Woodbury Phase 2

#1260 BC
8 May 14

Sediment Storage

Phase 2 3.36 A disturbed C = 0.6

Phase 1 2.41 A roof/pavement, 1.91 A C = 0.3

Total sediment storage 180 × 3.36 + 250 × 1.91 = 1082 cf/yr × 2 = 2165 cf/2yr required

Total detention basin storage 49,459 cf

100-yr storage 47,228 cf

2,231 cf

ok

Isolation Row

Phase 1 28.67 + 43.01 + 164.83 = 236.51 (33)

Phase 2 35.83×2 = 71.66 (10)

308.17 ft

Footprint area = 308.17 × 6.42 = 1978 sf

3025 / 1978 = 1.53 gpm/sf

Isolator row treats upto 2.5 gpm/sf

WQv Phase 1 + Phase 2

$WQ_v = [1.14''(0.05 + 0.009 \times 54.22)\ 8.32\ Ac]/12 = 0.43\ Ac\text{-}ft$

$= 0.43 \times 43560\ cf/Ac = 18{,}516\ cf$

$= 1.14(0.05 + 0.009 \times 54.2) = 0.61$ watershed inches

Peak Discharge (Claytor & Schueler, 1996, Design of Stormwater Filtering Systems)

$CN = 1000/[10 + 5(1.14) + 10(0.61) - 10[(0.61)^2 + 1.25(0.61)(1.14)]^{\frac{1}{2}}] = 93.8$

$T_c = (700^{0.8}[(1000/93.8) - 9]^{0.7})/(1140 \times 2^{0.5}) = 0.17$ hours

CN 93 $I_a = 0.151$ $\frac{94 - 93.8}{94 - 93} = \frac{0.128 - I_a}{0.128 - 0.151}$

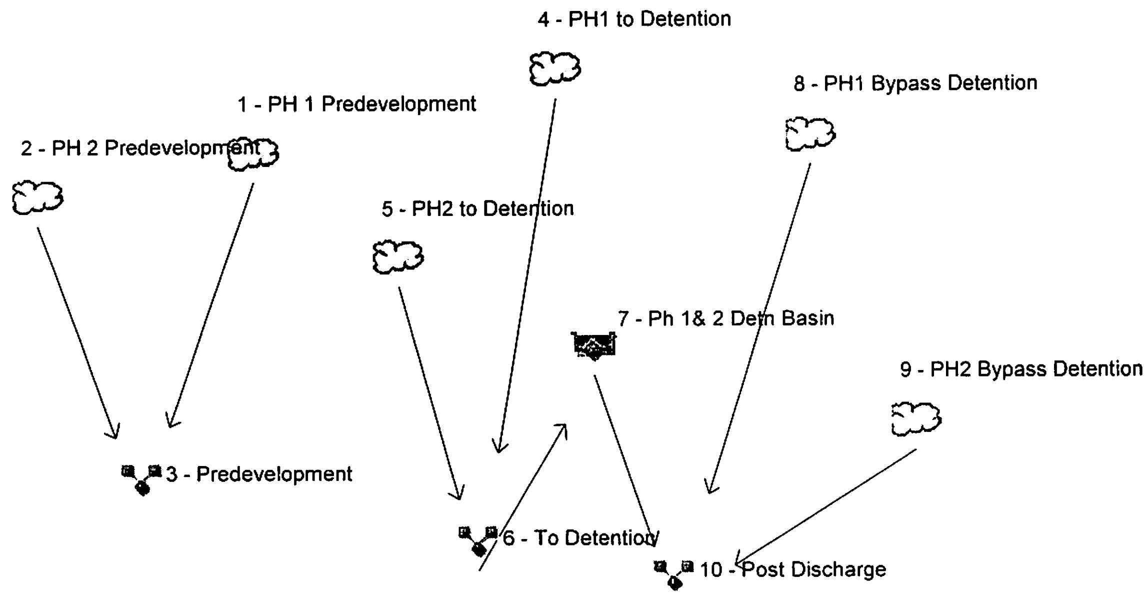
CN 94 $I_a = 0.128$ $-(0.2 \times (-0.023) - 0.128) = I_a = 0.133$

$I_a/P = 0.133/1.14 = 0.12$ $q_u = 850\ csm/in \times \frac{mi^2}{640\ Ac} = 1.33\ cfs/Ac/in$

$Q_p = 1.33 \times 8.32\ Ac \times 0.61 = 6.74\ cfs \times \frac{7.48\ gal}{cf} \times \frac{60\ s}{min} = 3025\ gpm$

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10



Project: Woodbury Phase 1 & 2 May-13-14.gpw	Tuesday, 05 / 13 / 2014

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr 15	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	5.694	-------	-------	14.75	17.97	-------	32.19	PH 1 Predevelopment
2	SCS Runoff	------	-------	5.428	-------	-------	13.75	16.67	-------	29.54	PH 2 Predevelopment
3	Combine	1, 2	-------	11.12	-------	-------	28.50	34.64	-------	61.73	Predevelopment
4	SCS Runoff	------	-------	8.428	-------	-------	17.36	20.33	-------	33.09	PH1 to Detention
5	SCS Runoff	------	-------	9.488	-------	-------	19.87	23.32	-------	38.19	PH2 to Detention
6	Combine	4, 5	-------	17.16	-------	-------	35.24	41.24	-------	67.05	To Detention
7	Reservoir	6	-------	9.986	-------	-------	26.56	31.83	-------	50.93	Ph 1& 2 Detn Basin
8	SCS Runoff	------	-------	0.749	-------	-------	1.801	2.162	-------	3.740	PH1 Bypass Detention
9	SCS Runoff	------	-------	0.317	-------	-------	0.783	0.944	-------	1.649	PH2 Bypass Detention
10	Combine	7, 8, 9	-------	10.34	-------	-------	28.06	33.62	-------	53.96	Post Discharge

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

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	5.694	6	732	23,737	------	------	------	PH 1 Predevelopment
2	SCS Runoff	5.428	6	732	22,541	------	------	------	PH 2 Predevelopment
3	Combine	11.12	6	732	46,277	1, 2	------	------	Predevelopment
4	SCS Runoff	8.428	6	726	34,225	------	------	------	PH1 to Detention
5	SCS Runoff	9.488	6	720	29,168	------	------	------	PH2 to Detention
6	Combine	17.16	6	726	63,392	4, 5	------	------	To Detention
7	Reservoir	9.986	6	738	63,274	6	585.98	15,663	Ph 1& 2 Detn Basin
8	SCS Runoff	0.749	6	720	2,327	------	------	------	PH1 Bypass Detention
9	SCS Runoff	0.317	6	720	991	------	------	------	PH2 Bypass Detention
10	Combine	10.34	6	738	66,592	7, 8, 9	------	------	Post Discharge

Hydrograph Report

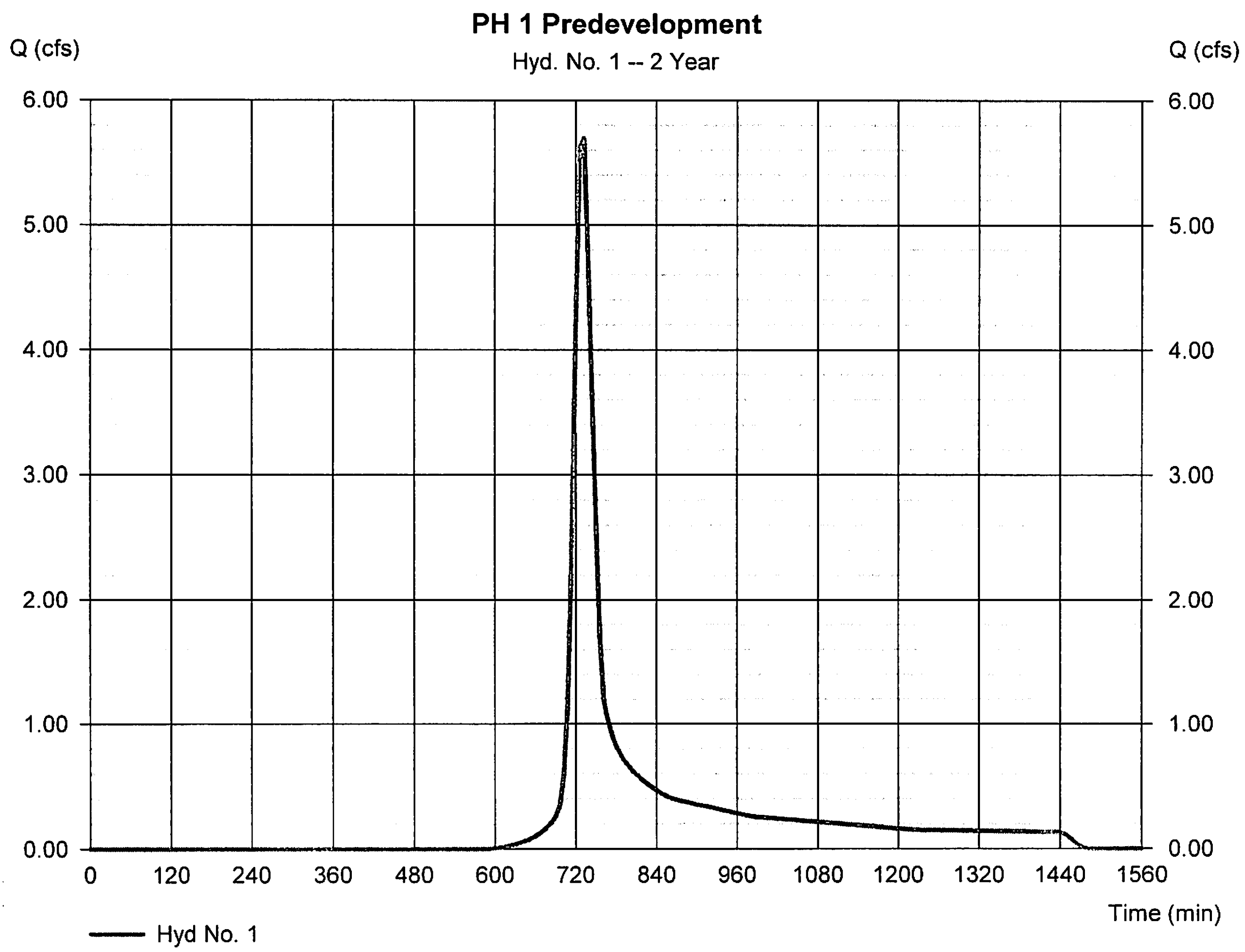
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 1

PH 1 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 5.694 cfs
Storm frequency	= 2 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 23,737 cuft
Drainage area	= 5.200 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.80 min
Total precip.	= 3.01 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.840 x 80) + (0.150 x 98) + (0.210 x 79)] / 5.200



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 1

PH 1 Predevelopment

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	136.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.00		0.00		0.00		
Land slope (%)	=	1.80		0.00		0.00		
Travel Time (min)	**=**	**19.66**	**+**	**0.00**	**+**	**0.00**	**=**	**19.66**
Shallow Concentrated Flow								
Flow length (ft)	=	570.00		0.00		0.00		
Watercourse slope (%)	=	2.00		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.28		0.00		0.00		
Travel Time (min)	**=**	**4.16**	**+**	**0.00**	**+**	**0.00**	**=**	**4.16**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)		({0})0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 23.80 min

Hydrograph Report

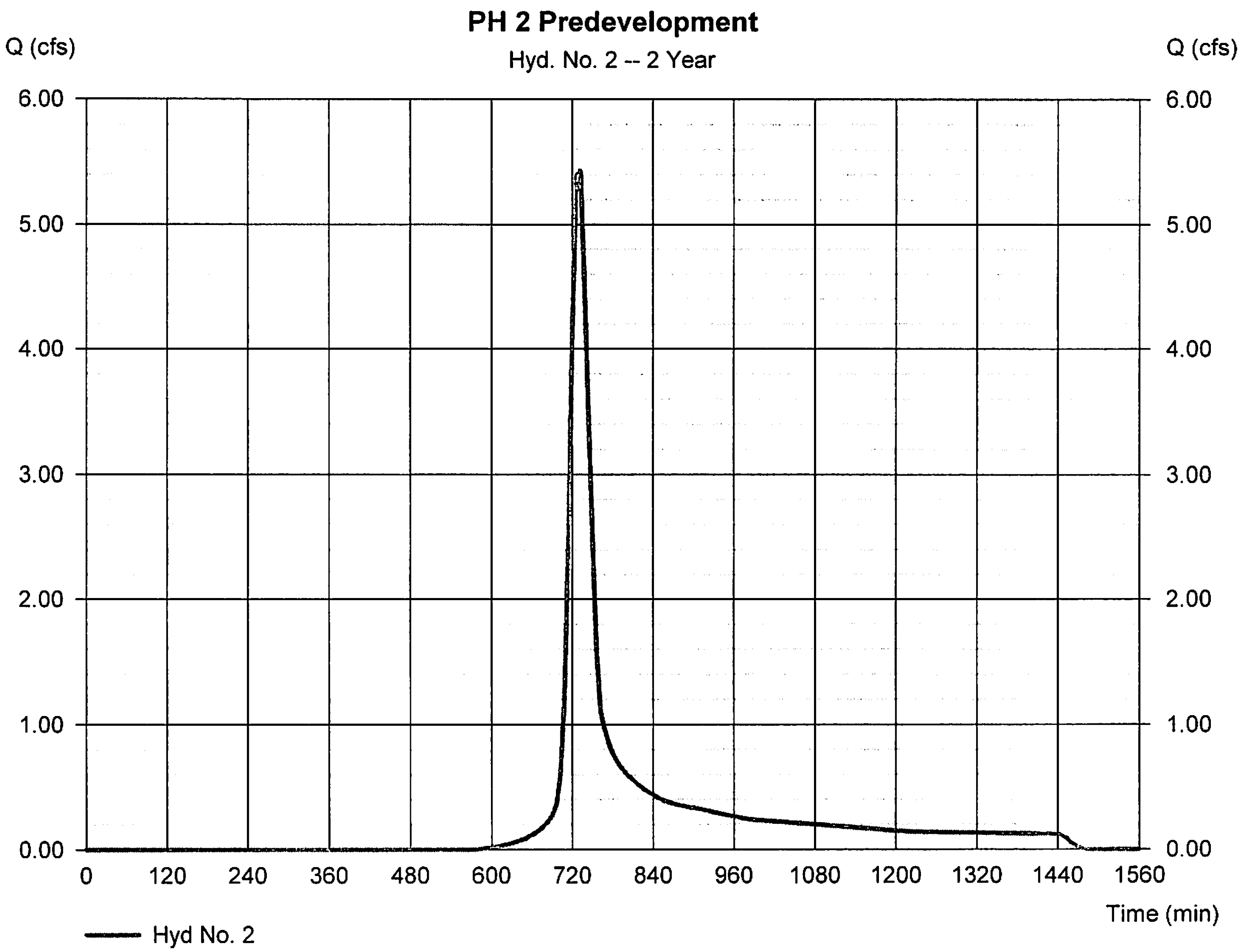
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 2

PH 2 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 5.428 cfs
Storm frequency	= 2 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 22,541 cuft
Drainage area	= 4.700 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.70 min
Total precip.	= 3.01 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.250 x 80) + (0.270 x 79) + (0.180 x 98)] / 4.700



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 2

PH 2 Predevelopment

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.00		0.00		0.00		
Land slope (%)	=	1.80		0.00		0.00		
Travel Time (min)	**=**	**15.37**	**+**	**0.00**	**+**	**0.00**	**=**	**15.37**
Shallow Concentrated Flow								
Flow length (ft)	=	400.00		0.00		0.00		
Watercourse slope (%)	=	2.00		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.28			0.00		0.00		
Travel Time (min)	**=**	**2.92**	**+**	**0.00**	**+**	**0.00**	**=**	**2.92**
Channel Flow								
X sectional flow area (sqft)	=	5.00		0.00		0.00		
Wetted perimeter (ft)	=	4.00		0.00		0.00		
Channel slope (%)	=	0.50		0.00		0.00		
Manning's n-value	=	0.200		0.015		0.015		
Velocity (ft/s)	=0.61							
				0.00				
						0.00		
Flow length (ft)	({0})200.0			0.0		0.0		
Travel Time (min)	**=**	**5.45**	**+**	**0.00**	**+**	**0.00**	**=**	**5.45**

Total Travel Time, Tc .... 23.70 min

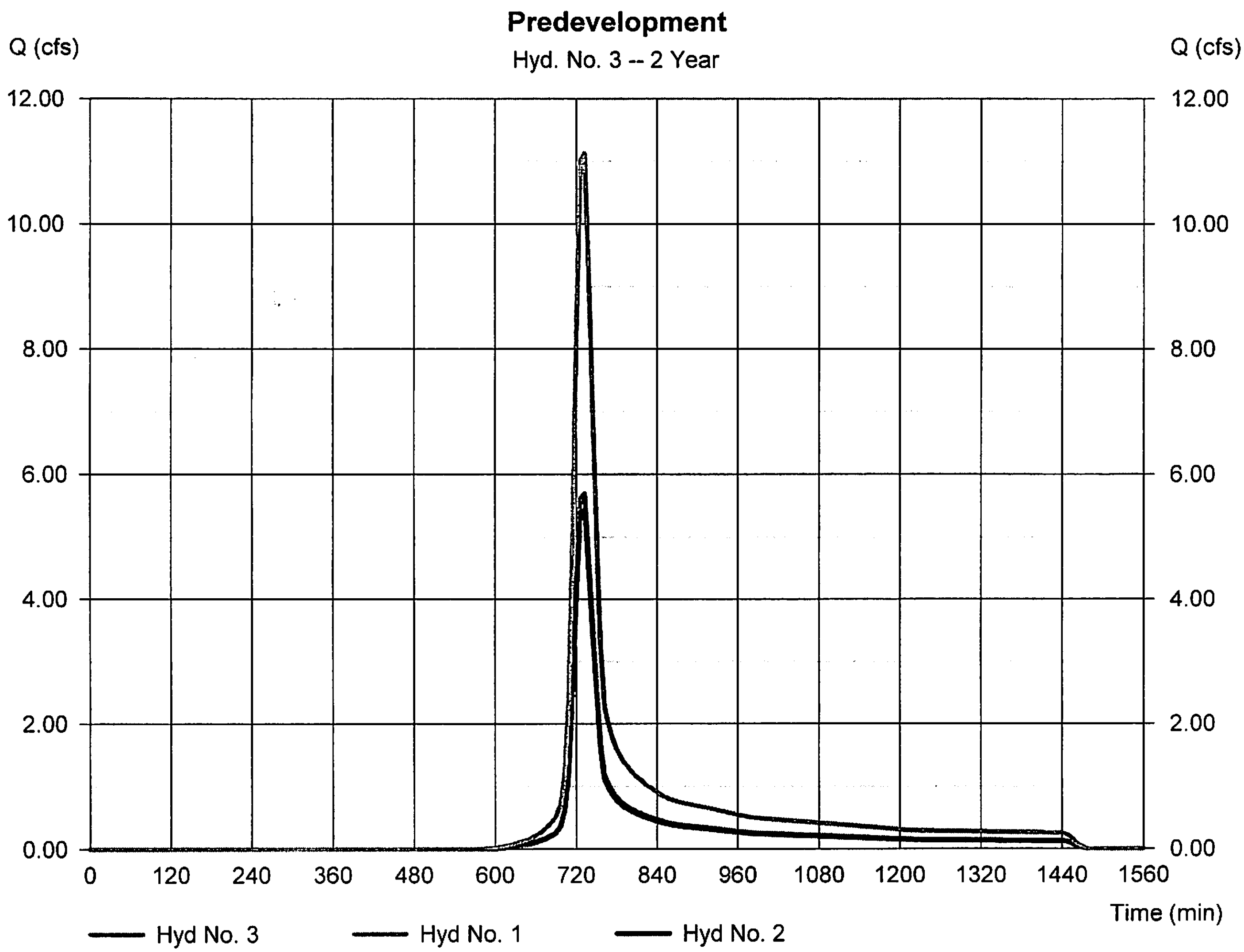
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 | Tuesday, 05 / 13 / 2014

Hyd. No. 3

Predevelopment

Hydrograph type	= Combine	Peak discharge	= 11.12 cfs
Storm frequency	= 2 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 46,277 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 9.900 ac



Hydrograph Report

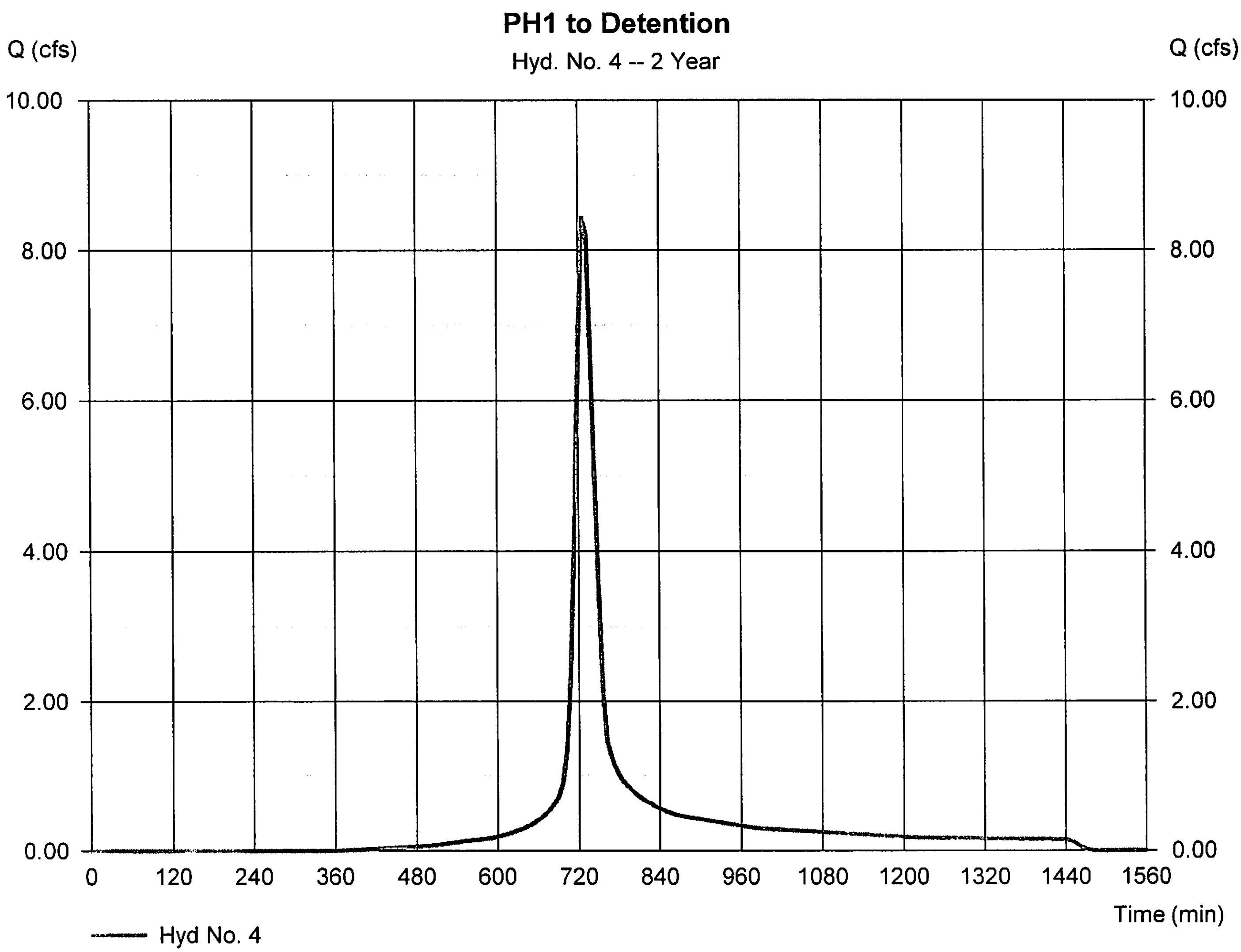
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 4

PH1 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 8.428 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 34,225 cuft
Drainage area	= 4.730 ac	Curve number	= 90*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 21.20 min
Total precip.	= 3.01 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.410 x 98) + (1.910 x 80) + (0.150 x 98) + (0.260 x 80)] / 4.730



TR55 Tc Worksheet

Hyd. No. 4

PH1 to Detention

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	136.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.01		0.00		0.00		
Land slope (%)	=	1.80		0.00		0.00		
Travel Time (min)	**=**	**19.63**	**+**	**0.00**	**+**	**0.00**	**=**	**19.63**
Shallow Concentrated Flow								
Flow length (ft)	=	0.00		0.00		0.00		
Watercourse slope (%)	=	0.00		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=0.00			0.00		0.00		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow								
X sectional flow area (sqft)	=	1.77		0.00		0.00		
Wetted perimeter (ft)	=	4.70		0.00		0.00		
Channel slope (%)	=	1.00		0.00		0.00		
Manning's n-value	=	0.013		0.015		0.015		
Velocity (ft/s)	=5.96							
				0.00				
						0.00		
Flow length (ft)	({0})550.0			0.0		0.0		
Travel Time (min)	**=**	**1.54**	**+**	**0.00**	**+**	**0.00**	**=**	**1.54**

Total Travel Time, Tc .... 21.20 min

Hydrograph Report

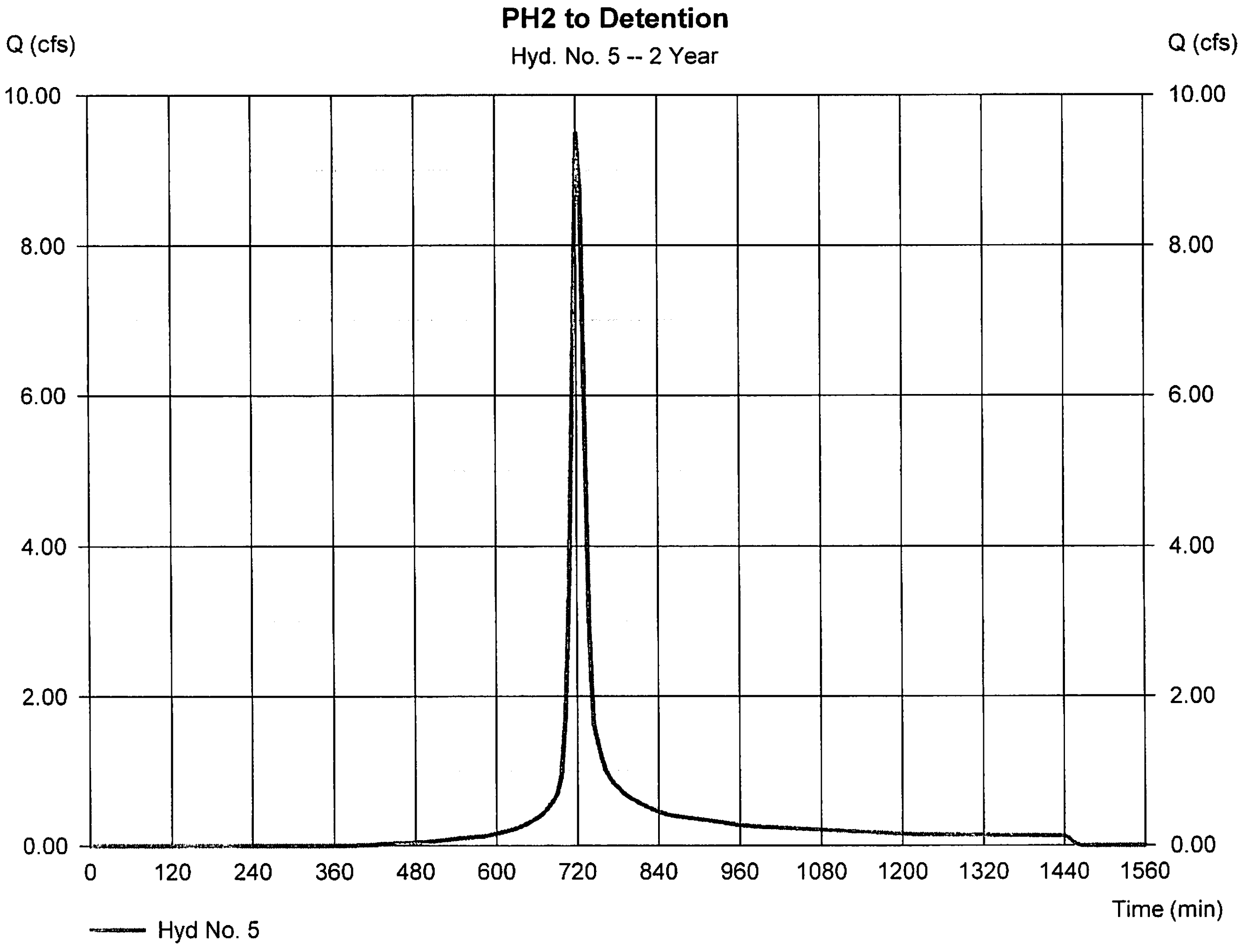
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 5

PH2 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 9.488 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 29,168 cuft
Drainage area	= 4.490 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.80 min
Total precip.	= 3.01 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.040 x 98) + (1.320 x 80) + (0.180 x 98) + (0.950 x 80)] / 4.490



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 5

PH2 to Detention

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	80.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.01		0.00		0.00		
Land slope (%)	=	1.80		0.00		0.00		
Travel Time (min)	**=**	**12.84**	**+**	**0.00**	**+**	**0.00**	**=**	**12.84**
Shallow Concentrated Flow								
Flow length (ft)	=	0.00		0.00		0.00		
Watercourse slope (%)	=	0.00		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	0.00		0.00		0.00		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow								
X sectional flow area (sqft)	=	1.77		0.00		0.00		
Wetted perimeter (ft)	=	4.70		0.00		0.00		
Channel slope (%)	=	1.00		0.00		0.00		
Manning's n-value	=	0.013		0.015		0.015		
Velocity (ft/s)	=	5.96		0.00		0.00		
Flow length (ft)		({0})330.0		0.0		0.0		
Travel Time (min)	**=**	**0.92**	**+**	**0.00**	**+**	**0.00**	**=**	**0.92**

Total Travel Time, Tc .... 13.80 min

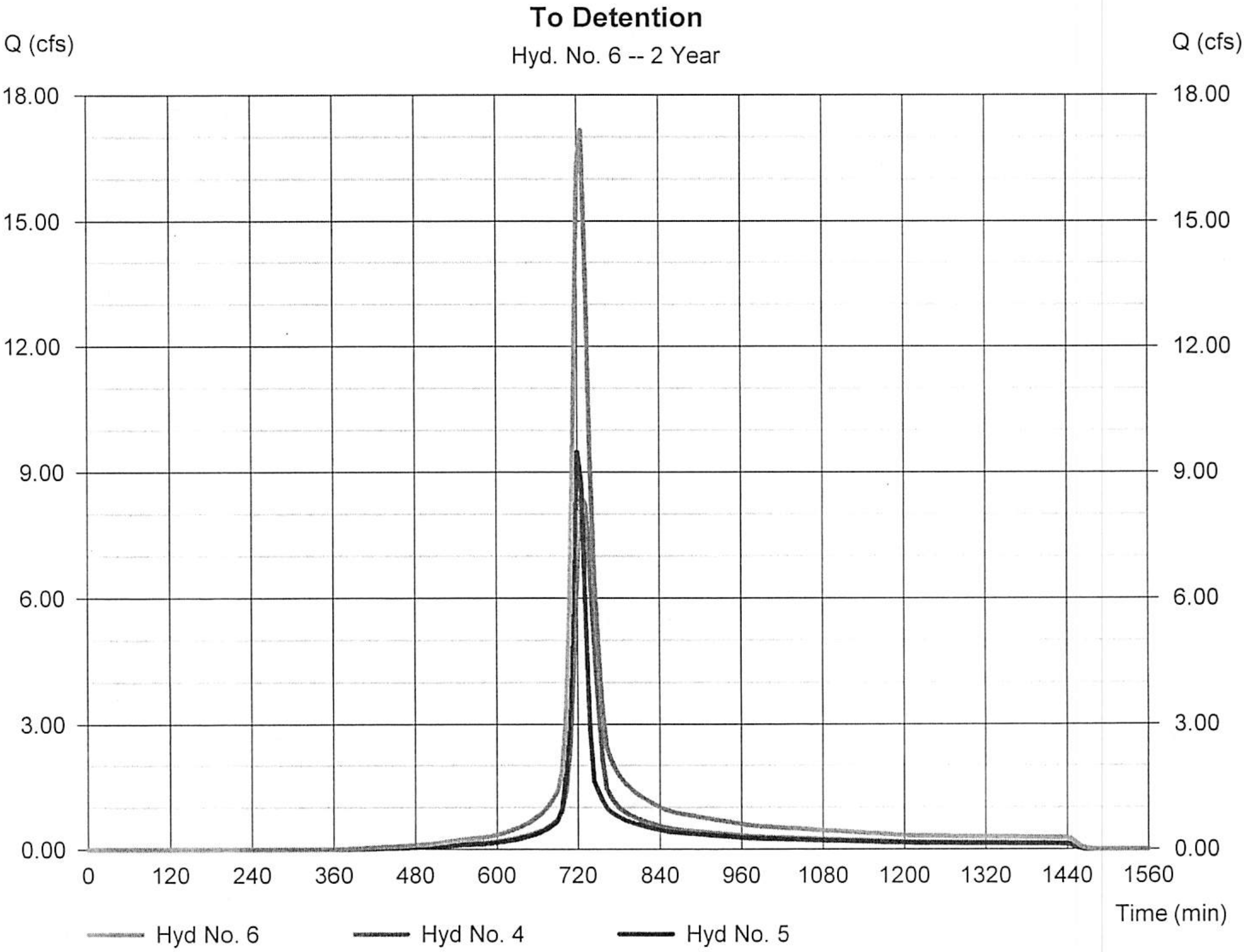
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 6

To Detention

Hydrograph type	= Combine	Peak discharge	= 17.16 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 63,392 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 9.220 ac



Hydrograph Report

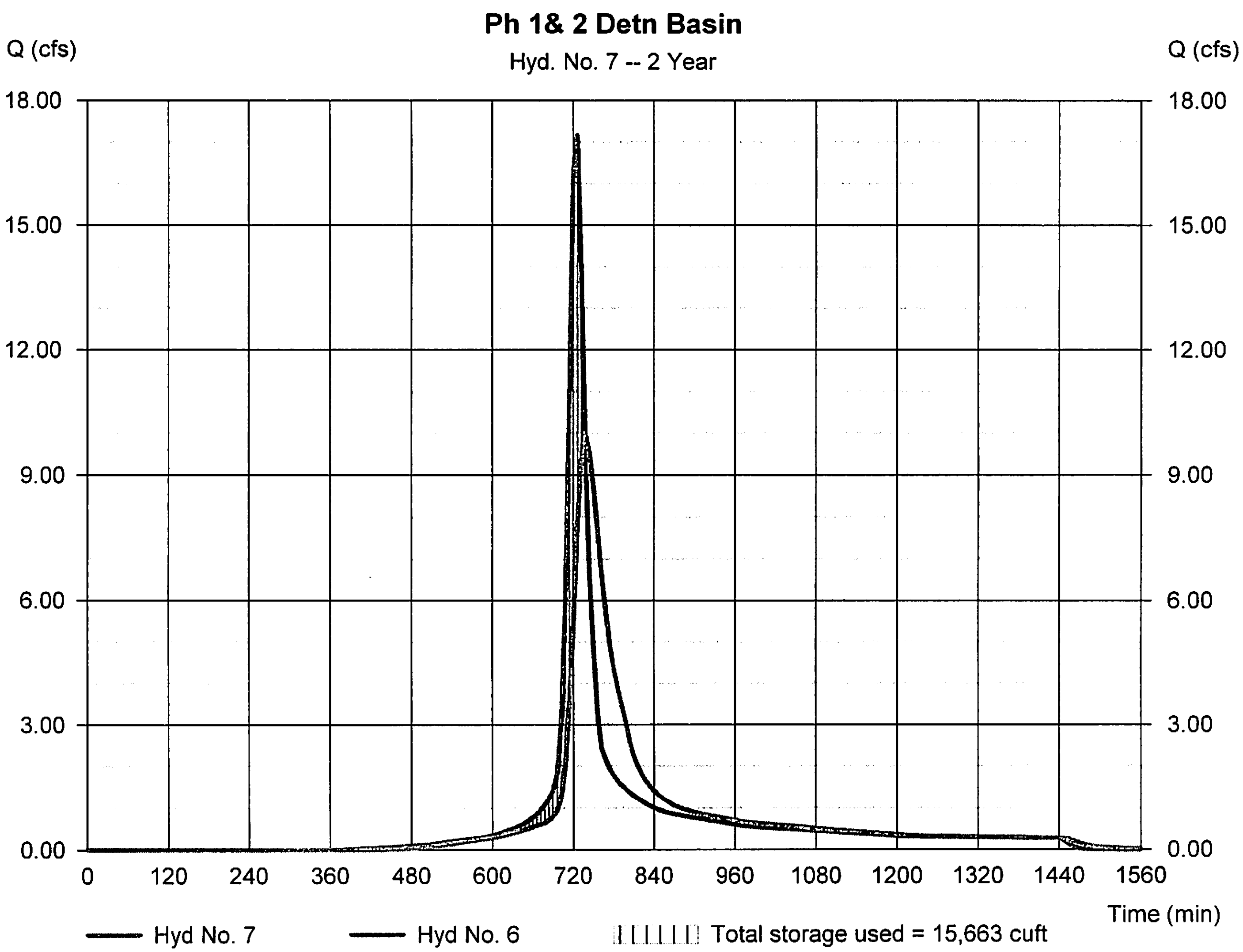
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 7

Ph 1& 2 Detn Basin

Hydrograph type	= Reservoir	Peak discharge	= 9.986 cfs
Storm frequency	= 2 yrs	Time to peak	= 738 min
Time interval	= 6 min	Hyd. volume	= 63,274 cuft
Inflow hyd. No.	= 6 - To Detention	Max. Elevation	= 585.98 ft
Reservoir name	= StormTech MC-3500	Max. Storage	= 15,663 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Pond No. 1 - StormTech MC-3500

Pond Data

UG Chambers -Invert elev. = 584.50 ft, Rise x Span = 3.75 x 6.42 ft, Barrel Len = 355.50 ft, No. Barrels = 5, Slope = 0.25%, Headers = No
Encasement -Invert elev. = 583.75 ft, Width = 6.92 ft, Height = 5.50 ft, Voids = 40.00%
Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 590.75 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	583.75	n/a	0	0
0.64	584.39	n/a	1,162	1,162
1.28	585.03	n/a	3,920	5,082
1.92	585.67	n/a	7,067	12,149
2.56	586.31	n/a	7,329	19,478
3.19	586.94	n/a	7,033	26,511
3.83	587.58	n/a	6,549	33,060
4.47	588.22	n/a	5,751	38,811
5.11	588.86	n/a	4,243	43,054
5.75	589.50	n/a	3,224	46,279
6.39	590.14	n/a	3,144	49,423
7.00	590.75	25	5	49,428
7.25	591.00	25	6	49,434
7.75	591.50	25	13	49,447
8.25	592.00	25	13	49,459

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 30.00	6.00	0.00	0.00
Span (in)	= 30.00	6.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 583.39	583.80	0.00	0.00
Length (ft)	= 146.00	0.00	0.00	0.00
Slope (%)	= 0.79	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)	= 1.33	3.67	Inactive	0.00
Crest El. (ft)	= 584.40	586.20	585.70	0.00
Weir Coeff.	= 3.50	3.33	3.33	3.33
Weir Type	= Rect	Rect	Rect	---
Multi-Stage	= Yes	Yes	Yes	No

Exfil.(in/hr) = 0.000 (by Contour)
TW Elev. (ft) = 0.00

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

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	583.75	0.00	0.00	---	---	0.00	0.00	0.00	---	---	---	0.000
0.64	1,162	584.39	0.91 ic	0.55 ic	---	---	0.00	0.00	0.00	---	---	---	0.550
1.28	5,082	585.03	3.32 ic	0.92 ic	---	---	2.32	0.00	0.00	---	---	---	3.231
1.92	12,149	585.67	7.76 ic	1.02 ic	---	---	6.58 s	0.00	0.00	---	---	---	7.596
2.56	19,478	586.31	13.11 ic	1.12 ic	---	---	11.57 s	0.42	0.00	---	---	---	13.11
3.19	26,511	586.94	24.70 ic	1.05 ic	---	---	15.80 s	7.85	0.00	---	---	---	24.70
3.83	33,060	587.58	34.35 oc	0.78 ic	---	---	16.77 s	16.79 s	0.00	---	---	---	34.34
4.47	38,811	588.22	40.75 oc	0.63 ic	---	---	17.62 s	22.49 s	0.00	---	---	---	40.75
5.11	43,054	588.86	45.66 oc	0.53 ic	---	---	18.28 s	26.85 s	0.00	---	---	---	45.66
5.75	46,279	589.50	49.79 oc	0.45 ic	---	---	18.89 s	30.44 s	0.00	---	---	---	49.79
6.39	49,423	590.14	53.46 oc	0.40 ic	---	---	19.48 s	33.57 s	0.00	---	---	---	53.45
7.00	49,428	590.75	56.67 oc	0.35 ic	---	---	20.05 s	36.26 s	0.00	---	---	---	56.66
7.25	49,434	591.00	57.91 oc	0.34 ic	---	---	20.27 s	37.29 s	0.00	---	---	---	57.90
7.75	49,447	591.50	60.31 oc	0.31 ic	---	---	20.73 s	39.27 s	0.00	---	---	---	60.31
8.25	49,459	592.00	62.60 oc	0.29 ic	---	---	21.18 s	41.12 s	0.00	---	---	---	62.59

Hydrograph Report

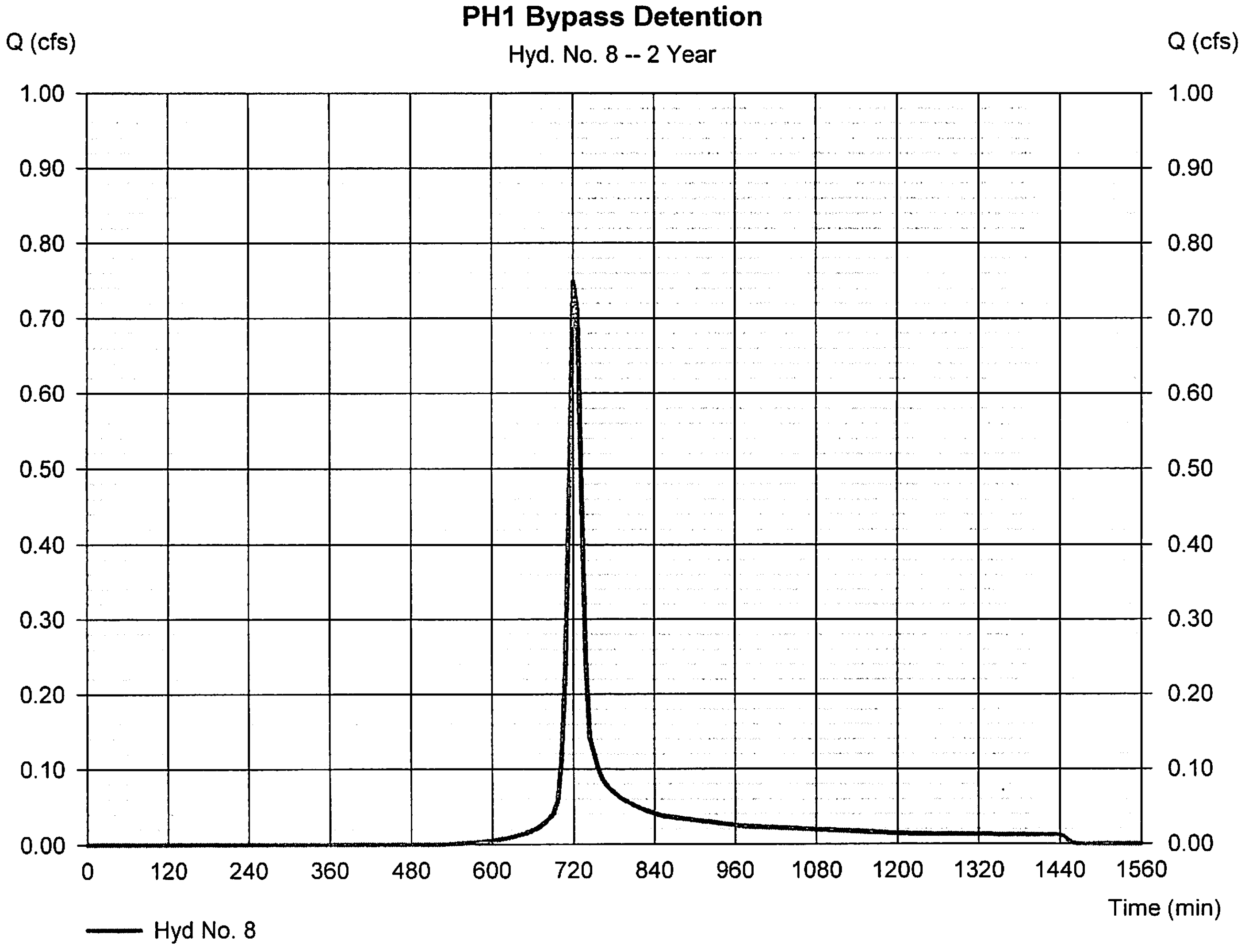
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 8

PH1 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 0.749 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 2,327 cuft
Drainage area	= 0.470 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 3.01 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.390 x 80)] / 0.470



TR55 Tc Worksheet

Hyd. No. 8

PH1 Bypass Detention

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	90.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.01		0.00		0.00		
Land slope (%)	=	4.00		0.00		0.00		
Travel Time (min)	**=**	**10.25**	**+**	**0.00**	**+**	**0.00**	**=**	**10.25**
Shallow Concentrated Flow								
Flow length (ft)	=	90.00		0.00		0.00		
Watercourse slope (%)	=	0.25		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	1.02		0.00		0.00		
Travel Time (min)	**=**	**1.48**	**+**	**0.00**	**+**	**0.00**	**=**	**1.48**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00						
				0.00				
						0.00		
Flow length (ft)		({0})0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 11.70 min

Hydrograph Report

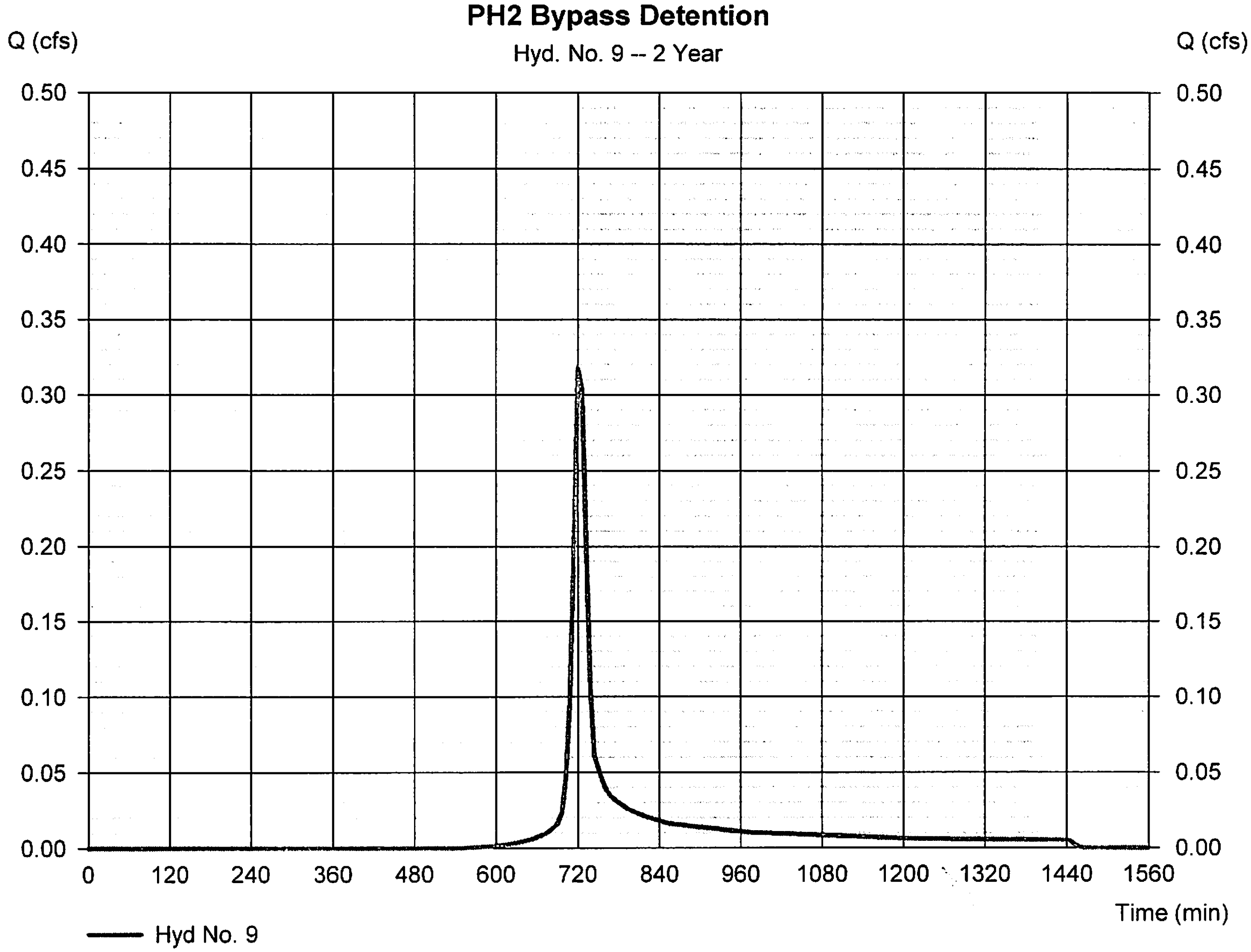
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 9

PH2 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 0.317 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 991 cuft
Drainage area	= 0.210 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 3.01 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98) + (0.190 x 80)] / 0.210



TR55 Tc Worksheet

Hyd. No. 9

PH2 Bypass Detention

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	90.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.01		0.00		0.00		
Land slope (%)	=	4.00		0.00		0.00		
Travel Time (min)	**=**	**10.25**	**+**	**0.00**	**+**	**0.00**	**=**	**10.25**
Shallow Concentrated Flow								
Flow length (ft)	=	90.00		0.00		0.00		
Watercourse slope (%)	=	0.25		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	1.02		0.00		0.00		
Travel Time (min)	**=**	**1.48**	**+**	**0.00**	**+**	**0.00**	**=**	**1.48**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)		({0})0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 11.70 min

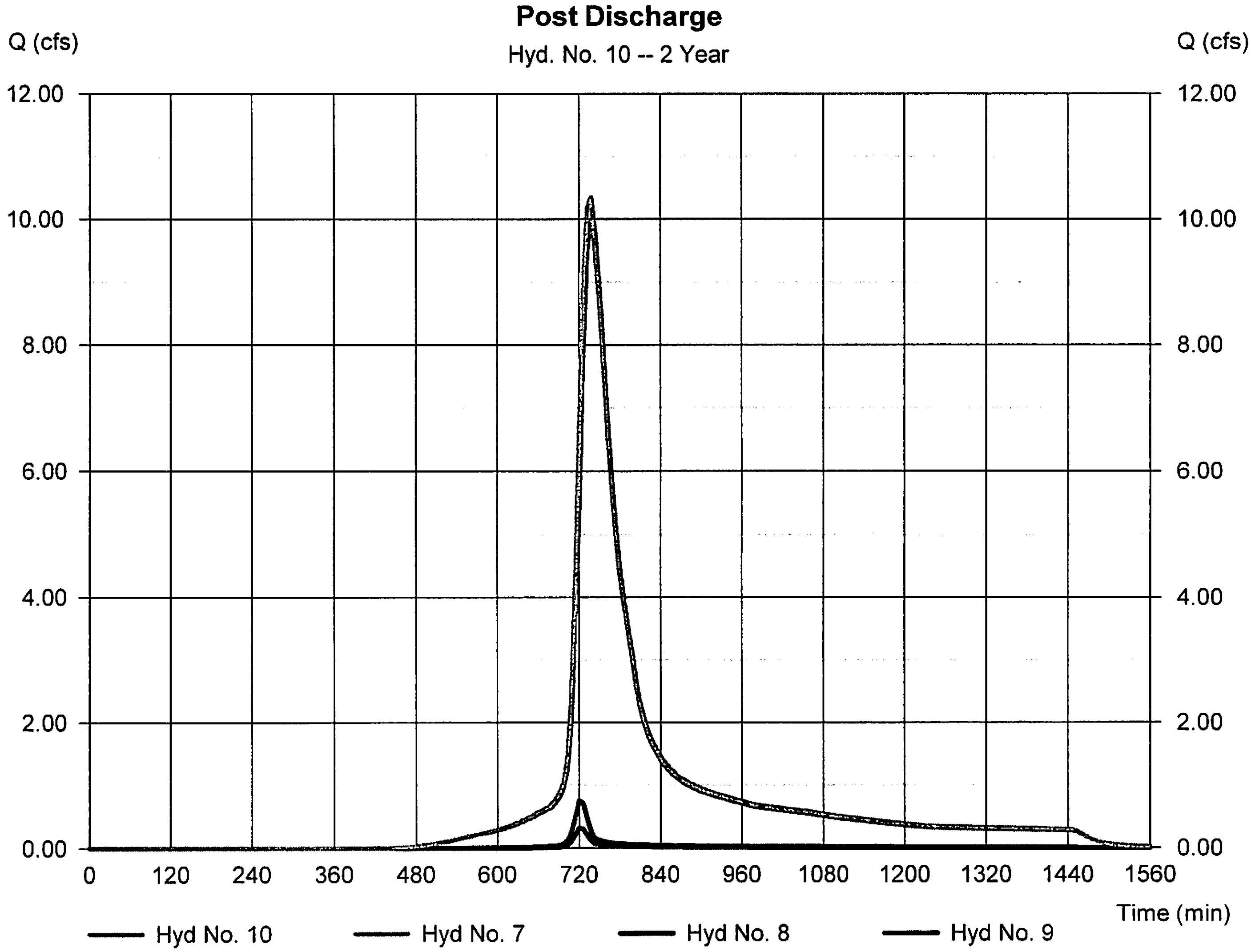
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 10

Post Discharge

Hydrograph type	= Combine	Peak discharge	= 10.34 cfs
Storm frequency	= 2 yrs	Time to peak	= 738 min
Time interval	= 6 min	Hyd. volume	= 66,592 cuft
Inflow hyds.	= 7, 8, 9	Contrib. drain. area	= 0.680 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

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	14.75	6	726	59,909	------	------	------	PH 1 Predevelopment
2	SCS Runoff	13.75	6	726	55,785	------	------	------	PH 2 Predevelopment
3	Combine	28.50	6	726	115,694	1, 2	------	------	Predevelopment
4	SCS Runoff	17.36	6	726	71,865	------	------	------	PH1 to Detention
5	SCS Runoff	19.87	6	720	62,327	------	------	------	PH2 to Detention
6	Combine	35.24	6	726	134,192	4, 5	------	------	To Detention
7	Reservoir	26.56	6	732	134,073	6	587.09	27,740	Ph 1& 2 Detn Basin
8	SCS Runoff	1.801	6	720	5,542	------	------	------	PH1 Bypass Detention
9	SCS Runoff	0.783	6	720	2,406	------	------	------	PH2 Bypass Detention
10	Combine	28.06	6	732	142,022	7, 8, 9	------	------	Post Discharge

Woodbury Phase 1 & 2 May-13-14.gpw	Return Period: ~~10~~ 15 Year	Tuesday, 05 / 13 / 2014

Hydrograph Report

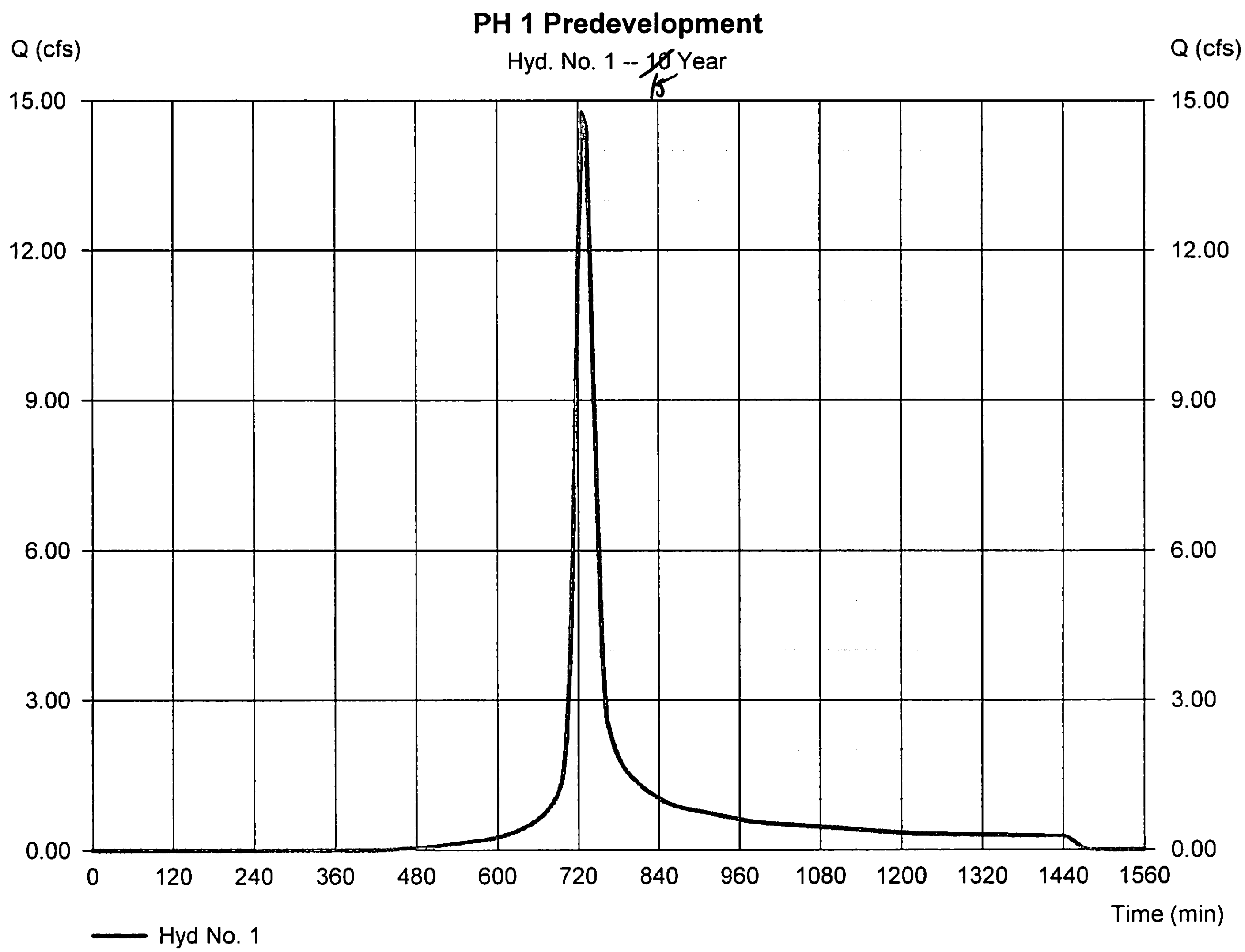
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 1

PH 1 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 14.75 cfs
Storm frequency	= ~~10~~ 15 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 59,909 cuft
Drainage area	= 5.200 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.80 min
Total precip.	= 5.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.840 x 80) + (0.150 x 98) + (0.210 x 79)] / 5.200



Hydrograph Report

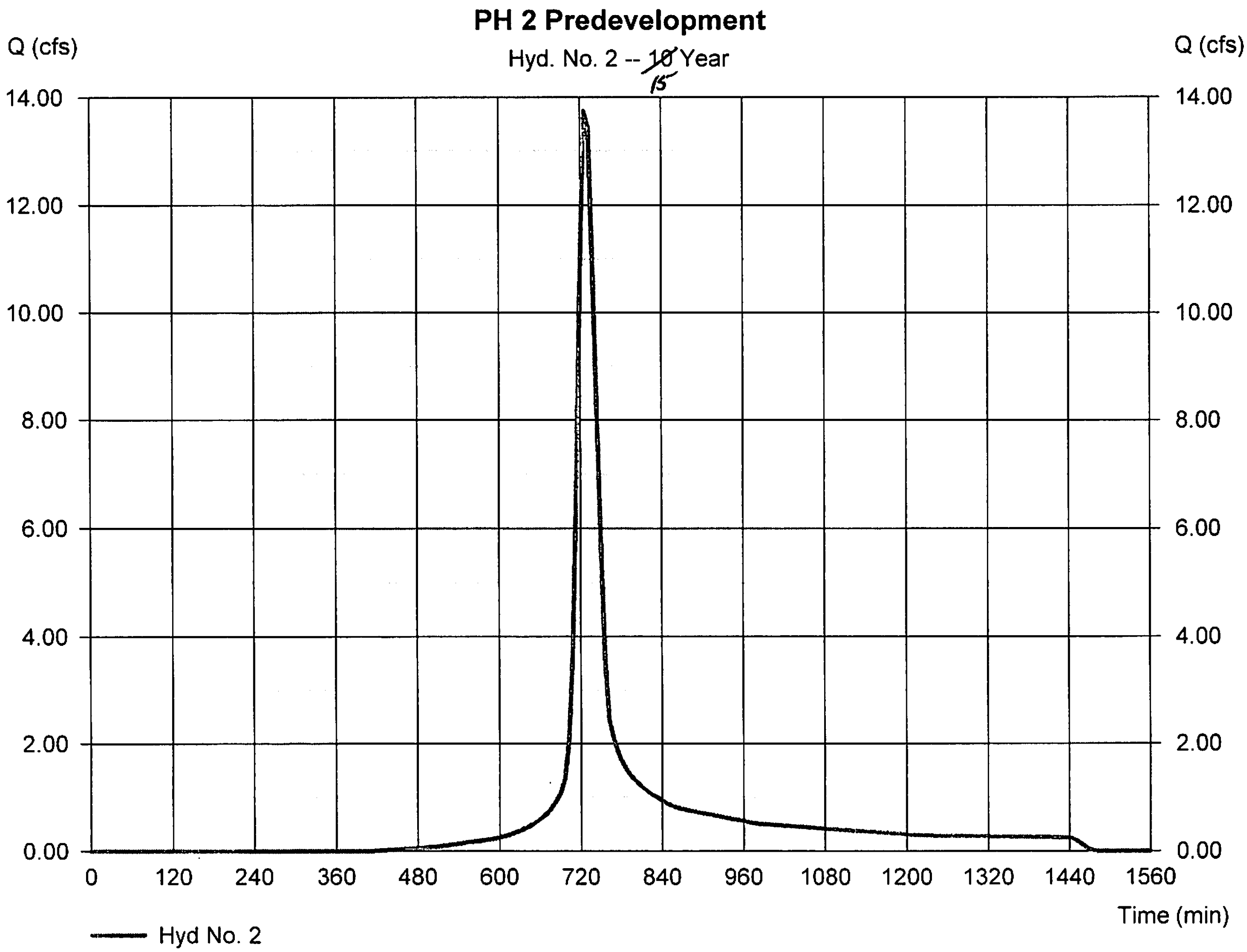
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 2

PH 2 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 13.75 cfs
Storm frequency	= ~~10~~ 15 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 55,785 cuft
Drainage area	= 4.700 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.70 min
Total precip.	= 5.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.250 x 80) + (0.270 x 79) + (0.180 x 98)] / 4.700



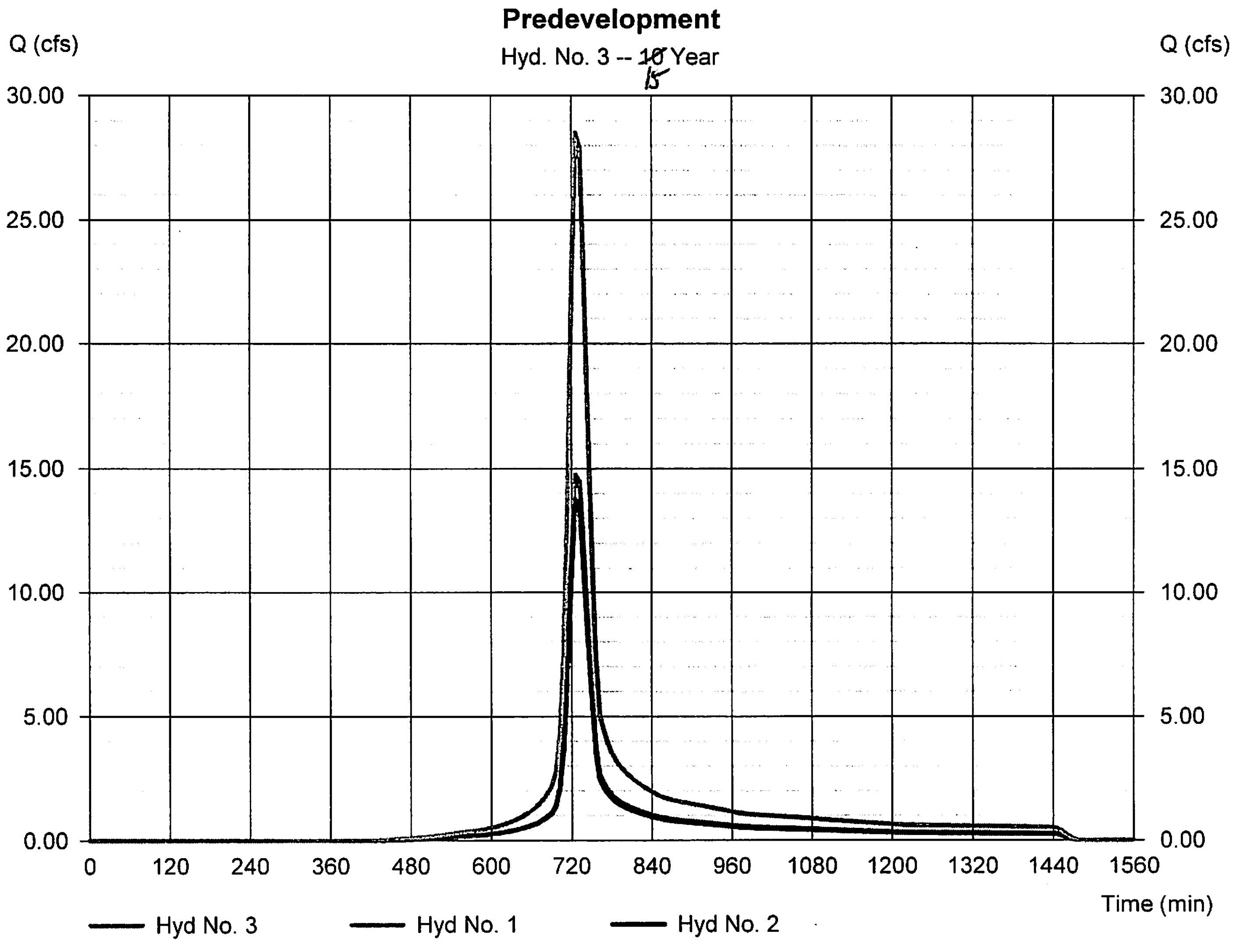
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 3

Predevelopment

Hydrograph type	= Combine	Peak discharge	= 28.50 cfs
Storm frequency	= ~~10~~ 15 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 115,694 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 9.900 ac



Hydrograph Report

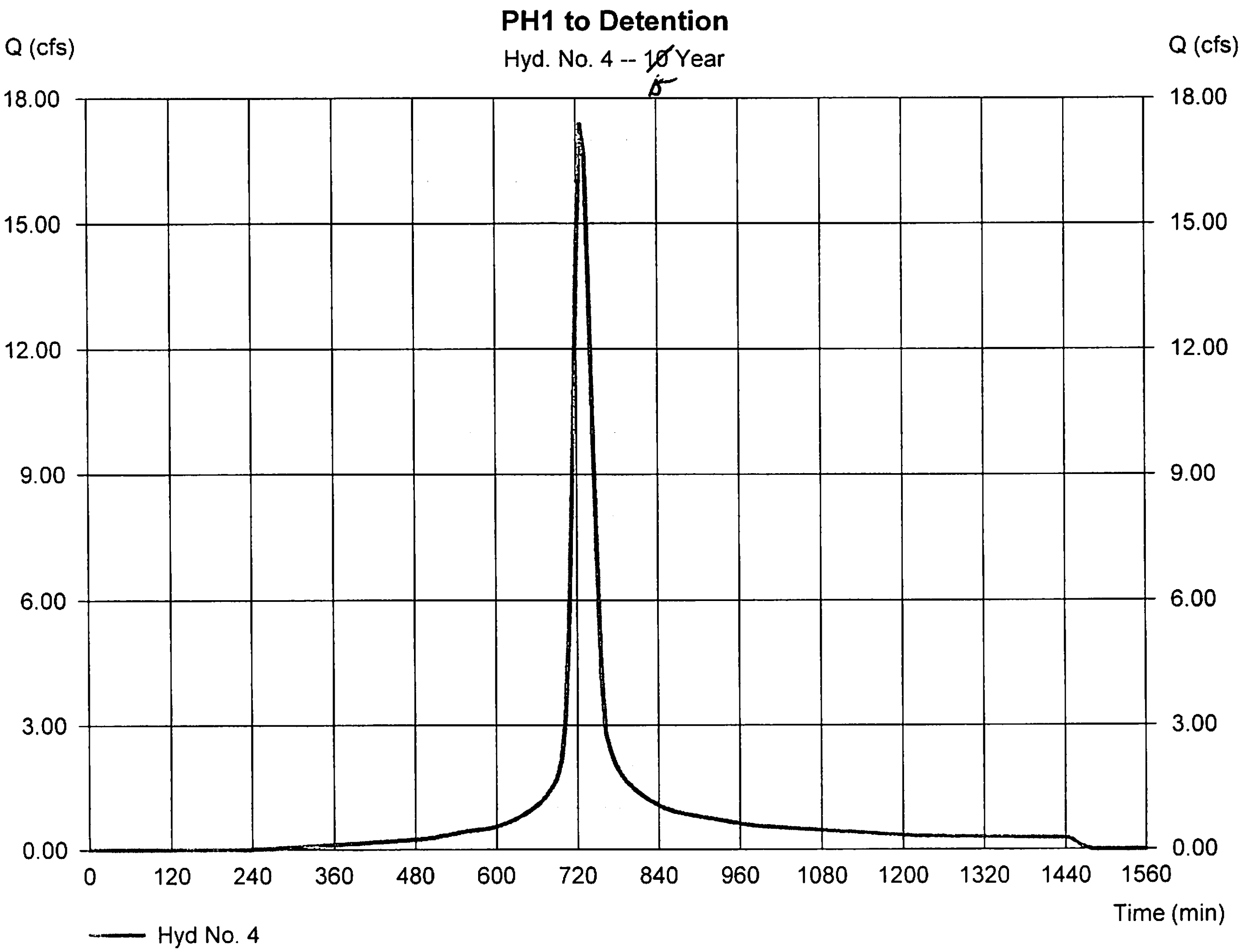
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 4

PH1 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 17.36 cfs
Storm frequency	= ~~10~~ 5 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 71,865 cuft
Drainage area	= 4.730 ac	Curve number	= 90*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 21.20 min
Total precip.	= 5.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.410 x 98) + (1.910 x 80) + (0.150 x 98) + (0.260 x 80)] / 4.730



Hydrograph Report

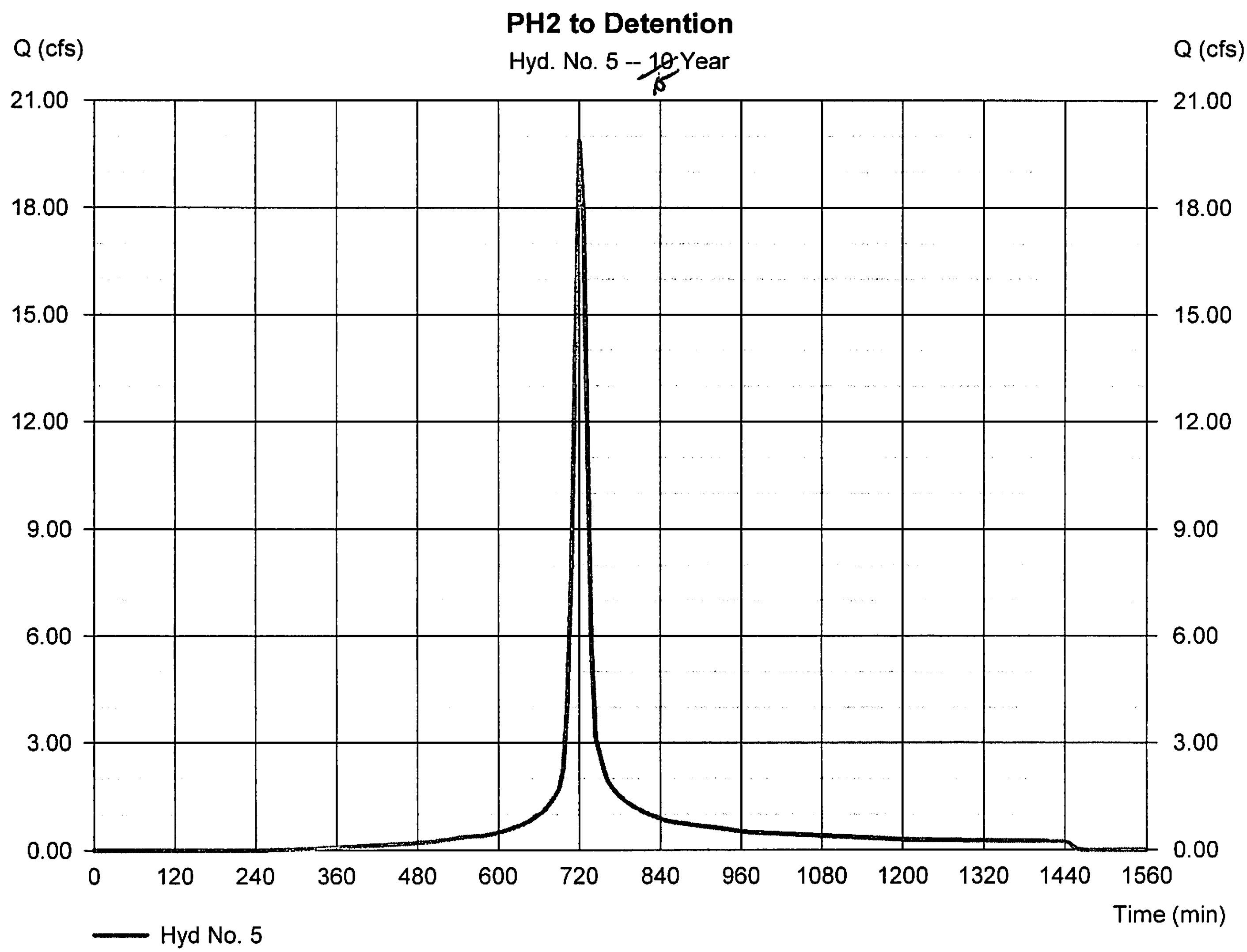
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 5

PH2 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 19.87 cfs
Storm frequency	= ~~10~~ 5 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 62,327 cuft
Drainage area	= 4.490 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.80 min
Total precip.	= 5.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.040 x 98) + (1.320 x 80) + (0.180 x 98) + (0.950 x 80)] / 4.490



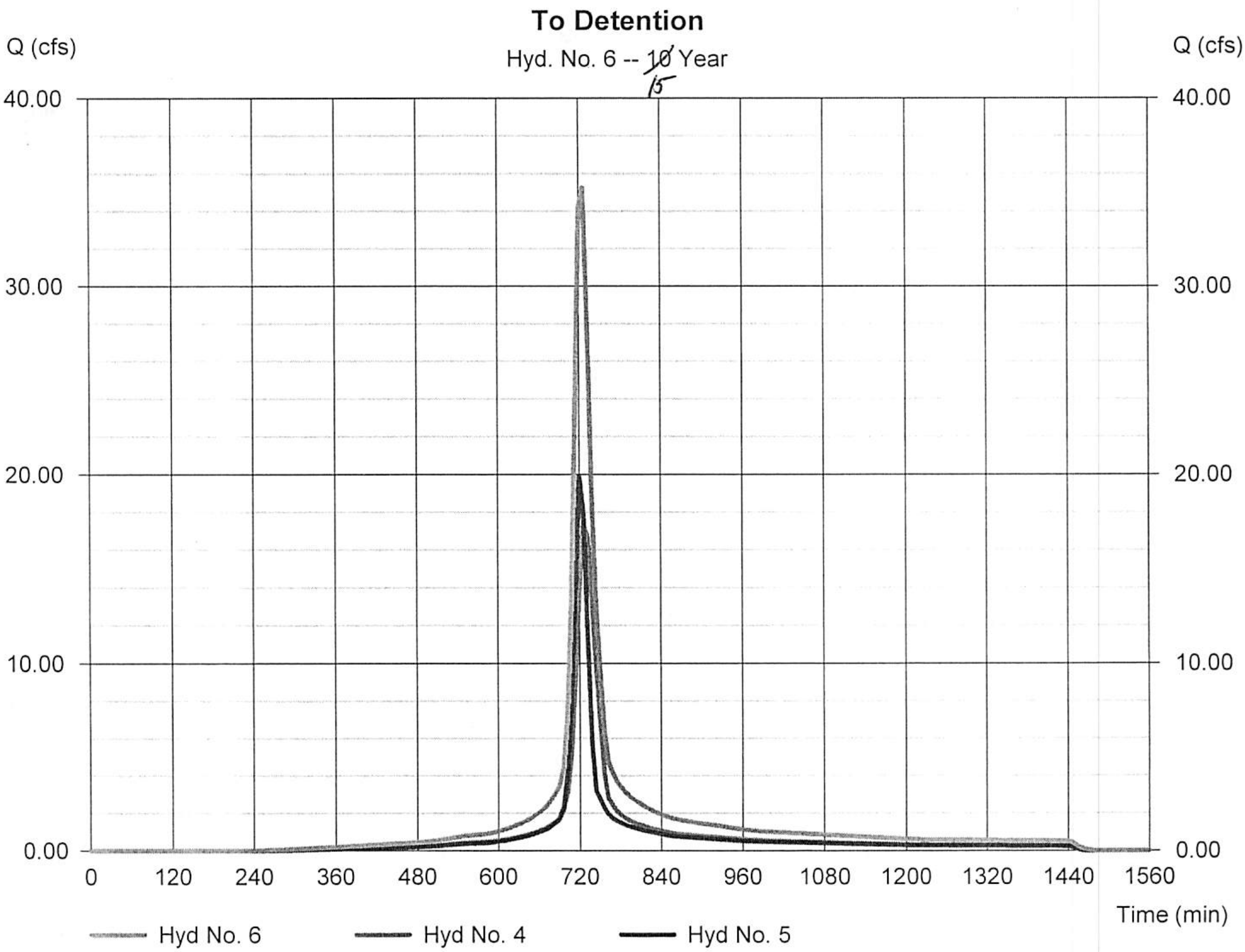
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 6

To Detention

Hydrograph type	= Combine	Peak discharge	= 35.24 cfs
Storm frequency	= ~~10~~ 15 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 134,192 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 9.220 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 7

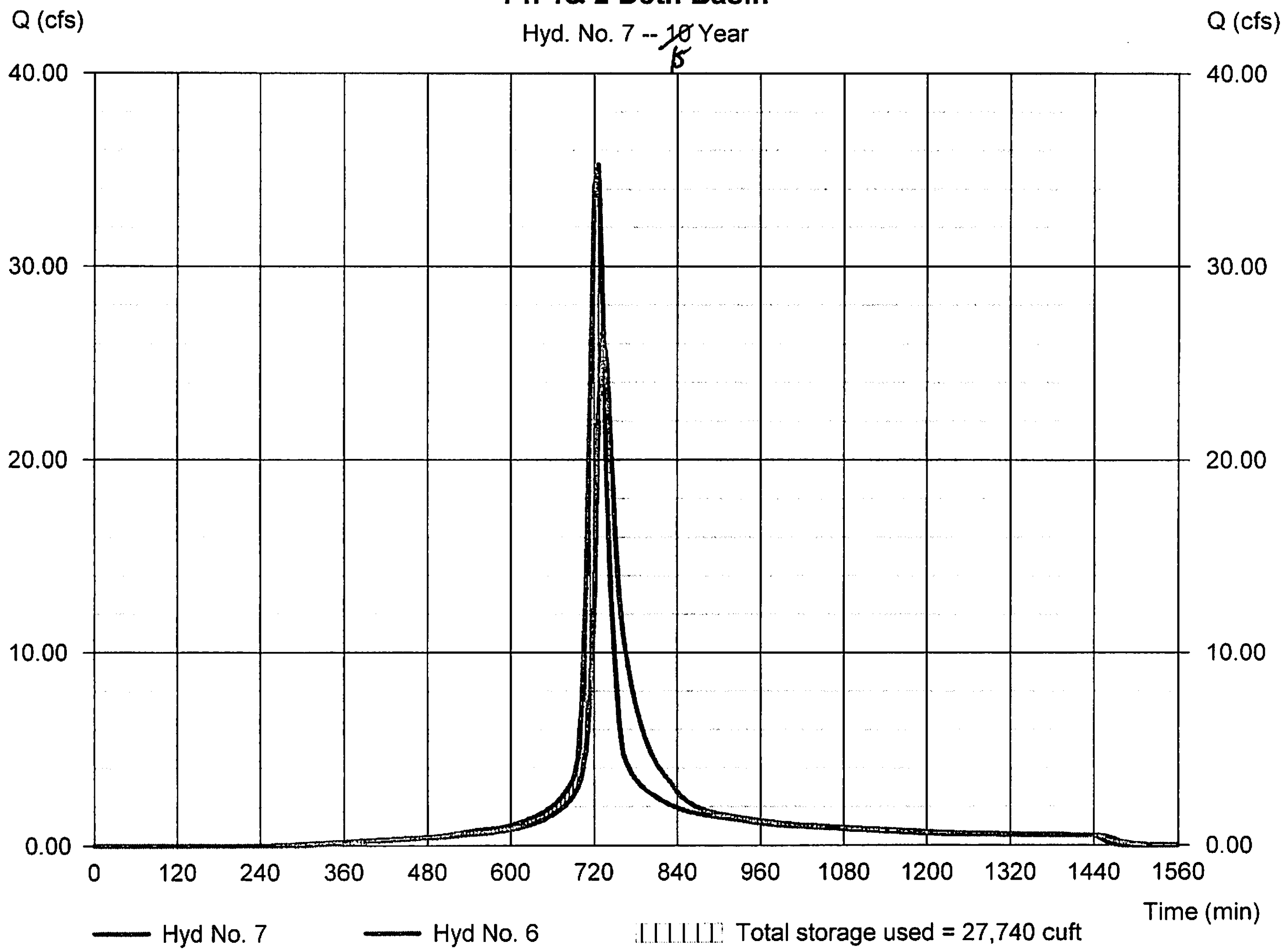
Ph 1& 2 Detn Basin

Hydrograph type	= Reservoir	Peak discharge	= 26.56 cfs
Storm frequency	= 15 ~~10~~ yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 134,073 cuft
Inflow hyd. No.	= 6 - To Detention	Max. Elevation	= 587.09 ft
Reservoir name	= StormTech MC-3500	Max. Storage	= 27,740 cuft

Storage Indication method used.

Ph 1& 2 Detn Basin

Hyd. No. 7 -- ~~10~~ 15 Year



Hydrograph Report

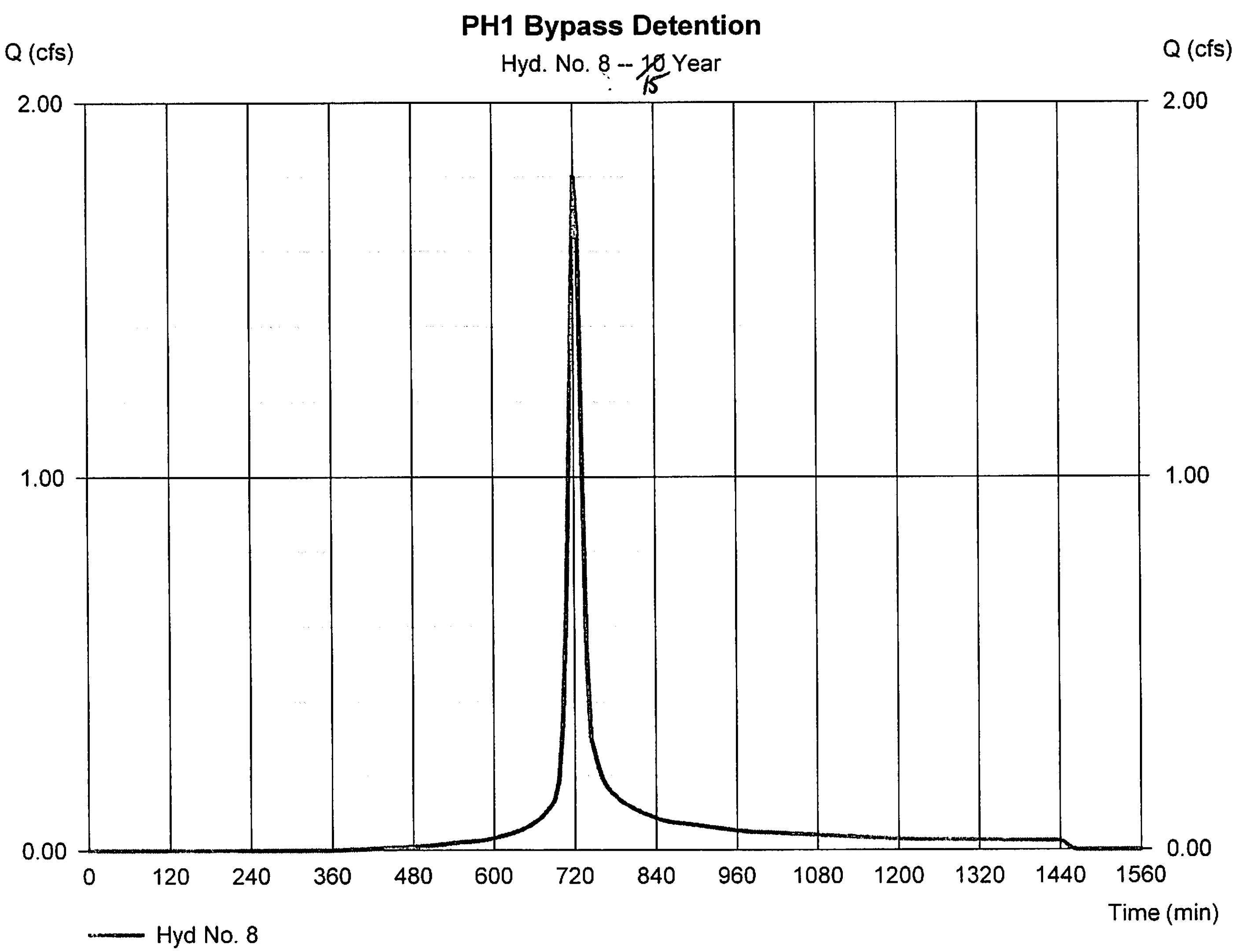
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 8

PH1 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 1.801 cfs
Storm frequency	= ~~10~~ 15 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 5,542 cuft
Drainage area	= 0.470 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 5.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.390 x 80)] / 0.470



Hydrograph Report

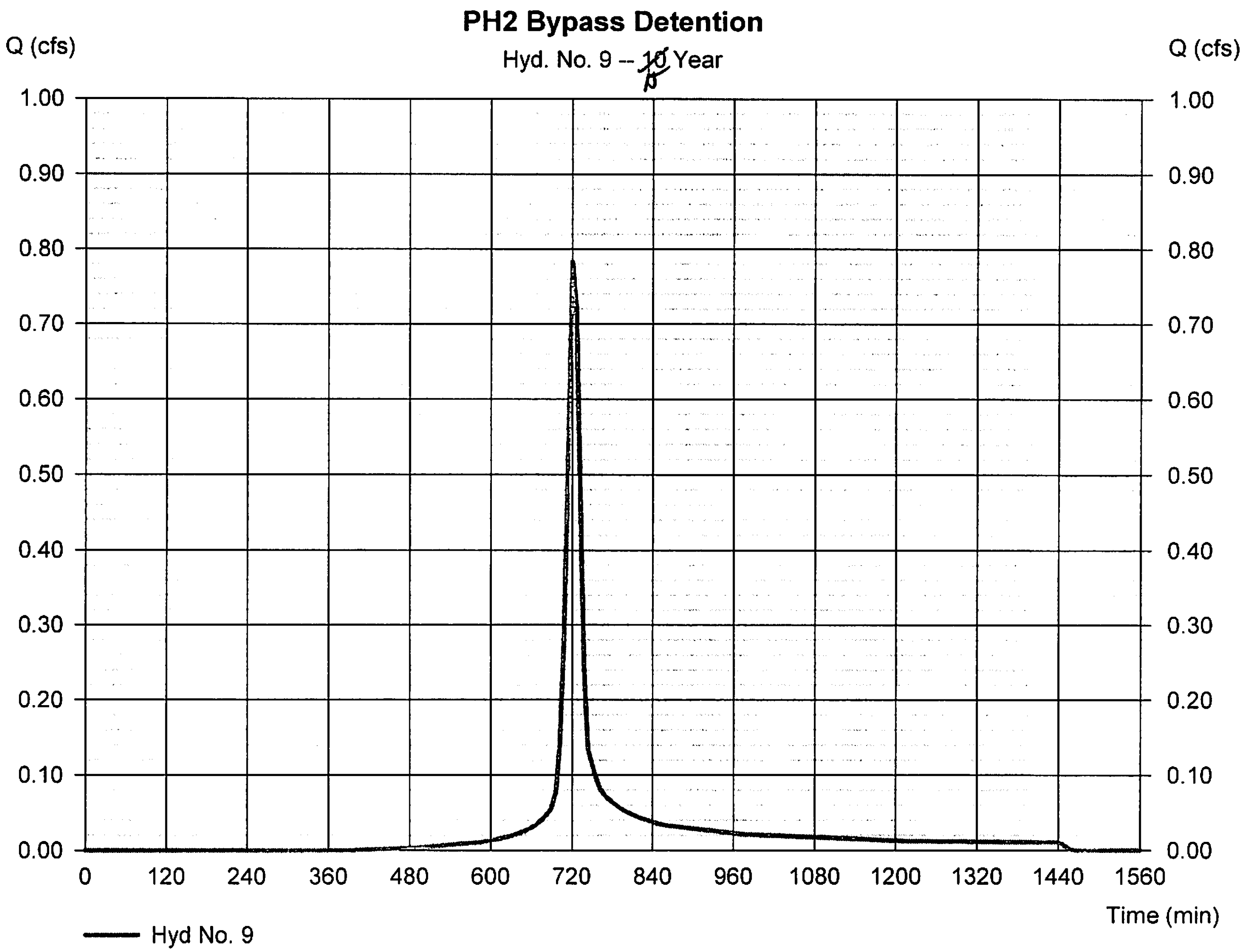
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 9

PH2 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 0.783 cfs
Storm frequency	= ~~10~~ 15 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 2,406 cuft
Drainage area	= 0.210 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 5.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98) + (0.190 x 80)] / 0.210



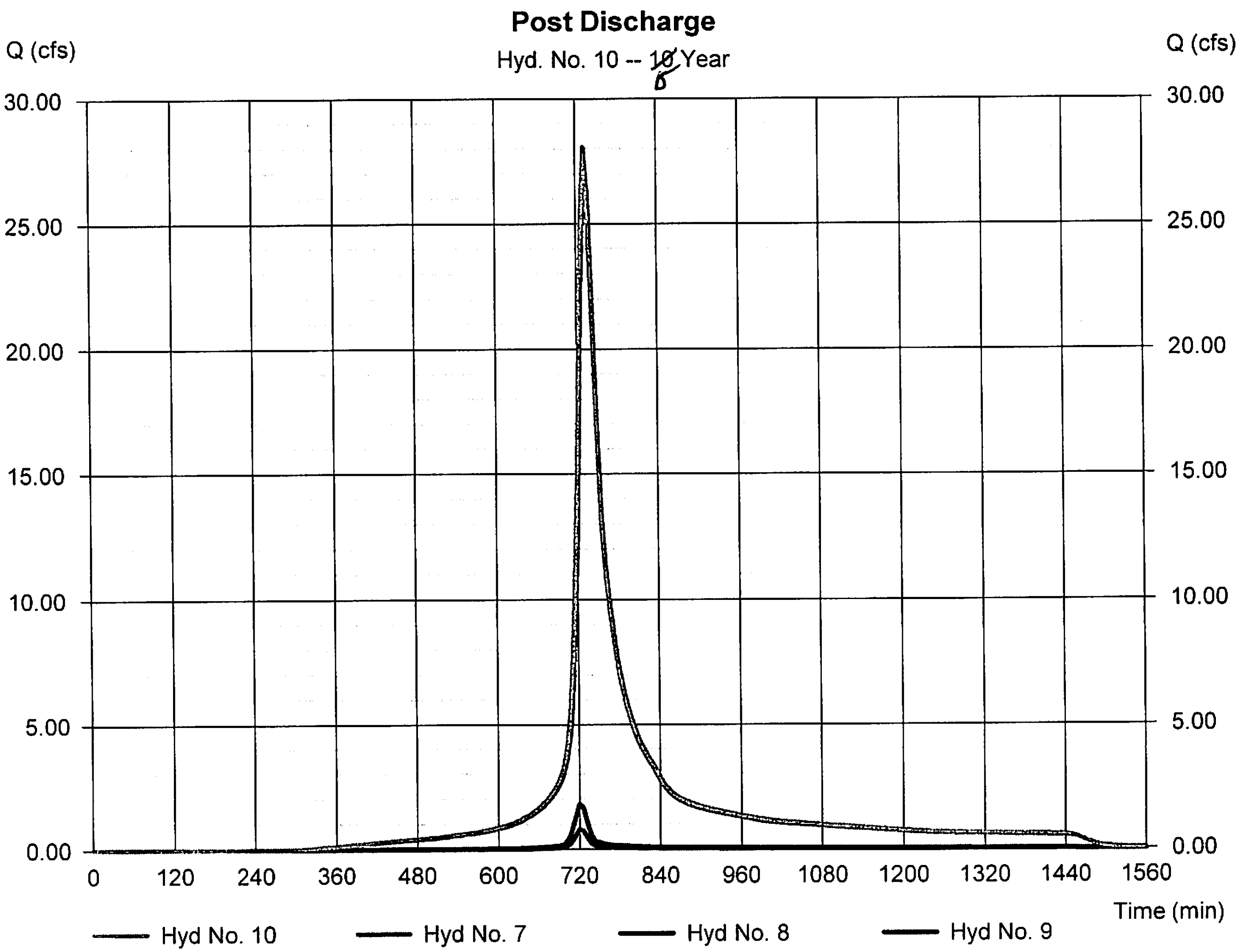
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 10

Post Discharge

Hydrograph type	= Combine	Peak discharge	= 28.06 cfs
Storm frequency	= ~~10~~ 5 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 142,022 cuft
Inflow hyds.	= 7, 8, 9	Contrib. drain. area	= 0.680 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

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	17.97	6	726	72,910	------	------	------	PH 1 Predevelopment
2	SCS Runoff	16.67	6	726	67,661	------	------	------	PH 2 Predevelopment
3	Combine	34.64	6	726	140,571	1, 2	------	------	Predevelopment
4	SCS Runoff	20.33	6	726	84,709	------	------	------	PH1 to Detention
5	SCS Runoff	23.32	6	720	73,690	------	------	------	PH2 to Detention
6	Combine	41.24	6	726	158,399	4, 5	------	------	To Detention
7	Reservoir	31.83	6	732	158,281	6	587.40	31,040	Ph 1& 2 Detn Basin
8	SCS Runoff	2.162	6	720	6,678	------	------	------	PH1 Bypass Detention
9	SCS Runoff	0.944	6	720	2,909	------	------	------	PH2 Bypass Detention
10	Combine	33.62	6	732	167,867	7, 8, 9	------	------	Post Discharge

Woodbury Phase 1 & 2 May-13-14.gpw	Return Period: 25 Year	Tuesday, 05 / 13 / 2014

Hydrograph Report

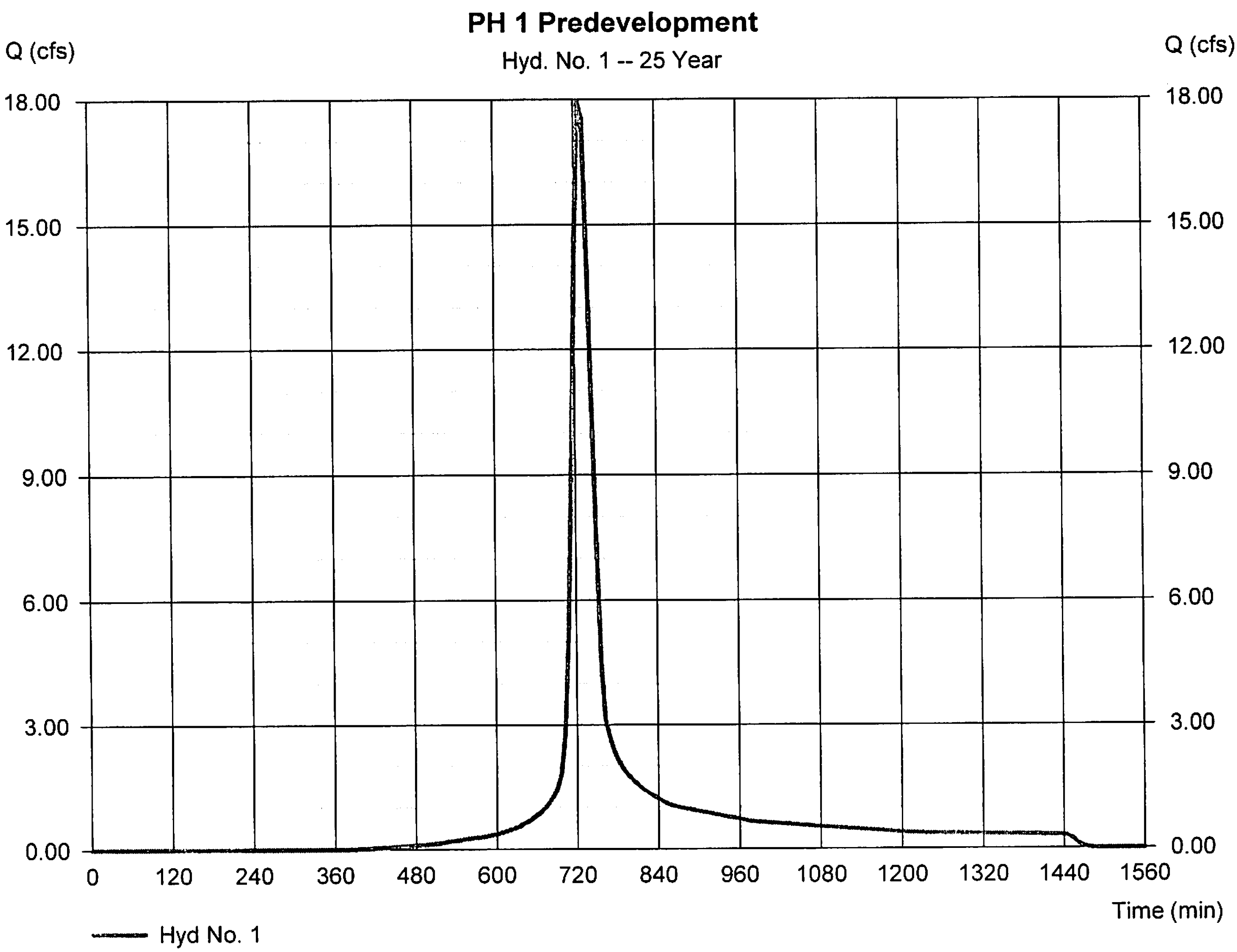
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 1

PH 1 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 17.97 cfs
Storm frequency	= 25 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 72,910 cuft
Drainage area	= 5.200 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.80 min
Total precip.	= 6.09 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.840 x 80) + (0.150 x 98) + (0.210 x 79)] / 5.200



Hydrograph Report

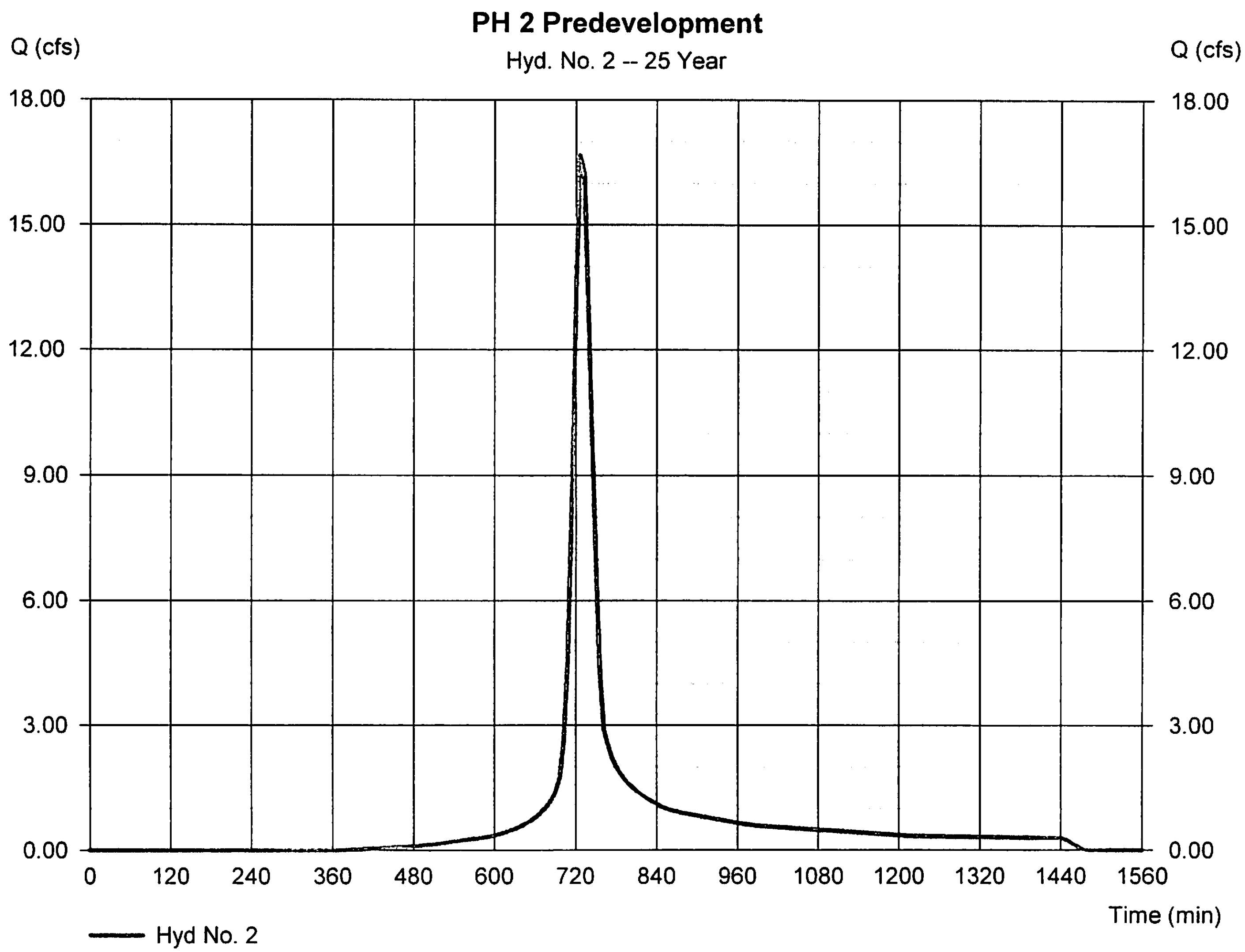
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 2

PH 2 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 16.67 cfs
Storm frequency	= 25 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 67,661 cuft
Drainage area	= 4.700 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.70 min
Total precip.	= 6.09 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.250 x 80) + (0.270 x 79) + (0.180 x 98)] / 4.700



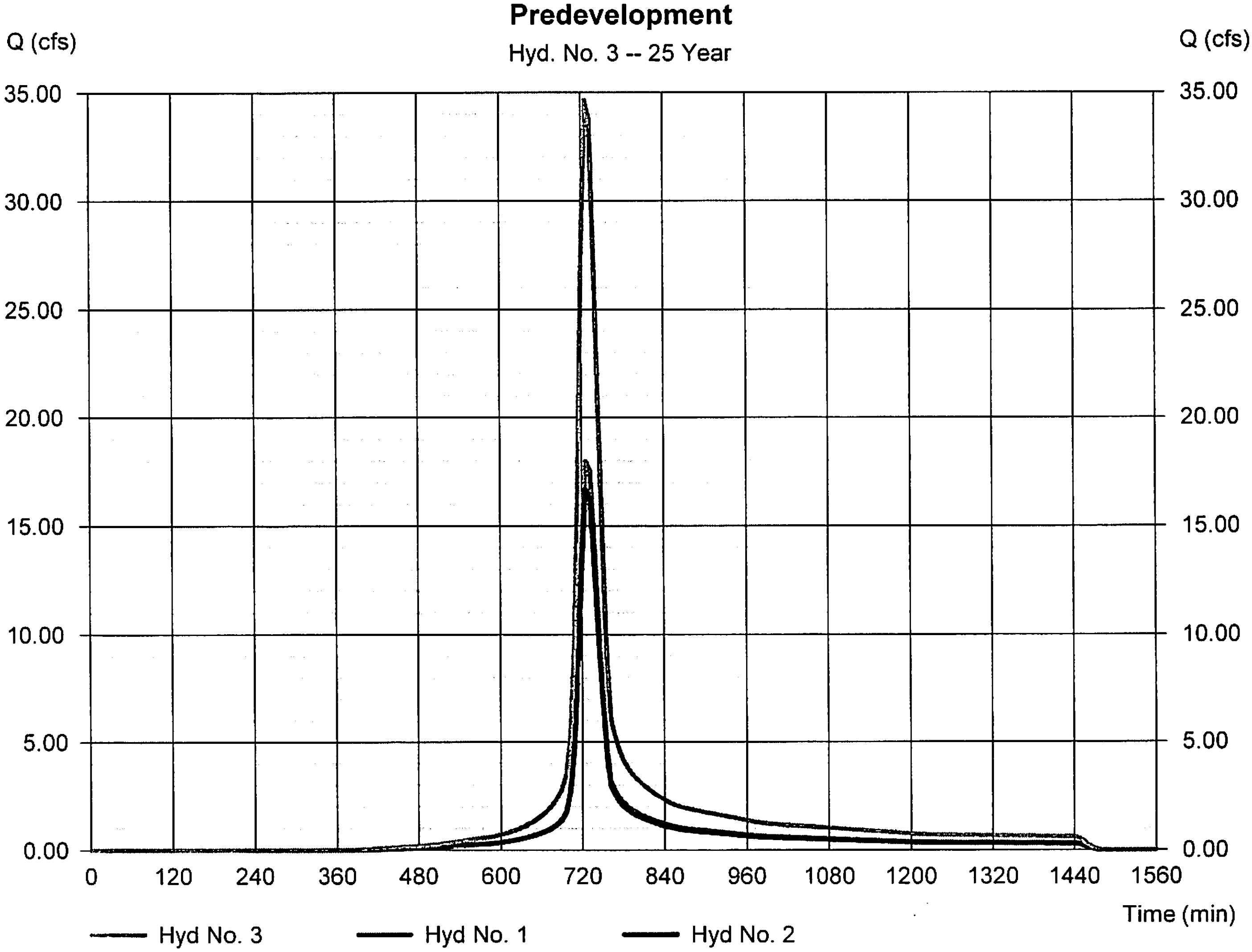
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 3

Predevelopment

Hydrograph type	= Combine	Peak discharge	= 34.64 cfs
Storm frequency	= 25 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 140,571 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 9.900 ac



Hydrograph Report

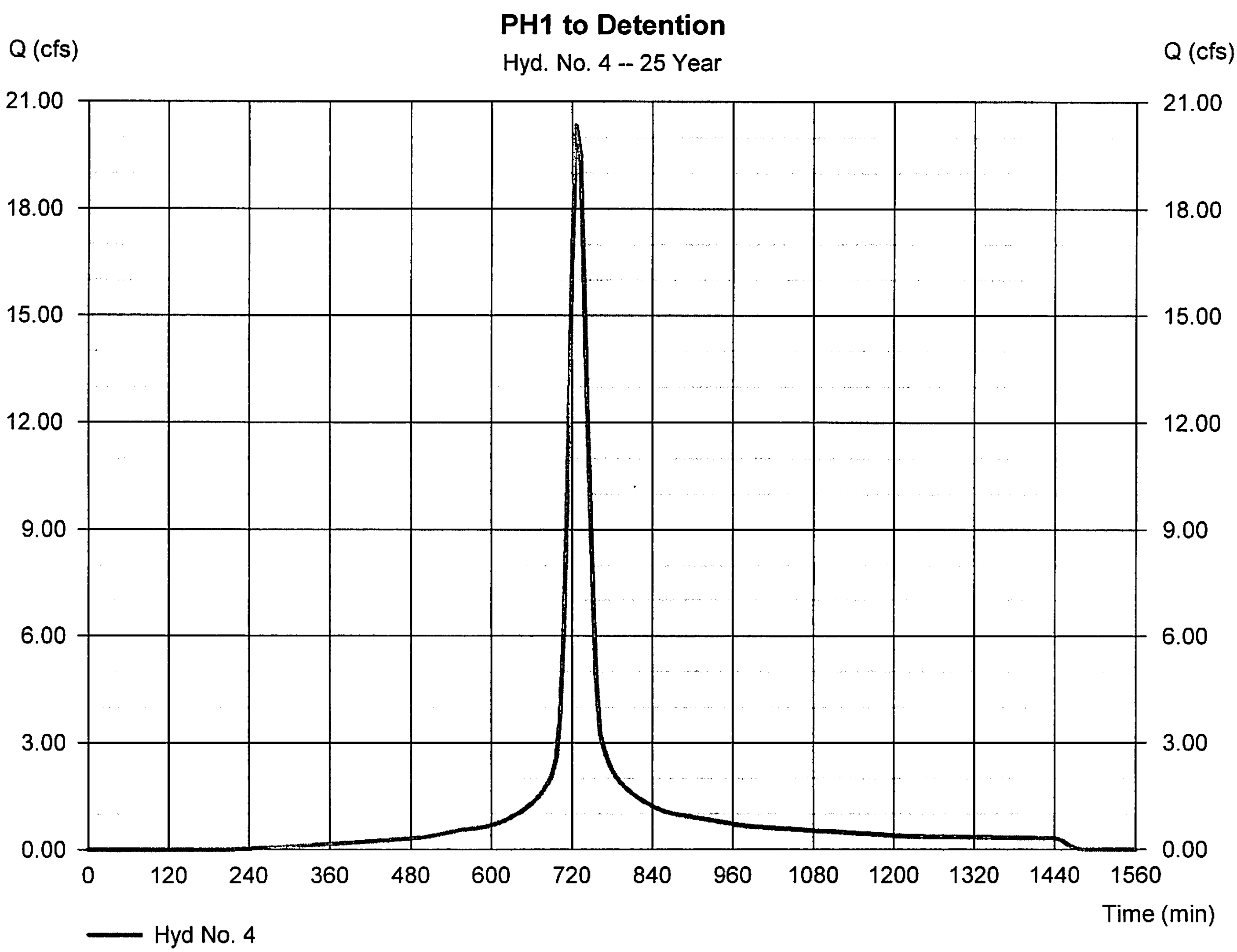
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 4

PH1 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 20.33 cfs
Storm frequency	= 25 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 84,709 cuft
Drainage area	= 4.730 ac	Curve number	= 90*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 21.20 min
Total precip.	= 6.09 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.410 x 98) + (1.910 x 80) + (0.150 x 98) + (0.260 x 80)] / 4.730



Hydrograph Report

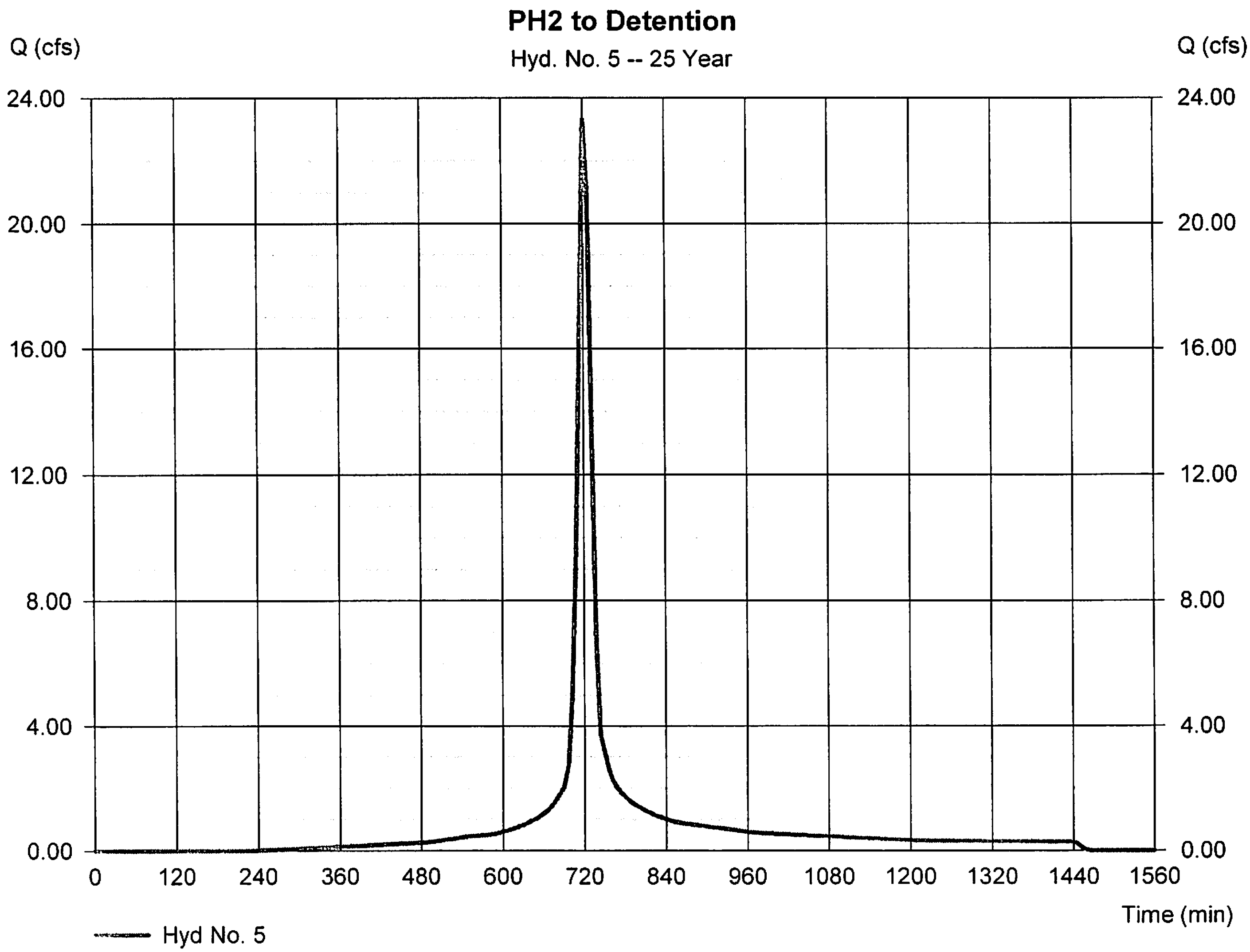
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 5

PH2 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 23.32 cfs
Storm frequency	= 25 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 73,690 cuft
Drainage area	= 4.490 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.80 min
Total precip.	= 6.09 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.040 x 98) + (1.320 x 80) + (0.180 x 98) + (0.950 x 80)] / 4.490



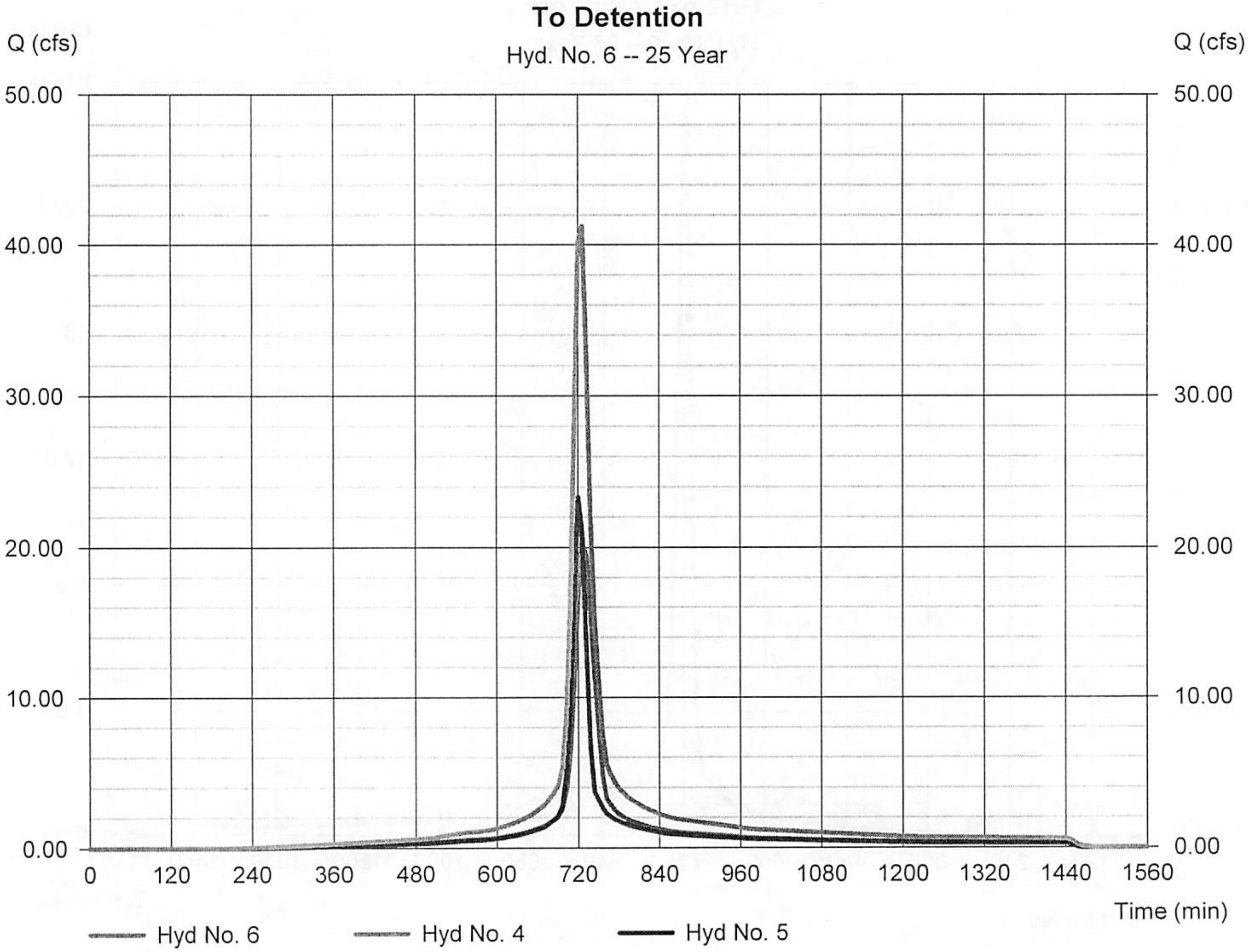
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 6

To Detention

Hydrograph type	= Combine	Peak discharge	= 41.24 cfs
Storm frequency	= 25 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 158,399 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 9.220 ac



Hydrograph Report

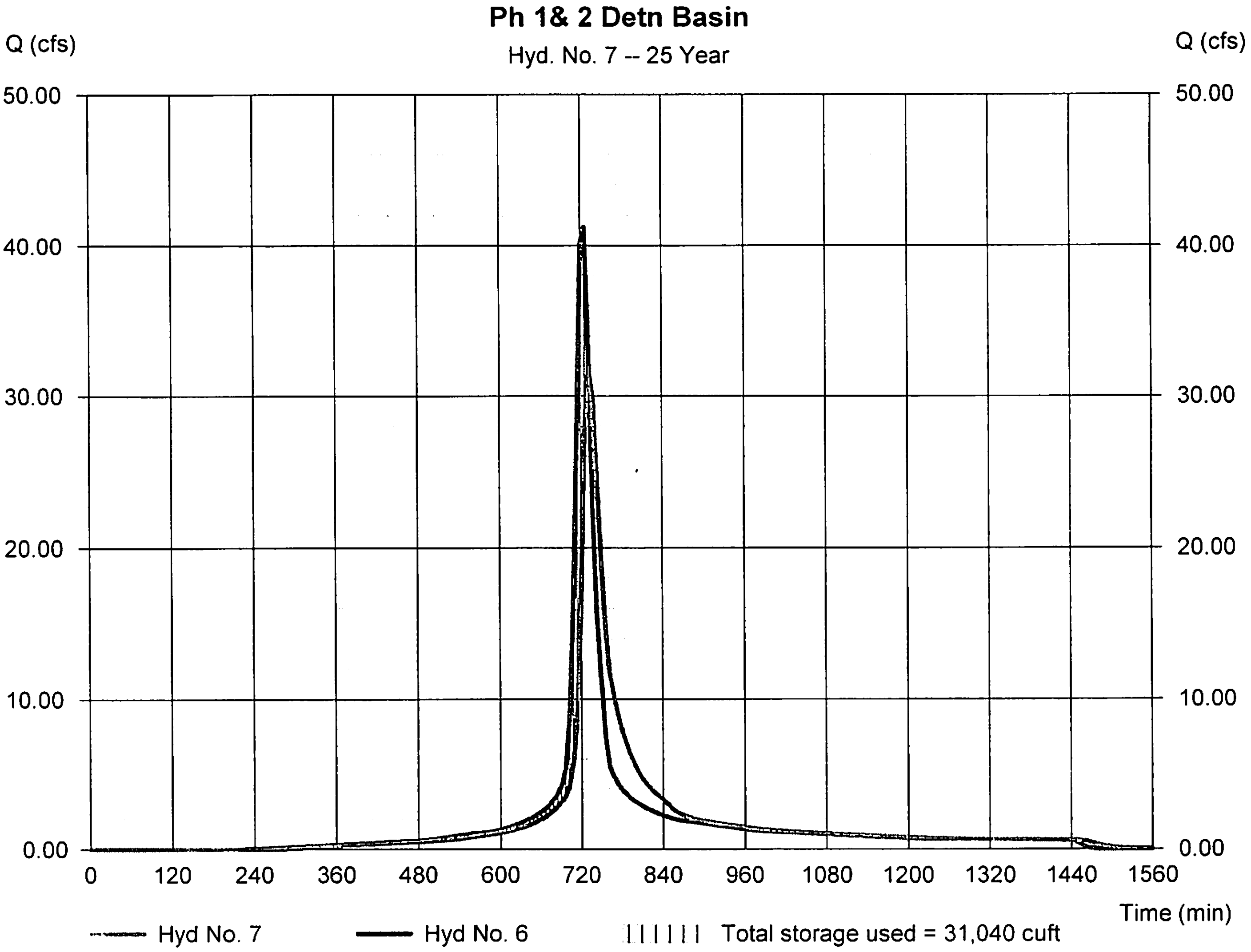
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 7

Ph 1& 2 Detn Basin

Hydrograph type	= Reservoir	Peak discharge	= 31.83 cfs
Storm frequency	= 25 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 158,281 cuft
Inflow hyd. No.	= 6 - To Detention	Max. Elevation	= 587.40 ft
Reservoir name	= StormTech MC-3500	Max. Storage	= 31,040 cuft

Storage Indication method used.



Hydrograph Report

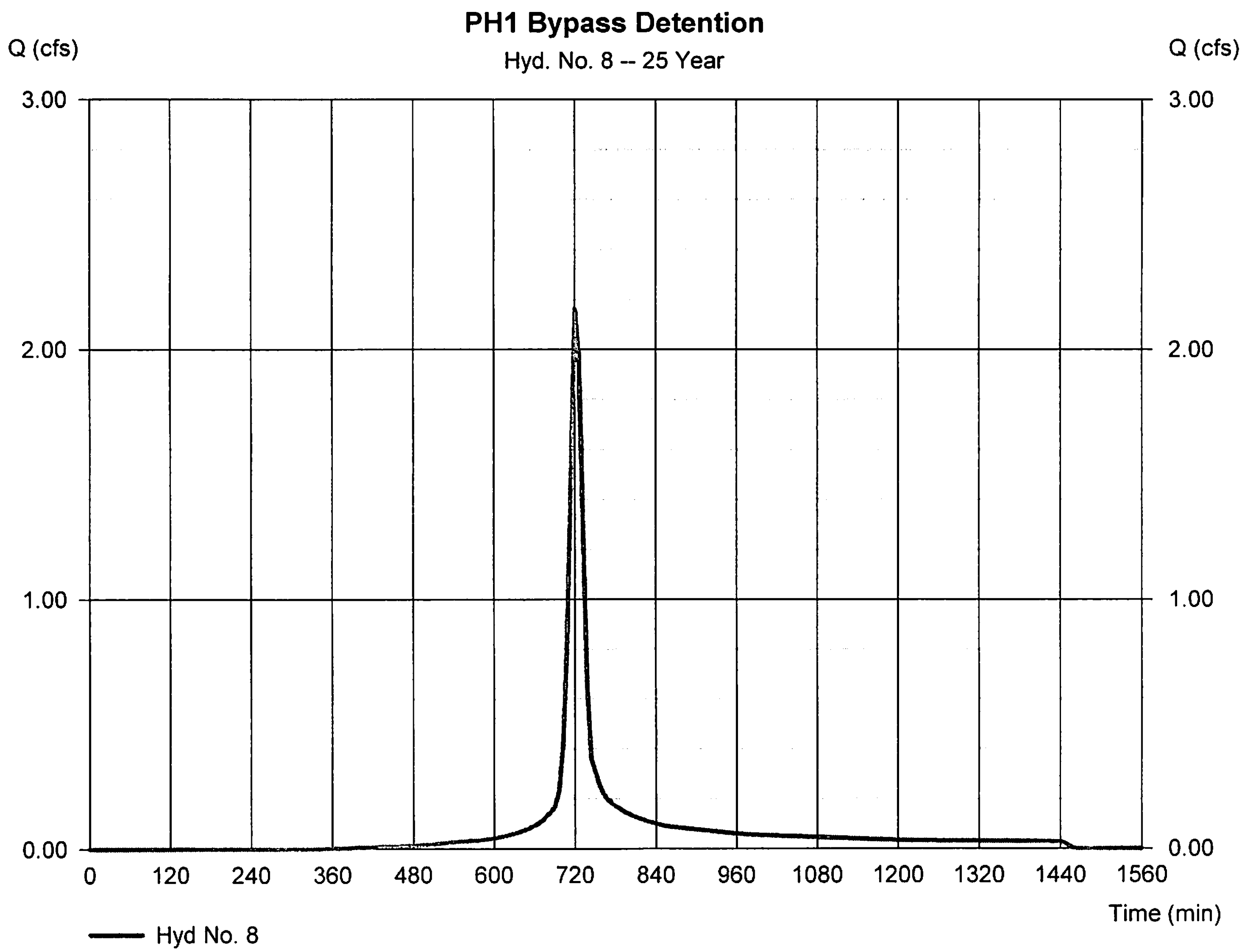
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 8

PH1 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 2.162 cfs
Storm frequency	= 25 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 6,678 cuft
Drainage area	= 0.470 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 6.09 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.390 x 80)] / 0.470



Hydrograph Report

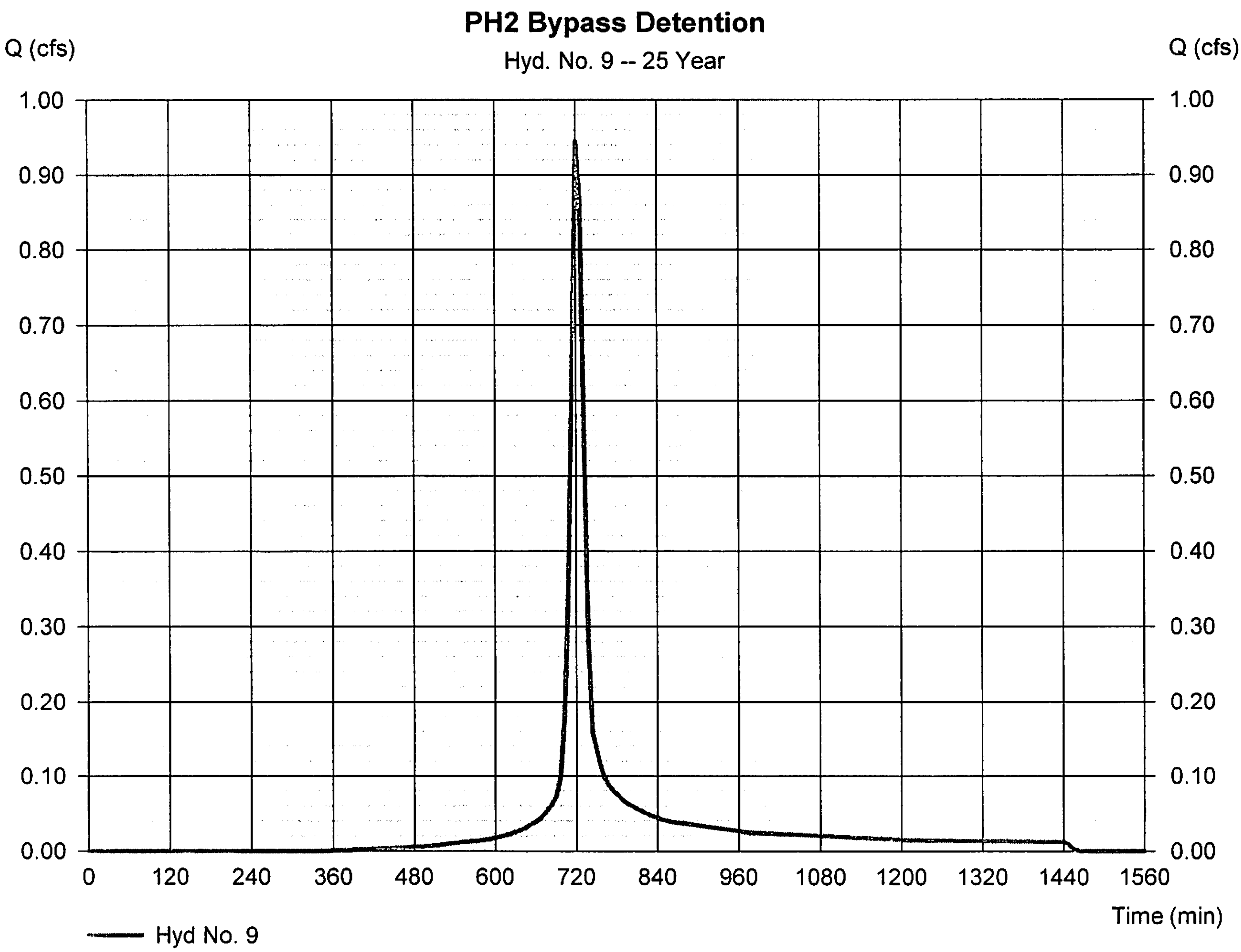
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 | Tuesday, 05 / 13 / 2014

Hyd. No. 9

PH2 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 0.944 cfs
Storm frequency	= 25 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 2,909 cuft
Drainage area	= 0.210 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 6.09 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98) + (0.190 x 80)] / 0.210



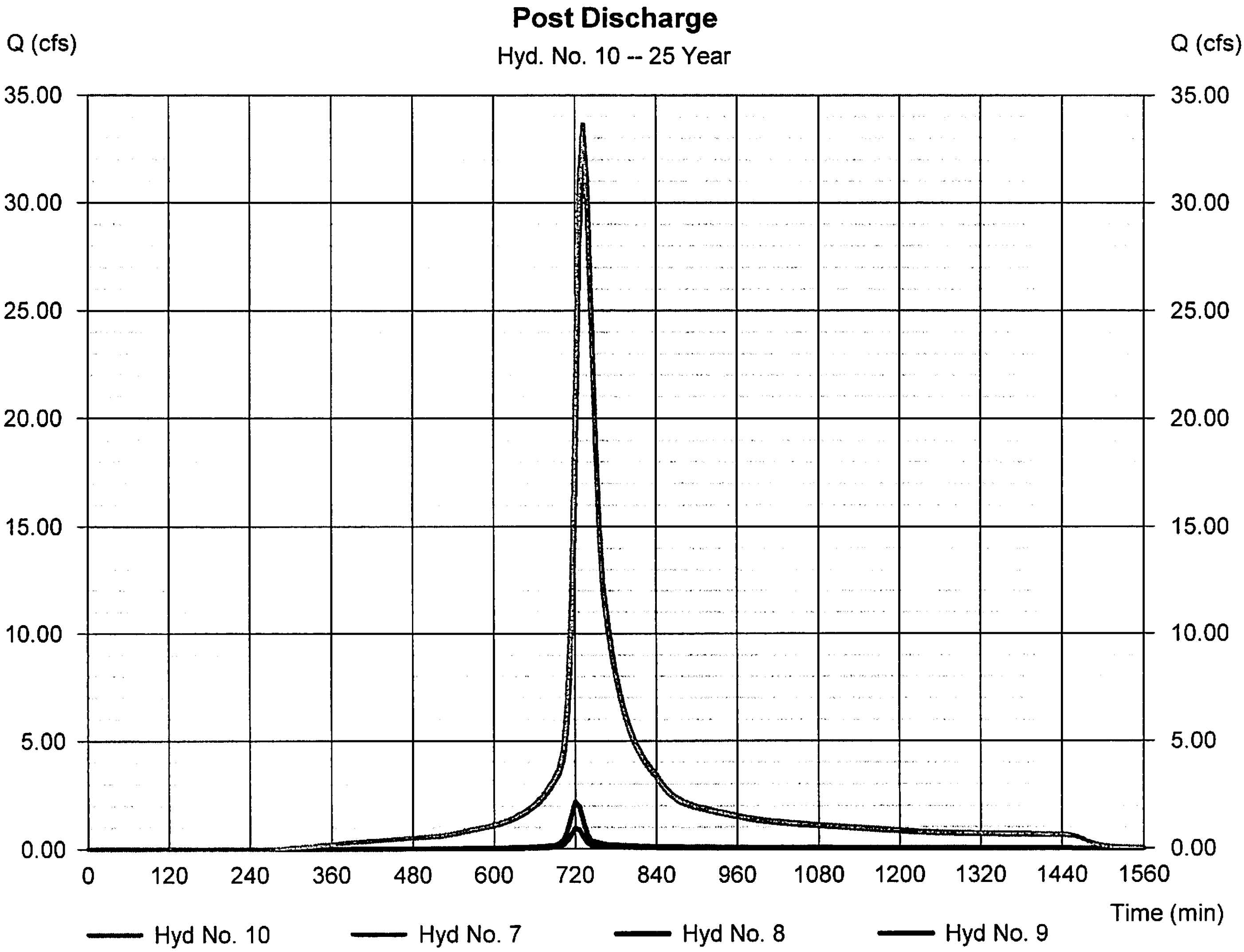
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 10

Post Discharge

Hydrograph type	= Combine	Peak discharge	= 33.62 cfs
Storm frequency	= 25 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 167,867 cuft
Inflow hyds.	= 7, 8, 9	Contrib. drain. area	= 0.680 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

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	32.19	6	726	131,874	------	------	------	PH 1 Predevelopment
2	SCS Runoff	29.54	6	726	121,327	------	------	------	PH 2 Predevelopment
3	Combine	61.73	6	726	253,201	1, 2	------	------	Predevelopment
4	SCS Runoff	33.09	6	726	141,243	------	------	------	PH1 to Detention
5	SCS Runoff	38.19	6	720	123,819	------	------	------	PH2 to Detention
6	Combine	67.05	6	726	265,062	4, 5	------	------	To Detention
7	Reservoir	50.93	6	732	264,943	6	589.76	47,228	Ph 1& 2 Detn Basin
8	SCS Runoff	3.740	6	720	11,773	------	------	------	PH1 Bypass Detention
9	SCS Runoff	1.649	6	720	5,171	------	------	------	PH2 Bypass Detention
10	Combine	53.96	6	732	281,888	7, 8, 9	------	------	Post Discharge

Hydrograph Report

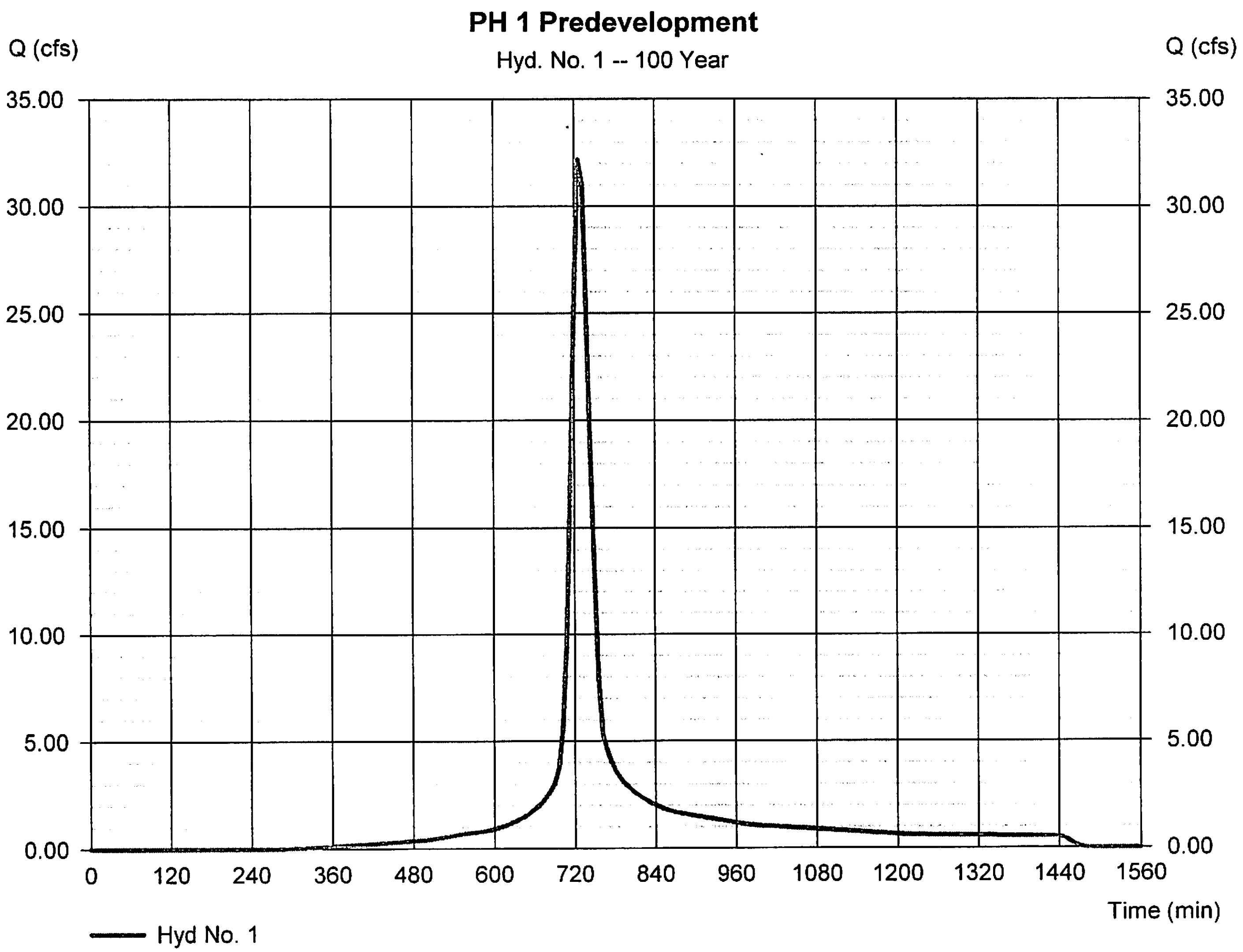
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 1

PH 1 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 32.19 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 131,874 cuft
Drainage area	= 5.200 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.80 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.840 x 80) + (0.150 x 98) + (0.210 x 79)] / 5.200



Hydrograph Report

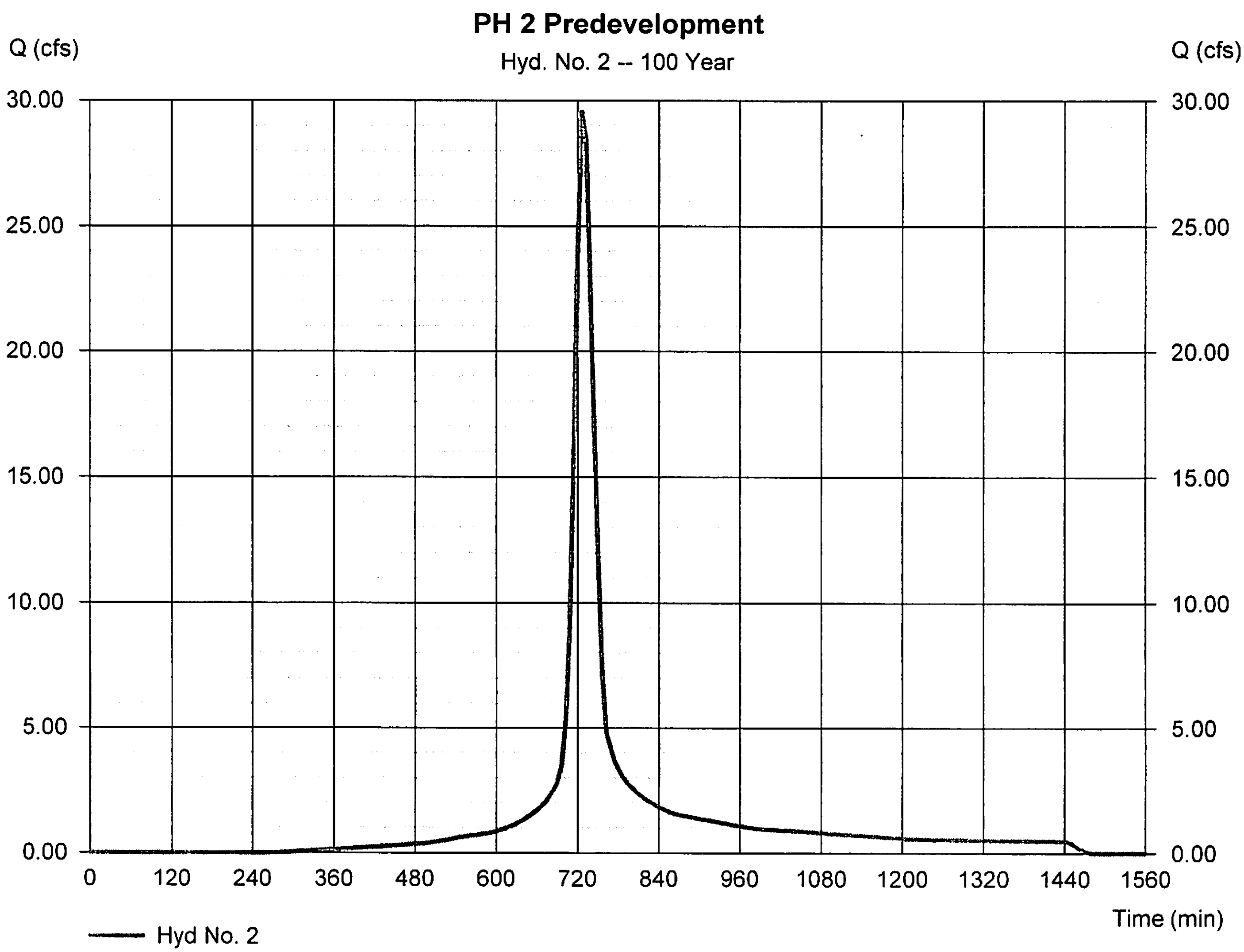
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 2

PH 2 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 29.54 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 121,327 cuft
Drainage area	= 4.700 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.70 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.250 x 80) + (0.270 x 79) + (0.180 x 98)] / 4.700



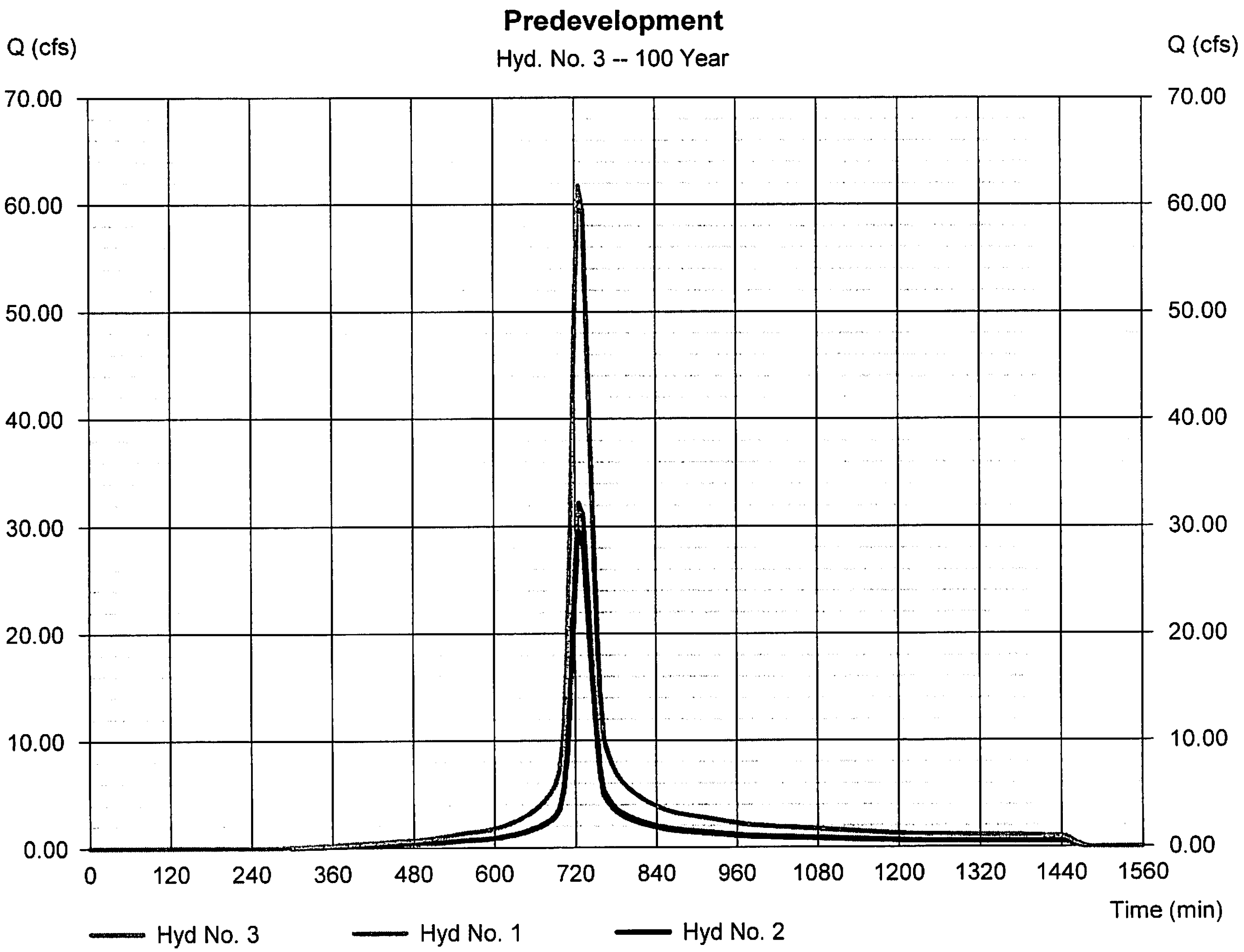
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 3

Predevelopment

Hydrograph type	= Combine	Peak discharge	= 61.73 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 253,201 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 9.900 ac



Hydrograph Report

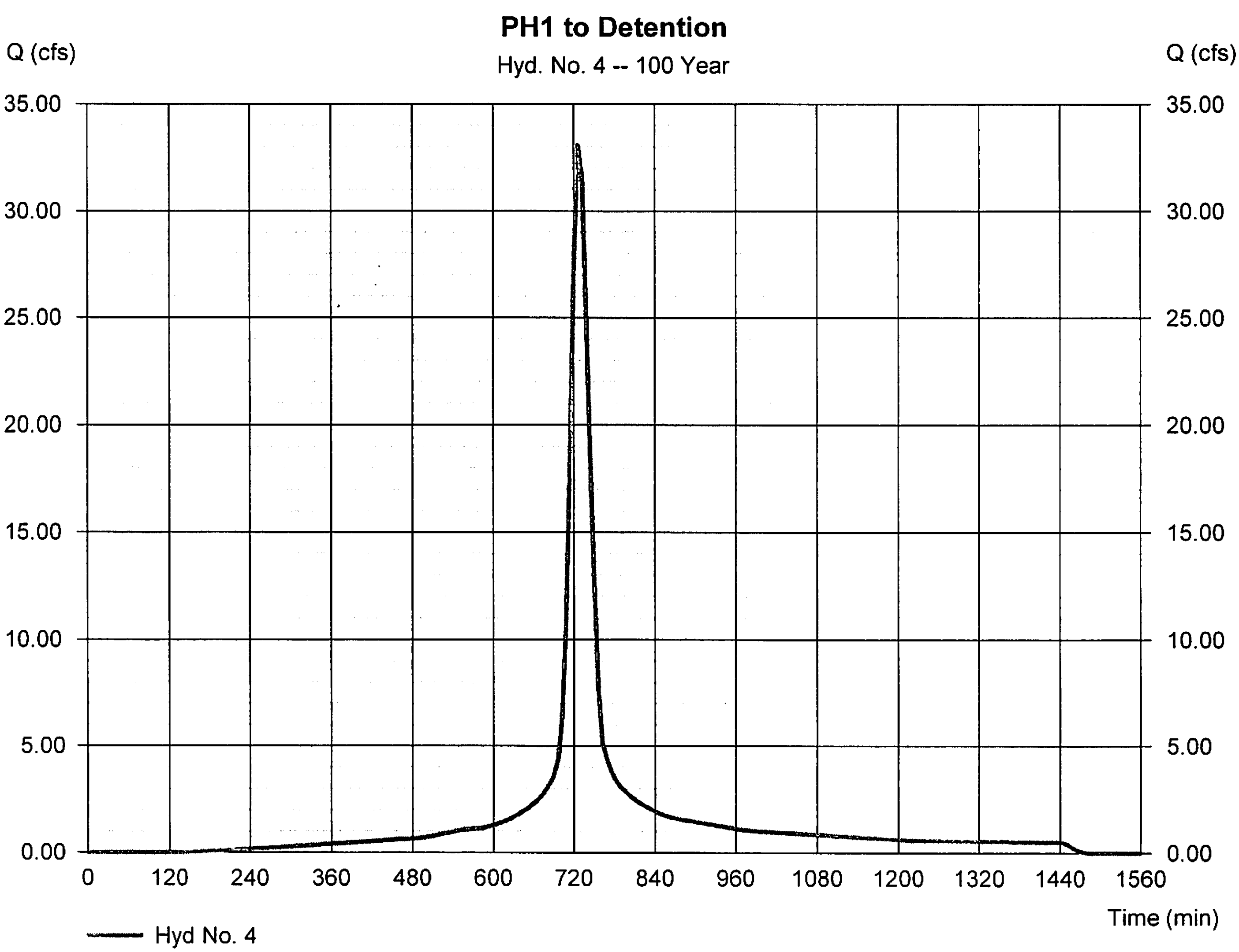
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 4

PH1 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 33.09 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 141,243 cuft
Drainage area	= 4.730 ac	Curve number	= 90*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 21.20 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.410 x 98) + (1.910 x 80) + (0.150 x 98) + (0.260 x 80)] / 4.730



Hydrograph Report

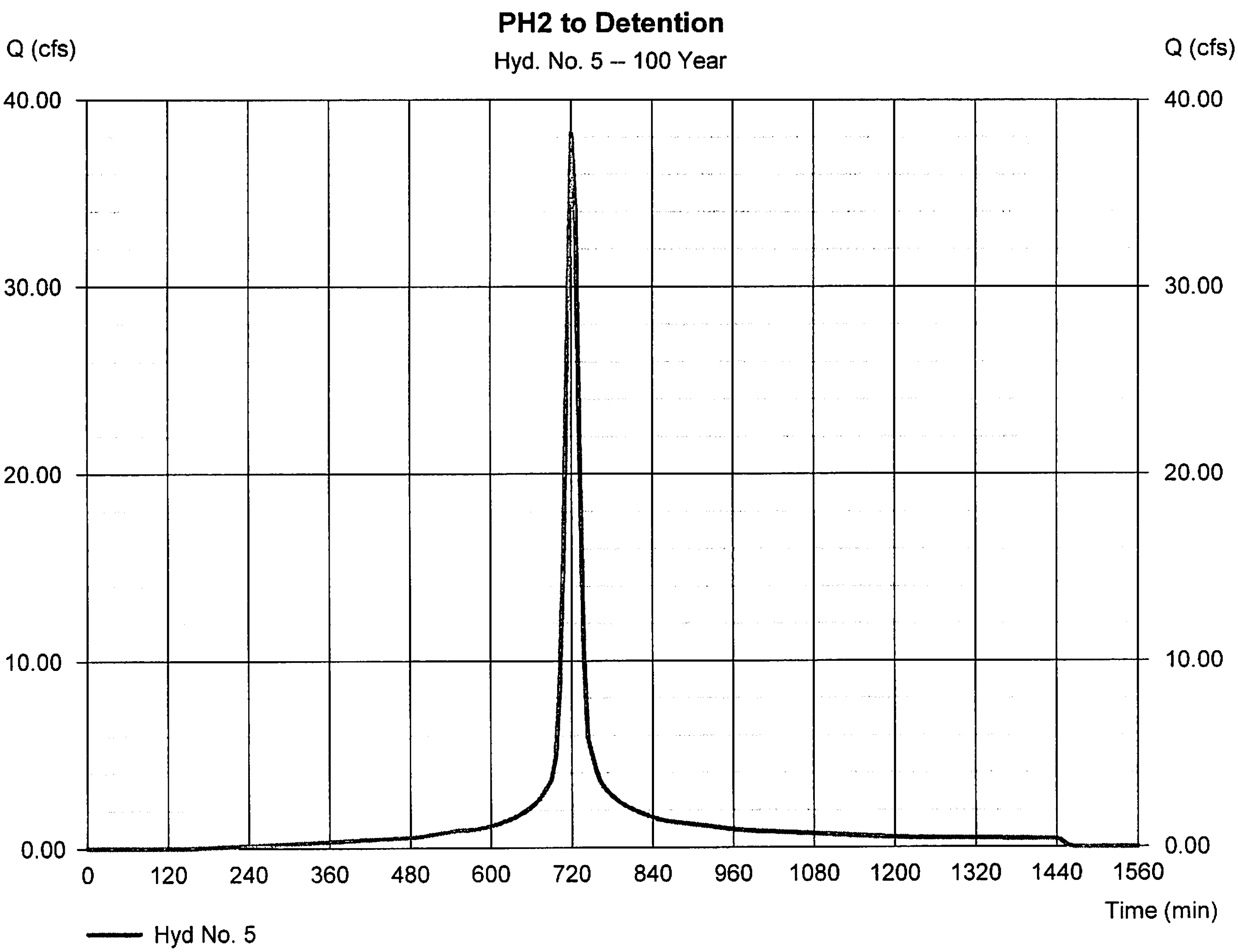
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 5

PH2 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 38.19 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 123,819 cuft
Drainage area	= 4.490 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.80 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.040 x 98) + (1.320 x 80) + (0.180 x 98) + (0.950 x 80)] / 4.490



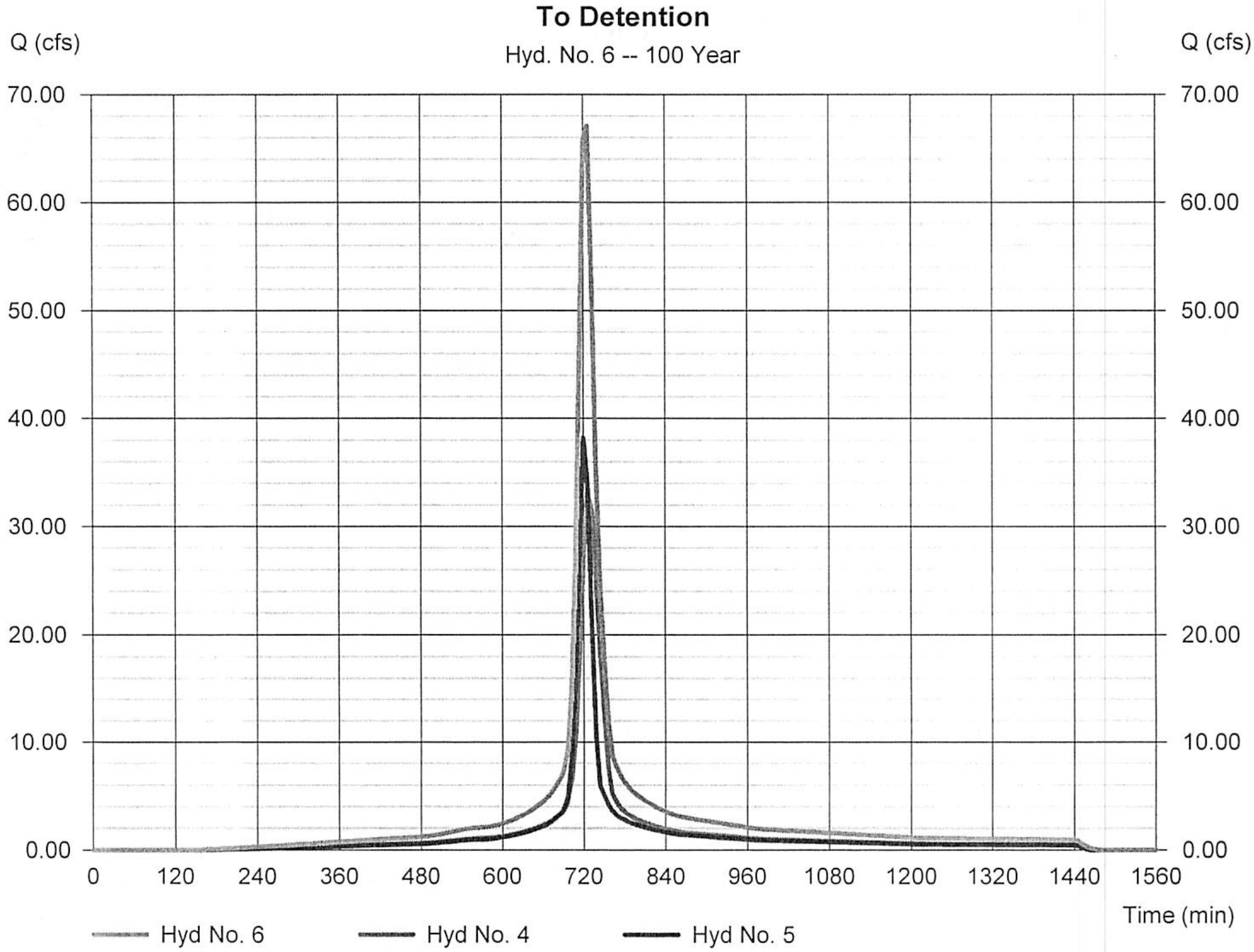
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 6

To Detention

Hydrograph type	= Combine	Peak discharge	= 67.05 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 265,062 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 9.220 ac



Hydrograph Report

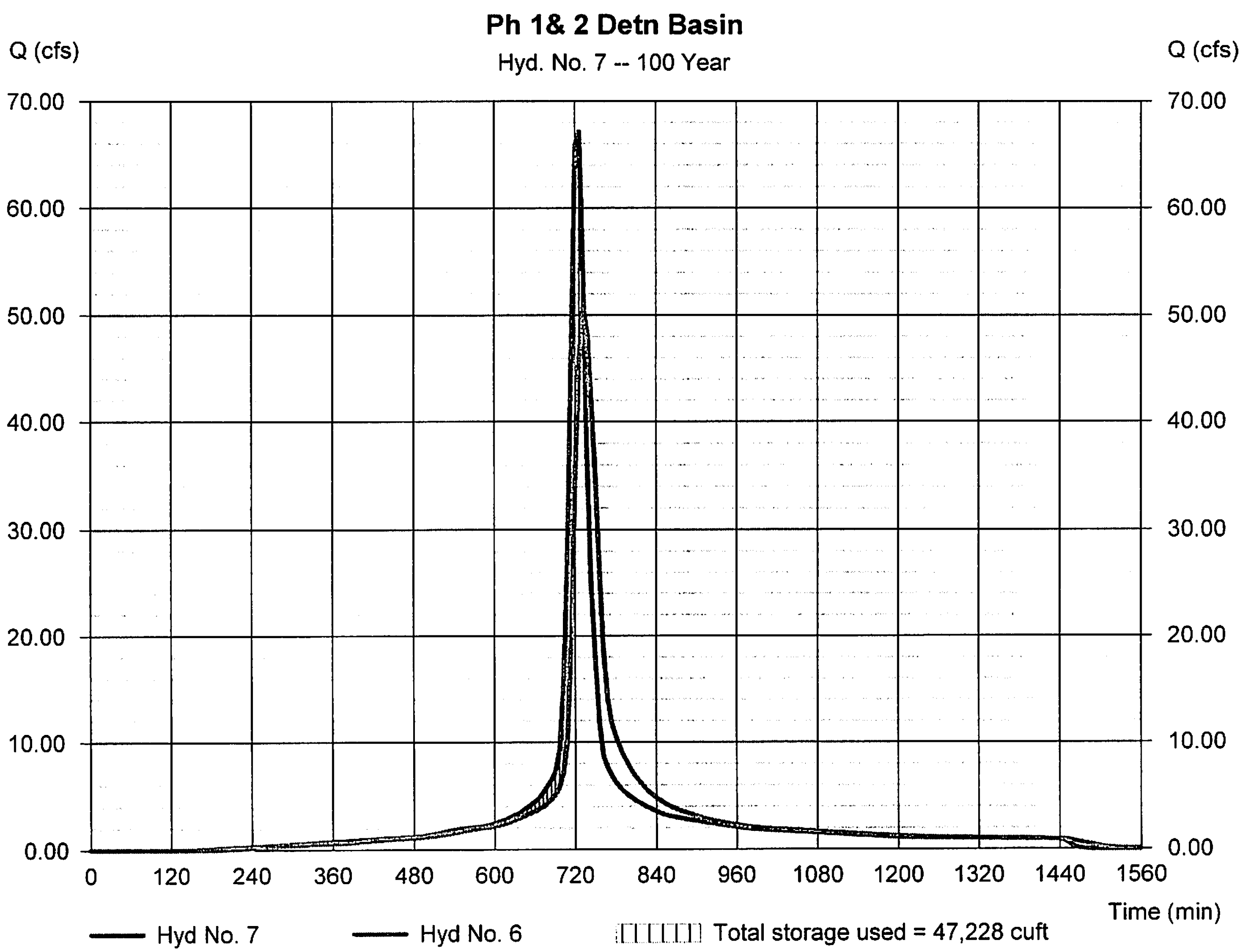
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 7

Ph 1& 2 Detn Basin

Hydrograph type	= Reservoir	Peak discharge	= 50.93 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 264,943 cuft
Inflow hyd. No.	= 6 - To Detention	Max. Elevation	= 589.76 ft
Reservoir name	= StormTech MC-3500	Max. Storage	= 47,228 cuft

Storage Indication method used.



Hydrograph Report

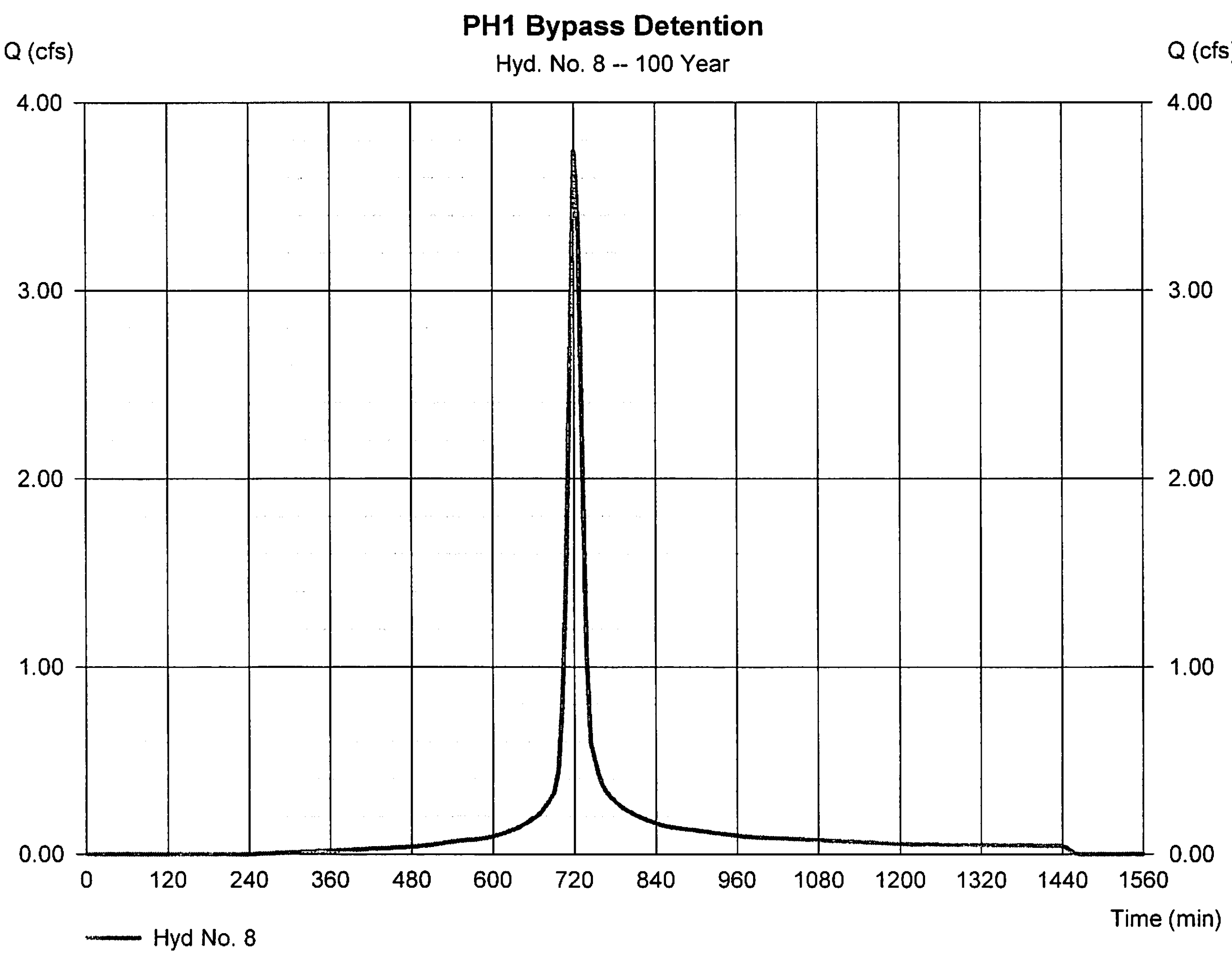
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 8

PH1 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 3.740 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 11,773 cuft
Drainage area	= 0.470 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.390 x 80)] / 0.470



Hydrograph Report

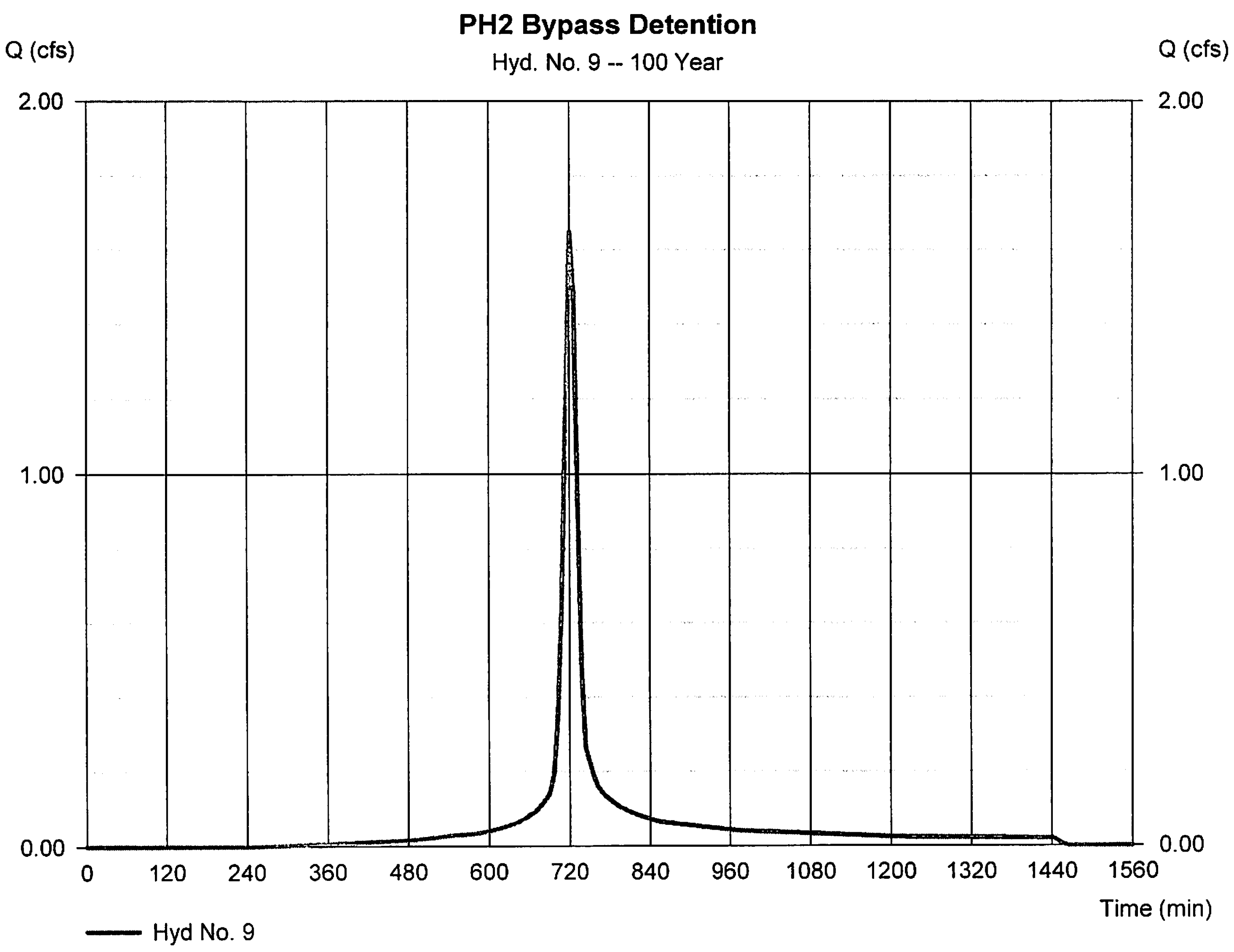
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 9

PH2 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 1.649 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 5,171 cuft
Drainage area	= 0.210 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98) + (0.190 x 80)] / 0.210



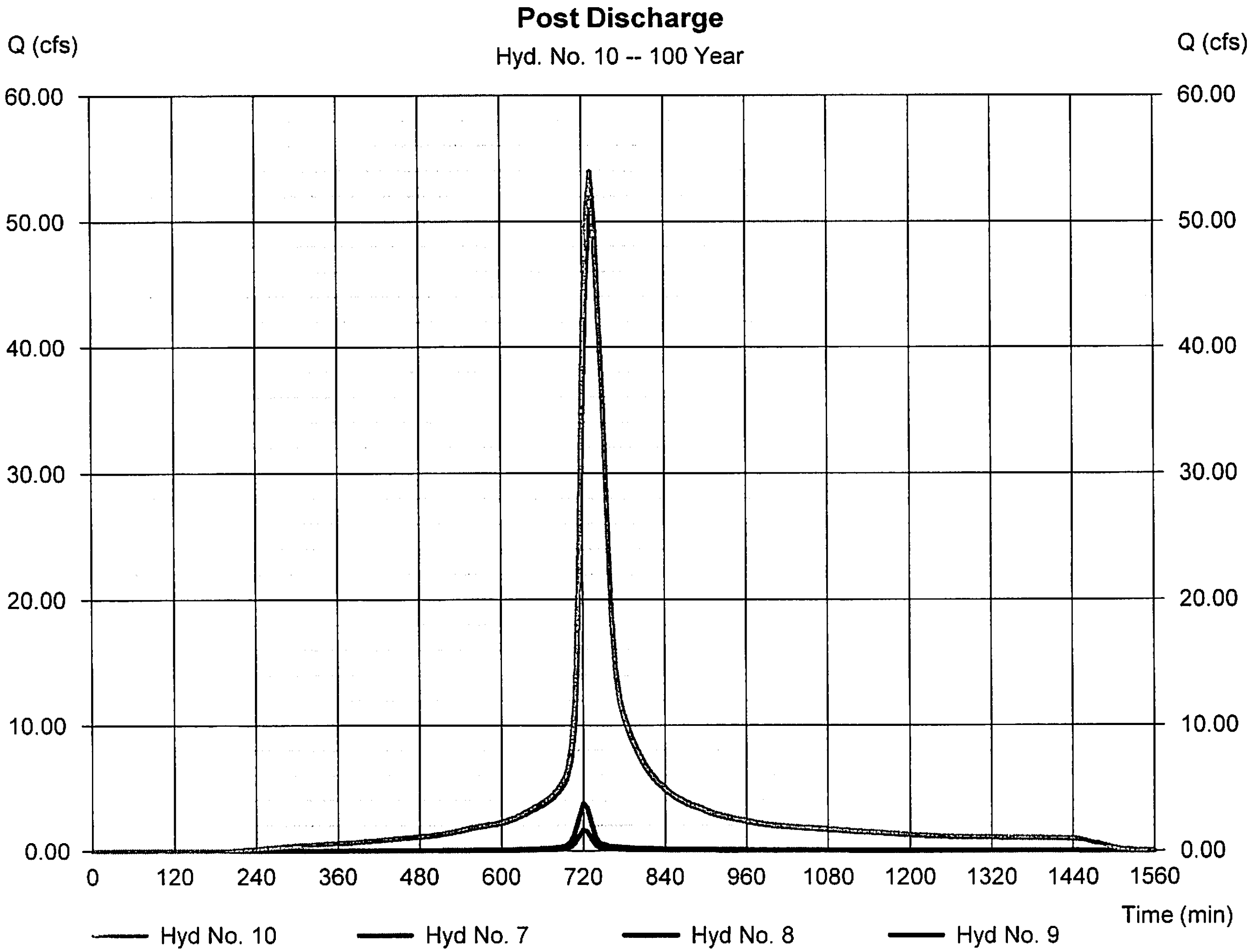
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 10

Post Discharge

Hydrograph type	= Combine	Peak discharge	= 53.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 281,888 cuft
Inflow hyds.	= 7, 8, 9	Contrib. drain. area	= 0.680 ac



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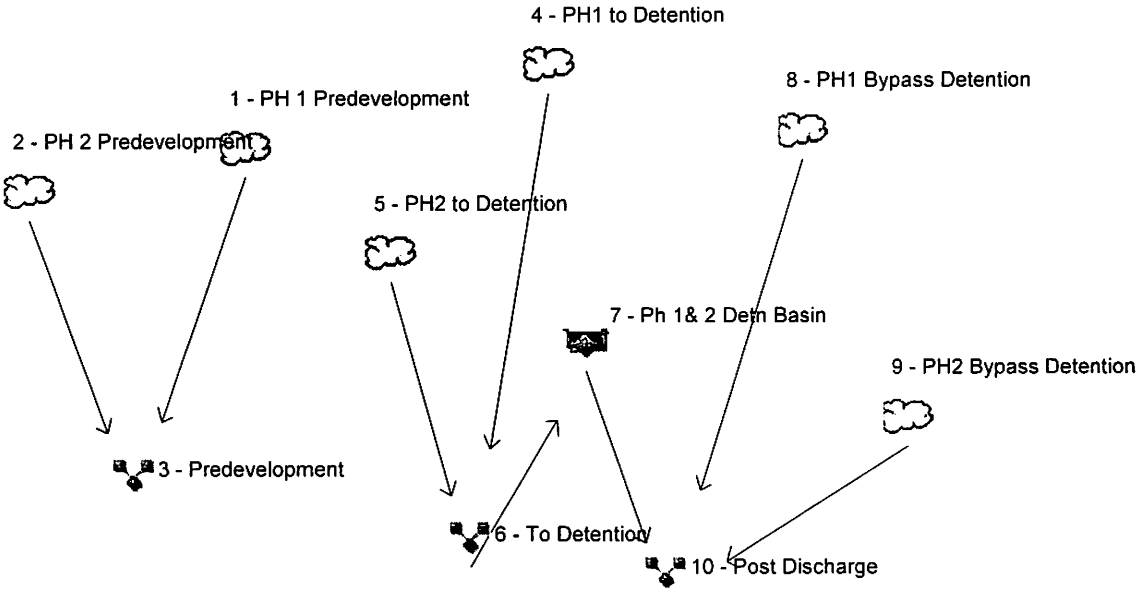
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10



Low flow blocked. Water level at 584.4

Project: Woodbury Phase 1 & 2 May-13-14.gpw	Tuesday, 05 / 13 / 2014

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	5.694	-------	-------	14.75	17.97	-------	32.19	PH 1 Predevelopment
2	SCS Runoff	------	-------	5.428	-------	-------	13.75	16.67	-------	29.54	PH 2 Predevelopment
3	Combine	1, 2	-------	11.12	-------	-------	28.50	34.64	-------	61.73	Predevelopment
4	SCS Runoff	------	-------	8.428	-------	-------	17.36	20.33	-------	33.09	PH1 to Detention
5	SCS Runoff	------	-------	9.488	-------	-------	19.87	23.32	-------	38.19	PH2 to Detention
6	Combine	4, 5	-------	17.16	-------	-------	35.24	41.24	-------	67.05	To Detention
7	Reservoir	6	-------	9.979	-------	-------	27.22	32.29	-------	51.34	Ph 1& 2 Detn Basin
8	SCS Runoff	------	-------	0.749	-------	-------	1.801	2.162	-------	3.740	PH1 Bypass Detention
9	SCS Runoff	------	-------	0.317	-------	-------	0.783	0.944	-------	1.649	PH2 Bypass Detention
10	Combine	7, 8, 9	-------	10.33	-------	-------	28.72	34.08	-------	54.37	Post Discharge

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

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	32.19	6	726	131,874	------	------	------	PH 1 Predevelopment
2	SCS Runoff	29.54	6	726	121,327	------	------	------	PH 2 Predevelopment
3	Combine	61.73	6	726	253,201	1, 2	------	------	Predevelopment
4	SCS Runoff	33.09	6	726	141,243	------	------	------	PH1 to Detention
5	SCS Runoff	38.19	6	720	123,819	------	------	------	PH2 to Detention
6	Combine	67.05	6	726	265,062	4, 5	------	------	To Detention
7	Reservoir	51.34	6	732	265,055	6	589.81	47,594	Ph 1& 2 Detn Basin
8	SCS Runoff	3.740	6	720	11,773	------	------	------	PH1 Bypass Detention
9	SCS Runoff	1.649	6	720	5,171	------	------	------	PH2 Bypass Detention
10	Combine	54.37	6	732	281,999	7, 8, 9	------	------	Post Discharge

Woodbury Phase 1 & 2 May-13-14.gpw	Return Period: 100 Year	Tuesday, 05 / 13 / 2014

Hydrograph Report

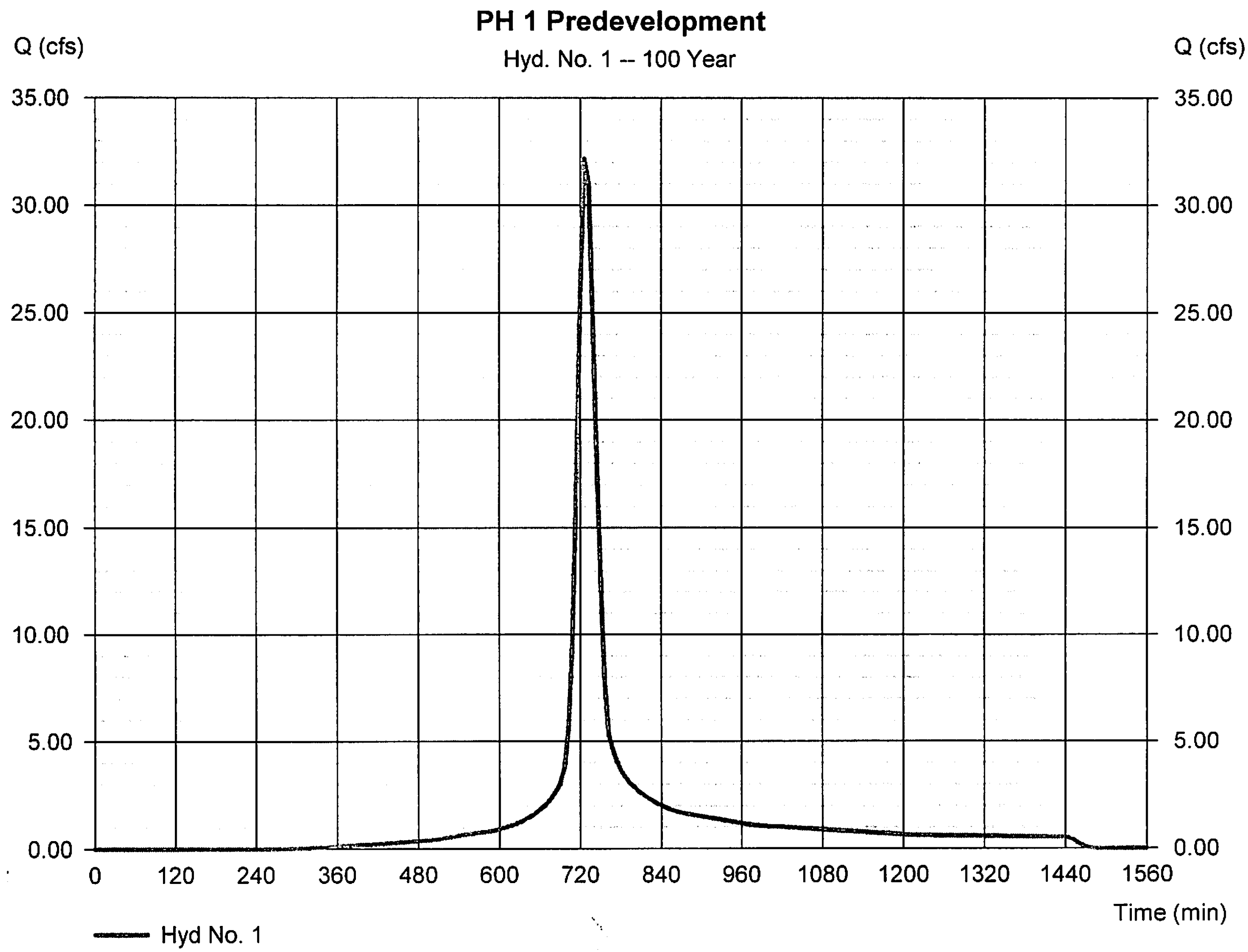
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 1

PH 1 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 32.19 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 131,874 cuft
Drainage area	= 5.200 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.80 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.840 x 80) + (0.150 x 98) + (0.210 x 79)] / 5.200



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 1

PH 1 Predevelopment

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.240		0.011		0.011		
Flow length (ft)	= 136.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.00		0.00		0.00		
Land slope (%)	= 1.80		0.00		0.00		
Travel Time (min)	**= 19.66**	**+**	**0.00**	**+**	**0.00**	**=**	**19.66**
Shallow Concentrated Flow							
Flow length (ft)	= 570.00		0.00		0.00		
Watercourse slope (%)	= 2.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.28		0.00		0.00		
Travel Time (min)	**= 4.16**	**+**	**0.00**	**+**	**0.00**	**=**	**4.16**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00		0.00		0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 23.80 min

Hydrograph Report

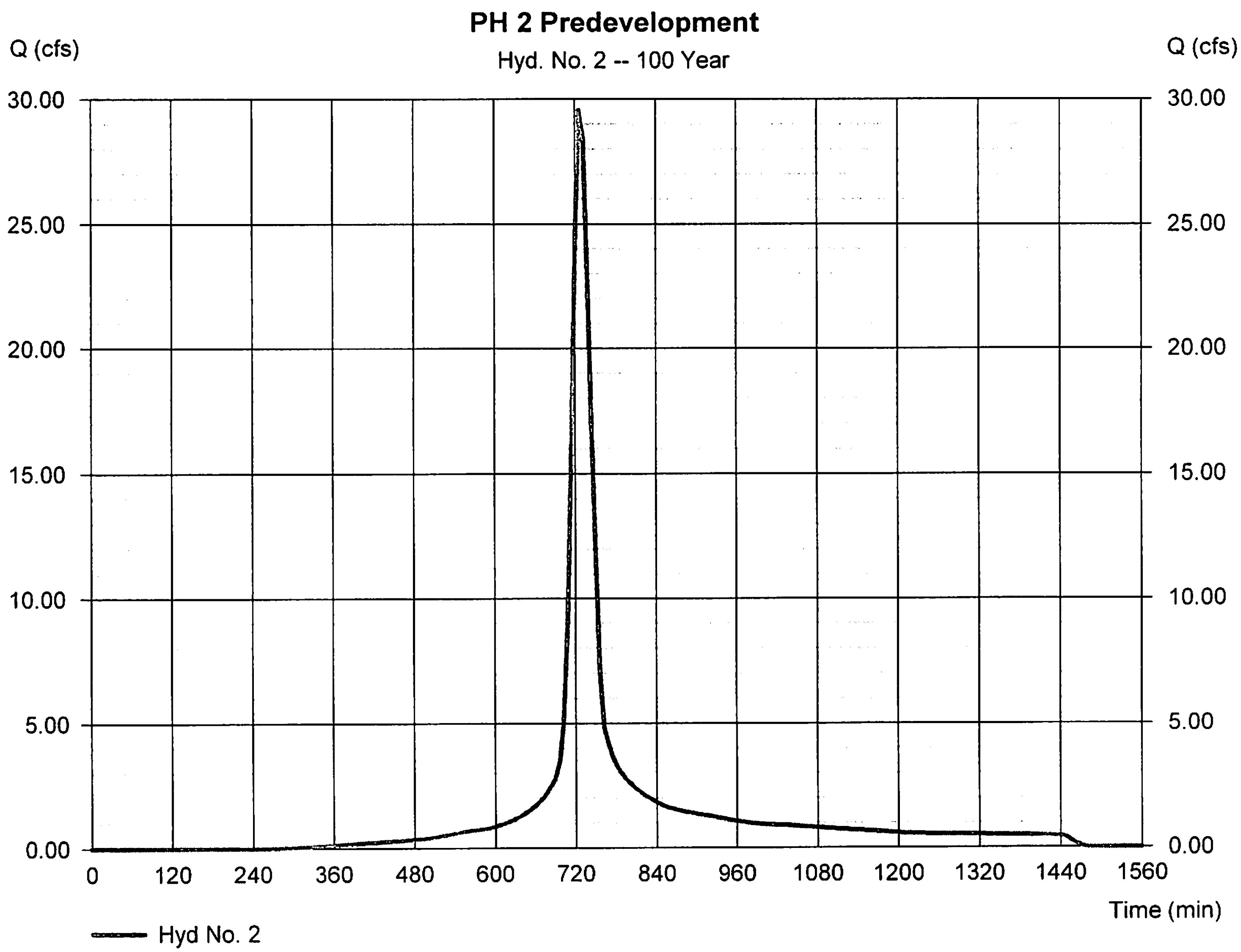
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 2

PH 2 Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 29.54 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 121,327 cuft
Drainage area	= 4.700 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.70 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.250 x 80) + (0.270 x 79) + (0.180 x 98)] / 4.700



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 2

PH 2 Predevelopment

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.00		0.00		0.00		
Land slope (%)	=	1.80		0.00		0.00		
Travel Time (min)	**=**	**15.37**	**+**	**0.00**	**+**	**0.00**	**=**	**15.37**
Shallow Concentrated Flow								
Flow length (ft)	=	400.00		0.00		0.00		
Watercourse slope (%)	=	2.00		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.28			0.00		0.00		
Travel Time (min)	**=**	**2.92**	**+**	**0.00**	**+**	**0.00**	**=**	**2.92**
Channel Flow								
X sectional flow area (sqft)	=	5.00		0.00		0.00		
Wetted perimeter (ft)	=	4.00		0.00		0.00		
Channel slope (%)	=	0.50		0.00		0.00		
Manning's n-value	=	0.200		0.015		0.015		
Velocity (ft/s)	=0.61							
				0.00				
						0.00		
Flow length (ft)	({0})200.0			0.0		0.0		
Travel Time (min)	**=**	**5.45**	**+**	**0.00**	**+**	**0.00**	**=**	**5.45**

Total Travel Time, Tc .... 23.70 min

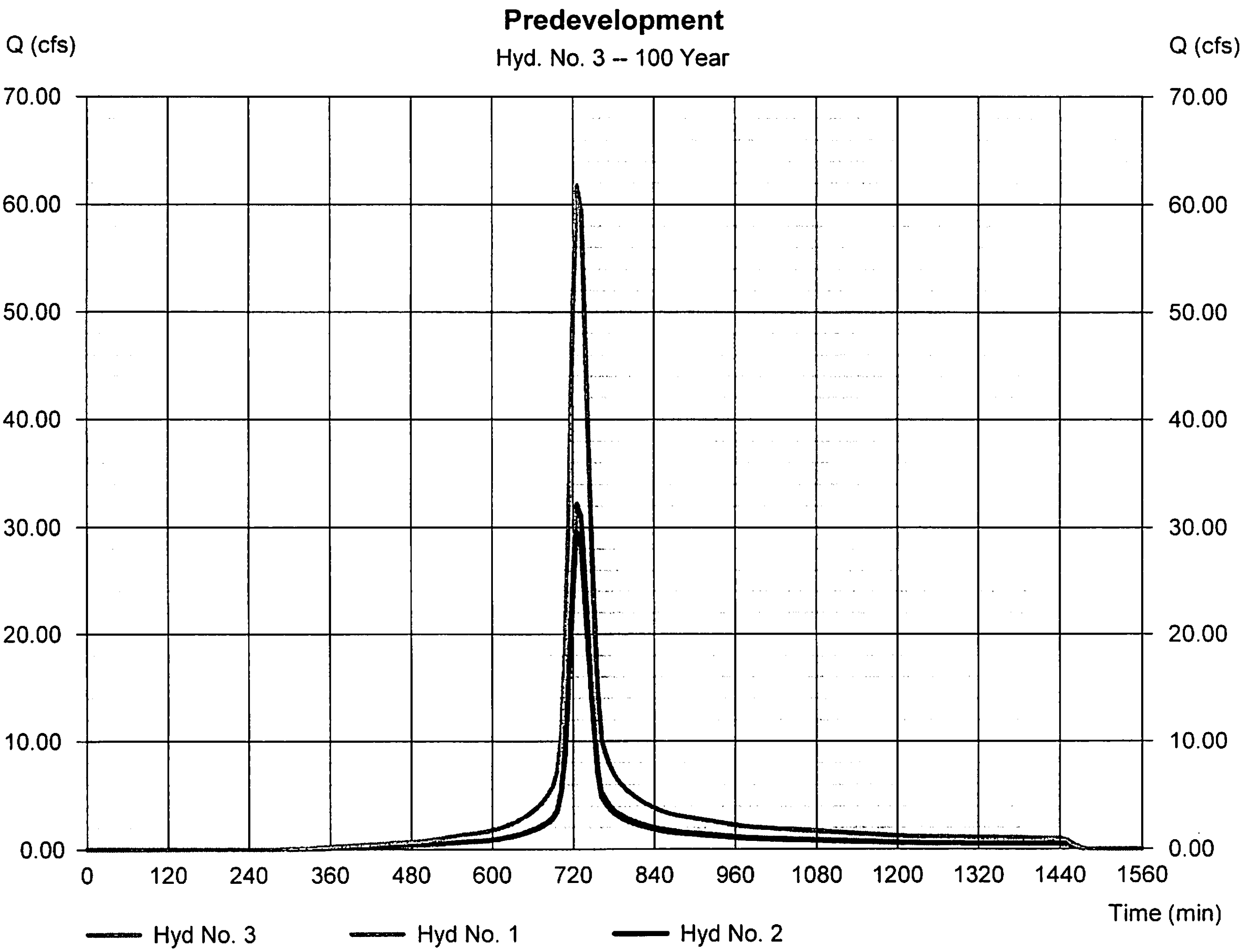
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 3

Predevelopment

Hydrograph type	= Combine	Peak discharge	= 61.73 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 253,201 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 9.900 ac



Hydrograph Report

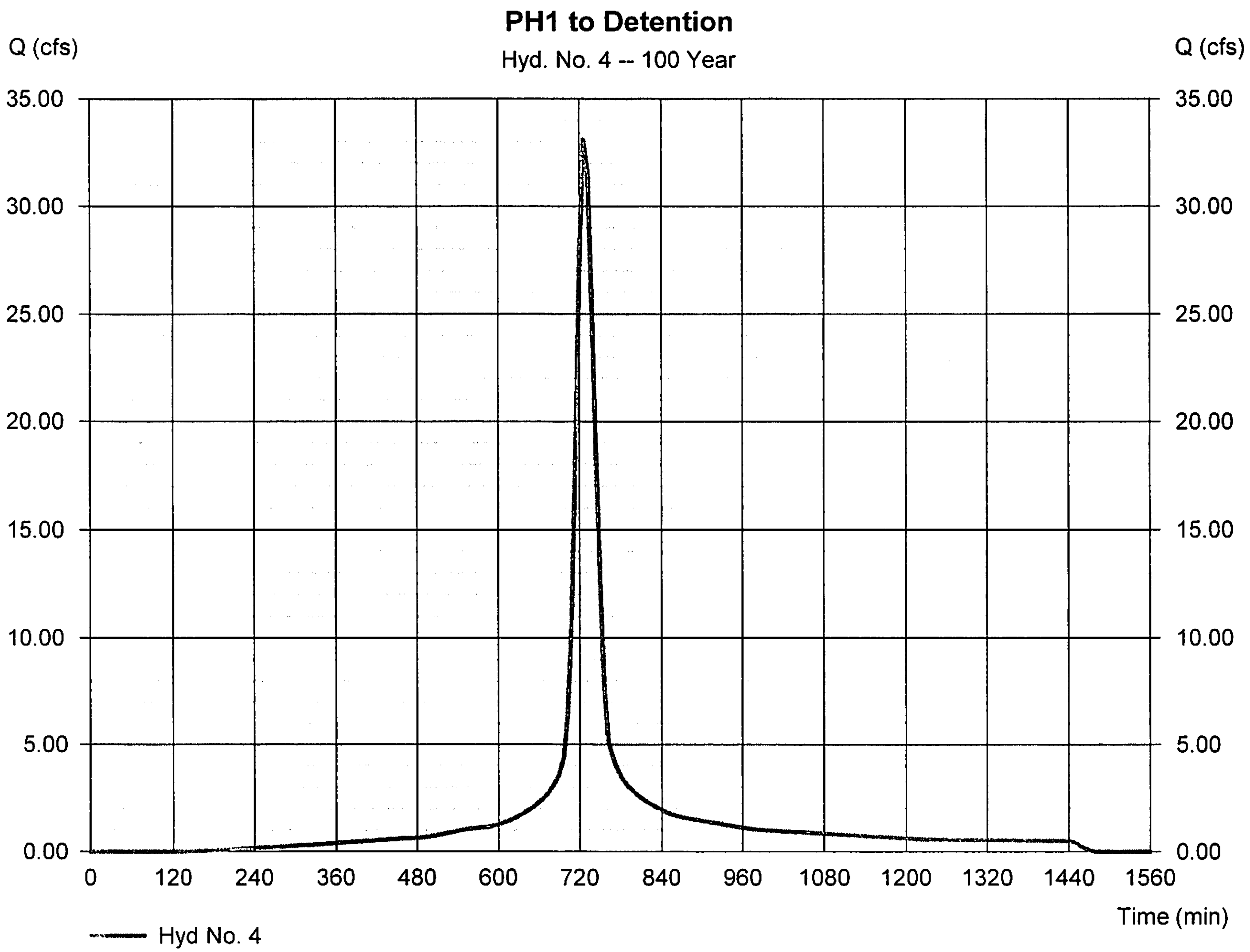
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 4

PH1 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 33.09 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 141,243 cuft
Drainage area	= 4.730 ac	Curve number	= 90*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 21.20 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.410 x 98) + (1.910 x 80) + (0.150 x 98) + (0.260 x 80)] / 4.730



TR55 Tc Worksheet

Hyd. No. 4

PH1 to Detention

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	136.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.01		0.00		0.00		
Land slope (%)	=	1.80		0.00		0.00		
Travel Time (min)	**=**	**19.63**	**+**	**0.00**	**+**	**0.00**	**=**	**19.63**
Shallow Concentrated Flow								
Flow length (ft)	=	0.00		0.00		0.00		
Watercourse slope (%)	=	0.00		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=0.00			0.00		0.00		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow								
X sectional flow area (sqft)	=	1.77		0.00		0.00		
Wetted perimeter (ft)	=	4.70		0.00		0.00		
Channel slope (%)	=	1.00		0.00		0.00		
Manning's n-value	=	0.013		0.015		0.015		
Velocity (ft/s)	=5.96							
				0.00				
						0.00		
Flow length (ft)	({0})550.0			0.0		0.0		
Travel Time (min)	**=**	**1.54**	**+**	**0.00**	**+**	**0.00**	**=**	**1.54**
Total Travel Time, Tc								**21.20 min**

Hydrograph Report

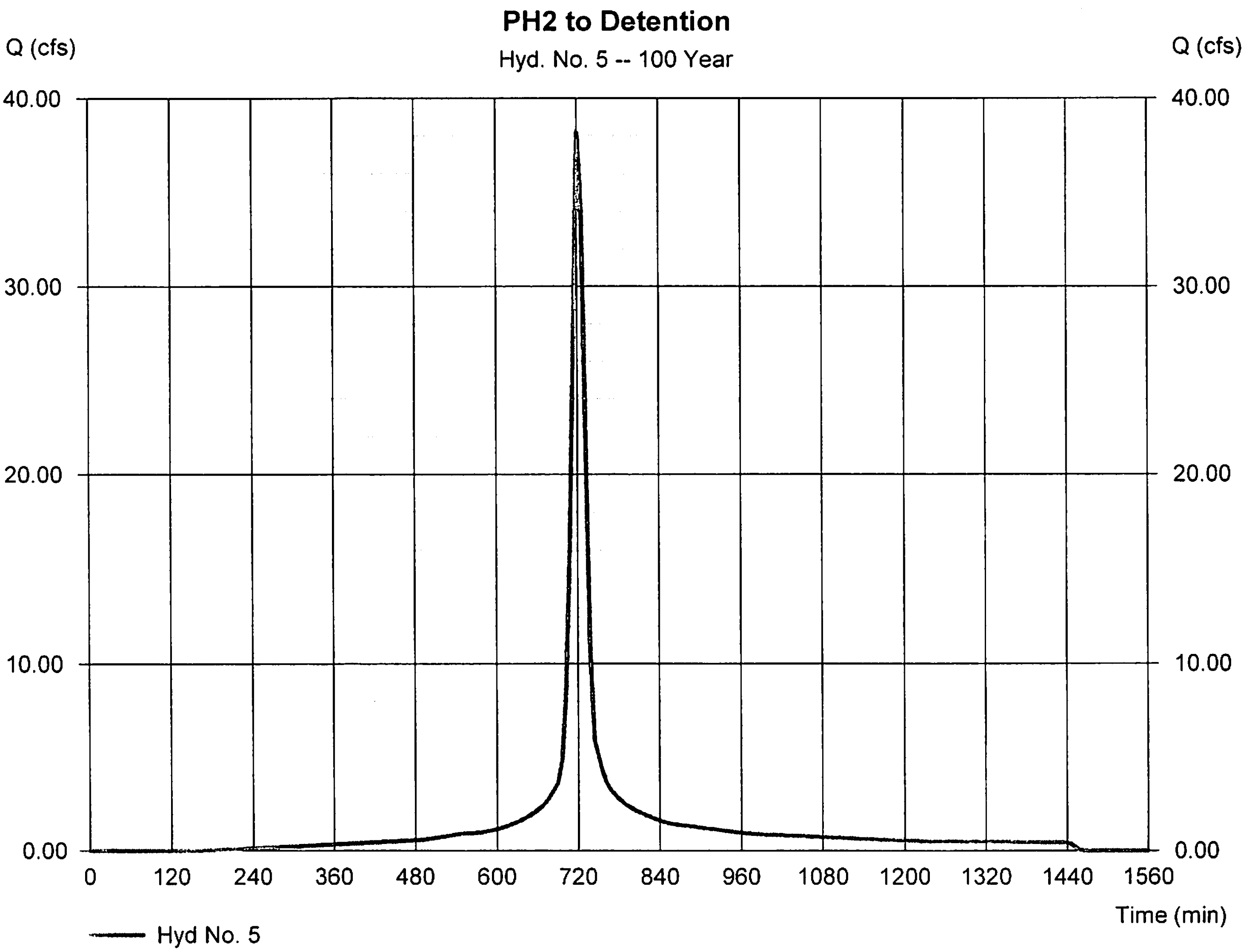
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 5

PH2 to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 38.19 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 123,819 cuft
Drainage area	= 4.490 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.80 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.040 x 98) + (1.320 x 80) + (0.180 x 98) + (0.950 x 80)] / 4.490



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 5

PH2 to Detention

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	80.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.01		0.00		0.00		
Land slope (%)	=	1.80		0.00		0.00		
Travel Time (min)	**=**	**12.84**	**+**	**0.00**	**+**	**0.00**	**=**	**12.84**
Shallow Concentrated Flow								
Flow length (ft)	=	0.00		0.00		0.00		
Watercourse slope (%)	=	0.00		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=0.00			0.00		0.00		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow								
X sectional flow area (sqft)	=	1.77		0.00		0.00		
Wetted perimeter (ft)	=	4.70		0.00		0.00		
Channel slope (%)	=	1.00		0.00		0.00		
Manning's n-value	=	0.013		0.015		0.015		
Velocity (ft/s)	=5.96			0.00		0.00		
Flow length (ft)	({0})330.0			0.0		0.0		
Travel Time (min)	**=**	**0.92**	**+**	**0.00**	**+**	**0.00**	**=**	**0.92**

Total Travel Time, Tc .... **13.80 min**

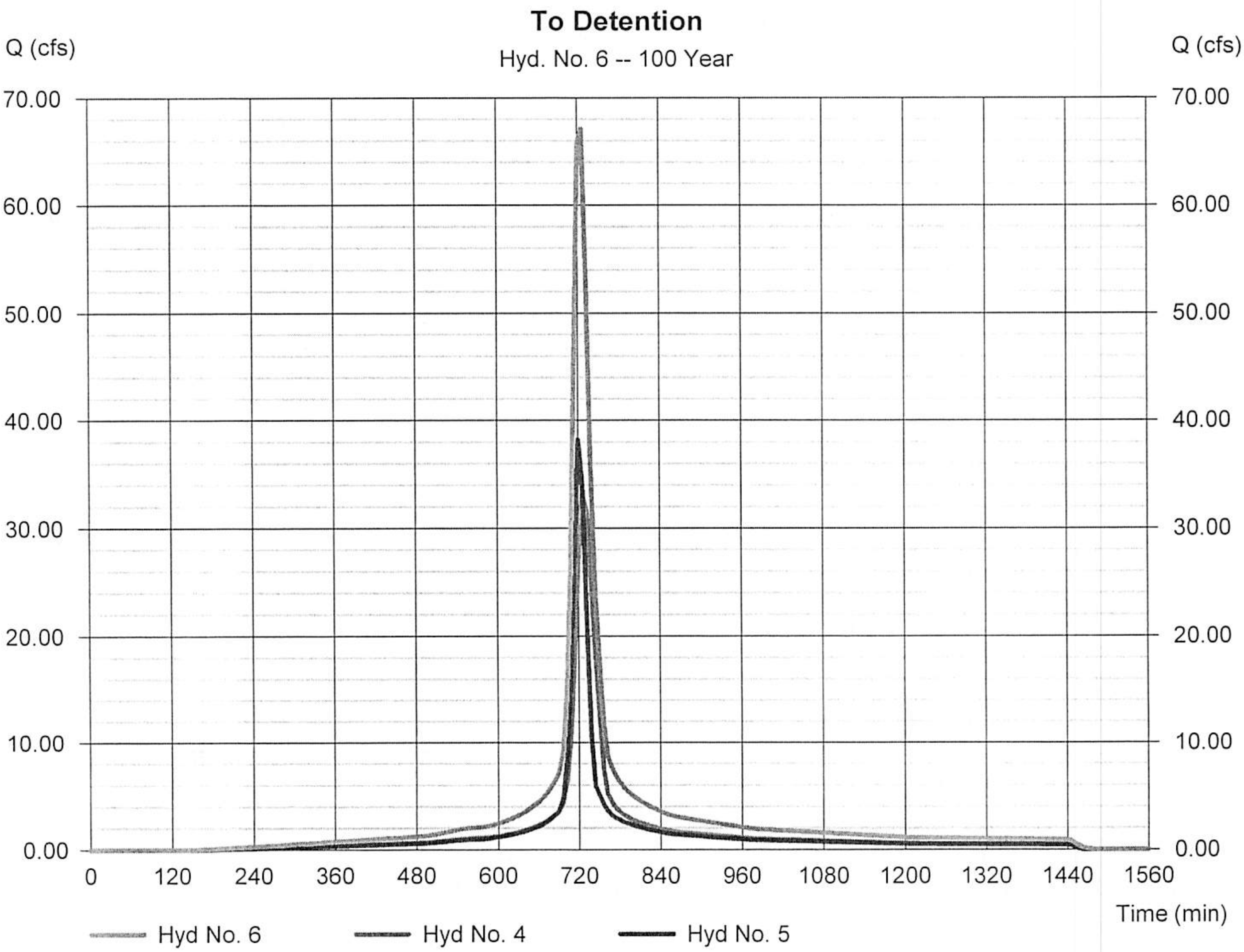
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 6

To Detention

Hydrograph type	= Combine	Peak discharge	= 67.05 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 6 min	Hyd. volume	= 265,062 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 9.220 ac



Hydrograph Report

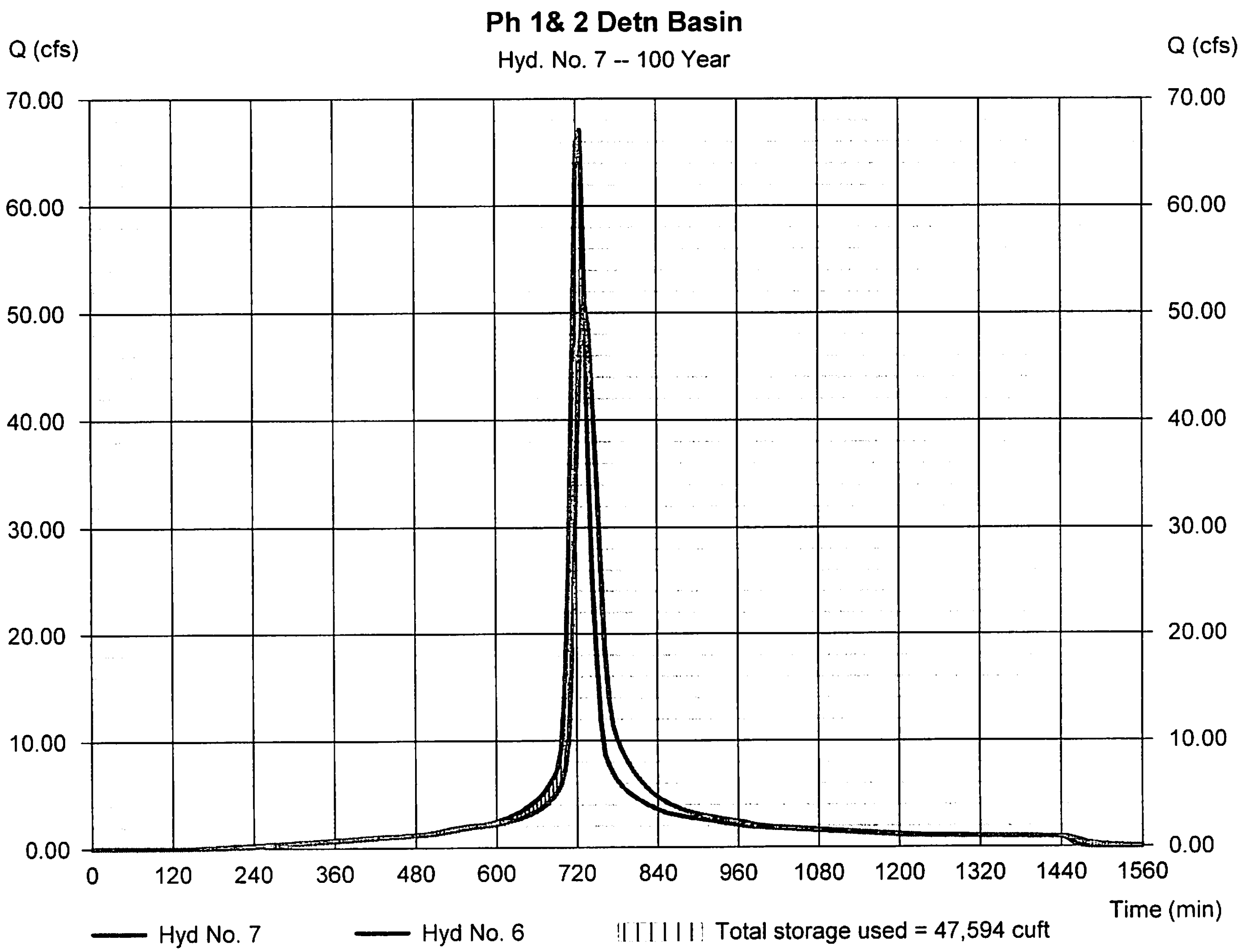
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 7

Ph 1& 2 Detn Basin

Hydrograph type	= Reservoir	Peak discharge	= 51.34 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 265,055 cuft
Inflow hyd. No.	= 6 - To Detention	Max. Elevation	= 589.81 ft
Reservoir name	= StormTech MC-3500	Max. Storage	= 47,594 cuft

Storage Indication method used. Wet pond routing start elevation = 584.39 ft.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Pond No. 1 - StormTech MC-3500

Pond Data

UG Chambers -Invert elev. = 584.50 ft, Rise x Span = 3.75 x 6.42 ft, Barrel Len = 355.50 ft, No. Barrels = 5, Slope = 0.25%, Headers = No
Encasement -Invert elev. = 583.75 ft, Width = 6.92 ft, Height = 5.50 ft, Voids = 40.00%
Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 590.75 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	583.75	n/a	0	0
0.64	584.39	n/a	1,162	1,162
1.28	585.03	n/a	3,920	5,082
1.92	585.67	n/a	7,067	12,149
2.56	586.31	n/a	7,329	19,478
3.19	586.94	n/a	7,033	26,511
3.83	587.58	n/a	6,549	33,060
4.47	588.22	n/a	5,751	38,811
5.11	588.86	n/a	4,243	43,054
5.75	589.50	n/a	3,224	46,279
6.39	590.14	n/a	3,144	49,423
7.00	590.75	25	5	49,428
7.25	591.00	25	6	49,434
7.75	591.50	25	13	49,447
8.25	592.00	25	13	49,459

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 30.00	Inactive	0.00	0.00
Span (in)	= 30.00	6.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 583.39	583.80	0.00	0.00
Length (ft)	= 146.00	0.00	0.00	0.00
Slope (%)	= 0.79	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)	= 1.33	3.67	Inactive	0.00
Crest El. (ft)	= 584.40	586.20	585.70	0.00
Weir Coeff.	= 3.50	3.33	3.33	3.33
Weir Type	= Rect	Rect	Rect	---
Multi-Stage	= Yes	Yes	Yes	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

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

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	583.75	0.00	0.00	---	---	0.00	0.00	0.00	---	---	---	0.000
0.64	1,162	584.39	0.91 ic	0.00	---	---	0.00	0.00	0.00	---	---	---	0.000
1.28	5,082	585.03	2.33 ic	0.00	---	---	2.32	0.00	0.00	---	---	---	2.315
1.92	12,149	585.67	6.63 ic	0.00	---	---	6.63 s	0.00	0.00	---	---	---	6.631
2.56	19,478	586.31	12.24 ic	0.00	---	---	11.71 s	0.42	0.00	---	---	---	12.13
3.19	26,511	586.94	23.91 ic	0.00	---	---	16.06 s	7.85	0.00	---	---	---	23.91
3.83	33,060	587.58	34.09 oc	0.00	---	---	17.05 s	17.03 s	0.00	---	---	---	34.09
4.47	38,811	588.22	40.64 oc	0.00	---	---	17.85 s	22.78 s	0.00	---	---	---	40.64
5.11	43,054	588.86	45.61 oc	0.00	---	---	18.47 s	27.13 s	0.00	---	---	---	45.60
5.75	46,279	589.50	49.76 oc	0.00	---	---	19.05 s	30.71 s	0.00	---	---	---	49.76
6.39	49,423	590.14	53.44 oc	0.00	---	---	19.62 s	33.82 s	0.00	---	---	---	53.44
7.00	49,428	590.75	56.66 oc	0.00	---	---	20.17 s	36.48 s	0.00	---	---	---	56.65
7.25	49,434	591.00	57.90 oc	0.00	---	---	20.39 s	37.50 s	0.00	---	---	---	57.89
7.75	49,447	591.50	60.31 oc	0.00	---	---	20.84 s	39.47 s	0.00	---	---	---	60.30
8.25	49,459	592.00	62.60 oc	0.00	---	---	21.28 s	41.31 s	0.00	---	---	---	62.59

Hydrograph Report

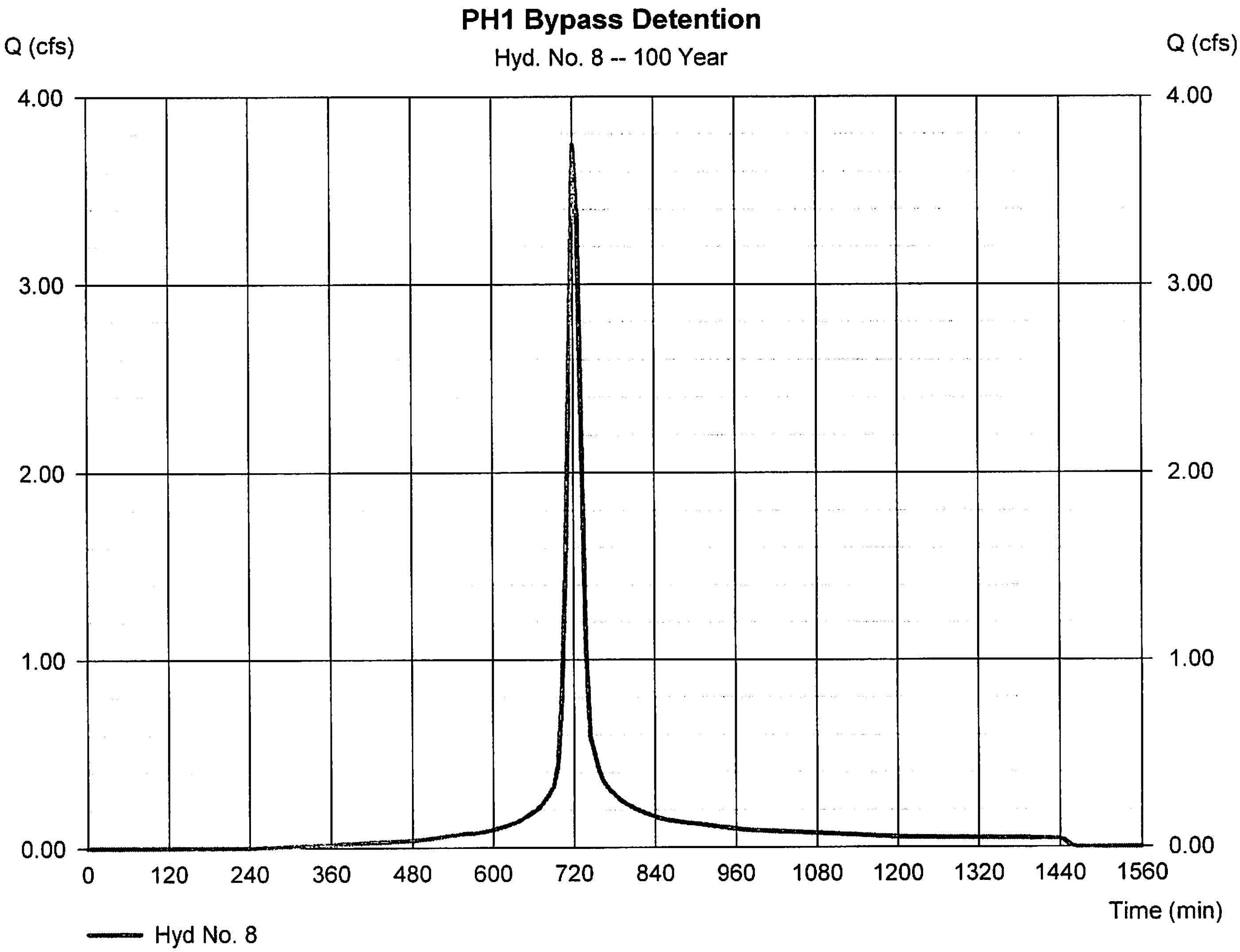
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 8

PH1 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 3.740 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 11,773 cuft
Drainage area	= 0.470 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.390 x 80)] / 0.470



TR55 Tc Worksheet

Hyd. No. 8

PH1 Bypass Detention

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	90.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.01		0.00		0.00		
Land slope (%)	=	4.00		0.00		0.00		
Travel Time (min)	**=**	**10.25**	**+**	**0.00**	**+**	**0.00**	**=**	**10.25**
Shallow Concentrated Flow								
Flow length (ft)	=	90.00		0.00		0.00		
Watercourse slope (%)	=	0.25		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	1.02		0.00		0.00		
Travel Time (min)	**=**	**1.48**	**+**	**0.00**	**+**	**0.00**	**=**	**1.48**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)		({0})0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 11.70 min

Hydrograph Report

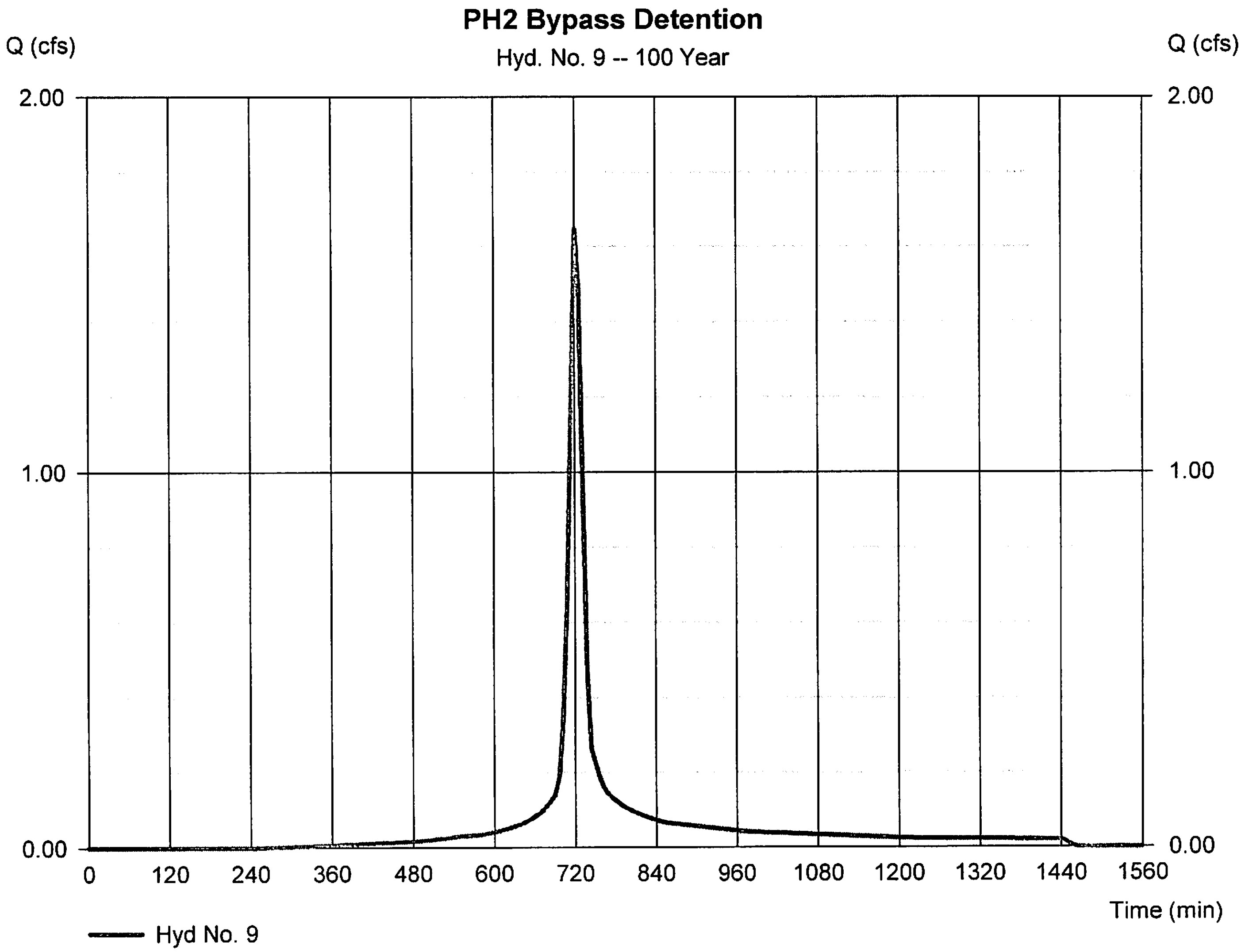
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 05 / 13 / 2014

Hyd. No. 9

PH2 Bypass Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 1.649 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 5,171 cuft
Drainage area	= 0.210 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 9.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98) + (0.190 x 80)] / 0.210



TR55 Tc Worksheet

Hyd. No. 9

PH2 Bypass Detention

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.240		0.011		0.011		
Flow length (ft)	= 90.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.01		0.00		0.00		
Land slope (%)	= 4.00		0.00		0.00		
Travel Time (min)	**= 10.25**	**+**	**0.00**	**+**	**0.00**	**=**	**10.25**
Shallow Concentrated Flow							
Flow length (ft)	= 90.00		0.00		0.00		
Watercourse slope (%)	= 0.25		0.00		0.00		
Surface description	= Paved		Paved		Paved		
Average velocity (ft/s)	=1.02		0.00		0.00		
Travel Time (min)	**= 1.48**	**+**	**0.00**	**+**	**0.00**	**=**	**1.48**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00		0.00		0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 11.70 min

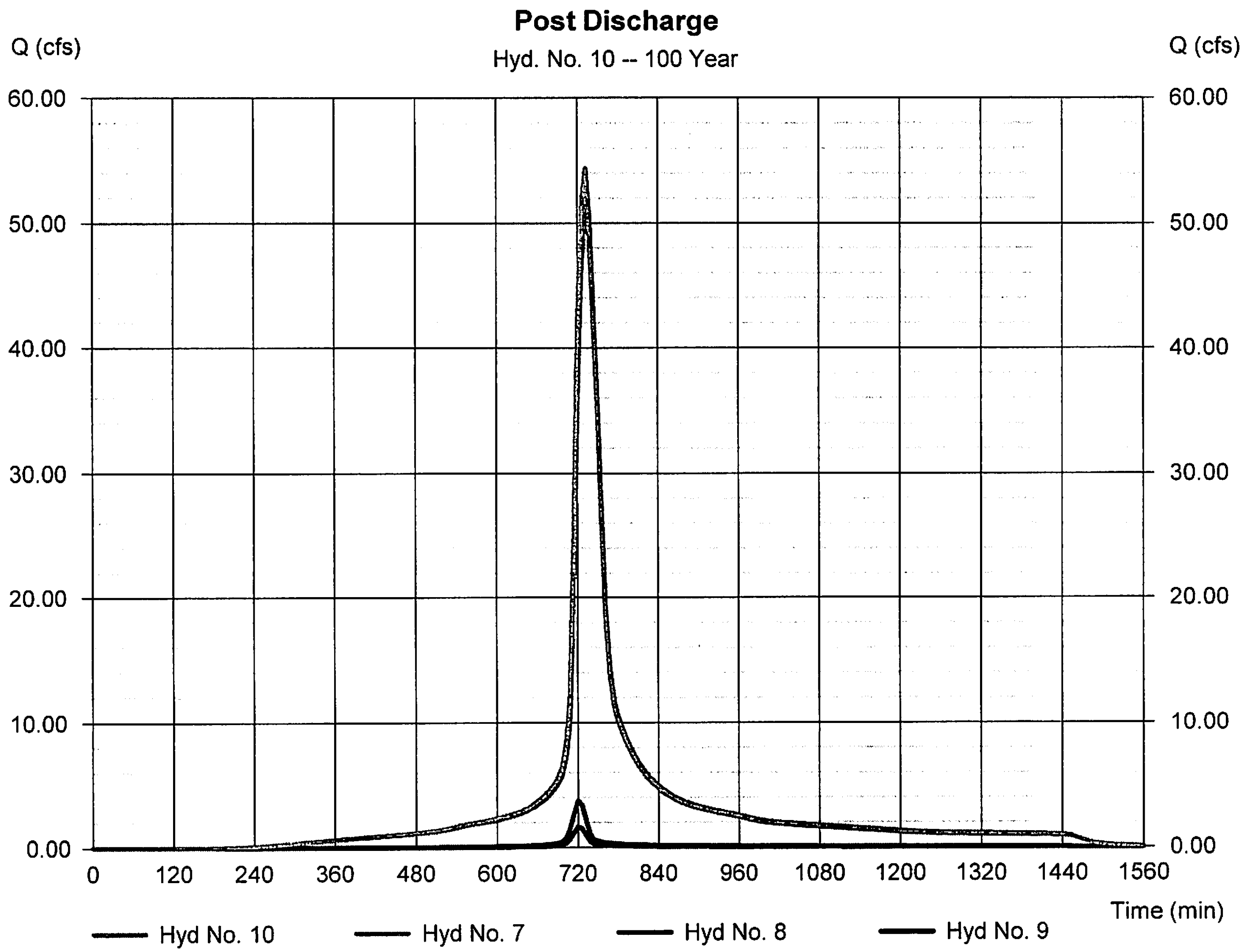
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Tuesday, 05 / 13 / 2014

Hyd. No. 10

Post Discharge

Hydrograph type	= Combine	Peak discharge	= 54.37 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 6 min	Hyd. volume	= 281,999 cuft
Inflow hyds.	= 7, 8, 9	Contrib. drain. area	= 0.680 ac



APPENDIX D
NJCAT REPORT ON STORMTECH UNITS

VERIFICATION

To: Ron Vitarelli, President
Dan Hurdis, Zone Manager
David J. Mailhot, PE, Engineering Manager
StormTech, LLC
20 Beaver Road
Wethersfield, CT 06109
860-257-2150

Re: Identification of Technology:
StormTech® SC-740 Isolator™ Row

Identification of Claims:
Technical Performance Claims

Claim 1: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 270 mg/L (range of 139 – 361 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of at least 60% for SIL-CO-SIL 106, a manufactured silica product with an average particle size of 22 microns, in laboratory studies using simulated stormwater.

Claim 2: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 318 mg/L (range of 129 – 441 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 84% for SIL-CO-SIL 250, a manufactured silica product with an average particle size of 45 microns, in laboratory studies using simulated stormwater.

Claim 3: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 6.5 gpm/ft^2 of bottom area, using a single layer of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 371 mg/L (range of 116 – 614 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of greater than 95% for OK-110, a manufactured silica product with an average particle size of 110 microns, in laboratory studies using simulated stormwater.

This will confirm that NJCAT has concluded the evaluation of the above captioned claims for the above captioned technology, pursuant to your application and our mutually agreed plan of evaluation. NJCAT is pleased to provide a copy of the final report, "NJCAT Technology Verification – **StormTech® SC-740 Isolator™ Row**" detailing the review procedures conducted to evaluate the claims.

The verification differs from typical NJCAT verifications in that final verification of the **StormTech® SC-740 Isolator™ Row** technology awaits completed field testing that meets the full requirements of the Technology Acceptance and Reciprocity Partnership (TARP) - Stormwater Best Management Practice Tier II Protocol for Interstate Reciprocity for stormwater treatment technology. This verification reflects an evaluation of **StormTech® SC-740 Isolator™ Row** initial performance claims for the technology based primarily on carefully conducted laboratory studies. These claims are expected to be modified and expanded following completion of the TARP required field testing.

NJCAT is pleased to confirm that the above captioned claim have been verified by our review procedures and that **StormTech** may use the notation *"NJCAT Verified"* and the Verification Mark in its literature describing the claim in accordance with this Verification Agreement.

Verified

Corporation for Advanced Technology

VERIFIED

StormTech® agrees that the notation "NJCAT Verified" and the Verification Mark will only be used in connection with the above-captioned claims, and the above-captioned technology. Breach by StormTech® of these conditions of use may result in the withdrawal of this verification and the right to use the notation "NJCAT Verified" and the Verification Mark. StormTech® agrees to provide NJCAT, upon request, with sample copies of any literature in which the notation "NJCAT Verified" or the Verification Mark are used. Any third party, who submits a written inquiry to NJCAT concerning this Verification, may be provided with a copy of this Verification Agreement, the final report, and any subsequent correspondence and/or revocation of StormTech® rights hereunder, upon terms and conditions established by NJCAT.

In consideration for participation in the NJCAT Technology Verification Program, the undersigned hereby releases and holds harmless NJCAT, its officers, directors, trustees, employees, members and subcontractors from any and all damages, claims and liabilities arising out of participation by StormTech® in the NJCAT Technology Verification Program.

Please confirm your acceptance of this Verification Agreement by executing the enclosed copy of this Verification Agreement and returning the same to NJCAT.

New Jersey Corporation for Advanced Technology

By: ____________________
RHEA WEINBERG BREKKE
Executive Director

Date: August 15, 2007

StormTech®

Accepted: ____________________
Dan Hurdis

Date: ____________________

NJCAT TECHNOLOGY VERIFICATION

StormTech® Isolator™ Row

August 2007

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1. Introduction

1.1 New Jersey Corporation for Advanced Technology (NJCAT) Program

NJCAT is a not-for-profit corporation to promote in New Jersey the retention and growth of technology-based businesses in emerging fields such as environmental and energy technologies. NJCAT provides innovators with the regulatory, commercial, technological and financial assistance required to bring their ideas to market successfully. Specifically, NJCAT functions to:

- Advance policy strategies and regulatory mechanisms to promote technology commercialization;
- Identify, evaluate, and recommend specific technologies for which the regulatory and commercialization process should be facilitated;
- Facilitate funding and commercial relationships/alliances to bring new technologies to market and new business to the state; and
- Assist in the identification of markets and applications for commercialized technologies.

The technology verification program specifically encourages collaboration between vendors and users of technology. Through this program, teams of academic and business professionals are formed to implement a comprehensive evaluation of vendor specific performance claims. Thus, suppliers have the competitive edge of an independent third party confirmation of claims.

Pursuant to N.J.S.A. 13:1D-134 et seq. (Energy and Environmental Technology Verification Program), the New Jersey Department of Environmental Protection (NJDEP) and NJCAT have established a Performance Partnership Agreement (PPA) whereby NJCAT performs the technology verification review and NJDEP certifies that the technology meets the regulatory intent and that there is a net beneficial environmental effect by using the technology. In addition, NJDEP/NJCAT work in conjunction to develop expedited or more efficient timeframes for review and decision-making of permits or approvals associated with the verified/certified technology.

The PPA also requires that:

- The NJDEP shall enter into reciprocal environmental technology agreements concerning the evaluation and verification protocols with the United States Environmental Protection Agency (USEPA), other local or national environmental agencies, entities or groups in other states and New Jersey for the purpose of encouraging and permitting the reciprocal acceptance of technology data and information concerning the evaluation and verification of energy and environmental technologies; and

- The NJDEP shall work closely with the State Treasurer to include in State bid specifications, as deemed appropriate by the State Treasurer, any technology verified under the Energy and Environment Technology Verification Program.

1.2 Technology Verification Report

In December 2006 StormTech®, LLC (20 Beaver Road, Suite 104, Wethersfield, Connecticut, 06109) submitted a formal request for participation in the NJCAT Technology Verification Program. The technology proposed, the StormTech® Isolator™ Row, filters sand, and silt sized particles from stormwater runoff from developed sites. It is considered a post-development BMP (best management practice) that is potentially an additional tool to meet the State's stormwater quality objectives.

The request (after pre-screening by NJCAT staff personnel in accordance with the technology assessment guidelines) was accepted into the verification program. This verification report covers the evaluation based upon the performance claims of the vendor, StormTech® (see Section 4). This verification report is intended to evaluate StormTech®'s initial performance claims for the technology based primarily on laboratory studies. This project included the evaluation of company manuals and laboratory testing reports to verify that the StormTech® Isolator™ Row meets the performance claims of StormTech®.

1.3 Technology Description

1.3.1 Technology Status

In 1990 Congress established deadlines and priorities for USEPA to require permits for discharges of stormwater that are not mixed or contaminated with household or industrial wastewater. Phase I regulations established that a NPDES (National Pollutant Discharge Elimination System) permit is required for stormwater discharge from municipalities with a separate storm sewer system that serves a population greater than 100,000 and certain defined industrial activities. To receive a NPDES permit, the municipality or specific industry has to develop a stormwater management plan and identify best management practices for stormwater treatment and discharge. Best management practices (BMPs) are measures, systems, processes or controls that reduce pollutants at the source to prevent the pollution of stormwater runoff discharge from the site. Phase II stormwater discharges include all discharges composed entirely of stormwater, except those specifically classified as Phase I discharge.

The StormTech® subsurface chamber system for stormwater management provides underground detention, retention, and storage of stormwater. This subsurface chamber system eliminates the need for surface detention ponds and optimizes space. The StormTech® chamber system for stormwater management can be used in commercial, residential, recreational, agricultural, and highway drainage applications. The StormTech® chamber system is accompanied by the StormTech® Isolator™ Row, which enhances total suspended solids (TSS) removal, as well as provides for inspection and maintenance of the chamber system.

The Isolator™ Row is a row of StormTech® chambers that is surrounded with filter fabric and connected to a manhole. The chambers allow for settling and filtration of sediment as stormwater rises within the Isolator™ Row and passes through the filter fabric. The open bottom chambers and the perforated sidewalls allow stormwater to flow in both a vertical and horizontal direction out of the chambers. Sediments are then captured in the Isolator™ Row, thereby protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

1.3.2 Specific Applicability

The Isolator™ Row can be designed on a volume basis or flow rate basis depending on regulatory requirements. An upstream manhole can typically include a high flow weir such that stormwater flow rates or volumes that exceed the capacity of the Isolator™ Row overtop the overflow weir and discharge through a manifold to the other chambers.

1.4 Project Description

This project included the evaluation of company manuals and laboratory testing reports to verify that the StormTech® Isolator™ Row meets the performance claims of StormTech®.

1.5 Key Contacts

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2. Evaluation of the Applicant *(As provided by David J. Mailhot, P.E. on 1/19/07)*

2.1 Corporate History

StormTech® was founded in the late 1990s by Jim Nichols to provide subsurface chamber systems exclusively for stormwater applications. Mr. Nichols, a mechanical engineer and entrepreneur, is known for successfully developing a plastic chamber system for on-site sanitary sewage applications and for ultimately creating the market for chambers.

Since a primary motivation for engineers and developers locating stormwater storage under ground is often to create more parking spaces, subsurface chamber applications are typically under parking lots and roadways. In these demanding applications, structural integrity is vital. StormTech® recognized the need for a structurally robust chamber and began a product development program to turn this vision into a reality.

StormTech®'s product development program spanned more than four years at a cost of over $7 million. Early chambers were thermoformed from sheets of polyethylene and installed in sixteen locations around the country for observation. Although the early chambers performed well, it became apparent that maintaining uniform wall thickness in the product was an important structural concern that could not be controlled using the thermoforming process. So StormTech® moved on, investing more money and time developing the means to injection mold chambers.

At about the same time as StormTech®'s move to injection molding, Dr. Timothy McGrath, P.E. of Simpson, Gumpertz & Heger was developing new design specifications for buried pipe under the National Cooperative Highway Research Program (NCHRP). After years of research and collaboration with others conducting state of the art work for flexible pipe design, Dr. McGrath framed the design requirements for flexible structures based on strain limits for long term loads and a time-dependent material modulus. Dr. McGrath's NCHRP work was adopted by the American Association of State Highway and Transportation Officials (AASHTO) and incorporated into the AASHTO LRFD Bridge Design Specifications. This design method is now the standard for structures buried under vehicle travel ways.

StormTech® seized an opportunity to hire Dr. McGrath as a consultant for their chamber development program. From that point forward, the chamber development would be evaluated under a higher standard, AASHTO. Dr. McGrath oversaw extensive field testing of the buried chambers using state-of-the-art instrumentation. The testing included several shallow cover tests under AASHTO H20 design vehicle loads for various structural aggregate gradations as well as deep cover tests that spanned months in duration. Test results were used to validate finite element analysis models and to verify structural safety factors.

The result of the product development program was a chamber that was designed in accordance with the same AASHTO specifications that structural engineers use in the design of highway structures. The product was unique since it was the only chamber produced from virgin, impact modified polypropylene, the only injection molded chamber and, at approximately 75 pounds, was the largest injection-molded, one-piece thermoplastic structure produced anywhere.

In 2002, with Jim Nichols as President and David Click as Vice President and General Manager, StormTech®, Inc. began manufacturing and distributing two models of yellow chambers called the StormTech® SC-740 and the StormTech® SC-310. However, StormTech®'s resources were limited to a small force of six outside sales personnel. Although the chamber system was proving to be a more cost effective alternative for underground stormwater storage than competing systems such as polyethylene pipe, it was clear that sales and distribution would need to be ramped up fast to realize the business potential of this product line.

In 2003 Jim Nichols and David Click found the perfect partner and StormTech®, Inc. became StormTech®, LLC as the result of a joint venture agreement between two corporate owners. The new joint venture partner was Advanced Drainage Systems (ADS). ADS brought access to an outside sales force of over 200 personnel, field engineers, an established distribution system and a fleet of trucks to move the product. Ronald Vitarelli was appointed President and General Manager and StormTech®, LLC was positioned as an independently operated, privately owned business.

Under Mr. Vitarelli, StormTech® is committed to a safe, conservative design philosophy. This is accomplished by strict adherence to national standards. StormTech® chamber systems are not only designed to AASHTO specifications, but the chamber itself is produced to ASTM standards. StormTech® played a key role in driving the development of ASTM F2418 "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers." This standard ensures that each chamber produced meets minimum standards for raw materials, dimensional consistency and overall product quality. The robust design and adherence to national standards separates StormTech® chambers from various other flexible structures and positions StormTech® with classes of established buried structures like reinforced concrete and high density polyethylene pipe.

With the creation of StormTech®, LLC, the outside sales group immediately transitioned into a team of Regional Product Managers who provide technical support and management to the ADS sales team.

Shortly after the inception of StormTech®, LLC, Mr. Vitarelli brought David J. Mailhot, P.E. to StormTech® to establish a technical department and the small inside sales team was replaced with a technical team comprised of engineers and technicians. David Mailhot brings many years of engineering experience from the flexible pipe industry including work with researchers to apply soil-structure interaction principles to flexible drainage structure design and also includes work with water quality systems for stormwater treatment. The technical team includes engineering for product development and the Technical Services Department which provides CAD services and specifications to the consulting engineers who specify StormTech® chambers and to the contractors who install StormTech® chambers.

Also in 2003, StormTech® introduced an innovative yet simple system to capture and remove sediments from stormwater called the Isolator™ Row. Removing the sediments from the incoming stormwater prevents sediments from accumulating in the chambers and in the surrounding aggregate. Since the chamber system utilizes the storage volume in the stone porosity, as well as the volume within the chambers, it is important to prevent any loss of void space. The Isolator™ Row intercepts sediments before they reach the surrounding stone voids and provides a means to inspect and conduct maintenance.

The Isolator™ Row is a row or rows of chambers that are completely wrapped by geotextile fabrics. Stormwater is directed into the Isolator™ Row so that flow must pass through the fabric before reaching the surrounding stone. Sediments are filtered out onto the fabric where they can later be jetted out and vactored from the access manhole upstream.

Since 2003, StormTech® chambers have gained wide acceptance as a stormwater detention method. The Isolator™ Row is a recent extension of this technology to address water quality.

In the spring of 2004, StormTech®, LLC received an award from The Society of the Plastics Industry, Inc. Structural Plastics Division for the "Stormwater Chamber & End Caps Model 740." This award was recognition for the sophistication and technology of the mold design for the production of what may be the largest injection molded structural part.

2005 was an important year for StormTech® and for the chamber industry. In early 2005, StormTech®'s significant investment in materials research paid dividends as StormTech® validated a short term materials test for creep modulus determination. This new testing technique enables StormTech® the ability to ensure that raw materials not only meet the initial properties that are commonly measured by resin suppliers, but also the 50-year creep modulus property that is an essential component of long-term design requirement in the AASHTO design specification. StormTech®'s materials research remains an important leg of the Company's leadership position in the Industry.

In the fall of 2005, ASTM F 2418 "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers" was passed by ASTM and became the standard for polypropylene chambers and the model specification for the chamber industry. StormTech® chambers are marked with the "ASTM F 2418" designation and with the ASTM F 4101 materials designation "PP0330B99945" as required by the ASTM standard.

Also in 2005, Tennessee Technological University completed the first series of laboratory tests for the Isolator™ Row and reported total suspended solids (TSS) removal efficiencies of over 95% for the manufactured silica product, US Silica OK-110. This testing resulted in an approval of the Isolator™ Row as a water quality BMP in the state of Maine. However, currently applications are more limited since the new Maine standards require other BMP techniques. The Ontario (Canada) Ministry of the Environment also has reviewed the Isolator™ Row testing by Tennessee Tech University and has issued a Certificate of Technology Assessment.

Currently StormTech® has 26 employees. Approximately 500,000 chambers are installed around the word in over 2,600 projects. Only a small percentage (less than 10%) of chambers nationwide are being used for water quality purposes. The large percentage of chambers is used for retention or detention applications. The Isolator™ Row concept with one-layer of geotextile fabric is used on approximately 90% of StormTech® projects. However, historically the primary application has been as a maintenance feature where sediments and debris are captured and prevented from entering the stone voids. In these applications, the objectives are to prevent accumulation of sediment in the stone voids in detention systems and to minimize occlusion at infiltration surfaces in retention systems.

2.2 Organization and Management

The Company is headquartered in Wethersfield, Connecticut with ten regional sales offices in the United States. StormTech® is also represented in Europe, Australia and the Middle East.

Ronald Vitarelli is the President and General Manager of StormTech®, LLC and reports to a Board of Directors consisting of executives from each of two corporate owners. Other members of the management team include: David J. Mailhot, P.E., Engineering Manager, Susan McNamee, Operations Manager, David K. Click, Director of International Sales & Southern Zone Manager, Daniel Hurdis, Northeastern Zone Manager and Mark Moeller, P.E., Western Zone Manager.

2.3 Technical Resources, Staff and Capital Equipment

StormTech® benefits from several technical resources. StormTech® has five registered professional Civil Engineers on staff, three non-registered degreed Civil Engineers, a geologist, a polymer scientist and a construction engineer. Several of the engineers have advanced degrees. StormTech® engineers bring with them decades of experience in buried structures from the drainage pipe industry and decades of experience from the water quality industry. Water quality experience includes design and sales of vortex separators, gravity grit separators, gravity filters and various media filters.

The corporate owners lead their respective industries in pipe extrusion and injection molding technologies. StormTech® owns multiple molds for injection molding chambers and end caps. Together with their corporate owners and outside consultants, StormTech® uses state-of-the-art molding techniques and has advanced the industry with their developmental work of materials test methods for the determination of long-term thermoplastic mechanical properties.

StormTech® retains Simpson, Gumpertz & Heger, Inc. (SGH) for structural analysis relative to applications and product design. SGH is uniquely qualified in areas of buried pipe design and soil-structure interaction systems including buried flexible structure behavior. StormTech® contracts with Dr. Vincent Neary, P.E., from Tennessee Technological University for water quality testing of the Isolator™ Row.

2.4 Patents

In January of 2006, the United States Patent Office issued a patent for the Isolator™ Row, Patent No: US 6,991,734 B1 entitled "Solids Retention in Stormwater System."

3. Treatment System Description

StormTech®, LLC is the owner and producer of two brand names of subsurface chambers that are designed for use under paved and unpaved surfaces for stormwater applications. The brand names are StormTech® and LandSaver. Respective chambers are identical in every way but are branded by name and color. LandSaver chambers are blue and StormTech® chambers are yellow. Identical chamber models are listed below.

- StormTech® SC-740 is the same as LandSaver LS-3051
- StormTech® SC-310 is the same as LandSaver LS-1633

The StormTech® SC-740 is 85.4" x 51.0" x 30.0" (L x W x H) and has a chamber storage of 45.9 ft^3. The StormTech® SC-310 is 85.4" x 34.0" x 16.0" (L x W x H) and has a chamber storage of 14.7 ft^3.

The Isolator™ Row is a row of StormTech® chambers (either SC-740 or SC-310 models) that is surrounded with filter fabric and connected to a manhole. The chambers allow for settling and filtration of sediment as stormwater rises within the Isolator™ Row and passes through the filter fabric. The open bottom chambers and the perforated sidewalls allow stormwater to flow in both a vertical and horizontal direction out of the chambers. Sediments are then captured in the Isolator™ Row, thereby protecting the storage areas of the adjacent stone and chambers from sediment accumulation (See Figure 1).

Typically, some level of pre-treatment of the stormwater is required prior to entry into the system. Pre-treatment devices differ greatly in complexity, design and effectiveness. Options include a simple deep sumped manhole with a 90° bend on its outlet, baffle boxes, swirl concentrators, sophisticated filtration devices and devices that combine these processes. Some of the most effective pre-treatment options combine engineering site grading with vegetation such as bio-swales or grass filter strips.

The Isolator™ Row is designed to capture the "first flush," and it can be sized on a volume basis or flow rate basis. The Isolator™ Row is designed with a manhole with an overflow weir at its upstream end (See Figure 1). The manhole is connected to the Isolator™ Row with a short 12" to 24" diameter pipe set near the bottom of the end cap. The diversion manhole provides access to the Isolator™ Row for inspection and maintenance. The overflow weir with its crest set even with the top of the chamber allows stormwater in excess of the Isolator™ Row's storage/conveyance capacity to bypass the chamber system through the downstream eccentric header/manifold system (See Figure 2). This diversion manhole is the only mechanism used to control flow into the system.

The Isolator™ Row typically rests on a 6-18 inch foundation of No. 3 gravel overlaid with a woven geotextile filter fabric (GEOTEX® 315 ST – see Appendix for product data sheet). A double-layer of fabric was introduced to address the need for removal of finer sediments in accordance with NJDEP requirements. StormTech® implemented the double layer approach to enhance protection of infiltration surfaces by targeting finer particles for removal. The individual slit films are woven together in such a manner as to provide dimensional stability relative to each other. This geotextile fabric provides a media for stormwater filtration and also provides a durable surface for maintenance operations. In addition, this geotextile fabric is designed to prevent scour of the underlying stone and is designed to remain intact during high pressure jetting. A non-woven fabric is also used for the Isolator™ Row (GEOTEX® 601 – see Appendix for product data sheet). GEOTEX® 601 is a polypropylene, staple fiber, needle-punched, non-woven geotextile. The fibers are needled to form a stable network that retains dimensional stability relative to each other. The non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The chamber has two rows of perforations along the side with the lowest row 2 ¾ inches above the base woven geotextile fabric. As head increases in the chamber, water is discharged through these perforations as it continues to be discharged through the underlying stone bed. The non-woven geotextile fabric provides some filtering capacity for the water exiting the system through the side perforations.

Since the majority of the StormTech® installations are detention systems, they are designed to have some type of outlet structure. These systems are installed on angular stone that has a porosity of 40% and the systems are designed to discharge stormwater through this stone bed. The water in the stone bed can either be allowed to percolate into the underlying soil or perforated piping can be embedded within the stone to collect and discharge the treated stormwater.

4. Technical Performance Claims

Claim 1: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 270 mg/L (range of 139 – 361 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of at least 60% for SIL-CO-SIL 106, a manufactured silica product with an average particle size of 22 microns, in laboratory studies using simulated stormwater.

Claim 2: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 318 mg/L (range of 129 – 441 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 84% for SIL-CO-SIL 250, a manufactured silica product with an average particle size of 45 microns, in laboratory studies using simulated stormwater.

Claim 3: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 6.5 gpm/ft^2 of bottom area, using a single layer of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 371 mg/L (range of 116 – 614 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of greater than 95% for OK-110, a manufactured silica product with an average particle size of 110 microns, in laboratory studies using simulated stormwater.

5. Technical System Performance

A StormTech® SC-740 Isolator™ Row was tested in a full-scale laboratory study by the Department of Civil and Environmental Engineering at Tennessee Technological University, Cookeville, TN. Three different silica-water slurry influent streams were used in the experiment. The first consisted of SIL-CO-SIL 106 with a median particle size of approximately 22 microns. The second consisted of SIL-CO-SIL 250 with a median particle size of approximately 45 microns. For both silica-water slurries, the system was tested at a hydraulic loading rate of 3.2 gpm/ft^2 of filter area. The SIL-CO-SIL 250 was also tested at a hydraulic loading rate of 1.7

gpm/ft^2 of filter area. Finally, a third silica-water slurry using US Silica OK-110 with a median particle size of 110 microns was tested in the laboratory at a range of hydraulic loading rates with maximum rates of 4.8 gpm/ft^2 and 8.1 gpm/ft^2. The removal efficiencies measured in these laboratory experiments were then used to calculate SSC removal efficiency to verify the claims presented above (See Section 4).

5.1 Test System Description

The main components of the laboratory set-up are shown in the design drawings (See Figure 3). Two (2) SC-740 chambers were secured to a wooden frame and laid over a 12-in. bed of No. 3 angular stone (AASHTO M43 #3) with a porosity of 40% contained in a wooden flume with interior W x L x H dimensions, 6.25-ft x 16.22-ft x 3-ft.

The chambers were covered with GEOTEX® 601 non-woven geotextile fabric with a thickness of 60 mils and an apparent opening size of 0.212 mm (see attached product data sheet). Two layers of GEOTEX® 315 ST woven geotextile fabric, each layer with a thickness of 20 mils and an apparent opening size of 0.212 mm (see Appendix for product data sheet), were placed at the bottom of the chamber to stabilize the stone foundation and to prevent scouring of the stone base. Both the nonwoven fabric covering the chamber and the woven fabric placed at the bottom provided filtration media for the Isolator™ Row. During testing, the water depth varied upstream to downstream from 3.5 inches to 4.75 inches, with an average depth of 4 inches. Variations in depth of ±20% were due to the roughness and non-uniformity of the gravel substrate underneath the geotextile fabric.

An 8-inch pipe fed the silica-water mixture through an expansion into the 12-inch inlet pipe of the Isolator™ Row. The target SSC influent concentration was set to 200 mg/L. A 1.5 lb/gal silica-water slurry was introduced to the 8-inch pipe from a 35-gallon mixing tank using a Watson-Marlow 323S/RL (220 rpm) pump. The silica–water slurry enters a 3/8″ feed tap located 10 inches upstream of a butterfly valve, which introduces turbulence and promotes uniform mixing of the influent stream. The Isolator™ Row resides in the recirculating flume, which collects and drains water discharged by the chamber to the stone substrate through an 8-inch drain that discharges to the laboratory trench and sump. The water was recirculated with a 25 horsepower Allis Chalmers (model AC7V) variable speed pump. A 1-micron filter, designed for flows up to 1.5 cfs, was placed at the end of the outlet, which was intended to trap all sediment that was not removed by the chambers.

For the OK-110 testing, the chambers were covered with Mirafli 160N non-woven geotextile fabric, meeting AASHTO M288 Class 2 standards. The Mirafli 160N geotextile has an apparent opening size of 0.212 mm. Mirafli 600X woven geotextile fabric, which meets ASSHTO's M288 Class 1 requirements, was placed at the bottom of the chamber to stabilize the stone foundation and to prevent scouring of the stone base. The Miralfi 600X fabric has an apparent opening size of 0.425 mm (see Appendix for product data sheet).

Flow rates were measured with a Thermo Electron Corporation Polysonic DCT 7088 portable digital correlation transit time flow meter placed on the 8″ aluminum water line. The DCT 7088 was factory calibrated by the manufacturer and was guaranteed accurate to ±0.5%.

The removal efficiency, η, for the Isolator™ Row was calculated as:

$$\eta = \frac{SSC_{Influent} - SSC_{Effluent}}{SSC_{Influent}} x100$$

where SSC is the suspended sediment concentration of the influent and the effluent grab samples, which were staggered by one detention time.

5.2 Procedure

Test runs for both SIL-CO-SIL 106 and SIL-CO-SIL 250 were completed at a treatment flow rate of 180 gpm (0.4 cfs), which corresponds to a hydraulic loading rate of 3.2 gpm/ft^2. Five (5) test runs were completed with SIL-CO-SIL 106 silica slurry. One (1) test run was completed with a SIL-CO-SIL 250 silica-water slurry. Additionally one (1) test run was completed with a SIL-CO-SIL 250 silica-water slurry at a treatment flow rate of 94 gpm (0.21 cfs), which corresponds to a hydraulic loading rate of 1.7 gpm/ft^2. All tests lasted fifteen detention times with sampling beginning after three detention times. Flow rates were regulated by an inlet valve.

Test runs for the OK-110 were completed at a range of treatment flows from 44.9 to 539 gpm (0.1 to 1.2 cfs), which corresponds to hydraulic loading rates of 0.4 to 4.8 gpm/ft^2. This experiment used four of the StormTech® Isolator™ Chambers. The experiment was then modified using two chambers with a maximum design hydraulic loading rate of 8.1 gpm/ft^2. Since the system was half the size (two chambers instead of four), the experiment could be run at higher flows.

Table 1 includes the results for the SIL-CO-SIL 106 test runs. The influent concentrations were generally above the target concentration of 200 mg/L, which suggests that the one-micron filter sock at the outlet was only partially effective at trapping the finer SIL-CO-SIL 106 particles. This was supported by visual observations, which noted that the trench went from clear to cloudy in less than one detention time. The average influent concentration was 270±59 mg/L, with a minimum value of 139 mg/L and a maximum value of 361 mg/L. The average effluent concentration was 109±35 mg/L, with a minimum value of 66 mg/L and a maximum value of 182 mg/L.

Table 2 shows how the average removal efficiency decreased on average with detention time during each test run as a result of recirculation. The removal efficiencies were calculated by averaging all influent and effluent samples with the same sample number, respectively (e.g., all influent samples with sample No. 1 and all effluent samples with sample No. 2). The results indicate that at the beginning of the test recirculation did not significantly increase influent concentrations above the target level of 200 mg/L. The average influent concentration for sample No. 1 was 219 mg/L. In addition, as discussed below, one can speculate that the recirculation of predominantly fine particles has not reduced the particle size distribution of the influent significantly. Under these conditions, the average removal efficiency (based solely on the first samples of each test run) is 66%. However, as the test progresses and recirculation of fines increases, the removal efficiency is reduced.

During the SIL-CO-SIL 106 tests, grab samples of the effluent were collected and sent to the laboratory for grain size analysis. These analyses indicated that the effluent sediments consisted mainly of very fine particles, 84% of which were 10 microns or smaller.

The observed variability in the influent and effluent concentrations was mainly due to the recirculation of fine grained particles not trapped by the filter sock. It was apparent starting with the first test (9-July) that the filter sock was not effective at trapping the fine effluent sediments and preventing their recirculation. As a result, there is a trend of increasing influent and effluent SSC concentrations with increasing detention time during each test run. Additionally, sediments occluded within the woven fabric and trapped in the gravel cannot be removed between each test run. As a result, the initial condition cannot be reestablished once testing has begun, and the sediments trapped in previous test runs may washout, raising effluent and influent SSC concentrations at latter test runs. One potential benefit of sediment occlusion and deposition over time may be increased removal efficiency as the geotextile fabric clogs and a filter cake develops on the Isolator™ Row bottom. (Note: The depth of accumulated sediment varies along the bottom of the Isolator™ Row.) Eventually, however, the cake will begin to reduce the flow through the bottom fabric and direct more flow through the chamber sides.

Note that removal efficiencies were calculated using the "indirect method" only, which relies on influent and effluent concentrations. The material trapped in the isolator row was intentionally not removed to allow the filter cake to develop with time. A rough estimate can be made by determining the total amount of sediment influent and effluent mass over the testing period. The difference is the amount trapped on the surface of the geotextile fabric, occluded in the fabric, and within the gravel substrate. A rough estimate indicates that about 50% of the total sediment trapped was on the surface of the fabric, with the remaining 50% occluded and within the gravel substrate.

Furthermore, the above "50%-50%" estimate is in fact an estimate for only the fine particle test runs since the testing was by indirect method and the sediment captured on the fabric is based on a rough measurement of the depth observed on the fabric at the conclusion of testing. The depth varied across the bottom of the test system. Earlier testing of the OK-110 by direct testing demonstrated 80% removal on the fabric. This is significant since the frequency of maintenance is driven very much by the accumulation of larger particles on the fabric based on the measured 80% capture.

In the SIL-CO-SIL 106 tests, the water depth varied from upstream to downstream from 3.5 inches to 4.75 inches, with an average depth of 4 inches. Variations in depth of ±20% were due to the roughness and nonuniformity of the gravel substrate underneath the geotextile fabric.

Results for the one SIL-CO-SIL 250 test are summarized in Tables 3 and 4. Recirculation of fine sediments was observed and would have reduced the particle size distribution of the influent concentrations below the mean particle size of D_{50}=45 microns. However, particle size analyses of influent sediments were not obtained as was done for the SIL-CO-SIL 106 experiment. The average removal efficiency was 71±14%, with a minimum value of 47% and a maximum value of 82% at 3.2 gpm/ft^2 and 88±1% at 1.7 gpm/ft^2. Compared to the results for the SIL-CO-SIL

106, these values appear reasonable since one would expect higher removal efficiencies when the particle size distribution is greater.

The results for the OK-110 tests at a range of hydraulic loading rates ranging from 0.1 to 1.2 cfs (0.4 to 4.8 gpm/ft^2) are summarized in Table 5. The scaled experiment is also presented in Table 5 for the hydraulic loading rate of 8.1 gpm/ft^2. Two types of influent sampling were conducted during the experiment: discrete sampling and grab sampling. These influent samples are greatly different in concentration. The removal rates exceed 95% for all samples.

5.3 Verification Procedures for All Claims

All the data provided to NJCAT were reviewed to fully understand the capabilities of the StormTech® Isolator™ Row. To verify the StormTech® claim for the Isolator™ Row, the laboratory data were reviewed and compared to the NJDEP TSS laboratory testing procedure.

5.3.1 NJDEP Recommended TSS Laboratory Testing Procedure

The NJDEP has prepared a TSS laboratory testing procedure, primarily designed for hydrodynamic devices, to help guide vendors as they prepare to test their stormwater treatment systems prior to applying for NJCAT verification. The testing procedure has three components:

1. Particle size distribution
2. Full scale laboratory testing requirements
3. Measuring treatment efficiency

1. <u>Particle size distribution:</u>

The following particle size distribution will be utilized to evaluate a manufactured treatment system (See Table 6) using a natural/commercial soil representing the USDA definition of a sandy loam material. This hypothetical distribution was selected as it represents the various particles that would be associated with typical stormwater runoff from a post construction site. NJDEP now requires that filter based BMPs be tested with SIL-CO-SIL 106.

2. <u>Full Scale lab test requirements:</u>
    A. At a minimum, complete a total of 15 test runs including three (3) tests each at a constant flow rate of 25, 50, 75, 100, and 125 percent of the treatment flow rate. These tests should be operated with initial sediment loading of 50% of the unit's capture capacity.
    B. The three tests for each treatment flow rate will be conducted for influent concentrations of 100, 200, and 300 mg/L.
    C. For an online system, complete two tests at the maximum hydraulic operating rate. Utilizing clean water, the tests will be operated with initial sediment loading at 50% and 100% of the unit's capture capacity. These tests will be utilized to check the potential for TSS re-suspension and washout.
    D. The test runs should be conducted at a temperature between 73-79 degrees Fahrenheit (°F) or colder.

3. <u>Measuring treatment efficiency:</u>
    A. Calculate the individual removal efficiency for the 15 test runs.

B. Average the three test runs for each operating rate.
C. The average percent removal efficiency will then be multiplied by a specified weight factor (See Table 7) for that particular operating rate.
D. The results of the five numbers will then be summed to obtain the theoretical annual TSS load removal efficiency of the system.

5.3.2 Laboratory Testing for the StormTech® Isolator™ Row

The results of the laboratory testing that were performed by Tennessee Tech are presented later in Tables 1, 2, 3, 4 and 5. Testing was performed for two different silica-water slurry influent streams at a target SSC influent concentration of 200 mg/L. The tests using the SIL-CO-SIL 106 slurry were performed at 3.2 gpm/ft^2, which was set to be 125% of the treatment operating rate. The tests using the SIL-CO-SIL 250 slurry were performed at 1.7 gpm/ft^2 and 3.2 gpm/ft^2, which were assumed to be 62.5% and 125% of the treatment operating rate, respectively. The tests using the OK-110 slurry were performed for a range of hydraulic loading rates (0.4 to 8.1 gpm/ft^2).

For the SIL-CO-SIL 106, laboratory testing shows a 60% removal efficiency at 3.2 gpm/ft^2 for an average SSC influent concentration of 270 mg/L. Since only one operating rate was tested, the 3.2 gpm/ft^2 was set to be 125% of the treatment operating rate. Since other verifications of pre-manufactured systems have indicated that as the operating rate increases, removal efficiency decreases, the 60% removal efficiency at 3.2 gpm/ft^2 was assumed as the minimum removal of this system at this operating rate. Therefore, the NJDEP weighting system can be used to determine an overall removal efficiency of the system by assuming that removal efficiency observed at the 125% treatment operating rates would also be applicable for the lower operating rates. Since the 3.2 gpm/ft^2 is set to be 125% of the treatment operating rate, the SSC removal efficiency for the system would be based upon 2.56 gpm/ft^2, which would be 100% of the treatment operating rate (see Table 8 and Figure 4).

For the SIL-CO-SIL 250, laboratory testing demonstrates a 71% removal efficiency at 3.2 gpm/ft^2 for an average SSC influent concentration of 211 mg/L and an 88% removal efficiency at 1.7 gpm/ft^2 for an average SSC influent concentration of 424 mg/L. Once again, the 3.2 gpm/ft^2 was set to be 125% of the treatment operating rate, and 1.7 gpm/ft^2 was set to be 62.5% of the treatment operating rate. These removal efficiencies, which were input into the NJDEP weighting system, can be used to determine an overall removal efficiency of the system. Since the 3.2 gpm/ft^2 is set to be 125% of the treatment operating rate, the SSC removal efficiency for the system would be based upon 2.56 gpm/ft^2, which would be 100% of the treatment operating rate (see Table 9 and Figure 5).

For the OK-110, laboratory testing data that are presented in Table 5 were used with the NJDEP protocol to develop an NJDEP weighted removal efficiency for the hydraulic loading rates of 4.8 and 8.1 gpm/ft^2 (see Tables 10 and 11). These loading rates were set to be 125% of the treatment operating rate. Removal efficiencies for 25, 50, 75, and 100% of the treatment operating rate were interpolated from the data presented in Table 5. The NJDEP weighted removal efficiencies were determined to be 98.8 and 98.4% for the hydraulic loading rates of 3.87 and 6.48 gpm/ft^2, respectively.

5.4 Inspection and Maintenance

The StormTech® Isolator™ Row requires minimal routine inspection and maintenance. However, it is important that the system be inspected at regular intervals and cleaned when necessary to ensure optimum performance. Initially, the StormTech® Isolator™ Row should be inspected every six months until information can be gathered to develop an inspection and maintenance routine for the particular site. The rate at which the system collects pollutants will depend more on site activities than on the size of the unit (i.e., heavy winter sanding will cause the lower chamber to fill more quickly, but regular sweeping will slow accumulation). The JetVac process can be used to clean the system. However, the JetVac process, as per StormTech® should only be performed on StormTech® Isolator™ Rows that have AASHTO class 1 woven geotextile over their angular base stone. When the average depth of sediment exceeds three inches, clean-out should be conducted.

The frequency of cleanout is related to the number of chambers in the Isolator™ Row. StormTech®'s cleanout experience includes systems receiving flows from paved areas that were cleaned in advance of actual need and systems that received construction sediments and were cleaned after a sedimentation event.

StormTech® does not recommend that the Isolator™ be used for construction sediments. Where erosion of disturbed sites is possible which could cause sedimentation of the subsurface system, StormTech® recommends plugging inlet pipes to both the Isolator™ Row and high flow manifolds until the site is stabilized and the post development conditions established.

A 20-chamber Isolator™ Row in Portland, Maine was cleaned after one year in service. Approximately 1/8" to 1/4" of sediment had accumulated and StormTech® cleaned the system as a maintenance demonstration. Four passes of a jet nozzle cleaned the Isolator™ Row to bare fabric. The nozzle pressure reached approximately 2200 psi. The fabric was not impacted by the jetting.

Other experience, for all Isolator™ Rows receiving flows from paved areas, indicates that a 1-year maintenance interval is too frequent. Only Isolator™ Rows that 1) have received construction sediments or 2) received sediments from gravel parking areas required maintenance within the first year.

In each cleaning event observed, solids were successfully moved from the fabric bottom to the access manhole and vactored. The solids movement includes both clumps of solids and slurry. Since murky water is produced, it is reasonable to assume that some amount of the clay size particles that go into suspension may be lost through the fabric during the cleanout process. Actual sediment removal is expected to include the larger particle sizes targeted during performance tests and some percentage of finer particles that are moved in the solid cake clumps and slurry that is vactored from the manhole.

5.4.1 Solids Disposal

Solids recovered from the StormTech® Isolator™ Row can typically be land filled or disposed of at a waste water treatment plant.

5.4.2 Damage Due to Lack of Maintenance

It is unlikely that the StormTech® Isolator™ Row will become damaged due to lack of maintenance since there are no fragile internal parts. However, adhering to a regular maintenance plan ensures optimal performance of the system, since filter cake build-up will eventually reduce treatment flow rate through the double layer bottom fabrics.

StormTech® has no reported clogged infiltration systems. The typical StormTech® design includes Isolator™ Rows downstream of all inlets with high flow bypasses to the balance of the chamber system. Therefore the infiltration surface is preserved while the Isolator™ Row collects sediments. Flow through the Isolator™ Row bottom material is expected to decrease over several years. As the bottom occludes and head builds, flow increases through perforations and joints which are covered with a single layer of filter fabric.

6. Technical Evaluation Analysis

6.1 Verification of Performance Claims

Claim 1: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 270 mg/L (range of 139 – 361 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 60% for SIL-CO-SIL 106, a manufactured silica product with an average particle size of 22 microns, in laboratory studies using simulated stormwater.

- *Since the claim laboratory test was performed at 3.2 gpm/ft^2 and this was set to be 125% of the treatment operating rate, the treatment operating rate in Claim 1 should be adjusted to reflect the true operation rate (100% value or 2.56 gpm/ft^2). Claim 1 is verified.*

Claim 2: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 318 mg/L (range of 129 – 441 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 84% for SIL-CO-SIL 250, a manufactured silica product with an average particle size of 45 microns, in laboratory studies using simulated stormwater.

- *For a treatment operating rate of 2.56 gpm/ft^2 and a mean event influent concentration of 318 mg/L (measured as SSC) the data at 3.20 gpm/ft^2 and 1.7 gpm/ft^2 were used to conservatively determine a TSS removal efficiency of 84% for SIL-CO-SIL 250, verifying Claim 2. The average influent concentration of 318 mg/L is simply the average concentration of the two sets of experiments that were run using the SIL-CO-SIL 250.*

Claim 3: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 6.5 gpm/ft^2 of bottom area, using a single layer of woven geotextile fabric and a mean event influent concentration of 371 mg/L (range of 116 – 614 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of greater than 95% for OK-110, a manufactured silica product with an average particle size of 110 microns, in laboratory studies using simulated stormwater.

- *Since the experiment was run at 8.1 gpm/ft², which was set at 125% of the treatment operating rate, Claim 3 is valid with 100% of the treatment operating rate of 6.5 gpm/ft². The weighted removal efficiency at rates of 8.1 gpm/ft² and 4.8 gpm/ft² exceeded 98% so a removal efficiency greater than 95% is valid.*

6.2 Limitations

6.2.1 Factors Causing Under-Performance

If the StormTech® Isolator™ Row is designed and installed correctly, there is minimal possibility of failure. There are no moving parts to bind or break, nor are there parts that are particularly susceptible to wear or corrosion. Lack of maintenance may cause the system to operate at a reduced efficiency, and it is possible that eventually the system will become totally filled with sediment.

6.2.2 Pollutant Transformation and Release

The StormTech® Isolator™ Row should not increase the net pollutant load to the downstream environment. However, pollutants may be transformed within the unit. For example, organic matter may decompose and release nitrogen in the form of nitrogen gas or nitrate. These processes are similar to those in wetlands but probably occur at slower rates in the StormTech® Isolator™ Row due to the absence of light and mixing by wind, thermal inputs, and biological activity. Accumulated sediment should not be lost from the system at or under the design flow rate.

6.2.3 Sensitivity to Heavy Sediment Loading

Heavy loads of sediment will increase the needed maintenance frequency.

6.2.4 Mosquitoes

Although the StormTech® Isolator™ Row normally drain completely, designs may include standing water in a sump in the diversion manhole, which can be a breeding site for mosquitoes. StormTech® advises that the sump is not a necessity for proper Isolator™ Row operation and maintenance. The sump can be eliminated or designed with drain holes where the intent is to preclude mosquito breeding sites. In addition, StormTech® advises that the stone is designed to drain so as to not leave standing water. Small amounts of water that may not drain due to depressions in the otherwise flat bottom would infiltrate.

7. Net Environmental Benefit

Once the StormTech® Isolator™ Row has been verified and granted interim approval use within the State of New Jersey, StormTech® will then proceed to install and monitor systems in the field for the purpose of achieving goals set by the Tier II Protocol and final certification. At that time a net environmental benefit evaluation will be completed. However, it should be noted that the StormTech® technology requires no input of raw material, has no moving parts, and therefore, uses no water or energy.

8. References

Christensen, A. and V. Neary. 2005. *Hydraulic Performance and Sediment Trap Efficiency for the StormTech® SC-740 Isolator™ Row*. Department of Civil and Environmental Engineering, Tennesee Technological University. February 23, 2005.

Neary, V. 2006. *Performance Evaluation of Sediment Removal Efficiency StormTech® Isolator™ Row*. Department of Civil and Environmental Engineering, Tennessee Tech University. October 20, 2006.

Patel, M. 2003, *Draft Total Suspended Solids Laboratory Testing Procedures*, December 23, 2003, New Jersey Department of Environmental Protection, Office of Innovative Technology and Market Development.

StormTech® Subsurface Stormwater Management Technical Resources CD: Product Literature, Design Tools, Isolator™ Row, Project Installation Video. April 2006.

FIGURES

Figure 1.	Isolator™ Row Profile View
Figure 2.	Treatment Train with Isolator™ Row
Figure 3.	Section and Profile Views of StormTech®Isolator™ as Installed in the Laboratory
Figure 4.	SSC Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 106
Figure 5.	SSC Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 250

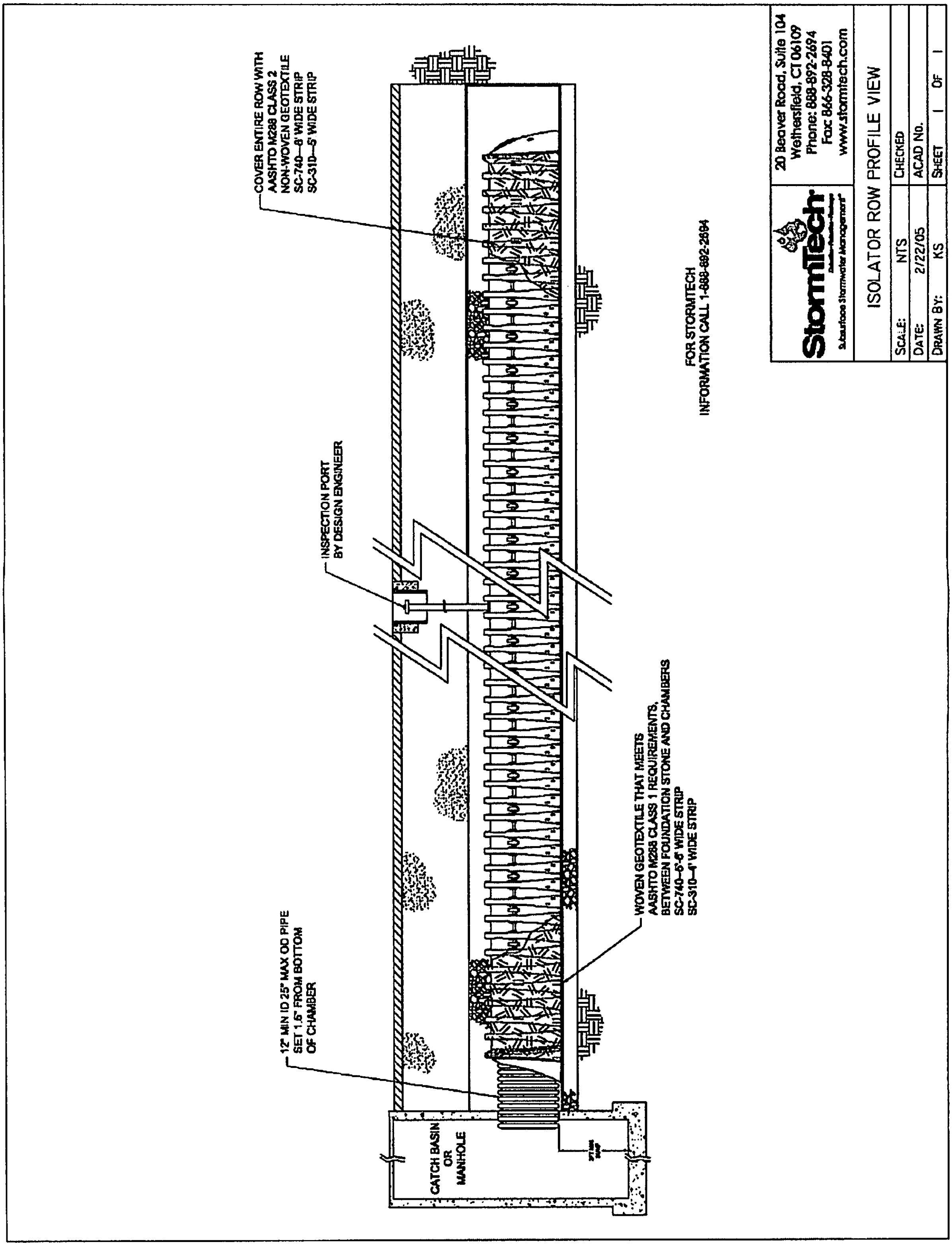

Figure 1. Isolator™ Row Profile View

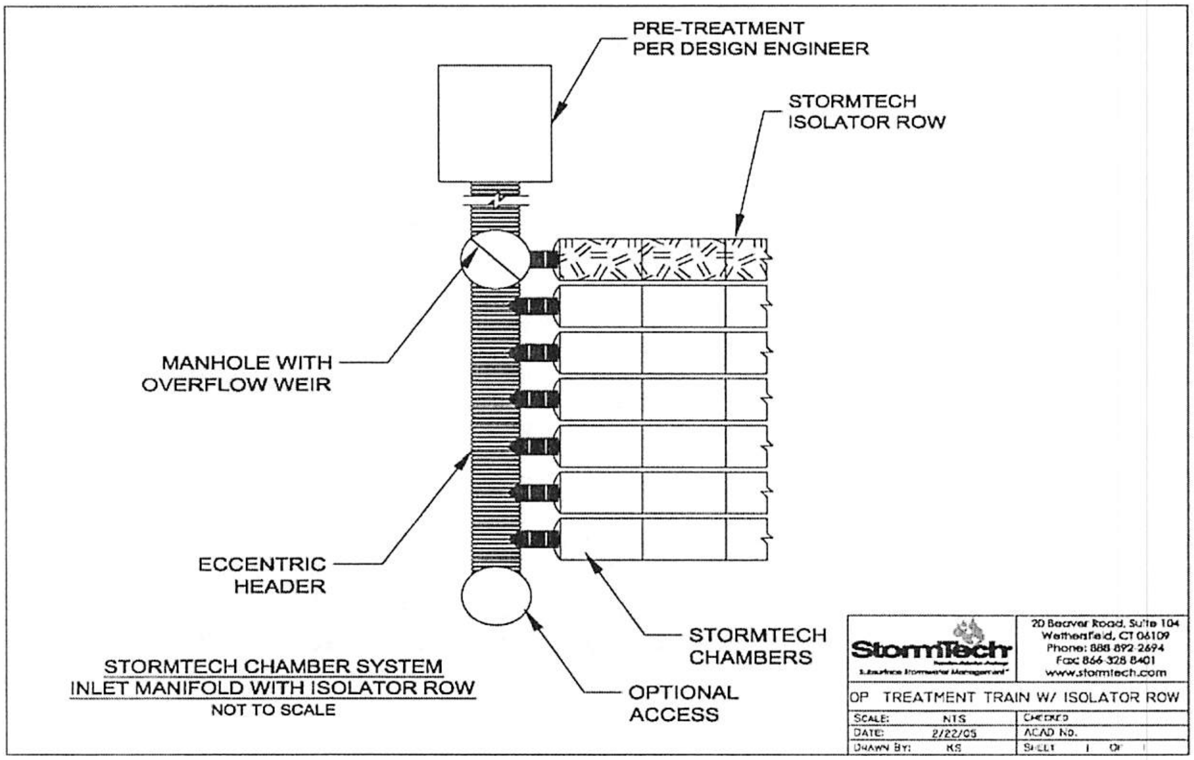

Figure 2. Treatment Train with Isolator™ Row
One StormTech® Recommended Configuration

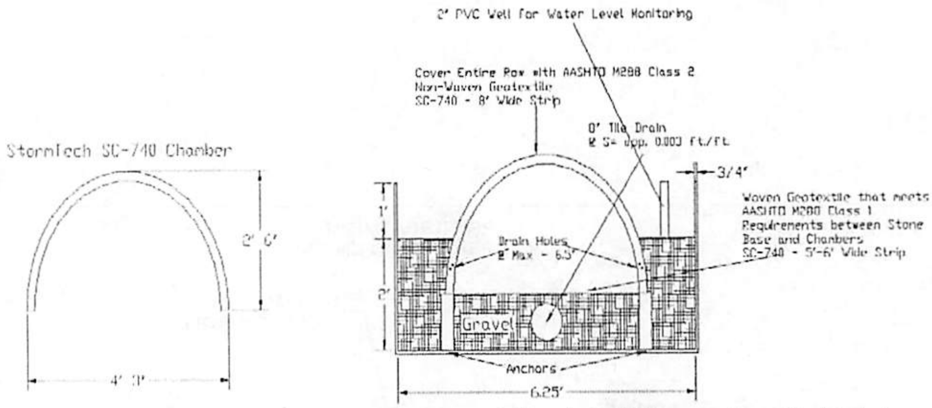

Figure 1.1: Section View of StormTech® Isolator™ Row as Installed in Lab

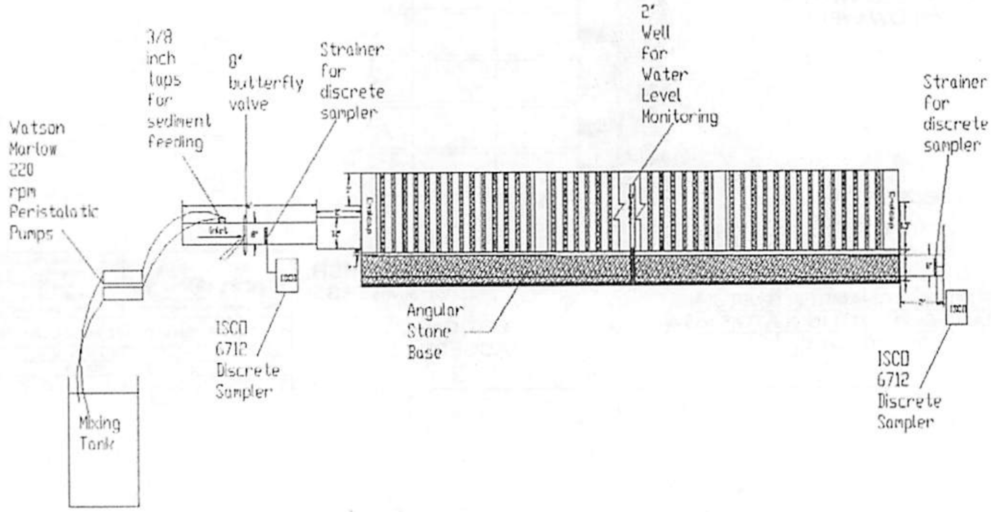

Figure 1. 2: Profile View of StormTech® Isolator™ Row as Installed in Lab.
Flow left to right.

Figure 3. Section and Profile Views of StormTech® Isolator™ Row as Installed in the Laboratory

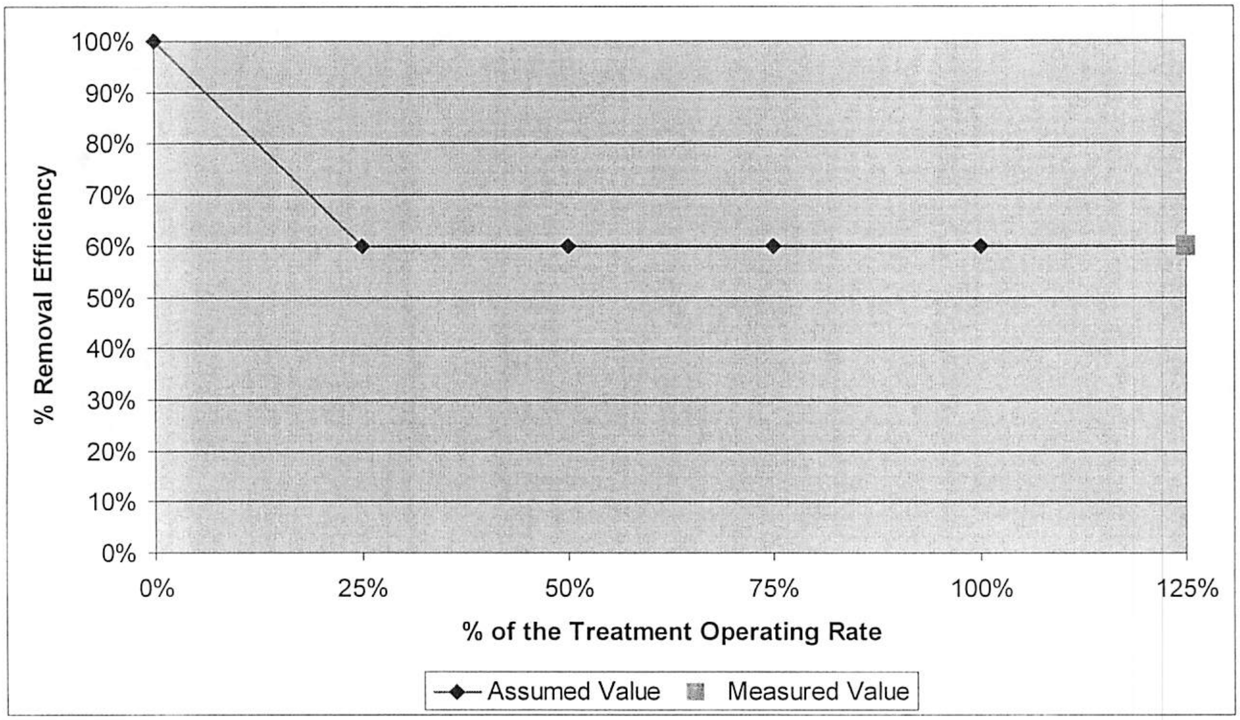

Figure 4. SSC Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 106 (assuming efficiency does not increase as flowrate decreases)

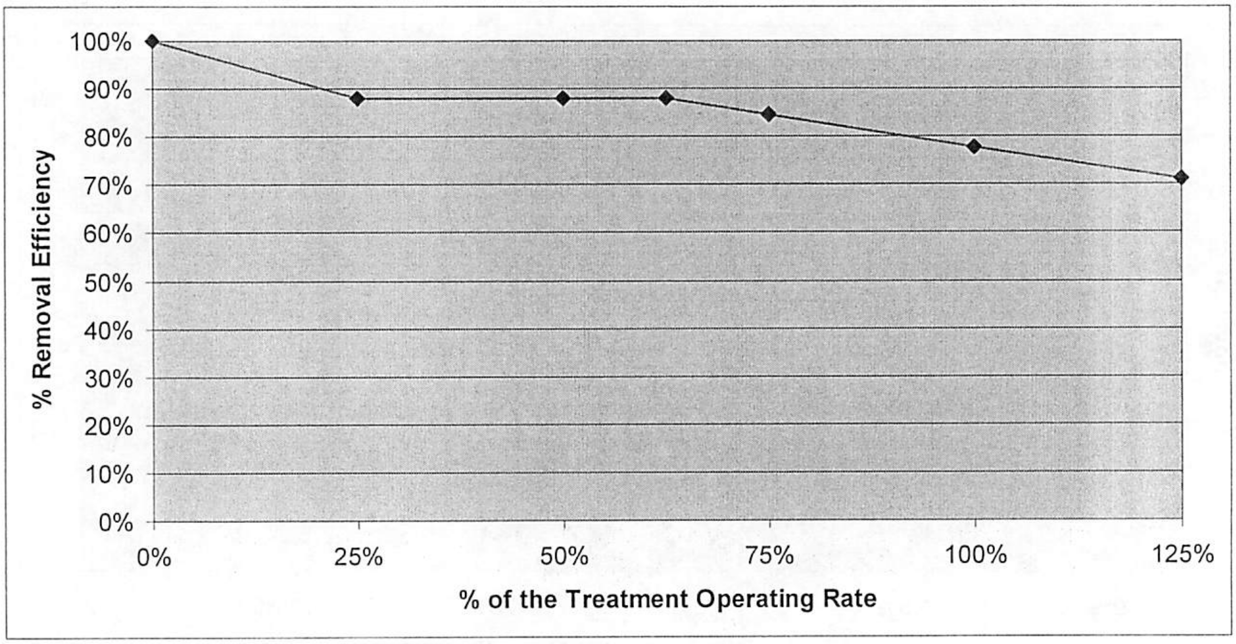

Figure 5. SSC Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 250

TABLES

Table 1.	Results: SIL-CO-SIL 106 Tests
Table 2.	Reduction of Removal Efficiency with Detention Time
Table 3.	Results: SIL-CO-SIL 250 Tests at 3.2 gpm/ft^2 (July 19, 2006)
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Table 6.	Particle Size Distribution
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Table 8.	NJDEP Weighted Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 106
Table 9.	NJDEP Weighted Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 250
Table 10.	NJDEP Weighted Removal Efficiency for 4.8 gpm/ft^2 for OK-110
Table 11.	NJDEP Weighted Removal Efficiency for 8.1 gpm/ft^2 for OK-110

Table 1. Results: SIL-CO-SIL 106 Tests

Date	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
9-Jul	180	81	55
9-Jul	177	100	44
9-Jul	292	122	58
9-Jul	315	147	53
9-Jul	318	162	49
17-Jul	212	72	66
17-Jul	266	95	64
17-Jul	278	135	51
25-Jul	236	77	67
25-Jul	229	66	71
25-Jul	139	74	47
25-Jul	293	87	70
1-Aug	240	70	71
1-Aug	290	124	57
1-Aug	294	144	51
1-Aug	341	146	57
1-Aug	361	132	63
28-Aug	227	74	67
28-Aug	266	67	75
28-Aug	328	137	58
28-Aug	308	100	68
28-Aug	353	182	48
Average:	**270**	**109**	**60**
Std. Deviation:	**59**	**35**	**9**
Minimum:	**139**	**66**	**44**
Maximum:	**361**	**182**	**75**

Table 2. Reduction of Removal Efficiency with Detention Time

Sample No.	No. of Detention Times	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
1	3	219	75	66
2	6	246	90	63
3	9	305	134	56
4	12	311	132	57
5	15	331	141	58

Table 3. Results: SIL-CO-SIL 250 Tests at 3.2 gpm/ft^2 (July 19, 2006)

Sample No.	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
1	226	40	82
2	169	47	72
3	244	53	78
4	288	67	77
5	129	68	47
Average:	**211**	**55**	**71**
Std. Deviation:	**63**	**12**	**14**
Minimum:	**129**	**40**	**47**
Maximum:	**288**	**68**	**82**

Table 4. Results: SIL-CO-SIL 250 Tests at 1.7 gpm/ft^2 (July 19, 2006)

Sample	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
1	416	27	89
2	407	44	88
3	441	48	87
4	417	56	89
5	441	61	87
Average:	**424**	**47**	**88**
Std. Deviation:	**16**	**13**	**1**
Minimum:	**407**	**27**	**87**
Maximum:	**441**	**61**	**89**

Table 5. Results: OK-110 Tests

Flow (cfs)	Hydraulic Loading Rate (gpm/ft^2)	Influent - Discrete SSC (mg/L)	Influent – Grab SSC (mg/L)	Effluent - Discrete SSC (mg/L)	% Removal - Discrete	% Removal - Grab
0.1	0.4	613.8	86.2	1.08	99.82%	98.75%
0.2	0.81	324.4	192.0	2.56	99.21%	98.67%
0.4	1.61	514.6	207.7	3.14	99.39%	98.49%
0.6	2.42	411.8	175.0	3.34	99.19%	98.09%
0.8	3.23	325.4	193.0	2.80	99.14%	98.55%
1.0	4.04	525.6	137.2	1.96	99.63%	98.57%
1.2	4.84	116.4	178.6	3.18	97.27%	98.22%
0.2	0.81	398.2	108.8	1.78	99.55%	98.37%
0.4	1.61	358.8	85.7	1.96	99.45%	97.71%
0.6	2.42	329.5	200.0	3.41	98.97%	98.30%
1.2	4.84	227.5	164.4	2.00	99.12%	98.79%
1.0 (scaled)	8.1	302.0	241.8	11.00	96.36%	95.45%
Average:		**370.7**	**164.2**	**3.18**	**99.14%**	**98.06%**
Minimum:		**116.4**	**85.7**	**1.08**	**96.36%**	**95.45%**
Maximum:		**613.8**	**241.8**	**11.0**	**99.82%**	**98.79%**

Table 6. Particle Size Distribution

Particle Size (microns)	Sandy loam (percent by mass)
500-1,000 (coarse sand)	5.0
250-500 (medium sand)	5.0
100-250 (fine sand)	30.0
50-100 (very fine sand)	15.0
2-50 (silt)	(8-50 μm, 25%) (2-8 μm, 15%)*
1-2 (clay)	5.0

Notes:
Recommended density of particles ≤2.65 g/cm^3
*The 8 μm diameter is the boundary between very fine silt and fine silt according to the definition of American Geophysical Union. The reference for this division/classification is: Lane, E. W., et al. (1947). "Report of the Subcommittee on Sediment Terminology," Transactions of the American Geophysical Union, Vol. 28, No. 6, pp. 936-938.

Table 7. Weight Factors for Different Treatment Operating Rates

Treatment operating rate	Weight factor
25%	0.25
50%	0.30
75%	0.20
100%	0.15
125%	0.10

Notes:
Weight factors were based upon the average annual distribution of runoff volumes in New Jersey and the assumed similarity with the distribution of runoff peaks. This runoff volume distribution was based upon accepted computation methods for small storm hydrology and a statistical analysis of 52 years of daily rainfall data at 92 rainfall gages.

Table 8. NJDEP Weighted Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 106 (assuming efficiency does not increase as flowrate decreases)

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	0.64	60	15
50%	0.30	1.28	60	18
75%	0.20	1.92	60	12
100%	0.15	2.56	60	9
125%	0.10	3.20	60	6
Total:				**60**

Table 9. NJDEP Weighted Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 250

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	0.64	0.88	0.22
50%	0.30	1.28	0.88	0.264
62.5		1.70	0.88	
75%	0.20	1.92	0.846	0.1692
100%	0.15	2.56	0.778	0.1167
125%	0.10	3.20	0.71	0.071
Total:				**84**

Table 10. NJDEP Weighted Removal Efficiency for 4.8 gpm/ft^2 for OK-110

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	0.97	98.9	24.7
50%	0.30	1.94	98.7	29.6
75%	0.20	2.90	98.7	19.7
100%	0.15	3.87	98.9	14.8
125%	0.10	4.84	98.4	9.8
Total:				**98.8**

Table 11. NJDEP Weighted Removal Efficiency for 8.1 gpm/ft^2 for OK-110

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	1.62	98.8	24.7
50%	0.30	3.24	98.8	29.7
75%	0.20	4.86	98.3	19.7
100%	0.15	6.48	98.3	14.8
125%	0.10	8.10	95.9	9.6
Total:				**98.4**

SI® Geosolutions

Product Data Sheet

GEOTEX® 315 ST

GEOTEX 315ST is a woven slit film geotextile manufactured at one of SI Corporations' facilities. The individual slit films are woven together in such a manner as to provide dimensional stability relative to each other. The construction of the geotextile makes GEOTEX 315ST ideal for soil separation and stabilization. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments for normally found in soils. GEOTEX 315ST conforms to the property values listed below[1] which have been derived from quality control testing performed by one of SI Corporations' GAI-LAP accredited laboratories:

		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
Physical			
Mass/Unit Area	ASTM D5261	6.5 oz/yd^2	220 g/m^2
Thickness	ASTM D5199	20 mils	.5 mm
Mechanical			
Tensile Strength (Grab)	ASTM D4632	315 x 315 lbs	1,400 x 1,400 N
Elongation	ASTM D4632	15 x 15%	15 x 15%
Wide Width Tensile	ASTM D4595	175 x 200 lbs/in	30.6 x 35.0 kN/m
Wide Width Elongation	ASTM D4595	10 x 8%	10 x 8%
Puncture	ASTM D4833	125 lbs	555 N
Mullen Burst	ASTM D3786	650 psi	4475 kPa
Trapezoidal Tear	ASTM D4533	120 x 120 lbs	530 x 530 N
CBR Burst	GRI-GSI	1075 lbs	4780 N
Endurance			
UV Resistance	ASTM D4355	90%	90%
Hydraulic			
Apparent Opening Size (AOS)	ASTM D4751	70 US Std. Sieve	0.212 mm
Permittivity	ASTM D4491	0.05 sec^{-1}	0.05 sec^{-1}
Permeability	ASTM D4491	.003 cm/sec	.003 cm/sec
Water Flow Rate	ASTM D4491	4 gpm/ft^2	161 l/min/m^2
Roll Sizes		12.5 ft x 360 ft 15.0 ft x 300 ft 17.5 ft x 258 ft	3.81 m x 109.73 m 4.57 m x 91.44 m 5.33 m x 78.64 m

NOTES:

1. **The property values listed above are effective 03/24/2006 and are subject to change without notice.**
2. Values for machine (warp) and cross-machine (fill), respectively, under dry or saturated conditions. Minimum average roll values (MARV) are calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.

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SI® Geosolutions

Product Data Sheet

GEOTEX® 601

GEOTEX 601 is a polypropylene, staple fiber, needlepunched nonwoven geotextile manufactured at one of SI Geosolutions' facilities that has achieved ISO-9002 certification for its systematic approach to quality. The fibers are needled to form a stable network that retains dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils. GEOTEX 601 conforms to the property values listed below[1] which have been derived from quality control testing performed by one of SI Geosolutions' GAI-LAP accredited laboratories:

		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
Physical			
Mass/Unit Area	ASTM D5261	5.0 oz/yd^2	170 g/m^2
Thickness	ASTM D5199	60 mils	1.5 mm
Mechanical			
Grab Tensile Strength	ASTM D4632	160 lbs	712 N
Grab Elongation	ASTM D4632	50%	50%
Puncture Strength	ASTM D4833	85 lbs	378 N
Mullen Burst	ASTM D3786	280 psi	1930 kPa
Trapezoidal Tear	ASTM D4533	60 lbs	267 N
Wide Width Tensile	ASTM D4595	720 lbs/ft	10.5 kN/m
Endurance			
UV Resistance @ 500 hrs	ASTM D4355	70%	70%
Hydraulic			
Apparent Opening Size (AOS)[3]	ASTM D4751	70 US Std. Sieve	0.212 mm
Permittivity	ASTM D4491	1.30 sec^{-1}	1.30 sec^{-1}
Permeability	ASTM D4491	0.24 cm/sec	0.24 cm/sec
Water Flow Rate	ASTM D4491	110 gpm/ft^2	4480 l/min/m^2
Typical Roll Sizes		150 in x 100 yds 180 in x 100 yds	3.81 m x 91.5 m 4.57 m x 91.5 m

NOTES:

[1] The property values listed below are effective 12/2003 are subject to change without notice.

[2] Values shown are in weaker principal direction. Minimum average roll values are calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.

[3] Maximum average roll value. Statistically, it yields a 97.7% degree of confidence that samples taken from quality assurance testing will be below the value reported.

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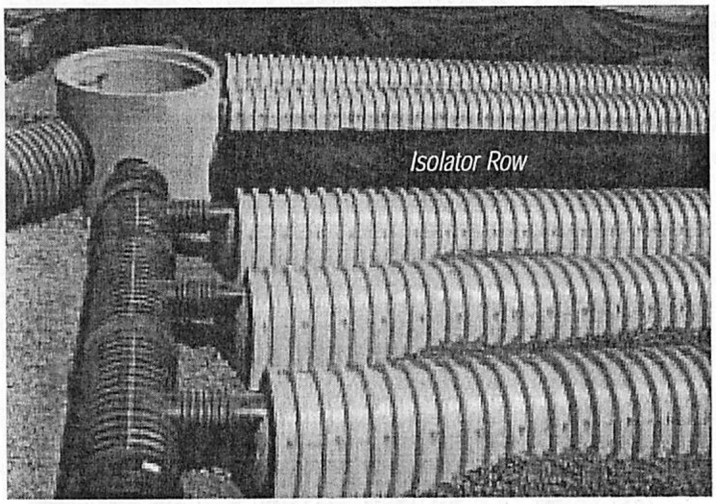
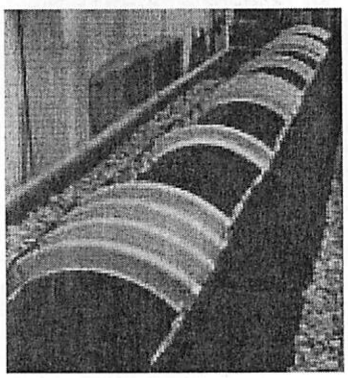
Isolator Row™ Performance Test Results

as reported by Tennessee Technological University



StormTech chambers are the only chambers that meet stringent AASHTO safety factors for traffic load and deep burial applications.



Four SC-740 chambers in test apparatus at Tennessee Tech.

Uniform sediment distribution (US Silica OK-110 SG=2.65).

The Isolator Row is an innovative yet simple system that inexpensively removes total suspended solids (TSS) from storm water and provides easy access for inspection and maintenance. In the Isolator Row, StormTech chambers are completely enclosed by geotextile fabrics. Sediment is captured in the Isolator Row as storm water passes through the fabric to the stone and adjacent chambers.

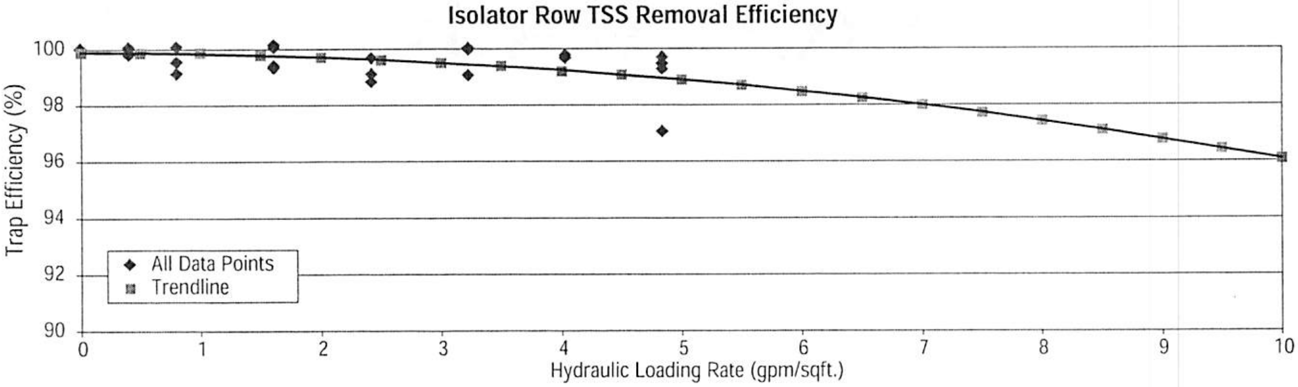
The recent completion of TSS removal testing at Tennessee Tech provides design engineers and regulators solid data that can be used to estimate the maintenance free interval and establishes the Isolator Row as a best management practice (BMP) for TSS removal.

For additional information on the Isolator Row (patent pending), contact StormTech at (888) 892-2694.

Performance Summary:

- 97% Overall TSS Removal
- 80% TSS Captured in the Isolator Row
- Estimated Maintenance Interval – 3 years

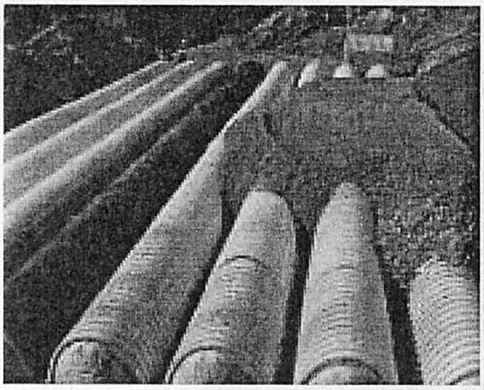
Isolator Row TSS Removal Efficiency

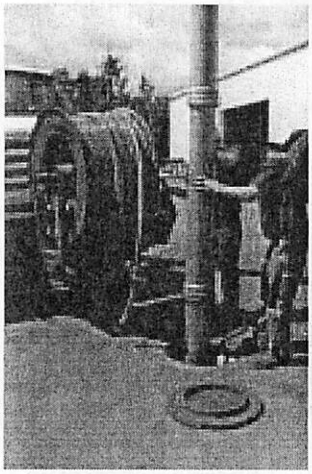


Another Success Story for the Isolator Row

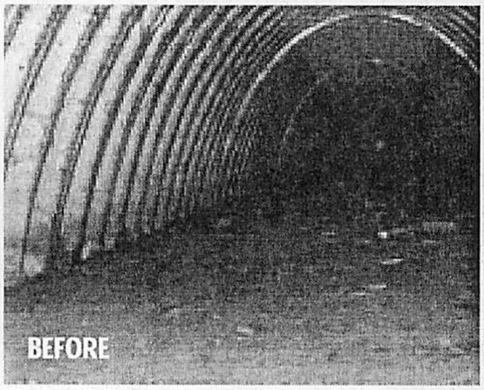
After One Year of Operation, Harvey Industries Inspected and Cleaned Their Isolator Row in Portland, Maine

150 StormTech SC-740 chambers were installed in April, 2003. On July 7, 2004, after one year in service, StormTech inspected the Isolator Row and observed maintenance procedures.





Vactor trucks are typically equipped with both jetting and vacuum equipment.



During maintenance, the jetting nozzle propels itself down the Isolator Row scouring up sediment and washing it down to the access manhole where it is vacuumed into the truck.

After four passes of the jetting nozzle at pressures up to 1900 psi, the bottom fabric was scoured clean.

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StormTech products are covered by one or more of the following patents: U.S. Patents: 5,401,459; 5,511,903; 5,716,163; 5,588,778; 5,839,844; Canadian Patents: 2,158,418 Other U.S. and Foreign Patents Pending

S150904-0

APPENDIX E
MAINTENANCE MANUAL

StormTech®
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Save Valuable Land and Protect Water Resources

Isolator™ Row O&M Manual

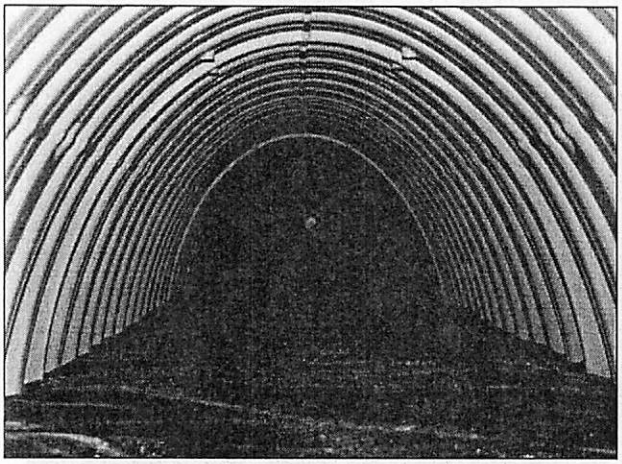
StormTech® Chamber System for Stormwater Management

U.S. GREEN BUILDING COUNCIL MEMBER

1.0 The Isolator™ Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patent pending technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.



Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR™ ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-740 or MC-3500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

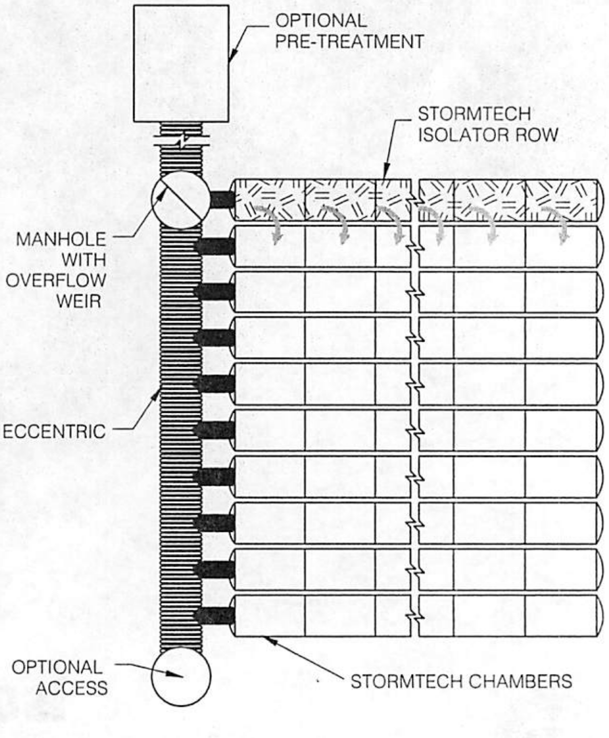
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

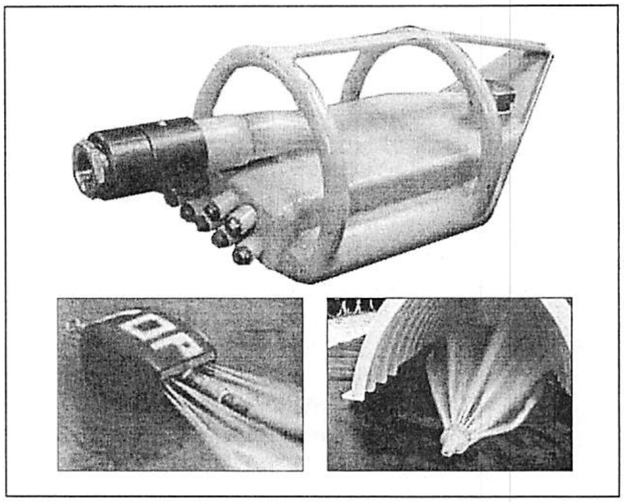
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

2.2 MAINTENANCE

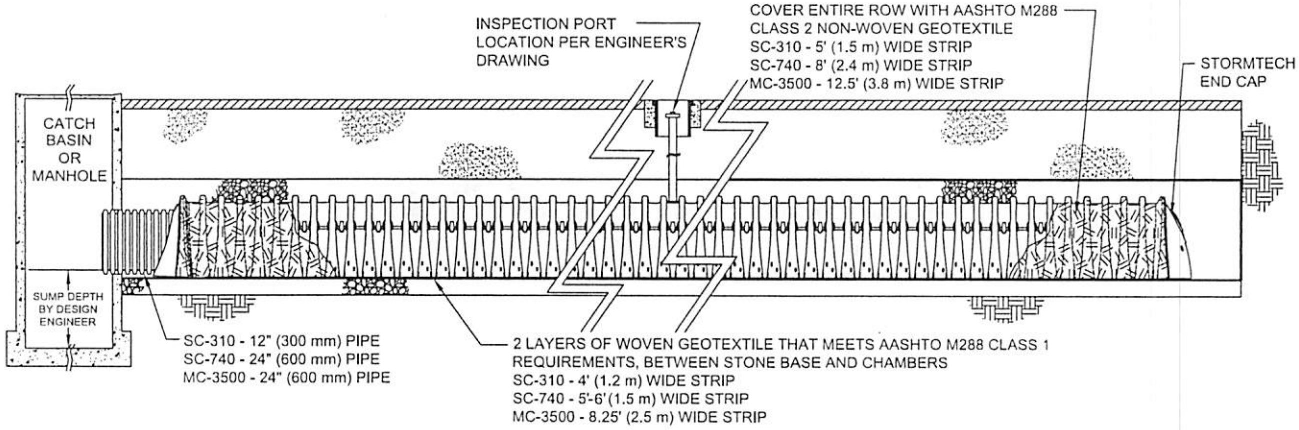
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

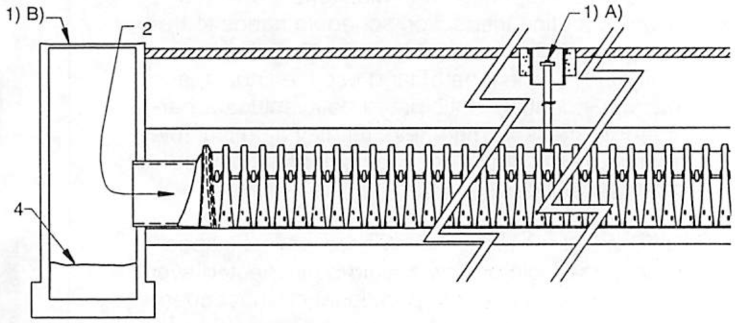
A) Inspection ports (if present)

i. Remove lid from floor box frame
ii. Remove cap from inspection riser
iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.
iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

i. Remove cover from manhole at upstream end of Isolator Row
ii. Using a flashlight, inspect down Isolator Row through outlet pipe
   1. Mirrors on poles or cameras may be used to avoid a confined space entry
   2. Follow OSHA regulations for confined space entry if entering manhole
iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
B) Apply multiple passes of JetVac until backflush water is clean
C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings: Fixed point to chamber bottom (1)	Stadia Rod Readings: Fixed point to top of sediment (2)	Sediment Depth (1) - (2)	Observations/Actions	Inspector
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

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APPENDIX F

Woodlawn Phase 2

#1260
8 May 14

Sediment Trap A

Area drainage = 2.0 Ac

Area disturbed = 1.9 Ac

Volume required = 3600 × 1.9 = 6840 cuft

588	0	2300
589	4600	5100
590	5600	2950
590.5	6200	
591	6800	

10,350 cubic feet

T_c = 10 min Intensity = 6

$Q_{10} = CiA = 0.6(6)(2.0) = 7.2$ cfs

$Q_{10} = C\sqrt{2g}\,LH^{3/2} = 0.45\sqrt{64.4}\,L(0.5)^{3/2} = 0.9L = 7.2$ $L = 8'$

Spillway Width 8'   Flow at 590.5   Flow Height 0.5'

Top dam 592   Freeboard = 1.0'

Woodbury Phase 2

#1260 [illegible]
8 Aug 14

Sediment Trap B

Area draining = 1.9 A
Area disturbed = 1.3 Ac
Volume required = 3,600 × 1.3 Ac = 4,680 cu ft

589.5	0	
		675
590	2700	3000
591	3300	
591.5	3650	1740
592	4000	
		5415 cu ft.

T_c = 10 min Intensity = 6
$Q_{10} = CiA = 0.6\,(6)(1.9) = 6.8$ cfs
$Q_{10} = 0.9L = 6.8$ L = 7.6′ ↗ 8′

Spillway width = 8′ Elev = 591.5 Flow Height 0.5′
Top dam 593 Freeboard 1.0′