



**Stormwater Management Report  
for  
Touchstone Veterinary Center  
382 Route 79**

**Block 153, Lot 12**

**Township of Marlboro  
Monmouth County, New Jersey**

**April 7, 2020**

**Prepared by:**

---

**Marc S. Leber, P.E., P.P., C.M.E.  
New Jersey Professional Engineer  
License No. 24GE04452400**

Applicability of the Stormwater Management Rules (7:8-1.6)

The project will disturb in excess of one acre and proposes more than 1/4 of new impervious. Therefore, in accordance with N.J.A.C. 7:8-1.2 it is classified as a major development.

The purpose of this report is to demonstrate that the proposed development will comply with the peak rate of runoff, groundwater recharge, and water quality requirements of N.J.A.C. 7:8.

### **III. Hydrologic Methodology**

In order to quantify the pre and post development peak rates of runoff, the Natural Resources Conservation Service (formerly SCS) TR-55 Method was used. The N.R.C.S. Method presents simplified procedures to calculate storm water runoff volume, peak rated of discharge, hydrographs, and storage volumes required for floodwater reservoirs. These procedures are applicable in small watersheds, especially urbanizing watersheds, in the Unites States.<sup>1</sup> The TR-55 model is generally used in analyzing watersheds under three (3) square miles (about 2,000 acres). The main parameters are described below:

CN = Curve Number. Based on soils, plant cover, amount of impervious areas, interception, and surface storage.

Tc = Time of Concentration. The time is takes from the most hydraulically distant point in a watershed to travel to a point of interest.

Lag Time = The distance from the center of mass of excess rainfall to the peak discharge. The lag equation is expressed as:

$$T_{lag} = \frac{L^{0.8} \times (S + 1)^{0.7}}{1900 \times \sqrt{Y}}$$

*L = length of the longest drainage path (feet)*

*S, the potential maximum retention of the soil in inches is expressed as:*

$$S = (1000 / CN) - 10$$

*Y = Average land slope (percent)*

Empirically, the Lag Time has been expressed as 0.6Tc

A = Drainage Area (acres). The watershed area that contributes to the point of interest.

Rainfall = The 24-hour uniform rainfall amount imposed on the watershed. The rainfall amounts for Monmouth County, as revised in August 2012 are as follows:

<b><u>Storm Event</u></b>	<b><u>24-hour Rainfall (inches)</u></b>
1	2.79
2	3.38
5	4.38
10	5.23
25	6.53
100	8.94

---

<sup>1</sup> United States Department of Agriculture, Soil Conservation Service, Engineering Division, Technical Release 55

## **V. Post Development Drainage Conditions**

This application results in an increase of impervious coverage. Therefore, a stormwater management system is proposed to attenuate the increase in peak rate of runoff leaving the site. The front developed portion of the site, the existing building, as well as the entire roof area of the proposed addition will drain into an above ground detention system. Part of the rear portion of the site (grass areas) will flow via overland flow into the basin, while the remaining areas will flow towards the brook.

In performing this analysis, East Point Engineering referred to the previously approved and constructed site plan for the adjacent northerly lot (386 Route 79). In order to ensure that no offsite runoff would be entering the new detention basin, the site plan for 386 Route 79 was overlayed onto the drainage area maps. The improvements installed at 386 Route 79 provided for a curb along 382 Route 79 as well as installation of an underground detention basin to serve their parking lot, driveway, and roof areas. A swale was proposed on the neighbors lot to convey offsite runoff in the wetlands thereby keeping offsite runoff from beyond 386 Route 79 out of their proposed underground detention system. Therefore, based on this analysis, there is no offsite runoff entering the proposed above ground detention basin at 382 Route 79.

Based on soils testing, the soils are classified as K3-K4 with an infiltration rate of 5.3 to 10.0 inches per hour. For the purposes of design, the assumed soil infiltration rate was 0.0 inches per hour.

The Post-Developed Drainage Area to the detention basin consists of the majority of the developed portion of the site, including roof and parking areas, which will be captured by a system of catch basins and inlets. The inflow hydrographs were separated out between pervious and impervious to better model the actual catchment area. Some overland areas will flow into the proposed detention basin. The hydrograph results are summarized below:

### **Proposed Condition – To Detention Basin 1 (Hydrograph 4)**

**Area = 0.53 acres**  
**CN = 98 (impervious areas)**  
**CN = 76 (pervious areas)**  
**Tc = 10.0 minutes**  
**2-yr. storm runoff = 1.28 cfs (5,404 C.F.)**  
**10-yr. storm runoff = 2.08 cfs (8,888 C.F.)**  
**100-yr. storm runoff = 3.72 cfs (16,057 C.F.)**

### Compliance with Runoff Quantity Requirements (7:8-5.4-3)

The N.J.D.E.P. regulates the runoff quantity requirements for Major Developments at N.J.A.C. 7:8-5.4(a)3. The rules permit an applicant to demonstrate compliance with the quantity requirements by selecting one (1) of the four (4) choices listed in subparts i. thru iv. These are provided below:

- i. Demonstrate through hydrologic and hydraulic analysis that for stormwater leaving the site, post-construction runoff hydrographs for the two, 10 and 100-year storm events do not exceed, at any point in time, the pre-construction runoff hydrographs for the same storm events;
- ii. Demonstrate through hydrologic and hydraulic analysis that there is no increase, as compared to the pre-construction condition, in the peak runoff rates of stormwater leaving the site for the two, 10 and 100-year storm events and that the increased volume or change in timing of stormwater runoff will not increase flood damage at or downstream of the site. This analysis shall include the analysis of impacts of existing land uses and projected land uses assuming full development under existing zoning and land use ordinances in the drainage area;
- iii. Design stormwater management measures so that the post-construction peak runoff rates for the two, 10 and 100-year storm events are 50, 75 and 80 percent, respectively, of the pre-construction peak runoff rates. The percentages apply only to the post-construction stormwater runoff that is attributable to the portion of the site on which the proposed development or project is to be constructed; or
- iv. In tidal flood hazard areas, stormwater runoff quantity analysis in accordance with (a)3i, ii and iii above shall only be applied if the increased volume of stormwater runoff could increase flood damages below the point of discharge.

Item i. above does not apply to the project. This choice is frequently selected when a site discharges to an isolated low area with no runoff leaving the site or when the net increase of impervious coverage is zero.

Item ii. above does not apply to the project since there will be a net increase of impervious surfaces.

Item iv. above does not apply to the project since the site is not located within a tidal flood hazard area.

Item iii. above is commonly known as the peak rate of runoff reductions or the "cutbacks". When a project proposes a net increase in impervious (pre vs post development) and a detention system is required, engineering designs demonstrate that this part of the rule is satisfied. **This is the portion of the regulations that is applicable to the project.**

### Compliance with Water Quality Standards (7:8-5.5)

N.J.A.C. 7:8 states that water quality measures are applicable when greater than  $\frac{1}{4}$  acre of new impervious surfaces are added. However, existing impervious areas are not subject to water quality requirements. Not all impervious surfaces are subject to water quality requirements. Roof runoff is considered clean, so is the runoff from patios and decks. For the subject site, water quality measures are applicable to the areas subject to new vehicular traffic only.

The project meets water quality as follows:

The portion of the site draining into the above ground detention basin has been routed with a minimal infiltration rate of 1.0 inch per hour and utilizing the water quality storm. In the analysis, there is no outflow from the basin and the depth of water in the basin is a maximum of 6-1/2 inches, which drains within 72 hours.

# Appendix 1

## Existing Runoff Calculations

### Worksheet 3: Time of Concentration (T<sub>c</sub>) or travel time (T<sub>t</sub>)

Project 382 Route 79	By MSL	Date 7-Apr-20
Location Marlboro Township, Monmouth County	Checked BNP	Date 7-Apr-20
Check one: <input checked="" type="checkbox"/> Present <input type="checkbox"/> Developed    Existing D.A.		
Check one: <input checked="" type="checkbox"/> T <sub>c</sub> <input type="checkbox"/> T <sub>t</sub> through subarea		
Notes: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic or description of flow segments.		
<b>Sheet Flow (Applicable to T<sub>c</sub> only)</b>		
Segment ID	AB	
1. Surface description (table 3-1).....	GRASS	
2. Manning's roughness coefficient, n (table 3-1).....	0.240	
3. Flow length, L (total L ≤ 300 ft.)..... ft	150	
4. Two-year 24-hour rainfall, p <sub>2</sub> ..... in	3.4	
5. Land slope, s ..... ft/ft	0.053	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T <sub>t</sub> ..... hr	0.22	+    =    0.22
<b>Shallow Concentrated Flow</b>		
Segment ID	BC	
7. Surface description (paved or unpaved).....	UNPAVED	
8. Flow Length, L..... ft	25	
9. Watercourse slope, s..... ft/ft	0.028	
10. Average velocity, V (figure 3-1)..... ft/s	2.7	
11. $T_t = \frac{L}{3600 V}$ Compute T <sub>t</sub> ..... hr	0.00	+    =    0.00
<b>Channel Flow</b>		
Segment ID		
12. Cross sectional flow area, a..... ft <sup>2</sup>		
13. Wetted perimeter, P <sub>w</sub> ..... ft		
14. Hydraulic radius, r=a/P <sub>w</sub> Compute r..... ft		
15. Channel slope, s..... ft/ft		
16. Manning's roughness coefficient, n.....		
17. $V = \frac{1.49r^{2/3}\sqrt{s}}{n}$ Compute V..... ft/s		
18. Flow length, L..... ft		
19. $T_t = \frac{L}{3600 V}$ Compute T <sub>t</sub> ..... hr		+    =    0.00
20. Watershed or subarea T <sub>c</sub> or T <sub>t</sub> (add T <sub>t</sub> in steps 6, 11, and 19)..... hr		0.22
		min <b>13.1</b>



# Hydrograph Return Period Recap

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	-----	-----	1.593	-----	-----	3.061	-----	-----	6.070	Existing D.A.
Proj. file: existing 04-07-20.gpw										Thursday, May 14, 2020	

# Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

Thursday, May 14, 2020

## Hyd. No. 1

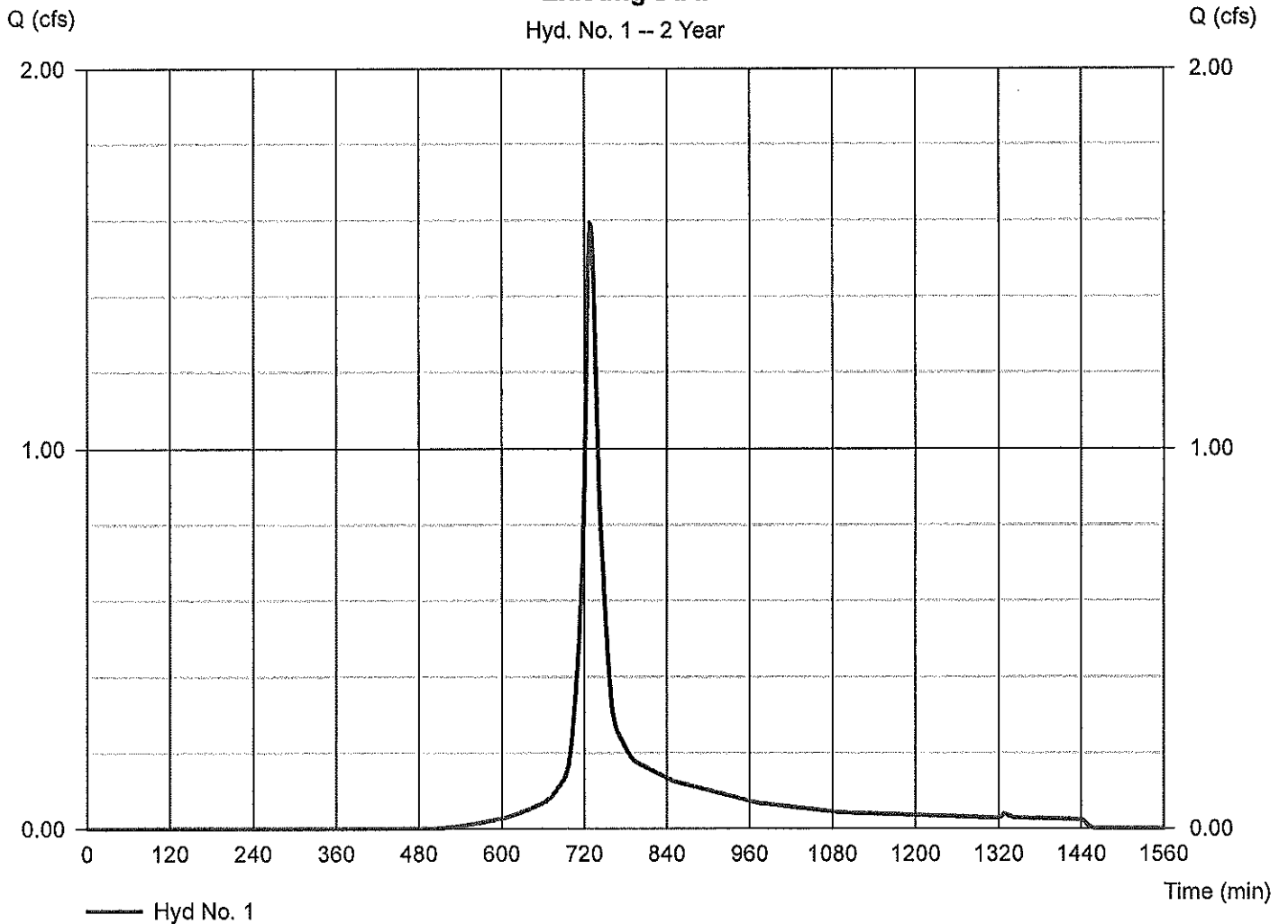
Existing D.A.

Hydrograph type = SCS Runoff  
 Storm frequency = 2 yrs  
 Time interval = 2 min  
 Drainage area = 0.930 ac  
 Basin Slope = 0.0 %  
 Tc method = USER  
 Total precip. = 3.38 in  
 Storm duration = 24 hrs

Peak discharge = 1.593 cfs  
 Time to peak = 728 min  
 Hyd. volume = 6,121 cuft  
 Curve number = 83  
 Hydraulic length = 0 ft  
 Time of conc. (Tc) = 13.10 min  
 Distribution = Type III  
 Shape factor = 484

### Existing D.A.

Hyd. No. 1 -- 2 Year



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

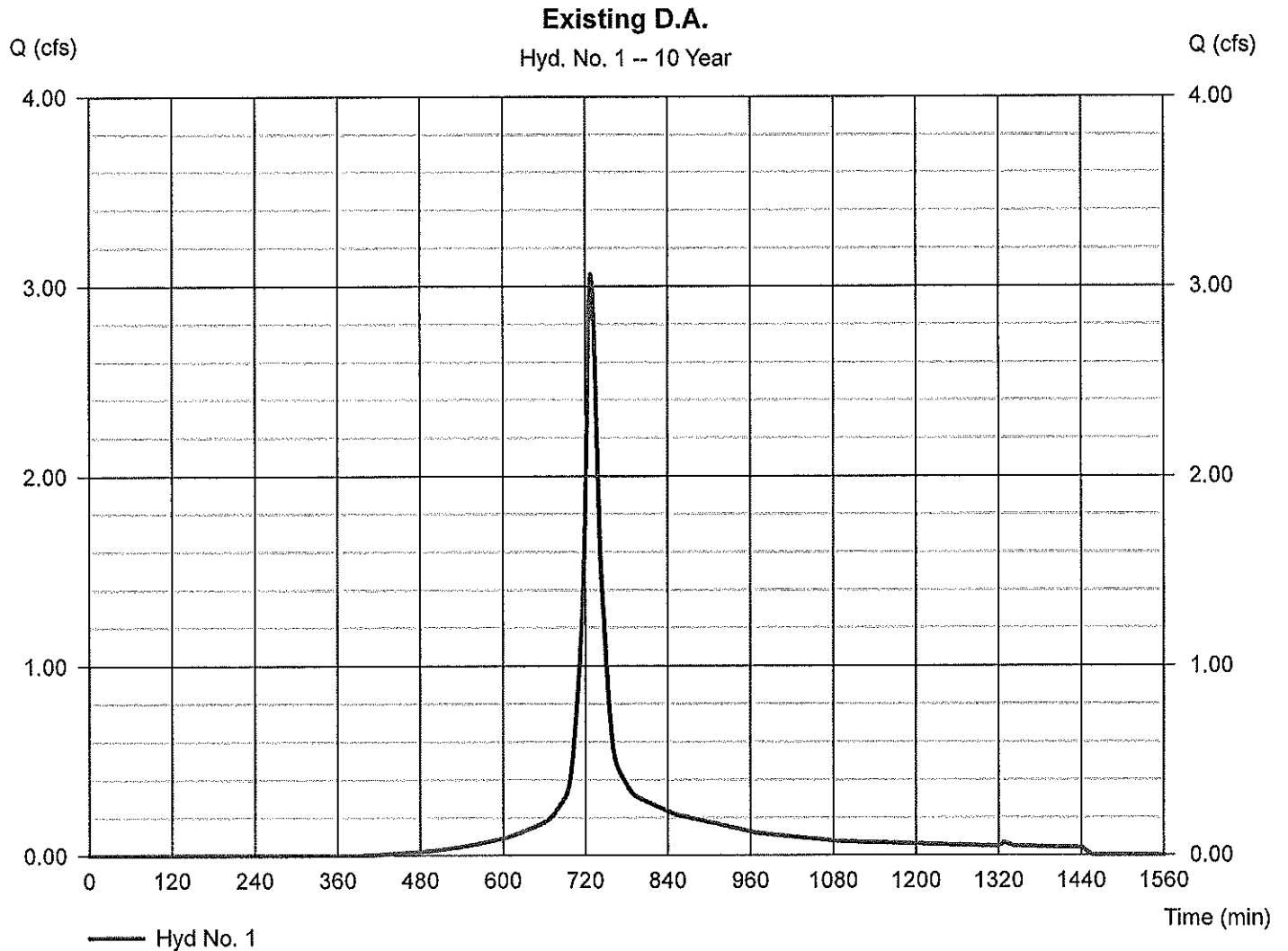
Thursday, May 14, 2020

## Hyd. No. 1

Existing D.A.

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Time interval = 2 min  
Drainage area = 0.930 ac  
Basin Slope = 0.0 %  
Tc method = USER  
Total precip. = 5.23 in  
Storm duration = 24 hrs

Peak discharge = 3.061 cfs  
Time to peak = 728 min  
Hyd. volume = 11,777 cuft  
Curve number = 83  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 13.10 min  
Distribution = Type III  
Shape factor = 484



# Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

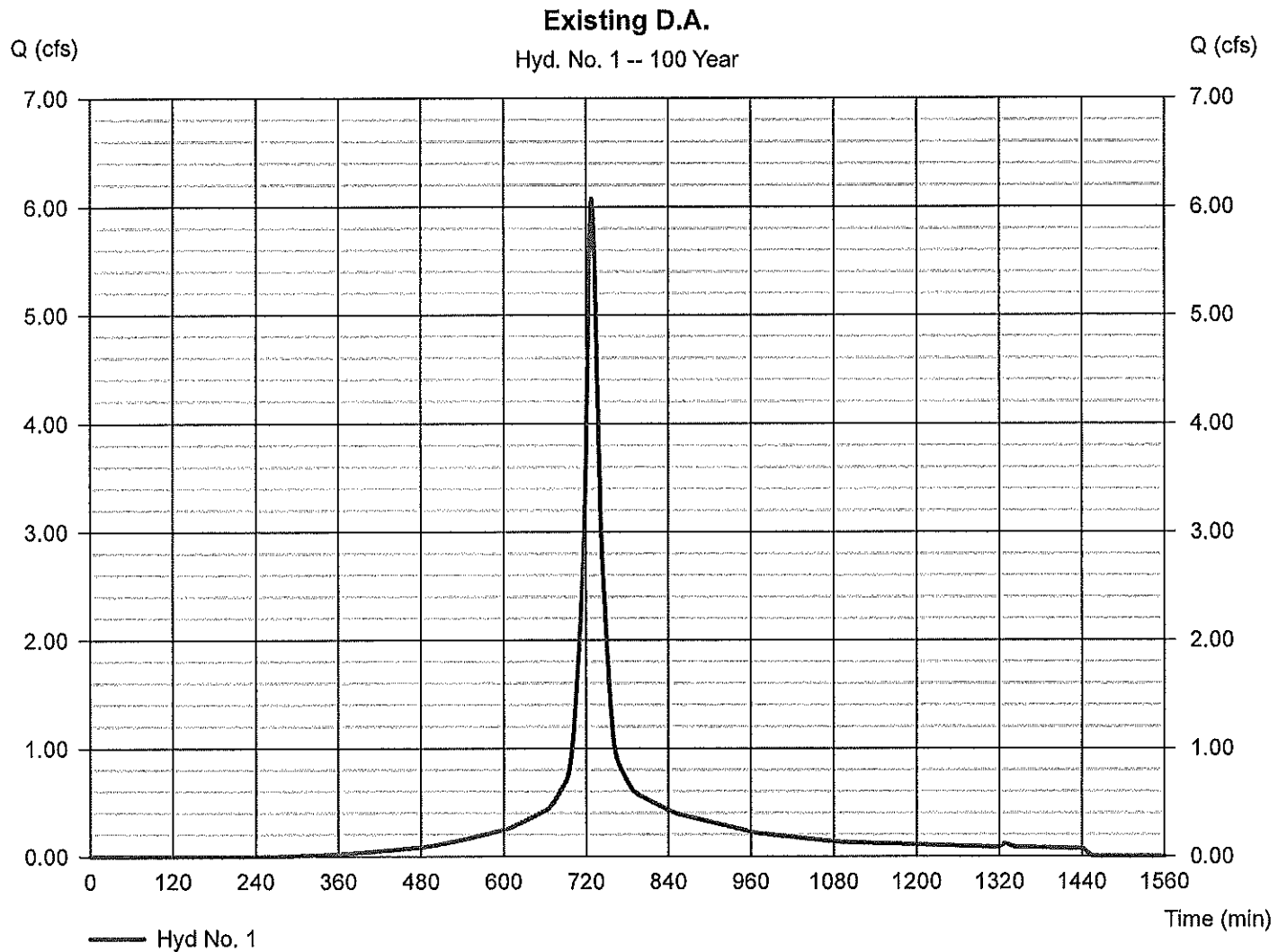
Thursday, May 14, 2020

## Hyd. No. 1

Existing D.A.

Hydrograph type = SCS Runoff  
 Storm frequency = 100 yrs  
 Time interval = 2 min  
 Drainage area = 0.930 ac  
 Basin Slope = 0.0 %  
 Tc method = USER  
 Total precip. = 8.94 in  
 Storm duration = 24 hrs

Peak discharge = 6.070 cfs  
 Time to peak = 728 min  
 Hyd. volume = 23,948 cuft  
 Curve number = 83  
 Hydraulic length = 0 ft  
 Time of conc. (Tc) = 13.10 min  
 Distribution = Type III  
 Shape factor = 484



### Worksheet 2: Runoff curve number and runoff

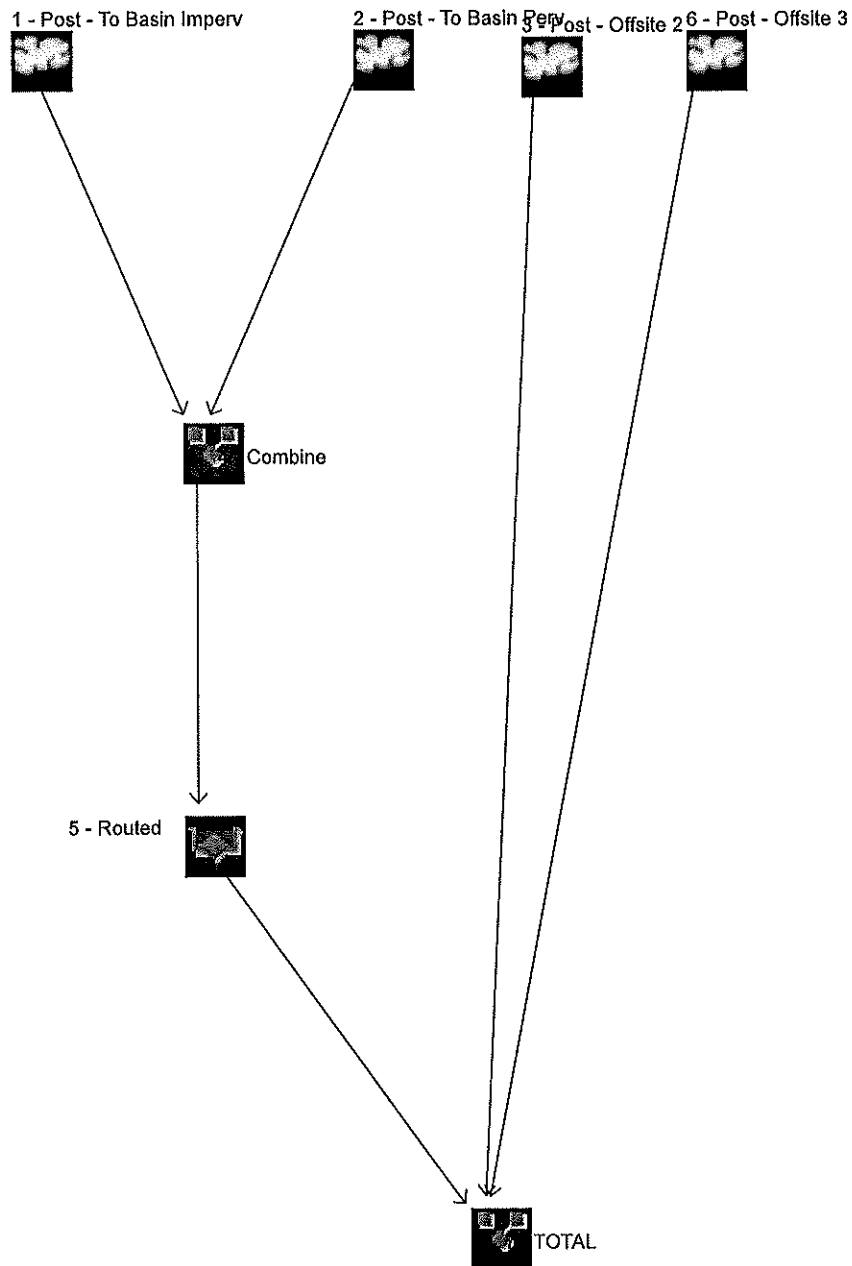
Project 382 Route 79		By MSL		Date 7-Apr-20		
Location Marlboro Township, Monmouth County		Checked BNP		Date 7-Apr-20		
Check one: <input type="checkbox"/> Present <input checked="" type="checkbox"/> Developed		Post-Developed D.A. 1 (To Basin, Imp)				
1. Runoff curve number						
Soil name and hydrologic group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN <sup>1</sup>			Area acres m <sup>2</sup> %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
D	Roof Areas & Walkways	98			0.18	17.64
D	Asphalt	98			0.21	20.58
D	Grass / Open	80			0.00	0.00
C	Impervious	98			0.02	1.96
C	Grass / Open	74			0.00	0.00
1. Use only one CN source per line					<b>Totals</b> ➔	0.41    40.18
$\text{CN (weighted)} = \frac{\text{tot.prod.}}{\text{tot. area}} = \frac{40.18}{0.410} = \underline{98.0}$					Use CN ➔	<b>98</b>
2. Runoff						
	Storm #1	Storm #2	Storm #3			
Frequency..... yr	2	10	100			
Rainfall, P (24-hour).... in						
Runoff, Q..... in						
Use P and CN with table 2-1, figure						

### Worksheet 2: Runoff curve number and runoff

Project 382 Route 79		By MSL		Date 7-Apr-20		
Location Marlboro Township, Monmouth County		Checked BNP		Date 7-Apr-20		
Check one: <input type="checkbox"/> Present <input checked="" type="checkbox"/> Developed			Post-Developed D.A. 2 (Offsite)			
1. Runoff curve number						
Soil name and hydrologic group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN <sup>1</sup>			Area <input type="checkbox"/> acres <input type="checkbox"/> m <sup>2</sup> <input type="checkbox"/> %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
D	Roof Areas & Walkways	98			0.00	0.00
D	Asphalt	98			0.12	11.76
D	Grass / Open	80			0.07	5.60
C	Impervious	98			0.00	0.00
C	Grass / Open	74			0.00	0.00
1. Use only one CN source per line					<b>Totals</b> ➔	0.19    17.36
$\text{CN (weighted)} = \frac{\text{tot. prod.}}{\text{tot. area}} = \frac{17.36}{0.190} = \underline{91.4} ; \text{ Use CN } \rightarrow \boxed{91}$						
2. Runoff						
	Storm #1	Storm #2	Storm #3			
Frequency..... yr	2	10	100			
Rainfall, P (24-hour).... in						
Runoff, Q..... in						
Use P and CN with table 2-1, figure						

# Watershed Model Schematic

Hydraflow Hydrographs by Intelisolve v9.23



### Legend

Hyd.	Origin	Description
1	SCS Runoff	Post - To Basin Imperv
2	SCS Runoff	Post - To Basin Perv
3	SCS Runoff	Post - Offsite 2
4	Combine	Combine
5	Reservoir	Routed
6	SCS Runoff	Post - Offsite 3
7	Combine	TOTAL

# Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuff)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuff)	Hydrograph description
1	SCS Runoff	1.131	2	728	4,830	---	----	-----	Post - To Basin Imperv
2	SCS Runoff	0.145	2	730	575	---	----	-----	Post - To Basin Perv
3	SCS Runoff	0.444	2	728	1,727	---	----	-----	Post - Offsite 2
4	Combine	1.275	2	728	5,404	1, 2,	----	-----	Combine
5	Reservoir	0.302	2	756	3,171	4	123.12	3,157	Routed
6	SCS Runoff	0.255	2	730	1,005	---	----	-----	Post - Offsite 3
7	Combine	0.738	2	732	5,903	3, 5, 6	----	-----	TOTAL
proposed 04-07-20.gpw					Return Period: 2 Year			Thursday, May 14, 2020	



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

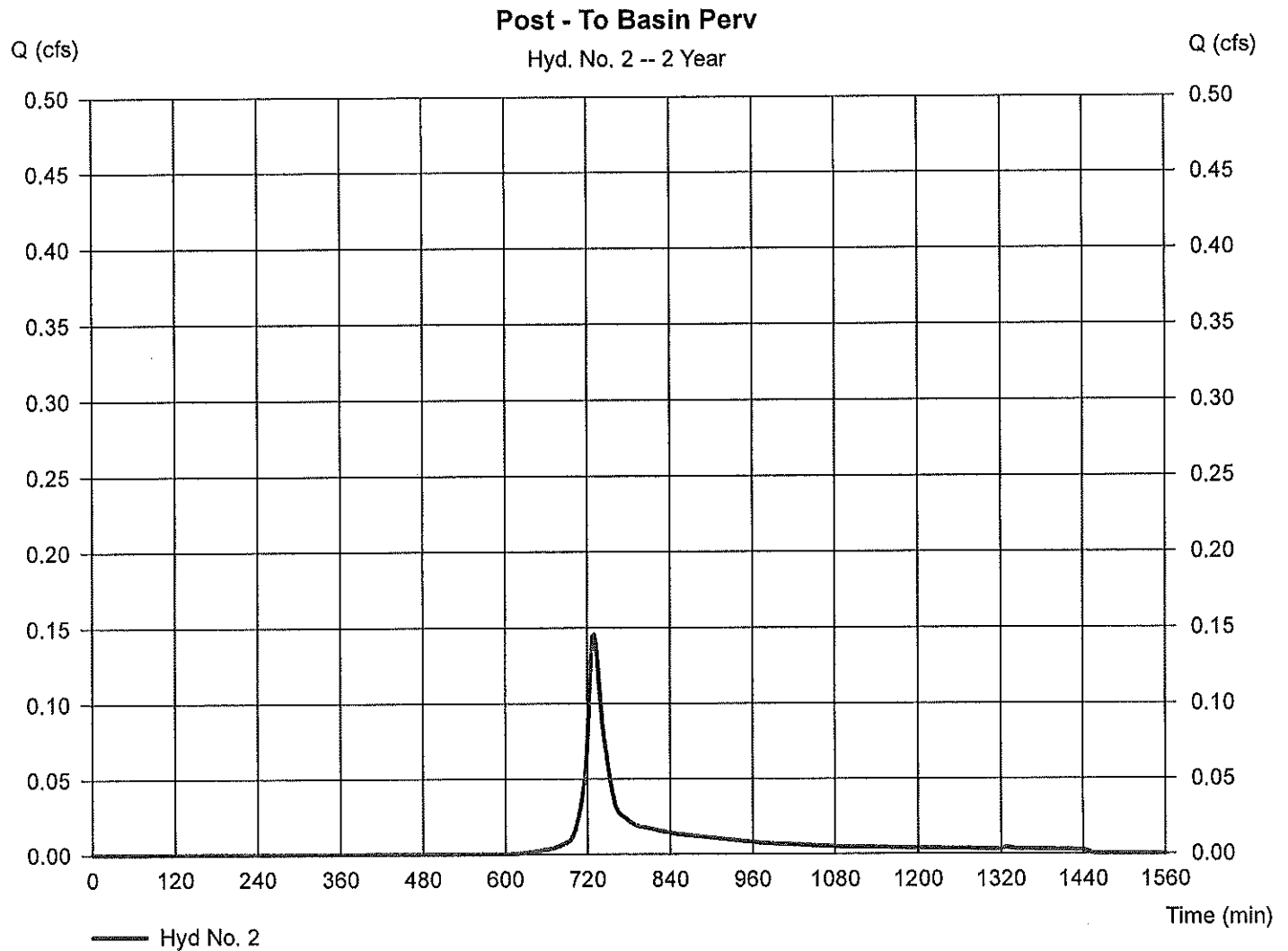
Thursday, May 14, 2020

## Hyd. No. 2

Post - To Basin Perv

Hydrograph type = SCS Runoff  
Storm frequency = 2 yrs  
Time interval = 2 min  
Drainage area = 0.120 ac  
Basin Slope = 0.0 %  
Tc method = USER  
Total precip. = 3.38 in  
Storm duration = 24 hrs

Peak discharge = 0.145 cfs  
Time to peak = 730 min  
Hyd. volume = 575 cuft  
Curve number = 76  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 10.00 min  
Distribution = Type III  
Shape factor = 484



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

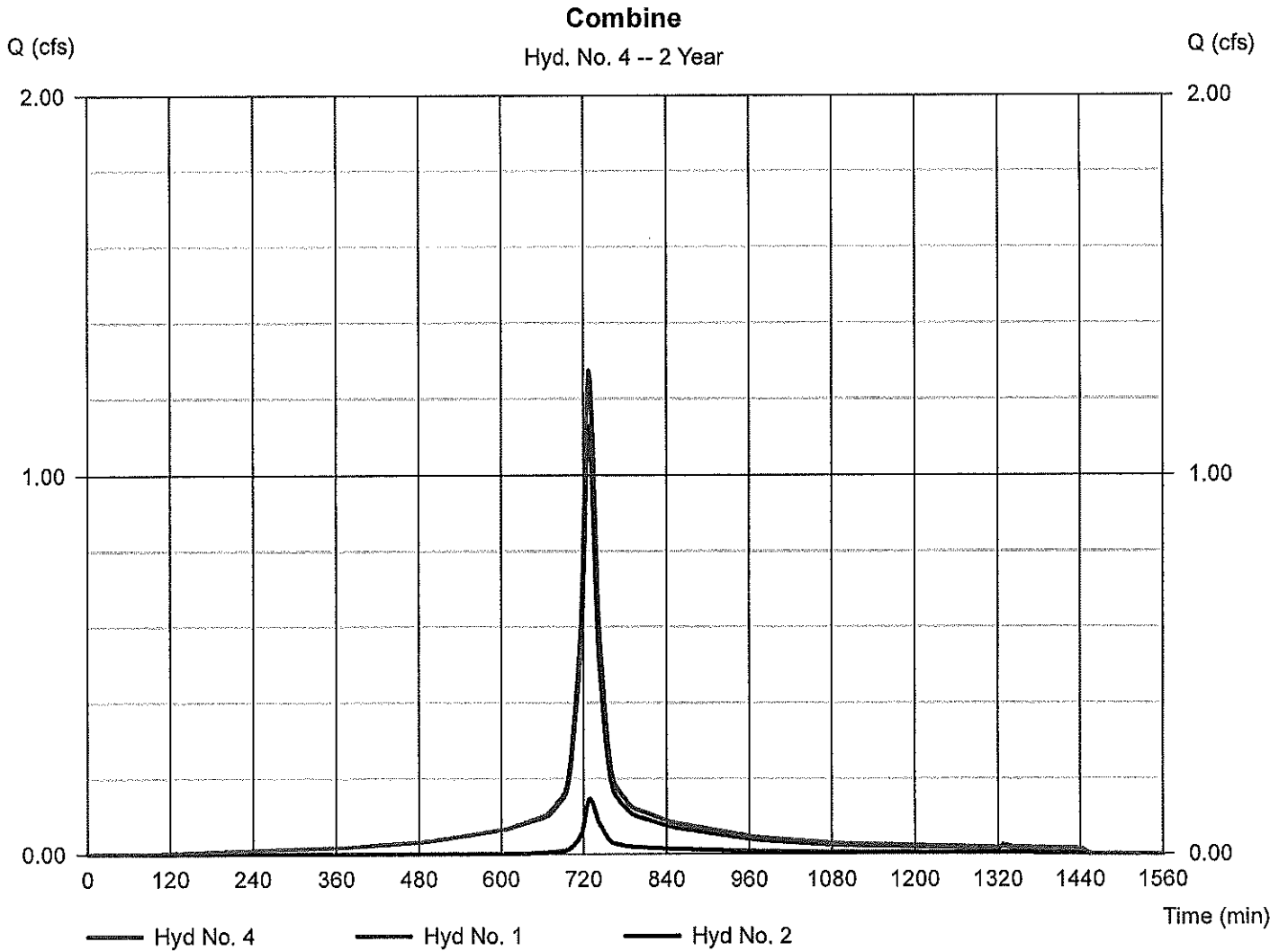
Thursday, May 14, 2020

## Hyd. No. 4

Combine

Hydrograph type = Combine  
Storm frequency = 2 yrs  
Time interval = 2 min  
Inflow hyds. = 1, 2

Peak discharge = 1.275 cfs  
Time to peak = 728 min  
Hyd. volume = 5,404 cuft  
Contrib. drain. area = 0.530 ac



# Pond Report

Hydraflow Hydrographs by Intelisolve v9.23

Thursday, May 14, 2020

## Pond No. 1 - Basin

### Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 121.95 ft

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	121.95	00	0	0
0.05	122.00	2,477	41	41
1.05	123.00	3,000	2,734	2,775
2.05	124.00	3,385	3,190	5,966

### Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.50	10.00	0.00	0.00
Crest El. (ft)	= 122.80	123.90	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	Rect	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Civ A cfs	Civ B cfs	Civ C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	121.95	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.01	4	121.96	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.01	8	121.96	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.02	12	121.97	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.02	17	121.97	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.03	21	121.98	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.03	25	121.98	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.04	29	121.99	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.04	33	121.99	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.04	37	122.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.05	41	122.00	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.15	315	122.10	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.25	588	122.20	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.35	861	122.30	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.45	1,135	122.40	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.55	1,408	122.50	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.65	1,682	122.60	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.75	1,955	122.70	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.85	2,229	122.80	---	---	---	---	0.00	0.00	---	---	---	---	0.000
0.95	2,502	122.90	---	---	---	---	0.05	0.00	---	---	---	---	0.053
1.05	2,775	123.00	---	---	---	---	0.15	0.00	---	---	---	---	0.149
1.15	3,094	123.10	---	---	---	---	0.27	0.00	---	---	---	---	0.274
1.25	3,413	123.20	---	---	---	---	0.42	0.00	---	---	---	---	0.421
1.35	3,732	123.30	---	---	---	---	0.59	0.00	---	---	---	---	0.589
1.45	4,051	123.40	---	---	---	---	0.77	0.00	---	---	---	---	0.774
1.55	4,370	123.50	---	---	---	---	0.98	0.00	---	---	---	---	0.975
1.65	4,689	123.60	---	---	---	---	1.19	0.00	---	---	---	---	1.191
1.75	5,009	123.70	---	---	---	---	1.42	0.00	---	---	---	---	1.422
1.85	5,328	123.80	---	---	---	---	1.66	0.00	---	---	---	---	1.665
1.95	5,647	123.90	---	---	---	---	1.92	0.00	---	---	---	---	1.921
2.05	5,966	124.00	---	---	---	---	2.19	1.05	---	---	---	---	3.242

# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

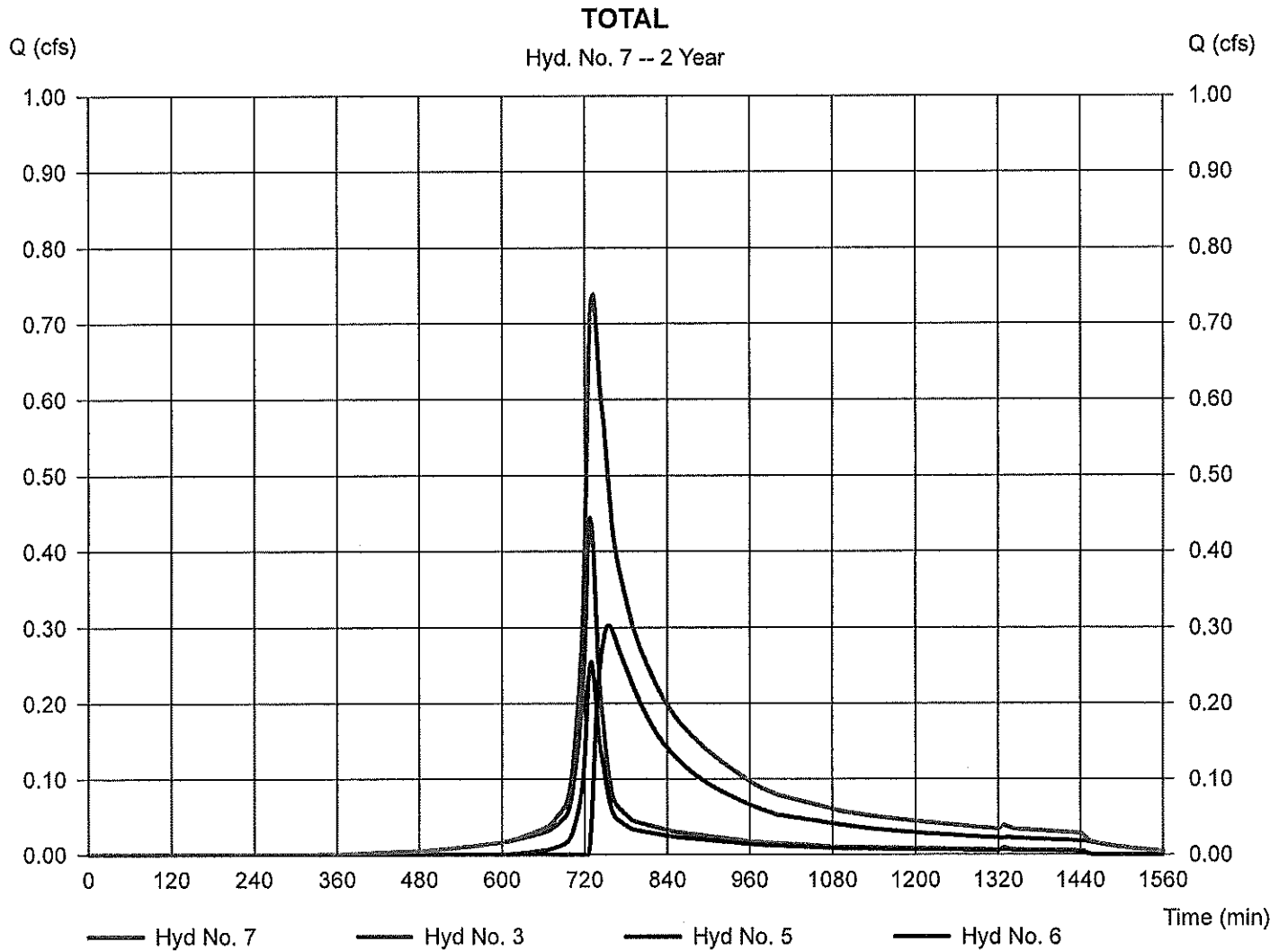
Thursday, May 14, 2020

## Hyd. No. 7

TOTAL

Hydrograph type = Combine  
 Storm frequency = 2 yrs  
 Time interval = 2 min  
 Inflow hyds. = 3, 5, 6

Peak discharge = 0.738 cfs  
 Time to peak = 732 min  
 Hyd. volume = 5,903 cuft  
 Contrib. drain. area = 0.400 ac



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

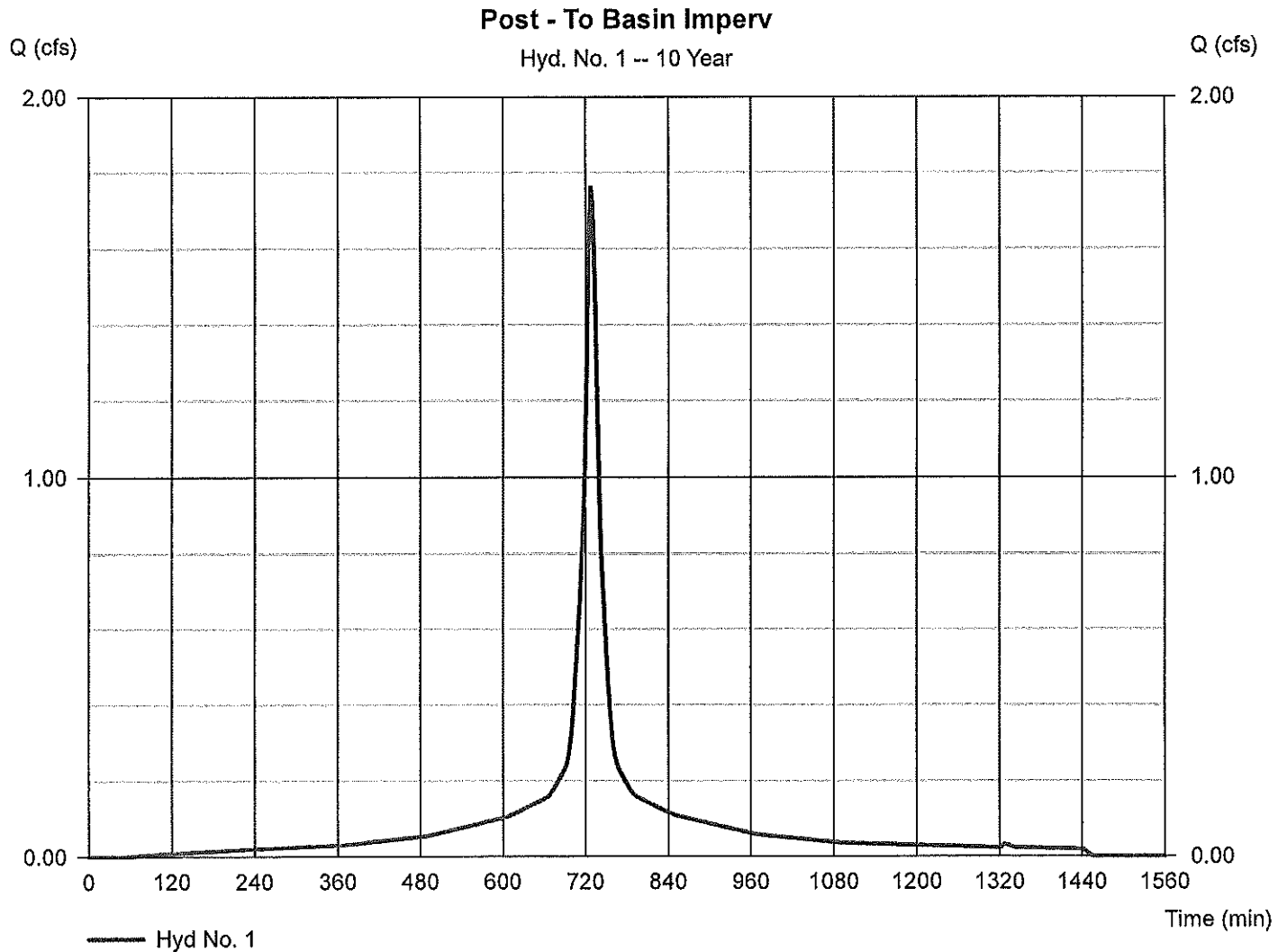
Thursday, May 14, 2020

## Hyd. No. 1

Post - To Basin Imperv

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Time interval = 2 min  
Drainage area = 0.410 ac  
Basin Slope = 0.0 %  
Tc method = USER  
Total precip. = 5.23 in  
Storm duration = 24 hrs

Peak discharge = 1.762 cfs  
Time to peak = 728 min  
Hyd. volume = 7,663 cuft  
Curve number = 98  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 10.00 min  
Distribution = Type III  
Shape factor = 484



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

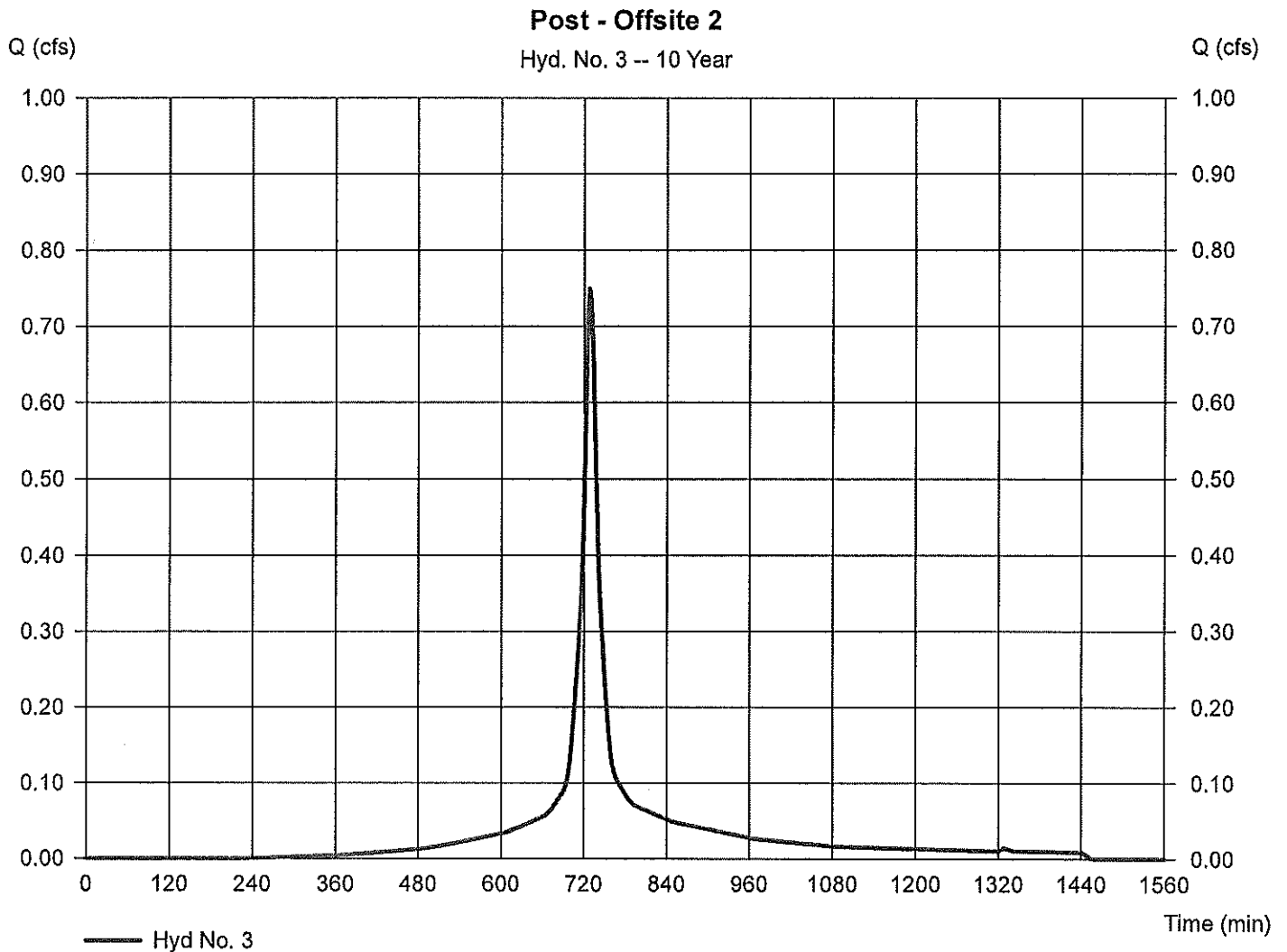
Thursday, May 14, 2020

## Hyd. No. 3

Post - Offsite 2

Hydrograph type = SCS Runoff  
 Storm frequency = 10 yrs  
 Time interval = 2 min  
 Drainage area = 0.190 ac  
 Basin Slope = 0.0 %  
 Tc method = USER  
 Total precip. = 5.23 in  
 Storm duration = 24 hrs

Peak discharge = 0.749 cfs  
 Time to peak = 728 min  
 Hyd. volume = 2,991 cuft  
 Curve number = 91  
 Hydraulic length = 0 ft  
 Time of conc. (Tc) = 10.00 min  
 Distribution = Type III  
 Shape factor = 484



# Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

Thursday, May 14, 2020

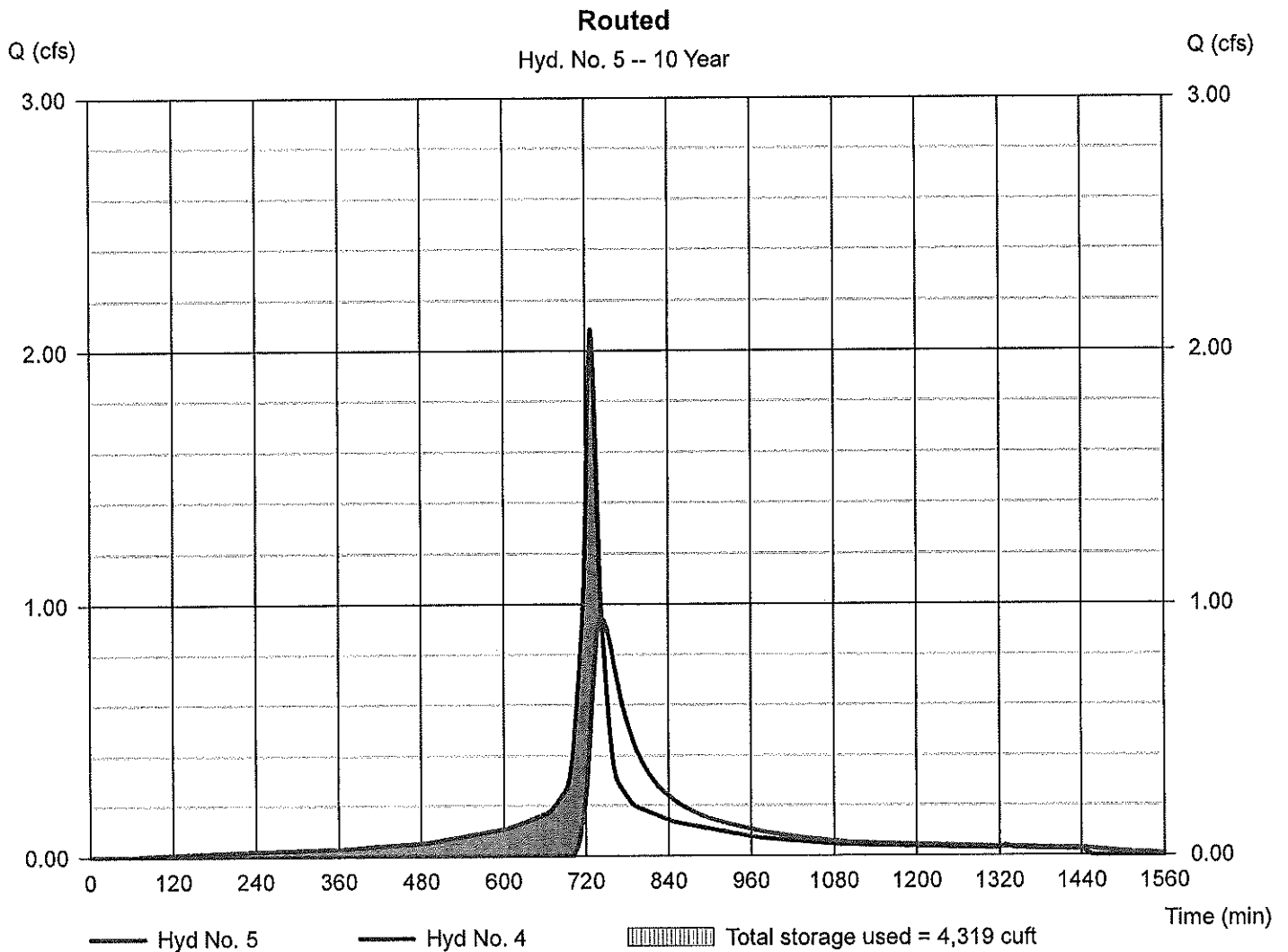
## Hyd. No. 5

Routed

Hydrograph type = Reservoir  
 Storm frequency = 10 yrs  
 Time interval = 2 min  
 Inflow hyd. No. = 4 - Combine  
 Reservoir name = Basin

Peak discharge = 0.943 cfs  
 Time to peak = 744 min  
 Hyd. volume = 6,654 cuft  
 Max. Elevation = 123.48 ft  
 Max. Storage = 4,319 cuft

Storage Indication method used.



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

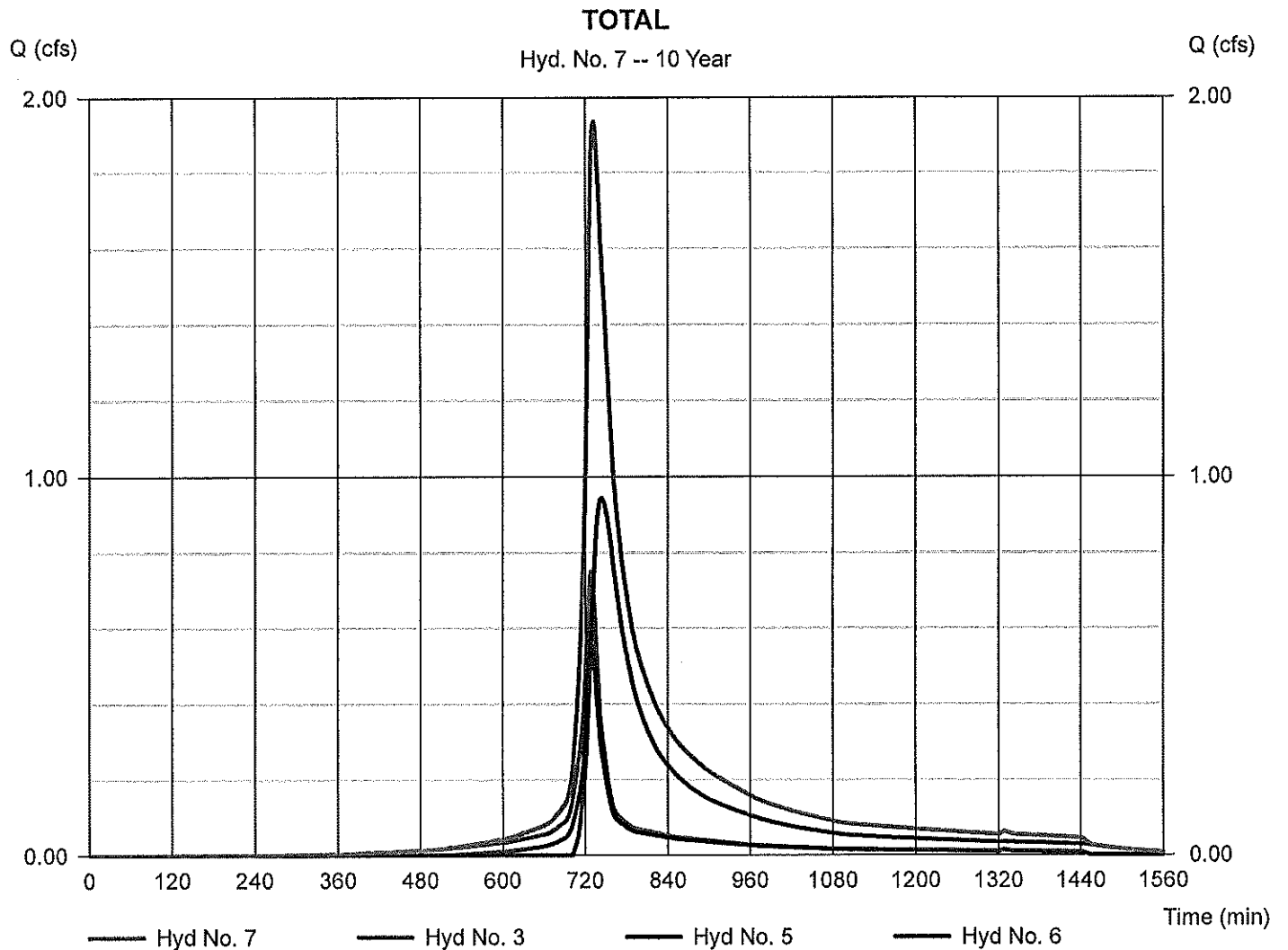
Thursday, May 14, 2020

## Hyd. No. 7

TOTAL

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Time interval = 2 min  
Inflow hyds. = 3, 5, 6

Peak discharge = 1.936 cfs  
Time to peak = 732 min  
Hyd. volume = 11,788 cuft  
Contrib. drain. area = 0.400 ac





# Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

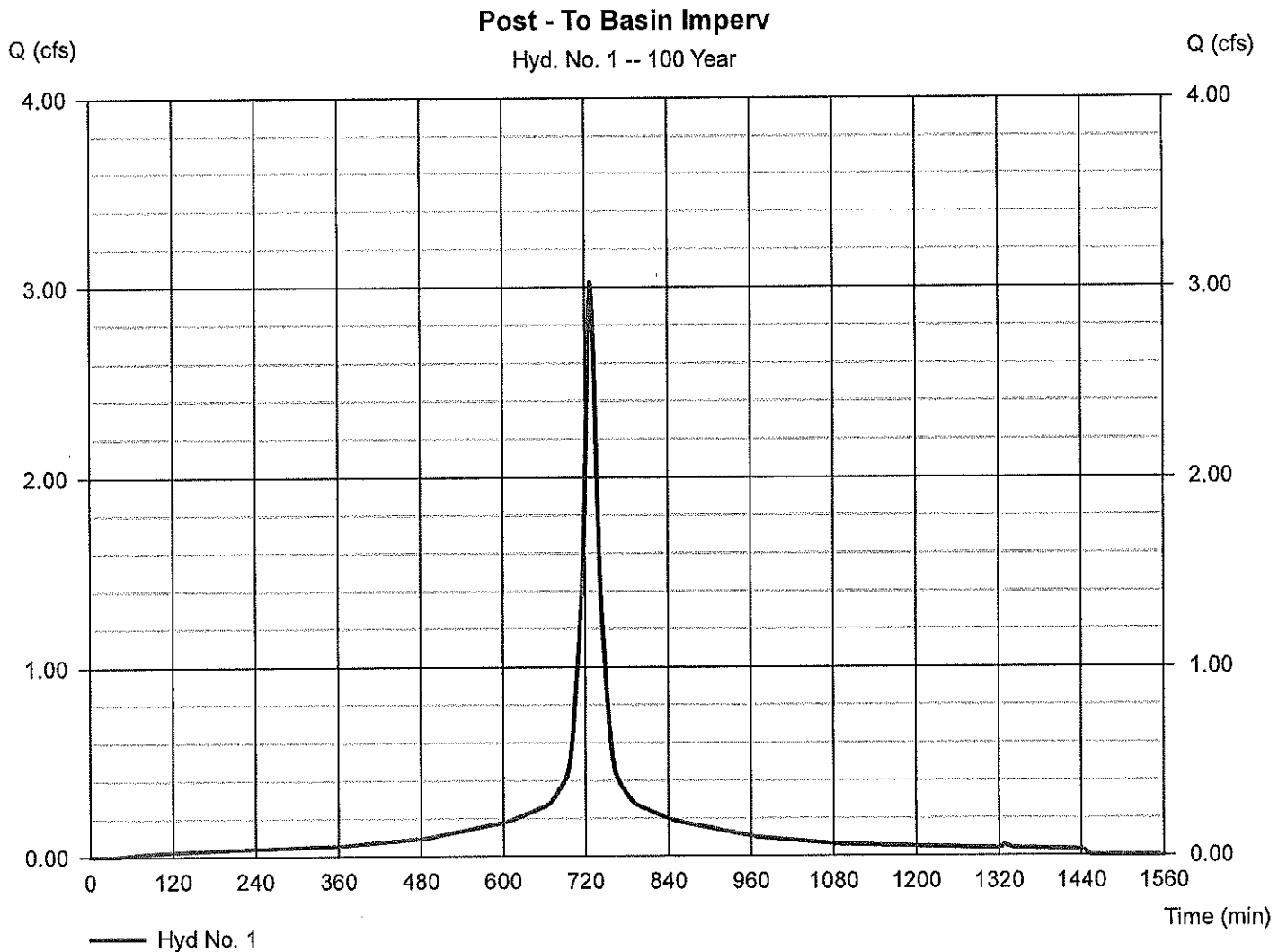
Thursday, May 14, 2020

## Hyd. No. 1

Post - To Basin Imperv

Hydrograph type = SCS Runoff  
 Storm frequency = 100 yrs  
 Time interval = 2 min  
 Drainage area = 0.410 ac  
 Basin Slope = 0.0 %  
 Tc method = USER  
 Total precip. = 8.94 in  
 Storm duration = 24 hrs

Peak discharge = 3.023 cfs  
 Time to peak = 728 min  
 Hyd. volume = 13,352 cuft  
 Curve number = 98  
 Hydraulic length = 0 ft  
 Time of conc. (Tc) = 10.00 min  
 Distribution = Type III  
 Shape factor = 484



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

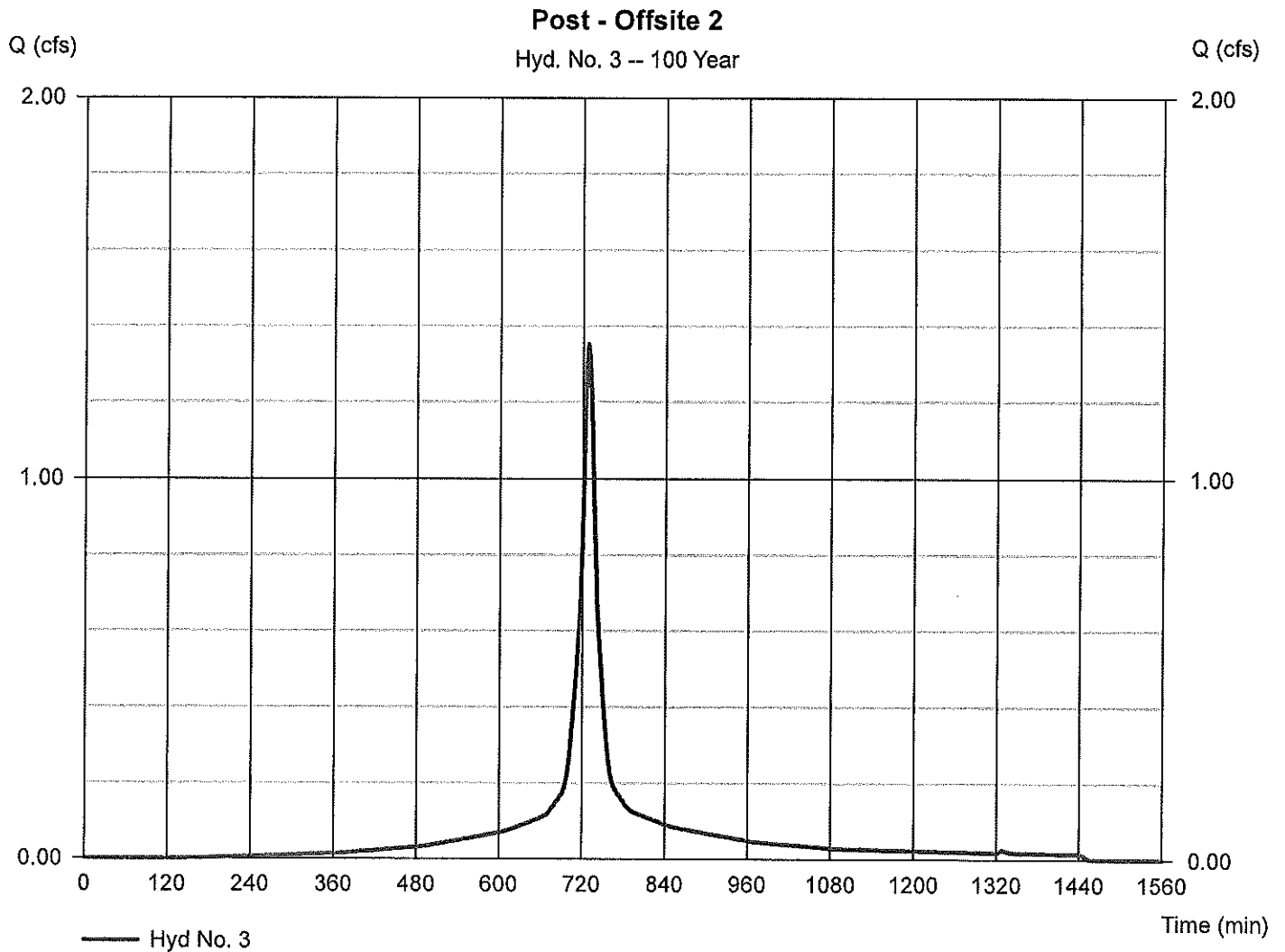
Thursday, May 14, 2020

## Hyd. No. 3

Post - Offsite 2

Hydrograph type = SCS Runoff  
 Storm frequency = 100 yrs  
 Time interval = 2 min  
 Drainage area = 0.190 ac  
 Basin Slope = 0.0 %  
 Tc method = USER  
 Total precip. = 8.94 in  
 Storm duration = 24 hrs

Peak discharge = 1.352 cfs  
 Time to peak = 728 min  
 Hyd. volume = 5,586 cuft  
 Curve number = 91  
 Hydraulic length = 0 ft  
 Time of conc. (Tc) = 10.00 min  
 Distribution = Type III  
 Shape factor = 484



# Hydrograph Report

Hydraflow Hydrographs by Intellsolve v9.23

Thursday, May 14, 2020

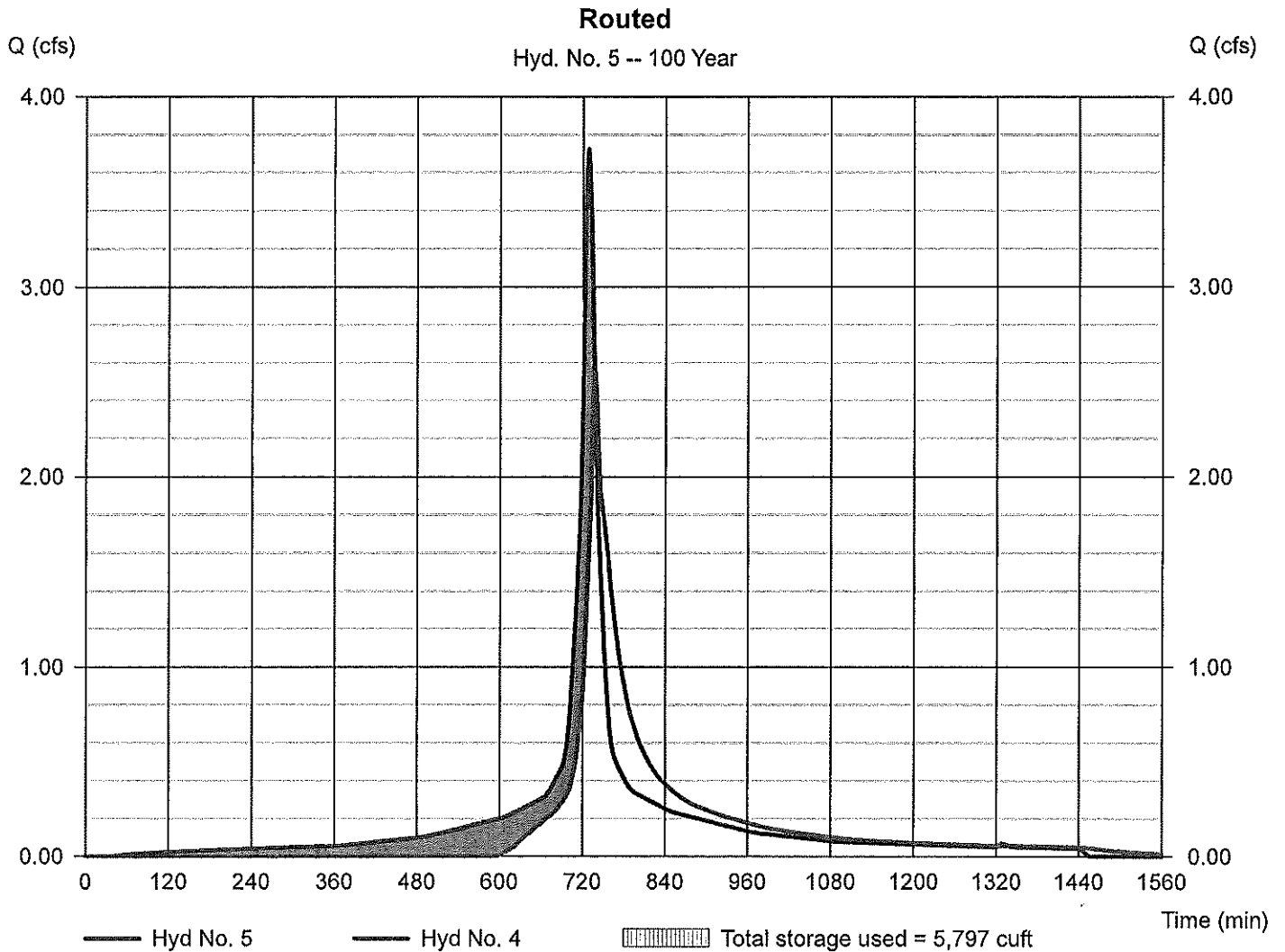
## Hyd. No. 5

Routed

Hydrograph type = Reservoir  
 Storm frequency = 100 yrs  
 Time interval = 2 min  
 Inflow hyd. No. = 4 - Combine  
 Reservoir name = Basin

Peak discharge = 2,545 cfs  
 Time to peak = 738 min  
 Hyd. volume = 13,823 cuft  
 Max. Elevation = 123.95 ft  
 Max. Storage = 5,797 cuft

Storage Indication method used.



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

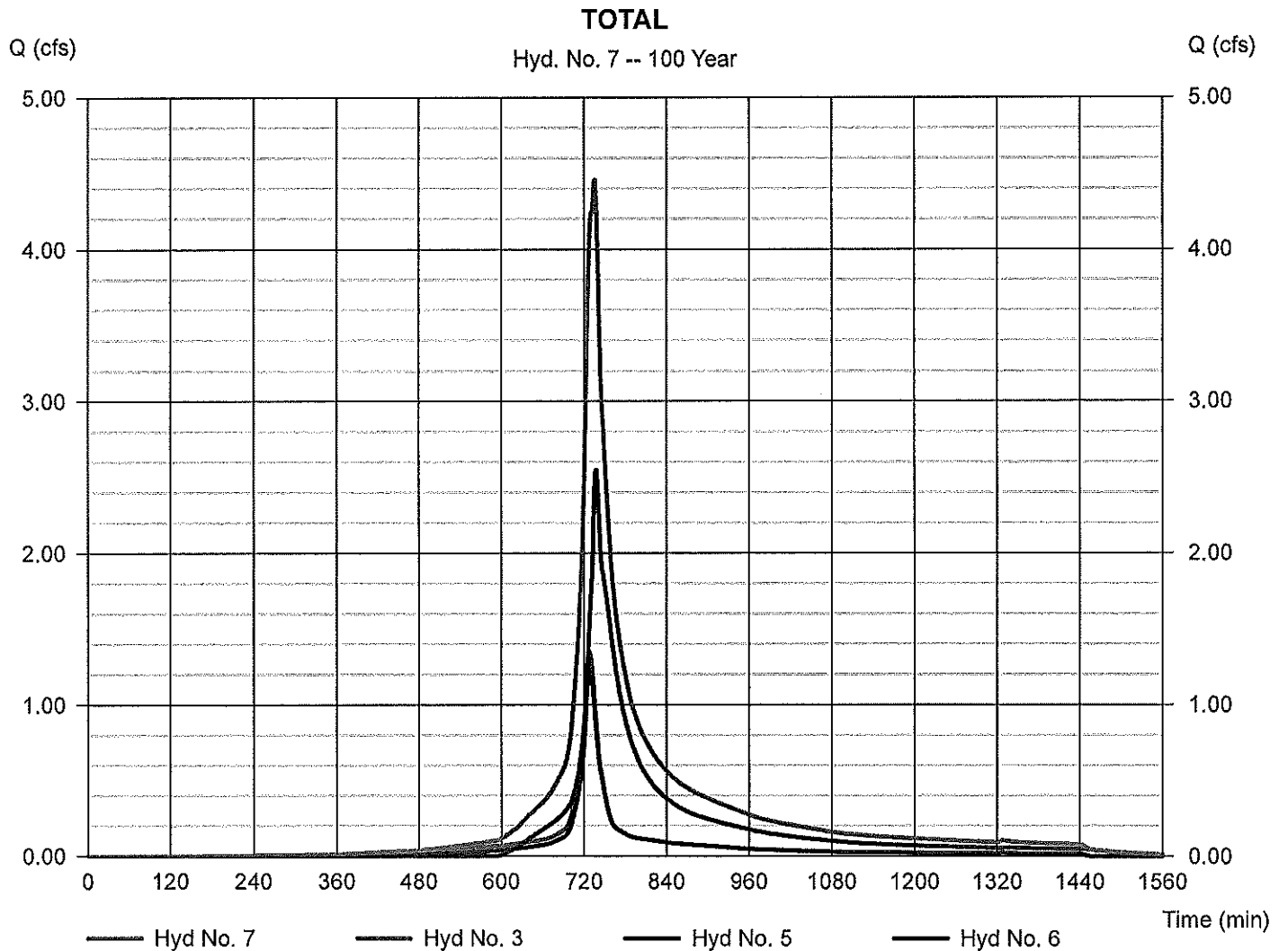
Thursday, May 14, 2020

## Hyd. No. 7

TOTAL

Hydrograph type = Combine  
Storm frequency = 100 yrs  
Time interval = 2 min  
Inflow hyds. = 3, 5, 6

Peak discharge = 4.457 cfs  
Time to peak = 736 min  
Hyd. volume = 24,142 cuft  
Contrib. drain. area = 0.400 ac










































Soil Map—Monmouth County, New Jersey  
(NRCS Soil Survey - 382 Route 79)



## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres In AOI	Percent of AOI
KemB	Keyport sandy loam, 2 to 5 percent slopes	0.9	46.9%
KkgkB	Klej loamy sand, clayey substratum, 0 to 5 percent slopes	0.1	4.6%
ShrA	Shrewsbury sandy loam, 0 to 2 percent slopes	0.9	48.5%
<b>Totals for Area of Interest</b>		<b>1.9</b>	<b>100.0%</b>

## MAP LEGEND

 Area of Interest (AOI)	 C
 Soils	 C/D
 Soil Rating Polygons	 D
 A	 Not rated or not available
 A/D	 Water Features
 B	 Streams and Canals
 B/D	 Transportation
 C	 Rails
 C/D	 Interstate Highways
 D	 US Routes
 Not rated or not available	 Major Roads
 Soil Rating Lines	 Local Roads
 A	 Background
 A/D	 Aerial Photography
 B	
 B/D	
 C	
 C/D	
 D	
 Not rated or not available	
 Soil Rating Points	
 A	
 A/D	
 B	
 B/D	

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL:  
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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

Soil Survey Area: Monmouth County, New Jersey  
Survey Area Data: Version 13, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 29, 2019—Jul 16, 2019

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

## Rating Options

*Aggregation Method:* Dominant Condition

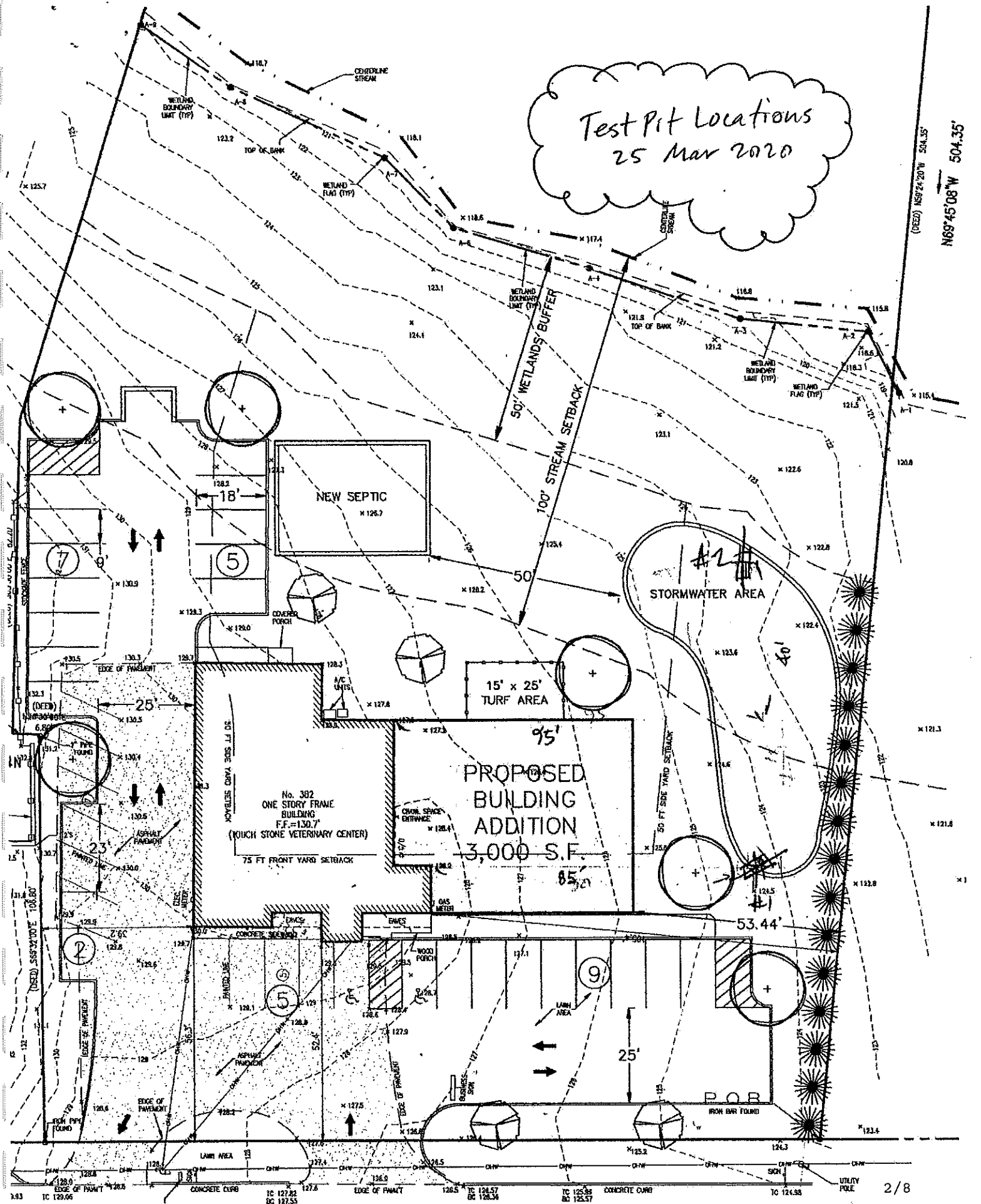
*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher



Test Pit Locations  
25 Mar 2020

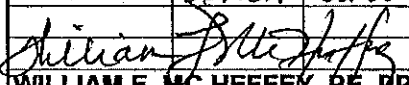
(DEED) N89°24'20"W 504.35'  
N69°45'08"W 504.35'



(DEED) N24°55'00"E 200.00'

*Handwritten signature or initials*



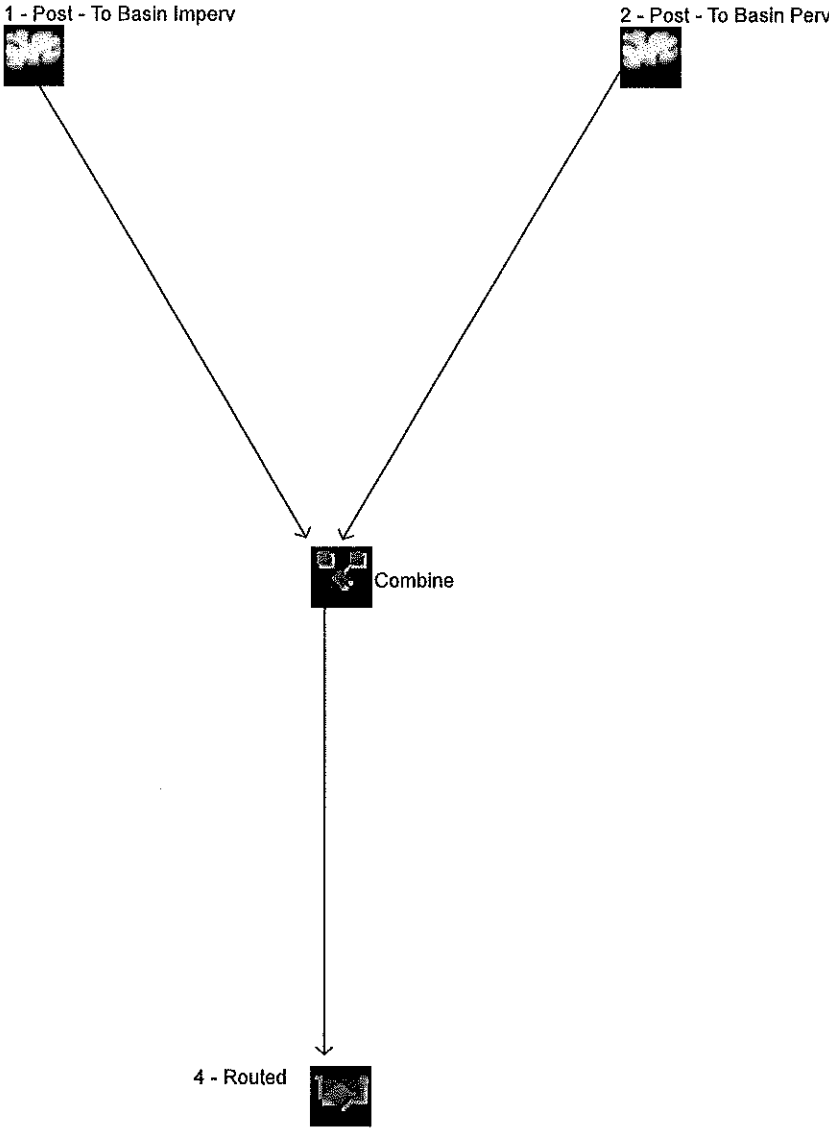
MONMOUTH COUNTY / Marlboro Twp.				FORM 3B	7:9A-6.2 TUBE PERMEAMETER TEST	
BLOCK/LOT Block 153 / Lot 12						
# 382 Rte. 79						
SAMPLE / DEPTH brown SP-SM 2' depth @ test pit #2						
SAMPLE DIMENSIONS				A	B	
RADIUS OF SAMPLE TUBE, CM				3.6cm	3.6cm	
LENGTH OF SAMPLE, INCHES				3.2"	3.0"	
SAMPLE VOLUME, CC				333.9cc	309.4cc	
SAMPLE WEIGHT, GRAMS				515.6g	449.3g	
BULK DENSITY, GRAMS/CC				1.54g/cc	1.45g/cc	
HEIGHT OF WATER ABOVE RIM, MM						
BEGINNING OF INTERVAL, H1				67	70	
END OF INTERVAL, H2				56	53	
TIME OF TEST INTERVAL, HH:MM:SS				Ha	Hb	
				15:37:00	16:07:00	
				67	70	
				38	12:00	52
				39	12:30	70
				40	17:30	53
				41	18:00	70
				42	23:00	53
				42:15		
				47:15		
H1				48:00		
H2				53:00		
INTERVAL, MIN. MIN				5.0	5.0	
CALCULATION OF PERMEABILITY				$A: 60 \times 3.2 \times \ln(67/56) / 5.0 = 6.9''/hr$ $B: 60 \times 3.0 \times \ln(70/53) / 5.0 = 10.0''/hr$		
K, INCHES/HOUR = 60 x LENGTH x LN(H1/H2) / TIME						
DEFECTS IN SAMPLE:				OK	OK	
PERMEABILITY RATING				K4 6-20''/hr	K4 6-20''/hr	
I HEREBY CERTIFY THAT THE INFORMATION FURNISHED ON THIS FORM OF THIS APPLICATION IS TRUE AND ACCURATE - I AM AWARE THAT FALSIFICATION OF DATA IS A VIOLATION OF THE WATER POLLUTION CONTROL ACT NJSA 58:10A-1 ET SEQ SUBJECT TO PENALTIES AS PRESCRIBED IN NJAC 7:14-8						
DATE: 26 Mar 2020						6/8
 <b>WILLIAM F. MC HEFFEY, PE, PP</b>				<b>MC ENGINEERING</b> 1041 HWY 36 - STE 202 ATLANTIC HIGHLANDS, NJ 07716 (732) 291-4110		
NJ 24GE03348600 & 33LI00448800						



TEST PIT #2 EXCAVATION

# Watershed Model Schematic

Hydraflow Hydrographs by Intellisolve v9.23



**Legend**

<u>Hyd.</u>	<u>Origin</u>	<u>Description</u>
1	SCS Runoff	Post - To Basin Imperv
2	SCS Runoff	Post - To Basin Perv
3	Combine	Combine
4	Reservoir	Routed

# Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description	
1	SCS Runoff	0.909	5	70	1,443	---	----	-----	Post - To Basin Imperv	
2	SCS Runoff	0.020	5	75	41	---	----	-----	Post - To Basin Perv	
3	Combine	0.924	5	70	1,484	1, 2	----	-----	Combine	
4	Reservoir	0.062	5	120	1,483	3	122.41	1,172	Routed	
proposed 04-07-20 WQ.gpw					Return Period: 1 Year			Thursday, May 14, 2020		

# Hydrograph Report

Hydraflow Hydrographs by Intellsolve v9.23

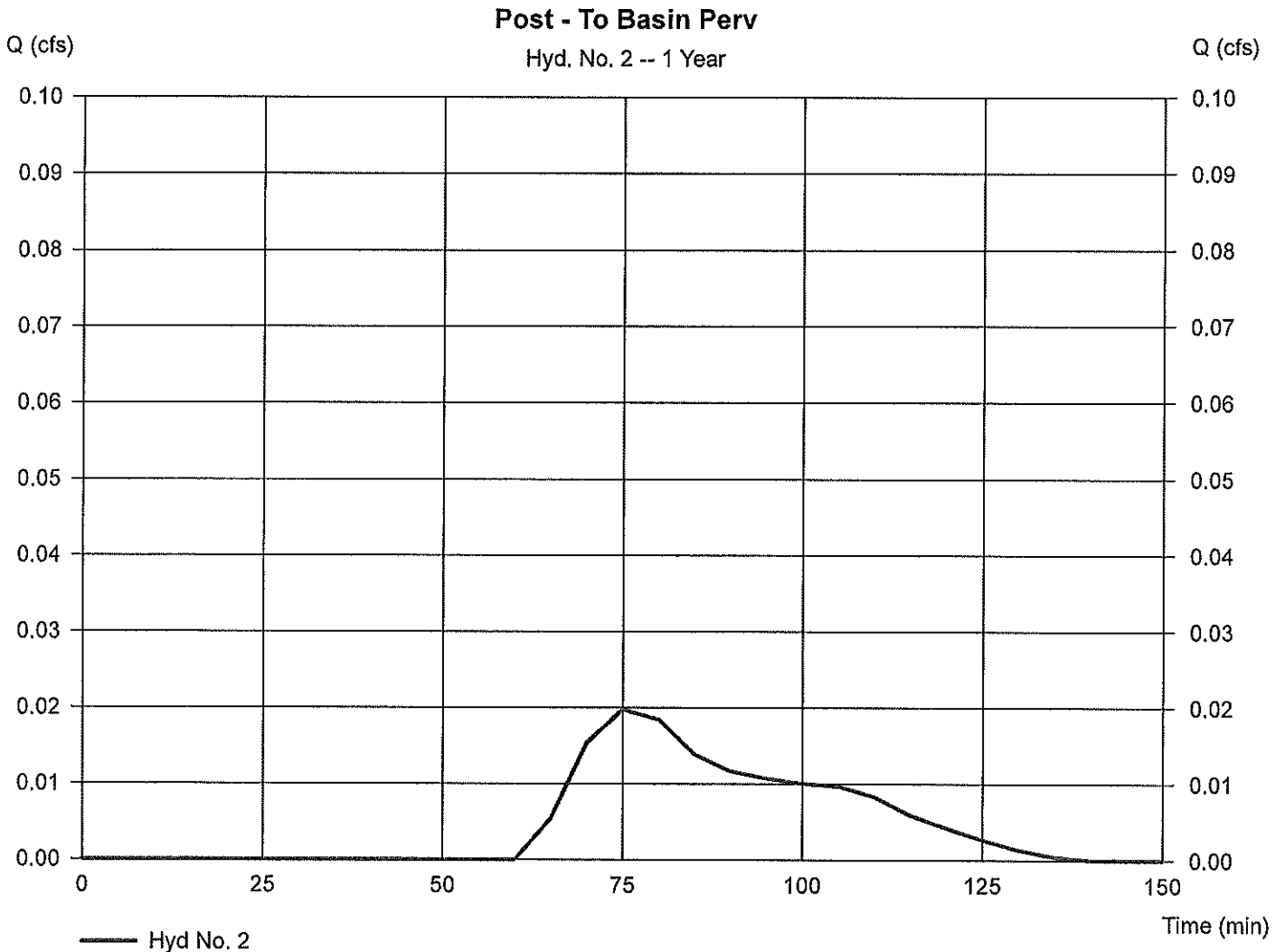
Thursday, May 14, 2020

## Hyd. No. 2

Post - To Basin Perv

Hydrograph type = SCS Runoff  
Storm frequency = 1 yrs  
Time interval = 5 min  
Drainage area = 0.120 ac  
Basin Slope = 0.0 %  
Tc method = USER  
Total precip. = 1.25 in  
Storm duration = njdep wq.cds

Peak discharge = 0.020 cfs  
Time to peak = 75 min  
Hyd. volume = 41 cuft  
Curve number = 76  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 10.00 min  
Distribution = Custom  
Shape factor = 484



# Hydrograph Report

Hydraflow Hydrographs by Intellisolve v9.23

Thursday, May 14, 2020

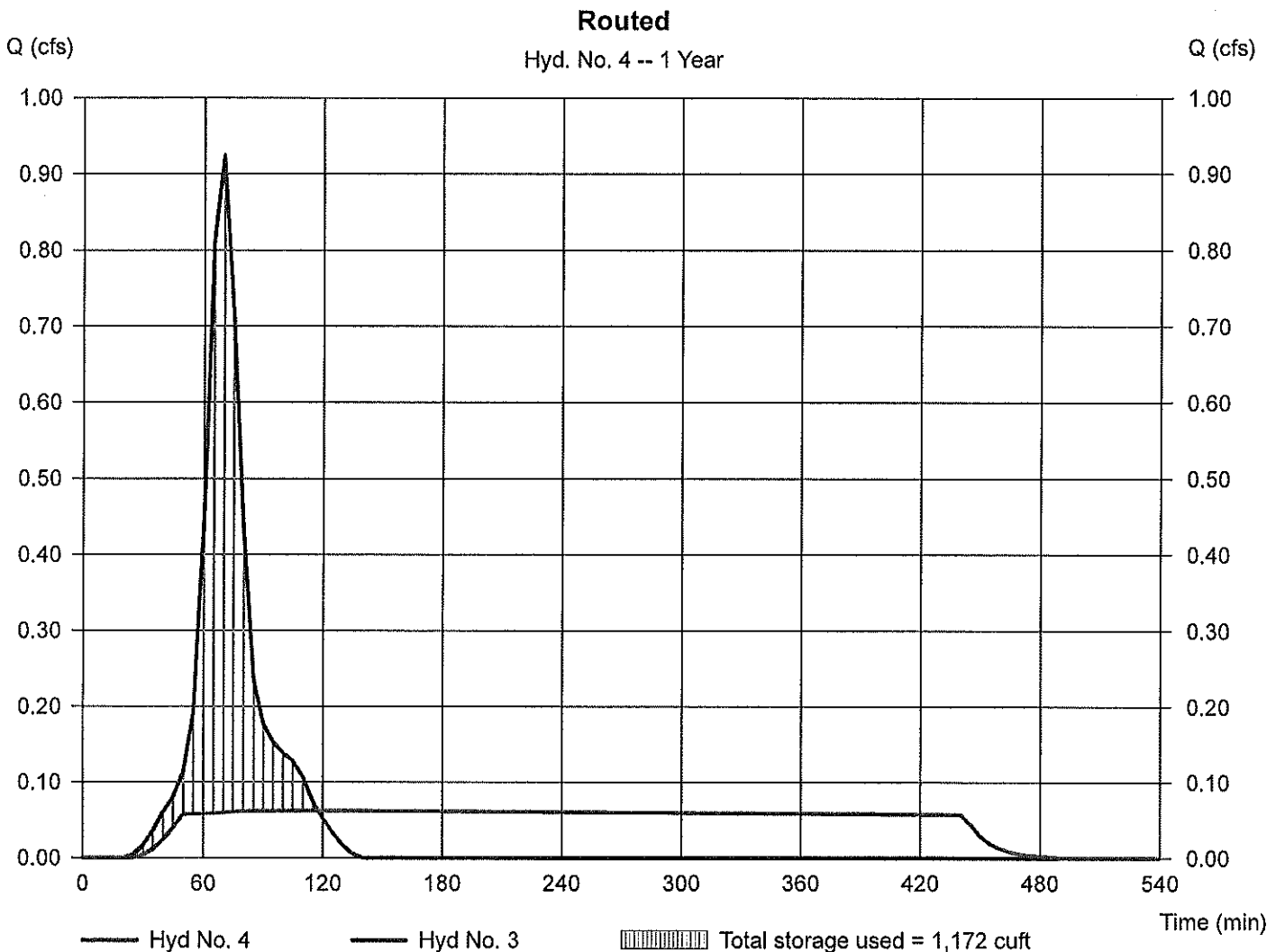
## Hyd. No. 4

Routed

Hydrograph type = Reservoir  
Storm frequency = 1 yrs  
Time interval = 5 min  
Inflow hyd. No. = 3 - Combine  
Reservoir name = Basin

Peak discharge = 0.062 cfs  
Time to peak = 120 min  
Hyd. volume = 1,483 cuft  
Max. Elevation = 122.41 ft  
Max. Storage = 1,172 cuft

Storage Indication method used. Outflow includes exfiltration.





# Appendix 5

## Groundwater Recharge Spreadsheet

Project Name		Description		Analysis Date		BMP or LID Type	
382 Route 79		Site Plan		04/07/20		Above Ground Detention Basin	
Recharge BMP Input Parameters				Root Zone Water Capacity Calculated Parameters			
Parameter	Symbol	Value	Unit	Parameter	Symbol	Value	Unit
BMP Area	ABMP	2477.0	sq.ft	Empty Portion of RWC under Post-D Natural Recharge	ERWC	0.00	in
BMP Effective Depth, this is the design variable Upper level of the BMP surface (negative if above ground)	dBMP	0.8	in	ERWC Modified to consider dEXC	EDRWC	0.00	in
Depth of lower surface of BMP, must be >= dBMPu	dBMPu	-23.4	in	Empty Portion of RWC under Infil. BMP	RERWC	0.00	in
Post-development Land Segment Location of BMP	SegBMP	3	unitless				
Input Zero if Location is distributed or undetermined							

Recharge Design Parameters			
Parameter	Symbol	Value	Unit
Inches of Runoff to capture	Qdesign	0.09	in
Inches of Rainfall to capture	Pdesign	0.14	in
Recharge Provided Avg. over Imp. Area		6.4	in
Runoff Captured Avg. over Imp. Area		6.4	in

BMP Calculated Size Parameters			
ABMP/Aimp	Aratio	0.11	unitless
BMP Volume	VBMP	164	cu.ft

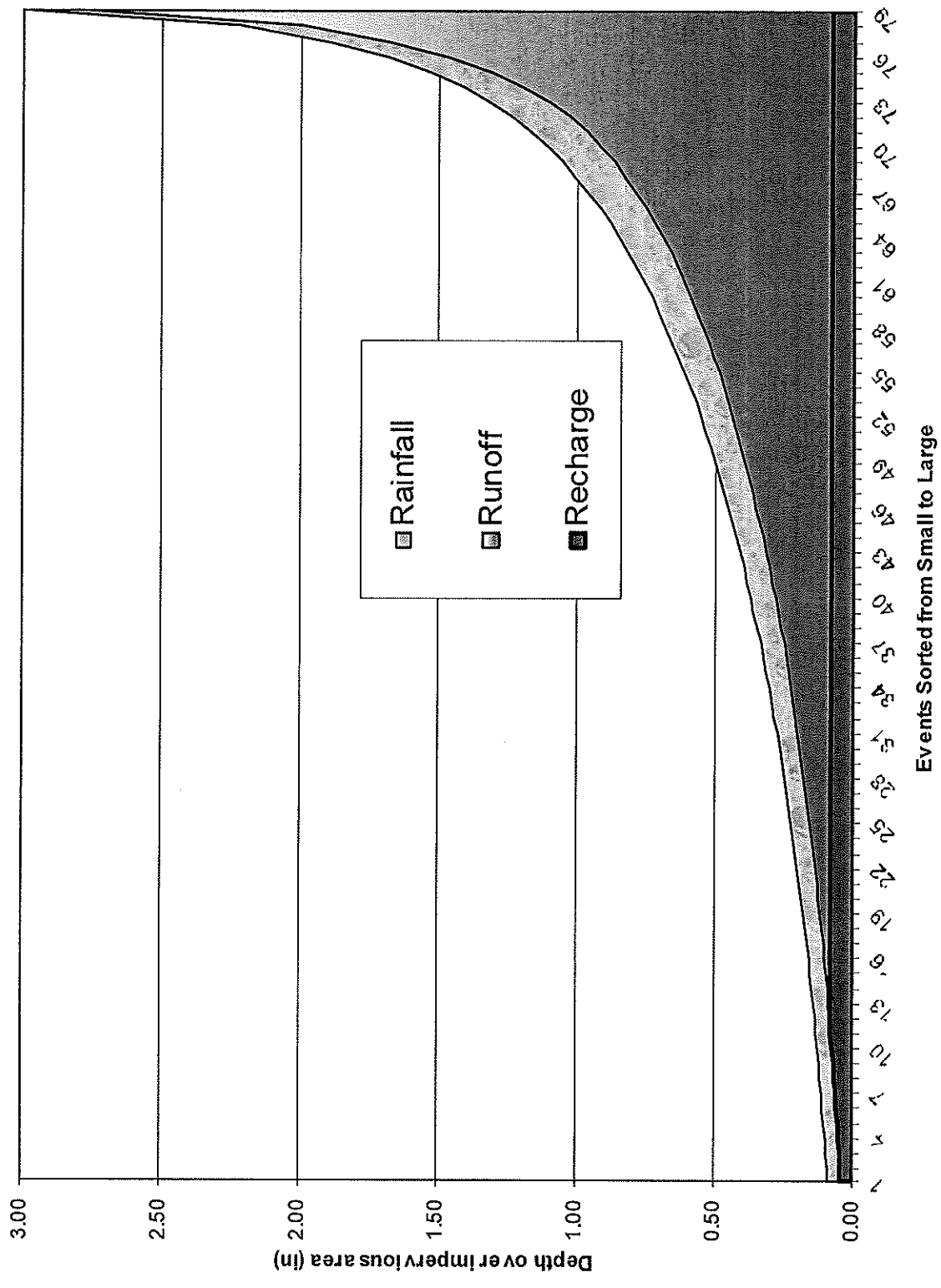
System Performance Calculated Parameters			
Annual BMP Recharge Volume	12,366	cu.ft	
Avg BMP Recharge Efficiency	100.0%	%	Represents % Infiltration Recharged
%Rainfall became Runoff	77.7%	%	
%Runoff Infiltrated	18.4%	%	
%Runoff Recharged	18.4%	%	
%Rainfall Recharged	14.3%	%	

Parameters from Annual Recharge Worksheet			
Post-D Deficit Recharge (or desired recharge volume)	Vdef	12,366	cu.ft
Post-D Impervious Area (or target Impervious Area)	Aimp	23,087	sq.ft
Root Zone Water Capacity	RWC	0.00	in
RWC Modified to consider dEXC	DRWC	0.00	in
Climatic Factor	C-factor	1.44	no units
Average Annual P	Pavg	44.9	in
Recharge Requirement over Imp. Area	dr	6.4	in

How to solve for different recharge volumes: By default the spreadsheet assigns the values of total deficit recharge volume "Vdef" and total proposed impervious area "Aimp" from the "Annual Recharge" sheet to "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 recharge volume=deficit volume of BMP infiltration prior to filling and the area occupied by BMP are ignored in these calculations  
 sensitive to dBMP, make sure dBMP selected is small enough for BMP to empty in less than 3  
 Segment Location of BMP if you select 'impervious areas' RWC will be minimal but not zero as the soil type and a shallow root zone for this Land Cover allowing consideration of lateral flow at



# Appendix 6

## Storm Sewer Pipe Calculations

# Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data							Line ID	
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Dmg area (ac)	Runoff coeff (C)	Inlet time (min)	Invert EI Dn (ft)	Line slope (%)	Invert EI Up (ft)	Line size (in)	Line type	N value (n)	J-loss coeff (K)		Inlet/Rim EI (ft)
1	End	92.0	179.9	MH	0.00	0.13	0.99	10.0	122.00	4.00	125.68	12	Cir	0.013	1.00	128.75	A INLET TO BASIN
2	1	19.4	-89.9	MH	0.00	0.08	0.99	10.0	125.68	0.98	125.87	6	Cir	0.013	1.00	130.00	ROOF TO A INLET

Project File: stormsewers pt1.stm

Number of lines: 2

Date: 05-14-2020

# Storm Sewer Tabulation

Station Line	To Line	Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (l) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
			Incr (ac)	Total (ac)		Incr (min)	Syst (min)	Incr (in)	Slope (%)					Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)			
1	End	92.0	0.13	0.21	0.99	0.13	0.21	10.0	10.1	6.4	1.33	7.12	3.47	12	4.00	125.68	122.00	126.17	122.49	128.75	126.00	A INLET TO BASI
2	1	19.4	0.08	0.08	0.99	0.08	0.08	10.0	10.0	6.4	0.51	0.55	2.59	6	0.98	125.87	125.68	126.37	126.25	130.00	128.75	ROOF TO A INLE

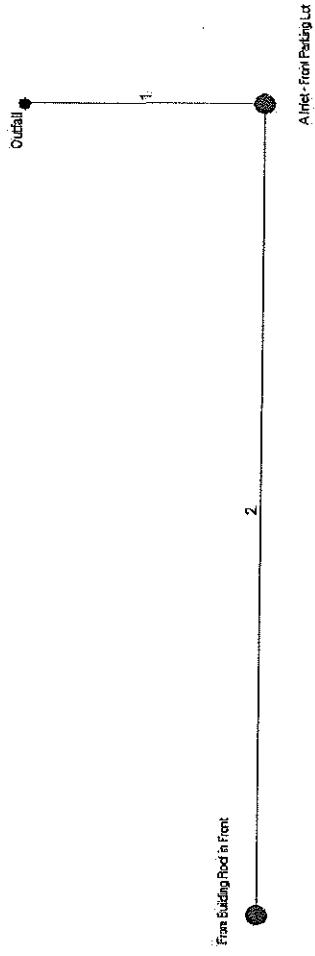
Project File: stormsewers pt1.stm

Number of lines: 2

Run Date: 05-14-2020

NOTES: Intensity = 125.35 / (Inlet time + 15.90) ^ 0.91; Return period = 25 Yrs.

# Hydraflow Plan View



382 Route 79

No. Lines: 2

05-14-2020

# Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	A INLET TO BASIN	1.10	15 c	44.0	122.00	124.20	5.000	122.42	124.62	n/a	124.62 j	End
2	ROOF TO A INLET	0.44	6 c	164.0	124.20	125.84	1.000	124.68	126.18	n/a	126.18 j	1
382 Route 79							Number of lines: 2			Run Date: 05-14-2020		
NOTES: c = cir; e = ellip; b = box; Return period = 25 Yrs. ; j - Line contains hyd. jump.												



# Storm Sewer Profile

