STORMWATER CALCULATIONS

Vertex Rail and Site Improvements
Phase 1

Vertex Property

Vertex Railcar Corporation
202 Raleigh Street
Wilmington, NC 28412

October 2015

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NC License No. F-0374

STORMWATER MANAGEMENT PERMIT APPLICATION FORM
401 CERTIFICATION APPLICATION FORM

WET DETENTION BASIN SUPPLEMENT

This form must be filled out, printed and submitted.
The Required Items Checklist (Part III) must be printed, filled out and submitted along with all of the required information.

I. PROJECT INFORMATION

Project name	Vertex Rail and Site Improvements Phase 1
Contact person	Daniel E. Dawson, PE
Phone number	910.762.4200
Date	10/1/2015
Drainage area number	1

II. DESIGN INFORMATION

Site Characteristics

Drainage area	453,250	ft^2
Impervious area, post-development	263,793	ft^2
% impervious	58.20	%
Design rainfall depth	1.5	in

Storage Volume: Non-SA Waters

Minimum volume required	32,510	ft^3	OK
Volume provided	33,134	ft^3	OK, volume provided is equal to or in excess of volume required.

Storage Volume: SA Waters

1.5" runoff volume		ft^3
Pre-development 1-yr, 24-hr runoff		ft^3
Post-development 1-yr, 24-hr runoff		ft^3
Minimum volume required		ft^3
Volume provided		ft^3

Peak Flow Calculations

Is the pre/post control of the 1yr 24hr storm peak flow required?	Y	(Y or N)
1-yr, 24-hr rainfall depth	3.86	in
Rational C, pre-development	N/A	(unitless)
Rational C, post-development		(unitless)
Rainfall intensity: 1-yr, 24-hr storm		in/hr
Pre-development 1-yr, 24-hr peak flow	25.66	ft^3/sec
Post-development 1-yr, 24-hr peak flow	26.61	ft^3/sec
Pre/Post 1-yr, 24-hr peak flow control	0.95	ft^3/sec

Elevations

Temporary pool elevation	41.40	fmsl
Permanent pool elevation	40.20	fmsl
SHWT elevation (approx. at the perm. pool elevation)	40.20	fmsl
Top of 10ft vegetated shelf elevation	40.70	fmsl
Bottom of 10ft vegetated shelf elevation	39.70	fmsl
Sediment cleanout, top elevation (bottom of pond)	34.00	fmsl
Sediment cleanout, bottom elevation	33.00	fmsl
Sediment storage provided	1.00	ft
Is there additional volume stored above the state-required temp. pool?	N	(Y or N)
Elevation of the top of the additional volume		fmsl

II. DESIGN INFORMATION

Surface Areas

Area, temporary pool	29,454 ft^2	
Area REQUIRED, permanent pool	20,850 ft^2	
SA/DA ratio	4.60 (unitless)	
Area PROVIDED, permanent pool, A$_{perm\_pool}$	24,331 ft^2	OK
Area, bottom of 10ft vegetated shelf, A$_{bot\_shelf}$	19,141 ft^2	
Area, sediment cleanout, top elevation (bottom of pond), A$_{bot\_pond}$	7,118 ft^2	

Volumes

Volume, temporary pool	33,134 ft^3	OK
Volume, permanent pool, V$_{perm\_pool}$	83,897 ft^3	
Volume, forebay (sum of forebays if more than one forebay)	19,013 ft^3	
Forebay % of permanent pool volume	22.7% %	Insufficient forebay volume.

SA/DA Table Data

Design TSS removal	90 %	
Coastal SA/DA Table Used?	Y	(Y or N)
Mountain/Piedmont SA/DA Table Used?	N	(Y or N)
SA/DA ratio	4.60 (unitless)	
Average depth (used in SA/DA table):		
Calculation option 1 used? (See Figure 10-2b)		(Y or N)
Volume, permanent pool, V$_{perm\_pool}$	ft^3	
Area provided, permanent pool, A$_{perm\_pool}$	ft^2	
Average depth calculated	ft	Need 3 ft min.
Average depth used in SA/DA, d$_{av}$, (Round to nearest 0.5ft)	ft	
Calculation option 2 used? (See Figure 10-2b)	Y	(Y or N)
Area provided, permanent pool, A$_{perm\_pool}$	24,331 ft^2	
Area, bottom of 10ft vegetated shelf, A$_{bot\_shelf}$	19,141 ft^2	
Area, sediment cleanout, top elevation (bottom of pond), A$_{bot\_pond}$	7,118 ft^2	
"Depth" (distance b/w bottom of 10ft shelf and top of sediment)	5.70 ft	
Average depth calculated	4.36 ft	OK
Average depth used in SA/DA, d$_{av}$, (Round to nearest 0.5ft)	4.5 ft	OK

Drawdown Calculations

Drawdown through orifice?	Y	(Y or N)
Diameter of orifice (if circular)	2.50 in	
Area of orifice (if-non-circular)	in^2	
Coefficient of discharge (C$_D$)	0.60 (unitless)	
Driving head (H$_o$)	1.10 ft	
Drawdown through weir?	N	(Y or N)
Weir type	(unitless)	
Coefficient of discharge (C$_w$)	(unitless)	
Length of weir (L)	ft	
Driving head (H)	ft	
Pre-development 1-yr, 24-hr peak flow	25.66 ft^3/sec	
Post-development 1-yr, 24-hr peak flow	26.61 ft^3/sec	
Storage volume discharge rate (through discharge orifice or weir)	0.18 ft^3/sec	
Storage volume drawdown time	2.10 days	OK, draws down in 2-5 days.

Additional Information

Vegetated side slopes	3 :1	OK
Vegetated shelf slope	10 :1	OK
Vegetated shelf width	10.0 ft	OK
Length of flowpath to width ratio	3 :1	OK
Length to width ratio	2.8 :1	OK
Trash rack for overflow & orifice?	Y	(Y or N) OK
Freeboard provided	1.0 ft	OK
Vegetated filter provided?	N	(Y or N) OK
Recorded drainage easement provided?	Y	(Y or N) OK
Capures all runoff at ultimate build-out?	Y	(Y or N) OK
Drain mechanism for maintenance or emergencies is:	Pump	

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VERTEX PHASE 1 – WET DETENTION POND #1

AREA DRAINING TO POND = 453,250 SF = 10.41 AC

IMPERVIOUS SURFACE AREA DRAINING TO POND:

IMPERVIOUS PAVEMENT	=	22,755 SF
SIDEWALK	=	0 SF
BUILDING	=	0 SF
OTHER	=	57,920 SF
FUTURE	=	68,724 SF
EXISTING IMPERVIOUS TO REMAIN	=	114,394 SF
TOTAL	=	263,793 SF

PERCENT IMPERVIOUS DRAINAGE AREA:

= (263,793 SF / 453,250 SF) x 100

= 58.2% **SAY 58%**

POND DEPTH (FT)	SA/DA %	POND SURFACE AREA (MIN.) (SF)
4.50	**4.6**	**20,850 SF**

IF POND DEPTH = 4.50, MINIMUM SURFACE AREA = 20,850 SF

USED 90% TSS REMOVAL EFFICIENT IN COASTAL REGION CHART TO SIZE POND

AREA @ ELEVATION 40.2 = 24,331 SF > 20,850 SF

REQUIRED STORAGE FOR FOREBAY: 20% OF TOTAL PERMANENT POOL VOLUME
= (0.2)(83,897)
= 16,779 CF (19,013 CF PROVIDED)

Pond Volume

	Contour Elevation	Area	Incremental Volume	Cumulative Volume
	(ft)	(sf)	(cf)	(cf)
Bottom Elevation	34.0	7118	0	0
Bottom of Shelf	39.7	19141	73056	73056
Permanent Pool	40.2	24331	10841	83897

Forebay Volume

	Contour Elevation	Area	Incremental Volume	Cumulative Volume
	(ft)	(sf)	(cf)	(cf)
Bottom Elevation	34.0	924	0	0
Bottom of Shelf	39.7	4805	16328	16328
Permanent Pool	40.2	5936	2685	19013

Forebay Volume is

22.7%

of Pond Volume

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REQUIRED STORAGE FOR 1.5-INCH OF RUNOFF FOR POND: (use Simple Method)

$$Volume = 3630*Rd*Rv*A$$

$$Rd = 1.5''$$

$$Rv = 0.05+0.9*I = 0.05 + 0.9(0.582) = 0.5738$$

$$A = 453,250 \ SF \ / \ 43,560 \ Acre/SF = 10.41 \ Acres$$

$$Volume = 3630*1.5''*0.5738*10.41 \ Acres$$

$$\mathbf{= 32,510 \ CF} \ (33,134 \ CF \ PROVIDED)$$

INFILTRATION BASIN DRAWDOWN CALCULATIONS

1 Design Event: 1.5" Volume per Schueler's Method =   32510 CF

2 Wet Detention Basin: Set Normal Bottom Elevation at SHW Elevation = 40.20

Contour Elevation	Area	Volume	Cumulative Volume
(FMSL)	(SF)	(CF)	(CF)
40.20	24331	0	0
40.70	27906	13048	13048
41.00	28566	8470	21518
42.00	30804	29675	51193
43.00	33097	31941	83134
44.00	35448	34262	117396

Water Surface Elevation for the 1.5" Volume =   41.4 EL

3 Wet Detention Basin Outlet:

          2.5 " diameter orifice

$$Q = Cd*A*sqrt(2gh) = (0.6)(\pi(d/(2*12))^2)(sqrt(64.4*h)$$

$$Q = (d^2/36.1)*sqrt(h) \quad cfs$$

4 Discharge from Wet Detention Pond to Infiltration Basin

Assume 1.5" Volume is Instantaneous

Orifice Head = h

h = 41.4-(40.2-((d/12)/2)) =   1.2-(d/24) =   1.1 in

Q =   0.18 cfs

Q = 0.18 cfs =   15,446 cf/day

Wet Detention Basin Release Time:

T = 1.5" Volume/Q (cf/day)

T =   2.10 days

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5 Infiltration Basin:

Bottom =   40.20 EL
Infiltration Rate =   30 in/hr

Contour Elevation (FMSL)	Area (SF)	Volume (CF)	Cumulative Volume (CF)
40.20	15695	0	0
41.00	17779	13379	13379
42.00	20437	19091	32470
43.00	23152	21778	54248
44.00	25924	24522	78770

6 Infiltration Basin Release & Storage

1st Hour:

1.5 Volume =	32510	CF
Detention Basin Release Rate =	0.18	cfs
Volume to Infiltration Basin =	644	CF/hr or CF/1st hr
WSE Infiltration Basin =	40.24	EL
Area at WSE =	15,795	SF

$Q_i = k(A)(h) = $ Q leaving the Infiltration Basin

$Q_i = $ 0.42 cfs

$Q_i = $ 0.42 cfs > Q =   0.18 cfs

1st 30 Minutes:

1.5 Volume =	32510	CF
Detention Basin Release Rate =	0.18	cfs
Volume to Infiltration Basin =	322	CF/30 mins
WSE Infiltration Basin =	40.22	EL
Area at WSE =	15,745	SF

$Q_i = k(A)(h) = $ Q leaving the Infiltration Basin

$Q_i = $ 0.21 cfs

$Q_i = $ 0.21 cfs > Q =   0.18 cfs

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Wet Detention Basin - Average Depth Calculation

Elevation at Bottom of Shelf	39.7
Elevation at Permanent Pool	40.2
Elevation at Bottom of Pond	34
Area Bottom of Shelf	19141
Area Permanent Pool	24331
Area Bottom of Pond	7118
Depth	5.7
Average Depth (1)	0.45
Average Depth (2)	3.91
Total Average Depth	4.36

Elevation	Area Main Pond	Area Forebay	Total Area
34	6194	924	7118
35	7490	1472	8962
36	8842	2076	10918
37	10250	2738	12988
38	11716	3455	15171
39	13237	4230	17467
39.7	14336	4805	19141
40.2	24331	0	24331
40.7	27906	0	27906
41	28566	0	28566
42	30804	0	30804
43	33097	0	33097
44	35448	0	35448
41.1	28787		
41.2	29009		
41.3	29231		
41.4	29454		

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan

DI-5

Pipe - 3

2

DI-4

Pipe - 2

1

Outfall

Outfall

Pipe - 4

4

DI-7

Outfall

Pipe - 1

3

DI-2
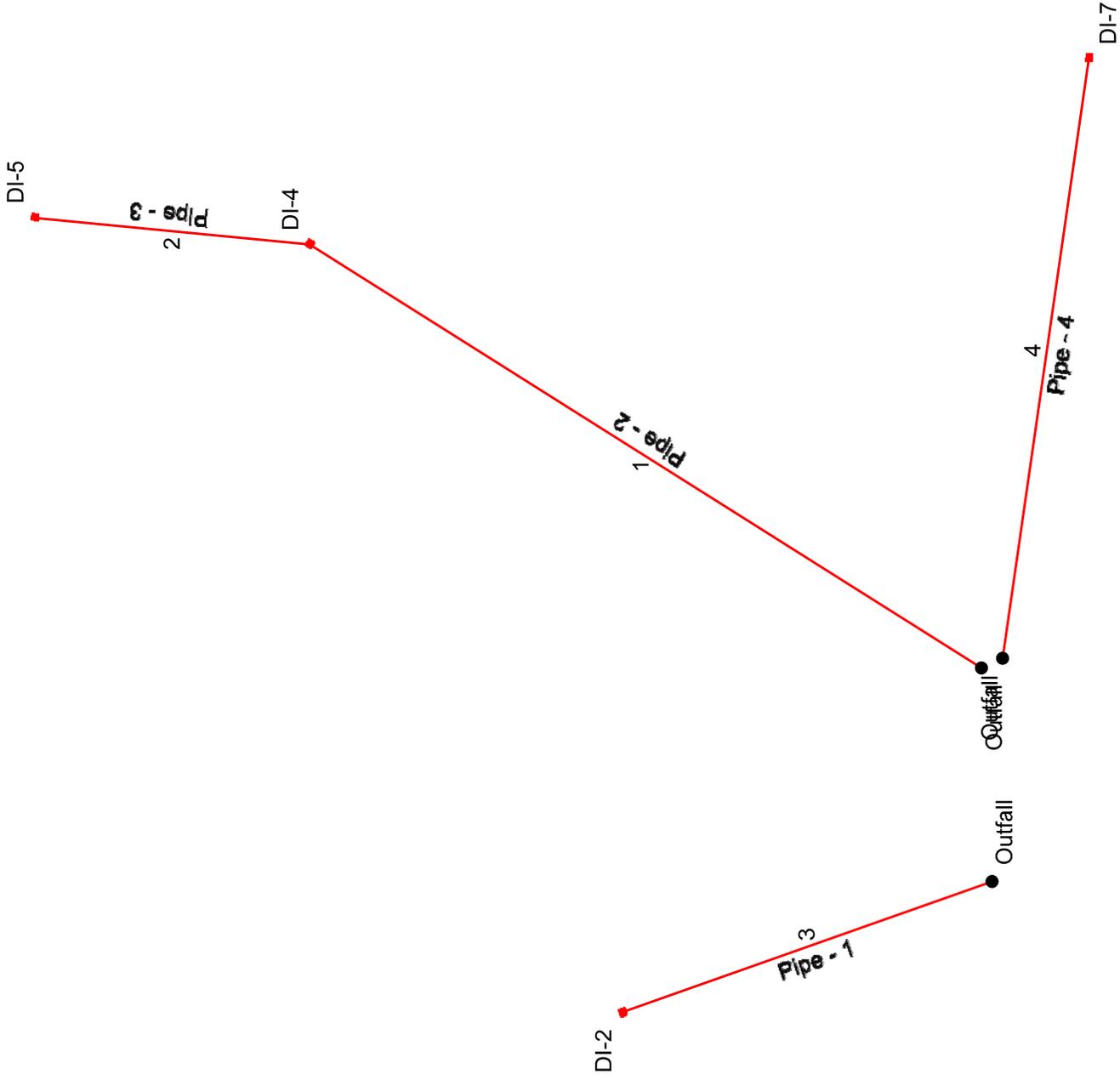
Storm Sewer Inventory Report

Line No.	Alignment			Flow Data							Physical Data						Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	225.563	-57.835	DrCrb	0.00	0.72	0.80	5.0	34.00	0.25	34.57	30	Cir	0.011	0.76	41.55	Pipe - 2
2	1	78.515	-26.628	DrCrb	0.00	2.01	0.80	5.0	36.76	3.17	39.25	24	Cir	0.011	1.00	43.50	Pipe - 3
3	End	111.410	-109.475	DrCrb	0.00	3.99	0.80	5.0	34.00	0.90	35.00	36	Cir	0.011	1.00	41.50	Pipe - 1
4	End	171.799	8.204	DrCrb	0.00	0.70	0.80	5.0	34.00	2.33	38.00	18	Cir	0.011	1.00	41.50	Pipe - 4

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure Shape	Length (ft)	Width (ft)	Line Out Size (in)	Shape	Invert (ft)	Line In Size (in)	Shape	Invert (ft)
1	DI-4	DropCurb	41.55	Rect	2.00	2.00	30	Cir	34.57	24	Cir	36.76
2	DI-5	DropCurb	43.50	Rect	2.00	2.00	24	Cir	39.25			
3	DI-2	DropCurb	41.50	Rect	2.00	2.00	36	Cir	35.00			
4	DI-7	DropCurb	41.50	Rect	2.00	2.00	18	Cir	38.00			

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	Pipe - 2	15.62	30	Cir	225.563	34.00	34.57	0.253	40.94*	41.17*	0.12	41.29	End	DropCurb
2	Pipe - 3	11.62	24	Cir	78.515	36.76	39.25	3.171	41.29*	41.44*	0.21	41.66	1	DropCurb
3	Pipe - 1	23.07	36	Cir	111.410	34.00	35.00	0.898	40.94*	41.04*	0.17	41.20	End	DropCurb
4	Pipe - 4	4.05	18	Cir	171.799	34.00	38.00	2.328	40.94*	41.12*	0.08	41.20	End	DropCurb

Project File: Proposed Storm WO Pond Outlets.stm

Number of lines: 4

NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown).

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total	(C)	Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)				(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	225.563	0.72	2.73	0.80	0.58	2.18	5.0	5.4	7.2	15.62	24.36	3.18	30	0.25	34.00	34.57	40.94	41.17	36.88	41.55	Pipe - 2
2	1	78.515	2.01	2.01	0.80	1.61	1.61	5.0	5.0	7.2	11.62	47.60	3.70	24	3.17	36.76	39.25	41.29	41.44	41.55	43.50	Pipe - 3
3	End	111.410	3.99	3.99	0.80	3.19	3.19	5.0	5.0	7.2	23.07	74.67	3.26	36	0.90	34.00	35.00	40.94	41.04	37.42	41.50	Pipe - 1
4	End	171.799	0.70	0.70	0.80	0.56	0.56	5.0	5.0	7.2	4.05	18.94	2.29	18	2.33	34.00	38.00	40.94	41.12	35.79	41.50	Pipe - 4

Project File: Proposed Storm WO Pond Outlets.stm

Number of lines: 4

Run Date: 10/1/2015

NOTES: Intensity = 121.80 / (Inlet time + 23.50) ^ 0.84; Return period =Yrs. 10 ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet Ht (in)	Curb Inlet L (ft)	Grate Inlet Area (sqft)	Grate Inlet L (ft)	Grate Inlet W (ft)	So (ft/ft)	W (ft)	Gutter Sw (ft/ft)	Gutter Sx (ft/ft)	Gutter n	Gutter Depth (ft)	Gutter Spread (ft)	Inlet Depth (ft)	Inlet Spread (ft)	Depr (in)	Byp Line No
1	DI-4	4.16	0.00	4.16	0.00	DrCrb	4.0	1.00	0.00	1.00	1.00	Sag	0.00	0.020	0.020	0.013	5.57	278.45	5.57	278.45	0.0	Off
2	DI-5	11.62	0.00	11.62	0.00	DrCrb	4.0	1.00	0.00	1.00	1.00	Sag	0.00	0.000	0.000	0.013	42.27	1.#J	42.27	1.#J	0.0	Off
3	DI-2	23.07	0.00	23.07	0.00	DrCrb	4.0	1.00	0.00	1.00	1.00	Sag	0.00	0.020	0.020	0.013	166.07	8303.64	166.07	8303.64	0.0	Off
4	DI-7	4.05	0.00	4.05	0.00	DrCrb	4.0	1.00	0.00	1.00	1.00	Sag	0.00	0.020	0.020	0.013	5.27	263.65	5.27	263.65	0.0	Off

Project File: Proposed Storm WO Pond Outlets.stm

Number of lines: 4

Run Date: 10/1/2015

NOTES: Inlet N-Values = 0.016; Intensity = 121.80 / (Inlet time + 23.50) ^ 0.84; Return period = 10 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.
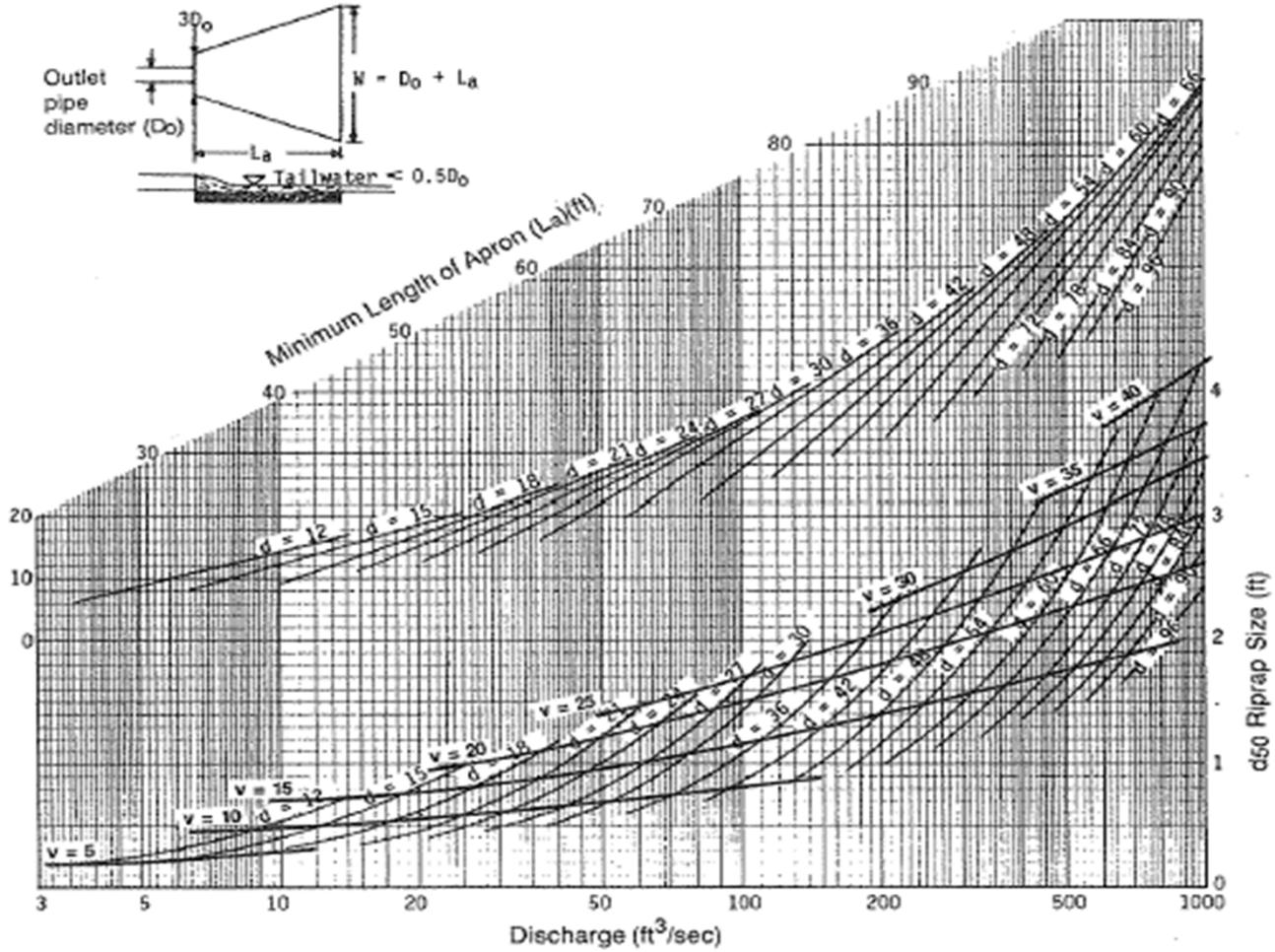
Design of outlet protection from a round pipe flowing full, minimum tailwater condition Tw<0.5 diameter

FES #	D_o (Pipe ø) (ft)	T_w (ft)	T_w<0.5ø	Q (cfs)	V (ft/s)	d_{50} (ft)	L_a (ft)	Apron width at pipe (ft)	Apron width at outlet (ft)	Max Stone ø (ft)	Apron Thickness(ft)
Stucture - 1	1.25	0	OKAY	6.68	5.44	0.25	9	3.75	10	0.38	0.56
Structure - 2	1.25	0	OKAY	6.68	5.44	0.25	9	3.75	10	0.38	0.56
Structure - 3	1.25	0	OKAY	6.68	5.44	0.25	9	3.75	10	0.38	0.56
FE-1	3	0	OKAY	23.07	3.26	0.5	22	9	25	0.75	1.13
FE-3	2.5	0	OKAY	15.62	3.18	0.5	20	7.5	23	0.75	1.13
FE-6	1.5	0	OKAY	4.05	2.29	0.25	11	4.5	13	0.38	0.56

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Wet Detention Basin #1 Phase 1 and Ultimate Buildout Summary

Predeveloped CN

Cover Type	Area (SF)	%	CN	Wtd. CN
Open Space (Poor)	221115	0.49	68	33.17
Gravel (Ballast)	6276	0.01	76	1.05
Impervious Area	225859	0.50	98	48.83
Total	453250			83.06
Composite CN	83.06		Use CN =	83

Postdeveloped CN

Cover Type	Area (SF)	%	CN	Wtd. CN
Open Space (Poor)	188843	0.42	68	28.33
Gravel (Ballast)	21776	0.05	76	3.65
Impervious Area	242631	0.54	98	52.46
Total	453250			84.44
Composite CN	84.44		Use CN =	84

Storm Summary

24 Hr. Storm Event	Pre (cfs)	Post (cfs)	Wet Basin Routed (cfs)	Infiltration Routed (cfs)
1 Year	25.66	26.61	5.88	0
2 Year	32.21	33.21	10.40	0
10 Year	55.31	56.35	20.06	0
25 Year	68.76	69.78	23.92	0
100 Year	89.42	90.39	27.64	0

Hydrograph Report

Hyd. No. 1

24 Hr Pre-Dev Event

Hydrograph type	= SCS Runoff		Peak discharge	= 25.66 cfs
Storm frequency	= 1 yrs		Time to peak	= 12.07 hrs
Time interval	= 2 min		Hyd. volume	= 76,702 cuft
Drainage area	= 10.410 ac		Curve number	= 83*
Basin Slope	= 0.0 %		Hydraulic length	= 0 ft
Tc method	= User		Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.86 in		Distribution	= Type III
Storm duration	= 24 hrs		Shape factor	= 484

* Composite (Area/CN) = [(5.080 x 68) + (5.190 x 98) + (0.140 x 76)] / 10.410

24 Hr Pre-Dev Event
Hyd. No. 1 -- 1 Year
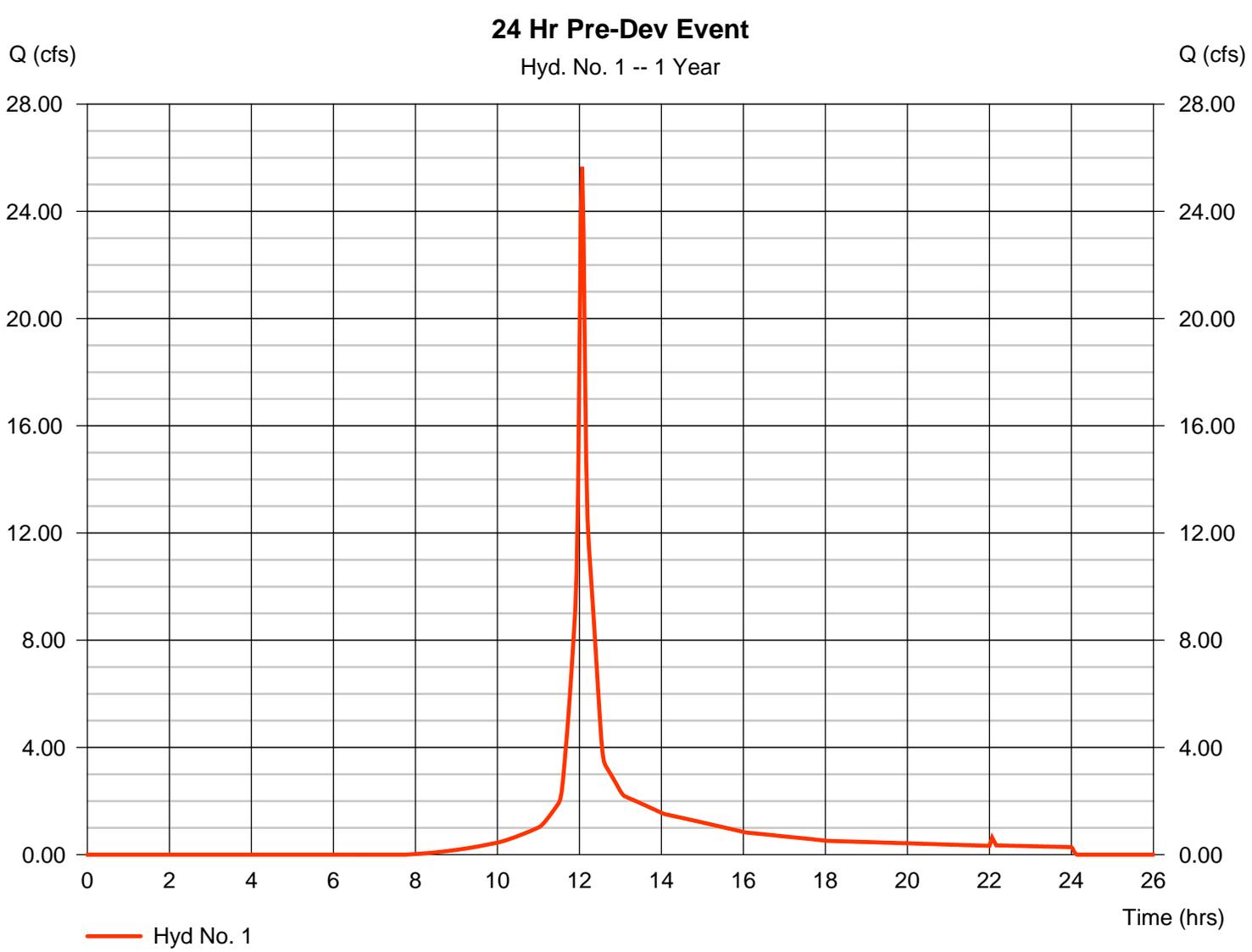
Hyd No. 1

Hydrograph Report

Hyd. No. 2

24 Hr Post Dev Events

Hydrograph type	= SCS Runoff		Peak discharge	= 26.61 cfs
Storm frequency	= 1 yrs		Time to peak	= 12.07 hrs
Time interval	= 2 min		Hyd. volume	= 79,645 cuft
Drainage area	= 10.410 ac		Curve number	= 84*
Basin Slope	= 0.0 %		Hydraulic length	= 0 ft
Tc method	= User		Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.86 in		Distribution	= Type III
Storm duration	= 24 hrs		Shape factor	= 484

* Composite (Area/CN) = [(5.580 x 98) + (4.330 x 68) + (0.500 x 76)] / 10.410

24 Hr Post Dev Events

Hyd. No. 2 -- 1 Year
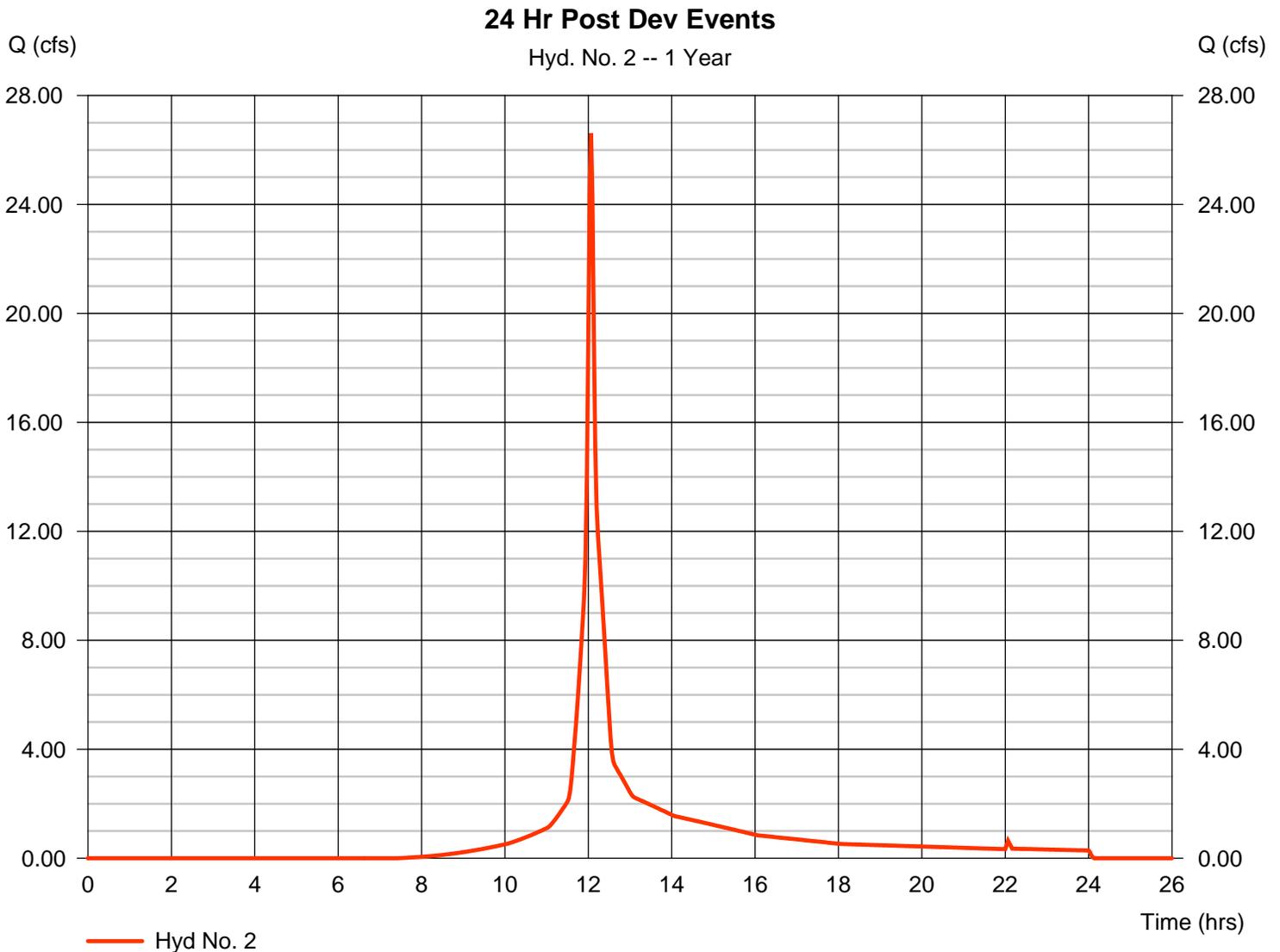
Hyd No. 2

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4　　　　　Wednesday, 09 / 30 / 2015

Hyd. No. 3

Wet Pond Routing

Hydrograph type	= Reservoir	Peak discharge	= 5.882 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 74,038 cuft
Inflow hyd. No.	= 2 - 24 Hr Post Dev Events	Max. Elevation	= 41.62 ft
Reservoir name	= SW Pond #1	Max. Storage	= 123,769 cuft

Storage Indication method used. Wet pond routing start elevation = 40.20 ft.

Wet Pond Routing

Hyd. No. 3 -- 1 Year
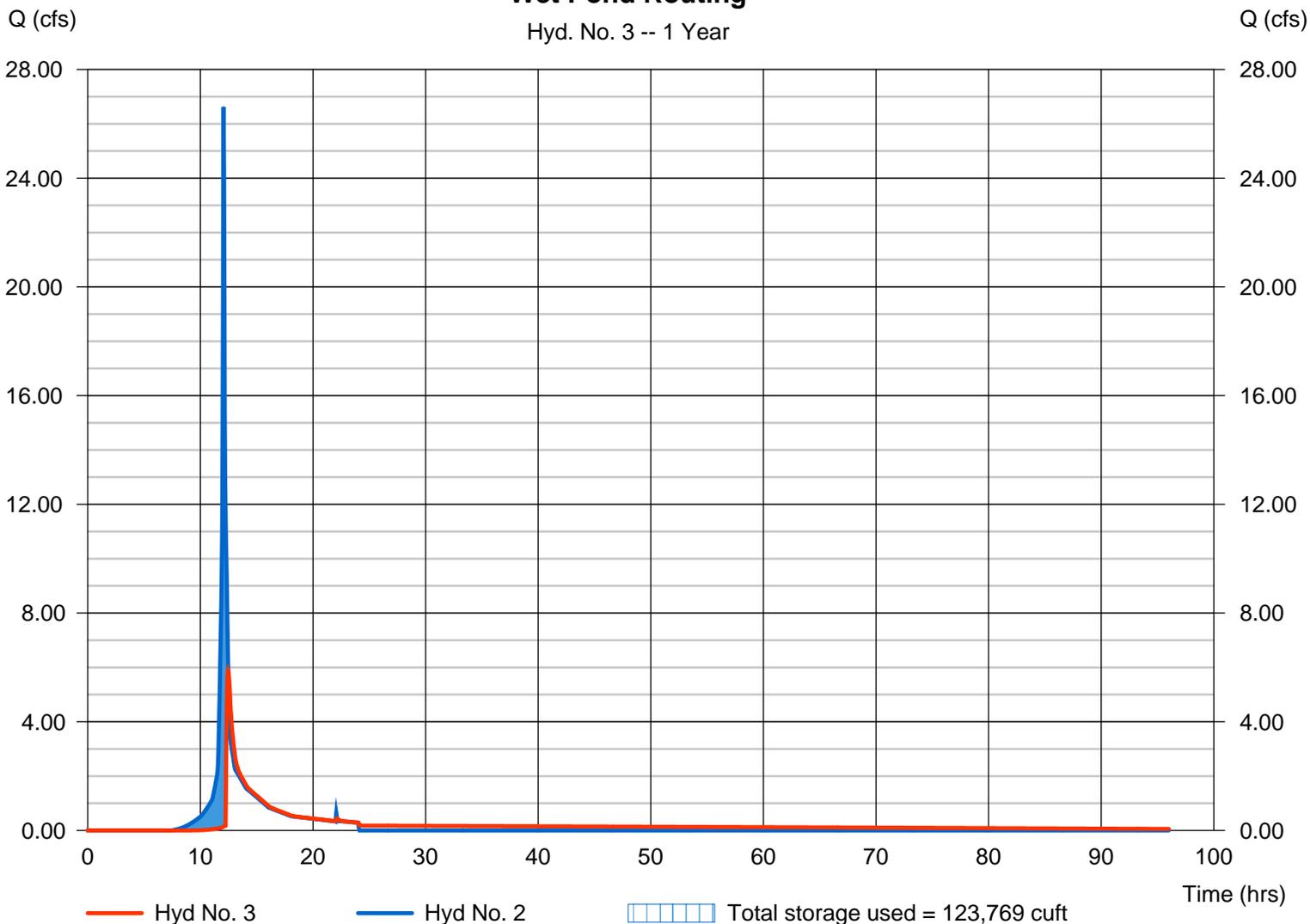
Q (cfs)

Hyd No. 3　　　　Hyd No. 2　　　　Total storage used = 123,769 cuft

Time (hrs)

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 4

Infiltration Routing

Hydrograph type	= Reservoir	Peak discharge	= 3.949 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.77 hrs
Time interval	= 2 min	Hyd. volume	= 73,978 cuft
Inflow hyd. No.	= 3 - Wet Pond Routing	Max. Elevation	= 40.46 ft
Reservoir name	= Large Infiltration Basin	Max. Storage	= 4,279 cuft

Storage Indication method used. Outflow includes exfiltration.
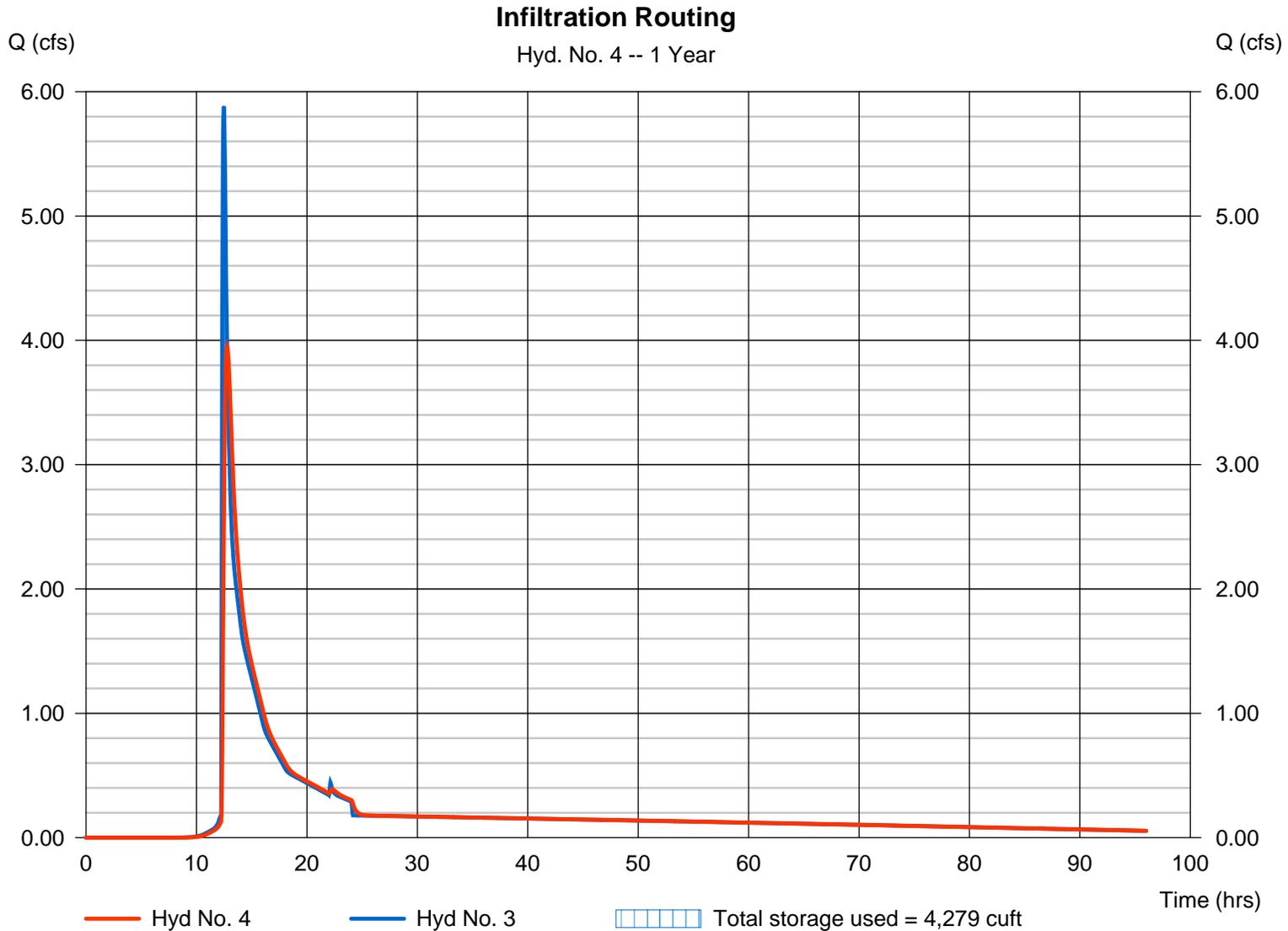
Infiltration Routing

Hyd. No. 4 -- 1 Year

Hyd No. 4   Hyd No. 3   Total storage used = 4,279 cuft

Hydrograph Report

Wednesday, 09 / 30 / 2015

Hyd. No. 1

24 Hr Pre-Dev Event

Hydrograph type	= SCS Runoff	Peak discharge	= 32.21 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 96,558 cuft
Drainage area	= 10.410 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.080 x 68) + (5.190 x 98) + (0.140 x 76)] / 10.410

24 Hr Pre-Dev Event

Hyd. No. 1 -- 2 Year
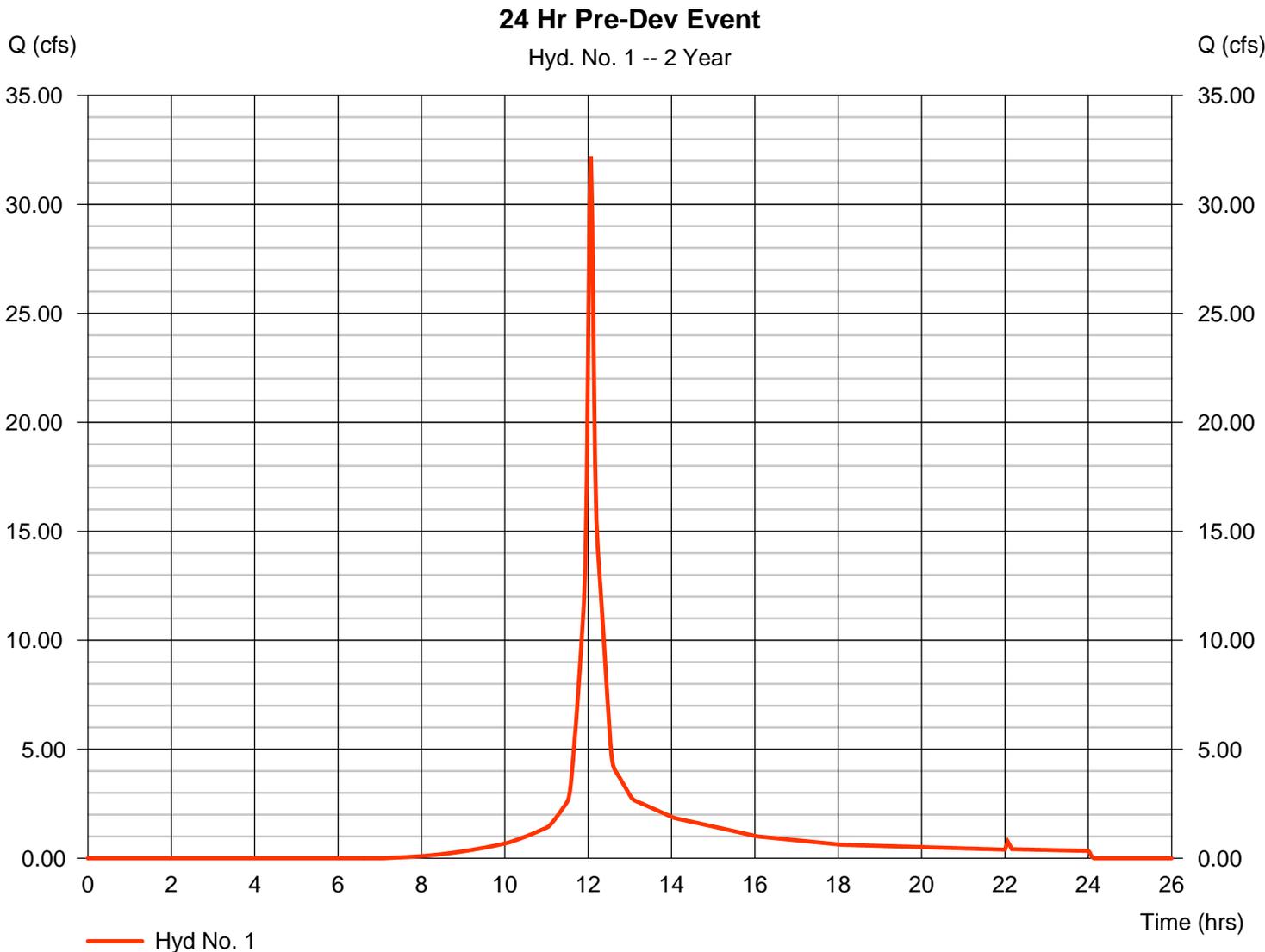
Hyd No. 1

Hydrograph Report

Hyd. No. 2

24 Hr Post Dev Events

Hydrograph type	= SCS Runoff		Peak discharge	= 33.21 cfs
Storm frequency	= 2 yrs		Time to peak	= 12.07 hrs
Time interval	= 2 min		Hyd. volume	= 99,782 cuft
Drainage area	= 10.410 ac		Curve number	= 84*
Basin Slope	= 0.0 %		Hydraulic length	= 0 ft
Tc method	= User		Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.50 in		Distribution	= Type III
Storm duration	= 24 hrs		Shape factor	= 484

* Composite (Area/CN) = [(5.580 x 98) + (4.330 x 68) + (0.500 x 76)] / 10.410

24 Hr Post Dev Events

Hyd. No. 2 -- 2 Year
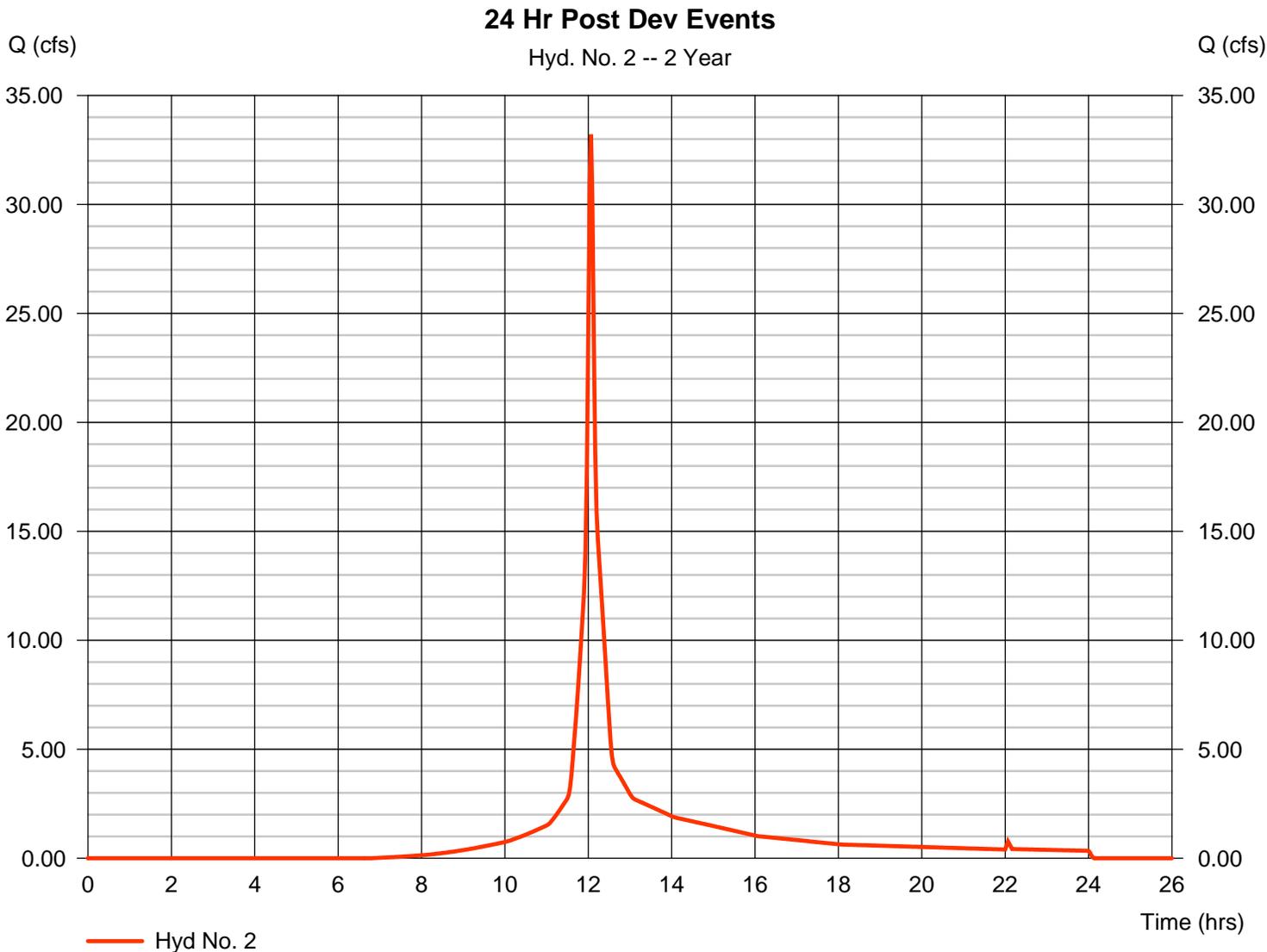
— Hyd No. 2

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 3

Wet Pond Routing

Hydrograph type	= Reservoir	Peak discharge	= 10.40 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 94,168 cuft
Inflow hyd. No.	= 2 - 24 Hr Post Dev Events	Max. Elevation	= 41.77 ft
Reservoir name	= SW Pond #1	Max. Storage	= 128,190 cuft

Storage Indication method used. Wet pond routing start elevation = 40.20 ft.
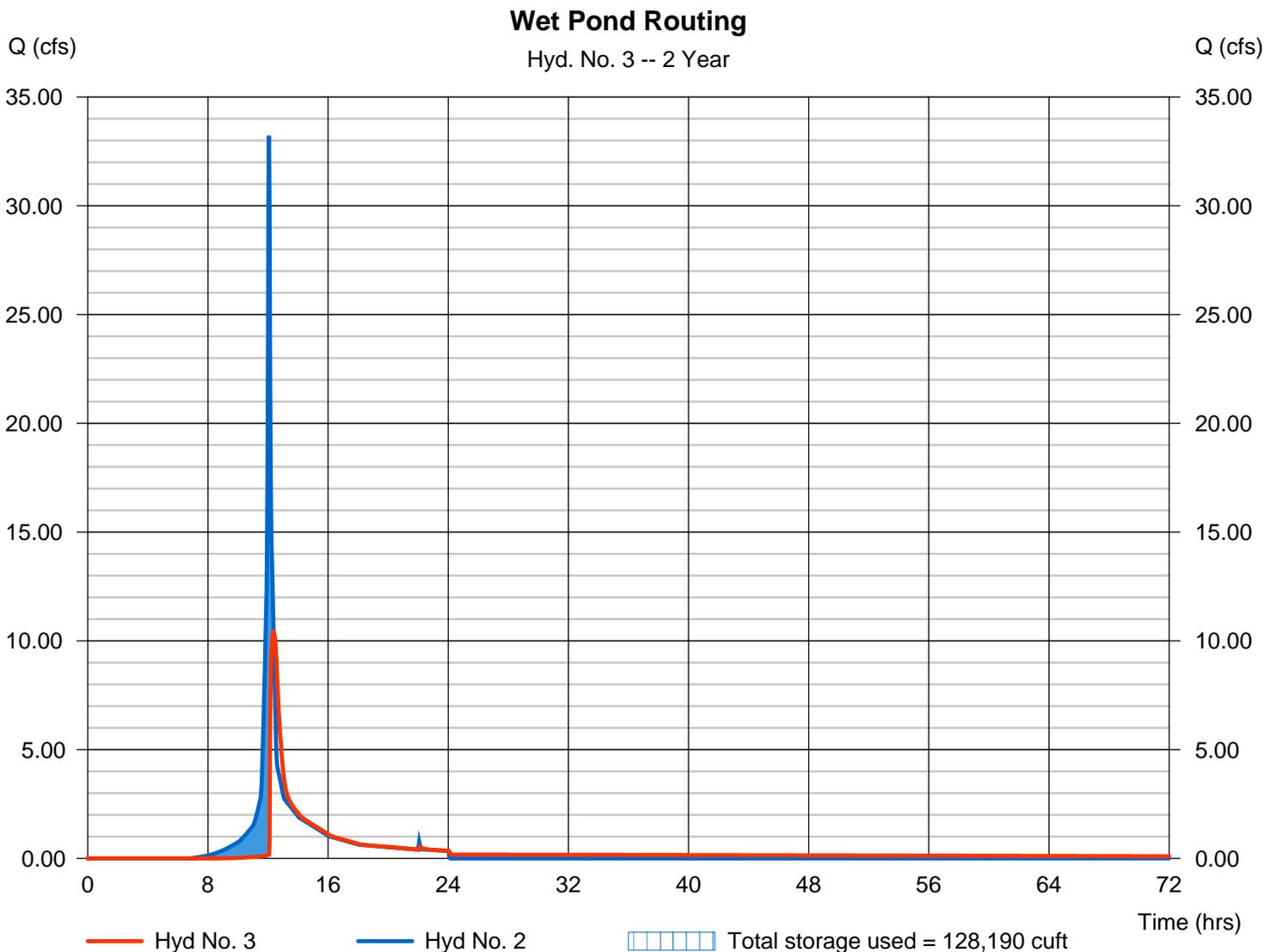
Wet Pond Routing
Hyd. No. 3 -- 2 Year

Hyd No. 3   Hyd No. 2   Total storage used = 128,190 cuft

Hydrograph Report

Hyd. No. 4

Infiltration Routing

Hydrograph type	= Reservoir	Peak discharge	= 7.724 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.63 hrs
Time interval	= 2 min	Hyd. volume	= 94,108 cuft
Inflow hyd. No.	= 3 - Wet Pond Routing	Max. Elevation	= 40.70 ft
Reservoir name	= Large Infiltration Basin	Max. Storage	= 8,370 cuft

Storage Indication method used. Outflow includes exfiltration.
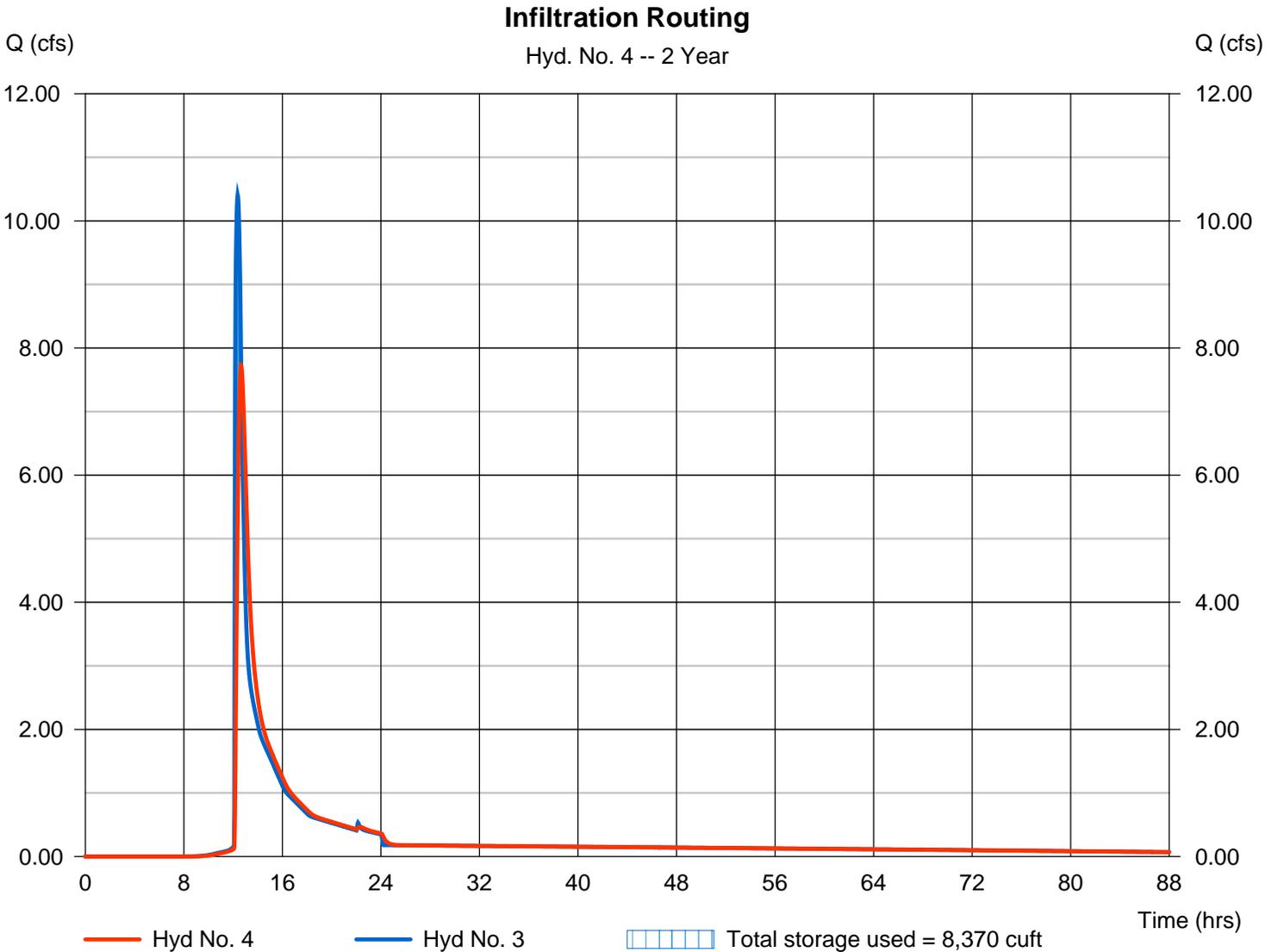
Infiltration Routing

Hyd. No. 4 -- 2 Year

Hyd No. 4   Hyd No. 3   Total storage used = 8,370 cuft

Hydrograph Report

Hyd. No. 1

24 Hr Pre-Dev Event

Hydrograph type	= SCS Runoff	Peak discharge	= 55.31 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 168,774 cuft
Drainage area	= 10.410 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.72 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.080 x 68) + (5.190 x 98) + (0.140 x 76)] / 10.410

24 Hr Pre-Dev Event

Hyd. No. 1 -- 10 Year
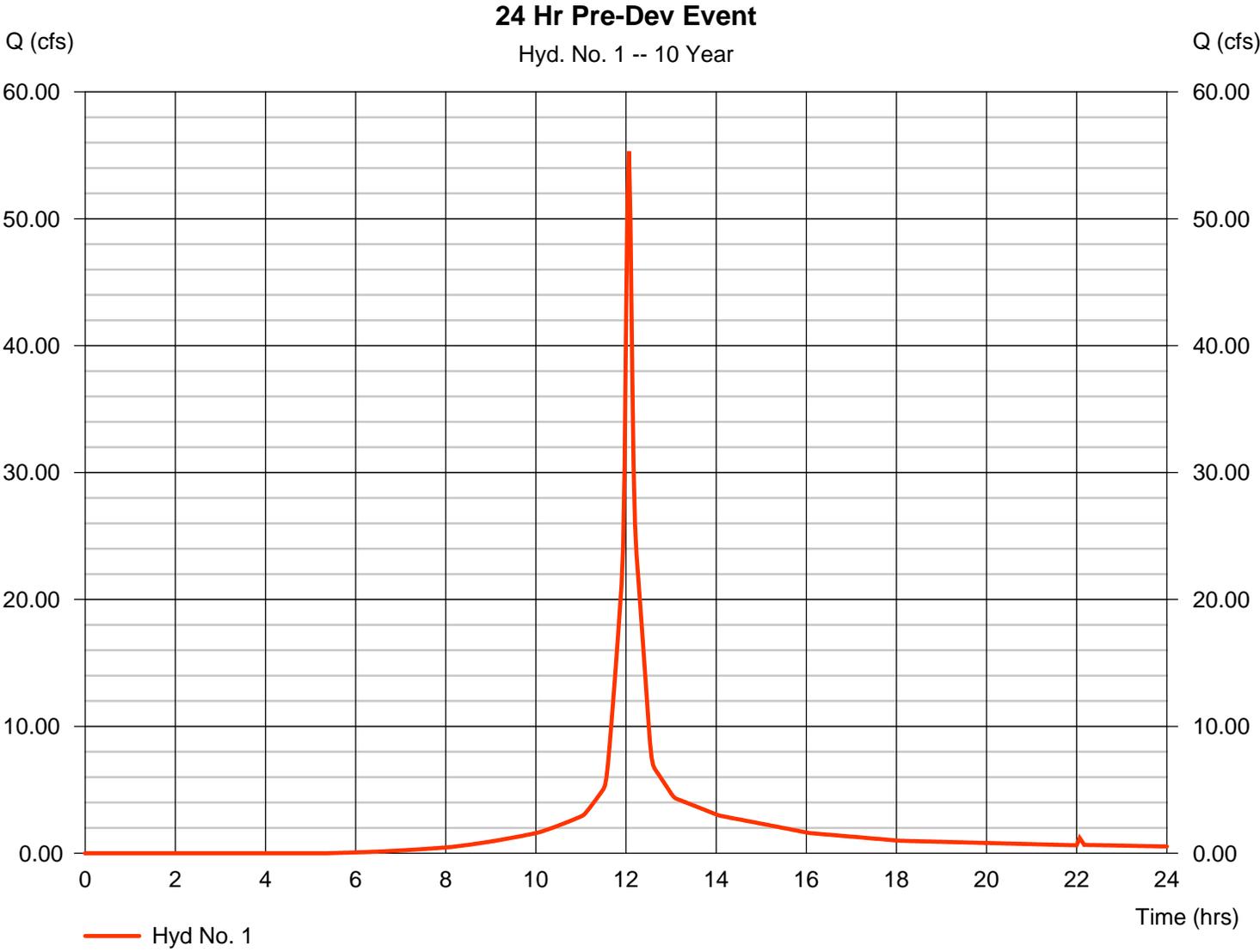
Hyd No. 1

Hydrograph Report

Hyd. No. 2

24 Hr Post Dev Events

Hydrograph type	= SCS Runoff		Peak discharge	= 56.35 cfs
Storm frequency	= 10 yrs		Time to peak	= 12.07 hrs
Time interval	= 2 min		Hyd. volume	= 172,683 cuft
Drainage area	= 10.410 ac		Curve number	= 84*
Basin Slope	= 0.0 %		Hydraulic length	= 0 ft
Tc method	= User		Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.72 in		Distribution	= Type III
Storm duration	= 24 hrs		Shape factor	= 484

* Composite (Area/CN) = [(5.580 x 98) + (4.330 x 68) + (0.500 x 76)] / 10.410

24 Hr Post Dev Events

Hyd. No. 2 -- 10 Year
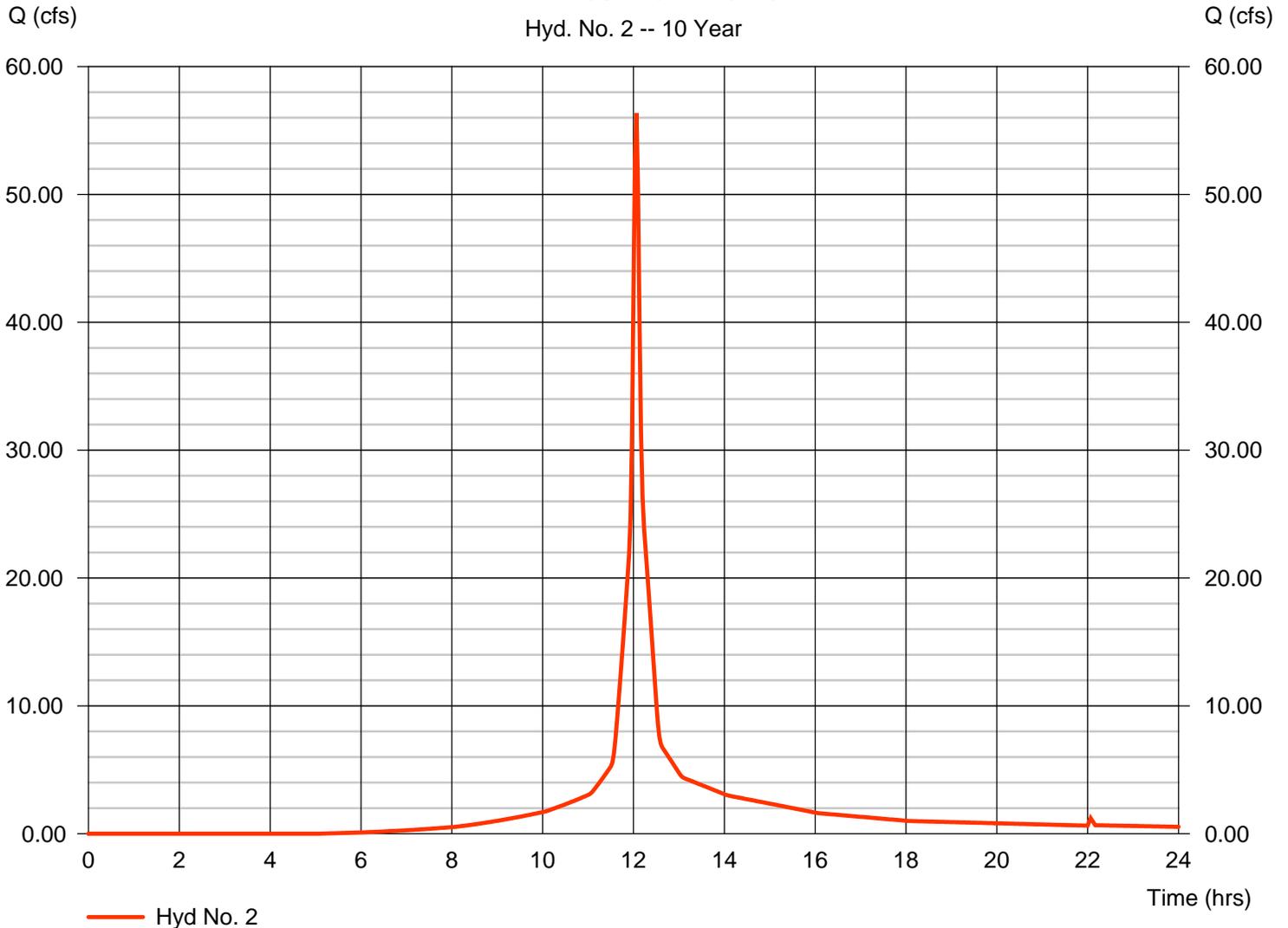
Hyd No. 2

Hydrograph Report

Hyd. No. 3

Wet Pond Routing

Hydrograph type	= Reservoir	Peak discharge	= 20.06 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.30 hrs
Time interval	= 2 min	Hyd. volume	= 167,054 cuft
Inflow hyd. No.	= 2 - 24 Hr Post Dev Events	Max. Elevation	= 42.54 ft
Reservoir name	= SW Pond #1	Max. Storage	= 152,204 cuft

Storage Indication method used. Wet pond routing start elevation = 40.20 ft.
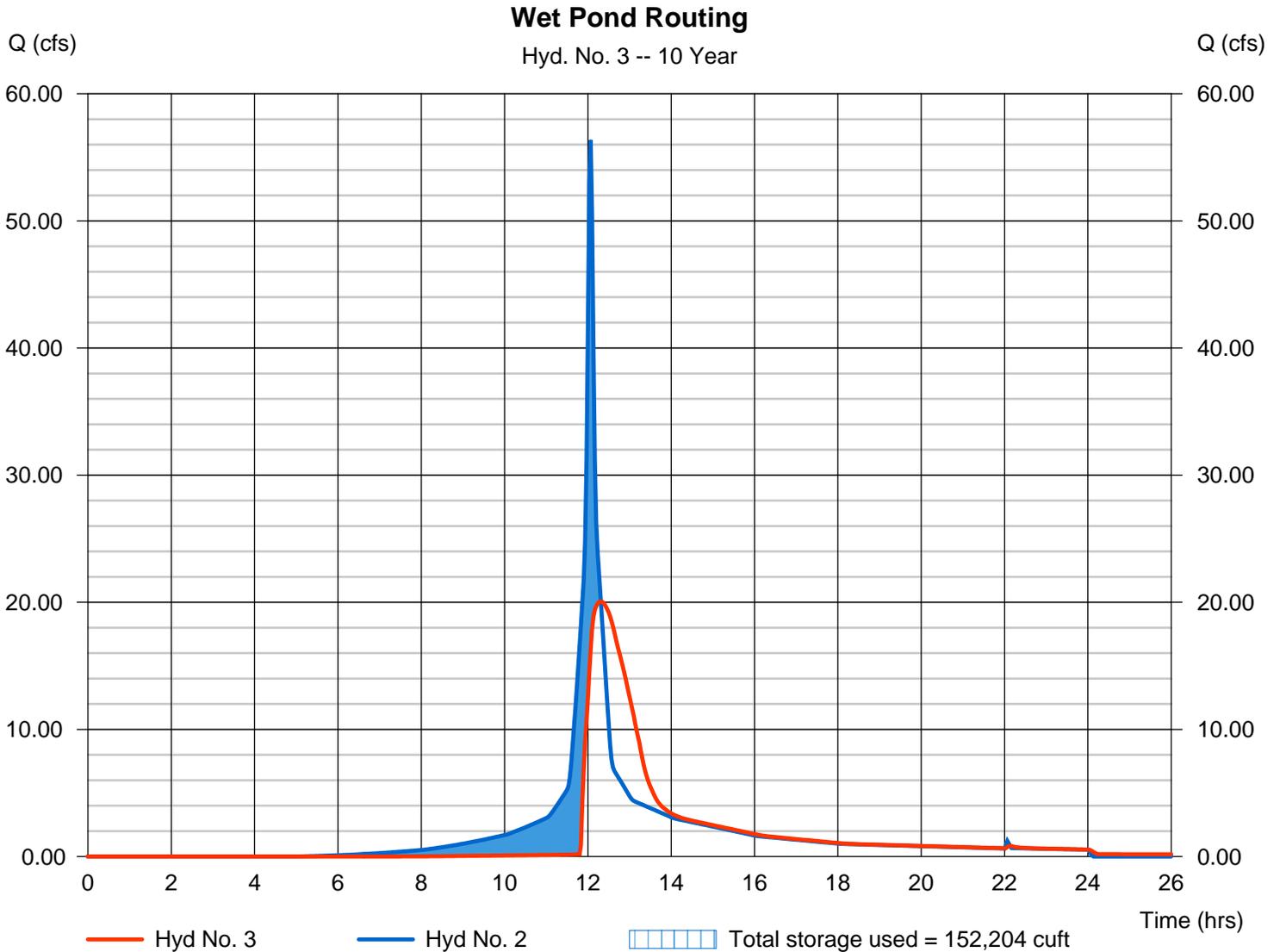
Wet Pond Routing

Hyd. No. 3 -- 10 Year

Hyd No. 3   Hyd No. 2   Total storage used = 152,204 cuft

Hydrograph Report

Hyd. No. 4

Infiltration Routing

Hydrograph type	= Reservoir	Peak discharge	= 13.41 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.93 hrs
Time interval	= 2 min	Hyd. volume	= 166,994 cuft
Inflow hyd. No.	= 3 - Wet Pond Routing	Max. Elevation	= 41.58 ft
Reservoir name	= Large Infiltration Basin	Max. Storage	= 24,381 cuft

Storage Indication method used. Outflow includes exfiltration.
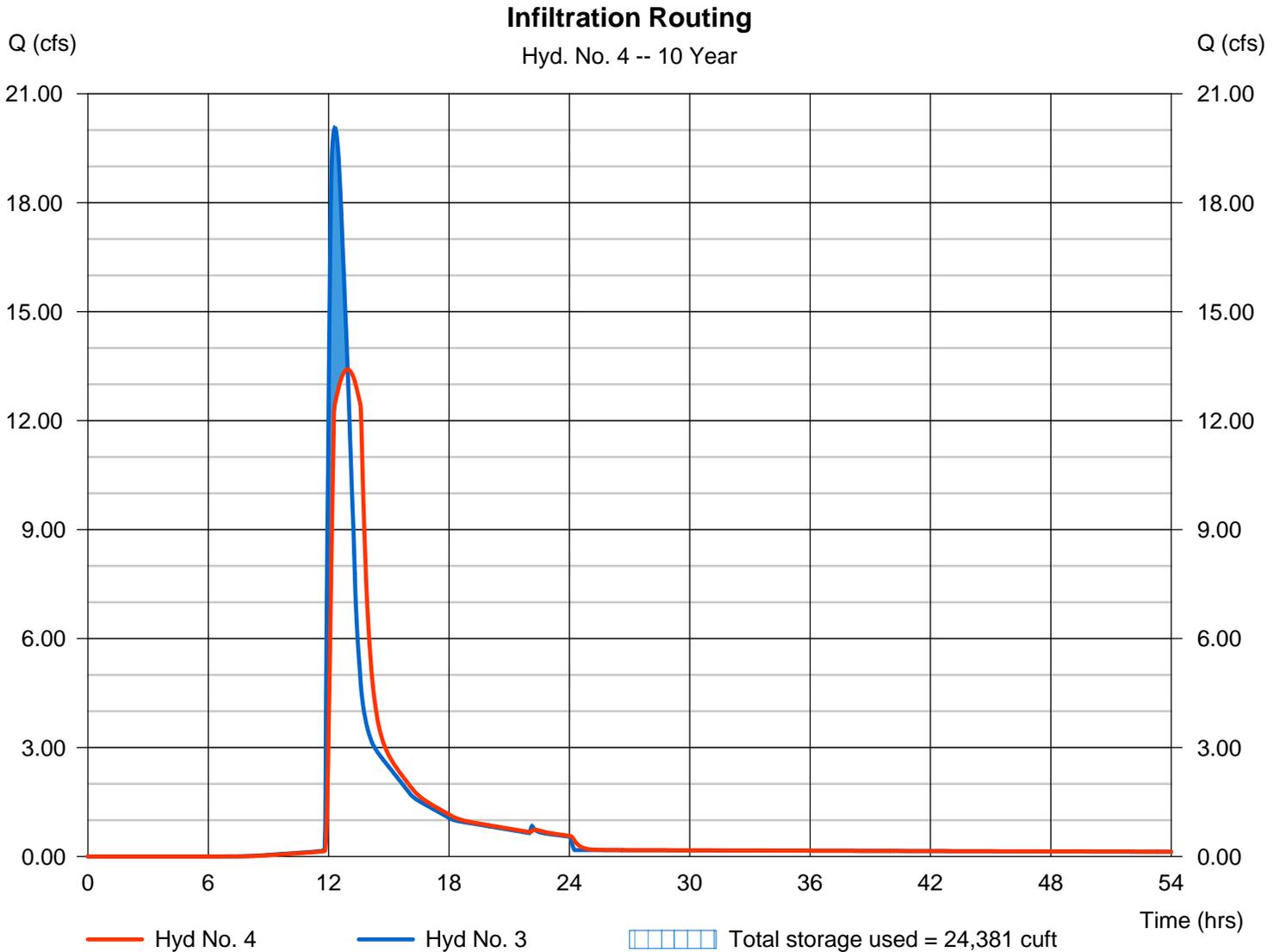
Infiltration Routing

Hyd. No. 4 -- 10 Year

Hyd No. 4   Hyd No. 3   Total storage used = 24,381 cuft

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 1

24 Hr Pre-Dev Event

Hydrograph type	= SCS Runoff	Peak discharge	= 68.76 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 212,097 cuft
Drainage area	= 10.410 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.01 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.080 x 68) + (5.190 x 98) + (0.140 x 76)] / 10.410

24 Hr Pre-Dev Event

Hyd. No. 1 -- 25 Year
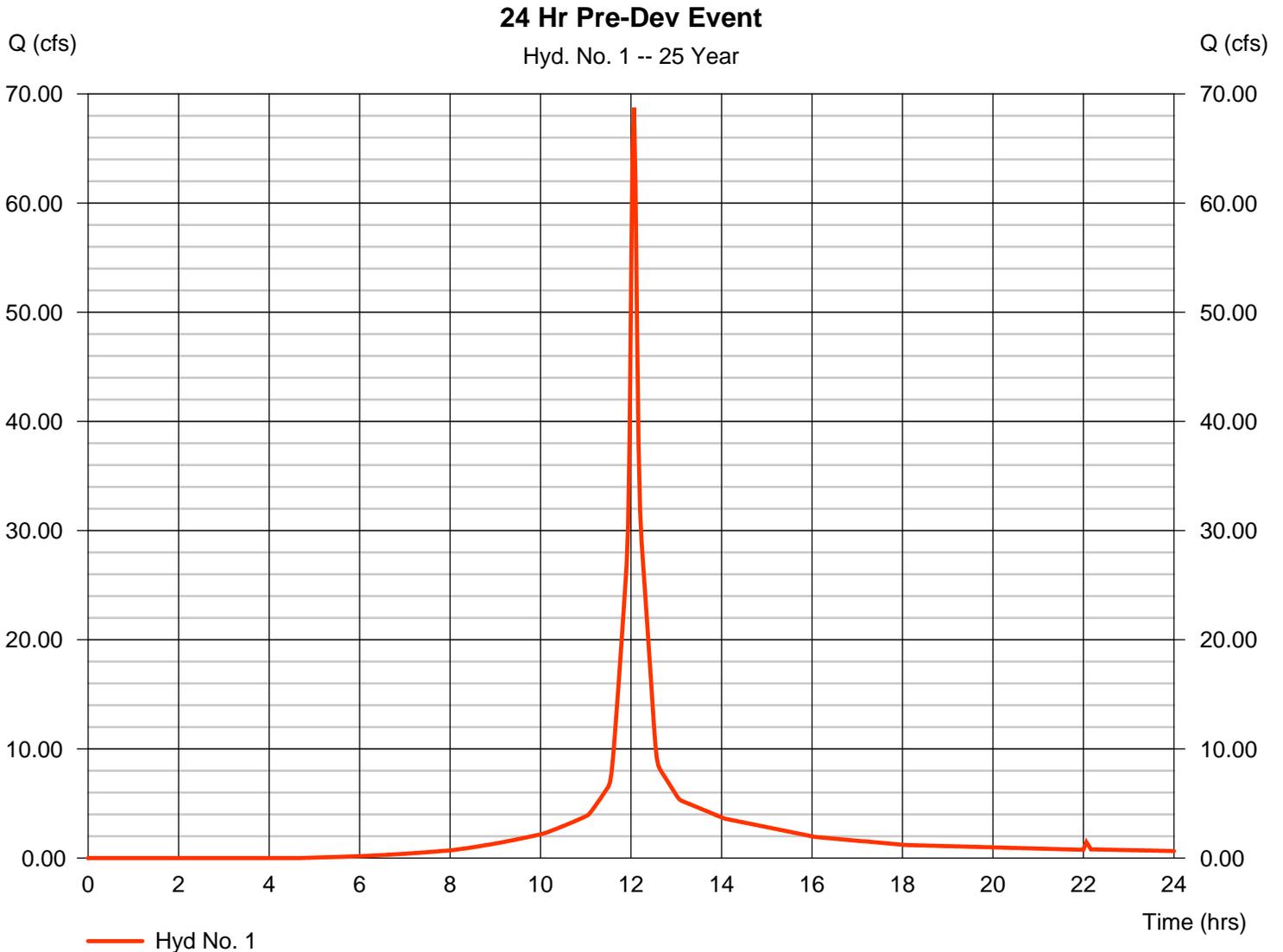
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 2

24 Hr Post Dev Events

Hydrograph type	= SCS Runoff	Peak discharge	= 69.78 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 216,273 cuft
Drainage area	= 10.410 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.01 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.580 x 98) + (4.330 x 68) + (0.500 x 76)] / 10.410

24 Hr Post Dev Events

Hyd. No. 2 -- 25 Year
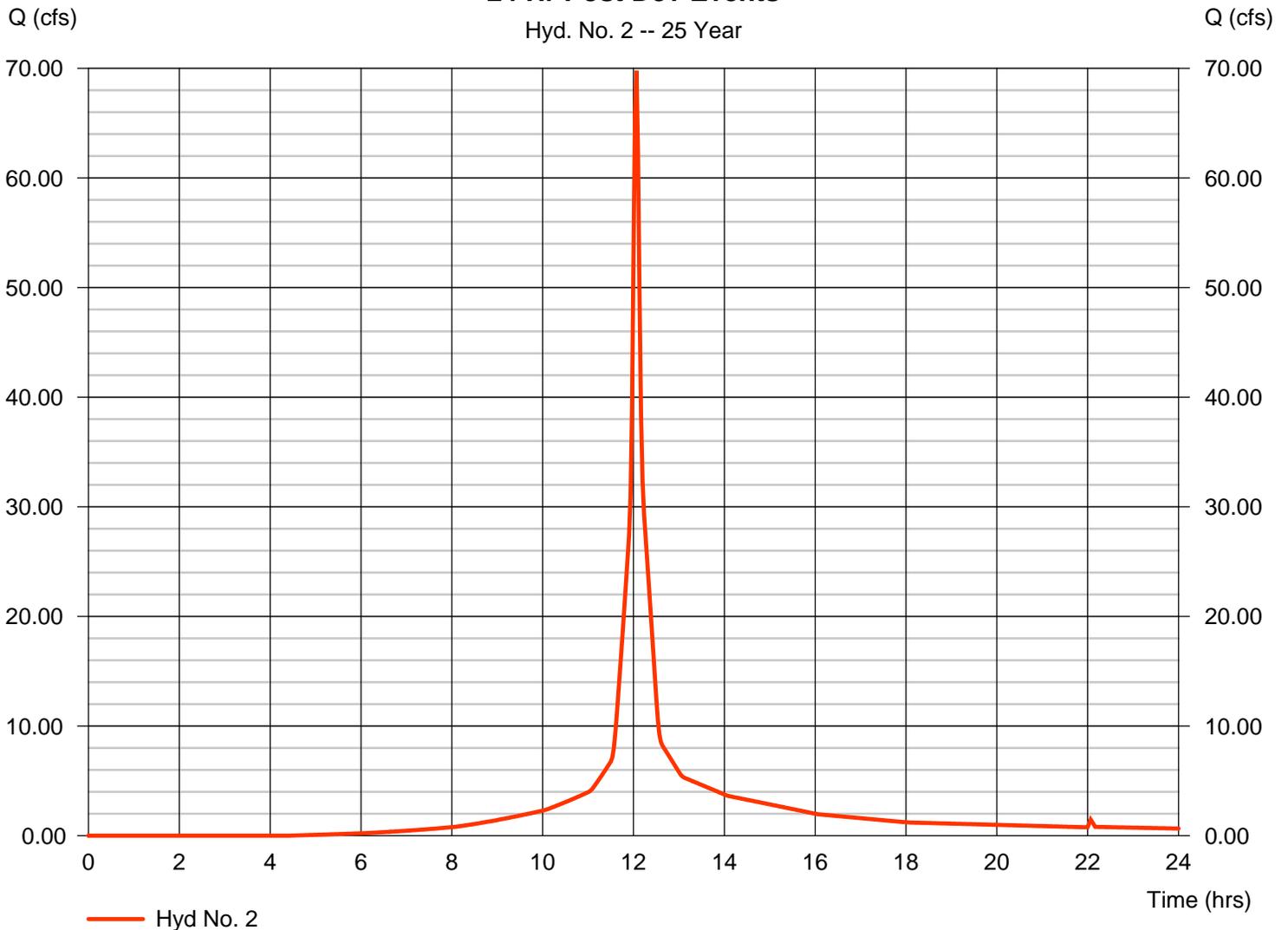
Hyd No. 2

Hydrograph Report

Hyd. No. 3

Wet Pond Routing

Hydrograph type	= Reservoir	Peak discharge	= 23.92 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.33 hrs
Time interval	= 2 min	Hyd. volume	= 210,639 cuft
Inflow hyd. No.	= 2 - 24 Hr Post Dev Events	Max. Elevation	= 42.97 ft
Reservoir name	= SW Pond #1	Max. Storage	= 166,118 cuft

Storage Indication method used. Wet pond routing start elevation = 40.20 ft.
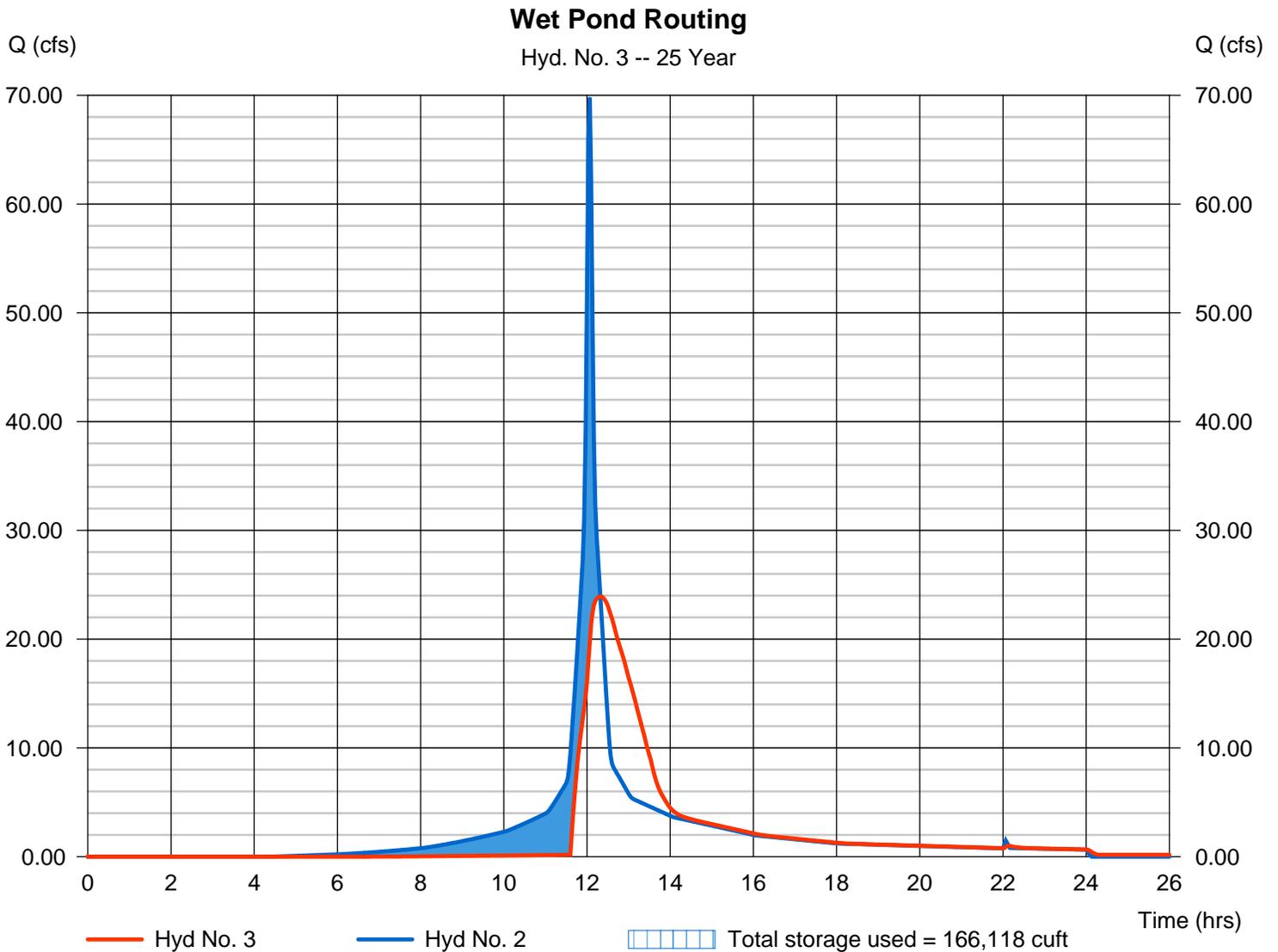
Wet Pond Routing

Hyd. No. 3 -- 25 Year

Q (cfs) ... Q (cfs)

Time (hrs)

—— Hyd No. 3   —— Hyd No. 2   Total storage used = 166,118 cuft

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 4

Infiltration Routing

Hydrograph type	= Reservoir	Peak discharge	= 14.64 cfs
Storm frequency	= 25 yrs	Time to peak	= 13.13 hrs
Time interval	= 2 min	Hyd. volume	= 210,579 cuft
Inflow hyd. No.	= 3 - Wet Pond Routing	Max. Elevation	= 42.24 ft
Reservoir name	= Large Infiltration Basin	Max. Storage	= 37,657 cuft

Storage Indication method used. Outflow includes exfiltration.
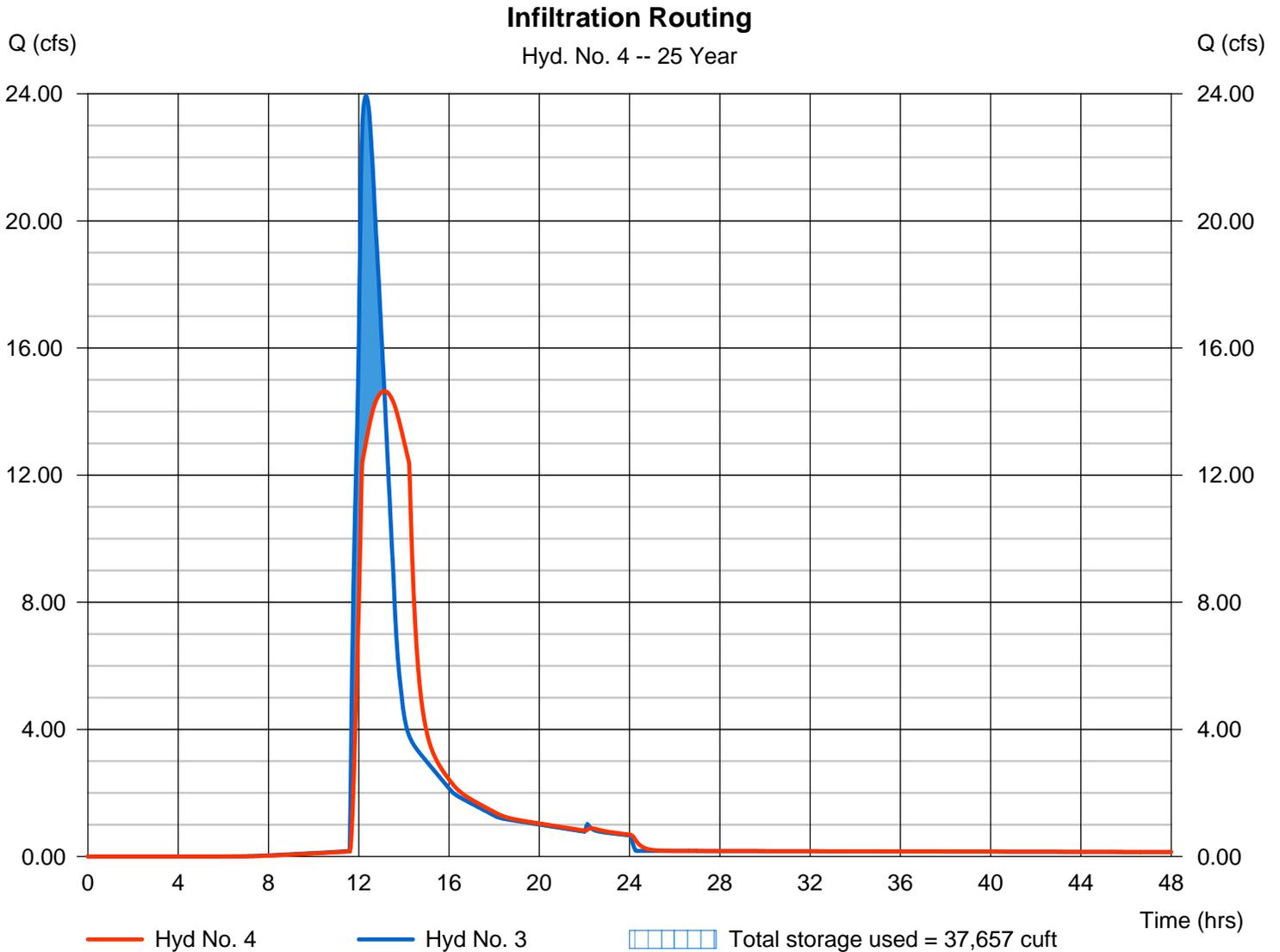
Infiltration Routing

Hyd. No. 4 -- 25 Year

Hyd No. 4   Hyd No. 3   Total storage used = 37,657 cuft

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 1

24 Hr Pre-Dev Event

Hydrograph type	= SCS Runoff	Peak discharge	= 89.42 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 279,962 cuft
Drainage area	= 10.410 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.080 x 68) + (5.190 x 98) + (0.140 x 76)] / 10.410

24 Hr Pre-Dev Event

Hyd. No. 1 -- 100 Year
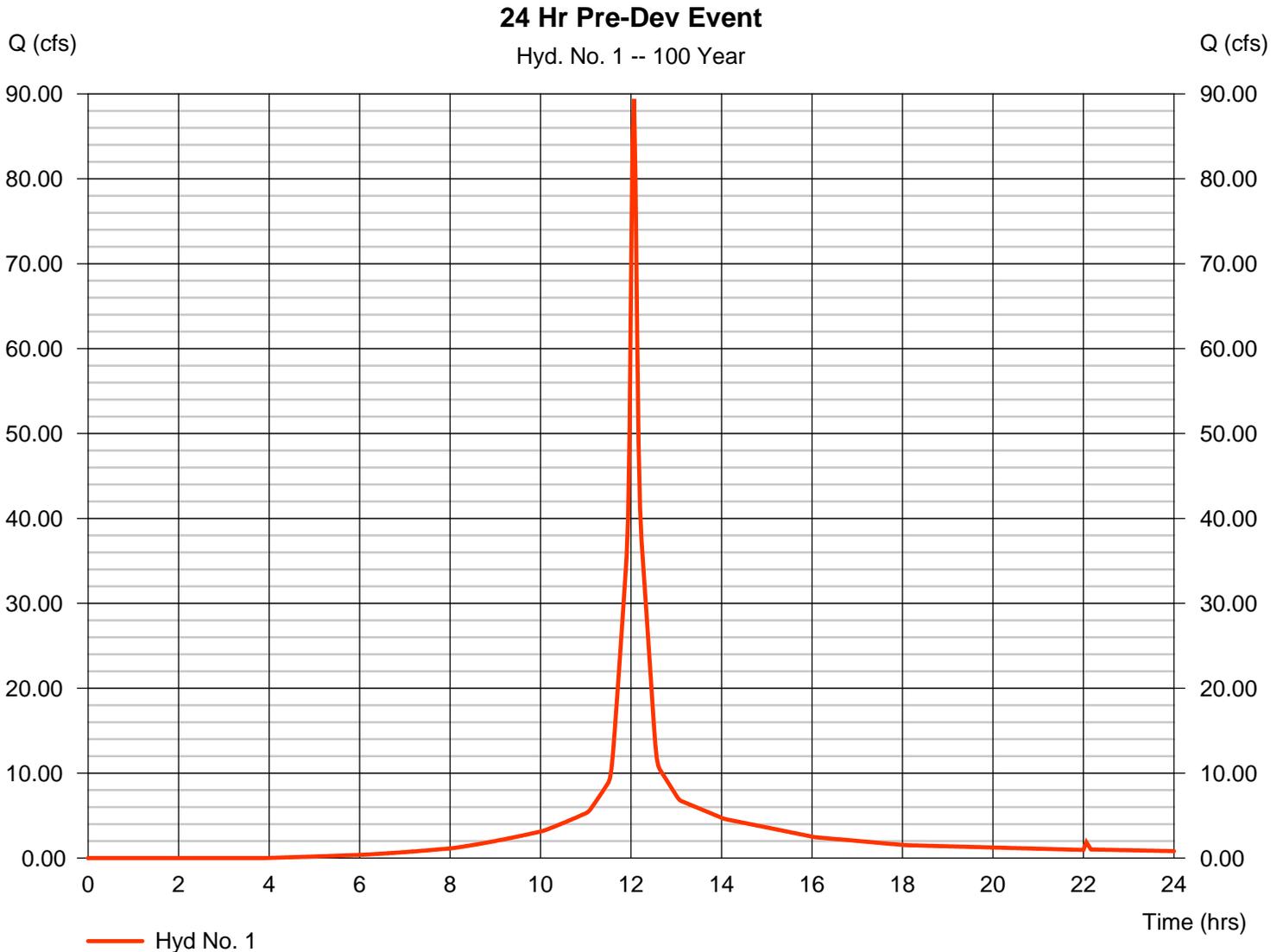
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

## Hyd. No. 2

24 Hr Post Dev Events

Hydrograph type	= SCS Runoff	Peak discharge	= 90.39 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 284,444 cuft
Drainage area	= 10.410 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.580 x 98) + (4.330 x 68) + (0.500 x 76)] / 10.410

24 Hr Post Dev Events

Hyd. No. 2 -- 100 Year
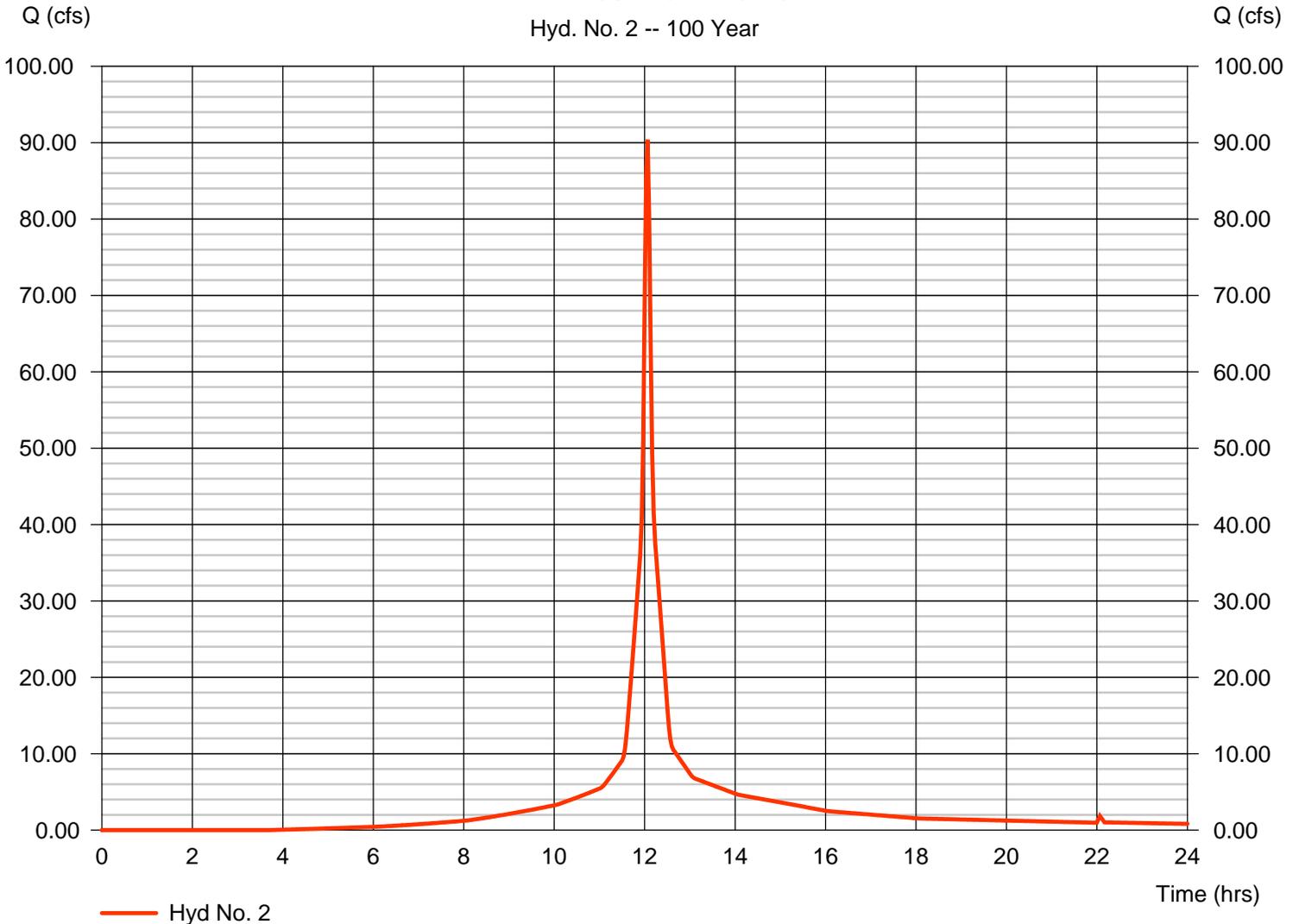
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 3

Wet Pond Routing

Hydrograph type	= Reservoir	Peak discharge	= 27.64 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 278,802 cuft
Inflow hyd. No.	= 2 - 24 Hr Post Dev Events	Max. Elevation	= 43.58 ft
Reservoir name	= SW Pond #1	Max. Storage	= 187,011 cuft

Storage Indication method used. Wet pond routing start elevation = 40.20 ft.
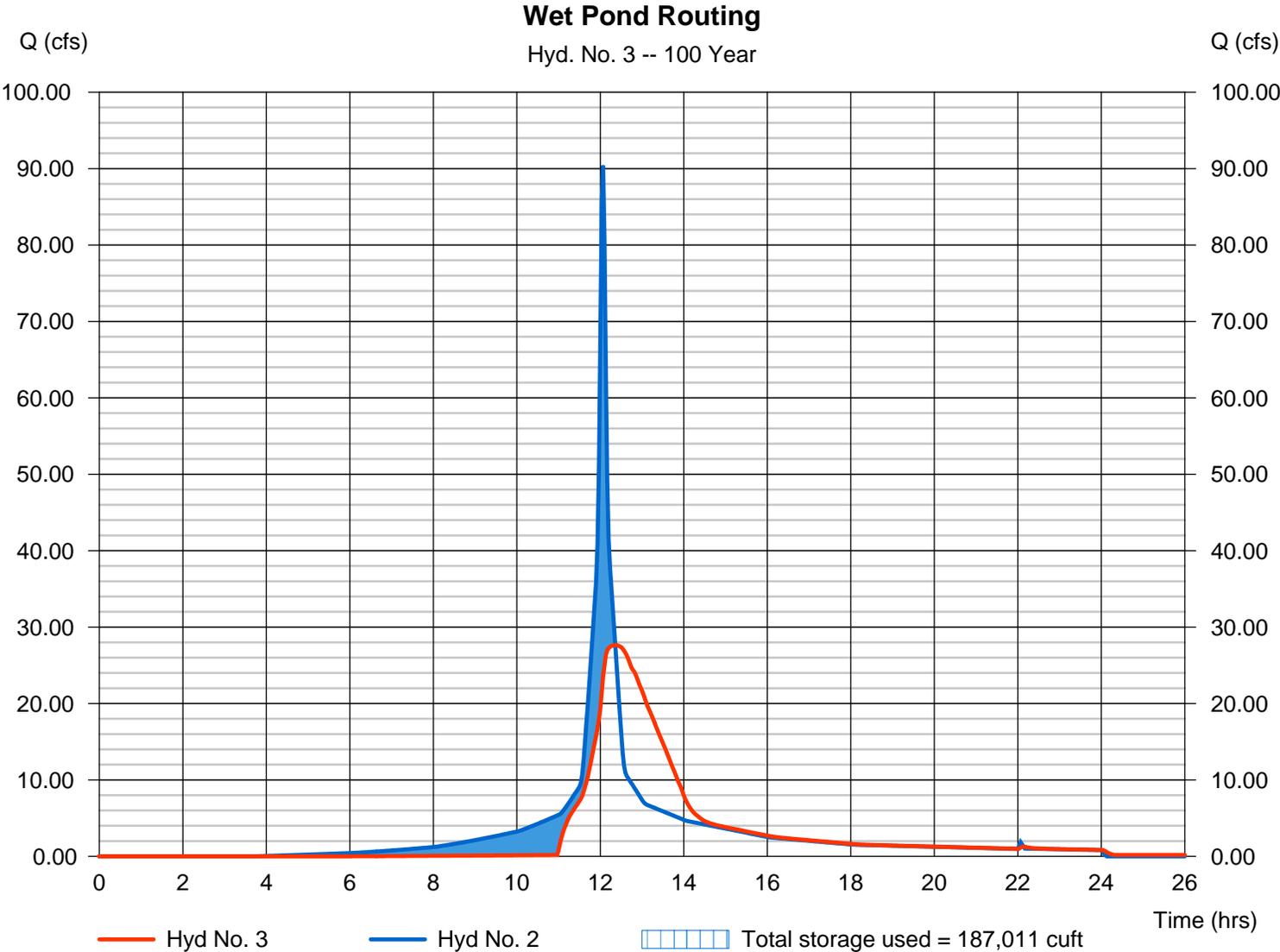
Wet Pond Routing

Hyd. No. 3 -- 100 Year

Q (cfs)

Time (hrs)

—— Hyd No. 3   —— Hyd No. 2   Total storage used = 187,011 cuft

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015

Hyd. No. 4

Infiltration Routing

Hydrograph type	= Reservoir	Peak discharge	= 16.29 cfs
Storm frequency	= 100 yrs	Time to peak	= 13.40 hrs
Time interval	= 2 min	Hyd. volume	= 278,742 cuft
Inflow hyd. No.	= 3 - Wet Pond Routing	Max. Elevation	= 43.11 ft
Reservoir name	= Large Infiltration Basin	Max. Storage	= 57,004 cuft

Storage Indication method used. Outflow includes exfiltration.

Infiltration Routing

Hyd. No. 4 -- 100 Year

Q (cfs)

| | Hyd No. 4 | | Hyd No. 3 | | Total storage used = 57,004 cuft |

Time (hrs)

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015
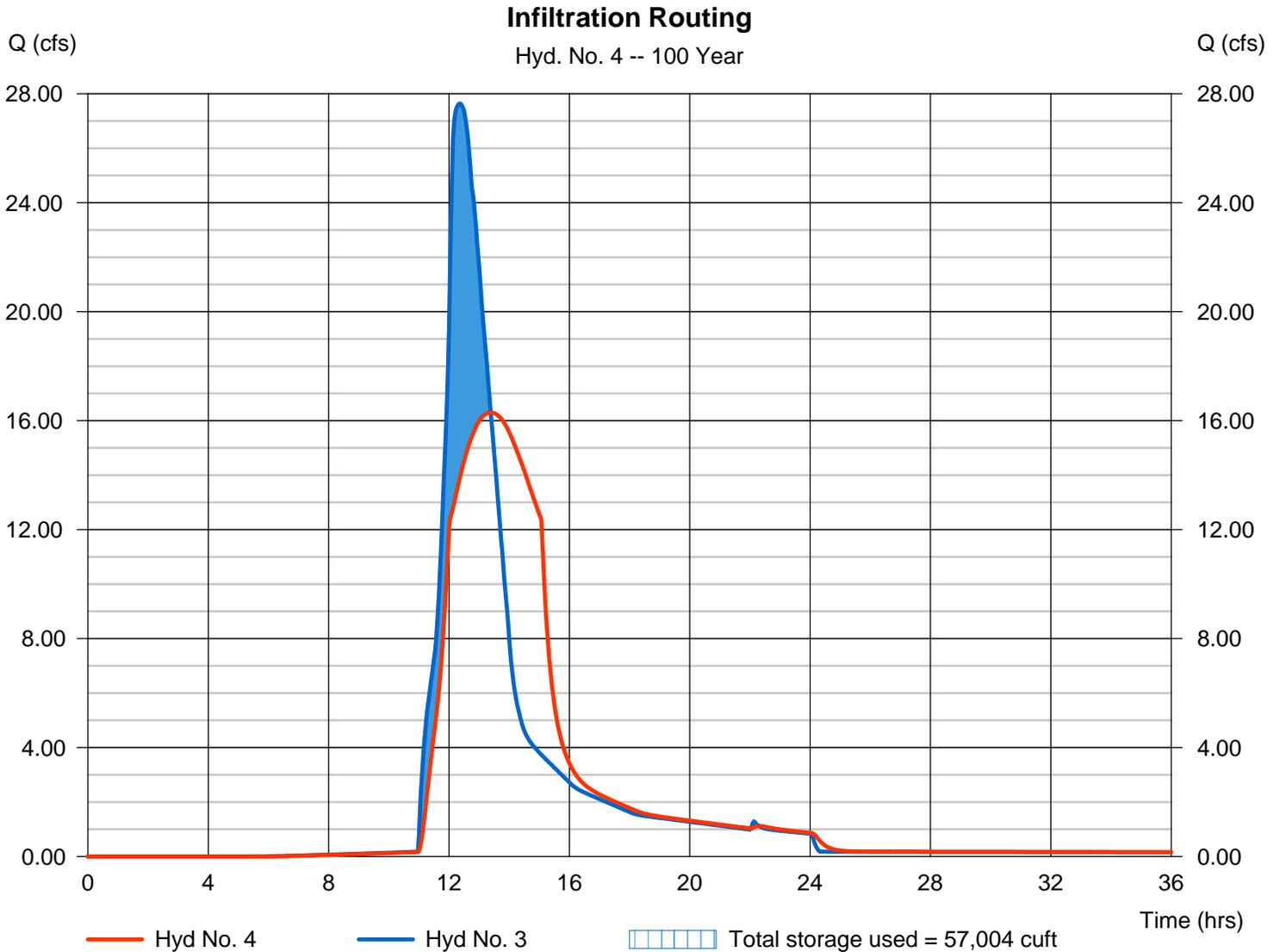
Pond No. 1 - SW Pond #1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 34.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	34.00	7,118	0	0
1.00	35.00	8,962	8,022	8,022
2.00	36.00	10,918	9,923	17,944
3.00	37.00	12,988	11,937	29,881
4.00	38.00	15,171	14,064	43,945
5.00	39.00	17,467	16,304	60,249
5.70	39.70	19,141	12,807	73,056
6.20	40.20	24,331	10,841	83,897
6.70	40.70	27,906	13,048	96,945
7.00	41.00	28,566	8,470	105,415
8.00	42.00	30,804	29,675	135,090
9.00	43.00	33,097	31,941	167,030
10.00	44.00	35,448	34,262	201,293

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	2.50	Inactive	0.00
Span (in)	= 15.00	2.50	0.00	0.00
No. Barrels	= 3	1	1	0
Invert El. (ft)	= 40.20	40.20	0.00	0.00
Length (ft)	= 35.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 16.00	16.00	16.00	0.00
Crest El. (ft)	= 41.50	41.50	41.50	0.00
Weir Coeff.	= 3.33	3.33	3.33	2.60
Weir Type	= Broad	Broad	Broad	Broad
Multi-Stage	= Yes	Yes	Yes	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

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

Stage / Discharge

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4   Wednesday, 09 / 30 / 2015
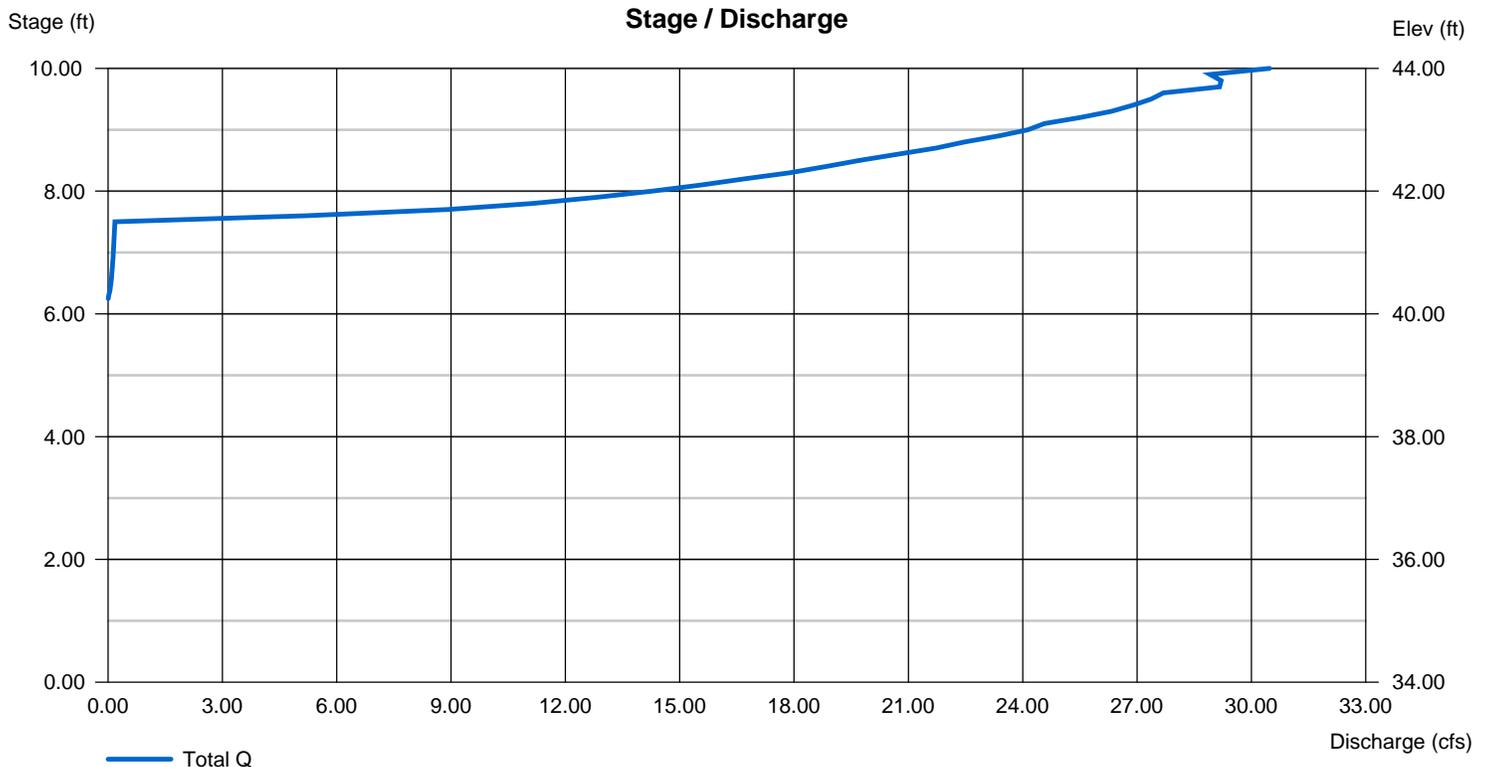
Pond No. 4 - Large Infiltration Basin

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 40.20 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	40.20	15,694	0	0
0.80	41.00	17,779	13,379	13,379
1.80	42.00	20,437	19,091	32,470
2.80	43.00	23,152	21,778	54,248
3.80	44.00	25,924	24,522	78,771

Culvert / Orifice Structures

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

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len (ft)	=	0.00	0.00	0.00	0.00
Crest El. (ft)	=	0.00	0.00	0.00	0.00
Weir Coeff.	=	3.33	3.33	3.33	3.33
Weir Type	=	---	---	---	---
Multi-Stage	=	No	No	No	No
Exfil.(in/hr)	=	30.000 (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 / Discharge