DURMM v2
Example Plan – Commercial Site
Stormwater Management Report

For

DNREC
Div. of Watershed Stewardship
Sediment and Stormwater Program

Prepared by:

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August 2011

Effective April 2016

Table of Contents

Section 1 – Introduction

1.1 Project Description
- 1.1.1 "Approved" and Constructed (As-Built) Plan (DURMM v1)
- 1.1.2 DURMM v2 Model using Constructed/As-Built Stormwater Management Facilities
- 1.1.3 DURMM v2 Model using Redesigned Stormwater Management Facilities (to comply with new Sediment and Stormwater Regulations)

Section 2 – DURMM v2 Evaluation

2.1 "Approved" and Constructed (As-Built) Plan (DURMM v1)
- 2.1.1 Pre-Developed Conditions
- 2.1.2 Post-Developed Conditions
- 2.1.3 Stormwater Management

2.2 DURMM v2 Model using the Constructed/As-built Stormwater Management Facilities
- 2.2.1 Evaluation of As-Built Stormwater Management Facilities

2.3 DURMM v2 Model using Redesigned Stormwater Management Facilities
- 2.3.1 Evaluation of Stormwater Management Treatment Train

Section 3 – Project Summary

Section 4 – General Outlook of New Model (DURMM v2)

Appendices

Appendix 1 – Plan Sheets
Appendix 2 – "Approved" and Constructed (As-Built) Report and Plan (DURMM v1 & HydroCAD)
Appendix 3 – DURMM v2 Model using the Constructed/As-Built Stormwater Management Facilities
Appendix 4 – DURMM v2 HydroCAD Model using the Constructed/As-Built Stormwater Management Facilities
Appendix 5 – DURMM v2 Model using Redesigned Stormwater Management Facilities
Appendix 6 – DURMM v2 HydroCAD Model using Redesigned Stormwater Management Facilities
Appendix 7 – Checklist

Section 1 – Introduction

This report provides a comparative analysis of stormwater management (SWM) design for an existing commercial site that was approved and constructed under Delaware's existing Sediment and Stormwater Regulations and the same site designed using the Delaware Urban Runoff Management Model v2 (DURMM v2). This report presents a summary of the approved SWM design (DURMM v1) and detailed SWM design using DURMM v2. DURMM v2 references within this report refer to the latest version provided by DNREC at the generation of this report, DURMM_v2_beta_110802. The primary objective of this analysis was to identify stormmwater management and related site approach and design changes associated with the DURMM v2 and the revised Sediment and Stormwater regulations (versus the existing regulations). Specifically this report presents: a summary of the approved SWM design (DURMM v1); detailed stormwater management design using DURMM v2; evaluation of compliance with: runoff reduction; the Resource Protection Event (RPv), Conveyance Event (Cv) and Flood Event (Fv); a conceptual stormwater management design using DURMM v2 output; and a comparison of SWM design using DURMM v1 and DURMM v2.

1.1 Project Description

The previously approved SWM report and associated modeling results for this project are provided in Appendix 1 & 2 of this report. It provides all of the information regarding the original pre-post analysis of the site and the stormwater management approach utilized. The purpose of this project was to remove an existing 1,185 square foot office building and stone parking area and construct a 5,700 square foot two story office building and adjacent parking lot.

The soils information for the project is found in the USDA Soil Conservation Service Soil Survey for New Castle County, Delaware (1970). The site is mapped as having a small portion of Matapeake Silt Loam Series (MeB2), in soils group B, but the site is predominately the Elkton Silt Loam Series (EmA), in soils group C\D. The Elkton Silt Loam series is described as poorly drained and therefore, soils group D was used for that portion of the site to be conservative.

Three separate DURMM Modeling and design scenarios are presented:

- The "Approved" and Constructed (As-Built) Plan (DURMM v1);
- DURMM v2 Model using the Constructed/As-Built Stormwater Management Facilities; and
- DURMM v2 Model using Redesigned Stormwater Management Facilities (to comply with new Sediment and Stormwater Regulations)

1.1.1 "Approved" and Constructed (As-Built) Plan (DURMM v1)

Stormwater quality and quantity management of the plan previously approved for this site were achieved using a bioretention facility with an overflow storage area. The approved site plan can be found in appendix 1 and a detailed description of the facility design can be found in section 2.1.3 of this report.

Additional details of the approved SWM design are included in Appendix 1 and 2.

1.1.2 DURMM v2 Model using the Constructed/As-Built Stormwater Management Facilities

The post-development flows as presented in Table 2 were routed through the as-built bioretention area using DURMM v2. The model results were then reviewed to evaluate compliance with the following requirements as proposed in the new Sediment and Stormwater Regulations:

- Runoff Reduction;
- Resource Protection Event (RPv);
- Total Maximum Daily Loads (TMDLs);
    - Total Suspended Solids;
    - Total Nitrogen; and
    - Total Phosphorus.

The revised Cv and Fv runoff curve numbers (RCN's) generated in the DURMM v2 model were then used in new HydroCAD H&H model runs to establish allowable Cv and Fv discharge rates and storage requirements.

Sizing of the as-built stormwater management facility was then reviewed to evaluate its ability to safely contain and manage the runoff generated. In addition, the as-built facility originally utilized exfiltration as a component of the design, however the advent of the revised RCN for the Cv and Fv events is meant to account for infiltration taking place, so the exfiltration outlet was removed from the hydraulic model.

Results of the model indicated that the as-built stormwater management facilities met the RPv requirements but were inadequate to meet some of the TMDL requirements, and the Cv and Fv requirements for the entire site. In addition, the as-built facility did not nhave adequate storage to successfully manage the Fv storm event.

1.1.3 DURMM v2 Model using Redesigned Stormwater Management Facilities (to comply with new Sediment and Stormwater Regulations)

The final stage in the DURMMv2 analysis was to conceptualize what changes could be made to the site design to maximize the runoff reduction and to obtain compliance with the TMDL's for the site.

As with the previous scenario, the post-development flows as presented in Table 2 were routed through the as-built bioretention area using DURMM v2. Based on DURMM v2 model results, new stormwater management facilities were design to comply with the following requirements as proposed in the new Sediment and Stormwater Regulations:

- Runoff Reduction;
- Resource Protection Event (RPv);
- Total Maximum Dail Loads (TMDLs);

- Total Suspended Solids;
- Total nitrogen; and
- Total Phosphorus.

The new stormwater management approach and facilities consist of a treatment train of impervious disconnection, a filter strip, a biofiltration swale and a bioretention facility.

Similarly, the revised Cv and Fv runoff curve numbers (RCN's) generated in the DURMM v2 model were then used in new HydroCAD H&H model runs to establish allowable Cv and Fv discharge rates and storage requirements. As modeled in the previous scenario, the exfiltration outlet was removed from the hydraulic model.

Based on the allowable discharge rates and storage requirements, the new bioretention facility's storage volume was designed.

Section 2 – DURMM v2 and HydroCAD Modeling

2.1 "Approved" and Constructed (As-Built) Plan (DURMM v1)

Stormwater quality and quantity management were achieved using a bioretention facility with an overflow storage area. The bioretention facility was designed in accordance with the criteria set forth in the Delaware Urban Runoff Management Model (DURMM v1).

2.1.1 Pre-Developed Conditions

There are four major points of analysis for the pre-developed site (Refer to associated plan sheets in Appendix 1). The site is relatively flat and has a slight ridge in the center splitting the site into four areas draining to each side of the property. There is an existing 1,185 square foot building, driveway and stone parking area covering most of the site. There is little off-site drainage contributing to this project site.

All stormwater management calculations were performed using methods outlined in the SCS Publication on Urban Hydrology for Small Watersheds, Technical Release 55, (TR-55) and computed by HydroCAD software. The approved detailed stormwater report is presented in Appendix 2.

Table 1 illustrates the peak discharge runoff rates and volume for the 2, 10 and 100 year storm events in the pre-developed conditions evaluated for each subarea and at the four main points of analysis on the site.

Table 1 – Pre-Development Summary

	2 year		10 year		100 year	
Analysis Point	**Q (cfs)**	**V (ac-ft)**	**Q (cfs)**	**V (ac-ft)**	**Q (cfs)**	**V (ac-ft)**
1	0.58	0.041	1.13	0.079	2.29	0.163
2	0.04	0.002	0.08	0.004	0.16	0.008
3	0.14	0.007	0.28	0.014	0.58	0.029
4	0.84	0.041	1.58	0.077	3.13	0.158

2.1.2 Post-Developed Conditions

The post-development site will have three major points of analysis. The majority of runoff from the post-developed site discharges to Analysis Point #1 (Refer to associated plan sheets in Appendix 1). Runoff to all other analysis points WAS significantly reduced or eliminated in post-development. The existing building and stone parking area was removed and replaced by the 5,700 square foot building and adjacent paved parking lot. Runoff from the post-development site will be in the form of sheet flow and discharge to a proposed bioretention area (Post-Development Drainage Plan – Appendix 1).

The bioretention area will discharge through a traditional outlet structure which ties into a proposed drainage inlet at Analysis Point #1. The existing inlet will be removed because its location interferes with the new entrance and conflicts with the waterline. Subarea 2

and Subarea 3 will discharge to the existing Analysis Points #2 and #3 respectively. The area originally discharging to Analysis Point #4 will be discharging to the new drainage inlet at Analysis Point #1.

Table 2 illustrates the peak discharge runoff rates and volume for the 2, 10 and 100 year storm events in the post-developed conditions evaluated for each subarea and at the points of analysis on the site. The post-development calculations can be found in Appendix B of this report. The approved detailed stormwater report is presented in Appendix 2.

Table 3 – Post-Development Summary						
	2 year		10 year		100 year	
Analysis Point	Q (cfs)	V (ac-ft)	Q (cfs)	V (ac-ft)	Q (cfs)	V (ac-ft)
1	0.38	0.113	0.82	0.195	2.14	0.363
3	0.14	0.007	0.26	0.013	0.52	0.026
4	0.11	0.005	0.22	0.011	0.44	0.022

2.1.3 Stormwater Management

Stormwater quality and quantity management were achieved using a bioretention facility with an overflow storage area (Post-Development Drainage Plan – Appendix 1). The bioretention facility was designed in accordance with the criteria set forth in the Delaware Urban Runoff Management Model (DURMM v1). The bioretention facility is capable of infiltrating the entire quality storm (2” rainfall event), thus meeting the requirement of reducing the total suspended solids by 80%, and is designed to drain completely within 48 hours. The bioretention facility has an overflow storage area to provide quantity management and volume control for larger storm events. The outlet structure is a modified concrete inlet box which connects to the existing 30” storm drain located in the street adjacent to the site.

The bioretention facility is capable of safely conveying the 100 year storm in the event that the outlet structure becomes completely clogged and the emergency spillway acts as the sole means of discharge from the facility.

2.2 DURMM v2 Model using the Constructed/As-Built Stormwater Management Facilities

The as-built site bioretention facility and drainage conditions as shown on the Post-Develeopment Drainage Plan in Appendix 1 were evaluated in this scenario to determine if as-built conditions meet the new stormwater requirements. DURMM v2 was used to develop RPv, Cv and Fv values for each of the four subareas (Appendix 3). For the runoff that is not infiltrated and will have to be managed for the Cv and Fv, HydroCAD runs where then performed using adjusted CV and Fv RCN values (Appendix 4). DURMM v2 and HydroCAD model output are summarized in Tables 3 and 4.

Table 3 – DURMM v2 Summary					
	SubArea 1	SubArea 3	SubArea 4	SubArea 5	
Site Data					
Contributing area to BMPs (ac.)	0.58	0.056	0.047	0.082	
C.A. RCN	89	80	80	86	
Subarea LOD (ac)	0.58	0.056	0.047	0.0385	
TMDL-TN (lbs/ac/yr)	5.70	5.70	5.70	5.70	
TMDL-P (lbs/ac/yr)	0.35	0.35	0.35	0.35	
TMDL-TSS (lbs/ac/yr)	N/A	N/A	N/A	N/A	
BMP Selection	Bio-retention	Impervious Disconnection	Impervious Disconnection	Imperv. Disconn.	Filter Strip
Resource Protection Event (RPv)					
RPv for contributing area	1.90	1.39	1.41	1.73	
Required Rpv Reduction for contributing area (in)	0.56	0.06	0.04	0.42	
Required Rpv Reduction for contributing area (%)	29%	5%	3%	24%	
C.A. allowable discharge rate (cfs)	0.05	0.00	0.00	0.00	
Unmanaged pollutant load, TN (lbs/ac/yr)	12.03	8.30	8.44	10.81	
Unmanaged pollutant load, TP (lbs/ac/yr)	1.62	1.12	1.14	1.46	
Unmanaged pollutant load, TSS (lbs/ac/yr)	361	249	253	324	
BMP Reduction Performance					
RPv runoff volume after all reductions (in)	0.49	1.27	1.29	1.58	1.38
Total RPv runoff reduction (in)	1.42	0.12	0.12	0.14	0.34
Total RPv runoff reduction (%)	74%	9%	95	8%	0.20
Required runoff reduction met?	YES	YES	YES	NO	NO
BMP TMDL Performance					
Adjusted pollutant load, TN (lbs/ac/yr)	4.81	7.47	7.59	9.73	8.27
Required TN reduction met?	YES	NO	NO	NO	NO
Adjusted pollutant load, TP (lbs/ac/yr)	0.81	1.01	1.02	1.31	1.12
Required TP reduction met?	NO	NO	NO	NO	NO
Adjusted pollutant load, TSS (lbs/ac/yr)	92	224	228	292	248
Required Tss reduction met?	YES	YES	YES	YES	YES
Offset Requirements					
RPv offset (cu. Ft)	N/A	N/A	N/A	82	22
Conveyance Event (Cv)					
Cv runoff volume (in)	3.58	2.72	2.75	3.31	
Stds-based allowable discharge (cfs)	0.44	0.04	0.04		
BMP Performance					
Cv runoff volume after all reductions (in)	0.78	2.66	2.70	3.24	3.18
Flooding Event (Fv)					
Fv runoff volume (in)	6.68	5.63	5.67	6.36	
Stds-based allowable discharge (cfs)	1.31	0.12	0.11		
BMP Performance					
Fv runoff volume after all reductions (in)	3.88	5.63	5.67	6.36	6.36
Adjusted Subarea Data for Downstream DURMM Modeling					
Contributing area (AC)	0.58	0.06	0.05	0.08	
C.A. RCN	89	80	80	86	
LOD area (ac)	0.59	0.06	0.05	0.04	
Weighted Target Runoff (in)	1.35	1.32	1.37	0.66	
Adjusted CN after all reductions	58.70	77.63	77.98	79.91	
Adjusted RPv (in)	0.49	1.27	1.29	1.48	
Adjusted Cv (in)					
Adjusted Fv (in)					
Adjusted Subarea Data for H&H Modeling					

Effective April 2016

Resource Protection Event				
Rain (in)	2.7	2.7	2.7	2.7
RCN	N/A	N/A	N/A	N/A
Conveyance Event				
Rain (in)	4.8	4.8	4.8	4.8
RCN	53.16	79.39	79.75	84.92
Flooding Event				
Rain (in)	8.0	8.0	8.0	8.0
RCN	64.91	80	80.36	86.27

Table 4 – HydroCAD Summary								
	SubArea 1		SubArea 3		SubArea 4		SubArea 5	
	Runoff							
	Q (cfs)	Vol Ac ft	Q cfs	Vol Ac ft	Q Cfs	Vol Ac ft	Q cfs	Vol Ac ft
Conveyance Event (Cv)								
Adjusted RCN at Analysis Point	0.50	0.022	0.26	0.012	0.23	0.011	-	-
Allowable Discharge (DURMM v2)	0.44		0.04		0.04		-	-
Meets Allowable Discharge?	NO		NO		NO			
Flooding Event (Fv)								
Adjusted RCN at Analysis Point	1.18	0.190	0.54	0.026	0.45	0.022	-	-
Allowable Discharge (DURMM v2)	1.31		0.12		0.11		-	-
Meets Allowable Discharge?	YES		NO		NO			

2.21 Evaluation of As-Built Stormwater Management Facilities

Subarea 1 - The Bioretention facility in Subarea 1 was able to meet runoff reduction, TN reduction and TSS reduction requirements. TP reduction was not met. Cv discharge rates are above allowable rates as calculated by DURMM v2. Fv discharge rates are acceptable rates as calculated by DURMM v2.

Subarea 3 – Due to the relatively small size of this subarea, impervious disconnection was the only feasible BMP. Impervious ddisconnection in this subarea met the runoff reduction and TSS reduction requirements but not the TN reduction and TP reduction requirements. Cv and Fv discharge rates are above allowable rates as calculated by DURMM v2.

SubArea 4 – Like Subarea 3, due to the relatively small size of this subarea, impervious disconnection was the only feasible BMP. Impervious ddisconnection in this subarea met the runoff reduction and TSS reduction requirements but not the TN reduction and TP reduction requirements. Cv and Fv discharge rates are above allowable rates as calculated by DURMM v2.

Subarea 5 – The size and orientation of this subarea allowed for the design impervious disconnection and a filter strip. These BMPs met the TSS reduction requirements, but did not meet the runoff reduction, TN reduction or TP reduction requirements. Cv and Fv discharge rates are above allowable rates as calculated by DURMM v2.

2.3 DURMM v2 Model using Redesigned Stormwater Management Facilities (to comply with new Sediment and Stormwater Regulations)

In this scenario, the site was redesigned to eliminate the small subareas areas that drain off-site. Accordingly, the site was regraded to allow all stormwater runoff to flow to one analysis point. (Refer to the plan sheets in Appendix 1). This is a significant design change that would require the import of fill material. Stormwater management was designed using a treatment train of impervious disconnection, a filter strip, a biofiltration swale and a bioretention facility.

DURMM v2 was used to develop RPv, Cv and Fv values (Appendix 5). For runoff that is not infiltrated and will have to be managed for the Cv and Fv, HydroCAD runs where then performed using adjusted CV and Fv RCN values (Appendix 6). DURMM v2 and HydroCAD model output are summarized in Tables 5 and 6.

Table 5 – DURMM v2 Summary				
	SubArea 1			
Site Data				
Contributing area to BMPs (ac.)	0.68			
C.A. RCN	88			
Subarea LOD (ac)	0.683			
TMDL-TN (lbs/ac/yr)	5.70			
TMDL-P (lbs/ac/yr)	0.35			
TMDL-TSS (lbs/ac/yr)	N/A			
BMP Selection	Impervious Disconnection	Filter Strip	Biofiltration	Bioretention
Resource Protection Event (RPv)				
RPv for contributing area	1.82			
Required Rpv Reduction for contributing area (in)	0.47			
Required Rpv Reduction for contributing area (%)	26%			
C.A. allowable discharge rate (cfs)	0.05			
Unmanaged pollutant load, TN (lbs/ac/yr)	11.42			
Unmanaged pollutant load, TP (lbs/ac/yr)	1.54			
Unmanaged pollutant load, TSS (lbs/ac/yr)	343			
BMP Reduction Performance				
RPv runoff volume after all reductions (in)	1.66	1.45	1.13	0.00
Total RPv runoff reduction (in)	0.16	0.37	0.69	1.82
Total RPv runoff reduction (%)	9%	0.21	0.38	1.00
Required runoff reduction met?	NO	NO	YES	YES
BMP TMDL Performance				
Adjusted pollutant load, TN (lbs/ac/yr)	10.28	8.74	6.55	2.62
Required TN reduction met?	NO	NO	NO	YES
Adjusted pollutant load, TP (lbs/ac/yr)	1.39	1.18	0.88	0.44
Required TP reduction met?	NO	NO	NO	NO
Adjusted pollutant load, TSS (lbs/ac/yr)	308	262	197	74
Required Tss reduction met?	YES	YES	YES	YES
Offset Requirements				
RPv offset (cu. Ft)	768	249	N/A	N/A
Conveyance Event (Cv)				
Cv runoff volume (in)	3.44			
Stds-based allowable discharge (cfs)	0.51			
BMP Performance				
Cv runoff volume after all reductions (in)	3.37	3.31	3.14	0.77

Effective April 2016

Flooding Event (Fv)				
Fv runoff volume (in)	6.52			
Stds-based allowable discharge (cfs)	1.53			
BMP Performance				
Fv runoff volume after all reductions (in)	6.52	6.52	6.46	4.08
Adjusted Subarea Data for Downstream DURMM Modeling				
Contributing area (AC)	0.68			
C.A. RCN	88			
LOD area (ac)	0.68			
Weighted Target Runoff (in)	1.35			
Adjusted CN after all reductions	32.37			
Adjusted RPv (in)	0.00			
Adjusted Cv (in)				
Adjusted Fv (in)				
Adjusted Subarea Data for H&H Modeling				
Resource Protection Event				
Rain (in)	2.7			
RCN	N/A			
Conveyance Event				
Rain (in)	4.8			
RCN	52.91			
Flooding Event				
Rain (in)	8.0			
RCN	66.67			

Table 6 – HydroCAD Summary		
	SubArea 1	
	Runoff	
	Q (cfs)	Vol Ac ft
Conveyance Event (Cv)		
Adjusted RCN at Analysis Point	0.44	0.025
Allowable Discharge (DURMM v2)	0.51	
Meets Allowable Discharge?	YES	
Flooding Event (Fv)		
Adjusted RCN at Analysis Point	1.19	0.236
Allowable Discharge (DURMM v2)	1.53	
Meets Allowable Discharge?	YES	

2.3.1 Evaluation of Stormwater Management Treatment Train

The impervious disconnection, a filter strip, a biofiltration swale and a bioretention facility stormwater treatment met the runoff reduction, TN reduction and TSS reduction requirements. The treatment train did not meet the TP reduction requirements. Cv and Fv discharge rates are acceptable rates as calculated by DURMM v2.

Section 3 – Project Summary

In its current configuration and with the approved/as-built stormwater management facilities (bioretention), the approved site can not meet all of the runoff, TN, TP and TSS reduction requirements of the new sediment and stormwater regulations (DURMM v2 methodology). The

Effective April 2016

primary reasons for non-compliance are the three small subareas for which adequate BMPs can not be implemented.

Using the DURMM v2 design methodology, the following site drainage and stormwater management modifications would have to be made to bring the site into compliance, with the exception of Total Phosphorous, with the new sediment and stormwater regulations:

- The site would have to be regarded to direct all runoff through a water quality treatment train;
- The as-built bioretention facility is adequately sized, however, impervious disconnection, a filter strip and a biofiltration swale would have to be added to the stormwater management treatment train (see Appendix 1 – Post Development Drainage Plan).

As presented in Tables 5 and 6, the impervious disconnection, filter strip, biofiltration swale and bioretention facility treatment train accomplishes the required runoff reduction, TN reduction and TSS reduction. In addition, bioretention facility discharge rates are below the allowable discharge rates identified in the DURMM v2 model. The treatment train did not meet the required TP reduction.

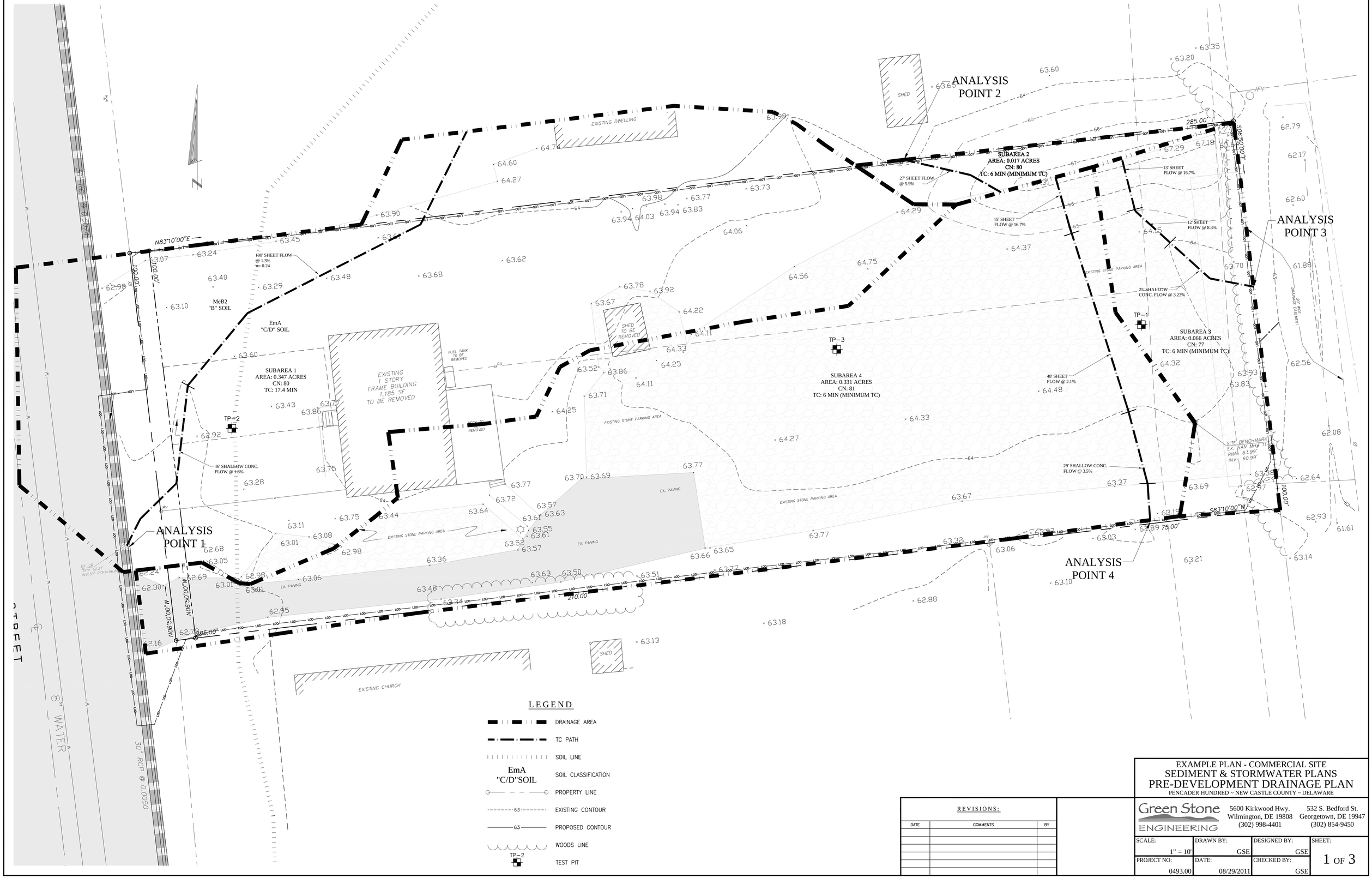
Section 4 – General Outlook of New Model (DURMM v2)

In general, the DURMM v2 model appears to be logical, more user friendly and more transparent than DURMM v1. There were a number of "glitches' in the model that we addressed during the period of this contract.

There does not appear to be documentation of the nutrient or TSS removal rates for the various BMPs that can be used in the model.

Appendix 1

Plan Sheets



EXAMPLE PLAN - COMMERCIAL SITE
SEDIMENT & STORMWATER PLANS
PRE-DEVELOPMENT DRAINAGE PLAN
PENCADER HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

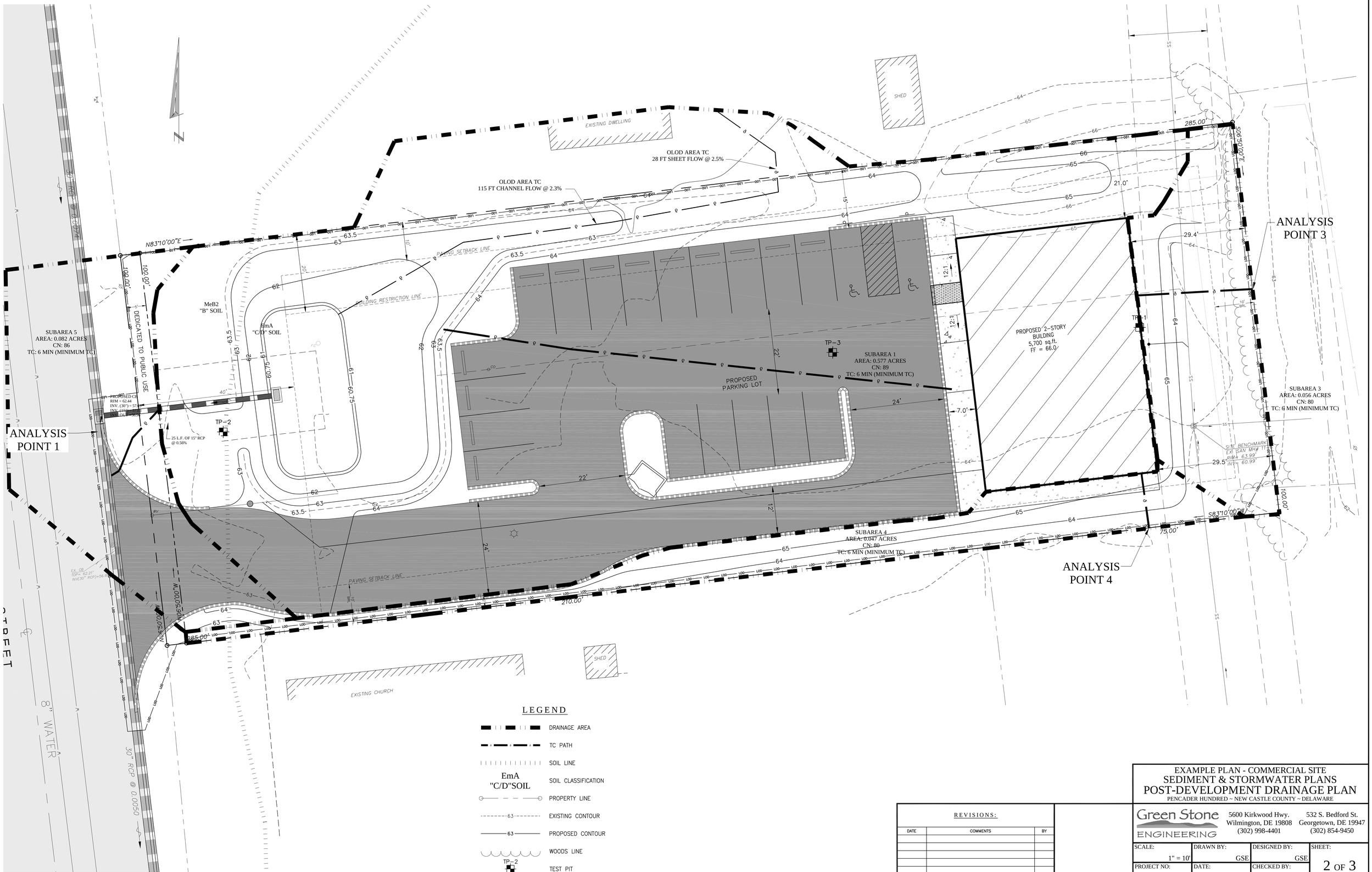
REVISIONS:

DATE	COMMENTS	BY

Green Stone ENGINEERING
5600 Kirkwood Hwy.
Wilmington, DE 19808
(302) 998-4401
532 S. Bedford St.
Georgetown, DE 19947
(302) 854-9450

SCALE:	DRAWN BY:	DESIGNED BY:	SHEET:
1" = 10'	GSE	GSE	1 OF 3
PROJECT NO: 0493.00	DATE: 08/29/2011	CHECKED BY: GSE	

Effective April 2016



LEGEND

	DRAINAGE AREA
	TC PATH
	SOIL LINE
EmA "C/D"SOIL	SOIL CLASSIFICATION
	PROPERTY LINE
63	EXISTING CONTOUR
63	PROPOSED CONTOUR
	WOODS LINE
TP-2	TEST PIT

EXAMPLE PLAN - COMMERCIAL SITE
SEDIMENT & STORMWATER PLANS
POST-DEVELOPMENT DRAINAGE PLAN
PENCADER HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

REVISIONS:

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SCALE:	DRAWN BY:	DESIGNED BY:	SHEET:
1" = 10'	GSE	GSE	2 OF 3
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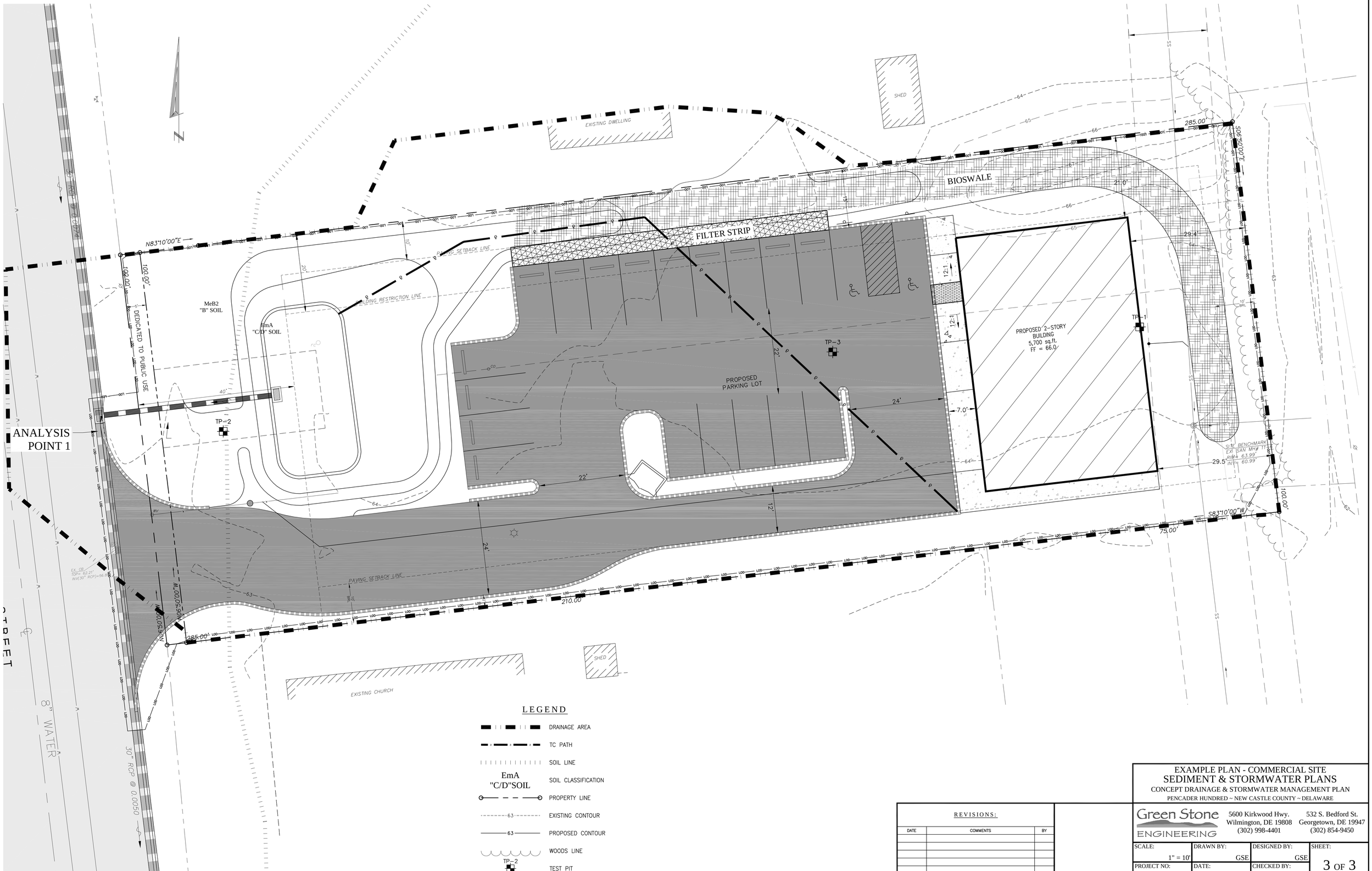

LEGEND

	DRAINAGE AREA
	TC PATH
	SOIL LINE
EmA "C/D"SOIL	SOIL CLASSIFICATION
	PROPERTY LINE
63	EXISTING CONTOUR
63	PROPOSED CONTOUR
	WOODS LINE
TP-2	TEST PIT

EXAMPLE PLAN - COMMERCIAL SITE
SEDIMENT & STORMWATER PLANS
CONCEPT DRAINAGE & STORMWATER MANAGEMENT PLAN
PENCADER HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

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SCALE:	DRAWN BY:	DESIGNED BY:	SHEET:
1" = 10'	GSE	GSE	3 OF 3
PROJECT NO: 0493.00	DATE: 08/29/2011	CHECKED BY: GSE	

Appendix 2

"Approved" and Constructed (As-Built) Report and Plan (DURMM v1 & HydroCAD)

Stormwater Management Report

For

Example Plan – Commercial Site

Prepared by:

Green Stone
ENGINEERING
5600 Kirkwood Highway
Wilmington, DE 19808

December 2007
Revised February 2008

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Table of Contents

I. Project Description
II. Pre-Developed Conditions
III. Post-Developed Conditions
IV. Stormwater Management Design
V. Erosion & Sediment Control

Figure 1 – Aerial

Figure 2 – USGS Map

Figure 3 – Soils Map

Figure 4 – 1954 Aerial

Appendix A – Pre-Development Calculations

Appendix B – Post-Development Calculations

Appendix C – Post-Development Calculations with Outlet Structure Blocked

Appendix D – Post-Development Calculations with Sediment Trap

Appendix E – Soils Investigation

Appendix F – Drainage Area Plan

I. Project Description

The purpose of this project is to remove an existing 1,185 square foot office building and stone parking area and construct a 5,700 square foot two story office building and adjacent parking lot in New Castle County, Delaware. The site is located on [redacted]

The soils information for the project is found in the USDA Soil Conservation Service Soil Survey for New Castle County, Delaware (1970). The site is mapped as having a small portion of Matapeake Silt Loam Series (MeB2), in soils group B, but the site is predominately the Elkton Silt Loam Series (EmA), in soils group C\D. The Elkton Silt Loam series is described as poorly drained and therefore, soils group D was used for that portion of the site to be conservative.

II. Pre-Developed Conditions

There are four major points of analysis for the pre-developed site. The site is relatively flat and has a slight ridge in the center splitting the site into four areas draining to each side of the property. There is an existing 1,185 square foot building, driveway and stone parking area covering most of the site. There is little off-site drainage contributing to this project site.

Most of the existing building and the western portion of the site make up Subarea 1 which discharges to Analysis Point 1 at the existing inlet on [redacted]. The northeastern portion of the site consisting of grass and a small amount of stone makes up Subarea 2 which discharges to the adjacent residential property to the north at Analysis Point 2. Subarea 3 is the most easterly portion of the site and discharges to the wooded area to the east at analysis point 3. Subarea 4 discharges to the adjacent church property to the south at Analysis point 4. Subarea 4 consists of the majority of the stone parking area and existing paving.

All stormwater management calculations were performed using methods outlined in the SCS Publication on Urban Hydrology for Small Watersheds, Technical Release 55, (TR-55) and computed by HydroCAD software. A curve number of 98 was used for all impervious area including the stone area. Based on comments from New Castle County, the 1954 aerials were used to generate curve numbers in the pre-development analysis because most of the current paving existed legally prior to adoption of the zoning code. A copy of the 1954 aerial is included as Figure 4 in this report. The curve numbers and time of concentration path calculations for each of the pre-development points of analysis, including peak discharge rates and volume, are included in Appendix A. The minimum time of concentration value of 6 minutes was used in Subareas 2, 3 and 4.

The table below illustrates the peak discharge runoff rates and volume for the 2, 10 and 100 year storm events in the pre-developed conditions evaluated for each subarea and at the four main points of analysis on the site.

Effective April 2016

Pre-Development Summary

	2 year		10 year		100 year	
Analysis Point	**Q (cfs)**	**V (ac-ft)**	**Q (cfs)**	**V (ac-ft)**	**Q (cfs)**	**V (ac-ft)**
1	0.58	0.041	1.13	0.079	2.29	0.163
2	0.04	0.002	0.08	0.004	0.16	0.008
3	0.14	0.007	0.28	0.014	0.58	0.029
4	0.84	0.041	1.58	0.077	3.13	0.158

III. Post-Developed Conditions

The post-development site will have three major points of analysis. The majority of runoff from the post-developed site will discharge to Analysis Point #1. Runoff to all other analysis points will be significantly reduced or eliminated in post-development. The existing building and stone parking area will be removed and replaced by the 5,700 square foot building and adjacent paved parking lot.

A curve number of 98 will be used for all impervious surfaces, including the road. Runoff from the post-development site will be in the form of sheet flow and discharge to a proposed bioretention area in the front of the site near [redacted]. A curb waiver is hereby requested along the north and western sides of the parking lot to promote drainage in the form of sheet flow to the proposed stormwater facility.

The bioretention area will discharge through a traditional outlet structure which ties into a proposed drainage inlet on [redacted] at Analysis Point #1. The existing inlet will be removed because its location interferes with the new entrance and conflicts with the waterline. Subarea 2 and Subarea 3 will discharge to the existing Analysis Points #2 and #3 respectively. The area originally discharging to Analysis Point #4 will be discharging to the new drainage inlet at Analysis Point #1.

The table below illustrates the peak discharge runoff rates and volume for the 2, 10 and 100 year storm events in the post-developed conditions evaluated for each subarea and at the points of analysis on the site. The post-development calculations can be found in Appendix B of this report.

Post-Development Summary

	2 year		10 year		100 year	
Analysis Point	**Q (cfs)**	**V (ac-ft)**	**Q (cfs)**	**V (ac-ft)**	**Q (cfs)**	**V (ac-ft)**
1	0.38	0.113	0.82	0.195	2.14	0.363
% Increase	-34%	176%	-27%	147%	-7%	123%
3	0.14	0.007	0.26	0.013	0.52	0.026
% Increase	0%	0%	-7%	-7%	-10%	-10%
4	0.11	0.005	0.22	0.011	0.44	0.022
% Increase	-87%	-88%	-86%	-86%	-86%	-86%

Effective April 2016

IV. Stormwater Management Design

Stormwater quality and quantity management will be achieved using a bioretention facility with an overflow storage area. The application of green technology best management practices will be utilized through the use of the bioretention facility, which will be designed in accordance with the criteria set forth in the Delaware Urban Runoff Management Model (DURMM). The bioretention facility will infiltrate the entire quality storm event to meet the requirement of reducing the total suspended solids by 80%. The 2" rainfall event was used for the quality storm event in accordance with the State Stormwater Regulations.

The bioretention facility will have an overflow storage area to provide quantity management and volume control for larger storm events. The outlet structure will be a modified concrete inlet box which connects to the existing storm system on [redacted]. The existing storm sewer system on [redacted] is a 30" concrete pipe and appears to be free of sedimentation and in good condition.

For an additional level of safety, calculations have also been provided to demonstrate that the bioretention facility can safely convey the 100 year storm in the event that the outlet structure becomes completely clogged and the emergency spillway acts as the sole means of discharge from the facility. The calculations can be found in Appendix C of this report.

During a geotechnical exploration of the site, three test pits were excavated and field infiltration testing was performed at the three locations shown on the attached Drainage Area Plan. The three locations (MW-1, 2, and 3) evaluated for infiltration potential each had an infiltration rate of 1.4 inches per hour with a depth to groundwater of 5.7 feet below existing grade. The State Sediment and Stormwater Regulations require that infiltration practices be limited to soils having an infiltration rate of at least 1.02 inches per hour. The design guidelines set forth in the State Sediment and Stormwater Regulations state that the design infiltration rate for an infiltration facility shall have a factor of safety of 2.0 based on the measured infiltration rate. The bioretention facility is designed to drain completely within 48 hours.

It is the intent of the owner to occupy the existing building until construction of the new office building is completed. The proposed bioretention facility will be located in the front of the existing building and will be used as a sediment trap during construction. Final conversion of the overflow storage area for the bioretention facility will occur after the remaining site work has been completed. Inspection and maintenance guidelines for the proposed bioretention facility are included on the sediment and stormwater plans for this project.

VI. Erosion and Sediment Control

The project will be constructed in a single phase, disturbing less than the maximum allowable twenty (20) acres. Erosion and Sediment Control practices will include the standard accepted practices from the Delaware Erosion and Sediment Control Handbook. The standard notes and details are included on the detail sheet of the Sediment and Stormwater Plans, and the locations of the individual practices are shown on the E&S Plan. Any dewatering necessary for

Effective April 2016

construction of the stormwater management facility or utility installations will be done through a dirt bag.

The bioretention facility will be used as temporary sediment trap during site construction. The sediment basin was designed such that the 100 year runoff from the site, assuming the site to be in bare soil, can pass safely through the basin. These supplemental calculations can be found in Appendix D of this report.

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FIGURE 1
EXAMPLE OFFICE BUILDING
AERIAL
SCALE 1" = 100'±

Green Stone
ENGINEERING

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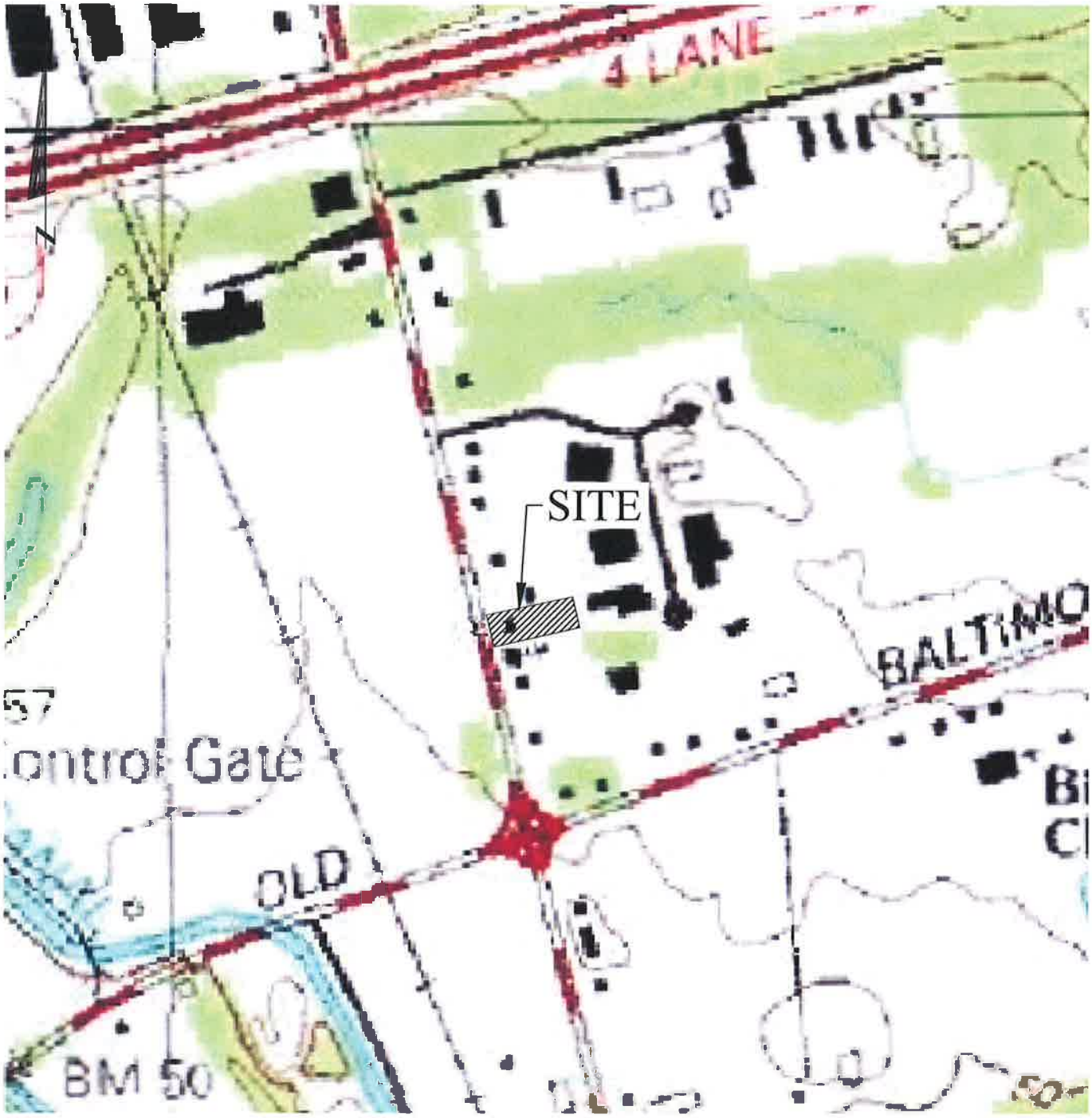

FIGURE 2

EXAMPLE OFFICE BUILDING

USGS MAP

SCALE 1" = 500'±

Green Stone ENGINEERING

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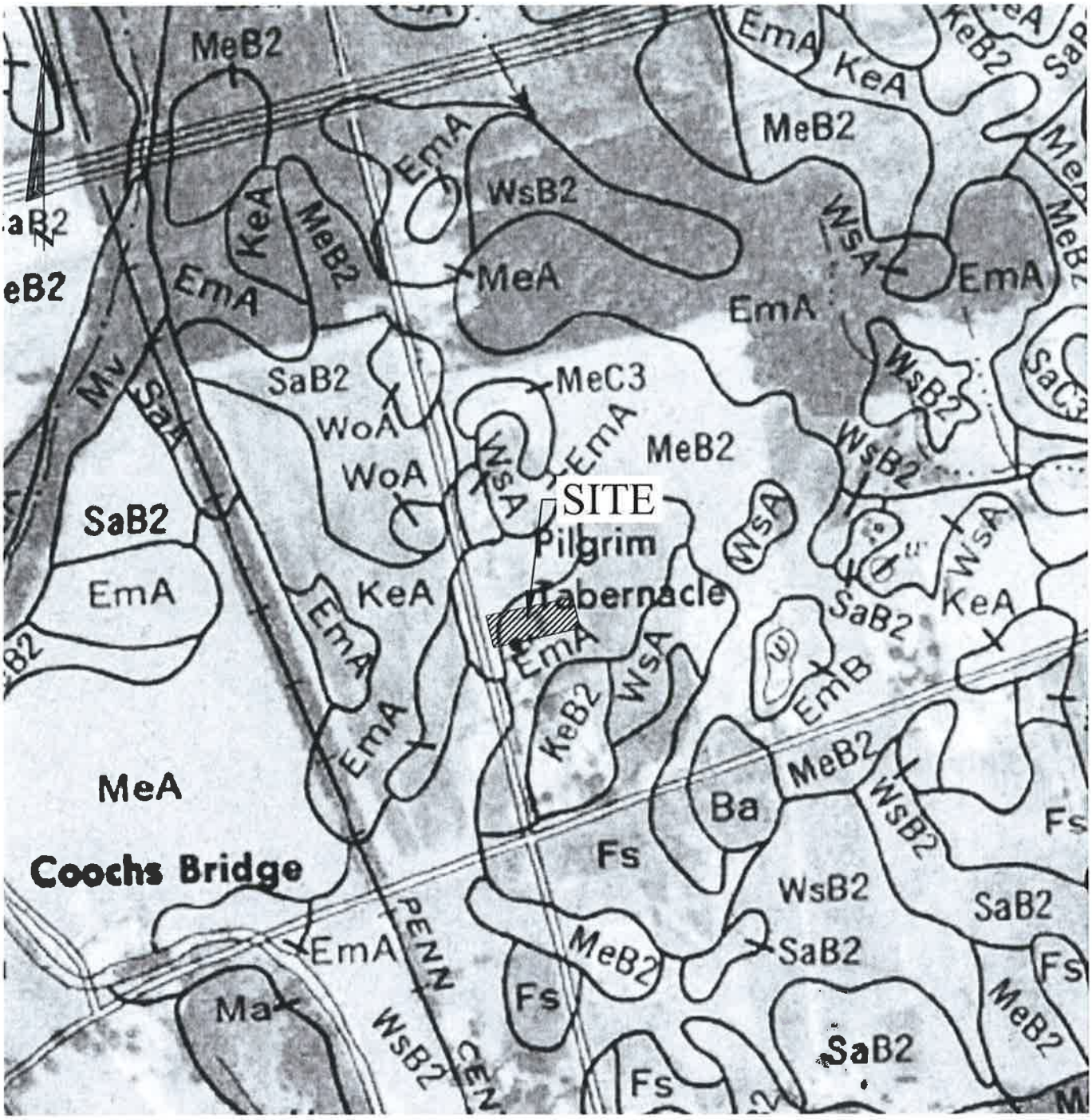

FIGURE 3

EXAMPLE OFFICE BUILDING

SOILS MAP

SCALE 1" = 500'±

Green Stone ENGINEERING

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FIGURE 4

EXAMPLE OFFICE BUILDING

1954 AERIAL

SCALE 1" = 500'±

Green Stone ENGINEERING

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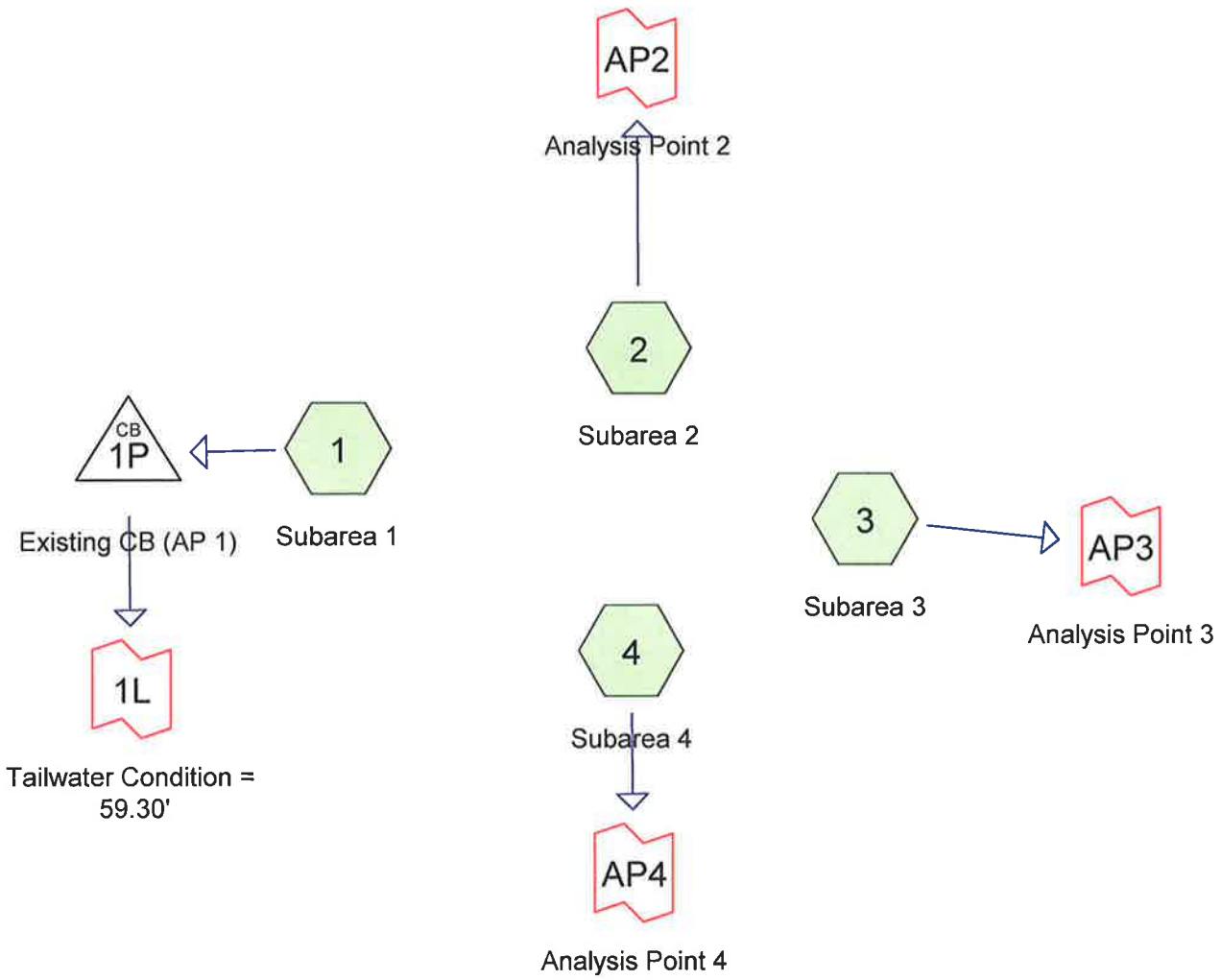

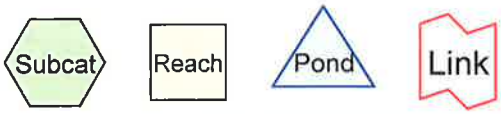

Drainage Diagram for 0348-Pre Dev
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

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Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.347 ac Runoff Depth=1.40"
Flow Length=146' Tc=17.4 min CN=80 Runoff=0.58 cfs 0.041 af

Subcatchment 2: Subarea 2 Runoff Area=0.017 ac Runoff Depth=1.40"
Tc=6.0 min CN=80 Runoff=0.04 cfs 0.002 af

Subcatchment 3: Subarea 3 Runoff Area=0.066 ac Runoff Depth=1.21"
Tc=6.0 min CN=77 Runoff=0.14 cfs 0.007 af

Subcatchment 4: Subarea 4 Runoff Area=0.331 ac Runoff Depth=1.47"
Tc=6.0 min CN=81 Runoff=0.84 cfs 0.041 af

Pond 1P: Existing CB (AP 1) Peak Elev=62.26' Inflow=0.58 cfs 0.041 af
Outflow=0.58 cfs 0.041 af

Link 1L: Tailwater Condition = 59.30' Inflow=0.58 cfs 0.041 af
Primary=0.58 cfs 0.041 af

Link AP2: Analysis Point 2 Inflow=0.04 cfs 0.002 af
Primary=0.04 cfs 0.002 af

Link AP3: Analysis Point 3 Inflow=0.14 cfs 0.007 af
Primary=0.14 cfs 0.007 af

Link AP4: Analysis Point 4 Inflow=0.84 cfs 0.041 af
Primary=0.84 cfs 0.041 af

Total Runoff Area = 0.761 ac Runoff Volume = 0.090 af Average Runoff Depth = 1.41"

Subcatchment1: Subarea 1

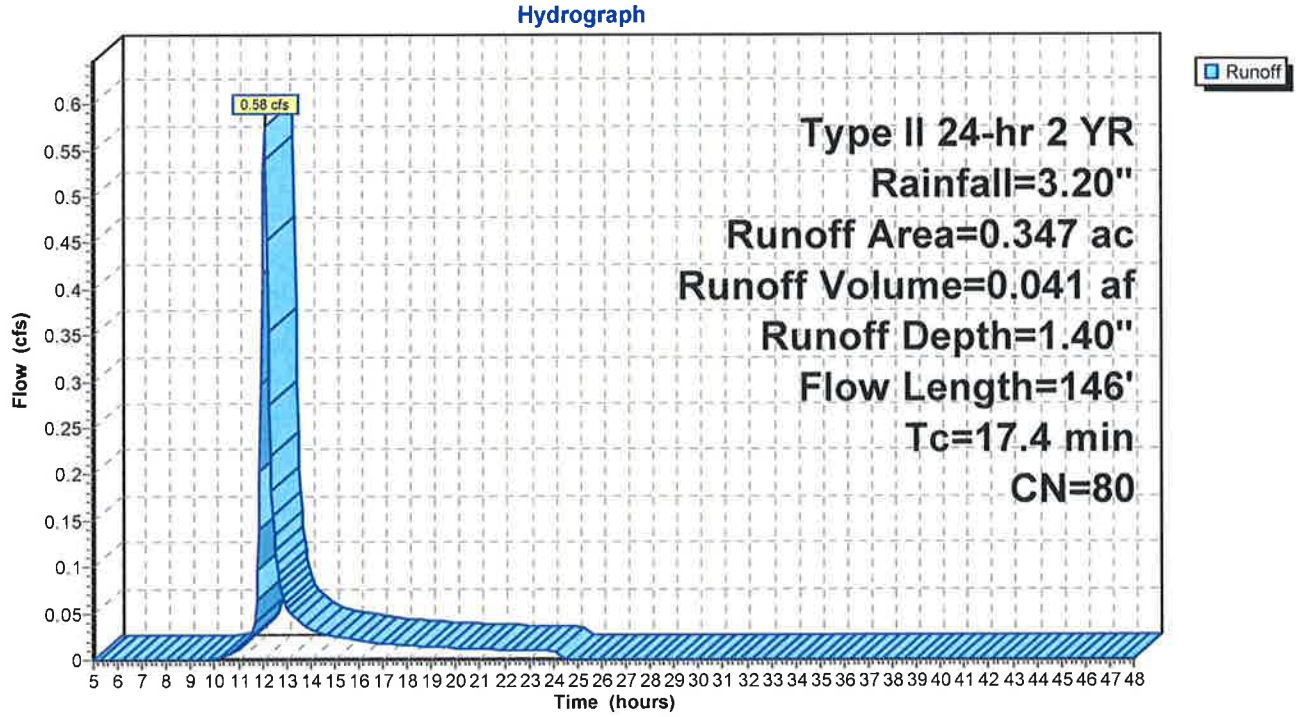
Runoff = 0.58 cfs @ 12.10 hrs, Volume= 0.041 af, Depth= 1.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.071	98	Paved parking & roofs
0.215	80	>75% Grass cover, Good, HSG D
0.061	61	>75% Grass cover, Good, HSG B
0.347	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.0	100	0.0130	0.1		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.20"
0.4	46	0.0180	2.2		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.4	146	Total			

Subcatchment1: Subarea 1



Subcatchment 2: Subarea 2

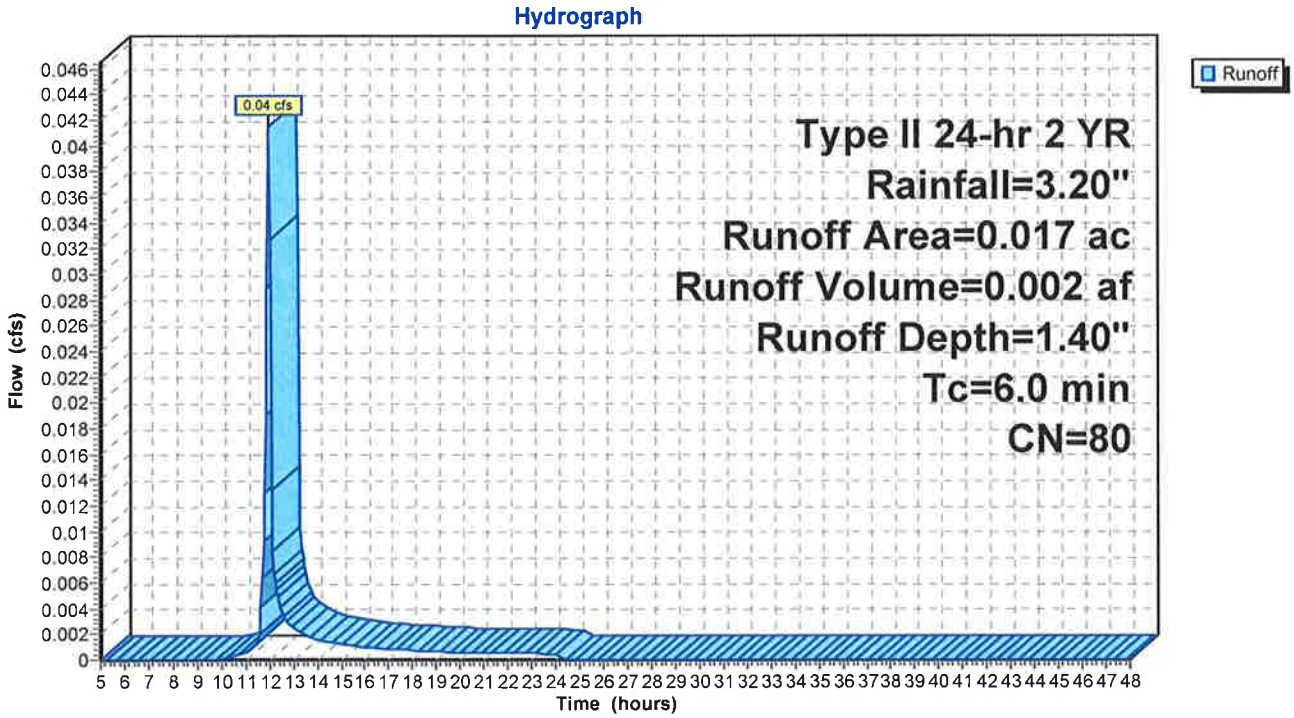
Runoff = 0.04 cfs @ 11.98 hrs, Volume= 0.002 af, Depth= 1.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.017	80	>75% Grass cover, Good, HSG D

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

Subcatchment 2: Subarea 2



Subcatchment3: Subarea 3

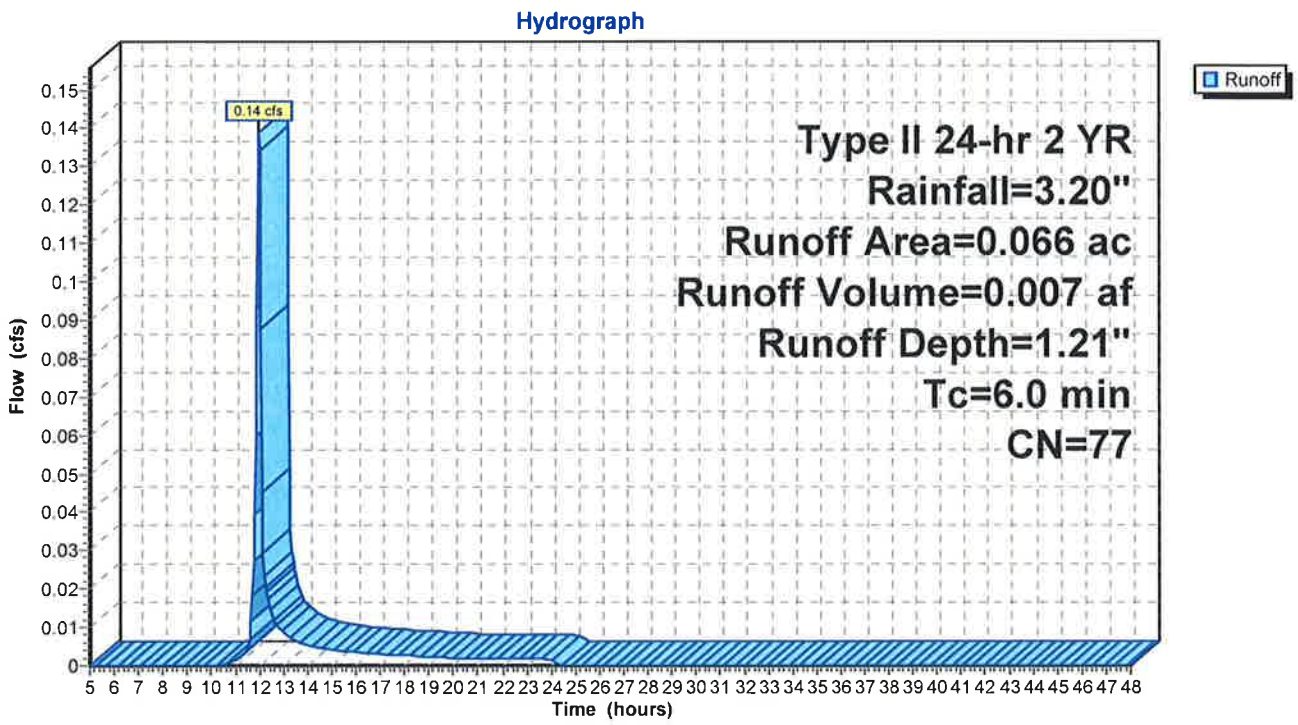
Runoff = 0.14 cfs @ 11.98 hrs, Volume= 0.007 af, Depth= 1.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.006	80	>75% Grass cover, Good, HSG D
0.060	77	Woods, Good, HSG D
0.066	77	Weighted Average

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

Subcatchment3: Subarea 3



Subcatchment4: Subarea 4

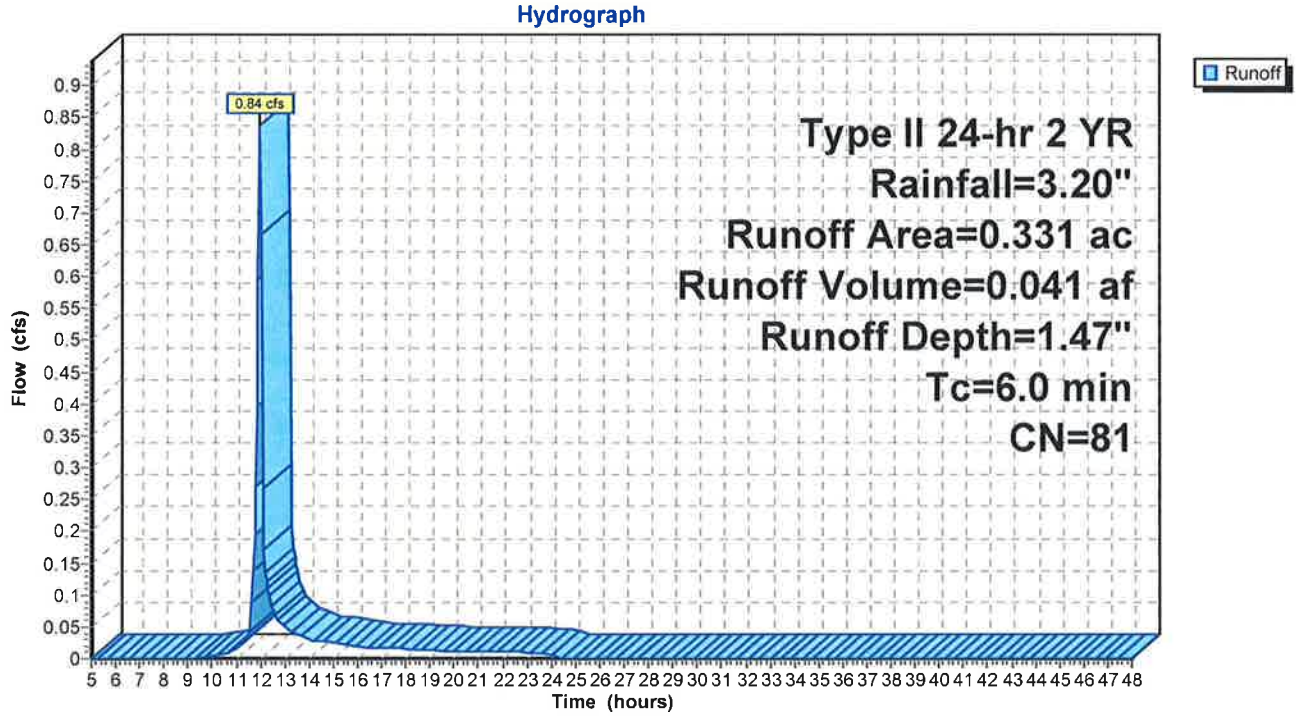
Runoff = 0.84 cfs @ 11.97 hrs, Volume= 0.041 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.028	98	Paved parking & roofs
0.295	80	>75% Grass cover, Good, HSG D
0.004	61	>75% Grass cover, Good, HSG B
0.004	77	Woods, Good, HSG D
0.331	81	Weighted Average

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

Subcatchment4: Subarea 4



Pond 1P: Existing CB (AP 1)

[57] Hint: Peaked at 62.26' (Flood elevation advised)

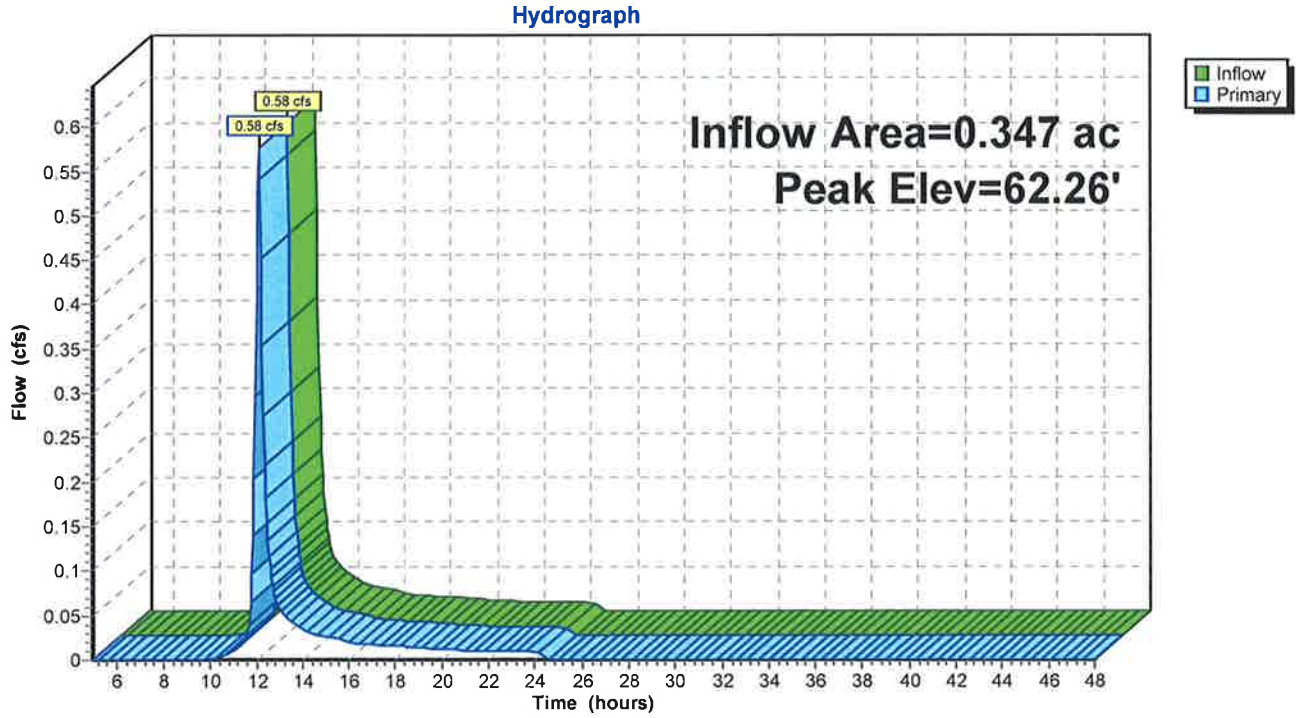
Inflow Area =	0.347 ac,	Inflow Depth =	1.40"	for	2 YR event	
Inflow =	0.58 cfs @	12.10 hrs,	Volume=		0.041 af	
Outflow =	0.58 cfs @	12.10 hrs,	Volume=		0.041 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.58 cfs @	12.10 hrs,	Volume=		0.041 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 62.26' @ 12.10 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	56.80'	**30.0" x 207.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0050 '/' n= 0.012 Cc= 0.900
2	Device 1	62.21'	**3.00' x 4.00' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=0.57 cfs @ 12.10 hrs HW=62.26' TW=59.30' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.57 cfs of 38.32 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 0.57 cfs @ 0.8 fps)

Pond 1P: Existing CB (AP 1)



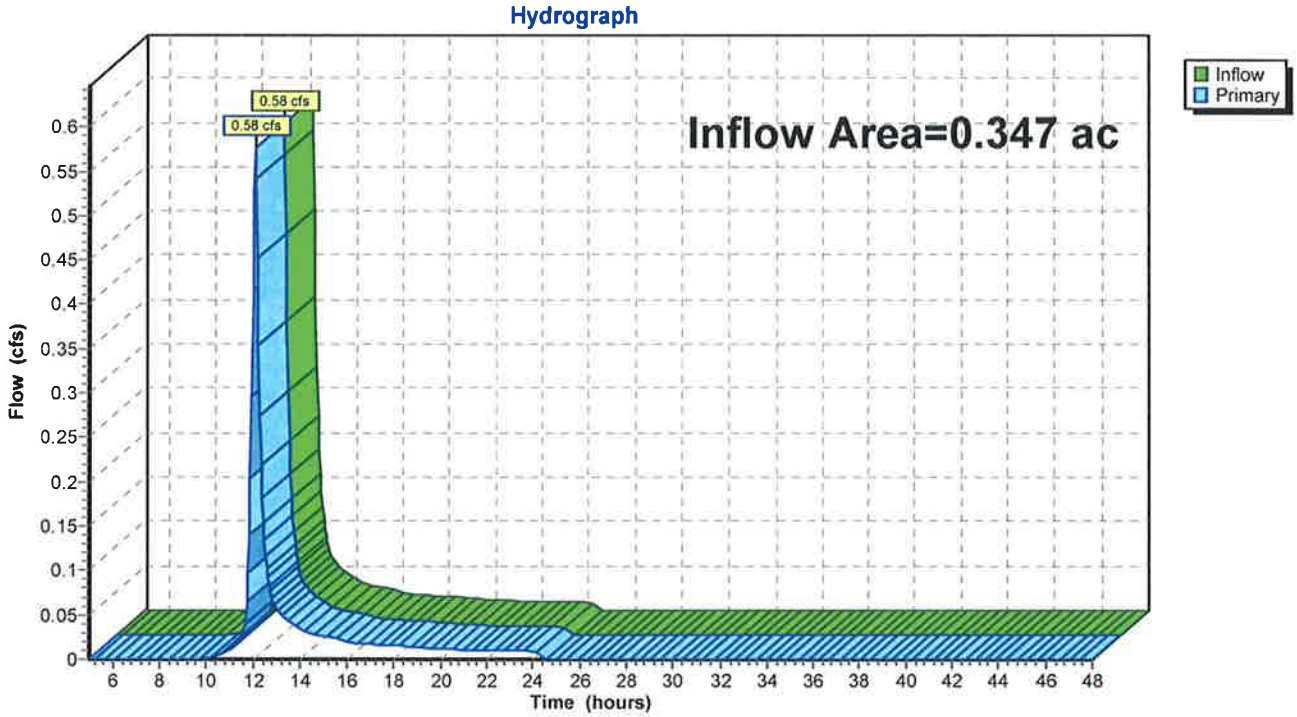
Link 1L: Tailwater Condition = 59.30'

Inflow Area = 0.347 ac, Inflow Depth = 1.40" for 2 YR event
Inflow = 0.58 cfs @ 12.10 hrs, Volume= 0.041 af
Primary = 0.58 cfs @ 12.10 hrs, Volume= 0.041 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 59.30'

Link 1L: Tailwater Condition = 59.30'

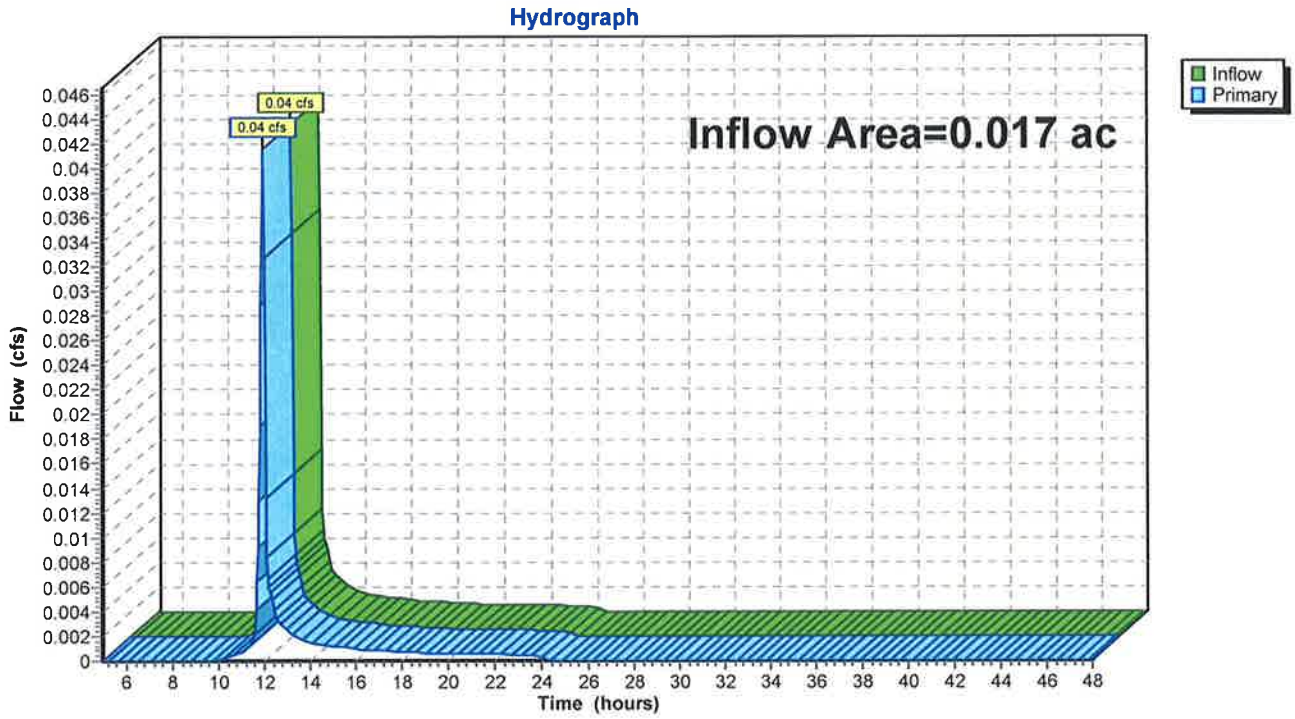


Link AP2: Analysis Point 2

Inflow Area =	0.017 ac,	Inflow Depth =	1.40"	for	2 YR event
Inflow =	0.04 cfs @	11.98 hrs,	Volume=	0.002 af	
Primary =	0.04 cfs @	11.98 hrs,	Volume=	0.002 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP2: Analysis Point 2

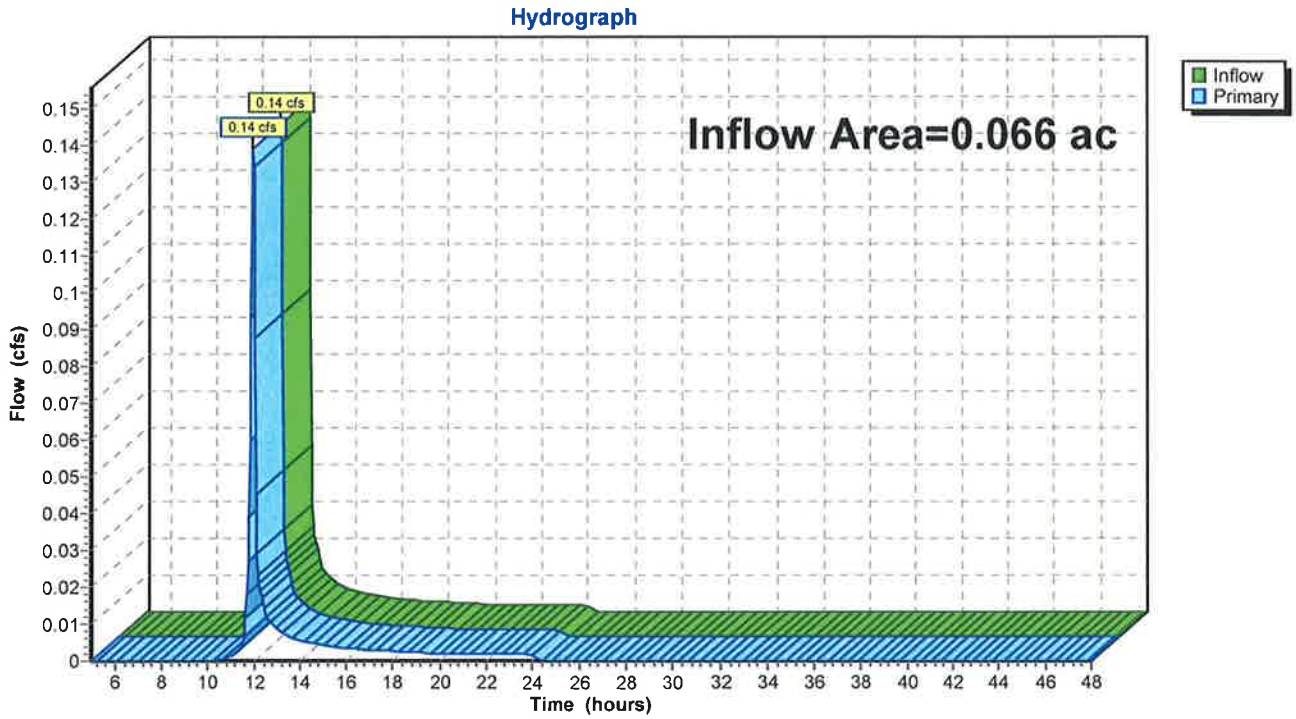


Link AP3: Analysis Point 3

Inflow Area = 0.066 ac, Inflow Depth = 1.21" for 2 YR event
Inflow = 0.14 cfs @ 11.98 hrs, Volume= 0.007 af
Primary = 0.14 cfs @ 11.98 hrs, Volume= 0.007 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP3: Analysis Point 3

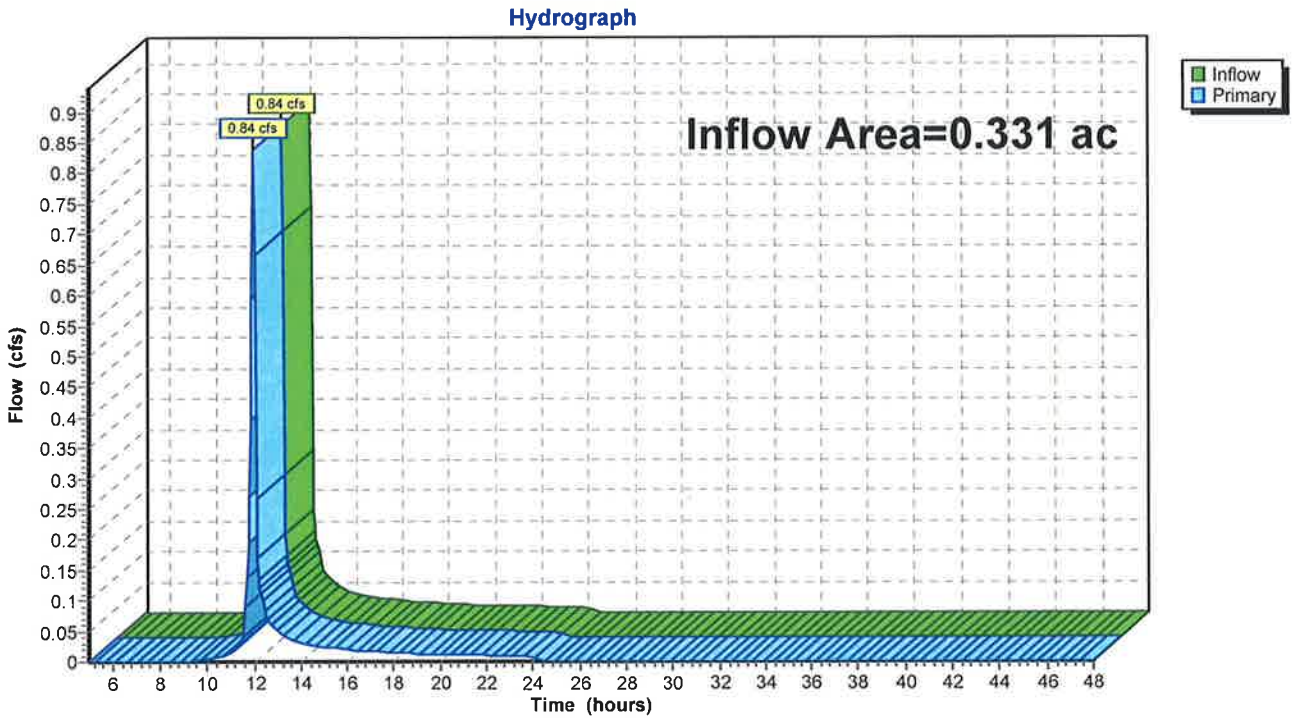


Link AP4: Analysis Point 4

Inflow Area =	0.331 ac,	Inflow Depth =	1.47"	for	2 YR event
Inflow =	0.84 cfs @	11.97 hrs,	Volume=	0.041 af	
Primary =	0.84 cfs @	11.97 hrs,	Volume=	0.041 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP4: Analysis Point 4



Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.347 ac Runoff Depth=2.72"
Flow Length=146' Tc=17.4 min CN=80 Runoff=1.13 cfs 0.079 af

Subcatchment 2: Subarea 2 Runoff Area=0.017 ac Runoff Depth=2.72"
Tc=6.0 min CN=80 Runoff=0.08 cfs 0.004 af

Subcatchment 3: Subarea 3 Runoff Area=0.066 ac Runoff Depth=2.46"
Tc=6.0 min CN=77 Runoff=0.28 cfs 0.014 af

Subcatchment 4: Subarea 4 Runoff Area=0.331 ac Runoff Depth=2.81"
Tc=6.0 min CN=81 Runoff=1.58 cfs 0.077 af

Pond 1P: Existing CB (AP 1) Peak Elev=62.29' Inflow=1.13 cfs 0.079 af
Outflow=1.13 cfs 0.079 af

Link 1L: Tailwater Condition = 59.30' Inflow=1.13 cfs 0.079 af
Primary=1.13 cfs 0.079 af

Link AP2: Analysis Point 2 Inflow=0.08 cfs 0.004 af
Primary=0.08 cfs 0.004 af

Link AP3: Analysis Point 3 Inflow=0.28 cfs 0.014 af
Primary=0.28 cfs 0.014 af

Link AP4: Analysis Point 4 Inflow=1.58 cfs 0.077 af
Primary=1.58 cfs 0.077 af

Total Runoff Area = 0.761 ac Runoff Volume = 0.173 af Average Runoff Depth = 2.74"

Subcatchment1: Subarea1

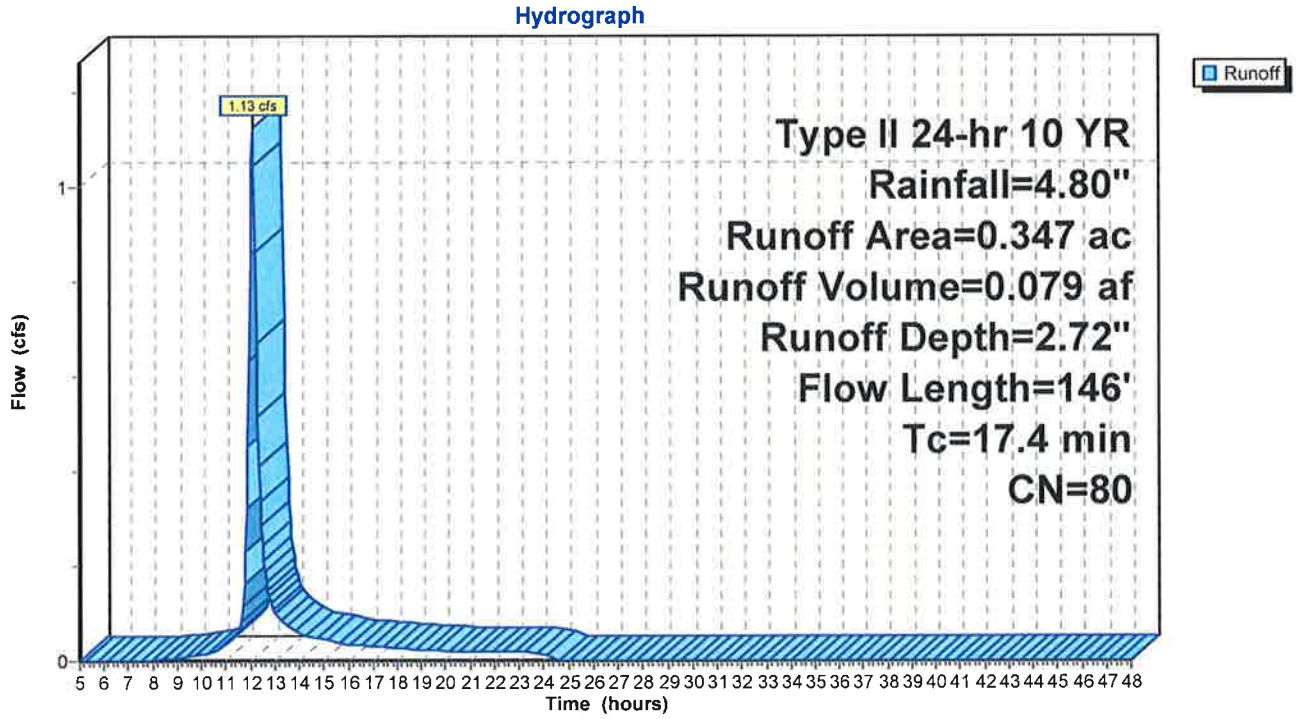
Runoff = 1.13 cfs @ 12.10 hrs, Volume= 0.079 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.071	98	Paved parking & roofs
0.215	80	>75% Grass cover, Good, HSG D
0.061	61	>75% Grass cover, Good, HSG B
0.347	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.0	100	0.0130	0.1		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.20"
0.4	46	0.0180	2.2		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.4	146	Total			

Subcatchment1: Subarea1



Subcatchment 2: Subarea 2

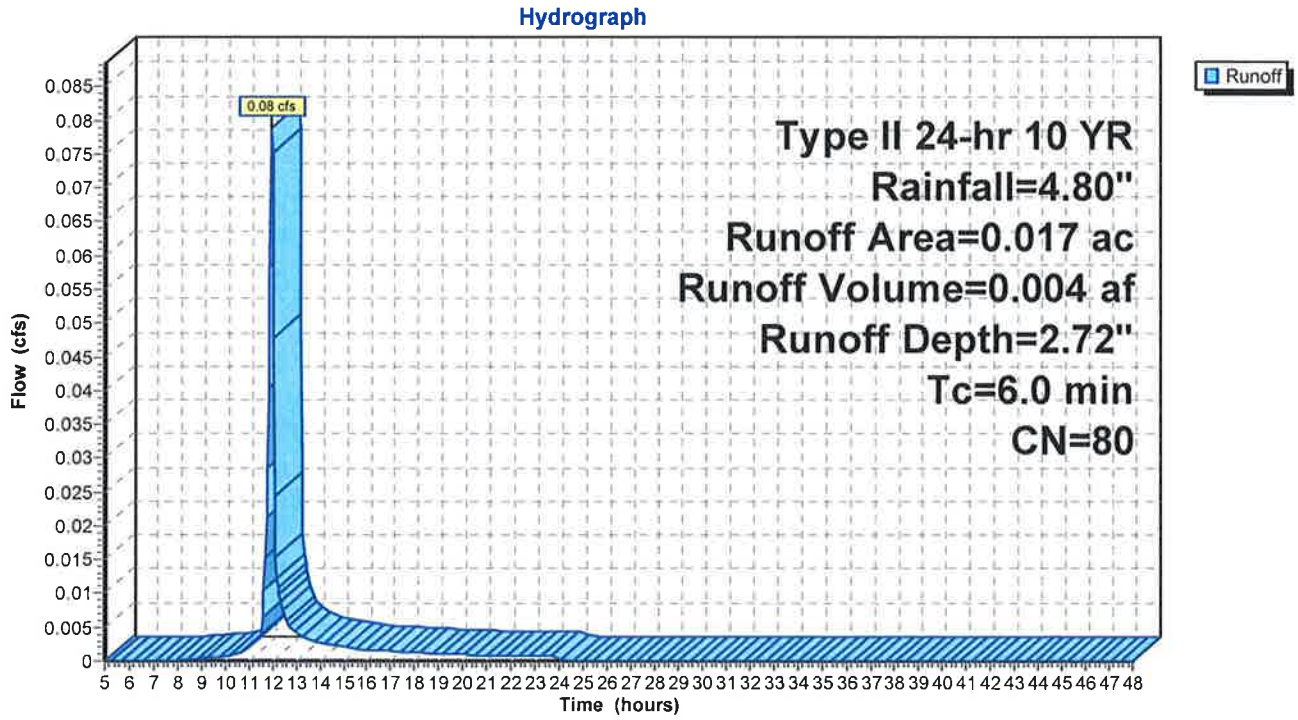
Runoff = 0.08 cfs @ 11.97 hrs, Volume= 0.004 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.017	80	>75% Grass cover, Good, HSG D

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

Subcatchment 2: Subarea 2



Subcatchment3: Subarea 3

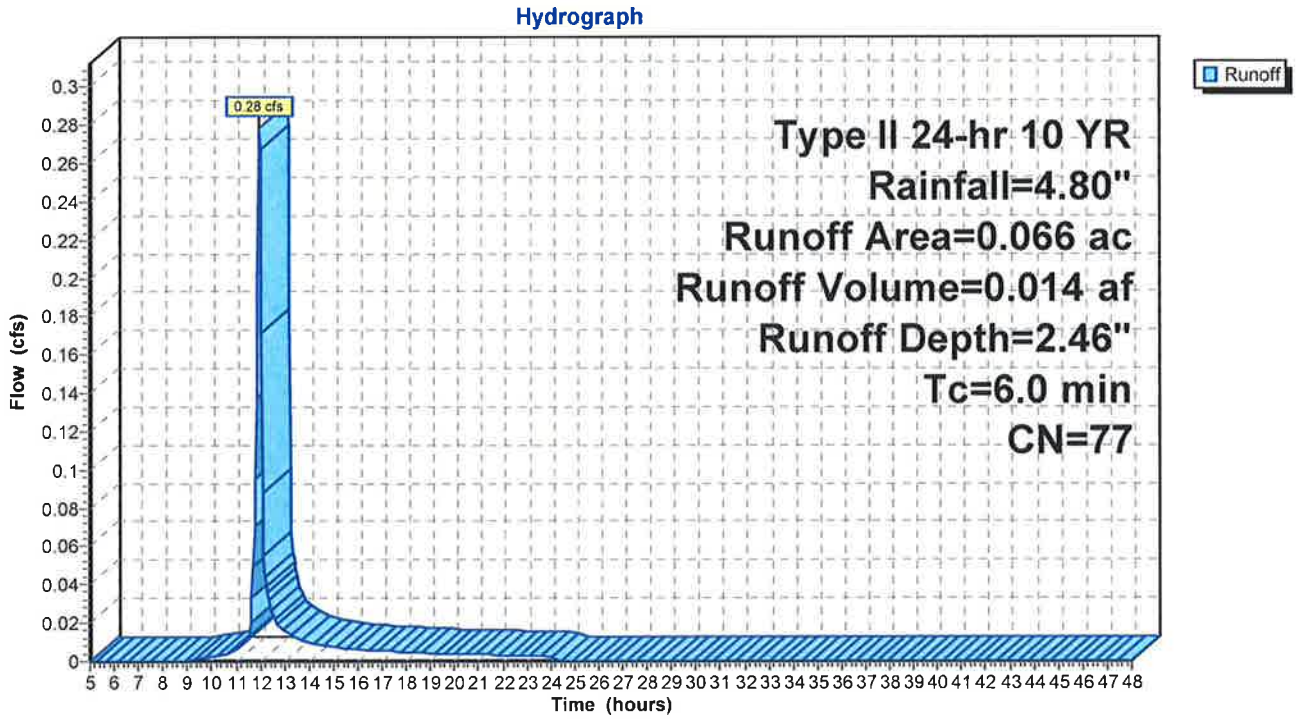
Runoff = 0.28 cfs @ 11.97 hrs, Volume= 0.014 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.006	80	>75% Grass cover, Good, HSG D
0.060	77	Woods, Good, HSG D
0.066	77	Weighted Average

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

Subcatchment3: Subarea 3



Subcatchment4: Subarea 4

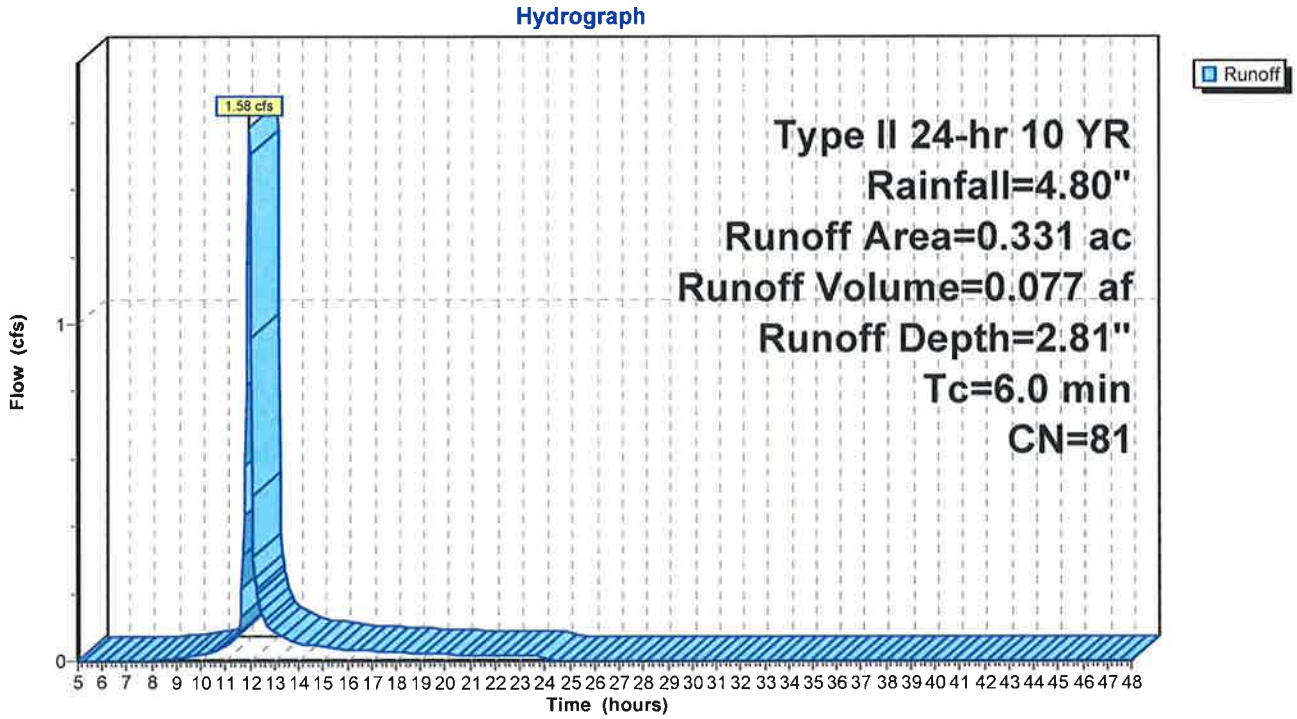
Runoff = 1.58 cfs @ 11.97 hrs, Volume= 0.077 af, Depth= 2.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.028	98	Paved parking & roofs
0.295	80	>75% Grass cover, Good, HSG D
0.004	61	>75% Grass cover, Good, HSG B
0.004	77	Woods, Good, HSG D
0.331	81	Weighted Average

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

Subcatchment4: Subarea 4



Pond 1P: Existing CB (AP 1)

[57] Hint: Peaked at 62.29' (Flood elevation advised)

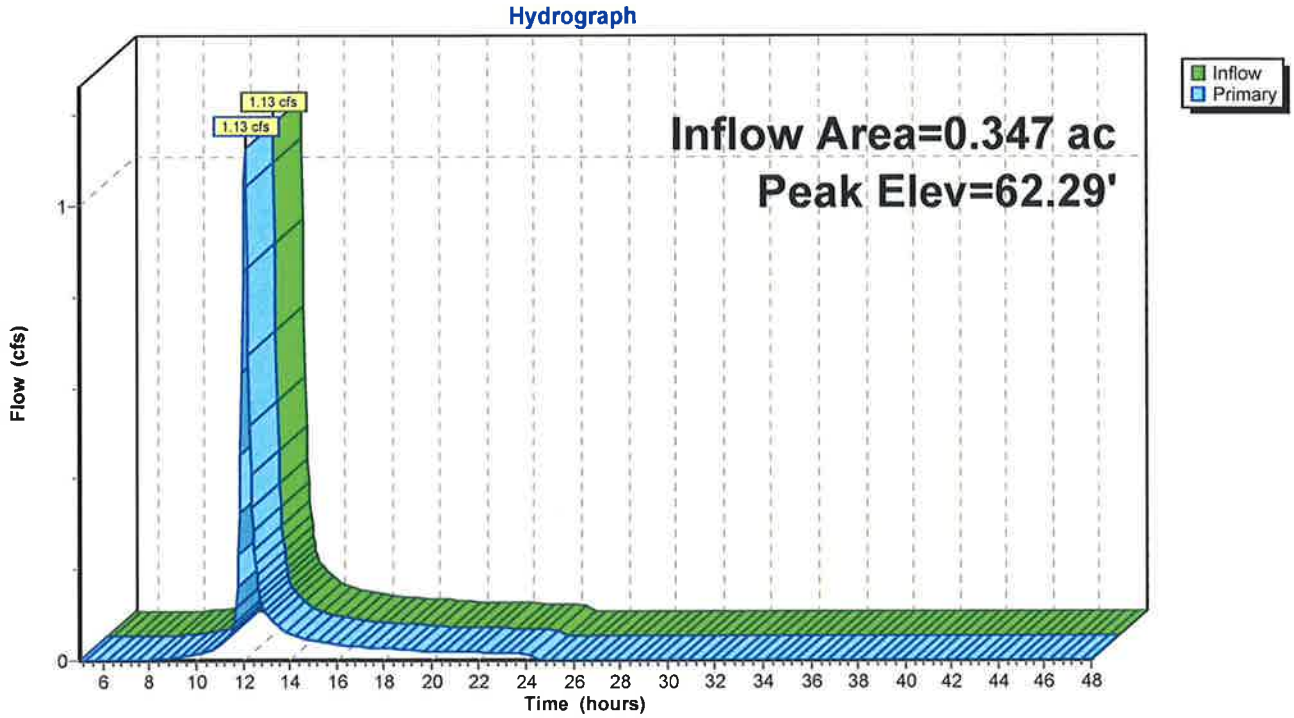
Inflow Area =	0.347 ac,	Inflow Depth =	2.72"	for	10 YR event
Inflow =	1.13 cfs @	12.10 hrs,	Volume=	0.079 af	
Outflow =	1.13 cfs @	12.10 hrs,	Volume=	0.079 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.13 cfs @	12.10 hrs,	Volume=	0.079 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 62.29' @ 12.10 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	56.80'	**30.0" x 207.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0050 '/' n= 0.012 Cc= 0.900
2	Device 1	62.21'	**3.00' x 4.00' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=1.12 cfs @ 12.10 hrs HW=62.29' TW=59.30' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.12 cfs of 38.51 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 1.12 cfs @ 1.0 fps)

Pond 1P: Existing CB (AP 1)



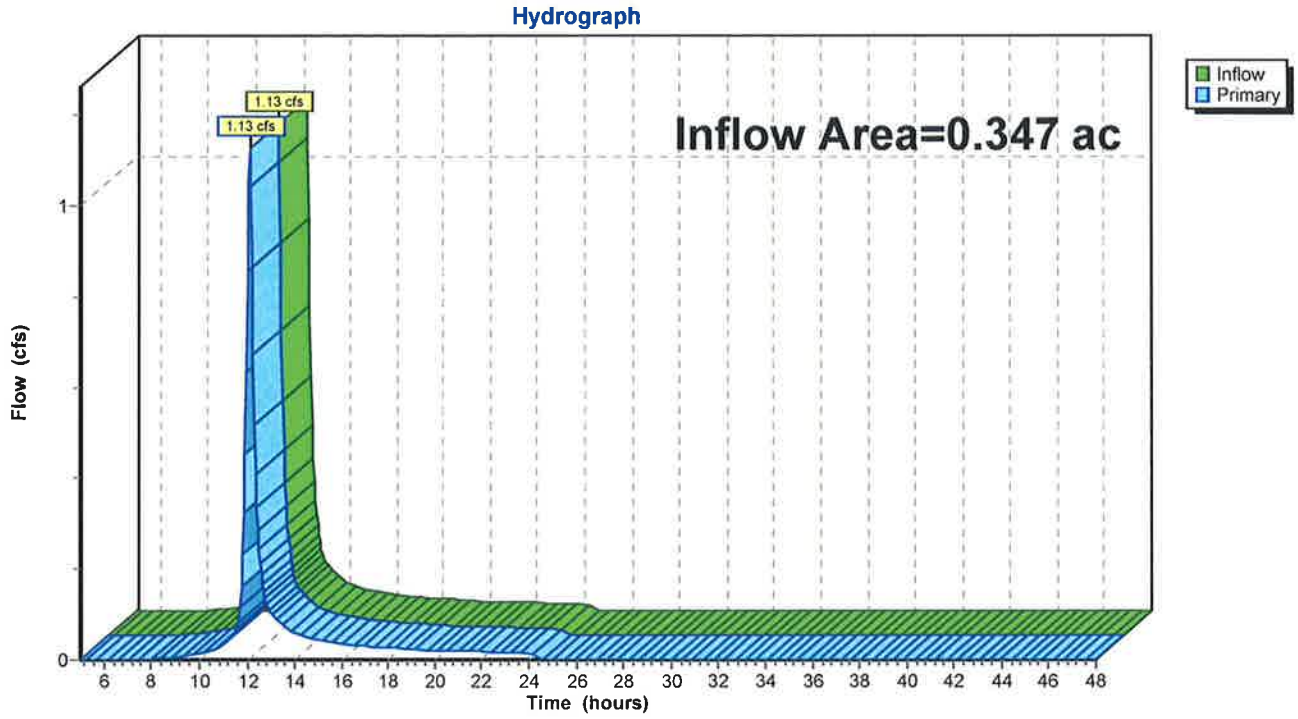
Link 1L: Tailwater Condition = 59.30'

Inflow Area = 0.347 ac, Inflow Depth = 2.72" for 10 YR event
Inflow = 1.13 cfs @ 12.10 hrs, Volume= 0.079 af
Primary = 1.13 cfs @ 12.10 hrs, Volume= 0.079 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 59.30'

Link 1L: Tailwater Condition = 59.30'

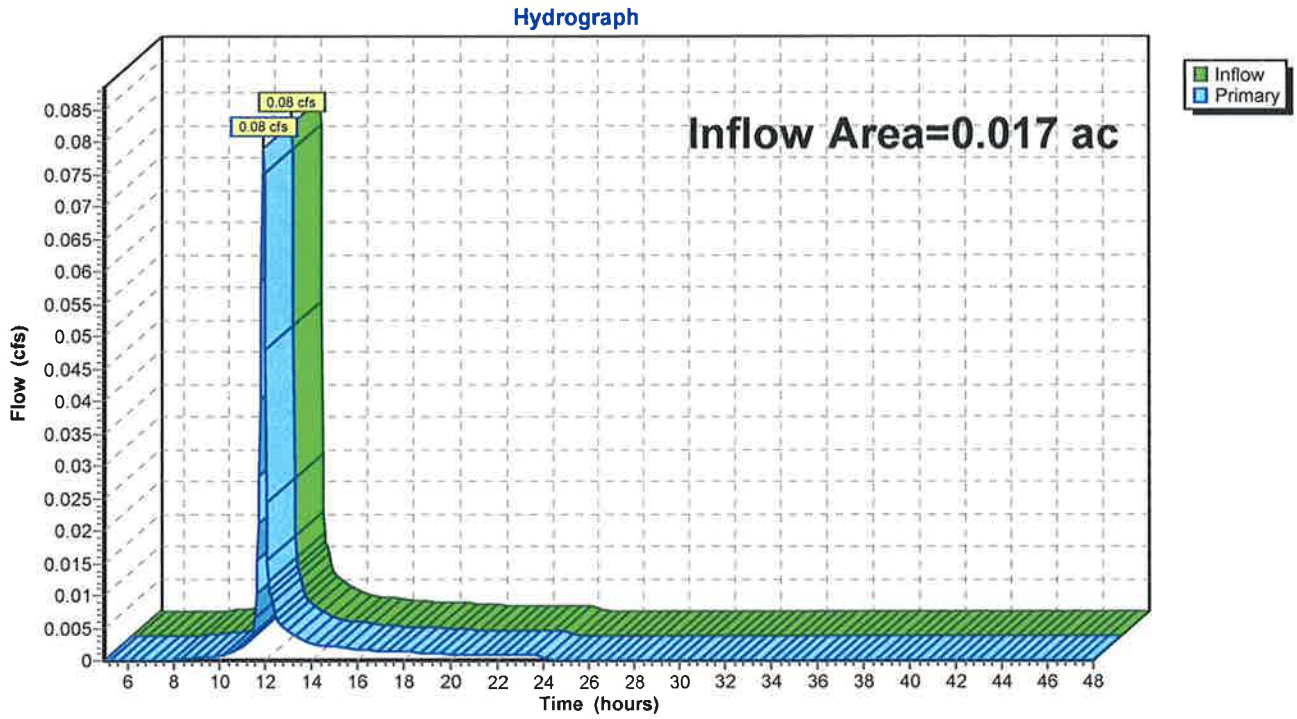


Link AP2: Analysis Point 2

Inflow Area = 0.017 ac, Inflow Depth = 2.72" for 10 YR event
Inflow = 0.08 cfs @ 11.97 hrs, Volume= 0.004 af
Primary = 0.08 cfs @ 11.97 hrs, Volume= 0.004 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP2: Analysis Point 2

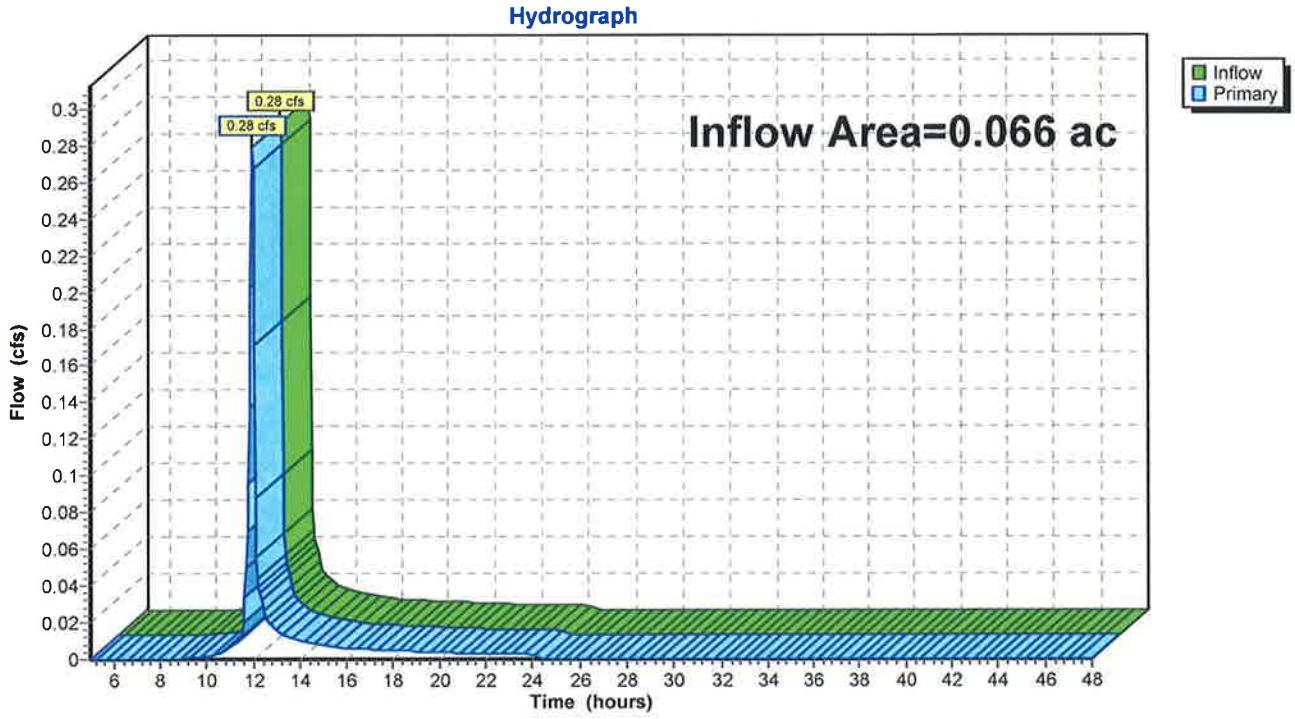


Link AP3: Analysis Point 3

Inflow Area = 0.066 ac, Inflow Depth = 2.46" for 10 YR event
Inflow = 0.28 cfs @ 11.97 hrs, Volume= 0.014 af
Primary = 0.28 cfs @ 11.97 hrs, Volume= 0.014 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP3: Analysis Point 3

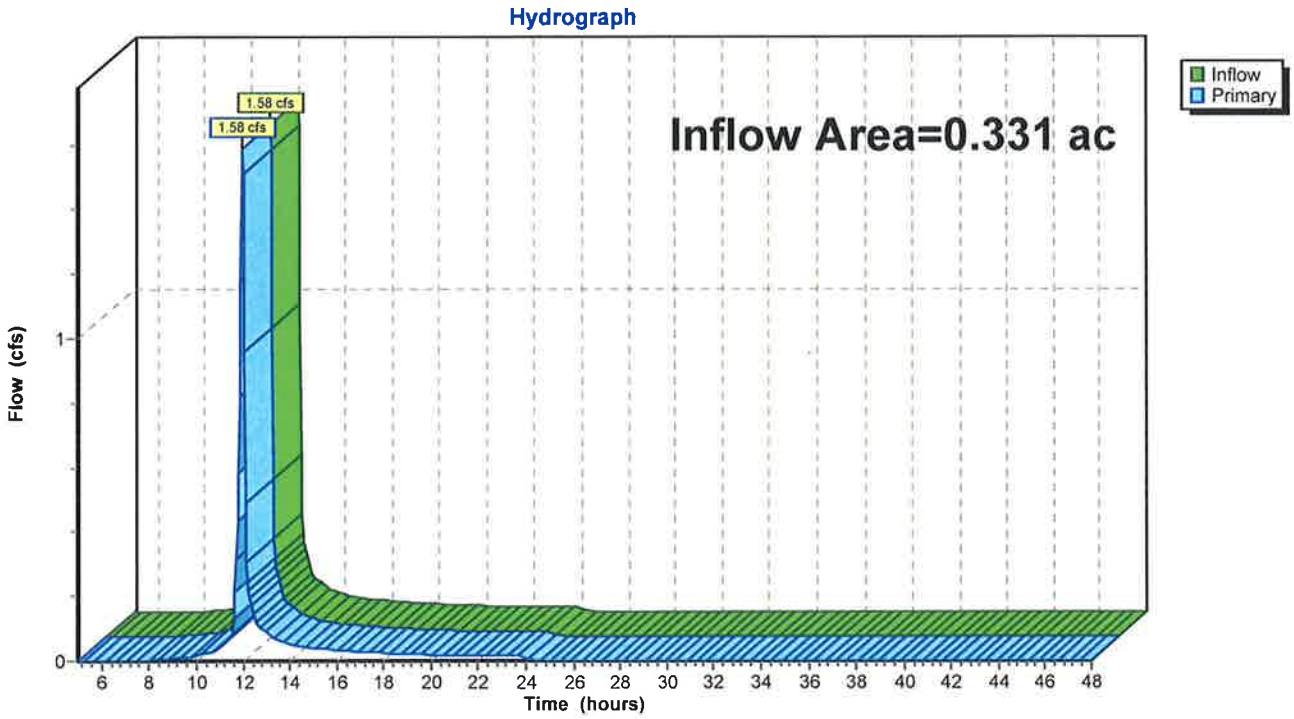


Link AP4: Analysis Point 4

Inflow Area = 0.331 ac, Inflow Depth = 2.81" for 10 YR event
Inflow = 1.58 cfs @ 11.97 hrs, Volume= 0.077 af
Primary = 1.58 cfs @ 11.97 hrs, Volume= 0.077 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP4: Analysis Point 4



Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.347 ac Runoff Depth=5.63"
Flow Length=146' Tc=17.4 min CN=80 Runoff=2.29 cfs 0.163 af

Subcatchment 2: Subarea 2 Runoff Area=0.017 ac Runoff Depth=5.62"
Tc=6.0 min CN=80 Runoff=0.16 cfs 0.008 af

Subcatchment 3: Subarea 3 Runoff Area=0.066 ac Runoff Depth=5.27"
Tc=6.0 min CN=77 Runoff=0.58 cfs 0.029 af

Subcatchment 4: Subarea 4 Runoff Area=0.331 ac Runoff Depth=5.74"
Tc=6.0 min CN=81 Runoff=3.13 cfs 0.158 af

Pond 1P: Existing CB (AP 1) Peak Elev=62.35' Inflow=2.29 cfs 0.163 af
Outflow=2.29 cfs 0.163 af

Link 1L: Tailwater Condition = 59.30' Inflow=2.29 cfs 0.163 af
Primary=2.29 cfs 0.163 af

Link AP2: Analysis Point 2 Inflow=0.16 cfs 0.008 af
Primary=0.16 cfs 0.008 af

Link AP3: Analysis Point 3 Inflow=0.58 cfs 0.029 af
Primary=0.58 cfs 0.029 af

Link AP4: Analysis Point 4 Inflow=3.13 cfs 0.158 af
Primary=3.13 cfs 0.158 af

Total Runoff Area = 0.761 ac Runoff Volume = 0.358 af Average Runoff Depth = 5.65"

Subcatchment1: Subarea 1

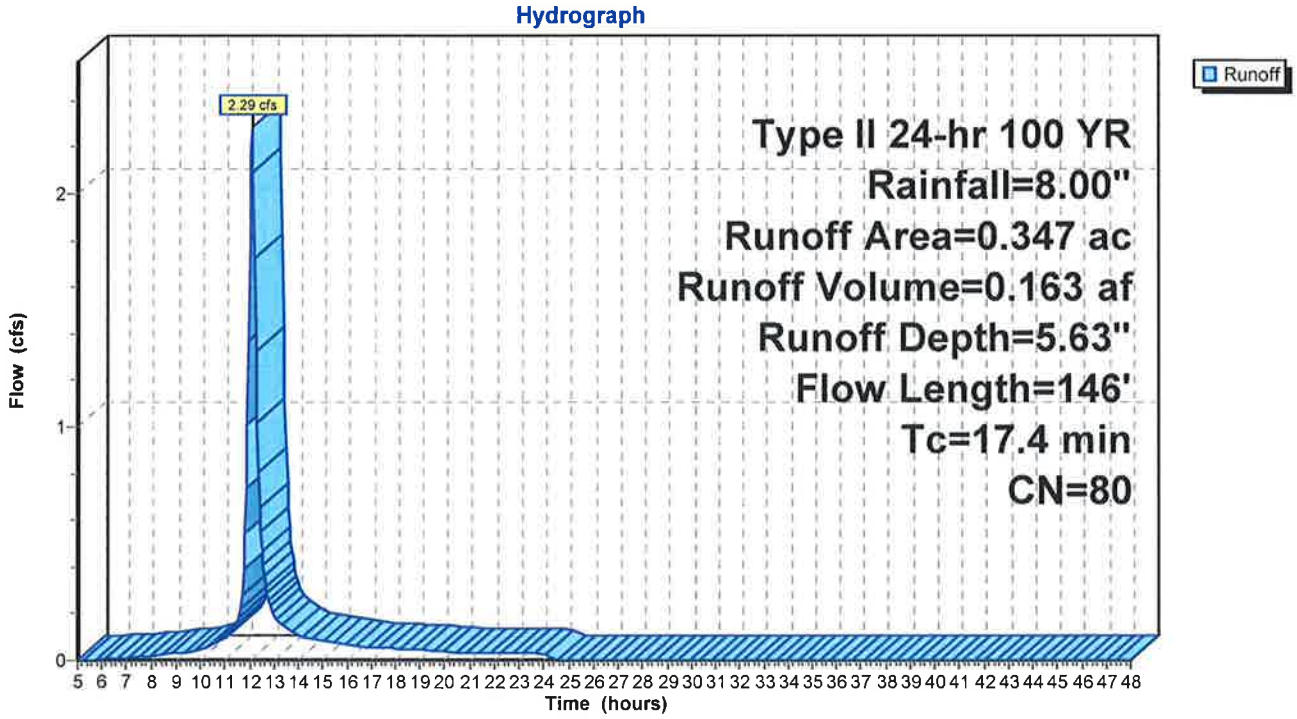
Runoff = 2.29 cfs @ 12.09 hrs, Volume= 0.163 af, Depth= 5.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.071	98	Paved parking & roofs
0.215	80	>75% Grass cover, Good, HSG D
0.061	61	>75% Grass cover, Good, HSG B
0.347	80	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.0	100	0.0130	0.1		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.20"
0.4	46	0.0180	2.2		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.4	146	Total			

Subcatchment1: Subarea 1



Subcatchment 2: Subarea 2

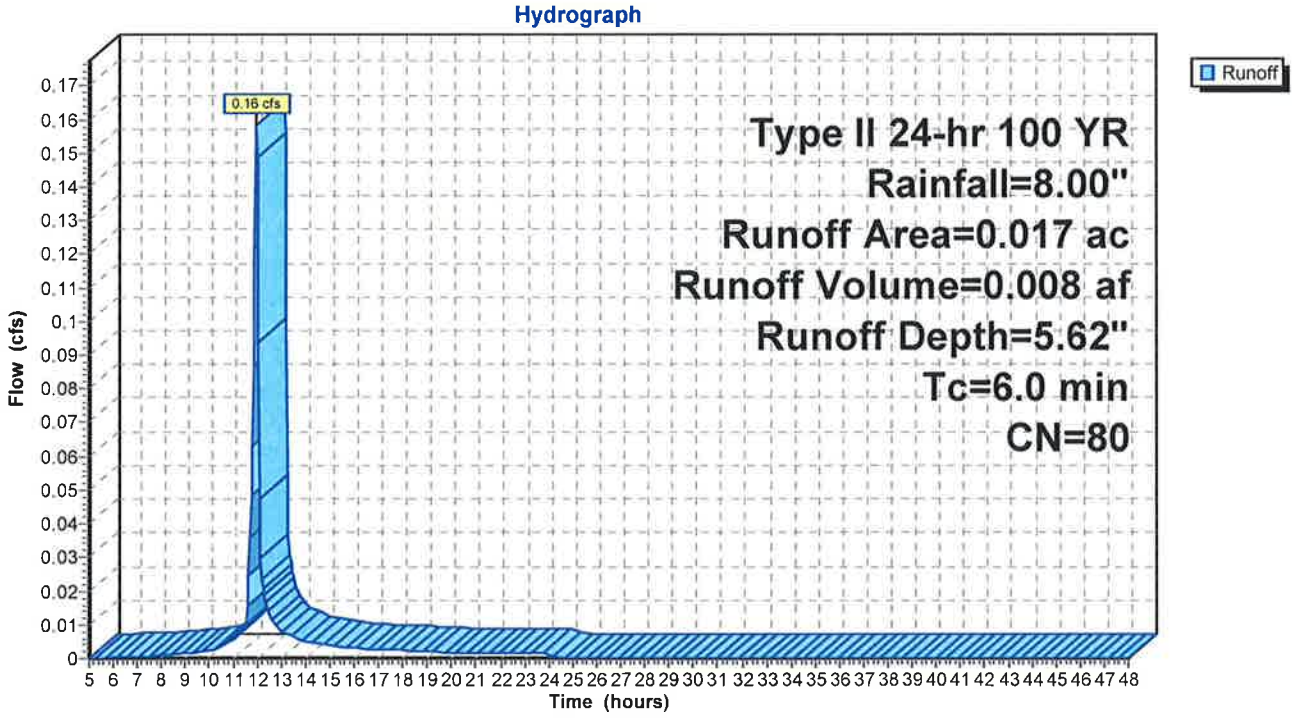
Runoff = 0.16 cfs @ 11.97 hrs, Volume= 0.008 af, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.017	80	>75% Grass cover, Good, HSG D

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

Subcatchment 2: Subarea 2



Subcatchment3: Subarea 3

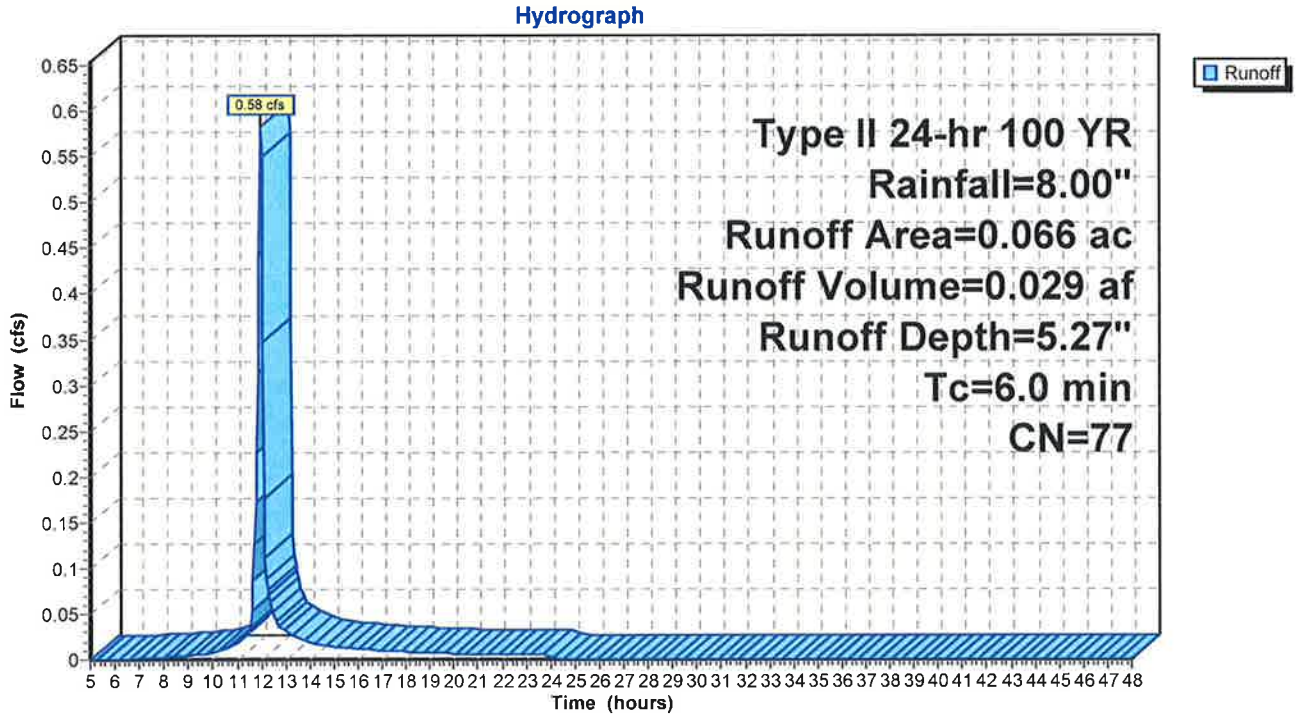
Runoff = 0.58 cfs @ 11.97 hrs, Volume= 0.029 af, Depth= 5.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.006	80	>75% Grass cover, Good, HSG D
0.060	77	Woods, Good, HSG D
0.066	77	Weighted Average

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

Subcatchment3: Subarea 3



Subcatchment4: Subarea 4

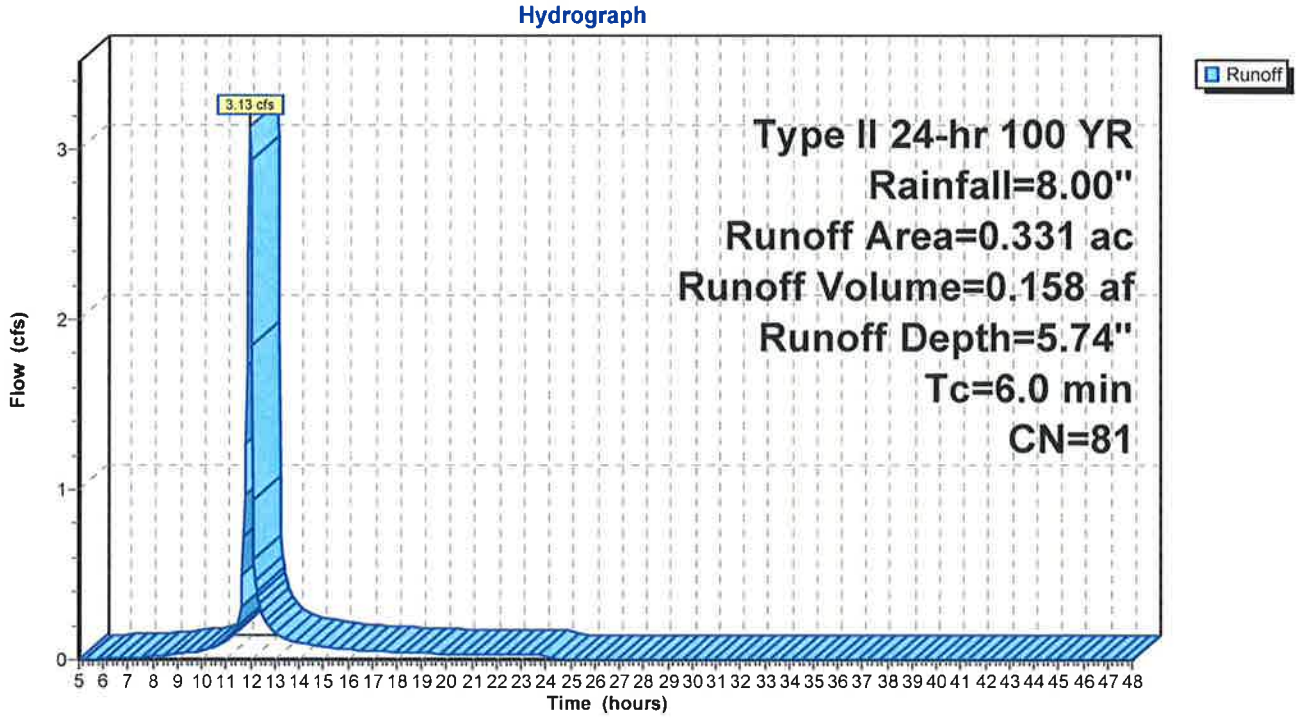
Runoff = 3.13 cfs @ 11.97 hrs, Volume= 0.158 af, Depth= 5.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.028	98	Paved parking & roofs
0.295	80	>75% Grass cover, Good, HSG D
0.004	61	>75% Grass cover, Good, HSG B
0.004	77	Woods, Good, HSG D
0.331	81	Weighted Average

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

Subcatchment4: Subarea 4



Pond 1P: Existing CB (AP 1)

[57] Hint: Peaked at 62.35' (Flood elevation advised)

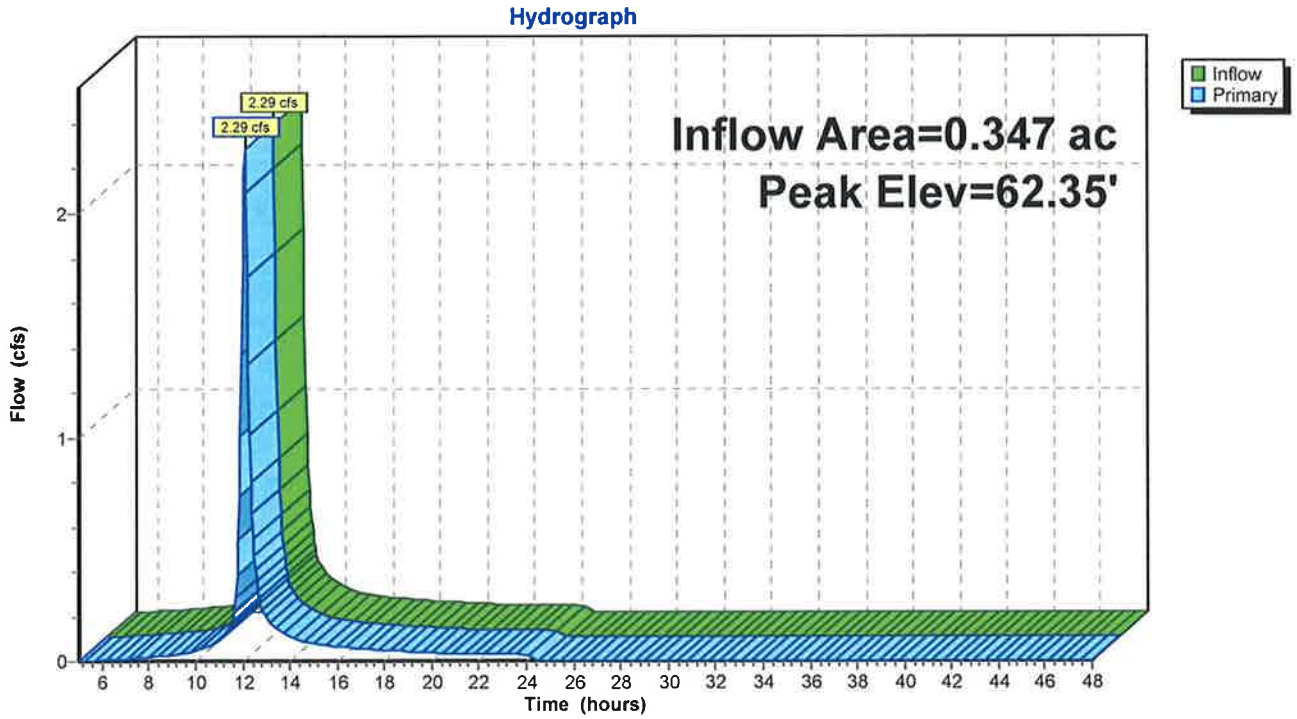
Inflow Area =	0.347 ac,	Inflow Depth =	5.63"	for	100 YR event
Inflow =	2.29 cfs @	12.09 hrs,	Volume=	0.163 af	
Outflow =	2.29 cfs @	12.09 hrs,	Volume=	0.163 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.29 cfs @	12.09 hrs,	Volume=	0.163 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 62.35' @ 12.09 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	56.80'	**30.0" x 207.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0050 '/' n= 0.012 Cc= 0.900
2	Device 1	62.21'	**3.00' x 4.00' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=2.28 cfs @ 12.09 hrs HW=62.35' TW=59.30' (Dynamic Tailwater)
└─**1=Culvert** (Passes 2.28 cfs of 38.84 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 2.28 cfs @ 1.2 fps)

Pond 1P: Existing CB (AP 1)



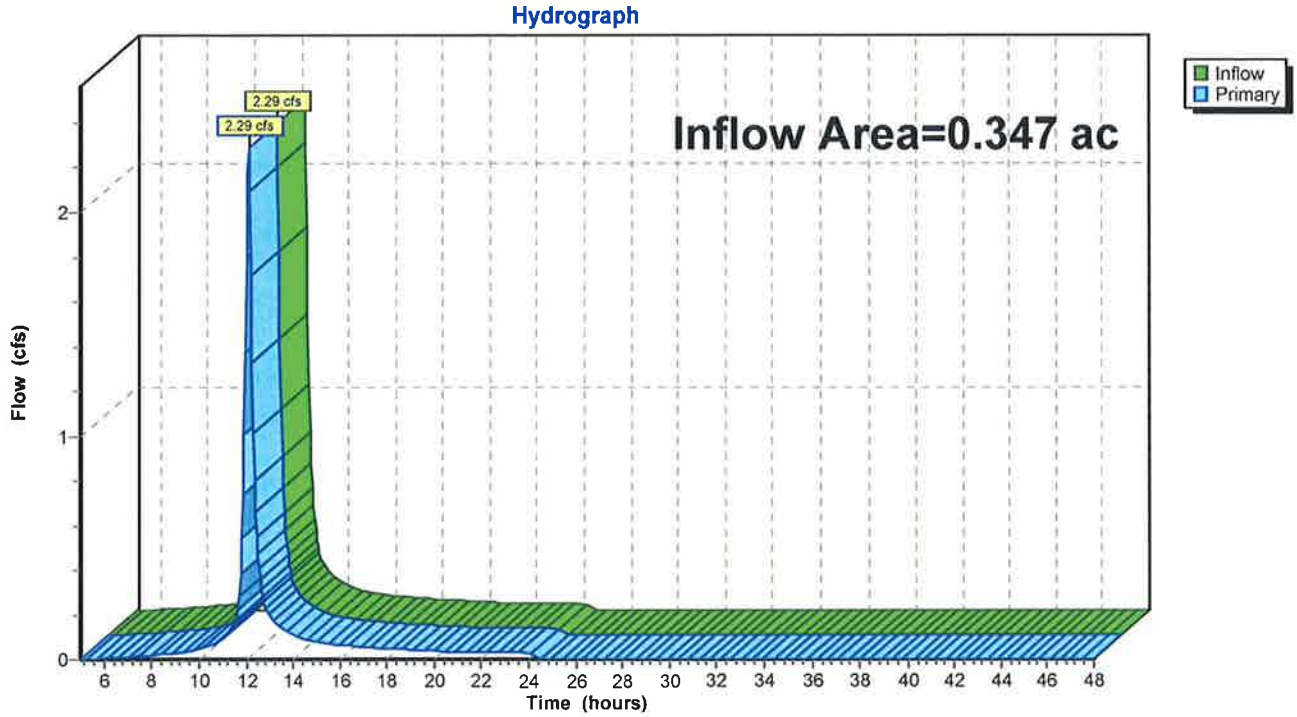
Link 1L: Tailwater Condition = 59.30'

Inflow Area = 0.347 ac, Inflow Depth = 5.63" for 100 YR event
Inflow = 2.29 cfs @ 12.09 hrs, Volume= 0.163 af
Primary = 2.29 cfs @ 12.09 hrs, Volume= 0.163 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 59.30'

Link 1L: Tailwater Condition = 59.30'

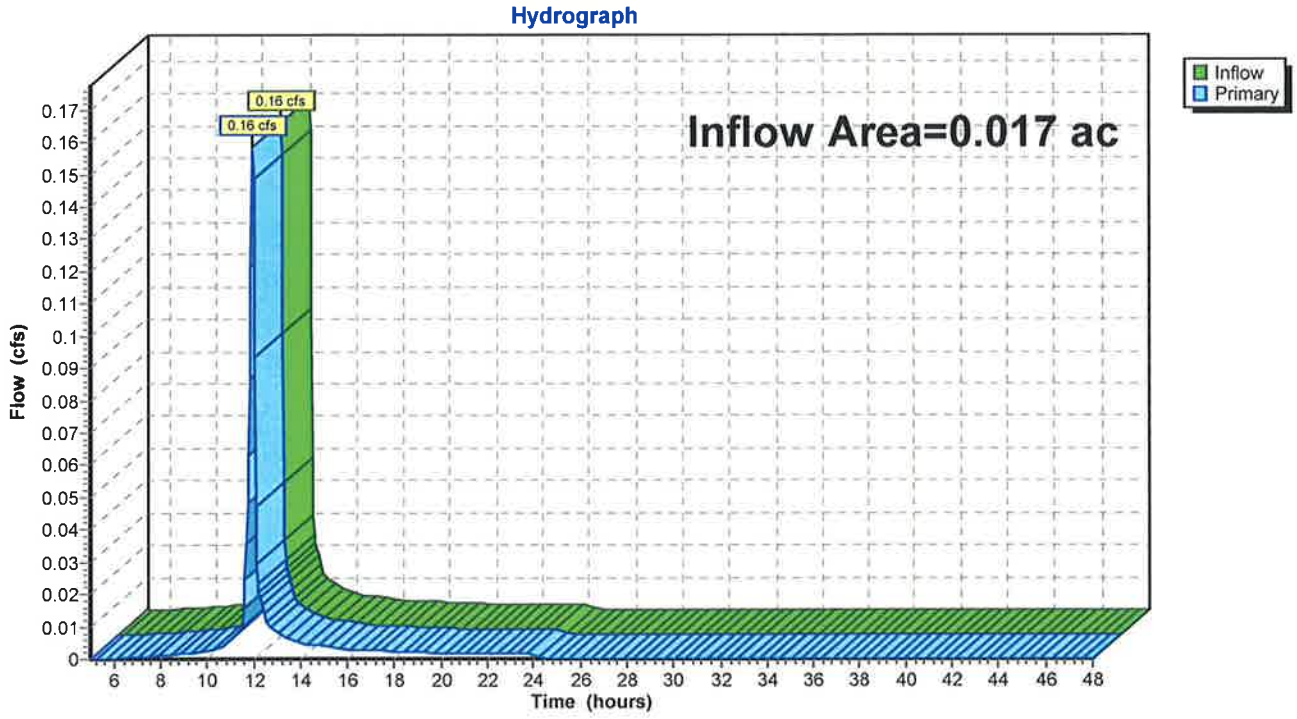


Link AP2: Analysis Point 2

Inflow Area = 0.017 ac, Inflow Depth = 5.62" for 100 YR event
Inflow = 0.16 cfs @ 11.97 hrs, Volume= 0.008 af
Primary = 0.16 cfs @ 11.97 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP2: Analysis Point 2

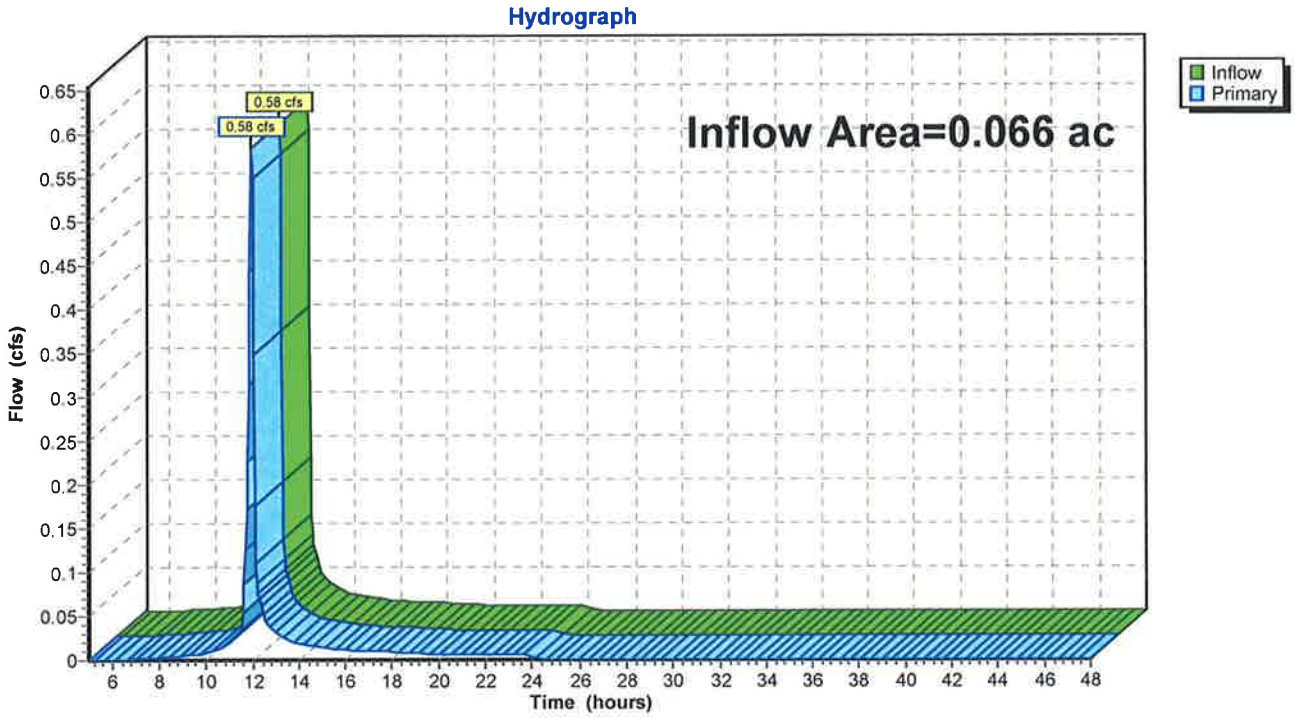


Link AP3: Analysis Point 3

Inflow Area =	0.066 ac,	Inflow Depth =	5.27"	for	100 YR event
Inflow =	0.58 cfs @	11.97 hrs,	Volume=	0.029 af	
Primary =	0.58 cfs @	11.97 hrs,	Volume=	0.029 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP3: Analysis Point 3

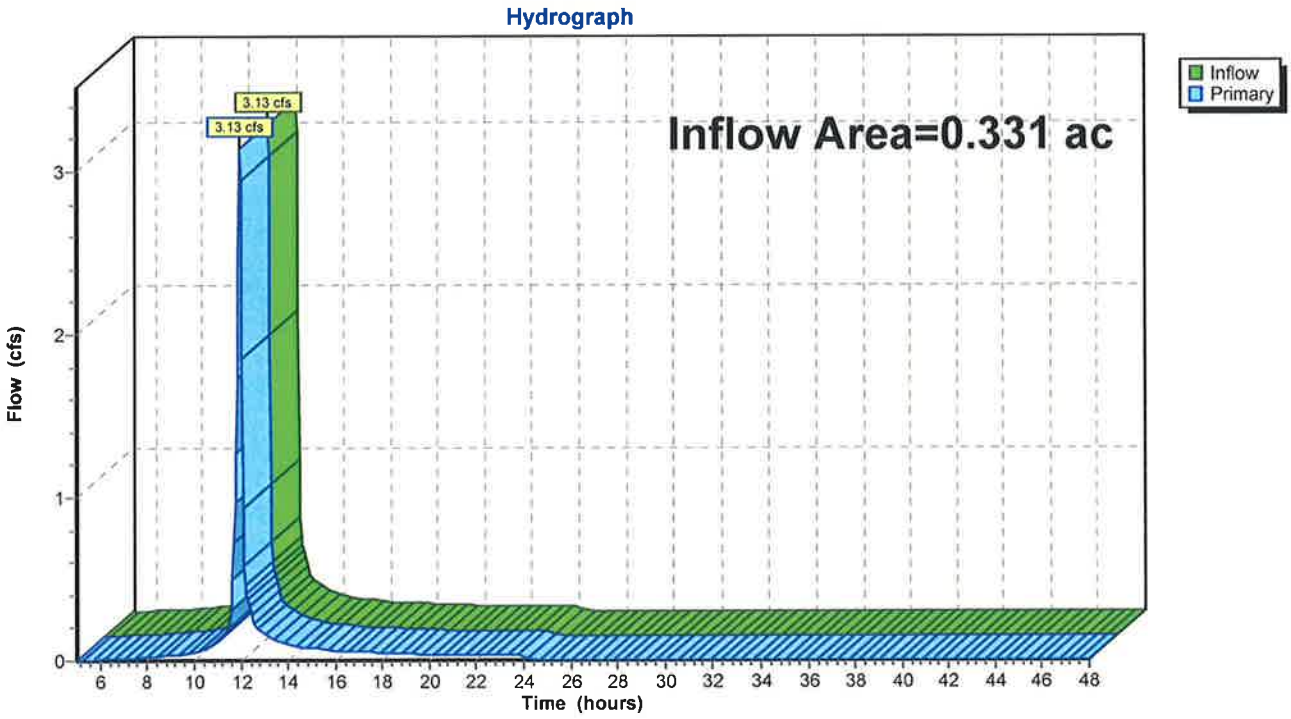


Link AP4: Analysis Point 4

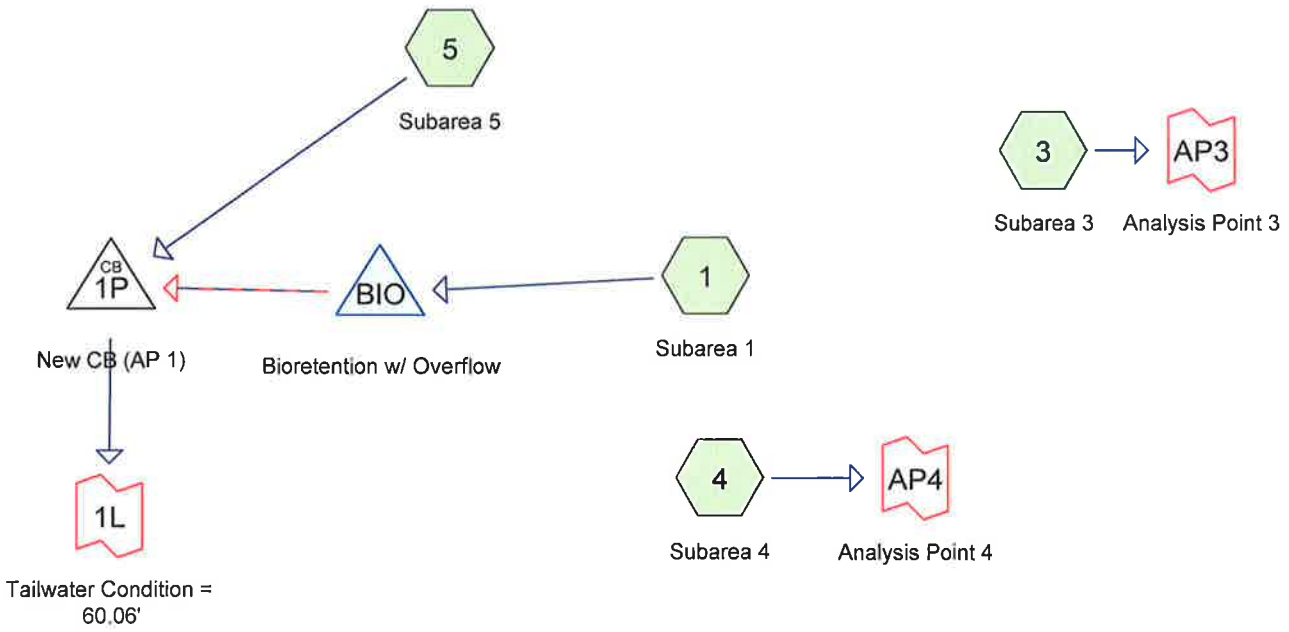
Inflow Area = 0.331 ac, Inflow Depth = 5.74" for 100 YR event
Inflow = 3.13 cfs @ 11.97 hrs, Volume= 0.158 af
Primary = 3.13 cfs @ 11.97 hrs, Volume= 0.158 af, Atten= 0%, Lag= 0.0 min

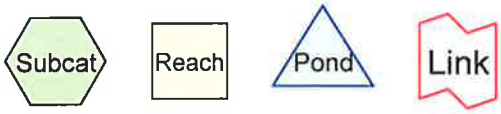
Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP4: Analysis Point 4



Effective April 2016





Drainage Diagram for 0348-Post Dev - Asbuilt Report
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

Effective April 2016

Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.577 ac Runoff Depth=2.08"
Tc=6.0 min CN=89 Runoff=2.02 cfs 0.100 af

Subcatchment 3: Subarea 3 Runoff Area=0.056 ac Runoff Depth=1.40"
Tc=6.0 min CN=80 Runoff=0.14 cfs 0.007 af

Subcatchment 4: Subarea 4 Runoff Area=0.047 ac Runoff Depth=1.40"
Tc=6.0 min CN=80 Runoff=0.11 cfs 0.005 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=1.84"
Tc=6.0 min CN=86 Runoff=0.26 cfs 0.013 af

Pond 1P: New CB (AP 1) Peak Elev=60.06' Inflow=0.40 cfs 0.113 af
30.0" x 234.0' Culvert Outflow=0.40 cfs 0.113 af

Pond BIO: Bioretention w/ Overflow Peak Elev=61.61' Storage=1,787 cf Inflow=2.02 cfs 0.100 af
Primary=0.34 cfs 0.100 af Secondary=0.00 cfs 0.000 af Outflow=0.34 cfs 0.100 af

Link 1L: Tailwater Condition = 60.06' Inflow=0.40 cfs 0.113 af
Primary=0.40 cfs 0.113 af

Link AP3: Analysis Point 3 Inflow=0.14 cfs 0.007 af
Primary=0.14 cfs 0.007 af

Link AP4: Analysis Point 4 Inflow=0.11 cfs 0.005 af
Primary=0.11 cfs 0.005 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.125 af Average Runoff Depth = 1.96"

Subcatchment1: Subarea 1

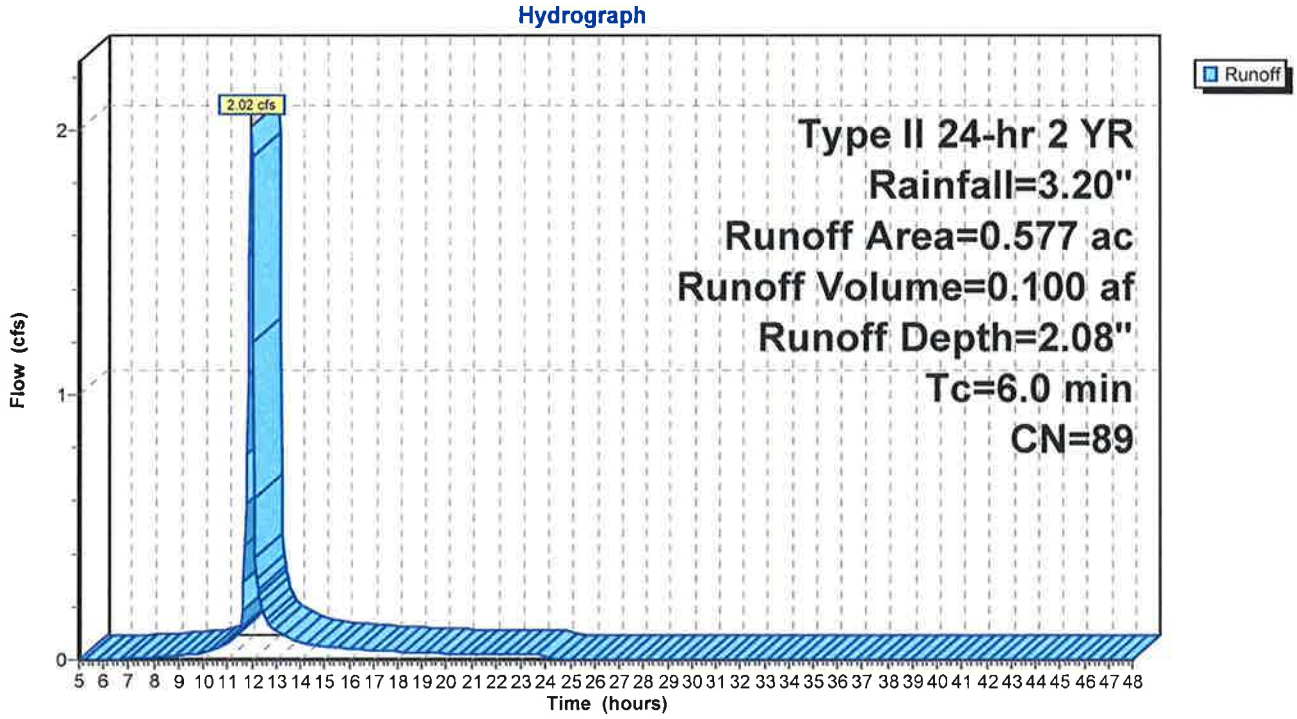
Runoff = 2.02 cfs @ 11.97 hrs, Volume= 0.100 af, Depth= 2.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.317	98	Paved parking & roofs
0.232	80	>75% Grass cover, Good, HSG D
0.028	61	>75% Grass cover, Good, HSG B
0.577	89	Weighted Average

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

Subcatchment1: Subarea 1



Subcatchment 3: Subarea 3

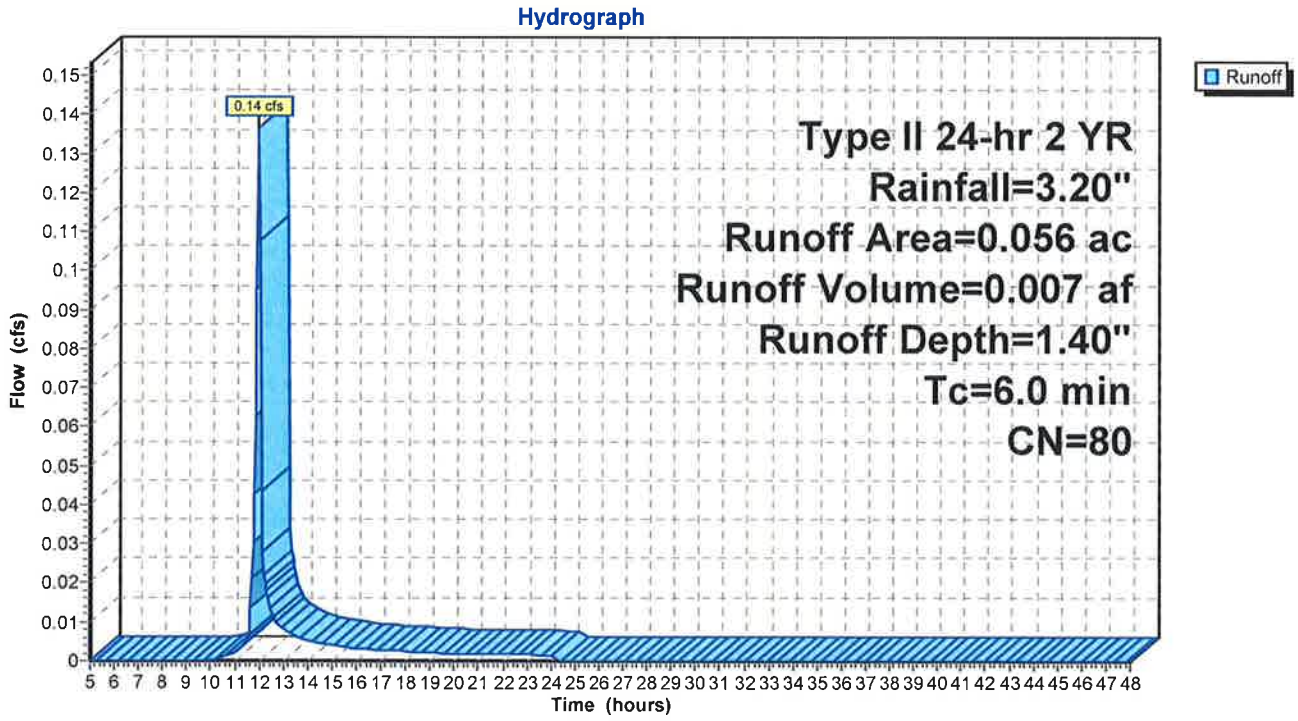
Runoff = 0.14 cfs @ 11.98 hrs, Volume= 0.007 af, Depth= 1.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.049	80	>75% Grass cover, Good, HSG D
0.007	77	Woods, Good, HSG D
0.056	80	Weighted Average

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

Subcatchment 3: Subarea 3



Subcatchment4: Subarea 4

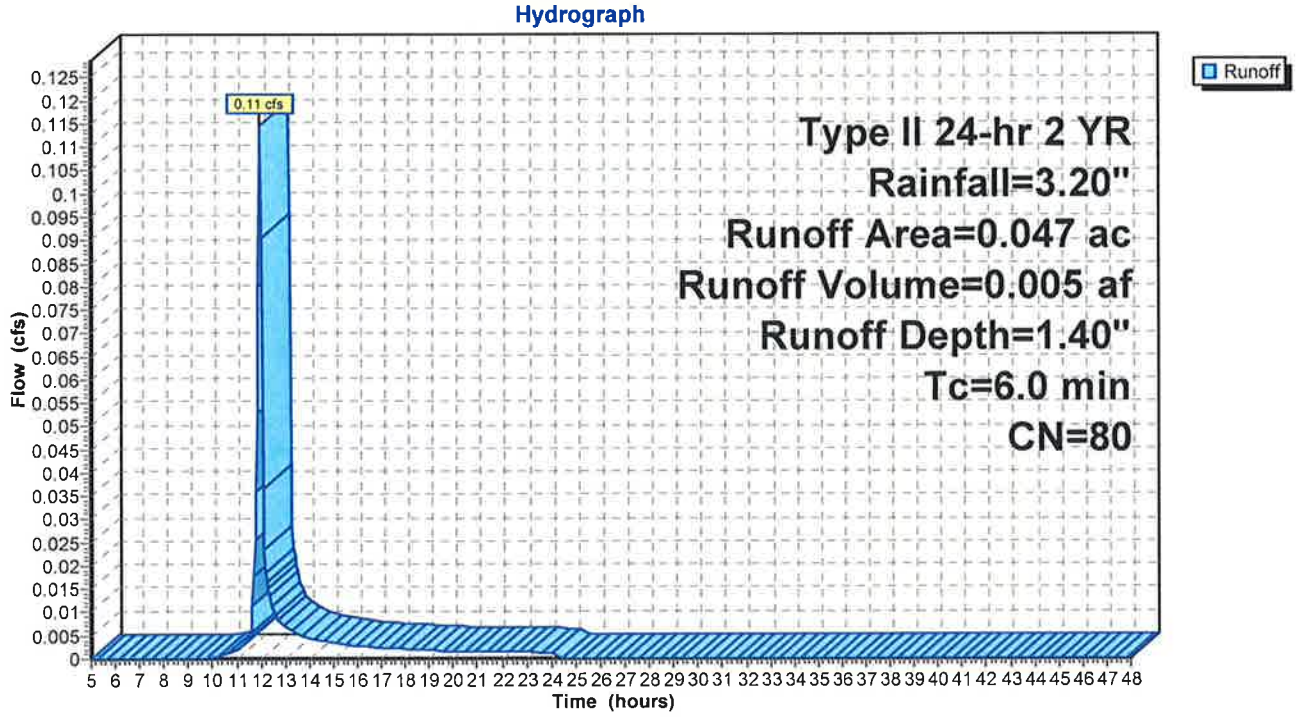
Runoff = 0.11 cfs @ 11.98 hrs, Volume= 0.005 af, Depth= 1.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.044	80	>75% Grass cover, Good, HSG D
0.001	61	>75% Grass cover, Good, HSG B
0.002	98	Paved parking & roofs
0.047	80	Weighted Average

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

Subcatchment4: Subarea 4



Subcatchment 5: Subarea 5

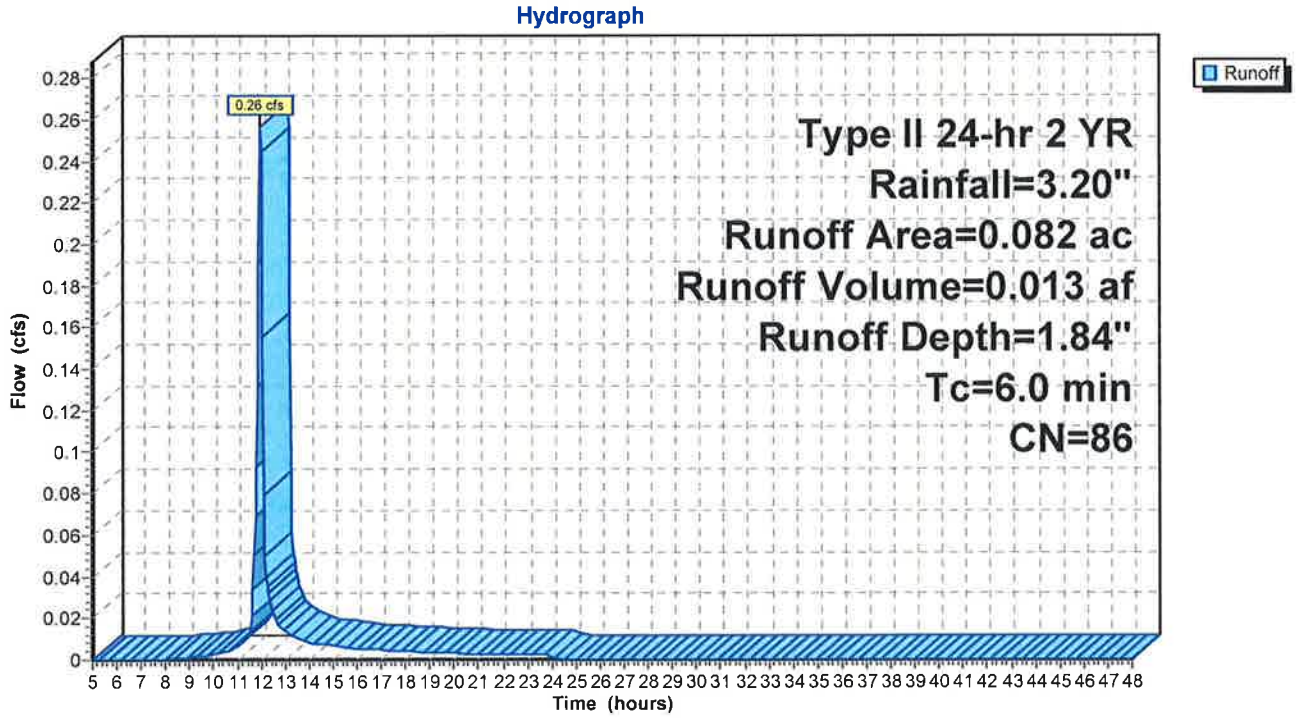
Runoff = 0.26 cfs @ 11.97 hrs, Volume= 0.013 af, Depth= 1.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=3.20"

Area (ac)	CN	Description
0.026	61	>75% Grass cover, Good, HSG B
0.056	98	Paved parking & roofs
0.082	86	Weighted Average

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

Subcatchment 5: Subarea 5



Pond 1P: New CB (AP 1)

[57] Hint: Peaked at 60.06' (Flood elevation advised)
[80] Warning: Exceeded Pond BIO by 1.61' @ 10.65 hrs (0.06 cfs)

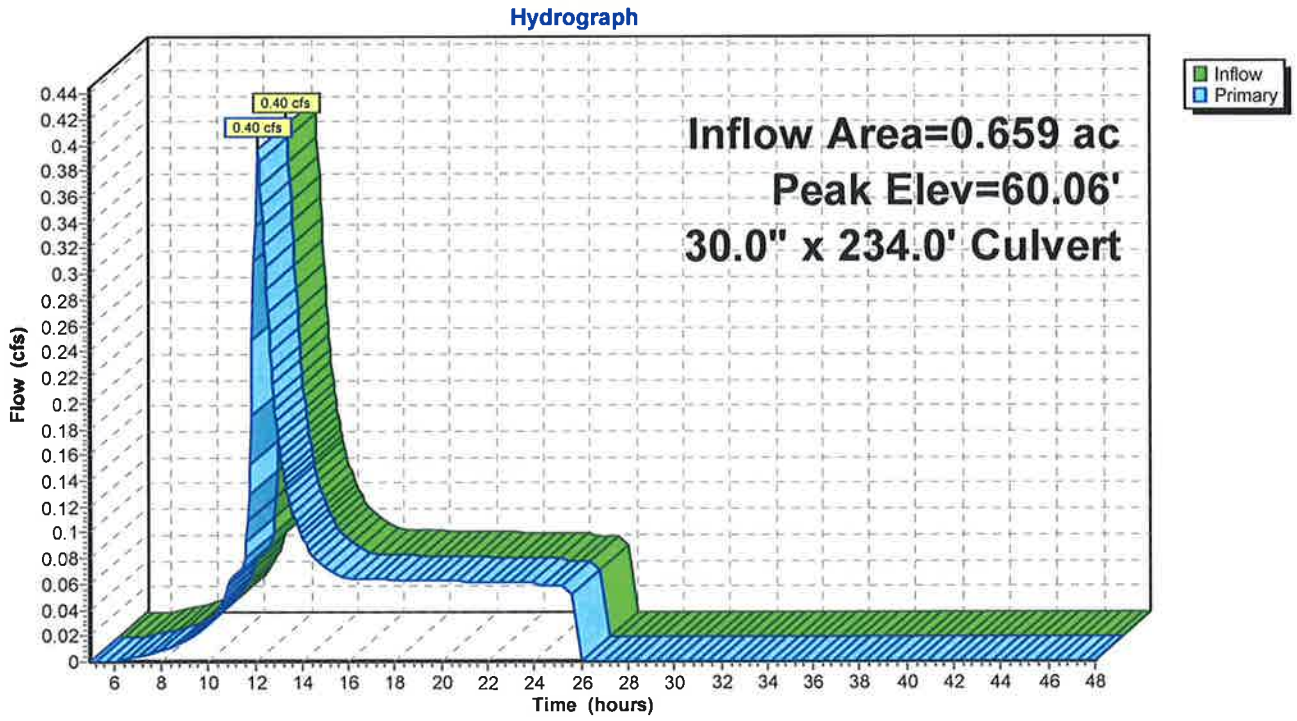
Inflow Area =	0.659 ac,	Inflow Depth =	2.05"	for	2 YR event	
Inflow =	0.40 cfs @	12.12 hrs,	Volume=		0.113 af	
Outflow =	0.40 cfs @	12.12 hrs,	Volume=		0.113 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.40 cfs @	12.12 hrs,	Volume=		0.113 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 60.06' @ 12.12 hrs
Plug-Flow detention time= 0.0 min calculated for 0.113 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (977.0 - 977.0)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=0.39 cfs @ 12.12 hrs HW=60.06' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.39 cfs @ 0.1 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

Inflow Area =	0.577 ac,	Inflow Depth =	2.08"	for	2 YR event
Inflow =	2.02 cfs @	11.97 hrs,	Volume=	0.100 af	
Outflow =	0.34 cfs @	12.18 hrs,	Volume=	0.100 af,	Atten= 83%, Lag= 12.5 min
Primary =	0.34 cfs @	12.18 hrs,	Volume=	0.100 af	
Secondary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 61.61' @ 12.18 hrs Surf.Area= 900 sf Storage= 1,787 cf
Plug-Flow detention time= 188.2 min calculated for 0.100 af (100% of inflow)
Center-of-Mass det. time= 188.7 min (996.7 - 808.0)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,006 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	882 cf	**20.00'W x 45.00'L x 2.45'H Prismatoid** 2,205 cf Overall x 40.0% Voids
		5,888 cf	Total Available Storage

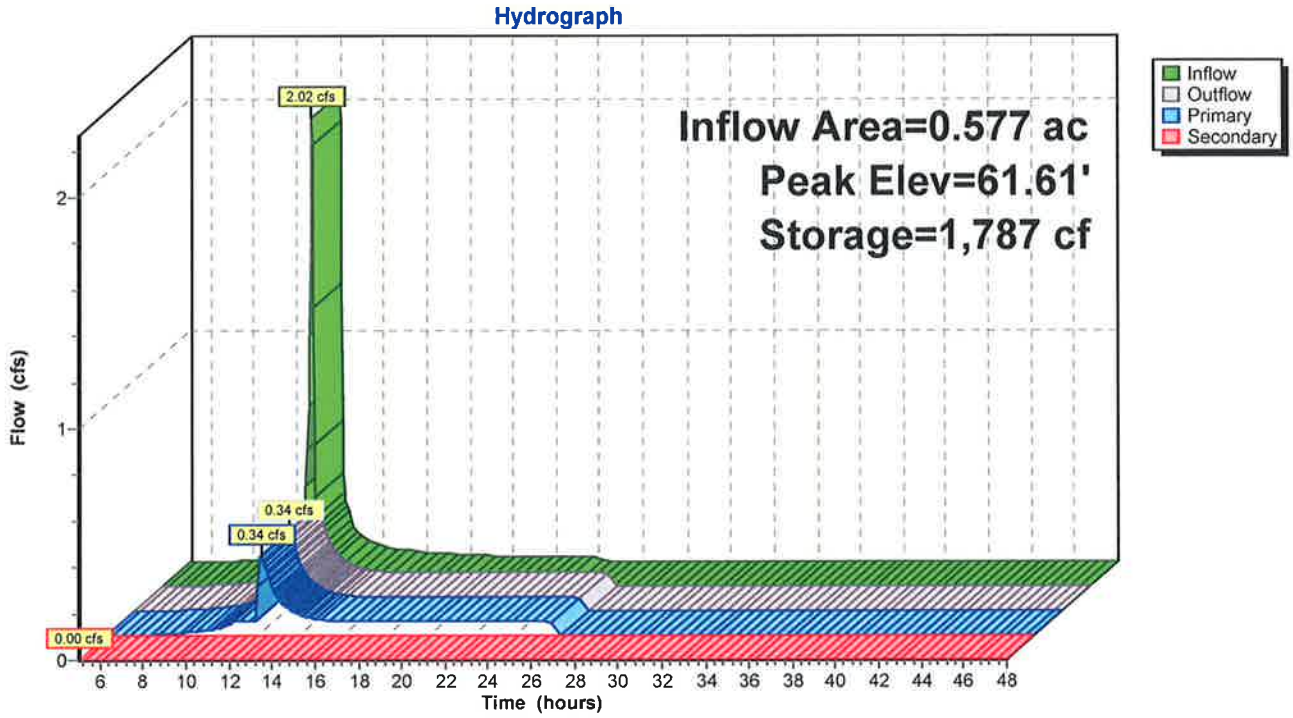
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	830	117.0	0	0	830
62.00	1,776	165.0	1,401	1,401	1,918
63.00	3,542	357.0	2,609	4,009	9,898
63.25	4,446	410.0	996	5,006	13,134

#	Routing	Invert	Outlet Devices
1	Primary	0.00'	**0.003930 fpm Exfiltration over entire Surface area**
2	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
3	Device 2	61.25'	**5.5" Vert. Orifice/Grate** C= 0.600
4	Device 2	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
5	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.34 cfs @ 12.18 hrs HW=61.61' TW=60.06' (Dynamic Tailwater)
- **1=Exfiltration** (Exfiltration Controls 0.06 cfs)
- **2=Culvert** (Passes 0.28 cfs of 7.35 cfs potential flow)
  - **3=Orifice/Grate** (Orifice Controls 0.28 cfs @ 2.0 fps)
  - **4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=58.45' TW=57.56' (Dynamic Tailwater)
- **5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

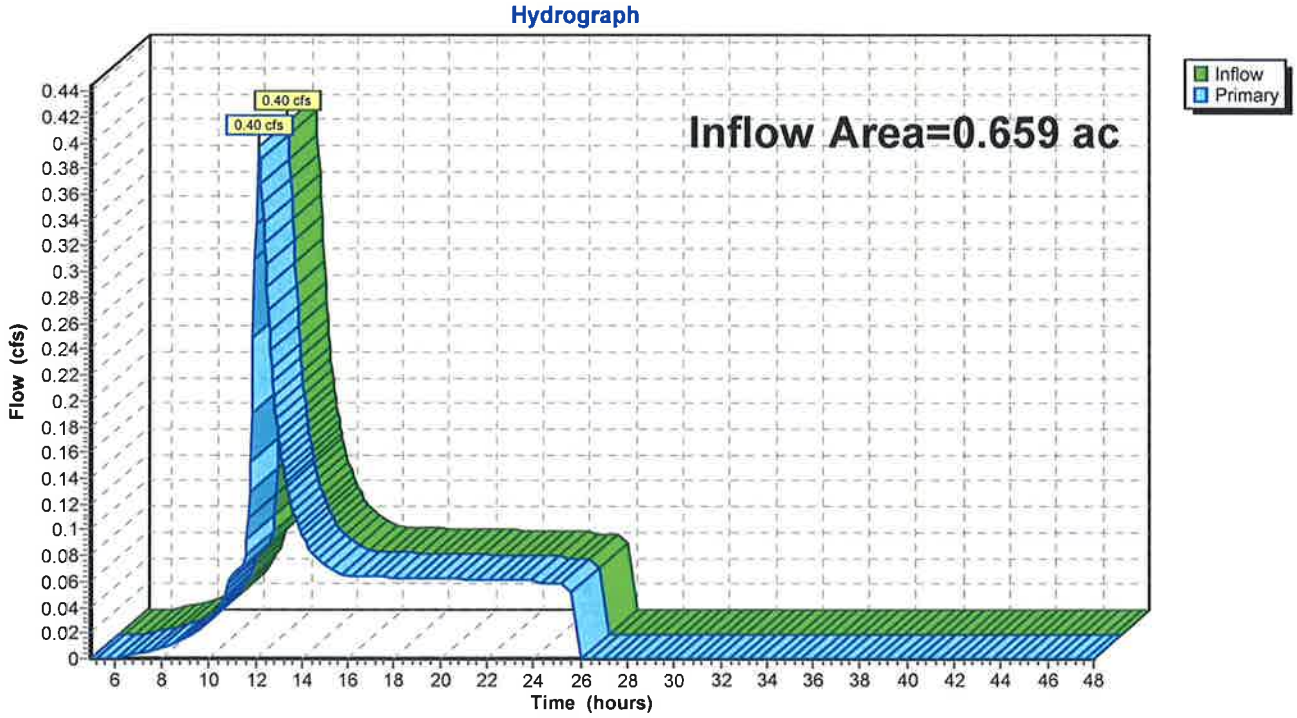
[80] Warning: Exceeded Pond 1P by 2.50' @ 5.00 hrs (26.43 cfs)

Inflow Area =	0.659 ac,	Inflow Depth =	2.05"	for	2 YR event
Inflow =	0.40 cfs @	12.12 hrs,	Volume=	0.113 af	
Primary =	0.40 cfs @	12.12 hrs,	Volume=	0.113 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'

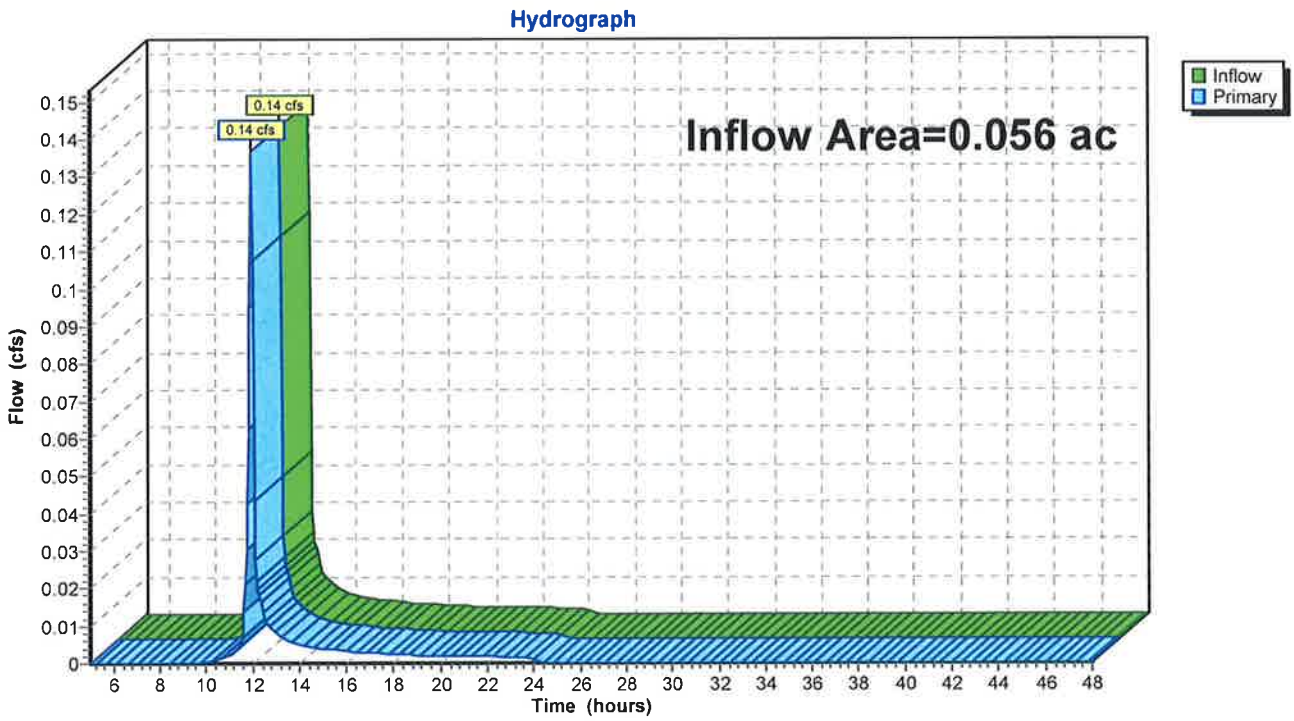


Link AP3: Analysis Point 3

Inflow Area = 0.056 ac, Inflow Depth = 1.40" for 2 YR event
Inflow = 0.14 cfs @ 11.98 hrs, Volume= 0.007 af
Primary = 0.14 cfs @ 11.98 hrs, Volume= 0.007 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP3: Analysis Point 3

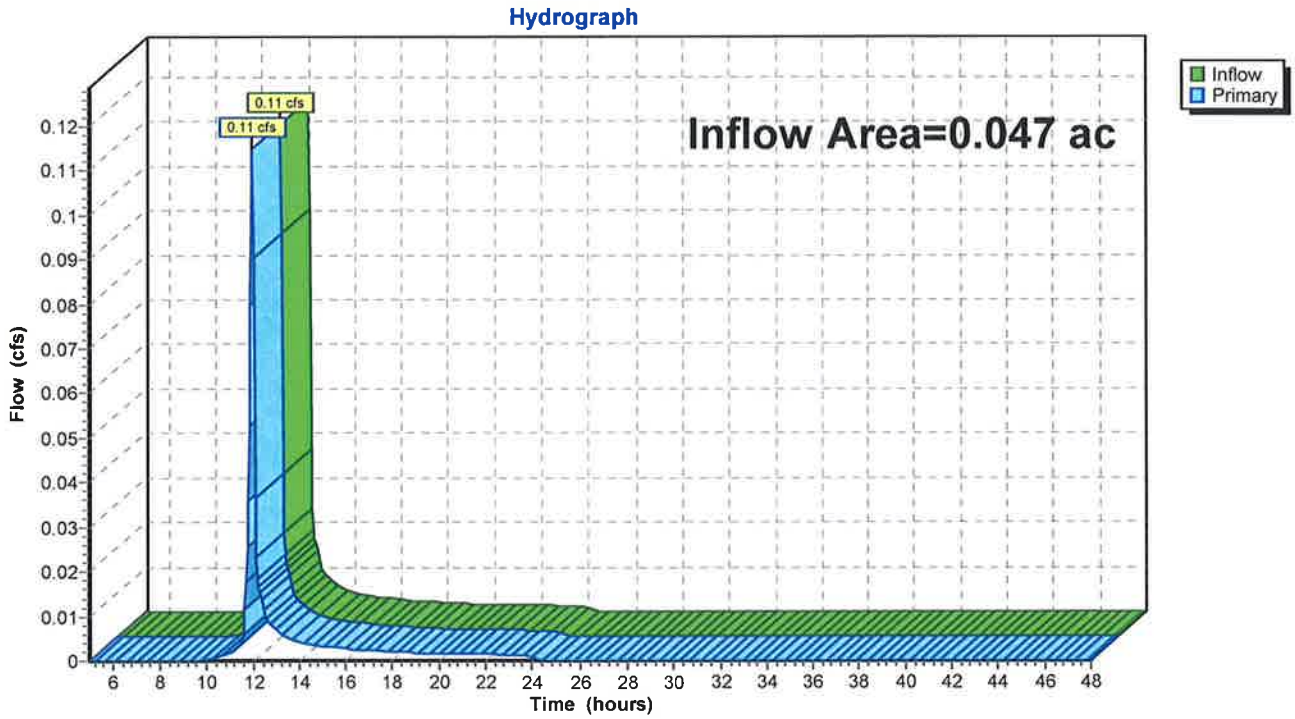


Link AP4: Analysis Point 4

Inflow Area = 0.047 ac, Inflow Depth = 1.40" for 2 YR event
Inflow = 0.11 cfs @ 11.98 hrs, Volume= 0.005 af
Primary = 0.11 cfs @ 11.98 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP4: Analysis Point 4



Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.577 ac Runoff Depth=3.58"
Tc=6.0 min CN=89 Runoff=3.37 cfs 0.172 af

Subcatchment 3: Subarea 3 Runoff Area=0.056 ac Runoff Depth=2.72"
Tc=6.0 min CN=80 Runoff=0.26 cfs 0.013 af

Subcatchment 4: Subarea 4 Runoff Area=0.047 ac Runoff Depth=2.72"
Tc=6.0 min CN=80 Runoff=0.22 cfs 0.011 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=3.28"
Tc=6.0 min CN=86 Runoff=0.45 cfs 0.022 af

Pond 1P: New CB (AP 1) Peak Elev=60.06' Inflow=1.11 cfs 0.195 af
30.0" x 234.0' Culvert Outflow=1.11 cfs 0.195 af

Pond BIO: Bioretention w/ Overflow Peak Elev=62.28' Storage=3,006 cf Inflow=3.37 cfs 0.172 af
Primary=0.77 cfs 0.172 af Secondary=0.00 cfs 0.000 af Outflow=0.77 cfs 0.172 af

Link 1L: Tailwater Condition = 60.06' Inflow=1.11 cfs 0.195 af
Primary=1.11 cfs 0.195 af

Link AP3: Analysis Point 3 Inflow=0.26 cfs 0.013 af
Primary=0.26 cfs 0.013 af

Link AP4: Analysis Point 4 Inflow=0.22 cfs 0.011 af
Primary=0.22 cfs 0.011 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.218 af Average Runoff Depth = 3.43"

Subcatchment1: Subarea 1

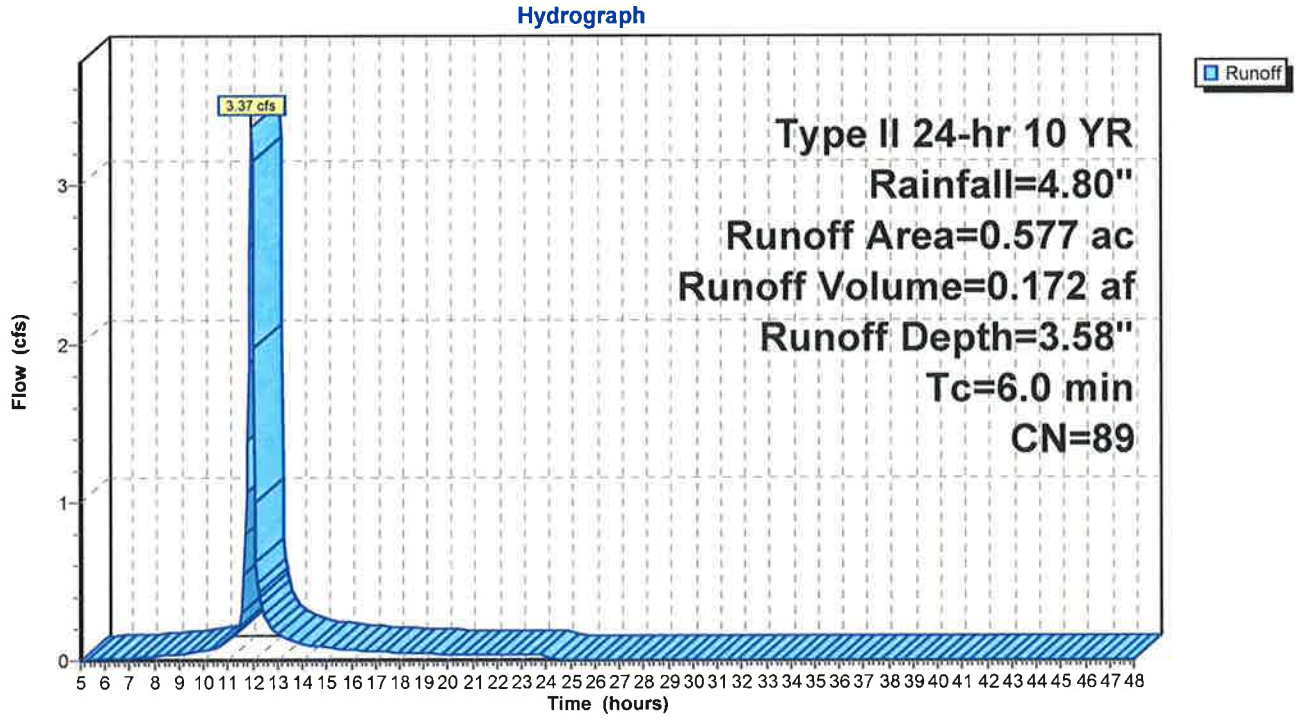
Runoff = 3.37 cfs @ 11.97 hrs, Volume= 0.172 af, Depth= 3.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.317	98	Paved parking & roofs
0.232	80	>75% Grass cover, Good, HSG D
0.028	61	>75% Grass cover, Good, HSG B
0.577	89	Weighted Average

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

Subcatchment1: Subarea 1



Subcatchment3: Subarea 3

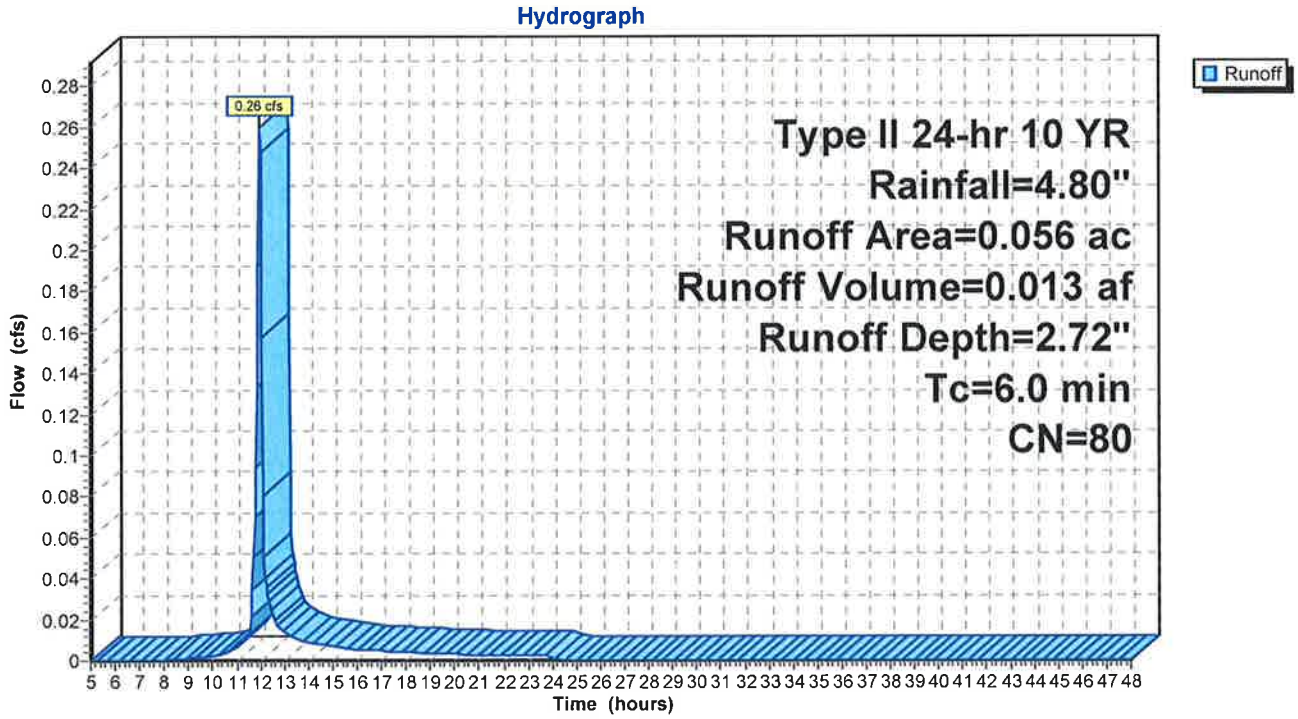
Runoff = 0.26 cfs @ 11.97 hrs, Volume= 0.013 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.049	80	>75% Grass cover, Good, HSG D
0.007	77	Woods, Good, HSG D
0.056	80	Weighted Average

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

Subcatchment3: Subarea 3



Subcatchment4: Subarea 4

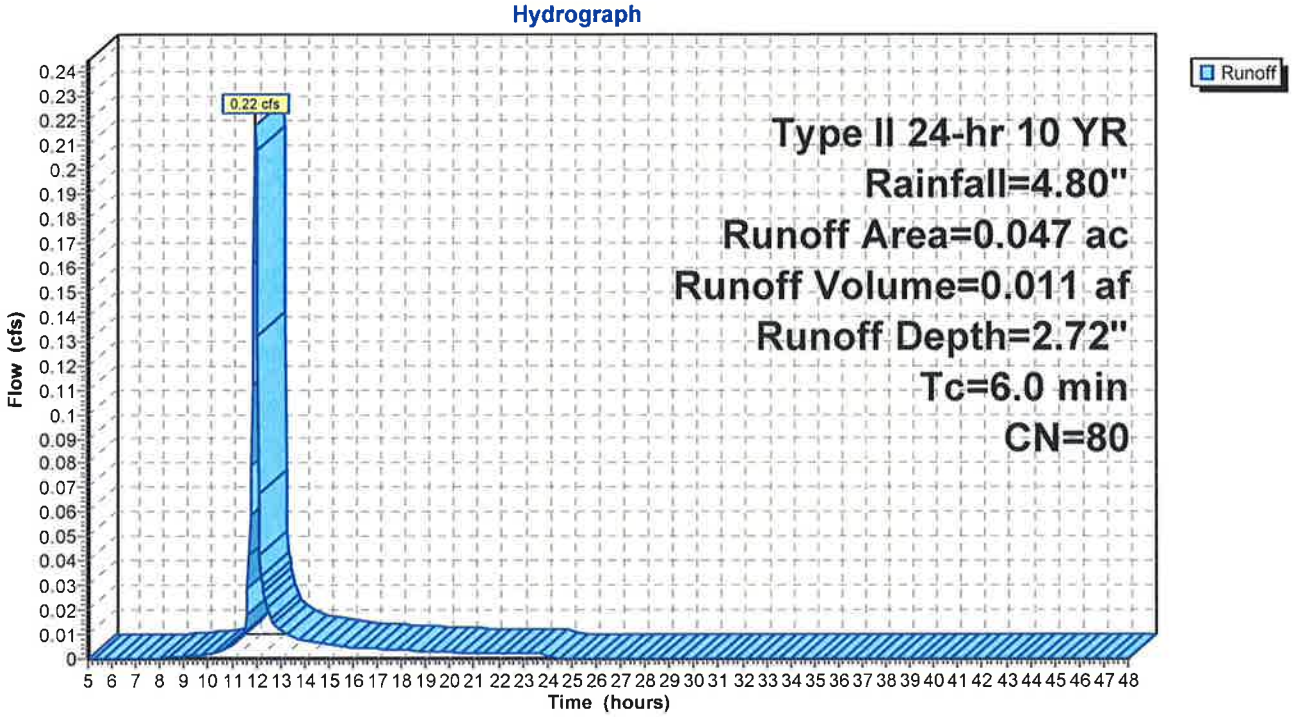
Runoff = 0.22 cfs @ 11.97 hrs, Volume= 0.011 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.044	80	>75% Grass cover, Good, HSG D
0.001	61	>75% Grass cover, Good, HSG B
0.002	98	Paved parking & roofs
0.047	80	Weighted Average

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

Subcatchment4: Subarea 4



Subcatchment5: Subarea 5

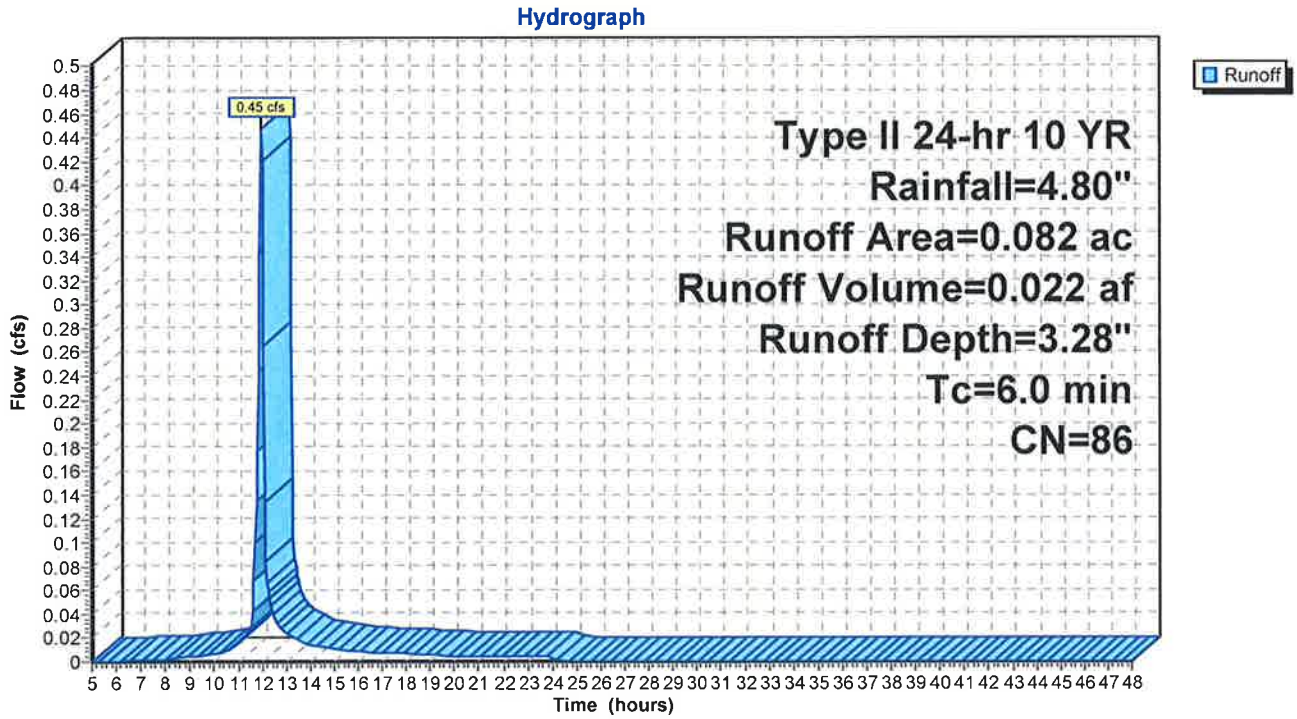
Runoff = 0.45 cfs @ 11.97 hrs, Volume= 0.022 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=4.80"

Area (ac)	CN	Description
0.026	61	>75% Grass cover, Good, HSG B
0.056	98	Paved parking & roofs
0.082	86	Weighted Average

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

Subcatchment5: Subarea 5



Pond 1P: New CB (AP 1)

[82] Warning: Early inflow requires earlier time span
[57] Hint: Peaked at 60.06' (Flood elevation advised)
[80] Warning: Exceeded Pond BIO by 1.61' @ 9.45 hrs (0.06 cfs)

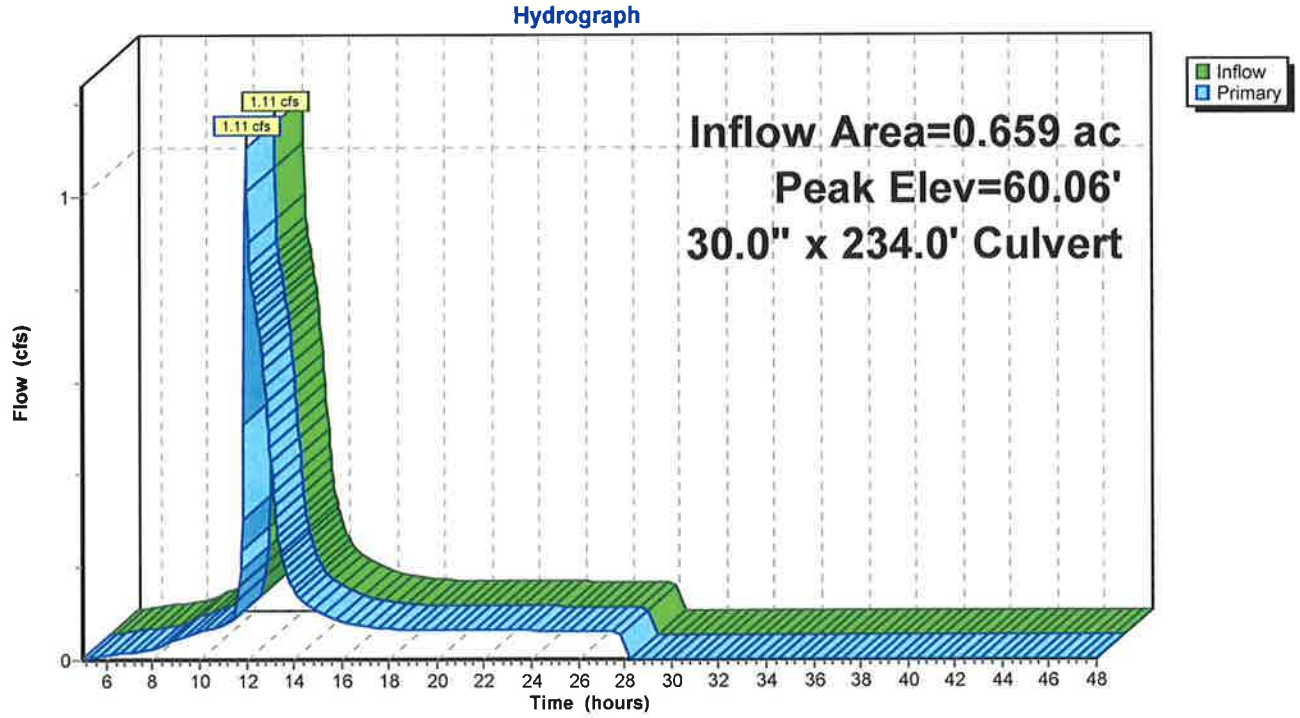
Inflow Area =	0.659 ac,	Inflow Depth =	3.54"	for	10 YR event
Inflow =	1.11 cfs @	12.00 hrs,	Volume=	0.195 af	
Outflow =	1.11 cfs @	12.00 hrs,	Volume=	0.195 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.11 cfs @	12.00 hrs,	Volume=	0.195 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 60.06' @ 12.00 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=1.10 cfs @ 12.00 hrs HW=60.06' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.10 cfs @ 0.3 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

Inflow Area =	0.577 ac,	Inflow Depth =	3.58"	for	10 YR event
Inflow =	3.37 cfs @	11.97 hrs,	Volume=	0.172 af	
Outflow =	0.77 cfs @	12.13 hrs,	Volume=	0.172 af,	Atten= 77%, Lag= 10.1 min
Primary =	0.77 cfs @	12.13 hrs,	Volume=	0.172 af	
Secondary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 62.28' @ 12.13 hrs Surf.Area= 900 sf Storage= 3,006 cf
Plug-Flow detention time= 151.1 min calculated for 0.172 af (100% of inflow)
Center-of-Mass det. time= 151.3 min (944.2 - 792.9)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,006 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	882 cf	**20.00'W x 45.00'L x 2.45'H Prismatoid**
			2,205 cf Overall x 40.0% Voids
		5,888 cf	Total Available Storage

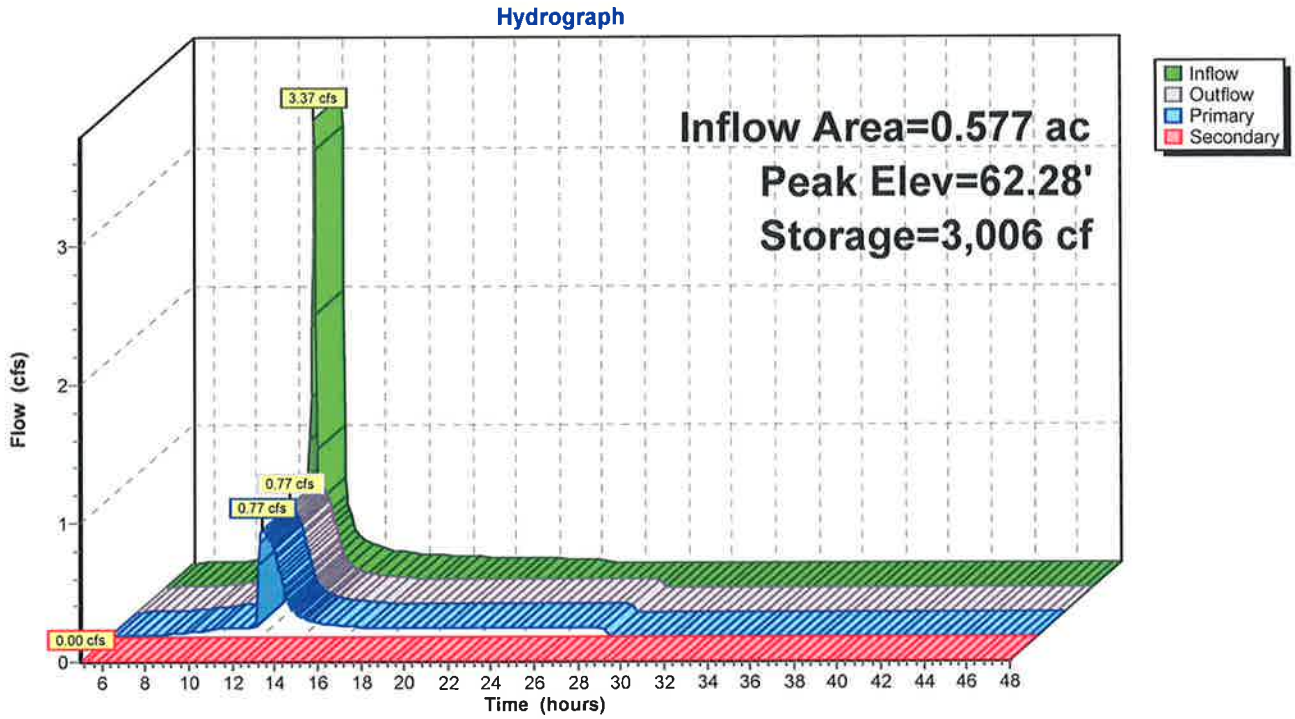
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	830	117.0	0	0	830
62.00	1,776	165.0	1,401	1,401	1,918
63.00	3,542	357.0	2,609	4,009	9,898
63.25	4,446	410.0	996	5,006	13,134

#	Routing	Invert	Outlet Devices
1	Primary	0.00'	**0.003930 fpm Exfiltration over entire Surface area**
2	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500
			Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
3	Device 2	61.25'	**5.5" Vert. Orifice/Grate** C= 0.600
4	Device 2	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
5	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
			Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.77 cfs @ 12.13 hrs HW=62.28' TW=60.06' (Dynamic Tailwater)
- **1=Exfiltration** (Exfiltration Controls 0.06 cfs)
- **2=Culvert** (Passes 0.71 cfs of 8.79 cfs potential flow)
  - **3=Orifice/Grate** (Orifice Controls 0.71 cfs @ 4.3 fps)
  - **4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=58.45' TW=57.59' (Dynamic Tailwater)
- **5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

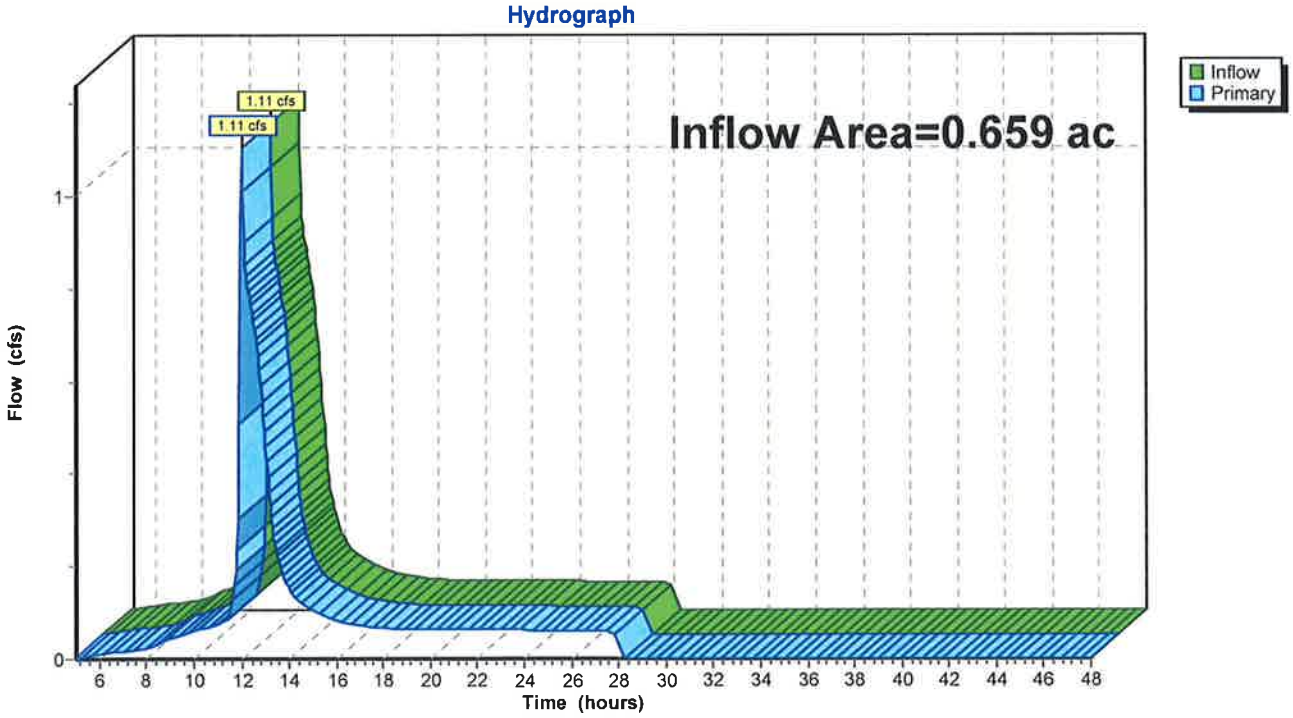
[80] Warning: Exceeded Pond 1P by 2.50' @ 28.10 hrs (26.43 cfs)

Inflow Area =	0.659 ac,	Inflow Depth =	3.54"	for	10 YR event
Inflow =	1.11 cfs @	12.00 hrs,	Volume=	0.195 af	
Primary =	1.11 cfs @	12.00 hrs,	Volume=	0.195 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'

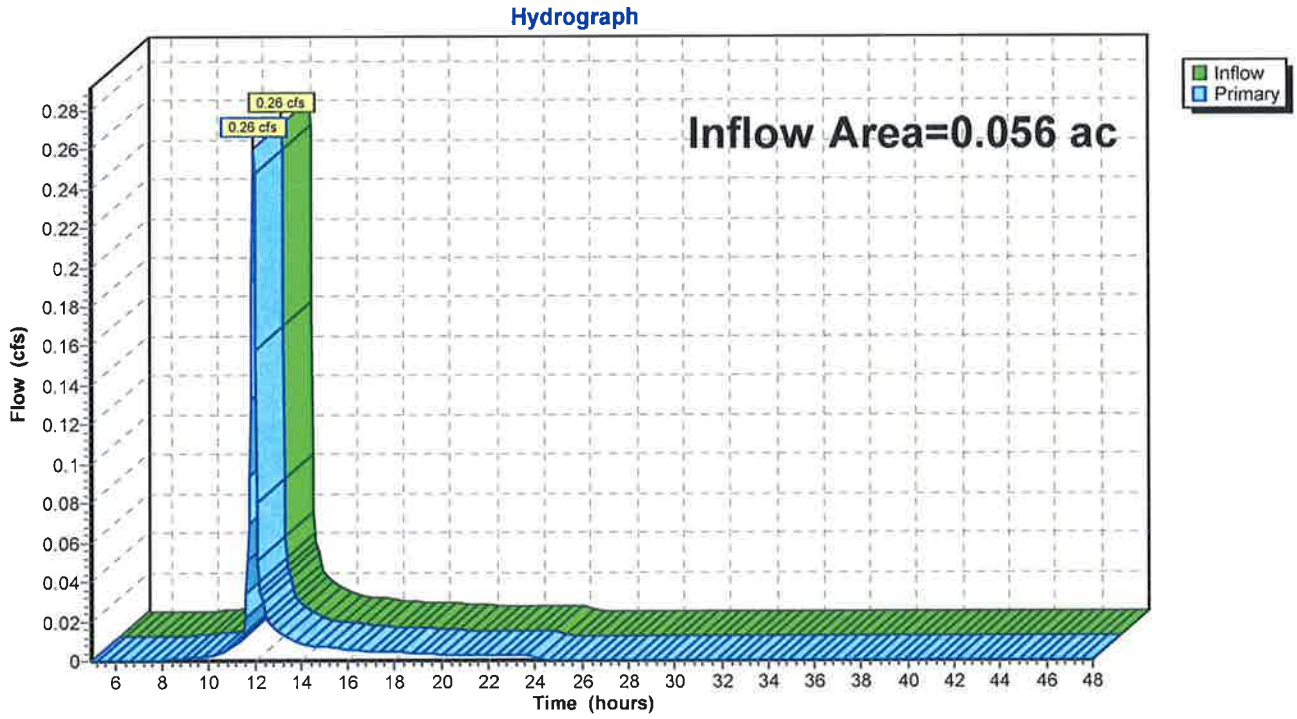


Link AP3: Analysis Point 3

Inflow Area = 0.056 ac, Inflow Depth = 2.72" for 10 YR event
Inflow = 0.26 cfs @ 11.97 hrs, Volume= 0.013 af
Primary = 0.26 cfs @ 11.97 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP3: Analysis Point 3

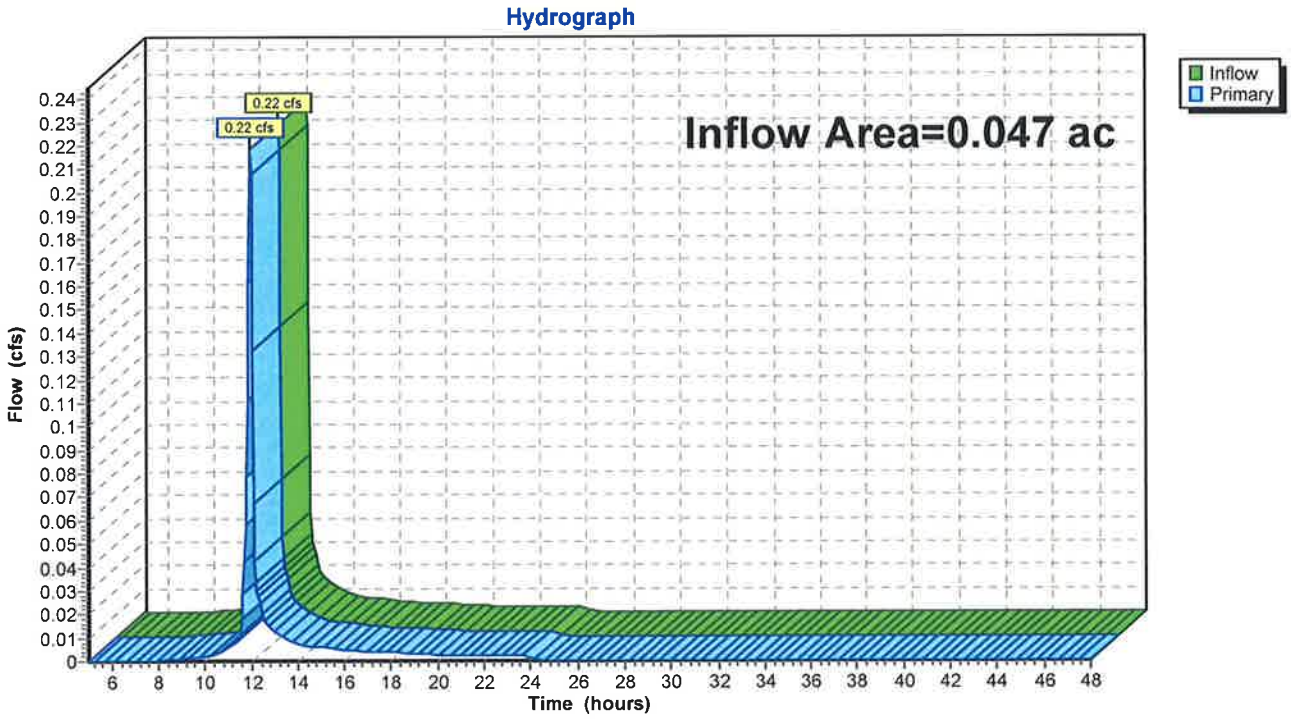


Link AP4: Analysis Point 4

Inflow Area = 0.047 ac, Inflow Depth = 2.72" for 10 YR event
Inflow = 0.22 cfs @ 11.97 hrs, Volume= 0.011 af
Primary = 0.22 cfs @ 11.97 hrs, Volume= 0.011 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP4: Analysis Point 4



Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.577 ac Runoff Depth=6.65"
Tc=6.0 min CN=89 Runoff=6.06 cfs 0.320 af

Subcatchment 3: Subarea 3 Runoff Area=0.056 ac Runoff Depth=5.62"
Tc=6.0 min CN=80 Runoff=0.52 cfs 0.026 af

Subcatchment 4: Subarea 4 Runoff Area=0.047 ac Runoff Depth=5.62"
Tc=6.0 min CN=80 Runoff=0.44 cfs 0.022 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=6.32"
Tc=6.0 min CN=86 Runoff=0.83 cfs 0.043 af

Pond 1P: New CB (AP 1) Peak Elev=60.07' Inflow=2.27 cfs 0.363 af
30.0" x 234.0' Culvert Outflow=2.27 cfs 0.363 af

Pond BIO: Bioretention w/ Overflow Peak Elev=63.21' Storage=5,737 cf Inflow=6.06 cfs 0.320 af
Primary=2.03 cfs 0.320 af Secondary=0.00 cfs 0.000 af Outflow=2.03 cfs 0.320 af

Link 1L: Tailwater Condition = 60.06' Inflow=2.27 cfs 0.363 af
Primary=2.27 cfs 0.363 af

Link AP3: Analysis Point 3 Inflow=0.52 cfs 0.026 af
Primary=0.52 cfs 0.026 af

Link AP4: Analysis Point 4 Inflow=0.44 cfs 0.022 af
Primary=0.44 cfs 0.022 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.411 af Average Runoff Depth = 6.47"

Subcatchment1: Subarea 1

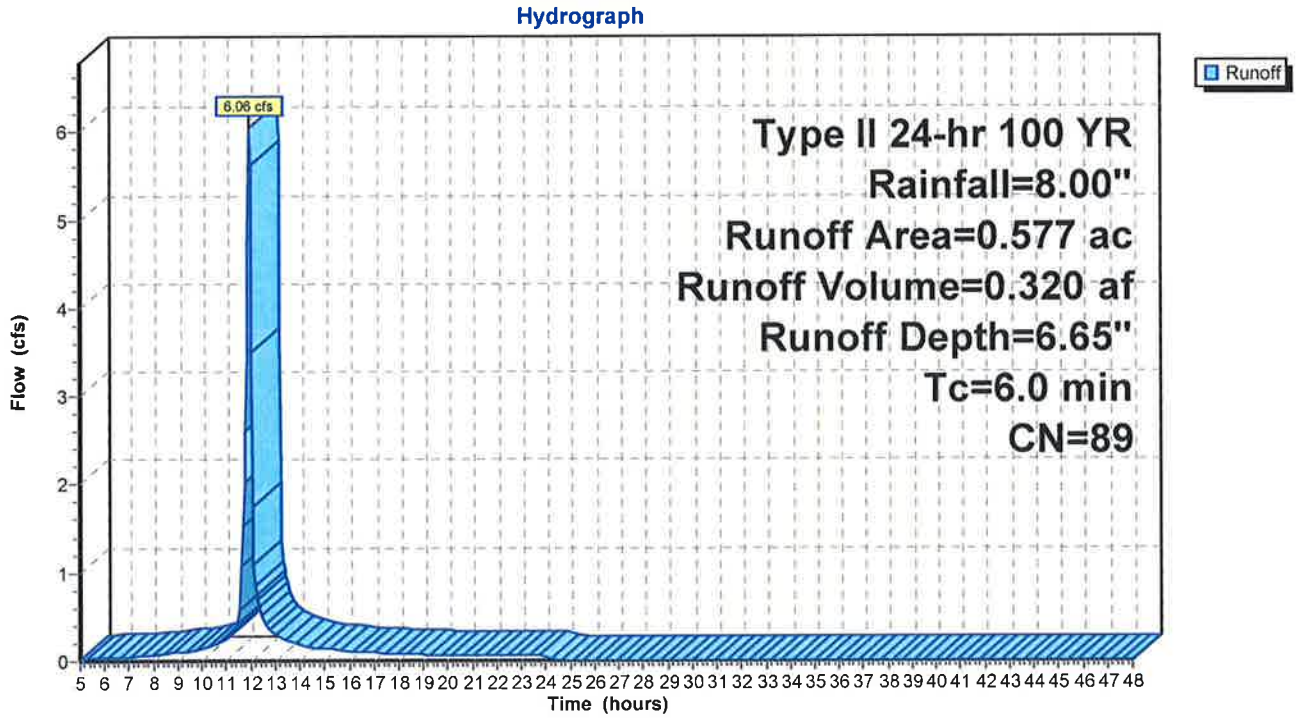
Runoff = 6.06 cfs @ 11.96 hrs, Volume= 0.320 af, Depth= 6.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.317	98	Paved parking & roofs
0.232	80	>75% Grass cover, Good, HSG D
0.028	61	>75% Grass cover, Good, HSG B
0.577	89	Weighted Average

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

Subcatchment1: Subarea 1



Subcatchment3: Subarea 3

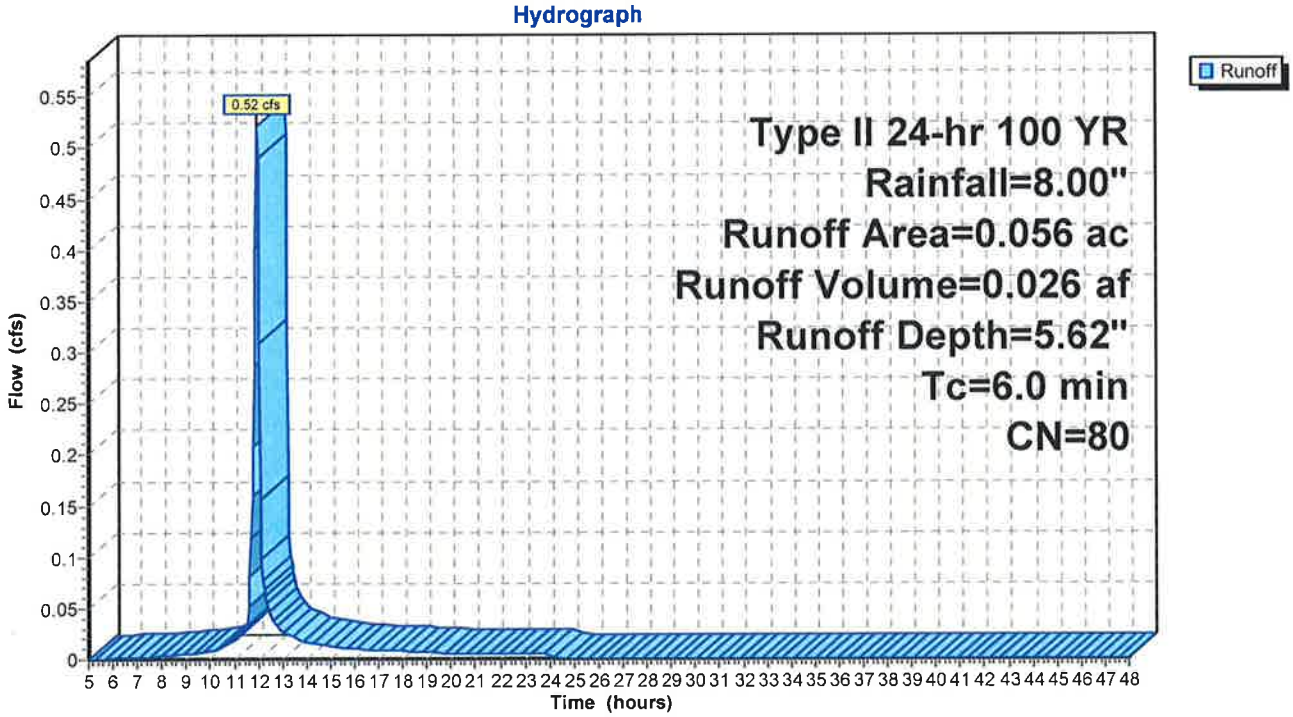
Runoff = 0.52 cfs @ 11.97 hrs, Volume= 0.026 af, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.049	80	>75% Grass cover, Good, HSG D
0.007	77	Woods, Good, HSG D
0.056	80	Weighted Average

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

Subcatchment3: Subarea 3



Subcatchment4: Subarea 4

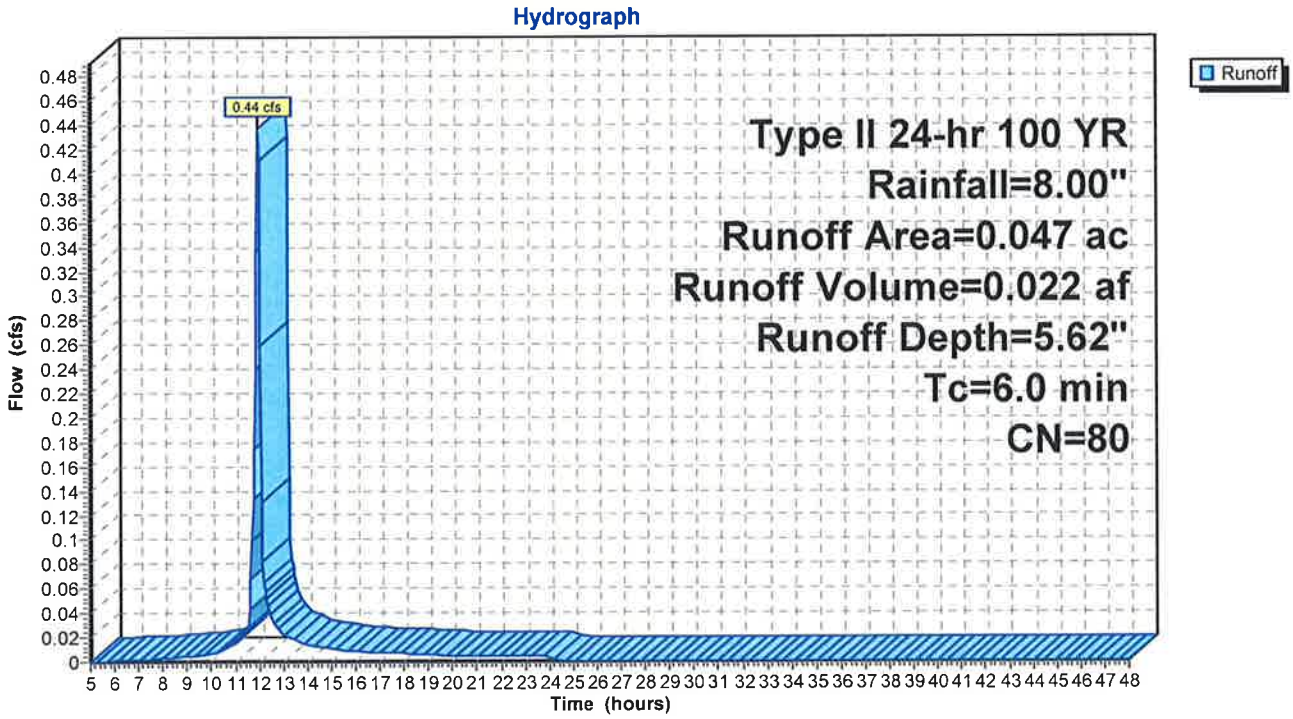
Runoff = 0.44 cfs @ 11.97 hrs, Volume= 0.022 af, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.044	80	>75% Grass cover, Good, HSG D
0.001	61	>75% Grass cover, Good, HSG B
0.002	98	Paved parking & roofs
0.047	80	Weighted Average

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

Subcatchment4: Subarea 4



Subcatchment5: Subarea 5

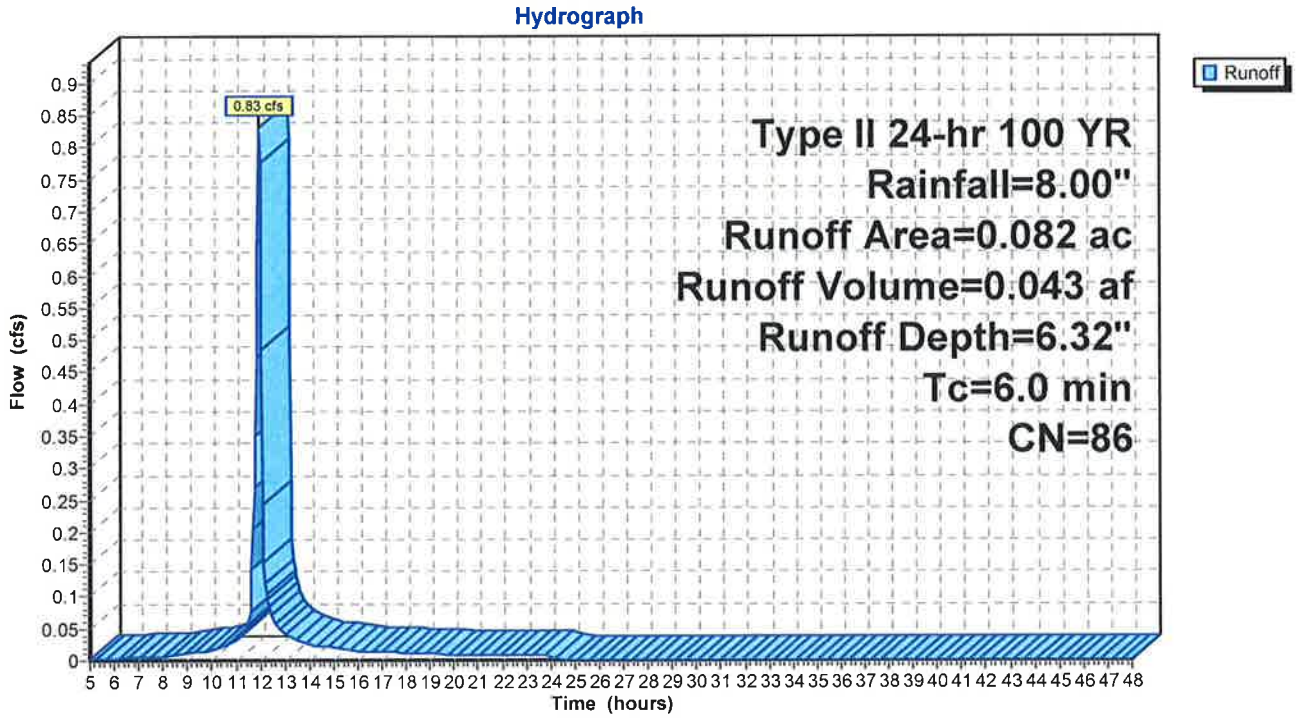
Runoff = 0.83 cfs @ 11.96 hrs, Volume= 0.043 af, Depth= 6.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=8.00"

Area (ac)	CN	Description
0.026	61	>75% Grass cover, Good, HSG B
0.056	98	Paved parking & roofs
0.082	86	Weighted Average

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

Subcatchment5: Subarea 5



Pond 1P: New CB (AP 1)

[82] Warning: Early inflow requires earlier time span
[57] Hint: Peaked at 60.07' (Flood elevation advised)
[80] Warning: Exceeded Pond BIO by 1.61' @ 6.80 hrs (0.06 cfs)

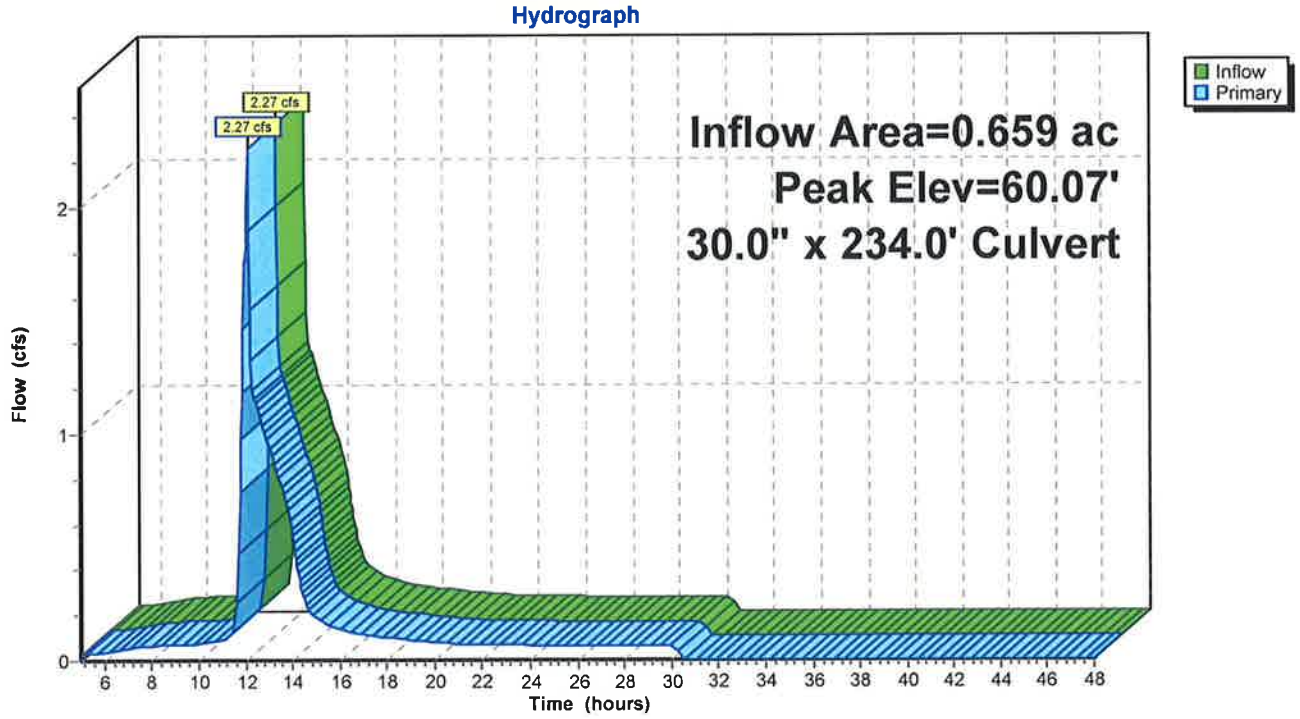
Inflow Area =	0.659 ac,	Inflow Depth =	6.61"	for	100 YR event	
Inflow =	2.27 cfs @	12.09 hrs,	Volume=		0.363 af	
Outflow =	2.27 cfs @	12.09 hrs,	Volume=		0.363 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.27 cfs @	12.09 hrs,	Volume=		0.363 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 60.07' @ 12.10 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=2.24 cfs @ 12.09 hrs HW=60.07' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.24 cfs @ 0.6 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

[82] Warning: Early inflow requires earlier time span

Inflow Area =	0.577 ac,	Inflow Depth =	6.65"	for	100 YR event
Inflow =	6.06 cfs @	11.96 hrs,	Volume=	0.320 af	
Outflow =	2.03 cfs @	12.11 hrs,	Volume=	0.320 af,	Atten= 67%, Lag= 8.6 min
Primary =	2.03 cfs @	12.11 hrs,	Volume=	0.320 af	
Secondary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 63.21' @ 12.11 hrs Surf.Area= 900 sf Storage= 5,737 cf
Plug-Flow detention time= 123.7 min calculated for 0.319 af (100% of inflow)
Center-of-Mass det. time= 124.2 min (903.0 - 778.8)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,006 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	882 cf	**20.00'W x 45.00'L x 2.45'H Prismatoid**
			2,205 cf Overall x 40.0% Voids
		5,888 cf	Total Available Storage

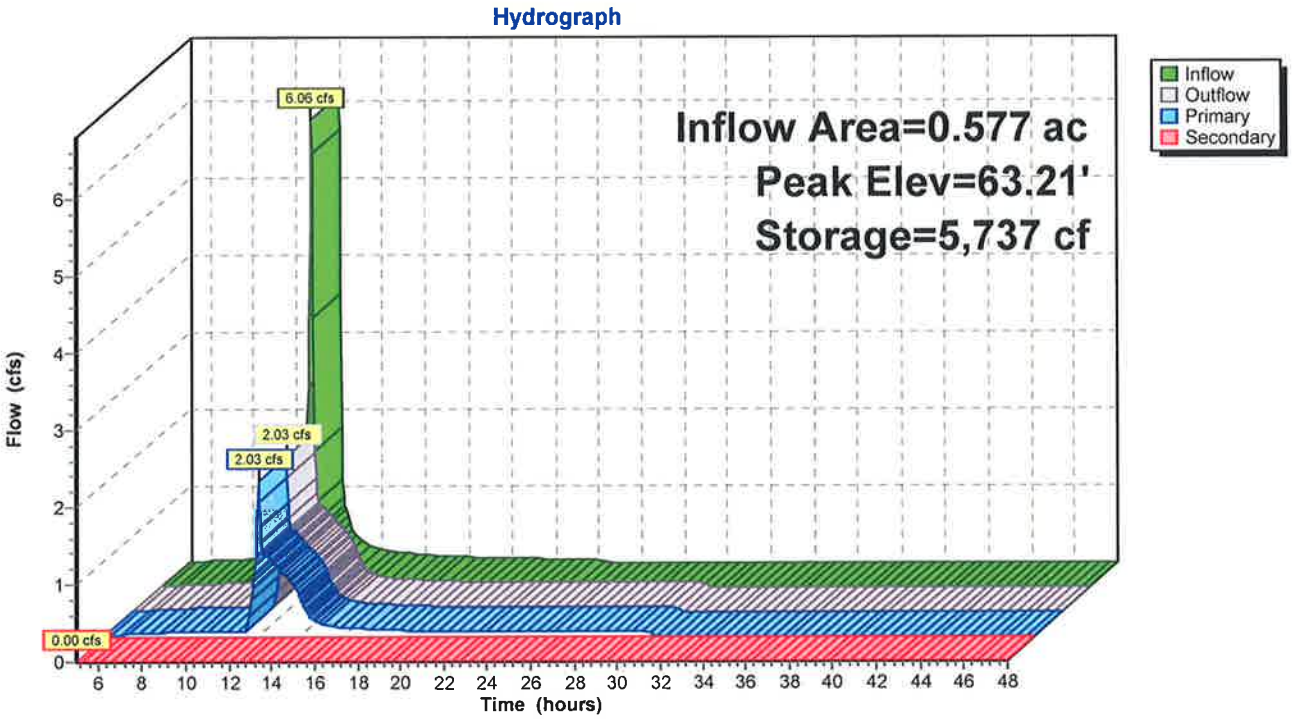
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	830	117.0	0	0	830
62.00	1,776	165.0	1,401	1,401	1,918
63.00	3,542	357.0	2,609	4,009	9,898
63.25	4,446	410.0	996	5,006	13,134

#	Routing	Invert	Outlet Devices
1	Primary	0.00'	**0.003930 fpm Exfiltration over entire Surface area**
2	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500
			Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
3	Device 2	61.25'	**5.5" Vert. Orifice/Grate** C= 0.600
4	Device 2	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
5	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
			Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=1.98 cfs @ 12.11 hrs HW=63.21' TW=60.07' (Dynamic Tailwater)
- **1=Exfiltration** (Exfiltration Controls 0.06 cfs)
- **2=Culvert** (Passes 1.92 cfs of 10.46 cfs potential flow)
  - **3=Orifice/Grate** (Orifice Controls 1.04 cfs @ 6.3 fps)
  - **4=Orifice/Grate** (Weir Controls 0.88 cfs @ 1.0 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=58.45' TW=57.62' (Dynamic Tailwater)
- **5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

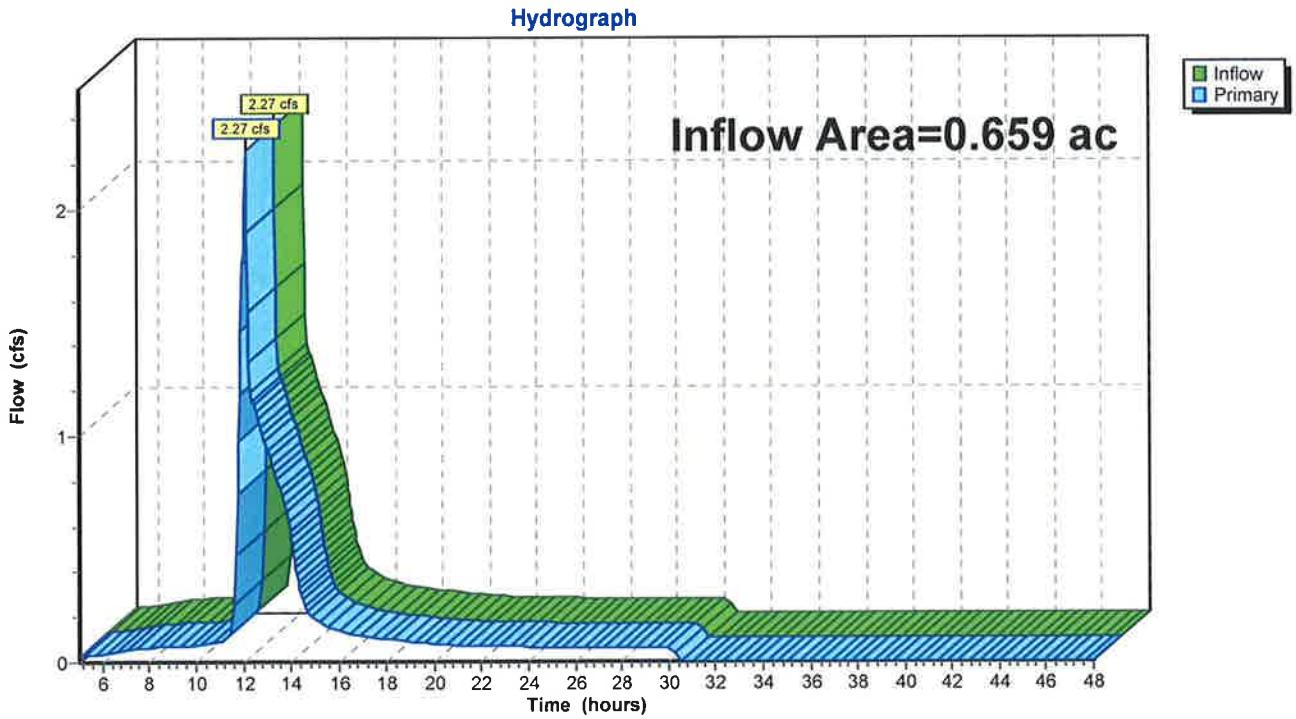
[80] Warning: Exceeded Pond 1P by 2.50' @ 30.35 hrs (26.43 cfs)

Inflow Area =	0.659 ac,	Inflow Depth =	6.61"	for	100 YR event
Inflow =	2.27 cfs @	12.09 hrs,	Volume=	0.363 af	
Primary =	2.27 cfs @	12.09 hrs,	Volume=	0.363 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'

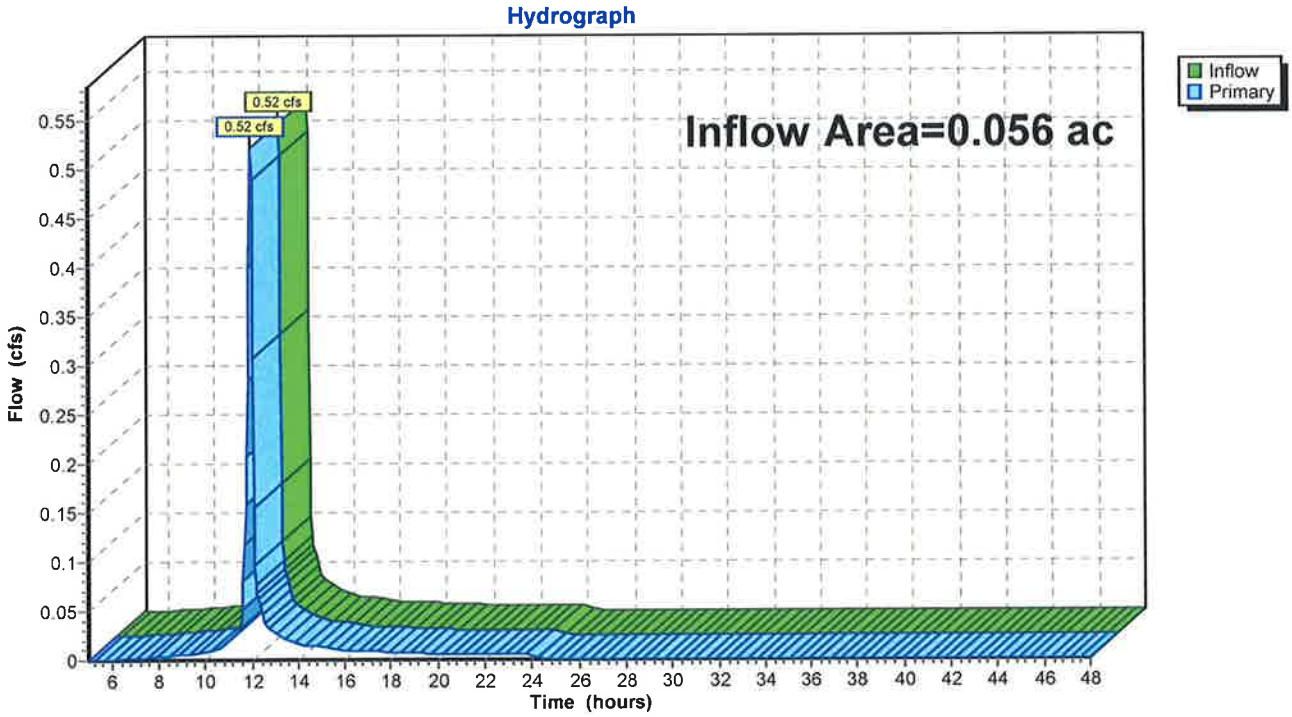


Link AP3: Analysis Point 3

Inflow Area = 0.056 ac, Inflow Depth = 5.62" for 100 YR event
Inflow = 0.52 cfs @ 11.97 hrs, Volume= 0.026 af
Primary = 0.52 cfs @ 11.97 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Link AP3: Analysis Point 3

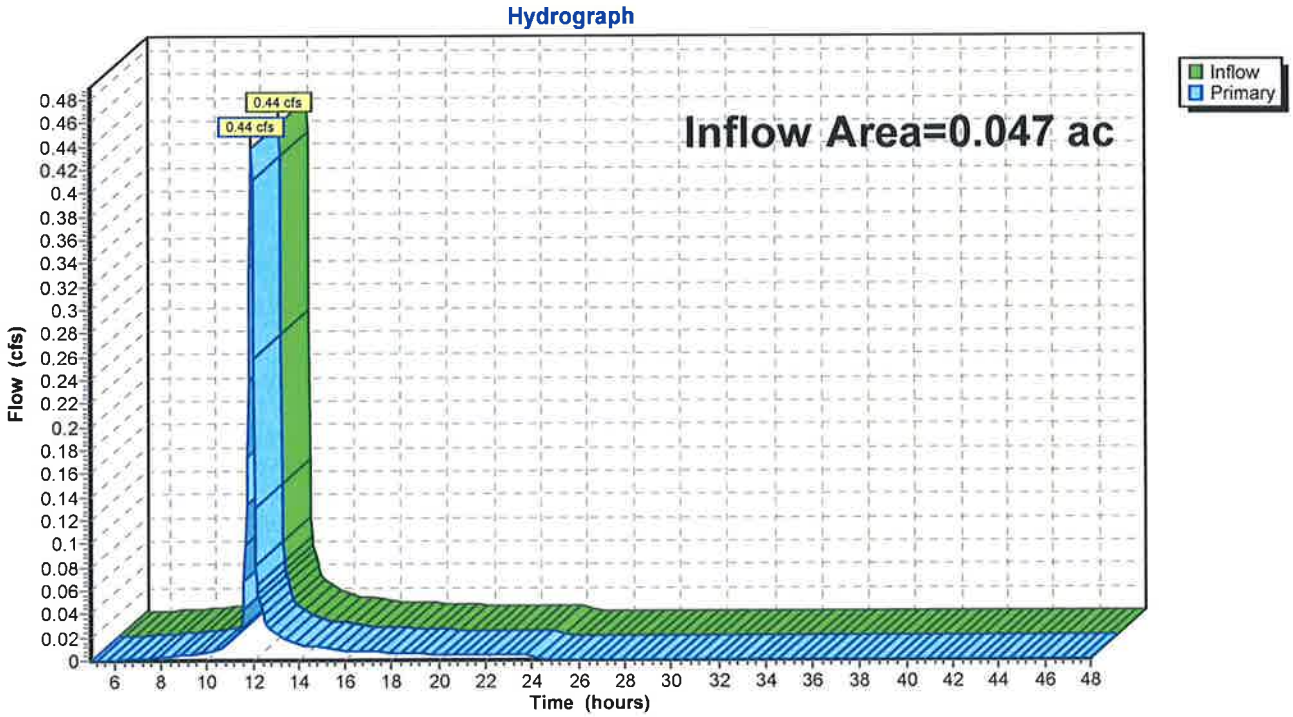


Link AP4: Analysis Point 4

Inflow Area = 0.047 ac, Inflow Depth = 5.62" for 100 YR event
Inflow = 0.44 cfs @ 11.97 hrs, Volume= 0.022 af
Primary = 0.44 cfs @ 11.97 hrs, Volume= 0.022 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

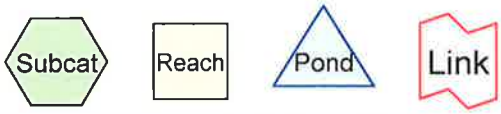
Link AP4: Analysis Point 4



Effective April 2016

New CB (AP 1)

Bioretention w/ structure blocked



Drainage Diagram for 0348-Post Dev, 100%blocked
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

Effective April 2016

Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Pond 1P: New CB (AP 1) Peak Elev=57.35' Inflow=0.89 cfs 0.315 af
Primary=0.89 cfs 0.315 af Secondary=0.00 cfs 0.000 af Outflow=0.89 cfs 0.315 af

Pond BIO: Bioretention w/ structure blocked Peak Elev=63.07' Storage=7,684 cf Inflow=6.06 cfs 0.322 af
Primary=0.06 cfs 0.207 af Secondary=0.46 cfs 0.065 af Outflow=0.51 cfs 0.272 af

Pond 1P: New CB (AP 1)

[57] Hint: Peaked at 57.35' (Flood elevation advised)

Inflow Area =	0.659 ac,	Inflow Depth =	5.73"	for	100 YR event
Inflow =	0.89 cfs @	11.96 hrs,	Volume=	0.315 af	
Outflow =	0.89 cfs @	11.96 hrs,	Volume=	0.315 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.89 cfs @	11.96 hrs,	Volume=	0.315 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

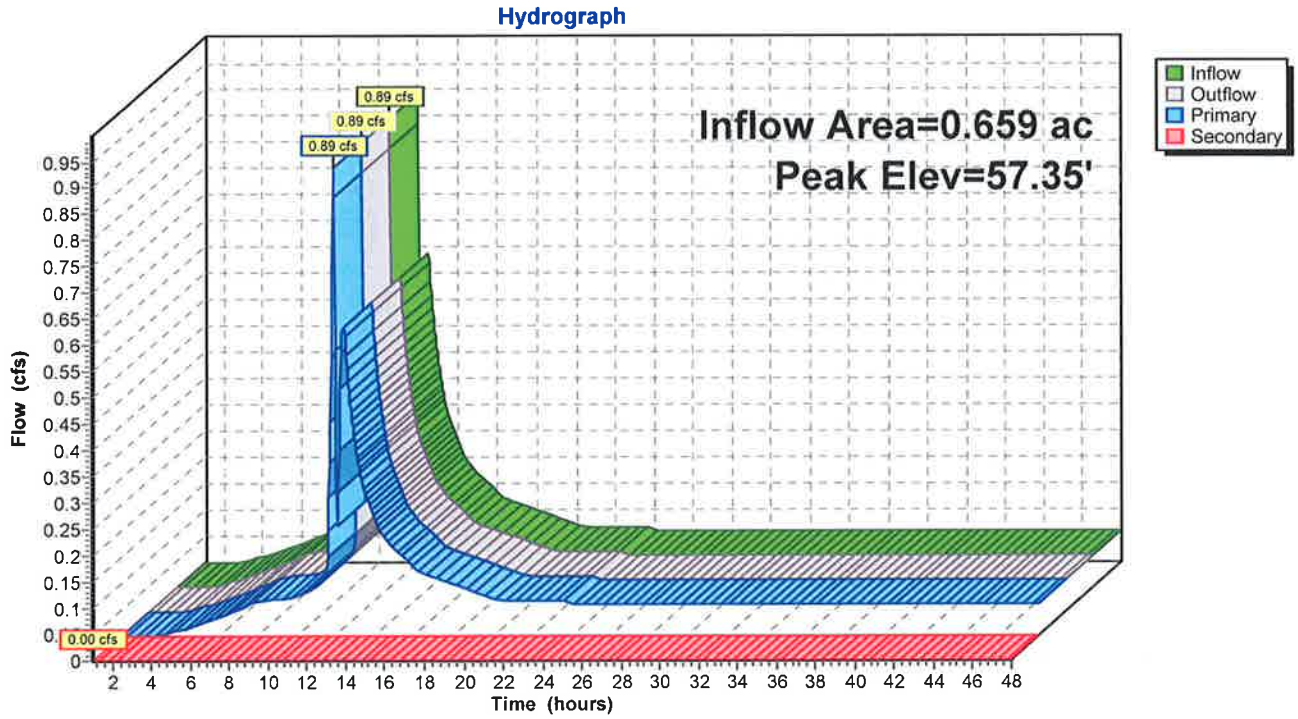
Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 57.35' @ 11.96 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	56.96'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0051 '/' n= 0.012 Cc= 0.900
2	Secondary	62.44'	**3.00' x 4.00' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=0.87 cfs @ 11.96 hrs HW=57.35' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.87 cfs @ 2.7 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=56.96' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ structure blocked

Inflow Area =	0.577 ac,	Inflow Depth =	6.69"	for	100 YR event
Inflow =	6.06 cfs @	11.96 hrs,	Volume=	0.322 af	
Outflow =	0.51 cfs @	12.47 hrs,	Volume=	0.272 af,	Atten= 91%, Lag= 30.6 min
Primary =	0.06 cfs @	8.05 hrs,	Volume=	0.207 af	
Secondary =	0.46 cfs @	12.47 hrs,	Volume=	0.065 af	

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 63.07' @ 12.47 hrs Surf.Area= 900 sf Storage= 7,684 cf
Plug-Flow detention time= 717.2 min calculated for 0.271 af (84% of inflow)
Center-of-Mass det. time= 649.2 min (1,424.9 - 775.7)

#	Invert	Avail.Storage	Storage Description
1	60.75'	8,938 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	57.75'	1,080 cf	**20.00'W x 45.00'L x 3.00'H Prismatoid** 2,700 cf Overall x 40.0% Voids
		10,018 cf	Total Available Storage

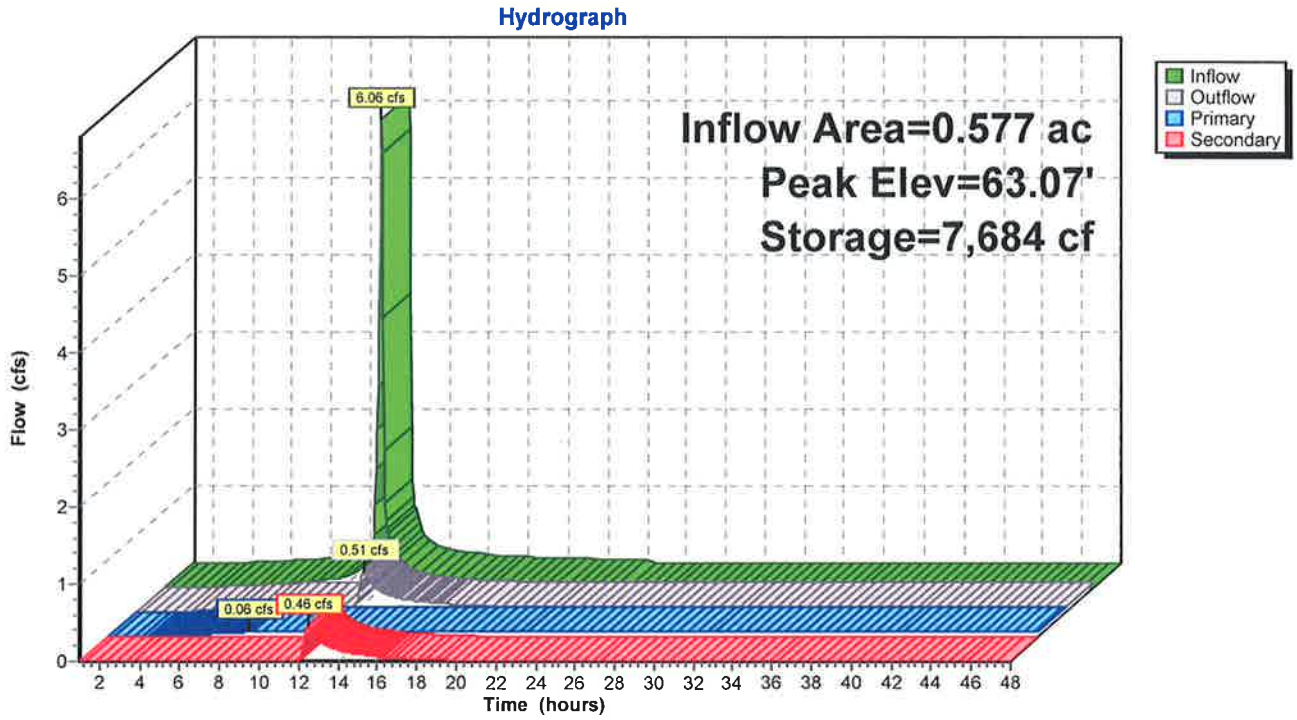
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.75	830	117.0	0	0	830
61.00	920	121.0	219	219	911
61.50	1,271	140.0	545	764	1,311
62.00	3,643	225.0	1,178	1,942	3,782
63.00	4,971	337.0	4,290	6,232	8,799
63.50	5,868	421.0	2,707	8,938	13,869

#	Routing	Invert	Outlet Devices
1	Primary	0.00'	**0.003930 fpm Exfiltration over entire Surface area**
2	Secondary	63.00'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.06 cfs @ 8.05 hrs HW=57.81' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Secondary OutFlow Max=0.43 cfs @ 12.47 hrs HW=63.07' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.43 cfs @ 0.6 fps)

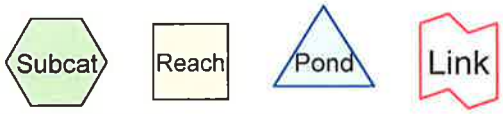
Pond BIO: Bioretention w/ structure blocked



Effective April 2016

New CB (AP 1)

Sediment Trap



Drainage Diagram for 0348-Sediment Trap
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Pond 1P: New CB (AP 1) Peak Elev=57.11' Inflow=0.12 cfs 0.006 af
Primary=0.12 cfs 0.006 af Secondary=0.00 cfs 0.000 af Outflow=0.12 cfs 0.006 af

Pond Trap: Sediment Trap Peak Elev=61.01' Storage=2,924 cf Inflow=1.34 cfs 0.067 af
Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.000 af

Pond 1P: New CB (AP 1)

[57] Hint: Peaked at 57.11' (Flood elevation advised)
[79] Warning: Submerged Pond Trap Primary device # 1 OUTLET by 0.07'

Inflow Area =	0.659 ac,	Inflow Depth =	0.11"	for	quality event
Inflow =	0.12 cfs @	11.98 hrs,	Volume=	0.006 af	
Outflow =	0.12 cfs @	11.98 hrs,	Volume=	0.006 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.12 cfs @	11.98 hrs,	Volume=	0.006 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

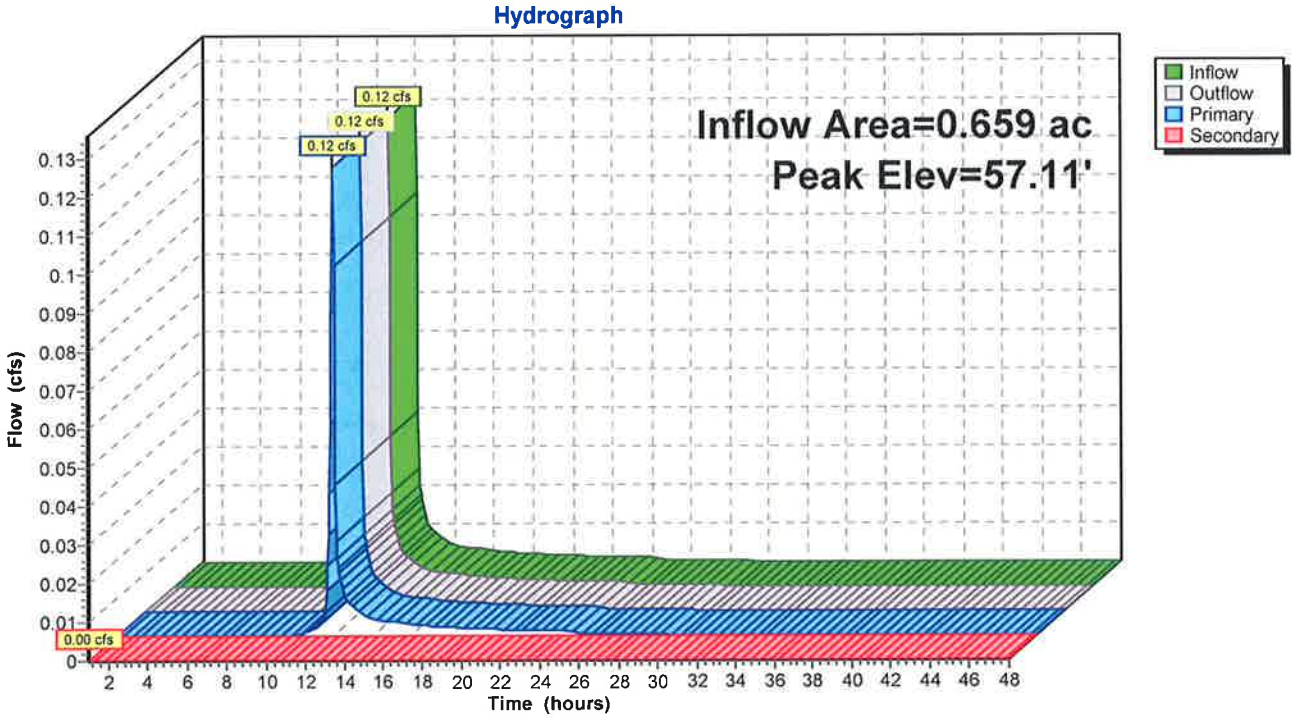
Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 57.11' @ 11.98 hrs
Plug-Flow detention time= 0.0 min calculated for 0.006 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (879.7 - 879.7)

#	Routing	Invert	Outlet Devices
1	Primary	56.96'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0051 '/' n= 0.012 Cc= 0.900
2	Secondary	62.44'	**3.00' x 4.00' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=0.11 cfs @ 11.98 hrs HW=57.10' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.11 cfs @ 1.5 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=56.96' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: New CB (AP 1)



Pond Trap: Sediment Trap

Inflow Area =	0.577 ac,	Inflow Depth =	1.40"	for	quality event
Inflow =	1.34 cfs @	11.97 hrs,	Volume=	0.067 af	
Outflow =	0.00 cfs @	24.18 hrs,	Volume=	0.000 af,	Atten= 100%, Lag= 733.0 min
Primary =	0.00 cfs @	24.18 hrs,	Volume=	0.000 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 61.01' @ 24.18 hrs Surf.Area= 2,896 sf Storage= 2,924 cf
Plug-Flow detention time= 1,305.1 min calculated for 0.000 af (0% of inflow)
Center-of-Mass det. time= 886.5 min (1,687.1 - 800.6)

#	Invert	Avail.Storage	Storage Description
1	60.75'	6,134 cf	**Custom Stage Data (Irregular)** Listed below
2	58.75'	2,676 cf	**20.00'W x 45.00'L x 2.00'H Prismatoid Z=3.0**
		8,810 cf	Total Available Storage

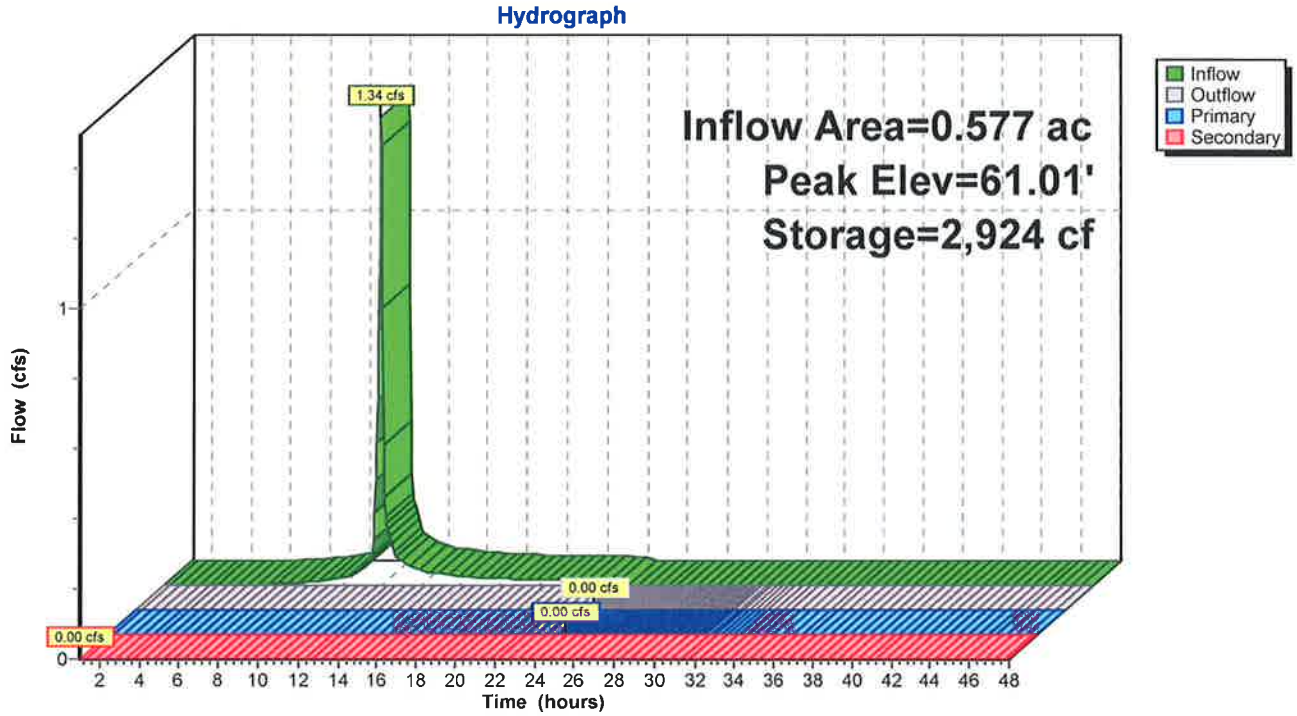
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.75	830	117.0	0	0	830
61.00	1,068	131.0	237	237	1,108
61.50	1,271	140.0	584	821	1,314
62.00	2,001	250.0	811	1,632	4,729
63.00	3,333	345.0	2,639	4,271	9,237
63.50	4,137	398.0	1,864	6,134	12,376

#	Routing	Invert	Outlet Devices
1	Primary	57.17'	**15.0" x 25.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 57.03' S= 0.0056 '/' n= 0.012 Cc= 0.900
2	Device 1	61.00'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Device 1	62.60'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
4	Secondary	63.00'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.00 cfs @ 24.18 hrs HW=61.01' (Free Discharge)
└─**1=Culvert** (Passes 0.00 cfs of 10.59 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.3 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=58.75' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Trap: Sediment Trap



Effective April 2016

[redacted]

[redacted]

September 25, 2007

[redacted]

RE: [redacted]
Stormwater Recharge Evaluation
[redacted]
Newark, New Castle County, Delaware

Dear [redacted]

[redacted] has completed a feasibility reconnaissance exploration for recharge of stormwater runoff at the referenced site. The Property (Tax Parcel No. [redacted], contains approximately 0.6 acres and has been improved with a 1-story building with gravel parking. The assessment consisted of a two phased approach with the first phase comprising a visual review of three test pit excavations for soil texture and groundwater depth, as well as redoximorphic indicators (mottling, iron-manganese concretions, and gleying) of apparent seasonal soil saturation / high groundwater level. The second phase consisted of the construction of observation wells and periodic monitoring of depth to groundwater. In addition, a single-ring infiltrometer test was performed to evaluate the potential for stormwater infiltration within selected horizons identified during the site exploration. It is our understanding that New Castle County required an evaluation of the potential for additional stormwater generated by the proposed redevelopment to be recharged into the subsurface. The initial evaluation indicated indeterminate seasonal high soil saturation due to the presence of redoximorphic features throughout the soil profile and an apparent perched water table. The results of the infiltration testing indicated limited, though potentially suitable, recharge capability in the area of the proposed stormwater management basin. The following summarizes our observations and conclusions made during the field exploration activities.

PHASE I – SEASONAL HIGH SOIL SATURATION EVALUATION

On January 24 and February 22, 2007, [redacted] reviewed the excavation of 3 test pits at the site, completed by [redacted], as a subcontractor to [redacted], using a rubber-tired, extending backhoe. Figure 1 depicts the approximate test pit locations. The test pits were excavated to depths of approximately 7.0 feet (TP-1), 8.6 feet (TP-2), and 11.0 feet (TP-3) below existing ground surface grade (bgs). Groundwater was observed in the test pits at depths of approximately 7.0 feet bgs in TP-1, 6.5 feet bgs in TP-2, and 9.0 feet bgs in TP-3. Test pit descriptive logs are attached.

A surficial layer of crushed stone, approximately 1.5 feet thick, was observed at test pits TP-1 and TP-3. The underlying soils, observed at Test Pits TP-1 and TP-3, below the crushed stone generally consisted of grey silt with varying amounts of clay ranging in depth from 7.0 feet bgs (TP-1) to approximately 8.2 feet bgs (TP-3). An approximately 1-foot thick layer of stiff, compact clay was observed at TP-1 between 2.6 feet bgs and 3.9 feet bgs. A textural change to fine to medium sand with varying amounts of silt and clay was observed at approximately 7.0 feet bgs (TP-1) and 8.2 feet bgs (TP-3).

Soils observed at Test Pit TP-2 from the ground surface to a depth of approximately 1.5 feet bgs were generally characterized as greyish brown silt with little to some fine to medium sand. Medium sand with trace to little silt and gravel, and trace clay was observed between 1.5 and 2.2 feet bgs. An apparent silt lens was observed on one side of the excavation between 2.2 feet bgs and 2.8 feet bgs. The soils observed to the termination of the test pit were characterized as variably textured sand, ranging from fine to coarse, with varying amounts of silt, clay, and gravel. See the attached descriptive test pit logs for additional information.

As indicated on the attached descriptive logs, redoximorphic features, such as mottling and low chroma (≤ 2) soil colors, were observed at test pits TP-1 and TP-3 beginning at a depth of approximately 1.5 feet bgs. At test pit TP-2, higher chroma (>4) colored soils were observed. Groundwater seepage, which is potentially indicative of the water-table at the time of excavation, was observed at depths of 7.0 feet (TP-1) 6.5 feet (TP-2), and 9.0 feet (TP-3) below ground surface grade. Based on observations made during the test pit excavations, the seasonal high water elevation appeared to be masked due to the presence of redoimorphic features throughout the profile and the presence of an apparent silt lens at test pit TP-2, which likely inhibits the infiltration of surface water resulting in impeded drainage. Therefore, it is unclear whether the observed redoximorphic features, potentially associated with seasonal high soil saturation, resulted from impeded drainage or seasonally fluctuating groundwater. However, observed soil conditions suggested greater recharge potential in the vicinity of TP-2 than at TP-1 or TP-3.

Effective April 2016

PHASE II- GROUNDWATER OBSERVATION / SEASONAL HIGH WATER ESTIMATE

On March 28, 2007, three groundwater observation wells (OW-1, OW-2, and OW-3) were constructed by [redacted] The wells were constructed of 1-inch nominal diameter polyvinyl chloride (PVC). [redacted] of Newark, Delaware, a Delaware-licensed well driller, constructed the wells in Geoprobe-type soil borings at depths of approximately 15 feet bgs (OW-1), 7 feet bgs (OW-2), and 12 feet bgs (OW-3). The wells were generally constructed to place 5 feet of No. 10 slot well screen across the first relatively permeable zone below the apparent water-table (OW-1 and OW-3), as observed in the geoprobe hole, or socketed just into apparently low-permeability soils to check for potentially "perched" groundwater conditions (OW-2). Observation wells OW-1 and OW-2 were constructed within close proximity of each other to further assess the potential "perched" groundwater condition noted during the subsurface exploration. Please see the attached soil boring logs for additional well construction details and the attached site plan for the approximate location of the observation wells.

The wells were monitored for a three month period, beginning on April 3, 2007 and ending on June 29, 2007, with depth to water measurements recorded on a weekly basis (see Table 1). The first round of readings indicated depth to water was approximately 5.9 feet bgs (OW-1), 2.4 feet bgs (OW-2), and 5.3 feet bgs (OW-3). As indicated above, there is an approximately 3.5 foot difference in depth to groundwater between the side-by-side wells OW-1 and OW-2, which suggests a "perched" groundwater condition at OW-2 (in the sand layer located at approximately 5-6 feet bgs).

[redacted] then compared the observed on-site depth to groundwater in OW-1 during the project period with those for a well, designated as Db24-10/18, for which the Delaware Geological Survey (DGS) has periodically monitored groundwater fluctuation since prior to 1963 (see Tables 2 and 3). Ten Bears used the comparison for the common monitoring period and historic trends for the DGS well to develop a "projected" seasonal high soil saturation level for the [redacted] property, since the soil assessment was indeterminate.

[redacted] utilized monitoring data from DGS well Db-24-10/18, located in New Castle County and constructed in Columbia Formation sediments. According to DGS personnel, well Db24-10 was replaced twice during the monitoring period (in the same general location) with wells designated as Db24-17 and Db24-18. The well is currently designated on the mapping as Db24-18 and all the water level data is reported under this well.

To estimate the seasonal high water level (SHWL) for [redacted] estimated the "normal" SHWL for Db24-10/18, compared this level with the recent observation period, and compared the magnitude of fluctuation during the observation period for the two wells. Based on their similar geographic location and precipitation levels, the site well (OW-1) and Db24-10/18 should be at similar positions during the observation period relative to their SHWL, with the difference proportional to their relative magnitude of fluctuation.

Effective April 2016

Therefore, [redacted] compared the relative magnitude of fluctuation for OW-1 (the well situated in the proposed on-site stormwater management area) with Db24-18 during the monitoring period (See Figure 2). As indicated in Figure 2, the magnitude of fluctuation during the monitoring period was similar, though slightly greater for OW-1 (2.87 feet) than for Db24-18 (2.06 feet). As indicated in Figure 3, the average water level for Db24-18 during the monitoring period (9.85 feet) was slightly above the normal SHWL (10.19 feet - mean of annual high water level readings since 1987). Similarly, it is anticipated that the SHWL at the site would be situated below recent on-site average a distance proportional to the relative fluctuation during the monitoring period. Based on a 2.87 feet / 2.32 feet (1.23 feet: 1 foot) proportion for fluctuation during the monitoring period and a difference of 0.34 feet (10.19 - 9.85 feet) for Db24-10/18 between SHWL and recent average, we estimate that the SHWL at the site would be situated below the recent average a distance of 0.42 feet (1.23 X 0.34 feet). This results in an estimated SHWL for OW-1 of 6.5 feet, approximately 0.42 feet below the average water level of 6.05 feet bgs observed in that well during the monitoring period. This generally corresponds with the depth (approximately 6.0 feet bgs) of redoximorphic features in soils observed during installation of monitoring well OW-1. As a conservative measure, we recommend using 6 feet as the SHWL.

INFILTRATION RATE TEST

[redacted] performed an infiltration rate test within the proposed stormwater basin utilizing a single ring infiltrometer to evaluate the potential for recharge. The infiltration test was performed in general accordance with the ASTM Standard D-5125-90, Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone, utilizing a single ring infiltrometer. The test was performed at a depth of approximately 3.0 feet bgs near test pit TP-2. The infiltrometer test consisted of driving an approximately 18-inch diameter metal ring into the ground approximately 6 inches. Approximately 2 inches of filter sand was placed in the ring, which was then filled with approximately 10 inches of water. Water was incrementally added to the ring to maintain a relatively constant "head," with readings taken each time water was added.

In accordance with the above mentioned ASTM standard, the estimated infiltration rate for the soil is obtained when the incremental test infiltration rate reaches equilibrium. Please refer to Table 1 for the Incremental Infiltration Rate and the associated graph for the equilibrium rate. The results of the infiltration test indicated an estimated infiltration rate of 1.4 inches per hour. The State of Delaware recommends use of ½ the measured infiltration rate of infiltration tests for use in design calculations. The resulting design infiltration rate of 0.7 inches per hour is below the level of 1 inch per hour typically required by New Castle County Department of Land Use for inclusion of infiltration in stormwater calculations.

CONCLUSIONS AND RECOMMENDATIONS

Based upon a relatively shallow "projected" seasonal high soil saturation depth of approximately 6 feet bgs and an estimated design infiltration rate of 0.7 inches per hour, there is limited potential for subsurface stormwater recharge at the site. In addition, the residual soils at the site are likely sensitive to disturbances during construction. Smearing, compaction, and reworking / remolding have the potential to further limit infiltration.

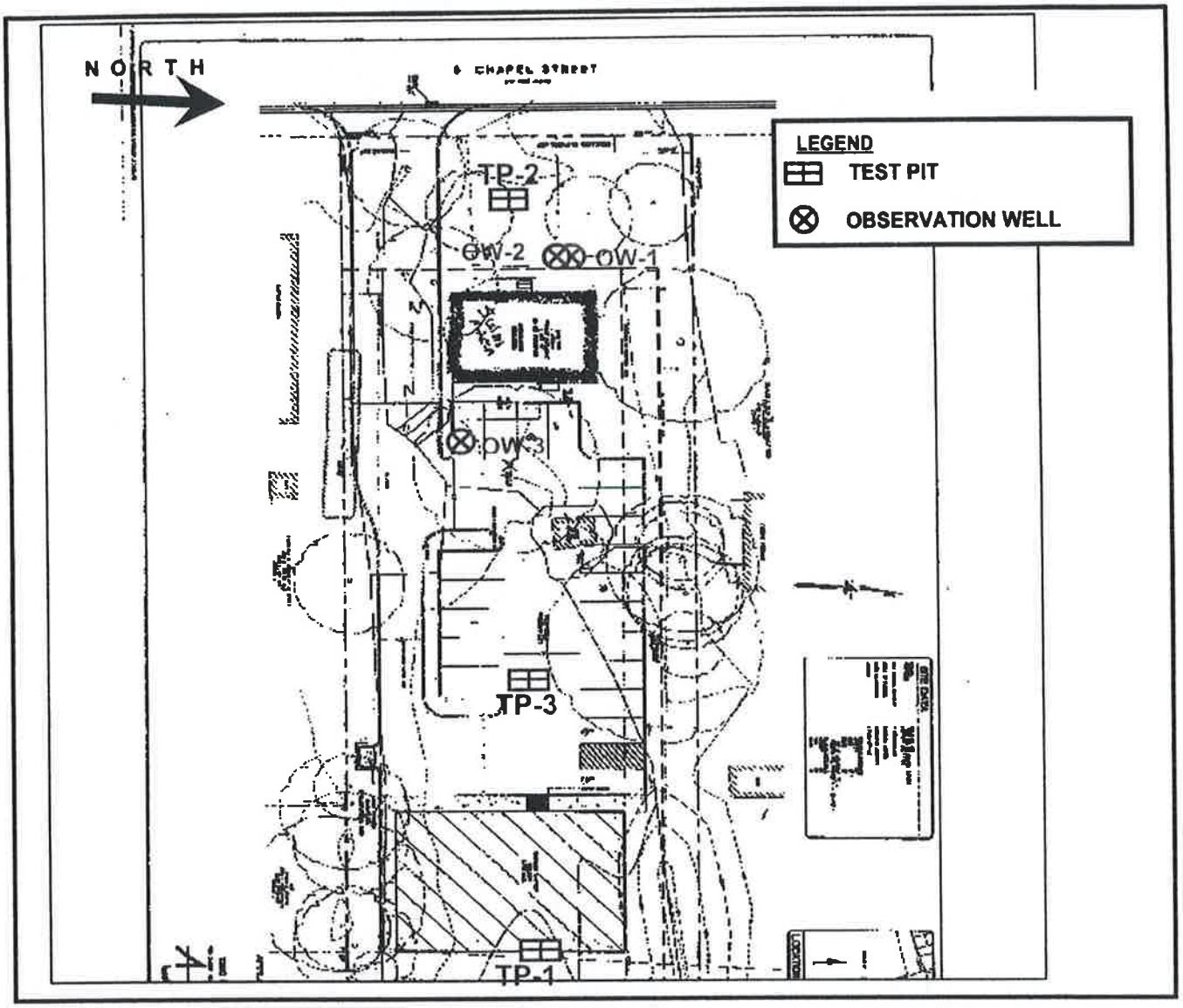
Please do not hesitate to contact us if you have any questions or require further information.

Sincerely,

[redacted]

Enclosures: Figure 1 – Test Pit and Soil Boring Location Sketch
Test Pit Descriptive Logs
Soil Boring and Well Construction Logs
Table 1 – Depth to Water Readings for On-Site Wells
Table 2 – Historical Depth to Water Readings for DGS Well Db24-10/18
Table 3 – Comparison of Depth to Water Readings for OW-1 and Db24-10/18
Figure 2 – Recent Water Level Fluctuation
Figure 3 – Depth to Water in Db24-10/18
Table 4 – Infiltration Rate Test
Figure 4 – Incremental Infiltration Rate (in/hr)

Effective April 2016



This figure derived from [redacted] Exploratory Sketch for [redacted], Newark, DE

[redacted] Newark, Delaware 19714-9711 Phone: [redacted] Fax: [redacted]	**FIGURE 1** **TEST PIT AND SOIL BORING LOCATIONS** [redacted] CITY OF NEWARK, NEW CASTLE COUNTY, DELAWARE	
DATE: 9/25/2007	JOB NUMBER: [redacted]	
DRAWN BY: RCG	SCALE: 1 inch : 45 feet ±	
CHECKED BY: RCG	FIGURE NO: 1	
FILE NO: [redacted]	SHEET 1 OF 1	

TEST PIT LOG

Test Pit No. 1 [redacted]

Project: [redacted]			Project No [redacted]	Date: 1/24/07
Location: [redacted]			Surface Elevation	Datum
Earthwork Contractor [redacted]	Operator	Excavation Equipment Rubber Tired Backhoe (Extend-a-hoe)	Weather 20-30 degrees F, windy	Logged by DPB

Depth (feet) From	Depth (feet) To	PID (deflection units)	Generalized Soil Description
0.0	1.4	NA	Crushed concrete / stone
1.4	2.6		SILT, trace fine sand, blocky
2.6	3.9		CLAY, stiff, compact
3.9			SILT, friable
	6.6		Low Plasticity SILT, trace fine sand, gleyed with mottles
7.0			Fine to medium SAND, little silt, saturated

Notes:

1. The test pit was terminated at a depth of approximately 7.0 feet below the ground surface.
2. Groundwater encountered at approximately 7.0 feet below the ground surface (bgs).

*PID = Photo-ionization detector, readings are in units above background

Test Pit No. 1

TEST PIT LOG

Test Pit No. 2 [redacted]

Project: [redacted]			Project No. 06-580.A	Date: 1/24/07
Location: [redacted]			Surface Elevation	Datum
Earthwork Contractor [redacted]	Operator	Excavation Equipment Rubber Tired Backhoe (Extend-a-hoe)	Weather 20-30 degrees F, windy	Logged by DPB

Depth (feet) From	Depth (feet) To	PID (deflection units)	Generalized Soil Description
0.0	1.5	NA	SILT, little to some, fine to medium sand
1.5			Medium SAND, trace to little silt, trace to little gravel, trace clay
	2.2		Apparent SILT lens, trace fine sand
2.8			Variably textured profile for remainder of test pit. Ranged from a coarse to medium sand, to a fine to medium sand, little silt, tarce clay, trace to little gravel.

Notes:

1. The test pit was terminated at a depth of approximately 8.6 feet below the ground surface.
2. Groundwater encountered at approximately 6.5 feet below the ground surface (bgs).

Test Pit No. 2

Page 1 of 1

*PID = Photo-ionization detector, readings are in units above background

TEST PIT LOG

Test Pit No. 3 [redacted]

Project: [redacted]			Project No. 06-580.A	Date: 2/23/07
Location: [redacted]			Surface Elevation	Datum
Earthwork Contractor [redacted]	Operator	Excavation Equipment Rubber Tired Backhoe (Extend-a-hoe)	Weather 20-30 degrees F, windy	Logged by DPB

Depth (feet) From	Depth (feet) To	Munsell Color	Generalized Soil Description
0.0	1.9	NA	Fill - crusher run and pulverized concrete
1.9	4.0	2.5Y 4/2	SILT, little to some fine sand
			(portions SILT, trace fine sand G1 6N to 5N color, 2.5Y 6/6 mottles, 15-20% distinct)
4.0	6.0	G1 6N to 7N	SILT, little to trace clay, trace to little fine to medium sand, trace mica
			(2.5Y 6/8 mottles, 20% distinct & 10YR 6/8 mottles, 20-30% distinct)
6.0	8.2	2.5 Y 6/3 to 6/4	SILT, little fine sand, trace clay (10YR 6/8 mottles, 20-25% distinct)
8.2	...	10 YR 5/8 to 6/8	Fine to medium SAND, some silt, clay, trace gravel, trace mica (wet)
			(little to some gravel, trace silt, saturated at bottom)

Notes:

1. The test pit was terminated at a depth of approximately 11 feet below the ground surface.
2. Groundwater seepage observed at 9 feet below the ground surface (bgs).

Test Pit No. 3

Page 1 of 1

[redacted]

Boring OW-1

SOIL-BORING DESCRIPTIVE LOG

Project Name [redacted]	**Project Location** [redacted]		**Project Number** 06-580.A
Drilling Agency [redacted]	**Driller** [redacted]	**Date Started:** 3/28/2007 **Date Finished:** 3/28/2007	
Drilling Equipment Truck Mounted Geoprobe	**Drilling Procedures** 2" Diameter Continuous Macrocore		**Logged by:** DPB
Weather Sunny	**Surface Conditions** Maintained Lawn	**Surface Elevation**	**Datum**

Spl. #	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Rec'y (ft)	Sample Description	Remarks PID*	Remarks Sample/ Time
1	0	4	0	3.1	3.1	Brown to light brown SILT, trace to little fine sand		
						trace to little clay, wet approximately 2.5 feet		
2	4	8	4		2.9	SAME, distinct mottling observed, trace gravel, trace clay		
				5				
			5			Light tan fine to medium SAND, little silt, trace clay, wet		
				6				
			6			Light grey to tan SILT with disticnt mottles, trace fine sand		
				8		trace gravel, compact		
3	8	12	8		3.7	SAME - saturated 8'-9.5'		
				9.5				
			9.5			Gray SILT, trace to little mica, trace clay		
4	12	15	12		1.5	Orange fine to medium SAND, trace silt, trace gravel		
				...		(saturated)		

Notes
1. Boring terminated at 15 feet below the existing ground surface (bgs).
2. Saturated soils observed at 2.5 feet bgs.
3. Observation well constructed in open borehole as follows:
   No. 20 slot well screen from 10' to 15' (1-inch nominal diameter, schedule 40 PVC)
   solid casing from 10' to stick up above ground surface (1-inch nominal diameter, shedule 40 PVC)
   No. 2 filter sand from 15' to 8'
   granular bentonite hole plug 8' to surface

* PID = Photo-ionization detector, readings are in deflection units above background.

[redacted]

[redacted]

Boring OW-2

SOIL-BORING DESCRIPTIVE LOG

Project Name	Project Location	Project Number
[redacted]	[redacted]	[redacted]

Drilling Agency	Driller	Date Started:	3/28/2007
[redacted]	[redacted]	Date Finished:	3/28/2007

Drilling Equipment	Drilling Procedures	Logged by:
Truck Mounted Geoprobe	2" Diameter Continuous Macrocore	DPB

Weather	Surface Conditions	Surface Elevation	Datum
Sunny	Maintained Lawn		

Spl. #	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Rec'y (ft)	Sample Description	Remarks PID*	Remarks Sample/ Time
	NA - Drove well installation tools to 7 feet without sampling - well location 1' from OW-1 - see OW-1							
	log for soil descriptions							

Notes

1. Boring terminated at 7 feet below the existing ground surface (bgs).
2. Observation well constructed in open borehole as follows:
   No. 20 slot well screen from 2' to 7' (1-inch nominal diameter, schedule 40 PVC)
   solid casing from 2' to stick up above ground surface (1-inch nominal diameter, shedule 40 PVC)
   No. 2 filter sand from 7' to 1.5'
   granular bentonite hole plug 1.5' to surface

* PID = Photo-ionization detector, readings are in deflection units above background.

[redacted]

Boring OW-3

SOIL-BORING DESCRIPTIVE LOG

Project Name [redacted]	**Project Location** [redacted]		**Project Number** [redacted]
Drilling Agency [redacted]	**Driller** [redacted]	**Date Started:** 3/28/2007 **Date Finished:** 3/28/2007	
Drilling Equipment Truck Mounted Geoprobe	**Drilling Procedures** 2" Diameter Continuous Macrocore		**Logged by:** DPB
Weather Sunny	**Surface Conditions** Maintained Lawn	**Surface Elevation**	**Datum**

Spl. #	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Rec'y (ft)	Sample Description	Remarks PID*	Remarks Sample/ Time
1	0	4	0	1	2.5	Brown SILT, trace fine sand, trace mica, organic material		
						(grass, roots)		
			1	2		Orange-brown SILT, little to trace fine sand, trace gravel		
						trace clay		
			2			Orange-brown fine to medium SAND, trace silt, apparent		
						iron concretions		
2	4	8	4	4.3	4	SAME		
			4.3	7		Light gray (with mottles) SILT, trace to little fine sand,		
						trace clay		
			7			Orange-brown fine to coarse SAND, trace to little silt,		
						trace gravel		
3	8	12		...	2.3	SAME		

Notes
1. Boring terminated at 12 feet below the existing ground surface (bgs).
2. Saturated soils observed at 9.5 feet bgs.
3. Observation well constructed in open borehole as follows:
   No. 20 slot well screen from 7' to 12' (1-inch nominal diameter, schedule 40 PVC)
   solid casing from 7' to stick up above ground surface (1-inch nominal diameter, shedule 40 PVC)
   No. 2 filter sand from 12' to 6'
   granular bentonite hole plug 6' to surface

* PID = Photo-ionization detector, readings are in deflection units above background.

TABLE 1
DEPTH TO WATER READINGS FOR ON-SITE WELLS

STORMWATER RECHARGE EVALUATION
[redacted]
NEWARK, DELAWARE

Date	OW-1	OW-2	OW-3
4/3/2007	5.92	6.8	5.33
4/12/2007	5.58	2.05	5.37
4/20/2007	4.54	2.33	4.56
4/30/2007	5.04	3.07	4.84
5/7/2007	5.55	4.32	5.39
5/10/2007	5.66	4.48	5.51
5/14/2007	5.87	4.74	5.71
5/23/2007	6.16	5.22	6.03
6/6/2007	7.41	5.33	6.28
6/22/2007	6.79	6.09	6.66
6/29/2007	6.98	6.44	6.86

NOTE:
Depths reported in feet below ground surface grade.

[redacted]
September 2007

Effective April 2016

TABLE 2
HISTORICAL DEPTH TO WATER READINGS FOR DGS WELL Db24-10/18

STORMWATER RECHARGE EVALUATION

[redacted]

NEWARK, DELAWARE

DATE	DB24-10 DTW
1/6/1987	12.58
2/4/1987	11.49
2/27/1987	11.24
3/9/1987	10.65
4/1/1987	11.10
4/23/1987	10.82
5/1/1987	10.89
6/1/1987	11.24
6/29/1987	12.04
7/30/1987	12.99
8/31/1987	13.85
10/2/1987	14.32
11/2/1987	14.80
12/1/1987	15.12
1/5/1988	14.54
1/29/1988	14.35
2/28/1988	12.59
4/1/1988	12.29
5/2/1988	12.48
5/25/1988	11.72
6/30/1988	12.15
8/3/1988	13.16
9/1/1988	13.69
9/30/1988	15.25
10/31/1988	14.88
12/2/1988	14.90
1/2/1989	14.59
1/31/1989	14.18
2/27/1989	13.71
3/31/1989	12.12
4/28/1989	11.11
5/25/1989	9.67
6/30/1989	9.23
8/1/1989	7.37
9/1/1989	9.60
9/28/1989	10.23
10/31/1989	9.86
11/30/1989	10.84
1/26/1990	11.61
2/28/1990	9.66
3/29/1990	10.96
4/27/1990	10.01
5/31/1990	10.08
7/3/1990	9.97
8/6/1990	11.06
8/31/1990	10.97
9/28/1990	12.62
10/30/1990	13.51

DATE	DB24-10 DTW
2/28/1991	11.87
3/29/1991	11.08
5/1/1991	10.30
5/31/1991	11.13
6/24/1991	12.00
7/31/1991	13.15
9/5/1991	13.96
10/1/1991	14.43
11/4/1991	14.99
11/19/1991	15.18
11/25/1991	15.28
12/18/1991	15.18
1/8/1992	15.11
1/31/1992	15.29
2/27/1992	15.34
4/1/1992	14.32
5/4/1992	13.69
5/29/1992	13.92
6/30/1992	13.87
8/3/1992	14.47
9/1/1992	14.79
9/29/1992	15.13
11/5/1992	15.40
12/2/1992	15.28
1/5/1993	14.02
1/29/1993	12.77
3/1/1993	12.12
3/30/1993	8.87
4/29/1993	7.42
6/2/1993	9.14
7/1/1993	10.23
8/3/1993	11.59
8/18/1993	11.58
8/30/1993	12.46
10/1/1993	13.79
11/3/1993	14.40
12/9/1993	12.69
1/5/1994	11.87
1/31/1994	11.27
3/8/1994	10.03
4/1/1994	7.82
5/2/1994	8.07
6/1/1994	8.93
7/1/1994	10.35
8/1/1994	11.44
9/1/1994	11.94
9/29/1994	12.60
10/28/1994	13.39

DATE	DB24-10 DTW
2/27/1995	13.64
3/28/1995	12.77
4/3/1995	12.64
4/28/1995	12.91
6/2/1995	13.25
6/30/1995	13.61
7/25/1995	14.09
8/16/1995	14.45
9/1/1995	14.75
9/27/1995	15.14
10/9/1995	15.35
10/25/1995	15.31
11/1/1995	15.10
11/28/1995	14.07
1/4/1996	13.26
1/29/1996	12.11
2/29/1996	11.33
3/27/1996	10.79
4/26/1996	8.95
6/6/1996	9.52
7/3/1996	9.83
8/2/1996	10.24
8/27/1996	10.22
10/1/1996	11.38
11/7/1996	11.05
12/5/1996	10.61
1/7/1997	8.52
1/28/1997	9.19
3/5/1997	9.61
3/31/1997	9.29
5/5/1997	8.92
6/3/1997	9.85
6/30/1997	10.72
7/29/1997	11.74
9/5/1997	12.86
10/3/1997	13.52
11/6/1997	14.36
12/3/1997	14.75
1/5/1998	14.95
1/28/1998	14.44
3/2/1998	12.76
4/2/1998	10.50
5/6/1998	10.96
6/4/1998	10.66
7/2/1998	11.40
7/28/1998	12.16
9/1/1998	13.19
9/28/1998	13.90

[redacted]

September 2007

Effective April 2016

TABLE 2
HISTORICAL DEPTH TO WATER READINGS FOR DGS WELL Db24-10/18

STORMWATER RECHARGE EVALUATION
[redacted]
NEWARK, DELAWARE

DATE	DB24-10 DTW
11/30/1990	14.05
1/2/1991	13.77
2/1/1991	11.55
1/28/1999	16.00
2/23/1999	15.66
4/1/1999	14.20
4/30/1999	13.53
5/26/1999	13.54
6/29/1999	13.86
7/19/1999	14.16
7/30/1999	14.37
8/11/1999	14.65
8/30/1999	15.07
9/28/1999	14.78
11/2/1999	14.52
12/3/1999	14.82
1/4/2000	14.42
1/18/2000	14.40
2/16/2000	14.17
3/14/2000	13.17
4/17/2000	10.44
5/12/2000	10.53
6/16/2000	11.89
7/14/2000	12.14
8/14/2000	12.87
9/26/2000	13.70
10/23/2000	13.95
11/17/2000	14.38
12/15/2000	14.95
1/16/2001	15.05
2/22/2001	14.14
3/12/2001	13.54
4/18/2001	11.76
5/17/2001	11.94
6/8/2001	11.71
7/2/2001	11.51
7/16/2001	11.82
9/17/2001	13.38
10/15/2001	14.04
11/14/2001	14.78
12/18/2001	15.53

DATE	DB24-10 DTW
12/13/1994	14.19
1/4/1995	14.33
1/30/1995	13.80
1/17/2002	16.02
2/18/2002	16.23
3/13/2002	16.40
4/11/2002	16.18
5/9/2002	16.00
6/12/2002	15.92
7/5/2002	15.78
7/15/2002	15.91
8/12/2002	16.27
8/28/2002	16.47
9/11/2002	16.56
10/2/2002	16.83
11/1/2002	16.55
12/1/2002	15.37
1/1/2003	13.17
2/1/2003	12.56
3/1/2003	10.27
4/1/2003	8.80
5/1/2003	8.19
6/1/2003	7.70
7/1/2003	7.87
8/1/2003	9.02
9/1/2003	9.43
10/1/2003	9.23
11/1/2003	8.96
12/1/2003	8.08
1/1/2004	8.18
2/1/2004	8.81
3/1/2004	9.36
4/1/2004	8.67
5/1/2004	8.54
6/1/2004	8.57
7/1/2004	8.31
8/1/2004	8.02
9/1/2004	9.19
10/1/2004	8.82
11/1/2004	9.47
12/1/2004	8.59

DATE	DB24-10 DTW
10/26/1998	14.57
11/23/1998	15.14
1/5/1999	15.90
1/1/2005	8.66
2/1/2005	8.77
3/1/2005	8.76
4/1/2005	7.54
5/1/2005	8.94
6/1/2005	10.09
7/1/2005	11.11
8/1/2005	12.09
9/1/2005	13.00
10/1/2005	13.62
11/1/2005	13.80
12/1/2005	13.87
1/1/2006	12.93
2/1/2006	11.75
3/1/2006	11.51
4/1/2006	11.36
5/1/2006	11.60
6/1/2006	12.22
7/1/2006	12.46
8/1/2006	12.64
9/1/2006	13.10
10/1/2006	13.10
11/9/2006	11.96
12/1/2006	11.32
1/1/2007	11.26
2/1/2007	11.59
3/1/2007	10.69
4/1/2007	9.68
5/1/2007	9.39
6/1/2007	10.49
7/1/2007	11.40

NOTES:
1. Depths reported in feet below ground surface grade.
2. As readings were recorded on a monthly basis for the majority of the historical record (through 2002), later readings were reduced through monthly averages.

[redacted]
September 2007

Effective April 2016

TABLE 3
COMPARISON OF DEPTH TO WATER READINGS FOR OW-1 AND Db24-10/18

STORMWATER RECHARGE EVALUATION
[redacted]
NEWARK, DELAWARE

Date	OW-1	Db24-10/18
4/3/2007	5.92	10.20
4/12/2007	5.58	10.69
4/20/2007	4.54	9.00
4/30/2007	5.04	8.82
5/7/2007	5.55	9.10
5/10/2007	5.66	9.14
5/14/2007	5.87	9.30
5/23/2007	6.16	9.68
6/6/2007	7.41	10.15
6/22/2007	6.79	10.67
6/29/2007	6.98	11.14

NOTES:
1. Depths reported in feet below ground surface grade.
2. While DGS reported readings on an approximate daily basis, for comparison purposes, only those taken on dates corresponding with on-site readings are shown here.

[redacted]
September 2007

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FIGURE 2
RECENT WATER LEVEL FLUCTUATION

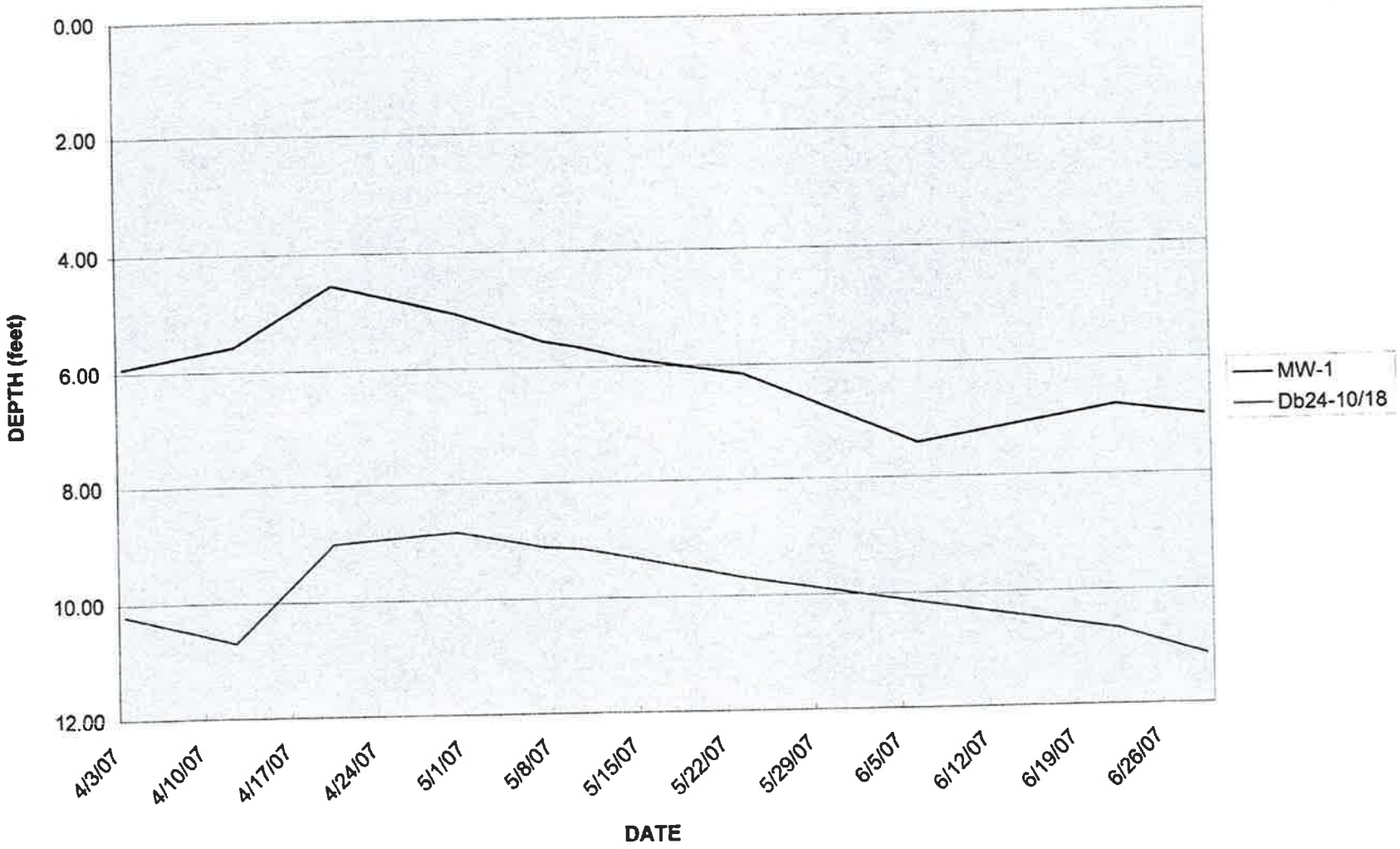

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FIGURE 3
Depth to Water in DB24-10/18

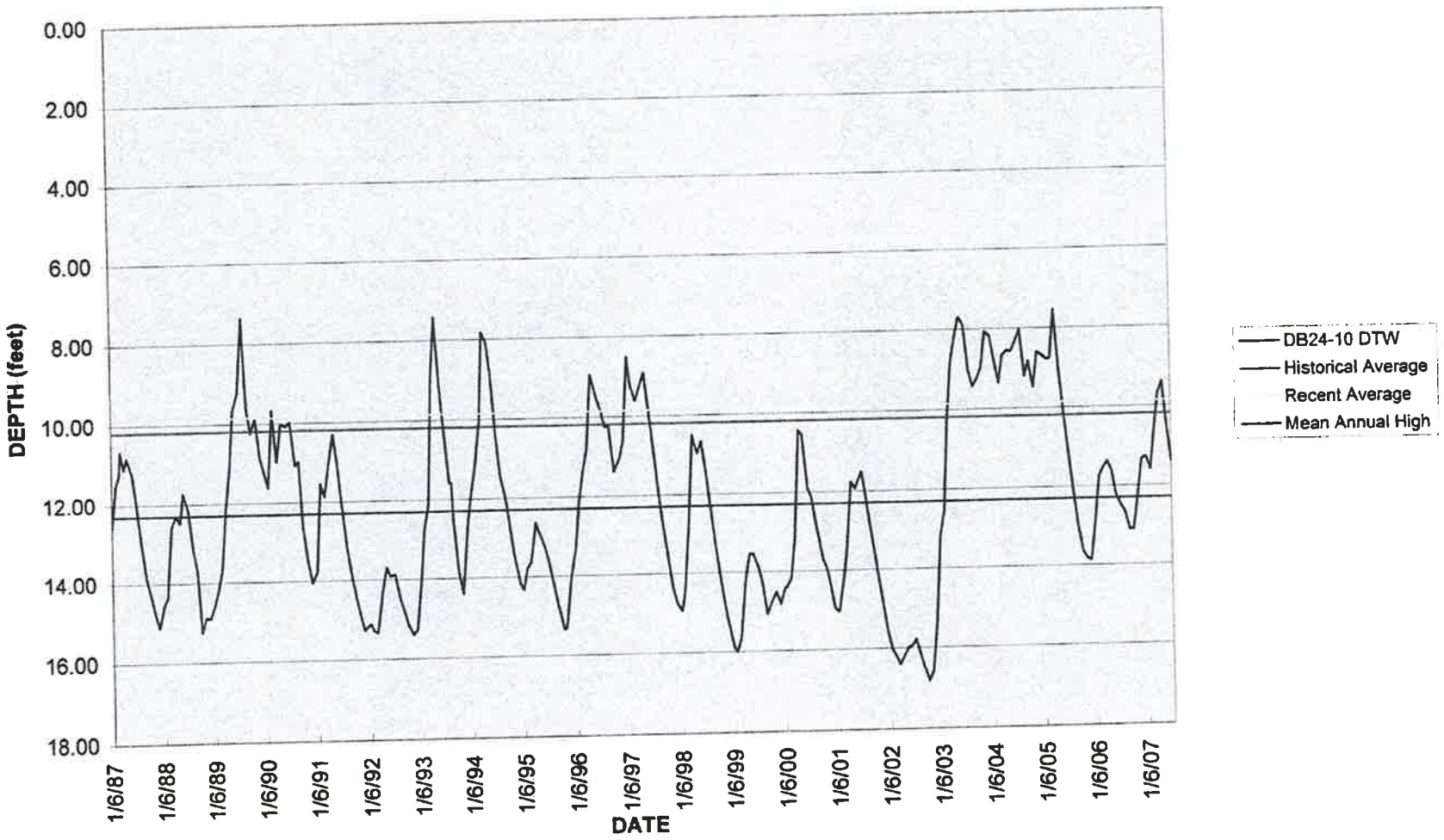

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TABLE 4
INFILTRATION RATE TEST

[redacted]
NEWARK, DELAWARE

Time	Time Difference	Run Time	Incremental Infiltration (ft)	Incremental Infiltration (in)	Incremental Infiltration Rate (in/hr)
9:56	0:00	0:00	0	0	
9:58	0:02	0:02	0.03	0.36	10.80
10:01	0:03	0:05	0.03	0.36	7.20
10:05	0:04	0:09	0.03	0.36	5.40
10:10	0:05	0:14	0.03	0.36	4.32
10:16	0:06	0:20	0.03	0.36	3.60
10:24	0:08	0:28	0.03	0.36	2.70
10:31	0:07	0:35	0.03	0.36	3.09
10:38	0:07	0:42	0.03	0.36	3.09
10:46	0:08	0:50	0.03	0.36	2.70
10:55	0:09	0:59	0.02	0.24	1.60
11:04	0:09	1:08	0.03	0.36	2.40
11:12	0:08	1:16	0.03	0.36	2.70
11:21	0:09	1:25	0.04	0.48	3.20
11:31	0:10	1:35	0.03	0.36	2.16
11:41	0:10	1:45	0.03	0.36	2.16
11:52	0:11	1:56	0.03	0.36	1.96
12:02	0:10	2:06	0.03	0.36	2.16
12:13	0:11	2:17	0.03	0.36	1.96
12:25	0:12	2:29	0.03	0.36	1.80
12:36	0:11	2:40	0.03	0.36	1.96
12:47	0:11	2:51	0.03	0.36	1.96
12:58	0:11	3:02	0.03	0.36	1.96
13:11	0:13	3:15	0.03	0.36	1.66
13:24	0:13	3:28	0.03	0.36	1.66
13:36	0:12	3:40	0.03	0.36	1.80
13:49	0:13	3:53	0.03	0.36	1.66
14:00	0:11	4:04	0.03	0.36	1.96
14:13	0:13	4:17	0.03	0.36	1.66
14:26	0:13	4:30	0.03	0.36	1.66
14:40	0:14	4:44	0.03	0.36	1.54
14:54	0:14	4:58	0.03	0.36	1.54
15:10	0:16	5:14	0.04	0.42	1.58
15:16	0:06	5:20	0.05	0.6	6.00
15:31	0:15	5:35	0.03	0.36	1.44
15:46	0:15	5:50	0.03	0.36	1.44
16:02	0:16	6:06	0.03	0.36	1.35
16:18	0:16	6:22	0.07	0.78	2.93

[redacted]
September 2007

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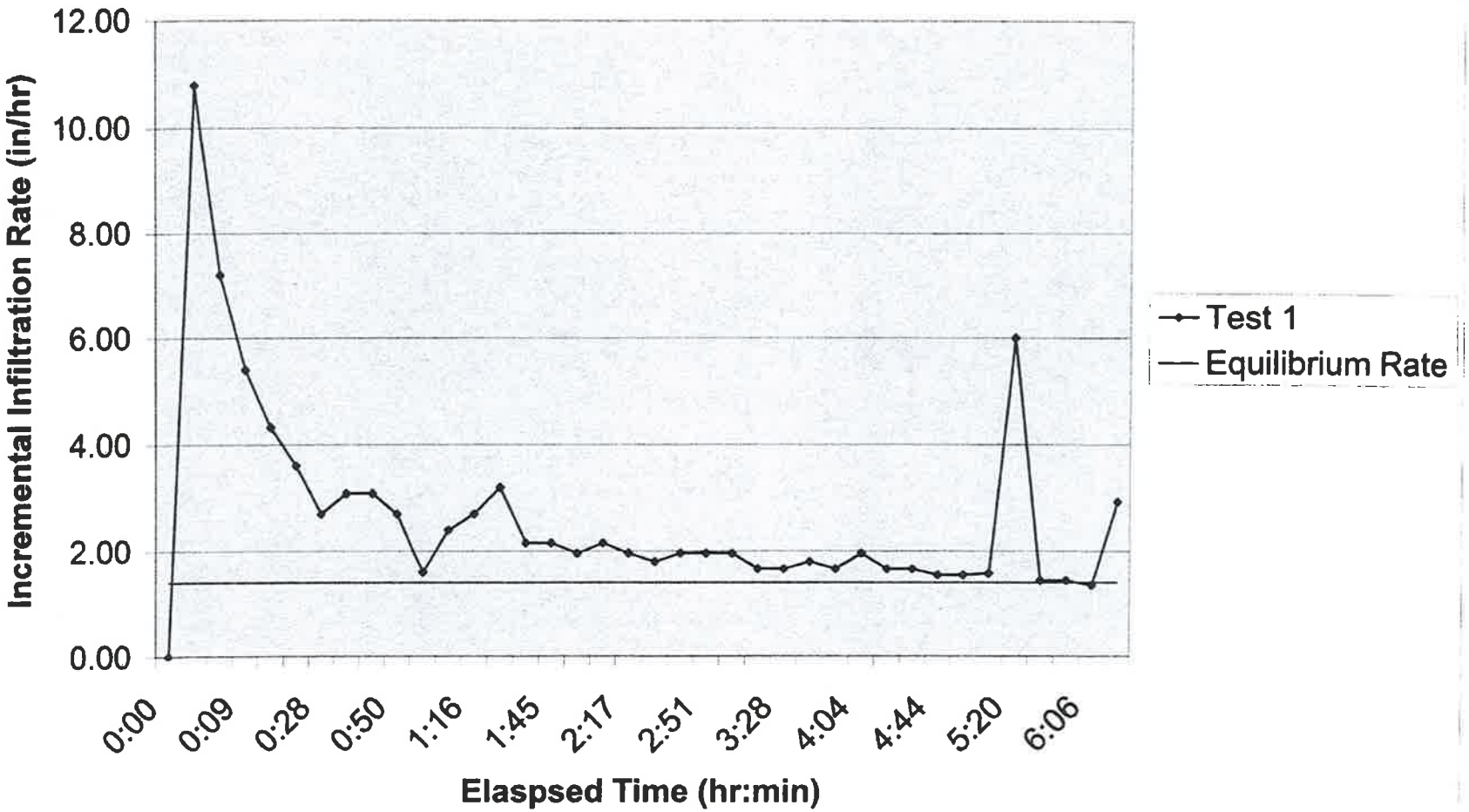
FIGURE 4
Incremental Infiltration Rate (in/hr)



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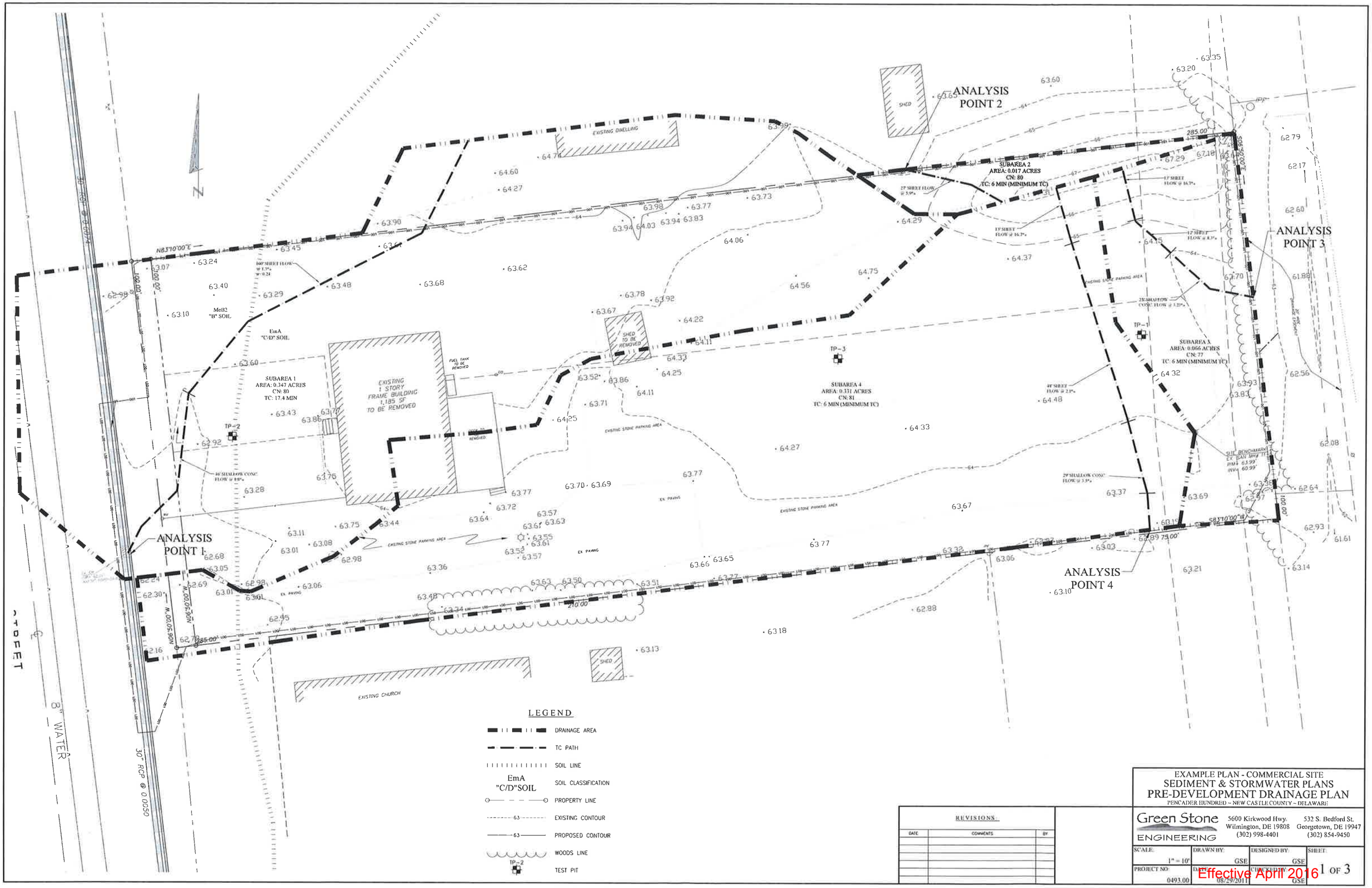
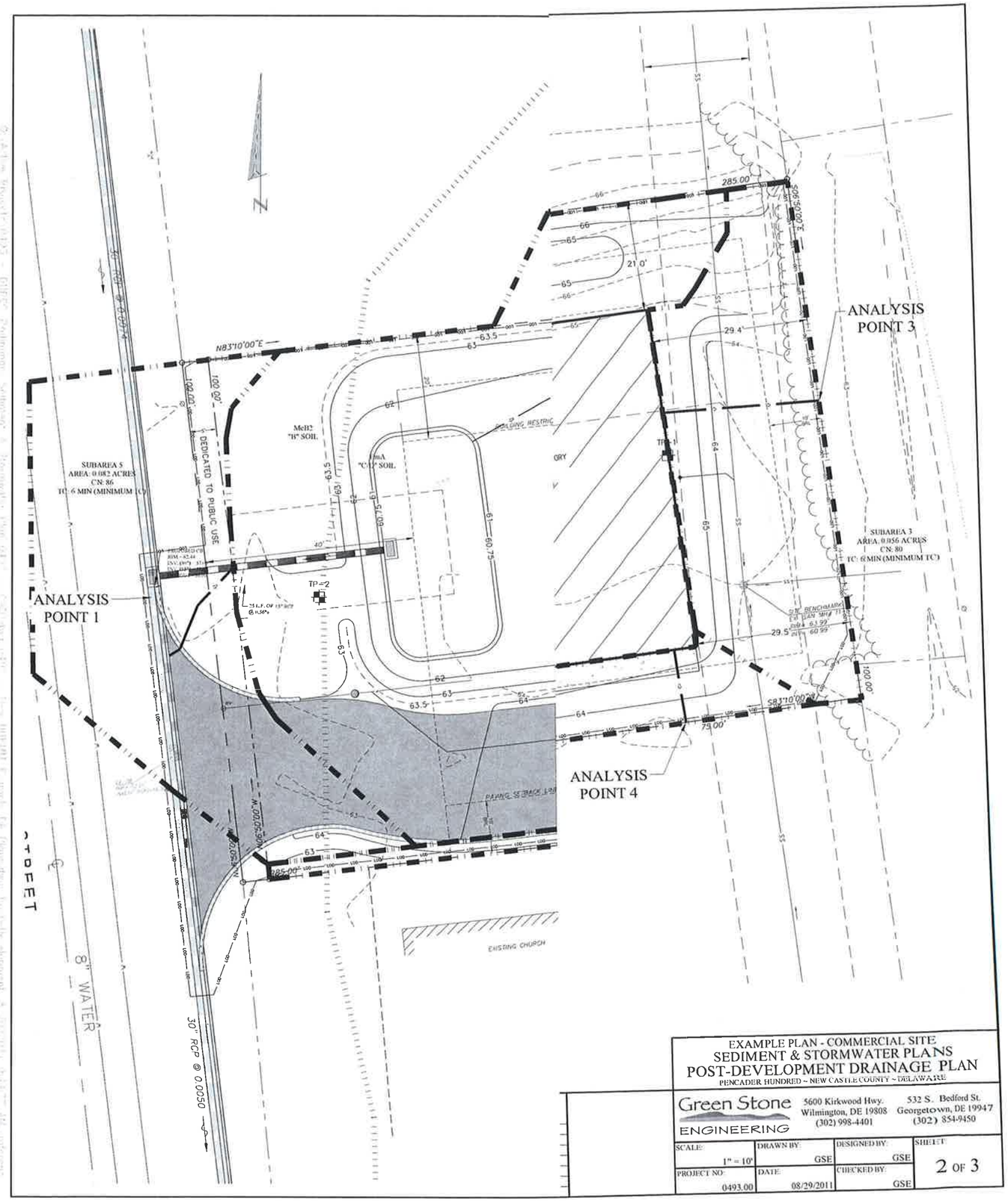
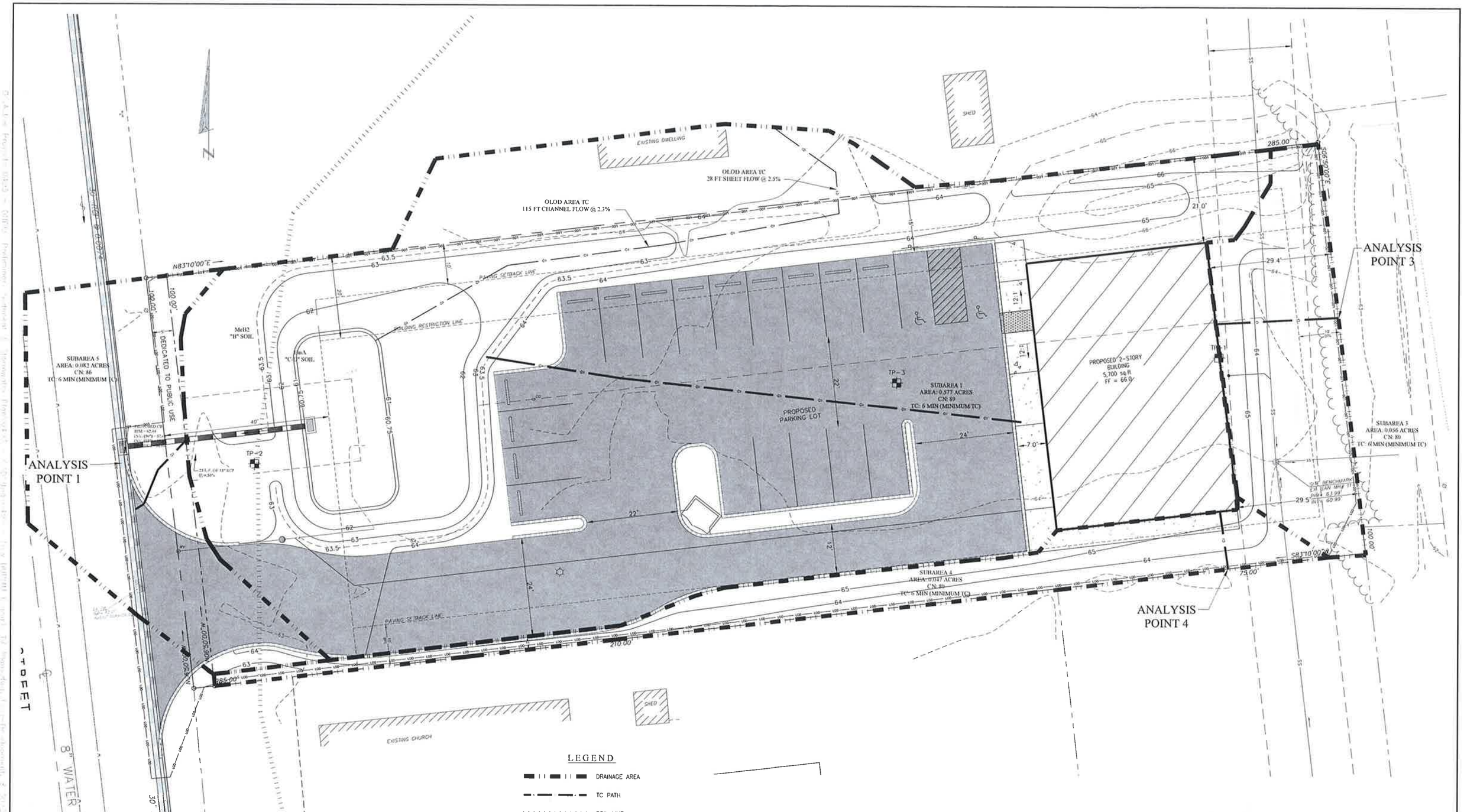

ANALYSIS POINT 1
ANALYSIS POINT 2
ANALYSIS POINT 3
ANALYSIS POINT 4
SUBAREA 1
AREA: 0.347 ACRES
CN: 80
TC: 17.4 MIN
SUBAREA 2
AREA: 0.017 ACRES
CN: 80
TC: 6 MIN (MINIMUM TC)
SUBAREA 3
AREA: 0.066 ACRES
CN: 77
TC: 6 MIN (MINIMUM TC)
SUBAREA 4
AREA: 0.331 ACRES
CN: 81
TC: 6 MIN (MINIMUM TC)
EXISTING 1 STORY FRAME BUILDING 1,185 SF TO BE REMOVED
EXISTING DWELLING
EXISTING CHURCH
SHED
SHED TO BE REMOVED
FUEL TANK TO BE REMOVED
EXISTING STONE PARKING AREA
EX PAVING
MeB2 "B" SOIL
EmA "C/D" SOIL
TP-1
TP-2
TP-3
8" WATER
30" RCP @ 0.0050
LEGEND
DRAINAGE AREA
TC PATH
SOIL LINE
EmA "C/D"SOIL
SOIL CLASSIFICATION
PROPERTY LINE
EXISTING CONTOUR
PROPOSED CONTOUR
WOODS LINE
TEST PIT
REVISIONS
DATE
COMMENTS
BY
EXAMPLE PLAN - COMMERCIAL SITE
SEDIMENT & STORMWATER PLANS
PRE-DEVELOPMENT DRAINAGE PLAN
PENCADER HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE
Green Stone ENGINEERING
5600 Kirkwood Hwy. Wilmington, DE 19808 (302) 998-4401
532 S. Bedford St. Georgetown, DE 19947 (302) 854-9450
SCALE: 1" = 10'
DRAWN BY: GSE
DESIGNED BY: GSE
SHEET: 1 OF 3
PROJECT NO: 0493.00
DATE: 08/29/2011
CHECKED BY: GSE
Effective April 2016



Effective April 2016



EXAMPLE PLAN - COMMERCIAL SITE
SEDIMENT & STORMWATER PLANS
POST-DEVELOPMENT DRAINAGE PLAN
PENCADER HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

REVISIONS		
DATE	COMMENTS	BY

Green Stone ENGINEERING
5600 Kirkwood Hwy.
Wilmington, DE 19808
(302) 998-4401
532 S. Bedford St.
Georgetown, DE 19947
(302) 854-9450

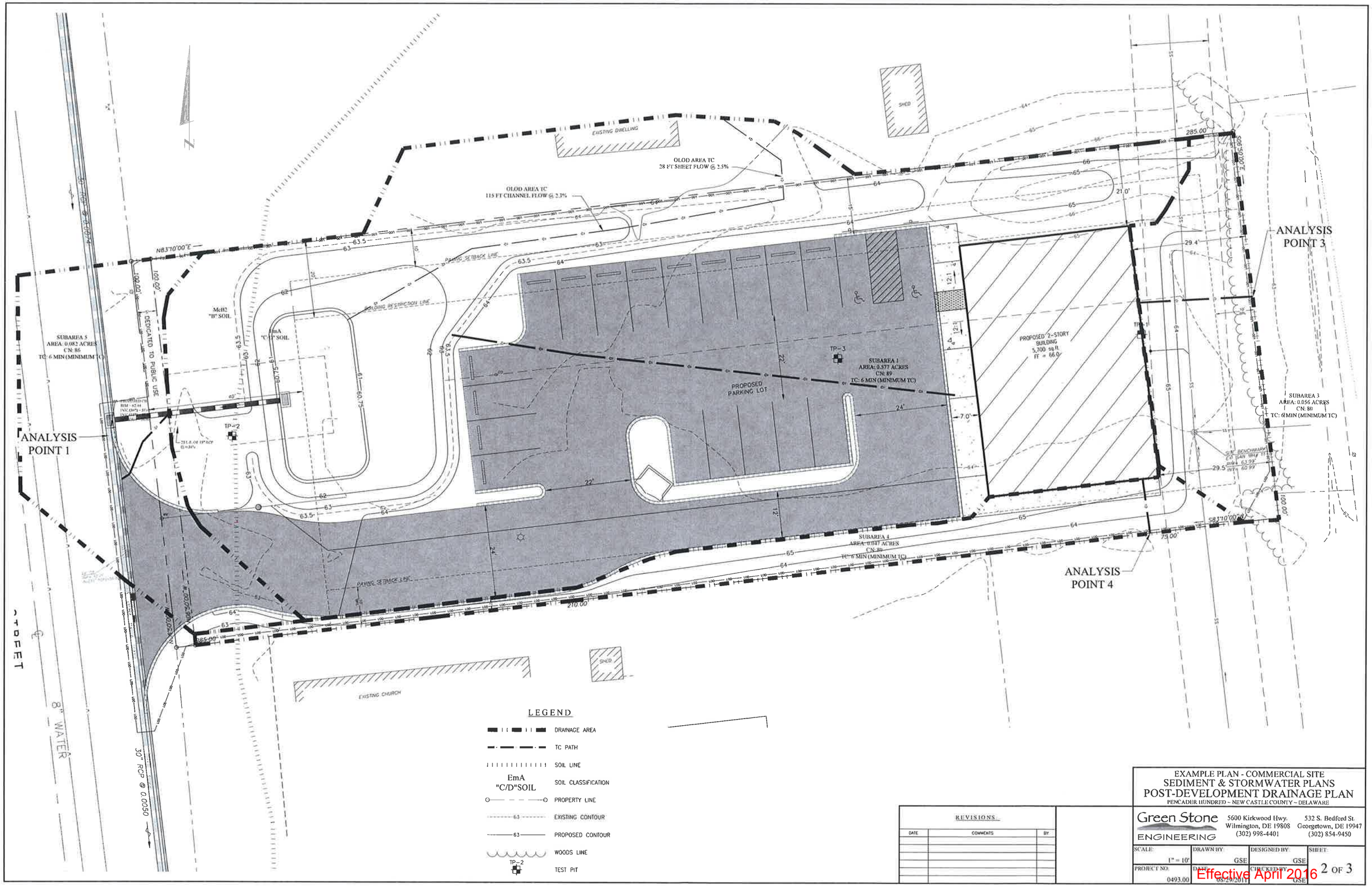
SCALE:	DRAWN BY:	DESIGNED BY:	SHEET:
1" = 10'	GSE	GSE	2 OF 3
PROJECT NO: 0493.00	DATE: 08/29/2011	REVIEWED BY: GSE	

Effective April 2016

Appendix 3

DURMM v2 Model using the Constructed/As-Built Stormwater Management Facilities

Effective April 2016



REVISIONS

DATE	COMMENTS	BY

EXAMPLE PLAN - COMMERCIAL SITE
SEDIMENT & STORMWATER PLANS
POST-DEVELOPMENT DRAINAGE PLAN
PENCADER HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

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(302) 854-9450

SCALE:	DRAWN BY:	DESIGNED BY:	SHEET:
1" = 10'	GSE	GSE	2 OF 3
PROJECT NO: 0493.00	DATE: 08/29/2011	CHECKED BY: GSE	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

CONTRIBUTING AREA RUNOFF CURVE NUMBER (C.A. RCN) WORKSHEET

Cover Type	Treatment	Hydrologic Condition	Curve Numbers for Hydrologic Soil Type: A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
CULTIVATED AGRICULTURAL LANDS										
Fallow	Bare soil	----		77		86		91		94
	Crop residue (CR)	poor		76		85		90		93
	Crop residue (CR)	good		74		83		88		90
Row Crops	Straight row (SR)	poor		72		81		88		91
	Straight row (SR)	good		67		78		85		89
	SR + Crop residue	poor		71		80		87		90
	SR + Crop residue	good		64		75		82		85
	Contoured (C)	poor		70		79		84		88
	Contoured (C)	good		65		75		82		86
	C + Crop residue	poor		69		78		83		87
	C + Crop residue	good		64		74		81		85
	Cont & terraced(C&T)	poor		66		74		80		82
	Cont & terraced(C&T)	good		62		71		78		81
	C&T + Crop residue	poor		65		73		79		81
	C&T + Crop residue	good		61		70		77		80
Small Grain	Straight row (SR)	poor		65		76		84		88
	Straight row (SR)	good		63		75		83		87
	SR + Crop residue	poor		64		75		83		86
	SR + Crop residue	good		60		72		80		84
	Contoured (C)	poor		63		74		82		85
	Contoured (C)	good		61		73		81		84
	C + Crop residue	poor		62		73		81		84
	C + Crop residue	good		60		72		80		83
	Cont & terraced(C&T)	poor		61		72		79		82
	Cont & terraces(C&T)	good		59		70		78		81
	C&T + Crop residue	poor		60		71		78		81
	C&T + Crop residue	good		58		69		77		80
Close-seeded	Straight row	poor		66		77		85		89
or broadcast	Straight row	good		58		72		81		85
legumes or	Contoured	poor		64		75		83		85
rotation	Contoured	good		55		69		78		83
meadow	Cont & terraced	poor		63		73		80		83
	Cont & terraced	good		51		67		76		80
OTHER AGRICULTURAL LANDS										
	Pasture, grassland or range	poor		68		79		86		89
		fair		49		69		79		84
		good		39		61		74		80
	Meadow -cont. grass (non grazed)	----		30		58		71		78
	Brush - brush, weed, grass mix	poor		48		67		77		83
		fair		35		56		70		77
		good		30		48		65		73
	Woods - grass combination	poor		57		73		82		86
		fair		43		65		76		82
		good		32		58		72		79
	Woods	poor		45		66		77		83
		fair		36		60		73		79
		good		30		55		70		77
	Farmsteads	----		59		74		82		86
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39	0.03	61		74	0.23	80
Impervious Areas										
	Paved parking lots, roofs, driveways		0.32	98		98		98		98

Effective April 2016

Streets and roads								
Paved; curbs and storm sewers			98		98		98		98
Paved; open ditches (w/right-of-way)			83		89		92		93
Gravel (w/ right-of-way)			76		85		89		91
Dirt (w/ right-of-way)			72		82		87		89
Urban Districts	Avg % impervious							
Commercial & business	85		89		92		94		95
Industrial	72		81		88		91		93
Residential districts by average lot size	Avg % impervious							
1/8 acre (town houses)	65		77		85		90		92
1/4 acre	38		61		75		83		87
1/3 acre	30		57		72		81		86
1/2 acre	25		54		70		80		85
1 acre	20		51		68		79		84
2 acre	12		46		65		77		82
DEVELOPING URBAN AREA (No Vegetation)								
Newly graded area (pervious only)			77		86		91		94
USER DEFINED								

Subarea Contributing Area per Soil Type (ac)	0.32	0.03	0	0.23

UPSTREAM CONTRIBUTING AREAS

	Subarea ID	*Acres*	*RCN*
Upstream Contributing Area 1			
Upstream Contributing Area 2			
Upstream Contributing Area 3			
Upstream Contributing Area 4			

Total Contributing Area (ac)	**0.58**
Weighted Runoff Curve Number (RCN)	**89**

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

LIMIT OF DISTURBANCE (LOD) WORKSHEET

Step 1 - Subarea LOD Data	HSG A	HSG B	HSG C	HSG D
1.1 HSG Area Within LOD (ac)		0.03		0.55
1.2 Pre-Developed Woods/Meadow Within LOD (ac)				
1.3 Pre-Developed Impervious Within LOD (ac)				
1.4.a Post-Developed Imperviousness Within LOD, Option #1 (ac); ***OR***				0.32
1.4.b Post-Developed Imperviousness Within LOD, Option #2 (%)	0%	0%	0%	58%

Step 2 - Subarea LOD Runoff Calculations				
2.1 RCN per HSG	0.00	61.00	0.00	90.47
2.2 RPv per HSG (in.)	0.00	0.58	0.00	1.98
2.3 Target Runoff per HSG (in.)	0.00	0.58	0.00	1.39
2.4 Cv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.75	0.00	0.75
2.5 Fv Weighted Unit Discharge per HSG (cfs/ac)	0.00	2.25	0.00	2.25

2.6 Subarea LOD (ac)	0.58
2.7 Subarea Weighted RCN	88.95
2.8 Subarea Weighted RPv (in.)	1.90
2.9 Subarea Weighted Target Runoff (in.)	1.35

Step 3 - Upstream LOD Areas *(from previous DURMM Report as applicable)*	Area 1	Area 2	Area 3	Area 4
3.1 Upstream Subarea ID				
3.2 Upstream LOD Area (ac)				
3.3 Target Runoff for Upstream Area (in.)				
3.4 Adjusted CN after all reductions				
3.5 Adjusted RPv (in.)				
3.6 Adjusted Cv (in.)				
3.7 Adjusted Fv (in.)				

Step 4 - RPv Calculations for Combined LOD	
4.1 Combined LOD (ac)	0.58
4.2 Weighted RCN	88.95
4.3 Weighted RPv (in.)	1.90
4.4 Weighted Target Runoff (in.)	1.35
4.5 Estimated Annual Runoff (in.)	26.55
4.6 Req'd Runoff Reduction within LOD (in.)	0.56
4.7 Req'd Runoff Reduction within LOD (%)	29%

Step 5 - Cv Unit Discharge

5. LOD Allowable Unit Discharge (cfs/ac)	0.75

Step 6 - Fv Unit Discharge

6. LOD Allowable Unit Discharge (cfs/ac)	2.25

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

OUTSIDE LIMIT OF DISTURBANCE (OLOD) WORKSHEET

Step 1 - Site Data

1.1 Total Contributing Area (ac)	N/A
1.2 C.A. RCN	N/A
1.3 LOD Area (ac)	N/A
1.4 LOD RCN	N/A
1.5 Outside LOD Area (ac)	N/A
1.6 Outside LOD RCN	N/A

Step 2 - Time of Concentration

FLOW TYPE	2.1 LENGTH (feet)	2.2 SLOPE (ft./ft.)	2.3 SURFACE CODE	2.4 MANNINGS "n"	2.5 VELOCITY (ft./sec.)	2.6 TRAVEL TIME (hrs)
Sheet	28	0.025	f	0.24	N/A	0.08
				----------	N/A	0.00
				----------	N/A	0.00
Shallow Concentrated				N/A	----------	0.00
				N/A	----------	0.00
				N/A	----------	0.00
Open Channel	115	3	N/A	0.03	6.1	0.01
			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00

2.7 Time of Concentration (Tc) 0.10 hrs

Sheet Flow Surface Codes

a Smooth Surface
b fallow (no residue)
c cultivated < 20% Res.
d cultivated > 20% Res.
e grass - range, short
f grass, dense
g grass, bermuda
h woods, light
i woods, dense
j range, natural

Shallow Concentrated Surface Codes

u unpaved surface
p paved surface

Step 3 - Peak Discharge

3.1 Unit Hydrograph Type	STD	
3.2 Frequency (yr)	10	100
3.3 24-HR Rainfall, P (in.)	4.8	8
3.4 Initial Abstraction, Ia (in.)	#N/A	#N/A
3.5 Ia/P ratio	#N/A	#N/A
3.6 Unit Peak Discharge, qu (csm/in)	#N/A	#N/A
3.7 Runoff (in.)	#VALUE!	#VALUE!
3.8 Peak Discharge, qp (cfs)	#VALUE!	#VALUE!
3.9 Equiv. unit peak discharge (cfs/ac)	0.00	0.00

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle

RESOURCE PROTECTION EVENT (RPv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type	Bioretention w/underdrain	Type	--	Type	--	Type	--	Type	--
Step 1 - Calculate Initial RPv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.58		0.58		0.58		0.58		0.58	
1.2 *Reserved*										
1.3 Initial RCN	88.95									
1.4 RPv for Contributing Area (in.)	1.90									
1.5 Req'd RPv Reduction for Contributing Area (in.)	0.56									
1.6 Req'd RPv Reduction for Contributing Area (%)	29%									
1.7 RPv allowable discharge rate (cfs)	0.05									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	5888									
2.2 Retention reduction allowance (%)	50%		N/A		N/A		N/A		N/A	
2.3 Retention reduction volume (ac-ft)	0.07		N/A		N/A		N/A		N/A	
2.4 Retention reduction volume (in.)	1.40		N/A		N/A		N/A		N/A	
2.5 Runoff volume after retention reduction (in.)	0.51		N/A		N/A		N/A		N/A	
2.6 Adjusted CN*	58.70		N/A		N/A		N/A		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Annual CN (ACN)	88.95		N/A		N/A		N/A		N/A	
3.2 Annual runoff (in.)	26.55		N/A		N/A		N/A		N/A	
3.3 Proportion A/B soils in BMP footprint (%)	0%									
3.4 Annual runoff reduction allowance (%)	0%		N/A		N/A		N/A		N/A	
3.5 Annual runoff after reduction (in.)	26.55		N/A		N/A		N/A		N/A	
3.6 Adjusted ACN	88.95		N/A		N/A		N/A		N/A	
3.7 Annual Runoff Reduction Allowance for RPv (in.)	0.02		N/A		N/A		N/A		N/A	
Step 4 - Calculate RPv with BMP Reductions										
4.1 RPv runoff volume after all reductions (in.)	0.49		N/A		N/A		N/A		N/A	
4.2 Total RPv runoff reduction (in.)	1.42		N/A		N/A		N/A		N/A	
4.3 Total RPv runoff reduction (%)	74%		N/A		N/A		N/A		N/A	
4.4 Adjusted CN after all reductions	58.70		N/A		N/A		N/A		N/A	
4.5 Equivalent TR-55 RCN for H&H modeling	68.20		N/A		N/A		N/A		N/A	
4.6 Req'd reduction met?	OK		N/A		N/A		N/A		N/A	
Step 5 - Determine Runoff Reduction Offset										
5.1 Runoff Reduction Shortfall (in.)	N/A		N/A		N/A		N/A		N/A	
5.2 Runoff Reduction Shortfall (cu.ft./ac)	N/A		N/A		N/A		N/A		N/A	
5.3 Total Offset Volume (cu.ft.)	N/A		N/A		N/A		N/A		N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LANDUSE TYPE:	Commercial
TMDL WATERSHED:	Christina River

TOTAL MAXIMUM DAILY LOAD (TMDL) WORKSHEET

	BMP 1				BMP 2				BMP 3				BMP 4				BMP 5			
	Type:	Bioretention w/underdrain			Type:	--			Type:	--			Type:	--			Type:	--		
Step 1 - Calculate Annual Runoff Volume	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS
1.1 Total contributing area to BMP (ac)	0.58																			
1.2 Initial RCN	89																			
1.3 Annual runoff volume (in.)	26.55																			
1.4 Annual runoff volume (liters)	1.58E+06																			
Step 2 - Calculate Annual Pollutant Load																				
2.1 EMC (mg/L)		2.00	0.27	60																
2.2 Load (mg/yr)		3.17E+06	4.27E+05	9.50E+07																
2.4 Stormwater Load (lb/ac/yr)		12.03	1.62	361		4.81	0.81	92		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 3 - Adjust for Runoff Reduction																				
3.1 BMP Runoff Reduction (%)	74%				N/A				N/A				N/A				N/A			
3.2 BMP Removal Efficiency (%)		60%	50%	74%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
3.3 Adjusted load (lb/ac/yr)		4.81	0.81	92		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 4 - Calculate Pollutant Reduction																				
4.1 TMDL (lb/ac/yr)		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A
4.2 Reduction met?		OK	No	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK
Step 5 - Determine TMDL Offset																				
5.1 TMDL Shortfall (lb/ac/yr)		0.00	0.46	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0
5.2 TMDL Shortfall (%)		0%	57%	0%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.3 Residual RPv Volume (in)		0.49	0.49	0.49		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
5.4 Req'd Additional RR to meet TMDL (in)*		0.00	0.28	0.00		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.5 Req'd Additional RR to meet TMDL (cu.ft./ac)		0	1004	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.6 Total Offset Volume (cu.ft.)		0	582	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle

CONVEYANCE EVENT (Cv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Bioretention w/underdrain	Type:	--	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Cv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.58		0.58		0.58		0.58		0.58	
1.2 Initial RCN	88.95									
1.3 **10-YR** Rainfall (in.)	4.8									
1.4 Cv runoff volume (in.)	3.58									
1.5 LOD allowable unit discharge (cfs/ac)	0.75									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Cv allowable discharge rate (cfs)	0.44									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	5888.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.14		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	2.80		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	0.78		0.78		#N/A		#N/A		#N/A	
2.5 CN*	53.16		53.16		#N/A		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	0%		#N/A		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	3.58		#N/A		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	88.95		#N/A		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.00		#N/A		#N/A		#N/A		#N/A	
Step 4 - Calculate Cv with BMP Reductions										
4.1 Cv runoff volume after all reductions (in.)	0.78		#N/A		#N/A		#N/A		#N/A	
4.2 Total Cv runoff reduction (%)	78%		#N/A		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	53.16		#N/A		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle

FLOODING EVENT (Fv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Bioretention w/underdrain	Type:	--	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Fv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.58		0.58		0.58		0.58		0.58	
1.2 Initial RCN	88.95									
1.3 **100-YR** Rainfall (in.)	8.0									
1.4 Fv runoff volume (in.)	6.68									
1.5 LOD allowable unit discharge (cfs/ac)	2.25									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Fv allowable discharge rate (cfs)	1.31									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	5888.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.14		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	2.80		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	3.88		3.88		#N/A		#N/A		#N/A	
2.5 CN*	64.91		64.91		#N/A		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	0%		#N/A		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	6.68		#N/A		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	88.95		#N/A		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.00		#N/A		#N/A		#N/A		#N/A	
Step 4 - Calculate Fv with BMP Reductions										
4.1 Fv runoff volume after all reductions (in.)	3.88		#N/A		#N/A		#N/A		#N/A	
4.2 Total Fv runoff reduction (%)	42%		#N/A		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	64.91		#N/A		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
TMDL Watershed:	Christina River

DURMM OUTPUT WORKSHEET

DURMM v2.beta.110802

Site Data

Contributing Area to BMPs (ac.)	0.58				
C.A. RCN	89				
Subarea LOD (ac.)	0.58				
Upstream Subarea ID	0	0	0	0	
Upstream Subarea LOD (ac.)	0.00	0.00	0.00	0.00	
Combined LOD with Upstream Areas (ac.)	0.58				
Combined RCN with Upstream Areas (ac.)	88.95				
TMDL-TN (lb/ac/yr)	5.70				
TMDL-TP (lb/ac/yr)	0.35				
TMDL-TSS (lb/ac/yr)	N/A				
BMP Selection	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
	Bioretention w/underdrain	--	--	--	--

Resource Protection Event (RPV)

RPv for Contributing Area (in.)	1.90				
Req'd RPv Reduction for Contributing Area (in.)	0.56				
Req'd RPv Reduction for Contributing Area (%)	29%				
C.A. allowable discharge rate (cfs)	0.05				
Unmanaged Polluant load, TN (lbs/ac/yr)	12.03				
Unmanaged Polluant load, TP (lbs/ac/yr)	1.62				
Unmanaged Polluant load, TSS (lbs/ac/yr)	361				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	0.49	N/A	N/A	N/A	N/A
Total RPv runoff reduction (in.)	1.42	N/A	N/A	N/A	N/A
Total RPv runoff reduction (%)	74%	N/A	N/A	N/A	N/A
Req'd runoff reduction met?	OK	N/A	N/A	N/A	N/A
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	4.81	#N/A	#N/A	#N/A	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	0.81	#N/A	#N/A	#N/A	#N/A
Adjusted pollutant load, TSS (lb/ac/yr)	92	#N/A	#N/A	#N/A	#N/A
Offsets Requirements					
RPv Offset (cu. ft.)	N/A	N/A	N/A	N/A	N/A

Conveyance Event (Cv)

Cv runoff volume (in.)	3.58				
Stds-based allowable discharge (cfs)	0.44				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	0.78	#N/A	#N/A	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in.)	6.68				
Stds-based allowable discharge (cfs)	1.31				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	3.88	#N/A	#N/A	#N/A	#N/A

Adjusted Subarea Data for Downstream DURMM Modeling

Contributing Area (ac.)	0.58
C.A. RCN	89
LOD Area (ac.)	0.58
Weighted Target Runoff (in.)	1.35
Adjusted CN after all reductions	58.70
Adjusted RPv (in.)	0.49
Adjusted Cv (in.)	
Adjusted Fv (in.)	

Effective April 2016

Adjusted Subarea Data for H&H Modeling

	Rain (in.)	RCN
Resource Protection Event, RPv	2.7	N/A
Conveyance Event, Cv	4.8	53.16
Flooding Event, Fv	8	64.91

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

CONTRIBUTING AREA RUNOFF CURVE NUMBER (C.A. RCN) WORKSHEET

Cover Type	Treatment	Hydrologic Condition	Curve Numbers for Hydrologic Soil Type A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
CULTIVATED AGRICULTURAL LANDS										
Fallow	Bare soil	----		77		86		91		94
	Crop residue (CR)	poor		76		85		90		93
	Crop residue (CR)	good		74		83		88		90
Row Crops	Straight row (SR)	poor		72		81		88		91
	Straight row (SR)	good		67		78		85		89
	SR + Crop residue	poor		71		80		87		90
	SR + Crop residue	good		64		75		82		85
	Contoured (C)	poor		70		79		84		88
	Contoured (C)	good		65		75		82		86
	C + Crop residue	poor		69		78		83		87
	C + Crop residue	good		64		74		81		85
	Cont & terraced(C&T)	poor		66		74		80		82
	Cont & terraced(C&T)	good		62		71		78		81
	C&T + Crop residue	poor		65		73		79		81
	C&T + Crop residue	good		61		70		77		80
Small Grain	Straight row (SR)	poor		65		76		84		88
	Straight row (SR)	good		63		75		83		87
	SR + Crop residue	poor		64		75		83		86
	SR + Crop residue	good		60		72		80		84
	Contoured (C)	poor		63		74		82		85
	Contoured (C)	good		61		73		81		84
	C + Crop residue	poor		62		73		81		84
	C + Crop residue	good		60		72		80		83
	Cont & terraced(C&T)	poor		61		72		79		82
	Cont & terraces(C&T)	good		59		70		78		81
	C&T + Crop residue	poor		60		71		78		81
	C&T + Crop residue	good		58		69		77		80
Close-seeded	Straight row	poor		66		77		85		89
or broadcast	Straight row	good		58		72		81		85
legumes or	Contoured	poor		64		75		83		85
rotation	Contoured	good		55		69		78		83
meadow	Cont & terraced	poor		63		73		80		83
	Cont & terraced	good		51		67		76		80
OTHER AGRICULTURAL LANDS										
	Pasture, grassland or range	poor		68		79		86		89
		fair		49		69		79		84
		good		39		61		74		80
	Meadow -cont. grass (non grazed)	----		30		58		71		78
	Brush - brush, weed, grass mix	poor		48		67		77		83
		fair		35		56		70		77
		good		30		48		65		73
	Woods - grass combination	poor		57		73		82		86
		fair		43		65		76		82
		good		32		58		72		79
	Woods	poor		45		66		77		83
		fair		36		60		73		79
		good		30		55		70	0.007	77
	Farmsteads	----		59		74		82		86
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39		61		74	0.049	80
Impervious Areas										
	Paved parking lots, roofs, driveways			98		98		98		98

Effective April 2016

Streets and roads								
Paved; curbs and storm sewers			98		98		98		98
Paved; open ditches (w/right-of-way)			83		89		92		93
Gravel (w/ right-of-way)			76		85		89		91
Dirt (w/ right-of-way)			72		82		87		89
Urban Districts	Avg % impervious							
Commercial & business	85		89		92		94		95
Industrial	72		81		88		91		93
Residential districts by average lot size	Avg % impervious							
1/8 acre (town houses)	65		77		85		90		92
1/4 acre	38		61		75		83		87
1/3 acre	30		57		72		81		86
1/2 acre	25		54		70		80		85
1 acre	20		51		68		79		84
2 acre	12		46		65		77		82
DEVELOPING URBAN AREA (No Vegetation)								
Newly graded area (pervious only)			77		86		91		94
USER DEFINED								

Subarea Contributing Area per Soil Type (ac)	0	0	0	0.056

UPSTREAM CONTRIBUTING AREAS

	Subarea ID	*Acres*	*RCN*
Upstream Contributing Area 1			
Upstream Contributing Area 2			
Upstream Contributing Area 3			
Upstream Contributing Area 4			

Total Contributing Area (ac)	**0.06**
Weighted Runoff Curve Number (RCN)	**80**

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

LIMIT OF DISTURBANCE (LOD) WORKSHEET

Step 1 - Subarea LOD Data	HSG A	HSG B	HSG C	HSG D
1.1 HSG Area Within LOD (ac)				0.056
1.2 Pre-Developed Woods/Meadow Within LOD (ac)				0.007
1.3 Pre-Developed Impervious Within LOD (ac)				
1.4.a Post-Developed Imperviousness Within LOD, Option #1 (ac); ***OR***				
1.4.b Post-Developed Imperviousness Within LOD, Option #2 (%)	0%	0%	0%	0%

Step 2 - Subarea LOD Runoff Calculations				
2.1 RCN per HSG	0.00	0.00	0.00	80.00
2.2 RPv per HSG (in.)	0.00	0.00	0.00	1.39
2.3 Target Runoff per HSG (in.)	0.00	0.00	0.00	1.32
2.4 Cv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.00	0.00	0.70
2.5 Fv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.00	0.00	2.13

2.6 Subarea LOD (ac)	0.06
2.7 Subarea Weighted RCN	80.00
2.8 Subarea Weighted RPv (in.)	1.39
2.9 Subarea Weighted Target Runoff (in.)	1.32

Step 3 - Upstream LOD Areas *(from previous DURMM Report as applicable)*	Area 1	Area 2	Area 3	Area 4
3.1 Upstream Subarea ID				
3.2 Upstream LOD Area (ac)				
3.3 Target Runoff for Upstream Area (in.)				
3.4 Adjusted CN after all reductions				
3.5 Adjusted RPv (in.)				
3.6 Adjusted Cv (in.)				
3.7 Adjusted Fv (in.)				

Step 4 - RPv Calculations for Combined LOD	
4.1 Combined LOD (ac)	0.06
4.2 Weighted RCN	80.00
4.3 Weighted RPv (in.)	1.39
4.4 Weighted Target Runoff (in.)	1.32
4.5 Estimated Annual Runoff (in.)	18.32
4.6 Req'd Runoff Reduction within LOD (in.)	0.06
4.7 Req'd Runoff Reduction within LOD (%)	5%

Step 5 - Cv Unit Discharge	
5. LOD Allowable Unit Discharge (cfs/ac)	0.70

Step 6 - Fv Unit Discharge	
6. LOD Allowable Unit Discharge (cfs/ac)	2.13

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

OUTSIDE LIMIT OF DISTURBANCE (OLOD) WORKSHEET

Step 1 - Site Data

1.1 Total Contributing Area (ac)	N/A
1.2 C.A. RCN	N/A
1.3 LOD Area (ac)	N/A
1.4 LOD RCN	N/A
1.5 Outside LOD Area (ac)	N/A
1.6 Outside LOD RCN	N/A

Step 2 - Time of Concentration

FLOW TYPE	2.1 LENGTH (feet)	2.2 SLOPE (ft./ft.)	2.3 SURFACE CODE	2.4 MANNINGS "n"	2.5 VELOCITY (ft./sec.)	2.6 TRAVEL TIME (hrs)
Sheet				----------	N/A	0.00
				----------	N/A	0.00
				----------	N/A	0.00
Shallow Concentrated				N/A	----------	0.00
				N/A	----------	0.00
				N/A	----------	0.00
Open Channel			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00

2.7 Time of Concentration (Tc) 0.00 hrs

Sheet Flow Surface Codes

a Smooth Surface
b fallow (no residue)
c cultivated < 20% Res.
d cultivated > 20% Res.
e grass - range, short
f grass, dense
g grass, bermuda
h woods, light
i woods, dense
j range, natural

Shallow Concentrated Surface Codes

u unpaved surface
p paved surface

Step 3 - Peak Discharge

3.1 Unit Hydrograph Type	STD	
3.2 Frequency (yr)	10	100
3.3 24-HR Rainfall, P (in.)	4.8	8
3.4 Initial Abstraction, Ia (in.)	#N/A	#N/A
3.5 Ia/P ratio	#N/A	#N/A
3.6 Unit Peak Discharge, qu (csm/in)	#N/A	#N/A
3.7 Runoff (in.)	#VALUE!	#VALUE!
3.8 Peak Discharge, qp (cfs)	#VALUE!	#VALUE!
3.9 Equiv. unit peak discharge (cfs/ac)	0.00	0.00

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
LOCATION (County):	New Castle

RESOURCE PROTECTION EVENT (RPv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type	Impervious disconnection	Type	--	Type	--	Type	--	Type	--
Step 1 - Calculate Initial RPv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.06		0.06		0.06		0.06		0.06	
1.2 *Reserved*										
1.3 Initial RCN	80.00									
1.4 RPv for Contributing Area (in.)	1.39									
1.5 Req'd RPv Reduction for Contributing Area (in.)	0.06									
1.6 Req'd RPv Reduction for Contributing Area (%)	5%									
1.7 RPv allowable discharge rate (cfs)	0.00									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)										
2.2 Retention reduction allowance (%)	0%		N/A		N/A		N/A		N/A	
2.3 Retention reduction volume (ac-ft)	0.00		N/A		N/A		N/A		N/A	
2.4 Retention reduction volume (in.)	0.00		N/A		N/A		N/A		N/A	
2.5 Runoff volume after retention reduction (in.)	1.39		N/A		N/A		N/A		N/A	
2.6 Adjusted CN*	80.00		N/A		N/A		N/A		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Annual CN (ACN)	80.00		N/A		N/A		N/A		N/A	
3.2 Annual runoff (in.)	18.32		N/A		N/A		N/A		N/A	
3.3 Proportion A/B soils in BMP footprint (%)										
3.4 Annual runoff reduction allowance (%)	10%		N/A		N/A		N/A		N/A	
3.5 Annual runoff after reduction (in.)	16.49		N/A		N/A		N/A		N/A	
3.6 Adjusted ACN	77.63		N/A		N/A		N/A		N/A	
3.7 Annual Runoff Reduction Allowance for RPv (in.)	0.12		N/A		N/A		N/A		N/A	
Step 4 - Calculate RPv with BMP Reductions										
4.1 RPv runoff volume after all reductions (in.)	1.27		N/A		N/A		N/A		N/A	
4.2 Total RPv runoff reduction (in.)	0.12		N/A		N/A		N/A		N/A	
4.3 Total RPv runoff reduction (%)	9%		N/A		N/A		N/A		N/A	
4.4 Adjusted CN after all reductions	77.63		N/A		N/A		N/A		N/A	
4.5 Equivalent TR-55 RCN for H&H modeling	83.93		N/A		N/A		N/A		N/A	
4.6 Req'd reduction met?	OK		N/A		N/A		N/A		N/A	
Step 5 - Determine Runoff Reduction Offset										
5.1 Runoff Reduction Shortfall (in.)	N/A		N/A		N/A		N/A		N/A	
5.2 Runoff Reduction Shortfall (cu.ft./ac)	N/A		N/A		N/A		N/A		N/A	
5.3 Total Offset Volume (cu.ft.)	N/A		N/A		N/A		N/A		N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
LANDUSE TYPE:	Commercial
TMDL WATERSHED:	Christina River

TOTAL MAXIMUM DAILY LOAD (TMDL) WORKSHEET

	BMP 1				BMP 2				BMP 3				BMP 4				BMP 5			
	Type:	Impervious disconnection			Type:	--			Type:	--			Type:	--			Type:	--		
Step 1 - Calculate Annual Runoff Volume	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS
1.1 Total contributing area to BMP (ac)	0.06																			
1.2 Initial RCN	80																			
1.3 Annual runoff volume (in.)	18.32																			
1.4 Annual runoff volume (liters)	1.05E+05																			
Step 2 - Calculate Annual Pollutant Load																				
2.1 EMC (mg/L)		2.00	0.27	60																
2.2 Load (mg/yr)		2.11E+05	2.85E+04	6.33E+06																
2.4 Stormwater Load (lb/ac/yr)		8.30	1.12	249		7.47	1.01	224		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 3 - Adjust for Runoff Reduction																				
3.1 BMP Runoff Reduction (%)	10%				N/A				N/A				N/A				N/A			
3.2 BMP Removal Efficiency (%)		10%	10%	10%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
3.3 Adjusted load (lb/ac/yr)		7.47	1.01	224		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 4 - Calculate Pollutant Reduction																				
4.1 TMDL (lb/ac/yr)		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A
4.2 Reduction met?		No	No	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK
Step 5 - Determine TMDL Offset																				
5.1 TMDL Shortfall (lb/ac/yr)		1.77	0.66	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0
5.2 TMDL Shortfall (%)		24%	65%	0%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.3 Residual RPv Volume (in)		1.27	1.27	1.27		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
5.4 Req'd Additional RR to meet TMDL (in)*		0.30	0.83	0.00		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.5 Req'd Additional RR to meet TMDL (cu.ft./ac)		1093	3007	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.6 Total Offset Volume (cu.ft.)		61	168	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
LOCATION (County):	New Castle

CONVEYANCE EVENT (Cv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	--	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Cv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.06		0.06		0.06		0.06		0.06	
1.2 Initial RCN	80.00									
1.3 10-YR Rainfall (in.)	4.8									
1.4 Cv runoff volume (in.)	2.72									
1.5 LOD allowable unit discharge (cfs/ac)	0.70									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Cv allowable discharge rate (cfs)	0.04									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	2.72		2.66		#N/A		#N/A		#N/A	
2.5 CN*	80.00		79.39		#N/A		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	2%		#N/A		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	2.66		#N/A		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	79.39		#N/A		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.05		#N/A		#N/A		#N/A		#N/A	
Step 4 - Calculate Cv with BMP Reductions										
4.1 Cv runoff volume after all reductions (in.)	2.66		#N/A		#N/A		#N/A		#N/A	
4.2 Total Cv runoff reduction (%)	2%		#N/A		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	79.39		#N/A		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
LOCATION (County):	New Castle

FLOODING EVENT (Fv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	--	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Fv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.06		0.06		0.06		0.06		0.06	
1.2 Initial RCN	80.00									
1.3 **100-YR** Rainfall (in.)	8.0									
1.4 Fv runoff volume (in.)	5.63									
1.5 LOD allowable unit discharge (cfs/ac)	2.13									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Fv allowable discharge rate (cfs)	0.12									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	5.63		5.63		#N/A		#N/A		#N/A	
2.5 CN*	80.00		80.00		#N/A		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	0%		#N/A		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	5.63		#N/A		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	80.00		#N/A		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.00		#N/A		#N/A		#N/A		#N/A	
Step 4 - Calculate Fv with BMP Reductions										
4.1 Fv runoff volume after all reductions (in.)	5.63		#N/A		#N/A		#N/A		#N/A	
4.2 Total Fv runoff reduction (%)	0%		#N/A		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	80.00		#N/A		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 3
TMDL Watershed:	Christina River

DURMM OUTPUT WORKSHEET

DURMM v2.beta.110802

Site Data

Contributing Area to BMPs (ac.)	0.056				
C.A. RCN	80				
Subarea LOD (ac.)	0.056				
Upstream Subarea ID	0	0	0	0	
Upstream Subarea LOD (ac.)	0.00	0.00	0.00	0.00	
Combined LOD with Upstream Areas (ac.)	0.06				
Combined RCN with Upstream Areas (ac.)	80.00				
TMDL-TN (lb/ac/yr)	5.70				
TMDL-TP (lb/ac/yr)	0.35				
TMDL-TSS (lb/ac/yr)	N/A				
BMP Selection	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
	Impervious disconnection	--	--	--	--

Resource Protection Event (RPV)

RPv for Contributing Area (in.)	1.39				
Req'd RPv Reduction for Contributing Area (in.)	0.06				
Req'd RPv Reduction for Contributing Area (%)	5%				
C.A. allowable discharge rate (cfs)	0.00				
Unmanaged Polluant load, TN (lbs/ac/yr)	8.30				
Unmanaged Polluant load, TP (lbs/ac/yr)	1.12				
Unmanaged Polluant load, TSS (lbs/ac/yr)	249				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	1.27	N/A	N/A	N/A	N/A
Total RPv runoff reduction (in.)	0.12	N/A	N/A	N/A	N/A
Total RPv runoff reduction (%)	9%	N/A	N/A	N/A	N/A
Req'd runoff reduction met?	OK	N/A	N/A	N/A	N/A
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	7.47	#N/A	#N/A	#N/A	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	1.01	#N/A	#N/A	#N/A	#N/A
Adjusted pollutant load, TSS (lb/ac/yr)	224	#N/A	#N/A	#N/A	#N/A
Offsets Requirements					
RPv Offset (cu. ft.)	N/A	N/A	N/A	N/A	N/A

Conveyance Event (Cv)

Cv runoff volume (in.)	2.72				
Stds-based allowable discharge (cfs)	0.04				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	2.66	#N/A	#N/A	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in.)	5.63				
Stds-based allowable discharge (cfs)	0.12				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	5.63	#N/A	#N/A	#N/A	#N/A

Adjusted Subarea Data for Downstream DURMM Modeling

Contributing Area (ac.)	0.06
C.A. RCN	80
LOD Area (ac.)	0.06
Weighted Target Runoff (in.)	1.32
Adjusted CN after all reductions	77.63

Effective April 2016

Adjusted RPv (in.)	1.27
Adjusted Cv (in.)	
Adjusted Fv (in.)	

Adjusted Subarea Data for H&H Modeling

	Rain (in.)	RCN
Resource Protection Event, RPv	2.7	N/A
Conveyance Event, Cv	4.8	79.39
Flooding Event, Fv	8	80.00

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

CONTRIBUTING AREA RUNOFF CURVE NUMBER (C.A. RCN) WORKSHEET

Cover Type	Treatment	Hydrologic Condition	Curve Numbers for Hydrologic Soil Type							
			A		B		C		D	
			Acres	*RCN*	*Acres*	*RCN*	*Acres*	*RCN*	*Acres*	*RCN*
CULTIVATED AGRICULTURAL LANDS										
Fallow	Bare soil	----		77		86		91		94
	Crop residue (CR)	poor		76		85		90		93
	Crop residue (CR)	good		74		83		88		90
Row Crops	Straight row (SR)	poor		72		81		88		91
	Straight row (SR)	good		67		78		85		89
	SR + Crop residue	poor		71		80		87		90
	SR + Crop residue	good		64		75		82		85
	Contoured (C)	poor		70		79		84		88
	Contoured (C)	good		65		75		82		86
	C + Crop residue	poor		69		78		83		87
	C + Crop residue	good		64		74		81		85
	Cont & terraced(C&T)	poor		66		74		80		82
	Cont & terraced(C&T)	good		62		71		78		81
	C&T + Crop residue	poor		65		73		79		81
	C&T + Crop residue	good		61		70		77		80
Small Grain	Straight row (SR)	poor		65		76		84		88
	Straight row (SR)	good		63		75		83		87
	SR + Crop residue	poor		64		75		83		86
	SR + Crop residue	good		60		72		80		84
	Contoured (C)	poor		63		74		82		85
	Contoured (C)	good		61		73		81		84
	C + Crop residue	poor		62		73		81		84
	C + Crop residue	good		60		72		80		83
	Cont & terraced(C&T)	poor		61		72		79		82
	Cont & terraces(C&T)	good		59		70		78		81
	C&T + Crop residue	poor		60		71		78		81
	C&T + Crop residue	good		58		69		77		80
Close-seeded	Straight row	poor		66		77		85		89
or broadcast	Straight row	good		58		72		81		85
legumes or	Contoured	poor		64		75		83		85
rotation	Contoured	good		55		69		78		83
meadow	Cont & terraced	poor		63		73		80		83
	Cont & terraced	good		51		67		76		80
OTHER AGRICULTURAL LANDS										
	Pasture, grassland or range	poor		68		79		86		89
		fair		49		69		79		84
		good		39		61		74		80
	Meadow -cont. grass (non grazed)	----		30		58		71		78
	Brush - brush, weed, grass mix	poor		48		67		77		83
		fair		35		56		70		77
		good		30		48		65		73
	Woods - grass combination	poor		57		73		82		86
		fair		43		65		76		82
		good		32		58		72		79
	Woods	poor		45		66		77		83
		fair		36		60		73		79
		good		30		55		70		77
	Farmsteads	----		59		74		82		86
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39	0.001	61		74	0.044	80
Impervious Areas										
	Paved parking lots, roofs, driveways			98	0.002	98		98		98

Effective April 2016

Streets and roads								
Paved; curbs and storm sewers			98		98		98		98
Paved; open ditches (w/right-of-way)			83		89		92		93
Gravel (w/ right-of-way)			76		85		89		91
Dirt (w/ right-of-way)			72		82		87		89
Urban Districts	Avg % impervious							
Commercial & business	85		89		92		94		95
Industrial	72		81		88		91		93
Residential districts by average lot size	Avg % impervious							
1/8 acre (town houses)	65		77		85		90		92
1/4 acre	38		61		75		83		87
1/3 acre	30		57		72		81		86
1/2 acre	25		54		70		80		85
1 acre	20		51		68		79		84
2 acre	12		46		65		77		82
DEVELOPING URBAN AREA (No Vegetation)								
Newly graded area (pervious only)			77		86		91		94
USER DEFINED								

Subarea Contributing Area per Soil Type (ac)	0	0.003	0	0.044

UPSTREAM CONTRIBUTING AREAS

	Subarea ID	*Acres*	*RCN*
Upstream Contributing Area 1			
Upstream Contributing Area 2			
Upstream Contributing Area 3			
Upstream Contributing Area 4			

Total Contributing Area (ac)	**0.05**
Weighted Runoff Curve Number (RCN)	**80**

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

LIMIT OF DISTURBANCE (LOD) WORKSHEET

Step 1 - Subarea LOD Data	HSG A	HSG B	HSG C	HSG D
1.1 HSG Area Within LOD (ac)		0.001		0.046
1.2 Pre-Developed Woods/Meadow Within LOD (ac)				
1.3 Pre-Developed Impervious Within LOD (ac)				
1.4.a Post-Developed Imperviousness Within LOD, Option #1 (ac); ***OR***				0.002
1.4.b Post-Developed Imperviousness Within LOD, Option #2 (%)	0%	0%	0%	4%

Step 2 - Subarea LOD Runoff Calculations				
2.1 RCN per HSG	0.00	61.00	0.00	80.78
2.2 RPv per HSG (in.)	0.00	0.58	0.00	1.43
2.3 Target Runoff per HSG (in.)	0.00	0.58	0.00	1.39
2.4 Cv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.75	0.00	0.75
2.5 Fv Weighted Unit Discharge per HSG (cfs/ac)	0.00	2.25	0.00	2.25

2.6 Subarea LOD (ac)	0.05
2.7 Subarea Weighted RCN	80.36
2.8 Subarea Weighted RPv (in.)	1.41
2.9 Subarea Weighted Target Runoff (in.)	1.37

Step 3 - Upstream LOD Areas *(from previous DURMM Report as applicable)*	Area 1	Area 2	Area 3	Area 4
3.1 Upstream Subarea ID				
3.2 Upstream LOD Area (ac)				
3.3 Target Runoff for Upstream Area (in.)				
3.4 Adjusted CN after all reductions				
3.5 Adjusted RPv (in.)				
3.6 Adjusted Cv (in.)				
3.7 Adjusted Fv (in.)				

Step 4 - RPv Calculations for Combined LOD	
4.1 Combined LOD (ac)	0.05
4.2 Weighted RCN	80.36
4.3 Weighted RPv (in.)	1.41
4.4 Weighted Target Runoff (in.)	1.37
4.5 Estimated Annual Runoff (in.)	18.61
4.6 Req'd Runoff Reduction within LOD (in.)	0.04
4.7 Req'd Runoff Reduction within LOD (%)	3%

Step 5 - Cv Unit Discharge	
5. LOD Allowable Unit Discharge (cfs/ac)	0.75

Step 6 - Fv Unit Discharge	
6. LOD Allowable Unit Discharge (cfs/ac)	2.25

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

OUTSIDE LIMIT OF DISTURBANCE (OLOD) WORKSHEET

Step 1 - Site Data

1.1 Total Contributing Area (ac)	N/A
1.2 C.A. RCN	N/A
1.3 LOD Area (ac)	N/A
1.4 LOD RCN	N/A
1.5 Outside LOD Area (ac)	N/A
1.6 Outside LOD RCN	N/A

Step 2 - Time of Concentration

FLOW TYPE	2.1 LENGTH (feet)	2.2 SLOPE (ft./ft.)	2.3 SURFACE CODE	2.4 MANNINGS "n"	2.5 VELOCITY (ft./sec.)	2.6 TRAVEL TIME (hrs)
Sheet				----------	N/A	0.00
				----------	N/A	0.00
				----------	N/A	0.00
Shallow Concentrated				N/A	----------	0.00
				N/A	----------	0.00
				N/A	----------	0.00
Open Channel			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00

2.7 Time of Concentration (Tc) 0.00 hrs

Sheet Flow Surface Codes

a Smooth Surface
b fallow (no residue)
c cultivated < 20% Res.
d cultivated > 20% Res.
e grass - range, short
f grass, dense
g grass, bermuda
h woods, light
i woods, dense
j range, natural

Shallow Concentrated Surf

u unpaved surface
p paved surface

Step 3 - Peak Discharge

3.1 Unit Hydrograph Type	STD	
3.2 Frequency (yr)	10	100
3.3 24-HR Rainfall, P (in.)	4.8	8
3.4 Initial Abstraction, Ia (in.)	#N/A	#N/A
3.5 Ia/P ratio	#N/A	#N/A
3.6 Unit Peak Discharge, qu (csm/in)	#N/A	#N/A
3.7 Runoff (in.)	#VALUE!	#VALUE!
3.8 Peak Discharge, qp (cfs)	#VALUE!	#VALUE!
3.9 Equiv. unit peak discharge (cfs/ac)	0.00	0.00

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
LOCATION (County):	New Castle

RESOURCE PROTECTION EVENT (RPv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type	Impervious disconnection	Type	--	Type	--	Type	--	Type	--
Step 1 - Calculate Initial RPv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.05		0.05		0.05		0.05		0.05	
1.2 *Reserved*										
1.3 Initial RCN	80.36									
1.4 RPv for Contributing Area (in.)	1.41									
1.5 Req'd RPv Reduction for Contributing Area (in.)	0.04									
1.6 Req'd RPv Reduction for Contributing Area (%)	3%									
1.7 RPv allowable discharge rate (cfs)	0.00									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)										
2.2 Retention reduction allowance (%)	0%		N/A		N/A		N/A		N/A	
2.3 Retention reduction volume (ac-ft)	0.00		N/A		N/A		N/A		N/A	
2.4 Retention reduction volume (in.)	0.00		N/A		N/A		N/A		N/A	
2.5 Runoff volume after retention reduction (in.)	1.41		N/A		N/A		N/A		N/A	
2.6 Adjusted CN*	80.44		N/A		N/A		N/A		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Annual CN (ACN)	80.36		N/A		N/A		N/A		N/A	
3.2 Annual runoff (in.)	18.61		N/A		N/A		N/A		N/A	
3.3 Proportion A/B soils in BMP footprint (%)										
3.4 Annual runoff reduction allowance (%)	10%		N/A		N/A		N/A		N/A	
3.5 Annual runoff after reduction (in.)	16.75		N/A		N/A		N/A		N/A	
3.6 Adjusted ACN	77.98		N/A		N/A		N/A		N/A	
3.7 Annual Runoff Reduction Allowance for RPv (in.)	0.12		N/A		N/A		N/A		N/A	
Step 4 - Calculate RPv with BMP Reductions										
4.1 RPv runoff volume after all reductions (in.)	1.29		N/A		N/A		N/A		N/A	
4.2 Total RPv runoff reduction (in.)	0.12		N/A		N/A		N/A		N/A	
4.3 Total RPv runoff reduction (%)	9%		N/A		N/A		N/A		N/A	
4.4 Adjusted CN after all reductions	77.98		N/A		N/A		N/A		N/A	
4.5 Equivalent TR-55 RCN for H&H modeling	84.19		N/A		N/A		N/A		N/A	
4.6 Req'd reduction met?	OK		N/A		N/A		N/A		N/A	
Step 5 - Determine Runoff Reduction Offset										
5.1 Runoff Reduction Shortfall (in.)	N/A		N/A		N/A		N/A		N/A	
5.2 Runoff Reduction Shortfall (cu.ft./ac)	N/A		N/A		N/A		N/A		N/A	
5.3 Total Offset Volume (cu.ft.)	N/A		N/A		N/A		N/A		N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
LANDUSE TYPE:	Commercial
TMDL WATERSHED:	Christina River

TOTAL MAXIMUM DAILY LOAD (TMDL) WORKSHEET

	BMP 1				BMP 2				BMP 3				BMP 4				BMP 5			
	Type:	Impervious disconnection			Type:	--			Type:	--			Type:	--			Type:	--		
Step 1 - Calculate Annual Runoff Volume	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS
1.1 Total contributing area to BMP (ac)	0.05																			
1.2 Initial RCN	80																			
1.3 Annual runoff volume (in.)	18.61																			
1.4 Annual runoff volume (liters)	8.99E+04																			
Step 2 - Calculate Annual Pollutant Load																				
2.1 EMC (mg/L)		2.00	0.27	60																
2.2 Load (mg/yr)		1.80E+05	2.43E+04	5.39E+06																
2.4 Stormwater Load (lb/ac/yr)		8.44	1.14	253		7.59	1.02	228		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 3 - Adjust for Runoff Reduction																				
3.1 BMP Runoff Reduction (%)	10%				N/A				N/A				N/A				N/A			
3.2 BMP Removal Efficiency (%)		10%	10%	10%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
3.3 Adjusted load (lb/ac/yr)		7.59	1.02	228		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 4 - Calculate Pollutant Reduction																				
4.1 TMDL (lb/ac/yr)		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A
4.2 Reduction met?		No	No	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK
Step 5 - Determine TMDL Offset																				
5.1 TMDL Shortfall (lb/ac/yr)		1.89	0.67	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0
5.2 TMDL Shortfall (%)		25%	66%	0%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.3 Residual RPv Volume (in)		1.29	1.29	1.29		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
5.4 Req'd Additional RR to meet TMDL (in)*		0.32	0.85	0.00		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.5 Req'd Additional RR to meet TMDL (cu.ft./ac)		1163	3074	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.6 Total Offset Volume (cu.ft.)		55	144	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A

Effective April 2016

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
LOCATION (County):	New Castle

CONVEYANCE EVENT (Cv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	--	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Cv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.05		0.05		0.05		0.05		0.05	
1.2 Initial RCN	80.36									
1.3 **10-YR** Rainfall (in.)	4.8									
1.4 Cv runoff volume (in.)	2.75									
1.5 LOD allowable unit discharge (cfs/ac)	0.75									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Cv allowable discharge rate (cfs)	0.04									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	2.75		2.70		#N/A		#N/A		#N/A	
2.5 CN*	80.36		79.75		#N/A		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	2%		#N/A		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	2.70		#N/A		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	79.75		#N/A		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.06		#N/A		#N/A		#N/A		#N/A	
Step 4 - Calculate Cv with BMP Reductions										
4.1 Cv runoff volume after all reductions (in.)	2.70		#N/A		#N/A		#N/A		#N/A	
4.2 Total Cv runoff reduction (%)	2%		#N/A		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	79.75		#N/A		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
LOCATION (County):	New Castle

FLOODING EVENT (Fv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	--	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Fv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.05		0.05		0.05		0.05		0.05	
1.2 Initial RCN	80.36									
1.3 100-YR Rainfall (in.)	8.0									
1.4 Fv runoff volume (in.)	5.67									
1.5 LOD allowable unit discharge (cfs/ac)	2.25									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Fv allowable discharge rate (cfs)	0.11									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	5.67		5.67		#N/A		#N/A		#N/A	
2.5 CN*	80.36		80.36		#N/A		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	0%		#N/A		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	5.67		#N/A		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	80.36		#N/A		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.00		#N/A		#N/A		#N/A		#N/A	
Step 4 - Calculate Fv with BMP Reductions										
4.1 Fv runoff volume after all reductions (in.)	5.67		#N/A		#N/A		#N/A		#N/A	
4.2 Total Fv runoff reduction (%)	0%		#N/A		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	80.36		#N/A		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial site
DRAINAGE SUBAREA ID:	Subarea 4
TMDL Watershed:	Christina River

DURMM OUTPUT WORKSHEET

DURMM v2.beta.110802

Site Data

Contributing Area to BMPs (ac.)	0.047				
C.A. RCN	80				
Subarea LOD (ac.)	0.047				
Upstream Subarea ID	0	0	0	0	
Upstream Subarea LOD (ac.)	0.00	0.00	0.00	0.00	
Combined LOD with Upstream Areas (ac.)	0.05				
Combined RCN with Upstream Areas (ac.)	80.36				
TMDL-TN (lb/ac/yr)	5.70				
TMDL-TP (lb/ac/yr)	0.35				
TMDL-TSS (lb/ac/yr)	N/A				
BMP Selection	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
	Impervious disconnection	--	--	--	--

Resource Protection Event (RPV)

RPv for Contributing Area (in.)	1.41				
Req'd RPv Reduction for Contributing Area (in.)	0.04				
Req'd RPv Reduction for Contributing Area (%)	3%				
C.A. allowable discharge rate (cfs)	0.00				
Unmanaged Polluant load, TN (lbs/ac/yr)	8.44				
Unmanaged Polluant load, TP (lbs/ac/yr)	1.14				
Unmanaged Polluant load, TSS (lbs/ac/yr)	253				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	1.29	N/A	N/A	N/A	N/A
Total RPv runoff reduction (in.)	0.12	N/A	N/A	N/A	N/A
Total RPv runoff reduction (%)	9%	N/A	N/A	N/A	N/A
Req'd runoff reduction met?	OK	N/A	N/A	N/A	N/A
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	7.59	#N/A	#N/A	#N/A	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	1.02	#N/A	#N/A	#N/A	#N/A
Adjusted pollutant load, TSS (lb/ac/yr)	228	#N/A	#N/A	#N/A	#N/A
Offsets Requirements					
RPv Offset (cu. ft.)	N/A	N/A	N/A	N/A	N/A

Conveyance Event (Cv)

Cv runoff volume (in.)	2.75				
Stds-based allowable discharge (cfs)	0.04				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	2.70	#N/A	#N/A	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in.)	5.67				
Stds-based allowable discharge (cfs)	0.11				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	5.67	#N/A	#N/A	#N/A	#N/A

Adjusted Subarea Data for Downstream DURMM Modeling

Contributing Area (ac.)	0.05
C.A. RCN	80
LOD Area (ac.)	0.05
Weighted Target Runoff (in.)	1.37
Adjusted CN after all reductions	77.98

Effective April 2016

Adjusted RPv (in.)	1.29
Adjusted Cv (in.)	
Adjusted Fv (in.)	

Adjusted Subarea Data for H&H Modeling

	Rain (in.)	RCN
Resource Protection Event, RPv	2.7	N/A
Conveyance Event, Cv	4.8	79.75
Flooding Event, Fv	8	80.36

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 5
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

CONTRIBUTING AREA RUNOFF CURVE NUMBER (C.A. RCN) WORKSHEET

Cover Type	Treatment	Hydrologic Condition	Curve Numbers for Hydrologic Soil Type: A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
CULTIVATED AGRICULTURAL LANDS										
Fallow	Bare soil	----		77		86		91		94
	Crop residue (CR)	poor		76		85		90		93
	Crop residue (CR)	good		74		83		88		90
Row Crops	Straight row (SR)	poor		72		81		88		91
	Straight row (SR)	good		67		78		85		89
	SR + Crop residue	poor		71		80		87		90
	SR + Crop residue	good		64		75		82		85
	Contoured (C)	poor		70		79		84		88
	Contoured (C)	good		65		75		82		86
	C + Crop residue	poor		69		78		83		87
	C + Crop residue	good		64		74		81		85
	Cont & terraced(C&T)	poor		66		74		80		82
	Cont & terraced(C&T)	good		62		71		78		81
	C&T + Crop residue	poor		65		73		79		81
	C&T + Crop residue	good		61		70		77		80
Small Grain	Straight row (SR)	poor		65		76		84		88
	Straight row (SR)	good		63		75		83		87
	SR + Crop residue	poor		64		75		83		86
	SR + Crop residue	good		60		72		80		84
	Contoured (C)	poor		63		74		82		85
	Contoured (C)	good		61		73		81		84
	C + Crop residue	poor		62		73		81		84
	C + Crop residue	good		60		72		80		83
	Cont & terraced(C&T)	poor		61		72		79		82
	Cont & terraces(C&T)	good		59		70		78		81
	C&T + Crop residue	poor		60		71		78		81
	C&T + Crop residue	good		58		69		77		80
Close-seeded	Straight row	poor		66		77		85		89
or broadcast	Straight row	good		58		72		81		85
legumes or	Contoured	poor		64		75		83		85
rotation	Contoured	good		55		69		78		83
meadow	Cont & terraced	poor		63		73		80		83
	Cont & terraced	good		51		67		76		80
OTHER AGRICULTURAL LANDS										
	Pasture, grassland or range	poor		68		79		86		89
		fair		49		69		79		84
		good		39		61		74		80
	Meadow -cont. grass (non grazed)	----		30		58		71		78
	Brush - brush, weed, grass mix	poor		48		67		77		83
		fair		35		56		70		77
		good		30		48		65		73
	Woods - grass combination	poor		57		73		82		86
		fair		43		65		76		82
		good		32		58		72		79
	Woods	poor		45		66		77		83
		fair		36		60		73		79
		good		30		55		70		77
	Farmsteads	----		59		74		82		86
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39	0.026	61		74		80
Impervious Areas										
	Paved parking lots, roofs, driveways			98	0.056	98		98		98

Effective April 2016

Streets and roads								
Paved; curbs and storm sewers			98		98		98		98
Paved; open ditches (w/right-of-way)			83		89		92		93
Gravel (w/ right-of-way)			76		85		89		91
Dirt (w/ right-of-way)			72		82		87		89
Urban Districts	Avg % impervious							
Commercial & business	85		89		92		94		95
Industrial	72		81		88		91		93
Residential districts by average lot size	Avg % impervious							
1/8 acre (town houses)	65		77		85		90		92
1/4 acre	38		61		75		83		87
1/3 acre	30		57		72		81		86
1/2 acre	25		54		70		80		85
1 acre	20		51		68		79		84
2 acre	12		46		65		77		82
DEVELOPING URBAN AREA (No Vegetation)								
Newly graded area (pervious only)			77		86		91		94
USER DEFINED								

Subarea Contributing Area per Soil Type (ac)	0	0.082	0	0

UPSTREAM CONTRIBUTING AREAS

	Subarea ID	*Acres*	*RCN*
Upstream Contributing Area 1			
Upstream Contributing Area 2			
Upstream Contributing Area 3			
Upstream Contributing Area 4			

Total Contributing Area (ac)	**0.08**
Weighted Runoff Curve Number (RCN)	**86**

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 5
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

LIMIT OF DISTURBANCE (LOD) WORKSHEET

Step 1 - Subarea LOD Data	HSG A	HSG B	HSG C	HSG D
1.1 HSG Area Within LOD (ac)		0.035		0.0035
1.2 Pre-Developed Woods/Meadow Within LOD (ac)				
1.3 Pre-Developed Impervious Within LOD (ac)				
1.4.a Post-Developed Imperviousness Within LOD, Option #1 (ac); ***OR***		0.02		0.0022
1.4.b Post-Developed Imperviousness Within LOD, Option #2 (%)	0%	57%	0%	63%

Step 2 - Subarea LOD Runoff Calculations				
2.1 RCN per HSG	0.00	82.14	0.00	91.31
2.2 RPv per HSG (in.)	0.00	1.50	0.00	2.03
2.3 Target Runoff per HSG (in.)	0.00	0.58	0.00	1.39
2.4 Cv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.75	0.00	0.75
2.5 Fv Weighted Unit Discharge per HSG (cfs/ac)	0.00	2.25	0.00	2.25

2.6 Subarea LOD (ac)	0.04
2.7 Subarea Weighted RCN	82.98
2.8 Subarea Weighted RPv (in.)	1.55
2.9 Subarea Weighted Target Runoff (in.)	0.66

Step 3 - Upstream LOD Areas *(from previous DURMM Report as applicable)*	Area 1	Area 2	Area 3	Area 4
3.1 Upstream Subarea ID				
3.2 Upstream LOD Area (ac)				
3.3 Target Runoff for Upstream Area (in.)				
3.4 Adjusted CN after all reductions				
3.5 Adjusted RPv (in.)				
3.6 Adjusted Cv (in.)				
3.7 Adjusted Fv (in.)				

Step 4 - RPv Calculations for Combined LOD	
4.1 Combined LOD (ac)	0.04
4.2 Weighted RCN	82.98
4.3 Weighted RPv (in.)	1.55
4.4 Weighted Target Runoff (in.)	0.66
4.5 Estimated Annual Runoff (in.)	20.82
4.6 Req'd Runoff Reduction within LOD (in.)	0.89
4.7 Req'd Runoff Reduction within LOD (%)	58%

Step 5 - Cv Unit Discharge	
5. LOD Allowable Unit Discharge (cfs/ac)	0.75

Step 6 - Fv Unit Discharge	
6. LOD Allowable Unit Discharge (cfs/ac)	2.25

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 5
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

OUTSIDE LIMIT OF DISTURBANCE (OLOD) WORKSHEET

Step 1 - Site Data

1.1 Total Contributing Area (ac)	0.082
1.2 C.A. RCN	86
1.3 LOD Area (ac)	0.0385
1.4 LOD RCN	83
1.5 Outside LOD Area (ac)	0.0435
1.6 Outside LOD RCN	89

Step 2 - Time of Concentration

FLOW TYPE	2.1 LENGTH (feet)	2.2 SLOPE (ft./ft.)	2.3 SURFACE CODE	2.4 MANNINGS "n"	2.5 VELOCITY (ft./sec.)	2.6 TRAVEL TIME (hrs)
Sheet				----------	N/A	0.00
				----------	N/A	0.00
				----------	N/A	0.00
Shallow Concentrated				N/A	----------	0.00
				N/A	----------	0.00
				N/A	----------	0.00
Open Channel			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00

2.7 Time of Concentration (Tc) 0.00 hrs

Sheet Flow Surface Codes

a Smooth Surface
b fallow (no residue)
c cultivated < 20% Res.
d cultivated > 20% Res.
e grass - range, short
f grass, dense
g grass, bermuda
h woods, light
i woods, dense
j range, natural

Shallow Concentrated Surface Codes

u unpaved surface
p paved surface

Step 3 - Peak Discharge

3.1 Unit Hydrograph Type	STD	
3.2 Frequency (yr)	10	100
3.3 24-HR Rainfall, P (in.)	4.8	8
3.4 Initial Abstraction, Ia (in.)	0.247	0.247
3.5 Ia/P ratio	0.05	0.03
3.6 Unit Peak Discharge, qu (csm/in)	#NUM!	#NUM!
3.7 Runoff (in.)	3.60	6.71
3.8 Peak Discharge, qp (cfs)	#NUM!	#NUM!
3.9 Equiv. unit peak discharge (cfs/ac)	#NUM!	#NUM!

PROJECT: Example Plan - Commercial Site
DRAINAGE SUBAREA ID: Subarea 5
LOCATION (County): New Castle

RESOURCE PROTECTION EVENT (RPv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type	Impervious disconnection	Type	Filter strip	Type	--	Type	--	Type	--
Step 1 - Calculate Initial RPv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.08		0.08		0.08		0.08		0.08	
1.2 *Reserved*										
1.3 Initial RCN	86.27									
1.4 RPv for Contributing Area (in.)	1.73									
1.5 Req'd RPv Reduction for Contributing Area (in.)	0.42									
1.6 Req'd RPv Reduction for Contributing Area (%)	24%									
1.7 RPv allowable discharge rate (cfs)	0.00									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)										
2.2 Retention reduction allowance (%)	0%		0%		N/A		N/A		N/A	
2.3 Retention reduction volume (ac-ft)	0.00		0.00		N/A		N/A		N/A	
2.4 Retention reduction volume (in.)	0.00		0.00		N/A		N/A		N/A	
2.5 Runoff volume after retention reduction (in.)	1.73		1.58		N/A		N/A		N/A	
2.6 Adjusted CN*	86.27		83.71		N/A		N/A		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Annual CN (ACN)	86.27		83.71		N/A		N/A		N/A	
3.2 Annual runoff (in.)	23.85		21.47		N/A		N/A		N/A	
3.3 Proportion A/B soils in BMP footprint (%)										
3.4 Annual runoff reduction allowance (%)	10%		15%		N/A		N/A		N/A	
3.5 Annual runoff after reduction (in.)	21.47		18.25		N/A		N/A		N/A	
3.6 Adjusted ACN	83.71		79.91		N/A		N/A		N/A	
3.7 Annual Runoff Reduction Allowance for RPv (in.)	0.14		0.34		N/A		N/A		N/A	
Step 4 - Calculate RPv with BMP Reductions										
4.1 RPv runoff volume after all reductions (in.)	1.58		1.38		N/A		N/A		N/A	
4.2 Total RPv runoff reduction (in.)	0.14		0.34		N/A		N/A		N/A	
4.3 Total RPv runoff reduction (%)	8%		20%		N/A		N/A		N/A	
4.4 Adjusted CN after all reductions	83.71		79.91		N/A		N/A		N/A	
4.5 Equivalent TR-55 RCN for H&H modeling	88.40		85.63		N/A		N/A		N/A	
4.6 Req'd reduction met?	No		No		N/A		N/A		N/A	
Step 5 - Determine Runoff Reduction Offset										
5.1 Runoff Reduction Shortfall (in.)	0.28		0.07		N/A		N/A		N/A	
5.2 Runoff Reduction Shortfall (cu.ft./ac)	1000		270		N/A		N/A		N/A	
5.3 Total Offset Volume (cu.ft.)	82		22		N/A		N/A		N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 5
LANDUSE TYPE:	Commercial
TMDL WATERSHED:	Christina River

TOTAL MAXIMUM DAILY LOAD (TMDL) WORKSHEET

	BMP 1				BMP 2				BMP 3				BMP 4				BMP 5			
	Type:	Impervious disconnection			Type:	Filter strip			Type:	--			Type:	--			Type:	--		
Step 1 - Calculate Annual Runoff Volume	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS
1.1 Total contributing area to BMP (ac)	0.08																			
1.2 Initial RCN	86																			
1.3 Annual runoff volume (in.)	23.85																			
1.4 Annual runoff volume (liters)	2.01E+05																			
Step 2 - Calculate Annual Pollutant Load																				
2.1 EMC (mg/L)		2.00	0.27	60																
2.2 Load (mg/yr)		4.02E+05	5.43E+04	1.21E+07																
2.4 Stormwater Load (lb/ac/yr)		10.81	1.46	324		9.73	1.31	292		8.27	1.12	248		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 3 - Adjust for Runoff Reduction																				
3.1 BMP Runoff Reduction (%)	10%				15%				N/A				N/A				N/A			
3.2 BMP Removal Efficiency (%)		10%	10%	10%		15%	15%	15%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
3.3 Adjusted load (lb/ac/yr)		9.73	1.31	292		8.27	1.12	248		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
Step 4 - Calculate Pollutant Reduction																				
4.1 TMDL (lb/ac/yr)		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A
4.2 Reduction met?		No	No	OK		No	No	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK
Step 5 - Determine TMDL Offset																				
5.1 TMDL Shortfall (lb/ac/yr)		4.03	0.96	0		2.57	0.77	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0
5.2 TMDL Shortfall (%)		41%	73%	0%		31%	69%	0%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.3 Residual RPv Volume (in)		1.58	1.58	1.58		1.38	1.38	1.38		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
5.4 Req'd Additional RR to meet TMDL (in)*		0.66	1.16	0.00		0.43	0.95	0.00		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.5 Req'd Additional RR to meet TMDL (cu.ft./ac)		2383	4219	0		1561	3447	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
5.6 Total Offset Volume (cu.ft.)		195	346	0		128	283	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 5
LOCATION (County):	New Castle

CONVEYANCE EVENT (Cv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	Filter strip	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Cv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.08		0.08		0.08		0.08		0.08	
1.2 Initial RCN	86.27									
1.3 **10-YR** Rainfall (in.)	4.8									
1.4 Cv runoff volume (in.)	3.31									
1.5 LOD allowable unit discharge (cfs/ac)	0.75									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	#NUM!									
1.7 Cv allowable discharge rate (cfs)	#NUM!									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	3.31		3.24		3.18		#N/A		#N/A	
2.5 CN*	86.27		85.59		84.92		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	2%		2%		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	3.24		3.18		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	85.59		84.92		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.07		0.13		#N/A		#N/A		#N/A	
Step 4 - Calculate Cv with BMP Reductions										
4.1 Cv runoff volume after all reductions (in.)	3.24		3.18		#N/A		#N/A		#N/A	
4.2 Total Cv runoff reduction (%)	2%		4%		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	85.59		84.92		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 5
LOCATION (County):	New Castle

FLOODING EVENT (Fv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	Filter strip	Type:	--	Type:	--	Type:	--
Step 1 - Calculate Initial Fv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.08		0.08		0.08		0.08		0.08	
1.2 Initial RCN	86.27									
1.3 **100-YR** Rainfall (in.)	8.0									
1.4 Fv runoff volume (in.)	6.36									
1.5 LOD allowable unit discharge (cfs/ac)	2.25									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	#NUM!									
1.7 Fv allowable discharge rate (cfs)	#NUM!									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	6.36		6.36		6.36		#N/A		#N/A	
2.5 CN*	86.27		86.27		86.27		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	0%		0%		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	6.36		6.36		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	86.27		86.27		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.00		0.00		#N/A		#N/A		#N/A	
Step 4 - Calculate Fv with BMP Reductions										
4.1 Fv runoff volume after all reductions (in.)	6.36		6.36		#N/A		#N/A		#N/A	
4.2 Total Fv runoff reduction (%)	0%		0%		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	86.27		86.27		#N/A		#N/A		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 5
TMDL Watershed:	Christina River

DURMM OUTPUT WORKSHEET

Site Data DURMM v2.beta.110802

Contributing Area to BMPs (ac.)	0.082				
C.A. RCN	86				
Subarea LOD (ac.)	0.0385				
Upstream Subarea ID	0	0	0	0	
Upstream Subarea LOD (ac.)	0.00	0.00	0.00	0.00	
Combined LOD with Upstream Areas (ac.)	0.04				
Combined RCN with Upstream Areas (ac.)	82.98				
TMDL-TN (lb/ac/yr)	5.70				
TMDL-TP (lb/ac/yr)	0.35				
TMDL-TSS (lb/ac/yr)	N/A				
BMP Selection	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
	Impervious disconnection	Filter strip	--	--	--

Resource Protection Event (RPV)

RPv for Contributing Area (in.)	1.73				
Req'd RPv Reduction for Contributing Area (in.)	0.42				
Req'd RPv Reduction for Contributing Area (%)	24%				
C.A. allowable discharge rate (cfs)	0.00				
Unmanaged Polluant load, TN (lbs/ac/yr)	10.81				
Unmanaged Polluant load, TP (lbs/ac/yr)	1.46				
Unmanaged Polluant load, TSS (lbs/ac/yr)	324				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	1.58	1.38	N/A	N/A	N/A
Total RPv runoff reduction (in.)	0.14	0.34	N/A	N/A	N/A
Total RPv runoff reduction (%)	8%	0.20	N/A	N/A	N/A
Req'd runoff reduction met?	No	No	N/A	N/A	N/A
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	9.73	8.27	#N/A	#N/A	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	1.31	1.12	#N/A	#N/A	#N/A
Adjusted pollutant load, TSS (lb/ac/yr)	292	248	#N/A	#N/A	#N/A
Offsets Requirements					
RPv Offset (cu. ft.)	82	22	N/A	N/A	N/A

Conveyance Event (Cv)

Cv runoff volume (in.)	3.31				
Stds-based allowable discharge (cfs)	#NUM!				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	3.24	3.18	#N/A	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in.)	6.36				
Stds-based allowable discharge (cfs)	#NUM!				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	6.36	6.36	#N/A	#N/A	#N/A

Adjusted Subarea Data for Downstream DURMM Modeling

Contributing Area (ac.)	0.08
C.A. RCN	86
LOD Area (ac.)	0.04
Weighted Target Runoff (in.)	0.66
Adjusted CN after all reductions	79.91
Adjusted RPv (in.)	1.38
Adjusted Cv (in.)	
Adjusted Fv (in.)	

Effective April 2016

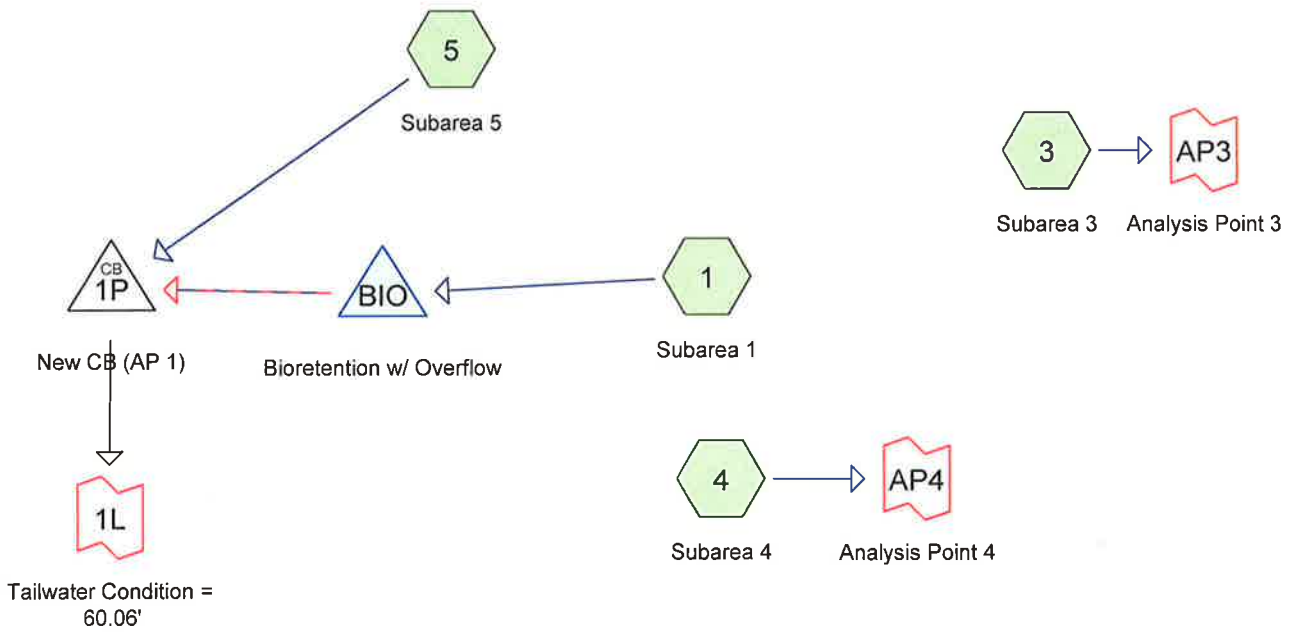
Adjusted Subarea Data for H&H Modeling

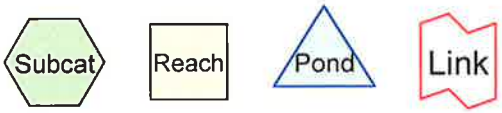
	Rain (in.)	RCN
Resource Protection Event, RPv	2.7	N/A
Conveyance Event, Cv	4.8	84.92
Flooding Event, Fv	8	86.27

Appendix 4

DURMM v2 HydroCAD Model using the Constructed/As-Built Stormwater Management Facilities

Effective April 2016





Drainage Diagram for Example Commercial Site New DURMM adj Cv RCN noexfil
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

Effective April 2016

Time span=1.00-48.00 hrs, dt=0.01 hrs, 4701 points x 9
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.577 ac Runoff Depth=0.77"
Tc=6.0 min CN=53 Runoff=0.68 cfs 0.037 af

Subcatchment 3: Subarea 3 Runoff Area=0.056 ac Runoff Depth=2.63"
Tc=6.0 min CN=79 Runoff=0.26 cfs 0.012 af

Subcatchment 4: Subarea 4 Runoff Area=0.047 ac Runoff Depth=2.72"
Tc=6.0 min CN=80 Runoff=0.23 cfs 0.011 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=3.18"
Tc=6.0 min CN=85 Runoff=0.45 cfs 0.022 af

Pond 1P: New CB (AP 1) Peak Elev=60.06' Inflow=0.45 cfs 0.022 af
30.0" x 234.0' Culvert Outflow=0.50 cfs 0.022 af

Pond BIO: Bioretention w/ Overflow Peak Elev=61.16' Storage=1,613 cf Inflow=0.68 cfs 0.037 af
Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.000 af

Link 1L: Tailwater Condition = 60.06' Inflow=0.50 cfs 0.022 af
Primary=0.50 cfs 0.022 af

Link AP3: Analysis Point 3 Inflow=0.26 cfs 0.012 af
Primary=0.26 cfs 0.012 af

Link AP4: Analysis Point 4 Inflow=0.23 cfs 0.011 af
Primary=0.23 cfs 0.011 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.082 af Average Runoff Depth = 1.29"

Subcatchment1: Subarea 1

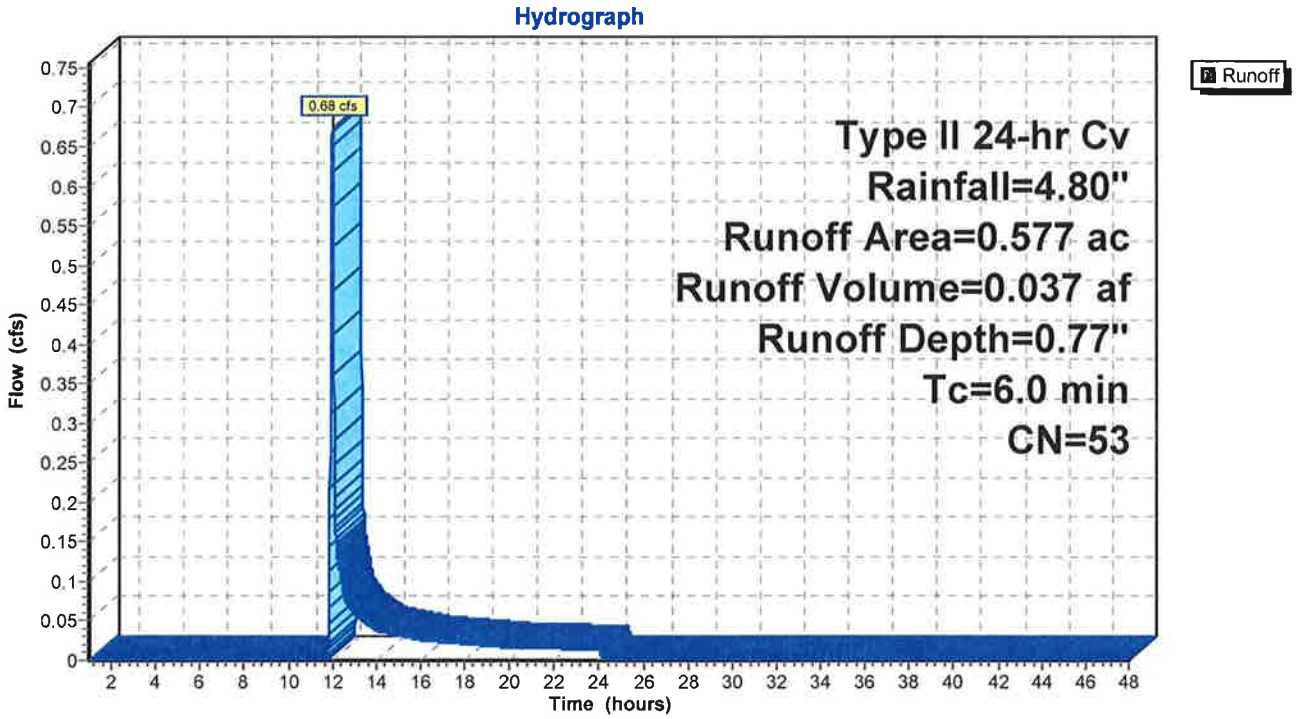
Runoff = 0.68 cfs @ 11.99 hrs, Volume= 0.037 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Cv Rainfall=4.80"

Area (ac)	CN	Description
0.577	53	Adjusted Cv RCN

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

Subcatchment1: Subarea 1



Subcatchment3: Subarea 3

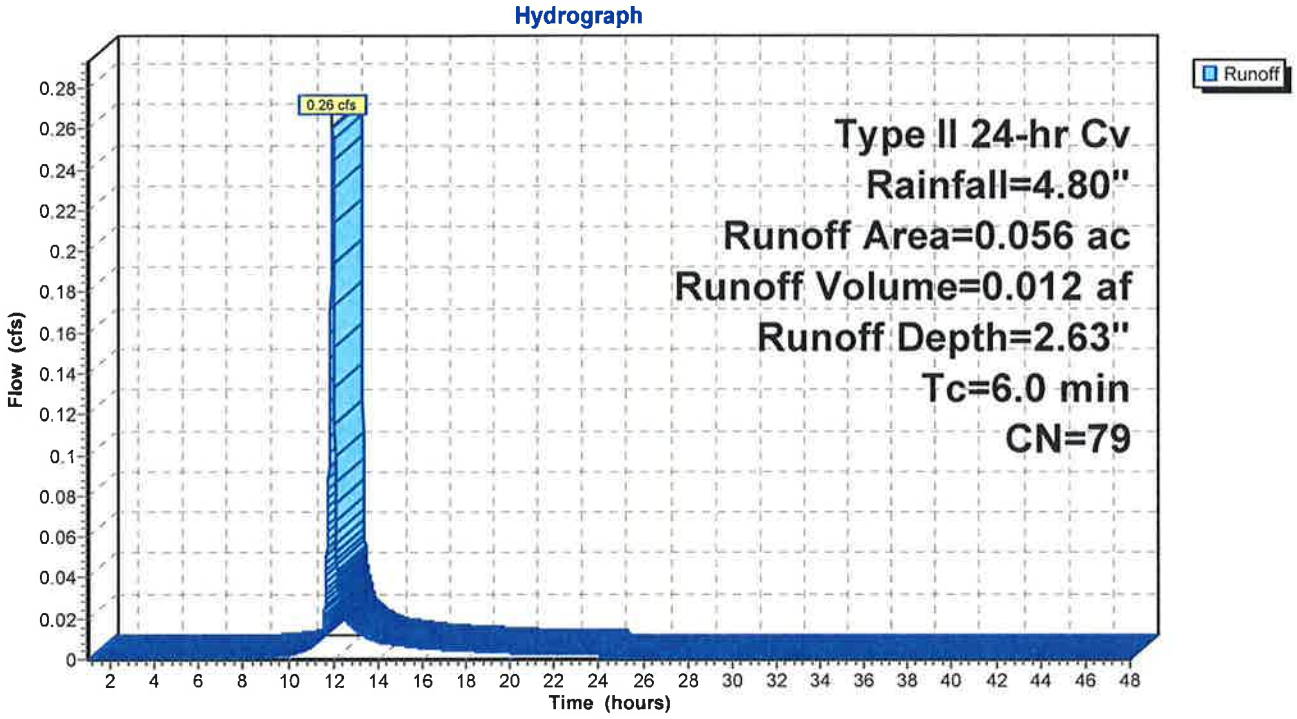
Runoff = 0.26 cfs @ 11.97 hrs, Volume= 0.012 af, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Cv Rainfall=4.80"

Area (ac)	CN	Description
0.056	79	Adjusted Cv RCN

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

Subcatchment3: Subarea 3



Subcatchment4: Subarea 4

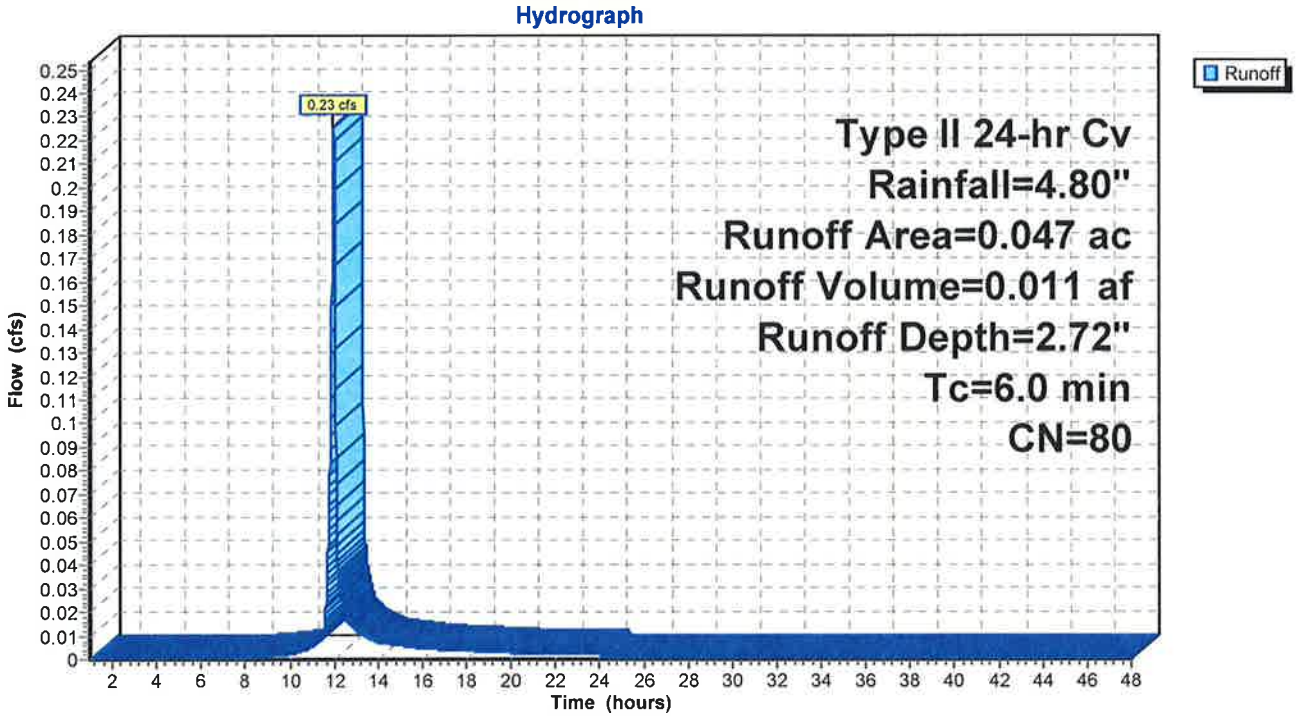
Runoff = 0.23 cfs @ 11.97 hrs, Volume= 0.011 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Cv Rainfall=4.80"

Area (ac)	CN	Description
0.047	80	Adjusted Cv RCN

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

Subcatchment4: Subarea 4



Subcatchment5: Subarea 5

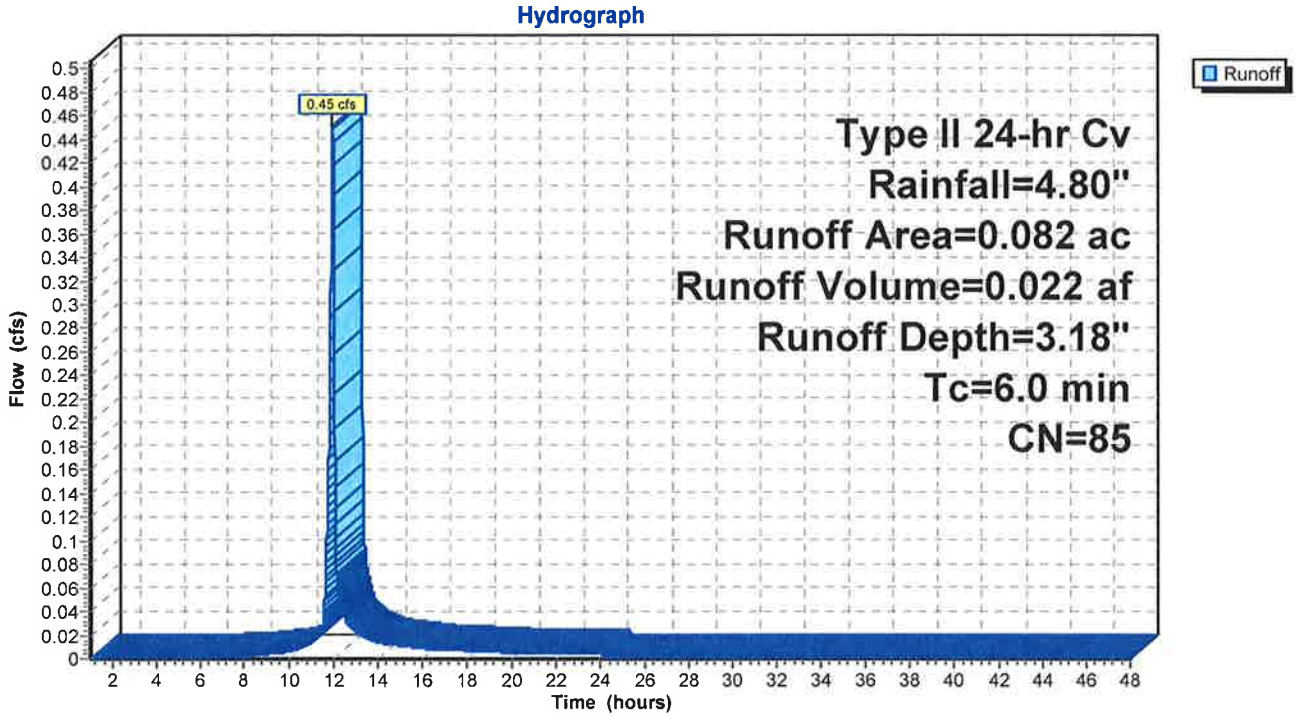
Runoff = 0.45 cfs @ 11.97 hrs, Volume= 0.022 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Cv Rainfall=4.80"

Area (ac)	CN	Description
0.082	85	Adusted Cv RCN

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

Subcatchment5: Subarea 5



Pond 1P: New CB (AP 1)

[90] Warning: Qout>Qin may require Finer Routing or smaller dt
[87] Warning: Oscillations may require Finer Routing or smaller dt

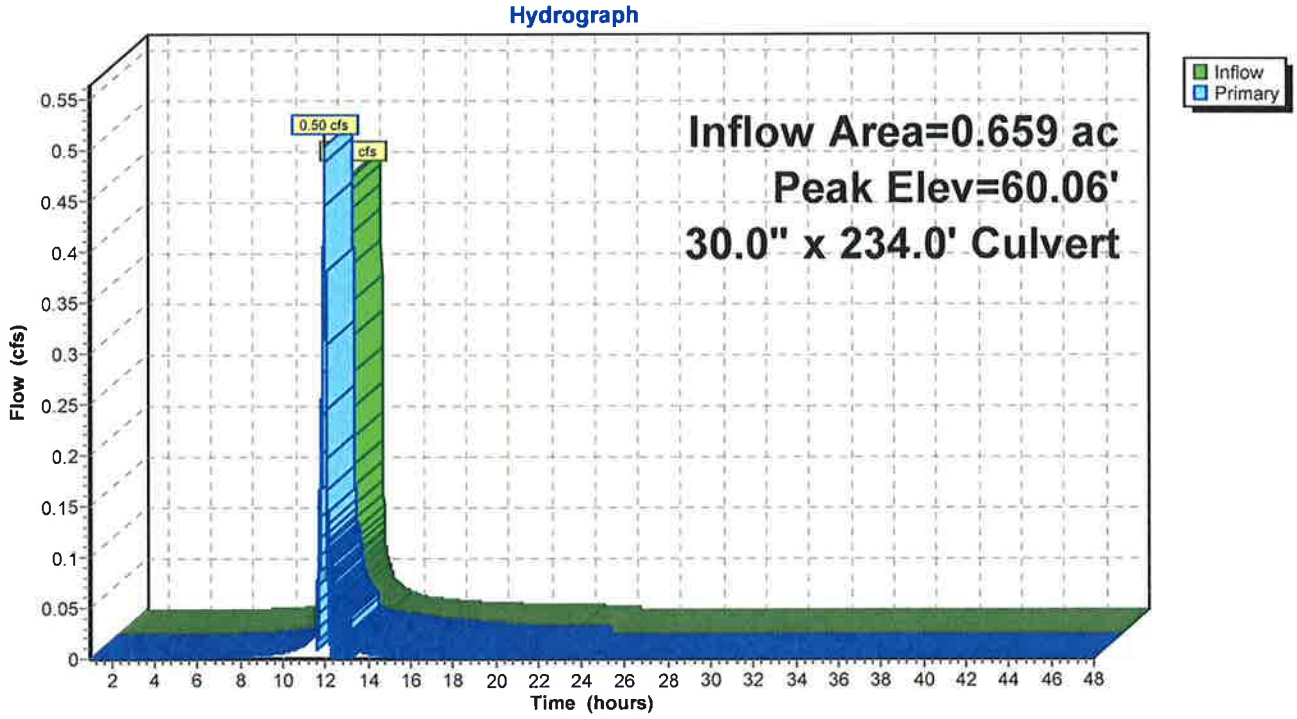
Inflow Area =	0.659 ac,	Inflow Depth =	0.40"	for	Cv event	
Inflow =	0.45 cfs @	11.97 hrs,	Volume=		0.022 af	
Outflow =	0.50 cfs @	11.97 hrs,	Volume=		0.022 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.50 cfs @	11.97 hrs,	Volume=		0.022 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 60.06' @ 11.97 hrs
Flood Elev= 62.44'
Plug-Flow detention time= 0.7 min calculated for 0.022 af (100% of inflow)
Center-of-Mass det. time= 0.2 min (806.2 - 806.0)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=0.50 cfs @ 11.97 hrs HW=60.06' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.50 cfs @ 0.1 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

Inflow Area =	0.577 ac,	Inflow Depth =	0.77"	for Cv event	
Inflow =	0.68 cfs @	11.99 hrs,	Volume=	0.037 af	
Outflow =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af,	Atten= 100%, Lag= 0.0 min
Primary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 61.16' @ 24.34 hrs Surf.Area= 1,250 sf Storage= 1,613 cf
Flood Elev= 63.25' Surf.Area= 1,250 sf Storage= 6,486 cf
Plug-Flow detention time= (not calculated)
Center-of-Mass det. time= (not calculated)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,261 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	1,225 cf	**25.00'W x 50.00'L x 2.45'H Prismatoid** 3,063 cf Overall x 40.0% Voids
		6,486 cf	Total Available Storage

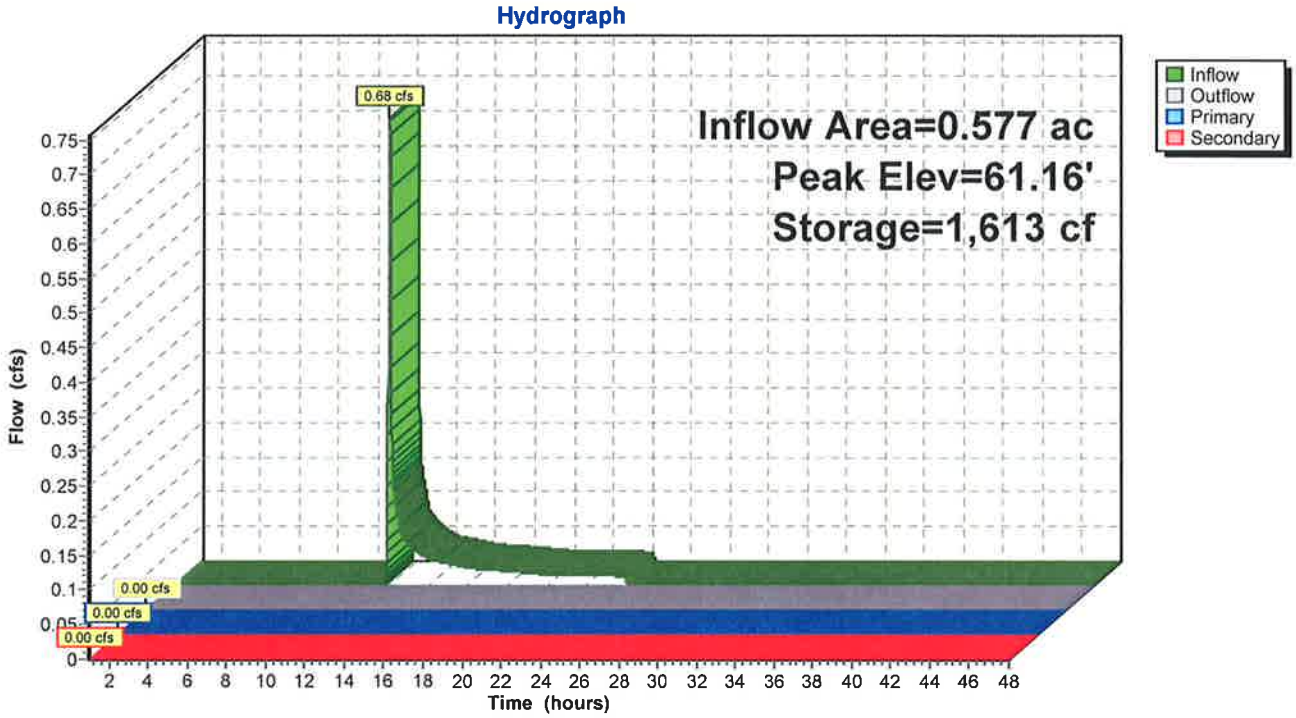
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	1,250	117.0	0	0	1,250
62.00	1,776	165.0	1,656	1,656	2,338
63.00	3,542	357.0	2,609	4,265	10,318
63.25	4,446	410.0	996	5,261	13,554

#	Routing	Invert	Outlet Devices
1	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
2	Device 1	61.25'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Device 1	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
4	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=58.45' TW=57.95' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.00 cfs of 1.55 cfs potential flow)
  ├─**2=Orifice/Grate** (Controls 0.00 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=58.45' TW=57.95' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

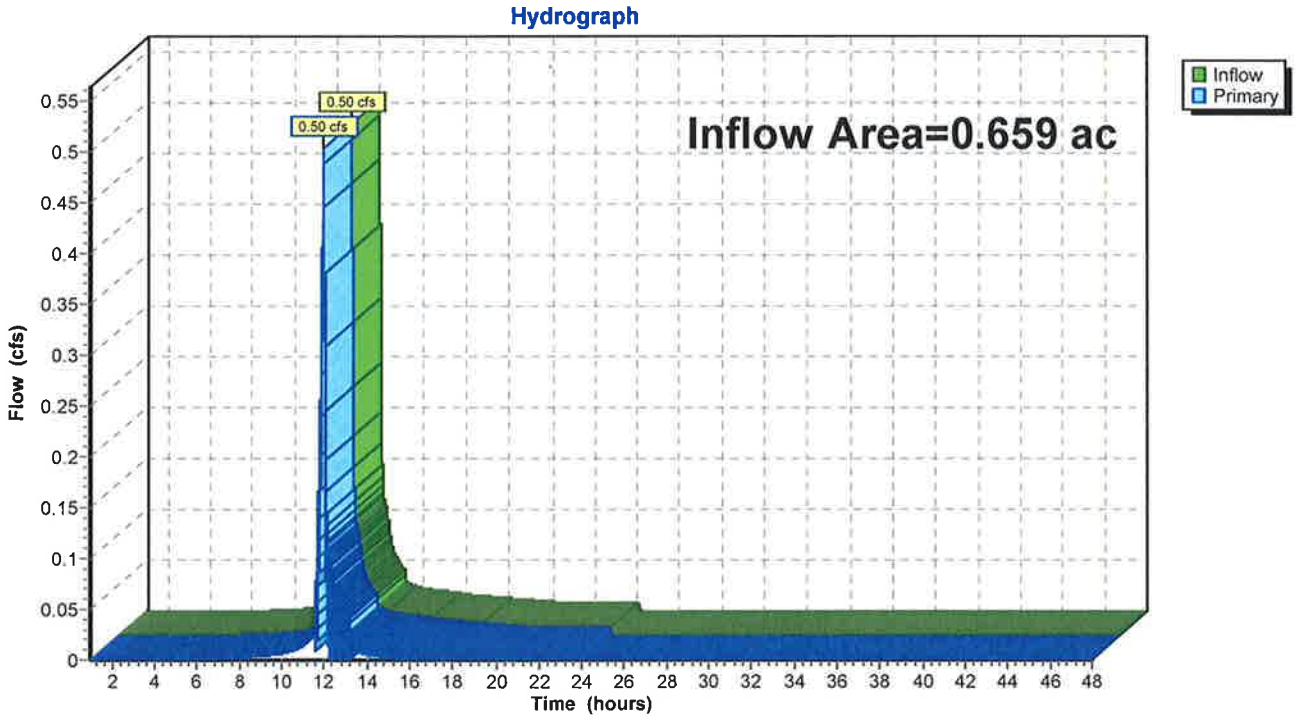
[80] Warning: Exceeded Pond 1P by 2.50' @ 12.34 hrs (26.43 cfs)

Inflow Area =	0.659 ac,	Inflow Depth =	0.40"	for	Cv event	
Inflow =	0.50 cfs @	11.97 hrs,	Volume=		0.022 af	
Primary =	0.50 cfs @	11.97 hrs,	Volume=		0.022 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'

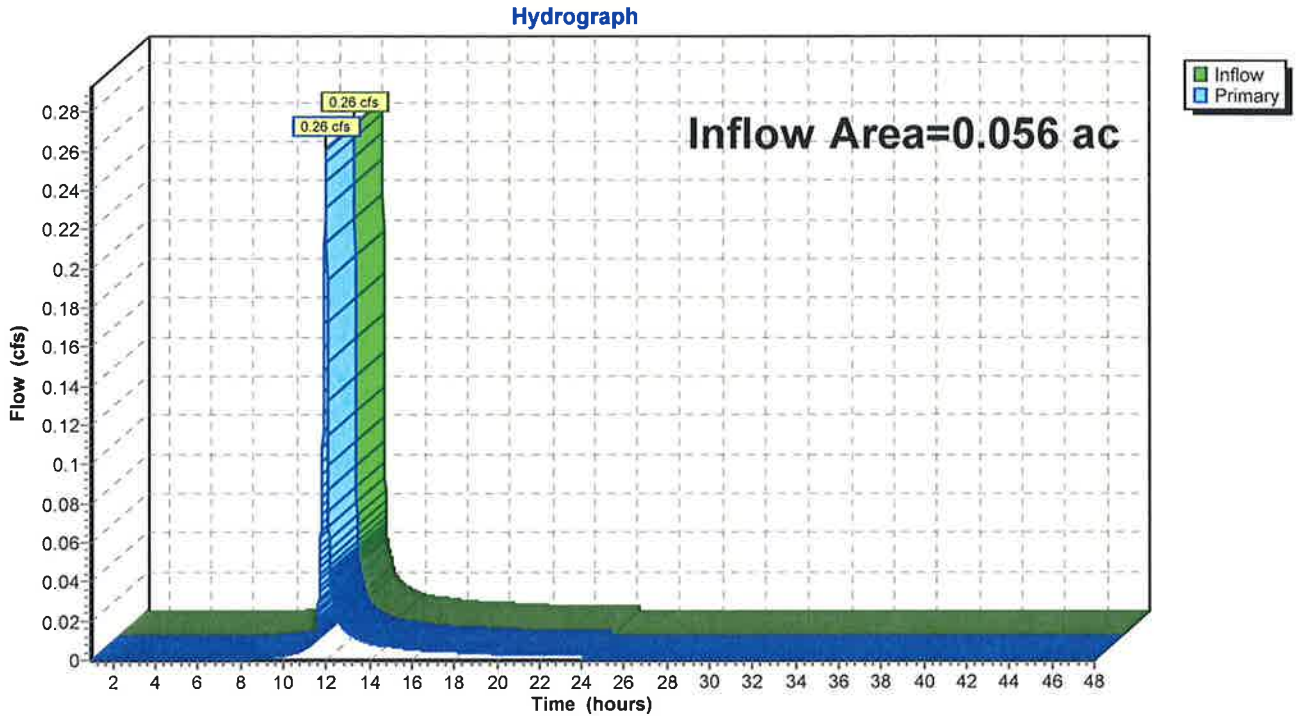


Link AP3: Analysis Point 3

Inflow Area = 0.056 ac, Inflow Depth = 2.63" for Cv event
Inflow = 0.26 cfs @ 11.97 hrs, Volume= 0.012 af
Primary = 0.26 cfs @ 11.97 hrs, Volume= 0.012 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs

Link AP3: Analysis Point 3

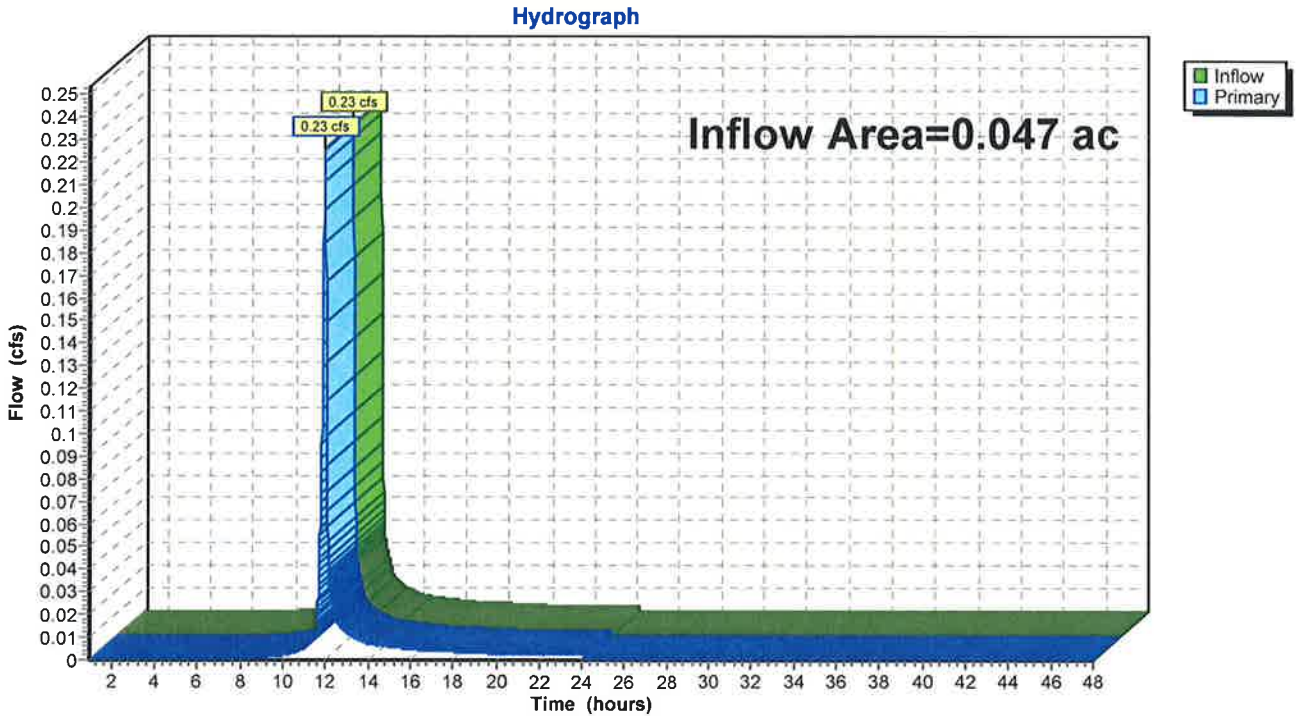


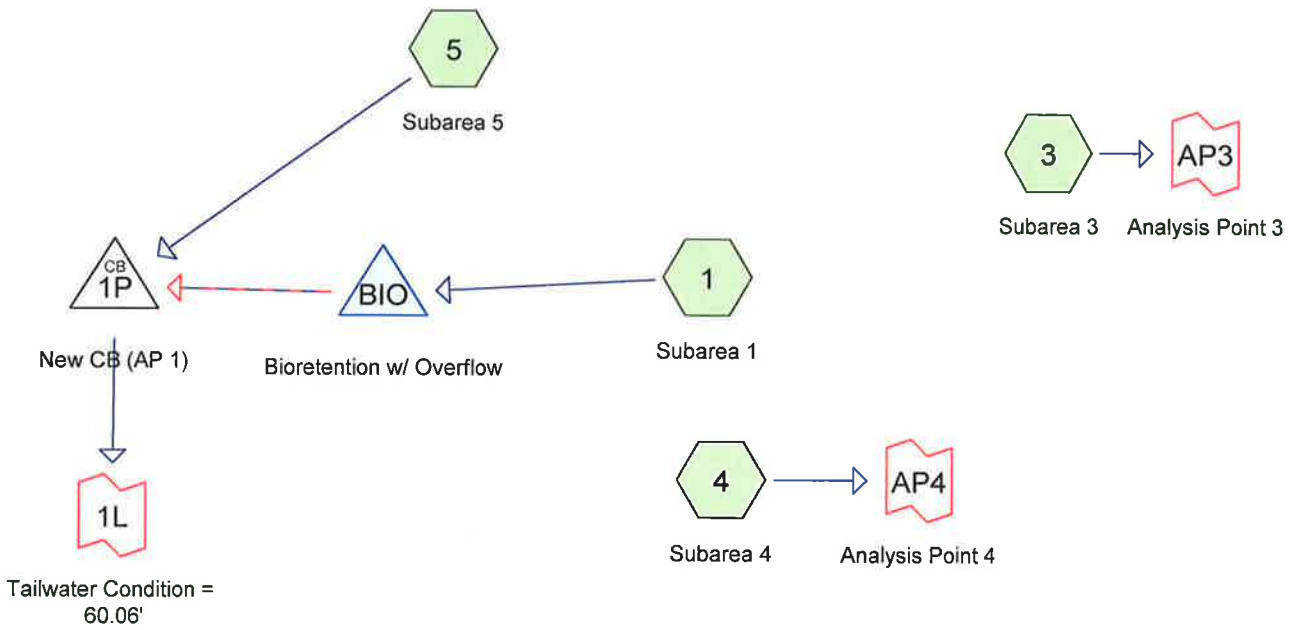
Link AP4: Analysis Point 4

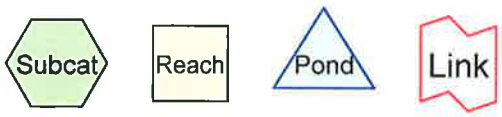
Inflow Area =	0.047 ac,	Inflow Depth =	2.72"	for	Cv event
Inflow =	0.23 cfs @	11.97 hrs,	Volume=	0.011 af	
Primary =	0.23 cfs @	11.97 hrs,	Volume=	0.011 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs

Link AP4: Analysis Point 4







Drainage Diagram for Example Commercial Site New DURMM adj Fv RCN noexfil
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

Effective April 2016

Time span=1.00-48.00 hrs, dt=0.01 hrs, 4701 points x 9
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.577 ac Runoff Depth=3.89"
Tc=6.0 min CN=65 Runoff=4.02 cfs 0.187 af

Subcatchment 3: Subarea 3 Runoff Area=0.056 ac Runoff Depth=5.63"
Tc=6.0 min CN=80 Runoff=0.54 cfs 0.026 af

Subcatchment 4: Subarea 4 Runoff Area=0.047 ac Runoff Depth=5.63"
Tc=6.0 min CN=80 Runoff=0.45 cfs 0.022 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=6.33"
Tc=6.0 min CN=86 Runoff=0.86 cfs 0.043 af

Pond 1P: New CB (AP 1) Peak Elev=60.06' Inflow=1.13 cfs 0.190 af
30.0" x 234.0' Culvert Outflow=1.18 cfs 0.190 af

Pond BIO: Bioretention w/ Overflow Peak Elev=62.38' Storage=3,863 cf Inflow=4.02 cfs 0.187 af
Primary=0.41 cfs 0.147 af Secondary=0.00 cfs 0.000 af Outflow=0.41 cfs 0.147 af

Link 1L: Tailwater Condition = 60.06' Inflow=1.18 cfs 0.190 af
Primary=1.18 cfs 0.190 af

Link AP3: Analysis Point 3 Inflow=0.54 cfs 0.026 af
Primary=0.54 cfs 0.026 af

Link AP4: Analysis Point 4 Inflow=0.45 cfs 0.022 af
Primary=0.45 cfs 0.022 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.279 af Average Runoff Depth = 4.39"

Subcatchment1: Subarea 1

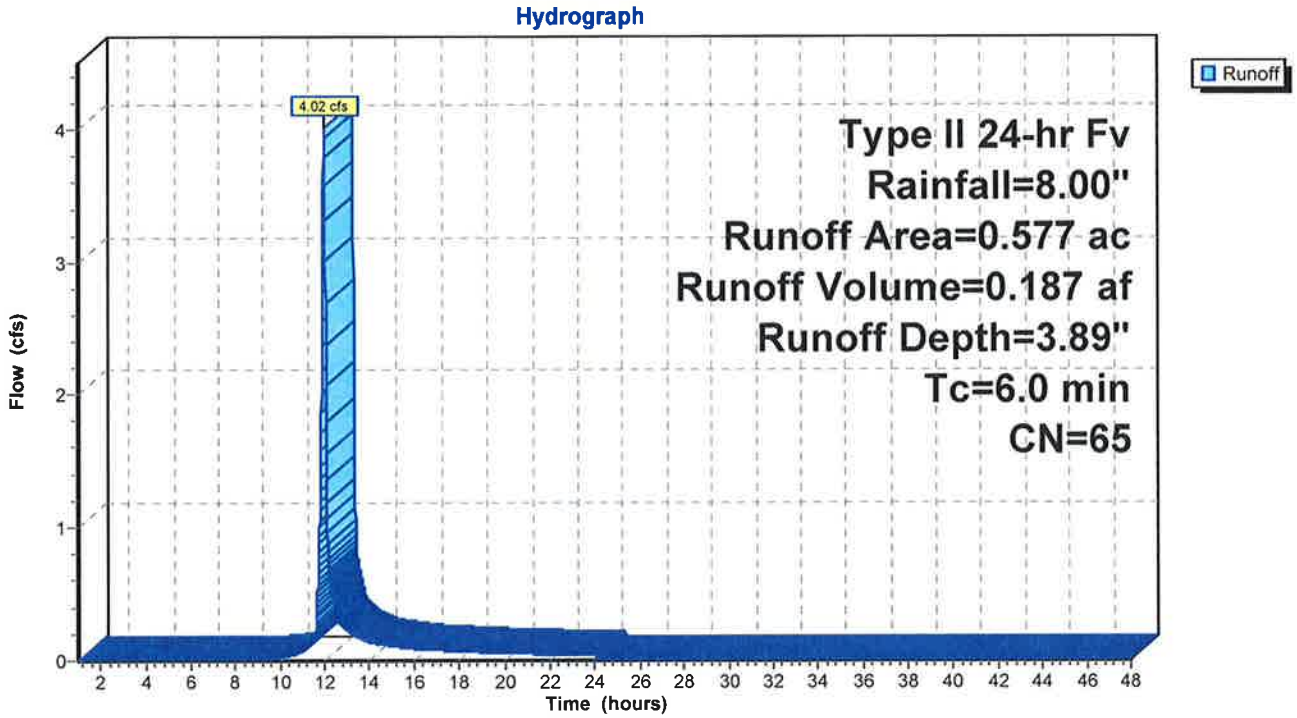
Runoff = 4.02 cfs @ 11.97 hrs, Volume= 0.187 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Fv Rainfall=8.00"

Area (ac)	CN	Description
0.577	65	Adjusted Fv RCN

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

Subcatchment1: Subarea 1



Subcatchment 3: Subarea 3

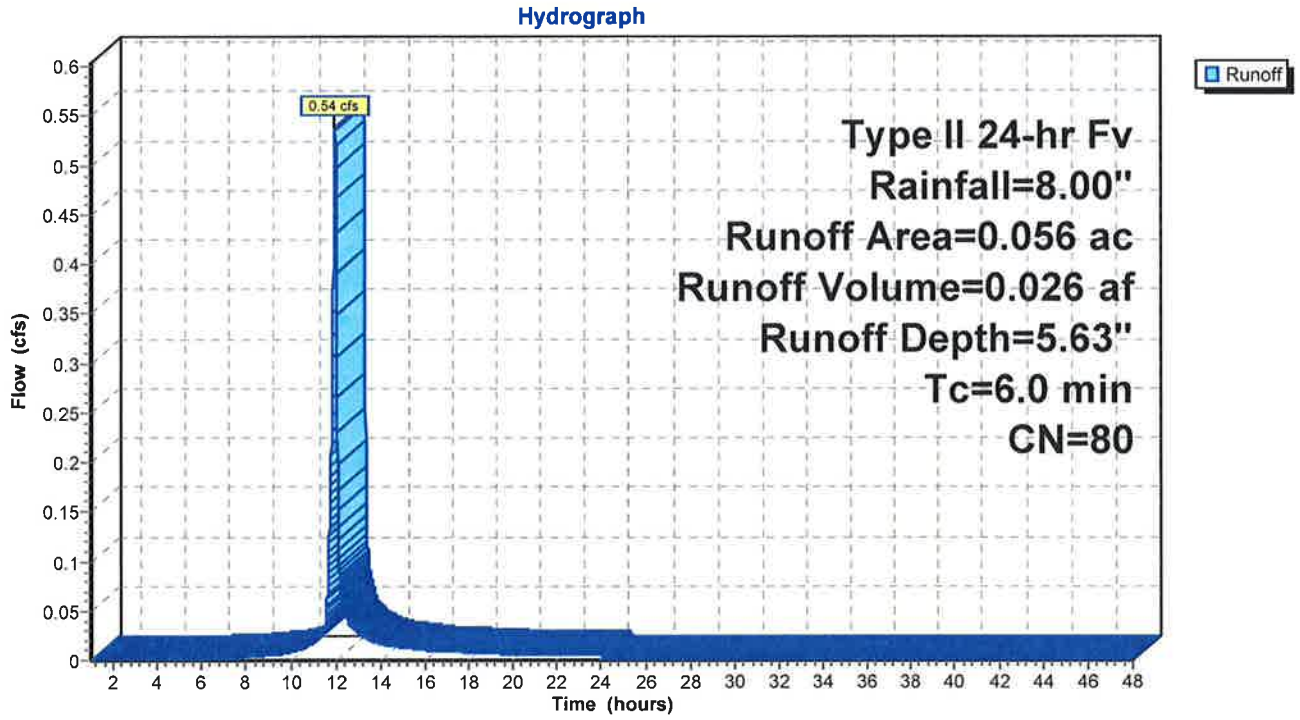
Runoff = 0.54 cfs @ 11.97 hrs, Volume= 0.026 af, Depth= 5.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Fv Rainfall=8.00"

Area (ac)	CN	Description
0.056	80	Adjusted Fv RCN

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

Subcatchment 3: Subarea 3



Subcatchment4: Subarea 4

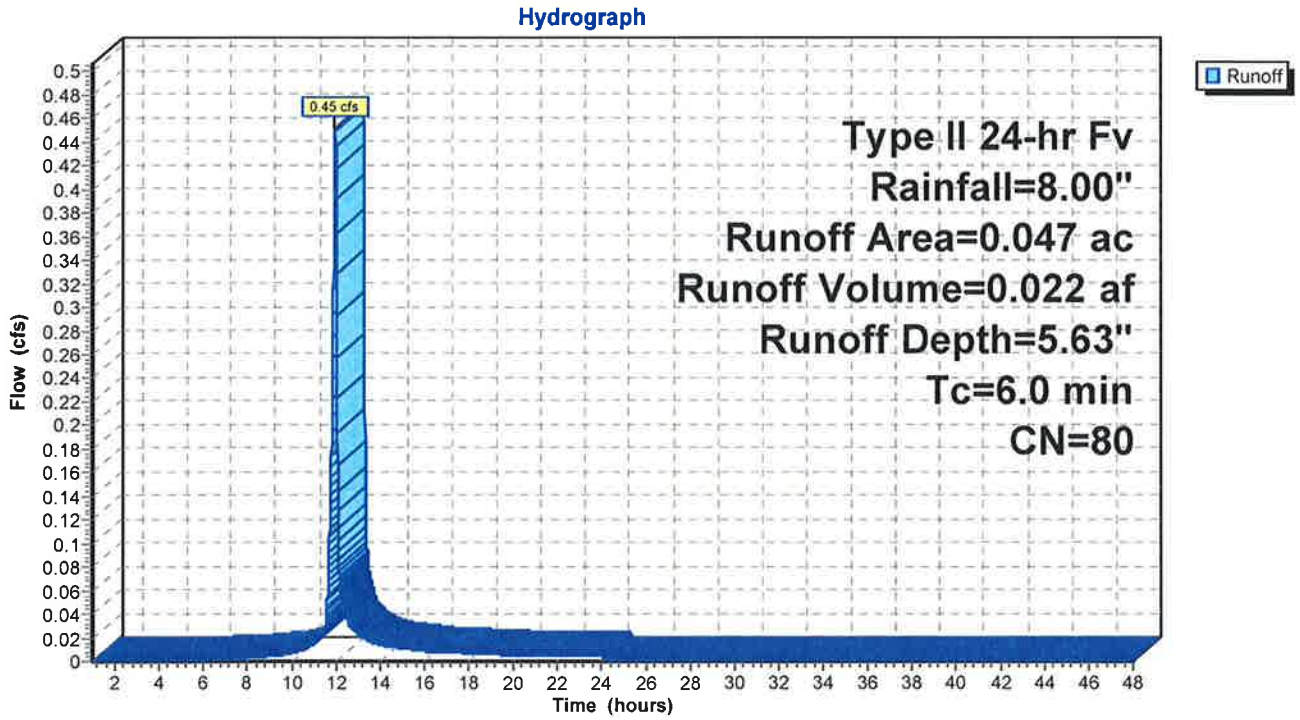
Runoff = 0.45 cfs @ 11.97 hrs, Volume= 0.022 af, Depth= 5.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Fv Rainfall=8.00"

Area (ac)	CN	Description
0.047	80	Adjusted Fv RCN

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

Subcatchment4: Subarea 4



Subcatchment5: Subarea 5

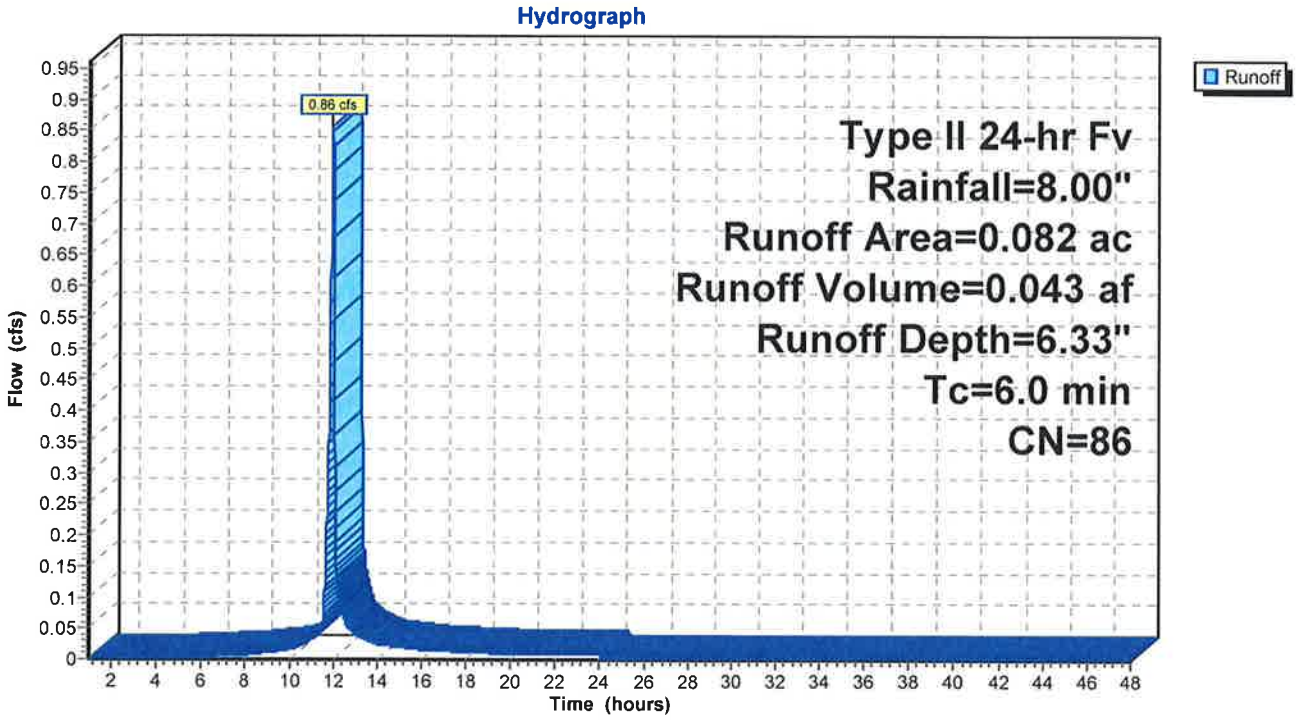
Runoff = 0.86 cfs @ 11.97 hrs, Volume= 0.043 af, Depth= 6.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Fv Rainfall=8.00"

Area (ac)	CN	Description
0.082	86	Adusted Fv RCN

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

Subcatchment5: Subarea 5



Pond 1P: New CB (AP 1)

[90] Warning: Qout>Qin may require Finer Routing or smaller dt
[87] Warning: Oscillations may require Finer Routing or smaller dt

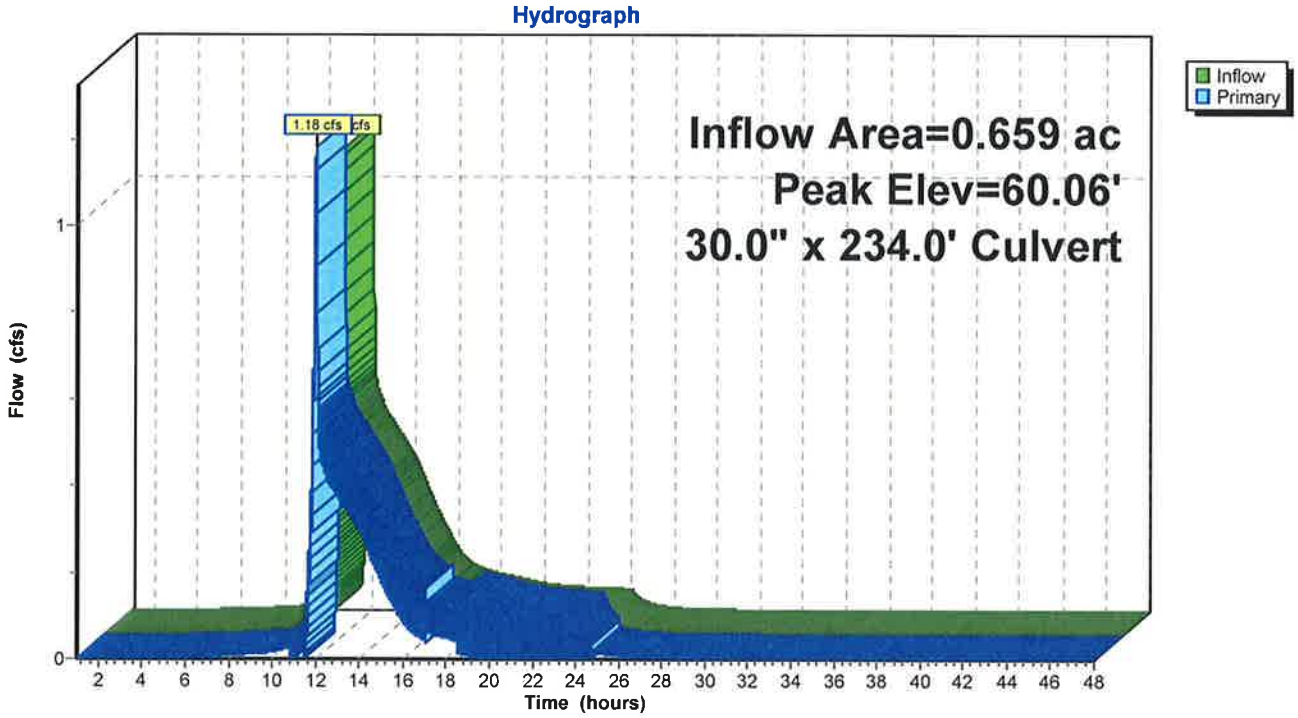
Inflow Area =	0.659 ac,	Inflow Depth =	3.46"	for	Fv event
Inflow =	1.13 cfs @	11.99 hrs,	Volume=	0.190 af	
Outflow =	1.18 cfs @	11.99 hrs,	Volume=	0.190 af,	Atten= 0%, Lag= 0.2 min
Primary =	1.18 cfs @	11.99 hrs,	Volume=	0.190 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 60.06' @ 11.99 hrs
Flood Elev= 62.44'
Plug-Flow detention time= 0.2 min calculated for 0.190 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (904.4 - 904.3)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=1.18 cfs @ 11.99 hrs HW=60.06' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.18 cfs @ 0.3 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

Inflow Area =	0.577 ac,	Inflow Depth =	3.89"	for Fv event	
Inflow =	4.02 cfs @	11.97 hrs,	Volume=	0.187 af	
Outflow =	0.41 cfs @	12.43 hrs,	Volume=	0.147 af,	Atten= 90%, Lag= 27.3 min
Primary =	0.41 cfs @	12.43 hrs,	Volume=	0.147 af	
Secondary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 62.38' @ 12.43 hrs Surf.Area= 1,250 sf Storage= 3,863 cf
Flood Elev= 63.25' Surf.Area= 1,250 sf Storage= 6,486 cf
Plug-Flow detention time= 195.7 min calculated for 0.147 af (78% of inflow)
Center-of-Mass det. time= 107.5 min (939.6 - 832.1)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,261 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	1,225 cf	**25.00'W x 50.00'L x 2.45'H Prismatoid** 3,063 cf Overall x 40.0% Voids
		6,486 cf	Total Available Storage

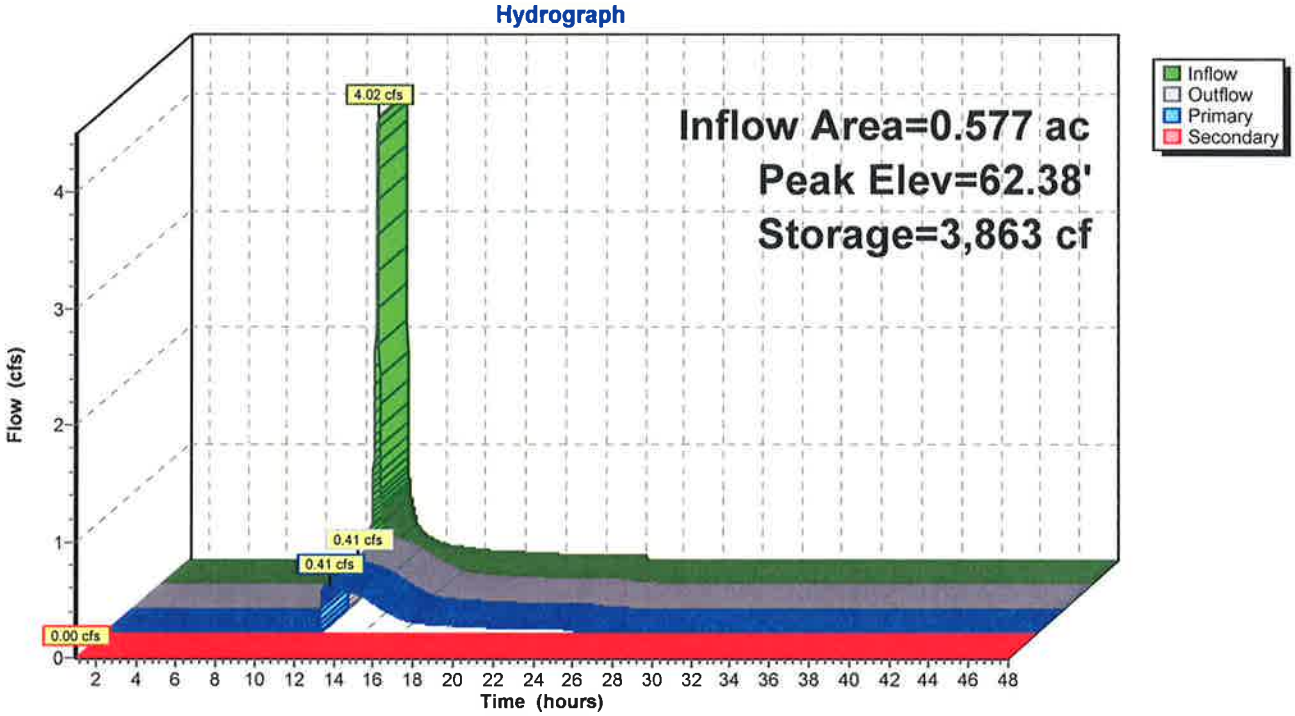
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	1,250	117.0	0	0	1,250
62.00	1,776	165.0	1,656	1,656	2,338
63.00	3,542	357.0	2,609	4,265	10,318
63.25	4,446	410.0	996	5,261	13,554

#	Routing	Invert	Outlet Devices
1	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
2	Device 1	61.25'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Device 1	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
4	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.41 cfs @ 12.43 hrs HW=62.38' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.41 cfs of 8.99 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.41 cfs @ 4.7 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=58.45' TW=57.95' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

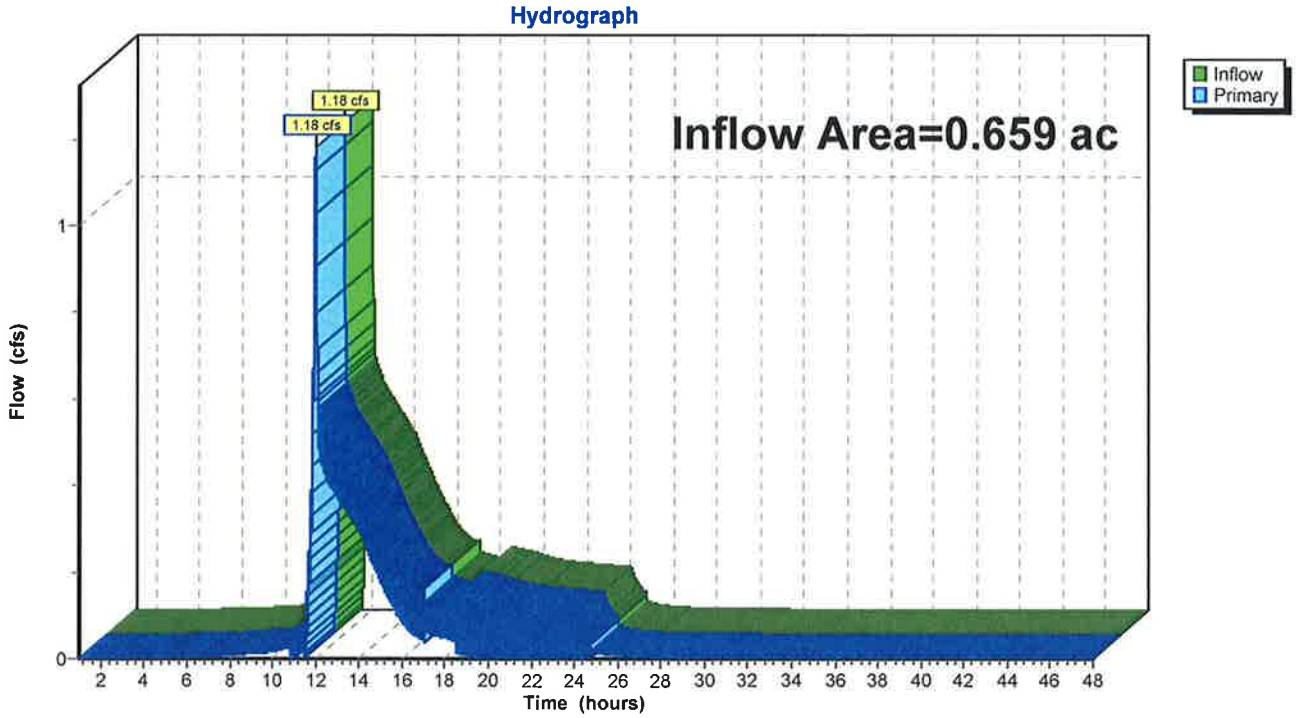
[80] Warning: Exceeded Pond 1P by 2.50' @ 19.64 hrs (26.43 cfs)

Inflow Area =	0.659 ac,	Inflow Depth =	3.46"	for	Fv event
Inflow =	1.18 cfs @	11.99 hrs,	Volume=	0.190 af	
Primary =	1.18 cfs @	11.99 hrs,	Volume=	0.190 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'

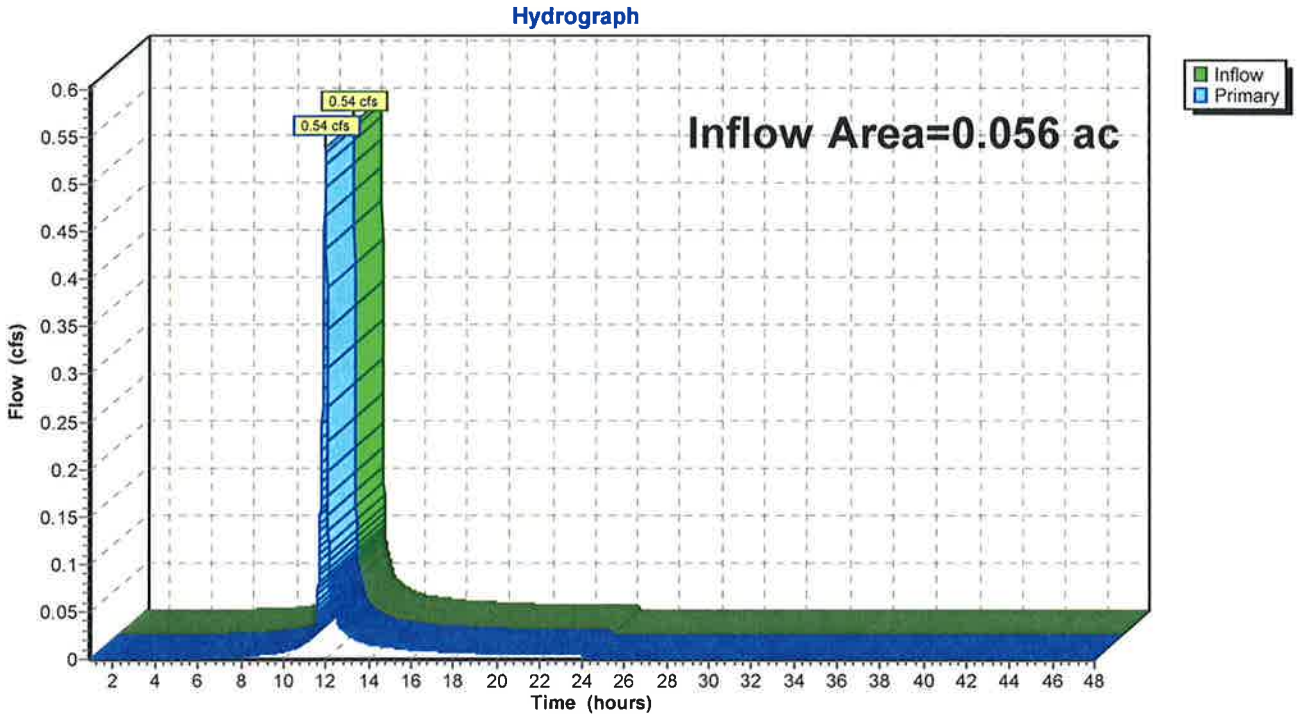


Link AP3: Analysis Point 3

Inflow Area = 0.056 ac, Inflow Depth = 5.63" for Fv event
Inflow = 0.54 cfs @ 11.97 hrs, Volume= 0.026 af
Primary = 0.54 cfs @ 11.97 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs

Link AP3: Analysis Point 3

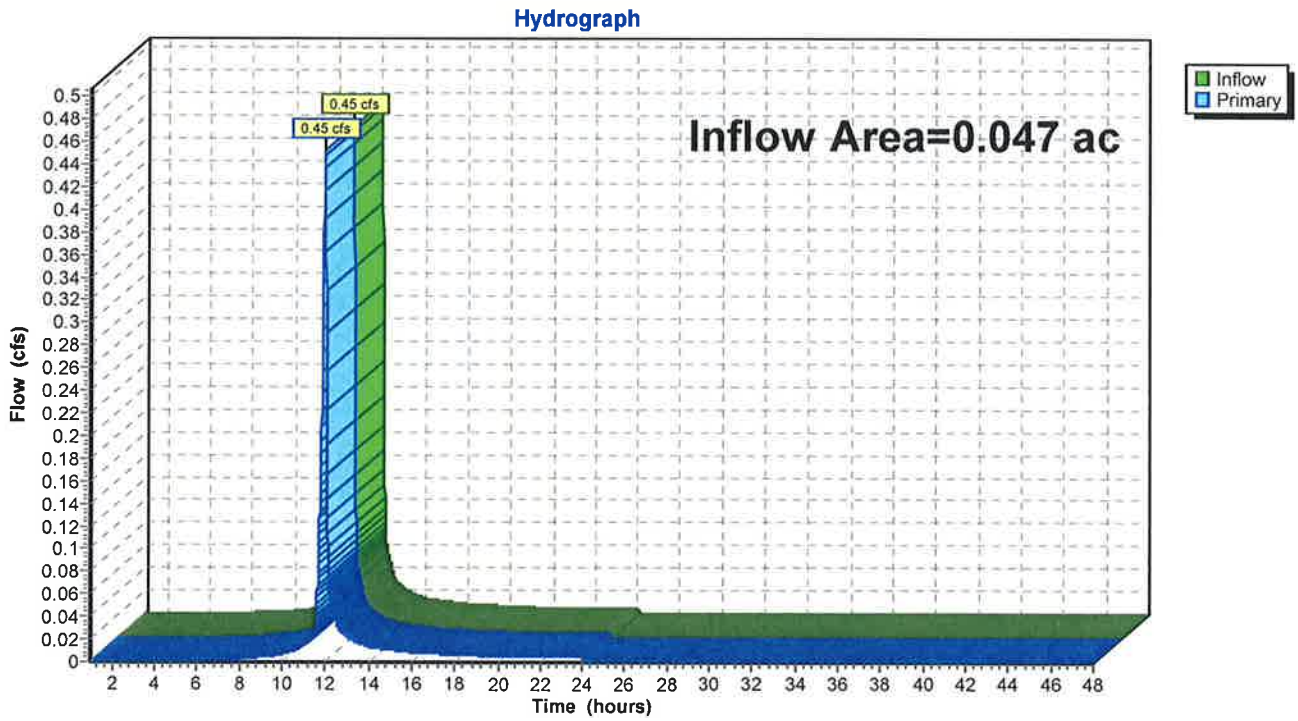


Link AP4: Analysis Point 4

Inflow Area = 0.047 ac, Inflow Depth = 5.63" for Fv event
Inflow = 0.45 cfs @ 11.97 hrs, Volume= 0.022 af
Primary = 0.45 cfs @ 11.97 hrs, Volume= 0.022 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-48.00 hrs, dt= 0.01 hrs

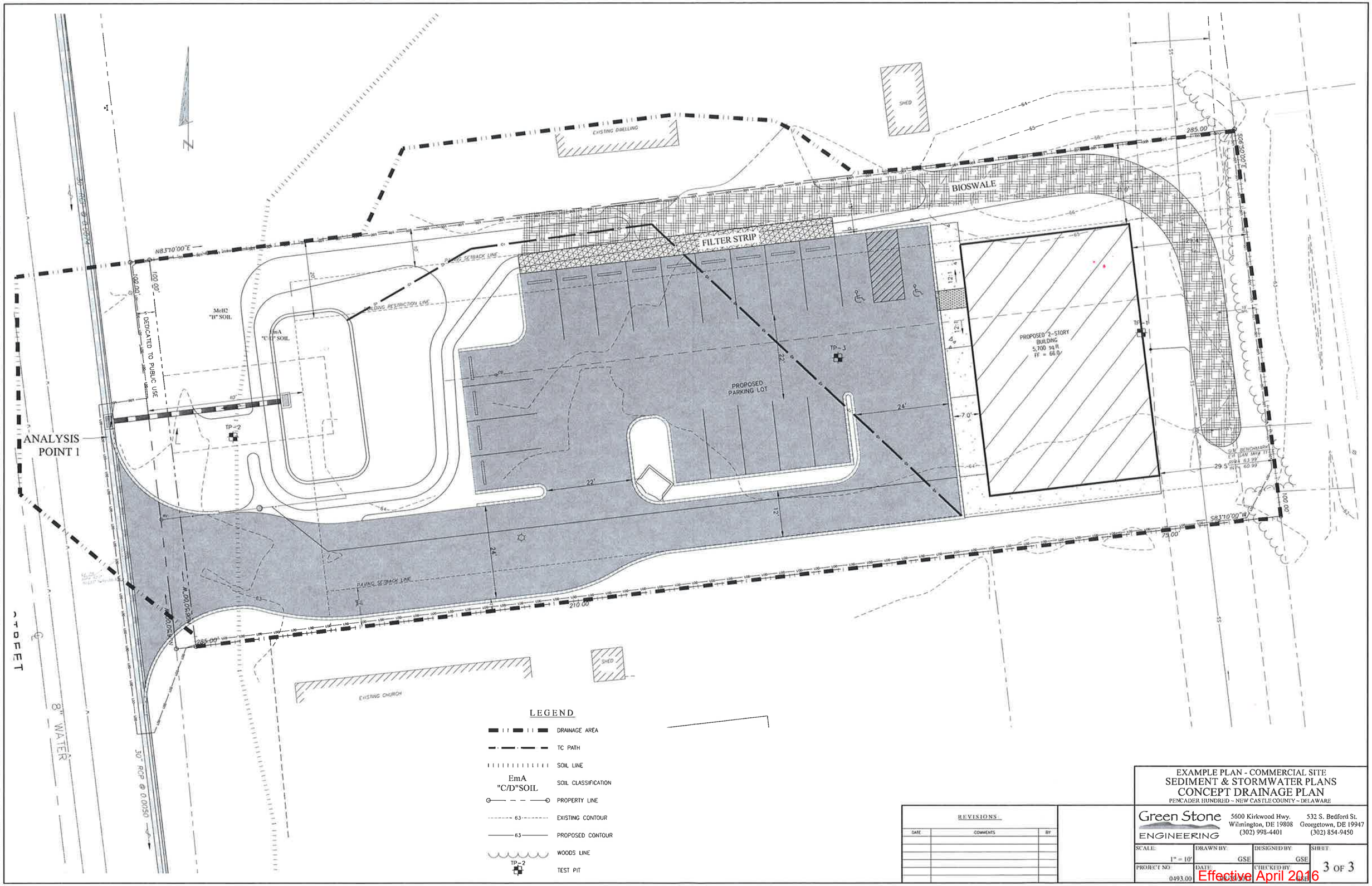
Link AP4: Analysis Point 4



Appendix 5

DURMM v2 Model using Redesigned Stormwater Management Facilities

Effective April 2016



EXAMPLE PLAN - COMMERCIAL SITE
SEDIMENT & STORMWATER PLANS
CONCEPT DRAINAGE PLAN
PENCADER HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

Green Stone ENGINEERING
5600 Kirkwood Hwy. Wilmington, DE 19808 (302) 998-4401
532 S. Bedford St. Georgetown, DE 19947 (302) 854-9450

REVISIONS

DATE	COMMENTS	BY

SCALE:	DRAWN BY:	DESIGNED BY:	SHEET:
1" = 10'	GSE	GSE	3 OF 3
PROJECT NO: 0493.00	DATE:	CHECKED BY:	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

CONTRIBUTING AREA RUNOFF CURVE NUMBER (C.A. RCN) WORKSHEET

Cover Type	Treatment	Hydrologic Condition	Curve Numbers for Hydrologic Soil Type A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
CULTIVATED AGRICULTURAL LANDS										
Fallow	Bare soil	----		77		86		91		94
	Crop residue (CR)	poor		76		85		90		93
	Crop residue (CR)	good		74		83		88		90
Row Crops	Straight row (SR)	poor		72		81		88		91
	Straight row (SR)	good		67		78		85		89
	SR + Crop residue	poor		71		80		87		90
	SR + Crop residue	good		64		75		82		85
	Contoured (C)	poor		70		79		84		88
	Contoured (C)	good		65		75		82		86
	C + Crop residue	poor		69		78		83		87
	C + Crop residue	good		64		74		81		85
	Cont & terraced(C&T)	poor		66		74		80		82
	Cont & terraced(C&T)	good		62		71		78		81
	C&T + Crop residue	poor		65		73		79		81
	C&T + Crop residue	good		61		70		77		80
Small Grain	Straight row (SR)	poor		65		76		84		88
	Straight row (SR)	good		63		75		83		87
	SR + Crop residue	poor		64		75		83		86
	SR + Crop residue	good		60		72		80		84
	Contoured (C)	poor		63		74		82		85
	Contoured (C)	good		61		73		81		84
	C + Crop residue	poor		62		73		81		84
	C + Crop residue	good		60		72		80		83
	Cont & terraced(C&T)	poor		61		72		79		82
	Cont & terraces(C&T)	good		59		70		78		81
	C&T + Crop residue	poor		60		71		78		81
	C&T + Crop residue	good		58		69		77		80
Close-seeded	Straight row	poor		66		77		85		89
or broadcast	Straight row	good		58		72		81		85
legumes or	Contoured	poor		64		75		83		85
rotation	Contoured	good		55		69		78		83
meadow	Cont & terraced	poor		63		73		80		83
	Cont & terraced	good		51		67		76		80
OTHER AGRICULTURAL LANDS										
	Pasture, grassland or range	poor		68		79		86		89
		fair		49		69		79		84
		good		39		61		74		80
	Meadow -cont. grass (non grazed)	----		30		58		71		78
	Brush - brush, weed, grass mix	poor		48		67		77		83
		fair		35		56		70		77
		good		30		48		65		73
	Woods - grass combination	poor		57		73		82		86
		fair		43		65		76		82
		good		32		58		72		79
	Woods	poor		45		66		77		83
		fair		36		60		73		79
		good		30		55		70	0.007	77
	Farmsteads	----		59		74		82		86
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39	0.031	61		74	0.323	80
Impervious Areas										
	Paved parking lots, roofs, driveways		0.32	98	0.002	98		98		98

Effective April 2016

Streets and roads								
Paved; curbs and storm sewers			98		98		98		98
Paved; open ditches (w/right-of-way)			83		89		92		93
Gravel (w/ right-of-way)			76		85		89		91
Dirt (w/ right-of-way)			72		82		87		89
Urban Districts	Avg % impervious							
Commercial & business	85		89		92		94		95
Industrial	72		81		88		91		93
Residential districts by average lot size	Avg % impervious							
1/8 acre (town houses)	65		77		85		90		92
1/4 acre	38		61		75		83		87
1/3 acre	30		57		72		81		86
1/2 acre	25		54		70		80		85
1 acre	20		51		68		79		84
2 acre	12		46		65		77		82
DEVELOPING URBAN AREA (No Vegetation)								
Newly graded area (pervious only)			77		86		91		94
USER DEFINED								

Subarea Contributing Area per Soil Type (ac)	0.32	0.033	0	0.33

UPSTREAM CONTRIBUTING AREAS

	Subarea ID	*Acres*	*RCN*
Upstream Contributing Area 1			
Upstream Contributing Area 2			
Upstream Contributing Area 3			
Upstream Contributing Area 4			

Total Contributing Area (ac)	**0.68**
Weighted Runoff Curve Number (RCN)	**88**

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

LIMIT OF DISTURBANCE (LOD) WORKSHEET

Step 1 - Subarea LOD Data	**HSG A**	**HSG B**	**HSG C**	**HSG D**
1.1 HSG Area Within LOD (ac)		0.031		0.652
1.2 Pre-Developed Woods/Meadow Within LOD (ac)				0.007
1.3 Pre-Developed Impervious Within LOD (ac)				
1.4.a Post-Developed Imperviousness Within LOD, Option #1 (ac); ***OR***				0.322
1.4.b Post-Developed Imperviousness Within LOD, Option #2 (%)	0%	0%	0%	49%

Step 2 - Subarea LOD Runoff Calculations				
2.1 RCN per HSG	0.00	61.00	0.00	88.89
2.2 RPv per HSG (in.)	0.00	0.58	0.00	1.88
2.3 Target Runoff per HSG (in.)	0.00	0.58	0.00	1.38
2.4 Cv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.75	0.00	0.75
2.5 Fv Weighted Unit Discharge per HSG (cfs/ac)	0.00	2.25	0.00	2.24

2.6 Subarea LOD (ac)	0.68
2.7 Subarea Weighted RCN	87.62
2.8 Subarea Weighted RPv (in.)	1.82
2.9 Subarea Weighted Target Runoff (in.)	1.35

Step 3 - Upstream LOD Areas *(from previous DURMM Report as applicable)*	**Area 1**	**Area 2**	**Area 3**	**Area 4**
3.1 Upstream Subarea ID				
3.2 Upstream LOD Area (ac)				
3.3 Target Runoff for Upstream Area (in.)				
3.4 Adjusted CN after all reductions				
3.5 Adjusted RPv (in.)				
3.6 Adjusted Cv (in.)				
3.7 Adjusted Fv (in.)				

Step 4 - RPv Calculations for Combined LOD	
4.1 Combined LOD (ac)	0.68
4.2 Weighted RCN	87.62
4.3 Weighted RPv (in.)	1.82
4.4 Weighted Target Runoff (in.)	1.35
4.5 Estimated Annual Runoff (in.)	25.19
4.6 Req'd Runoff Reduction within LOD (in.)	0.47
4.7 Req'd Runoff Reduction within LOD (%)	26%

Step 5 - Cv Unit Discharge	
5. LOD Allowable Unit Discharge (cfs/ac)	0.75

Step 6 - Fv Unit Discharge	
6. LOD Allowable Unit Discharge (cfs/ac)	2.24

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle
UNIT HYDROGRAPH:	STD

OUTSIDE LIMIT OF DISTURBANCE (OLOD) WORKSHEET

Step 1 - Site Data

1.1 Total Contributing Area (ac)	N/A
1.2 C.A. RCN	N/A
1.3 LOD Area (ac)	N/A
1.4 LOD RCN	N/A
1.5 Outside LOD Area (ac)	N/A
1.6 Outside LOD RCN	N/A

Step 2 - Time of Concentration

FLOW TYPE	2.1 LENGTH (feet)	2.2 SLOPE (ft./ft.)	2.3 SURFACE CODE	2.4 MANNINGS "n"	2.5 VELOCITY (ft./sec.)	2.6 TRAVEL TIME (hrs)
Sheet	28	0.025	a	0.011	N/A	0.01
				----------	N/A	0.00
				----------	N/A	0.00
Shallow Concentrated				N/A	----------	0.00
				N/A	----------	0.00
				N/A	----------	0.00
Open Channel	115	0.023	N/A	0.03	6.1	0.01
			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00

2.7 Time of Concentration (Tc) 0.10 hrs

Sheet Flow Surface Codes

a Smooth Surface
b fallow (no residue)
c cultivated < 20% Res.
d cultivated > 20% Res.
e grass - range, short
f grass, dense
g grass, bermuda
h woods, light
i woods, dense
j range, natural

Shallow Concentrated Surf

u unpaved surface
p paved surface

Step 3 - Peak Discharge

	STD	
3.1 Unit Hydrograph Type		
3.2 Frequency (yr)	10	100
3.3 24-HR Rainfall, P (in.)	4.8	8
3.4 Initial Abstraction, Ia (in.)	#N/A	#N/A
3.5 Ia/P ratio	#N/A	#N/A
3.6 Unit Peak Discharge, qu (csm/in)	#N/A	#N/A
3.7 Runoff (in.)	#VALUE!	#VALUE!
3.8 Peak Discharge, qp (cfs)	#VALUE!	#VALUE!
3.9 Equiv. unit peak discharge (cfs/ac)	0.00	0.00

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle

RESOURCE PROTECTION EVENT (RPv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type	Impervious disconnection	Type	Filter strip	Type	Bioswale	Type	Bioretention w/underdrain	Type	--
Step 1 - Calculate Initial RPv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.68		0.68		0.68		0.68		0.68	
1.2 *Reserved*										
1.3 Initial RCN	87.62									
1.4 RPv for Contributing Area (in.)	1.82									
1.5 Req'd RPv Reduction for Contributing Area (in.)	0.47									
1.6 Req'd RPv Reduction for Contributing Area (%)	26%									
1.7 RPv allowable discharge rate (cfs)	0.05									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)							5888			
2.2 Retention reduction allowance (%)	0%		0%		0%		50%		N/A	
2.3 Retention reduction volume (ac-ft)	0.00		0.00		0.00		0.07		N/A	
2.4 Retention reduction volume (in.)	0.00		0.00		0.00		1.19		N/A	
2.5 Runoff volume after retention reduction (in.)	1.82		1.66		1.45		0.00		N/A	
2.6 Adjusted CN*	87.89		85.03		81.17		32.37		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Annual CN (ACN)	87.62		85.03		81.17		74.76		N/A	
3.2 Annual runoff (in.)	25.19		22.67		19.27		14.45		N/A	
3.3 Proportion A/B soils in BMP footprint (%)	0%		0%		0%		0%			
3.4 Annual runoff reduction allowance (%)	10%		15%		25%		0%		N/A	
3.5 Annual runoff after reduction (in.)	22.67		19.27		14.45		14.45		N/A	
3.6 Adjusted ACN	85.03		81.17		74.76		74.76		N/A	
3.7 Annual Runoff Reduction Allowance for RPv (in.)	0.16		0.37		0.69		0.69		N/A	
Step 4 - Calculate RPv with BMP Reductions										
4.1 RPv runoff volume after all reductions (in.)	1.66		1.45		1.13		0.00		N/A	
4.2 Total RPv runoff reduction (in.)	0.16		0.37		0.69		1.82		N/A	
4.3 Total RPv runoff reduction (%)	9%		21%		38%		100%		N/A	
4.4 Adjusted CN after all reductions	85.03		81.17		74.76		32.37		N/A	
4.5 Equivalent TR-55 RCN for H&H modeling	89.34		86.56		81.74		42.55		N/A	
4.6 Req'd reduction met?	No		No		OK		OK		N/A	
Step 5 - Determine Runoff Reduction Offset										
5.1 Runoff Reduction Shortfall (in.)	0.31		0.10		N/A		N/A		N/A	
5.2 Runoff Reduction Shortfall (cu.ft./ac)	1124		365		N/A		N/A		N/A	
5.3 Total Offset Volume (cu.ft.)	768		249		N/A		N/A		N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LANDUSE TYPE:	Commercial
TMDL WATERSHED:	Christina River

TOTAL MAXIMUM DAILY LOAD (TMDL) WORKSHEET

	BMP 1				BMP 2				BMP 3				BMP 4				BMP 5			
	Type:	Impervious disconnection			Type:	Filter strip			Type:	Bioswale			Type:	Bioretention w/underdrain			Type:	--		
Step 1 - Calculate Annual Runoff Volume	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS
1.1 Total contributing area to BMP (ac)	0.68																			
1.2 Initial RCN	88																			
1.3 Annual runoff volume (in.)	25.19																			
1.4 Annual runoff volume (liters)	1.77E+06																			
Step 2 - Calculate Annual Pollutant Load																				
2.1 EMC (mg/L)		2.00	0.27	60																
2.2 Load (mg/yr)		3.54E+06	4.77E+05	1.06E+08																
2.4 Stormwater Load (lb/ac/yr)		11.42	1.54	343		10.28	1.39	308		8.74	1.18	262		6.55	0.88	197		2.62	0.44	74
Step 3 - Adjust for Runoff Reduction																				
3.1 BMP Runoff Reduction (%)	10%				15%				25%				62%				N/A			
3.2 BMP Removal Efficiency (%)		10%	10%	10%		15%	15%	15%		25%	25%	25%		60%	50%	62%		#N/A	#N/A	#N/A
3.3 Adjusted load (lb/ac/yr)		10.28	1.39	308		8.74	1.18	262		6.55	0.88	197		2.62	0.44	74		#N/A	#N/A	#N/A
Step 4 - Calculate Pollutant Reduction																				
4.1 TMDL (lb/ac/yr)		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A		5.70	0.35	N/A
4.2 Reduction met?		No	No	OK		No	No	OK		No	No	OK		OK	No	OK		#N/A	#N/A	OK
Step 5 - Determine TMDL Offset																				
5.1 TMDL Shortfall (lb/ac/yr)		4.58	1.04	0		3.04	0.83	0		0.85	0.53	0		0.00	0.09	0		#N/A	#N/A	0
5.2 TMDL Shortfall (%)		45%	75%	0%		35%	70%	0%		13%	60%	0%		0%	21%	0%		#N/A	#N/A	#N/A
5.3 Residual RPv Volume (in)		1.66	1.66	1.66		1.45	1.45	1.45		1.13	1.13	1.13		0.00	0.00	0.00		N/A	N/A	N/A
5.4 Req'd Additional RR to meet TMDL (in)*		0.74	1.24	0.00		0.50	1.02	0.00		0.15	0.68	0.00		0.00	0.00	0.00		#N/A	#N/A	#N/A
5.5 Req'd Additional RR to meet TMDL (cu.ft./ac)		2679	4499	0		1827	3697	0		534	2482	0		0	0	0		#N/A	#N/A	#N/A
5.6 Total Offset Volume (cu.ft.)		1830	3073	0		1248	2525	0		365	1695	0		0	0	0		#N/A	#N/A	#N/A

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle

CONVEYANCE EVENT (Cv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	Filter strip	Type:	Bioswale	Type:	Bioretention w/underdrain	Type:	--
Step 1 - Calculate Initial Cv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.68		0.68		0.68		0.68		0.68	
1.2 Initial RCN	87.62									
1.3 **10-YR** Rainfall (in.)	4.8									
1.4 Cv runoff volume (in.)	3.44									
1.5 LOD allowable unit discharge (cfs/ac)	0.75									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Cv allowable discharge rate (cfs)	0.51									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		5888.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.14		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		2.37		0.00	
2.4 Runoff volume after reduction (in.)	3.44		3.37		3.31		0.77		0.77	
2.5 CN*	87.62		86.93		86.25		52.91		52.91	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	2%		2%		5%		0%		#N/A	
3.2 Annual runoff after reduction (in.)	3.37		3.31		3.14		3.14		#N/A	
3.3 Adjusted ACN	86.93		86.25		84.54		84.54		#N/A	
3.4 Event-based runoff reduction (in.)	0.07		0.14		0.30		0.30		#N/A	
Step 4 - Calculate Cv with BMP Reductions										
4.1 Cv runoff volume after all reductions (in.)	3.37		3.31		3.14		0.77		#N/A	
4.2 Total Cv runoff reduction (%)	2%		4%		9%		78%		#N/A	
4.3 Adjusted RCN for H&H modeling	86.93		86.25		84.54		52.91		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
LOCATION (County):	New Castle

FLOODING EVENT (Fv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	Filter strip	Type:	Bioswale	Type:	Bioretention w/underdrain	Type:	--
Step 1 - Calculate Initial Fv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.68		0.68		0.68		0.68		0.68	
1.2 Initial RCN	87.62									
1.3 100-YR Rainfall (in.)	8.0									
1.4 Fv runoff volume (in.)	6.52									
1.5 LOD allowable unit discharge (cfs/ac)	2.24									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Fv allowable discharge rate (cfs)	1.53									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		5888.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.14		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		2.37		0.00	
2.4 Runoff volume after reduction (in.)	6.52		6.52		6.52		4.08		4.08	
2.5 CN*	87.62		87.62		87.62		66.67		66.67	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	0%		0%		1%		0%		#N/A	
3.2 Annual runoff after reduction (in.)	6.52		6.52		6.46		6.46		#N/A	
3.3 Adjusted ACN	87.62		87.62		87.07		87.07		#N/A	
3.4 Event-based runoff reduction (in.)	0.00		0.00		0.07		0.07		#N/A	
Step 4 - Calculate Fv with BMP Reductions										
4.1 Fv runoff volume after all reductions (in.)	6.52		6.52		6.46		4.08		#N/A	
4.2 Total Fv runoff reduction (%)	0%		0%		1%		37%		#N/A	
4.3 Adjusted RCN for H&H modeling	87.62		87.62		87.07		66.67		#N/A	

Effective April 2016

PROJECT:	Example Plan - Commercial Site
DRAINAGE SUBAREA ID:	Subarea 1
TMDL Watershed:	Christina River

DURMM OUTPUT WORKSHEET

DURMM v2.beta.110802

Site Data

Contributing Area to BMPs (ac.)	0.683				
C.A. RCN	88				
Subarea LOD (ac.)	0.683				
Upstream Subarea ID	0	0	0	0	
Upstream Subarea LOD (ac.)	0.00	0.00	0.00	0.00	
Combined LOD with Upstream Areas (ac.)	0.68				
Combined RCN with Upstream Areas (ac.)	87.62				
TMDL-TN (lb/ac/yr)	5.70				
TMDL-TP (lb/ac/yr)	0.35				
TMDL-TSS (lb/ac/yr)	N/A				
BMP Selection	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
	Impervious disconnection	Filter strip	Bioswale	Bioretention w/underdrain	--

Resource Protection Event (RPV)

RPv for Contributing Area (in.)	1.82				
Req'd RPv Reduction for Contributing Area (in.)	0.47				
Req'd RPv Reduction for Contributing Area (%)	26%				
C.A. allowable discharge rate (cfs)	0.05				
Unmanaged Polluant load, TN (lbs/ac/yr)	11.42				
Unmanaged Polluant load, TP (lbs/ac/yr)	1.54				
Unmanaged Polluant load, TSS (lbs/ac/yr)	343				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	1.66	1.45	1.13	0.00	N/A
Total RPv runoff reduction (in.)	0.16	0.37	0.69	1.82	N/A
Total RPv runoff reduction (%)	9%	0.21	0.38	1.00	N/A
Req'd runoff reduction met?	No	No	OK	OK	N/A
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	10.28	8.74	6.55	2.62	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	1.39	1.18	0.88	0.44	#N/A
Adjusted pollutant load, TSS (lb/ac/yr)	308	262	197	74	#N/A
Offsets Requirements					
RPv Offset (cu. ft.)	768	249	N/A	N/A	N/A

Conveyance Event (Cv)

Cv runoff volume (in.)	3.44				
Stds-based allowable discharge (cfs)	0.51				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	3.37	3.31	3.14	0.77	#N/A

Flooding Event (Fv)

Fv runoff volume (in.)	6.52				
Stds-based allowable discharge (cfs)	1.53				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	6.52	6.52	6.46	4.08	#N/A

Adjusted Subarea Data for Downstream DURMM Modeling

Contributing Area (ac.)	0.68
C.A. RCN	88
LOD Area (ac.)	0.68
Weighted Target Runoff (in.)	1.35
Adjusted CN after all reductions	32.37
Adjusted RPv (in.)	0.00
Adjusted Cv (in.)	
Adjusted Fv (in.)	

Effective April 2016

Adjusted Subarea Data for H&H Modeling

	Rain (in.)	RCN
Resource Protection Event, RPv	2.7	N/A
Conveyance Event, Cv	4.8	52.91
Flooding Event, Fv	8	66.67

Appendix 6

DURMM v2 HydroCAD Model using Redesigned Stormwater Management Facilities

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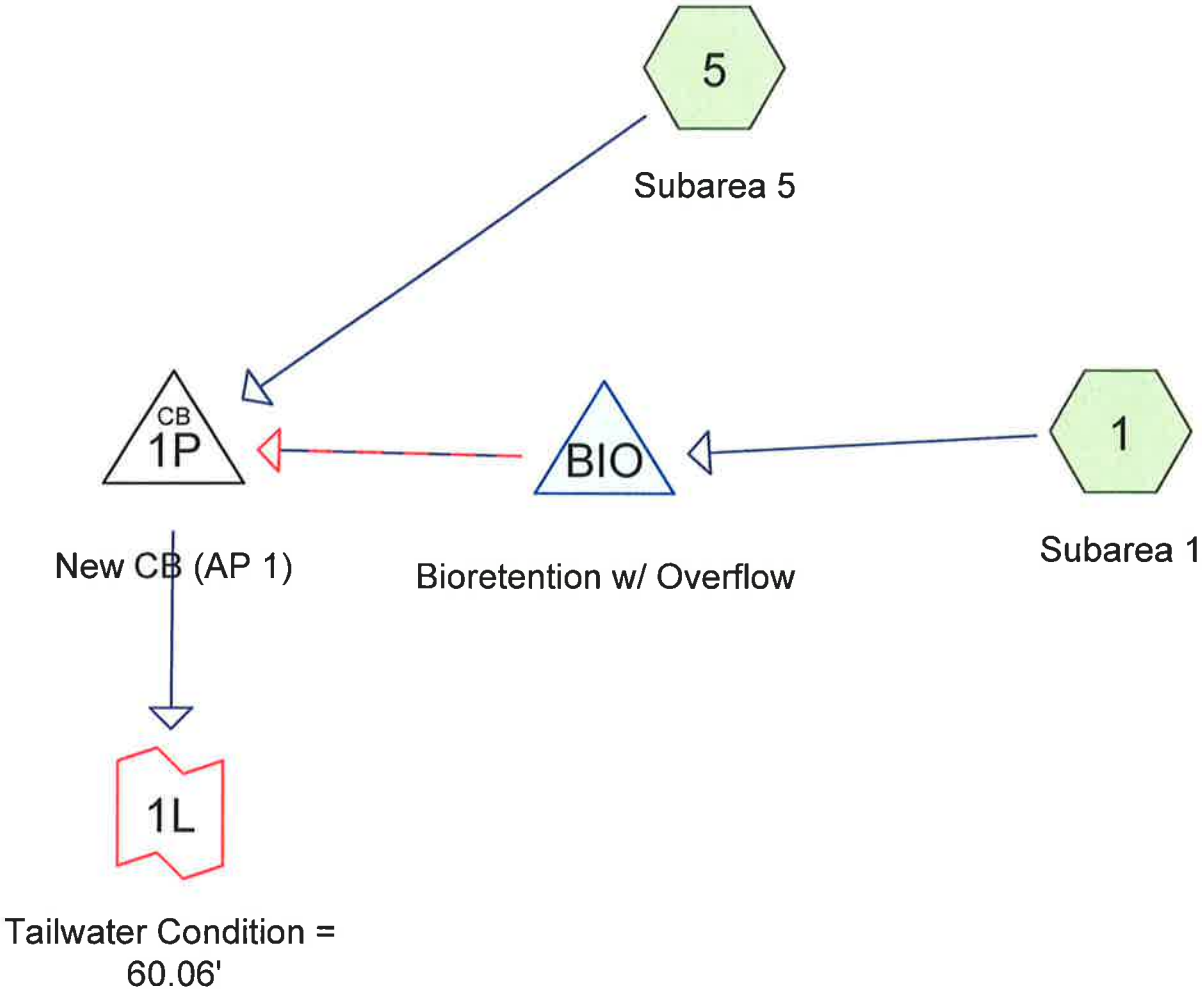

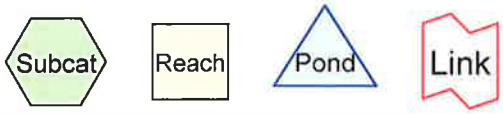

Drainage Diagram for Example Commercial Site New DURMM whole site
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

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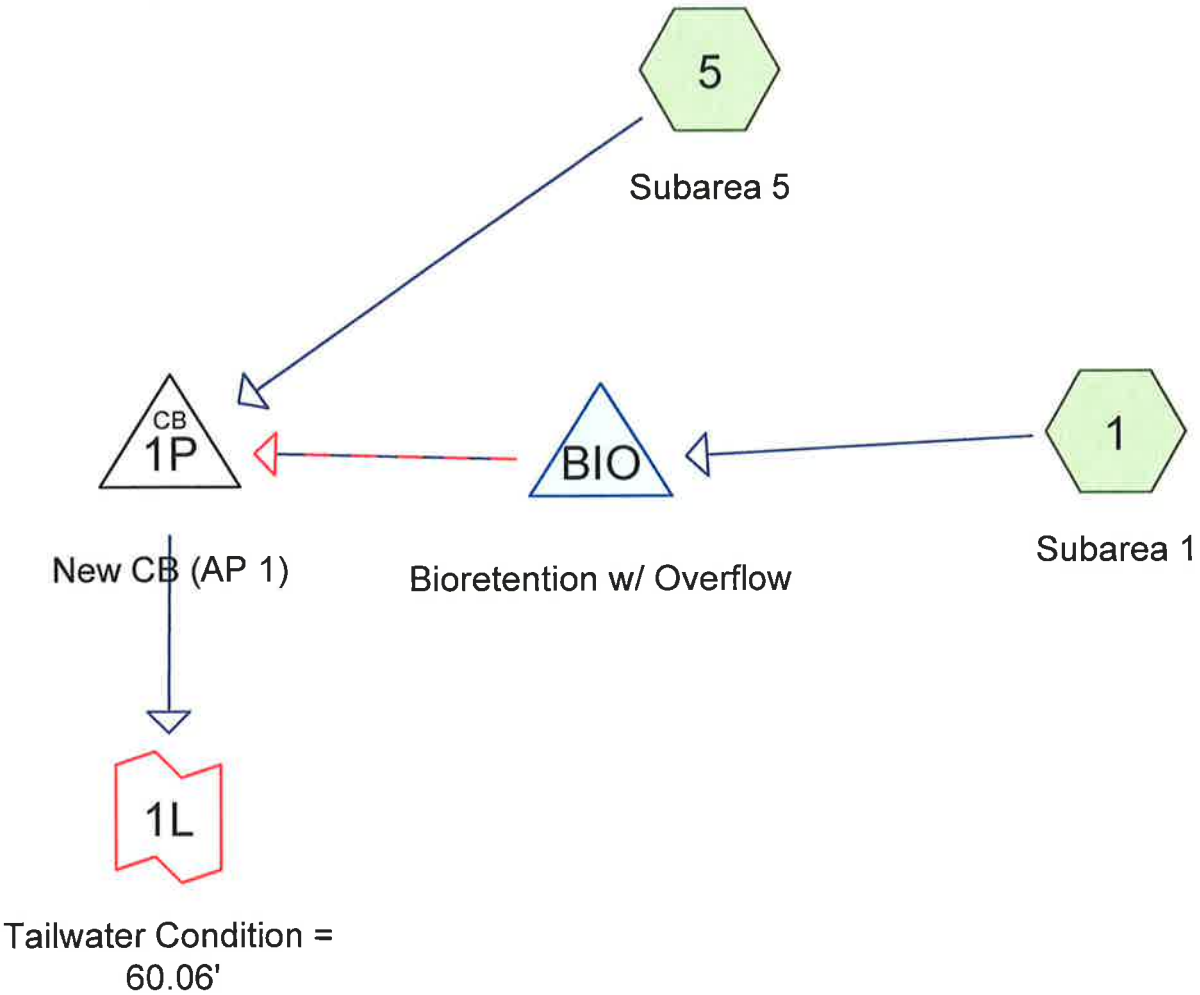

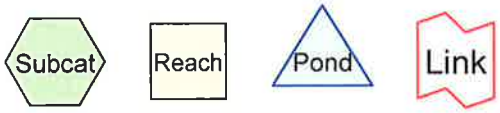

Drainage Diagram for Example Commercial Site New DURMM whole site adj Fv RCN noexfil
Prepared by {enter your company name here} 8/30/2011
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Effective April 2016

Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.680 ac Runoff Depth=1.55"
Tc=6.0 min CN=88 Runoff=1.80 cfs 0.088 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=1.41"
Tc=6.0 min CN=86 Runoff=0.20 cfs 0.010 af

Pond 1P: New CB (AP 1) Peak Elev=60.06' Inflow=0.28 cfs 0.098 af
30.0" x 234.0' Culvert Outflow=0.28 cfs 0.098 af

Pond BIO: Bioretention w/ Overflow Peak Elev=61.28' Storage=1,796 cf Inflow=1.80 cfs 0.088 af
Primary=0.08 cfs 0.088 af Secondary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.088 af

Link 1L: Tailwater Condition = 60.06' Inflow=0.28 cfs 0.098 af
Primary=0.28 cfs 0.098 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.098 af Average Runoff Depth = 1.54"

Subcatchment1: Subarea 1

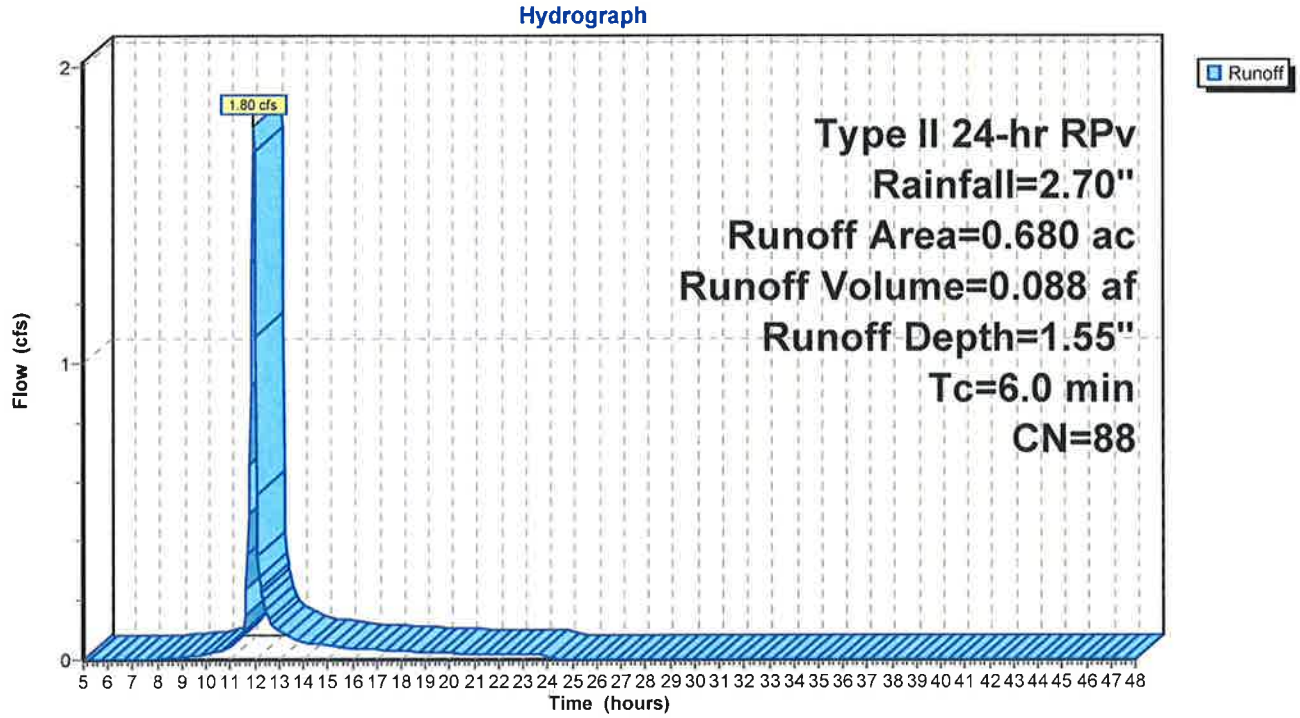
Runoff = 1.80 cfs @ 11.97 hrs, Volume= 0.088 af, Depth= 1.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr RPv Rainfall=2.70"

Area (ac)	CN	Description
0.319	98	Paved parking & roofs
0.325	80	>75% Grass cover, Good, HSG D
0.029	61	>75% Grass cover, Good, HSG B
0.007	77	Woods, Good, HSG D
0.680	88	Weighted Average

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

Subcatchment1: Subarea 1



Subcatchment5: Subarea 5

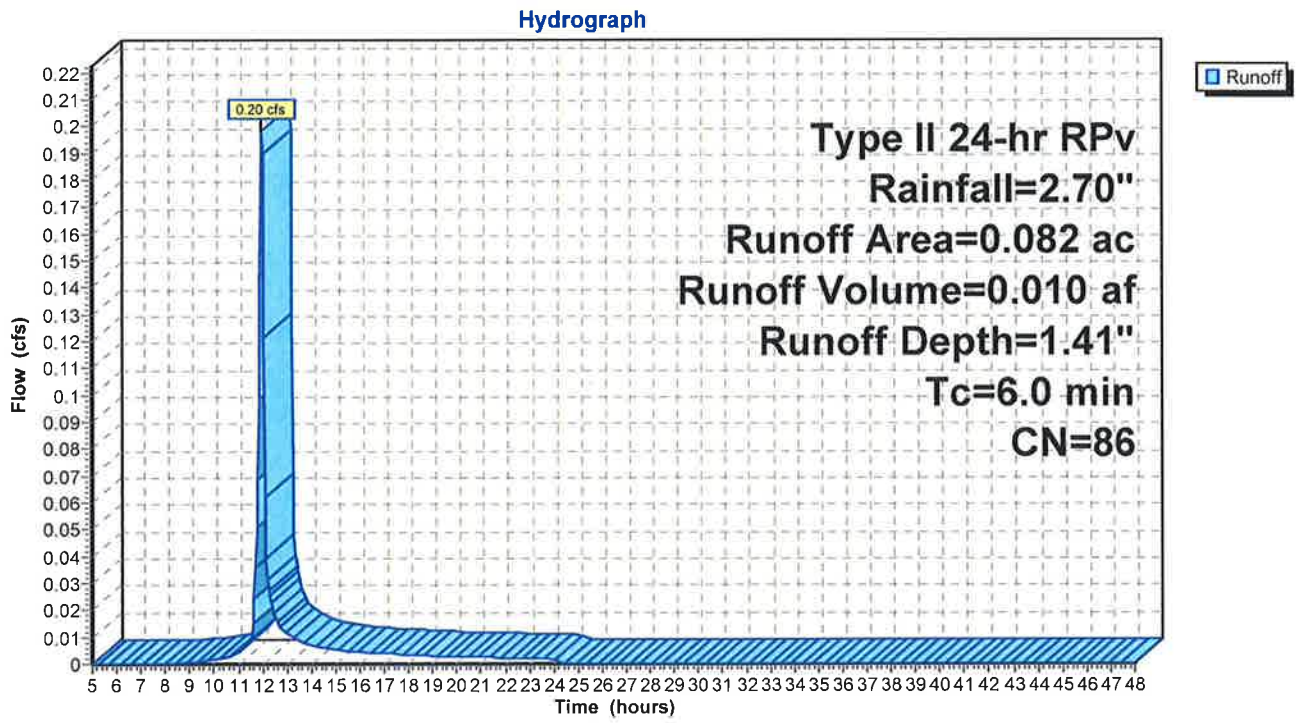
Runoff = 0.20 cfs @ 11.97 hrs, Volume= 0.010 af, Depth= 1.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr RPv Rainfall=2.70"

Area (ac)	CN	Description
0.026	61	>75% Grass cover, Good, HSG B
0.056	98	Paved parking & roofs
0.082	86	Weighted Average

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

Subcatchment5: Subarea 5



Pond 1P: New CB (AP 1)

[57] Hint: Peaked at 60.06' (Flood elevation advised)
[80] Warning: Exceeded Pond BIO by 1.61' @ 11.25 hrs (0.08 cfs)

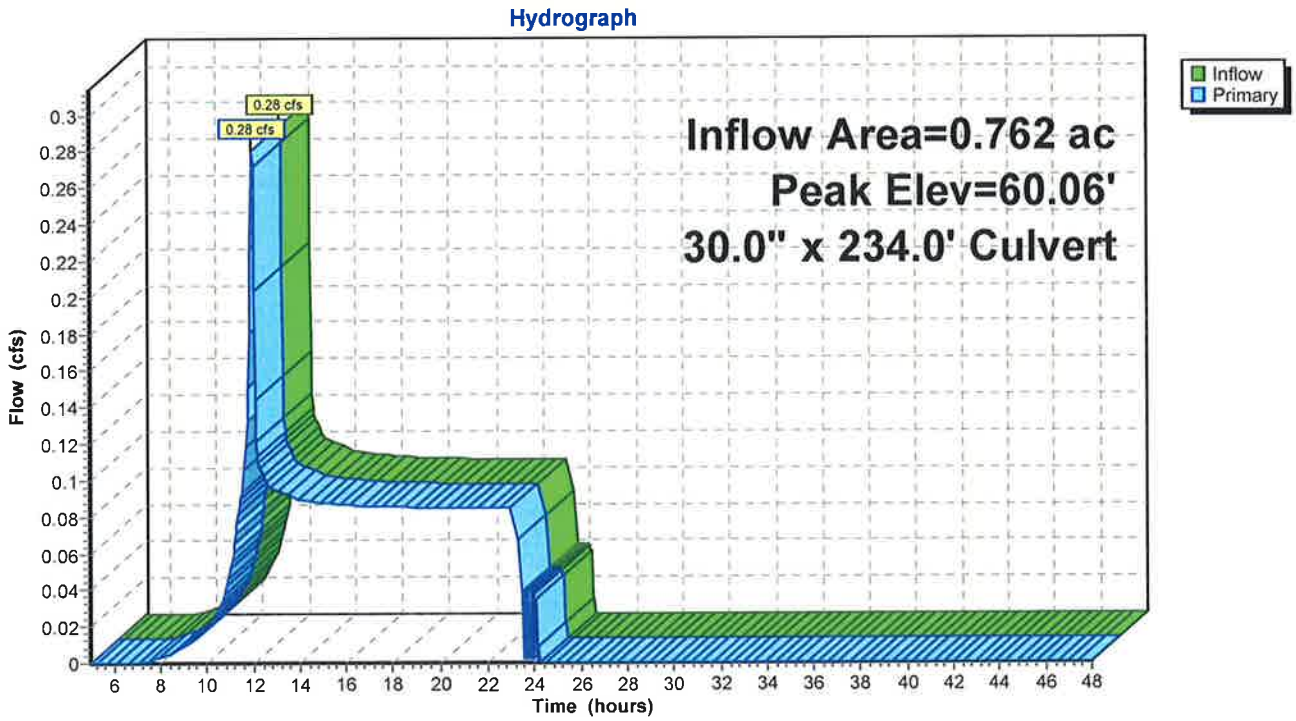
Inflow Area =	0.762 ac,	Inflow Depth =	1.54"	for	RPv event	
Inflow =	0.28 cfs @	11.97 hrs,	Volume=		0.098 af	
Outflow =	0.28 cfs @	11.97 hrs,	Volume=		0.098 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.28 cfs @	11.97 hrs,	Volume=		0.098 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 60.06' @ 11.97 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=0.27 cfs @ 11.97 hrs HW=60.06' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.27 cfs @ 0.1 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

[87] Warning: Oscillations may require Finer Routing or smaller dt

Inflow Area =	0.680 ac,	Inflow Depth =	1.55"	for RPv event	
Inflow =	1.80 cfs @	11.97 hrs,	Volume=	0.088 af	
Outflow =	0.08 cfs @	13.29 hrs,	Volume=	0.088 af,	Atten= 95%, Lag= 79.4 min
Primary =	0.08 cfs @	13.29 hrs,	Volume=	0.088 af	
Secondary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 61.28' @ 13.29 hrs Surf.Area= 1,250 sf Storage= 1,796 cf
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,261 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	1,225 cf	**25.00'W x 50.00'L x 2.45'H Prismatoid** 3,063 cf Overall x 40.0% Voids
		6,486 cf	Total Available Storage

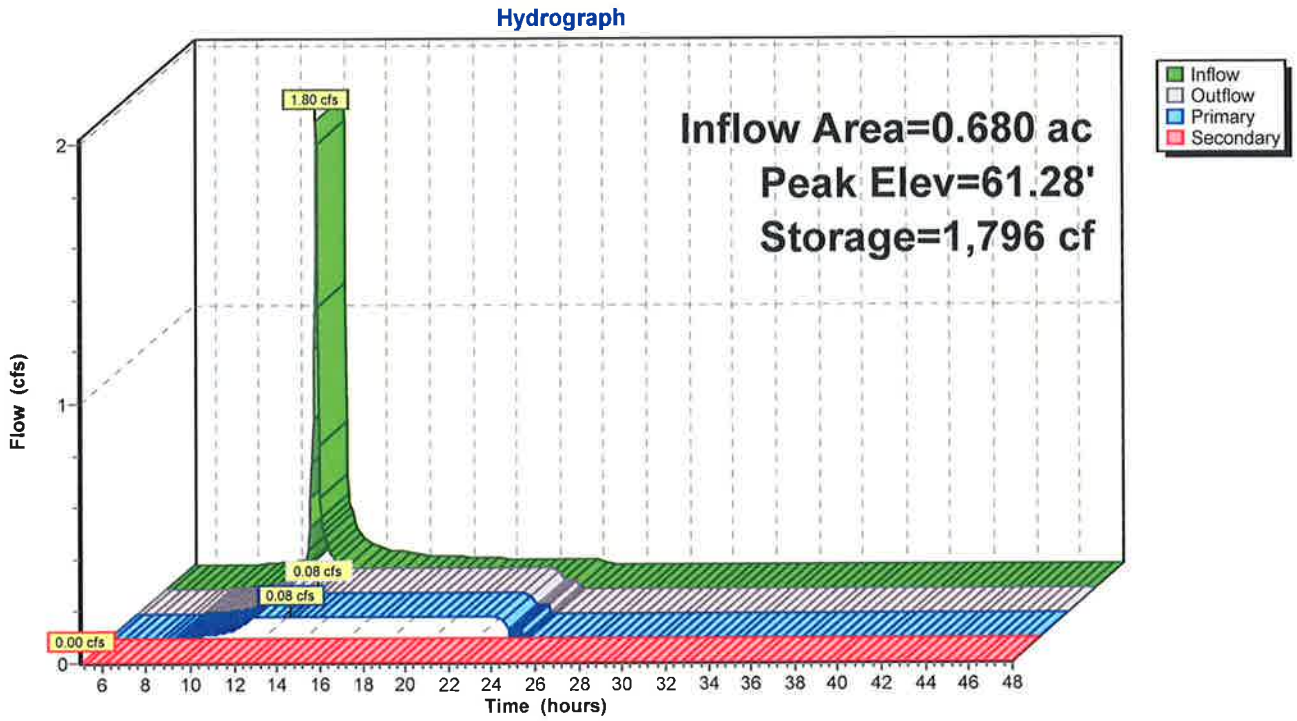
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	1,250	117.0	0	0	1,250
62.00	1,776	165.0	1,656	1,656	2,338
63.00	3,542	357.0	2,609	4,265	10,318
63.25	4,446	410.0	996	5,261	13,554

#	Routing	Invert	Outlet Devices
1	Primary	0.00'	**0.003930 fpm Exfiltration over entire Surface area**
2	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
3	Device 2	61.25'	**4.0" Vert. Orifice/Grate** C= 0.600
4	Device 2	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
5	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.08 cfs @ 13.29 hrs HW=61.28' TW=60.06' (Dynamic Tailwater)
- **1=Exfiltration** (Exfiltration Controls 0.08 cfs)
- **2=Culvert** (Passes 0.00 cfs of 6.52 cfs potential flow)
  - **3=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.6 fps)
  - **4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=58.45' TW=57.56' (Dynamic Tailwater)
- **5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

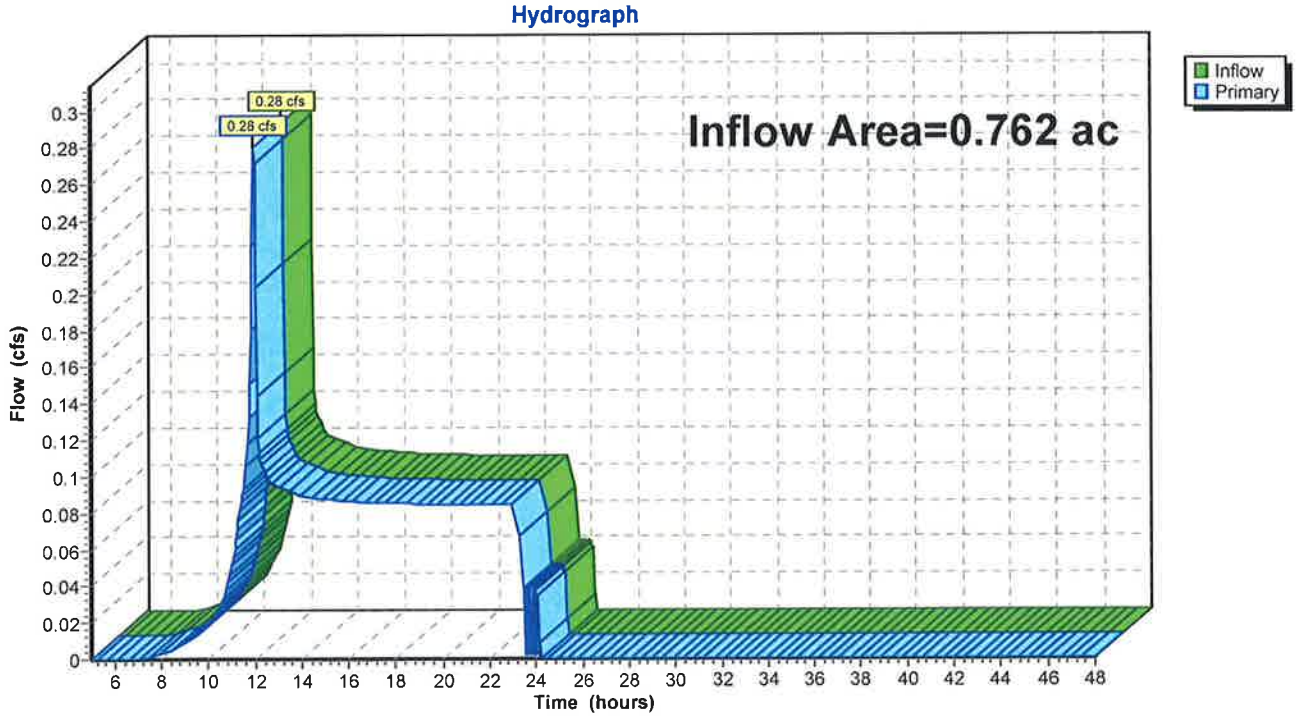
[80] Warning: Exceeded Pond 1P by 2.50' @ 5.00 hrs (26.43 cfs)

Inflow Area =	0.762 ac,	Inflow Depth =	1.54"	for	RPv event	
Inflow =	0.28 cfs @	11.97 hrs,	Volume=		0.098 af	
Primary =	0.28 cfs @	11.97 hrs,	Volume=		0.098 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'



Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.680 ac Runoff Depth=4.12"
Tc=6.0 min CN=67 Runoff=4.82 cfs 0.234 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=6.32"
Tc=6.0 min CN=86 Runoff=0.83 cfs 0.043 af

Pond 1P: New CB (AP 1) Peak Elev=60.06' Inflow=1.19 cfs 0.236 af
30.0" x 234.0' Culvert Outflow=1.19 cfs 0.236 af

Pond BIO: Bioretention w/ Overflow Peak Elev=62.78' Storage=4,911 cf Inflow=4.82 cfs 0.234 af
Primary=0.49 cfs 0.193 af Secondary=0.00 cfs 0.000 af Outflow=0.49 cfs 0.193 af

Link 1L: Tailwater Condition = 60.06' Inflow=1.19 cfs 0.236 af
Primary=1.19 cfs 0.236 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.277 af Average Runoff Depth = 4.36"

Subcatchment1: Subarea 1

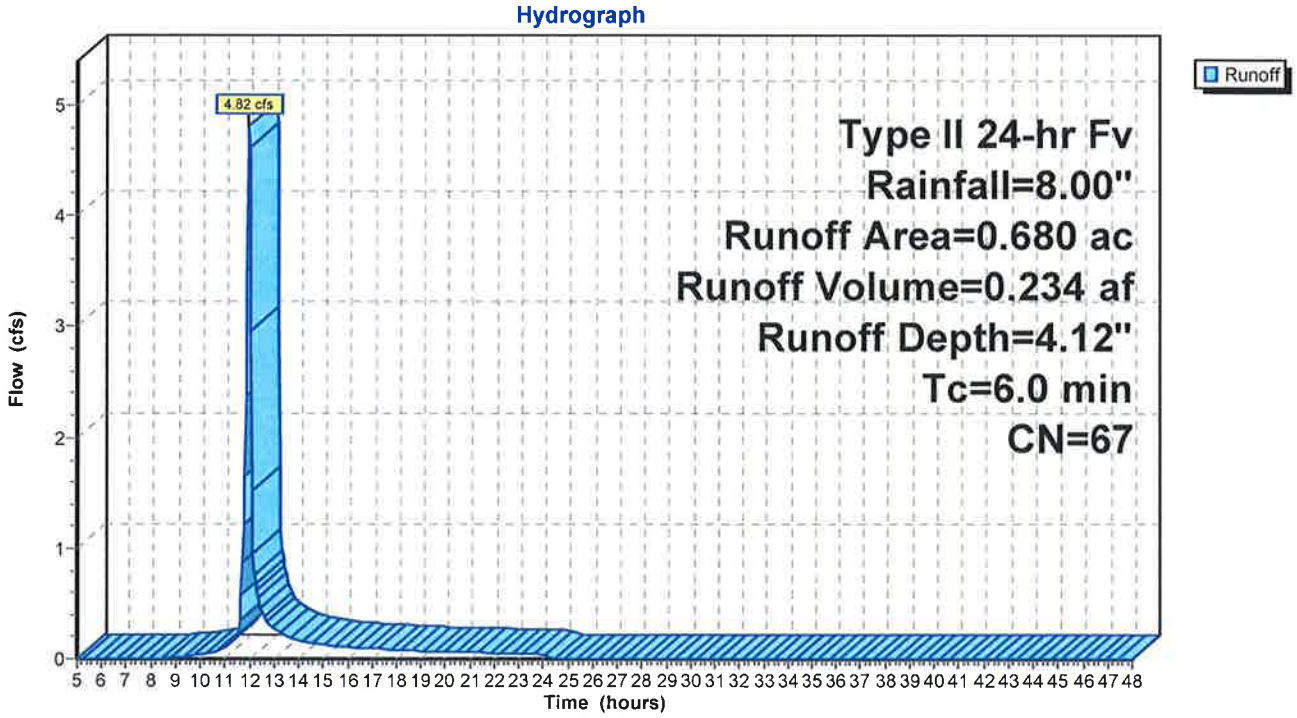
Runoff = 4.82 cfs @ 11.97 hrs, Volume= 0.234 af, Depth= 4.12"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr Fv Rainfall=8.00"

Area (ac)	CN	Description
0.680	67	Adjusted Fv RCN

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

Subcatchment1: Subarea 1



Subcatchment5: Subarea 5

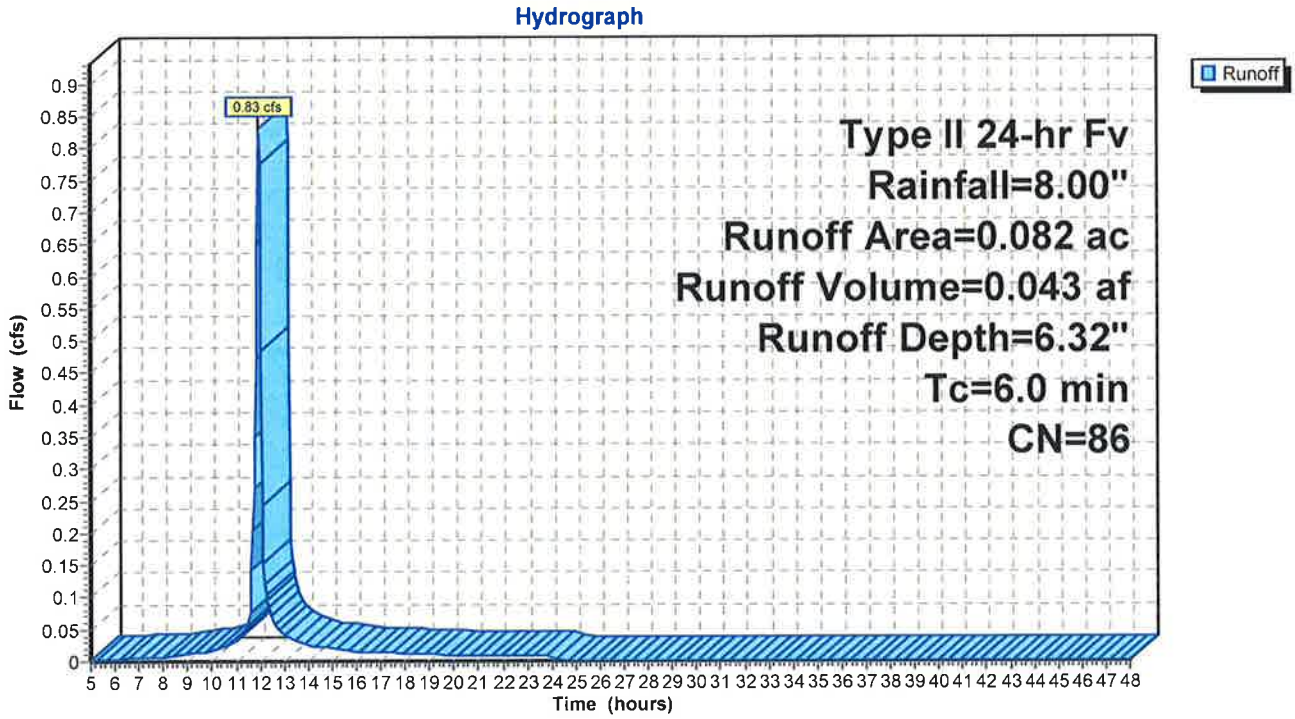
Runoff = 0.83 cfs @ 11.96 hrs, Volume= 0.043 af, Depth= 6.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr Fv Rainfall=8.00"

Area (ac)	CN	Description
0.082	86	Adjusted Fv RCN

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

Subcatchment5: Subarea 5



Pond 1P: New CB (AP 1)

[82] Warning: Early inflow requires earlier time span
[57] Hint: Peaked at 60.06' (Flood elevation advised)

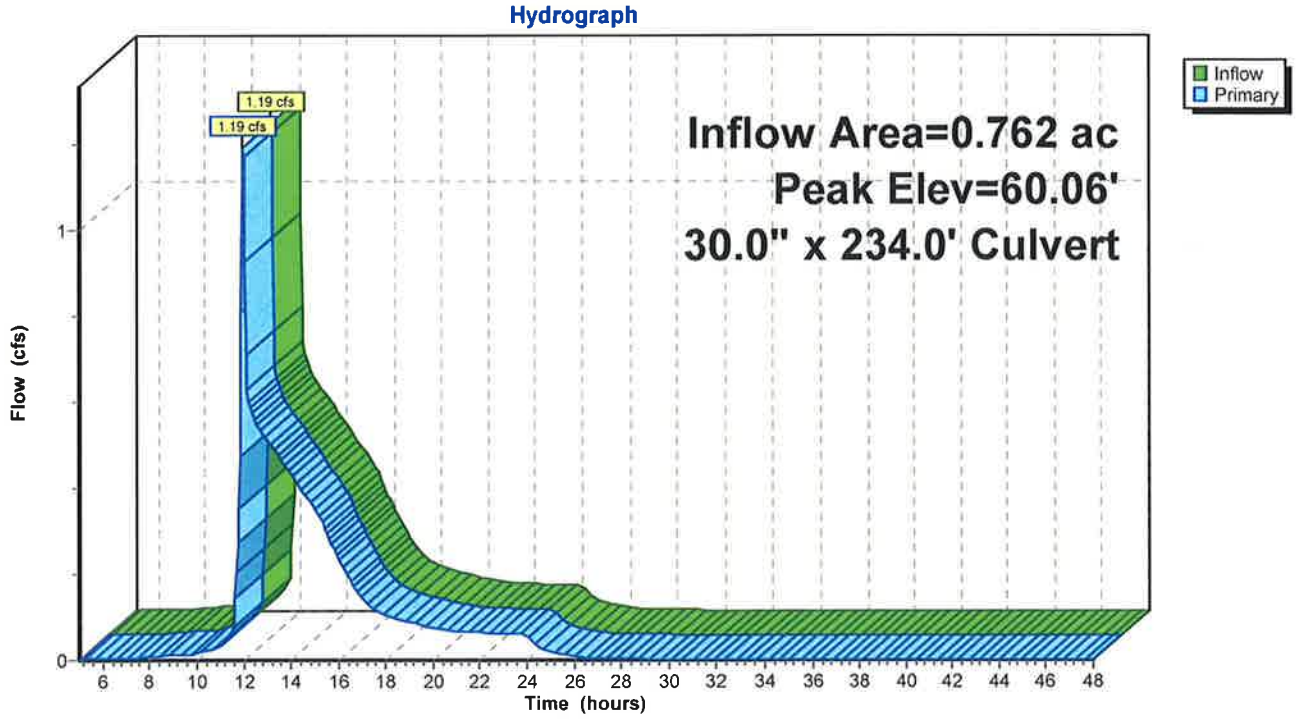
Inflow Area =	0.762 ac,	Inflow Depth =	3.72"	for	Fv event	
Inflow =	1.19 cfs @	11.98 hrs,	Volume=		0.236 af	
Outflow =	1.19 cfs @	11.98 hrs,	Volume=		0.236 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.19 cfs @	11.98 hrs,	Volume=		0.236 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 60.06' @ 11.98 hrs
Plug-Flow detention time= 0.0 min calculated for 0.236 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (909.2 - 909.2)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=1.16 cfs @ 11.98 hrs HW=60.06' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.16 cfs @ 0.3 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

Inflow Area =	0.680 ac,	Inflow Depth =	4.12"	for Fv event	
Inflow =	4.82 cfs @	11.97 hrs,	Volume=	0.234 af	
Outflow =	0.49 cfs @	12.45 hrs,	Volume=	0.193 af,	Atten= 90%, Lag= 28.4 min
Primary =	0.49 cfs @	12.45 hrs,	Volume=	0.193 af	
Secondary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 62.78' @ 12.45 hrs Surf.Area= 1,250 sf Storage= 4,911 cf
Plug-Flow detention time= 185.6 min calculated for 0.193 af (83% of inflow)
Center-of-Mass det. time= 108.9 min (936.9 - 827.9)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,261 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	1,225 cf	**25.00'W x 50.00'L x 2.45'H Prismatoid**
			3,063 cf Overall x 40.0% Voids
		6,486 cf	Total Available Storage

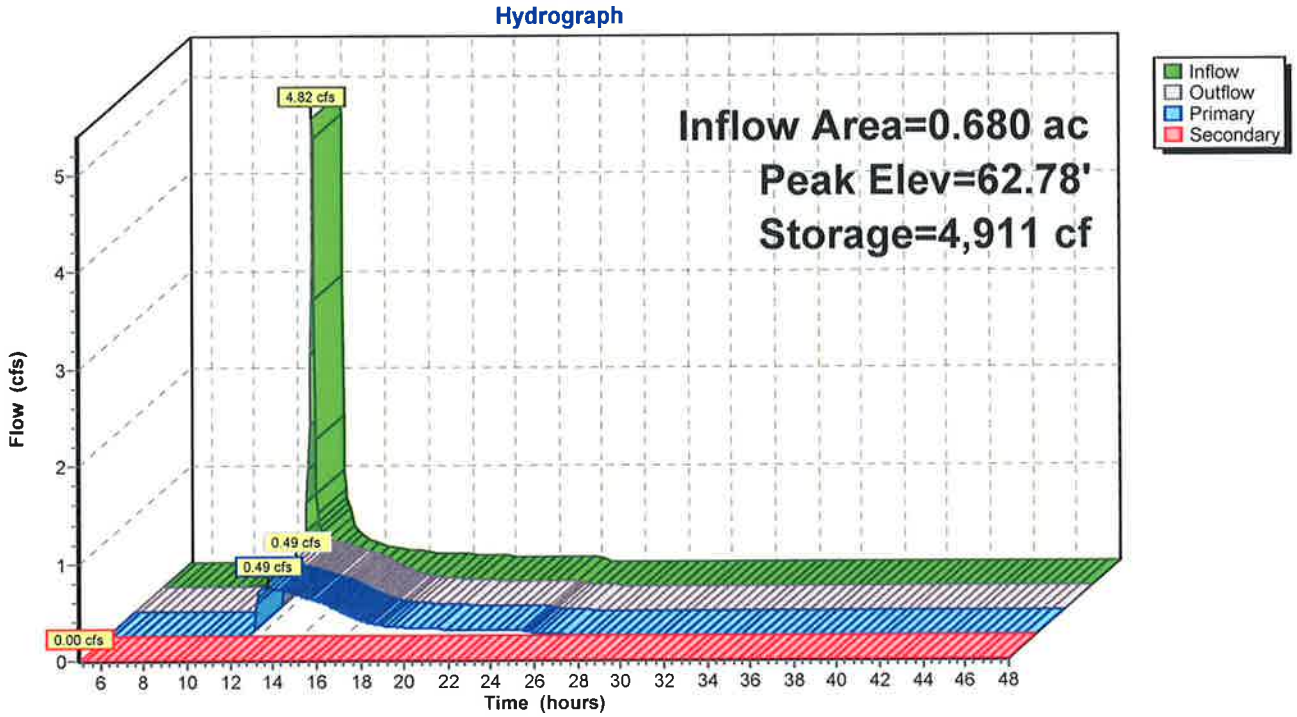
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	1,250	117.0	0	0	1,250
62.00	1,776	165.0	1,656	1,656	2,338
63.00	3,542	357.0	2,609	4,265	10,318
63.25	4,446	410.0	996	5,261	13,554

#	Routing	Invert	Outlet Devices
1	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500
			Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
2	Device 1	61.25'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Device 1	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
4	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
			Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.49 cfs @ 12.45 hrs HW=62.78' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.49 cfs of 9.74 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.49 cfs @ 5.6 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=58.45' TW=57.58' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

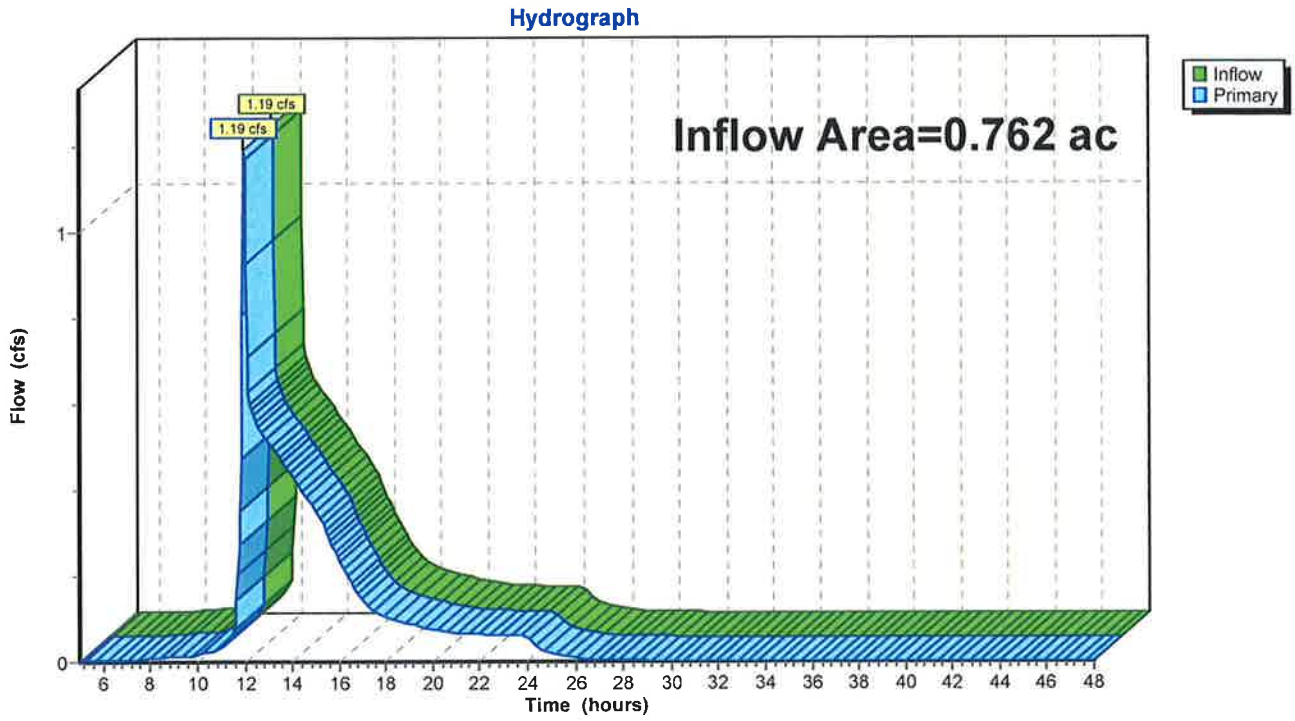
[80] Warning: Exceeded Pond 1P by 2.48' @ 5.00 hrs (26.43 cfs)

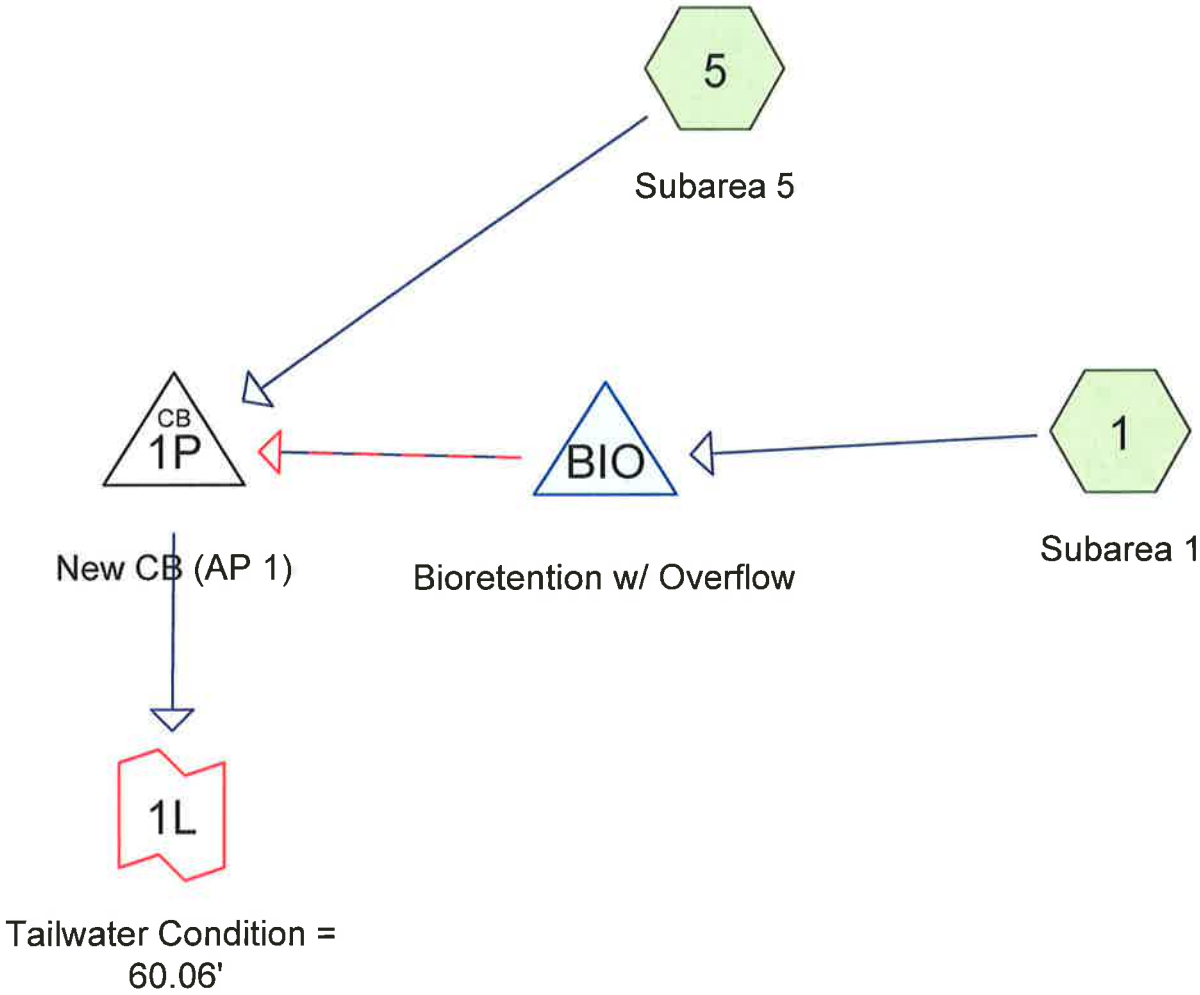
Inflow Area =	0.762 ac,	Inflow Depth =	3.72"	for	Fv event
Inflow =	1.19 cfs @	11.98 hrs,	Volume=	0.236 af	
Primary =	1.19 cfs @	11.98 hrs,	Volume=	0.236 af,	Atten= 0%, Lag= 0.0 min

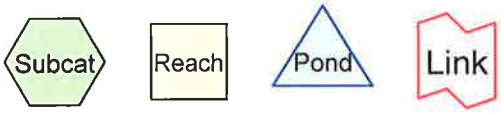
Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'







Drainage Diagram for Example Commercial Site New DURMM whole site adj Cv RCN
Prepared by {enter your company name here} 8/30/2011
HydroCAD® 7.00 s/n 002959 © 1986-2003 Applied Microcomputer Systems

Effective April 2016

Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=0.680 ac Runoff Depth=0.77"
Tc=6.0 min CN=53 Runoff=0.78 cfs 0.044 af

Subcatchment 5: Subarea 5 Runoff Area=0.082 ac Runoff Depth=3.18"
Tc=6.0 min CN=85 Runoff=0.44 cfs 0.022 af

Pond 1P: New CB (AP 1) Peak Elev=60.06' Inflow=0.44 cfs 0.025 af
30.0" x 234.0' Culvert Outflow=0.44 cfs 0.025 af

Pond BIO: Bioretention w/ Overflow Peak Elev=61.32' Storage=1,854 cf Inflow=0.78 cfs 0.044 af
Primary=0.01 cfs 0.003 af Secondary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.003 af

Link 1L: Tailwater Condition = 60.06' Inflow=0.44 cfs 0.025 af
Primary=0.44 cfs 0.025 af

Total Runoff Area = 0.762 ac Runoff Volume = 0.065 af Average Runoff Depth = 1.03"

Subcatchment1: Subarea 1

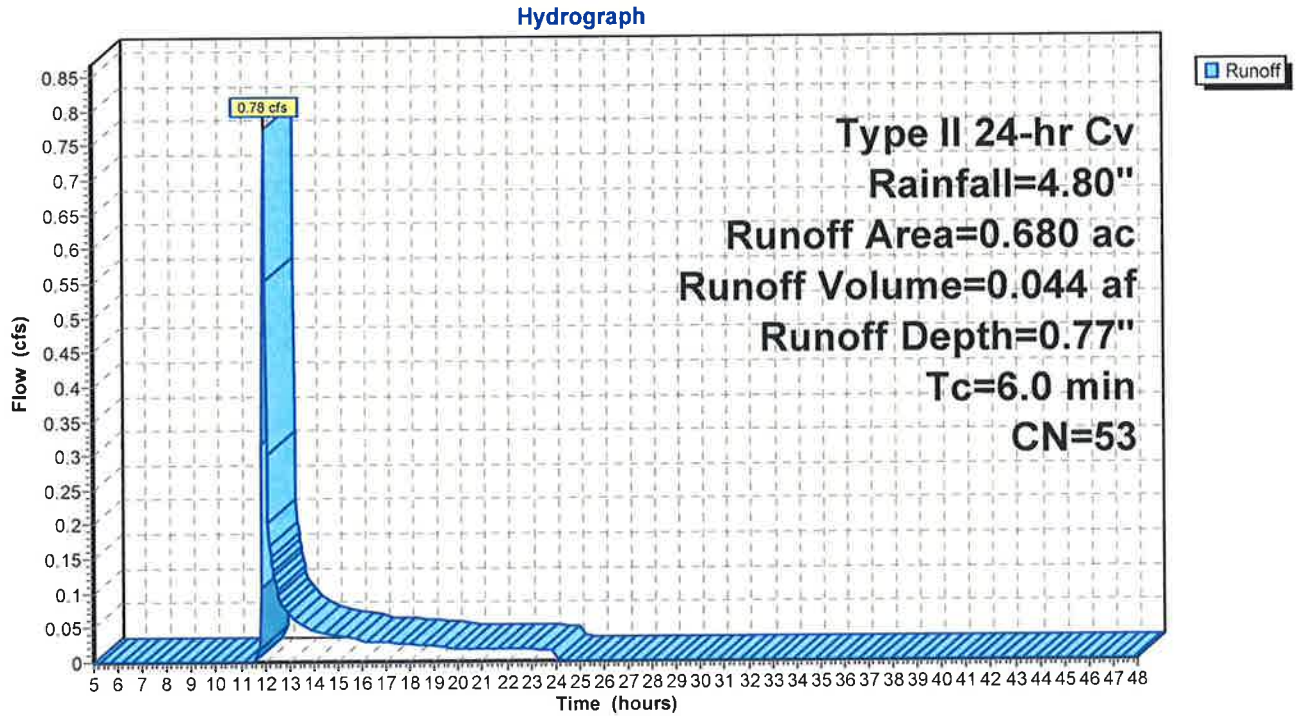
Runoff = 0.78 cfs @ 11.99 hrs, Volume= 0.044 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr Cv Rainfall=4.80"

Area (ac)	CN	Description
0.680	53	Adjusted Cv RCN

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

Subcatchment1: Subarea 1



Subcatchment 5: Subarea 5

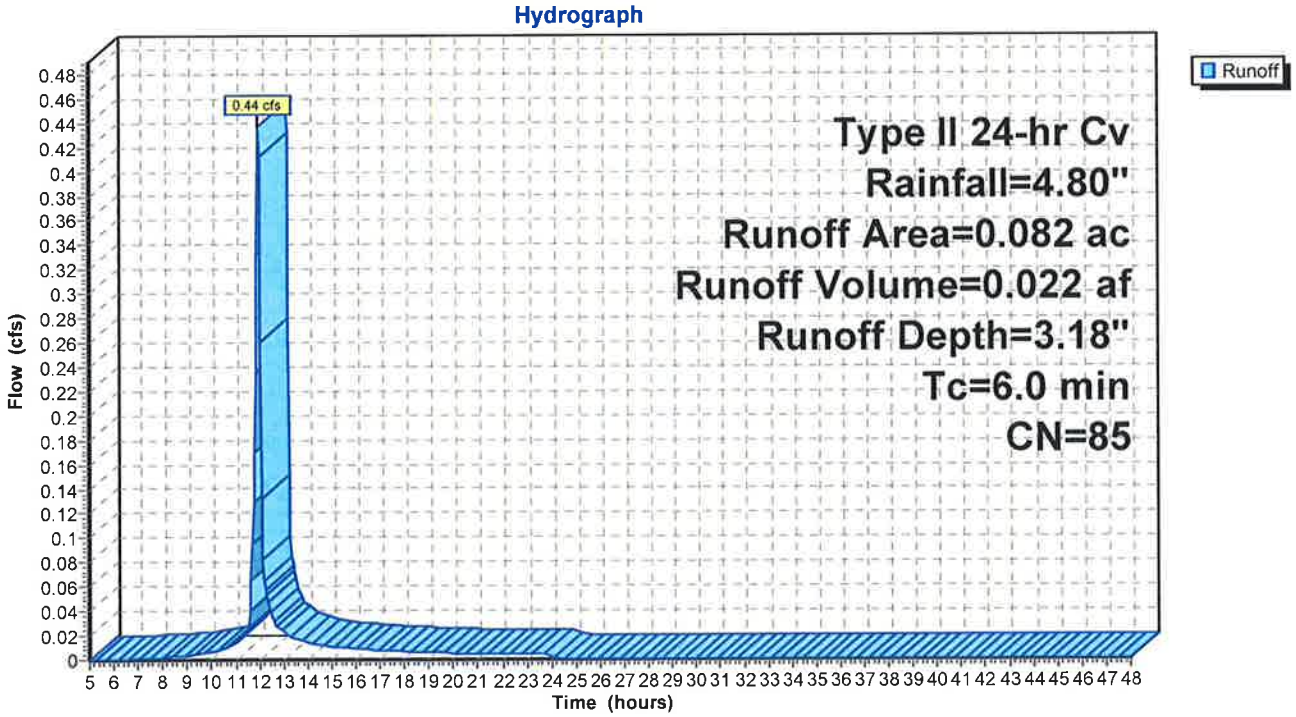
Runoff = 0.44 cfs @ 11.97 hrs, Volume= 0.022 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr Cv Rainfall=4.80"

Area (ac)	CN	Description
0.082	85	Adjusted Cv RCN

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

Subcatchment 5: Subarea 5



Pond 1P: New CB (AP 1)

[57] Hint: Peaked at 60.06' (Flood elevation advised)

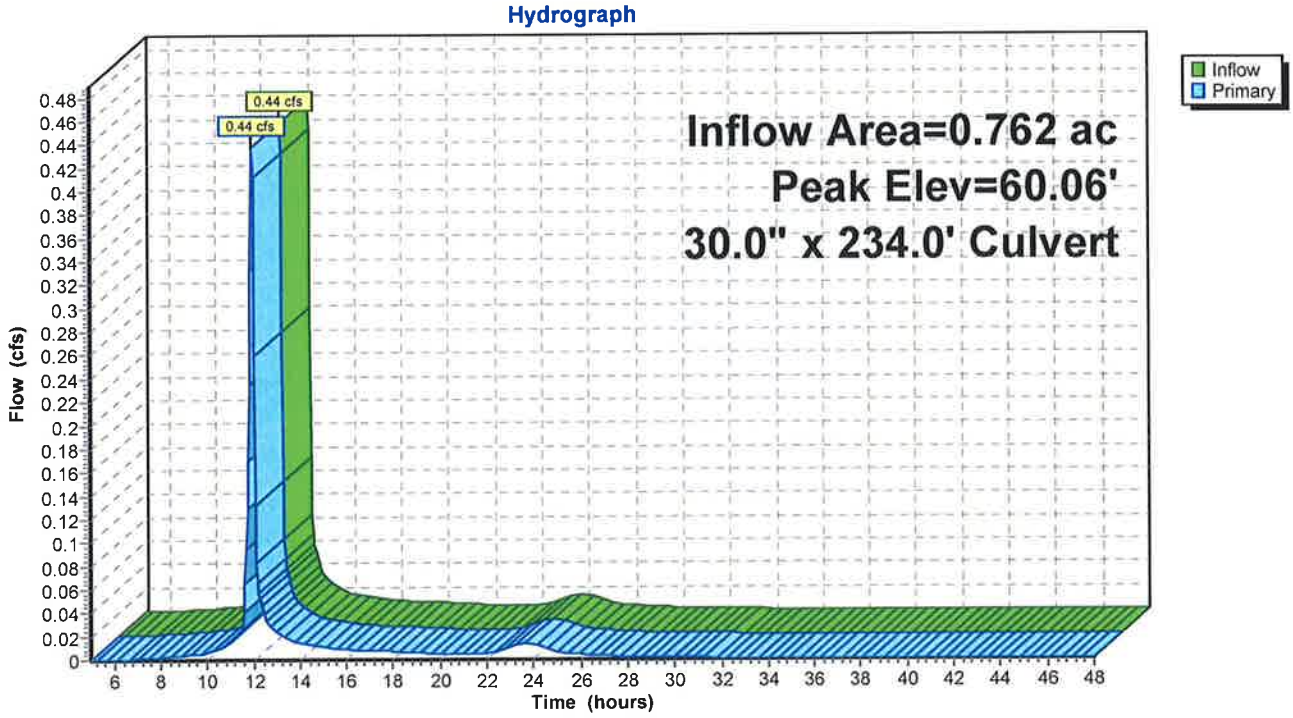
Inflow Area =	0.762 ac,	Inflow Depth =	0.39"	for	Cv event	
Inflow =	0.44 cfs @	11.97 hrs,	Volume=		0.025 af	
Outflow =	0.44 cfs @	11.97 hrs,	Volume=		0.025 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.44 cfs @	11.97 hrs,	Volume=		0.025 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 60.06' @ 11.97 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated)

#	Routing	Invert	Outlet Devices
1	Primary	57.56'	**30.0" x 234.0' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 55.76' S= 0.0077 '/' n= 0.012 Cc= 0.900

Primary OutFlow Max=0.42 cfs @ 11.97 hrs HW=60.06' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.42 cfs @ 0.1 fps)

Pond 1P: New CB (AP 1)



Pond BIO: Bioretention w/ Overflow

Inflow Area =	0.680 ac,	Inflow Depth =	0.77"	for Cv event	
Inflow =	0.78 cfs @	11.99 hrs,	Volume=	0.044 af	
Outflow =	0.01 cfs @	24.06 hrs,	Volume=	0.003 af,	Atten= 99%, Lag= 724.0 min
Primary =	0.01 cfs @	24.06 hrs,	Volume=	0.003 af	
Secondary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 61.32' @ 24.06 hrs Surf.Area= 1,250 sf Storage= 1,854 cf
Plug-Flow detention time= 875.6 min calculated for 0.003 af (7% of inflow)
Center-of-Mass det. time= 687.0 min (1,590.3 - 903.3)

#	Invert	Avail.Storage	Storage Description
1	60.90'	5,261 cf	**Custom Stage Data (Irregular)** Listed below -Impervious
2	58.45'	1,225 cf	**25.00'W x 50.00'L x 2.45'H Prismatoid**
			3,063 cf Overall x 40.0% Voids
		6,486 cf	Total Available Storage

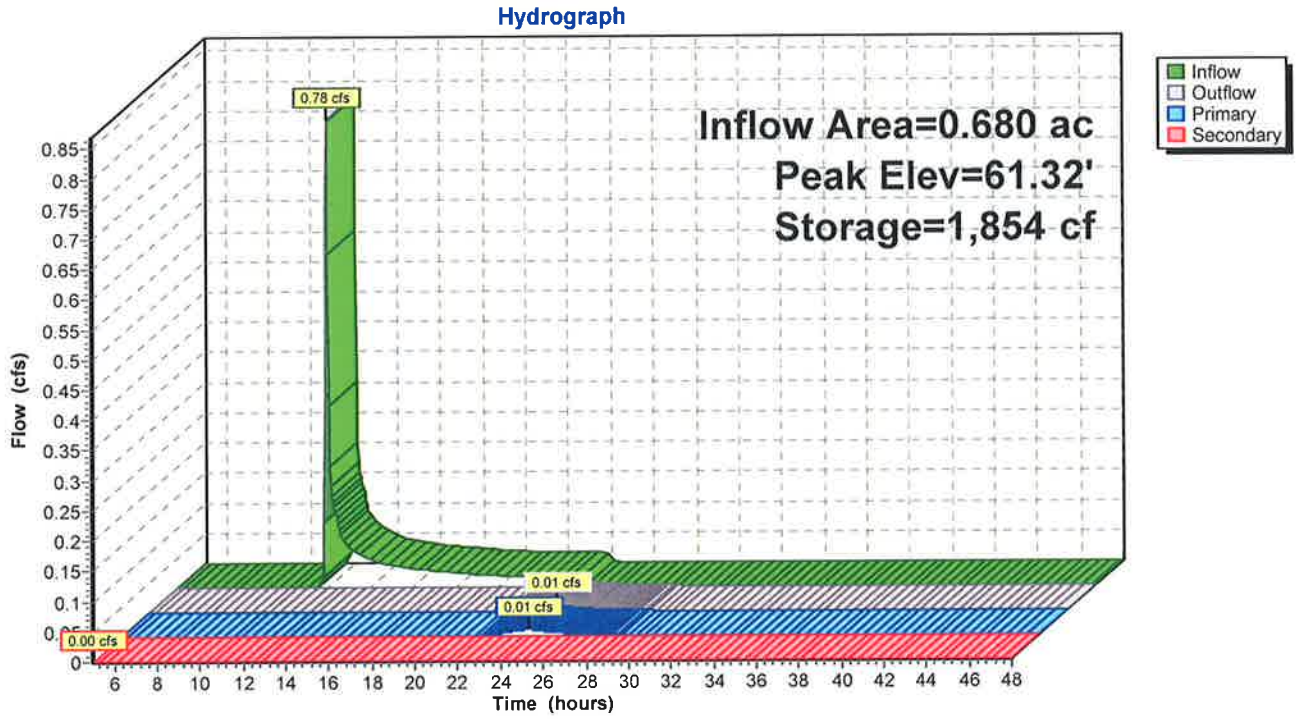
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.90	1,250	117.0	0	0	1,250
62.00	1,776	165.0	1,656	1,656	2,338
63.00	3,542	357.0	2,609	4,265	10,318
63.25	4,446	410.0	996	5,261	13,554

#	Routing	Invert	Outlet Devices
1	Primary	57.72'	**15.0" x 43.0' long Culvert** RCP, square edge headwall, Ke= 0.500
			Outlet Invert= 57.56' S= 0.0037 '/' n= 0.012 Cc= 0.900
2	Device 1	61.25'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Device 1	63.11'	**1.50' x 2.83' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
4	Secondary	63.25'	**10.0' long x 6.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
			Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.01 cfs @ 24.06 hrs HW=61.32' TW=60.06' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.01 cfs of 6.63 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.9 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=58.45' TW=57.56' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond BIO: Bioretention w/ Overflow



Link 1L: Tailwater Condition = 60.06'

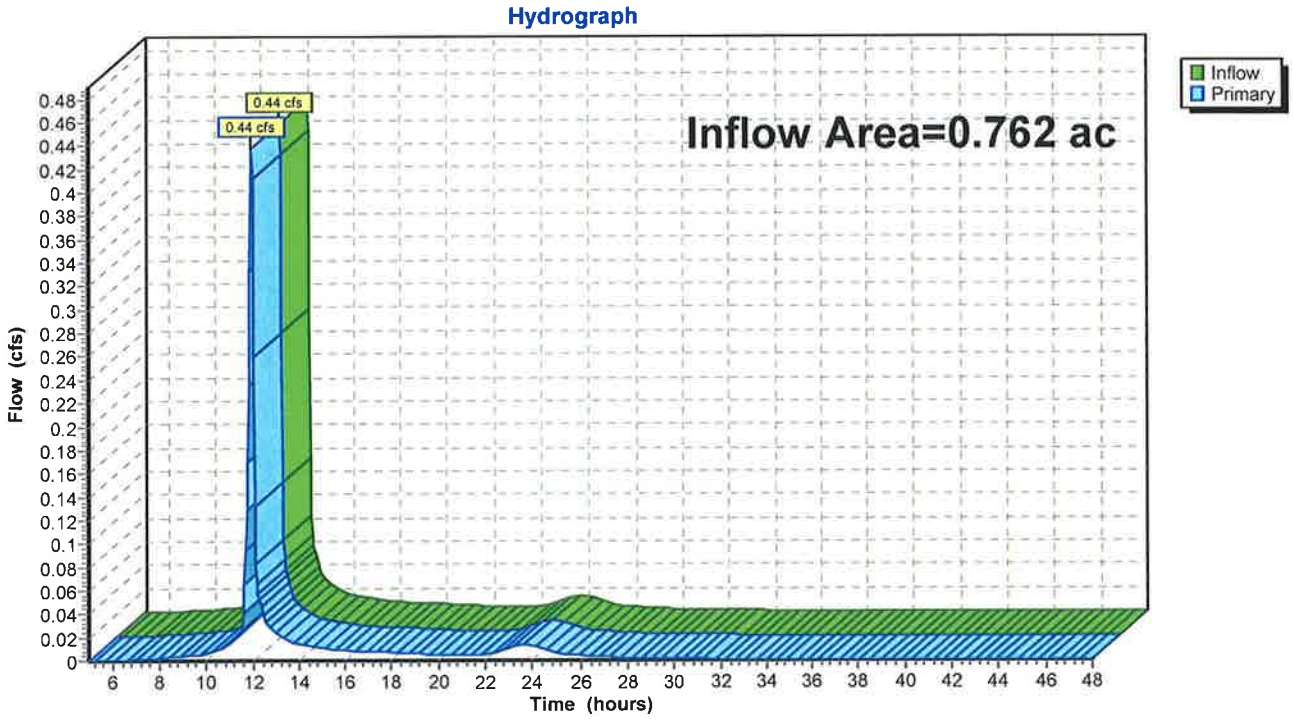
[80] Warning: Exceeded Pond 1P by 2.50' @ 5.00 hrs (26.43 cfs)

Inflow Area =	0.762 ac,	Inflow Depth =	0.39"	for	Cv event	
Inflow =	0.44 cfs @	11.97 hrs,	Volume=		0.025 af	
Primary =	0.44 cfs @	11.97 hrs,	Volume=		0.025 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Fixed water surface elevation= 60.06'

Link 1L: Tailwater Condition = 60.06'



Appendix 7

Checklist

Preliminary Sediment & Stormwater Management Plan Review Checklist

DATE RECEIVED: _____ **PROJECT NUMBER:** 0493

PROJECT NAME: Example Plan - Commercial Site

General Information:

1. _____ Completed application signed by the owner, review fee, one set of plans and reports, and a completed checklist must be submitted for review. Electronic plan and report program files (i.e., AutoCAD, Microstation, DURMM, HydroCAD, and/or equal/similar) shall be transmitted upon agency request.
2. _____ Provide a copy of the notice to DelDOT, a municipality, or a private entity (i.e., neighboring Homeowner's Association) for the intent to discharge or connect to their stormwater system. The notice shall indicate the proposed condition and that any comments regarding the discharge shall be returned within 30 calendar days, and if no comments are received than consent to discharge is assumed. If directly copied on the notice, indicate the date of the notice and the reviewer copied: _____.
3. ✓ Hydraulic and Hydrology computations shall reflect the proposed site conditions.
4. ✓ All plans should be submitted on 24" x 36" (minimum) sheets unless otherwise approved.
5. N/A When two (2) or more sheets are used to illustrate the plan view, an index sheet is required, illustrating the entire project on one (1) 24" x 36" (minimum) sheet.
6. ✓ Provide a north arrow on all plans.
7. ✓ Provide all plan views to a defined scale with a scale bar.
8. ✓ Provide names of adjacent property owners on all plans.
9. ✓ Provide existing and proposed contours (if provided) based on NAVD 88 vertical datum at one (1) foot intervals (2 foot intervals can be provided for offsite drainage information based on the latest Lidar information).
10. N/A For small projects less than ½ acre of disturbance, provide existing and proposed spot elevations based on NAVD 88 vertical datum on a fifty-foot grid system. Include high and low points.
11. ✓ Locate the site in NAD83 horizontal datum.
12. _____ Provide the contact information for the person or entity responsible for preparing the plans and report, including name, company, address and telephone number. Locate on both the plans and report.
13. _____ Provide the seal of a Licensed Professional in the State of Delaware on all submitted plans and reports.
14. _____ Provide the Preliminary Sediment and Stormwater Management plans in the following order and title. The sheet list is to appear on the Coversheet, and on each plan sheet shall be respectively titled (include the title of the plan within the title block or lower righthand corner of the sheet):
    a. _____ Coversheet
    b. _____ Schematic Pre-Construction Site Stormwater Management Plan
    c. _____ Schematic Construction Site Stormwater Management Plan
    d. _____ Contributing Drainage Area Plan
    e. _____ Pre-Limit of Disturbance Drainage Area Plan
    f. _____ Post Limit of Disturbance Drainage Area Plan

Coversheet:

15. _____ Project Header (to duplicate in the title block on each sheet):
    a. _____ Project Name (and Phase, if applicable).
    b. _____ Title of Plan Set: Preliminary Sediment and Stormwater Management Plans
    c. _____ Project Location (including watershed, hundred, town, county, etc., as applicable).
    d. _____ Project tax map identification number(s).
16. ✓ Legend indicating plan symbols and lines, including but not limited to, soils, drainage area information, grading and site information.
17. _____ Provide a vicinity map with a scale either at 1" = ½ mile or 1" = 1 mile, depending on project size, and indicate the site boundary within the map. The map shall be no smaller than 4"x4" in size.
18. _____ Project Notes:
    a. Parcel Data:
        i. _____ Tax Map Number(s)
        ii. _____ PLUS Number (if applicable)
        iii. _____ DNREC Sediment and Stormwater Program [or relevant Delegated Agency] Number
        iv. _____ Site Address (or Nearest Intersecting Street and Distance between)
        v. _____ Latitude and Longitude State Plane coordinates, with approximate geographical location (ie, Benchmark #1, Northeast Site Corner, etc). Provide in degree decimal format.
        vi. _____ Existing Site Area
        vii. _____ Proposed Site Area
        viii. _____ Existing Wetland Area
        ix. _____ Proposed Discharge Location(s)
        x. _____ Proposed Total Limit of Disturbance per Discharge Location
    b. Contact Data:
        i. Owner's Name, Title: _____ Owner _____ Land Developer _____ Designer
        ii. Company/LLC: _____ Owner _____ Land Developer _____ Designer
        iii. Full Street Address: _____ Owner _____ Land Developer _____ Designer
        iv. Phone Number: _____ Owner _____ Land Developer _____ Designer
        v. Fax Number: _____ Owner _____ Land Developer _____ Designer
19. _____ Include a Site Designer Certification that states "I hereby certify that this plan has been prepared under my supervision and to the best of my knowledge complies with the applicable state and local regulations and ordinances." <u>This shall be signed in ink or an original reproducible.</u>
20. _____ Provide a list of all sheets and their corresponding sheet number for all Preliminary Sediment and Stormwater Management Plans.

Schematic Construction Site Stormwater Management Plans:

The purpose of the Schematic Construction Site Stormwater Management Plan is to provide a preliminary design of the site's phasing in relation to the site's existing conditions and it's construction and stormwater facility locations. It will eventually be further developed into the Pre-Construction and Construction Site Stormwater Management Plan for the full plan submittal.

21. _____ Schematic Pre-Construction Site Stormwater Management Plan (if required, as determined at the SAS review meeting):
    a. _____ Include the entire site boundary in an existing conditions plan view (i.e., site boundary, existing contours, wetlands, treelines, existing structures/utilities to remain or to be removed, etc).
    b. _____ Indicate the approximate limit of disturbance per phase of construction. Provide a legend indicating the total disturbed acreage per limit of construction.
    c. _____ Indicate the location of all perimeter controls, stockpile locations, sediment trapping facilities, and other construction stormwater management controls needed for demolition and bulk grading (i.e., silt fence, stabilized construction entrances, temporary swales, sediment basins, etc).
    d. _____ Proposed contours are not required.
    e. _____ Provide a legend indicating the lines and symbols used to define the site and construction stormwater controls.
22. _____ Schematic Construction Site Stormwater Management Plan:
    a. _____ Include the entire site boundary in an existing conditions plan view (i.e., site boundary, existing contours, wetlands, treelines, existing structures to remain, etc).
    b. _____ Include a preliminary site plan view overlaid with the existing conditions. Include all lot and/or building outlines; right-of-ways and/or paved areas (whichever is less constrictive); and proposed stormwater locations including facilities, structures and pipes.
    c. _____ Indicate the approximate limit of disturbance per phase of construction. Provide a legend indicating the total disturbed acreage per limit of construction.
    d. _____ Indicate the location of all construction site stormwater controls, including perimeter controls, sediment controls, water controls, and pollution prevention controls. (i.e., silt fence, stabilized construction entrances, temporary swales, sediment basins, etc).
    e. _____ Proposed contours are not required, but should be included when available. If not flow arrows showing the drainage intent can suffice.
    f. _____ Provide a legend indicating the lines and symbols used to define the site and construction stormwater controls.

Drainage Area Plans:

The drainage area plans shall provide a graphic portrayal of the information that is contained with the DURMM worksheets. Any additional hydraulic or hydrologic computations that are required to show compliance with the *Delaware Sediment and Stormwater Regulations* may require additional drainage area or watershed plans (i.e., to satisfy the Cv and Fv requirements). These plans are not prescribed below, but shall follow similar guidelines, clearly indicate the parameters used within the calculations, and be contained within the plan Sediment and Stormwater Management Plan set.

23. ✓ Contributing Drainage Area Plan
    - a. ✓ Provide a plan correlating to the Contributing Area RCN worksheet (post development model for the entire drainage area) for each subarea (subareas may be combined onto the same sheet, so long as they are clearly distinguishable).
    - b. _____ Provide soils mapping on the plan, using the latest NRCS soil information, with a general description of each soil.
    - c. ✓ Indicate the LOD and the OLOD contributing areas, separated per their respective land cover and soil type classification. Provide the area of each designation.
    - d. _____ Provide a legend indicating the various landuse covers (a hatch shall be provided for each type of landuse).
    - e. _____ Provide a summary table indicating the sub-areas and their respective point of analysis, total area, and RCN.
    - f. ✓ Show the Tc path for the area outside the LOD as used in the OLOD worksheet.
    - g. ✓ Show the Tc path for any other areas that require further analysis using other H&H software.
24. _____ Pre-Limit of Disturbance Drainage Area Plan
    - a. _____ Provide a plan correlating to the Pre LOD information requested in the LOD worksheet (location of woods and meadow condition within the LOD per sub-area prior to disturbance) for each subarea (subareas may be combined onto the same sheet, so long as they are clearly distinguishable).
    - b. _____ Provide soils mapping on the plan, using the latest NRCS soil information, with a general description of each soil.
    - c. _____ Indicate the areas of woods and/or meadow condition per soil type classification. Provide the area of each designation.
    - d. _____ Provide a legend indicating the various landuse covers (a hatch shall be provided for each type of landuse).
    - e. _____ Provide a summary table indicating the sub-areas and their respective point of analysis, total area, and RCN.
25. _____ Post Limit of Disturbance Drainage Area Plan
    - a. _____ Provide a plan correlating to the Post LOD information requested in the LOD worksheet (location of all impervious areas). This should only be done if the LOD and OLOD cannot be shown on the Contributing Area Plan due to sizing.
    - b. _____ Provide soils mapping on plan, using the latest NRCS soil information, with a general description of each soil.
    - c. _____ Indicate the impervious area with the subarea. Provide the area of each designation.
    - d. _____ Provide a legend indicating the various landuse covers (a hatch shall be provided for each type of landuse).
    - e. _____ Provide a summary table indicating the sub-areas and their respective point of analysis, total area, and RCN.

Stormwater Management Report:

26. ✓ Provide information in the report in the following order:
    a. ✓ Coverpage
    b. ✓ Table of Contents
    c. ✓ Site Narrative:
        a. ✓ Introduction
        b. _____ Existing Conditions describing the drainage patterns, landuse(s), and existing features. Include 2007 site aerial, photos of site conditions and at all discharge locations.
        c. ✓ Existing Soils description per the NRCS Web Soil Survey including the hydrologic soil group; and soil testing results from on-site soil testing.
        d. ✓ Post Development Conditions, including summary of the proposed development, the proposed drainage system, indication of why the standards or performance approach was utilized, methods for RPv, Cv, and Fv compliance, requests for waivers and/or offsets, etc.
        e. ✓ Construction Site Conditions, describing methods to prevent sediment and pollution discharge and illicit transportation.
        f. ✓ Conclusion
    d. ✓ DURMM computations
    e. ✓ Additional hydraulic and hydrologic computations, such as pond and discharge pipe/swale routings.
    f. ✓ Supplementary Construction Site computations (i.e., temporary sediment basin design worksheet, anti-seep collar sizing, forebay sizing, etc).
    g. _____ Soil report(s) including boring locations and log reports.
    h. _____ Appendix containing any supplemental information (information previously included within the Stormwater Assessment Study report does not need to be duplicated).
27. ✓ Provide drainage calculations for the RPv, Cv, and Fv events using the latest DURMM model and other approved H&H software as required.
28. ✓ All inputted data must be supported by surveys, Lidar information, photos, aerials, maps, etc. and shall be referenced in the report and/or drainage area plans. Information previously included within the Stormwater Assessment Study submittal is acceptable and does not need to be duplicated.
29. ✓ All hydrologic computations shall be accomplished using the most recent version of USDA, Soil Conservation Service TR-20 or TR-55. The storm duration for computational purposes shall be the 24-hour rainfall event. For projects south of the Chesapeake and Delaware (C&D) Canal, the Delmarva Unit Hydrograph shall be used.
30. ✓ The pre-development condition shall be based off of the 2007 aerial photography provided by the State of Delaware, through the Delaware DataMIL and online GIS mapping. This may not directly correlate to current site conditions if the landuse has changed; however, the 2007 landuse shall be used regardless if more or less conservative than the current landuse.
31. ✓ The pre-development peak discharge rate shall be computed assuming that all land uses in the site to be developed are in good hydrologic conditions.