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## STORMWATER REPORT

# Cloverdale Estates

Cloverdale Drive  
Middlefield, Ohio

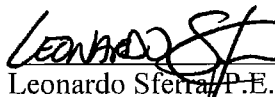
Design Engineer:  
Travis Saunier, PE

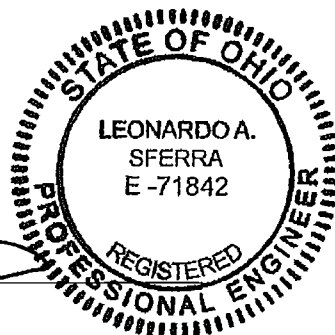
Project Manager:  
Richard DeMarco

Design Date:  
August 30, 2018

Revision Date:  
xxx

Project Number:  
2018359.02

  
Leonardo Sferra, P.E.



08/30/18  
Date

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**Section 1**

## Project Narrative

### Background

The project site is a residential development in Middlefield, Ohio. A few of the housing units have flooded during heavy rainfall events. Reviewing the site conditions, there is a large amount of offsite area, about 30-acres, contributing runoff toward the development. Currently, the offsite runoff is directed between the units to a roadside ditch along Cloverdale Drive. During heavy rain events, the ditch becomes overwhelmed and floods the housing units.

The proposed solution is to divert the offsite runoff into an open channel along the south side of the units. This will decrease the amount of runoff contributing to the roadside ditch and prevent the units from flooding.

### Channel Sizing and Design

LIDAR generated topography and aerial imagery was used to determine the size of the contributing offsite watershed. See Section 2 for drainage map. The overall area is about 30-acres. The watershed was modeled using Hydraflow Hydrographs and the SCS method to estimate the amount of runoff for the 1 thru 100 year design rainfall events. A curve number of 80 was used as the area is generally agricultural and rural residential with little pavement. The time of concentration was determined to be 54 minutes, using the TR-55 method. The resulting hydrographs and report are attached later in the report for reference.

The channel section was designed with a 4-ft. wide bottom and 4:1 side slopes so it can be mowed and maintained. The average depth will be about 3-ft. The bottom slope will vary, with 2% as a minimum. See table below for the anticipated depth of flow in the channel and velocity information.

Channel Design Summary					
Storm Event	Design Flow (cfs)	Depth of Flow in Channel (ft)	Velocity (ft/s)		
1-year	9.824	0.45	4.00		
2-year	14.81	0.50	4.33		
5-year	22.79	0.70	5.20		
10-year	29.59	0.80	5.60		
25-year	39.79	0.90	5.97		
50-year	48.32	1.00	6.33		
100-year	57.32	1.10	6.67		

### Post-Construction Storm Water Control

The scope of the project will not add impervious area to the site. A construction entrance will be installed as a temporary erosion control measure, but will be removed at the conclusion of the project. Section 4.04 of the Geauga County Water Management and Sediment Control Regulations notes that construction activities that do not include the installation of any impervious surface are exempt from the post-construction storm water control requirements. With no new impervious area, the pre and post runoff volumes and runoff rates will remain the same. Maps and stormwater model calculations have been provided for reference in this report.

**Water Quality**

As noted above, the scope of the project will not add impervious area or increase the amount of runoff from the site. Generally, the work will involve re-grading to alter the movement of the runoff through the site. The work will, however, disturb more than an acre of ground. To address the Ohio EPA Water Quality requirements, a SWPP plan has been prepared and the proposed channel will be constructed as a vegetated swale. Rock check dams will be installed in the channel to reduce velocity, minimize erosion, and capture sediment. At the termination of the channel, a rigid lip level spreader will be installed to further dissipate energy and control discharge flows.

The water quality volume has been calculated for the 3.75 acres of disturbed area. This will be considered a redevelopment site, as there is no new impervious area. Detention will be provided in the swale to store and treat the water quality volume. With the small required storage volume, the required orifice will be less than 3-inches and prone to clogging. To overcome this design challenge, the proposed design includes a rock check dam which will serve as an outlet for the water quality volume. Similar to the dewatering of a sediment trap, the stored water quality volume will discharge by flowing through the aggregate check dam. This will provide the necessary retention time and filter the water as it flows through the stone.

Cloverdale

Middlefield, OH

2018359.02

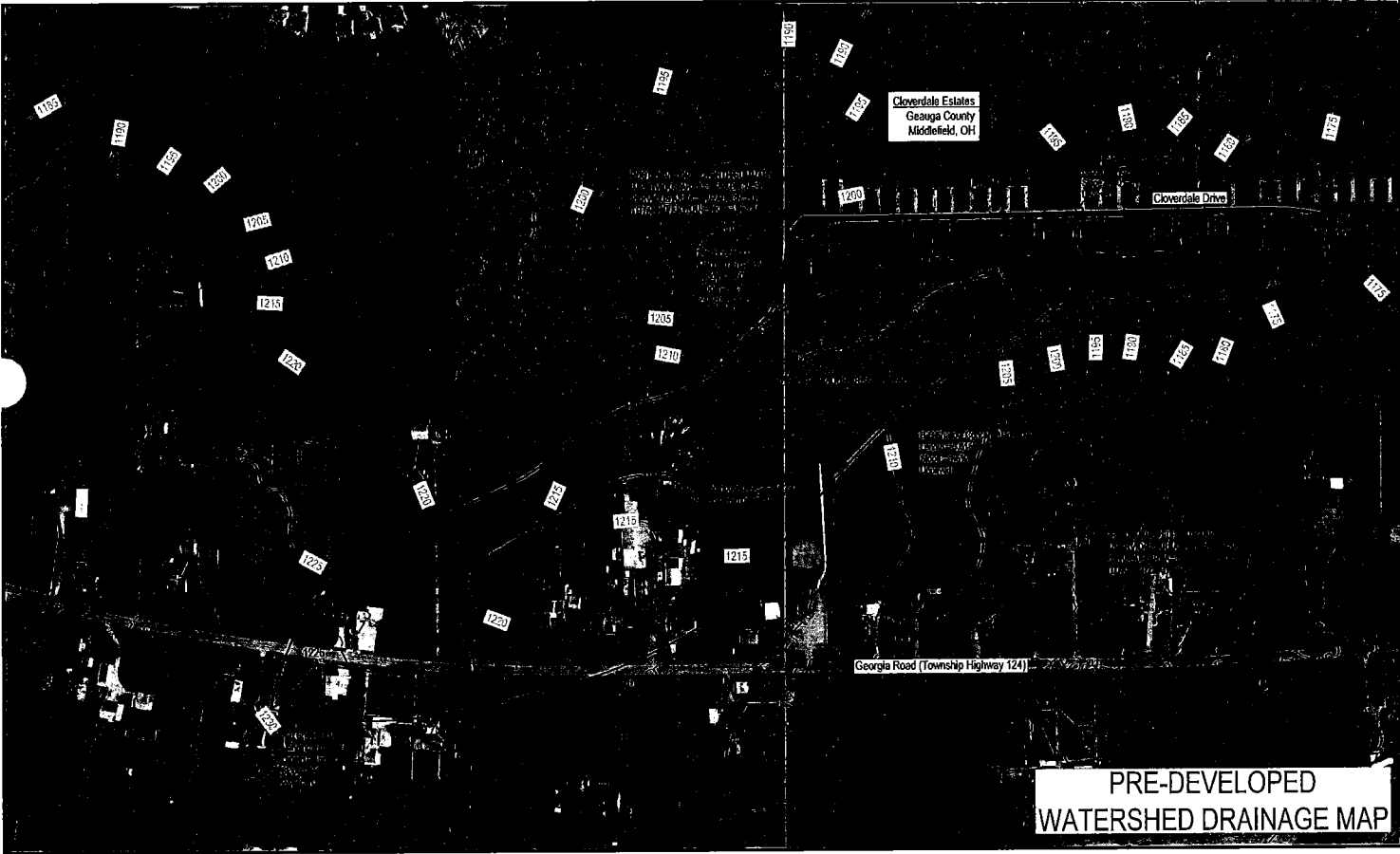
## Section 2

GEAUGA MHA  
CLOVERDALE ESTATES  
DRAINAGE IMPROVEMENTS  
MIDDLEFIELD, OH

JOB NO.  
2018359.02



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Cloverdale

Middlefield, OH

2018359.02

## **Section 3**



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Job Clowderdale Estates - Drainage Swale

Sheet No. 2018359.02 of \_\_\_\_\_

Calculated by \_\_\_\_\_ Date \_\_\_\_\_

Checked by JRS Date 8/29/18

Water Quality, Volume Calculation.

Total Project Area = 3.75 Ac.

Disturbed Area = 3.75 Ac.

$$WQ_v = C * P * \frac{A}{12}$$

$$= (0.2)(0.75) \left( \frac{3.75}{12} \right)$$

C = 0.2 Open Space & Recreation Area

P = 0.75"

A = 3.75 Ac.

$$WQ_v = 0.046875 \text{ Ac.-ft.}$$

$$= 2,042 \text{ ft.}^3$$

Re-Development Site (No New ImperVIOUS Area)

∴ Treat 20% of WQ<sub>v</sub>.

$$20\% WQ_v = (2,042 \text{ ft.}^3)(0.20)$$

$$WQ_v = 408 \text{ ft.}^3$$

+ 82 20% for Sediment

$$490 \text{ ft.}^3 = \text{Required } WQ_v.$$

$$\text{Volume Provided} = 659 \text{ ft.}^3 > 490 \text{ ft.}^3$$

OK

Cloverdale

Middlefield, OH

2018359.02

## Section 4

# Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Wednesday, Aug 22 2018

<Name>

## Trapezoidal

Bottom Width (ft) = 4.00  
Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 2.00  
Invert Elev (ft) = 100.00  
Slope (%) = 2.00  
N-Value = 0.025

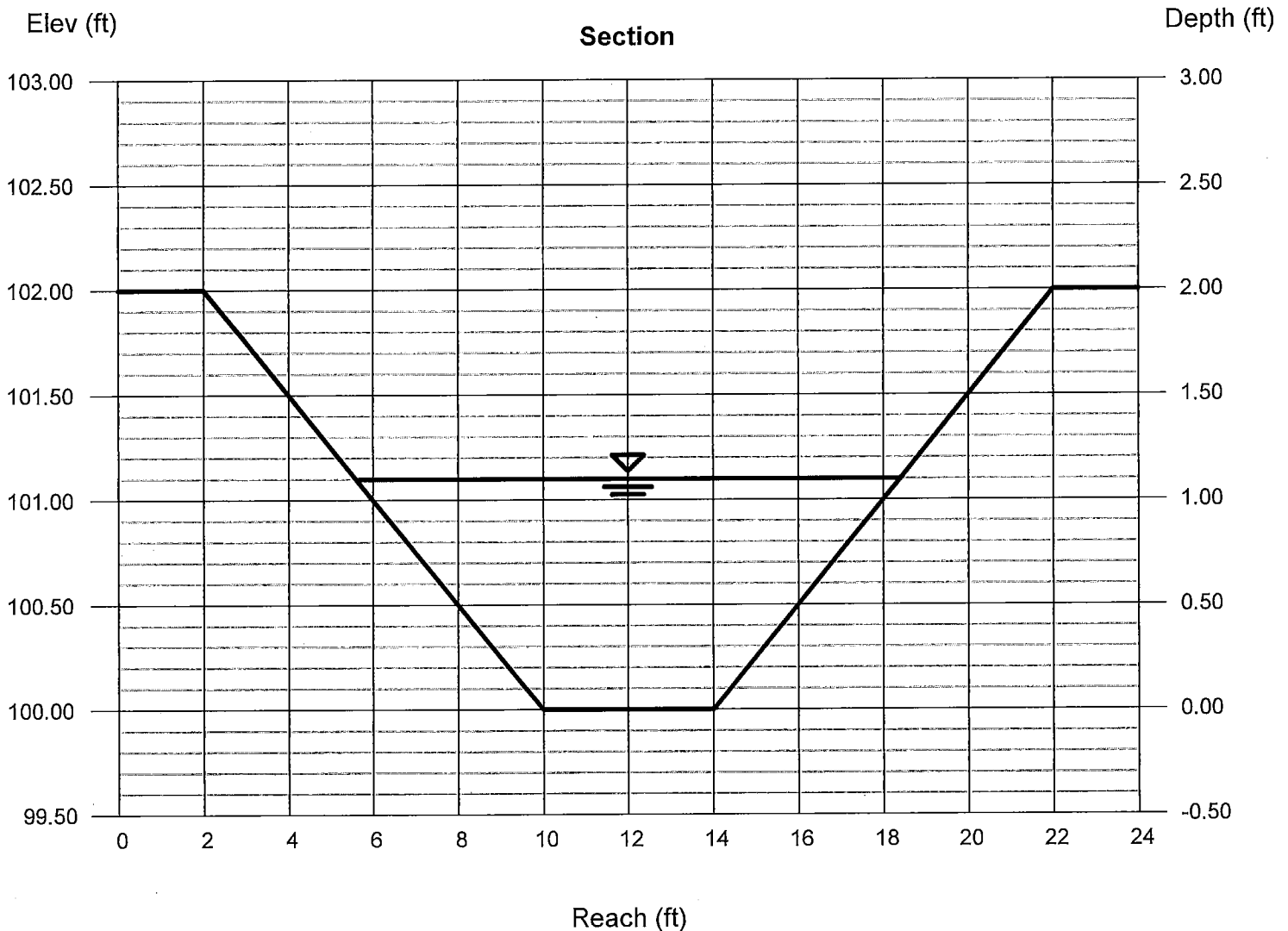
## Highlighted

Depth (ft) = 1.10  
Q (cfs) = 61.63  
Area (sqft) = 9.24  
Velocity (ft/s) = 6.67  
Wetted Perim (ft) = 13.07  
Crit Depth, Yc (ft) = 1.30  
Top Width (ft) = 12.80  
EGL (ft) = 1.79

## Calculations

Compute by: Q vs Depth  
No. Increments = 20

Reinforce channel with Pyramat 25 Turf Reinforcement Matting.  
Maximum velocity = 20 ft/s > 6.67 ft/s Required.



Depth	Q	Area	Veloc	Wp	Yc	TopWidth	Energy
(ft)	(cfs)	(sqft)	(ft/s)	(ft)	(ft)	(ft)	(ft)
0.10	0.749	0.440	1.70	4.82	0.10	4.80	0.15
0.20	2.474	0.960	2.58	5.65	0.22	5.60	0.30
0.30	5.076	1.560	3.25	6.47	0.33	6.40	0.46
0.40	8.564	2.240	3.82	7.30	0.45	7.20	0.63
0.50	12.98	3.000	4.33	8.12	0.57	8.00	0.79
0.60	18.36	3.840	4.78	8.95	0.69	8.80	0.96
0.70	24.76	4.760	5.20	9.77	0.81	9.60	1.12
0.80	32.24	5.760	5.60	10.60	0.93	10.40	1.29
0.90	40.84	6.840	5.97	11.42	1.06	11.20	1.45
1.00	50.62	8.000	6.33	12.25	1.18	12.00	1.62
1.10	61.63	9.240	6.67	13.07	1.30	12.80	1.79
1.20	73.92	10.56	7.00	13.90	1.43	13.60	1.96
1.30	87.53	11.96	7.32	14.72	1.55	14.40	2.13
1.40	102.5	13.44	7.63	15.54	1.68	15.20	2.30
1.50	119.0	15.00	7.93	16.37	1.80	16.00	2.48
1.60	136.9	16.64	8.22	17.19	1.92	16.80	2.65
1.70	156.3	18.36	8.51	18.02	2.00	17.60	2.83
1.80	177.3	20.16	8.79	18.84	2.00	18.40	3.00
1.90	199.9	22.04	9.07	19.67	2.00	19.20	3.18
2.00	224.2	24.00	9.34	20.49	2.00	20.00	3.36



# PYRAMAT®

## Product Data

### PYRAMAT® 25 TRM

PYRAMAT® 25 turf reinforcement mat (TRM) is a three-dimensional, lofty, woven polypropylene geotextile that is available in green which is specially designed for erosion control applications on steep slopes and vegetated waterways. The matrix is composed of polypropylene monofilament yarns featuring X3® technology woven into a uniform configuration of resilient pyramid-like projections. The material exhibits very high interlock and reinforcement capacity with both soil and root systems, demonstrates superior UV resistance, and enhances seedling emergence. The expected design life of PYRAMAT® 25 is up to 25 years because of its superior UV resistance, resistance to corrosion, strength, and durability in the most demanding environments.

PYRAMAT® 25 conforms to the property values listed below<sup>1</sup> and is manufactured at a Propex facility having achieved ISO 9001:2008 certification. Propex performs internal Manufacturing Quality Control (MQC) tests that have been accredited by the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP).

PROPERTY	TEST METHOD	ENGLISH	METRIC
<b>ORIGIN OF MATERIALS</b>			
% U.S. Manufactured Inputs		100%	100%
% U.S. Manufactured		100%	100%
<b>PHYSICAL</b>			
Mass/Unit Area <sup>4</sup>	ASTM D-6566	8.0 oz/yd <sup>2</sup>	271 g/m <sup>2</sup>
Thickness <sup>2</sup>	ASTM D-6525	0.25 in	6.4 mm
Light Penetration (% Passing) <sup>3</sup>	ASTM D-6567	35%	35%
Color	Visual	Green or Tan	
<b>MECHANICAL</b>			
Tensile Strength <sup>2</sup>	ASTM D-6818	2000 x 1800 lbs/ft	29.2 x 26.3 kN/m
Elongation <sup>2</sup>	ASTM D-6818	20 x 20 %	20 x 20 %
Resiliency <sup>2</sup>	ASTM D-6524	70%	70%
Flexibility <sup>4</sup>	ASTM D-6575	0.195 in-lb	225,000 mg-cm
<b>ENDURANCE</b>			
UV Resistance % Retained at 1,000 hrs <sup>4</sup>	ASTM D-4355	90%	90%
UV Resistance % Retained at 3,000 hrs <sup>4</sup>	ASTM D-4355	90%	90%
<b>PERFORMANCE</b>			
Velocity (Vegetated) <sup>4,5</sup>	Large Scale	20 ft/sec	6.1 m/sec
Shear Stress (Vegetated) <sup>4,5</sup>	Large Scale	12 lb/ft <sup>2</sup>	575 Pa
Manning's n (Unvegetated) <sup>4,6</sup>	Calculated	0.028	0.028
Seedling Emergence <sup>4</sup>	ASTM D-7322	255%	255%
<b>ROLL SIZES</b>		8.5 ft x 120 ft	2.6 m x 36.6 m

**NOTES:**

1. The property values listed above are effective 03/09/2018 and are subject to change without notice. Values represent testing at time of manufacture.
2. Minimum average roll values (MARV) are calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.
3. Maximum Average Roll Value (MaxARV), calculated as the typical plus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will meet to the value reported.
4. Typical Value.
5. Maximum permissible velocity and shear stress has been obtained through vegetated testing programs featuring specific soil types, vegetation classes, flow conditions, and failure criteria. These conditions may not be relevant to every project nor are they replicated by other manufacturers. Please contact Propex for further information.
6. Calculated as typical values from large-scale flexible channel lining test programs with a flow depth of 6 to 12 inches.



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**Section 5**

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# Watershed Model Schematic

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



## Legend

<u>Hyd. Origin</u>	<u>Description</u>
1	SCS Runoff Pre-Developed
2	SCS Runoff Post-Developed North
3	SCS Runoff Post-Developed South
4	Reservoir WQ Pond

# Hydrograph Return Period Recap

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

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	----	12.26	18.13	-----	27.46	35.37	47.17	57.00	67.34	Pre-Developed
2	SCS Runoff	----	2.626	3.601	-----	5.095	6.325	8.125	9.605	11.14	Post-Developed North
3	SCS Runoff	----	10.62	15.99	-----	24.58	31.90	42.87	52.04	61.70	Post-Developed South
4	Reservoir	3	10.62	15.97	-----	24.58	31.90	42.89	52.07	61.75	WQ Pond

# Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	12.26	2	748	82,497	----	----	----	Pre-Developed
2	SCS Runoff	2.626	2	746	16,013	----	----	----	Post-Developed North
3	SCS Runoff	10.62	2	744	66,863	----	----	----	Post-Developed South
4	Reservoir	10.62	2	746	66,860	3	1186.29	1,085	WQ Pond

# Hydrograph Report

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

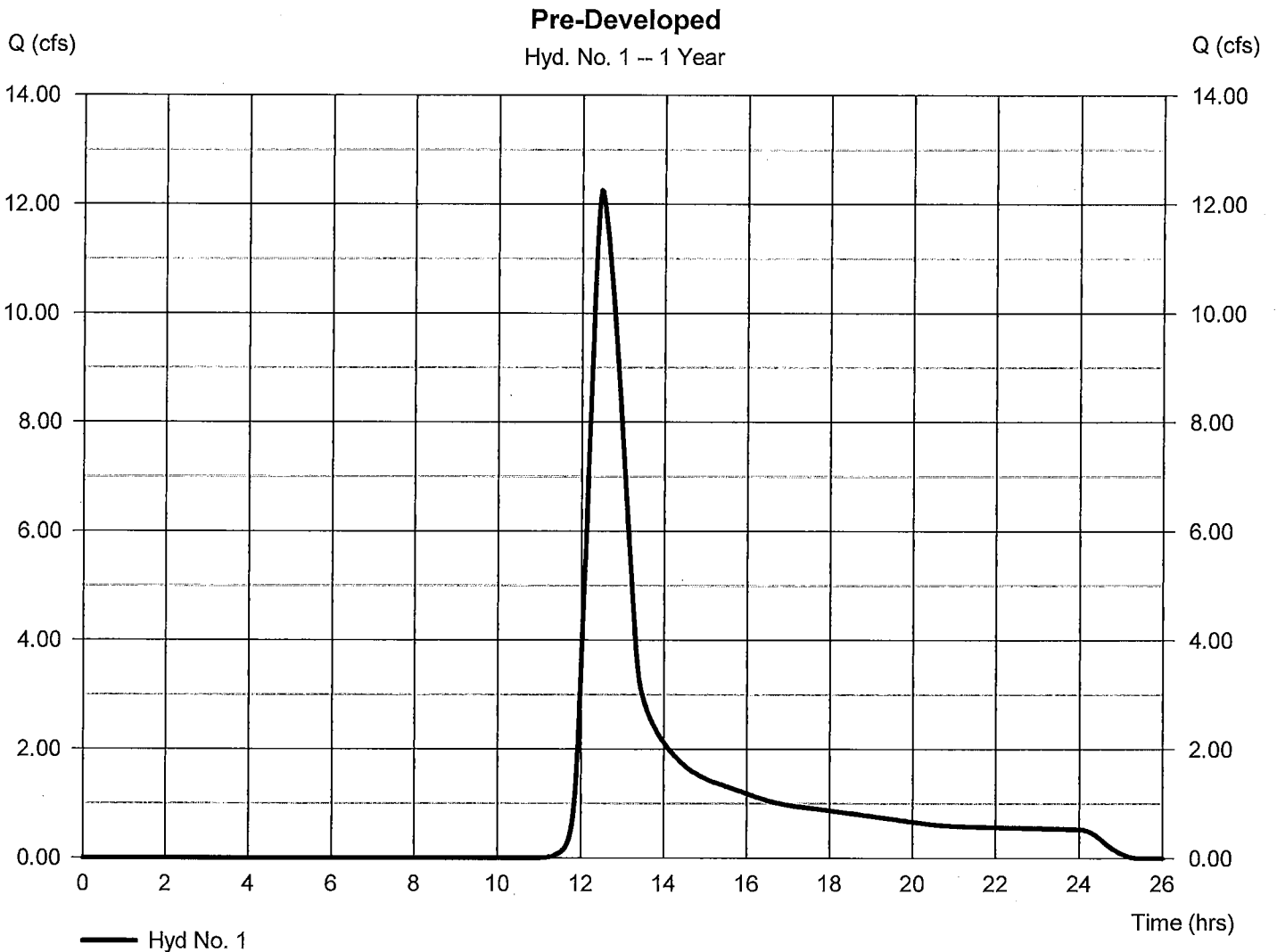
Wednesday, 08 / 29 / 2018

## Hyd. No. 1

Pre-Developed

Hydrograph type	= SCS Runoff	Peak discharge	= 12.26 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 82,497 cuft
Drainage area	= 34.230 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 55.90 min
Total precip.	= 2.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (32.650 x 80)] / 34.230



# TR55 Tc Worksheet

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

## Hyd. No. 1

Pre-Developed

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
<b>Sheet Flow</b>				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 185.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00	
Land slope (%)	= 2.20	0.00	0.00	
<b>Travel Time (min)</b>	<b>= 25.42</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 25.42</b>
<b>Shallow Concentrated Flow</b>				
Flow length (ft)	= 3615.00	0.00	0.00	
Watercourse slope (%)	= 1.50	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 1.98	0.00	0.00	
<b>Travel Time (min)</b>	<b>= 30.49</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 30.49</b>
<b>Channel Flow</b>				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
<b>Travel Time (min)</b>	<b>= 0.00</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 0.00</b>
<b>Total Travel Time, Tc .....</b>				<b>55.90 min</b>

# Hydrograph Report

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

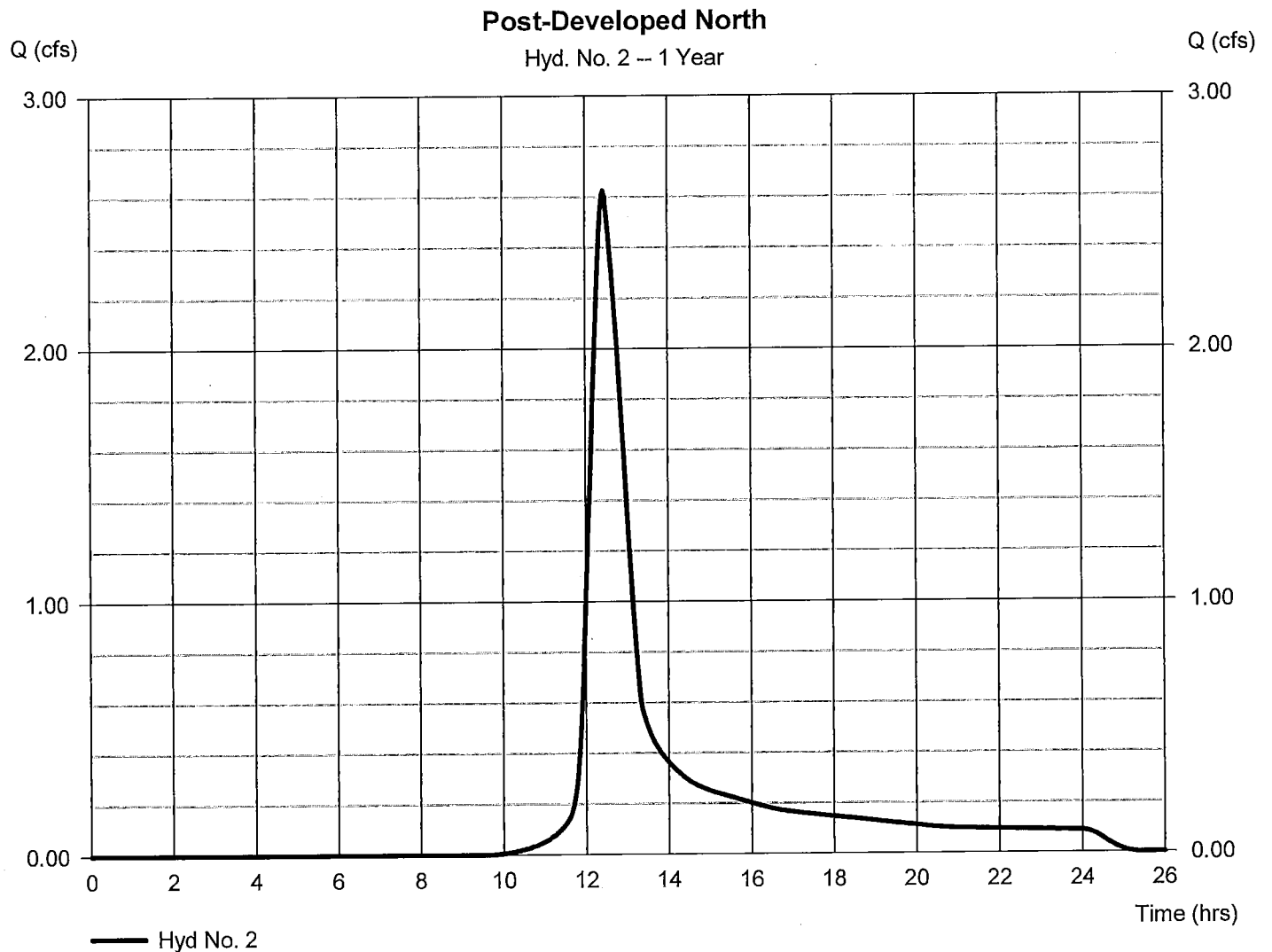
Wednesday, 08 / 29 / 2018

## Hyd. No. 2

Post-Developed North

Hydrograph type	= SCS Runoff	Peak discharge	= 2.626 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 16,013 cuft
Drainage area	= 4.730 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 54.10 min
Total precip.	= 2.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (3.150 x 80)] / 4.730



# TR55 Tc Worksheet

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

## Hyd. No. 2

Post-Developed North

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
<b>Sheet Flow</b>				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 250.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00	
Land slope (%)	= 1.20	0.00	0.00	
<b>Travel Time (min)</b>	<b>= 41.14</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 41.14</b>
<b>Shallow Concentrated Flow</b>				
Flow length (ft)	= 1775.00	0.00	0.00	
Watercourse slope (%)	= 2.00	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.28	0.00	0.00	
<b>Travel Time (min)</b>	<b>= 12.97</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 12.97</b>
<b>Channel Flow</b>				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
<b>Travel Time (min)</b>	<b>= 0.00</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 0.00</b>
<b>Total Travel Time, Tc .....</b>				<b>54.10 min</b>



# Hydrograph Report

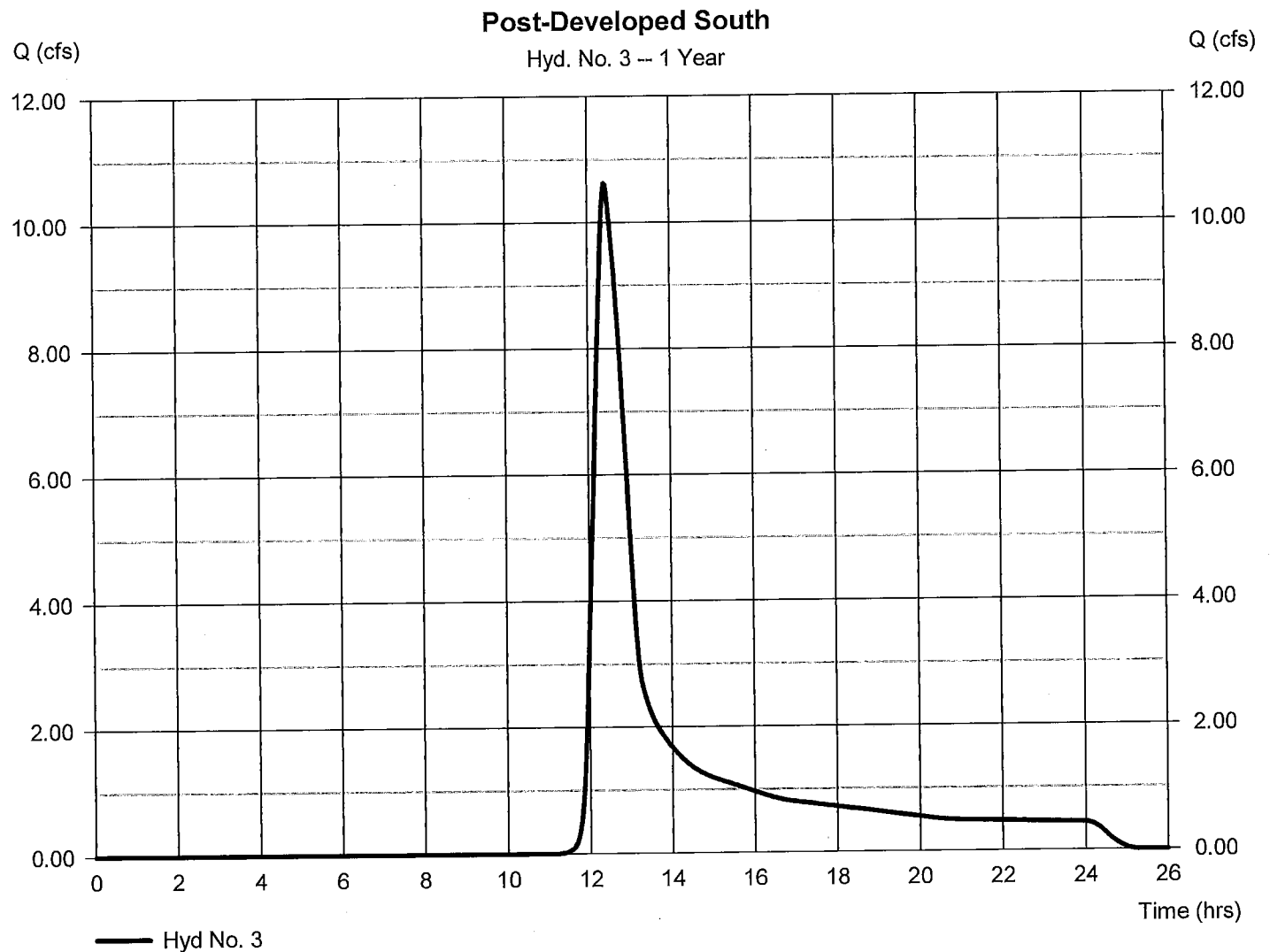
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Wednesday, 08 / 29 / 2018

## Hyd. No. 3

Post-Developed South

Hydrograph type	= SCS Runoff	Peak discharge	= 10.62 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 66,863 cuft
Drainage area	= 29.500 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.50 min
Total precip.	= 2.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# TR55 Tc Worksheet

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

## Hyd. No. 3

Post-Developed South

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
<b>Sheet Flow</b>				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 185.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00	
Land slope (%)	= 2.20	0.00	0.00	
<b>Travel Time (min)</b>	<b>= 25.37</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 25.37</b>
<b>Shallow Concentrated Flow</b>				
Flow length (ft)	= 3415.00	0.00	0.00	
Watercourse slope (%)	= 1.60	0.00	0.00	
Surface description	= Paved	Paved	Paved	
Average velocity (ft/s)	=2.57	0.00	0.00	
<b>Travel Time (min)</b>	<b>= 22.14</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 22.14</b>
<b>Channel Flow</b>				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{{0}}0.0	0.0	0.0	
<b>Travel Time (min)</b>	<b>= 0.00</b>	<b>+ 0.00</b>	<b>+ 0.00</b>	<b>= 0.00</b>
<b>Total Travel Time, Tc .....</b>				<b>47.50 min</b>

# Hydrograph Report

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

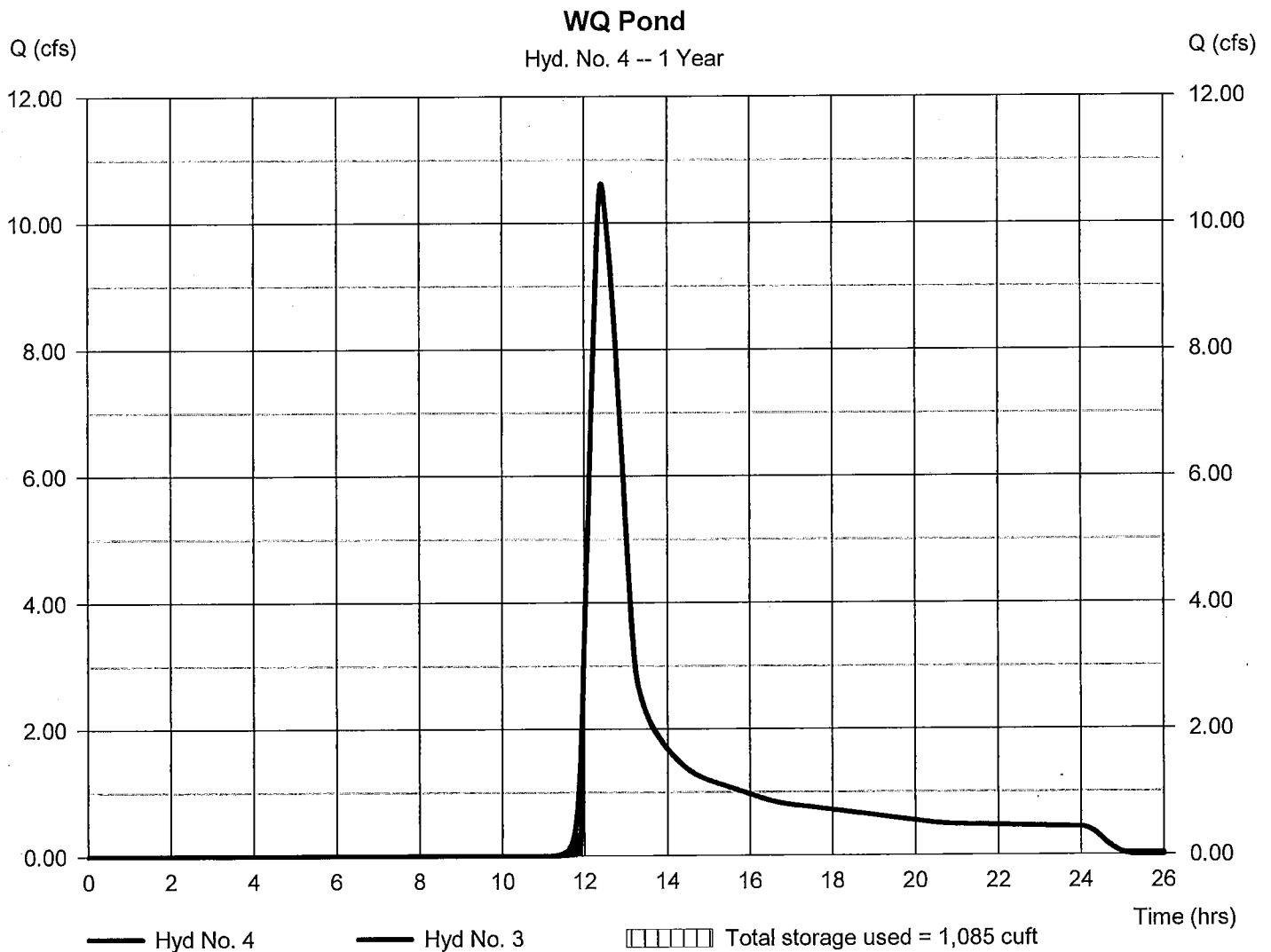
Wednesday, 08 / 29 / 2018

## Hyd. No. 4

WQ Pond

Hydrograph type	= Reservoir	Peak discharge	= 10.62 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 66,860 cuft
Inflow hyd. No.	= 3 - Post-Developed South	Max. Elevation	= 1186.29 ft
Reservoir name	= WQ Swale	Max. Storage	= 1,085 cuft

Storage Indication method used.



# Pond Report

## Pond No. 1 - WQ Swale

### Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 1184.33 ft

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1184.33	76	0	0
0.67	1185.00	219	99	99
1.67	1186.00	902	561	659
2.67	1187.00	2,003	1,453	2,112

### Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 1.00	0.00	0.00	0.00
Span (in)	= 1.00	0.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 1184.33	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 20.00	0.00	0.00	0.00
Crest El. (ft)	= 1186.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Cipiti	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

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

### Stage / 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	1184.33	0.00	---	---	---	0.00	---	---	---	---	---	0.000
0.07	10	1184.40	0.00 ic	---	---	---	0.00	---	---	---	---	---	0.004
0.13	20	1184.46	0.01 ic	---	---	---	0.00	---	---	---	---	---	0.008
0.20	30	1184.53	0.01 ic	---	---	---	0.00	---	---	---	---	---	0.010
0.27	40	1184.60	0.01 ic	---	---	---	0.00	---	---	---	---	---	0.012
0.34	49	1184.67	0.01 ic	---	---	---	0.00	---	---	---	---	---	0.014
0.40	59	1184.73	0.02 ic	---	---	---	0.00	---	---	---	---	---	0.016
0.47	69	1184.80	0.02 ic	---	---	---	0.00	---	---	---	---	---	0.017
0.54	79	1184.87	0.02 ic	---	---	---	0.00	---	---	---	---	---	0.018
0.60	89	1184.93	0.02 ic	---	---	---	0.00	---	---	---	---	---	0.020
0.67	99	1185.00	0.02 ic	---	---	---	0.00	---	---	---	---	---	0.021
0.77	155	1185.10	0.02 ic	---	---	---	0.00	---	---	---	---	---	0.022
0.87	211	1185.20	0.02 ic	---	---	---	0.00	---	---	---	---	---	0.024
0.97	267	1185.30	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.025
1.07	323	1185.40	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.027
1.17	379	1185.50	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.028
1.27	435	1185.60	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.029
1.37	491	1185.70	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.030
1.47	547	1185.80	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.031
1.57	603	1185.90	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.032
1.67	659	1186.00	0.03 ic	---	---	---	0.00	---	---	---	---	---	0.034
1.77	805	1186.10	0.03 ic	---	---	---	2.11	---	---	---	---	---	2.140
1.87	950	1186.20	0.04 ic	---	---	---	5.95	---	---	---	---	---	5.990
1.97	1,095	1186.30	0.04 ic	---	---	---	10.94	---	---	---	---	---	10.98
2.07	1,240	1186.40	0.04 ic	---	---	---	16.84	---	---	---	---	---	16.88
2.17	1,386	1186.50	0.04 ic	---	---	---	23.54	---	---	---	---	---	23.58
2.27	1,531	1186.60	0.04 ic	---	---	---	30.94	---	---	---	---	---	30.98
2.37	1,676	1186.70	0.04 ic	---	---	---	38.99	---	---	---	---	---	39.03
2.47	1,821	1186.80	0.04 ic	---	---	---	47.64	---	---	---	---	---	47.68
2.57	1,967	1186.90	0.04 ic	---	---	---	56.84	---	---	---	---	---	56.89
2.67	2,112	1187.00	0.04 ic	---	---	---	66.60	---	---	---	---	---	66.64

# Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	18.13	2	748	117,115	----	----	----	Pre-Developed
2	SCS Runoff	3.601	2	746	21,659	----	----	----	Post-Developed North
3	SCS Runoff	15.99	2	744	95,928	----	----	----	Post-Developed South
4	Reservoir	15.97	2	744	95,925	3	1186.39	1,218	WQ Pond
Offsite Watershed Model.gpw					Return Period: 2 Year		Wednesday, 08 / 29 / 2018		

# Hydrograph Report

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

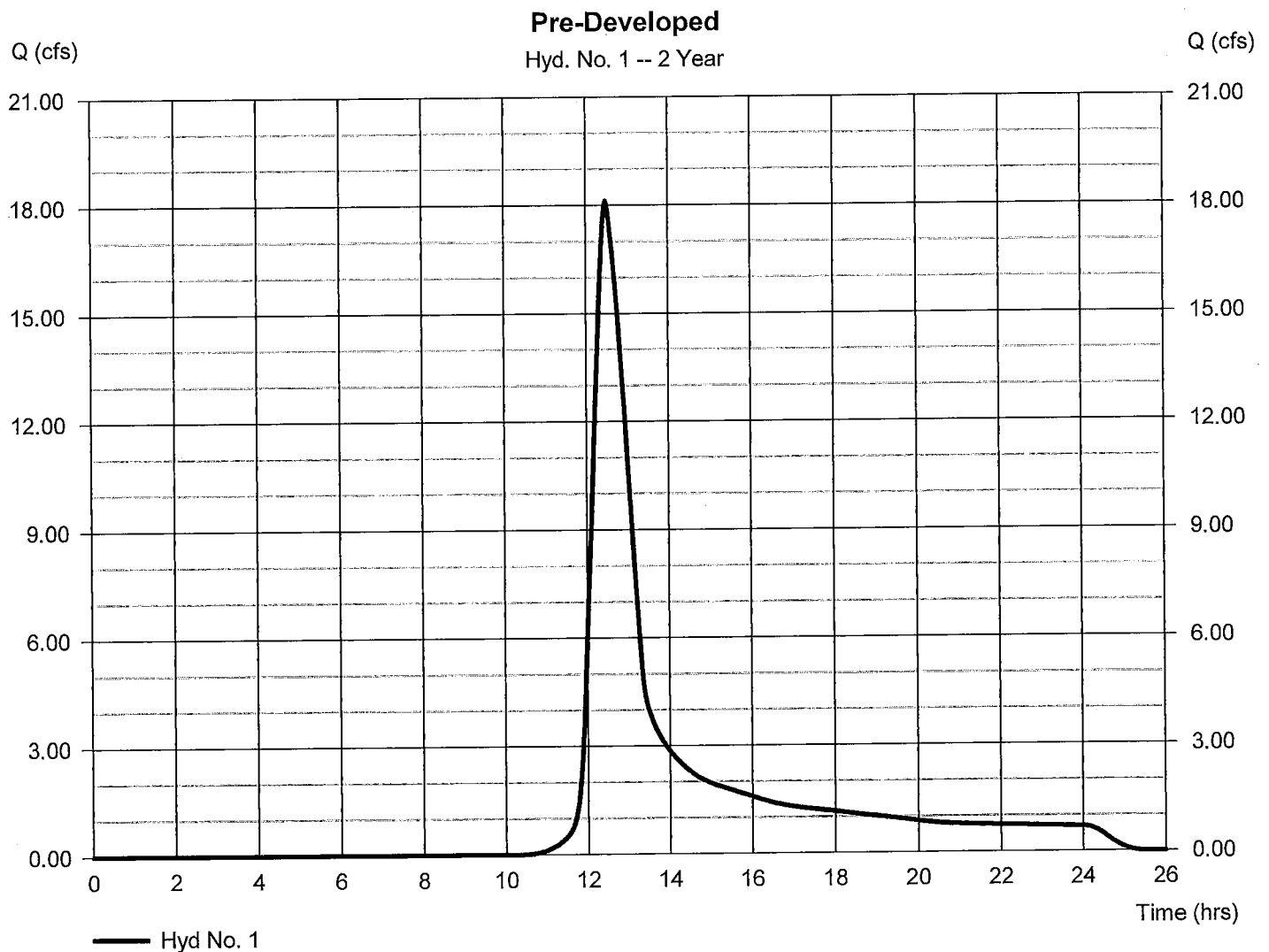
Wednesday, 08 / 29 / 2018

## Hyd. No. 1

Pre-Developed

Hydrograph type	= SCS Runoff	Peak discharge	= 18.13 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 117,115 cuft
Drainage area	= 34.230 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 55.90 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (32.650 x 80)] / 34.230



# Hydrograph Report

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

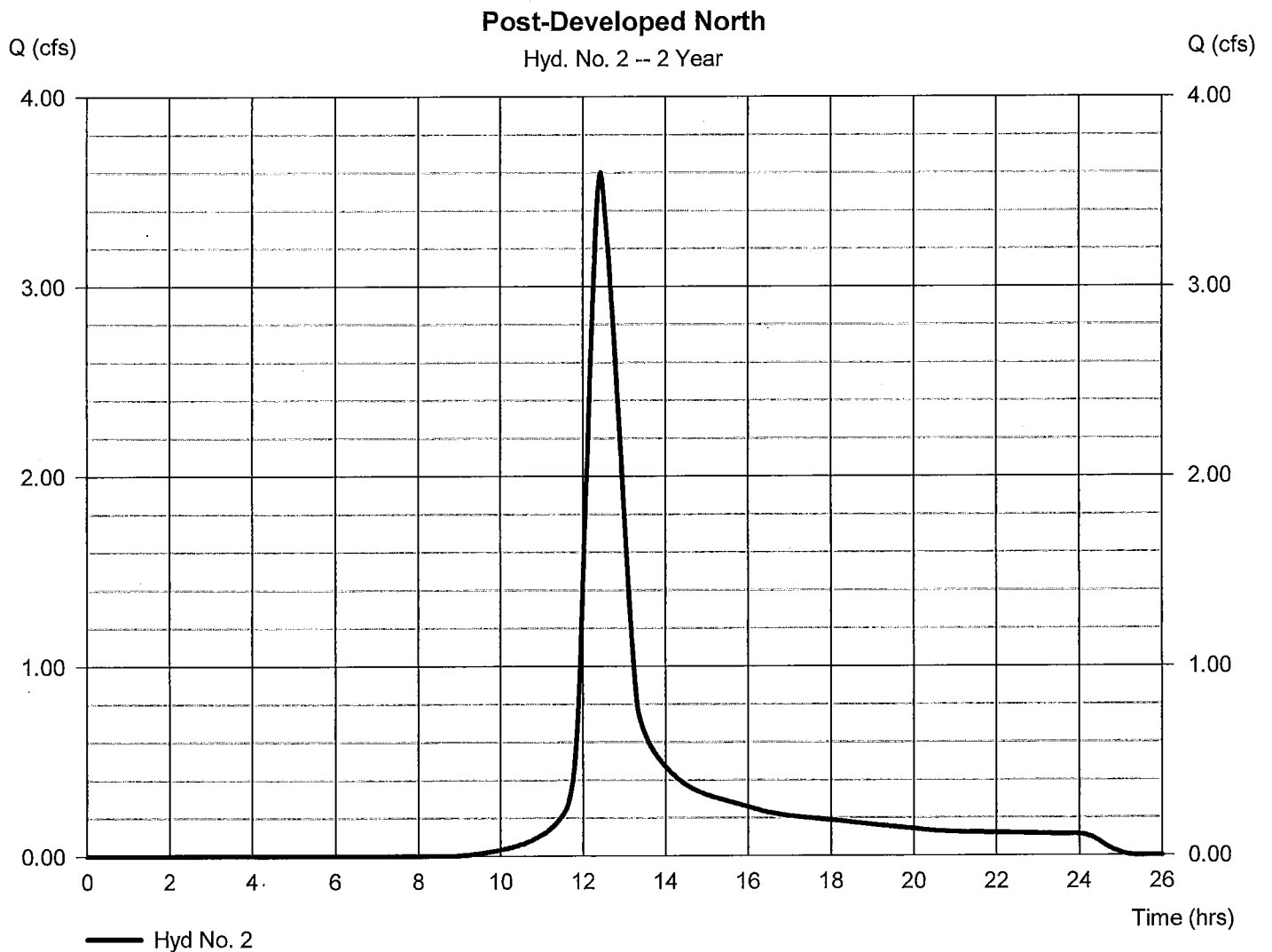
Wednesday, 08 / 29 / 2018

## Hyd. No. 2

Post-Developed North

Hydrograph type	= SCS Runoff	Peak discharge	= 3.601 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 21,659 cuft
Drainage area	= 4.730 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 54.10 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (3.150 x 80)] / 4.730



# Hydrograph Report

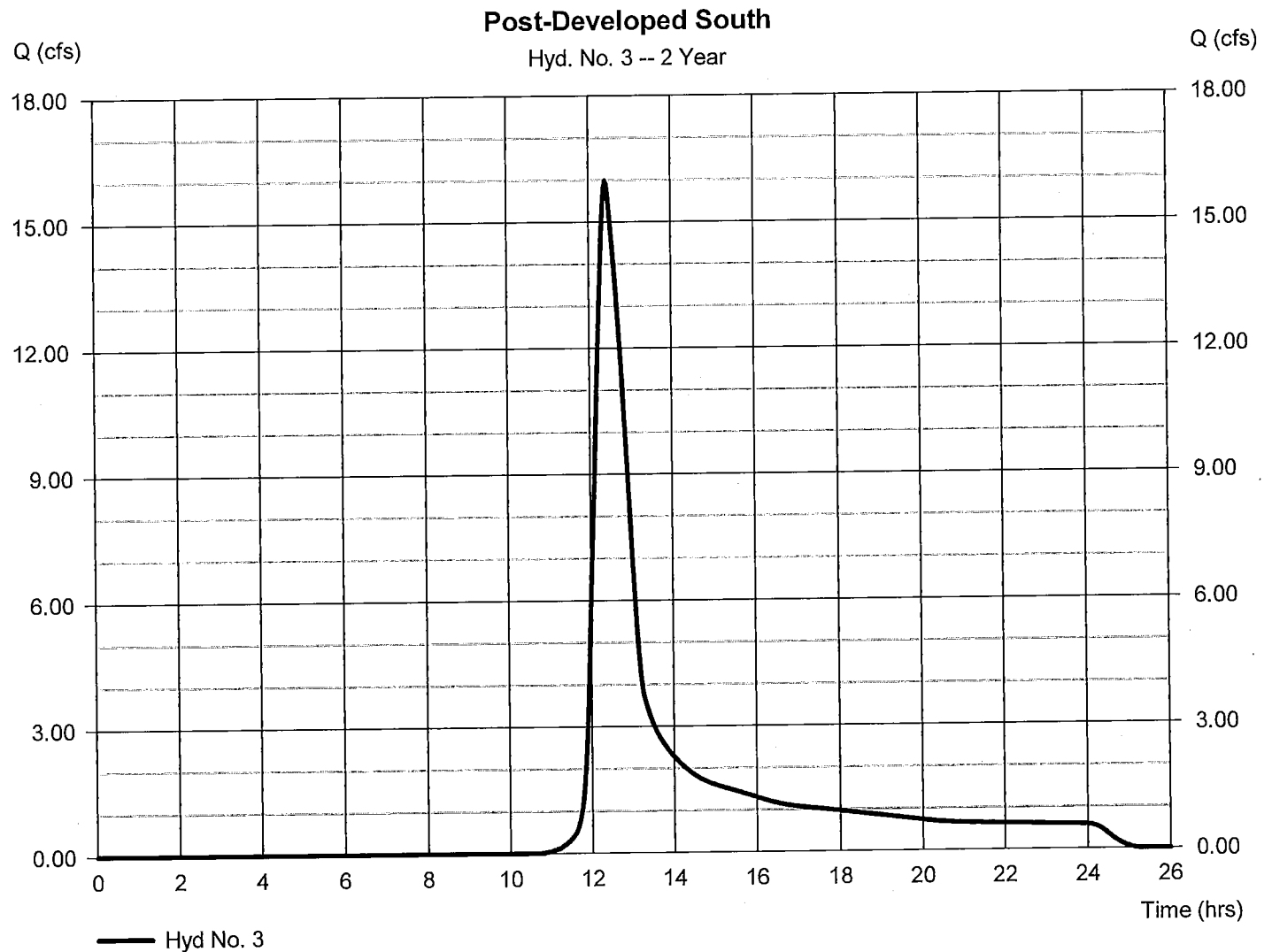
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Wednesday, 08 / 29 / 2018

## Hyd. No. 3

Post-Developed South

Hydrograph type	= SCS Runoff	Peak discharge	= 15.99 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 95,928 cuft
Drainage area	= 29.500 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.50 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484





# Hydrograph Report

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

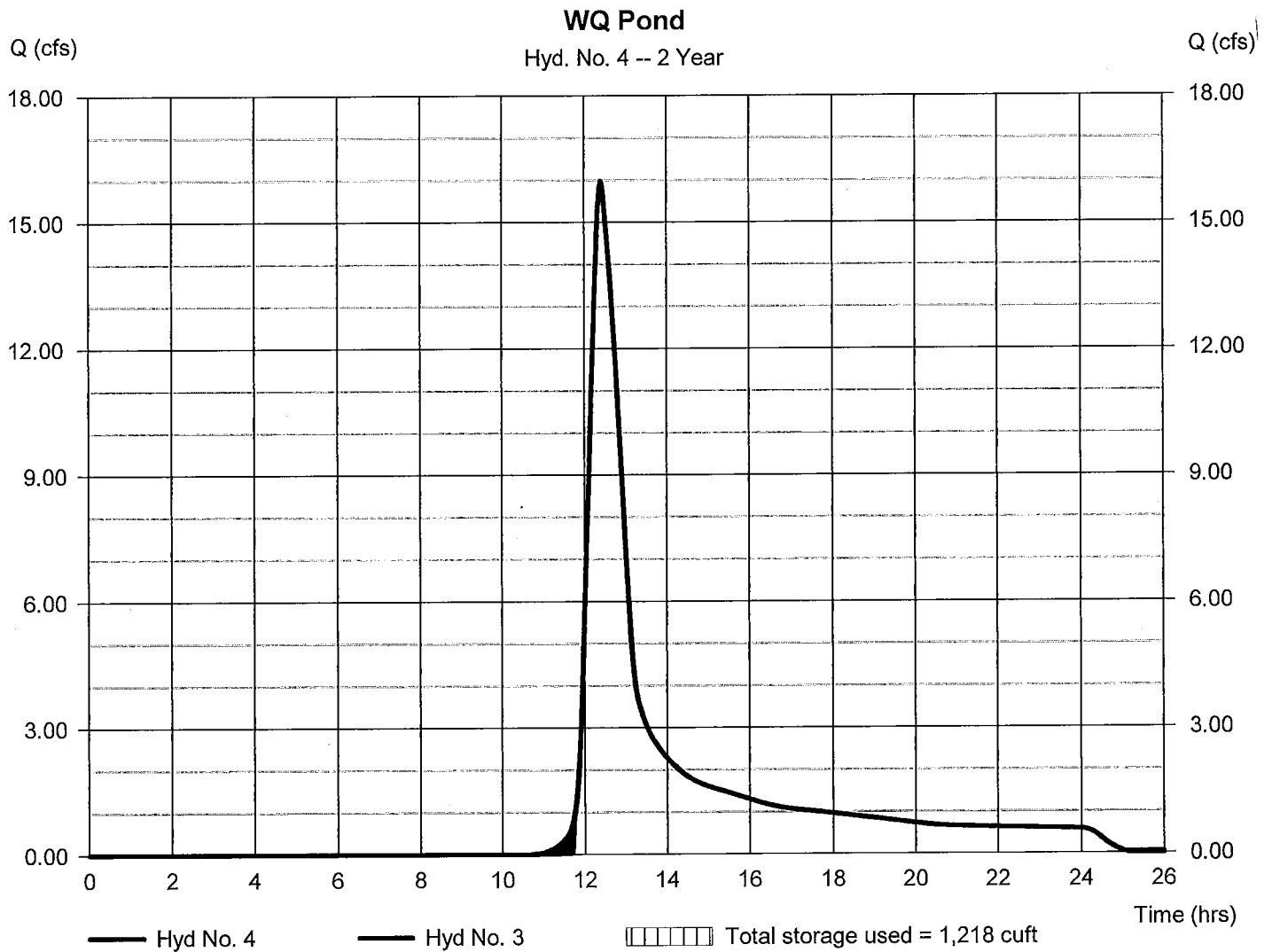
Wednesday, 08 / 29 / 2018

## Hyd. No. 4

WQ Pond

Hydrograph type	= Reservoir	Peak discharge	= 15.97 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 95,925 cuft
Inflow hyd. No.	= 3 - Post-Developed South	Max. Elevation	= 1186.39 ft
Reservoir name	= WQ Swale	Max. Storage	= 1,218 cuft

Storage Indication method used.



# Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	27.46	2	748	172,505	----	----	----	Pre-Developed
2	SCS Runoff	5.095	2	746	30,405	----	----	----	Post-Developed North
3	SCS Runoff	24.58	2	744	142,754	----	----	----	Post-Developed South
4	Reservoir	24.58	2	744	142,752	3	1186.51	1,405	WQ Pond

# Hydrograph Report

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

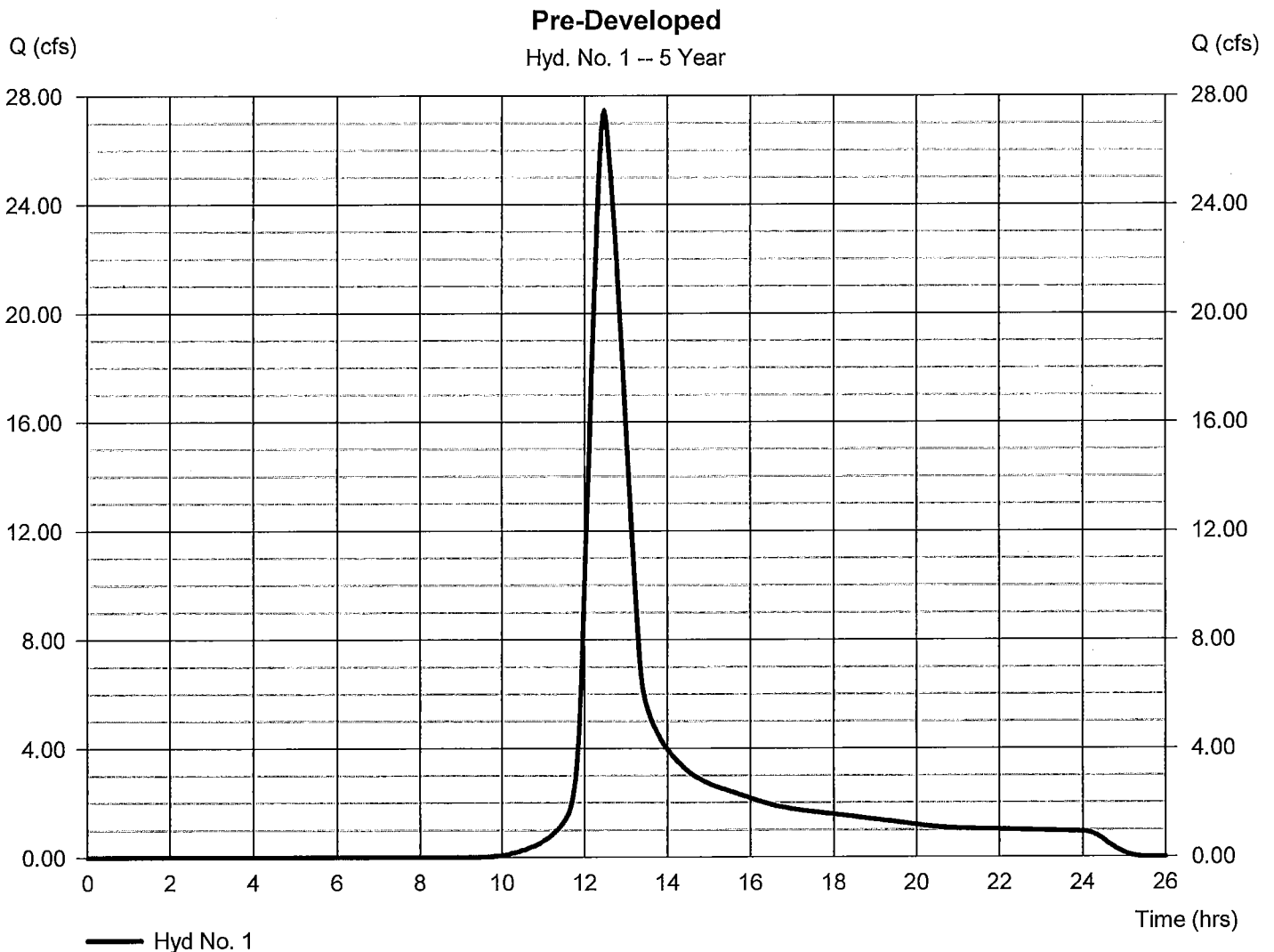
Wednesday, 08 / 29 / 2018

## Hyd. No. 1

Pre-Developed

Hydrograph type	= SCS Runoff	Peak discharge	= 27.46 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 172,505 cuft
Drainage area	= 34.230 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 55.90 min
Total precip.	= 3.11 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (32.650 x 80)] / 34.230



# Hydrograph Report

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

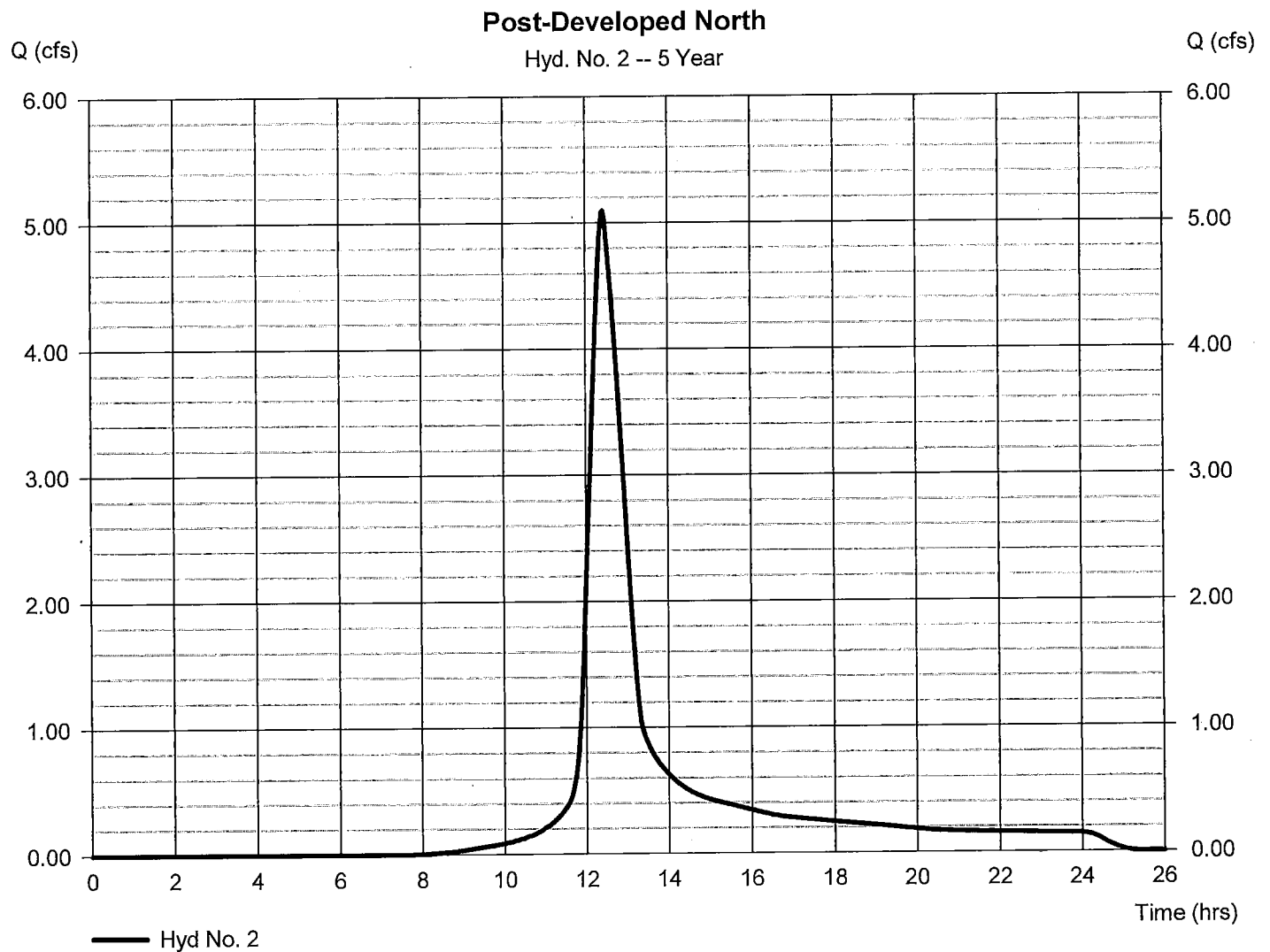
Wednesday, 08 / 29 / 2018

## Hyd. No. 2

Post-Developed North

Hydrograph type	= SCS Runoff	Peak discharge	= 5.095 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 30,405 cuft
Drainage area	= 4.730 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 54.10 min
Total precip.	= 3.11 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (3.150 x 80)] / 4.730



# Hydrograph Report

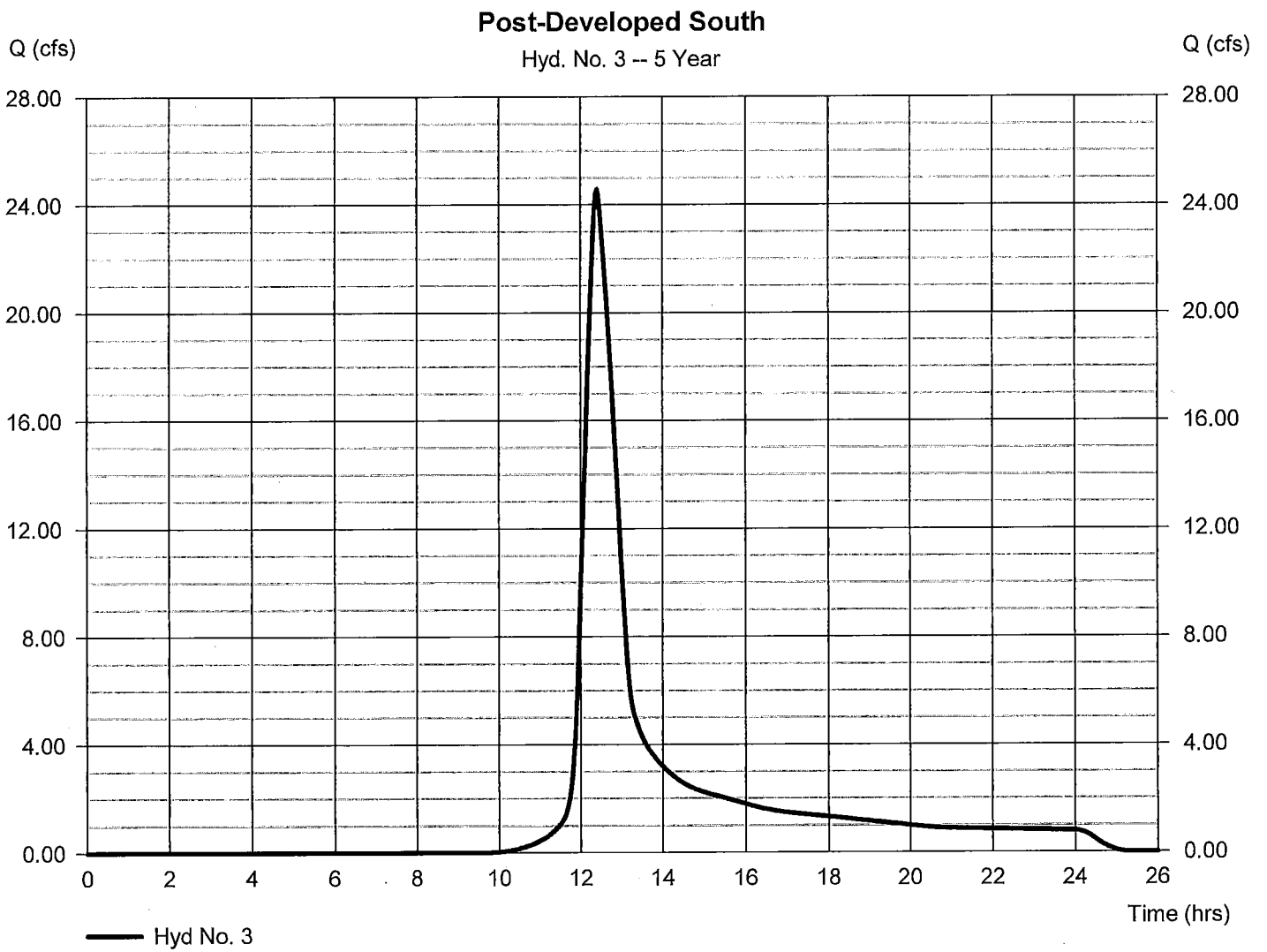
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Wednesday, 08 / 29 / 2018

## Hyd. No. 3

Post-Developed South

Hydrograph type	= SCS Runoff	Peak discharge	= 24.58 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 142,754 cuft
Drainage area	= 29.500 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.50 min
Total precip.	= 3.11 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

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

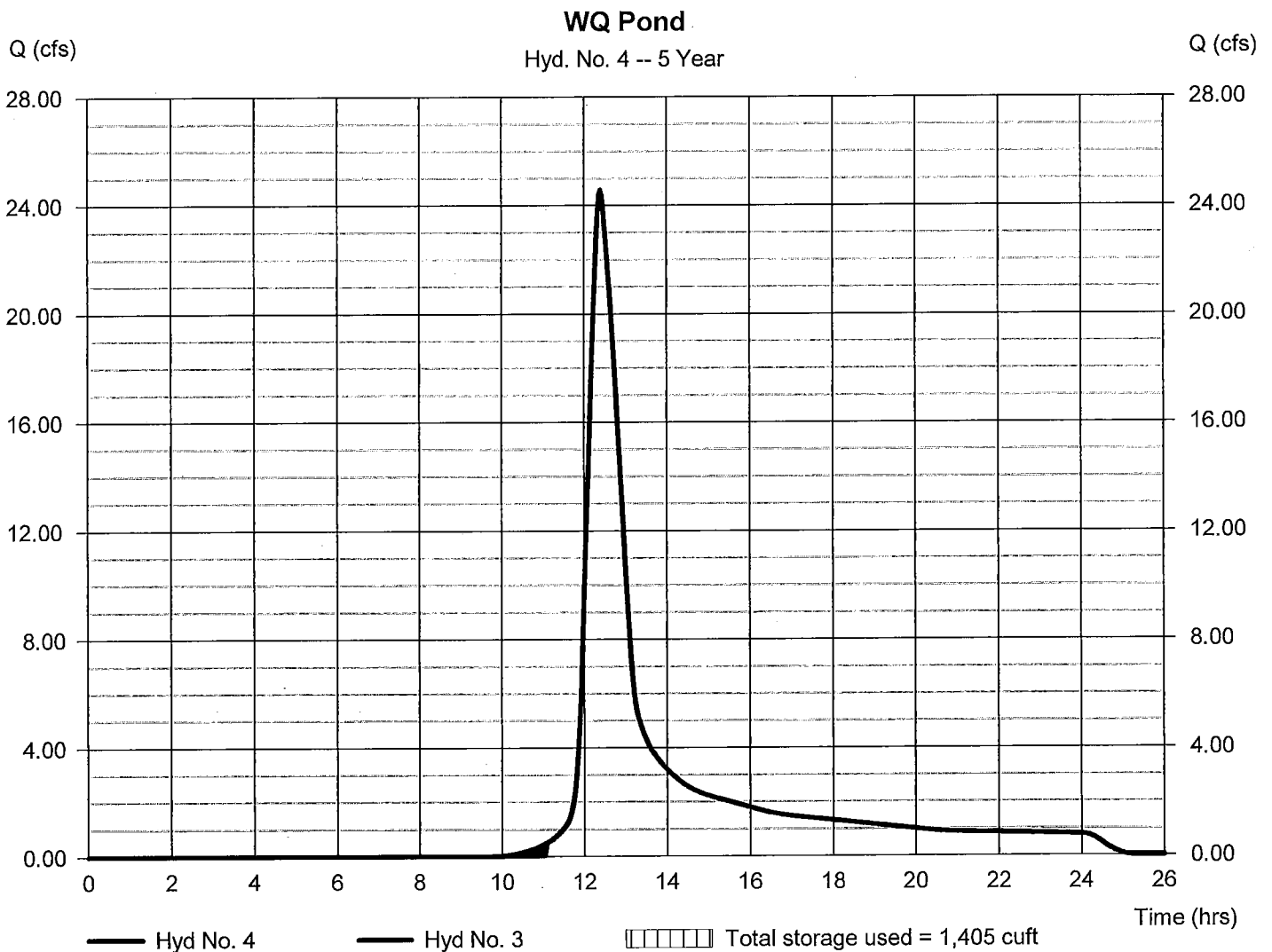
Wednesday, 08 / 29 / 2018

## Hyd. No. 4

WQ Pond

Hydrograph type	= Reservoir	Peak discharge	= 24.58 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 142,752 cuft
Inflow hyd. No.	= 3 - Post-Developed South	Max. Elevation	= 1186.51 ft
Reservoir name	= WQ Swale	Max. Storage	= 1,405 cuft

Storage Indication method used.



# Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	35.37	2	748	219,758	----	----	----	Pre-Developed
2	SCS Runoff	6.325	2	746	37,692	----	----	----	Post-Developed North
3	SCS Runoff	31.90	2	744	182,908	----	----	----	Post-Developed South
4	Reservoir	31.90	2	744	182,906	3	1186.61	1,547	WQ Pond

# Hydrograph Report

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

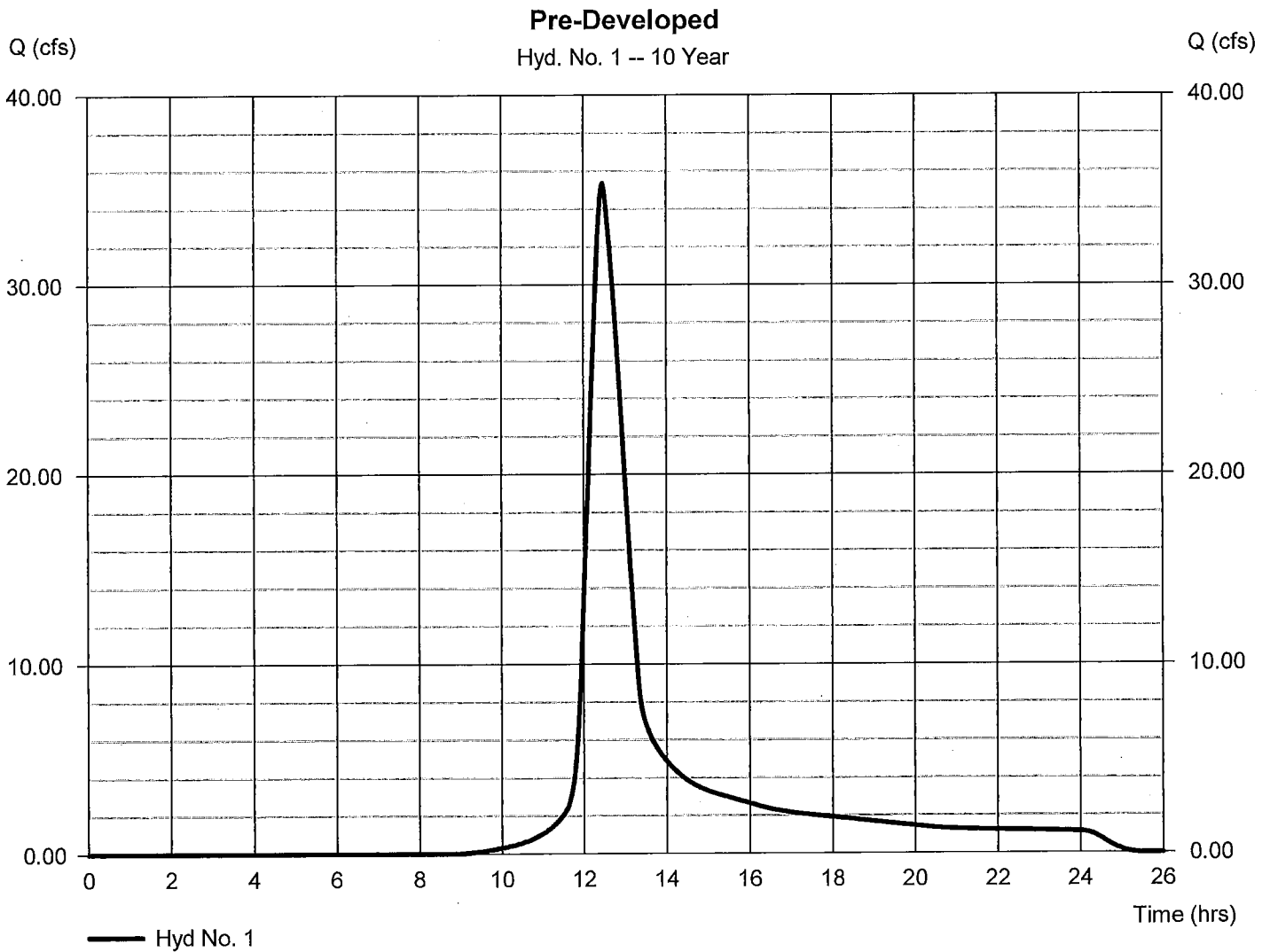
Wednesday, 08 / 29 / 2018

## Hyd. No. 1

Pre-Developed

Hydrograph type	= SCS Runoff	Peak discharge	= 35.37 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 219,758 cuft
Drainage area	= 34.230 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 55.90 min
Total precip.	= 3.59 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (32.650 x 80)] / 34.230





# Hydrograph Report

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

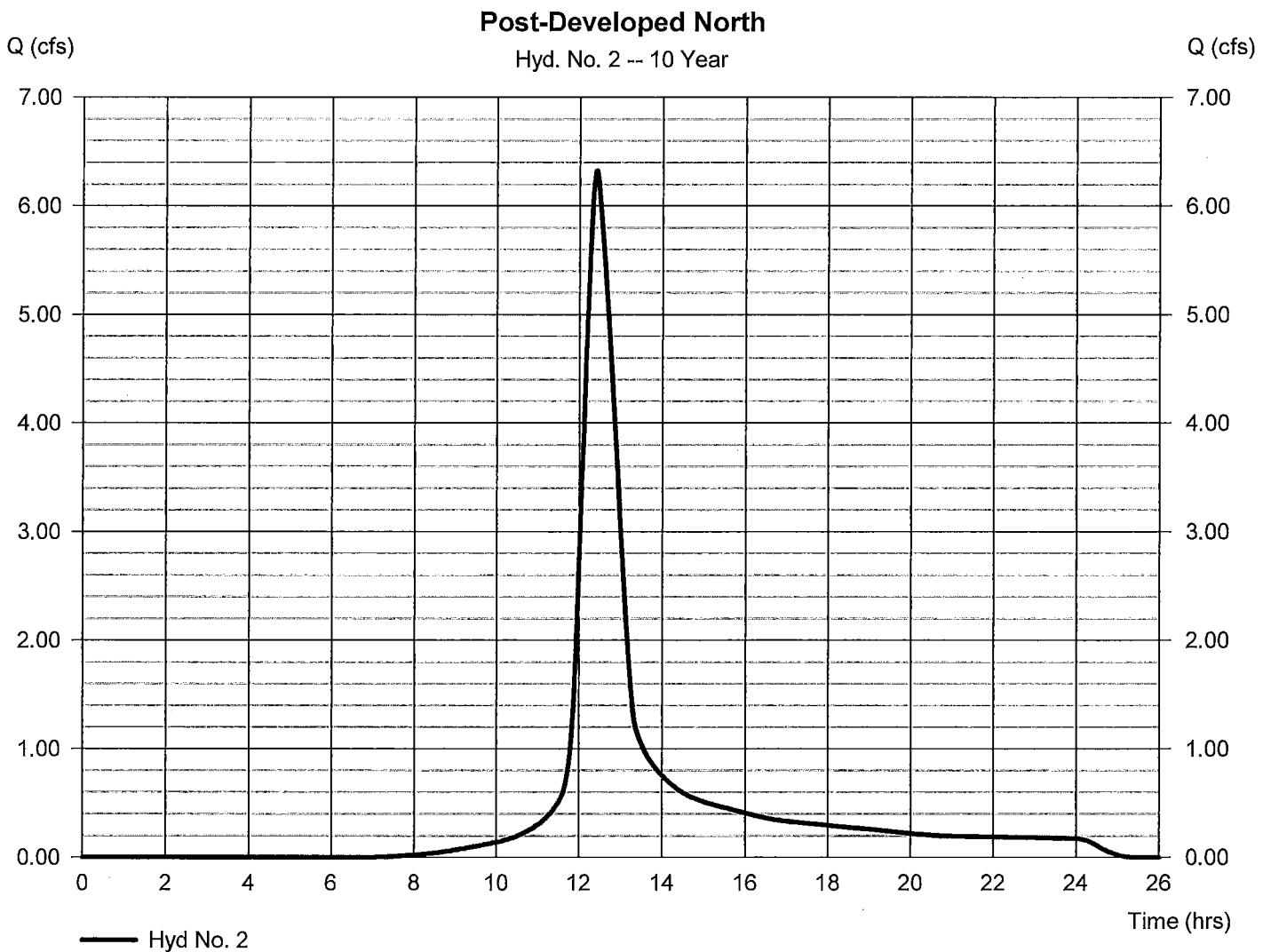
Wednesday, 08 / 29 / 2018

## Hyd. No. 2

Post-Developed North

Hydrograph type	= SCS Runoff	Peak discharge	= 6.325 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 37,692 cuft
Drainage area	= 4.730 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 54.10 min
Total precip.	= 3.59 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (3.150 x 80)] / 4.730



# Hydrograph Report

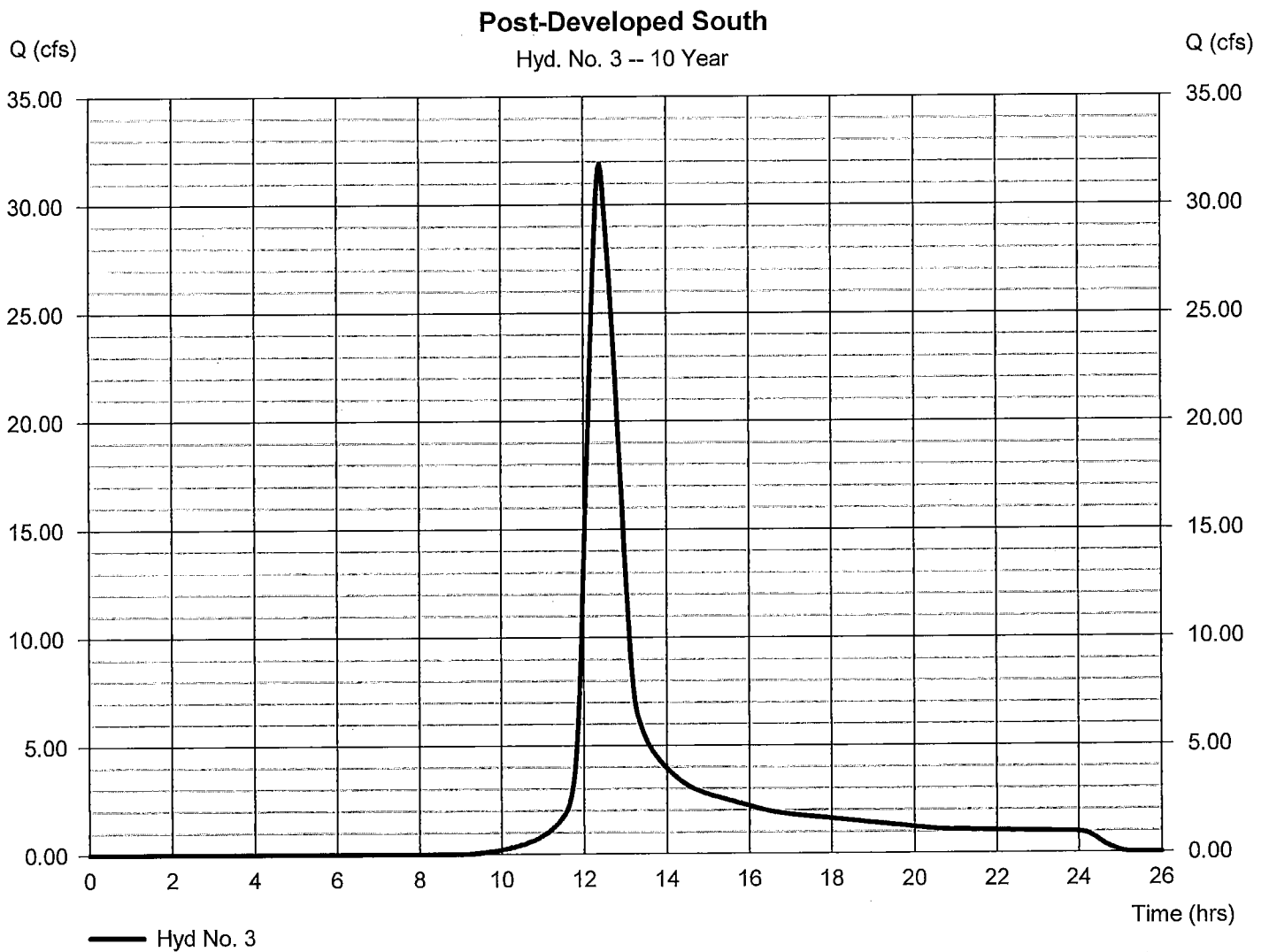
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Wednesday, 08 / 29 / 2018

## Hyd. No. 3

Post-Developed South

Hydrograph type	= SCS Runoff	Peak discharge	= 31.90 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 182,908 cuft
Drainage area	= 29.500 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.50 min
Total precip.	= 3.59 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

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

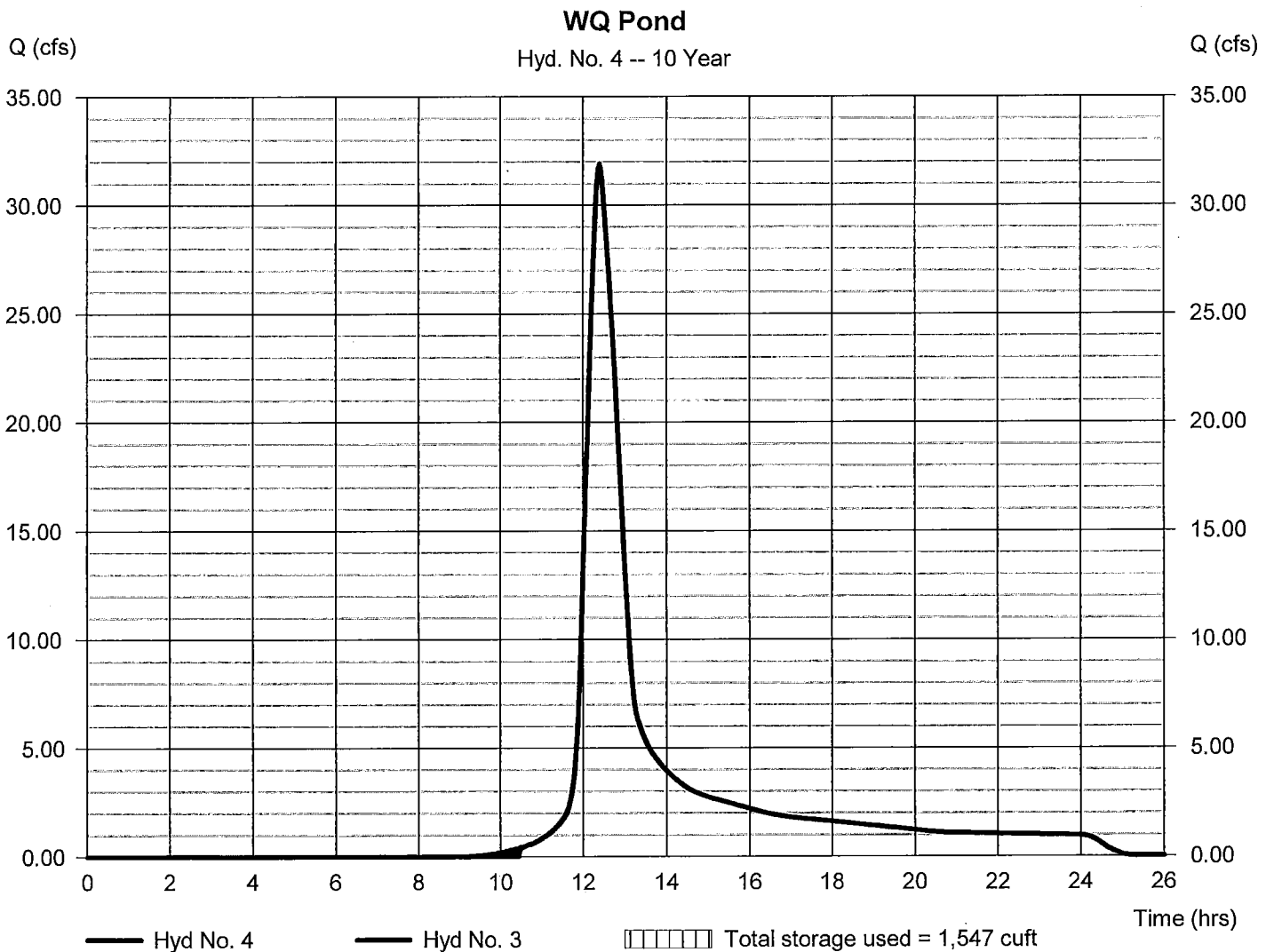
Wednesday, 08 / 29 / 2018

## Hyd. No. 4

WQ Pond

Hydrograph type	= Reservoir	Peak discharge	= 31.90 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 182,906 cuft
Inflow hyd. No.	= 3 - Post-Developed South	Max. Elevation	= 1186.61 ft
Reservoir name	= WQ Swale	Max. Storage	= 1,547 cuft

Storage Indication method used.



# Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	47.17	2	748	290,950	----	----	----	Pre-Developed
2	SCS Runoff	8.125	2	744	48,473	----	----	----	Post-Developed North
3	SCS Runoff	42.87	2	744	243,642	----	----	----	Post-Developed South
4	Reservoir	42.89	2	744	243,640	3	1186.75	1,741	WQ Pond
Offsite Watershed Model.gpw					Return Period: 25 Year		Wednesday, 08 / 29 / 2018		

# Hydrograph Report

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

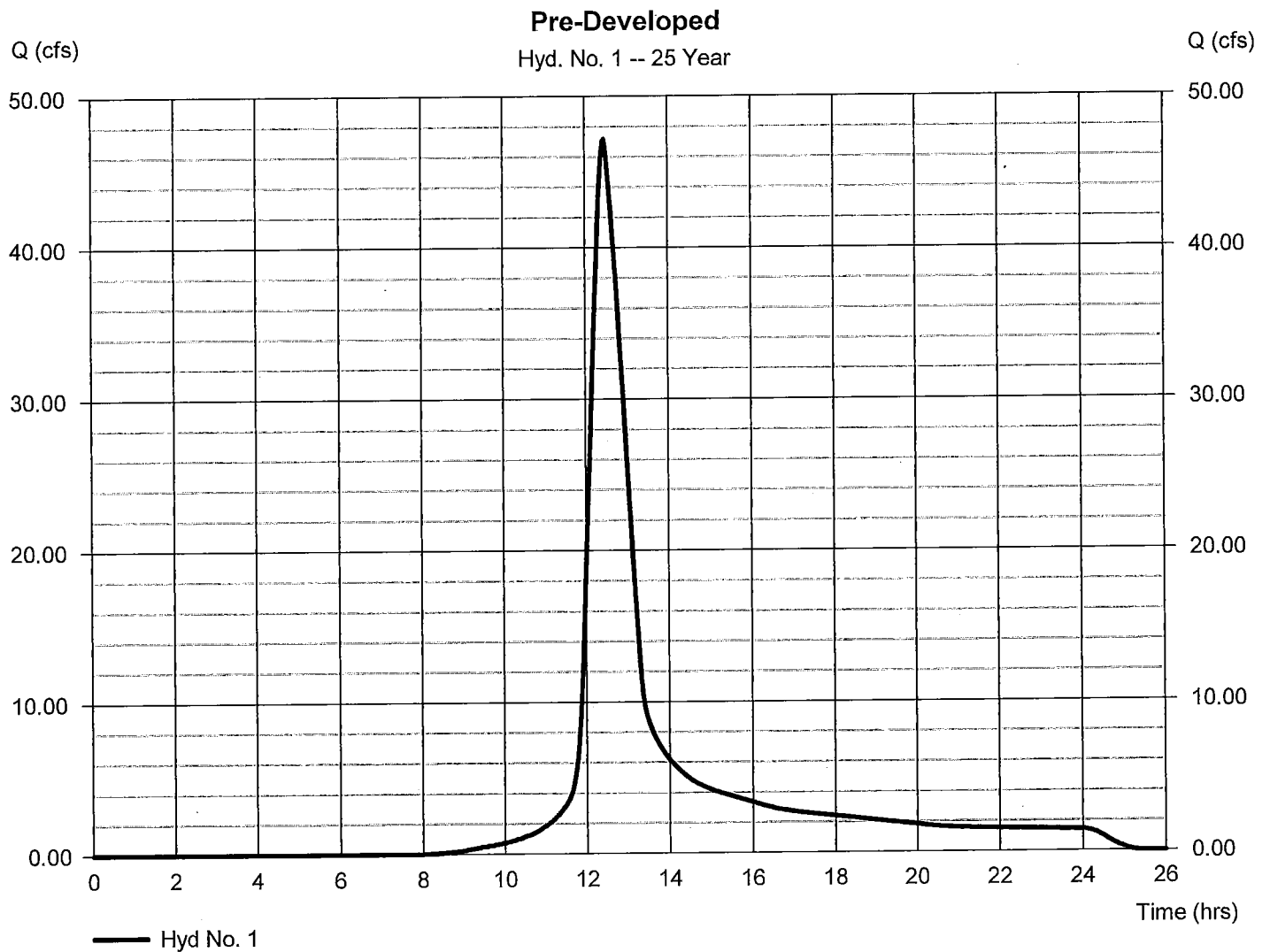
Wednesday, 08 / 29 / 2018

## Hyd. No. 1

Pre-Developed

Hydrograph type	= SCS Runoff	Peak discharge	= 47.17 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 290,950 cuft
Drainage area	= 34.230 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 55.90 min
Total precip.	= 4.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (32.650 x 80)] / 34.230



# Hydrograph Report

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

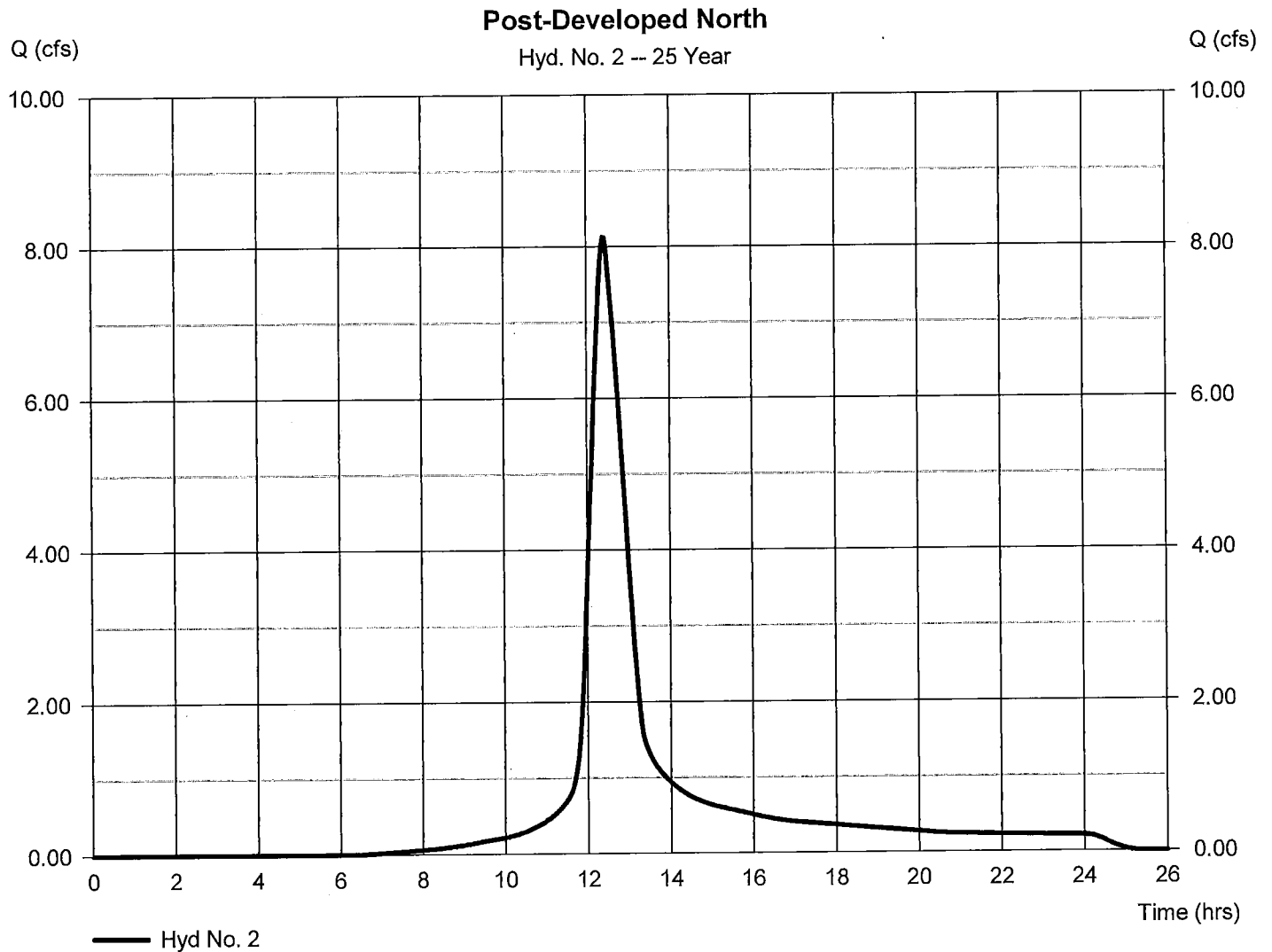
Wednesday, 08 / 29 / 2018

## Hyd. No. 2

### Post-Developed North

Hydrograph type	= SCS Runoff	Peak discharge	= 8.125 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 48,473 cuft
Drainage area	= 4.730 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 54.10 min
Total precip.	= 4.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (3.150 x 80)] / 4.730



# Hydrograph Report

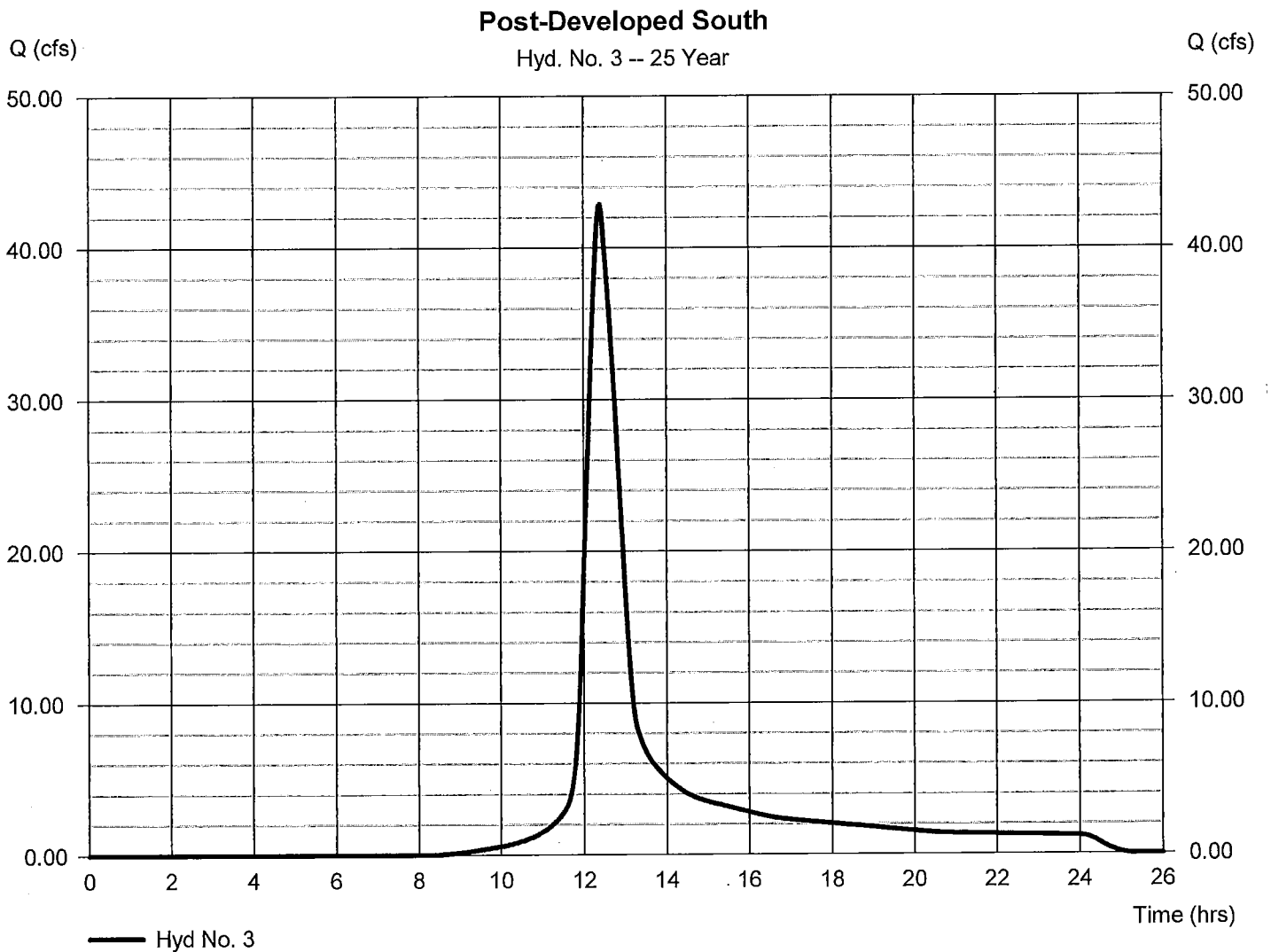
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Wednesday, 08 / 29 / 2018

## Hyd. No. 3

Post-Developed South

Hydrograph type	= SCS Runoff	Peak discharge	= 42.87 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 243,642 cuft
Drainage area	= 29.500 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.50 min
Total precip.	= 4.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

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

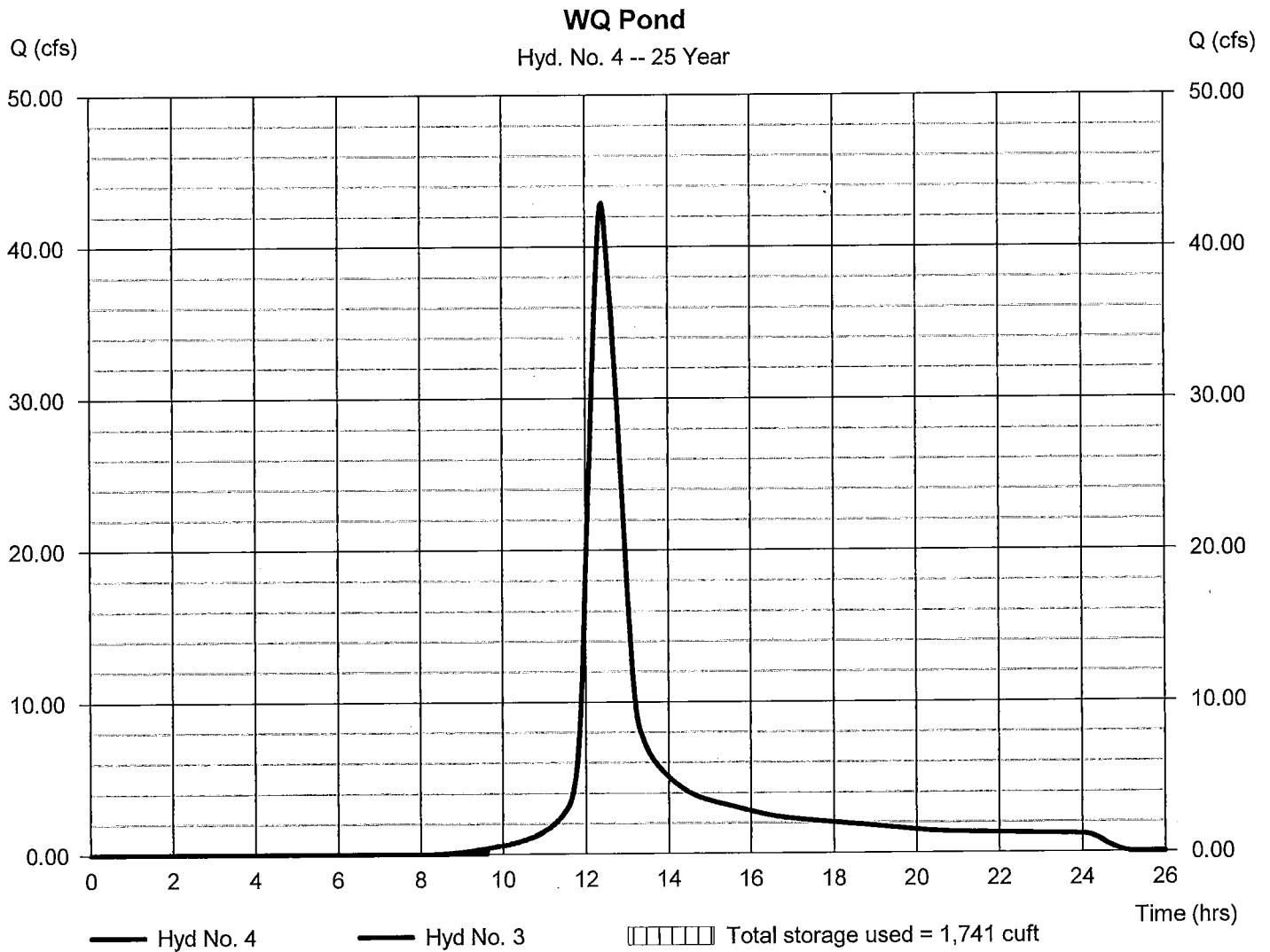
Wednesday, 08 / 29 / 2018

## Hyd. No. 4

WQ Pond

Hydrograph type	= Reservoir	Peak discharge	= 42.89 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 243,640 cuft
Inflow hyd. No.	= 3 - Post-Developed South	Max. Elevation	= 1186.75 ft
Reservoir name	= WQ Swale	Max. Storage	= 1,741 cuft

Storage Indication method used.





# Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	57.00	2	748	350,830	----	----	----	Pre-Developed
2	SCS Runoff	9.605	2	744	57,414	----	----	----	Post-Developed North
3	SCS Runoff	52.04	2	744	294,884	----	----	----	Post-Developed South
4	Reservoir	52.07	2	744	294,882	3	1186.85	1,891	WQ Pond
Offsite Watershed Model.gpw					Return Period: 50 Year		Wednesday, 08 / 29 / 2018		

# Hydrograph Report

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

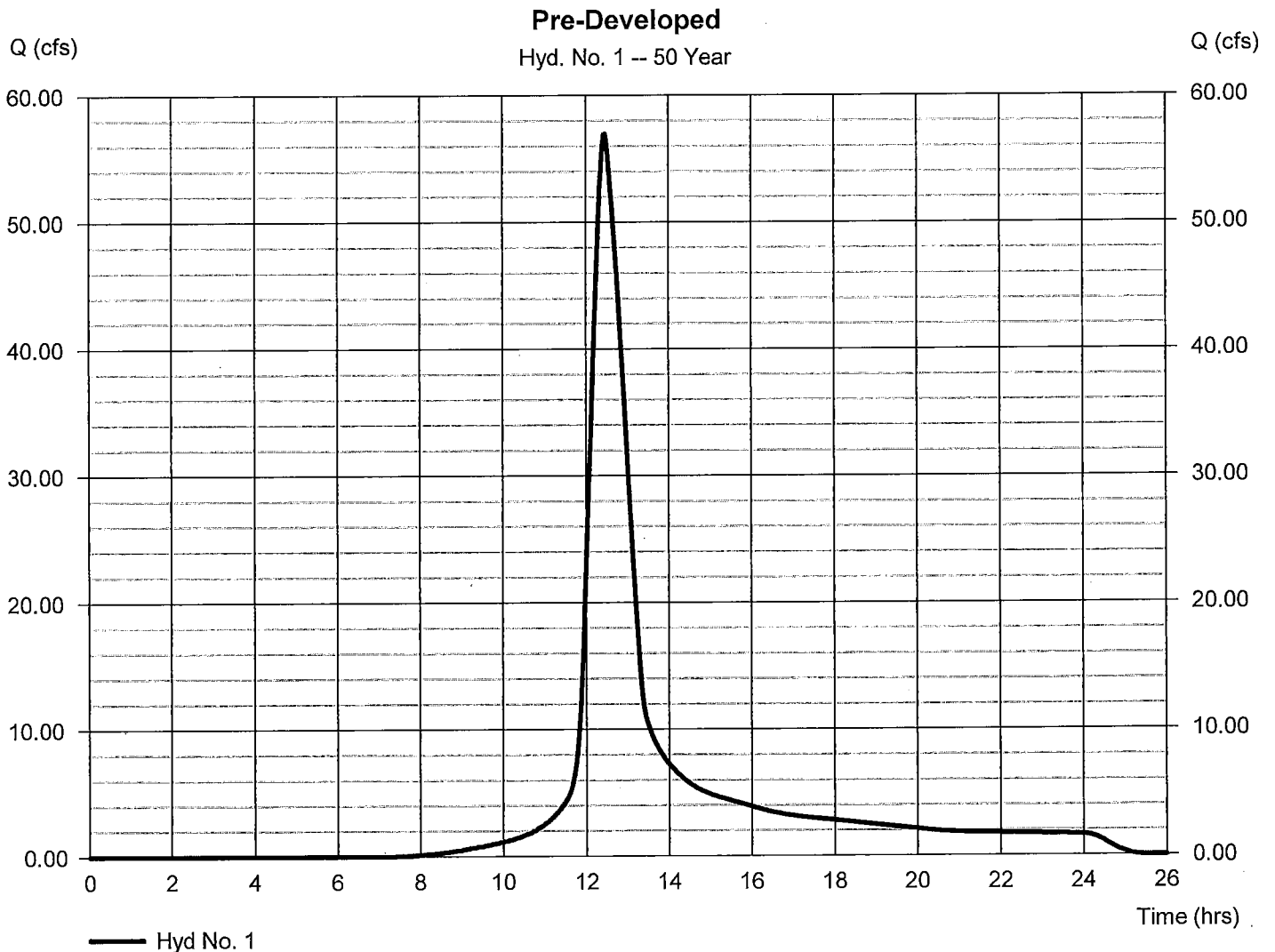
Wednesday, 08 / 29 / 2018

## Hyd. No. 1

Pre-Developed

Hydrograph type	= SCS Runoff	Peak discharge	= 57.00 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 350,830 cuft
Drainage area	= 34.230 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 55.90 min
Total precip.	= 4.84 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (32.650 x 80)] / 34.230



# Hydrograph Report

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

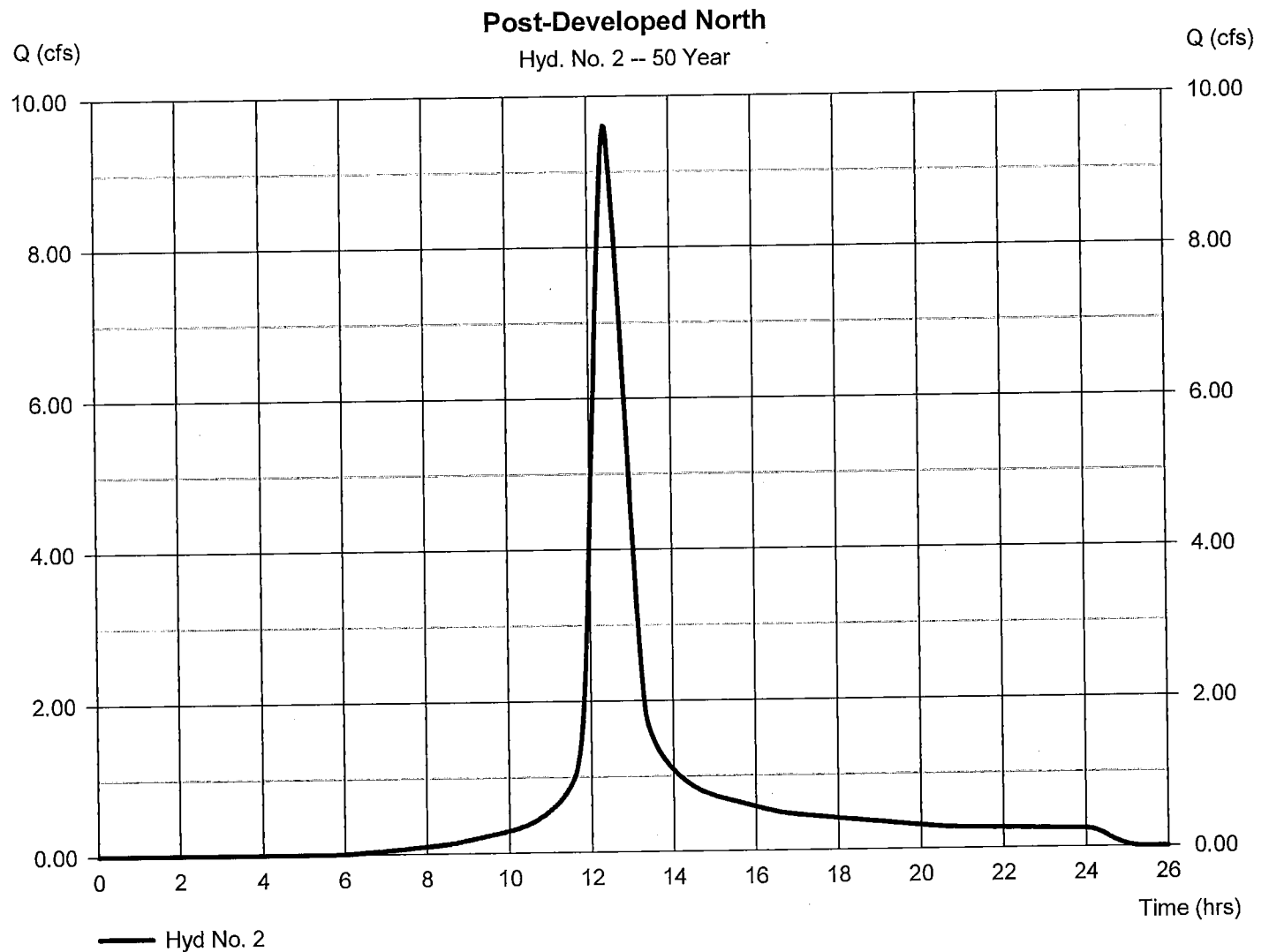
Wednesday, 08 / 29 / 2018

## Hyd. No. 2

Post-Developed North

Hydrograph type	= SCS Runoff	Peak discharge	= 9.605 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 57,414 cuft
Drainage area	= 4.730 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 54.10 min
Total precip.	= 4.84 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (3.150 x 80)] / 4.730



# Hydrograph Report

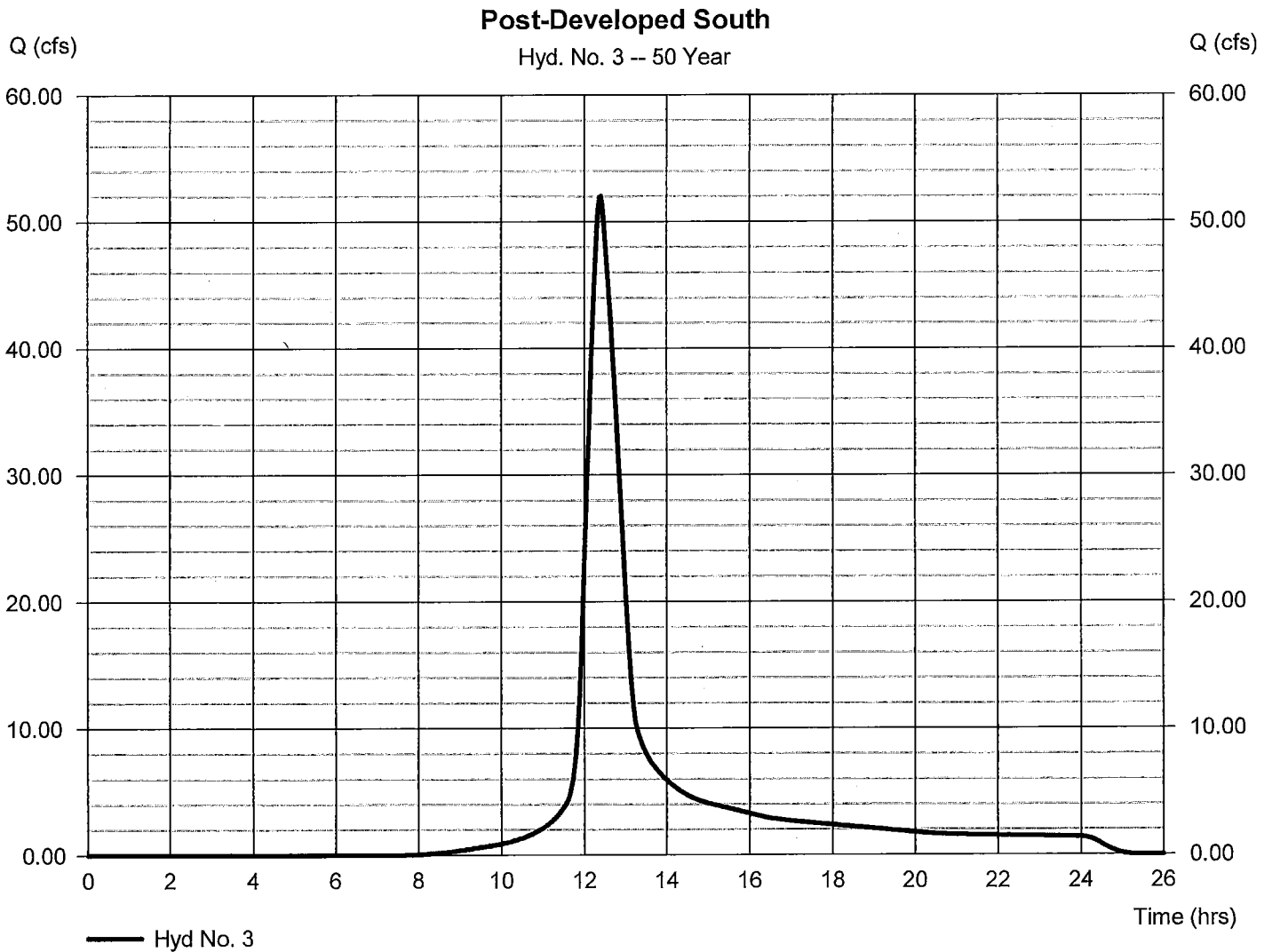
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Wednesday, 08 / 29 / 2018

## Hyd. No. 3

Post-Developed South

Hydrograph type	= SCS Runoff	Peak discharge	= 52.04 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 294,884 cuft
Drainage area	= 29.500 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.50 min
Total precip.	= 4.84 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

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

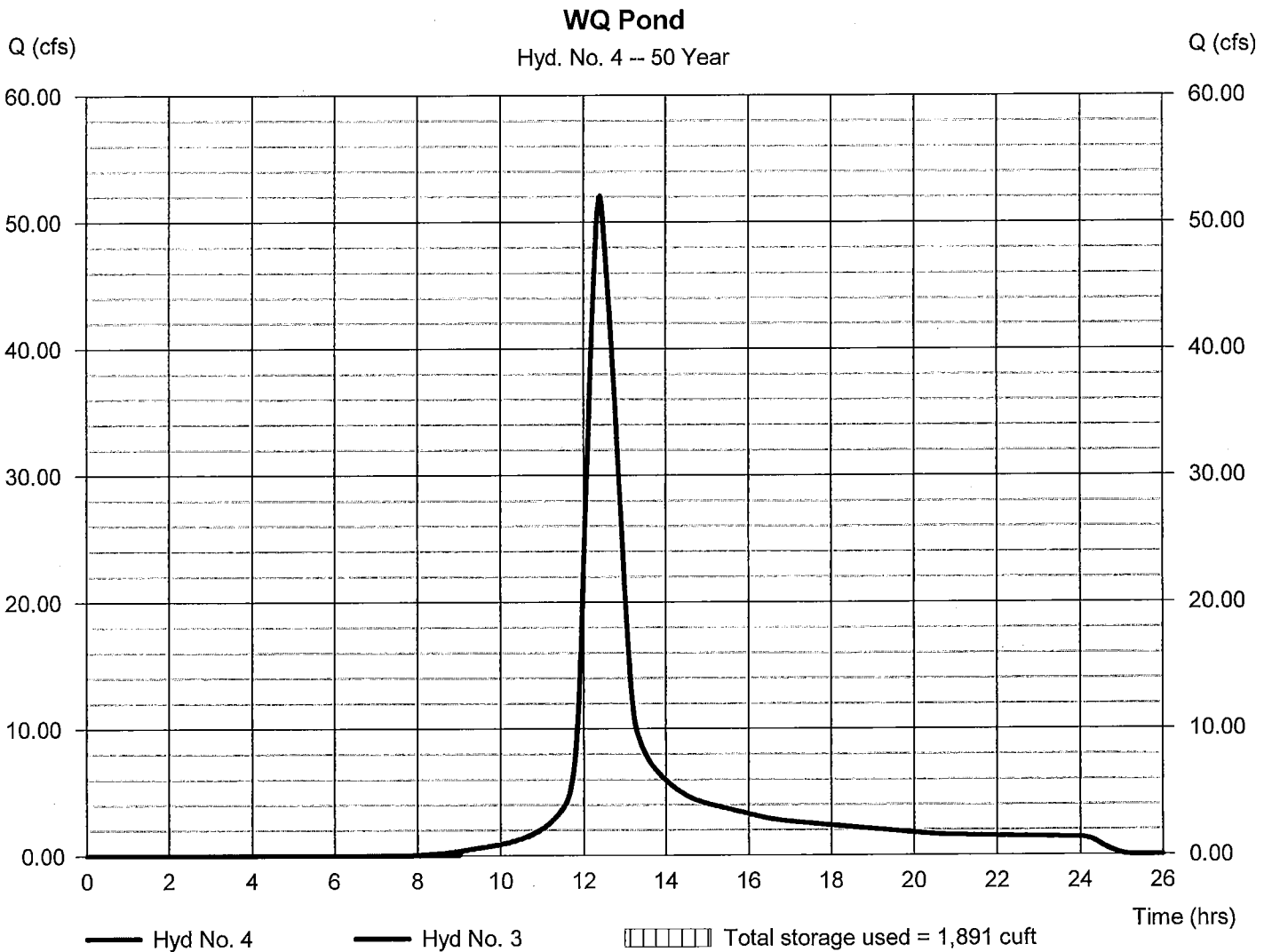
Wednesday, 08 / 29 / 2018

## Hyd. No. 4

WQ Pond

Hydrograph type	= Reservoir	Peak discharge	= 52.07 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 294,882 cuft
Inflow hyd. No.	= 3 - Post-Developed South	Max. Elevation	= 1186.85 ft
Reservoir name	= WQ Swale	Max. Storage	= 1,891 cuft

Storage Indication method used.



# Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	67.34	2	748	414,337	----	----	----	Pre-Developed	
2	SCS Runoff	11.14	2	744	66,806	----	----	----	Post-Developed North	
3	SCS Runoff	61.70	2	744	349,345	----	----	----	Post-Developed South	
4	Reservoir	61.75	2	744	349,343	3	1186.95	2,039	WQ Pond	
Offsite Watershed Model.gpw					Return Period: 100 Year			Wednesday, 08 / 29 / 2018		

# Hydrograph Report

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

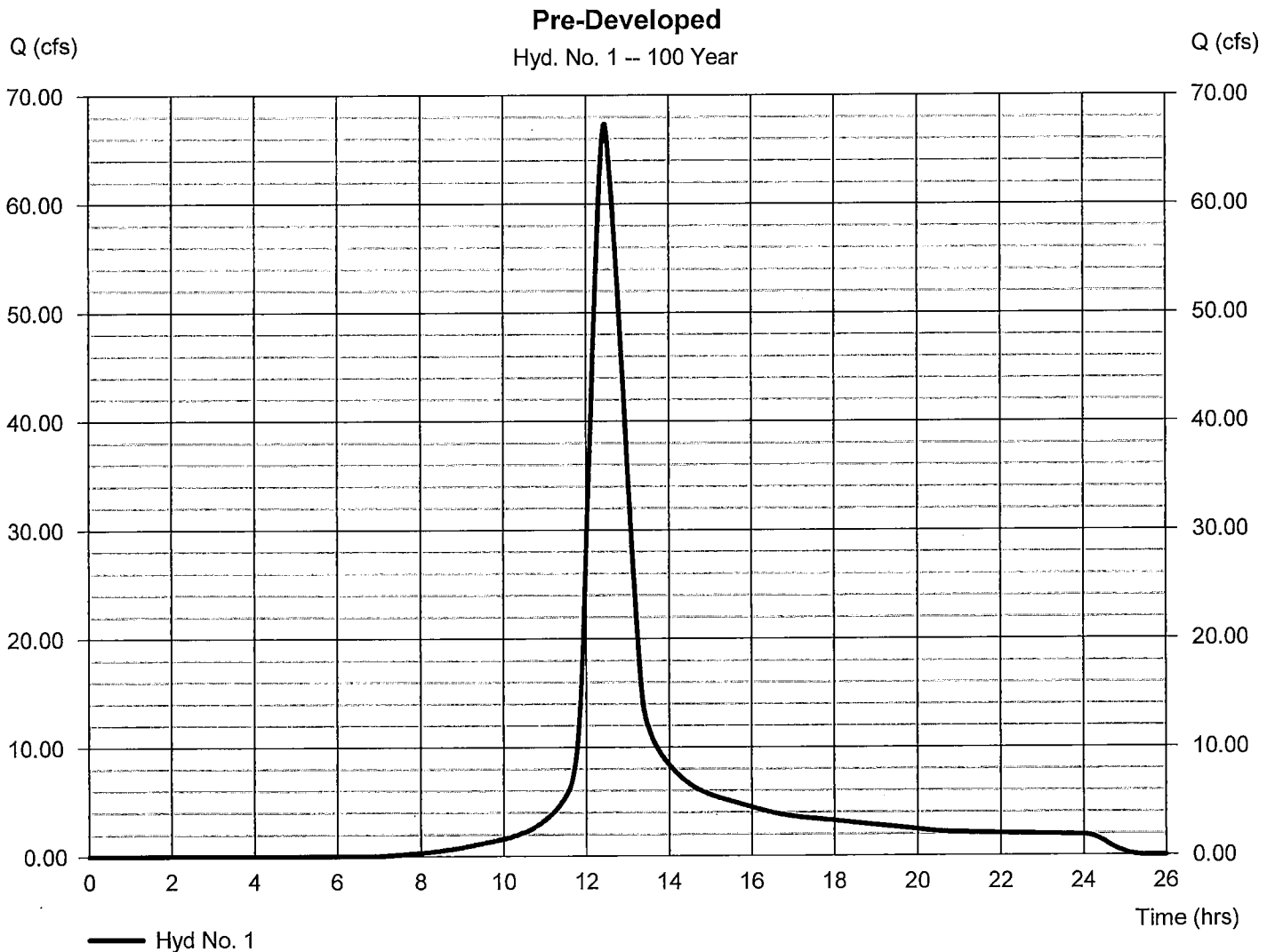
Wednesday, 08 / 29 / 2018

## Hyd. No. 1

Pre-Developed

Hydrograph type	= SCS Runoff	Peak discharge	= 67.34 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 414,337 cuft
Drainage area	= 34.230 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 55.90 min
Total precip.	= 5.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (32.650 x 80)] / 34.230



# Hydrograph Report

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

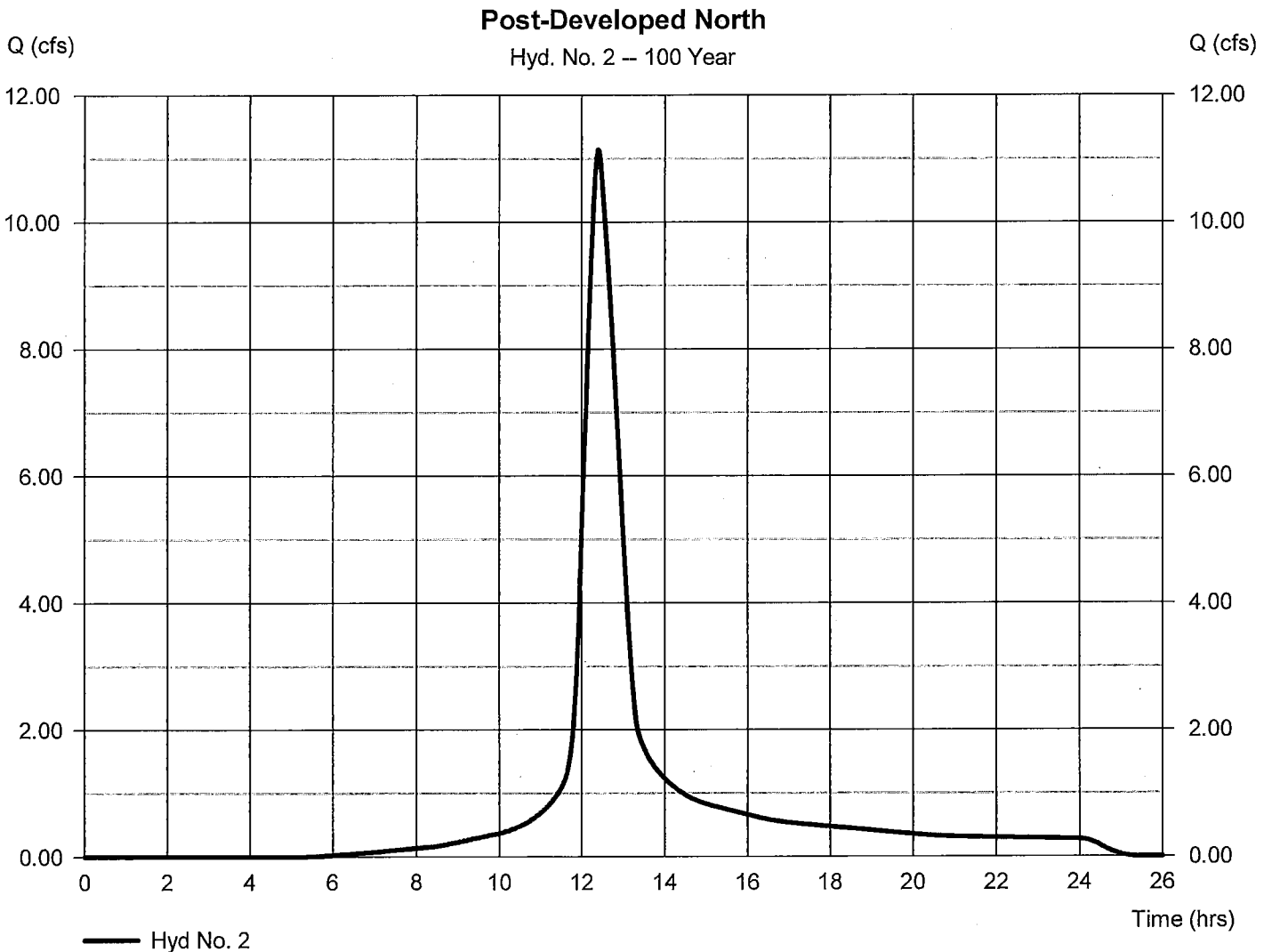
Wednesday, 08 / 29 / 2018

## Hyd. No. 2

Post-Developed North

Hydrograph type	= SCS Runoff	Peak discharge	= 11.14 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 66,806 cuft
Drainage area	= 4.730 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 54.10 min
Total precip.	= 5.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(1.580 x 98) + (3.150 x 80)] / 4.730





# Hydrograph Report

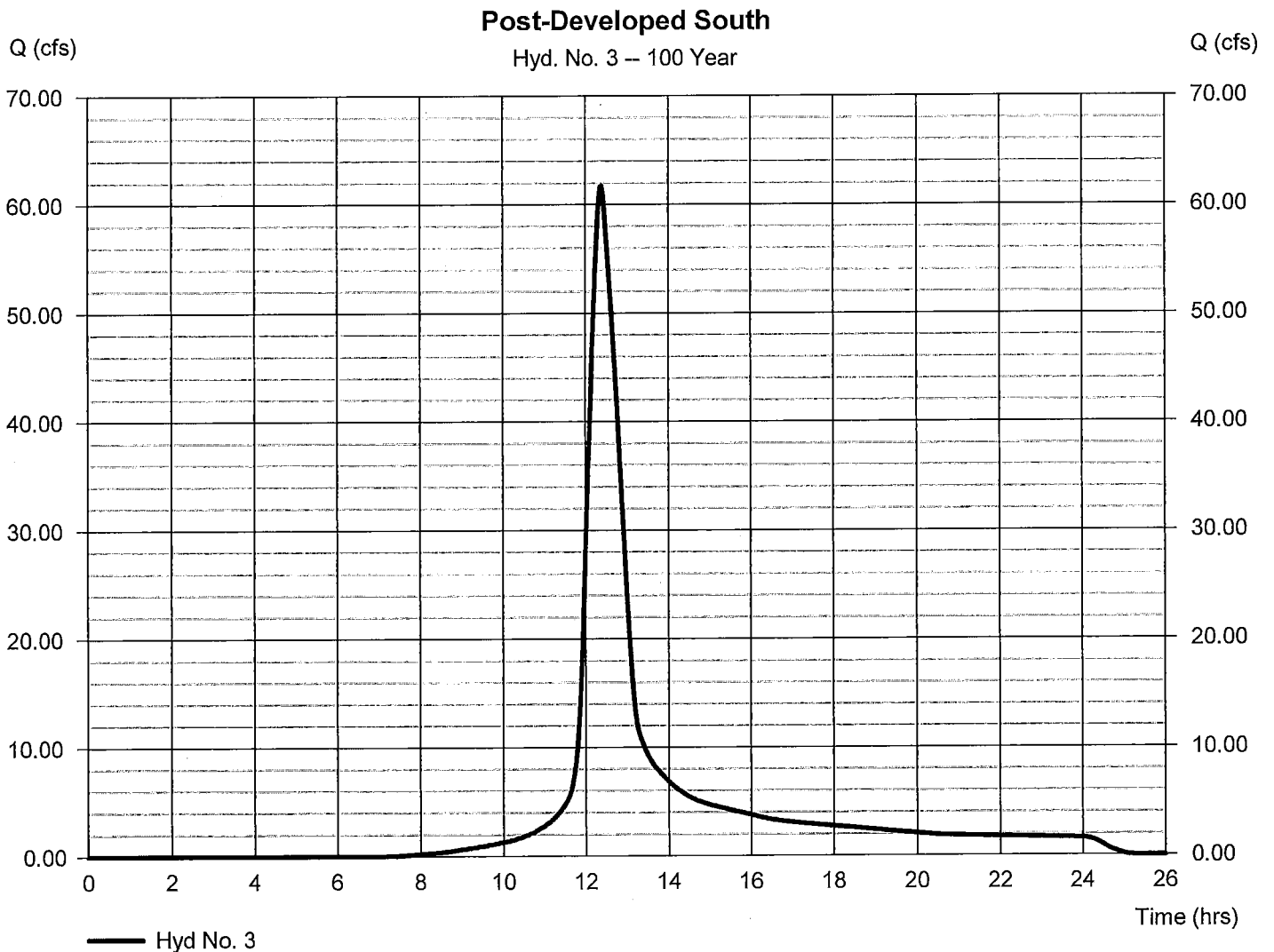
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514

Wednesday, 08 / 29 / 2018

## Hyd. No. 3

Post-Developed South

Hydrograph type	= SCS Runoff	Peak discharge	= 61.70 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 349,345 cuft
Drainage area	= 29.500 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.50 min
Total precip.	= 5.42 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

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

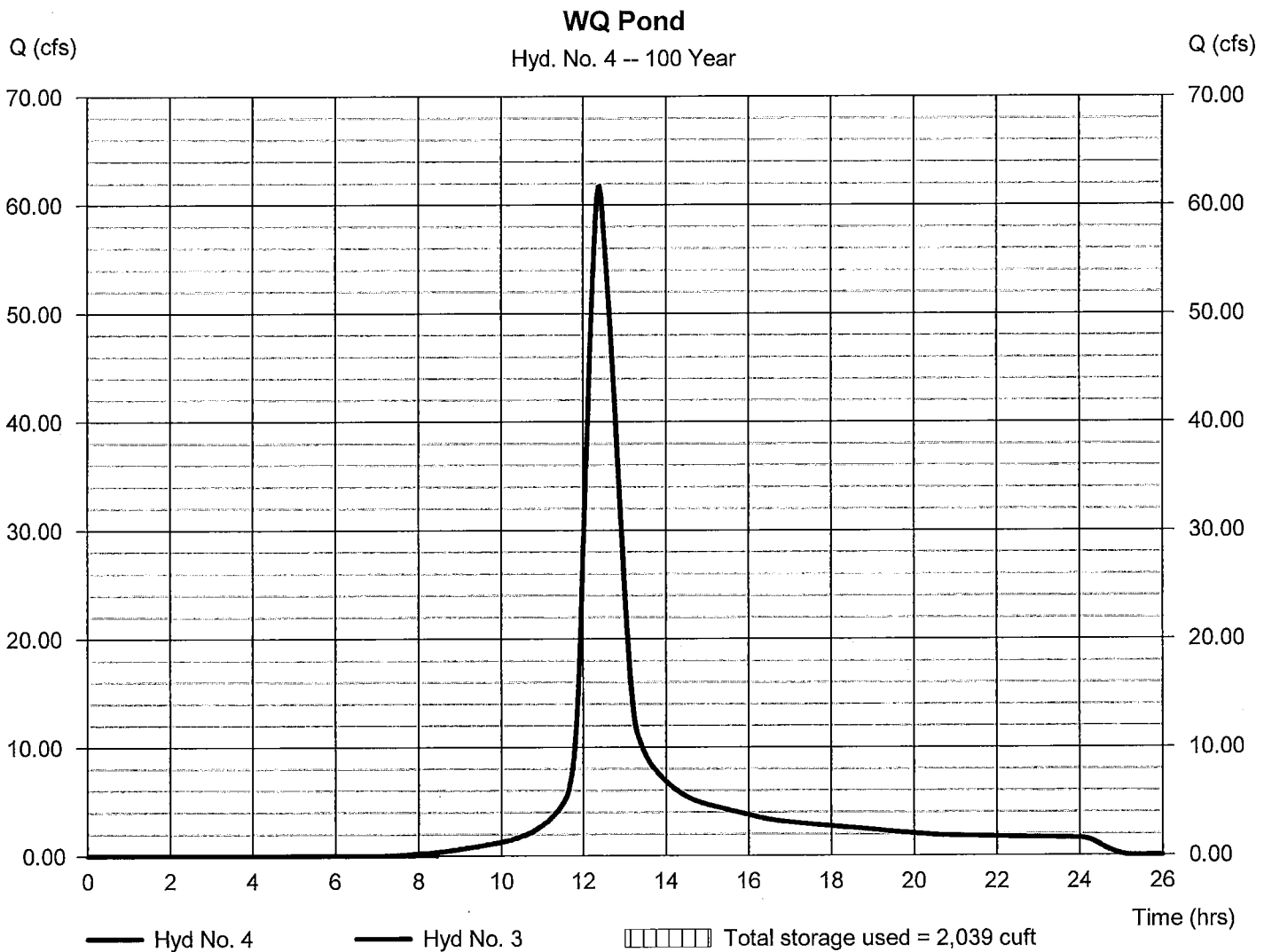
Wednesday, 08 / 29 / 2018

## Hyd. No. 4

WQ Pond

Hydrograph type	= Reservoir	Peak discharge	= 61.75 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 349,343 cuft
Inflow hyd. No.	= 3 - Post-Developed South	Max. Elevation	= 1186.95 ft
Reservoir name	= WQ Swale	Max. Storage	= 2,039 cuft

Storage Indication method used.





## **Section 6**



**NOAA Atlas 14, Volume 2, Version 3**  
**Location name: Middlefield, Ohio, USA\***  
**Latitude: 41.4617°, Longitude: -81.0733°**  
**Elevation: 1125.21 ft\*\***  
 \* source: ESRI Maps  
 \*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

**PF tabular**

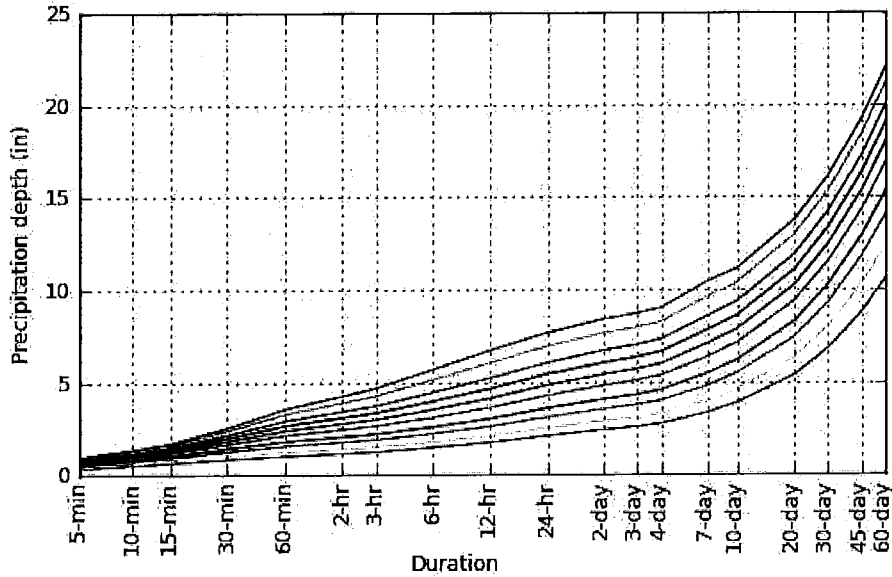
<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.328 (0.295-0.365)	0.392 (0.353-0.438)	0.474 (0.426-0.528)	0.536 (0.480-0.596)	0.614 (0.548-0.683)	0.674 (0.599-0.750)	0.733 (0.648-0.815)	0.791 (0.696-0.880)	0.870 (0.759-0.969)	0.927 (0.802-1.03)
10-min	0.509 (0.459-0.567)	0.613 (0.552-0.683)	0.736 (0.662-0.820)	0.827 (0.742-0.920)	0.939 (0.838-1.05)	1.02 (0.908-1.14)	1.10 (0.976-1.23)	1.18 (1.04-1.31)	1.28 (1.12-1.42)	1.35 (1.17-1.50)
15-min	0.624 (0.562-0.695)	0.749 (0.675-0.836)	0.904 (0.812-1.01)	1.02 (0.912-1.13)	1.16 (1.04-1.29)	1.26 (1.12-1.41)	1.37 (1.21-1.52)	1.47 (1.29-1.63)	1.60 (1.39-1.78)	1.69 (1.46-1.88)
30-min	0.826 (0.744-0.920)	1.00 (0.903-1.12)	1.24 (1.11-1.38)	1.41 (1.27-1.57)	1.64 (1.46-1.82)	1.81 (1.61-2.01)	1.98 (1.75-2.20)	2.14 (1.89-2.38)	2.37 (2.06-2.63)	2.53 (2.19-2.82)
60-min	1.01 (0.908-1.12)	1.23 (1.11-1.37)	1.55 (1.40-1.73)	1.80 (1.61-2.00)	2.13 (1.90-2.36)	2.38 (2.12-2.65)	2.65 (2.34-2.94)	2.91 (2.56-3.24)	3.27 (2.85-3.64)	3.55 (3.07-3.96)
2-hr	1.15 (1.04-1.27)	1.39 (1.26-1.55)	1.76 (1.59-1.95)	2.05 (1.85-2.27)	2.44 (2.19-2.71)	2.76 (2.46-3.06)	3.09 (2.73-3.42)	3.42 (3.02-3.79)	3.88 (3.39-4.31)	4.25 (3.67-4.71)
3-hr	1.23 (1.11-1.37)	1.50 (1.35-1.67)	1.89 (1.71-2.11)	2.20 (1.98-2.44)	2.63 (2.36-2.92)	2.98 (2.65-3.30)	3.35 (2.96-3.71)	3.72 (3.27-4.12)	4.25 (3.69-4.72)	4.68 (4.02-5.19)
6-hr	1.47 (1.33-1.62)	1.77 (1.60-1.95)	2.22 (2.01-2.45)	2.58 (2.33-2.85)	3.10 (2.78-3.41)	3.52 (3.15-3.87)	3.97 (3.52-4.36)	4.45 (3.91-4.88)	5.13 (4.44-5.64)	5.68 (4.86-6.27)
12-hr	1.74 (1.58-1.94)	2.10 (1.90-2.34)	2.60 (2.36-2.90)	3.02 (2.73-3.36)	3.62 (3.25-4.01)	4.12 (3.68-4.56)	4.65 (4.12-5.14)	5.22 (4.58-5.77)	6.03 (5.23-6.68)	6.71 (5.74-7.44)
24-hr	2.10 (1.93-2.29)	2.51 (2.31-2.75)	3.11 (2.86-3.39)	3.59 (3.29-3.92)	4.28 (3.90-4.66)	4.84 (4.38-5.27)	5.42 (4.89-5.92)	6.05 (5.41-6.62)	6.94 (6.12-7.63)	7.67 (6.70-8.46)
2-day	2.41 (2.24-2.62)	2.89 (2.67-3.13)	3.54 (3.28-3.83)	4.07 (3.76-4.40)	4.81 (4.41-5.21)	5.42 (4.94-5.87)	6.05 (5.48-6.57)	6.71 (6.03-7.32)	7.65 (6.77-8.41)	8.40 (7.35-9.33)
3-day	2.59 (2.41-2.78)	3.09 (2.88-3.33)	3.78 (3.51-4.06)	4.32 (4.01-4.65)	5.09 (4.69-5.48)	5.71 (5.24-6.16)	6.35 (5.79-6.86)	7.02 (6.35-7.63)	7.96 (7.10-8.71)	8.71 (7.69-9.61)
4-day	2.76 (2.58-2.95)	3.29 (3.08-3.52)	4.01 (3.75-4.29)	4.58 (4.27-4.90)	5.37 (4.98-5.76)	6.00 (5.54-6.44)	6.66 (6.10-7.16)	7.33 (6.68-7.93)	8.27 (7.44-9.01)	9.02 (8.02-9.90)
7-day	3.34 (3.12-3.57)	3.97 (3.72-4.25)	4.80 (4.49-5.13)	5.46 (5.09-5.83)	6.36 (5.91-6.80)	7.08 (6.54-7.58)	7.82 (7.18-8.38)	8.57 (7.82-9.23)	9.61 (8.66-10.4)	10.4 (9.30-11.4)
10-day	3.88 (3.63-4.13)	4.60 (4.31-4.89)	5.49 (5.14-5.84)	6.18 (5.79-6.58)	7.12 (6.64-7.59)	7.85 (7.29-8.39)	8.59 (7.94-9.20)	9.34 (8.59-10.0)	10.4 (9.42-11.2)	11.1 (10.0-12.1)
20-day	5.36 (5.07-5.67)	6.33 (5.98-6.70)	7.42 (7.02-7.86)	8.27 (7.81-8.76)	9.38 (8.83-9.94)	10.2 (9.60-10.9)	11.1 (10.3-11.8)	11.9 (11.0-12.7)	13.0 (11.9-14.0)	13.8 (12.6-14.9)
30-day	6.79 (6.44-7.17)	7.99 (7.58-8.44)	9.28 (8.80-9.80)	10.3 (9.71-10.8)	11.5 (10.9-12.2)	12.4 (11.7-13.2)	13.3 (12.5-14.2)	14.2 (13.3-15.1)	15.3 (14.2-16.4)	16.1 (14.9-17.3)
45-day	8.74 (8.32-9.19)	10.3 (9.76-10.8)	11.8 (11.2-12.3)	12.9 (12.2-13.5)	14.3 (13.6-15.0)	15.3 (14.5-16.1)	16.3 (15.4-17.2)	17.2 (16.2-18.2)	18.4 (17.2-19.5)	19.2 (17.9-20.5)
60-day	10.6 (10.1-11.1)	12.3 (11.8-13.0)	14.0 (13.4-14.7)	15.3 (14.6-16.0)	16.8 (16.0-17.7)	17.9 (17.0-18.9)	19.0 (18.0-20.0)	20.0 (18.9-21.1)	21.1 (19.9-22.5)	22.0 (20.6-23.4)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

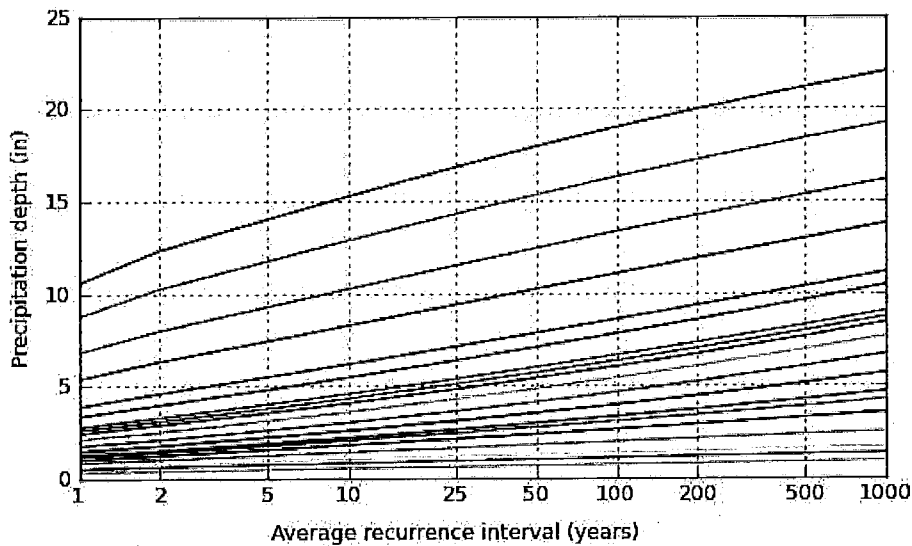
[Back to Top](#)

**PF graphical**

PDS-based depth-duration-frequency (DDF) curves  
 Latitude: 41.4617°, Longitude: -81.0733°



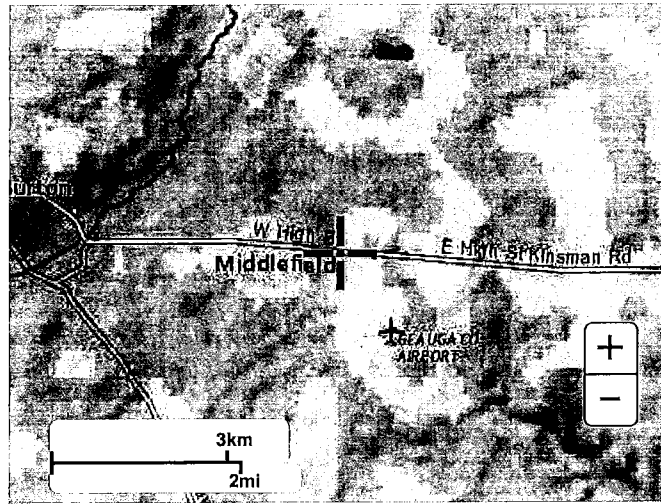
Average recurrence interval (years)
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2
5
10
25
50
100
200
500
1000



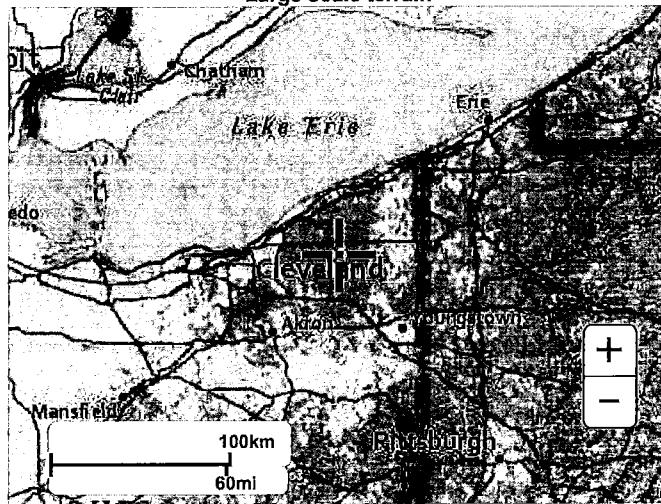
Duration	
5-min	2-day
10-min	3-day
15-min	4-day
30-min	7-day
60-min	10-day
2-hr	20-day
3-hr	30-day
6-hr	45-day
12-hr	60-day
24-hr	

**Maps & aerials**

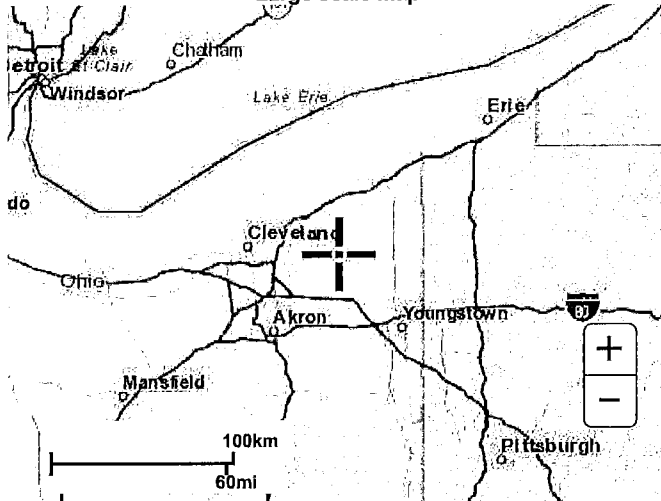
Small scale terrain



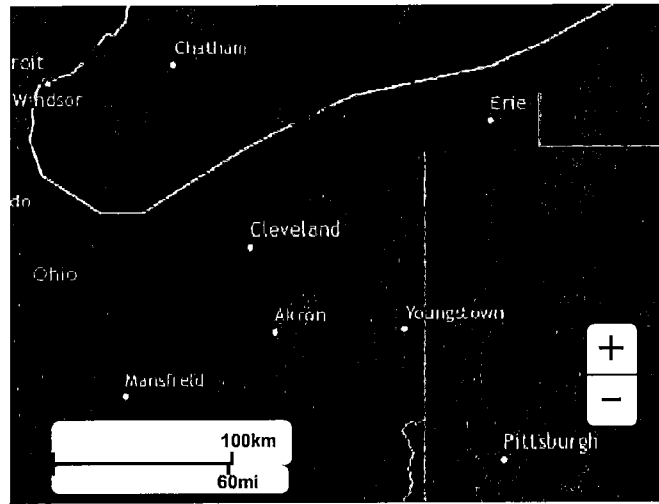
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

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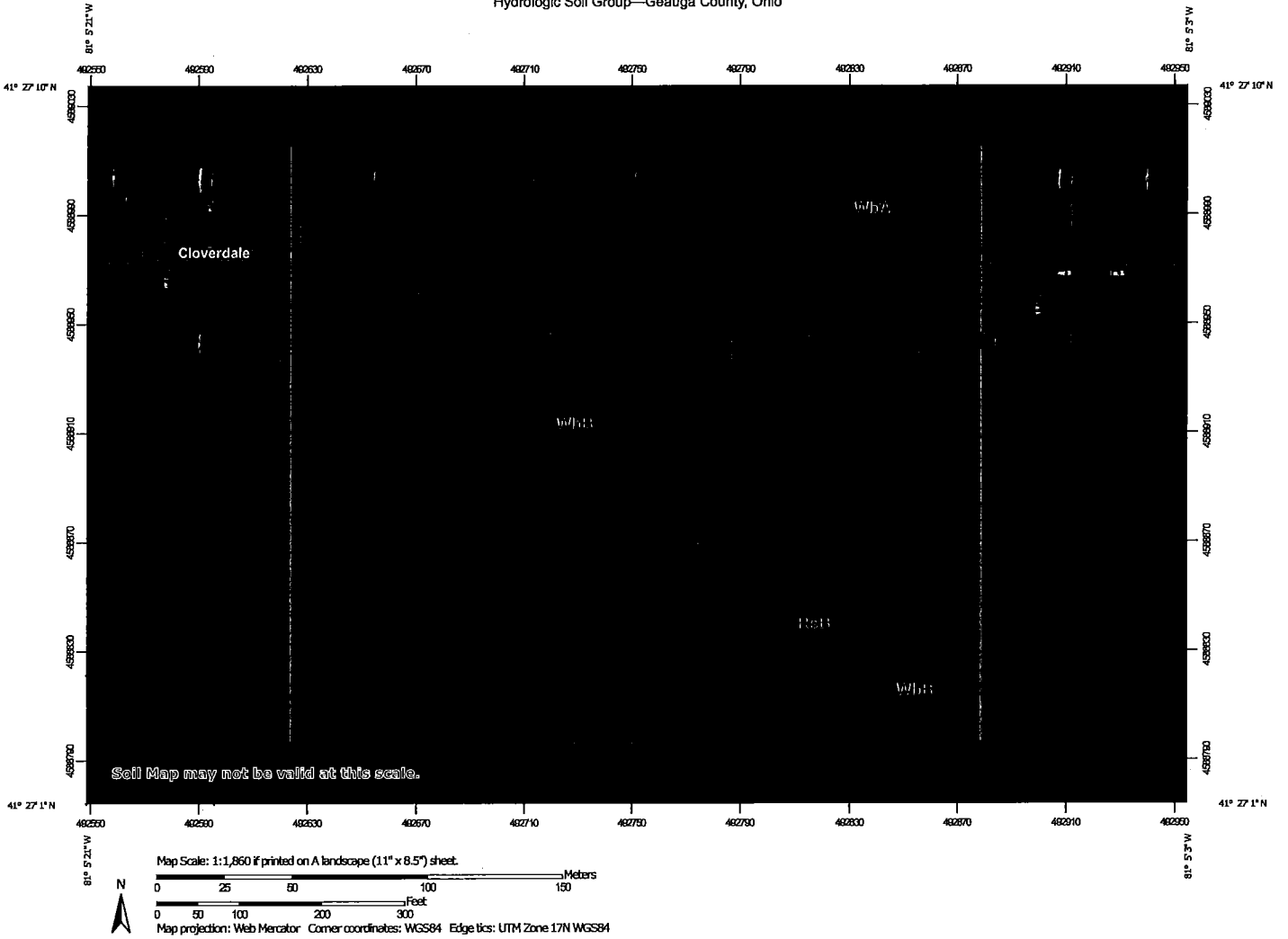
[US Department of Commerce](#)  
[National Oceanic and Atmospheric Administration](#)  
[National Weather Service](#)  
[National Water Center](#)  
1325 East West Highway  
Silver Spring, MD 20910  
Questions?: [HDSC.Questions@noaa.gov](mailto:HDSC.Questions@noaa.gov)

[Disclaimer](#)

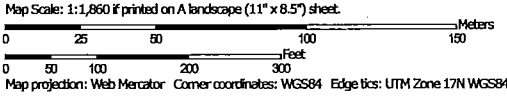


## **Section 7**

Hydrologic Soil Group—Geauga County, Ohio



































Soil Map may not be valid at this scale.



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**MAP LEGEND**

- Area of Interest (AOI)**  
 Area of Interest (AOI)
- Soils**
- Soil Rating Polygons**
-  A
  -  A/D
  -  B
  -  B/D
  -  C
  -  C/D
  -  D
  -  Not rated or not available
- Soil Rating Lines**
-  A
  -  A/D
  -  B
  -  B/D
  -  C
  -  C/D
  -  D
  -  Not rated or not available
- Soil Rating Points**
-  A
  -  A/D
  -  B
  -  B/D
- Water Features**
-  C
  -  C/D
  -  D
  -  Not rated or not available
  -  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 1:15,800.

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: Geauga County, Ohio  
 Survey Area Data: Version 18, Sep 25, 2017

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

Date(s) aerial images were photographed: Nov 24, 2015—Mar 21, 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.

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
RsB	Rittman silt loam, 2 to 6 percent slopes	D	1.8	12.6%
WbA	Wadsworth silt loam, 0 to 2 percent slopes	D	0.9	6.5%
WbB	Wadsworth silt loam, 2 to 6 percent slopes	D	11.2	80.8%
<b>Totals for Area of Interest</b>			<b>13.9</b>	<b>100.0%</b>

### Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## Rating Options

*Aggregation Method: Dominant Condition*

*Component Percent Cutoff: None Specified*

*Tie-break Rule: Higher*

**Section 8**

**Operation and Maintenance Manual Guideline  
For GMHA Cloverdale Estates  
Drainage Swale**

(Source: EPA 1999, 2003; ODNR Rainwater and Land Development 2006)

***Maintenance Tasks***

<b>Task</b>	<b>Frequency</b>	<b>Maintenance Notes</b>
Activity log	Every physical event related to the swale and detention area	Maintain an active neatly organized log of all events that disturb, modify, or change the physical operation and maintenance activities. Keep log available for officials to review at any time.
Pruning	1 - 2 times / year	Nutrients in runoff often cause vegetation to flourish. Do not let surrounding area vegetation become overgrown "jungle like" into the swale area.
Mowing	2 - 12 times / year	Frequency depends upon location and desired aesthetic appeal. Collect all clippings leaves and other yard waste.
General Inspection	1 - 2 time / years	Inspect embankment and outlet structures for damage, deterioration, and proper flow. Remove woody vegetation and fix any eroding areas. Monitor sediment accumulations in check dam and spillway areas.
Fertilization	1 time initially	One time spot fertilization for "first year" vegetation only.
Miscellaneous upkeep	12 times / year and as necessary	Tasks include trash collection, spot weeding, and removing obstructions from overflow devices, ensure drainage system is always free of debris and is functioning as intended. Remove any and all debris, clippings, leaves, ect. from all catch basins and control structure inlet and outlet.
Remove sediment buildup	3 - 7 years	Tasks includes removal of sediment build up from the swale to the original elevations, re-stabilize basin with permanent seeding in accordance with current environmental regulations and standard practices.

**Additional Maintenance Considerations and Requirements**

The site facility maintenance individuals shall be provided all of these requirements as well as access to the maintenance log for event entries. The individuals responsible for the everyday and regular maintenance of the swale and water quality areas shall be informed on how and why these living water quality feature work to ensure premature failure does not occur. The surface of the rock check dams may become clogged with fine sediment over time. The removal and replacement with clean rock as originally installed may be require to provide adequate filtration/dewatering functionality. Should ponding persist, the rock check dams may be removed and replaced with the specified mix with in the current environmental regulations and current standard practices for water quality swale areas. Regular inspection and maintenance is critical to the effective operation of extended detention facilities as designed. The up to date Maintenance Log will provide an accurate history of the functionality of the water quality swale areas which will also be used for future maintenance task decisions and task due dates. Maintenance responsibility for the swale area should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.