Stormwater Report

Comfort Station—Wellesley Country Club

Submitted: August 9, 2012

Applicant:

Wellesley Country Club
294 Wellesley Avenue
Wellesley, MA 02481

Submitted for:

Wetlands Protection Committee Review
525 Washington Street
Wellesley, MA 02482

Prepared by:

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A&M PROJECT #1828-02

August 9, 2012

STORMWATER MANAGEMENT REPORT

COMFORT STATION
WELLESLEY COUNTRY CLUB – WELLESLEY, MA

PROPONENT:

WELLESLEY COUNTRY CLUB
294 WELLESLEY AVENUE
WELLESLEY, MA 02481

PREPARED BY:

ALLEN & MAJOR ASSOCIATES, INC.
10 MAIN STREET
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A&M PROJECT #1828-02

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1 Drainage Report

INTRODUCTION

The purpose of this drainage report is to provide a detailed review of the stormwater runoff, both quality and quantity, as it pertains to the existing and proposed developed conditions. The report will show by means of narrative, calculations and exhibits that appropriate best management practices have been used to mitigate the impacts from the proposed redevelopment. The report will demonstrate that the proposed site development reduces the rate of runoff at the overall site runoff point during all storm events. Further, the report will show that the proposed stormwater management system complies with the ten stormwater standards as presented in the Massachusetts Department of Environmental Protection (MA DEP) Stormwater Management Regulations.

The proposed project consists of the construction of 460 square foot structure to be located in the north east corner of the Wellesley Country Club golf course and will house two bathrooms. The structure will be used as a 'comfort station' to provide on-course facilities for Club patrons. It is located adjacent to Brookside Road at an existing entrance point to the course. The entrance point provides a point of entry for emergency vehicles to respond quickly to incidents located near fairways thirteen and fourteen. A bituminous asphalt path will be constructed to provide access to the comfort station from the course. The area between the comfort station and Brookside Road will be regarded to provide for stormwater mitigation.

The development of the comfort station is very minor in nature and requires very little infrastructure. A 1" water service will be sought from Brookside Road. Sanitary services will be via an eOne package sanitary pump station. The pump station will provide grinder pumps that will lift sanitary waste and discharge it to an existing sewer manhole located at Oakland Street. The force main can be installed with minimal disturbance to the existing area. Installation can be performed using a standard 'Ditch Witch', often used for irrigation systems.

The existing comfort station is mostly developed and used for recreational purposes. This will classify the project as a mix of new development and redevelopment under the Massachusetts Stormwater standards. Any increase in impervious surfaces will be mitigated by the use of underground infiltration systems to promote recharge to groundwater. These systems will be constructed on preformed HDPE chambers in stone envelopes that will serve to temporarily store the runoff, while allowing recharge into the ground.

SITE LOCATION AND DESCRIPTION

The Country Club site is located at 300 Wellesley Avenue in Wellesley, MA. The site is bounded to the south by Wellesley Avenue, Brookside Road to the east, Forest Street to the west, and Oakland Street to the north. Residential areas abut the site on all sides with conservation lands to the east along Brookside Road. The development area for the comfort station is located along Brookside Road.

The project site falls entirely within the Business A Zone as defined by the Town of Wellesley Zoning Map as amended through June 13, 2005.

The work at the comfort station falls within buffer zones to bordering vegetated wetlands and the riparian zone to Rosemary Brook.

The slopes of the property vary widely. In long portions of the site, slopes are generally flat sloping between 2%-5%. In other areas, steep slopes act as transition areas between course elements. In

general, the property slopes from west, at a high elevation of 150'±-, to the east, at a low elevation of 80'±, towards the identified wetland areas that are tributary to Rosemary Brook.

An underlying soil report was obtained from the Natural Resources Conservation Service, formerly Soil Conservation Service, and varies across the site. The soil types include:

• *30*	Raynham silt loam	Hydrologic Soil Group (HSG) –C
• *51*	Swansea muck	Hydrologic Soil Group (HSG) –D
• *245 (B,C,D)*	Hinckley sandy loam	Hydrologic Soil Group (HSG) –A
• *253D*	Hinckley sandy loam	Hydrologic Soil Group (HSG) –A
• *254B*	Merrimac	Hydrologic Soil Group (HSG) –A
• *260B*	Sudbury fine sandy loam	Hydrologic Soil Group (HSG) –B
• *305C*	Paxton fine sandy loam	Hydrologic Soil Group (HSG) –C
• *310B*	Woodbridge fine sandy loam	Hydrologic Soil Group (HSG) –C
• *420B*	Canton fine sandy loam	Hydrologic Soil Group (HSG) –B
• *602*	Urban Land	HSG- N/A (see below)
• *626B*	Merrimac-Urban Land	Hydrologic Soil Group (HSG) –A
• *653*	Udorthents	Hydrologic Soil Group (HSG) –B

The Urban Land soil type does not have a hydrologic soil group. Following the Soil Evaluation procedure in the MA Stormwater Management Handbook, Volume 3, Chapter 1, the hydrologic capacity of the soil needs to be determined onsite. Since no area of development is proposed in this mapped area, a soil assessment was not conducted.

Allen & Major Associates, Inc. conducted test pits in December 2011 and April 2012 in the proposed area for stormwater recharge. The sampled soils were consistently loamy sand or sand capable with percolation rates less than 2 minutes per inch. This is consistent with Hydrologic Soil Group A characteristics.

A copy of the NRCS Soil Map is provided in the Appendix of this report.

EXISTING DRAINAGE PATTERNS

To demonstrate compliance with the stormwater regulations, the existing drainage patterns were analyzed at "design points". The points were chosen based on available data and the survey information provided by Andrews survey. The design point was selected based visual observation of drainage patterns. The comfort station project is of very little impact to the surrounding area and will not alter the existing drainage patterns.

For the most part, surface runoff surface sheds towards the eastern boundary of the site towards Brookside Road. Since the site is a recreational golf facility, runoff is limited and recharge levels are high. The watershed drainage area around the comfort station is approximately 1.05 acres.

1. Design Point #100: This design point is the easterly border of the site at Brookside Road. It is the collection point for this watershed area. Comprised primarily of overland flow generated by the 'green" state of the golf course. Cart paths in this area drain via country drainage. Within the area are smaller pockets of wooded tree cover and transitional slopes. Runoff flows directly to the design point with a time of concentration of 6.0 minutes (refer to HydroCad worksheets

for calculation). This watershed totals 1.05 acres with a weighted curve number of 44.

PROPOSED DRAINAGE PATTERNS

Proposed drainage patterns will be maintained in existing conditions. Where existing watersheds are altered by construction, the stormwater generated by the proposed structures will be recharged to groundwater to mitigate peak flows and volume. At the location of the comfort station, the area altered by impervious structures (cart path and building) is approximately 1,350 square feet.

The site improvements will comply with the standards to the maximum extent practicable by reducing the overall amount of runoff, provide recharge on the site, and create an operation and maintenance plan for the drainage system in accordance with the Massachusetts Department of Environmental Protection.

A hydrologic study of the site was conducted in order to determine the impact of the proposed development on the existing stormwater runoff. The study determined the rates of runoff at the design point discussed in the existing conditions analysis. Below is a discussion of the drainage areas:

1. Design Point #100:

   Consisting of the area that will be affected by the construction of the comfort station and cart paths. Stormwater flows generated by this area will flow into an underground infiltration system consisting of 2 preformed StormTech SC-740 underground chambers. Since the runoff is from building surfaces it will not require pretreatment. Within this watershed, the minimum time of concentration of 6.0 minutes was used.

   The proposed underground infiltration system is designed to control up to the 100-year storm event. In larger storm events and emergency conditions, stormwater will pond on the surface until conditions allow for drainage through the system.

   The remainder of the watershed will be graded and directed towards a water quality grassed lined swale. The swale will add approximately 125' of flow length. Within the swale, the runoff will receive treatment and allow for further recharge. At the end of the swale, a drywell surrounded by a gravel apron will be used. This is also intended to retain the stormwater and allow it to infiltrate onsite and minimize any runoff from the site that may drain towards Brookside Road. A small earthen berm will be installed at the drywell to create a pond to retain the stormwater while allowing it to recharge.

Drainage Area	Total Area (sf)	Curve Number	Time of Concentration
Design Point 100	45,874	44	6 min (assumed)

Table 1 – Proposed Drainage Areas

PEAK RATE OF RUNOFF

The storm water runoff analysis of the existing and proposed conditions includes an estimation of the peak rate of runoff from various rainfall events. Peak runoff rates were developed using TR-55 Urban Hydrology for Small Watersheds, developed by the U.S. Department of Commerce, Engineering Division and the HydroCAD 8.50 computer program. Further, the analysis has been prepared in accordance with the Town of Wellesley Zoning By-law requirements as well as standard engineering

practices. The peak rate of runoff has been estimated for each watershed during the 2, 10, 25, and 100-year storm events.

The stormwater runoff model shows that the proposed development reduces the rate of runoff for each design point analyzed. This is accomplished by providing subsurface infiltration systems for each building. The following table provides a summary of the estimated peak rate of runoff at each study point during each storm event.

Design Point #100

	2-Year	10-Year	25-Year	100-Year
Existing Runoff (CFS)	0.00	0.10	0.27	0.80
Developed Runoff (CFS)	0.00	0.00	0.00	0.00

The HydroCAD worksheets and hydrographs are included in the "HydroCAD Worksheets" Section of this report.

METHODOLOGY

The peak rate of runoff was determined using techniques and data found in the following:

1. Urban Hydrology for Small Watersheds – Technical Release 55 by the United States Department of Agriculture Soils Conservation Service, June 1986. Runoff curve numbers and 24-hour precipitation values were obtained from this reference.

2. HydroCAD© Stormwater Modeling System by HydroCAD Software Solutions LLC, version 8.50, 2007. The HydroCAD program was used to generate the runoff hydrographs for the watershed areas, to determine discharge/stage/storage characteristics for the infiltration systems, to perform drainage routing and to combine the results of the runoff hydrographs.

3. Soil Survey of Norfolk County Massachusetts, by United States Department of Agriculture, Natural Resources Conservation Service. Soil types and boundaries were obtained from this reference.

STORMWATER MANAGEMENT STANDARDS

The proposed project is designed to meet or exceed all of the Stormwater Management Standards as determined by MassDEP to the maximum extent practicable. A description of each standard and if it is met is below.

Standard #1 – No New Untreated Discharges or Erosion:
Discharge points will remain unchanged from pre-construction to post-construction. No new discharges are created. Existing discharges off the site currently drain through well-established areas with vegetation and no signs of erosion.

Standard #2 – Peak Rate Attenuation:
Calculations have been provided to show that the proposed redevelopment will not cause an increase in peak discharge rates. Refer to the HydroCAD calculations provided within this report for detailed breakdowns of each study point.

Standard #3 – Recharge to Groundwater:
In order to meet this standard the "post-development site shall approximate the annual recharge from the pre-development conditions". Under existing conditions, recharge is only attained through the large amounts of green space on the property. Under proposed conditions, recharge is provided for the impervious areas being introduced based on the table below:

Hydrologic Group Volume to Recharge (x Total Impervious Area)	
Hydrologic Group	Volume to Recharge x Total Impervious Area
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

The required recharge volume is given by the following equation:

$R_v = F \times IA$ (Equation 1 Stormwater Handbook Volume 3)

where R_v = Required Recharge Volume, ft^3
F = Target Depth factor (Hydrologic Group A)
IA = Impervious drainage area

For Watershed 100, 1,350 square feet of impervious surface will be constructed.

R_v = F x IA
= (0.60 inches)(12 inches/foot)(1,350 square feet)
=67.50 cubic feet

217.80 cubic feet of available storage is provided in the underground system.

Each infiltration system is based on the Static Method of calculation as outlined in the Stormwater Management Handbook).

The system drawdown time is defined as:

$$Time_{drawdown} = R_v / (K)(bottom\ area)$$

where R_v = Required Recharge Volume, ft3
K =Saturated Hydraulic Conductivity (Rawls table)
Bottom area =bottom area of recharge structure

For Watershed 100, with a bottom area of 6.25' x 16.24'

$=67.50\ ft^3 / (8.27in/hour)(101.50\ s.f.)(1ft/12\ in)$
=0.96 hours (<72 hours drain time = ok)

*8.27 inches per hour is based on field investigation of Loamy Sand Soil, Hydrologic Group A as defined in the Rawl's table.

A capture area adjustment is not required as all stormwater is treated through stormwater controls.

Therefore, this standard has been met.

Standard 4 – Water Quality:

The project is a redevelopment project. Stormwater water quliaty units are not proposed. The runoff directed towards the infiltration system is from the roof area of the comfort station and does not require treatment and therefore Standard 4 does not apply to this project.

Standard 5 – Land Use with Higher Potential Pollutant Loads (LUHPPLs):
The proposed project is not a Land Use with Higher Potential Pollutant Loads and therefore Standard 5 does not apply to this project.

Standard 6 – Critical Areas
The proposed project is not located in an area defined as a Critical Area and therefore Standard 6 does not apply to this project.

where R_v = Required Recharge Volume, ft^3
F = Target Depth factor (Hydrologic Group A)
IA = Impervious drainage area

For Watershed 100, 1,350 square feet of impervious surface will be constructed.

R_v = F x IA
= (0.60 inches)(12 inches/foot)(1,350 square feet)
=67.50 cubic feet

217.80 cubic feet of available storage is provided in the underground system.

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The system drawdown time is defined as:

$$Time_{drawdown} = R_v / (K)(bottom\ area)$$

where R_v = Required Recharge Volume, ft3
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The proposed project is not a Land Use with Higher Potential Pollutant Loads and therefore Standard 5 does not apply to this project.

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Standard 7 – Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

Standards are met to the maximum extent practicable as described in this section thereby meeting this Standard.

Standard 8 – Construction Period Pollution Prevention & Erosion & Sediment Control

An Erosion Control plan has been incorporated with the design plans. Also, the project requires a Stormwater Pollution Prevention Plan under the EPA NPDES program. This will be prepared prior to construction thereby meeting this standard.

Standard 9 – Operations and Maintenance Plan

Refer to the Operations and Maintenance Plan included in this report.

Standard 10 – Prohibition of Illicit Discharges

No illicit discharges exist on site. The storm water management system proposed shall not be connected to the wastewater management system and shall not be contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease per Massachusetts DEP Storm Water Standard 10. The Illicit discharge statement is included in the appendix of this report.

2 Operation & Maintenance Plan

OPERATION AND MAINTENANCE PLAN

In accordance with the standards set forth by the Stormwater Management Regulations issued by the Department of Environmental Protection (DEP), Allen & Major Associates, Inc. (A&M) has prepared the following Operation and Maintenance (O&M) plan for the proposed stormwater management system at the Wellesley Country Club site. This O&M plan addressed post construction pollution prevention and maintenance of stormwater systems. Reference is made to the Stormwater Pollution Prevention Plan (SWPPP) prepared to mitigate any potential pollution during construction.

This plan is broken into two major sections. The first section describes pollution prevention techniques to encourage source controls that prevent pollution. The second section is devoted to a post-development operation and maintenance plan of the stormwater management system. An operation and maintenance schedule has been included at the end of the report.

Basic Information

Proponent: Wellesley Country Club
Address: 300 Wellesley Avenue
City: Wellesley, MA 02481

Section 1 Pollution Prevention

As a manicured facility, the largest potential sources of pollution including fertilizers and other lawn treatment chemicals. It is anticipated that all of these materials will be stored and maintained inside specialized containers that are only access by trained club personnel. However the following pollution prevention techniques are provided in the event that there is a spill outside the facility that may enter the stormwater management system.

Good House Keeping

The following measures will be employed to control potential sources of contamination and prevent pollution at The Project property:

Deicing

To prevent increased pollutant concentrations in stormwater discharges, the amount of road salt applied will be controlled. Calibration devices for spreaders in trucks will be encouraged to contractors employed to plow the parking area. The amount of deicing materials used will be monitored with the goal of using only enough to make the roadway and parking areas safe.

Snow Storage/Disposal

Snow storage/disposal will be allowed in unused areas of the property away from storm drainage systems and wetland resource areas.

Pavement Sweeping

The Project will implement a pavement sweeping program to remove contaminants directly from paved surfaces to prevent their release into the drainage system. Pavement sweeping can be an effective initial treatment for reducing pollutant loadings in stormwater. Once removed from paved surfaces, the sweeping will be handled and disposed of in accordance with the MassDEP's Bureau of Waste Prevention's written policy regarding the reuse and disposal of street sweepings.

Fertilizer/Pesticide/Herbicide Application

Applications of treatment materials will be used throughout the site. Their application adjacent to the stormwater systems will be limited. Slow release fertilizer will be used and applied in the minimum amounts recommended by the manufacturer. Once applied, the fertilizer will be worked into the soil to limit exposure to stormwater. Storage will be in a closed structure; and the contents of any partially used bags will be transferred to a sealable, plastic bin to avoid spills.

Materials Management/Housekeeping Practices

The following product-specific practices will be followed on-site. Recommendations are provided for petroleum products, fertilizers, solvents, paints, and other hazardous substances, and concrete.

Petroleum Products – Routine maintenance of course equipment is anticipated. No chemicals, fluids or fuels from vehicles will be drained into the stormwater system. All fluids will be collected in appropriate containers and disposed of according to State regulations. Storage of diesel and unleaded fuel will be regulated by the State Fire Marshall and will be in an approved container. No petroleum-based or asphalt substances will be stored within 100 feet of a waterway.

Solvents, Paints, and other Hazardous Substances - All containers will be tightly sealed and stored indoors when not required for use. Excess materials will not be discharged to the storm sewer system, but will be properly disposed according to manufacturer's instructions or state and local regulations. Outside storage on the property will be prohibited.

Spill Prevention and Control

The Property Manager/Groundskeeper will be responsible for training of people in the proper handling and cleanup of spilled materials. No spilled hazardous materials or hazardous wastes will be allowed to come in contact with storm water discharges. If such contact occurs, the storm water discharge will be contained on site until appropriate measures in compliance with State and Federal regulations are taken to dispose of such contaminated storm water.

In order to minimize the potential for a spill of hazardous materials to come into contact with storm water, the following steps will be implemented:

1. All materials with hazardous properties (such as pesticides, petroleum products, fertilizers, detergents, construction chemicals, acids, paints, paint solvents, cleaning solvents, additives for soil stabilization, concrete curing compounds and additives, etc.) will be stored in a secure location, with their lids on, preferably under cover, when not in use.

2. The minimum practical quantity of all such materials will be kept on the site.

3. A spill control and containment kit (containing, for example, absorbent materials, acid neutralizing powder, brooms, dust pans, mops, rags, gloves, goggles, plastic and metal trash containers, etc.) will be provided at the maintenance area of the site.

4. Manufacturers recommended methods for spill cleanup will be clearly posted and site personnel will be trained regarding these procedures and the location of the information and cleanup supplies.

In the event of a spill, the following procedures should be followed:

1. All spills will be cleaned up immediately after discovery.

2. The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with the hazardous substances.

3. The Owner and Property Manager will be notified immediately.

4. Spills of toxic or hazardous materials will be reported to the appropriate federal, state, and/or local government agency, regardless of the size of the spill.

5. If the spilt material enters the drainage system, the catch basin or other structure acting as the inlet shall be cleaned via a vac truck as soon as possible and before the next rainfall event to the extent practicable.

The Property Manager will be the spill prevention and response coordinator. He will designate the individuals who will receive spill prevention and response training. These individuals will each become responsible for a particular phase of prevention and response. The names of these personnel will be posted in the material storage area and other applicable areas onsite.

Section 2 Stormwater Management System – Operation and Maintenance

1. Paved Areas – Paved areas should be swept as part of the routine site maintenance. Pavement sweeping is an excellent source control for sedimentation to the existing drainage system and should be performed on a quarterly basis (four times a year).

2. Salt for de-icing on the paved areas during the winter months shall be limited to the minimum amount practicable. Sand containing the minimum amount of calcium chloride (or approved equivalent) needed for handling may be applied as part of the routine winter maintenance activities.

3. The StormTech Infiltration System: Inspect and maintain according to the StormTech Inspection and Maintenance Manual.

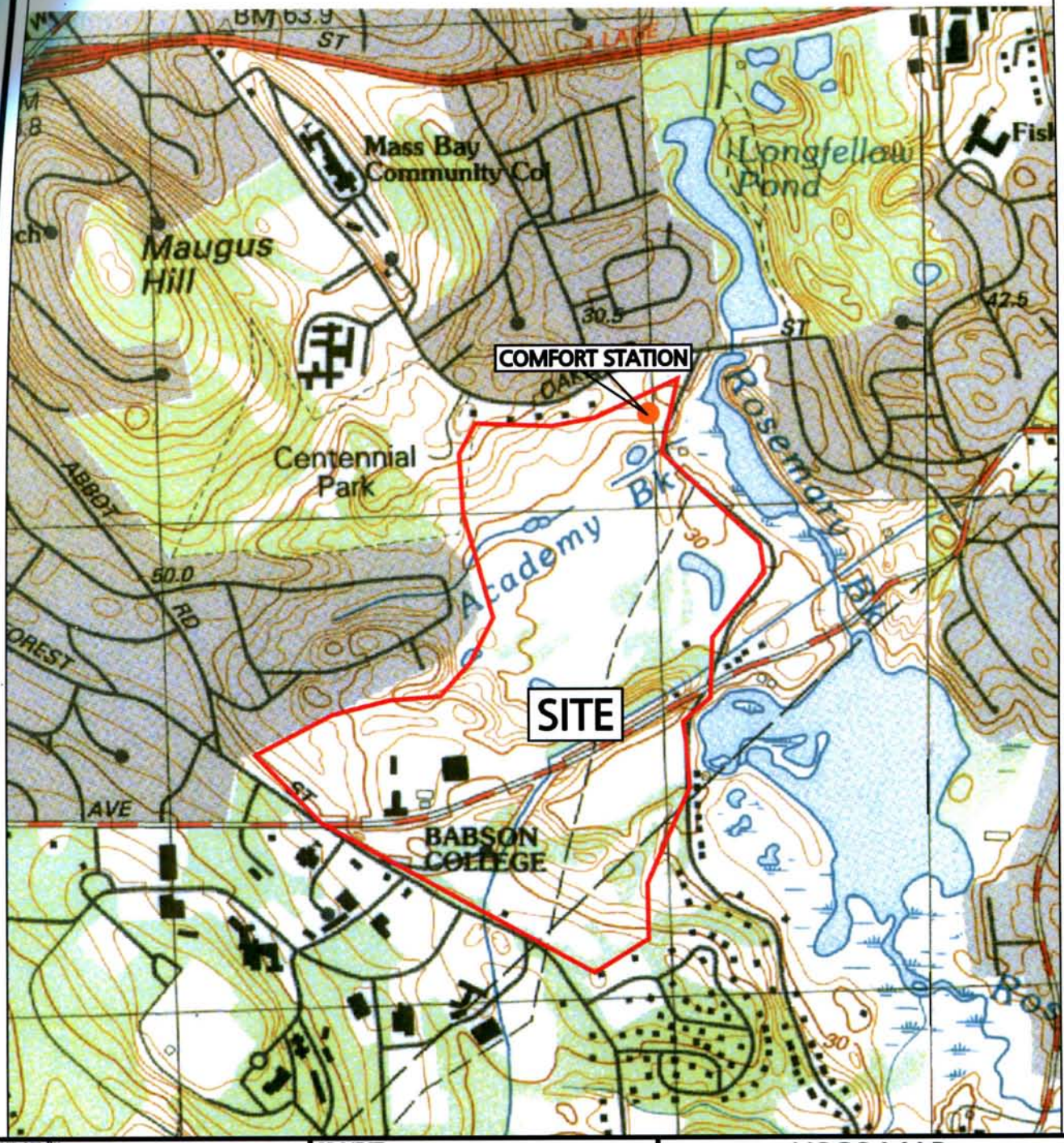
4. All sediments removed from the infiltration systems and catch basin sumps shall be disposed of properly, and in accordance with applicable local and state regulations.

5. All vegetated areas on the site shall be stabilized and maintained to control erosion. Any disturbed areas shall be re-seeded as soon as practicable. Trash and debris should be removed on a regular basis.

6. Work within any drainage structures shall performed in accordance with the latest OSHA regulations, and only by individuals with appropriate OSHA certification.

Maintenance Responsibilities - All post-construction maintenance activities shall be documented and kept on file for up to 3 years. Copies of said document shall be submitted to the Zoning Board of Appeals and the Town Engineer.

3 Exhibits



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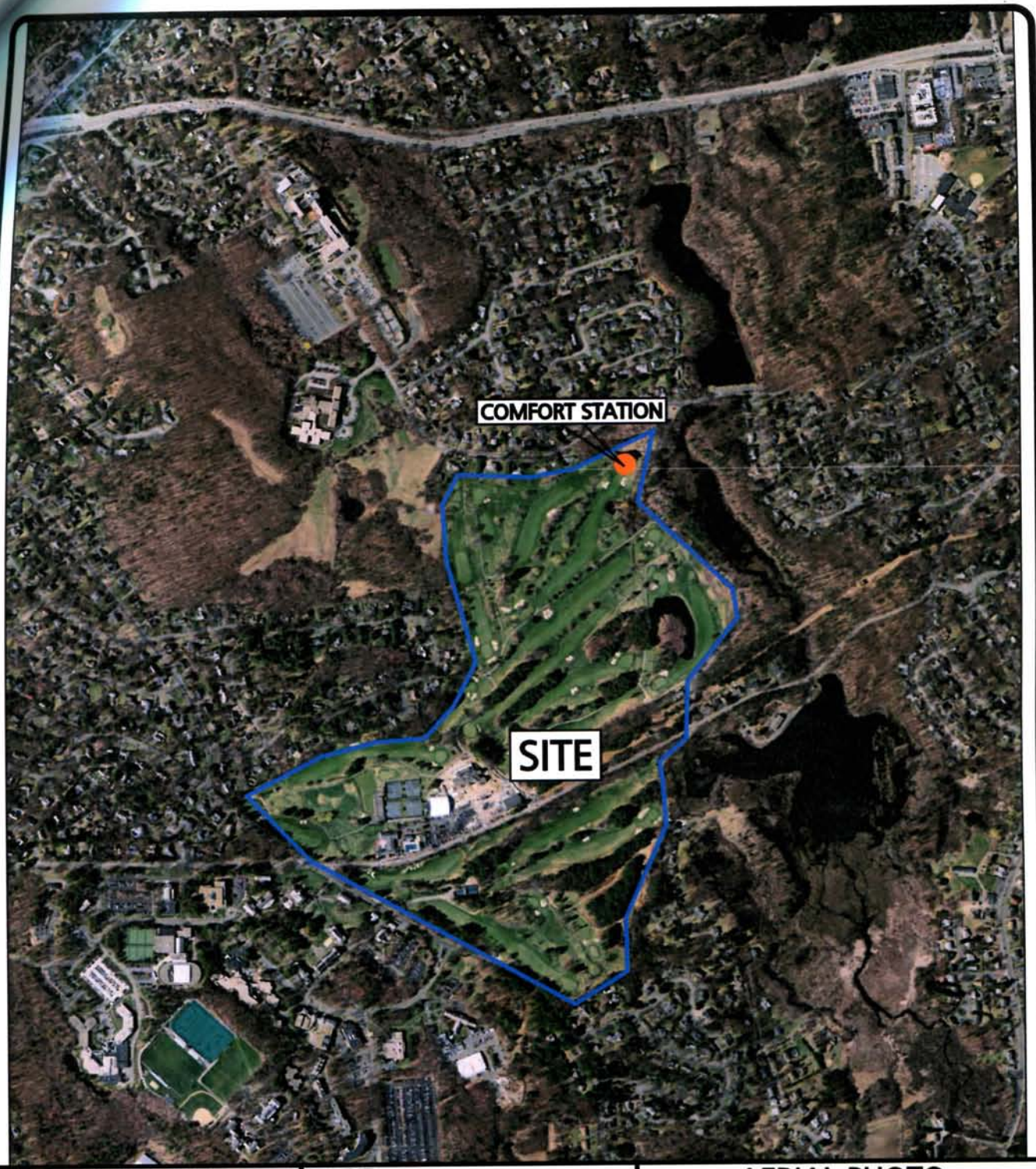
PROJECT:
WELLESLEY COUNTRY CLUB
294 WELLESLEY AVENUE
WELLESLEY, MA

USGS MAP

PROJECT NO.	1828-02	DATE:	08/09/12
SCALE:	1"=1000'	DWG. NAME:	EXHIBITS
DESIGNED BY:	PLC	CHECKED BY:	PLC

APPLICANT/OWNER: NEW ENGLAND CONSTRUCTION

SHEET No.
FIG-1



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PROJECT:

WELLESLEY COUNTRY CLUB
294 WELLESLEY AVE
WELLESLEY, MA, MA

AERIAL PHOTO

PROJECT NO.	1828-02	DATE:	08/09/12
SCALE:	1"=1000'	DWG. NAME:	EXHIBITS
DESIGNED BY:	PLC	CHECKED BY:	PLC

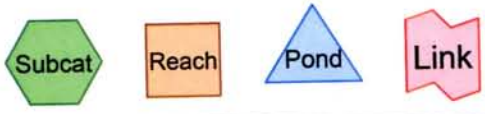
APPLICANT/OWNER: WELLESLEY COUNTRY CLUB

SHEET No.

FIG-2

4 HydroCad Worksheets

E-100 - COMFORT STATION



Drainage Diagram for Proposed Conditions
Prepared by Allen & Major Associates, Printed 8/3/2012

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.189	36	Woods, Fair, HSG A (12S)
0.714	39	>75% Grass cover, Good, HSG A (12S)
0.150	76	Gravel roads, HSG A (12S)
1.053		**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
1.053	HSG A	12S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
1.053		**TOTAL AREA**

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 12S: E-100 - COMFORT Runoff Area=45,874 sf 0.00% Impervious Runoff Depth=0.02"
Tc=6.0 min CN=44 Runoff=0.00 cfs 0.002 af

Total Runoff Area = 1.053 ac Runoff Volume = 0.002 af Average Runoff Depth = 0.02"
100.00% Pervious = 1.053 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 12S: E-100 - COMFORT STATION

Existing watershed at Equipment Service station

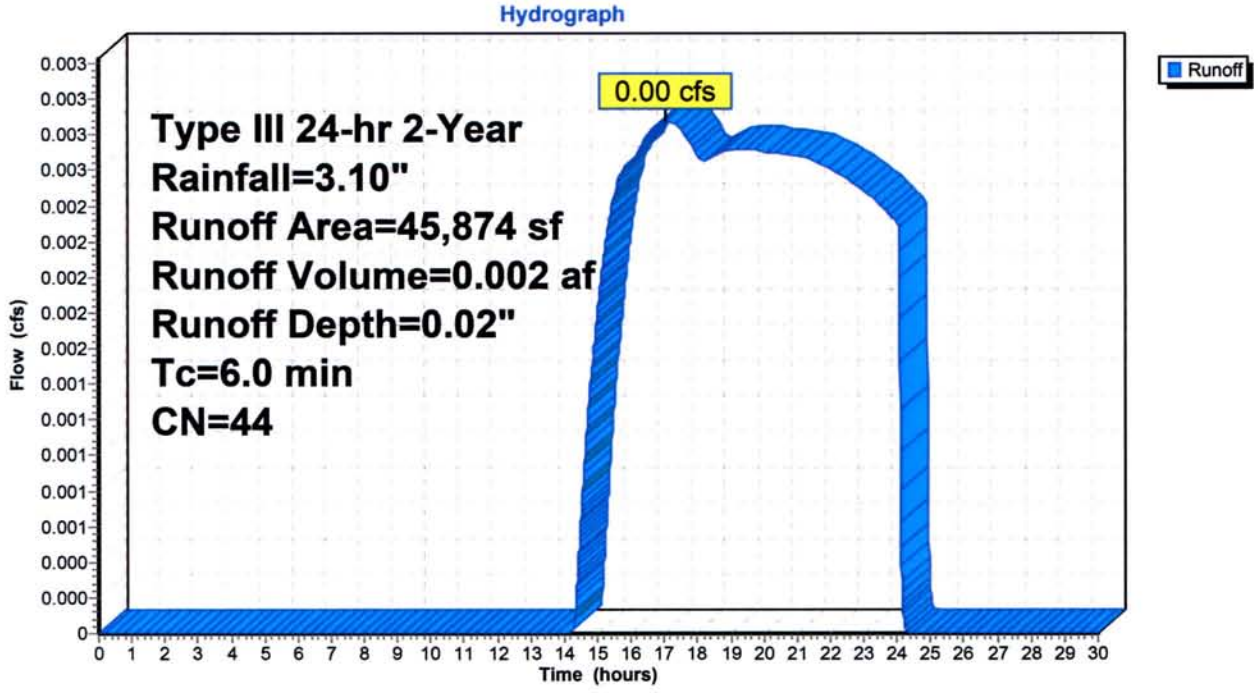
Runoff = 0.00 cfs @ 17.06 hrs, Volume= 0.002 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	31,121	39	>75% Grass cover, Good, HSG A
	8,235	36	Woods, Fair, HSG A
*	6,518	76	Gravel roads, HSG A
	45,874	44	Weighted Average
	45,874		100.00% Pervious Area

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

Subcatchment 12S: E-100 - COMFORT STATION



Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 12S: E-100 - COMFORT Runoff Area=45,874 sf 0.00% Impervious Runoff Depth=0.29"
Tc=6.0 min CN=44 Runoff=0.10 cfs 0.025 af

Total Runoff Area = 1.053 ac Runoff Volume = 0.025 af Average Runoff Depth = 0.29"
100.00% Pervious = 1.053 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 12S: E-100 - COMFORT STATION

Existing watershed at Equipment Service station

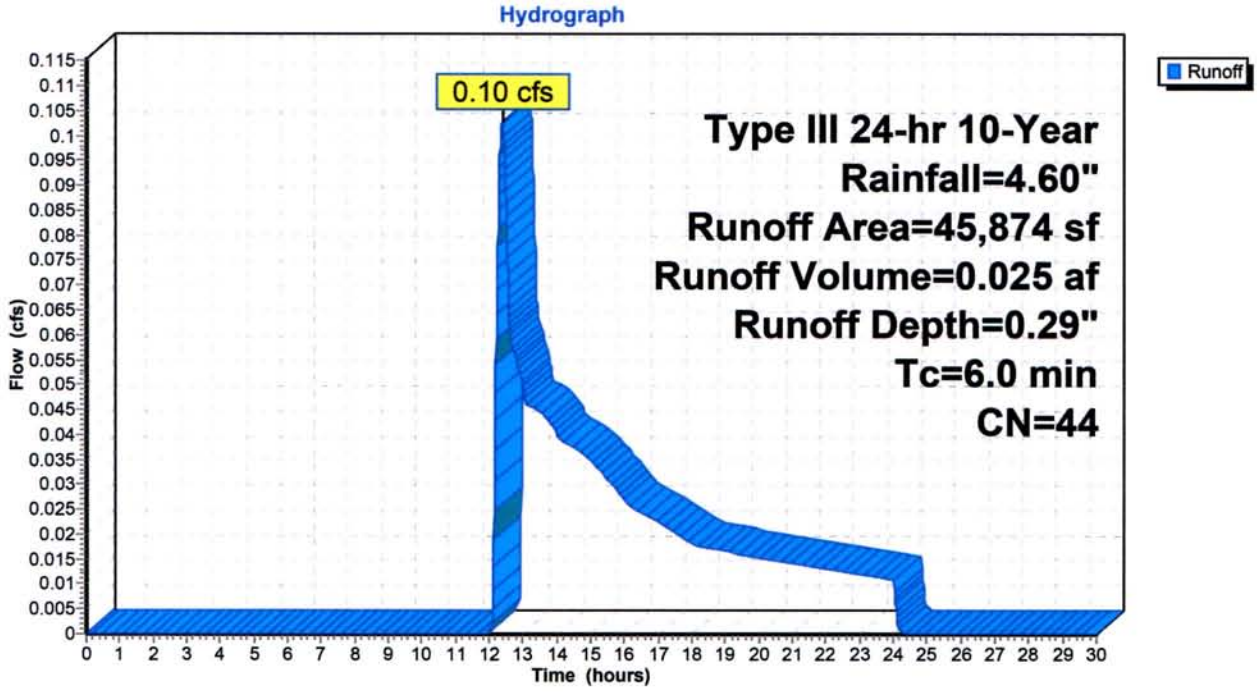
Runoff = 0.10 cfs @ 12.38 hrs, Volume= 0.025 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.60"

	Area (sf)	CN	Description
*	31,121	39	>75% Grass cover, Good, HSG A
	8,235	36	Woods, Fair, HSG A
*	6,518	76	Gravel roads, HSG A
	45,874	44	Weighted Average
	45,874		100.00% Pervious Area

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

Subcatchment 12S: E-100 - COMFORT STATION



Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 12S: E-100 - COMFORT Runoff Area=45,874 sf 0.00% Impervious Runoff Depth=0.54"
Tc=6.0 min CN=44 Runoff=0.27 cfs 0.047 af

Total Runoff Area = 1.053 ac Runoff Volume = 0.047 af Average Runoff Depth = 0.54"
100.00% Pervious = 1.053 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 12S: E-100 - COMFORT STATION

Existing watershed at Equipment Service station

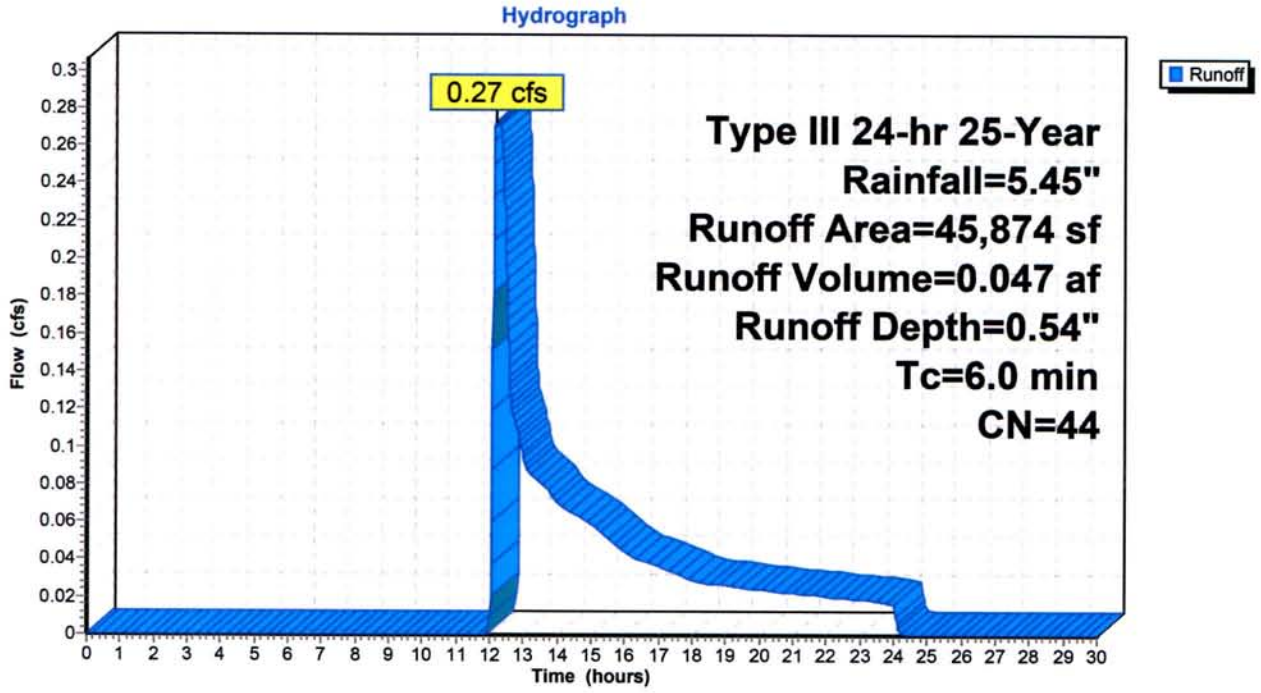
Runoff = 0.27 cfs @ 12.16 hrs, Volume= 0.047 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=5.45"

	Area (sf)	CN	Description
*	31,121	39	>75% Grass cover, Good, HSG A
	8,235	36	Woods, Fair, HSG A
*	6,518	76	Gravel roads, HSG A
	45,874	44	Weighted Average
	45,874		100.00% Pervious Area

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

Subcatchment 12S: E-100 - COMFORT STATION



Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 12S: E-100 - COMFORT Runoff Area=45,874 sf 0.00% Impervious Runoff Depth=0.98"
Tc=6.0 min CN=44 Runoff=0.80 cfs 0.086 af

Total Runoff Area = 1.053 ac Runoff Volume = 0.086 af Average Runoff Depth = 0.98"
100.00% Pervious = 1.053 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 12S: E-100 - COMFORT STATION

Existing watershed at Equipment Service station

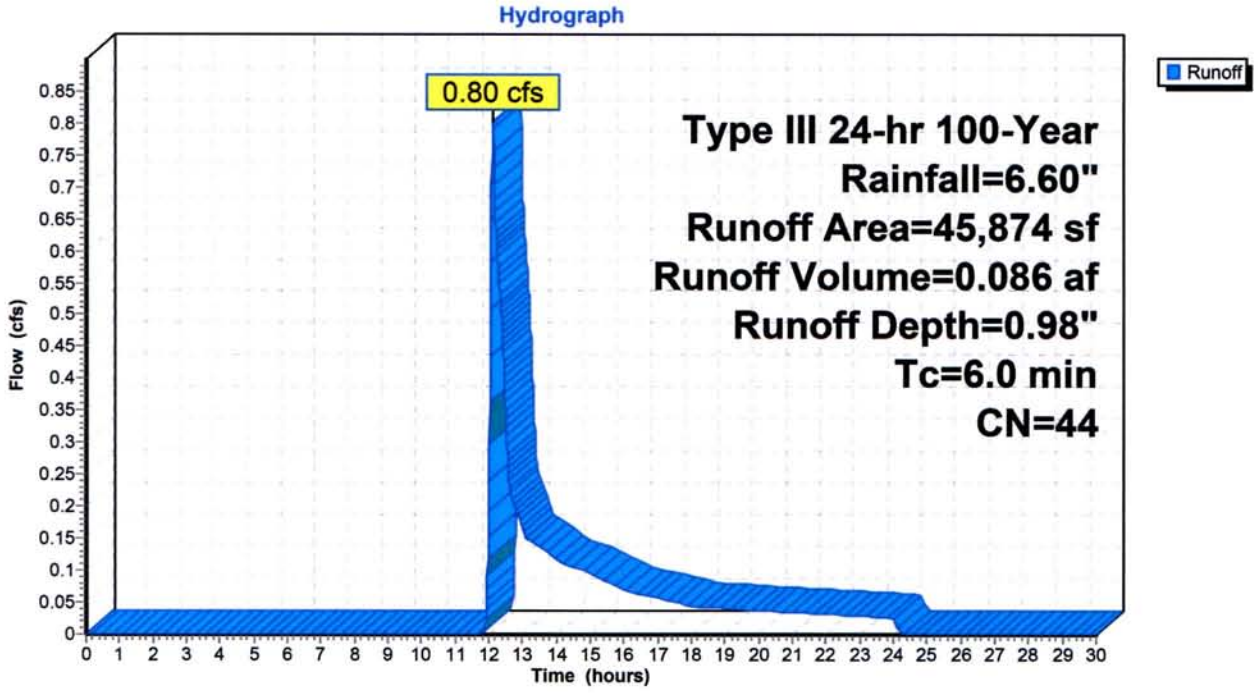
Runoff = 0.80 cfs @ 12.12 hrs, Volume= 0.086 af, Depth= 0.98"

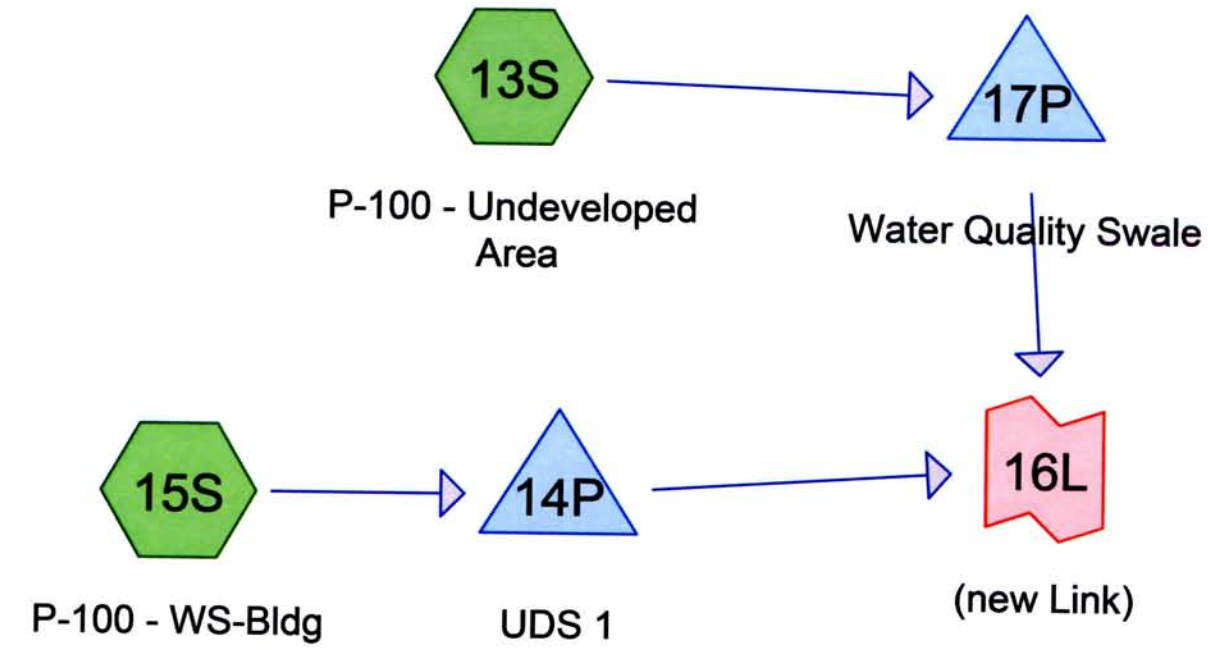
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.60"

	Area (sf)	CN	Description
*	31,121	39	>75% Grass cover, Good, HSG A
	8,235	36	Woods, Fair, HSG A
*	6,518	76	Gravel roads, HSG A
	45,874	44	Weighted Average
	45,874		100.00% Pervious Area

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

Subcatchment 12S: E-100 - COMFORT STATION





Subcat Reach Pond Link

Drainage Diagram for Proposed Conditions
Prepared by Allen & Major Associates, Printed 8/3/2012

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.189	36	Woods, Fair, HSG A (13S)
0.706	39	>75% Grass cover, Good, HSG A (13S)
0.127	76	Gravel roads, HSG A (13S)
0.031	98	Buildings and Roadway (15S)
1.053		**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
1.022	HSG A	13S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.031	Other	15S
1.053		**TOTAL AREA**

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Fill (inches)
1	17P	84.00	83.90	10.0	0.0100	0.009	0.1	0.0	0.0

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 13S: P-100 - Undeveloped Runoff Area=44,524 sf 0.00% Impervious Runoff Depth=0.01"
Tc=6.0 min CN=43 Runoff=0.00 cfs 0.001 af

Subcatchment 15S: P-100 - WS-Bldg Runoff Area=1,350 sf 100.00% Impervious Runoff Depth=2.87"
Tc=6.0 min CN=98 Runoff=0.09 cfs 0.007 af

Pond 14P: UDS 1 Peak Elev=86.90' Storage=0.001 af Inflow=0.09 cfs 0.007 af
Outflow=0.03 cfs 0.007 af

Pond 17P: Water Quality Swale Peak Elev=85.00' Storage=0.000 af Inflow=0.00 cfs 0.001 af
Discarded=0.00 cfs 0.001 af Primary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.001 af

Link 16L: (new Link) Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 1.053 ac Runoff Volume = 0.009 af Average Runoff Depth = 0.10"
97.06% Pervious = 1.022 ac 2.94% Impervious = 0.031 ac

Summary for Subcatchment 13S: P-100 - Undeveloped Area

Existing watershed at Equipment Service station

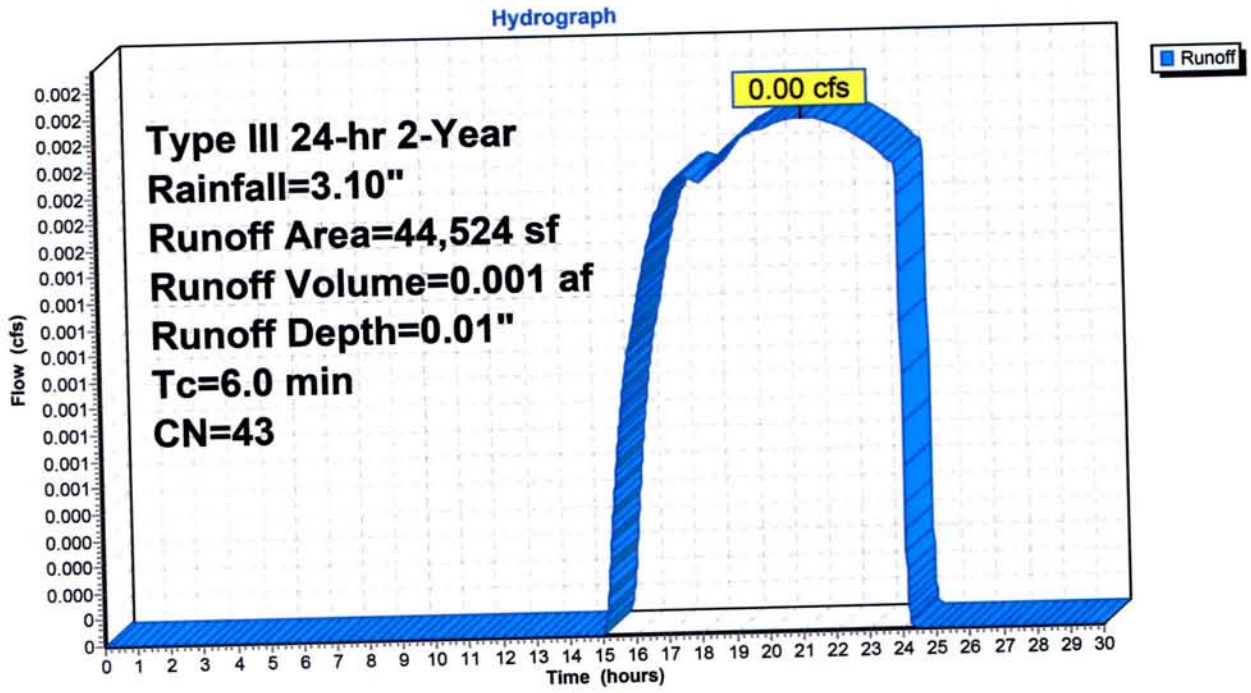
Runoff = 0.00 cfs @ 21.26 hrs, Volume= 0.001 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	30,771	39	>75% Grass cover, Good, HSG A
	8,235	36	Woods, Fair, HSG A
*	5,518	76	Gravel roads, HSG A
	44,524	43	Weighted Average
	44,524		100.00% Pervious Area

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

Subcatchment 13S: P-100 - Undeveloped Area



Summary for Subcatchment 15S: P-100 - WS-Bldg

Existing watershed at Equipment Service station

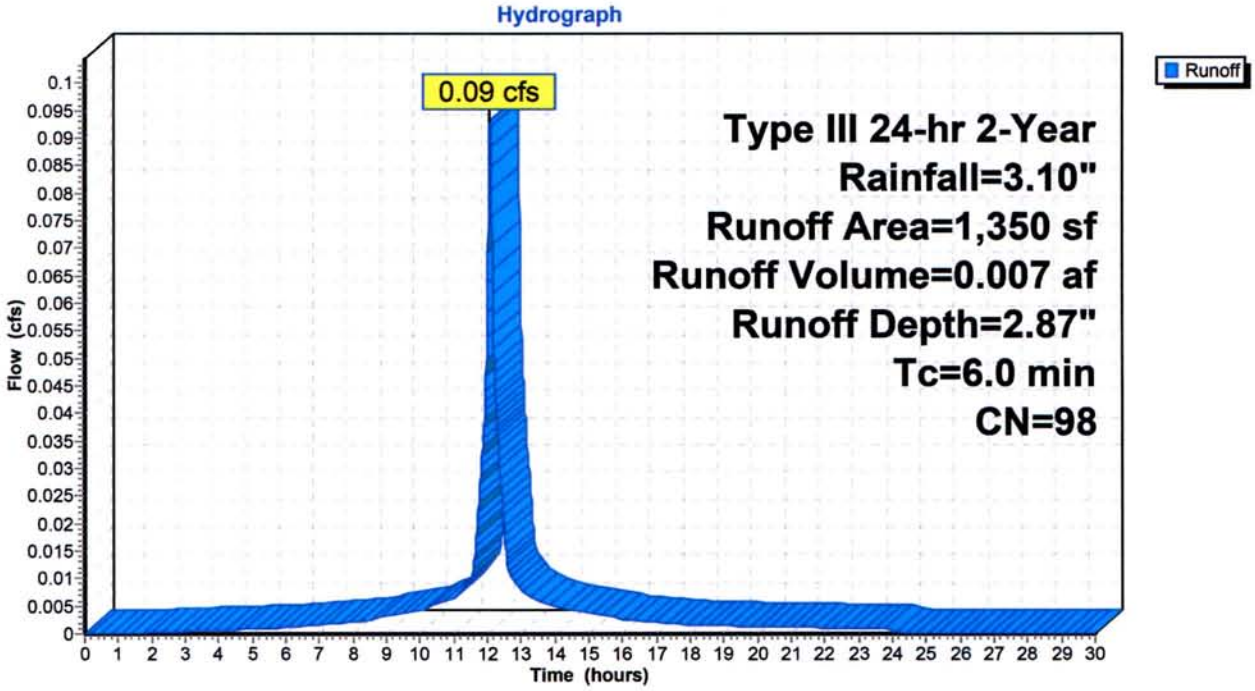
Runoff = 0.09 cfs @ 12.08 hrs, Volume= 0.007 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	1,350	98	Buildings and Roadway
	1,350		100.00% Impervious Area

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

Subcatchment 15S: P-100 - WS-Bldg



Summary for Pond 14P: UDS 1

Inflow Area = 0.031 ac,100.00% Impervious, Inflow Depth = 2.87" for 2-Year event
Inflow = 0.09 cfs @ 12.08 hrs, Volume= 0.007 af
Outflow = 0.03 cfs @ 12.35 hrs, Volume= 0.007 af, Atten= 65%, Lag= 15.8 min
Discarded = 0.03 cfs @ 12.35 hrs, Volume= 0.007 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 86.90' @ 12.35 hrs Surf.Area= 0.002 ac Storage= 0.001 af

Plug-Flow detention time= 8.8 min calculated for 0.007 af (100% of inflow)
Center-of-Mass det. time= 8.8 min (765.8 - 757.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	85.94'	0.002 af	**6.25'W x 16.24'L x 3.50'H Field A** 0.008 af Overall - 0.002 af Embedded = 0.006 af x 40.0% Voids
#2A	86.44'	0.002 af	**StormTech SC-740** x 2 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
		0.005 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.94'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 84.50'

Discarded OutFlow Max=0.03 cfs @ 12.35 hrs HW=86.90' (Free Discharge)
1=Exfiltration (Controls 0.03 cfs)

Pond 14P: UDS 1 - Chamber Wizard Field A

Chamber Model = StormTech SC-740
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

51.0" Wide + 6.0" Spacing = 57.0" C-C

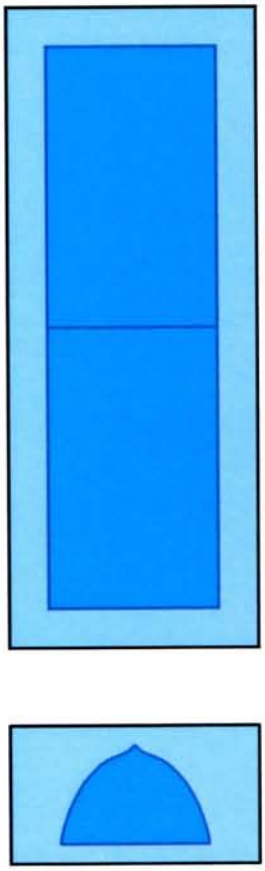
2 Chambers/Row x 7.12' Long = 14.24' + 12.0" End Stone x 2 = 16.24' Base Length
1 Rows x 51.0" Wide + 12.0" Side Stone x 2 = 6.25' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

2 Chambers x 45.9 cf = 91.9 cf Chamber Storage

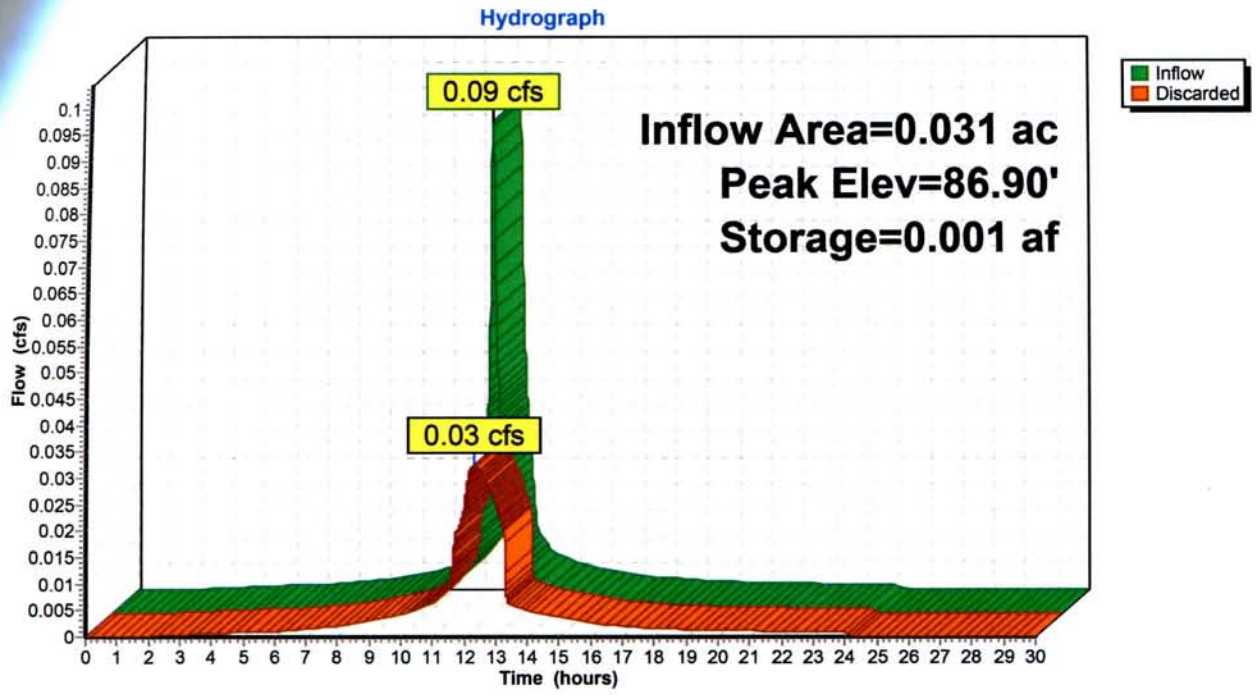
355.2 cf Field - 91.9 cf Chambers = 263.4 cf Stone x 40.0% Voids = 105.3 cf Stone Storage

Stone + Chamber Storage = 197.2 cf = 0.005 af

2 Chambers
13.2 cy Field
9.8 cy Stone



Pond 14P: UDS 1



Summary for Pond 17P: Water Quality Swale

Inflow Area =	1.022 ac,	0.00% Impervious,	Inflow Depth =	0.01"	for 2-Year event
Inflow =	0.00 cfs @	21.26 hrs,	Volume=	0.001 af	
Outflow =	0.00 cfs @	21.27 hrs,	Volume=	0.001 af,	Atten= 0%, Lag= 0.5 min
Discarded =	0.00 cfs @	21.27 hrs,	Volume=	0.001 af	
Primary =	0.00 cfs @	21.27 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 85.00' @ 21.27 hrs Surf.Area= 0.000 ac Storage= 0.000 af

Plug-Flow detention time= 0.9 min calculated for 0.001 af (100% of inflow)
Center-of-Mass det. time= 0.9 min (1,202.1 - 1,201.2)

Volume	Invert	Avail.Storage	Storage Description
#1	85.00'	1,078.500 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

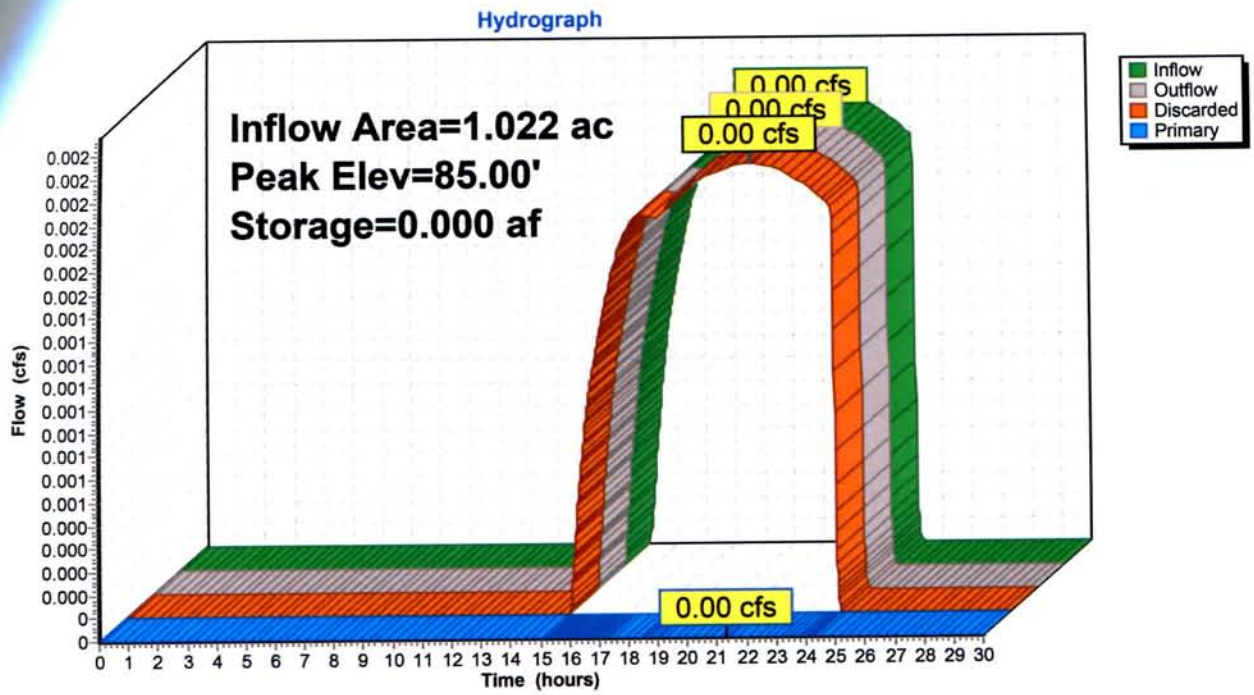
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
85.00	0.000	0.000	0.000
86.00	298.000	149.000	149.000
87.00	1,561.000	929.500	1,078.500

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.00'	**8.270 in/hr Exfiltration over Surface area**
#2	Primary	84.00'	**0.1" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 84.00' / 83.90' S= 0.0100 '/' Cc= 0.900 n= 0.009 PVC, smooth interior

Discarded OutFlow Max=0.00 cfs @ 21.27 hrs HW=85.00' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 21.27 hrs HW=85.00' (Free Discharge)
↑**2=Culvert** (Barrel Controls 0.00 cfs @ 0.88 fps)

Pond 17P: Water Quality Swale

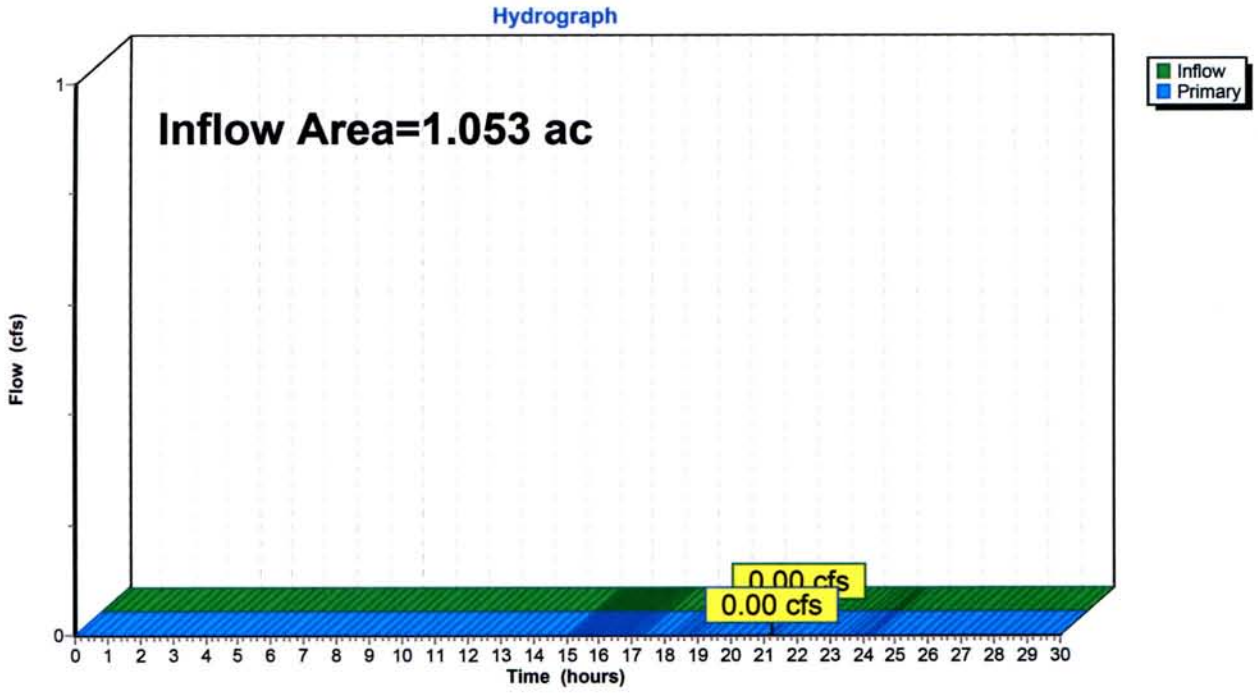


Summary for Link 16L: (new Link)

Inflow Area =	1.053 ac,	2.94% Impervious,	Inflow Depth =	0.00"	for 2-Year event
Inflow =	0.00 cfs @	21.27 hrs,	Volume=	0.000 af	
Primary =	0.00 cfs @	21.27 hrs,	Volume=	0.000 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link 16L: (new Link)



Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 13S: P-100 - Undeveloped Runoff Area=44,524 sf 0.00% Impervious Runoff Depth=0.25"
Tc=6.0 min CN=43 Runoff=0.08 cfs 0.021 af

Subcatchment 15S: P-100 - WS-Bldg Runoff Area=1,350 sf 100.00% Impervious Runoff Depth=4.36"
Tc=6.0 min CN=98 Runoff=0.14 cfs 0.011 af

Pond 14P: UDS 1 Peak Elev=87.58' Storage=0.002 af Inflow=0.14 cfs 0.011 af
Outflow=0.04 cfs 0.011 af

Pond 17P: Water Quality Swale Peak Elev=85.00' Storage=0.000 af Inflow=0.08 cfs 0.021 af
Discarded=0.08 cfs 0.021 af Primary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.021 af

Link 16L: (new Link) Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 1.053 ac Runoff Volume = 0.033 af Average Runoff Depth = 0.37"
97.06% Pervious = 1.022 ac 2.94% Impervious = 0.031 ac

Summary for Subcatchment 13S: P-100 - Undeveloped Area

Existing watershed at Equipment Service station

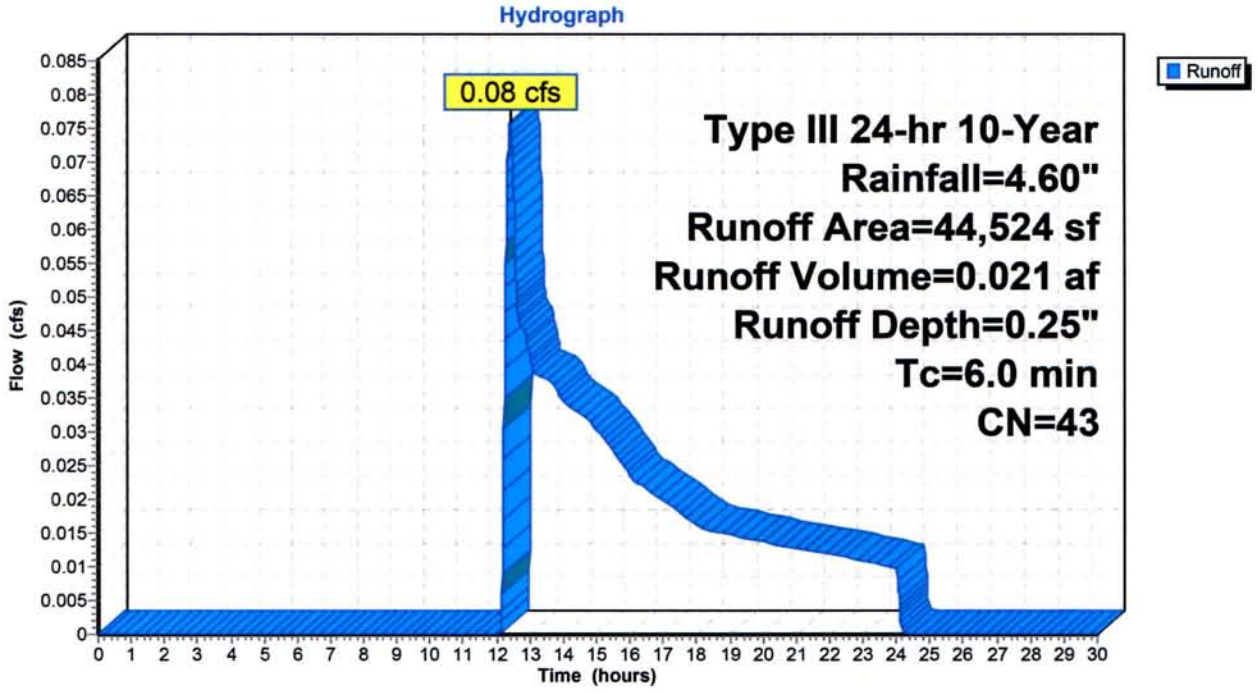
Runoff = 0.08 cfs @ 12.41 hrs, Volume= 0.021 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.60"

	Area (sf)	CN	Description
*	30,771	39	>75% Grass cover, Good, HSG A
	8,235	36	Woods, Fair, HSG A
*	5,518	76	Gravel roads, HSG A
	44,524	43	Weighted Average
	44,524		100.00% Pervious Area

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

Subcatchment 13S: P-100 - Undeveloped Area



Summary for Subcatchment 15S: P-100 - WS-Bldg

Existing watershed at Equipment Service station

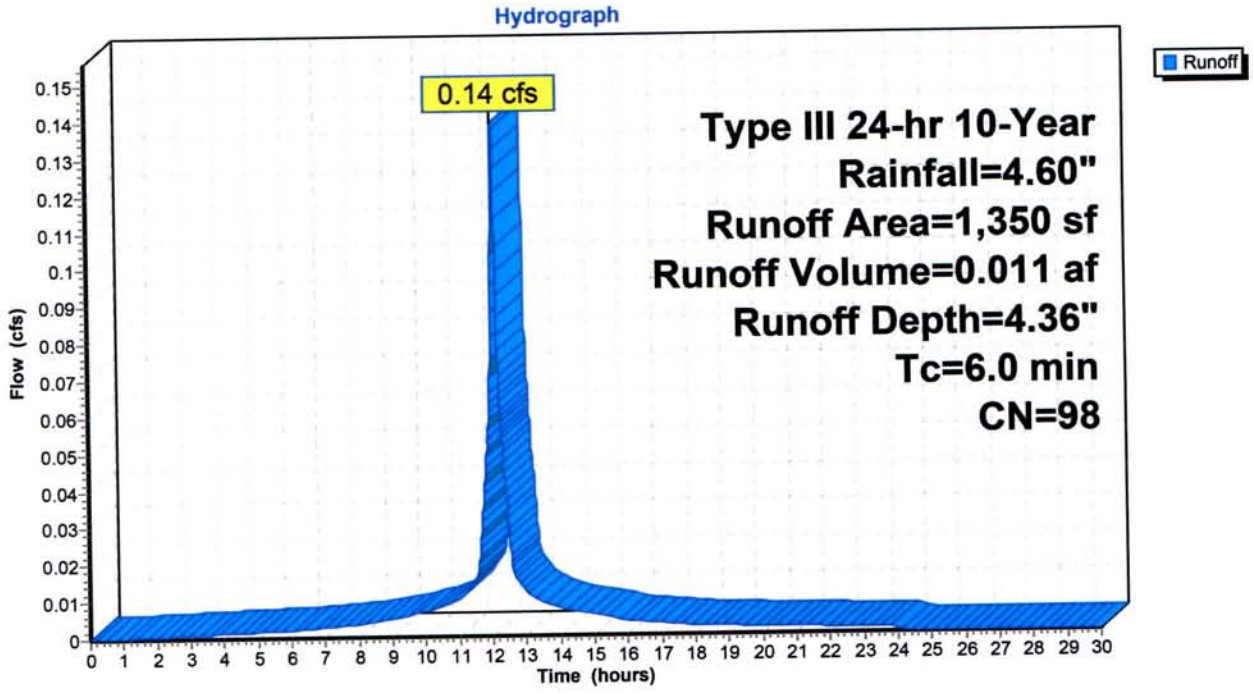
Runoff = 0.14 cfs @ 12.08 hrs, Volume= 0.011 af, Depth= 4.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.60"

	Area (sf)	CN	Description
*	1,350	98	Buildings and Roadway
	1,350		100.00% Impervious Area

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

Subcatchment 15S: P-100 - WS-Bldg



Summary for Pond 14P: UDS 1

Inflow Area = 0.031 ac,100.00% Impervious, Inflow Depth = 4.36" for 10-Year event
Inflow = 0.14 cfs @ 12.08 hrs, Volume= 0.011 af
Outflow = 0.04 cfs @ 12.40 hrs, Volume= 0.011 af, Atten= 70%, Lag= 18.9 min
Discarded = 0.04 cfs @ 12.40 hrs, Volume= 0.011 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 87.58' @ 12.40 hrs Surf.Area= 0.002 ac Storage= 0.002 af

Plug-Flow detention time= 14.2 min calculated for 0.011 af (100% of inflow)
Center-of-Mass det. time= 14.2 min (763.6 - 749.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	85.94'	0.002 af	**6.25'W x 16.24'L x 3.50'H Field A** 0.008 af Overall - 0.002 af Embedded = 0.006 af x 40.0% Voids
#2A	86.44'	0.002 af	**StormTech SC-740** x 2 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
		0.005 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.94'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 84.50'

Discarded OutFlow Max=0.04 cfs @ 12.40 hrs HW=87.58' (Free Discharge)
↑**1=Exfiltration** (Controls 0.04 cfs)

Pond 14P: UDS 1 - Chamber Wizard Field A

Chamber Model = StormTech SC-740
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

51.0" Wide + 6.0" Spacing = 57.0" C-C

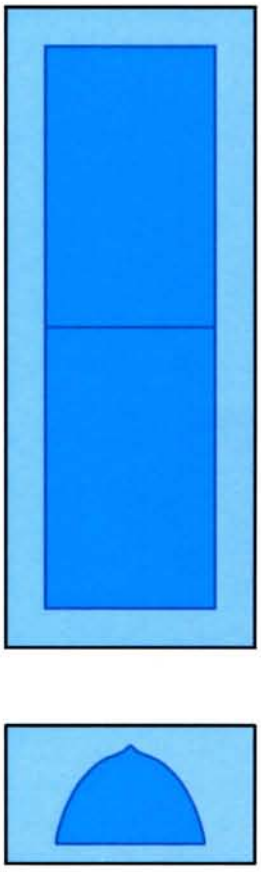
2 Chambers/Row x 7.12' Long = 14.24' + 12.0" End Stone x 2 = 16.24' Base Length
1 Rows x 51.0" Wide + 12.0" Side Stone x 2 = 6.25' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

2 Chambers x 45.9 cf = 91.9 cf Chamber Storage

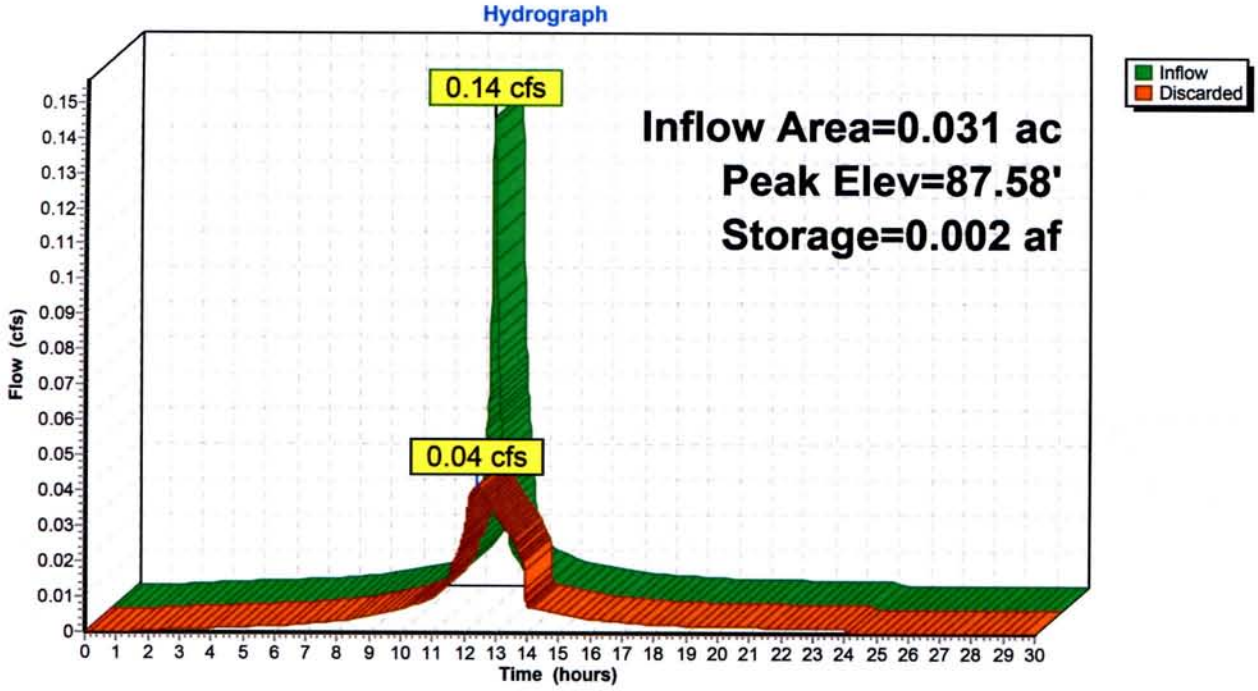
355.2 cf Field - 91.9 cf Chambers = 263.4 cf Stone x 40.0% Voids = 105.3 cf Stone Storage

Stone + Chamber Storage = 197.2 cf = 0.005 af

2 Chambers
13.2 cy Field
9.8 cy Stone



Pond 14P: UDS 1



Summary for Pond 17P: Water Quality Swale

Inflow Area =	1.022 ac,	0.00% Impervious,	Inflow Depth =	0.25"	for 10-Year event
Inflow =	0.08 cfs @	12.41 hrs,	Volume=	0.021 af	
Outflow =	0.08 cfs @	12.42 hrs,	Volume=	0.021 af,	Atten= 0%, Lag= 0.9 min
Discarded =	0.08 cfs @	12.42 hrs,	Volume=	0.021 af	
Primary =	0.00 cfs @	12.42 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 85.00' @ 12.42 hrs Surf.Area= 0.009 ac Storage= 0.000 af

Plug-Flow detention time= 0.9 min calculated for 0.021 af (100% of inflow)
Center-of-Mass det. time= 0.9 min (985.4 - 984.5)

Volume	Invert	Avail.Storage	Storage Description
#1	85.00'	1,078.500 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

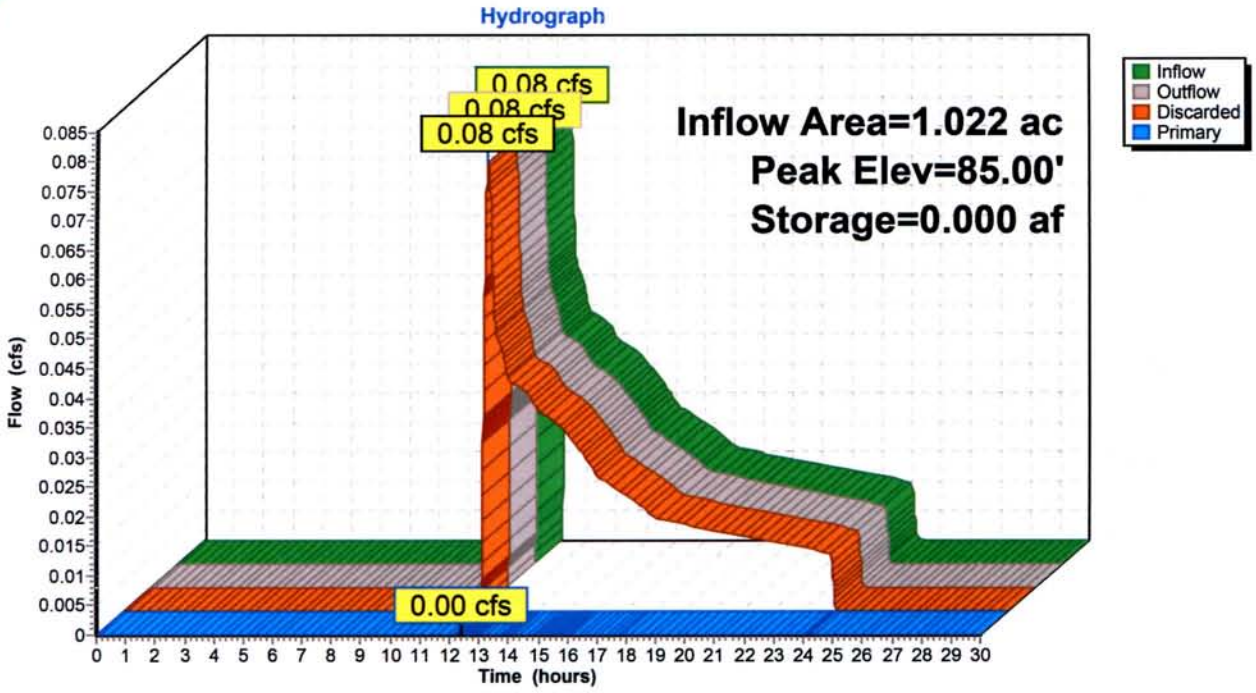
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
85.00	0.000	0.000	0.000
86.00	298.000	149.000	149.000
87.00	1,561.000	929.500	1,078.500

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.00'	**8.270 in/hr Exfiltration over Surface area**
#2	Primary	84.00'	**0.1" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 84.00' / 83.90' S= 0.0100 '/' Cc= 0.900 n= 0.009 PVC, smooth interior

Discarded OutFlow Max=0.08 cfs @ 12.42 hrs HW=85.00' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 12.42 hrs HW=85.00' (Free Discharge)
↑**2=Culvert** (Barrel Controls 0.00 cfs @ 0.88 fps)

Pond 17P: Water Quality Swale

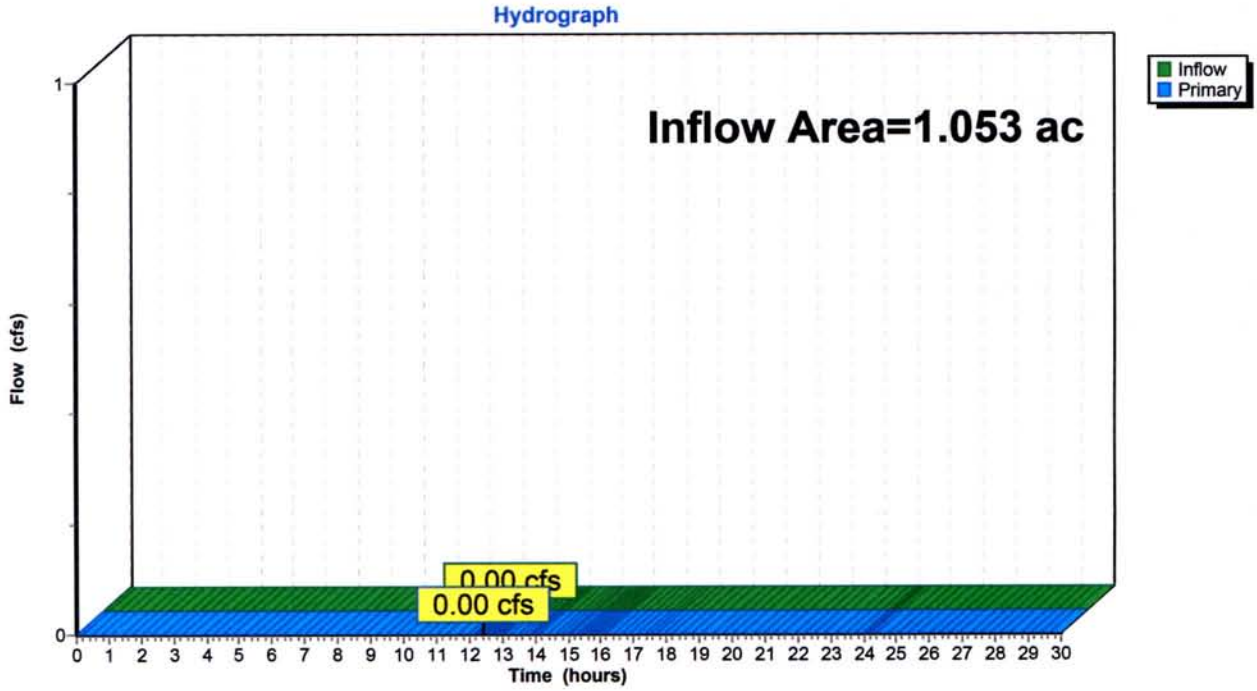


Summary for Link 16L: (new Link)

Inflow Area =	1.053 ac,	2.94% Impervious,	Inflow Depth =	0.00"	for 10-Year event
Inflow =	0.00 cfs @	12.42 hrs,	Volume=	0.000 af	
Primary =	0.00 cfs @	12.42 hrs,	Volume=	0.000 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link 16L: (new Link)



Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 13S: P-100 - Undeveloped Runoff Area=44,524 sf 0.00% Impervious Runoff Depth=0.49"
Tc=6.0 min CN=43 Runoff=0.23 cfs 0.042 af

Subcatchment 15S: P-100 - WS-Bldg Runoff Area=1,350 sf 100.00% Impervious Runoff Depth=5.21"
Tc=6.0 min CN=98 Runoff=0.17 cfs 0.013 af

Pond 14P: UDS 1 Peak Elev=88.00' Storage=0.003 af Inflow=0.17 cfs 0.013 af
Outflow=0.05 cfs 0.013 af

Pond 17P: Water Quality Swale Peak Elev=85.00' Storage=0.000 af Inflow=0.23 cfs 0.042 af
Discarded=0.22 cfs 0.042 af Primary=0.00 cfs 0.000 af Outflow=0.22 cfs 0.042 af

Link 16L: (new Link) Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 1.053 ac Runoff Volume = 0.055 af Average Runoff Depth = 0.63"
97.06% Pervious = 1.022 ac 2.94% Impervious = 0.031 ac