected?***

- The Stormceptor System can be inspected through a standard surface manhole

access cover.

- Sediment and oil depth inspections are performed with a sediment probe and oil dipstick. Oil depth is measured through the oil inspection port. Sediment depth can be measured through the oil inspection port or exit riser pipe.
- Inspections also involve a visual inspection of the internal components of the system.

***What equipment is typically required for maintenance?***

- Vacuum truck equipped with water hose and jet nozzle
- Small pump and tubing for oil removal
- Manhole access cover lifting tool
- Oil dipstick
- Sediment probe
- Flashlight
- Camera
- Data log
- Safety cones and caution tape
- Hard hats, safety shoes, safety glasses, chemical-resistant gloves, and hearing protection for service providers
- Gas analyzer, respiratory gear, and safety harness for specially trained personnel if confined space entry is required

***How is the Stormceptor System maintained?***

- The Stormceptor System can be maintained through a standard surface manhole access cover.
- Insert the oil dipstick into the oil inspection port. If oil is present, pump off the oil layer into separate containment using a small pump and tubing.
- Maintenance cleaning of accumulated sediment is performed with a vacuum truck.
- For 6-ft diameter models and larger, the vacuum hose is inserted into the lower chamber via the 24-inch outlet riser pipe.
- For 4-ft diameter model, the removable drop tee is lifted out, and the vacuum hose is inserted into the lower chamber via the 12-inch drop tee hole.
- Using the vacuum hose, decant the water from the lower chamber to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank.
- Remove the sludge from the bottom of the unit using the vacuum hose.
- Re-fill the lower chamber with water where required by the local jurisdiction.
- Units that have not been maintained regularly, have surpassed the maximum recommended sediment capacity, or contain damaged components may require manned entry by trained personnel using proper confined space entry procedures.

.

***What is required for proper disposal?***

- Disposal requirements for recovered pollutants may vary depending on local guidelines. In most areas the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste.

***What about oil spills?***

- Petroleum-based pollutants captured by the Stormceptor system (oil/chemical/fuel spills) should be removed and disposed of by a licensed waste management company.
- Although Stormceptor captures virtually all free oil, a sheen at the outlet **does not** mean the unit isn't working. A rainbow or sheen can be visible at oil concentrations of less than 10 mg/L (ppm).

***What factors affect the costs involved with inspection/maintenance?***

- Inspection and maintenance costs are based on unit size, sediment/oil/hazardous material loads, transportation distances, tipping fees, disposal requirements and other local regulations.

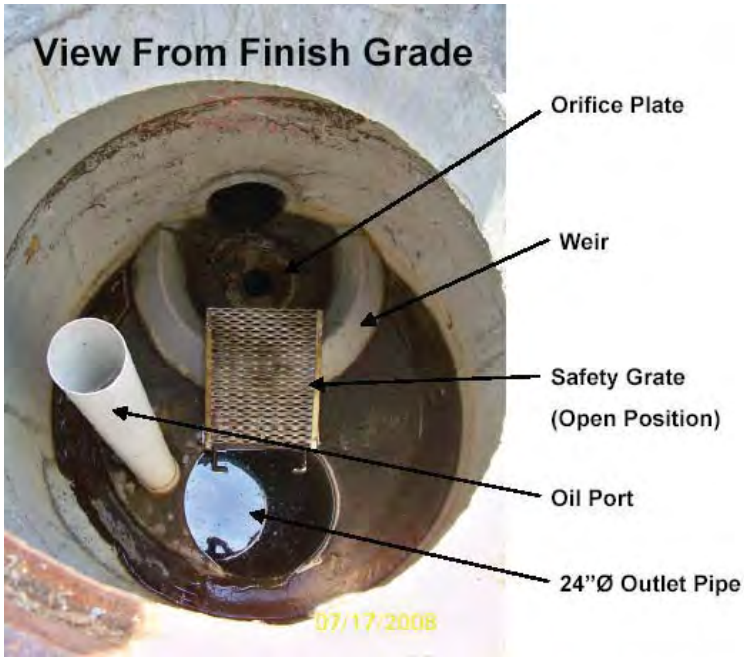
***System schematic and component functions***

Below is a schematic of the Stormceptor System with key components identified and their functions briefly described.

- **Manhole access cover** – provides access to the subsurface components
- **Precast reinforced concrete structure** – provides the vessel's watertight structural support
- **Fiberglass insert** – separates vessel into upper and lower chambers
- **Weir** – directs incoming stormwater and oil spills into the lower treatment chamber
- **Orifice plate** – controls water flow rate into the lower treatment chamber and prevents scour of accumulated pollutants
- **Inlet drop tee** – conveys stormwater into the lower treatment chamber and splits flow into two opposite tangential streams
- **Fiberglass skirt** – provides double-wall containment of hydrocarbons
- **Outlet riser pipe** – conveys treated water to the upper chamber; primary vactor access port for sediment removal

- **Oil inspection port** – primary access for measuring oil depth and oil removal
- **Safety grate** – safety measure to cover riser pipe in the event of manned entry into vessel

The Stormceptor System has no moving parts to wear out and therefore maintenance activities are generally focused on pollutant removal.




The depth of sediment can be measured from the surface by using a sediment probe or dipstick tube equipped with a ball check valve and inserted through the 24-inch outlet riser pipe. Oil level can similarly be checked through the oil inspection port.

A maintenance worker stationed on the surface uses a vacuum hose to evacuate water, sediment, and debris from the system.

***Purchasing replacement parts***

Since there are no moving parts in the Stormceptor System, broken, damaged, or worn parts are not typically encountered. However, if replacements parts are necessary, they may be obtained by contacting the following supplier of authentic Stormceptor components.

In New Jersey, contact:

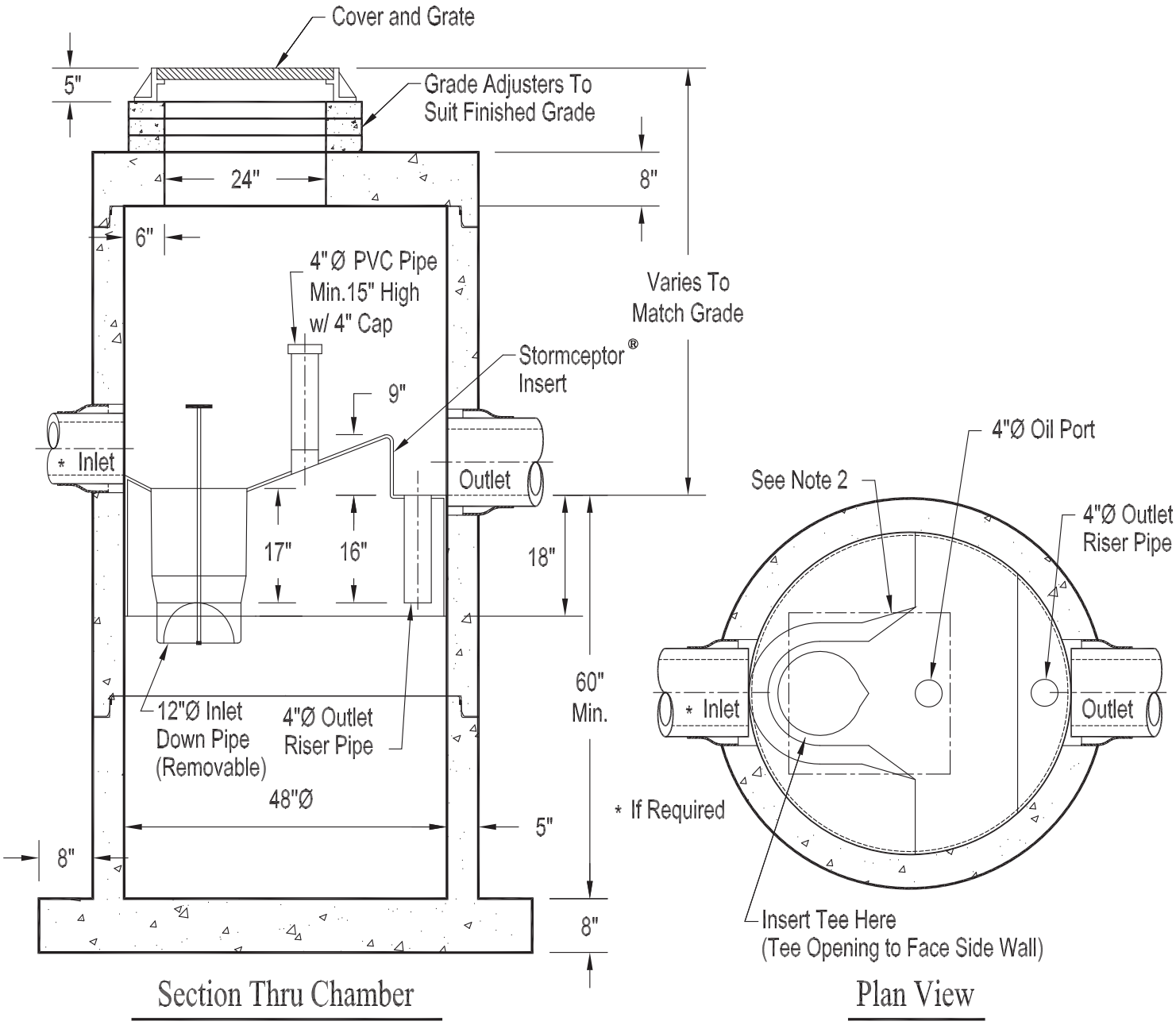
Camtek Construction Products Corp.
3481 Treeline Drive
Murrysville, PA 15668
Phone: (724) 327-3400

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

# Appendix F

Stormceptor 450i Specifications

# STC 450i Precast Concrete Stormceptor®
# (450 U.S. Gallon Capacity)




Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The Cover Should be Positioned Over The Inlet Drop Pipe and The Oil Port.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.

# Appendix G

Stormceptor Total Suspended Solids (TSS) Removal Efficiency Calculations

# Stormceptor Design Summary

**PCSWMM for Stormceptor**

## Project Information

| | |
|---|---|
| Date | 10/27/2014 |
| Project Name | HAYWARD FARM |
| Project Number | 1821 |
| Location | ACTON,MA |

## Designer Information

| | |
|---|---|
| Company | FORESITE ENGINEERING |
| Contact | SCOTT HAYES |

## Notes

N/A

## Drainage Area

| | |
|---|---|
| Total Area (ac) | 1.03 |
| Imperviousness (%) | 33 |

The Stormceptor System model STC 450i achieves the water quality objective removing 86% TSS for a Fine (organics, silts and sand) particle size distribution.

## Rainfall

| | |
|---|---|
| Name | BLUE HILL |
| State | MA |
| ID | 736 |
| Years of Records | 1948 to 2005 |
| Latitude | 42°12'44"N |
| Longitude | 71°6'53"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** | **86** |
| STC 900 | 91 |
| STC 1200 | 92 |
| STC 1800 | 92 |
| STC 2400 | 94 |
| STC 3600 | 94 |
| STC 4800 | 95 |
| STC 6000 | 96 |
| STC 7200 | 96 |
| STC 11000 | 98 |
| STC 13000 | 98 |
| STC 16000 | 98 |

## 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

# Appendix H

DEP 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.

[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.

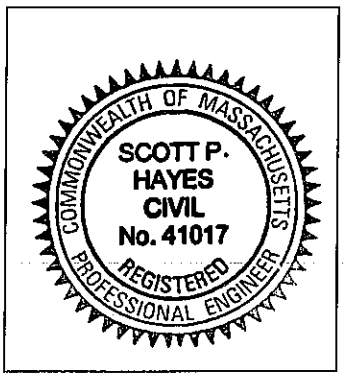
*Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that 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




8-29-14

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:

- [x] No disturbance to any Wetland Resource Areas
- [x] 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**

- [x] No new untreated discharges
- [x] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [x] 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.

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

N/A **Standard 6: Critical Areas**

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

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

# Checklist for Stormwater Report

## Checklist (continued)

N/A **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**

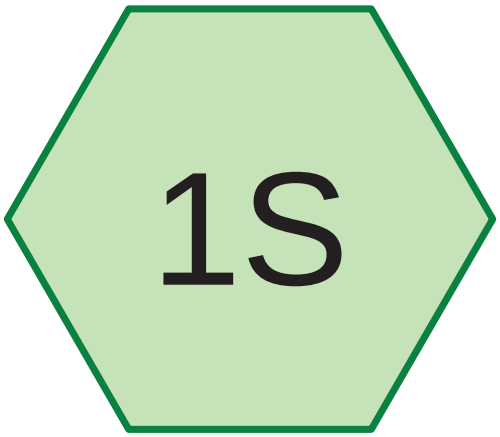
- ☑ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
  - ☑ Name of the stormwater management system owners;
  - ☑ Party responsible for operation and maintenance;
  - ☑ Schedule for implementation of routine and non-routine 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**

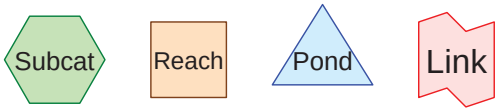
- ☑ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- ☑ An Illicit Discharge Compliance Statement is attached;
- ☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

# Appendix I

HydroCAD Output




# OFF SITE NORTH




**Routing Diagram for 1821 PRE**
Prepared by FORESITE Engineering
HydroCAD® 10.00-13 s/n 01697 © 2014 HydroCAD Software Solutions LLC

## Area Listing (all nodes)

| Area (sq-ft) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 8,958 | 98 | Paved parking, HSG C (1S) |
| 99,794 | 70 | Woods, Good, HSG C (1S) |
| **108,752** | **72** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (sq-ft) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0 | HSG A | |
| 0 | HSG B | |
| 108,752 | HSG C | 1S |
| 0 | HSG D | |
| 0 | Other | |
| **108,752** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (sq-ft) | HSG-B (sq-ft) | HSG-C (sq-ft) | HSG-D (sq-ft) | Other (sq-ft) | Total (sq-ft) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 8,958 | 0 | 0 | 8,958 | Paved parking | 1S |
| 0 | 0 | 99,794 | 0 | 0 | 99,794 | Woods, Good | 1S |
| **0** | **0** | **108,752** | **0** | **0** | **108,752** | **TOTAL AREA** | |

## Summary for Subcatchment 1S: OFF SITE NORTH

Runoff = 1.98 cfs @ 12.20 hrs, Volume= 8,394 cf, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.20"

| Area (sf) | CN | Description |
|---|---|---|
| 99,794 | 70 | Woods, Good, HSG C |
| 8,958 | 98 | Paved parking, HSG C |
| 108,752 | 72 | Weighted Average |
| 99,794 | | 91.76% Pervious Area |
| 8,958 | | 8.24% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.1 | 25 | 0.0800 | 0.06 | | **Sheet Flow, TR-55 SHEET FLOW**<br>Woods: Dense underbrush n= 0.800 P2= 3.20" |
| 6.1 | 485 | 0.0700 | 1.32 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW**<br>Woodland Kv= 5.0 fps |
| 13.2 | 510 | Total | | | |

## Summary for Subcatchment 1S: OFF SITE NORTH

Runoff = 4.14 cfs @ 12.19 hrs, Volume= 16,445 cf, Depth> 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 99,794 | 70 | Woods, Good, HSG C |
| 8,958 | 98 | Paved parking, HSG C |
| 108,752 | 72 | Weighted Average |
| 99,794 | | 91.76% Pervious Area |
| 8,958 | | 8.24% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.1 | 25 | 0.0800 | 0.06 | | **Sheet Flow, TR-55 SHEET FLOW** |
| | | | | | Woods: Dense underbrush n= 0.800 P2= 3.20" |
| 6.1 | 485 | 0.0700 | 1.32 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** |
| | | | | | Woodland Kv= 5.0 fps |
| 13.2 | 510 | Total | | | |

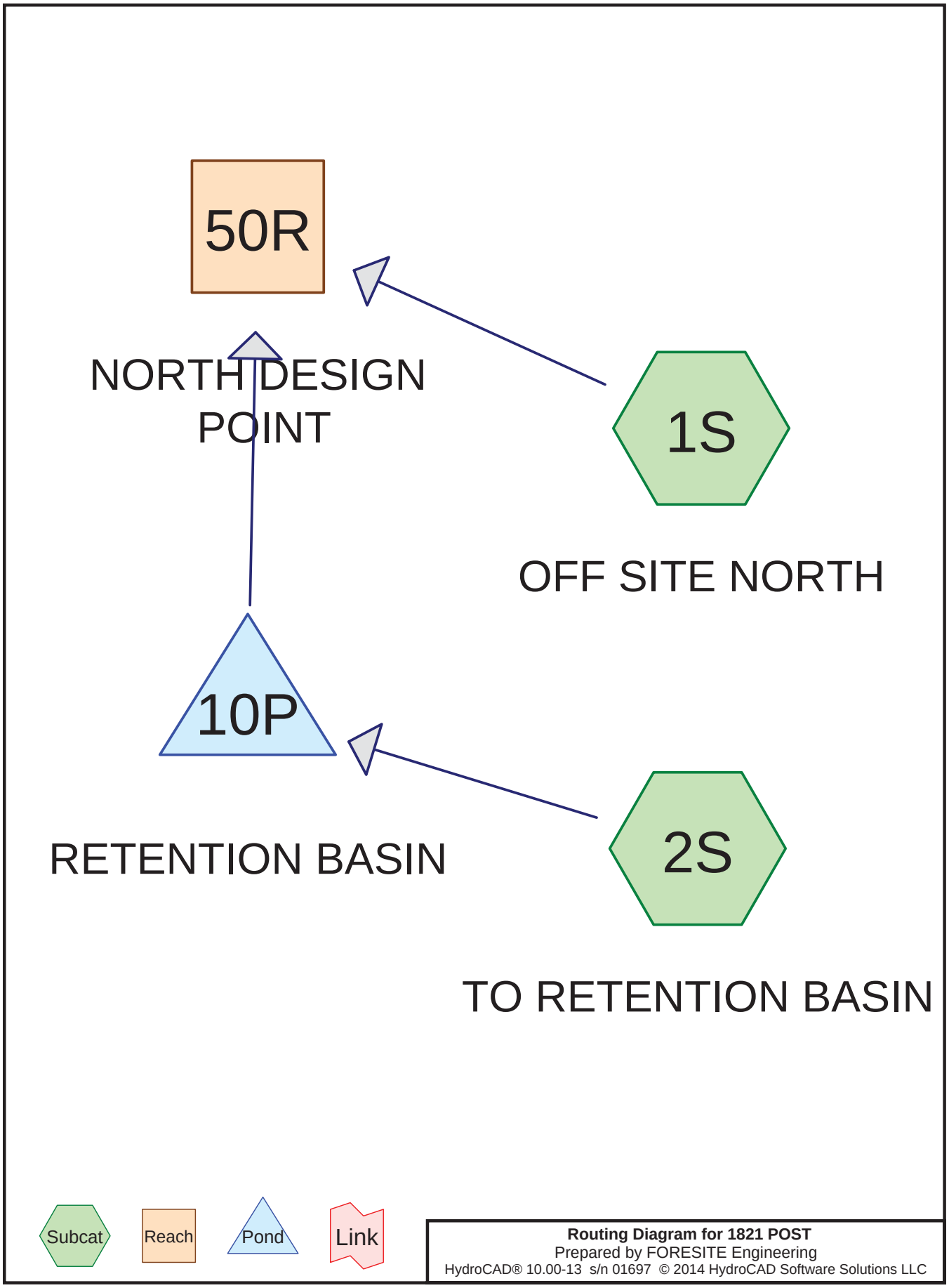
## Summary for Subcatchment 1S: OFF SITE NORTH

Runoff = 8.11 cfs @ 12.19 hrs, Volume= 31,548 cf, Depth> 3.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=6.60"

| Area (sf) | CN | Description |
|---|---|---|
| 99,794 | 70 | Woods, Good, HSG C |
| 8,958 | 98 | Paved parking, HSG C |
| 108,752 | 72 | Weighted Average |
| 99,794 | | 91.76% Pervious Area |
| 8,958 | | 8.24% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.1 | 25 | 0.0800 | 0.06 | | **Sheet Flow, TR-55 SHEET FLOW** Woods: Dense underbrush n= 0.800 P2= 3.20" |
| 6.1 | 485 | 0.0700 | 1.32 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** Woodland Kv= 5.0 fps |
| 13.2 | 510 | Total | | | |




**Routing Diagram for 1821 POST**
Prepared by FORESITE Engineering
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## Area Listing (all nodes)

| Area (sq-ft) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 52,527 | 74 | >75% Grass cover, Good, HSG C (1S, 2S) |
| 24,000 | 98 | Paved parking, HSG C (1S, 2S) |
| 32,225 | 70 | Woods, Good, HSG C (1S, 2S) |
| **108,752** | **78** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (sq-ft) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0 | HSG A | |
| 0 | HSG B | |
| 108,752 | HSG C | 1S, 2S |
| 0 | HSG D | |
| 0 | Other | |
| **108,752** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (sq-ft) | HSG-B (sq-ft) | HSG-C (sq-ft) | HSG-D (sq-ft) | Other (sq-ft) | Total (sq-ft) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 52,527 | 0 | 0 | 52,527 | >75% Grass cover, Good | 1S, 2S |
| 0 | 0 | 24,000 | 0 | 0 | 24,000 | Paved parking | 1S, 2S |
| 0 | 0 | 32,225 | 0 | 0 | 32,225 | Woods, Good | 1S, 2S |
| **0** | **0** | **108,752** | **0** | **0** | **108,752** | **TOTAL AREA** | |

## Summary for Subcatchment 1S: OFF SITE NORTH

Runoff = 1.91 cfs @ 12.09 hrs, Volume= 6,114 cf, Depth> 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.20"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 28,395 | 70 | Woods, Good, HSG C |
| | 26,114 | 74 | >75% Grass cover, Good, HSG C |
| * | 9,271 | 98 | Paved parking, HSG C |
| | 63,780 | 76 | Weighted Average |
| | 54,509 | | 85.46% Pervious Area |
| | 9,271 | | 14.54% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.3 | 25 | 0.0400 | 1.38 | | **Sheet Flow, TR-55 SHEET FLOW** Smooth surfaces n= 0.011 P2= 3.20" |
| 2.5 | 200 | 0.0700 | 1.32 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** Woodland Kv= 5.0 fps |
| 2.8 | 225 | Total, Increased to minimum Tc = 6.0 min | | | |

## Summary for Subcatchment 2S: TO RETENTION BASIN

Runoff = 1.86 cfs @ 12.09 hrs, Volume= 5,757 cf, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.20"

| Area (sf) | CN | Description |
|---|---|---|
| 26,413 | 74 | >75% Grass cover, Good, HSG C |
| 14,729 | 98 | Paved parking, HSG C |
| 3,830 | 70 | Woods, Good, HSG C |
| 44,972 | 82 | Weighted Average |
| 30,243 | | 67.25% Pervious Area |
| 14,729 | | 32.75% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.3 | 25 | 0.0400 | 1.38 | | **Sheet Flow, TR-55 SHEET FLOW** Smooth surfaces n= 0.011 P2= 3.20" |
| 3.8 | 375 | 0.0550 | 1.64 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** Short Grass Pasture Kv= 7.0 fps |
| 4.1 | 400 | Total, Increased to minimum Tc = 6.0 min | | | |

## Summary for Reach 50R: NORTH DESIGN POINT

Inflow Area = 108,752 sf, 22.07% Impervious, Inflow Depth > 0.72" for 2-YR event
Inflow = 1.91 cfs @ 12.09 hrs, Volume= 6,481 cf
Outflow = 1.91 cfs @ 12.09 hrs, Volume= 6,481 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

## Summary for Pond 10P: RETENTION BASIN

Inflow Area = 44,972 sf, 32.75% Impervious, Inflow Depth > 1.54" for 2-YR event
Inflow = 1.86 cfs @ 12.09 hrs, Volume= 5,757 cf
Outflow = 0.09 cfs @ 15.30 hrs, Volume= 2,869 cf, Atten= 95%, Lag= 192.6 min
Discarded = 0.06 cfs @ 15.30 hrs, Volume= 2,502 cf
Primary = 0.03 cfs @ 15.30 hrs, Volume= 367 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 236.02' @ 15.30 hrs Surf.Area= 2,335 sf Storage= 3,501 cf

Plug-Flow detention time= 316.2 min calculated for 2,868 cf (50% of inflow)
Center-of-Mass det. time= 197.7 min ( 1,033.1 - 835.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 234.00' | 9,375 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 234.00 | 1,252 | 0 | 0 |
| 235.00 | 1,668 | 1,460 | 1,460 |
| 236.00 | 2,324 | 1,996 | 3,456 |
| 237.00 | 2,910 | 2,617 | 6,073 |
| 238.00 | 3,693 | 3,302 | 9,375 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 234.00' | **1.020 in/hr Exfiltration over Surface area** |
| #2 | Primary | 237.00' | **10.0' long (Profile 1) Broad-Crested Rectangular Weir**<br>Head (feet) 0.49 0.98 1.48<br>Coef. (English) 2.92 3.37 3.59 |
| #3 | Primary | 235.90' | **6.0" Round Culvert** L= 25.0' Ke= 0.900<br>Inlet / Outlet Invert= 235.90' / 235.65' S= 0.0100 '/' Cc= 0.900<br>n= 0.010, Flow Area= 0.20 sf |

**Discarded OutFlow** Max=0.06 cfs @ 15.30 hrs HW=236.02' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

**Primary OutFlow** Max=0.03 cfs @ 15.30 hrs HW=236.02' (Free Discharge)
├─**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)
└─**3=Culvert** (Inlet Controls 0.03 cfs @ 0.93 fps)

## Summary for Subcatchment 1S: OFF SITE NORTH

Runoff = 3.64 cfs @ 12.09 hrs, Volume= 11,306 cf, Depth> 2.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=4.50"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 28,395 | 70 | Woods, Good, HSG C |
| | 26,114 | 74 | >75% Grass cover, Good, HSG C |
| * | 9,271 | 98 | Paved parking, HSG C |
| | 63,780 | 76 | Weighted Average |
| | 54,509 | | 85.46% Pervious Area |
| | 9,271 | | 14.54% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.3 | 25 | 0.0400 | 1.38 | | **Sheet Flow, TR-55 SHEET FLOW** Smooth surfaces n= 0.011 P2= 3.20" |
| 2.5 | 200 | 0.0700 | 1.32 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** Woodland Kv= 5.0 fps |
| 2.8 | 225 | Total, Increased to minimum Tc = 6.0 min | | | |

## Summary for Subcatchment 2S: TO RETENTION BASIN

Runoff = 3.19 cfs @ 12.09 hrs, Volume= 9,868 cf, Depth> 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 26,413 | 74 | >75% Grass cover, Good, HSG C |
| 14,729 | 98 | Paved parking, HSG C |
| 3,830 | 70 | Woods, Good, HSG C |
| 44,972 | 82 | Weighted Average |
| 30,243 | | 67.25% Pervious Area |
| 14,729 | | 32.75% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.3 | 25 | 0.0400 | 1.38 | | **Sheet Flow, TR-55 SHEET FLOW** Smooth surfaces n= 0.011 P2= 3.20" |
| 3.8 | 375 | 0.0550 | 1.64 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** Short Grass Pasture Kv= 7.0 fps |
| 4.1 | 400 | Total, Increased to minimum Tc = 6.0 min | | | |

## Summary for Reach 50R: NORTH DESIGN POINT

Inflow Area = 108,752 sf, 22.07% Impervious, Inflow Depth > 1.68" for 10-YR event
Inflow = 3.64 cfs @ 12.09 hrs, Volume= 15,208 cf
Outflow = 3.64 cfs @ 12.09 hrs, Volume= 15,208 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

## Summary for Pond 10P: RETENTION BASIN

Inflow Area = 44,972 sf, 32.75% Impervious, Inflow Depth > 2.63" for 10-YR event
Inflow = 3.19 cfs @ 12.09 hrs, Volume= 9,868 cf
Outflow = 0.49 cfs @ 12.59 hrs, Volume= 6,676 cf, Atten= 84%, Lag= 30.3 min
Discarded = 0.06 cfs @ 12.59 hrs, Volume= 2,774 cf
Primary = 0.43 cfs @ 12.59 hrs, Volume= 3,902 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 236.49' @ 12.59 hrs Surf.Area= 2,610 sf Storage= 4,658 cf

Plug-Flow detention time= 199.7 min calculated for 6,673 cf (68% of inflow)
Center-of-Mass det. time= 101.7 min ( 921.7 - 820.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 234.00' | 9,375 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 234.00 | 1,252 | 0 | 0 |
| 235.00 | 1,668 | 1,460 | 1,460 |
| 236.00 | 2,324 | 1,996 | 3,456 |
| 237.00 | 2,910 | 2,617 | 6,073 |
| 238.00 | 3,693 | 3,302 | 9,375 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 234.00' | **1.020 in/hr Exfiltration over Surface area** |
| #2 | Primary | 237.00' | **10.0' long (Profile 1) Broad-Crested Rectangular Weir**<br>Head (feet) 0.49 0.98 1.48<br>Coef. (English) 2.92 3.37 3.59 |
| #3 | Primary | 235.90' | **6.0" Round Culvert** L= 25.0' Ke= 0.900<br>Inlet / Outlet Invert= 235.90' / 235.65' S= 0.0100 '/' Cc= 0.900<br>n= 0.010, Flow Area= 0.20 sf |

**Discarded OutFlow** Max=0.06 cfs @ 12.59 hrs HW=236.49' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

**Primary OutFlow** Max=0.43 cfs @ 12.59 hrs HW=236.49' (Free Discharge)
├─**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)
└─**3=Culvert** (Inlet Controls 0.43 cfs @ 2.21 fps)

## Summary for Subcatchment 1S: OFF SITE NORTH

Runoff = 6.70 cfs @ 12.09 hrs, Volume= 20,722 cf, Depth> 3.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=6.60"

| | Area (sf) | CN | Description |
|---|---|---|---|
| | 28,395 | 70 | Woods, Good, HSG C |
| | 26,114 | 74 | >75% Grass cover, Good, HSG C |
| * | 9,271 | 98 | Paved parking, HSG C |
| | 63,780 | 76 | Weighted Average |
| | 54,509 | | 85.46% Pervious Area |
| | 9,271 | | 14.54% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.3 | 25 | 0.0400 | 1.38 | | **Sheet Flow, TR-55 SHEET FLOW** Smooth surfaces n= 0.011 P2= 3.20" |
| 2.5 | 200 | 0.0700 | 1.32 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** Woodland Kv= 5.0 fps |
| 2.8 | 225 | Total, Increased to minimum Tc = 6.0 min | | | |

## Summary for Subcatchment 2S: TO RETENTION BASIN

Runoff = 5.43 cfs @ 12.09 hrs, Volume= 17,006 cf, Depth> 4.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=6.60"

| Area (sf) | CN | Description |
|---|---|---|
| 26,413 | 74 | >75% Grass cover, Good, HSG C |
| 14,729 | 98 | Paved parking, HSG C |
| 3,830 | 70 | Woods, Good, HSG C |
| 44,972 | 82 | Weighted Average |
| 30,243 | | 67.25% Pervious Area |
| 14,729 | | 32.75% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.3 | 25 | 0.0400 | 1.38 | | **Sheet Flow, TR-55 SHEET FLOW** Smooth surfaces n= 0.011 P2= 3.20" |
| 3.8 | 375 | 0.0550 | 1.64 | | **Shallow Concentrated Flow, SH. CONC. UPLAND FLOW** Short Grass Pasture Kv= 7.0 fps |
| 4.1 | 400 | Total, Increased to minimum Tc = 6.0 min | | | |

## Summary for Reach 50R: NORTH DESIGN POINT

Inflow Area = 108,752 sf, 22.07% Impervious, Inflow Depth > 3.45" for 100-YR event
Inflow = 7.26 cfs @ 12.09 hrs, Volume= 31,245 cf
Outflow = 7.26 cfs @ 12.09 hrs, Volume= 31,245 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

## Summary for Pond 10P: RETENTION BASIN

Inflow Area = 44,972 sf, 32.75% Impervious, Inflow Depth > 4.54" for 100-YR event
Inflow = 5.43 cfs @ 12.09 hrs, Volume= 17,006 cf
Outflow = 2.71 cfs @ 12.24 hrs, Volume= 13,626 cf, Atten= 50%, Lag= 9.0 min
Discarded = 0.07 cfs @ 12.24 hrs, Volume= 3,103 cf
Primary = 2.64 cfs @ 12.24 hrs, Volume= 10,522 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 237.16' @ 12.24 hrs Surf.Area= 3,036 sf Storage= 6,552 cf

Plug-Flow detention time= 145.6 min calculated for 13,626 cf (80% of inflow)
Center-of-Mass det. time= 70.3 min ( 874.9 - 804.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 234.00' | 9,375 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 234.00 | 1,252 | 0 | 0 |
| 235.00 | 1,668 | 1,460 | 1,460 |
| 236.00 | 2,324 | 1,996 | 3,456 |
| 237.00 | 2,910 | 2,617 | 6,073 |
| 238.00 | 3,693 | 3,302 | 9,375 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 234.00' | **1.020 in/hr Exfiltration over Surface area** |
| #2 | Primary | 237.00' | **10.0' long (Profile 1) Broad-Crested Rectangular Weir**<br>Head (feet) 0.49 0.98 1.48<br>Coef. (English) 2.92 3.37 3.59 |
| #3 | Primary | 235.90' | **6.0" Round Culvert** L= 25.0' Ke= 0.900<br>Inlet / Outlet Invert= 235.90' / 235.65' S= 0.0100 '/' Cc= 0.900<br>n= 0.010, Flow Area= 0.20 sf |

**Discarded OutFlow** Max=0.07 cfs @ 12.24 hrs HW=237.16' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.07 cfs)

**Primary OutFlow** Max=2.63 cfs @ 12.24 hrs HW=237.16' (Free Discharge)
├─**2=Broad-Crested Rectangular Weir** (Weir Controls 1.88 cfs @ 1.17 fps)
└─**3=Culvert** (Inlet Controls 0.75 cfs @ 3.82 fps)