MACRO STORM WATER DRAINAGE STUDY

The Townhomes of Chapel Ridge – 2nd Plat
Lots 9 – 17, 29, 30

The Estates of Chapel Ridge – 2nd Plat
Lots 23 & 24

SITE ACREAGE: 7.32 ACRES

Lee's Summit, MO

PREPARED BY:

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Submittal Date: April 10, 2020

Revision

Date	Comment	By

Matthew J. Schlicht, PE

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3. GENERAL INFORMATION

This storm study has been prepared to evaluate potential impacts from the proposed initial phase of development. The initial phase shall consist of two estate style lots and eleven townhome style lots along with associated infrastructure. At ultimate buildout the proposed Development Plan will provide 9 Estate style lots and 22 Townhome style lots. A storm study for the Development Plan at ultimate buildout was approved during the PDP stage of this project. The existing retention facility that was constructed with the first phase will be utilized to serve as the storm water controls for the previously studied Development Plan. The existing Phase I drainage map and storm tables are provided as Exhibit "A" within the appendix of this report. The amount of offsite drainage area that was designed to be conveyed into the existing retention facility is shown in blue on both the Pre and Post Development Drainage Area Maps. The purpose of this study is to confirm no adverse impacts are anticipated during the initial phase of construction.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29093C0430G, effective January 20, 2017.

See Exhibit B for a FIRMette which includes the proposed project site.

3.2 NRCS SOIL CLASSIFICATION

Soil classifications published by the United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) website for Jackson County, Missouri, Version 18, September 16, 2017. The existing site contains five major soil types:

10024	Greenton-Urban Land Complex, 5 to 9 Percent Slopes Hydrologic Soils Group (HSG): Type D
10129	Sharpsburg-Urban Land Complex, 5 to 9 Percent Slopes (HSG): Type D
10136	Sibley-Urban Land Complex, 2 to 5 Percent Slopes (HSG): Type C
10143	Snead-Urban Land Complex, 9 to 30 Percent Slopes (HSG): Type D
10183	Udarents-Urban Land Polo-Complex, 5 to 9 Percent Slopes (HSG): Type C

See Exhibit C for a detailed soils report of the proposed project site.

4. METHODOLOGY

This Macro Storm Drainage Study has been prepared to evaluate potential hydrologic impacts from the proposed development and recommend improvements to eliminate potential negative impacts. The study utilized existing city contours to create the Pre-Development Drainage Area Map. The study conforms to the requirements of the City of Lee's Summit, Missouri "Design and Construction Manual" and all applicable codes and criteria referred to therein.

Using the above criteria, the proposed site was evaluated using SCS Methods to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. The analysis contains results for the 2, 10 and 100-year design storms.

5. EXISTING CONDITIONS ANALYSIS

The site has four (4) drainage Subareas all consisting of meadow land that drain offsite with the following drainage patterns.

- Subarea A, 2.79 acres, drains to the Northwest and drains into an existing swale that conveys the storm water to an existing road crossing pipe that is located west of the development. Subarea A will be evaluated at Point of Interest A

-Subarea B, 5.76 acres, drains to the north and through an existing residential development area. Subarea B drains to a large swale area to the north for the purposes of this report the subarea will be evaluated at Point of Interest B. No flooding concerns have been raised downstream therefore the evaluation will focus solely on the land that is being proposed for development.

-Subarea C, 6.64 acres, drains to the Northeast and drains into an existing road side ditch channel for the old highway outer road that is no longer in use. A sizeable portion of the subarea consists of offsite property. Subarea C will be evaluated at the offsite roadside ditch known as Point of Interest C. See Exhibit D for details and calculations of composite curve numbers as required.

-Subarea D, 4.92 acres, drains to the southwest where it is intercepted and attenuated by the Phase I retention system.

A Pre-Development Drainage Map may be found in Exhibit E. Hydraflow Hydrograph software was utilized to calculate SCS Method peak discharge rates. A complete breakdown of Existing and Proposed hydrographs may be found in Exhibit F. The following tables summarize the results of the Existing Conditions analysis.

Table 5.1 Existing Conditions Subarea

Subarea	Area (ac.)	Curve Number	Tc (min)
A	2.79	74	11.9
B	5.76	74	12.5
C	6.64	76	10.1
D*	4.92		

*Subarea D consisting entirely of Proposed Phase II Development drains to the Existing Chapel Ridge Phase I Retention System. The Existing Chapel Ridge Phase I Retention System was designed to accept and convey 11.10 acres of the Chapel Ridge Phase II Development.

Table 5.2 Existing Conditions Runoff Data: Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	4.80	9.96	18.26
B	9.90	20.57	37.70
C	13.75	27.40	48.96

Per APWA Section 5608.4 and City of Lee's Summit criteria, the performance criteria for detention is to provide detention to limit peak flow rates at downstream points of interest to maximum release rates:

- 50% storm peak rate less than or equal to 0.5 cfs per site acre
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
- 1% storm peak rate less than or equal to 3.0 cfs per site acre

Allowable release rates are comprised of a combination of peak offsite flows and allowable onsite post development peak flows at each point of interest. The area ratio method will be used to determine allowable release rates.
Allowable Release Example Calculation: Subarea C (2-Yr) = 2.08 x 0.5 + (6.64-2.08) / 6.64 x 13.75 = 6.05 cfs

Table 5.3 Existing Conditions APWA Allowable Peak Discharge Release Rates

Subarea	Total Area (ac.)	Onsite Area (ac.)	*Developed Area (ac.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	2.79	2.79	0.34	4.39	8.75	17.05
B	5.76	5.76	1.31	8.30	18.51	33.06
C	6.64	4.90	2.08	10.48	22.98	39.86

*Developed Area – Area to be developed this Phase

6. PROPOSED CONDITIONS ANALYSIS

The Proposed Conditions analysis assumes completion of two new estate lots and eleven townhome lots along with associated infrastructure. The difference between Existing and Proposed Conditions is a direct result of new residential single and multi-family housing. Subareas A and B have been reduced significantly due to redirection of their tributary areas with the use of new streets and storm sewer systems. Subarea C increased slightly. A new detention system shall be used to attenuate post development runoff tributary to Point of Interest C. Subarea D represents area tributary to the Phase I retention system. A Post Development Drainage Map may be found in Exhibit G.

Post-Development Flow Rates

The post development flow rates were calculated with the use of composite curve numbers as applicable. The curve numbers were determined based on APWA Table 5602-3 for residential lots and multi-family lots. A curve number of 88 was used for multi-family areas and a curve number of 82 was used for single family areas.

Table 6.1 Proposed Conditions Subarea Data

Subarea	Area (ac.)	Composite CN	Tc (min)
A	0.60	74	10.1
B	4.43	74	12.2
C	2.91	84	10.5
C1	3.88	80	10.8
D*	8.30		

*Subarea D consisting entirely of Proposed Phase II Development contains 8.30 acres and drains to the Existing Chapel Ridge Phase I Retention System. The Existing Chapel Ridge Phase I Retention System was designed to accept and convey 11.10 acres of the Chapel Ridge Phase II Development. Subarea D will also contain 0.86 acres of Green Space which was not originally anticipated during the Phase I design of the Retention System (See Exhibit A). Conclusion Proposed Subarea D acreage is below that which was originally anticipated during the design of the Phase I Retention System therefore no adverse impacts are anticipated downstream due to the development of this Subarea. No further analysis will be provided for Subarea D.

Table 6.2 Proposed Conditions Runoff Data: Sub-Area Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	1.12	2.31	4.24
B	7.61	15.82	28.99
C	8.59	15.08	24.72
C1	9.69	18.09	30.89

As shown in Table 6.2 above Subarea C1 will require detention to attenuate peak discharge rates below both Existing Conditions and Allowable at POI C.

6.1. DETENTION

A new single stage earthen detention basin C1 is being proposed in Sub-basin C1 to attenuate proposed peak discharge rates. Following are a list of design parameters for the detention system.

Designation: Detention Basin C1
Type: Earthen Basin
Side Slopes: 3:1 Max.
Bottom Slope: 2% Min., Turf Lined
Basin Bottom Elevation: 929.00 @ Influent Pipe
Basin Top Berm Elevation: 940.00
Basin Volume: 73,920 cf @ 940.00
Control Structure: 5'x4' Precast Concrete Box with Interior 6" Baffle/Weir Wall
Baffle Wall Orifices: (8) 1" Diameter on 4" Centers, FL=927.60 (Bottom Orifice)
(1) 6" Diameter, FL=936.00
Baffle Wall Crest Elevation: 939.00
Control Structure Top Elevation: 940.00
Control Structure Overflow Weir Openings: (3) – 6" NW, SW & SE
Control Structure Influent Pipe: 30" HDPE, FL (In) = 929.00, FL (Out) = 927.70, L=34.46', S= 3.77%
Control Structure Effluent Pipe: 30" HDPE, FL (In) = 927.50, FL (Out) = 926.00, L=40', S=3.75%
Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=938.65, Crest Length=85'
Consecutive 100-YR Q=30.89 cfs, Emergency Spillway HGL=938.92', Freeboard=1.08'

The Detention Basin Plan for the Development may be found in Exhibit H. Basin C1 emergency spillway calculations may be found in Exhibit I. See Table 6.3 for a summary of detention basin data.

Table 6.3 Proposed Conditions Detention Basin C1 Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin C1						
2-Year	9.69	720	0.48	818	933.47	12,698
10-Year	18.09	720	0.83	816	935.43	25,296
100-Year	30.89	720	2.24	765	937.38	42,572

As shown in the table above all proposed peak flowrates have been attenuated. See Table 6.4 below for a summary of proposed peak discharge rates at point of interest C. Hydrographs tributary to each point of interest have been combined to determine subsequent peak discharge rates.

Table 6.4 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
C	8.87	15.59	25.58

As shown in the above table all peak discharge rates attributable to Subareas C & C1 improvements have been attenuated below Existing Peak Discharge rates as outlined in Table 5.2.

Table 6.5 below provides a comparison of runoff data between Proposed, Existing and Allowable Conditions for the Proposed Phase II Development.

Table 6.5 Point of Interest Discharge Comparison

		Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Point A	Proposed	1.12	2.31	4.24
	Existing	4.80	9.96	18.26
	Difference	-3.68	-7.65	-14.02
	Allowable	4.39	8.75	17.05
	Difference	-3.27	-6.44	-12.81
Point B	Proposed	7.61	15.82	28.99
	Existing	9.90	20.57	37.70
	Difference	-2.29	-4.75	-8.71
	Allowable	8.30	18.51	33.06
	Difference	-0.69	-2.69	-4.07
Point C	Proposed	8.87	15.59	25.58
	Existing	13.75	27.40	48.96
	Difference	-4.88	-11.81	-23.38
	Allowable	10.48	22.98	39.86
	Difference	-1.61	-7.39	-14.28

Peak discharge rates for the proposed initial phase of Development will be reduced below both Existing and Allowable Peak Discharge Rates for all regulatory design storms.

7. 40 HOUR EXTENDED DETENTION

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). The proposed detention facility will release the water quality event over a period of 40-72 hours. See Exhibit J for Detention Basin C1 extended detention calculations. The Water Quality Volume is released in approximately 40 hours from Basin C1.

8. CONCLUSIONS & RECOMMENDATIONS

Runoff from the initial phase of the proposed development will be reduced below both Existing and Allowable Peak Discharge Rates for all subareas. A detention basin will be provided in the initial development phase in Subarea C1 to attenuate peak discharge rates at Point of Interest C. The basin will be designed to accommodate the entire PDP Phase 2 development as outlined in the previously approved storm study. A few modifications were made to the detention basin design to accommodate buildout conditions and improve overall operation. Tributary area for Subarea D is below the original design for Phase I retention. No negative impacts are anticipated downstream from the proposed initial phase of development. Engineering Solutions recommends approval of this macro storm water drainage study.

Waiver Requests: None

9. EXHIBITS

- **Exhibit A**
  - **Existing Chapel Ridge Drainage Map & Tables**
- **Exhibit B**
  - **FEMA FIRMette**
- **Exhibit C**
  - **NRCS Soils Report**
- **Exhibit D**
  - **Composite Curve Numbers**
- **Exhibit E**
  - **Pre-Development Drainage Area Map**
- **Exhibit F**
  - **Hydraflow Hydrograph Report**
- **Exhibit G**
  - **Post Development Drainage Area Map**
- **Exhibit H**
  - **Detention Plan**
- **Exhibit I**
  - **Emergency Spillway Calculations**
- **Exhibit J**
  - **Extended Detention Calculations**

Exhibit A

Existing Chapel Ridge Phase I Drainage Map & Tables

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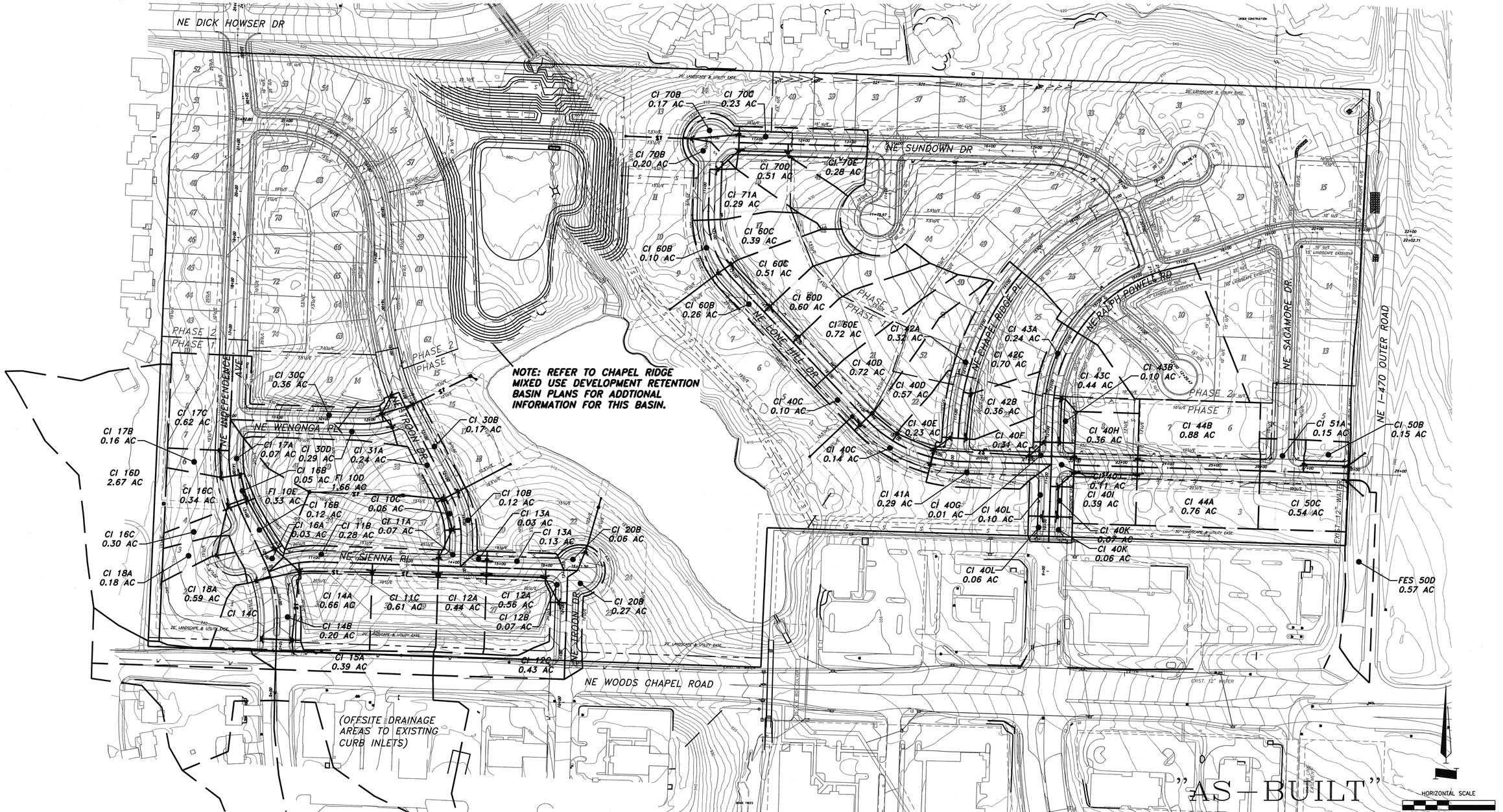

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FILES ATTACHED: 5	DESIGNED BY: MDM	DRAWN BY: MDM	CHECKED BY: JPB
ATTACHED FILE NAMES: XRF00274RD.DWG, XRF00274ST.DWG, XRF00274CT.DWG XRF00274SS.DWG, XRF00274WA.DWG			

NO.	DATE	BY	REVISION
1	02/17/06	MDM	PER CITY COMMENTS DATED 02/07/06
2	04/06/06	MDM	PER CITY COMMENTS DATED 03/31/06
3	05/02/06	MDM	PER CITY COMMENTS DATED 05/01/06
4	06/01/07	LJC	AS-BUILT
5	3/7/08	WAS	AS-BUILT REVISIONS

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CHAPEL RIDGE - PHASE 1
LEE'S SUMMIT, MISSOURI
GOLF AMERICA, LLC.

PROJECT NO. 0300000274

STORM SEWER DRAINAGE MAP

DRAWING NO. ST-01

PIPE	NODE UPSTREAM	NODE DOWNSTREAM	10-YEAR HGL UPSTREAM (FT)	10-YEAR HGL DOWNSTREAM (FT)	100-YEAR HGL UPSTREAM (FT)	100-YEAR HGL DOWNSTREAM (FT)	INVERT UPSTREAM	INVERT DOWNSTREAM (FT)	INLET TC (MIN)	INLET AREA (ACRES)	RUNOFF COEFFICIENT	TOTAL CA (ACRES)	RAINFALL INTENSITY (IN/HR)	10-YEAR PIPE FLOW (CFS)	FULL FLOW CAPACITY (CFS)	10-YEAR RUNOFF (CFS)	TOTAL 10-YEAR RUNOFF (CFS)	80% INLET L CAPACITY (10-YR) (CFS)	100-YEAR RUNOFF (CFS)	100-YEAR STORM	100-YEAR SYSTEM FLOW (CFS)	SECTION MATERIAL	SECTION SECTION SIZE	CONSTRUCTED SLOPE (%)	LENGTH (FT)	DESIGN VELOCITY (FT/S)	FULL FLOW VELOCITY (FT/S)	10-YEAR SPREAD (FT)	50-YEAR SPREAD (FT)
LINE 10																													
	10B		907.07	909.97	904.65				5.2	0.12	0.65	0.08	7.3	75.25	190.07	0.57	0.57	0.50	1.00	PIPE	141.31	RCP	60	0.53	122.00	7.99	9.68	5.45	N/A
	10A		906.42	907.32	904.00																								
	10C		907.98	908.90	905.50				5.0	0.06	0.65	0.04	7.4	74.75	195.27	0.29	0.33	0.30	0.50	PIPE	140.52	RCP	54	0.99	35.50	8.14	12.28	4.72	N/A
	10B		907.72	908.38	905.15																								
	10D		909.38	910.76	908.50				10.9	1.66	0.51	0.85	5.9	6.16	17.10	4.99	4.99	4.99 (FIELD INLET)	8.84	SURCHARGE	10.91	HDPE	24	0.57	87.43	6.16	5.44	N/A	N/A
	10C		909.00	910.56	908.00																								
	10E		913.68	913.83	913.25				6.3	0.33	0.51	0.17	7.0	1.17	9.10	1.17	1.17	1.17 (FIELD INLET)	2.07	PIPE	2.07	HDPE	15	1.99	201.25	3.03	7.42	N/A	N/A
	10D		909.70	911.00	909.25																								
LINE 11	11A		918.68	920.36	914.10				5.0	0.07	0.65	0.05	7.4	68.29	263.29	0.33	0.47	0.43	0.59	SURCHARGE	129.03	HDPE	48	3.36	68.46	11.45	20.95	5.34	N/A
	10C		913.20	913.78	911.80																								
	11B		919.79	920.70	917.35				5.9	0.28	0.65	0.18	7.1	67.86	140.43	1.29	1.29	1.15	2.26	PIPE	128.22	HDPE	48	0.96	68.01	8.38	11.17	8.55	N/A
	11A		919.18	920.36	916.70																								
	11C		920.67	921.57	918.25				14.0	0.61	0.51	0.31	5.3	66.71	152.48	1.66	2.08	1.74	2.94	PIPE	126.35	RCP	48	1.13	35.50	8.04	12.13	9.93	N/A
	11B		920.46	921.15	917.85																								
LINE 12	12A		922.46	924.18	921.50				12.6	1.00	0.51	0.51	5.6	6.26	8.92	2.84	3.27	3.27 (LOW POINT)	5.04	SURCHARGE	11.70	HDPE	18	0.72	104.01	5.35	5.05	11.15 (W)	N/A
	11C		921.68	922.88	920.75																							11.49 (E)	
	12B		924.90	926.13	924.30				5.0	0.07	0.65	0.05	7.4	2.24	7.31	0.33	0.98	0.88	0.59	SURCHARGE	3.55	HDPE	15	1.28	125.00	3.32	5.95	6.79	N/A
	12A		923.48	925.75	922.70																								
	12C		932.97	933.04	932.50				5.6	0.43	0.65	0.28	7.2	1.36	22.64	2.00	2.00	1.36	3.52	SURCHARGE	1.81	HDPE	15	12.29	62.64	4.48	18.45	7.57	N/A
	12B		925.11	926.40	924.80																								
LINE 13	13A		923.52	925.88	922.55				5.4	0.16	0.65	0.10	7.2	0.75	5.54	0.75	0.75	0.75 (LOW POINT)	1.32	SURCHARGE	1.32	RCP	15	0.74	34.00	0.68	4.51	5.80 (W)	N/A
	12A		923.51	925.86	922.30																							8.95 (E)	
LINE 14	14A		923.27	924.13	921.00				15.0	0.66	0.51	0.34	5.2	58.71	145.17	1.74	2.10	1.68	3.10	PIPE	111.65	HDPE	48	1.02	142.00	9.07	11.55	9.45	N/A
	11C		921.43	922.34	919.55																								
	14B		926.28	927.14	924.05				5.7	0.20	0.70	0.14	7.2	57.03	183.49	1.00	1.57	1.21	1.76	PIPE	109.02	HDPE	48	1.63	156.28	7.50	14.60	7.81	N/A
	14A		923.94	924.70	921.50																								
	14C		932.34	932.46	931.90				11.3	0.42	0.51	0.21	5.8	1.20	10.77	1.24	1.24	1.20	2.20	PIPE	1.97	RCP	15	2.78	95.29	4.45	8.78	7.37	8.41
	14B		929.53	929.61	929.25																								
LINE 15	15A		935.26	939.76	933.25				5.8	0.39	0.70	0.27	7.1	39.66	130.96	1.94	1.94	1.74	3.41	SURCHARGE	78.69	HDPE	36	3.86	149.14	12.04	18.53	8.15	9.31
	14B		928.64	929.18	927.50																								
	EX		936.07	939.91	934.15				N/A	N/A	N/A	N/A	N/A	36.15	76.46	0.00	36.15	N/A	N/A	SURCHARGE	45.60	HDPE	36	1.31	30.44	7.27	10.82	N/A	N/A
	15A		935.82	939.76	933.75																								
LINE 16	16A		927.44	928.58	926.15				5.7	0.03	0.65	0.02	7.2	14.96	37.59	0.14	0.14	0.14	0.25	SURCHARGE	26.68	RCP	30	0.84	71.44	5.24	7.66	4.18	4.65
	14B		927.11	928.28	925.55																								
	16B		928.69	929.12	927.40				5.3	0.17	0.65	0.11	7.3	14.82	31.78	0.80	0.82	0.82 (LOW POINT)	1.41	PIPE	26.44	HDPE	30	0.63	118.49	6.14	6.65	9.08 (S)	10.41 (S)
	16A		927.84	928.58	926.65																							7.00 (N)	8.01 (N)
	16C		929.40	930.93	928.20				11.1	0.64	0.51	0.33	5.9	11.37	19.00	1.91	2.02	2.02 (LOW POINT)	3.38	SURCHARGE	20.54	RCP	24	0.71	42.50	6.04	6.05	10.18 (S)	11.99 (S)
	16B		929.02	929.90	927.90																							10.14 (N)	11.92 (N)
	16D		933.81	934.14	932.80				15.0	2.67	0.51	1.36	5.2	7.05	17.94	7.05	7.05	7.05 (FIELD INLET)	12.53	SURCHARGE	12.53	HDPE	18	2.92	140.46	4.77	10.15	N/A	N/A
	16C		930.33	930.93	928.70																								
LINE 17	17A		929.65	930.24	929.00				5.0	0.07	0.65	0.05	7.4	2.63	5.25	0.33	0.33	0.32	0.59	SURCHARGE	4.45	HDPE	15	0.59	59.35	4.07	4.04	5.68	6.41
	16B		929.30	929.75	928.65																								
	17B		930.41	930.59	929.80				10.0	0.16	0.51	0.08	6.1	2.31	5.46	0.50	0.89	0.82	0.88	SURCHARGE	3.89	RCP	15	0.71	42.00	3.49	4.45	7.54	9.09
	17A		930.24	930.28	929.50																								
	17C		931.69	931.80	931.20				10.5	0.62	0.51	0.32	6.0	1.49	7.99	1.89	1.89	1.49	3.34	SURCHARGE	2.23	HDPE	15	1.53	58.77	4.16	6.51	8.81	10.10
	17B		930.67	931.42	930.30																								
LINE 18	18A		930.64	931.35	929.80				10.5	0.75	0.51	0.38	6.0	2.30	5.30	2.30	2.30	2.30 (LOW POINT)	4.07	SURCHARGE	4.07	HDPE	15	0.71	105.07	2.25	4.45	10.21 (S)	11.75 (S)
	16C		930.52	930.93	929.05																							7.02 (N)	8.28 (N)
LINE 19	19A		936.18	940.12	935.45				N/A	N/A	N/A	N/A	N/A	1.77	34.12	0.00	1.77	1.77 (DEPRESSION)	0.00	SURCHARGE	30.43	RCP	30	0.69	65.00	1.13	6.95	16.53	7.10
	15A		936.18	939.76	935.00																								
LINE 20	20B		908.75	908.91	908.25				N/A	N/A	N/A	N/A	N/A	1.55	8.34	1.55	1.55	1.55	2.71	PIPE	2.71	RCP	15	1.67	15.00	3.40	6.79	N/A	N/A
	20A		908.38	908.52	908.00																								
	20C		924.00	924.16	923.50				5.5	0.33	0.65	0.21	7.2	1.55	24.46	1.55	1.55	1.55	2.71	PIPE	2.71	HDPE	15	14.58	101.16	7.30	20.09	6.43 (W)	N/A
	20B		908.96	909.10	908.75																							10.17 (E)	
LINE 30	30B		904.97	905.63	904.10				N/A	N/A	N/A	N/A	N/A	4.65	6.76	N/A	N/A	N/A	N/A	PIPE	7.43	RCP	15	1.13	8.83	5.02	5.60	N/A	N/A
	30A		904.90	905.25	904.00																								
	30C		906.96	907.64	906.10				5.5	0.17	0.65	0.11	7.2	4.65	6.74	0.80	0.87	0.80	1.40	PIPE	7.43	HDPE	15	1.09	138.03	5.02	5.49	7.37	N/A
	30B		905.50	906.20	904.60																								
	30D		907.98	908.84	907.05				5.9	0.36	0.65	0.23	7.1	3.85	5.11	1.66	1.66	1.19	2.92	SURCHARGE	6.06	RCP	15	0.63	71.41	4.58	4.18	7.58	N/A
	30C		907.41	908.21	906.60																								
	30E		908.86	909.78	908.45				5.4	0.29	0.65	0.19	7.2	1.07	5.80	1.36	1.36	1.07	2.39	PIPE	1.58	RCP	15	0.80	37.34	3.29	4.72	7.34	N/A
	30D		908.52	909.76	908.15																								
LINE 31	31A		908.40	909.79	907.90				5.6	0.24	0.65	0.16	7.2	1.59	5.65	1.12	1.91	1.59	1.97	SURCHARGE	2.82	HDPE	15	0.66	45.80	2.74	4.60	9.40	N/A
	30C		908.30	909.70	907.55																								

FLOWTABLE NOTES:

TOTAL 10-YR RUNOFF INCLUDES BYPASS FROM UPSTREAM INLETS.

CURB INLET 19A IS CONSTRUCTED WITH A LOCAL DEPRESSION, THERFORE COLLECTING ALL BYPASS FLOW FROM EXISTING CURB INLETS ON NE WOODS CHAPEL ROAD.

CONTROLLED FILL NOTE:

IN ALL AREAS WHERE THERE ARE LESS THAN 18" OF EXISTING COVER OVER PROPOSED STORM SEWER, COMPACTED FILL OF 80% STANDARD PROCTOR DENSITY (95% STD. PROCTOR IN STREET RIGHT-OF-WAYS) SHALL BE PLACED ABOVE THE PROPOSED TOP OF PIPE OR TO THE PROPOSED FINISHED GRADE, WHICHEVER IS LESS, PRIOR TO EXCAVATION FOR THE PROPOSED PIPE.

MATERIAL NOTES:

CONCRETE PIPE SHALL CONFORM TO ASTM C76, CLASS III, WALL TYPE B.

HDPE PIPE SHALL CONFORM TO AASHTO M294, TYPE S. HDPE PIPE MAY BE USED IN LIEU OF CONCRETE PIPE.

ALUMINIZED CORRUGATED METAL PIPE MAY BE USED IN LIEU OF HDPE PIPE OR CONCRETE PIPE. MANNING'S N VALUE SHALL BE EQUAL TO OR LESS THAN 0.013. THE PIPE SHALL CONFORM TO AASHTO M274. PIPE GAUGE SHALL BE 14 FOR 30" DIAMETER AND SMALLER PIPES, AND 12 GAUGE FOR 36" DIAMATER THROUGH 54" DIAMETER PIPES.

"AS-BUILT"
March 7, 2008

DRAWING FILE NAME:	PLOT SCALE:	DATE ISSUED:
00274-P1ST02.DWG	1:100	12/21/05

FILES ATTACHED:	DESIGNED BY:	DRAWN BY:	CHECKED BY:
	MDM	MDM	JPB

ATTACHED FILE NAMES:

NO.	DATE	BY	REVISION
1	02/17/06	MDM	PER CITY COMMENTS DATED 02/07/06
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3	05/02/06	MDM	PER CITY COMMENTS DATED 05/01/06
4	06/01/07	LJC	AS-BUILT
5	3/7/08	WAS	AS-BUILT REVISIONS

STATE OF MISSOURI
JOSEPH PATRICK BAUER
NUMBER 2001033240
REGISTERED PROFESSIONAL ENGINEER
3/7/08

E. T. ARCHER CORPORATION D.B.A.
Archer
TOTAL PROJECT MANAGEMENT
CORPORATE OFFICE:
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CHAPEL RIDGE - PHASE 1
LEE'S SUMMIT, MISSOURI
GOLF AMERICA, LLC.

PROJECT NO. 0300000274

FLOWTABLE

DRAWING NO. ST-02

PIPE	NODE UPSTREAM / DOWNSTREAM	10-YEAR HGL UPSTREAM DOWNSTREAM (FT)	100-YEAR HGL UPSTREAM DOWNSTREAM (FT)	INVERT UPSTREAM DOWNSTREAM (FT)	INLET TC (MIN)	INLET AREA (ACRES)	RUNOFF COEFFICIENT	TOTAL CA (ACRES)	RAINFALL INTENSITY (IN/HR)	10-YEAR PIPE FLOW (CFS)	FULL FLOW CAPACITY (CFS)	10-YEAR RUNOFF (CFS)	TOTAL 10-YEAR RUNOFF (CFS)	80% INLET L CAPACITY (10-YR) (CFS)	100-YEAR RUNOFF (CFS)	100-YEAR STORM	100-YEAR SYSTEM FLOW (CFS)	SECTION MATERIAL	SECTION SECTION SIZE	CONSTRUCTED SLOPE (%)	LENGTH (FT)	DESIGN VELOCITY (FT/S)	FULL FLOW VELOCITY (FT/S)	10-YEAR SPREAD (FT)	50-YEAR SPREAD (FT)
LINE 40	40B	914.21	914.78	912.50	N/A	N/A	N/A	N/A	N/A	28.80	113.20	N/A	N/A	N/A	N/A	PIPE	51.34	RCP	36	2.88	121.50	6.92	16.01	N/A	N/A
	40A	910.71	911.28	909.00																					
	40C	919.93	921.59	917.55	5.5	0.24	0.65	0.16	7.2	28.80	59.87	1.13	1.63	1.63 (LOW POINT)	1.97	PIPE	51.34	HDPE	36	0.81	24.82	7.13	8.47	9.81 (S)	N/A
	40B	918.82	919.49	917.35																				7.95 (N)	
	40D	920.05	923.42	918.30	14.6	1.29	0.51	0.66	5.2	27.17	34.18	3.45	3.80	3.80 (LOW POINT)	6.12	SURCHARGE	48.04	RCP	30	0.69	36.00	7.13	6.96	11.48 (S)	N/A
	40C	919.93	921.59	918.05																				11.46 (N)	
	40E	922.00	924.07	919.50	9.5	0.23	0.51	0.12	6.2	23.37	41.19	0.73	1.66	1.31	1.28	SURCHARGE	39.47	HDPE	30	1.01	69.39	4.76	8.39	8.22	N/A
	40D	921.82	923.42	918.80																					
	40F	924.77	925.23	923.20	8.1	0.31	0.60	0.19	6.5	22.06	79.01	1.21	2.29	1.35	2.13	SURCHARGE	36.86	HDPE	30	3.71	86.22	5.80	16.10	8.07	N/A
	40E	922.21	924.70	920.00																					
	40G	935.35	935.78	933.95	5.0	0.01	0.70	0.01	7.4	15.67	49.23	0.05	0.30	0.28	0.09	PIPE	28.05	RCP	24	4.74	205.77	9.03	15.67	4.73	N/A
	40F	925.10	925.28	924.20																					
	40H	936.39	938.20	935.15	10.9	0.36	0.66	0.24	5.9	12.20	19.21	1.40	3.21	1.92	2.48	SURCHARGE	22.39	RCP	24	0.72	97.00	5.68	6.12	9.12	N/A
	40G	935.91	936.45	934.45																					
	40I	937.04	938.52	935.90	10.1	0.39	0.66	0.26	6.1	10.28	19.39	1.56	3.06	1.87	2.76	SURCHARGE	19.87	RCP	24	0.74	34.00	5.61	3.76	8.99	N/A
	40H	936.78	938.20	935.65																					
	40J	937.57	938.66	936.75	6.6	0.11	0.75	0.08	6.9	5.34	20.06	0.57	3.35	2.21	1.00	SURCHARGE	13.85	HDPE	24	0.79	44.48	3.76	6.39	10.48	N/A
	40I	937.48	938.52	936.40																					
	40K	938.71	941.50	938.00	6.7	0.13	0.66	0.09	6.9	3.13	5.66	0.59	2.23	2.23 (LOW POINT)	1.04	SURCHARGE	10.35	HDPE	15	0.77	65.00	4.53	4.62	9.23 (S)	N/A
	40J	938.17	939.02	937.50																				11.50 (N)	
	40L	939.40	941.52	938.75	6.2	0.16	0.81	0.13	7.0	0.90	5.54	0.90	0.90	0.90 (LOW POINT)	1.59	SURCHARGE	1.59	RCP	15	0.74	34.00	1.17	4.51		N/A
	40K	939.40	941.50	938.50																					
LINE 41	41A	925.45	926.38	924.70	6.4	0.29	0.81	0.23	7.0	1.12	5.50	1.63	1.63	1.12	2.87	SURCHARGE	1.54	RCP	15	0.72	34.50	1.26	4.48	7.34	N/A
	40F	925.45	926.36	924.45																					
LINE 42	42A	929.09	929.23	928.30	5.8	0.32	0.65	0.21	7.1	3.92	19.17	1.48	1.48	1.13	2.60	SURCHARGE	5.41	HDPE	15	8.81	43.69	4.51	15.62	7.50	N/A
	40F	925.33	926.09	924.45																					
	42B	929.72	929.83	929.05	8.8	0.36	0.51	0.18	6.3	2.79	5.54	1.16	2.19	1.48	2.05	PIPE	3.77	RCP	15	0.74	34.00	4.32	4.51	8.46	N/A
	42A	929.43	929.56	928.80																					
	42C	934.71	934.76	934.25	8.0	0.70	0.51	0.36	6.5	1.31	14.16	2.33	2.33	1.31	4.12	PIPE	1.62	HDPE	15	4.81	97.79	2.37	11.54	7.96	N/A
	42B	930.37	930.65	929.55																					
LINE 43	43A	942.36	942.54	941.65	6.1	0.24	0.65	0.16	7.0	3.19	15.38	1.10	1.18	0.93	1.93	PIPE	4.96	HDPE	15	5.67	43.23	7.13	12.53	6.89	N/A
	40G	939.59	939.69	939.20																					
	43B	943.00	943.39	942.40	6.6	0.10	0.70	0.07	6.9	2.26	5.54	0.48	1.33	1.02	0.85	PIPE	3.53	RCP	15	0.74	34.00	4.05	4.51	7.15	N/A
	43A	942.71	943.34	942.15																					
	43C	948.00	948.07	947.55	10.8	0.44	0.51	0.22	5.9	1.24	14.32	1.33	2.09	1.24	2.35	PIPE	1.66	HDPE	15	4.92	94.51	2.52	11.67	7.72	N/A
	43B	943.56	943.81	942.90																					
LINE 44	44A	951.60	951.65	950.90	10.4	0.76	0.66	0.50	6.0	3.07	16.28	3.00	3.00	1.50	5.31	PIPE	3.53	HDPE	15	6.36	136.00	7.22	13.27	8.19	N/A
	40I	942.62	942.65	942.25																					
	44B	952.15	952.18	956.65	11.3	0.88	0.66	0.58	5.8	1.57	5.54	3.37	3.37	1.57	5.97	PIPE	1.78	RCP	15	0.74	34.00	3.57	4.51	8.48	N/A
	44A	951.87	951.95	951.40																					
LINE 50	50B	960.79	961.41	959.50	7.2	0.15	0.66	0.10	6.7	4.34	4.94	0.67	0.76	0.66	1.17	SURCHARGE	6.93	RCP	15	0.59	42.73	4.54	4.03	6.15	N/A
	50A	960.16	960.30	959.25																					
	50C	960.95	961.61	960.25	10.4	0.54	0.66	0.36	6.0	3.05	5.54	2.14	2.14	1.44	3.78	SURCHARGE	4.83	RCP	15	0.74	34.00	4.03	4.51	8.35	N/A
	50B	960.79	961.41	960.00																					
	50D	961.96	962.13	961.45	12.8	0.57	0.51	0.29	5.5	1.61	8.30	1.61	1.61	1.61 (FES)	2.86	PIPE	2.86	RCP	15	1.65	42.33	3.67	6.77	N/A	N/A
	50C	961.21	962.05	960.75																					
LINE 51	51A	964.82	964.90	964.50	6.7	0.15	0.70	0.11	6.9	0.63	12.80	0.72	0.72	0.63	1.27	PIPE	1.00	HDPE	15	3.93	95.50	3.97	10.43	6.06	N/A
	50B	960.94	961.41	960.75																					
LINE 60	60B	915.61	915.92	914.55	6.0	0.36	0.65	0.23	7.1	7.70	24.00	1.66	1.66	1.66 (LOW POINT)	2.91	PIPE	13.63	RCP	18	5.22	125.51	5.77	13.58	11.08 (S)	N/A
	60A	909.06	909.37	908.00																				8.25 (N)	
	60C	916.24	917.54	915.30	12.6	0.90	0.51	0.46	5.6	6.04	9.00	2.56	2.91	2.91 (LOW POINT)	4.53	SURCHARGE	10.72	RCP	18	0.74	34.00	5.31	5.10	11.42 (S)	N/A
	60B	915.95	916.55	915.05																				10.85 (N)	
	60D	918.21	918.38	917.50	15.0	0.60	0.51	0.31	5.2	3.13	7.00	1.58	2.02	1.66	2.81	SURCHARGE	4.88	HDPE	15	1.18	123.23	3.53	5.71	8.82	N/A
	60C	917.18	917.54	916.05																					
	60E	920.74	920.84	920.25	15.0	0.72	0.51	0.37	5.2	1.47	10.21	1.90	1.90	1.47	3.38	PIPE	2.17	HDPE	15	2.50	90.00	3.35	8.32	8.66	N/A
	60D	918.48	918.77	918.00																					
LINE 70	70B	911.74	912.27	910.00	5.4	0.37	0.65	0.24	7.2	27.21	99.03	1.74	3.49	3.49 (LOW POINT)	3.05	PIPE	47.47	RCP	30	5.83	137.32	7.44	20.17	8.82 (S)	N/A
	70A	902.92	904.27	902.00																				11.21 (N)	
	70C	913.18	913.66	911.55	5.0	0.23	0.65	0.15	7.4	23.72	41.34	1.10	2.60	1.74	1.93	PIPE	39.73	RCP	30	1.02	103.36	6.75	8.42	9.21	N/A
	70B	912.24	912.85	910.50																					
	70D	913.87	915.04	912.30	9.2	0.51	0.51	0.26	6.2	21.98	35.17	1.62	2.43	1.67	2.87	SURCHARGE	37.69	RCP	30	0.74	34.00	6.76	7.16	9.02	N/A
	70C	913.63	914.34	912.05																					
	70E	916.43	916.90	914.95	6.2	0.28	0.51	0.14	7.0	19.54	58.41	1.00	2.51	1.70	1.76	SURCHARGE	33.95	HDPE	30	2.03	106.00	6.32	11.90	9.11	N/A
	70D	914.34	916.04	912.80																					
LINE 71	71A	914.90	916.05	914.55	10.0	0.29	0.51	0.15	6.1	0.77	6.13	0.90	0.90	0.77	1.59	SURCHARGE	1.23	HDPE	15	0.74	60.83	2.26	4.99	6.65	N/A
	70D	914.58	916.04	914.10																					

FLOWTABLE NOTES:

TOTAL 10-YR RUNOFF INCLUDES BYPASS FROM UPSTREAM INLETS.

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"AS-BUILT"
March 7, 2008

DRAWING FILE NAME:	PLOT SCALE:	DATE ISSUED:
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FILES ATTACHED:	DESIGNED BY:	DRAWN BY:	CHECKED BY:
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4	06/01/07	LJC	AS-BUILT
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STATE OF MISSOURI
JOSEPH PATRICK BAUER
NUMBER E-2001033240
REGISTERED PROFESSIONAL ENGINEER
3/7/08

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CHAPEL RIDGE - PHASE 1
LEE'S SUMMIT, MISSOURI
GOLF AMERICA, LLC.

PROJECT NO.
0300000274

FLOWTABLE

DRAWING NO.
ST-03

Exhibit B

FEMA FIRMette

National Flood Hazard Layer FIRMette

FEMA

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/11/2019 at 2:36:06 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Exhibit C

NRCS Soils Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Jackson County, Missouri

November 11, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:2,150 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 20, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 11, 2017—Sep 22, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10024	Greenton-Urban land complex, 5 to 9 percent slopes	0.9	4.7%
10129	Sharpsburg-Urban land complex, 5 to 9 percent slopes	3.7	20.0%
10136	Sibley-Urban land complex, 2 to 5 percent slopes	12.6	68.5%
10143	Snead-Urban land complex, 9 to 30 percent slopes	0.1	0.7%
10183	Udarents-Urban land-Polo complex, 5 to 9 percent slopes	1.1	6.1%
Totals for Area of Interest		**18.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it

was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Jackson County, Missouri

10024—Greenton-Urban land complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2qky4
Elevation: 800 to 1,100 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Greenton and similar soils: 60 percent
Urban land: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Greenton

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex, concave
Parent material: Loess over residuum weathered from limestone and shale

Typical profile

A - 0 to 16 inches: silty clay loam
Bt1 - 16 to 26 inches: silty clay loam
2Bt2 - 26 to 80 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: About 16 inches to abrupt textural change
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: Loess Upland Prairie (R109XY002MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Across-slope shape: Convex, concave

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10129—Sharpsburg-Urban land complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2ql0b
Elevation: 1,000 to 1,300 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

A - 0 to 7 inches: silt loam
Bt - 7 to 48 inches: silty clay loam
C - 48 to 60 inches: silty clay loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 35 inches

Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: Loess Upland Prairie (R109XY002MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10136—Sibley-Urban land complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2ql0j
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Sibley and similar soils: 60 percent
Urban land: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sibley

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

A - 0 to 17 inches: silt loam
Bt - 17 to 65 inches: silty clay loam
C - 65 to 80 inches: silt loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: Deep Loess Upland Prairie (R107BY002MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10143—Snead-Urban land complex, 9 to 30 percent slopes

Map Unit Setting

National map unit symbol: 2ql0r
Elevation: 700 to 900 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Snead and similar soils: 65 percent
Urban land: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Snead

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from calcareous shale

Typical profile

A - 0 to 12 inches: flaggy silty clay loam
Bw - 12 to 40 inches: silty clay
Cr - 40 to 80 inches: bedrock

Properties and qualities

Slope: 9 to 30 percent
Depth to restrictive feature: 39 to 50 inches to paralithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Interbedded Sedimentary Backslope Savanna (R109XY012MO)
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Hills
Landform position (two-dimensional): Backslope

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10183—Udarents-Urban land-Polo complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 1n85d
Elevation: 600 to 1,000 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 175 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Udarents and similar soils: 41 percent
Urban land: 39 percent
Polo and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mine spoil or earthy fill

Typical profile

C1 - 0 to 5 inches: silt loam
C2 - 5 to 80 inches: silty clay loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Deep Loess Upland Prairie (R107BY002MO)
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Polo

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Concave, convex
Parent material: Loess over residuum

Typical profile

A - 0 to 12 inches: silt loam
BA - 12 to 29 inches: silty clay loam
Bt1 - 29 to 35 inches: silty clay loam
2Bt2 - 35 to 80 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Loess Upland Prairie (R107BY007MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

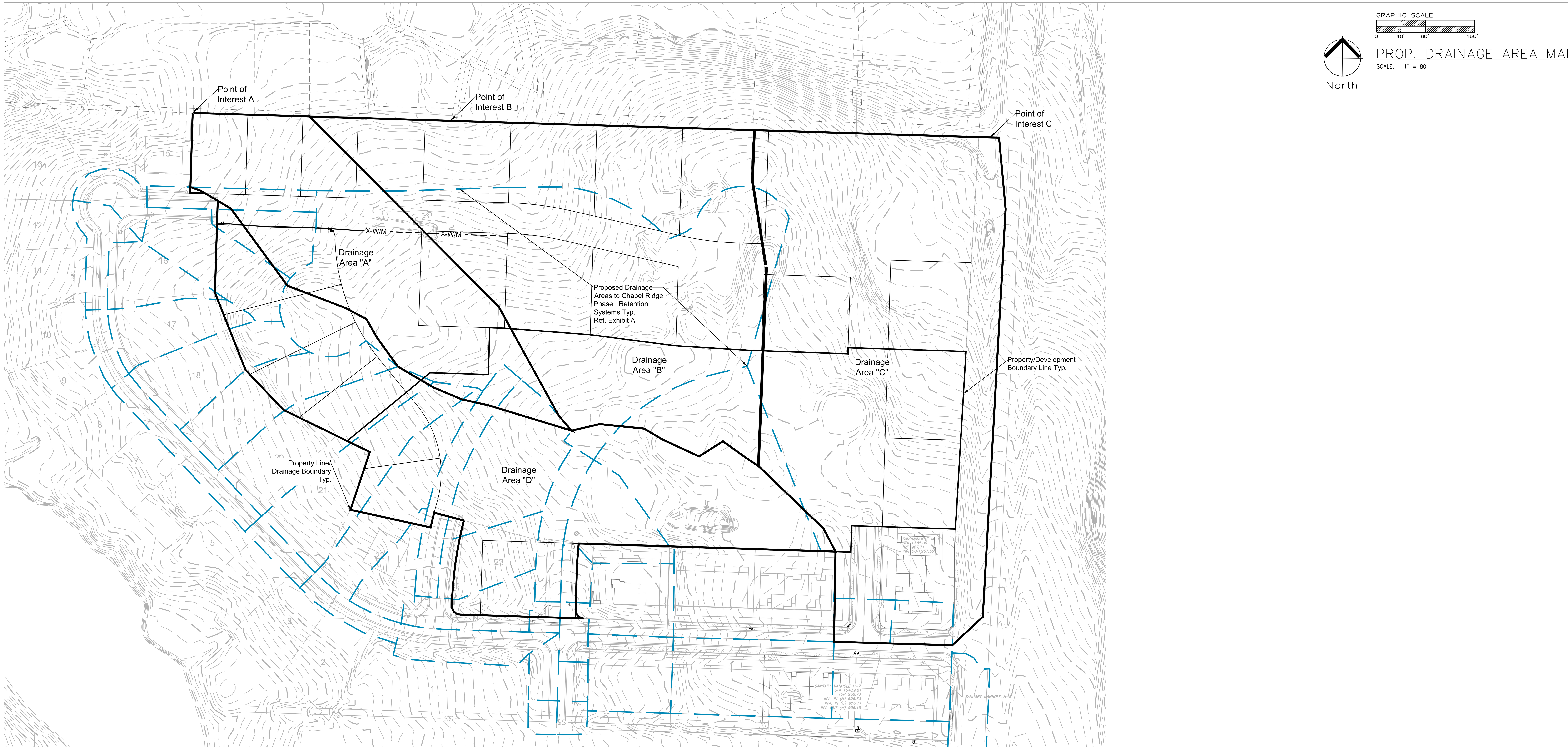
Exhibit D

Composite Curve Numbers

POST DEV						
	TOTAL	0.30	0.51	0.66	CCN	
A	0.69	0.69			0.30	74
B	4.43	4.43			0.30	74
C	2.91	0.48	0.93	1.51	0.55	84
C1	3.88	2.31		1.57	0.45	80
D	8.30					
	PRE DEV					
	TOTAL	0.30	0.51	0.66	CCN	
A						
B						
C	6.64	4.86	0.93	0.85	0.38	77
C1						
D						

Exhibit E

Pre-Development Drainage Area Map



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THE ESTATES OF CHAPEL RIDGE-2ND PLAT
LOTS 23 & 24 AND
THE TOWNHOMES OF CHAPEL RIDGE-2ND PLAT
LOTS 9-19 & TRACTS A-D
Lee's Summit, Jackson County, Missouri

Project: VILLAS OF CHAPEL RIDGE, LSMO
Issue Date: April 10, 2020

Existing Drainage Area Map

Construction Plans for:
THE ESTATES OF CHAPEL RIDGE-2ND PLAT
LOTS 23 & 24 AND
THE TOWNHOMES OF CHAPEL RIDGE-2ND PLAT
LOTS 9-19 & TRACTS A-D
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

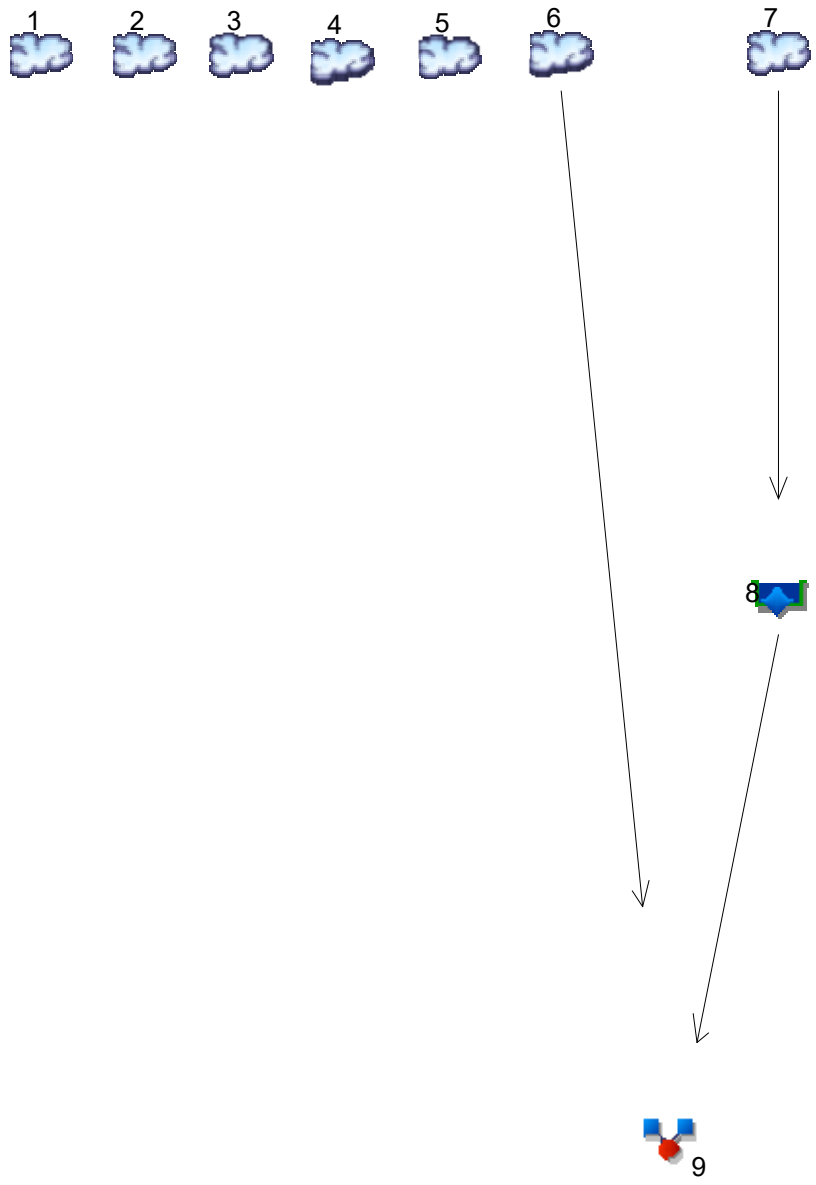
C.202

Exhibit F

Hydraflow Hydrograph Report

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Pre Subarea A
2	SCS Runoff	Pre Subarea B
3	SCS Runoff	Pre Subarea C
4	SCS Runoff	Post Subarea A
5	SCS Runoff	Post Subarea B
6	SCS Runoff	Post Subarea C
7	SCS Runoff	Post Subarea C1
8	Reservoir	Detained Subarea C1
9	Combine	Combined (C + Detained C1)

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	------	-------	4.796	-------	-------	9.964	-------	-------	18.26	Pre Subarea A
2	SCS Runoff	------	-------	9.901	-------	-------	20.57	-------	-------	37.70	Pre Subarea B
3	SCS Runoff	------	-------	13.75	-------	-------	27.40	-------	-------	48.96	Pre Subarea C
4	SCS Runoff	------	-------	1.120	-------	-------	2.314	-------	-------	4.238	Post Subarea A
5	SCS Runoff	------	-------	7.614	-------	-------	15.82	-------	-------	28.99	Post Subarea B
6	SCS Runoff	------	-------	8.593	-------	-------	15.08	-------	-------	24.72	Post Subarea C
7	SCS Runoff	------	-------	9.693	-------	-------	18.09	-------	-------	30.89	Post Subarea C1
8	Reservoir	7	-------	0.482	-------	-------	0.830	-------	-------	2.239	Detained Subarea C1
9	Combine	6, 8	-------	8.871	-------	-------	15.59	-------	-------	25.58	Combined (C + Detained C1)

Hydrograph Summary Report

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

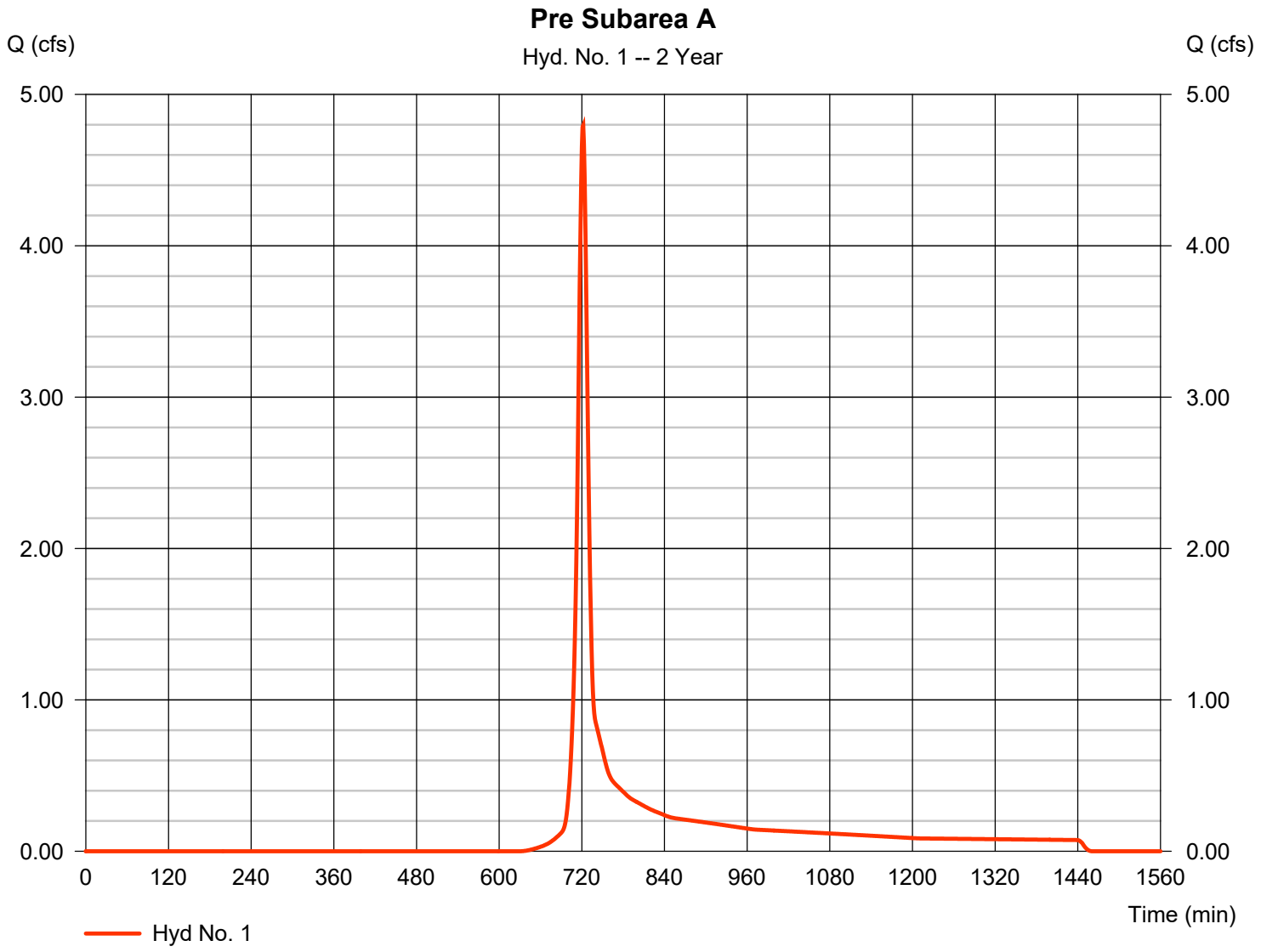
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	4.796	1	722	12,361	------	------	------	Pre Subarea A
2	SCS Runoff	9.901	1	722	25,520	------	------	------	Pre Subarea B
3	SCS Runoff	13.75	1	721	33,496	------	------	------	Pre Subarea C
4	SCS Runoff	1.120	1	721	2,749	------	------	------	Post Subarea A
5	SCS Runoff	7.614	1	722	19,627	------	------	------	Post Subarea B
6	SCS Runoff	8.593	1	720	20,821	------	------	------	Post Subarea C
7	SCS Runoff	9.693	1	720	23,459	------	------	------	Post Subarea C1
8	Reservoir	0.482	1	818	23,430	7	933.47	12,698	Detained Subarea C1
9	Combine	8.871	1	720	44,251	6, 8	------	------	Combined (C + Detained C1)

Hydrograph Report

Hyd. No. 1

Pre Subarea A

Hydrograph type	= SCS Runoff	Peak discharge	= 4.796 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 12,361 cuft
Drainage area	= 2.790 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.90 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

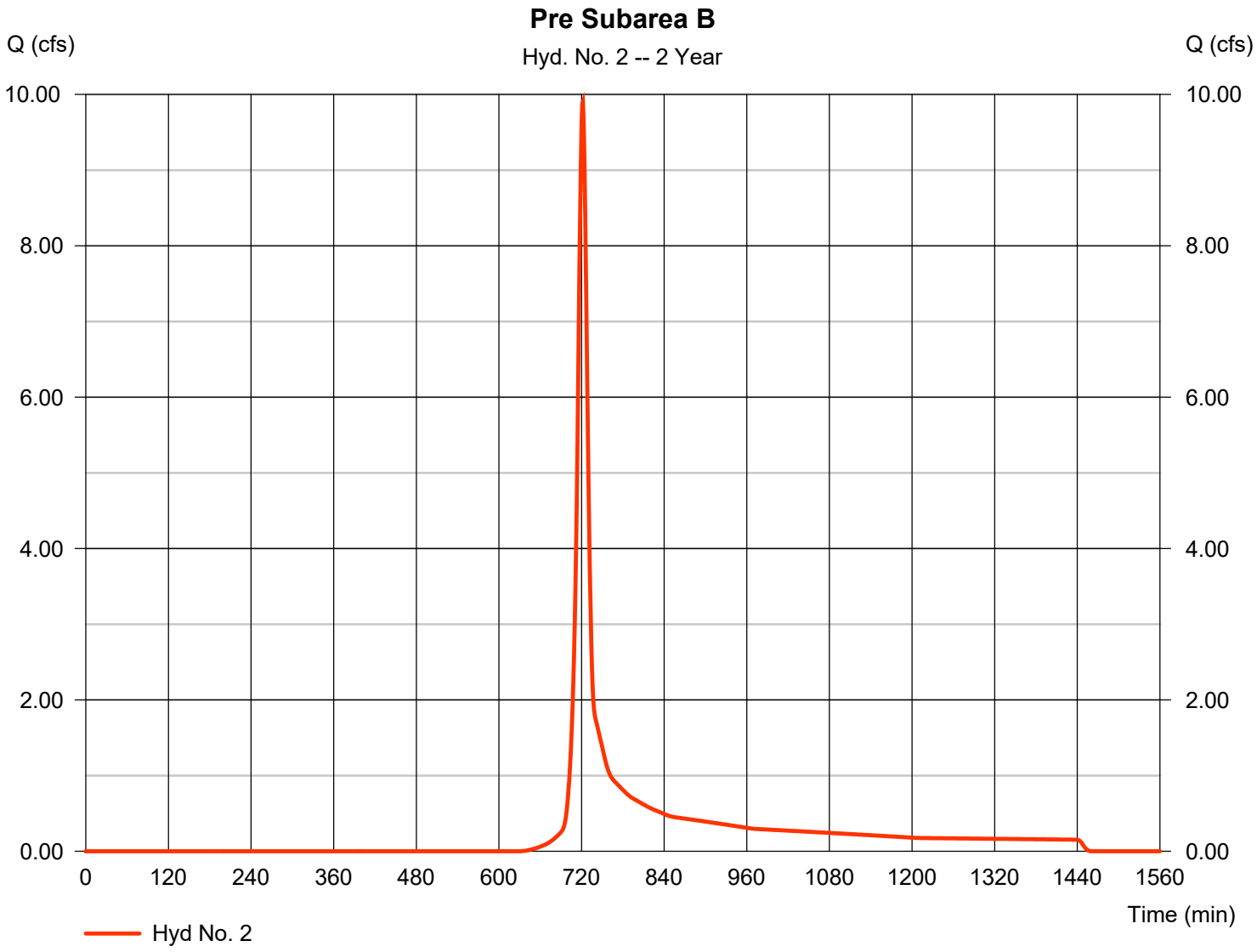


Hydrograph Report

Hyd. No. 2

Pre Subarea B

Hydrograph type	= SCS Runoff	Peak discharge	= 9.901 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 25,520 cuft
Drainage area	= 5.760 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 12.50 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

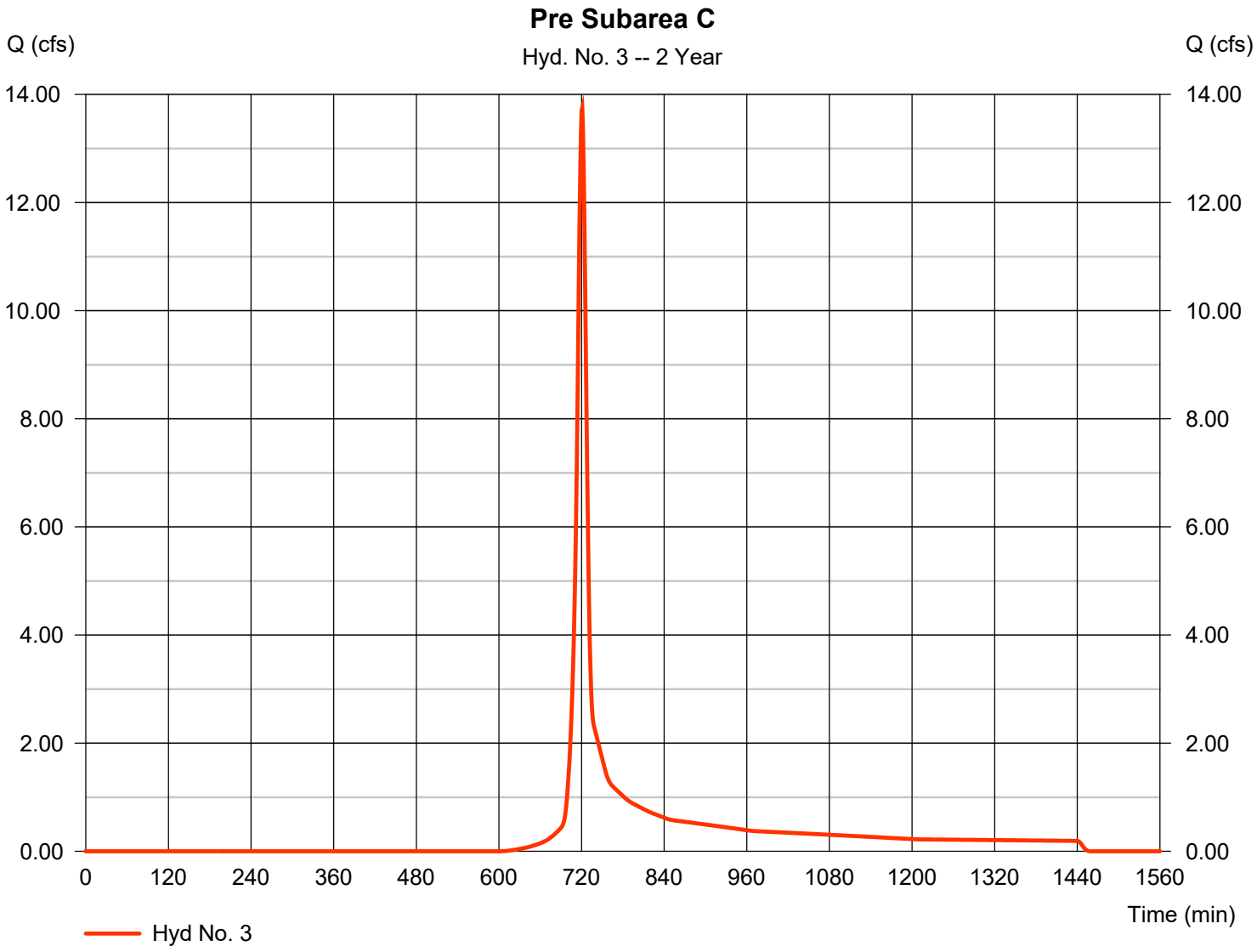


Hydrograph Report

Hyd. No. 3

Pre Subarea C

Hydrograph type	= SCS Runoff	Peak discharge	= 13.75 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 33,496 cuft
Drainage area	= 6.640 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.10 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

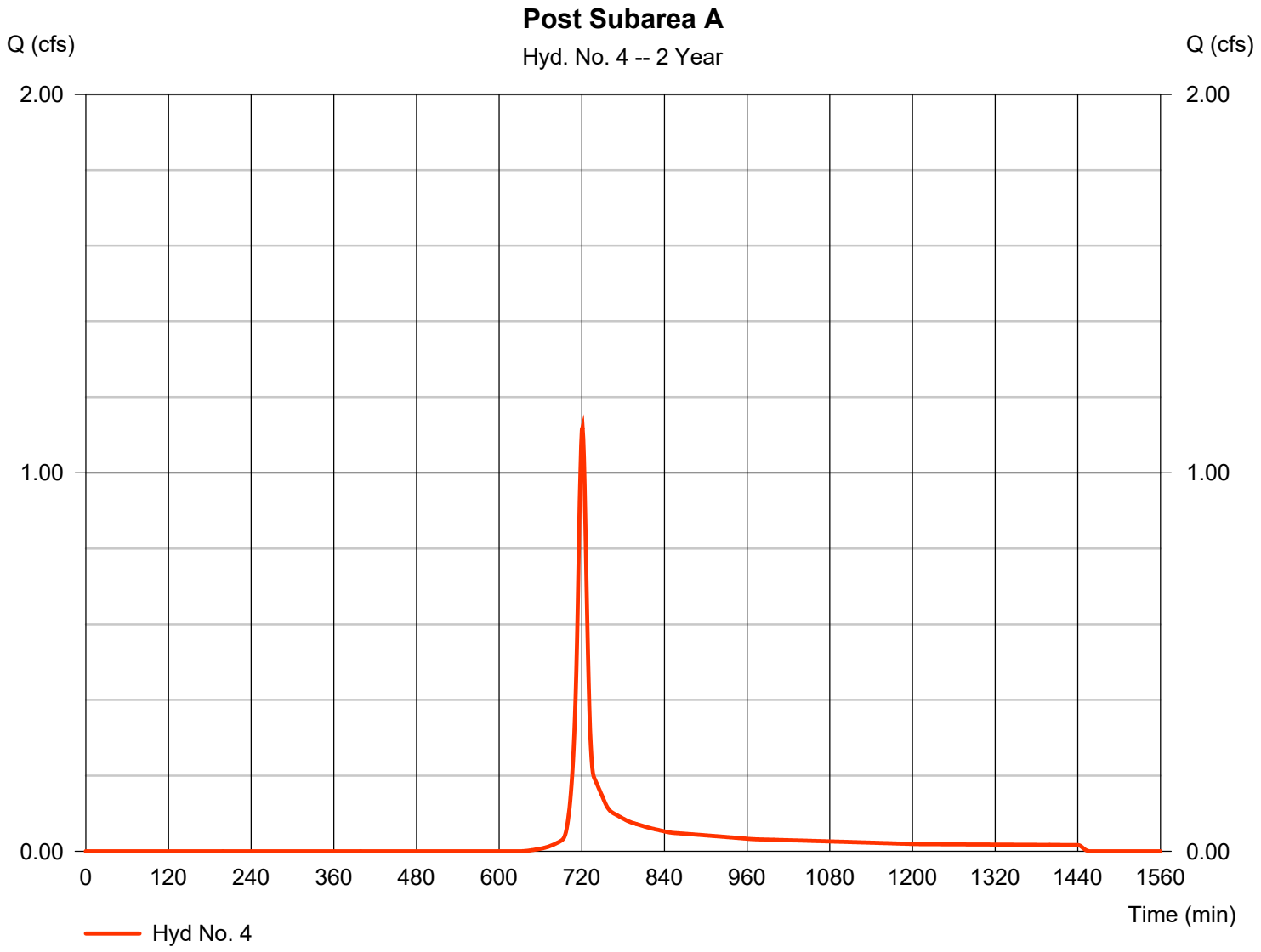


Hydrograph Report

Hyd. No. 4

Post Subarea A

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.120 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	2,749 cuft
Drainage area	=	0.600 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.10 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

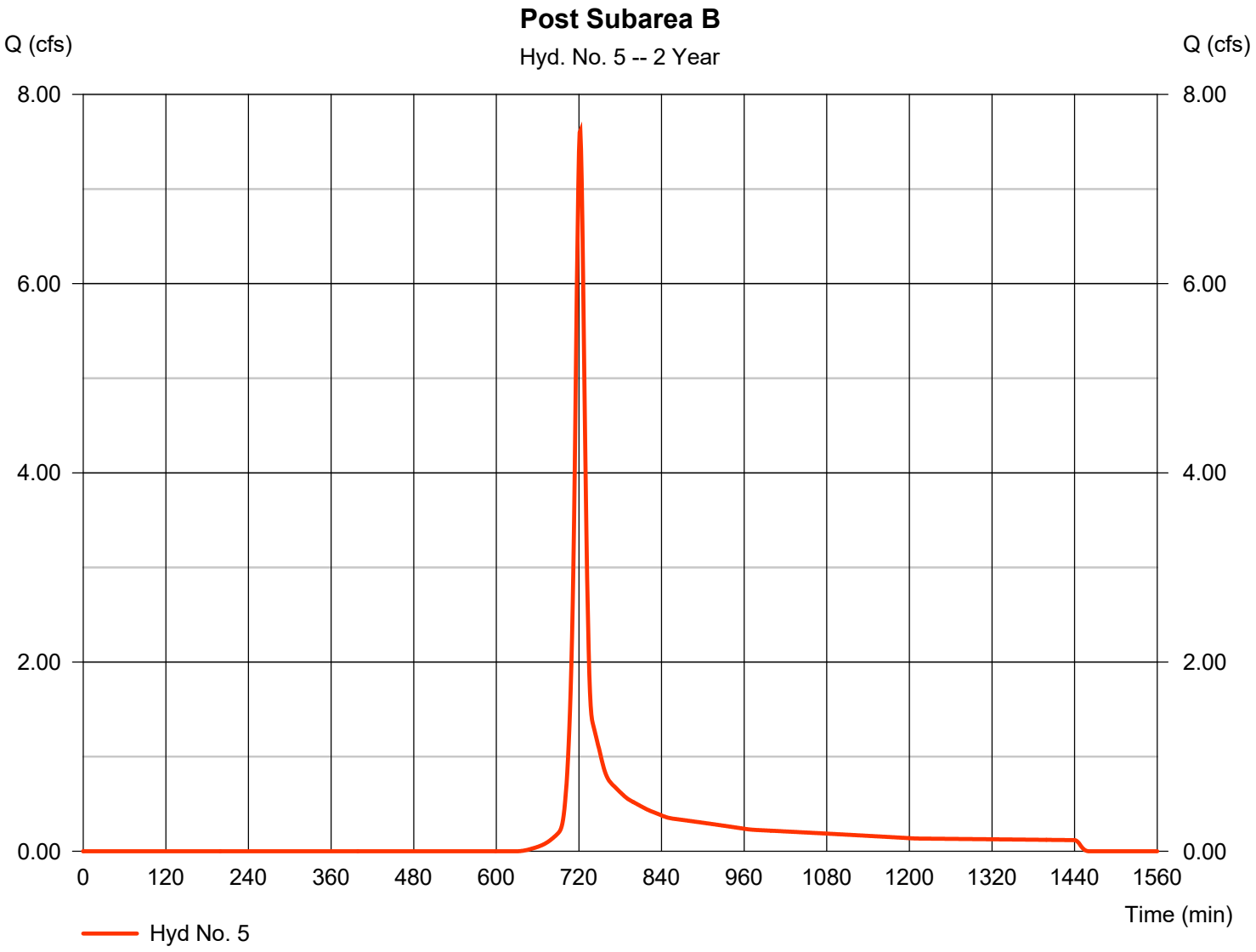


Hydrograph Report

Hyd. No. 5

Post Subarea B

Hydrograph type	= SCS Runoff	Peak discharge	= 7.614 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 19,627 cuft
Drainage area	= 4.430 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 12.20 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

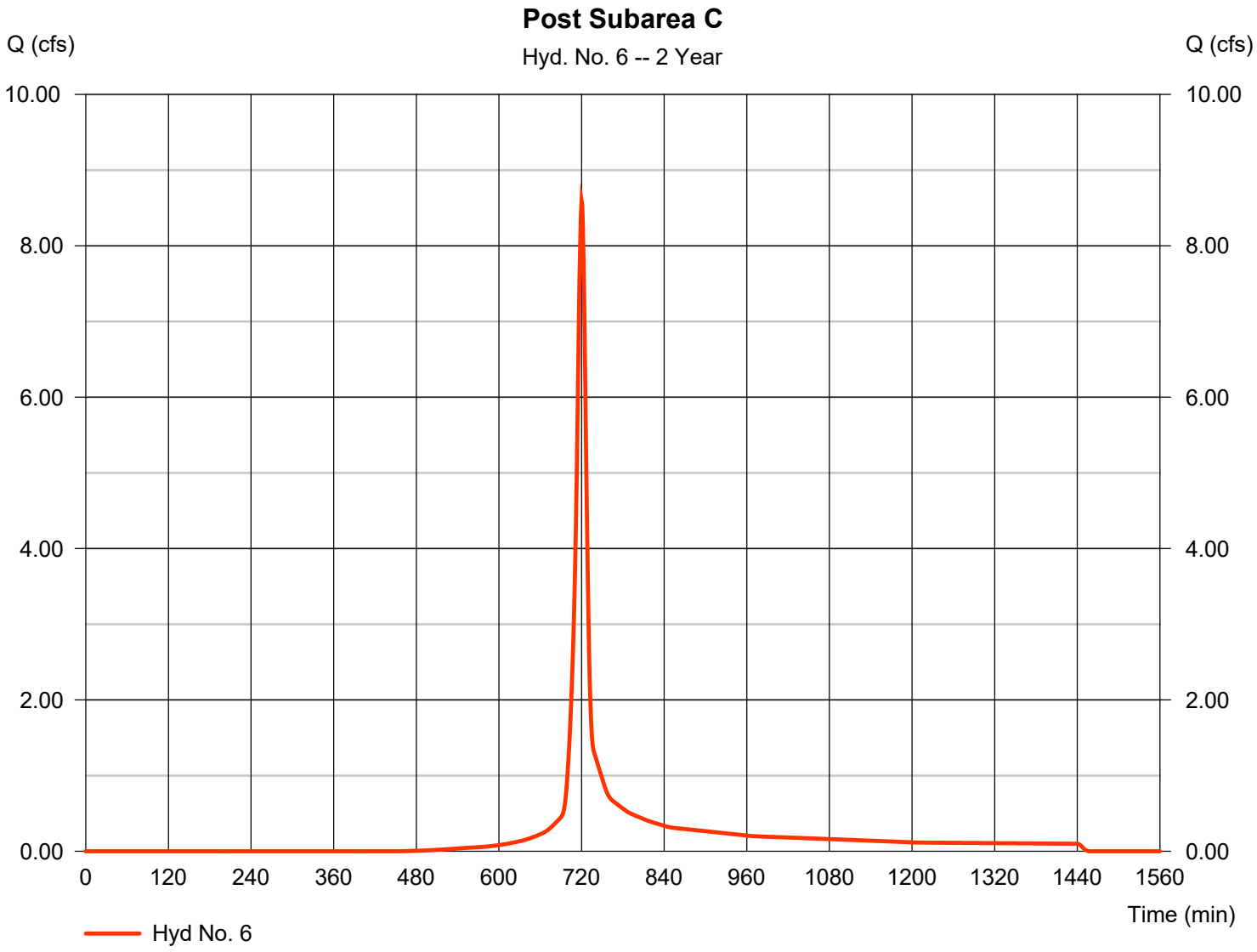


Hydrograph Report

Hyd. No. 6

Post Subarea C

Hydrograph type	= SCS Runoff	Peak discharge	= 8.593 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 20,821 cuft
Drainage area	= 2.910 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.50 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

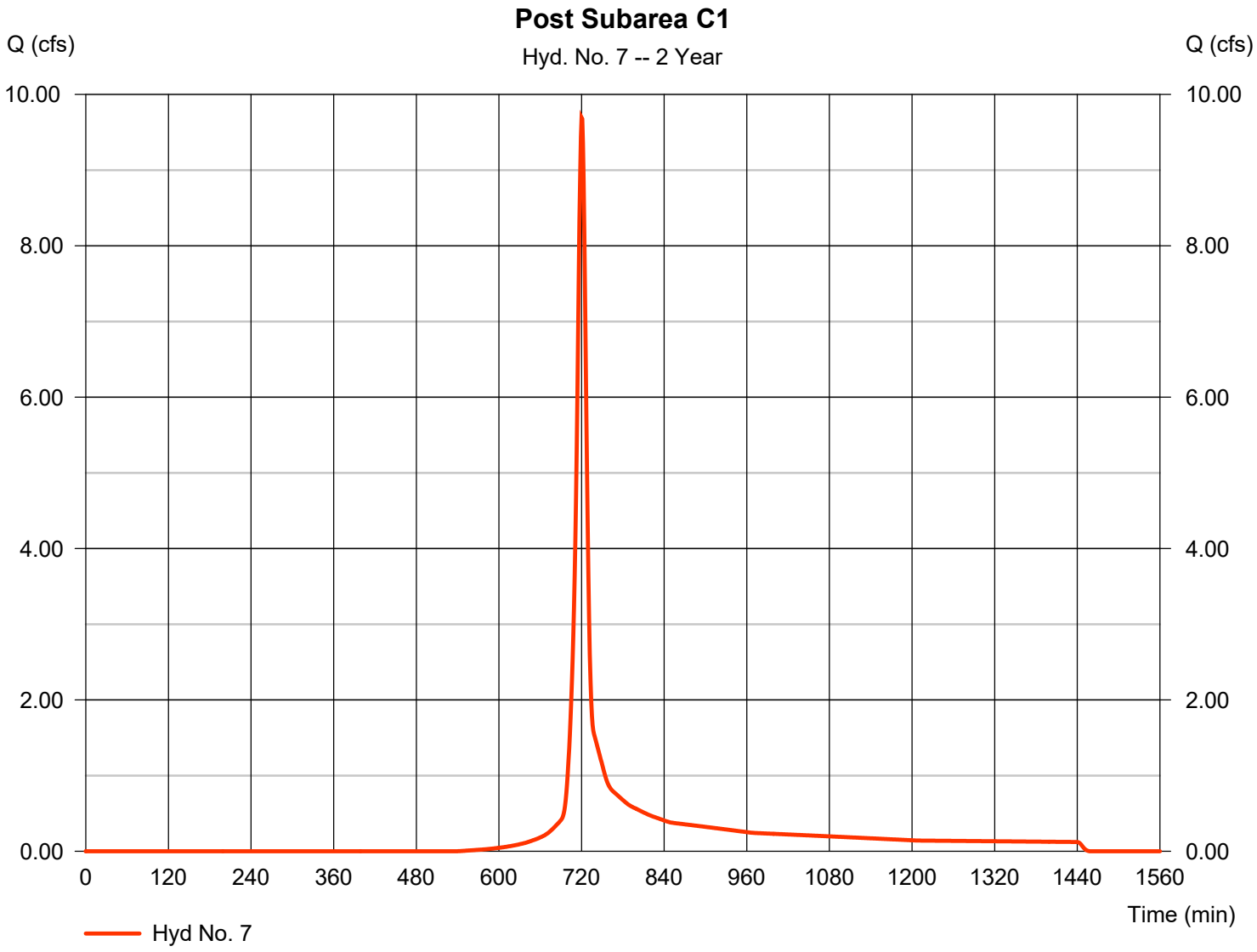


Hydrograph Report

Hyd. No. 7

Post Subarea C1

Hydrograph type	= SCS Runoff	Peak discharge	= 9.693 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 23,459 cuft
Drainage area	= 3.880 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.80 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



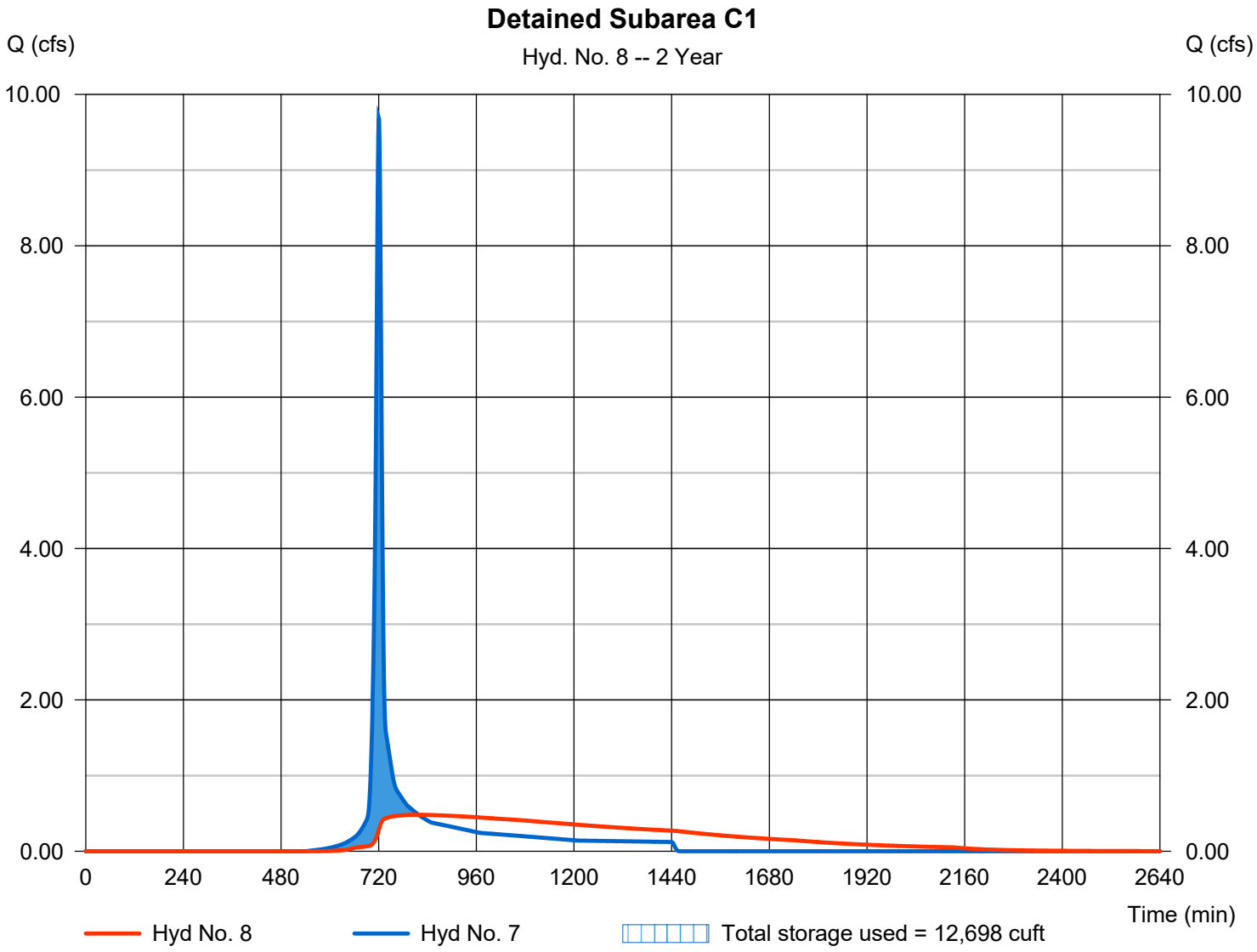
Hydrograph Report

Hyd. No. 8

Detained Subarea C1

Hydrograph type	=	Reservoir	Peak discharge	=	0.482 cfs
Storm frequency	=	2 yrs	Time to peak	=	818 min
Time interval	=	1 min	Hyd. volume	=	23,430 cuft
Inflow hyd. No.	=	7 - Post Subarea C1	Max. Elevation	=	933.47 ft
Reservoir name	=	DETENTION	Max. Storage	=	12,698 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 = 929.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	929.00	00	0	0
1.00	930.00	1,253	418	418
2.00	931.00	2,928	2,032	2,449
3.00	932.00	3,848	3,377	5,826
4.00	933.00	4,843	4,335	10,161
5.00	934.00	5,914	5,369	15,530
6.00	935.00	7,067	6,481	22,012
7.00	936.00	8,314	7,681	29,693
8.00	937.00	9,645	8,970	38,663
9.00	938.00	11,055	10,341	49,004
10.00	939.00	12,466	11,752	60,756
11.00	940.00	13,876	13,164	73,920

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 30.00	6.00	0.00	1.00
Span (in)	= 30.00	6.00	0.00	1.00
No. Barrels	= 1	1	0	8
Invert El. (ft)	= 927.50	936.00	0.00	927.60
Length (ft)	= 40.00	1.00	0.00	2.75
Slope (%)	= 3.75	1.00	0.00	n/a
N-Value	= .010	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	Yes

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 85.00	0.00	0.00	0.00
Crest El. (ft)	= 938.65	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	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

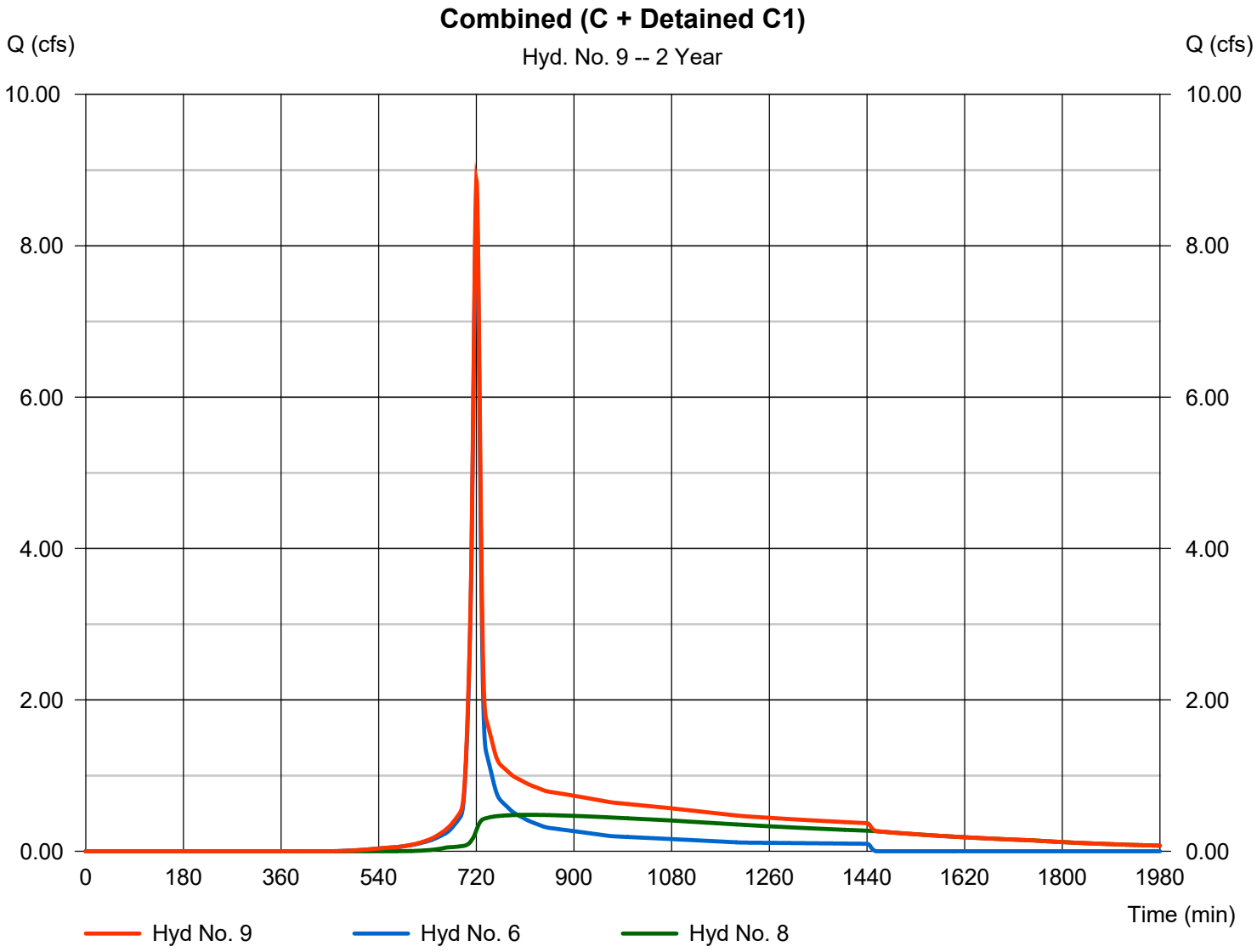
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	929.00	0.00	0.00	---	0.00	0.00	---	---	---	---	---	0.000
1.00	418	930.00	12.86 ic	0.00	---	0.05	0.00	---	---	---	---	---	0.051
2.00	2,449	931.00	12.86 ic	0.00	---	0.14	0.00	---	---	---	---	---	0.144
3.00	5,826	932.00	12.86 ic	0.00	---	0.26	0.00	---	---	---	---	---	0.265
4.00	10,161	933.00	12.86 ic	0.00	---	0.41	0.00	---	---	---	---	---	0.407
5.00	15,530	934.00	12.86 ic	0.00	---	0.57	0.00	---	---	---	---	---	0.569
6.00	22,012	935.00	12.86 ic	0.00	---	0.75	0.00	---	---	---	---	---	0.748
7.00	29,693	936.00	12.86 ic	0.00	---	0.94	0.00	---	---	---	---	---	0.943
8.00	38,663	937.00	12.86 ic	0.82 ic	---	1.15	0.00	---	---	---	---	---	1.971
9.00	49,004	938.00	12.86 ic	1.25 ic	---	1.37	0.00	---	---	---	---	---	2.625
10.00	60,756	939.00	12.86 ic	1.57 ic	---	1.61	45.76	---	---	---	---	---	48.93
11.00	73,920	940.00	12.86 ic	1.83 ic	---	1.86	346.64	---	---	---	---	---	350.33

Hydrograph Report

Hyd. No. 9

Combined (C + Detained C1)

Hydrograph type	=	Combine	Peak discharge	=	8.871 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	44,251 cuft
Inflow hyds.	=	6, 8	Contrib. drain. area	=	2.910 ac



Hydrograph Summary Report

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

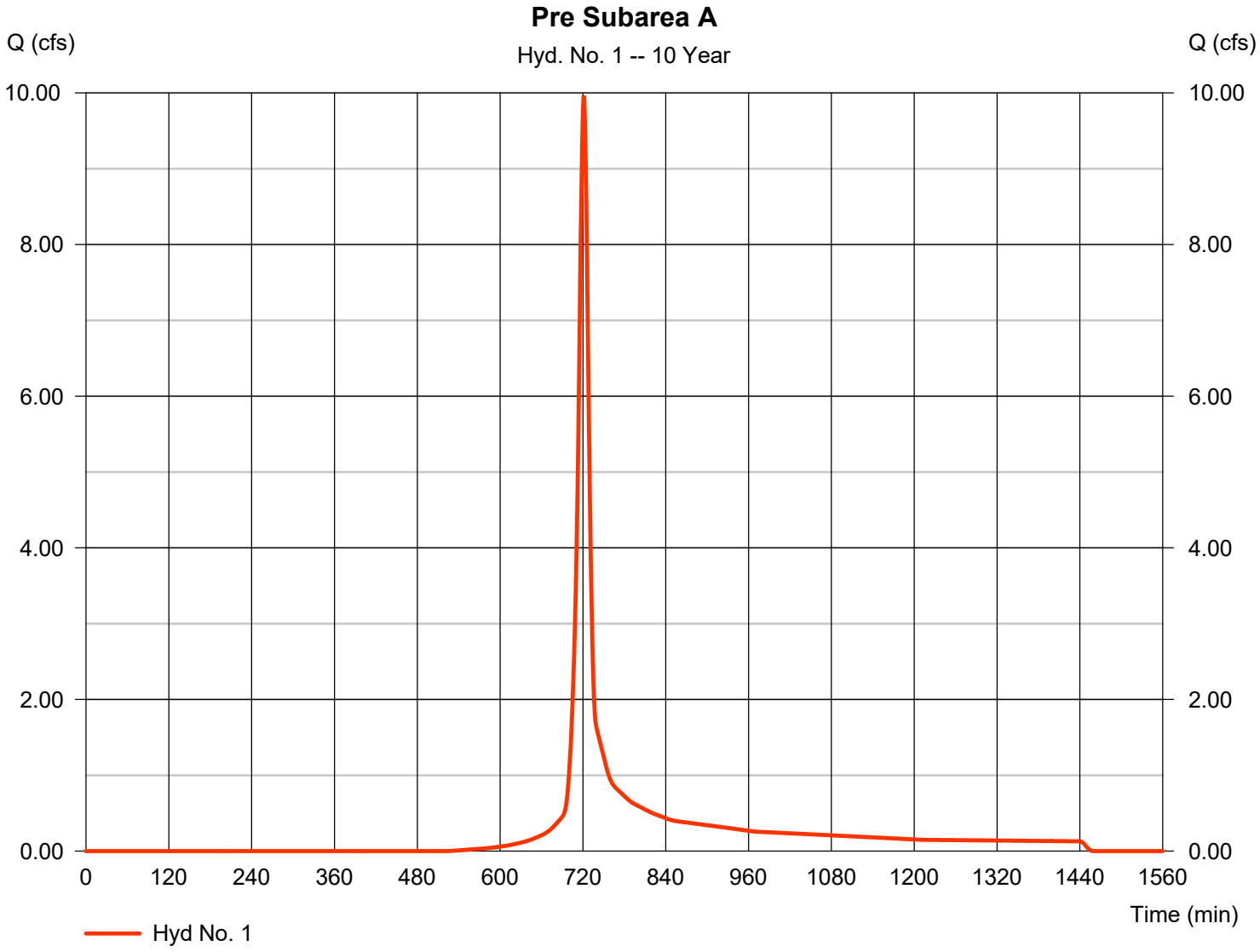
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.964	1	721	25,171	------	------	------	Pre Subarea A
2	SCS Runoff	20.57	1	721	51,966	------	------	------	Pre Subarea B
3	SCS Runoff	27.40	1	720	66,271	------	------	------	Pre Subarea C
4	SCS Runoff	2.314	1	720	5,597	------	------	------	Post Subarea A
5	SCS Runoff	15.82	1	721	39,967	------	------	------	Post Subarea B
6	SCS Runoff	15.08	1	720	37,136	------	------	------	Post Subarea C
7	SCS Runoff	18.09	1	720	43,983	------	------	------	Post Subarea C1
8	Reservoir	0.830	1	816	43,923	7	935.43	25,296	Detained Subarea C1
9	Combine	15.59	1	720	81,058	6, 8	------	------	Combined (C + Detained C1)

Hydrograph Report

Hyd. No. 1

Pre Subarea A

Hydrograph type	= SCS Runoff	Peak discharge	= 9.964 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 25,171 cuft
Drainage area	= 2.790 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.90 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

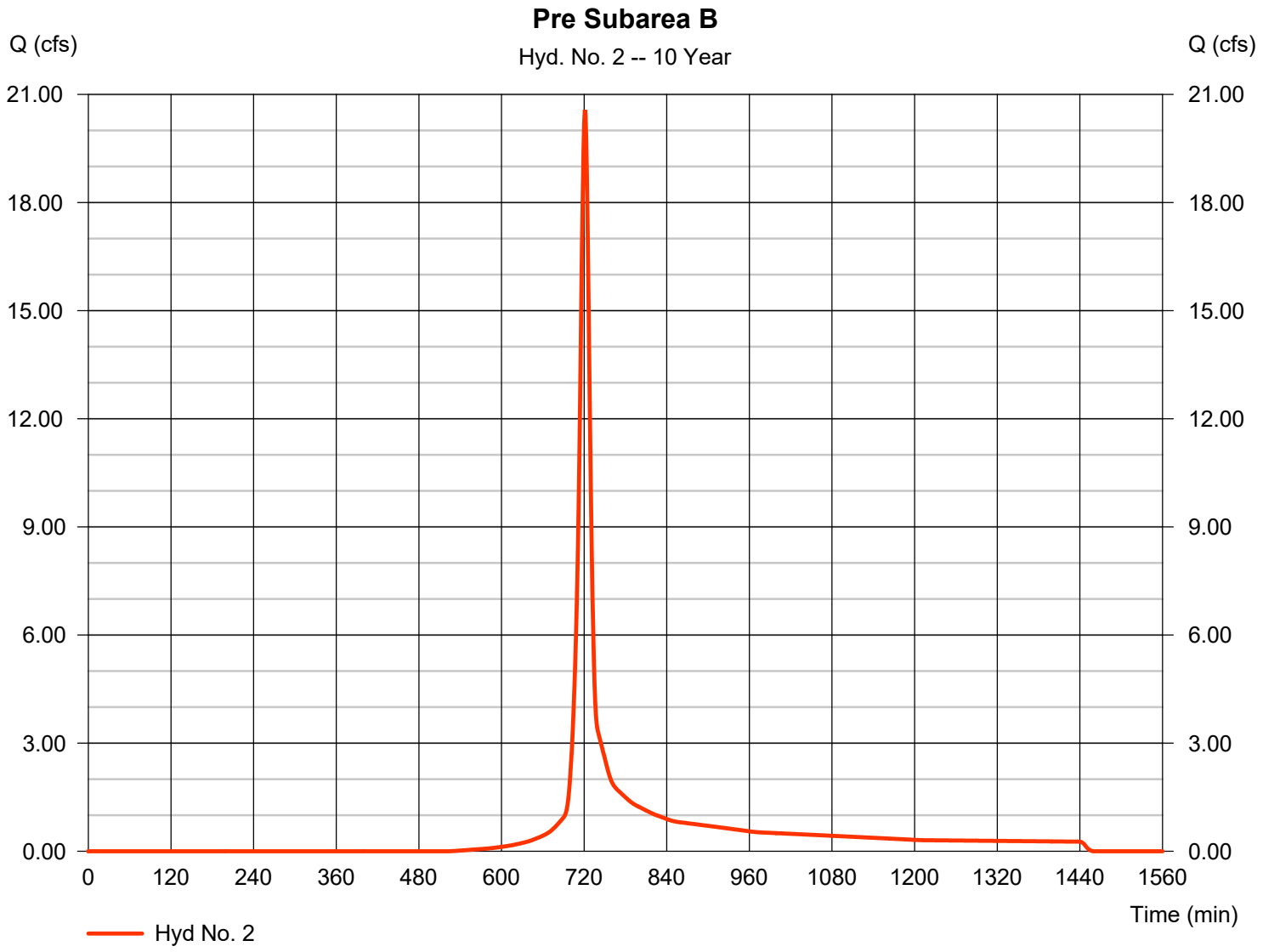


Hydrograph Report

Hyd. No. 2

Pre Subarea B

Hydrograph type	= SCS Runoff	Peak discharge	= 20.57 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 51,966 cuft
Drainage area	= 5.760 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 12.50 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

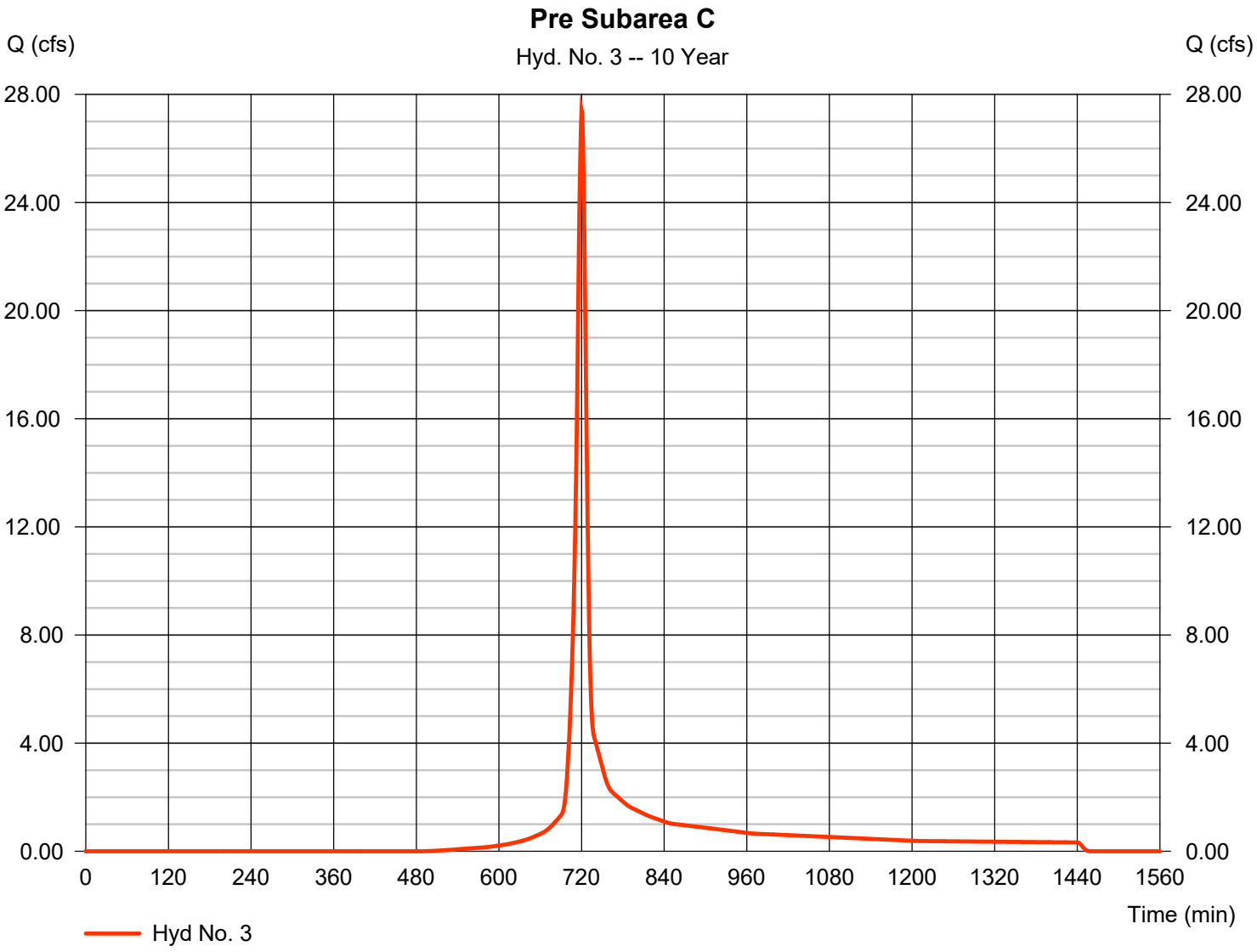


Hydrograph Report

Hyd. No. 3

Pre Subarea C

Hydrograph type	= SCS Runoff	Peak discharge	= 27.40 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 66,271 cuft
Drainage area	= 6.640 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.10 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

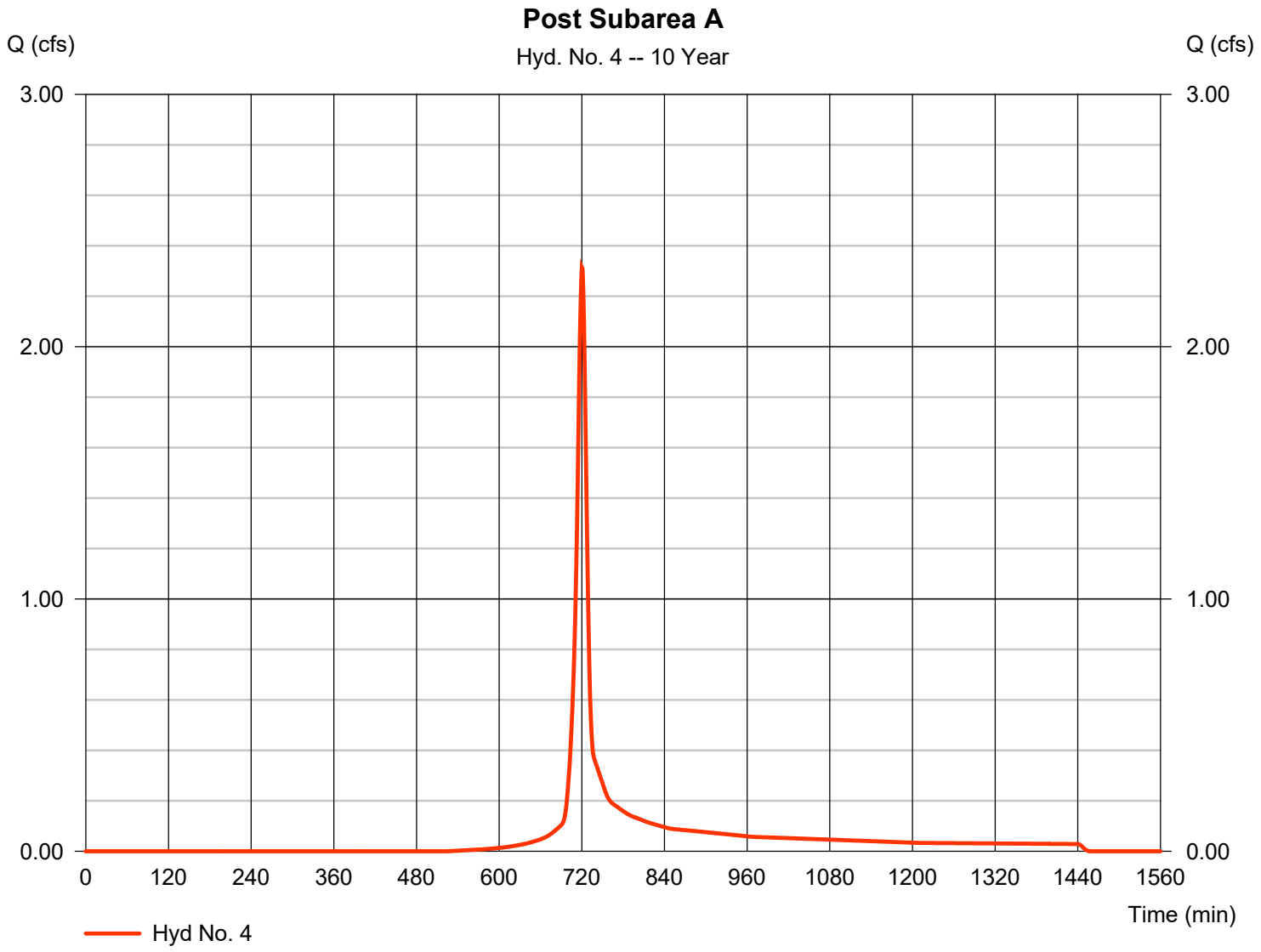


Hydrograph Report

Hyd. No. 4

Post Subarea A

Hydrograph type	= SCS Runoff	Peak discharge	= 2.314 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 5,597 cuft
Drainage area	= 0.600 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.10 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

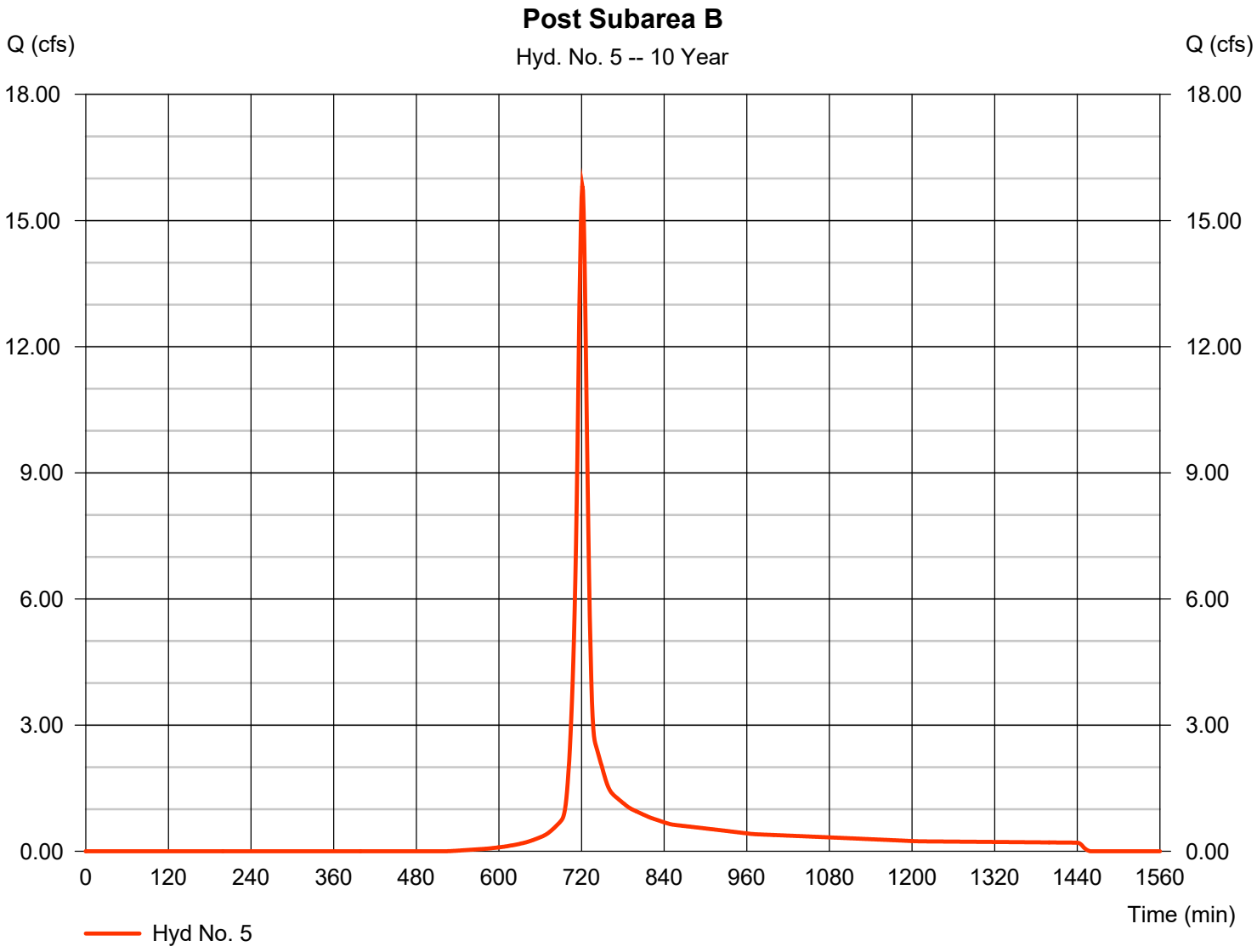


Hydrograph Report

Hyd. No. 5

Post Subarea B

Hydrograph type	=	SCS Runoff	Peak discharge	=	15.82 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	39,967 cuft
Drainage area	=	4.430 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	12.20 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

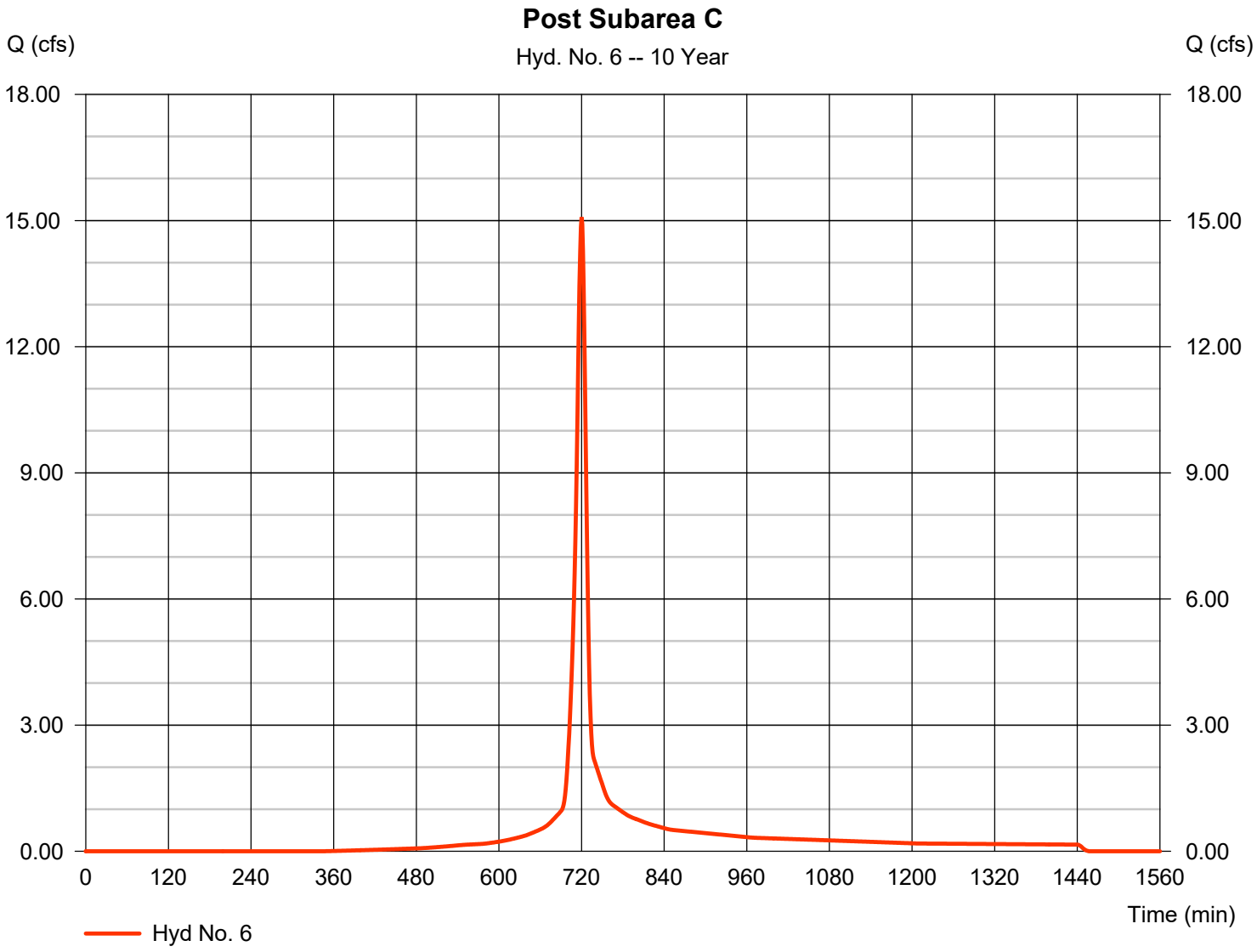


Hydrograph Report

Hyd. No. 6

Post Subarea C

Hydrograph type	= SCS Runoff	Peak discharge	= 15.08 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 37,136 cuft
Drainage area	= 2.910 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.50 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

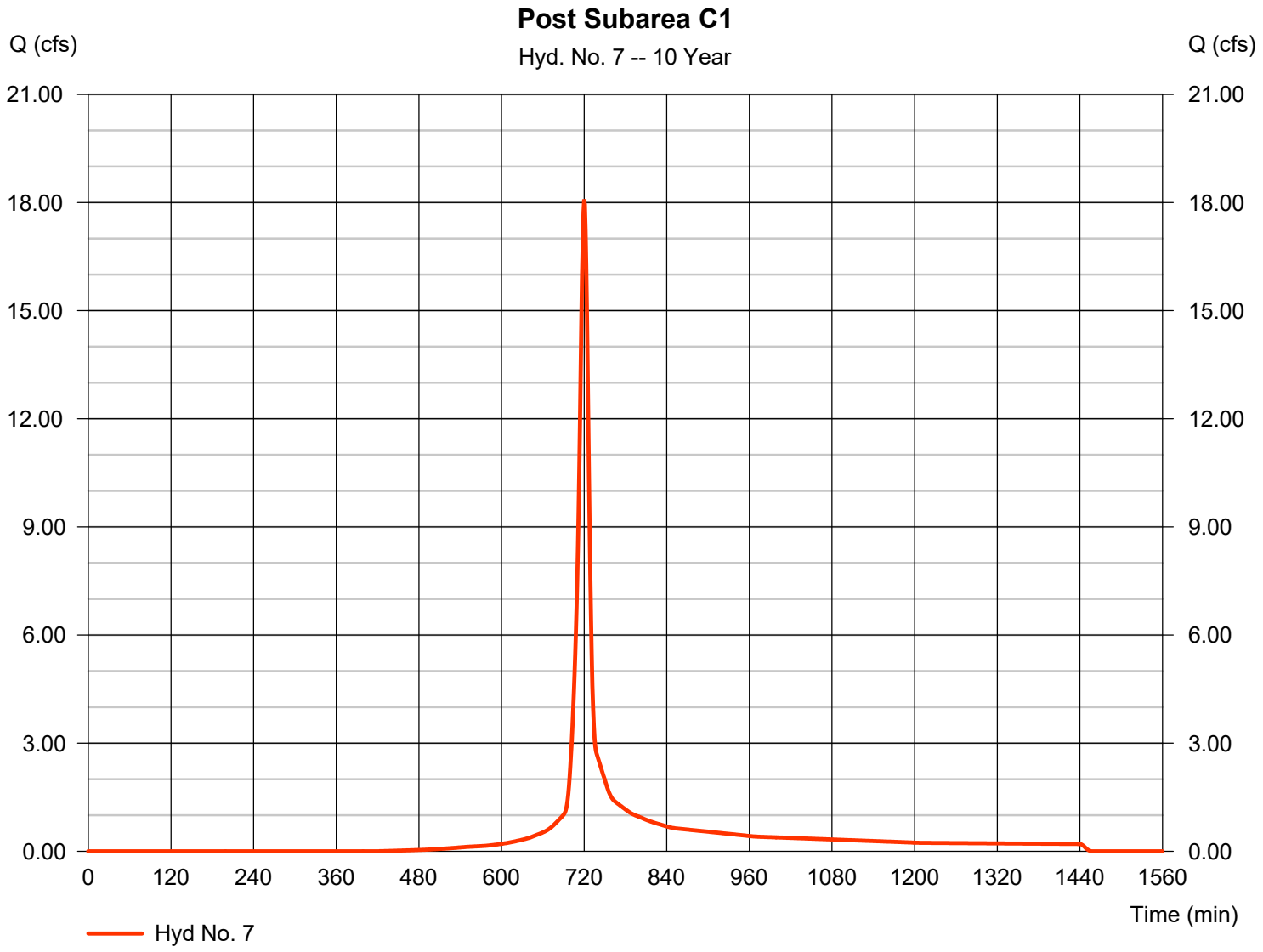


Hydrograph Report

Hyd. No. 7

Post Subarea C1

Hydrograph type	= SCS Runoff	Peak discharge	= 18.09 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 43,983 cuft
Drainage area	= 3.880 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.80 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



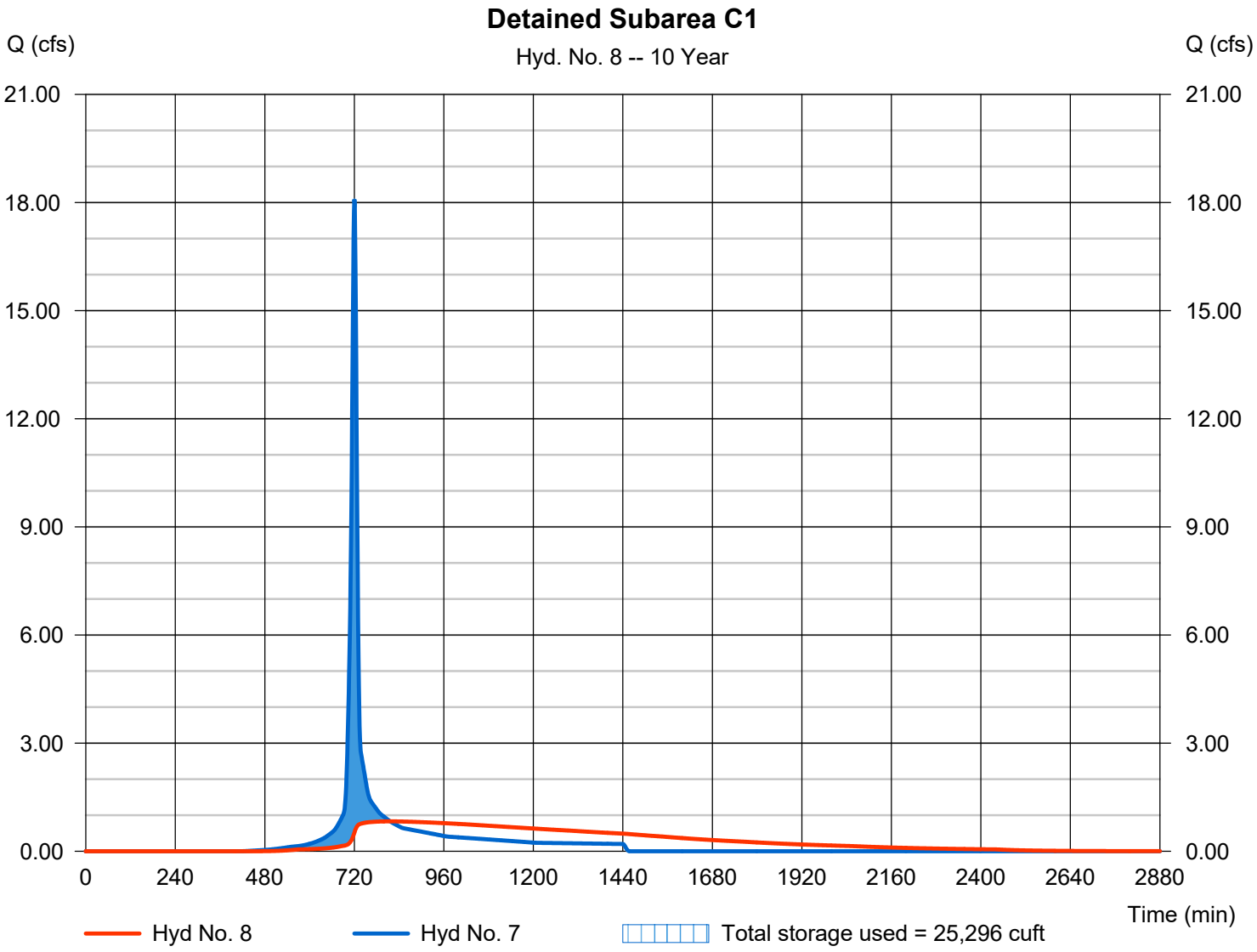
Hydrograph Report

Hyd. No. 8

Detained Subarea C1

Hydrograph type	=	Reservoir	Peak discharge	=	0.830 cfs
Storm frequency	=	10 yrs	Time to peak	=	816 min
Time interval	=	1 min	Hyd. volume	=	43,923 cuft
Inflow hyd. No.	=	7 - Post Subarea C1	Max. Elevation	=	935.43 ft
Reservoir name	=	DETENTION	Max. Storage	=	25,296 cuft

Storage Indication method used.

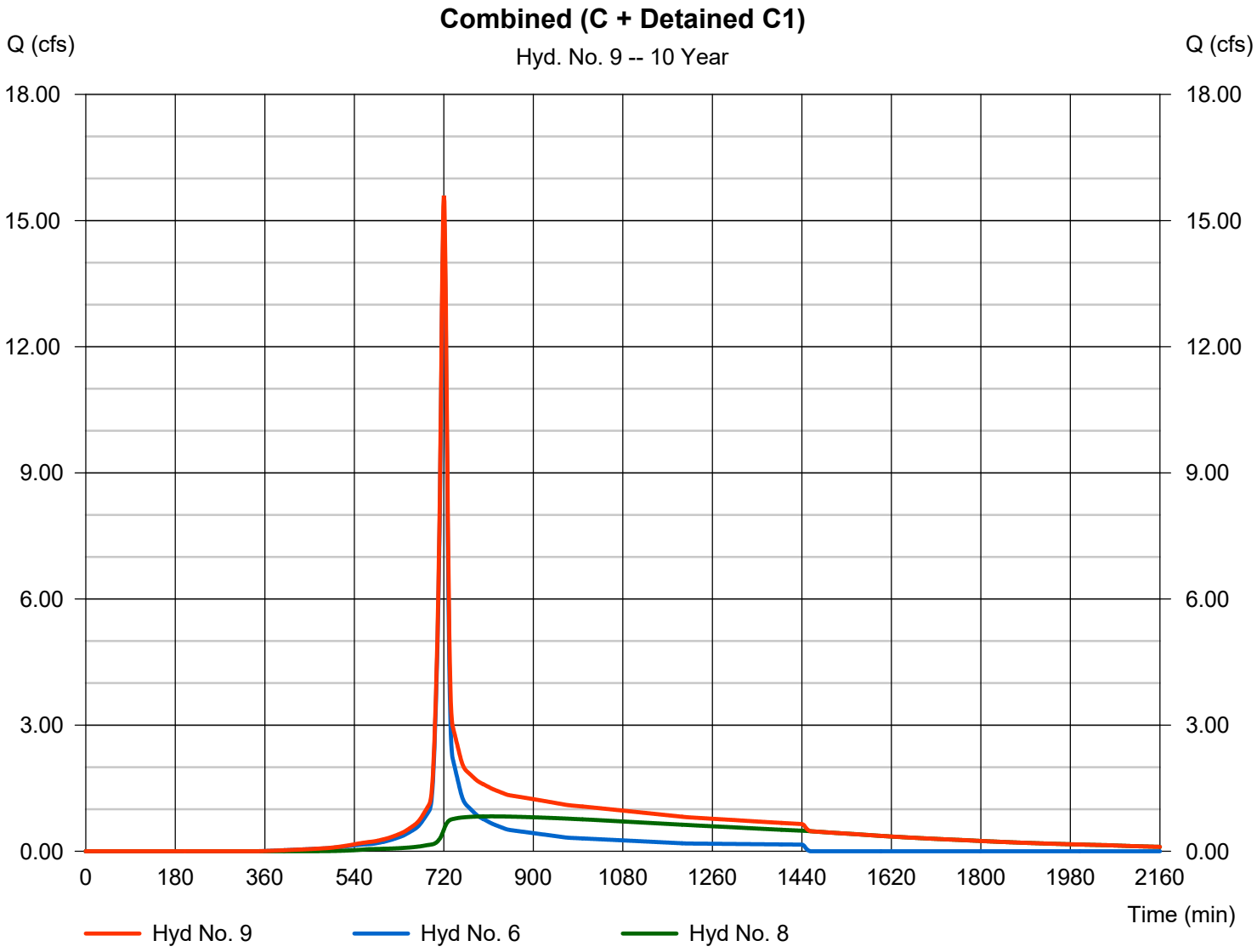


Hydrograph Report

Hyd. No. 9

Combined (C + Detained C1)

Hydrograph type	=	Combine	Peak discharge	=	15.59 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	81,058 cuft
Inflow hyds.	=	6, 8	Contrib. drain. area	=	2.910 ac



Hydrograph Summary Report

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

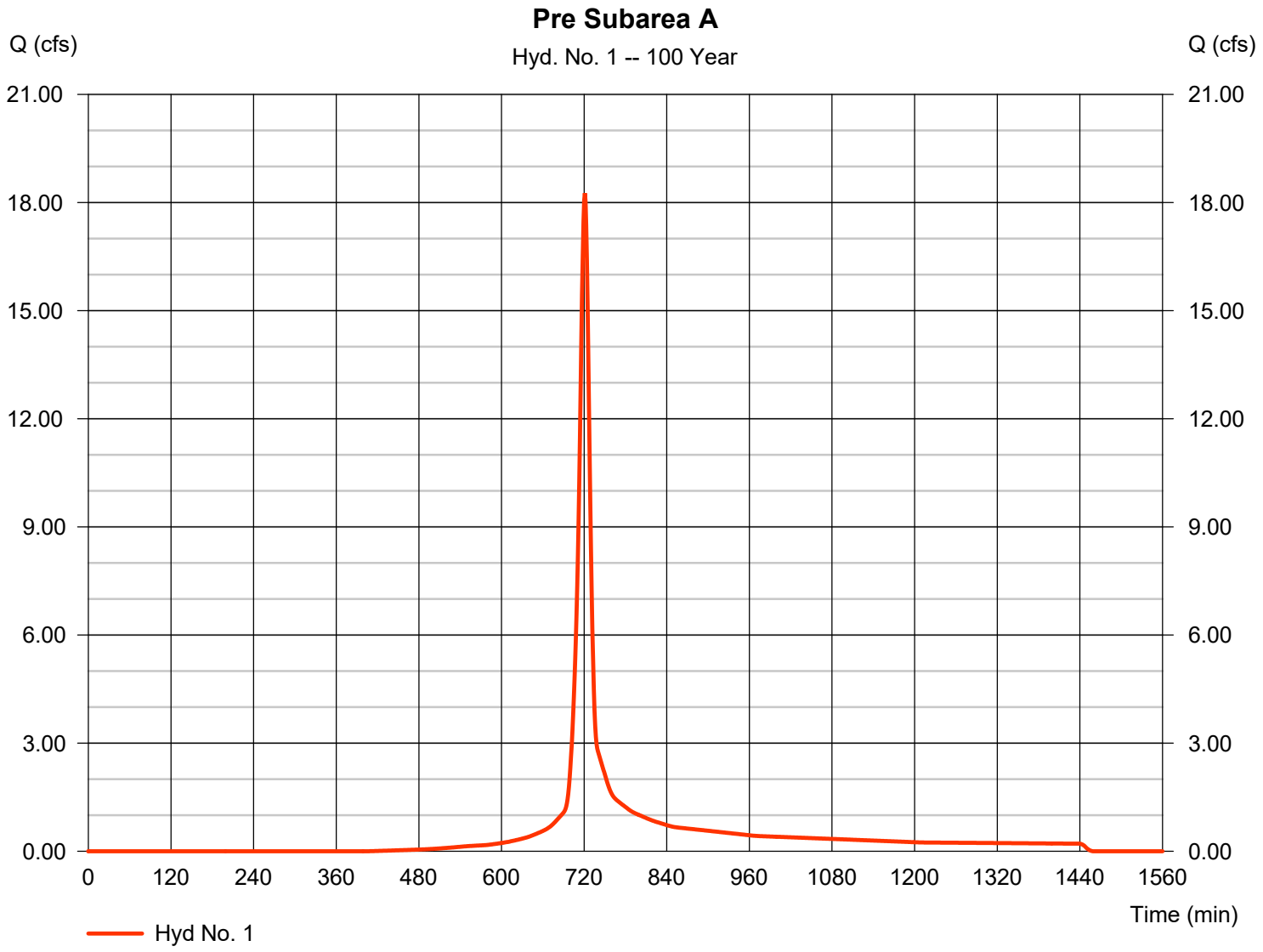
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	18.26	1	721	46,440	------	------	------	Pre Subarea A
2	SCS Runoff	37.70	1	721	95,877	------	------	------	Pre Subarea B
3	SCS Runoff	48.96	1	720	119,864	------	------	------	Pre Subarea C
4	SCS Runoff	4.238	1	720	10,327	------	------	------	Post Subarea A
5	SCS Runoff	28.99	1	721	73,739	------	------	------	Post Subarea B
6	SCS Runoff	24.72	1	720	62,443	------	------	------	Post Subarea C
7	SCS Runoff	30.89	1	720	76,616	------	------	------	Post Subarea C1
8	Reservoir	2.239	1	765	76,494	7	937.38	42,572	Detained Subarea C1
9	Combine	25.58	1	720	138,937	6, 8	------	------	Combined (C + Detained C1)

Hydrograph Report

Hyd. No. 1

Pre Subarea A

Hydrograph type	= SCS Runoff	Peak discharge	= 18.26 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 46,440 cuft
Drainage area	= 2.790 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.90 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

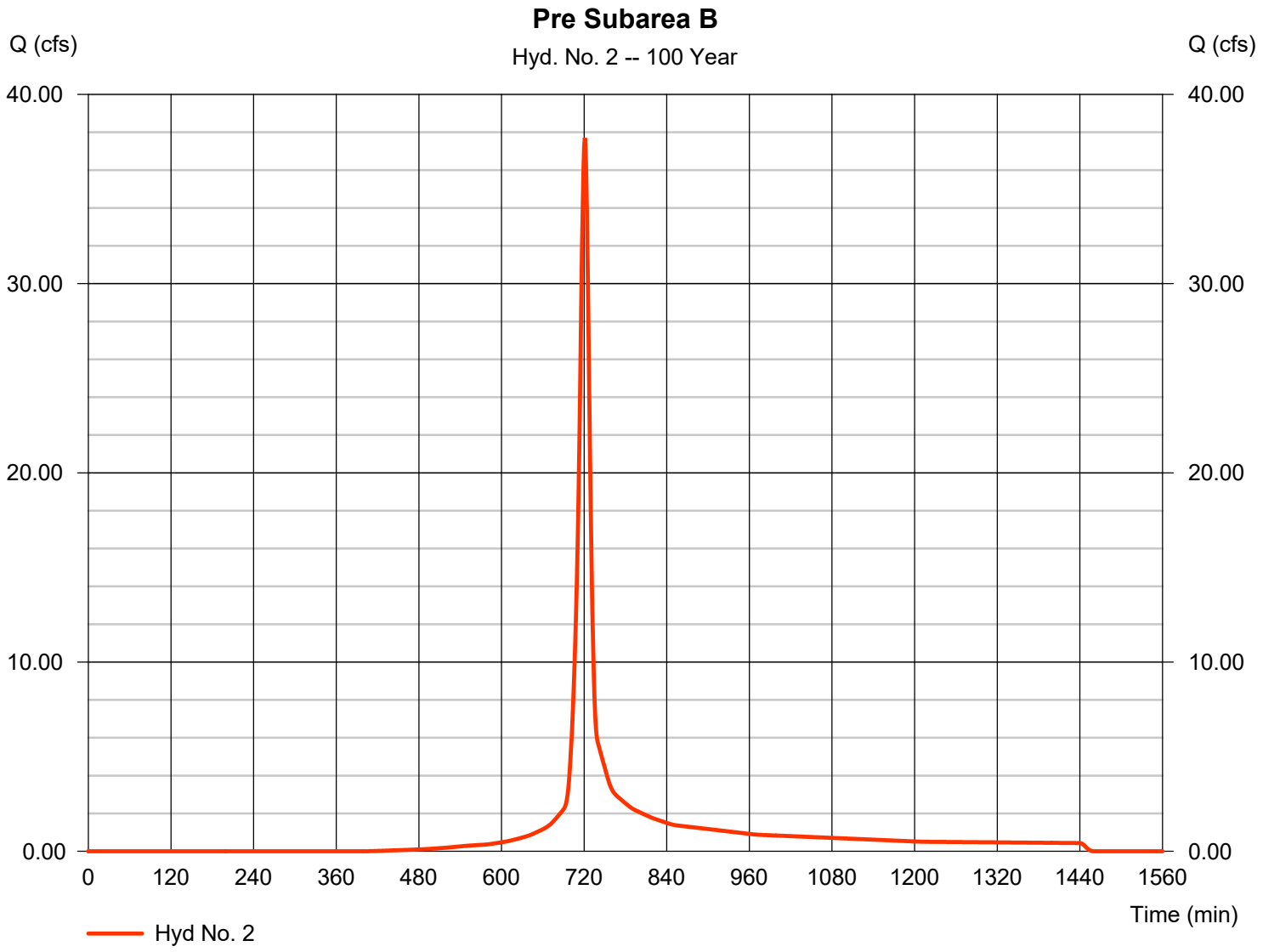


Hydrograph Report

Hyd. No. 2

Pre Subarea B

Hydrograph type	= SCS Runoff	Peak discharge	= 37.70 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 95,877 cuft
Drainage area	= 5.760 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 12.50 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

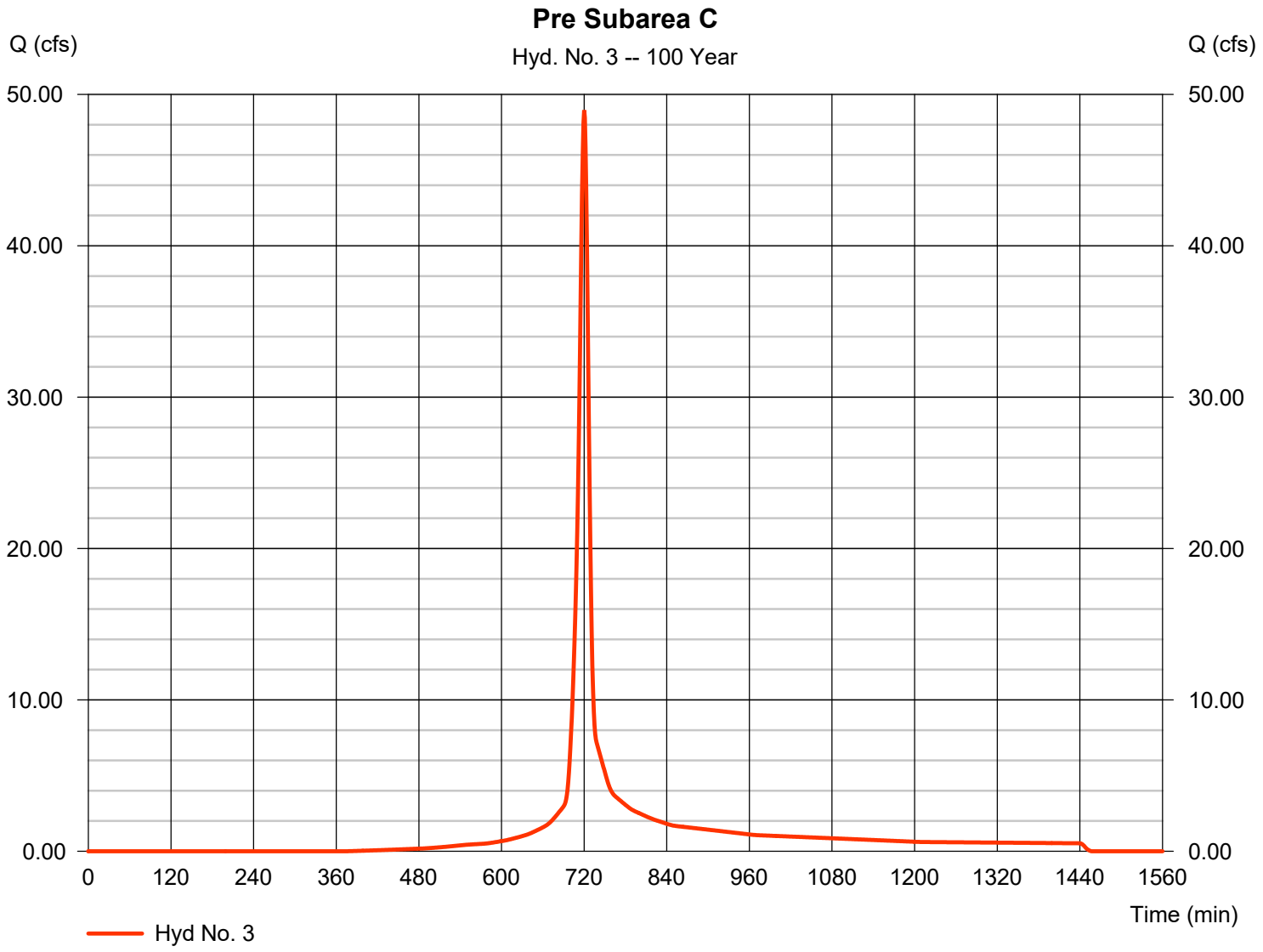


Hydrograph Report

Hyd. No. 3

Pre Subarea C

Hydrograph type	= SCS Runoff	Peak discharge	= 48.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 119,864 cuft
Drainage area	= 6.640 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.10 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

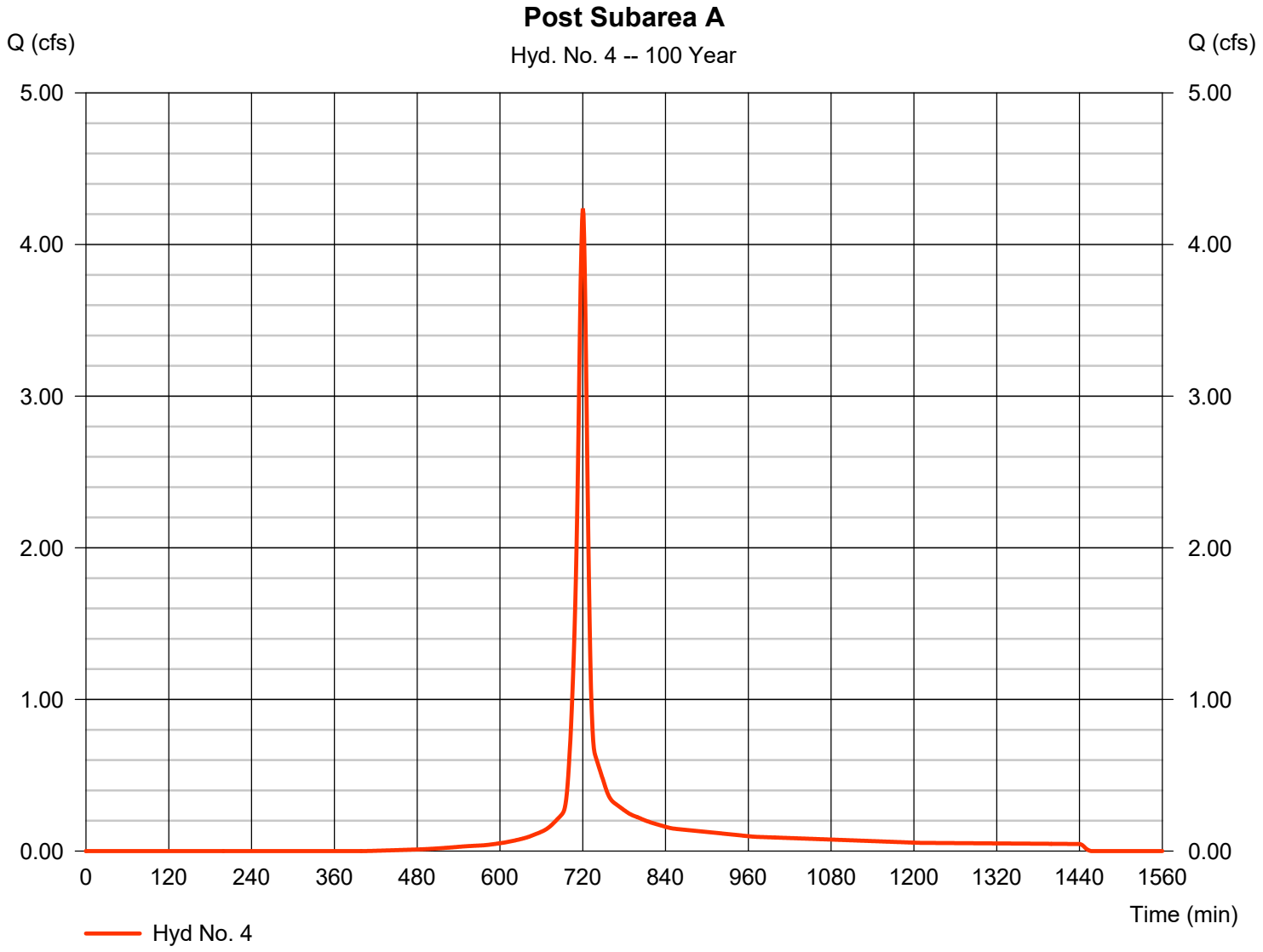


Hydrograph Report

Hyd. No. 4

Post Subarea A

Hydrograph type	= SCS Runoff	Peak discharge	= 4.238 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 10,327 cuft
Drainage area	= 0.600 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.10 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

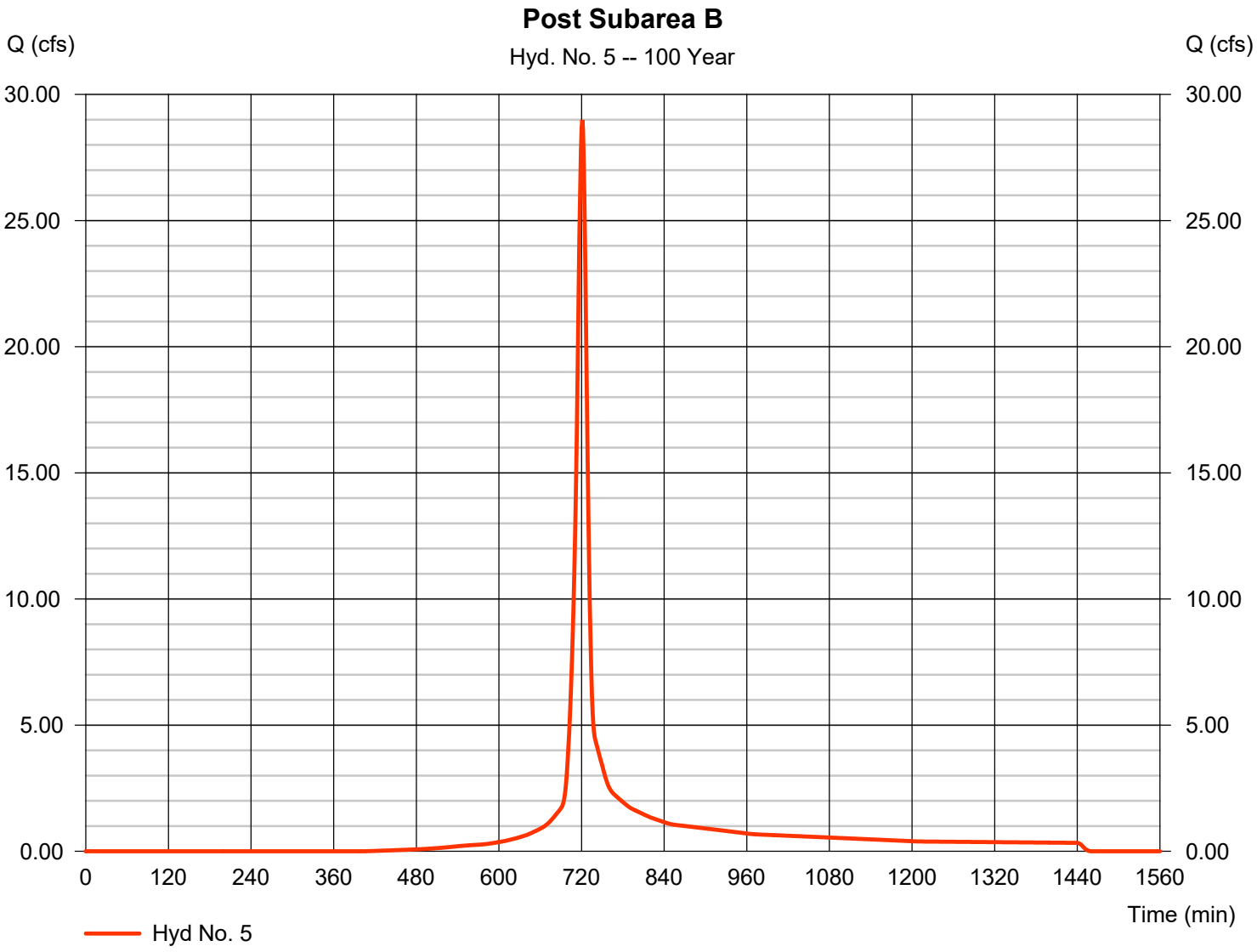


Hydrograph Report

Hyd. No. 5

Post Subarea B

Hydrograph type	=	SCS Runoff	Peak discharge	=	28.99 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	73,739 cuft
Drainage area	=	4.430 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	12.20 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

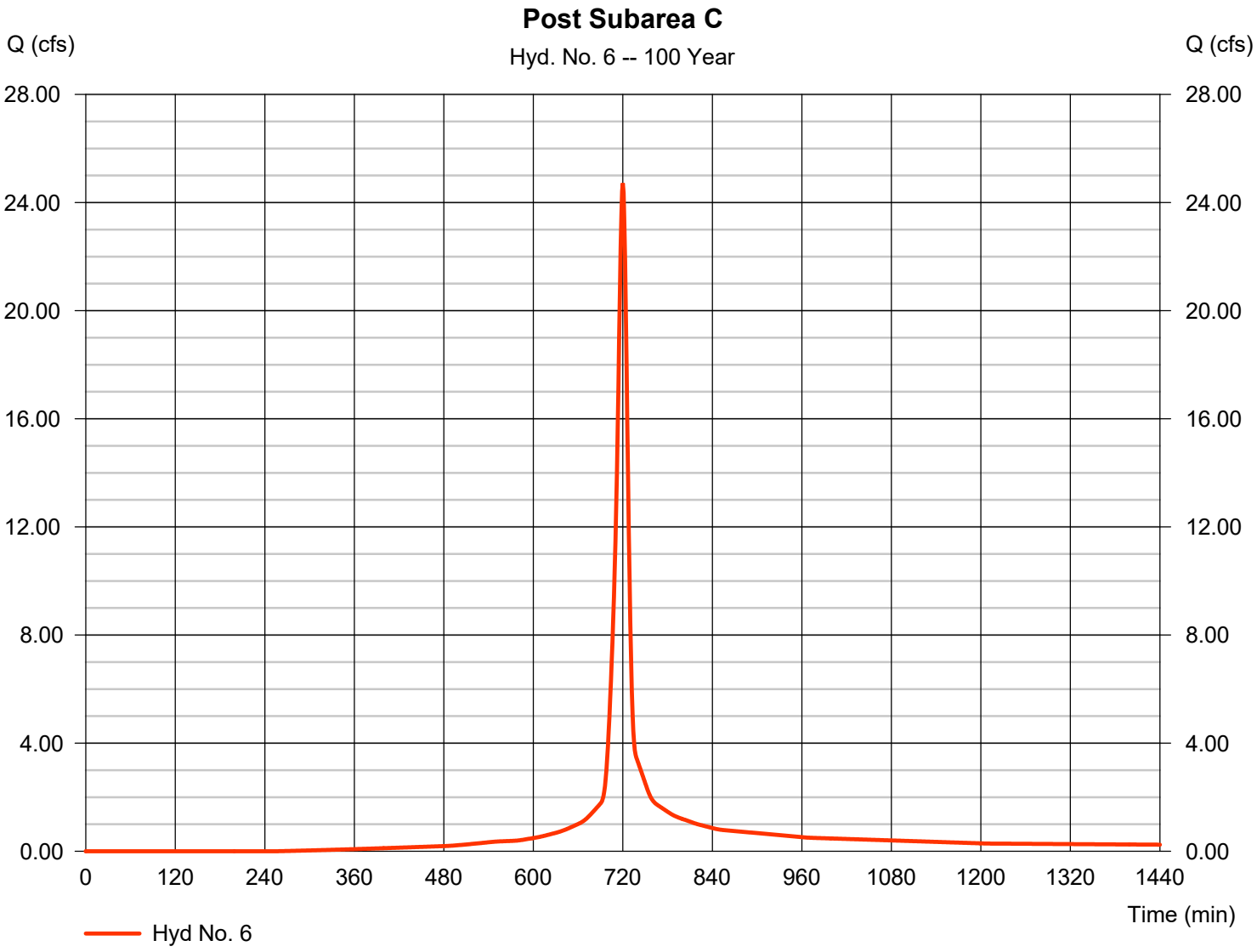


Hydrograph Report

Hyd. No. 6

Post Subarea C

Hydrograph type	= SCS Runoff	Peak discharge	= 24.72 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 62,443 cuft
Drainage area	= 2.910 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.50 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

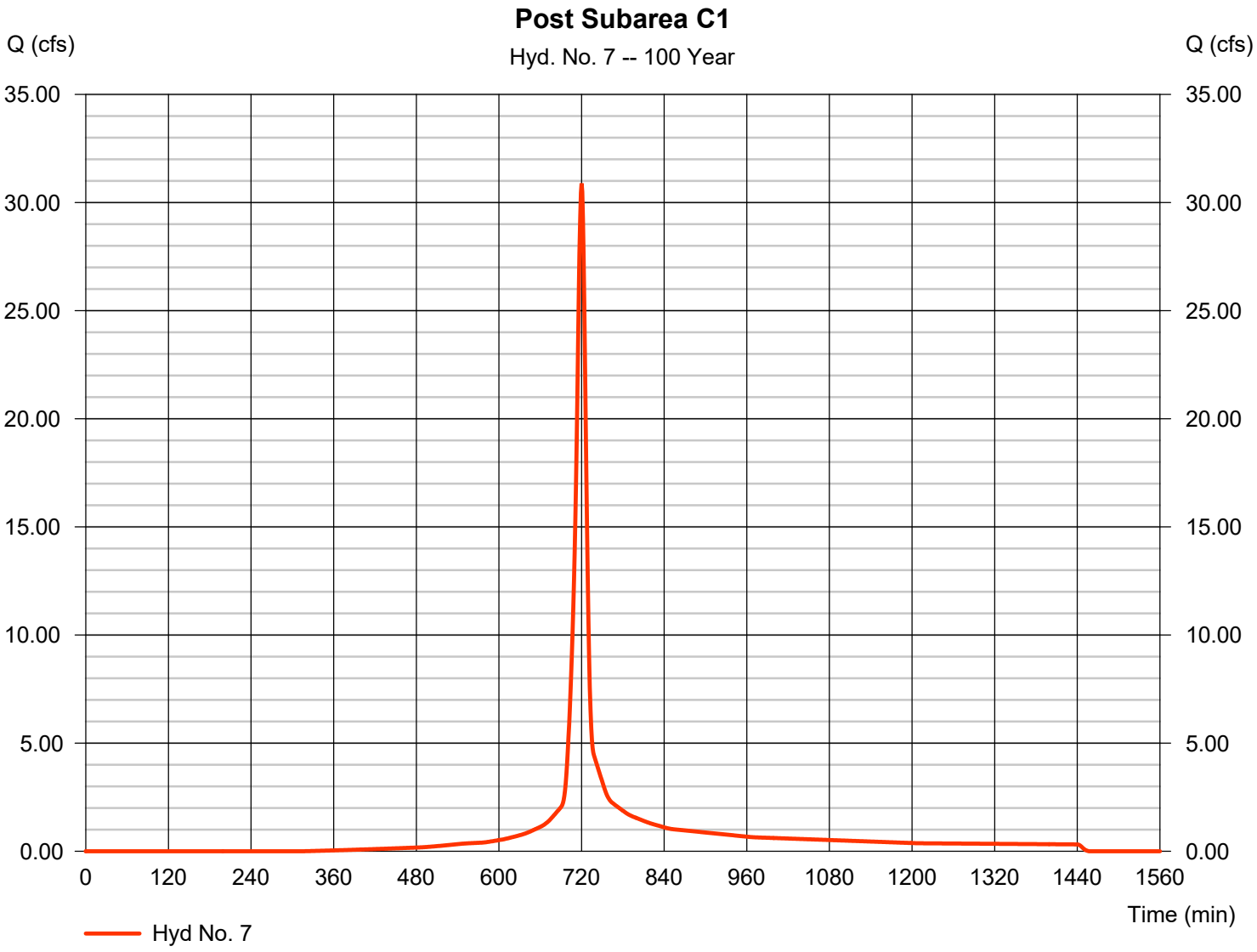


Hydrograph Report

Hyd. No. 7

Post Subarea C1

Hydrograph type	=	SCS Runoff	Peak discharge	=	30.89 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	76,616 cuft
Drainage area	=	3.880 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.80 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



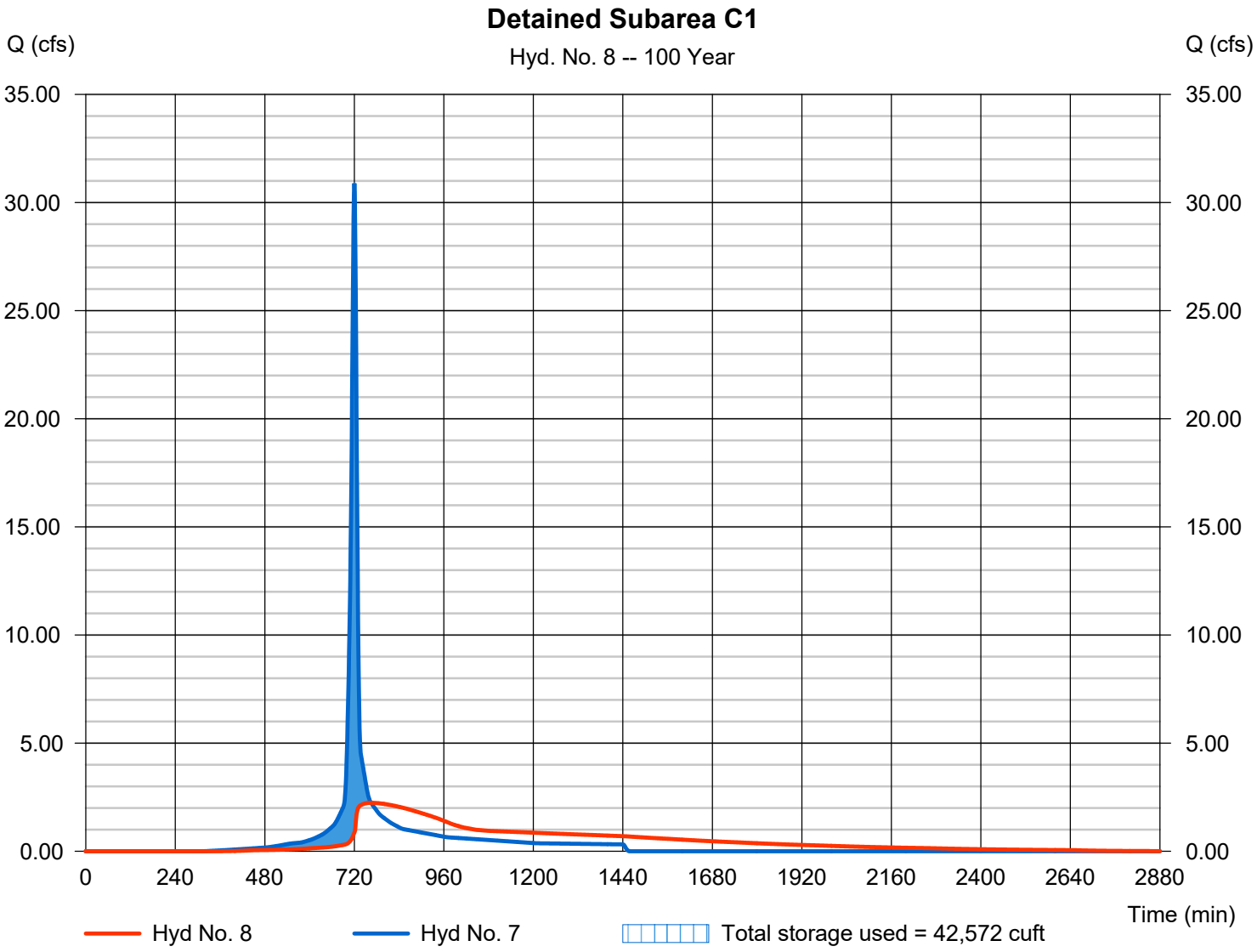
Hydrograph Report

Hyd. No. 8

Detained Subarea C1

Hydrograph type	=	Reservoir	Peak discharge	=	2.239 cfs
Storm frequency	=	100 yrs	Time to peak	=	765 min
Time interval	=	1 min	Hyd. volume	=	76,494 cuft
Inflow hyd. No.	=	7 - Post Subarea C1	Max. Elevation	=	937.38 ft
Reservoir name	=	DETENTION	Max. Storage	=	42,572 cuft

Storage Indication method used.

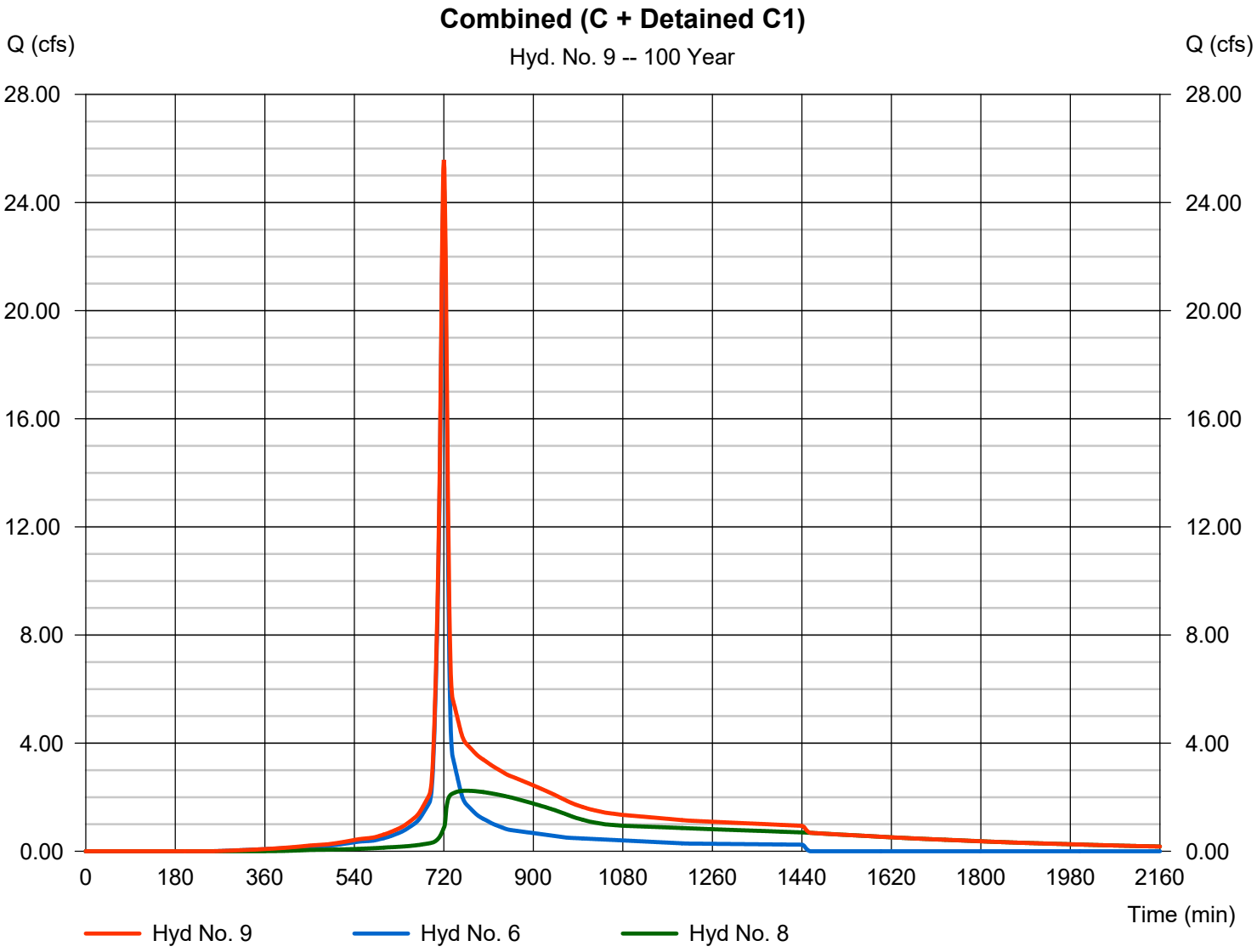


Hydrograph Report

Hyd. No. 9

Combined (C + Detained C1)

Hydrograph type	=	Combine	Peak discharge	=	25.58 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	138,937 cuft
Inflow hyds.	=	6, 8	Contrib. drain. area	=	2.910 ac



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

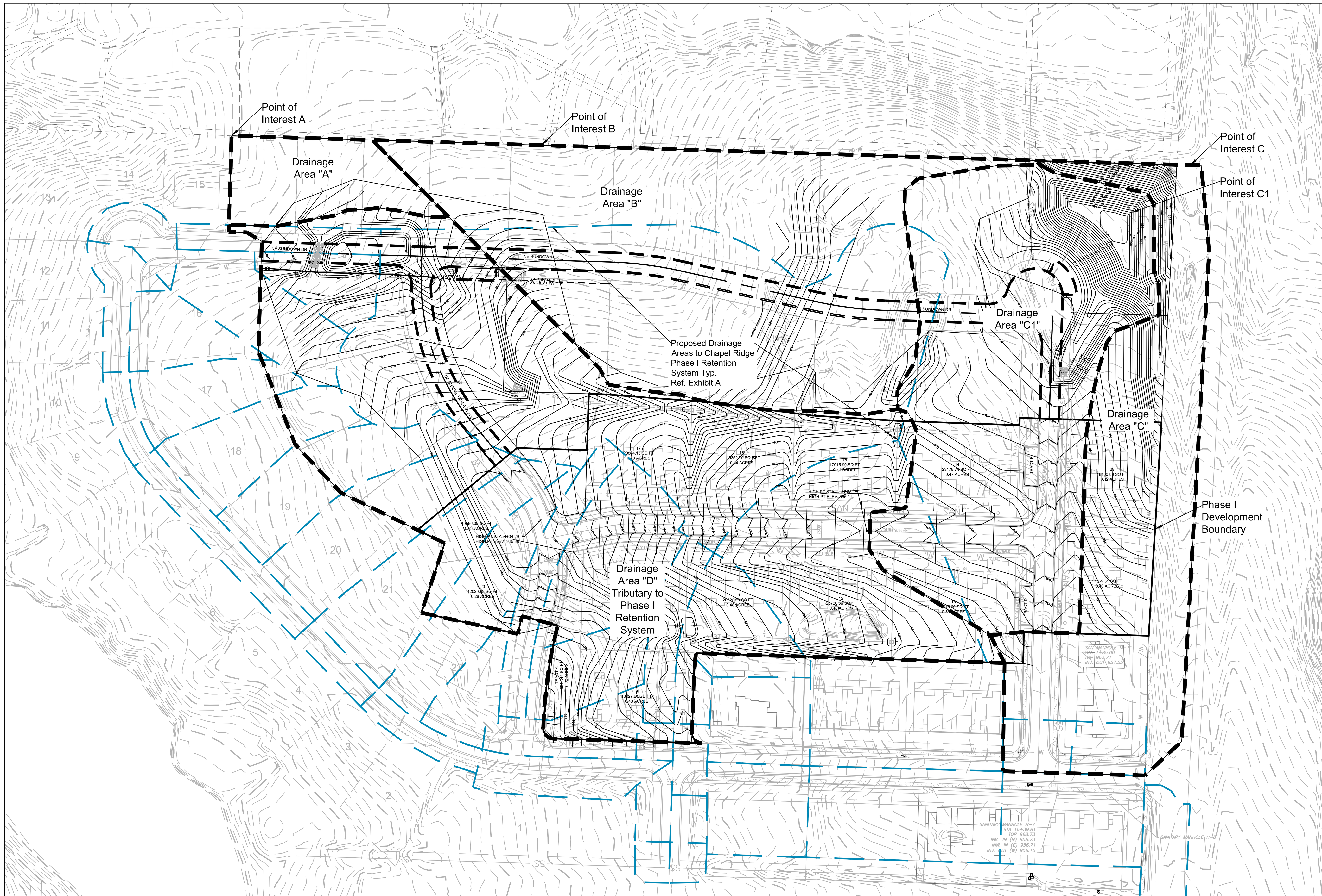
Tc = time in minutes. Values may exceed 60.

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

Exhibit G

Post Development Drainage Area Map



North

GRAPHIC SCALE
0 40' 80' 160'

PROP. DRAINAGE AREA MAP
SCALE: 1" = 80'

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Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

THE ESTATES OF CHAPEL RIDGE-2ND PLAT
LOTS 23 & 24 AND
THE TOWNHOMES OF CHAPEL RIDGE-2ND PLAT
LOTS 9-19 & TRACTS A-D
Lee's Summit, Jackson County, Missouri

Project: VILLAS OF CHAPEL RIDGE, LSMO
Issue Date: April 10, 2020

Proposed Drainage Area Map
Construction Plans for:
THE ESTATES OF CHAPEL RIDGE-2ND PLAT
LOTS 23 & 24 AND
THE TOWNHOMES OF CHAPEL RIDGE-2ND PLAT
LOTS 9-19 & TRACTS A-D
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

C.202

Exhibit H

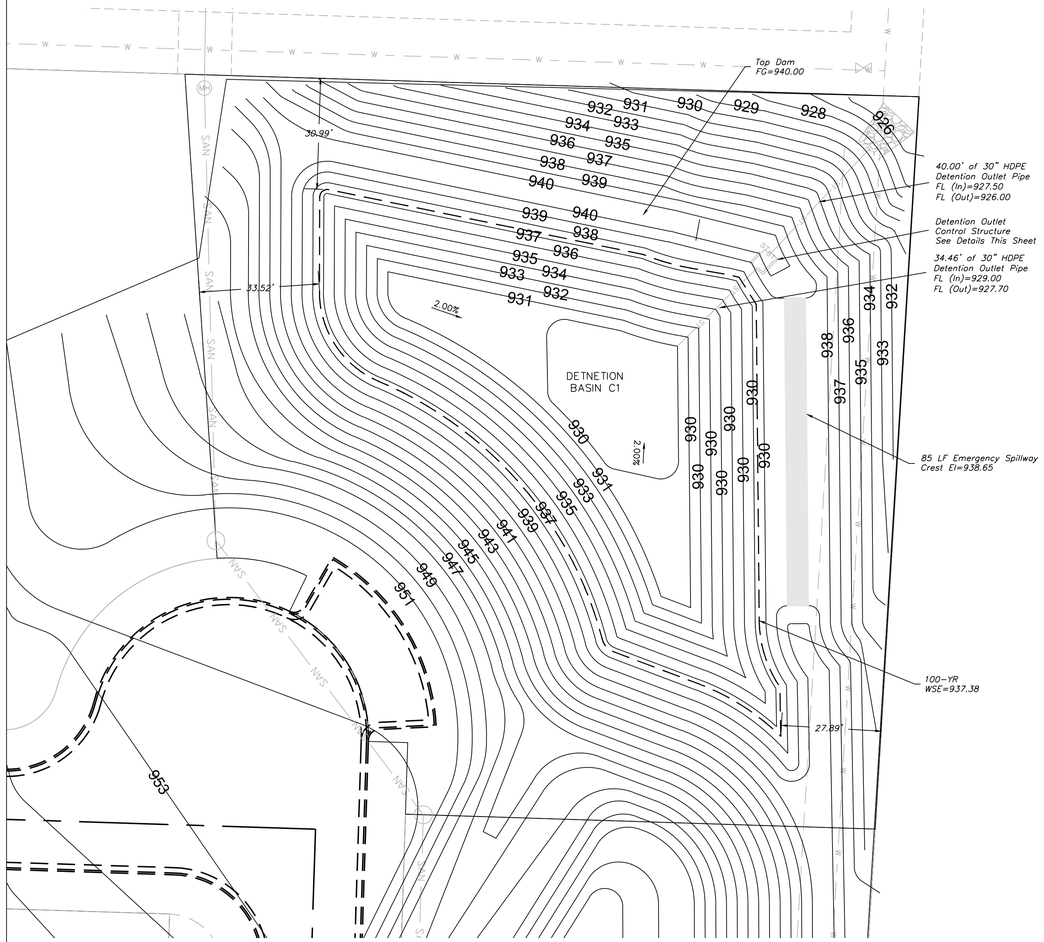
Detention Plan

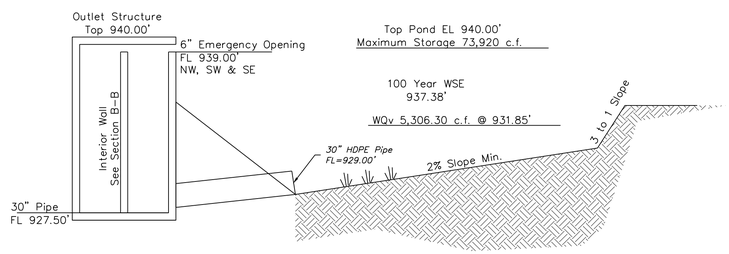
North

0 10' 20' 40'

DETENTION BASIN PLAN

SCALE: 1" = 20'





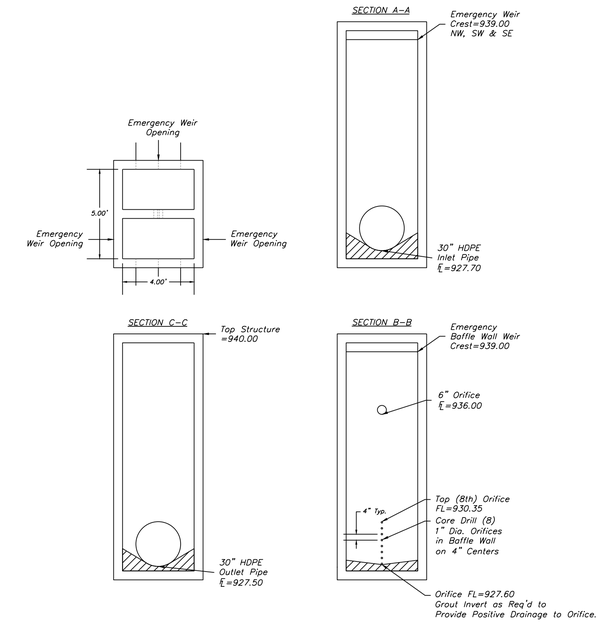
SECTION VIEW

N.T.S.

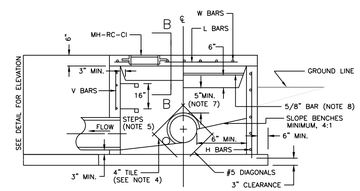
0 2' 4' 8'

DETENTION OUTLET STRUCTURE

SCALE: 1" = 4'



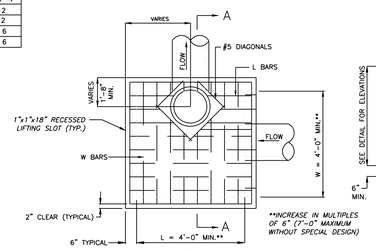
Detention Outlet Structure



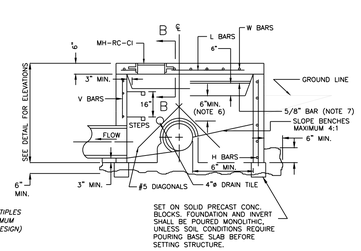
SECTION A-A
CAST IN PLACE

REINFORCING

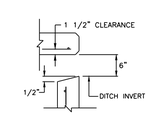
BARS	SIZE	SPACING (IN.)
H	4	12
V	4	12
L	5	6
W	5	6



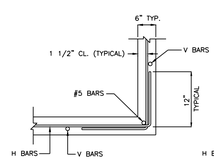
PLAN



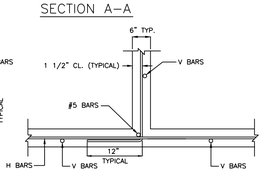
SECTION A-A



SECTION B-B



CORNER DETAIL



T-SECTION DETAIL

GENERAL NOTES:

1. *Locate ring and cover over outlet.*
2. *All work and materials shall conform to APWA Sect. 2600.*
3. *Use 3/4" chamfer strip on all exposed concrete corners.*
4. *Steps required @ 16" O.C. when depth from top of casting to invert exceeds 4 feet.*
5. *Boxouts will not be allowed to project through the corners of the structure.*
6. *The minimum reinforcing shall be 1 H-bar over a cast-in place pipe and 2 H-bars over a precast boxout.*
7. *Limit opening height to 6" with No. 5 galvanized bars extending to corner rebars.*
9. *Show field inlet orientation on plans plus number and size of opening.*
10. *O.R. = one half outside pipe diameter (O.D.).*
11. *4" ø field tile or precast hole shall be located at entering pipe and in the front face sump points. These tiles or openings shall be capped with ¼" galvanized wire mesh on the outside of the inlet and clear the invert and base concrete.*
12. *Location of the Manhole shall be located along the Northeast side of the structure.*

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Nebraska
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LOTS 23 & 24 AND
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Detention Basin Plan
Construction Plans for:
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LOTS 23 & 24 AND
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LOTS 9-19 & TRACTS A-D
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

Exhibit

Exhibit I

Emergency Spillway Calculations

Weir Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Apr 9 2020

EMERGENCY SPILLWAY DETENTION BASIN C1

Rectangular Weir

Crest	= Broad
Bottom Length (ft)	= 85.00
Total Depth (ft)	= 1.45

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 30.89

Highlighted

Depth (ft)	= 0.27
Q (cfs)	= 30.89
Area (sqft)	= 22.88
Velocity (ft/s)	= 1.35
Top Width (ft)	= 85.00

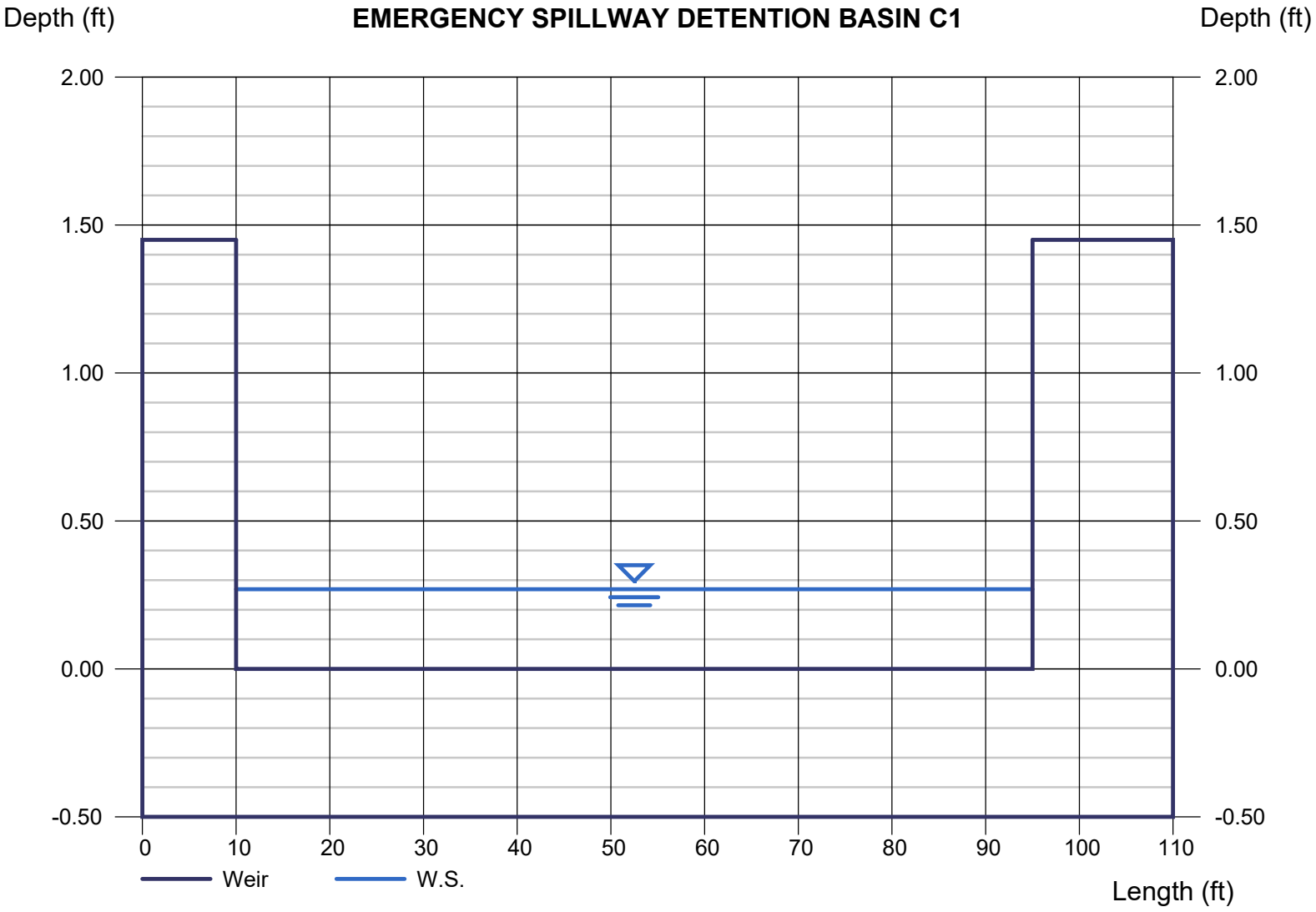

Exhibit J

Extended Detention Calculations

Calculate Water Quality for Storm Study

Project: Villas of Chapel Ridge 4/10/2020

To Calculate: WQv = P * Rv * A

LEGEND:

Enter data in these Fields	
Values of Interest	

Unit Conversions:	
1 Acre = 43,560 Sq. Ft.	

P (in) =	1.37	
P (ft) =	0.11	
Impervious Area (sq. ft.) =	42,253	
Total Area (sq. ft.) =	169,013	
Impervious Area (ac) =	0.97	
Total Area (acre) =	3.88	
Rv = (0.05 * 0.009(I)) =	0.28	
Percent Impervious (I) =	25.00	CN = 80
WQ_v (cu. ft.) =	5,306	
WQ_v (ac. ft.) =	0.122	

40 HOUR DETENTION CALC.

To Calculate: 40 Hour Detention (EDDB)

I. Basin Water Quality Storage Volume

Step 1) Tributary area To EDDB, A_t (ac) =	A_T (ac) =	3.88
Step 2) Calculate WQ_v using Sec. 6 (ac-ft) =	WQ_v (ac. ft.)=	0.122
Step 3) Add 20 Percent to Step 2.	V_{design} (ac-ft) =	0.146

II.a. Water Quality Outlet Type

Step 1) Set water quality outlet type
Type 1 = single orifice
Type 2 = perforated riser or plate
Type 3 = v-notch weir

Outlet Type = 2

Step 2) Proceed to Step IIb, IIc, or IId based on selection

To Calculate Z_{WQ} (ft) interpolated from the contours above.

Elevation 1 =	931.00	Storage 1 =	2,449.00
Elevation X =		Storage X =	5,306.30
Elevation 2 =	932.00	Storage 2 =	5,826.00
		Elevation X =	931.85
Lowest Elevation of Pond =	929.00		
Elevation X =	931.85		
Z_{WQ} (ft) =	2.85		

IIc. Water Quality Outlet, Perforated Riser

Step 1) Depth at outlet above lowest perforation:	Z_{WQ} (ft) =	2.85	
Step 2) Recommended maximum outlet area per row:	A_0 (in^2) =	0.231	
Total Eqivalent Diameter of orifice given A_0:	D_T (in) =	0.543	
Step 3) Circular perforation diameter per row assuming a single column:	D_1 (in) =	0.186	Calculates the diameter of each hole given the depth of Z_{WQ} and the Area given in Step 2. Assuming 4" spacing. If less than use 1" as D_{perf}.
Step 4) Number of Columns:	n_c (unitless) =	1	
Step 5) Design circular perforation diameter (should be between 1 and 2 inches):	D_{perf} (in) =	1.000	
Step 6) Horizontal perforation column spacing when $n_c > 1$, center to center:	S_c (in) =	4	
Note: If $D_{perf} \geq 1.0$ inch, $S_c = 4$			
Step 7) Number of rows (4" vertical spacing between perforations, center to center):	n_r (unitless) =	8.00	

Recommended Method: Perforated Riser