STORMWATER MANAGEMENT REPORT

for

DRP Gibbstown Logistics Center-Phase 1
Township of Greenwich, Gloucester County
New Jersey

Prepared For:

Delaware River Partners LLC
C/O Fortress Worldwide Transportation and Infrastructure
1345 Avenue of Americas, 45th Floor
New York, 10105

Prepared By:

Langan Engineering and Environmental Services, Inc.
989 Lenox Drive
Suite 124
Lawrenceville, NJ 08648
NJ Certificate of Authorization No: 24GA27996400

Edward F. Wilkes Jr., P.E.
Professional Engineer License No. 24GE049372

Kevin J. Webb, P.E.
Professional Engineer License No. 24GE04075100

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INTRODUCTION

Purpose of Report

The purpose of this report is to present the criteria and methods utilized in the design of the stormwater management facilities and the storm sewer collection system for the project known as Repauno Redevelopment Warehouse Building 1. This report has been prepared in conjunction with plans titled "Preliminary and Final Site Plan Application, Repauno Redevelopment Warehouse Building 1", and addresses the stormwater management requirements per NJAC 7:8.

Project Location

The total site is part of Block 8, Lot 4 in the Township of Greenwich, Gloucester County, New Jersey, which is a portion of the former DuPont Repauno tract. The site is bounded on the north by undeveloped wooded areas, to the east by residential homes and an active day care facility, and to the south and west by 'A' Line Road.

A site location map has been provided in Appendix J of this report for reference.

Hydrologic Methodologies

The SCS Unit Hydrograph Method was utilized to calculate the stormwater runoff volumes and rates from the project site. Technical Release No. 55 (TR55) was utilized to obtain runoff curve numbers (CNs) for the various land cover types, and to obtain coefficients to calculate the time of concentration (TC) for each drainage area. The hydrologic model was analyzed and designed with the HydroCAD software program.

The following parameters were utilized in the design of the stormwater management system:

Water Quantity – The site lies within a tidal flood area; therefore, the development is not subject to peak runoff reduction rates per NJAC 7:8-5.4(a)3.iv. However, in order to demonstrate downstream stability according to the applicable soil erosion and sediment control standards, we have reduced peak development runoff rates to 50% and 75% for the respective 2-year and 10-year storm events. Hydrographs have been generated utilizing the Delmarva Unit hydrograph and regional rainfall data for Gloucester County (as contained in the New Jersey Department of Agriculture Technical Bulletin 2004-4.0, dated January 1, 2005). Hydrographs for impervious & pervious areas have been calculated separately, per NJAC 7:8-5.6(a)4.

Water Quality – The development must treat runoff volume generated by the NJDEP 1.25-inch, 2-hour Water Quality Storm by utilizing stormwater management methods that reduce the developed site's average annual total suspended solids (TSS) load for all drainage areas, per NJAC 7:8-5.5. Hydrographs for impervious & pervious areas have been calculated separately, per NJAC 7:8-5.6(a)4.

Groundwater Recharge – The development must maintain 100 percent of the existing annual groundwater recharge volume on site under developed conditions, per NJAC 7:8-5.4 and the New Jersey Stormwater BMP Manual, Chapter 6.

PRESENT LAND USE & DRAINAGE PATTERNS

Land Use

Currently the site is undeveloped with aerial utility lines and dirt roadways traversing the portion of the property to be redeveloped under this application. The site is predominantly covered with trees, low vegetation, and areas of grass. Three existing wetlands areas have been assigned 50-foot transition areas along the west side and in the central area of the site. The wetlands areas are connected by manmade ditches classified as ordinary resource value with no associated buffers. There is also large area of exceptional resource value wetlands west of 'A' Line road with a 150-foot transition area that encroaches onto the site.

Topography and Soils

Based on a recent topographic survey performed by Langan, existing grades at the site generally range from approximate el 4 to el 9 (NAVD88) and are characterized by ponding topography. The majority of the site drains westward into the large wetlands area, while the remainder of the site drains east towards the alley that separates the property from the residential units.

The following soil types are located within the site.

Symbol	Description	Slopes	HSG
MamuAv	Mannington-Nanticoke-Udorthents Complex	0-1%	C/D
UddcB	Udorthents, Dredged Coarse Materials	0-8%	D
USDOWB	Urban Land – Downer Complex	0-5%	D*

The soil boundaries and soil unit symbols for the soil types was determined by the NRCS Web Soil Survey, as specified in the New Jersey Department of Agriculture Technical Bulletin 2006-1.0, dated June 1, 2006. A copy of the Soil Survey has been provided in Appendix J for reference.

*Hydraulic soil group D was attributed to soils classified as Urban Land, based on the site's surrounding soils, test borings, observed depths to groundwater, and susceptibility to coastal flooding. Test Pit Logs are provided in Appendix I.

Present Drainage Areas

A map titled "Present Drainage Areas" is included in Appendix J of this report. This map delineates the present drainage areas and the time of concentration flow path to the analysis points. Runoff hydrographs have been calculated for each area shown under its present conditions in order to determine present drainage characteristics for the portion of the site under development.

The present drainage areas are defined as follows:

"DA-1A" – Central portion of the site to be developed that drains to the large wetlands area to the west and requires reduction;
"DA-1B" – Western portion of the site in wetlands not being disturbed and does not require reduction factors;
"DA-1C" – Central portion of the site in wetlands not being disturbed and does not require reduction factors;
"DA-2" – Eastern portion of the site to the drains toward the residential lots;

Refer to Appendix A for a complete summary of the present drainage areas.

The peak runoff rates for the present conditions were calculated by adding the hydrographs of drainage areas contributing to Analysis Point Out-Site, because of the varying site conditions and time of concentrations the times at which peak rate occurred were not equal. A detailed hydrograph calculation sheet is located in Appendix A. Also included are the peak reduction rates utilized to determine the maximum discharge rates under developed conditions as designated by NJAC 7:8-5.4(a)3iii.

Table 1 below summarizes the peak runoff rates that were calculated to the large wetlands area to the west for the present conditions, as calculated by the hydrograph addition calculations provided in Appendix A.

TABLE No. 1
Peak Discharge Summary for Present Conditions
Storm Frequency / Peak Runoff Rate (CFS)

Analysis Point	2-Year	10-Year	100-Year
DA-1A	9.80	21.72	49.29
Required Reduction Factors	50%	75%	N/A
Target Discharge	**4.90**	**16.29**	**N/A**
DA-1B	5.89	12.50	27.44
DA-1C	0.61	1.30	2.86
Target Total Peak Discharge	**11.40***	**30.09***	**79.57***

* The peak site discharge rate is derived from the addition of the hydrographs. See Appendix A for the target total peak discharge rate calculations

Table 2 below summarizes the peak runoff rates that were calculated to the residential units for the present conditions, as calculated by the hydrograph calculations provided in Appendix A.

TABLE No. 2
Peak Discharge Summary for Present Conditions
Storm Frequency / Peak Runoff Rate (CFS)

Analysis Point	2-Year	10-Year	100-Year
Target Total Peak Discharge	3.36	6.73	14.10

Refer to Appendix A for supporting calculations.

DEVELOPED LAND USE & DRAINAGE DESIGN

Land Use

The site will be developed in two phases, each containing one warehouse building and associated loading areas, and parking for both cars and trucks. When fully developed, the floor area of the two warehouse buildings will total 301,196 SF. Two ponds are proposed to provide stormwater management for the development of the two proposed buildings; those ponds are hydraulically connected by a 36" pipe. In total, the project proposes 15.37 acres of impervious surface and an overall disturbance of 20.2 acres.

The normal water surface elevation (N.W.S.) of the ponds was determined based on the results of the geotechnical investigation. Specifically the two test pits in Wet Pond 1 indicate an average seasonal high water table elevation 3.00 (NGVD 88). Since the two wet ponds are hydraulically connected, Wet Pond 2 will have the same N.W.S.. Refer to appendix I for the soil test pit logs.

Wet Pond 1:

N.W.S Elevation: 3.00

Test Pit No. 3	
Surface Elevation	6.0'
Seasonal High Water Elevation (SHWE)	4.5'
Groundwater Elevation	1.6'

Test Pit No. 4	
Surface Elevation	8.3'
Seasonal High Water Elevation (SHWE)	2.3'
Groundwater Elevation	1.8'

Developed Drainage Areas

A map titled "Developed Drainage Areas" is included in Appendix J of this report. This map delineates the developed drainage areas to the analysis points. Runoff hydrographs have been calculated for each area shown under its developed conditions in order to determine developed drainage characteristics for the portion of the site under development.

The developed drainage areas are defined as follows:

"DA-1A" – The portion of the site that is directed to the wet ponds;
"DA-1B" – Central portion of the site in undisturbed wetlands that is be routed around the ponds;
"DA-1C" – Western portion of the site that continues to drain into the existing wetlands;
"DA-1A UNC" – The disturbed portion of the site that drains off-site and toward the existing wetlands;
"DA-2 UNC" – The disturbed portion of the site that drains off-site and toward the residential lots;

Refer to Appendix B for a complete summary of the developed drainage areas.

Stormwater Quantity

The proposed detention basins have been designed to reduce the peak runoff rates under developed conditions for the 2-year and 10-year storm event. The total peak discharge from the site under developed conditions must be at or below the reduced present peak runoff rates at the analysis point calculated above in Table 1 and 2.

Table No. 1 summarizes the results of the runoff calculations under developed conditions showing that all discharge rate reductions are met at the existing wetlands area.

TABLE No. 1
Total Peak Discharge Summary for Developed Conditions
Storm Frequency / Peak Runoff Rate (CFS)

Analysis Point	2-Year	10-Year	100-Year
DA-1A	2.32	12.10	43.60
DA-1A UNC	1.36	2.52	5.03
Total Peak Discharge	**4.83***	**12.53***	**45.28***
Target Peak Discharge	4.90	16.29	N/A
DA-1B	5.89	12.50	27.44
DA-1C	0.31	1.30	2.86
Total Peak Discharge	**11.20***	**20.91***	**67.19***

* The total peak discharge rate is derived from the addition of the hydrographs of the basins discharge & the uncontrolled drainage areas. See Appendix B for the target total peak discharge rate calculations.

Table No. 2 summarizes the results of the runoff calculations under developed conditions showing that all discharge rate reductions are met for discharge Off-Site.

TABLE No. 2
Peak Discharge Summary for Developed Conditions
Storm Frequency / Peak Runoff Rate (CFS)

Analysis Point	2-Year	10-Year	100-Year
Target Total Peak Discharge	0.59	1.19	2.49

Refer to Appendix B for supporting calculations.

Stormwater Quality

The proposed development will incorporate a wet pond providing extended detention of 18 hours to meet the required TSS removal rate of 80%.

The wet ponds have been designed to meet New Jersey Stormwater Quality Requirements per NJAC 7:8-5.5 and the New Jersey Stormwater BMP Manual, Chapter 9.11. The TSS removal rate for a wet pond is based on the ratio of its permanent pool volume to the Water Quality storm runoff volume & the extended detention time. The ratio of permanent pool volume to the water quality storm is 3.88 and the extended detention time is 20.2 hours. The TSS removal rate for Basin 1 is 88%.

Refer to Appendix C for supporting calculations.

Groundwater Recharge

The proposed development was analyzed utilizing the NJDEP Annual Groundwater Recharge Analysis Spreadsheet (based on GSR-32), described in Chapter 6 of the New Jersey Stormwater BMP Manual, along with existing and proposed impervious/pervious coverage information. Based on spreadsheet, the existing soils and land coverage have no annual groundwater recharge volume. Therefore, there will be no post development annual recharge volume deficit.

Refer to Appendix F for supporting calculations.

Emergency Spillway

The ponds have an effective height less than or equal to 5 feet. Therefore, the ponds are not classified as a dam, per NJAC 7:20-1.8(a)4.

The minimum design storm that was utilized to calculate the required emergency spillway capacity is the 24-hour, 100-year frequency, Type III storm. The emergency spillway has been designed assuming the principal spillway is malfunctioning and will not allow any discharge or flow.

The minimum width of the spillway at the highest settled embankment height is 10 feet.

The top of wall around each basin has been designed to be a minimum of one foot above the water surface in the detention basin with the emergency spillway flowing at the design depth.

Two eight-inch thick, anti-seep collars are proposed along the outlet pipes and are designed per NRCS requirements.

Refer to Appendix D for supporting calculations.

Low Impact Design Strategies

The NJDEP Low Impact Development checklist has been included in Appendix G to discuss the Low Impact Development strategies incorporated into the design of this project.

Soil Erosion and Sediment Control

The project has been designed to meet all soil erosion and sediment control criteria including provisions for the prevention of soil erosion during construction, as shown on the Soil Erosion & Sediment Control plan and detail sheets.

Point of Discharge Stability – There is no well-defined channel to discharge to and it can be reasonably assumed due to the naturally flat topography that developed flow from the ponds will disperse over a broad area. To meet the Standards for SESC in NJ, Chapter 21, page 4, two basin outlet structures have been designed to ensure peak flows from the 25-year storm

event do not exceed 10 CFS. The discharge locations have been separated by at least 50 feet horizontally to avoid mixing of flows. The diameter of the outlet pipe has been increased and its slope has been reduced to minimize discharge velocities. Supporting calculations can be found in Appendix G.

Demonstrating Off-Site Stability – In order to demonstrate stability downstream of the point of discharge, the developed condition peak flow rate was reduced to 50% and 75% of the predevelopment peak flow rate for the 2- and 10-year storm events, as required in the Standards for SESC in NJ, Chapter 21, page 6.

A summary of the flow velocity through the emergency spillway exit channel has been provided in Appendix D.

Permanent conduit outlet protection has been provided at all headwall and flared end section discharge points throughout the site. Calculations for all proposed riprap aprons and scour holes can be found in Appendix G.

Storm Sewer

The storm sewer system has been designed in accordance with the Township Ordinances. The Greenwich Township IDF curve, as determined by NOAA Atlas 14 was utilized to determine the storm intensity. A minimum time of concentration of 10 minutes was utilized in the design.

All proposed storm sewer has been designed for the 25-year storm event. The storm pipe discharging from the stormwater management basin has been designed for the 100-year routed outflow from the basin.

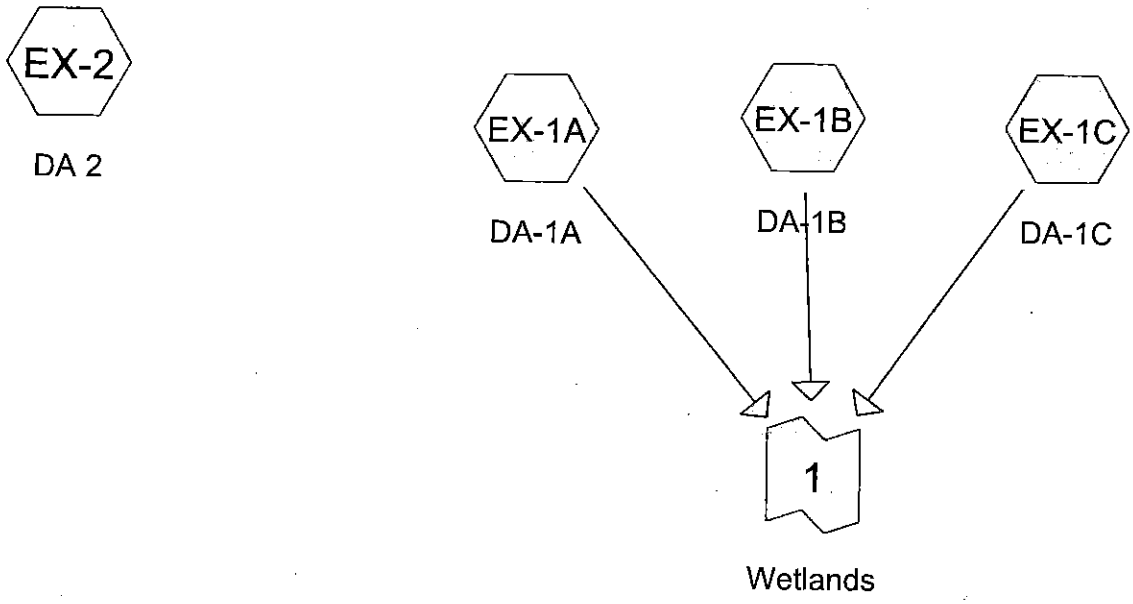
All storm sewer calculations have been tabulated and may be seen in Appendix H of this report. A map titled "Inlet Drainage Areas" is included in Appendix J of this report.

CONCLUSION

In conclusion, the proposed development has been designed in accordance with NJAC 7:8 (NJDEP Stormwater Management Regulations) and the New Jersey Stormwater BMP Manual criteria for water quantity, water quality and groundwater recharge, as well as the latest Standards for Soil Erosion and Sediment Control. The proposed stormwater management design will safely convey all developed runoff from the project.

Appendix A

Present Drainage Analysis



Subcat Reach Pond Link

Routing Diagram for Existing DA
Prepared by Langan Eng & Env Srvcs, Inc, Printed 11/3/2015
HydroCAD® 10.00 s/n 08132 © 2013 HydroCAD Software Solutions LLC

Summary for Subcatchment EX-1A: DA-1A

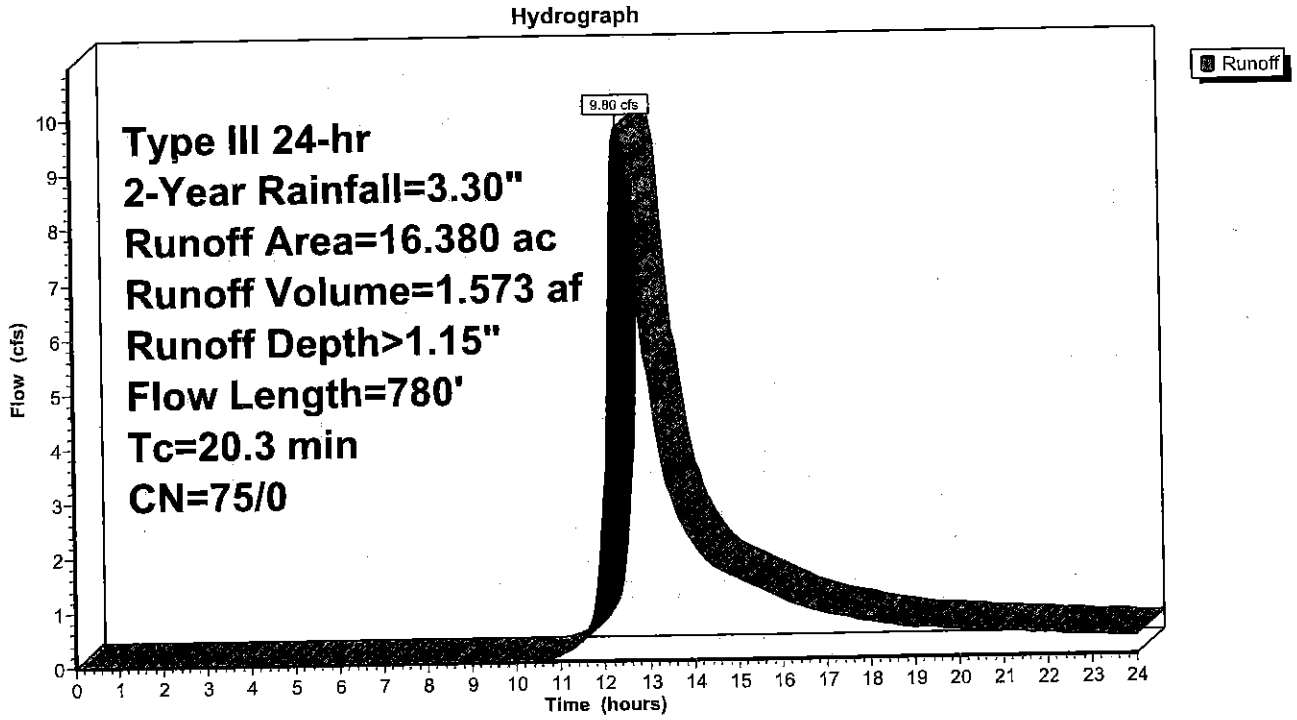
Runoff = 9.80 cfs @ 12.39 hrs, Volume= 1.573 af, Depth> 1.15"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
3.660	80	>75% Grass cover, Good, HSG D
6.190	77	Woods, Good, HSG D
6.450	70	Woods, Good, HSG C
0.080	89	Dirt roads, HSG D
16.380	75	Weighted Average
16.380	75	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	150	0.0160	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"
5.7	630	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
20.3	780	Total			

Subcatchment EX-1A: DA-1A



Summary for Subcatchment EX-1B: DA-1B

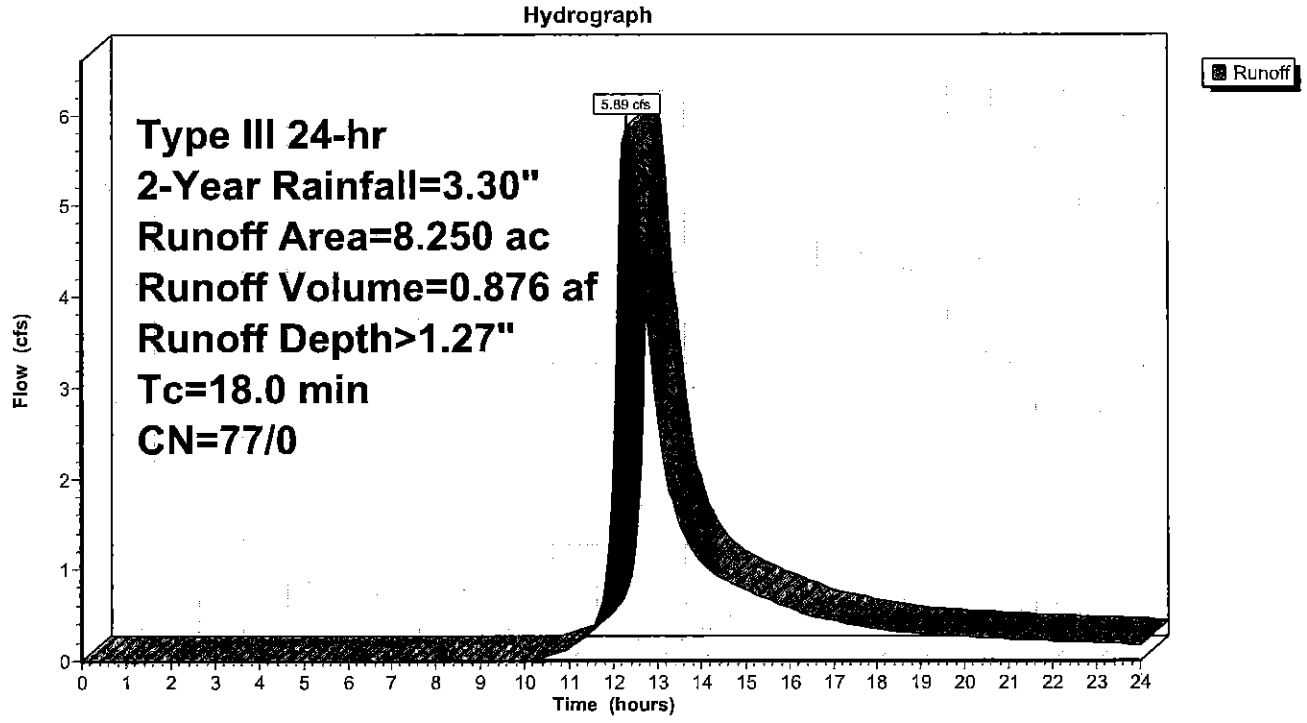
Runoff = 5.89 cfs @ 12.33 hrs, Volume= 0.876 af, Depth> 1.27"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
7.950	77	Woods, Good, HSG D
0.260	80	>75% Grass cover, Good, HSG D
0.040	89	Dirt roads, HSG D
8.250	77	Weighted Average
8.250	77	100.00% Pervious Area

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

Subcatchment EX-1B: DA-1B



Summary for Subcatchment EX-1C: DA-1C

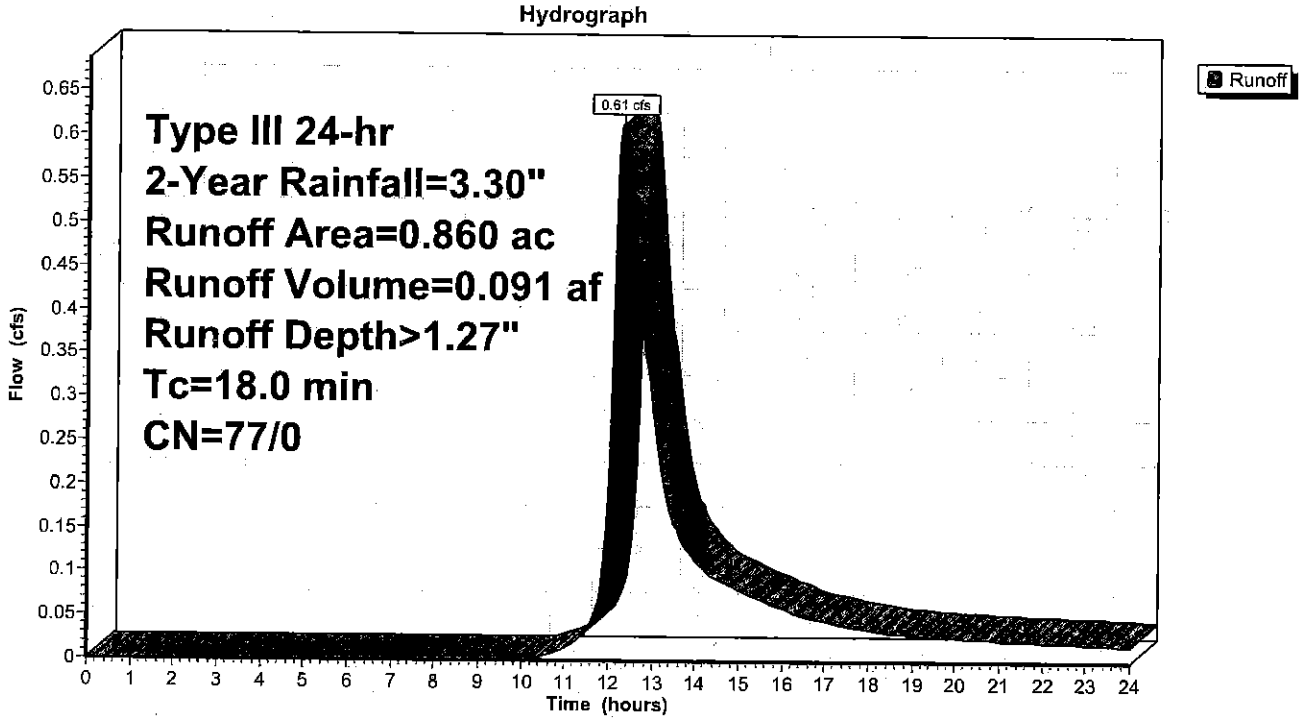
Runoff = 0.61 cfs @ 12.33 hrs, Volume= 0.091 af, Depth> 1.27"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
0.820	77	Woods, Good, HSG D
0.040	70	Woods, Good, HSG C
0.860	77	Weighted Average
0.860	77	100.00% Pervious Area

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

Subcatchment EX-1C: DA-1C



Summary for Subcatchment EX-1C: DA-1C

@ 12.33 hrs, Volume= 0.091 af, Depth> 1.27"

UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
3.30"

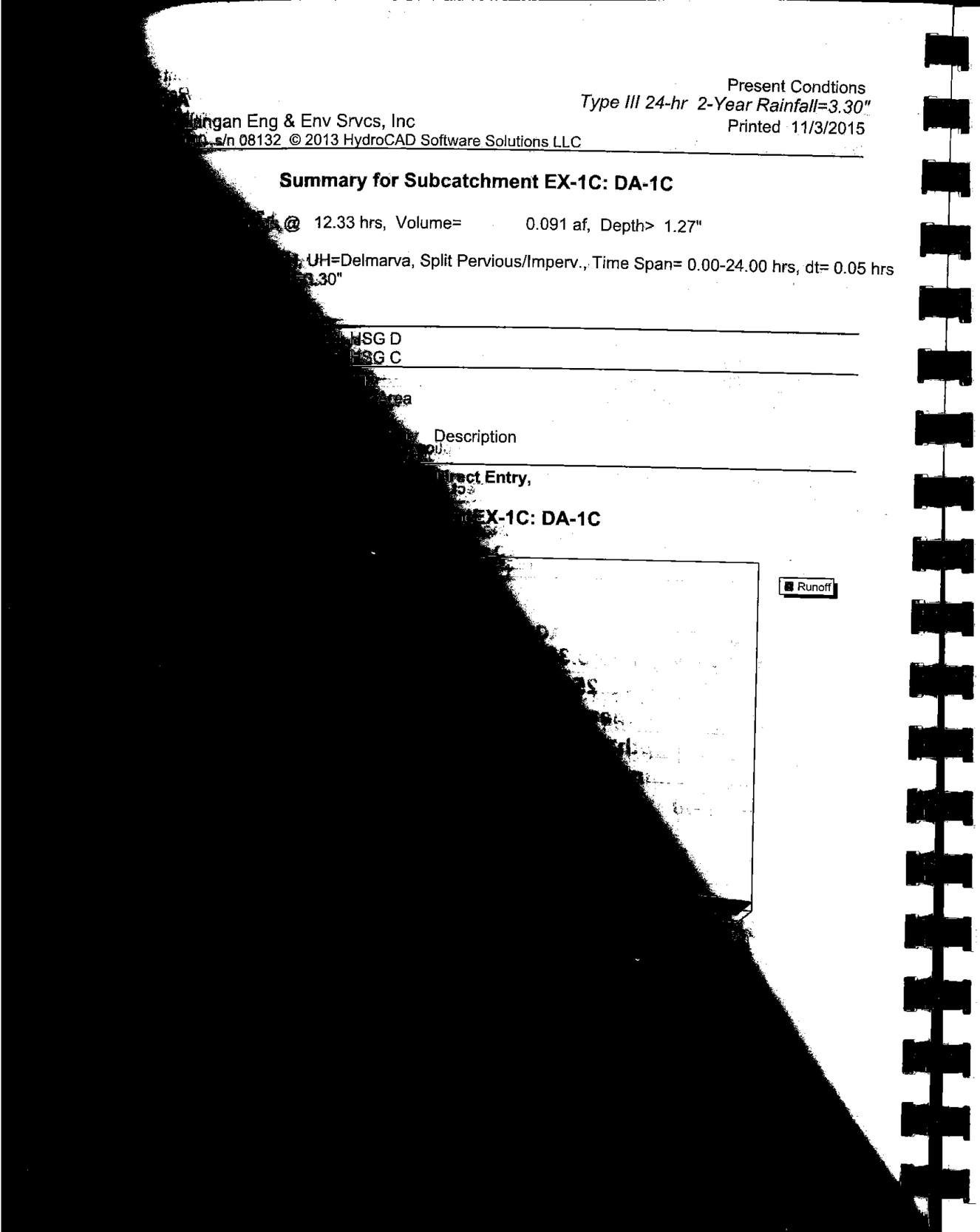
HSG D
HSG C

rea

Description

rect Entry,

X-1C: DA-1C



Summary for Subcatchment EX-2: DA 2

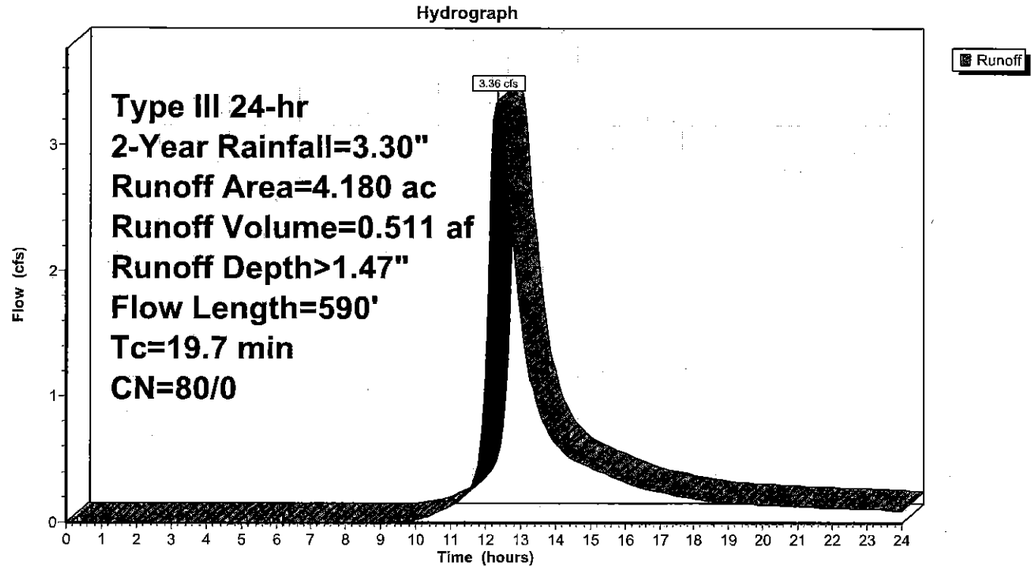
Runoff = 3.36 cfs @ 12.35 hrs, Volume= 0.511 af, Depth> 1.47"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
0.300	77	Woods, Good, HSG D
3.640	80	>75% Grass cover, Good, HSG D
0.240	89	Dirt roads, HSG D
4.180	80	Weighted Average
4.180	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	150	0.0140	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"
4.3	440	0.0110	1.69		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
19.7	590	Total			

Subcatchment EX-2: DA 2



Summary for Subcatchment EX-1A: DA-1A

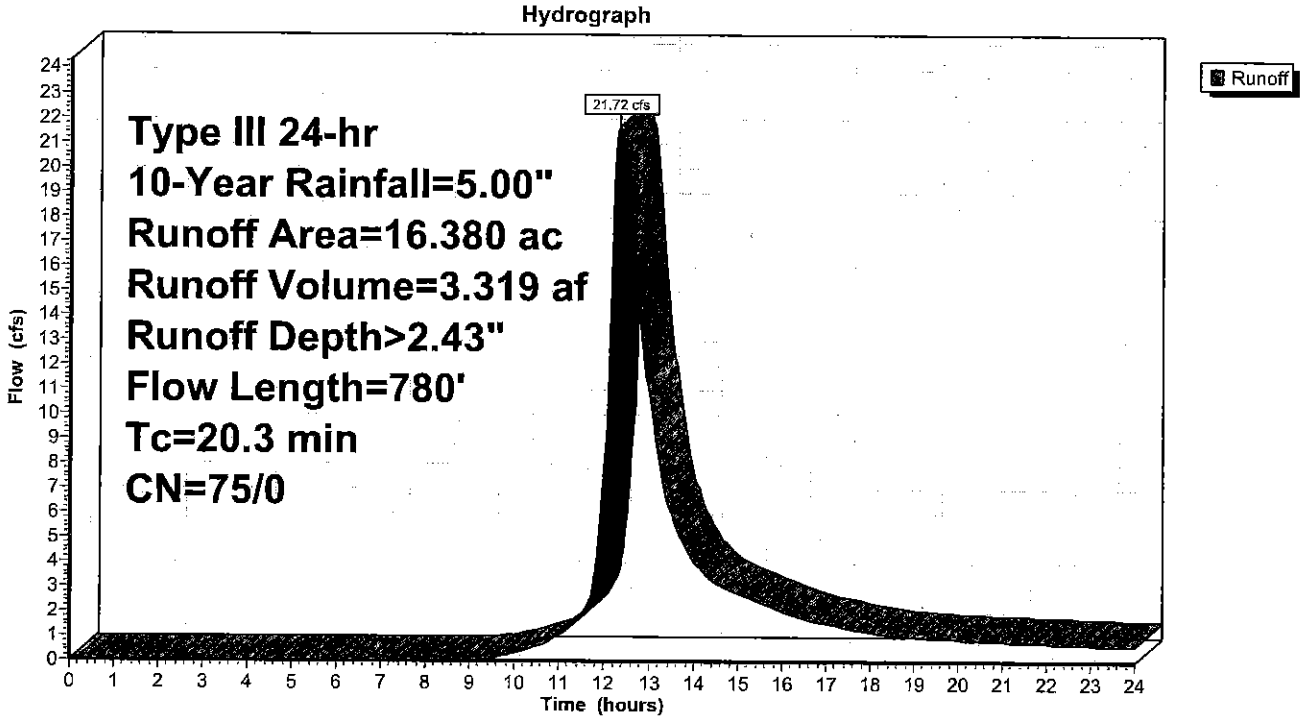
Runoff = 21.72 cfs @ 12.35 hrs, Volume= 3.319 af, Depth> 2.43"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
3.660	80	>75% Grass cover, Good, HSG D
6.190	77	Woods, Good, HSG D
6.450	70	Woods, Good, HSG C
0.080	89	Dirt roads, HSG D
16.380	75	Weighted Average
16.380	75	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	150	0.0160	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"
5.7	630	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
20.3	780	Total			

Subcatchment EX-1A: DA-1A



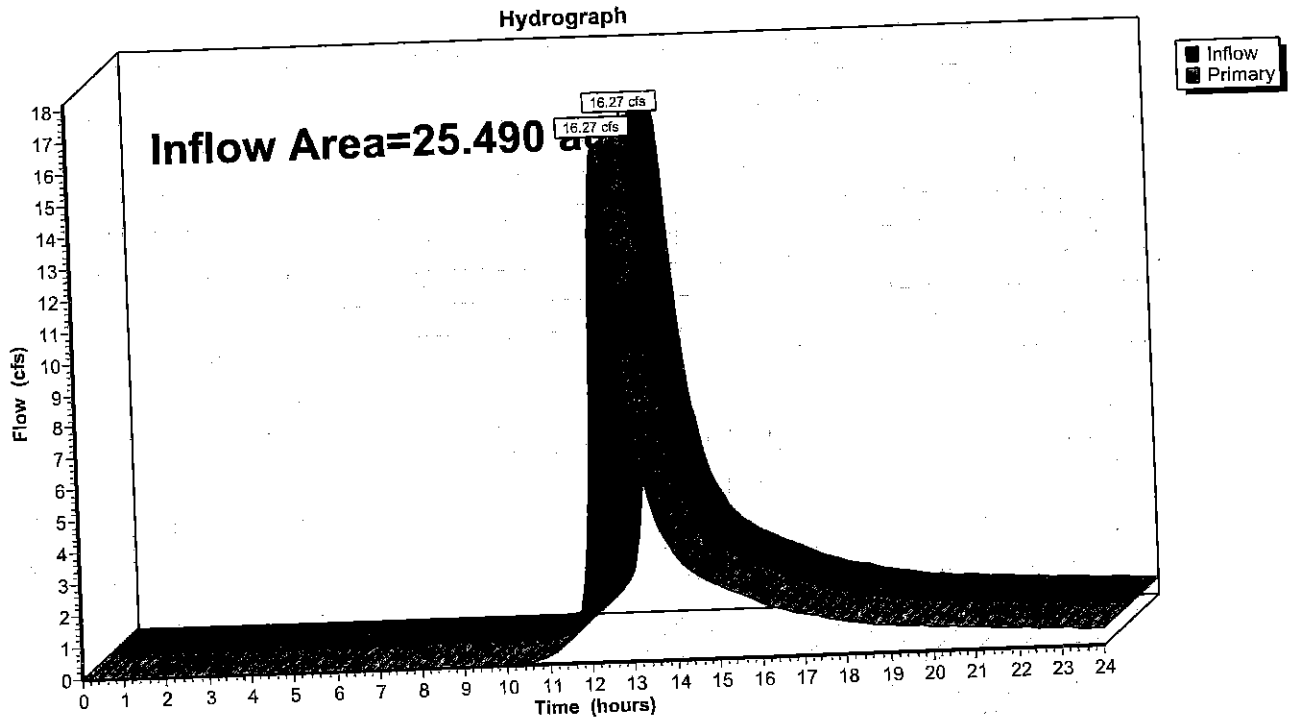
Existing DA
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Link 1: Wetlands

Inflow Area = 25.490 ac, 0.00% Impervious, Inflow Depth > 1.20" for 2-Year event
Inflow = 16.27 cfs @ 12.37 hrs, Volume= 2.540 af
Primary = 16.27 cfs @ 12.37 hrs, Volume= 2.540 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 1: Wetlands



Existing DA
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment EX-1B: DA-1B

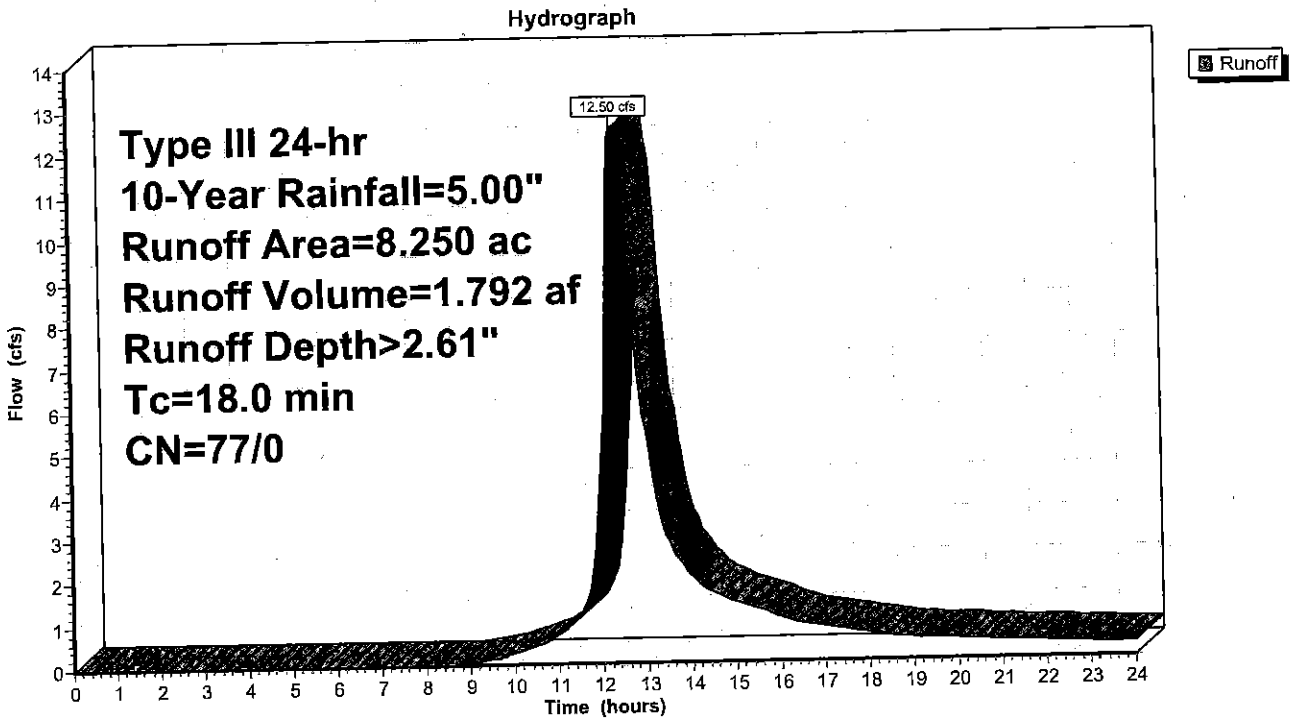
Runoff = 12.50 cfs @ 12.31 hrs, Volume= 1.792 af, Depth> 2.61"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
7.950	77	Woods, Good, HSG D
0.260	80	>75% Grass cover, Good, HSG D
0.040	89	Dirt roads, HSG D
8.250	77	Weighted Average
8.250	77	100.00% Pervious Area

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

Subcatchment EX-1B: DA-1B



Summary for Subcatchment EX-1C: DA-1C

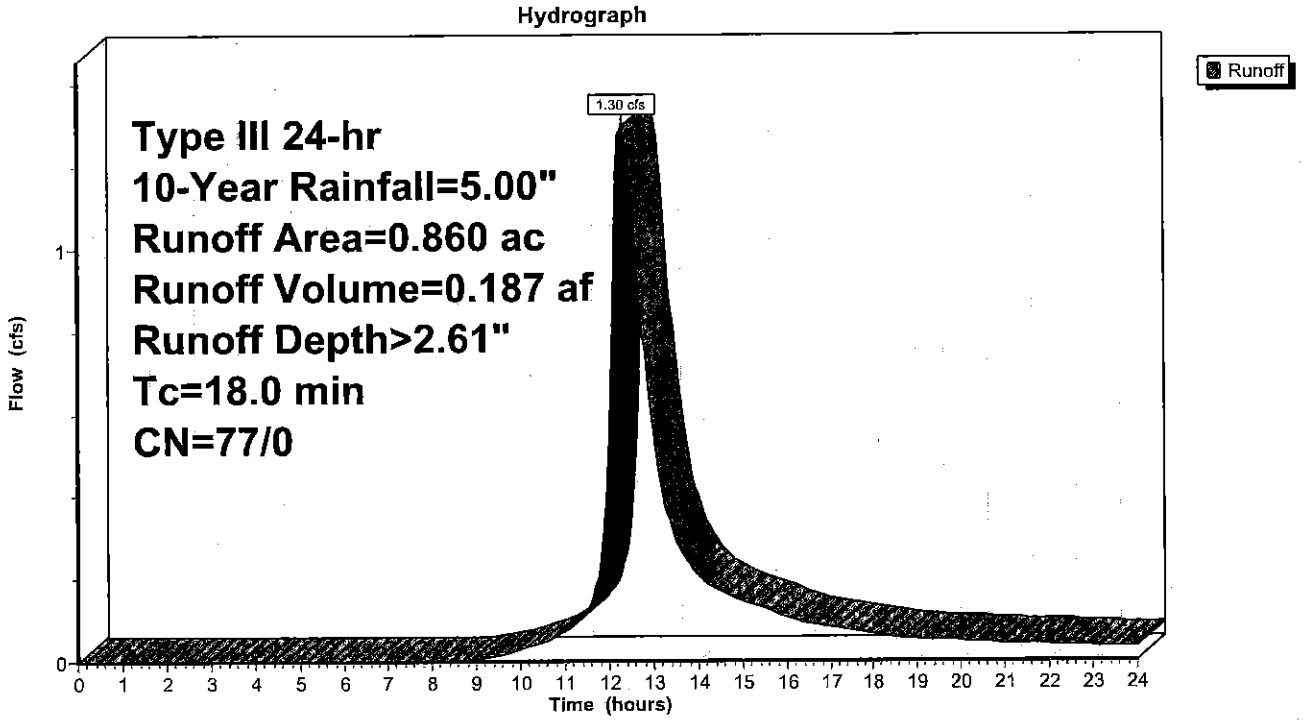
Runoff = 1.30 cfs @ 12.31 hrs, Volume= 0.187 af, Depth> 2.61"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
0.820	77	Woods, Good, HSG D
0.040	70	Woods, Good, HSG C
0.860	77	Weighted Average
0.860	77	100.00% Pervious Area

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

Subcatchment EX-1C: DA-1C



Existing DA
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment EX-2: DA 2

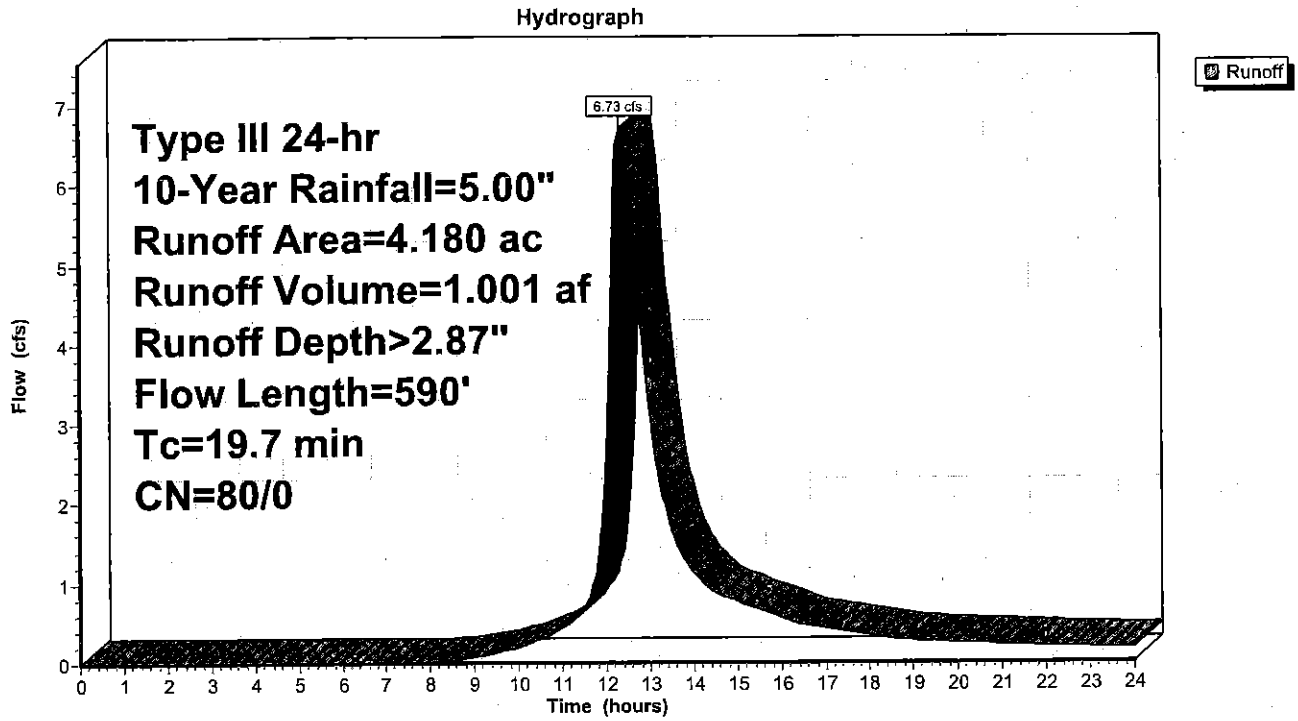
Runoff = 6.73 cfs @ 12.32 hrs, Volume= 1.001 af, Depth> 2.87"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
0.300	77	Woods, Good, HSG D
3.640	80	>75% Grass cover, Good, HSG D
0.240	89	Dirt roads, HSG D
4.180	80	Weighted Average
4.180	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	150	0.0140	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"
4.3	440	0.0110	1.69		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
19.7	590	Total			

Subcatchment EX-2: DA 2

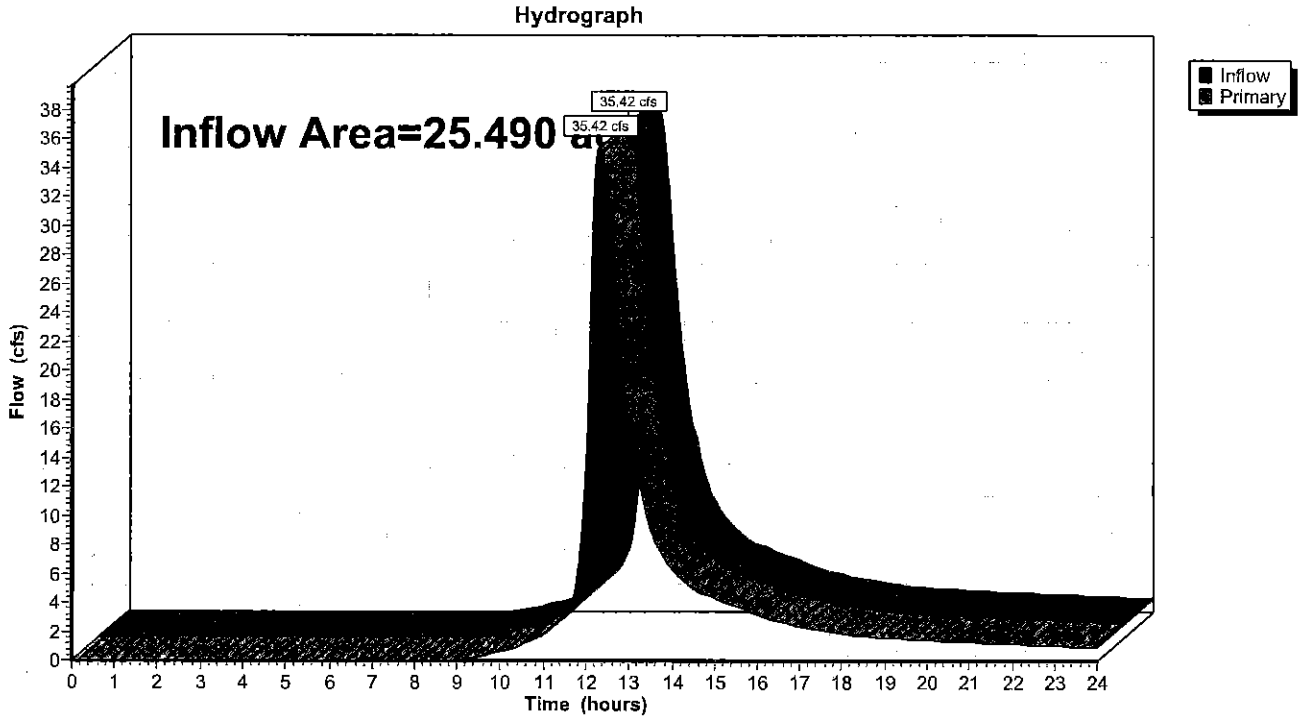


Summary for Link 1: Wetlands

Inflow Area = 25.490 ac, 0.00% Impervious, Inflow Depth > 2.49" for 10-Year event
Inflow = 35.42 cfs @ 12.33 hrs, Volume= 5.298 af
Primary = 35.42 cfs @ 12.33 hrs, Volume= 5.298 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 1: Wetlands



Existing DA
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment EX-1A: DA-1A

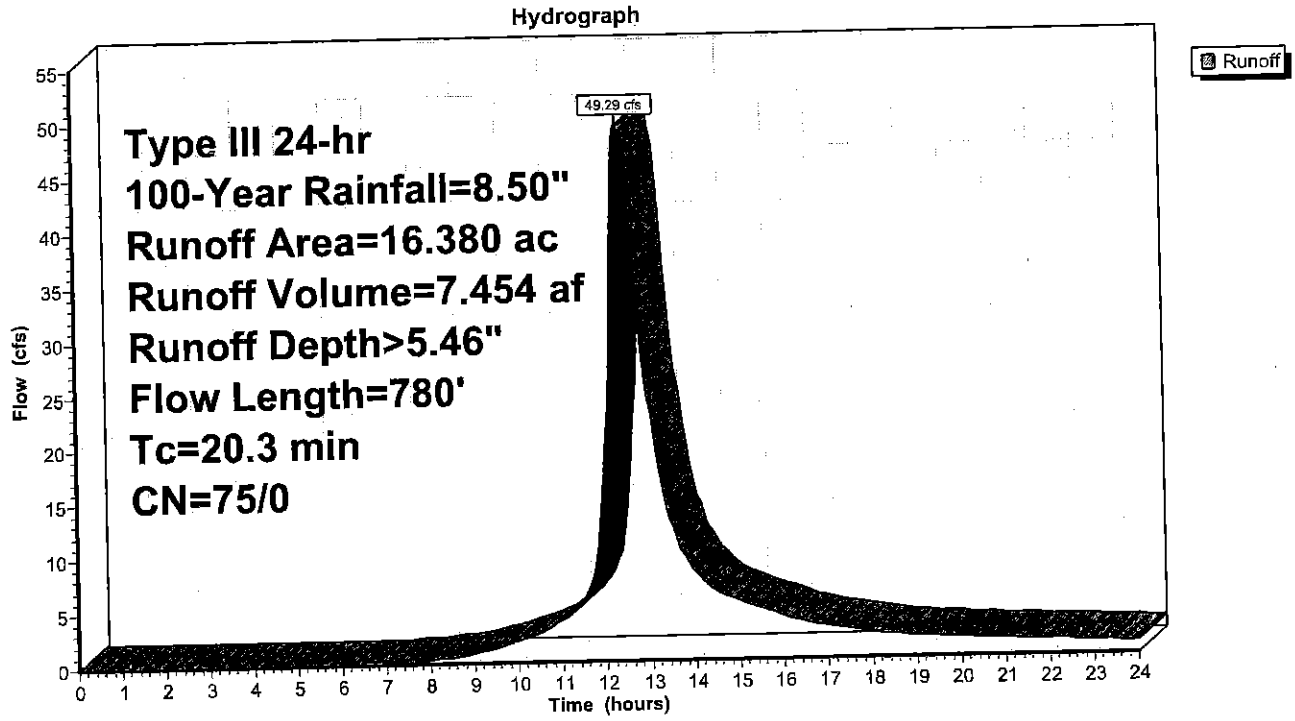
Runoff = 49.29 cfs @ 12.33 hrs, Volume= 7.454 af, Depth> 5.46"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
3.660	80	>75% Grass cover, Good, HSG D
6.190	77	Woods, Good, HSG D
6.450	70	Woods, Good, HSG C
0.080	89	Dirt roads, HSG D
16.380	75	Weighted Average
16.380	75	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.6	150	0.0160	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"
5.7	630	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
20.3	780	Total			

Subcatchment EX-1A: DA-1A



Summary for Subcatchment EX-1B: DA-1B

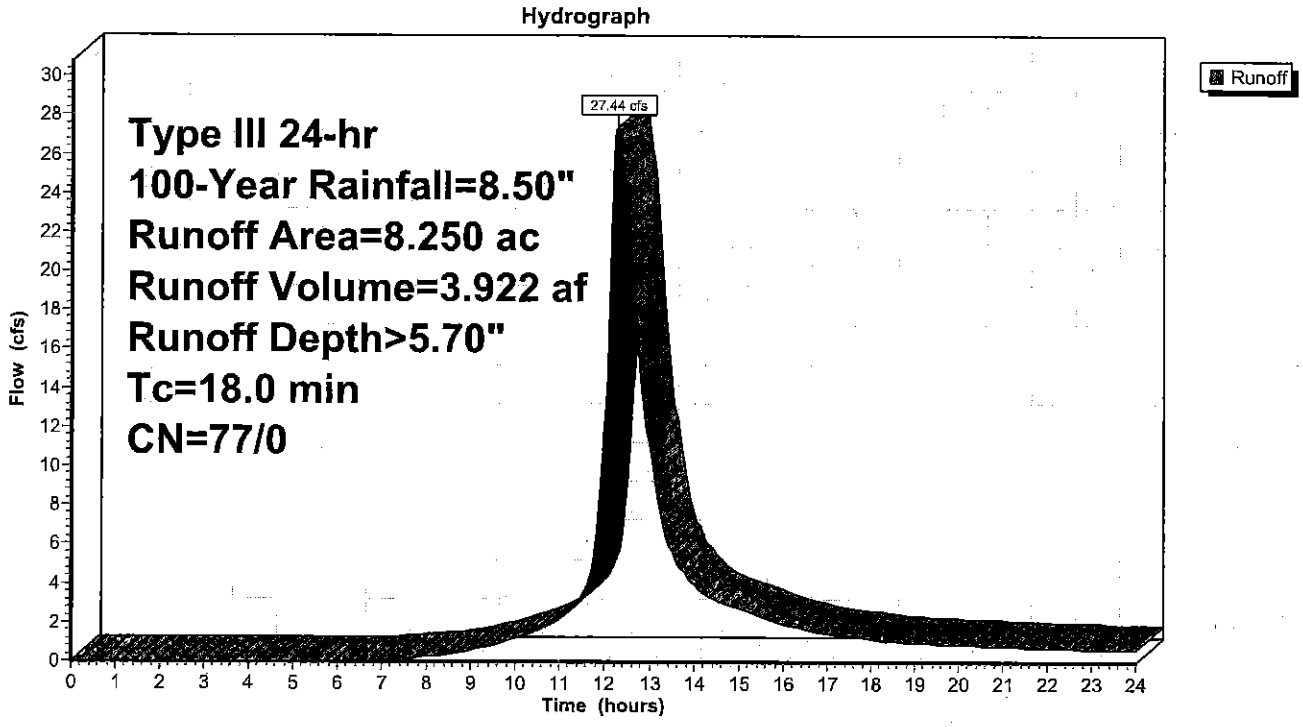
Runoff = 27.44 cfs @ 12.29 hrs, Volume= 3.922 af, Depth> 5.70"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
7.950	77	Woods, Good, HSG D
0.260	80	>75% Grass cover, Good, HSG D
0.040	89	Dirt roads, HSG D
8.250	77	Weighted Average
8.250	77	100.00% Pervious Area

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

Subcatchment EX-1B: DA-1B



Existing DA
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment EX-1C: DA-1C

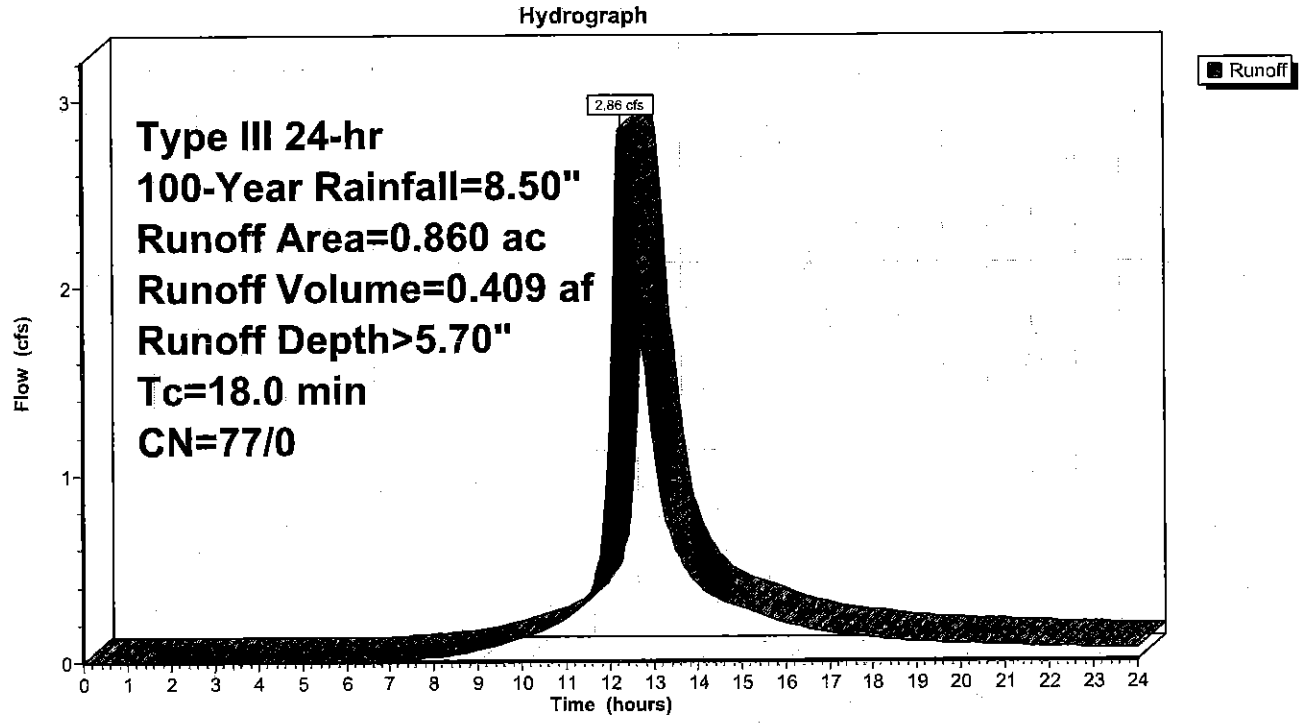
Runoff = 2.86 cfs @ 12.29 hrs, Volume= 0.409 af, Depth> 5.70"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
0.820	77	Woods, Good, HSG D
0.040	70	Woods, Good, HSG C
0.860	77	Weighted Average
0.860	77	100.00% Pervious Area

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

Subcatchment EX-1C: DA-1C



Existing DA
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment EX-2: DA 2

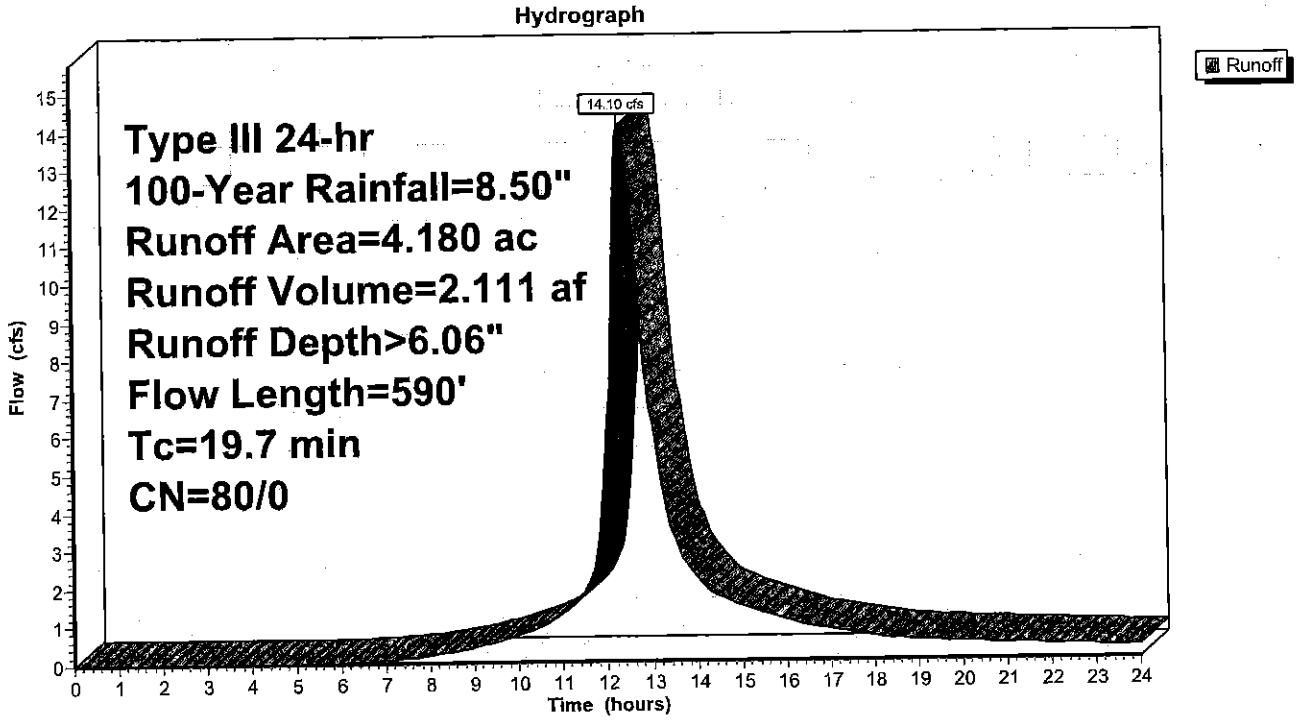
Runoff = 14.10 cfs @ 12.31 hrs, Volume= 2.111 af, Depth> 6.06"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
0.300	77	Woods, Good, HSG D
3.640	80	>75% Grass cover, Good, HSG D
0.240	89	Dirt roads, HSG D
4.180	80	Weighted Average
4.180	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	150	0.0140	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"
4.3	440	0.0110	1.69		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
19.7	590	Total			

Subcatchment EX-2: DA 2



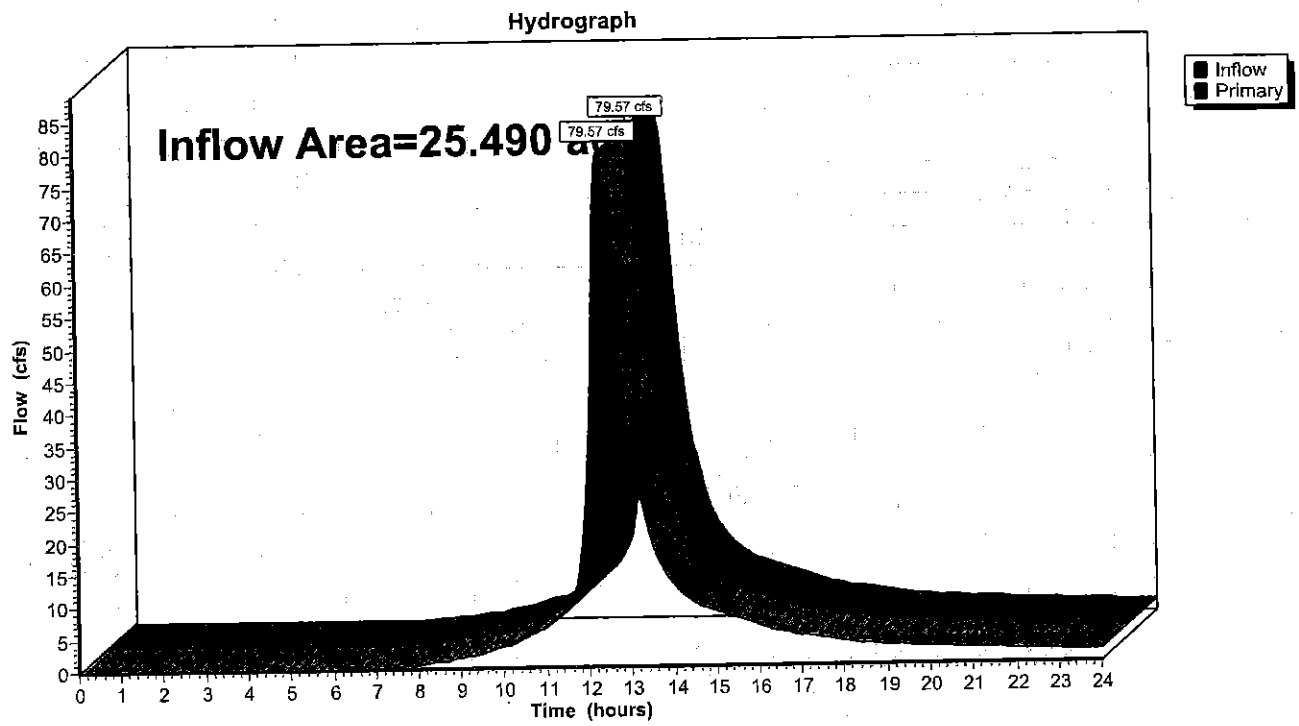
Existing DA
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Link 1: Wetlands

Inflow Area = 25.490 ac, 0.00% Impervious, Inflow Depth > 5.55" for 100-Year event
Inflow = 79.57 cfs @ 12.31 hrs, Volume= 11.785 af
Primary = 79.57 cfs @ 12.31 hrs, Volume= 11.785 af, Atten= 0%, Lag= 0.0 min

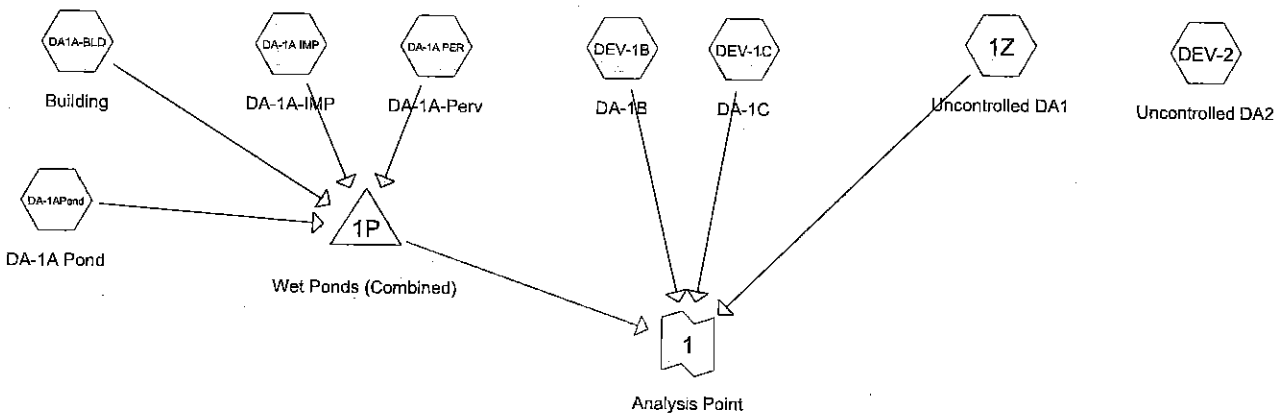
Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 1: Wetlands



Appendix B

Developed Drainage Analysis



Subcat Reach Pond Link

Routing Diagram for Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc, Printed 11/3/2015

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Z: UncontrolledDA1 Runoff Area=1.050 ac 18.10% Impervious Runoff Depth=1.77"
Tc=10.0 min CN=80/98 Runoff=1.36 cfs 0.155 af

SubcatchmentDA-1AIMP: DA-1A-IMP Runoff Area=8.340 ac 100.00% Impervious Runoff Depth=3.07"
Tc=15.0 min CN=0/98 Runoff=14.87 cfs 2.132 af

SubcatchmentDA-1APER: DA-1A-Perv Runoff Area=2.320 ac 0.00% Impervious Runoff Depth=1.35"
Tc=15.0 min CN=78/0 Runoff=1.91 cfs 0.260 af

SubcatchmentDA-1APond:DA-1APond Runoff Area=1.470 ac 100.00% Impervious Runoff Depth=3.07"
Tc=10.0 min CN=0/98 Runoff=3.14 cfs 0.376 af

SubcatchmentDA1A-BLD:Building Runoff Area=6.840 ac 100.00% Impervious Runoff Depth=3.07"
Tc=15.0 min CN=0/98 Runoff=12.20 cfs 1.748 af

SubcatchmentDEV-1B: DA-1B Runoff Area=8.250 ac 0.00% Impervious Runoff Depth=1.28"
Tc=18.0 min CN=77/0 Runoff=5.89 cfs 0.883 af

SubcatchmentDEV-1C: DA-1C Runoff Area=0.860 ac 0.00% Impervious Runoff Depth=1.28"
Tc=18.0 min CN=77/0 Runoff=0.61 cfs 0.092 af

SubcatchmentDEV-2: UncontrolledDA2 Runoff Area=0.540 ac 0.00% Impervious Runoff Depth=1.48"
Tc=10.0 min CN=80/0 Runoff=0.59 cfs 0.067 af

Pond 1P: Wet Ponds (Combined) Peak Elev=4.84' Storage=8.118 af Inflow=32.02 cfs 4.516 af
Primary=2.32 cfs 2.208 af Secondary=2.32 cfs 2.208 af Outflow=4.63 cfs 4.415 af

Link 1: AnalysisPoint Inflow=11.20 cfs 5.545 af
Primary=11.20 cfs 5.545 af

Total Runoff Area = 29.670 ac Runoff Volume = 5.712 af Average Runoff Depth = 2.31"
43.24% Pervious = 12.830 ac 56.76% Impervious = 16.840 ac

Summary for Subcatchment 1Z: Uncontrolled DA1

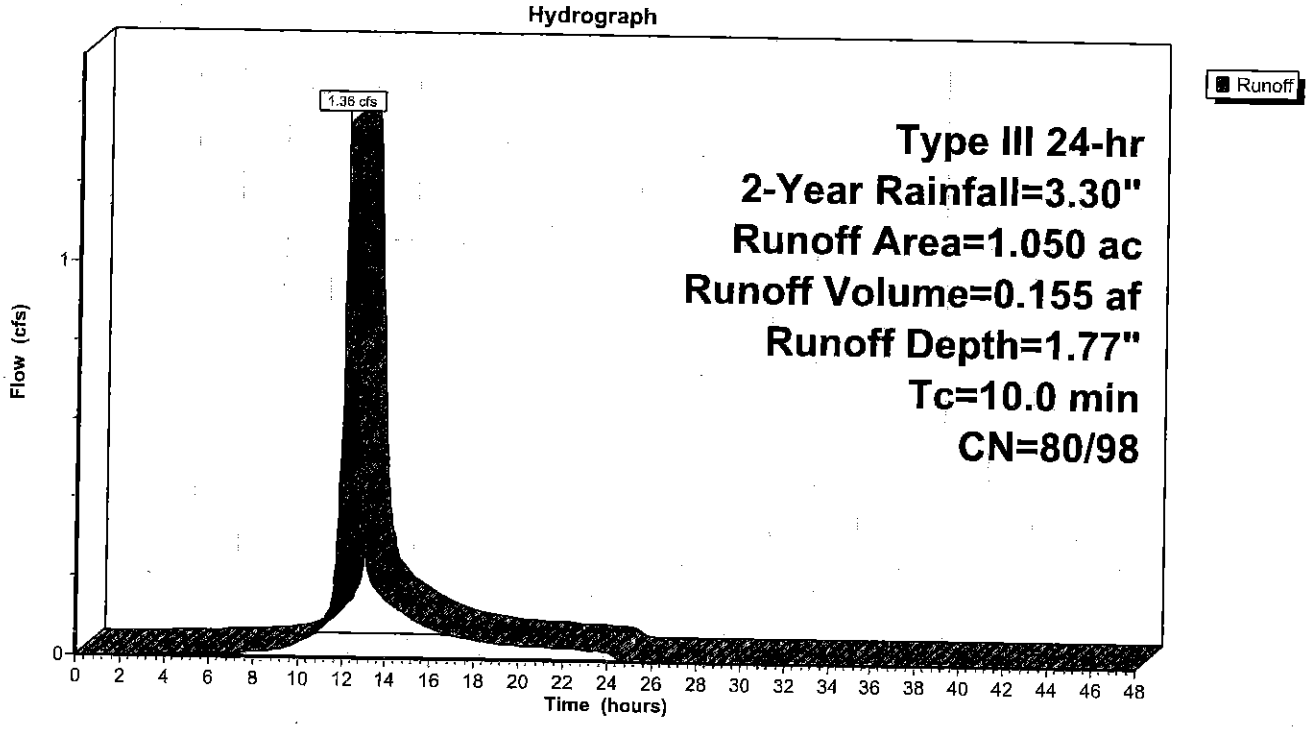
Runoff = 1.36 cfs @ 12.17 hrs, Volume= 0.155 af, Depth= 1.77"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

	Area (ac)	CN	Description
	0.860	80	>75% Grass cover, Good, HSG D
*	0.190	98	Impervious
	1.050	83	Weighted Average
	0.860	80	81.90% Pervious Area
	0.190	98	18.10% Impervious Area

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

Subcatchment 1Z: Uncontrolled DA1



Summary for Subcatchment DA-1A IMP: DA-1A-IMP

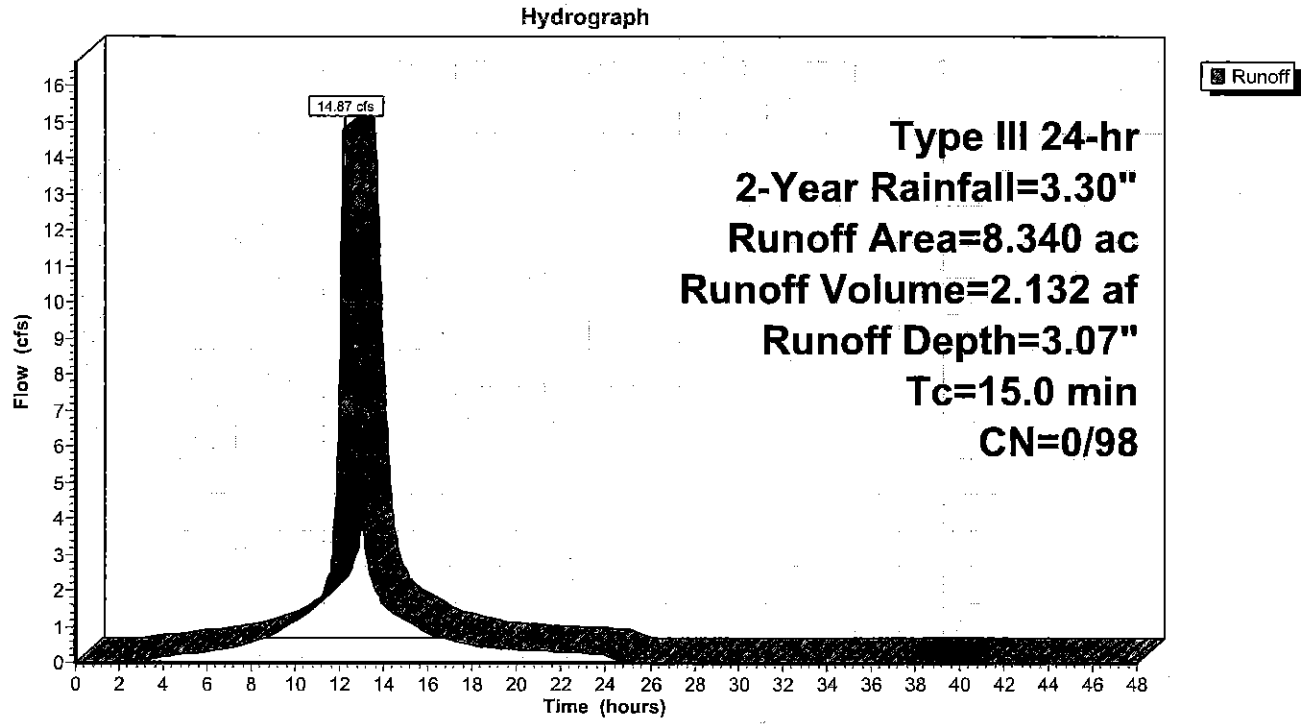
Runoff = 14.87 cfs @ 12.23 hrs, Volume= 2.132 af, Depth= 3.07"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

	Area (ac)	CN	Description
*	8.340	98	Paved
	8.340	98	100.00% Impervious Area

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

Subcatchment DA-1A IMP: DA-1A-IMP



Summary for Subcatchment DA-1A PER: DA-1A-Perv

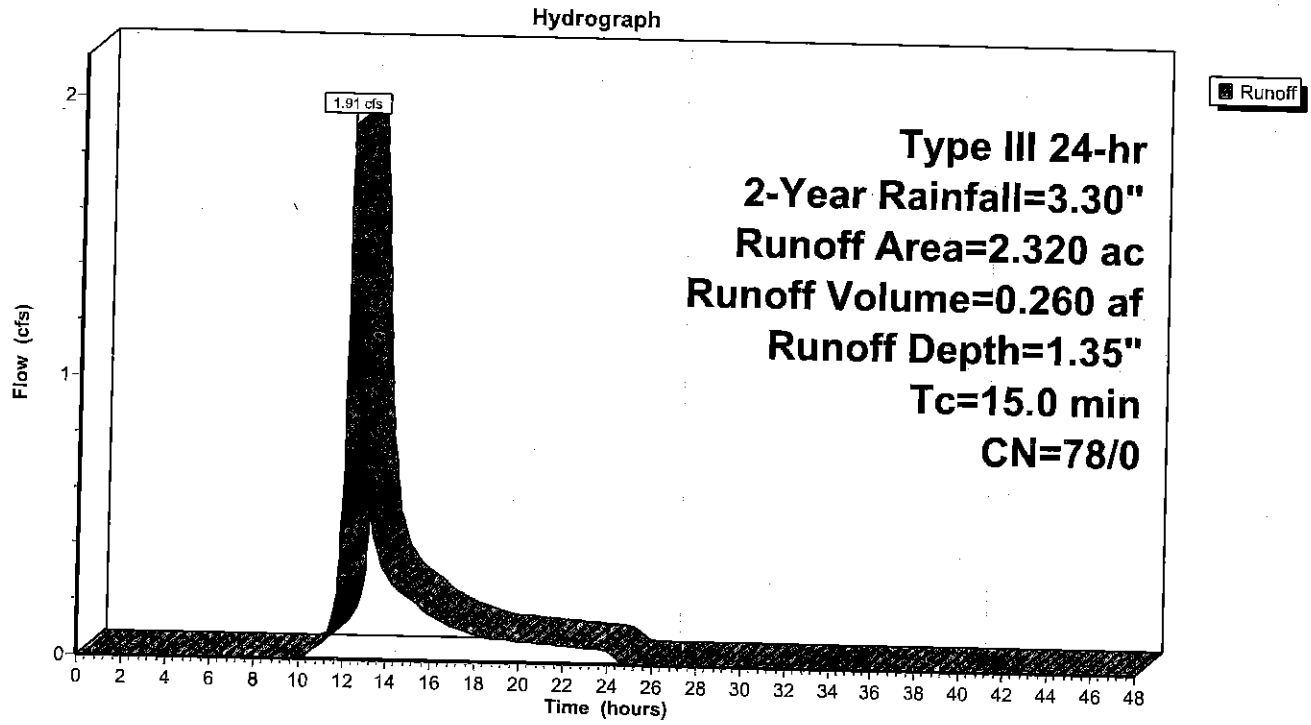
Runoff = 1.91 cfs @ 12.27 hrs, Volume= 0.260 af, Depth= 1.35"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
1.480	80	>75% Grass cover, Good, HSG D
0.840	74	>75% Grass cover, Good, HSG C
2.320	78	Weighted Average
2.320	78	100.00% Pervious Area

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

Subcatchment DA-1A PER: DA-1A-Perv



Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Hydrograph for Subcatchment DA-1A PER: DA-1A-Perv

Time (hours)	Precip. (inches)	Perv.Excess (inches)	Imp.Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	**0.00**	0.00
1.00	0.03	0.00	0.00	0.00
2.00	0.07	0.00	0.00	0.00
3.00	0.10	0.00	0.00	0.00
4.00	0.14	0.00	0.00	0.00
5.00	0.19	0.00	0.00	0.00
6.00	0.24	0.00	0.00	0.00
7.00	0.30	0.00	0.00	0.00
8.00	0.38	0.00	0.00	0.00
9.00	0.48	0.00	0.00	0.00
10.00	0.62	0.00	0.00	0.00
11.00	0.83	0.02	0.00	0.06
12.00	1.65	0.30	0.00	**0.71**
13.00	2.47	0.77	0.00	**0.71**
14.00	2.68	0.90	0.00	0.30
15.00	2.82	1.00	0.00	0.22
16.00	2.92	1.07	0.00	0.16
17.00	3.00	1.13	0.00	0.13
18.00	3.06	1.17	0.00	0.10
19.00	3.11	1.21	0.00	0.08
20.00	3.16	1.24	0.00	0.08
21.00	3.20	1.27	0.00	0.07
22.00	3.24	1.30	0.00	0.06
23.00	3.27	1.32	0.00	0.06
24.00	**3.30**	**1.35**	0.00	0.05
25.00	3.30	1.35	0.00	0.00
26.00	3.30	1.35	0.00	0.00
27.00	3.30	1.35	0.00	0.00
28.00	3.30	1.35	0.00	0.00
29.00	3.30	1.35	0.00	0.00
30.00	3.30	1.35	0.00	0.00
31.00	3.30	1.35	0.00	0.00
32.00	3.30	1.35	0.00	0.00
33.00	3.30	1.35	0.00	0.00
34.00	3.30	1.35	0.00	0.00
35.00	3.30	1.35	0.00	0.00
36.00	3.30	1.35	0.00	0.00
37.00	3.30	1.35	0.00	0.00
38.00	3.30	1.35	0.00	0.00
39.00	3.30	1.35	0.00	0.00
40.00	3.30	1.35	0.00	0.00
41.00	3.30	1.35	0.00	0.00
42.00	3.30	1.35	0.00	0.00
43.00	3.30	1.35	0.00	0.00
44.00	3.30	1.35	0.00	0.00
45.00	3.30	1.35	0.00	0.00
46.00	3.30	1.35	0.00	0.00
47.00	3.30	1.35	0.00	0.00
48.00	3.30	1.35	0.00	0.00

Summary for Subcatchment DA-1APond: DA-1A Pond

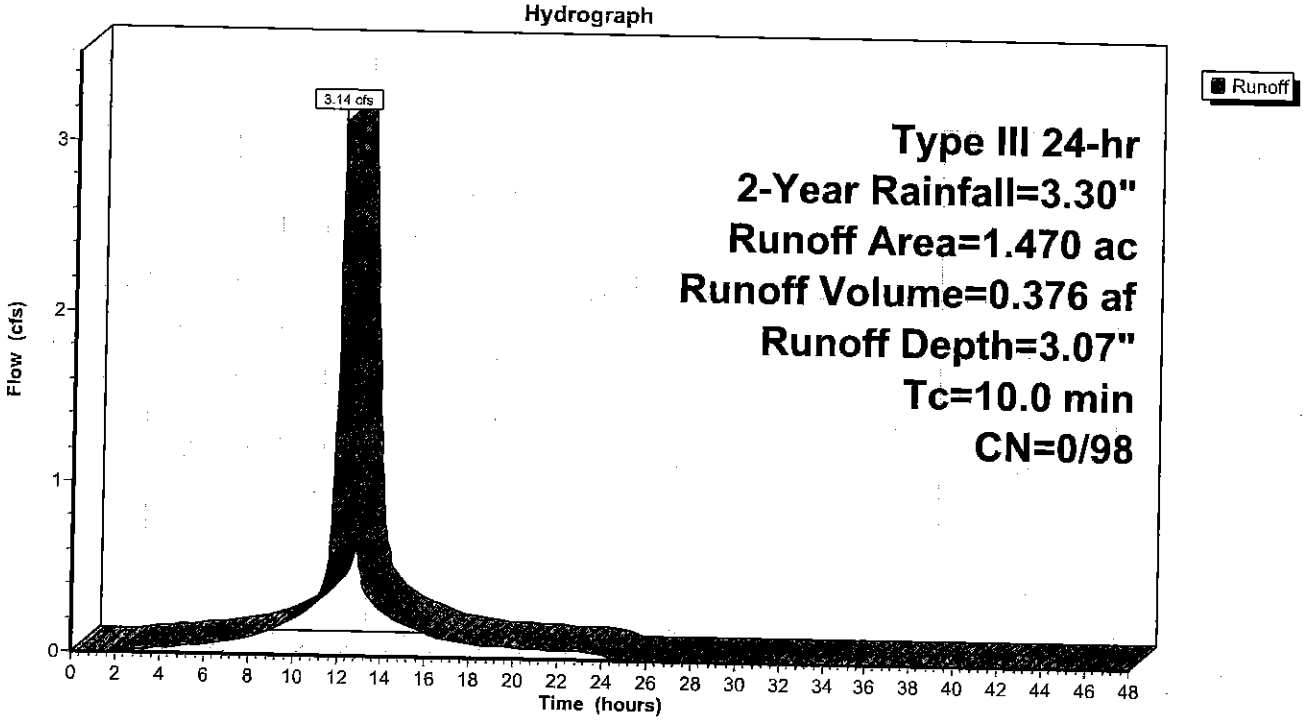
Runoff = 3.14 cfs @ 12.16 hrs, Volume= 0.376 af, Depth= 3.07"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

	Area (ac)	CN	Description
*	1.470	98	Wet Pond
	1.470	98	100.00% Impervious Area

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

Subcatchment DA-1APond: DA-1A Pond



Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment DA1A-BLD: Building

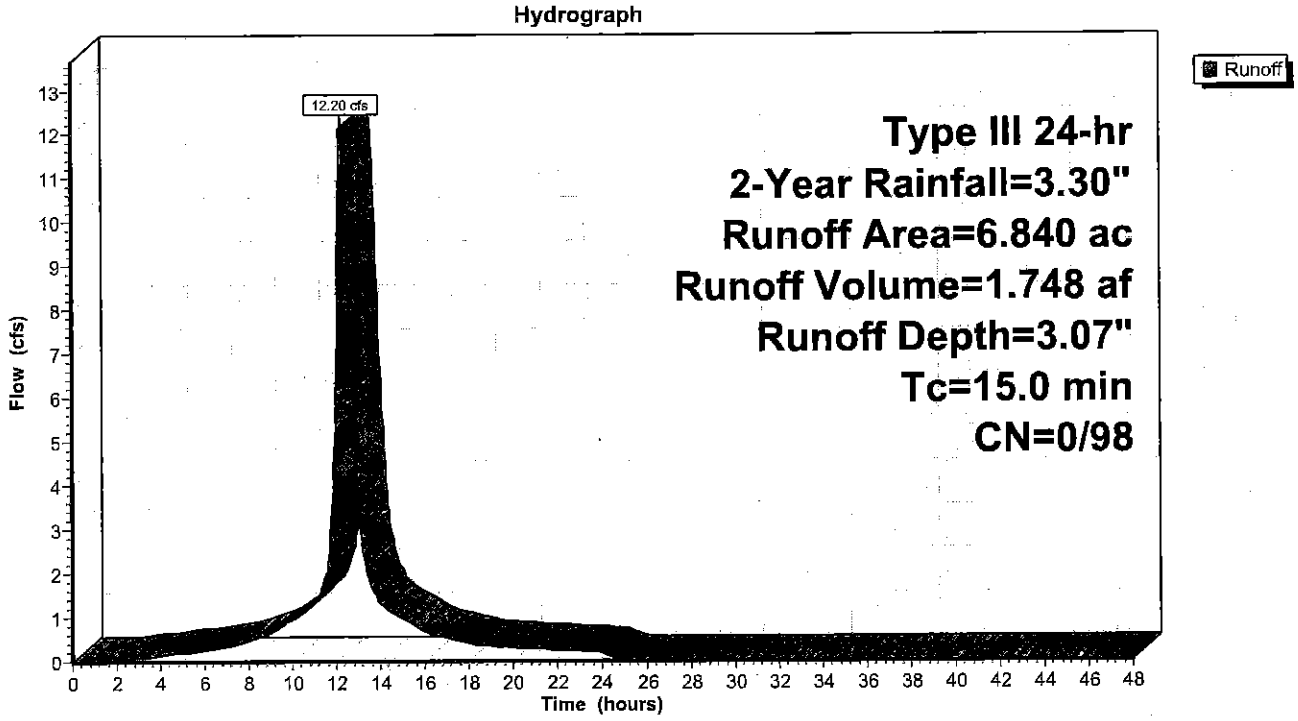
Runoff = 12.20 cfs @ 12.23 hrs, Volume= 1.748 af, Depth= 3.07"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

	Area (ac)	CN	Description
*	6.840	98	Roofs
	6.840	98	100.00% Impervious Area

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

Subcatchment DA1A-BLD: Building



Summary for Subcatchment DEV-1B: DA-1B

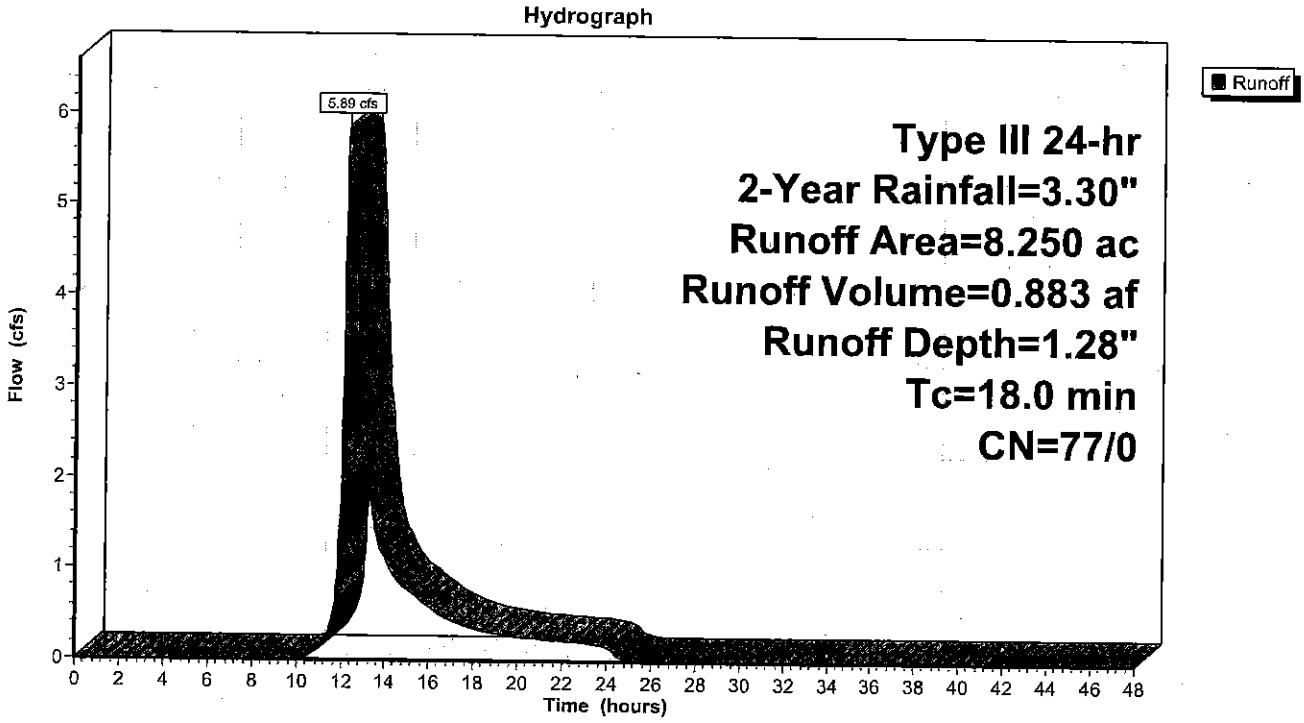
Runoff = 5.89 cfs @ 12.33 hrs, Volume= 0.883 af, Depth= 1.28"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
7.950	77	Woods, Good, HSG D
0.300	80	>75% Grass cover, Good, HSG D
8.250	77	Weighted Average
8.250	77	100.00% Pervious Area

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

Subcatchment DEV-1B: DA-1B



Summary for Subcatchment DEV-1C: DA-1C

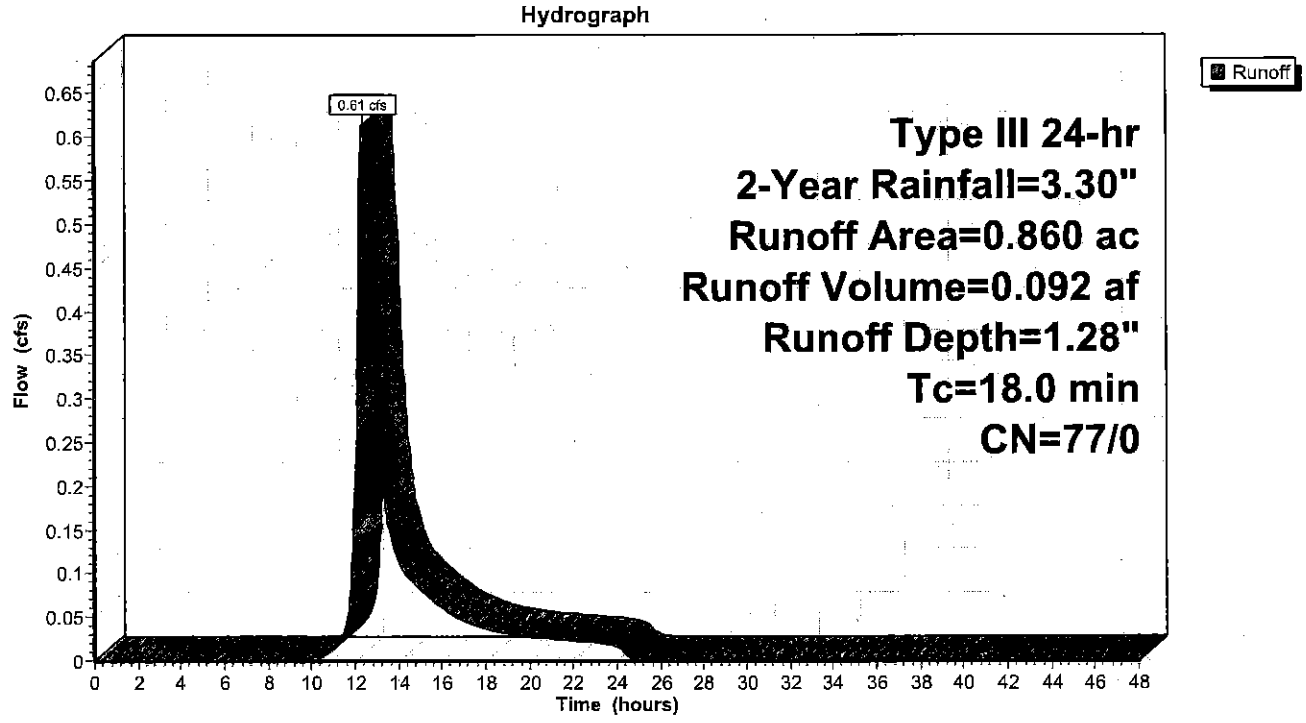
Runoff = 0.61 cfs @ 12.33 hrs, Volume= 0.092 af, Depth= 1.28"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
0.040	70	Woods, Good, HSG C
0.820	77	Woods, Good, HSG D
0.860	77	Weighted Average
0.860	77	100.00% Pervious Area

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

Subcatchment DEV-1C: DA-1C



Summary for Subcatchment DEV-2: Uncontrolled DA2

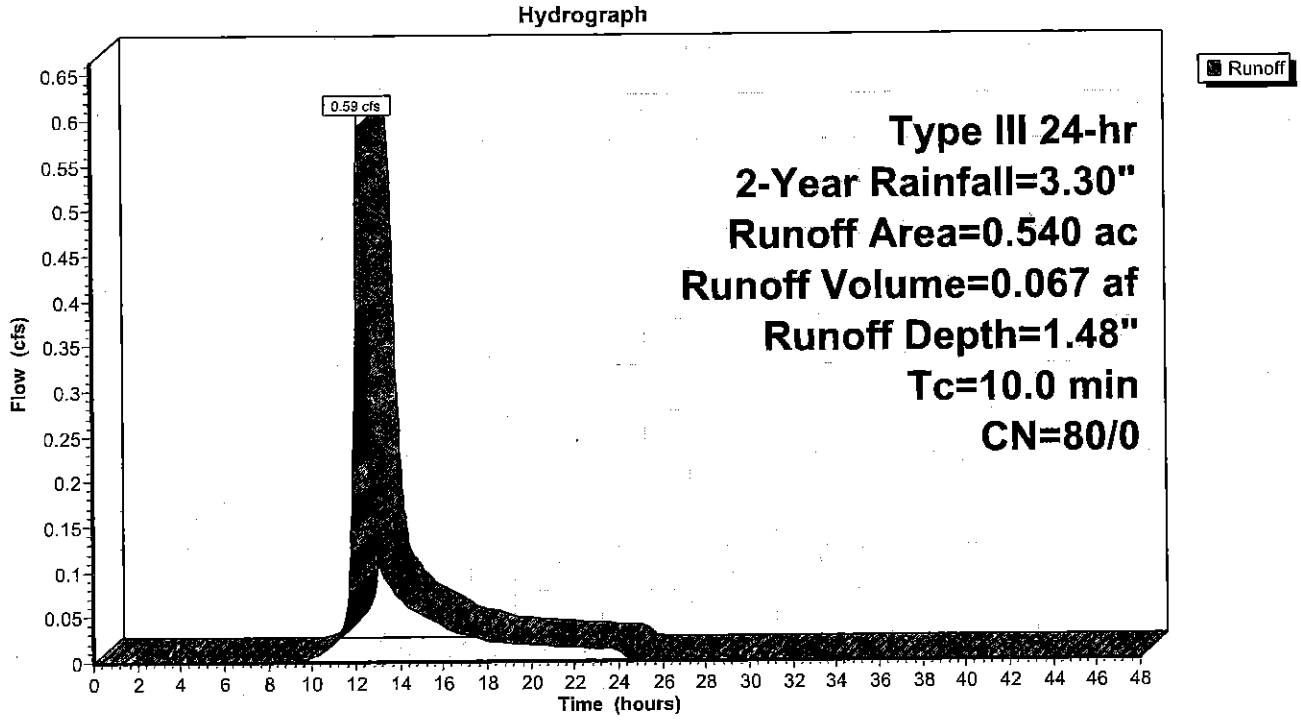
Runoff = 0.59 cfs @ 12.18 hrs, Volume= 0.067 af, Depth= 1.48"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (ac)	CN	Description
0.540	80	>75% Grass cover, Good, HSG D
0.540	80	100.00% Pervious Area

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

Subcatchment DEV-2: Uncontrolled DA2



Summary for Pond 1P: Wet Ponds (Combined)

Inflow Area = 18.970 ac, 87.77% Impervious, Inflow Depth = 2.86" for 2-Year event
Inflow = 32.02 cfs @ 12.22 hrs, Volume= 4.516 af
Outflow = 4.63 cfs @ 13.53 hrs, Volume= 4.415 af, Atten= 86%, Lag= 78.6 min
Primary = 2.32 cfs @ 13.53 hrs, Volume= 2.208 af
Secondary = 2.32 cfs @ 13.53 hrs, Volume= 2.208 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Starting Elev= 3.00' Surf.Area= 1.330 ac Storage= 5.620 af
Peak Elev= 4.84' @ 13.53 hrs Surf.Area= 1.368 ac Storage= 8.118 af (2.498 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 342.6 min (1,120.5 - 777.9)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	12.485 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
-3.00	0.550	0.000	0.000
-2.00	0.610	0.580	0.580
-1.00	0.770	0.690	1.270
0.00	0.900	0.835	2.105
1.00	1.150	1.025	3.130
2.00	1.250	1.200	4.330
3.00	1.330	1.290	5.620
4.00	1.360	1.345	6.965
5.00	1.370	1.365	8.330
6.00	1.380	1.375	9.705
7.00	1.390	1.385	11.090
8.00	1.400	1.395	12.485

Device	Routing	Invert	Outlet Devices
#1	Device 7	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#2	Device 8	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#3	Device 7	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 8	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Device 7	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Device 8	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#7	Primary	2.90'	**36.0" Round Culvert** L= 60.0' RCP, square edge headwall, Ke= 0.500

APPENDIX B

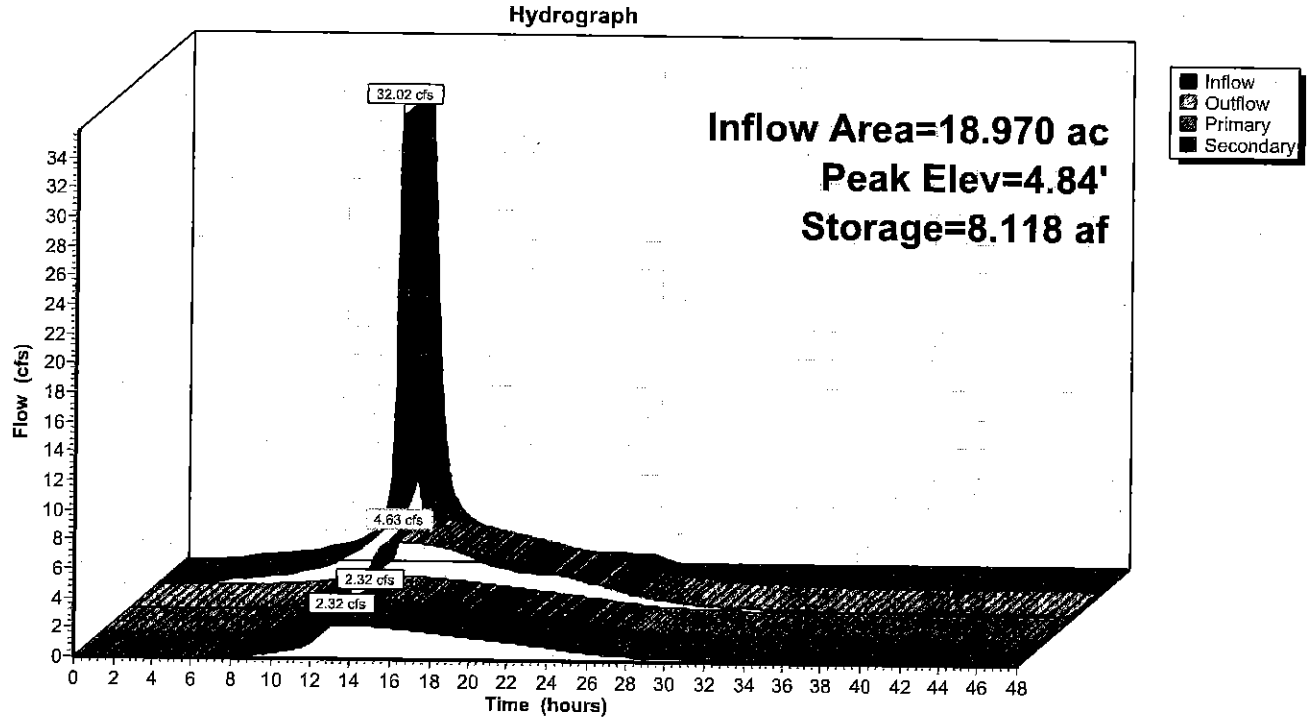
Inlet / Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
n= 0.013, Flow Area= 7.07 sf

#8 Secondary 2.90' **36.0" Round Culvert**
L= 60.0' RCP, square edge headwall, Ke= 0.500
Inlet / Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=2.32 cfs @ 13.53 hrs HW=4.84' (Free Discharge)
└**7=Culvert** (Passes 2.32 cfs of 18.46 cfs potential flow)
├**1=Orifice/Grate** (Orifice Controls 2.32 cfs @ 5.88 fps)
├**3=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)
└**5=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Secondary OutFlow Max=2.32 cfs @ 13.53 hrs HW=4.84' (Free Discharge)
└**8=Culvert** (Passes 2.32 cfs of 18.46 cfs potential flow)
├**2=Orifice/Grate** (Orifice Controls 2.32 cfs @ 5.88 fps)
├**4=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)
└**6=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 1P: Wet Ponds (Combined)



Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Hydrograph for Pond 1P: Wet Ponds (Combined)

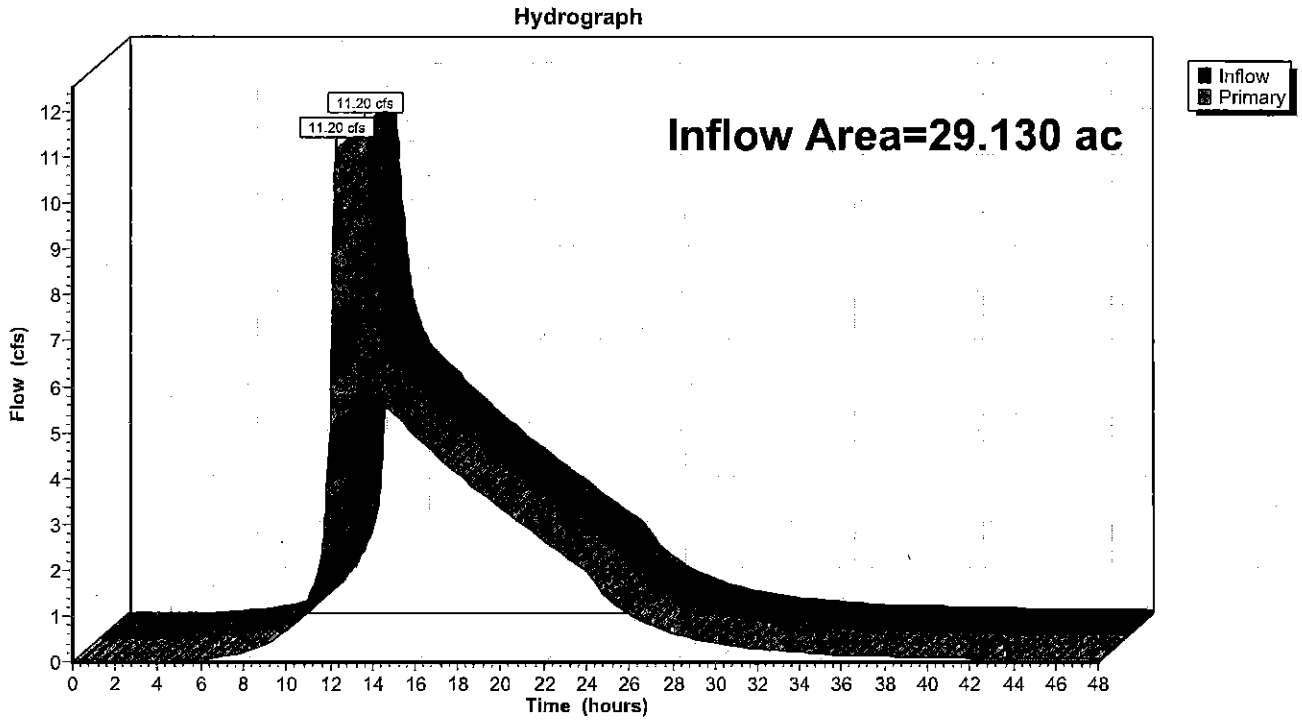
Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	5.620	3.00	0.00	0.00	0.00
1.00	0.00	5.620	3.00	0.00	0.00	0.00
2.00	0.07	5.621	3.00	0.00	0.00	0.00
3.00	0.21	5.632	3.01	0.00	0.00	0.00
4.00	0.35	5.655	3.03	0.01	0.00	0.00
5.00	0.48	5.688	3.05	0.02	0.01	0.01
6.00	0.61	5.730	3.08	0.07	0.03	0.03
7.00	0.83	5.780	3.12	0.12	0.06	0.06
8.00	1.12	5.848	3.17	0.21	0.10	0.10
9.00	1.63	5.935	3.23	0.39	0.19	0.19
10.00	2.29	6.053	3.32	0.69	0.34	0.34
11.00	3.43	6.210	3.44	1.16	0.58	0.58
12.00	**16.26**	6.598	3.73	2.32	1.16	1.16
13.00	**9.16**	**8.042**	**4.79**	**4.55**	**2.27**	**2.27**
14.00	3.52	**8.094**	**4.83**	**4.60**	**2.30**	**2.30**
15.00	2.53	7.962	4.73	4.45	2.23	2.23
16.00	1.83	7.783	4.60	4.23	2.12	2.12
17.00	1.39	7.575	4.45	3.97	1.98	1.98
18.00	1.08	7.361	4.29	3.67	1.84	1.84
19.00	0.92	7.152	4.14	3.36	1.68	1.68
20.00	0.82	6.960	4.00	3.04	1.52	1.52
21.00	0.75	6.787	3.87	2.71	1.36	1.36
22.00	0.68	6.634	3.75	2.39	1.20	1.20
23.00	0.61	6.503	3.66	2.08	1.04	1.04
24.00	0.54	6.392	3.57	1.76	0.88	0.88
25.00	0.02	6.278	3.49	1.38	0.69	0.69
26.00	0.00	6.178	3.41	1.06	0.53	0.53
27.00	0.00	6.101	3.36	0.82	0.41	0.41
28.00	0.00	6.041	3.31	0.65	0.32	0.32
29.00	0.00	5.993	3.28	0.52	0.26	0.26
30.00	0.00	5.954	3.25	0.43	0.21	0.21
31.00	0.00	5.922	3.22	0.36	0.18	0.18
32.00	0.00	5.894	3.20	0.30	0.15	0.15
33.00	0.00	5.871	3.19	0.26	0.13	0.13
34.00	0.00	5.852	3.17	0.22	0.11	0.11
35.00	0.00	5.835	3.16	0.18	0.09	0.09
36.00	0.00	5.821	3.15	0.17	0.08	0.08
37.00	0.00	5.808	3.14	0.15	0.08	0.08
38.00	0.00	5.796	3.13	0.14	0.07	0.07
39.00	0.00	5.785	3.12	0.13	0.06	0.06
40.00	0.00	5.775	3.12	0.12	0.06	0.06
41.00	0.00	5.766	3.11	0.11	0.05	0.05
42.00	0.00	5.757	3.10	0.10	0.05	0.05
43.00	0.00	5.750	3.10	0.09	0.04	0.04
44.00	0.00	5.743	3.09	0.08	0.04	0.04
45.00	0.00	5.737	3.09	0.07	0.04	0.04
46.00	0.00	5.731	3.08	0.07	0.03	0.03
47.00	0.00	5.726	3.08	0.06	0.03	0.03
48.00	0.00	5.721	3.07	0.06	0.03	0.03

Summary for Link 1: Analysis Point

Inflow Area = 29.130 ac, 57.81% Impervious, Inflow Depth > 2.28" for 2-Year event
Inflow = 11.20 cfs @ 12.37 hrs, Volume= 5.545 af
Primary = 11.20 cfs @ 12.37 hrs, Volume= 5.545 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link 1: Analysis Point



Hydrograph for Link 1: Analysis Point

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	**0.00**	0.00	25.50	1.21	0.00	1.21
0.50	0.00	0.00	0.00	26.00	1.06	0.00	1.06
1.00	0.00	0.00	0.00	26.50	0.92	0.00	0.92
1.50	0.00	0.00	0.00	27.00	0.82	0.00	0.82
2.00	0.00	0.00	0.00	27.50	0.73	0.00	0.73
2.50	0.00	0.00	0.00	28.00	0.65	0.00	0.65
3.00	0.01	0.00	0.01	28.50	0.58	0.00	0.58
3.50	0.01	0.00	0.01	29.00	0.52	0.00	0.52
4.00	0.01	0.00	0.01	29.50	0.47	0.00	0.47
4.50	0.02	0.00	0.02	30.00	0.43	0.00	0.43
5.00	0.03	0.00	0.03	30.50	0.39	0.00	0.39
5.50	0.05	0.00	0.05	31.00	0.36	0.00	0.36
6.00	0.07	0.00	0.07	31.50	0.33	0.00	0.33
6.50	0.10	0.00	0.10	32.00	0.30	0.00	0.30
7.00	0.13	0.00	0.13	32.50	0.28	0.00	0.28
7.50	0.17	0.00	0.17	33.00	0.26	0.00	0.26
8.00	0.22	0.00	0.22	33.50	0.24	0.00	0.24
8.50	0.31	0.00	0.31	34.00	0.22	0.00	0.22
9.00	0.41	0.00	0.41	34.50	0.20	0.00	0.20
9.50	0.53	0.00	0.53	35.00	0.18	0.00	0.18
10.00	0.72	0.00	0.72	35.50	0.17	0.00	0.17
10.50	0.98	0.00	0.98	36.00	0.17	0.00	0.17
11.00	1.40	0.00	1.40	36.50	0.16	0.00	0.16
11.50	2.04	0.00	2.04	37.00	0.15	0.00	0.15
12.00	**5.10**	0.00	**5.10**	37.50	0.14	0.00	0.14
12.50	**10.85**	0.00	**10.85**	38.00	0.14	0.00	0.14
13.00	7.85	0.00	7.85	38.50	0.13	0.00	0.13
13.50	6.48	0.00	6.48	39.00	0.13	0.00	0.13
14.00	5.96	0.00	5.96	39.50	0.12	0.00	0.12
14.50	5.65	0.00	5.65	40.00	0.12	0.00	0.12
15.00	5.42	0.00	5.42	40.50	0.11	0.00	0.11
15.50	5.20	0.00	5.20	41.00	0.11	0.00	0.11
16.00	4.96	0.00	4.96	41.50	0.10	0.00	0.10
16.50	4.72	0.00	4.72	42.00	0.10	0.00	0.10
17.00	4.52	0.00	4.52	42.50	0.09	0.00	0.09
17.50	4.31	0.00	4.31	43.00	0.09	0.00	0.09
18.00	4.11	0.00	4.11	43.50	0.08	0.00	0.08
18.50	3.90	0.00	3.90	44.00	0.08	0.00	0.08
19.00	3.72	0.00	3.72	44.50	0.08	0.00	0.08
19.50	3.55	0.00	3.55	45.00	0.07	0.00	0.07
20.00	3.37	0.00	3.37	45.50	0.07	0.00	0.07
20.50	3.19	0.00	3.19	46.00	0.07	0.00	0.07
21.00	3.02	0.00	3.02	46.50	0.06	0.00	0.06
21.50	2.85	0.00	2.85	47.00	0.06	0.00	0.06
22.00	2.67	0.00	2.67	47.50	0.06	0.00	0.06
22.50	2.50	0.00	2.50	48.00	0.06	0.00	0.06
23.00	2.32	0.00	2.32				
23.50	2.16	0.00	2.16				
24.00	1.98	0.00	1.98				
24.50	1.65	0.00	1.65				
25.00	1.40	0.00	1.40				

Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Z: UncontrolledDA1 Runoff Area=1.050 ac 18.10% Impervious Runoff Depth=3.23"
Tc=10.0 min CN=80/98 Runoff=2.52 cfs 0.283 af

SubcatchmentDA-1AIMP: DA-1A-IMP Runoff Area=8.340 ac 100.00% Impervious Runoff Depth=4.76"
Tc=15.0 min CN=0/98 Runoff=22.72 cfs 3.310 af

SubcatchmentDA-1APER: DA-1A-Perv Runoff Area=2.320 ac 0.00% Impervious Runoff Depth=2.71"
Tc=15.0 min CN=78/0 Runoff=3.98 cfs 0.524 af

SubcatchmentDA-1APond:DA-1APond Runoff Area=1.470 ac 100.00% Impervious Runoff Depth=4.76"
Tc=10.0 min CN=0/98 Runoff=4.80 cfs 0.583 af

SubcatchmentDA1A-BLD:Building Runoff Area=6.840 ac 100.00% Impervious Runoff Depth=4.76"
Tc=15.0 min CN=0/98 Runoff=18.63 cfs 2.715 af

SubcatchmentDEV-1B: DA-1B Runoff Area=8.250 ac 0.00% Impervious Runoff Depth=2.62"
Tc=18.0 min CN=77/0 Runoff=12.50 cfs 1.803 af

SubcatchmentDEV-1C: DA-1C Runoff Area=0.860 ac 0.00% Impervious Runoff Depth=2.62"
Tc=18.0 min CN=77/0 Runoff=1.30 cfs 0.188 af

SubcatchmentDEV-2: UncontrolledDA2 Runoff Area=0.540 ac 0.00% Impervious Runoff Depth=2.89"
Tc=10.0 min CN=80/0 Runoff=1.19 cfs 0.130 af

Pond 1P: Wet Ponds (Combined) Peak Elev=5.68' Storage=9.264 af Inflow=49.99 cfs 7.133 af
Primary=6.05 cfs 3.511 af Secondary=6.05 cfs 3.511 af Outflow=12.10 cfs 7.022 af

Link 1: AnalysisPoint Inflow=20.91 cfs 9.296 af
Primary=20.91 cfs 9.296 af

Total Runoff Area = 29.670 ac Runoff Volume = 9.537 af Average Runoff Depth = 3.86"
43.24% Pervious = 12.830 ac 56.76% Impervious = 16.840 ac

Summary for Subcatchment 1Z: Uncontrolled DA1

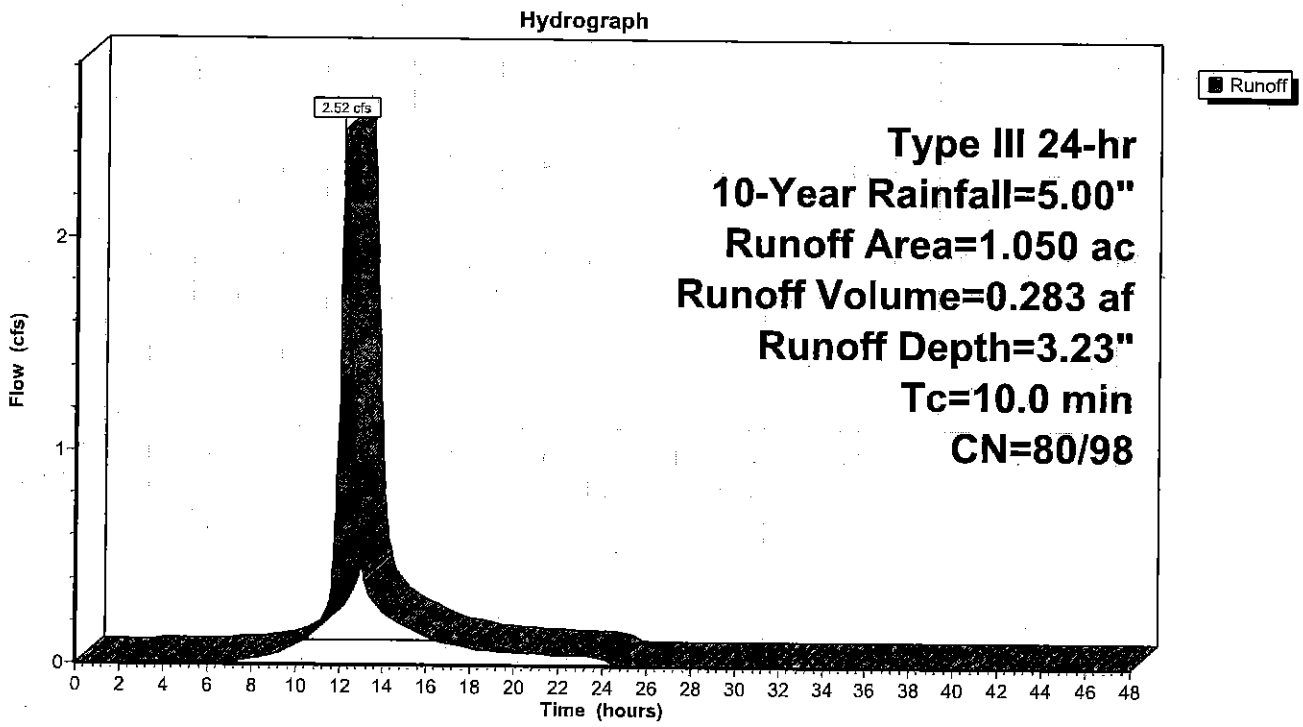
Runoff = 2.52 cfs @ 12.17 hrs, Volume= 0.283 af, Depth= 3.23"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

	Area (ac)	CN	Description
	0.860	80	>75% Grass cover, Good, HSG D
*	0.190	98	Impervious
	1.050	83	Weighted Average
	0.860	80	81.90% Pervious Area
	0.190	98	18.10% Impervious Area

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

Subcatchment 1Z: Uncontrolled DA1



Summary for Subcatchment DA-1A IMP: DA-1A-IMP

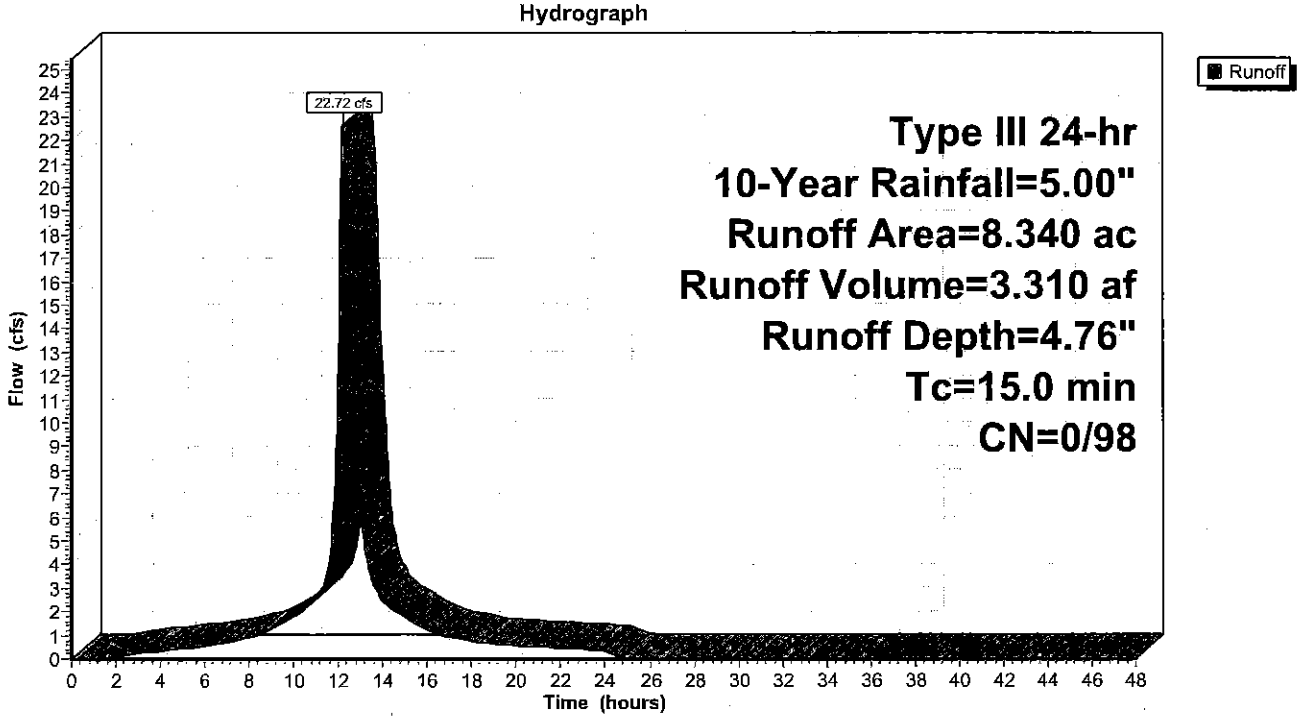
Runoff = 22.72 cfs @ 12.23 hrs, Volume= 3.310 af, Depth= 4.76"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

	Area (ac)	CN	Description
*	8.340	98	Paved
	8.340	98	100.00% Impervious Area

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

Subcatchment DA-1A IMP: DA-1A-IMP



Summary for Subcatchment DA-1A PER: DA-1A-Perv

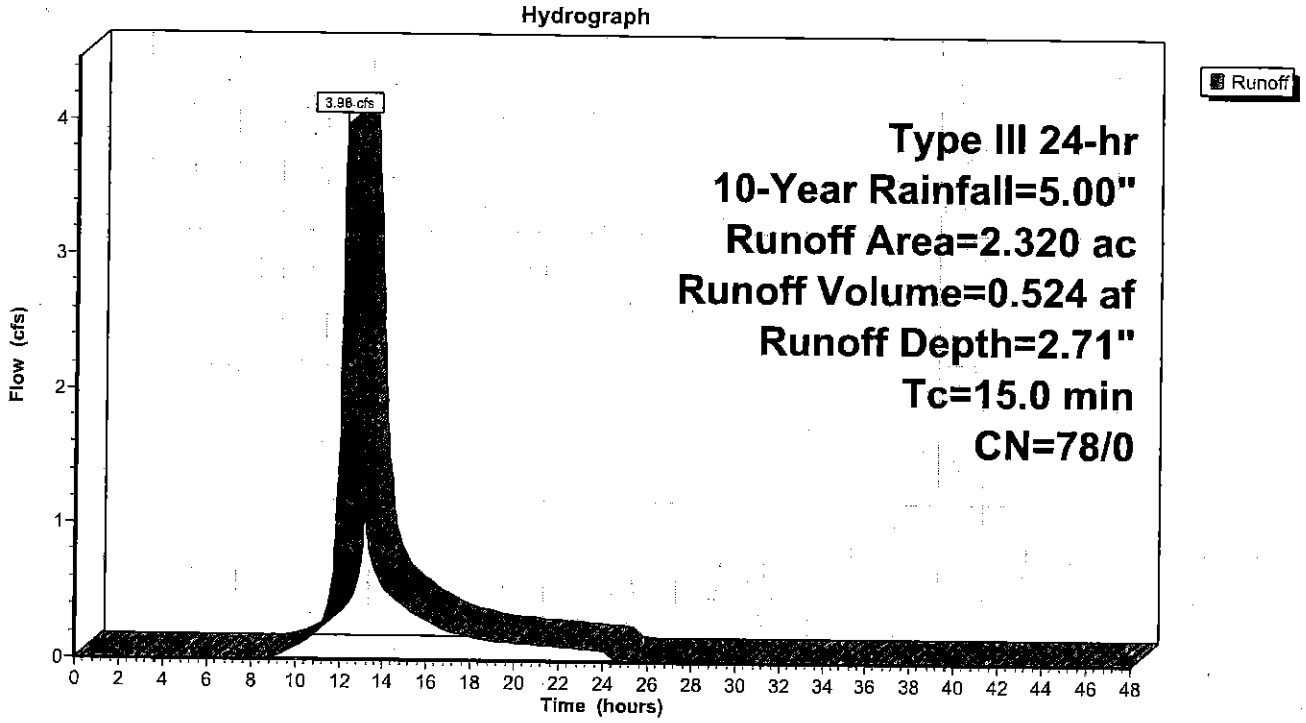
Runoff = 3.98 cfs @ 12.26 hrs, Volume= 0.524 af, Depth= 2.71"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
1.480	80	>75% Grass cover, Good, HSG D
0.840	74	>75% Grass cover, Good, HSG C
2.320	78	Weighted Average
2.320	78	100.00% Pervious Area

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

Subcatchment DA-1A PER: DA-1A-Perv



Summary for Subcatchment DA-1APond: DA-1A Pond

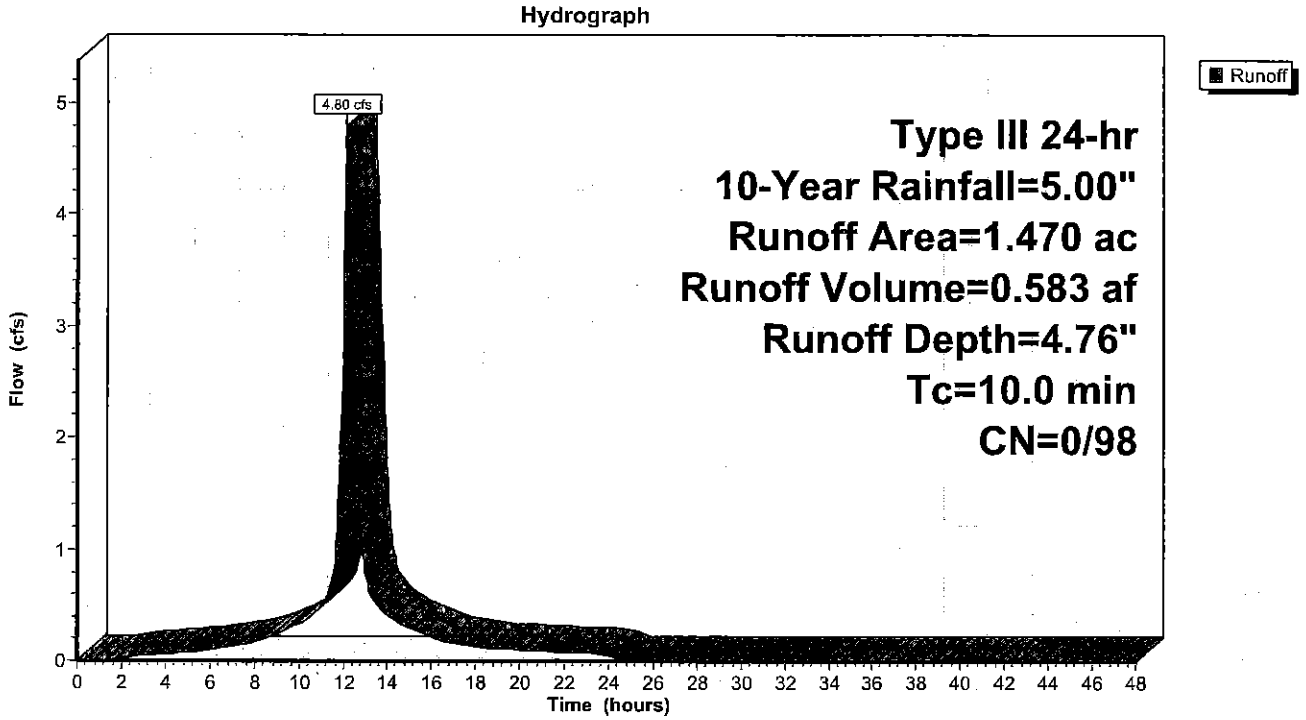
Runoff = 4.80 cfs @ 12.16 hrs, Volume= 0.583 af, Depth= 4.76"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

	Area (ac)	CN	Description
*	1.470	98	Wet Pond
	1.470	98	100.00% Impervious Area

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

Subcatchment DA-1APond: DA-1A Pond



Summary for Subcatchment DA1A-BLD: Building

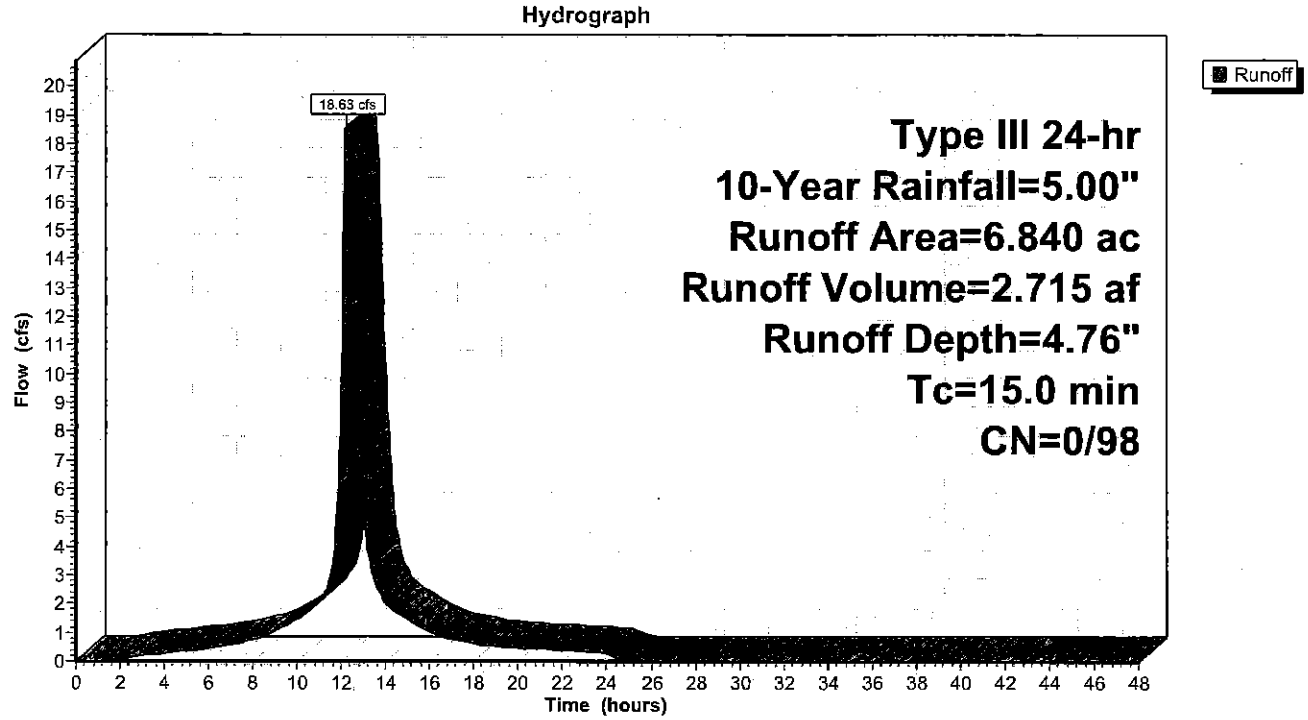
Runoff = 18.63 cfs @ 12.23 hrs, Volume= 2.715 af, Depth= 4.76"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

	Area (ac)	CN	Description
*	6.840	98	Roofs
	6.840	98	100.00% Impervious Area

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

Subcatchment DA1A-BLD: Building



Summary for Subcatchment DEV-1B: DA-1B

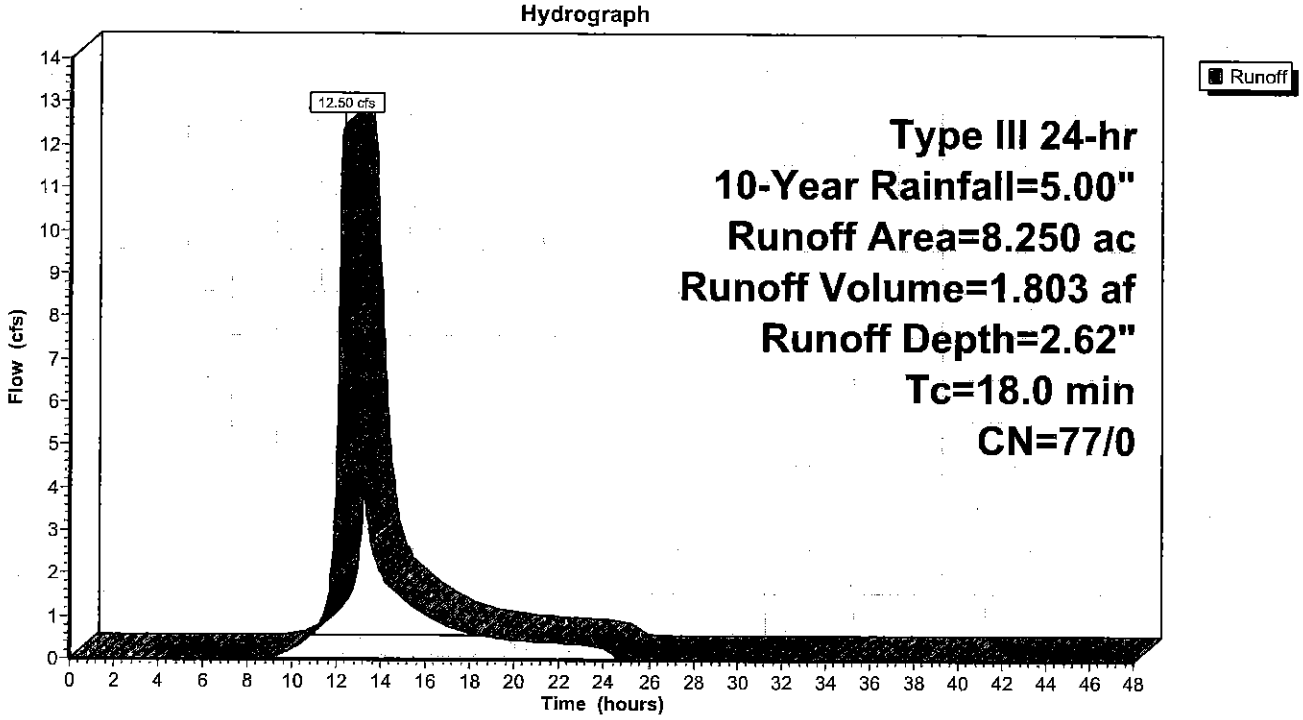
Runoff = 12.50 cfs @ 12.31 hrs, Volume= 1.803 af, Depth= 2.62"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
7.950	77	Woods, Good, HSG D
0.300	80	>75% Grass cover, Good, HSG D
8.250	77	Weighted Average
8.250	77	100.00% Pervious Area

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

Subcatchment DEV-1B: DA-1B



Dev DA two outlets
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Summary for Subcatchment DEV-1C: DA-1C

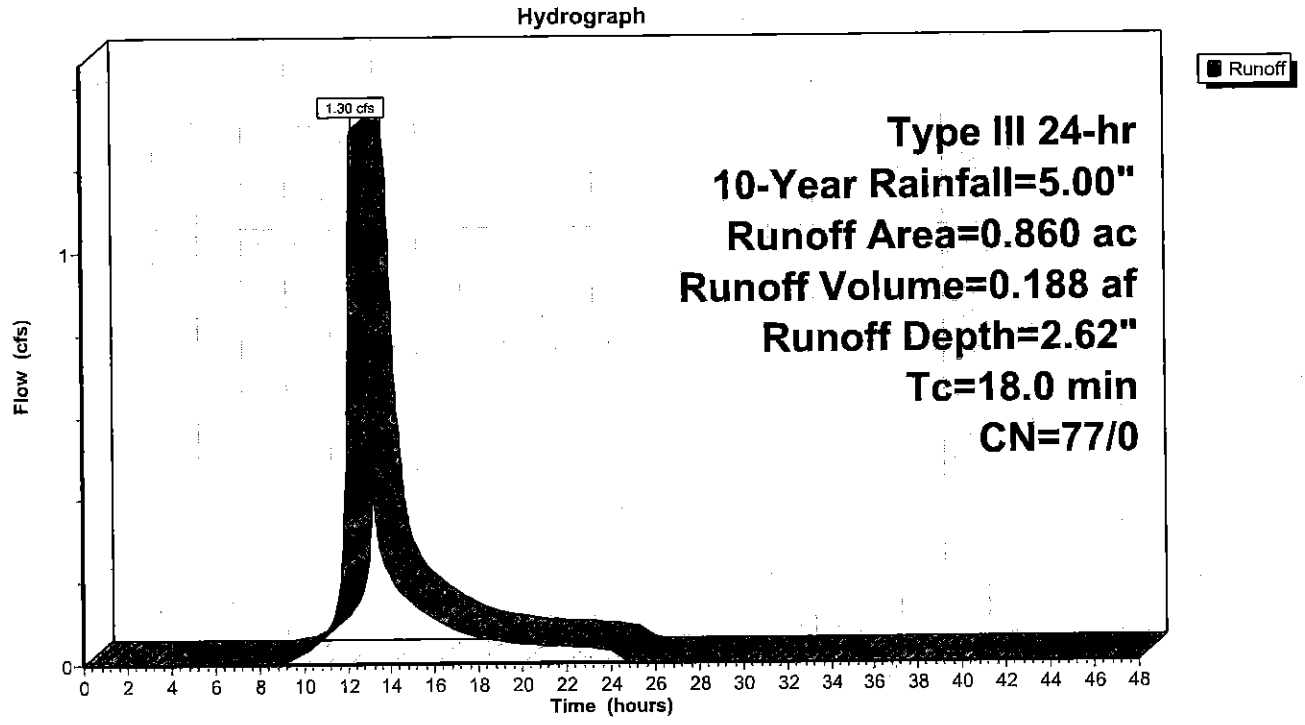
Runoff = 1.30 cfs @ 12.31 hrs, Volume= 0.188 af, Depth= 2.62"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
0.040	70	Woods, Good, HSG C
0.820	77	Woods, Good, HSG D
0.860	77	Weighted Average
0.860	77	100.00% Pervious Area

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

Subcatchment DEV-1C: DA-1C



Summary for Subcatchment DEV-2: Uncontrolled DA2

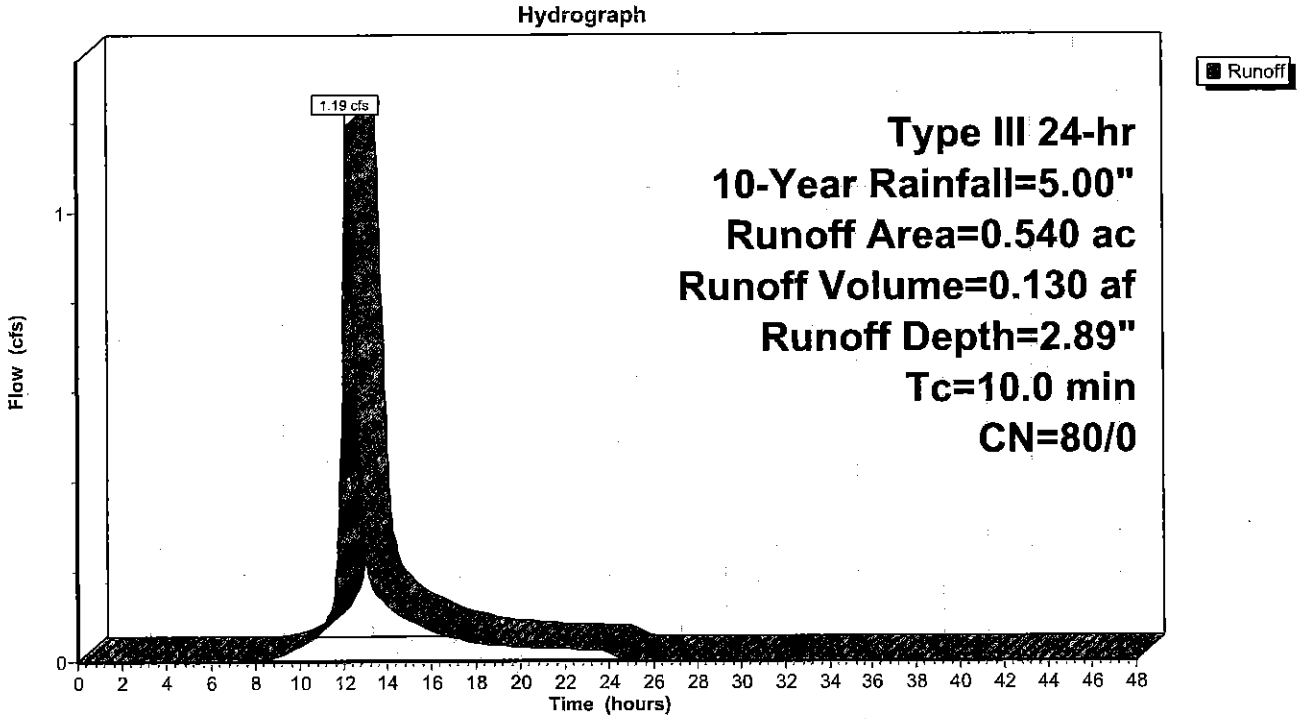
Runoff = 1.19 cfs @ 12.17 hrs, Volume= 0.130 af, Depth= 2.89"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.00"

Area (ac)	CN	Description
0.540	80	>75% Grass cover, Good, HSG D
0.540	80	100.00% Pervious Area

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

Subcatchment DEV-2: Uncontrolled DA2



Summary for Pond 1P: Wet Ponds (Combined)

Inflow Area = 18.970 ac, 87.77% Impervious, Inflow Depth = 4.51" for 10-Year event
Inflow = 49.99 cfs @ 12.22 hrs, Volume= 7.133 af
Outflow = 12.10 cfs @ 13.09 hrs, Volume= 7.022 af, Atten= 76%, Lag= 52.3 min
Primary = 6.05 cfs @ 13.09 hrs, Volume= 3.511 af
Secondary = 6.05 cfs @ 13.09 hrs, Volume= 3.511 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Starting Elev= 3.00' Surf.Area= 1.330 ac Storage= 5.620 af
Peak Elev= 5.68' @ 13.09 hrs Surf.Area= 1.377 ac Storage= 9.264 af (3.644 af above start)

Plug-Flow detention time= 1,154.1 min calculated for 1.400 af (20% of inflow)
Center-of-Mass det. time= 310.8 min (1,081.5 - 770.7)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	12.485 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
-3.00	0.550	0.000	0.000
-2.00	0.610	0.580	0.580
-1.00	0.770	0.690	1.270
0.00	0.900	0.835	2.105
1.00	1.150	1.025	3.130
2.00	1.250	1.200	4.330
3.00	1.330	1.290	5.620
4.00	1.360	1.345	6.965
5.00	1.370	1.365	8.330
6.00	1.380	1.375	9.705
7.00	1.390	1.385	11.090
8.00	1.400	1.395	12.485

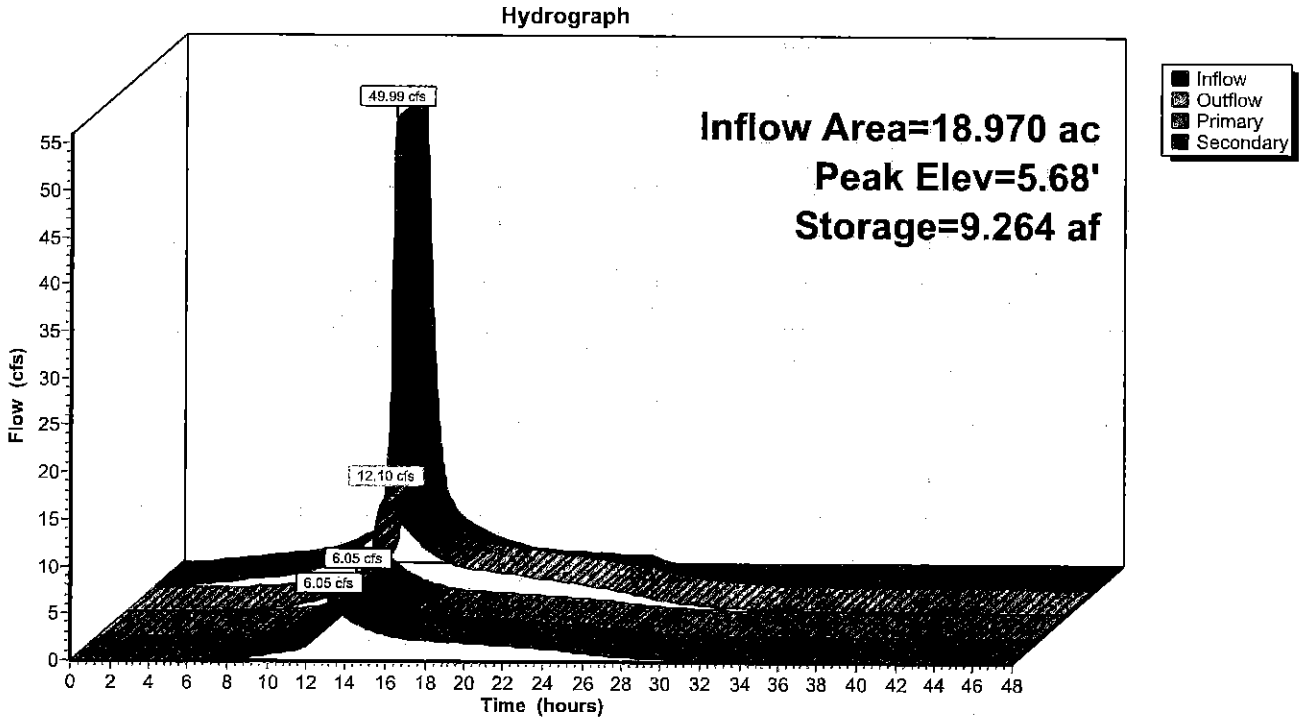
Device	Routing	Invert	Outlet Devices
#1	Device 7	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#2	Device 8	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#3	Device 7	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 8	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Device 7	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Device 8	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#7	Primary	2.90'	**36.0" Round Culvert** L= 60.0' RCP, square edge headwall, Ke= 0.500

			Inlet / Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
			n= 0.013, Flow Area= 7.07 sf
#8	Secondary	2.90'	**36.0" Round Culvert**
			L= 60.0' RCP, square edge headwall, Ke= 0.500
			Inlet / Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
			n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=6.05 cfs @ 13.09 hrs HW=5.68' (Free Discharge)
└**7=Culvert** (Passes 6.05 cfs of 32.37 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 2.89 cfs @ 7.34 fps)
  ├**3=Broad-Crested Rectangular Weir**(Weir Controls 3.15 cfs @ 2.89 fps)
  └**5=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Secondary OutFlow Max=6.05 cfs @ 13.09 hrs HW=5.68' (Free Discharge)
└**8=Culvert** (Passes 6.05 cfs of 32.37 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 2.89 cfs @ 7.34 fps)
  ├**4=Broad-Crested Rectangular Weir**(Weir Controls 3.15 cfs @ 2.89 fps)
  └**6=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 1P: Wet Ponds (Combined)



Hydrograph for Pond 1P: Wet Ponds (Combined)

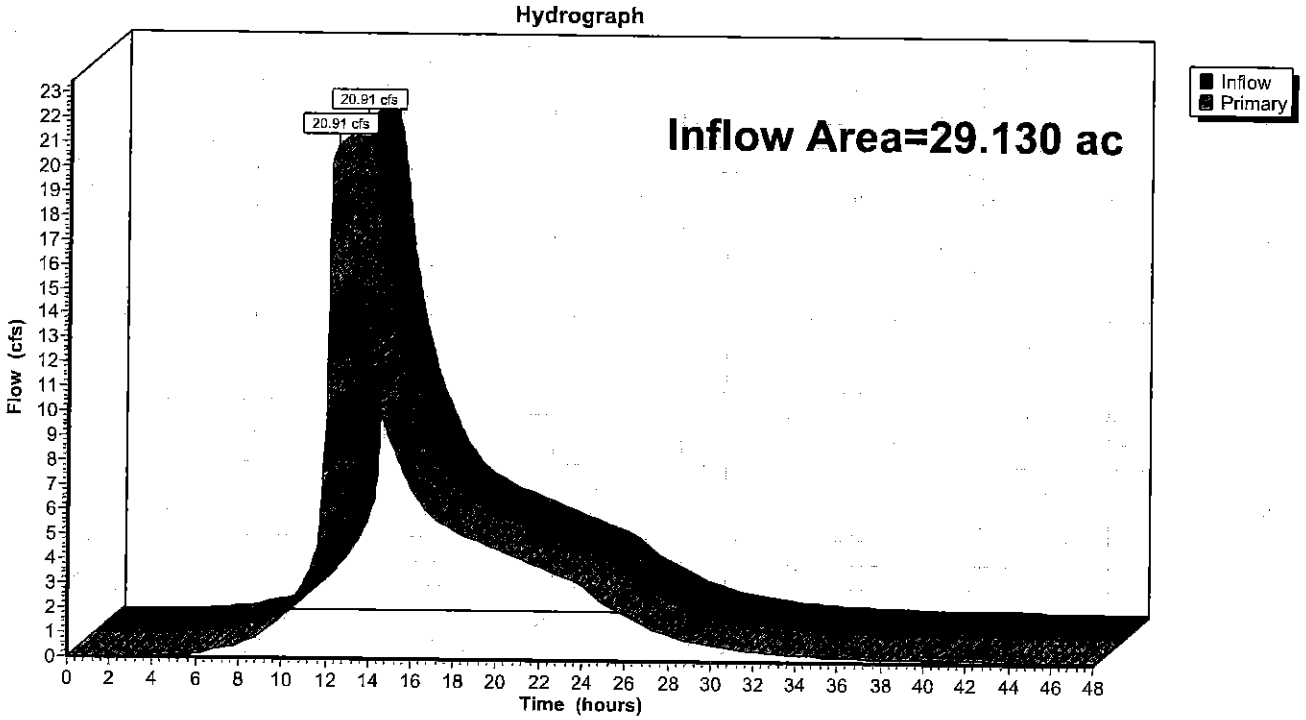
Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	5.620	3.00	0.00	0.00	0.00
1.00	0.01	5.620	3.00	0.00	0.00	0.00
2.00	0.25	5.630	3.01	0.00	0.00	0.00
3.00	0.48	5.660	3.03	0.01	0.01	0.01
4.00	0.70	5.707	3.06	0.04	0.02	0.02
5.00	0.89	5.767	3.11	0.11	0.05	0.05
6.00	1.07	5.836	3.16	0.18	0.09	0.09
7.00	1.41	5.915	3.22	0.35	0.17	0.17
8.00	1.85	6.013	3.29	0.57	0.29	0.29
9.00	2.65	6.134	3.38	0.91	0.46	0.46
10.00	3.70	6.299	3.50	1.45	0.73	0.73
11.00	5.48	6.522	3.67	2.13	1.06	1.06
12.00	**25.54**	7.131	4.12	3.32	1.66	1.66
13.00	**14.22**	**9.256**	**5.67**	**12.02**	**6.01**	**6.01**
14.00	5.44	**9.010**	**5.49**	**9.52**	**4.76**	**4.76**
15.00	3.90	8.707	5.27	7.13	3.57	3.57
16.00	2.83	8.459	5.09	5.70	2.85	2.85
17.00	2.14	8.230	4.93	4.80	2.40	2.40
18.00	1.67	8.005	4.76	4.50	2.25	2.25
19.00	1.41	7.769	4.59	4.22	2.11	2.11
20.00	1.27	7.544	4.42	3.92	1.96	1.96
21.00	1.15	7.331	4.27	3.63	1.81	1.81
22.00	1.05	7.135	4.12	3.33	1.66	1.66
23.00	0.94	6.954	3.99	3.03	1.51	1.51
24.00	0.84	6.790	3.87	2.72	1.36	1.36
25.00	0.02	6.605	3.73	2.33	1.17	1.17
26.00	0.00	6.431	3.60	1.89	0.94	0.94
27.00	0.00	6.295	3.50	1.44	0.72	0.72
28.00	0.00	6.191	3.42	1.10	0.55	0.55
29.00	0.00	6.111	3.37	0.85	0.42	0.42
30.00	0.00	6.048	3.32	0.67	0.34	0.34
31.00	0.00	5.999	3.28	0.53	0.27	0.27
32.00	0.00	5.959	3.25	0.44	0.22	0.22
33.00	0.00	5.926	3.23	0.37	0.18	0.18
34.00	0.00	5.898	3.21	0.31	0.16	0.16
35.00	0.00	5.874	3.19	0.26	0.13	0.13
36.00	0.00	5.854	3.17	0.22	0.11	0.11
37.00	0.00	5.837	3.16	0.19	0.09	0.09
38.00	0.00	5.823	3.15	0.17	0.08	0.08
39.00	0.00	5.810	3.14	0.15	0.08	0.08
40.00	0.00	5.797	3.13	0.14	0.07	0.07
41.00	0.00	5.786	3.12	0.13	0.06	0.06
42.00	0.00	5.776	3.12	0.12	0.06	0.06
43.00	0.00	5.767	3.11	0.11	0.05	0.05
44.00	0.00	5.759	3.10	0.10	0.05	0.05
45.00	0.00	5.751	3.10	0.09	0.04	0.04
46.00	0.00	5.744	3.09	0.08	0.04	0.04
47.00	0.00	5.737	3.09	0.07	0.04	0.04
48.00	0.00	5.732	3.08	0.07	0.03	0.03

Summary for Link 1: Analysis Point

Inflow Area = 29.130 ac, 57.81% Impervious, Inflow Depth > 3.83" for 10-Year event
Inflow = 20.91 cfs @ 12.51 hrs, Volume= 9.296 af
Primary = 20.91 cfs @ 12.51 hrs, Volume= 9.296 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link 1: Analysis Point



Hydrograph for Link 1: Analysis Point

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	**0.00**	0.00	25.50	2.11	0.00	2.11
0.50	0.00	0.00	0.00	26.00	1.89	0.00	1.89
1.00	0.00	0.00	0.00	26.50	1.65	0.00	1.65
1.50	0.00	0.00	0.00	27.00	1.44	0.00	1.44
2.00	0.01	0.00	0.01	27.50	1.26	0.00	1.26
2.50	0.01	0.00	0.01	28.00	1.10	0.00	1.10
3.00	0.02	0.00	0.02	28.50	0.96	0.00	0.96
3.50	0.02	0.00	0.02	29.00	0.85	0.00	0.85
4.00	0.05	0.00	0.05	29.50	0.75	0.00	0.75
4.50	0.08	0.00	0.08	30.00	0.67	0.00	0.67
5.00	0.12	0.00	0.12	30.50	0.60	0.00	0.60
5.50	0.16	0.00	0.16	31.00	0.53	0.00	0.53
6.00	0.20	0.00	0.20	31.50	0.48	0.00	0.48
6.50	0.28	0.00	0.28	32.00	0.44	0.00	0.44
7.00	0.36	0.00	0.36	32.50	0.40	0.00	0.40
7.50	0.46	0.00	0.46	33.00	0.37	0.00	0.37
8.00	0.60	0.00	0.60	33.50	0.34	0.00	0.34
8.50	0.77	0.00	0.77	34.00	0.31	0.00	0.31
9.00	1.02	0.00	1.02	34.50	0.29	0.00	0.29
9.50	1.39	0.00	1.39	35.00	0.26	0.00	0.26
10.00	1.84	0.00	1.84	35.50	0.24	0.00	0.24
10.50	2.39	0.00	2.39	36.00	0.22	0.00	0.22
11.00	3.07	0.00	3.07	36.50	0.20	0.00	0.20
11.50	4.11	0.00	4.11	37.00	0.19	0.00	0.19
12.00	9.93	0.00	9.93	37.50	0.18	0.00	0.18
12.50	**20.91**	0.00	**20.91**	38.00	0.17	0.00	0.17
13.00	18.43	0.00	18.43	38.50	0.16	0.00	0.16
13.50	14.64	0.00	14.64	39.00	0.15	0.00	0.15
14.00	11.99	0.00	11.99	39.50	0.15	0.00	0.15
14.50	10.17	0.00	10.17	40.00	0.14	0.00	0.14
15.00	8.88	0.00	8.88	40.50	0.13	0.00	0.13
15.50	7.86	0.00	7.86	41.00	0.13	0.00	0.13
16.00	6.99	0.00	6.99	41.50	0.12	0.00	0.12
16.50	6.26	0.00	6.26	42.00	0.12	0.00	0.12
17.00	5.78	0.00	5.78	42.50	0.11	0.00	0.11
17.50	5.51	0.00	5.51	43.00	0.11	0.00	0.11
18.00	5.27	0.00	5.27	43.50	0.10	0.00	0.10
18.50	5.05	0.00	5.05	44.00	0.10	0.00	0.10
19.00	4.86	0.00	4.86	44.50	0.09	0.00	0.09
19.50	4.68	0.00	4.68	45.00	0.09	0.00	0.09
20.00	4.51	0.00	4.51	45.50	0.08	0.00	0.08
20.50	4.33	0.00	4.33	46.00	0.08	0.00	0.08
21.00	4.16	0.00	4.16	46.50	0.08	0.00	0.08
21.50	3.98	0.00	3.98	47.00	0.07	0.00	0.07
22.00	3.81	0.00	3.81	47.50	0.07	0.00	0.07
22.50	3.64	0.00	3.64	48.00	0.07	0.00	0.07
23.00	3.47	0.00	3.47				
23.50	3.29	0.00	3.29				
24.00	3.11	0.00	3.11				
24.50	2.67	0.00	2.67				
25.00	2.35	0.00	2.35				

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Z: UncontrolledDA1 Runoff Area=1.050 ac 18.10% Impervious Runoff Depth=6.49"
Tc=10.0 min CN=80/98 Runoff=5.03 cfs 0.568 af

SubcatchmentDA-1AIMP: DA-1A-IMP Runoff Area=8.340 ac 100.00% Impervious Runoff Depth=8.26"
Tc=15.0 min CN=0/98 Runoff=38.80 cfs 5.741 af

SubcatchmentDA-1APER: DA-1A-Perv Runoff Area=2.320 ac 0.00% Impervious Runoff Depth=5.85"
Tc=15.0 min CN=78/0 Runoff=8.58 cfs 1.132 af

SubcatchmentDA-1APond:DA-1APond Runoff Area=1.470 ac 100.00% Impervious Runoff Depth=8.26"
Tc=10.0 min CN=0/98 Runoff=8.19 cfs 1.012 af

SubcatchmentDA1A-BLD:Building Runoff Area=6.840 ac 100.00% Impervious Runoff Depth=8.26"
Tc=15.0 min CN=0/98 Runoff=31.82 cfs 4.708 af

SubcatchmentDEV-1B: DA-1B Runoff Area=8.250 ac 0.00% Impervious Runoff Depth=5.73"
Tc=18.0 min CN=77/0 Runoff=27.44 cfs 3.943 af

SubcatchmentDEV-1C: DA-1C Runoff Area=0.860 ac 0.00% Impervious Runoff Depth=5.73"
Tc=18.0 min CN=77/0 Runoff=2.86 cfs 0.411 af

SubcatchmentDEV-2: UncontrolledDA2 Runoff Area=0.540 ac 0.00% Impervious Runoff Depth=6.10"
Tc=10.0 min CN=80/0 Runoff=2.49 cfs 0.274 af

Pond 1P: Wet Ponds (Combined) Peak Elev=6.84' Storage=10.873 af Inflow=87.19 cfs 12.593 af
Primary=21.80 cfs 6.235 af Secondary=21.80 cfs 6.235 af Outflow=43.60 cfs 12.470 af

Link 1: AnalysisPoint Inflow=67.19 cfs 17.391 af
Primary=67.19 cfs 17.391 af

Total Runoff Area = 29.670 ac Runoff Volume = 17.788 af Average Runoff Depth = 7.19"
43.24% Pervious = 12.830 ac 56.76% Impervious = 16.840 ac

Summary for Subcatchment 1Z: Uncontrolled DA1

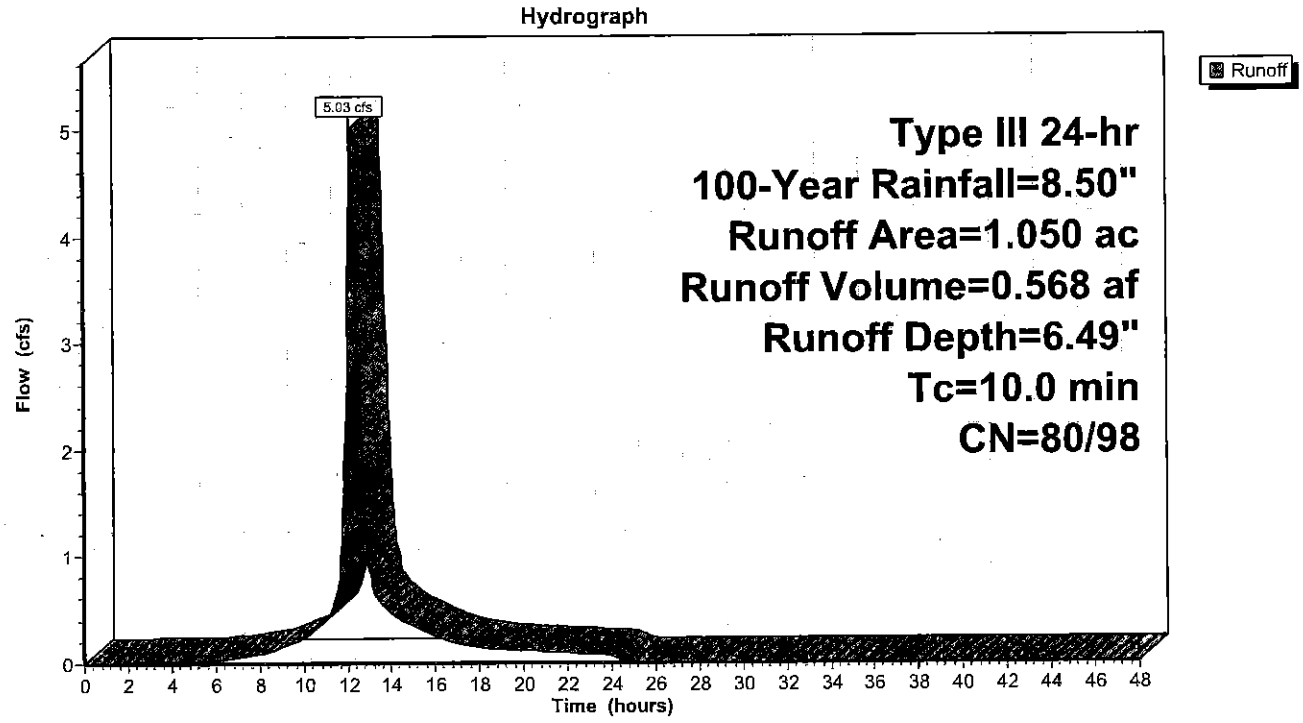
Runoff = 5.03 cfs @ 12.16 hrs, Volume= 0.568 af, Depth= 6.49"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

	Area (ac)	CN	Description
	0.860	80	>75% Grass cover, Good, HSG D
*	0.190	98	Impervious
	1.050	83	Weighted Average
	0.860	80	81.90% Pervious Area
	0.190	98	18.10% Impervious Area

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

Subcatchment 1Z: Uncontrolled DA1



Summary for Subcatchment DA-1A IMP: DA-1A-IMP

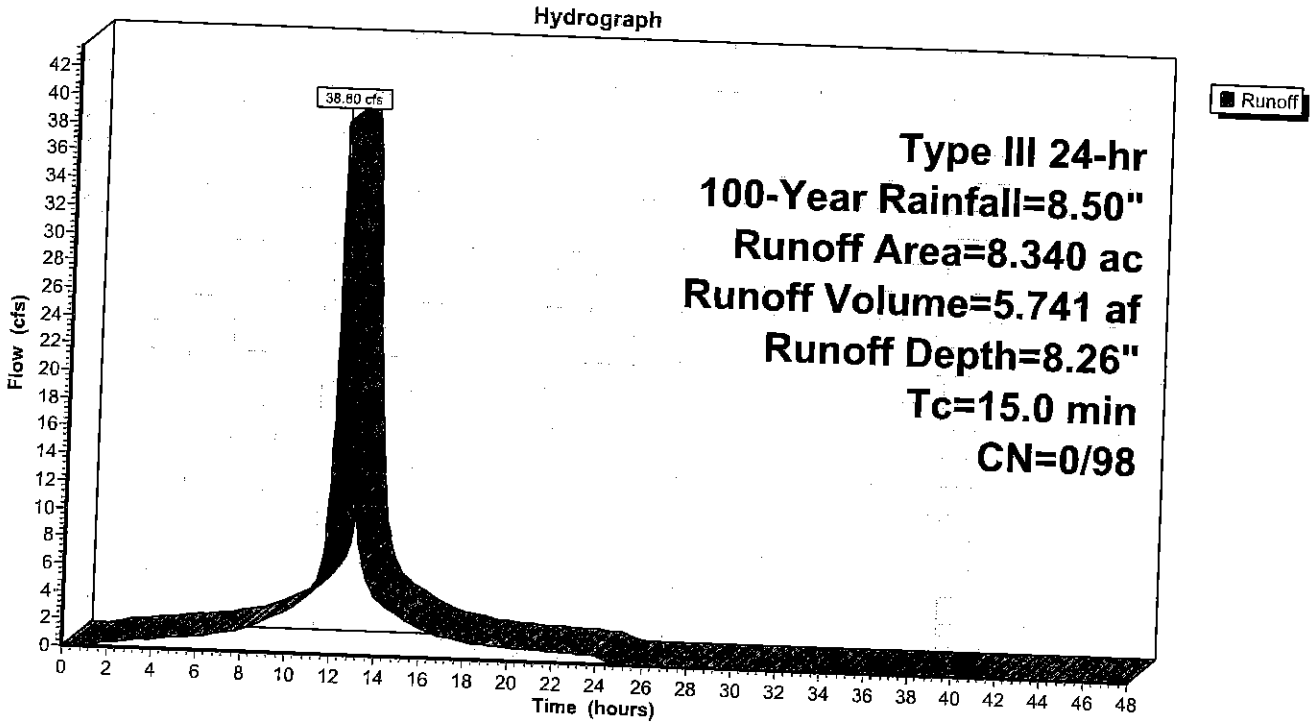
Runoff = 38.80 cfs @ 12.23 hrs, Volume= 5.741 af, Depth= 8.26"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

	Area (ac)	CN	Description
*	8.340	98	Paved
	8.340	98	100.00% Impervious Area

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

Subcatchment DA-1A IMP: DA-1A-IMP



Dev DA two outlets
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Summary for Subcatchment DA-1A PER: DA-1A-Perv

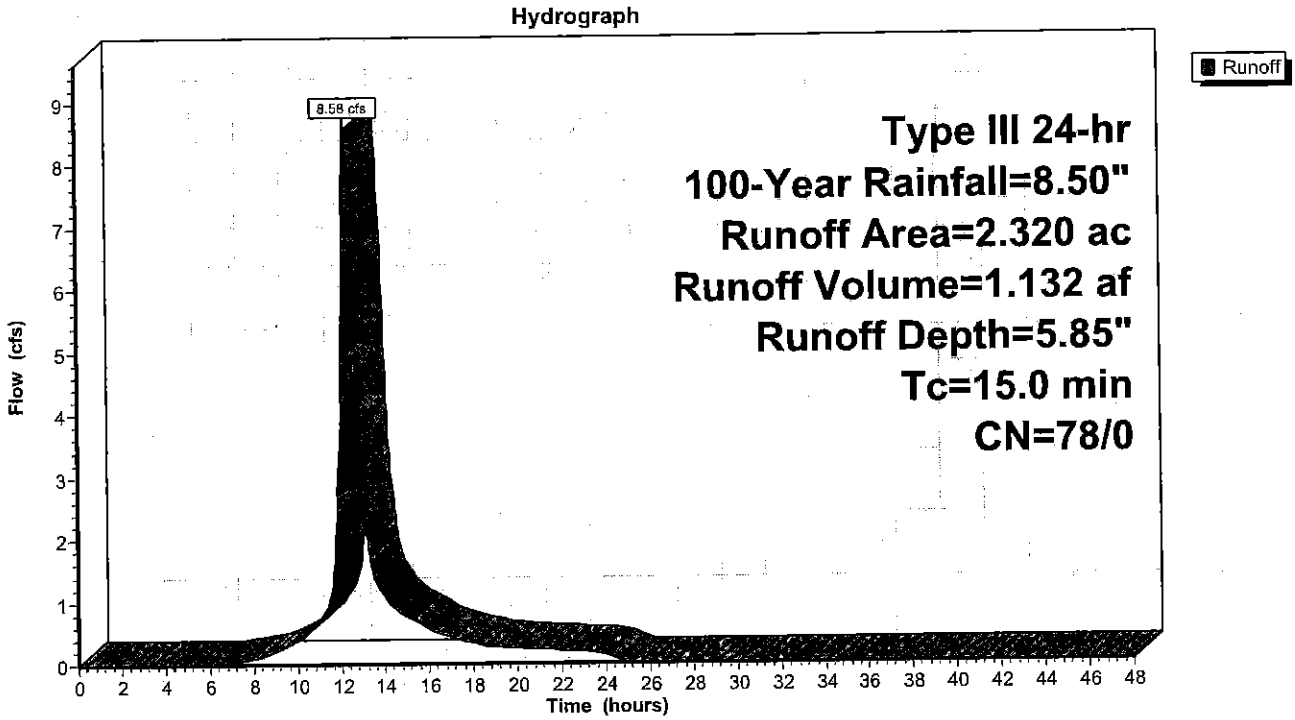
Runoff = 8.58 cfs @ 12.24 hrs, Volume= 1.132 af, Depth= 5.85"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
1.480	80	>75% Grass cover, Good, HSG D
0.840	74	>75% Grass cover, Good, HSG C
2.320	78	Weighted Average
2.320	78	100.00% Pervious Area

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

Subcatchment DA-1A PER: DA-1A-Perv



Summary for Subcatchment DA-1APond: DA-1A Pond

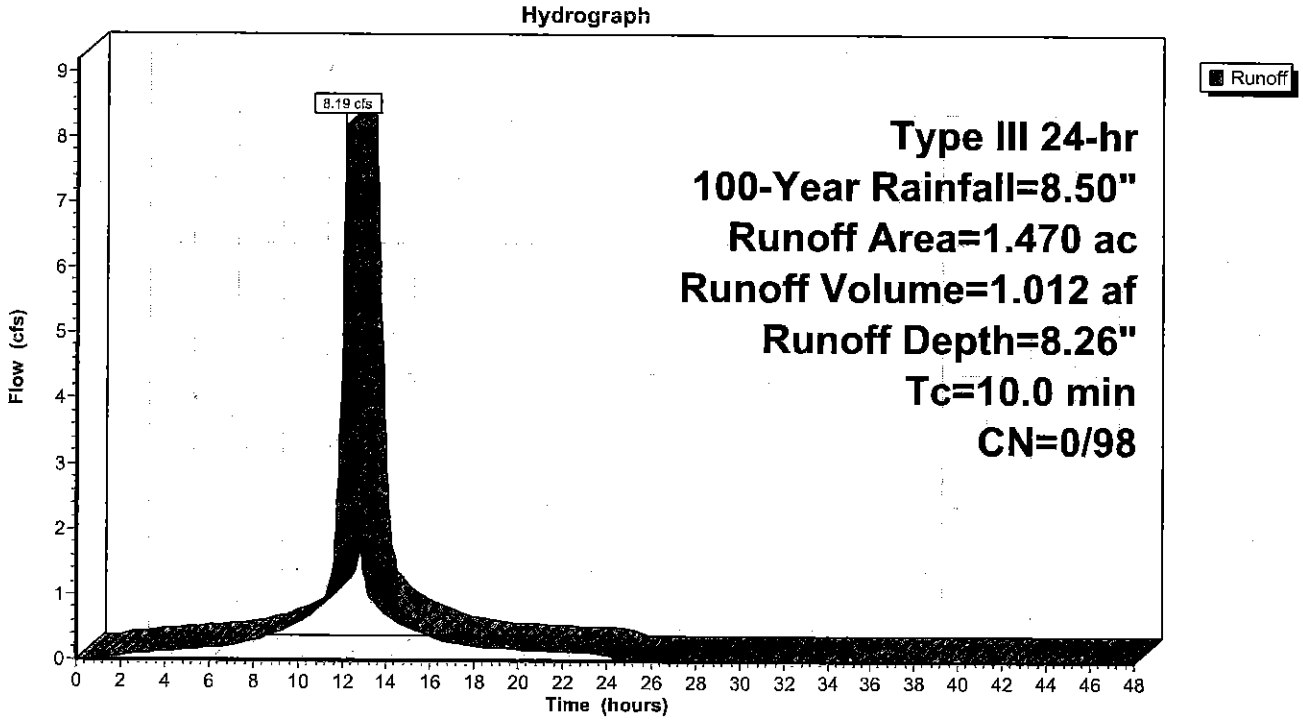
Runoff = 8.19 cfs @ 12.16 hrs, Volume= 1.012 af, Depth= 8.26"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

	Area (ac)	CN	Description
*	1.470	98	Wet Pond
	1.470	98	100.00% Impervious Area

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

Subcatchment DA-1APond: DA-1A Pond



Dev DA two outlets
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Summary for Subcatchment DA1A-BLD: Building

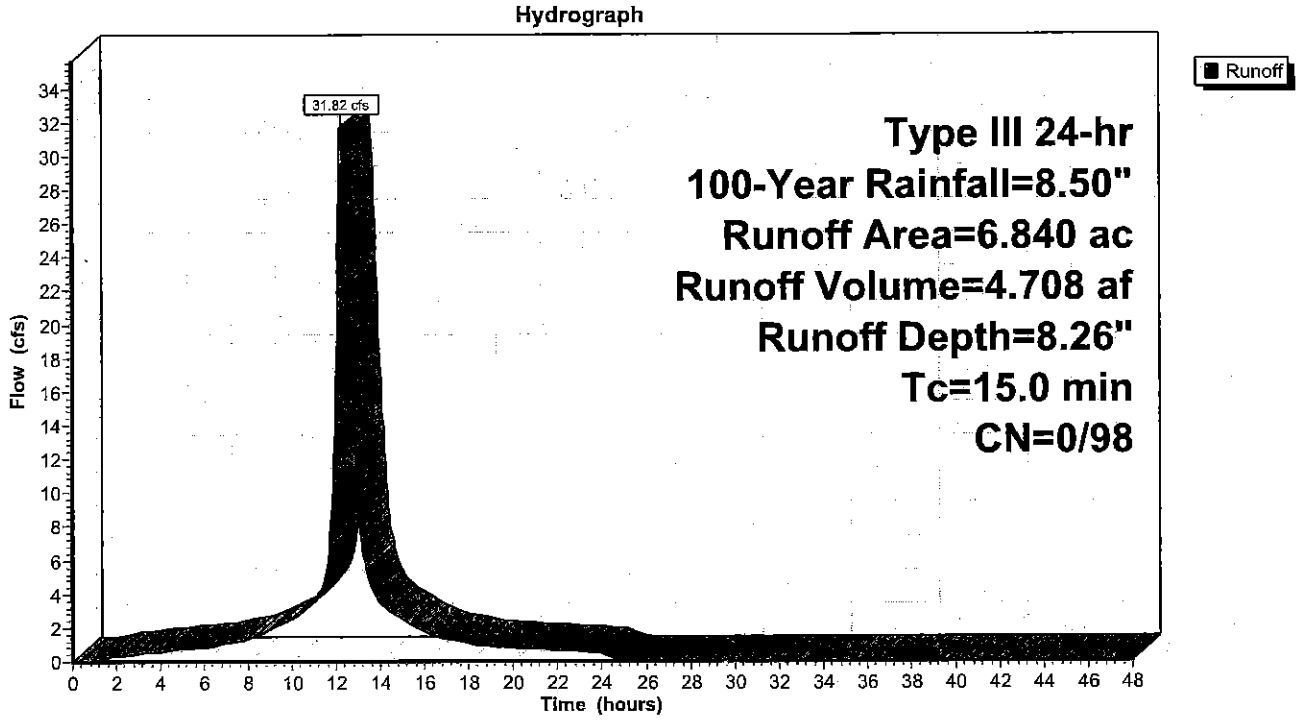
Runoff = 31.82 cfs @ 12.23 hrs, Volume= 4.708 af, Depth= 8.26"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

	Area (ac)	CN	Description
*	6.840	98	Roofs
	6.840	98	100.00% Impervious Area

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

Subcatchment DA1A-BLD: Building



Summary for Subcatchment DEV-1B: DA-1B

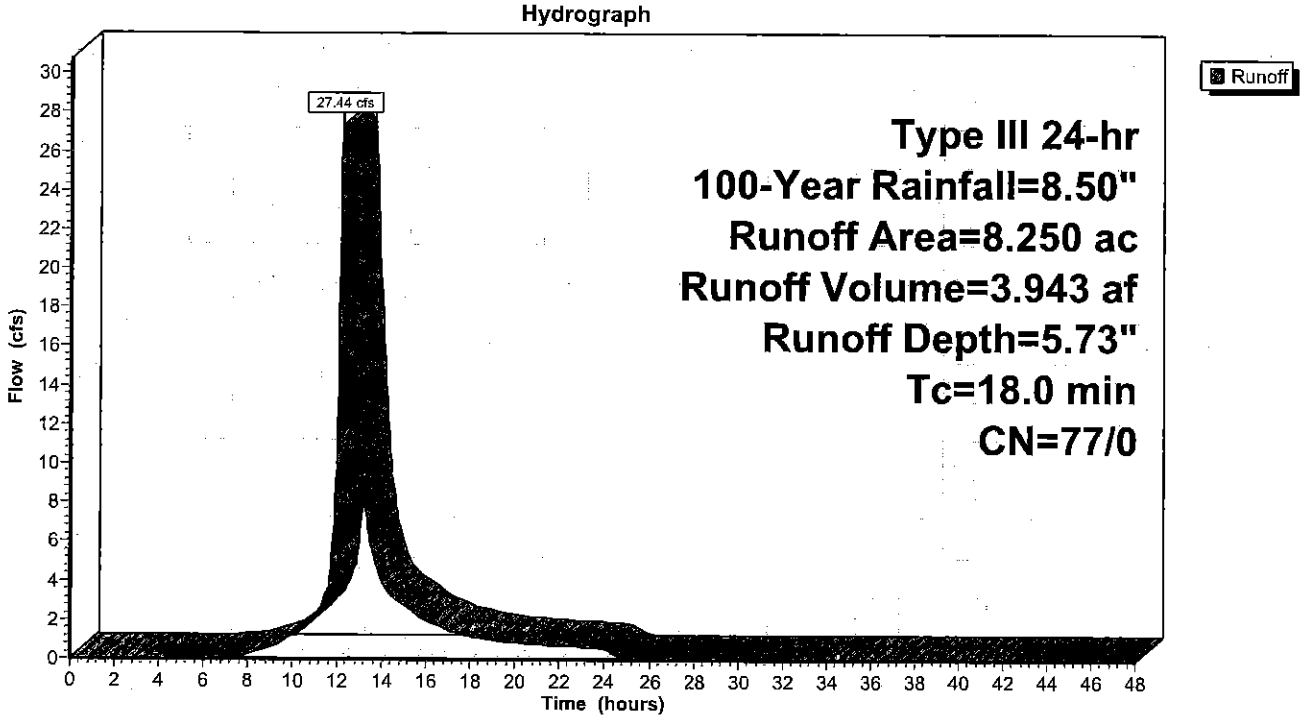
Runoff = 27.44 cfs @ 12.29 hrs, Volume= 3.943 af, Depth= 5.73"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
7.950	77	Woods, Good, HSG D
0.300	80	>75% Grass cover, Good, HSG D
8.250	77	Weighted Average
8.250	77	100.00% Pervious Area

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

Subcatchment DEV-1B: DA-1B



Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment DEV-1C: DA-1C

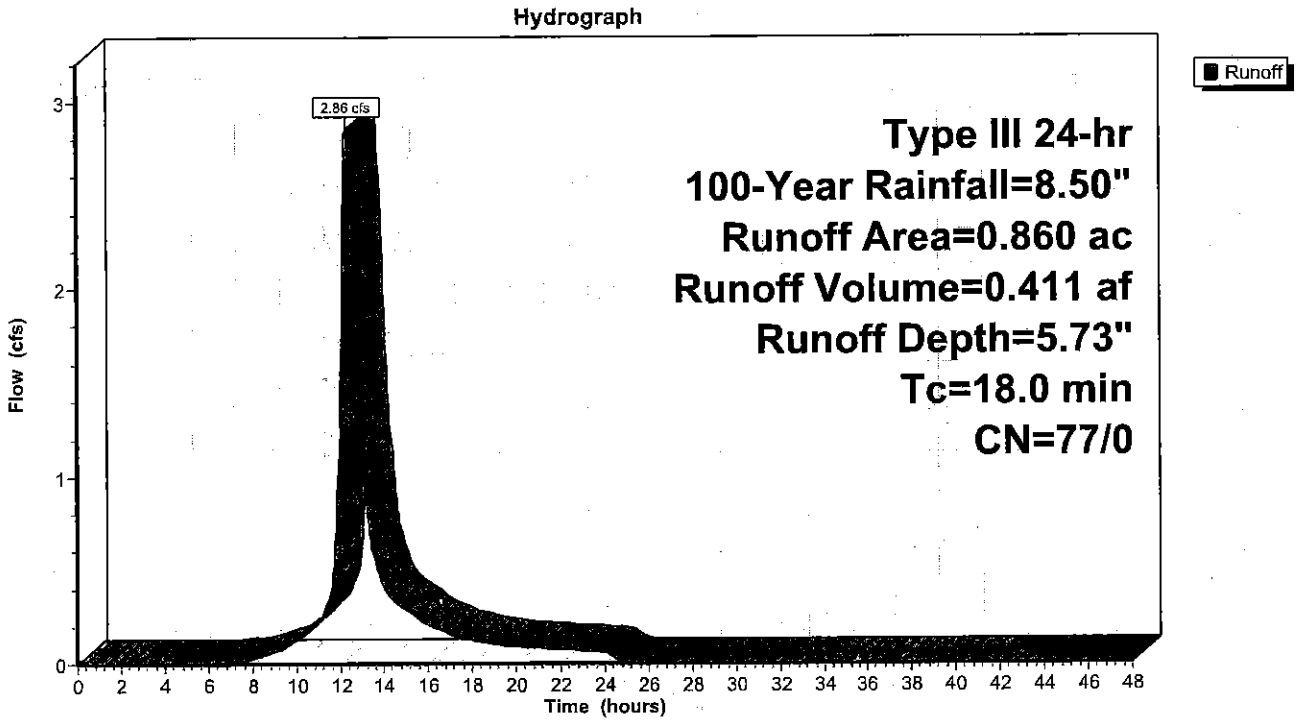
Runoff = 2.86 cfs @ 12.29 hrs, Volume= 0.411 af, Depth= 5.73"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
0.040	70	Woods, Good, HSG C
0.820	77	Woods, Good, HSG D
0.860	77	Weighted Average
0.860	77	100.00% Pervious Area

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

Subcatchment DEV-1C: DA-1C



Summary for Subcatchment DEV-2: Uncontrolled DA2

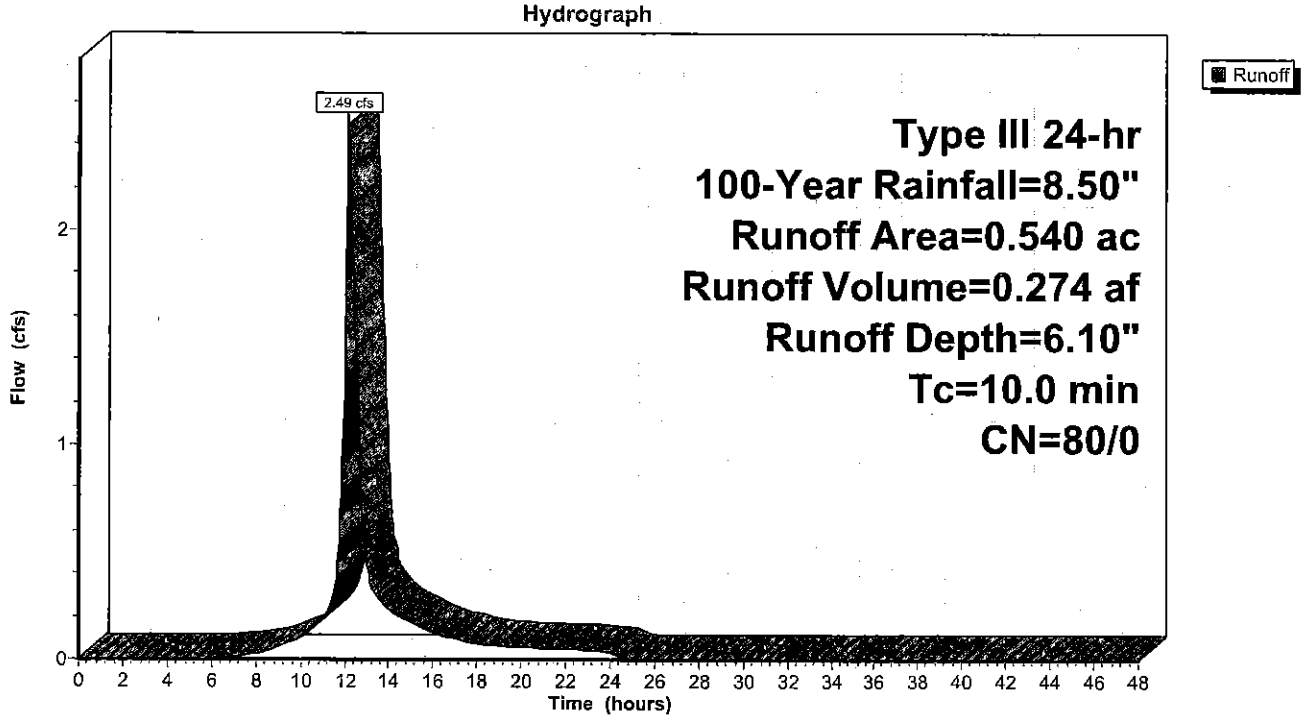
Runoff = 2.49 cfs @ 12.17 hrs, Volume= 0.274 af, Depth= 6.10"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
0.540	80	>75% Grass cover, Good, HSG D
0.540	80	100.00% Pervious Area

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

Subcatchment DEV-2: Uncontrolled DA2



Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Pond 1P: Wet Ponds (Combined)

Inflow Area = 18.970 ac, 87.77% Impervious, Inflow Depth = 7.97" for 100-Year event
Inflow = 87.19 cfs @ 12.22 hrs, Volume= 12.593 af
Outflow = 43.60 cfs @ 12.70 hrs, Volume= 12.470 af, Atten= 50%, Lag= 28.8 min
Primary = 21.80 cfs @ 12.70 hrs, Volume= 6.235 af
Secondary = 21.80 cfs @ 12.70 hrs, Volume= 6.235 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Starting Elev= 3.00' Surf.Area= 1.330 ac Storage= 5.620 af
Peak Elev= 6.84' @ 12.70 hrs Surf.Area= 1.388 ac Storage= 10.873 af (5.253 af above start)

Plug-Flow detention time= 578.4 min calculated for 6.850 af (54% of inflow)
Center-of-Mass det. time= 236.3 min (999.4 - 763.2)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	12.485 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
-3.00	0.550	0.000	0.000
-2.00	0.610	0.580	0.580
-1.00	0.770	0.690	1.270
0.00	0.900	0.835	2.105
1.00	1.150	1.025	3.130
2.00	1.250	1.200	4.330
3.00	1.330	1.290	5.620
4.00	1.360	1.345	6.965
5.00	1.370	1.365	8.330
6.00	1.380	1.375	9.705
7.00	1.390	1.385	11.090
8.00	1.400	1.395	12.485

Device	Routing	Invert	Outlet Devices
#1	Device 7	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#2	Device 8	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#3	Device 7	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 8	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Device 7	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Device 8	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#7	Primary	2.90'	**36.0" Round Culvert** L= 60.0' RCP, square edge headwall, Ke= 0.500

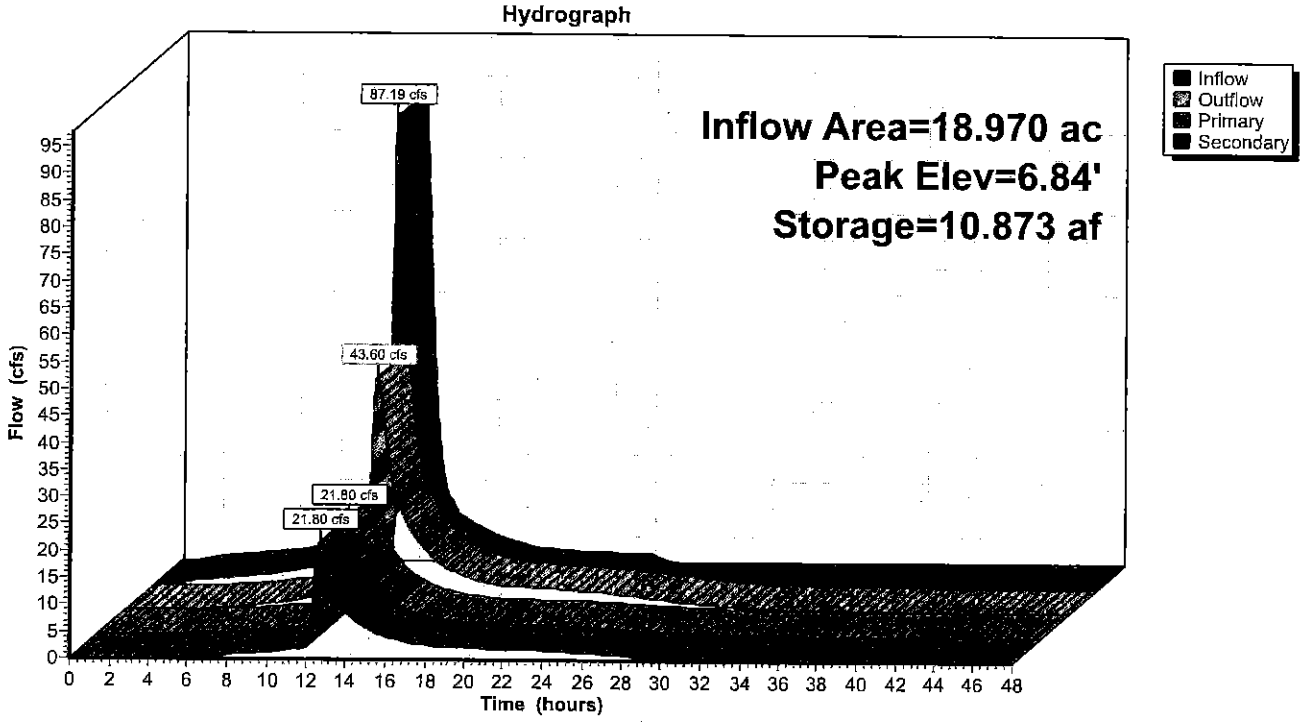
Inlet / Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
n= 0.013, Flow Area= 7.07 sf

#8 Secondary 2.90' **36.0" Round Culvert**
L= 60.0' RCP, square edge headwall, Ke= 0.500
Inlet / Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=21.74 cfs @ 12.70 hrs HW=6.84' (Free Discharge)
└**7=Culvert** (Passes 21.74 cfs of 48.39 cfs potential flow)
├**1=Orifice/Grate** (Orifice Controls 3.54 cfs @ 8.99 fps)
├**3=Broad-Crested Rectangular Weir** (Weir Controls 12.59 cfs @ 4.63 fps)
└**5=Broad-Crested Rectangular Weir** (Weir Controls 5.61 cfs @ 2.37 fps)

Secondary OutFlow Max=21.74 cfs @ 12.70 hrs HW=6.84' (Free Discharge)
└**8=Culvert** (Passes 21.74 cfs of 48.39 cfs potential flow)
├**2=Orifice/Grate** (Orifice Controls 3.54 cfs @ 8.99 fps)
├**4=Broad-Crested Rectangular Weir** (Weir Controls 12.59 cfs @ 4.63 fps)
└**6=Broad-Crested Rectangular Weir** (Weir Controls 5.61 cfs @ 2.37 fps)

Pond 1P: Wet Ponds (Combined)



Hydrograph for Pond 1P: Wet Ponds (Combined)

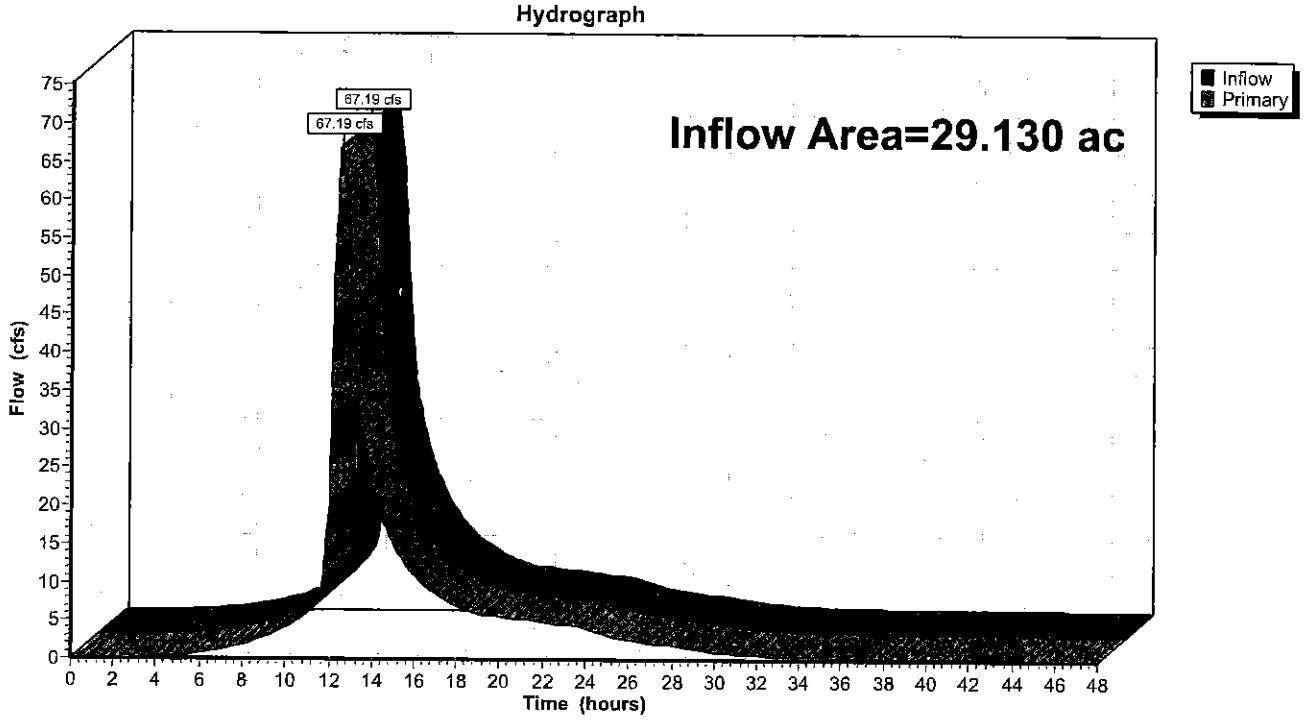
Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	5.620	3.00	0.00	0.00	0.00
1.00	0.20	5.623	3.00	0.00	0.00	0.00
2.00	0.76	5.664	3.03	0.01	0.01	0.01
3.00	1.13	5.740	3.09	0.08	0.04	0.04
4.00	1.46	5.837	3.16	0.18	0.09	0.09
5.00	1.76	5.945	3.24	0.41	0.21	0.21
6.00	2.03	6.057	3.32	0.70	0.35	0.35
7.00	2.62	6.175	3.41	1.05	0.52	0.52
8.00	3.41	6.318	3.52	1.52	0.76	0.76
9.00	4.83	6.503	3.66	2.08	1.04	1.04
10.00	6.66	6.780	3.86	2.70	1.35	1.35
11.00	9.75	7.192	4.17	3.42	1.71	1.71
12.00	**44.82**	**8.317**	**4.99**	**5.07**	**2.54**	**2.54**
13.00	**24.64**	**10.677**	**6.70**	**36.65**	**18.33**	**18.33**
14.00	9.38	9.788	6.06	17.86	8.93	8.93
15.00	6.73	9.237	5.66	11.81	5.91	5.91
16.00	4.87	8.891	5.41	8.51	4.25	4.25
17.00	3.69	8.621	5.21	6.59	3.29	3.29
18.00	2.88	8.400	5.05	5.42	2.71	2.71
19.00	2.43	8.199	4.90	4.73	2.36	2.36
20.00	2.18	8.008	4.76	4.51	2.25	2.25
21.00	1.98	7.817	4.62	4.28	2.14	2.14
22.00	1.80	7.630	4.49	4.04	2.02	2.02
23.00	1.62	7.447	4.35	3.79	1.90	1.90
24.00	1.44	7.271	4.22	3.54	1.77	1.77
25.00	0.04	7.035	4.05	3.17	1.58	1.58
26.00	0.00	6.792	3.87	2.73	1.36	1.36
27.00	0.00	6.585	3.72	2.29	1.14	1.14
28.00	0.00	6.415	3.59	1.84	0.92	0.92
29.00	0.00	6.282	3.49	1.40	0.70	0.70
30.00	0.00	6.181	3.42	1.07	0.53	0.53
31.00	0.00	6.104	3.36	0.83	0.41	0.41
32.00	0.00	6.043	3.31	0.66	0.33	0.33
33.00	0.00	5.994	3.28	0.52	0.26	0.26
34.00	0.00	5.955	3.25	0.43	0.22	0.22
35.00	0.00	5.923	3.23	0.36	0.18	0.18
36.00	0.00	5.895	3.20	0.31	0.15	0.15
37.00	0.00	5.872	3.19	0.26	0.13	0.13
38.00	0.00	5.852	3.17	0.22	0.11	0.11
39.00	0.00	5.836	3.16	0.18	0.09	0.09
40.00	0.00	5.821	3.15	0.17	0.08	0.08
41.00	0.00	5.808	3.14	0.15	0.08	0.08
42.00	0.00	5.796	3.13	0.14	0.07	0.07
43.00	0.00	5.785	3.12	0.13	0.06	0.06
44.00	0.00	5.775	3.12	0.12	0.06	0.06
45.00	0.00	5.766	3.11	0.11	0.05	0.05
46.00	0.00	5.758	3.10	0.10	0.05	0.05
47.00	0.00	5.750	3.10	0.09	0.04	0.04
48.00	0.00	5.743	3.09	0.08	0.04	0.04

Summary for Link 1: Analysis Point

Inflow Area = 29.130 ac, 57.81% Impervious, Inflow Depth > 7.16" for 100-Year event
Inflow = 67.19 cfs @ 12.59 hrs, Volume= 17.391 af
Primary = 67.19 cfs @ 12.59 hrs, Volume= 17.391 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Link 1: Analysis Point



Hydrograph for Link 1: Analysis Point

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	**0.00**	0.00
0.50	0.00	0.00	0.00
1.00	0.00	0.00	0.00
1.50	0.01	0.00	0.01
2.00	0.02	0.00	0.02
2.50	0.04	0.00	0.04
3.00	0.09	0.00	0.09
3.50	0.14	0.00	0.14
4.00	0.20	0.00	0.20
4.50	0.31	0.00	0.31
5.00	0.43	0.00	0.43
5.50	0.56	0.00	0.56
6.00	0.73	0.00	0.73
6.50	0.92	0.00	0.92
7.00	1.19	0.00	1.19
7.50	1.52	0.00	1.52
8.00	1.91	0.00	1.91
8.50	2.36	0.00	2.36
9.00	2.91	0.00	2.91
9.50	3.56	0.00	3.56
10.00	4.27	0.00	4.27
10.50	5.15	0.00	5.15
11.00	6.30	0.00	6.30
11.50	8.27	0.00	8.27
12.00	20.78	0.00	20.78
12.50	**65.45**	0.00	**65.45**
13.00	**49.77**	0.00	**49.77**
13.50	30.14	0.00	30.14
14.00	22.67	0.00	22.67
14.50	18.24	0.00	18.24
15.00	15.18	0.00	15.18
15.50	12.81	0.00	12.81
16.00	10.97	0.00	10.97
16.50	9.52	0.00	9.52
17.00	8.44	0.00	8.44
17.50	7.58	0.00	7.58
18.00	6.87	0.00	6.87
18.50	6.31	0.00	6.31
19.00	5.95	0.00	5.95
19.50	5.77	0.00	5.77
20.00	5.60	0.00	5.60
20.50	5.43	0.00	5.43
21.00	5.27	0.00	5.27
21.50	5.11	0.00	5.11
22.00	4.94	0.00	4.94
22.50	4.78	0.00	4.78
23.00	4.61	0.00	4.61
23.50	4.44	0.00	4.44
24.00	4.26	0.00	4.26
24.50	3.60	0.00	3.60
25.00	3.21	0.00	3.21
25.50	2.96	0.00	2.96
26.00	2.73	0.00	2.73
26.50	2.50	0.00	2.50
27.00	2.29	0.00	2.29
27.50	2.06	0.00	2.06
28.00	1.84	0.00	1.84
28.50	1.60	0.00	1.60
29.00	1.40	0.00	1.40
29.50	1.22	0.00	1.22
30.00	1.07	0.00	1.07
30.50	0.93	0.00	0.93
31.00	0.83	0.00	0.83
31.50	0.74	0.00	0.74
32.00	0.66	0.00	0.66
32.50	0.58	0.00	0.58
33.00	0.52	0.00	0.52
33.50	0.47	0.00	0.47
34.00	0.43	0.00	0.43
34.50	0.40	0.00	0.40
35.00	0.36	0.00	0.36
35.50	0.33	0.00	0.33
36.00	0.31	0.00	0.31
36.50	0.28	0.00	0.28
37.00	0.26	0.00	0.26
37.50	0.24	0.00	0.24
38.00	0.22	0.00	0.22
38.50	0.20	0.00	0.20
39.00	0.18	0.00	0.18
39.50	0.17	0.00	0.17
40.00	0.17	0.00	0.17
40.50	0.16	0.00	0.16
41.00	0.15	0.00	0.15
41.50	0.15	0.00	0.15
42.00	0.14	0.00	0.14
42.50	0.13	0.00	0.13
43.00	0.13	0.00	0.13
43.50	0.12	0.00	0.12
44.00	0.12	0.00	0.12
44.50	0.11	0.00	0.11
45.00	0.11	0.00	0.11
45.50	0.10	0.00	0.10
46.00	0.10	0.00	0.10
46.50	0.09	0.00	0.09
47.00	0.09	0.00	0.09
47.50	0.08	0.00	0.08
48.00	0.08	0.00	0.08

Appendix C

NJDEP Water Quality Analysis

LANGAN

Repauno Redevelopment - 130088802

Designed By EFW Checked By KJW Date 10/27/15

WET POND SUMMARY

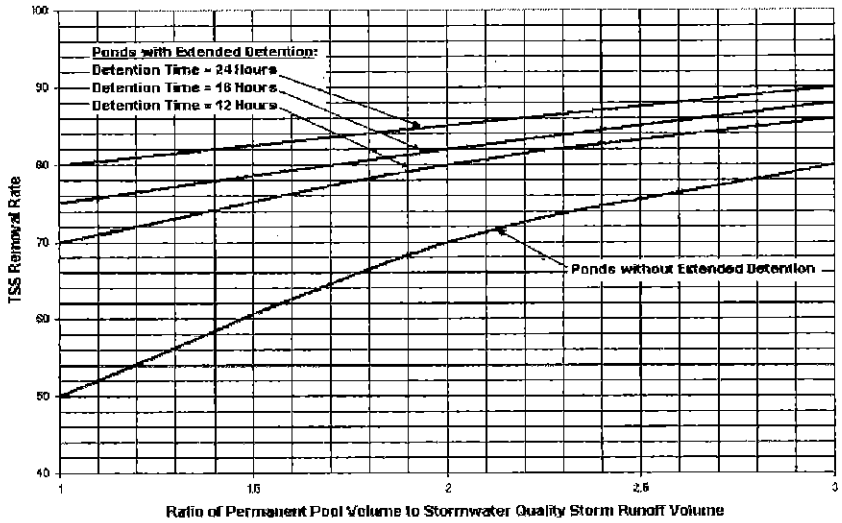
Basin	Permanent Pond Volume (ac-ft)	WQ Storm Runoff Volume (ac-ft)	Ratio Permanent/WQ	Max WQ Storage Volume (ac-ft)	Time of Max WQ Storage (hours)	10% of Max WQ Volume (ac-ft)	Time When 10% of WQ Remains (hours)	Extended Detention Time (hours)	Total TSS Removal Rate	Drainage Area to Pond (ac)	Surface Area of Pond (ac)	Mean Depth of Pond (ft)
1	5.6200	1.4470	3.88	1.4470	2.22	0.1447	22.40	20.18	88	18.9700	1.0700	5.3

Drainage area should be greater than 20ac

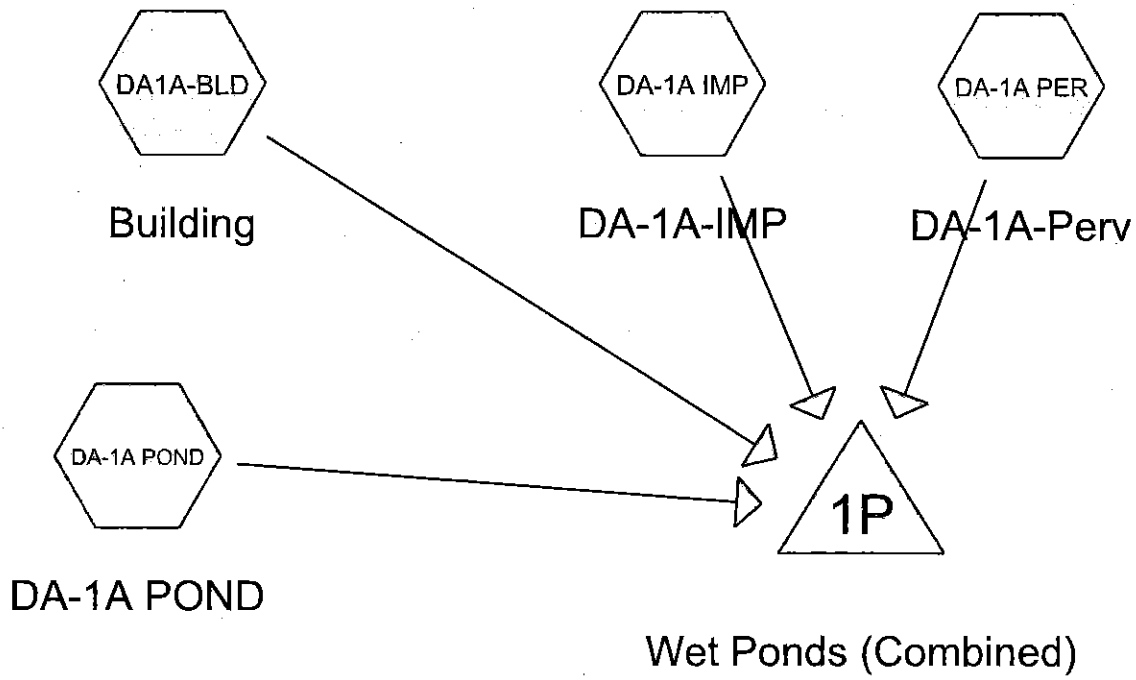
Surface area should be greater than 0.25ac

Mean depth should be between 3-6 feet

Figure 9.11-2: TSS Removal Rates for Wet Ponds



Notes:



Subcat Reach Pond Link

Routing Diagram for Dev DA WQ
Prepared by Langan Eng & Env Srvcs, Inc, Printed 11/3/2015

Dev DA WQ
Prepared by Langan Eng & Env Srvcs, Inc

Time span=0.00-48.00 hrs, dt=0.03 hrs, 1601 points
Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentDA-1AIMP: DA-1A-IMP Runoff Area=8.340 ac 100.00% Impervious Runoff Depth=1.02"
Tc=15.0 min CN=0/98 Runoff=12.24 cfs 0.712 af

SubcatchmentDA-1APER: DA-1A-Perv Runoff Area=2.320 ac 0.00% Impervious Runoff Depth=0.13"
Tc=15.0 min CN=78/0 Runoff=0.34 cfs 0.025 af

SubcatchmentDA-1APOND: DA-1APOND Runoff Area=1.470 ac 100.00% Impervious Runoff Depth=1.02"
Tc=10.0 min CN=0/98 Runoff=2.72 cfs 0.126 af

SubcatchmentDA1A-BLD:Building Runoff Area=6.840 ac 100.00% Impervious Runoff Depth=1.02"
Tc=15.0 min CN=0/98 Runoff=10.04 cfs 0.584 af

Pond 1P: Wet Ponds (Combined) Peak Elev=3.89' Storage=6.823 af Inflow=25.04 cfs 1.447 af
Primary=1.39 cfs 0.695 af Secondary=1.39 cfs 0.695 af Outflow=2.79 cfs 1.390 af

Total Runoff Area = 18.970 ac Runoff Volume = 1.447 af Average Runoff Depth = 0.92"
12.23% Pervious = 2.320 ac 87.77% Impervious = 16.650 ac

Summary for Subcatchment DA-1A IMP: DA-1A-IMP

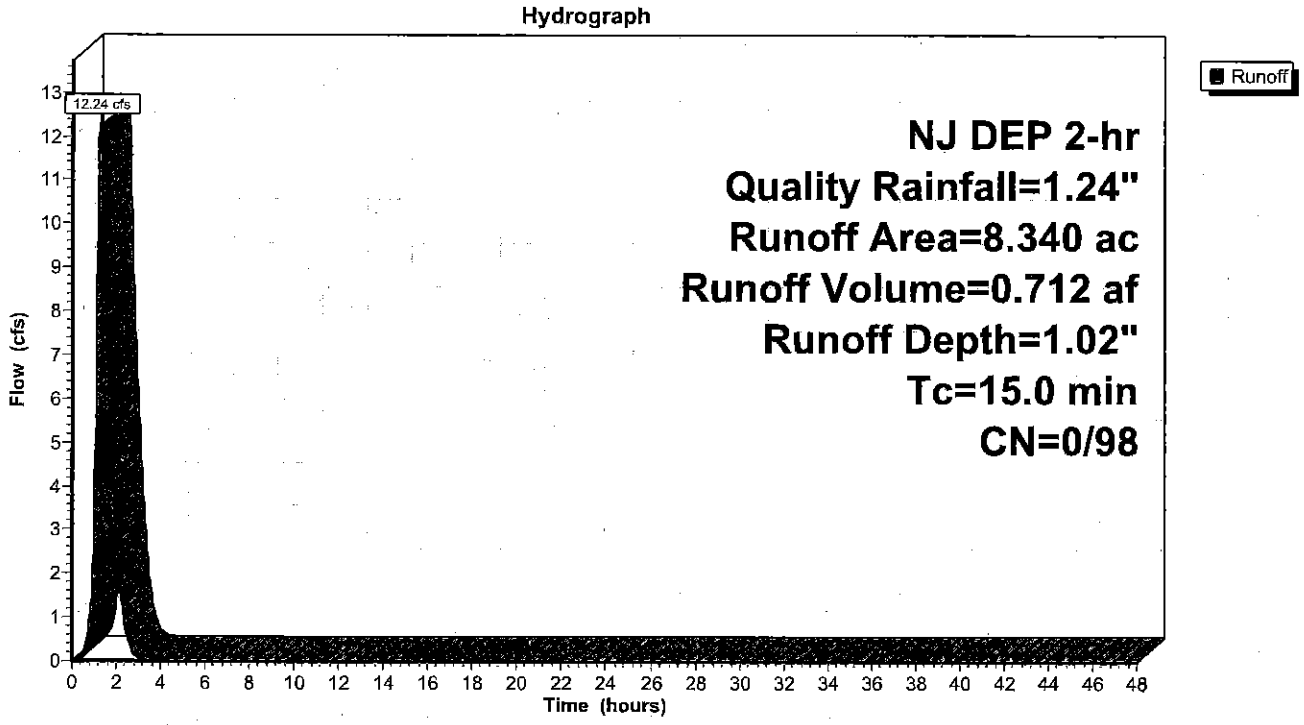
Runoff = 12.24 cfs @ 1.24 hrs, Volume= 0.712 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
NJ DEP 2-hr Quality Rainfall=1.24"

	Area (ac)	CN	Description
*	8.340	98	Paved
	8.340	98	100.00% Impervious Area

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

Subcatchment DA-1A IMP: DA-1A-IMP



Summary for Subcatchment DA-1A PER: DA-1A-Perv

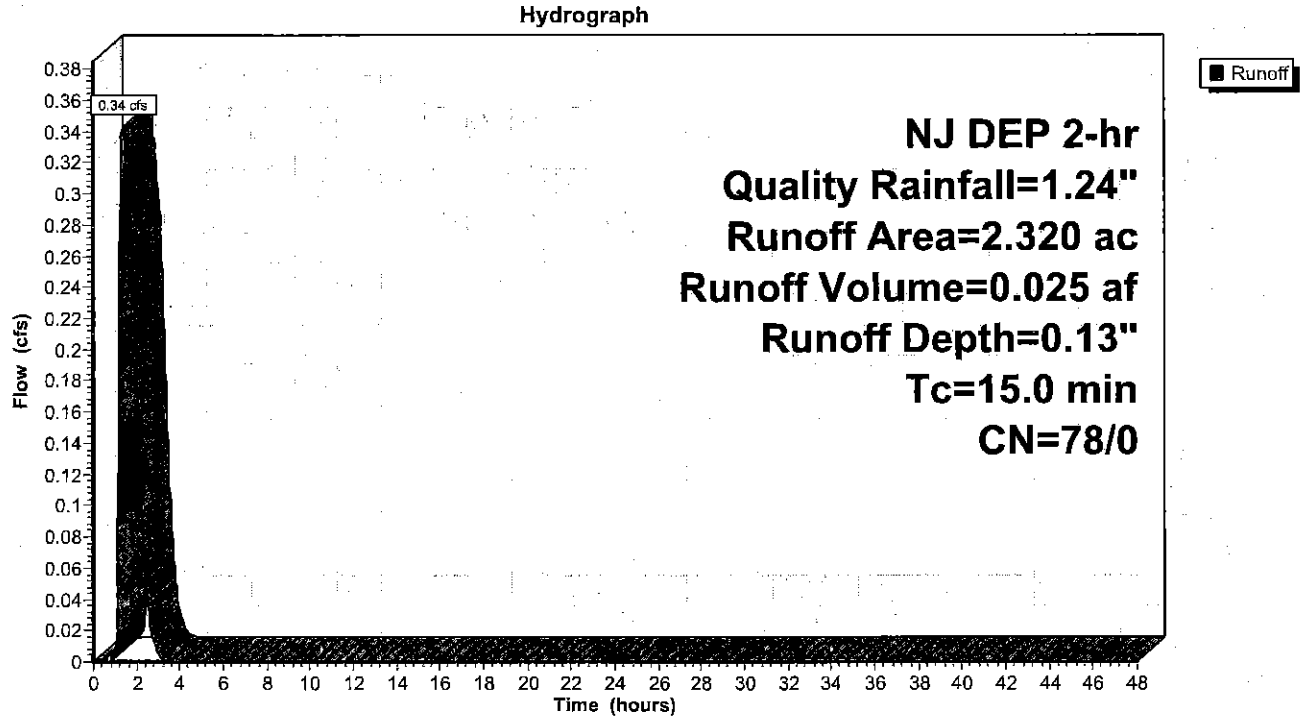
Runoff = 0.34 cfs @ 1.36 hrs, Volume= 0.025 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
NJ DEP 2-hr Quality Rainfall=1.24"

Area (ac)	CN	Description
1.480	80	>75% Grass cover, Good, HSG D
0.840	74	>75% Grass cover, Good, HSG C
2.320	78	Weighted Average
2.320	78	100.00% Pervious Area

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

Subcatchment DA-1A PER: DA-1A-Perv



Summary for Subcatchment DA-1A POND: DA-1A POND

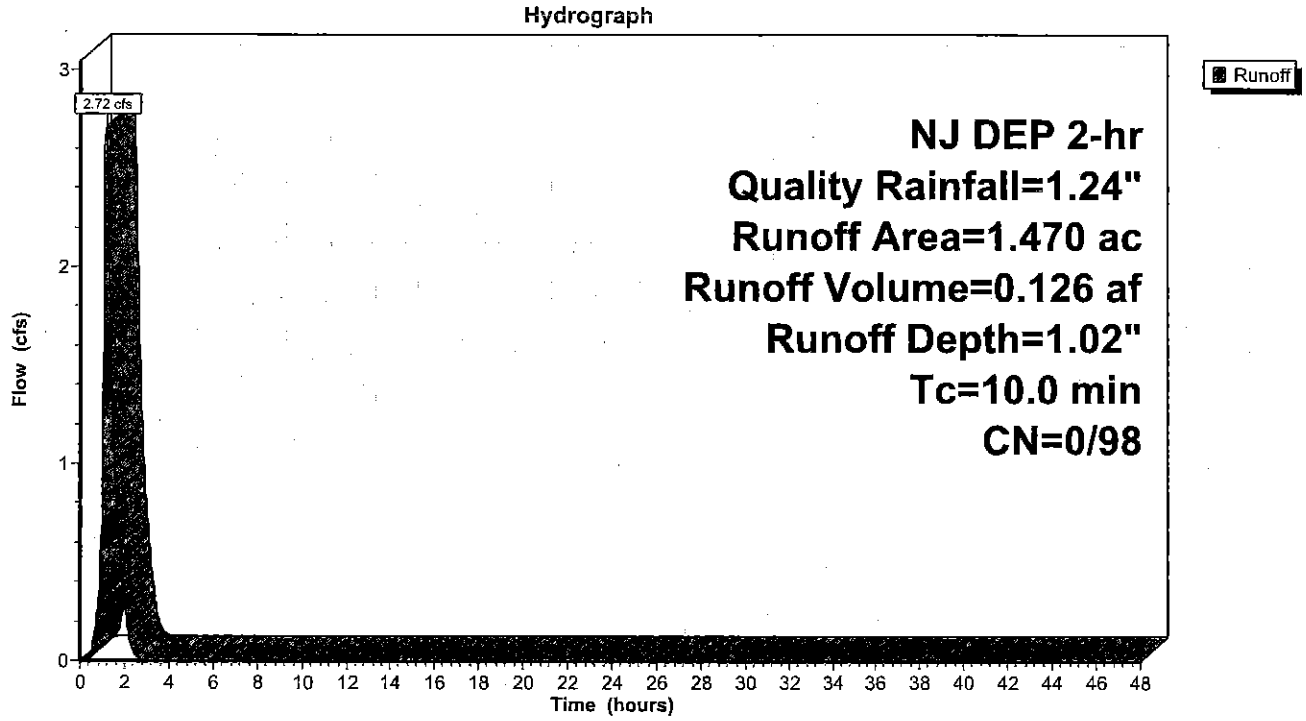
Runoff = 2.72 cfs @ 1.17 hrs, Volume= 0.126 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
NJ DEP 2-hr Quality Rainfall=1.24"

	Area (ac)	CN	Description
*	1.470	98	Pond
	1.470	98	100.00% Impervious Area

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

Subcatchment DA-1A POND: DA-1A POND



Summary for Subcatchment DA1A-BLD: Building

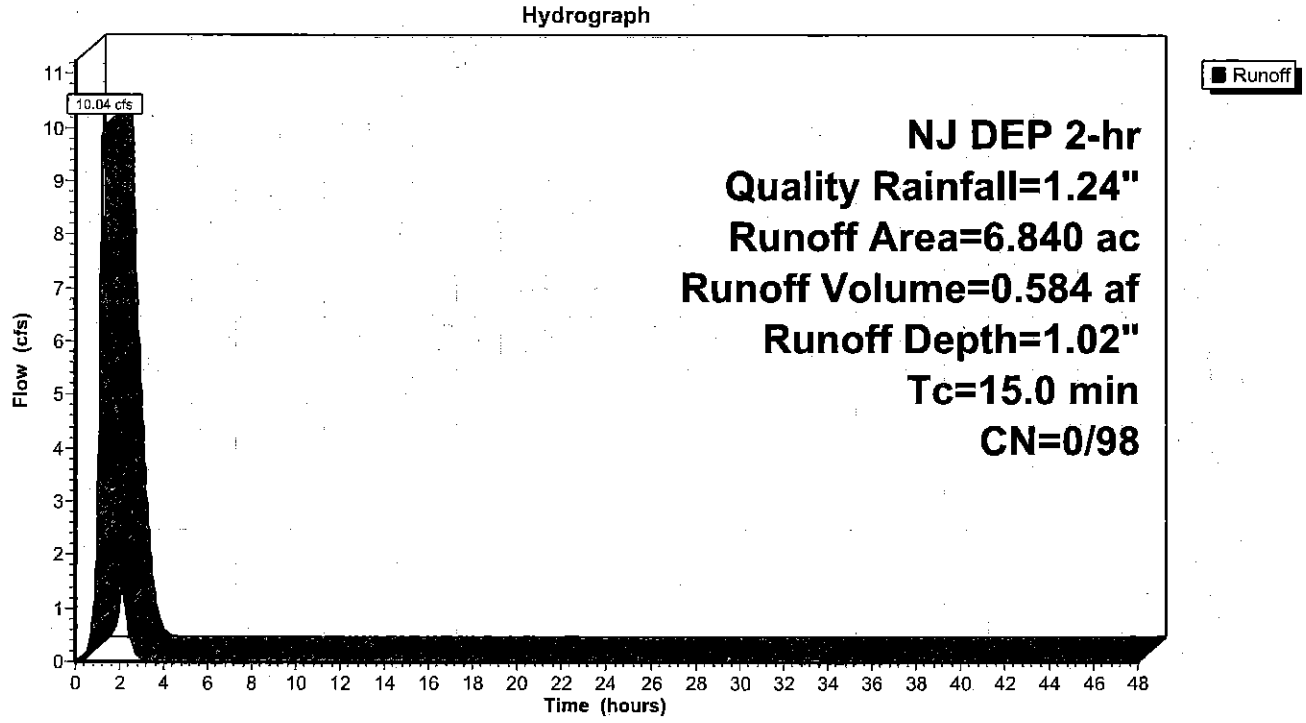
Runoff = 10.04 cfs @ 1.24 hrs, Volume= 0.584 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
NJ DEP 2-hr Quality Rainfall=1.24"

	Area (ac)	CN	Description
*	6.840	98	Roofs
	6.840	98	100.00% Impervious Area

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

Subcatchment DA1A-BLD: Building



Summary for Pond 1P: Wet Ponds (Combined)

Inflow Area = 18.970 ac, 87.77% Impervious, Inflow Depth = 0.92" for Quality event
Inflow = 25.04 cfs @ 1.23 hrs, Volume= 1.447 af
Outflow = 2.79 cfs @ 2.22 hrs, Volume= 1.390 af, Atten= 89%, Lag= 59.4 min
Primary = 1.39 cfs @ 2.22 hrs, Volume= 0.695 af
Secondary = 1.39 cfs @ 2.22 hrs, Volume= 0.695 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.03 hrs
Starting Elev= 3.00' Surf.Area= 1.330 ac Storage= 5.620 af
Peak Elev= 3.89' @ 2.22 hrs Surf.Area= 1.357 ac Storage= 6.823 af (1.203 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 367.9 min (455.3 - 87.4)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	12.485 af	**Custom Stage Data (Prismatic)** Listed below

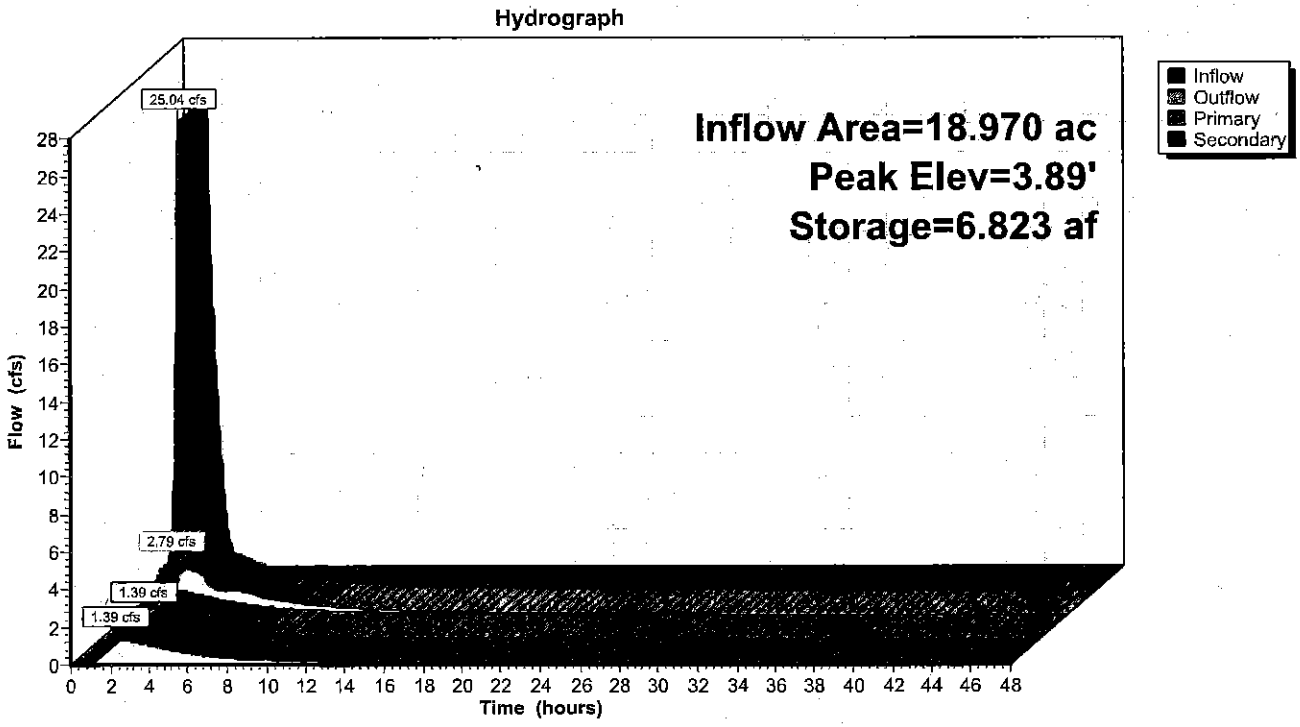
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
-3.00	0.550	0.000	0.000
-2.00	0.610	0.580	0.580
-1.00	0.770	0.690	1.270
0.00	0.900	0.835	2.105
1.00	1.150	1.025	3.130
2.00	1.250	1.200	4.330
3.00	1.330	1.290	5.620 ← Permanent Pool Volume
4.00	1.360	1.345	6.965
5.00	1.370	1.365	8.330
6.00	1.380	1.375	9.705
7.00	1.390	1.385	11.090
8.00	1.400	1.395	12.485

Device	Routing	Invert	Outlet Devices
#1	Primary	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#2	Secondary	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#3	Primary	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Secondary	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Primary	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Secondary	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=1.39 cfs @ 2.22 hrs HW=3.89' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 1.39 cfs @ 3.54 fps)
- **3=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)
- **5=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Secondary OutFlow Max=1.39 cfs @ 2.22 hrs HW=3.89' (Free Discharge)
- **2=Orifice/Grate** (Orifice Controls 1.39 cfs @ 3.54 fps)
- **4=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)
- **6=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 1P: Wet Ponds (Combined)



Hydrograph for Pond 1P: Wet Ponds (Combined)

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	**0.00**	5.620	3.00	0.00	0.00	0.00
1.50	**15.76**	**6.477**	**3.64**	**2.01**	**1.00**	**1.00**
3.00	0.08	**6.704**	**3.81**	**2.55**	**1.27**	**1.27**
4.50	0.00	6.430	3.60	1.89	0.94	0.94
6.00	0.00	6.238	3.46	1.25	0.63	0.63
7.50	0.00	6.110	3.36	0.85	0.42	0.42
9.00	0.00	6.022	3.30	0.60	0.30	0.30
10.50	0.00	5.959	3.25	0.44	0.22	0.22
12.00	0.00	5.911	3.22	0.34	0.17	0.17
13.50	0.00	5.874	3.19	0.26	0.13	0.13
15.00	0.00	5.845	3.17	0.20	0.10	0.10
16.50	0.00	5.823	3.15	0.17	0.08	0.08
18.00	0.00	5.803	3.14	0.15	0.07	0.07
19.50	0.00	5.786	3.12	0.13	0.06	0.06
21.00	0.00	5.771	3.11	0.11	0.06	0.06
22.50	0.00	5.759	3.10	0.10	0.05	0.05
24.00	0.00	5.747	3.09	0.08	0.04	0.04
25.50	0.00	5.737	3.09	0.07	0.04	0.04
27.00	0.00	5.729	3.08	0.06	0.03	0.03
28.50	0.00	5.721	3.08	0.06	0.03	0.03
30.00	0.00	5.715	3.07	0.05	0.02	0.02
31.50	0.00	5.709	3.07	0.04	0.02	0.02
33.00	0.00	5.704	3.06	0.04	0.02	0.02
34.50	0.00	5.700	3.06	0.03	0.02	0.02
36.00	0.00	5.696	3.06	0.03	0.01	0.01
37.50	0.00	5.693	3.05	0.02	0.01	0.01
39.00	0.00	5.690	3.05	0.02	0.01	0.01
40.50	0.00	5.687	3.05	0.02	0.01	0.01
42.00	0.00	5.685	3.05	0.02	0.01	0.01
43.50	0.00	5.683	3.05	0.02	0.01	0.01
45.00	0.00	5.681	3.05	0.02	0.01	0.01
46.50	0.00	5.679	3.04	0.02	0.01	0.01
48.00	0.00	5.677	3.04	0.02	0.01	0.01

Peak WQ Volume @ 2.20 hrs

10% WQ Volume @ 22.40 hrs

Appendix D

Emergency Spillway Analysis

&

Anti-Seep Collar Calculations

Date 10/27/15

100-Year Rainfall

8.5

Designed By EFW

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Checked By KJW

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EMERGENCY SPILLWAY SUMMARY

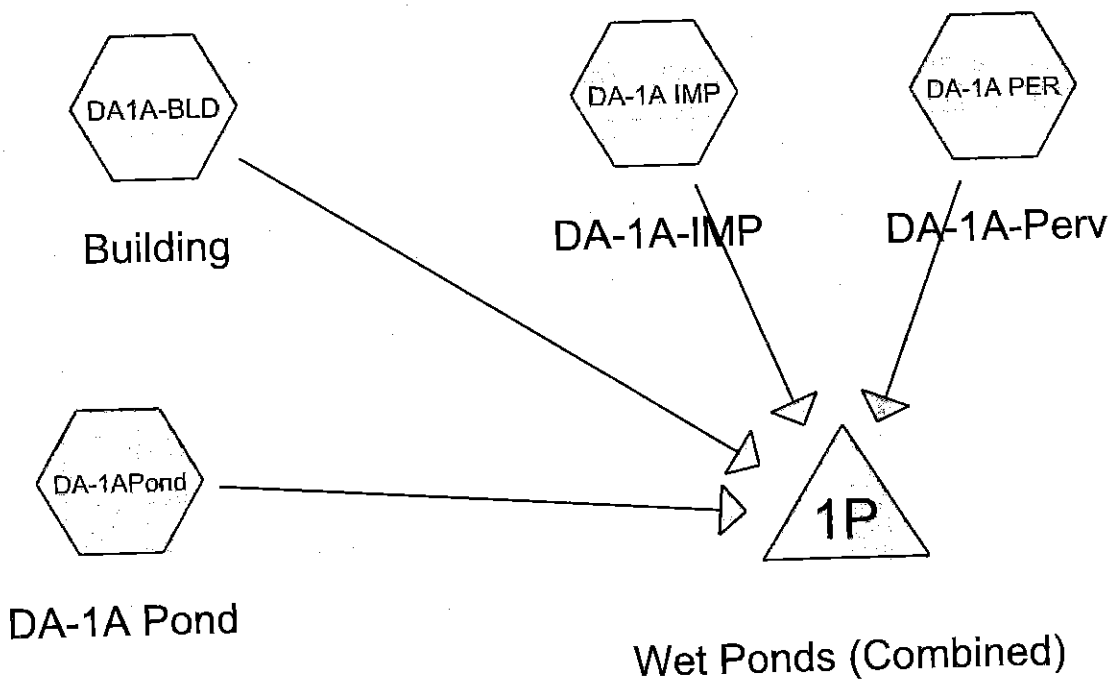
(per Municipal requirements)

Basin Number	Drainage Area (Acres)	Effective Height of the Basin (ft)	Basin classified as a Dam?	Basin 100-Year Water Elevation	Spillway Elevation	Spillway Length (ft)	Design 100-Year Storm Elevation (Required)	Water Elevation + Freeboard (ft)	Minimum Basin Berm Elevation	Required Berm Elevation	Provided Freeboard over Water Elevation	Spillway Elevation	Water Elevation + Freeboard (ft)
1	18.97	4.20	NO	6.84	6.90	100	8.50	7.32	8.32	8.50	1.18	69.50	1.65

(1) The emergency spillway for a basin that is classified as a dam, per NJAC 7:20-1.8(a)4, must be analyzed with the 100-year storm + 50%. The effective height of a basin is defined as the vertical distance between the emergency spillway and the junction of the downstream face of a dam with the ground surface or the invert of the outlet pipe, whichever is the lowest point, per NJAC 7:20-1.2. The emergency spillway for a basin that is not classified as a dam is to be analyzed with the 100-year storm. The principal spillway is assumed to be malfunctioning and not allowing any flow in both cases.

(2) The settled embankment for a basin shall be a minimum of 1ft over the water surface with the emergency spillway at design depth.

Notes:



Subcat Reach Pond Link

Routing Diagram for Dev DA Spillway
Prepared by Langan Eng & Env Srvcs, Inc, Printed 11/3/2015
HydroCAD® 10.00 s/n 08132 © 2013 HydroCAD Software Solutions LLC

Dev DA Spillway
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment DA-1A IMP: DA-1A-IMP

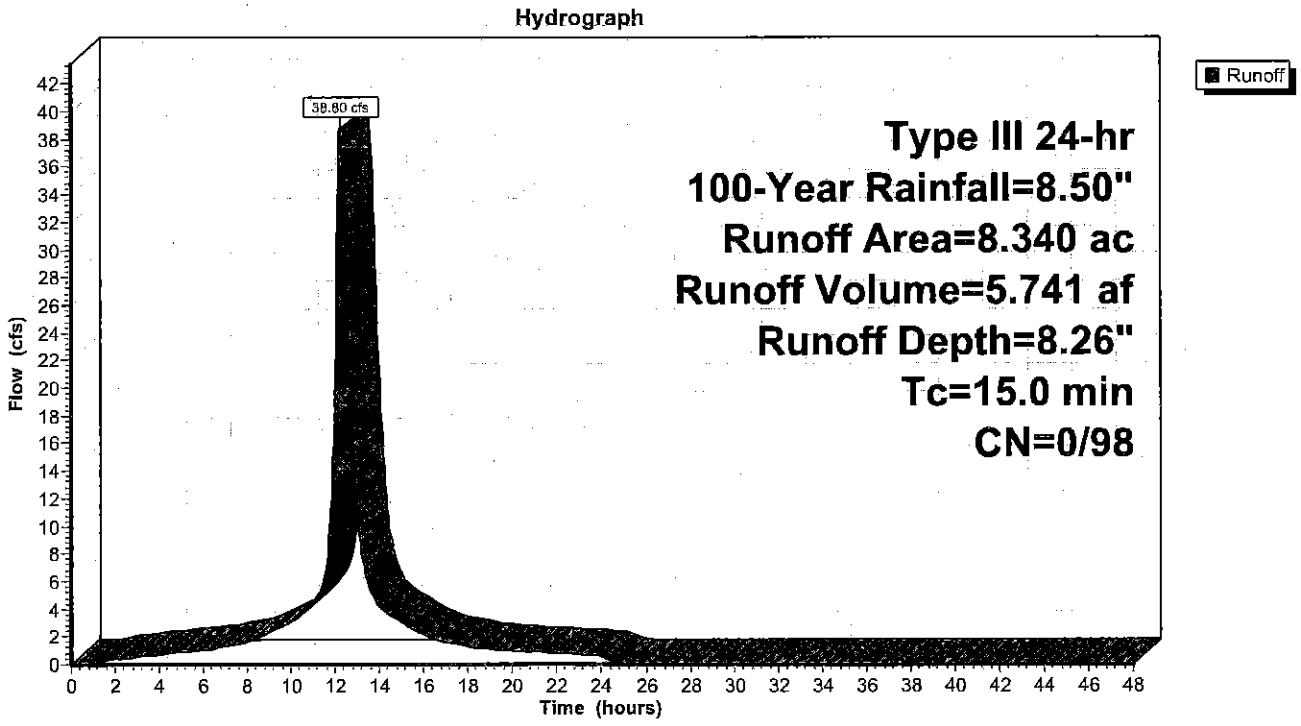
Runoff = 38.80 cfs @ 12.23 hrs, Volume= 5.741 af, Depth= 8.26"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

	Area (ac)	CN	Description
*	8.340	98	Paved
	8.340	98	100.00% Impervious Area

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

Subcatchment DA-1A IMP: DA-1A-IMP



Dev DA Spillway
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment DA-1A PER: DA-1A-Perv

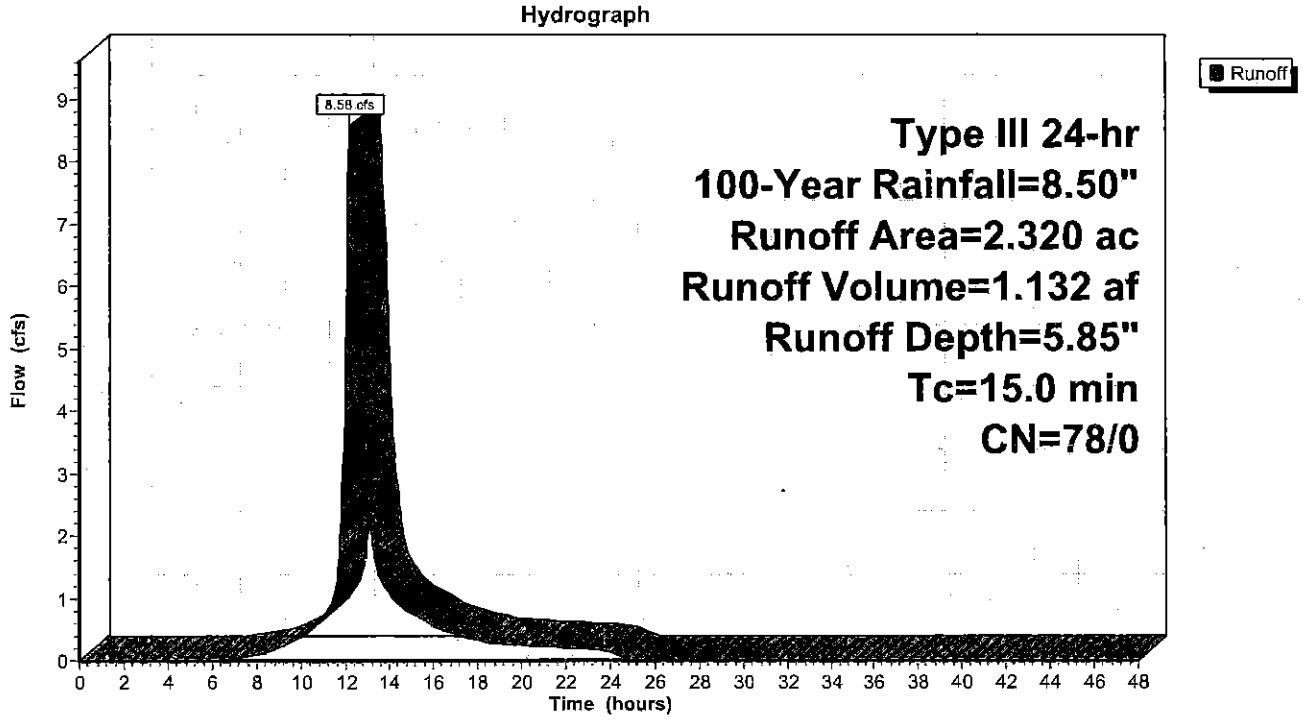
Runoff = 8.58 cfs @ 12.24 hrs, Volume= 1.132 af, Depth= 5.85"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

Area (ac)	CN	Description
1.480	80	>75% Grass cover, Good, HSG D
0.840	74	>75% Grass cover, Good, HSG C
2.320	78	Weighted Average
2.320	78	100.00% Pervious Area

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

Subcatchment DA-1A PER: DA-1A-Perv



Dev DA Spillway
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment DA-1APond: DA-1A Pond

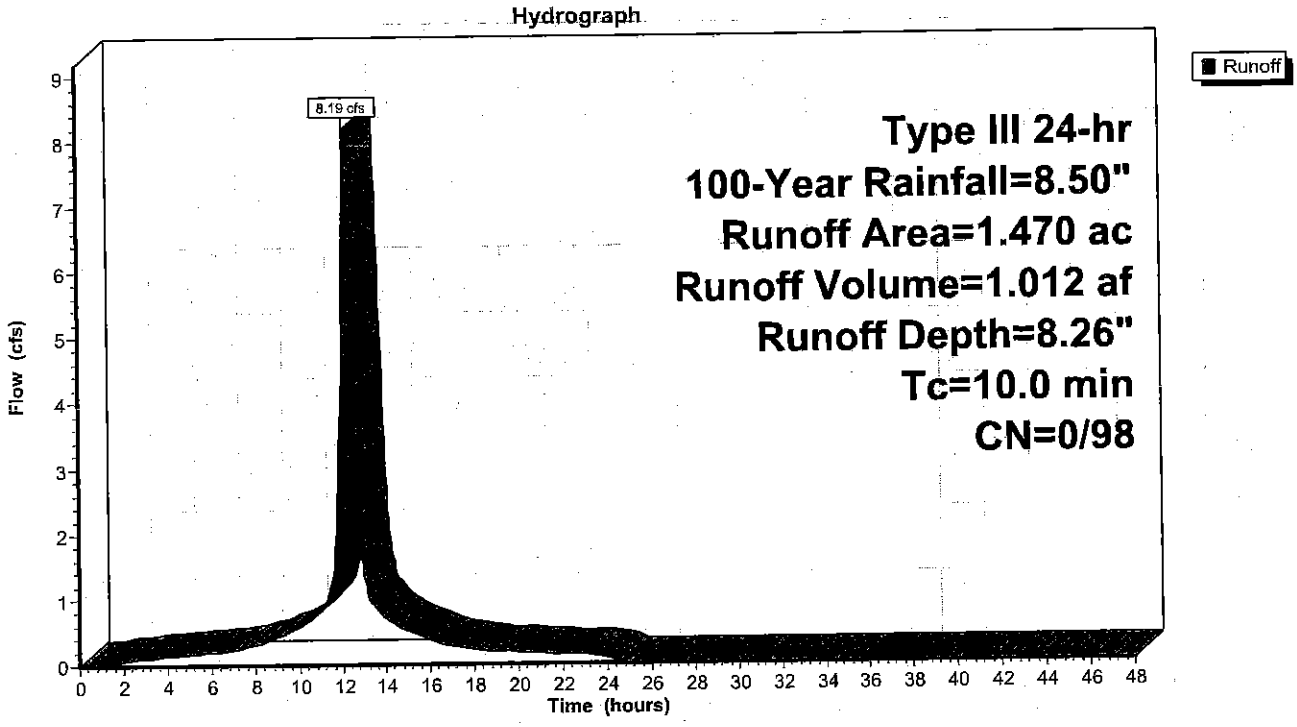
Runoff = 8.19 cfs @ 12.16 hrs, Volume= 1.012 af, Depth= 8.26"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

	Area (ac)	CN	Description
*	1.470	98	Wet Pond
	1.470	98	100.00% Impervious Area

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

Subcatchment DA-1APond: DA-1A Pond



Dev DA Spillway
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment DA1A-BLD: Building

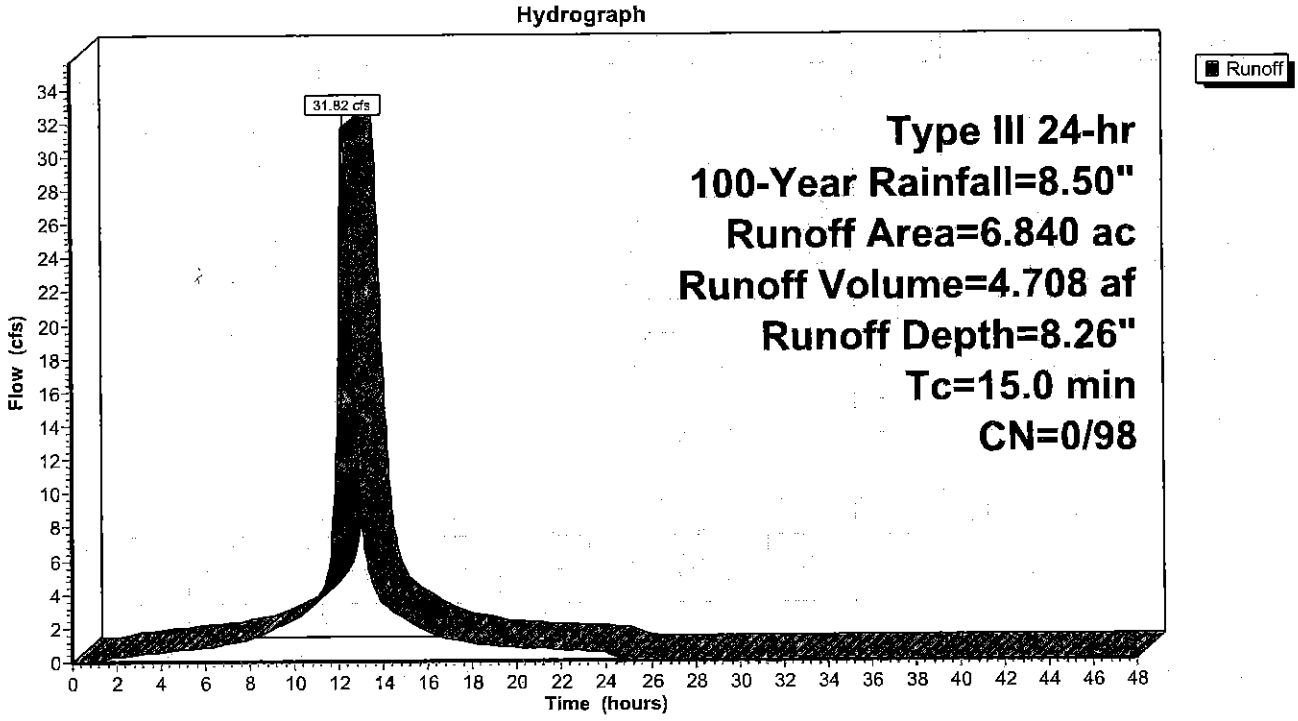
Runoff = 31.82 cfs @ 12.23 hrs, Volume= 4.708 af, Depth= 8.26"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.50"

	Area (ac)	CN	Description
*	6.840	98	Roofs
	6.840	98	100.00% Impervious Area

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

Subcatchment DA1A-BLD: Building



Summary for Pond 1P: Wet Ponds (Combined)

Inflow Area = 18.970 ac, 87.77% Impervious, Inflow Depth = 7.97" for 100-Year event
Inflow = 87.19 cfs @ 12.22 hrs, Volume= 12.593 af
Outflow = 69.50 cfs @ 12.46 hrs, Volume= 7.261 af, Atten= 20%, Lag= 14.4 min
Primary = 69.50 cfs @ 12.46 hrs, Volume= 7.261 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Starting Elev= 3.00' Surf.Area= 1.330 ac Storage= 5.620 af
Peak Elev= 7.32' @ 12.46 hrs Surf.Area= 1.393 ac Storage= 11.531 af (5.911 af above start)

Plug-Flow detention time= 763.7 min calculated for 1.639 af (13% of inflow)
Center-of-Mass det. time= 123.4 min (886.6 - 763.2)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	12.485 af	**Custom Stage Data (Prismatic)** Listed below

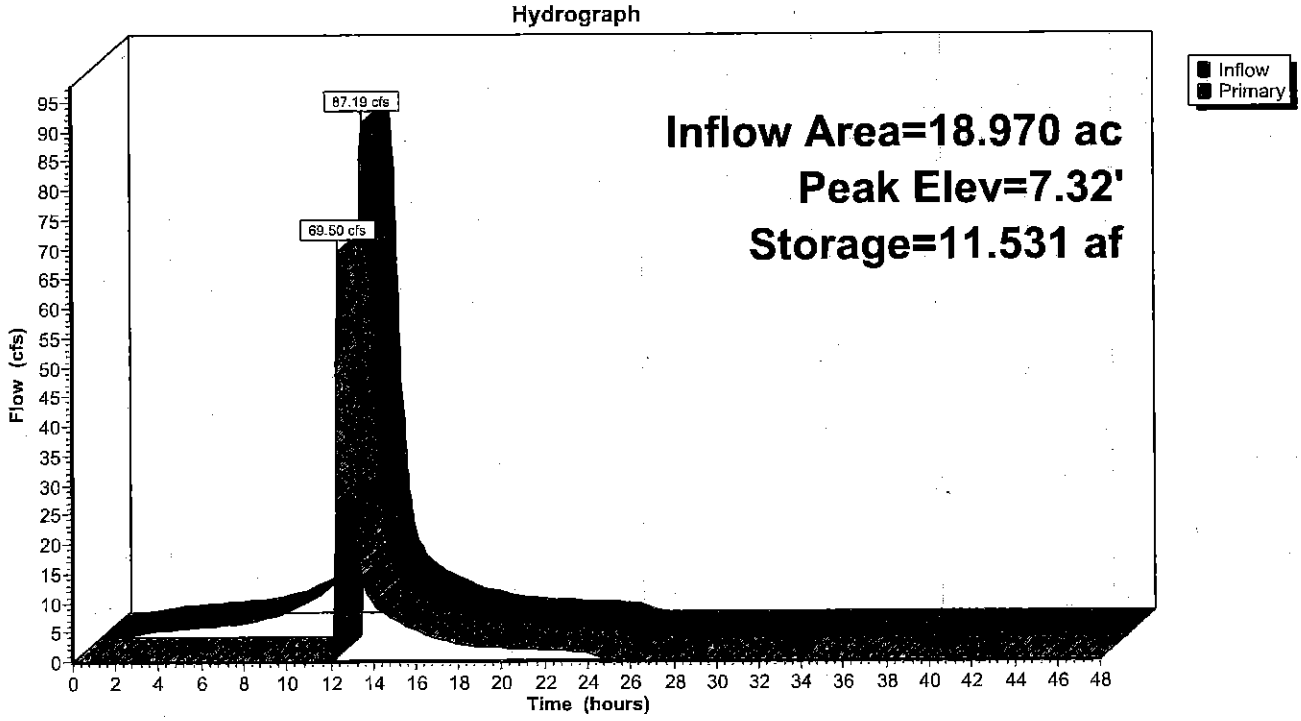
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
-3.00	0.550	0.000	0.000
-2.00	0.610	0.580	0.580
-1.00	0.770	0.690	1.270
0.00	0.900	0.835	2.105
1.00	1.150	1.025	3.130
2.00	1.250	1.200	4.330
3.00	1.330	1.290	5.620
4.00	1.360	1.345	6.965
5.00	1.370	1.365	8.330
6.00	1.380	1.375	9.705
7.00	1.390	1.385	11.090
8.00	1.400	1.395	12.485

Device	Routing	Invert	Outlet Devices
#1	Primary	6.90'	**100.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=68.47 cfs @ 12.46 hrs HW=7.31' (Free Discharge)
↳**1=Broad-Crested Rectangular Weir** (Weir Controls 68.47 cfs @ 1.65 fps)

Dev DA Spillway
Prepared by Langan Eng & Env Srvcs, Inc

Pond 1P: Wet Ponds (Combined)



Dev DA Spillway
Prepared by Langan Eng & Env Srvcs, Inc

Hydrograph for Pond 1P: Wet Ponds (Combined)

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	5.620	3.00	0.00
1.00	0.20	5.623	3.00	0.00
2.00	0.76	5.665	3.03	0.00
3.00	1.13	5.743	3.09	0.00
4.00	1.46	5.851	3.17	0.00
5.00	1.76	5.984	3.27	0.00
6.00	2.03	6.141	3.39	0.00
7.00	2.62	6.329	3.53	0.00
8.00	3.41	6.578	3.71	0.00
9.00	4.83	6.911	3.96	0.00
10.00	6.66	7.385	4.31	0.00
11.00	9.75	8.049	4.79	0.00
12.00	**44.82**	**9.500**	**5.85**	**0.00**
13.00	**24.64**	**11.280**	**7.14**	**29.02**
14.00	9.38	11.112	7.02	9.95
15.00	6.73	11.077	6.99	7.14
16.00	4.87	11.044	6.97	5.27
17.00	3.69	11.020	6.95	3.88
18.00	2.88	11.005	6.94	3.05
19.00	2.43	10.995	6.93	2.49
20.00	2.18	10.991	6.93	2.24
21.00	1.98	10.987	6.93	2.02
22.00	1.80	10.984	6.92	1.84
23.00	1.62	10.981	6.92	1.66
24.00	1.44	10.977	6.92	1.48
25.00	0.04	10.954	6.90	0.16
26.00	0.00	10.952	6.90	0.00
27.00	0.00	10.952	6.90	0.00
28.00	0.00	10.952	6.90	0.00
29.00	0.00	10.952	6.90	0.00
30.00	0.00	10.952	6.90	0.00
31.00	0.00	10.952	6.90	0.00
32.00	0.00	10.952	6.90	0.00
33.00	0.00	10.952	6.90	0.00
34.00	0.00	10.952	6.90	0.00
35.00	0.00	10.952	6.90	0.00
36.00	0.00	10.952	6.90	0.00
37.00	0.00	10.952	6.90	0.00
38.00	0.00	10.952	6.90	0.00
39.00	0.00	10.952	6.90	0.00
40.00	0.00	10.952	6.90	0.00
41.00	0.00	10.952	6.90	0.00
42.00	0.00	10.952	6.90	0.00
43.00	0.00	10.952	6.90	0.00
44.00	0.00	10.952	6.90	0.00
45.00	0.00	10.952	6.90	0.00
46.00	0.00	10.952	6.90	0.00
47.00	0.00	10.952	6.90	0.00
48.00	0.00	10.952	6.90	0.00

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Repauno Redevelopment - 130088802

Designed By EFW Checked By KJW Date 10/27/15

ANTI-SEEP COLLAR DESIGN SUMMARY

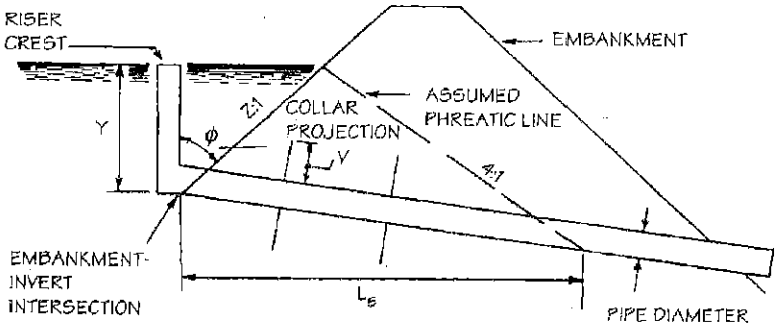
Basin Name	**OS 500**	**OS 600**				
Max 100-Year Water Elevation in Basin (ft)	**6.84**	**6.84**				
Upstream Invert of Outlet Pipe (ft)	**2.71**	**2.73**				
Vert. Dist. From Upstream Pipe Invert to Highest Water Elev. (Y, ft)	**4.13**	**4.11**				
Slope of Embankment Inside Basin at Outlet (Z:1)	**3.0**	**3.0**				
Slope of Outlet Pipe (S, ft/ft)	**0.0030**	**0.0030**				
Calculated Length of Saturation Zone (Ls, ft)	**29.3**	**29.1**				
Length of Conduit from Riser to Discharge Point (L, ft)	**65.0**	**72.0**				
Minimum Length of Ls, L to be Utilized in Calculations (ft)	**29.3**	**29.1**				

Refer to graph to determine number of collars and dimensions

Number of Collars Proposed (n)	**2**	**2**				
Diameter of Outlet Pipe (D, ft)	**3.00**	**3.00**				
Dimension of Each Side of a Square Collar (ft)	**6.00**	**6.00**				
Collar Projection (V, ft)	**1.50**	**1.50**				
(Ls + 2nV) / Ls =	**1.20**	**1.21**				
Collar Spacing (start from outlet structure) (ft)	**9.8**	**9.7**				

(Ls + 2nv) / Ls shall be at least 1.15

Maximum collar spacing shall be 25 feet



$$L_s = Y(z+4)\left[1 + \frac{Sp}{0.25-Sp}\right]$$

Where: Ls = length of pipe in the saturated zone (ft.)

Y = distance in feet from upstream invert of pipe to highest normal water level expected to occur during the life of the structure, usually the top of the riser.

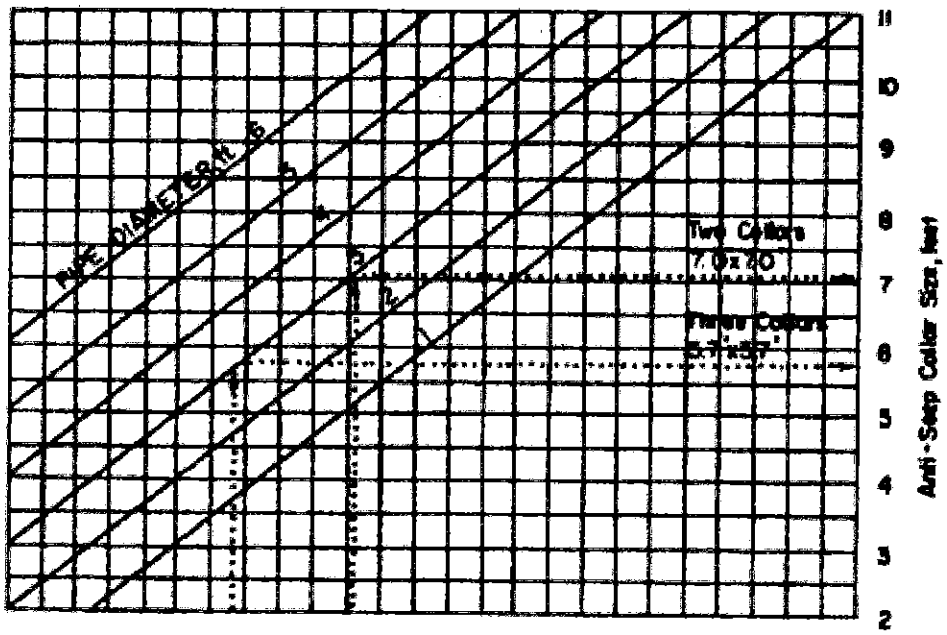
Z = slope of upstream embankment as a ratio of z ft. horizontal to one ft. vertical.

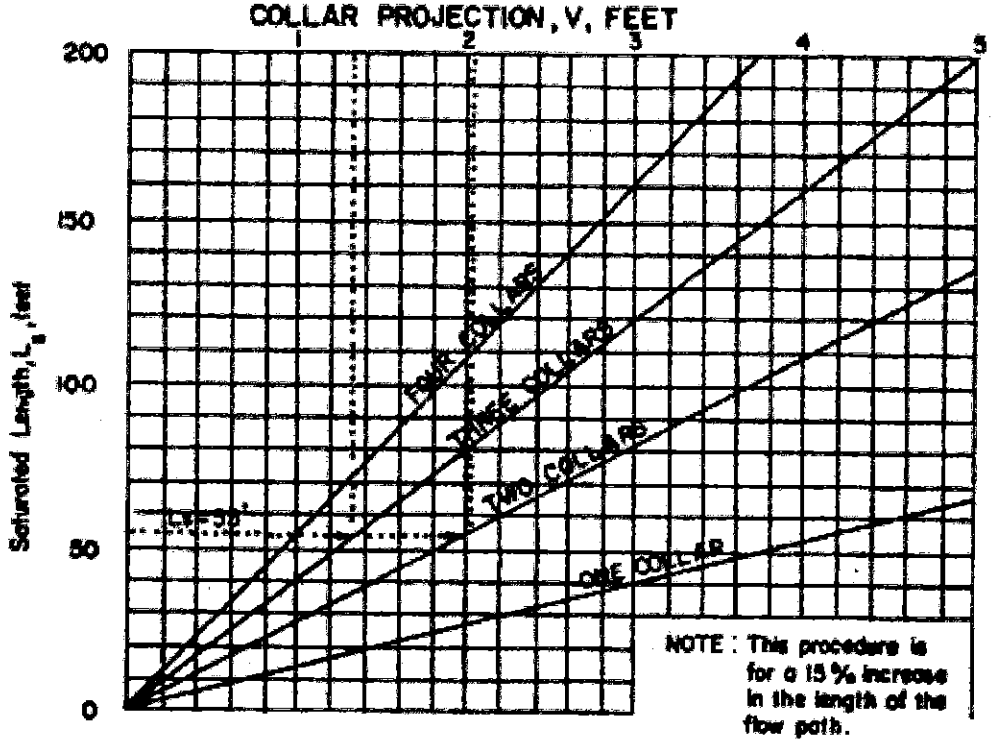
Sp = slope of pipe in feet per foot.

Notes:

9

ANTI-SEEP COLLAR DESIGN





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Anti-seep collar design graph
USDA-NRCS

Appendix E

NJDEP LID Checklist

APPENDIX A

Low Impact Development Checklist

A checklist for identifying nonstructural stormwater management strategies incorporated into proposed land development

According to the NJDEP Stormwater Management Rules at N.J.A.C. 7:8, the groundwater recharge, stormwater quality, and stormwater quantity standards established by the Rules for major land development projects must be met by incorporating nine specific nonstructural stormwater management strategies into the project's design to the maximum extent practicable.

To accomplish this, the Rules require an applicant seeking land development approval from a regulatory board or agency to identify those nonstructural strategies that have been incorporated into the project's design. In addition, if an applicant contends that it is not feasible to incorporate any of the specific strategies into the project's design, particularly for engineering, environmental, or safety reasons, the Rules further require that the applicant provide a basis for that contention.

This checklist has been prepared to assist applicants, site designers, and regulatory boards and agencies in ensuring that the nonstructural stormwater management requirements of the Rules are met. It provides an applicant with a means to identify both the nonstructural strategies incorporated into the development's design and the specific low impact development BMPs (LID-BMPs) that have been used to do so. It can also help an applicant explain the engineering, environmental, and/or safety reasons that a specific nonstructural strategy could not be incorporated into the development's design.

The checklist can also assist municipalities and other land development review agencies in the development of specific requirements for both nonstructural strategies and LID-BMPs in zoning and/or land use ordinances and regulations. As such, where requirements consistent with the Rules have been adopted, they may supersede this checklist.

Finally, the checklist can be used during a pre-design meeting between an applicant and pertinent review personnel to discuss local nonstructural strategies and LID-BMPs requirements in order to optimize the development's nonstructural stormwater management design.

Since this checklist is intended to promote the use of nonstructural stormwater management strategies and provide guidance in their incorporation in land development projects, municipalities are permitted to revise it as necessary to meet the goals and objectives of their specific stormwater management program and plan within the limits of N.J.A.C. 7:8.

Low Impact Development Checklist

A checklist for identifying nonstructural stormwater management strategies incorporated into proposed land development

Municipality: Township of Greenwich

County: Gloucester County Date: 03/31/2016

Review board or agency: Township of Greenwich

Proposed land development name: DRP Gibbstown Logistics Center - Phase 1

Lot(s): 4 Block(s): 8 (P/O)

Project or application number: 130088802 (Langan Engineering Project Number)

Applicant's name: Delaware River Partners LLC, C/O Fortress Worldwide Transportation and Infrastructure General Partnership

Applicant's address: 1345 Avenue of the Americas, 46th floor

New York, NY 10105

Telephone: 305-520-2300 Fax:

Email address:

Designer's name: Langan Engineering and Environmental Services, Inc

Designer's address: 989 Lenox Drive, Suite 124,

Lawrenceville, NJ 08648

Telephone: 609-282-8000 Fax: 609-282-8001

Email address: ewilkes@langan.com

Part 1: Description of Nonstructural Approach to Site Design

In narrative form, provide an overall description of the nonstructural stormwater management approach and strategies incorporated into the proposed site's design. Attach additional pages as necessary. Details of each nonstructural strategy are provided in Part 3 below.

The disturbance during construction will be limited to the necessary areas as required. Specifically retaining walls are utilized to reduce impact to wetlands wooded areas. Curb cuts have been proposed to disconnect impervious surfaces and allow stormwater to flow through grassed areas prior to entering the storm sewer and extend the developed time of concentration. Scour holes and retaining walls will be constructed to minimize disturbance within wetlands. A landscape buffer has been provided between the proposed warehouse and residents. All disturbance is within HSG D soils that do not encourage ground water recharge.

Part 2: Review of Local Stormwater Management Regulations

Title and date of stormwater management regulations used in development design:

Township of Greenwich Codes

Do regulations include nonstructural requirements? Yes: X No: _____

If yes, briefly describe:

Use of nonstructural BMPS, or Low Impact Development Techniques are required as part of the stormwater management design.

List LID-BMPs prohibited by local regulations: NONE

Pre-design meeting held? Yes: _____ Date: _____ No: X

Meeting held with: _____

Pre-design site walk held? Yes: _____ Date: _____ No: X

Site walk held with: _____

Other agencies with stormwater review jurisdiction:

Name: Gloucester Soil Conservation District

Required approval: Soil Erosion and Sediment Control Certification

Name: NJDEP

Required approval: Wetlands GP and FHA IP

Name: _____

Required approval: _____

Part 3: Nonstructural Strategies and LID-BMPs in Design

3.1 Vegetation and Landscaping

Effective management of both existing and proposed site vegetation can reduce a development's adverse impacts on groundwater recharges and runoff quality and quantity. This section of the checklist helps identify the vegetation and landscaping strategies and nonstructural LID-BMPs that have been incorporated into the proposed development's design to help maintain existing recharge rates and/or minimize or prevent increases in runoff quantity and pollutant loading.

A. Has an inventory of existing site vegetation been performed? Yes: _____ No: X

If yes, was this inventory a factor in the site's layout and design? Yes: _____ No: _____

B. Does the site design utilize any of the following nonstructural LID-BMPs?

Preservation of natural areas? Yes: X No: _____ If yes, specify % of site: 33%

Native ground cover? Yes: X No: _____ If yes, specify % of site: 14%

Vegetated buffers? Yes: X No: _____ If yes, specify % of site: 2%

C. Do the land development regulations require these nonstructural LID-BMPs?

Preservation of natural areas? Yes: _____ No: X If yes, specify % of site: _____

Native ground cover? Yes: _____ No: X If yes, specify % of site: _____

Vegetated buffers? Yes: _____ No: X If yes, specify % of site: _____

D. If vegetated filter strips or buffers are utilized, specify their functions:

Reduce runoff volume increases through lower runoff coefficient: Yes: _____ No: N/A

Reduce runoff pollutant loads through runoff treatment: Yes: _____ No: N/A

Maintain groundwater recharge by preserving natural areas: Yes: _____ No: N/A

3.2 Minimize Land Disturbance

Minimizing land disturbance is a nonstructural LID-BMP that can be applied during both the development's construction and post-construction phases. This section of the checklist helps identify those land disturbance strategies and nonstructural LID-BMPs that have been incorporated into the proposed development's design to minimize land disturbance and the resultant change in the site's hydrologic character.

A. Have inventories of existing site soils and slopes been performed? Yes: X No: _____

If yes, were these inventories factors in the site's layout and design? Yes: X No: _____

B. Does the development's design utilize any of the following nonstructural LID-BMPs?

Restrict permanent site disturbance by land owners? Yes: _____ No: X

If yes, how: _____

Restrict temporary site disturbance during construction? Yes: X No: _____

If yes, how: Silt fencing will discourage construction equipment from leaving approved limit of distrubance.

Consider soils and slopes in selecting disturbance limits? Yes: X No: _____

If yes, how: The development minimizes disturbance to the wetlands area and existing woods as much as possible.

C. Specify percentage of site to be cleared: 67% Regraded: 16%

D. Specify percentage of cleared areas done so for buildings: 23%

For driveways and parking: 28% For roadways: 0%

E. What design criteria and/or site changes would be required to reduce the percentages in C and D above?

The project was designed to adequately park the anticipated use. Retaining walls have been utilized to reduce clearing limits.

F. Specify site's hydrologic soil group (HSG) percentages:

HSG A: _____ HSG B: _____ HSG C: _____ HSG D: 100.0%

G. Specify percentage of each HSG that will be permanently disturbed:

HSG A: _____ HSG B: _____ HSG C: _____ HSG D: 67.0%

H. Locating site disturbance within areas with less permeable soils (HSG C and D) and minimizing disturbance within areas with greater permeable soils (HSG A and B) can help maintain groundwater recharge rates and reduce runoff volume increases. In light of the HSG percentages in F and G above, what other practical measures if any can be taken to achieve this?

All disturbance takes place within HSG D soils.

I. Does the site include Karst topography? Yes: _____ No: X

If yes, discuss measures taken to limit Karst impacts:

3.3 Impervious Area Management

New impervious surfaces at a development site can have the greatest adverse effect on groundwater recharge and stormwater quality and quantity. This section of the checklist helps identify those nonstructural strategies and LID-BMPs that have been incorporated into a proposed development's design to comprehensively manage the extent and impacts of new impervious surfaces.

A. Specify impervious cover at site: Existing: 1.0% Proposed: 51.0%

B. Specify maximum site impervious coverage allowed by regulations: 80%

C. Compare proposed street cartway widths with those required by regulations:

Type of Street	Proposed Cartway Width (feet)	Required Cartway Width (feet)
Residential access – low intensity	N/A	
Residential access – medium intensity	N/A	
Residential access – high intensity with parking	N/A	
Residential access – high intensity without parking	N/A	
Neighborhood	N/A	
Minor collector – low intensity without parking	N/A	
Minor collector – with one parking lane	N/A	
Minor collector – with two parking lanes	N/A	
Minor collector – without parking	N/A	
Major collector	N/A	

D. Compare proposed parking space dimensions with those required by regulations:

Proposed: 9'x18' Regulations: 9'x18'

E. Compare proposed number of parking spaces with those required by regulations:

Proposed: 277 Regulations: 273

F. Specify percentage of total site impervious cover created by buildings:

By driveways and parking: _____ By roadways: _____

G. What design criteria and/or site changes would be required to reduce the percentages in F above?

_____

_____

_____

_____

H. Specify percentage of total impervious area that will be unconnected:

Total site: 0% Buildings: 0% Driveways and parking: 0% Roads: 0%

I. Specify percentage of total impervious area that will be porous:

Total site: 0% Buildings: 0% Driveways and parking: 0% Roads: 0%

J. Specify percentage of total building roof area that will be vegetated: 0%

K. Specify percentage of total parking area located beneath buildings: 0%

L. Specify percentage of total parking located within multi-level parking deck: 0%

3.4 Time of Concentration Modifications

Decreasing a site's time of concentration (Tc) can lead directly to increased site runoff rates which, in turn, can create new and/or aggravate existing erosion and flooding problems downstream. This section of the checklist helps identify those nonstructural strategies and LID-BMPs that have been incorporated into the proposed development's design to effectively minimize such Tc decreases.

When reviewing Tc modification strategies, it is important to remember that a drainage area's Tc should reflect the general conditions throughout the area. As a result, Tc modifications must generally be applied throughout a drainage area, not just along a specific Tc route.

A. Specify percentage of site's total stormwater conveyance system length that will be:

Storm sewer: 95% Vegetated swale: 0% Natural channel: 0%

Stormwater management facility: 5% Other: _____

Note: the total length of the stormwater conveyance system should be measured from the site's downstream property line to the downstream limit of sheet flow at the system's headwaters.

B. What design criteria and/or site changes would be required to reduce the storm sewer percentages and increase the vegetated swale and natural channel percentages in A above?

The introduction of additional drainage swales would result in additional disturbance to the adjacent wetlands as well as the removal of additional trees.

C. In conveyance system subareas that have overland or sheet flow over impervious surfaces or turf grass, what practical and effective site changes can be made to:

Decrease overland flow slope: The landscaped areas have been designed to the minimum slopes possible to maintain adequate flow.

Increase overland flow roughness: _____

3.5 Preventative Source Controls

The most effective way to address water quality concerns is by pollution prevention. This section of the checklist helps identify those nonstructural strategies and LID-BMPs that have been incorporated into the proposed development's design to reduce the exposure of pollutants to prevent their release into the stormwater runoff.

A. Trash Receptacles

Specify the number of trash receptacles provided: NONE

Specify the spacing between the trash receptacles: NONE

Compare trash receptacles proposed with those required by regulations:

Proposed: NONE Regulations: NONE

B. Pet Waste Stations

Specify the number of pet waste stations provided: NONE

Specify the spacing between the pet waste stations: NONE

Compare pet waste stations proposed with those required by regulations:

Proposed: NONE Regulations: NONE

C. Inlets, Trash Racks, and Other Devices that Prevent Discharge of Large Trash and Debris

Specify percentage of total inlets that comply with the NJPDES storm drain inlet criteria: 100%

D. Maintenance

Specify the frequency of the following maintenance activities:

Street sweeping: Proposed: NONE Regulations: NONE

Litter collection: Proposed: NONE Regulations: NONE

Identify other stormwater management measures on the site that prevent discharge of large trash and debris:

E. Prevention and Containment of Spills

Identify locations where pollutants are located on the site, and the features that prevent these pollutants from being exposed to stormwater runoff:

Pollutant: Fluids from vehicles Location: Parking Lots

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: _____ Location: _____

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: _____ Location: _____

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: _____ Location: _____

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: _____ Location: _____

Part 4: Compliance with Nonstructural Requirements of NJDEP Stormwater Management Rules

1. Based upon the checklist responses above, indicate which nonstructural strategies have been incorporated into the proposed development's design in accordance with N.J.A.C. 7:8-5.3(b):

No.	Nonstructural Strategy	Yes	No
1.	Protect areas that provide water quality benefits or areas particularly susceptible to erosion and sediment loss.	X	
2.	Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces.	X	
3.	Maximize the protection of natural drainage features and vegetation.	X	
4.	Minimize the decrease in the pre-construction time of concentration.	X	
5.	Minimize land disturbance including clearing and grading.	X	
6.	Minimize soil compaction.	X	
7.	Provide low maintenance landscaping that encourages retention and planting of native vegetation and minimizes the use of lawns, fertilizers, and pesticides.	X	
8.	Provide vegetated open-channel conveyance systems discharge into and through stable vegetated areas.	X	
9.	Provide preventative source controls.	X	

2. For those strategies that have not been incorporated into the proposed development's design, provide engineering, environmental, and/or safety reasons. Attached additional pages as necessary.

Appendix F

NJDEP Annual Groundwater Recharge Analysis
(GSR-32)

New Jersey Groundwater Recharge Spreadsheet
Version 2.0
November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓	Average Annual P (in)	Climatic Factor
GLOUCESTER CO., GREENWICH TWP	44.6	1.36

Project Name:	Sample Project
Description:	This is a test application
Analysis Date:	09/01/03

Pre-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	0.03	Gravel, dirt	Urban Land*	0.0	-
2	0.18	Open space	Urban Land*	0.0	-
3	0.29	Gravel, dirt	Udorthents	0.0	-
4	6.33	Woods	Udorthents	0.0	-
5	0.07	Residential 1/8 acre or less	Udorthents	0.0	-
6	8.3	Woods-grass combination	Udorthents	0.0	-
7	14.32	Woods	Udorthents	0.0	-
8	0.61	Open space	Udorthents	0.0	-
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	30.1			Total Annual Recharge (in)	Total Annual Recharge (cu-ft)
				0.0	-

Post-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	0.22	Open space	Urban Land*	0.0	-
2	3.93	Open space	Udorthents	0.0	-
3	11.07	Impervious areas	Udorthents	0.0	-
4	1.53	Open space	Udorthents	0.0	-
5	7.59	Woods	Udorthents	0.0	-
6	5.8	Impervious areas	Udorthents	0.0	-
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	30.1	Warning: make total area equal to Pre-Developed Conditions		Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				0.0	-

Annual Recharge Requirements Calculation ↓

% of Pre-Developed Annual Recharge to Preserve =	100%	Total Impervious Area (sq.ft)	734,857
Post-Development Annual Recharge Deficit=	*0*	(cubic feet)	

Recharge Efficiency Parameters Calculations (area averages)

RWC=	0.00	(in)	DRWC=	0.00	(in)
ERWC =	0.00	(in)	EDRWC=	0.00	(in)

Procedure to fill the Pre-Development and Post-Development Conditions Tables

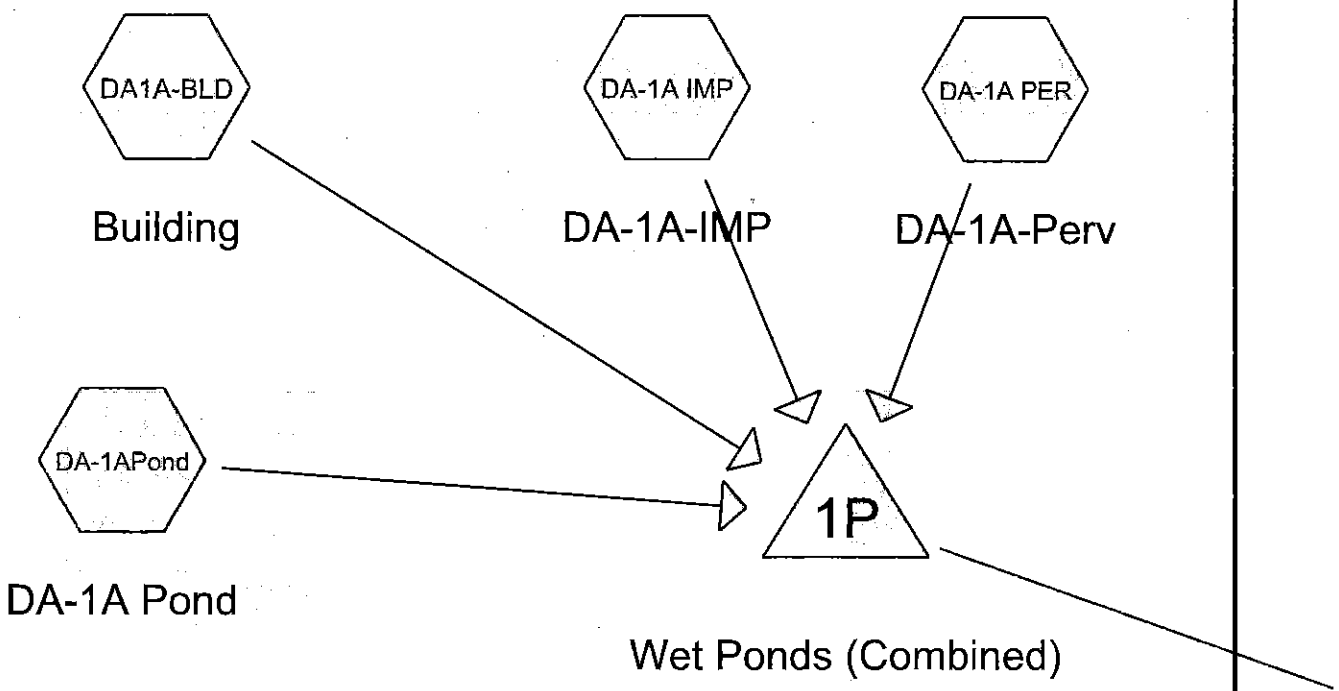
For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover. Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

Appendix G

Soil Erosion & Sediment Control Stability Analysis

&

Conduit Outlet Protection Calculations



Subcat Reach Pond Link

Routing Diagram for Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc, Printed 11/3/2015

Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Subcatchment DA-1A IMP: DA-1A-IMP

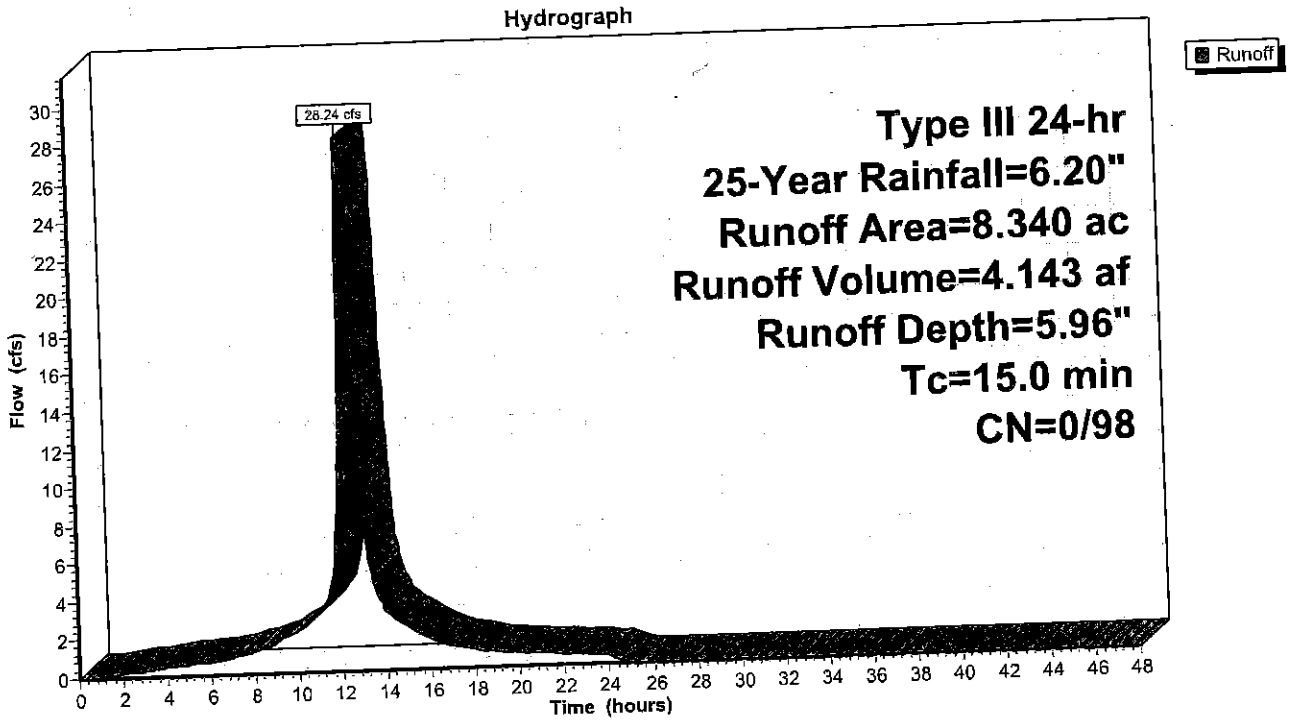
Runoff = 28.24 cfs @ 12.23 hrs, Volume= 4.143 af, Depth= 5.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

	Area (ac)	CN	Description
*	8.340	98	Paved
	8.340	98	100.00% Impervious Area

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

Subcatchment DA-1A IMP: DA-1A-IMP



Summary for Subcatchment DA-1A PER: DA-1A-Perv

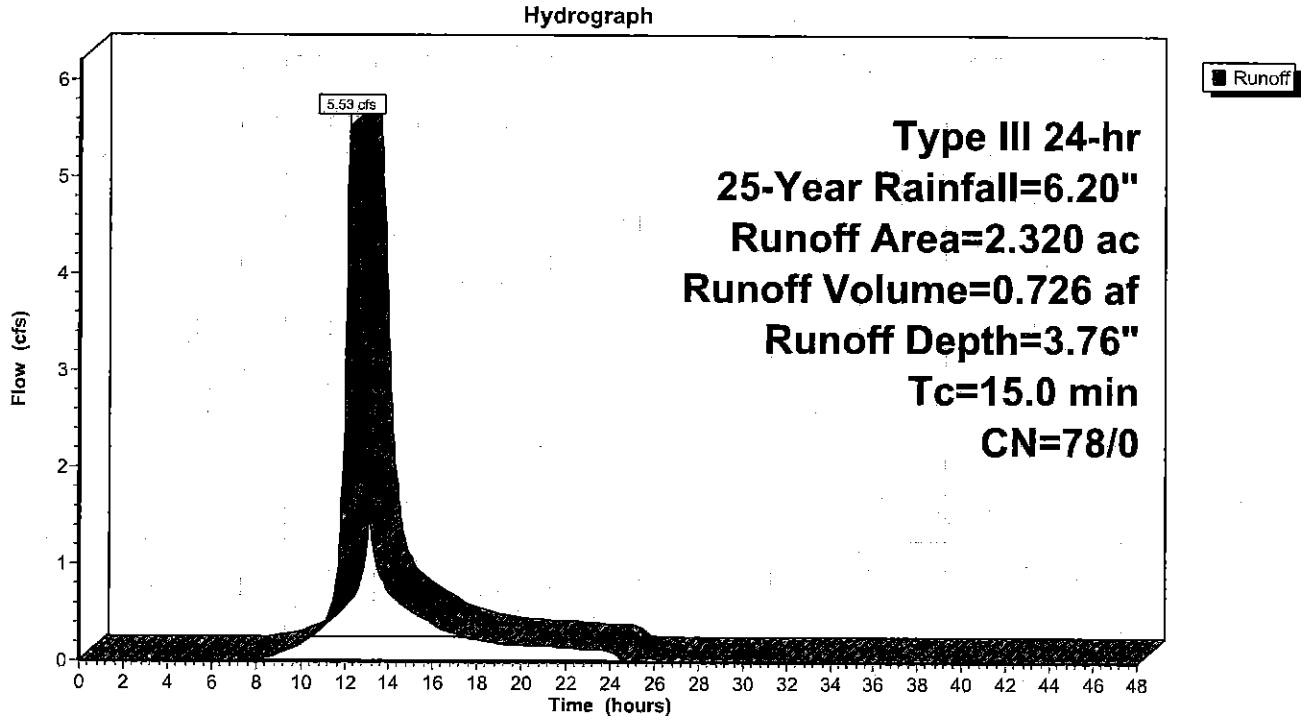
Runoff = 5.53 cfs @ 12.25 hrs, Volume= 0.726 af, Depth= 3.76"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (ac)	CN	Description
1.480	80	>75% Grass cover, Good, HSG D
0.840	74	>75% Grass cover, Good, HSG C
2.320	78	Weighted Average
2.320	78	100.00% Pervious Area

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

Subcatchment DA-1A PER: DA-1A-Perv



Summary for Subcatchment DA-1APond: DA-1A Pond

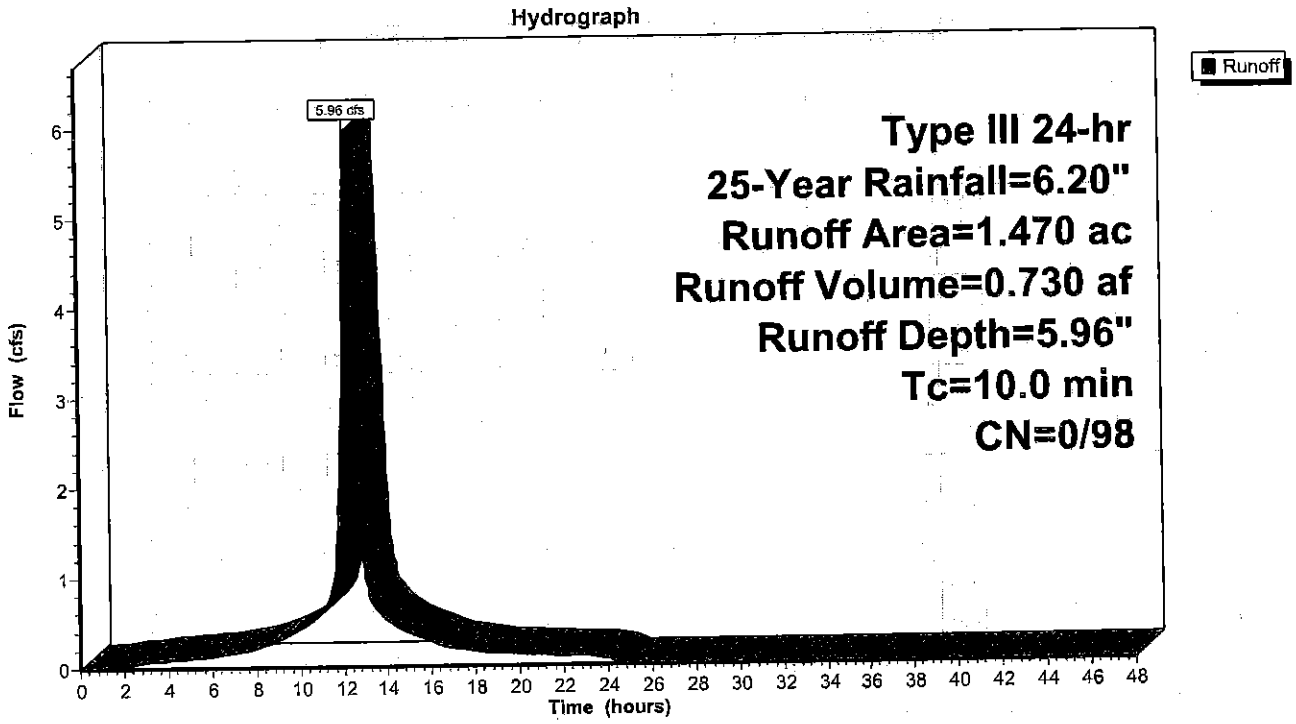
Runoff = 5.96 cfs @ 12.16 hrs, Volume= 0.730 af, Depth= 5.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

	Area (ac)	CN	Description
*	1.470	98	Wet Pond
	1.470	98	100.00% Impervious Area

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

Subcatchment DA-1APond: DA-1A Pond



Summary for Subcatchment DA1A-BLD: Building

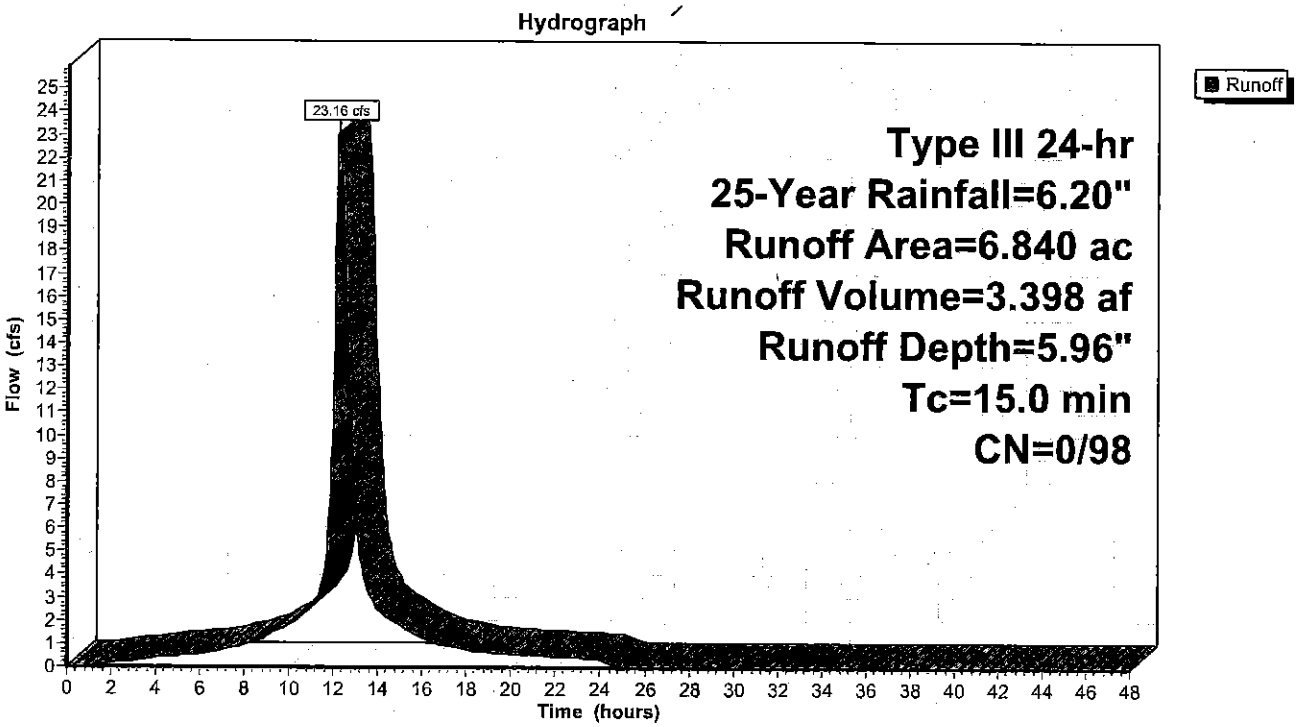
Runoff = 23.16 cfs @ 12.23 hrs, Volume= 3.398 af, Depth= 5.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

	Area (ac)	CN	Description
*	6.840	98	Roofs
	6.840	98	100.00% Impervious Area

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

Subcatchment DA1A-BLD: Building



Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Summary for Pond 1P: Wet Ponds (Combined)

Inflow Area =	18.970 ac,	87.77% Impervious,	Inflow Depth =	5.69"	for 25-Year event
Inflow =	62.73 cfs @	12.22 hrs,	Volume=	8.998 af	
Outflow =	19.47 cfs @	12.95 hrs,	Volume=	8.882 af,	Atten= 69%, Lag= 43.7 min
Primary =	9.73 cfs @	12.95 hrs,	Volume=	4.441 af	
Secondary =	9.73 cfs @	12.95 hrs,	Volume=	4.441 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Starting Elev= 3.00' Surf.Area= 1.330 ac Storage= 5.620 af
Peak Elev= 6.16' @ 12.95 hrs Surf.Area= 1.382 ac Storage= 9.923 af (4.303 af above start)

Plug-Flow detention time= 837.9 min calculated for 3.259 af (36% of inflow)
Center-of-Mass det. time= 279.9 min (1,047.3 - 767.4)

Volume	Invert	Avail.Storage	Storage Description
#1	-3.00'	12.485 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
-3.00	0.550	0.000	0.000
-2.00	0.610	0.580	0.580
-1.00	0.770	0.690	1.270
0.00	0.900	0.835	2.105
1.00	1.150	1.025	3.130
2.00	1.250	1.200	4.330
3.00	1.330	1.290	5.620
4.00	1.360	1.345	6.965
5.00	1.370	1.365	8.330
6.00	1.380	1.375	9.705
7.00	1.390	1.385	11.090
8.00	1.400	1.395	12.485

Device	Routing	Invert	Outlet Devices
#1	Device 7	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#2	Device 8	3.00'	**8.5" Vert. Orifice/Grate** C= 0.600
#3	Device 7	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Device 8	4.90'	**1.4' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Device 7	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Device 8	6.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#7	Primary	2.90'	**36.0" Round Culvert** L= 60.0' RCP, square edge headwall, Ke= 0.500

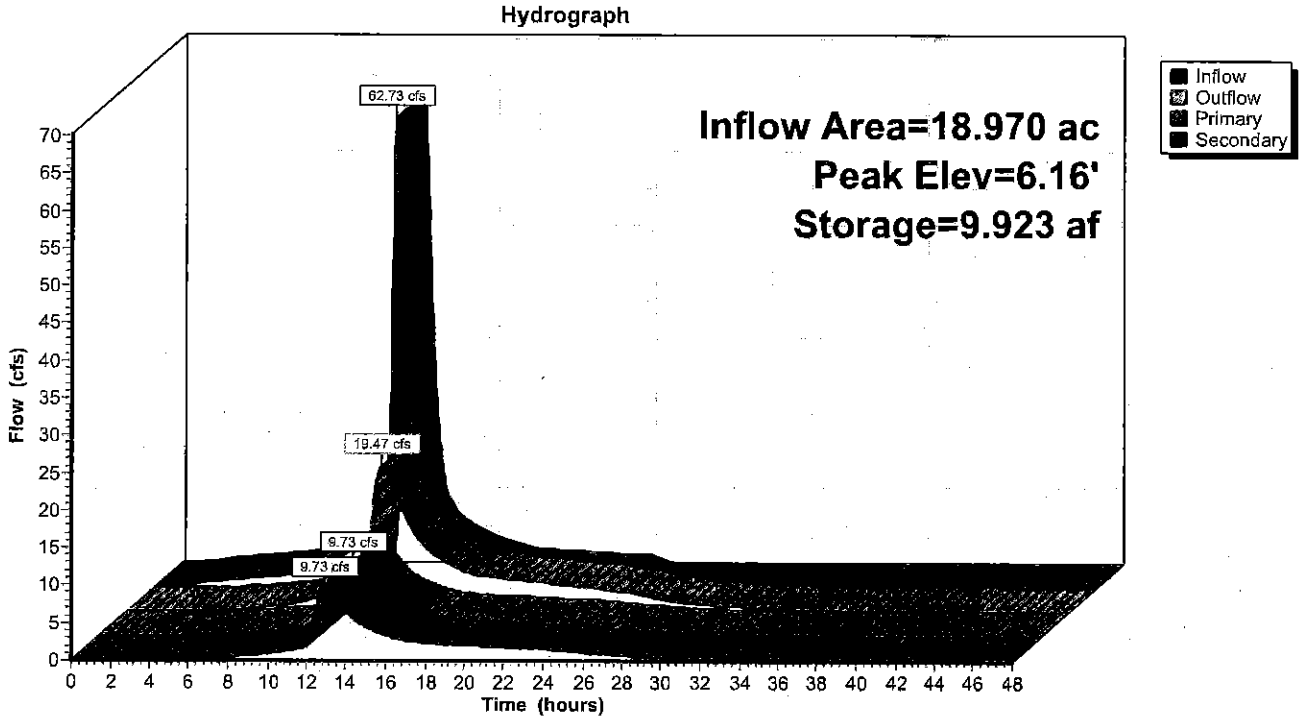
Inlet / Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
n= 0.013, Flow Area= 7.07 sf

#8 Secondary 2.90' **36.0" Round Culvert**
L= 60.0' RCP, square edge headwall, Ke= 0.500
Inlet./ Outlet Invert= 2.90' / 2.50' S= 0.0067 '/' Cc= 0.900
n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=9.73 cfs @ 12.95 hrs HW=6.16' (Free Discharge)
└**7=Culvert** (Passes 9.73 cfs of 40.24 cfs potential flow)
├**1=Orifice/Grate** (Orifice Controls 3.18 cfs @ 8.06 fps)
├**3=Broad-Crested Rectangular Weir**(Weir Controls 6.55 cfs @ 3.72 fps)
└**5=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Secondary OutFlow Max=9.73 cfs @ 12.95 hrs HW=6.16' (Free Discharge)
└**8=Culvert** (Passes 9.73 cfs of 40.24 cfs potential flow)
├**2=Orifice/Grate** (Orifice Controls 3.18 cfs @ 8.06 fps)
├**4=Broad-Crested Rectangular Weir**(Weir Controls 6.55 cfs @ 3.72 fps)
└**6=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 1P: Wet Ponds (Combined)



Dev DA two outlets
Prepared by Langan Eng & Env Srvcs, Inc

Hydrograph for Pond 1P: Wet Ponds (Combined)

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	5.620	3.00	0.00	0.00	0.00
1.00	0.05	5.620	3.00	0.00	0.00	0.00
2.00	0.41	5.640	3.01	0.01	0.00	0.00
3.00	0.70	5.685	3.05	0.02	0.01	0.01
4.00	0.96	5.749	3.10	0.09	0.04	0.04
5.00	1.19	5.827	3.15	0.17	0.09	0.09
6.00	1.40	5.914	3.22	0.34	0.17	0.17
7.00	1.81	6.008	3.29	0.56	0.28	0.28
8.00	2.37	6.121	3.37	0.88	0.44	0.44
9.00	3.39	6.264	3.48	1.34	0.67	0.67
10.00	4.71	6.462	3.63	1.97	0.98	0.98
11.00	6.93	6.744	3.84	2.63	1.32	1.32
12.00	**32.14**	**7.524**	**4.41**	**3.90**	**1.95**	**1.95**
13.00	**17.79**	**9.920**	**6.16**	**19.43**	**9.71**	**9.71**
14.00	6.79	9.386	5.77	13.38	6.69	6.69
15.00	4.87	8.951	5.45	9.00	4.50	4.50
16.00	3.53	8.654	5.24	6.78	3.39	3.39
17.00	2.67	8.404	5.05	5.44	2.72	2.72
18.00	2.08	8.186	4.89	4.71	2.35	2.35
19.00	1.76	7.963	4.73	4.45	2.23	2.23
20.00	1.58	7.744	4.57	4.19	2.09	2.09
21.00	1.44	7.534	4.42	3.91	1.96	1.96
22.00	1.30	7.336	4.27	3.63	1.82	1.82
23.00	1.17	7.149	4.14	3.35	1.68	1.68
24.00	1.04	6.976	4.01	3.07	1.53	1.53
25.00	0.03	6.768	3.85	2.68	1.34	1.34
26.00	0.00	6.566	3.70	2.24	1.12	1.12
27.00	0.00	6.399	3.58	1.79	0.89	0.89
28.00	0.00	6.270	3.48	1.36	0.68	0.68
29.00	0.00	6.172	3.41	1.04	0.52	0.52
30.00	0.00	6.096	3.35	0.81	0.40	0.40
31.00	0.00	6.037	3.31	0.64	0.32	0.32
32.00	0.00	5.990	3.27	0.51	0.25	0.25
33.00	0.00	5.952	3.25	0.42	0.21	0.21
34.00	0.00	5.920	3.22	0.36	0.18	0.18
35.00	0.00	5.892	3.20	0.30	0.15	0.15
36.00	0.00	5.870	3.19	0.25	0.13	0.13
37.00	0.00	5.850	3.17	0.21	0.11	0.11
38.00	0.00	5.834	3.16	0.18	0.09	0.09
39.00	0.00	5.820	3.15	0.16	0.08	0.08
40.00	0.00	5.807	3.14	0.15	0.08	0.08
41.00	0.00	5.795	3.13	0.14	0.07	0.07
42.00	0.00	5.784	3.12	0.13	0.06	0.06
43.00	0.00	5.774	3.11	0.11	0.06	0.06
44.00	0.00	5.765	3.11	0.10	0.05	0.05
45.00	0.00	5.757	3.10	0.10	0.05	0.05
46.00	0.00	5.749	3.10	0.09	0.04	0.04
47.00	0.00	5.742	3.09	0.08	0.04	0.04
48.00	0.00	5.736	3.09	0.07	0.04	0.04

Based on "Standards for Soil Erosion and Sediment Control in New Jersey," Jan. 2014

TABLE 12-1 ALLOWABLE VELOCITIES FOR VARIOUS SOILS

SOIL TEXTURE	ALLOWABLE VELOCITY (ft./sec.)
1. Sand	1.8
2. Sandy Loam	2.5
3. Silt loam (also high lime clay), loam	3.0
4. Sandy clay loam	3.5
5. Clay loam	4.0
6. Clay, fine gravel, gradded loam to gravel	5.0
7. Cobbles	5.5
8. Shale (non-weathered)	6.0

Soil type where outfall is located = 2 (Note: Select number designating soil texture above)
allowable velocity = 2.5 ft/sec
v (velocity) = 6.49 ft/sec from Storm Sewer Conveyance
Rip Rap Apron required? yes (1 = yes, 0 = no)

Given:

D_o (max inside height) = 4 feet
W_o (max inside width) = 4 feet
Q (discharge) = 43.86 cfs (25-year Storm) from Storm Sewer Conveyance
*q (unit discharge, = Q/W_o) = 11.0 cfs / foot
** T_w (tail water) = 3.00 feet

* for the conduit design storm or the 25 year storm, whichever is greater
** for areas where T_w cannot be computed, use $T_w = 0.2\ D_o$. For discharge into detention basins, Tw shall equal the 2 year storm elevation in the basin.

Riprap Apron Dimensions

I. The length of the apron, L (in feet), shall be determined from the formula:

$$L_a = (1.8\frac{q}{D_o^{1/2}}) + 7D_o$$

$T_w < ½\ D_o$ $L_a =$ 0 feet

$$L_a = 3\frac{q}{D_o^{1/2}}$$

$T_w > ½\ D_o$ **$L_a =$ 17 feet**

II. Where there is no well-defined channel immediately downstream of the apron, the width, W, of the outlet end of the apron shall be as follows:

For tailwater elevation greater than or equal to the elevation of the center of the pipe,

$$W = 3W_o + 0.4L_a$$

W = **19 feet**

For tailwater elevation less than the elevation of the center of the pipe,

$$W = 3W_o + L_a$$

W = 0 feet

Where L_a is the length of the apron determined from the formula and W_o is the culvert width.

LANGAN
ENGINEERING & ENVIRONMENTAL SERVICES
989 Lennox Drive Lawrenceville, NJ
P: 609.282.8000 F: 609.282.8001
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Project: **HW-100**
RIP-RAP APRON DESIGN CALCULATIONS
Repauno Redevelopment
TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet. No.
130088802	11/3/2015	DTF	EFW	1 of 2

Riprap Median Stone Diameter

The median stone diameter, D_{50}, in feet, shall be determined from the formula:

For Horizontal Apron: $$D_{50} = \frac{0.016}{T_w} q^{1.33}$$ Where $q = Q/D_o$

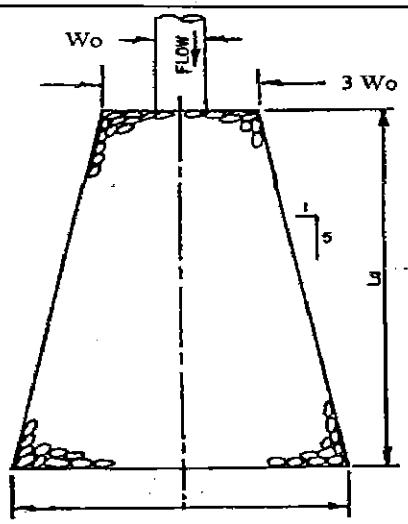
D_{50} = 0.13 feet *OR* **D_{50} = 3.0 inches**

Note: For discharge into Detention Basins, analyze the hydraulic characteristics of the basin for the design storm to determine the combination of conduit discharge and tailwater that results in the largest required D50 stone size. 3 inch minimum

Riprap Lining Thickness

The thickness of riprap lining shall meet at least one of the following criteria:

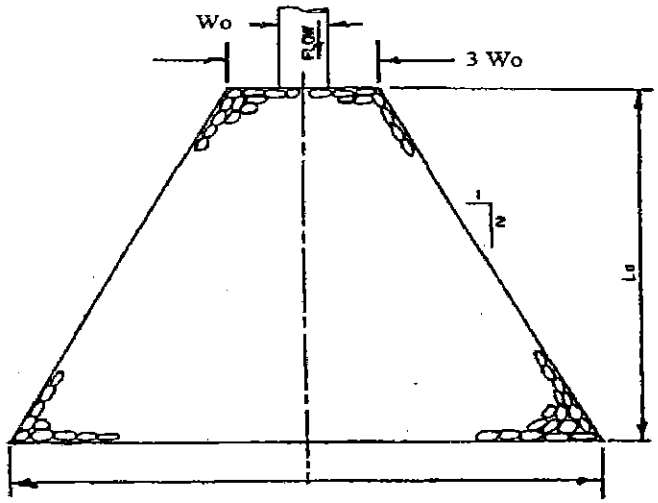
1. A thickness of at least three times the D_{50} size if a filter layer is not used. t = **9.0 inches**
2. A thickness of at least two times the D_{50} size if a filter layer is used. t = 6.0 inches



For tailwater elevation greater than or equal to the elevation of the center of the pipe

L_a = **17 feet**

W= **19 feet**



For tailwater elevation less than the elevation of the center of the pipe

L_a = 0 **feet**

W= 0 **feet**

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P: 609.282.8000 F: 609.282.8001
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Project: **HW-100**

RIP-RAP APRON DESIGN CALCULATIONS

Repauno Redevelopment

TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet. No.
130088802	11/3/2015	DTF	EFW	2 of 2

Based on "Standards for Soil Erosion and Sediment Control in New Jersey," Jan. 2014

TABLE 12-1 ALLOWABLE VELOCITIES FOR VARIOUS SOILS

SOIL TEXTURE	ALLOWABLE VELOCITY (ft./sec.)
1. Sand	1.8
2. Sandy Loam	2.5
3. Silt loam (also high lime clay), loam	3.0
4. Sandy clay loam	3.5
5. Clay loam	4.0
6. Clay, fine gravel, gradded loam to gravel	5.0
7. Cobbles	5.5
8. Shale (non-weathered)	6.0

Soil type where outfall is located = 2 (Note: Select number designating soil texture above)
allowable velocity = 2.5 ft/sec
v (velocity) = 4.36 ft/sec — from Storm Sewer Conveyance
Rip Rap Apron required? yes (1 = yes, 0 = no)

Given:

D_o (max inside height) = 1.5 feet
W_o (max inside width) = 1.5 feet
Q (discharge) = 13.65 cfs (25-year Storm) — from Storm Sewer Conveyance
*q (unit discharge, = Q/W_o) = 9.1 cfs / foot
** T_w (tail water) = 4.00 feet

* for the conduit design storm or the 25 year storm, whichever is greater

** for areas where T_w cannot be computed, use $T_w = 0.2\ D_o$. For discharge into detention basins; Tw shall equal the 2 year storm elevation in the basin.

Riprap Apron Dimensions

I. The length of the apron, L (in feet), shall be determined from the formula:

$$L_a = (1.8\frac{q}{D_o^{1/2}}) + 7D_o$$

$T_w < \frac{1}{2} D_o$ **L_a =** 0 feet

$$L_a = 3\frac{q}{D_o^{1/2}}$$

$T_w > \frac{1}{2} D_o$ L_a = **23 feet**

II. Where there is no well-defined channel immediately downstream of the apron, the width, W, of the outlet end of the apron shall be as follows:

For tailwater elevation greater than or equal to the elevation of the center of the pipe,

$$W = 3W_o + 0.4L_a$$

W = **14 feet**

For tailwater elevation less than the elevation of the center of the pipe,

$$W = 3W_o + L_a$$

W = 0 feet

Where L_a is the length of the apron determined from the formula and W_o is the culvert width.

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989 Lennox Drive Lawrenceville, NJ
P: 609.282.8000 F: 609.282.8001
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Project: HW-200
RIP-RAP APRON DESIGN CALCULATIONS
REPAUNO REDEVELOPMENT
TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet. No.
130088802	11/3/2015	DTF	EFW	1 of 2

Riprap Median Stone Diameter

The median stone diameter, D_{50}, in feet, shall be determined from the formula:

For Horizontal Apron: $$D_{50} = \frac{0.016}{T_w} q^{1.33}$$ Where q = Q/D_o

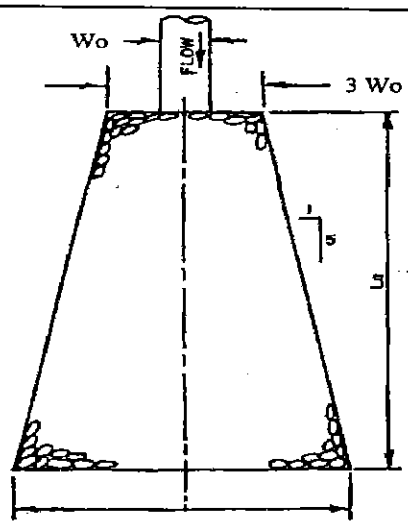
D_{50} = 0.08 feet *OR* **D_{50} = 3.0 inches**

Note: For discharge into Detention Basins, analyze the hydraulic characteristics of the basin for the design storm to determine the combination of conduit discharge and tailwater that results in the largest required D50 stone size. 3 inch minimum

Riprap Lining Thickness

The thickness of riprap lining shall meet at least one of the following criteria:

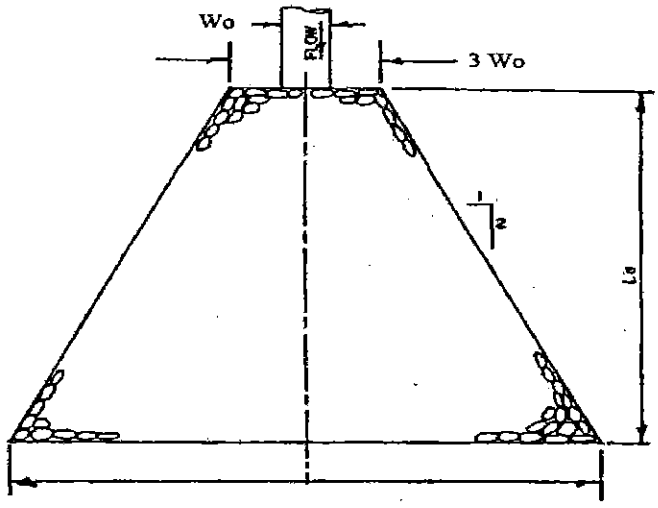
1. A thickness of at least three times the D_{50} size if a filter layer is not used. **t = 9.0 inches**
2. A thickness of at least two times the D_{50} size if a filter layer is used. t = 6.0 inches



For tailwater elevation greater than or equal to the elevation of the center of the pipe

L_a = **23 feet**

W= **14 feet**



For tailwater elevation less than the elevation of the center of the pipe

L_a = 0 **feet**

W= 0 **feet**

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P: 609.282.8000 F: 609.282.8001
NJ Certificate of Authorization No: 24GA27996400

Project: **HW-200**

RIP-RAP APRON DESIGN CALCULATIONS
REPAUNO REDEVELOPMENT
TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet. No.
130088802	11/3/2015	DTF	EFW	2 of 2

Based on "Standards for Soil Erosion and Sediment Control in New Jersey," Jan. 2014

TABLE 12-1 ALLOWABLE VELOCITIES FOR VARIOUS SOILS

SOIL TEXTURE	ALLOWABLE VELOCITY (ft./sec.)
1. Sand	1.8
2. Sandy Loam	2.5
3. Silt loam (also high lime clay), loam	3.0
4. Sandy clay loam	3.5
5. Clay loam	4.0
6. Clay, fine gravel, gradded loam to gravel	5.0
7. Cobbles	5.5
8. Shale (non-weathered)	6.0

Soil type where outfall is located = 1 (Note: Select number designating soil texture above)
allowable velocity = 1.8 ft/sec
v (velocity) = 4.11 ft/sec — from Storm Sewer Conveyance
Rip Rap Apron required? yes (1 = yes, 0 = no)

Given:

D_o (max inside height) = 1.5 feet
W_o (max inside width) = 1.5 feet
Q (discharge) = 1.83 cfs (25-year Storm) — from Storm Sewer Conveyance
*q (unit discharge, = Q/W_o) = 1.2 cfs / foot
** T_w (tail water) = 0.30 feet — 20% of diameter of pipe

* for the conduit design storm or the 25 year storm, whichever is greater

** for areas where T_w cannot be computed, use $T_w = 0.2\ D_o$. For discharge into detention basins, Tw shall equal the 2 year storm elevation in the basin.

Riprap Apron Dimensions

I. The length of the apron, L (in feet), shall be determined from the formula:

$$L_a = (1.8\frac{q}{D_o^{1/2}}) + 7D_o$$

$T_w < ½\ D_o$ — **L_a = 12 feet**

$$L_a = 3\frac{q}{D_o^{1/2}}$$

$T_w > ½\ D_o$ — L_a = 0 feet

II. Where there is no well-defined channel immediately downstream of the apron, the width, W, of the outlet end of the apron shall be as follows:

For tailwater elevation greater than or equal to the elevation of the center of the pipe,

$$W = 3W_o + 0.4L_a$$

W = **0 feet**

For tailwater elevation less than the elevation of the center of the pipe,

$$W = 3W_o + L_a$$

W = 17 feet

Where L_a is the length of the apron determined from the formula and W_o is the culvert width.

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989 Lennox Drive Lawrenceville, NJ
P: 609.282.8000 F: 609.282.8001
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Project: **HW-400**
RIP-RAP APRON DESIGN CALCULATIONS
Repauno Redevelopment
TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet No.
130088802	11/3/2015	DTF	EFW	1 of 2

Riprap Median Stone Diameter

The median stone diameter, D_{50}, in feet, shall be determined from the formula:

For Horizontal Apron: $$D_{50} = \frac{0.016}{T_w} q^{1.33}$$ Where $q = Q/D_o$

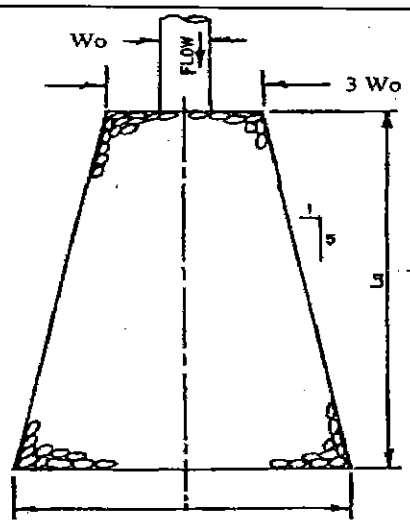
D_{50} = 0.07 feet *OR* **D_{50} = 3.0 inches**

Note: For discharge into Detention Basins, analyze the hydraulic characteristics of the basin for the design storm to determine the combination of conduit discharge and tailwater that results in the largest required D50 stone size. 3 inch minimum

Riprap Lining Thickness

The thickness of riprap lining shall meet at least one of the following criteria:

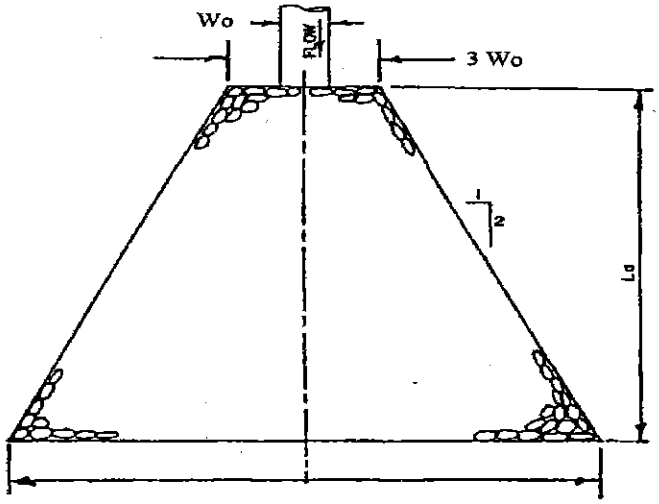
1. A thickness of at least three times the D_{50} size if a filter layer is not used. **t = 9.0 inches**
2. A thickness of at least two times the D_{50} size if a filter layer is used. t = 6.0 inches



For tailwater elevation greater than or equal to the elevation of the center of the pipe

L_a = 0 feet

W= **0 feet**



For tailwater elevation less than the elevation of the center of the pipe

L_a = 12 feet

W= 17 **feet**

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Project: **HW-400**

RIP-RAP APRON DESIGN CALCULATIONS

Repauno Redevelopment

TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet. No.
130088802	11/3/2015	DTF	EFW	2 of 2

Based on "Standards for Soil Erosion and Sediment Control in New Jersey," Jan. 2014

TABLE 12-1 ALLOWABLE VELOCITIES FOR VARIOUS SOILS

SOIL TEXTURE	ALLOWABLE VELOCITY (ft./sec.)
1. Sand	1.8
2. Sandy Loam	2.5
3. Silt loam (also high lime clay), loam	3.0
4. Sandy clay loam	3.5
5. Clay loam	4.0
6. Clay, fine gravel, gradded loam to gravel	5.0
7. Cobbles	5.5
8. Shale (non-weathered)	6.0

Soil type where outfall is located = 2 (Note: Select number designating soil texture above)
allowable velocity = 2.5 ft/sec
v (velocity) = 6.44 ft/sec from Storm Sewer Conveyance
Rip Rap Apron required? yes (1 = yes, 0 = no)

Given:

D_o (max inside height) = 3 feet
W_o (max inside width) = 3 feet
Q (discharge) = 35.11 cfs (25-year Storm) from Storm Sewer Conveyance
*q (unit discharge, = Q/W_o) = 11.7 cfs / foot
** T_w (tail water) = 3.00 feet

* for the conduit design storm or the 25 year storm, whichever is greater
** for areas where T_w cannot be computed, use $T_w = 0.2\ D_o$. For discharge into detention basins, Tw shall equal the 2 year storm elevation in the basin.

Riprap Apron Dimensions

I. The length of the apron, L (in feet), shall be determined from the formula:

$$L_a = (1.8\frac{q}{D_o^{1/2}}) + 7D_o$$

$T_w < \frac{1}{2}\ D_o$ $L_a =$ 0 feet

$$L_a = 3\frac{q}{D_o^{1/2}}$$

$T_w > \frac{1}{2}\ D_o$ **$L_a =$ 21 feet**

II. Where there is no well-defined channel immediately downstream of the apron, the width, W, of the outlet end of the apron shall be as follows:

For tailwater elevation greater than or equal to the elevation of the center of the pipe,

$$W = 3W_o + 0.4L_a$$

W = **18 feet**

For tailwater elevation less than the elevation of the center of the pipe,

$$W = 3W_o + L_a$$

W = 0 feet

Where L_a is the length of the apron determined from the formula and W_o is the culvert width.

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989 Lennox Drive Lawrenceville, NJ
P: 609.282.8000 F: 609.282.8001
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Project: **HW-700**
RIP-RAP APRON DESIGN CALCULATIONS
Repauno Redevelopment
TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet. No.
130088802	11/3/2015	DTF	EFW	1 of 2

Riprap Median Stone Diameter

The median stone diameter, D_{50}, in feet, shall be determined from the formula:

For Horizontal Apron: $$D_{50} = \frac{0.016}{T_w} q^{1.33}$$ Where $q = Q/D_o$

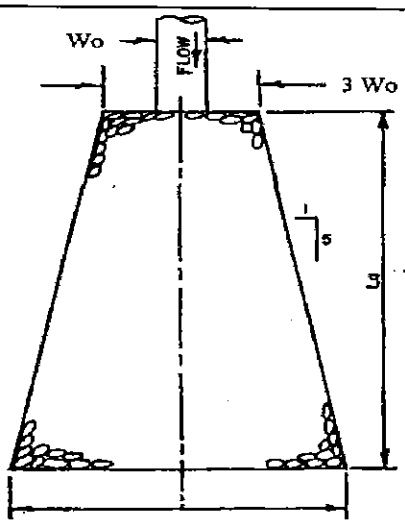
D_{50} = 0.14 feet *OR* **D_{50} = 3.0 inches**

Note: For discharge into Detention Basins, analyze the hydraulic characteristics of the basin for the design storm to determine the combination of conduit discharge and tailwater that results in the largest required D50 stone size. 3 inch minimum

Riprap Lining Thickness

The thickness of riprap lining shall meet at least one of the following criteria:

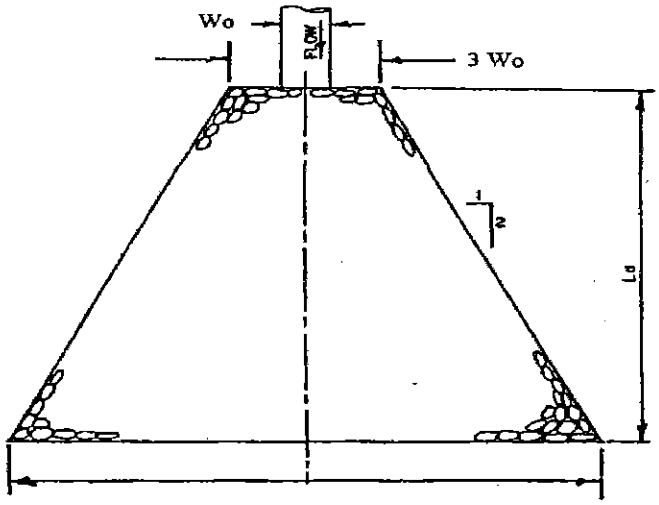
1. A thickness of at least three times the D_{50} size if a filter layer is not used. **t = 9.0 inches**
2. A thickness of at least two times the D_{50} size if a filter layer is used. t = 6.0 inches



For tailwater elevation greater than or equal to the elevation of the center of the pipe

L_a = 21 feet

W= **18 feet**



For tailwater elevation less than the elevation of the center of the pipe

L_a = 0 **feet**

W= 0 **feet**

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Project: **HW-700**

RIP-RAP APRON DESIGN CALCULATIONS

Repauno Redevelopment

TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NJ

Project No.	Date:	By:	Ckd:	Sheet. No.
130088802	11/3/2015	DTF	EFW	2 of 2

3/31/2016

SCOUR HOLE CALCULATIONS

NJ Standards for SESC, Ch. 12, January 2014

Structure: HW 501

Job # 130088802
Job Name: Repauno Flagler
Designed by: EFW
Checked by: KJW

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Q =	**21.80 c.f.s.**	W_o=	**3.00 Ft.**
D_o=	**3.00 Ft.**	q=Q/W_o=	**7.27 c.f.s.**
TW=	**0.60 Ft.**		

(For areas where Tw cannot be computed, use Tw = 0.2D_o)

d_{50} Stone size formula **When Y = 1/2 D_o**

$$d_{50} = \frac{0.0125 * q^{1.33}}{TW} = \textbf{0.29 Ft.} =$$

4 " Stone Calculated
4 " Stone Used for Construction
1.50 ' = Y

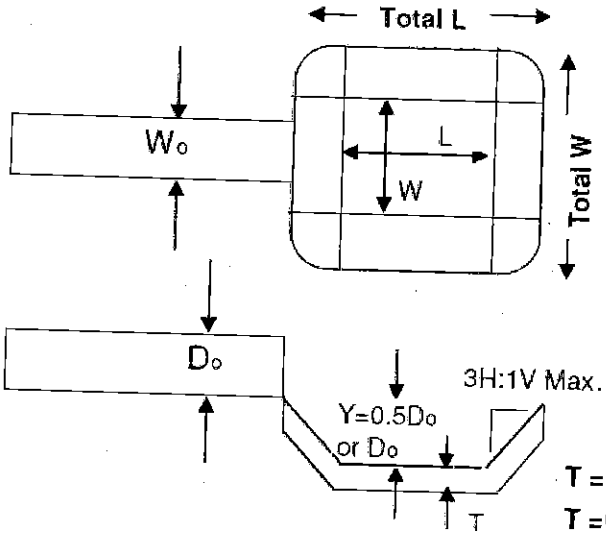
d_{50} Stone size formula **When Y = D_o**

$$d_{50} = \frac{0.0082 * q^{1.33}}{TW} = \textbf{0.19 Ft.} =$$

3 " Stone Calculated
3 " Stone Used for Construction
3.00 ' = Y

NJ Standards require d_{50}=3" min, NJDOT requires d_{50}=6" min

Y = Depth of scour hole below culvert invert



L = 3 D_o = 9.00 '
W = 2 W_o = 6.00 '

If Y = 1/2D_o
Total L = 18.00 , Total W = 15.00

If Y = D_o
Total L = 27.00 , Total W = 24.00

T = d_{50} Stone size x 2 if filter fabric is used
T = d_{50} Stone size x 3 if *no* filter fabric is used

Structure HW 501 Design Summary

Select Scour Hole Design

Y = 1/2 Do Use Filter Fabric

Total L =	**18 '**	**L =**	**9 '**
Total W =	**15 '**	**W =**	**6 '**
Depth of scour hole (Y) =			**1.5 '**
d_{50} stone size =			**4 "**
Thickness of riprap (T) =			**8 "**
Volume of riprap (V) =			**6.67 CY**

Notes:

SCOUR HOLE CALCULATIONS

NJ Standards for SESC, Ch. 12, January 2014

Structure: HW 601

Job # 130088802
Job Name: Repauno Flagler
Designed by: EFW
Checked by: KJW

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Q =	**21.80 c.f.s.**	W_o=	**3.00 Ft.**
D_o=	**3.00 Ft.**	q=Q/W_o=	**7.27 c.f.s.**
TW=	**0.60 Ft.**		

(For areas where Tw cannot be computed, use Tw = 0.2D_o)

d_{50} Stone size formula **When Y = 1/2 D_o**

$$d_{50} = \frac{0.0125 * q^{1.33}}{TW} = \mathbf{0.29\ Ft.}$$

= 4 " Stone Calculated
4 " Stone Used for Construction
1.50 ' = Y

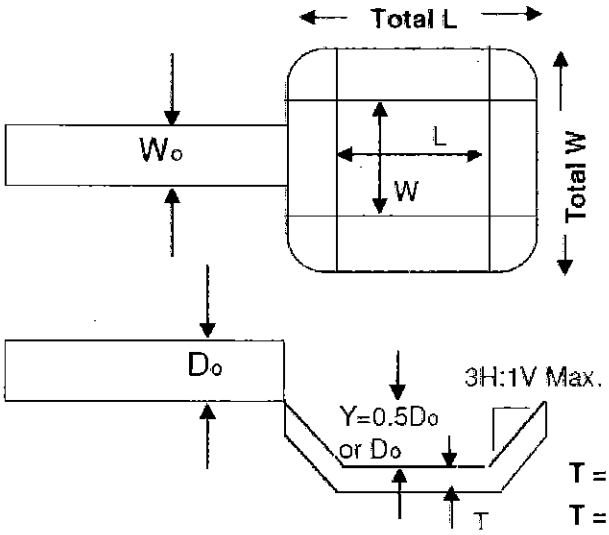
d_{50} Stone size formula **When Y = D_o**

$$d_{50} = \frac{0.0082 * q^{1.33}}{TW} = \mathbf{0.19\ Ft.}$$

= 3 " Stone Calculated
3 " Stone Used for Construction
3.00 ' = Y

NJ Standards require d_{50}=3" min, NJDOT requires d_{50}=6" min

Y = Depth of scour hole below culvert invert



L = 3 D_o = 9.00 '
W = 2 W_o = 6.00 '

If Y = 1/2D_o
Total L = 18.00 , Total W = 15.00

If Y = D_o
Total L = 27.00 , Total W = 24.00

T = d_{50} Stone size x 2 if filter fabric is used
T = d_{50} Stone size x 3 if *no* filter fabric is used

Structure HW 601 Design Summary

Select Scour Hole Design	**Total L =**	**18 '**	**L = 9 '**
	Total W =	**15 '**	**W = 6 '**
	Depth of scour hole (Y) =		**1.5 '**
Y = 1/2 Do Use Filter Fabric	**d_{50} stone size =**		**4 "**
	Thickness of riprap (T) =		**8 "**
	Volume of riprap (V) =		**6.67 CY**

Notes:

Appendix H

Storm Sewer Tabulation

Repauno Building 1 -Weighted 'C' Values

SOIL TYPE(S) : (MamuAv, UddcB and USDOWB)
Mannington-Naticoke-Udorthents Complex, Udothents, Urban land-downer complex
(TYPE 'B/D', 'C/D', 'D')

STRUCTURE	TOTAL AREA (acres)	IMPERVIOUS		'C' =	0.99	GRASS		'C' =	0.70	TOTAL WEIGHTED 'C' (F+J)
		AREA (acres)	%	'C'	IMPERV 'C'	AREA (acres)	%	'C'	GRASS 'C'	
I-101	0.80	0.76	95%	0.99	0.94	0.04	5%	0.70	0.04	0.98
I-102	0.82	0.67	82%	0.99	0.81	0.15	18%	0.70	0.13	0.94
I-103	1.12	0.77	69%	0.99	0.68	0.35	31%	0.70	0.22	0.90
I-104	0.34	0.13	38%	0.99	0.38	0.21	62%	0.70	0.43	0.81
I-105	0.37	0.20	54%	0.99	0.54	0.17	46%	0.70	0.32	0.86
YI-106	0.51	0.43	84%	0.99	0.83	0.08	16%	0.70	0.11	0.94
I-107	0.11	0.08	73%	0.99	0.72	0.03	27%	0.70	0.19	0.91
I-108	0.16	0.13	78%	0.99	0.77	0.04	22%	0.70	0.15	0.93
I-109	0.60	0.50	83%	0.99	0.83	0.10	17%	0.70	0.12	0.94
I-110	0.22	0.12	55%	0.99	0.54	0.10	45%	0.70	0.32	0.86
I-111	0.58	0.54	93%	0.99	0.92	0.04	7%	0.70	0.05	0.97
MH-112	0.60	0.60	100%	0.99	0.99	0.00	0%	0.70	0.00	0.99
MH-113	1.19	1.19	100%	0.99	0.99	0.00	0%	0.70	0.00	0.99
MH-114	1.70	1.70	100%	0.99	0.99	0.00	0%	0.70	0.00	0.99
MH-115	1.19	1.19	100%	0.99	0.99	0.00	0%	0.70	0.00	0.99
I-201	0.04	0.04	98%	0.99	0.97	0.00	3%	0.70	0.02	0.98
I-202	0.13	0.12	90%	0.99	0.89	0.01	10%	0.70	0.07	0.96
I-203	0.26	0.20	77%	0.99	0.76	0.06	23%	0.70	0.16	0.92
I-204	0.14	0.12	89%	0.99	0.88	0.02	11%	0.70	0.08	0.96
I-205	0.25	0.19	76%	0.99	0.75	0.06	24%	0.70	0.17	0.92
I-206	0.32	0.28	88%	0.99	0.87	0.04	13%	0.70	0.09	0.95
TOTALS	11.45	9.96	87%	0.99	0.86	1.50	13%	0.70	0.09	0.95

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	121.929	0.80	10.31	0.98	0.78	9.83	10.0	16.4	4.8	47.40	132.1	3.77	48	0.50	-3.00	-2.39	3.00	3.08	1.75	7.00	I-101 to HW-100
2	1	180.000	0.82	4.25	0.94	0.77	3.85	10.0	15.7	4.9	18.98	37.70	3.87	30	0.50	-0.89	0.01	3.41	3.64	7.00	7.00	I-102 TO I-101
3	2	180.000	1.12	3.43	0.90	1.01	3.08	10.0	15.0	5.0	15.45	20.79	4.92	24	0.50	0.51	1.41	3.75	4.25	7.00	7.02	I-103 to I-102
4	3	214.059	0.34	2.31	0.81	0.28	2.08	10.0	14.0	5.2	10.72	20.79	3.41	24	0.50	1.41	2.48	4.44	4.72	7.02	9.22	I-104 to I-103
5	4	141.363	0.37	1.97	0.86	0.32	1.80	10.0	13.6	5.2	9.42	9.67	5.33	18	0.50	2.98	3.69	4.86	5.54	9.22	9.36	I-105 to I-104
6	5	156.972	0.51	1.38	0.94	0.48	1.29	10.0	12.6	5.4	6.96	9.62	3.94	18	0.50	3.69	4.47	6.05	6.46	9.36	9.01	YI-106 to I-105
7	6	116.204	0.11	0.87	0.91	0.10	0.81	10.0	11.9	5.5	4.49	9.64	2.54	18	0.50	4.47	5.05	6.69	6.81	9.01	10.91	I-107 to YI-106
8	7	99.126	0.16	0.76	0.93	0.15	0.71	10.0	11.4	5.6	4.00	5.96	3.26	15	0.50	5.30	5.80	6.94	7.16	10.91	10.87	I-108 to I-107
9	8	218.768	0.60	0.60	0.94	0.56	0.56	10.0	10.0	5.9	3.31	5.95	3.55	15	0.50	5.80	6.90	7.25	7.64	10.87	9.63	I-109 to I-108
10	5	193.269	0.22	0.22	0.86	0.19	0.19	10.0	10.0	5.9	1.11	5.95	0.91	15	0.50	3.69	4.66	6.05	6.09	9.36	9.58	I-110 to I-105
11	1	180.000	0.58	0.58	0.97	0.56	0.56	10.0	10.0	5.9	3.30	9.60	1.87	18	0.49	0.11	1.00	3.41	3.52	7.00	7.00	I-111 to I-101
12	1	70.000	0.60	4.68	0.99	0.59	4.63	10.0	11.8	5.5	25.62	61.31	3.62	36	0.50	-2.39	-2.04	3.41	3.47	7.00	8.34	MH-112 to I-101
13	12	198.000	1.19	2.89	0.99	1.18	2.86	10.0	11.1	5.6	16.16	20.79	5.14	24	0.50	-2.04	-1.05	3.68	4.27	8.34	8.34	MH-113 to MH-1
14	13	216.390	1.70	1.70	0.99	1.68	1.68	10.0	10.0	5.9	9.89	20.77	3.15	24	0.50	-1.05	0.03	4.34	4.58	8.34	8.34	MH-114 to MH-1
15	12	216.360	1.19	1.19	0.99	1.18	1.18	10.0	10.0	5.9	6.92	9.65	3.92	18	0.50	-2.04	-0.96	3.68	4.23	8.34	8.34	MH-115 to MH-1

Project File: Storm-100.stm | Number of lines: 15 | Run Date: 4/4/2016

NOTES:Intensity = 57.82 / (Inlet time + 11.30) ^ 0.75 ; Return period =Yrs. 25 ; c = cir e = ellip b = box

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	20.088	0.04	1.14	0.98	0.04	1.07	10.0	16.0	4.9	5.23	10.98	2.96	18	0.65	-1.00	-0.87	3.00	3.03	1.17	8.82	I-201 to FES-20(
2	1	144.000	0.13	0.78	0.96	0.12	0.73	10.0	15.2	5.0	3.63	6.75	2.96	15	0.65	-0.62	0.31	3.23	3.50	8.82	10.87	I-202 to I-201
3	2	203.235	0.26	0.65	0.92	0.24	0.60	10.0	14.0	5.2	3.12	6.69	2.54	15	0.63	0.31	1.60	3.57	3.86	10.87	7.49	I-203 to I-202
4	3	263.034	0.25	0.25	0.92	0.23	0.23	10.0	10.0	5.9	1.35	8.41	2.25	15	1.00	2.91	5.55	4.01	6.01	7.49	10.57	I-205 to I-203
5	1	69.000	0.32	0.32	0.95	0.30	0.30	10.0	10.0	5.9	1.79	8.39	2.72	15	1.00	2.31	3.00	3.23	3.53	8.82	7.00	I-206 to I-201
6	3	43.625	0.14	0.14	0.96	0.13	0.13	10.0	10.0	5.9	0.79	5.96	1.76	15	0.50	2.91	3.13	4.01	3.48	7.49	7.00	I-204 to I-203

Project File: Storm-200.stm

Number of lines: 6

Run Date: 4/4/2016

NOTES:Intensity = 57.82 / (Inlet time + 11.30) ^ 0.75 ; Return period =Yrs. 25 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	34.375	0.00	0.00	0.00	0.00	0.00	0.0	2.7	0.0	2.86	9.10	3.96	18	0.64	2.60	2.82	3.24	3.46	4.85	8.10	MH-402 to FES-
2	1	54.489	0.00	0.00	0.00	0.00	0.00	0.0	2.2	0.0	2.86	9.25	3.96	18	0.66	2.82	3.18	3.46	3.82	8.10	7.70	MH-403 to MH-4
3	2	153.564	0.00	0.00	0.00	0.00	0.00	0.0	0.6	0.0	2.86	9.13	3.96	18	0.64	3.18	4.17	3.82	4.81	7.70	7.48	MH-404 to MH-4
4	3	42.553	0.00	0.00	0.00	0.00	0.00	0.0	0.2	0.0	2.86	9.23	4.00	18	0.66	4.18	4.46	4.81	5.10	7.48	8.14	MH-405 TO MH-
5	4	14.600	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.86	8.93	3.96	18	0.62	4.46	4.55	5.10	5.19	8.14	6.80	FES-406 TO MH

Project File: Storm-400.stm

Number of lines: 5

Run Date: 4/1/2016

NOTES:Intensity = 46.91 / (Inlet time + 9.20) ^ 0.66 ; Return period =Yrs. 100 ; c = cir e = ellip b = box

Line	To Line	(ft)	Drng Area Incr (ac)	Drng Area Total (ac)	Rnoff coeff (C)	Area x C Incr	Area x C Total	Tc Inlet (min)	Tc Syst (min)	Rain (I) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe Size (in)	Pipe Slope (%)	Invert Elev Dn (ft)	Invert Elev Up (ft)	HGL Elev Dn (ft)	HGL Elev Up (ft)	Grnd / Rim Elev Dn (ft)	Grnd / Rim Elev Up (ft)	Line ID
1	End	77.563	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	21.80	39.34	5.87	36	0.30	2.50	2.73	4.00	4.36	6.42	6.15	OS-501 to HW-5

Project File: Storm-500.stm

Number of lines: 1

Run Date: 4/1/2016

NOTES:Intensity = 46.91 / (Inlet time + 9.20) ^ 0.66 ; Return period =Yrs. 100 ; c = cir e = ellip b = box

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	70.315	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	21.80	39.48	5.88	36	0.30	2.50	2.71	4.00	4.33	6.42	6.13	OS-601 to HW 6

Project File: Storm-600.stm

Number of lines: 1

Run Date: 4/1/2016

NOTES:Intensity = 46.91 / (Inlet time + 9.20) ^ 0.66 ; Return period =Yrs. 100 ; c = cir e = ellip b = box

NOAA Atlas 14, Volume 2, Version 3
Location name: Greenwich Township, New Jersey, US*
Latitude: 39.8279°, Longitude: -75.2937°
Elevation: 6 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF tabular | PF graphical | Maps & aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.18 (3.84–4.55)	4.97 (4.56–5.41)	5.83 (5.34–6.35)	6.44 (5.90–7.02)	7.19 (6.54–7.82)	7.69 (6.96–8.39)	8.18 (7.37–8.96)	8.60 (7.69–9.46)	9.11 (8.05–10.1)	9.48 (8.32–10.5)
10-min	3.34 (3.07–3.64)	3.97 (3.65–4.33)	4.67 (4.28–5.08)	5.15 (4.72–5.62)	5.72 (5.21–6.24)	6.13 (5.54–6.68)	6.50 (5.86–7.12)	6.82 (6.10–7.50)	7.21 (6.37–7.97)	7.47 (6.55–8.30)
15-min	2.78 (2.56–3.03)	3.33 (3.06–3.63)	3.94 (3.61–4.29)	4.35 (3.98–4.74)	4.84 (4.40–5.27)	5.17 (4.68–5.64)	5.48 (4.93–6.00)	5.74 (5.13–6.31)	6.04 (5.34–6.68)	6.25 (5.48–6.95)
30-min	1.91 (1.75–2.08)	2.30 (2.11–2.51)	2.80 (2.56–3.05)	3.15 (2.88–3.43)	3.58 (3.26–3.90)	3.89 (3.52–4.25)	4.19 (3.78–4.59)	4.47 (3.99–4.91)	4.81 (4.25–5.32)	5.06 (4.43–5.63)
60-min	1.19 (1.09–1.29)	1.44 (1.33–1.57)	1.79 (1.64–1.95)	2.05 (1.88–2.23)	2.39 (2.17–2.60)	2.64 (2.39–2.88)	2.89 (2.60–3.16)	3.13 (2.80–3.44)	3.45 (3.05–3.82)	3.69 (3.24–4.11)
2-hr	0.716 (0.652–0.784)	0.868 (0.793–0.951)	1.08 (0.988–1.19)	1.25 (1.13–1.37)	1.47 (1.32–1.61)	1.63 (1.47–1.79)	1.80 (1.61–1.99)	1.97 (1.74–2.18)	2.20 (1.92–2.44)	2.37 (2.05–2.65)
3-hr	0.519 (0.476–0.569)	0.629 (0.575–0.689)	0.787 (0.718–0.862)	0.909 (0.827–0.996)	1.07 (0.968–1.18)	1.20 (1.08–1.32)	1.33 (1.19–1.47)	1.47 (1.29–1.62)	1.65 (1.43–1.83)	1.79 (1.53–1.99)
6-hr	0.322 (0.295–0.354)	0.389 (0.356–0.428)	0.484 (0.442–0.532)	0.562 (0.511–0.617)	0.671 (0.605–0.736)	0.759 (0.679–0.835)	0.852 (0.754–0.939)	0.949 (0.830–1.05)	1.08 (0.931–1.21)	1.19 (1.01–1.34)
12-hr	0.194 (0.177–0.214)	0.234 (0.213–0.258)	0.293 (0.267–0.323)	0.342 (0.311–0.377)	0.415 (0.372–0.457)	0.477 (0.423–0.525)	0.543 (0.476–0.601)	0.615 (0.531–0.683)	0.719 (0.606–0.804)	0.807 (0.667–0.907)
24-hr	0.112 (0.103–0.122)	0.136 (0.125–0.148)	0.172 (0.158–0.187)	0.202 (0.185–0.221)	0.247 (0.225–0.269)	0.286 (0.259–0.310)	0.328 (0.295–0.354)	0.374 (0.333–0.404)	0.442 (0.389–0.476)	0.499 (0.435–0.538)
2-day	0.064 (0.059–0.070)	0.078 (0.071–0.085)	0.099 (0.091–0.107)	0.116 (0.106–0.126)	0.141 (0.128–0.153)	0.162 (0.147–0.176)	0.185 (0.167–0.201)	0.210 (0.188–0.228)	0.246 (0.218–0.267)	0.276 (0.242–0.299)
3-day	0.045 (0.042–0.049)	0.055 (0.050–0.060)	0.069 (0.064–0.075)	0.081 (0.075–0.088)	0.099 (0.090–0.107)	0.113 (0.103–0.123)	0.129 (0.116–0.140)	0.146 (0.131–0.158)	0.170 (0.151–0.185)	0.191 (0.168–0.207)
4-day	0.036 (0.033–0.039)	0.043 (0.040–0.047)	0.055 (0.050–0.059)	0.064 (0.059–0.069)	0.077 (0.071–0.084)	0.089 (0.081–0.096)	0.101 (0.091–0.109)	0.114 (0.102–0.123)	0.133 (0.118–0.144)	0.148 (0.131–0.161)
7-day	0.024 (0.022–0.026)	0.028 (0.026–0.031)	0.035 (0.033–0.038)	0.041 (0.038–0.044)	0.049 (0.046–0.053)	0.056 (0.052–0.061)	0.064 (0.058–0.069)	0.072 (0.065–0.078)	0.083 (0.075–0.090)	0.093 (0.083–0.100)
10-day	0.019 (0.017–0.020)	0.022 (0.021–0.024)	0.027 (0.025–0.029)	0.031 (0.029–0.034)	0.037 (0.034–0.040)	0.042 (0.039–0.045)	0.047 (0.043–0.050)	0.052 (0.047–0.056)	0.059 (0.054–0.064)	0.066 (0.059–0.071)
20-day	0.013 (0.012–0.013)	0.015 (0.014–0.016)	0.018 (0.017–0.019)	0.020 (0.019–0.021)	0.023 (0.022–0.025)	0.026 (0.024–0.027)	0.028 (0.026–0.030)	0.031 (0.029–0.033)	0.034 (0.032–0.037)	0.037 (0.034–0.040)
30-day	0.010 (0.010–0.011)	0.012 (0.012–0.013)	0.014 (0.014–0.015)	0.016 (0.015–0.017)	0.018 (0.017–0.019)	0.020 (0.019–0.021)	0.022 (0.020–0.023)	0.023 (0.022–0.025)	0.025 (0.024–0.027)	0.027 (0.025–0.029)
45-day	0.009 (0.008–0.009)	0.010 (0.010–0.011)	0.012 (0.011–0.013)	0.013 (0.012–0.014)	0.015 (0.014–0.016)	0.016 (0.015–0.017)	0.017 (0.016–0.018)	0.018 (0.017–0.019)	0.019 (0.018–0.020)	0.020 (0.019–0.021)
60-day	0.008 (0.007–0.008)	0.009 (0.009–0.010)	0.011 (0.010–0.011)	0.012 (0.011–0.012)	0.013 (0.012–0.013)	0.014 (0.013–0.014)	0.015 (0.014–0.015)	0.015 (0.015–0.016)	0.016 (0.015–0.017)	0.017 (0.016–0.018)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

Appendix I

Test Pit Logs

LANGAN

River Drive Center 1 619 River Drive Elmwood Park, NJ 07407 T: 201.794.6900 F: 201.794.0366

Memorandum

To: Kevin Webb / Langan

From: Arthur C. Roesler, P.E.

Info: Ed Wilkes / Langan

Date: 23 October 2015

Re: Preliminary Geotechnical Evaluation
Proposed Flagler Repauno Warehouse Development
Greenwich, Gloucester County, NJ
Langan Project No.: 130088801

This memorandum provides a brief summary of our initial findings from our preliminary geotechnical investigation and our geotechnical thoughts regarding foundation support for the proposed Flagler Repauno Warehouse Development in Greenwich Township, Gloucester County, New Jersey.

SITE DESCRIPTION

Site Location

The approximate 34-acre development site is located in Greenwich Township, Gloucester County, New Jersey (a portion of Tax Block 8, Lot 4). The site is bound by wooded land and a warehouse development to the north, an existing road, railroad lines, and wooded land to the west, existing railroad lines and residential development to the south, and North Repauno Avenue, a residential development, and a daycare facility to the east.

The site is currently covered with trees, low vegetation, and areas of grass. Existing wetlands are identified at the west side of the site and the central portion of the site. Based on a recent topographic survey performed by our firm, existing grades at the site generally range from approximate el 4 to el 9 (NAVD88).

Proposed Construction

Based on the Concept Constraints Plan dated 22 October 2015 prepared by our firm, we understand that the development will consist of the following:

- Construction of two warehouse buildings having approximate footprints of approximately 204,120 ft^2 and 94,500 ft^2 with finished floor elevations (FFE) at approximate el 14.8. The warehouse will have associated loading dock aprons.
- Construction of asphalt surface parking lots and access drives.
- Construction of two stormwater basins.

Based on the concept plan, proposed site grades will generally range from approximately el 6 to el 14, which will require fills up to approximately 10 feet.

At the time of this report, we have not been provided information regarding the proposed structure loads. Based on our experience, we have assumed typical column and floor loads associated with similar structures for our analysis. Once it becomes available, we should review the preliminary structural loading information for the building so that we may evaluate and modify, if necessary, the preliminary recommendations provided herein.

SUBSURFACE INVESTIGATION

The geotechnical field investigation for this study consisted of drilling 8 borings, excavating 6 test pits, and installing 2 temporary groundwater monitoring wells at accessible site areas. Refer to the attached figure for boring/test pit/well locations.

The borings and test pits were completed under the full-time inspection of a field engineer from our office and with the direct supervision of our project Professional Engineer. Our field engineer maintained logs of all explorations, classified encountered soils, and obtained representative material samples. The individual boring logs and test pit logs are provided in Appendices A and B, respectively. Surface elevations at the boring and test pit locations were provided by our surveyors.

Borings

The borings for the preliminary investigation were drilled by Craig Geotechnical Drilling Company, Inc. between 13 and 16 October 2015 using a CME-75 truck-mounted drill rig. The borings were advanced to depths of 25 and 50 feet below existing grade using mud-rotary techniques. In general, soil samples were collected continuously to 12 feet and at 5-foot intervals thereafter. A standard 2-inch-outer-diameter split-spoon sampler was used to obtain samples of the underlying soil strata. The Standard Penetration Test (SPT)[1] was accomplished as part of the sampling procedure (in accordance with ASTM D-1586) and the SPT results were recorded by our inspecting engineer. A safety hammer was used as part of the SPT test for all sampling in the borings.

Groundwater levels were recorded when first observed within each boring. In addition, water levels were measured during our field work within the two temporary groundwater monitoring wells.

[1] The Standard Penetration Test (SPT) is a measure of the soil density and consistency. The SPT N-value is defined as the number of blows required to drive a 2-inch O.D. split-barrel sampler 12 inches, after an initial penetration of 6 inches using a 140 pound hammer falling freely for 30 inches.

Boreholes were grouted upon completion in accordance with NJDEP requirements.

Test Pits

The test pits for this study were excavated by Hemmel Excavating on 12 October 2015 using a John Deere 310 Backhoe. Test pits were excavated to depths ranging from 5 to 10 feet below surrounding grade. The test pits were excavated to determine the general nature of the fill material beneath the site, to determine the depth that below-grade elements extend, and to determine the type of foundation support for the existing buildings throughout the site. Our field engineer observed and recorded subsurface conditions and groundwater levels in the test pit excavations.

Upon completion, all test pits were backfilled in lifts and lightly compacted with the bucket of the backhoe.

SUBSURFACE CONDITIONS

Based on the results of the borings and test pits performed for this study, the subsurface conditions generally consisted of a surface layer of topsoil overlying successive layers of sand, clay, and a lower sand. The following sections describe the encountered subsurface conditions.

- Topsoil – Dark brown fine to coarse sand with varying amounts of silt, gravel, and roots was encountered in the majority borings and test pits. The topsoil layer was found to be approximately 6 to 12 inches thick.
- Sand – Brown to gray fine to coarse sand with varying amounts of silt and gravel was encountered across the site. This layer was found to be loose to very dense as evidenced by SPT N-values obtained from the drilled borings.
- Clay – Dark gray clay with varying amounts of silt and sand and trace amounts of organics, wood, and mica was encountered beneath the sand in borings B-3, B-4, B-5, B-7, and B-8. This layer was typically found to be medium stiff to very stiff as evidenced by SPT N-values obtained from the drilled borings. The clay was found to be approximately 3 feet to over 30 feet thick. The clay was encountered to the termination depth at several of the boring locations.

  An approximate 4 to 10 foot thick layer of soft clay was encountered in borings B-5 and B-8. The top of the soft clay was encountered at approximately 15 to 30 feet below existing grades, corresponding to approximate el -8 to el -24.
- Lower Sand – Gray fine to coarse sand with varying amounts of silt and gravel was encountered beneath the clay. This layer was typically found to be dense to very dense as evidenced by SPT N-values obtained from the drilled borings.

- Groundwater was first encountered in the borings at depths ranging from 4 to 6 feet below existing grades, corresponding to approximate el 0 to el 4. The groundwater level in the borings was determined based on the inferred moisture content of the soil samples.

  Groundwater was also first observed in the test pits at depths ranging from approximately 3.5 to 7.5 feet below existing grades, corresponding to approximate el 1 to el 2. The groundwater level in the test pits was inferred from observed water seepage from the sidewalls of the test pits.

  Temporary groundwater level observation wells were installed in borings B-1 and B-7. The groundwater levels were observed at approximate el 0 to el 3.

  Evidence of a seasonal high groundwater table was only evident in test pits TP-4 and TP-5. Soil mottling was observed in these two test pits at or slightly above the observed groundwater levels. In TP-4 soil mottling was observed at approximate el 2.3. The soil mottling was observed in a layer that contained a higher fines content than the soil above and blotches of gray, brown, and reddish-brown were noted. Soil mottling within coarse textured sandy soils is typically less distinct and not as gray in color as those associated with finer textured soils. Therefore, it is possible that the water levels rise higher than indicated by the observed groundwater levels in the other test pits but that evidence of soil mottling was not observed due to the coarser nature of the soils.

  Please note that groundwater levels are expected to fluctuate with weather and seasonal conditions.

GEOTECHNICAL THOUGHTS

The following is a summary of our geotechnical thoughts regarding the proposed site development.

Foundation Support

Due to the presence of loose sand beneath the proposed warehouse building footprints, we anticipate that these soils are currently unsuitable to provide foundation support for the proposed building. We recommend that the following options be considered for support of the proposed warehouse building.

1. Shallow foundations with slab-on-grade construction subsequent to ground improvement consisting of either deep dynamic compaction (DDC) or rapid impact compaction (RIC).

2. Shallow foundations with slab-on-grade construction subsequent to ground improvement consisting of Compacted Stone Columns.

3. Deep foundations consisting of driven timber piles to support column/wall and floor loads. For this option, the floor slab needs to be a pile supported structural slab.

We anticipate that an option to remove the loose sand and replace with approved, compacted fill would be impracticable due to the shallow depth of groundwater.

Additional evaluation of the underlying clay is necessary to determine whether the options presented above are still feasible. Due to the presence of the soft clay at two of the boring locations, additional ground improvement consisting of surcharging, installation of deeper compacted stone columns, or driving of deeper piles would be necessary.

Deep Dynamic Compaction

DDC would typically consist of using a crane to repeatedly drop a heavy weight in a grid pattern over the building footprint and 10 feet beyond.

The dynamic compaction program should consist of three separate passes as discussed below:

- The first high-energy pass should consist of dropping the weight at least four times at each location on a 12 foot spacing square grid.
- The second high-energy pass should consist of dropping the weight at least four times at each location on a 12 foot spacing square grid, offset 6 feet from the previous location.
- A final ironing pass should be performed to give 100% coverage to the proposed building footprint using a square weight with a drop height of approximately 15 feet.

After each pass, the craters would be leveled with a bulldozer by grading the soil subgrade into the craters.

For DDC, there is a risk associated with causing damage to adjacent structures and utilities due to vibrations during the DDC operations. This risk could be mitigated by excavating isolation trenches along the perimeter of the site, of keeping an adequate distance away from sensitive structures and utilities.

Rapid Impact Compaction (RIC)

RIC achieves shallow ground densification at sites consisting of loose, granular soils by using energy waves from a hydraulic hammer varying in weight from 7 to 10 tons that rapidly and repeatedly impacts the ground.

RIC should be performed in a grid pattern within the proposed building limits and 10 feet beyond. At this time, we recommend that the RIC program consist of 1 to 3 separate passes dependent on the soil response during densification. Adequate rest periods between passes is anticipated to be necessary due to the high water table.

After each pass, the craters should be leveled with a bulldozer by grading the soil subgrade into the craters.

Compacted Stone Columns

Compacted Stone Columns are columns constructed of rammed aggregate which act as a soil reinforcing element. The elements typically are constructed by augering a hole and backfilling the excavated shaft with compacted lifts of crushed stone. The crushed stone is placed in approximately one-foot-thick lifts and compacted with a special hydraulic tamper attached to an excavator. The compacted stone columns improve the ground conditions by providing a still composite ground mass.

Due to the shallow groundwater table, we recommend that the Impact Pier System by Geopier® or approved equivalent method be used to construct the compacted stone columns. The Impact Pier method displaces the soil during stone column installation rather than creating an augered hole with spoils. The cavity associated with the Impact Pier is created by a specially designed mandrel that is pushed and vibrated into the ground. Stone is placed into the cavity as the mandrel is withdrawn. The mandrel also acts as a tamper to compact the stone. Grout can be added to the compacted stone matrix to provide additional stiffness to the element.

Deep Foundations

Alternatively, the proposed building can be supported on a deep foundation system consisting of driven piles. At this time, we anticipate a suitable deep foundation for the proposed buildings can be timber piles to provide an individual pile capacity of about 20 to 25 tons. Timber pile lengths are expected to about 20 to 30 feet.

A pile-supported structural slab should be used in building areas where pile foundations are utilized. The structural slab should be designed to include support for below slab utilities which should be hung from the structural slab.

Other Considerations

- Grades within the proposed buildings and throughout the site will be raised by up to 10 feet to achieve finished grades. We recommend that finished construction be delayed as long as possible after placing the fill so that the majority of any potential fill-induced settlements can occur prior to the finished surface construction.

- Clearing and grubbing of all trees (including removal of any associated root systems) and vegetation designated for removal should be performed prior to commencing grading or fill placement. Topsoil should be stripped from all proposed building and pavement areas, and should be stockpiled and protected from erosion. Topsoil should be evaluated by the Environmental Engineer and Landscape Architect for re-use in landscape areas.
- Any environmental issues should be considered with respect to impacts on the geotechnical aspects of the work as described in this report and together with recommendations regarding on-site reuse of site materials, construction dewatering, and off-site disposal of materials and groundwater.
- All work should also be performed so as not to adversely impact neighboring structures, adjacent roadways, and utilities to remain. Protection of these elements should be provided as necessary during the course of all construction activities at the site.

Additional Work

- During our preliminary investigation, we collected undisturbed samples of the clay layer. However, we have not budgeted for the consolidation and strength testing of the undisturbed samples in our original proposal. We recommend performing this additional laboratory testing to help us evaluate the potential long-term settlements associated with placing fill and constructing warehouse buildings above a layer of potentially soft, compressible clay. The cost for this additional testing and our evaluation would be approximately $3,000.
- Once the conceptual design has been finalized, we recommend performing a final geotechnical investigation consisting of drilling additional borings, excavation of additional test pits, and installation of permanent groundwater monitoring wells.

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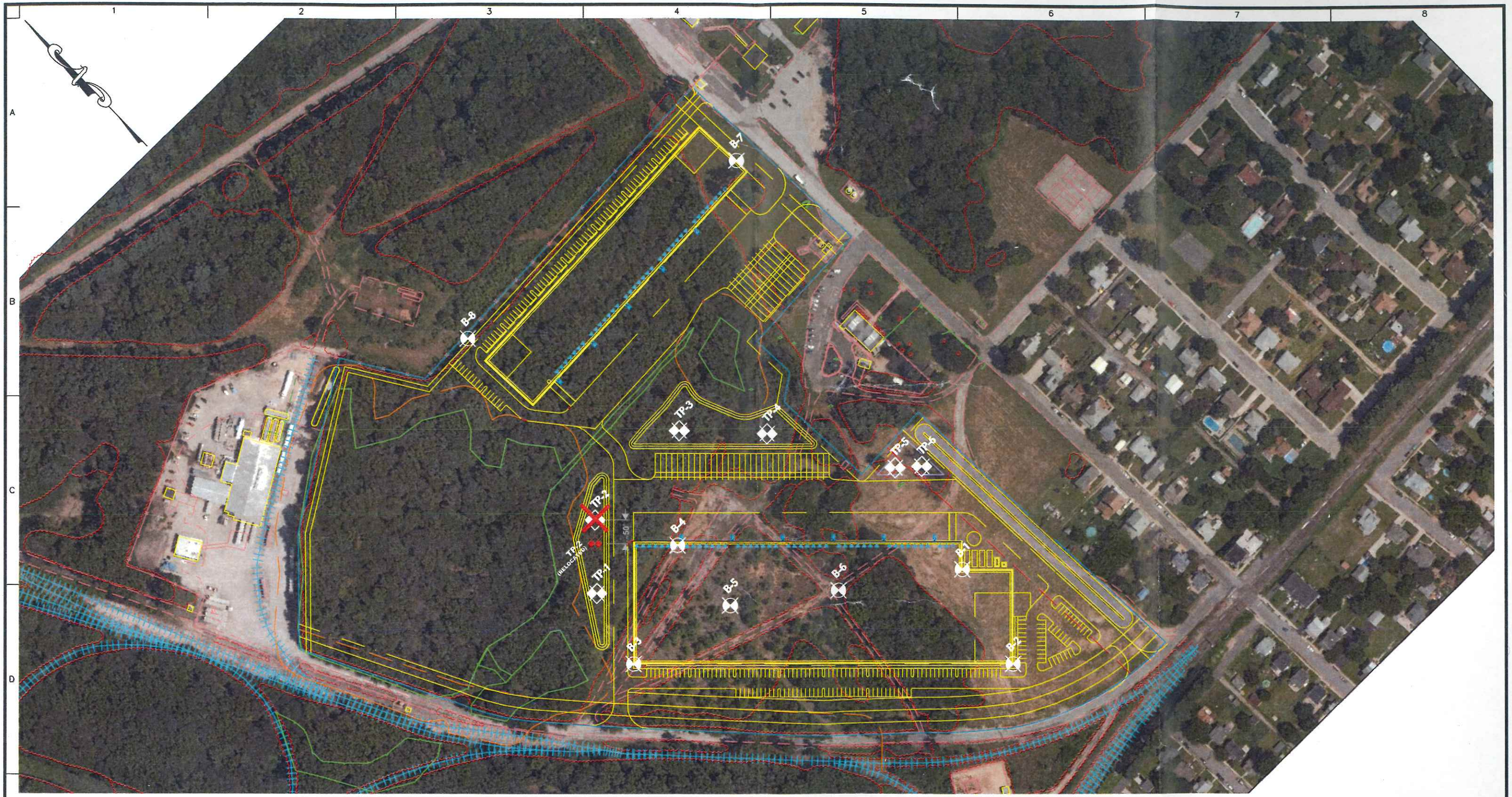

LEGEND

TP-1 TEST PIT

B-1 BORING

200 0 100 200

SCALE IN FEET

LANGAN

989 Lenox Drive, Suite 124
Lawrenceville, NJ 08648
T: 609.282.8000 F: 609.282.8001 www.langan.com

Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C. S.A
Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C.
Langan Engineering and Environmental Services, Inc.
Langan CT, Inc.
Langan International LLC
Collectively known as Langan

NJ CERTIFICATE OF AUTHORIZATION No. 24GA27996400

Project

FLAGLER REPAUNO

BLOCK No. 8, LOT No. 4
GREENWICH TOWNSHIP
GLOUCESTER COUNTY NEW JERSEY

Drawing Title

PROPOSED GEOTECHNICAL INVESTIGATION EXHIBIT

Project No. 130088801	Drawing No. BL101
Date 09/02/2015	
Scale 1" = 200'	
Drawn By DTF / Checked By KJW	
	Sheet 1 of 1

Filename: \\langan.com\data\TR\data8\130088801\Cadd Data - 130088801\SheetFiles\130088801-BL001-0101.dwg Date: 9/2/2015 Time: 16:36 User: dfrost Style Table: Langan.stb Layout: ANSIB-BL

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Log of Boring **B-1 (MW-1)** Sheet 1 of 2

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 5.9 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/13/15 / Date Finished: 10/13/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 35 ft / Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 11 / Undisturbed - / Core -
Casing Diameter (in): 4" I.D. Steel / Casing Depth (ft): 4'	Water Level (ft.): First ▽ 5 / Completion ▼ 5.5 / 24 HR. ▼ 5.8
Casing Hammer: Auto / Weight (lbs): 140 lbs / Drop (in): 30"	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety / Weight (lbs): 140 lbs / Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+5.9		0						Began drilling at 8:50 AM.
	+5.4	Dark brown f-m SAND, some silt, trace roots, trace organics (moist) [TOPSOIL]							
		Brown f-m SAND, some silt (moist)	1	S-1A / S-1B	SS	20	2 3 3 2	6	SS 0' to 2'
		Brown f-m SAND, some silt (moist)	2	S-2	SS	16	3 3 2 4	5	SS 2' to 4'
	+1.9	Brown f-c SAND, trace silt, trace fine gravel (moist to wet)	3 4	S-3	SS	14	4 4 6 5	10	Drilled to 4'. SS 4' to 6'
		Brown Silty f-c SAND (wet)	5						Sample wet at 5'.
		Brown f-c SAND, trace silt, trace shells (wet)	6 7	S-4	SS	20	3 7 10 15	17	SS 6' to 8'
	-2.1	Brown f-c SAND, some silt, trace fine gravel (wet)	8 9	S-5	SS	20	3 16 15 8	31	Drilled to 8'. SS 8' to 10'
	-3.9								q_u = 1.25 to 1.5 tsf
	-4.1	Light gray Silty CLAY (wet)	10	S-6	SS	18	6 18 40 30	58	SS 10' to 12'
		Light gray f-c SAND, trace silt, trace fine gravel (wet)	11 12 13 14						
		Light gray f-c SAND, some fine gravel, trace silt (wet)	15 16 17 18	S-7	SS	12	18 65 50/2"	50/2"	Drilled to 15'. SS 15' to 16'-2"

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Log of Boring **B-1 (MW-1)** Sheet 2 of 2

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 5.9 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			18						
			19						
			20						
		Light gray to reddish-brown f-c SAND, some silt, trace f-c gravel (wet)	21	S-8	SS	14	25 24 35 44	59	Drilled to 20'. SS 20' to 22'
			22						
			23						
			24						
			25						
		Light gray f-c SAND, trace fine gravel, trace silt (wet)	26	S-9	SS	18	31 39 47 50/4"	86	Drilled to 25'. SS 25' to 26'-10"
			27						
			28						
			29						
			30						
		Light gray f-c SAND, trace fine gravel, trace silt (wet)	31	S-10	SS	16	18 50 64 50/3"	114	Drilled to 30'. SS 30' to 31'-9"
			32						
			33						
		Light gray Silty f-c SAND (wet)	34	S-11	SS	24	13 25 36 45	61	Drilled to 33'. SS 33' to 35'
	-29.1		35						
		End of Boring at 35'.	36						Finished boring at 10:30 AM. Borehole flushed with clean water and a temporary well installed upon completion. Soil cuttings placed in steel drum. Prior to demobilization, the temporary well was removed and the borehole was grouted.
			37						
			38						
			39						
			40						
			40.5						

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Log of Boring **B-2** Sheet 1 of 2

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 8 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/15/15 — Date Finished: 10/15/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 25 ft — Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 9 — Undisturbed - — Core -
Casing Diameter (in): N/A — Casing Depth (ft): -	Water Level (ft.): First ▽ 6 — Completion ▼ - — 24 HR. ▼ -
Casing Hammer: - — Weight (lbs): - — Drop (in): -	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety — Weight (lbs): 140 lbs — Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+8.0		0						
	+7.5	Dark brown f-m SAND, some silt, trace roots, trace organics (moist) [TOPSOIL]							Began drilling at 10:40 PM.
		Brown f-m SAND, trace silt (moist)	1	S-1A	SS	18	2, 4	7	SS 0' to 2'
				S-1B			3, 3		
	+6.0	Brown f-m SAND, some silt (moist)	2	S-2	SS	20	1, 3	6	SS 2' to 4'
			3				3, 5		
		Brown f-m SAND, some silt, trace fine gravel (moist)	4	S-3	SS	16	9, 13	25	SS 4' to 6'
	+3.0		5				12, 25		
		Light gray SAND, trace fine gravel, trace silt (moist)							
		Light gray f-c SAND, trace fine gravel, trace silt (wet)	6	S-4	SS	16	18, 15	31	SS 6' to 8' Sample wet at 6'.
			7				16, 19		
		Brownish-gray f-m SAND, trace fine gravel, trace silt (wet)	8	S-5	SS	6	20, 39	65	Drilled to 8'. SS 8' to 10'
			9				26, 21		
		Light gray f-c SAND, trace fine gravel, trace silt (wet)	10	S-6	SS	12	6, 12	24	SS 10' to 12'
			11				12, 11		
			12						
			13						
			14						
			15	S-7	SS	9	39, 50/1"	50/1"	Drilled to 15'. SS 15' to 15'-7"
		Light gray to tan f-m SAND, trace silt (wet)	16						
			17						
			18						

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Log of Boring **B-2** Sheet 2 of 2

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 8 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		Light gray to tan f-c SAND, trace fine gravel, trace silt, trace clay (wet)	18 19 20 21 22	S-8	SS	18	19 47 50 48	97	Drilled to 20'. SS 20' to 23'
		Light gay f-c SAND, some silt, trace fine gravel (wet)	23 24 25	S-9	SS	16	19 26 22 19	48	Drilled to 23'. SS 23' to 25'
	-17.0	End of Boring at 25'.	26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 40.5						Finished drilling at 11:15 AM. Borehole grouted upon completion.

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Log of Boring **B-3** Sheet 1 of 3

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 4.1 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/16/15 — Date Finished: 10/16/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 50 ft — Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 16 — Undisturbed - — Core -
Casing Diameter (in): N/A — Casing Depth (ft): -	Water Level (ft.): First ▽ 3.8 — Completion ▼ - — 24 HR. ▼ -
Casing Hammer: - — Weight (lbs): - — Drop (in): -	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety — Weight (lbs): 140 lbs — Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+4.1		0					10 20 30 40	Began Drilling at 11:50 AM.
	+3.6	Dark gray to brown fine SAND, some silt, trace fine gravel, trace organics, trace grass (moist) [FILL]		S-1A	SS	18	3 5	10	SS 0' to 2'
		Brown f-m SAND, some silt, trace roots (moist)	1	S-1B			5 7		
		Brown f-m SAND, some silt (moist to wet)	2	S-2	SS	16	3 5 6 6	11	SS 2' to 4' Wet at 3.75'. Drilled to 4'.
			3 ▽						
		Brown f-m SAND, some silt, trace mica (wet)	4	S-3	SS	24	4 5 3 5	8	SS 4' to 6'
	-1.9	Brown to gray Silty f-c SAND (wet)	5 6						SS 6' to 8'
	-3.9	Brown f-m SAND, trace silt (wet)	7 8	S-4	SS	18	3 3 4 3	7	Drilled to 8'. SS 8' to 10'
		Brownish gray f-c SAND, trace silt (wet)	9 10	S-5	SS	18	9 10 16 10	26	SS 10' to 12'
			11 12	S-6	SS	16	6 8 8 8	16	Drilled to 15'.
		Brownish gray f-c SAND, trace silt (wet)	13 14 15	S-7	SS	16	8 11 12 12	23	SS 15' to 17'
			16 17						Drilled to 20'.
			18						

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Log of Boring **B-3** Sheet 2 of 3

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 4.1 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			18						
			19						
		Brown Silty f-c SAND, trace clay, trace fine gravel (wet)	20	S-8	SS	24	8 5 4 5	9	SS 20' to 22'
	-16.9	Dark gray to gray Sandy CLAY, some silt, trace fine gravel (wet)	21						q_u=0.25-0.5 tsf
		Dark gray Silty f-m SAND, trace fine gravel (wet)	22						Drilled to 25'.
			23						
			24						
		Dark gray Silty CLAY, some organics, trace wood, trace roots (wet)	25	S-9	SS	24	7 9 13 10	22	SS 25' to 27'
		Dark gray Silty CLAY, trace organics, trace wood, trace roots (wet)	26						q_u=1.75-2.5 tsf
		Dark gray Silty CLAY, trace organics, trace fine sand (wet)	27	S-10A / S-10B	SS	24	14 12 8 10	20	SS 27' to 29'
			28						q_u=1.5-1.75 tsf
			29						q_u=1.5 tsf
	-25.9		30						Drilled to 30'.
		Dark gray Silty CLAY, trace fine sand, trace mica (wet)	31	S-11	SS	24	4 6 8 1	14	SS 30' to 32'
		Dark gray Silty CLAY, trace f-m sand, trace mica (wet)	32	S-12	SS	24	16 11 12 13	23	q_u=1.5-2 tsf
			33						SS 32' to 34'
			34						q_u=2 tsf
			35						Drilled to 35'.
		Dark gray Silty Clay, trace f-m sand, trace mica (wet)	36	S-13	SS	24	6 6 6 7	12	SS 35' to 37'
			37						q_u=1.5-2 tsf
			38						Drilled to 40'.
			39						
		Dark gray Silty CLAY, trace f-m sand, trace mica (wet)	40		SS	24	5		SS 40' to 42'
			40.5						

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Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 4.1 (NAVD 88)

Elev. (ft)	Sample Description	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		40.5–42	S-14	SS	24	6, 7, 12	13	q_u=2.5 tsf Drilled to 45'.
	Dark gray Silty CLAY, trace f-m sand, trace mica (wet)	45–47	S-15	SS	24	6, 7, 7, 12	14	SS 45' to 47' q_u=2.0 tsf Drilled to 48'.
	Dark gray Silty CLAY, trace f-m sand, trace mica (wet)	48–50	S-16	SS	24	3, 7, 8, 11	15	SS 48' to 50' q_u=1.5-1.75 tsf
-45.9	End Boring at 50'.	50						Finished drilling at 1:30 PM. Borehole grouted upon completion.

Depth scale: 40.5, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63

N-Value scale: 10 20 30 40

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Log of Boring **B-4** Sheet 1 of 2

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 6 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/16/15 / Date Finished: 10/16/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 25 ft / Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 9 / Undisturbed - / Core -
Casing Diameter (in): N/A / Casing Depth (ft): -	Water Level (ft.): First ▽ 4 / Completion ▼ - / 24 HR. ▼ -
Casing Hammer / Weight (lbs): - / Drop (in): -	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety / Weight (lbs): 140 lbs / Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+6.0		0						Began drilling at 7:40 AM.
	+5.6	Brown f-c SAND, some silt, trace fine gravel (moist) Grayish brown f-m SAND, trace silt (moist)	1	S-1A	SS	18	4 7 7 5	14	SS 0' to 2' SS 2' to 4'
			2	S-1B					
		Brown f-m SAND, trace silt (moist)	3	S-2	SS	16	3 3 4 4	7	SS 2' to 4'
		Brown f-m SAND, trace silt (wet)	4 ▽						Sample wet at 4'.
			5	S-3	SS	12	5 5 6 8	11	Drilled to 4'. SS 4' to 6'
		Brown f-m SAND, trace silt (wet)	6	S-4	SS	12	4 5 3 3	8	SS 6' to 8'
		Brown f-m SAND, trace silt (wet)	8	S-5	SS	16	4 5 6 10	11	Drilled to 8'. SS 8' to 10'
	-4.0	Grayish brown Silty f-m SAND, trace clay (wet)	10	S-6	SS	24	2 2 2 6	4	SS 10' to 12'
	-5.6	Grayish brown Silty f-m SAND, trace clay (wet)	12						Drilled to 15'.
	-9.0	Brown f-m SAND, trace silt (wet)	15	S-7	SS	18	7 7 9 10	16	SS 15' to 17'
			17						Drilled to 20'.
			18						

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Log of Boring **B-4** Sheet 2 of 2

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 6 (NAVD 88)

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			18						
			19						
			20						
		Brownish gray f-c SAND, trace silt, trace fine gravel (wet)	21	S-8	SS	14	9 17 20 24	37	SS 20' to 22'
			22						Drilled to 23'.
	-17.0		23						
		Dark gray Silty CLAY, some organics, trace fine sand (wet)	24	S-9	SS	24	3 8 10 13	18	SS 23' to 25' (Organic odor) q_u=1.0-1.25 tsf
	-19.0		25						
		End of Boring at 25'.	26						Finished drilling at 8:30 AM. Borehole backfilled with bentonite pellets upon completion.
			27						
			28						
			29						
			30						
			31						
			32						
			33						
			34						
			35						
			36						
			37						
			38						
			39						
			40						
			40.5						

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Log of Boring **B-5** Sheet 1 of 2

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 6.8 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/16/15 / Date Finished: 10/16/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 34.4 ft / Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 9 / Undisturbed - / Core -
Casing Diameter (in): N/A / Casing Depth (ft): -	Water Level (ft.): First ▽ 4.5 / Completion ▼ - / 24 HR. ▼ -
Casing Hammer: - / Weight (lbs): - / Drop (in): -	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety / Weight (lbs): 140 lbs / Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+6.8	Brown f-c SAND, trace fine gravel, trace silt (moist)	0	S-1A	SS	18	3, 5, 6	11	Began drilling at 9:10 AM.
	+6.2	Brown f-m SAND, trace silt (moist)	1	S-1B	SS		7		SS 0' to 2'
		Reddish-brown f-m SAND, some silt (moist)	2	S-2	SS	16	2, 4, 3, 4	7	SS 2' to 4'
		Reddish-brown f-m SAND, some silt (moist) ▽	3						
			4	S-3	SS	20	4, 6, 5, 3	11	SS 4' to 6'
	+0.8	Brown f-m SAND, some silt, trace clay (wet)	5						
			6	S-4	SS	16	1, 2, 3, 5	5	SS 6' to 8'
	-1.2	Brown f-m SAND, trace silt (wet)	7						
			8	S-5	SS	14	7, 9, 6, 7	15	Drilled to 8'. SS 8' to 10'
		Brown f-m SAND, trace silt (wet)	9						
			10	S-6	SS	18	5, 9, 12, 14	21	SS 10' to 12'
			11						
			12						Drilled to 15'.
	-7.2		13						
		Dark gray Silty CLAY, trace fine sand (wet)	14						
			15	S-7	SS	10	1, WOH, WOH, WOH		SS 15' to 17' (Organic odor)
			16						q_u=< 0.25 tsf
		Dark gray Silty CLAY, trace fine sand (wet)	17	S-8A	SS	24	1, WOH		Sand content increases at bottom of spoon. SS 17' to 19'
	-11.2		18						q_u=0.15 tsf

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Log of Boring B-5 Sheet 2 of 2

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 6.8 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale
		Dark gray CLAY, some silt, trace fine sand, trace organics (wet)	18
		Dark gray CLAY, some silt, trace fine sand, trace organics (wet)	19
			20
		Dark gray Silty CLAY, trace fine sand, trace organics (wet)	21
			22
			23
			24
		Dark gray Clayey SILT, trace fine sand, trace mica (wet)	25
			26
			27
			28
			29
	-23.2	Gray f-m SAND, trace silt (wet)	30
			31
			32
		Gray f-c SAND, trace silt (wet)	33
			34
	-27.6	End of Borehole at 34' 5".	35
			36
			37
			38
			39
			40
			40.5

Sample Data					N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
Number	Type	Recov. (in)	Penetr. resist BL/6in			
S-8B	SS	24	2 3			q_u=0.25-0.5 tsf Drilled to 19'. Take Shelby tube 19' to 21' 10:00 AM to 10:25 AM
SH-1	SH	24	PUSH			q_u=1.25 tsf SS 21' to 23'
S-9	SS	24	4 5 6 8	11		q_u=1.75-2.0 tsf Drilled to 25'.
S-10	SS	24	2 5 6 16	11		SS 25' to 27' q_u=1.0-1.25 tsf Sand content increases at tip of spoon. Drilled to 30'.
S-11	SS	9	29 50/4"	50/4"		SS 30' to 30' 10"
S-12	SS	12	29 49 50/5"	50/5"		SS 33' to 34' 5" Finished drilling at 11:00 AM. Borehole grouted upon completion.

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Log of Boring **B-6** Sheet 1 of 3

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 7.7 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/15/15 / Date Finished: 10/15/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 30 ft / Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 14 / Undisturbed - / Core -
Casing Diameter (in): N/A / Casing Depth (ft): -	Water Level (ft.): First ▽ 5 / Completion ▼ - / 24 HR. ▼ -
Casing Hammer: - / Weight (lbs): - / Drop (in): -	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety / Weight (lbs): 140 lbs / Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist Bl/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+7.7		0						
	+7.2	Dark brown f-c SAND, some silt, trace roots, trace organics (moist) [TOPSOIL]							
		Brown f-m SAND, trace silt, trace roots (moist)	1	S-1A	SS	20	1 5 7 6	12	Began drilling at 12:10 PM. SS 0' to 2'
		Brown f-m SAND, trace silt, trace roots (moist)	2	S-1B					
			3	S-2	SS	24	4 4 4 6	8	SS 2' to 4'
	+3.7	Orangish-brown f-m SAND, some silt (wet)	4						Drilled to 4'. SS 4' to 6'
			5	S-3	SS	14	2 5 4 4	9	
		Orangish-brown f-m SAND, some silt (wet)	6	S-4	SS	14	3 3 3 3	6	SS 6' to 8'
		Brown f-m SAND, some silt (wet)	7						Drilled to 8'. SS 8' to 10'
	-1.3	Brown f-c SAND, trace silt (wet)	8						
			9	S-5	SS	22	6 9 10 7	19	
		Orangish-brown f-c SAND, trace silt, trace fine gravel (wet)	10						SS 10' to 12'
			11	S-6	SS	18	4 6 14 12	20	
			12						
			13						
			14						
			15						
		Brownish-gray f-c SAND, trace silt, trace fine gravel (wet)	16	S-7	SS	12	11 12 6 5	18	Drilled to 15'. SS 15' to 17' q_u = 0.25 to 0.5 tsf
	-9.0		17						
		Brownish-gray CLAY, some silt, trace fine sand (wet)	18						

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Log of Boring **B-6** Sheet 2 of 3

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 7.7 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			18						
			19						
	-12.3	Light gray f-m SAND, trace silt (wet)	20	S-8	SS	18	12 20 35 22	55	SS 20' to 22'
			21						
			22						
			23						
			24						
		Light gray f-m SAND, trace fine gravel, trace silt (wet)	25	S-9	SS	16	24 20 32 27	52	Drilled to 25'. SS 25' to 27'
			26						
			27						
			28						
			29						
		Light gray f-m SAND, trace fine gravel, trace silt (wet)	30	S-10	SS	12	13 19 24 22	43	Drilled to 30'. SS 30' to 32'
			31						
			32						
			33						
			34						
		Brownish-gray f-m SAND, trace fine gravel, trace silt (wet)	35	S-11	SS	12	24 25 26 41	51	Drilled to 35'. SS 35' to 37'
			36						
			37						
			38						
			39						
		Light gray f-c SAND, trace fine gravel, trace silt (wet)	40	S-12	SS	9	49		Drilled to 40'.
			40.5						

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Log of Boring **B-6** Sheet 3 of 3

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 7.7 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			40.5			9	50/3"	50/3"	SS 40' to 40'-9"
			41						
			42						
			43						
			44						
		Light gray f-c SAND, trace f-c gravel, trace silt (wet)	45	S-13	SS	14	35		Drilled to 45'. SS 48' to 50'
			46				50	100	
			47				50		
							32		
		Light gray f-c SAND, trace fine gravel, trace silt (wet)	48	S-14	SS	12	20		
			49				24	49	
	-42.3						25		
		End of Boring at 50'.	50				31		Finished drilling at 1:05 PM. Borehole grouted upon completion.
			51						
			52						
			53						
			54						
			55						
			56						
			57						
			58						
			59						
			60						
			61						
			62						
			63						

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Log of Boring **B-7 (MW-2)** Sheet 1 of 2

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 8 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/14/15 — Date Finished: 10/14/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 36 ft — Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 11 — Undisturbed - — Core -
Casing Diameter (in): N/A — Casing Depth (ft): -	Water Level (ft.): First ▽ 4 — Completion ▼ 4.8 — 24 HR. ▼ 4.9
Casing Hammer: - — Weight (lbs): - — Drop (in): -	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety — Weight (lbs): 140 lbs — Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+8.0								
	+7.5	Dark brown Silty f-m SAND, trace organics, trace roots (moist) [TOPSOIL]	0						Began drilling at 11:10 AM.
		Brown Silty f-m SAND (moist)	1	S-1	SS	18	4 4 3 3	7	SS 0' to 2'
		Brown f-m SAND, some silt (moist)	2						
			3	S-2	SS	14	2 4 3 2	7	SS 2' to 4'
		Brown f-m SAND, some silt (wet)	4						
			5	S-3	SS	18	5 5 4 4	9	Drilled to 4'. SS 4' to 6' Sample wet at 4'. SS 6' to 8'
		Brown f-m SAND, trace silt (wet)	6						q_u=2.0 to 2.25 tsf
			7	S-4	SS	16	4 5 5 6	10	
		Brown f-m SAND, trace silt (wet)	8						Drilled to 8'. SS 8' to 10'
	-1.8		9	S-5	SS	16	6 5 6 6	11	
	-2.0	Gray SILT, trace clay (wet)	10						SS 10' to 12'
		Gray Silty SAND (wet)	11	S-6	SS	20	2 2 7 9	9	
	-3.5	Gray f-m SAND, trace silt (wet)	12						
			13						
			14						
		Gray f-c SAND, trace silt (wet)	15						Drilled to 15'. SS 15 to 17'
	-7.8		16	S-7	SS	16	6 9 12 11	21	
	-8.3	Gray to brown Sandy SILT (wet)	17						
		Brown f-m SAND, some silt (wet)	18						

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Log of Boring **B-7 (MW-2)** Sheet 2 of 2

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 8 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-12.0	Gray f-m SAND, trace silt (wet)	18–40.5	S-8	SS	15	10, 12, 13, 13	25	Drilled to 20'. SS 20' to 22'
		Brownish-gray f-m SAND, trace silt (wet)		S-9	SS	16	8, 11, 14, 13	25	Drilled to 25'. SS 25' to 27'.
	-22.0	Dark gray CLAY, some silt, trace fine sand, trace mica (wet)		S-10	SS	24	3, 5, 5, 5	10	Drilled to 30'. SS 30' to 32' q_u = 0.75 to 1 tsf s_u = 0.3 tsf
		Dark gray Silty CLAY (wet)		SH-1	SH	24	PUSH		Drilled to 32'. Took Shelby Tube 32' to 34'.
		Dark gray Silty CLAY, trace fine sand, trace mica (wet)		S-11	SS	24	5, 8, 8, 7	16	SS 34' to 36'
	-28.0	End of Boring at 36'.							Finished drilling at 1:00 PM. Borehole flushed with clean water and installed temporary groundwater observation well upon completion. Prior to demobilization, the temporary well was removed and the borehole was grouted.

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Log of Boring **B-8** Sheet 1 of 3

Project: Flagler Repauno - Proposed Warehouse Development	Project No.: 130088801
Location: Repauno Avenue, Greenwich Twp., NJ	Elevation and Datum: Approx. el 6 (NAVD 88)
Drilling Company: Craig Geotechnical Drilling Co., Inc.	Date Started: 10/14/15 — Date Finished: 10/14/15
Drilling Equipment: CME 75 Truck-Mounted Drill Rig	Completion Depth: 50 ft — Rock Depth: N/E
Size and Type of Bit: 3-7/8" Drag Bit	Number of Samples: Disturbed 14 — Undisturbed - — Core -
Casing Diameter (in): 4" I.D. Steel — Casing Depth (ft): -	Water Level (ft.): First ▽ 3.8 — Completion ▼ - — 24 HR. ▼ -
Casing Hammer: - — Weight (lbs): - — Drop (in): -	Drilling Foreman: Tom Ward
Sampler: 2" O.D. Split Spoon	Inspecting Engineer: Kyle Lawson
Sampler Hammer: Safety — Weight (lbs): 140 lbs — Drop (in): 30"	

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+6.0								
	+5.5	Dark brown Silty f-c SAND, trace roots, trace organics, trace wood (moist) [TOPSOIL]	0						Began boring at 2:25 PM.
		Brown f-m SAND, trace silt (moist)	1	S-1	SS	20	2 4 3 2	7	SS 0' to 2'
		Brown f-m SAND, some silt (moist)	2	S-2	SS	20	2 3 4 3	7	SS 2' to 4'
			3						Sample wet at 3.75'.
		Brown f-m SAND, trace silt (wet)	4	S-3	SS	24	4 5 4 5	9	Drilled to 4'. SS 4' to 6'
		Brownish-gray f-m SAND, trace silt (wet)	5						
	-1.0		6	S-4	SS	16	3 5 4 5	9	SS 6' to 8'
		Brownish-gray f-m SAND, some silt (wet)	7						
		Grayish brown Silty f-m SAND (wet)	8	S-5	SS	24	4 10 18 20	28	Drilled to 8'. SS 8' to 10' q_u = 2.5 tsf
		Brown f-m SAND, trace silt (wet)	9						
		Brown f-m SAND, trace silt (wet)	10	S-6	SS	16	10 13 12 14	25	SS 10' to 12'
			11						
			12						
			13						
			14						
		Grayish-brown f-m SAND, trace silt (wet)	15	S-7	SS	16	13 19 6 7	25	Drilled to 15'. SS 15' to 17'
	-10.8		16						
	-11.0	Gray SILT, some fine sand (wet)	17						
			18						

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APPENDIX J

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Log of Boring **B-8** Sheet 2 of 3

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 6 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			18						
			19						
		Grayish-brown f-m SAND, some silt (wet)	20	S-8A	SS	18	14		Drilled to 20'.
	-15.0						16		SS 20' to 22'
		Grayish-brown f-c SAND, trace silt (wet)	21	S-8B	SS		20	36	
			22				27		
			23						
			24						
		Reddish-brown f-c SAND, trace silt (wet)	25	S-9	SS	14	14		Drilled to 25'.
			26				17	38	SS 25' to 27'
			27				21		
							14		
	-24.0		28						
			29						
		Dark gray Silty CLAY, trace fine sand, trace mica (wet)	30	S-10	SS	24	1		Drilled to 30'.
							1		SS 30' to 32'
			31				1	2	q_u = 0.25 to 0.5 tsf
							1		
		Dark gray Silty CLAY (wet)	32	SH-1	SH	24	PUSH		Stopped drilling at 3:30 PM on 10/14/15. Continued drilling at 7:30 AM on 10/15/15. Drilled to 32'. Shelby Tube taken from 32 to 34'; Started at 7:35 AM, ended at 7:50 AM. q_u = 0.25 to 0.5 tsf.
			33						
			34						
		Dark gray CLAY, some silt, trace fine sand, trace mica (wet)	35	S-11	SS	16	1		Drilled to 35'.
							2		SS 35' to 37'
			36				2	4	q_u = 0.75 tsf.
							3		
			37						
			38						
			39						
			40						
		No Recovery	40.5	SS		0	2		Drilled to 40'.

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Log of Boring **B-8** Sheet 3 of 3

Project	Project No.
Flagler Repauno - Proposed Warehouse Development	130088801
Location	**Elevation and Datum**
Repauno Avenue, Greenwich Twp., NJ	Approx. el 6 (NAVD 88)

Material Symbol	Elev. (ft)	Sample Description	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			40.5						SS 40' to 42'
			41	S-12	SS	0	3 4 5	7	
	-36.0		42						
		Dark gray Silty f-m SAND, trace mica (wet)	43	S-13	SS	20	5 7 10 10	17	Drilled to 42', SS 42' to 44'
			44						
			45						
			46						
			47						
		Dark gray f-m SAND, some silt, trace mica (wet)	48						Drilled to 48'. SS 48' to 50'
			49	S-14	SS	22	12 20 21 23	41	
	-44.0		50						
		End of Boring at 50'.	51						Finished drilling at 8:45 AM on 10/15/15. Borehole grouted upon completion.
			52						
			53						
			54						
			55						
			56						
			57						
			58						
			59						
			60						
			61						
			62						
			63						

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LOG OF TEST PIT TP-1

Sheet 1 of 1

PROJECT NAME: Flagler Repauno - Proposed Warehouse Development	PROJECT NUMBER: 130088801	DATE: 10/12/15
LOCATION: Repauno Avenue, Greenwich Twp., NJ	ELEVATION: Approx. el 4.4 (NAVD 88)	
EXCAVATION CONTRACTOR: Hemmel Excavating	DEPTH: 5 ft	WATER LEVEL - First: 3.83 ft ▽ / WATER LEVEL - Completion: 3.4 ft ▼
EQUIPMENT: John Deere 310 Backhoe	FOREMAN: John	LANGAN PERSONNEL: Kyle Lawson

Symbol	ELEV (feet)	DESCRIPTION	Depth Scale	SAMPLE Number	SAMPLE Type	REMARKS
	+4.4	4.5" ROOT MAT, trace f-m sand (moist)	0	S-1	GRAB	Began excavating at 9:00 AM.
	+4.0	Light brown to grayish brown f-m SAND, some silt, trace roots, trace wood, trace organics (moist to wet)	1			Sidewalls collapsing between 1' 2" and 4'.
			2	S-2	GRAB	
			3			
			4			Groundwater seepage observed at 3' 10".
	-0.6	End of Test Pit at 5'.	5			Finished Test Pit at 9:30 AM. Groundwater level at 3'-5" below grade at 2:40 PM. Backfilled Test Pit at 3:00 PM using excavated material. Excavated adjacent Test Pit and performed percolation test starting at 1' below grade.
			6			
			7			
			8			
			9			
			10			
			11			
			12			
			13			
			14			
			15			
			16			
			17			
			18			

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LOG OF TEST PIT TP-2

Sheet 1 of 1

PROJECT NAME	PROJECT NUMBER	DATE
Flagler Repauno - Proposed Warehouse Development	130088801	10/12/15
LOCATION	**ELEVATION**	
Repauno Avenue, Greenwich Twp., NJ	Approx. el 5 (NAVD 88)	
EXCAVATION CONTRACTOR	**DEPTH**	**WATER LEVEL - First** / **WATER LEVEL - Completion**
Hemmel Excavating	6 ft	3.5 ft ▽ / 3.9 ft ▼
EQUIPMENT	**FOREMAN**	**LANGAN PERSONNEL**
John Deere 310 Backhoe	John	Kyle Lawson

Symbol	ELEV (feet)	DESCRIPTION	Depth Scale	SAMPLE Number	SAMPLE Type	REMARKS
	+5.0	5" ROOT MAT	0			Began excavating at 10:30 AM.
	+4.6	Dark brown f-m SAND, some silt, trace roots, trace organics (moist) [TOPSOIL]	1	S1	GRAB	Moved location to approx. 4.0' south of TP-2's original location.
	+4.0	Light brown to tan f-m SAND, trace to some silt (moist to wet)	2			
			3	S2	GRAB	Collect bulk sample BLK 1: 1' to 3'.
			4			Soils wet starting at 3.5'. Groundwater seepage observed at 3' 10".
			5			Sidewalls collapsing from 3' to 6'.
	-1.0	End of Test Pit at 6'.	6			Finished Test Pit at 11:15 AM. Groundwater level at 3' 11" below grade at 2:35 PM. Backfilled Test Pit at 3:15 PM using excavated material.
			7			
			8			Excavated adjacent Test Pit and performed percolation test starting at 1' below grade.
			9			
			10			
			11			
			12			
			13			
			14			
			15			
			16			
			17			
			18			

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LOG OF TEST PIT TP-3

Sheet 1 of 1

PROJECT NAME: Flagler Repauno - Proposed Warehouse Development	PROJECT NUMBER: 130088801	DATE: 10/12/15	
LOCATION: Repauno Avenue, Greenwich Twp., NJ	ELEVATION: Approx. el 6 (NAVD 88)		
EXCAVATION CONTRACTOR: Hemmel Excavating	DEPTH: 8 ft	WATER LEVEL - First: 6 ft ▽	WATER LEVEL - Completion: 4.4 ft ▼
EQUIPMENT: John Deere 310 Backhoe	FOREMAN: John	LANGAN PERSONNEL: Kyle Lawson	

Symbol	ELEV (feet)	DESCRIPTION	Depth Scale	SAMPLE Number	SAMPLE Type	REMARKS
	+6.0	4" ROOT MAT	0			Began excavating at 11:50 AM.
	+5.5					
	+5.0	Dark brown Silty f-m SAND, trace roots, trace organics, trace pine needles (moist) [TOPSOIL]	1			
		Light brown to tan f-m SAND, trace to some silt, trace roots (moist to wet)	2			
			3			
			4			
			▼	S-1	GRAB	Sidewalls sloughing at 4'.
			5			
			▽ 6			Soils wet starting at 6'.
			7			
	-2.0		8			Unable to excavate below 8'; sidewalls unstable and collapsing.
		End of Test Pit at 8'.	9			Sidewalls collapsed below 5'. Finished Test Pit at 12:20 PM. Groundwater level at 4' 5" below grade at 2:30 PM. Backfilled test pit at 3:30 PM using excavated material.
			10			
			11			Excavated adjacent Test Pit and performed percolation test starting at 2' below grade.
			12			
			13			
			14			
			15			
			16			
			17			
			18			

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LOG OF TEST PIT TP-4

DRAFT

Sheet 1 of 1

PROJECT NAME: Flagler Repauno - Proposed Warehouse Development	PROJECT NUMBER: 130088801	DATE: 10/12/15
LOCATION: Repauno Avenue, Greenwich Twp., NJ	ELEVATION: Approx. el 8.3 (NAVD 88)	
EXCAVATION CONTRACTOR: Hemmel Excavating	DEPTH: 10 ft	WATER LEVEL - First: 8 ft ▽ / WATER LEVEL - Completion: 6.5 ft ▼
EQUIPMENT: John Deere 310 Backhoe	FOREMAN: John	LANGAN PERSONNEL: Kyle Lawson

Symbol	ELEV (feet)	DESCRIPTION	Depth Scale	SAMPLE Number	SAMPLE Type	REMARKS
	+8.3	Dark brown Silty f-m SAND, trace roots, trace organics (moist) [TOPSOIL]	0	S-1	GRAB	Began excavating at 11:30 AM.
	+7.8	Light brown to tan f-m SAND, trace to some silt, trace roots (moist)	1			
			2			Collected bulk sample BLK-1: 2' to 5'.
			3	S-2	GRAB	
			4			
			5			
	+2.3	Light brown to tan to gray f-m SAND, some silt, trace clay (moist to wet) ▼	6			Soil mottling observed from 6' to 8'.
		▽	7			
			8	S-3	GRAB	Soils wet starting at 8'.
			9			
	-1.7	End of Test Pit at 10'.	10			Sidewall sloughing between 3' and 8'.
			11			Finished excavating at 11:40 AM. Sidewall collapsed below 6.5'. Groundwater level measured at 6.5' below grade at 2:35 PM. Backfilled Test Pit at 3:45 PM using excavated soils. Excavated adjacent Test Pit and performed percolation test starting at 2' below grade.
			12			
			13			
			14			
			15			
			16			
			17			
			18			

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APPENDIX J

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LOG OF TEST PIT TP-5

Sheet 1 of 1

PROJECT NAME: Flagler Repauno - Proposed Warehouse Development	PROJECT NUMBER: 130088801	DATE: 10/12/15	
LOCATION: Repauno Avenue, Greenwich Twp., NJ	ELEVATION: Approx. el 8.8 (NAVD 88)		
EXCAVATION CONTRACTOR: Hemmel Excavating	DEPTH: 10 ft	WATER LEVEL - First: 7.5 ft ▽	WATER LEVEL - Completion: 8.3 ft ▼
EQUIPMENT: John Deere 310 Backhoe	FOREMAN: John	LANGAN PERSONNEL: Kyle Lawson	

Symbol	ELEV (feet)	DESCRIPTION	Depth Scale	SAMPLE Number	SAMPLE Type	REMARKS
	+8.8		0			
	+8.3	Dark brown f-m SAND, some silt, trace orgnaics, trace roots (moist) [TOPSOIL]				Began excavating at 1:10 PM.
		Brown f-m SAND, trcae to some silt, trace roots (moist)	1			
			2			Collected bulk sample BLK-1: 1' to 6'.
			3			
			4			
			5	S-1	GRAB	
			6			Sidewalls sloughing below 6'.
			7			
	+1.3	▽				
		Gray to orange brown Sandy SILT, trace mica, trace roots (wet) ▼	8	S-2	GRAB	Soil mottling observed at 7.5'. Collected bulk sample BLK-2: 8' to 10'. Sidewalls collapsing at 8'.
	-0.2		9	S-3	GRAB	
		Grayish brown f-m SAND, trace to some silt (wet)				
	-1.2		10			
		End of Test Pit at 10'.				Finished Test Pit at 1:40 PM. Test pit collapsed to 8'-6" upon completion. Groundwater level at 8'-3" below grade at 2:10 PM. Backfilled Test Pit at 4:00 PM using excavated material.
			11			
			12			
			13			Excavated adjacent Test Pit and performed percolation test starting at 3' below grade.
			14			
			15			
			16			
			17			
			18			

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LOG OF TEST PIT TP-6

Sheet 1 of 1

PROJECT NAME: Flagler Repauno - Proposed Warehouse Development	PROJECT NUMBER: 130088801	DATE: 10/12/15	
LOCATION: Repauno Avenue, Greenwich Twp., NJ	ELEVATION: Approx. el 7 (NAVD 88)		
EXCAVATION CONTRACTOR: Hemmel Excavating	DEPTH: 9 ft	WATER LEVEL - First: 6 ft ▽	WATER LEVEL - Completion: 6.5 ft ▼
EQUIPMENT: John Deere 310 Backhoe	FOREMAN: John	LANGAN PERSONNEL: Kyle Lawson	

Symbol	ELEV (feet)	DESCRIPTION	Depth Scale	SAMPLE Number	SAMPLE Type	REMARKS
	+7.0	Dark brown Silty f-c SAND, trace roots, trace organics (moist) [TOPSOIL]	0			Began excavation at 12:30 PM.
	+6.3	Brown to orange brown f-m SAND, some silt, trace roots (moist)	1			
			2			
			3			
			4			
			5	S-1	GRAB	
	+1.5	Brown to orange brown Silty f-m SAND (moist to wet) ▽	6	S-2	GRAB	Soils wet starting at 6'.
	+0.5	Gray Sandy SILT (wet) ▼	7			Groundwater seepage observed at 7'-4".
	-1.0		8	S-3	GRAB	Sidewalls sloughing between 6' and 9'. Unable to excavate beyond 9' due to sidewalls collpasing.
	-2.0	Gray f-m SAND, some silt, trace mica (wet)	9			
		End of Test Pit at 9'.	10			Finished Test Pit at 12:50 PM. Sidewall collapsed below 7'. Groundwater level at 6.5' at 2:00 PM. Backfilled test pit at 2:15 PM using excavated material.
			11			
			12			Excavated adjacent Test Pit and performed percolation test starting at 2' below grade.
			13			
			14			
			15			
			16			
			17			
			18			

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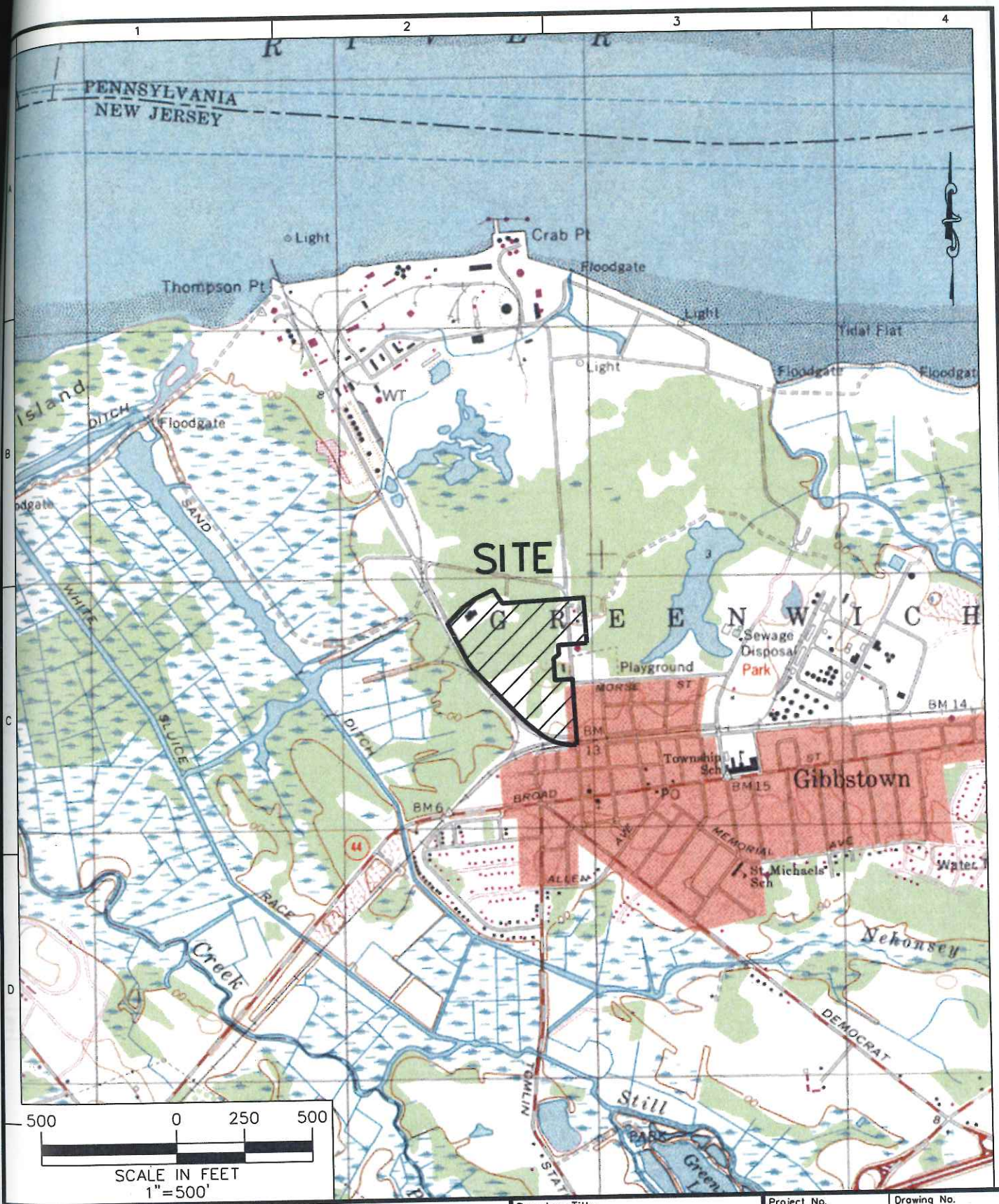

LANGAN

989 Lenox Drive, Suite 124
Lawrenceville, NJ 08648
T: 609.282.8000 F: 609.282.8001 www.langan.com

Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C. S.A
Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C.
Langan Engineering and Environmental Services, Inc.
Langan CT, Inc.
Langan International LLC
Collectively known as Langan

NJ CERTIFICATE OF AUTHORIZATION No. 24GA27996400

Project

FLAGLER REPAUNO

BLOCK No. 04, LOT No.08
TOWNSHIP OF GREENWICH
GLOUCESTER COUNTY NEW JERSEY

Drawing Title

SITE LOCATION MAP

Project No. 130088802	Drawing No. ----
Date 11/02/15	CS701
Scale 1" = 500'	--------
Drawn By AMS / Checked By EFW	
Submission Date ----	Sheet 1 of 1

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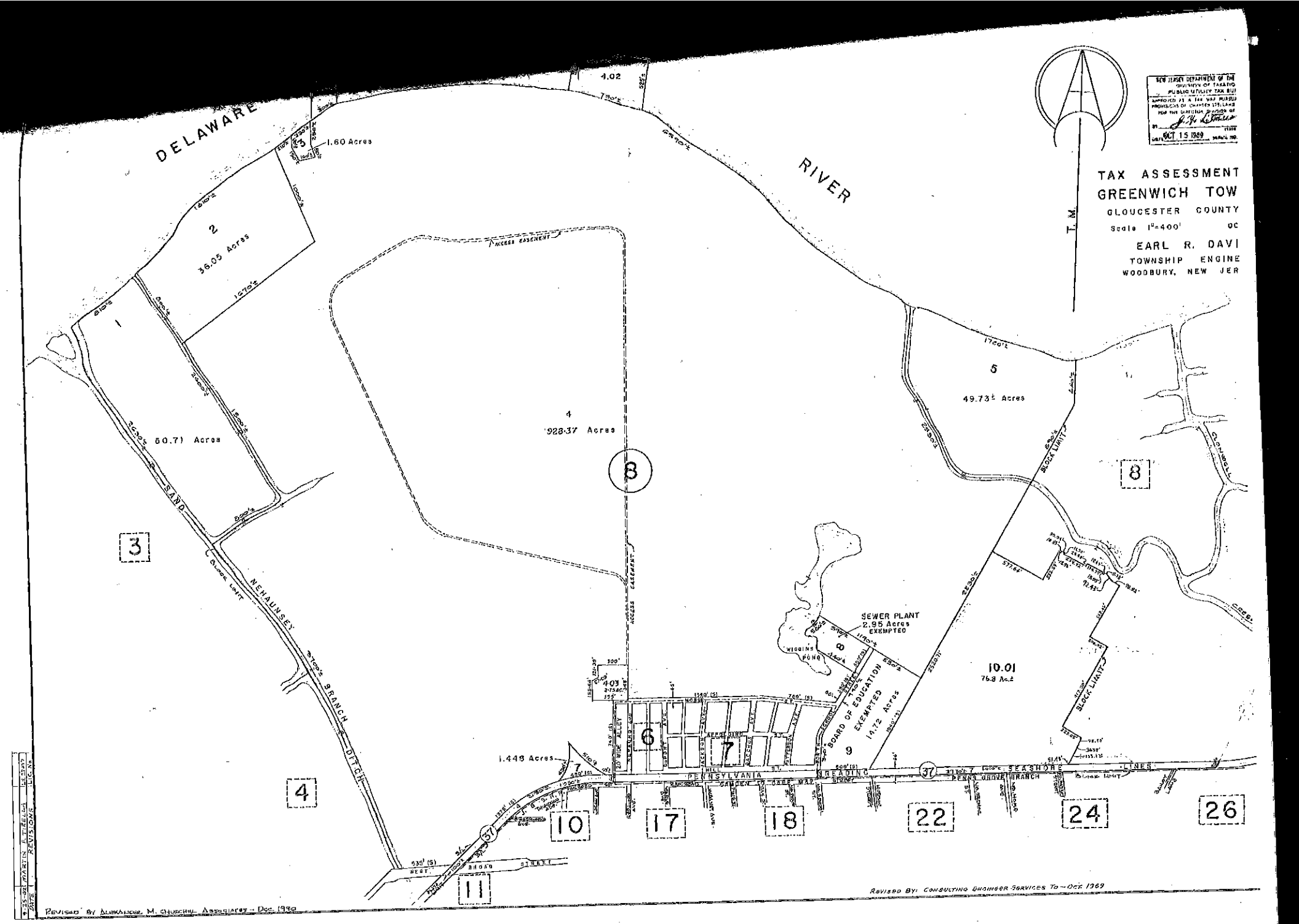
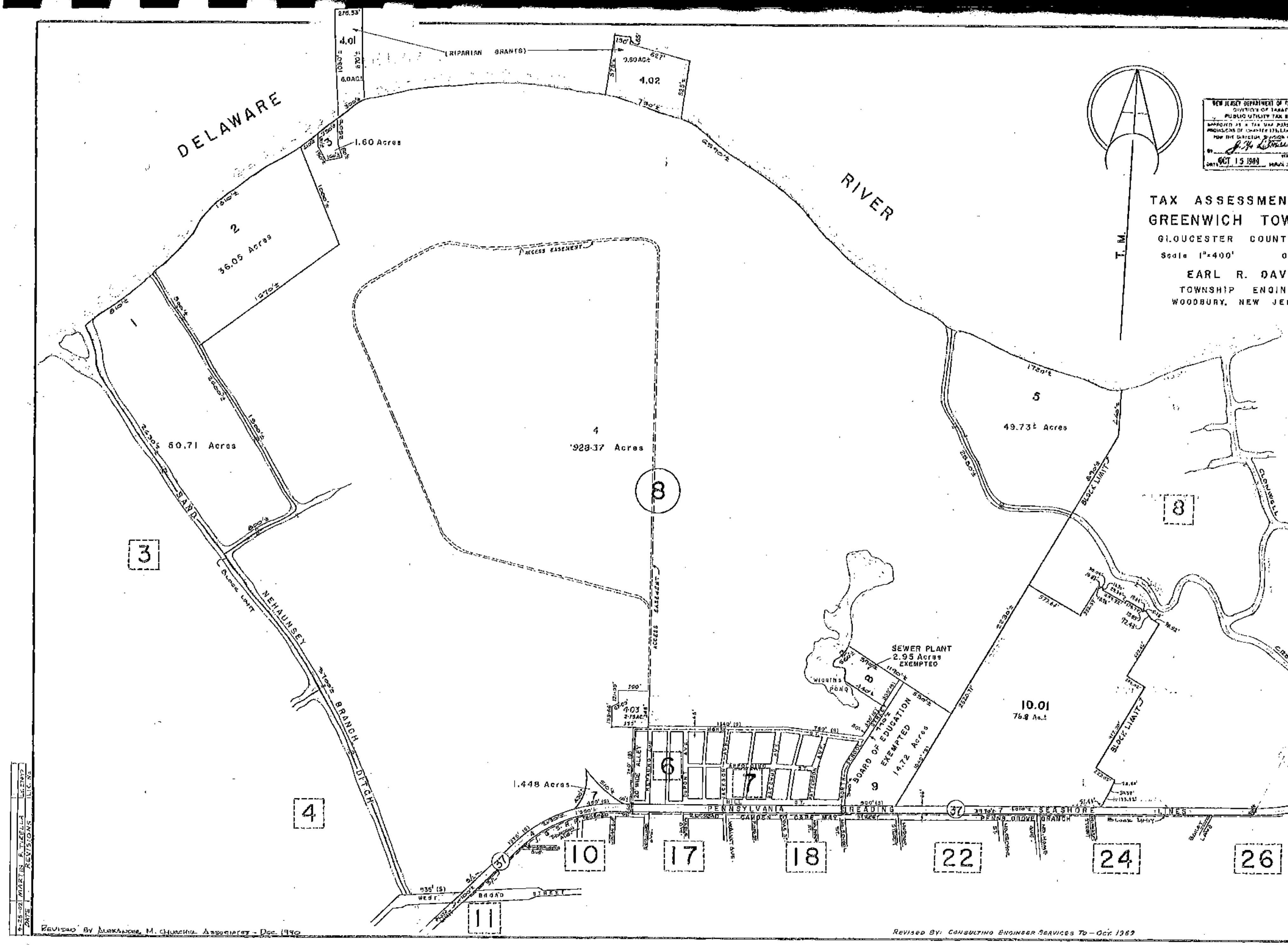

DELAWARE
RIVER
4.02
1.60 Acres
2
36.05 Acres
1
36.90± 60.71 Acres
4
928.37 Acres
5
49.73± Acres
8
3
SAND
NEHAUNSEY
BRANCH
DITCH
BLOCK LIMIT
ACCESS EASEMENT
SEWER PLANT
2.95 Acres
EXEMPTED
WIGGINS
POND
4.03
10.01
76.8 Ac.±
BOARD OF EDUCATION
EXEMPTED
14.72 Acres
1.448 Acres
6
7
9
10
17
18
22
24
26
11
PENNSYLVANIA
READING
SEASHORE
LINES
PENN GROVE BRANCH
HILL ST.
CAMDEN
DEEP WATER
BROADWAY
WEST
T. M.
TAX ASSESSMENT
GREENWICH TOW
GLOUCESTER COUNTY
Scale 1"=400'
EARL R. DAVI
TOWNSHIP ENGINE
WOODBURY, NEW JER
NEW JERSEY DEPARTMENT OF THE TREASURY-DIVISION OF TAXATION
PUBLIC UTILITY TAX BUT
APPROVED AS A TAX MAP PURSUANT TO PROVISIONS OF CHAPTER 173, LAWS
FOR THE DIRECTOR, DIVISION OF TAXATION
OCT. 15 1969
REVISIONS
DATE
MARTIN R. TIBELLI
LIC. No.
Revised By: Consulting Engineer Services To - Oct 1969
Revised By: Alaimo, Alaimo, M. Church, Associates - Dec. 1990



TAX ASSESSMENT
GREENWICH TOW
GLOUCESTER COUNTY
Scale 1"=400'
EARL R. DAVI
TOWNSHIP ENGINE
WOODBURY, NEW JER
DELAWARE
RIVER
T.M.
(RIPARIAN GRANTS)
4.01
4.02
1.60 Acres
36.05 Acres
60.71 Acres
928.37 Acres
49.73± Acres
SEWER PLANT
2.95 Acres
EXEMPTED
BOARD OF EDUCATION
EXEMPTED
14.72 Acres
10.01
1.448 Acres
ACCESS EASEMENT
BLOCK LIMIT
NEHAUNSEY BRANCH DITCH
SAND
WIGGINS POND
PENNSYLVANIA
READING
SEASHORE
LINES
PENNS GROVE BRANCH
CAMDEN TO CAPE MAY
20' WIDE ALLEY
BROAD STREET
CLONMELL
3
4
8
10
11
17
18
22
24
26
REVISED BY ALEXANDER M. CHURCHILL ASSOCIATES - DEC 1990
REVISED BY: CONSULTING ENGINEER SERVICES TO - OCT 1989
4-25-02 MARTIN F. TIZELLA
DATE REVISIONS
OCT 15 1989


75° 17' 57" W
75° 17' 26" W
39° 49' 50" N
39° 49' 34" N
474410
474480
474550
474620
474690
474760
474830
474900
474970
475040
475110
4408980
4408910
4408840
4408770
4408700
4408630
4408560
MamuAv
MamuAv
MamuAv
FamA
UddcB
USDOWB
Morse Ave
Driveway
Hill St
Map Scale: 1:3,380 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0
50
100
200
300
Feet
0
150
300
600
900
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

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

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

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

Soil Survey Area: Gloucester County, New Jersey
Survey Area Data: Version 12, Sep 24, 2014

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

Date(s) aerial images were photographed: Aug 18, 2014—Sep 22, 2014

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 — Gloucester County, New Jersey (NJ015)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
FamA	Fallsington sandy loam, 0 to 2 percent slopes	B/D	0.3	1.1%
MamuAv	Mannington-Nanticoke-Udorthents complex, 0 to 1 percent slopes, very frequently flooded	C/D	5.1	16.4%
UddcB	Udorthents, dredged coarse materials, 0 to 8 percent slopes	D	22.0	70.3%
USDOWB	Urban land-Downer complex, 0 to 5 percent slopes		3.8	12.2%
Totals for Area of Interest			**31.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was New Jersey State Plane (FIPSZONE 2900) zone. The **horizontal datum** was NAD 83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was provided in digital format by the New Jersey Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS). The aerial photography was captured in March and April of 2012 at a scale of 1:2,400 with a 1 foot pixel resolution.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

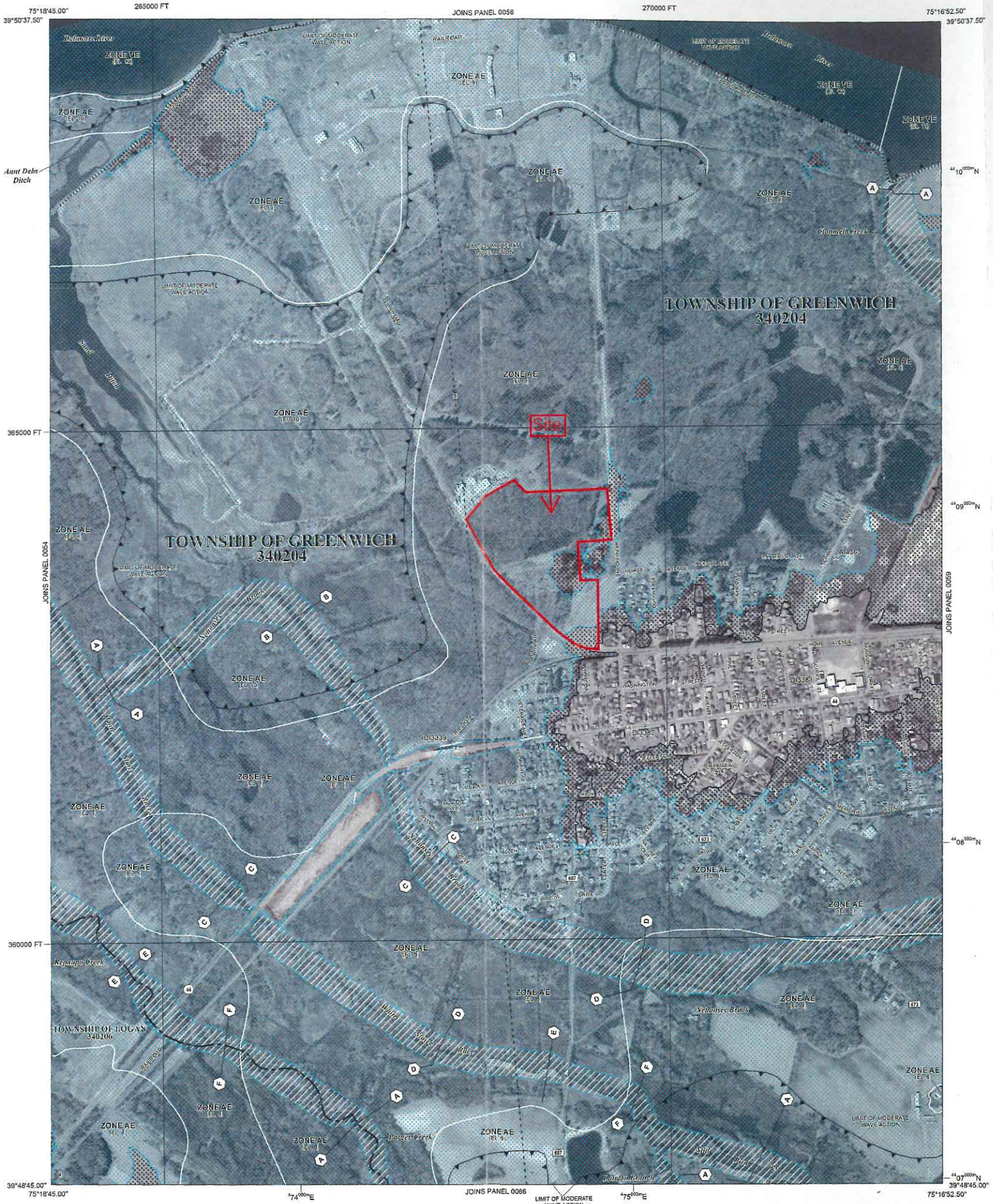
The AE Zone category has been divided by a **Limit of Moderate Wave Action (LiMWA)**. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between the VE Zone and the LiMWA (or between the shoreline and the LiMWA for areas where VE Zones are not identified) will be similar to, but less severe than those in the VE Zone.

Contact the **FEMA Map Information eXchange** at **1-877-FEMA MAP** (1-877-336-2627) for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Information eXchange may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.

CTP Cooperating Technical Partners

This digital FIRM was produced through a unique cooperative partnership between the New Jersey Department of Environmental Protection (NJDEP) and FEMA. As part of the effort, NJDEP has joined in a Cooperative Technical Partnership agreement to produce and maintain FEMA's digital FIRM.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Limit of Moderate Wave Action
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A — A — Cross section line
- 23 — 23 — Transect line
- 87°07'45", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4275000mN — 1000-meter Universal Transverse Mercator grid value, zone 18
- 6000000 FT — 5000-foot grid value: New Jersey State Plane coordinate system (FIPSZONE 2900), Transverse Mercator projection
- DX5910 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
January 20, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
- to update corporate limits, to change Base Flood Elevations, to change Special Flood Hazard Areas, to incorporate new detailed coastal flood hazard analysis, to update roads and road names, to reflect updated topographic information, and to add floodway.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1,000 FEET
150 0 150 300 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0058F

FIRM
FLOOD INSURANCE RATE MAP

GLOUCESTER COUNTY, NEW JERSEY
(ALL JURISDICTIONS)

PANEL 58 OF 320
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GREENWICH, TOWNSHIP OF	340204	0058	F
LOGAN, TOWNSHIP OF	340206	0058	F

PRELIMINARY
SEPTEMBER 19, 2014

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

MAP NUMBER
34015C0058F

MAP REVISED

Federal Emergency Management Agency

NEW JERSEY 24 HOUR RAINFALL FREQUENCY DATA

Rainfall amounts in Inches

County	1 year	2 year	5 year	10 year	25 year	50 year	100 year
Atlantic	2.72	3.31	4.30	5.16	6.46	7.61	8.90
Bergen	2.75	3.34	4.27	5.07	6.28	7.32	8.47
Burlington	2.77	3.36	4.34	5.18	6.45	7.56	8.81
Camden	2.73	3.31	4.25	5.06	6.28	7.34	8.52
Cape May	2.67	3.25	4.22	5.07	6.34	7.47	8.73
Cumberland	2.69	3.27	4.25	5.09	6.37	7.49	8.76
Essex	2.85	3.44	4.40	5.22	6.44	7.49	8.66
Gloucester	2.71	3.29	4.24	5.05	6.29	7.36	8.55
Hudson	2.73	3.31	4.23	5.02	6.19	7.20	8.31
Hunterdon	2.80	3.38	4.26	5.00	6.09	7.02	8.03
Mercer	2.74	3.31	4.23	5.01	6.19	7.20	8.33
Middlesex	2.76	3.35	4.30	5.12	6.36	7.43	8.63
Monmouth	2.79	3.38	4.38	5.23	6.53	7.66	8.94
Morris	2.94	3.54	4.47	5.24	6.37	7.32	8.35
Ocean	2.81	3.42	4.45	5.33	6.68	7.87	9.20
Passaic	2.87	3.47	4.42	5.23	6.43	7.47	8.62
Salem	2.69	3.26	4.20	5.00	6.22	7.28	8.45
Somerset	2.76	3.34	4.25	5.01	6.15	7.13	8.21
Sussex	2.68	3.22	4.02	4.70	5.72	6.60	7.58
Union	2.80	3.39	4.35	5.17	6.42	7.49	8.69
Warren	2.78	3.34	4.18	4.89	5.93	6.83	7.82

Notes: The average point rainfall amounts listed above were developed from data contained in NOAA Atlas 14 Volume 2.

Point rainfall estimates for specific locations may be obtained from the Precipitation Frequency Data Server located at http://www.nws.noaa.gov/ohd/hdsc/

For most hydrologic design procedures, the rainfall amounts listed above may be rounded to the nearest tenth of an inch.