MACRO STORM WATER DRAINAGE STUDY

Tailormade Landing
Lot 2, Williams Crossing
SITE ACREAGE: 8.29 ACRES

Lee's Summit, MO

PREPARED BY:

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Submittal Date: January 2, 2018

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Revision

Date	Comment	By

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3. GENERAL INFORMATION

The proposed development of this parcel is to create one commercial lot. The site has been planned for a future development plan that will create 5 additional commercial lots. The detention / BMP facility will be constructed in this phase (Phase 1) to control the entire 8.29 acres of development. The site contains 8.29 acres that is currently undeveloped and grass covered. The Offsite drainage to the west of the site will be controlled with the onsite detention facility. The site will meet the APWA Section 5600 storm drainage requirements utilizing the Detention/BMP Facility located at the northeast corner of the site. The site generally drains from southwest to northeast.

4. METHODOLOGY

Post-Development Flow Rates

The post development flow rates were calculated based on a curve number of 94 for the developed site area. Hydroflow Hydrograph which utilized the SCS method was utilized to calculate the storm water runoff rates.

Detention Volume and Release Rates

The detention facility does meet the current APWA Section 5600 guidelines and the flows reduced by to the allowable release rates for the 2, 10 and 100 year event.

Frequency	APWA Section 5600 Requirement	Allowable Flows
2 Year	0.5 * 8.29	4.15 c.f.s.
10 Year	2.0 * 8.29	16.58 c.f.s.
100 Year	3.0 * 8.29	24.87 c.f.s.

5. Proposed Condition Analysis

Post Development Flows as Calculated by HydroFlow Hydrograph

Frequency	Developed Flow (c.f.s.)
2	35.09
10	54.14
100	81.80

Post Development Flows as Calculated by HydroFlow Hydrograph

Frequency	Developed Flow (c.f.s.) Detention
2	3.79
10	7.76
100	17.78

The 100 year event will be controlled within the site at a maximum elevation of

2 year	39,130 c.f. @ 1007.70'
10 year	61,226 c.f. @ 1009.54'
100 year	95,491 c.f. @ 1011.78'

The pond will be vegetated with sidewall slopes not to exceed 3 to 1, reference plan sheet PDP 300. The basin will be a minimum slope of 2% and will drain to the east into an existing storm system.

6. Best Management Practices Report

The development will use 40 hour detention within the basin to provide storm water Best Management Practices. The basin will utilize a plant mix in the basin bottom and soil mix to encourage infiltration

The attached calculations demonstrate the evaluation of the various outlet types and the V-Notch weir was selected. (See attached calculations)

Water Quality Volume
WQv = 42,820 c.f. Required
Pond provides 42,820 c.f. @ 1007.7 (See attached calculations)

The Water Quality Volume will be stored at a maximum elevation of 1007.7

7. Conclusions & Recommendations

This development will provide detention for 8.29-acre site. The storm water release rate will be reduced to meet APWA Section 5600 requirements.

The BMP Pond will serve as a pre-treatment pond for the system to help remove sediment from the site. 40 Hour detention will be provided by the detention system as the structure will utilize a V-Notch weir to control the outflow rate of the 40 hour detention.

8. SUPPORTING CALCULATIONS

EXHIBITS:

- **HYDROFLOW HYDROGRAPH CALCULATIONS**
  - SCS Method Calculations
  - Water Quality Volume Calculations
  - 40 Hour Detention Calculations

9. MAPS & EXHIBITS

EXHIBITS:

- **FIGURE 1**
  - **BMP/Detention Plan**

APWA STORM DRAINAGE "TC" COMPUTATIONS FOR : 1600 HAMBLEN ROAD

yellow areas are self computing
overwrite if necessary

Surface types:	Asph/Conc	Bus/Com	Dirt	Grass/Park	Lake	MultFam	SnglFam	Undev	Other
SURFACE CODES	A	B	D	G	L	M	S	U	Z
"C" Values	0.90	0.87	0.60	0.30	0.90	0.66	0.51	0.3	

		TOTAL WATERSHED				Overwrite Length - DnElev or Slope if necessary					SURFACE CODE	P=Paved U=Unpaved			Overwrite Slope or Elevations if necessary		TC COMPUTATION						
						OVERLAND FLOW - 300' MAX					P	CHANNEL FLOW - FIRST REACH					Cal	Used	Cal	Cal			
AREA ID	TOTAL ACRES	WTRSHD LENGTH	UP ELEV	DN ELEV	SURFACE CODE	"C" VALUE	OVRLND LENGTH	UP ELEV	DN ELEV	SLOPE %	or U	CHANNEL LENGTH	UP ELEV	DN ELEV	SLOPE %	VELOCITY F/S	Overland Flow T(I)	Max 15 T(I)	Channel One T(T)	Channel Two T(T)	Total T@ 10	Intensity 10 I	Intensity 100 I	AREA ID
Pre																								Pre
A	8.29	839.0	1029.0	1006.0	S	0.56	100.0	1029.0	1027.0	2.0	U	739.0	1027.0	1006.0	2.84	2.7	7.7	7.7	4.5	0.0	12.2	5.6	8.0	A
Post																								Post
1	8.29	839.0	1029.0	1003.0	S	0.87	100.0	1029.0	1027.0	2.0	P	739.0	1027.0	1003.0	3.25	3.7	3.3	5.0	3.4	0.0	8.4	6.4	9.1	1.0
2	1.65	501.1	1031.0	1015.0	U	0.30	100.0	1031.0	1015.0	16.0	U	401.1	1028.2	1015.0	3.28	2.9	5.7	5.7	2.3	0.0	8.0	6.5	9.2	2.0
3	1.45	530.6	1026.0	1011.0	Z	0.45	100.0	1026.0	1011.0	15.0	U	430.6	1021.0	1011.0	2.32	2.5	4.7	5.0	2.9	0.0	7.9	6.5	9.2	3.0

* Velocity = 16.1345 x SQRT(slope) [Unpaved] Velocity = 20.3282 x SQRT(slope) [Paved] Formula taken from "Urban Hydrology for Small Watersheds - Technical Release 55", Appendix F, Figure

** T(I) = 1.8 x (1.1-C) x SQRT(overland length) / (slope)^1/3 Formula taken from American Public Works Association 5602.5.

*** T(T) = Channel Length / Velocity Formula taken from "Urban Hydrology for Small Watersheds - Technical Release 55", Eq. 3-1.

HYDROFLOW HYDROGRAPHCALCULASTIONS

Hydraflow Table of Contents

PRELIMINARY STUDY.gpw

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 — Tuesday, 01 / 2 / 2018

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

Legend

Hyd.	Origin	Description
1	SCS Runoff	SITE
2	Reservoir	Detention

Hydrograph Return Period Recap

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	------	28.63	35.09	-------	32.83	54.14	63.03	71.88	81.80	SITE
2	Reservoir	1	2.033	3.785	-------	3.021	7.761	8.873	9.789	17.78	Detention

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

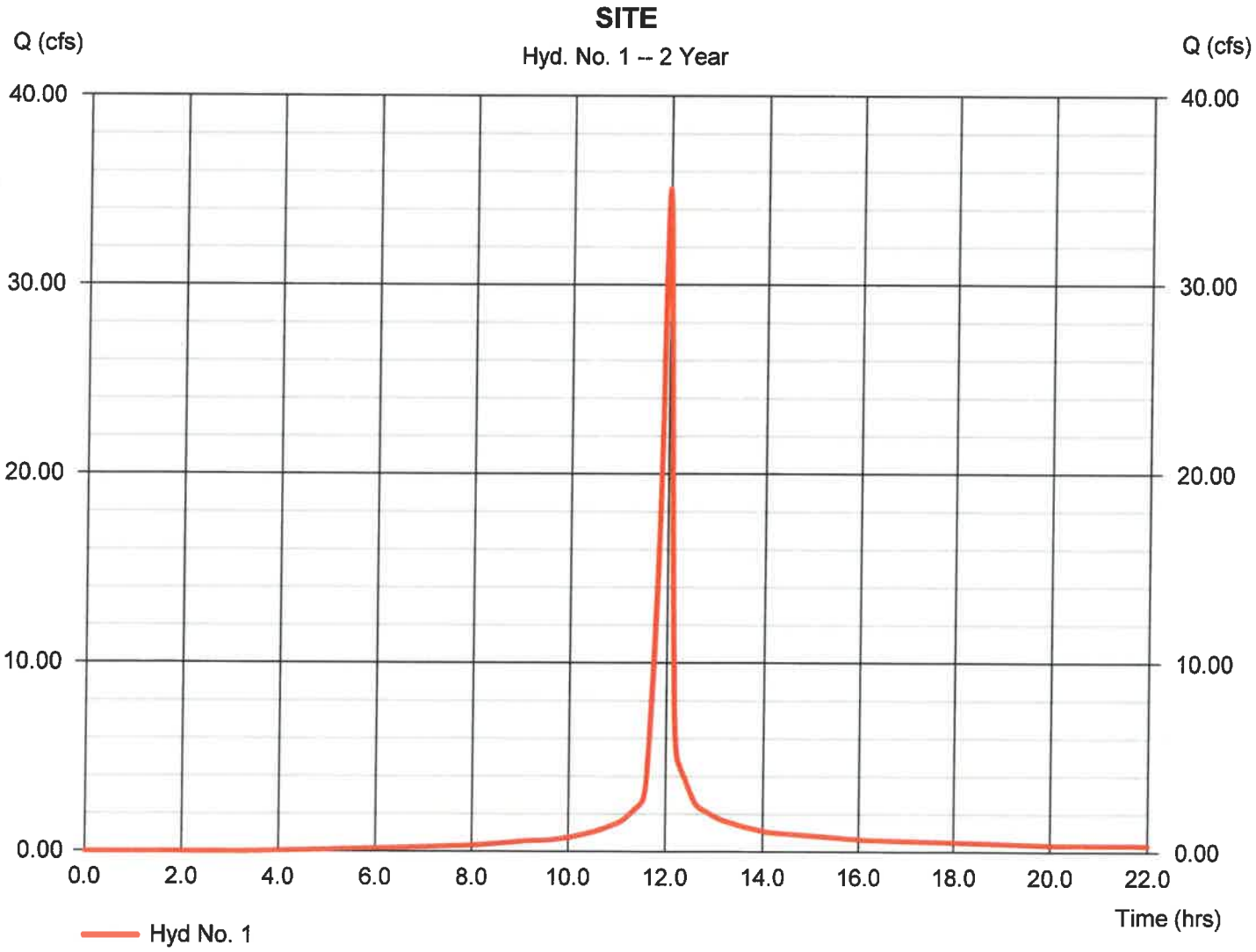
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	35.09	1	719	85,332	------	------	------	SITE
2	Reservoir	3.785	1	744	85,327	1	1007.70	39,130	Detention

Hydrograph Report

Hyd. No. 1

SITE

Hydrograph type	= SCS Runoff	Peak discharge	= 35.09 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 85,332 cuft
Drainage area	= 8.290 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 8.40 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



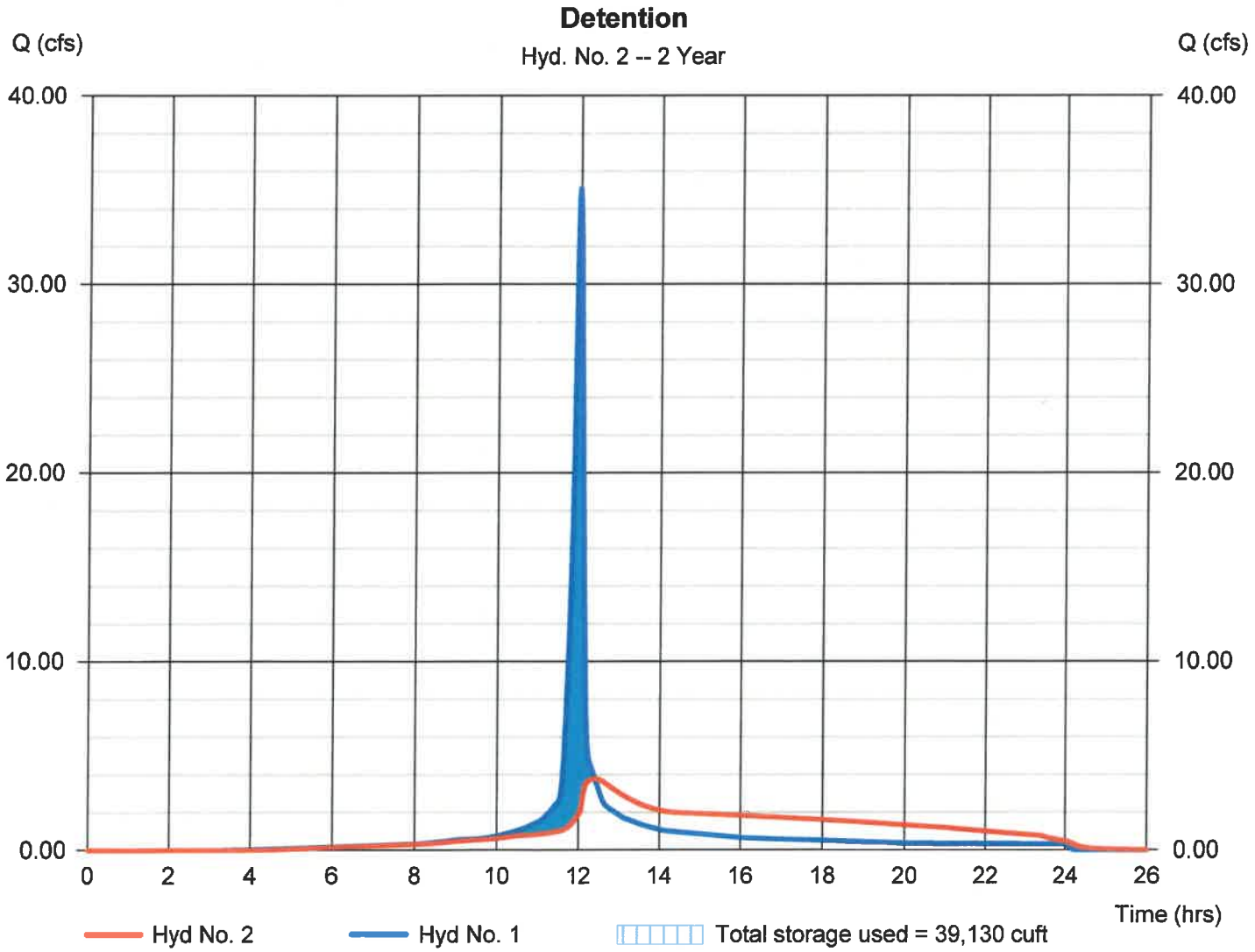
Hydrograph Report

Hyd. No. 2

Detention

Hydrograph type	= Reservoir	Peak discharge	= 3.785 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.40 hrs
Time interval	= 1 min	Hyd. volume	= 85,327 cuft
Inflow hyd. No.	= 1 - SITE	Max. Elevation	= 1007.70 ft
Reservoir name	= DETENTION	Max. Storage	= 39,130 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - DETENTION

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 1002.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1002.00	00	0	0
1.00	1003.00	3,882	1,294	1,294
2.00	1004.00	6,716	5,234	6,528
3.00	1005.00	7,838	7,269	13,797
4.00	1006.00	8,920	8,372	22,169
5.00	1007.00	10,058	9,482	31,652
6.00	1008.00	11,252	10,648	42,300
7.00	1009.00	12,504	11,871	54,171
8.00	1010.00	13,812	13,151	67,323
9.00	1011.00	15,903	14,844	82,166
10.00	1012.00	18,325	17,098	99,264

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	6.00	12.00	0.00
Span (in)	= 24.00	6.00	12.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 1002.00	1002.00	1007.00	0.00
Length (ft)	= 39.00	1.00	1.00	0.00
Slope (%)	= 1.00	1.00	1.00	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)	= 15.00	0.00	0.00	0.00
Crest El. (ft)	= 1011.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= Yes	No	No	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	1002.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
1.00	1,294	1003.00	0.78 ic	0.76 ic	0.00	---	0.00	---	---	---	---	---	0.762
2.00	6,528	1004.00	1.20 ic	1.18 ic	0.00	---	0.00	---	---	---	---	---	1.181
3.00	13,797	1005.00	1.50 ic	1.50 ic	0.00	---	0.00	---	---	---	---	---	1.495
4.00	22,169	1006.00	1.81 ic	1.76 ic	0.00	---	0.00	---	---	---	---	---	1.757
5.00	31,652	1007.00	1.99 ic	1.99 ic	0.00	---	0.00	---	---	---	---	---	1.989
6.00	42,300	1008.00	4.87 ic	2.13 ic	2.67 ic	---	0.00	---	---	---	---	---	4.801
7.00	54,171	1009.00	7.03 oc	2.28 ic	4.63 ic	---	0.00	---	---	---	---	---	6.913
8.00	67,323	1010.00	8.46 oc	2.43 ic	5.98 ic	---	0.00	---	---	---	---	---	8.413
9.00	82,166	1011.00	9.72 oc	2.58 ic	7.07 ic	---	0.00	---	---	---	---	---	9.652
10.00	99,264	1012.00	27.92 ic	2.24 ic	8.02 ic	---	17.66	---	---	---	---	---	27.92

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

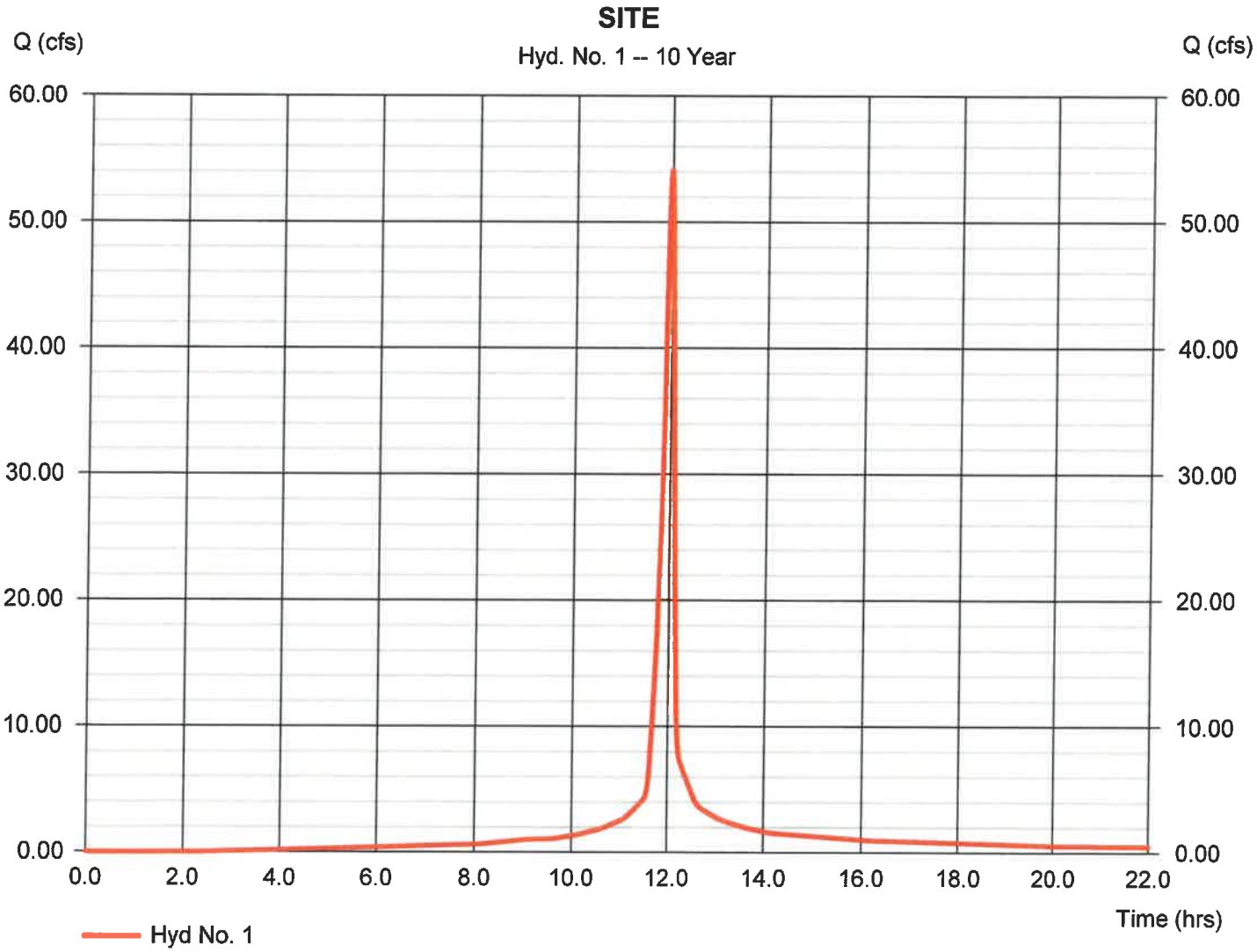
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	54.14	1	719	135,579	------	------	------	SITE
2	Reservoir	7.761	1	733	135,574	1	1009.54	61,226	Detention

Hydrograph Report

Hyd. No. 1

SITE

Hydrograph type	= SCS Runoff	Peak discharge	= 54.14 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 135,579 cuft
Drainage area	= 8.290 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 8.40 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



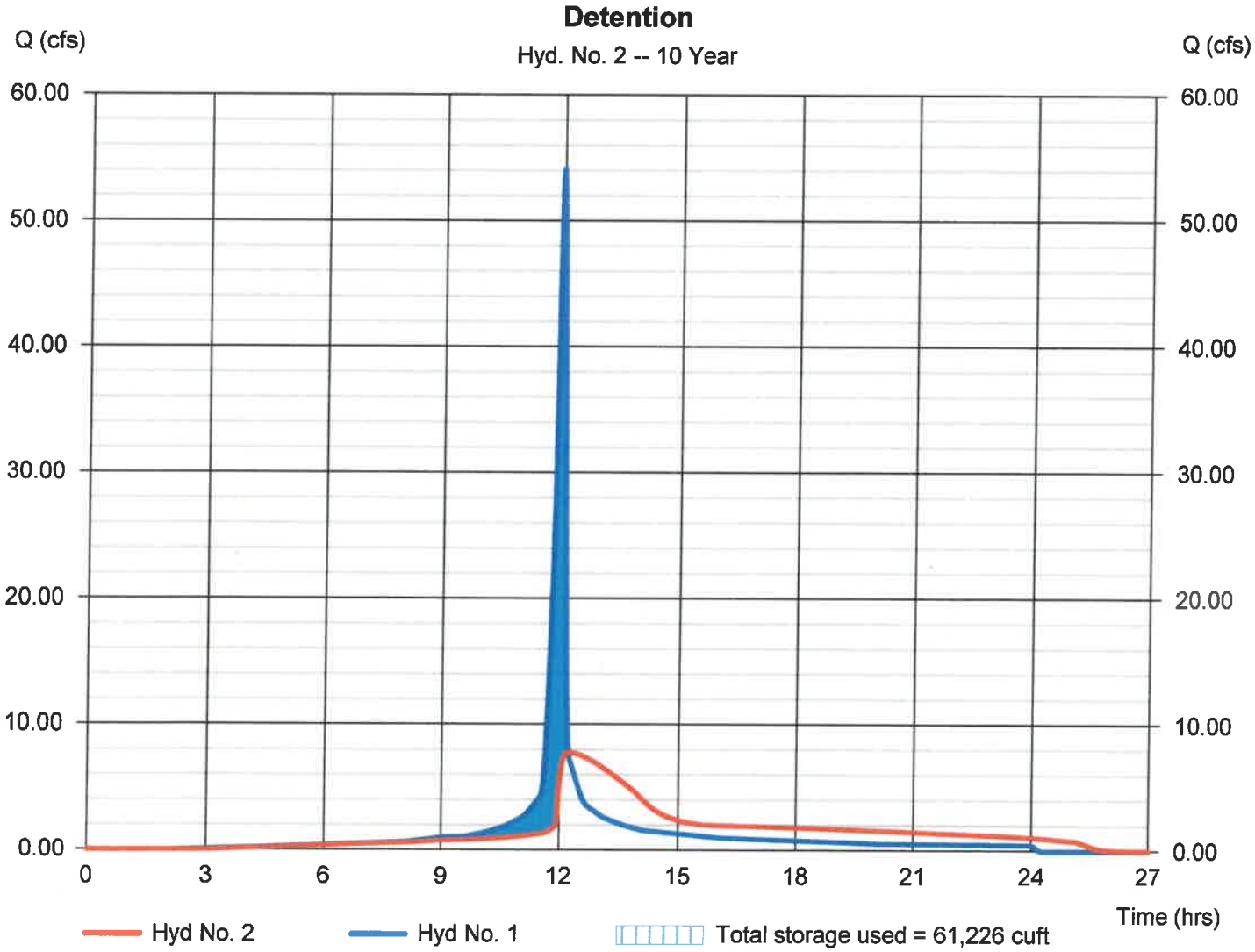
Hydrograph Report

Hyd. No. 2

Detention

Hydrograph type	= Reservoir	Peak discharge	= 7.761 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.22 hrs
Time interval	= 1 min	Hyd. volume	= 135,574 cuft
Inflow hyd. No.	= 1 - SITE	Max. Elevation	= 1009.54 ft
Reservoir name	= DETENTION	Max. Storage	= 61,226 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

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	81.80	1	719	210,157	------	------	------	SITE
2	Reservoir	17.78	1	730	210,152	1	1011.78	95,491	Detention

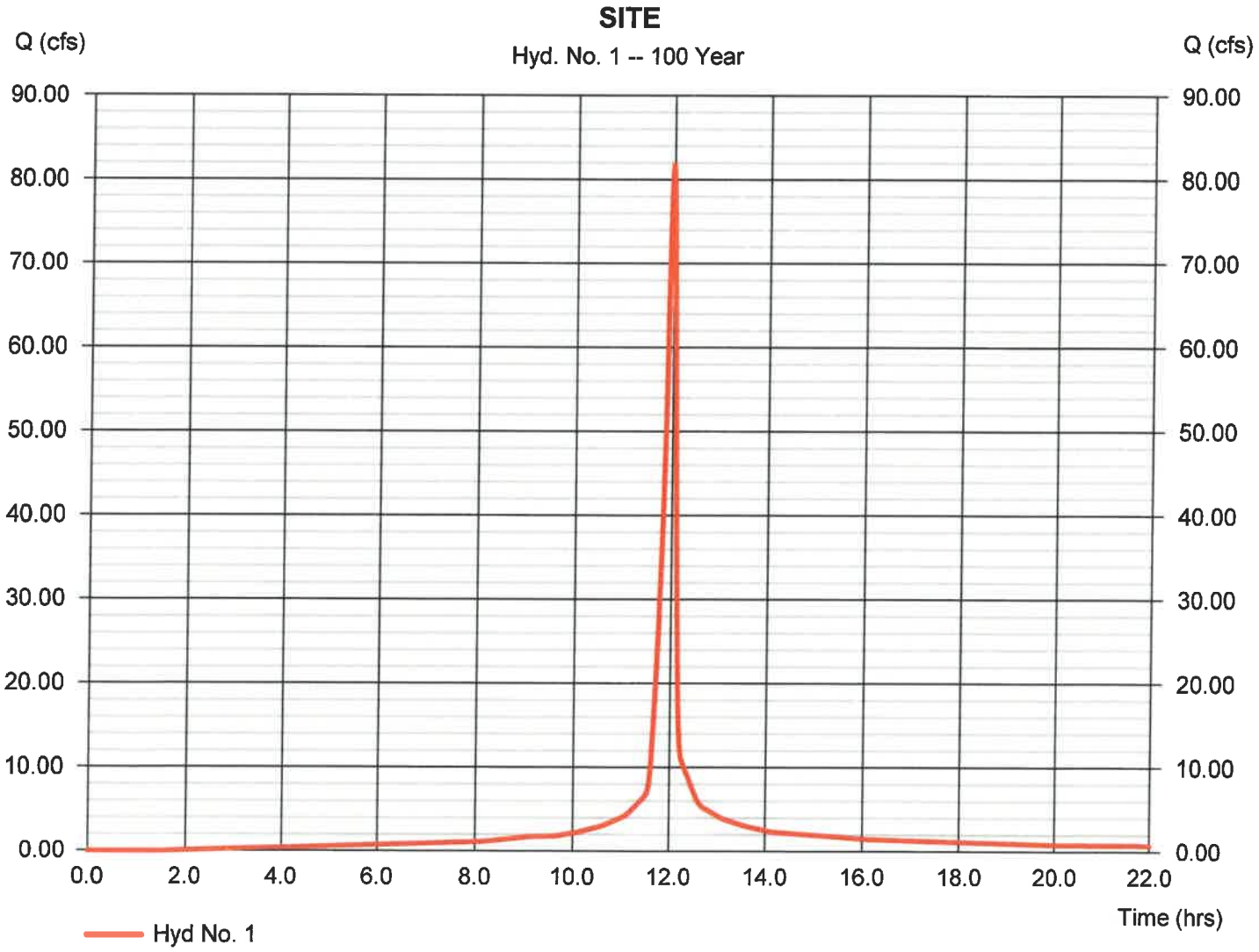
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Tuesday, 01 / 2 / 2018

Hyd. No. 1

SITE

Hydrograph type	= SCS Runoff	Peak discharge	= 81.80 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 210,157 cuft
Drainage area	= 8.290 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 8.40 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



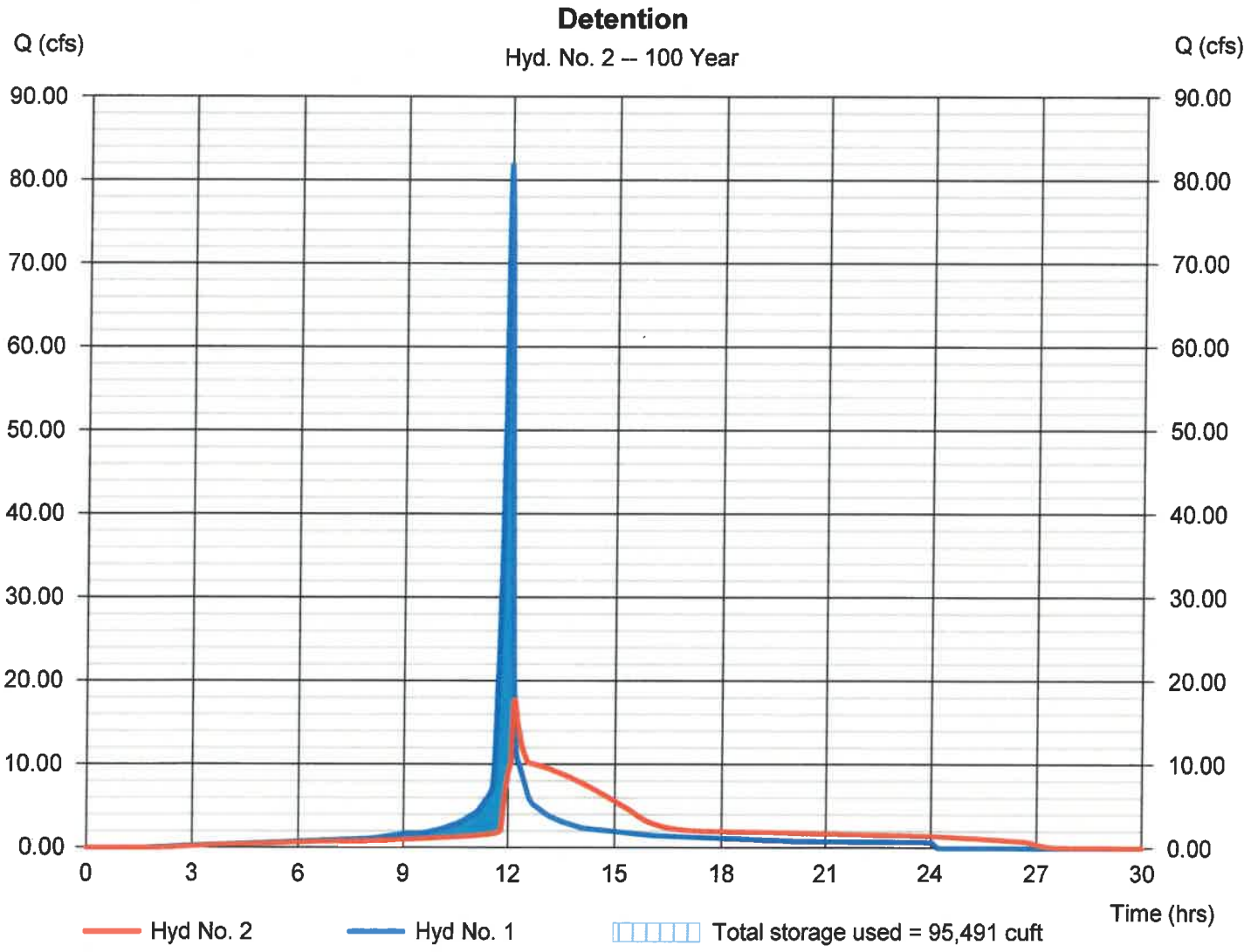
Hydrograph Report

Hyd. No. 2

Detention

Hydrograph type	= Reservoir	Peak discharge	= 17.78 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.17 hrs
Time interval	= 1 min	Hyd. volume	= 210,152 cuft
Inflow hyd. No.	= 1 - SITE	Max. Elevation	= 1011.78 ft
Reservoir name	= DETENTION	Max. Storage	= 95,491 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	64.1474	17.7000	0.8922	--------
2	95.7859	19.2000	0.9317	--------
3	0.0000	0.0000	0.0000	--------
5	118.7799	19.1000	0.9266	--------
10	125.1300	18.2000	0.9051	--------
25	158.9867	18.7000	0.9180	--------
50	171.2459	18.3000	0.9078	--------
100	187.3624	18.1000	0.9031	--------

File name: KCMO.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	3.96	3.31	2.86	2.52	2.25	2.04	1.87	1.72	1.60	1.49	1.40	1.32
2	4.92	4.13	3.56	3.14	2.81	2.54	2.32	2.14	1.98	1.85	1.73	1.63
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	6.23	5.23	4.51	3.98	3.56	3.22	2.94	2.71	2.52	2.35	2.20	2.07
10	7.27	6.09	5.26	4.63	4.14	3.75	3.43	3.16	2.93	2.74	2.57	2.42
25	8.70	7.30	6.30	5.54	4.96	4.49	4.10	3.78	3.51	3.27	3.07	2.89
50	9.83	8.24	7.11	6.26	5.60	5.07	4.64	4.27	3.97	3.70	3.47	3.27
100	11.00	9.21	7.95	7.00	6.26	5.67	5.19	4.78	4.44	4.14	3.89	3.66

Tc = time in minutes. Values may exceed 60.

Precip. file name: Z:\acad\KCMO.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	2.93	3.50	0.00	3.30	5.20	6.00	6.80	7.70
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	2.49	3.10	0.00	4.01	4.64	5.52	6.21	6.90
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	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 — Tuesday, 01 / 2 / 2018

Pond No. 1 - DETENTION

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 1002.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1002.00	00	0	0
1.00	1003.00	3,882	1,294	1,294
2.00	1004.00	6,716	5,234	6,528
3.00	1005.00	7,838	7,269	13,797
4.00	1006.00	8,920	8,372	22,169
5.00	1007.00	10,058	9,482	31,652
6.00	1008.00	11,252	10,648	42,300
7.00	1009.00	12,504	11,871	54,171
8.00	1010.00	13,812	13,151	67,323
9.00	1011.00	15,903	14,844	82,166
10.00	1012.00	18,325	17,098	99,264

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	6.00	12.00	0.00
Span (in)	= 24.00	6.00	12.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 1002.00	1002.00	1007.00	0.00
Length (ft)	= 39.00	1.00	1.00	0.00
Slope (%)	= 1.00	1.00	1.00	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)	= 15.00	0.00	0.00	0.00
Crest El. (ft)	= 1011.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= Yes	No	No	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).