EVANS
ENGINEERING

Drainage Calculations

May 21, 2018

For: AP Tech – Rialto Rd
5090 Rialto Rd.,
West Chester Twp., Butler County, OH

By: Evans Engineering
4240 Airport Rd., Suite 211
Cincinnati, Ohio 45226

Project Narrative

This project consists of a new 30,000 square foot warehouse building on a currently vacant lot, on the North side of Rialto Road in West Chester Township, Butler County. The site is an open grass field which will be developed into an area with 35% imperviousness. To provide the necessary storm water detention for this development, a detention pond with an outlet control structure will be used. We have modeled our storm water design on current Butler County Storm Water Regulations.

Existing Conditions

The project site is located at 5090 Rialto Rd in Butler County, Ohio. The site is approximately 6.43 acres of open grassland. Storm water runoff from this site drains from a knob in the center toward the southeast and northwest at a general slope of 1-3% to ditches along the east side and at the northwest corner of the property. The time of concentration for the existing conditions was found to be 28 minutes using the overland flow chart found in the Butler County regulations appendix D, table D-4. The predeveloped runoff coefficient used in the calculations was 0.3.

Proposed Drainage

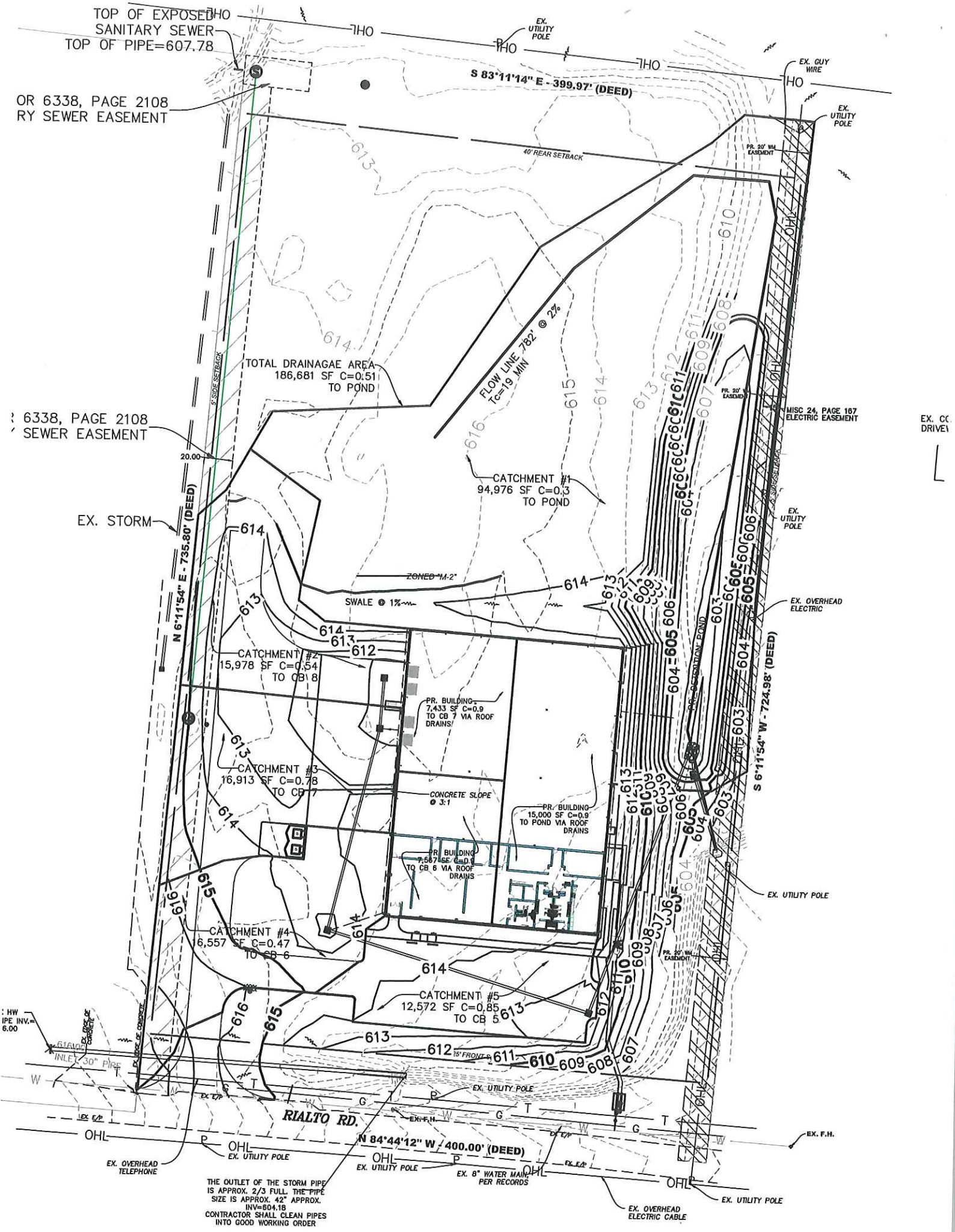
The drainage area to the detention system will be approximately 4.28 acres. Some small grass areas along the perimeter of the site will remain as direct runoff. This development will result in 35% imperviousness of the site, and an overall C-value of 0.51.

The required storage volume was determined by finding the critical storm and then using Hydraflow to model the detention system. An orifice through a weir wall in the detention structure will restrict a volume of ~4,061 cf to be released over a 48 hour period. The exceeds the minimum water quality volume of 3,548 cf. A rectangular notch in the weir wall will control the release rates from the detention structure above the water quality volume. The orifice is sized such that the release rate due to the critical storm event in the post-developed condition is restricted to the runoff rate due to a 1-year storm in the pre-developed conditions. Less frequent, more intense storms are restricted to the pre-developed runoff rate due to one design storm lower (i.e. $Q_{50\text{-year-post}} < Q_{25\text{-year-pre}}$). In this case the critical storm was found to be the 25-year storm.

The post-developed time of concentration was found to be less than 19 minutes using the overland flow chart, which is similar to the pre-developed time of concentration because the flow path was undisturbed. The post-developed runoff coefficient was calculated to be 0.51. Through an iterative process of sizing the detention pond and controlling weir to meet the requirements, the required storage volume was found to be 13,832 cf during the 100-year storm event and the release rates are controlled by the notch in the weir. The detention pond is designed to hold 16,698 cf of stormwater. Hydrographs are attached showing that all design storms are restricted to the peak discharge rate of the 1-year storm in predeveloped conditions.

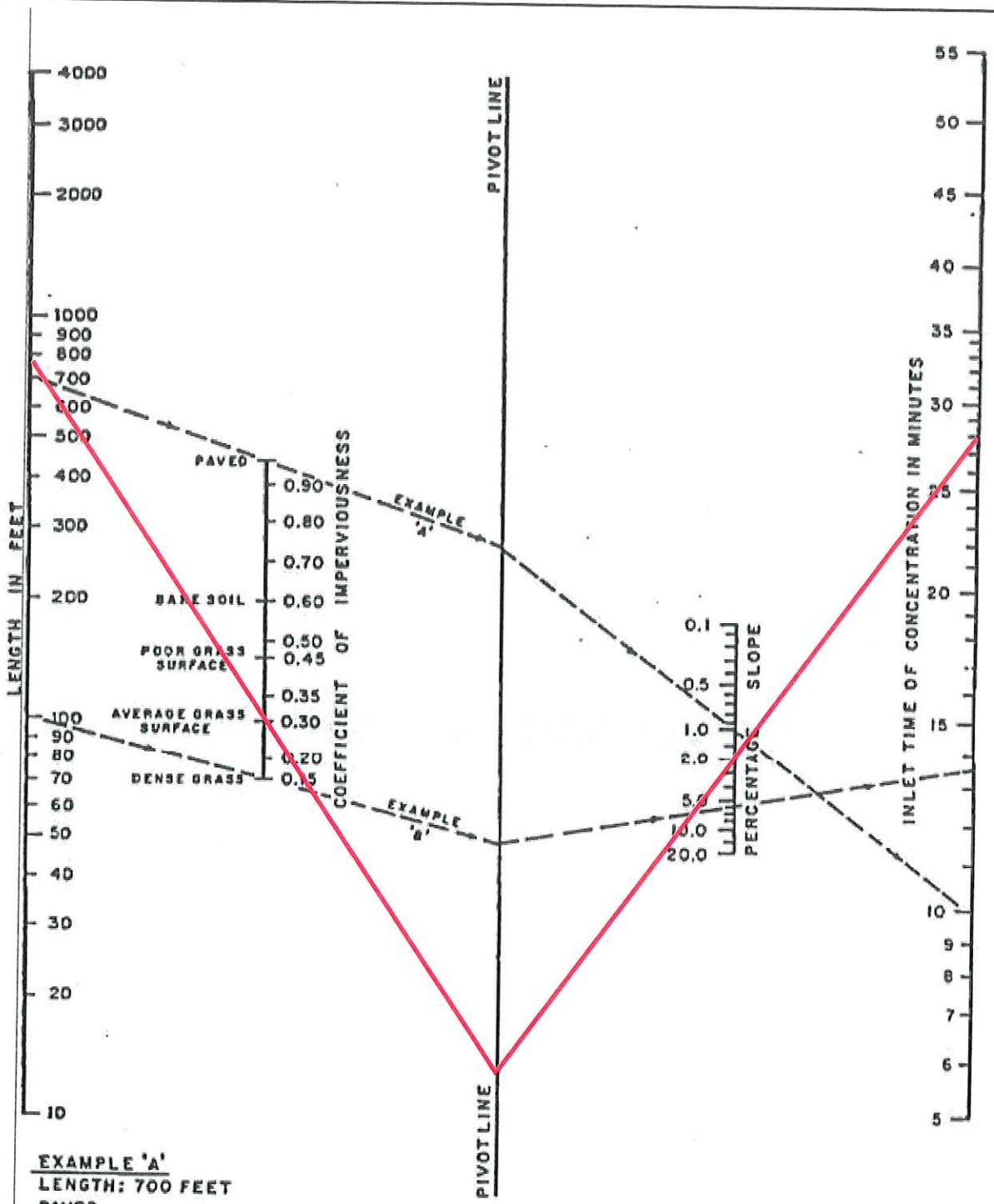
We have designed the erosion and sediment control to minimize sediment loss during construction by using silt fencing, inlet controls, and temporary sediment control. We have included notes to discuss stabilization of ground. Upon completion and stabilization there will be grass and landscaping to be placed around the perimeter of the property. Upon completion, this project should have a good stable buffer around the property which should help water quality and storm water management.

Drainage Map


TOP OF EXPOSED SANITARY SEWER TOP OF PIPE=607.78
OR 6338, PAGE 2108 RY SEWER EASEMENT
S 83°11'14" E - 399.97' (DEED)
EX. UTILITY POLE
EX. GUY WIRE
40' REAR SETBACK
PR. 20' WM. EASEMENT
TOTAL DRAINAGAE AREA 186,681 SF C=0.51 TO POND
FLOW LINE 782' @ 2% TC=19 MIN
5' SIDE SETBACK
MISC 24, PAGE 167 ELECTRIC EASEMENT
EX. DRIVE
6338, PAGE 2108 SEWER EASEMENT
20.00
CATCHMENT #1 94,976 SF C=0.3 TO POND
EX. STORM
N 6°11'54" E - 735.80' (DEED)
ZONED "M-2"
SWALE @ 1%
EX. OVERHEAD ELECTRIC
CATCHMENT #2 15,978 SF C=0.54 TO CB 8
PR. BUILDING 7,433 SF C=0.9 TO CB 7 VIA ROOF DRAINS
CATCHMENT #3 16,913 SF C=0.78 TO CB 7
CONCRETE SLOPE @ 3:1
PR. BUILDING 15,000 SF C=0.9 TO POND VIA ROOF DRAINS
PR. BUILDING 2,567 SF C=0.9 TO CB 6 VIA ROOF DRAINS
PR. DETENTION POND
S 6°11'54" W - 724.98' (DEED)
EX. UTILITY POLE
CATCHMENT #4 6,557 SF C=0.47 TO CB 6
CATCHMENT #5 12,572 SF C=0.85 TO CB 5
15' FRONT
RIALTO RD.
N 84°44'12" W - 400.00' (DEED)
EX. F.H.
EX. OVERHEAD TELEPHONE
EX. UTILITY POLE
EX. 8" WATER MAIN, PER RECORDS
EX. OVERHEAD ELECTRIC CABLE
THE OUTLET OF THE STORM PIPE IS APPROX. 2/3 FULL. THE PIPE SIZE IS APPROX. 42" APPROX. INV=604.18
CONTRACTOR SHALL CLEAN PIPES INTO GOOD WORKING ORDER

Overland Flow Chart

APPENDIX D, TABLE D-4



EXAMPLE 'A'
LENGTH: 700 FEET
PAVED
SLOPE: 1.0 %
TIME: 10 MINUTES

EXAMPLE 'B'
LENGTH: 100 FEET
DENSE GRASS
SLOPE: 6.0 %
TIME: 13 ½ MINUTES

SEELYE CHART

TIME OF CONCENTRATION

Critical Storm Determination

Critical Storm Determination Using SCS Method for Runoff Volume Due to 24-hour Storm

$Q = (P-0.2S)^2 / (P + 0.8S)$
$S = 1000 / CN - 10$

Drainage Area (ft^2)	186415
$P_{1yr-24hr}$ (in.)	2.4
CN_{pre}	61
CN_{post}	74

CN_{pre} for open space, good condition (grass cover > 75%), Soil Group B
CN_{post} from TR-55 Figure 2-3 with 28% imperviousness

S_{pre}	6.393
S_{post}	3.514
Q_{pre} (in.)=	0.17
Q_{post} (in.)=	0.55
V_{pre} (ft^3)	2599
V_{post} (ft^3)	8588
Percent Volume Increase	230
Critical Storm (yr)	25

% Increase in Runoff Volume from a 1-yr, 24 hour Storm		Storm Frequency (Years)
Equal or Greater than (percent)	Less Than (percent)	
-	10	1
10	20	2
20	50	5
50	100	10
100	250	25
250	500	50
500	-	100

Drainage Calculations

C-Value Calculation

Area	C-Value	Description	CA
94379	0.3	Catchment 1	28313.7
15983	0.54	Catchment 2	8630.82
16921	0.78	Catchment 3	13198.38
16557	0.47	Catchment 4	7781.79
12575	0.85	Catchment 5	10688.75
30000	0.9	Building	27000
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

	SF	AC
Total Area:	186415	4.2795
Composite C Value:	0.51	

Water Quality Calculation-

Post Developed Properties	Area (sf)	Area (acres)
Total	186638	4.28
Pervious	120852	2.77
Impervious	65786	1.51

$> i = 0.64719$

WQv "C" = $0.858i^3 - 0.78i^2 + 0.774i + 0.04$

where i = impervious area ratio	0.3525	
Total Area=	4.2846	
WQv C =	0.2535	

$R_v = 0.6324$

Water Quality Volume (WQv) Required

Precipitation	0.75	in	0.9 in
Area, A	4.2846	acres	
WQv req=WQv C * 0.75 * A/12	0.0679	acre-feet	0.2 ac·ft
	2956.86	cubic feet	8712 cu. ft
Add 20% for sedimentation	**3548**	**cubic feet**	10,454.4 cu.ft (dry)

Orifice Sizing

Flow Rate (Q)= 0.021 cfs

Using Extended Detention with 48 hour draw down

volume/48 hr*1 hr/60min *1 min/60 sec

Q=0.6 *A * sqrt (2 g h)

solve for area, convert to orifice diameter

where h= elevation at WQv minus invert

WQv elevation=	603.7	
orifice invert elevation=	602	
Average head(h)=	0.85	ft
A=	0.0046	ft
Radius	0.0384	ft
Diameter =	**0.921**	**in**

JOB 18-127 PROJECT AP-Tech Rialto Rd
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE 5/21/2018
CHECKED BY _____ DATE _____
SUBJECT OPEN CHANNEL SPILLWAY DESIGN

Q=100-year storm frequency flow
c=post develped runoff coefficient — c= 0.51 — input values
i=100-year intensity — i= 6.00
t_c=time of concentration — t_c= 19
A=Drainage area — A= 4.28
Q=ciA — Q= 13.10

$Q_{(max)}$= 13.10 (cfs) for 100 year storm
n= 0.03 roughness coeff.
s= 0.01 (ft/ft)

$Q=(1.486/n)\cdot(A\cdot r^{2/3}\cdot s^{1/2})$

w= width of channel (ft) at bottom
h= height of water in channel (ft)

3:1 Side slopes for channel

Summary: (for different size ditch lines)

Actual Q (cfs)	n	s (ft/ft)	w (ft)	h (ft)	A (ft^2)	r (ft)	Actual V (fps)
15.57	0.03	0.01	6	1	9.00	10.47	1.73

Evans Engineering
4240 Airport Rd., Suite 211
Cincinnati, Ohio 45226
513-321-2168 513-321-2173 Fax

10 Yr Design Storm n= 0.013

Storm Sewer Design Sheet

Project: AP-Tech Rialto Rd
Job No.: 18-127
Contact: Jonathan Evans, P.E.

Date: 5/21/2018
Revised:
Revised:
Revised:

Struc.	Struc. Index	Sta.	Drainage Area Trib	Cumul.	C	Cumul CA	Time Delta t Min.	Sum t Min.	Intensity in/hr	Des Q CFS	Length ft.	Dia. In	Slope%	Vel	Cap. Flowing Full	Status	In	Out	RIM	Remarks
8	CB	558.65	0.367	0.37	0.54		5.00	5.00	6.07	1.20									726.29	
						0.20					35.17	15	1.280%	5.96	7.31	OK	720.79	720.79		
											dwg say 12									
7	CB	523.48	0.388	0.93	0.78		0.10	5.10	6.05	3.96									709.65	
			0.171	RD	0.90	0.65					143.96	15	0.870%	4.91	6.03	OK	704.15	704.15		
6	CB	379.52	0.380	1.48	0.47		0.49	5.59	5.95	5.88									694.90	
			0.174	RD	0.90	0.99					190.36	18	0.820%	5.39	9.52	OK	689.40	689.40		
											dwg say 15									
5	CB	189.16	0.289	1.77	0.85		0.59	6.18	5.83	7.19									694.90	
						1.23					189.16	18	0.840%	5.45	9.63	OK	689.40	689.40		
																			654.33	
4	HW																	649.33		

? basin outlet pipes

do not match dwg.

Pond Stage Storage Chart

STAGE STORAGE TABLE

ELEV	AREA (sq. ft.)	DEPTH (ft)	INC. VOL. (cu. ft.)	TOTAL VOL. (cu. ft.)
601.6	7.11	N/A	N/A	0
601.7	28.54	0.1	1.78	1.78
601.8	65.74	0.1	4.71	6.5
601.9	119.45	0.1	9.26	15.76
602	190.62	0.1	15.5	31.26
602.1	280.51	0.1	23.56	54.82
602.2	390.4	0.1	33.55	88.36
602.3	521.91	0.1	45.62	133.98
602.4	676.12	0.1	59.9	193.88
602.5	854.97	0.1	76.55	270.43
602.6	1,060.23	0.1	95.76	366.19
602.7	1,293.87	0.1	117.7	483.9
602.8	1,560.41	0.1	142.71	626.61
602.9	1,862.52	0.1	171.15	797.76
603	2,204.47	0.1	203.35	1001.11
603.1	2,590.00	0.1	239.72	1240.83
603.2	3,022.90	0.1	280.65	1521.48
603.3	3,509.08	0.1	326.6	1848.08
603.4	4,052.55	0.1	378.08	2226.16
603.5	4,660.50	0.1	435.65	2661.81
603.6	5,340.68	0.1	500.06	3161.87
603.7	6,101.45	0.1	572.11	3733.98
603.8	6,960.26	0.1	653.09	4387.06
603.9	7,939.31	0.1	744.98	5132.04
604	9,091.51	0.1	851.54	5983.58
604.1	2.59	0.1	454.7	6438.29
604.2	10,900.23	0.1	893.8	7332.08
604.3	11,100.91	0.1	1100.06	8432.14
604.4	11,302.06	0.1	1120.15	9552.29
604.5	11,503.66	0.1	1140.29	10692.57
604.6	11,705.72	0.1	1160.47	11853.04
604.7	11,908.25	0.1	1180.7	13033.74
604.8	12,111.24	0.1	1200.97	14234.71
604.9	12,314.68	0.1	1221.3	15456.01
605	12,518.59	0.1	1241.66	16697.67

new WQv elev.

Hydrographs

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

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	Mod. Rational	2.446	1	28	4,109	------	------	------	Pre-Dev
2	Mod. Rational	4.158	1	28	6,985	------	------	------	Post-Dev
3	Reservoir	0.632	1	52	6,842	2	604.04	6,363	Post-Dev Routed

Hydrograph Report

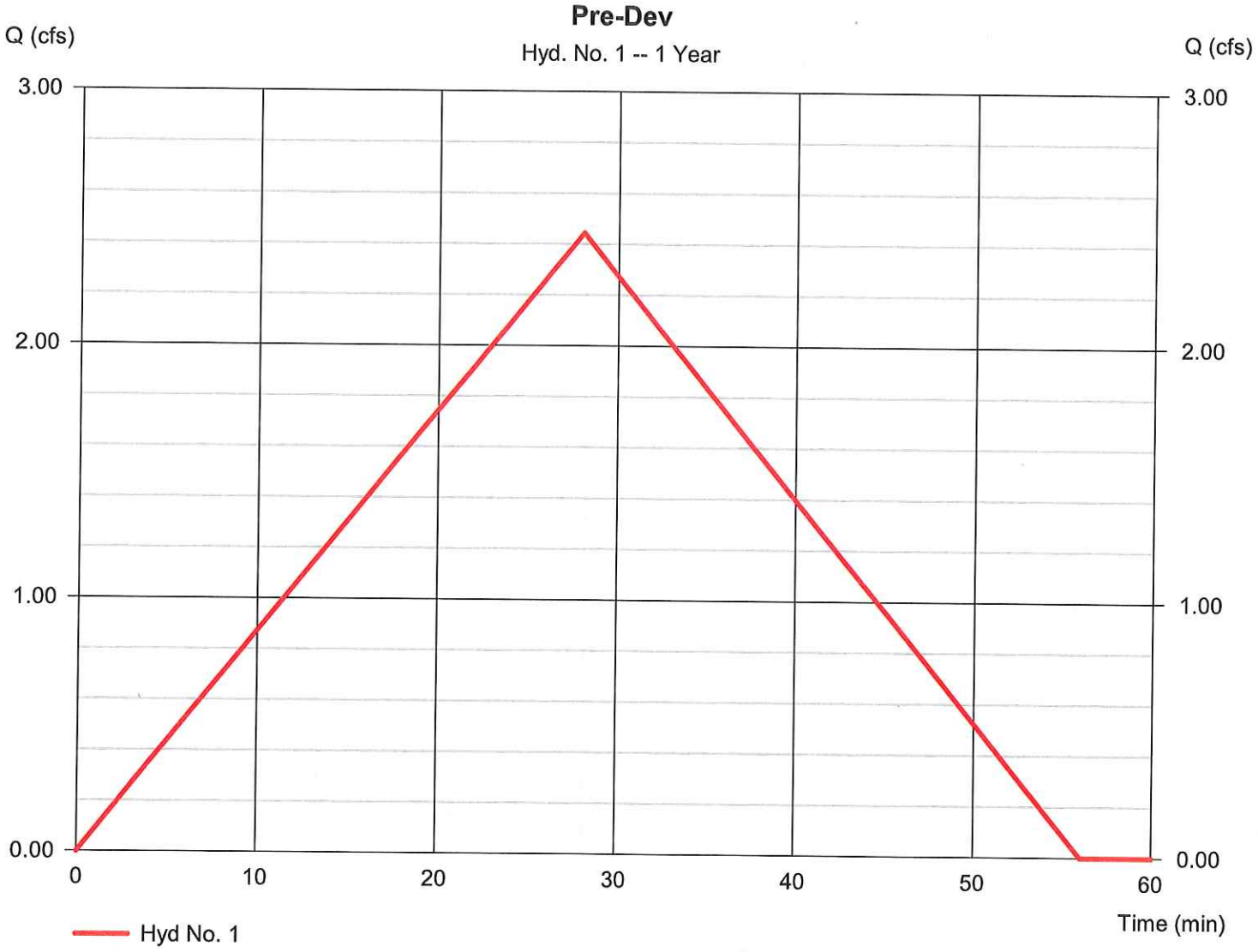
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 1

Pre-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 2.446 cfs
Storm frequency	= 1 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 4,109 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.3
Intensity	= 1.905 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a

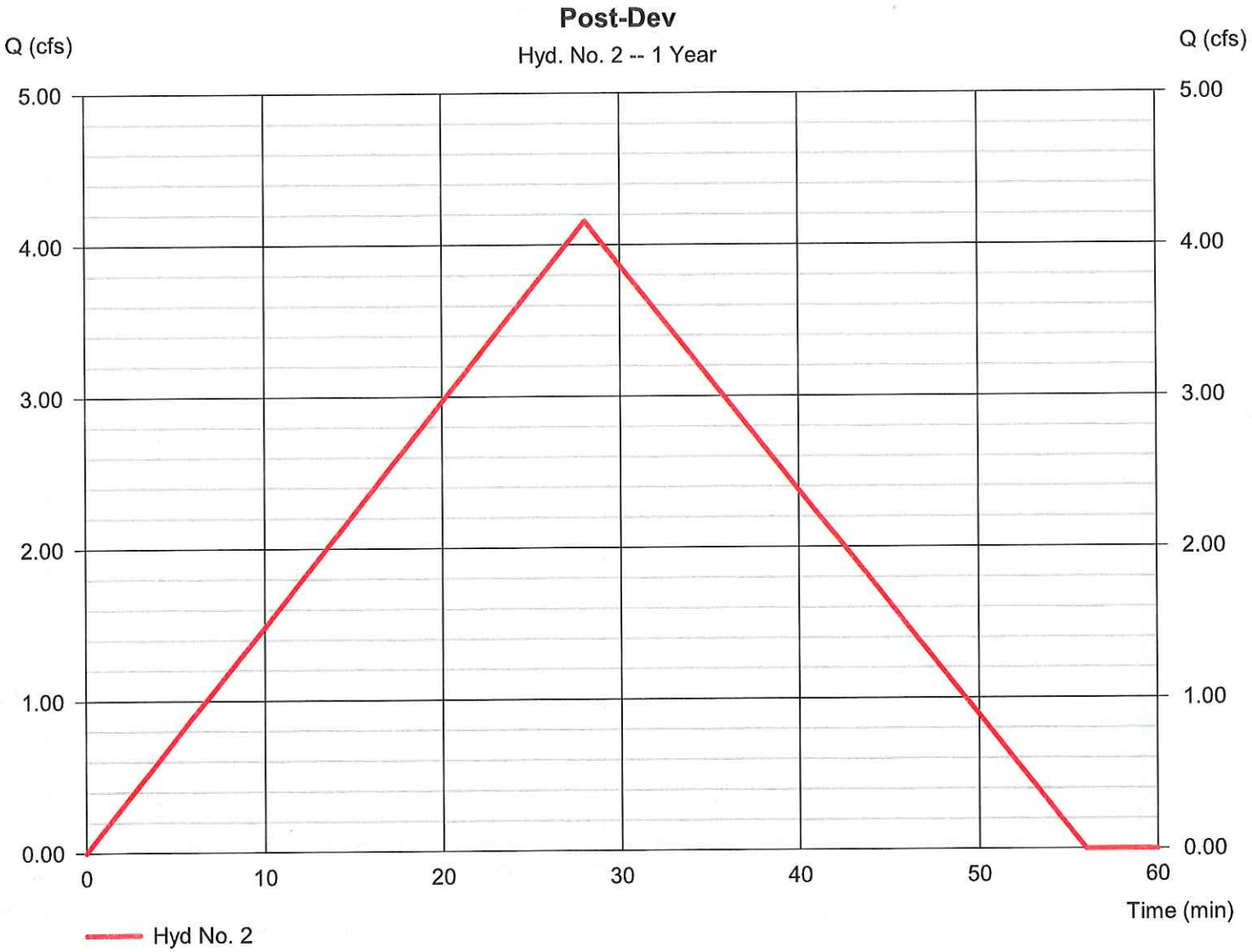


Hydrograph Report

Hyd. No. 2

Post-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 4.158 cfs
Storm frequency	= 1 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 6,985 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.51
Intensity	= 1.905 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

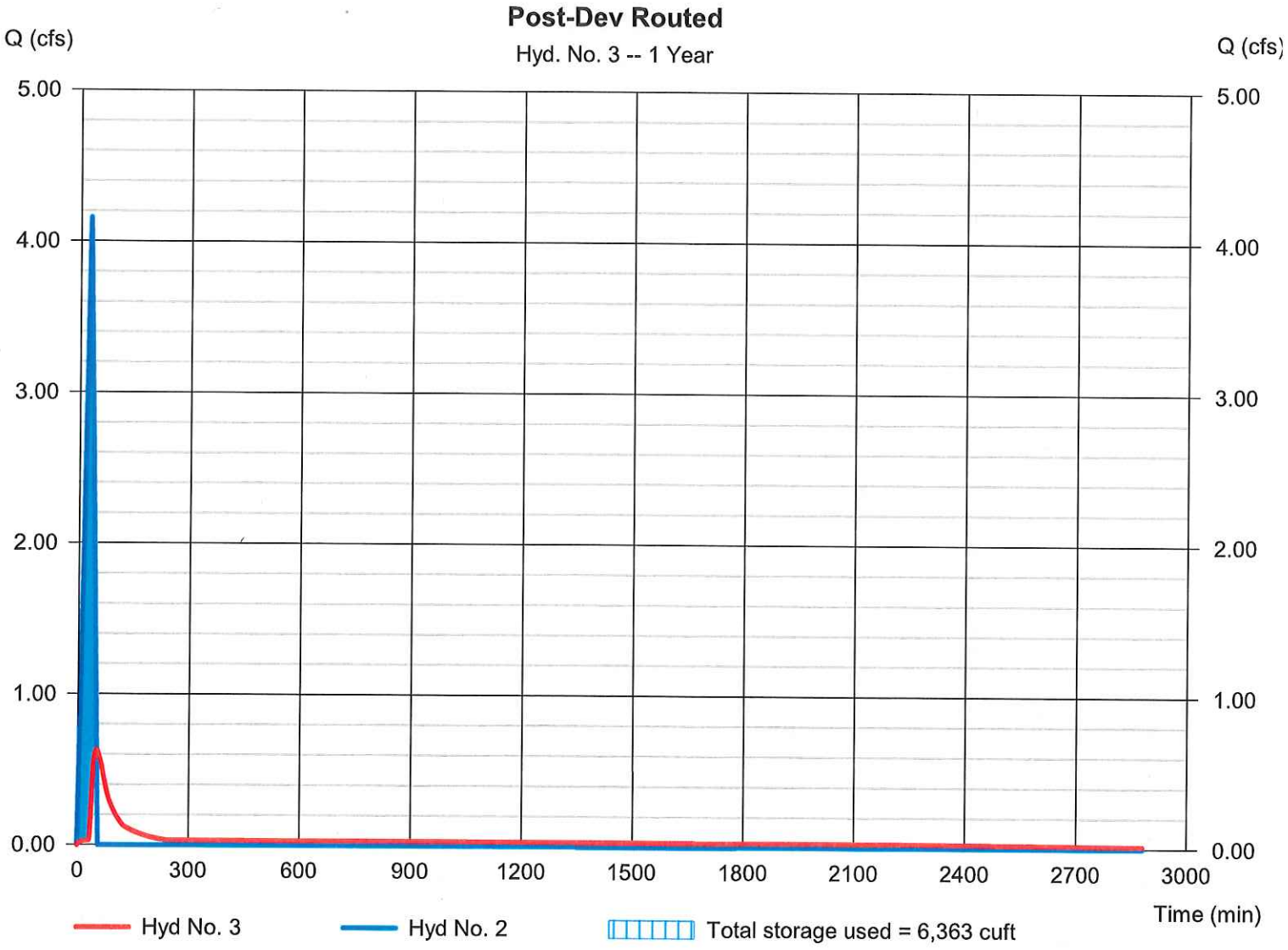
Monday, 05 / 21 / 2018

Hyd. No. 3

Post-Dev Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.632 cfs
Storm frequency	= 1 yrs	Time to peak	= 52 min
Time interval	= 1 min	Hyd. volume	= 6,842 cuft
Inflow hyd. No.	= 2 - Post-Dev	Max. Elevation	= 604.04 ft
Reservoir name	= APTech Pond 1	Max. Storage	= 6,363 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

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	Mod. Rational	3.025	1	28	5,081	------	------	------	Pre-Dev
2	Mod. Rational	5.142	1	28	8,638	------	------	------	Post-Dev
3	Reservoir	0.955	1	51	8,470	2	604.15	7,567	Post-Dev Routed

Hydrograph Report

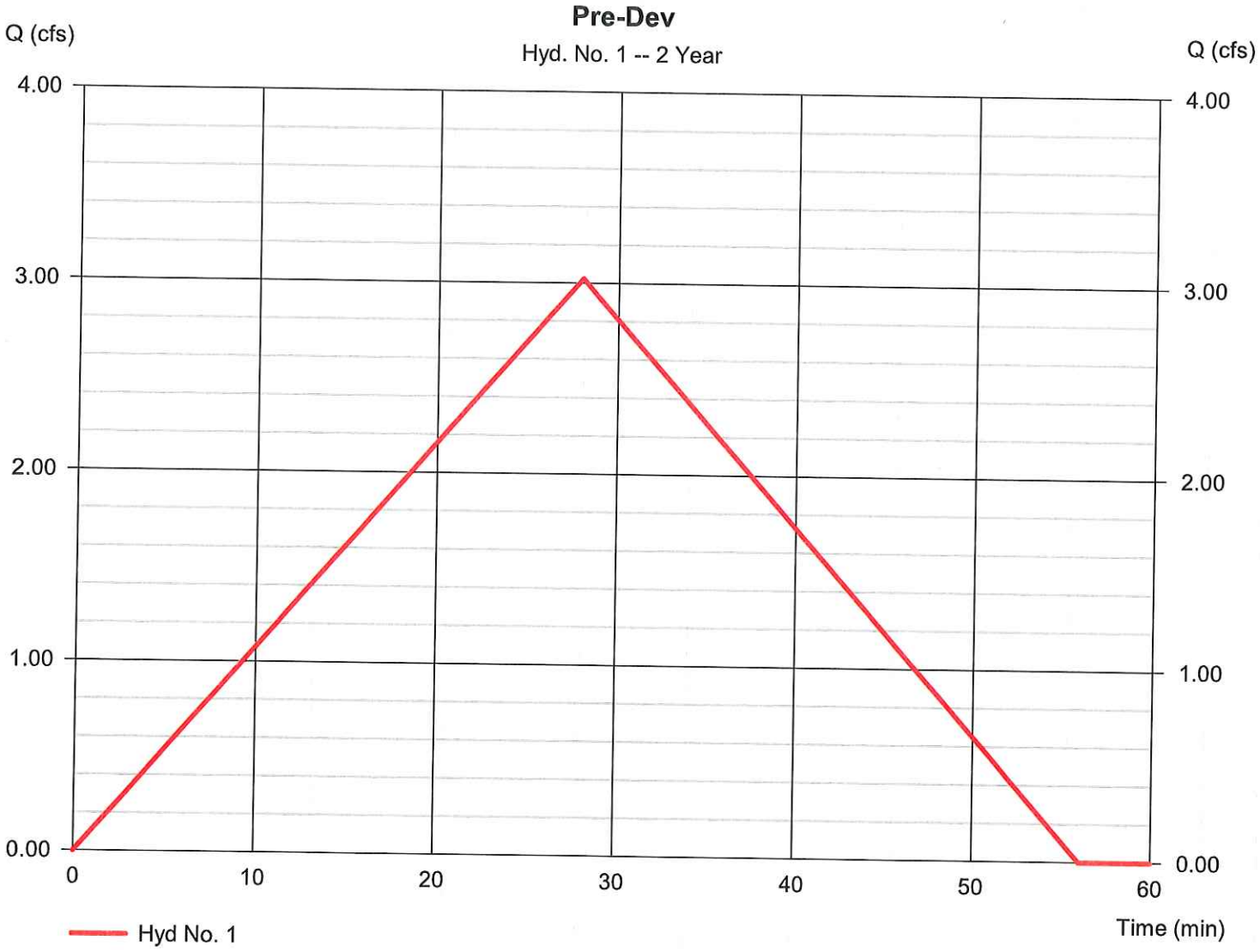
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 1

Pre-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 3.025 cfs
Storm frequency	= 2 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 5,081 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.3
Intensity	= 2.356 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



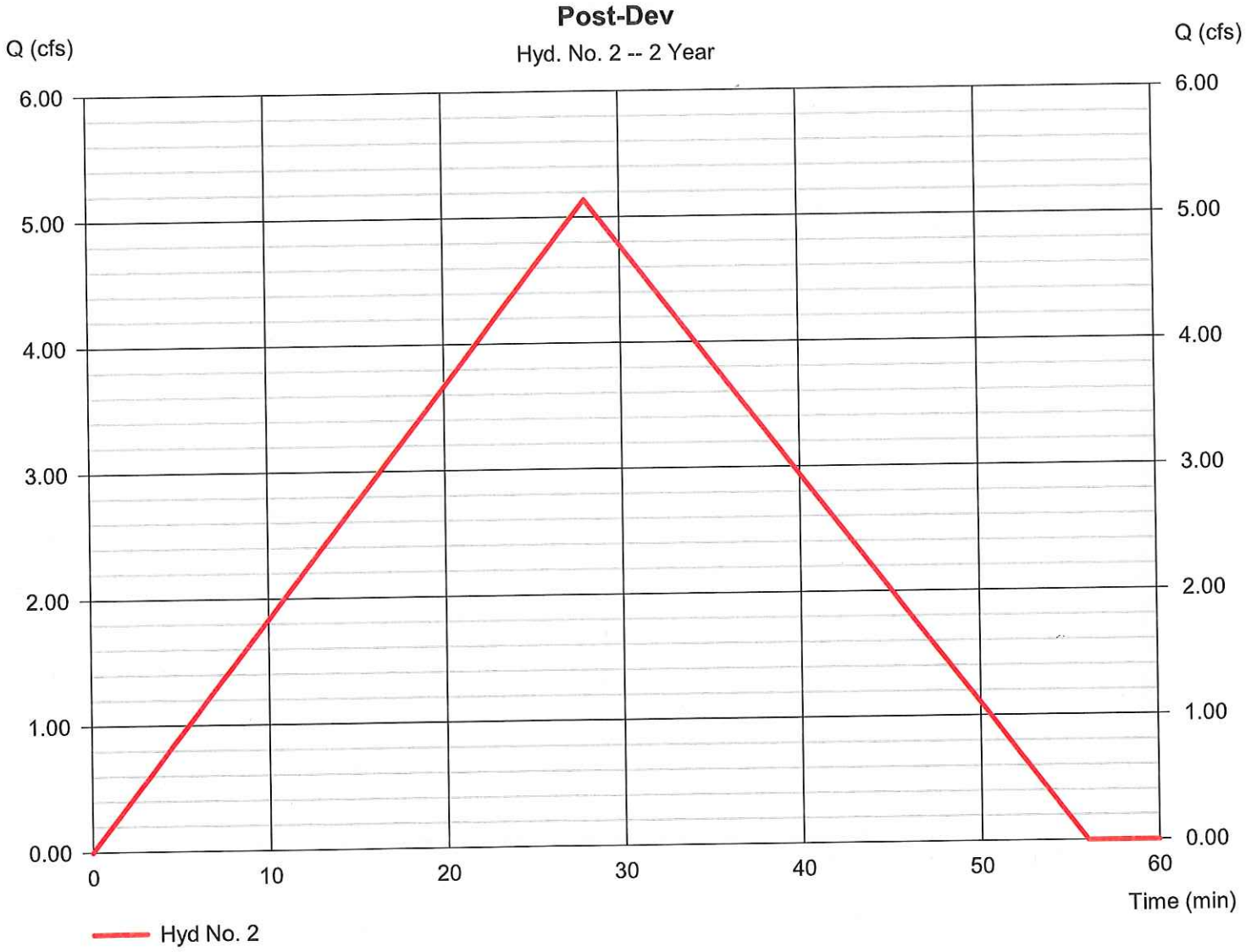
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Monday, 05 / 21 / 2018

Hyd. No. 2

Post-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 5.142 cfs
Storm frequency	= 2 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 8,638 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.51
Intensity	= 2.356 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

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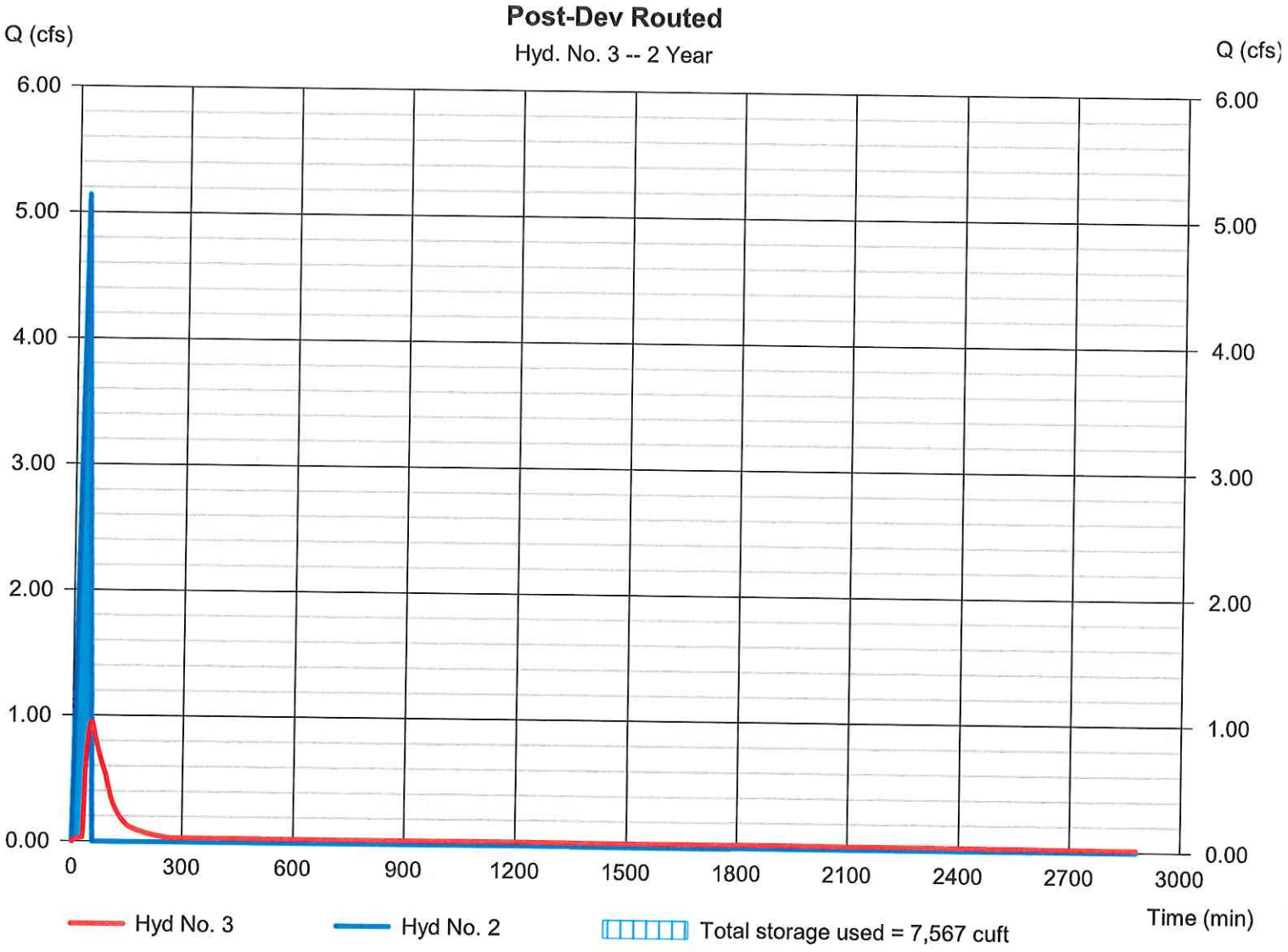
Monday, 05 / 21 / 2018

Hyd. No. 3

Post-Dev Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.955 cfs
Storm frequency	= 2 yrs	Time to peak	= 51 min
Time interval	= 1 min	Hyd. volume	= 8,470 cuft
Inflow hyd. No.	= 2 - Post-Dev	Max. Elevation	= 604.15 ft
Reservoir name	= APTech Pond 1	Max. Storage	= 7,567 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

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	Mod. Rational	3.579	1	28	6,012	------	------	------	Pre-Dev
2	Mod. Rational	6.084	1	28	10,221	------	------	------	Post-Dev
3	Reservoir	1.296	1	50	10,036	2	604.25	8,692	Post-Dev Routed

Hydrograph Report

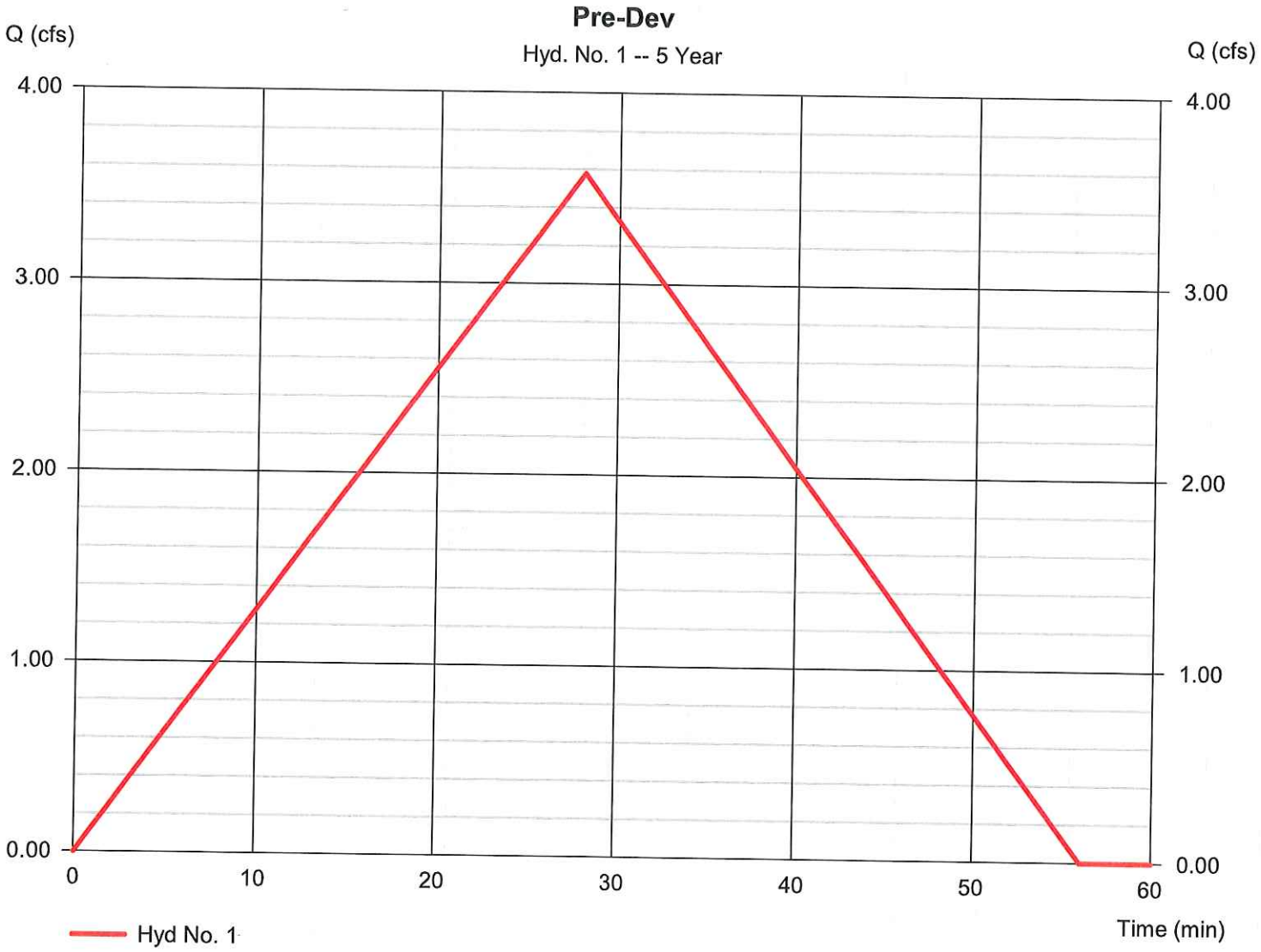
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 1

Pre-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 3.579 cfs
Storm frequency	= 5 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 6,012 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.3
Intensity	= 2.787 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a

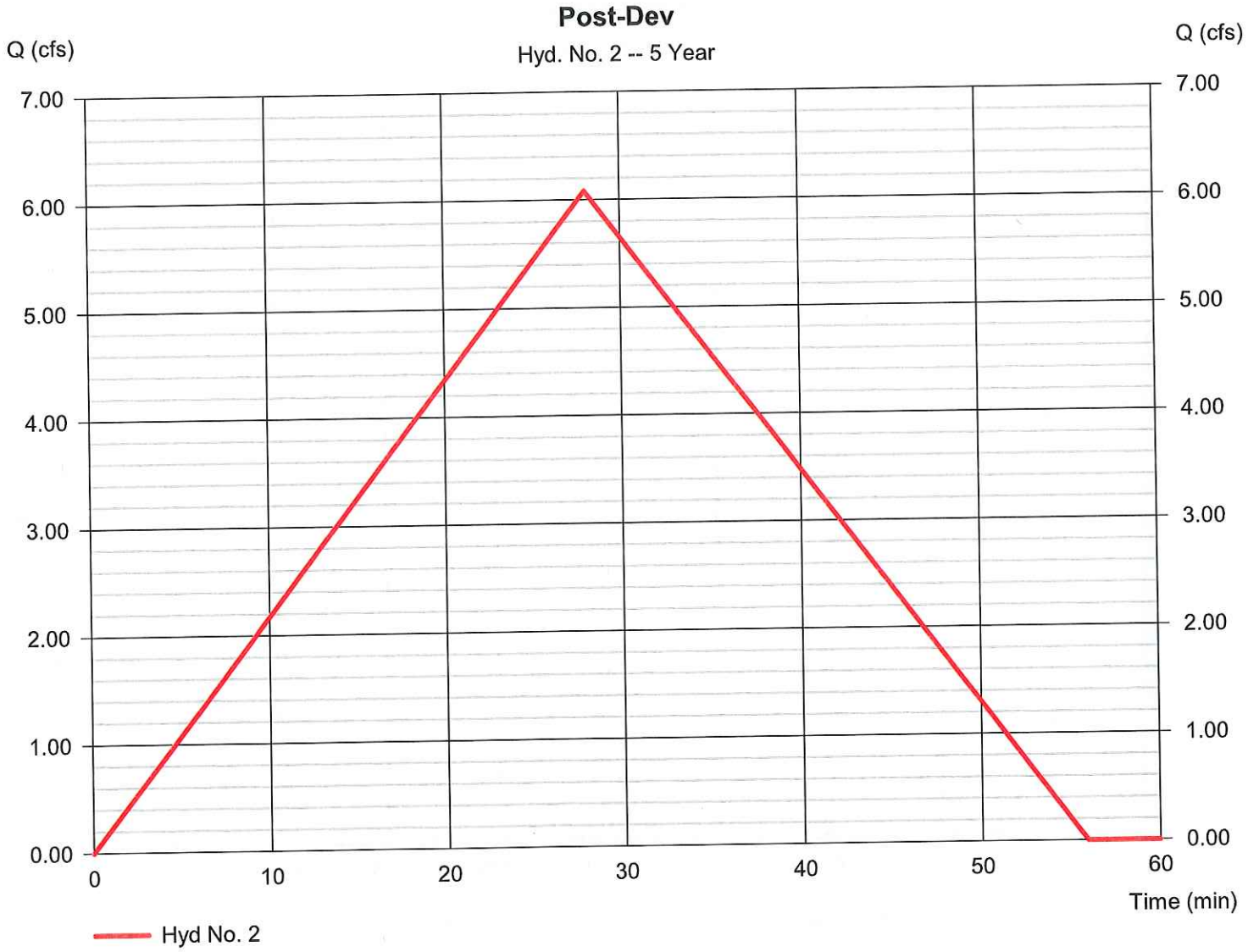


Hydrograph Report

Hyd. No. 2

Post-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 6.084 cfs
Storm frequency	= 5 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 10,221 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.51
Intensity	= 2.787 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

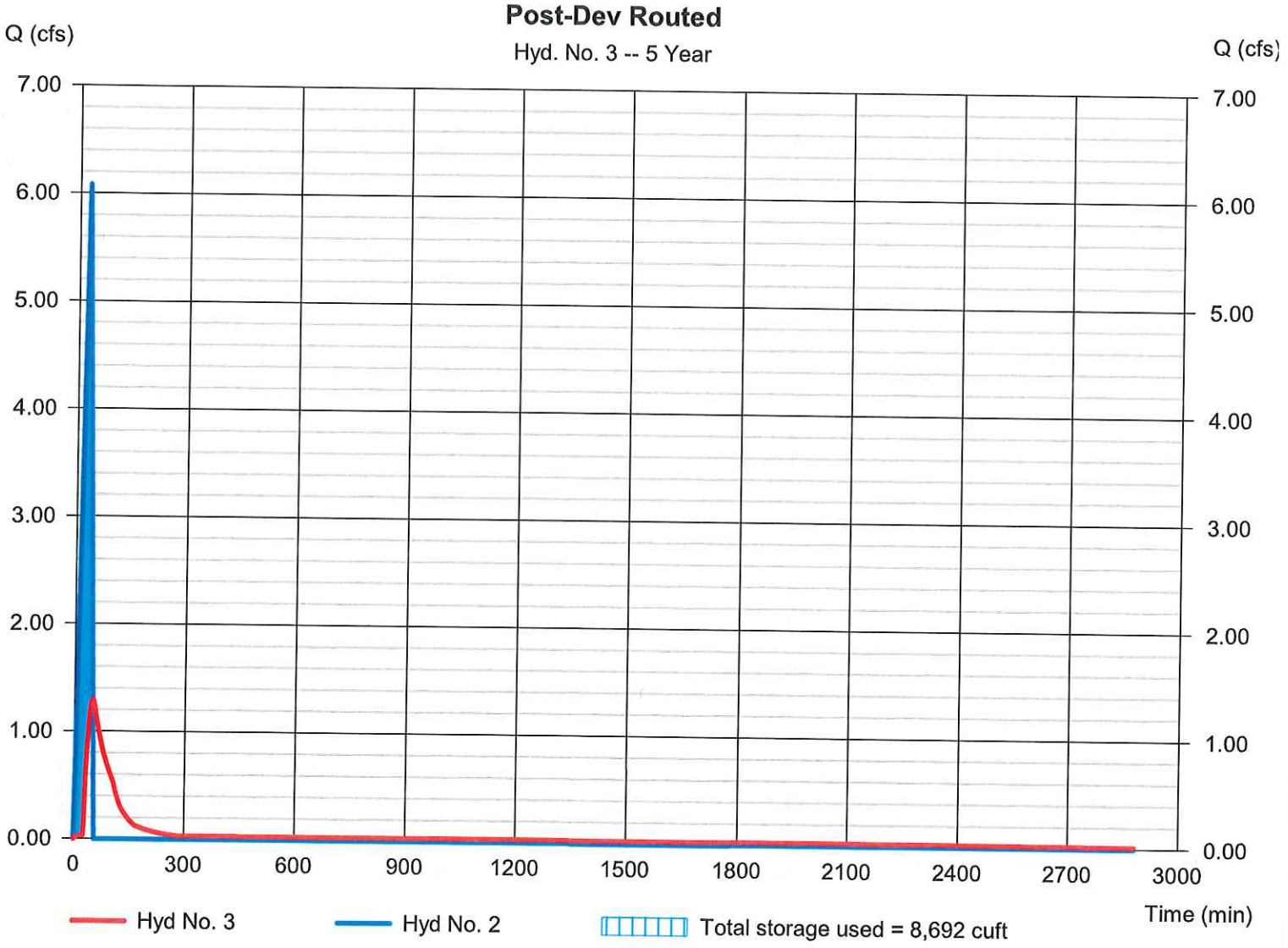
Monday, 05 / 21 / 2018

Hyd. No. 3

Post-Dev Routed

Hydrograph type	= Reservoir	Peak discharge	= 1.296 cfs
Storm frequency	= 5 yrs	Time to peak	= 50 min
Time interval	= 1 min	Hyd. volume	= 10,036 cuft
Inflow hyd. No.	= 2 - Post-Dev	Max. Elevation	= 604.25 ft
Reservoir name	= APTech Pond 1	Max. Storage	= 8,692 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

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	Mod. Rational	4.280	1	28	7,190	------	------	------	Pre-Dev
2	Mod. Rational	7.276	1	28	12,224	------	------	------	Post-Dev
3	Reservoir	1.758	1	49	12,023	2	604.38	10,071	Post-Dev Routed

Hydrograph Report

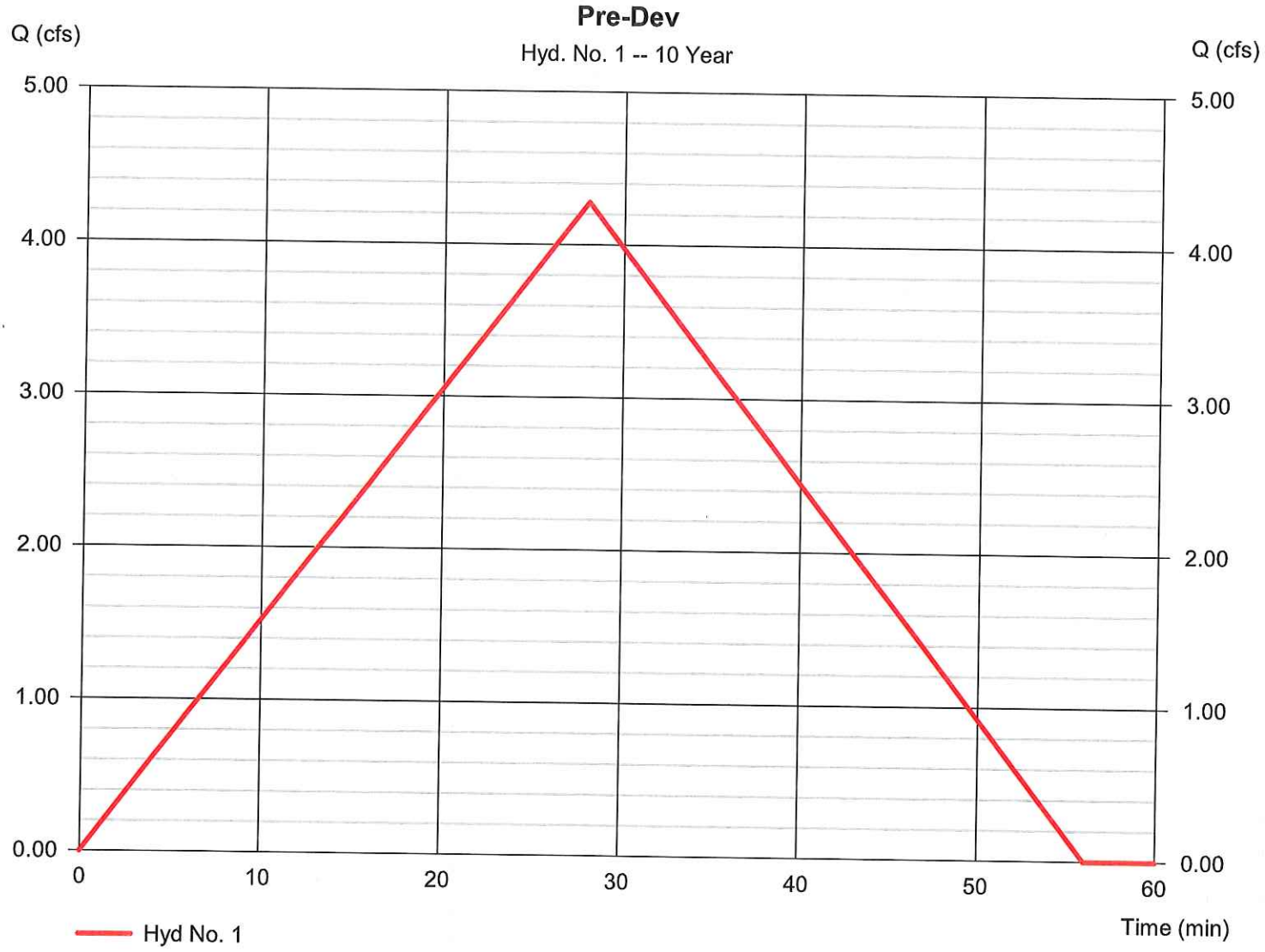
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 1

Pre-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 4.280 cfs
Storm frequency	= 10 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 7,190 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.3
Intensity	= 3.333 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



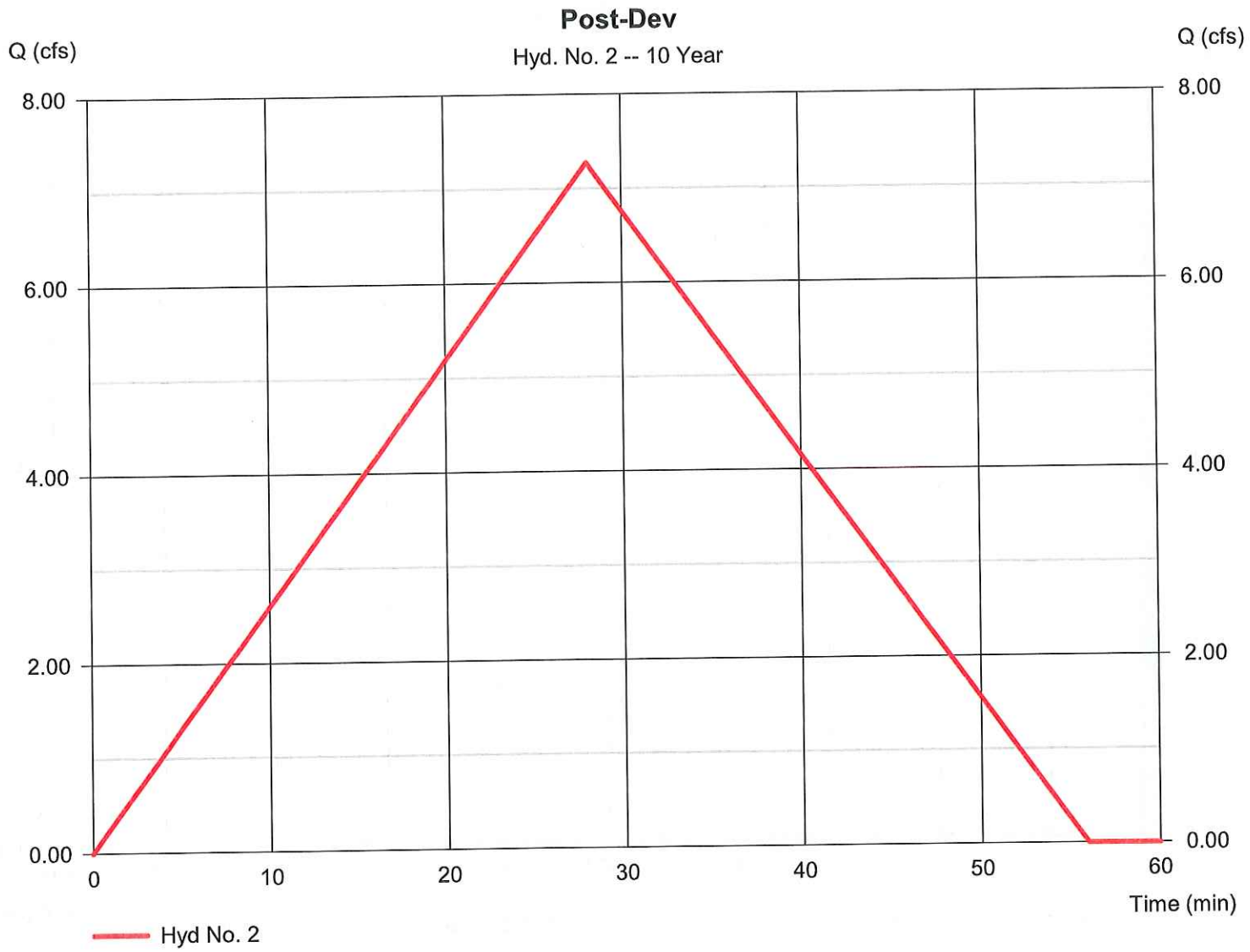
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 — Monday, 05 / 21 / 2018

Hyd. No. 2

Post-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 7.276 cfs
Storm frequency	= 10 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 12,224 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.51
Intensity	= 3.333 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

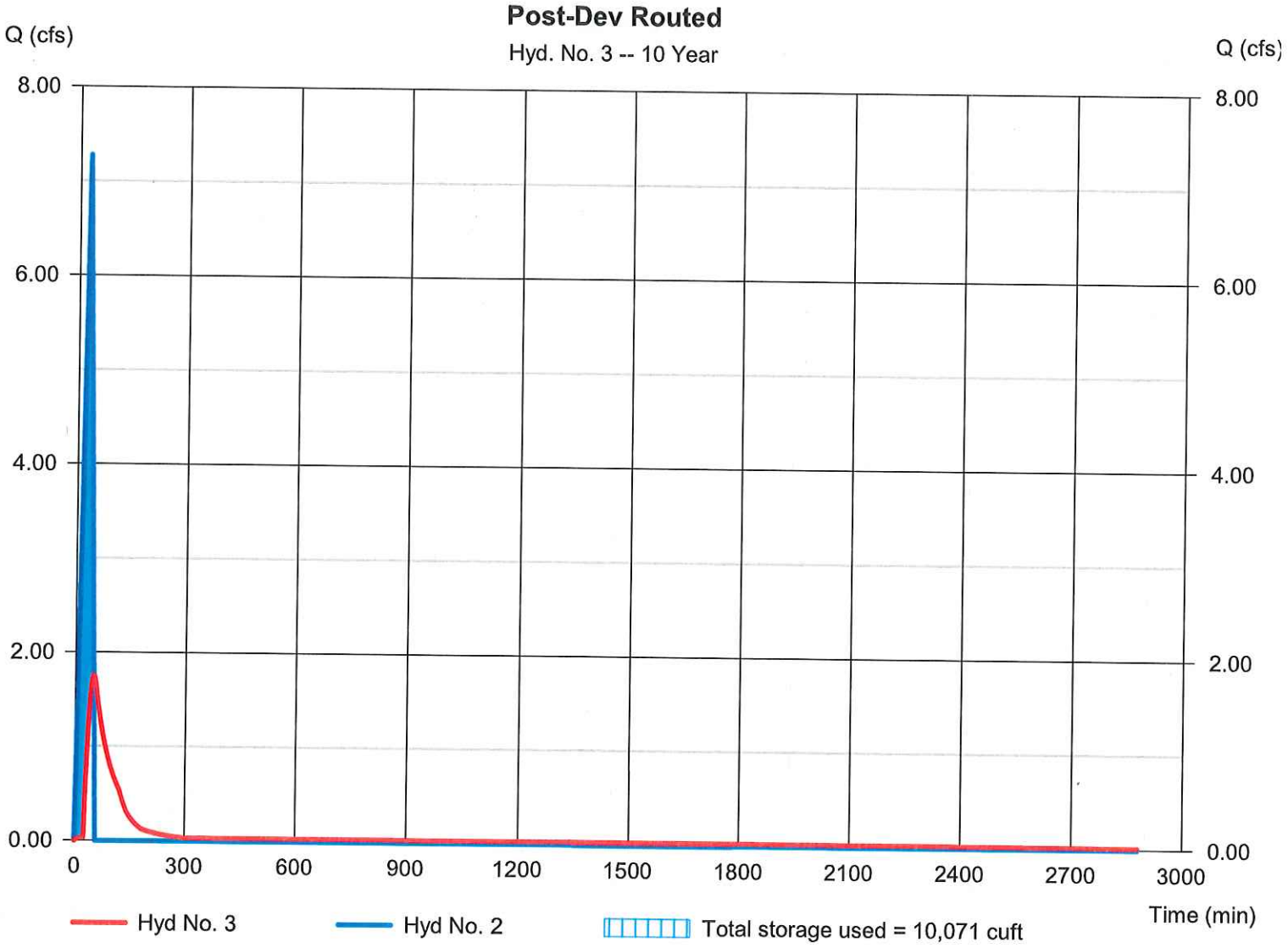
Monday, 05 / 21 / 2018

Hyd. No. 3

Post-Dev Routed

Hydrograph type	= Reservoir	Peak discharge	= 1.758 cfs
Storm frequency	= 10 yrs	Time to peak	= 49 min
Time interval	= 1 min	Hyd. volume	= 12,023 cuft
Inflow hyd. No.	= 2 - Post-Dev	Max. Elevation	= 604.38 ft
Reservoir name	= APTech Pond 1	Max. Storage	= 10,071 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

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	Mod. Rational	5.092	1	28	8,554	------	------	------	Pre-Dev
2	Mod. Rational	8.656	1	28	14,542	------	------	------	Post-Dev
3	Reservoir	2.332	1	48	14,329	2	604.53	11,610	Post-Dev Routed

Hydrograph Report

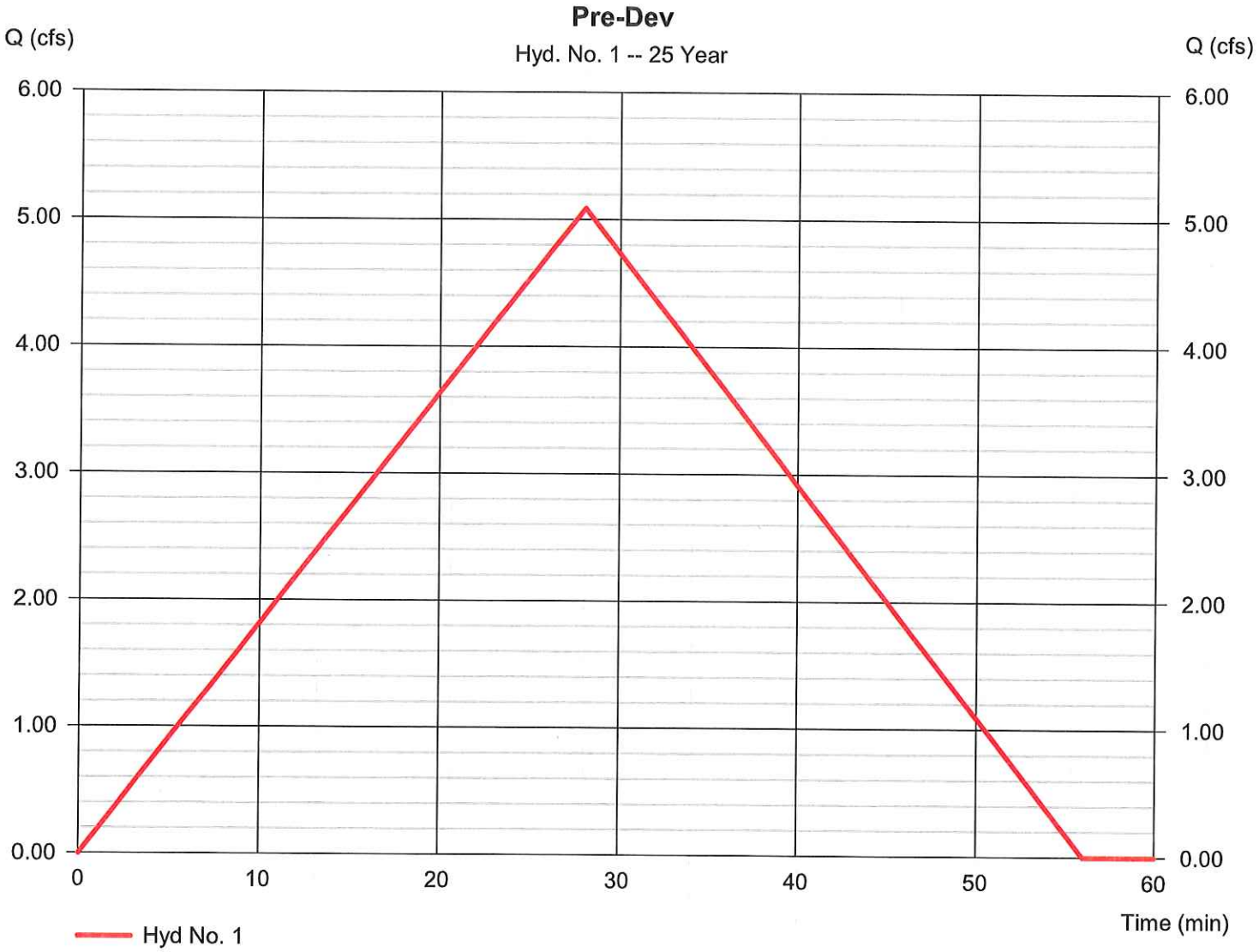
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 1

Pre-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 5.092 cfs
Storm frequency	= 25 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 8,554 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.3
Intensity	= 3.966 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a

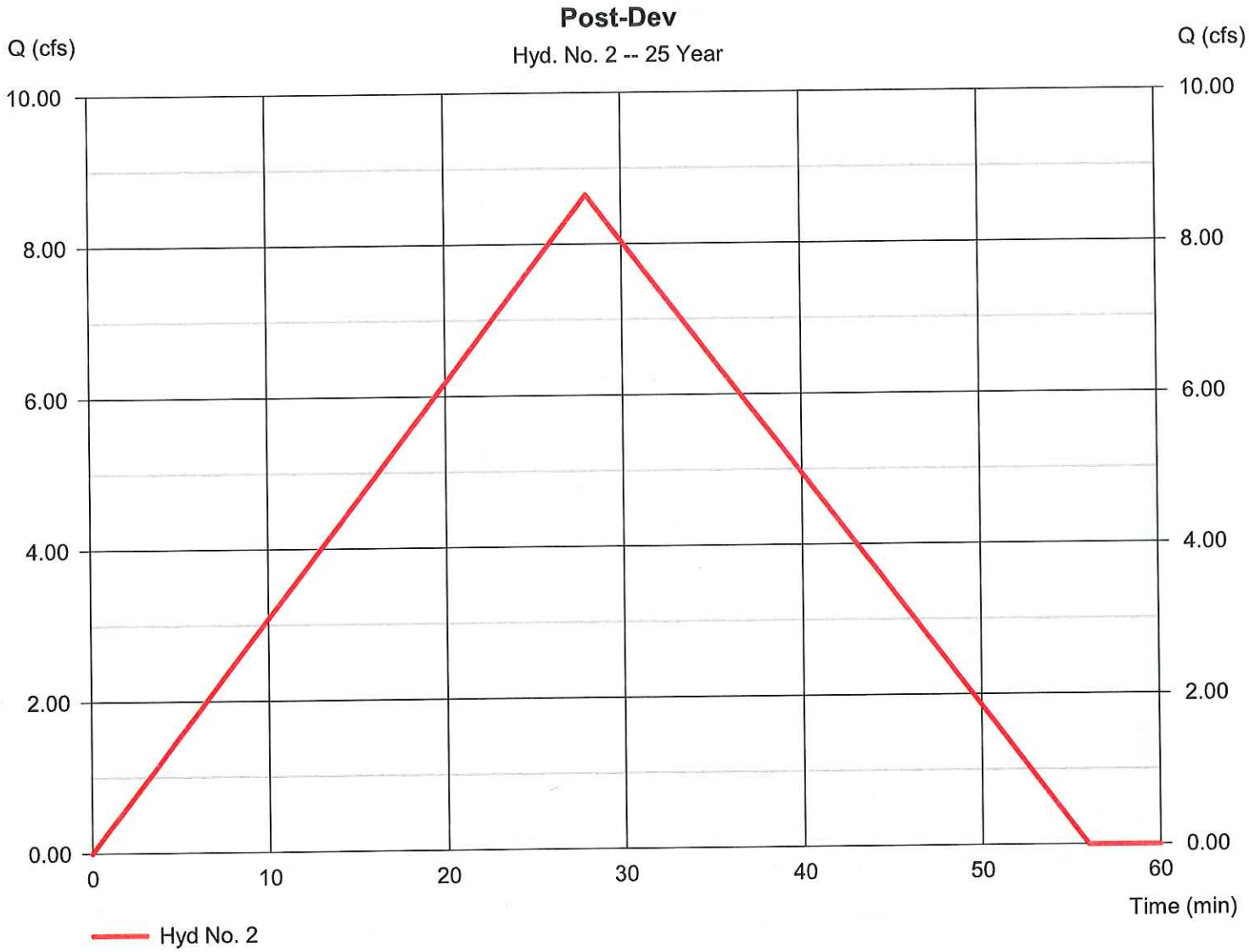


Hydrograph Report

Hyd. No. 2

Post-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 8.656 cfs
Storm frequency	= 25 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 14,542 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.51
Intensity	= 3.966 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

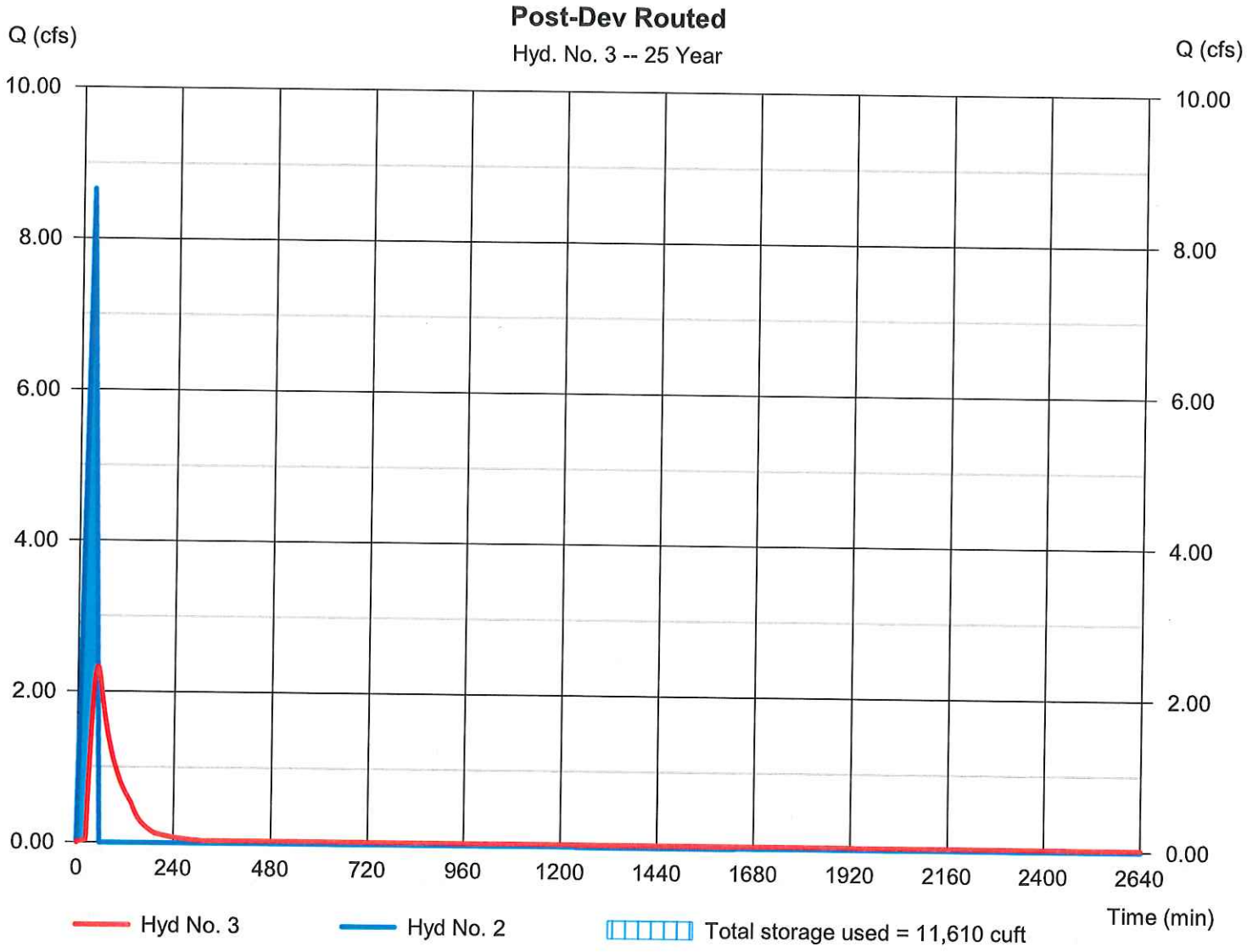
Monday, 05 / 21 / 2018

Hyd. No. 3

Post-Dev Routed

Hydrograph type	= Reservoir	Peak discharge	= 2.332 cfs
Storm frequency	= 25 yrs	Time to peak	= 48 min
Time interval	= 1 min	Hyd. volume	= 14,329 cuft
Inflow hyd. No.	= 2 - Post-Dev	Max. Elevation	= 604.53 ft
Reservoir name	= APTech Pond 1	Max. Storage	= 11,610 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

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	Mod. Rational	5.836	1	28	9,805	------	------	------	Pre-Dev
2	Mod. Rational	9.922	1	28	16,669	------	------	------	Post-Dev
3	Reservoir	2.886	1	48	16,446	2	604.65	12,980	Post-Dev Routed

Hydrograph Report

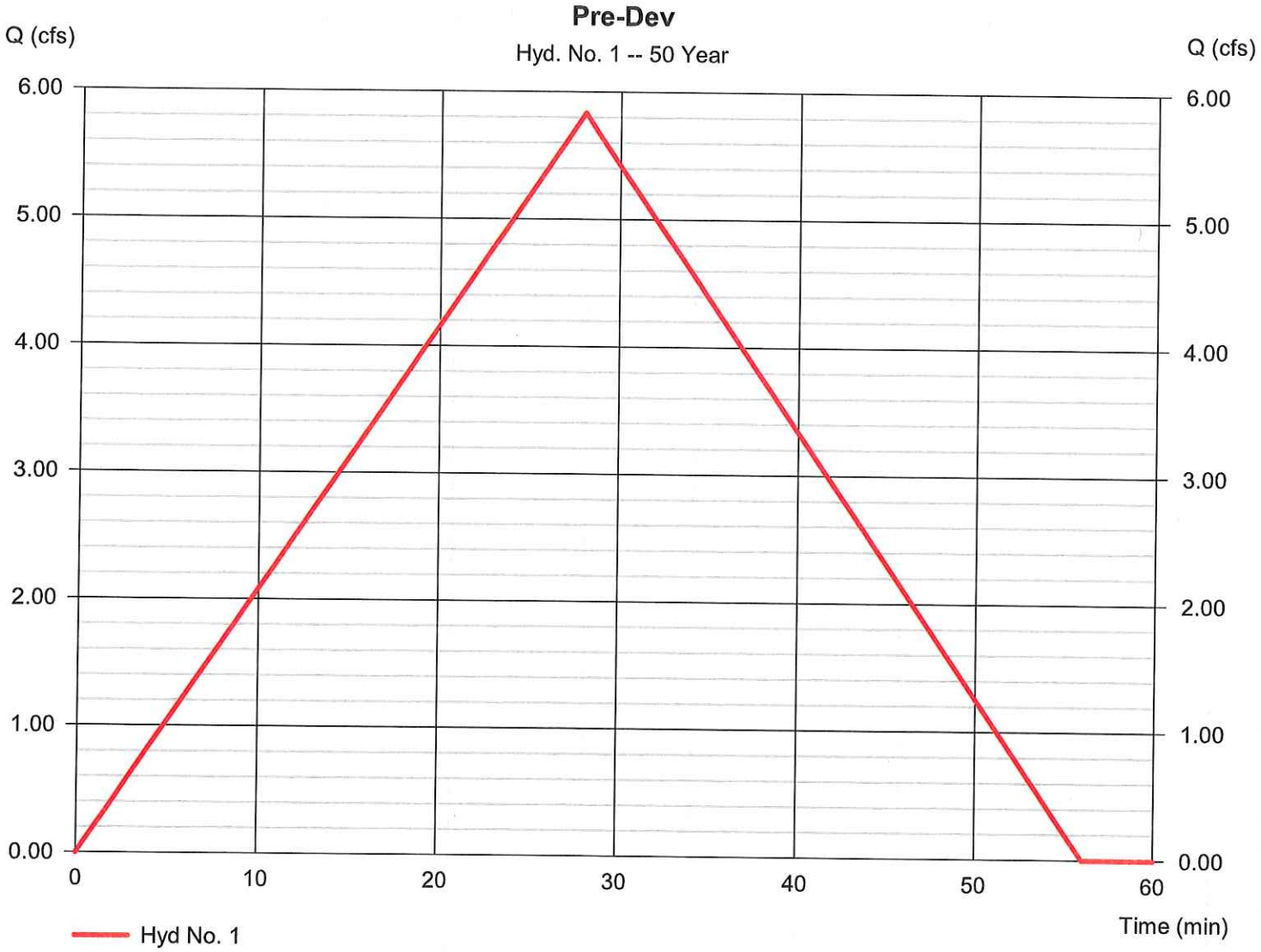
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 1

Pre-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 5.836 cfs
Storm frequency	= 50 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 9,805 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.3
Intensity	= 4.545 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

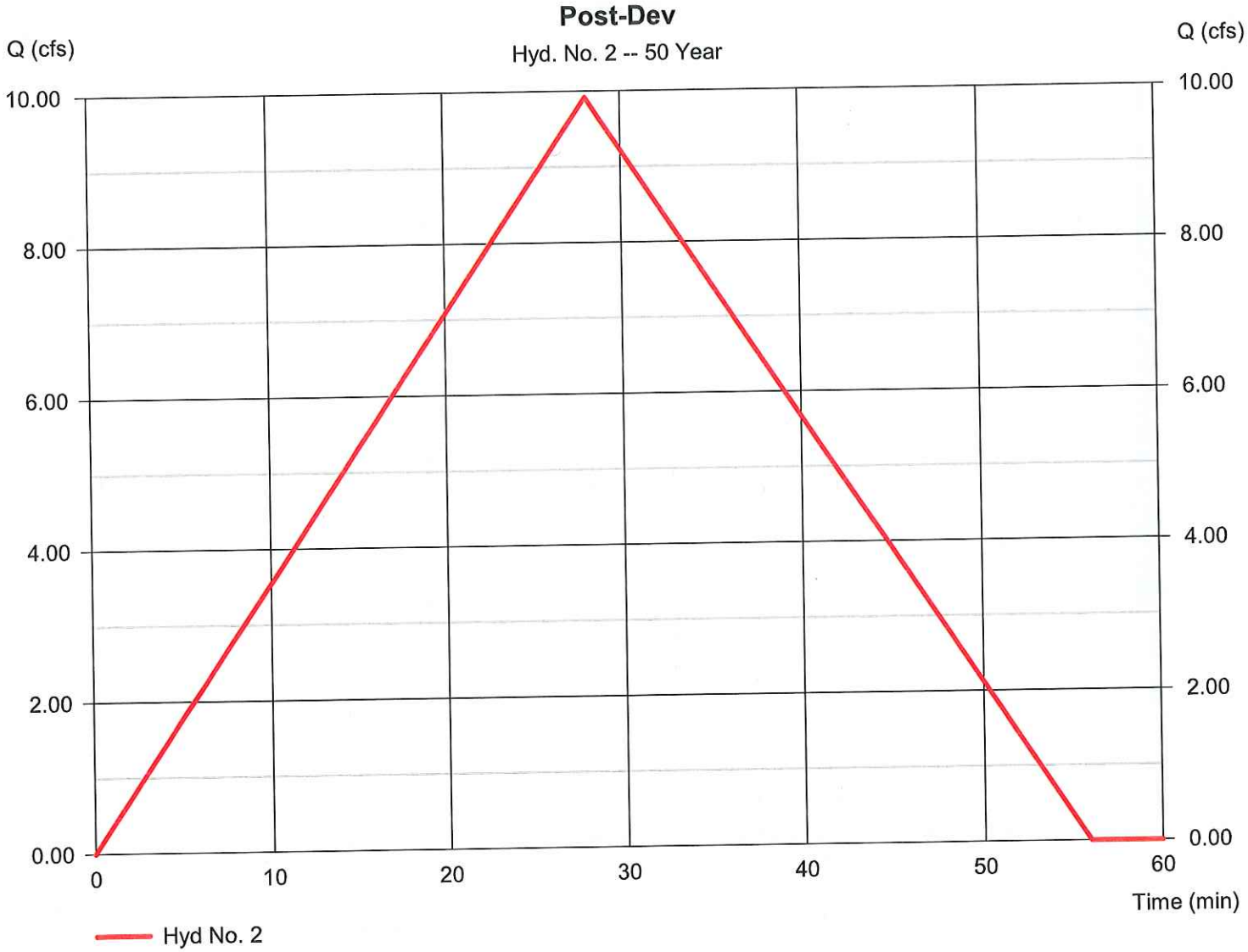
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 2

Post-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 9.922 cfs
Storm frequency	= 50 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 16,669 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.51
Intensity	= 4.545 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a

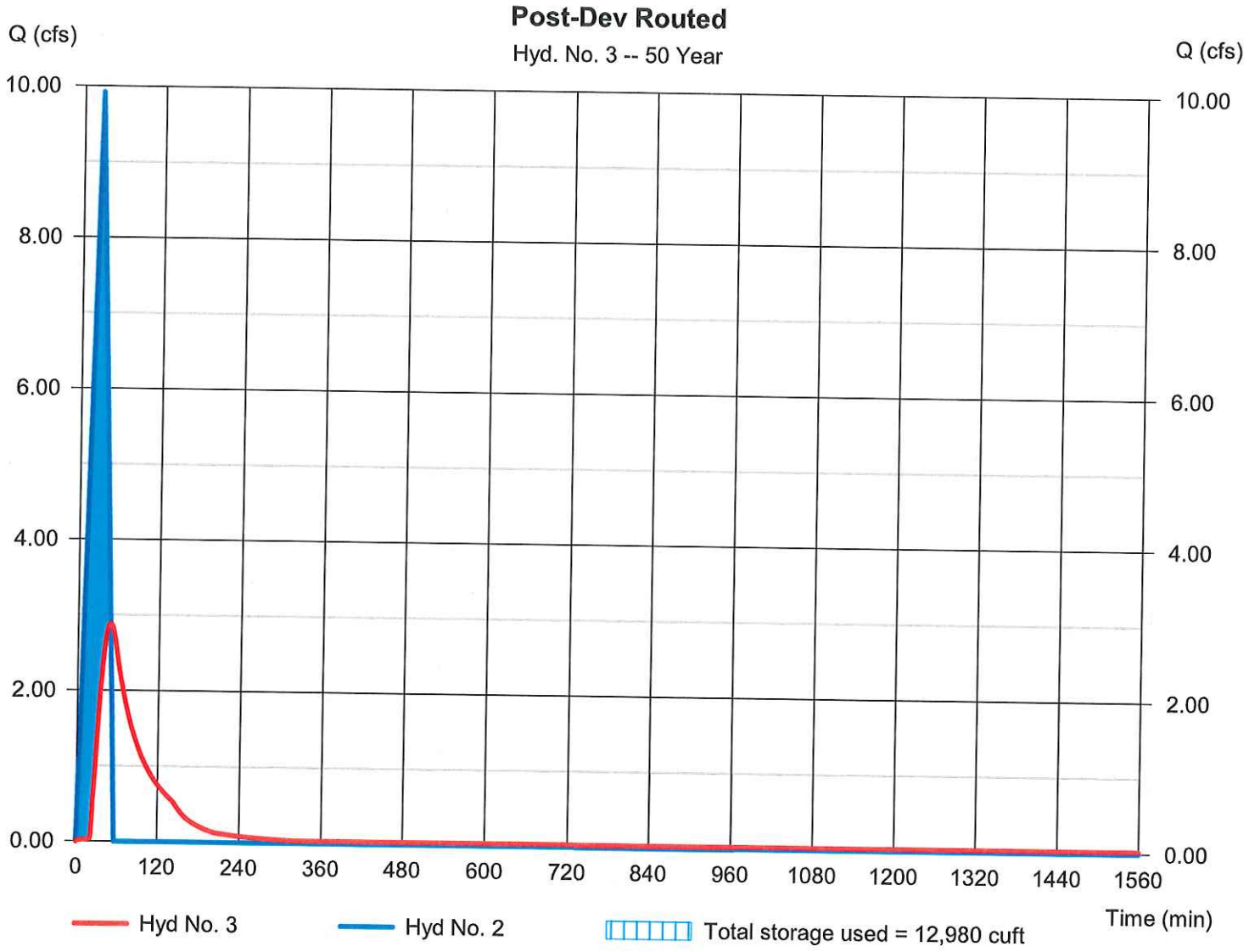


Hyd. No. 3

Post-Dev Routed

Hydrograph type	= Reservoir	Peak discharge	= 2.886 cfs
Storm frequency	= 50 yrs	Time to peak	= 48 min
Time interval	= 1 min	Hyd. volume	= 16,446 cuft
Inflow hyd. No.	= 2 - Post-Dev	Max. Elevation	= 604.65 ft
Reservoir name	= APTech Pond 1	Max. Storage	= 12,980 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

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	Mod. Rational	6.311	1	28	10,603	------	------	------	Pre-Dev
2	Mod. Rational	10.73	1	28	18,025	------	------	------	Post-Dev
3	Reservoir	3.249	1	48	17,797	2	604.73	13,832	Post-Dev Routed

Hydrograph Report

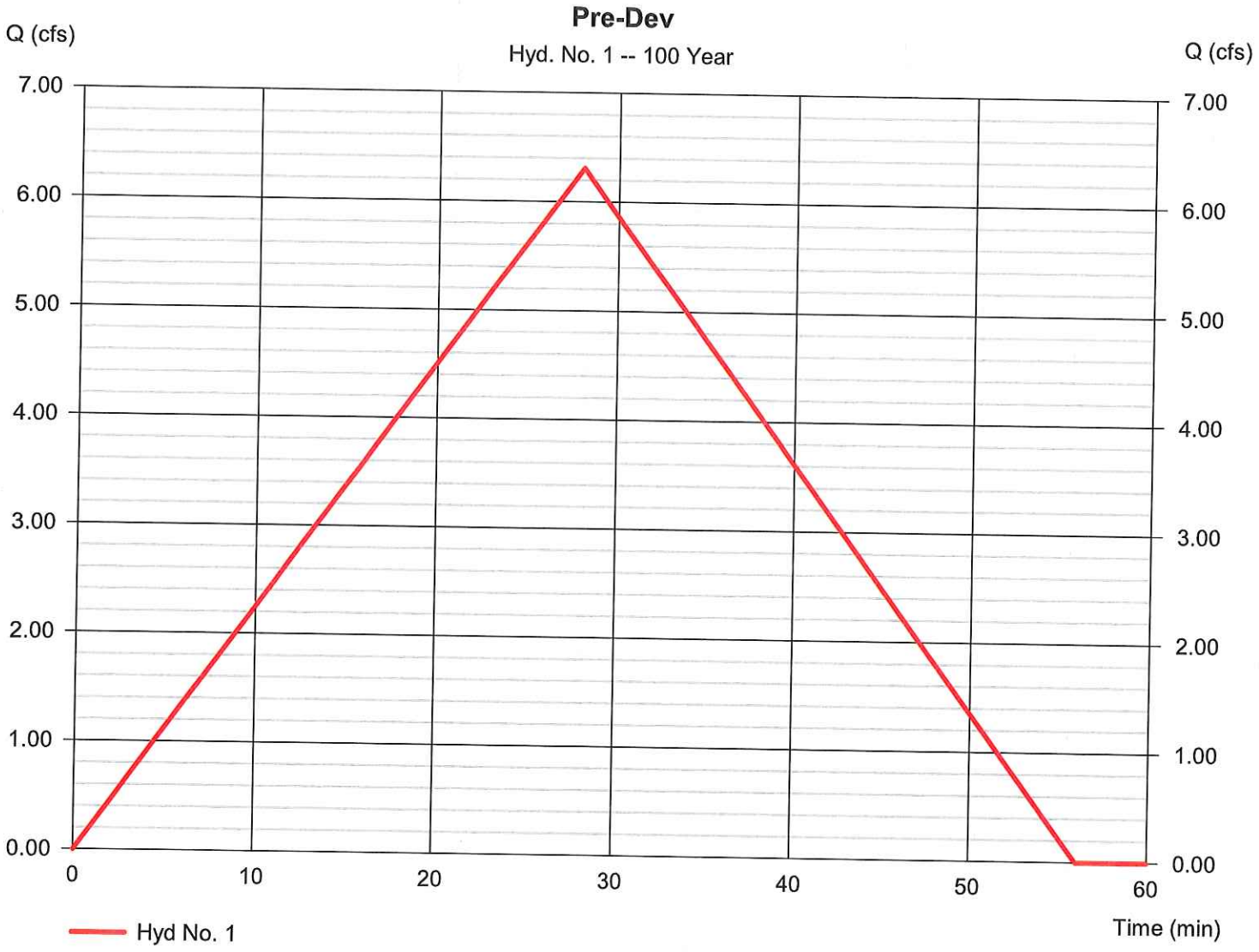
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 1

Pre-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 6.311 cfs
Storm frequency	= 100 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 10,603 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.3
Intensity	= 4.915 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

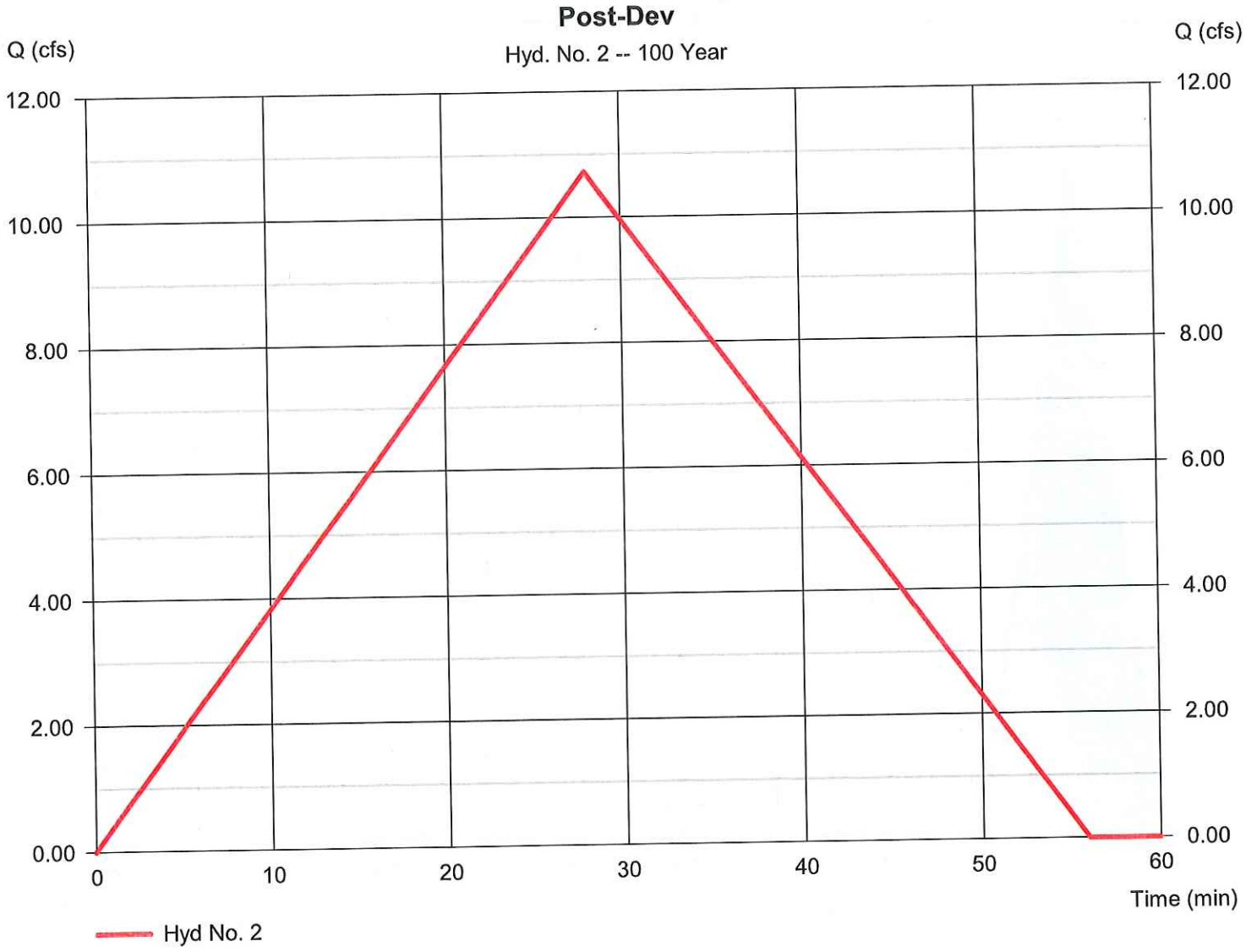
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Monday, 05 / 21 / 2018

Hyd. No. 2

Post-Dev

Hydrograph type	= Mod. Rational	Peak discharge	= 10.73 cfs
Storm frequency	= 100 yrs	Time to peak	= 28 min
Time interval	= 1 min	Hyd. volume	= 18,025 cuft
Drainage area	= 4.280 ac	Runoff coeff.	= 0.51
Intensity	= 4.915 in/hr	Tc by User	= 28.00 min
IDF Curve	= butler county.IDF	Storm duration	= 1.0 x Tc
Target Q	=n/a	Est. Req'd Storage	=n/a



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

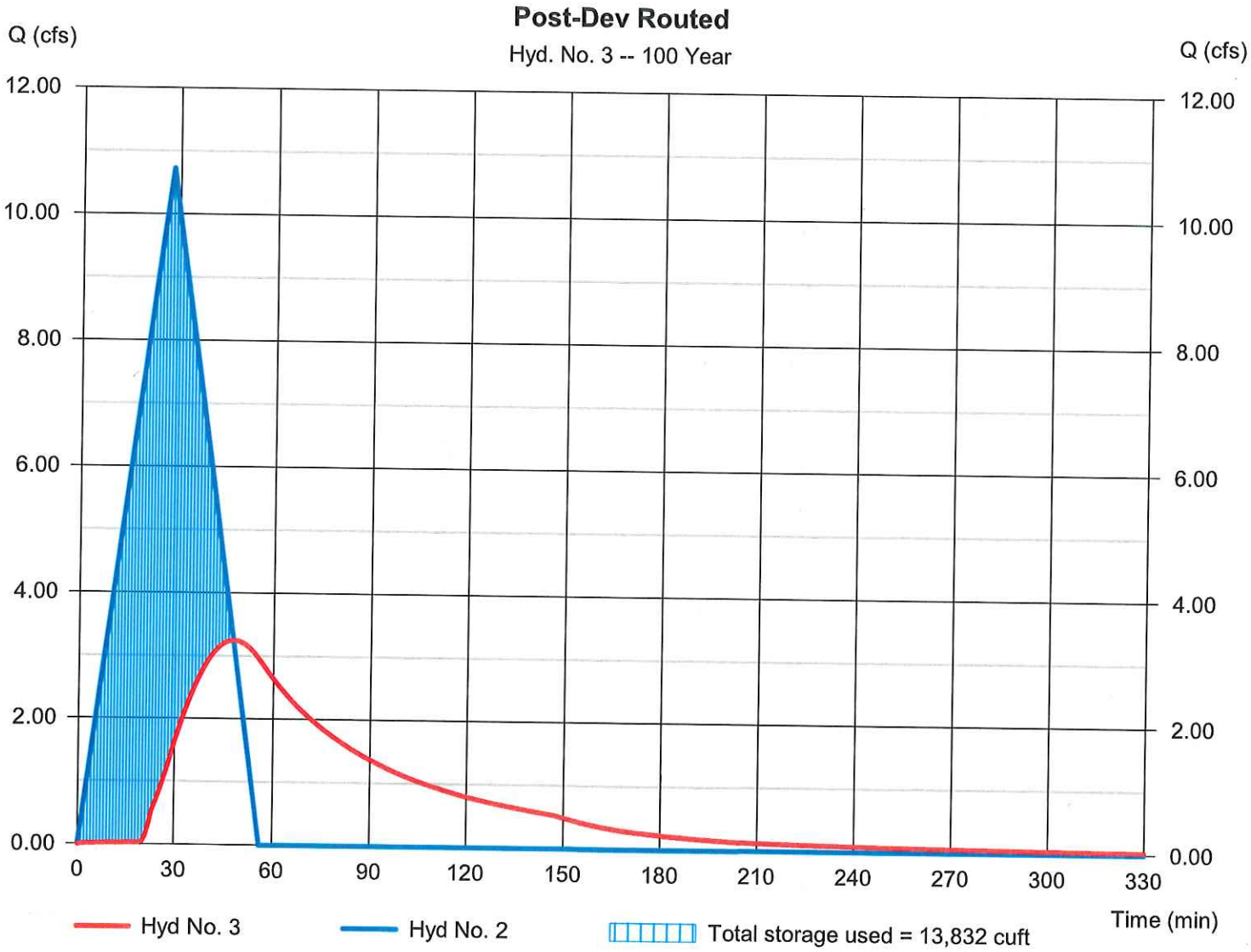
Monday, 05 / 21 / 2018

Hyd. No. 3

Post-Dev Routed

Hydrograph type	= Reservoir	Peak discharge	= 3.249 cfs
Storm frequency	= 100 yrs	Time to peak	= 48 min
Time interval	= 1 min	Hyd. volume	= 17,797 cuft
Inflow hyd. No.	= 2 - Post-Dev	Max. Elevation	= 604.73 ft
Reservoir name	= APTech Pond 1	Max. Storage	= 13,832 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	80.0000	14.0000	1.0000	--------
2	106.0000	17.0000	1.0000	--------
3	0.0000	0.0000	1.0000	--------
5	131.0000	19.0000	1.0000	--------
10	170.0000	23.0000	1.0000	--------
25	230.0000	30.0000	1.0000	--------
50	250.0000	27.0000	1.0000	--------
100	290.0000	31.0000	1.0000	--------

File name: butler county.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.21	3.33	2.76	2.35	2.05	1.82	1.63	1.48	1.36	1.25	1.16	1.08
2	4.82	3.93	3.31	2.86	2.52	2.26	2.04	1.86	1.71	1.58	1.47	1.38
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	5.46	4.52	3.85	3.36	2.98	2.67	2.43	2.22	2.05	1.90	1.77	1.66
10	6.07	5.15	4.47	3.95	3.54	3.21	2.93	2.70	2.50	2.33	2.18	2.05
25	6.57	5.75	5.11	4.60	4.18	3.83	3.54	3.29	3.07	2.88	2.71	2.56
50	7.81	6.76	5.95	5.32	4.81	4.39	4.03	3.73	3.47	3.25	3.05	2.87
100	8.06	7.07	6.30	5.69	5.18	4.75	4.39	4.08	3.82	3.58	3.37	3.19

Tc = time in minutes. Values may exceed 60.

Precip. file name: S:\Land Projects 2008\Warren County GIS\Hydro\Warren County-total rainfall.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00