May 1, 2013

STORMWATER REPORT

ATTACHMENT D

For

XAVERIAN BROTHERS HIGH SCHOOL
BUILDING ADDITION & SITE IMPROVEMENTS
800 Clapboardtree Street
Westwood, MA

Prepared for:

BEACON ARCHITECTURAL ASSOCIATES
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Nitsch Project #9556

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1.0 INTRODUCTION

Nitsch Engineering has prepared this Stormwater Report for the Notice of Intent for the proposed building additions and site improvements at Xaverian Brothers High School in Westwood, Massachusetts. The proposed project includes the construction of a building addition to be used as a Wellness Center, access driveway, parking lot, and other associated utility and site improvements (subsequently referred to as the "Project"). The Project also includes a stormwater management system which has been designed in compliance with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards.

2.0 EXISTING CONDITIONS

Xaverian Brothers High School is located at 800 Clapboardtree Street in Westwood, Massachusetts, near the Westwood/Norwood town line (Figure 1). The Project Site encompasses the existing High School campus and six additional parcels located east of the High School campus (i.e. parcels 23-003, 23-004, 23-005, 23-006, 23-007, 23-008, and 23-010). The Project Site is bounded by residential properties and Purgatory Brook to the north, residential properties to the east and west, and Clapboardtree Street, commercial and residential properties to the south.

The School's property includes approximately 31 acres, the majority of which is developed and includes the main school building, a front parking area, a rear parking area, a fire lane and parking along the building rear and athletic fields. There are three sport fields on campus: the football and baseball fields are artificial turf and the upper field is natural turf. A football field with running track, bleachers and a small concession building is located on the east side of the campus. The varsity baseball/practice field is north of the campus, and an upper practice field is located north of the baseball field.

Topography at the Site varies with elevations that range from Elevation 124± along the northeast corner to about Elevation 157 along the southwest boundary of the study area. The site generally slopes toward the northeast corner.

2.1 Existing Drainage Infrastructure

A portion of the Site is currently served by an existing closed drainage system made up of underground pipes conveying stormwater runoff collected in catch basins. The parking area on the western side of the site discharges to an underground detention system which then discharges to the wetland area north of the site via a headwall. The parking area on the eastern portion of the Site is directed to a retention pond which overflows to the same northern wetland system. Runoff from the portion of the site that is undeveloped flows overland before entering the wetlands.

2.2 NRSC Soil Designations

Based on the Natural Resources Conservation Service (NRCS) Web Soil Survey (2013), the developed portion of the XBHS campus classified as Udorthents, loamy. To the north and east, the soils are classified as Canton fine sandy loam, 8 to 15 percent slopes, extremely stony and Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes, respectively. All of these soils are moderately drained soil with a hydraulic soil group of B (HSG B). The NRCS Soils Map is provided in Appendix D.

2.3 On-site Soil Explorations

Haley & Aldrich (H&A) prepared a Geotechnical Memorandum, dated April 11, 2013, which included the findings for the soil borings performed around the location of the proposed parking lot. Additional test pits were also completed for the area around the proposed building. Subsurface explorations in the proposed areas generally encountered Silty Sand or Sandy Silt.

The geotechnical report documenting these explorations is provided in Appendix D. Based on the on-site soil testing and the NRCS Soil Survey, HSG B was used for stormwater calculations with an infiltration rate of 1.02 in/hour for sandy loam (Rawls, 1982).

A separation of two feet was provided between groundwater and the bottom of each infiltration system. Table 1 summarizes the groundwater elevations in each area of the infiltration systems and demonstrates the two feet separation.

Table 1 - Infiltration Systems and Depth to Groundwater

System	Bottom Elevation of System	Nearest Test Pit	Groundwater Elevation
Infiltration System 1 (1P)	144.50	TP-10	NE @141.5
Infiltration System 2 (2P)	140.00	TP-6	138.0
Infiltration System 3 (3P)	127.19	TP-3	NE@121.0
Infiltration System 4 (4P)	144.32	TP-9 TP-5	NE@146.0 NE@144.5
Infiltration System 5 (5P)	151.00	B-6	149.0
Infiltration System 6 (6P)	147.00	B-1	145.0

2.4 Wetland Resource Areas

The wetland resources areas located within the Project Site were delineated by Epsilon Associates, Inc. on February 6 and 7, 2013. These resource areas include:

- Inland Bank and Land Under Water Bodies and Waterways (LUWW) associated with Purgatory Brook, a USGS-mapped perennial stream, and an intermittent stream
- Bordering Vegetated Wetland (BVW),
- 100-year Floodplain (Bordering Land Subject to Flooding – BLSF),
- Riverfront Area (RFA) to Purgatory Brook, and
- 100-foot Buffer Zone to the intermittent stream and BVWs.

Detailed information on these resources is provided in the Wetland Resource Area Delineation Summary Memo, prepared by Epsilon Associates, Inc. and provided as Attachment C in the Notice of Intent.

3.0 PROPOSED CONDITIONS

3.1 Project Description

The Applicant is proposing the construction of a New Wellness Center, which is an addition to the existing XBHS building with a footprint of approximately 25,000 SF. The building addition will house a three (3) court gymnasium, locker room facilities, meeting room, offices, and fitness center. The building addition is located outside of the all wetland resource areas, including the 200-foot Riverfront Area.

A new campus access drive is proposed to provide campus circulation and emergency and fire access. The 1,200± linear feet driveway follows the route of the existing drive and then extends further north to provide access to the new building addition. Parking spaces, light fixtures, a concrete sidewalk, and approximately 20 street trees are provided along the access drive. Approximately ten trees that were planted as part of the previous site mitigation will be relocated or replanted. The access road is partially located within the outermost 75-feet of the 200-foot Riverfront Area. To reduce the environmental impact of the access drive, the width was reduced from 24 feet to 22 feet.

A new 68,000 square-foot parking area is proposed to the east of the proposed building addition. The parking lot is located entirely outside of all jurisdictional wetland resource areas. The parking lot includes 197 parking spaces, new light fixtures, and eight-foot wide landscaped medians with 43 trees and 175 shrubs, exceeding the Town planting requirements. There are two retaining walls proposed to minimize the off-grading associated with the parking lot: (1) Four (4) foot retaining wall at 80 linear feet, and (1) 14 foot retaining wall (at highest point) that tapers with grade at 275 linear feet.

Other project components that are located outside of the wetland resource areas include:

- Construction of a new entry plaza created by the conversion of existing entry drive to pedestrian plaza between the gymnasium and stadium;
- Resurfacing of the existing track and field and replacement of the existing football field playing surface;
- Installation of new varsity field lights in approximately 4 locations at the corners of the football field; and
- New synthetic baseball/multi-purpose field with dug-outs with storage and press box extensions, fence at field perimeter, accessible ramp and path with small retaining walls, centerfield scoreboard, and planting of approximately 20 trees and 80 shrubs.

The proposed project will result in a net increase in overall impervious area (building and pavement) of 4.67 acres (Table 2). The increase in impervious area is partially due to the expansion of on-site parking to meet Zoning requirements and parking demand on campus. Infiltration systems have been proposed throughout the site to mitigate this change in impervious area. Although the northern portion of the site is currently developed, the Project is considered a new development under the MassDEP Stormwater Management Standards due to the increase in impervious area.

Table 2 – Proposed Land Use Change

Land Use	Existing (Acres)	Proposed (Acres)	Change (Acres)
Impervious (Building, Roads, parking, sidewalks, gravel)	2.44	7.11	+4.67
Grass	2.97	3.46	+0.49
Woods	6.04	0.88	-5.16
Total	**11.45**	**11.45**	-

3.2 Stormwater Management System

The Project also includes a stormwater management system to mitigate the potential environmental impact of the proposed Project. The stormwater management system was designed in accordance with the MassDEP Stormwater Management Standards using a combination of conventional and LID Best Management Practices. The design prevents the generation of stormwater and non-point source pollution by disconnecting flow paths, treating and infiltrating stormwater at its source, and protecting natural processes. Stormwater systems have been designed to model natural hydrologic features, including promoting infiltration throughout the site.

Deep Sump and Hooded Catch Basins

Deep sump and hooded catch basins are proposed to provide pretreatment in the impervious areas of the parking lot and access driveway.

Vortechnic Water Quality Structures

Water quality structures are proposed for water quality pretreatment in an area of the Site where pretreatment is required prior to entering the infiltration systems. Sizing calculations are provided to document that the structure will remove 80% TSS prior to discharging into the drainage basin.

Subsurface Infiltration Systems

Subsurface infiltration systems are proposed throughout the Site to collect, treat, and infiltrate runoff from the proposed driveways and parking lots. The systems consist of StormTech SC-740 chambers, StormTech SC-310 chambers, or 36-inch perforated pipe enveloped within a crushed stone base that extends 6-12 inches above, below, and around the perimeter of the chambers.

All site area that is tributary to these systems will be pretreated using deep sump and hooded catch basins and a proprietary water quality treatment structure prior to infiltration.

Stormwater Outfall with Level Spreader

A level spreader will be included at stormwater discharge locations. These level spreaders will receive concentrated flow and convert it to sheet flow so it can disperse uniformly across a stable slope. The level spreaders will improve the efficiency of all other BMPs on site.

Refer to the TSS Removal spreadsheets in Appendix A for TSS removal summaries for each treatment train.

4.0 STORMWATER MANAGEMENT ANALYSIS

4.1 Methodology

Nitsch Engineering completed a hydrologic analysis of the existing project site utilizing Soil Conservation Service (SCS) Runoff Curve Number (CN) methodology. The SCS method calculates the rate at which the runoff reaches the design point considering several factors: the slope and flow lengths of the subcatchment area, the soil type of the subcatchment area, and the type of surface cover in the subcatchment area. HydroCAD Version 10.00 computer modeling software was used in conjunction with the SCS method to determine the peak runoff rates and runoff volumes for the 2-, 10-, and 100-year, 24-hour storm events. The proposed project site is being analyzed with the same methodology.

The Site was divided into multiple drainage areas, or subcatchments, which drain to the design points along the property boundary and within the site. For each subcatchment area, SCS Runoff Curve Numbers (CNs) were selected by using the cover type and hydrologic soil group of each area. The peak runoff rates and runoff volumes for the 2-, 10-, and 100-year 24-hour storm events were then determined by inputting the drainage areas, CNs, and time of concentration (T_c) paths into the HydroCAD model.

4.2 HydroCAD Version 10.00

The HydroCAD computer program uses SCS and TR-20 methods to model drainage systems. TR-20 (Technical Release 20) was developed by the Soil Conservation Service to estimate runoff and peak discharges in small watersheds. TR-20 is generally accepted by engineers and reviewing authorities as the standard method for estimating runoff and peak discharges.

HydroCAD Version 10.00 uses up to four types of components to analyze the hydrology of a given site: subcatchments, reaches, basins, and links. Subcatchments are areas of land that produce surface runoff. The area, weighted CN, and T_c characterize each individual subcatchment area.

Reaches are generally uniform streams, channels, or pipes that convey water from one point to another. A basin is any impoundment that fills with water from one or more sources and empties via an outlet structure. Links are used to introduce hydrographs into a project from another source or to provide a junction for more than one hydrograph within a project.

4.3 Precipitation Data

Nitsch Engineering used Technical Paper 40 (TP-40) to estimate the rainfall for the 2-, 10-, and 100-year, 24-hour storm events. The rainfall amounts that were used in the HydroCAD model are listed in Table 3.

Table 3 – Storm Event Rainfall Totals

Storm Event	24–hour Rainfall
2-year	3.2 in.
10-year	4.7 in.
100-year	6.7 in.

4.4 Existing Hydrologic Conditions

As summarized in Table 4, Nitsch Engineering delineated the existing project site into four (4) on-site watershed areas that discharge to Purgatory Brook utilizing an existing conditions survey and on-site observations (See Figure 1). Table 4 summarizes the design point, location and area of each watershed.

The HydroCAD model for existing conditions is provided in Appendix A.

Table 4 – Existing Drainage Area Summary

Watershed	Area (sf)	Description
A	403,465	Eastern Parking Area/Undeveloped Area
B	30,138	Central Parking Area
C	26,563	Area in between Track and Building
D	38,482	Western Parking Area

4.5 Proposed Hydrologic Conditions

The proposed project has been designed to mitigate the change in stormwater runoff to Purgatory Brook as required by the MassDEP Stormwater Management Standards. The existing watershed areas were modified to reflect the proposed topography, storm drainage structures and BMPs, and roof areas. (See Figure 2 and Table 5). The proposed Subsurface Infiltration Systems are included as ponds in the HydroCAD model.

Table 5 – Proposed Drainage Area Summary

Watershed	Area (sf)	Description	Treatment/Recharge BMP(s)
AA	213,310	New Athletic Fields and Surround Area	Infiltration System 1
BB	78,881	New Parking Area	Infiltration Systems 2 &3
CC	34,727	Northeastern Side of Site	N/A
DD	90,182	Parking Areas and Driveways	Infiltration System 4
EE	38,546	Area on Western Side of Track	N/A

FF	25,307	Proposed Addition	Infiltration Systems 5 & 6
GG	17,695	Area on Western Side of Proposed Addition	Infiltration System 6

4.6 Peak Runoff Flow Rates and Volumes

Through the use of subsurface infiltration systems, the proposed stormwater management system will reduce the proposed peak runoff rate and volumes to Purgatory Brook to be less than the existing peak runoff rate and volume (Tables 6 & 7). Drainage calculations for the proposed stormwater condition are included in Appendix C.

Table 6 – Peak Runoff Rate Summary to Purgatory Brook

Storm Event	Existing Peak Runoff Rate (cfs)	Proposed Peak Runoff Rate (cfs)
2-Year	4.54	2.52
10-Year	11.69	8.14
100-Year	24.84	18.97

Table 7 – Runoff Volume Summary to Purgatory Brook

Storm Event	Existing Runoff Volume (af)	Proposed Runoff Volume (af)
2-Year	0.832	0.284
10-Year	1.771	0.843
100-Year	3.238	1.916

5.0 MassDEP Stormwater Management Standards

Although the XBHS campus is developed under existing conditions, the project will result in an increase in impervious areas. Therefore, the project is considered a new development under the MassDEP Stormwater Management Standards. The MassDEP Checklist for Stormwater Reports is provided in Appendix E.

The proposed project was designed to meet the MassDEP Stormwater Management Standards as summarized below:

Standard 1: No New Untreated Discharges

The proposed project will not discharge any untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. Stormwater from the proposed project site will be collected and treated in accordance with the MassDEP Stormwater Management Standards and stormwater outfalls will be stabilized with level spreaders to prevent erosion to adjacent wetland resource areas.

Standard 2: Peak Rate Attenuation

The proposed stormwater management system was designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates for the offsite design points. To prevent storm damage and downstream flooding, the proposed stormwater management practices will mitigate peak runoff rates for the 2-, 10-, and 100-year, 24-hour storm events.

The existing and proposed conditions hydrologic calculations for the 2-, 10-, and 100-year, 24-hour storm events are included with this report in Appendix A and B, respectively.

Standard 3: Groundwater Recharge

The proposed project site was designed using environmentally-sensitive site design and stormwater BMP treatment trains to minimize the loss of annual recharge to groundwater. The annual recharge from the proposed site will approximate the annual recharge from existing conditions based on soil type using the guidelines provided in the MassDEP Stormwater Management Handbook.

Impervious Area	= 4.67 acres
Rv (Recharge Volume)	= 0.35 in. / (12 inches/ft) x 4.67 acres x 43,560 sf/acre
	= 5,933 cubic feet

The subsurface infiltration systems have been are sized to exceed the recharge volume required under the MassDEP Stormwater Management Standards (Table 8):

Table 8 – Proposed Recharge Volumes for Stormwater BMPs

Infiltration BMP	Recharge Volume (cf)
Infiltration System 1	9,685
Infiltration System 2	5,732
Infiltration System 3	5,377
Infiltration System 4	7,643
Infiltration System 5	2,177
Infiltration System 6	3,253
Total	**33,867**

The subsurface infiltration systems were designed to provide a minimum 2-foot offset to estimated seasonal high groundwater. The Proposed Conditions HydroCAD reports provided in Appendix C indicate that the proposed infiltration BMPs will completely dewater within 30 hours for the 2-, 10-, and 100-year storm events, exceeding the 72-hour MassDEP drawdown requirement.

Standard 4: Water Quality Treatment

The proposed stormwater management system is designed to remove at least 80% of the average annual post-construction load of Total Suspended Solids (TSS). Structural stormwater BMPs including deep-sump and hooded catch basins, proprietary water quality structures, and subsurface infiltration systems have been designed to capture the required water quality volume and remove a minimum 80% of total suspended solids. Refer to the calculations provided in Appendix E for more information on the design of the proposed BMPs.

Source control and pollution prevention measures, such as street sweeping, proper snow management, and stabilization of eroded surfaces, are included in the Long-Term Pollution Prevention and Stormwater Operation and Maintenance Plan in Appendix C.

Standard 5: Land Uses with Higher Potential Pollutant Loads

The Project is not associated with Land Uses with Higher Potential Pollutant Loads. Therefore, this standard is not applicable.

Standard 6: Critical Areas

The Project is not located within any critical areas. Therefore, this standard is not applicable.

Standard 7: Redevelopments

The project is not considered a redevelopment. Therefore, this standard is not applicable.

Standard 8: Construction Period Pollution Prevention and Sedimentation Control

The Project will comply with this standard. Sedimentation and erosion control plans are included in the application. Sedimentation and erosion control measures will include, but are not limited to, minimizing land disturbance, providing temporary stabilization and covers, installing perimeter controls (silt fence and straw wattles/bales), constructing temporary sediment basins, and providing stormwater inlet protection (silt sack, straw wattles/bales).

The contractor will be required to do inspections of all controls regularly to ensure that the controls are working properly. The contractor shall clean and reinstall any control that needs to be cleaned or replaced. Additionally, the contractor will clean/flush the entire stormwater management system prior to final acceptance by the owner.

Since the proposed project will disturb more than one (1) acre of land, a Notice of Intent will be submitted to the Environmental Protection Agency (EPA) for coverage under the National Pollution Discharge Elimination System (NPDES) Construction General Permit. As part of this application the Applicant is required to prepare a Stormwater Pollution Prevention Plan (SWPPP) and implement the measures in the SWPPP. The SWPPP, which is to be kept onsite, includes erosion and sediment controls (stabilization practices and structural practices), temporary and permanent stormwater management measures, Contractor inspection schedules and reporting of all SWPPP features, materials management, waste disposal, off-site vehicle tracking, spill prevention and response, sanitation, and non-stormwater discharges. A draft of the SWPPP will be provided to the Conservation Commission prior to construction.

Standard 9: Operation and Maintenance Plan

A post-construction operation and maintenance plan has been prepared and will be implemented to ensure that stormwater management systems function as designed. Source control and stormwater BMP operation requirements for the site are summarized in the Long-Term Pollution Prevention and Stormwater Operation and Maintenance Plan in Appendix C.

Standard 10: Prohibition of Illicit Discharges

There will be no illicit discharges to the stormwater management system associated with this project. An illicit discharge compliance statement will be provided prior to construction.

6.0 CONCLUSION

In conclusion, the proposed Penn Brook Elementary School stormwater management system will reduce peak runoff rates and volumes, increase groundwater recharge, and improve the water quality of stormwater being discharged from the project site. The project was designed in accordance with the MassDEP Stormwater Management Standards.

FIGURES

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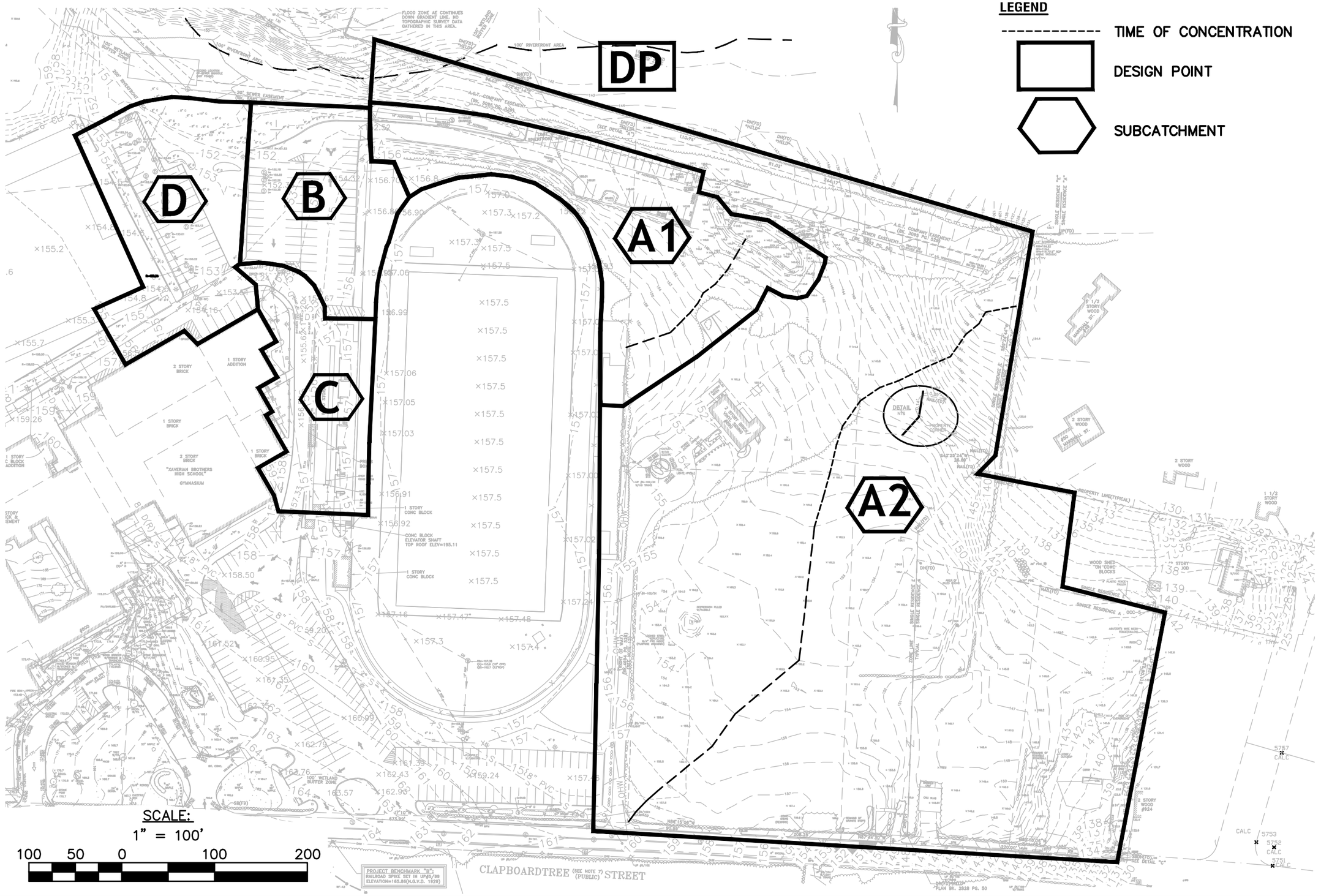

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- Planning
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EXISTING CONDITIONS DRAINAGE MAP

XAVERIAN BROTHERS HIGH SCHOOL
800 CLAPBOARDTREE STREET WESTWOOD, MA

PREPARED FOR:

BEACON ARCHITECTURAL ASSOCIATES
145 SOUTH STREET, BOSTON, MA 02111

PROJECT #	9556
FILE:	XXXXCXX.DWG
SCALE:	1"=100'
DATE:	04/29/2013
PROJECT MGR:	
SURVEYOR:	
DRAFTED BY:	JLY
CHECKED BY:	

SHEET:

FIG. 1.0

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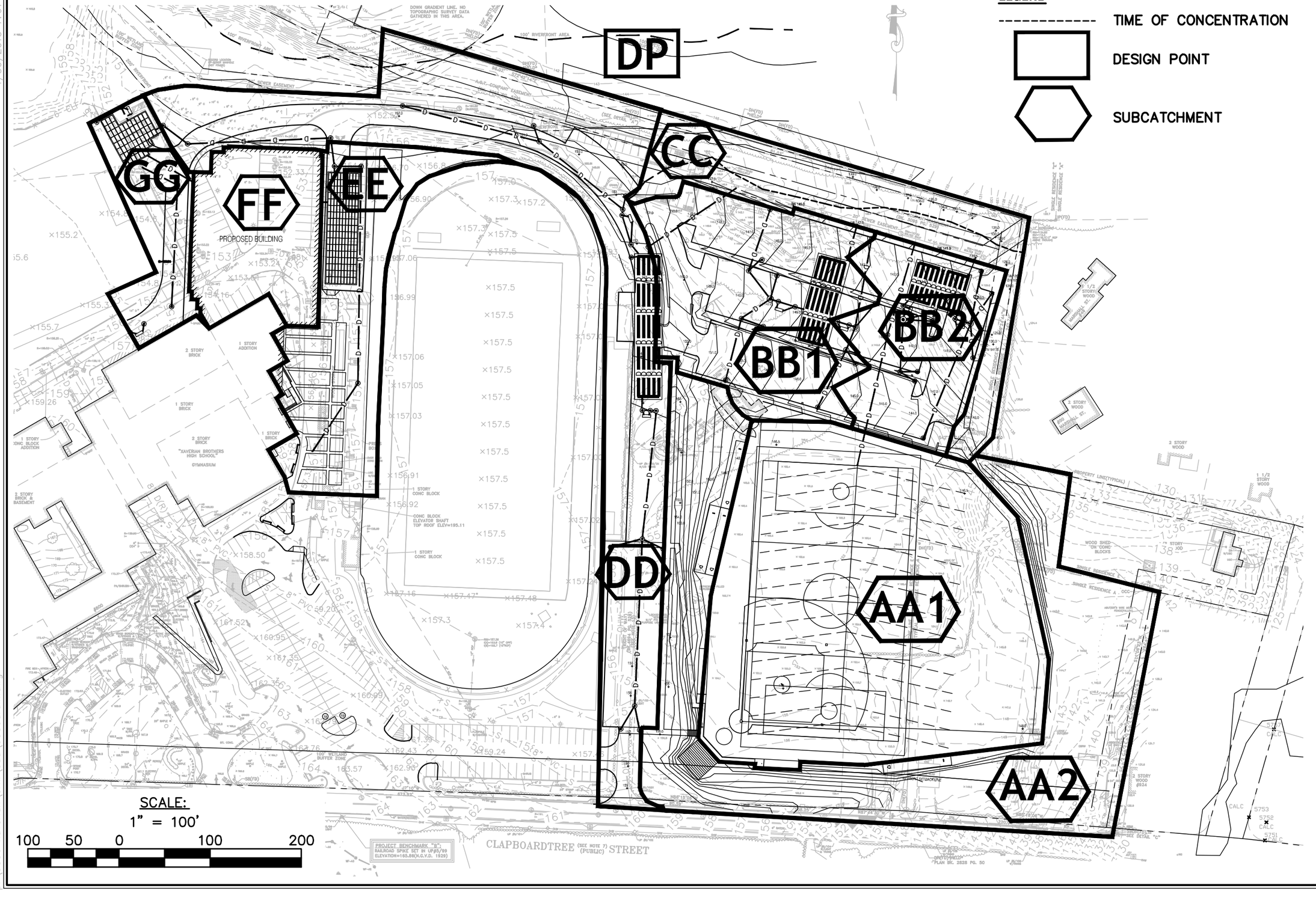

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PROPOSED CONDITIONS DRAINAGE MAP
XAVERIAN BROTHERS HIGH SCHOOL
800 CLAPBOARDTREE STREET WESTWOOD, MA

PREPARED FOR:
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PROJECT # 9556
FILE: XXXXCXX.DWG
SCALE: 1"=100'
DATE: 04/29/2013
PROJECT MGR:
SURVEYOR:
DRAFTED BY: JLY
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FIG. 2.0

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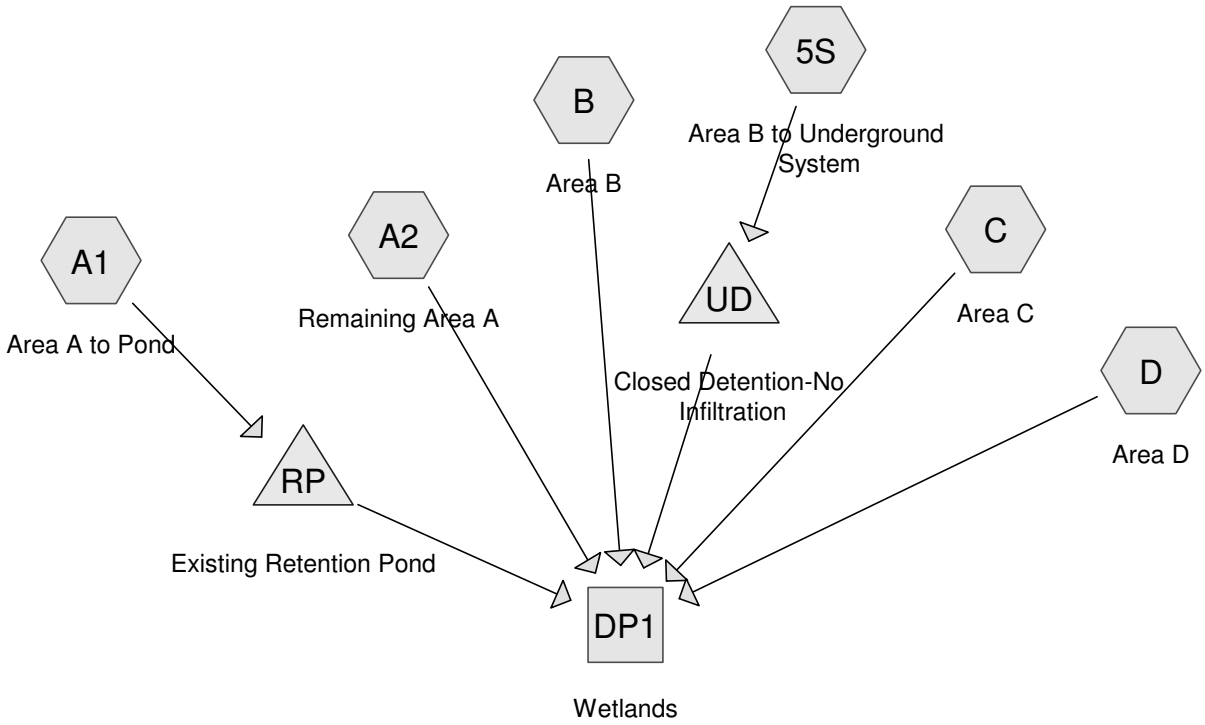
APPENDIX A

Existing Conditions – HydroCAD Calculations



Subcat Reach Pond Link

Routing Diagram for 9556drainage-pre
Prepared by Nitsch Engineering, Printed 4/30/2013
HydroCAD® 10.00 s/n 00546 © 2011 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.040	60	Woods, Fair, HSG B (A1, A2)
2.970	69	50-75% Grass cover, Fair, HSG B (5S, A1, A2, B, C, D)
0.534	98	Impervious (5S, B)
1.903	98	impervious area (A1, A2, C, D)
11.447	**70**	**TOTAL AREA**

Summary for Subcatchment 5S: Area B to Underground System

Runoff = 1.33 cfs @ 12.09 hrs, Volume= 0.097 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	17,257	98	Impervious
	4,247	69	50-75% Grass cover, Fair, HSG B
	21,504	92	Weighted Average
	4,247		19.75% Pervious Area
	17,257		80.25% Impervious Area

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

Summary for Subcatchment A1: Area A to Pond

Runoff = 1.45 cfs @ 12.14 hrs, Volume= 0.121 af, Depth= 1.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	18,204	98	impervious area
	20,222	60	Woods, Fair, HSG B
	19,319	69	50-75% Grass cover, Fair, HSG B
	57,745	75	Weighted Average
	39,541		68.48% Pervious Area
	18,204		31.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	92	0.0650	1.27		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	38	0.1600	2.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.3	180	Total			

Summary for Subcatchment A2: Remaining Area A

Runoff = 2.77 cfs @ 12.40 hrs, Volume= 0.397 af, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	24,691	98	impervious area
	242,876	60	Woods, Fair, HSG B
	78,153	69	50-75% Grass cover, Fair, HSG B
	345,720	65	Weighted Average
	321,029		92.86% Pervious Area
	24,691		7.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
2.3	118	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.5	235	0.0085	0.46		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.2	350	0.0770	1.39		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
23.5	753	Total			

Summary for Subcatchment B: Area B

Runoff = 0.48 cfs @ 12.09 hrs, Volume= 0.034 af, Depth= 2.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	6,006	98	Impervious
	2,628	69	50-75% Grass cover, Fair, HSG B
	8,634	89	Weighted Average
	2,628		30.44% Pervious Area
	6,006		69.56% Impervious Area

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

Summary for Subcatchment C: Area C

Runoff = 1.74 cfs @ 12.08 hrs, Volume= 0.129 af, Depth= 2.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	23,045	98	impervious area
	3,518	69	50-75% Grass cover, Fair, HSG B
	26,563	94	Weighted Average
	3,518		13.24% Pervious Area
	23,045		86.76% Impervious Area

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

Summary for Subcatchment D: Area D

Runoff = 1.59 cfs @ 12.09 hrs, Volume= 0.113 af, Depth= 1.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	16,969	98	impervious area
	21,513	69	50-75% Grass cover, Fair, HSG B
	38,482	82	Weighted Average
	21,513		55.90% Pervious Area
	16,969		44.10% Impervious Area

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

Summary for Reach DP1: Wetlands

Inflow Area = 11.447 ac, 21.29% Impervious, Inflow Depth = 0.87" for 2-Year event
Inflow = 4.54 cfs @ 12.10 hrs, Volume= 0.832 af
Outflow = 4.54 cfs @ 12.10 hrs, Volume= 0.832 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Pond RP: Existing Retention Pond

Inflow Area = 1.326 ac, 31.52% Impervious, Inflow Depth = 1.09" for 2-Year event
Inflow = 1.45 cfs @ 12.14 hrs, Volume= 0.121 af
Outflow = 0.13 cfs @ 14.09 hrs, Volume= 0.087 af, Atten= 91%, Lag= 117.0 min
Discarded = 0.01 cfs @ 14.09 hrs, Volume= 0.025 af
Primary = 0.12 cfs @ 14.09 hrs, Volume= 0.061 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 143.82' @ 14.09 hrs Surf.Area= 2,363 sf Storage= 2,804 cf

Plug-Flow detention time= 487.9 min calculated for 0.087 af (72% of inflow)
Center-of-Mass det. time= 388.0 min (1,249.8 - 861.9)

Volume	Invert	Avail.Storage	Storage Description
#1	142.30'	9,763 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
142.30	1,297	0	0
143.00	1,824	1,092	1,092
144.00	2,483	2,154	3,246
145.00	3,176	2,830	6,075
146.00	4,200	3,688	9,763

Device	Routing	Invert	Outlet Devices
#1	Primary	143.40'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#2	Discarded	142.30'	**0.170 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 14.09 hrs HW=143.82' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.12 cfs @ 14.09 hrs HW=143.82' (Free Discharge)
↑—**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.12 cfs @ 1.65 fps)

Summary for Pond UD: Closed Detention-No Infiltration

Inflow Area = 0.494 ac, 80.25% Impervious, Inflow Depth = 2.35" for 2-Year event
Inflow = 1.33 cfs @ 12.09 hrs, Volume= 0.097 af
Outflow = 0.22 cfs @ 12.56 hrs, Volume= 0.097 af, Atten= 84%, Lag= 28.7 min
Primary = 0.22 cfs @ 12.56 hrs, Volume= 0.097 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1.58' @ 12.56 hrs Surf.Area= 0 sf Storage= 1,733 cf

Plug-Flow detention time= 111.5 min calculated for 0.097 af (100% of inflow)
Center-of-Mass det. time= 111.7 min (909.4 - 797.8)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	3,291 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	0	0
1.00	1,097	1,097
2.00	1,097	2,194
3.00	1,097	3,291

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	2.80'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.0' Crest Height
#3	Primary	1.50'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.21 cfs @ 12.56 hrs HW=1.58' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.20 cfs @ 5.85 fps)
- **2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
- **3=Orifice/Grate** (Orifice Controls 0.02 cfs @ 0.96 fps)

Summary for Subcatchment 5S: Area B to Underground System

Runoff = 2.09 cfs @ 12.08 hrs, Volume= 0.156 af, Depth= 3.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	17,257	98	Impervious
	4,247	69	50-75% Grass cover, Fair, HSG B
	21,504	92	Weighted Average
	4,247		19.75% Pervious Area
	17,257		80.25% Impervious Area

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

Summary for Subcatchment A1: Area A to Pond

Runoff = 3.05 cfs @ 12.13 hrs, Volume= 0.244 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	18,204	98	impervious area
	20,222	60	Woods, Fair, HSG B
	19,319	69	50-75% Grass cover, Fair, HSG B
	57,745	75	Weighted Average
	39,541		68.48% Pervious Area
	18,204		31.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	92	0.0650	1.27		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	38	0.1600	2.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.3	180	Total			

Summary for Subcatchment A2: Remaining Area A

Runoff = 7.98 cfs @ 12.35 hrs, Volume= 0.964 af, Depth= 1.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	24,691	98	impervious area
	242,876	60	Woods, Fair, HSG B
	78,153	69	50-75% Grass cover, Fair, HSG B
	345,720	65	Weighted Average
	321,029		92.86% Pervious Area
	24,691		7.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
2.3	118	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.5	235	0.0085	0.46		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.2	350	0.0770	1.39		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
23.5	753	Total			

Summary for Subcatchment B: Area B

Runoff = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af, Depth= 3.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	6,006	98	Impervious
	2,628	69	50-75% Grass cover, Fair, HSG B
	8,634	89	Weighted Average
	2,628		30.44% Pervious Area
	6,006		69.56% Impervious Area

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

Summary for Subcatchment C: Area C

Runoff = 2.68 cfs @ 12.08 hrs, Volume= 0.204 af, Depth= 4.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	23,045	98	impervious area
	3,518	69	50-75% Grass cover, Fair, HSG B
	26,563	94	Weighted Average
	3,518		13.24% Pervious Area
	23,045		86.76% Impervious Area

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

Summary for Subcatchment D: Area D

Runoff = 2.91 cfs @ 12.09 hrs, Volume= 0.207 af, Depth= 2.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	16,969	98	impervious area
	21,513	69	50-75% Grass cover, Fair, HSG B
	38,482	82	Weighted Average
	21,513		55.90% Pervious Area
	16,969		44.10% Impervious Area

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

Summary for Reach DP1: Wetlands

Inflow Area = 11.447 ac, 21.29% Impervious, Inflow Depth = 1.86" for 10-Year event
Inflow = 11.69 cfs @ 12.34 hrs, Volume= 1.771 af
Outflow = 11.69 cfs @ 12.34 hrs, Volume= 1.771 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Pond RP: Existing Retention Pond

Inflow Area = 1.326 ac, 31.52% Impervious, Inflow Depth = 2.21" for 10-Year event
Inflow = 3.05 cfs @ 12.13 hrs, Volume= 0.244 af
Outflow = 1.00 cfs @ 12.51 hrs, Volume= 0.209 af, Atten= 67%, Lag= 22.5 min
Discarded = 0.01 cfs @ 12.51 hrs, Volume= 0.027 af
Primary = 0.99 cfs @ 12.51 hrs, Volume= 0.183 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 144.37' @ 12.51 hrs Surf.Area= 2,742 sf Storage= 4,224 cf

Plug-Flow detention time= 253.0 min calculated for 0.209 af (86% of inflow)
Center-of-Mass det. time= 190.2 min (1,031.2 - 840.9)

Volume	Invert	Avail.Storage	Storage Description
#1	142.30'	9,763 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
142.30	1,297	0	0
143.00	1,824	1,092	1,092
144.00	2,483	2,154	3,246
145.00	3,176	2,830	6,075
146.00	4,200	3,688	9,763

Device	Routing	Invert	Outlet Devices
#1	Primary	143.40'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#2	Discarded	142.30'	**0.170 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.51 hrs HW=144.37' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.99 cfs @ 12.51 hrs HW=144.37' (Free Discharge)
↑—**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.99 cfs @ 2.53 fps)

Summary for Pond UD: Closed Detention-No Infiltration

Inflow Area = 0.494 ac, 80.25% Impervious, Inflow Depth = 3.80" for 10-Year event
Inflow = 2.09 cfs @ 12.08 hrs, Volume= 0.156 af
Outflow = 0.57 cfs @ 12.43 hrs, Volume= 0.156 af, Atten= 73%, Lag= 20.9 min
Primary = 0.57 cfs @ 12.43 hrs, Volume= 0.156 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2.29' @ 12.43 hrs Surf.Area= 0 sf Storage= 2,513 cf

Plug-Flow detention time= 99.0 min calculated for 0.156 af (100% of inflow)
Center-of-Mass det. time= 98.9 min (883.6 - 784.7)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	3,291 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	0	0
1.00	1,097	1,097
2.00	1,097	2,194
3.00	1,097	3,291

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	2.80'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.0' Crest Height
#3	Primary	1.50'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.57 cfs @ 12.43 hrs HW=2.29' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.24 cfs @ 7.12 fps)
- **2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
- **3=Orifice/Grate** (Orifice Controls 0.33 cfs @ 3.80 fps)

Summary for Subcatchment 5S: Area B to Underground System

Runoff = 3.10 cfs @ 12.08 hrs, Volume= 0.237 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	17,257	98	Impervious
	4,247	69	50-75% Grass cover, Fair, HSG B
	21,504	92	Weighted Average
	4,247		19.75% Pervious Area
	17,257		80.25% Impervious Area

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

Summary for Subcatchment A1: Area A to Pond

Runoff = 5.39 cfs @ 12.13 hrs, Volume= 0.429 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	18,204	98	impervious area
	20,222	60	Woods, Fair, HSG B
	19,319	69	50-75% Grass cover, Fair, HSG B
	57,745	75	Weighted Average
	39,541		68.48% Pervious Area
	18,204		31.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	92	0.0650	1.27		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	38	0.1600	2.80		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.3	180	Total			

Summary for Subcatchment A2: Remaining Area A

Runoff = 16.56 cfs @ 12.35 hrs, Volume= 1.900 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	24,691	98	impervious area
	242,876	60	Woods, Fair, HSG B
	78,153	69	50-75% Grass cover, Fair, HSG B
	345,720	65	Weighted Average
	321,029		92.86% Pervious Area
	24,691		7.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
2.3	118	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.5	235	0.0085	0.46		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.2	350	0.0770	1.39		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
23.5	753	Total			

Summary for Subcatchment B: Area B

Runoff = 1.20 cfs @ 12.08 hrs, Volume= 0.089 af, Depth= 5.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	6,006	98	Impervious
	2,628	69	50-75% Grass cover, Fair, HSG B
	8,634	89	Weighted Average
	2,628		30.44% Pervious Area
	6,006		69.56% Impervious Area

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

Summary for Subcatchment C: Area C

Runoff = 3.91 cfs @ 12.08 hrs, Volume= 0.304 af, Depth= 5.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	23,045	98	impervious area
	3,518	69	50-75% Grass cover, Fair, HSG B
	26,563	94	Weighted Average
	3,518		13.24% Pervious Area
	23,045		86.76% Impervious Area

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

Summary for Subcatchment D: Area D

Runoff = 4.74 cfs @ 12.09 hrs, Volume= 0.341 af, Depth= 4.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	16,969	98	impervious area
	21,513	69	50-75% Grass cover, Fair, HSG B
	38,482	82	Weighted Average
	21,513		55.90% Pervious Area
	16,969		44.10% Impervious Area

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

Summary for Reach DP1: Wetlands

Inflow Area = 11.447 ac, 21.29% Impervious, Inflow Depth = 3.39" for 100-Year event
Inflow = 24.84 cfs @ 12.30 hrs, Volume= 3.238 af
Outflow = 24.84 cfs @ 12.30 hrs, Volume= 3.238 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Pond RP: Existing Retention Pond

Inflow Area = 1.326 ac, 31.52% Impervious, Inflow Depth = 3.89" for 100-Year event
Inflow = 5.39 cfs @ 12.13 hrs, Volume= 0.429 af
Outflow = 3.14 cfs @ 12.30 hrs, Volume= 0.394 af, Atten= 42%, Lag= 9.9 min
Discarded = 0.01 cfs @ 12.30 hrs, Volume= 0.028 af
Primary = 3.13 cfs @ 12.30 hrs, Volume= 0.366 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 144.94' @ 12.30 hrs Surf.Area= 3,135 sf Storage= 5,889 cf

Plug-Flow detention time= 159.8 min calculated for 0.394 af (92% of inflow)
Center-of-Mass det. time= 118.4 min (943.0 - 824.6)

Volume	Invert	Avail.Storage	Storage Description
#1	142.30'	9,763 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
142.30	1,297	0	0
143.00	1,824	1,092	1,092
144.00	2,483	2,154	3,246
145.00	3,176	2,830	6,075
146.00	4,200	3,688	9,763

Device	Routing	Invert	Outlet Devices
#1	Primary	143.40'	**45.0 deg Sharp-Crested Vee/Trap Weir** Cv= 2.56 (C= 3.20)
#2	Discarded	142.30'	**0.170 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.30 hrs HW=144.94' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=3.12 cfs @ 12.30 hrs HW=144.94' (Free Discharge)
↑—**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 3.12 cfs @ 3.18 fps)

Summary for Pond UD: Closed Detention-No Infiltration

Inflow Area = 0.494 ac, 80.25% Impervious, Inflow Depth = 5.76" for 100-Year event
Inflow = 3.10 cfs @ 12.08 hrs, Volume= 0.237 af
Outflow = 1.80 cfs @ 12.19 hrs, Volume= 0.237 af, Atten= 42%, Lag= 6.6 min
Primary = 1.80 cfs @ 12.19 hrs, Volume= 0.237 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2.96' @ 12.19 hrs Surf.Area= 0 sf Storage= 3,247 cf

Plug-Flow detention time= 87.7 min calculated for 0.237 af (100% of inflow)
Center-of-Mass det. time= 87.7 min (861.6 - 774.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	3,291 cf	**Custom Stage Data** Listed below

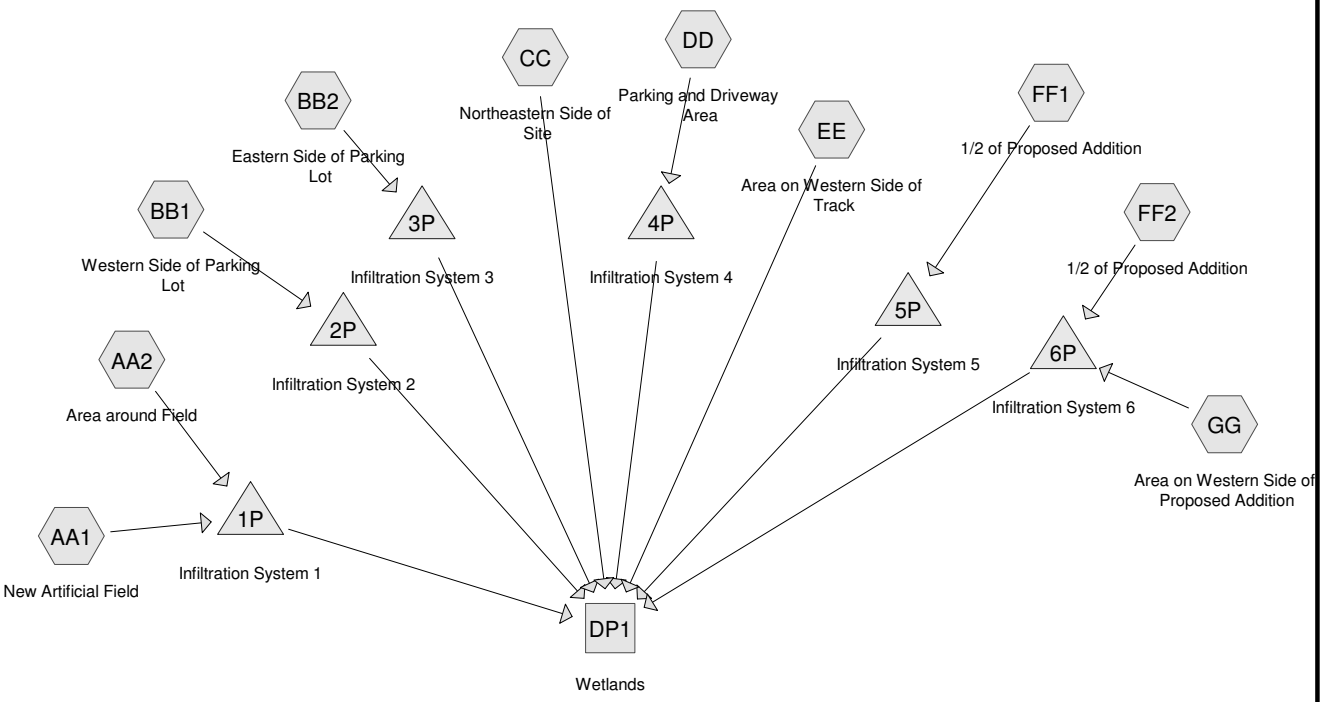
Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	0	0
1.00	1,097	1,097
2.00	1,097	2,194
3.00	1,097	3,291

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	2.80'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.0' Crest Height
#3	Primary	1.50'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.79 cfs @ 12.19 hrs HW=2.96' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.28 cfs @ 8.14 fps)
- **2=Sharp-Crested Rectangular Weir** (Weir Controls 1.04 cfs @ 1.31 fps)
- **3=Orifice/Grate** (Orifice Controls 0.48 cfs @ 5.47 fps)

APPENDIX B

Proposed Conditions – HydroCAD Calculations



Subcat Reach Pond Link

Routing Diagram for 9556drainage-post
Prepared by Nitsch Engineering, Printed 4/30/2013
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.876	60	Woods, Fair, HSG B (AA2, CC, DD)
3.459	61	>75% Grass cover, Good, HSG B (AA2, BB1, BB2, CC, DD, EE, GG)
0.544	98	Paved parking, HSG B (BB2)
4.990	98	impervious (AA1, AA2, BB1, EE, GG)
0.997	98	impervious area (DD)
1.162	98	roof (FF1, FF2)
12.028	**85**	**TOTAL AREA**

Summary for Pond 1P: Infiltration System 1

Inflow Area = 4.897 ac, 62.50% Impervious, Inflow Depth = 2.00" for 2-Year event
Inflow = 9.50 cfs @ 12.11 hrs, Volume= 0.817 af
Outflow = 3.05 cfs @ 11.93 hrs, Volume= 0.817 af, Atten= 68%, Lag= 0.0 min
Discarded = 3.05 cfs @ 11.93 hrs, Volume= 0.817 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 144.65' @ 12.44 hrs Surf.Area= 129,129 sf Storage= 5,890 cf

Plug-Flow detention time= 10.9 min calculated for 0.817 af (100% of inflow)
Center-of-Mass det. time= 10.9 min (784.0 - 773.1)

Volume	Invert	Avail.Storage	Storage Description
#1	144.50'	77,477 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 258,258 cf Overall x 30.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
144.50	129,129	0	0
146.50	129,129	258,258	258,258

Device	Routing	Invert	Outlet Devices
#1	Discarded	144.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	144.75'	**12.0" Round Culvert** L= 215.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 144.75' / 136.00' S= 0.0407 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Discarded OutFlow Max=3.05 cfs @ 11.93 hrs HW=144.52' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=144.50' (Free Discharge)
↑—**2=Culvert** (Controls 0.00 cfs)

Summary for Pond 2P: Infiltration System 2

Inflow Area = 1.125 ac, 81.60% Impervious, Inflow Depth = 2.26" for 2-Year event
Inflow = 2.93 cfs @ 12.09 hrs, Volume= 0.212 af
Outflow = 0.08 cfs @ 10.20 hrs, Volume= 0.212 af, Atten= 97%, Lag= 0.0 min
Discarded = 0.08 cfs @ 10.20 hrs, Volume= 0.212 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 142.93' @ 16.23 hrs Surf.Area= 3,600 sf Storage= 5,571 cf

Plug-Flow detention time= 622.4 min calculated for 0.212 af (100% of inflow)
Center-of-Mass det. time= 622.5 min (1,425.0 - 802.5)

Volume	Invert	Avail.Storage	Storage Description
#1	140.00'	4,816 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 600 18,000 cf Overall - 4,241 cf Embedded = 13,759 cf x 35.0% Voids
#2	141.00'	4,241 cf	**36.0" D x 600.0'L Pipe Storage** Inside #1
		9,057 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
140.00	6	0	0
145.00	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Primary	143.00'	**12.0" Round Culvert** L= 42.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 143.00' / 139.50' S= 0.0833 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Discarded	140.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.08 cfs @ 10.20 hrs HW=140.05' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=140.00' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Summary for Pond 3P: Infiltration System 3

Inflow Area = 0.686 ac, 79.29% Impervious, Inflow Depth = 2.17" for 2-Year event
Inflow = 1.73 cfs @ 12.09 hrs, Volume= 0.124 af
Outflow = 0.07 cfs @ 10.75 hrs, Volume= 0.124 af, Atten= 96%, Lag= 0.0 min
Discarded = 0.07 cfs @ 10.75 hrs, Volume= 0.124 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 129.38' @ 15.47 hrs Surf.Area= 2,820 sf Storage= 2,962 cf

Plug-Flow detention time= 427.3 min calculated for 0.124 af (100% of inflow)
Center-of-Mass det. time= 427.3 min (1,234.2 - 806.9)

Volume	Invert	Avail.Storage	Storage Description
#1	127.19'	3,772 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 470 14,100 cf Overall - 3,322 cf Embedded = 10,778 cf x 35.0% Voids
#2	128.19'	3,322 cf	**36.0" D x 470.0'L Pipe Storage** Inside #1
		7,094 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
127.19	6	0	0
132.19	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Primary	130.69'	**6.0" Round Culvert** L= 19.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 130.69' / 130.50' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Discarded	127.19'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 10.75 hrs HW=127.24' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=127.19' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)

Summary for Pond 4P: Infiltration System 4

Inflow Area = 2.070 ac, 48.16% Impervious, Inflow Depth = 1.34" for 2-Year event
Inflow = 3.20 cfs @ 12.09 hrs, Volume= 0.231 af
Outflow = 0.11 cfs @ 11.42 hrs, Volume= 0.231 af, Atten= 96%, Lag= 0.0 min
Discarded = 0.11 cfs @ 11.42 hrs, Volume= 0.231 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 146.78' @ 16.56 hrs Surf.Area= 4,800 sf Storage= 5,900 cf

Plug-Flow detention time= 542.4 min calculated for 0.231 af (100% of inflow)
Center-of-Mass det. time= 542.5 min (1,388.5 - 846.0)

Volume	Invert	Avail.Storage	Storage Description
#1	144.32'	6,421 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 800 24,000 cf Overall - 5,655 cf Embedded = 18,345 cf x 35.0% Voids
#2	145.32'	5,655 cf	**36.0" D x 800.0'L Pipe Storage** Inside #1
		12,076 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
144.32	6	0	0
149.32	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Discarded	144.32'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	148.50'	**3.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	147.32'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.11 cfs @ 11.42 hrs HW=144.37' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=144.32' (Free Discharge)
├**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Controls 0.00 cfs)

Summary for Pond 5P: Infiltration System 5

Inflow Area = 0.581 ac,100.00% Impervious, Inflow Depth = 2.97" for 2-Year event
Inflow = 1.80 cfs @ 12.08 hrs, Volume= 0.144 af
Outflow = 0.17 cfs @ 12.92 hrs, Volume= 0.144 af, Atten= 91%, Lag= 50.3 min
Discarded = 0.09 cfs @ 10.23 hrs, Volume= 0.132 af
Primary = 0.08 cfs @ 12.92 hrs, Volume= 0.012 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 152.17' @ 12.92 hrs Surf.Area= 3,685 sf Storage= 2,637 cf

Plug-Flow detention time= 214.4 min calculated for 0.144 af (100% of inflow)
Center-of-Mass det. time= 214.3 min (970.7 - 756.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	151.00'	2,774 cf	**30.33'W x 121.48'L x 2.83'H Field A** 10,441 cf Overall - 2,515 cf Embedded = 7,925 cf x 35.0% Voids
#2A	151.50'	2,515 cf	**StormTech SC-310** x 170 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 10 rows
		5,289 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	151.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.09 cfs @ 10.23 hrs HW=151.03' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=0.08 cfs @ 12.92 hrs HW=152.17' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 0.08 cfs @ 1.38 fps)

Summary for Pond 6P: Infiltration System 6

Inflow Area = 0.987 ac, 84.04% Impervious, Inflow Depth = 2.44" for 2-Year event
Inflow = 2.60 cfs @ 12.09 hrs, Volume= 0.201 af
Outflow = 0.96 cfs @ 12.34 hrs, Volume= 0.201 af, Atten= 63%, Lag= 15.3 min
Discarded = 0.05 cfs @ 8.40 hrs, Volume= 0.139 af
Primary = 0.91 cfs @ 12.34 hrs, Volume= 0.062 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 149.74' @ 12.34 hrs Surf.Area= 1,910 sf Storage= 3,618 cf

Plug-Flow detention time= 478.9 min calculated for 0.201 af (100% of inflow)
Center-of-Mass det. time= 479.0 min (1,256.2 - 777.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	147.00'	1,363 cf	**53.00'W x 36.04'L x 3.50'H Field A** 6,685 cf Overall - 2,790 cf Embedded = 3,895 cf x 35.0% Voids
#2A	147.50'	2,790 cf	**StormTech SC-740** x 60 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 12 rows
		4,154 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	149.40'	**12.0" Vert. Orifice/Grate X 2.00** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 8.40 hrs HW=147.04' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.91 cfs @ 12.34 hrs HW=149.74' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 0.91 cfs @ 1.97 fps)

Summary for Subcatchment AA1: New Artificial Field

Runoff = 8.67 cfs @ 12.11 hrs, Volume= 0.733 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	129,129	98	impervious
	129,129		100.00% Impervious Area

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

Summary for Subcatchment AA2: Area around Field

Runoff = 0.84 cfs @ 12.11 hrs, Volume= 0.084 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	4,187	98	impervious
	17,495	60	Woods, Fair, HSG B
	62,499	61	>75% Grass cover, Good, HSG B
	84,181	63	Weighted Average
	79,994		95.03% Pervious Area
	4,187		4.97% Impervious Area

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

Summary for Subcatchment BB1: Western Side of Parking Lot

Runoff = 2.93 cfs @ 12.09 hrs, Volume= 0.212 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
	9,016	61	>75% Grass cover, Good, HSG B
*	39,973	98	impervious
	48,989	91	Weighted Average
	9,016		18.40% Pervious Area
	39,973		81.60% Impervious Area

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

Summary for Subcatchment BB2: Eastern Side of Parking Lot

Runoff = 1.73 cfs @ 12.09 hrs, Volume= 0.124 af, Depth= 2.17"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	23,701	98	Paved parking, HSG B
	6,191	61	>75% Grass cover, Good, HSG B
	29,892	90	Weighted Average
	6,191		20.71% Pervious Area
	23,701		79.29% Impervious Area

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

Summary for Subcatchment CC: Northeastern Side of Site

Runoff = 0.20 cfs @ 12.26 hrs, Volume= 0.029 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
6,629	60	Woods, Fair, HSG B
28,098	61	>75% Grass cover, Good, HSG B
34,727	61	Weighted Average
34,727		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
4.4	416	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.7	466	Total			

Summary for Subcatchment DD: Parking and Driveway Area

Runoff = 3.20 cfs @ 12.09 hrs, Volume= 0.231 af, Depth= 1.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	43,434	98	impervious area
	14,044	60	Woods, Fair, HSG B
	32,704	61	>75% Grass cover, Good, HSG B
	90,182	79	Weighted Average
	46,748		51.84% Pervious Area
	43,434		48.16% Impervious Area

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

Summary for Reach DP1: Wetlands

Inflow Area = 12.028 ac, 63.96% Impervious, Inflow Depth = 0.28" for 2-Year event
Inflow = 2.52 cfs @ 12.09 hrs, Volume= 0.284 af
Outflow = 2.52 cfs @ 12.09 hrs, Volume= 0.284 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Subcatchment EE: Area on Western Side of Track

Runoff = 2.46 cfs @ 12.09 hrs, Volume= 0.180 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	33,265	98	impervious
	5,281	61	>75% Grass cover, Good, HSG B
	38,546	93	Weighted Average
	5,281		13.70% Pervious Area
	33,265		86.30% Impervious Area

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

Summary for Subcatchment FF1: 1/2 of Proposed Addition

Runoff = 1.80 cfs @ 12.08 hrs, Volume= 0.144 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	25,307	98	roof
	25,307		100.00% Impervious Area

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

Summary for Subcatchment FF2: 1/2 of Proposed Addition

Runoff = 1.80 cfs @ 12.08 hrs, Volume= 0.144 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	25,307	98	roof
	25,307		100.00% Impervious Area

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

Summary for Subcatchment GG: Area on Western Side of Proposed Addition

Runoff = 0.80 cfs @ 12.09 hrs, Volume= 0.057 af, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.20"

	Area (sf)	CN	Description
*	10,830	98	impervious
	6,865	61	>75% Grass cover, Good, HSG B
	17,695	84	Weighted Average
	6,865		38.80% Pervious Area
	10,830		61.20% Impervious Area

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

Summary for Pond 1P: Infiltration System 1

Inflow Area = 4.897 ac, 62.50% Impervious, Inflow Depth = 3.22" for 10-Year event
Inflow = 15.56 cfs @ 12.10 hrs, Volume= 1.316 af
Outflow = 3.09 cfs @ 12.56 hrs, Volume= 1.316 af, Atten= 80%, Lag= 27.2 min
Discarded = 3.05 cfs @ 11.78 hrs, Volume= 1.313 af
Primary = 0.04 cfs @ 12.56 hrs, Volume= 0.002 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 144.86' @ 12.56 hrs Surf.Area= 129,129 sf Storage= 14,064 cf

Plug-Flow detention time= 26.3 min calculated for 1.315 af (100% of inflow)
Center-of-Mass det. time= 26.3 min (796.5 - 770.1)

Volume	Invert	Avail.Storage	Storage Description
#1	144.50'	77,477 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 258,258 cf Overall x 30.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
144.50	129,129	0	0
146.50	129,129	258,258	258,258

Device	Routing	Invert	Outlet Devices
#1	Discarded	144.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	144.75'	**12.0" Round Culvert** L= 215.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 144.75' / 136.00' S= 0.0407 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Discarded OutFlow Max=3.05 cfs @ 11.78 hrs HW=144.52' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.05 cfs)

Primary OutFlow Max=0.04 cfs @ 12.56 hrs HW=144.86' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.04 cfs @ 0.90 fps)

Summary for Pond 2P: Infiltration System 2

Inflow Area = 1.125 ac, 81.60% Impervious, Inflow Depth = 3.69" for 10-Year event
Inflow = 4.68 cfs @ 12.08 hrs, Volume= 0.346 af
Outflow = 1.05 cfs @ 12.49 hrs, Volume= 0.346 af, Atten= 78%, Lag= 24.3 min
Discarded = 0.08 cfs @ 8.81 hrs, Volume= 0.241 af
Primary = 0.96 cfs @ 12.49 hrs, Volume= 0.105 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 143.58' @ 12.49 hrs Surf.Area= 3,600 sf Storage= 7,028 cf

Plug-Flow detention time= 479.9 min calculated for 0.346 af (100% of inflow)
Center-of-Mass det. time= 479.8 min (1,268.7 - 788.9)

Volume	Invert	Avail.Storage	Storage Description
#1	140.00'	4,816 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 600 18,000 cf Overall - 4,241 cf Embedded = 13,759 cf x 35.0% Voids
#2	141.00'	4,241 cf	**36.0" D x 600.0'L Pipe Storage** Inside #1
		9,057 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
140.00	6	0	0
145.00	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Primary	143.00'	**12.0" Round Culvert** L= 42.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 143.00' / 139.50' S= 0.0833 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Discarded	140.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.08 cfs @ 8.81 hrs HW=140.05' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.96 cfs @ 12.49 hrs HW=143.58' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.96 cfs @ 2.04 fps)

Summary for Pond 3P: Infiltration System 3

Inflow Area = 0.686 ac, 79.29% Impervious, Inflow Depth = 3.59" for 10-Year event
Inflow = 2.80 cfs @ 12.09 hrs, Volume= 0.205 af
Outflow = 0.10 cfs @ 15.60 hrs, Volume= 0.205 af, Atten= 96%, Lag= 210.9 min
Discarded = 0.07 cfs @ 9.46 hrs, Volume= 0.199 af
Primary = 0.03 cfs @ 15.60 hrs, Volume= 0.006 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 130.80' @ 15.60 hrs Surf.Area= 2,820 sf Storage= 5,563 cf

Plug-Flow detention time= 748.7 min calculated for 0.205 af (100% of inflow)
Center-of-Mass det. time= 748.9 min (1,541.7 - 792.8)

Volume	Invert	Avail.Storage	Storage Description
#1	127.19'	3,772 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 470 14,100 cf Overall - 3,322 cf Embedded = 10,778 cf x 35.0% Voids
#2	128.19'	3,322 cf	**36.0" D x 470.0'L Pipe Storage** Inside #1
		7,094 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
127.19	6	0	0
132.19	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Primary	130.69'	**6.0" Round Culvert** L= 19.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 130.69' / 130.50' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Discarded	127.19'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 9.46 hrs HW=127.24' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.03 cfs @ 15.60 hrs HW=130.80' (Free Discharge)
└**1=Culvert** (Inlet Controls 0.03 cfs @ 0.91 fps)

Summary for Pond 4P: Infiltration System 4

Inflow Area = 2.070 ac, 48.16% Impervious, Inflow Depth = 2.55" for 10-Year event
Inflow = 6.18 cfs @ 12.09 hrs, Volume= 0.439 af
Outflow = 0.85 cfs @ 12.68 hrs, Volume= 0.439 af, Atten= 86%, Lag= 35.2 min
Discarded = 0.11 cfs @ 10.34 hrs, Volume= 0.307 af
Primary = 0.73 cfs @ 12.68 hrs, Volume= 0.132 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 147.75' @ 12.68 hrs Surf.Area= 4,800 sf Storage= 8,962 cf

Plug-Flow detention time= 516.7 min calculated for 0.439 af (100% of inflow)
Center-of-Mass det. time= 516.9 min (1,344.1 - 827.2)

Volume	Invert	Avail.Storage	Storage Description
#1	144.32'	6,421 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 800 24,000 cf Overall - 5,655 cf Embedded = 18,345 cf x 35.0% Voids
#2	145.32'	5,655 cf	**36.0" D x 800.0'L Pipe Storage** Inside #1
		12,076 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
144.32	6	0	0
149.32	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Discarded	144.32'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	148.50'	**3.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	147.32'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.11 cfs @ 10.34 hrs HW=144.37' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=0.73 cfs @ 12.68 hrs HW=147.75' (Free Discharge)
├**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.73 cfs @ 2.24 fps)

Summary for Pond 5P: Infiltration System 5

Inflow Area = 0.581 ac,100.00% Impervious, Inflow Depth = 4.46" for 10-Year event
Inflow = 2.67 cfs @ 12.08 hrs, Volume= 0.216 af
Outflow = 0.64 cfs @ 12.46 hrs, Volume= 0.216 af, Atten= 76%, Lag= 22.9 min
Discarded = 0.09 cfs @ 8.89 hrs, Volume= 0.153 af
Primary = 0.55 cfs @ 12.46 hrs, Volume= 0.063 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 152.59' @ 12.46 hrs Surf.Area= 3,685 sf Storage= 3,628 cf

Plug-Flow detention time= 182.5 min calculated for 0.216 af (100% of inflow)
Center-of-Mass det. time= 182.5 min (931.5 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	151.00'	2,774 cf	**30.33'W x 121.48'L x 2.83'H Field A** 10,441 cf Overall - 2,515 cf Embedded = 7,925 cf x 35.0% Voids
#2A	151.50'	2,515 cf	**StormTech SC-310** x 170 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 10 rows
		5,289 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	151.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.09 cfs @ 8.89 hrs HW=151.03' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=0.55 cfs @ 12.46 hrs HW=152.59' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 0.55 cfs @ 2.80 fps)

Summary for Pond 6P: Infiltration System 6

Inflow Area = 0.987 ac, 84.04% Impervious, Inflow Depth = 3.86" for 10-Year event
Inflow = 4.09 cfs @ 12.08 hrs, Volume= 0.318 af
Outflow = 3.88 cfs @ 12.11 hrs, Volume= 0.318 af, Atten= 5%, Lag= 1.6 min
Discarded = 0.05 cfs @ 6.82 hrs, Volume= 0.150 af
Primary = 3.84 cfs @ 12.11 hrs, Volume= 0.168 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 150.16' @ 12.11 hrs Surf.Area= 1,910 sf Storage= 3,929 cf

Plug-Flow detention time= 331.7 min calculated for 0.317 af (100% of inflow)
Center-of-Mass det. time= 331.9 min (1,101.4 - 769.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	147.00'	1,363 cf	**53.00'W x 36.04'L x 3.50'H Field A** 6,685 cf Overall - 2,790 cf Embedded = 3,895 cf x 35.0% Voids
#2A	147.50'	2,790 cf	**StormTech SC-740** x 60 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 12 rows
		4,154 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	149.40'	**12.0" Vert. Orifice/Grate X 2.00** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 6.82 hrs HW=147.04' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=3.83 cfs @ 12.11 hrs HW=150.16' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 3.83 cfs @ 2.98 fps)

Summary for Subcatchment AA1: New Artificial Field

Runoff = 12.82 cfs @ 12.11 hrs, Volume= 1.103 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	129,129	98	impervious
	129,129		100.00% Impervious Area

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

Summary for Subcatchment AA2: Area around Field

Runoff = 2.75 cfs @ 12.10 hrs, Volume= 0.213 af, Depth= 1.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	4,187	98	impervious
	17,495	60	Woods, Fair, HSG B
	62,499	61	>75% Grass cover, Good, HSG B
	84,181	63	Weighted Average
	79,994		95.03% Pervious Area
	4,187		4.97% Impervious Area

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

Summary for Subcatchment BB1: Western Side of Parking Lot

Runoff = 4.68 cfs @ 12.08 hrs, Volume= 0.346 af, Depth= 3.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
	9,016	61	>75% Grass cover, Good, HSG B
*	39,973	98	impervious
	48,989	91	Weighted Average
	9,016		18.40% Pervious Area
	39,973		81.60% Impervious Area

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

Summary for Subcatchment BB2: Eastern Side of Parking Lot

Runoff = 2.80 cfs @ 12.09 hrs, Volume= 0.205 af, Depth= 3.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	23,701	98	Paved parking, HSG B
	6,191	61	>75% Grass cover, Good, HSG B
	29,892	90	Weighted Average
	6,191		20.71% Pervious Area
	23,701		79.29% Impervious Area

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

Summary for Subcatchment CC: Northeastern Side of Site

Runoff = 0.77 cfs @ 12.21 hrs, Volume= 0.079 af, Depth= 1.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
6,629	60	Woods, Fair, HSG B
28,098	61	>75% Grass cover, Good, HSG B
34,727	61	Weighted Average
34,727		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
4.4	416	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.7	466	Total			

Summary for Subcatchment DD: Parking and Driveway Area

Runoff = 6.18 cfs @ 12.09 hrs, Volume= 0.439 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	43,434	98	impervious area
	14,044	60	Woods, Fair, HSG B
	32,704	61	>75% Grass cover, Good, HSG B
	90,182	79	Weighted Average
	46,748		51.84% Pervious Area
	43,434		48.16% Impervious Area

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

Summary for Reach DP1: Wetlands

Inflow Area = 12.028 ac, 63.96% Impervious, Inflow Depth = 0.84" for 10-Year event
Inflow = 8.14 cfs @ 12.10 hrs, Volume= 0.843 af
Outflow = 8.14 cfs @ 12.10 hrs, Volume= 0.843 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Subcatchment EE: Area on Western Side of Track

Runoff = 3.82 cfs @ 12.08 hrs, Volume= 0.288 af, Depth= 3.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	33,265	98	impervious
	5,281	61	>75% Grass cover, Good, HSG B
	38,546	93	Weighted Average
	5,281		13.70% Pervious Area
	33,265		86.30% Impervious Area

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

Summary for Subcatchment FF1: 1/2 of Proposed Addition

Runoff = 2.67 cfs @ 12.08 hrs, Volume= 0.216 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	25,307	98	roof
	25,307		100.00% Impervious Area

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

Summary for Subcatchment FF2: 1/2 of Proposed Addition

Runoff = 2.67 cfs @ 12.08 hrs, Volume= 0.216 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	25,307	98	roof
	25,307		100.00% Impervious Area

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

Summary for Subcatchment GG: Area on Western Side of Proposed Addition

Runoff = 1.42 cfs @ 12.09 hrs, Volume= 0.101 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
*	10,830	98	impervious
	6,865	61	>75% Grass cover, Good, HSG B
	17,695	84	Weighted Average
	6,865		38.80% Pervious Area
	10,830		61.20% Impervious Area

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

Summary for Pond 1P: Infiltration System 1

Inflow Area = 4.897 ac, 62.50% Impervious, Inflow Depth = 4.97" for 100-Year event
Inflow = 24.23 cfs @ 12.10 hrs, Volume= 2.027 af
Outflow = 3.63 cfs @ 12.63 hrs, Volume= 2.027 af, Atten= 85%, Lag= 31.6 min
Discarded = 3.05 cfs @ 11.67 hrs, Volume= 1.953 af
Primary = 0.58 cfs @ 12.63 hrs, Volume= 0.074 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 145.19' @ 12.63 hrs Surf.Area= 129,129 sf Storage= 26,539 cf

Plug-Flow detention time= 51.8 min calculated for 2.027 af (100% of inflow)
Center-of-Mass det. time= 51.7 min (819.0 - 767.3)

Volume	Invert	Avail.Storage	Storage Description
#1	144.50'	77,477 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 258,258 cf Overall x 30.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
144.50	129,129	0	0
146.50	129,129	258,258	258,258

Device	Routing	Invert	Outlet Devices
#1	Discarded	144.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	144.75'	**12.0" Round Culvert** L= 215.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 144.75' / 136.00' S= 0.0407 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Discarded OutFlow Max=3.05 cfs @ 11.67 hrs HW=144.52' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.05 cfs)

Primary OutFlow Max=0.58 cfs @ 12.63 hrs HW=145.19' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.58 cfs @ 1.77 fps)

Summary for Pond 2P: Infiltration System 2

Inflow Area = 1.125 ac, 81.60% Impervious, Inflow Depth = 5.64" for 100-Year event
Inflow = 6.99 cfs @ 12.08 hrs, Volume= 0.529 af
Outflow = 3.36 cfs @ 12.24 hrs, Volume= 0.529 af, Atten= 52%, Lag= 9.2 min
Discarded = 0.08 cfs @ 7.45 hrs, Volume= 0.260 af
Primary = 3.28 cfs @ 12.24 hrs, Volume= 0.269 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 144.70' @ 12.24 hrs Surf.Area= 3,600 sf Storage= 8,685 cf

Plug-Flow detention time= 348.2 min calculated for 0.529 af (100% of inflow)
Center-of-Mass det. time= 348.3 min (1,126.0 - 777.7)

Volume	Invert	Avail.Storage	Storage Description
#1	140.00'	4,816 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 600 18,000 cf Overall - 4,241 cf Embedded = 13,759 cf x 35.0% Voids
#2	141.00'	4,241 cf	**36.0" D x 600.0'L Pipe Storage** Inside #1
		9,057 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
140.00	6	0	0
145.00	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Primary	143.00'	**12.0" Round Culvert** L= 42.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 143.00' / 139.50' S= 0.0833 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Discarded	140.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.08 cfs @ 7.45 hrs HW=140.05' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=3.28 cfs @ 12.24 hrs HW=144.70' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 3.28 cfs @ 4.17 fps)

Summary for Pond 3P: Infiltration System 3

Inflow Area = 0.686 ac, 79.29% Impervious, Inflow Depth = 5.53" for 100-Year event
Inflow = 4.21 cfs @ 12.08 hrs, Volume= 0.316 af
Outflow = 0.75 cfs @ 12.54 hrs, Volume= 0.316 af, Atten= 82%, Lag= 27.1 min
Discarded = 0.07 cfs @ 8.28 hrs, Volume= 0.216 af
Primary = 0.69 cfs @ 12.54 hrs, Volume= 0.100 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 131.79' @ 12.54 hrs Surf.Area= 2,820 sf Storage= 6,700 cf

Plug-Flow detention time= 549.3 min calculated for 0.316 af (100% of inflow)
Center-of-Mass det. time= 549.3 min (1,330.5 - 781.2)

Volume	Invert	Avail.Storage	Storage Description
#1	127.19'	3,772 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 470 14,100 cf Overall - 3,322 cf Embedded = 10,778 cf x 35.0% Voids
#2	128.19'	3,322 cf	**36.0" D x 470.0'L Pipe Storage** Inside #1
		7,094 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
127.19	6	0	0
132.19	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Primary	130.69'	**6.0" Round Culvert** L= 19.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 130.69' / 130.50' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Discarded	127.19'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 8.28 hrs HW=127.24' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.69 cfs @ 12.54 hrs HW=131.79' (Free Discharge)
└**1=Culvert** (Inlet Controls 0.69 cfs @ 3.51 fps)

Summary for Pond 4P: Infiltration System 4

Inflow Area = 2.070 ac, 48.16% Impervious, Inflow Depth = 4.31" for 100-Year event
Inflow = 10.41 cfs @ 12.09 hrs, Volume= 0.744 af
Outflow = 5.55 cfs @ 12.22 hrs, Volume= 0.744 af, Atten= 47%, Lag= 8.1 min
Discarded = 0.11 cfs @ 9.03 hrs, Volume= 0.328 af
Primary = 5.43 cfs @ 12.22 hrs, Volume= 0.415 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 148.81' @ 12.22 hrs Surf.Area= 4,800 sf Storage= 11,221 cf

Plug-Flow detention time= 332.8 min calculated for 0.744 af (100% of inflow)
Center-of-Mass det. time= 333.0 min (1,145.1 - 812.2)

Volume	Invert	Avail.Storage	Storage Description
#1	144.32'	6,421 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) x 800 24,000 cf Overall - 5,655 cf Embedded = 18,345 cf x 35.0% Voids
#2	145.32'	5,655 cf	**36.0" D x 800.0'L Pipe Storage** Inside #1
		12,076 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
144.32	6	0	0
149.32	6	30	30

Device	Routing	Invert	Outlet Devices
#1	Discarded	144.32'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	148.50'	**3.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	147.32'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.11 cfs @ 9.03 hrs HW=144.37' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=5.43 cfs @ 12.22 hrs HW=148.81' (Free Discharge)
├**2=Sharp-Crested Rectangular Weir** (Weir Controls 1.66 cfs @ 1.82 fps)
└**3=Orifice/Grate** (Orifice Controls 3.76 cfs @ 4.79 fps)

Summary for Pond 5P: Infiltration System 5

Inflow Area = 0.581 ac,100.00% Impervious, Inflow Depth = 6.46" for 100-Year event
Inflow = 3.82 cfs @ 12.08 hrs, Volume= 0.313 af
Outflow = 1.19 cfs @ 12.38 hrs, Volume= 0.313 af, Atten= 69%, Lag= 17.9 min
Discarded = 0.09 cfs @ 7.72 hrs, Volume= 0.175 af
Primary = 1.11 cfs @ 12.38 hrs, Volume= 0.138 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 153.62' @ 12.38 hrs Surf.Area= 3,685 sf Storage= 5,017 cf

Plug-Flow detention time= 159.0 min calculated for 0.313 af (100% of inflow)
Center-of-Mass det. time= 159.0 min (902.6 - 743.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	151.00'	2,774 cf	**30.33'W x 121.48'L x 2.83'H Field A** 10,441 cf Overall - 2,515 cf Embedded = 7,925 cf x 35.0% Voids
#2A	151.50'	2,515 cf	**StormTech SC-310** x 170 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 10 rows
		5,289 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	151.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.09 cfs @ 7.72 hrs HW=151.03' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=1.11 cfs @ 12.38 hrs HW=153.62' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 1.11 cfs @ 5.64 fps)

Summary for Pond 6P: Infiltration System 6

Inflow Area = 0.987 ac, 84.04% Impervious, Inflow Depth = 5.80" for 100-Year event
Inflow = 6.08 cfs @ 12.08 hrs, Volume= 0.477 af
Outflow = 5.73 cfs @ 12.11 hrs, Volume= 0.477 af, Atten= 6%, Lag= 1.7 min
Discarded = 0.05 cfs @ 4.77 hrs, Volume= 0.156 af
Primary = 5.68 cfs @ 12.11 hrs, Volume= 0.321 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 150.46' @ 12.11 hrs Surf.Area= 1,910 sf Storage= 4,130 cf

Plug-Flow detention time= 234.7 min calculated for 0.477 af (100% of inflow)
Center-of-Mass det. time= 234.9 min (997.7 - 762.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	147.00'	1,363 cf	**53.00'W x 36.04'L x 3.50'H Field A** 6,685 cf Overall - 2,790 cf Embedded = 3,895 cf x 35.0% Voids
#2A	147.50'	2,790 cf	**StormTech SC-740** x 60 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 12 rows
		4,154 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	149.40'	**12.0" Vert. Orifice/Grate X 2.00** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 4.77 hrs HW=147.04' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=5.68 cfs @ 12.11 hrs HW=150.46' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 5.68 cfs @ 3.61 fps)

Summary for Subcatchment AA1: New Artificial Field

Runoff = 18.34 cfs @ 12.11 hrs, Volume= 1.596 af, Depth= 6.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	129,129	98	impervious
	129,129		100.00% Impervious Area

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

Summary for Subcatchment AA2: Area around Field

Runoff = 5.95 cfs @ 12.09 hrs, Volume= 0.431 af, Depth= 2.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	4,187	98	impervious
	17,495	60	Woods, Fair, HSG B
	62,499	61	>75% Grass cover, Good, HSG B
	84,181	63	Weighted Average
	79,994		95.03% Pervious Area
	4,187		4.97% Impervious Area

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

Summary for Subcatchment BB1: Western Side of Parking Lot

Runoff = 6.99 cfs @ 12.08 hrs, Volume= 0.529 af, Depth= 5.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
	9,016	61	>75% Grass cover, Good, HSG B
*	39,973	98	impervious
	48,989	91	Weighted Average
	9,016		18.40% Pervious Area
	39,973		81.60% Impervious Area

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

Summary for Subcatchment BB2: Eastern Side of Parking Lot

Runoff = 4.21 cfs @ 12.08 hrs, Volume= 0.316 af, Depth= 5.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	23,701	98	Paved parking, HSG B
	6,191	61	>75% Grass cover, Good, HSG B
	29,892	90	Weighted Average
	6,191		20.71% Pervious Area
	23,701		79.29% Impervious Area

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

Summary for Subcatchment CC: Northeastern Side of Site

Runoff = 1.76 cfs @ 12.20 hrs, Volume= 0.165 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
6,629	60	Woods, Fair, HSG B
28,098	61	>75% Grass cover, Good, HSG B
34,727	61	Weighted Average
34,727		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
4.4	416	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.7	466	Total			

Summary for Subcatchment DD: Parking and Driveway Area

Runoff = 10.41 cfs @ 12.09 hrs, Volume= 0.744 af, Depth= 4.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	43,434	98	impervious area
	14,044	60	Woods, Fair, HSG B
	32,704	61	>75% Grass cover, Good, HSG B
	90,182	79	Weighted Average
	46,748		51.84% Pervious Area
	43,434		48.16% Impervious Area

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

Summary for Reach DP1: Wetlands

Inflow Area = 12.028 ac, 63.96% Impervious, Inflow Depth = 1.91" for 100-Year event
Inflow = 18.97 cfs @ 12.18 hrs, Volume= 1.916 af
Outflow = 18.97 cfs @ 12.18 hrs, Volume= 1.916 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Summary for Subcatchment EE: Area on Western Side of Track

Runoff = 5.62 cfs @ 12.08 hrs, Volume= 0.433 af, Depth= 5.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	33,265	98	impervious
	5,281	61	>75% Grass cover, Good, HSG B
	38,546	93	Weighted Average
	5,281		13.70% Pervious Area
	33,265		86.30% Impervious Area

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

Summary for Subcatchment FF1: 1/2 of Proposed Addition

Runoff = 3.82 cfs @ 12.08 hrs, Volume= 0.313 af, Depth= 6.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	25,307	98	roof
	25,307		100.00% Impervious Area

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

Summary for Subcatchment FF2: 1/2 of Proposed Addition

Runoff = 3.82 cfs @ 12.08 hrs, Volume= 0.313 af, Depth= 6.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	25,307	98	roof
	25,307		100.00% Impervious Area

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

Summary for Subcatchment GG: Area on Western Side of Proposed Addition

Runoff = 2.26 cfs @ 12.09 hrs, Volume= 0.164 af, Depth= 4.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.70"

	Area (sf)	CN	Description
*	10,830	98	impervious
	6,865	61	>75% Grass cover, Good, HSG B
	17,695	84	Weighted Average
	6,865		38.80% Pervious Area
	10,830		61.20% Impervious Area

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

APPENDIX C

Long-Term Pollution Prevention and Stormwater Operation and Maintenance Plan

Nitsch Engineering

2 Center Plaza, Suite 430
Boston, MA 02108-1928
T: 617-338-0063
F: 617-338-6472
www.nitscheng.com

Stormwater System Operations and Maintenance Plan

Project: Xaverian Brothers High School
Location: 800 Clapboardtree Street, Westwood, MA

Owner: Xaverian Brothers High School

Date: April 29, 2013

Prepared by: Nitsch Engineering, Inc.
2 Center Plaza, Suite 430
Boston, MA 02111-2403
(617) 338-0063

Prepared for: ***Xavarian Brothers High School*** ***Nitsch Project # 9556***

I. Stormwater management system owner: Xaverian Brothers High School
II. Parties responsible for O&M during construction: Contractor
III. Parties responsible for O&M post-construction: Xaverian Brothers High School
IV. A schedule for O&M: See below
V. Routine and non-routine maintenance tasks to be undertaken during and after construction: See below
VI. The entire stormwater management system will be inspected and cleaned by the Contractor prior to the completion of construction. A report of the inspection/cleaning will be forwarded to the owner and the design engineer.
VII. The stormwater management system shall be inspected the first year of operation after large rainfall events (all storms greater than 0.5-inch in 24-hour period) to verify functionality.
VIII. The driveways and parking areas shall be swept two times per year.
IX. All material removed during the cleaning operations shall be disposed of in accordance with applicable guidelines and regulations.
X. All post construction maintenance activities will be documented and kept on file and made available upon request.
XI. The drainage system shall be maintained. The repair of any component of the system shall be made as soon as possible to prevent any potential pollutants (including silt) from entering the resource areas or the existing closed drainage system.

Part I: Construction of the System

Sediment and erosion control during construction will prevent possible damage to the drainage systems. The following guidelines shall be adhered to during construction.

1. Keep land disturbance to a minimum. Plan the phases of development so that only the areas actively being developed are exposed. All other areas should have natural vegetation preserved, have good temporary cover, or permanent vegetation established.

2. Stabilize disturbed areas. Permanent structures, temporary or permanent vegetation, and mulch should be employed as quickly as possible after land is disturbed.

3. Protect disturbed areas from stormwater runoff. Install erosion control or stormwater management measures to prevent water from entering and running over disturbed areas, and to prevent erosion damage to downstream facilities.

4. Install perimeter control practices. Use practices that isolate the development site from surrounding areas. Siltation fence, haybales, and temporary settlement basin shall be utilized.

5. The swales, area drains and underground infiltration systems shall not be used as temporary sediment traps for construction. Sediment and erosion controls should be used to keep runoff and sediment away from these systems/structures. During and after excavation, all excavated materials should be placed downstream, away from these stormwater management systems, to prevent the redeposit of these materials during runoff events. These materials should be properly handled and disposed of during and after construction. Light earth-moving equipment shall be used to excavate the infiltration systems to minimize the compaction of the soils beneath the trench floor.

6. If necessary, temporary dewatering and groundwater control systems shall be designed to keep excavations free of water and to avoid disturbance of the sub-grade. The flows of all water resulting from pumping shall be managed so as not to cause erosion, siltation of drainage systems, or damage to adjacent properties or resource areas associated with the project site.

7. Contractor shall clean/flush entire stormwater system prior to final acceptance by the owner. The Contractor shall clean the interior of all drainage piping and structures of dirt and other superfluous material as work progresses. Care shall be taken to prevent earth, water and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes being careful to prevent soil, water and debris from entering the proposed infiltration systems, any storm drains, the isolated wetland area, and adjacent properties. The Contractor shall place plugs in the ends of uncompleted pipe at the end of the work day or whenever work stops. Flush lines between manholes if required to remove collected debris. Remove and dispose all debris, mortar, and soil from the bottom of all structures. The Contractor shall remove and dispose of sediment and debris from the catch basins and water quality structures.

Part II: Maintenance of the System

Maintenance Schedule during Construction

Sediment Control	***Inspection***	***Maintenance Thresholds***	***Maintenance Action***
Street Sweeping	Sweep six (6) times per year	Per Schedule	Sweep access roads and all parking lots
Erosion control silt fences, haybales	Weekly and after large storm events (more than 0.5-inch of rainfall in 24-hour period)	If integrity of the system is compromised	Restore the integrity of the system and/or clean sediment out
Catch Basins w/deep sumps	Weekly and after large storm events (more than 0.5-inches of rainfall in 24-hour period)	If the sump is 1/3 full with sediment	Clean sediment out
Water Quality Structures (VortSentry HS Units®)	Weekly and after large storm events (more than 0.5-inches of rainfall in 24-hour period)	If the sediment depth is 25% of the interceptor's sediment storage (approximately 0.5 feet for Model HS48)	Clean sediment out with a vacuum truck
Adjacent Roadways	Weekly and after large storm events (more than 0.5-inches of rainfall in 24-hour period)	If sediment is greater than 1/2 inch in any area of the paved surfaces	Sweep/clean sediment from street
Sub-surface Infiltration System	Weekly and after large storm events (more than 0.5-inches of rainfall in 24-hour period)	When sediment is observed in infiltration basin	Remove sediment by jetting system in accordance with Manufacturer's recommendations. Replace system if infiltration component is compromised.
Porous Pavement**	Isolate and restrict all vehicular traffic over porous pavement area during Construction with wattles until Construction is complete.		

If installed

After all slopes have been fully stabilized all erosion control measures shall be cleaned out. All temporary erosion control measures shall be removed.

Post-Construction Maintenance Schedule

Maintenance Schedule Post-Construction

Sediment Control	***Inspection***	***Maintenance Thresholds***	***Maintenance Action***
Street Sweeping	Sweep two (2) times per year	two (2) times per year	Sweep access roads and all parking lots
Catch Basins w/deep sumps	Semi-annually and after large storm events (more than 3.2-inches of rainfall in 24-hour period)	If the sump is 1/3 full with sediment or at least once per year	Clean sediment out
Water Quality Structures (VortSentry HS Units®)	Semi-annually and after large storm events (more than 3.2-inches of rainfall in 24-hour period)	If the sediment depth is 75% of the interceptor's sediment storage (approximately 1.5 feet for Model HS48) or at least once per year	Clean sediment out with a vacuum truck
Sub-surface infiltration systems	Semi-annually and after large storm events (more than 3.2-inches of rainfall in 24-hour period)	When sediment is observed in the access manholes	Remove sediment by jetting system in accordance with Manufacturer's recommendations
Porous Pavement** (see page 5 for restrictions)	After large storm events (more than 0.5-inches of rainfall in 24-hour period) and annually for deterioration or spalling.	Monthly or if pavement appears not to be draining properly	Clean surface using vacuum sweeping machines
Level Spreader	**SEE INSPECTION AND MAINTENANCE REQUIREMENTS BELOW (page 5 of 8)**		

If installed

The Xaverian Brothers High School should prepare and maintain a report for each semi-annual inspection of the Stormwater Management System.

Level Spreader Inspection and Maintenance

During Construction

Inspections/Maintenance: Level Spreaders should not be constructed until all up gradient surfaces are stabilized. If the schedule does not allow for this, then additional erosion control methods including diversion swales shall be installed to protect these areas.

1. Weekly and after rainfall events greater than 1/4 inch in 24 hours.
   a. Check for sediment, trash, and or debris. Remove immediately.
   b. Check for erosion. Repair immediately.

Post-Construction

Inspections:

1. Semi-annual regular inspections of the level spreader; once before new growth emerges in the spring, and once at seed dispersal in the fall.
   a. Check for sediment, trash.
   b. For woody material, inspect for pests and ice damage.
   c. Check for erosion. Repair immediately.
   d. Check for soil compaction.
2. Inspect after severe storm events (greater than 2 inches in 24 hours).

Maintenance:

1. Where stone diaphragms are provided, remove accumulated sediment on filter strip of stone diaphragm. Stabilize eroded areas with appropriate geotextile and replant as required.
2. When sediment depth exceeds 1", remove sediment from level spreader with flat shovel.
3. Applicant of herbicides must be approved by Conservation Commission or other approving authority. To eliminate competition from invasive plants and undesirable vegetation, selectively apply appropriate herbicide with a cut stump applicator or directed foliar sprays.

Porous Asphalt** Maintenance

Frequent cleaning and maintenance of the porous asphalt surface is critical to prevent clogging. Frequent vacuum sweeping along with jet washing of porous asphalt is required. ***No winter sanding shall be conducted on the porous surface***. For proper maintenance:

- Minimize salt use during winter months.
- No winter sanding is allowed.
- Keep landscaped areas well maintained to prevent soil from being transported onto the pavement.
- Clean the surface using vacuum sweeping as required to keep the pavement functioning as designed.
- Regularly monitor the paving surface to make sure it drains properly after storms.
- Never reseal or repave with impermeable materials.
- Inspect the surface annually for deterioration or spalling.

***** If installed***

Part IV: Repair of the System

The drainage system shall be maintained. The repair of any component of the system shall be made as soon as possible to prevent any potential pollutants including silt from discharging offsite or to the resource areas located on the property.

Part V: Snow Management

Snow will be managed by the Xaverian Brothers High School's snow removal crews. Snow will be placed on the sides and edges of the driveways. Snow should not be stockpiled in water quality swales. Salt use is prohibited in the new rear parking area.

Part VI: Reporting

Construction Maintenance Reporting

The Contractor shall maintain a record of erosion control measures and drainage system inspections and maintenance during construction. Attached is a prototype of the Erosion and Sedimentation Controls Inspection and Maintenance Report and the Stormwater Management System Report to be used.

Post-Construction Maintenance Reporting

The owner shall maintain a record of drainage system inspections and maintenance. Attached is a prototype of the Stormwater Management System Report to be used.

EROSION AND SEDIMENTATION CONTROLS INSPECTION AND MAINTENANCE REPORT

INSPECTOR: _____ DATE: _____ NUMBER: _____

DAYS SINCE LAST RAINFALL: _____ AMOUNT LAST RAINFALL: _____ INCHES

TEMPORARY STABILIZATION

CATCH BASIN SILT SACKS? (YES/NO)	PAVED AREAS? (YES/NO)	LANDSCAPED AREAS? (YES/NO)

COMMENTS/ACTION:

TO BE PERFORMED BY: _____ ON OR BEFORE: _____

STABILIZED CONSTRUCTION ENTRANCES

IS SEDIMENT TRACKED ONTO ROAD? (YES/NO)	IS THE GRAVEL CLEAN? (YES/NO)	DOES ALL TRAFFIC USE THE STABILIZED ENTRANCE TO LEAVE THE SITE? (YES/NO)

COMMENTS/ACTION:

TO BE PERFORMED BY: _____ ON OR BEFORE: _____

SILT FENCES AND WATTLES

	DEPTH OF SEDIMENT	CONDITION OF EFFLUENT?	CONDITION OF SILT FENCE	ANY EVIDENCE OF SEDIMENT BYPASSING THE FENCE
SILT FENCE				

COMMENTS/ACTION:

TO BE PERFORMED BY: _____ ON OR BEFORE: _____

CHANGES REQUIRED TO THE POLLUTION PREVENTION PLAN/REASONS FOR CHANGES:

INSPECTED BY _____ SIGNATURE _____ DATE _____

STORMWATER MANAGEMENT SYSTEM REPORT

Xaverian Brothers High School Westwood, MA		Inspected by:_____ Date:_____
Component	Status	Action Taken
Catch Basin		
Water Quality Unit (Vortenic)		
Infiltration System		
Level Spreader		
Parking Lot Sweeping		
Porous Pavement** Vacuuming		

***** If Installed***

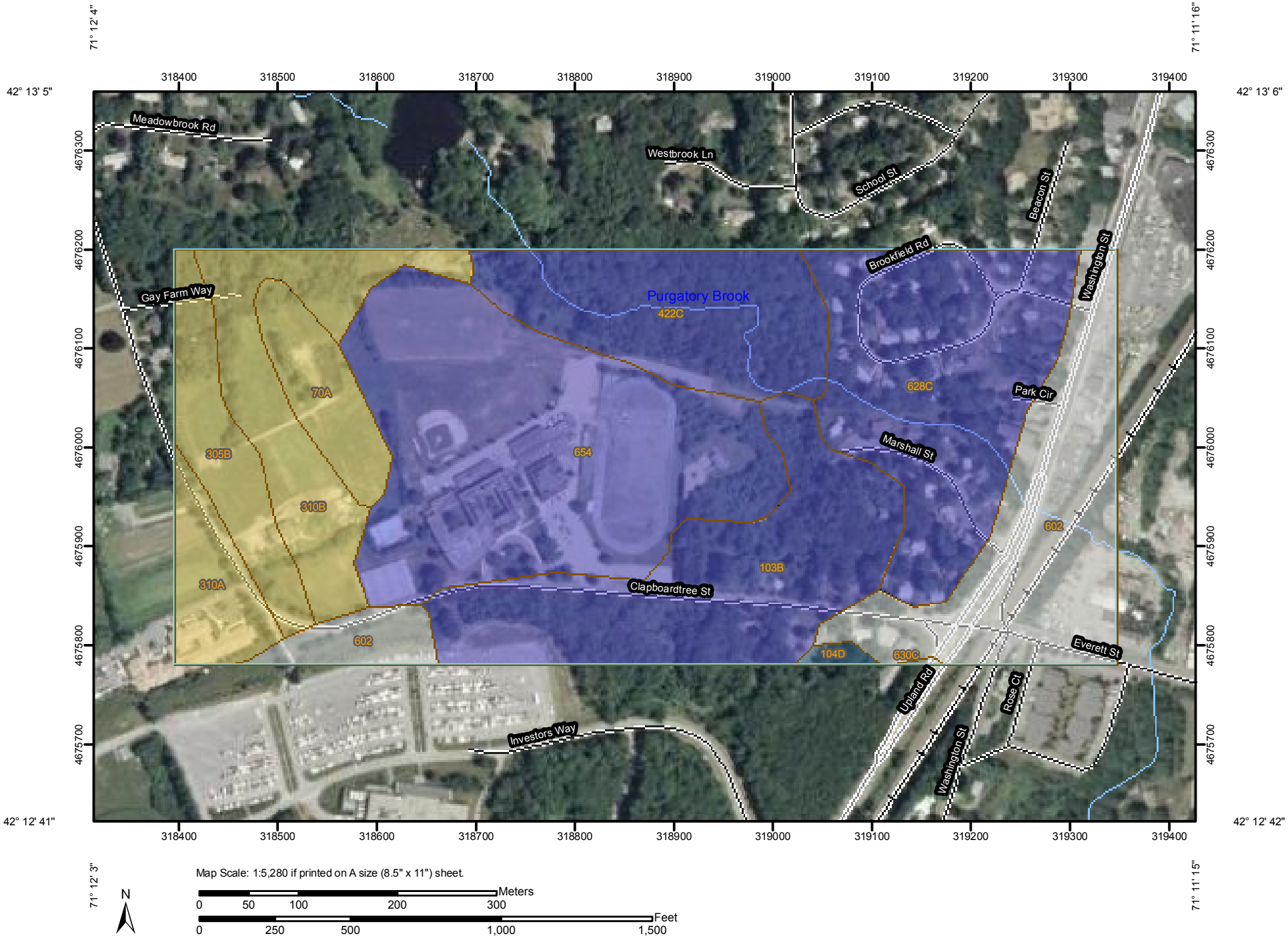
APPENDIX D

Soils Information

NRCS Soils Map

Geotechnical Report

Hydrologic Soil Group—Norfolk and Suffolk Counties, Massachusetts
(Xaverian Brothers High School)



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

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

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

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

MAP INFORMATION

Map Scale: 1:5,280 if printed on A size (8.5" × 11") sheet.

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

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

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

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

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

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

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 8, Jul 23, 2010

Date(s) aerial images were photographed: 7/10/2003

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Norfolk and Suffolk Counties, Massachusetts (MA616)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
70A	Ridgebury fine sandy loam, 0 to 5 percent slopes	C	3.5	3.6%
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	B	14.7	14.9%
104D	Hollis-Rock outcrop-Charlton complex, 15 to 35 percent slopes	C/D	0.3	0.3%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	4.7	4.7%
310A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C	3.4	3.4%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C	8.0	8.1%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	B	10.0	10.2%
602	Urban land, 0 to 15 percent slopes		14.6	14.8%
628C	Canton-Urban land complex, 3 to 15 percent slopes	B	15.4	15.7%
630C	Charlton-Hollis-Urban land complex, 3 to 15 percent slopes		0.0	0.0%
654	Udorthents, loamy	B	23.8	24.2%
Totals for Area of Interest			**98.4**	**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

Tie-break Rule: Higher

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HALEY & ALDRICH

MEMORANDUM

11 April 2013
File No. 39579-001

TO: Beacon Architectural Associates
J. Michael Sullivan A.I.A. LEED AP

FROM: Haley & Aldrich, Inc.
Todd R. Butler, P.E.; Bryan P. Sweeney, P.E.

SUBJECT: Summary of Subsurface Explorations and Geotechnical Design Recommendations
Xaverian Brother's High School
New Parking Lot
Westwood, Massachusetts

This memorandum summarizes the results of subsurface explorations, provides recommendations for geotechnical design, and comments on geotechnical-related construction considerations for a new parking lot proposed for Xaverian Brother's High School (Xaverian) located at 800 Clapboardtree Street in Westwood, Massachusetts. This work was undertaken in accordance with our proposal dated 26 March 2013 and your subsequent written authorization.

SITE CONDITIONS

The proposed parking lot site is located to the northeast of the existing football field and track, and is presently primarily a wooded area. A two-story, brick and vinyl-sided building is located on the southwest side of the site, partially overlapping the proposed parking lot footprint. An approximately 45-ft x 40-ft septic system with a 250-gallon septic tank is located on the south side of the site near the two-story, brick and vinyl-sided house.

An approximately 20-ft wide sewer-line easement is located roughly 8 ft north of the proposed northern edge of the parking lot. Additionally, a gas-line easement is located approximately 20 ft north of the proposed northern edge of the parking lot. Both easements run approximately parallel to the proposed parking lot boundary.

Existing site grades are variable, sloping from approximately El. 157[1] in the southwest corner to El. 126 in the northeast corner of the site. A drainage swale with a bottom grade at approximately El. 142 is located in the northwest portion of the site.

[1] Elevations are in feet and reference National Geodetic Vertical Datum of 1929 (NGVD 1929).

PROPOSED CONSTRUCTION

Based on review of the latest proposed site plans dated 4 April 2013, the proposed finished parking lot grades range from approximately El. 153 in the southwest corner to approximately El. 139.5 in the northeast corner. The lot will be graded at an approximate 3% slope to the southeast.

To accommodate differences between proposed and existing site grades beyond the proposed parking lot boundaries, grade separation walls are planned around the northeast, east, and southeast sides of the proposed parking lot.

SUBSURFACE EXPLORATIONS

A total of eleven (11) test pits were excavated by Earthwork Industries of Plainville, Massachusetts, to provide information on subsurface soil and groundwater conditions to facilitate project design and construction. Test pit excavations were completed on 28 and 29 March 2013 and were advanced no deeper than 10 ft below ground surface (bgs) at the exploration location; conditions encountered in each test pit were documented by a Haley & Aldrich field geologist/licensed Soil Evaluator. The designations and approximately locations of the test pits, (TP-1 through TP-11), are shown on Figure 2 – Site and Subsurface Exploration Location Plan.

Table I provides a summary of data obtained during the subsurface exploration program. Detailed descriptions of the subsurface conditions encountered at each test pit location are provided on the test pit logs included in Appendix A.

Soil Conditions

Subsurface strata encountered in the recently completed test pits are described below, generally in the order of occurrence below ground surface. At some locations, strata may be missing or in a different sequence.

- Topsoil – A layer of topsoil or topsoil mixed with fill was encountered at ground surface in all of the test pits except TP-3 and TP-4. Where encountered, the thickness of the topsoil ranged from 0.8 to 1.4 ft. Topsoil was typically described as dark brown silty SAND with roots and forest mat debris.

- Loess – A layer of loess was encountered beneath the topsoil in test pits TP-5 through TP-9 and TP-11. Where encountered, the thickness of the loess ranged from 1.0 to 3.2 ft. Loess was typically described as orange-brown sandy SILT with roots. The top of the loess ranged from El. 132.2 to El. 154.0.

- Fill – A layer of fill soil was encountered either at ground surface or beneath the topsoil in test pits TP-1 through TP-4 and TP-10. Where encountered, the thickness of the fill ranged from 0.4 to 8.0 ft. Fill was typically described as orange to olive to dark brown silty SAND. The fill in TP-4 consisted of dark gray poorly graded GRAVEL. Fill soils were observed to contain roots, cobbles and boulders. The top of the fill ranged from El. 131.0 to El. 146.5.

- Glaciolacustrine Deposits – a layer of glaciolacustrine deposits were encountered below the fill soils in TP-2. Measured at 1.4 ft in thickness, the glaciolacustrine deposits were described as olive-gray and orange SILT with sand. The top of the glaciolacustrine deposits was observed at El. 136.9.

- Glacial Till – Glacial till was observed in all eleven (11) test pits below the loess, fill, or glaciolacustrine deposits. Glacial till was typically described as olive-gray silty SAND with gravel and cobbles and boulders. Excavation of the glacial till was difficult due to the density of the material and the presence of gravel, cobbles, and boulders. The top of the glacial till ranged from El. 123.0 to El. 152.5.

Groundwater

Groundwater seepage was observed only in test pits TP-1 and TP-6, at 3.8 ft and 6.5 ft bgs, respectively.

All eleven (11) test pits were evaluated by a licensed Soil Evaluator to estimate the seasonal high groundwater table. Based on observed subsurface conditions, there were no observed redoximorphic features (i.e. soil mottles) within the soil profile indicative of seasonal high groundwater within these pits. Soil mottles observed in the glaciolacustrine deposits in TP-2 appeared to be the result of trapped or perched groundwater rather than indicative of seasonal high groundwater within the pit. However, during periods of precipitation, we expect that groundwater would be present several feet below existing grades.

Laboratory Testing

Sieve and hydrometer tests, performed in accordance with ASTM D422, were conducted on three (3) soil samples collected from the test pits. Samples were tested at GeoTesting Express in Acton, Massachusetts. Results of sieve and hydrometer tests are included in Appendix B.

Natural Resources Conservation Service (NRCS) Soil Textural Classes

We understand from the project Civil Engineer that the storm water design for the project is being conducted in accordance with the Simple Dynamic Method of the Massachusetts Department of Environmental Protection Stormwater Handbook. This method utilizes soil partial size analysis to estimate infiltration rates. In support of the storm water design a Soil Textural Analysis was completed using standard U.S. Department of Agriculture (USDA) soil physical analyses, as required by Natural Resources Conservation Service (NRCS) methods. Soil texture represents the relative composition of sand, silt and clay in soil. Soil texture is determined using procedures described in the USDA, 2007, National Soil Survey Handbook, Section 618.67.

Soil laboratory reports included in Appendix B have been published consistent with the United Soil Classification System (USCS), which is the customary soil classification method utilized by Geotechnical Engineers and Soils Laboratories in the United States. As the USCS and USDA soil

classification methods differ slightly in their definitions of gravel, sand, silt and clay, the information provided on the laboratory reports was reclassified in accordance with the USDA for the soil texture analysis.

Once the relative proportions of sand, silt, and clay were determined, the information was plotted on a soil texture triangle to classify the site soils. A soil texture triangle for laboratory soil samples collected for storm water management purposes are included in Appendix B. Site soils are classified as Sandy Loam in accordance with USDA soil physical analyses.

GEOTECHNICAL DESIGN RECOMMENDATIONS

Grade Separation Structures

Current project design includes construction of grade separation structures along the northeast, east, and southeast sides of the proposed parking lot. Based on the most recent proposed site contours, we understand grade differences up to 15 ft are planned. The maximum proposed grade difference will be in the northeast corner of the site.

Options for grade separation structures that would be appropriate for the project site include the following:

- Rip rap protected slopes. This option is appropriate where space is available for up to 1V:1H or shallower slopes.
- Mechanically Stabilized Earth (MSE) walls are typically the most economical option in fill areas. These walls are typically designed and constructed by contractors based on performance specifications provided by the owner's consultants.
- Conventional reinforced concrete walls are an option, but typically are the most expensive option for fill areas.

We would be happy to provide additional information once the project has selected appropriate grade separation structures.

Parking Lot Design Recommendations

We recommend that the site be stripped of all topsoil and organic soils, trees, roots, stumps, loess, and fill soils and backfilled to desired grades with compacted granular fill for subgrade. We recommend that the pavement subgrade for access roads and parking areas consist of a minimum 12-in. thickness of dense-graded crushed stone (MHD 2.01.7). It is typically not economically feasible to excavate and replace 4 ft of fine-grained soils (frost susceptible materials) that may be present below the access roads and parking areas. Therefore, periodic maintenance to these areas to repair frost heaves and potholes should be anticipated.

We assume the project Civil Engineer will incorporate a drainage swale at the base of slopes adjacent to the roads and parking areas to divert slope water away from the roadway.

Reuse of On-Site Soils

Excavated topsoil, loess, and fill soils could likely be reused as Common Fill in landscaped areas, subject to requirements for gradation, planting media and other site engineering considerations. These materials may need processing or nutritional amendments for reuse as topsoil or other planting medium.

Existing on-site fill soils and glacial till soils are considered suitable to raise grades in deep fill areas under the parking lot, subject to removal of oversized particles and any weather-related compaction limitations. A minimum of 3 ft. of imported granular soils should be placed over these soils below pavement sections. Due to high sensitivity to moisture the on-site fill and glacial soils will only be able to be reused during warm dry summer weather that typically occurs during the months of July and August.

CONSTRUCTION CONSIDERATIONS

Excavation

Excavation for construction will encounter very dense, well-bonded, glacial till with cobbles and boulders. Cobbles and boulders are also present in the site fill soils. Most of the soil excavation can be accomplished using conventional earth-moving equipment.

Dewatering

Groundwater may be encountered during construction. Contractors shall control precipitation and run-off; we expect that localized dewatering could be accomplished with sumps. Excavation, subgrade preparation, and backfilling should be conducted "in the dry."

Backfilling

Following excavation and removal of all topsoil, loess, and fill soils, we recommend the site be backfilled to desired grades using compacted granular fill, or suitable on-site soils in deep fill areas subject to moisture control. Common fill may be used within landscaped areas.

Backfill should be compacted with suitable vibratory compaction equipment in controlled lifts. A summary of recommended compaction requirements will be provided in the project specifications.

Compacted Granular (Structural) Fill

Compacted granular fill should consist of clean sandy gravel or gravelly sand, free of organic material, environmentally impacted material, snow, ice, frozen soil, concrete, brick, asphalt or other deleterious or unsuitable material, and well-graded within the following limits:

U.S. Standard Sieve Size	Percent Finer by Weight
4 in.	100
No. 4	40-80
No. 40	10-50
No. 200	0-5

Common Fill

Common fill shall not contain stones larger than 6 in. in largest diameter and shall have a maximum of 40 percent passing the No. 40 sieve and a maximum of 30 percent passing the No. 200 sieve. These soils typically require moisture control during placement and compaction. Common Fill should not contain broken concrete, masonry rubble or other similar material and shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice, and frozen soil shall not be permitted.

Excavated Soil Management

We understand that all excavated soil will be reused on site. If project development generates excess or unsuitable soil that will generate offsite disposal, the management of the materials must be performed in accordance with all applicable federal, state, and local laws and regulations, including the requirements of the Massachusetts Contingency Plan (MCP, 310 CMR 40.000). Soil designated for off-site disposal requires chemical testing. If reportable concentrations of contaminants are detected in the soils, regulatory compliance would be required in accordance with the timelines established in the MCP.

Environmental site evaluations or chemical characterization of on-site soils and groundwater were not conducted.

CLOSURE

Please feel free to contact us for additional information or to discuss.

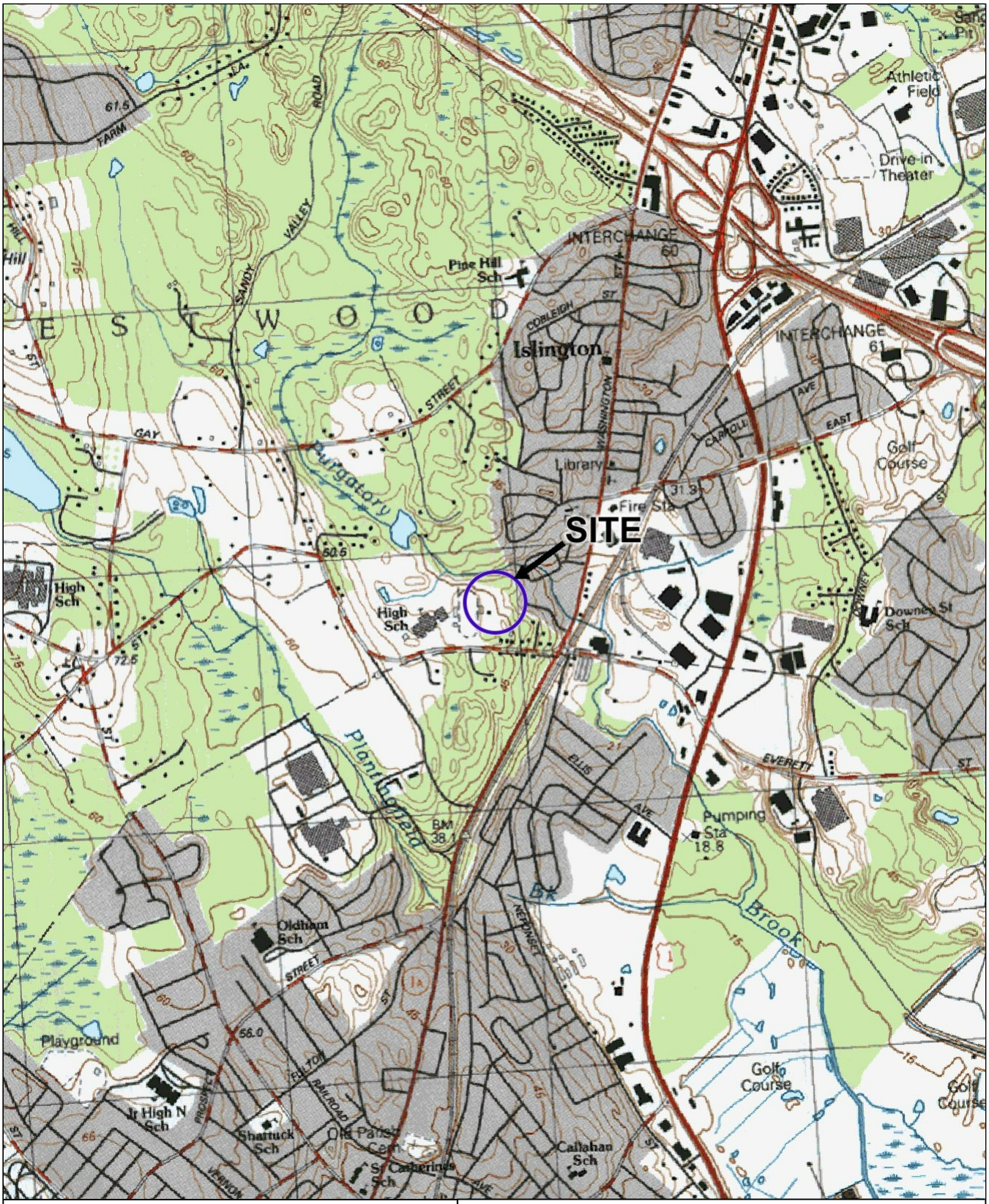
Enclosures

Table I – Summary of Test Pit Data
Figure 1 – Project Locus
Figure 2 – Site and Subsurface Exploration Location Plan
Appendix A – Test Pit Logs
Appendix B – Laboratory Test Data & Soil Textural Classifications

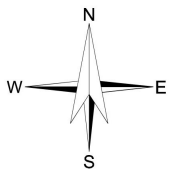
TABLE I - SUMMARY OF TEST PIT DATA
XAVERIAN BROTHERS HIGH SCHOOL
NEW PARKING LOT
800 CLAPBOARDTREE STREET
WESTWOOD, MASSACHUSETTS
39579-001

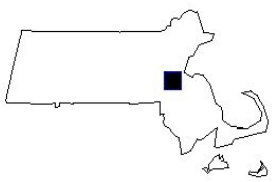
Test Pit ID	Date	Ground Surface El. [ft]	Total Test Pit Depth [ft]	Bottom of Test Pit Elevation [ft]	Groundwater		Topsoil		Loess		Fill		Glaciolacustrine Deposits		Glacial Till
					Depth to Ground Water [ft]	Top of GW Elevation [ft]	Top Elevation [ft]	Thickness [ft]	Top Elevation [ft]	Thickness [ft]	Top Elevation [ft]	Thickness [ft]	Top Elevation [ft]	Thickness [ft]	Top Elevation [ft]
TP-1	3/28/2013	146.5	4.5	142.0	3.8	142.7	146.5	1.4	NE	NE	145.1	0.8	NE	NE	144.3
TP-2	3/28/2013	139.5	5.4	134.1	NE	NE	139.5	0.8	NE	NE	138.7	1.8	136.9	1.4	135.5
TP-3	3/28/2013	131.0	10.0	121.0	NE	NE	NE	NE	NE	NE	131.0	8.0	NE	NE	123.0
TP-4	3/28/2013	142.0	5.0	137.0	NE	NE	NE	NE	NE	NE	142.0	0.4	NE	NE	141.6
TP-5	3/28/2013	150.0	5.5	144.5	NE	NE	150.0	0.8	149.2	1.0	NE	NE	NE	NE	148.2
TP-6	3/28/2013	144.5	9.0	135.5	6.5	138.0	144.5	1.0	143.5	2.0	NE	NE	NE	NE	141.5
TP-7	3/28/2013	133.0	7.5	125.5	NE	NE	133.0	0.8	132.2	3.2	NE	NE	NE	NE	129.0
TP-8	3/29/2013	149.0	6.0	143.0	NE	NE	149.0	1.0	148.0	1.4	NE	NE	NE	NE	146.6
TP-9	3/29/2013	155.0	9.0	146.0	NE	NE	155.0	1.0	154.0	1.5	NE	NE	NE	NE	152.5
TP-10	3/29/2013	147.5	6.0	141.5	NE	NE	147.5	1.0	NE	NE	146.5	1.3	NE	NE	145.2
TP-11	3/29/2013	145.0	6.0	139.0	NE	NE	145.0	1.0	144.0	1.3	NE	NE	NE	NE	142.7

NOTES:
1. NE = Not Encountered



SITE COORDINATES:42°12'55"N 71°11'36"W





U.S.G.S. QUADRANGLE: NORWOOD, MA

HALEY & ALDRICH

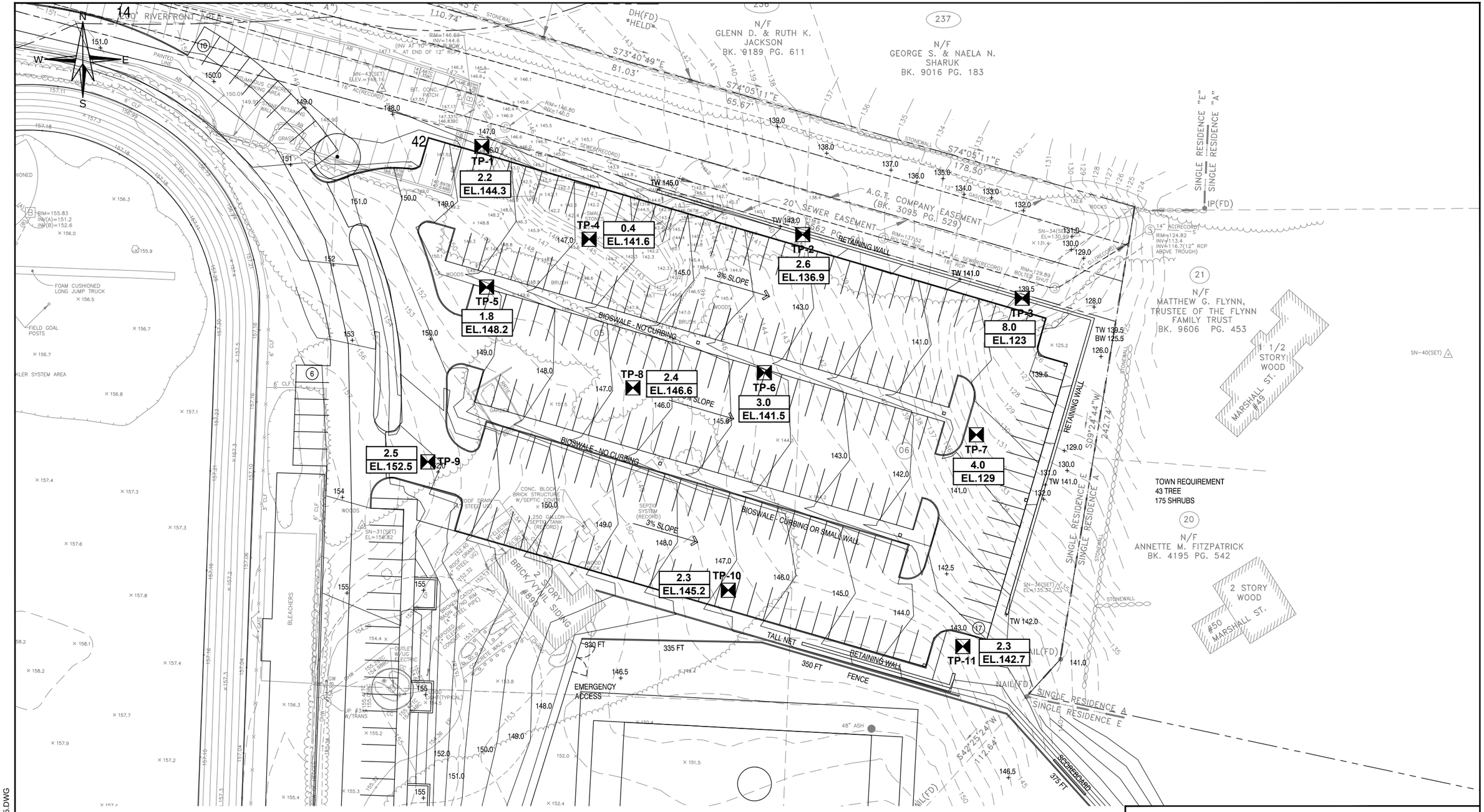
XAVERIAN BROTHERS HIGH SCHOOL
NEW PARKING LOT
800 CLAPBOARDTREE STREET
WESTWOOD, MASSACHUSETTS

PROJECT LOCUS

SCALE: 1:24,000
APRIL 2013

FIGURE 1

39579-001 1.PDF



LEGEND:

TP-1 — DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXPLORATION ADVANCED BY EARTHWORK INDUSTRIES INC. OF PLAINVILLE, MASSACHUSETTS BETWEEN 28 AND 29 MARCH 2013 AND OBSERVED BY HALEY & ADRICH, INC.

SUBSURFACE DATA BOX:

2.2 — APPROXIMATE DEPTH TO TOP OF GLACIAL SOILS (FT.)

EL.144.3 — APPROXIMATE ELEVATION OF TOP OF GLACIAL SOILS (FT.)

NOTES:

1. BASE PLAN TAKEN FROM ELECTRONIC FILE TITLED "XR-SURVEY.DWG" PROVIDED BY JUDITH NITSCH ENGINEERING, INC., RECEIVED 15 MARCH 2013.
2. PROPOSED FEATURES TAKEN FROM ELECTRONIC FILE TITLED "2013-04-04-Xaverian CGI Site Plan.dwg" PROVIDED BY THE CECIL GROUP ON 9 APRIL 2013.
3. ELEVATIONS SHOWN REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 1929).

HALEY & ALDRICH

XAVERIAN BROTHERS HIGH SCHOOL
NEW PARKING LOT
800 CLAPBOARDTREE STREET
WESTWOOD, MASSACHUSETTS

SITE AND SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
APRIL 2013

FIGURE 2

J:\GRAPHICS\39579\39579-001-B005.DWG

APPENDIX A

Test Pit Logs

IDENTIFICATION AND DESCRIPTION OF SUBSURFACE MATERIALS

SOIL

Soil description on logs of subsurface explorations are based on Standard Penetration Test results, visual-manual examination of exposed soil and soil samples, and the results of laboratory tests on selected samples. The criteria, descriptive terms and definitions are as follows:

DENSITY OR CONSISTENCY

Density of Cohesionless Soils	Penetration Resistance (Blows per ft.)	Consistency of Cohesive Soils	Penetration Resistance (Blows per ft.)
Very Loose	0-4	Very Soft	0-2
Loose	5-10	Soft	3-4
Medium	11-30	Medium	5-8
Dense	31-50	Stiff	9-15
Very Dense	over 50	Very Stiff	16-30
		Hard	over 30

PENETRATION RESISTANCE

Standard Penetration Test (ASTM D-1586) - Number of blows required to drive a standard 2 in. O.D. split spoon sampler 1 ft. with a 140 lb. weight falling freely through 30 in.

COLOR: Basic colors and combinations: black, brown, gray, yellow-brown, etc.

SUPPLEMENTAL SOIL TERMINOLOGY:

Laminae	- 0 to 1/16 in. thick (cohesive)
Parting	- 0 to 1/16 in. thick (granular)
Seam	- 1/16 to 1/2 in. thick
Layer	- 1/2 to 12 in. thick
Stratum	- > 12 in. thick
Pocket	- Small, erratic deposit less than 12 in. size
Lens	- Lenticular deposit larger than a pocket
Occasional	- One or less per 12 in. of thickness
Frequent	- More than one per 12 in. of thickness
Interbedded	- Alternating soil layers of differing composition
Varved	- Alternating thin seams of silt and clay
Mottled	- Variation of color

GEOLOGIC INTERPRETATION

Deposit type - GLACIAL TILL, ALLUVIUM, FILL.....

The natural soils are identified by criteria of Unified Soil Classification System (USCS), with appropriate group symbol in parenthesis for each soil description. Fill materials may not be classified by USCS criteria.

U.S. Standard Series Seive — Clear Square Sieve Openings

12"	3"	3/4"	4	10	40	200
Boulders	Cobbles	Gravel: Coarse / Fine		Sand: Coarse / Medium / Fine		Silts and Clays
305 mm	76 mm	19 mm	4.75 mm	2.00 mm	0.43 mm	0.074 mm

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			Group Symbol	Graphic Symbol	TYPICAL NAMES
Coarse grained soils: more than half is larger than number 200 sieve	Gravels: More than half of coarse fraction is larger than number 4 sieve	Gravels with little or no fines	GW		Well graded gravels, gravel-sand mixtures
			GP		Poorly graded gravels, gravel-sand mixtures
		Gravels with over 12% fines	GM		Silty gravels, poorly graded gravel-sand-silt mixtures
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures
	Sands: More than half of coarse fraction is smaller than number 4 sieve	Sands with little or no fines	SW		Well graded sands, gravelly sands
			SP		Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM		Silty sands, poorly graded sand-silt mixtures
			SC		Clayey sands, poorly graded sand-clay mixtures
Fined-grained soils: more than half smaller than number 200 sieve	Silts and Clays: Liquid limit 50% or less		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL		Organic clays and organic silty clays of low plasticity
	Silts and Clays: Liquid limit greater than 50%		MH		Inorganic silty, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
Highly organic soils			PT		Peat and other highly organic soils

GENERAL NOTES

1. Logs of subsurface explorations depict soil, rock and groundwater conditions only at the locations specified on the dates indicated. Subsurface conditions may vary at other locations and at other times.
2. Water levels noted on the logs were measured at the times and under the conditions indicated. During test borings, these water levels could have been affected by the introduction of water into the borehole, extraction of tools on other procedures and thus may not reflect actual groundwater level at the test boring location. Groundwater level fluctuations may also occur as a result of variations in precipitation, temperature, season, tides, adjacent construction activities and pumping of water supply wells and construction dewatering systems.

ROCK

Rock descriptions noted on logs of subsurface explorations are based on visual-manual examination of exposed rock outcrops and core samples. The criteria, descriptive terms and definitions used are as follows:

FIELD HARDNESS: A measure of resistance to scratching.

Very Hard	Cannot be scratched with a knife point or sharp pick.
Hard	Can be scratched with a knife point or sharp pick, only with difficulty.
Moderately Hard	Can be readily scratched with a knife point or pick.
Medium Hard	Can be grooved or gouged 1/16 in. deep with firm pressure on a knife point or sharp pick.
Soft	Can be grooved or gouged easily with a knife point or pick.
Very Soft	Can be carved with a knife and excavated with a pick point.

WEATHERING: The action of organic and inorganic and chemical and physical processes resulting in alteration of color, texture and composition.

Fresh-FR	No visible sign of alteration, except perhaps slight discoloration on major discontinuity surfaces.
Slight-SL	Discoloration of rock material and discontinuity surfaces. All rock may be discolored and/or somewhat weaker than in its fresh condition.
Moderate-MOD	Less than half the rock material is decomposed and/or disintegrated to a soil. Some fresh or discolored rock is present as either a continuous framework or as corestones.
High-HIGH	More than half the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present as either a discontinuous framework or as corestones.
Complete-COMP	All rock material is decomposed and/or disintegrated to soil. The original mass structure is largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There has been a large change of volume, but the material has not been significantly transported.

COLOR: Basic colors and combinations: gray, light gray, brown, red-brown.

TEXTURE: Size, shape and arrangements of constituents.

Term	Size: Igneous	Size: Sedimentary
Coarse-grained	> 5 mm	> 2 mm
Medium-grained	1 - 5 mm	0.625 - 2 mm
Fine-grained	< 1 mm	< 0.625 mm
Aphanitic	Individual grains invisible to the unaided eye.	

LITHOLOGY: Rock classification and modifiers; accepted formation names.

DISCONTINUITIES:

Type	Definition
Joint	A natural fracture along which no displacement has occurred. May occur in parallel groups called sets.
Shear	A natural fracture along which displacement has occurred. Surface may be slickensided or striated.
Fault	A natural fracture along which displacement has occurred. Usually lined with gouge and slickensides.
Shear or Fault Zone	Zone of fractured rock and gouge bordering the displacement plane.

ORIENTATION/ATTITUDE:

Term	Angle (degrees)
Horizontal	0-5
Low Angle	6-35
Moderately Dipping	36-55
High Angle	56-85
Vertical	86-100

SPACING:

Discontinuity Term	Bedding Term	Inches
Extremely Close	Extremely Thin	< 3/4
Very Close	Very Thin	3/4 - 2.5
Close	Thin	2.5 - 8
Moderate	Medium	8 - 24
Wide	Thick	24 - 80
Very Wide	Very Thick	80 - 240
Extremely Wide	Extremely Thick	> 240

PERSISTENCE/CONTINUITY:

Term	Feet
Very Low	0-3
Low	3-10
Medium	10-35
High	35-65
Very High	> 65

APERTURE/GAP:

Term	Distance
Very Tight	< 0.1mm
Tight	0.1mm-0.25mm
Partly Open	0.25mm-0.5mm
Open	0.5mm-2.5mm
Moderately Wide	2.5mm-1cm
Wide	> 1cm
Very Wide	1cm-10cm
Extremely Wide	10cm-1m
Cavernous	> 1m

POROSITY:

Type

Primary:
Pre-depositional and depositional inter- and intra- granular, particle, or crystalline pores.

Secondary:
Solution features including pits, vugs, caverns, molds, and channels.
Fracture features including joints, shears, faults, shrinkage and breccia fabrics.

Term	Size
Micro	< 0.0625 mm
Meso	0.0625-4.0 mm
Mega	4.0-256 mm

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SUBSURFACE EXPLORATION KEY

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HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-1

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	28 Mar 2013
Weather	mostly cloudy, 30's ° F

Ground El.: 146.5 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** Entering pit at 3.8 ft. Spot seepage only.

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SP- SM	Dark brown poorly graded SAND with silt (SP-SM), mps 3.5 in., no structure, no odor, dry, 2% cobbles, trace glass, trace roots		10	20	20	40	10				
				-TOPSOIL/FILL-										
1		145.1												
		1.4	SM	Yellow-brown mottled with orange-brown (from disturbance) silty SAND (SM), mps 3 in., no structure, no odor, moist, cobbles	5	5	15	15	35	25				
				-FILL-										
2		144.3												
		2.2	SM	Olive-gray silty SAND with gravel (SM), mps 6 in., no structure although soils are difficult to excavate, no odor, moist, cobbles	10	15	10	10	35	20				
3				-GLACIAL TILL DEPOSITS-										
4		142.0												
		4.5		BOTTOM OF EXPLORATION 4.5 FT										

Obstructions: none

Remarks: Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth see above ft
measured after hours elapsed

Boulders

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

Test Pit Dimensions (ft)

Pit Length x Width (ft) 6.5 x 3.0
Pit Depth (ft) 4.5

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-2

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT	**File No.**	39579-001
Location	WESTWOOD, MA	**H&A Rep**	S. Shay
Client	BEACON ARCHITECTURAL ASSOCIATES	**Date**	28 Mar 2013
Contractor	EARTHWORK INDUSTRIES	**Weather**	Overcast, 30's ° F
Equipment Used	Komatsu PC75R		

Ground El.: 139.5 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering pit

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SM	Dark brown silty SAND (SM), mps 2.5 in., no structure, no odor, moist, no oversized, 20% roots			10	10	40	40				
				-TOPSOIL/ FILL-										
		138.7												
1		0.8	SM	Light olive-brown silty SAND (SM), mps 1.0 in., no structure, no odor, moist, oversize as boulders	5	5	20	20	30	25				
		138.3		-FILL-										
		1.2	SM	Orange-brown silty SAND (SM), mps 4 in., no structure, no odor, moist, cobbles, trace roots, appears to be disturbed		10	20	20	20	30				
2				-FILL-										
		136.9												
		2.6	ML	Olive-gray with vivid orange-brown mottling at 3.5 ft SILT with sand (ML), mps 1 in. as trace gravel, no odor, moist, no oversize			5	5	10	80				
3				-GLACIOLACUSTRINE DEPOSITS-										
		135.5												
4		4.0	SM	Olive-gray silty SAND with gravel (SM), mps 4 in., no structure although soils are difficult to excavate, no odor, moist, cobbles	5	10	10	15	35	25				
				-GLACIAL TILL DEPOSITS-										
5				Note: Very difficult soil to excavate with increased gravel content from 5.0 ft, well-bonded soils										
		134.1												
		5.4		BOTTOM OF EXPLORATION 5.4 FT										

Obstructions: none

Remarks: Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number		Approx. Vol. (cu.ft)
12 to 24	3	=	4.8
over 24	-	=	-

Test Pit Dimensions (ft)

Pit Length x Width (ft) 7.5 x 3.0
Pit Depth (ft) 5.4

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-3

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	28 Mar 2013
Weather	sunny, 30's ° F

Ground El.: 131.0 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering pit

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0														
2			SM	Dark brown silty SAND (SM), mps 2.5 ft, no structure, no odor, dry, 25% oversize, mostly as boulders, 10% roots, disturbed -FILL-	10	10	10	15	25	30				
4														
		126.0												
		5.0	ML	Orange-brown to brown sandy SILT with gravel (ML), mps 6 in., no structure although appears disturbed/intermixed soil, no odor, moist, oversize as cobbles -PROBABLE FILL-	10	10	5	5	5	65				
6														
		123.0												
8		8.0	GM	Olive-gray silty GRAVEL with sand (GM), mps 9 in., no structure although soils difficult to excavate, no odor, moist, cobbles -GLACIAL TILL DEPOSITS-	26	13	6	11	15	29				
	TP-3 8.0 - 10.0													
		121.0												
10		10.0		BOTTOM OF EXPLORATION 10.0 FT										

Obstructions: none

Remarks: Bottom of test pit near machine limits.
Boulder count high 0.0 to 5.0 ft.
Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number		Approx. Vol. (cu.ft)
12 to 24	18	=	55
over 24	2	=	20

Test Pit Dimensions (ft)

Pit Length x Width (ft) 8.0 x 5.0
Pit Depth (ft) 10.0

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-4

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	28 Mar 2013
Weather	overcast, 30's ° F

Ground El.: 142.0 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0		141.6	GP	Dark gray poorly graded GRAVEL (GP), mps 1.5 in., loose, no odor, dry, no oversize	100									
				-FILL-										
		0.4	SM	Olive-gray silty SAND with gravel (SM), mps 1.2 ft., no structure although soils are difficult to excavate, no odor, moist, oversize as cobbles and boulders	10	15	10	15	30	20				
1														
2				-GLACIAL TILL DEPOSITS-										
3														
4														
5		137.0		BOTTOM OF EXPLORATION 5.0 FT										
		5.0												

Obstructions: none

Remarks: Test Pit located within detention basin. Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number		Approx. Vol. (cu.ft)
12 to 24	1	=	1.2
over 24	-	=	-

Test Pit Dimensions (ft)

Pit Length x Width (ft) 6.5 x 3.0
Pit Depth (ft) 5.0

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-5

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT	**File No.**	39579-001
Location	WESTWOOD, MA	**H&A Rep**	S. Shay
Client	BEACON ARCHITECTURAL ASSOCIATES	**Date**	28 Mar 2013
Contractor	EARTHWORK INDUSTRIES	**Weather**	overcast, 30's ° F
Equipment Used	Komatsu PC75R		

Ground El.: 150.0 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SP- SM	Dark brown poorly graded SAND with silt (SP-SM), mps 1.5 in., no structure, no odor, moist, no oversize, soil intermixed with forest mat debris, roots -TOPSOIL-		5	15	25	45	10				
		149.2 0.8	ML	Orange-brown sandy SILT (ML), mps 2 in., no structure, no odor, moist, no oversize, trace roots -LOESS DEPOSITS-				10	25	65				
1														
		148.2 1.8	SM	Olive-gray silty SAND with gravel (SM), mps 7.5 in., no structure although soils are difficult to excavate, no odor, moist, oversize as cobbles -GLACIAL TILL DEPOSITS-	10	15	10	10	35	20				
2														
3														
4														
5														
		144.5 5.5		BOTTOM OF EXPLORATION 5.5 FT										

Obstructions: none

Remarks: Soils difficult to excavate. Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

Test Pit Dimensions (ft)

Pit Length x Width (ft) 7.0 x 3.0
Pit Depth (ft) 5.5

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-6

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	28 Mar 2013
Weather	overcast, 30's ° F

Ground El.: 144.5 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** entering pit at 6.5 ft, seepage only

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SM	Dark brown silty SAND (SM), mps 1 in., no structure, no odor, moist, no oversize, soil intermixed with forest mat debris -TOPSOIL-			10	20	40	30				
		143.5 1.0	ML	Orange-brown sandy SILT (ML), mps 2 in., no structure, no odor, moist, no oversize, trace roots -LOESS DEPOSITS-				5	25	70				
2		141.5 3.0	SM	Olive-gray silty SAND with gravel (SM), mps 1.1 ft, no structure, although soils are difficult to excavate, no odor, moist, oversize as cobbles	8	11	8	17	22	34				
4														
6				-GLACIAL TILL DEPOSITS-										
	TP-6 6.0 - 9.0													
8				Note: Increased gravel content below 8.0 ft and hole difficult to excavate.										
		135.5 9.0		BOTTOM OF EXPLORATION 9.0 FT										

Obstructions: none

Remarks: Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth see above ft
measured after hours elapsed

Boulders

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

Test Pit Dimensions (ft)

Pit Length x Width (ft) 7.0 x 3.5
Pit Depth (ft) 9.0

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

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TEST PIT LOG

Test Pit No. TP-7

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	28 Mar 2013
Weather	overcast, 30's ° F

Ground El.: 133.0 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0		132.2	SM	Dark brown silty SAND (SM), mps 1.25 in., no structure, no odor, moist, no oversize, soil with forest mat debris, roots -TOPSOIL-		5	20	25	30	20				
		0.8	ML	Orange-brown sandy SILT (ML), mps 9 in., no structure, no odor, moist, oversize as cobbles, 10% roots -LOESS DEPOSITS-				10	25	65				
2														
4		129.0 4.0	SM	Olive-gray silty SAND with gravel (SM), mps 8 in., no structure, difficult to excavate, no odor, moist, oversize as cobbles -GLACIAL TILL DEPOSITS-	10	15	10	10	30	25				
6	TP-7 6.0 - 7.5													
		125.5 7.5		BOTTOM OF EXPLORATION 7.5 FT										

Obstructions: none

Remarks: Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

Test Pit Dimensions (ft)

Pit Length x Width (ft) 8.0 x 3.5
Pit Depth (ft) 7.5

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-8

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	29 Mar 2013
Weather	bright sun, 40's° F

Ground El.: 149.0 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SM	Dark brown silty SAND (SM), mps 1 in., no structure, no odor, moist, no oversize, soil intermixed with forest mat debris -TOPSOIL-			10	20	40	30				
1		148.0 1.0	ML	Orange-brown sandy SILT (ML), mps 2 in., no structure, no odor, moist, no oversize except occasional embedded boulder, trace roots -LOESS DEPOSITS-				5	25	70				
2		146.6 2.4												
3														
4			SM	Olive-gray silty SAND with gravel (SM), mps 1.5 ft, no structure, although soils are difficult to excavate, no odor, moist, oversize as cobbles and boulders	10	20	10	10	30	20				
5				-GLACIAL TILL DEPOSITS-										
6		143.0 6.0		BOTTOM OF EXPLORATION 6.0 FT										

Obstructions: none

Remarks: Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number		Approx. Vol. (cu.ft)
12 to 24	4	=	6.5
over 24	-	=	-

Test Pit Dimensions (ft)

Pit Length x Width (ft) 7.0 x 3.5
Pit Depth (ft) 6.0

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-9

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	29 Mar 2013
Weather	bright sun, 40's° F

Ground El.: 155.0 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SM	Dark brown silty SAND (SM) with forest mat debris, mps 0.25 in., no odor, moist, no oversize -TOPSOIL-			5	20	40	35				
		154.0 1.0	ML	Orange-brown sandy SILT (ML), mps 1.25 in., no structure, no odor, moist, no oversize, trace roots -LOESS-					30	70				
2		152.5 2.5	SM	Olive-gray silty SAND with gravel (SM), mps 1.5 ft, no structure, no odor, moist, cobbles and boulders, soils difficult to excavate -GLACIAL TILL DEPOSITS-	13	9	5	18	22	33				
4														
6														
8	TP-9 1 7.0 - 9.0			Note: Very difficult excavation below 8.0 ft.										
		146.0 9.0		BOTTOM OF EXPLORATION 9.0 FT										

Obstructions: none

Remarks: Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	5	= 10.5
over 24	-	= -

Test Pit Dimensions (ft)

Pit Length x Width (ft) 7.5 x 3.5
Pit Depth (ft) 9.0

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-10

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT	**File No.**	39579-001
Location	WESTWOOD, MA	**H&A Rep**	S. Shay
Client	BEACON ARCHITECTURAL ASSOCIATES	**Date**	29 Mar 2013
Contractor	EARTHWORK INDUSTRIES	**Weather**	Sun, 40's° F
Equipment Used	Komatsu PC75R		

Ground El.: 147.5 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SM	Dark brown silty SAND (SM), mps 0.75 in., no structure, no odor, moist, no oversize, trace rootlets -TOPSOIL/FILL-			5	20	40	35				
1		146.5 1.0	ML	Brown to orange-brown sandy SILT (ML), mps 3 in., no structure, no odor, moist, cobbles, appears to be disturbed -FILL- Note: Sloping stratum change at bottom of fill.		5	5	5	20	65				
2		145.2 2.3	SM	Olive-gray silty SAND with gravel (SM), mps 9 in., no structure, no odor, moist, cobbles	10	10	15	15	30	20				
3														
4				-GLACIAL TILL DEPOSITS-										
5														
6		141.5 6.0		BOTTOM OF EXPLORATION 6.0 FT										

Obstructions: none

Remarks: Test Pit located on Residence lawn. Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

Test Pit Dimensions (ft)

Pit Length x Width (ft) 6.5 x 3.5
Pit Depth (ft) 6.0

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

HALEY & ALDRICH

TEST PIT LOG

Test Pit No. TP-11

Project	XAVERIAN BROTHERS HIGH SCHOOL PARKING LOT
Location	WESTWOOD, MA
Client	BEACON ARCHITECTURAL ASSOCIATES
Contractor	EARTHWORK INDUSTRIES
Equipment Used	Komatsu PC75R
File No.	39579-001
H&A Rep	S. Shay
Date	29 Mar 2013
Weather	Sunny, 40's ° F

Ground El.: 145.0 (est.) **El. Datum:** NGVD 1929 | **Location:** See Plan | **Groundwater depths/entry rates (in./min.):** no water entering

Depth (ft)	Sample ID	Stratum Change Elev./ Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (color, natural grain size and artificial component percentage estimates, maximum particle size, manual test properties, structure, odors, moisture, other descriptions and observations GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Tests Dilatancy	Toughness	Plasticity	Strength
0			SM	Dark brown silty SAND (SM), mps 0.5 in., no structure, no odor, moist, no oversize, with forest mat debris -TOPSOIL-			5	20	40	35				
1		144.0 1.0	ML	Orange-brown sandy SILT (ML), mps 2 in., no structure, no odor, moist, no oversize, trace roots -LOESS DEPOSITS-				5	25	70				
2		142.7 2.3	SM	Olive-gray silty SAND with gravel (SM), mps 1.2 ft, no structure, no odor, moist, cobbles and boulders, soils difficult to excavate -GLACIAL TILL DEPOSITS-	10	10	15	15	30	20				
3														
4														
5														
6		139.0 6.0		BOTTOM OF EXPLORATION 6.0 FT										

Obstructions: none

Remarks: Test Pit backfilled with excavated materials.

Field Tests

Dilatancy R - Rapid S - Slow N - None
Toughness L - Low M - Medium H - High
Plasticity N - Nonplastic L - Low M - Medium H - High
Dry Strength N - None L - Low M - Medium H - High V - Very High

Standing Water in Completed Pit

at depth no standing water ft
measured after hours elapsed

Boulders

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	2	= 2.2
over 24	-	= -

Test Pit Dimensions (ft)

Pit Length x Width (ft) 6.5 x 3.5
Pit Depth (ft) 6.0

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

HA TESTPIT-07-1 HA-LIB07-1-BOS.GLB HA-TP07-1.GDT G:\39579\001 - PARKING LOT\GINT\39579-001_TP.GPJ Apr 10, 13

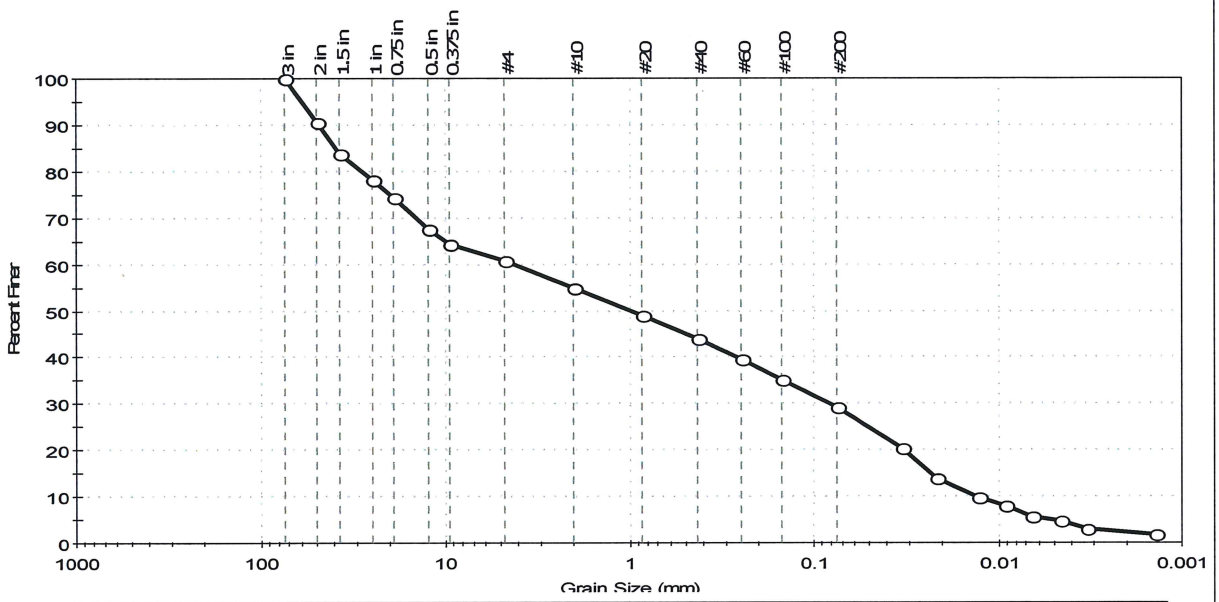
APPENDIX B

Laboratory Test Data &
Soil Textural Classifications

GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.				
Project:	Xaverian Brothers High School - Parking Lot				
Location:	Westwood, MA			Project No:	GTX-300410
Boring ID:	TP-3	Sample Type:	bag	Tested By:	jbr
Sample ID:	S01	Test Date:	04/09/13	Checked By:	jdt
Depth :	8-10 ft.	Test Id:	263228		
Test Comment:	---				
Sample Description:	Moist, yellowish brown silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	39.4	31.5	29.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	91		
1.5 in	37.50	84		
1 in	25.00	78		
0.75 in	19.00	74		
0.5 in	12.50	68		
0.375 in	9.50	64		
#4	4.75	61		
#10	2.00	55		
#20	0.85	49		
#40	0.42	44		
#60	0.25	39		
#100	0.15	35		
#200	0.075	29		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0335	20		
---	0.0216	14		
---	0.0128	10		
---	0.0091	8		
---	0.0066	5		
---	0.0046	5		
---	0.0033	3		
---	0.0014	2		

Coefficients

D_{85} = 39.2804 mm D_{30} = 0.0829 mm

D_{60} = 4.2905 mm D_{15} = 0.0232 mm

D_{50} = 0.9908 mm D_{10} = 0.0132 mm

C_u = 325.038 C_c = 0.121

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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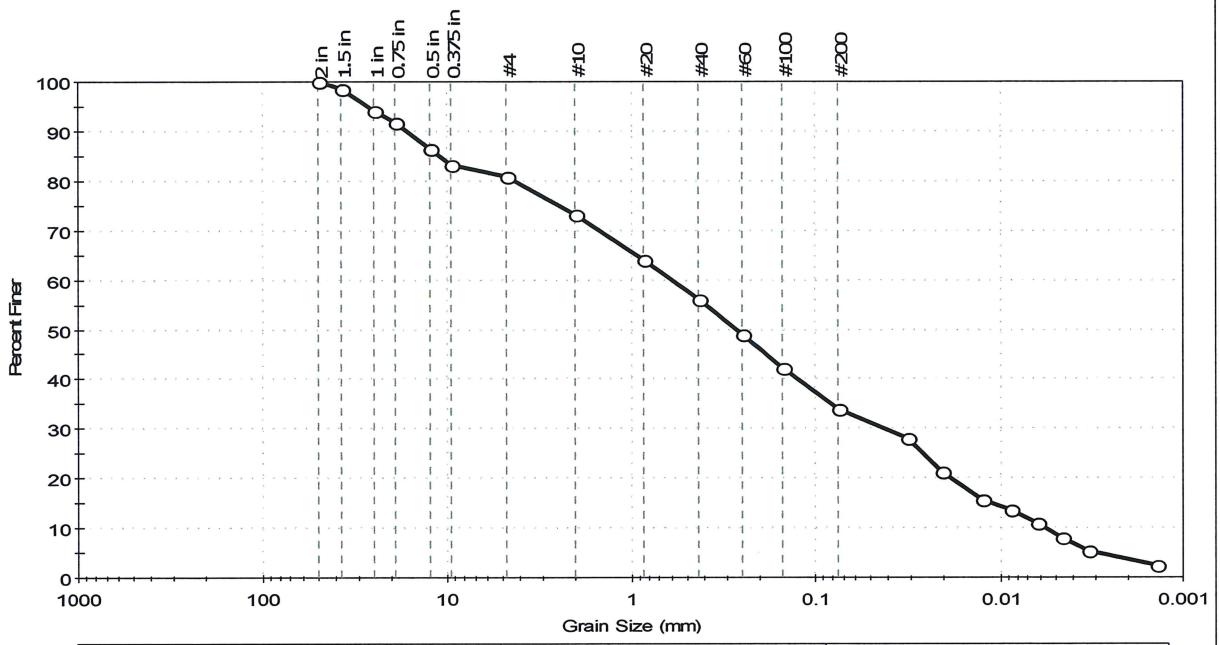
GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.				
Project:	Xaverian Brothers High School - Parking Lot				
Location:	Westwood, MA			Project No:	GTX-300410
Boring ID:	TP-6	Sample Type:	bag	Tested By:	jbr
Sample ID:	S01	Test Date:	04/09/13	Checked By:	jdt
Depth :	6-9 ft.	Test Id:	263229		
Test Comment:	---				
Sample Description:	Moist, olive brown silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	19.3	46.9	33.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	98		
1 in	25.00	94		
0.75 in	19.00	92		
0.5 in	12.50	86		
0.375 in	9.50	83		
#4	4.75	81		
#10	2.00	73		
#20	0.85	64		
#40	0.42	56		
#60	0.25	49		
#100	0.15	42		
#200	0.075	34		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0317	28		
---	0.0209	21		
---	0.0124	16		
---	0.0088	14		
---	0.0063	11		
---	0.0046	8		
---	0.0033	5		
---	0.0014	2		

Coefficients

D_{85} = 11.1293 mm D_{30} = 0.0431 mm
D_{60} = 0.5929 mm D_{15} = 0.0111 mm
D_{50} = 0.2695 mm D_{10} = 0.0057 mm
C_u = 104.018 C_c = 0.550

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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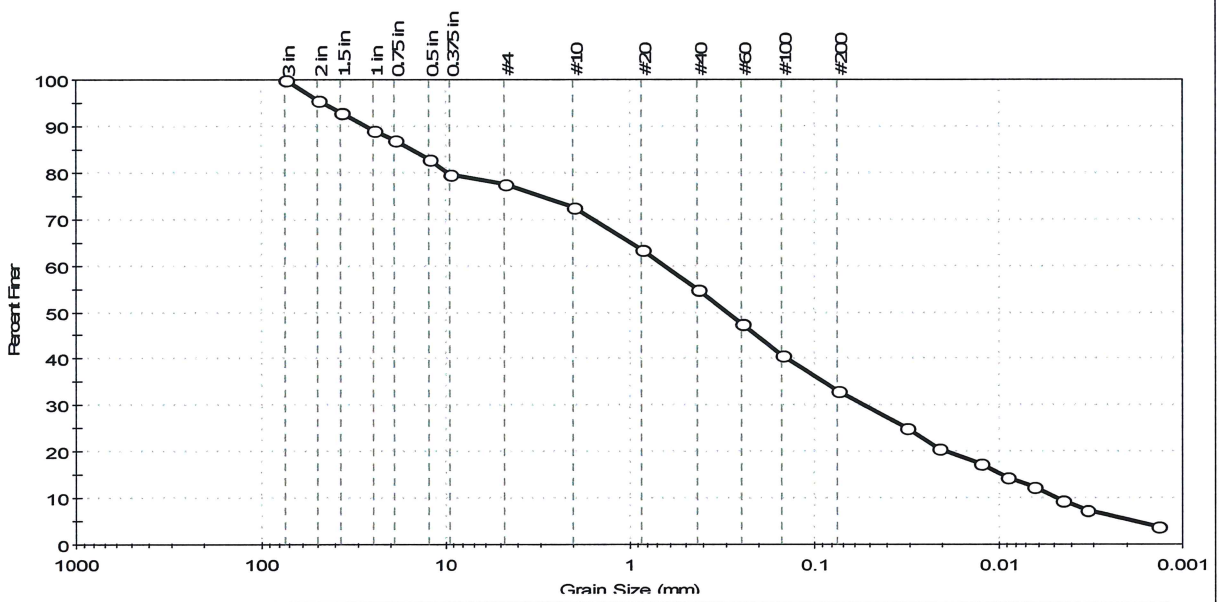
GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.				
Project:	Xaverian Brothers High School - Parking Lot				
Location:	Westwood, MA			Project No:	GTX-300410
Boring ID:	TP-9	Sample Type:	bag	Tested By:	jbr
Sample ID:	S01	Test Date:	04/09/13	Checked By:	jdt
Depth :	7-9 ft.	Test Id:	263230		
Test Comment:	---				
Sample Description:	Moist, olive brown silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	22.4	44.6	33.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	96		
1.5 in	37.50	93		
1 in	25.00	89		
0.75 in	19.00	87		
0.5 in	12.50	83		
0.375 in	9.50	80		
#4	4.75	78		
#10	2.00	73		
#20	0.85	63		
#40	0.42	55		
#60	0.25	47		
#100	0.15	41		
#200	0.075	33		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0318	25		
---	0.0214	21		
---	0.0125	17		
---	0.0090	15		
---	0.0064	12		
---	0.0045	9		
---	0.0033	7		
---	0.0014	4		

Coefficients

D_{85} = 15.3856 mm D_{30} = 0.0541 mm
D_{60} = 0.6429 mm D_{15} = 0.0095 mm
D_{50} = 0.3004 mm D_{10} = 0.0048 mm
C_u = 133.938 C_c = 0.948

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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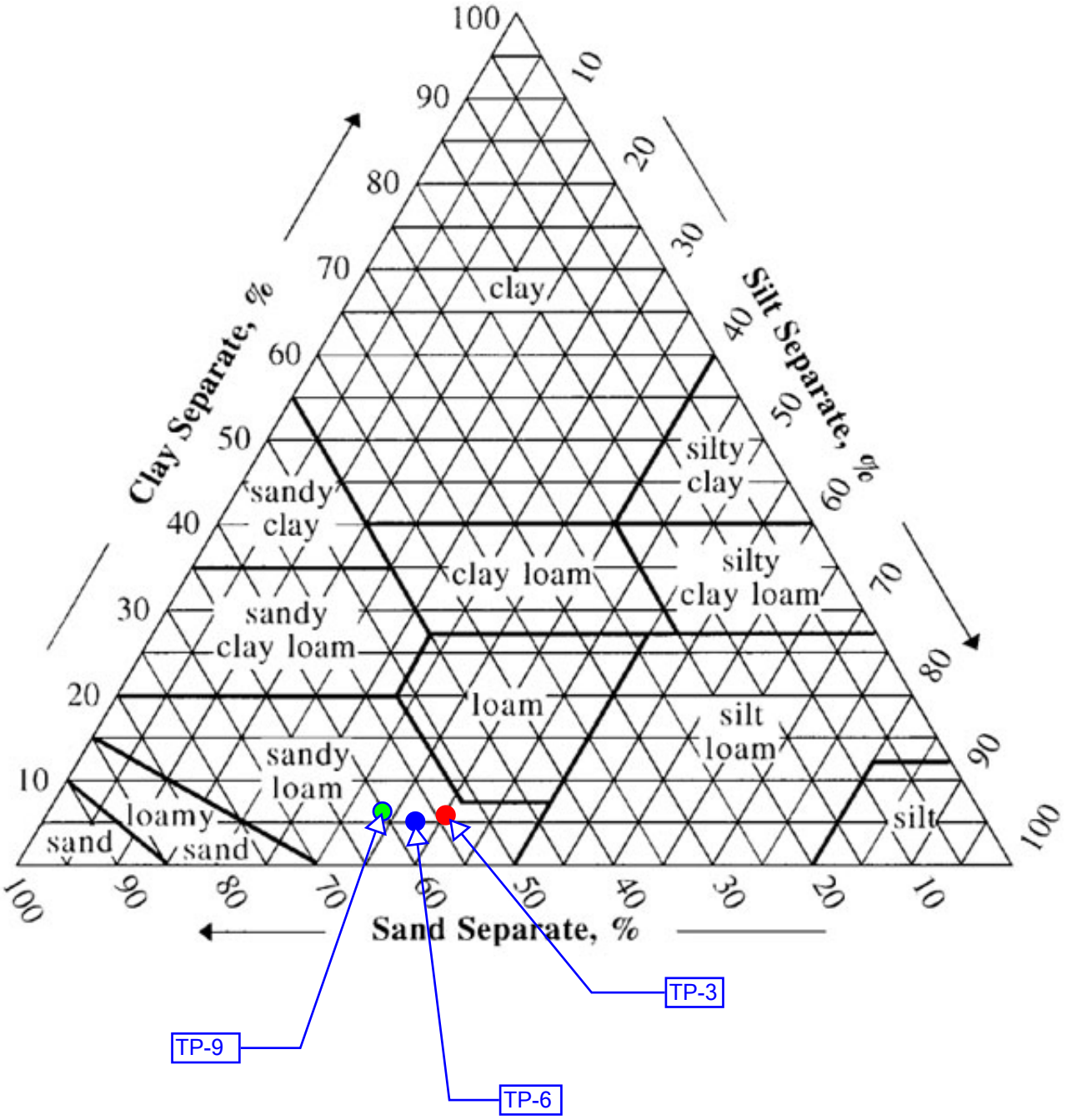


HALEY & ALDRICH

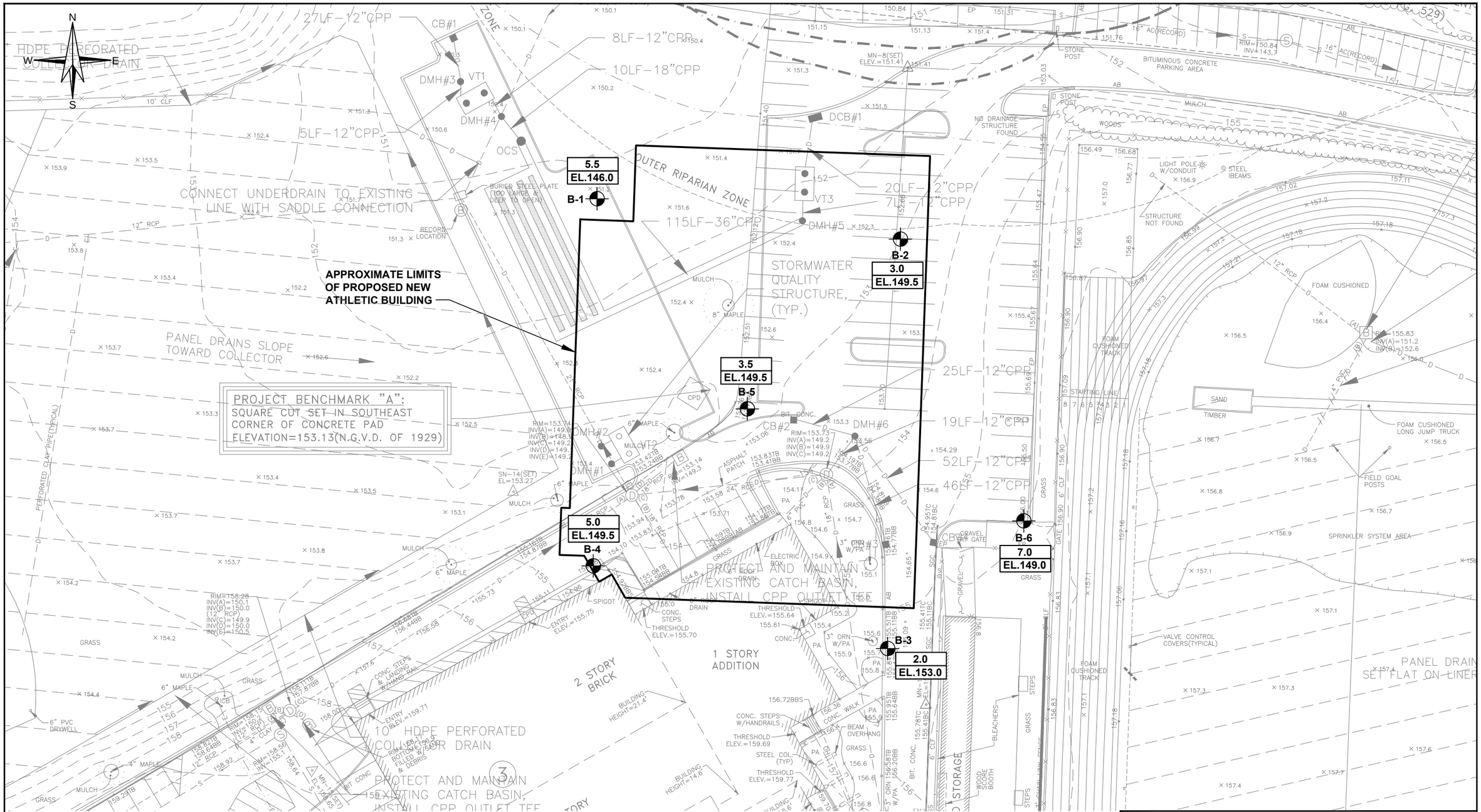
XAVERIAN BROTHERS HIGH SCHOOL
NEW PARKING LOT
800 CLAPBOARDTREE STREET
WESTWOOD, MASSACHUSETTS

USDA SOIL TEXTURAL CLASSIFICATIONS

APRIL 2013

FIGURE B-1

soils.usda.gov/technical/aids/investigations/texture/triangle.jpg



LEGEND:

B-1 — DESIGNATION AND APPROXIMATE LOCATION OF TEST BORING DRILLED BY NEW HAMPSHIRE BORING, INC. AND MONITORED BY HALEY & ALDRICH, INC. ON 3 AND 4 APRIL 2013

SUBSURFACE DATA BOX:

5.5 — APPROXIMATE DEPTH TO TOP OF GLACIAL SOILS (FT.)
EL.146.0 — APPROXIMATE ELEVATION OF TOP OF GLACIAL SOILS (FT.)

NOTES:

1. BASE PLAN TAKEN FROM ELECTRONIC FILE TITLED "XR-SURVEY.DWG" PROVIDED BY JUDITH NITSCH ENGINEERING, INC., RECEIVED 15 MARCH 2013.
2. PROPOSED FEATURES DIGITIZED FROM ELECTRONIC FILE TITLED "350-A-100-A-100.pdf" PREPARED BY BEACON ARCHITECTURAL ASSOCIATES, RECEIVED ON 2 APRIL 2013 VIA EMAIL.

0 40 80
SCALE IN FEET

HALEY & ALDRICH

XAVERIAN BROTHERS HIGH SCHOOL
NEW ATHLETIC BUILDING
800 CLAPBOARDTREE STREET
WESTWOOD, MASSACHUSETTS

SITE AND SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
APRIL 2013

FIGURE 2

J:\GRAPHICS\139579\39579-001-B004.DWG

HALEY & ALDRICH

TEST BORING REPORT

Boring No. B-6

Project XAVERIAN BROTHERS, WESTWOOD, MA
Client BEACON ARCHITECTURE ASSOCIATES
Contractor NEW HAMPSHIRE BORING, INC.

File No. 39579-002
Sheet No. 1 of 1
Start April 5, 2013
Finish April 5, 2013
Driller M. D'Ambrosio
H&A Rep. D. Warren
Elevation 156.0 (est.)
Datum NGVD
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HW	S	-	Rig Make & Model: Acker AD-11 on Truck
Inside Diameter (in.)	4	1 3/8	-	Bit Type: Roller Bit
Hammer Weight (lb)	300	140	-	Drill Mud: None
Hammer Fall (in.)	24	30	-	Casing: HW Driven 18 ft
				Hoist/Hammer: Winch Safety Hammer
				PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0					155.7	-BLACK BITUMINOUS ASPHALT-										
					0.3 155.0	-GRANULAR FILL-										
	10 100 63 49	S1 15	1.0 3.0	ML/ SP-SM	1.0	Very dense dark brown sandy SILT with gravel (ML) grading to brown poorly graded SAND with silt and gravel (SP-SM), mps 1.5 in., no structure, no odor, dry, with cobbles	5	10	5	5	45	30				
5	35 30 26 27	S2 16	4.0 6.0	SM		Very dense brown silty SAND with gravel (SM), mps 1.5 in., no structure, no odor, moist, with cobbles	10	10	5	5	50	20				
					149.0	-FILL-										
					7.0	Note: Drill action indicates stratum change at approximately 7.0 ft.										
10	25 23 32 40	S3 14	9.0 11.0	SM		Very dense brown silty SAND with gravel (SM), mps 1.5 in., no odor, moist, with cobbles, moderately bonded	10	10	5	5	50	20				
						-GLACIAL TILL-										
15	40 19 15 32	S4 16	14.0 16.0	SP-SM	141.0	S4 top: Dense brown poorly graded SAND with silt and gravel (SP-SM), mps 1.5 in., no structure, no odor, wet	10	10	5	10	55	10				
				ML	15.0	S4 bottom: Dense brown sandy SILT with gravel (ML), mps 1.5 in., no structure, no odor, wet, with cobbles, well bonded in situ	5	10	5		30	50				
						Note: Drilled through cobble/boulder from approximately 17.0 to 18.5 ft.										
						-GLACIAL TILL-										
20	96 115	S5 10	19.0 20.0	SM	136.0	Very dense brown silty SAND with gravel (SM), mps 1.5 in., no structure, no odor, wet	5	10	5		50	30				
					20.0	BOTTOM OF EXPLORATION 20.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
4/5/13			-	20 +/-	6.8*

*Not stabilized at completion.

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 20.0
Rock Cored (ft) -
Samples S5

Boring No. B-6

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 REV HA-LIB07-1-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\39579\002 - LIGHT POLES\GINT\39579-002_TB.GPJ Apr 22, 13

APPENDIX E

Stormwater Management Standards Documentation

MassDEP Checklist for Stormwater Report

Standard 4: TSS Removal Calculations

Standard 4: Proprietary Structure Sizing Calculations

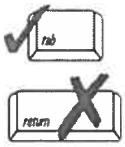
Standard 10: Illicit Discharge Compliance Statement

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.

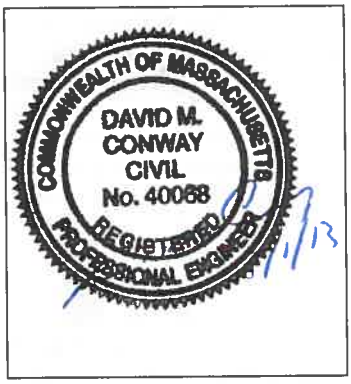
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



5/1/13
Signature and Date

Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

XAVERIAN BROTHERS HIGH SCHOOL
WATER QUALITY TREATMENT SUMMARY (04/30/2013)

Nitsch Engineering has prepared this Water Quality Treatment Summary for the proposed Xaverian Brothers High School Building Addition and Site Improvements. In compliance with MassDEP Stormwater Management Standard #4, the proposed stormwater management system is designed to remove at least 80% of the average annual post-construction load of Total Suspended Solids (TSS).

A summary of treatment trains proposed to provide water quantity control and water quality improvement at the proposed project site is provided below.

Treatment Train A

Deep Sump & Hooded Catch Basin → Vortechs Treatment System → Infiltration System → Discharge

Treatment Train A

Deep Sump & Hooded Catch Basin → Vortechs Treatment System → Infiltration System → Discharge

B BMP	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Vortechs Treatment System	**0.80**	**0.75**	**0.60**	**0.15**
Infiltration System	**0.80**	**0.15**	**0.12**	**0.03**

Total TSS Removal = **97%** **Meets 80% TSS removal requirement**

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Nitsch Job # 9556
Calc: JLY
Date: 4/30/2013

This spreadsheet should be used to convert water quality volume to an equivilent water quality peak flow rate as outlined in the new MA DEP guidelines that take effect on February 1, 2011.

Glossary

Water Quality Flow Rate = WQF
Water Quality Volume = WQV*
unit peak discharge (csm/in) = qu**
Impervious Area in watershed (square miles) = Ai ----------> Convert Acres Square Feet to Square Miles 0.000000

*WQV is expressed in watershed inches (you must use 1.0-inches in all cases with this method and not 0.5-inches)
** calculate the qu based on the time of concentration (see Sheet 2 of this spreadsheet)

Compute Water Quality Flow with the following Equation

WQF = (qu)(A)(WQV)

Input Information (in red cells only)

			Enter qu (from Sheet 2)	Enter Ai (sq/mi)	WQV		WQF		Site Plan Callout
GG	WQF 1	=	774	0.00039	1	=	0.30	cfs	VT1
	WQF 2	=	774	0.00078	1	=	0.60	cfs	VT2
	WQF 3	=	774	0.00078	1	=	0.60	cfs	VT3
	WQF 4	=	774	0.00036	1	=	0.28	cfs	VT4
	WQF 5	=	774	0.00036	1	=	0.28	cfs	VT5
	WQF 6	=	774	0.00021	1	=	0.16	cfs	VT6
	WQF 7	=	774	0.00021	1	=	0.16	cfs	VT7
	WQF 8	=			1	=	0.00	cfs	
	WQF 9	=			1	=	0.00	cfs	
	WQF 10	=			1	=	0.00	cfs	

SECTION 02721

STORMWATER TREATMENT SYSTEM

PART 1.00 GENERAL

1.1 DESCRIPTION

A. Work included:

The Contractor, and/or a manufacturer selected by the Contractor and approved by the Engineer, shall furnish all labor, materials, equipment and incidentals required and install all precast concrete stormwater treatment systems and appurtenances in accordance with the Drawings and these specifications.

1.2 QUALITY CONTROL INSPECTION

A. The quality of materials, the process of manufacture, and the finished sections shall be subject to inspection by the Engineer. Such inspection may be made at the place of manufacture, or on the work site after delivery, or at both places, and the sections shall be subject to rejection at any time if material conditions fail to meet any of the specification requirements, even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the site shall be marked for identification and shall be removed from the site at once. All sections which have been damaged beyond repair during delivery will be rejected and, if already installed, shall be repaired to the Engineer's acceptance level, if permitted, or removed and replaced, entirely at the Contractor's expense.

B. All sections shall be inspected for general appearance, dimensions, soundness, etc. The surface shall be dense, close textured and free of blisters, cracks, roughness and exposure of reinforcement.

C. Imperfections may be repaired, subject to the acceptance of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final acceptance. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi (28 MPa) at the end of 7 days and 5,000 psi (34 MPa) at the end of 28 days when tested in 3 inch (76 mm) diameter by 6 inch (152 mm) long cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs.

1.3 SUBMITTALS

A. Shop Drawings

The Contractor shall be provided with dimensional drawings and, when specified, utilize these drawings as the basis for preparation of shop drawings showing details for construction, reinforcing, joints and any cast-in-place appurtenances. Shop drawings shall be annotated to indicate all materials to be used and all applicable standards for materials, required tests of materials and design assumptions for structural analysis. Shop drawings shall be prepared at a scale of not less than 3/16-inches per foot (1:75). Six (6) hard copies of said shop drawings shall be submitted to the Engineer for review and approval.

PART 2.00 PRODUCTS

2.1 MATERIALS AND DESIGN

A. Concrete for precast stormwater treatment systems shall conform to ASTM C 857 and C 858 and meet the following additional requirements:

1. The wall thickness shall not be less than 6 inches (152 mm) or as shown on the dimensional drawings. In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20-44 (MS18) loading requirements as determined by a Licensed Professional Engineer.

2. Sections shall have tongue and groove or ship-lap joints with a butyl mastic sealant conforming to ASTM C 990.

3. Cement shall be Type II Portland cement conforming to ASTM C 150.

4. All sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or until 5 days after fabrication and/or repair, whichever is the longer.

5. Pipe openings shall be sized to accept pipes of the specified size(s) and material(s), and shall be sealed by the Contractor with a hydraulic cement conforming to ASTM C 595M

B. Internal aluminum plate components shall be aluminum alloy 5052-H32 in accordance with ASTM B 209.

C. Sealant to be utilized at the base of the swirl chamber shall be 60 durometer extruded nitrile butadiene rubber (Buna N) and shall be provided to the concrete precaster for installation.

D. Brick or masonry used to build the manhole frame to grade shall conform to ASTM C 32 or ASTM C 139 and shall be installed in conformance with all local requirements.

E. Casting for manhole frames and covers shall be in accordance with ASTM A48, CL.30B and AASHTO M105. The manhole frame and cover shall be equivalent to Campbell Foundry Pattern #1009A or #1012D custom cast with the CONTECH Stormwater Solutions logo and the words “Vortechs® Stormwater Treatment System”.

F. A bitumen sealant in conformance with ASTM C 990 shall be utilized in the sealing of the joint between the swirl chamber and the vault at the long wall tangent points. The butyl material shall be 3/4-inch thick by 3/4-inch wide.

2.2 PERFORMANCE

Each stormwater treatment system shall adhere to the following performance specifications at the design treatment capacities, as listed below:

Table 2.2

Vortechs® Model	**Design Treatment Capacity** (cfs)/(l/s)	**Sediment Storage** (yd^3)/(m^3)
1000	**0 - 1.6 (0 - 45)**	**0.7 (0.54)**
2000	**1.6 - 2.8 (45-80)**	**1.2 (0.91)**
3000	**2.8 - 4.5 (80-125)**	**1.8 (1.38)**
4000	**4.5 - 6.0 (125-175)**	**2.4 (1.84)**
5000	**6.0 - 8.5 (175-240)**	**3.2 (2.45)**
7000	**8.5 - 11.0 (240-315)**	**4.0 (3.06)**
9000	**11.0 - 14.0 (315-400)**	**4.8 (3.67)**
11000	**14.0 - 17.5 (400-495)**	**5.6 (4.28)**
16000	**17.5 - 25.0 (495-710)**	**7.1 (5.43)**

Each stormwater treatment system shall include a circular aluminum “swirl chamber” (or “grit chamber”) with a tangential inlet to induce a swirling flow pattern that will accumulate and store settleable solids in a manner and a location that will prevent re-suspension of previously captured particulates.

Each stormwater treatment system shall be of a hydraulic design that includes flow controls designed and certified by a professional engineer using accepted principles of fluid mechanics that raise the water surface inside the tank to a pre-determined level in order to prevent the re-entrainment of trapped floating contaminants.

Each stormwater treatment system shall be capable of removing **80% of the net annual Total Suspended Solids (TSS)** load based on a 50-micron particle size. Annual TSS removal efficiency models shall be based on documented removal efficiency performance from full scale laboratory tests. Annual TSS removal efficiency models shall only be considered valid if they are corroborated by independent third party field testing. Said field testing shall include influent and effluent composite samples from a minimum of ten storms at one location. Individual stormwater treatment systems shall have the Design Treatment Capacity listed in Table 2.2, and shall not re-suspend trapped sediments or re-entrain floating contaminants at flow rates up to and including the specified Design Treatment Capacity.

Individual stormwater treatment systems shall have usable sediment storage capacity of not less than the corresponding volume listed in Table 2.2. The systems shall be designed such that the pump-out volume is less than ½ of the total system volume. The systems shall be designed to not allow surcharge of the upstream piping network during dry weather conditions.

A water-lock feature shall be incorporated into the design of the stormwater treatment system to prevent the introduction of trapped oil and floatable contaminants to the downstream piping during routine maintenance and to ensure that no oil escapes the system during the ensuing rain event. Direct access shall be provided to the sediment and floatable contaminant storage chambers to facilitate maintenance. There shall be no appurtenances or restrictions within these chambers.

Stormwater treatment systems shall be completely housed within one rectangular structure.

2.3 MANUFACTURER

Each stormwater treatment system shall be of a type that has been installed and used successfully for a minimum of 5 years. The manufacturer of said system shall have been regularly engaged in the engineering design and production of systems for the physical treatment of stormwater runoff during the aforementioned period.

Each stormwater treatment system shall be a Vortechs® System as manufactured by CONTECH Stormwater Solutions Inc., 200 Enterprise Drive, Scarborough, Maine 04074, phone: 207-885-9830, fax: 207-885-9825; and as protected under U.S. Patent #5,759,415.

PART 3.00 EXECUTION

3.1 INSTALLATION

A. Each Stormwater Treatment System shall be constructed according to the sizes shown on the Drawings and as specified herein. Install at elevations and locations shown on the Drawings or as otherwise directed by the Engineer.

B. Place the precast base unit on a granular subbase of minimum thickness of six inches (152 mm) after compaction or of greater thickness and compaction if specified elsewhere. The granular subbase shall be checked for level prior to setting and the precast base section of the trap shall be checked for level at all four corners after it is set. If the slope from any corner to any other corner exceeds 0.5% the base section shall be removed and the granular subbase material re-leveled.

C. Prior to setting subsequent sections place bitumen sealant in conformance with ASTM C 990 along the construction joint in the section that is already in place.

D. After setting the base and wall or riser sections, prepare to install the swirl chamber. Place the 3/4-inch (19 mm) thick by 3/4-inch (19 mm) wide butyl mastic seal vertically on the outside of the swirl chamber starting one inch above the bottom of the swirl chamber and continuing to a height equal to the elevation of the bottom of the upper aperture of the swirl chamber. The butyl mastic seal should abut the downstream side of the pre-drilled mounting holes that attach the swirl chamber to the long walls of the concrete vault. Next, install the extruded Buna N seal on the bottom edge of the 180 degree downstream section of the swirl chamber by first applying a bead of Sikaflex-1a polyurethane elastomeric sealant into the extruded slot then slide the seal onto the swirl chamber. The extruded seal should extend 3-inches (76 mm) upstream of the mounting holes, toward the inlet end of the vault. Set the swirl chamber into position and keep the seal approximately ½-inch (13 mm) above the floor of the concrete vault. Apply a continuous bead of Sikaflex-1a sealant under the cupped bottom of the seal. Set the circular swirl chamber on the floor of the vault and anchor it by bolting the swirl chamber to the side walls of the concrete vault at the three (3) tangent points and at the inlet tab using HILTI brand stainless steel drop-in wedge anchors or equivalent 3/8-inch (10 mm) diameter by 2-3/4 inch (70 mm) minimum length at heights of approximately three inches (3”) (76 mm) off the floor and at fifteen inch (15”) (381 mm) intervals to approximately the same height of the butyl mastic sealant (at locations of pre-drilled holes in aluminum components). Apply a continuous bead of Sikaflex-1a sealant to the intersection of the inside bottom edge of the extruded seal and the vault floor.

E. If the oil baffle wall (Baffle A) and flow control wall (Baffle B) are not integrally cast-in to riser/wall sections then the Baffle wall panels shall be placed in the formed keyways or between

bolted-in-place angle flanges as provided by the manufacturer. Apply non-shrink grout or Sikaflex-1a sealant to each end of Baffle A and Baffle B at the upstream intersection with the side walls of the concrete vault.

F. Prior to setting the precast roof section, bitumen sealant equal to ASTM C 990 shall be placed along the top of the oil baffle wall (Baffle A), using more than one layer of mastic if necessary, to a thickness at least 1-inch (25 mm) greater than the nominal gap between the top of the baffle and the roof section. The nominal gap shall be determined either by field measurement or the shop drawings. Do not seal the top of Baffle B unless specified on the shop drawings to do so. After placement of the roof section has compressed the butyl mastic sealant in the gap over Baffle A, finish sealing the gap with an approved non-shrink grout on both sides of the gap using the butyl mastic as a backing material to which to apply the grout. If roof section is "clamshell" or "bathtub" halves, then finish sealing the ends of the Baffle walls by applying non-shrink grout or Sikaflex-1a sealant to each end of Baffle A at the upstream intersection with the side walls of the concrete vault and to each end of Baffle B at the downstream intersection with the side walls of the concrete vault.

G. After setting the precast roof section of the stormwater treatment system, set precast concrete manhole riser sections, to the height required to bring the cast iron manhole covers to grade, so that the sections are vertical and in true alignment with a ¼-inch (6 mm) maximum tolerance allowed. Backfill in a careful manner, bringing the fill up in 6-inch (152 mm) lifts on all sides. If leaks appear, clean the inside joints and caulk with lead wool to the satisfaction of the Engineer. Precast sections shall be set in a manner that will result in a watertight joint. In all instances, installation of Stormwater Treatment Systems shall conform to ASTM specification C 891 "Standard Practice for Installation of Underground Precast Utility Structures".

H. Holes made in the concrete sections for handling or other purposes shall be plugged with a nonshrink grout or by using grout in combination with concrete plugs.

I. Where holes must be cut in the precast sections to accommodate pipes, do all cutting before setting the sections in place to prevent any subsequent jarring which may loosen the mortar joints. The Contractor shall make all pipe connections.

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May 1, 2013

Xaverian Brothers High School
Westwood, Massachusetts

STANDARD 10: Illicit Discharge Compliance Statement

Standard 10 states: All illicit discharges to the stormwater management system are prohibited.

This is to verify:

1. Based on the information available there are no known or suspected illicit discharges to the stormwater management system at the Xaverian Brothers High School site as defined in the MassDEP Stormwater Handbook.

2. The design of the stormwater system includes no proposed illicit discharges.

David Conway, PE

5/1/13
Date