

Detention Calculations

Walmart Supercenter No. 4590-01
3410 SW Market Street
Lee's Summit, MO. 64082

Project No. 12-5082
November 25, 2015

RECEIVED

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Planning & Codes Admin



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Date 11/30/15

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Executive Summary

Walmart is planning a new Supercenter development on Market St. just north of Highway 150. The development will consist of a new 160,499 s.f. Walmart Supercenter and two outlots. There are no users defined at this time for the two outlots so the outlots are assumed to be 100% impervious for the purposes of storm water detention at the site.

The site is currently undeveloped. The existing use of the property is agriculture. The site gently slopes from the west to the east. The drainage on the site is split into three areas. Drainage Area #1 flows to the southeast corner of the site to a 30" diameter storm sewer culvert under Market St. Drainage Area #1 is tributary to Lake Winnebago. Drainage Area #2 flows to the northeast corner of the site to the west ditchline along Market St. Drainage Area #2 is tributary to Big Creek. Drainage Area #3 flows to the north of the site to the west ditchline along Market St. Drainage Area #3 is tributary to Big Creek. The locations of the storm water discharge from the site are shown on the attached pre-developed drainage area map. The pre-developed peak storm water runoff for each drainage area are summarized below:

Pre-developed Flow Rates
Drainage Area #1 (Lake Winnebago)
2-year storm = 9.74 cfs
10-year storm = 22.32 cfs
100-year storm = 37.79 cfs

Drainage Area #2 (Big Creek)
2-year storm = 13.57 cfs
10-year storm = 31.10 cfs
100-year storm = 52.65 cfs

Drainage Area #3 (Big Creek)
2-year storm = 3.61 cfs
10-year storm = 8.24 cfs
100-year storm = 13.91 cfs

The post-developed tributary areas for the site will roughly follow the existing drainage patterns. The two outlots and a portion of the front parking field will be tributary to Drainage Area #1. The storm water runoff from Drainage Area #1 will be detained in Storm Water Detention Basin #1. The Walmart building, rear truck drive, and remainder of the front parking field will be tributary to Drainage Area #2. The storm water runoff from Drainage Area #2 will be detained in Storm Water Detention Basin #2. Detention was not provided for drainage area #3, as the post developed flow rates decreased of that from the pre-developed flow rates. Storm water quality was not provided, as the drainage area is all pervious. The post-developed peak storm water runoff for each drainage area are summarized below:

Post-Developed Flow Rates
Drainage Area #1 (Lake Winnebago)
2-year storm = 4.74 cfs
10-year storm = 11.41 cfs
100-year storm = 16.67 cfs

Drainage Area #2 (Big Creek)
2-year storm = 6.38 cfs
10-year storm = 23.61 cfs
100-year storm = 37.33 cfs

Drainage Area #3 (Big Creek)
2-year storm = 1.69 cfs
10-year storm = 3.84 cfs
100-year storm = 6.49 cfs

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The peak storm water runoff was reduced for all three design storms. A summary of the percentage reduction of peak storm water runoff is summarized below:

Drainage Area #1 (Lake Winnebago)	2-year storm = 51% reduction	Drainage Area #2 (Big Creek)	2-year storm = 53% reduction	Drainage Area #3 (Big Creek)	2-year storm = 53% reduction
	10-year storm = 49% reduction		10-year storm = 24% reduction		10-year storm = 53% reduction
	100-year storm = 56% reduction		100-year storm = 29% reduction		100-year storm = 53% reduction

The storm water quality requirements for the project will be satisfied in the bottom portions of each of the storm water detention basins. A PVC standpipe riser pipe protected by a cone of 2" clean limestone will provide the outlet for the storm water quality. The standpipe and gravel will also be utilized in the bottom of the storm water detention basins throughout construction activities on the site. When construction is complete on the site, the sediment captured in the bottom of the basins will be removed and new gravel installed around the standpipe.

The required water quality volume for Drainage Area #1 is 24,470 ft³. The water quality volume provided in Storm Water Detention Basin #1 is 31,143 ft³.

The required water quality volume for Drainage Area #2 is 56,439 ft³. The water quality volume provided in Storm Water Detention Basin #2 is 58,598 ft³.

Groundwater infiltration was a water quality option that was discussed with City staff. The high plastic soils on the site do not allow the groundwater infiltration as an option for meeting the water quality requirements. An alternative to the high plastic clay would be soil remediation in the upper two feet of the bottom of the storm water detention basin. This option would allow the water to filtrate into the remediated soil, but the water would then not infiltrate into the clay beneath the remediated soil. We have found that the gravel standpipe is an effective, low maintenance option for water quality on large commercial developments.

DETENTION CALCULATIONS
Walmart Supercenter No. 4590-01
3410 SW Market St., Lee's Summit, MO. 64082
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November 25, 2015

The following detention calculations have been performed for final design for the Walmart Supercenter Store No. 4590-01 located in Lee's Summit, Missouri. Said calculations were performed in accordance with the City of Lee's Summit and Kansas City AWP/A Regulations. All detention design was performed with the aid of Hydroflow Hydrographs Software. Developed, tributary, and routed hydrographs for the 2, 10, and 100 year storms are attached.

DETENTION BASIN CALCULATIONS SUMMARY:

A summary of the Detention Basin Calculations is shown below. All detention calculations, including release rates and volumes, are included in this report. The release rates were calculated utilizing the comprehensive control, per the APWA regulations. The 2-year storm maximum release rate from the site is 0.5 cfs/site acre, the 10-year storm maximum release rate from the site is 2.0 cfs/site acre, and the 100-year storm maximum release rate allows for 3.0 cfs/site acre. A drainage area map is also included at the end of this report.

DETENTION BASIN #1

Year of Storm Frequency	Pre-Developed Flow Rate (cfs)	Post-Developed Flow Rate (cfs)	Total Runoff Tributary to Detention Basin (cfs) [A]	Detention Basin Release Rate (cfs) [B]	On-Site runoff directly to Outflow #1 [C]	Total Release Rate To Outflow #1 (cfs) [B+C] = [D]	Maximum Allowable Release Rate to Outflow #1 (cfs) (See Table 1)	Total Detention Provided (cfs) [A-D]
2	9.74	36.24	22.15	2.91	1.83	4.74	4.82	17.86
10	22.32	64.56	43.44	8.00	3.41	11.41	19.26	29.12
100	37.79	95.99	67.84	11.48	5.19	16.67	28.89	47.08

Watershed: Lake Winnebago

DETENTION BASIN #2

Year of Storm Frequency	Pre-Developed Flow Rate (cfs)	Post-Developed Flow Rate (cfs)	Total Runoff Tributary to Detention Basin (cfs) [A]	Detention Basin Release Rate (cfs) [B]	On-Site runoff directly to Outflow #2 [C]	Total Release Rate to Outflow #2 (cfs) [B+C] = [D]	Maximum Allowable Release Rate to Outflow #2 (cfs) (See Table 1)	Total Detention Provided (cfs) [A-D]
2	13.57	37.29	30.49	4.28	2.10	6.38	7.48	25.93
10	31.10	63.54	50.64	19.71	4.51	23.61	29.90	30.73
100	52.65	92.50	72.87	29.96	7.37	37.33	44.85	42.83

Watershed: Big Creek

DETENTION CALCULATIONS
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Table 1					
Year of Storm Frequency	Release Rate Per Site Acre* (cfs/ac)	Total Site Acreage to Drainage Area		Outflow #1	Outflow #2
		1	2		
2	0.5	9.63	14.95	4.82	7.48
10	2.0	9.63	14.95	19.26	29.90
100	3.0	9.63	14.95	28.89	44.85

*Based on Kansas City Metropolitan Chapter American Public Works Association Standard Specifications & Design Criteria – Section 5608.3 C

	Water Elevation			Top of Berm
	2 Year Elevation	10 Year Elevation	100 Year Elevation	
Basin #1	1010.89	1012.83	1014.97	1016.00
Basin #2	1015.02	1016.48	1017.98	1019.00

Water Quality Calculation Summary

24-Hour Storm WQCV (cf)	1.37" Rainfall - Basin #1	1.37" Rainfall - Basin #2	1.37" Rainfall - Entire Site
	24,470	56,439	80,909

WATER QUALITY CALCULATION NOTES

Walmart Supercenter No. 4590-01
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1.37" RAINFALL OVER ENTIRE SITE

Total Onsite Area

Area = 24.58 Ac.

Volumetric Runoff Coefficient

$R_v = 0.05 + 0.009(I)$ I = % Impervious

Basin #1 - $R_v = 0.05 + 0.009(51\%) = 0.51$

Basin #2 - $R_v = 0.05 + 0.009(79\%) = 0.76$

Water Quality Volume (inches)

$WQ_v = P \times R_v$

Basin #1 - $WQ_v = 1.37" \times 0.51 = 0.70"$

Basin #2 - $WQ_v = 1.37" \times 0.76 = 1.04"$

Watershed Breakdown - 1.37" Rainfall - 24-hour Storm

$WQ_v = \frac{q(in)}{12(in/ft)} \times \text{Total Onsite Area}(ft^2)$

Basin #1 - $WQ_v = \frac{0.70"(in)}{12(in/ft)} \times 419,483 (ft^2) = 24,470 \text{ CF}$

Basin #2 - $WQ_v = \frac{1.04"(in)}{12(in/ft)} \times 651,222 (ft^2) = 56,439 \text{ CF}$

Total Water Quality Control Volume = 80,909 CF

OUTFLOW #1

2 YEAR STORM

Hydrograph Report

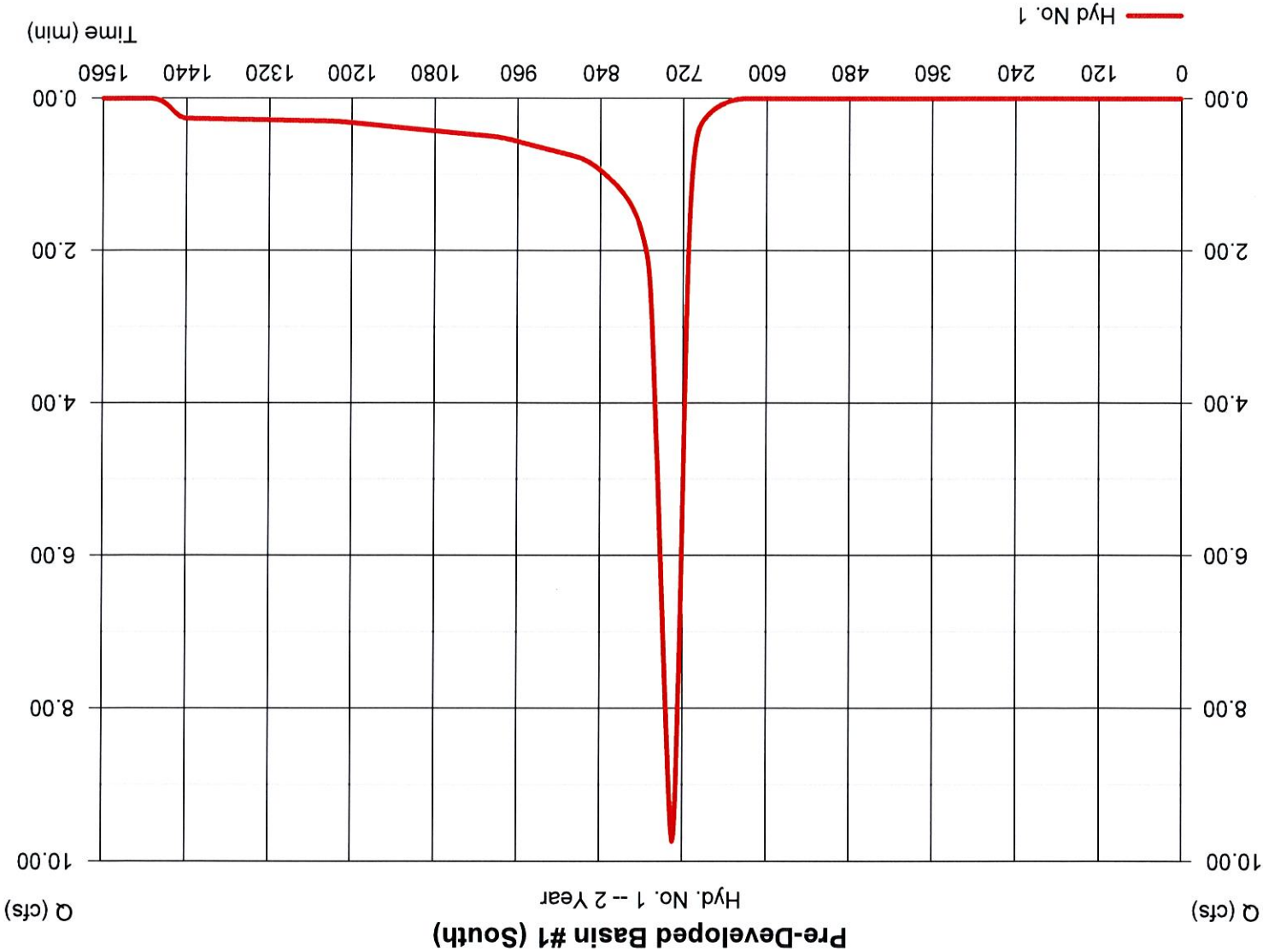
Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Monday, 11 / 30 / 2015

Hyd. No. 1

Pre-Developed Basin #1 (South)

Hydrograph type	= SCS Runoff	Peak discharge	= 9.739 cfs
Storm frequency	= 2 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 44,035 cuft
Drainage area	= 9.150 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 31.80 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydrowflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

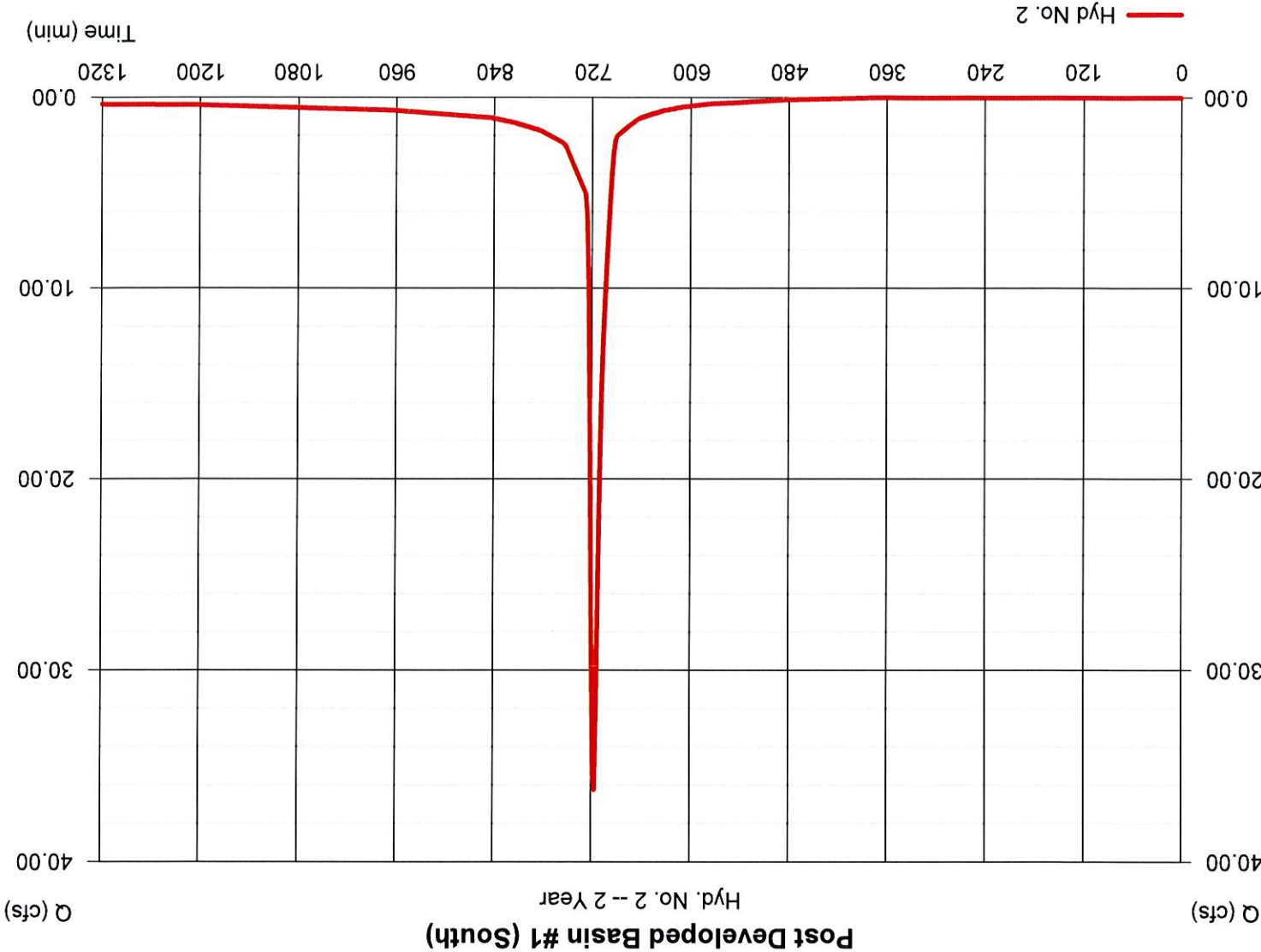
Monday, 11 / 30 / 2015

Hyd. No. 2

Post Developed Basin #1 (South)

Hydrograph type	=	SCS Runoff	Peak discharge	=	36.24 cfs
Storm frequency	=	2 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	74,397 cuft
Drainage area	=	9.620 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.910 x 98) + (5.710 x 74)] / 9.620



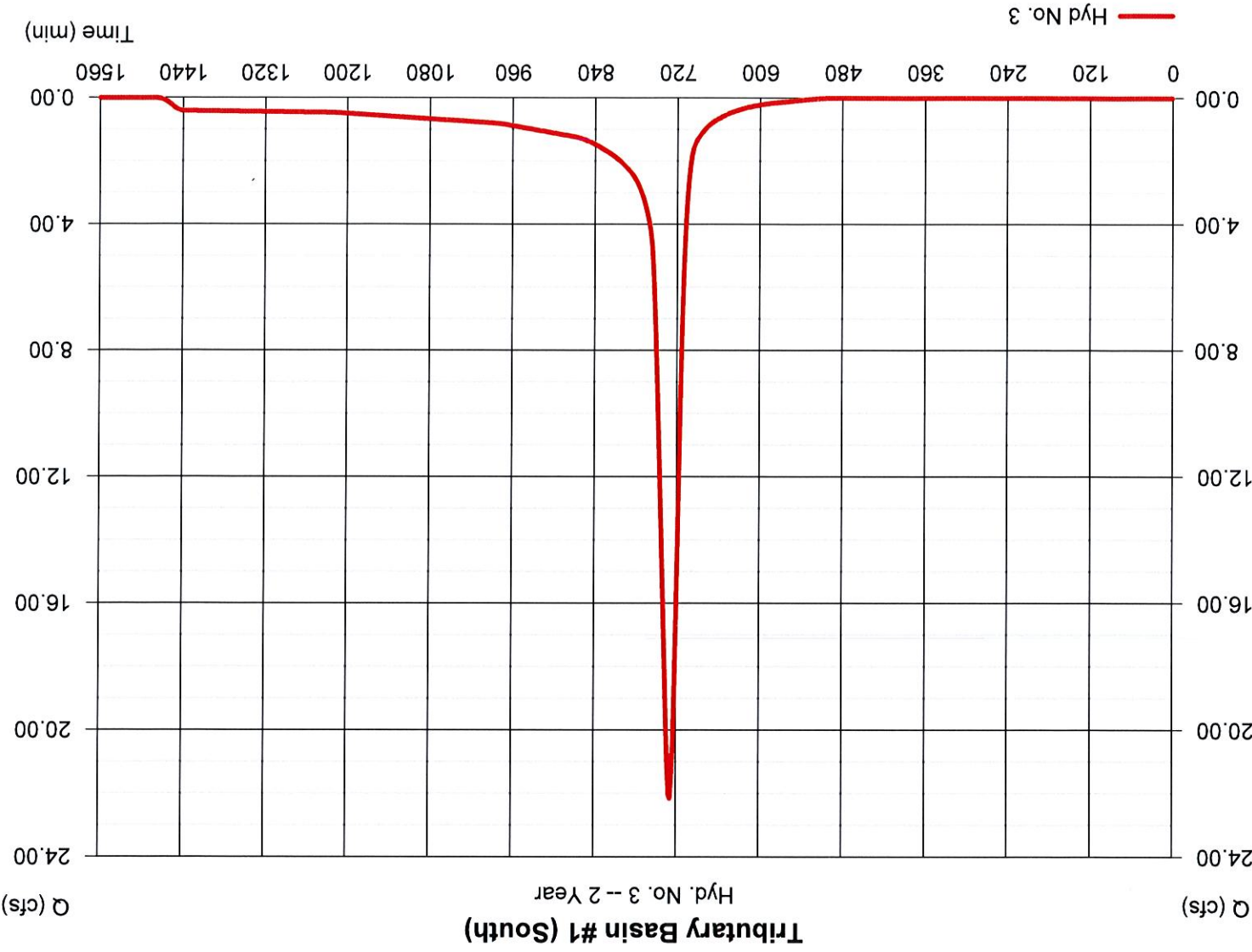
Hydrograph Report

Hyd. No. 3

Tributary Basin #1 (South)

Hydrograph type	=	SCS Runoff	Peak discharge	=	22.15 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	81,524 cuft
Drainage area	=	12.230 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	24.90 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.120 x 98) + (8.110 x 74)] / 12.230



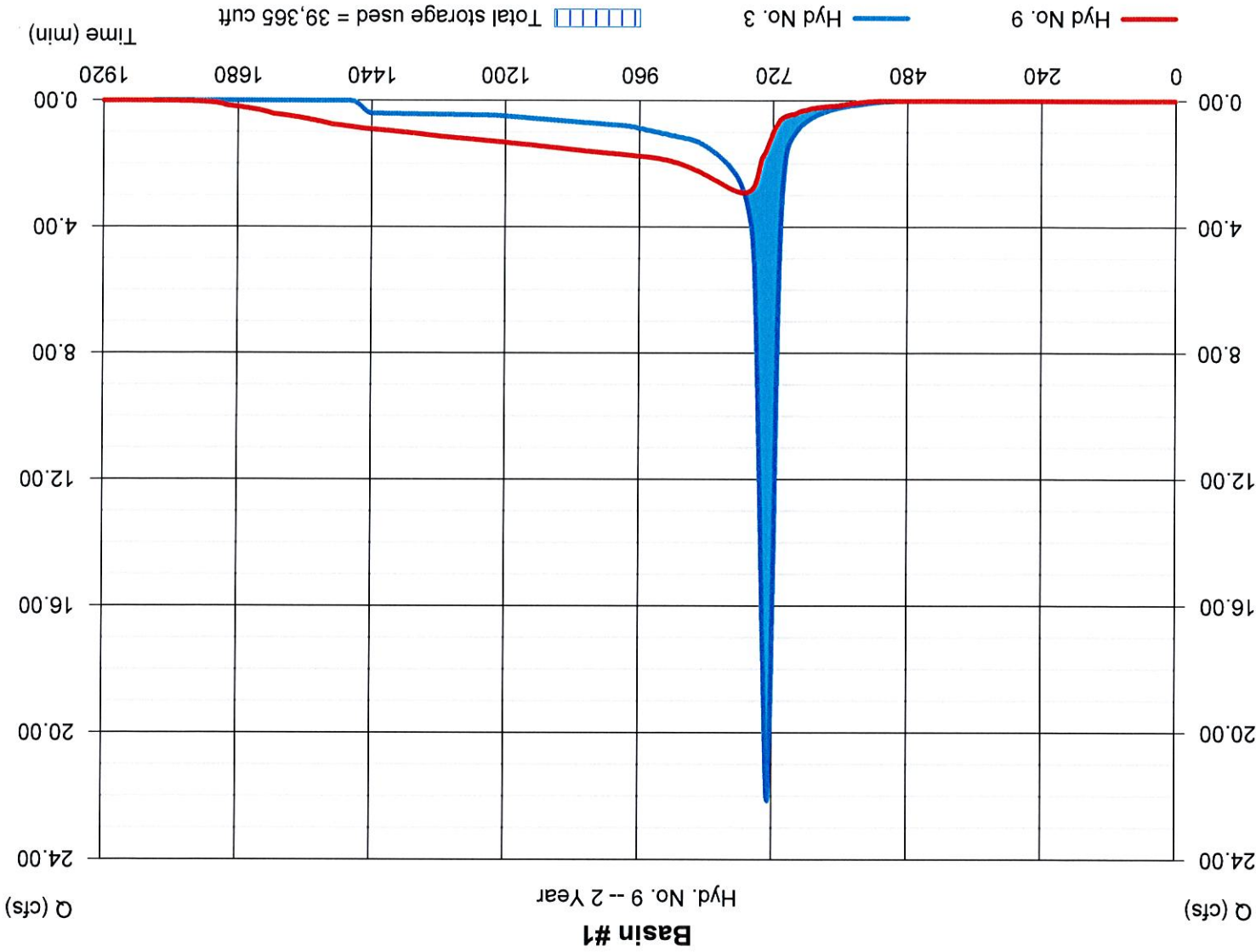
Hydrograph Report

Hyd. No. 9

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 2.910 cfs
Storm frequency	= 2 yrs	Time to peak	= 772 min
Time interval	= 2 min	Hyd. volume	= 81,518 cuft
Inflow hyd. No.	= 3 - Tributary Basin #1 (South)	Max. Elevation	= 1010.90 ft
Reservoir name	= South Basin #1	Max. Storage	= 39,365 cuft

Storage Indication method used.



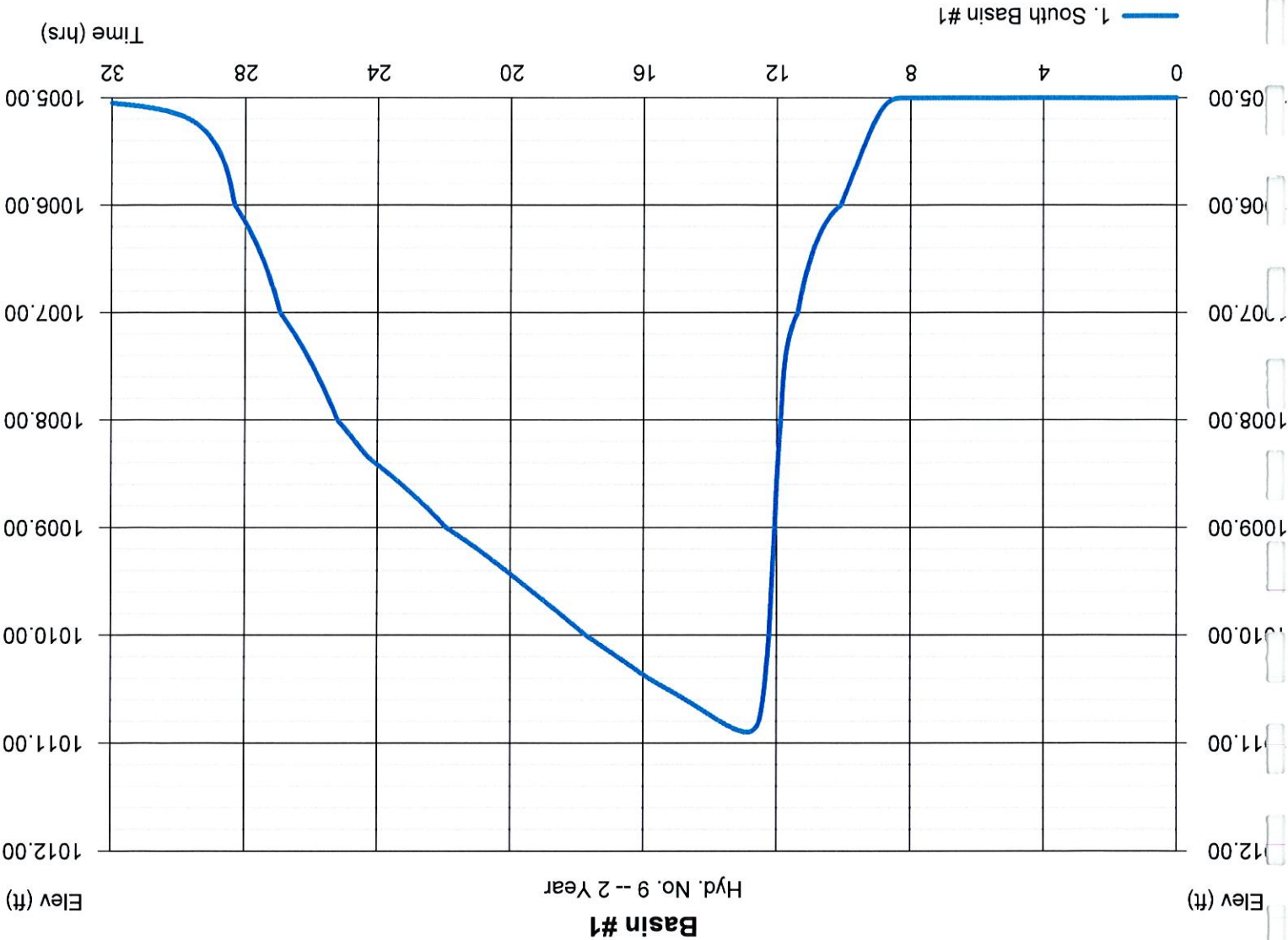
Hydrograph Report

Hyd. No. 9

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 2.910 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.87 hrs
Time interval	= 2 min	Hyd. volume	= 81,518 cuft
Inflow hyd. No.	= 3 - Tributary Basin #1 (South)	Max. Elevation	= 1010.90 ft
Reservoir name	= South Basin #1	Max. Storage	= 39,365 cuft

Storage Indication method used.



Hyd. No. 12

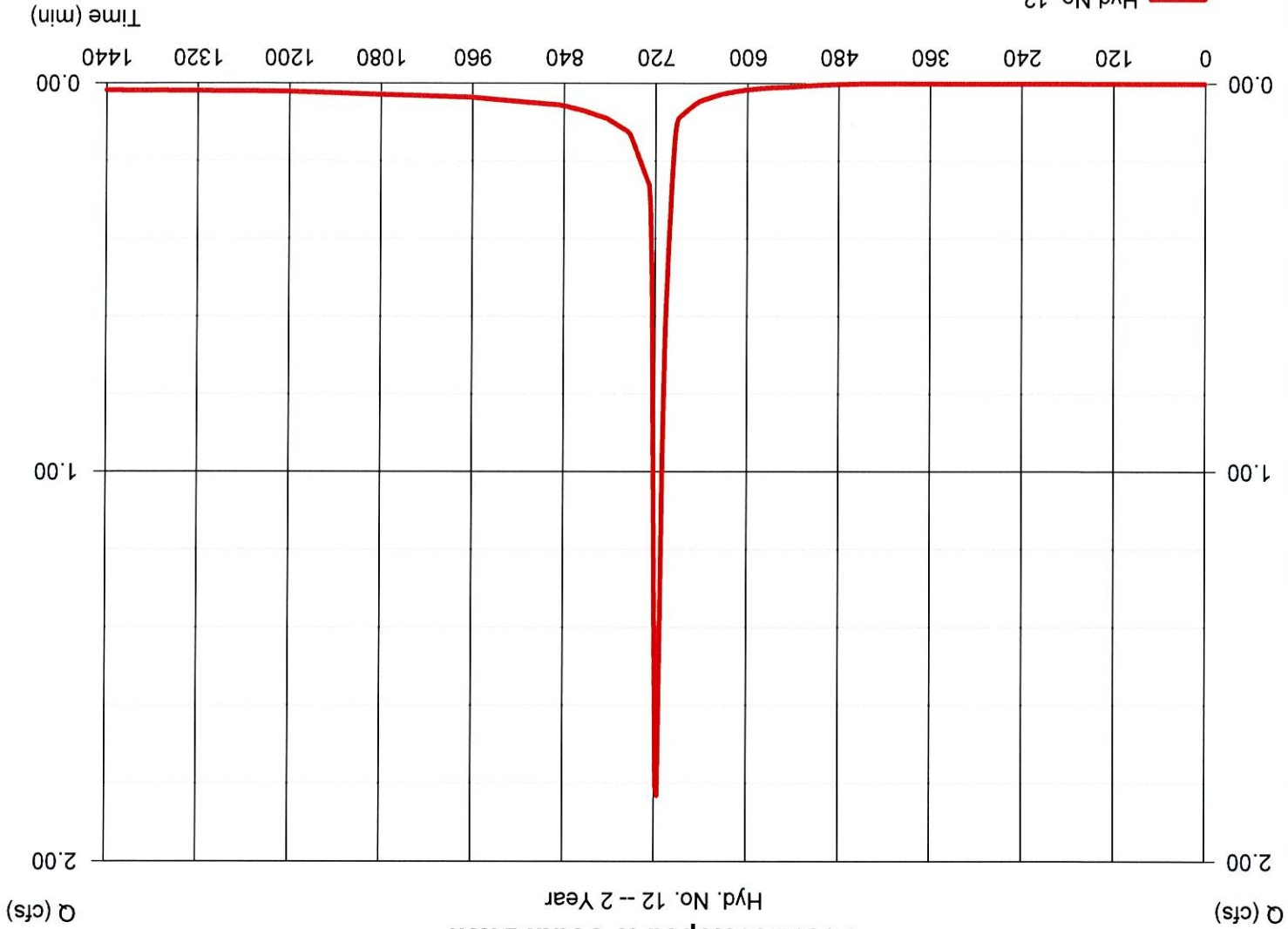
Post Developed to South Ditch

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.831 cfs
Storm frequency	=	2 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	3,716 cuft
Drainage area	=	0.540 ac	Curve number	=	84*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.250 x 98) + (0.350 x 74)] / 0.540

Post Developed to South Ditch

Hyd. No. 12 -- 2 Year



10 YEAR STORM

Hydrograph Report

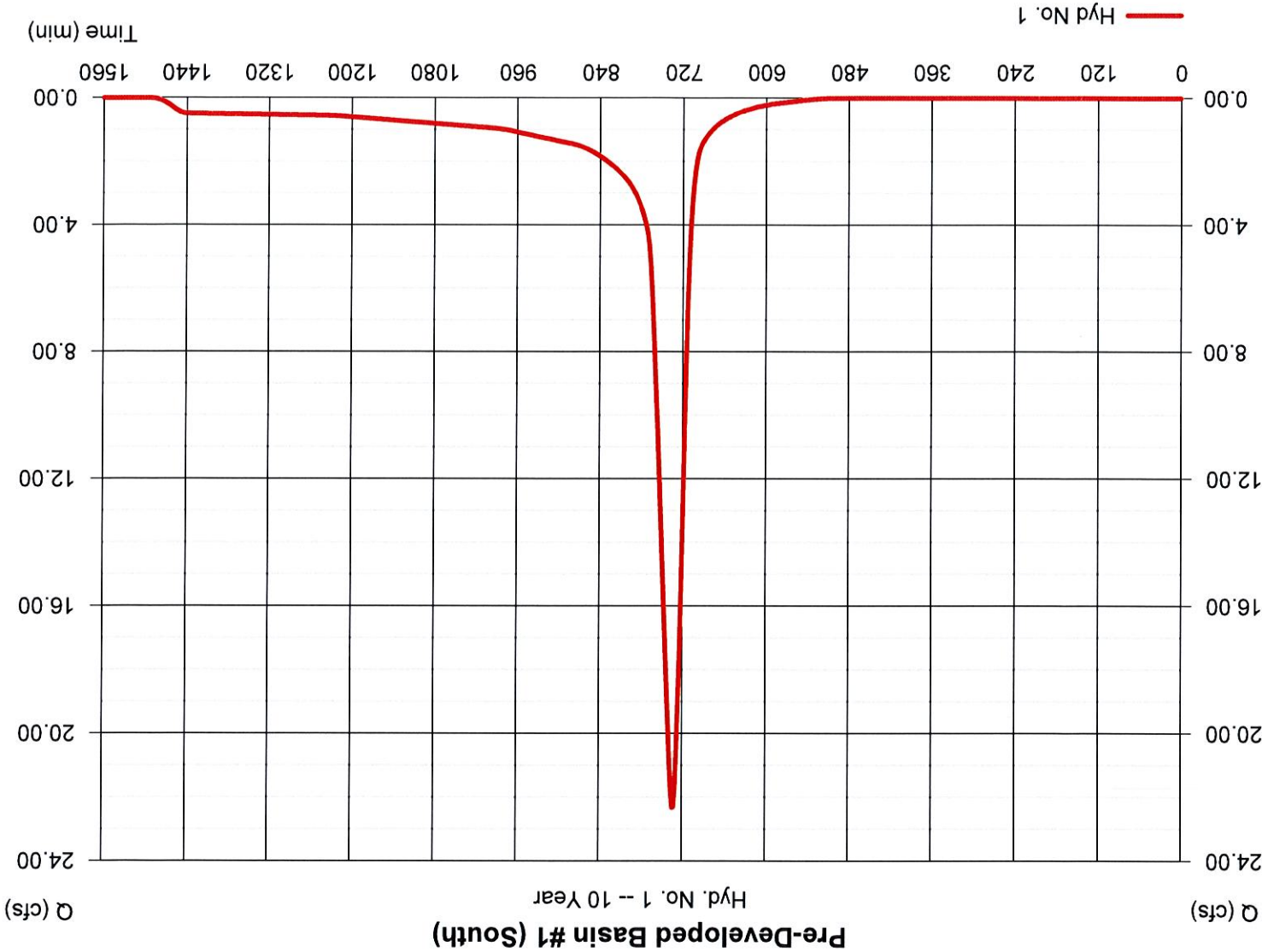
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Monday, 11 / 30 / 2015

Hyd. No. 1

Pre-Developed Basin #1 (South)

Hydrograph type	=	SCS Runoff	Peak discharge	=	22.32 cfs
Storm frequency	=	10 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	97,007 cuft
Drainage area	=	9.150 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	31.80 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



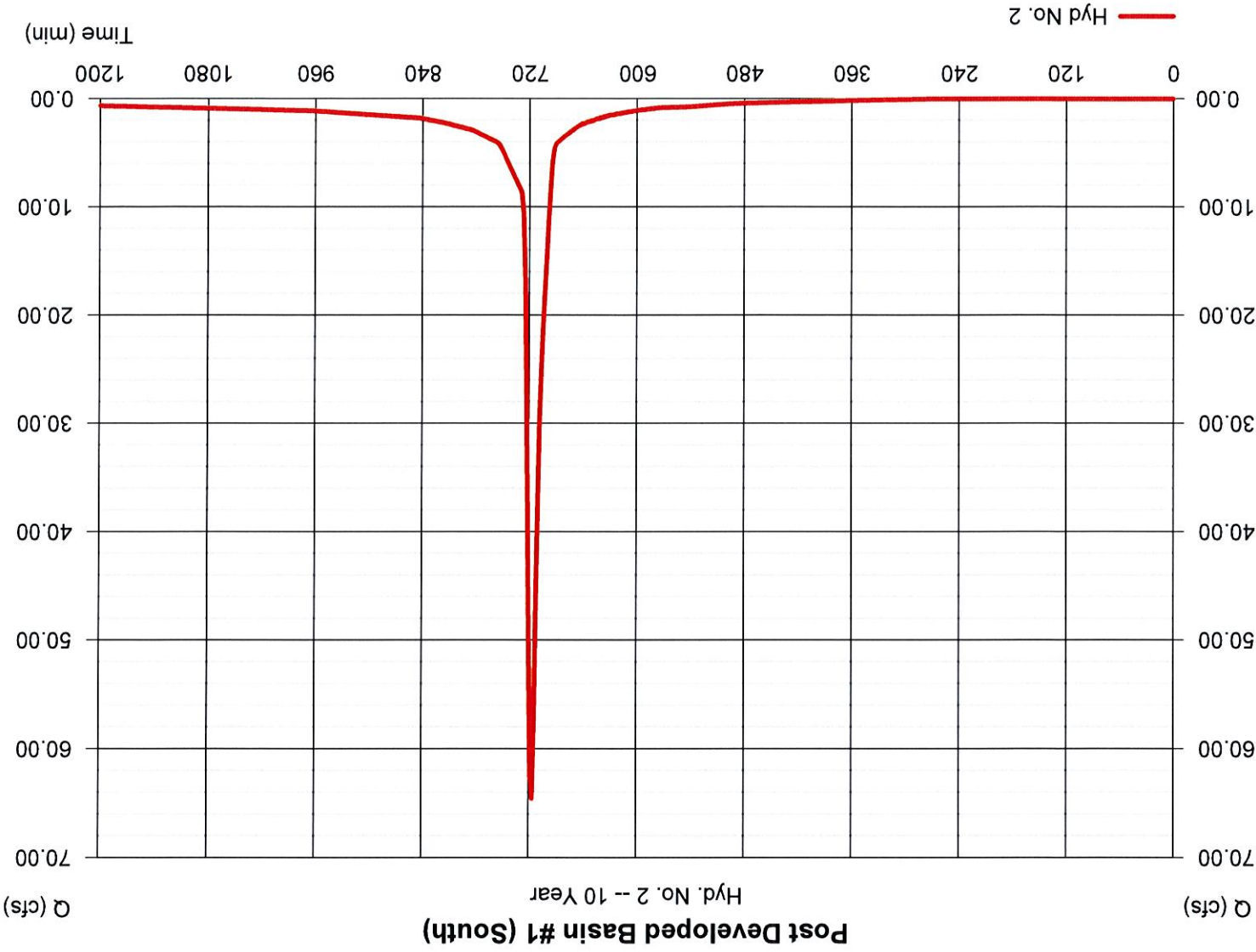
Hydrograph Report

Hyd. No. 2

Post Developed Basin #1 (South)

Hydrograph type	=	SCS Runoff	Peak discharge	=	64.56 cfs
Storm frequency	=	10 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	136,634 cuft
Drainage area	=	9.620 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.910 x 98) + (5.710 x 74)] / 9.620



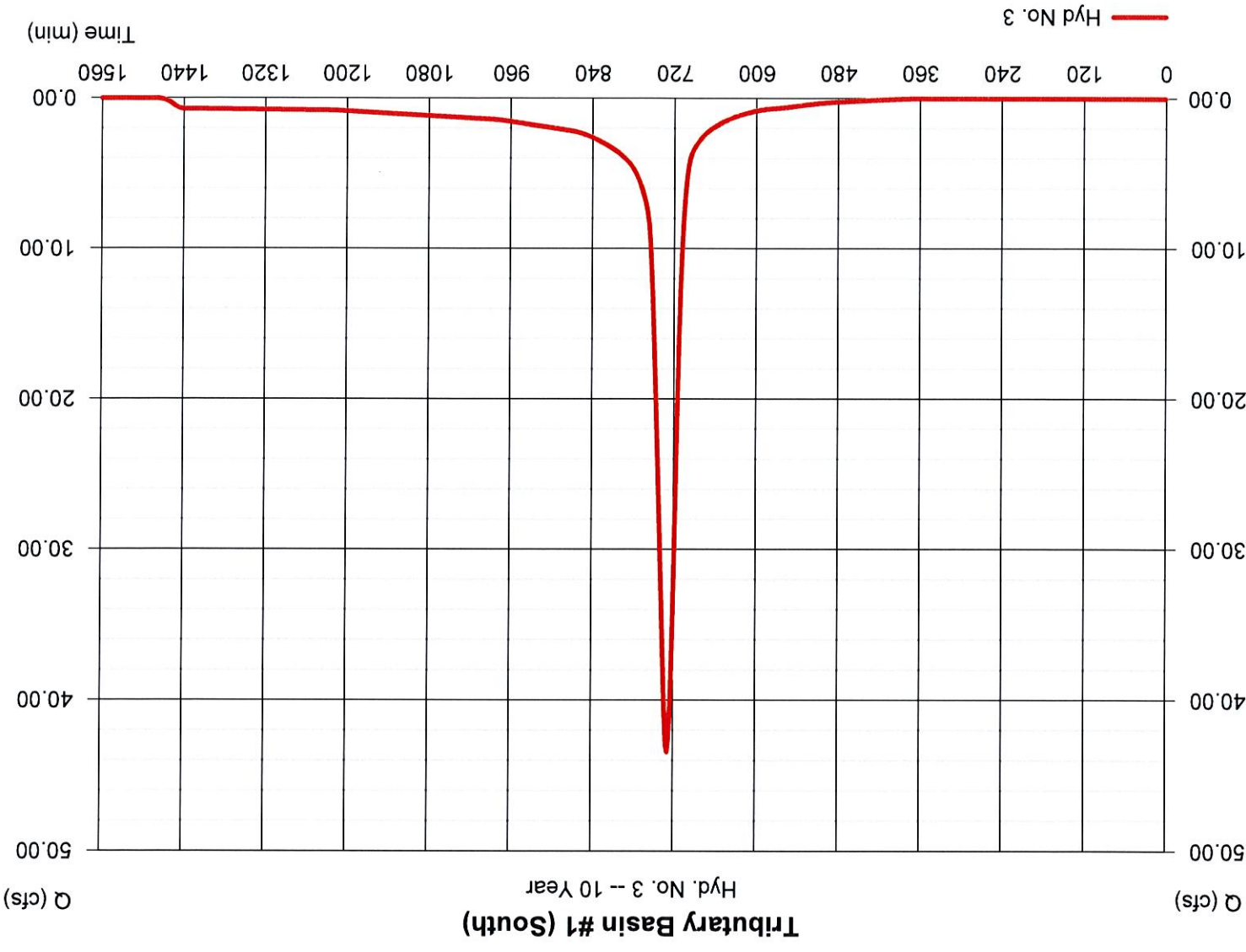
Hydrograph Report

Hyd. No. 3

Tributary Basin #1 (South)

Hydrograph type	=	SCS Runoff	Peak discharge	=	43.44 cfs
Storm frequency	=	10 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	159,831 cuft
Drainage area	=	12.230 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	24.90 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.120 x 98) + (8.110 x 74)] / 12.230



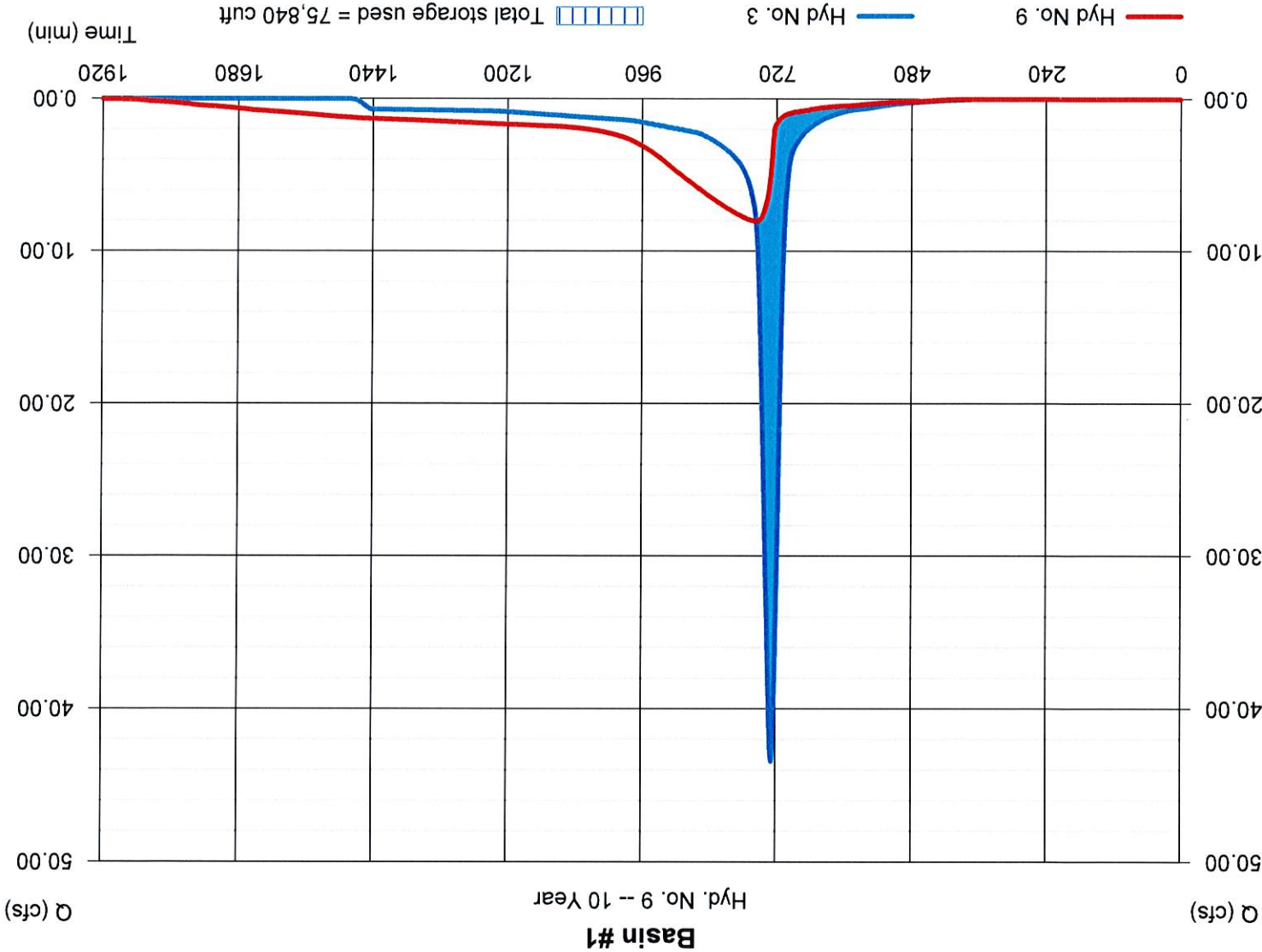
Hydrograph Report

Hyd. No. 9

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 8.001 cfs
Storm frequency	= 10 yrs	Time to peak	= 756 min
Time interval	= 2 min	Hyd. volume	= 159,824 cuft
Inflow hyd. No.	= 3 - Tributary Basin #1 (South)	Max. Elevation	= 1012.85 ft
Reservoir name	= South Basin #1	Max. Storage	= 75,840 cuft

Storage Indication method used.



Hydrograph Report

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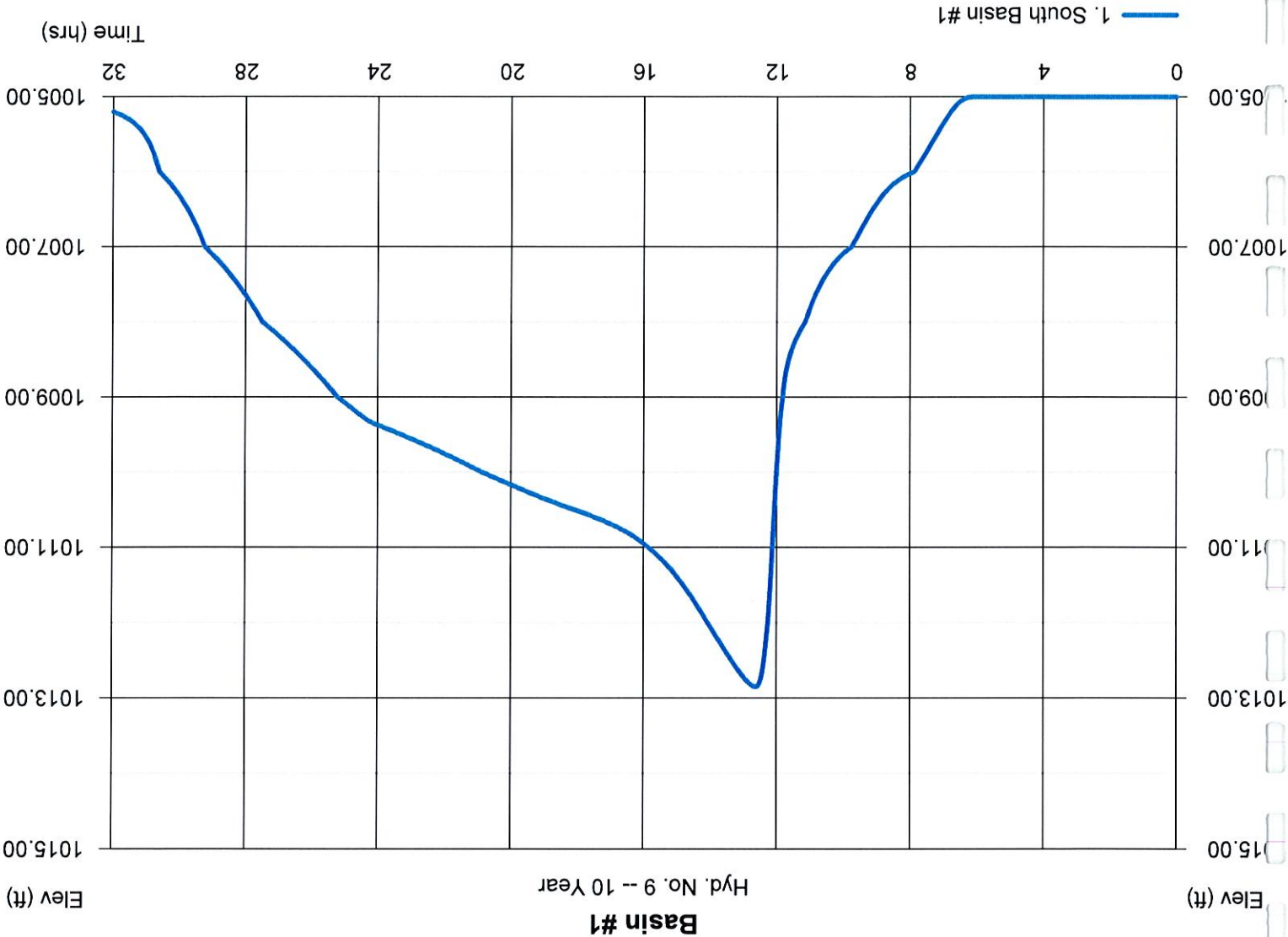
Monday, 11 / 30 / 2015

Hyd. No. 9

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 8.001 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.60 hrs
Time interval	= 2 min	Hyd. volume	= 159,824 cuft
Inflow hyd. No.	= 3 - Tributary Basin #1 (South)	Max. Elevation	= 1012.85 ft
Reservoir name	= South Basin #1	Max. Storage	= 75,840 cuft

Storage Indication method used.

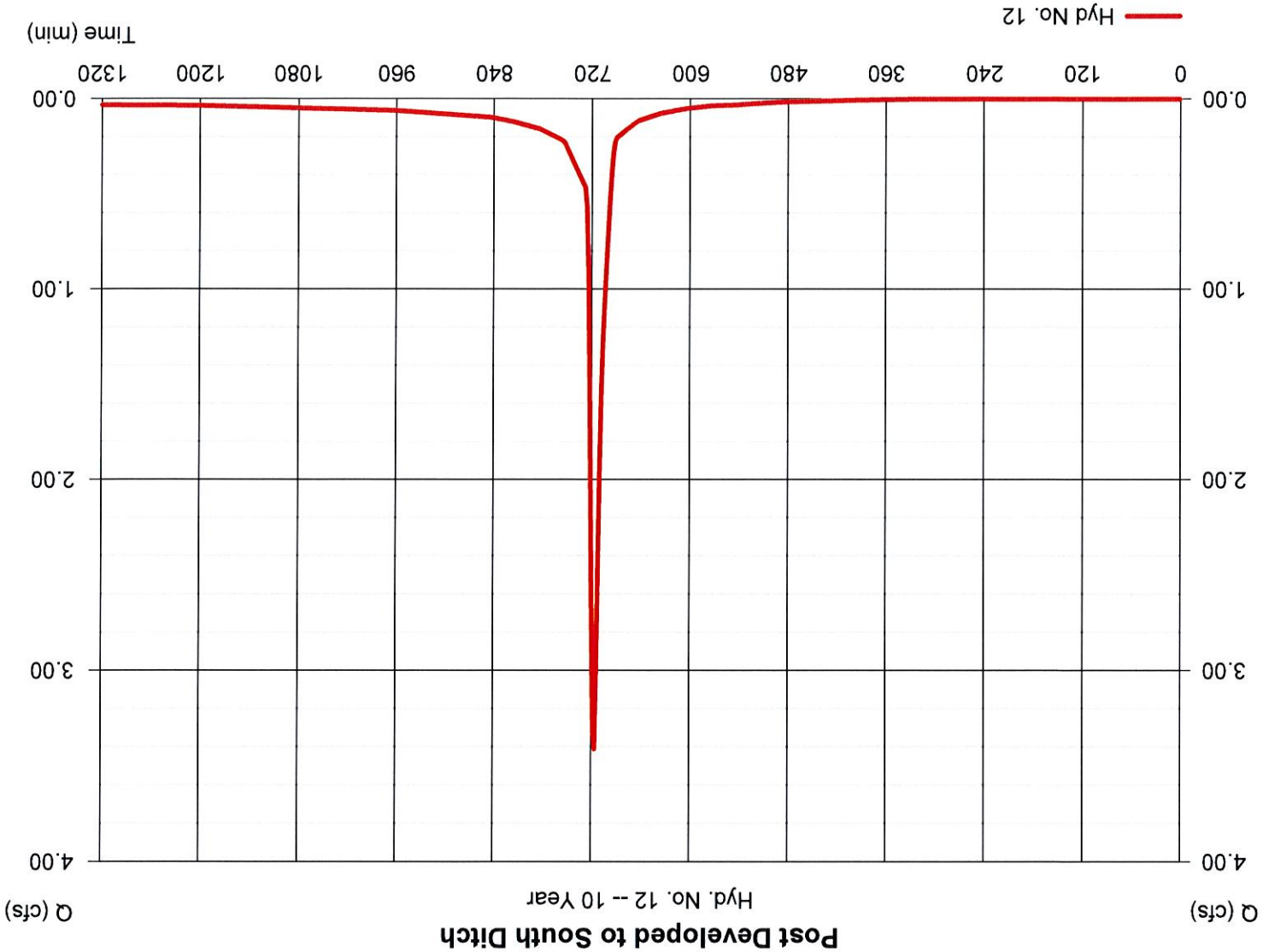


Hyd. No. 12

Post Developed to South Ditch

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.412 cfs
Storm frequency	=	10 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	7,095 cuft
Drainage area	=	0.540 ac	Curve number	=	84*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.250 x 98) + (0.350 x 74)] / 0.540



100 YEAR STORM

Hydrograph Report

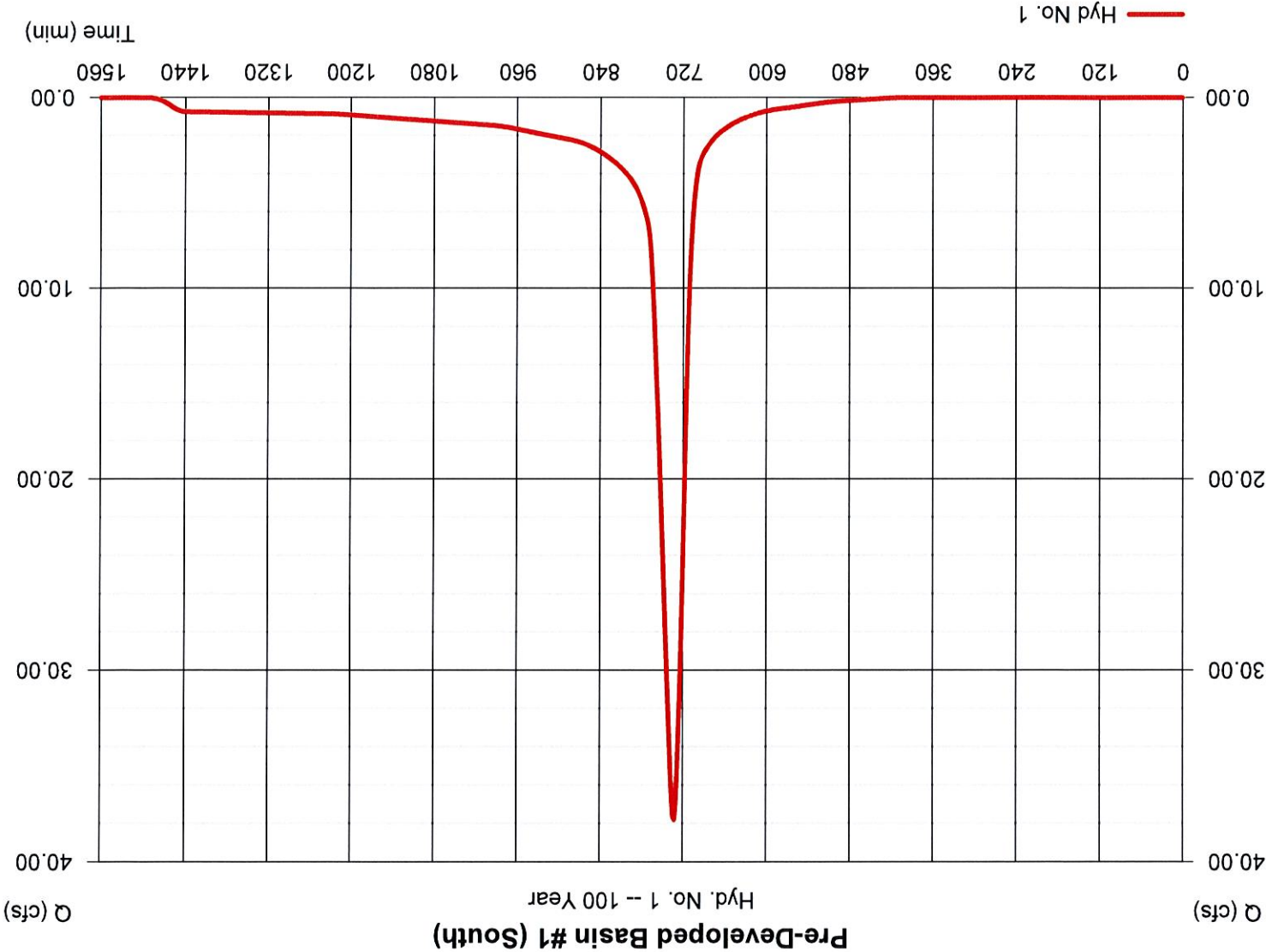
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Hyd. No. 1

Pre-Developed Basin #1 (South)

Hydrograph type	=	SCS Runoff	Peak discharge	=	37.79 cfs
Storm frequency	=	100 yrs	Time to peak	=	732 min
Time interval	=	2 min	Hyd. volume	=	163,245 cuft
Drainage area	=	9.150 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	31.80 min
Total precip.	=	7.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



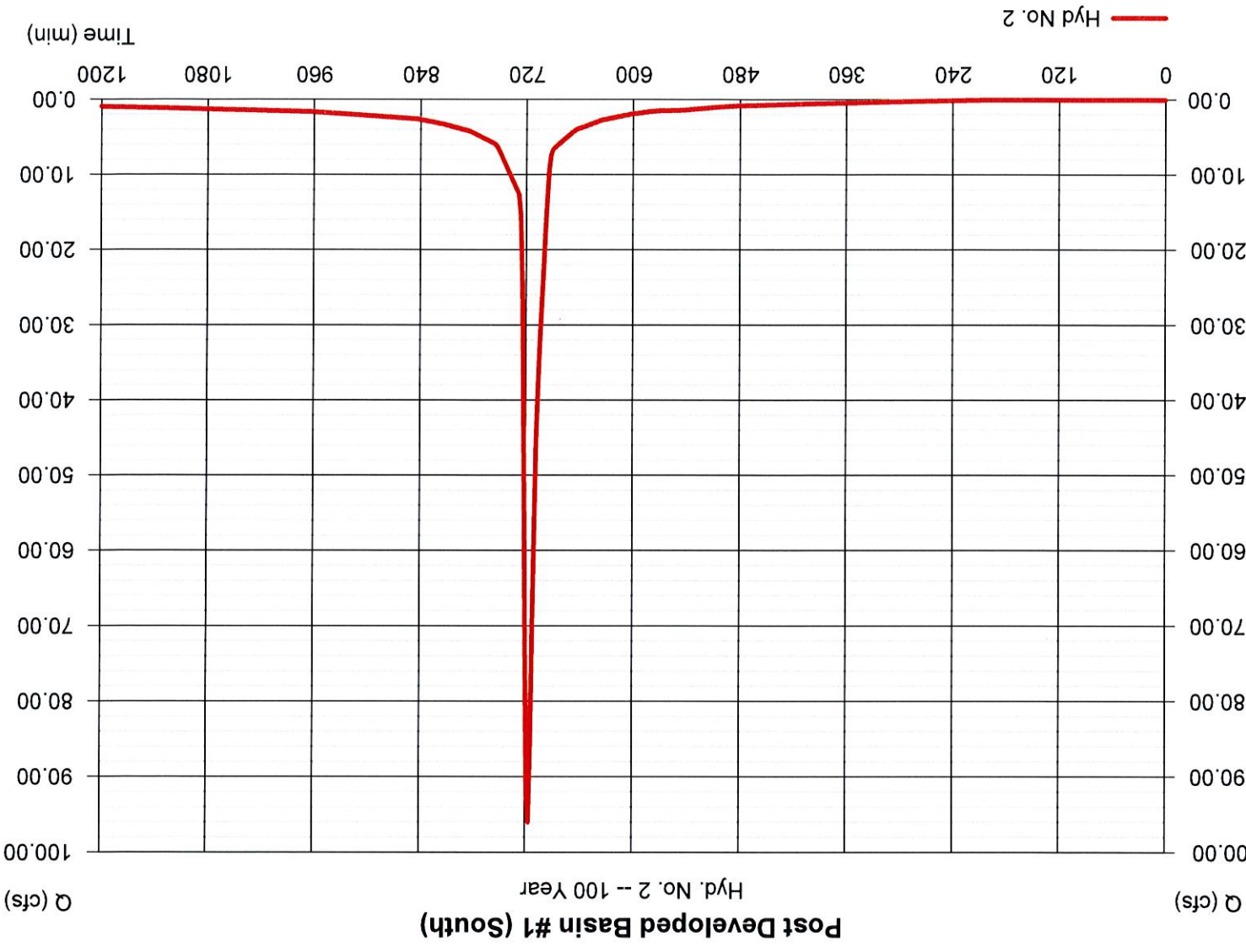
Hydrograph Report

Hyd. No. 2

Post Developed Basin #1 (South)

Hydrograph type	= SCS Runoff	Peak discharge	= 95.99 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 208,602 cuft
Drainage area	= 9.620 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.910 x 98) + (5.710 x 74)] / 9.620



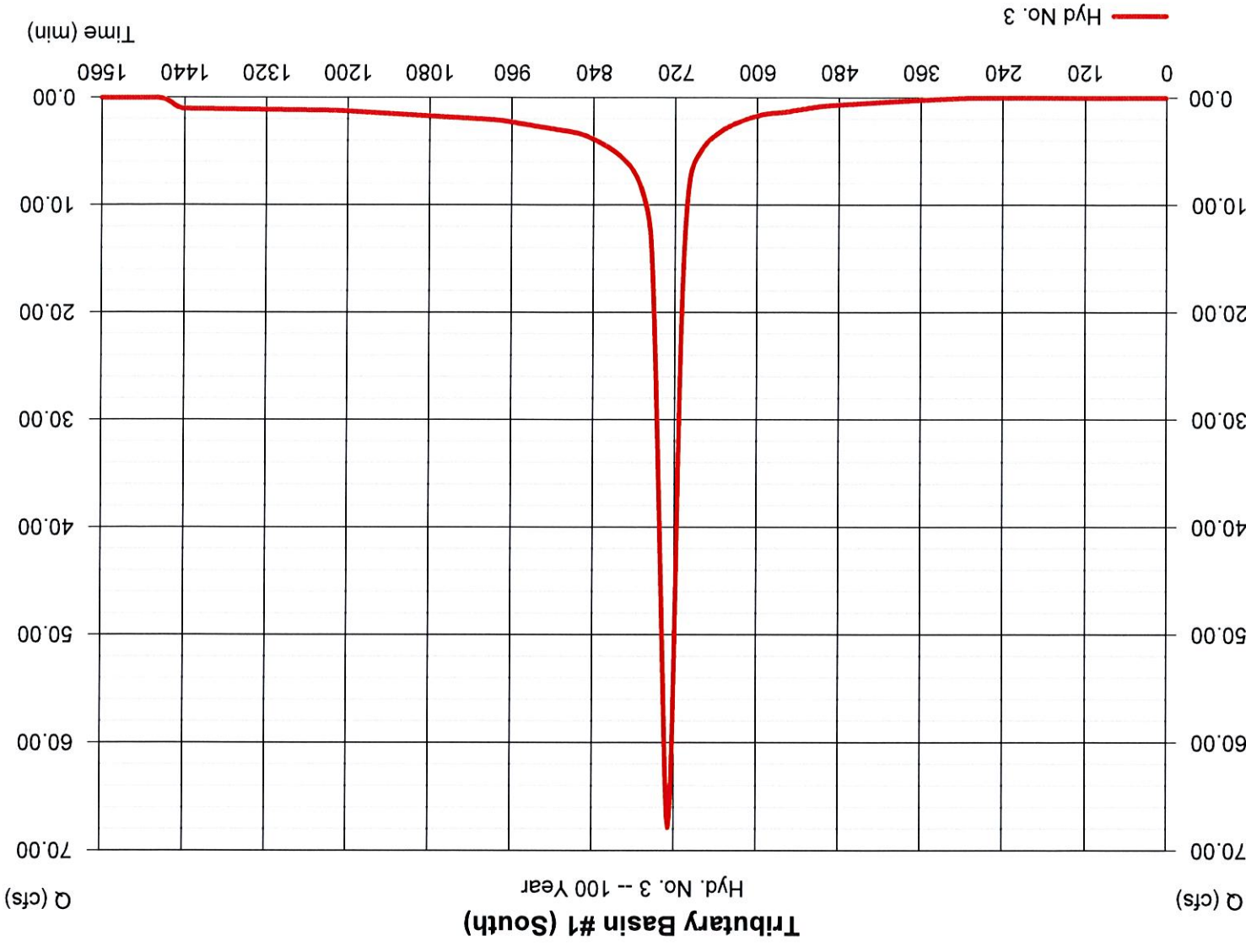
Hydrograph Report

Hyd. No. 3

Tributary Basin #1 (South)

Hydrograph type	=	SCS Runoff	Peak discharge	=	67.84 cfs
Storm frequency	=	100 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	252,761 cuft
Drainage area	=	12.230 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	24.90 min
Total precip.	=	7.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.120 x 98) + (8.110 x 74)] / 12.230

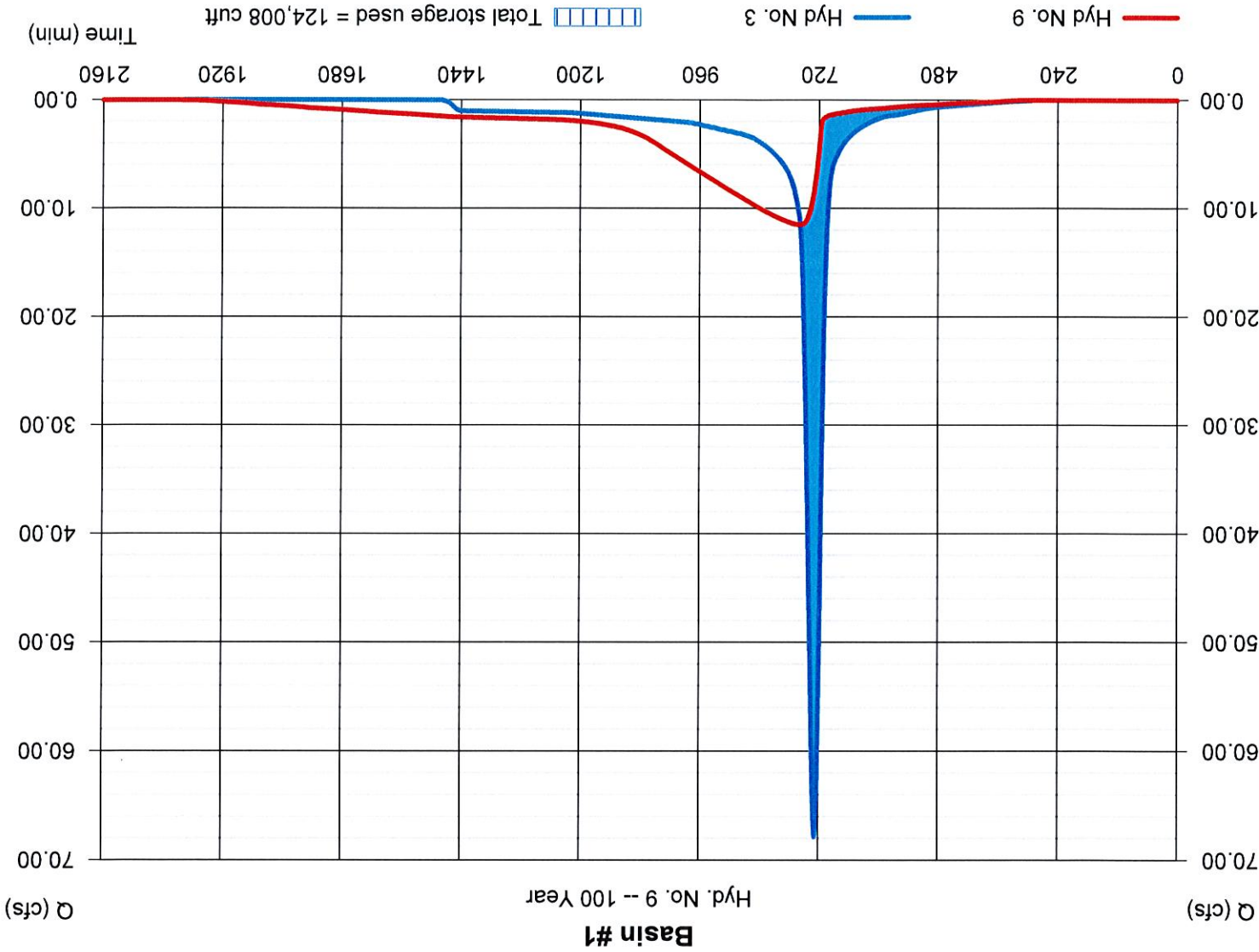


Hyd. No. 9

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 11.48 cfs
Storm frequency	= 100 yrs	Time to peak	= 758 min
Time interval	= 2 min	Hyd. volume	= 252,755 cuft
Inflow hyd. No.	= 3 - Tributary Basin #1 (South)	Max. Elevation	= 1014.99 ft
Reservoir name	= South Basin #1	Max. Storage	= 124,008 cuft

Storage Indication method used.



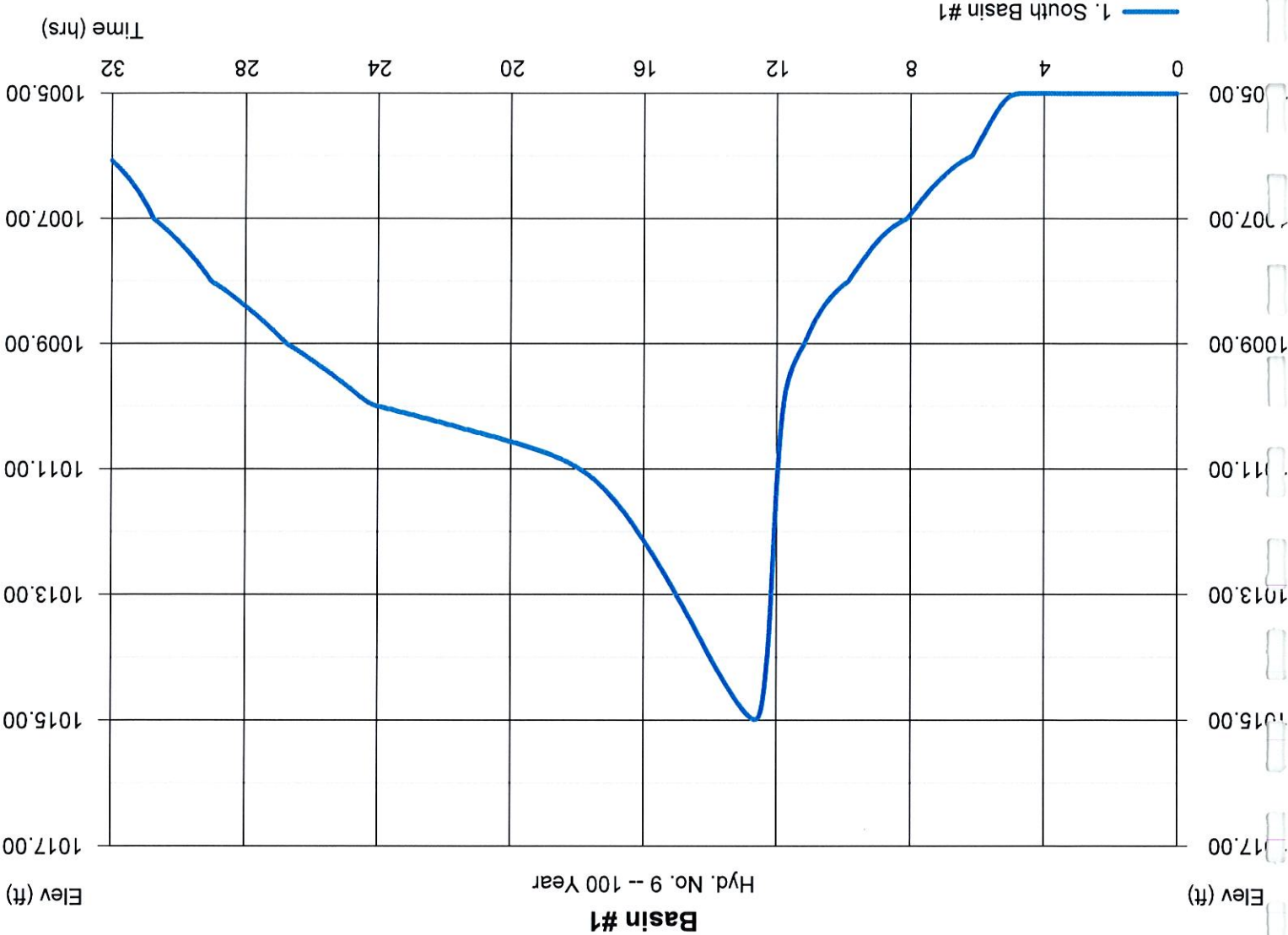
Hydrograph Report

Hyd. No. 9

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 11.48 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.63 hrs
Time interval	= 2 min	Hyd. volume	= 252,755 cuft
Inflow hyd. No.	= 3 - Tributary Basin #1 (South)	Max. Elevation	= 1014.99 ft
Reservoir name	= South Basin #1	Max. Storage	= 124,008 cuft

Storage Indication method used.

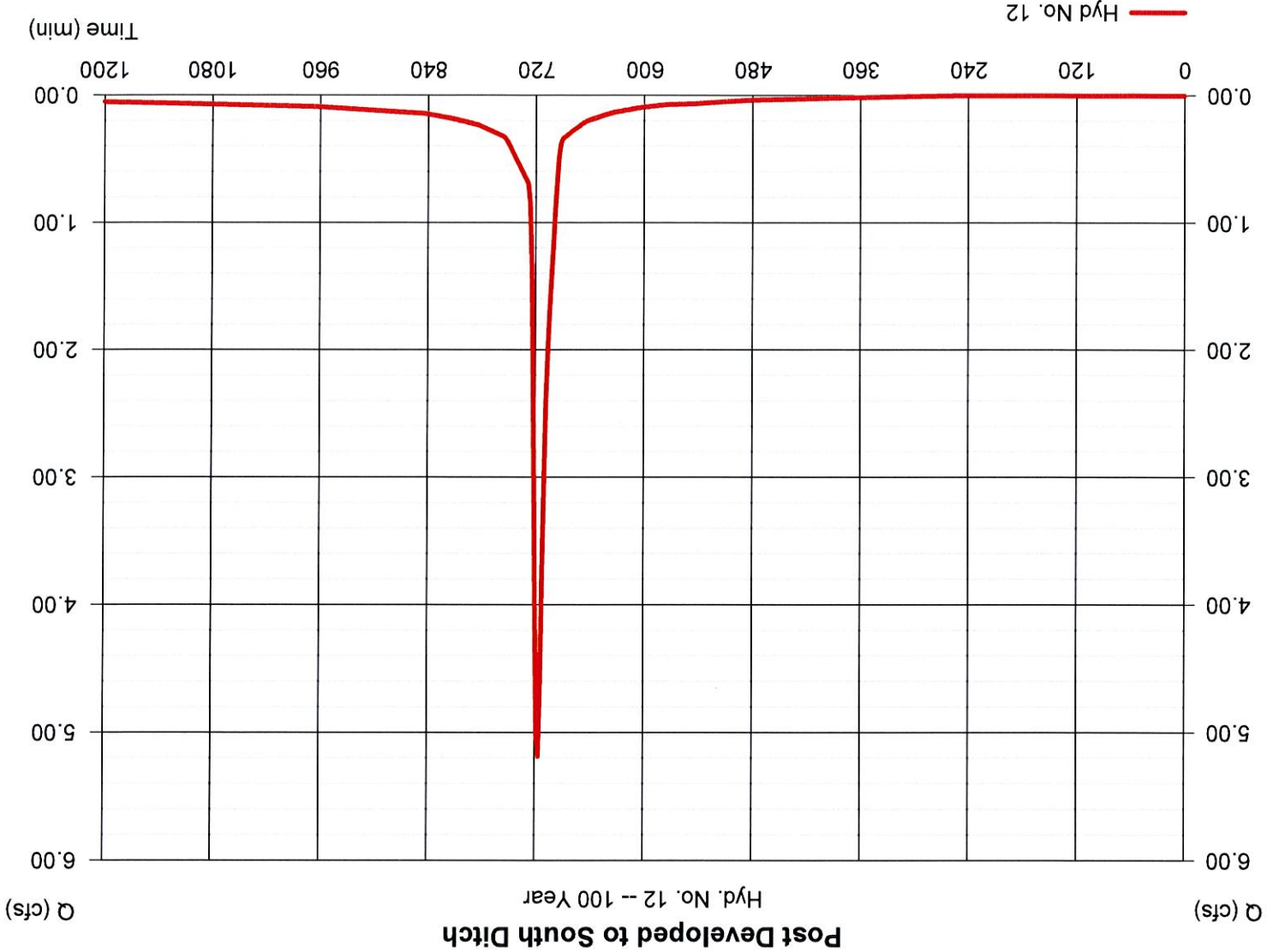


Hyd. No. 12

Post Developed to South Ditch

Hydrograph type	= SCS Runoff	Peak discharge	= 5.187 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 11,060 cuft
Drainage area	= 0.540 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.250 x 98) + (0.350 x 74)] / 0.540



OUTFLOW #2

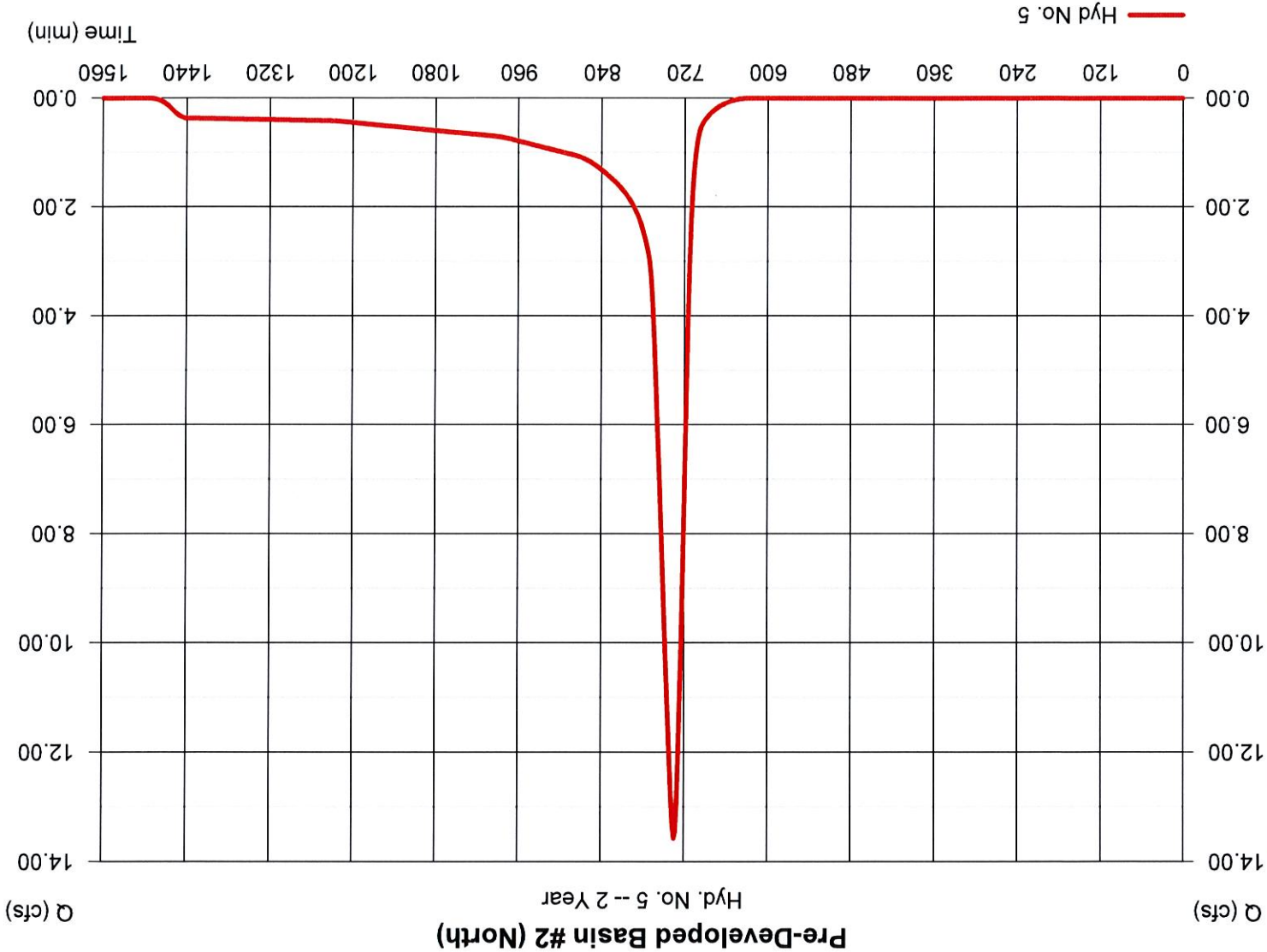
2 YEAR STORM

Hydrograph Report

Hyd. No. 5

Pre-Developed Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.57 cfs
Storm frequency	=	2 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	61,360 cuft
Drainage area	=	12.750 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	31.80 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

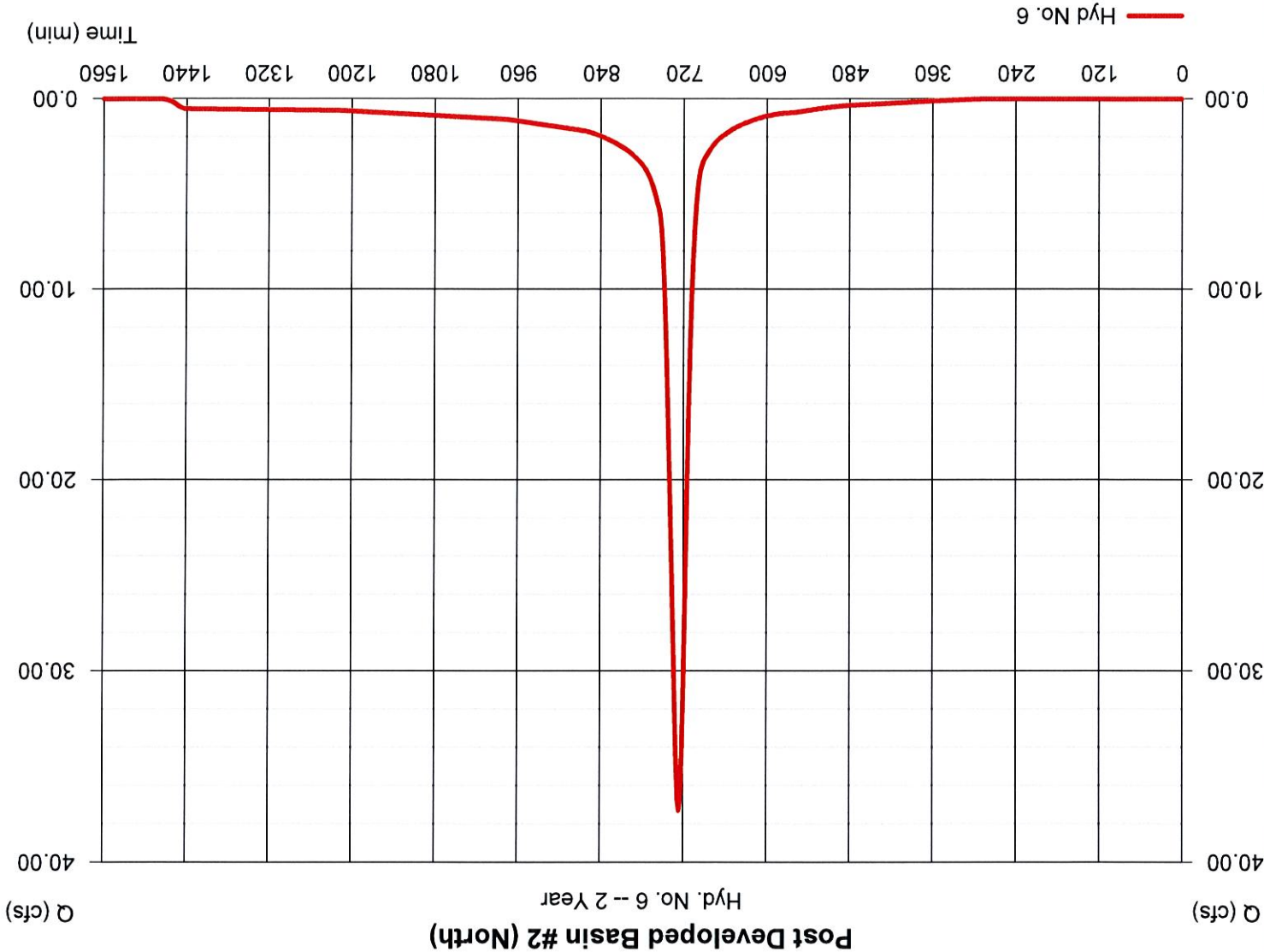


Hyd. No. 6

Post Developed Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	37.29 cfs
Storm frequency	=	2 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	130,896 cuft
Drainage area	=	13.440 ac	Curve number	=	91*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.10 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.790 x 74) + (9.650 x 98)] / 13.440



Hydrograph Report

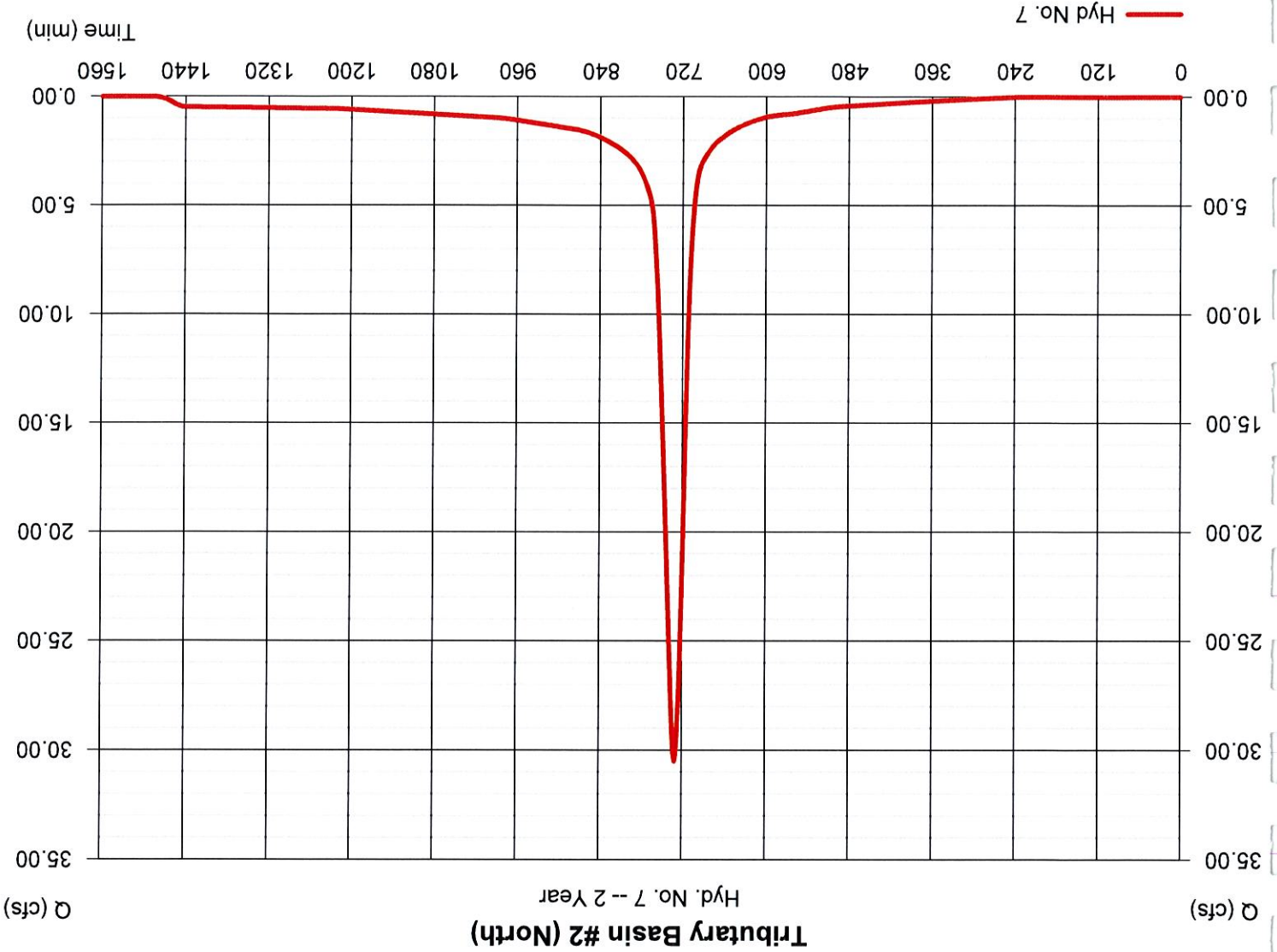
Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4
Monday, 11 / 30 / 2015

Hyd. No. 7

Tributary Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	30.49 cfs
Storm frequency	=	2 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	125,194 cuft
Drainage area	=	12.180 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	28.30 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(9.650 x 98) + (2.530 x 74)] / 12.180



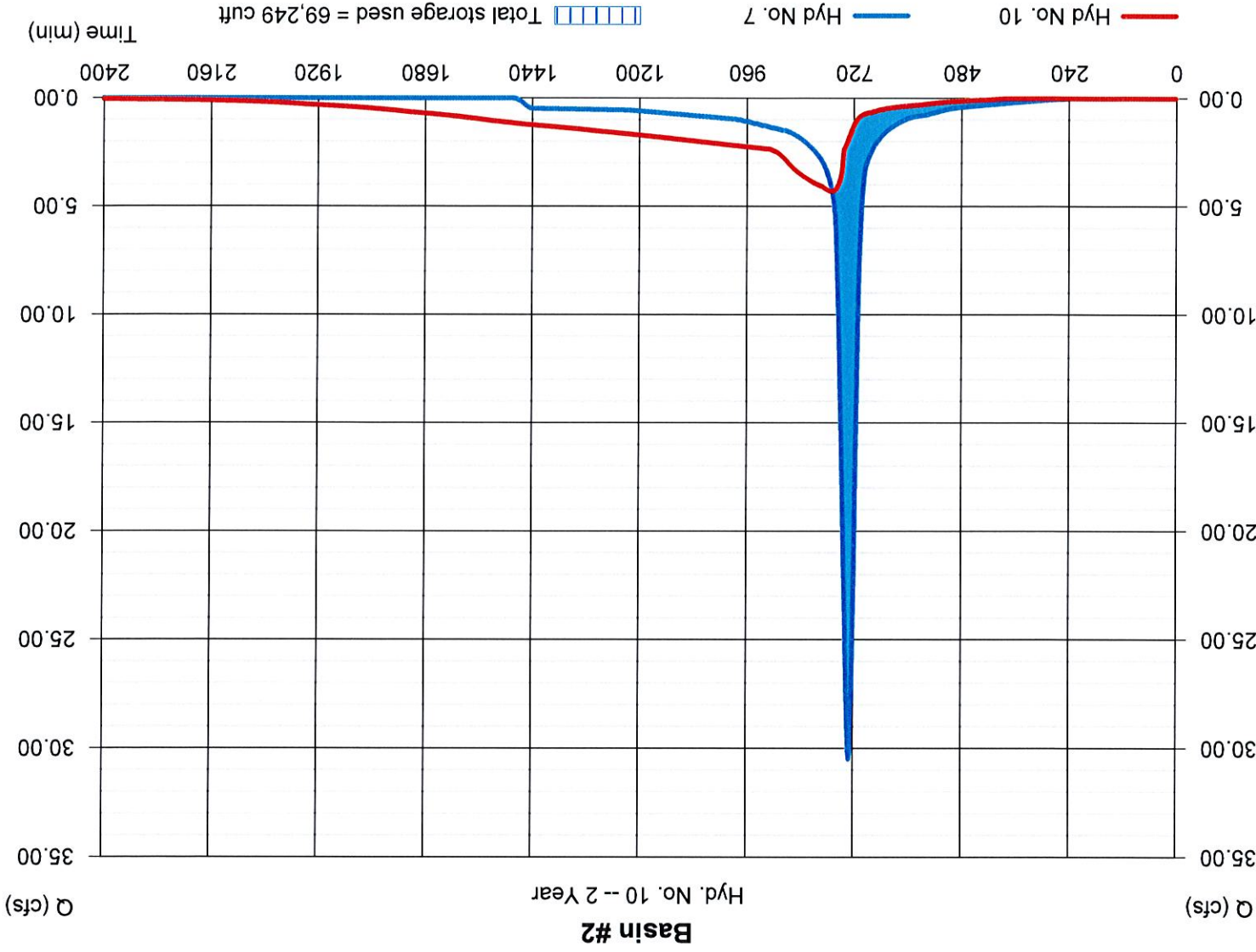
Hydrograph Report

Hyd. No. 10

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 4.284 cfs
Storm frequency	= 2 yrs	Time to peak	= 770 min
Time interval	= 2 min	Hyd. volume	= 124,363 cuft
Inflow hyd. No.	= 7 - Tributary Basin #2 (North)	Max. Elevation	= 1015.04 ft
Reservoir name	= North Basin #2	Max. Storage	= 69,249 cuft

Storage Indication method used.



Hydrograph Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

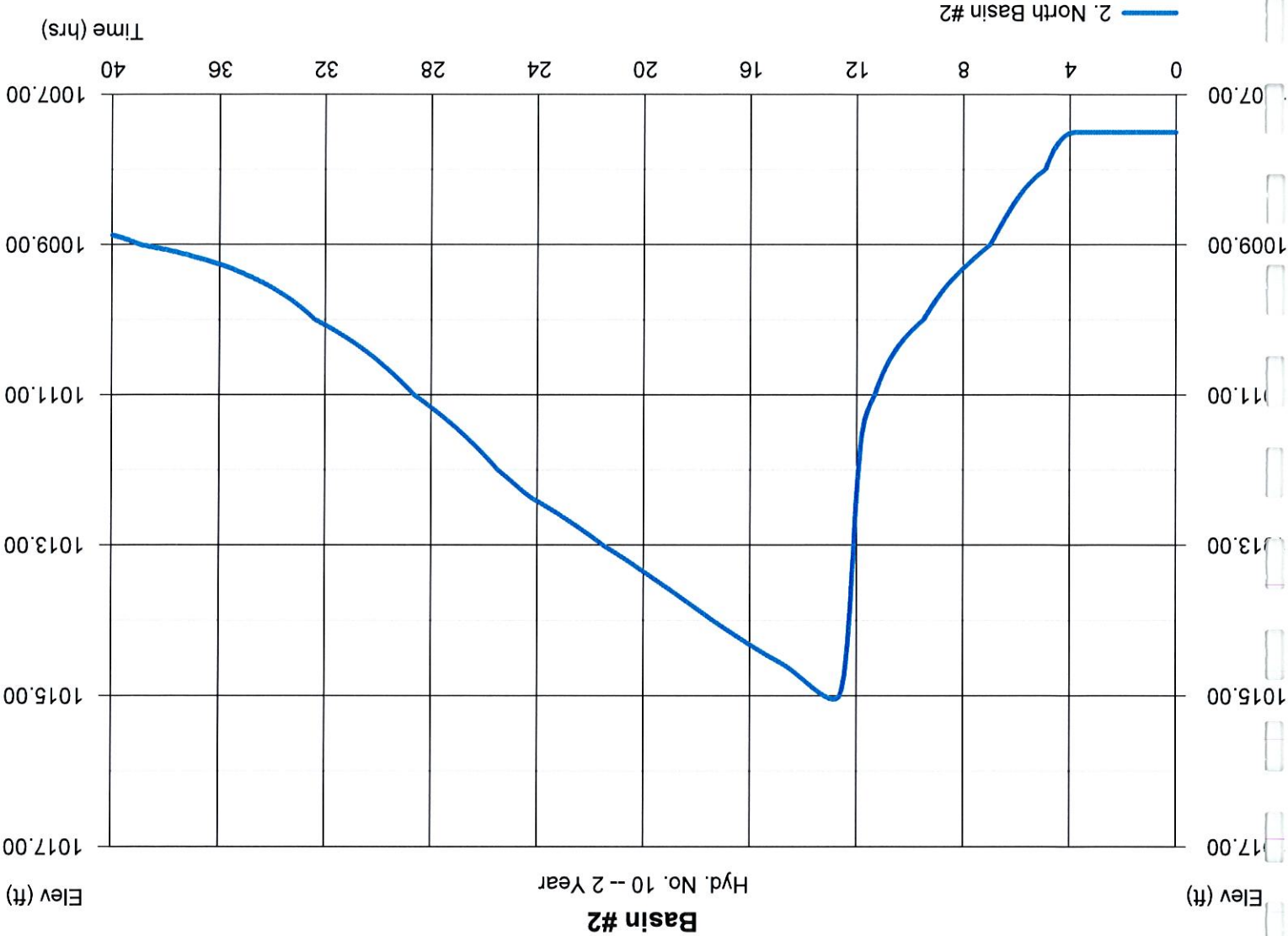
Monday, 11 / 30 / 2015

Hyd. No. 10

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 4.284 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.83 hrs
Time interval	= 2 min	Hyd. volume	= 124,363 cuft
Inflow hyd. No.	= 7 - Tributary Basin #2 (North)	Max. Elevation	= 1015.04 ft
Reservoir name	= North Basin #2	Max. Storage	= 69,249 cuft

Storage Indication method used.

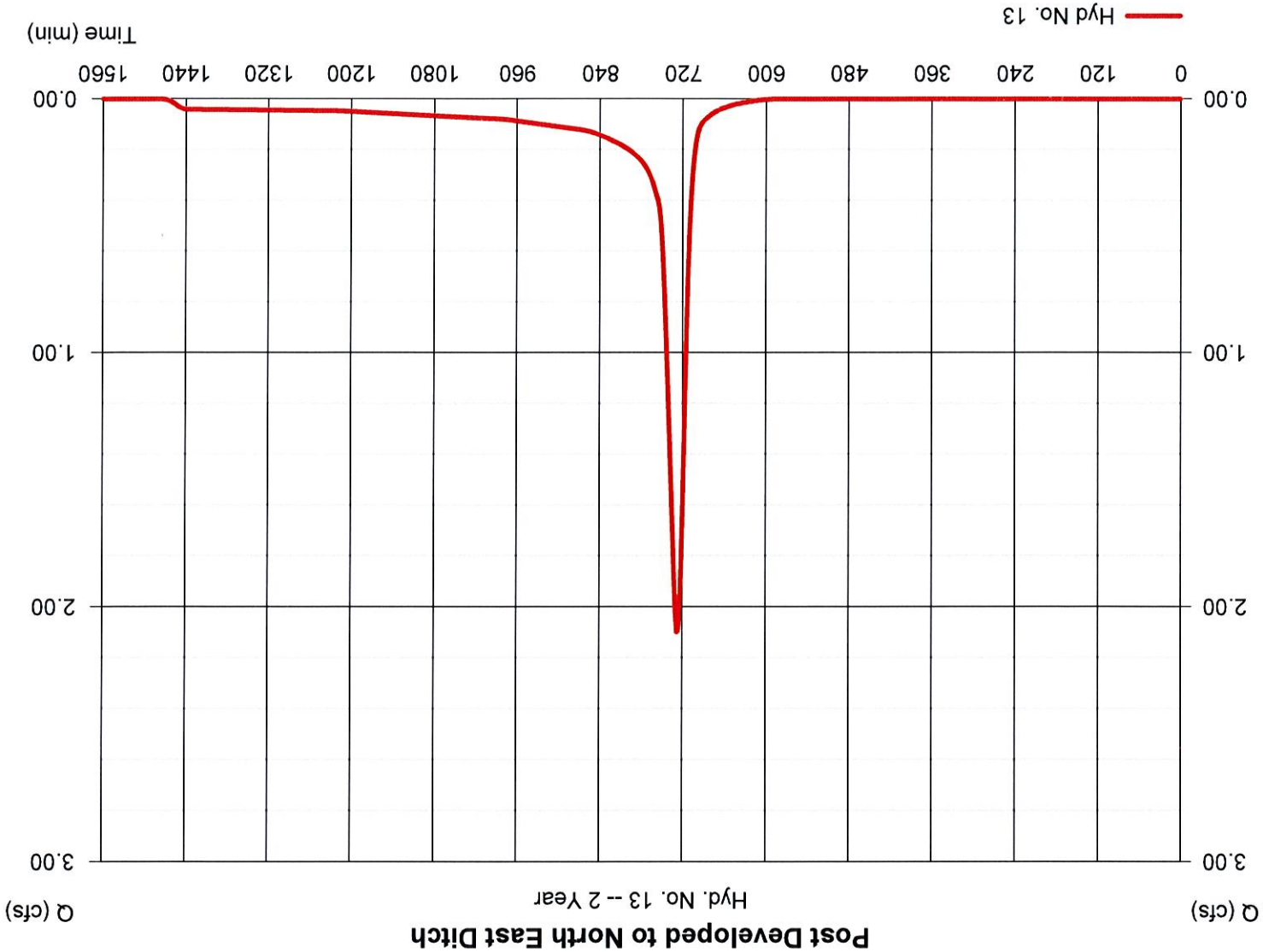


Hyd. No. 13

Post Developed to North East Ditch

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.098 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	7,397 cuft
Drainage area	=	1.330 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.170 x 98) + (1.160 x 74)] / 1.330



10 YEAR STORM

Hydrograph Report

Hyd. No. 5

Pre-Developed Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	31.10 cfs
Storm frequency	=	10 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	135,174 cuft
Drainage area	=	12.750 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	31.80 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



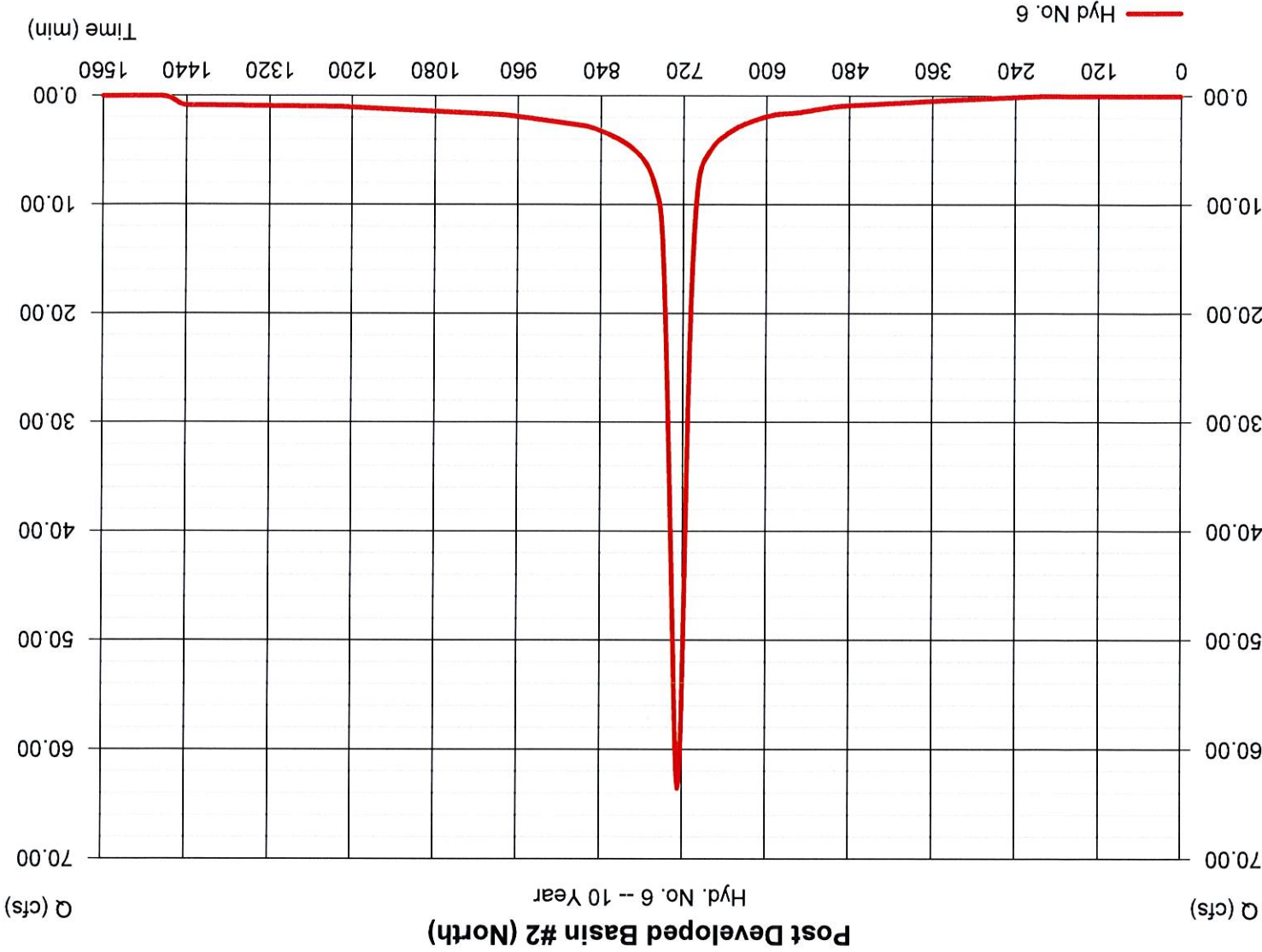
Hydrograph Report

Hyd. No. 6

Post Developed Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	63.54 cfs
Storm frequency	=	10 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	228,691 cuft
Drainage area	=	13.440 ac	Curve number	=	91*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.10 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.790 x 74) + (9.650 x 98)] / 13.440



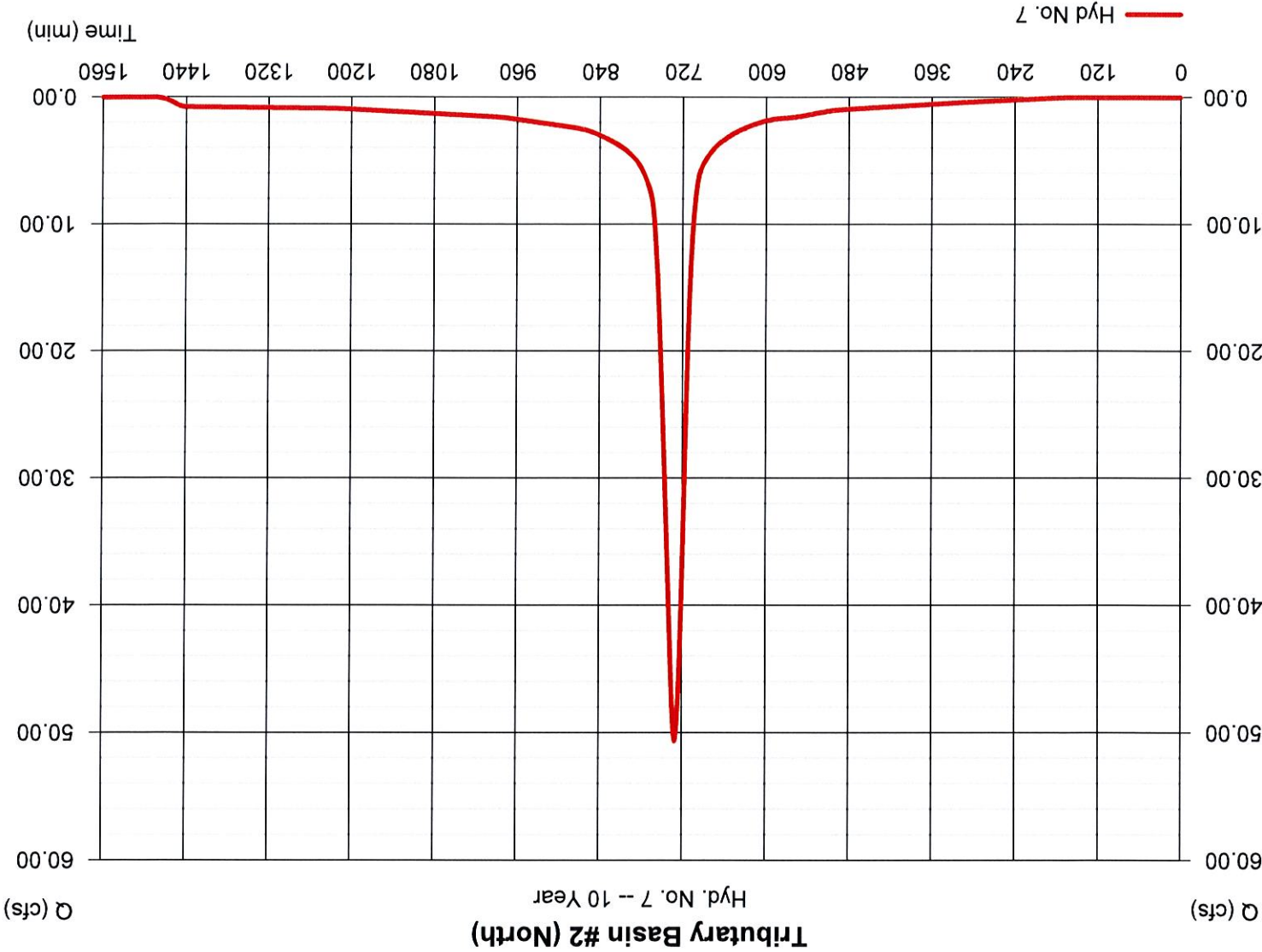
Hydrograph Report

Hyd. No. 7

Tributary Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	50.64 cfs
Storm frequency	=	10 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	213,442 cuft
Drainage area	=	12.180 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	28.30 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(9.650 \times 98) + (2.530 \times 74)] / 12.180$



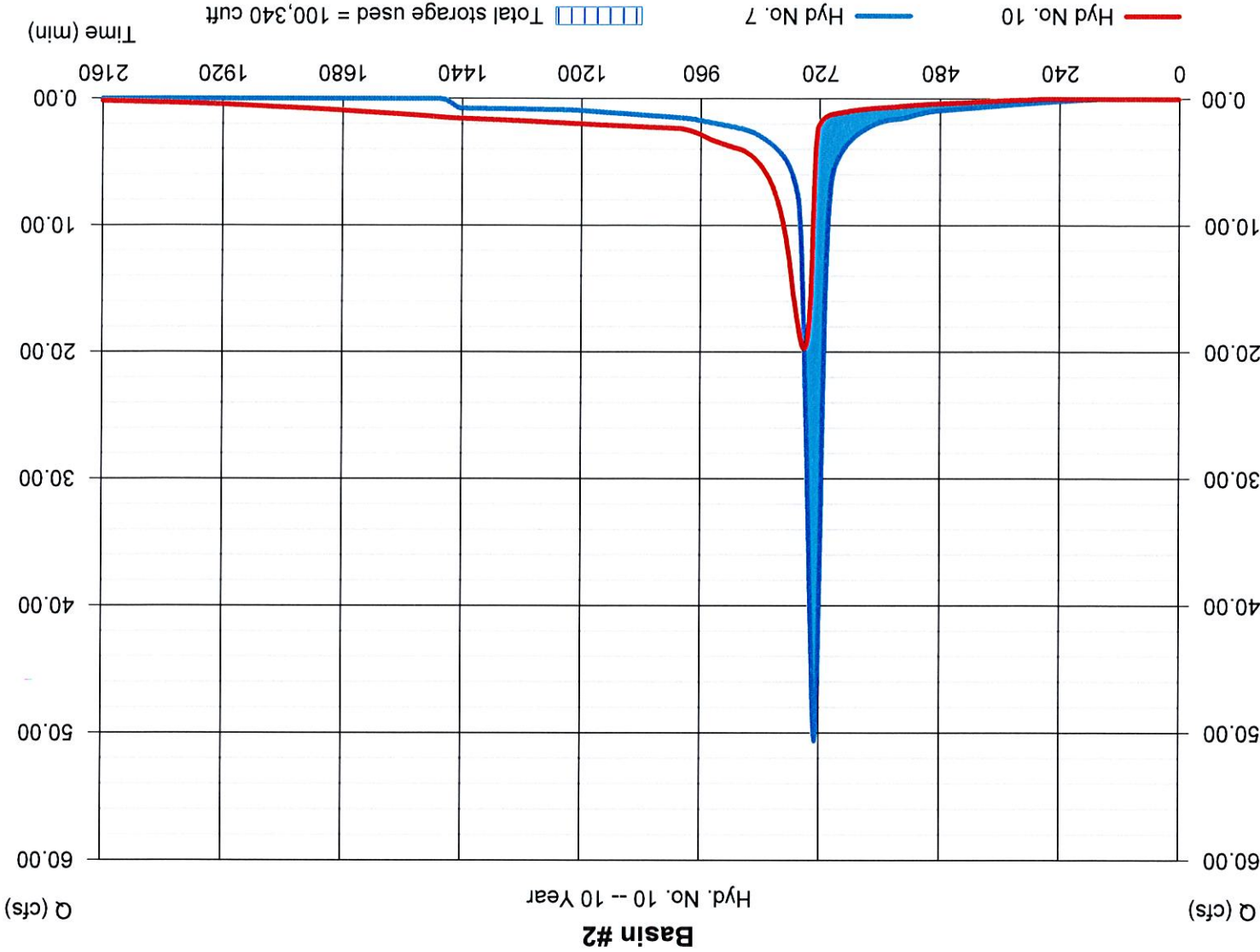
Hydrograph Report

Hyd. No. 10

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 19.71 cfs
Storm frequency	= 10 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 212,610 cuft
Inflow hyd. No.	= 7 - Tributary Basin #2 (North)	Max. Elevation	= 1016.48 ft
Reservoir name	= North Basin #2	Max. Storage	= 100,340 cuft

Storage Indication method used.



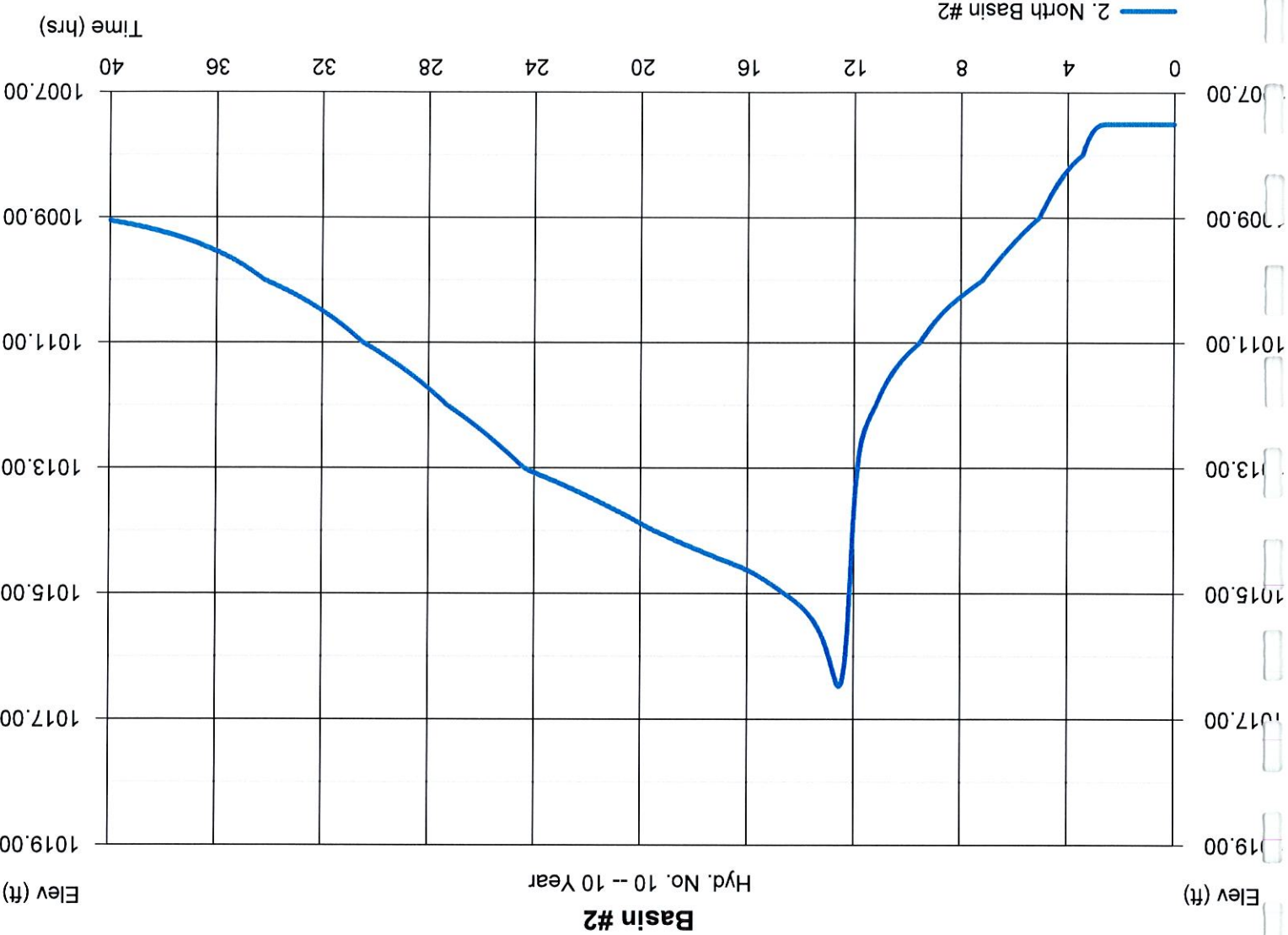
Hydrograph Report

Hyd. No. 10

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 19.71 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.53 hrs
Time interval	= 2 min	Hyd. volume	= 212,610 cuft
Inflow hyd. No.	= 7 - Tributary Basin #2 (North)	Max. Elevation	= 1016.48 ft
Reservoir name	= North Basin #2	Max. Storage	= 100,340 cuft

Storage Indication method used.



Hyd. No. 13

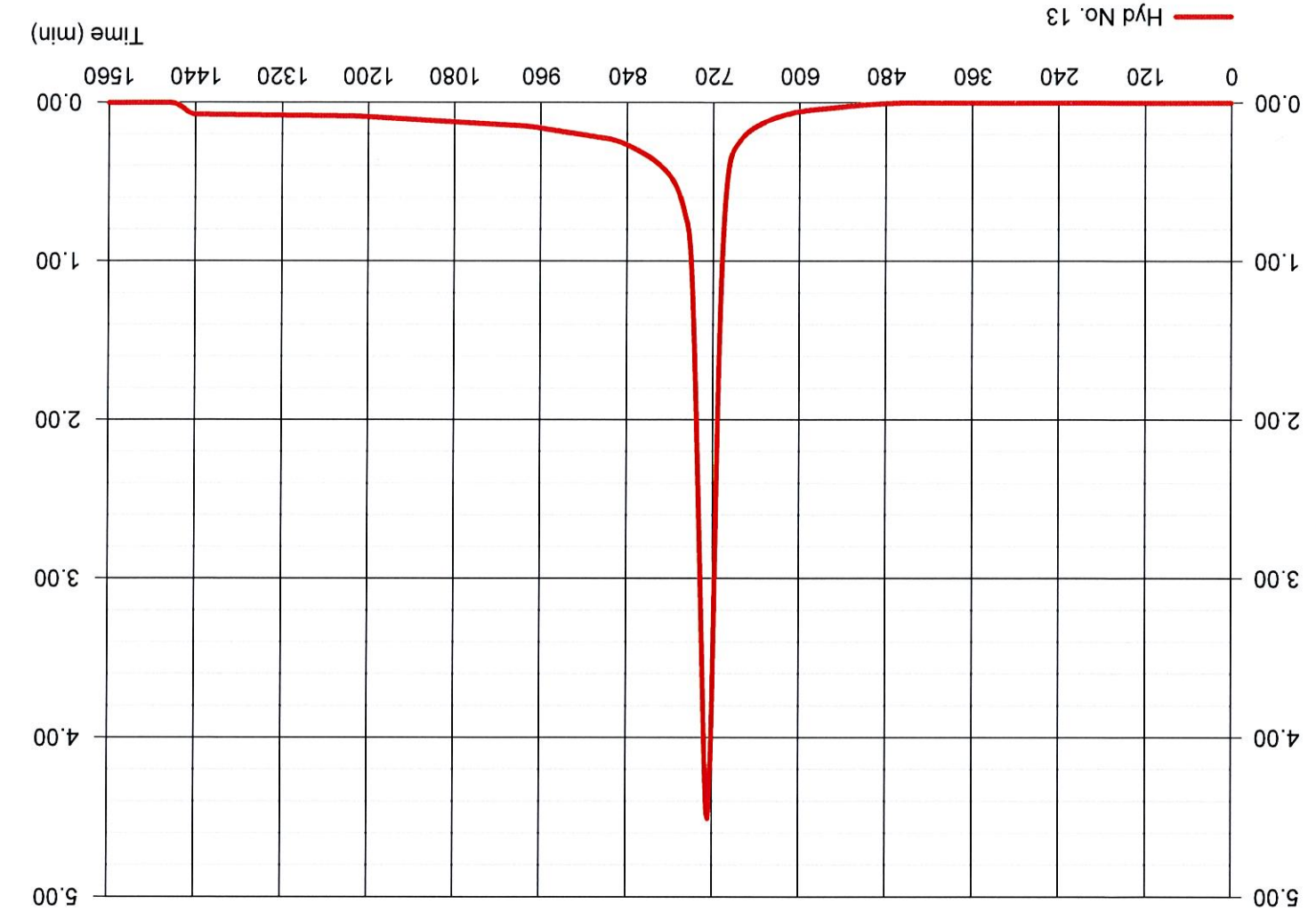
Post Developed to North East Ditch

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.506 cfs
Storm frequency	=	10 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	15,562 cuft
Drainage area	=	1.330 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.00 min
Total precip.	=	5.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.170 x 98) + (1.160 x 74)] / 1.330

Post Developed to North East Ditch

Hyd. No. 13 -- 10 Year



100 YEAR STORM

Hydrograph Report

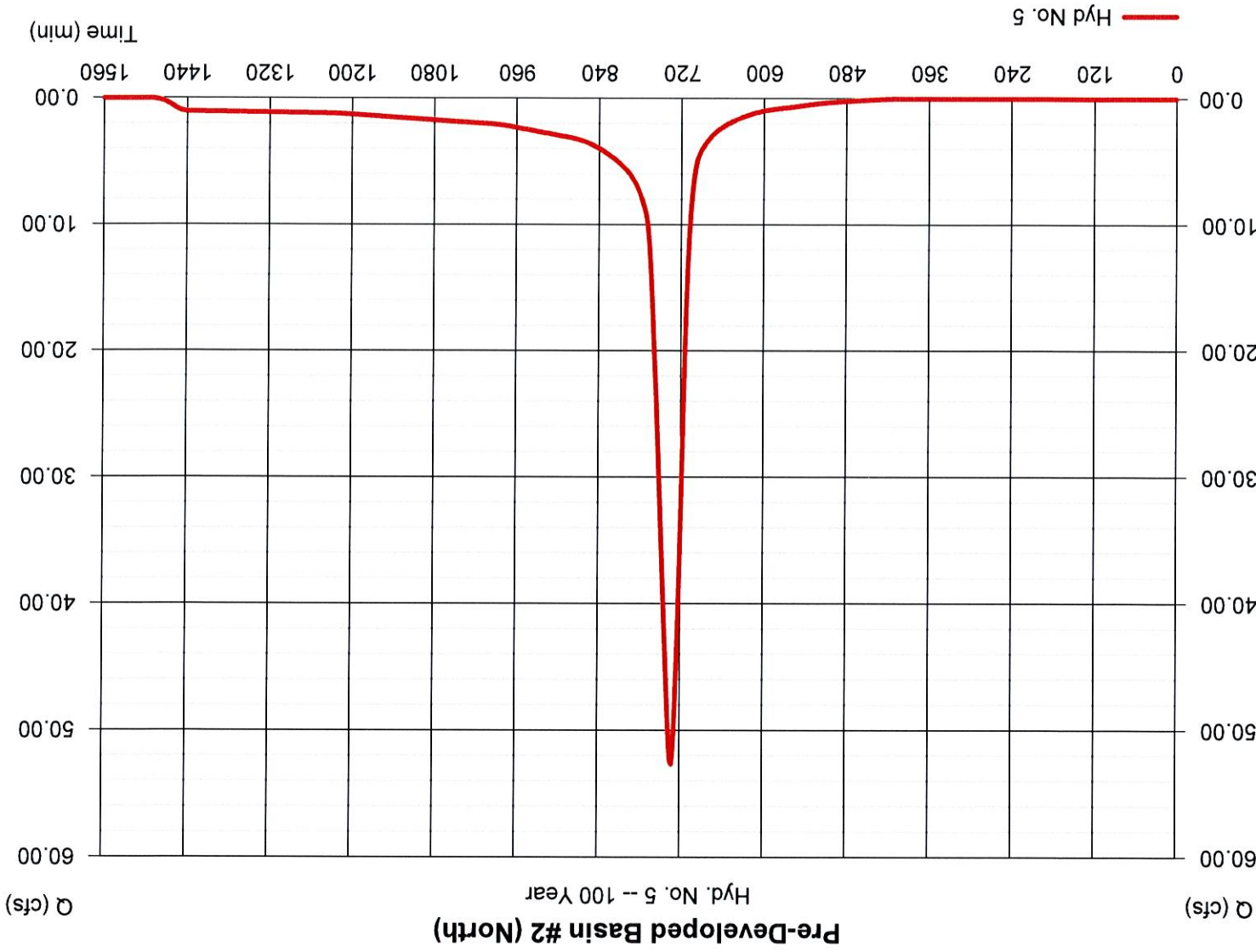
Hydrowflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Monday, 11 / 30 / 2015

Hyd. No. 5

Pre-Developed Basin #2 (North)

Hydrograph type	=	SCS Runoff
Storm frequency	=	100 yrs
Time interval	=	2 min
Drainage area	=	12.750 ac
Basin Slope	=	0.0 %
Tc method	=	TR55
Total precip.	=	7.92 in
Storm duration	=	24 hrs
Peak discharge	=	52.65 cfs
Time to peak	=	732 min
Hyd. volume	=	227,472 cuft
Curve number	=	74
Hydraulic length	=	0 ft
Time of conc. (Tc)	=	31.80 min
Distribution	=	Type II
Shape factor	=	484



Hydrograph Report

Hydrowflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

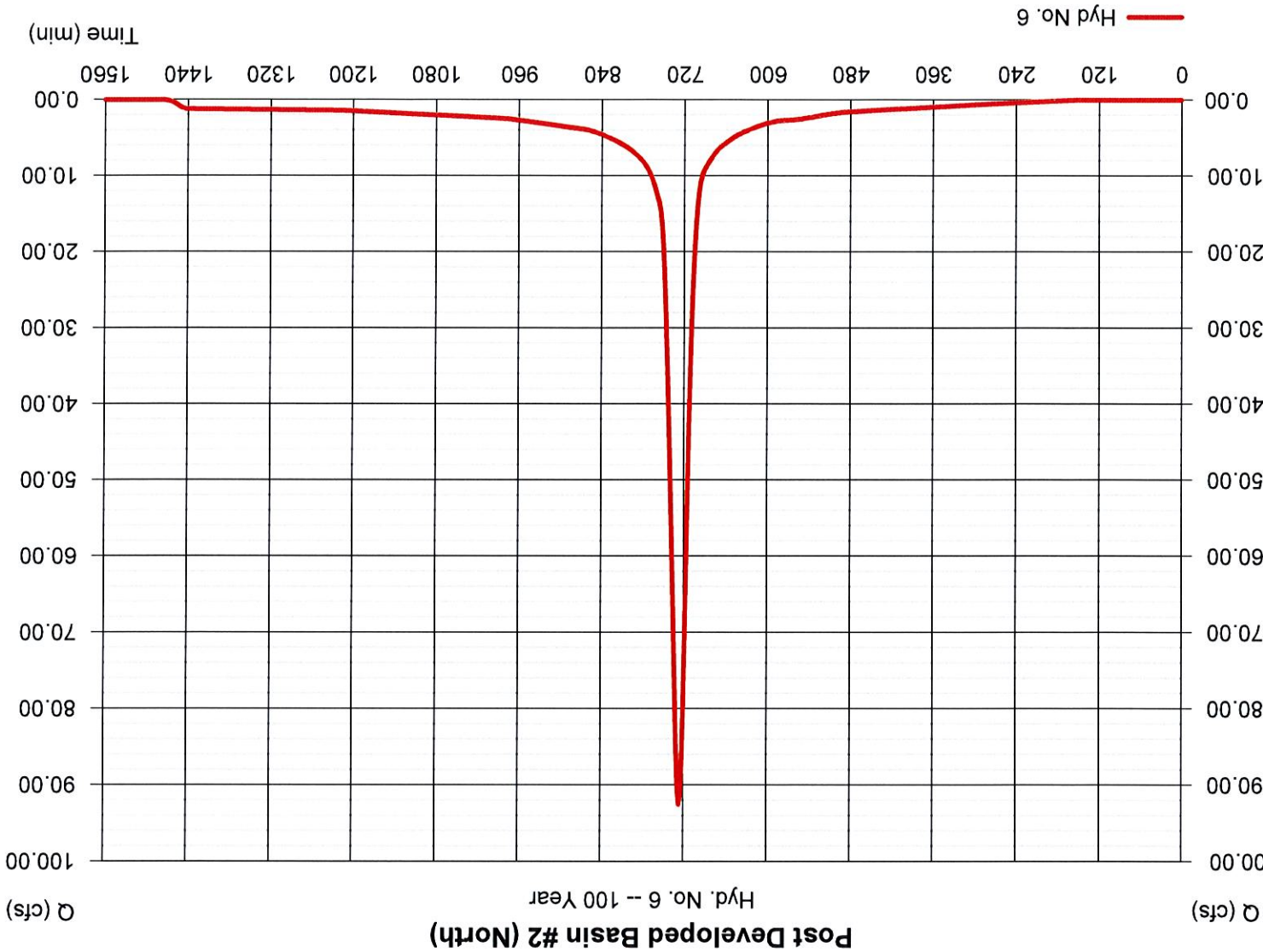
Monday, 11 / 30 / 2015

Hyd. No. 6

Post Developed Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	92.50 cfs
Storm frequency	=	100 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	339,935 cuft
Drainage area	=	13.440 ac	Curve number	=	91*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.10 min
Total precip.	=	7.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.790 x 74) + (9.650 x 98)] / 13.440



Hydrograph Report

Hydrowflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

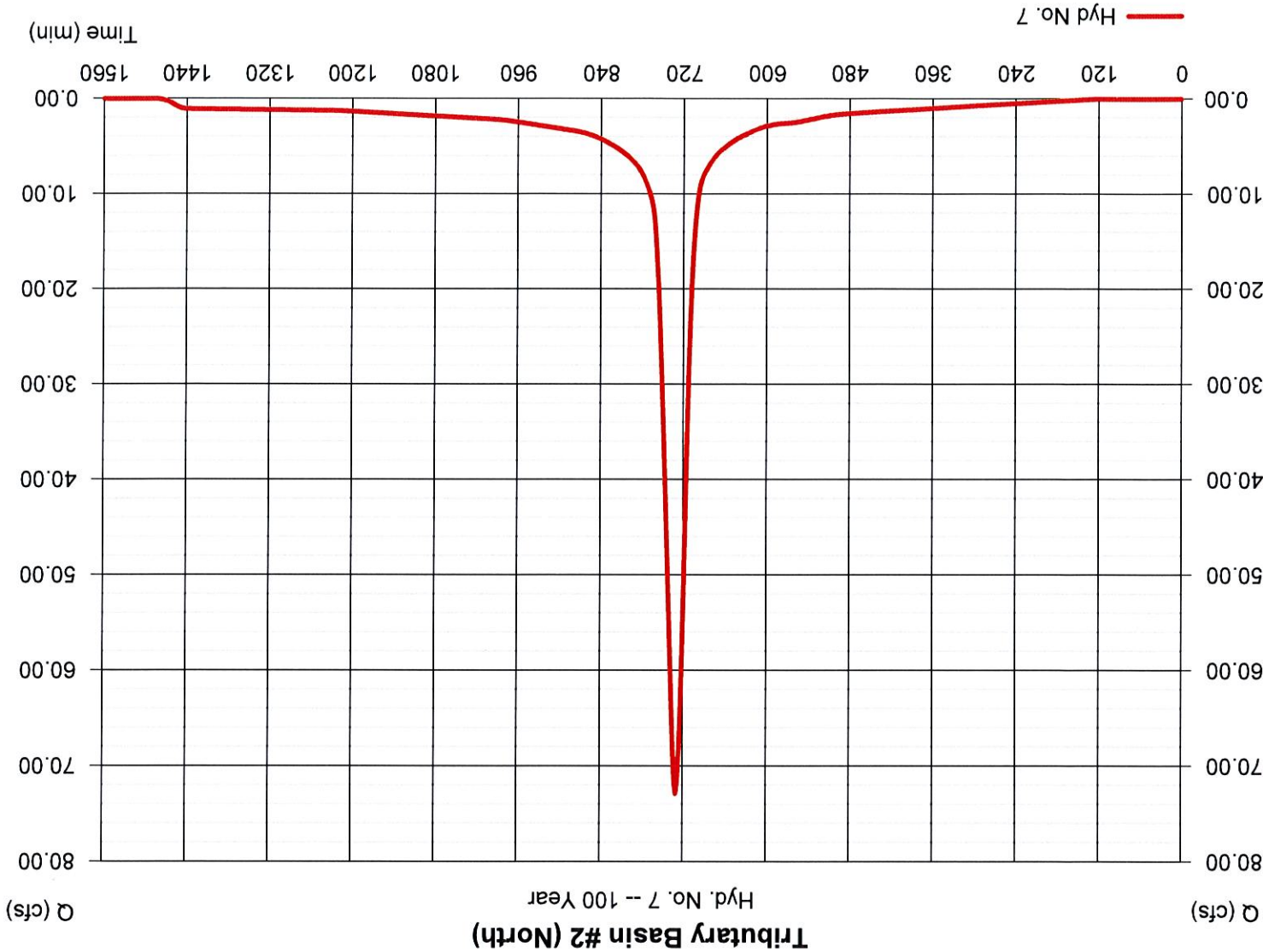
Monday, 11 / 30 / 2015

Hyd. No. 7

Tributary Basin #2 (North)

Hydrograph type	=	SCS Runoff	Peak discharge	=	72.87 cfs
Storm frequency	=	100 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	313,174 cuft
Drainage area	=	12.180 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	28.30 min
Total precip.	=	7.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(9.650 x 98) + (2.530 x 74)] / 12.180



Hydrograph Report

Hydrowflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

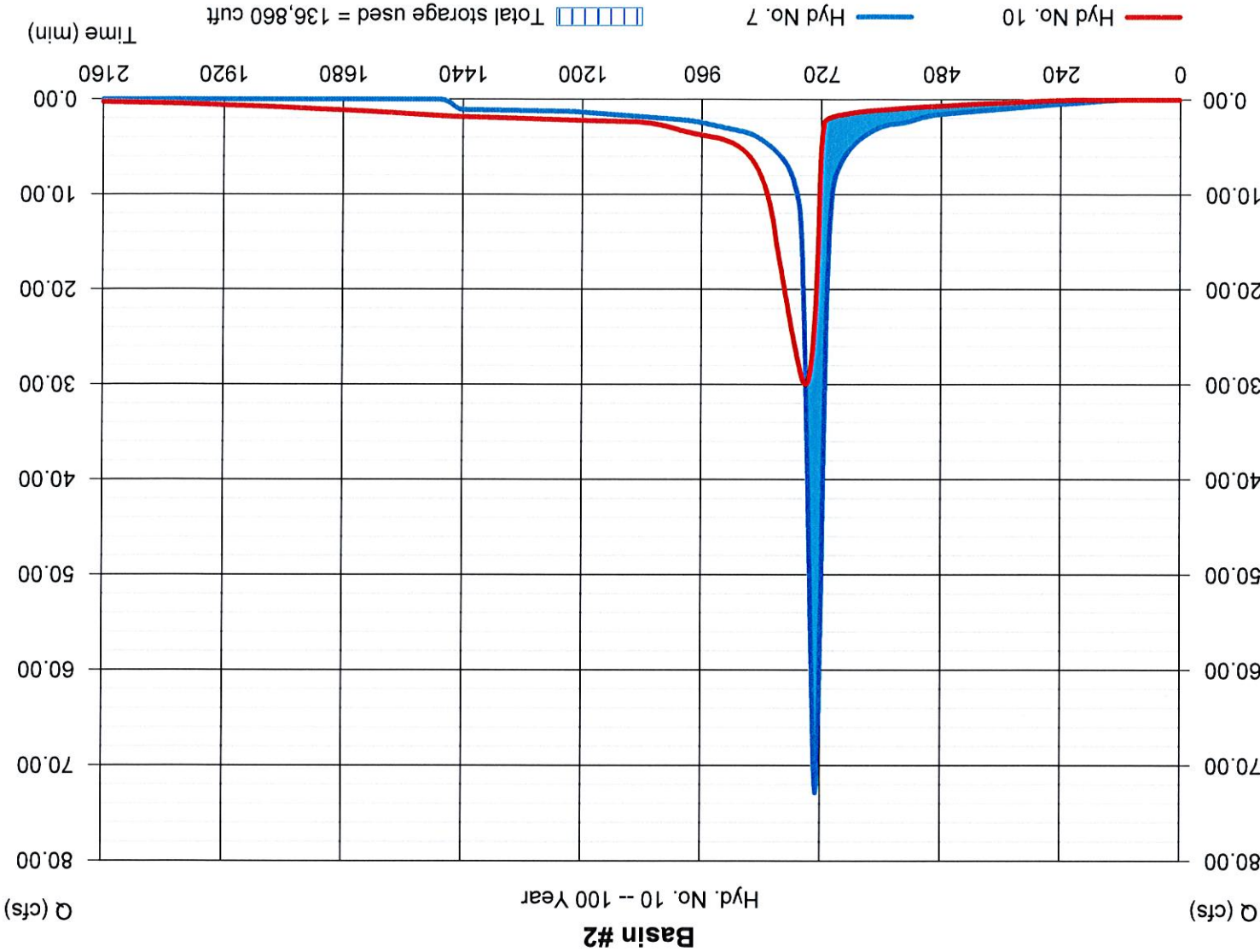
Monday, 11 / 30 / 2015

Hyd. No. 10

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 29.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 312,343 cuft
Inflow hyd. No.	= 7 - Tributary Basin #2 (North)	Max. Elevation	= 1017.97 ft
Reservoir name	= North Basin #2	Max. Storage	= 136,860 cuft

Storage Indication method used.



Hydrograph Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

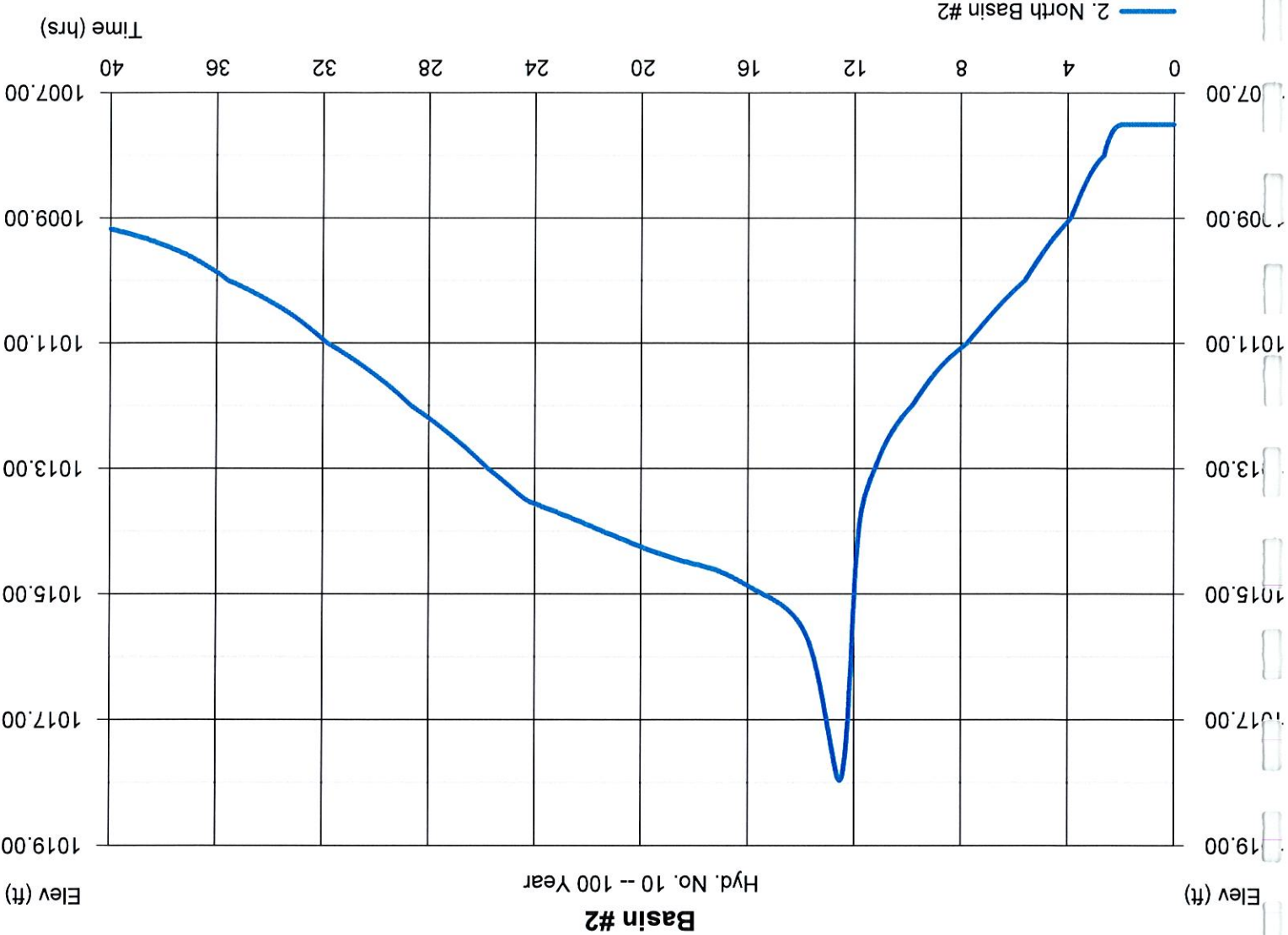
Monday, 11 / 30 / 2015

Hyd. No. 10

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 29.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.50 hrs
Time interval	= 2 min	Hyd. volume	= 312,343 cuft
Inflow hyd. No.	= 7 - Tributary Basin #2 (North)	Max. Elevation	= 1017.97 ft
Reservoir name	= North Basin #2	Max. Storage	= 136,860 cuft

Storage Indication method used.

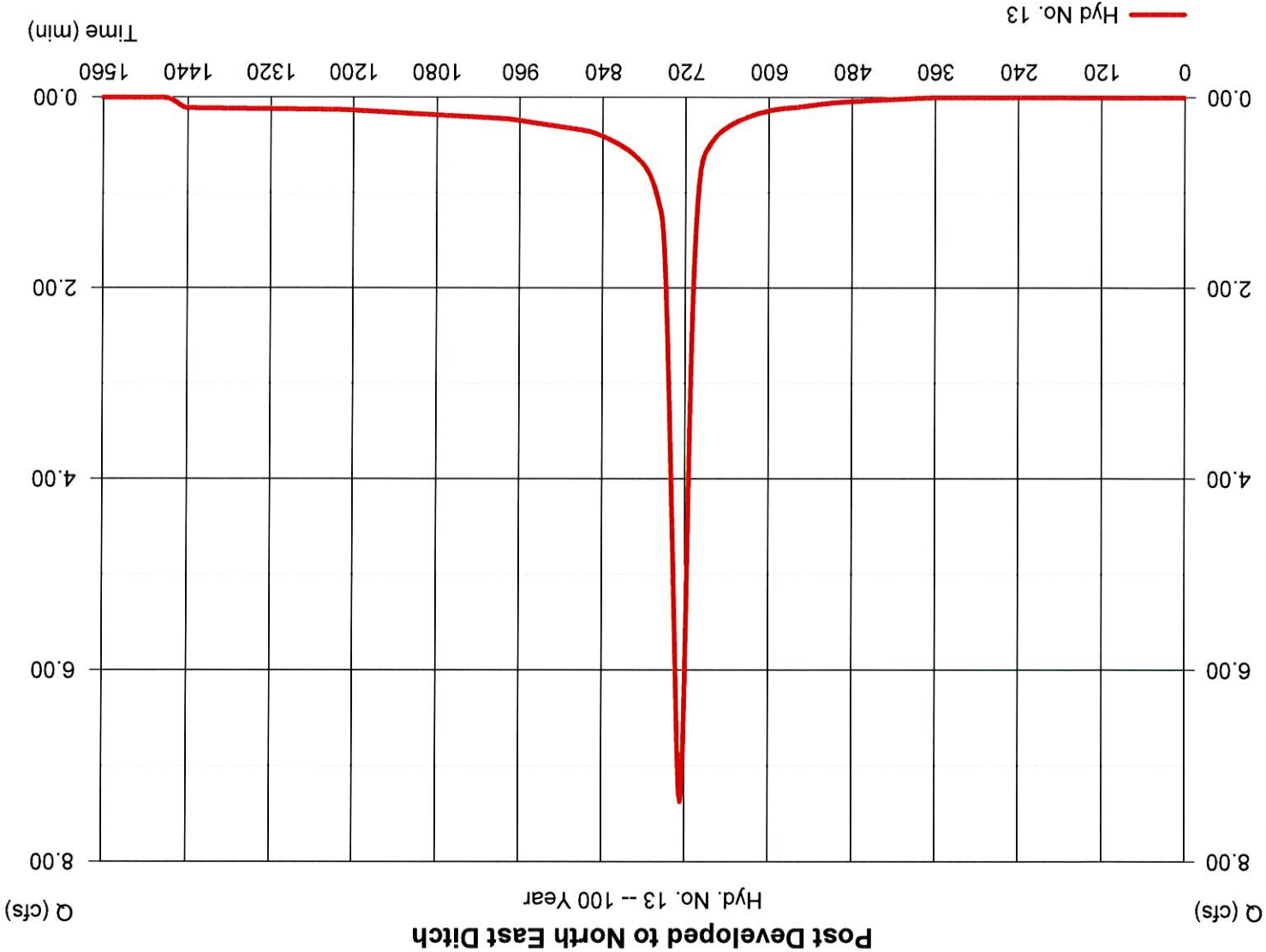


Hyd. No. 13

Post Developed to North East Ditch

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.373 cfs
Storm frequency	=	100 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	25,558 cuft
Drainage area	=	1.330 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.00 min
Total precip.	=	7.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.170 x 98) + (1.160 x 74)] / 1.330



OUTFLOW #3

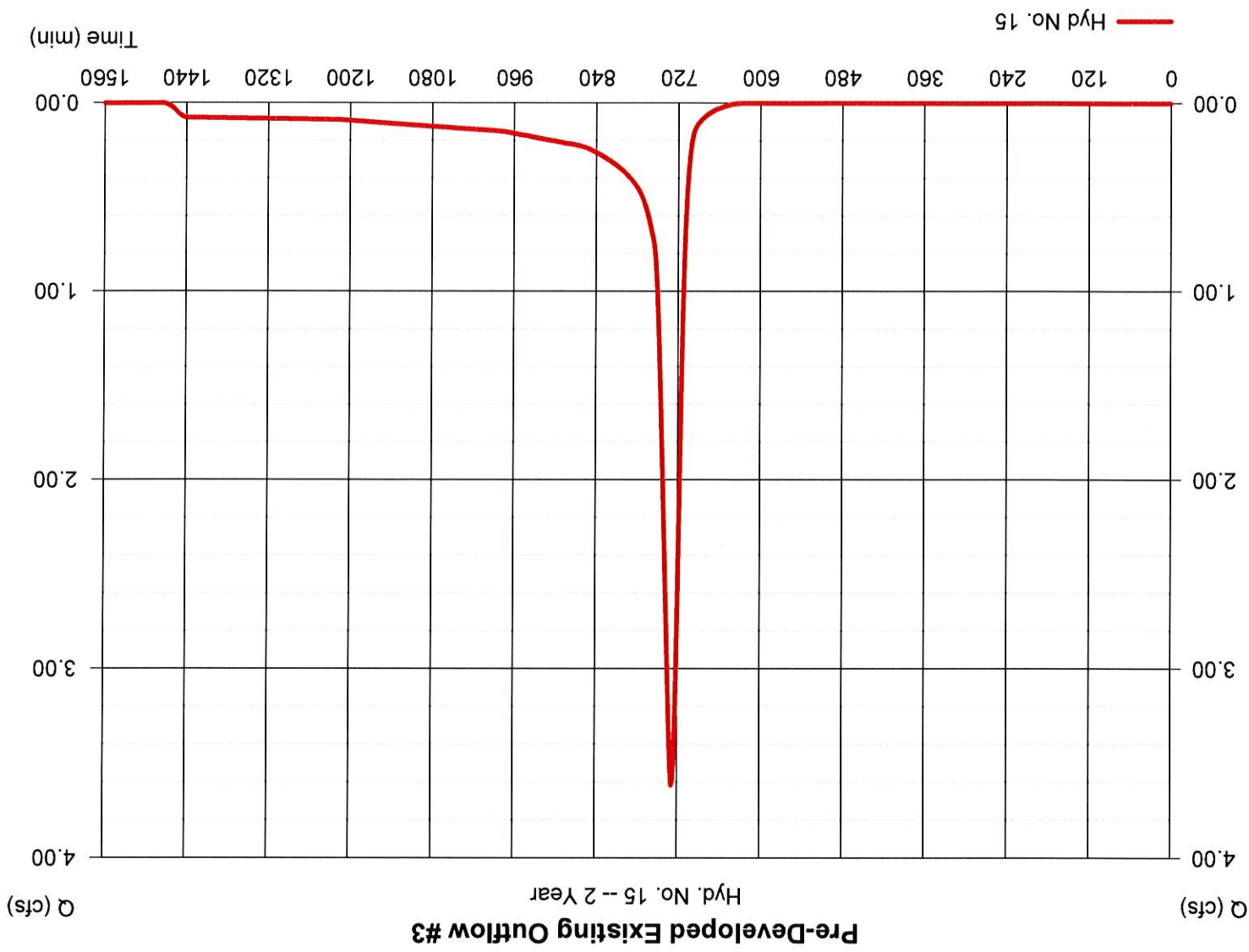
2 YEAR STORM

Hydrograph Report

Hyd. No. 15

Pre-Developed Existing Outflow #3

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.616 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	12,966 cuft
Drainage area	=	2.680 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.80 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

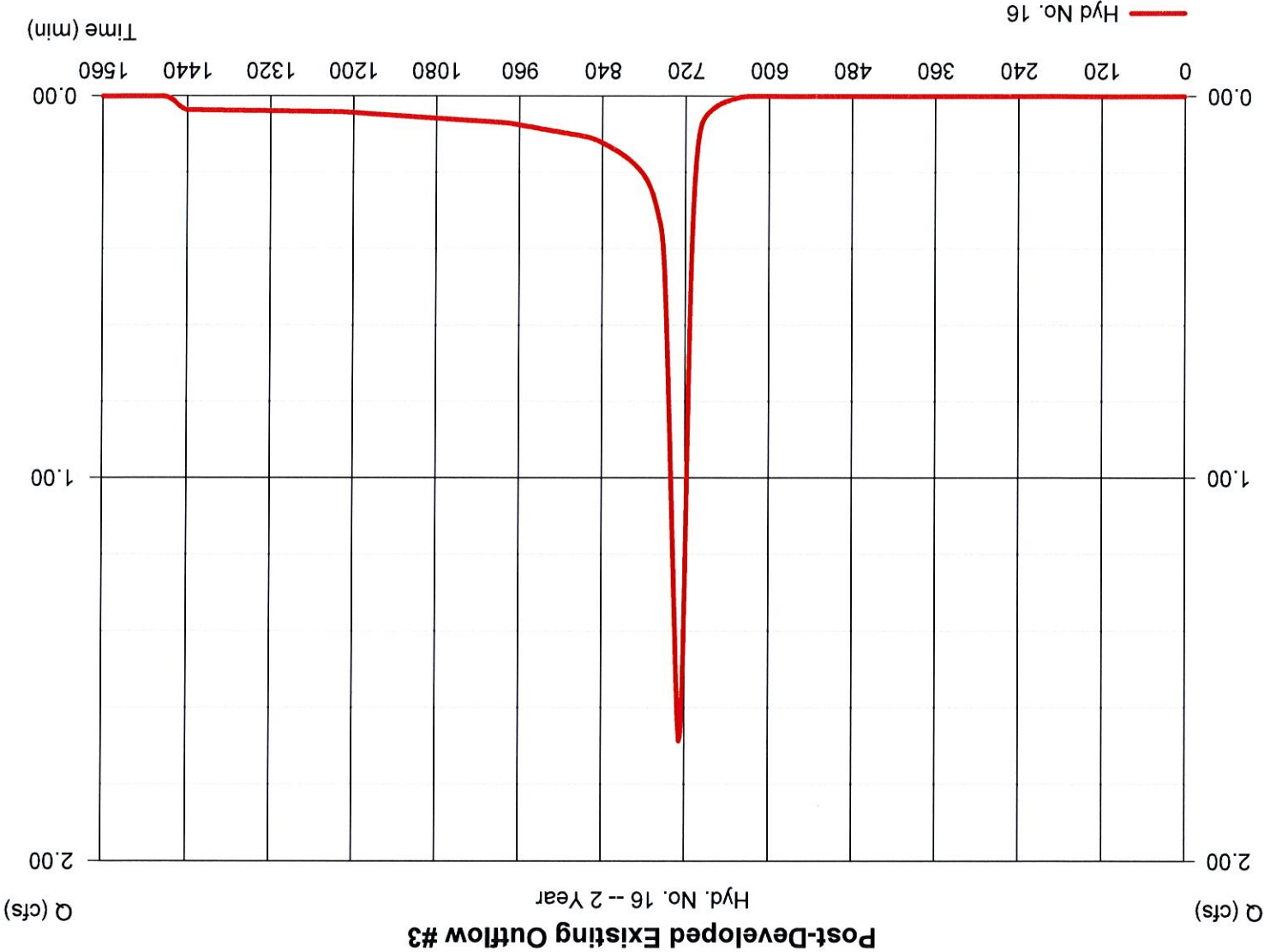
Hydrowflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Monday, 11 / 30 / 2015

Hyd. No. 16

Post-Developed Existing Outflow #3

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.686 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	6,048 cuft
Drainage area	=	1.250 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

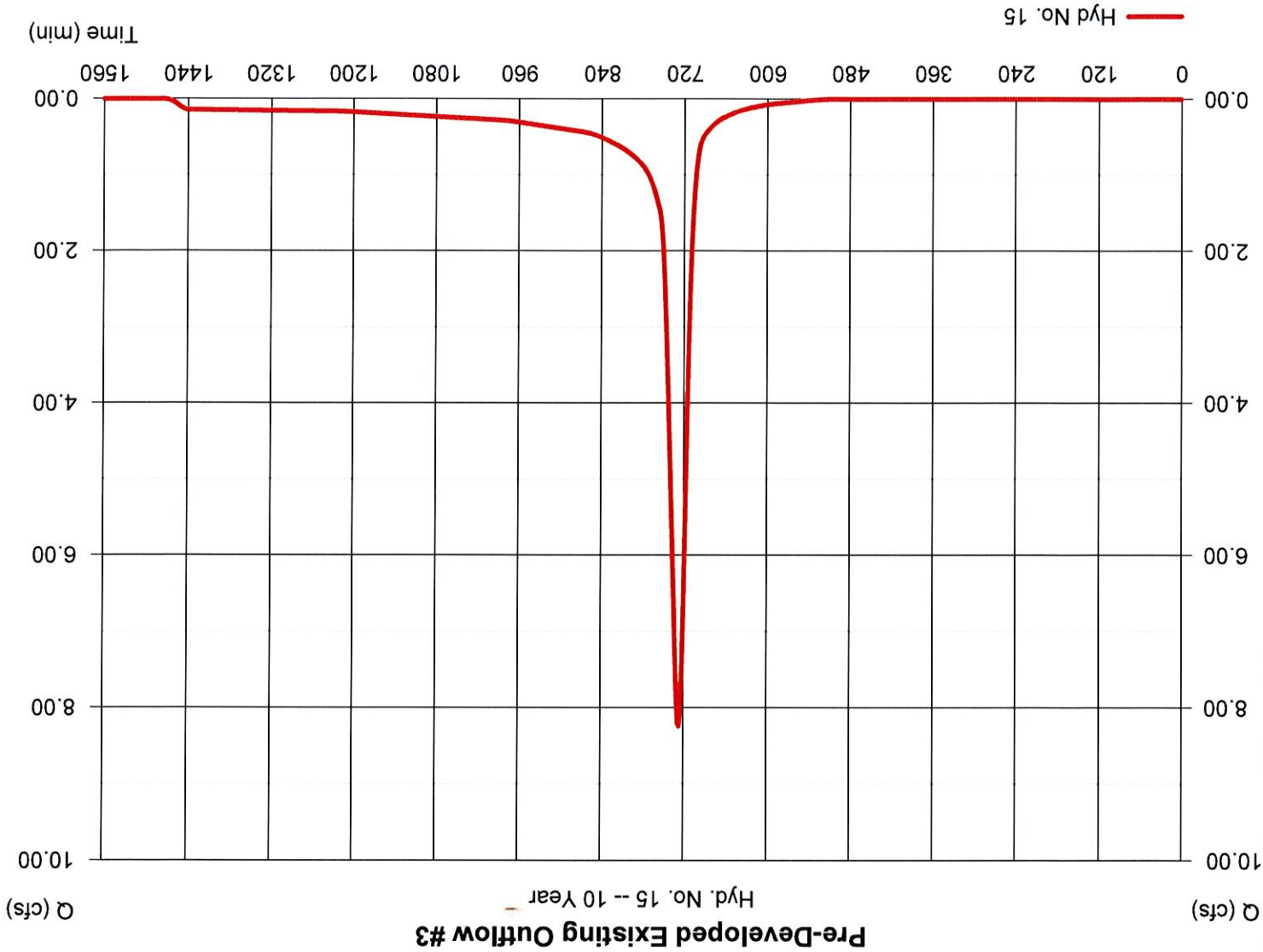


10 YEAR STORM

Hyd. No. 15

Pre-Developed Existing Outflow #3

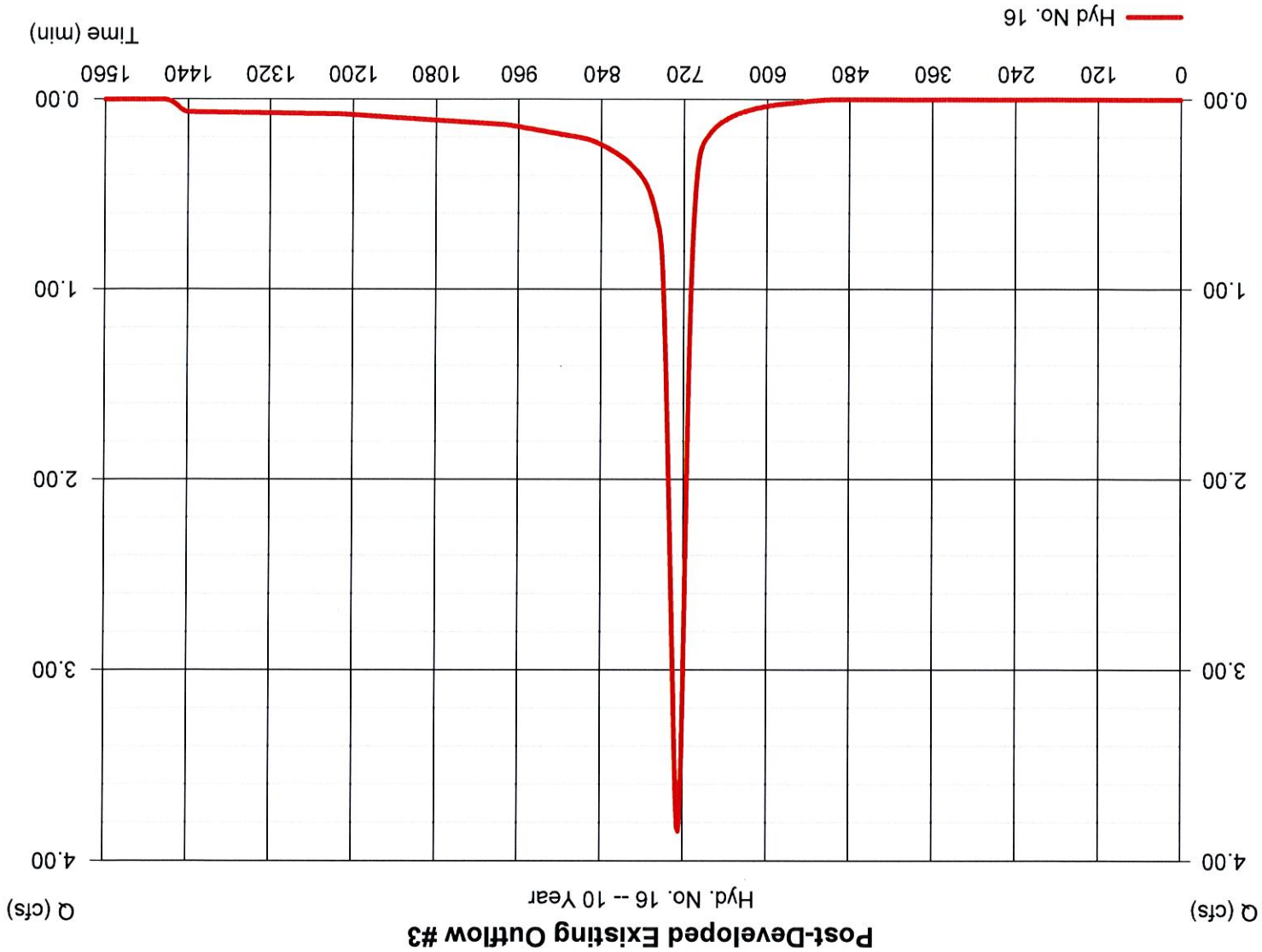
Hydrograph type	= SCS Runoff	Peak discharge	= 8,242 cfs
Storm frequency	= 10 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 28,563 cuft
Drainage area	= 2.680 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.80 min
Total precip.	= 5.64 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hyd. No. 16

Post-Developed Existing Outflow #3

Hydrograph type	=	SCS Runoff
Storm frequency	=	10 yrs
Time interval	=	2 min
Drainage area	=	1.250 ac
Basin Slope	=	0.0 %
Tc method	=	TR55
Total precip.	=	5.64 in
Storm duration	=	24 hrs
Peak discharge	=	3.844 cfs
Time to peak	=	726 min
Hyd. volume	=	13,322 cuft
Curve number	=	74
Hydraulic length	=	0 ft
Time of conc. (Tc)	=	22.00 min
Distribution	=	Type II
Shape factor	=	484

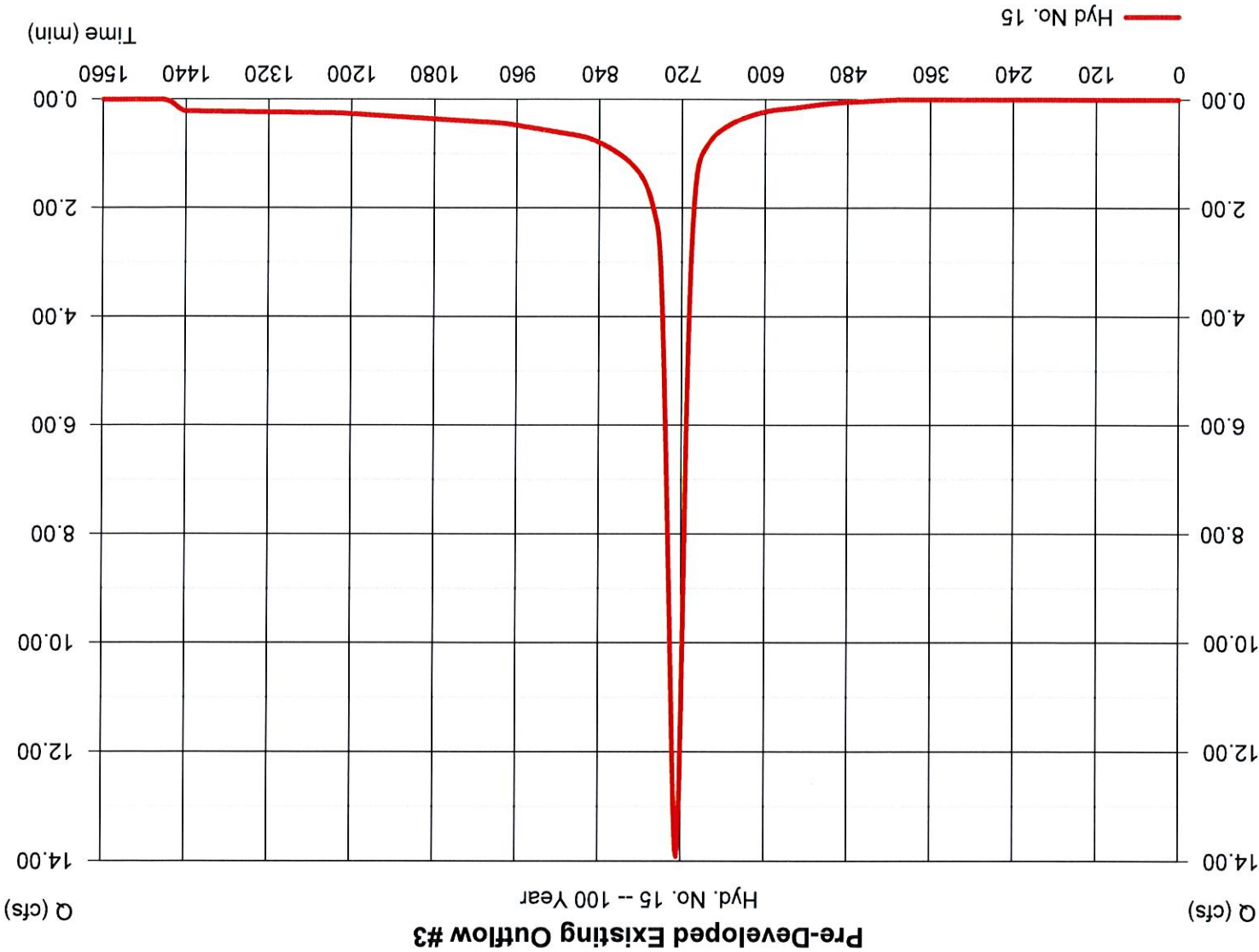


100 YEAR STORM

Hyd. No. 15

Pre-Developed Existing Outflow #3

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.91 cfs
Storm frequency	=	100 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	48,067 cuft
Drainage area	=	2.680 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	22.80 min
Total precip.	=	7.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

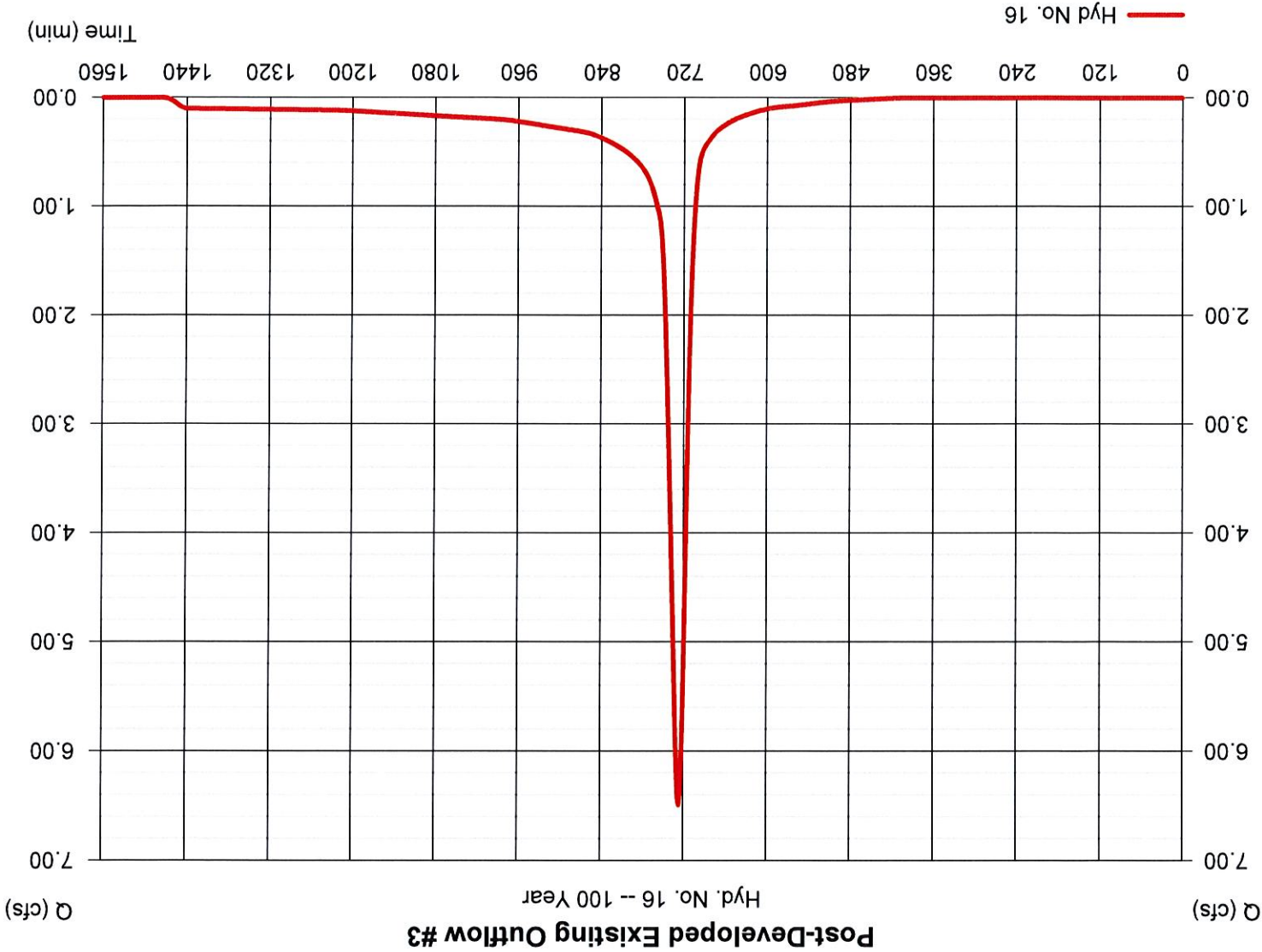
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Monday, 11 / 30 / 2015

Hyd. No. 16

Post-Developed Existing Outflow #3

Hydrograph type	=	SCS Runoff
Storm frequency	=	100 yrs
Time interval	=	2 min
Drainage area	=	1.250 ac
Basin Slope	=	0.0 %
Tc method	=	TR55
Total precip.	=	7.92 in
Storm duration	=	24 hrs
Peak discharge	=	6.489 cfs
Time to peak	=	726 min
Hyd. volume	=	22,419 cuft
Curve number	=	74
Hydraulic length	=	0 ft
Time of conc. (Tc)	=	22.00 min
Distribution	=	Type II
Shape factor	=	484



POND REPORT

Pond Report

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

Monday, 11 / 30 / 2015

Pond No. 1 - South Basin #1

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Beginning Elevation = 1005.00 ft

Stage / Storage Table

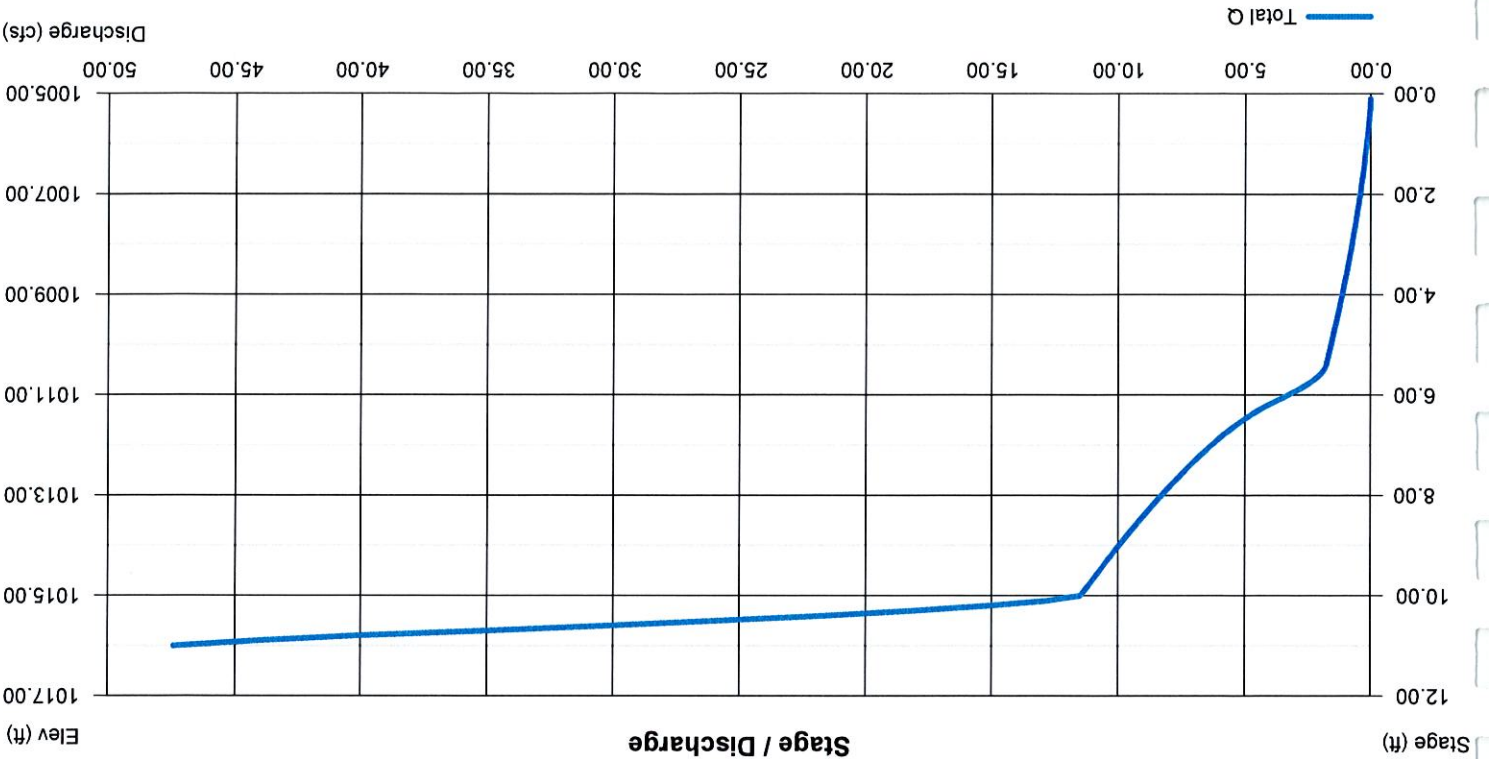
Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1005.00	0	0	0
1.00	1006.00	627	314	314
2.00	1007.00	1,983	1,305	1,619
3.00	1008.00	5,044	3,513	5,132
4.00	1009.00	10,030	7,537	12,669
5.00	1010.00	14,662	12,346	25,015
5.40	1010.40	15,976	6,128	31,143
6.00	1011.00	17,049	9,907	41,050
6.46	1011.46	17,886	8,035	49,085
7.00	1012.00	18,879	9,926	59,012
8.00	1013.00	20,773	19,826	78,837
9.00	1014.00	22,710	21,741	100,579
10.00	1015.00	24,723	23,716	124,295
11.00	1016.00	26,783	25,753	150,048

Culvert / Orifice Structures

Weir Structures

	[A]	[B]	[C]	[Prrsr]	[A]	[B]	[C]	[D]
Rise (in)	= 30.00	12.00	10.00	1.00	Inactive	0.00	0.00	0.00
Span (in)	= 30.00	12.00	36.00	1.00		0.00	0.00	0.00
No. Barrels	= 1	1	4	40	Weir Coeff.	= 3.33	3.33	3.33
Invert El. (ft)	= 1004.83	1010.40	1015.00	1005.00	Weir Type	= Rect	---	---
Length (ft)	= 87.00	0.00	0.00	4.50	Multi-Stage	= No	No	No
Slope (%)	= 0.40	0.00	0.00	n/a				
N-Value	= .013	.013	.013	n/a	Exfil.(in/hr)	= 0.000 (by Wet area)		
Orifice Coeff.	= 0.60	0.60	0.60	0.60	TW Elev. (ft)	= 0.00		
Multi-Stage	= n/a	Yes	Yes	Yes				

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



Pond No. 2 - North Basin #2

Pond Data

Contours - User-defined contour areas. Average end area method used for volume calculation. Beginning Elevation = 1007.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
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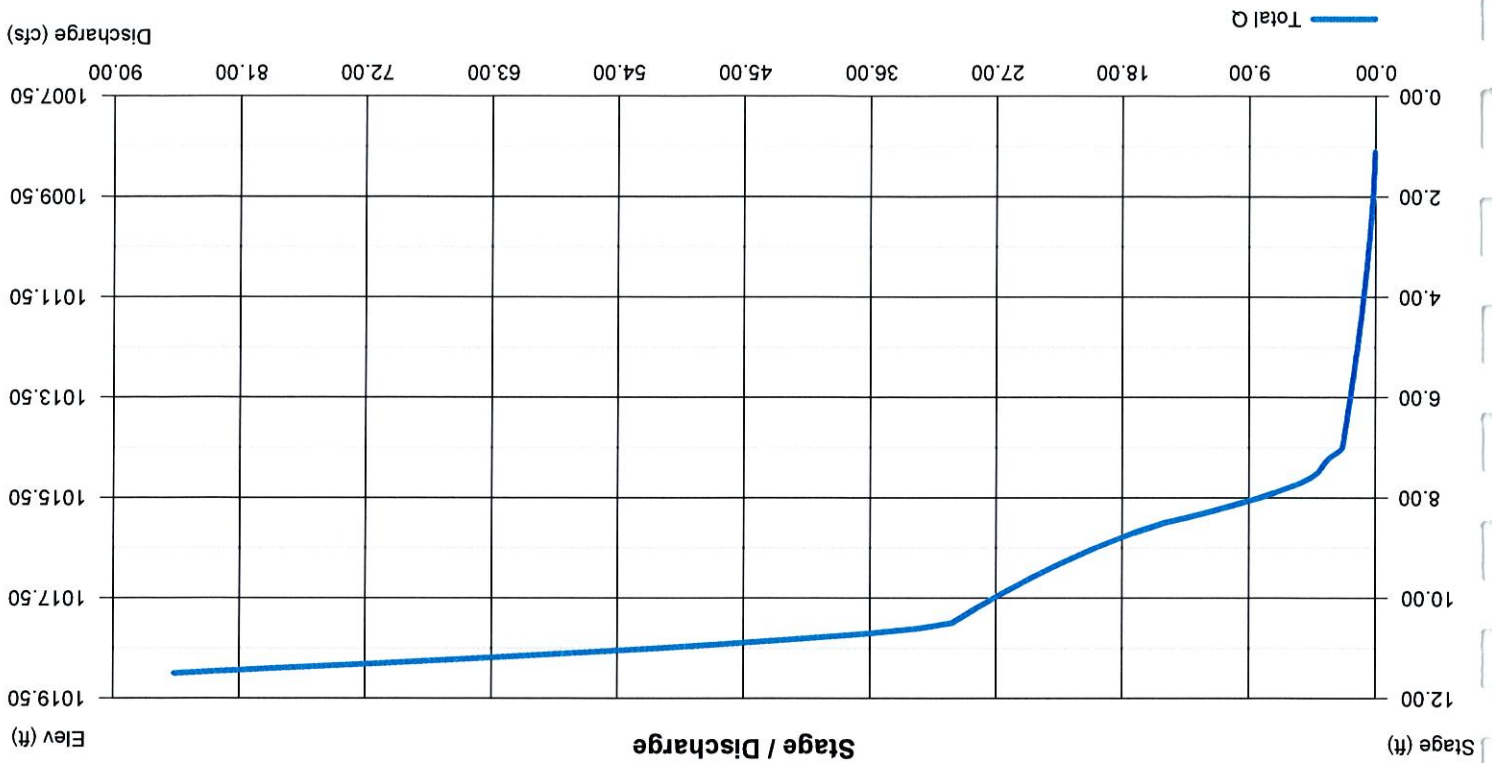
11.50	1019.00	28,716	27,581	165,421
10.50	1018.00	26,446	25,339	137,840
9.50	1017.00	24,231	23,152	112,502
8.50	1016.00	22,073	21,023	89,349
7.50	1015.00	19,972	9,729	68,327
7.00	1014.50	18,942	9,217	58,598
6.50	1014.00	17,927	16,525	49,381
6.50	1013.00	15,123	13,155	32,856
4.50	1012.00	11,187	9,273	19,700
3.50	1011.00	7,359	5,808	10,427
2.50	1010.00	4,258	3,154	4,619
1.50	1009.00	2,051	1,318	1,464
0.50	1008.00	585	146	146
0.00	1007.50	00	0	0

Culvert / Orifice Structures

Weir Structures

	[A]	[B]	[C]	[Prrsr]	[A]	[B]	[C]	[D]
Rise (in)	= 36.00	2.00	12.00	1.00	Crest Len (ft)	= 16.00	0.00	0.00
Span (in)	= 36.00	36.00	36.00	1.00	Crest El. (ft)	= 1018.00	0.00	0.00
No. Barrels	= 1	1	1	50	Weir Coeff.	= 3.33	3.33	3.33
Invert El. (ft)	= 1007.70	1014.50	1015.00	1008.50	Weir Type	= Rect	---	---
Length (ft)	= 24.00	0.00	0.00	5.50	Multi-Stage	= Yes	No	No
Slope (%)	= 0.40	0.00	0.00	n/a				
N-Value	= .013	.013	.013	n/a				
Orifice Coeff.	= 0.60	0.60	0.60	0.60	Exfil.(in/hr)	= 0.000 (by Wet area)		
Multi-Stage	= n/a	Yes	Yes	Yes	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).



DETENTION BASIN
OUTLET STRUCTURE DETAILS

DRAINAGE AREA MAPS