

**STORMWATER MANAGEMENT  
REPORT  
FOR  
BLOCK 262, LOT 1.03  
DENNIS TOWNSHIP  
CAPE MAY COUNTY, NJ**

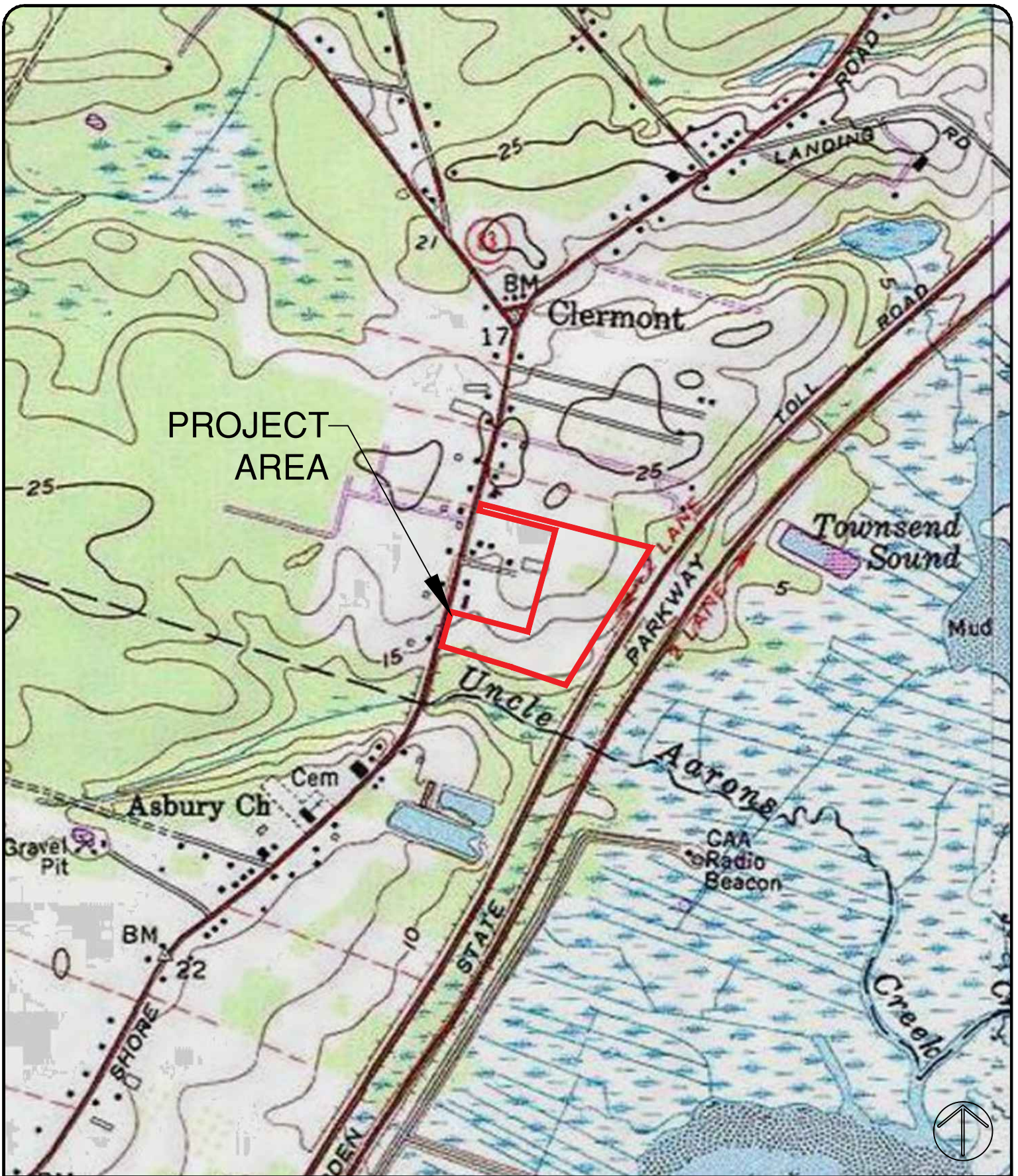
**EDA #9306**

---

**Vincent C. Orlando P.E., P.P., L.L.A.**

**Date  
N.J.P.E. #32498**





U.S.G.S. MAP  
BLOCK 262, LOT 1.03  
TOWNSHIP OF DENNIS, CAPE MAY COUNTY, NJ

DATE: 9/22/2021  
SCALE: 1"=1000'

DRAWN BY: MAJ  
PROJECT #: 9306

**EDA** Engineering  
Design  
Associates, P.A.  
Engineers Environmental Planners Landscape Architects  
CAMBRIDGE PROFESSIONAL OFFICES  
5 Cambridge Drive Ocean View, NJ 08230  
(609) 390-0332 FAX (609) 390-9204





PROJECT  
AREA



TOWNSHIP OF DENNIS AERIAL MAP  
BLOCK 262, LOT 1.03  
TOWNSHIP OF DENNIS, CAPE MAY COUNTY, NJ

DATE: 9/22/2021  
SCALE: 1"=300'

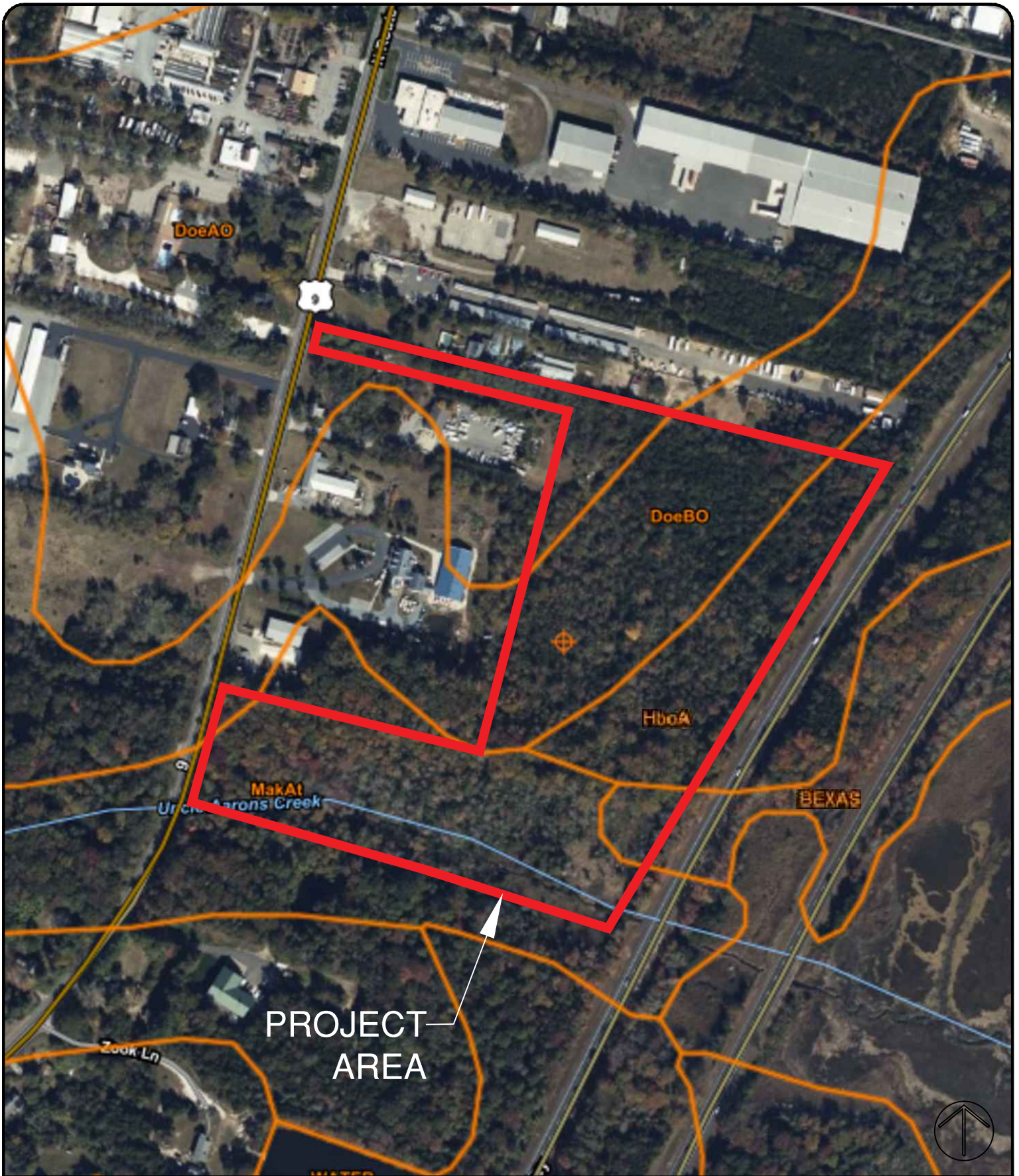
DRAWN BY: MAJ  
PROJECT #: 9306



Engineering  
Design  
Associates, P.A.

Engineers Environmental Planners Landscape Architects  
CAMBRIDGE PROFESSIONAL OFFICES  
5 Cambridge Drive Ocean View, NJ 08230  
(609) 390-0332 FAX (609) 390-9204





CAPE MAY COUNTY SOIL SURVEY MAP  
BLOCK 262, LOT 1.03  
TOWNSHIP OF DENNIS, CAPE MAY COUNTY, NJ

DATE: 9/22/2021  
SCALE: 1"=300'

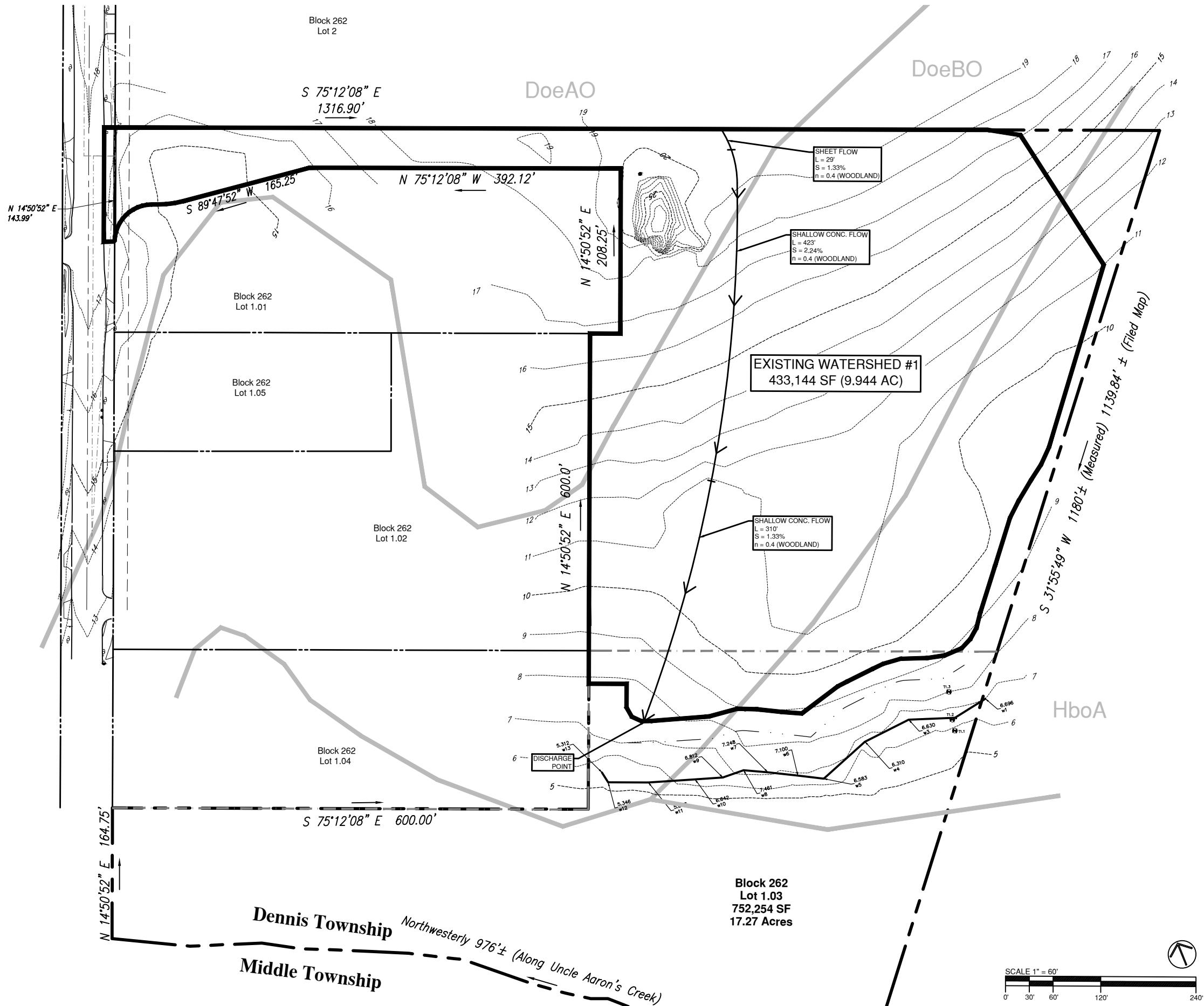
DRAWN BY: MAJ  
PROJECT #: 9306




Engineering  
Design  
Associates, P.A.

Engineers Environmental Planners Landscape Architects  
CAMBRIDGE PROFESSIONAL OFFICES  
5 Cambridge Drive Ocean View, NJ 08230  
(609) 390-0332 FAX (609) 390-9204








Engineering  
Design  
Associates, P.A.  
CAMBRIDGE PROFESSIONAL OFFICES  
5 Cambridge Drive Ocean View New Jersey 08230  
(609) 390-0332 • Fax (609) 390-9204  
certificates of authorization #35272636

**PRE-DEV DRAINAGE MAP**  
BLOCK 262, LOT 1.03  
TOWNSHIP OF DENNIS  
CAPE MAY COUNTY, NEW JERSEY

**VINCENT C. ORLANDO**  
PROFESSIONAL ENGINEER  
N.J.P.E. LIC. #32498

IF THIS PLAN OR DOCUMENT DOES NOT CONTAIN A  
RAISED SEAL IMPRESSION BEARING THE NAME AND  
REGISTRATION NUMBER OF THE ABOVE SIGNED  
PROFESSIONAL, IT MAY NOT BE AN AUTHORIZED  
COPY OF THE ORIGINAL DOCUMENT AND MAY HAVE  
BEEN ALTERED. REPRODUCTION OR FURTHER  
DISSEMINATION OF THE CONTENTS IN WHOLE OR  
IN PART REQUIRES PERMISSION IN WRITING FROM  
ENGINEERING DESIGN ASSOCIATES, P.A.

REVISION	DATE	BY



DATE: 6/8/22

DRAWN BY: MSB

SCALE: 1" = 60'

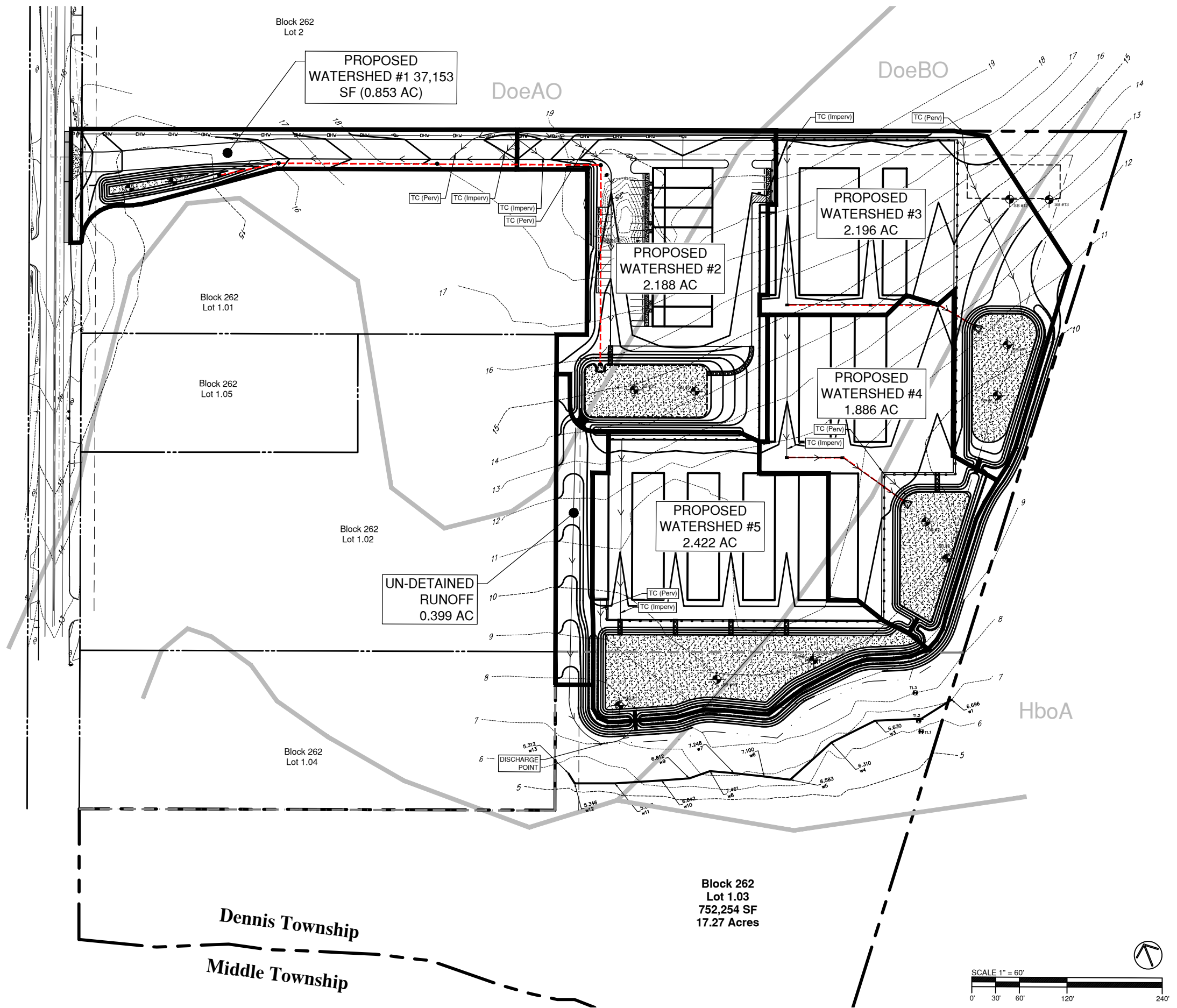
CHECKED BY: VCO

PROJECT #: 9306



# PRE-DEVELOPMENT DRAINAGE MAP





**EDA** Engineering Design Associates, P.A.  
Environmental Planners Landscape Architects  
CAMBRIDGE PROFESSIONAL OFFICES  
100 Newbury Street, Suite 200  
Cambridge, MA 02142  
(609) 390-0332 • Fax (609) 390-3204  
CERTIFICATE OF AUTHORITY: 2506070000

**POST-DEV DRAINAGE MAP**  
BLOCK 262, LOT 1.03  
TOWNSHIP OF DENNIS  
CAPE MAY COUNTY, NEW JERSEY

**VINCENT C. ORLANDO**  
PROFESSIONAL ENGINEER  
N.J.P.E. LIC. #32498

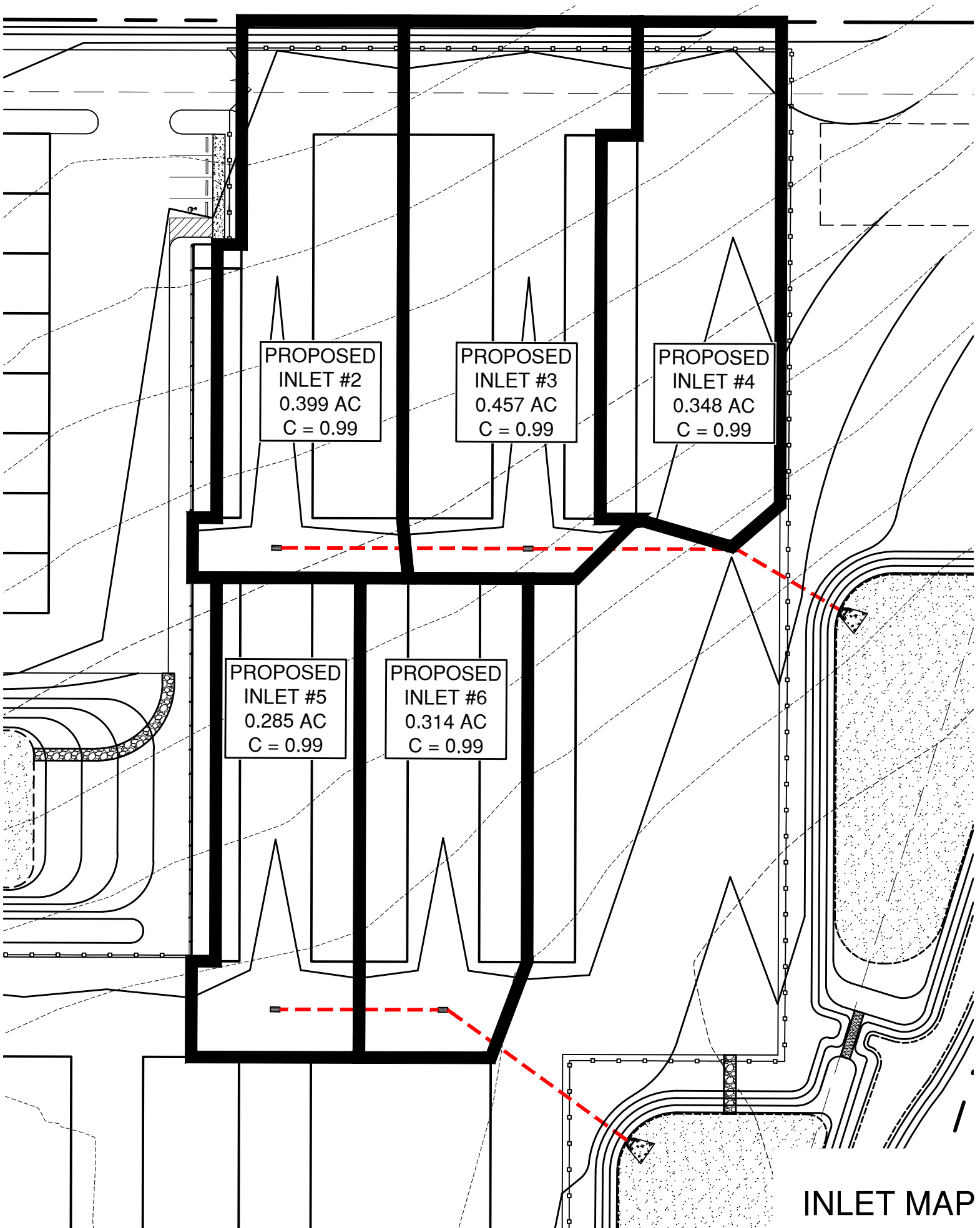
IF THIS PLAN OR DOCUMENT DOES NOT CONTAIN A RAISED SEAL IMPRESSION BEARING THE NAME AND REGISTRATION NUMBER OF THE ABOVE SIGNED PROFESSIONAL, IT MAY NOT BE AN AUTHORIZED COPY OF THE ORIGINAL DOCUMENT AND MAY HAVE BEEN ALTERED. REPRODUCTION OR FURTHER DISSEMINATION OF THE CONTENTS IN WHOLE OR IN PART REQUIRES PERMISSION IN WRITING FROM ENGINEERING DESIGN ASSOCIATES, P.A.

REVISION	DATE	BY

**EDA**

DATE: 6/8/22	DRAWN BY: MSB
SCALE: 1" = 60'	CHECKED BY: VCO
PROJECT #: 9306	





INLET MAP

## STORMWATER MANAGEMENT CALCULATIONS

### Existing Conditions

The project site consists of an area of 9.944 Acres (17.27 Acre lot). The parcel consists of woodland conditions. The soil types for the project site are (DoeAO) Downer Sandy loam 0 to 2% slopes, (DoeBO) Downer Sandy loam, 2 to 5% slopes, and (HboA) Hammonton Sandy Loam 0 to 2% slopes.

### Drainage Design

The project site consists of one (1) watershed area:

Existing Watershed #1 consists of woodland conditions. This watershed consists of all disturbed area of disturbance for the project site. The watershed drains in a south towards the existing wetlands on the south portion of the site. Ultimately the site drains into Uncle Aaron's Creek along the property line. There are five (5) proposed small-scale infiltration stormwater basins within this watershed.

### **Post Development Design Storm Groundwater Recharge (See attached Groundwater Recharge Spreadsheet)**

- Total Storage Required: 3,392 CF
- Total Storage Available: 134,789 CF

#### Basin Schedule to Discharge Elevation

Basin #1	3,719 CF (Elev. 13.00)
Basin #2	30,224 CF (Elev. 13.00)
Basin #3	24,314 CF (Elev. 10.80)
Basin #4	23,323 CF (Elev. 10.80)
Basin #5	53,209 CF (Elev. 11.00)

### Meteorological Data

(New Jersey 24 Hour Rainfall Frequency Data – Dennis Township)

2-Year	3.31 Inches
10-Year	5.16 Inches
100- Year	8.90 Inches

### **Pre-Development Conditions – Existing Watershed #1 – 9.944 Acres**

<u>Cover Type</u>	<u>CN Value</u>	<u>Area</u>
Woodland - A	30	7.752 Acres
Woodland - B	55	2.192 Acres

TC = 27.3 Minutes



<u>Design Storm</u>	<u>Pre-Development Peak Inflow</u>	<u>Pre-Development Peak Outflow</u>
2-YR	0.00 CFS	0.00 CFS
10-YR	0.16 CFS	0.16 CFS
100-YR	3.84 CFS	3.84 CFS

#### Pre-Development Flows at Discharge Point (DP)

<u>Design Storm</u>	<u>Pre-Development Peak Inflow</u>	<u>Pre-Development Peak Outflow at DC Point #1</u>
2-YR	0.00 CFS	0.00 CFS
10-YR	0.16 CFS	0.16 CFS
100-YR	3.84 CFS	3.84 CFS

#### Post-Development Runoff – Watershed #1 – 0.853 Acres

<u>Cover Type</u>	<u>CN Value</u>	<u>Area</u>
Impervious	98	0.326 Acres
Grass/Landscaping - A	39	0.527 Acres

TC (Pervious) = 11.10 Minutes; TC (Impervious) = 3.3 Minutes

<u>Design Storm</u>	<u>Post-Development Peak Inflow</u>	<u>Post-Development Routed Peak Outflow Basin #1</u>
2-YR	1.08 CFS	0.00 CFS
10-YR	1.69 CFS	0.34 CFS
100-YR	3.15 CFS	2.14 CFS

#### Post-Development Runoff – Watershed #2 – 2.188 Acres

<u>Cover Type</u>	<u>CN Value</u>	<u>Area</u>
Grass/Landscaping - A	39	1.010 Acres
Impervious	98	1.178 Acres

TC (Pervious) = 11.0 Minutes; TC (Impervious) = 3.0 Minutes

<u>Design Storm</u>	<u>Post-Development Peak Inflow</u>	<u>Post-Development Routed Peak Outflow Basin #2</u>
2-YR	3.98 CFS	0.00 CFS
10-YR	6.25 CFS	0.00 CFS
100-YR	13.30 CFS	2.66 CFS

**Post-Development Runoff – Watershed #3 – 2.196 Acres**

<u>Cover Type</u>	<u>CN Value</u>	<u>Area</u>
Grass/Landscaping - A	39	0.374 Acres
Grass/Landscaping - B	61	0.674 Acres
Impervious	98	1.148 Acres

TC (Pervious) = 6.6 Minutes; TC (Impervious) = 2.9 Minutes

<u>Design Storm</u>	<u>Post-Development Peak Inflow</u>	<u>Post-Development Routed Peak Outflow Basin #3</u>
2-YR	3.91 CFS	0.00 CFS
10-YR	6.68 CFS	0.00 CFS
100-YR	13.31 CFS	2.12 CFS

**Post-Development Runoff – Watershed #4 – 1.886 Acres**

<u>Cover Type</u>	<u>CN Value</u>	<u>Area</u>
Grass/Landscaping - B	61	0.509 Acres
Impervious	98	1.377 Acres

TC (Pervious) = 6.1 Minutes; TC (Impervious) = 2.5 Minutes

<u>Design Storm</u>	<u>Post-Development Peak Inflow</u>	<u>Post-Development Routed Peak Outflow Basin #4</u>
2-YR	4.95 CFS	0.00 CFS
10-YR	8.17 CFS	0.14 CFS
100-YR	15.00 CFS	4.29 CFS



### **Post-Development Runoff – Watershed #5 – 2.422 Acres**

<b><u>Cover Type</u></b>	<b><u>CN Value</u></b>	<b><u>Area</u></b>
Grass/Landscaping - A	39	0.593 Acres
Grass/Landscaping - B	61	0.369 Acres
Impervious	98	1.460 Acres

TC (Pervious) = 6.9 Minutes; TC (Impervious) = 2.7 Minutes

<b><u>Design Storm</u></b>	<b><u>Post-Development Peak Inflow</u></b>	<b><u>Post-Development Routed Peak Outflow Basin #5</u></b>
2-YR	5.05 CFS	0.00 CFS
10-YR	8.06 CFS	0.00 CFS
100-YR	15.45 CFS	2.11 CFS

### **Post-Development Flows at Discharge Point (DP)**

<b><u>Design Storm</u></b>	<b><u>Pre-Development Peak Flows DC Point #1</u></b>	<b><u>Post-Development Peak Flows DC Point #1</u></b>	
2-YR	0.00 CFS	0.00 CFS	00.00%
10-YR	0.16 CFS	0.02 CFS	12.50%
100-YR	3.84 CFS	3.04 CFS	79.16%

The proposed stormwater storage facilities have been designed to incorporate Green Infrastructure measures by capturing, filtering and infiltrating stormwater to help restore the natural water cycle. Specifically, the stormwater system incorporates grassland areas to provide a simple disconnection of flows and to infiltrate clean runoff close to the initial source.

All of the proposed watershed areas have been created to be less than the 2.50 acre maximum required for small scale structures.

The proposed stormwater storage facility has been designed to release the post-development peak flows for the 2-YR, 10-YR and 100-YR Design Storms below their respective pre-development peak flows.

The proposed stormwater system has been designed to meet the NJDEP Stormwater Management Rules. The Stormwater Management System has been designed to reduce the post-construction load of total suspended solids (TSS) in stormwater runoff generated from the Water Quality Design Storm by 80% utilizing a treatment train of infiltration basins. All water quality storms have been designed to infiltrate into their respective basin (see tables below).

### **Infiltration Basin #1 – Storage Volumes**

<u>Elevation</u>	<u>Storage Volume</u>	
11.00	0 CF	
12.00	1,344 CF	
13.00	3,719 CF	
14.00	7,262 CF	
14.50	9,711 CF	
<u>Elevation</u>		
Water Quality Design Storm.....	11.93	< 13.00 (1 <sup>st</sup> outlet)
2-Year Design Storm .....	12.97	
10-Year Design Storm .....	13.04	
100-Year Design Storm .....	13.25	

### **Infiltration Basin #2 – Storage Volumes**

<u>Elevation</u>	<u>Storage Volume</u>	
10.67	0 CF	
11.00	3,486 CF	
12.00	15,657 CF	
13.00	30,224 CF	
14.00	47,407 CF	
<u>Elevation</u>		
Water Quality Design Storm.....	11.08	< 11.10 (1 <sup>st</sup> outlet)
2-Year Design Storm .....	11.81	
10-Year Design Storm .....	12.63	
100-Year Design Storm .....	12.95	



### Infiltration Basin 3 Storage Volumes

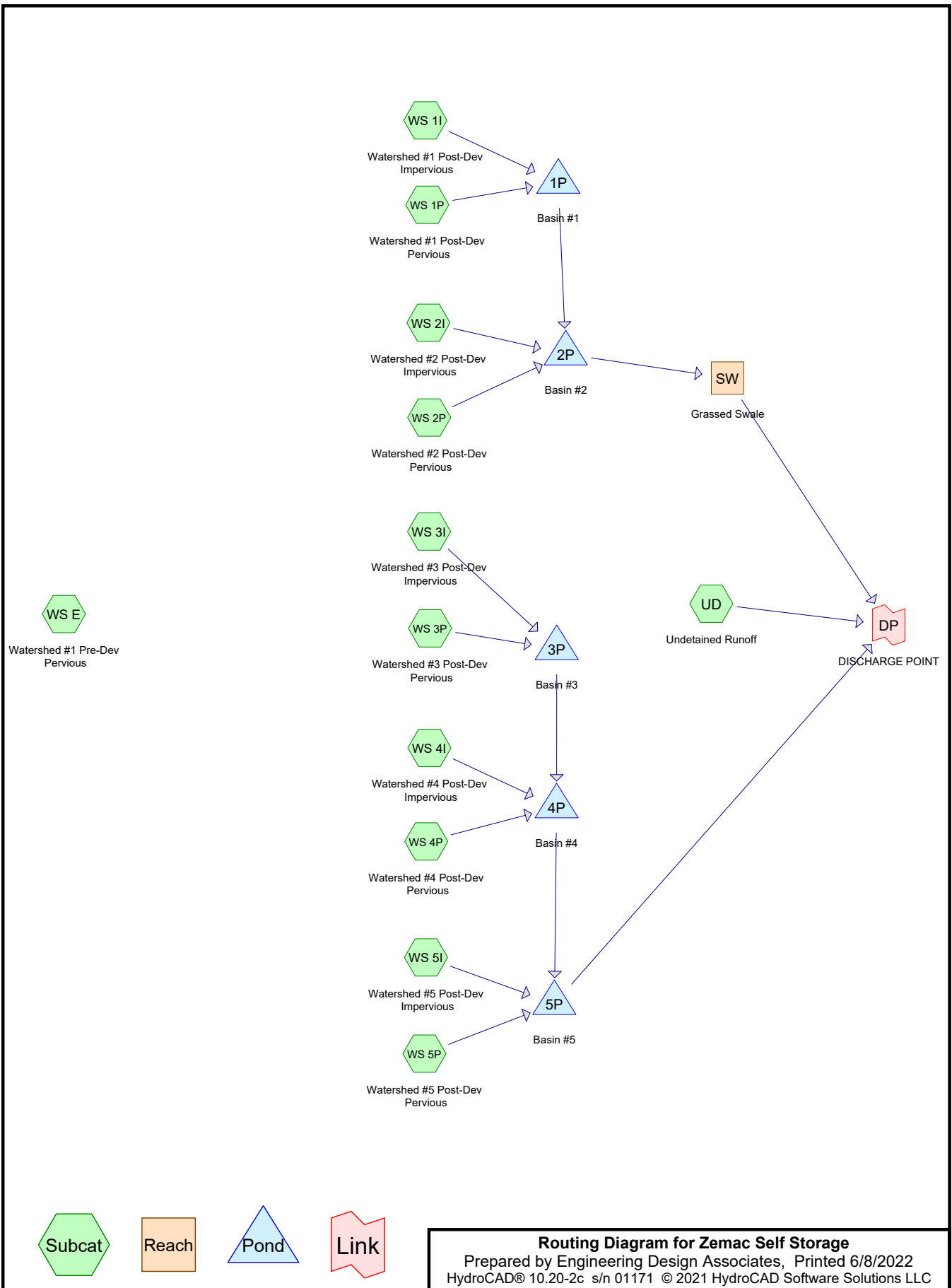
<u>Elevation</u>	<u>Storage Volume</u>	
8.80	0 CF	
9.00	2,097 CF	
10.00	13,838 CF	
11.00	27,084 CF	
12.00	41,842 CF	
<u>Elevation</u>		
Water Quality Design Storm.....	9.20	< 10.80 (1 <sup>st</sup> outlet)
2-Year Design Storm .....	9.99	
10-Year Design Storm .....	10.78	
100-Year Design Storm .....	11.14	

### Infiltration Basin 4 Storage Volumes

<u>Elevation</u>	<u>Storage Volume</u>	
8.80	0 CF	
9.00	2,042 CF	
10.00	13,313 CF	
11.00	25,923 CF	
12.00	39,735 CF	
<u>Elevation</u>		
Water Quality Design Storm.....	9.29	< 10.80 (1 <sup>st</sup> outlet)
2-Year Design Storm .....	10.24	
10-Year Design Storm .....	10.86	
100-Year Design Storm .....	11.34	

**Infiltration Basin 5 Storage Volumes**

<u>Elevation</u>	<u>Storage Volume</u>	
9.00	0 CF	
10.00	25,049 CF	
11.00	53,209 CF	
12.00	84,099 CF	
	<u>Elevation</u>	
Water Quality Design Storm.....	9.23	< 10.80 (1 <sup>st</sup> outlet)
2-Year Design Storm .....	9.68	
10-Year Design Storm .....	10.26	
100-Year Design Storm .....	11.35	





# **PRE-DEVELOPMENT RUNOFF**



**NOAA Atlas 14, Volume 2, Version 3**  
**Location name: Cape May Court House, New Jersey, USA\***  
**Latitude: 39.1464°, Longitude: -74.7621°**  
**Elevation: m/ft\*\***  
 \* source: ESRI Maps  
 \*\* source: USGS



### POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps\\_&\\_aerials](#)

### PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) <sup>1</sup>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.347 (0.312-0.386)	0.405 (0.363-0.448)	0.462 (0.413-0.511)	0.534 (0.478-0.592)	0.601 (0.536-0.667)	0.662 (0.589-0.736)	0.715 (0.633-0.796)	0.765 (0.672-0.854)	0.821 (0.713-0.922)	0.876 (0.754-0.990)
10-min	0.555 (0.498-0.617)	0.647 (0.581-0.716)	0.739 (0.661-0.819)	0.854 (0.764-0.946)	0.958 (0.855-1.06)	1.06 (0.937-1.17)	1.14 (1.01-1.26)	1.21 (1.07-1.35)	1.30 (1.13-1.46)	1.38 (1.19-1.56)
15-min	0.694 (0.622-0.772)	0.814 (0.730-0.901)	0.935 (0.837-1.03)	1.08 (0.966-1.20)	1.22 (1.08-1.35)	1.34 (1.19-1.48)	1.44 (1.27-1.60)	1.53 (1.34-1.71)	1.63 (1.42-1.84)	1.73 (1.49-1.96)
30-min	0.951 (0.853-1.06)	1.12 (1.01-1.24)	1.33 (1.19-1.47)	1.56 (1.40-1.73)	1.80 (1.61-2.00)	2.01 (1.79-2.24)	2.20 (1.95-2.45)	2.38 (2.09-2.66)	2.60 (2.26-2.92)	2.80 (2.41-3.17)
60-min	1.19 (1.06-1.32)	1.41 (1.26-1.56)	1.70 (1.52-1.89)	2.04 (1.82-2.26)	2.40 (2.14-2.66)	2.73 (2.42-3.03)	3.03 (2.68-3.37)	3.34 (2.93-3.73)	3.73 (3.24-4.19)	4.09 (3.52-4.63)
2-hr	1.45 (1.28-1.63)	1.72 (1.53-1.94)	2.09 (1.85-2.35)	2.52 (2.23-2.83)	2.99 (2.63-3.37)	3.43 (3.00-3.87)	3.84 (3.35-4.34)	4.27 (3.69-4.85)	4.81 (4.12-5.50)	5.33 (4.51-6.12)
3-hr	1.59 (1.42-1.80)	1.89 (1.68-2.13)	2.30 (2.04-2.59)	2.78 (2.45-3.13)	3.32 (2.91-3.74)	3.83 (3.34-4.32)	4.32 (3.74-4.88)	4.84 (4.15-5.48)	5.50 (4.66-6.28)	6.14 (5.14-7.04)
6-hr	1.97 (1.75-2.24)	2.33 (2.07-2.64)	2.82 (2.50-3.19)	3.42 (3.02-3.87)	4.11 (3.61-4.66)	4.80 (4.18-5.43)	5.47 (4.73-6.21)	6.19 (5.29-7.05)	7.16 (6.01-8.20)	8.10 (6.70-9.34)
12-hr	2.36 (2.10-2.68)	2.78 (2.49-3.15)	3.38 (3.01-3.82)	4.13 (3.67-4.67)	5.05 (4.45-5.71)	5.98 (5.22-6.77)	6.92 (5.97-7.86)	7.97 (6.77-9.09)	9.42 (7.82-10.8)	10.9 (8.85-12.6)
24-hr	2.72 (2.47-3.03)	3.31 (3.00-3.68)	4.30 (3.89-4.78)	5.16 (4.64-5.72)	6.46 (5.77-7.14)	7.61 (6.75-8.38)	8.90 (7.83-9.78)	10.4 (9.02-11.4)	12.6 (10.8-13.8)	14.5 (12.3-15.9)
2-day	3.13 (2.82-3.48)	3.81 (3.44-4.24)	4.95 (4.46-5.50)	5.93 (5.32-6.57)	7.41 (6.61-8.19)	8.70 (7.71-9.61)	10.1 (8.92-11.2)	11.8 (10.3-13.0)	14.2 (12.2-15.7)	16.4 (13.9-18.0)
3-day	3.29 (3.00-3.63)	4.00 (3.65-4.41)	5.17 (4.71-5.70)	6.18 (5.60-6.79)	7.68 (6.93-8.42)	8.99 (8.06-9.85)	10.4 (9.29-11.4)	12.1 (10.6-13.2)	14.5 (12.6-15.9)	16.7 (14.3-18.2)
4-day	3.45 (3.17-3.77)	4.19 (3.86-4.59)	5.40 (4.96-5.90)	6.43 (5.88-7.01)	7.96 (7.25-8.66)	9.28 (8.40-10.1)	10.8 (9.66-11.7)	12.4 (11.0-13.4)	14.8 (13.0-16.1)	16.9 (14.7-18.4)
7-day	3.99 (3.70-4.35)	4.82 (4.46-5.25)	6.11 (5.65-6.65)	7.20 (6.64-7.83)	8.82 (8.08-9.56)	10.2 (9.30-11.0)	11.7 (10.6-12.7)	13.4 (12.0-14.5)	15.9 (14.1-17.2)	18.0 (15.8-19.5)
10-day	4.48 (4.17-4.84)	5.39 (5.01-5.82)	6.71 (6.24-7.25)	7.81 (7.24-8.43)	9.40 (8.67-10.1)	10.7 (9.85-11.5)	12.2 (11.1-13.1)	13.7 (12.4-14.7)	16.0 (14.4-17.2)	18.1 (16.1-19.5)
20-day	5.99 (5.63-6.39)	7.13 (6.70-7.61)	8.62 (8.09-9.19)	9.83 (9.22-10.5)	11.5 (10.8-12.3)	12.9 (12.0-13.7)	14.3 (13.3-15.2)	15.8 (14.6-16.8)	17.8 (16.3-19.0)	19.4 (17.7-20.7)
30-day	7.49 (7.05-7.94)	8.87 (8.35-9.40)	10.6 (9.95-11.2)	11.9 (11.2-12.6)	13.8 (12.9-14.6)	15.2 (14.3-16.1)	16.7 (15.6-17.7)	18.2 (16.9-19.3)	20.2 (18.7-21.5)	21.8 (20.1-23.2)
45-day	9.47 (8.99-9.98)	11.2 (10.6-11.8)	13.1 (12.4-13.8)	14.6 (13.8-15.3)	16.5 (15.6-17.4)	18.0 (17.0-18.9)	19.4 (18.3-20.4)	20.8 (19.5-21.9)	22.6 (21.1-23.9)	24.0 (22.3-25.3)
60-day	11.3 (10.7-11.8)	13.2 (12.6-13.9)	15.3 (14.6-16.1)	16.9 (16.0-17.7)	18.8 (17.9-19.8)	20.3 (19.2-21.3)	21.7 (20.5-22.8)	23.0 (21.7-24.2)	24.6 (23.2-26.0)	25.8 (24.2-27.2)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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

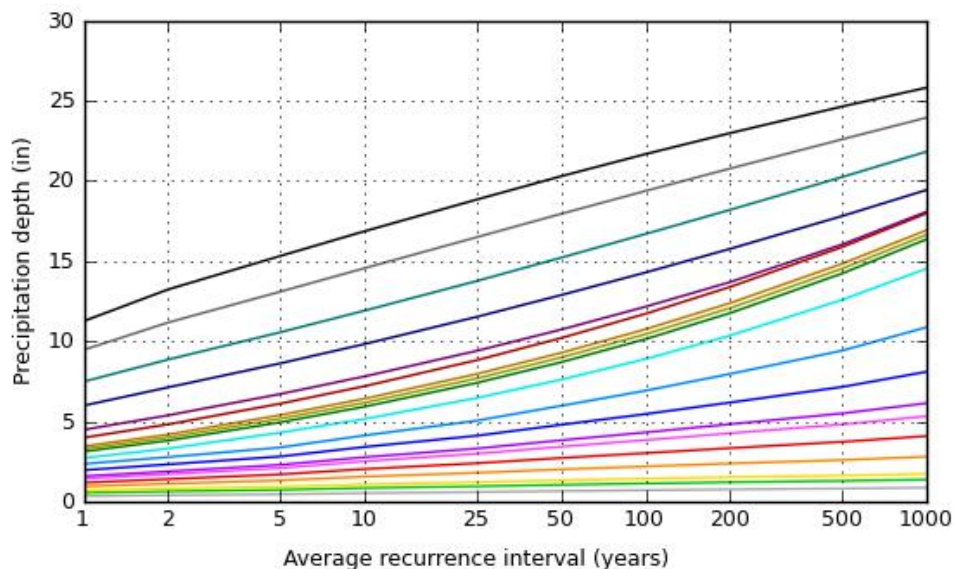
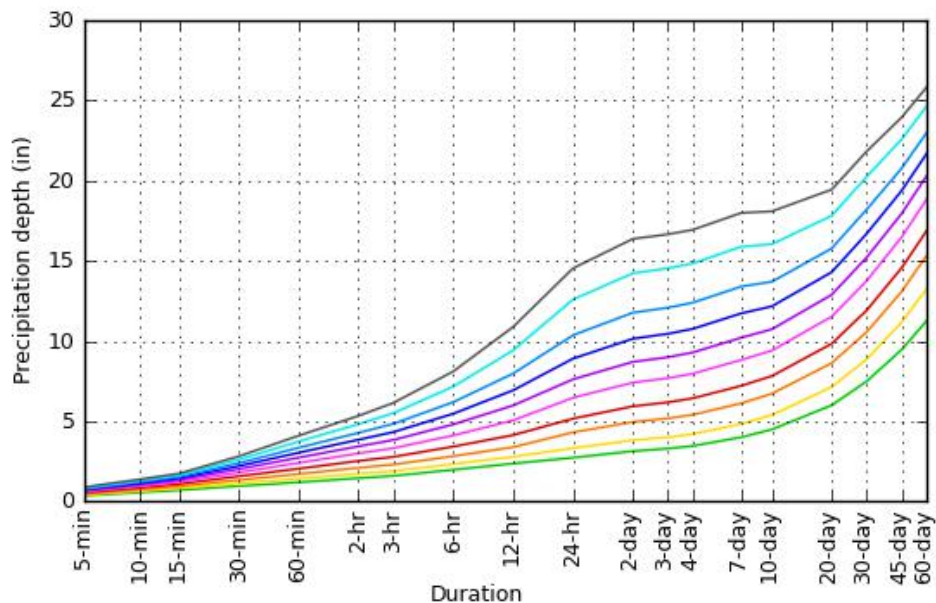
Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

### PF graphical

## PDS-based depth-duration-frequency (DDF) curves

Latitude: 39.1464°, Longitude: -74.7621°



NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Tue Jun 7 15:14:02 2022

[Back to Top](#)**Maps & arials****Small scale terrain**



Large scale terrain



Large scale map



Large scale aerial





[Back to Top](#)

---

[US Department of Commerce](#)  
[National Oceanic and Atmospheric Administration](#)  
[National Weather Service](#)  
[National Water Center](#)  
1325 East West Highway  
Silver Spring, MD 20910  
Questions?: [HDSC.Questions@noaa.gov](mailto:HDSC.Questions@noaa.gov)

[Disclaimer](#)

## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 1

### Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 Year Storm	NOAA 24-hr	C	Default	24.00	1	3.31	2
2	10 Year Storm	NOAA 24-hr	C	Default	24.00	1	5.16	2
3	100 Year Storm	NOAA 24-hr	C	Default	24.00	1	8.90	2
4	WQ	NJ DEP 2-hr		Default	2.00	1	1.25	2

## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 2

### Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
7.752	30	Woods, Good, HSG A (WS E)
2.192	55	Woods, Good, HSG B (WS E)
<b>9.944</b>	<b>36</b>	<b>TOTAL AREA</b>

## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 3

### Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
7.752	HSG A	WS E
2.192	HSG B	WS E
0.000	HSG C	
0.000	HSG D	
0.000	Other	
<b>9.944</b>		<b>TOTAL AREA</b>



## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 4

### Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
7.752	2.192	0.000	0.000	0.000	9.944	Woods, Good	WS E
<b>7.752</b>	<b>2.192</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>9.944</b>	<b>TOTAL</b>	
						<b>AREA</b>	

**Summary for Subcatchment WS E: Watershed #1 Pre-Dev Pervious**

[45] Hint: Runoff=Zero

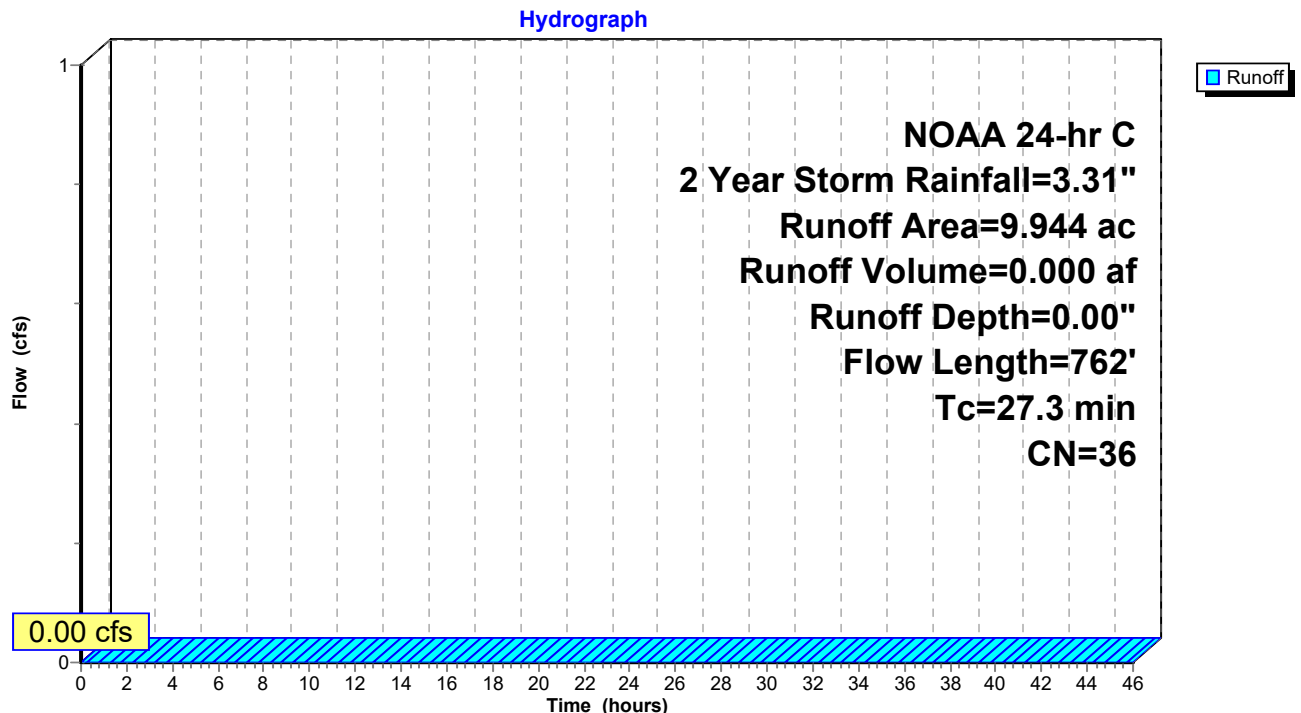
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
* 7.752	30	Woods, Good, HSG A
2.192	55	Woods, Good, HSG B
9.944	36	Weighted Average
9.944		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	29	0.0133	0.05		<b>Sheet Flow, Sheet Flow</b> Woods: Light underbrush n= 0.400 P2= 3.31"
9.1	423	0.0242	0.78		<b>Shallow Concentrated Flow, Shallow Flow Woods</b> Woodland Kv= 5.0 fps
9.0	310	0.0133	0.58		<b>Shallow Concentrated Flow, Shallow Flow Woods</b> Woodland Kv= 5.0 fps
27.3	762	Total			

**Subcatchment WS E: Watershed #1 Pre-Dev Pervious**

**Summary for Subcatchment WS E: Watershed #1 Pre-Dev Pervious**

Runoff = 0.16 cfs @ 14.54 hrs, Volume= 0.110 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 10 Year Storm Rainfall=5.16"

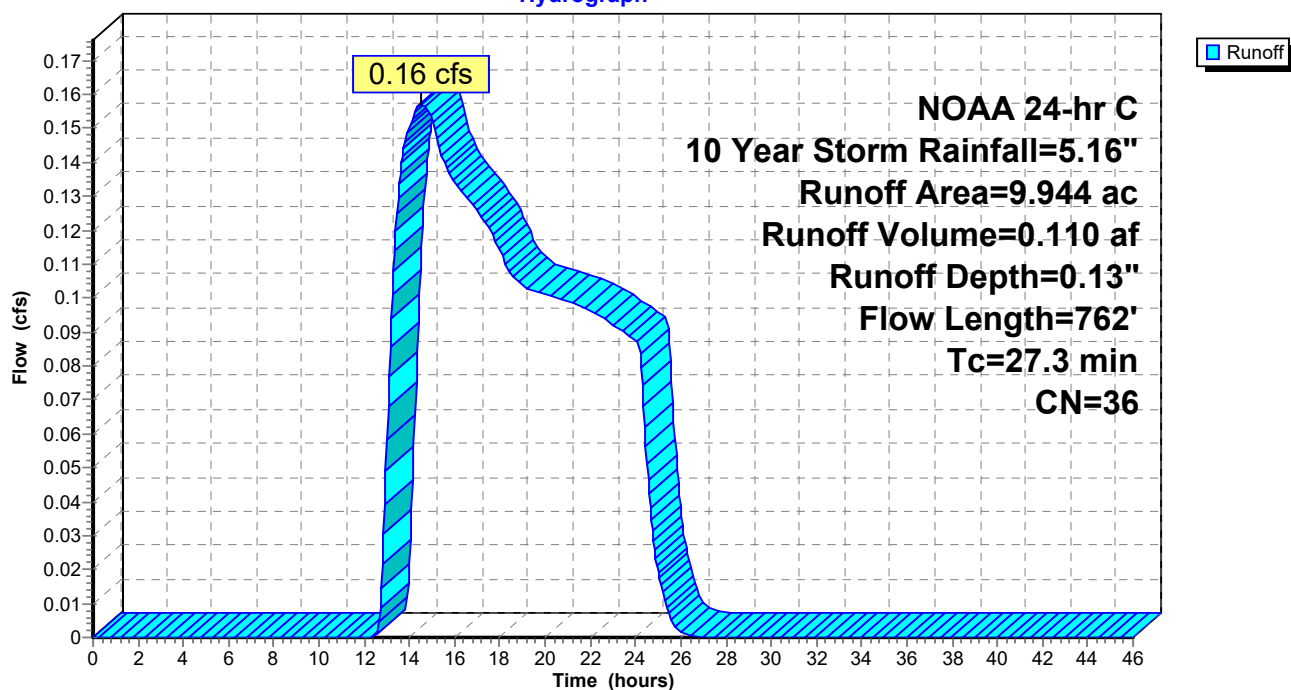
Area (ac)	CN	Description
* 7.752	30	Woods, Good, HSG A
2.192	55	Woods, Good, HSG B
9.944	36	Weighted Average
9.944		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	29	0.0133	0.05		<b>Sheet Flow, Sheet Flow</b>
					Woods: Light underbrush n= 0.400 P2= 3.31"
9.1	423	0.0242	0.78		<b>Shallow Concentrated Flow, Shallow Flow Woods</b>
					Woodland Kv= 5.0 fps
9.0	310	0.0133	0.58		<b>Shallow Concentrated Flow, Shallow Flow Woods</b>
					Woodland Kv= 5.0 fps
27.3	762	Total			

**Subcatchment WS E: Watershed #1 Pre-Dev Pervious**

Hydrograph



**Summary for Subcatchment WS E: Watershed #1 Pre-Dev Pervious**

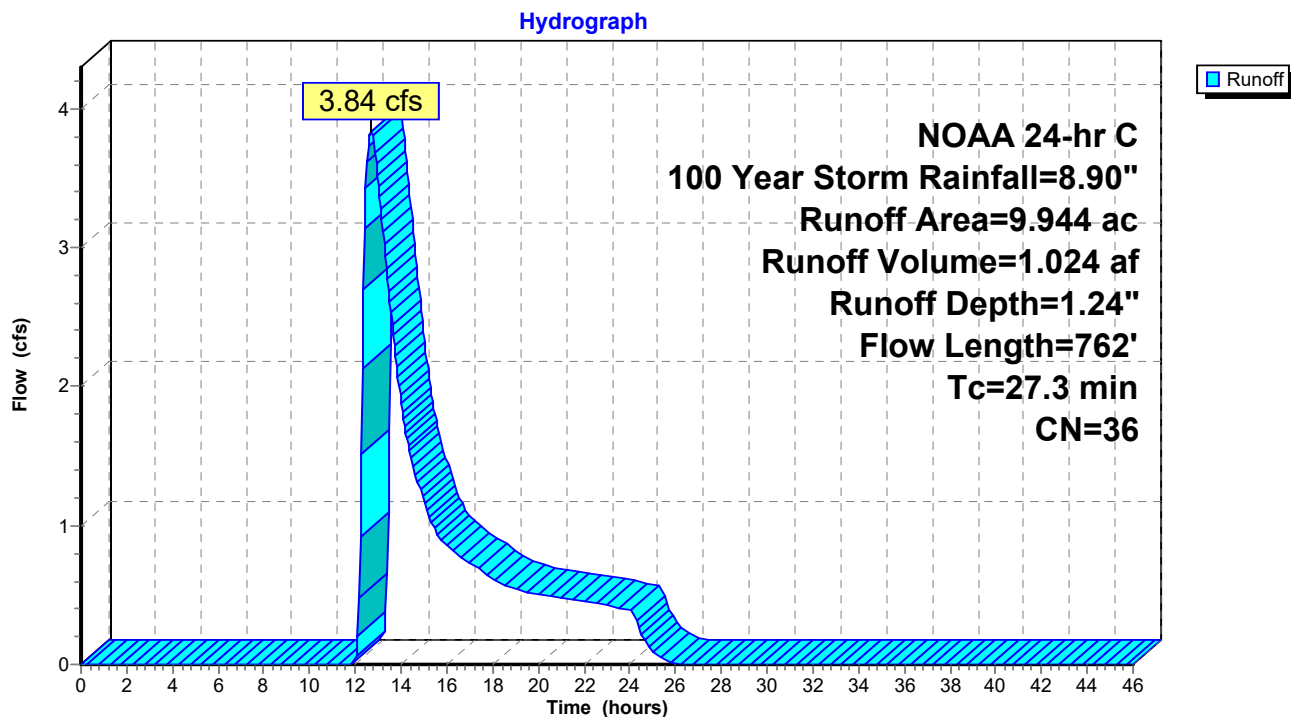
Runoff = 3.84 cfs @ 12.67 hrs, Volume= 1.024 af, Depth= 1.24"

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
* 7.752	30	Woods, Good, HSG A
2.192	55	Woods, Good, HSG B
9.944	36	Weighted Average
9.944		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	29	0.0133	0.05		<b>Sheet Flow, Sheet Flow</b>
					Woods: Light underbrush n= 0.400 P2= 3.31"
9.1	423	0.0242	0.78		<b>Shallow Concentrated Flow, Shallow Flow Woods</b>
					Woodland Kv= 5.0 fps
9.0	310	0.0133	0.58		<b>Shallow Concentrated Flow, Shallow Flow Woods</b>
					Woodland Kv= 5.0 fps
27.3	762	Total			

**Subcatchment WS E: Watershed #1 Pre-Dev Pervious**



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 8

**Summary for Subcatchment WS E: Watershed #1 Pre-Dev Pervious**

[45] Hint: Runoff=Zero

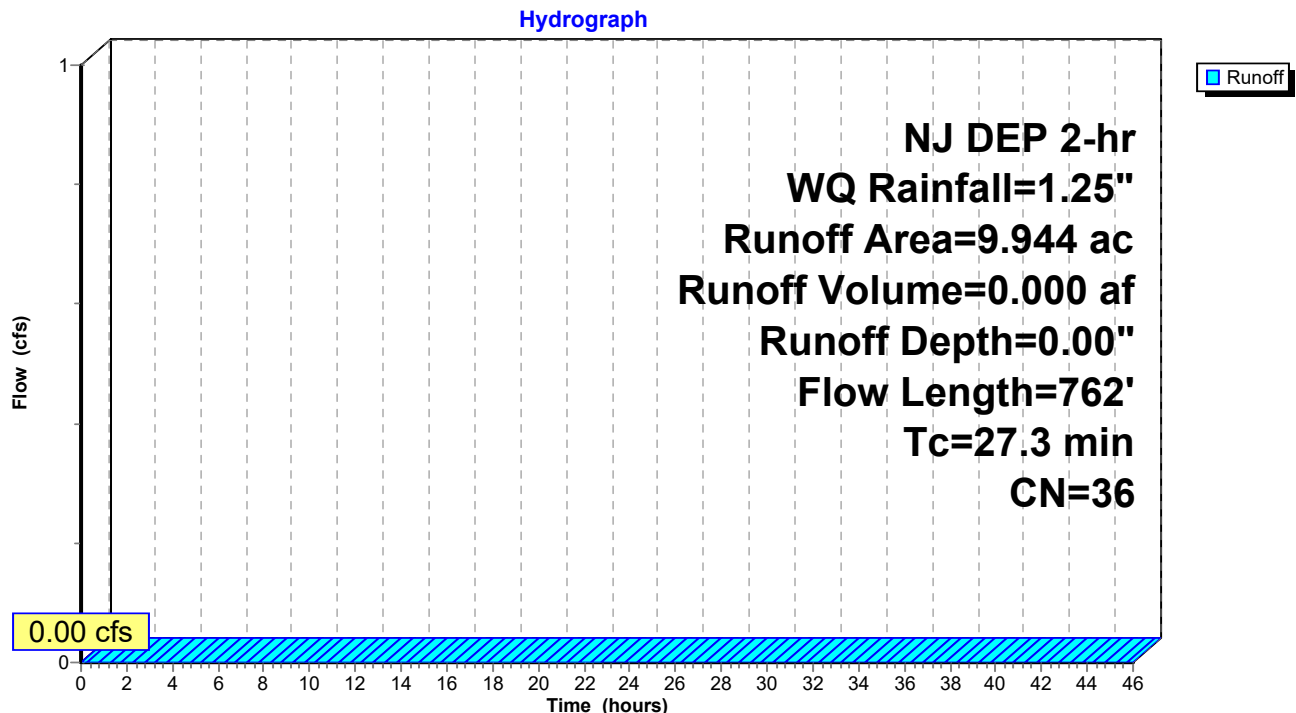
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
* 7.752	30	Woods, Good, HSG A
2.192	55	Woods, Good, HSG B
9.944	36	Weighted Average
9.944		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	29	0.0133	0.05		<b>Sheet Flow, Sheet Flow</b> Woods: Light underbrush n= 0.400 P2= 3.31"
9.1	423	0.0242	0.78		<b>Shallow Concentrated Flow, Shallow Flow Woods</b> Woodland Kv= 5.0 fps
9.0	310	0.0133	0.58		<b>Shallow Concentrated Flow, Shallow Flow Woods</b> Woodland Kv= 5.0 fps
27.3	762	Total			

**Subcatchment WS E: Watershed #1 Pre-Dev Pervious**

# **POST-DEVELOPMENT RUNOFF**

## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 2

### Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 Year Storm	NOAA 24-hr	C	Default	24.00	1	3.31	2
2	10 Year Storm	NOAA 24-hr	C	Default	24.00	1	5.16	2
3	100 Year Storm	NOAA 24-hr	C	Default	24.00	1	8.90	2
4	WQ	NJ DEP 2-hr		Default	2.00	1	1.25	2

## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 3

### Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.903	39	>75% Grass cover, Good, HSG A (UD, WS 1P, WS 2P, WS 3P, WS 5P)
1.552	61	>75% Grass cover, Good, HSG B (WS 3P, WS 4P, WS 5P)
5.489	98	Paved parking, HSG A (WS 1I, WS 2I, WS 3I, WS 4I, WS 5I)
<b>9.944</b>	<b>75</b>	<b>TOTAL AREA</b>



## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 4

### Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
8.392	HSG A	UD, WS 1I, WS 1P, WS 2I, WS 2P, WS 3I, WS 3P, WS 4I, WS 5I, WS 5P
1.552	HSG B	WS 3P, WS 4P, WS 5P
0.000	HSG C	
0.000	HSG D	
0.000	Other	
<b>9.944</b>		<b>TOTAL AREA</b>

## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 5

### Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
2.903	1.552	0.000	0.000	0.000	4.455	>75% Grass cover, Good	UD, WS 1P, WS 2P, WS 3P, WS 4P, WS 5P
5.489	0.000	0.000	0.000	0.000	5.489	Paved parking	WS 1I, WS 2I, WS 3I, WS 4I, WS 5I
<b>8.392</b>	<b>1.552</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>9.944</b>	<b>TOTAL AREA</b>	

## Zemac Self Storage

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 6

### Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	WS 3I	0.00	0.00	242.0	0.0100	0.011	0.0	18.0	0.0
2	WS 4I	0.00	0.00	165.0	0.0080	0.011	0.0	18.0	0.0
3	1P	11.10	11.10	750.0	0.0000	0.013	0.0	15.0	0.0

**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Printed 6/8/2022

Page 7

Time span=0.00-46.00 hrs, dt=0.05 hrs, 921 points  
 Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>Subcatchment UD: Undetained Runoff</b>	Runoff Area=0.399 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=452' Tc=8.7 min CN=39 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 1I: Watershed #1</b>	Runoff Area=0.326 ac 100.00% Impervious Runoff Depth=3.08" Flow Length=394' Tc=3.3 min CN=98 Runoff=1.08 cfs 0.084 af
<b>Subcatchment WS 1P: Watershed #1</b>	Runoff Area=0.527 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=386' Tc=11.1 min CN=39 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 2I: Watershed #2</b>	Runoff Area=1.178 ac 100.00% Impervious Runoff Depth=3.08" Flow Length=345' Tc=3.0 min CN=98 Runoff=3.98 cfs 0.302 af
<b>Subcatchment WS 2P: Watershed #2</b>	Runoff Area=1.010 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=330' Tc=11.0 min CN=39 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 3I: Watershed #3</b>	Runoff Area=1.148 ac 100.00% Impervious Runoff Depth=3.08" Flow Length=442' Tc=2.9 min CN=98 Runoff=3.91 cfs 0.294 af
<b>Subcatchment WS 3P: Watershed #3</b>	Runoff Area=1.048 ac 0.00% Impervious Runoff Depth=0.23" Flow Length=237' Tc=6.6 min CN=53 Runoff=0.07 cfs 0.020 af
<b>Subcatchment WS 4I: Watershed #4</b>	Runoff Area=1.377 ac 100.00% Impervious Runoff Depth=3.08" Flow Length=345' Tc=2.5 min CN=98 Runoff=4.84 cfs 0.353 af
<b>Subcatchment WS 4P: Watershed #4</b>	Runoff Area=0.509 ac 0.00% Impervious Runoff Depth=0.49" Flow Length=47' Tc=6.1 min CN=61 Runoff=0.17 cfs 0.021 af
<b>Subcatchment WS 5I: Watershed #5</b>	Runoff Area=1.460 ac 100.00% Impervious Runoff Depth=3.08" Flow Length=250' Tc=2.7 min CN=98 Runoff=5.05 cfs 0.374 af
<b>Subcatchment WS 5P: Watershed #5</b>	Runoff Area=0.962 ac 0.00% Impervious Runoff Depth=0.09" Flow Length=62' Tc=6.9 min CN=47 Runoff=0.01 cfs 0.007 af
<b>Reach SW: Grassed Swale</b>	Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af n=0.022 L=380.0' S=0.0149 '/' Capacity=62.48 cfs Outflow=0.00 cfs 0.000 af
<b>Pond 1P: Basin #1</b>	Peak Elev=12.97' Storage=3,645 cf Inflow=1.08 cfs 0.084 af Outflow=0.00 cfs 0.000 af
<b>Pond 2P: Basin #2</b>	Peak Elev=11.81' Storage=13,166 cf Inflow=3.98 cfs 0.302 af Outflow=0.00 cfs 0.000 af
<b>Pond 3P: Basin #3</b>	Peak Elev=9.99' Storage=13,686 cf Inflow=3.91 cfs 0.314 af Outflow=0.00 cfs 0.000 af
<b>Pond 4P: Basin #4</b>	Peak Elev=10.24' Storage=16,286 cf Inflow=4.95 cfs 0.374 af Outflow=0.00 cfs 0.000 af

## **Zemac Self Storage**

NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 8

### **Pond 5P: Basin #5**

Peak Elev=9.68' Storage=16,623 cf Inflow=5.05 cfs 0.382 af

Outflow=0.00 cfs 0.000 af

### **Link DP: DISCHARGE POINT**

Inflow=0.00 cfs 0.000 af

Primary=0.00 cfs 0.000 af

**Total Runoff Area = 9.944 ac   Runoff Volume = 1.456 af   Average Runoff Depth = 1.76"**  
**44.80% Pervious = 4.455 ac   55.20% Impervious = 5.489 ac**



**Summary for Subcatchment UD: Undetained Runoff**

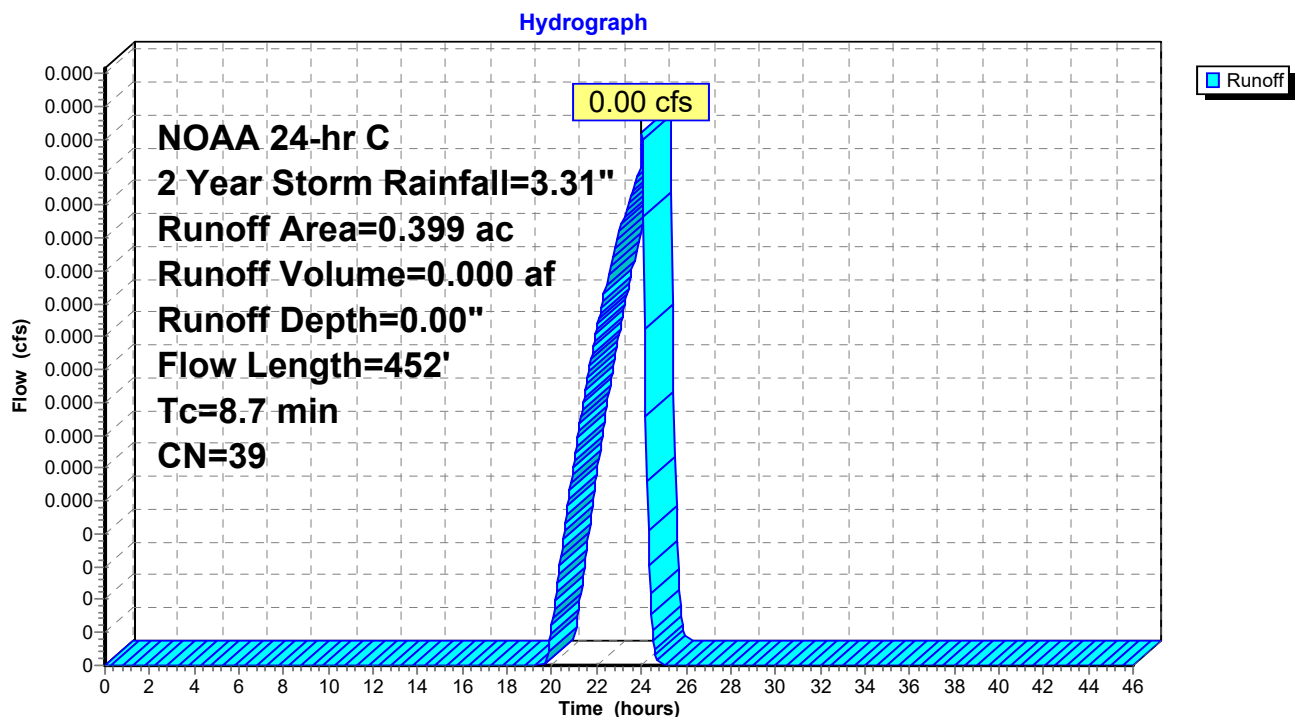
Runoff = 0.00 cfs @ 24.03 hrs, Volume= 0.000 af, Depth= 0.00"  
 Routed to Link DP : DISCHARGE POINT

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
0.399	39	>75% Grass cover, Good, HSG A
0.399		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	52	0.0252	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
1.1	400	0.0150	6.26	62.64	<b>Parabolic Channel,</b> W=15.00' D=1.00' Area=10.0 sf Perim=15.2' n= 0.022 Earth, clean & straight
8.7	452	Total			

**Subcatchment UD: Undetained Runoff**

**Summary for Subcatchment WS 1I: Watershed #1 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

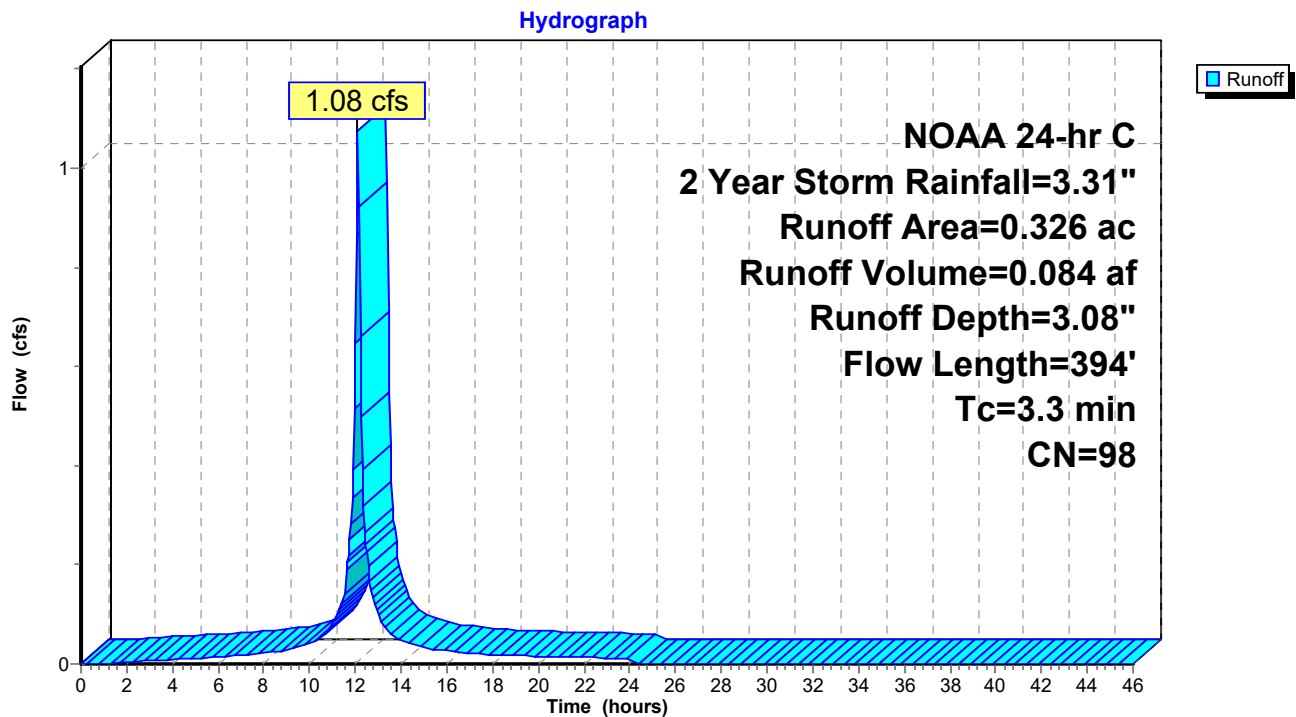
Runoff = 1.08 cfs @ 12.10 hrs, Volume= 0.084 af, Depth= 3.08"  
 Routed to Pond 1P : Basin #1

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
0.326	98	Paved parking, HSG A
0.326		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	33	0.0200	1.12		<b>Sheet Flow, Paved Sheet Flow</b> Smooth surfaces $n=0.011$ $P2=3.31"$
2.7	331	0.0100	2.03		<b>Shallow Concentrated Flow, Paved Flow</b> Paved $K_v=20.3$ fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass to Basin Flow</b> Grassed Waterway $K_v=15.0$ fps
3.3	394	Total			

**Subcatchment WS 1I: Watershed #1 Post-Dev Impervious**

### Summary for Subcatchment WS 1P: Watershed #1 Post-Dev Pervious

Runoff = 0.00 cfs @ 24.04 hrs, Volume= 0.000 af, Depth= 0.00"  
 Routed to Pond 1P : Basin #1

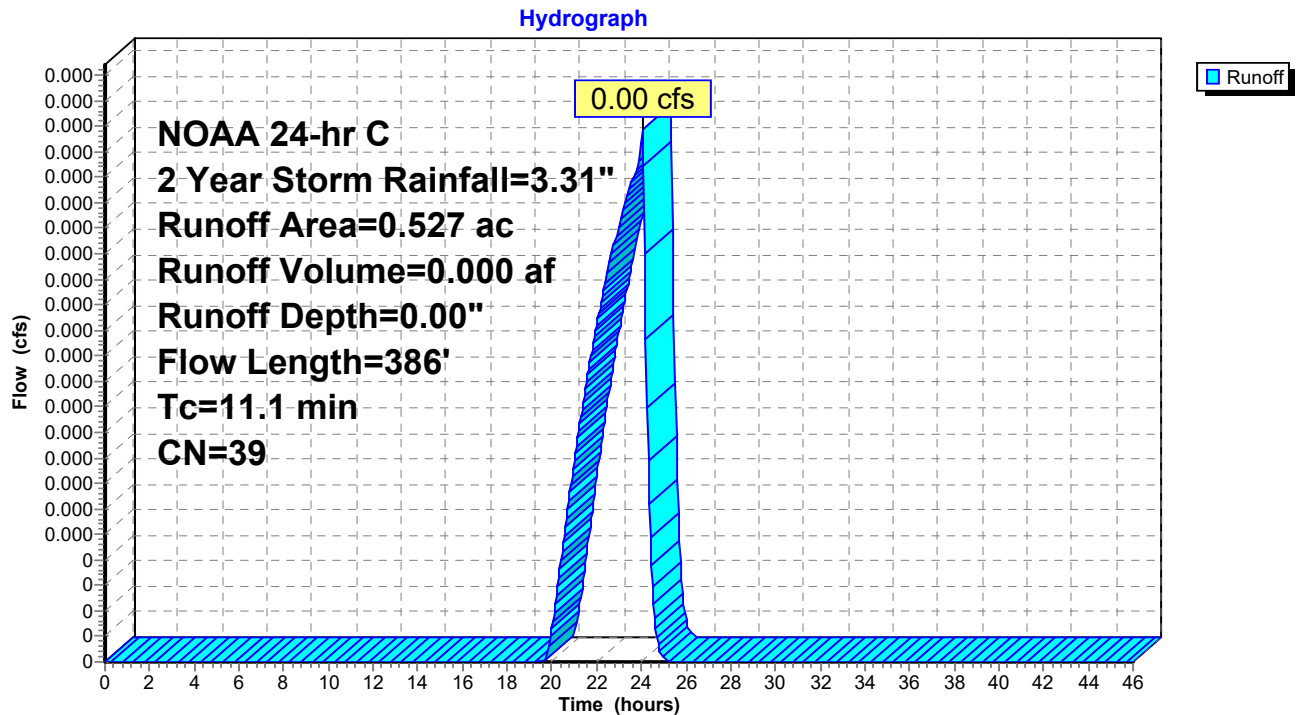
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
0.527	39	>75% Grass cover, Good, HSG A
0.527		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	55	0.0212	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
2.5	301	0.0100	2.03		<b>Shallow Concentrated Flow, Driveway Flow</b> Paved Kv= 20.3 fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass Flow to Basin</b> Grassed Waterway Kv= 15.0 fps
11.1	386	Total			

### Subcatchment WS 1P: Watershed #1 Post-Dev Pervious



**Summary for Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

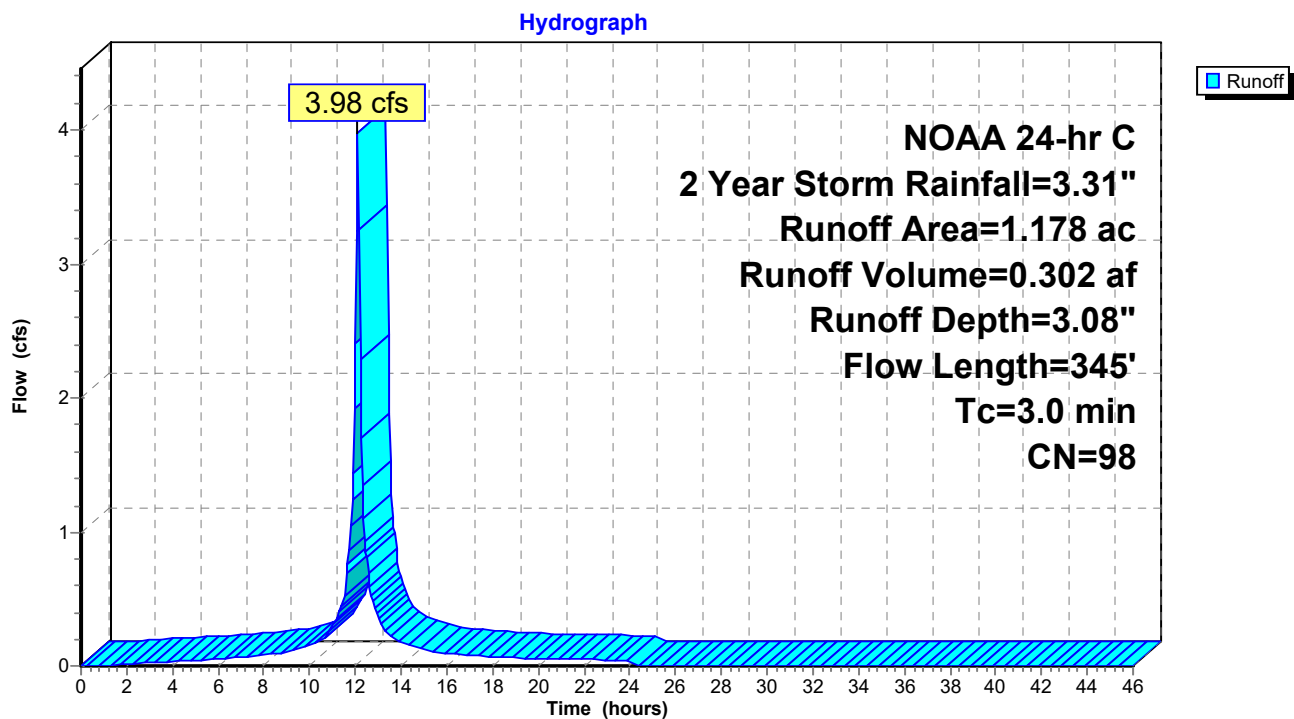
Runoff = 3.98 cfs @ 12.10 hrs, Volume= 0.302 af, Depth= 3.08"  
 Routed to Pond 2P : Basin #2

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
1.178	98	Paved parking, HSG A
1.178		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	33	0.0321	1.35		<b>Sheet Flow, Sheet Flow Grass</b> Smooth surfaces $n=0.011$ $P2=3.31"$
2.6	312	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved $K_v=20.3$ fps
3.0	345	Total			

**Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**

**Summary for Subcatchment WS 2P: Watershed #2 Post-Dev Pervious**

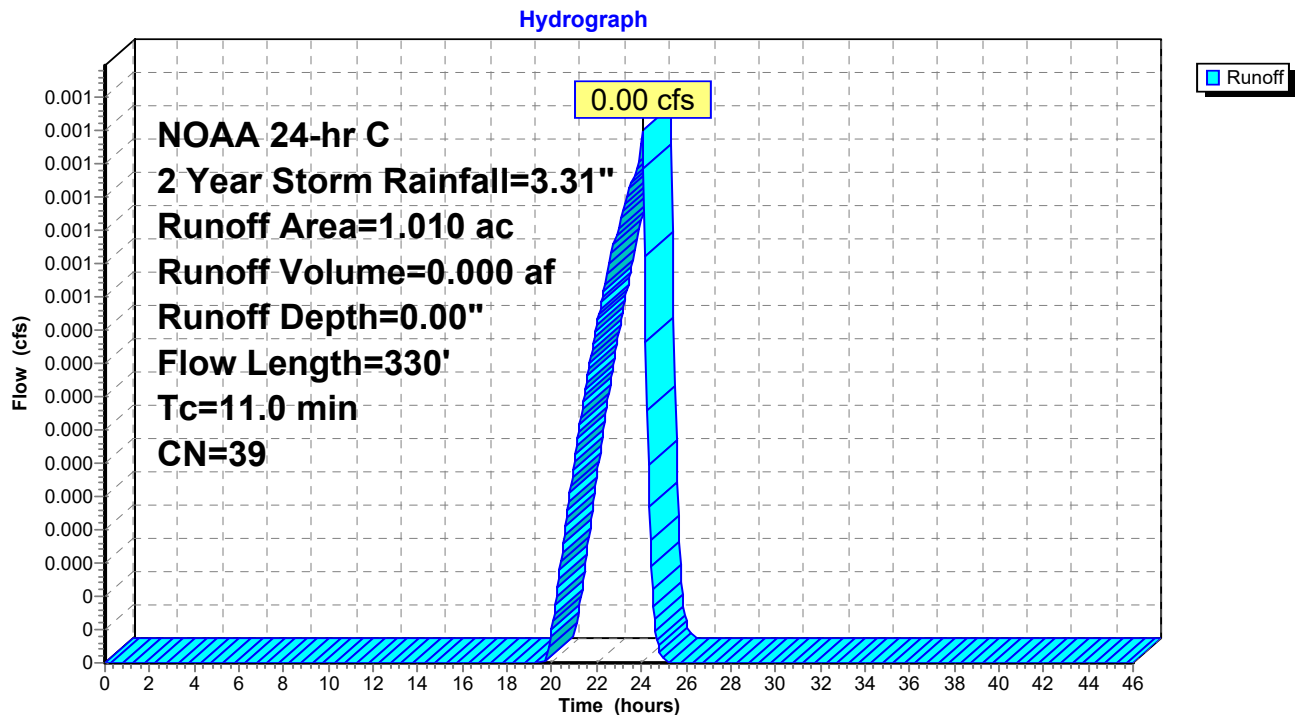
Runoff = 0.00 cfs @ 24.04 hrs, Volume= 0.000 af, Depth= 0.00"  
 Routed to Pond 2P : Basin #2

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
1.010	39	>75% Grass cover, Good, HSG A
1.010		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	57	0.0210	0.11		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
2.2	273	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved Kv= 20.3 fps
11.0	330	Total			

**Subcatchment WS 2P: Watershed #2 Post-Dev Pervious**

**Summary for Subcatchment WS 3I: Watershed #3 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

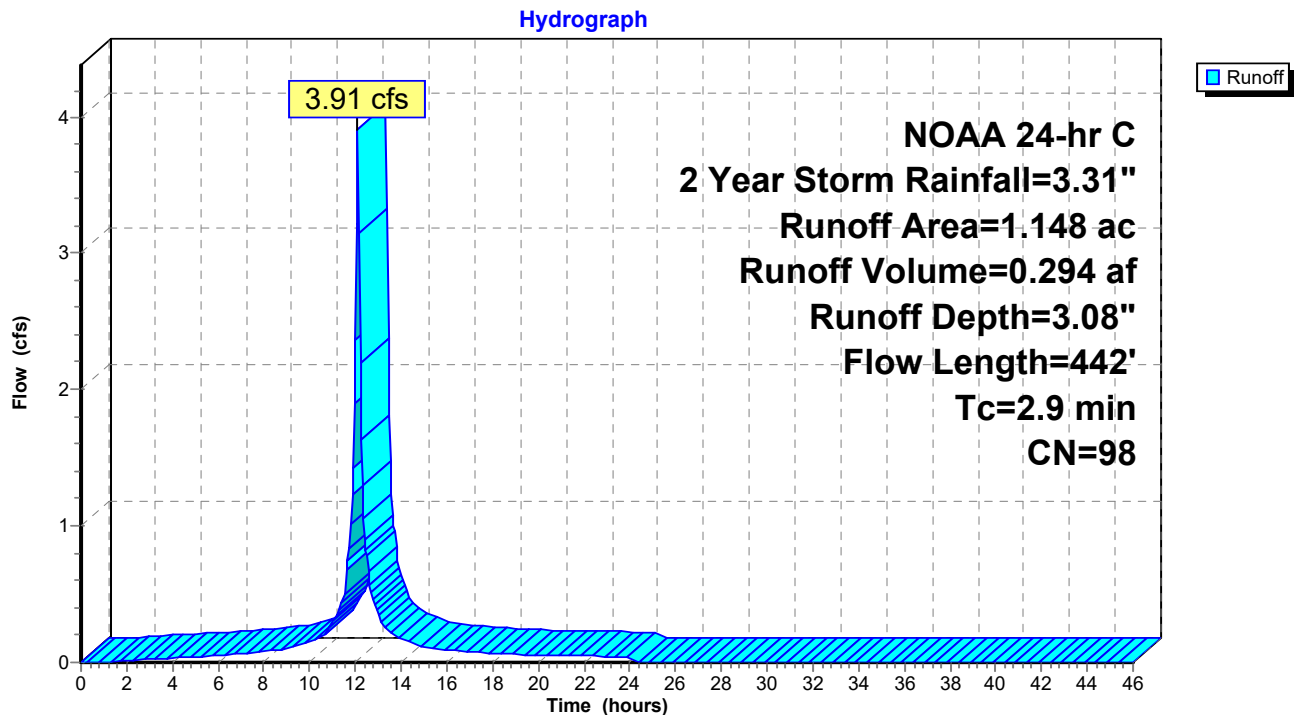
Runoff = 3.91 cfs @ 12.10 hrs, Volume= 0.294 af, Depth= 3.08"  
 Routed to Pond 3P : Basin #3

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
1.148	98	Paved parking, HSG A
1.148		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	200	0.0050	1.44		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.6	242	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.9	442	Total			

**Subcatchment WS 3I: Watershed #3 Post-Dev Impervious**



### Summary for Subcatchment WS 3P: Watershed #3 Post-Dev Pervious

Runoff = 0.07 cfs @ 12.52 hrs, Volume= 0.020 af, Depth= 0.23"  
Routed to Pond 3P : Basin #3

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 2 Year Storm Rainfall=3.31"

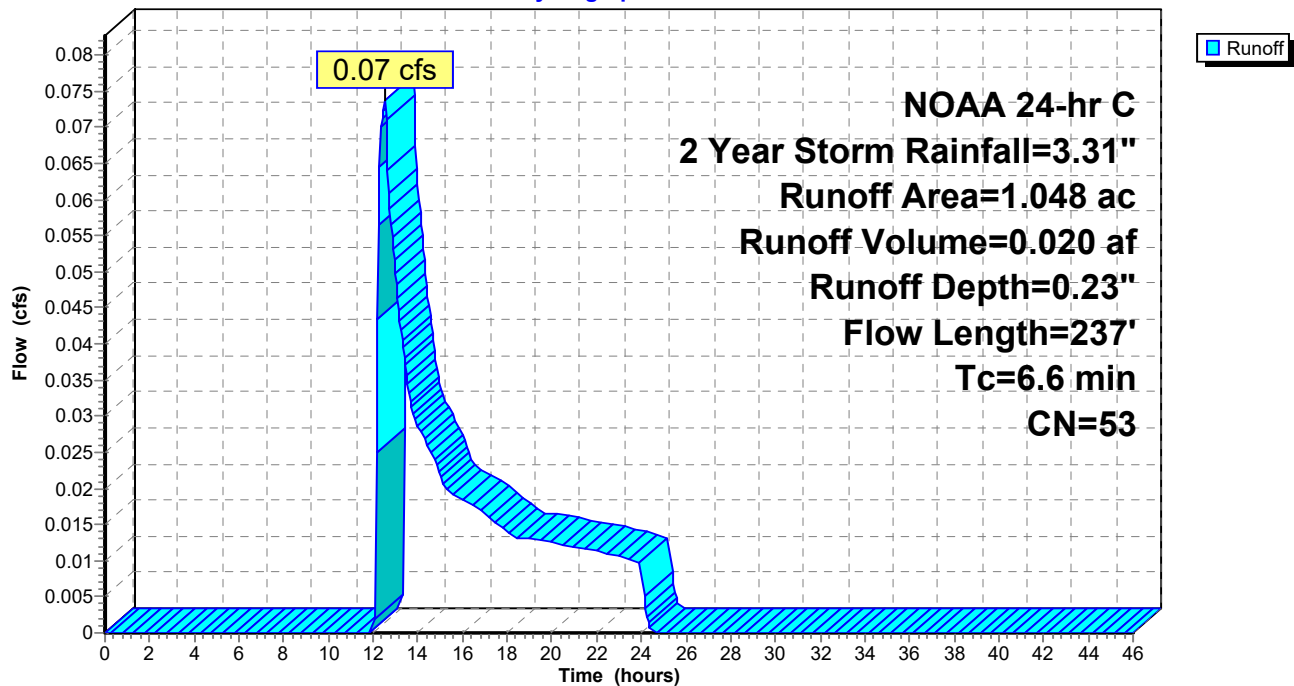
Area (ac)	CN	Description
0.374	39	>75% Grass cover, Good, HSG A
0.674	61	>75% Grass cover, Good, HSG B
1.048	53	Weighted Average
1.048		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	35	0.0330	0.12		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
1.6	202	0.0189	2.06		<b>Shallow Concentrated Flow, Grass Flow</b> Grassed Waterway Kv= 15.0 fps
6.6	237	Total			

### Subcatchment WS 3P: Watershed #3 Post-Dev Pervious

Hydrograph



**Summary for Subcatchment WS 4I: Watershed #4 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

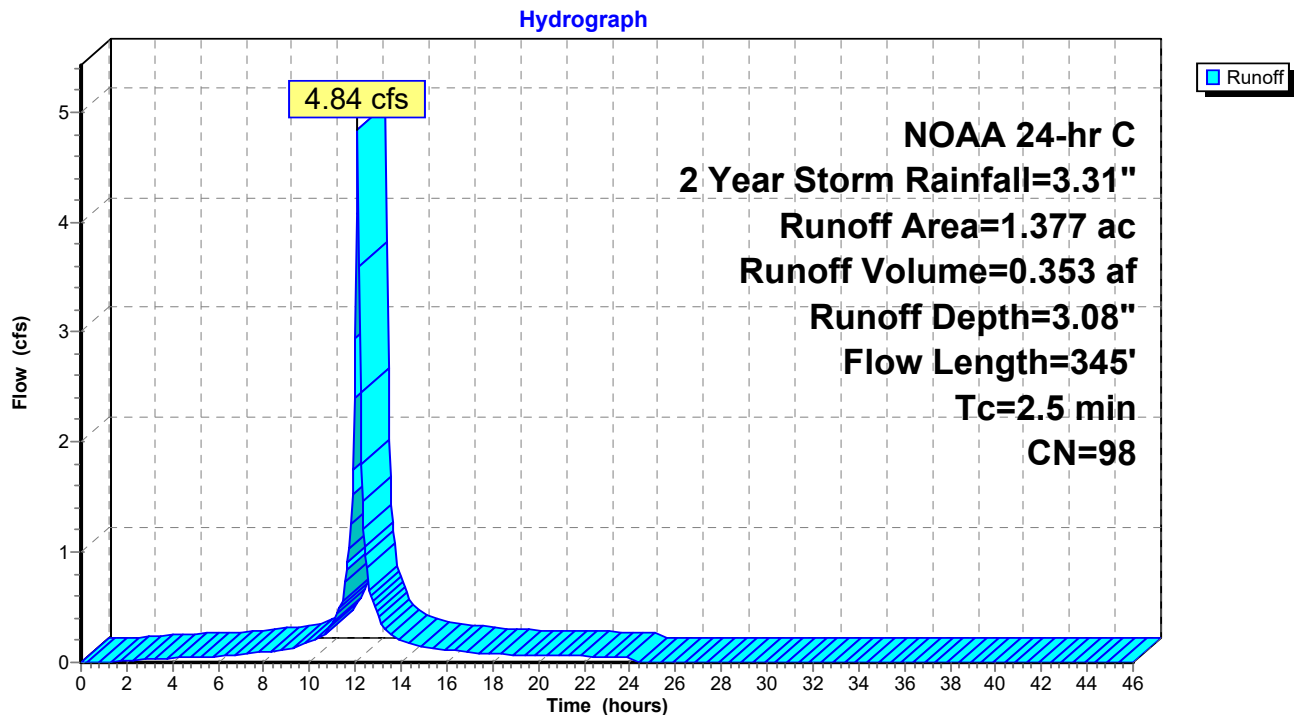
Runoff = 4.84 cfs @ 12.09 hrs, Volume= 0.353 af, Depth= 3.08"  
 Routed to Pond 4P : Basin #4

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
1.377	98	Paved parking, HSG A
1.377		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	180	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.4	165	0.0080	6.28	11.10	<b>Pipe Channel, RCP_Round 18"</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.5	345	Total			

**Subcatchment WS 4I: Watershed #4 Post-Dev Impervious**

### Summary for Subcatchment WS 4P: Watershed #4 Post-Dev Pervious

Runoff = 0.17 cfs @ 12.17 hrs, Volume= 0.021 af, Depth= 0.49"  
Routed to Pond 4P : Basin #4

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 2 Year Storm Rainfall=3.31"

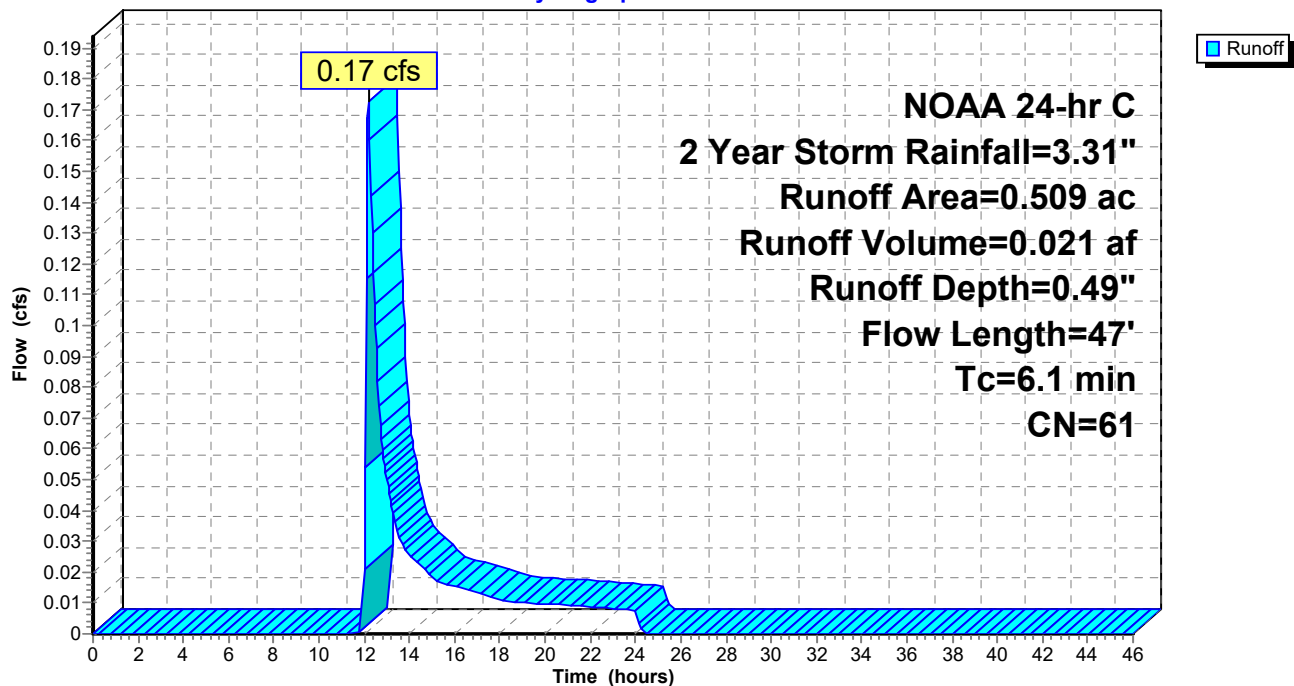
Area (ac)	CN	Description
0.509	61	>75% Grass cover, Good, HSG B
0.509		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	35	0.0200	0.10		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.3300	8.62		<b>Shallow Concentrated Flow, Shallow Flow Grass</b> Grassed Waterway Kv= 15.0 fps
6.1	47	Total			

### Subcatchment WS 4P: Watershed #4 Post-Dev Pervious

Hydrograph



**Summary for Subcatchment WS 5I: Watershed #5 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

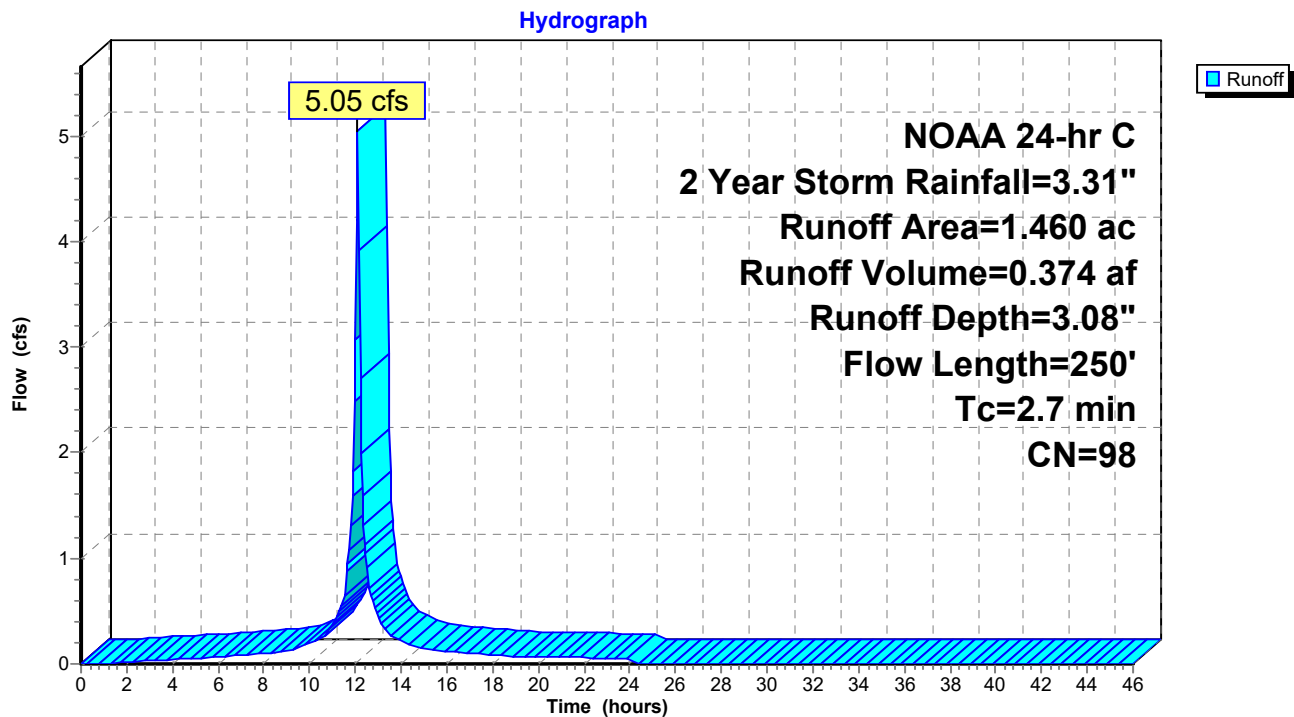
Runoff = 5.05 cfs @ 12.10 hrs, Volume= 0.374 af, Depth= 3.08"  
 Routed to Pond 5P : Basin #5

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
1.460	98	Paved parking, HSG A
1.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	230	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.0	20	0.2500	8.05		<b>Shallow Concentrated Flow, Stone Slope Flow</b> Unpaved Kv= 16.1 fps
2.7	250	Total			

**Subcatchment WS 5I: Watershed #5 Post-Dev Impervious**

### Summary for Subcatchment WS 5P: Watershed #5 Post-Dev Pervious

Runoff = 0.01 cfs @ 13.27 hrs, Volume= 0.007 af, Depth= 0.09"  
Routed to Pond 5P : Basin #5

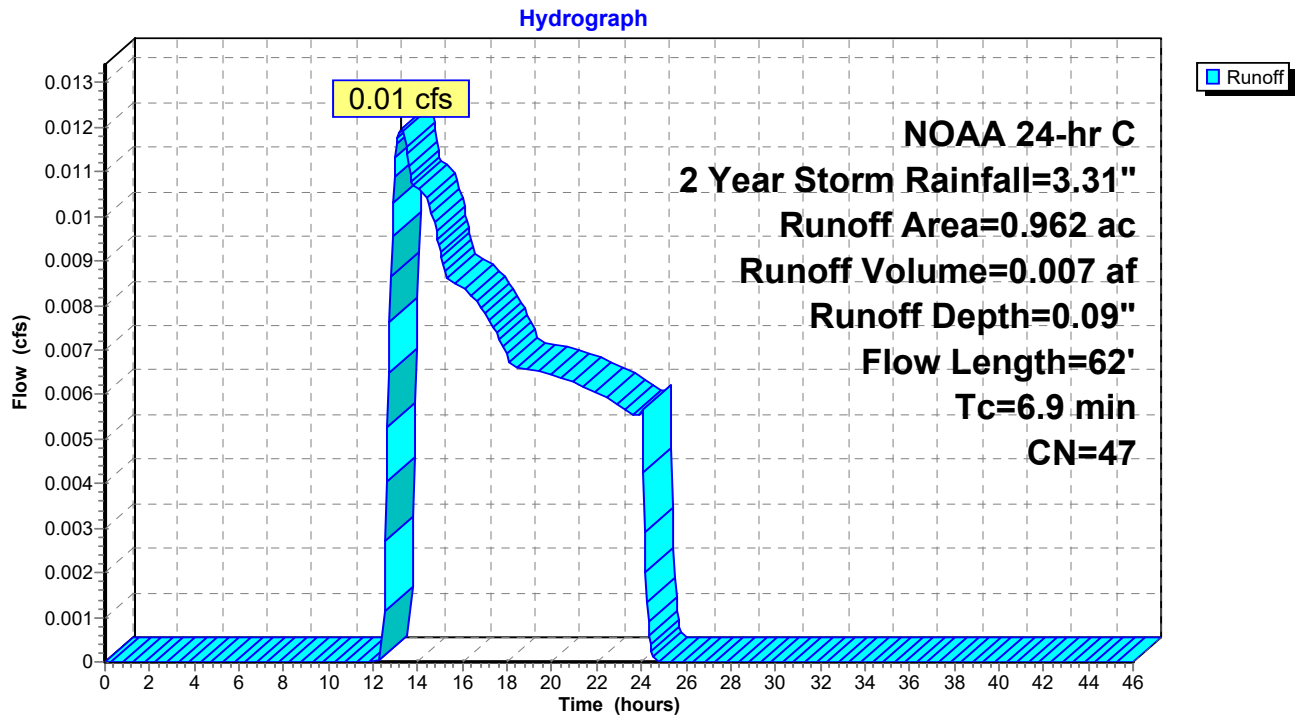
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Area (ac)	CN	Description
0.593	39	>75% Grass cover, Good, HSG A
0.369	61	>75% Grass cover, Good, HSG B
0.962	47	Weighted Average
0.962		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	50	0.0300	0.12		<b>Sheet Flow, Grass Sheet Flow</b>
					Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.2500	7.50		<b>Shallow Concentrated Flow, Grass Shallow Flow</b>
					Grassed Waterway Kv= 15.0 fps
6.9	62	Total			

### Subcatchment WS 5P: Watershed #5 Post-Dev Pervious



**Summary for Reach SW: Grassed Swale**

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 0.00" for 2 Year Storm event  
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min  
Routed to Link DP : DISCHARGE POINT

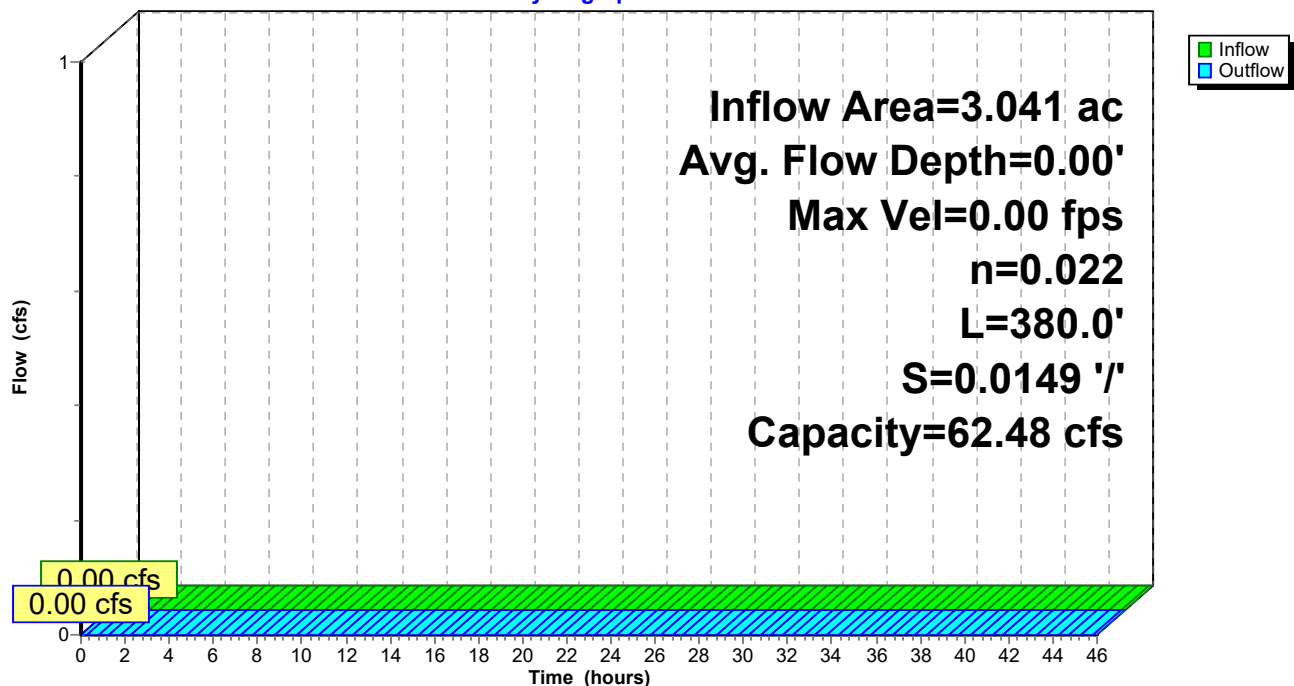
Routing by Stor-Ind+Trans method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min  
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs  
Average Depth at Peak Storage= 0.00'  
Bank-Full Depth= 1.00' Flow Area= 10.0 sf, Capacity= 62.48 cfs

15.00' x 1.00' deep Parabolic Channel, n= 0.022 Earth, clean & straight  
Length= 380.0' Slope= 0.0149 '/'  
Inlet Invert= 12.67', Outlet Invert= 7.00'

**Reach SW: Grassed Swale**

Hydrograph





**Zemac Self Storage**

NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 21

**Summary for Pond 1P: Basin #1**

Inflow Area = 0.853 ac, 38.22% Impervious, Inflow Depth = 1.18" for 2 Year Storm event  
 Inflow = 1.08 cfs @ 12.10 hrs, Volume= 0.084 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Pond 2P : Basin #2

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 12.97' @ 25.25 hrs Surf.Area= 2,935 sf Storage= 3,645 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	9,711 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
11.00	903	0	0
12.00	1,785	1,344	1,344
13.00	2,965	2,375	3,719
14.00	4,120	3,543	7,262
14.50	5,678	2,450	9,711

Device	Routing	Invert	Outlet Devices
#1	Primary	11.10'	<b>15.0" Round Culvert</b> L= 750.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 11.10' / 11.10' S= 0.0000 ' S= 0.0000 ' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	13.00'	<b>48.0" x 30.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=11.00' (Free Discharge)

↑ **1=Culvert** ( Controls 0.00 cfs)

↑ **2=Orifice/Grate** ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

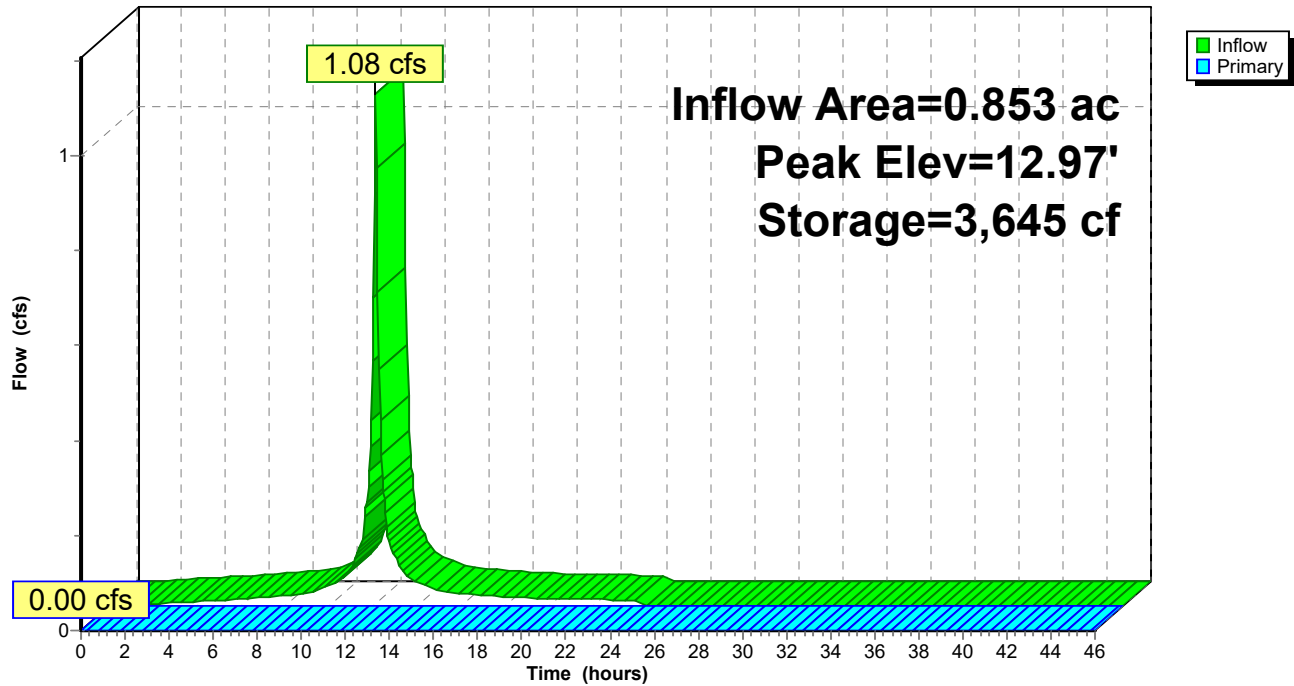
NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Printed 6/8/2022

Page 22

### Pond 1P: Basin #1

#### Hydrograph



**Zemac Self Storage**

NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 23

**Summary for Pond 2P: Basin #2**

[79] Warning: Submerged Pond 1P Primary device # 1 by 0.71'

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 1.19" for 2 Year Storm event  
 Inflow = 3.98 cfs @ 12.10 hrs, Volume= 0.302 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Reach SW : Grassed Swale

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 11.81' @ 25.25 hrs Surf.Area= 12,814 sf Storage= 13,166 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	10.67'	47,407 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.67	10,000	0	0
11.00	11,128	3,486	3,486
12.00	13,213	12,171	15,657
13.00	15,922	14,568	30,224
14.00	18,444	17,183	47,407

Device	Routing	Invert	Outlet Devices
#1	Primary	12.67'	<b>7.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=10.67' (Free Discharge)  
 ↑1=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

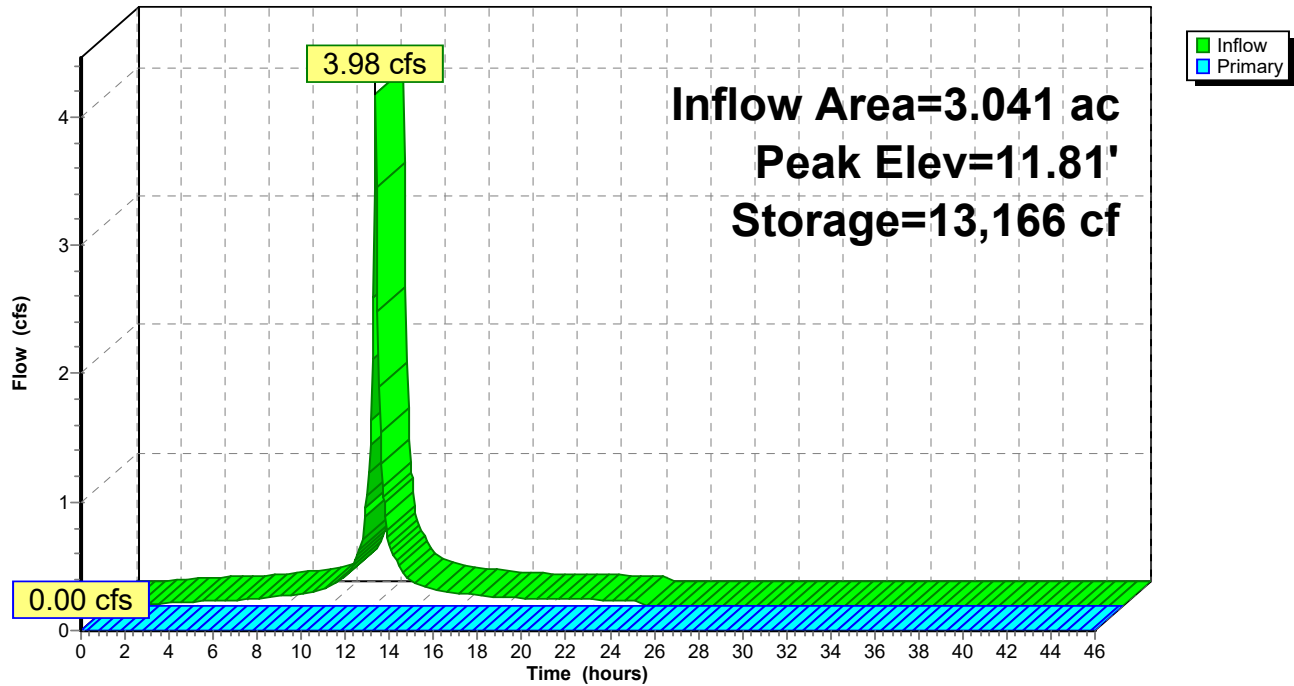
NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Printed 6/8/2022

Page 24

### Pond 2P: Basin #2

#### Hydrograph



**Zemac Self Storage**

NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 25

**Summary for Pond 3P: Basin #3**

Inflow Area = 2.196 ac, 52.28% Impervious, Inflow Depth = 1.72" for 2 Year Storm event  
 Inflow = 3.91 cfs @ 12.10 hrs, Volume= 0.314 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Pond 4P : Basin #4

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 9.99' @ 24.80 hrs Surf.Area= 12,475 sf Storage= 13,686 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

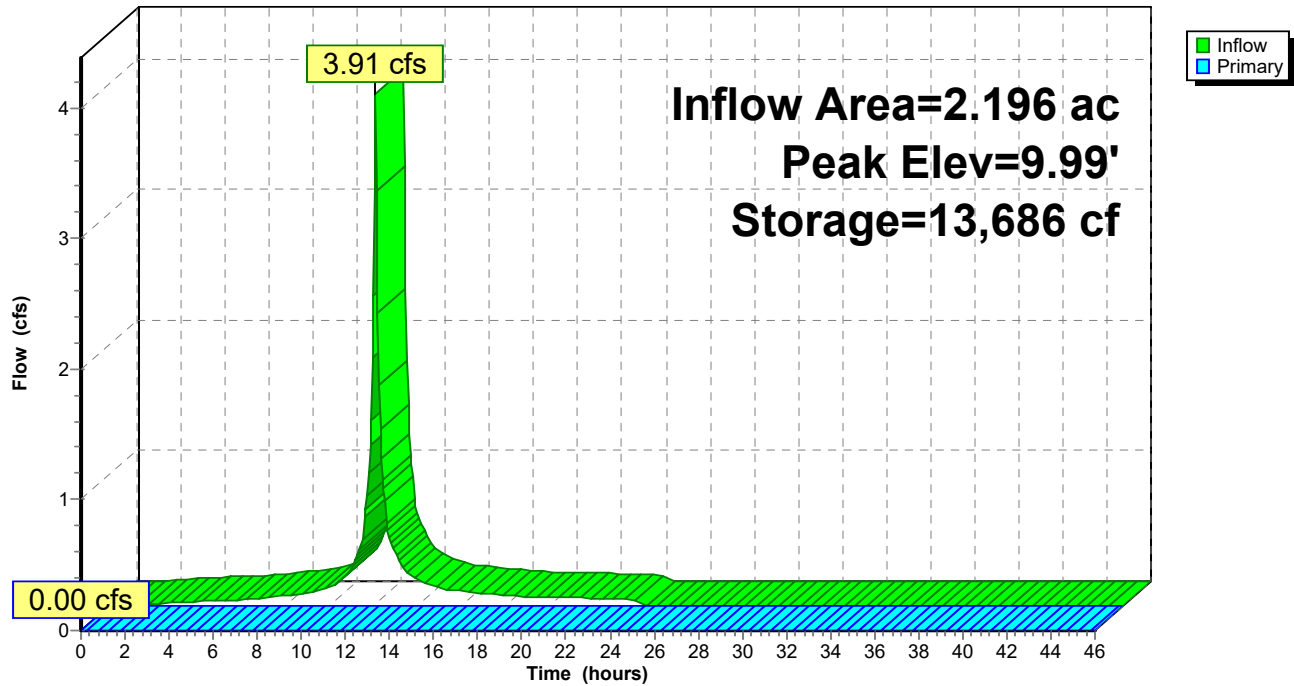
Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	41,842 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,985	0	0
9.00	10,988	2,097	2,097
10.00	12,493	11,741	13,838
11.00	14,000	13,247	27,084
12.00	15,516	14,758	41,842

Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=8.80' (Free Discharge)  
 ↑1=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

**Pond 3P: Basin #3**

**Hydrograph**





**Zemac Self Storage**

NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 27

**Summary for Pond 4P: Basin #4**

Inflow Area = 4.082 ac, 61.86% Impervious, Inflow Depth = 1.10" for 2 Year Storm event  
 Inflow = 4.95 cfs @ 12.10 hrs, Volume= 0.374 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Pond 5P : Basin #5

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 10.24' @ 24.70 hrs Surf.Area= 12,359 sf Storage= 16,286 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	39,735 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,996	0	0
9.00	10,421	2,042	2,042
10.00	12,121	11,271	13,313
11.00	13,100	12,611	25,923
12.00	14,523	13,812	39,735

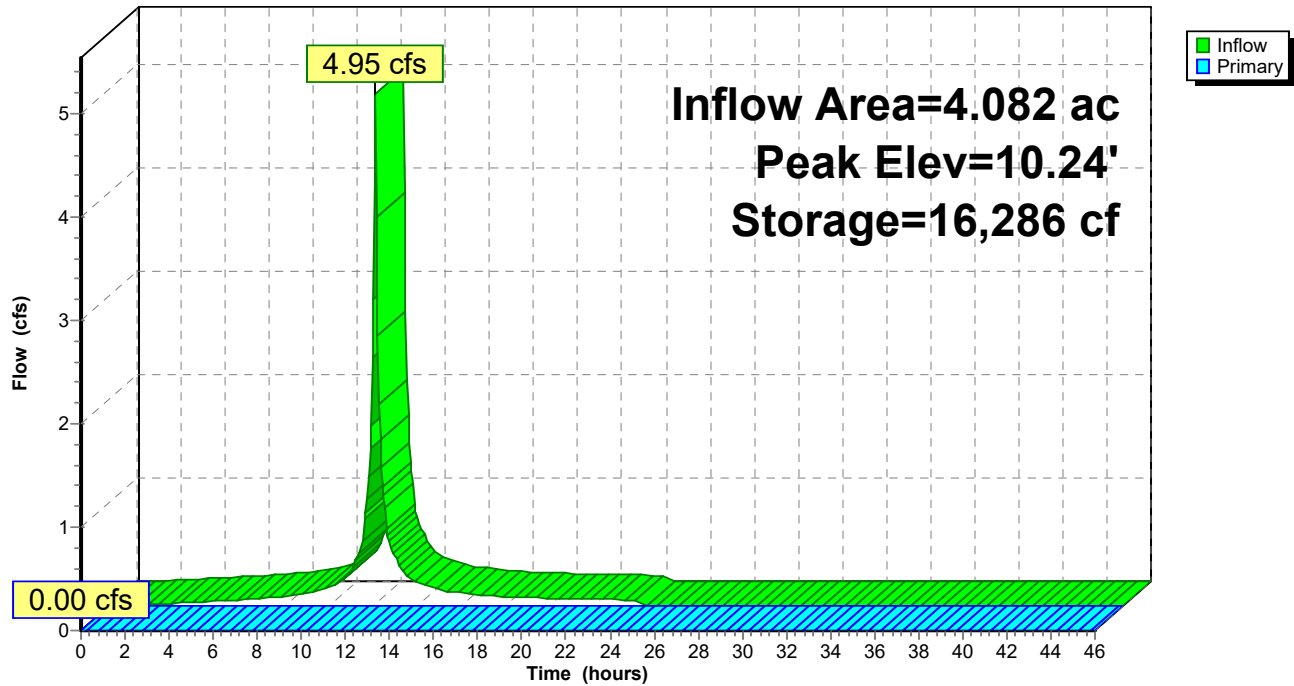
Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=8.80' (Free Discharge)

↑1=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

**Pond 4P: Basin #4**

**Hydrograph**



**Zemac Self Storage**

NOAA 24-hr C 2 Year Storm Rainfall=3.31"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 29

**Summary for Pond 5P: Basin #5**

Inflow Area = 6.504 ac, 61.27% Impervious, Inflow Depth = 0.70" for 2 Year Storm event  
 Inflow = 5.05 cfs @ 12.10 hrs, Volume= 0.382 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Link DP : DISCHARGE POINT

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 9.68' @ 24.80 hrs Surf.Area= 25,704 sf Storage= 16,623 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	84,099 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
9.00	23,222	0	0
10.00	26,875	25,049	25,049
11.00	29,445	28,160	53,209
12.00	32,336	30,891	84,099

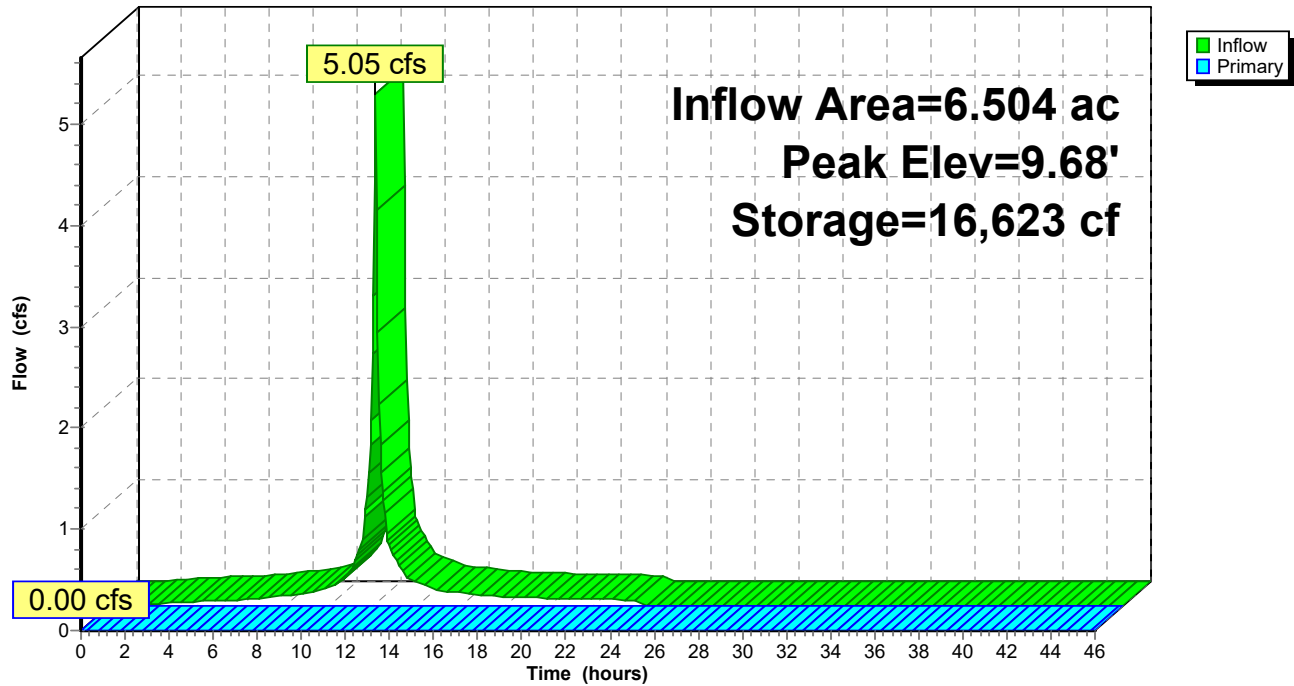
Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	<b>4.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=9.00' (Free Discharge)

↑1=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

**Pond 5P: Basin #5**

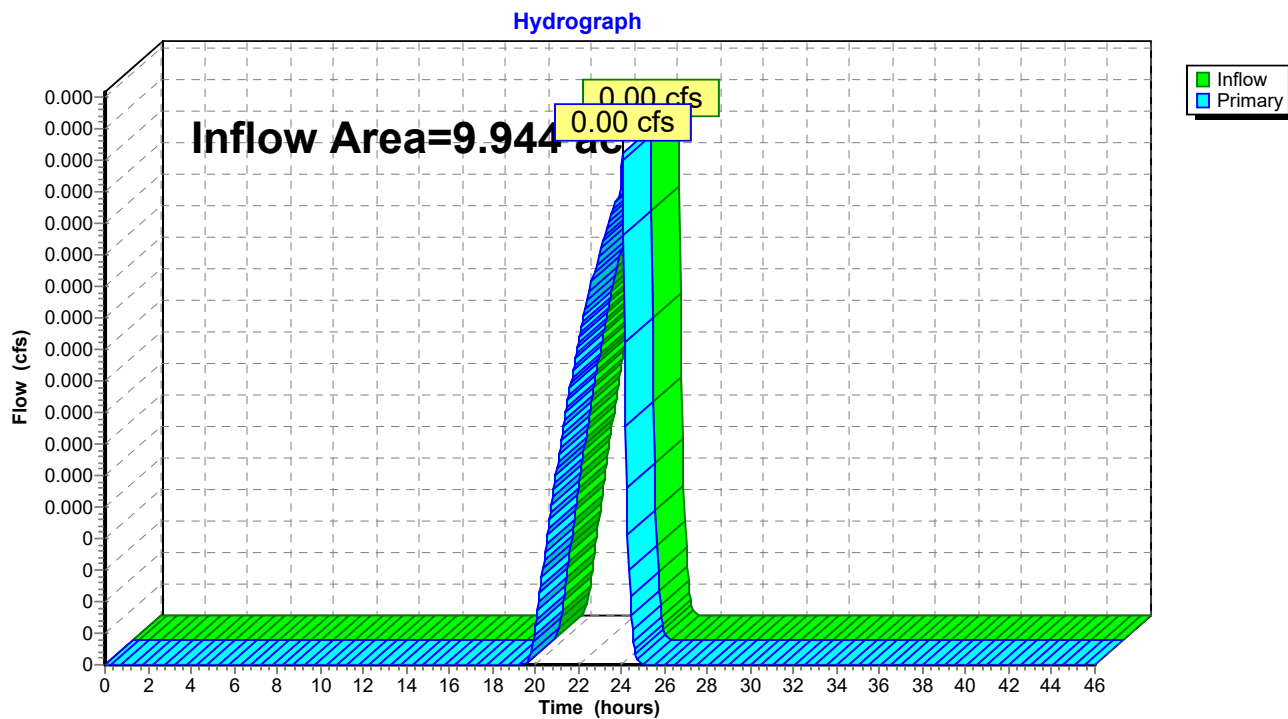
**Hydrograph**



**Summary for Link DP: DISCHARGE POINT**

Inflow Area = 9.944 ac, 55.20% Impervious, Inflow Depth = 0.00" for 2 Year Storm event  
Inflow = 0.00 cfs @ 24.03 hrs, Volume= 0.000 af  
Primary = 0.00 cfs @ 24.03 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs

**Link DP: DISCHARGE POINT**

**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Printed 6/8/2022

Page 32

Time span=0.00-46.00 hrs, dt=0.05 hrs, 921 points  
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>Subcatchment UD: Undetained Runoff</b>	Runoff Area=0.399 ac 0.00% Impervious Runoff Depth=0.23" Flow Length=452' Tc=8.7 min CN=39 Runoff=0.02 cfs 0.008 af
<b>Subcatchment WS 1I: Watershed #1</b>	Runoff Area=0.326 ac 100.00% Impervious Runoff Depth=4.92" Flow Length=394' Tc=3.3 min CN=98 Runoff=1.69 cfs 0.134 af
<b>Subcatchment WS 1P: Watershed #1</b>	Runoff Area=0.527 ac 0.00% Impervious Runoff Depth=0.23" Flow Length=386' Tc=11.1 min CN=39 Runoff=0.02 cfs 0.010 af
<b>Subcatchment WS 2I: Watershed #2</b>	Runoff Area=1.178 ac 100.00% Impervious Runoff Depth=4.92" Flow Length=345' Tc=3.0 min CN=98 Runoff=6.25 cfs 0.483 af
<b>Subcatchment WS 2P: Watershed #2</b>	Runoff Area=1.010 ac 0.00% Impervious Runoff Depth=0.23" Flow Length=330' Tc=11.0 min CN=39 Runoff=0.05 cfs 0.020 af
<b>Subcatchment WS 3I: Watershed #3</b>	Runoff Area=1.148 ac 100.00% Impervious Runoff Depth=4.92" Flow Length=442' Tc=2.9 min CN=98 Runoff=6.14 cfs 0.471 af
<b>Subcatchment WS 3P: Watershed #3</b>	Runoff Area=1.048 ac 0.00% Impervious Runoff Depth=0.94" Flow Length=237' Tc=6.6 min CN=53 Runoff=0.75 cfs 0.082 af
<b>Subcatchment WS 4I: Watershed #4</b>	Runoff Area=1.377 ac 100.00% Impervious Runoff Depth=4.92" Flow Length=345' Tc=2.5 min CN=98 Runoff=7.60 cfs 0.565 af
<b>Subcatchment WS 4P: Watershed #4</b>	Runoff Area=0.509 ac 0.00% Impervious Runoff Depth=1.47" Flow Length=47' Tc=6.1 min CN=61 Runoff=0.71 cfs 0.062 af
<b>Subcatchment WS 5I: Watershed #5</b>	Runoff Area=1.460 ac 100.00% Impervious Runoff Depth=4.92" Flow Length=250' Tc=2.7 min CN=98 Runoff=7.93 cfs 0.599 af
<b>Subcatchment WS 5P: Watershed #5</b>	Runoff Area=0.962 ac 0.00% Impervious Runoff Depth=0.59" Flow Length=62' Tc=6.9 min CN=47 Runoff=0.29 cfs 0.048 af
<b>Reach SW: Grassed Swale</b>	Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af n=0.022 L=380.0' S=0.0149 '/' Capacity=62.48 cfs Outflow=0.00 cfs 0.000 af
<b>Pond 1P: Basin #1</b>	Peak Elev=13.04' Storage=3,834 cf Inflow=1.69 cfs 0.144 af Outflow=0.34 cfs 0.059 af
<b>Pond 2P: Basin #2</b>	Peak Elev=12.63' Storage=24,461 cf Inflow=6.25 cfs 0.562 af Outflow=0.00 cfs 0.000 af
<b>Pond 3P: Basin #3</b>	Peak Elev=10.78' Storage=24,075 cf Inflow=6.68 cfs 0.553 af Outflow=0.00 cfs 0.000 af
<b>Pond 4P: Basin #4</b>	Peak Elev=10.86' Storage=24,040 cf Inflow=8.17 cfs 0.627 af Outflow=0.14 cfs 0.092 af

## **Zemac Self Storage**

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 33

### **Pond 5P: Basin #5**

Peak Elev=10.26' Storage=32,161 cf Inflow=8.06 cfs 0.738 af

Outflow=0.00 cfs 0.000 af

### **Link DP: DISCHARGE POINT**

Inflow=0.02 cfs 0.008 af

Primary=0.02 cfs 0.008 af

**Total Runoff Area = 9.944 ac   Runoff Volume = 2.481 af   Average Runoff Depth = 2.99"**  
**44.80% Pervious = 4.455 ac   55.20% Impervious = 5.489 ac**



**Summary for Subcatchment UD: Undetained Runoff**

Runoff = 0.02 cfs @ 12.84 hrs, Volume= 0.008 af, Depth= 0.23"  
 Routed to Link DP : DISCHARGE POINT

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

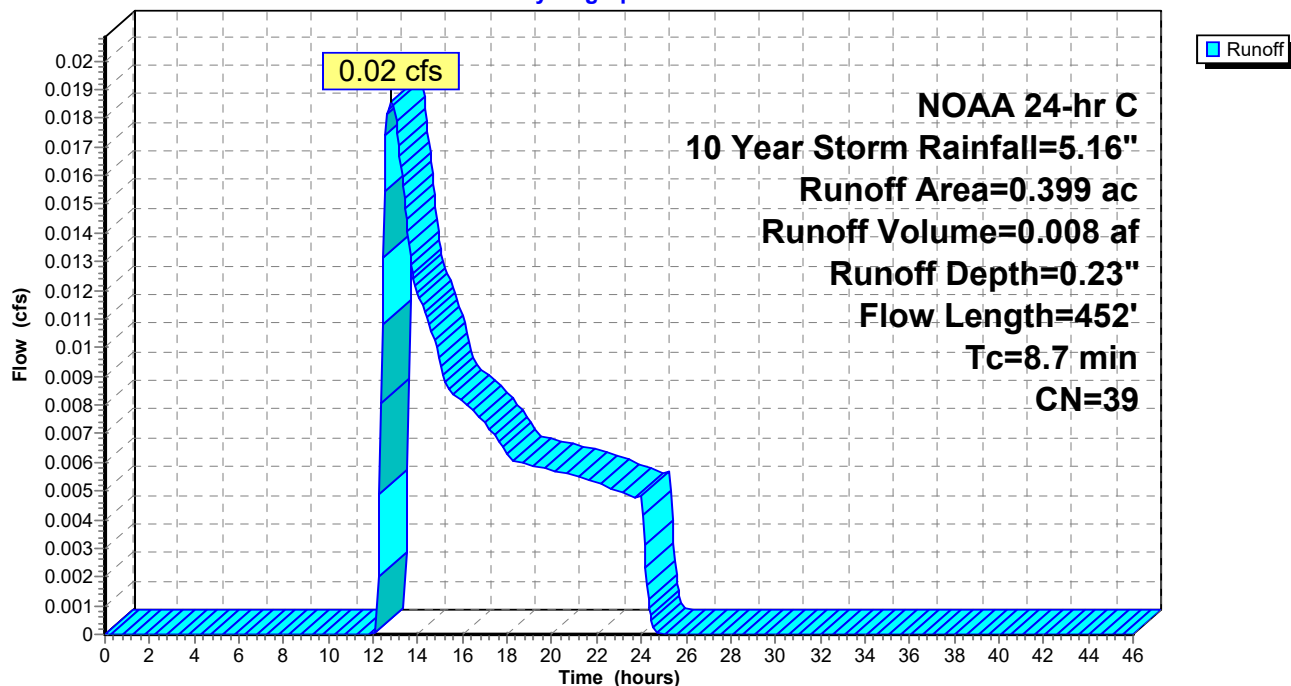
Area (ac)	CN	Description
0.399	39	>75% Grass cover, Good, HSG A
0.399		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	52	0.0252	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
1.1	400	0.0150	6.26	62.64	<b>Parabolic Channel,</b> W=15.00' D=1.00' Area=10.0 sf Perim=15.2' n= 0.022 Earth, clean & straight
8.7	452	Total			

**Subcatchment UD: Undetained Runoff**

Hydrograph



**Summary for Subcatchment WS 1I: Watershed #1 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

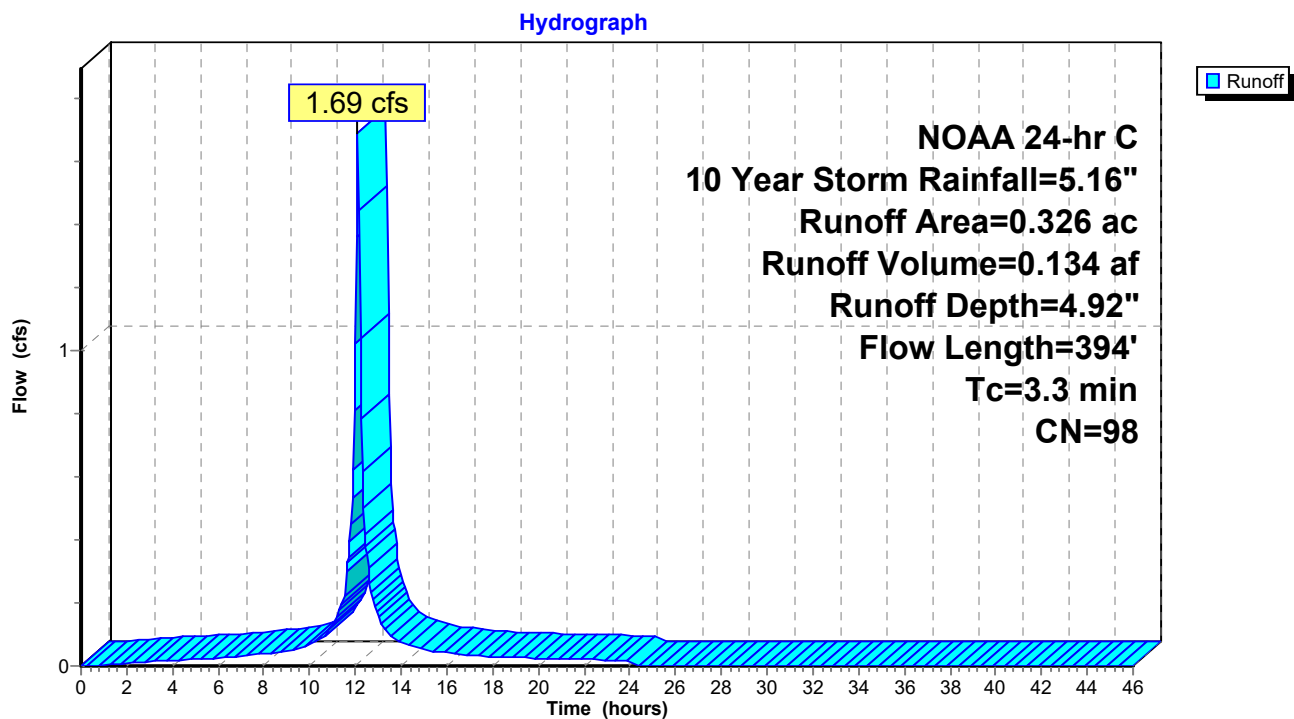
Runoff = 1.69 cfs @ 12.10 hrs, Volume= 0.134 af, Depth= 4.92"  
 Routed to Pond 1P : Basin #1

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Area (ac)	CN	Description
0.326	98	Paved parking, HSG A
0.326		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	33	0.0200	1.12		<b>Sheet Flow, Paved Sheet Flow</b> Smooth surfaces $n=0.011$ $P2=3.31"$
2.7	331	0.0100	2.03		<b>Shallow Concentrated Flow, Paved Flow</b> Paved $K_v=20.3$ fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass to Basin Flow</b> Grassed Waterway $K_v=15.0$ fps
3.3	394	Total			

**Subcatchment WS 1I: Watershed #1 Post-Dev Impervious**

**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Printed 6/8/2022

Page 36

**Summary for Subcatchment WS 1P: Watershed #1 Post-Dev Pervious**

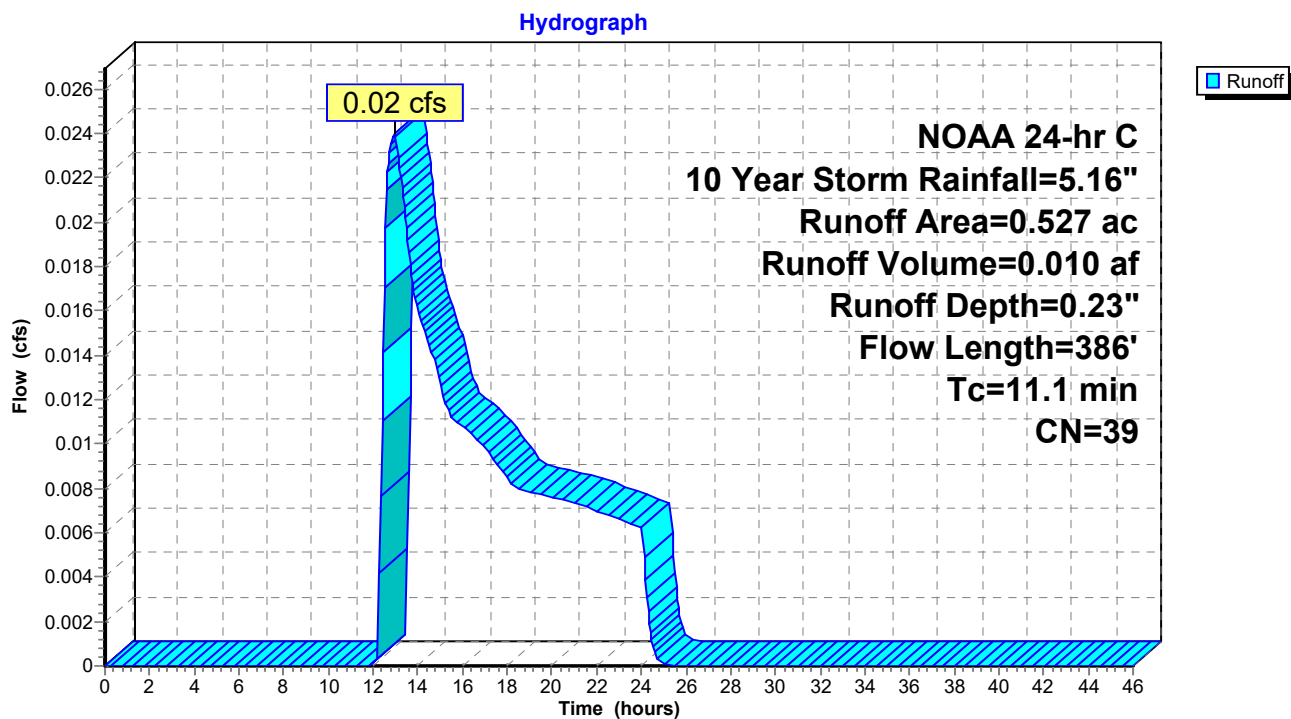
Runoff = 0.02 cfs @ 12.94 hrs, Volume= 0.010 af, Depth= 0.23"  
Routed to Pond 1P : Basin #1

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Area (ac)	CN	Description
0.527	39	>75% Grass cover, Good, HSG A
0.527		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	55	0.0212	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
2.5	301	0.0100	2.03		<b>Shallow Concentrated Flow, Driveway Flow</b> Paved Kv= 20.3 fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass Flow to Basin</b> Grassed Waterway Kv= 15.0 fps
11.1	386	Total			

**Subcatchment WS 1P: Watershed #1 Post-Dev Pervious**

**Summary for Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

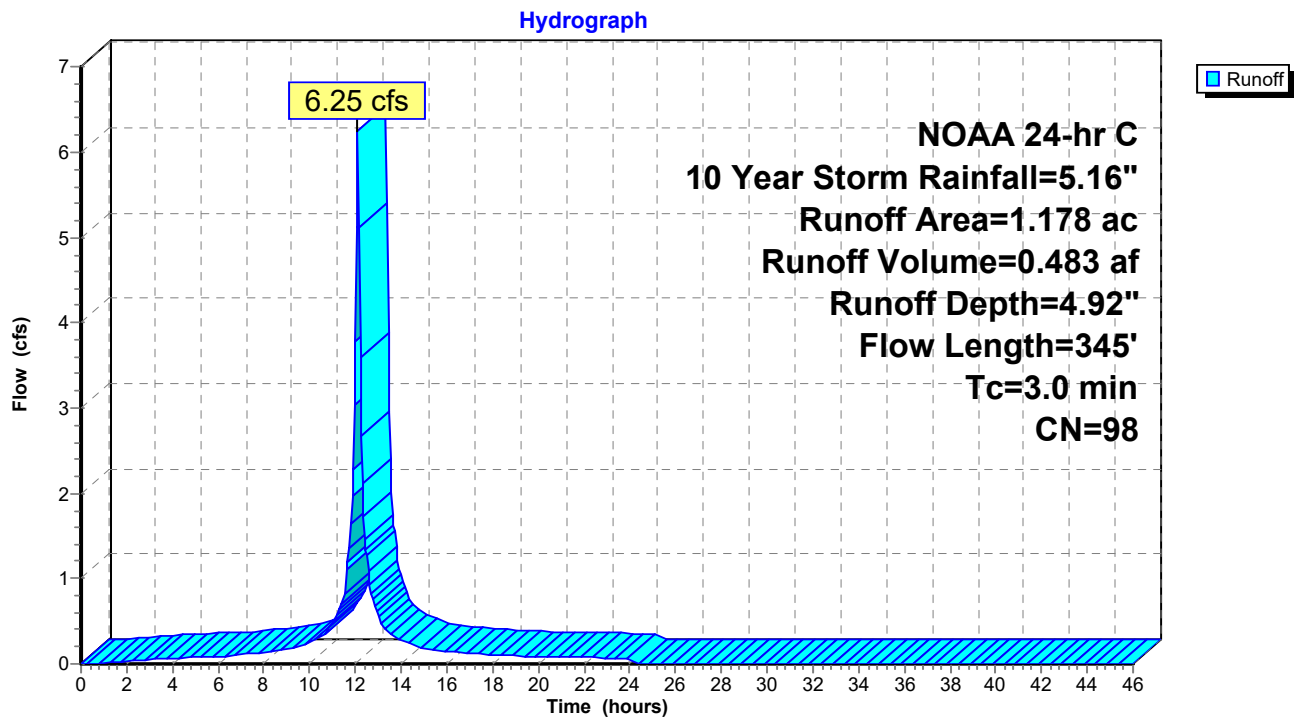
Runoff = 6.25 cfs @ 12.10 hrs, Volume= 0.483 af, Depth= 4.92"  
 Routed to Pond 2P : Basin #2

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Area (ac)	CN	Description
1.178	98	Paved parking, HSG A
1.178		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	33	0.0321	1.35		<b>Sheet Flow, Sheet Flow Grass</b> Smooth surfaces n= 0.011 P2= 3.31"
2.6	312	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved Kv= 20.3 fps
3.0	345	Total			

**Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**

### Summary for Subcatchment WS 2P: Watershed #2 Post-Dev Pervious

Runoff = 0.05 cfs @ 12.94 hrs, Volume= 0.020 af, Depth= 0.23"  
Routed to Pond 2P : Basin #2

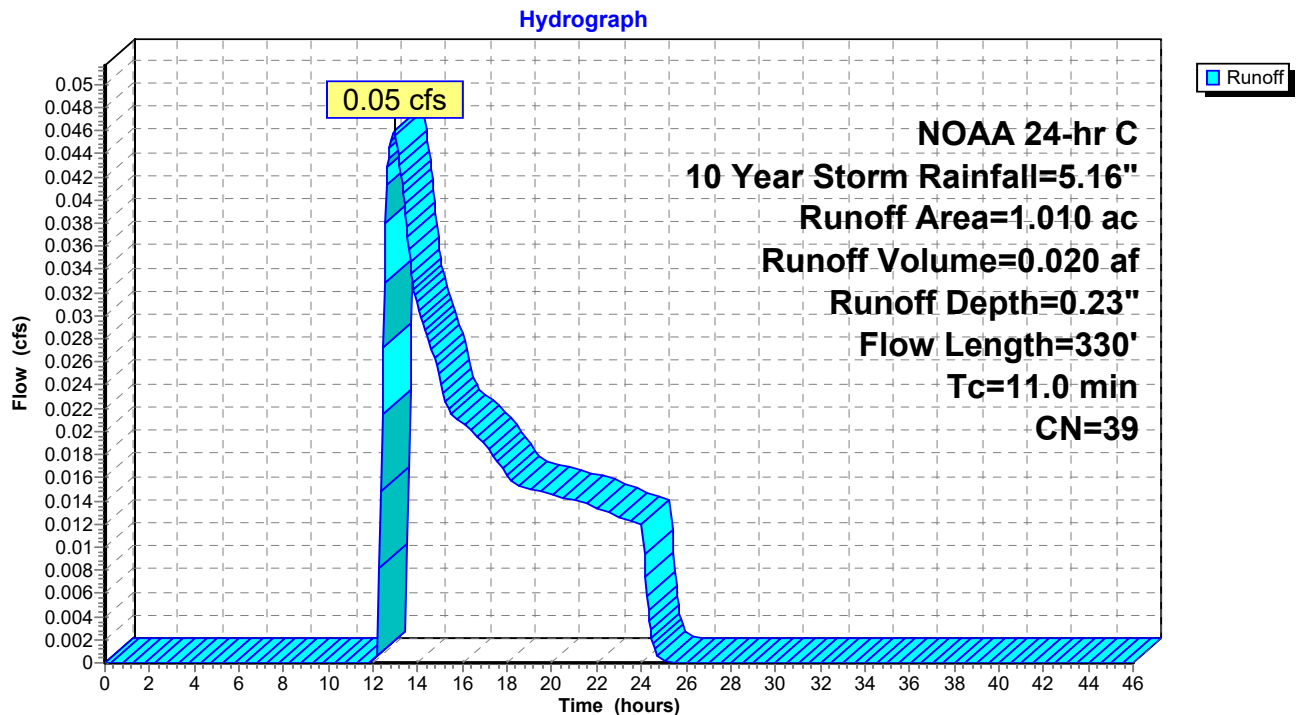
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Area (ac)	CN	Description
1.010	39	>75% Grass cover, Good, HSG A
1.010		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	57	0.0210	0.11		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
2.2	273	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved Kv= 20.3 fps
11.0	330	Total			

### Subcatchment WS 2P: Watershed #2 Post-Dev Pervious



**Summary for Subcatchment WS 3I: Watershed #3 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

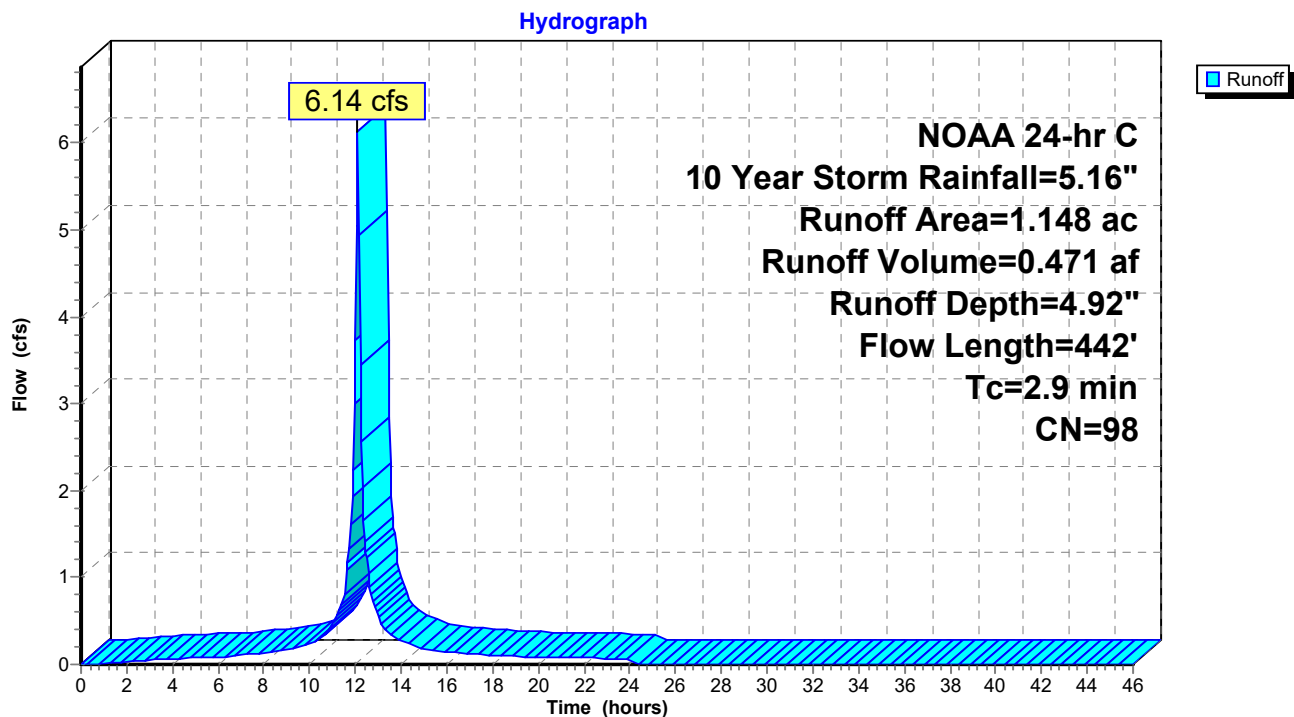
Runoff = 6.14 cfs @ 12.10 hrs, Volume= 0.471 af, Depth= 4.92"  
 Routed to Pond 3P : Basin #3

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Area (ac)	CN	Description
1.148	98	Paved parking, HSG A
1.148		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	200	0.0050	1.44		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.6	242	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.9	442	Total			

**Subcatchment WS 3I: Watershed #3 Post-Dev Impervious**

**Summary for Subcatchment WS 3P: Watershed #3 Post-Dev Pervious**

Runoff = 0.75 cfs @ 12.17 hrs, Volume= 0.082 af, Depth= 0.94"  
 Routed to Pond 3P : Basin #3

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

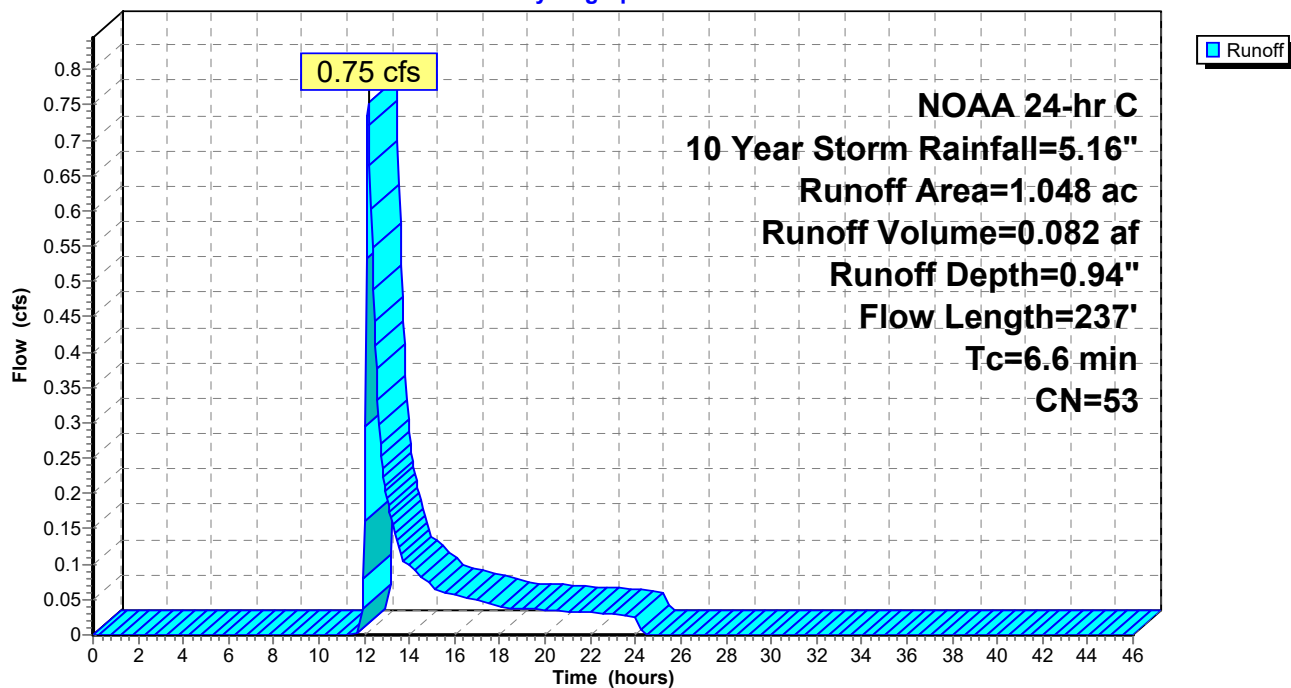
Area (ac)	CN	Description
0.374	39	>75% Grass cover, Good, HSG A
0.674	61	>75% Grass cover, Good, HSG B
1.048	53	Weighted Average
1.048		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	35	0.0330	0.12		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
1.6	202	0.0189	2.06		<b>Shallow Concentrated Flow, Grass Flow</b> Grassed Waterway Kv= 15.0 fps
6.6	237	Total			

**Subcatchment WS 3P: Watershed #3 Post-Dev Pervious**

Hydrograph



**Summary for Subcatchment WS 4I: Watershed #4 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

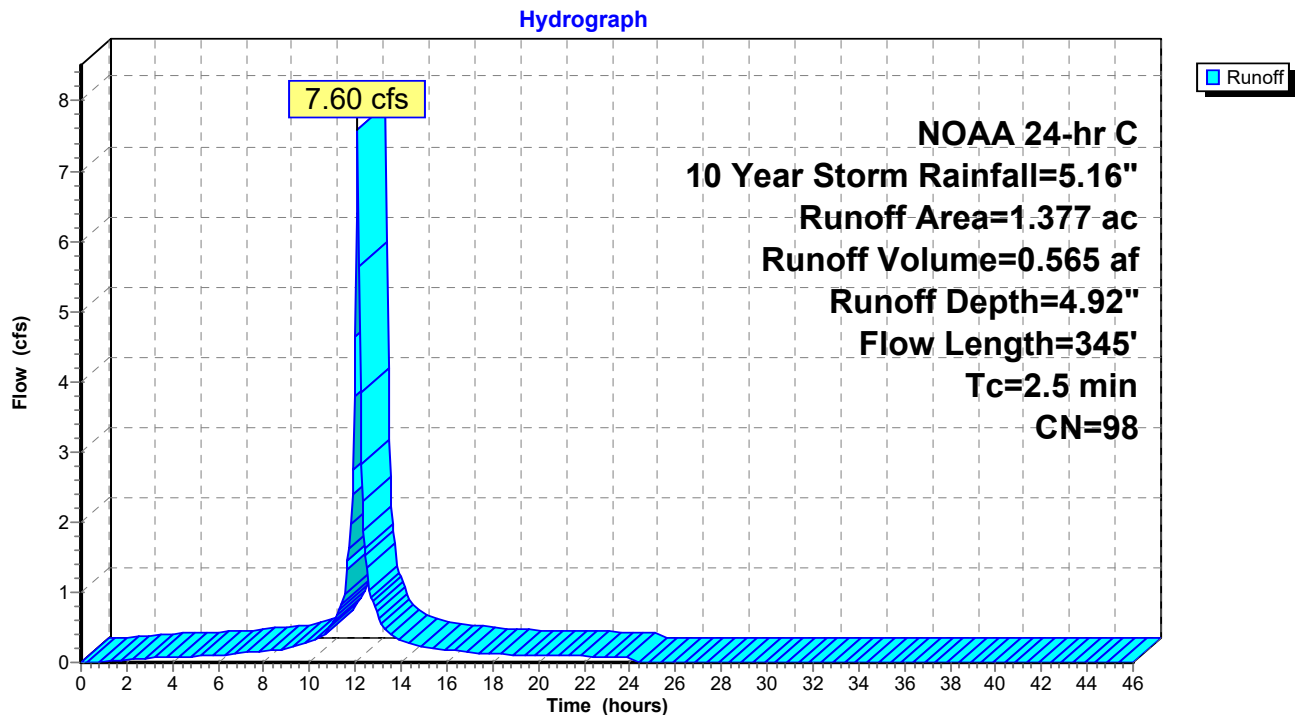
Runoff = 7.60 cfs @ 12.09 hrs, Volume= 0.565 af, Depth= 4.92"  
 Routed to Pond 4P : Basin #4

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Area (ac)	CN	Description
1.377	98	Paved parking, HSG A
1.377		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	180	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.4	165	0.0080	6.28	11.10	<b>Pipe Channel, RCP_Round 18"</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.5	345	Total			

**Subcatchment WS 4I: Watershed #4 Post-Dev Impervious**



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Printed 6/8/2022

Page 42

**Summary for Subcatchment WS 4P: Watershed #4 Post-Dev Pervious**

Runoff = 0.71 cfs @ 12.16 hrs, Volume= 0.062 af, Depth= 1.47"  
Routed to Pond 4P : Basin #4

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 10 Year Storm Rainfall=5.16"

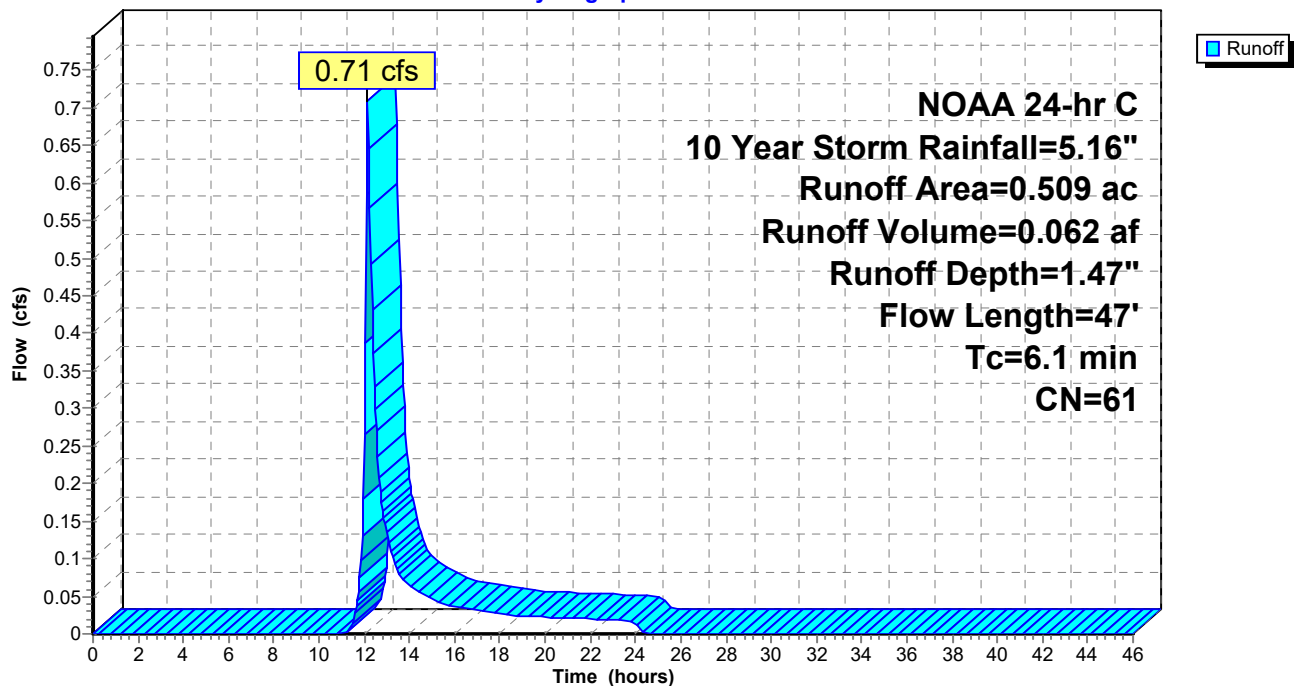
Area (ac)	CN	Description
0.509	61	>75% Grass cover, Good, HSG B
0.509		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	35	0.0200	0.10		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.3300	8.62		<b>Shallow Concentrated Flow, Shallow Flow Grass</b> Grassed Waterway Kv= 15.0 fps
6.1	47	Total			

**Subcatchment WS 4P: Watershed #4 Post-Dev Pervious**

Hydrograph



**Summary for Subcatchment WS 5I: Watershed #5 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

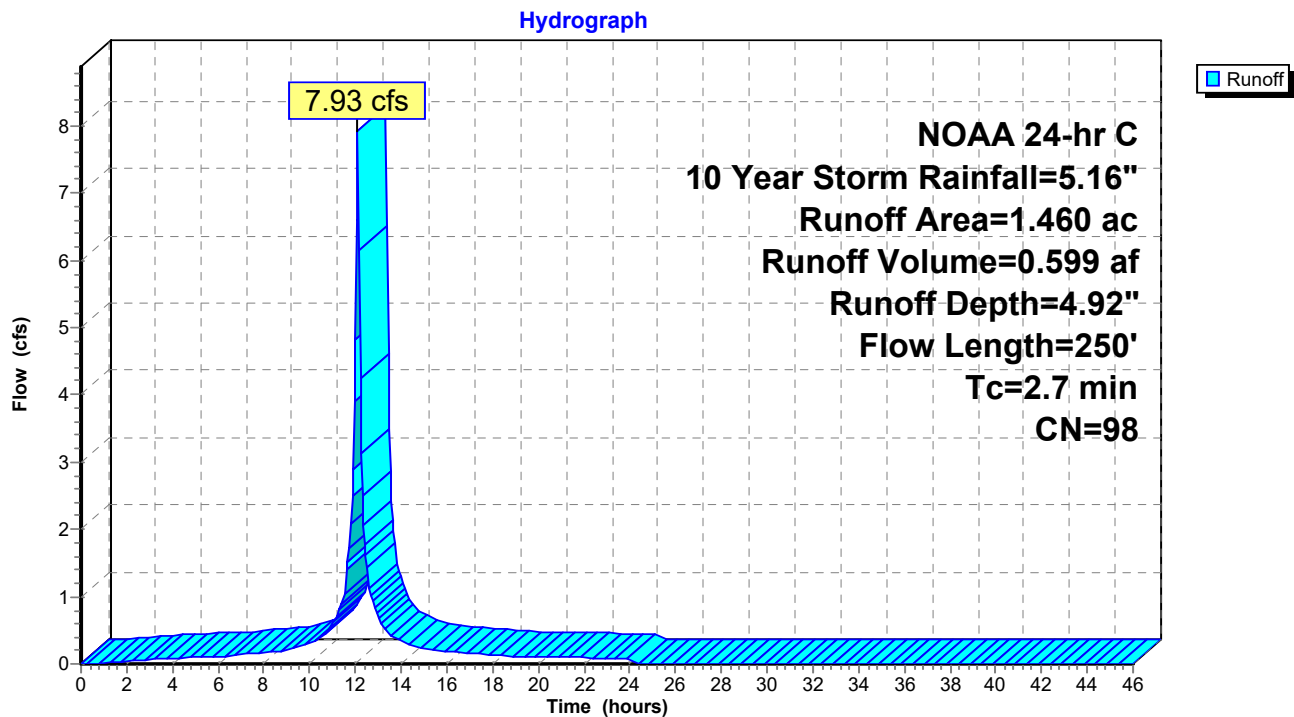
Runoff = 7.93 cfs @ 12.10 hrs, Volume= 0.599 af, Depth= 4.92"  
 Routed to Pond 5P : Basin #5

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Area (ac)	CN	Description
1.460	98	Paved parking, HSG A
1.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	230	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.0	20	0.2500	8.05		<b>Shallow Concentrated Flow, Stone Slope Flow</b> Unpaved Kv= 16.1 fps
2.7	250	Total			

**Subcatchment WS 5I: Watershed #5 Post-Dev Impervious**

**Summary for Subcatchment WS 5P: Watershed #5 Post-Dev Pervious**

Runoff = 0.29 cfs @ 12.23 hrs, Volume= 0.048 af, Depth= 0.59"  
 Routed to Pond 5P : Basin #5

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 10 Year Storm Rainfall=5.16"

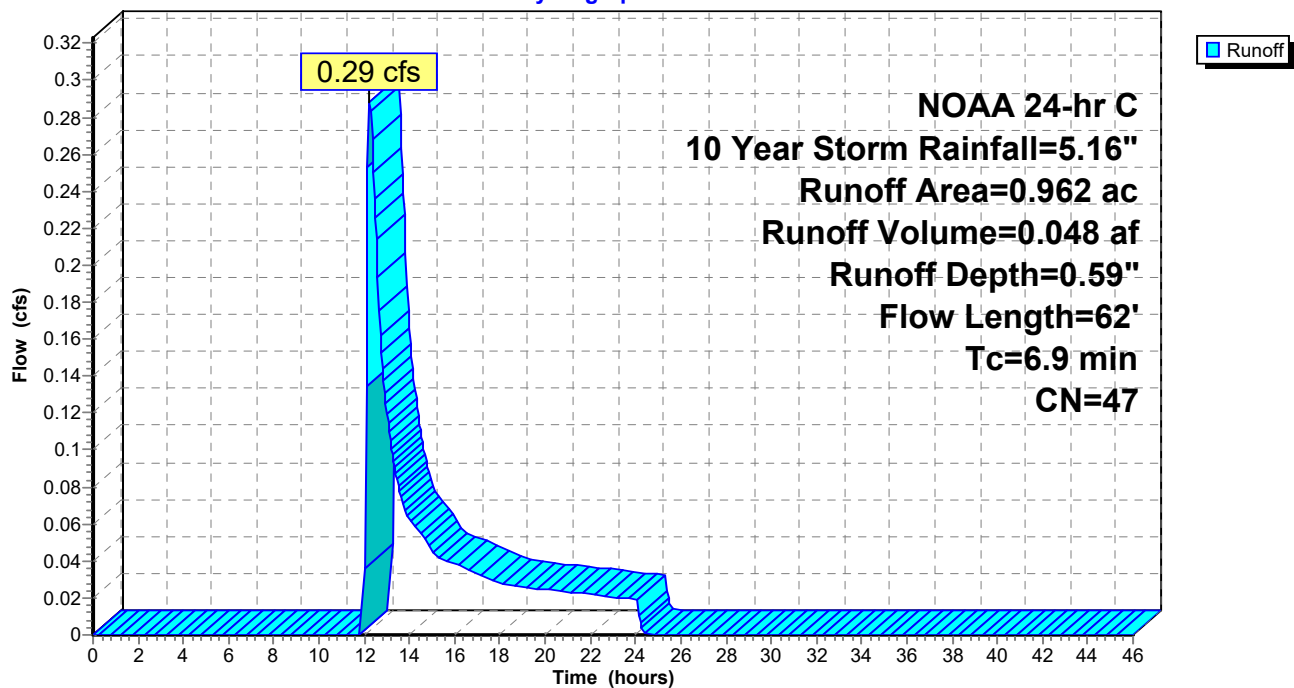
Area (ac)	CN	Description
0.593	39	>75% Grass cover, Good, HSG A
0.369	61	>75% Grass cover, Good, HSG B
0.962	47	Weighted Average
0.962		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	50	0.0300	0.12		<b>Sheet Flow, Grass Sheet Flow</b>
					Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.2500	7.50		<b>Shallow Concentrated Flow, Grass Shallow Flow</b>
					Grassed Waterway Kv= 15.0 fps
6.9	62	Total			

**Subcatchment WS 5P: Watershed #5 Post-Dev Pervious**

Hydrograph



**Summary for Reach SW: Grassed Swale**

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 0.00" for 10 Year Storm event  
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min  
Routed to Link DP : DISCHARGE POINT

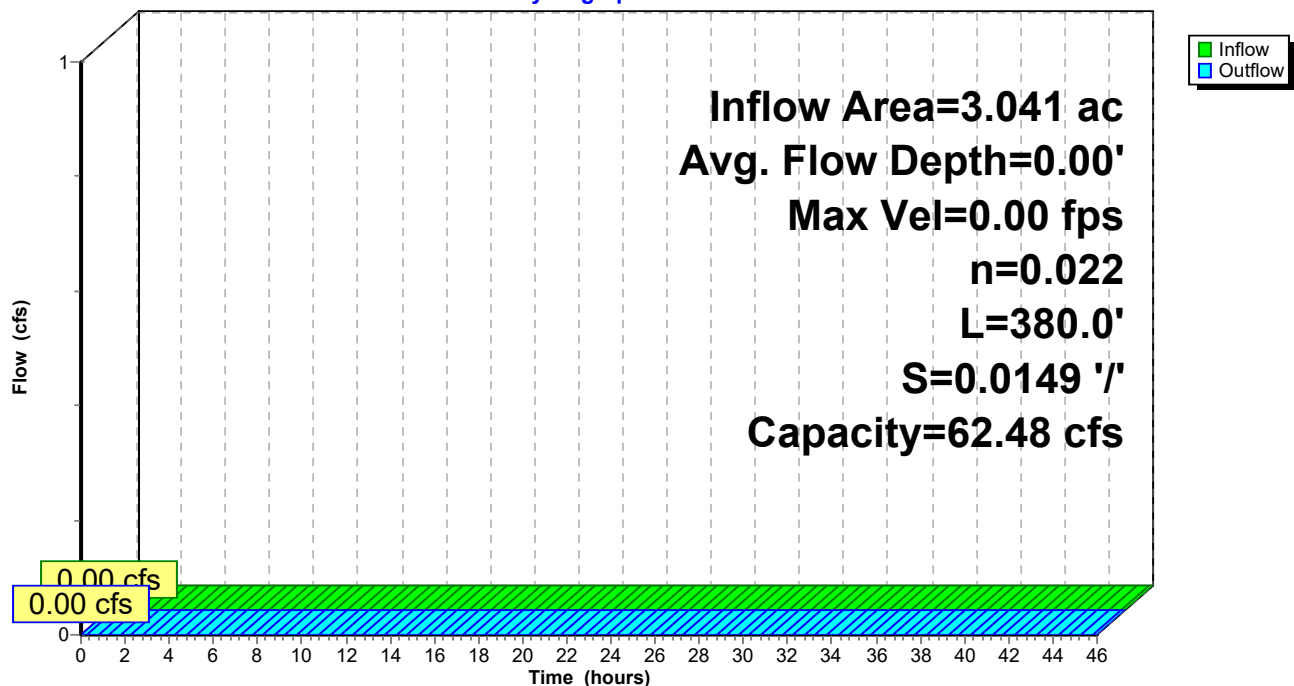
Routing by Stor-Ind+Trans method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min  
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs  
Average Depth at Peak Storage= 0.00'  
Bank-Full Depth= 1.00' Flow Area= 10.0 sf, Capacity= 62.48 cfs

15.00' x 1.00' deep Parabolic Channel, n= 0.022 Earth, clean & straight  
Length= 380.0' Slope= 0.0149 '/'  
Inlet Invert= 12.67', Outlet Invert= 7.00'

**Reach SW: Grassed Swale**

Hydrograph



**Zemac Self Storage**

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 46

**Summary for Pond 1P: Basin #1**

Inflow Area = 0.853 ac, 38.22% Impervious, Inflow Depth = 2.03" for 10 Year Storm event  
 Inflow = 1.69 cfs @ 12.10 hrs, Volume= 0.144 af  
 Outflow = 0.34 cfs @ 12.55 hrs, Volume= 0.059 af, Atten= 80%, Lag= 26.6 min  
 Primary = 0.34 cfs @ 12.55 hrs, Volume= 0.059 af  
 Routed to Pond 2P : Basin #2

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 13.04' @ 12.55 hrs Surf.Area= 3,009 sf Storage= 3,834 cf

Plug-Flow detention time= 358.7 min calculated for 0.059 af (41% of inflow)  
 Center-of-Mass det. time= 190.9 min ( 958.1 - 767.2 )

Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	9,711 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
11.00	903	0	0
12.00	1,785	1,344	1,344
13.00	2,965	2,375	3,719
14.00	4,120	3,543	7,262
14.50	5,678	2,450	9,711

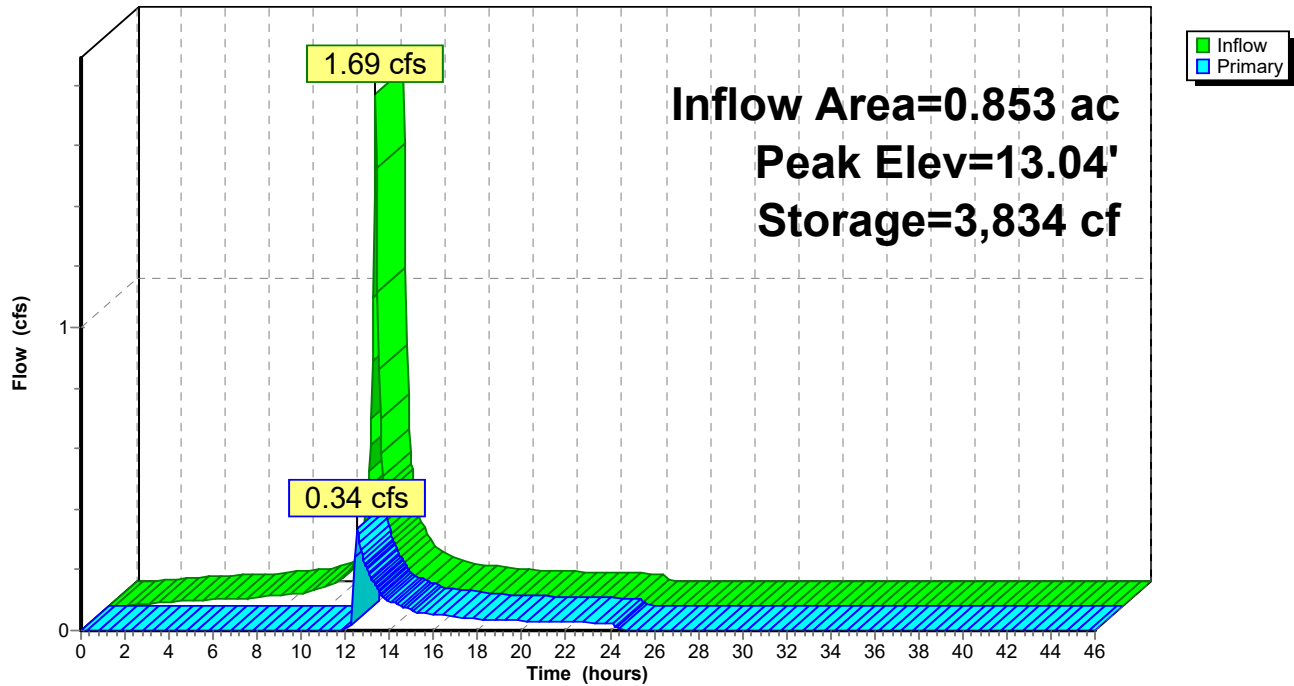
Device	Routing	Invert	Outlet Devices
#1	Primary	11.10'	<b>15.0" Round Culvert</b> L= 750.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 11.10' / 11.10' S= 0.0000 ' S= 0.0000 ' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	13.00'	<b>48.0" x 30.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.32 cfs @ 12.55 hrs HW=13.04' (Free Discharge)

↑ **1=Culvert** (Passes 0.32 cfs of 1.88 cfs potential flow)  
 ↑ **2=Orifice/Grate** (Weir Controls 0.32 cfs @ 0.64 fps)

**Pond 1P: Basin #1**

**Hydrograph**



**Zemac Self Storage**

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 48

**Summary for Pond 2P: Basin #2**

[79] Warning: Submerged Pond 1P Primary device # 1 by 1.53'

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 2.22" for 10 Year Storm event  
 Inflow = 6.25 cfs @ 12.10 hrs, Volume= 0.562 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Reach SW : Grassed Swale

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 12.63' @ 27.50 hrs Surf.Area= 14,909 sf Storage= 24,461 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	10.67'	47,407 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.67	10,000	0	0
11.00	11,128	3,486	3,486
12.00	13,213	12,171	15,657
13.00	15,922	14,568	30,224
14.00	18,444	17,183	47,407

Device	Routing	Invert	Outlet Devices
#1	Primary	12.67'	<b>7.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=10.67' (Free Discharge)  
 ↑1=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

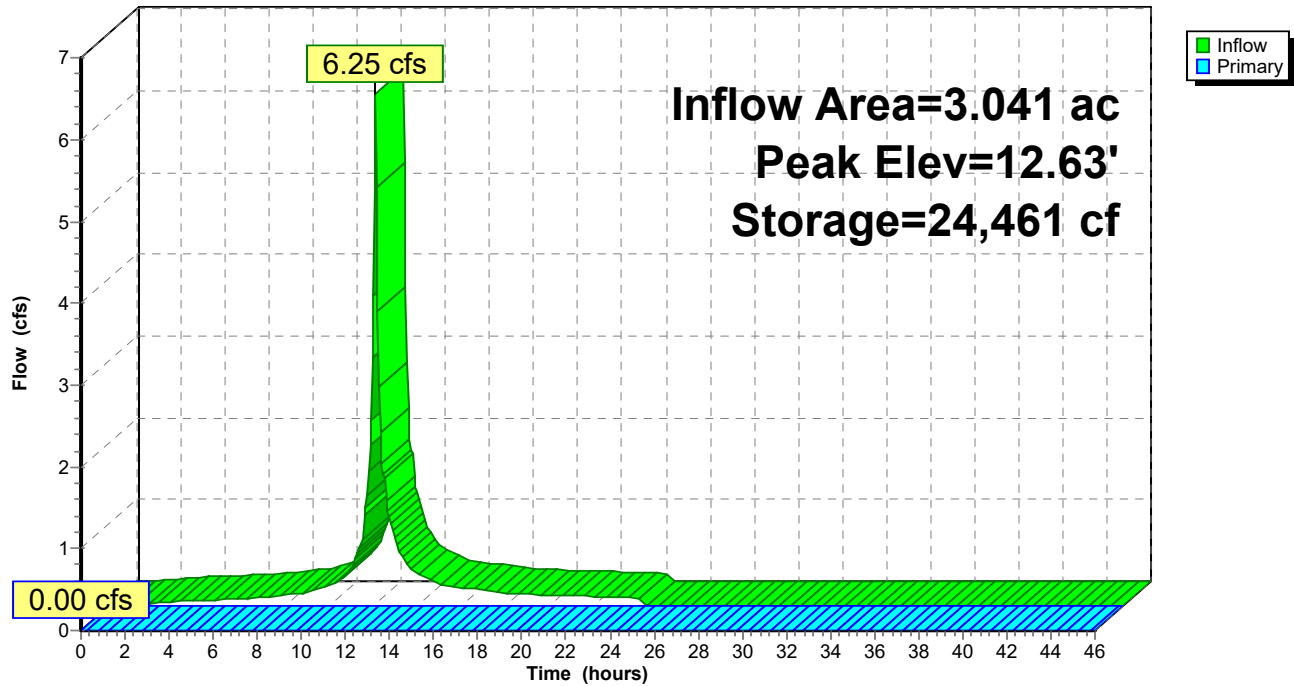
NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Printed 6/8/2022

Page 49

### Pond 2P: Basin #2

Hydrograph





**Zemac Self Storage**

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 50

**Summary for Pond 3P: Basin #3**

Inflow Area = 2.196 ac, 52.28% Impervious, Inflow Depth = 3.02" for 10 Year Storm event  
 Inflow = 6.68 cfs @ 12.10 hrs, Volume= 0.553 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Pond 4P : Basin #4

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 10.78' @ 24.80 hrs Surf.Area= 13,672 sf Storage= 24,075 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	41,842 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,985	0	0
9.00	10,988	2,097	2,097
10.00	12,493	11,741	13,838
11.00	14,000	13,247	27,084
12.00	15,516	14,758	41,842

Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=8.80' (Free Discharge)

↑1=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

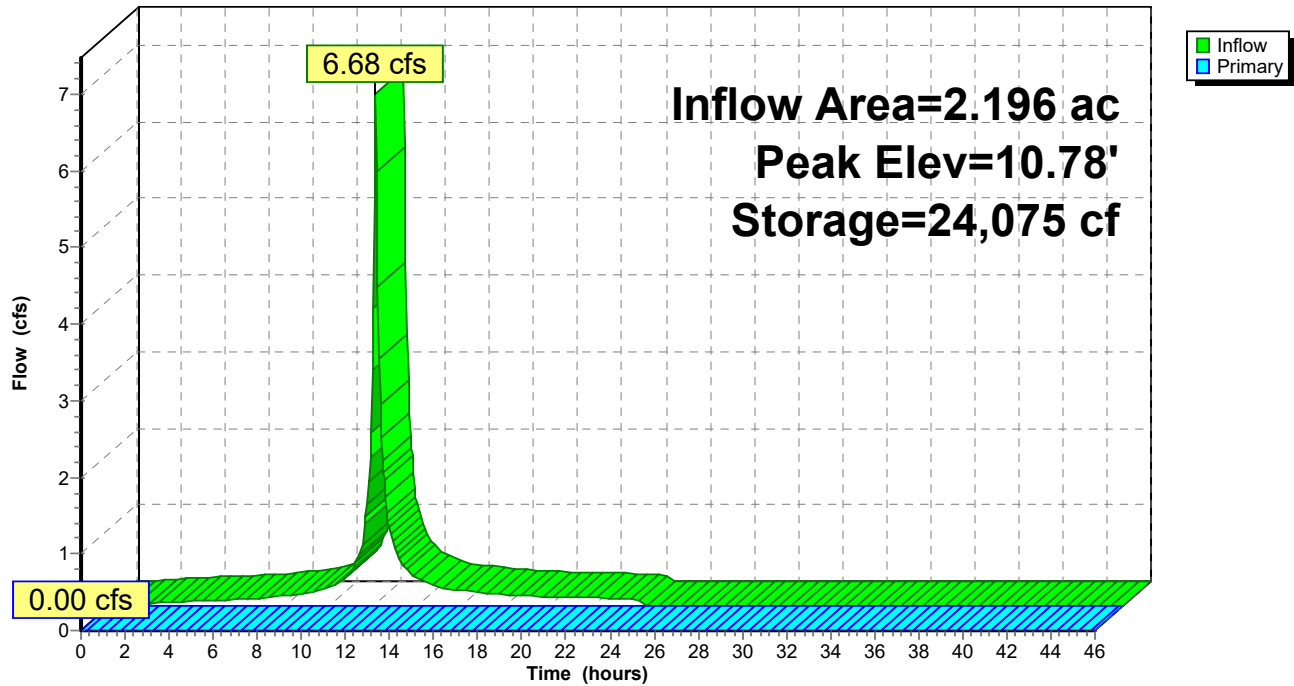
NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Printed 6/8/2022

Page 51

### Pond 3P: Basin #3

#### Hydrograph



**Zemac Self Storage**

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 52

**Summary for Pond 4P: Basin #4**

[81] Warning: Exceeded Pond 3P by 0.31' @ 15.95 hrs

Inflow Area = 4.082 ac, 61.86% Impervious, Inflow Depth = 1.84" for 10 Year Storm event  
 Inflow = 8.17 cfs @ 12.10 hrs, Volume= 0.627 af  
 Outflow = 0.14 cfs @ 18.04 hrs, Volume= 0.092 af, Atten= 98%, Lag= 356.6 min  
 Primary = 0.14 cfs @ 18.04 hrs, Volume= 0.092 af  
 Routed to Pond 5P : Basin #5

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 10.86' @ 18.04 hrs Surf.Area= 12,959 sf Storage= 24,040 cf

Plug-Flow detention time= 819.5 min calculated for 0.092 af (15% of inflow)  
 Center-of-Mass det. time= 496.3 min ( 1,255.9 - 759.6 )

Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	39,735 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

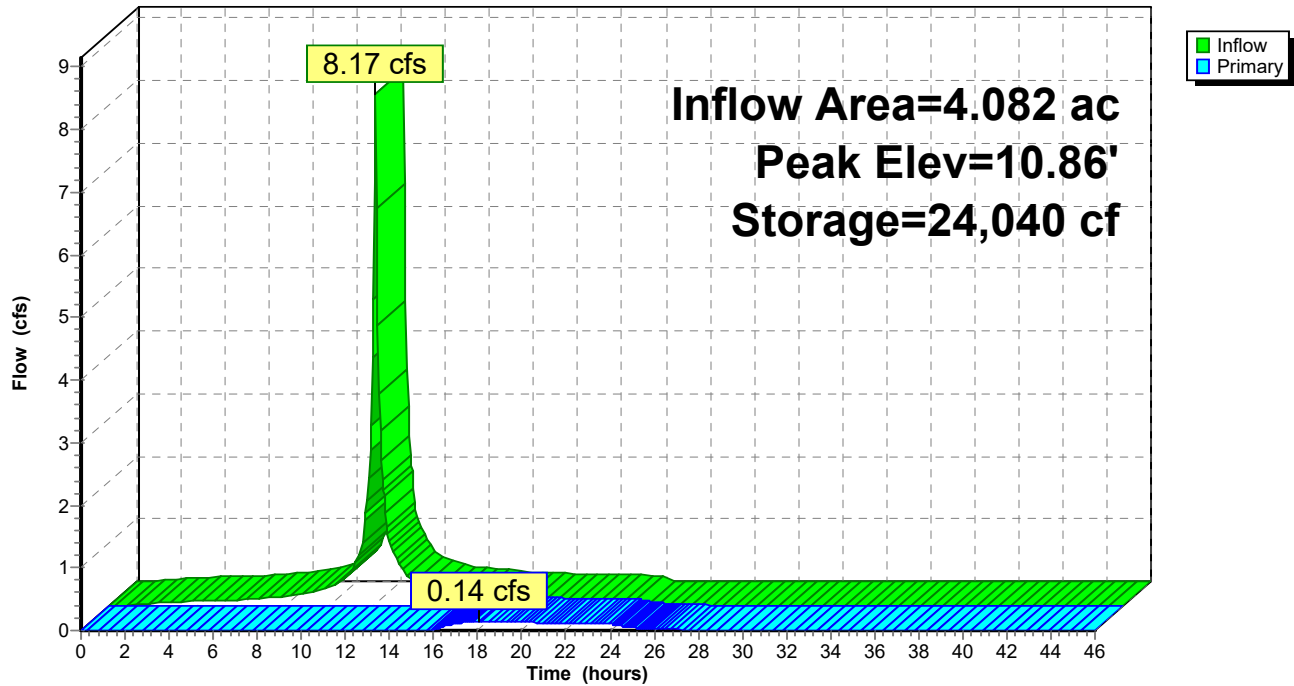
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,996	0	0
9.00	10,421	2,042	2,042
10.00	12,121	11,271	13,313
11.00	13,100	12,611	25,923
12.00	14,523	13,812	39,735

Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=0.14 cfs @ 18.04 hrs HW=10.86' (Free Discharge)  
 ↑1=Broad-Crested Rectangular Weir (Weir Controls 0.14 cfs @ 0.63 fps)

**Pond 4P: Basin #4**

**Hydrograph**



**Zemac Self Storage**

NOAA 24-hr C 10 Year Storm Rainfall=5.16"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 54

**Summary for Pond 5P: Basin #5**

Inflow Area = 6.504 ac, 61.27% Impervious, Inflow Depth = 1.36" for 10 Year Storm event  
 Inflow = 8.06 cfs @ 12.10 hrs, Volume= 0.738 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Link DP : DISCHARGE POINT

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 10.26' @ 46.00 hrs Surf.Area= 27,547 sf Storage= 32,161 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	84,099 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
9.00	23,222	0	0
10.00	26,875	25,049	25,049
11.00	29,445	28,160	53,209
12.00	32,336	30,891	84,099

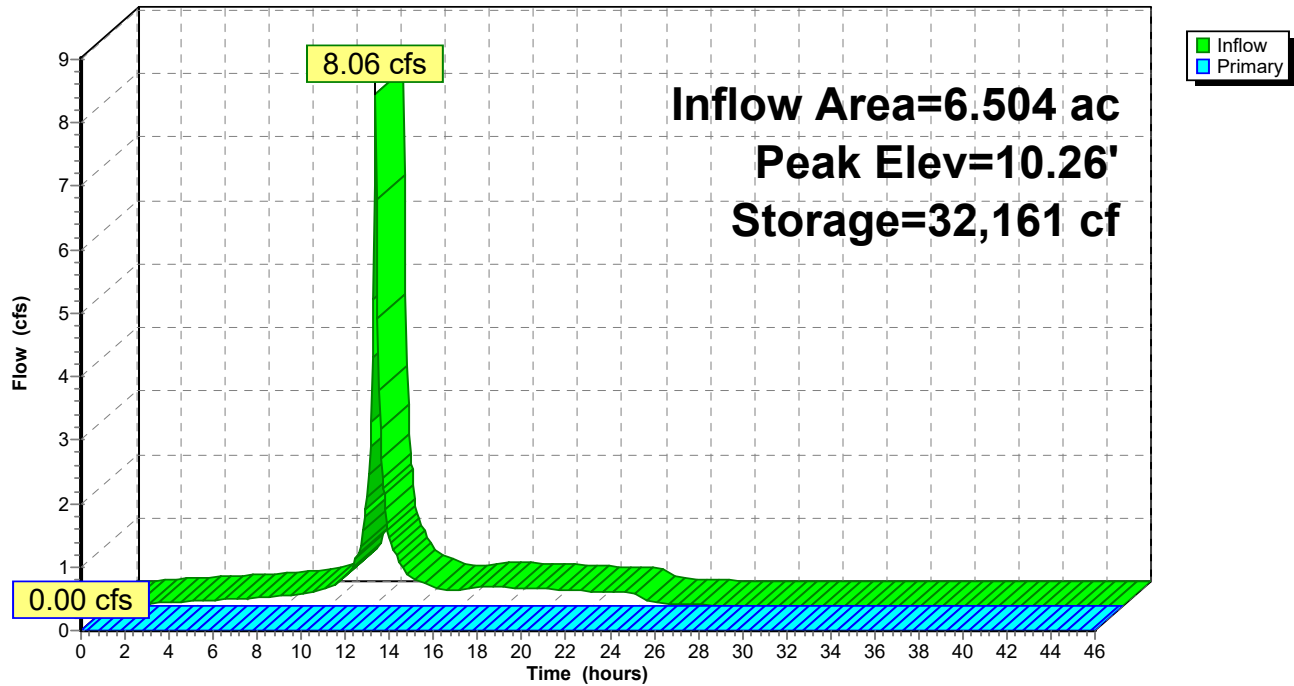
Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	<b>4.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=9.00' (Free Discharge)

↑1=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

**Pond 5P: Basin #5**

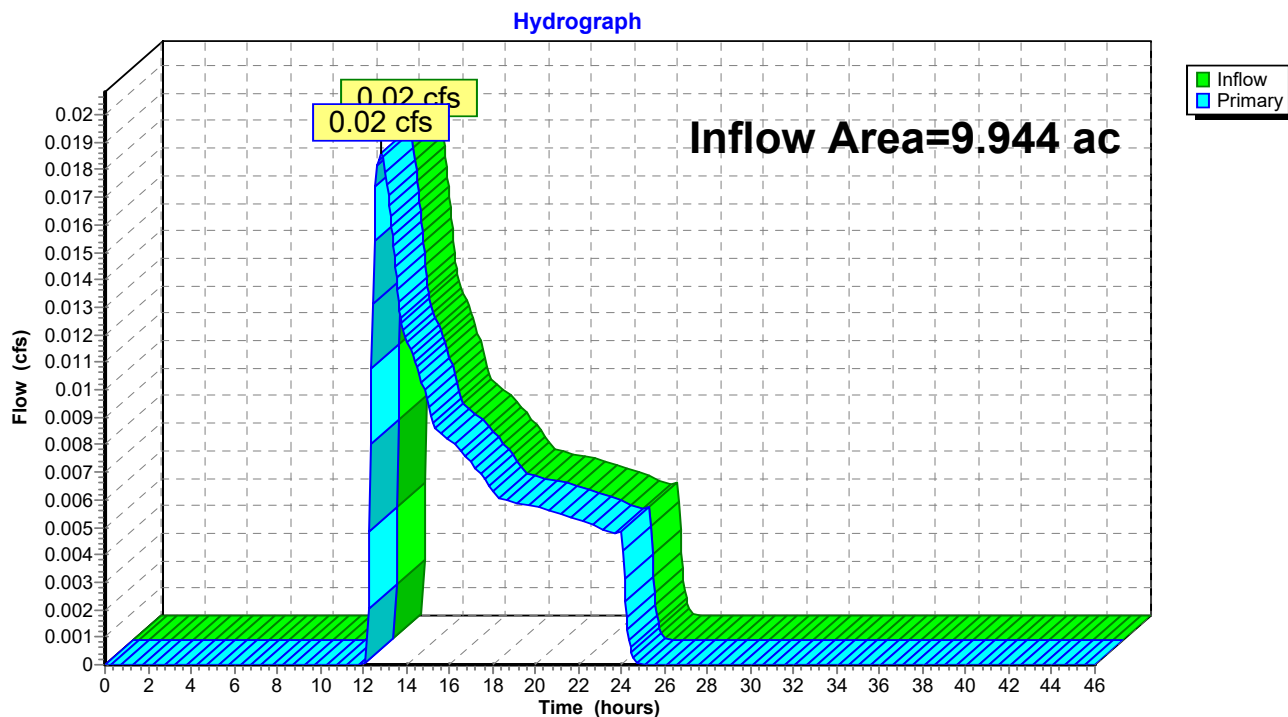
**Hydrograph**



**Summary for Link DP: DISCHARGE POINT**

Inflow Area = 9.944 ac, 55.20% Impervious, Inflow Depth = 0.01" for 10 Year Storm event  
Inflow = 0.02 cfs @ 12.84 hrs, Volume= 0.008 af  
Primary = 0.02 cfs @ 12.84 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs

**Link DP: DISCHARGE POINT**

**Zemac Self Storage**

NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 57

Time span=0.00-46.00 hrs, dt=0.05 hrs, 921 points  
 Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>Subcatchment UD: Undetained Runoff</b>	Runoff Area=0.399 ac 0.00% Impervious Runoff Depth=1.56" Flow Length=452' Tc=8.7 min CN=39 Runoff=0.40 cfs 0.052 af
<b>Subcatchment WS 1I: Watershed #1</b>	Runoff Area=0.326 ac 100.00% Impervious Runoff Depth=8.66" Flow Length=394' Tc=3.3 min CN=98 Runoff=2.93 cfs 0.235 af
<b>Subcatchment WS 1P: Watershed #1</b>	Runoff Area=0.527 ac 0.00% Impervious Runoff Depth=1.56" Flow Length=386' Tc=11.1 min CN=39 Runoff=0.47 cfs 0.068 af
<b>Subcatchment WS 2I: Watershed #2</b>	Runoff Area=1.178 ac 100.00% Impervious Runoff Depth=8.66" Flow Length=345' Tc=3.0 min CN=98 Runoff=10.82 cfs 0.850 af
<b>Subcatchment WS 2P: Watershed #2</b>	Runoff Area=1.010 ac 0.00% Impervious Runoff Depth=1.56" Flow Length=330' Tc=11.0 min CN=39 Runoff=0.90 cfs 0.131 af
<b>Subcatchment WS 3I: Watershed #3</b>	Runoff Area=1.148 ac 100.00% Impervious Runoff Depth=8.66" Flow Length=442' Tc=2.9 min CN=98 Runoff=10.62 cfs 0.828 af
<b>Subcatchment WS 3P: Watershed #3</b>	Runoff Area=1.048 ac 0.00% Impervious Runoff Depth=3.18" Flow Length=237' Tc=6.6 min CN=53 Runoff=3.21 cfs 0.277 af
<b>Subcatchment WS 4I: Watershed #4</b>	Runoff Area=1.377 ac 100.00% Impervious Runoff Depth=8.66" Flow Length=345' Tc=2.5 min CN=98 Runoff=13.15 cfs 0.994 af
<b>Subcatchment WS 4P: Watershed #4</b>	Runoff Area=0.509 ac 0.00% Impervious Runoff Depth=4.14" Flow Length=47' Tc=6.1 min CN=61 Runoff=2.15 cfs 0.176 af
<b>Subcatchment WS 5I: Watershed #5</b>	Runoff Area=1.460 ac 100.00% Impervious Runoff Depth=8.66" Flow Length=250' Tc=2.7 min CN=98 Runoff=13.72 cfs 1.054 af
<b>Subcatchment WS 5P: Watershed #5</b>	Runoff Area=0.962 ac 0.00% Impervious Runoff Depth=2.46" Flow Length=62' Tc=6.9 min CN=47 Runoff=2.12 cfs 0.198 af
<b>Reach SW: Grassed Swale</b>	Avg. Flow Depth=0.23' Max Vel=2.37 fps Inflow=2.66 cfs 0.623 af n=0.022 L=380.0' S=0.0149 '/' Capacity=62.48 cfs Outflow=2.65 cfs 0.623 af
<b>Pond 1P: Basin #1</b>	Peak Elev=13.25' Storage=4,499 cf Inflow=3.15 cfs 0.304 af Outflow=2.14 cfs 0.218 af
<b>Pond 2P: Basin #2</b>	Peak Elev=12.95' Storage=29,478 cf Inflow=13.30 cfs 1.199 af Outflow=2.66 cfs 0.623 af
<b>Pond 3P: Basin #3</b>	Peak Elev=11.14' Storage=29,028 cf Inflow=13.31 cfs 1.106 af Outflow=2.12 cfs 0.548 af
<b>Pond 4P: Basin #4</b>	Peak Elev=11.34' Storage=30,469 cf Inflow=15.00 cfs 1.717 af Outflow=4.29 cfs 1.182 af



## **Zemac Self Storage**

*NOAA 24-hr C 100 Year Storm Rainfall=8.90"*

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 58

### **Pond 5P: Basin #5**

Peak Elev=11.35' Storage=63,711 cf Inflow=15.45 cfs 2.433 af  
Outflow=2.11 cfs 1.208 af

### **Link DP: DISCHARGE POINT**

Inflow=3.04 cfs 1.882 af  
Primary=3.04 cfs 1.882 af

**Total Runoff Area = 9.944 ac   Runoff Volume = 4.863 af   Average Runoff Depth = 5.87"**  
**44.80% Pervious = 4.455 ac   55.20% Impervious = 5.489 ac**

**Summary for Subcatchment UD: Undetained Runoff**

Runoff = 0.40 cfs @ 12.22 hrs, Volume= 0.052 af, Depth= 1.56"  
 Routed to Link DP : DISCHARGE POINT

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

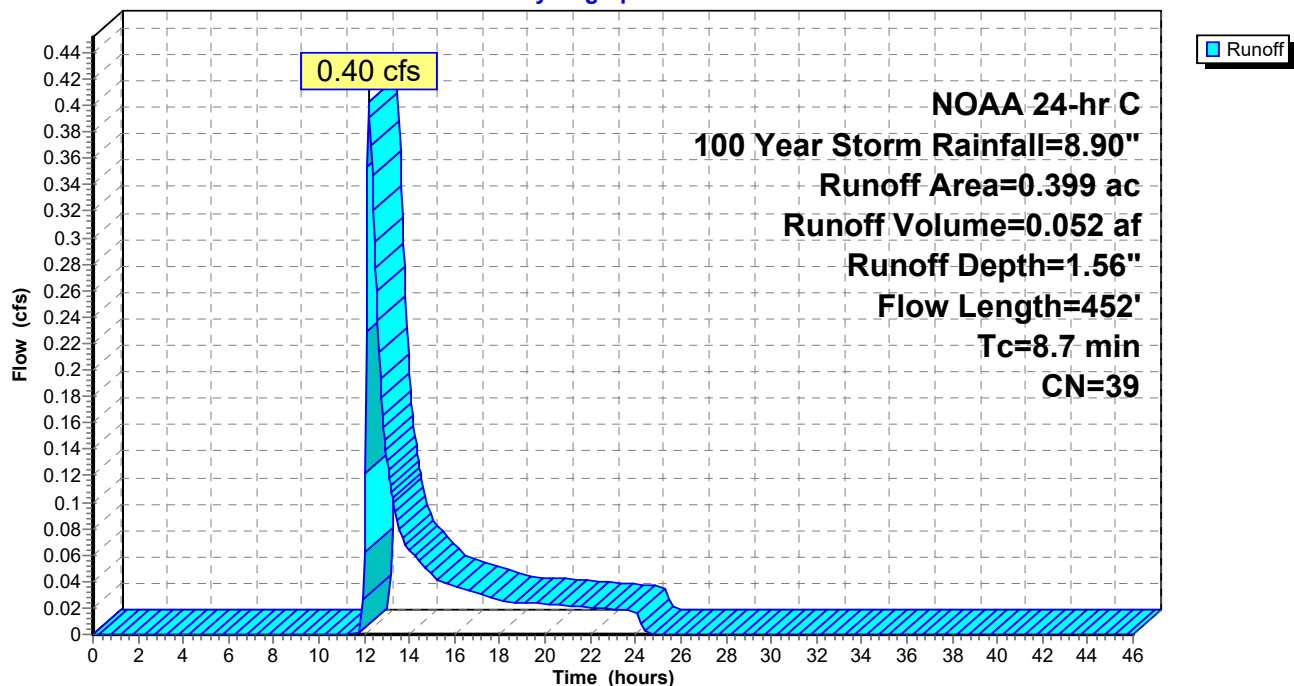
Area (ac)	CN	Description
0.399	39	>75% Grass cover, Good, HSG A
0.399		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	52	0.0252	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
1.1	400	0.0150	6.26	62.64	<b>Parabolic Channel,</b> W=15.00' D=1.00' Area=10.0 sf Perim=15.2' n= 0.022 Earth, clean & straight
8.7	452	Total			

**Subcatchment UD: Undetained Runoff**

Hydrograph



## Summary for Subcatchment WS 1I: Watershed #1 Post-Dev Impervious

[49] Hint:  $T_c < 2dt$  may require smaller  $dt$

Runoff = 2.93 cfs @ 12.10 hrs, Volume= 0.235 af, Depth= 8.66"  
Routed to Pond 1P : Basin #1

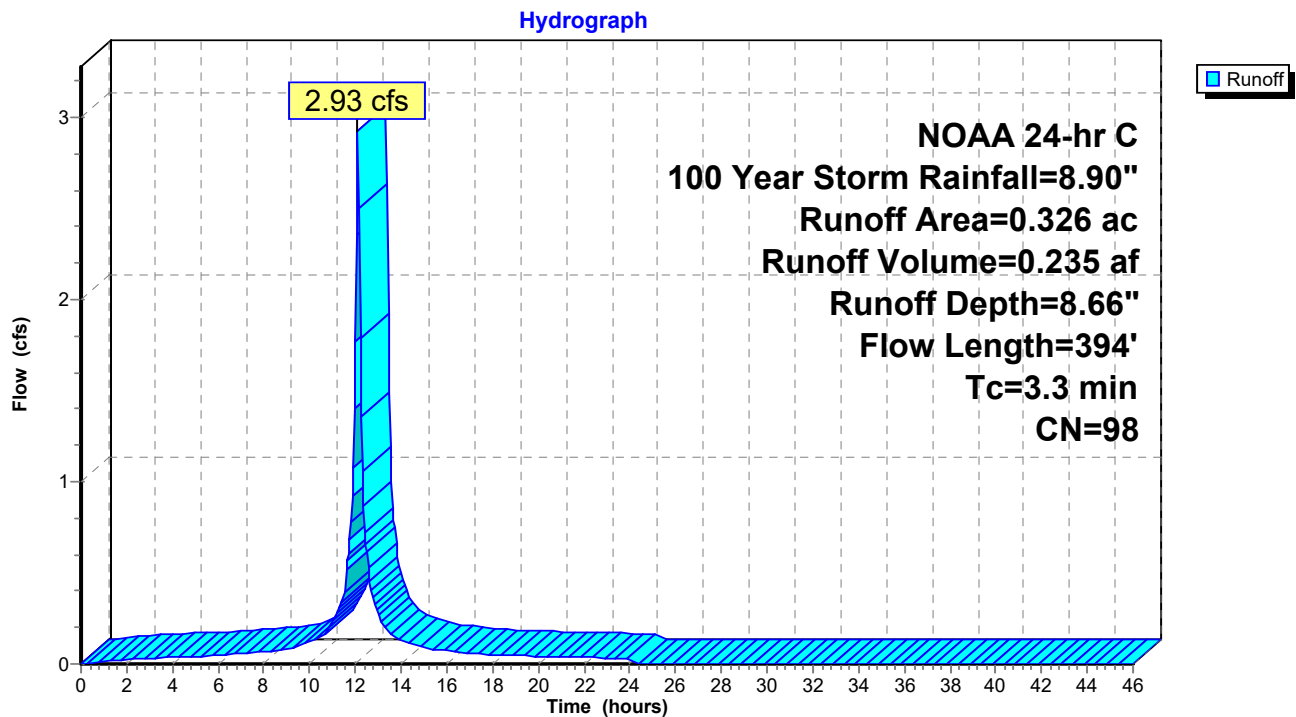
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
0.326	98	Paved parking, HSG A
0.326		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	33	0.0200	1.12		<b>Sheet Flow, Paved Sheet Flow</b> Smooth surfaces $n=0.011$ $P2=3.31"$
2.7	331	0.0100	2.03		<b>Shallow Concentrated Flow, Paved Flow</b> Paved $K_v=20.3$ fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass to Basin Flow</b> Grassed Waterway $K_v=15.0$ fps
3.3	394	Total			

## Subcatchment WS 1I: Watershed #1 Post-Dev Impervious



**Summary for Subcatchment WS 1P: Watershed #1 Post-Dev Pervious**

Runoff = 0.47 cfs @ 12.26 hrs, Volume= 0.068 af, Depth= 1.56"  
 Routed to Pond 1P : Basin #1

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

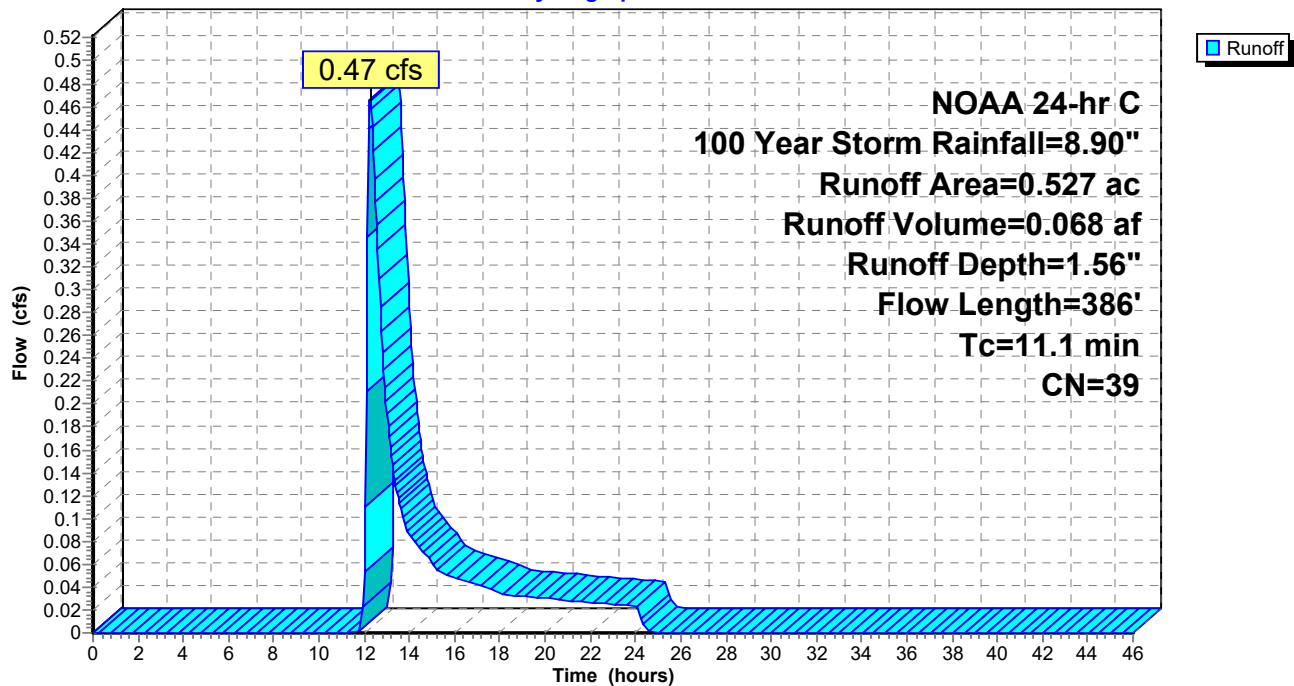
Area (ac)	CN	Description
0.527	39	>75% Grass cover, Good, HSG A
0.527		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	55	0.0212	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
2.5	301	0.0100	2.03		<b>Shallow Concentrated Flow, Driveway Flow</b> Paved Kv= 20.3 fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass Flow to Basin</b> Grassed Waterway Kv= 15.0 fps
11.1	386	Total			

**Subcatchment WS 1P: Watershed #1 Post-Dev Pervious**

Hydrograph



**Summary for Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

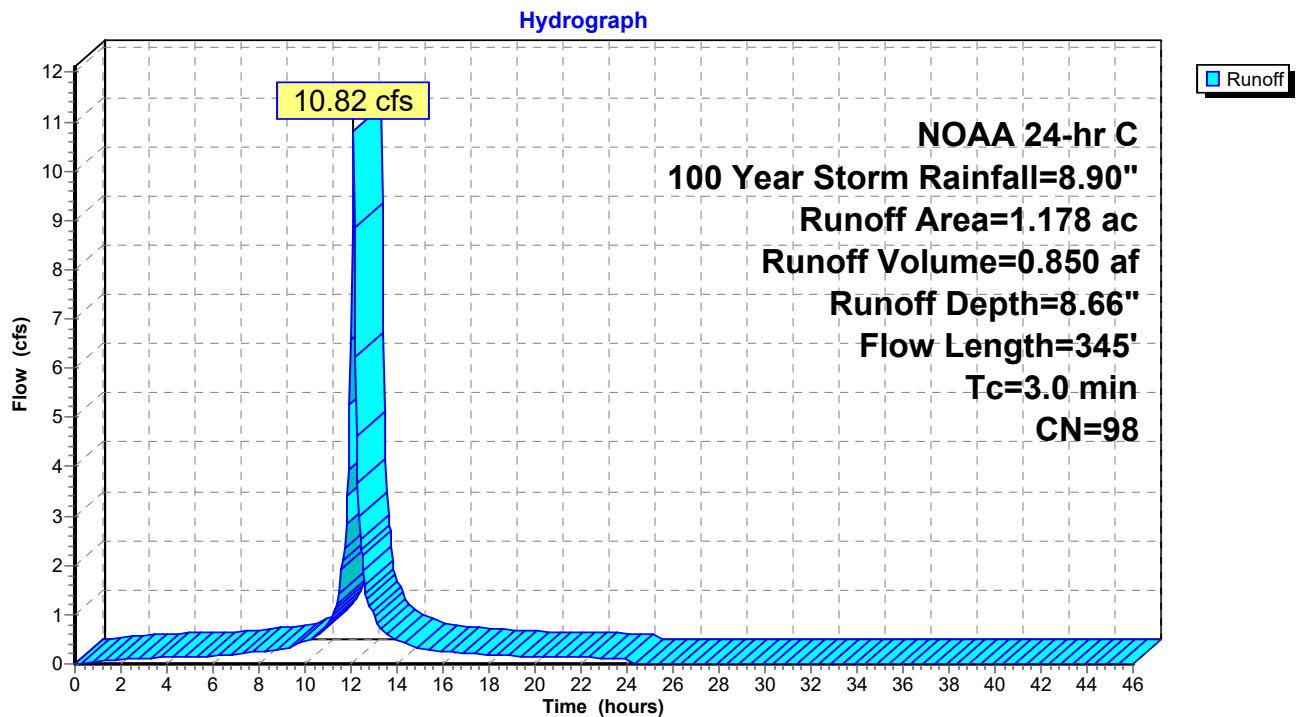
Runoff = 10.82 cfs @ 12.10 hrs, Volume= 0.850 af, Depth= 8.66"  
 Routed to Pond 2P : Basin #2

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
1.178	98	Paved parking, HSG A
1.178		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	33	0.0321	1.35		<b>Sheet Flow, Sheet Flow Grass</b> Smooth surfaces n= 0.011 P2= 3.31"
2.6	312	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved Kv= 20.3 fps
3.0	345	Total			

**Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**

**Summary for Subcatchment WS 2P: Watershed #2 Post-Dev Pervious**

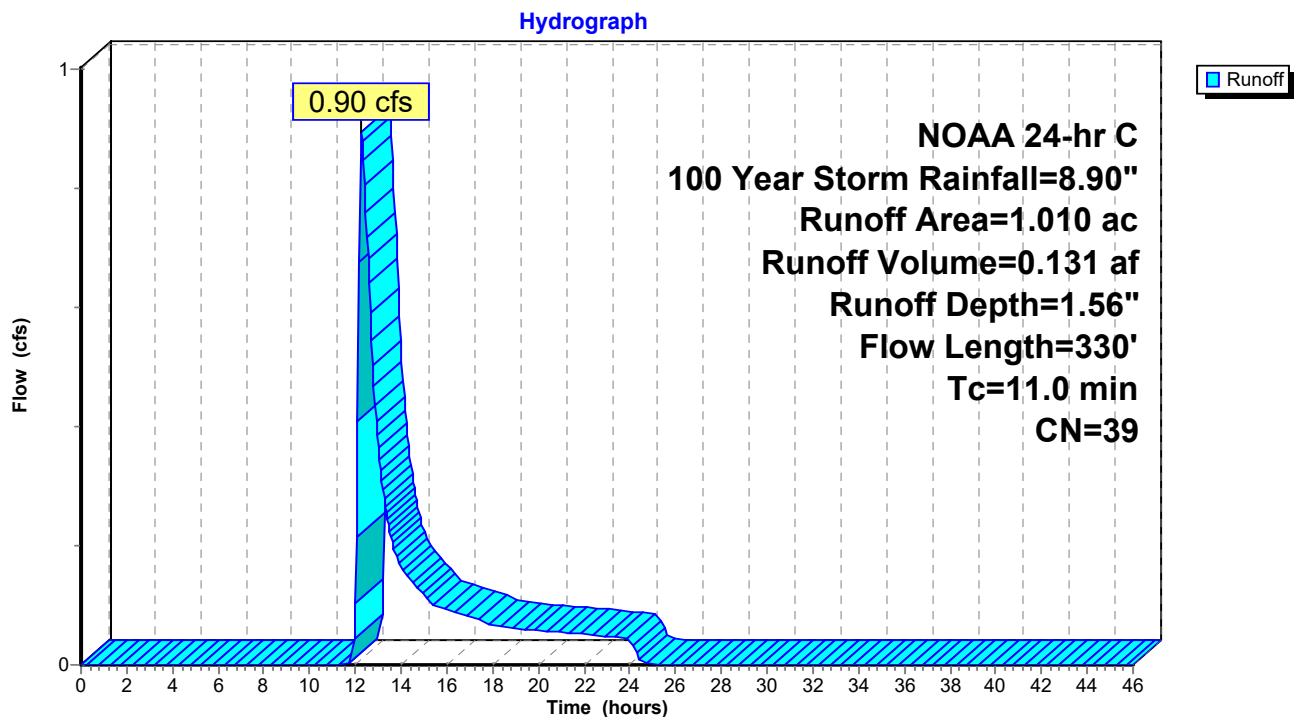
Runoff = 0.90 cfs @ 12.26 hrs, Volume= 0.131 af, Depth= 1.56"  
 Routed to Pond 2P : Basin #2

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
1.010	39	>75% Grass cover, Good, HSG A
1.010		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	57	0.0210	0.11		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
2.2	273	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved Kv= 20.3 fps
11.0	330	Total			

**Subcatchment WS 2P: Watershed #2 Post-Dev Pervious**

**Summary for Subcatchment WS 3I: Watershed #3 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

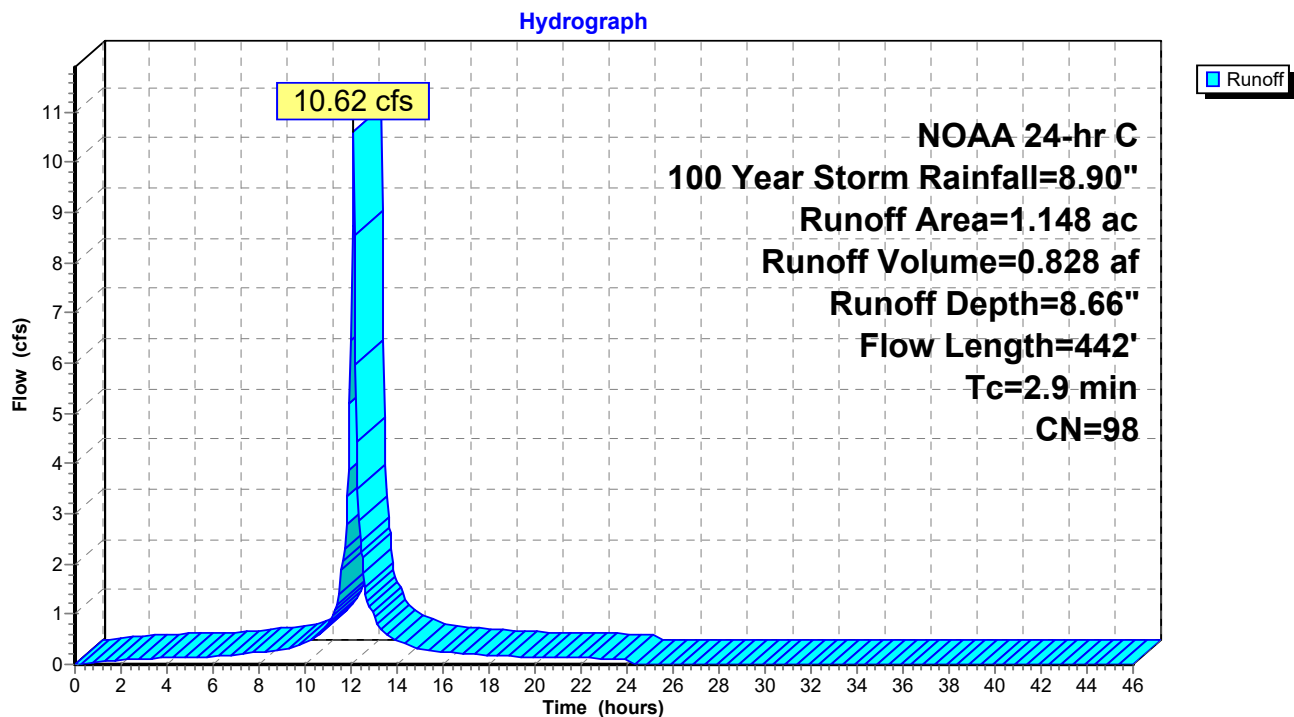
Runoff = 10.62 cfs @ 12.10 hrs, Volume= 0.828 af, Depth= 8.66"  
 Routed to Pond 3P : Basin #3

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
1.148	98	Paved parking, HSG A
1.148		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	200	0.0050	1.44		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.6	242	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.9	442	Total			

**Subcatchment WS 3I: Watershed #3 Post-Dev Impervious**

**Summary for Subcatchment WS 3P: Watershed #3 Post-Dev Pervious**

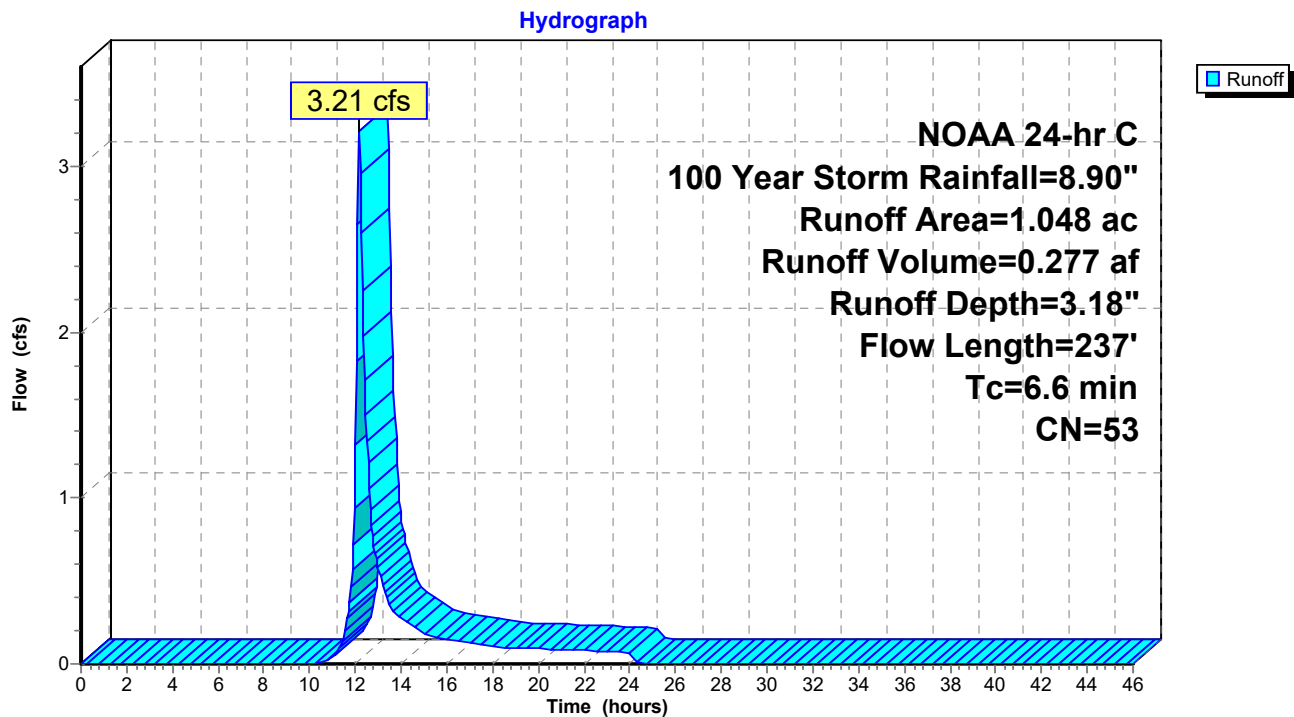
Runoff = 3.21 cfs @ 12.16 hrs, Volume= 0.277 af, Depth= 3.18"  
 Routed to Pond 3P : Basin #3

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
0.374	39	>75% Grass cover, Good, HSG A
0.674	61	>75% Grass cover, Good, HSG B
1.048	53	Weighted Average
1.048		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	35	0.0330	0.12		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
1.6	202	0.0189	2.06		<b>Shallow Concentrated Flow, Grass Flow</b> Grassed Waterway Kv= 15.0 fps
6.6	237	Total			

**Subcatchment WS 3P: Watershed #3 Post-Dev Pervious**



**Summary for Subcatchment WS 4I: Watershed #4 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

[47] Hint: Peak is 118% of capacity of segment #2

Runoff = 13.15 cfs @ 12.09 hrs, Volume= 0.994 af, Depth= 8.66"  
 Routed to Pond 4P : Basin #4

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

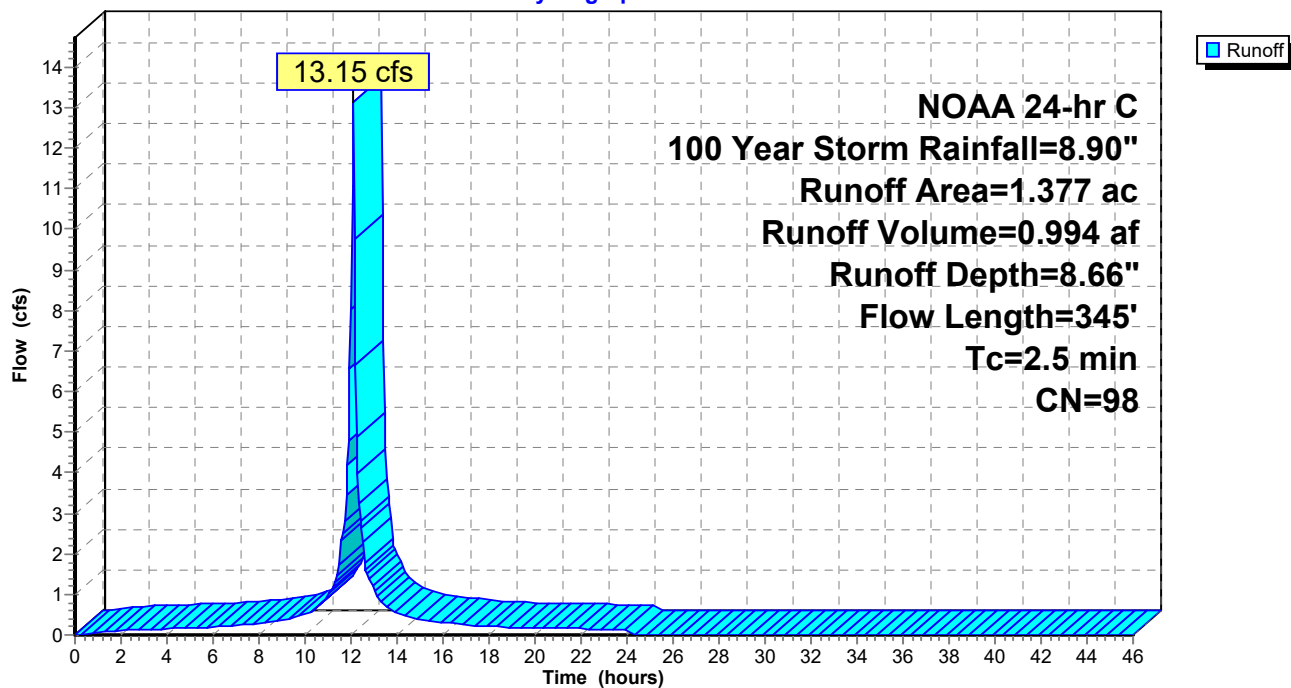
Area (ac)	CN	Description
1.377	98	Paved parking, HSG A
1.377		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	180	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.4	165	0.0080	6.28	11.10	<b>Pipe Channel, RCP_Round 18"</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.5	345	Total			

**Subcatchment WS 4I: Watershed #4 Post-Dev Impervious**

Hydrograph



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Printed 6/8/2022

Page 67

**Summary for Subcatchment WS 4P: Watershed #4 Post-Dev Pervious**

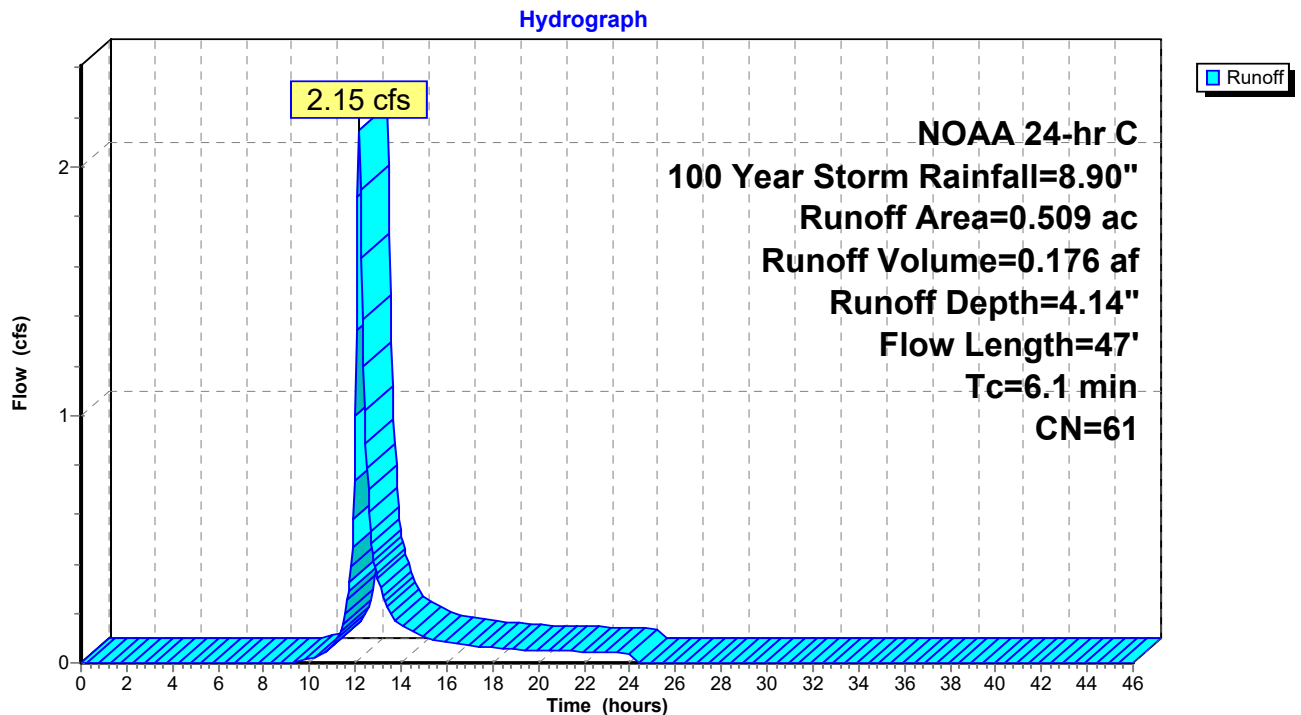
Runoff = 2.15 cfs @ 12.15 hrs, Volume= 0.176 af, Depth= 4.14"  
Routed to Pond 4P : Basin #4

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
0.509	61	>75% Grass cover, Good, HSG B
0.509		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	35	0.0200	0.10		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.3300	8.62		<b>Shallow Concentrated Flow, Shallow Flow Grass</b> Grassed Waterway Kv= 15.0 fps
6.1	47	Total			

**Subcatchment WS 4P: Watershed #4 Post-Dev Pervious**

**Summary for Subcatchment WS 5I: Watershed #5 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

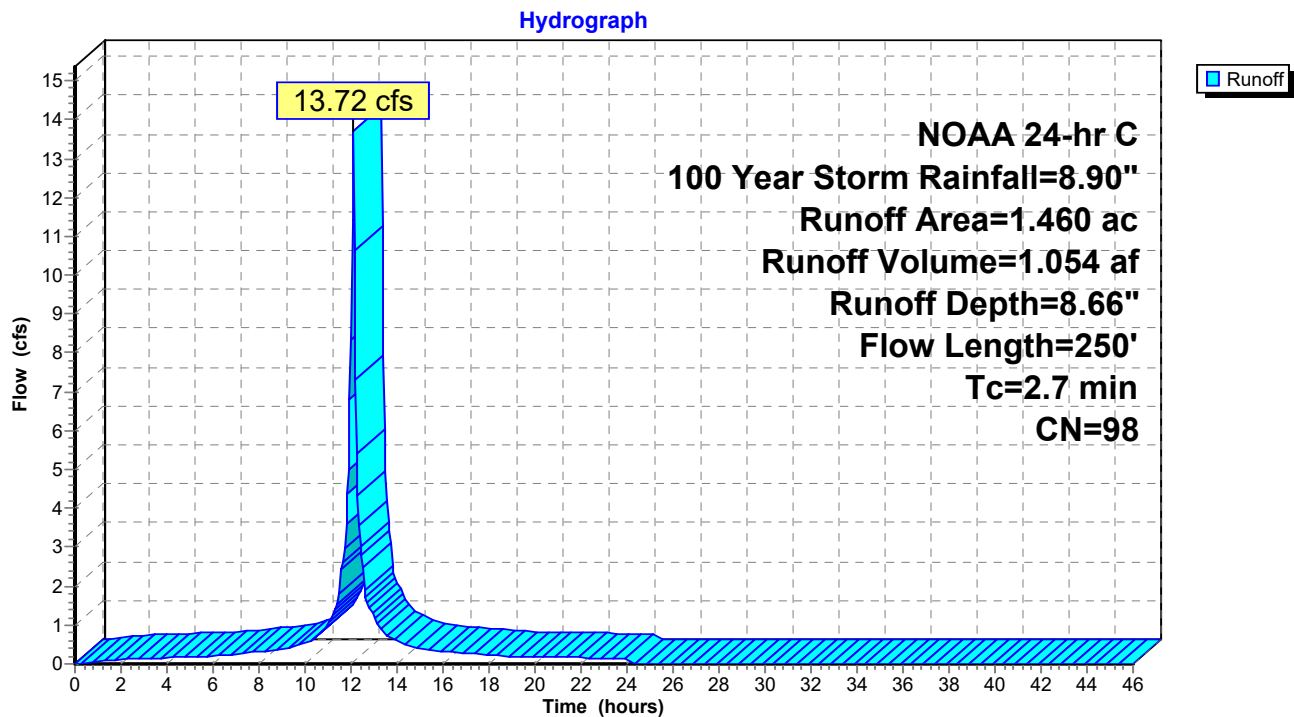
Runoff = 13.72 cfs @ 12.10 hrs, Volume= 1.054 af, Depth= 8.66"  
 Routed to Pond 5P : Basin #5

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
1.460	98	Paved parking, HSG A
1.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	230	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.0	20	0.2500	8.05		<b>Shallow Concentrated Flow, Stone Slope Flow</b> Unpaved Kv= 16.1 fps
2.7	250	Total			

**Subcatchment WS 5I: Watershed #5 Post-Dev Impervious**

**Summary for Subcatchment WS 5P: Watershed #5 Post-Dev Pervious**

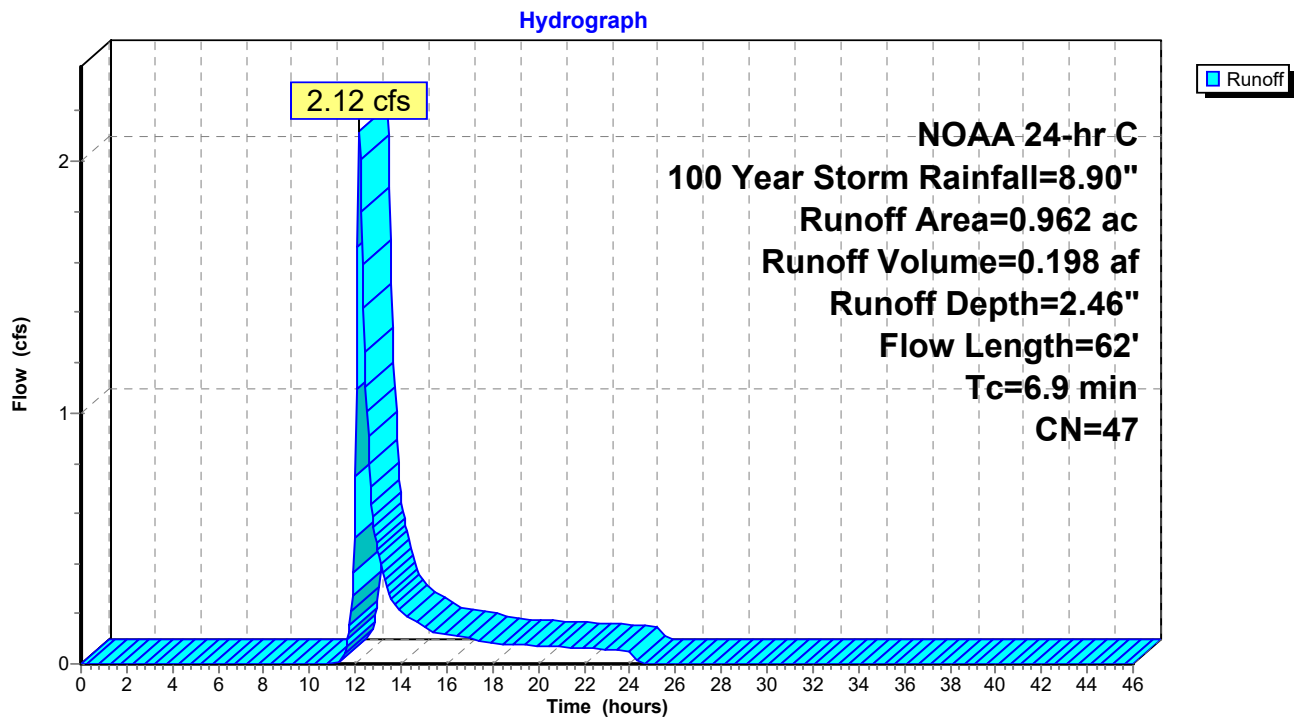
Runoff = 2.12 cfs @ 12.17 hrs, Volume= 0.198 af, Depth= 2.46"  
 Routed to Pond 5P : Basin #5

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Area (ac)	CN	Description
0.593	39	>75% Grass cover, Good, HSG A
0.369	61	>75% Grass cover, Good, HSG B
0.962	47	Weighted Average
0.962		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	50	0.0300	0.12		<b>Sheet Flow, Grass Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.2500	7.50		<b>Shallow Concentrated Flow, Grass Shallow Flow</b> Grassed Waterway Kv= 15.0 fps
6.9	62	Total			

**Subcatchment WS 5P: Watershed #5 Post-Dev Pervious**

**Summary for Reach SW: Grassed Swale**

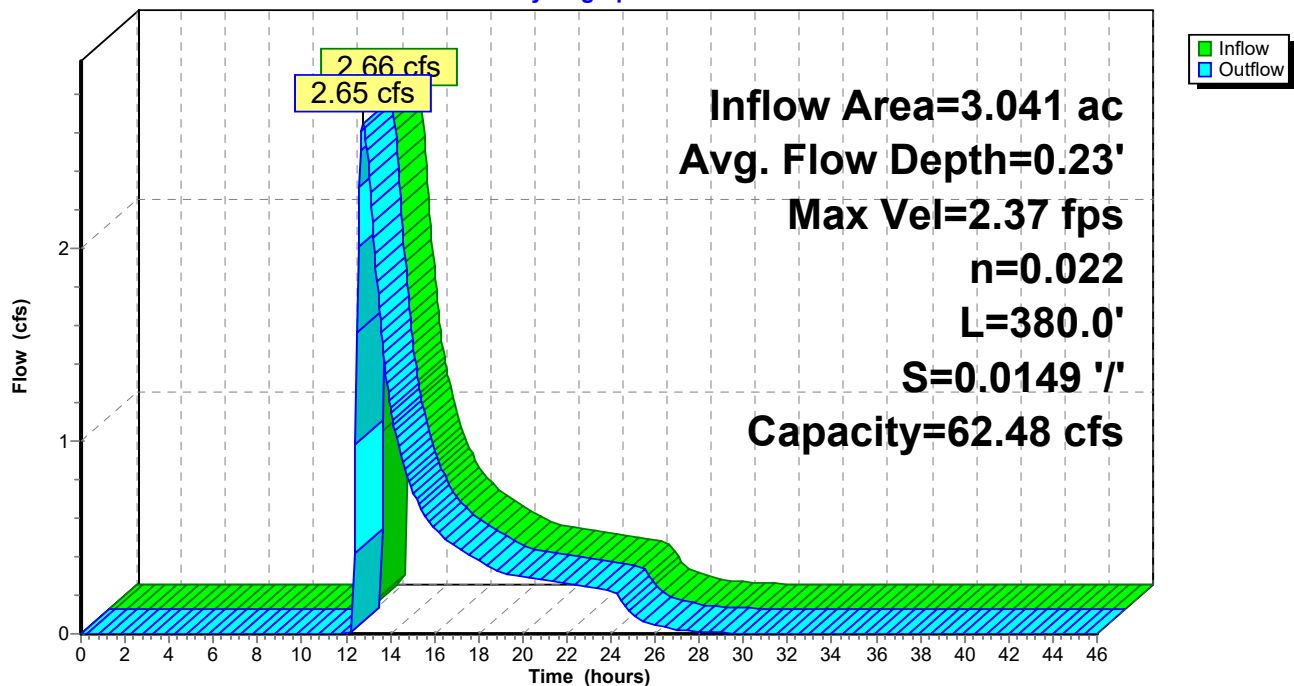
[81] Warning: Exceeded Pond 2P by 0.02' @ 24.40 hrs

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 2.46" for 100 Year Storm event  
Inflow = 2.66 cfs @ 12.69 hrs, Volume= 0.623 af  
Outflow = 2.65 cfs @ 12.77 hrs, Volume= 0.623 af, Atten= 0%, Lag= 4.8 min  
Routed to Link DP : DISCHARGE POINT

Routing by Stor-Ind+Trans method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
Max. Velocity= 2.37 fps, Min. Travel Time= 2.7 min  
Avg. Velocity = 0.92 fps, Avg. Travel Time= 6.9 min

Peak Storage= 425 cf @ 12.72 hrs  
Average Depth at Peak Storage= 0.23' , Surface Width= 7.23'  
Bank-Full Depth= 1.00' Flow Area= 10.0 sf, Capacity= 62.48 cfs

15.00' x 1.00' deep Parabolic Channel, n= 0.022 Earth, clean & straight  
Length= 380.0' Slope= 0.0149 '/'  
Inlet Invert= 12.67', Outlet Invert= 7.00'

**Reach SW: Grassed Swale****Hydrograph**

**Zemac Self Storage**

NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 71

**Summary for Pond 1P: Basin #1**

Inflow Area = 0.853 ac, 38.22% Impervious, Inflow Depth = 4.27" for 100 Year Storm event  
 Inflow = 3.15 cfs @ 12.11 hrs, Volume= 0.304 af  
 Outflow = 2.14 cfs @ 12.21 hrs, Volume= 0.218 af, Atten= 32%, Lag= 6.3 min  
 Primary = 2.14 cfs @ 12.21 hrs, Volume= 0.218 af  
 Routed to Pond 2P : Basin #2

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 13.25' @ 12.21 hrs Surf.Area= 3,255 sf Storage= 4,499 cf

Plug-Flow detention time= 200.1 min calculated for 0.218 af (72% of inflow)  
 Center-of-Mass det. time= 92.5 min ( 872.1 - 779.6 )

Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	9,711 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
11.00	903	0	0
12.00	1,785	1,344	1,344
13.00	2,965	2,375	3,719
14.00	4,120	3,543	7,262
14.50	5,678	2,450	9,711

Device	Routing	Invert	Outlet Devices
#1	Primary	11.10'	<b>15.0" Round Culvert</b> L= 750.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 11.10' / 11.10' S= 0.0000 ' S= 0.0000 ' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	13.00'	<b>48.0" x 30.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

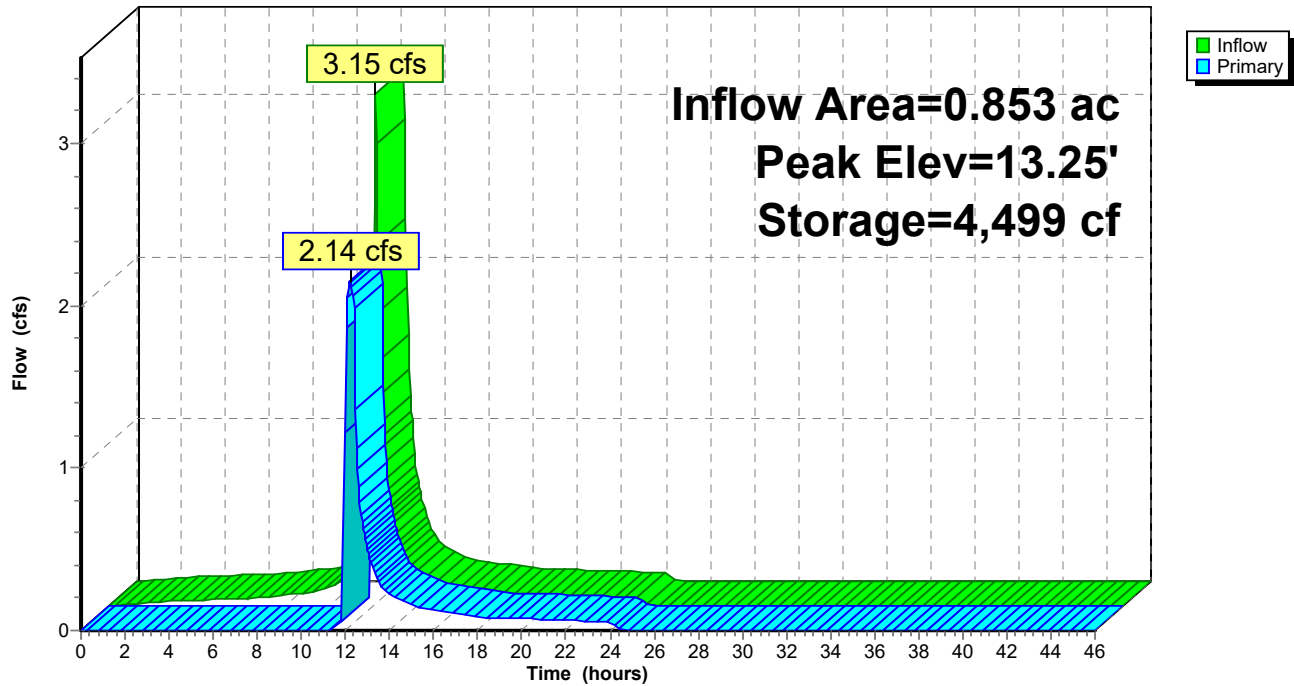
**Primary OutFlow** Max=2.14 cfs @ 12.21 hrs HW=13.25' (Free Discharge)

1=Culvert (Barrel Controls 2.14 cfs @ 1.75 fps)

2=Orifice/Grate (Passes 2.14 cfs of 5.25 cfs potential flow)

**Pond 1P: Basin #1**

**Hydrograph**



**Zemac Self Storage**

NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 73

**Summary for Pond 2P: Basin #2**

[79] Warning: Submerged Pond 1P Primary device # 1 by 1.85'

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 4.73" for 100 Year Storm event  
 Inflow = 13.30 cfs @ 12.10 hrs, Volume= 1.199 af  
 Outflow = 2.66 cfs @ 12.69 hrs, Volume= 0.623 af, Atten= 80%, Lag= 35.1 min  
 Primary = 2.66 cfs @ 12.69 hrs, Volume= 0.623 af  
 Routed to Reach SW : Grassed Swale

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 12.95' @ 12.69 hrs Surf.Area= 15,795 sf Storage= 29,478 cf

Plug-Flow detention time= 317.6 min calculated for 0.622 af (52% of inflow)  
 Center-of-Mass det. time= 178.8 min ( 961.7 - 782.9 )

Volume	Invert	Avail.Storage	Storage Description
#1	10.67'	47,407 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.67	10,000	0	0
11.00	11,128	3,486	3,486
12.00	13,213	12,171	15,657
13.00	15,922	14,568	30,224
14.00	18,444	17,183	47,407

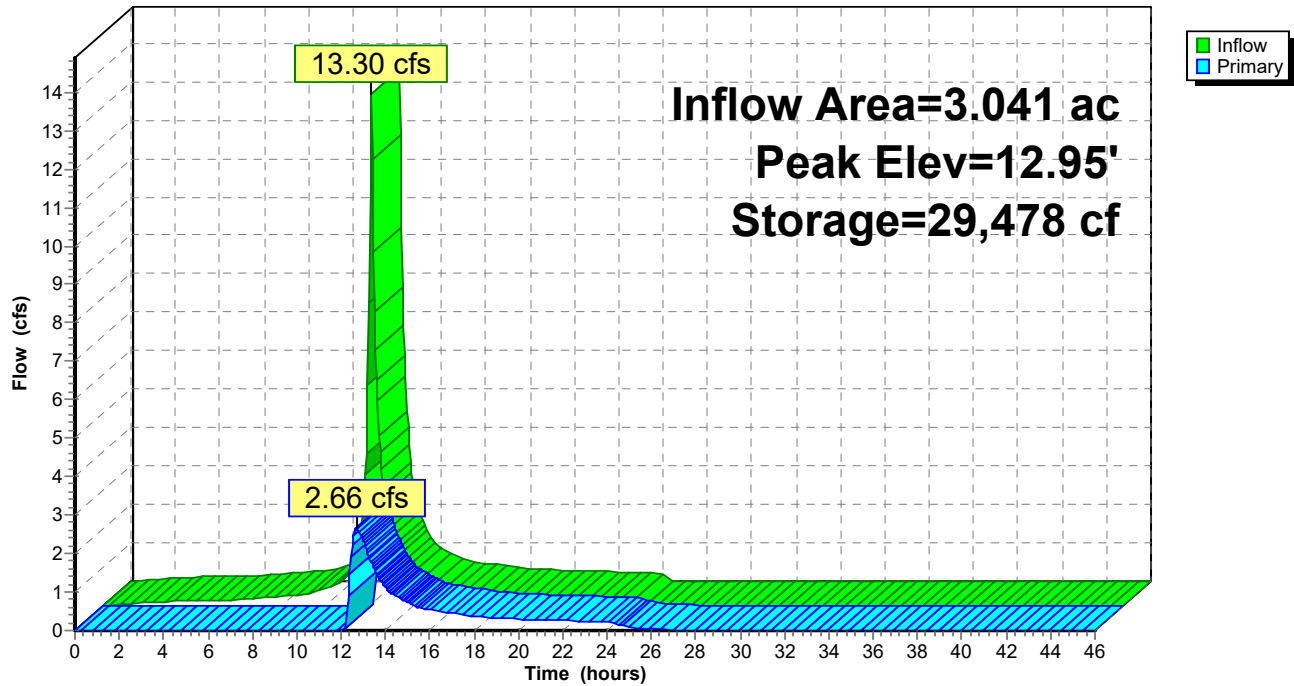
Device	Routing	Invert	Outlet Devices
#1	Primary	12.67'	<b>7.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=2.65 cfs @ 12.69 hrs HW=12.95' (Free Discharge)  
 ↑1=Broad-Crested Rectangular Weir (Weir Controls 2.65 cfs @ 1.34 fps)



**Pond 2P: Basin #2**

**Hydrograph**



**Zemac Self Storage**

NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 75

**Summary for Pond 3P: Basin #3**

Inflow Area = 2.196 ac, 52.28% Impervious, Inflow Depth = 6.04" for 100 Year Storm event  
 Inflow = 13.31 cfs @ 12.11 hrs, Volume= 1.106 af  
 Outflow = 2.12 cfs @ 12.71 hrs, Volume= 0.548 af, Atten= 84%, Lag= 36.2 min  
 Primary = 2.12 cfs @ 12.71 hrs, Volume= 0.548 af  
 Routed to Pond 4P : Basin #4

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 11.14' @ 12.71 hrs Surf.Area= 14,209 sf Storage= 29,028 cf

Plug-Flow detention time= 334.6 min calculated for 0.547 af (49% of inflow)  
 Center-of-Mass det. time= 196.8 min ( 967.5 - 770.7 )

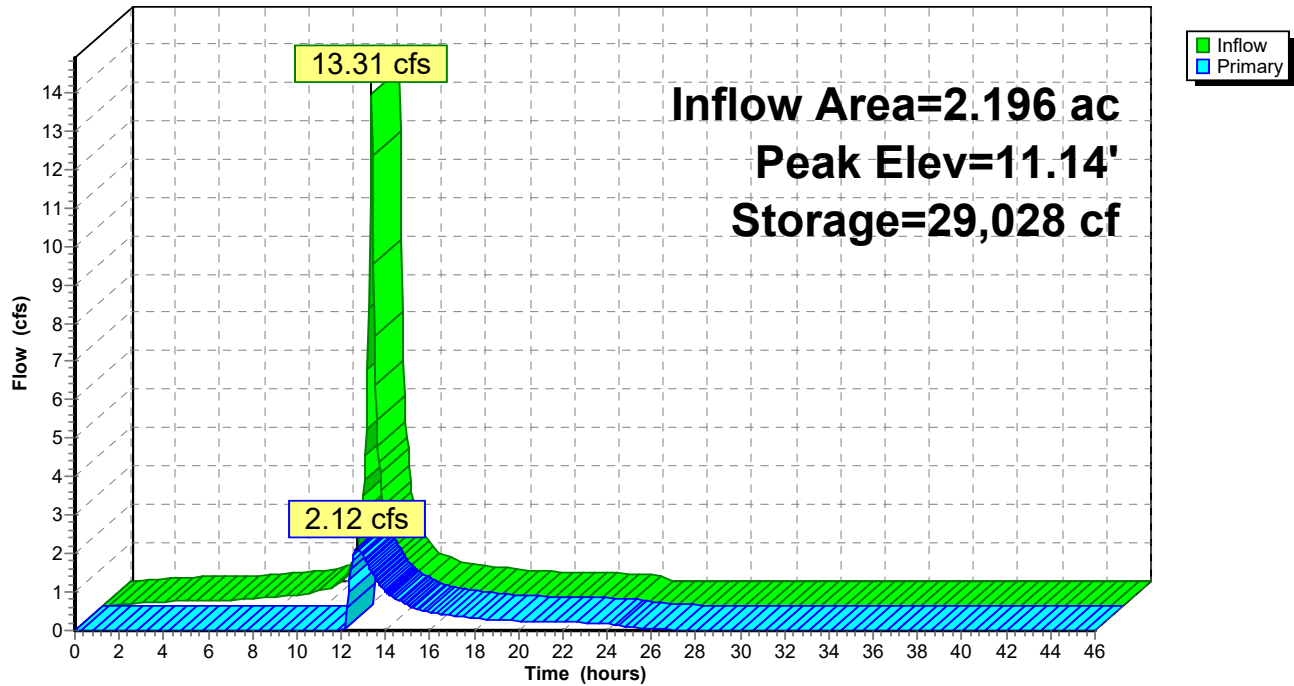
Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	41,842 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,985	0	0
9.00	10,988	2,097	2,097
10.00	12,493	11,741	13,838
11.00	14,000	13,247	27,084
12.00	15,516	14,758	41,842

Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=2.11 cfs @ 12.71 hrs HW=11.14' (Free Discharge)  
 ↑1=**Broad-Crested Rectangular Weir** (Weir Controls 2.11 cfs @ 1.57 fps)

**Pond 3P: Basin #3**

**Hydrograph**



**Zemac Self Storage**

NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 77

**Summary for Pond 4P: Basin #4**

[81] Warning: Exceeded Pond 3P by 0.37' @ 12.15 hrs

Inflow Area = 4.082 ac, 61.86% Impervious, Inflow Depth = 5.05" for 100 Year Storm event  
 Inflow = 15.00 cfs @ 12.10 hrs, Volume= 1.717 af  
 Outflow = 4.29 cfs @ 12.64 hrs, Volume= 1.182 af, Atten= 71%, Lag= 32.7 min  
 Primary = 4.29 cfs @ 12.64 hrs, Volume= 1.182 af  
 Routed to Pond 5P : Basin #5

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 11.34' @ 12.64 hrs Surf.Area= 13,585 sf Storage= 30,469 cf

Plug-Flow detention time= 263.4 min calculated for 1.180 af (69% of inflow)  
 Center-of-Mass det. time= 139.1 min ( 961.7 - 822.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	39,735 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

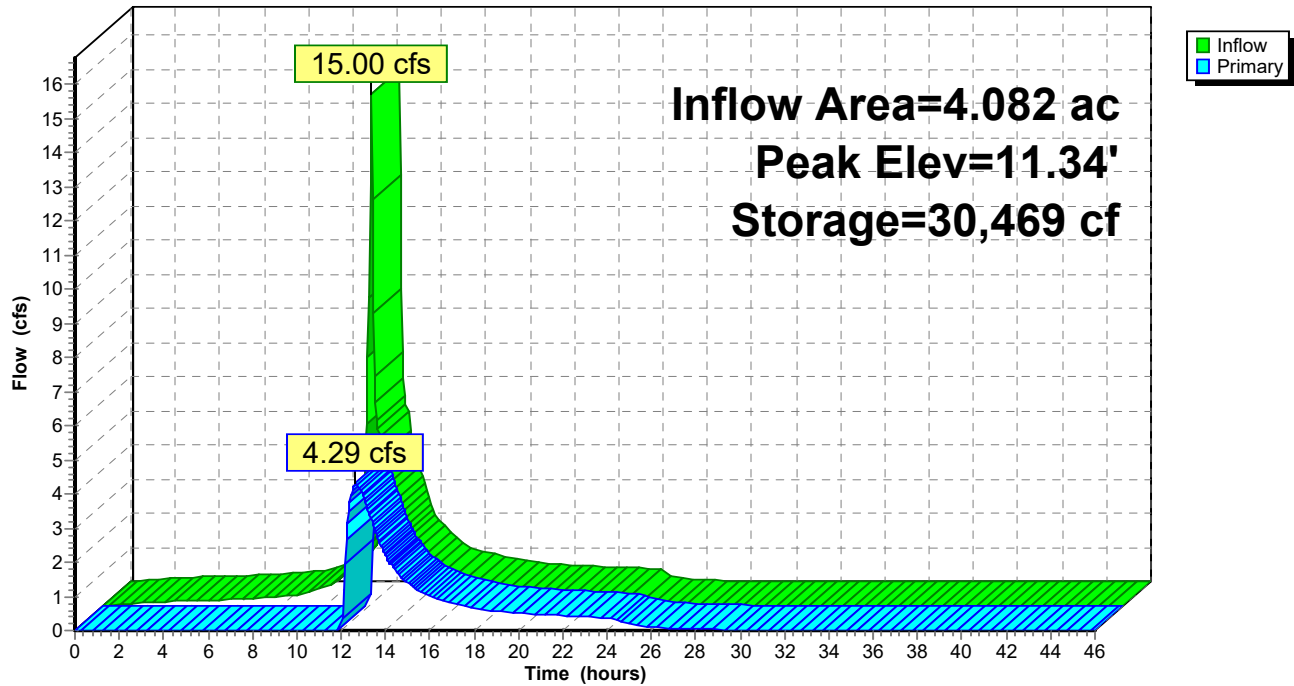
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,996	0	0
9.00	10,421	2,042	2,042
10.00	12,121	11,271	13,313
11.00	13,100	12,611	25,923
12.00	14,523	13,812	39,735

Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=4.29 cfs @ 12.64 hrs HW=11.34' (Free Discharge)  
 ↑1=**Broad-Crested Rectangular Weir** (Weir Controls 4.29 cfs @ 1.99 fps)

**Pond 4P: Basin #4**

**Hydrograph**



**Zemac Self Storage**

NOAA 24-hr C 100 Year Storm Rainfall=8.90"

Prepared by Engineering Design Associates

Printed 6/8/2022

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

Page 79

**Summary for Pond 5P: Basin #5**

[81] Warning: Exceeded Pond 4P by 0.31' @ 15.75 hrs

Inflow Area = 6.504 ac, 61.27% Impervious, Inflow Depth = 4.49" for 100 Year Storm event  
 Inflow = 15.45 cfs @ 12.11 hrs, Volume= 2.433 af  
 Outflow = 2.11 cfs @ 14.78 hrs, Volume= 1.208 af, Atten= 86%, Lag= 160.6 min  
 Primary = 2.11 cfs @ 14.78 hrs, Volume= 1.208 af  
 Routed to Link DP : DISCHARGE POINT

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 11.35' @ 14.78 hrs Surf.Area= 30,459 sf Storage= 63,711 cf

Plug-Flow detention time= 452.5 min calculated for 1.208 af (50% of inflow)  
 Center-of-Mass det. time= 279.9 min ( 1,138.6 - 858.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	84,099 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

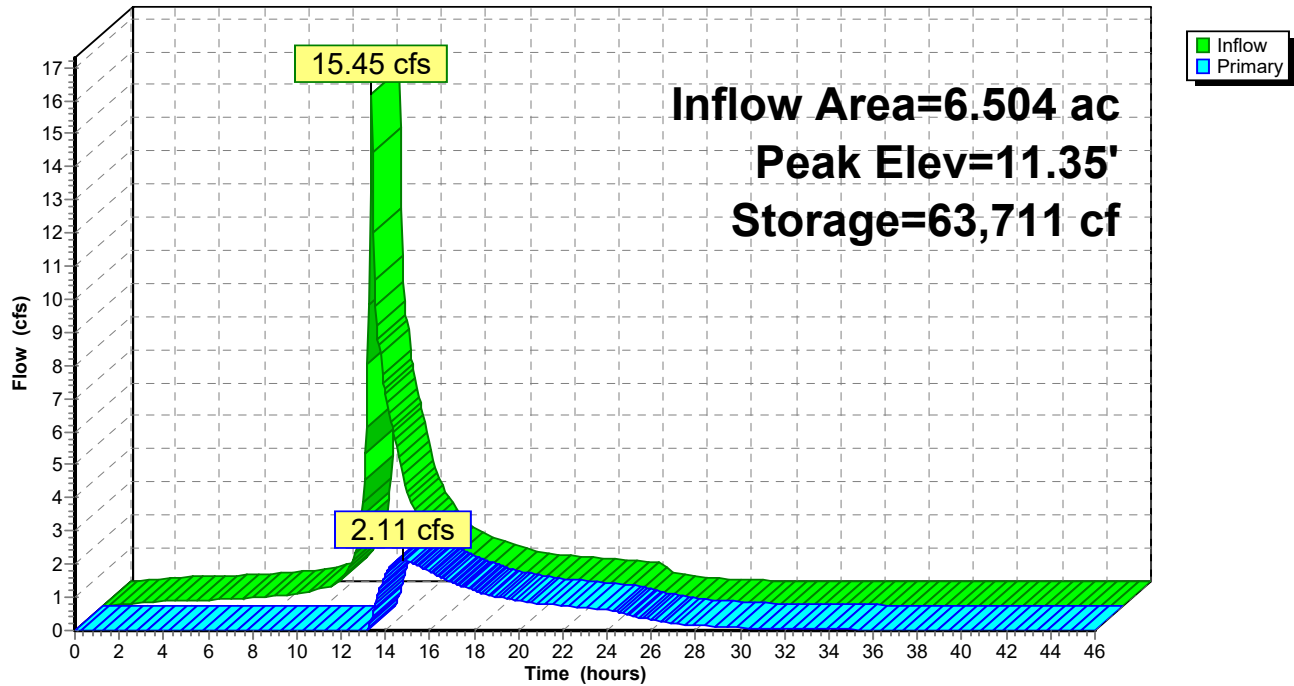
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
9.00	23,222	0	0
10.00	26,875	25,049	25,049
11.00	29,445	28,160	53,209
12.00	32,336	30,891	84,099

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	<b>4.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=2.11 cfs @ 14.78 hrs HW=11.35' (Free Discharge)↑1=**Broad-Crested Rectangular Weir** (Weir Controls 2.11 cfs @ 1.51 fps)

**Pond 5P: Basin #5**

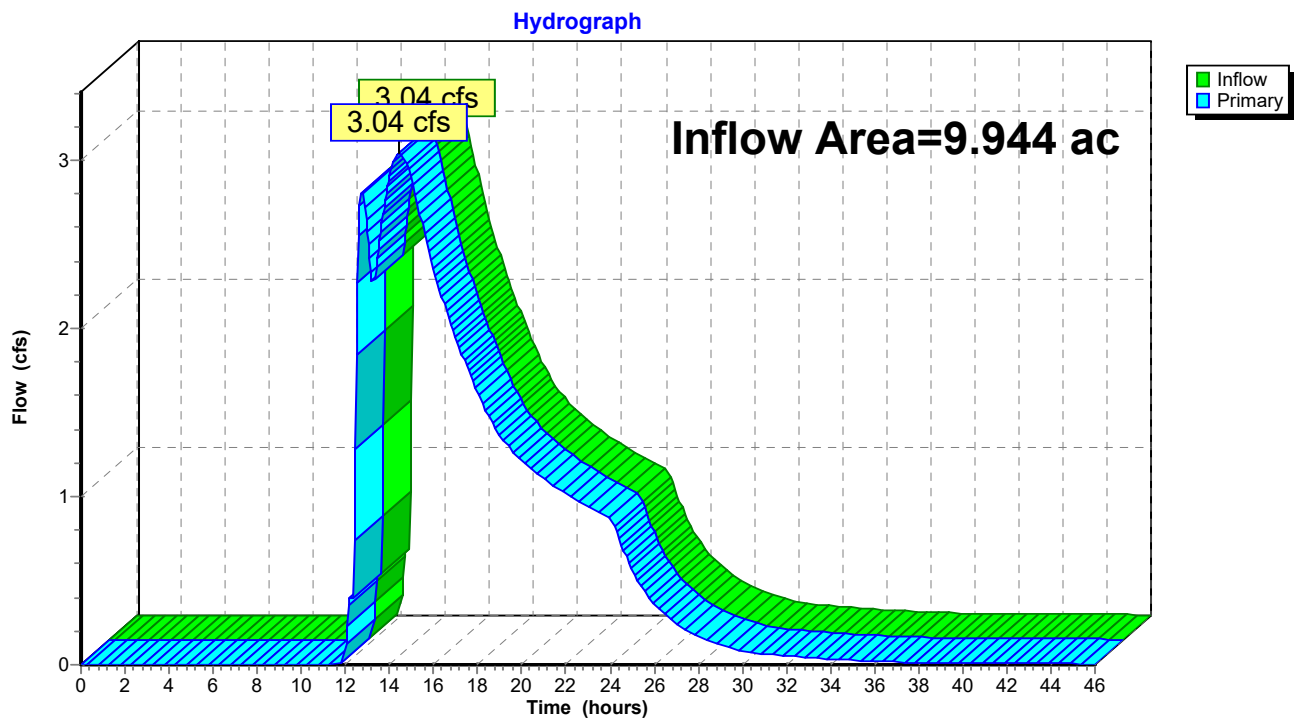
**Hydrograph**



**Summary for Link DP: DISCHARGE POINT**

Inflow Area = 9.944 ac, 55.20% Impervious, Inflow Depth > 2.27" for 100 Year Storm event  
Inflow = 3.04 cfs @ 14.45 hrs, Volume= 1.882 af  
Primary = 3.04 cfs @ 14.45 hrs, Volume= 1.882 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs

**Link DP: DISCHARGE POINT**



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 82

Time span=0.00-46.00 hrs, dt=0.05 hrs, 921 points  
 Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>Subcatchment UD: Undetained Runoff</b>	Runoff Area=0.399 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=452' Tc=8.7 min CN=39 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 1I: Watershed #1</b>	Runoff Area=0.326 ac 100.00% Impervious Runoff Depth=1.03" Flow Length=394' Tc=3.3 min CN=98 Runoff=0.92 cfs 0.028 af
<b>Subcatchment WS 1P: Watershed #1</b>	Runoff Area=0.527 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=386' Tc=11.1 min CN=39 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 2I: Watershed #2</b>	Runoff Area=1.178 ac 100.00% Impervious Runoff Depth=1.03" Flow Length=345' Tc=3.0 min CN=98 Runoff=3.36 cfs 0.102 af
<b>Subcatchment WS 2P: Watershed #2</b>	Runoff Area=1.010 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=330' Tc=11.0 min CN=39 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 3I: Watershed #3</b>	Runoff Area=1.148 ac 100.00% Impervious Runoff Depth=1.03" Flow Length=442' Tc=2.9 min CN=98 Runoff=3.30 cfs 0.099 af
<b>Subcatchment WS 3P: Watershed #3</b>	Runoff Area=1.048 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=237' Tc=6.6 min CN=53 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 4I: Watershed #4</b>	Runoff Area=1.377 ac 100.00% Impervious Runoff Depth=1.03" Flow Length=345' Tc=2.5 min CN=98 Runoff=3.95 cfs 0.119 af
<b>Subcatchment WS 4P: Watershed #4</b>	Runoff Area=0.509 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=47' Tc=6.1 min CN=61 Runoff=0.00 cfs 0.000 af
<b>Subcatchment WS 5I: Watershed #5</b>	Runoff Area=1.460 ac 100.00% Impervious Runoff Depth=1.03" Flow Length=250' Tc=2.7 min CN=98 Runoff=4.23 cfs 0.126 af
<b>Subcatchment WS 5P: Watershed #5</b>	Runoff Area=0.962 ac 0.00% Impervious Runoff Depth=0.00" Flow Length=62' Tc=6.9 min CN=47 Runoff=0.00 cfs 0.000 af
<b>Reach SW: Grassed Swale</b>	Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af n=0.022 L=380.0' S=0.0149 '/' Capacity=62.48 cfs Outflow=0.00 cfs 0.000 af
<b>Pond 1P: Basin #1</b>	Peak Elev=11.93' Storage=1,224 cf Inflow=0.92 cfs 0.028 af Outflow=0.00 cfs 0.000 af
<b>Pond 2P: Basin #2</b>	Peak Elev=11.08' Storage=4,424 cf Inflow=3.36 cfs 0.102 af Outflow=0.00 cfs 0.000 af
<b>Pond 3P: Basin #3</b>	Peak Elev=9.20' Storage=4,311 cf Inflow=3.30 cfs 0.099 af Outflow=0.00 cfs 0.000 af
<b>Pond 4P: Basin #4</b>	Peak Elev=9.29' Storage=5,171 cf Inflow=3.95 cfs 0.119 af Outflow=0.00 cfs 0.000 af

## **Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

*NJ DEP 2-hr WQ Rainfall=1.25"*

Printed 6/8/2022

Page 83

### **Pond 5P: Basin #5**

Peak Elev=9.23' Storage=5,483 cf Inflow=4.23 cfs 0.126 af

Outflow=0.00 cfs 0.000 af

### **Link DP: DISCHARGE POINT**

Inflow=0.00 cfs 0.000 af

Primary=0.00 cfs 0.000 af

**Total Runoff Area = 9.944 ac   Runoff Volume = 0.473 af   Average Runoff Depth = 0.57"**  
**44.80% Pervious = 4.455 ac   55.20% Impervious = 5.489 ac**

**Summary for Subcatchment UD: Undetained Runoff**

[45] Hint: Runoff=Zero

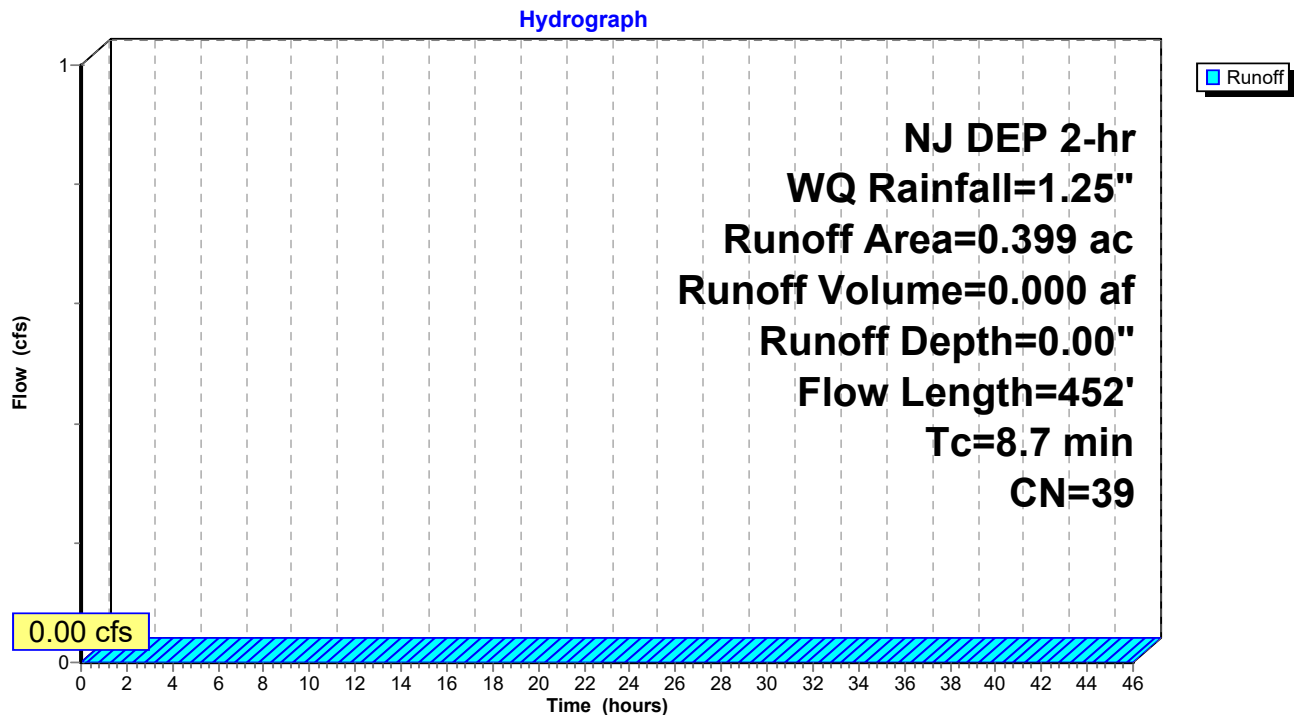
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"  
 Routed to Link DP : DISCHARGE POINT

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
0.399	39	>75% Grass cover, Good, HSG A
0.399		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	52	0.0252	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
1.1	400	0.0150	6.26	62.64	<b>Parabolic Channel,</b> W=15.00' D=1.00' Area=10.0 sf Perim=15.2' n= 0.022 Earth, clean & straight
8.7	452	Total			

**Subcatchment UD: Undetained Runoff**

**Summary for Subcatchment WS 1I: Watershed #1 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

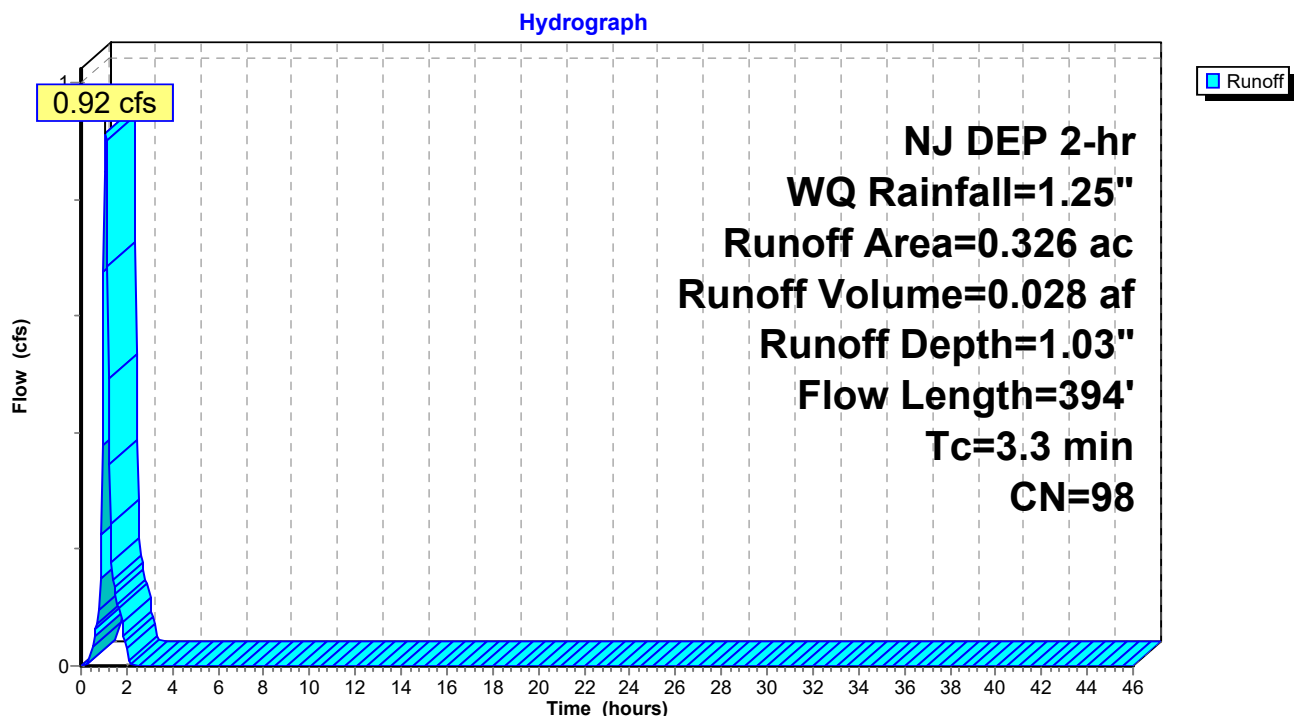
Runoff = 0.92 cfs @ 1.09 hrs, Volume= 0.028 af, Depth= 1.03"  
 Routed to Pond 1P : Basin #1

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
0.326	98	Paved parking, HSG A
0.326		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	33	0.0200	1.12		<b>Sheet Flow, Paved Sheet Flow</b> Smooth surfaces $n=0.011$ $P2=3.31"$
2.7	331	0.0100	2.03		<b>Shallow Concentrated Flow, Paved Flow</b> Paved $K_v=20.3$ fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass to Basin Flow</b> Grassed Waterway $K_v=15.0$ fps
3.3	394	Total			

**Subcatchment WS 1I: Watershed #1 Post-Dev Impervious**

**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 86

**Summary for Subcatchment WS 1P: Watershed #1 Post-Dev Pervious**

[45] Hint: Runoff=Zero

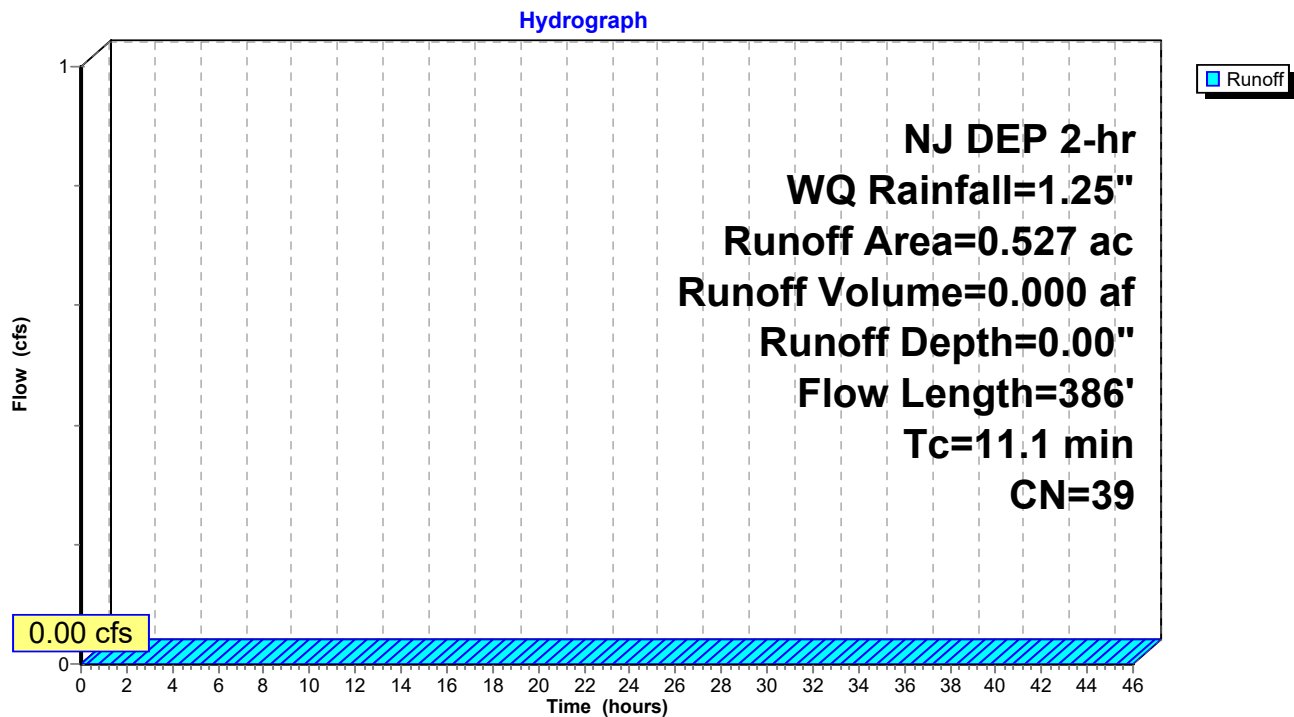
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"  
 Routed to Pond 1P : Basin #1

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
0.527	39	>75% Grass cover, Good, HSG A
0.527		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	55	0.0212	0.11		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
2.5	301	0.0100	2.03		<b>Shallow Concentrated Flow, Driveway Flow</b> Paved Kv= 20.3 fps
0.1	30	0.2000	6.71		<b>Shallow Concentrated Flow, Grass Flow to Basin</b> Grassed Waterway Kv= 15.0 fps
11.1	386	Total			

**Subcatchment WS 1P: Watershed #1 Post-Dev Pervious**

**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 87

**Summary for Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**[49] Hint:  $T_c < 2dt$  may require smaller  $dt$ 

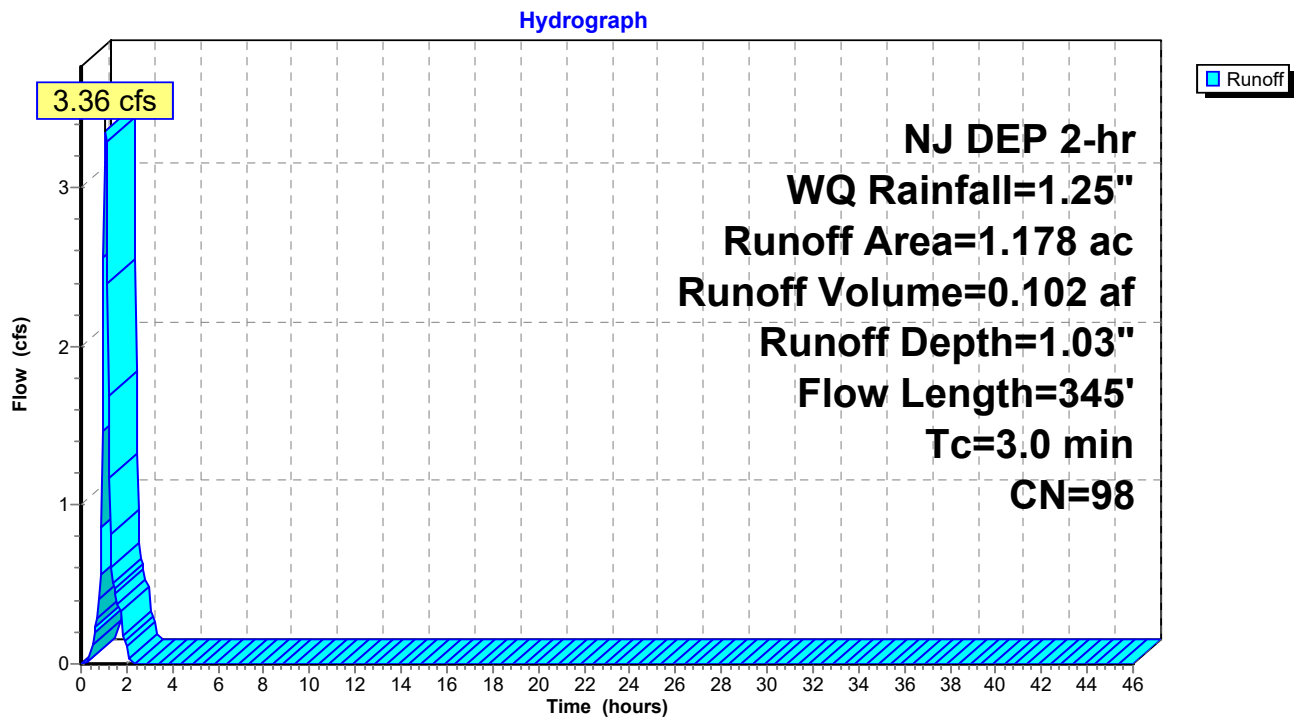
Runoff = 3.36 cfs @ 1.08 hrs, Volume= 0.102 af, Depth= 1.03"  
 Routed to Pond 2P : Basin #2

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
 NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
1.178	98	Paved parking, HSG A
1.178		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	33	0.0321	1.35		<b>Sheet Flow, Sheet Flow Grass</b> Smooth surfaces n= 0.011 P2= 3.31"
2.6	312	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved Kv= 20.3 fps
3.0	345	Total			

**Subcatchment WS 2I: Watershed #2 Post-Dev Impervious**

**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 88

**Summary for Subcatchment WS 2P: Watershed #2 Post-Dev Pervious**

[45] Hint: Runoff=Zero

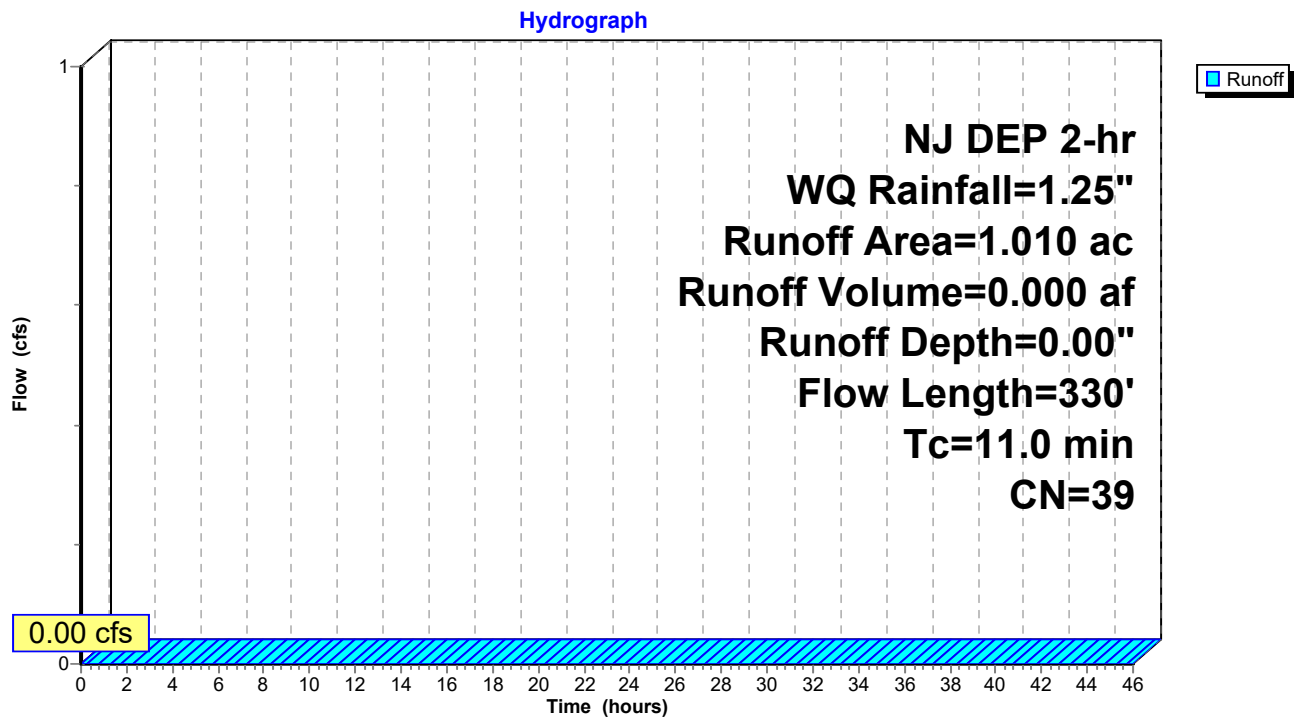
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"  
Routed to Pond 2P : Basin #2

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
1.010	39	>75% Grass cover, Good, HSG A
1.010		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	57	0.0210	0.11		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
2.2	273	0.0100	2.03		<b>Shallow Concentrated Flow, Asphalt Flow</b> Paved Kv= 20.3 fps
11.0	330	Total			

**Subcatchment WS 2P: Watershed #2 Post-Dev Pervious**

## Summary for Subcatchment WS 3I: Watershed #3 Post-Dev Impervious

[49] Hint:  $T_c < 2dt$  may require smaller  $dt$

Runoff = 3.30 cfs @ 1.08 hrs, Volume= 0.099 af, Depth= 1.03"  
Routed to Pond 3P : Basin #3

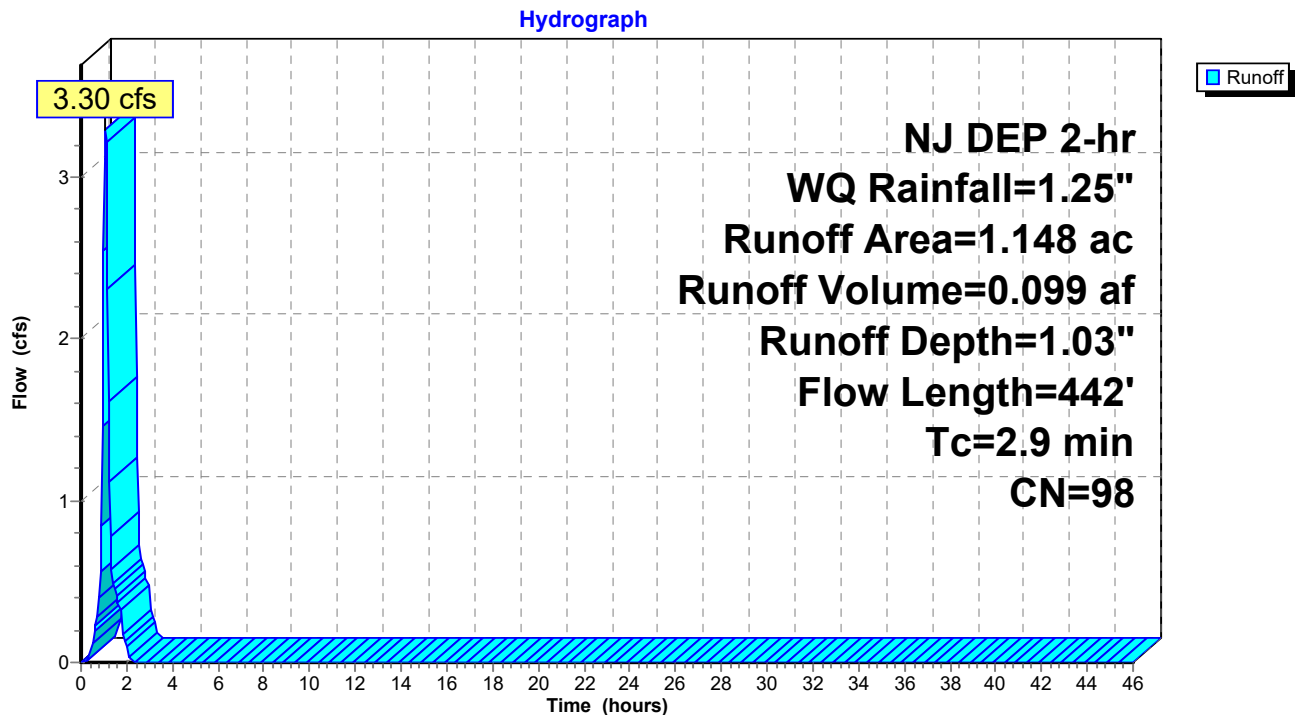
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
1.148	98	Paved parking, HSG A
1.148		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	200	0.0050	1.44		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.6	242	0.0100	7.03	12.41	Pipe Channel, RCP_Round 18" 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.9	442	Total			

## Subcatchment WS 3I: Watershed #3 Post-Dev Impervious





### Summary for Subcatchment WS 3P: Watershed #3 Post-Dev Pervious

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"  
Routed to Pond 3P : Basin #3

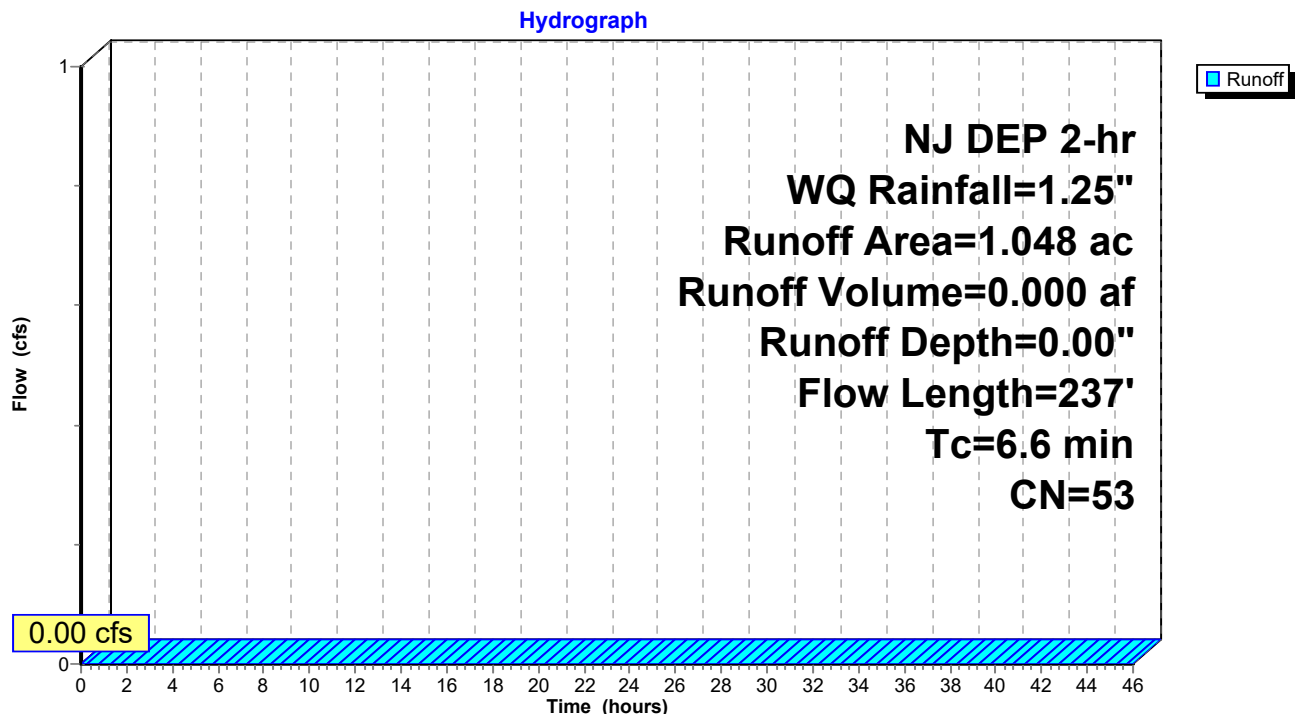
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
0.374	39	>75% Grass cover, Good, HSG A
0.674	61	>75% Grass cover, Good, HSG B
1.048	53	Weighted Average
1.048		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	35	0.0330	0.12		<b>Sheet Flow, Sheet Flow Grass</b> Grass: Dense n= 0.240 P2= 3.31"
1.6	202	0.0189	2.06		<b>Shallow Concentrated Flow, Grass Flow</b> Grassed Waterway Kv= 15.0 fps
6.6	237	Total			

### Subcatchment WS 3P: Watershed #3 Post-Dev Pervious



## Summary for Subcatchment WS 4I: Watershed #4 Post-Dev Impervious

[49] Hint:  $T_c < 2dt$  may require smaller  $dt$

Runoff = 3.95 cfs @ 1.07 hrs, Volume= 0.119 af, Depth= 1.03"  
Routed to Pond 4P : Basin #4

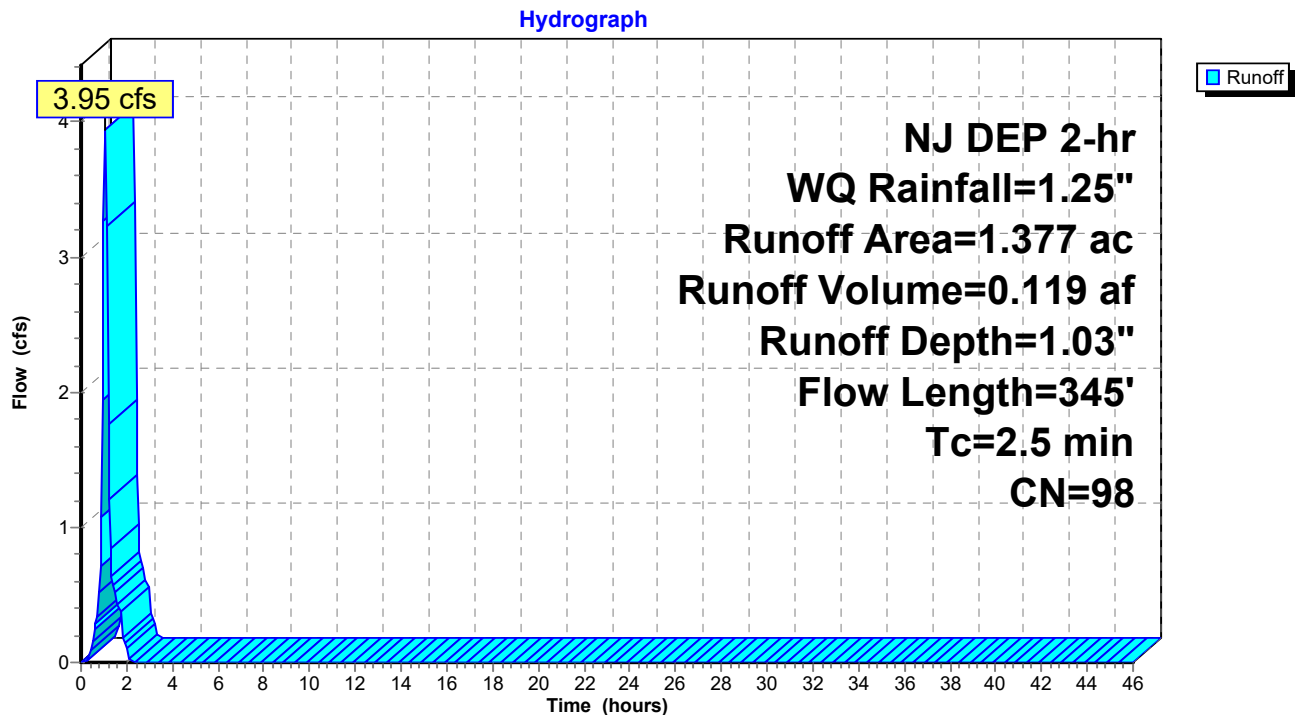
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
1.377	98	Paved parking, HSG A
1.377		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	180	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.4	165	0.0080	6.28	11.10	<b>Pipe Channel, RCP_Round 18"</b> 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
2.5	345	Total			

## Subcatchment WS 4I: Watershed #4 Post-Dev Impervious



### Summary for Subcatchment WS 4P: Watershed #4 Post-Dev Pervious

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"  
Routed to Pond 4P : Basin #4

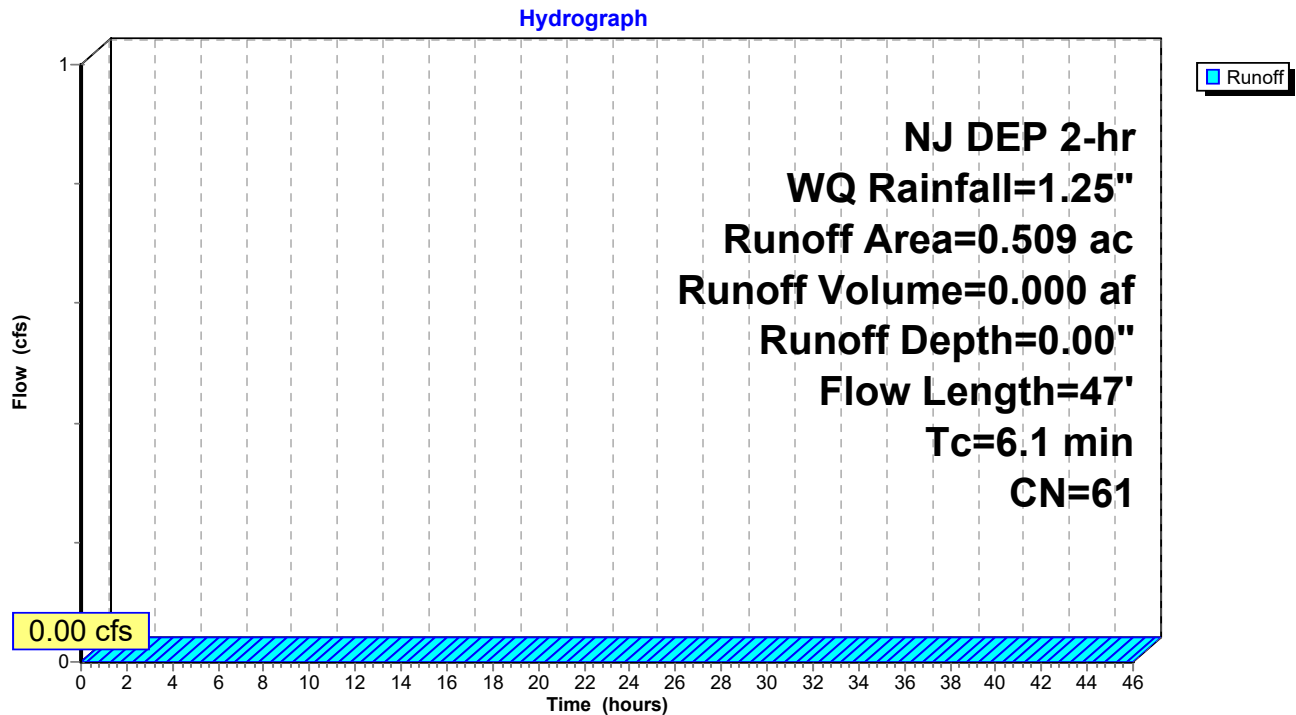
Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
0.509	61	>75% Grass cover, Good, HSG B
0.509		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	35	0.0200	0.10		<b>Sheet Flow, Sheet Flow</b> Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.3300	8.62		<b>Shallow Concentrated Flow, Shallow Flow Grass</b> Grassed Waterway Kv= 15.0 fps
6.1	47	Total			

### Subcatchment WS 4P: Watershed #4 Post-Dev Pervious



## Summary for Subcatchment WS 5I: Watershed #5 Post-Dev Impervious

[49] Hint:  $T_c < 2dt$  may require smaller  $dt$

Runoff = 4.23 cfs @ 1.08 hrs, Volume= 0.126 af, Depth= 1.03"  
Routed to Pond 5P : Basin #5

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs,  $dt=0.05$  hrs  
NJ DEP 2-hr WQ Rainfall=1.25"

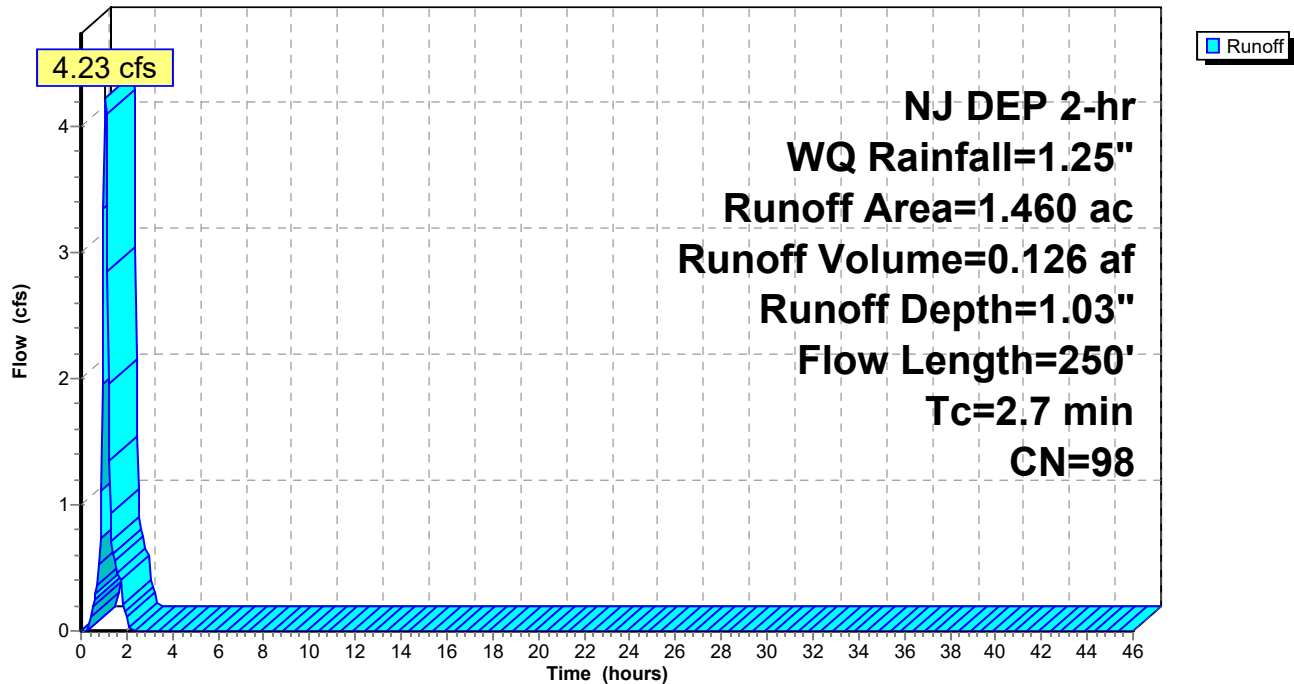
Area (ac)	CN	Description
1.460	98	Paved parking, HSG A
1.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	230	0.0050	1.44		<b>Shallow Concentrated Flow, Paved Flow</b> Paved Kv= 20.3 fps
0.0	20	0.2500	8.05		<b>Shallow Concentrated Flow, Stone Slope Flow</b> Unpaved Kv= 16.1 fps
2.7	250	Total			

## Subcatchment WS 5I: Watershed #5 Post-Dev Impervious

Hydrograph



**Summary for Subcatchment WS 5P: Watershed #5 Post-Dev Pervious**

[45] Hint: Runoff=Zero

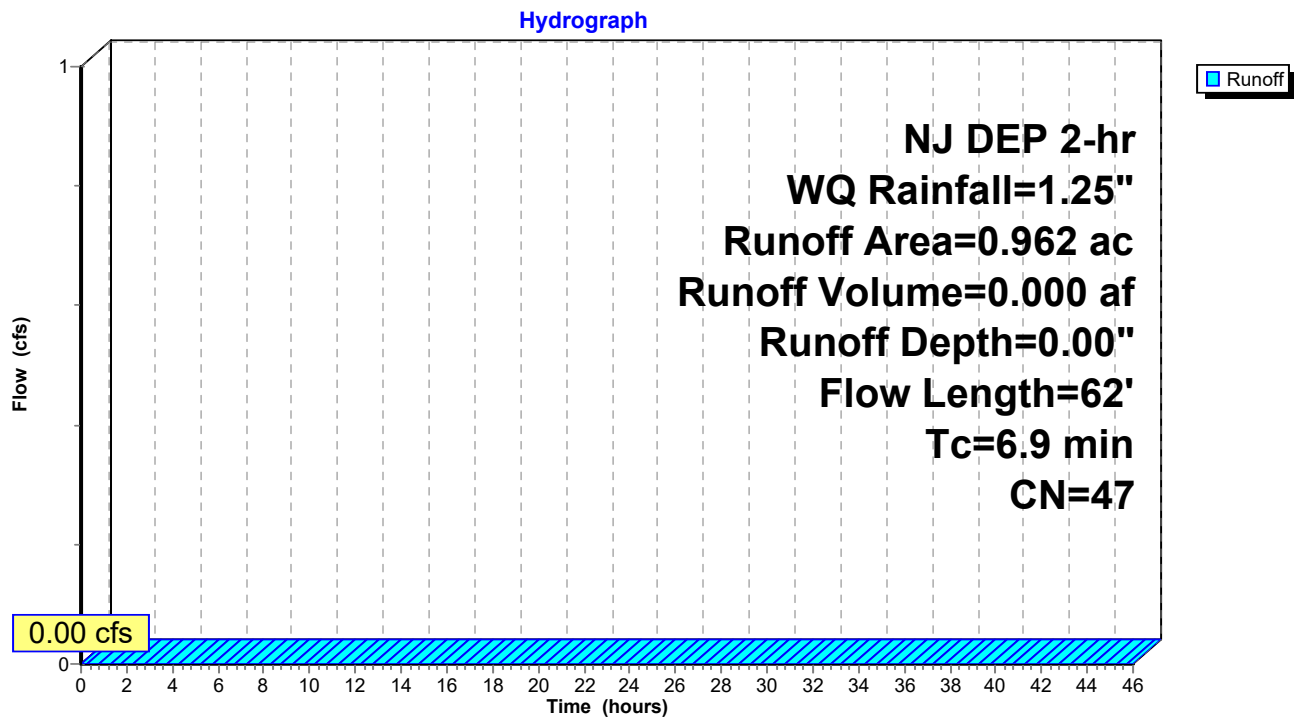
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"  
 Routed to Pond 5P : Basin #5

Runoff by SCS TR-20 method, UH=Delmarva, Weighted-CN, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
0.593	39	>75% Grass cover, Good, HSG A
0.369	61	>75% Grass cover, Good, HSG B
0.962	47	Weighted Average
0.962		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	50	0.0300	0.12		<b>Sheet Flow, Grass Sheet Flow</b>
					Grass: Dense n= 0.240 P2= 3.31"
0.0	12	0.2500	7.50		<b>Shallow Concentrated Flow, Grass Shallow Flow</b>
					Grassed Waterway Kv= 15.0 fps
6.9	62	Total			

**Subcatchment WS 5P: Watershed #5 Post-Dev Pervious**

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 95

### Summary for Reach SW: Grassed Swale

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 0.00" for WQ event  
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min  
Routed to Link DP : DISCHARGE POINT

Routing by Stor-Ind+Trans method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min  
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

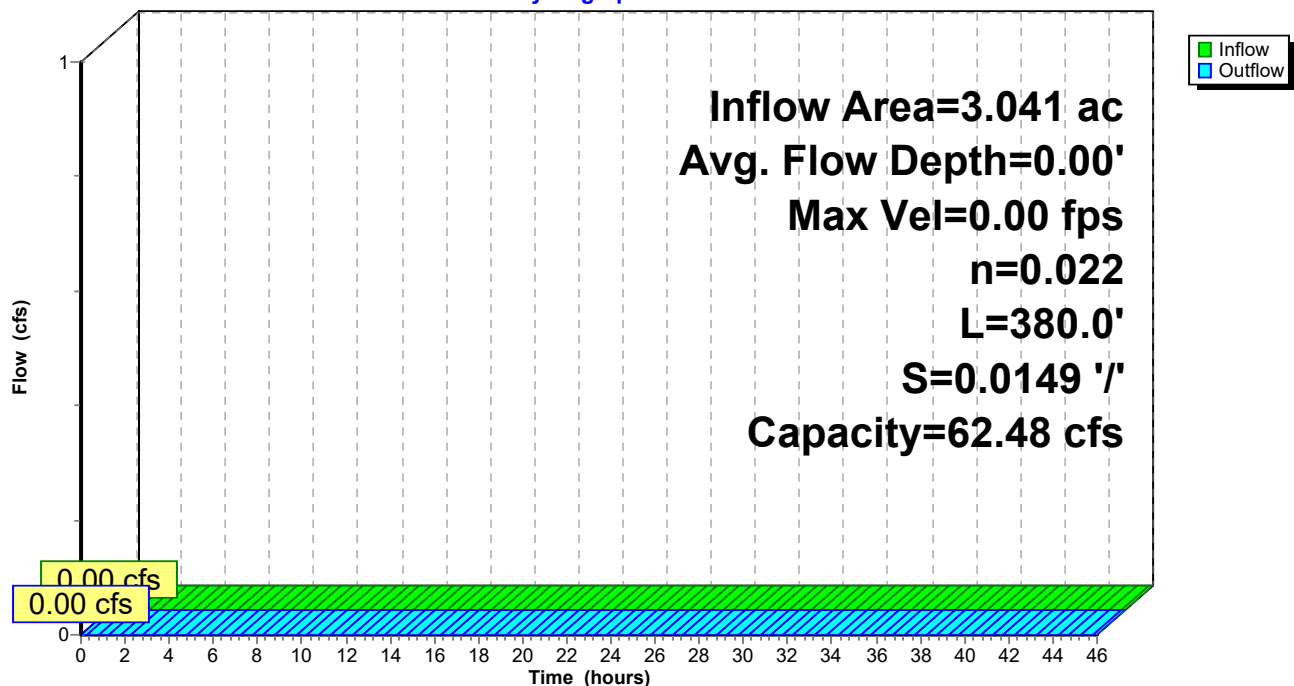
Peak Storage= 0 cf @ 0.00 hrs  
Average Depth at Peak Storage= 0.00'  
Bank-Full Depth= 1.00' Flow Area= 10.0 sf, Capacity= 62.48 cfs

15.00' x 1.00' deep Parabolic Channel, n= 0.022 Earth, clean & straight  
Length= 380.0' Slope= 0.0149 '/'  
Inlet Invert= 12.67', Outlet Invert= 7.00'



### Reach SW: Grassed Swale

Hydrograph



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 96

**Summary for Pond 1P: Basin #1**

Inflow Area = 0.853 ac, 38.22% Impervious, Inflow Depth = 0.40" for WQ event  
 Inflow = 0.92 cfs @ 1.09 hrs, Volume= 0.028 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Pond 2P : Basin #2

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 11.93' @ 2.40 hrs Surf.Area= 1,725 sf Storage= 1,224 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	9,711 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
11.00	903	0	0
12.00	1,785	1,344	1,344
13.00	2,965	2,375	3,719
14.00	4,120	3,543	7,262
14.50	5,678	2,450	9,711

Device	Routing	Invert	Outlet Devices
#1	Primary	11.10'	<b>15.0" Round Culvert</b> L= 750.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 11.10' / 11.10' S= 0.0000 ' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	13.00'	<b>48.0" x 30.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=11.00' (Free Discharge)

↑ **1=Culvert** ( Controls 0.00 cfs)

↑ **2=Orifice/Grate** ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

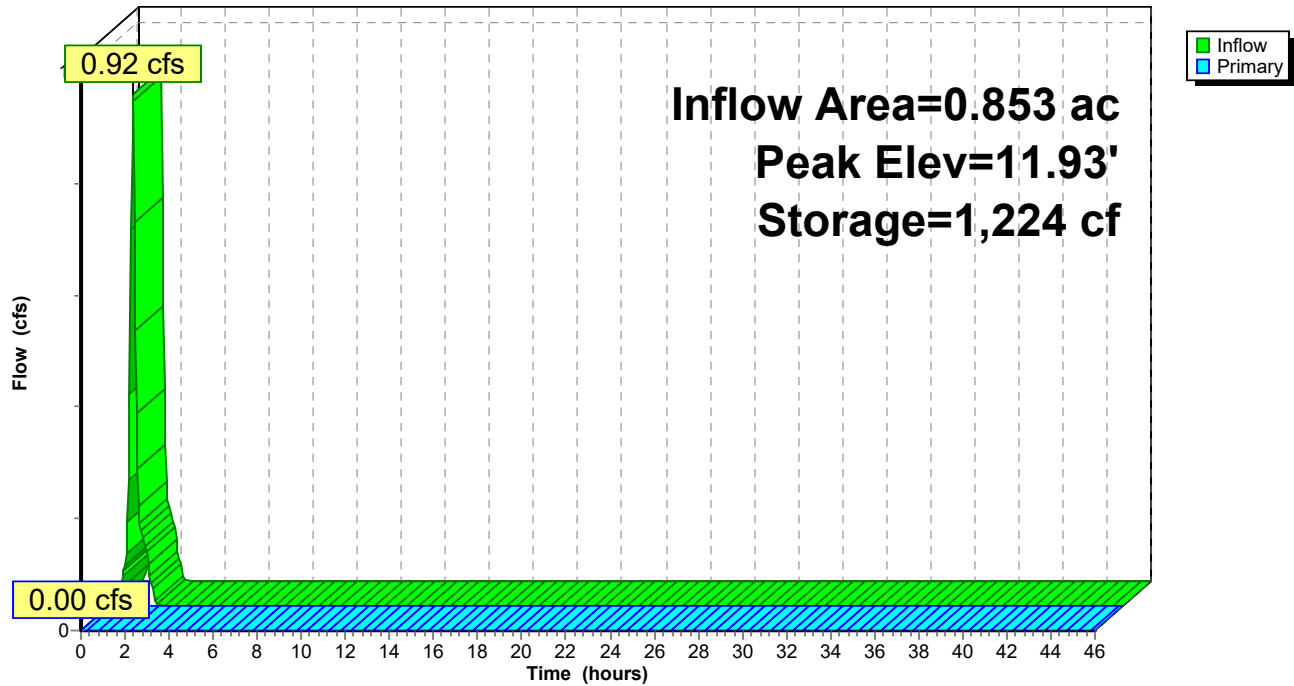
NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 97

### Pond 1P: Basin #1

Hydrograph





**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 98

**Summary for Pond 2P: Basin #2**

Inflow Area = 3.041 ac, 49.46% Impervious, Inflow Depth = 0.40" for WQ event  
 Inflow = 3.36 cfs @ 1.08 hrs, Volume= 0.102 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Reach SW : Grassed Swale

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 11.08' @ 2.40 hrs Surf.Area= 11,302 sf Storage= 4,424 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	10.67'	47,407 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
10.67	10,000	0	0
11.00	11,128	3,486	3,486
12.00	13,213	12,171	15,657
13.00	15,922	14,568	30,224
14.00	18,444	17,183	47,407

Device	Routing	Invert	Outlet Devices
#1	Primary	12.67'	<b>7.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=10.67' (Free Discharge)

↑1=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

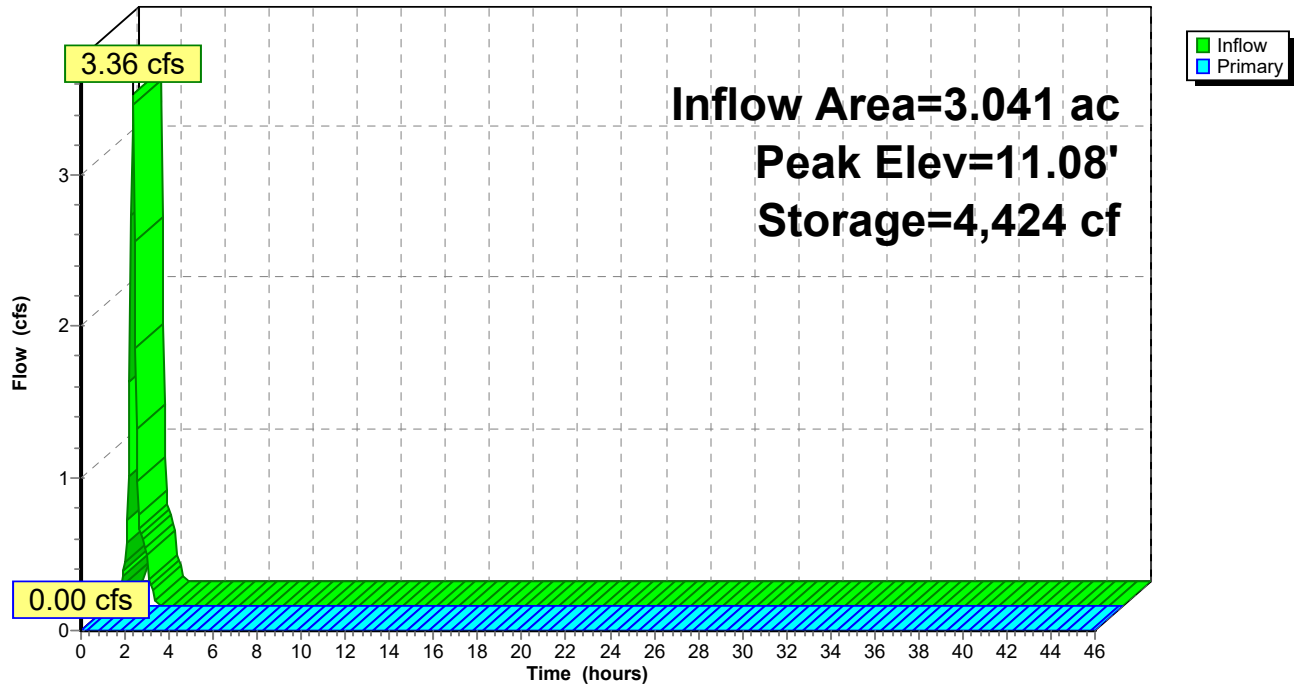
NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 99

### Pond 2P: Basin #2

#### Hydrograph



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 100

**Summary for Pond 3P: Basin #3**

Inflow Area = 2.196 ac, 52.28% Impervious, Inflow Depth = 0.54" for WQ event  
 Inflow = 3.30 cfs @ 1.08 hrs, Volume= 0.099 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Pond 4P : Basin #4

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 9.20' @ 2.35 hrs Surf.Area= 11,287 sf Storage= 4,311 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	41,842 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,985	0	0
9.00	10,988	2,097	2,097
10.00	12,493	11,741	13,838
11.00	14,000	13,247	27,084
12.00	15,516	14,758	41,842

Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=8.80' (Free Discharge)  
 ↑1=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

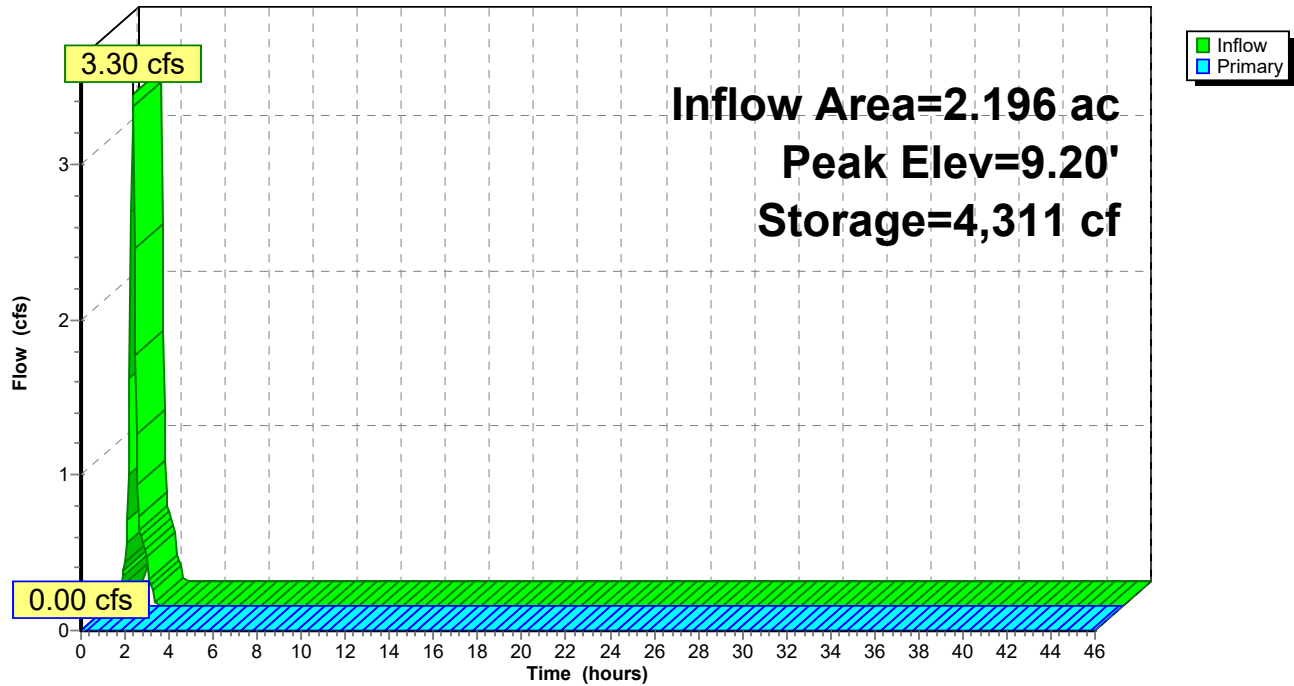
NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 101

### Pond 3P: Basin #3

#### Hydrograph



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 102

**Summary for Pond 4P: Basin #4**

Inflow Area = 4.082 ac, 61.86% Impervious, Inflow Depth = 0.35" for WQ event  
 Inflow = 3.95 cfs @ 1.07 hrs, Volume= 0.119 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Pond 5P : Basin #5

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 9.29' @ 2.30 hrs Surf.Area= 10,920 sf Storage= 5,171 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	8.80'	39,735 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.80	9,996	0	0
9.00	10,421	2,042	2,042
10.00	12,121	11,271	13,313
11.00	13,100	12,611	25,923
12.00	14,523	13,812	39,735

Device	Routing	Invert	Outlet Devices
#1	Primary	10.80'	<b>4.0' long x 20.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=8.80' (Free Discharge)  
 ↑1=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

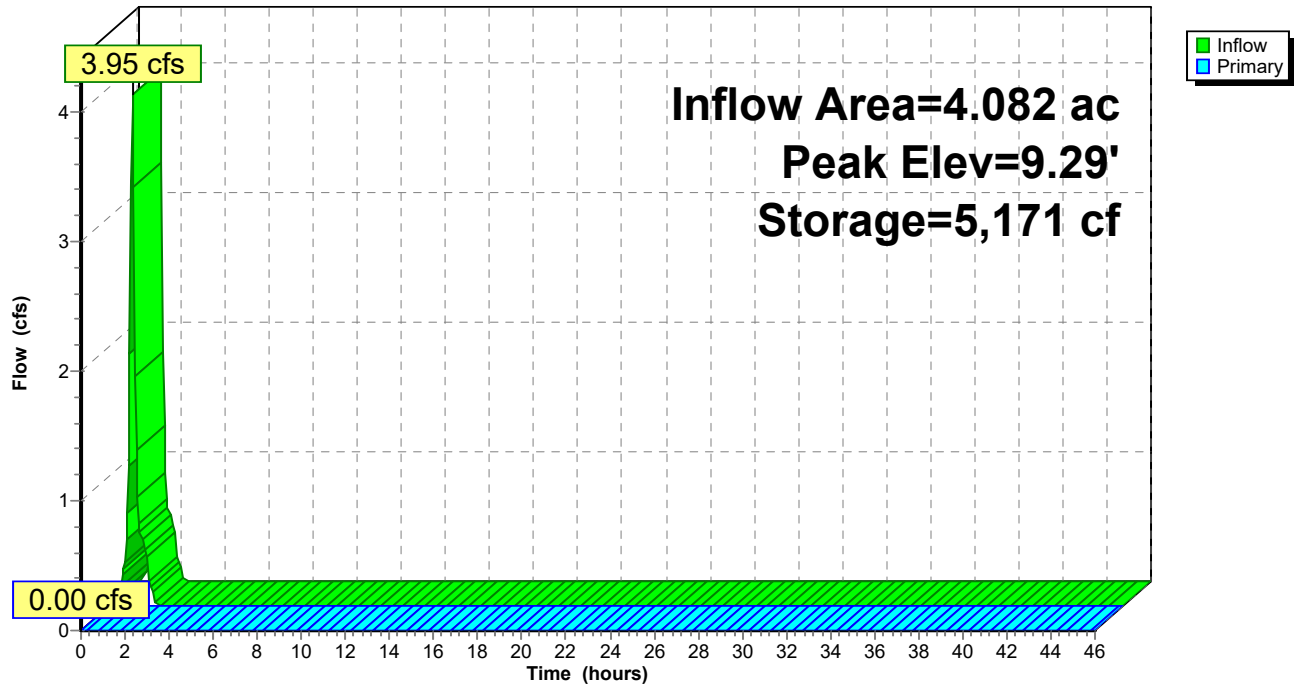
NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 103

### Pond 4P: Basin #4

#### Hydrograph



**Zemac Self Storage**

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 104

**Summary for Pond 5P: Basin #5**

Inflow Area = 6.504 ac, 61.27% Impervious, Inflow Depth = 0.23" for WQ event  
 Inflow = 4.23 cfs @ 1.08 hrs, Volume= 0.126 af  
 Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
 Routed to Link DP : DISCHARGE POINT

Routing by Stor-Ind method, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs  
 Peak Elev= 9.23' @ 2.35 hrs Surf.Area= 24,069 sf Storage= 5,483 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)  
 Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	84,099 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
9.00	23,222	0	0
10.00	26,875	25,049	25,049
11.00	29,445	28,160	53,209
12.00	32,336	30,891	84,099

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	<b>4.0' long x 10.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=9.00' (Free Discharge)

↑1=**Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Zemac Self Storage

Prepared by Engineering Design Associates

HydroCAD® 10.20-2c s/n 01171 © 2021 HydroCAD Software Solutions LLC

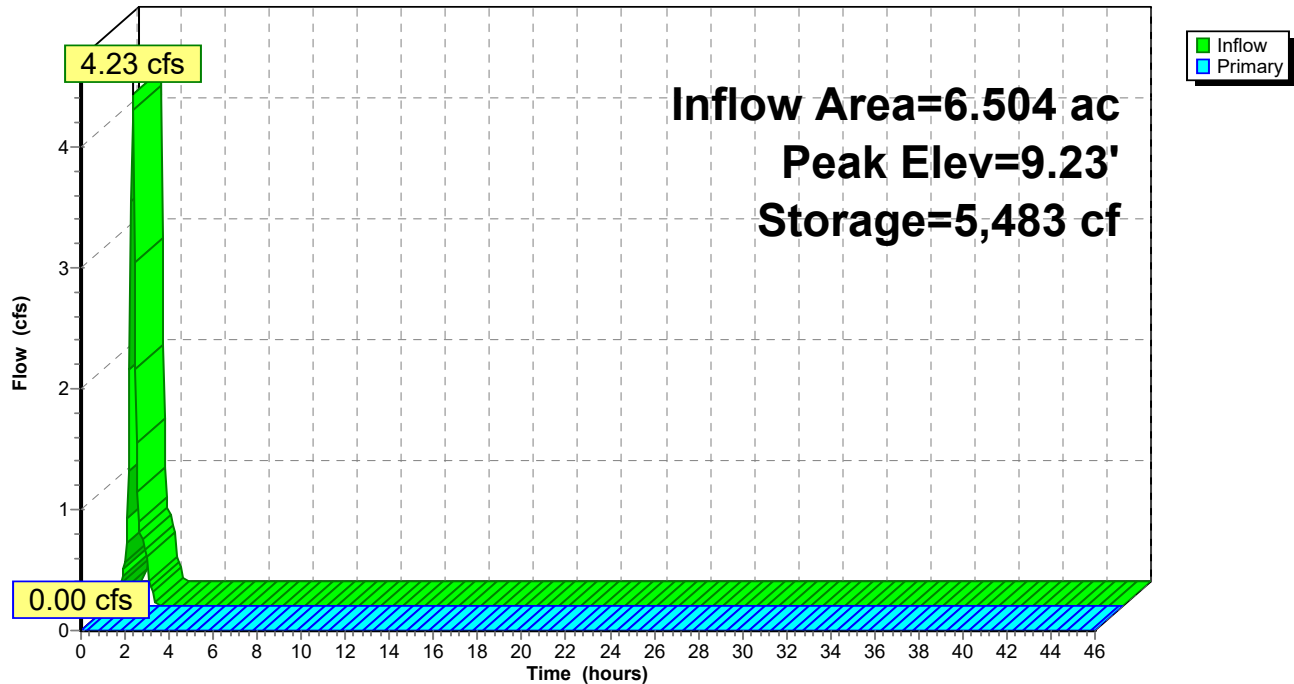
NJ DEP 2-hr WQ Rainfall=1.25"

Printed 6/8/2022

Page 105

### Pond 5P: Basin #5

#### Hydrograph

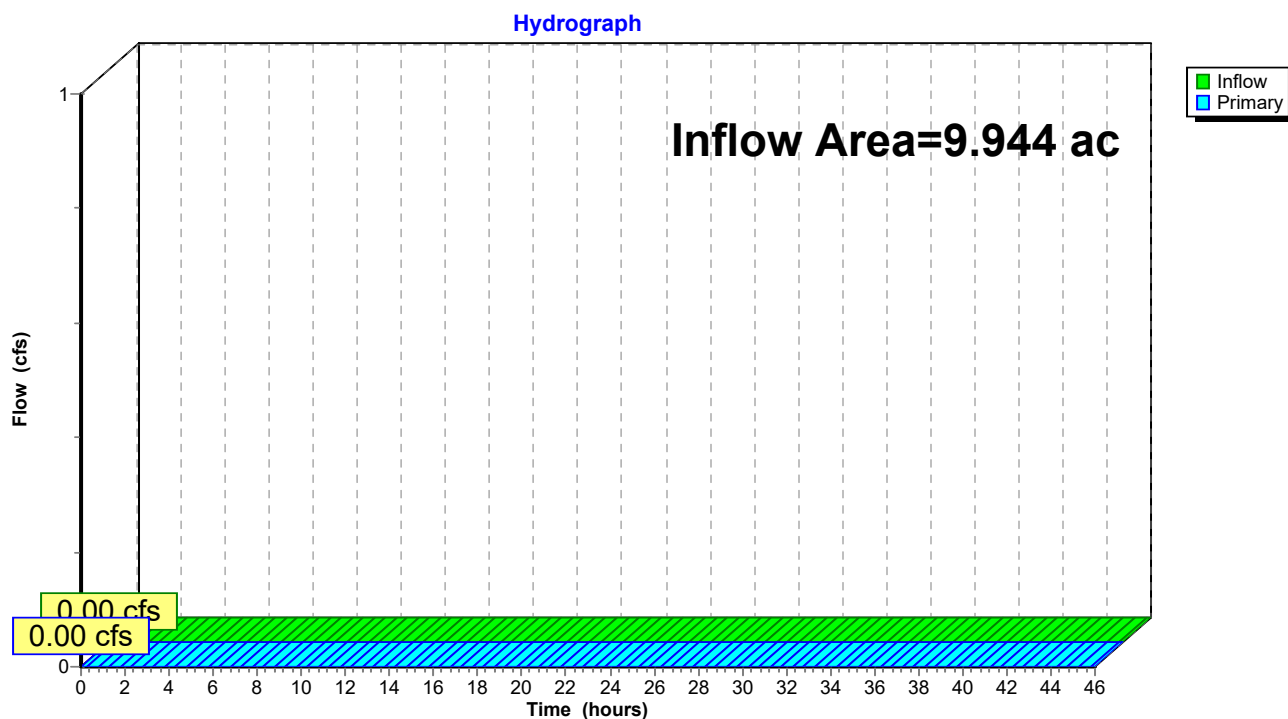




**Summary for Link DP: DISCHARGE POINT**

Inflow Area = 9.944 ac, 55.20% Impervious, Inflow Depth = 0.00" for WQ event  
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-46.00 hrs, dt= 0.05 hrs

**Link DP: DISCHARGE POINT**

# **PIPE ROUTING CALCULATIONS**

5 CAMBRIDGE DR.  
OCEAN VIEW, NJ 08230  
(609) 390-0332

OCEAN VIEW, NJ 08230

(609) 390-0332

JOB NO. 9306

PAGE \_\_\_\_\_ OF \_\_\_\_\_

CALCULATED BY MSB

DATE 6/8/22

VERIFIED BY

DATE \_\_\_\_\_

[illegible]

$$Q = VA = \frac{1.49}{n} AR^{2/3} \sqrt{S}$$

$$n = 0.011 \text{ RCP}$$

LINE NUMBER	BEGIN	END	INCREMENTS OF AREA ACRES	"C"	"CA"	TIME OF (min) CONCENTRATION	STORM	"I"	"Q"	SLOPE	PIPE DIAMETER	VELOCITY (F.P.S.)	LENGTH OF LINE (FT)	TIME FLOW (MIN.)	CAPACITY C.F.S.	Q = CIA Q = CFS I = INTENSITY (IN/HR) C = RUNOFF COEFFICIENT A = AREA (ACRES)
1	#2	#3	0.399	.99	.395	7.1	25	7.3	2.88	1.01	18"	1.61	144	.23	12.79	✓
2	#3	#4	0.856	.99	.847	7.33	25	7.2	6.49	1.01	18"	3.38	81	.19	12.79	✓
3	#4	FES 2	1.204	.99	1.19	7.52	25	7.1	8.45	1.01	18"	4.69	54	.18	12.79	✓
4																
5	#5	#6	0.285	.99	.282	6.4	25	7.5	2.12	0.81	18"	1.18	66	.93	11.43	✓
6	#6	FES 3	0.599	.99	.593	7.33	25	7.2	4.26	0.81	18"	2.37	93	.85	11.43	✓
7																
8																
9																
10																
11																
12																

JOB NAME Zenac CM  
 JOB NO. 9306  
 CALCULATED BY MSB  
 VERIFIED BY —

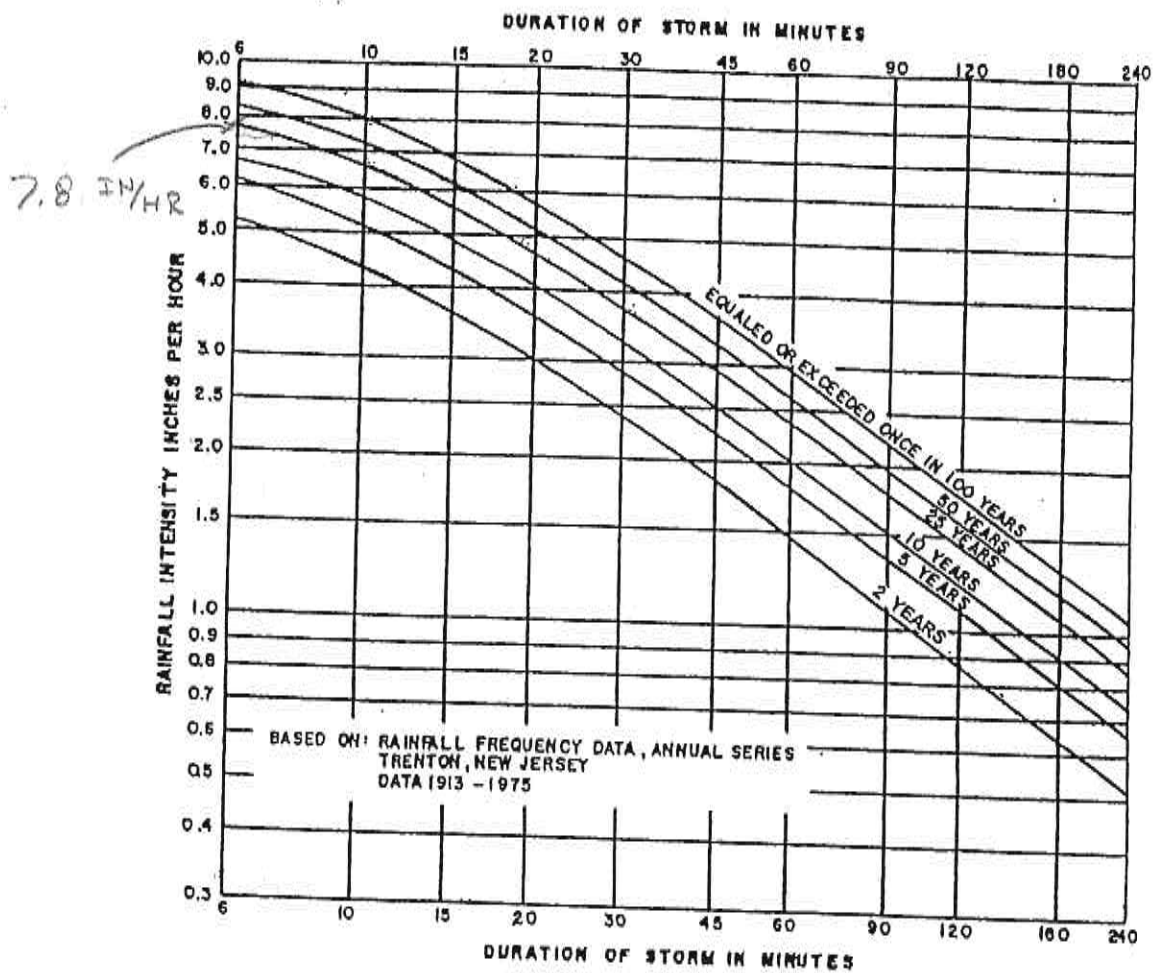
PAGE 1 OF 1  
 DATE 6/8/22  
 DATE —

**ENGINEERING DESIGN**  
 ASSOCIATES, P.A.  
 engineers • planners • landscape architects  
 Cambridge professional offices  
 5 Cambridge drive • ocean view, new jersey 08230  
 (609) 390-0332 • fax (609) 390-9204

or other approved methods may be employed.

TABLE 7.1 TYPICAL RUNOFF COEFFICIENTS (C VALUES) FOR 100-YEAR FREQUENCY STORM				
LAND-USE DESCRIPTION	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Cultivated land: without conservation treatment	0.49	0.67	0.81	0.88
with conservation treatment	0.27	0.43	0.61	0.67
Pasture or range land: poor condition	0.38	0.63	0.78	0.84
good condition	NA	0.25	0.51	0.65
Meadow: good condition	NA	NA	0.44	0.61
Wood or forest land: thin stand, poor cover, no mulch	NA	NA	0.59	0.79
good cover	NA	NA	0.45	0.59
Open spaces, lawns, parks, golf courses, cemeteries: good condition, grass cover on 75% or more of area	NA	0.25	0.51	0.65
fair condition, grass cover on 50-75% of area	NA	0.45	0.63	0.74
Commercial and business areas (85% impervious)	0.84	0.90	0.93	0.96
Industrial districts (72% impervious)	0.67	0.81	0.88	0.92
Residential:				
<u>Average lot size</u> <u>Average impervious</u>				
1/8 acre                  65%	0.59	0.76	0.86	0.90
1/4 acre                  38%	0.25	0.55	0.70	0.80
1/3 acre                  30%	NA	0.49	0.67	0.78
1/2 acre                  25%	NA	0.45	0.65	0.76
1 acre                    20%	NA	0.41	0.63	0.74
Paved parking lots, roofs, driveways, etc.	0.99	0.99	0.99	0.99
Streets and roads:				
paved with curbs and storm sewers	0.99	0.99	0.99	0.99
gravel	0.57	0.76	0.84	0.88
dirt	0.49	0.69	0.80	0.84
NOTE: NA denotes information is not available; design engineers should rely on another authoritative source.				
SOURCE: <i>Technical Manual for Land Use Regulation Program</i> , Department of Environmental Protection, Bureau of Inland and Coastal Regulations, Stream Encroachment Permits (Trenton, New Jersey, revised September 1995), p. 12.				

FIGURE 7.2 RAINFALL INTENSITY CURVES



Note: Adapted from Figure 2.1-2 in the NJDEP Technical Manual for Stream Encroachment Permits.

#9306

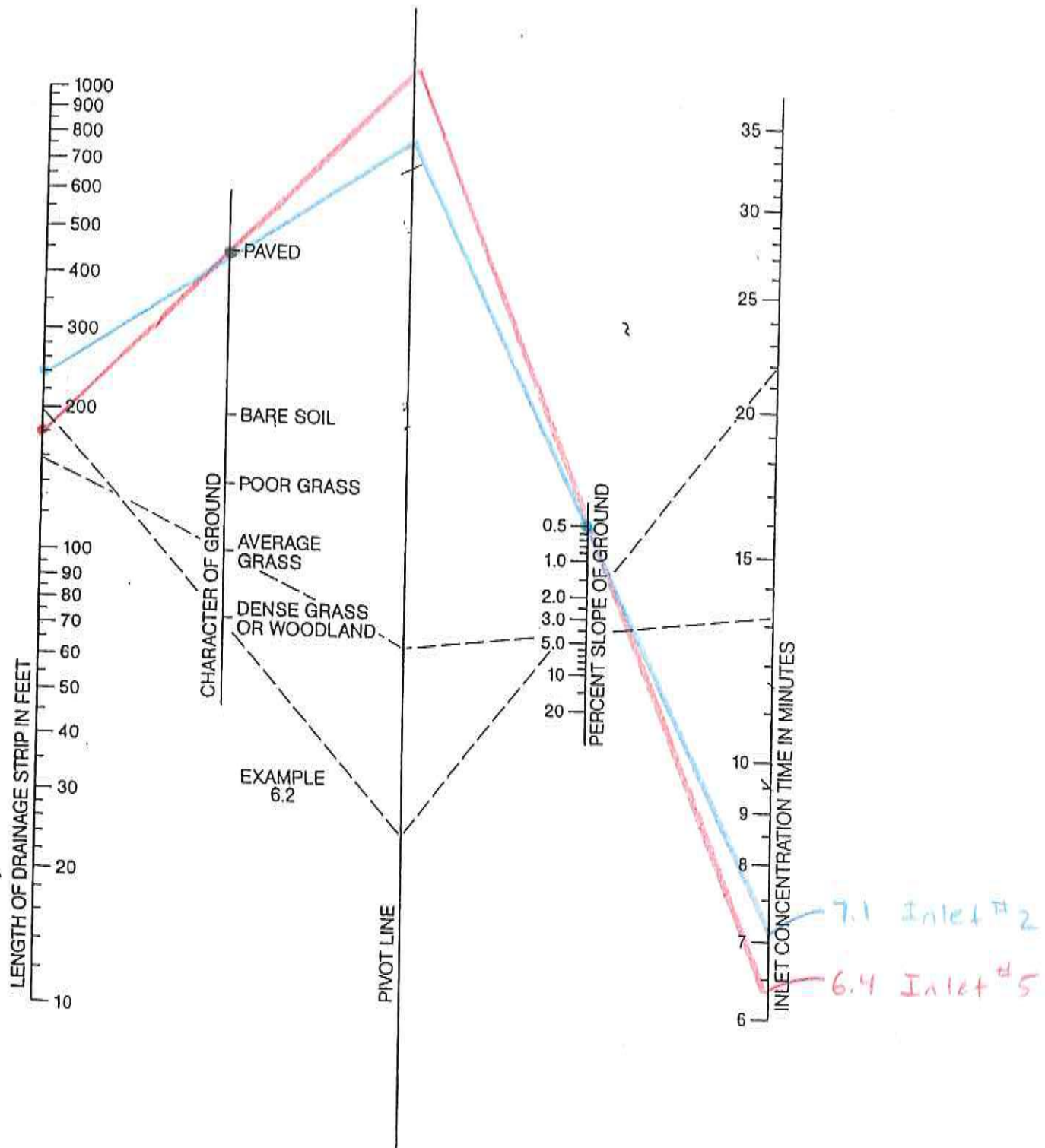


Fig. 6.13. NOMOGRAPH FOR OVERLAND FLOW TIME

# **CONDUIT OUTLET PROTECTION**



### Calculate Stone Apron #1 Size

$$Q = 2.14 \text{ CFS}$$

$$T_w > 1/2 D_o$$

$$D_o = 1.25 \text{ FT}$$

### Calculate Length

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

$$q = Q/D_o$$
$$q = 2.14/1.25 = 1.72$$

$$L_a = 4.61 \text{ FT}$$

**Use 5' Length**

### Calculate Width

$$W = 3W_o + 0.40L_a$$

$$W_o = D_o$$

$$W = 5.75 \text{ FT}$$

**Use 6' Width**

### Calculate D50 Stone Size

$$D_{50} = \frac{0.016}{T_w} (q^{1.33})$$

$$T_w = 0.71 \text{ Ft}$$

$$D_{50} = 0.05 \text{ FT}$$

**Use 6" Diameter Stone**

### Calculate Stone Apron #2 Size

$$Q = 8.45 \text{ CFS}$$

$$T_w > 1/2 D_o$$

$$D_o = 1.50 \text{ FT}$$

### Calculate Length

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

$$q = Q/D_o$$
$$q = 8.45/1.50 = 5.63$$

$$L_a = 13.7 \text{ FT}$$

**Use 14' Length**

### Calculate Width

$$W = 3W_o + 0.40L_a$$

$$W_o = D_o$$

$$W = 6.75 \text{ FT}$$

**Use 6' Width**

### Calculate D50 Stone Size

$$D_{50} = \frac{0.016}{T_w} (q^{1.33})$$

$$T_w = 1.19 \text{ Ft}$$

$$D_{50} = 0.13 \text{ FT}$$

**Use 6" Diameter Stone**

### **Calculate Stone Apron #3 Size**

$$Q = 4.26 \text{ CFS}$$

$$T_w > 1/2 D_o$$

$$D_o = 1.50 \text{ FT}$$

### **Calculate Length**

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

$$q = Q/D_o$$

$$q = 4.26/1.50 = 2.84$$

$$L_a = 7.1 \text{ FT}$$

**Use 8' Length**

### **Calculate Width**

$$W = 3W_o + 0.40L_a$$

$$W_o = D_o$$

$$W = 7.7 \text{ FT}$$

**Use 8' Width**

### **Calculate D50 Stone Size**

$$D_{50} = \frac{0.016}{T_w} (q^{1.33})$$

$$T_w = 1.44 \text{ Ft}$$

$$D_{50} = 0.04 \text{ FT}$$

**Use 6" Diameter Stone**

# **SOILS DATA**

**TEST PIT #1**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0" - 11"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
11" - 32"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
32" - 39"	10YR 6/6 Brownish Yellow, Loamy Sand, Subangular Blocky, Friable
39" - 90"	10YR 7/6 Yellow, Sand, Single Grain, Loose
90" - 113"	10YR 7/3 Very Pale Brown, Sand, Single Grain, Loose w/mottles of 10YR 8/1 White, Few, Fine & Faint
113" - 150"	10YR 8/2 Very Pale Brown, Fine Sand, Single Grain, Loose

Depth of Seasonal High Water: 90"  
Depth of Groundwater: 130"  
Date Performed: 5/26/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #2**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0" - 11"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
11" - 24"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
24" - 42"	10YR 5/6 Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
42" - 88"	10YR 6/6 Brownish Yellow, Loamy Sand, Subangular Blocky, Friable
88" - 145"	10YR 7/2 Light Gray, Sand, Single Grain, Loose w/mottles of 10YR 8/1 White, Few, Fine & Faint

Depth of Seasonal High Water: 88"  
Depth of Groundwater: 127"  
Date Performed: 5/26/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #3**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0" - 6"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
6" - 20"	10YR 6/4 Light Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
20" - 39"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
39" - 57"	10YR 7/6 Yellow, Loamy Sand, Subangular Blocky, Friable
57" - 80"	10YR 7/4 Very Pale Brown, Loamy Sand, Subangular Blocky, Friable
80" - 156"	10YR 7/2 Light Gray, Fine Sand, Single Grain, Loose w/mottles of 10YR 8/1 White, Few, Fine & Faint

Depth of Seasonal High Water: 80"  
Depth of Groundwater: 134"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #4**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 5"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
5"- 21"	10YR 6/4 Light Yellowish Brown, Loamy Sand, Subangular Blocky, Friable
21"- 43"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
43"- 80"	10YR 7/4 Very Pale Brown, Sandy Loam, Subangular Blocky, Friable
80"- 93"	10YR 7/3 Very Pale Brown, Loamy Sand, Subangular Blocky, Friable w/mottles of 10YR 8/1 White, Few, Fine & Faint
93"- 156"	10YR 8/1 White, Fine Sand, Single Grain, Loose

Depth of Seasonal High Water: 80"  
Depth of Groundwater: 130"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #5**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 7"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
7"- 18"	10YR 6/4 Light Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
18"- 29"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
29"- 55"	10YR 7/6 Yellow, Loamy Sand, Subangular Blocky, Friable
55"- 96"	10YR 6/4 Light Yellowish Brown, Loamy Sand, Subangular Blocky, Friable w/mottles of 10YR 7/1 Light Gray, Few, Fine & Faint
96"- 135"	10YR 7/2 Light Gray, Sand, Single Grain, Loose

Depth of Seasonal High Water: 55"  
Depth of Groundwater: 98"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #6**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 6"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
6"- 17"	10YR 6/4 Light Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
17"- 45"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
45"- 84"	10YR 6/6 Brownish Yellow, Loamy Sand, Subangular Blocky, Friable w/mottles of 10YR 7/1 Light Gray, Few, Fine & Faint
84"- 128"	10YR 6/3 Pale Brown, Sand, Single Grain, Loose w/mottles of 10YR 8/1 White, Common, Medium & Distinct

Depth of Seasonal High Water: 45"  
Depth of Groundwater: 93"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #7**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 7"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
7"- 20"	10YR 6/4 Light Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
20"- 38"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
38"- 52"	10YR 7/4 Very Pale Brown, Loamy Sand, Subangular Blocky, Friable
52"- 90"	10YR 7/2 Light Gray, Fine Sand, Single Grain, Loose w/mottles of 10YR 8/1 White, Few, Fine & Faint
90"- 138"	10YR 6/1 Gray, Sand, Single Grain, Loose

Depth of Seasonal High Water: 52"  
Depth of Groundwater: 102"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #8**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 7"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
7"- 19"	10YR 6/3 Pale Brown, Sandy Loam, Subangular Blocky, Friable
19"- 36"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
36"- 58"	10YR 7/4 Very Pale Brown, Loamy Sand, Subangular Blocky, Friable
58"- 136"	10YR 7/2 Light Gray, Fine Sand, Single Grain, Loose w/mottles of 10YR 7/1 Light Gray, Few, Fine & Faint

Depth of Seasonal High Water: 58"  
Depth of Groundwater: 126"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #9**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 6"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
6"- 17"	10YR 6/4 Light Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
17"- 30"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
30"- 50"	10YR 7/4 Very Pale Brown, Loamy Sand, Subangular Blocky, Friable w/layers of 10YR 6/6 Brownish Yellow, Subangular Blocky, Friable
50"- 85"	10YR 7/3 Very Pale Brown, Sand, Single Grain, Loose w/mottles of 10YR 7/1 Light Gray, Few, Fine & Faint
85"- 128"	10YR 7/1 Light Gray, Sand, Single Grain, Loose

Depth of Seasonal High Water: 50"  
Depth of Groundwater: 103"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #10**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 7"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
7"- 23"	10YR 6/4 Light Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
23"- 33"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
33"- 42"	10YR 7/3 Very Pale Brown, Loamy Sand, Subangular Blocky, Friable
42"- 86"	10YR 6/4 Light Yellowish Brown, Loamy Sand, Subangular Blocky, w/mottles of 10YR 8/1 White, Few, Fine & Faint, layers of 10YR 5/6 Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
86"- 120"	10YR 7/2 Light Gray, Loamy Sand, Subangular Blocky, Friable

Depth of Seasonal High Water: 42"  
Depth of Groundwater: 99"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #11**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 3"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
3"- 26"	10YR 6/6 Brownish Yellow, Sandy Clay Loam, Subangular Blocky, Friable
26"- 72"	10YR 6/2 Light Brownish Gray, Sandy Clay Loam, Subangular Blocky, Friable w/mottles of 10YR 6/4 Light Yellowish Brown, Common, Medium & Distinct
72"- 110"	10YR 7/2 Light Gray, Sand, Single Grain, Loose

Depth of Seasonal High Water: 26"  
Depth of Groundwater: 48"  
Date Performed: 5/25/2022  
Performed By: Christopher J. Carey, LLA

**TEST PIT #12**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 9"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
9"- 19"	10YR 6/4 Light Yellowish Brown, Sandy Loam, Subangular Blocky, Friable
19"- 34"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
34"- 52"	10YR 6/6 Brownish Yellow, Loamy Sand, Subangular Blocky, Friable
52"- 81"	10YR 6/4 Light Yellowish Brown, Loamy Sand, Subangular Blocky, Friable w/mottles of 10YR 7/1 Light Gray, Few, Fine & Faint
81"- 103"	10YR 6/2 Light Brownish Gray, Sandy Clay Loam, Subangular Blocky, Friable
103"- 129"	10YR 6/1 Gray, Fine Sand, Single Grain, Loose

Depth of Seasonal High Water: 52"  
Depth of Groundwater: 115"  
Date Performed: 5/26/2022  
Witnessed By: Heather Carr Johnson, Cape May County Health Dept.  
Performed By: Christopher J. Carey, LLA



**TEST PIT #13**

<b><u>DEPTH</u></b>	<b><u>DESCRIPTION</u></b>
0"- 10"	10YR 4/2 Dark Grayish Brown, Sandy Loam, Subangular Blocky, Friable
10"- 19"	10YR 6/4 Light Yellowish Brown, Loamy Sand, Subangular Blocky, Friable
19"- 32"	10YR 6/6 Brownish Yellow, Sandy Loam, Subangular Blocky, Friable
32"- 55"	10YR 6/6 Brownish Yellow, Loamy Sand, Subangular Blocky, Friable
55"- 84"	10YR 7/6 Yellow, Loamy Sand, Subangular Blocky, Friable w/mottles of 10YR 7/1 Light Gray, Few, Fine & Faint
84"- 102"	10YR 6/2 Light Brownish Gray, Sandy Clay Loam, Subangular Blocky, Friable
102"- 132"	10YR 6/2 Light Brownish Gray, Sand, Single Grain, Loose

Depth of Seasonal High Water: 55"  
Depth of Groundwater: 115"  
Date Performed: 5/26/2022  
Witnessed By: Heather Carr Johnson, Cape May County Health Dept.  
Performed By: Christopher J. Carey, LLA

CJC/tt

**Szeker - EDA #9306  
Block 262, Lot 1.03**

**CAPE MAY COUNTY DEPARTMENT OF HEALTH  
SEWAGE DISPOSAL SYSTEM APPLICATION - ATTACHMENT "B"**

**SOIL PERMEABILITY CLASS RATING DATA**

**MUNICIPALITY – Dennis Township**

1. Test Number 1 Replicate Letter A
2. Sample Depth 84" Soil Pit Boring Number TP#1 Date Collected 5/26/2022
3. Coarse Fragment Content  
Total Wt. of Sample, W.T., Grams (g) 520.6  
Wt. of Material Retained on 2 mm Sieve, W.C.F., g 138.2  
Wt. % Coarse Fragment (W.C.F./W.T. x 100): 26.5%
4. Oven Dry Weight (24 Hrs., 105° C) of 40 g Air Dry Sample, g. Wt. 39.8
5. Hydrometer Calibration, Rc 3  
Temperature of Suspension, °F 73°
6. Hydrometer Reading - 40 Sec., g, R1 5  
Temperature of Suspension, °F 73°
7. Corrected Hydrometer Reading, g, R1<sup>1</sup> 3
8. Hydrometer Reading - 2 Hrs., g, R2 4  
Temperature of Suspension, °F 74°
9. Corrected Hydrometer Reading, g, R2<sup>1</sup> 2.2
10. % Sand =  $(39.8 - 3)/39.8 \times 100 =$  92.5%
11. % Clay =  $2.2/39.8 \times 100 =$  5.5%
12. Sieve Analysis:
  - (a) Oven Dry Wt. (2 Hrs., 105° C) Total Sand Fraction  
(Soil Retained in 0.047 mm Sieve), g 39.4
  - (b) Wt. of Fine Plus Very Fine Sand Fraction  
(Sand Passing 0.25 mm Sieve), g 7.5
  - (c) % Fine Plus Very Fine Sand (b/a) 19.0%
13. Soil Morphology (Natural Soil Samples Only):  
Structure of Soil Horizon Tested \_\_\_\_\_  
Consistence of Soil Horizon Tested: \_\_\_\_\_ Dry \_\_\_\_\_ Moist \_\_\_\_\_
14. Soil Permeability Class Rating (Based upon Average Textural Analysis of this Replicate and other Replicate Samples)  
K-5
15. I HEREBY CERTIFY THAT THE INFORMATION FURNISHED ON THIS ATTACHMENT "B" IS TRUE AND ACCURATE. I AM AWARE THAT FALSIFICATION OF DATA IS A VIOLATION OF THE WATER POLLUTION CONTROL ACT (N.J.S.A.) 58:10A-1 et seq.) AND IS SUBJECT TO PENALTIES AS PRESCRIBED IN N.J.A.C. 7:14-8.

SIGNATURE OF SOIL EVALUATOR \_\_\_\_\_

DATE \_\_\_\_\_

SIGNATURE OF PROFESSIONAL ENGINEER \_\_\_\_\_

LICENSE NUMBER \_\_\_\_\_

**Szeker - EDA #9306  
Block 262, Lot 1.03**

**CAPE MAY COUNTY DEPARTMENT OF HEALTH  
SEWAGE DISPOSAL SYSTEM APPLICATION - ATTACHMENT "B"**

**SOIL PERMEABILITY CLASS RATING DATA**

**MUNICIPALITY – Dennis Township**

1. Test Number 1 Replicate Letter B
2. Sample Depth 84" Soil Pit Boring Number TP#1 Date Collected 5/26/2022
3. Coarse Fragment Content  
Total Wt. of Sample, W.T., Grams (g) 520.6  
Wt. of Material Retained on 2 mm Sieve, W.C.F., g 138.2  
Wt. % Coarse Fragment (W.C.F./W.T. x 100): 26.5%
4. Oven Dry Weight (24 Hrs., 105° C) of 40 g Air Dry Sample, g. Wt. 39.8
5. Hydrometer Calibration, Rc 3  
Temperature of Suspension, °F 73°
6. Hydrometer Reading - 40 Sec., g, R1 5  
Temperature of Suspension, °F 73°
7. Corrected Hydrometer Reading, g, R1<sup>1</sup> 3
8. Hydrometer Reading - 2 Hrs., g, R2 5  
Temperature of Suspension, °F 73°
9. Corrected Hydrometer Reading, g, R2<sup>1</sup> 3
10. % Sand =  $(39.8 - 3)/39.8 \times 100 =$  92.5%
11. % Clay =  $3/39.8 \times 100 =$  7.5%
12. Sieve Analysis:
  - (a) Oven Dry Wt. (2 Hrs., 105° C) Total Sand Fraction  
(Soil Retained in 0.047 mm Sieve), g 38.9
  - (b) Wt. of Fine Plus Very Fine Sand Fraction  
(Sand Passing 0.25 mm Sieve), g 7.8
  - (c) % Fine Plus Very Fine Sand (b/a) 20.0%
13. Soil Morphology (Natural Soil Samples Only):  
Structure of Soil Horizon Tested \_\_\_\_\_  
Consistence of Soil Horizon Tested: \_\_\_\_\_ Dry \_\_\_\_\_ Moist \_\_\_\_\_
14. Soil Permeability Class Rating (Based upon Average Textural Analysis of this Replicate and other Replicate Samples)  
K-5
15. I HEREBY CERTIFY THAT THE INFORMATION FURNISHED ON THIS ATTACHMENT "B" IS TRUE AND ACCURATE. I AM AWARE THAT FALSIFICATION OF DATA IS A VIOLATION OF THE WATER POLLUTION CONTROL ACT (N.J.S.A.) 58:10A-1 et seq.) AND IS SUBJECT TO PENALTIES AS PRESCRIBED IN N.J.A.C. 7:14-8.

SIGNATURE OF SOIL EVALUATOR \_\_\_\_\_  
DATE \_\_\_\_\_  
SIGNATURE OF PROFESSIONAL ENGINEER \_\_\_\_\_  
LICENSE NUMBER \_\_\_\_\_

**Szeker - EDA #9306  
Block 262, Lot 1.03**

**CAPE MAY COUNTY DEPARTMENT OF HEALTH  
SEWAGE DISPOSAL SYSTEM APPLICATION - ATTACHMENT "B"**

**SOIL PERMEABILITY CLASS RATING DATA**

**MUNICIPALITY – Dennis Township**

1. Test Number 1 Replicate Letter A
2. Sample Depth 120" Soil Pit Boring Number TP#1 Date Collected 5/26/2022
3. Coarse Fragment Content  
Total Wt. of Sample, W.T., Grams (g) 571.8  
Wt. of Material Retained on 2 mm Sieve, W.C.F., g 75.0  
Wt. % Coarse Fragment (W.C.F./W.T. x 100): 13.1%
4. Oven Dry Weight (24 Hrs., 105° C) of 40 g Air Dry Sample, g. Wt. 40.0
5. Hydrometer Calibration, Rc 3  
Temperature of Suspension, °F 71°
6. Hydrometer Reading - 40 Sec., g, R1 5  
Temperature of Suspension, °F 71°
7. Corrected Hydrometer Reading, g, R1<sup>1</sup> 2.6
8. Hydrometer Reading - 2 Hrs., g, R2 4  
Temperature of Suspension, °F 72°
9. Corrected Hydrometer Reading, g, R2<sup>1</sup> 1.8
10. % Sand =  $(40.0 - 2.6)/40.0 \times 100 =$  93.5%
11. % Clay =  $1.8/40.0 \times 100 =$  4.5%
12. Sieve Analysis:
  - (a) Oven Dry Wt. (2 Hrs., 105° C) Total Sand Fraction  
(Soil Retained in 0.047 mm Sieve), g 38.8
  - (b) Wt. of Fine Plus Very Fine Sand Fraction  
(Sand Passing 0.25 mm Sieve), g 21.0
  - (c) % Fine Plus Very Fine Sand (b/a) 54.1%
13. Soil Morphology (Natural Soil Samples Only):  
Structure of Soil Horizon Tested \_\_\_\_\_  
Consistence of Soil Horizon Tested: \_\_\_\_\_ Dry \_\_\_\_\_ Moist \_\_\_\_\_
14. Soil Permeability Class Rating (Based upon Average Textural Analysis of this Replicate and other Replicate Samples)  
K-4 (Adjusted)
15. I HEREBY CERTIFY THAT THE INFORMATION FURNISHED ON THIS ATTACHMENT "B" IS TRUE AND ACCURATE. I AM AWARE THAT FALSIFICATION OF DATA IS A VIOLATION OF THE WATER POLLUTION CONTROL ACT (N.J.S.A.) 58:10A-1 et seq.) AND IS SUBJECT TO PENALTIES AS PRESCRIBED IN N.J.A.C. 7:14-8.

SIGNATURE OF SOIL EVALUATOR \_\_\_\_\_

DATE \_\_\_\_\_

SIGNATURE OF PROFESSIONAL ENGINEER \_\_\_\_\_

LICENSE NUMBER \_\_\_\_\_

**Szeker - EDA #9306  
Block 262, Lot 1.03**

**CAPE MAY COUNTY DEPARTMENT OF HEALTH  
SEWAGE DISPOSAL SYSTEM APPLICATION - ATTACHMENT "B"**

**SOIL PERMEABILITY CLASS RATING DATA**

**MUNICIPALITY – Dennis Township**

1. Test Number 1 Replicate Letter B
2. Sample Depth 120" Soil Pit Boring Number TP#1 Date Collected 5/26/2022
3. Coarse Fragment Content  
Total Wt. of Sample, W.T., Grams (g) 571.8  
Wt. of Material Retained on 2 mm Sieve, W.C.F., g 75.0  
Wt. % Coarse Fragment (W.C.F./W.T. x 100): 13.1%
4. Oven Dry Weight (24 Hrs., 105° C) of 40 g Air Dry Sample, g. Wt. 40.0
5. Hydrometer Calibration, Rc 3  
Temperature of Suspension, °F 71°
6. Hydrometer Reading - 40 Sec., g, R1 5  
Temperature of Suspension, °F 71°
7. Corrected Hydrometer Reading, g, R1<sup>1</sup> 2.6
8. Hydrometer Reading - 2 Hrs., g, R2 4  
Temperature of Suspension, °F 71°
9. Corrected Hydrometer Reading, g, R2<sup>1</sup> 1.6
10. % Sand =  $(40.0 - 2.6)/40.0 \times 100 =$  93.5%
11. % Clay =  $1.6/40.0 \times 100 =$  4.0%
12. Sieve Analysis:
  - (a) Oven Dry Wt. (2 Hrs., 105° C) Total Sand Fraction  
(Soil Retained in 0.047 mm Sieve), g 37.9
  - (b) Wt. of Fine Plus Very Fine Sand Fraction  
(Sand Passing 0.25 mm Sieve), g 21.9
  - (c) % Fine Plus Very Fine Sand (b/a) 57.8%
13. Soil Morphology (Natural Soil Samples Only):  
Structure of Soil Horizon Tested \_\_\_\_\_  
Consistence of Soil Horizon Tested: \_\_\_\_\_ Dry \_\_\_\_\_ Moist \_\_\_\_\_
14. Soil Permeability Class Rating (Based upon Average Textural Analysis of this Replicate and other Replicate Samples)  
K-4 (Adjusted)
15. I HEREBY CERTIFY THAT THE INFORMATION FURNISHED ON THIS ATTACHMENT "B" IS TRUE AND ACCURATE. I AM AWARE THAT FALSIFICATION OF DATA IS A VIOLATION OF THE WATER POLLUTION CONTROL ACT (N.J.S.A.) 58:10A-1 et seq.) AND IS SUBJECT TO PENALTIES AS PRESCRIBED IN N.J.A.C. 7:14-8.

SIGNATURE OF SOIL EVALUATOR \_\_\_\_\_  
DATE \_\_\_\_\_  
SIGNATURE OF PROFESSIONAL ENGINEER \_\_\_\_\_  
LICENSE NUMBER \_\_\_\_\_

**Szeker - EDA #9306  
Block 262, Lot 1.03**

**CAPE MAY COUNTY DEPARTMENT OF HEALTH  
SEWAGE DISPOSAL SYSTEM APPLICATION - ATTACHMENT "B"**

**SOIL PERMEABILITY CLASS RATING DATA**

**MUNICIPALITY – Dennis Township**

1. Test Number 1 Replicate Letter A
2. Sample Depth 72" Soil Pit Boring Number TP#7 Date Collected 5/25/2022
3. Coarse Fragment Content  
Total Wt. of Sample, W.T., Grams (g) 544.3  
Wt. of Material Retained on 2 mm Sieve, W.C.F., g 56.2  
Wt. % Coarse Fragment (W.C.F./W.T. x 100): 10.3%
4. Oven Dry Weight (24 Hrs., 105° C) of 40 g Air Dry Sample, g. Wt. 39.9
5. Hydrometer Calibration, Rc 3  
Temperature of Suspension, °F 71°
6. Hydrometer Reading - 40 Sec., g, R1 5  
Temperature of Suspension, °F 71°
7. Corrected Hydrometer Reading, g, R1<sup>1</sup> 2.6
8. Hydrometer Reading - 2 Hrs., g, R2 4  
Temperature of Suspension, °F 72°
9. Corrected Hydrometer Reading, g, R2<sup>1</sup> 1.8
10. % Sand =  $(39.9 - 2.6)/39.9 \times 100 =$  93.5%
11. % Clay =  $1.8/39.9 \times 100 =$  4.5%
12. Sieve Analysis:
  - (a) Oven Dry Wt. (2 Hrs., 105° C) Total Sand Fraction  
(Soil Retained in 0.047 mm Sieve), g 38.7
  - (b) Wt. of Fine Plus Very Fine Sand Fraction  
(Sand Passing 0.25 mm Sieve), g 35.3
  - (c) % Fine Plus Very Fine Sand (b/a) 91.2%
13. Soil Morphology (Natural Soil Samples Only):  
Structure of Soil Horizon Tested \_\_\_\_\_  
Consistence of Soil Horizon Tested: \_\_\_\_\_ Dry \_\_\_\_\_ Moist \_\_\_\_\_
14. Soil Permeability Class Rating (Based upon Average Textural Analysis of this Replicate and other Replicate Samples)  
K-4 (Adjusted)
15. I HEREBY CERTIFY THAT THE INFORMATION FURNISHED ON THIS ATTACHMENT "B" IS TRUE AND ACCURATE. I AM AWARE THAT FALSIFICATION OF DATA IS A VIOLATION OF THE WATER POLLUTION CONTROL ACT (N.J.S.A.) 58:10A-1 et seq.) AND IS SUBJECT TO PENALTIES AS PRESCRIBED IN N.J.A.C. 7:14-8.

SIGNATURE OF SOIL EVALUATOR \_\_\_\_\_

DATE \_\_\_\_\_

SIGNATURE OF PROFESSIONAL ENGINEER \_\_\_\_\_

LICENSE NUMBER \_\_\_\_\_

**Szeker - EDA #9306**  
**Block 262, Lot 1.03**

**CAPE MAY COUNTY DEPARTMENT OF HEALTH**  
**SEWAGE DISPOSAL SYSTEM APPLICATION - ATTACHMENT "B"**

**SOIL PERMEABILITY CLASS RATING DATA**

**MUNICIPALITY – Dennis Township**

1. Test Number 1 Replicate Letter B
2. Sample Depth 72" Soil Pit Boring Number TP#7 Date Collected 5/25/2022
3. Coarse Fragment Content  
Total Wt. of Sample, W.T., Grams (g) 544.3  
Wt. of Material Retained on 2 mm Sieve, W.C.F., g 56.2  
Wt. % Coarse Fragment (W.C.F./W.T. x 100): 10.3%
4. Oven Dry Weight (24 Hrs., 105° C) of 40 g Air Dry Sample, g. Wt. 39.9
5. Hydrometer Calibration, Rc 3  
Temperature of Suspension, °F 71°
6. Hydrometer Reading - 40 Sec., g, R1 5  
Temperature of Suspension, °F 71°
7. Corrected Hydrometer Reading, g, R1<sup>1</sup> 2.6
8. Hydrometer Reading - 2 Hrs., g, R2 4  
Temperature of Suspension, °F 72°
9. Corrected Hydrometer Reading, g, R2<sup>1</sup> 1.8
10. % Sand =  $(39.9 - 2.6)/39.9 \times 100 =$  93.5%
11. % Clay =  $1.8/39.9 \times 100 =$  4.5%
12. Sieve Analysis:
  - (a) Oven Dry Wt. (2 Hrs., 105° C) Total Sand Fraction  
(Soil Retained in 0.047 mm Sieve), g 37.9
  - (b) Wt. of Fine Plus Very Fine Sand Fraction  
(Sand Passing 0.25 mm Sieve), g 34.9
  - (c) % Fine Plus Very Fine Sand (b/a) 92.1%
13. Soil Morphology (Natural Soil Samples Only):  
Structure of Soil Horizon Tested \_\_\_\_\_  
Consistence of Soil Horizon Tested: \_\_\_\_\_ Dry \_\_\_\_\_ Moist \_\_\_\_\_
14. Soil Permeability Class Rating (Based upon Average Textural Analysis of this Replicate and other Replicate Samples)  
K-4 (Adjusted)
15. I HEREBY CERTIFY THAT THE INFORMATION FURNISHED ON THIS ATTACHMENT "B" IS TRUE AND ACCURATE. I AM AWARE THAT FALSIFICATION OF DATA IS A VIOLATION OF THE WATER POLLUTION CONTROL ACT (N.J.S.A.) 58:10A-1 et seq.) AND IS SUBJECT TO PENALTIES AS PRESCRIBED IN N.J.A.C. 7:14-8.

SIGNATURE OF SOIL EVALUATOR \_\_\_\_\_  
DATE \_\_\_\_\_  
SIGNATURE OF PROFESSIONAL ENGINEER \_\_\_\_\_  
LICENSE NUMBER \_\_\_\_\_

# **GROUNDWATER MOUNDING ANALYSIS**



**GROUNDWATER RECHARGE MOUNDING ANALYSIS**  
**BLOCK 262 LOTS 1.03**  
**DENNIS TOWNSHIP, CAPE MAY COUNTY, NJ**  
**STORMWATER BASIN #1**

**EDA #9306**

- |    |  |   |  |
|----|--|---|--|
| 1. | Recharge Rate (in./hr)                     | = | 3 in/hr (K-4 Adj, with factor of safety = 2)   |
| 2. | Specific yield                             | = | 0.15   |
| 3. | Horizontal Hydraulic Conductivity (ft/day) | = | 15 in/hr   |
| 4. | Basin Dimensions                           | = | 90' x 10'<br>X = 45<br>Y = 5   |
| 5. | Initial Thickness of Saturated Zone        | = | 10'  |
| 6. | Duration of infiltration Period (days)     | = | $\frac{(\text{WQ Volume to be Infiltrated, CF}) \times (12 \text{ in/ft})}{(\text{Infiltration Area, SF}) \times (\text{Recharge Rate, in/hr})}$ |

$$t = (1,224 \times 12) / (903 \times 3) = 5.42 \text{ Hrs}$$

Recharge Rate	=	3 in/hr
Specific yield	=	0.15
Horizontal Hydraulic Conductivity	=	15 in/hr
Width	=	45'
Length	=	5'
Duration of infiltration	=	5.42 Hrs
Thickness of Saturation Zone	=	10.00'

Seasonal High Water Elevation	=	7.40
Max Ground Water Mounding Height (SHWT + Δh)	=	<b>9.395</b>
Bottom of Basin Elevation	=	<b>11.00</b>

**Groundwater Mounding Analysis**

A groundwater mounding analysis was performed in association with the proposed infiltration basin. It has been determined that at distance of 100 feet that the height or elevation of the seasonal highwater elevation will increase by 0.016 feet (less than 1 inch).

This slight increase will have little or no impact on the basin bottom or the surrounding adjacent properties, buildings, adjacent water bodies, wetlands or subsurface structures. It has been determined that seasonal high water is at elevation 7.40. Groundwater mounding associated with the proposed basin will increase this elevation to 9.395, well below the proposed basin bottom elevation of 11.00.

#### Input Values

3.00
0.150
15.00
45.000
5.000
5.42
10.00

<i>R</i>	Recharge rate (permeability rate) (in/hr)
<i>Sy</i>	Specific yield, <i>Sy</i> (dimensionless) default value is 0.15; max value is 0.2 provided that a lab test data is submitted
<i>Kh</i>	Horizontal hydraulic conductivity (in/hr) $Kh = 5 \times \text{Recharge Rate (R)}$ in the costal plan; $Kh=R$ outside the coastal plan
<i>x</i>	1/2 length of basin (x direction, in feet)
<i>y</i>	1/2 width of basin (y direction, in feet)
<i>t</i>	Duration of infiltration period (hours)
<i>hi(0)</i>	Initial thickness of saturated zone (feet)

11.995
1.995

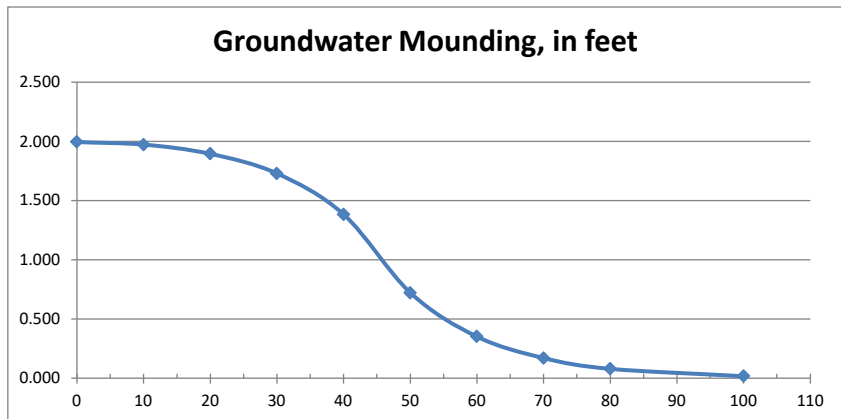
<i>h(max)</i>	Maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
$\Delta h(max)$	Maximum groundwater mounding (beneath center of basin at end of infiltration period)

Distance from  
Ground-water center of basin in x  
Mounding, in feet direction, in feet

1.995	0
1.973	10
1.895	20
1.729	30
1.383	40
0.721	50
0.351	60
0.169	70
0.078	80
0.016	100



**Re-Calculate Now**



#### Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

**GROUNDWATER RECHARGE MOUNDING ANALYSIS**  
**BLOCK 262 LOTS 1.03**  
**DENNIS TOWNSHIP, CAPE MAY COUNTY, NJ**  
**STORMWATER BASIN #2**

**EDA #9306**

1. Recharge Rate (in./hr) = 3 in/hr (K-4 Adj, with factor of safety = 2)
2. Specific yield = 0.15
3. Horizontal Hydraulic Conductivity (ft/day) = 15 in/hr
4. Basin Dimensions = 155' x 65'  
X = 77.5  
Y = 32.5
5. Initial Thickness of Saturated Zone = 10'
6. Duration of infiltration Period (days) =  $\frac{(\text{WQ Volume to be Infiltrated, CF}) \times (12 \text{ in/ft})}{(\text{Infiltration Area, SF}) \times (\text{Recharge Rate, in/hr})}$

$$t = (4,424 \times 12) / (10000 \times 3) = 1.770 \text{ Hrs}$$

Recharge Rate	=	3 in/hr
Specific yield	=	0.15
Horizontal Hydraulic Conductivity	=	15 in/hr
Width	=	77.5'
Length	=	32.5'
Duration of infiltration	=	1.770 Hrs
Thickness of Saturation Zone	=	10.00'

Seasonal High Water Elevation	=	8.13
Max Ground Water Mounding Height (SHWT + Δh)	=	10.51*
Bottom of Basin Elevation	=	<b>10.67</b>

\*Basin mounding modified to adjusted recharge rate and duration of infiltration as per Chapter 13 of the NJBMP. See table below for initial and other adjusted model values.

Recharge Rate, R (in/hr)	Duration of infiltration, t (Hrs)	Mounding Height (Ft)
3.00	1.77	2.884
1.50	3.54	2.702
0.75	7.08	2.375

**Groundwater Mounding Analysis**

A groundwater mounding analysis was performed in association with the proposed infiltration basin. It has been determined that at distance of 100 feet that the height or elevation of the seasonal highwater elevation will increase by 0.107 feet (1.28 inches).

This slight increase will have little or no impact on the basin bottom or the surrounding adjacent properties, buildings, adjacent water bodies, wetlands or subsurface structures. It has been determined that seasonal high water is at elevation 8.13. Groundwater mounding associated with the proposed basin will increase this elevation to 10.51 with an adjusted recharge rate, below the proposed basin bottom elevation of 10.67.

#### Input Values

0.75
0.150
15.00
77.500
32.500
7.08
10.00

<i>R</i>	Recharge rate (permeability rate) (in/hr)
<i>Sy</i>	Specific yield, <i>Sy</i> (dimensionless) default value is 0.15; max value is 0.2 provided that a lab test data is submitted
<i>Kh</i>	Horizontal hydraulic conductivity (in/hr) $Kh = 5 \times \text{Recharge Rate } (R) \text{ in the costal plan; } Kh=R \text{ outside the coastal plan}$
<i>x</i>	1/2 length of basin (x direction, in feet)
<i>y</i>	1/2 width of basin (y direction, in feet)
<i>t</i>	Duration of infiltration period (hours)
<i>hi(0)</i>	Initial thickness of saturated zone (feet)

12.375
2.375

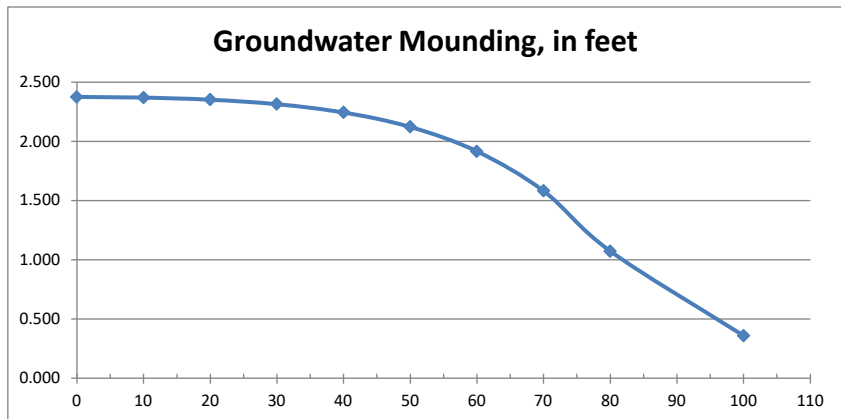
<i>h(max)</i>	Maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
$\Delta h(max)$	Maximum groundwater mounding (beneath center of basin at end of infiltration period)

Distance from  
Ground-water center of basin in x  
Mounding, in feet direction, in feet

2.375	0
2.370	10
2.352	20
2.315	30
2.245	40
2.122	50
1.916	60
1.582	70
1.071	80
0.357	100



**Re-Calculate Now**



#### Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

**GROUNDWATER RECHARGE MOUNDING ANALYSIS**  
**BLOCK 262 LOTS 1.03**  
**DENNIS TOWNSHIP, CAPE MAY COUNTY, NJ**  
**STORMWATER BASIN #3**

**EDA #9306**

- |     |  |   |  |
|-----|--|---|--|
| 7.  | Recharge Rate (in./hr)                     | = | 3 in/hr (K-4 Adj, with factor of safety = 2)   |
| 8.  | Specific yield                             | = | 0.15   |
| 9.  | Horizontal Hydraulic Conductivity (ft/day) | = | 15 in/hr   |
| 10. | Basin Dimensions                           | = | 160' x 62.5'<br>X = 80<br>Y = 31.25  |
| 11. | Initial Thickness of Saturated Zone        | = | 10'  |
| 12. | Duration of infiltration Period (days)     | = | $\frac{(\text{WQ Volume to be Infiltrated, CF}) \times (12 \text{ in/ft})}{(\text{Infiltration Area, SF}) \times (\text{Recharge Rate, in/hr})}$ |

$$t = (4311 \times 12) / (9985 \times 3) = 1.73 \text{ Hrs}$$

Recharge Rate	=	3 in/hr
Specific yield	=	0.15
Horizontal Hydraulic Conductivity	=	15 in/hr
Width	=	80'
Length	=	31.25'
Duration of infiltration	=	1.73 Hrs
Thickness of Saturation Zone	=	10.00'

Seasonal High Water Elevation	=	5.82
Max Ground Water Mounding Height (SHWT + Δh)	=	8.63
Bottom of Basin Elevation	=	<b>8.80</b>

**Groundwater Mounding Analysis**

A groundwater mounding analysis was performed in association with the proposed infiltration basin. It has been determined that at distance of 100 feet that the height or elevation of the seasonal highwater elevation will increase by 0.001 feet (less than 1 inch).

This slight increase will have little or no impact on the basin bottom or the surrounding adjacent properties, buildings, adjacent water bodies, wetlands or subsurface structures. It has been determined that seasonal high water is at elevation 5.82. Groundwater mounding associated with the proposed basin will increase this elevation to 8.63, well below the proposed basin bottom elevation of 8.80.

#### Input Values

3.00
0.150
15.00
31.250
80.000
1.73
10.00

<i>R</i>	Recharge rate (permeability rate) (in/hr)
<i>Sy</i>	Specific yield, <i>Sy</i> (dimensionless) default value is 0.15; max value is 0.2 provided that a lab test data is submitted
<i>Kh</i>	Horizontal hydraulic conductivity (in/hr) $Kh = 5 \times \text{Recharge Rate } (R) \text{ in the costal plan; } Kh=R \text{ outside the coastal plan}$
<i>x</i>	1/2 length of basin (x direction, in feet)
<i>y</i>	1/2 width of basin (y direction, in feet)
<i>t</i>	Duration of infiltration period (hours)
<i>hi(0)</i>	Initial thickness of saturated zone (feet)

12.810
2.810

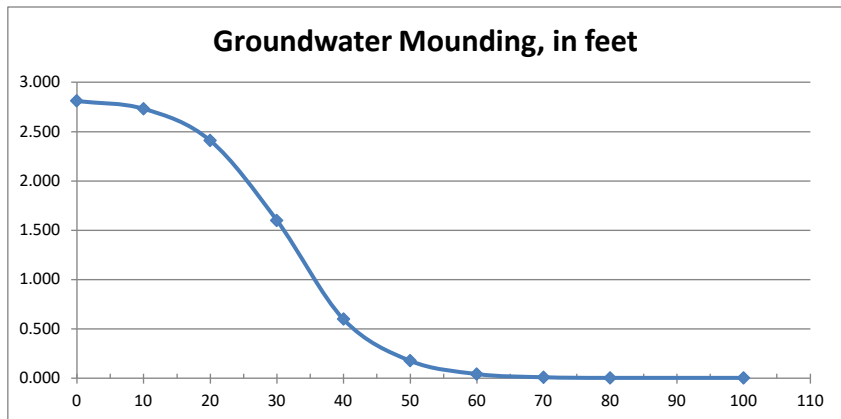
<i>h(max)</i>	Maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
$\Delta h(max)$	Maximum groundwater mounding (beneath center of basin at end of infiltration period)

Distance from  
Ground-water center of basin in x  
Mounding, in feet direction, in feet

2.810	0
2.730	10
2.408	20
1.597	30
0.597	40
0.175	50
0.041	60
0.008	70
0.002	80
0.001	100



**Re-Calculate Now**



#### Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

**GROUNDWATER RECHARGE MOUNDING ANALYSIS**  
**BLOCK 262 LOTS 1.03**  
**DENNIS TOWNSHIP, CAPE MAY COUNTY, NJ**  
**STORMWATER BASIN #4**

**EDA #9306**

13. Recharge Rate (in./hr) = 3 in/hr (K-4 Adj, with factor of safety = 2)
14. Specific yield = 0.15
15. Horizontal Hydraulic Conductivity (ft/day) = 15 in/hr
16. Basin Dimensions = 160' x 62.5'  
X = 80  
Y = 31.25
17. Initial Thickness of Saturated Zone = 10'
18. Duration of infiltration Period (days) =  $\frac{(\text{WQ Volume to be Infiltrated, CF}) \times (12 \text{ in/ft})}{(\text{Infiltration Area, SF}) \times (\text{Recharge Rate, in/hr})}$

$$t = (5,171 \times 12) / (9,985 \times 3) = 2.07 \text{ Hrs}$$

- Recharge Rate = 3 in/hr
- Specific yield = 0.15
- Horizontal Hydraulic Conductivity = 15 in/hr
- Width = 77.5'
- Length = 32.5'
- Duration of infiltration = 2.07 Hrs
- Thickness of Saturation Zone = 10.00'

- Seasonal High Water Elevation = 5.93
- Max Ground Water Mounding Height (SHWT + Δh) = 8.54\*
- Bottom of Basin Elevation = **8.80**

\*Basin mounding modified to adjusted recharge rate and duration of infiltration as per Chapter 13 of the NJBMP. See table below for initial and other adjusted model values.

Recharge Rate, R (in/hr)	Duration of infiltration, t (Hrs)	Mounding Height (Ft)
3.00	2.07	2.884
1.50	4.14	3.041
0.75	8.28	2.614

**Groundwater Mounding Analysis**

A groundwater mounding analysis was performed in association with the proposed infiltration basin. It has been determined that at distance of 100 feet that the height or elevation of the seasonal highwater elevation will increase by 0.031 feet (less than 1 inch).

This slight increase will have little or no impact on the basin bottom or the surrounding adjacent properties, buildings, adjacent water bodies, wetlands or subsurface structures. It has been determined that seasonal high water is at elevation 5.93. Groundwater mounding associated with the proposed basin will increase this elevation to 8.54 with an adjusted recharge rate, below the proposed basin bottom elevation of 8.80.

#### Input Values

0.75
0.150
15.00
31.250
80.000
8.28
10.00

<i>R</i>	Recharge rate (permeability rate) (in/hr)
<i>Sy</i>	Specific yield, <i>Sy</i> (dimensionless) default value is 0.15; max value is 0.2 provided that a lab test data is submitted
<i>Kh</i>	Horizontal hydraulic conductivity (in/hr) $Kh = 5 \times \text{Recharge Rate (R)}$ in the costal plan; $Kh=R$ outside the coastal plan
<i>x</i>	1/2 length of basin (x direction, in feet)
<i>y</i>	1/2 width of basin (y direction, in feet)
<i>t</i>	Duration of infiltration period (hours)
<i>hi(0)</i>	Initial thickness of saturated zone (feet)

12.614
2.614

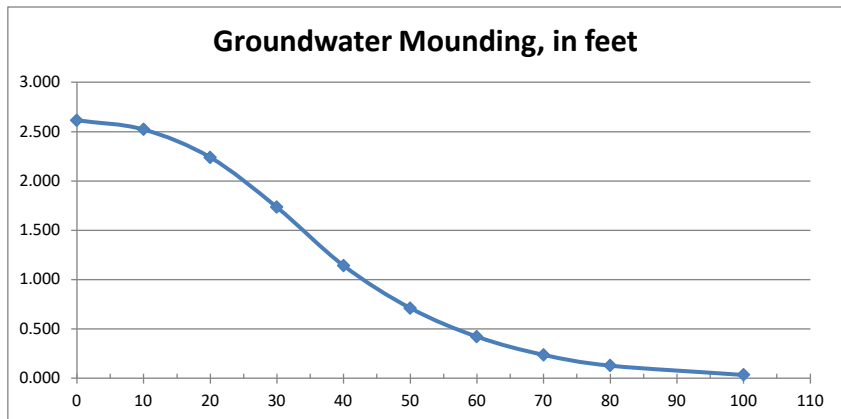
<i>h(max)</i>	Maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
$\Delta h(max)$	Maximum groundwater mounding (beneath center of basin at end of infiltration period)

Distance from  
Ground-water center of basin in x  
Mounding, in feet direction, in feet

2.614	0
2.522	10
2.238	20
1.733	30
1.140	40
0.709	50
0.419	60
0.235	70
0.126	80
0.031	100



**Re-Calculate Now**



#### Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.



**GROUNDWATER RECHARGE MOUNDING ANALYSIS**  
**BLOCK 262 LOTS 1.03**  
**DENNIS TOWNSHIP, CAPE MAY COUNTY, NJ**  
**STORMWATER BASIN #5**

**EDA #9306**

19.	Recharge Rate (in./hr)	=	3 in/hr (K-4 Adj, with factor of safety = 2)
20.	Specific yield	=	0.15
21.	Horizontal Hydraulic Conductivity (ft/day)	=	15 in/hr
22.	Basin Dimensions	=	275' x 72' X = 137.5 Y = 36
23.	Initial Thickness of Saturated Zone	=	10'
24.	Duration of infiltration Period (days)	=	$\frac{(\text{WQ Volume to be Infiltrated, CF}) \times (12 \text{ in/ft})}{(\text{Infiltration Area, SF}) \times (\text{Recharge Rate, in/hr})}$

$$t = (5,483 \times 12) / (19,800 \times 3) = 1.11 \text{ Hrs}$$

Recharge Rate	=	3 in/hr
Specific yield	=	0.15
Horizontal Hydraulic Conductivity	=	15 in/hr
Width	=	137.5'
Length	=	36'
Duration of infiltration	=	1.11 Hrs
Thickness of Saturation Zone	=	10.00'

Seasonal High Water Elevation	=	6.30
Max Ground Water Mounding Height (SHWT + Δh)	=	8.15
Bottom of Basin Elevation	=	<b>9.00</b>

**Groundwater Mounding Analysis**

A groundwater mounding analysis was performed in association with the proposed infiltration basin. It has been determined that at distance of 100 feet that the height or elevation of the seasonal highwater elevation will increase by 0.001 feet (less than 1 inch).

This slight increase will have little or no impact on the basin bottom or the surrounding adjacent properties, buildings, adjacent water bodies, wetlands or subsurface structures. It has been determined that seasonal high water is at elevation 6.30. Groundwater mounding associated with the proposed basin will increase this elevation to 8.15, well below the proposed basin bottom elevation of 9.00.

#### Input Values

3.00
0.150
15.00
36.000
137.500
1.11
10.00

<i>R</i>	Recharge rate (permeability rate) (in/hr)
<i>Sy</i>	Specific yield, <i>Sy</i> (dimensionless) default value is 0.15; max value is 0.2 provided that a lab test data is submitted
<i>Kh</i>	Horizontal hydraulic conductivity (in/hr) $Kh = 5 \times \text{Recharge Rate } (R) \text{ in the costal plan; } Kh=R \text{ outside the coastal plan}$
<i>x</i>	1/2 length of basin (x direction, in feet)
<i>y</i>	1/2 width of basin (y direction, in feet)
<i>t</i>	Duration of infiltration period (hours)
<i>hi(0)</i>	Initial thickness of saturated zone (feet)

11.846
1.846

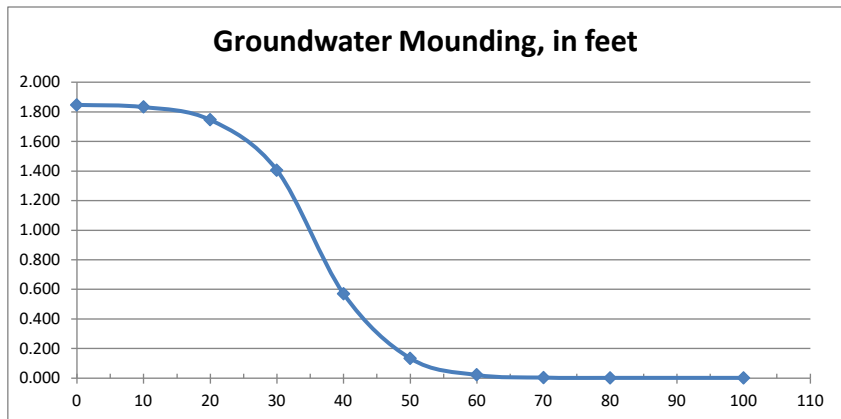
<i>h(max)</i>	Maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
$\Delta h(max)$	Maximum groundwater mounding (beneath center of basin at end of infiltration period)

Distance from  
Ground-water center of basin in x  
Mounding, in feet direction, in feet

1.846	0
1.832	10
1.746	20
1.405	30
0.569	40
0.132	50
0.022	60
0.003	70
0.001	80
0.001	100



**Re-Calculate Now**



#### Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

# **GROUNDWATER RECHARGE ANALYSIS**

## Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓	Average Annual P (in)	Climatic Factor
CAPE_MAY CO., DENNIS TWP	43.2	1.33

Project Name:	Zemac Self-Storage
Description:	9306 - Groundwater Recharge
Analysis Date:	06/07/22

Pre-Developed Conditions				
Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)
1	7.893	Woods	Downer	11.6
2	2.051	Woods	Hammononton	11.2
3	0			
4	0			
5	0			
6	0			
7	0			
8	0			
9	0			
10	0			
11	0			
12	0			
13	0			
14	0			
15	0			
Total =	9.9			Total Annual Recharge (in)
				11.5
				Total Annual Recharge (cu.ft)
				416,806

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	5.489	Impervious areas	Downer	0.0	-
2	2.903	Open space	Downer	12.5	131,619
3	1.552	Open space	Hammononton	12.1	68,308
4	0				
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	9.9			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				5.5	199,927

### Annual Recharge Requirements Calculation ↓

% of Pre-Developed Annual Recharge to Preserve =		100%
Post-Development Annual Recharge Deficit=		216,880
Recharge Efficiency Parameters Calculations (area averages)		
RWC= 2.35 (in)	DRWC= 0.00	(in)
ERWC= 0.79 (in)	EDRWC= 0.00	(in)

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

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

Project Name

Zemac Self-Storage

Description

9306 - Groundwater Recharge

Analysis Date

06/07/22

BMP or LID Type

Infiltration Basins x 5

Recharge BMP Input Parameters

Parameter	Symbol	Value	Unit
BMP Area	ABMP	50880.0	sq.ft
BMP Effective Depth, this is the design variable	dBMP	0.8	in
Upper level of the BMP surface (negative if above ground)	dBMPu	36.0	in
Depth of lower surface of BMP, must be >= dBMPu	dEXC	60.0	in
Post-development Land Segment Location of BMP, Input Zero if Location is distributed or undetermined	SegBMP	2	unitless

Root Zone Water Capacity Calculated Parameters

Parameter	Symbol	Value	Unit
Empty Portion of RWC under Post-D Natural Recharge	ERWC	0.88	in
ERWC Modified to consider dEXC	EDRWC	0.00	in
Empty Portion of RWC under Infiltr BMP	RERWC	0.00	in

Recharge Design Parameters

Parameter	Symbol	Value	Unit
Inches of Runoff to capture	Qdesign	0.17	in
Inches of Rainfall to capture	Pdesign	0.24	in
Recharge Provided Avg. over Imp. Area		10.9	in
Runoff Captured Avg. over imp. Area		10.9	in

Parameters from Annual Recharge Worksheet

Post-D Deficit Recharge (or desired recharge volume)	Vdef	216,880	cu.ft
Post-D Impervious Area (or target Impervious Area)	Aimp	239,101	sq.ft
Root Zone Water Capacity	RWC	2.63	in
RWC Modified to consider dEXC	DRWC	0.00	in
Climatic Factor	C-factor	1.33	no units
Average Annual P	Pavg	43.2	in
Recharge Requirement over Imp. Area	dr	10.9	in

BMP Calculated Size Parameters

ABMP/Aimp	Aratio	0.21	unitless
BMP Volume	VBMP	3,225	cu.ft

System Performance Calculated Parameters

Annual BMP Recharge Volume		216,880	cu.ft
Avg BMP Recharge Efficiency		100.0%	Represents % Infiltration Recharged
%Rainfall became Runoff		77.4%	%
%Runoff Infiltrated		32.6%	%
%Runoff Recharged		32.6%	%
%Rainfall Recharged		25.2%	%

How to solve for different recharge volumes:

By default the spreadsheet assigns the values of total deficit recharge volume "Vdef" and "Aimp" on this page. This allows solution for a single BMP to handle the entire recharge requirement assuming the runoff from entire impervious area is available to the BMP. To solve for a smaller BMP or a LID-IMP to recharge only part of the recharge requirement, set Vdef to your target value and Aimp to impervious area directly connected to your infiltration facility and then solve for ABMP or dBMP. To go back to the default configuration click the "Default Vdef & Aimp" button.

Calculation Check Messages

Volume Balance--> OK

dBMP Check--> OK

dEXC Check--> OK

BMP Location--> OK

Other Notes

Pdesign is accurate only after BMP dimensions are updated to make rech volume= deficit volume. The portion of BMP infiltration prior to filling and the area occupied by BMP are ignored in these calculations. Results are sensitive to dBMP, make sure dBMP selected is small enough for BMP to empty in less than 3 days. For land Segment Location of BMP if you select "impervious areas" RWC will be minimal but not zero as determined by the soil type and a shallow root zone for this Land Cover allowing consideration of lateral flow and other losses.

# **LOW IMPACT DEVELOPMENT CHECKLIST**

# Low Impact Development Checklist

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

Municipality: \_\_\_\_\_

County: \_\_\_\_\_ Date: \_\_\_\_\_

Review board or agency: \_\_\_\_\_

Proposed land development name: \_\_\_\_\_

Lot(s): \_\_\_\_\_ Block(s): \_\_\_\_\_

Project or application number: \_\_\_\_\_

Applicant's name: \_\_\_\_\_

Applicant's address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_ Fax: \_\_\_\_\_

Email address: \_\_\_\_\_

Designer's name: \_\_\_\_\_

Designer's address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_ Fax: \_\_\_\_\_

Email address: \_\_\_\_\_

## Part 1: Description of Nonstructural Approach to Site Design

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

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



## Part 2: Review of Local Stormwater Management Regulations

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

\_\_\_\_\_

Do regulations include nonstructural requirements? Yes: \_\_\_\_\_ No: \_\_\_\_\_

If yes, briefly describe: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

List LID-BMPs prohibited by local regulations: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Pre-design meeting held? Yes: \_\_\_\_\_ Date: \_\_\_\_\_ No: \_\_\_\_\_

Meeting held with: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Pre-design site walk held? Yes: \_\_\_\_\_ Date: \_\_\_\_\_ No: \_\_\_\_\_

Site walk held with: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Other agencies with stormwater review jurisdiction:

Name: \_\_\_\_\_

Required approval: \_\_\_\_\_

Name: \_\_\_\_\_

Required approval: \_\_\_\_\_

Name: \_\_\_\_\_

Required approval: \_\_\_\_\_

## Part 3: Nonstructural Strategies and LID-BMPs in Design

### 3.1 Vegetation and Landscaping

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

A. Has an inventory of existing site vegetation been performed? Yes: \_\_\_\_\_ No: \_\_\_\_\_

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

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

Preservation of natural areas? Yes: \_\_\_\_\_ No: \_\_\_\_\_ If yes, specify % of site: \_\_\_\_\_

Native ground cover? Yes: \_\_\_\_\_ No: \_\_\_\_\_ If yes, specify % of site: \_\_\_\_\_

Vegetated buffers? Yes: \_\_\_\_\_ No: \_\_\_\_\_ If yes, specify % of site: \_\_\_\_\_

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

Preservation of natural areas? Yes: \_\_\_\_\_ No: \_\_\_\_\_ If yes, specify % of site: \_\_\_\_\_

Native ground cover? Yes: \_\_\_\_\_ No: \_\_\_\_\_ If yes, specify % of site: \_\_\_\_\_

Vegetated buffers? Yes: \_\_\_\_\_ No: \_\_\_\_\_ If yes, specify % of site: \_\_\_\_\_

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

Reduce runoff volume increases through lower runoff coefficient: Yes: \_\_\_\_\_ No: \_\_\_\_\_

Reduce runoff pollutant loads through runoff treatment: Yes: \_\_\_\_\_ No: \_\_\_\_\_

Maintain groundwater recharge by preserving natural areas: Yes: \_\_\_\_\_ No: \_\_\_\_\_

### 3.2 Minimize Land Disturbance

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

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

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

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

Restrict permanent site disturbance by land owners? Yes: \_\_\_\_\_ No: \_\_\_\_\_

If yes, how: \_\_\_\_\_

\_\_\_\_\_

Restrict temporary site disturbance during construction? Yes: \_\_\_\_\_ No: \_\_\_\_\_

If yes, how: \_\_\_\_\_

\_\_\_\_\_

Consider soils and slopes in selecting disturbance limits? Yes: \_\_\_\_\_ No: \_\_\_\_\_

If yes, how: \_\_\_\_\_

\_\_\_\_\_

C. Specify percentage of site to be cleared: \_\_\_\_\_ Regraded: \_\_\_\_\_

D. Specify percentage of cleared areas done so for buildings: \_\_\_\_\_

For driveways and parking: \_\_\_\_\_ For roadways: \_\_\_\_\_

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

---

---

---

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

HSG A: \_\_\_\_\_ HSG B: \_\_\_\_\_ HSG C: \_\_\_\_\_ HSG D: \_\_\_\_\_

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

HSG A: \_\_\_\_\_ HSG B: \_\_\_\_\_ HSG C: \_\_\_\_\_ HSG D: \_\_\_\_\_

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

---

---

---

I. Does the site include Karst topography?

Yes: \_\_\_\_\_ No: \_\_\_\_\_

If yes, discuss measures taken to limit Karst impacts:

---

---

---

---

---

---

### 3.3 Impervious Area Management

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

A. Specify impervious cover at site: Existing: \_\_\_\_\_ Proposed: \_\_\_\_\_

B. Specify maximum site impervious coverage allowed by regulations: \_\_\_\_\_

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

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

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

Proposed: \_\_\_\_\_ Regulations: \_\_\_\_\_

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

Proposed: \_\_\_\_\_ Regulations: \_\_\_\_\_

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

By driveways and parking: \_\_\_\_\_ By roadways: \_\_\_\_\_

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

---

---

---

---

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

Total site: \_\_\_\_\_ Buildings: \_\_\_\_\_ Driveways and parking: \_\_\_\_\_ Roads: \_\_\_\_\_

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

Total site: \_\_\_\_\_ Buildings: \_\_\_\_\_ Driveways and parking: \_\_\_\_\_ Roads: \_\_\_\_\_

J. Specify percentage of total building roof area that will be vegetated: \_\_\_\_\_

K. Specify percentage of total parking area located beneath buildings: \_\_\_\_\_

L. Specify percentage of total parking located within multi-level parking deck: \_\_\_\_\_



### 3.4 Time of Concentration Modifications

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

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

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

Storm sewer: \_\_\_\_\_ Vegetated swale: \_\_\_\_\_ Natural channel: \_\_\_\_\_

Stormwater management facility: \_\_\_\_\_ Other: \_\_\_\_\_

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

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

---

---

---

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

Decrease overland flow slope: \_\_\_\_\_

---

---

Increase overland flow roughness: \_\_\_\_\_

---

---

### 3.5 Preventative Source Controls

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

#### A. Trash Receptacles

Specify the number of trash receptacles provided: \_\_\_\_\_

Specify the spacing between the trash receptacles: \_\_\_\_\_

Compare trash receptacles proposed with those required by regulations:

Proposed: \_\_\_\_\_ Regulations: \_\_\_\_\_

#### B. Pet Waste Stations

Specify the number of pet waste stations provided: \_\_\_\_\_

Specify the spacing between the pet waste stations: \_\_\_\_\_

Compare pet waste stations proposed with those required by regulations:

Proposed: \_\_\_\_\_ Regulations: \_\_\_\_\_

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

Specify percentage of total inlets that comply with the NJPDES storm drain inlet criteria: \_\_\_\_\_

#### D. Maintenance

Specify the frequency of the following maintenance activities:

Street sweeping: Proposed: \_\_\_\_\_ Regulations: \_\_\_\_\_

Litter collection: Proposed: \_\_\_\_\_ Regulations: \_\_\_\_\_

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

---

---



E. Prevention and Containment of Spills

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

Pollutant: \_\_\_\_\_ Location: \_\_\_\_\_

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

Pollutant: \_\_\_\_\_ Location: \_\_\_\_\_

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

Pollutant: \_\_\_\_\_ Location: \_\_\_\_\_

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

Pollutant: \_\_\_\_\_ Location: \_\_\_\_\_

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

Pollutant: \_\_\_\_\_ Location: \_\_\_\_\_

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

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

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

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

---



---



---



---



---



---



---



---