Van Cleef
ENGINEERING ASSOCIATES

Storm Sewer Calculations
and
Stormwater Management Report
Prepared for
Princeton Audi Service Center
Lot 64 in Block 34001
Montgomery Township
Somerset County, New Jersey

November 10, 2015

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I. Narrative

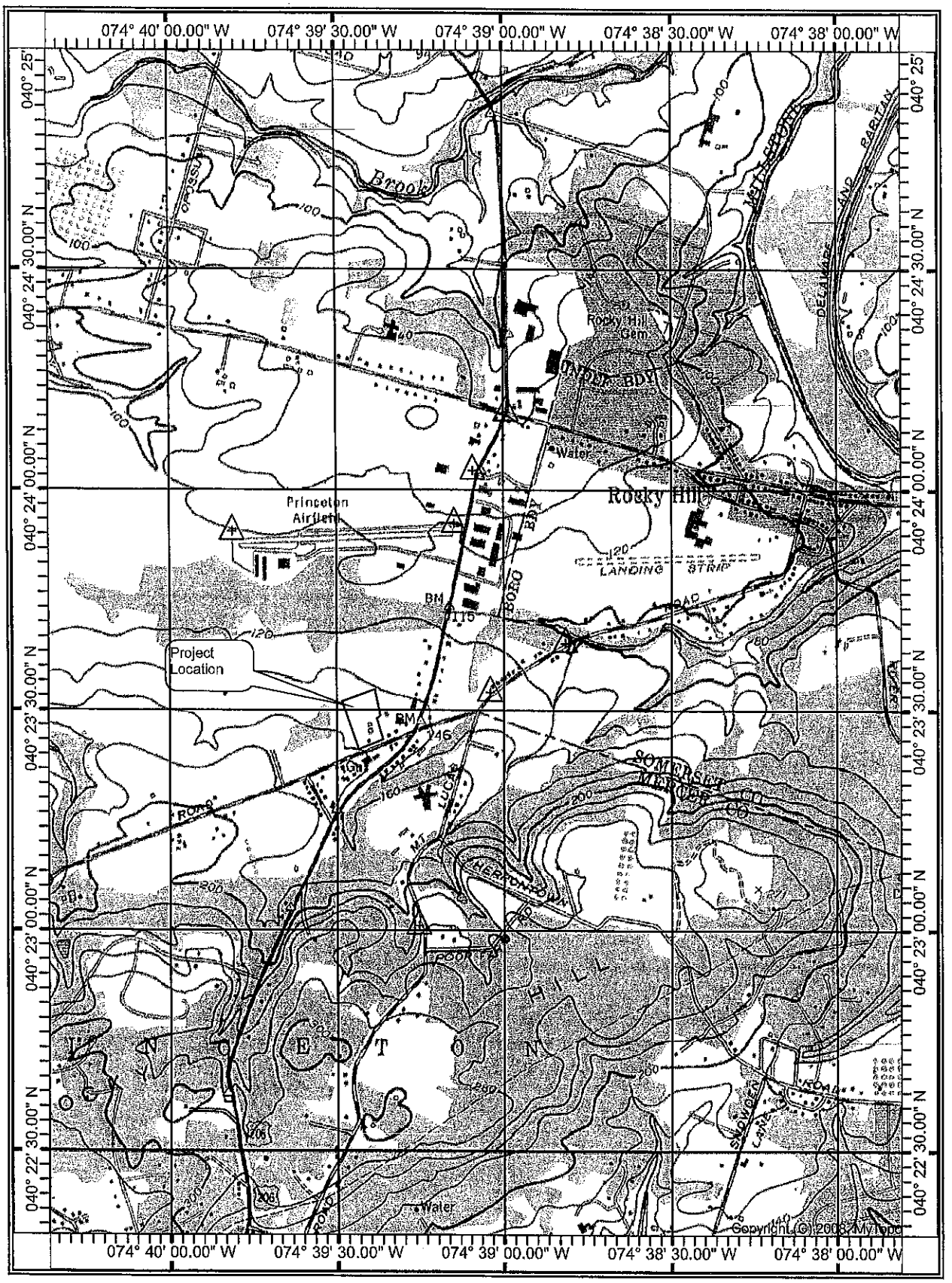
The purpose of this report is to provide supporting storm sewer and stormwater management calculations for Lot 64 in Block 34001, a proposed car service center located in Montgomery Township, Somerset County, New Jersey.

The property encompasses 13.6 acres and is located North of Cherry Valley Road, west of its intersection with State Highway Route U.S. 206.

The calculations presented in this report are based on the requirements set forth in the NJAC 7:8-2004 NJDEP Stormwater Regulations. This project meets NJDEP stormwater quantity, stormwater quality and groundwater recharge requirements.

The proposed project will consist of the construction of one car service facility building 48,900 sf, along with an appropriate parking facility.

The property is currently a mix of woods and open space with one residential house.



SCALE 1:24000

0 1000 2000 3000 4000 5000 6000 7000

FEET

Map Scale: 1:2,160 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

Map Unit Legend

Somerset County, New Jersey (NJ035)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CoxB	Croton silt loam, 2 to 6 percent slopes	0.1	0.4%
LemB	Lehigh silt loam, 2 to 6 percent slopes	1.3	9.4%
RehB	Reaville silt loam, 2 to 6 percent slopes	12.5	90.2%
Totals for Area of Interest		**13.9**	**100.0%**

II. Storm Sewer Calculations

A. Introduction

In order to comply with the requirements of the Residential Site Improvement Standards, Subchapter 7-Stormwater Management published January 6, 1997, our storm sewer design calculations for a proposed development were prepared using the Rational Method.

B. Rational Method

The rational method equation relates rainfall intensity, a runoff coefficient and the size of the watershed to the direct peak runoff rate. This relationship is expressed by the equation:

$$Q = CIA$$

where Q = The peak runoff rate in cubic feet per second at the point of concentration,
C = a coefficient representing the area-average ratio of runoff to rainfall rates,
I = the time-average rainfall intensity in inches per hour corresponding to the time of concentration,
A = the watershed area in acres.

The validity of the relationship expressed by the rational method equation holds true only if certain assumptions are reasonably correct. Three basic assumptions are:

a. The peak runoff rate occurs where all parts of the watershed are contributing to the runoff.

b. The design rainfall is uniform over the watershed tributary to the point of concentration and the intensity is essentially constant during the storm duration equal to the time of concentration.

c. Storm runoff contained within the pipe system is negligible when compared to the total runoff during the flow time in the pipe.

Determination of the runoff coefficient is based on proper evaluation of vegetation type, cover density, soil type, moisture content of the soil, ground slope of the watershed and surface storage. Therefore, any estimate of the runoff coefficient is subject to the thorough evaluation and may appreciably affect the estimate of the peak rate of runoff.

1. Runoff Coefficient

A uniform composite runoff coefficient that was used for majority drainage areas was developed as follows:

Impervious:	4.85 Acres	Runoff Coefficient:	.99
Lawn:	3.15Acres	Runoff Coefficient:	.51

$$\text{Composite } c = \frac{(4.85 \times 0.99) + (3.15 \times 0.51)}{8.0} = 0.80$$

Composite c =0 .80

2. Time of Concentration

The time of concentration can be defined as the time for runoff to travel from the most hydraulically distant point in the watershed to the study point. The time of concentration is assumed to coincide with the time at which the peak rainfall intensity occurs. It should be noted that the time of concentration has no relationship to the time of beginning of rainfall, being related rather to the position of the peak rainfall intensity within any given storm having a reoccurrence interval equal to the design frequency.

The time of concentration can be divided into three components: Sheet/overland, shallow concentrated and channel (or pipe) flow. The typical watershed may have one or more of these characteristics, depending upon the size, slope and type of surface or vegetation. Sheet or overland flow usually occurs over plane surfaces at the upper reaches of a drainage basin. Sheet flow is a function of the surface roughness along the flow path (i.e., assuming equal slopes, it takes longer for water to flow through a wooded area than through a lawn). After a maximum of 150 feet, sheet flow usually becomes shallow concentrated flow. This occurs where flow begins to concentrate to a depth of about an inch and is a function of the watercourse slope and the type of surface (unpaved or paved). Shallow concentrated flow usually lasts for 800 to 1,200 feet before becoming channel flow.

The time of concentration of 10 minutes was utilized in the design.

3. Rainfall Intensity

As per the Residential Site Improvement Standards and the Montgomery Township requirements, storm sewer network should be designed for 25-year storm frequency. However since the detention facilities are located underground they are designed for the 100 year storm.

4. Hydraulics

Pipes and/or conduits were designed using Mannings Equation:

$$Q = \frac{1.486}{n} A R^{2/3} A^{1/2}$$

where Q = Computed flow in the pipe in cubic feet per second,
A = pipe full flow area in square feet,
R = pipe full flow hydraulic radius in feet,
n = Mannings roughness coefficient,
s = friction slope in feet per foot.

Line	To Line	Line ID	Line Length	Incr. Area	Total Area	Runoff Coeff.	Incr C x A	Total C x A	Inlet Time	Time Conc	Rnfal Int	Total Runoff	Adnl Flow	Total Flow	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up
			(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)
1	Outfall	113-VAULT1	5.499	0.00	2.35	0.00	0.00	1.88	0.0	12.5	6.5	12.16	0.00	12.16	18.10	5.30	24	0.55	151.11	151.14	152.64	152.39
2	1	112-113	53.097	0.19	2.35	0.80	0.15	1.88	10.0	12.4	6.5	12.22	0.00	12.22	17.47	5.90	24	0.51	151.14	151.41	152.39	152.67
3	2	111-112	93.648	0.06	2.16	0.80	0.05	1.73	10.0	12.1	6.6	11.34	0.00	11.34	17.36	5.59	24	0.50	151.41	151.88	152.67	153.09
4	3	110-111	91.081	0.09	2.10	0.80	0.07	1.68	10.0	11.8	6.6	11.13	0.00	11.13	17.22	5.65	24	0.49	151.88	152.33	153.09	153.53
5	4	109-110	35.473	0.19	2.01	0.80	0.15	1.61	10.0	11.7	6.7	10.69	0.00	10.69	30.79	5.53	24	1.58	152.33	152.89	153.53	154.06
6	5	158-159	22.765	0.26	1.82	0.80	0.21	1.46	10.0	11.6	6.7	9.71	0.00	9.71	17.03	5.24	24	0.48	152.89	153.00	154.06	154.11
7	6	107-108	152.000	0.07	1.38	0.80	0.06	1.10	10.0	11.2	6.8	7.48	0.00	7.48	19.13	5.47	18	2.83	153.00	157.30	154.11	158.36
8	7	106-107	52.165	0.12	1.04	0.80	0.10	0.83	10.0	11.0	6.8	5.68	0.00	5.68	16.14	4.63	18	2.01	157.30	158.35	158.36	159.27
9	8	105-106	75.895	0.04	0.89	0.80	0.03	0.71	10.0	10.7	6.9	4.91	0.00	4.91	11.18	5.14	15	2.56	158.35	160.29	159.27	161.19
10	9	104-105	24.975	0.03	0.85	0.80	0.02	0.68	10.0	10.6	6.9	4.70	0.00	4.70	5.42	4.98	15	0.60	160.54	160.69	161.44	161.59
11	10	103-104	24.000	0.13	0.82	0.80	0.10	0.66	10.0	10.5	6.9	4.55	0.00	4.55	5.34	3.71	15	0.58	160.69	160.83	162.02	162.08
12	11	102-103	70.909	0.16	0.69	0.80	0.13	0.55	10.0	10.2	7.0	3.89	0.00	3.89	5.38	3.17	15	0.59	160.83	161.25	162.40	162.62
13	12	101-102	24.588	0.53	0.53	0.80	0.42	0.42	10.0	10.0	7.1	3.00	0.00	3.00	5.46	2.45	15	0.61	161.25	161.40	162.85	162.90
14	7	107A-107	20.301	0.07	0.27	0.80	0.06	0.22	10.0	10.5	7.0	1.50	0.00	1.50	9.94	2.60	15	2.02	157.55	157.96	158.36	158.44
15	14	107B-107A	24.164	0.09	0.20	0.80	0.07	0.16	10.0	10.3	7.0	1.12	0.00	1.12	9.86	2.84	15	1.99	157.96	158.44	158.44	158.86
16	15	107C-107B	45.137	0.11	0.11	0.80	0.09	0.09	10.0	10.0	7.1	0.62	0.00	0.62	9.88	2.20	15	1.99	158.44	159.34	158.86	159.65
17	8	106A-106	30.115	0.03	0.03	0.80	0.02	0.02	10.0	10.0	7.1	0.17	0.00	0.17	5.41	1.03	15	0.60	158.35	158.53	159.27	158.69
18	6	108A-108	30.416	0.07	0.18	0.80	0.06	0.14	10.0	10.2	7.0	1.01	0.00	1.01	4.91	3.10	15	0.49	154.00	154.15	154.39	154.55
19	18	108B-108A	21.400	0.11	0.11	0.80	0.09	0.09	10.0	10.0	7.1	0.62	0.00	0.62	5.02	2.26	15	0.51	154.15	154.26	154.55	154.57
20	Outfall	207-VAULT2	5.007	0.00	1.43	0.00	0.00	1.14	0.0	12.1	6.6	7.51	0.00	7.51	21.90	3.84	24	0.80	151.21	151.25	152.85	152.22
21	20	206-207	60.022	0.07	1.43	0.80	0.06	1.14	10.0	11.9	6.6	7.56	0.00	7.56	36.88	4.97	24	2.27	151.25	152.61	152.22	153.59
22	21	205-206	112.400	0.06	0.84	0.80	0.05	0.67	10.0	11.6	6.7	4.49	0.00	4.49	19.07	6.71	18	2.81	153.11	156.27	153.61	157.08
23	22	204-205	54.062	0.00	0.61	0.00	0.00	0.49	0.0	11.4	6.7	3.28	0.00	3.28	17.84	4.78	18	2.46	156.52	157.85	157.08	158.54
24	23	203-204	40.223	0.04	0.38	0.80	0.03	0.30	10.0	11.3	6.8	2.05	0.00	2.05	9.87	4.25	15	1.99	158.06	158.86	158.54	159.43
25	24	202-203	52.894	0.20	0.34	0.80	0.16	0.27	10.0	11.0	6.8	1.86	0.00	1.86	6.08	3.52	15	0.76	158.86	159.26	159.43	159.80
26	25	201-202	132.376	0.14	0.14	0.80	0.11	0.11	10.0	10.0	7.1	0.79	0.00	0.79	6.99	2.20	15	1.00	159.26	160.58	159.80	160.93
27	23	204A-204	24.770	0.23	0.23	0.80	0.18	0.18	10.0	10.0	7.1	1.30	0.00	1.30	4.87	3.14	15	0.48	158.06	158.18	158.54	158.63
28	22	205A-205	83.419	0.17	0.17	0.80	0.14	0.14	10.0	10.0	7.1	0.96	0.00	0.96	9.90	2.42	15	2.00	156.53	158.20	157.08	158.59
29	21	Pipe - (192)	26.043	0.08	0.45	0.80	0.06	0.36	10.0	10.2	7.0	2.53	0.00	2.53	9.89	5.38	15	2.00	153.36	153.88	153.79	154.52
30	29	Pipe - (193)	49.211	0.37	0.37	0.80	0.30	0.30	10.0	10.0	7.1	2.10	0.00	2.10	9.87	3.56	15	1.99	153.88	154.86	154.52	155.44
31	21	206C-206	49.100	0.07	0.07	0.80	0.06	0.06	10.0	10.0	7.1	0.40	0.00	0.40	9.88	2.48	15	2.00	153.36	154.34	153.59	154.58
32	Outfall	403-400	78.244	0.00	0.00	0.00	0.00	0.00	0.0	0.5	0.0	0.00	0.00	26.73	80.52	9.33	24	10.80	139.00	147.45	140.64	149.25
33	32	402-403	141.853	0.00	0.00	0.00	0.00	0.00	0.0	0.2	0.0	0.00	0.00	26.73	44.46	8.97	24	3.29	147.45	152.12	149.25	153.92
34	33	401-402	124.824	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	26.73	26.73	30.07	8.97	24	1.51	152.12	154.00	153.92	155.80
35	Outfall	302-GWRF	15.000	0.00	1.15	0.00	0.00	1.14	0.0	10.6	6.9	7.88	0.00	7.88	28.29	3.94	24	1.33	150.28	150.48	151.92	151.48

Line	To Line	Line ID	Line Length	Incr. Area	Total Area	Runoff Coeff.	Incr C x A	Total C x A	Inlet Time	Time Conc	Rnfal Int	Total Runoff	Adnl Flow	Total Flow	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up
			(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)
36	35	301-302	183.387	1.15	1.15	0.99	1.14	1.14	10.0	10.0	7.1	8.06	0.00	8.06	28.72	5.11	24	1.37	150.48	153.00	151.48	154.01
37	Outfall	DD-500	35.463	0.00	1.91	0.00	0.00	1.53	0.0	11.2	6.8	10.36	0.00	10.36	48.16	4.64	24	3.86	139.00	140.37	140.64	141.52
38	37	504-DD UNIT	5.303	0.17	1.91	0.80	0.14	1.53	10.0	11.1	6.8	10.37	0.00	10.37	38.37	5.53	24	2.45	140.37	140.50	141.52	141.65
39	38	503-504	84.027	0.22	1.38	0.80	0.18	1.10	10.0	10.8	6.9	7.58	0.00	7.58	42.43	4.50	24	3.00	140.50	143.02	141.65	144.00
40	39	502-503	92.660	0.11	0.35	0.80	0.09	0.28	10.0	10.4	7.0	1.95	0.00	1.95	31.16	3.78	18	7.50	143.52	150.47	144.00	151.00
41	40	501-502	72.659	0.24	0.24	0.80	0.19	0.19	10.0	10.0	7.1	1.36	0.00	1.36	19.71	2.82	18	3.00	150.47	152.65	151.00	153.09
42	38	504A-504	51.490	0.17	0.36	0.80	0.14	0.29	10.0	10.9	6.8	1.97	0.00	1.97	22.75	5.72	18	4.00	144.25	146.31	144.55	146.84
43	42	504B-504A	69.890	0.00	0.19	0.00	0.00	0.15	0.0	10.4	7.0	1.06	0.00	1.06	22.77	2.43	18	4.01	146.31	149.11	146.84	149.49
44	43	504C-504B	74.771	0.19	0.19	0.80	0.15	0.15	10.0	10.0	7.1	1.08	0.00	1.08	22.75	3.00	18	4.00	149.11	152.10	149.49	152.49
45	39	503A-503	163.475	0.61	0.81	0.80	0.49	0.65	10.0	10.2	7.0	4.55	0.00	4.55	9.87	5.04	18	0.75	143.52	144.75	144.24	145.57
46	45	503B-503A	30.000	0.20	0.20	0.80	0.16	0.16	10.0	10.0	7.1	1.13	0.00	1.13	9.74	2.09	18	0.73	144.75	144.97	145.57	145.37
47	Outfall	601-600	144.930	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.0	0.00	0.00	19.82	33.01	5.61	30	0.55	137.00	137.80	138.95	139.31
48	47	OS1-601	38.107	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	19.82	19.82	32.19	6.40	30	0.52	137.80	138.00	139.31	139.51

Line	Grnd/Rim Dn	Grnd/Rim Up
	(ft)	(ft)
1	0.00	160.00
2	160.00	158.80
3	158.80	162.50
4	162.50	156.50
5	156.50	157.00
6	157.00	156.97
7	156.97	161.17
8	161.17	162.62
9	162.62	164.44
10	164.44	164.83
11	164.83	165.13
12	165.13	165.70
13	165.70	165.40
14	161.17	162.40
15	162.40	162.40
16	162.40	164.35
17	162.62	162.62
18	156.97	156.97
19	156.97	156.71
20	0.00	160.00
21	160.00	161.30
22	161.30	164.25
23	164.25	164.20
24	164.20	164.60
25	164.60	164.00
26	164.00	164.58
27	164.20	161.00
28	164.25	164.00
29	161.30	161.25
30	161.25	160.00
31	161.30	161.60
32	141.56	152.51
33	152.51	157.81
34	157.81	160.00
35	0.00	160.00

Line	Grnd/Rim Dn	Grnd/Rim Up
	(ft)	(ft)
36	160.00	165.50
37	141.04	148.00
38	148.00	150.00
39	150.00	150.70
40	150.70	154.00
41	154.00	157.00
42	150.00	151.35
43	151.35	153.50
44	153.50	157.00
45	150.70	148.20
46	148.20	148.20
47	140.08	143.41
48	143.41	144.10

III. Stormwater Management Study - General System Design

In order to evaluate the impact of the proposed improvements on the runoff from the site and the use of the detention basin to control it, a procedure based upon the USDA Soil Conservation Service (SCS), TR-20 Method was chosen.

A. Procedures

The SCS methods developed in TR-20 model the drainage shed's response to rainfall in the form of an excess rainfall (runoff) hydrograph. A drainage shed's response is dependent upon the individual parameters which affect runoff. These parameters include:

1. Storm rainfall amount
2. Watershed size and shape
3. Hydrologic soils group
4. Land use and treatment classification
5. Time of concentration

VCEA has used a computer program developed by Intelisolve, Hydraflow, Version 6.0. The program is modeled after the Soil Conservation Service, US Department of Agriculture TR-20 Program and makes use of the Soil Conservation Service "Soil-Cover Complex" method for developing excess rainfall (runoff). All excess rainfall is then converted to stormwater runoff by use of the SCS Standard Synthetic Triangular Unit Hydrograph.

B. Criteria

1. Rainfall

The total duration of a storm is used in estimating the runoff hydrograph. Two storm patterns are available:

- Short duration storms of less than 24-hours duration are assumed to produce an average intensity rainfall for the duration of the storm.

- For storms of 24-hours duration or longer, the most intense rainfall is centered around the middle of the one-day storm, additional one-day storms are taken to maintain the same pattern at greater or lesser rates as determined by the user.

The total maximum accumulative rainfall always equals the rainfall frequency values established for the study area. For this study a Type III 24-hour rainfall distribution was used.

2. Design Frequencies

Rainfalls for the 2, 10 and 100-year frequency design storms were used to analyze the peak rates and runoff characteristics for the drainage sheds.

24-hour rainfall data has been interpreted from "Urban Hydrology for Small Watersheds (TR-55), USDA Soil Conservation Service, June 1986" and distributed by Rutgers -The State University of New Jersey, Cook College in tabular form.

For Somerset County, New Jersey these 24-hour rainfall amounts are as follows:

2-years	=	3.3 inches
10-years	=	5.0 inches
100-years	=	8.2 inches

3. Time of Concentration

Times of concentration used in detention basins routings are that of storm sewer headwalls discharging into basins.

4. Runoff Curve Number

The SCS Runoff Curve Number (CN) are computed based upon procedures established in TR-55, Chapter 2: Estimating Runoff. To develop an inflow hydrograph to a reservoir, composite pervious CN values are computed using TR-55 procedures. The impervious surfaces are assigned a CN value of 98.

C. Hydrograph Generation

1. Stormwater Runoff

a. Hydrologic Analysis

In order to calculate the direct runoff hydrograph, an excess precipitation hyetograph is needed. Hydraflow offers different ways in which the design storm can be specified. Most of which are the SCS 24 hour distributions. Other options include the Synthetic Storm and the Custom Storm that can be input directly.

Hydraflow will provide the 24-hour distributions in any time interval specified. The incremental rainfall amounts are computed from a polynomial equation. This equation is used with coefficients that vary depending on the elapsed time of the storm.

b. Excess Precipitation Hyetograph

The precipitation increments of the specified storm are converted to excess precipitation by use of the following equation:

$Q = (P - 0.2 \times S)^2/P+0.8 \times S$

Q = excess volume of precipitation in inches,
P = accumulated precipitation in inches,
S = potential maximum retention; equals 100/CN-10,
CN = SCS curve number.

The computed volumes are then converted to excess increments. These excess increments are then used for the final excess precipitation hyetograph.

c. SCS Unit Hydrograph

Hydraflow uses the Unit Hydrograph Method for calculating runoff hydrographs. More specifically, it uses the triangular D-hour Unit Hydrograph approach. The peak discharge for the unit graph is computed using the following equation:

$Qp = 484 \times A \times Q/Tp$

Qp = peak outflow in cfs,
A = area in square miles,
Q = total excess precipitation (1 inch),
Tp = time to peak in hours.

The shape factor is a user definable variable. The default value is set to 484. The time to peak, Tp and the time base, Tb are what determines the characteristics of the unit hydrograph. Hydraflow computes these values using the following relationships:

$Tp = (Tc + D)/1.7$

Tp = time to peak in hours,
Tc = time of concentration in hours,
D = unit duration or time interval in hours,
Tc = 1.67 x Lag Time (L).

$L = 1^{0.8} \times (S+1)^{0.7}/1900 \times Y^{0.5}$

L = lag time in hours,
I = hydraulic length in feet,
S = 1000/CN-10,
Y = basin slope in %,
CN = SCS curve number.

Time Base: Tb = 2.67 x Tp

Tb = time base in hours,
Tp = time to peak in hours.

2. S.C.S. Runoff Hydrographs

After computing the excess precipitation hyetograph, Hydraflow computes the direct runoff hydrograph using the concept of convolution of linear superpositioning. Each increment of the design storm hyetograph is multiplied by each ordinate of the unit hydrograph. The resulting hydrographs are then added or superimposed to obtain a final runoff hydrograph.

D. Detention Pond Routing

1. Flow Calculations

Hydraflow can model up to 6 outlet structures at once for use in reservoir routing. The operation of these structures is treated as a function of the water surface elevation in the reservoir.

Culverts/Orifices

The equation used for culvert/orifice structures is:

$Q = CoA[2gh/k]^{0.5}Nb$

Inlet Control
Q = discharge in cfs,
A = culvert area in square feet,
h = distance between the water surface and the center of the culvert barrel in feet,
Nb = number of barrels,
Co = orifice coefficient = 0.6.
k = 1

Outlet Control

Q = discharge in cfs,
A = culvert area in square feet,
h = distance between upstream and downstream water surface,
Nb = number of barrels,
Co = 1,
k = $1.5 + (29n^{2L})/R^{1.33}$,
n = Manning's n-value,
L = culvert length in feet,
R = area/wetted perimeter in feet.

Note: When a non-zero tail water (TW) elevation has been entered, Hydraflow compares the pond stage with TW and computes a tail water head, hTW. If this head is less than the head computed as above (h), then h = hTW.

During the calculation process, both inlet and outlet control are evaluated. Under inlet control, the discharge depends on the barrel shape, cross-sectional area and inlet edge. Under outlet control, the discharge depends on the slope, length and roughness of the barrel.

Hydraflow computes the discharge at each stage, including intermediate stage points that it generates, using both inlet and outlet control equation parameters. The smallest value is used as the discharge at that elevation.

Weirs

The equation used to calculate weir flow is:

$Q = Cw\ LH^{EXP}$,

Q = discharge over weir in cfs,
L = length of the weir crest; equals 1 for V-notch weirs,
H = distance between the water surface and the crest in feet,
Cw = weir coefficient,
EXP = exponent = 1.5; equals 2.5 for V-notch weirs.

2. Reservoir Routing

The routing procedure used by Hydraflow is known as the Storage Indication Method and begins with a stage/storage/discharge relationship, an inflow hydrograph and the following relationship:

I-O = ds/dt

I = inflow
O = outflow
ds/dt = change in storage

The outflow hydrograph and elevation are printed at multiples of the main increment and at the peak discharge.

3. Summation of Hydrographs

Each hydrograph is converted by the program to a common time frame set by the user. The program adds the resultant runoff values for each time period, taking into account any preset lag time for each hydrograph.

IV. Stormwater Management Study - Existing Condition

A. Description

The property encompasses 13.6 acres and is located North of Cherry Valley Road, west of its intersection with State Highway Route U.S. 206.

The existing topography of the site could be described as mildly sloping from southwest to northeast. The surface elevations range from a low of approximately 136 to a high of 170 near the existing house. The existing area drains towards the northeastern side of the site and into an existing wetland and swale, then ultimately into a tributary of Van Horn Brook. The property is currently a mix of woods and open space with one residential house.

Summary Table - Existing Conditions						
Subwatershed Characteristics				**Peak Flow Rates (CFS)**		
Name	**Area (Acres)**	**TC (Minutes)**	**CN**	**Q2**	**Q10**	**Q100**
Area 1	8.0	22	72	5.5	13.12	29.5

Legend: TC = Time of Concentration
CN = Curve Number
Q-1 through 100 = Peak Flow Rates from 1-through 100-Year Storm

Worksheet 2: Runoff curve number and runoff

Project
Location Montgomery Twp, NJ
Select One: Undeveloped
Area Name Area 1

By CRA Date 9/28/2015
Checked Date

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
C	Woods Good Condition	70			3.9	273
C	Open Space Good Condition	74			4.1	303.4
						0
						0
						0
						0
				Totals	8	576.4

CN (weighted) = total product/ total area= 576.4 / 8

Use CN = 72.1

Worksheet 3: Time of Concentration (Tc) or Travel Time (Tt)

Project _____ By CRA Date 9/28/2015

Location Montgomery Twp, NJ Checked _____ Date _____

Select One: Pre Developed

Select One: Tc

Area Name Area 1

Notes: Space for as many as two segements per flow type can be used for each worksheet
Include a Map, schematic, or description of flow segments

Sheet Flow (Applicable to Tc only)			Segment ID	A-B		
1	Surface Description (table 3-1)			grass		
2	Mannings Roughness Coeff.,n (table 3-1)			0.2		
3	Flow Length, L (total L < 300 ft)		ft	150		
4	Two-yr 24-hr rainfall, P_2		in	3.3		
5	land slope, s		ft/ft	0.027		
6	$T_t=(0.007*(nL)^{0.8}/((P_2^{0.5})*(s^{0.4}))$	Compute T_t	hr	0.25		0.25

Shallow Concentrated Flow			Segment ID	B-C		
7	Surface Description (paved or unpaved)			Unpaved		
8	Flow Length, L		ft	915		
9	Watercourse Slope, s		ft/ft	0.029		
10	Average velocity, V (figure 3-1)		ft/s	2.2		
11	$T_t = L/(3600*V)$	Compute Tt	hr	0.12		0.12

Channel Flow			Segment ID			
12	Cross sectional flow area, a		ft^2			
13	Wetted Perimeter, Pw		ft			
14	Hydraulic Radius, r=a/Pw Compute r		ft			
15	Channel Slope, s		ft/ft			
16	Mannings roughness Coeff., n					
17	$V = 1.49(r^{(2/3)})*(s^{(1/2)})/n$	Compute V	ft/s		Assumed	
18	Flow Length, L		ft			
19	$T_t = L/(3600*V)$	Compute Tt	hr			0.00
20	Water shed or Subarea Tc or Tt (add Tt in steps 6, 11,19)		hr			0.36
			min			21.83

V. Stormwater Management Study - Proposed Conditions

A. Description

In order to comply with the NJAC 7:8-2004 NJDEP Stormwater Regulations, an extended detention facility along with a manufactured treatment device is proposed to handle the increased runoff from the improved areas.

The system will discharge to a wetlands area located at the Northeast corner of the site.

In order to generate the peak flow rates from the entire project routed hydrographs and the hydrographs of the undetained portions of the site were summed up in the common time frame.

Summary Table - Proposed Conditions						
Subwatershed Characteristics				**Peak Flow Rates (CFS/Peak Water Surface Elevations**		
Name	**Area (AC)**	**TC (Min)**	**CN**	**Q2/WSE**	**Q10/WSE**	**Q100/WSE**
Area 1 – Pervious Detain.	2.94	10	74	2.67	5.94	12.79
Area 1 – Impervious Detain	4.71	10	98	10.94	16.69	27.47
Area 1-Detention Basin	7.65	-	-	1.29 / 141.29	6.61 / 142.26	19.82 / 143.71
Area 2 – Bypass	0.35	10	84	0.40	0.77	1.49
Site Total	8.0	--	--	1.33	6.85	20.50

Legend: TC = Time of Concentration
CN = Curve Number
Q-1 through 100 = Peak Flow Rates from 1-through 100-Year Storm
WSE-1 through 100 = Water Surface Elevations From 1 through 100-Year Storm

Worksheet 2: Runoff curve number and runoff

Project
Location Montgomery Twp, NJ
Select One: developed
Area Name Area 1 - Pervious Detained

By CRA Date 9/28/2015
Checked Date

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
C	Open Space Good Condition	74			2.94	217.56
						0
						0
						0
						0
						0
				Totals	2.94	217.56

CN (weighted) = total product/ total area= $\frac{217.56}{2.94}$

Use CN = 74.0

Worksheet 2: Runoff curve number and runoff

Project _____ By CRA Date 9/28/2015

Location Montgomery Twp, NJ Checked _____ Date _____

Select One: developed

Area Name Area 1 - Impervious Detained

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
C	Building	98			1.12	109.76
C	Parking Lot and Road	98			3.44	337.12
C	Sidewalk	98			0.15	14.7
						0
						0
						0
				Totals	4.71	461.58

CN (weighted) = total product/ total area= 461.58 / 4.71

Use CN = 98.0

Worksheet 2: Runoff curve number and runoff

Project
Location Montgomery Twp, NJ
Select One: developed
Area Name Area 2 - Bypass

By CRA Date 9/28/2015
Checked Date

1. Runoff Curve Number

Names	Cover Description	CN			Area	Product
Soil Name and Hydrologic Group (appendix A)	(cover type, treatment, and hydrologic condition; percent impervious; unconnected/ connected area ratio)	Tab 2-2	Fig 2-3	Fig 2-4	acres miles %	CN x area
C	Road	98			0.14	13.72
C	Open Space Good Condition	74			0.21	15.54
						0
						0
						0
						0
						0
				Totals	0.35	29.26

CN (weighted) = total product/ total area= 29.26 / 0.35

Use CN = 83.6

E. Water Quality

In order to comply with the water quality requirements set in the N.J.A.C. 7:8 -5.5, post construction load of total suspended solids (TSS) in stormwater runoff generated from the water quality design storm must be reduced by 80 percent.

This will be accomplished by the use of multiple manufactured treatment devices and an extended detention basin.

Soil percolation testing within the basin was not acceptable. The use of an underground Groundwater Recharge Facility, in the only location on site with passing percolation rates, is proposed. Two manufactured treatment devices are utilized to provided 80% TSS removal prior to stormwater entering the Groundwater Recharge Facility. The parking lot located at the northern end of the site will utilize a manufactured treatment device and an extended detention basin to achieve 80%TSS removal. Please see the appendix for design calculations.

Groundwater Recharge

The groundwater recharge amount was calculated using the NJDEP GSR-32 Spreadsheet. (See Appendix for Spreadsheet Calculations). The stone bed which the underground detention system is built upon, for the roof area, provides groundwater recharge by infiltrating more than 100 percent of the Annual Recharge Deficit.

Recharge Area

The Post Development Annual Recharge Deficit	223,548 cf
Required Min BMP/Recharge Volume	4,562 cf
Proposed BMP/Recharge Volume	4,635 cf
Design Permeability	0.7 in/hr
Min.Infiltration Rate	0.2 in/hr

F. Comparison of Existing Peak Flow Rates Versus Proposed Peak Flow Rates at Point of Study

Storm Frequency	Existing Flows (cfs)	Required Reduction	Allowable Flows(cfs)	Proposed Flows (cfs)
2	5.5	50%	2.5	1.33
10	13.12	75%	9.84	6.85
100	29.50	80%	23.6	20.50

Conclusion

The proposed development will generate less quantity of runoff than previously existing conditions. The site closely mirrors existing condition discharge patterns. Accordingly, the new development will not negatively impact runoff on-site or downstream.

All engineering calculations and their associated drainage area maps are incorporated in the appendix for further review.

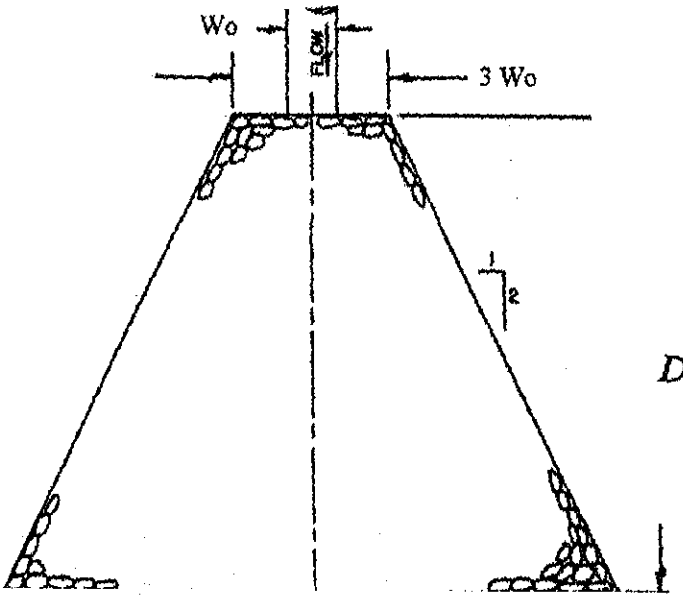
A. Conduit Outlet Protection

RIPRAP APRON DATA SHEET

PROJECT NAME: Princeton Audi
STORM FREQENCIES:

TRG #: 01-42-M-A
DATE: 2-Nov-15
REV:
BY:

OUTLET STRUCT.	YEAR STORM	Q (cfs)	PIPE HEIGHT (in)	PIPE WIDTH (in)	TAILWATER (ft)	La (ft)	W (beg) (ft)	W (end) (ft)	d50 (in)
FES 600	**100**	**19.82**	**30**	**30**	**0.50**	**26.5**	**7.5**	**34.0**	**6.0**



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

TW < ½ D_o

$$W = 3\ W_o + L_a$$

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

where $q = Q/D_o$

Tailwater > .5 Do

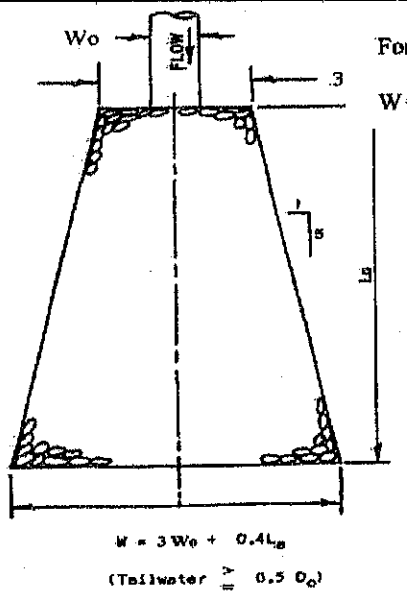
RIPRAP APRON DATA SHEET

PROJECT NAME: Princeton Audi | Job #: 11/12/2015

STORM FREQENCIES: 25 year storm | DATE:

BY:

OUTLET STRUCT.	YEAR STORM	Q (cfs)	PIPE HEIGHT (in)	PIPE WIDTH (in)	TAILWATER (ft)	La (ft)	W (beg) (ft)	W (end) (ft)	d50 (in)
FES-400	25	**26.73**	24	24	0.40	**28.4**	**6.0**	**17.3**	**15.1**
FES-500	25	**10.36**	24	24	0.40	**11.0**	**6.0**	**10.4**	**4.3**



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

$W = 3\ W_o + 0.4\ L_a$

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

TW > ½ D_o

TW = 0.2 D_o

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

where q = Q/D_o

B. Emergency Spillway Design

A spillway design for the proposed detention basins is based on the 100 year storm with the primary outlet structure not functioning.

Detention Basin 1

100 year storm water surface elevation = 144.17
Elevation of the spillway = 143.75

$Q = CLH^{3/2} =$
$= 2.64 \times 35 \times 0.42^{3/2} =$ 25.15 cfs

$v = \frac{Q}{A} = \frac{25.15}{14.7} =$ 1.71 fps

$(v,allowable = 3F_{ps})$

H = depth of flow = 0.42ft
C = coefficient = 2.64
L = length of spillway = 35 ft
A = area of flow = 34 x 0.42 = 14.7 sf

The spillway is stable.

Appendices

1. Computer Output

A. Reservoirs Report
B. 2-Year Storm Frequency
C. 10-Year Storm Frequency
D. 100-Year Storm Frequency
E. Water Quality Calculations & Soil Testing Data
F. Groundwater Recharge
G. Drainage Area Plans

Appendix A

Reservoir Reports

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Thursday, 11 / 5 / 2015

Pond No. 3 - Extended Detention Basin

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 138.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	138.00	00	0	0
1.00	139.00	11,400	5,700	5,700
2.00	140.00	12,800	12,100	17,800
4.00	142.00	15,820	28,620	46,420
6.00	144.00	19,090	34,910	81,330
7.00	145.00	20,780	19,935	101,265

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 30.00	2.50	0.00	0.00
Span (in)	= 30.00	2.50	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 138.00	138.00	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	Yes	No	No

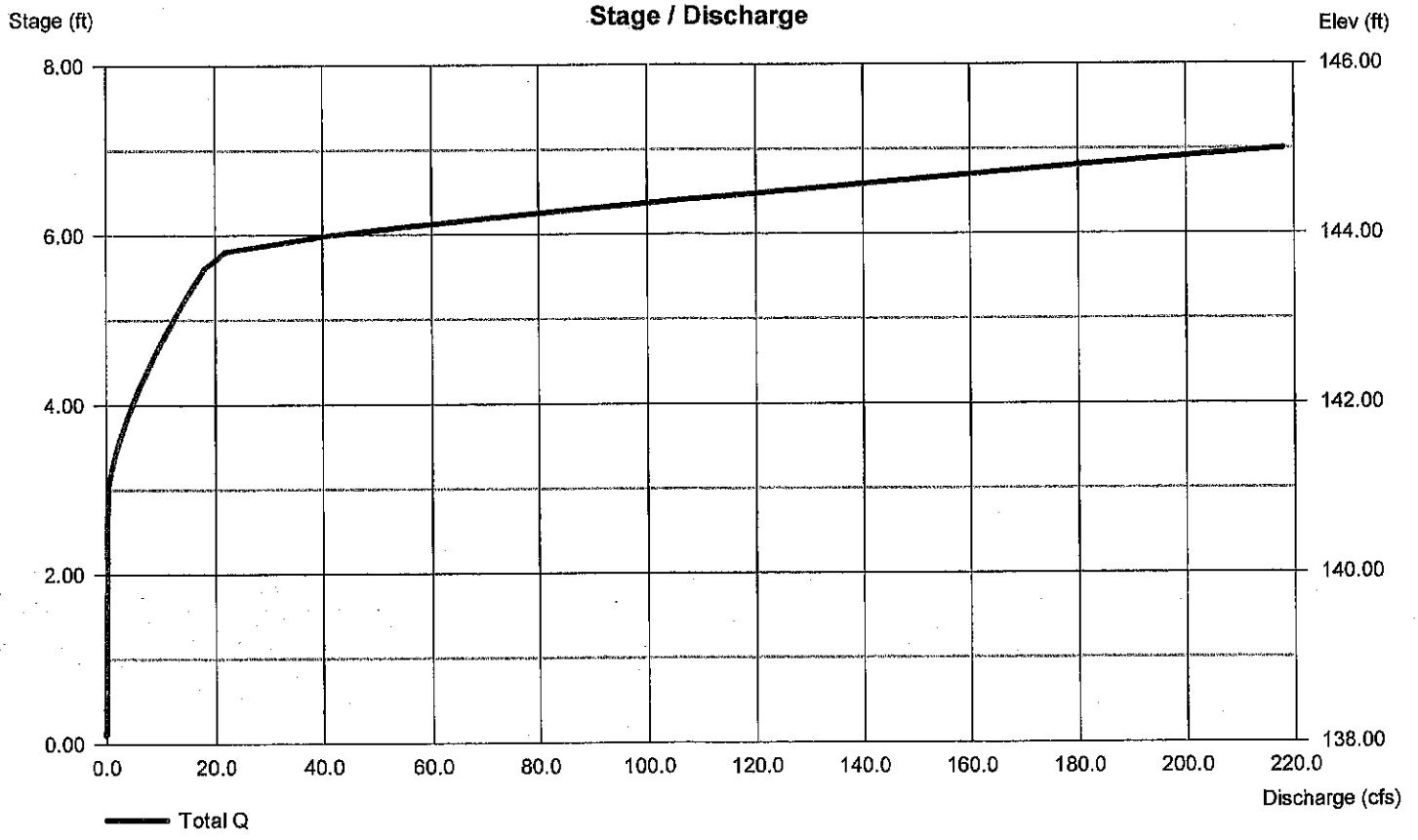
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 13.50	1.20	35.00	0.00
Crest El. (ft)	= 143.75	140.90	143.75	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	Rect	---
Multi-Stage	= Yes	Yes	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).



Appendix B

2-Year Storm Frequency

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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	5.515	5	735	28,815	------	------	------	Ex Area (Disturbed Post Dev)
3	SCS Runoff	10.94	5	730	49,162	------	------	------	Post Development Impervious Area
4	SCS Runoff	2.665	5	730	11,045	------	------	------	Post Development Area 1 Pervious
5	Combine	13.61	5	730	60,207	3, 4	------	------	Post Development
6	Reservoir	1.286	5	810	60,175	5	141.29	36,305	Area 1 Detained
7	SCS Runoff	0.397	5	730	1,581	------	------	------	Area 2 Bypass
8	Combine	1.330	5	810	61,755	6, 7	------	------	Post Development Conditions

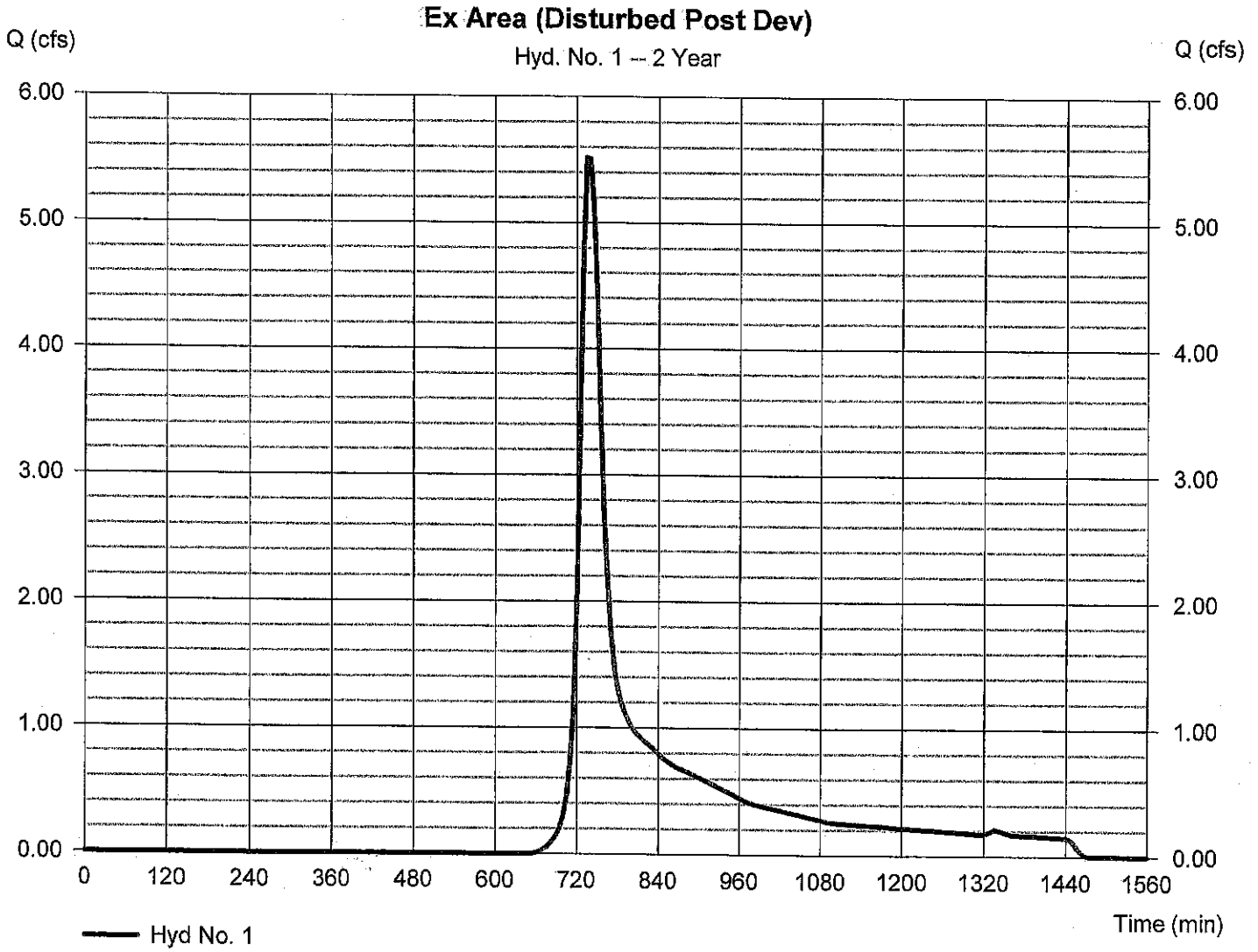
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Thursday, 11 / 5 / 2015

Hyd. No. 1

Ex Area (Disturbed Post Dev)

Hydrograph type	= SCS Runoff	Peak discharge	= 5.515 cfs
Storm frequency	= 2 yrs	Time to peak	= 735 min
Time interval	= 5 min	Hyd. volume	= 28,815 cuft
Drainage area	= 8.000 ac	Curve number	= 72
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



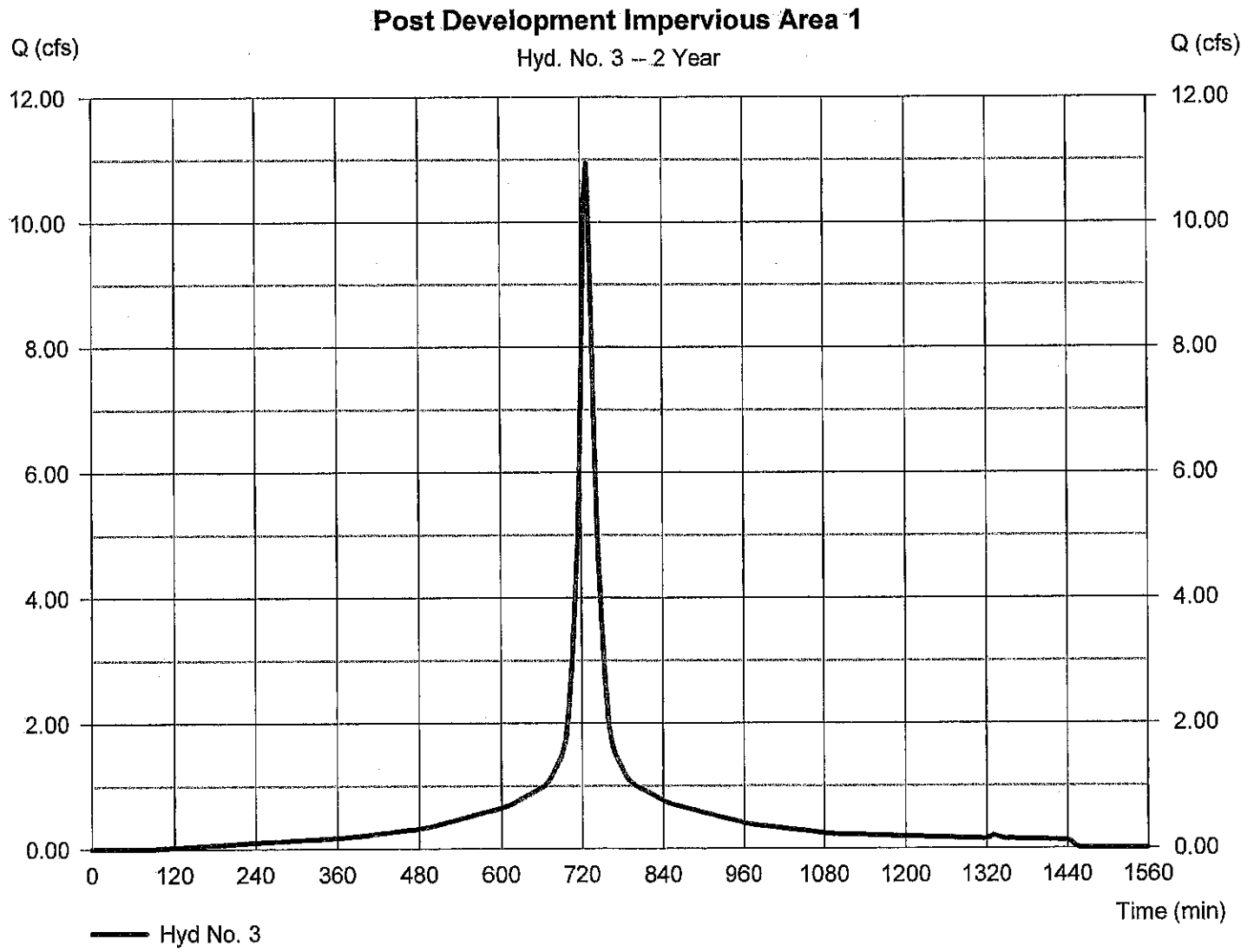
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 11 / 5 / 2015

Hyd. No. 3

Post Development Impervious Area 1

Hydrograph type	= SCS Runoff	Peak discharge	= 10.94 cfs
Storm frequency	= 2 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 49,162 cuft
Drainage area	= 4.710 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

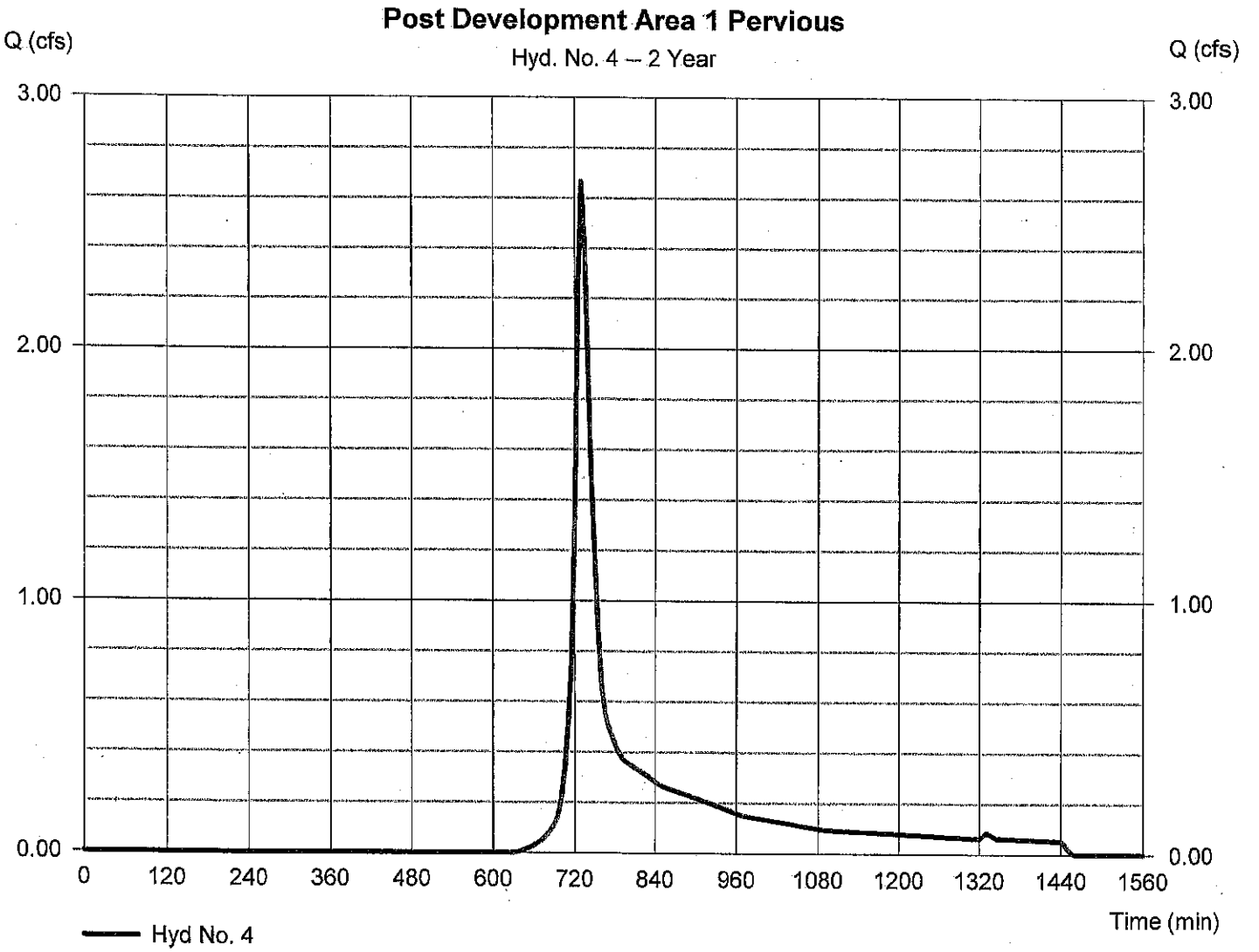


Hydrograph Report

Hyd. No. 4

Post Development Area 1 Pervious

Hydrograph type	= SCS Runoff	Peak discharge	= 2.665 cfs
Storm frequency	= 2 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 11,045 cuft
Drainage area	= 2.940 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



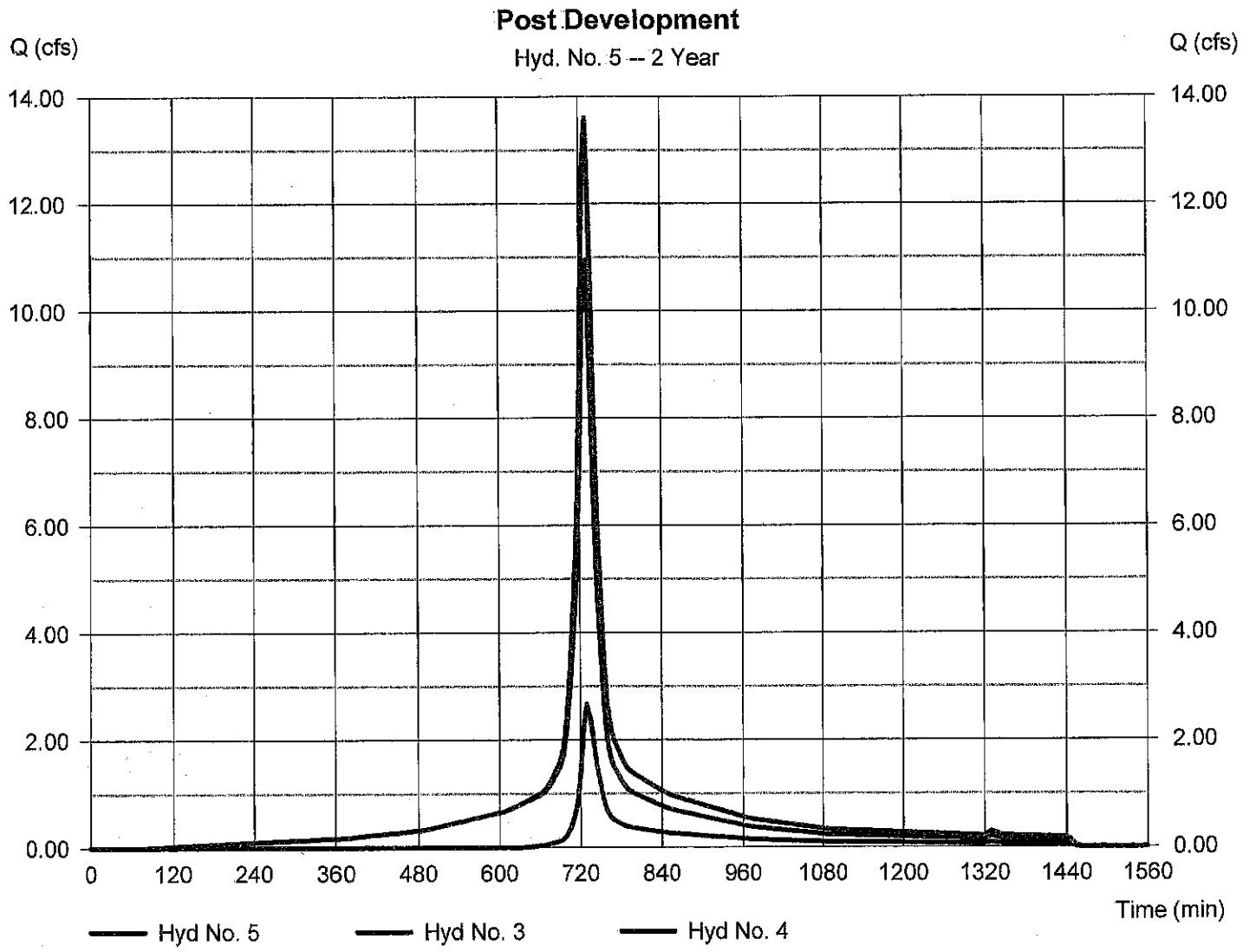
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 11 / 5 /.2015

Hyd. No. 5

Post Development

Hydrograph type	= Combine	Peak discharge	= 13.61 cfs
Storm frequency	= 2 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 60,207 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 7.650 ac



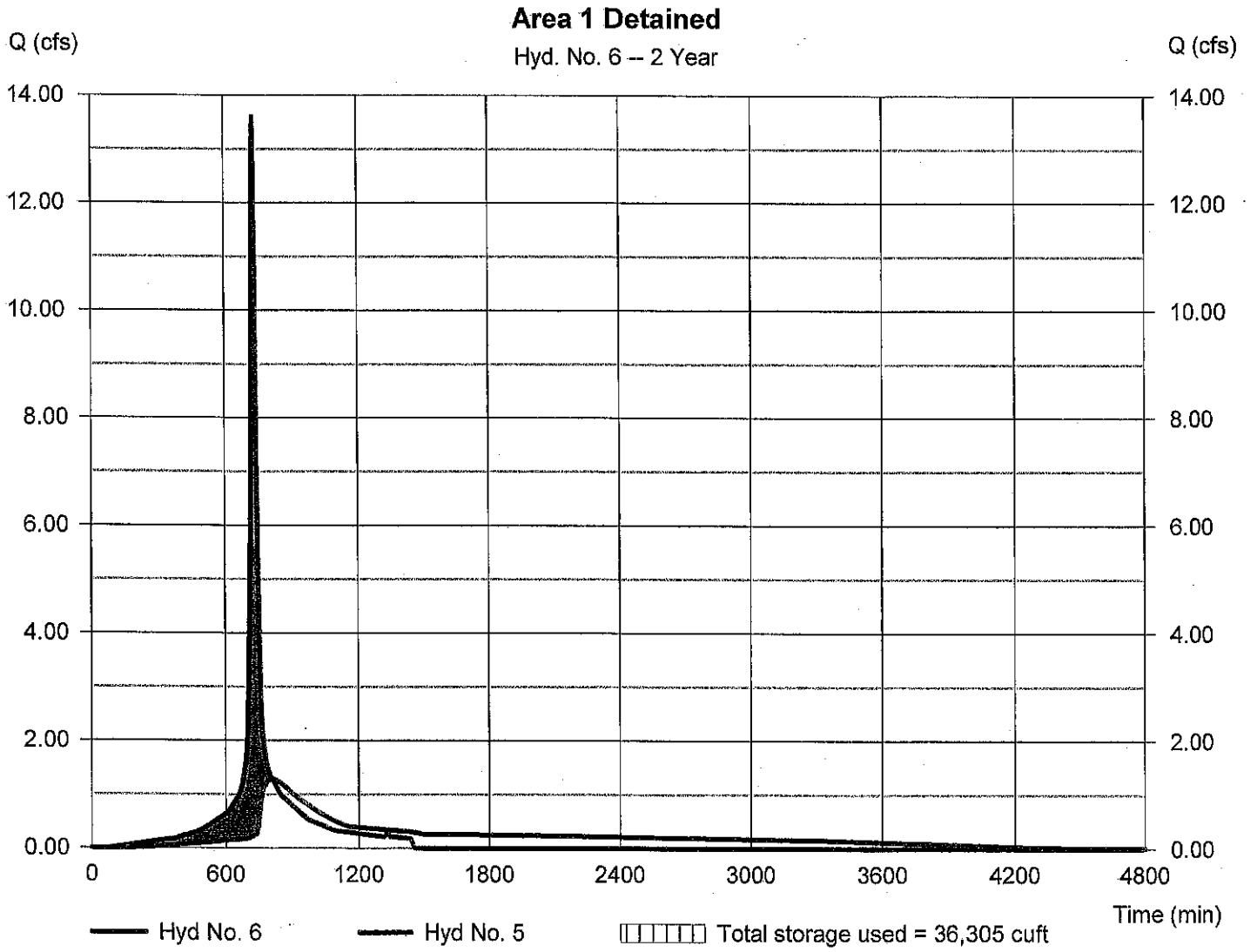
Hydrograph Report

Hyd. No. 6

Area 1 Detained

Hydrograph type	= Reservoir	Peak discharge	= 1.286 cfs
Storm frequency	= 2 yrs	Time to peak	= 810 min
Time interval	= 5 min	Hyd. volume	= 60,175 cuft
Inflow hyd. No.	= 5 - Post Development	Max. Elevation	= 141.29 ft
Reservoir name	= Extended Detention Basin	Max. Storage	= 36,305 cuft

Storage Indication method used.

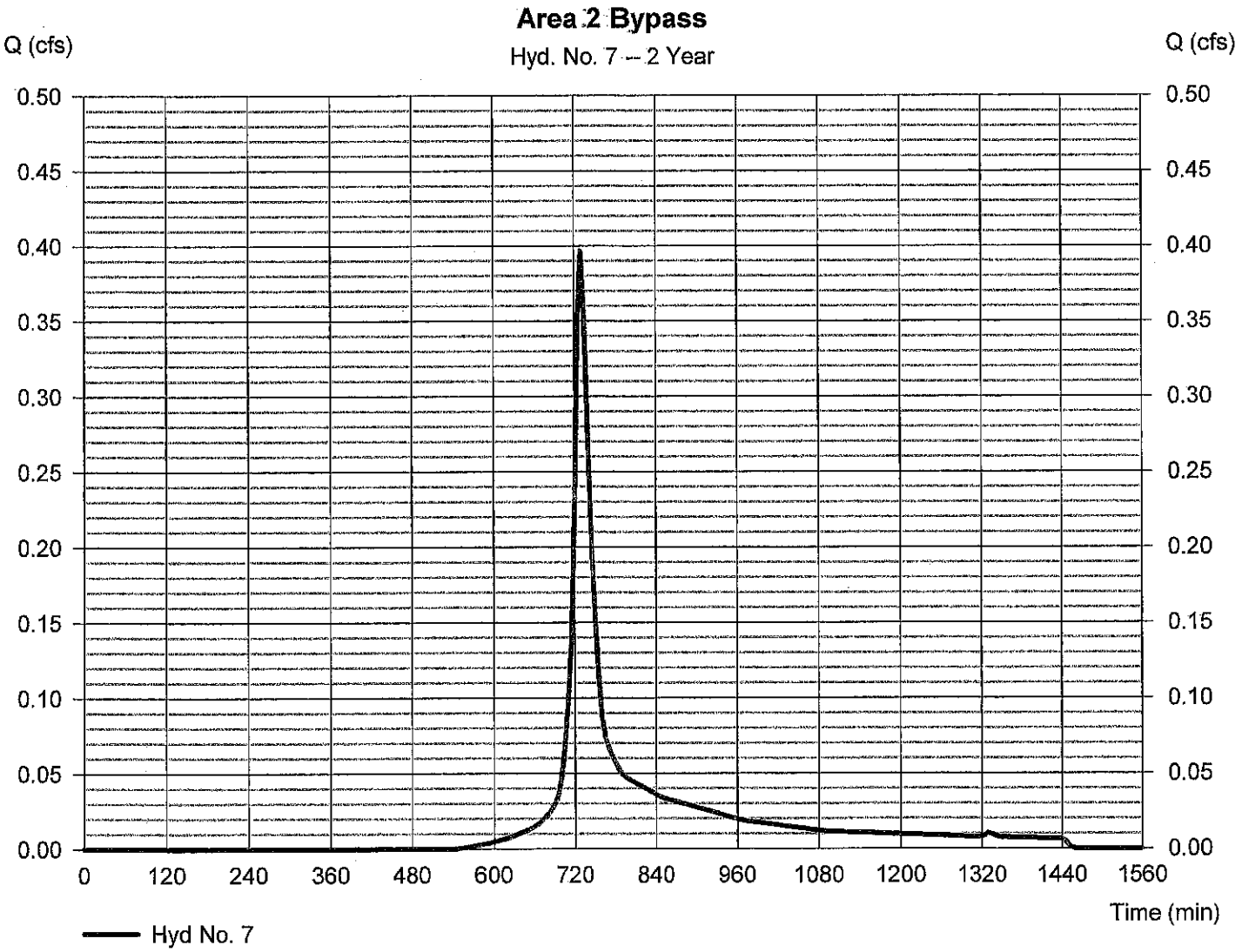


Hydrograph Report

Hyd. No. 7

Area 2 Bypass

Hydrograph type	= SCS Runoff	Peak discharge	= 0.397 cfs
Storm frequency	= 2 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 1,581 cuft
Drainage area	= 0.300 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

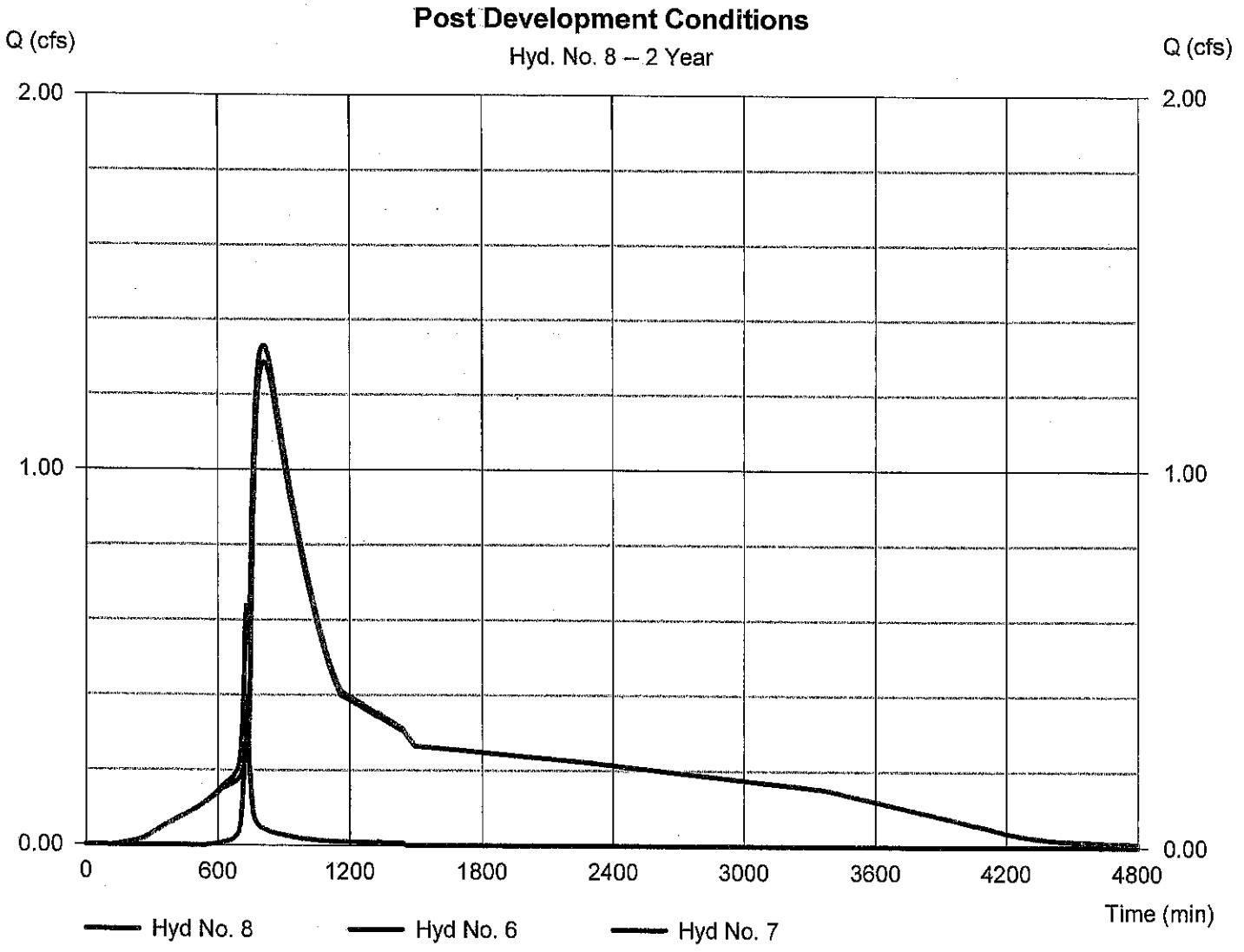


Hydrograph Report

Hyd. No. 8

Post Development Conditions

Hydrograph type	= Combine	Peak discharge	= 1.330 cfs
Storm frequency	= 2 yrs	Time to peak	= 810 min
Time interval	= 5 min	Hyd. volume	= 61,755 cuft
Inflow hyds.	= 6, 7	Contrib. drain. area	= 0.300 ac



Appendix C

10-Year Storm Frequency

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

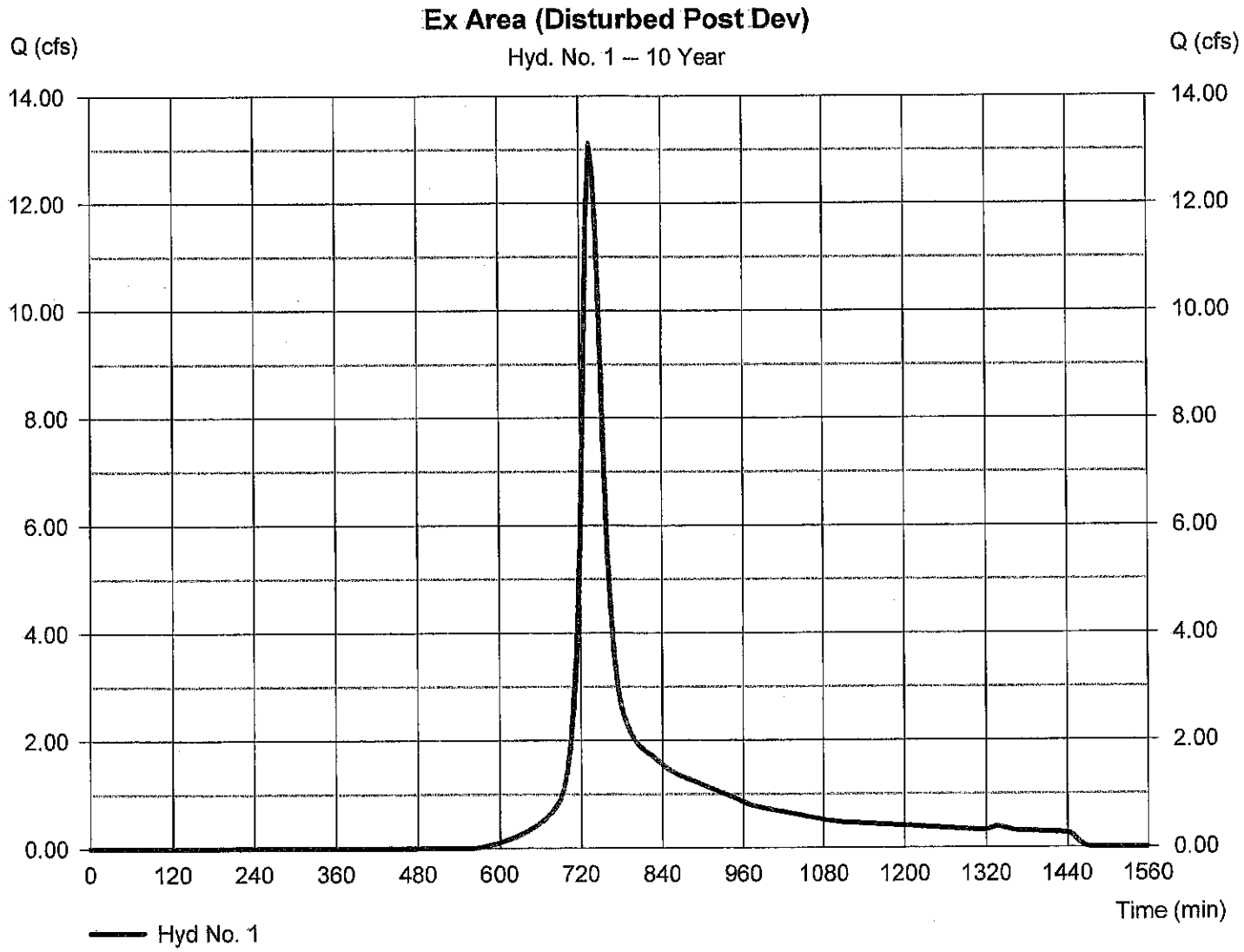
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	13.12	5	735	63,826	------	------	------	Ex Area (Disturbed Post Dev)
3	SCS Runoff	16.69	5	730	76,347	------	------	------	Post Development Impervious Area
4	SCS Runoff	5.938	5	730	23,655	------	------	------	Post Development Area 1 Pervious
5	Combine	22.63	5	730	100,002	3, 4	------	------	Post Development
6	Reservoir	6.607	5	755	99,970	5	142.26	50,870	Area 1 Detained
7	SCS Runoff	0.765	5	730	3,048	------	------	------	Area 2 Bypass
8	Combine	6.849	5	750	103,018	6, 7	------	------	Post Development Conditions

Hydrograph Report

Hyd. No. 1

Ex Area (Disturbed Post Dev)

Hydrograph type	= SCS Runoff	Peak discharge	= 13.12 cfs
Storm frequency	= 10 yrs	Time to peak	= 735 min
Time interval	= 5 min	Hyd. volume	= 63,826 cuft
Drainage area	= 8.000 ac	Curve number	= 72
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 5.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

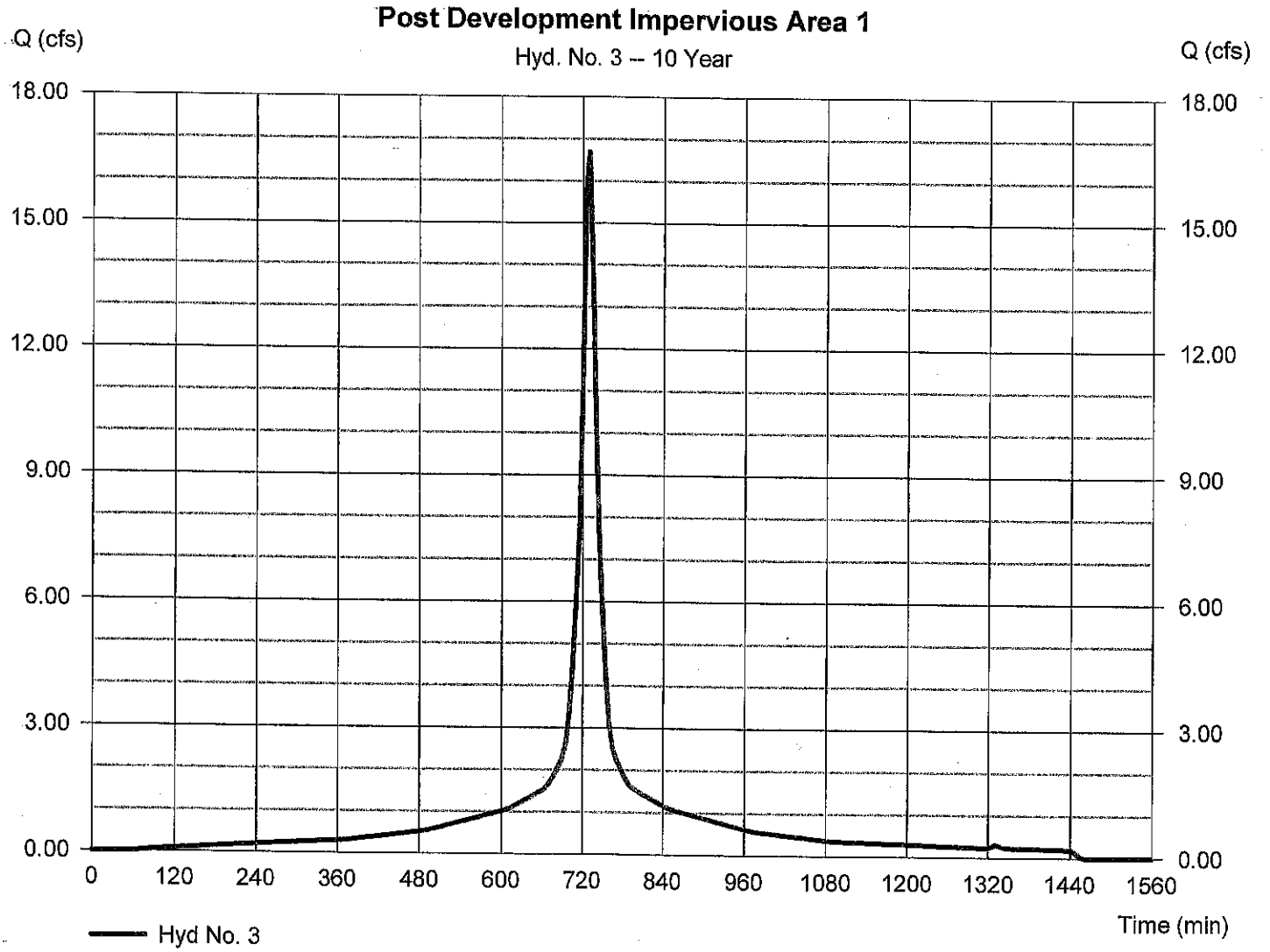


Hydrograph Report

Hyd. No. 3

Post Development Impervious Area 1

Hydrograph type	= SCS Runoff	Peak discharge	= 16.69 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 76,347 cuft
Drainage area	= 4.710 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

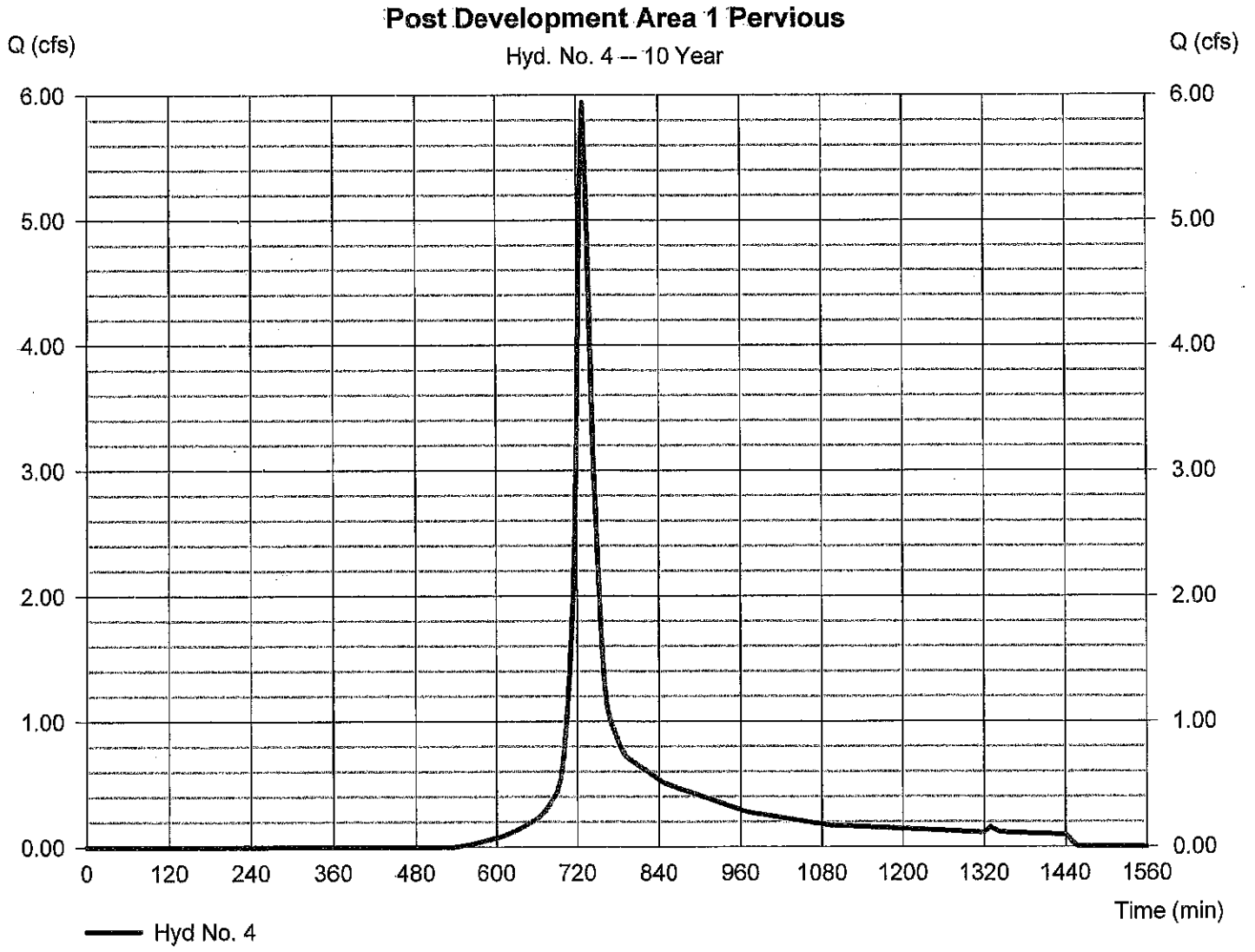


Hydrograph Report

Hyd. No. 4

Post Development Area 1 Pervious

Hydrograph type	= SCS Runoff	Peak discharge	= 5.938 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 23,655 cuft
Drainage area	= 2.940 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

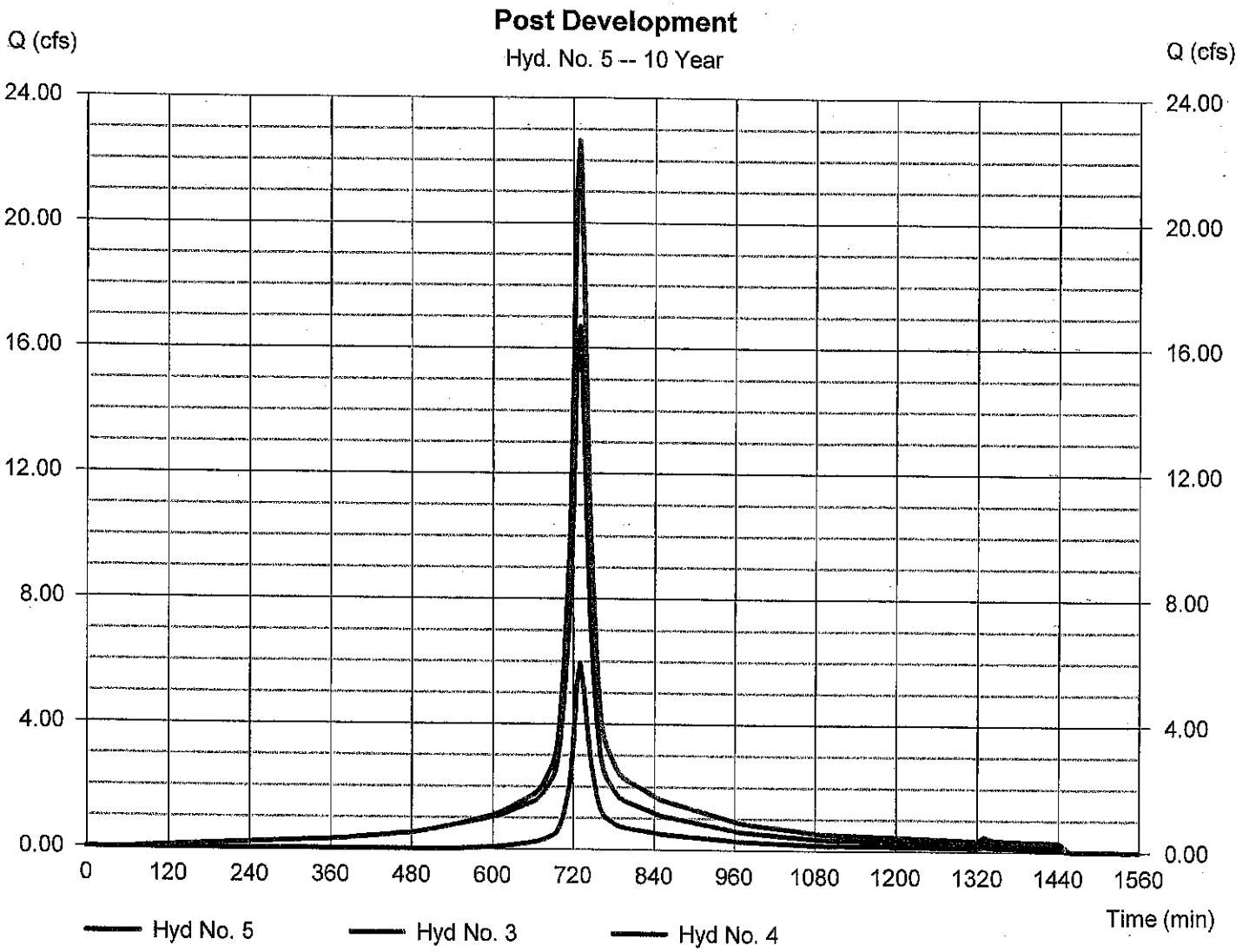


Hydrograph Report

Hyd. No. 5

Post Development

Hydrograph type	= Combine	Peak discharge	= 22.63 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 100,002 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 7.650 ac



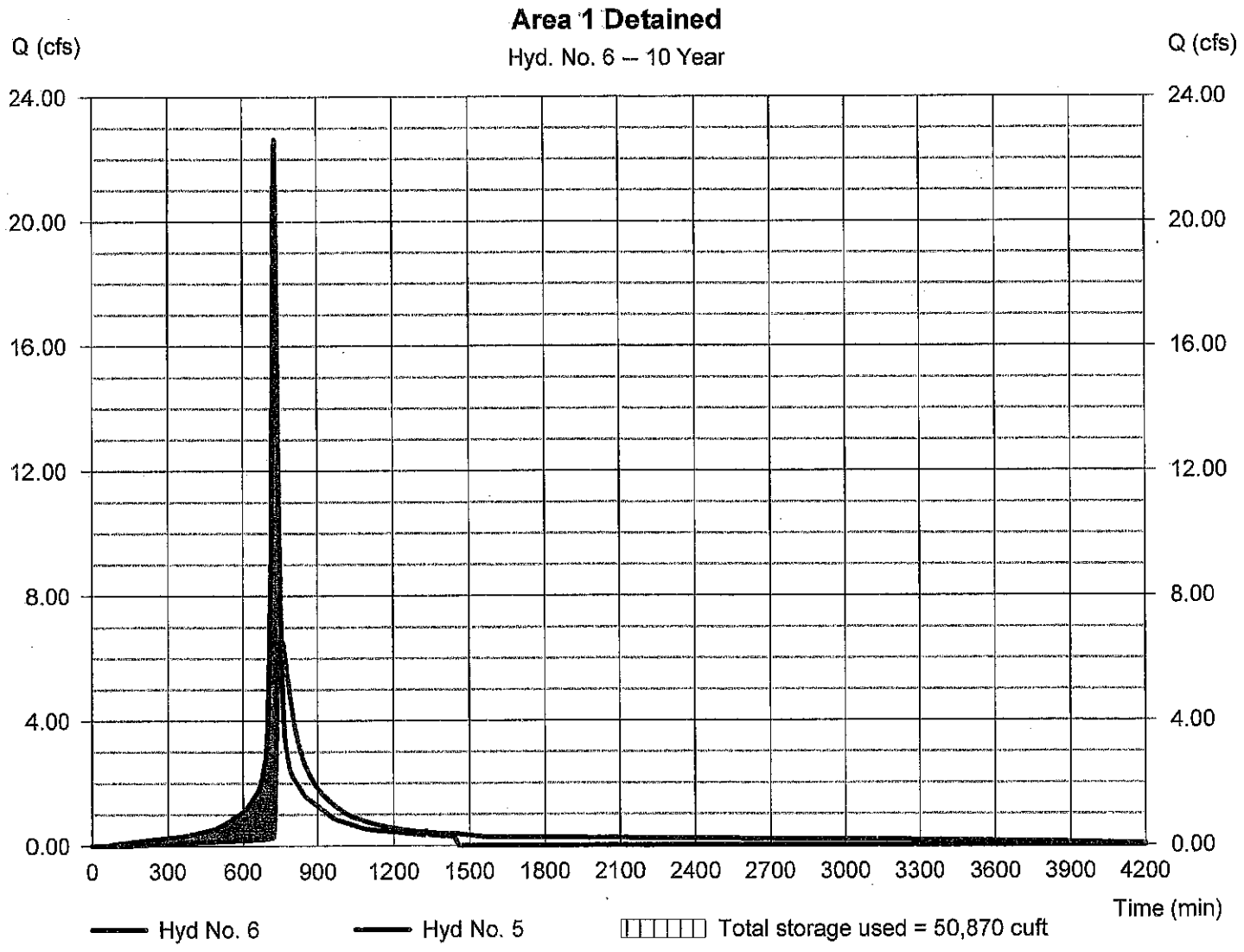
Hydrograph Report

Hyd. No. 6

Area 1 Detained

Hydrograph type	= Reservoir	Peak discharge	= 6.607 cfs
Storm frequency	= 10 yrs	Time to peak	= 755 min
Time interval	= 5 min	Hyd. volume	= 99,970 cuft
Inflow hyd. No.	= 5 - Post Development	Max. Elevation	= 142.26 ft
Reservoir name	= Extended Detention Basin	Max. Storage	= 50,870 cuft

Storage Indication method used.

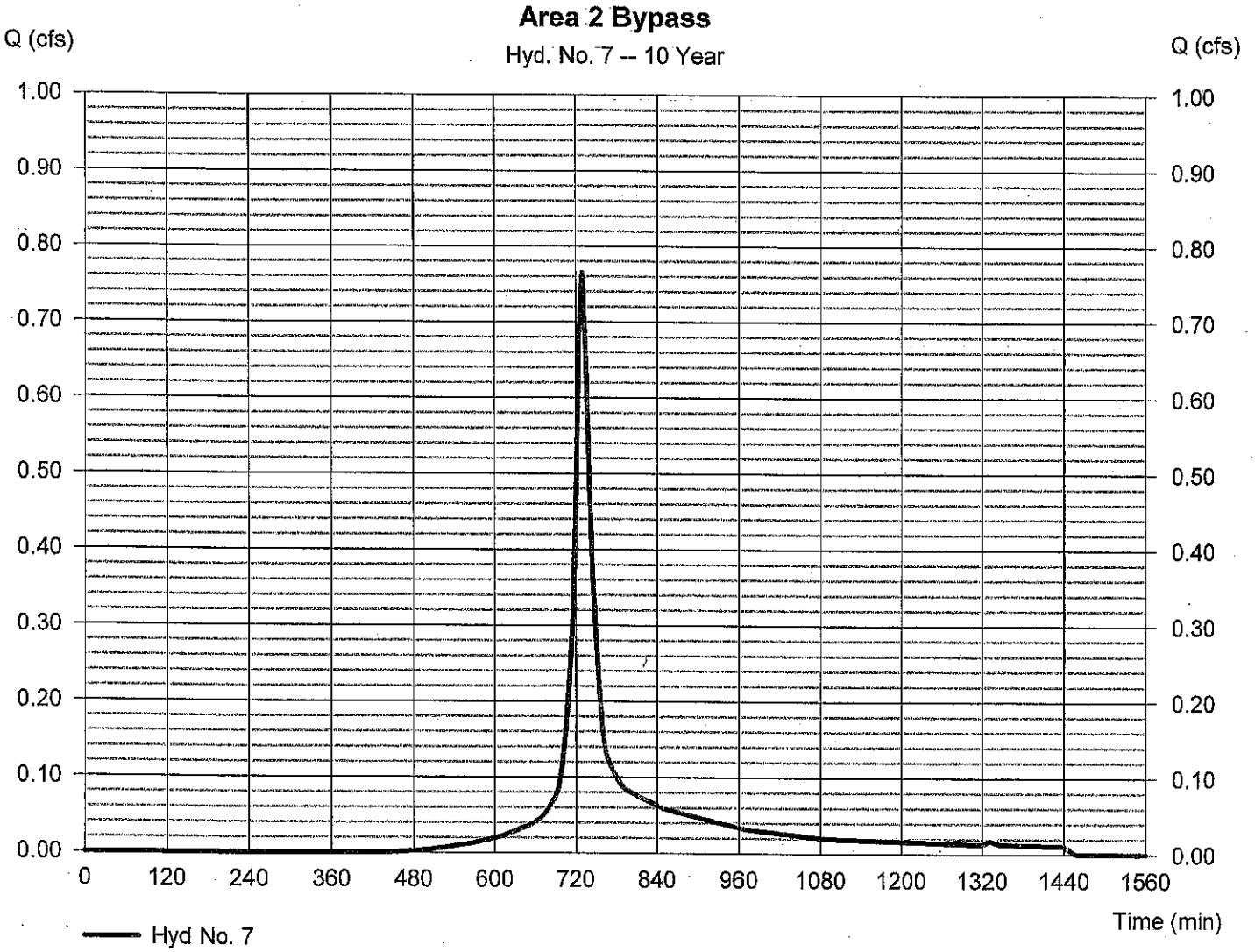


Hydrograph Report

Hyd. No. 7

Area 2 Bypass

Hydrograph type	= SCS Runoff	Peak discharge	= 0.765 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 3,048 cuft
Drainage area	= 0.300 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

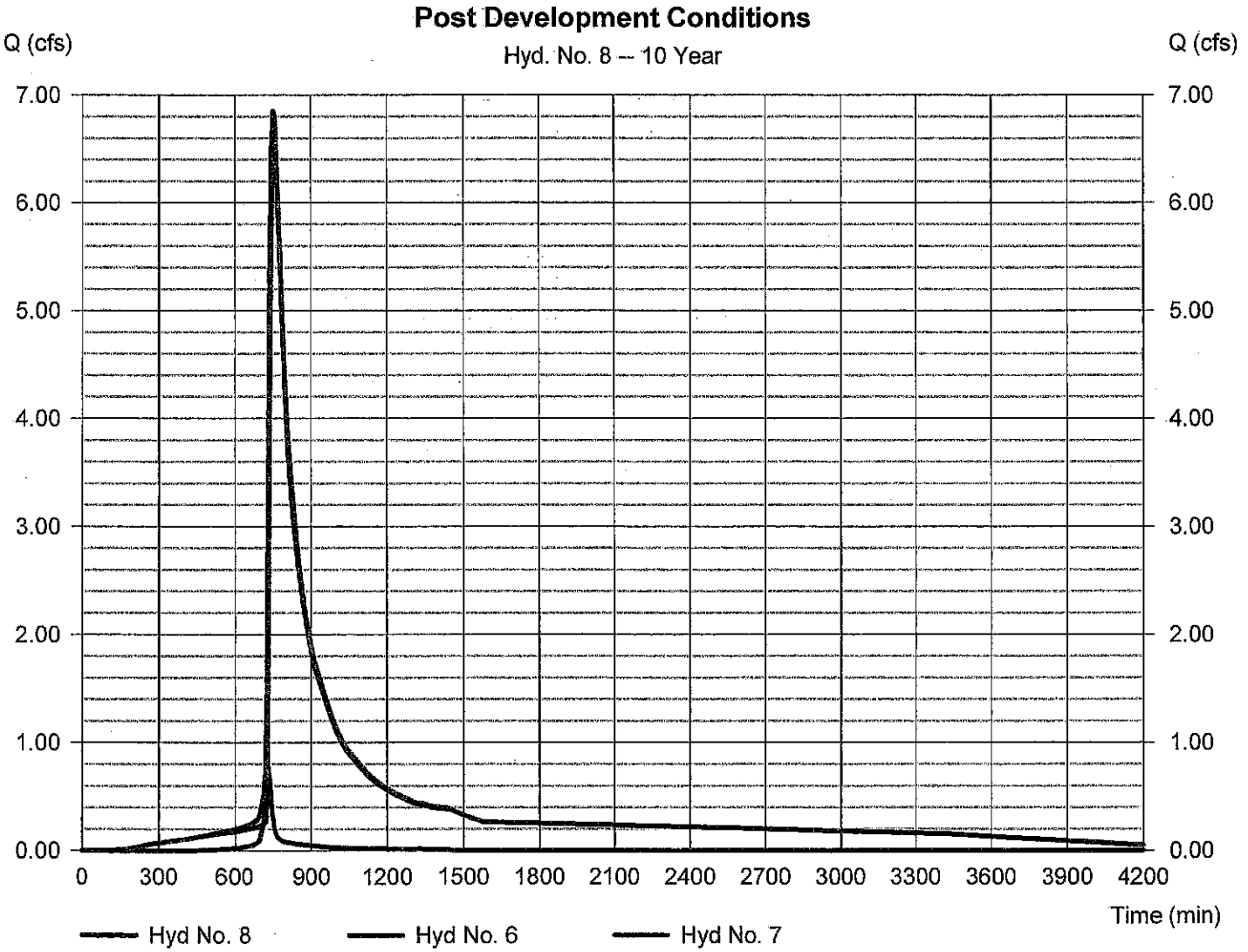


Hydrograph Report

Hyd. No. 8

Post Development Conditions

Hydrograph type	= Combine	Peak discharge	= 6.849 cfs
Storm frequency	= 10 yrs	Time to peak	= 750 min
Time interval	= 5 min	Hyd. volume	= 103,018 cuft
Inflow hyds.	= 6, 7	Contrib. drain. area	= 0.300 ac



Appendix D

100-Year Storm Frequency

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

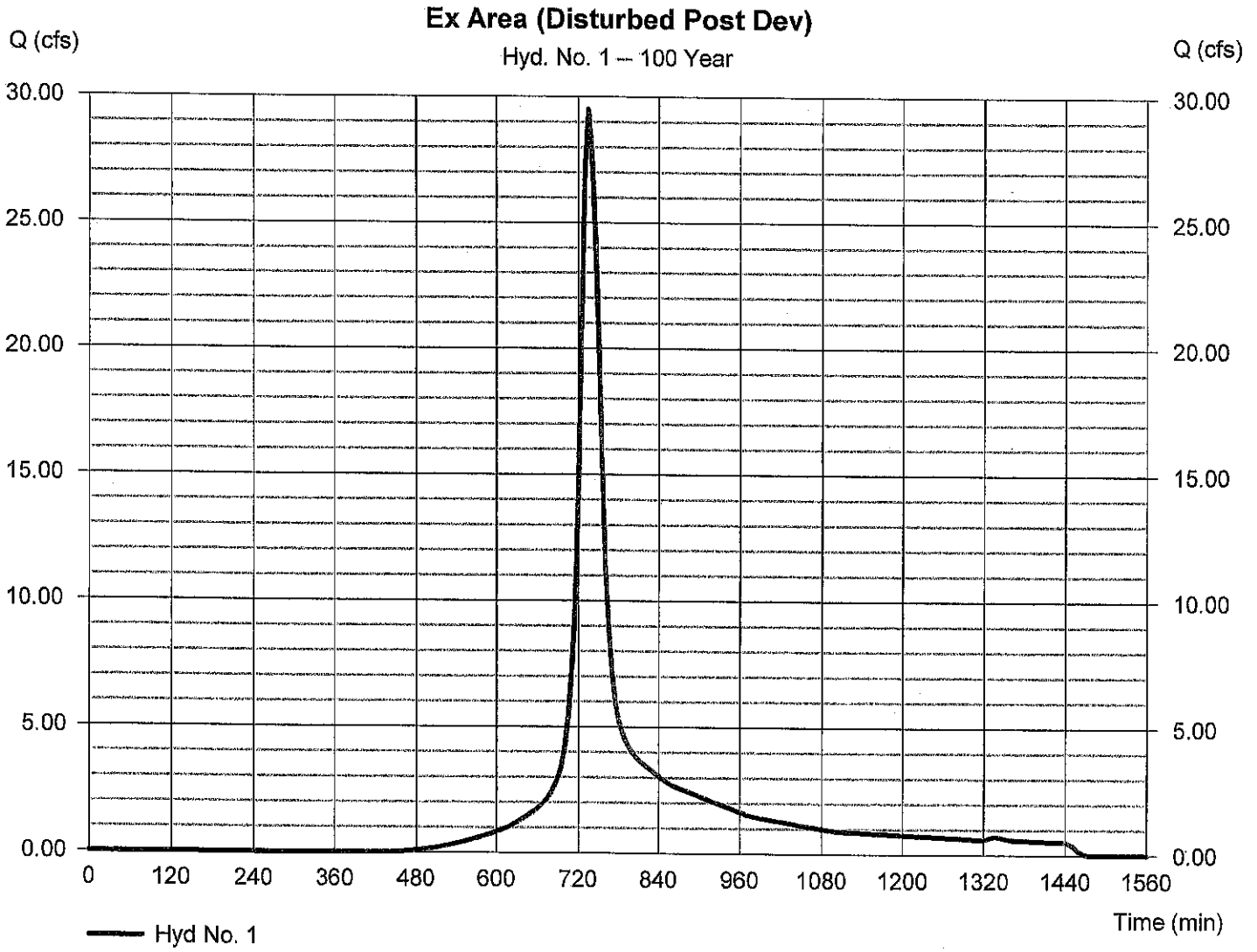
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	29.48	5	735	141,436	------	------	------	Ex Area (Disturbed Post Dev)
3	SCS Runoff	27.47	5	730	127,590	------	------	------	Post Development Impervious Area
4	SCS Runoff	12.79	5	730	51,076	------	------	------	Post Development Area 1 Pervious
5	Combine	40.26	5	730	178,666	3, 4	------	------	Post Development
6	Reservoir	19.82	5	745	178,633	5	143.71	75,975	Area 1 Detained
7	SCS Runoff	1.486	5	730	6,055	------	------	------	Area 2 Bypass
8	Combine	20.50	5	745	184,689	6, 7	------	------	Post Development Conditions

Hydrograph Report

Hyd. No. 1

Ex Area (Disturbed Post Dev)

Hydrograph type	= SCS Runoff	Peak discharge	= 29.48 cfs
Storm frequency	= 100 yrs	Time to peak	= 735 min
Time interval	= 5 min	Hyd. volume	= 141,436 cuft
Drainage area	= 8.000 ac	Curve number	= 72
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 8.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

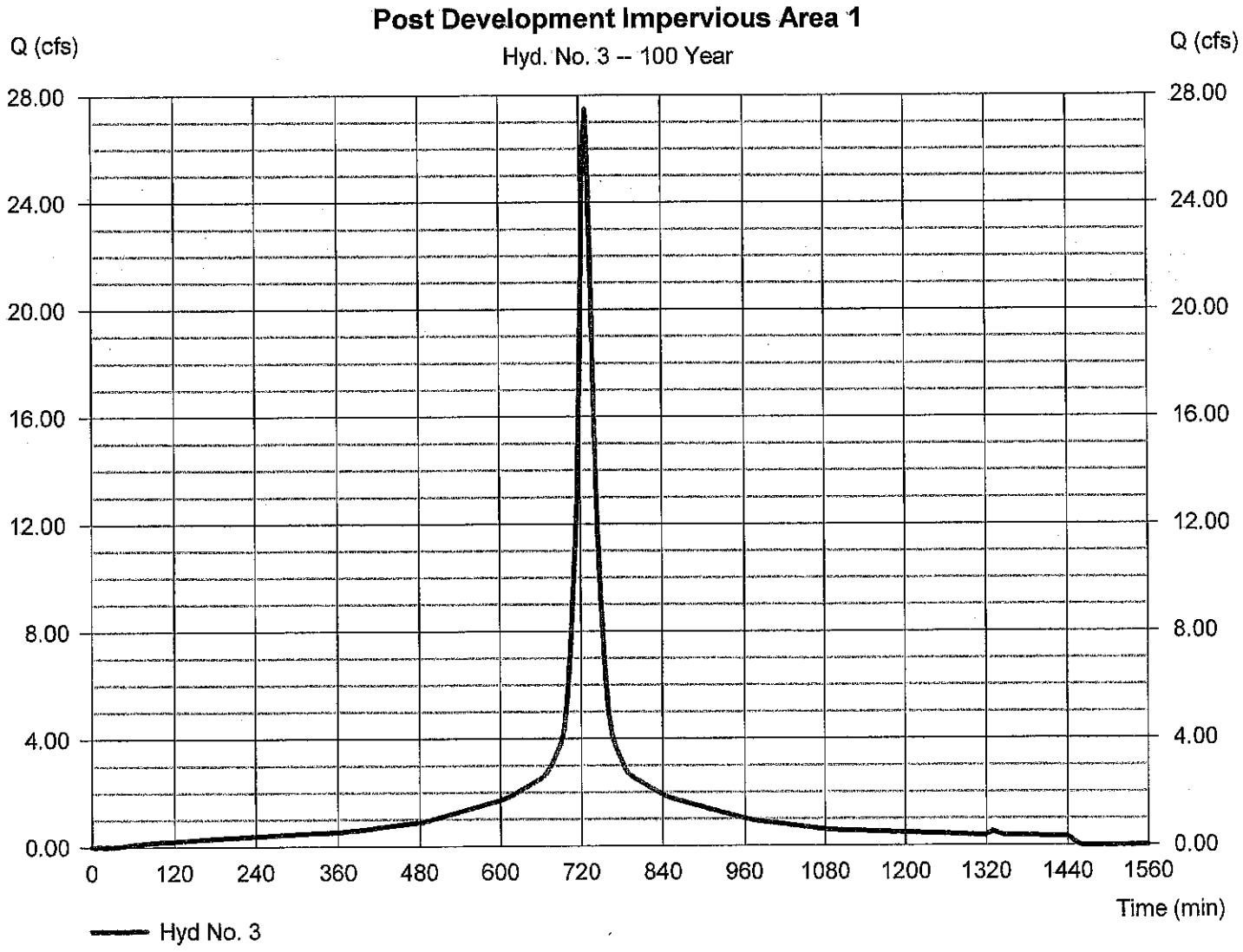


Hydrograph Report

Hyd. No. 3

Post Development Impervious Area 1

Hydrograph type	= SCS Runoff	Peak discharge	= 27.47 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 127,590 cuft
Drainage area	= 4.710 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



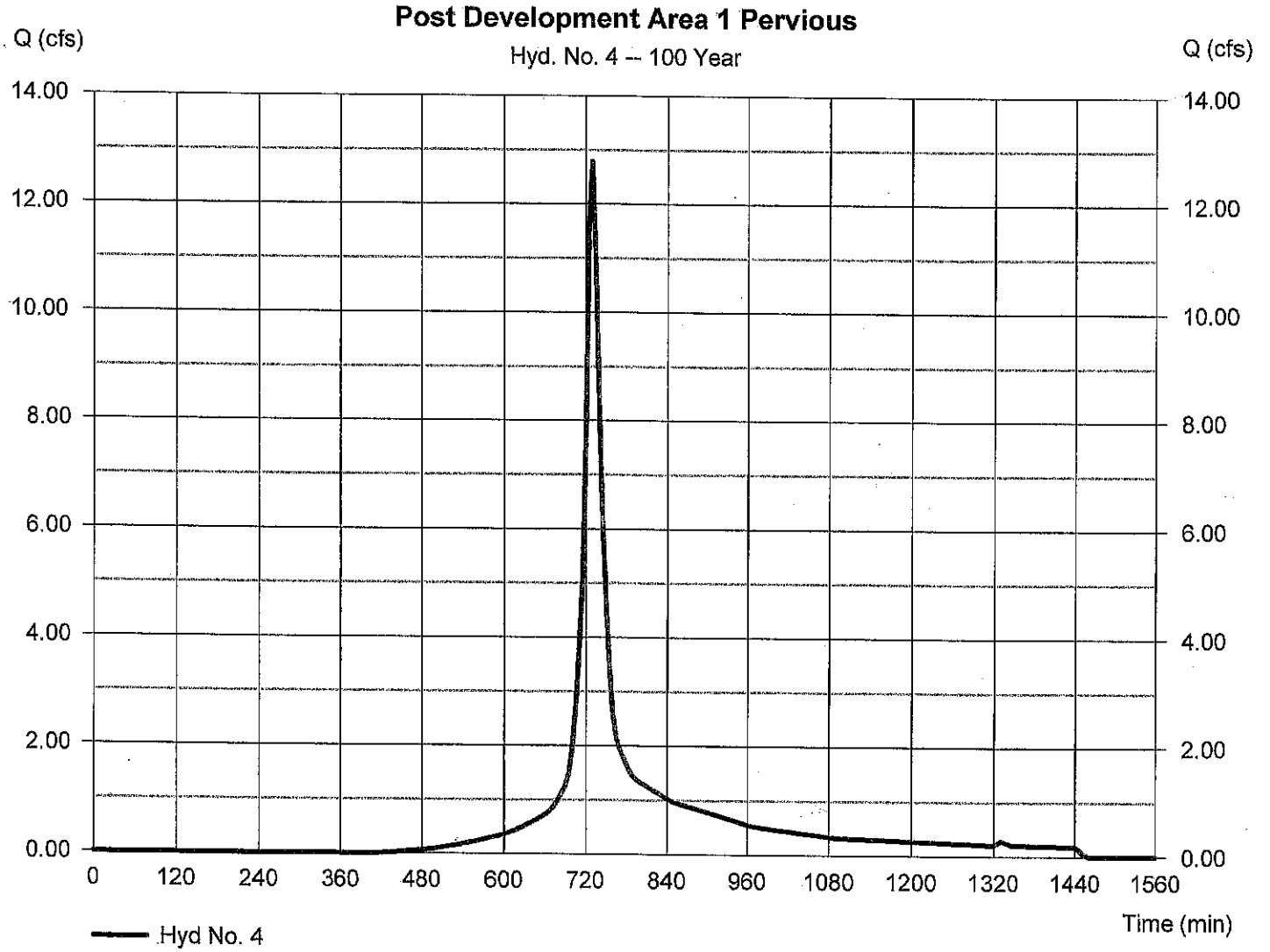
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Thursday, 11 / 5 / 2015

Hyd. No. 4

Post Development Area 1 Pervious

Hydrograph type	= SCS Runoff	Peak discharge	= 12.79 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 51,076 cuft
Drainage area	= 2.940 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



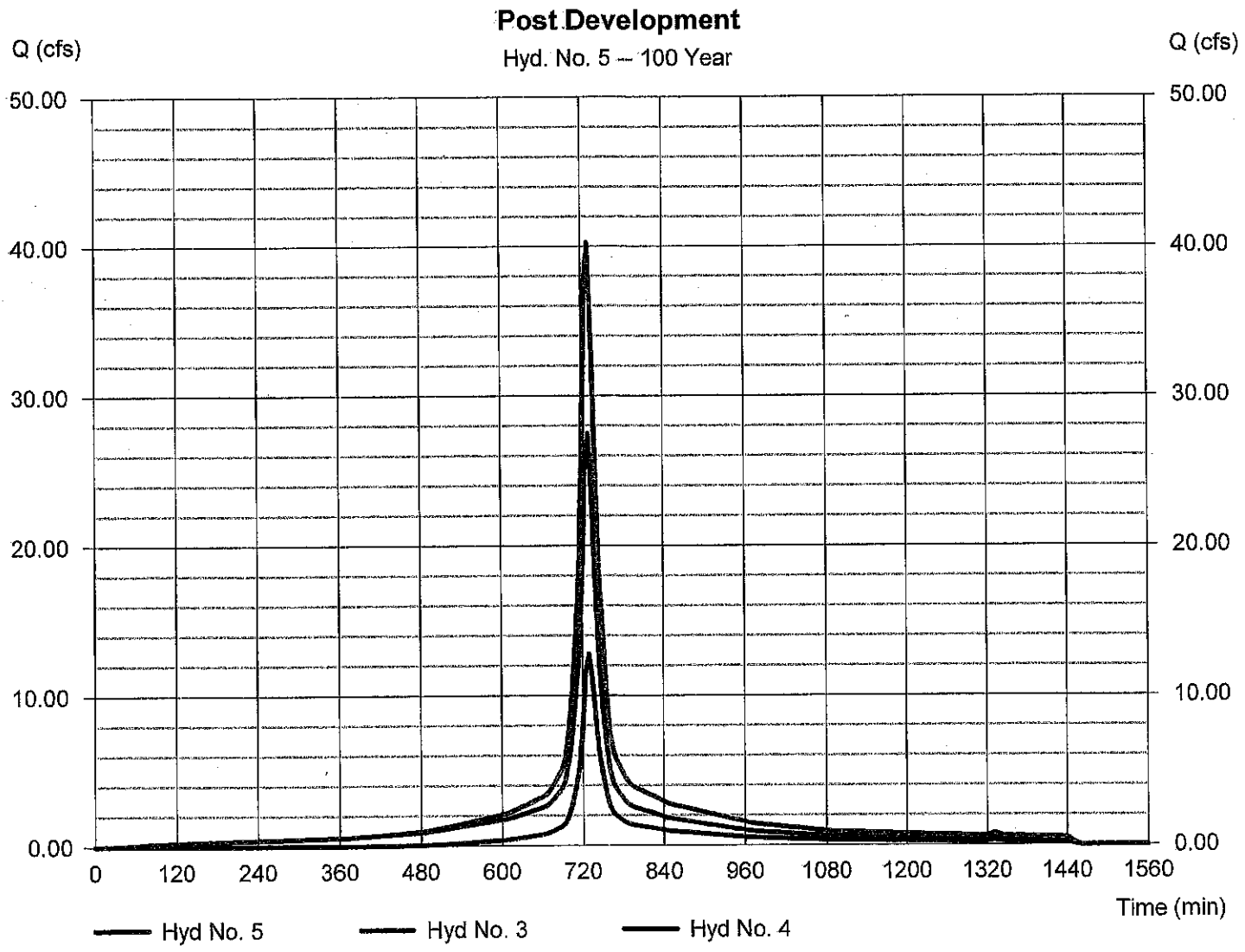
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 11 / 5 / 2015

Hyd. No. 5

Post Development

Hydrograph type	= Combine	Peak discharge	= 40.26 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 178,666 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 7.650 ac



Hydrograph Report

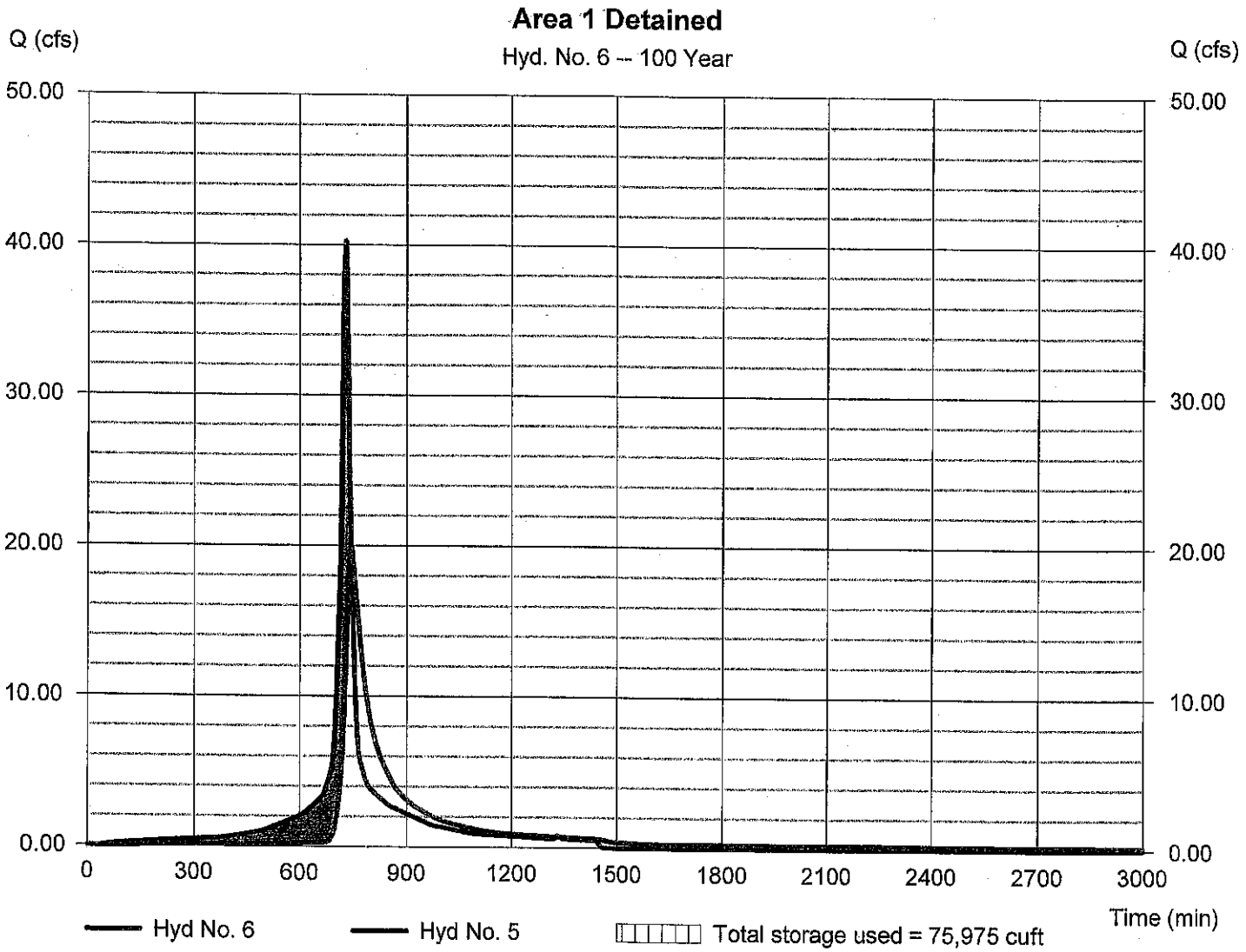
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Thursday, 11 / 5 / 2015

Hyd. No. 6

Area 1 Detained

Hydrograph type	= Reservoir	Peak discharge	= 19.82 cfs
Storm frequency	= 100 yrs	Time to peak	= 745 min
Time interval	= 5 min	Hyd. volume	= 178,633 cuft
Inflow hyd. No.	= 5 - Post Development	Max. Elevation	= 143.71 ft
Reservoir name	= Extended Detention Basin	Max. Storage	= 75,975 cuft

Storage Indication method used.

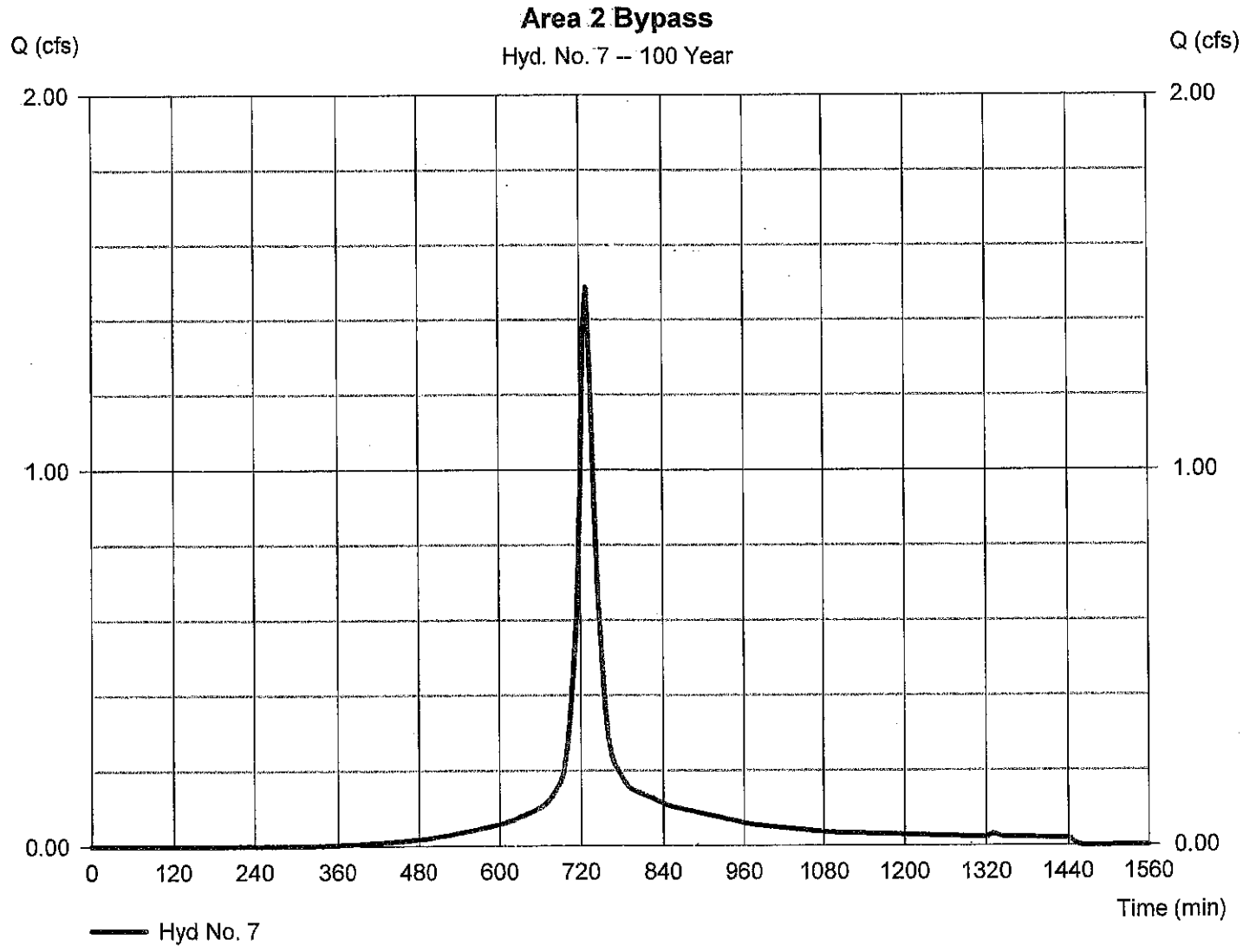


Hydrograph Report

Hyd. No. 7

Area 2 Bypass

Hydrograph type	= SCS Runoff	Peak discharge	= 1.486 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 5 min	Hyd. volume	= 6,055 cuft
Drainage area	= 0.300 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

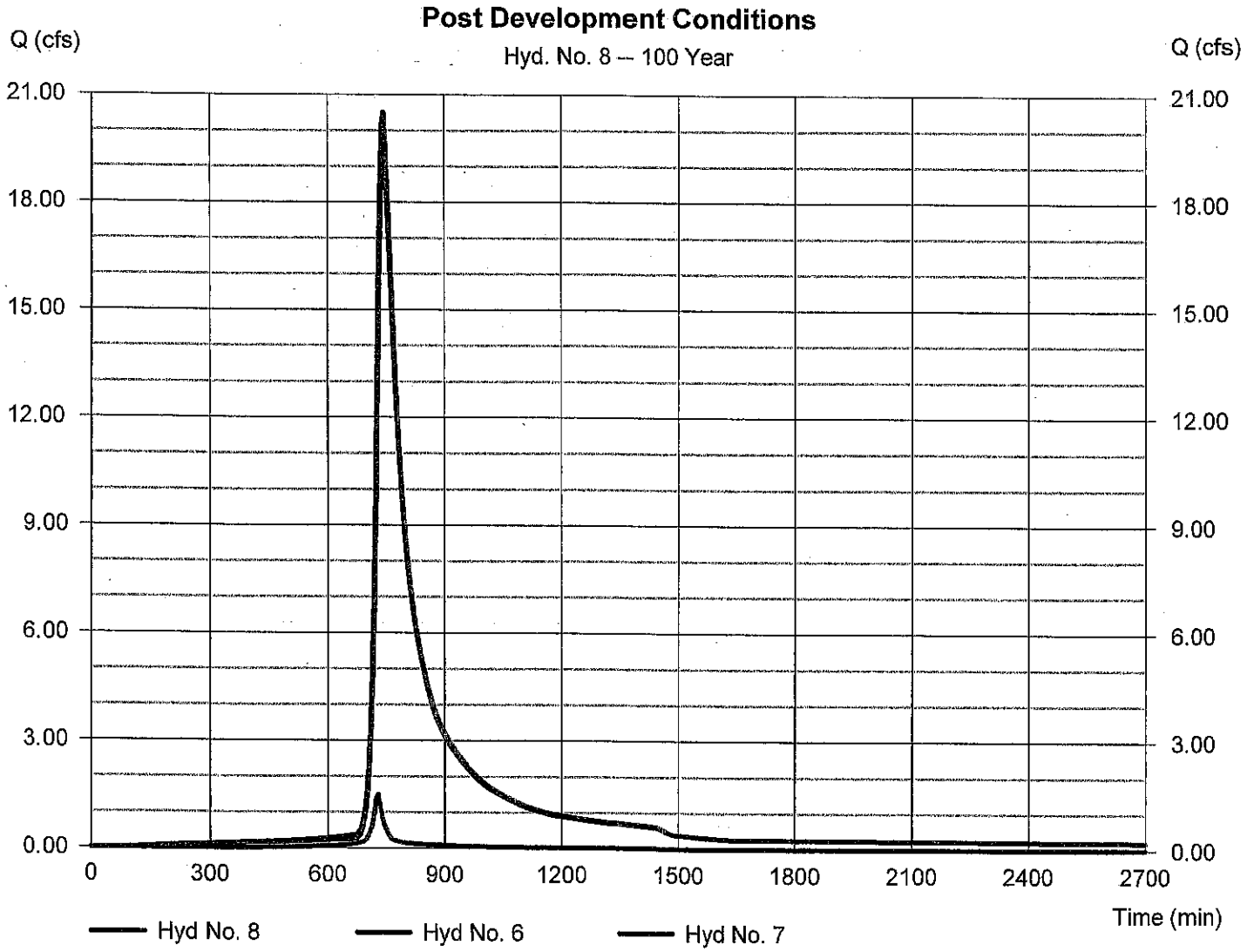


Hydrograph Report

Hyd. No. 8

Post Development Conditions

Hydrograph type	= Combine	Peak discharge	= 20.50 cfs
Storm frequency	= 100 yrs	Time to peak	= 745 min
Time interval	= 5 min	Hyd. volume	= 184,689 cuft
Inflow hyds.	= 6, 7	Contrib. drain. area	= 0.300 ac



Appendix E

Water Quality Calculations & Soil Testing Data

Water Quality Calculation Sheet

Design: CRA

Date: November 6, 2015

Project: Princeton Audi Service Center

Project No.: 01-42-M-A

Northern Parking Lot and Driveway

1. Manufactured Treatment Devices
   TSS Removal = 50%

2. Extended Detention Basin
   TSS Removal Rate = 60%

$$R = A\&B = \frac{(AxB)}{100}$$

$$R = [50+60] - \left[\frac{(50x60)}{100} \right]$$

TSS Removal Rate = 80%

Southern Parking Lot and Driveway

1. Manufactured Treatment Devices
   TSS Removal = 80%

- The flow of 5.3 cfs is divide in half to 2.65cfs and diverted to two Treatment Devices that provide 80% TSS Removal.

- The flow from the roof area 1.12 Ac is not treated and is discharged to the underground recharge facility directly

Somerset County/Montgomery Township

Application for Permit to Construct/Alter/Repair an Individual Subsurface Sewage Disposal System
Form 2b - Soil Log and Interpretation Block: 34001 Lot: 64

1. Log Number 1 Method: Profile Pit: X Boring:
Date Recorded: June 24 & 25, 2015 Soil Evaluator: Kyle Paterson
2. Soil Log Existing Elevation 141.00

Depth (inches) Top-Bottom	**Munsell Color Name and Symbol; Estimated Textural Class; Estimated Volume % Coarse Fragment, If Present; Structure; Moist or Dry Consistence; Mottling - Abundance, Size and Contrast, If Present**
Description:	
0-8"	(2.5YR5/4) silt loam, angular blocky, friable, oxidized foot channels, (7.5YR4/6) mottles
8-18"	(5YR4/3) highly weathered shale, 15% loam, pockets of (10YR6/1) and (10YR5/6) mottles
18-60"	(2.5YR4/3) blocky shale, 10% loam
60-100"	(2.5YR4/3) hard shale
	Machine Refusal
	No Water

---

1. Log Number 2 Method: Profile Pit: X Boring:
2. Soil Log Existing Elevation 141.00

Description:

0-10"	(10YR3/3) loam topsoil, subangular blocky, friable
10-24"	(7.5YR4/4) silt loam, angular blocky, firm, (10YR6/1) mottles
24-72"	(2.5YR4/4) shale, 5%
	Machine Refusal
	No Water

---

1. Log Number 3 Method: Profile Pit: X Boring:
2. Soil Log Existing Elevation 154.00

Description:

0-12"	(2.5YR4/3) gravelly silt loam, granular, friable
12-40"	(7.5YR4/4) silty clay loam, angular blocky, firm
40-84"	(2.5YR3/4) fractured shale
	No Water

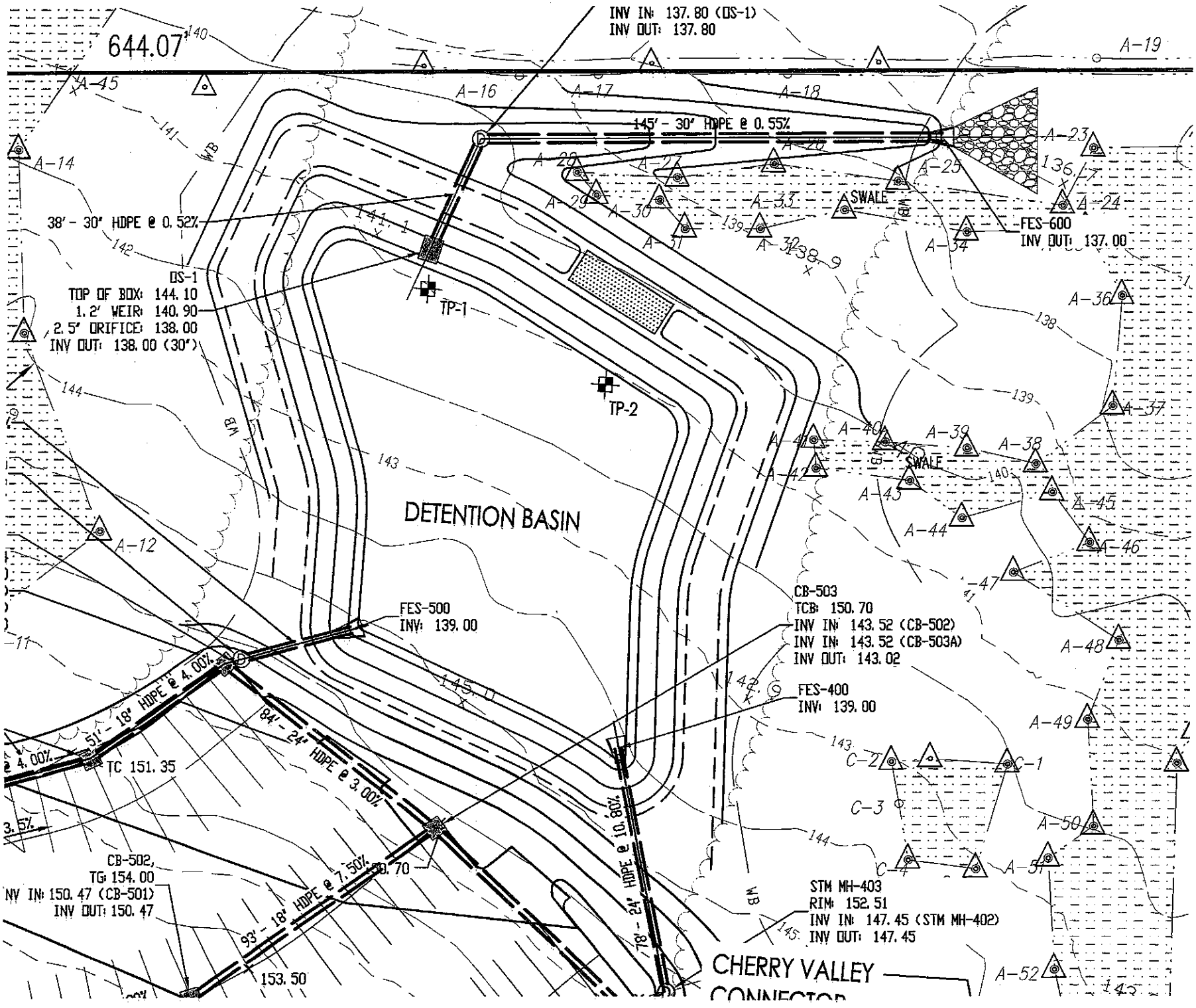
---

1. Log Number 4 Method: Profile Pit: X Boring:
2. Soil Log Existing Elevation 154.00

Description:

0-12"	(7.5YR4/3) clay loam, subangular blocky, friable
12-40"	(7.5YR5/4) silt loam, subangular blocky, friable to slightly firm
40-84"	(2.5YR4/3) shale, 10% loam
	No Water

Basin Flood T.P. 4 – Depth 48" – Dimensions 16' x 4'
7/16/15: 2:08 pm, fill of 500 gallons.
7/17/15: 7:08 am, empty.
12" in 17 Hrs = 0.71 in/hr

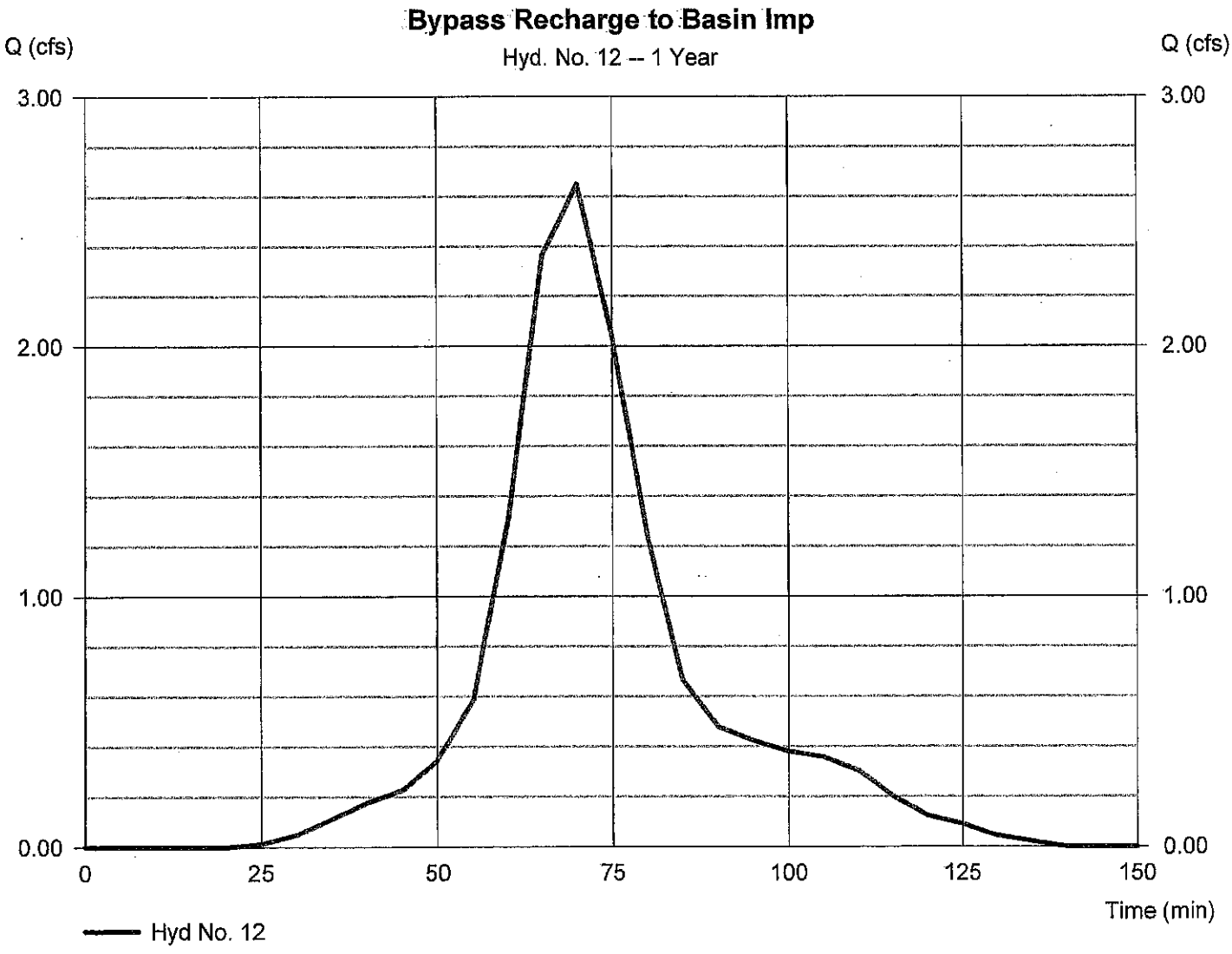

644.07
INV IN: 137.80 (DS-1)
INV OUT: 137.80
145' - 30" HDPE @ 0.55%
38' - 30" HDPE @ 0.52%
DS-1
TOP OF BOX: 144.10
1.2' WEIR: 140.90
2.5" ORIFICE: 138.00
INV OUT: 138.00 (30")
TP-1
TP-2
SWALE
SWALE
FES-600
INV OUT: 137.00
DETENTION BASIN
FES-500
INV: 139.00
CB-503
TCB: 150.70
INV IN: 143.52 (CB-502)
INV IN: 143.52 (CB-503A)
INV OUT: 143.02
FES-400
INV: 139.00
51' - 18" HDPE @ 4.00%
84' - 24" HDPE @ 3.00%
78' - 24" HDPE @ 10.80%
93' - 18" HDPE @ 7.50%
TC 151.35
CB-502,
TG: 154.00
INV IN: 150.47 (CB-501)
INV OUT: 150.47
153.50
STM MH-403
RIM: 152.51
INV IN: 147.45 (STM MH-402)
INV OUT: 147.45
CHERRY VALLEY
CONNECTOR
WB

Hydrograph Report

Hyd. No. 12

Bypass Recharge to Basin Imp

Hydrograph type	= SCS Runoff	Peak discharge	= 2.647 cfs
Storm frequency	= 1 yrs	Time to peak	= 70 min
Time interval	= 5 min	Hyd. volume	= 4,259 cuft
Drainage area	= 1.210 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.25 in	Distribution	= Custom
Storm duration	= F:\Shared_Users\calfaro\1.25Storm\SCS1.25inch.cds	Shape factor	= 484

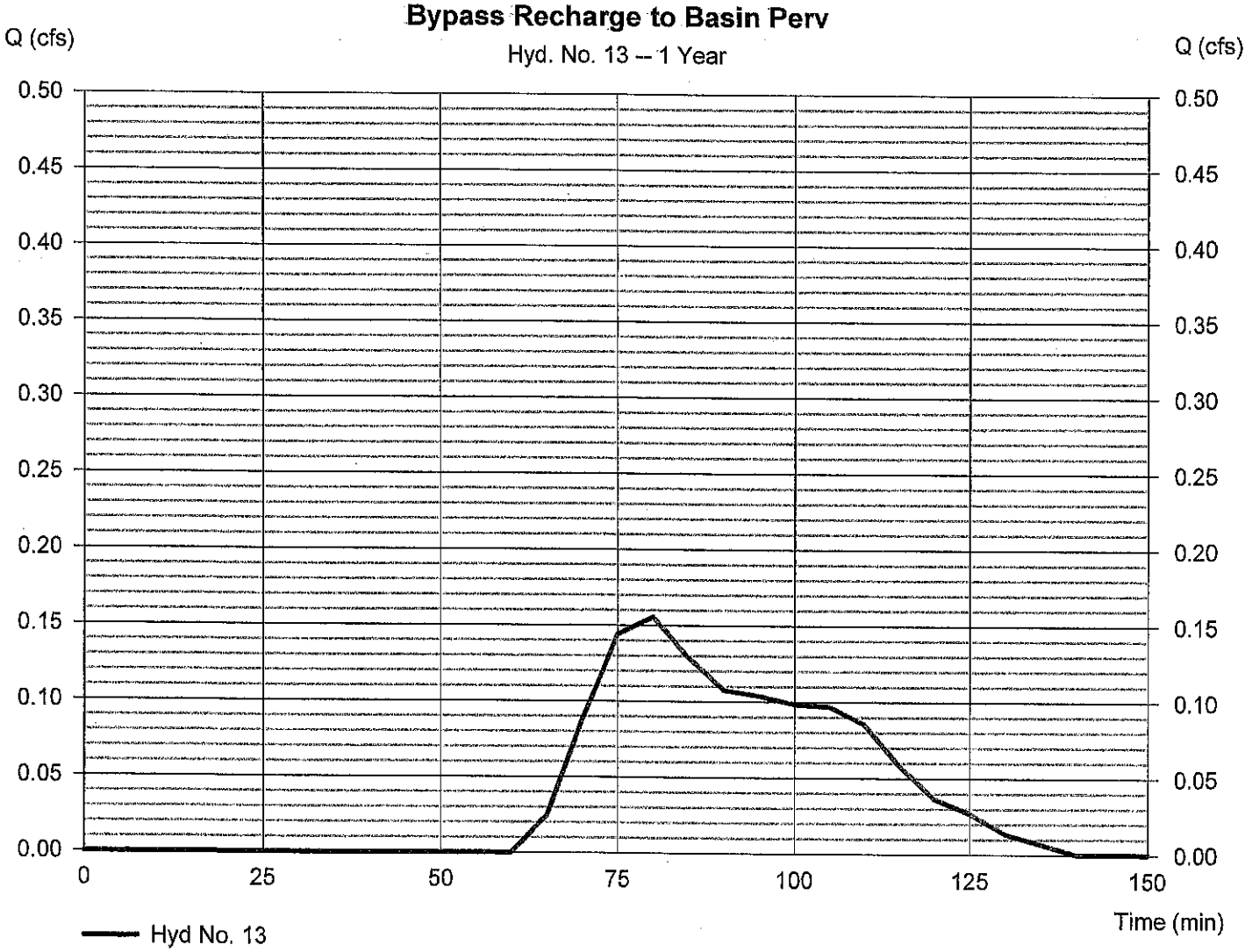


Hydrograph Report

Hyd. No. 13

Bypass Recharge to Basin Perv

Hydrograph type	= SCS Runoff	Peak discharge	= 0.156 cfs
Storm frequency	= 1 yrs	Time to peak	= 80 min
Time interval	= 5 min	Hyd. volume	= 353 cuft
Drainage area	= 1.440 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.25 in	Distribution	= Custom
Storm duration	= F:\Shared_Users\calfaro\1.25Storm\SCS1.25inch.cds	Shape factor	= 484

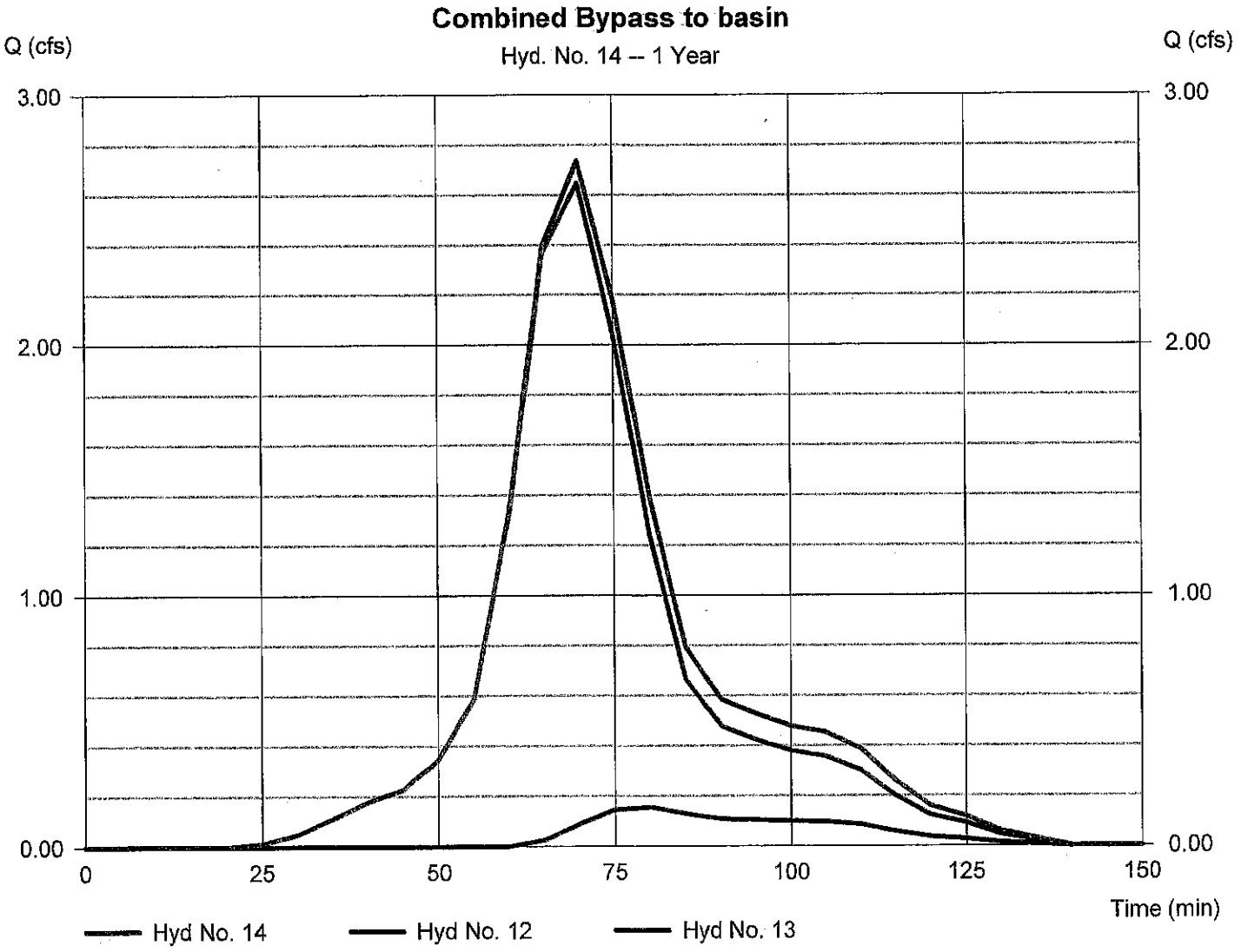


Hydrograph Report

Hyd. No. 14

Combined Bypass to basin

Hydrograph type	= Combine	Peak discharge	= 2.735 cfs
Storm frequency	= 1 yrs	Time to peak	= 70 min
Time interval	= 5 min	Hyd. volume	= 4,611 cuft
Inflow hyds.	= 12, 13	Contrib. drain. area	= 2.650 ac



This is a regional document for **New Jersey**

New Jersey Stormwater Design Guide
Downstream Defender®

Hydro International

Rated for 50% TSS Removal by NJDEP

The Downstream Defender® is an advanced vortex separator certified by the New Jersey Department of Environmental Protection (NJDEP) for 50% TSS removal and independently verified by the New Jersey Corporation for Advanced Technologies (NJCAT).

The Downstream Defender® has been the approved product of choice for the majority of New Jersey Turnpike Authority installations.

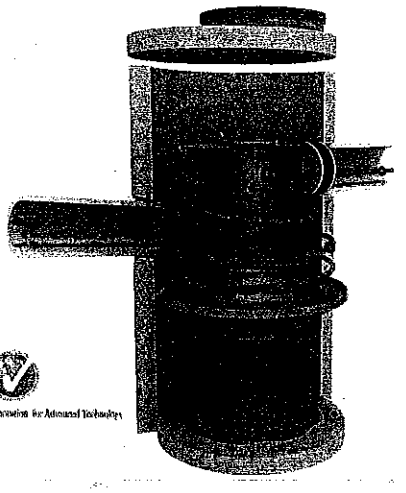


Table 1. Approved Treatment Flow Rates for the 1.25" / 2hr NJ Design Storm

Certified NJDEP Water Quality Treatment Flow Rate	Recommended Peak Online Flow	Downstream Defender® Model & Diameter	Maximum Pipe Size	Recommended Inlet pipe/outlet pipe size for offline design	Rim Elevation to Outlet Invert[1,2]	Outlet Invert to Sump Floor
(cfs)	(cfs)	(ft)	(in)	(in)	(ft)	(ft)
1.12	3.0	4	12	10 / 12	2.8	4.08
2.52	8.0	6	18	15 / 18	3.4	5.86
4.49	15.0	8	24	20 / 24	4.2	7.67
7.00	25.0	10	30	24 / 30	5.0	9.44
10.08	38.0	12	36	30 / 36	5.7	11.18

[1]Including 4" frame and cover.

[2] Please contact your Hydro representative at (703) 424-3340 for product applications involving shallow or minimum cover.

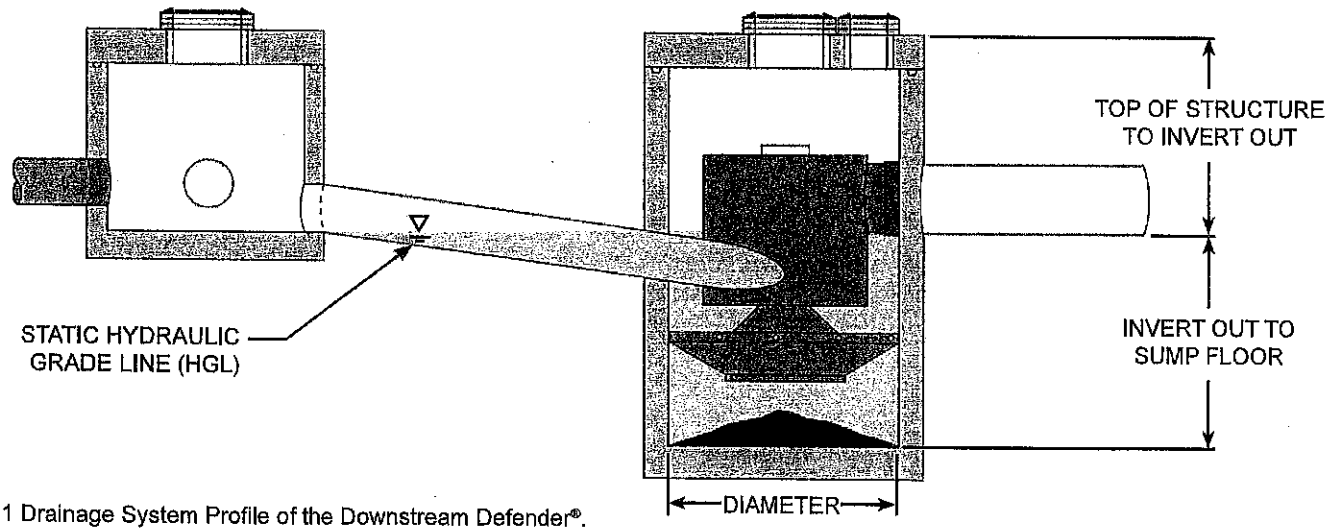


Fig.1 Drainage System Profile of the Downstream Defender®.

Downstream Defender®

Layout

Minimal Head Loss

The Downstream Defender® has a submerged tangential inlet and includes no internal orifices or weirs. These key features reduce the risk of blockage and decrease system headloss. The headloss through the Downstream Defender® is dependent on the pipe sizes. However, at recommended pipe sizes and NJDEP treatment flow rates, headloss through the Downstream Defender® will only be 2-3 inches.

Setting the Inverts of the Downstream Defender®

The inlet pipe of the Downstream Defender® enters the manhole tangentially to generate rotational flow and is submerged to reduce the risk of blockage and decrease system headloss. The inlet pipe invert is exactly one pipe diameter lower than the outlet invert. The outlet pipe is set to match, or be lower than the outlet invert of the upstream bypass/junction structures. With this configuration, the overall HGL is not adversely affected (Fig.1).

No Bypass Manhole – Online Configuration

The Downstream Defender® is certified by the NJDEP for Online Use (Fig.2). To prevent peak storm flows from washing previously captured pollutants out of stormwater treatment devices, NJDEP limits Online Use Designation to devices that are independently proven to prevent pollutant washout. As shown in Fig.2, an Online Downstream Defender® does not require an additional bypass or junction manhole and the entire peak storm flow is conveyed through its vortex chamber (i.e. there is no internal bypass).

A Downstream Defender® can be placed Online as long as the Water Quality Treatment Flow Rate (Refer to Table 1: Column 1) is greater than or equal to the "NJ Design Storm" flow rate and the drainage system pipe diameter is less than or equal to the Downstream Defender®'s maximum inlet pipe diameter (Refer to Table 1, Column 4). If the Downstream Defender®'s maximum inlet pipe size is too small compared to the drainage pipe, a larger model should be considered or a bypass/junction manhole should be provided.

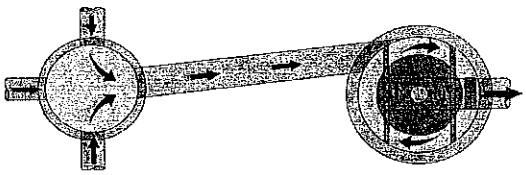


Fig.2 Online Downstream Defender®.

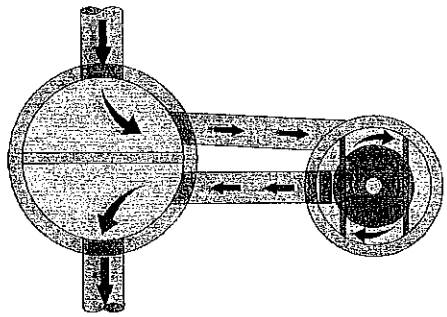


Fig.3 Offline Downstream Defender®.

Single Bypass/Junction Manhole – Offline Configuration

The Downstream Defender® can be designed with an external bypass or junction manhole (Fig.3). The advantages of this layout include diverting peak storm flows away from the treatment system, avoiding oversized treatment systems due to pipe size or peak flow and the treatment system can be located to avoid utilities or difficult maintenance and inspection areas.

Due to the flexibility of the Downstream Defender®'s internal components and tangential inlet, the offline design may only require one manhole for both bypass and junction.

Downstream Defender®

Downstream Defender® Sizing Calculator for New Jersey Projects

Hydro International recommends that consultants considering a Downstream Defender® for use on a New Jersey project use Hydro International's online Downstream Defender® Sizing Calculator for Engineers.

Using basic project-specific inputs such as Water Quality Flow Rate, the calculator determines the most appropriate Downstream Defender® model size for the job (Fig.4).

As the Downstream Defender® is approved for online or offline use by NJDEP, the calculator also uses inputs such as Peak Flow Rate to recommend whether an offline configuration is more appropriate than an online configuration.

The Downstream Defender® Sizing Calculator for Engineers can also be used to generate site-specific detail drawings for either online or offline devices. Users may opt to submit their design to Hydro International for a technical review and pricing.

To use the online Sizing Calculator for Engineers visit http://sizingcalculator.hydro-int.com/.

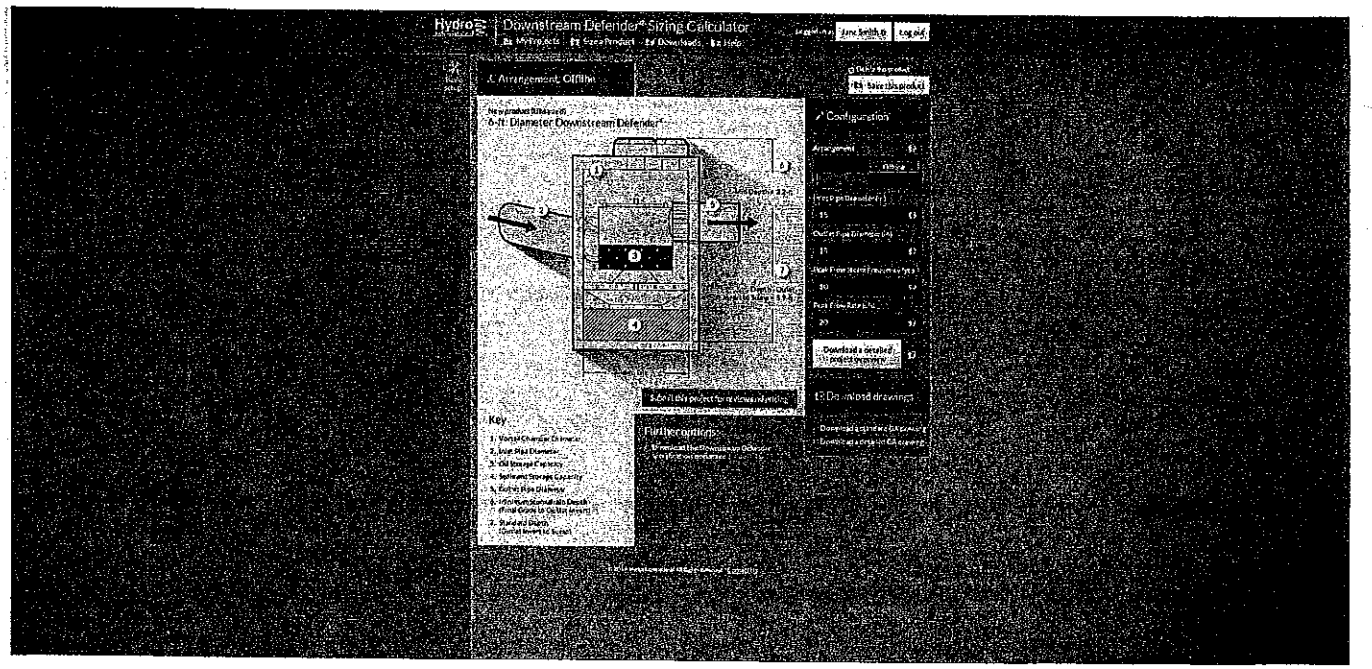


Fig.4 The Downstream Defender® Sizing Calculator for Engineers is an online tool that determines the most appropriate Downstream Defender® model size for a specific project.

Important Links

Downstream Defender® on Hydro International Site: http://www.hydro-int.com/us/products/downstream-defender
Interactive Downstream Defender® Sizing Calculator for Engineers: http://sizingcalculator.hydro-int.com/
NJDEP Certification Letter: http://www.njstormwater.org/pdf/downstream-defender-signed-final-certification-w-maintenance.pdf
NJCAT Testing Report: http://www.njcat.org/uploads/newDocs/DDVerificationReportFinal.pdf

New Jersey Representative - Nick Burns, E.I. (703) 424-3340 nburns@hydro-int.com
Hydro International, 94 Hutchins Drive, Portland, ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212
Email: stormwaterinquiry@hydro-int.com Web: www.hydro-int.com

Water Quality Calculation

Routed 1 year storm event. The peak Flow Qpeac 0.22 cfs

Time of peak flow occurs Tpeak 2.17 hrs

Max Elevation 139.88 ft

x=	139.88	**x0=**	139	**x1=**	140	Elevation
y=	Unknown	**y0=**	5700	**y1=**	17800	Volume

y= y0 + (x-x0) (y1-y0 / x1-x0)

$$\frac{y1-y0}{x1-x0} = 12100$$

x-x0= 0.88

y= 16348 Peak Voulume (cf)

Volume of water detained at 24 hrs after peak flow occurs

Time= 26.17 hrs
Elevation= 138.41 ft

x=	138.41	**x0=**	138	**x1=**	139	Elevation
y=	Unknown	**y0=**	0	**y1=**	5700	Volume

y= y0 + (x-x0) (y1-y0 / x1-x0)

$$\frac{y1-y0}{x1-x0} = 5700$$

x-x0= 0.41

y= 2337 Peak Voulume (cf)

10% of peak flow volume = 1635 (cf)

Volume detained = 2337 (cf)

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Friday, 11 / 6 / 2015

Hyd. No. 5

Area 1 Detained

Hydrograph type	= Reservoir	Peak discharge	= 0.215 cfs
Storm frequency	= 1 yrs	Time to peak	= 2.17 hrs
Time interval	= 5 min	Hyd. volume	= 17,265 cuft
Inflow hyd. No.	= 4 - Post Development	Reservoir name	= Extended Detentio
Max. Elevation	= 139.88 ft	Max. Storage	= 16,373 cuft

Storage Indication method used.

Hydrograph Discharge Table

(Printed values >= 20.00% of Qp.)

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
0.92	2.294	138.24	0.061	0.061	-----	-----	-----	-----	-----	-----	-----	0.061
1.00	5.086	138.43	0.101	0.093	-----	-----	-----	-----	-----	-----	-----	0.093
1.08	9.245	138.80	0.144	0.134	-----	-----	-----	-----	-----	-----	-----	0.134
1.17	10.48 <<	139.15	0.166	0.164	-----	-----	-----	-----	-----	-----	-----	0.164
1.25	8.240	139.38	0.184	0.181	-----	-----	-----	-----	-----	-----	-----	0.181
1.33	5.155	139.54	0.207	0.192	-----	-----	-----	-----	-----	-----	-----	0.192
1.42	2.855	139.63	0.207	0.199	-----	-----	-----	-----	-----	-----	-----	0.199
1.50	2.082	139.69	0.207	0.203	-----	-----	-----	-----	-----	-----	-----	0.203
1.58	1.861	139.73	0.208	0.205	-----	-----	-----	-----	-----	-----	-----	0.205
1.67	1.678	139.77	0.209	0.208	-----	-----	-----	-----	-----	-----	-----	0.208
1.75	1.590	139.81	0.211	0.210	-----	-----	-----	-----	-----	-----	-----	0.210
1.83	1.350	139.84	0.218	0.212	-----	-----	-----	-----	-----	-----	-----	0.212
1.92	0.903	139.86	0.223	0.213	-----	-----	-----	-----	-----	-----	-----	0.213
2.00	0.554	139.87	0.226	0.214	-----	-----	-----	-----	-----	-----	-----	0.214
2.08	0.404	139.88	0.227	0.214	-----	-----	-----	-----	-----	-----	-----	0.214
2.17	0.202	139.88 <<	0.228	0.215	-----	-----	-----	-----	-----	-----	-----	0.215
2.25	0.101	139.88	0.227	0.214	-----	-----	-----	-----	-----	-----	-----	0.214
2.33	0.000	139.88	0.226	0.214	-----	-----	-----	-----	-----	-----	-----	0.214
2.42	0.000	139.87	0.225	0.214	-----	-----	-----	-----	-----	-----	-----	0.214

Continues on next page...

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
2.50	0.000	139.87	0.224	0.214	-----	-----	-----	-----	-----	-----	-----	0.214
2.58	0.000	139.86	0.223	0.213	-----	-----	-----	-----	-----	-----	-----	0.213
2.67	0.000	139.86	0.222	0.213	-----	-----	-----	-----	-----	-----	-----	0.213
2.75	0.000	139.85	0.221	0.213	-----	-----	-----	-----	-----	-----	-----	0.213
2.83	0.000	139.84	0.219	0.212	-----	-----	-----	-----	-----	-----	-----	0.212
2.92	0.000	139.84	0.218	0.212	-----	-----	-----	-----	-----	-----	-----	0.212
3.00	0.000	139.83	0.217	0.212	-----	-----	-----	-----	-----	-----	-----	0.212
3.08	0.000	139.83	0.216	0.211	-----	-----	-----	-----	-----	-----	-----	0.211
3.17	0.000	139.82	0.215	0.211	-----	-----	-----	-----	-----	-----	-----	0.211
3.25	0.000	139.82	0.214	0.211	-----	-----	-----	-----	-----	-----	-----	0.211
3.33	0.000	139.81	0.213	0.210	-----	-----	-----	-----	-----	-----	-----	0.210
3.42	0.000	139.81	0.211	0.210	-----	-----	-----	-----	-----	-----	-----	0.210
3.50	0.000	139.80	0.210	0.210	-----	-----	-----	-----	-----	-----	-----	0.210
3.58	0.000	139.80	0.210	0.209	-----	-----	-----	-----	-----	-----	-----	0.209
3.67	0.000	139.79	0.209	0.209	-----	-----	-----	-----	-----	-----	-----	0.209
3.75	0.000	139.79	0.209	0.209	-----	-----	-----	-----	-----	-----	-----	0.209
3.83	0.000	139.78	0.209	0.208	-----	-----	-----	-----	-----	-----	-----	0.208
3.92	0.000	139.78	0.209	0.208	-----	-----	-----	-----	-----	-----	-----	0.208
4.00	0.000	139.77	0.209	0.208	-----	-----	-----	-----	-----	-----	-----	0.208
4.08	0.000	139.77	0.209	0.208	-----	-----	-----	-----	-----	-----	-----	0.208
4.17	0.000	139.76	0.209	0.207	-----	-----	-----	-----	-----	-----	-----	0.207
4.25	0.000	139.76	0.208	0.207	-----	-----	-----	-----	-----	-----	-----	0.207
4.33	0.000	139.75	0.208	0.207	-----	-----	-----	-----	-----	-----	-----	0.207
4.42	0.000	139.75	0.208	0.206	-----	-----	-----	-----	-----	-----	-----	0.206
4.50	0.000	139.74	0.208	0.206	-----	-----	-----	-----	-----	-----	-----	0.206
4.58	0.000	139.74	0.208	0.206	-----	-----	-----	-----	-----	-----	-----	0.206
4.67	0.000	139.73	0.208	0.205	-----	-----	-----	-----	-----	-----	-----	0.205

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
4.75	0.000	139.73	0.208	0.205	-----	-----	-----	-----	-----	-----	-----	0.205
4.83	0.000	139.72	0.207	0.205	-----	-----	-----	-----	-----	-----	-----	0.205
4.92	0.000	139.72	0.207	0.204	-----	-----	-----	-----	-----	-----	-----	0.204
5.00	0.000	139.71	0.207	0.204	-----	-----	-----	-----	-----	-----	-----	0.204
5.08	0.000	139.71	0.207	0.204	-----	-----	-----	-----	-----	-----	-----	0.204
5.17	0.000	139.70	0.207	0.203	-----	-----	-----	-----	-----	-----	-----	0.203
5.25	0.000	139.70	0.207	0.203	-----	-----	-----	-----	-----	-----	-----	0.203
5.33	0.000	139.69	0.207	0.203	-----	-----	-----	-----	-----	-----	-----	0.203
5.42	0.000	139.69	0.207	0.202	-----	-----	-----	-----	-----	-----	-----	0.202
5.50	0.000	139.68	0.207	0.202	-----	-----	-----	-----	-----	-----	-----	0.202
5.58	0.000	139.68	0.207	0.202	-----	-----	-----	-----	-----	-----	-----	0.202
5.67	0.000	139.67	0.207	0.201	-----	-----	-----	-----	-----	-----	-----	0.201
5.75	0.000	139.67	0.207	0.201	-----	-----	-----	-----	-----	-----	-----	0.201
5.83	0.000	139.66	0.207	0.201	-----	-----	-----	-----	-----	-----	-----	0.201
5.92	0.000	139.66	0.207	0.200	-----	-----	-----	-----	-----	-----	-----	0.200
6.00	0.000	139.65	0.207	0.200	-----	-----	-----	-----	-----	-----	-----	0.200
6.08	0.000	139.65	0.207	0.200	-----	-----	-----	-----	-----	-----	-----	0.200
6.17	0.000	139.64	0.207	0.199	-----	-----	-----	-----	-----	-----	-----	0.199
6.25	0.000	139.64	0.207	0.199	-----	-----	-----	-----	-----	-----	-----	0.199
6.33	0.000	139.63	0.207	0.199	-----	-----	-----	-----	-----	-----	-----	0.199
6.42	0.000	139.63	0.207	0.198	-----	-----	-----	-----	-----	-----	-----	0.198
6.50	0.000	139.62	0.207	0.198	-----	-----	-----	-----	-----	-----	-----	0.198
6.58	0.000	139.62	0.207	0.198	-----	-----	-----	-----	-----	-----	-----	0.198
6.67	0.000	139.61	0.207	0.197	-----	-----	-----	-----	-----	-----	-----	0.197
6.75	0.000	139.61	0.207	0.197	-----	-----	-----	-----	-----	-----	-----	0.197
6.83	0.000	139.60	0.207	0.197	-----	-----	-----	-----	-----	-----	-----	0.197
6.92	0.000	139.60	0.207	0.196	-----	-----	-----	-----	-----	-----	-----	0.196

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
7.00	0.000	139.59	0.207	0.196	-----	-----	-----	-----	-----	-----	-----	0.196
7.08	0.000	139.59	0.207	0.196	-----	-----	-----	-----	-----	-----	-----	0.196
7.17	0.000	139.58	0.207	0.195	-----	-----	-----	-----	-----	-----	-----	0.195
7.25	0.000	139.58	0.207	0.195	-----	-----	-----	-----	-----	-----	-----	0.195
7.33	0.000	139.57	0.207	0.195	-----	-----	-----	-----	-----	-----	-----	0.195
7.42	0.000	139.57	0.207	0.194	-----	-----	-----	-----	-----	-----	-----	0.194
7.50	0.000	139.56	0.207	0.194	-----	-----	-----	-----	-----	-----	-----	0.194
7.58	0.000	139.56	0.207	0.194	-----	-----	-----	-----	-----	-----	-----	0.194
7.67	0.000	139.55	0.207	0.193	-----	-----	-----	-----	-----	-----	-----	0.193
7.75	0.000	139.55	0.207	0.193	-----	-----	-----	-----	-----	-----	-----	0.193
7.83	0.000	139.54	0.207	0.193	-----	-----	-----	-----	-----	-----	-----	0.193
7.92	0.000	139.54	0.207	0.192	-----	-----	-----	-----	-----	-----	-----	0.192
8.00	0.000	139.53	0.207	0.192	-----	-----	-----	-----	-----	-----	-----	0.192
8.08	0.000	139.53	0.207	0.192	-----	-----	-----	-----	-----	-----	-----	0.192
8.17	0.000	139.52	0.207	0.191	-----	-----	-----	-----	-----	-----	-----	0.191
8.25	0.000	139.52	0.207	0.191	-----	-----	-----	-----	-----	-----	-----	0.191
8.33	0.000	139.51	0.207	0.191	-----	-----	-----	-----	-----	-----	-----	0.191
8.42	0.000	139.51	0.207	0.190	-----	-----	-----	-----	-----	-----	-----	0.190
8.50	0.000	139.51	0.207	0.190	-----	-----	-----	-----	-----	-----	-----	0.190
8.58	0.000	139.50	0.207	0.190	-----	-----	-----	-----	-----	-----	-----	0.190
8.67	0.000	139.50	0.206	0.189	-----	-----	-----	-----	-----	-----	-----	0.189
8.75	0.000	139.49	0.205	0.189	-----	-----	-----	-----	-----	-----	-----	0.189
8.83	0.000	139.49	0.204	0.189	-----	-----	-----	-----	-----	-----	-----	0.189
8.92	0.000	139.48	0.203	0.188	-----	-----	-----	-----	-----	-----	-----	0.188
9.00	0.000	139.48	0.202	0.188	-----	-----	-----	-----	-----	-----	-----	0.188
9.08	0.000	139.47	0.201	0.188	-----	-----	-----	-----	-----	-----	-----	0.188
9.17	0.000	139.47	0.200	0.188	-----	-----	-----	-----	-----	-----	-----	0.188

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
9.25	0.000	139.46	0.198	0.187	-----	-----	-----	-----	-----	-----	-----	0.187
9.33	0.000	139.46	0.197	0.187	-----	-----	-----	-----	-----	-----	-----	0.187
9.42	0.000	139.45	0.196	0.187	-----	-----	-----	-----	-----	-----	-----	0.187
9.50	0.000	139.45	0.195	0.186	-----	-----	-----	-----	-----	-----	-----	0.186
9.58	0.000	139.44	0.194	0.186	-----	-----	-----	-----	-----	-----	-----	0.186
9.67	0.000	139.44	0.193	0.186	-----	-----	-----	-----	-----	-----	-----	0.186
9.75	0.000	139.44	0.192	0.185	-----	-----	-----	-----	-----	-----	-----	0.185
9.83	0.000	139.43	0.191	0.185	-----	-----	-----	-----	-----	-----	-----	0.185
9.92	0.000	139.43	0.190	0.185	-----	-----	-----	-----	-----	-----	-----	0.185
10.00	0.000	139.42	0.189	0.185	-----	-----	-----	-----	-----	-----	-----	0.185
10.08	0.000	139.42	0.188	0.184	-----	-----	-----	-----	-----	-----	-----	0.184
10.17	0.000	139.41	0.187	0.184	-----	-----	-----	-----	-----	-----	-----	0.184
10.25	0.000	139.41	0.186	0.184	-----	-----	-----	-----	-----	-----	-----	0.184
10.33	0.000	139.40	0.185	0.183	-----	-----	-----	-----	-----	-----	-----	0.183
10.42	0.000	139.40	0.184	0.183	-----	-----	-----	-----	-----	-----	-----	0.183
10.50	0.000	139.39	0.184	0.183	-----	-----	-----	-----	-----	-----	-----	0.183
10.58	0.000	139.39	0.184	0.182	-----	-----	-----	-----	-----	-----	-----	0.182
10.67	0.000	139.39	0.184	0.182	-----	-----	-----	-----	-----	-----	-----	0.182
10.75	0.000	139.38	0.184	0.182	-----	-----	-----	-----	-----	-----	-----	0.182
10.83	0.000	139.38	0.184	0.181	-----	-----	-----	-----	-----	-----	-----	0.181
10.92	0.000	139.37	0.184	0.181	-----	-----	-----	-----	-----	-----	-----	0.181
11.00	0.000	139.37	0.184	0.181	-----	-----	-----	-----	-----	-----	-----	0.181
11.08	0.000	139.36	0.184	0.180	-----	-----	-----	-----	-----	-----	-----	0.180
11.17	0.000	139.36	0.184	0.180	-----	-----	-----	-----	-----	-----	-----	0.180
11.25	0.000	139.35	0.184	0.180	-----	-----	-----	-----	-----	-----	-----	0.180
11.33	0.000	139.35	0.184	0.179	-----	-----	-----	-----	-----	-----	-----	0.179
11.42	0.000	139.35	0.184	0.179	-----	-----	-----	-----	-----	-----	-----	0.179

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
11.50	0.000	139.34	0.184	0.179	-----	-----	-----	-----	-----	-----	-----	0.179
11.58	0.000	139.34	0.184	0.178	-----	-----	-----	-----	-----	-----	-----	0.178
11.67	0.000	139.33	0.184	0.178	-----	-----	-----	-----	-----	-----	-----	0.178
11.75	0.000	139.33	0.184	0.178	-----	-----	-----	-----	-----	-----	-----	0.178
11.83	0.000	139.32	0.184	0.177	-----	-----	-----	-----	-----	-----	-----	0.177
11.92	0.000	139.32	0.184	0.177	-----	-----	-----	-----	-----	-----	-----	0.177
12.00	0.000	139.31	0.184	0.177	-----	-----	-----	-----	-----	-----	-----	0.177
12.08	0.000	139.31	0.184	0.176	-----	-----	-----	-----	-----	-----	-----	0.176
12.17	0.000	139.31	0.184	0.176	-----	-----	-----	-----	-----	-----	-----	0.176
12.25	0.000	139.30	0.184	0.176	-----	-----	-----	-----	-----	-----	-----	0.176
12.33	0.000	139.30	0.184	0.175	-----	-----	-----	-----	-----	-----	-----	0.175
12.42	0.000	139.29	0.183	0.175	-----	-----	-----	-----	-----	-----	-----	0.175
12.50	0.000	139.29	0.182	0.175	-----	-----	-----	-----	-----	-----	-----	0.175
12.58	0.000	139.28	0.181	0.174	-----	-----	-----	-----	-----	-----	-----	0.174
12.67	0.000	139.28	0.181	0.174	-----	-----	-----	-----	-----	-----	-----	0.174
12.75	0.000	139.28	0.180	0.174	-----	-----	-----	-----	-----	-----	-----	0.174
12.83	0.000	139.27	0.179	0.173	-----	-----	-----	-----	-----	-----	-----	0.173
12.92	0.000	139.27	0.179	0.173	-----	-----	-----	-----	-----	-----	-----	0.173
13.00	0.000	139.26	0.178	0.173	-----	-----	-----	-----	-----	-----	-----	0.173
13.08	0.000	139.26	0.177	0.172	-----	-----	-----	-----	-----	-----	-----	0.172
13.17	0.000	139.25	0.177	0.172	-----	-----	-----	-----	-----	-----	-----	0.172
13.25	0.000	139.25	0.176	0.172	-----	-----	-----	-----	-----	-----	-----	0.172
13.33	0.000	139.25	0.175	0.171	-----	-----	-----	-----	-----	-----	-----	0.171
13.42	0.000	139.24	0.175	0.171	-----	-----	-----	-----	-----	-----	-----	0.171
13.50	0.000	139.24	0.174	0.171	-----	-----	-----	-----	-----	-----	-----	0.171
13.58	0.000	139.23	0.173	0.170	-----	-----	-----	-----	-----	-----	-----	0.170
13.67	0.000	139.23	0.173	0.170	-----	-----	-----	-----	-----	-----	-----	0.170

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
13.75	0.000	139.22	0.172	0.170	-----	-----	-----	-----	-----	-----	-----	0.170
13.83	0.000	139.22	0.171	0.169	-----	-----	-----	-----	-----	-----	-----	0.169
13.92	0.000	139.22	0.170	0.169	-----	-----	-----	-----	-----	-----	-----	0.169
14.00	0.000	139.21	0.170	0.169	-----	-----	-----	-----	-----	-----	-----	0.169
14.08	0.000	139.21	0.169	0.168	-----	-----	-----	-----	-----	-----	-----	0.168
14.17	0.000	139.20	0.168	0.168	-----	-----	-----	-----	-----	-----	-----	0.168
14.25	0.000	139.20	0.168	0.168	-----	-----	-----	-----	-----	-----	-----	0.168
14.33	0.000	139.19	0.168	0.167	-----	-----	-----	-----	-----	-----	-----	0.167
14.42	0.000	139.19	0.167	0.167	-----	-----	-----	-----	-----	-----	-----	0.167
14.50	0.000	139.19	0.167	0.167	-----	-----	-----	-----	-----	-----	-----	0.167
14.58	0.000	139.18	0.167	0.167	-----	-----	-----	-----	-----	-----	-----	0.167
14.67	0.000	139.18	0.167	0.166	-----	-----	-----	-----	-----	-----	-----	0.166
14.75	0.000	139.17	0.167	0.166	-----	-----	-----	-----	-----	-----	-----	0.166
14.83	0.000	139.17	0.167	0.166	-----	-----	-----	-----	-----	-----	-----	0.166
14.92	0.000	139.17	0.166	0.165	-----	-----	-----	-----	-----	-----	-----	0.165
15.00	0.000	139.16	0.166	0.165	-----	-----	-----	-----	-----	-----	-----	0.165
15.08	0.000	139.16	0.166	0.165	-----	-----	-----	-----	-----	-----	-----	0.165
15.17	0.000	139.15	0.166	0.164	-----	-----	-----	-----	-----	-----	-----	0.164
15.25	0.000	139.15	0.166	0.164	-----	-----	-----	-----	-----	-----	-----	0.164
15.33	0.000	139.15	0.165	0.164	-----	-----	-----	-----	-----	-----	-----	0.164
15.42	0.000	139.14	0.165	0.163	-----	-----	-----	-----	-----	-----	-----	0.163
15.50	0.000	139.14	0.165	0.163	-----	-----	-----	-----	-----	-----	-----	0.163
15.58	0.000	139.13	0.165	0.163	-----	-----	-----	-----	-----	-----	-----	0.163
15.67	0.000	139.13	0.165	0.163	-----	-----	-----	-----	-----	-----	-----	0.163
15.75	0.000	139.13	0.164	0.162	-----	-----	-----	-----	-----	-----	-----	0.162
15.83	0.000	139.12	0.164	0.162	-----	-----	-----	-----	-----	-----	-----	0.162
15.92	0.000	139.12	0.164	0.162	-----	-----	-----	-----	-----	-----	-----	0.162

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
16.00	0.000	139.11	0.164	0.161	-----	-----	-----	-----	-----	-----	-----	0.161
16.08	0.000	139.11	0.164	0.161	-----	-----	-----	-----	-----	-----	-----	0.161
16.17	0.000	139.11	0.164	0.161	-----	-----	-----	-----	-----	-----	-----	0.161
16.25	0.000	139.10	0.163	0.160	-----	-----	-----	-----	-----	-----	-----	0.160
16.33	0.000	139.10	0.163	0.160	-----	-----	-----	-----	-----	-----	-----	0.160
16.42	0.000	139.09	0.163	0.160	-----	-----	-----	-----	-----	-----	-----	0.160
16.50	0.000	139.09	0.163	0.159	-----	-----	-----	-----	-----	-----	-----	0.159
16.58	0.000	139.09	0.163	0.159	-----	-----	-----	-----	-----	-----	-----	0.159
16.67	0.000	139.08	0.163	0.159	-----	-----	-----	-----	-----	-----	-----	0.159
16.75	0.000	139.08	0.163	0.158	-----	-----	-----	-----	-----	-----	-----	0.158
16.83	0.000	139.07	0.163	0.158	-----	-----	-----	-----	-----	-----	-----	0.158
16.92	0.000	139.07	0.163	0.158	-----	-----	-----	-----	-----	-----	-----	0.158
17.00	0.000	139.07	0.163	0.157	-----	-----	-----	-----	-----	-----	-----	0.157
17.08	0.000	139.06	0.163	0.157	-----	-----	-----	-----	-----	-----	-----	0.157
17.17	0.000	139.06	0.163	0.157	-----	-----	-----	-----	-----	-----	-----	0.157
17.25	0.000	139.05	0.163	0.156	-----	-----	-----	-----	-----	-----	-----	0.156
17.33	0.000	139.05	0.163	0.156	-----	-----	-----	-----	-----	-----	-----	0.156
17.42	0.000	139.05	0.163	0.156	-----	-----	-----	-----	-----	-----	-----	0.156
17.50	0.000	139.04	0.163	0.155	-----	-----	-----	-----	-----	-----	-----	0.155
17.58	0.000	139.04	0.163	0.155	-----	-----	-----	-----	-----	-----	-----	0.155
17.67	0.000	139.03	0.163	0.155	-----	-----	-----	-----	-----	-----	-----	0.155
17.75	0.000	139.03	0.163	0.154	-----	-----	-----	-----	-----	-----	-----	0.154
17.83	0.000	139.03	0.163	0.154	-----	-----	-----	-----	-----	-----	-----	0.154
17.92	0.000	139.02	0.163	0.154	-----	-----	-----	-----	-----	-----	-----	0.154
18.00	0.000	139.02	0.163	0.153	-----	-----	-----	-----	-----	-----	-----	0.153
18.08	0.000	139.02	0.163	0.153	-----	-----	-----	-----	-----	-----	-----	0.153
18.17	0.000	139.01	0.163	0.153	-----	-----	-----	-----	-----	-----	-----	0.153

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
18.25	0.000	139.01	0.163	0.152	-----	-----	-----	-----	-----	-----	-----	0.152
18.33	0.000	139.00	0.163	0.152	-----	-----	-----	-----	-----	-----	-----	0.152
18.42	0.000	139.00	0.163	0.152	-----	-----	-----	-----	-----	-----	-----	0.152
18.50	0.000	138.99	0.162	0.151	-----	-----	-----	-----	-----	-----	-----	0.151
18.58	0.000	138.99	0.161	0.151	-----	-----	-----	-----	-----	-----	-----	0.151
18.67	0.000	138.98	0.159	0.150	-----	-----	-----	-----	-----	-----	-----	0.150
18.75	0.000	138.97	0.158	0.149	-----	-----	-----	-----	-----	-----	-----	0.149
18.83	0.000	138.96	0.156	0.149	-----	-----	-----	-----	-----	-----	-----	0.149
18.92	0.000	138.95	0.155	0.148	-----	-----	-----	-----	-----	-----	-----	0.148
19.00	0.000	138.95	0.153	0.147	-----	-----	-----	-----	-----	-----	-----	0.147
19.08	0.000	138.94	0.152	0.147	-----	-----	-----	-----	-----	-----	-----	0.147
19.17	0.000	138.93	0.150	0.146	-----	-----	-----	-----	-----	-----	-----	0.146
19.25	0.000	138.92	0.149	0.145	-----	-----	-----	-----	-----	-----	-----	0.145
19.33	0.000	138.92	0.147	0.145	-----	-----	-----	-----	-----	-----	-----	0.145
19.42	0.000	138.91	0.146	0.144	-----	-----	-----	-----	-----	-----	-----	0.144
19.50	0.000	138.90	0.144	0.143	-----	-----	-----	-----	-----	-----	-----	0.143
19.58	0.000	138.89	0.144	0.143	-----	-----	-----	-----	-----	-----	-----	0.143
19.67	0.000	138.89	0.144	0.142	-----	-----	-----	-----	-----	-----	-----	0.142
19.75	0.000	138.88	0.144	0.141	-----	-----	-----	-----	-----	-----	-----	0.141
19.83	0.000	138.87	0.144	0.141	-----	-----	-----	-----	-----	-----	-----	0.141
19.92	0.000	138.86	0.144	0.140	-----	-----	-----	-----	-----	-----	-----	0.140
20.00	0.000	138.86	0.144	0.139	-----	-----	-----	-----	-----	-----	-----	0.139
20.08	0.000	138.85	0.144	0.138	-----	-----	-----	-----	-----	-----	-----	0.138
20.17	0.000	138.84	0.144	0.138	-----	-----	-----	-----	-----	-----	-----	0.138
20.25	0.000	138.83	0.144	0.137	-----	-----	-----	-----	-----	-----	-----	0.137
20.33	0.000	138.83	0.144	0.136	-----	-----	-----	-----	-----	-----	-----	0.136
20.42	0.000	138.82	0.144	0.136	-----	-----	-----	-----	-----	-----	-----	0.136

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
20.50	0.000	138.81	0.144	0.135	-----	-----	-----	-----	-----	-----	-----	0.135
20.58	0.000	138.81	0.144	0.134	-----	-----	-----	-----	-----	-----	-----	0.134
20.67	0.000	138.80	0.144	0.134	-----	-----	-----	-----	-----	-----	-----	0.134
20.75	0.000	138.79	0.143	0.133	-----	-----	-----	-----	-----	-----	-----	0.133
20.83	0.000	138.78	0.141	0.132	-----	-----	-----	-----	-----	-----	-----	0.132
20.92	0.000	138.78	0.140	0.132	-----	-----	-----	-----	-----	-----	-----	0.132
21.00	0.000	138.77	0.139	0.131	-----	-----	-----	-----	-----	-----	-----	0.131
21.08	0.000	138.76	0.138	0.130	-----	-----	-----	-----	-----	-----	-----	0.130
21.17	0.000	138.76	0.137	0.130	-----	-----	-----	-----	-----	-----	-----	0.130
21.25	0.000	138.75	0.135	0.129	-----	-----	-----	-----	-----	-----	-----	0.129
21.33	0.000	138.74	0.134	0.128	-----	-----	-----	-----	-----	-----	-----	0.128
21.42	0.000	138.74	0.133	0.128	-----	-----	-----	-----	-----	-----	-----	0.128
21.50	0.000	138.73	0.132	0.127	-----	-----	-----	-----	-----	-----	-----	0.127
21.58	0.000	138.72	0.131	0.126	-----	-----	-----	-----	-----	-----	-----	0.126
21.67	0.000	138.72	0.130	0.126	-----	-----	-----	-----	-----	-----	-----	0.126
21.75	0.000	138.71	0.129	0.125	-----	-----	-----	-----	-----	-----	-----	0.125
21.83	0.000	138.70	0.127	0.125	-----	-----	-----	-----	-----	-----	-----	0.125
21.92	0.000	138.70	0.126	0.124	-----	-----	-----	-----	-----	-----	-----	0.124
22.00	0.000	138.69	0.125	0.123	-----	-----	-----	-----	-----	-----	-----	0.123
22.08	0.000	138.68	0.125	0.122	-----	-----	-----	-----	-----	-----	-----	0.122
22.17	0.000	138.68	0.124	0.122	-----	-----	-----	-----	-----	-----	-----	0.122
22.25	0.000	138.67	0.123	0.121	-----	-----	-----	-----	-----	-----	-----	0.121
22.33	0.000	138.66	0.122	0.120	-----	-----	-----	-----	-----	-----	-----	0.120
22.42	0.000	138.66	0.121	0.120	-----	-----	-----	-----	-----	-----	-----	0.120
22.50	0.000	138.65	0.120	0.119	-----	-----	-----	-----	-----	-----	-----	0.119
22.58	0.000	138.65	0.119	0.118	-----	-----	-----	-----	-----	-----	-----	0.118
22.67	0.000	138.64	0.119	0.118	-----	-----	-----	-----	-----	-----	-----	0.118

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
22.75	0.000	138.63	0.118	0.117	-----	-----	-----	-----	-----	-----	-----	0.117
22.83	0.000	138.63	0.117	0.116	-----	-----	-----	-----	-----	-----	-----	0.116
22.92	0.000	138.62	0.116	0.116	-----	-----	-----	-----	-----	-----	-----	0.116
23.00	0.000	138.62	0.115	0.115	-----	-----	-----	-----	-----	-----	-----	0.115
23.08	0.000	138.61	0.114	0.114	-----	-----	-----	-----	-----	-----	-----	0.114
23.17	0.000	138.60	0.114	0.114	-----	-----	-----	-----	-----	-----	-----	0.114
23.25	0.000	138.60	0.113	0.113	-----	-----	-----	-----	-----	-----	-----	0.113
23.33	0.000	138.59	0.113	0.112	-----	-----	-----	-----	-----	-----	-----	0.112
23.42	0.000	138.59	0.113	0.112	-----	-----	-----	-----	-----	-----	-----	0.112
23.50	0.000	138.58	0.113	0.111	-----	-----	-----	-----	-----	-----	-----	0.111
23.58	0.000	138.57	0.113	0.110	-----	-----	-----	-----	-----	-----	-----	0.110
23.67	0.000	138.57	0.113	0.109	-----	-----	-----	-----	-----	-----	-----	0.109
23.75	0.000	138.56	0.112	0.109	-----	-----	-----	-----	-----	-----	-----	0.109
23.83	0.000	138.56	0.112	0.108	-----	-----	-----	-----	-----	-----	-----	0.108
23.92	0.000	138.55	0.112	0.107	-----	-----	-----	-----	-----	-----	-----	0.107
24.00	0.000	138.55	0.112	0.107	-----	-----	-----	-----	-----	-----	-----	0.107
24.08	0.000	138.54	0.112	0.106	-----	-----	-----	-----	-----	-----	-----	0.106
24.17	0.000	138.53	0.112	0.105	-----	-----	-----	-----	-----	-----	-----	0.105
24.25	0.000	138.53	0.112	0.105	-----	-----	-----	-----	-----	-----	-----	0.105
24.33	0.000	138.52	0.111	0.104	-----	-----	-----	-----	-----	-----	-----	0.104
24.42	0.000	138.52	0.111	0.103	-----	-----	-----	-----	-----	-----	-----	0.103
24.50	0.000	138.51	0.111	0.103	-----	-----	-----	-----	-----	-----	-----	0.103
24.58	0.000	138.51	0.111	0.102	-----	-----	-----	-----	-----	-----	-----	0.102
24.67	0.000	138.50	0.111	0.101	-----	-----	-----	-----	-----	-----	-----	0.101
24.75	0.000	138.50	0.110	0.101	-----	-----	-----	-----	-----	-----	-----	0.101
24.83	0.000	138.49	0.110	0.100	-----	-----	-----	-----	-----	-----	-----	0.100
24.92	0.000	138.49	0.109	0.099	-----	-----	-----	-----	-----	-----	-----	0.099

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
25.00	0.000	138.48	0.108	0.099	-----	-----	-----	-----	-----	-----	-----	0.099
25.08	0.000	138.48	0.107	0.098	-----	-----	-----	-----	-----	-----	-----	0.098
25.17	0.000	138.47	0.107	0.097	-----	-----	-----	-----	-----	-----	-----	0.097
25.25	0.000	138.46	0.106	0.097	-----	-----	-----	-----	-----	-----	-----	0.097
25.33	0.000	138.46	0.105	0.096	-----	-----	-----	-----	-----	-----	-----	0.096
25.42	0.000	138.45	0.104	0.095	-----	-----	-----	-----	-----	-----	-----	0.095
25.50	0.000	138.45	0.104	0.095	-----	-----	-----	-----	-----	-----	-----	0.095
25.58	0.000	138.44	0.103	0.094	-----	-----	-----	-----	-----	-----	-----	0.094
25.67	0.000	138.44	0.102	0.093	-----	-----	-----	-----	-----	-----	-----	0.093
25.75	0.000	138.44	0.102	0.093	-----	-----	-----	-----	-----	-----	-----	0.093
25.83	0.000	138.43	0.101	0.092	-----	-----	-----	-----	-----	-----	-----	0.092
25.92	0.000	138.43	0.100	0.092	-----	-----	-----	-----	-----	-----	-----	0.092
26.00	0.000	138.42	0.100	0.091	-----	-----	-----	-----	-----	-----	-----	0.091
26.08	0.000	138.42	0.099	0.090	-----	-----	-----	-----	-----	-----	-----	0.090
26.17	0.000	138.41	0.098	0.090	-----	-----	-----	-----	-----	-----	-----	0.090
26.25	0.000	138.41	0.098	0.089	-----	-----	-----	-----	-----	-----	-----	0.089
26.33	0.000	138.40	0.097	0.088	-----	-----	-----	-----	-----	-----	-----	0.088
26.42	0.000	138.40	0.096	0.088	-----	-----	-----	-----	-----	-----	-----	0.088
26.50	0.000	138.39	0.095	0.087	-----	-----	-----	-----	-----	-----	-----	0.087
26.58	0.000	138.39	0.094	0.086	-----	-----	-----	-----	-----	-----	-----	0.086
26.67	0.000	138.38	0.093	0.086	-----	-----	-----	-----	-----	-----	-----	0.086
26.75	0.000	138.38	0.092	0.085	-----	-----	-----	-----	-----	-----	-----	0.085
26.83	0.000	138.37	0.090	0.084	-----	-----	-----	-----	-----	-----	-----	0.084
26.92	0.000	138.37	0.089	0.084	-----	-----	-----	-----	-----	-----	-----	0.084
27.00	0.000	138.37	0.088	0.083	-----	-----	-----	-----	-----	-----	-----	0.083
27.08	0.000	138.36	0.087	0.082	-----	-----	-----	-----	-----	-----	-----	0.082
27.17	0.000	138.36	0.086	0.082	-----	-----	-----	-----	-----	-----	-----	0.082

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
27.25	0.000	138.35	0.085	0.081	-----	-----	-----	-----	-----	-----	-----	0.081
27.33	0.000	138.35	0.084	0.080	-----	-----	-----	-----	-----	-----	-----	0.080
27.42	0.000	138.34	0.083	0.080	-----	-----	-----	-----	-----	-----	-----	0.080
27.50	0.000	138.34	0.082	0.079	-----	-----	-----	-----	-----	-----	-----	0.079
27.58	0.000	138.34	0.081	0.078	-----	-----	-----	-----	-----	-----	-----	0.078
27.67	0.000	138.33	0.080	0.078	-----	-----	-----	-----	-----	-----	-----	0.078
27.75	0.000	138.33	0.079	0.077	-----	-----	-----	-----	-----	-----	-----	0.077
27.83	0.000	138.32	0.078	0.076	-----	-----	-----	-----	-----	-----	-----	0.076
27.92	0.000	138.32	0.077	0.076	-----	-----	-----	-----	-----	-----	-----	0.076
28.00	0.000	138.32	0.076	0.075	-----	-----	-----	-----	-----	-----	-----	0.075
28.08	0.000	138.31	0.075	0.074	-----	-----	-----	-----	-----	-----	-----	0.074
28.17	0.000	138.31	0.075	0.074	-----	-----	-----	-----	-----	-----	-----	0.074
28.25	0.000	138.30	0.074	0.073	-----	-----	-----	-----	-----	-----	-----	0.073
28.33	0.000	138.30	0.073	0.073	-----	-----	-----	-----	-----	-----	-----	0.073
28.42	0.000	138.30	0.072	0.072	-----	-----	-----	-----	-----	-----	-----	0.072
28.50	0.000	138.29	0.071	0.071	-----	-----	-----	-----	-----	-----	-----	0.071
28.58	0.000	138.29	0.070	0.070	-----	-----	-----	-----	-----	-----	-----	0.070
28.67	0.000	138.29	0.070	0.069	-----	-----	-----	-----	-----	-----	-----	0.069
28.75	0.000	138.28	0.069	0.069	-----	-----	-----	-----	-----	-----	-----	0.069
28.83	0.000	138.28	0.068	0.068	-----	-----	-----	-----	-----	-----	-----	0.068
28.92	0.000	138.27	0.068	0.067	-----	-----	-----	-----	-----	-----	-----	0.067
29.00	0.000	138.27	0.067	0.066	-----	-----	-----	-----	-----	-----	-----	0.066
29.08	0.000	138.27	0.066	0.066	-----	-----	-----	-----	-----	-----	-----	0.066
29.17	0.000	138.26	0.065	0.065	-----	-----	-----	-----	-----	-----	-----	0.065
29.25	0.000	138.26	0.065	0.064	-----	-----	-----	-----	-----	-----	-----	0.064
29.33	0.000	138.26	0.064	0.063	-----	-----	-----	-----	-----	-----	-----	0.063
29.42	0.000	138.25	0.063	0.063	-----	-----	-----	-----	-----	-----	-----	0.063

Area 1 Detained

Hydrograph Discharge Table

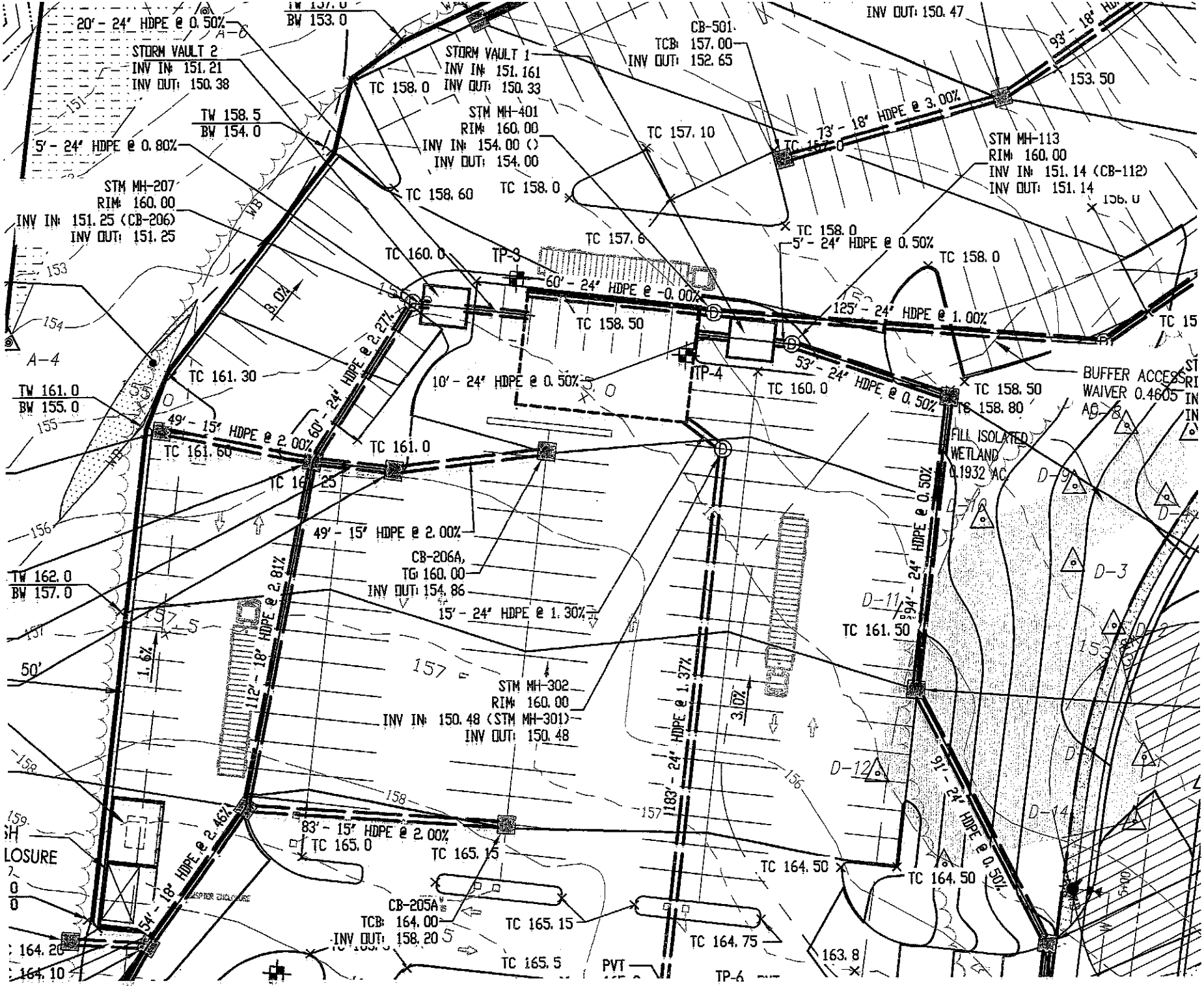
Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
29.50	0.000	138.25	0.063	0.062	-----	-----	-----	-----	-----	-----	-----	0.062
29.58	0.000	138.25	0.062	0.061	-----	-----	-----	-----	-----	-----	-----	0.061
29.67	0.000	138.24	0.061	0.061	-----	-----	-----	-----	-----	-----	-----	0.061
29.75	0.000	138.24	0.061	0.060	-----	-----	-----	-----	-----	-----	-----	0.060
29.83	0.000	138.24	0.060	0.059	-----	-----	-----	-----	-----	-----	-----	0.059
29.92	0.000	138.23	0.059	0.059	-----	-----	-----	-----	-----	-----	-----	0.059
30.00	0.000	138.23	0.059	0.058	-----	-----	-----	-----	-----	-----	-----	0.058
30.08	0.000	138.23	0.058	0.057	-----	-----	-----	-----	-----	-----	-----	0.057
30.17	0.000	138.23	0.058	0.057	-----	-----	-----	-----	-----	-----	-----	0.057
30.25	0.000	138.22	0.057	0.056	-----	-----	-----	-----	-----	-----	-----	0.056
30.33	0.000	138.22	0.056	0.055	-----	-----	-----	-----	-----	-----	-----	0.055
30.42	0.000	138.22	0.056	0.055	-----	-----	-----	-----	-----	-----	-----	0.055
30.50	0.000	138.21	0.055	0.054	-----	-----	-----	-----	-----	-----	-----	0.054
30.58	0.000	138.21	0.055	0.054	-----	-----	-----	-----	-----	-----	-----	0.054
30.67	0.000	138.21	0.054	0.053	-----	-----	-----	-----	-----	-----	-----	0.053
30.75	0.000	138.21	0.054	0.052	-----	-----	-----	-----	-----	-----	-----	0.052
30.83	0.000	138.20	0.053	0.052	-----	-----	-----	-----	-----	-----	-----	0.052
30.92	0.000	138.20	0.052	0.051	-----	-----	-----	-----	-----	-----	-----	0.051
31.00	0.000	138.20	0.052	0.050	-----	-----	-----	-----	-----	-----	-----	0.050
31.08	0.000	138.19	0.051	0.050	-----	-----	-----	-----	-----	-----	-----	0.050
31.17	0.000	138.19	0.050	0.049	-----	-----	-----	-----	-----	-----	-----	0.049
31.25	0.000	138.19	0.049	0.048	-----	-----	-----	-----	-----	-----	-----	0.048
31.33	0.000	138.19	0.048	0.047	-----	-----	-----	-----	-----	-----	-----	0.047
31.42	0.000	138.18	0.048	0.046	-----	-----	-----	-----	-----	-----	-----	0.046
31.50	0.000	138.18	0.047	0.045	-----	-----	-----	-----	-----	-----	-----	0.045
31.58	0.000	138.18	0.046	0.045	-----	-----	-----	-----	-----	-----	-----	0.045
31.67	0.000	138.18	0.045	0.044	-----	-----	-----	-----	-----	-----	-----	0.044

Area 1 Detained

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
31.75	0.000	138.18	0.045	0.043	-----	-----	-----	-----	-----	-----	-----	0.043

...End


20' - 24" HDPE @ 0.50%
STORM VAULT 2
INV IN: 151.21
INV OUT: 150.38
TW 158.5
BW 154.0
5' - 24" HDPE @ 0.80%
STM MH-207
RIM: 160.00
INV IN: 151.25 (CB-206)
INV OUT: 151.25
TW 161.0
BW 155.0
TW 162.0
BW 157.0
BW 153.0
STORM VAULT 1
INV IN: 151.161
INV OUT: 150.33
TC 158.0
STM MH-401
RIM: 160.00
INV IN: 154.00 ()
INV OUT: 154.00
TC 158.60
TC 158.0
CB-501
TCB: 157.00
INV OUT: 152.65
INV OUT: 150.47
93' - 18" HDPE @ 3.00%
153.50
TC 157.10
73' - 18" HDPE @ 3.00%
TC 157.0
STM MH-113
RIM: 160.00
INV IN: 151.14 (CB-112)
INV OUT: 151.14
TC 158.0
5' - 24" HDPE @ 0.50%
TC 158.0
TC 157.6
TC 160.0
TP-3
60' - 24" HDPE @ -0.00%
TC 158.50
125' - 24" HDPE @ 1.00%
TC 15
TP-4
53' - 24" HDPE @ 0.50%
TC 160.0
TC 158.50
TC 158.80
BUFFER ACCESS
WAIVER 0.4605 AC
FILL ISOLATED
WETLAND
0.1932 AC
TC 161.30
10' - 24" HDPE @ 0.50%
49' - 15" HDPE @ 2.00%
TC 161.60
TC 161.0
TC 161.25
60' - 24" HDPE @ 2.27%
49' - 15" HDPE @ 2.00%
CB-206A,
TG: 160.00
INV OUT: 154.86
15' - 24" HDPE @ 1.30%
112' - 18" HDPE @ 2.81%
194' - 24" HDPE @ 0.50%
TC 161.50
STM MH-302
RIM: 160.00
INV IN: 150.48 (STM MH-301)
INV OUT: 150.48
183' - 24" HDPE @ 1.37%
91' - 24" HDPE @ 0.50%
83' - 15" HDPE @ 2.00%
TC 165.0
TC 165.15
54' - 18" HDPE @ 2.46%
CB-205A
TCB: 164.00
INV OUT: 158.20
TC 165.15
TC 165.5
PVT
TC 164.75
TC 164.50
TC 164.50
163.8
TP-6
D-1
D-2
D-3
D-9
D-11
D-12
D-14
A-4
A-5
A-6
WB
9.0%
1.6%
3.0%
50'
LOSURE

Hydrograph Report

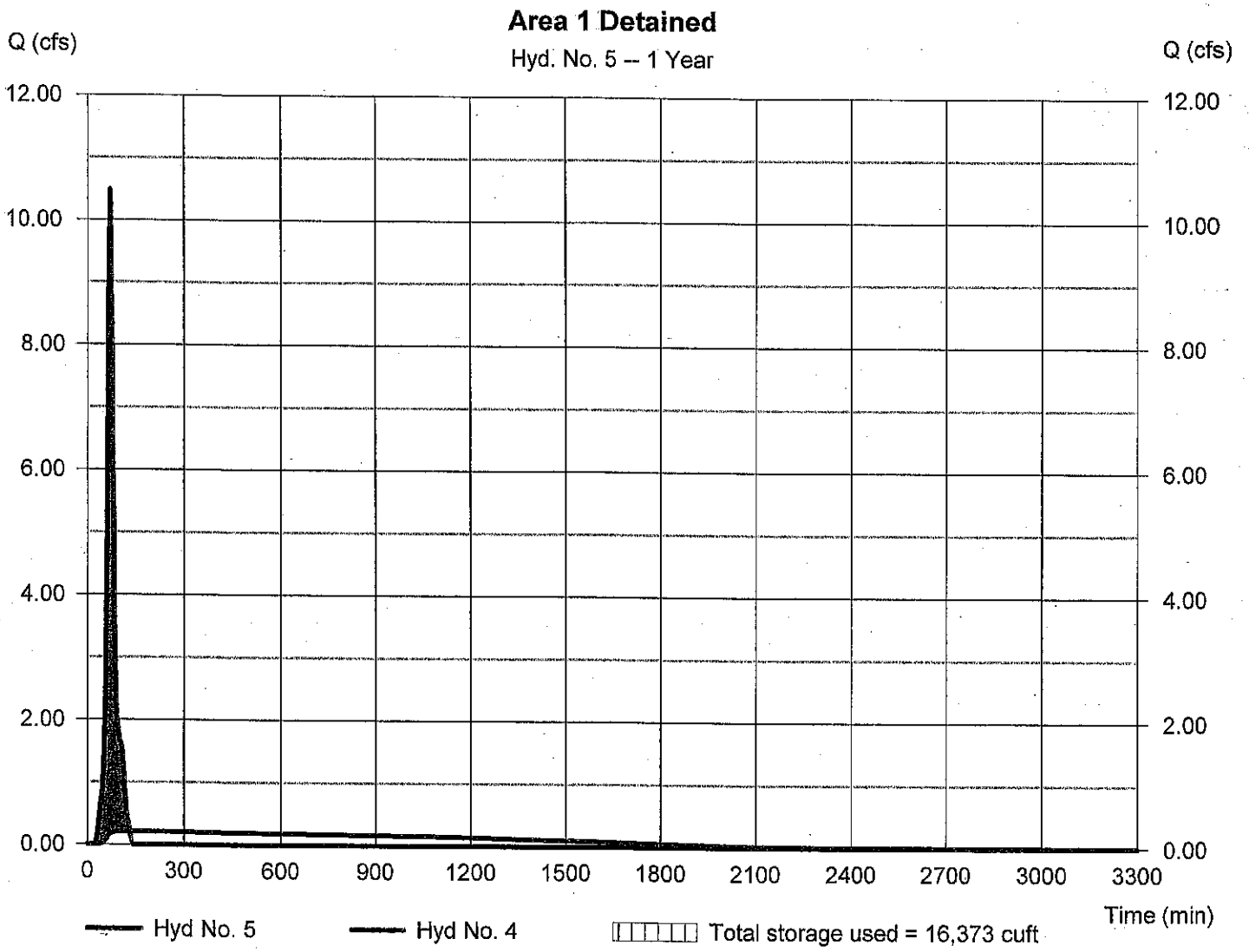
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Friday, 11 / 6 / 2015

Hyd. No. 5

Area 1 Detained

Hydrograph type	= Reservoir	Peak discharge	= 0.215 cfs
Storm frequency	= 1 yrs	Time to peak	= 130 min
Time interval	= 5 min	Hyd. volume	= 17,265 cuft
Inflow hyd. No.	= 4 - Post Development	Max. Elevation	= 139.88 ft
Reservoir name	= Extended Detention Basin	Max. Storage	= 16,373 cuft

Storage Indication method used.



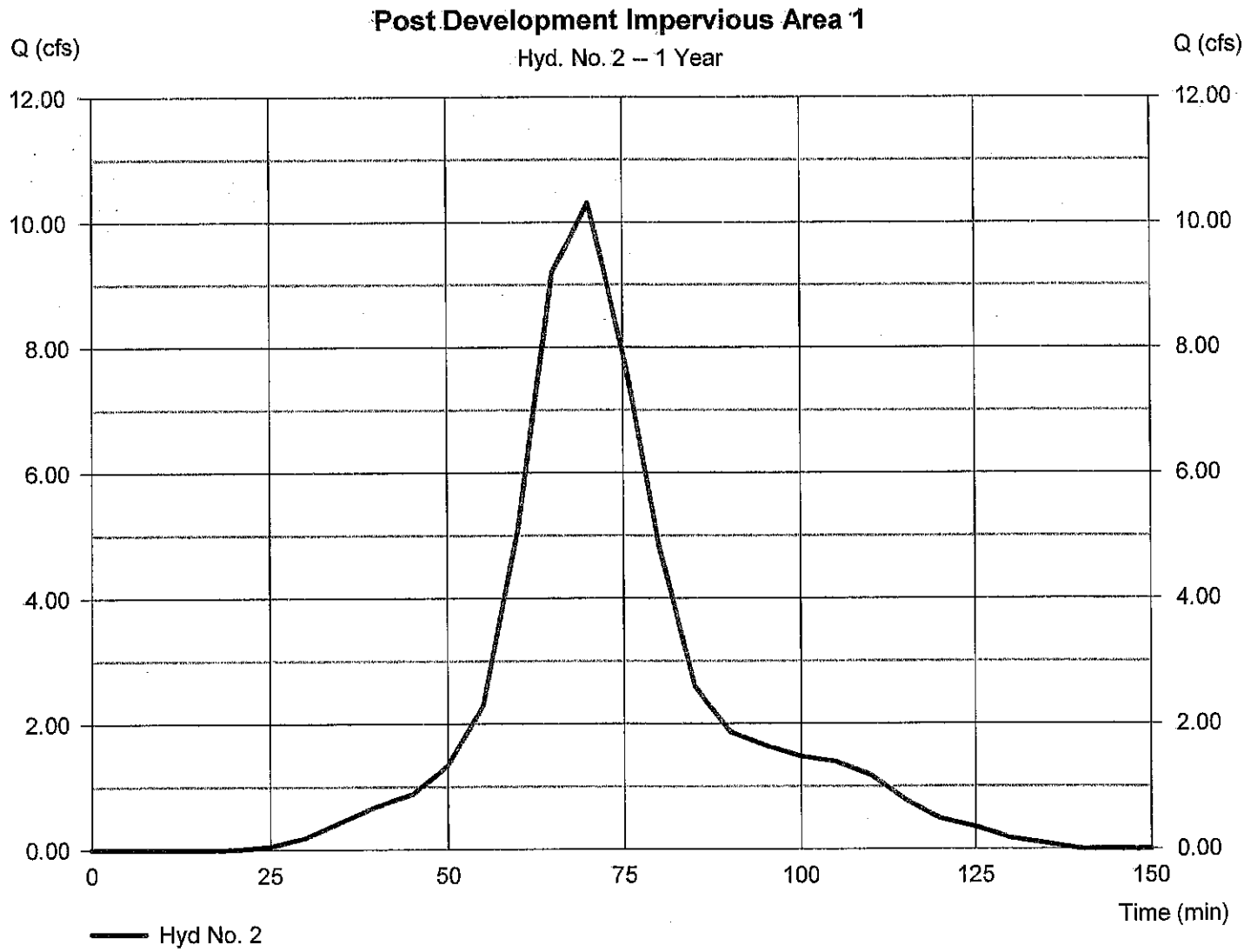
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Friday, 11 / 6 / 2015

Hyd. No. 2

Post Development Impervious Area 1

Hydrograph type	= SCS Runoff	Peak discharge	= 10.30 cfs
Storm frequency	= 1 yrs	Time to peak	= 70 min
Time interval	= 5 min	Hyd. volume	= 16,577 cuft
Drainage area	= 4.710 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.25 in	Distribution	= Custom
Storm duration	= F:\Shared_Users\calfaro\1.25Storm_CDS\1.25inch.cds	Shape factor	= 484



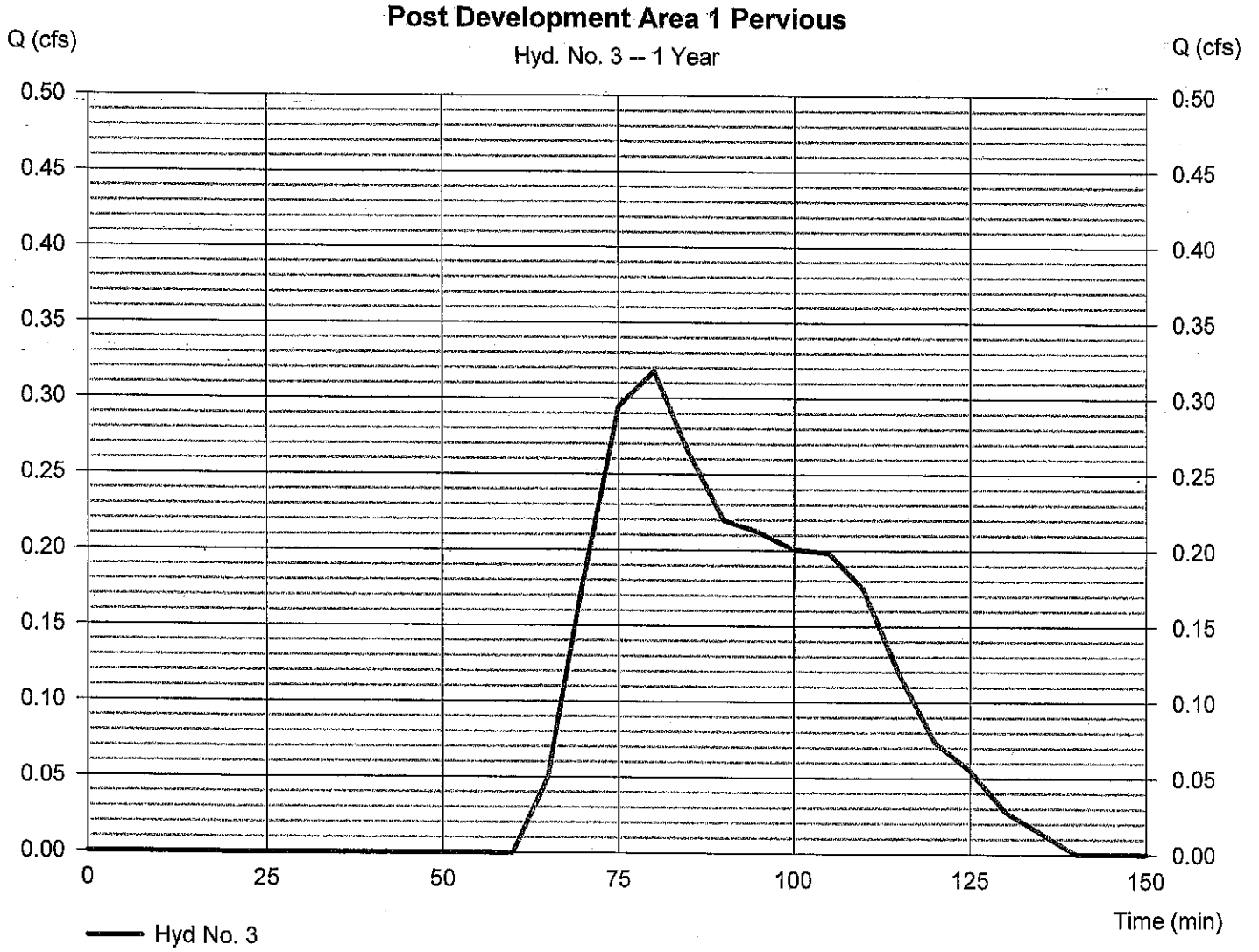
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Friday, 11 / 6 / 2015

Hyd. No. 3

Post Development Area 1 Pervious

Hydrograph type	= SCS Runoff	Peak discharge	= 0.318 cfs
Storm frequency	= 1 yrs	Time to peak	= 80 min
Time interval	= 5 min	Hyd. volume	= 720 cuft
Drainage area	= 2.940 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.25 in	Distribution	= Custom
Storm duration	= F:\Shared_Users\calfaro\1.25Storm\CDS1.25inch.cds	Shape factor	= 484



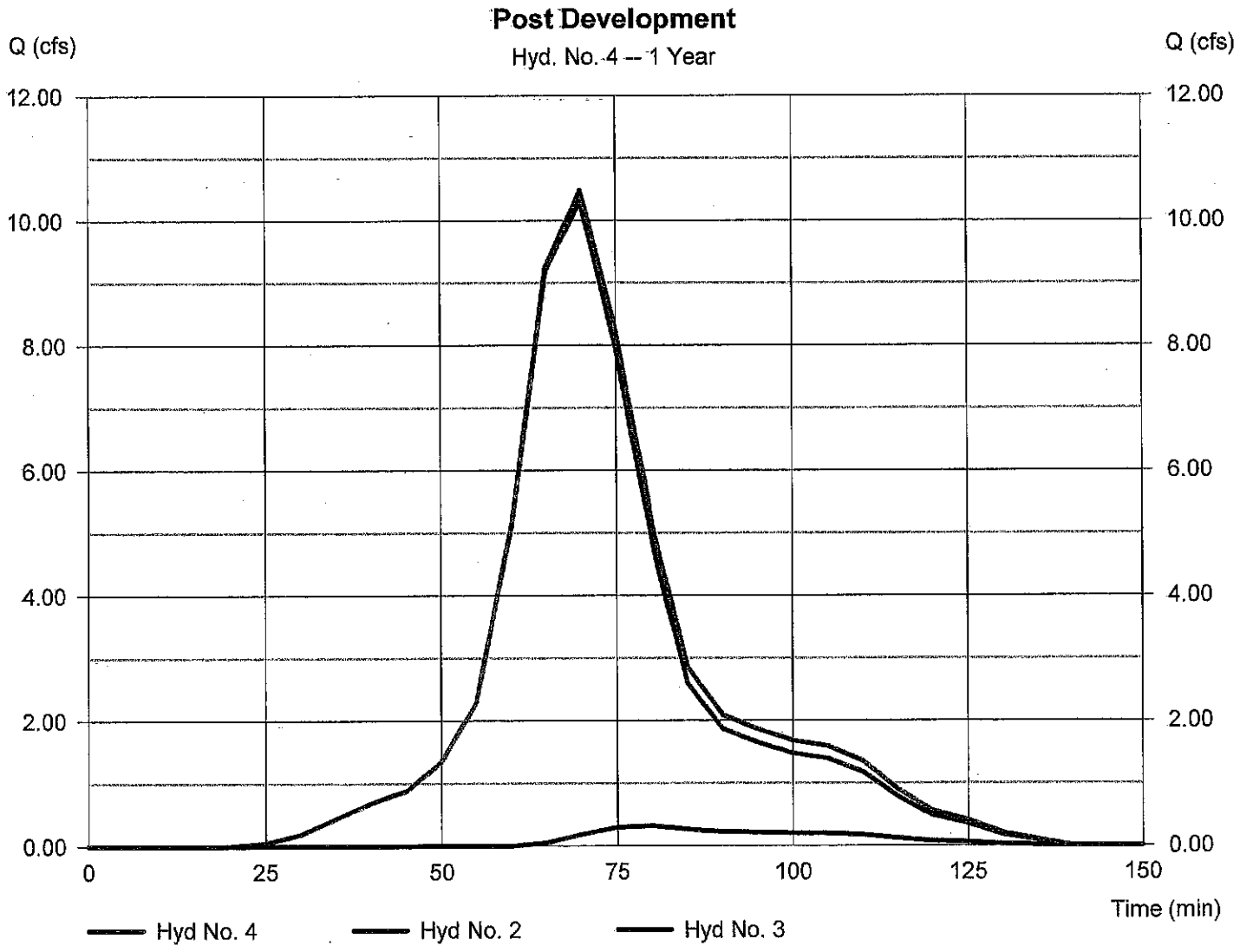
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Friday, 11 / 6 / 2015

Hyd. No. 4

Post Development

Hydrograph type	= Combine	Peak discharge	= 10.48 cfs
Storm frequency	= 1 yrs	Time to peak	= 70 min
Time interval	= 5 min	Hyd. volume	= 17,297 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 7.650 ac



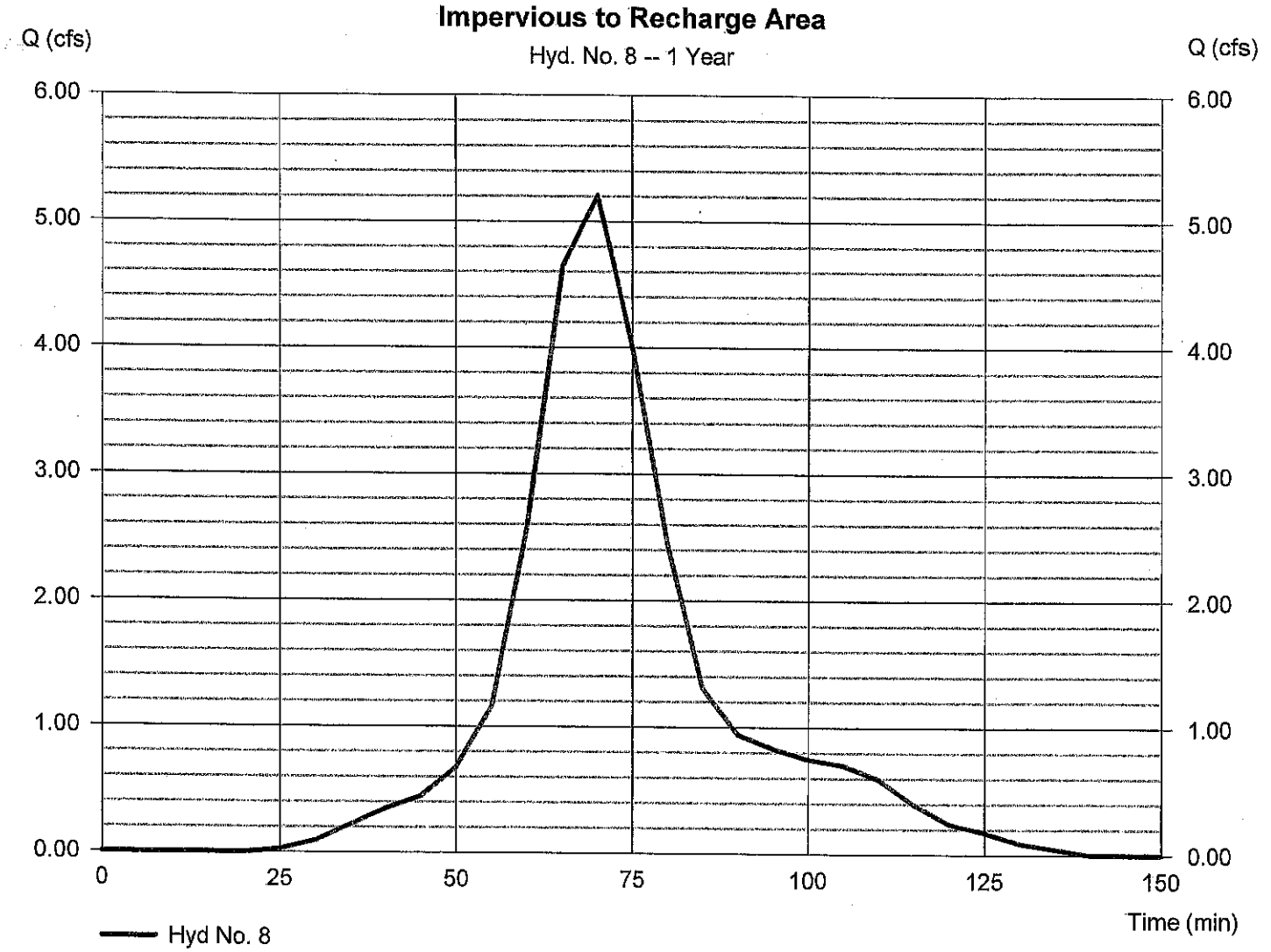
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Friday, 11 / 6 / 2015

Hyd. No. 8

Impervious to Recharge Area

Hydrograph type	= SCS Runoff	Peak discharge	= 5.207 cfs
Storm frequency	= 1 yrs	Time to peak	= 70 min
Time interval	= 5 min	Hyd. volume	= 8,376 cuft
Drainage area	= 2.380 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.25 in	Distribution	= Custom
Storm duration	= F:\Shared_Users\calfaro\1.25Storm factor\1.25inch.cds	Shape factor	= 484

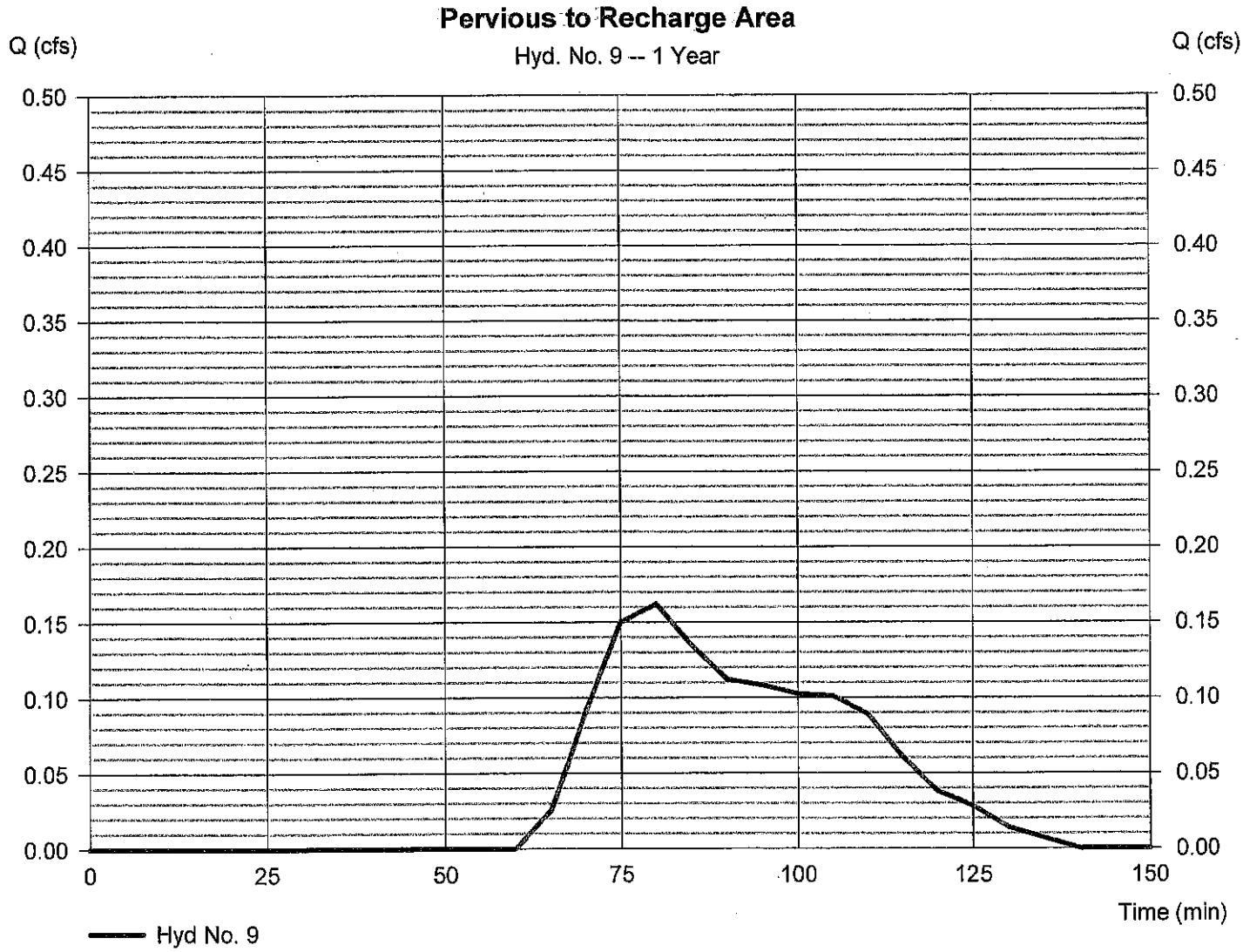


Hydrograph Report

Hyd. No. 9

Pervious to Recharge Area

Hydrograph type	= SCS Runoff	Peak discharge	= 0.162 cfs
Storm frequency	= 1 yrs	Time to peak	= 80 min
Time interval	= 5 min	Hyd. volume	= 368 cuft
Drainage area	= 1.500 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.25 in	Distribution	= Custom
Storm duration	= F:\Shared_Users\calfaro\1.25Storm\1.25inch.cds	Storage Coef.	= 484

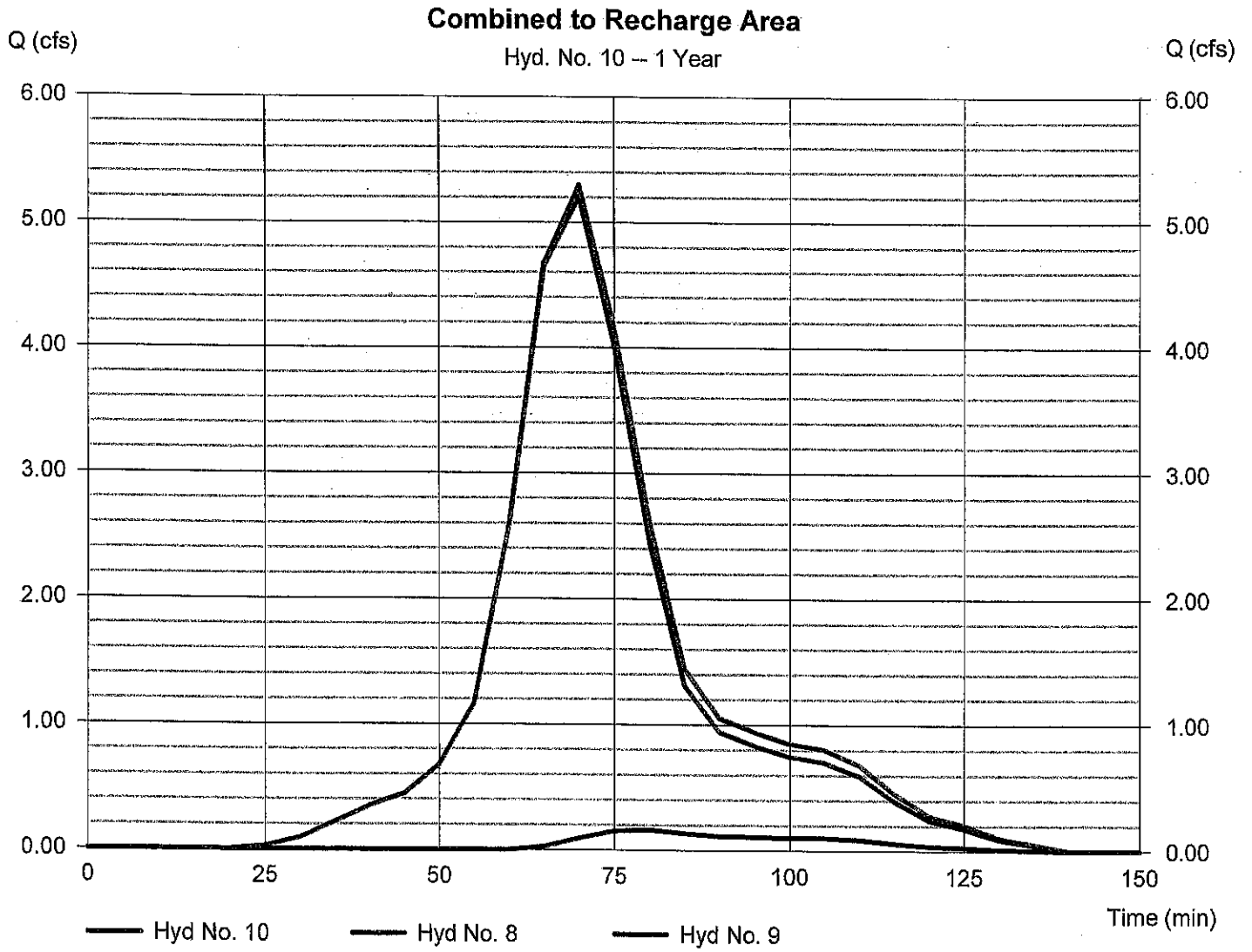


Hydrograph Report

Hyd. No. 10

Combined to Recharge Area

Hydrograph type	= Combine	Peak discharge	= 5.299 cfs
Storm frequency	= 1 yrs	Time to peak	= 70 min
Time interval	= 5 min	Hyd. volume	= 8,744 cuft
Inflow hyds.	= 8, 9	Contrib. drain. area	= 3.880 ac



This is a regional document for New Jersey

Hydro International

Up-Flo® Filter

New Jersey Stormwater Design Guide

Rated for 80% TSS Removal by NJDEP

The Up-Flo® Filter is a modular, high-rate stormwater filtration technology certified by the New Jersey Department of Environmental Protection (NJDEP) for 80% TSS removal and independently verified by the New Jersey Corporation for Advanced Technologies (NJCAT).

The Up-Flo® Filter modules are housed in vaults (Table 1) and manholes (Table 2) with size and layout depending on site specific criteria.

NJDEP Certified Sizing Methodologies

Water Quality Flow Rate based on NJ Design Storm (1.25" / 2hr)
The Up-Flo® Filter has been designed as a modular filtration system. Therefore, it can be sized to treat any flow rate resulting from the 1.25"/ 2hr NJ Water Quality Design Storm. Each filter module has a NJDEP certified treatment capacity of 0.056 cfs (25 gpm).

The quantity of Up-Flo® Filter modules comes from the following equation:

$$\#\ \text{Filter Modules} = [Q_{wq} / 0.056\ \text{cfs}]$$

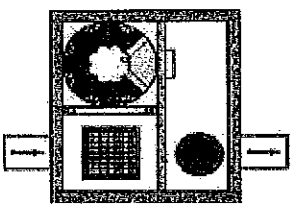
Mass Loading for Filters Downstream of Extended Detention
The Up-Flo® Filter may also be sized based upon the maximum sediment load generated from the site's impervious drainage area when the Up-Flo® Filter is downstream of extended detention. For this design, one filter module is required for every 0.66 impervious acres.

NOTE: The consulting engineer will want to confirm which sizing method, flow based or mass load, is more conservative for final Up-Flo® Filter module count determination.

Inline Up-Flo® Filter Sizing

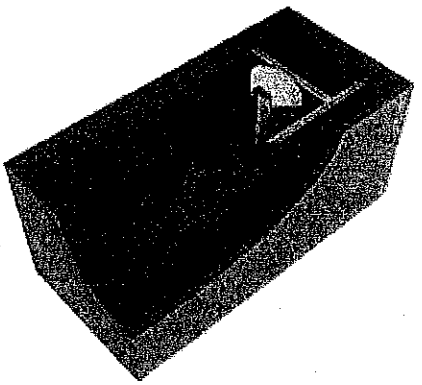
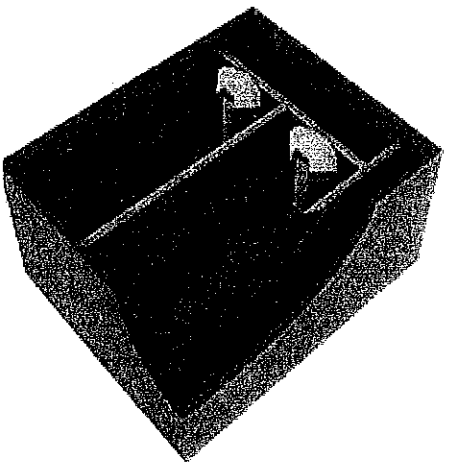
Up-Flo® Filter Inline Vault configurations contain an internal inlet bay, weir wall, and outlet bay, making each Up-Flo® Filter vault a stand-alone offline device. Sizing for inline systems is shown in Table 1. Hydro International's design engineers will assist in hydraulic modeling.

Table 1. Inline Vault Up-Flo® Filter Sizing Certified by NJDEP for 80% TSS Removal

Certified NJDEP Water Quality Treatment Flow Rate		Up-Flo® Filter Modules	Inline Vault Dimensions
(cfs)	(gpm)	(No.)	(Length x Width I.D.)
0.056	25	1	 7' x 8'
0.112	50	2	
0.168	75	3	
0.224	101	4	
0.280	126	5	
0.336	151	6	
0.392	176	7	

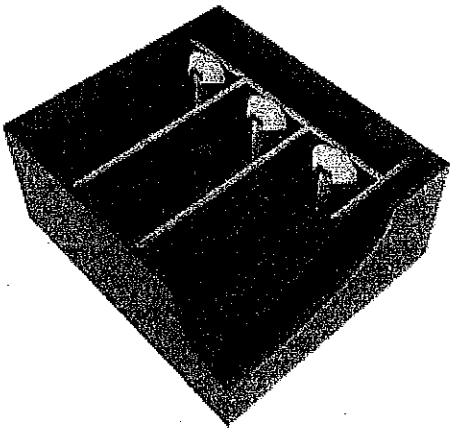
Up-Flo® Filter

Table 1 (Cont'd from Page 1). Inline Up-Flo® Filter Sizing.

Certified NJDEP Water Quality Treatment Flow Rate		Up-Flo® Filter Modules	Inline Vault Dimensions
(cfs)	(gpm)	(No.)	(Length x Width I.D.)
0.448	201	8	 6.5' x 10.5'
0.504	226	9	
0.560	251	10	
0.616	276	11	
0.672	302	12	
0.728	327	13	
0.784	352	14	
0.840	377	15	
0.896	402	16	
0.952	427	17	
1.008	452	18	
1.064	478	19	
1.120	503	20	 11' x 13'
1.176	528	21	
1.232	553	22	
1.288	578	23	
1.344	603	24	
1.400	628	25	
1.456	653	26	
1.512	679	27	
1.568	704	28	
1.624	729	29	
1.680	754	30	
1.736	779	31	
1.792	804	32	
1.848	829	33	
1.904	855	34	
1.960	880	35	
2.016	905	36	
2.072	930	37	
2.128	955	38	

Up-Flo® Filter

Table 1 (Cont'd from Page 2). Inline Up-Flo® Filter Sizing.

Certified NJDEP Water Quality Treatment Flow Rate		Up-Flo® Filter Modules	Inline Vault Dimensions
(cfs)	(gpm)	(No.)	(Length x Width I.D.)
2.184	980	39	 13' x 15'
2.240	1005	40	
2.296	1030	41	
2.352	1056	42	
2.408	1081	43	
2.464	1106	44	
2.520	1131	45	
2.576	1156	46	
2.632	1181	47	
2.688	1206	48	
2.744	1232	49	
2.800	1257	50	
2.856	1282	51	
2.912	1307	52	
2.968	1332	53	
3.024	1357	54	
3.080	1382	55	
3.136	1407	56	
3.192	1433	57	

Contact Hydro International for sizing recommendations when the required Water Quality flow rate is greater than 3.192 cfs.

Layout - Inline and Offline Systems

Offline Design Plan View

The NJDEP certifies all manufactured filtration systems are for offline use only, meaning that the peak design flow must be routed around the filtration chamber. The Inline Up-Flo® Filter vault systems in Table 1 incorporate a high-flow channel that directs peak flows around the treatment chamber, meeting NJDEP's requirement for offline systems.

Hydro International can also provide offline Up-Flo® manholes or vaults. Offline Up-Flo® Filter designs use external junction manholes instead of incorporating internal high flow channels like the Inline systems (Fig.1). Table 2 shows the common offline Up-Flo® Filter manhole specifications.

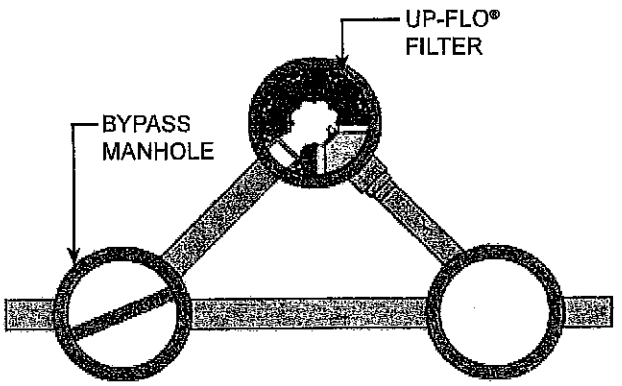


Fig.1 Plan View of an Offline Up-Flo® Filter.

Table 2. Offline Up-Flo® Filter Manhole Sizing Certified by NJDEP for 80% TSS Removal

Certified NJDEP Water Quality Treatment Flow Rate		Up-Flo® Filter Modules	Manhole Dimensions
(cfs)	(gpm)	(No.)	(I.D.)
0.056	25	1	 48" Round (Offline only)
0.112	50	2	
0.168	75	3	
0.224	101	4	
0.280	126	5	
0.336	151	6	

NOTE: For flows greater than 0.336 cfs, use a vaulted arrangement from Table 1.

Offline Design Profile View

It is recommended for the consulting engineer to provide 9.5" of drop between the Up-Flo® Filter manhole inlet and outlet pipes. The weir height in the external bypass manhole should then be set 29.5" above the invert of the Up-Flo® Filter outlet pipe. This provides approximately 30" of driving head from the top of the external weir in the bypass manhole, to the invert of the outlet pipe of the Up-Flo® Filter. This concept is displayed in Figure 2 below. In the case that 30" of driving head is not available due to site restrictions the consulting engineer should contact the NJ Hydro International representative at (703) 424-3340.

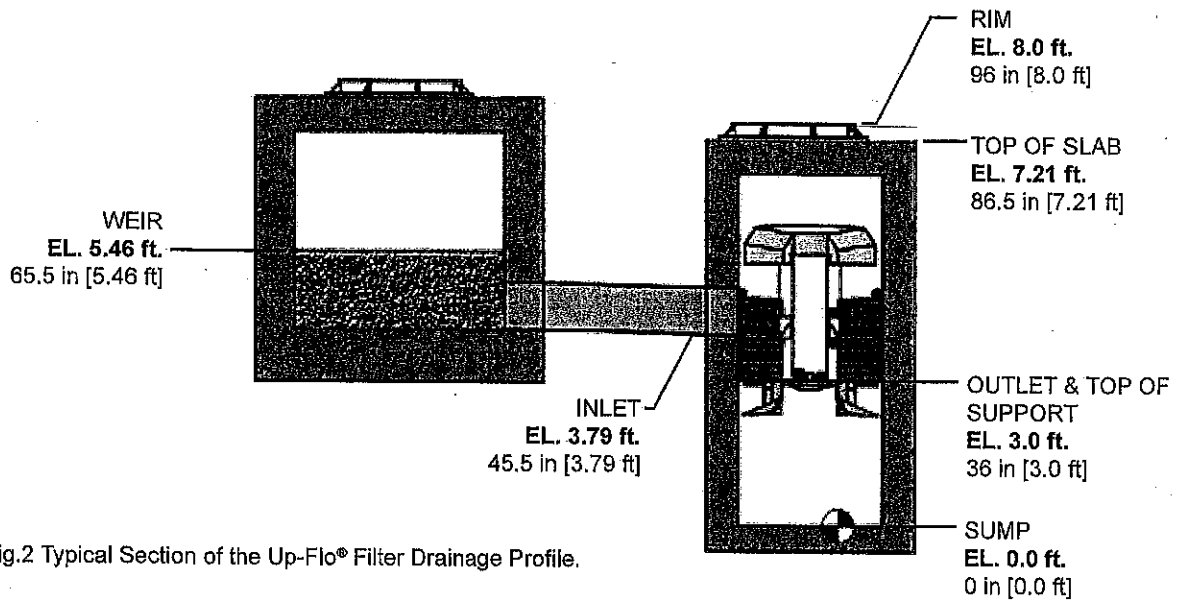


Fig.2 Typical Section of the Up-Flo® Filter Drainage Profile.

Appendix F

Groundwater Recharge Analysis

New Jersey Groundwater Recharge Spreadsheet
Version 2.0
November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓	Average Annual P (in)	Climatic Factor
SOMERSET CO, MONTGOMERY TWP	46.0	1.50

Project Name:	Princeton Audi
Description:	
Analysis Date:	06/29/15

Pre-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	0.36	Woods	Lehigh	12.8	16,411
2	0.06	Impervious areas	Lehigh	0.0	0
3	1.27	Open space	Lehigh	12.0	55,183
4	8.03	Woods	Reaville	13.2	383,454
5	3.88	Open space	Reaville	12.6	177,252
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	13.6			Total Annual Recharge (in)	Total Annual Recharge (cu-ft)
				12.8	632,100

Post-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	0.4	Impervious areas	Lehigh	0.0	0
2	0.1	Woods	Lehigh	12.8	4,503
3	0.5	Open space	Lehigh	12.0	21,726
4	4.4	Impervious areas	Reaville	0.0	0
5	3.73	Woods	Reaville	13.2	178,117
6	4.47	Open space	Reaville	12.6	204,205
7	0				
8	0				
9	0		Penn		
10	0				
11	0		Penn		
12	0				
13	0				
14	0				
15	0				
Total =	13.6			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				8.3	408,551

Annual Recharge Requirements Calculation ↓

% of Pre-Developed Annual Recharge to Preserve =	100%	Total Impervious Area (sq.ft)	209,088
Post-Development Annual Recharge Deficit=	223,548	(cubic feet)	

Recharge Efficiency Parameters Calculations (area averages)

RWC=	2.18	(in)	DRWC=	4.18	(in)
ERWC =	1.05	(in)	EDRWC=	1.05	(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	Description	Analysis Date	BMP or LID Type
Princeton Audi	0	06/29/15	

Recharge BMP Input Parameters

Parameter	Symbol	Value	Unit
BMP Area	ABMP	4562.5	sq.ft
BMP Effective Depth, this is the design variable	dBMP	12.0	in
Upper level of the BMP surface (negative if above ground)	dBMPu	12.0	in
Depth of lower surface of BMP, must be>=dBMPu	dEXC	0.0	in
Post-development Land Segment Location of BMP, Input Zero if Location is distributed or undetermined	SegBMP	0	unitless

Root Zone Water capacity Calculated Parameters

Parameter	Symbol	Value	Unit
Empty Portion of RWC under Post-D Natural Recharge	ERWC	4.18	in
ERWC Modified to consider dEXC	EDRWC	4.18	in
Empty Portion of RWC under Infilt. BMP	RERWC	0.82	in

Recharge Design Parameters

Parameter	Symbol	Value	Unit
Inches of Runoff to capture	Qdesign	0.36	in
Inches of Rainfall to capture	Pdesign	0.46	in
Recharge Provided Avg. over Imp. Area		17.6	in
Runoff Captured Avg. over imp. Area		13.5	in

BMP Calculated Size Parameters

ABMP/Aimp	Aratio	0.03	unitless
BMP Volume	VBMP	4,562	cu.ft

Parameters from Annual Recharge Worksheet

Post-D Deficit Recharge (or desired recharge volume)	Vdef	223,548	cu.ft
Post-D Impervious Area (or target Impervious Area)	Aimp	152,460	sq.ft
Root Zone Water Capacity	RWC	4.18	in
RWC Modified to consider dEXC	DRWC	4.18	in
Climatic Factor	C-factor	1.50	no units
Average Annual P	Pavg	46.0	in
Recharge Requirement over Imp. Area	dr	12.8	in

System Performance Calculated Parameters

Annual BMP Recharge Volume		223,548	cu.ft
Avg BMP Recharge Efficiency		90.1%	Represents % Infiltration Recharged
%Rainfall became Runoff		78.0%	%
%Runoff Infiltrated		54.5%	%
%Runoff Recharged		35.6%	%
%Rainfall Recharged		27.8%	%

CALCULATION CHECK MESSAGES

Volume Balance-> OK
dBMP Check—> OK
dEXC Check—> OK

BMP Location—> Location is selected as distributed or undetermined

OTHER NOTES

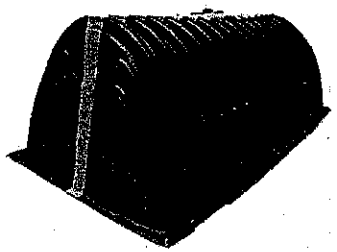
Pdesign is accurate only after BMP dimensions are updated to make rech volume= deficit volume. The portion of BMP infiltration prior to filling and the area occupied by BMP are ignored in these calculations. Results are sensetive to dBMP, make sure dBMP selected is small enough for BMP to empty in less 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.

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 clik the "Default Vdef & Aimp" button.

Prepared For:	Project Information:	Engineer:	Calculations Performed By:
Princeton Audi	Princeton Audi	CRA	CRA
VCEA	Cherry Valley Road	VCEA	VCEA
	Montgomery Twp	32 Brower Lane	32 Brower Lane
Montgomery Twp	NJ 08844	Hillsborough	Hillsborough
NJ Zip		NJ 08844	NJ 08844
Phone	Date: October 23, 2015	908-359-8291	908-359-8291
Fax		Fax	Fax
Email		calfaro@vcea.org	calfaro@vcea.org

Input Given Parameters

Unit of Measure	English	
Select Model	Recharger 280HD	
Stone Porosity	40.0%	
Number of Header Systems	2 Header	
Stone Depth **Above** Chamber	18	inches
Stone Depth **Below** Chamber	6	inches
Workable Bed Depth	5.00	feet
Max. Bed Width	40.00	feet
Storage Volume Required	4565.00	cu. feet



Chamber Specifications

Height	26.5	inches
Width	47.00	inches
Length	8.00	feet
Installed Length	7.00	feet
Bare Chamber Volume	42.55	cu. feet
Installed Chamber Volume	76.59	cu. feet

Image for visual reference only.May not reflect selected model.

Bed Depth	4.13	feet
Bed Width	36.25	feet
Storage Volume Provided	4635.23	cu. feet

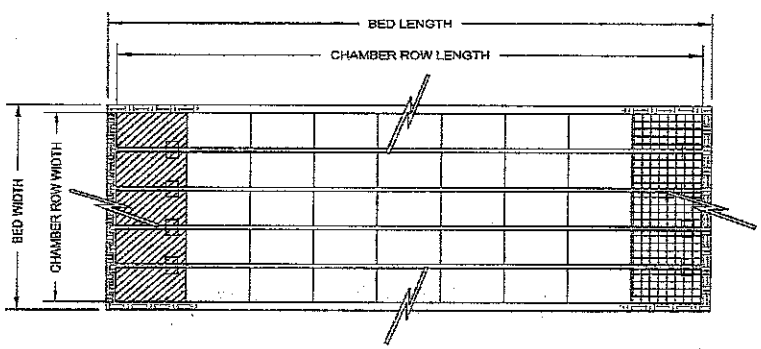
Materials List

Recharger 280HD Stormwater System by CULTEC, Inc.

Approx. Unit Count - not for construction	59	pieces
Actual Number of Chambers Required	56	pieces
Starter Chambers	8	pieces
Intermediate Chambers	40	pieces
End Chambers	8	pieces

HVLV FC-24 Feed Connector	14	pieces
CULTEC No. 410™ Filter Fabric	551.56	sq. yards
CULTEC No. 20L Polyethylene Liner	72.50	feet
Stone	203.55	cu. yards

Bed Detail



Number of Rows Wide	8	pieces
Number of Chambers Long	7	pieces
Chamber Row Width	34.25	feet
Chamber Row Length	50.00	feet
Bed Width	36.25	feet
Bed Length	52.00	feet
Bed Area Required	1885.00	sq. feet

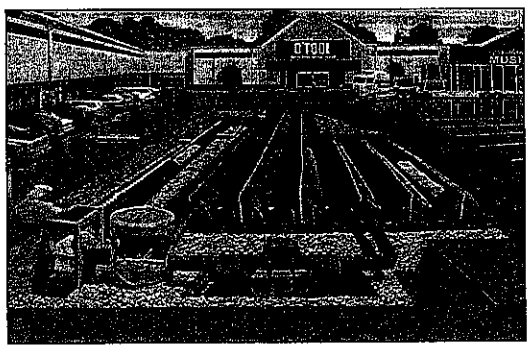
Bed detail for reference only. Not project specific. Not to scale. Use CULTEC StormGenie to output project specific detail.

Founder of Plastic Chamber Technology
Stormwater and Septic Solutions
Since 1986
CULTEC
1-800-4-CULTEC
custservice@cultec.com

Project Name: Princeton Audi

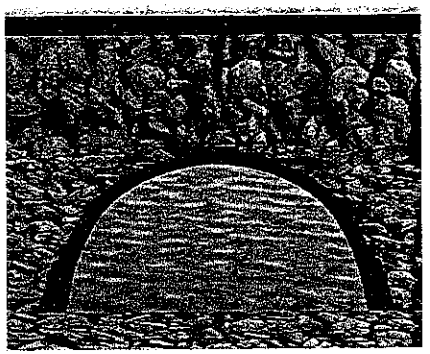
Date: October 23, 2015

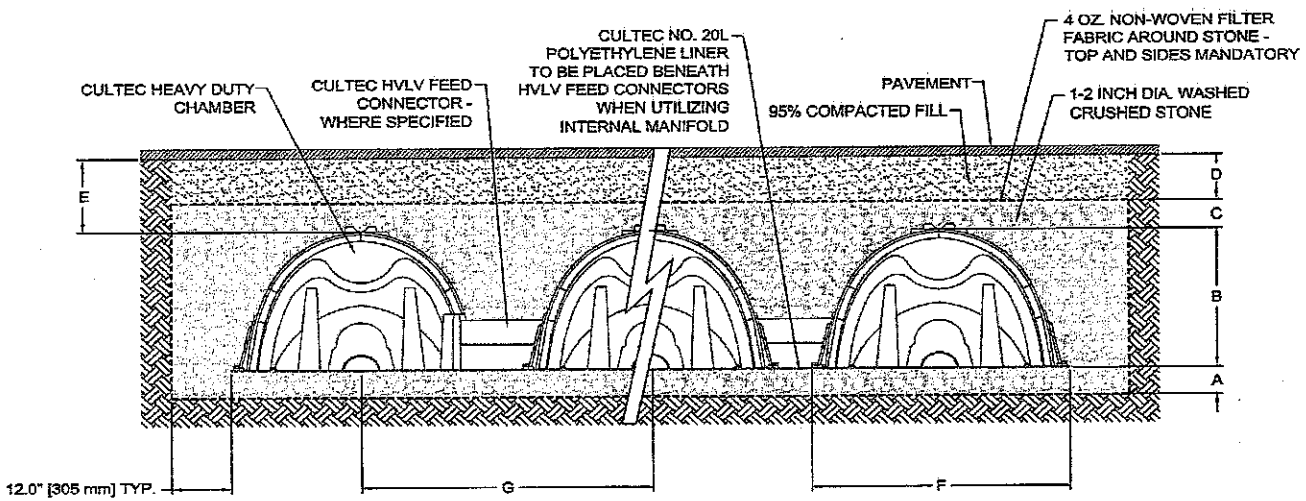
Cross Section Detail



Conceptual graphic only. Not job specific.

Recharger 280HD		
Pavement	3	inches
95% Compacted Fill	0	inches
Stone Above	18	inches
Chamber Height	26.5	inches
Stone Below	6	inches
Effective Depth	50.5	inches
Bed Depth	53.5	inches





A	Depth of Stone Base	6.0	inches
B	Chamber Height	26.5	inches
C	Depth of Stone Above Units	18.0	inches
D	Depth of 95% Compacted Fill	0	inches
E	Max. Depth of Cover Allowed Above Crown of Chamber	12.0	feet
F	Chamber Width	47.0	inches
G	Center to Center Spacing	4.33	feet

Breakdown of Storage Provided by Recharger 280HD	Stormwater System	
Chambers	2431.60	cu. feet
Feed Connectors	5.31	cu. feet
Stone	2198.32	cu. feet
Total Storage Provided	4635.23	cu. feet

CULTEC, Inc.
P.O. Box 280, Brookfield, CT 06804 USA
Phone: 203-775-4416 - Fax: 203-775-1462 - www.cultec.com

Appendix G

Drainage Area Plans

REVISIONS	AUTH.	DATE

DATE: NOVEMBER 13, 2015
SCALE: 1" = 40'
DESIGNED BY: R.B.H.
DRAWN BY: A.B.
CHECKED BY: R.B.H.
JOB No. 0142M-A

BY: Robert B. Heibell
Robert B. Heibell
New Jersey Professional Engineer
And Land Surveyor No. 20792

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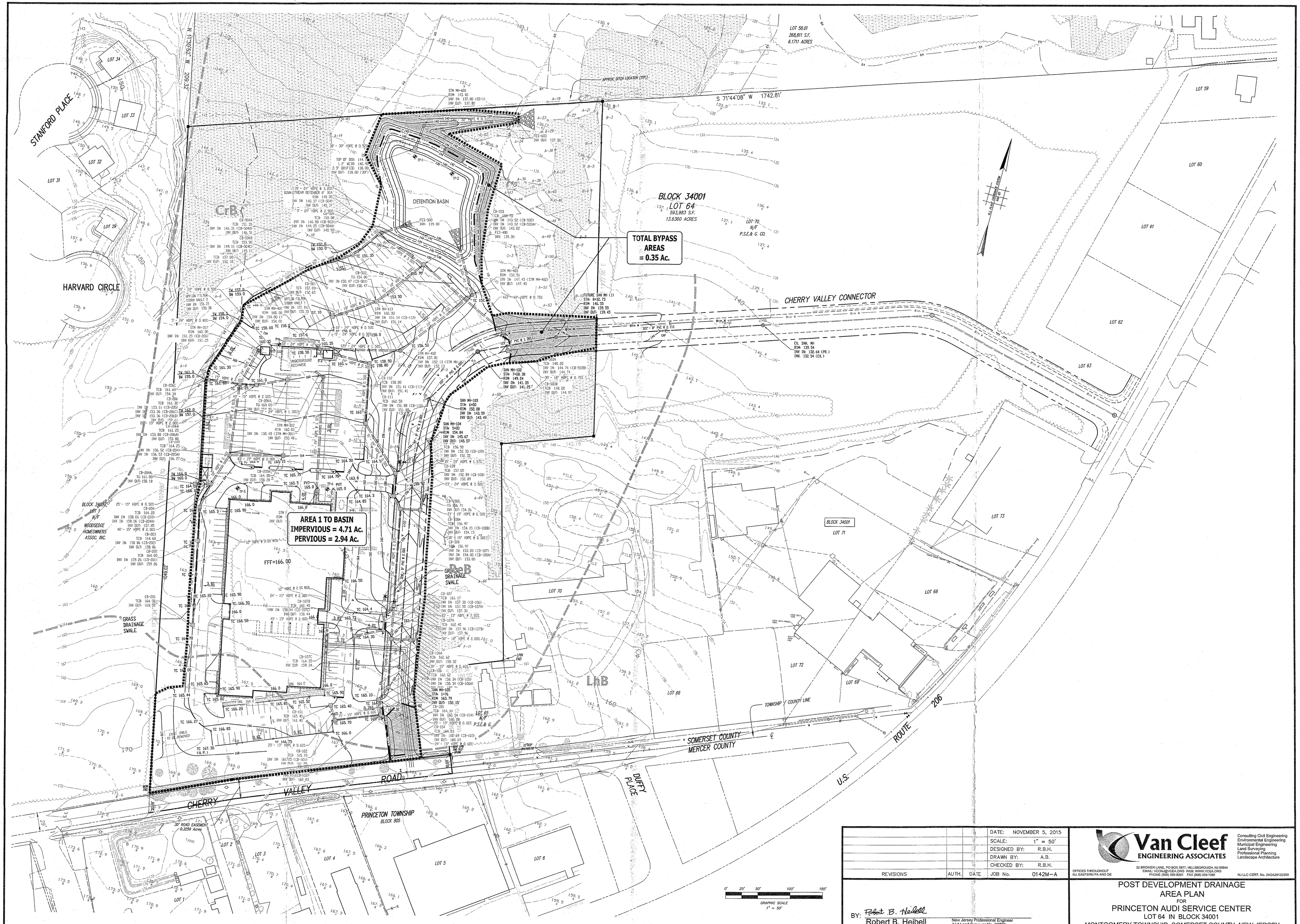
PHONE (908) 359-8291 FAX (908) 359-1580
NJ LLC CERT. No. 24GA28132300

DRAINAGE AREA PLAN
FOR
PRINCETON AUDI SERVICE CENTER
LOT 64 IN BLOCK 34001
MONTGOMERY TOWNSHIP,
SOMERSET COUNTY, NEW JERSEY

F.Bk. Pg.
FILE No. 8055-X



REVISIONS	AUTH.	DATE

DATE: NOVEMBER 5, 2015
SCALE: 1" = 50'
DESIGNED BY: R.B.H.
DRAWN BY: A.B.
CHECKED BY: R.B.H.
JOB No. 0142M-A

BY: Robert B. Heibell
Robert B. Heibell
New Jersey Professional Engineer
And Land Surveyor No. 20792

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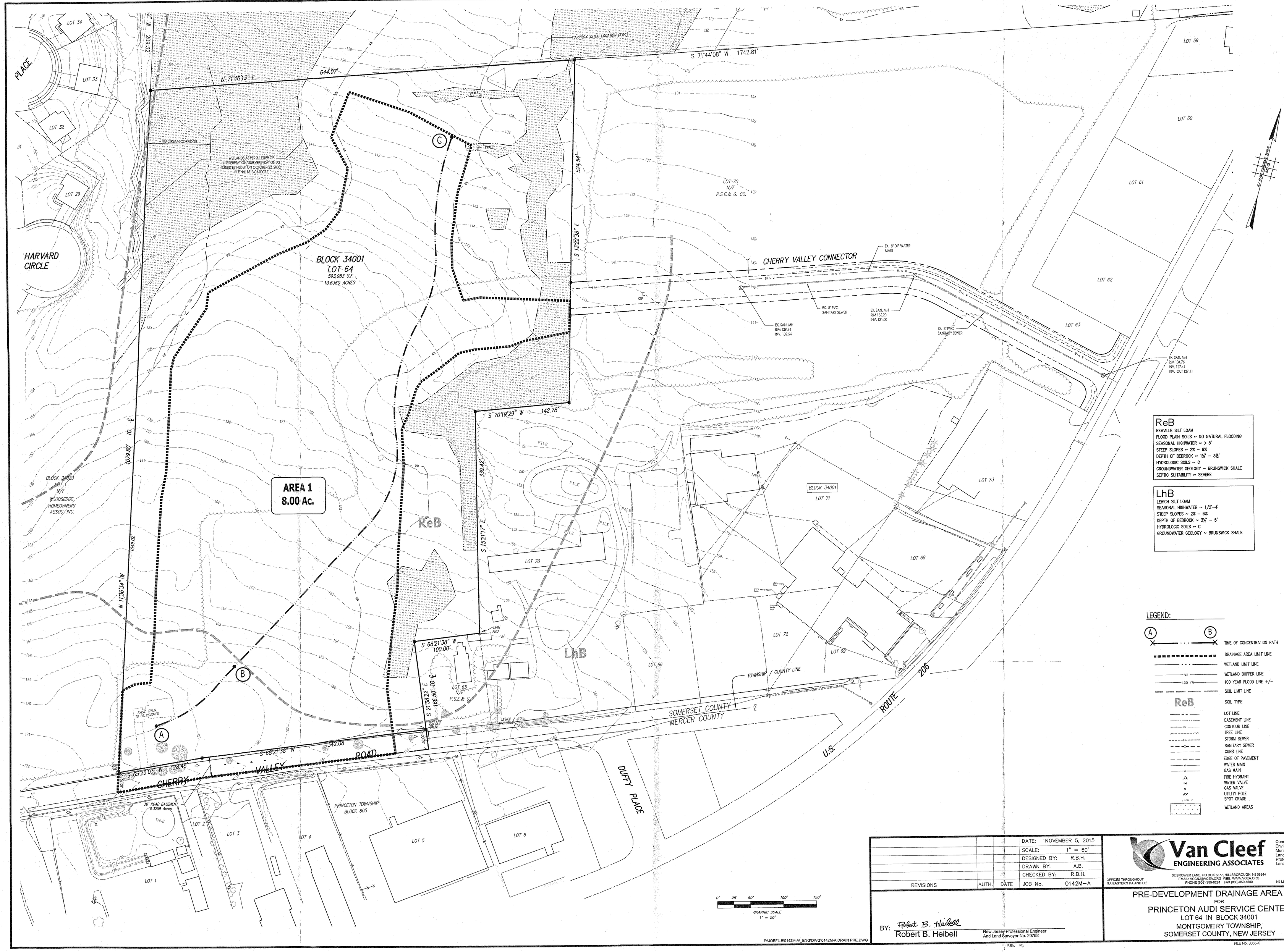
NJ LLC CERT. No. 24GA28132300

POST DEVELOPMENT DRAINAGE AREA PLAN
FOR
PRINCETON AUDI SERVICE CENTER
LOT 64 IN BLOCK 34001
MONTGOMERY TOWNSHIP, SOMERSET COUNTY, NEW JERSEY

FILE No. 8055-X



REVISIONS	AUTH.	DATE

DATE: NOVEMBER 5, 2015
SCALE: 1" = 50'
DESIGNED BY: R.B.H.
DRAWN BY: A.B.
CHECKED BY: R.B.H.
JOB No. 0142M-A

BY: Robert B. Heibell
Robert B. Heibell
New Jersey Professional Engineer
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F.B. Pg.

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PRE-DEVELOPMENT DRAINAGE AREA PLAN

FOR

PRINCETON AUDI SERVICE CENTER
LOT 64 IN BLOCK 34001
MONTGOMERY TOWNSHIP,
SOMERSET COUNTY, NEW JERSEY

FILE No. 8055-X