DEWEY
ENGINEERING

Drainage Calculations

For

Old Hydes Ferry Pike

January 15, 2021

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Project Description

This project consists of a single commercial lot located along Old Hydes Ferry Pike at the intersection with Harper Lane. The site boundary contains 1.60 acres, and construction of this project will ultimately disturb 1.57 acres. Upon completion of this project, this development will include a gas station, a restaurant, parking, stormwater infrastructure, and private utilities.

Summaries for the following are included below along with associated calculations: Existing Conditions and Erosion Control Summary, Stormwater Infrastructure Summary, Water Quality Summary, and Water Quantity Summary.

Existing Conditions and Erosion Control Summary

This site contains a single outfall near the western corner of the property. A tributary of Marrowbone Creek, which is exceptional waters of the state, drains through this outfall. Soil types for this development were identified using the USGS Web Soil Survey printout attached in Appendix A. Since the site ultimately drains to exceptional waters, erosion control measures have been designed to control runoff generated from the 5-year, 24-hour storm event and include wire-backed silt fence and a construction exit.

Stormwater Infrastructure Summary

All catch basins and pipes were sized to pass at least the 10 year storm event. Attached in Appendix B are drain area maps, storm profiles, and printouts from Autodesk Storm and Sanitary Analysis 2019. The software was used to calculate hydraulic grade lines, velocities, inlet spreads and all other required design parameters.

Water Quality

The 80% TSS removal requirement for this site will be accomplished using a bioretention area. The bioretention area was sized using Version 9 of Metro Nashville Stormwater's LID Site Design Tool. Additionally, TNRAT was used to verify the design meets state requirements set in the Tennessee Permanent Stormwater Management & Design Guidance Manual. The required water quality volume for the bioretention area was obtained using the following attachments located in Appendix C: LID Drain Area Maps, Forebay Sizing Worksheets, LID worksheet, and TNRAT report. The volume sizing for the bioretention area is summarized in Table 1 below:

Table 1: Water Quality Sizing Calculations

	Bioretention Area
Required WQ Volume	4,388 cf
Surface Area	3,598 sf
Depth of Ponding	0.5 ft
Depth of Storage Media	3 ft
Depth of Gravel	3 ft
Equivalent Depth	2.45 ft
Proposed WQ Volume (cf)	8,815
Tv Provided/Tv Required (%)	201%

Water Quantity

Water Quantity for this site will also be accomplished using the bioretention area. Using USDA's Web Soil Survey, the soils for this site were determined to be Ennis Gravelly Silt Loam. Web Soil Survey list the capacity of the most limiting layer of Ennis Gravelly Silt Loam to transmit water as high with infiltration rates of 2 to 6 in/hr. Since the bioretention area will be managed through infiltration and an overflow weir, the infiltration rate in Hydraflow was set to the minimum 2 in/hr. The pre-developed and post-developed conditions for the site are summarized in the table below:

Table 1: Pre-Developed & Post-Developed Basins

	Existing Basin	Prop. to Bio
Total Acres	1.11	1.11
Weighted Curve Numbers	69	93
Time of Concentration (min)	16.1	2.1

All pre-post development requirements for the 2-100 year events have been met. The tables below summarize the pre vs. post developed release rates. Refer to the Water Quantity Section in Appendix D for detailed information including Maps, Calculations, Summaries, Hydrographs, and other pertinent information.

Table 2: Runoff Release Rates (CFS)

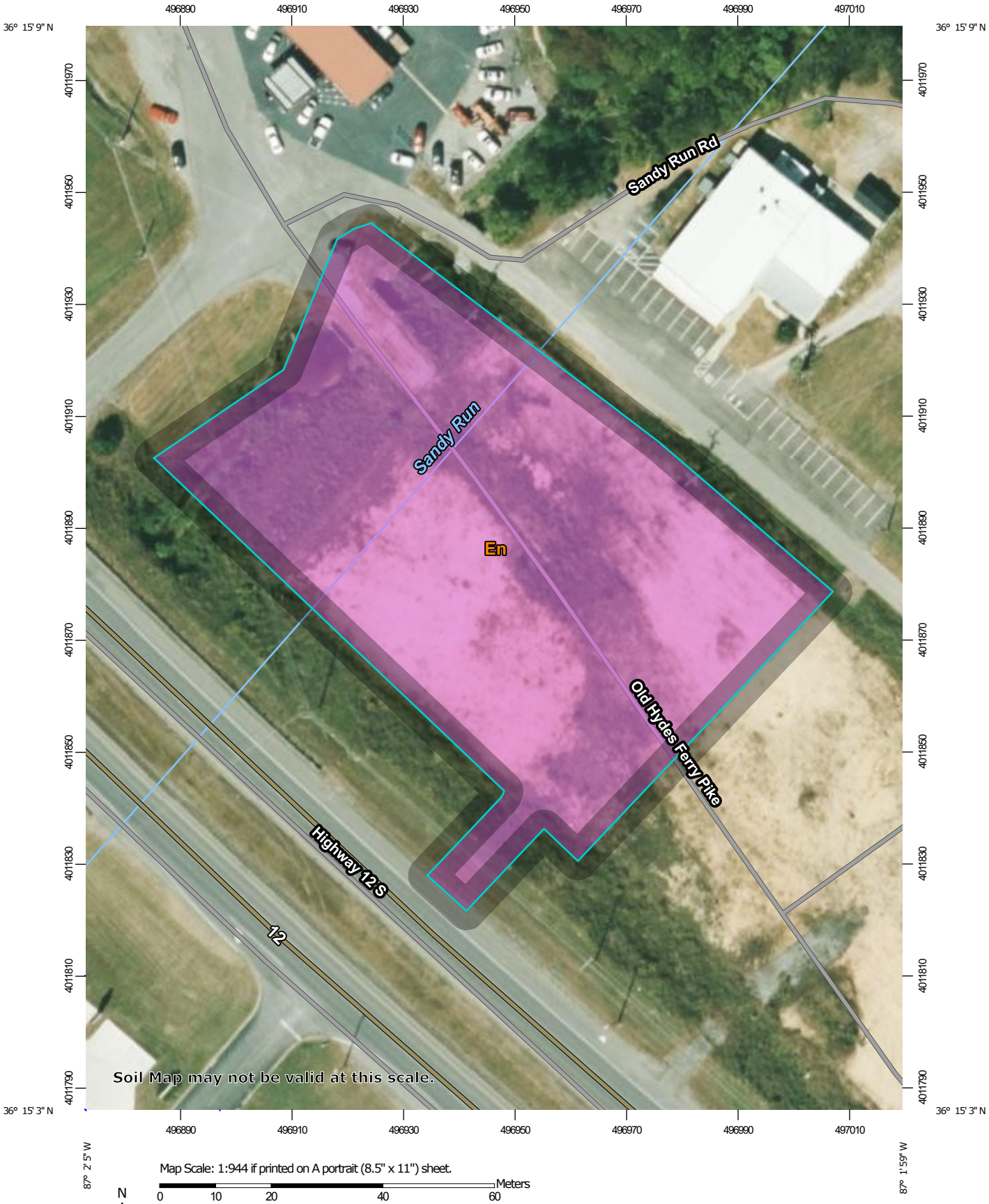
	2-yr	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Existing Basin (Pre-Developed Flow)	1.166	2.229	2.999	4.044	4.848	5.658
From Bioretention (Post-Developed Flow)	0.000	0.000	0.000	0.497	2.013	5.208
Flow Reduction (= Pre – Post)	1.166	2.229	2.999	3.547	2.835	0.450

Appendix: Table of Contents

Appendix A: Existing Conditions and Erosion Control

- USGS Web Soil Survey Printout
- FEMA FIRM

Hydrologic Soil Group—Cheatham County, Tennessee
(USGS Boundary)



Map Scale: 1:944 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

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
C
C/D
D
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Cheatham County, Tennessee
Survey Area Data: Version 14, May 29, 2020

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

Date(s) aerial images were photographed: Sep 21, 2019—Apr 10, 2020

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
En	Ennis gravelly silt loam, occasionally flooded	A	1.6	100.0%
Totals for Area of Interest			**1.6**	**100.0%**

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

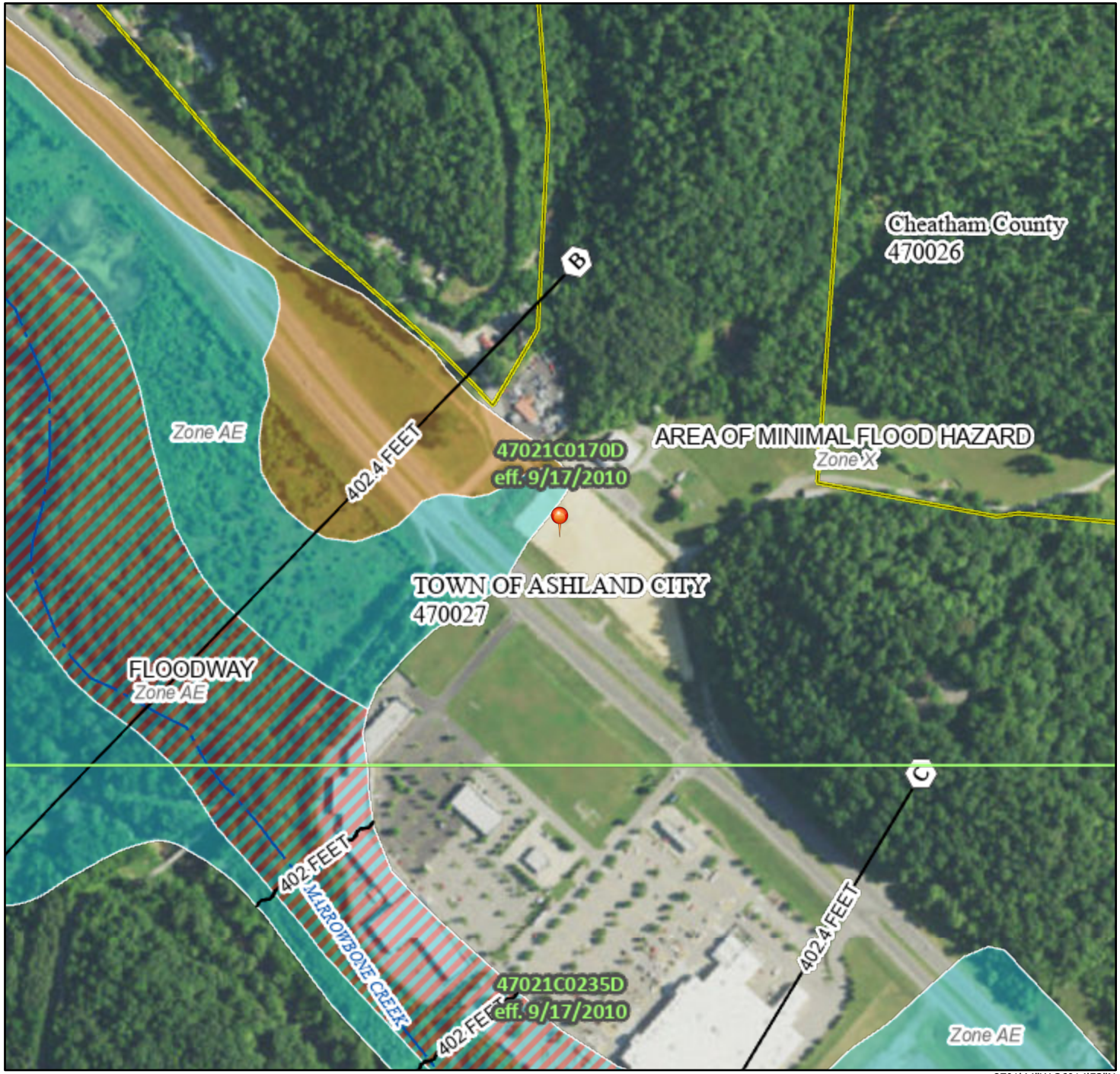
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette

FEMA

87°2'21"W 36°15'21"N



87°1'44"W 36°14'52"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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

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

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

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

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

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

N

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

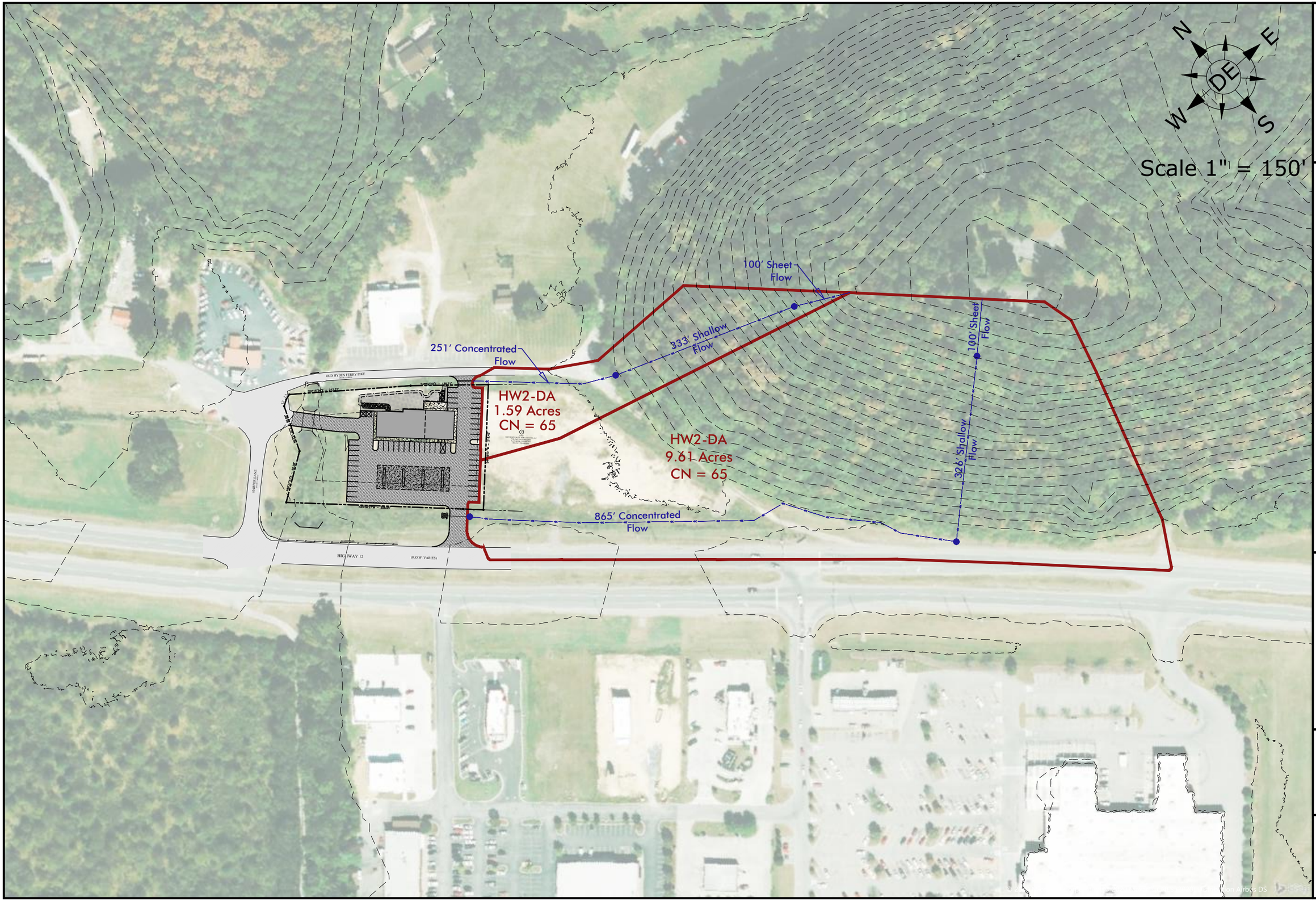
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/13/2021 at 4:35 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Appendix B: Stormwater Infrastructure Calculations

- Drain Area Map
- 100 Year Storm Calculations – Pipe Printout



Date: January 15, 2021

Old Hydes Ferry Pike

Being Parcel 4.01 on Tax Map 62
Ashland City, Cheatham County, Tennessee

DEWEY ENGINEERING

Drain Area Map (Pipes)

1

1 of 1

Project Description

File Name 20053.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-55
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	TS-01	Cumulative	inches	Tennessee	Cheatham	10	4.90	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	HW02-DA	9.61	65.00	4.90	1.59	15.25	19.97	0 00:11:30
2	Sub-02	1.59	65.00	4.90	1.59	2.52	3.52	0 00:08:16

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	HW02	Junction	406.00	411.00	0.00	0.00	0.00	19.58	407.63	0.00	3.37	0 00:00	0.00	0.00
2	HW04	Junction	407.00	409.00	0.00	0.00	0.00	3.51	407.68	0.00	1.32	0 00:00	0.00	0.00
3	HW01	Outfall	405.80					19.48	407.42					
4	HW03	Outfall	406.70					3.50	407.38					

Subbasin Hydrology

Subbasin : HW02-DA

Input Data

Area (ac) 9.61
Weighted Curve Number 65.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
2 acre lots, 12% impervious	9.61	B	65.00
Composite Area & Weighted CN	9.61		65.00

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.40	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	33	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.25	0.00	0.00
Computed Flow Time (min) :	6.69	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	325	0.00	0.00
Slope (%) :	20	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	7.22	0.00	0.00
Computed Flow Time (min) :	0.75	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.032	0.00	0.00
Flow Length (ft) :	865	0.00	0.00
Channel Slope (%) :	1	0.00	0.00
Cross Section Area (ft²) :	8	0.00	0.00
Wetted Perimeter (ft) :	12	0.00	0.00
Velocity (ft/sec) :	3.55	0.00	0.00
Computed Flow Time (min) :	4.06	0.00	0.00

Total TOC (min) 11.50

Subbasin Runoff Results

Total Rainfall (in)	4.90
Total Runoff (in)	1.59
Peak Runoff (cfs)	19.97
Weighted Curve Number	65.00
Time of Concentration (days hh:mm:ss)	0 00:11:30

Subbasin : Sub-02

Input Data

Area (ac) 1.59
Weighted Curve Number 65.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	1.59	-	65.00
Composite Area & Weighted CN	1.59		65.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	33	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.25	0.00	0.00
Computed Flow Time (min) :	6.69	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	334	0.00	0.00
Slope (%) :	25	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	8.07	0.00	0.00
Computed Flow Time (min) :	0.69	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.032	0.00	0.00
Flow Length (ft) :	251	0.00	0.00
Channel Slope (%) :	1	0.00	0.00
Cross Section Area (ft^2) :	8	0.00	0.00
Wetted Perimeter (ft) :	8	0.00	0.00
Velocity (ft/sec) :	4.66	0.00	0.00
Computed Flow Time (min) :	0.90	0.00	0.00

Total TOC (min) 8.28

Subbasin Runoff Results

Total Rainfall (in) 4.90
Total Runoff (in) 1.59
Peak Runoff (cfs) 3.52
Weighted Curve Number 65.00
Time of Concentration (days hh:mm:ss) 0 00:08:17

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	HW02	406.00	411.00	5.00	0.00	-406.00	0.00	-411.00	0.00	0.00
2	HW04	407.00	409.00	2.00	0.00	-407.00	0.00	-409.00	0.00	0.00

Junction Results

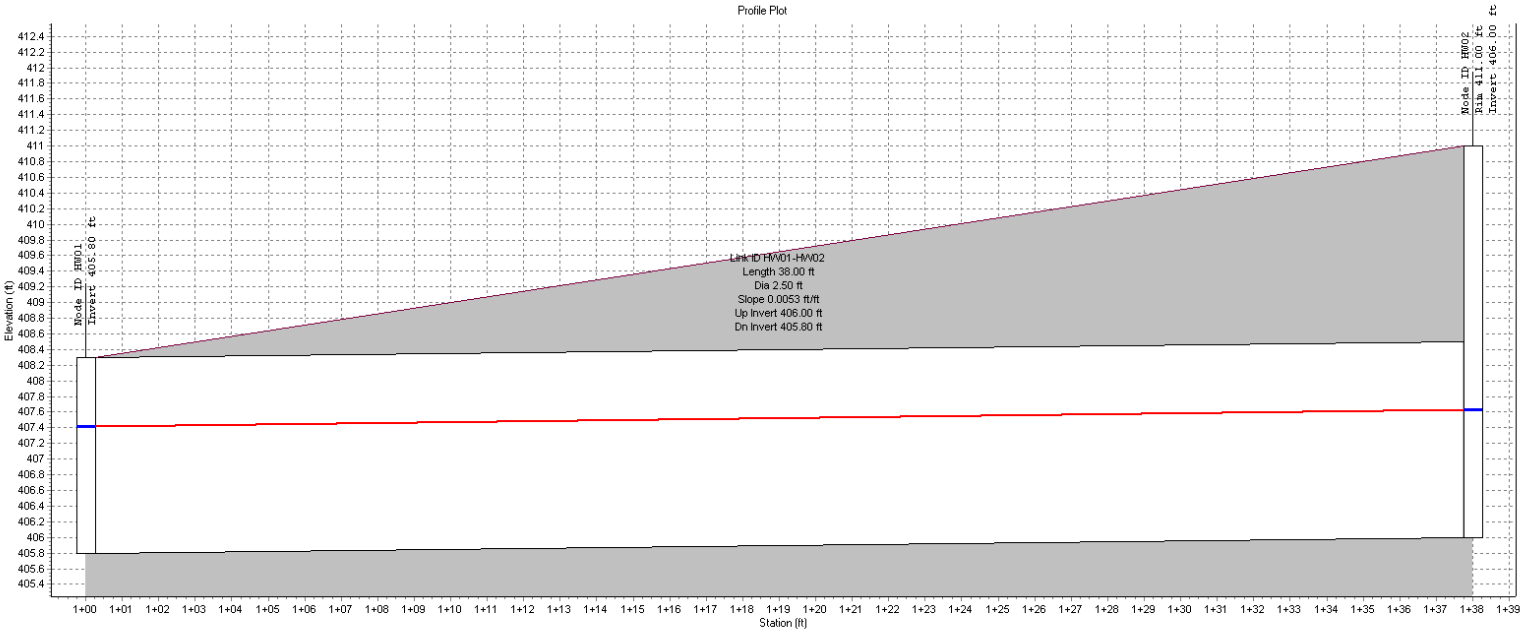
SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	HW02	19.58	19.58	407.63	1.63	0.00	3.37	406.17	0.17	0 12:05	0 00:00	0.00	0.00
2	HW04	3.51	3.51	407.68	0.68	0.00	1.32	407.04	0.04	0 12:05	0 00:00	0.00	0.00

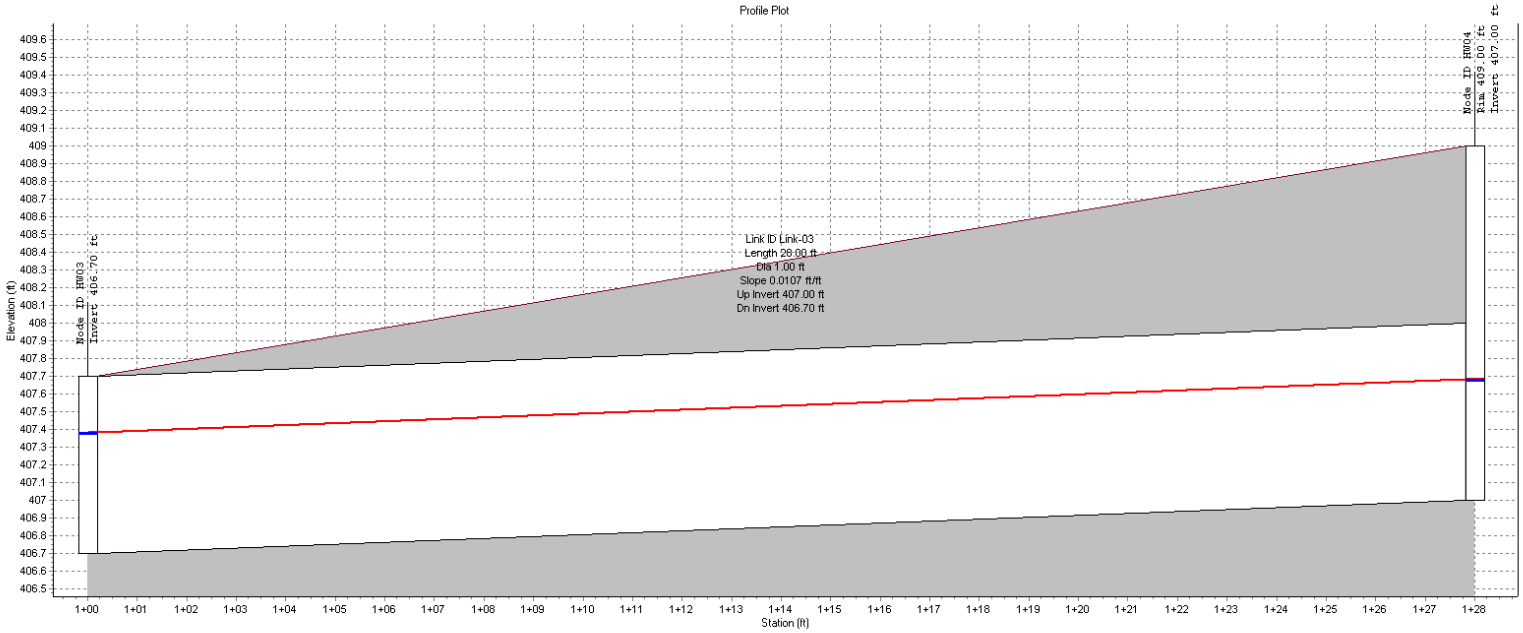
Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	HW01-HW02	38.00	406.00	0.00	405.80	0.00	0.20	0.5300	CIRCULAR	30.000	30.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1
2	Link-03	28.00	407.00	0.00	406.70	0.00	0.30	1.0700	Rectangular	12.000	12.000	0.0130	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	HW01-HW02	19.48	0 12:05	25.79	0.76	5.79	0.11	1.63	0.65	0.00		Calculated
2	Link-03	3.50	0 12:05	4.70	0.75	5.15	0.09	0.68	0.68	0.00		Calculated


Profile Plot
Elevation (ft)
Station (ft)
Node ID HW01
Invert 405.80 ft
Link ID HW01-HW02
Length 38.00 ft
Dia 2.50 ft
Slope 0.0053 ft/ft
Up Invert 406.00 ft
Dn Invert 405.80 ft
Node ID HW02
Rim 411.00 ft
Invert 406.00 ft


Profile Plot
Elevation (ft)
Station (ft)
Node ID HW03
Invert 406.70 ft
Link ID Link-03
Length 28.00 ft
Dia 1.00 ft
Slope 0.0107 ft/ft
Up Invert 407.00 ft
Dn Invert 406.70 ft
Node ID HW04
Rim 409.00 ft
Invert 407.00 ft

Appendix C: Water Quality Calculations

- Drain Area Map – Proposed
- Metro Nashville LID Worksheet
- TNRAT Report
- Forebay Sizing Calculations

Color	Description	Acreage
	Impervious to Bio to FA	0.660
	Impervious to Bio to FB	0.340
	Grass (A) to Bio to FA	0.004
	Grass (A) to Bio to FB	0.005
	To Bio	0.100
	Total	1.109

N
W DE E
S

Scale 1" = 50'

Date: January 15, 2021

Old Hydes Ferry Pike

Being Parcel 4.01 on Tax Map 62
Ashland City, Cheatham County, Tennessee

DEWEY ENGINEERING

DA Map (Post-Developed)

1

1 of 1

MWS LID Site Design Tool

Project Name	*Old Hydes Ferry Pike*
Parcel Identification #	*Tax Map 62, Parcel 4.01*
Combined Sewer Overlay?	**NO**
Pre-Development Impervious Area (acres)	**0.05**
Post-Development Impervious Area (acres)	**1.05**
Pre-Development Rv =	**0.18**
Target Runoff Reduction Requirement =	**80%**

See Section 7.2.1 in Metro SWMM Volume 1

Capture Depth=	**1**	**inch**
Cistern Capture=		**% Total Vol captured**

From Cistern Design Tool

MWS LID SITE DESIGN TOOL VERSION 9 - August 1, 2016

Instructions

1. Input cells are in Green.
2. Break Site Into Sub areas by single soils and land use type combinations.
3. Assign a code to each subarea and input the code into column C. Descriptions can be entered in column B.
4. Input the subarea drainage area in column D.
5. Input treatment credit code (Column F) for the first tier of treatments
6. Input additional treatment code as desired (Column I) for any subarea
7. Adjust until you reach 80% reduction or better (Cell N turns green if 80% reached).
8. If 80% reduction is not reached and it has been decided that GIPs in series is an option use Step 3a to place GIPs in series . Their respective treatment volumes are calculated in column W. This volume is separate from GIPs upstream.
9. When using GIPs in Series the user will look to Cell T for confirmation the 80% goal has been met.

Percent Volume Reduction-Based Calculations

Step 1: Lay out the site and divide it into sub-areas each of a specific land use type and Rv.					Step 1a: Change any basic land use types through reforesting, permeable pavement or green roofs - or through use of open space for a GIP.			Step 2: Treat impervious areas through the use of disconnection or sheet flow			Step 3: Treat primarily impervious areas with structural GIPs either in series with Step 3 intrinsic GIPs or alone downstream from Steps 1 and 2 land use.			Size controls for Step 3 by assigning structure ID to each sub-area, combining sub-areas into one structure if appropriate.			Step 3a Treatment in Series Calculation - Place Structural GIPs in same row as upstream GIP			Size controls for Step 3a in series by assigning a sequential structure ID to each area treated in series.			
Step1 Basic Land Use					**Step 1a Modified LU**			**Step 2 Intrinsic GIPs**			**Step 3 Structural GIPs**			**Structure ID**	**IA Capture**		**Step 3a Structural GIPs in Series**			**Structure ID**	**IA Capture**		**Nominal Cu**
Subarea	Description	Code	Acres	Base Rv	Code	Acres	Eff Rv1	Code	Trtmt VR1	Eff Rv2	Code	Trtmt VR2	Eff Rv3		Tv Multiplier	Tv (cf)	Code	Trtmt VR2	Eff Rv4	Site GIP ID Number	Tv Multiplier	Structure in Series Tv (cf)	Step 1
1				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
2	Imp to Bio to FA	IA	0.66	0.95	IA	0.66	0.95		0	0.95	B2	0.8	0.19		1.25	2,845		0	0.19		0.00	-	98
3	Grass to Bio to FA	TA	0.004	0.15	TA	0.004	0.15		0	0.15	B2	0.8	0.03		1.25	3		0	0.03		0.00	-	49
4	Imp to Bio to FB	IA	0.34	0.95	IA	0.34	0.95		0	0.95	B2	0.8	0.19		1.25	1,466		0	0.19		0.00	-	98
5	Grass to Bio to FB	TA	0.005	0.15	TA	0.005	0.15		0	0.15	B2	0.8	0.03		1.25	3		0	0.03		0.00	-	49
6	Bio	TA	0.1	0.15	TA	0.1	0.15		0	0.15	B2	0.8	0.03		1.25	68		0	0.03		0.00	-	49
7				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
8				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
9				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
10				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
11				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
12				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
13				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
14				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
15				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
16				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
17				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
18				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
19				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
20				0.00		0	0.00		0	0.00		0	0.00		0.00	-		0	0.00		0.00	-	0
		Weighted Rv		0.871		Weighted Rv	0.871		Weighted Rv	0.871		Weighted Rv	0.174						0.174				93.2
		Total Area=	1.109	0.97		Total Area=	1.109	0.97		0.97			0.19		Step 3 Tv Total	**4,385**			0.19		Final Tv Total	**4,385**	
	% Removal			12.9%		% Removal		12.9%	% Removal		12.9%	% Removal		**82.6%**				% Removal		**82.6%**			

THIS CELL WILL TURN GREEN WHEN TARGET RUNOFF REDUCTION MET

THIS CELL WILL TURN GREEN WHEN TARGET RUNOFF REDUCTION MET

MWS LID Site Design Tool

Project Name	*Old Hydes Ferry Pike*
Parcel Identification #	*Tax Map 62, Parcel 4.01*

MWS LID SITE DESIGN TOOL VERSION 9 - August 1, 2016

PreDev CN	50.9

METRO RAINFALL	
Return Period	Rainfall (in)
2-yr	3.39
5-yr	4.50
10-yr	5.23
25-yr	6.16
50-yr	6.85
100-yr	7.53

Curve Number Instructions

1. Enter the composite pre-development curve number (CN), to the left, for the watershed.
2. The tool automatically assigns curve numbers for each subarea based on MWS policy matching the land uses of Steps 1 and 1a to curve numbers (see column **G COVER SHEET**).
3. Curve numbers are shown for both Step 1 and Step 1a in columns **X** and **Y** as well as the composite curve number for the site in line 59 of those columns.
4. The ratio of the **Tv provided/Tv required** for each GIP (as a %) is entered in column **AG** (e.g. if only required Tv is provided then this should be 100%).
5. Select the rainfall in **Cell AC19** based on return periods shown in table to left.
6. Adjusted curve numbers for each subarea are shown in the table below in column **AK**, as well as the composite adjusted curve number in **Cell AK59**, for the rainfall selected. If this value is greater than the composite Pre-Development CN then **Cell AK60** will state "Detention Required"
7. These are the curve numbers to be used in flood control design calculations. Each watershed must be calculated independently. If there are multiple watersheds for the project, then the composite pre-development curve number and composite adjusted curve number should be compared for each watershed to determine if detention is required.
8. If there are GIPs in series, use the 2nd table to calculate the additional reduction in CN.

Adjusted Curve Number Calculations (Step 3 only)

ve Number	No Controls				With Structural Controls &Treatment Vol Removed						
Step 1A	Original CN	Rainfall (in)	S (in)	Q (in)	Tv required (cu ft)	Tv provided (%)	RO Vol Red (cu ft)	Q reduction (in)	Q adj (in)	Adjusted CN	Difference
0	0.0	7.53	-	-	-			0	-	0.0	0.0
98	98.0	7.53	0.204	7.29	2845	100.0%	2845	1.1875	6.103	87.9	-10.1
49	49.0	7.53	10.408	1.87	3	100.0%	3	0.1875	1.685	47.0	-2.0
98	98.0	7.53	0.204	7.29	1466	100.0%	1466	1.1875	6.103	87.9	-10.1
49	49.0	7.53	10.408	1.87	3	100.0%	3	0.1875	1.685	47.0	-2.0
49	49.0	7.53	10.408	1.87	68	100.0%	68	0.1875	1.685	47.0	-2.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
0	0.0	7.53	-	-	-			0	-	0.0	0.0
93.2	93.2		0.731	0.04	4384.8131			1.089213255	-1.053	83.9	-9.3

Note that this assumes the same Pre- and Post-developpmentTc and Drainage Areas
if this is not the case additional routing calculations will be required

DETENTION REQ

Adjusted Curve Number Calculations (Step 3a added)

No Controls				With Structural Controls &Treatment Vol Removed						
Adjusted CN (St 3)	Rainfall (in)	S (in)	Q (in)	Tv required (cu ft)	Tv provided (%)	RO Vol Red (cu ft)	Q reduction (in)	Q adj (in)	Adjusted CN	Difference
0.0	7.53	-	-	-			0	-	0.0	0.0
87.9	7.53	1.371	6.10	-			0	6.103	87.9	0.0
47.0	7.53	11.259	1.68	-			0	1.685	47.0	0.0
87.9	7.53	1.371	6.10	-			0	6.103	87.9	0.0
47.0	7.53	11.259	1.68	-			0	1.685	47.0	0.0
47.0	7.53	11.259	1.68	-			0	1.685	47.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
0.0	7.53	-	-	-			0	-	0.0	0.0
93.2		0.731	0.04	0			#DIV/0!	#DIV/0!	83.9	-9.3

Note that this assumes the same Pre- and Post-developpmentTc and Drainage Areas
if this is not the case additional routing calculations will be required

DETENTION REQ

TN Runoff Reduction Assessment Tool (RRAT)

Site Name: Old Hydes Ferry
Assigned Site Number:
Design submitter:

NOTES:

Access: R2_TN_RRAT_Basic
Version #: 2.5.6.1

Design File Name: tn-rrat-runs\Ashland City

Design Results:
Design OK?: GREEN
Pollutant removal OK?: GREEN Portion action vol captured: 100 % Portion pollutant removed: 100 %
Volume red. OK?: GREEN Net volume red. depth: 1.65 in.

Inputs:
Location: Nashville Total surface area: 48300 ft2 Imp:active ratio (X:1): 6.52

General Design Conditions:

Design element #	*Discharges to design element #*	*Area, ft2*	*Special conditions*	*Soil*	*Base SCM / management*	*Design element description*
1	0	4386	none	silt loam	04. bioretention\bioretention	Bioretention Area
2	1	28590	none	silt loam	impervious\impervious	Impervious to Bio to FA
3	1	205.0	none	silt loam	06. infiltration areas\turf, fair	Grass to Bio to FA
4	1	14930	none	silt loam	06. infiltration areas\turf, fair	Impervious to Bio to FB
5	1	218.0	none	silt loam	06. infiltration areas\turf, fair	Grass to to Bio to FB

Specific Element Design Values:

Design element #	*Base SCM / management*	*Surface removal eff, %*	*Drain disch rem eff, %*	*Drain invert depth, in.*	*Drain disch element #*	*Storage vol, gal*	*Withdrawal rate, gal*	*Layer #*	*Layer material*	*Layer design depth, in.*
1	tn-rrat-scms\04. bioretention\bioretention	10.0					0	1	(none)	6.00
					0			2	tn-rrat-materials\Mulch	3.00
					0			3	tn-rrat-materials\Media, soil-based, loamy sand	12.0
2	tn-rrat-scms\impervious\impervious	0					0	1	(none)	0
3	tn-rrat-scms\06. infiltration areas\turf, fair	15.0					0	1	(none)	0
4	tn-rrat-scms\06. infiltration areas\turf, fair	15.0					0	1	(none)	0
5	tn-rrat-scms\06. infiltration areas\turf, fair	15.0					0	1	(none)	0

Appendix A: Pond Calculations
Contour Area Calculations for Forebay A

Required Volume

	Input	
Required Treatment Volume =	2848	cu ft

Required Forebay Volume = 0.15(Req Trt Vol) 427.2 cu ft

Volume Calculations

** Calculations Based on the Average End Area Method*

	Elevation (ft)	***Area (ft^2)***	***Length Between Contours (ft)***	***Volume (cf)***
TOB	406.8	427		
			2	467.0
BOB	404.8	40		

Appendix A: Pond Calculations
Contour Area Calculations for Forebay B

Required Volume

	Input	
Required Treatment Volume =	1569	cu ft

Required Forebay Volume = 0.15(Req Trt Vol) 235.35 cu ft

Volume Calculations

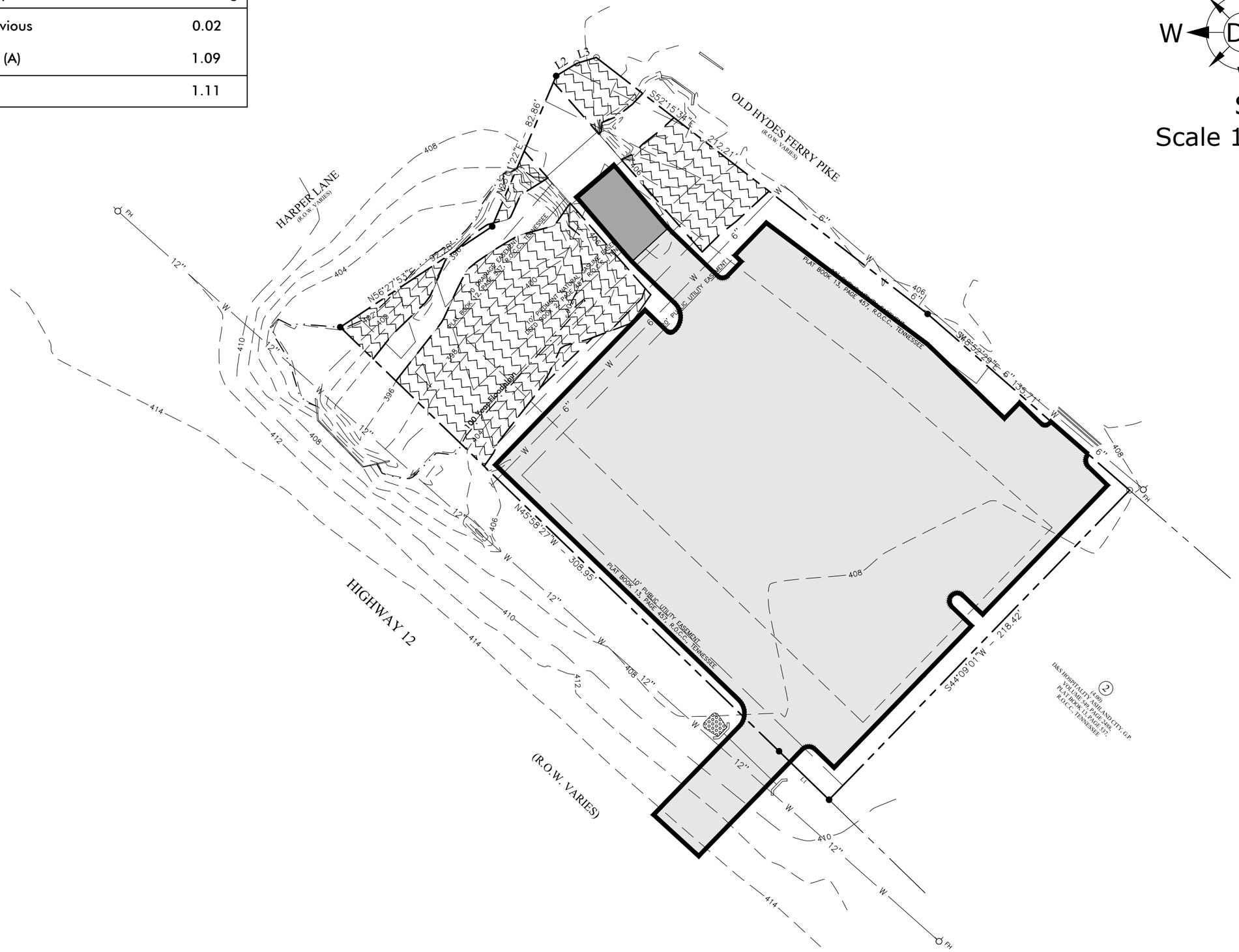
** Calculations Based on the Average End Area Method*

	Elevation (ft)	***Area (ft^2)***	***Length Between Contours (ft)***	***Volume (cf)***
TOB	406.8	252		
			2	272.0
BOB	404.8	20		

Appendix D: Pond Calculations

- Drain Area Map – Existing for Detention
- Drain Area Map – Proposed for Detention
- Contour Area Calculations (Input for Pond Calculations)
- Pond Calculations

Color	Description	Acreage
	Impervious	0.02
	Grass (A)	1.09
	Total	1.11



N

W DE E

S

Scale 1" = 50'

Date: January 15, 2021

Old Hydes Ferry Pike

Being Parcel 4.01 on Tax Map 62

Ashland City, Cheatham County, Tennessee

DEWEY ENGINEERING

DA Map (Pre-Developed)

1

1 of 1

Color	Description	Acreage
	Impervious to Bio to FA	0.660
	Impervious to Bio to FB	0.340
	Grass (A) to Bio to FA	0.004
	Grass (A) to Bio to FB	0.005
	To Bio	0.100
	Total	1.109

N
W DE E
S

Scale 1" = 50'

Date: January 15, 2021

Old Hydes Ferry Pike

Being Parcel 4.01 on Tax Map 62
Ashland City, Cheatham County, Tennessee

DEWEY ENGINEERING

DA Map (Post-Developed)

1

1 of 1

Appendix D: Pond Calculations
Contour Area Calculations for Bio Area 1

Inputs

Surface Area of Bioretention =	3598	sf
Surface Area of Bottom Bank of Bio =	2224	sf

Contour Area Calculations

Elevation Description	*Elevation*	*Calculation*	*Contour Area*
Bio Invert	398.80	=SA of Bioretention*0.40	1439.20
Top of Storage Layer	399.79	=SA of Bioretention*0.40	1439.20
Bottom of Bio Gravel	399.80	=SA of Bioretention*0.40	1439.20
Top of Bio Gravel	401.79	=SA of Bioretention*0.40	1439.20
Bottom Of Media	401.80	=SA of Bioretention*0.25	899.50
Top of Media	404.79	=SA of Bioretention*0.25	899.50
Bottom of Bank Bio	404.80	=SA of Bottom of Bank of Bioretention + Forebay	2284.00
Top of Bank Bio/Contour	406.80	=SA of Top of Bank of Bioretention + Forebay	4276.00

**Contour Areas and Elevations used in Hydraflow to Model Pond*

Hydraflow Table of Contents

20053 - 2.gpw

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Friday, 01 / 15 / 2021

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	------	-------	1.166	-------	2.229	2.999	4.044	4.848	5.658	Existing to Outfall 1
3	SCS Runoff	------	-------	5.186	-------	7.139	8.413	10.03	11.22	12.39	Proposed to Bio 1 to Outfall 1
4	Reservoir	3	-------	0.000	-------	0.000	0.000	0.497	2.013	5.208	From Bioretention Area

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	1.166	1	724	3,626	------	------	------	Existing to Outfall 1
3	SCS Runoff	5.186	1	715	9,930	------	------	------	Proposed to Bio 1 to Outfall 1
4	Reservoir	0.000	1	931	0	3	404.80	7,033	From Bioretention Area

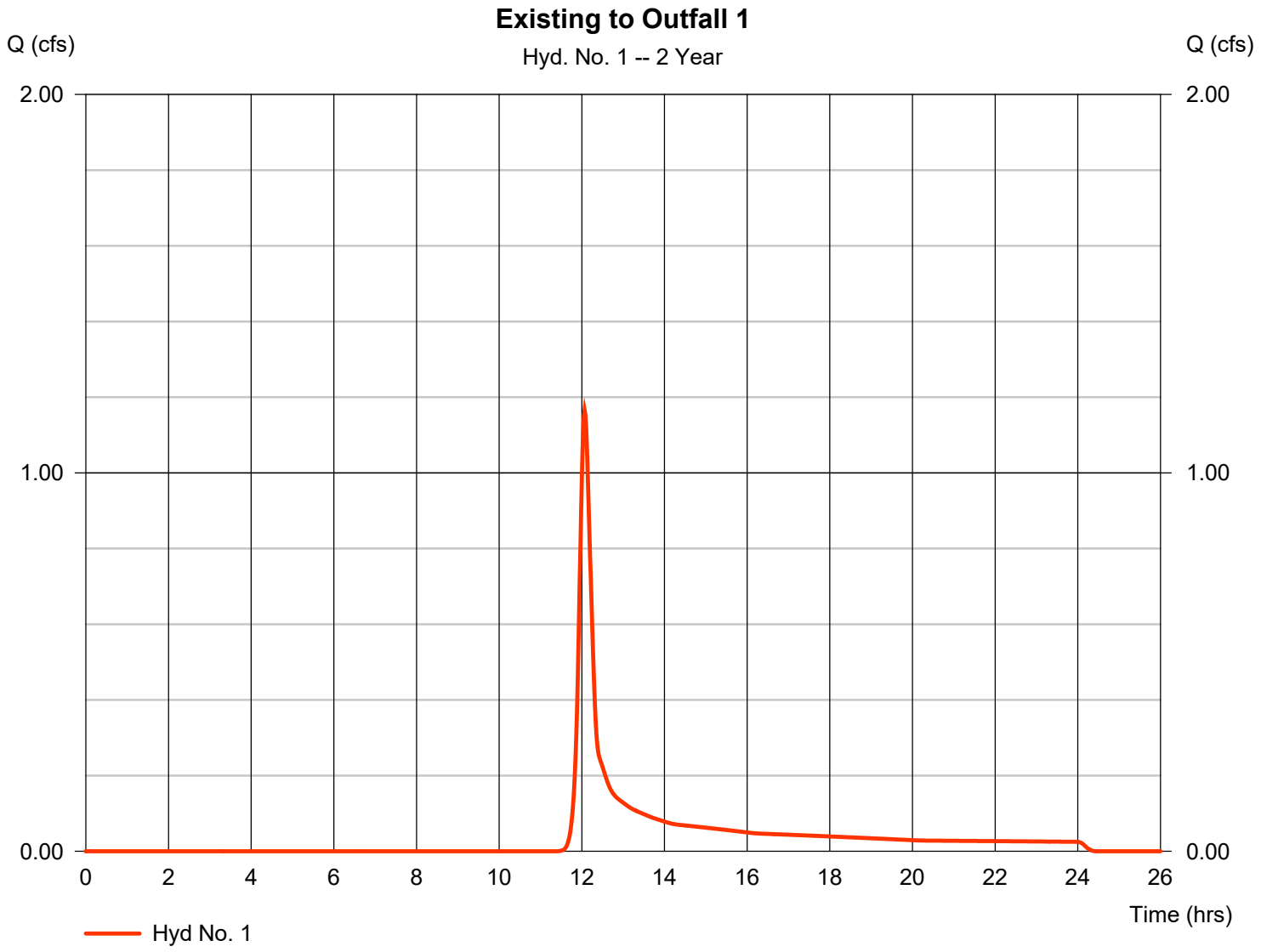
Hydrograph Report

Hyd. No. 1

Existing to Outfall 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.166 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.07 hrs
Time interval	=	1 min	Hyd. volume	=	3,626 cuft
Drainage area	=	1.110 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.10 min
Total precip.	=	3.39 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.020 x 98) + (1.090 x 68)] / 1.110



TR55 Tc Worksheet

Hyd. No. 1

Existing to Outfall 1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.39		0.00		0.00		
Land slope (%)	= 1.00		0.00		0.00		
Travel Time (min)	**= 12.56**	**+**	**0.00**	**+**	**0.00**	**=**	**12.56**
Shallow Concentrated Flow							
Flow length (ft)	= 408.00		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		
Travel Time (min)	**= 2.98**	**+**	**0.00**	**+**	**0.00**	**=**	**2.98**
Channel Flow							
X sectional flow area (sqft)	= 10.00		0.00		0.00		
Wetted perimeter (ft)	= 12.00		0.00		0.00		
Channel slope (%)	= 1.00		0.00		0.00		
Manning's n-value	= 0.025		0.015		0.015		
Velocity (ft/s)	=5.27						
			0.00				
					0.00		
Flow length (ft)	({0})191.0		0.0		0.0		
Travel Time (min)	**= 0.60**	**+**	**0.00**	**+**	**0.00**	**=**	**0.60**

Total Travel Time, Tc ..... 16.10 min

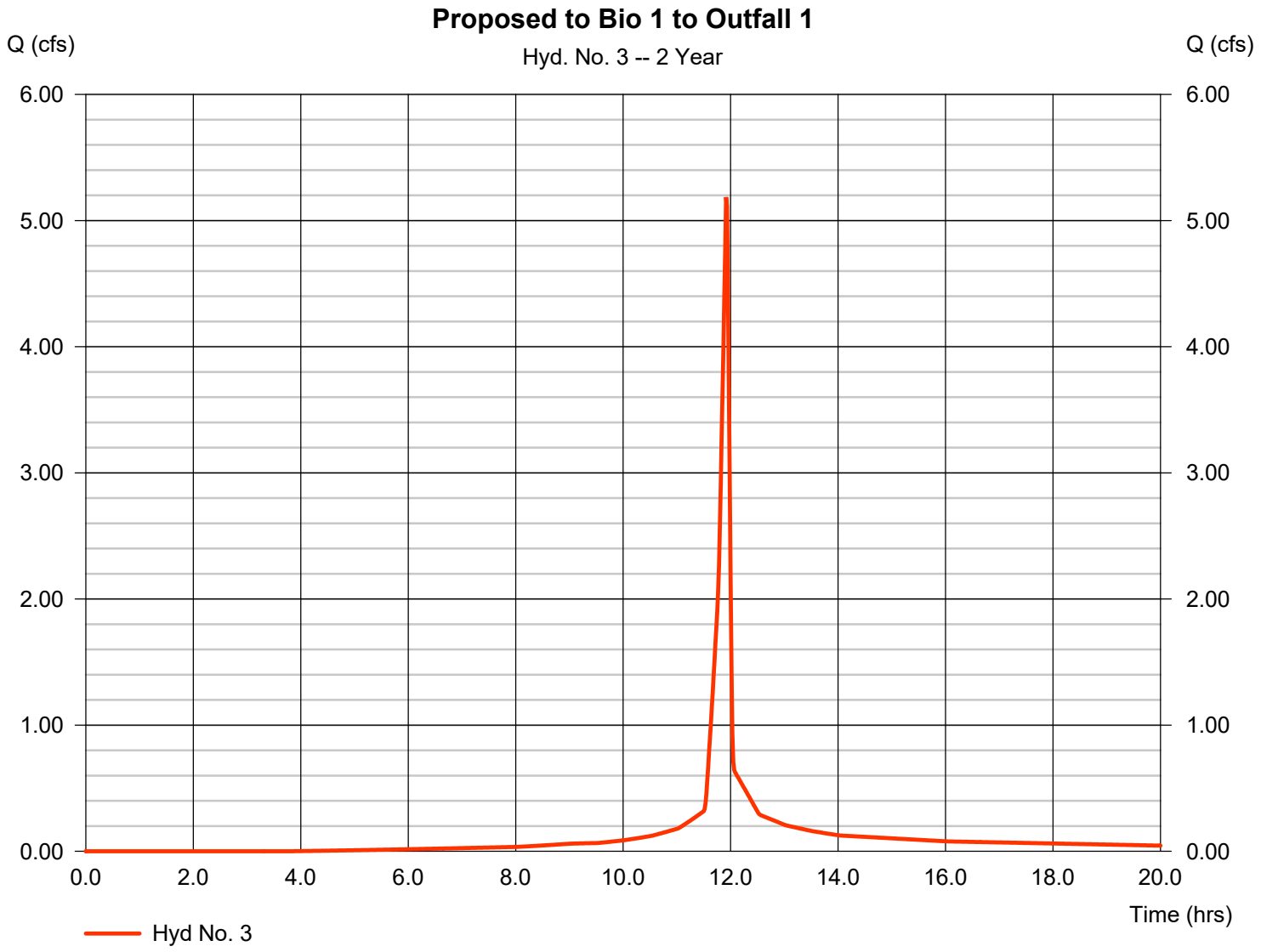
Hydrograph Report

Hyd. No. 3

Proposed to Bio 1 to Outfall 1

Hydrograph type	= SCS Runoff	Peak discharge	= 5.186 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 9,930 cuft
Drainage area	= 1.110 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.10 min
Total precip.	= 3.39 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.009 x 68) + (0.100 x 49)] / 1.110



TR55 Tc Worksheet

Hyd. No. 3

Proposed to Bio 1 to Outfall 1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.013		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.39		0.00		0.00		
Land slope (%)	= 1.00		0.00		0.00		
Travel Time (min)	**= 1.78**	**+**	**0.00**	**+**	**0.00**	**=**	**1.78**
Shallow Concentrated Flow							
Flow length (ft)	= 0.00		0.00		0.00		
Watercourse slope (%)	= 0.00		0.00		0.00		
Surface description	= Paved		Paved		Paved		
Average velocity (ft/s)	=0.00		0.00		0.00		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow							
X sectional flow area (sqft)	= 10.00		0.00		0.00		
Wetted perimeter (ft)	= 10.00		0.00		0.00		
Channel slope (%)	= 1.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=9.93						
			0.00				
					0.00		
Flow length (ft)	({0})179.0		0.0		0.0		
Travel Time (min)	**= 0.30**	**+**	**0.00**	**+**	**0.00**	**=**	**0.30**

Total Travel Time, Tc ..... 2.10 min

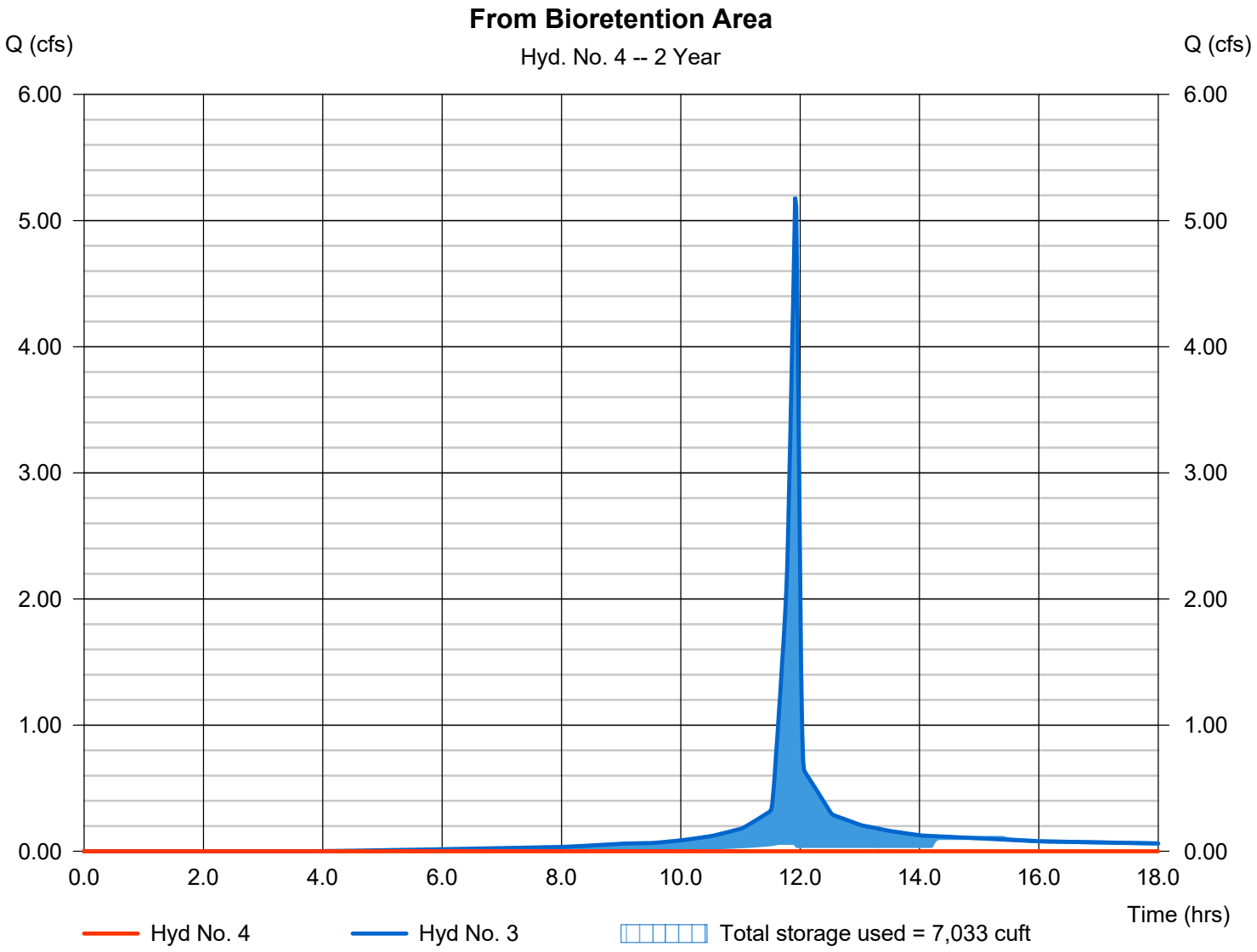
Hydrograph Report

Hyd. No. 4

From Bioretention Area

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	15.52 hrs
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	3 - Proposed to Bio 1 to Outfall	Max. Elevation	=	404.80 ft
Reservoir name	=	Bioretention Area	Max. Storage	=	7,033 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond No. 1 - Bioretention Area

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 398.80 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	398.80	1,439	0	0
0.99	399.79	1,439	1,425	1,425
1.00	399.80	1,439	14	1,439
2.99	401.79	1,439	2,864	4,303
3.00	401.80	900	12	4,314
5.99	404.79	900	2,691	7,005
6.00	404.80	2,284	16	7,021
8.00	406.80	4,276	6,560	13,581

Culvert / Orifice Structures

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

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	0.00	0.00	0.00
Crest El. (ft)	= 406.30	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 2.000 (by Contour)

TW Elev. (ft) = 0.00

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

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	398.80	---	---	---	---	0.00	---	---	---	0.000	---	0.000
0.10	142	398.90	---	---	---	---	0.00	---	---	---	0.007	---	0.007
0.20	285	399.00	---	---	---	---	0.00	---	---	---	0.013	---	0.013
0.30	427	399.10	---	---	---	---	0.00	---	---	---	0.020	---	0.020
0.40	570	399.20	---	---	---	---	0.00	---	---	---	0.027	---	0.027
0.50	712	399.30	---	---	---	---	0.00	---	---	---	0.033	---	0.033
0.59	855	399.39	---	---	---	---	0.00	---	---	---	0.040	---	0.040
0.69	997	399.49	---	---	---	---	0.00	---	---	---	0.047	---	0.047
0.79	1,140	399.59	---	---	---	---	0.00	---	---	---	0.053	---	0.053
0.89	1,282	399.69	---	---	---	---	0.00	---	---	---	0.060	---	0.060
0.99	1,425	399.79	---	---	---	---	0.00	---	---	---	0.067	---	0.067
0.99	1,426	399.79	---	---	---	---	0.00	---	---	---	0.067	---	0.067
0.99	1,428	399.79	---	---	---	---	0.00	---	---	---	0.067	---	0.067
0.99	1,429	399.79	---	---	---	---	0.00	---	---	---	0.067	---	0.067
0.99	1,430	399.79	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.00	1,432	399.80	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.00	1,433	399.80	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.00	1,435	399.80	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.00	1,436	399.80	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.00	1,438	399.80	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.00	1,439	399.80	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.20	1,725	400.00	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.40	2,012	400.20	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.60	2,298	400.40	---	---	---	---	0.00	---	---	---	0.067	---	0.067
1.80	2,584	400.60	---	---	---	---	0.00	---	---	---	0.067	---	0.067
2.00	2,871	400.80	---	---	---	---	0.00	---	---	---	0.067	---	0.067
2.19	3,157	400.99	---	---	---	---	0.00	---	---	---	0.067	---	0.067
2.39	3,444	401.19	---	---	---	---	0.00	---	---	---	0.067	---	0.067
2.59	3,730	401.39	---	---	---	---	0.00	---	---	---	0.067	---	0.067
2.79	4,016	401.59	---	---	---	---	0.00	---	---	---	0.067	---	0.067
2.99	4,303	401.79	---	---	---	---	0.00	---	---	---	0.067	---	0.067
2.99	4,304	401.79	---	---	---	---	0.00	---	---	---	0.064	---	0.064
2.99	4,305	401.79	---	---	---	---	0.00	---	---	---	0.062	---	0.062
2.99	4,306	401.79	---	---	---	---	0.00	---	---	---	0.059	---	0.059
2.99	4,307	401.79	---	---	---	---	0.00	---	---	---	0.057	---	0.057

Continues on next page...

Bioretention Area

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
3.00	4,308	401.80	---	---	---	---	0.00	---	---	---	0.054	---	0.054
3.00	4,310	401.80	---	---	---	---	0.00	---	---	---	0.052	---	0.052
3.00	4,311	401.80	---	---	---	---	0.00	---	---	---	0.049	---	0.049
3.00	4,312	401.80	---	---	---	---	0.00	---	---	---	0.047	---	0.047
3.00	4,313	401.80	---	---	---	---	0.00	---	---	---	0.044	---	0.044
3.00	4,314	401.80	---	---	---	---	0.00	---	---	---	0.042	---	0.042
3.30	4,583	402.10	---	---	---	---	0.00	---	---	---	0.042	---	0.042
3.60	4,853	402.40	---	---	---	---	0.00	---	---	---	0.042	---	0.042
3.90	5,122	402.70	---	---	---	---	0.00	---	---	---	0.042	---	0.042
4.20	5,391	403.00	---	---	---	---	0.00	---	---	---	0.042	---	0.042
4.50	5,660	403.30	---	---	---	---	0.00	---	---	---	0.042	---	0.042
4.79	5,929	403.59	---	---	---	---	0.00	---	---	---	0.042	---	0.042
5.09	6,198	403.89	---	---	---	---	0.00	---	---	---	0.042	---	0.042
5.39	6,467	404.19	---	---	---	---	0.00	---	---	---	0.042	---	0.042
5.69	6,736	404.49	---	---	---	---	0.00	---	---	---	0.042	---	0.042
5.99	7,005	404.79	---	---	---	---	0.00	---	---	---	0.042	---	0.042
5.99	7,007	404.79	---	---	---	---	0.00	---	---	---	0.048	---	0.048
5.99	7,009	404.79	---	---	---	---	0.00	---	---	---	0.054	---	0.054
5.99	7,010	404.79	---	---	---	---	0.00	---	---	---	0.061	---	0.061
5.99	7,012	404.79	---	---	---	---	0.00	---	---	---	0.067	---	0.067
6.00	7,013	404.80	---	---	---	---	0.00	---	---	---	0.074	---	0.074
6.00	7,015	404.80	---	---	---	---	0.00	---	---	---	0.080	---	0.080
6.00	7,016	404.80	---	---	---	---	0.00	---	---	---	0.087	---	0.087
6.00	7,018	404.80	---	---	---	---	0.00	---	---	---	0.093	---	0.093
6.00	7,020	404.80	---	---	---	---	0.00	---	---	---	0.099	---	0.099
6.00	7,021	404.80	---	---	---	---	0.00	---	---	---	0.106	---	0.106
6.20	7,677	405.00	---	---	---	---	0.00	---	---	---	0.115	---	0.115
6.40	8,333	405.20	---	---	---	---	0.00	---	---	---	0.124	---	0.124
6.60	8,989	405.40	---	---	---	---	0.00	---	---	---	0.133	---	0.133
6.80	9,645	405.60	---	---	---	---	0.00	---	---	---	0.143	---	0.143
7.00	10,301	405.80	---	---	---	---	0.00	---	---	---	0.152	---	0.152
7.20	10,957	406.00	---	---	---	---	0.00	---	---	---	0.161	---	0.161
7.40	11,613	406.20	---	---	---	---	0.00	---	---	---	0.170	---	0.170
7.60	12,269	406.40	---	---	---	---	0.66	---	---	---	0.180	---	0.838
7.80	12,925	406.60	---	---	---	---	3.42	---	---	---	0.189	---	3.608
8.00	13,581	406.80	---	---	---	---	7.35	---	---	---	0.198	---	7.552

...End

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	2.229	1	724	6,537	------	------	------	Existing to Outfall 1
3	SCS Runoff	7.139	1	715	14,006	------	------	------	Proposed to Bio 1 to Outfall 1
4	Reservoir	0.000	1	1538	0	3	405.52	9,392	From Bioretention Area

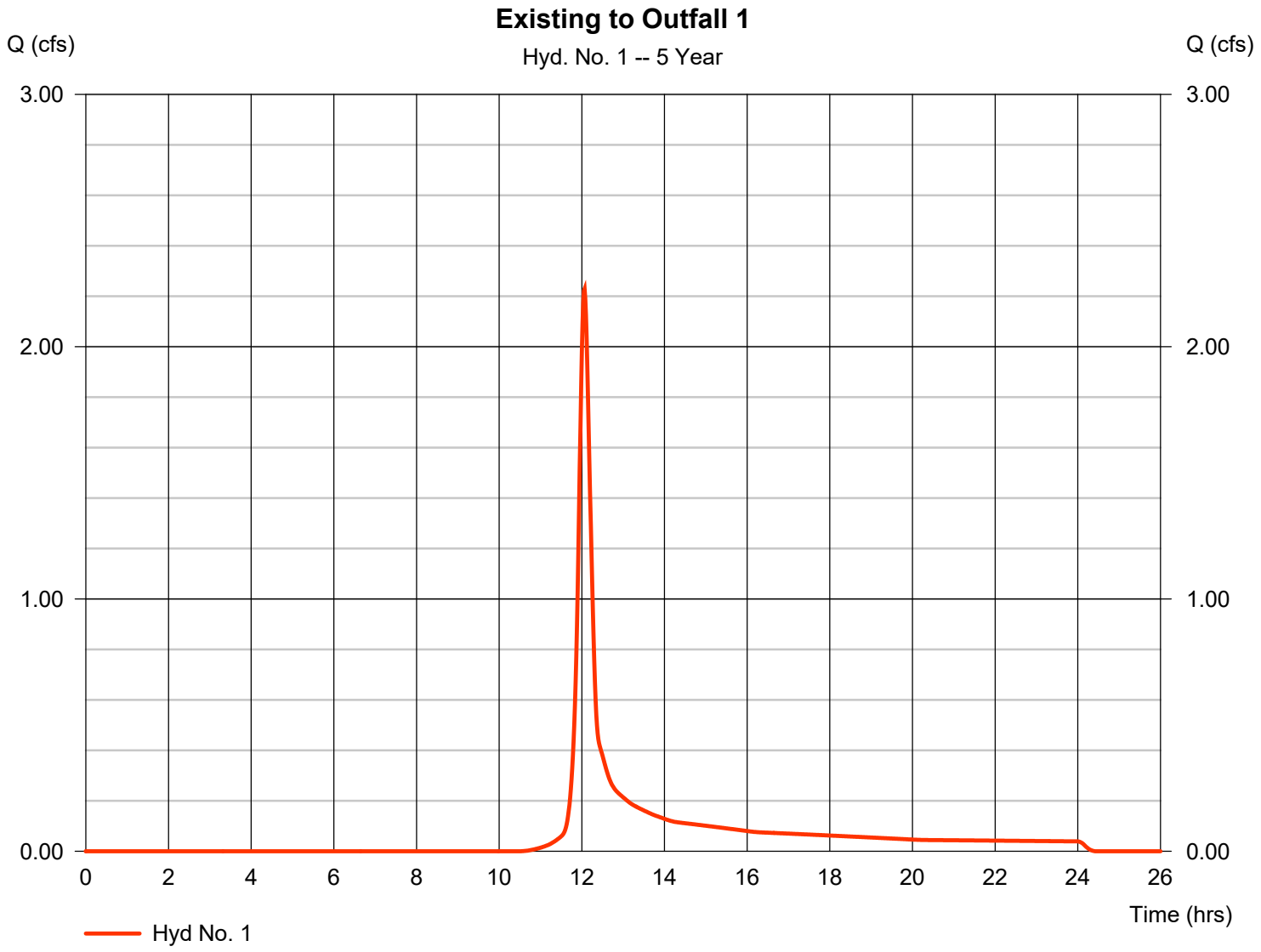
Hydrograph Report

Hyd. No. 1

Existing to Outfall 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.229 cfs
Storm frequency	=	5 yrs	Time to peak	=	12.07 hrs
Time interval	=	1 min	Hyd. volume	=	6,537 cuft
Drainage area	=	1.110 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.10 min
Total precip.	=	4.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.020 x 98) + (1.090 x 68)] / 1.110



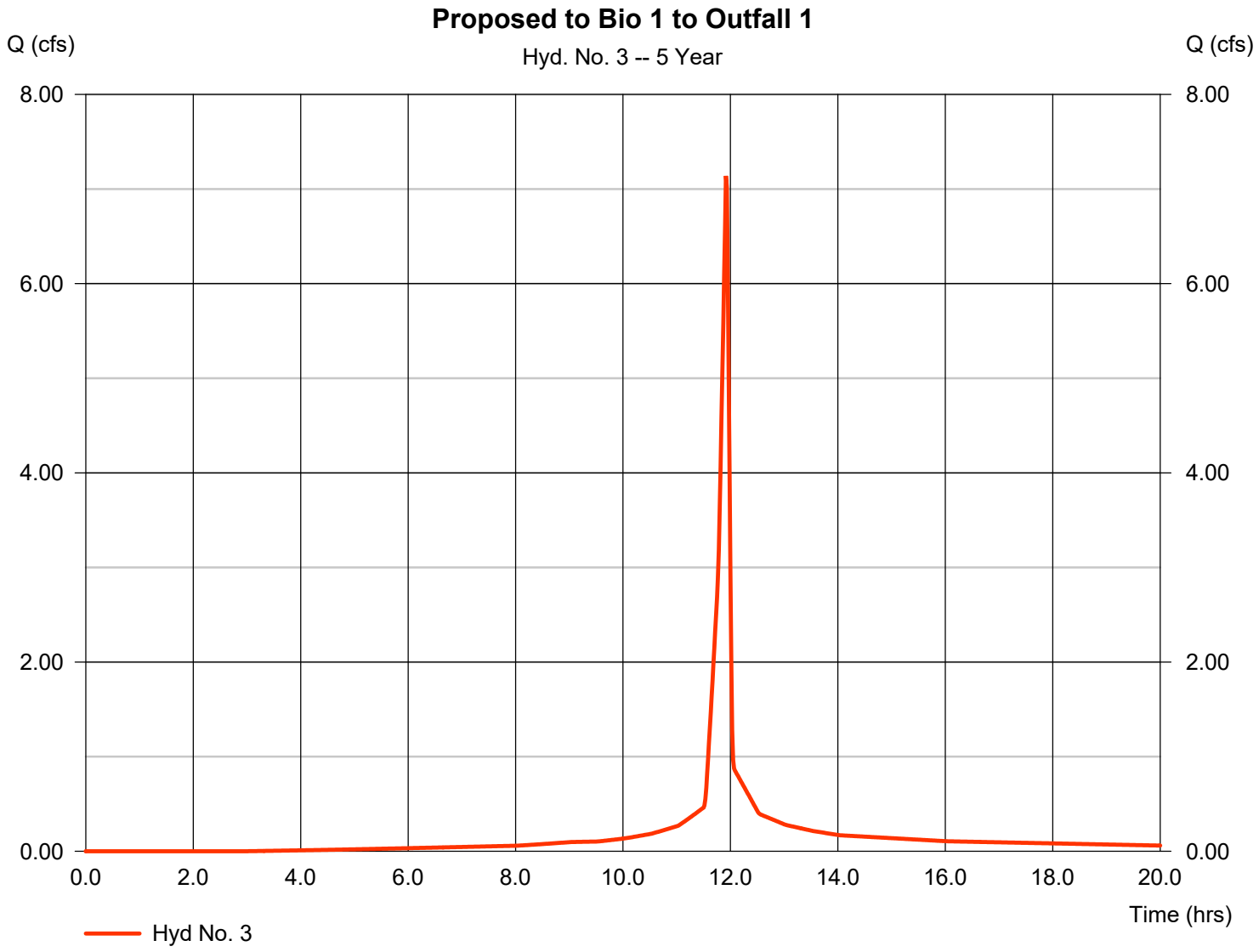
Hydrograph Report

Hyd. No. 3

Proposed to Bio 1 to Outfall 1

Hydrograph type	= SCS Runoff	Peak discharge	= 7.139 cfs
Storm frequency	= 5 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 14,006 cuft
Drainage area	= 1.110 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.10 min
Total precip.	= 4.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.009 x 68) + (0.100 x 49)] / 1.110



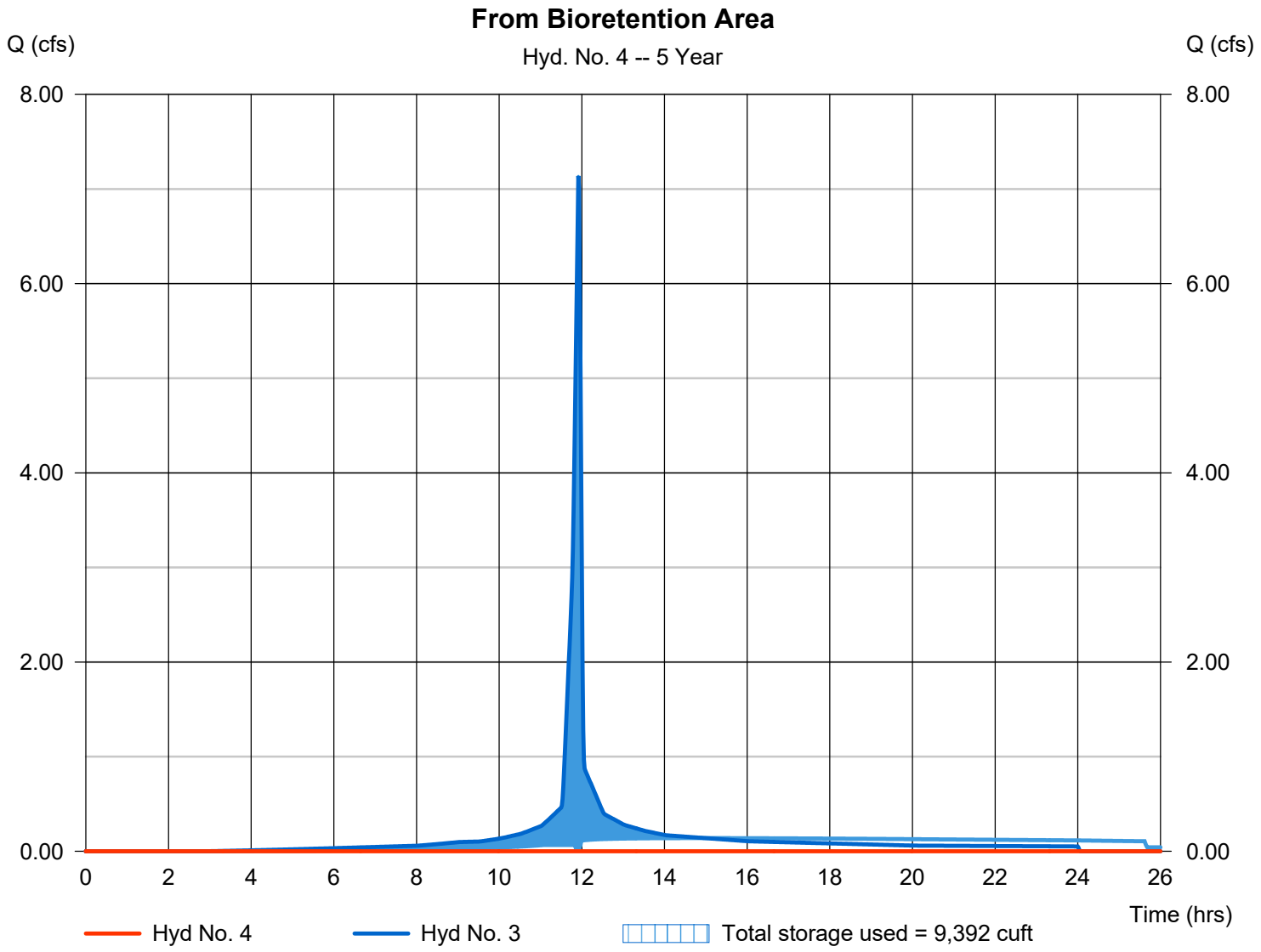
Hydrograph Report

Hyd. No. 4

From Bioretention Area

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	5 yrs	Time to peak	=	25.63 hrs
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	3 - Proposed to Bio 1 to Outfall	Max. Elevation	=	405.52 ft
Reservoir name	=	Bioretention Area	Max. Storage	=	9,392 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	2.999	1	723	8,674	------	------	------	Existing to Outfall 1
3	SCS Runoff	8.413	1	715	16,711	------	------	------	Proposed to Bio 1 to Outfall 1
4	Reservoir	0.000	1	720	0	3	406.09	11,238	From Bioretention Area

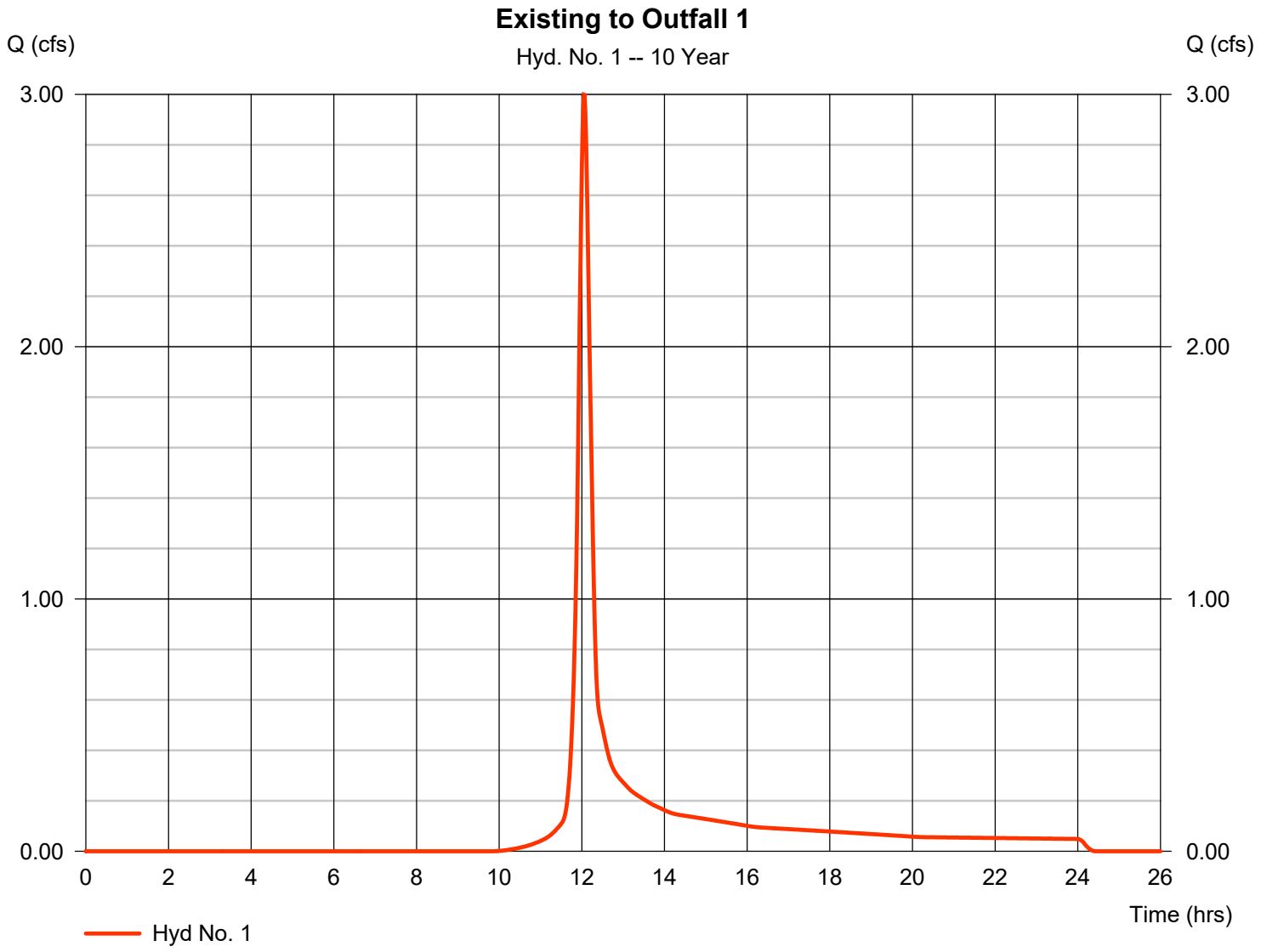
Hydrograph Report

Hyd. No. 1

Existing to Outfall 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.999 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.05 hrs
Time interval	=	1 min	Hyd. volume	=	8,674 cuft
Drainage area	=	1.110 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.10 min
Total precip.	=	5.23 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.020 x 98) + (1.090 x 68)] / 1.110



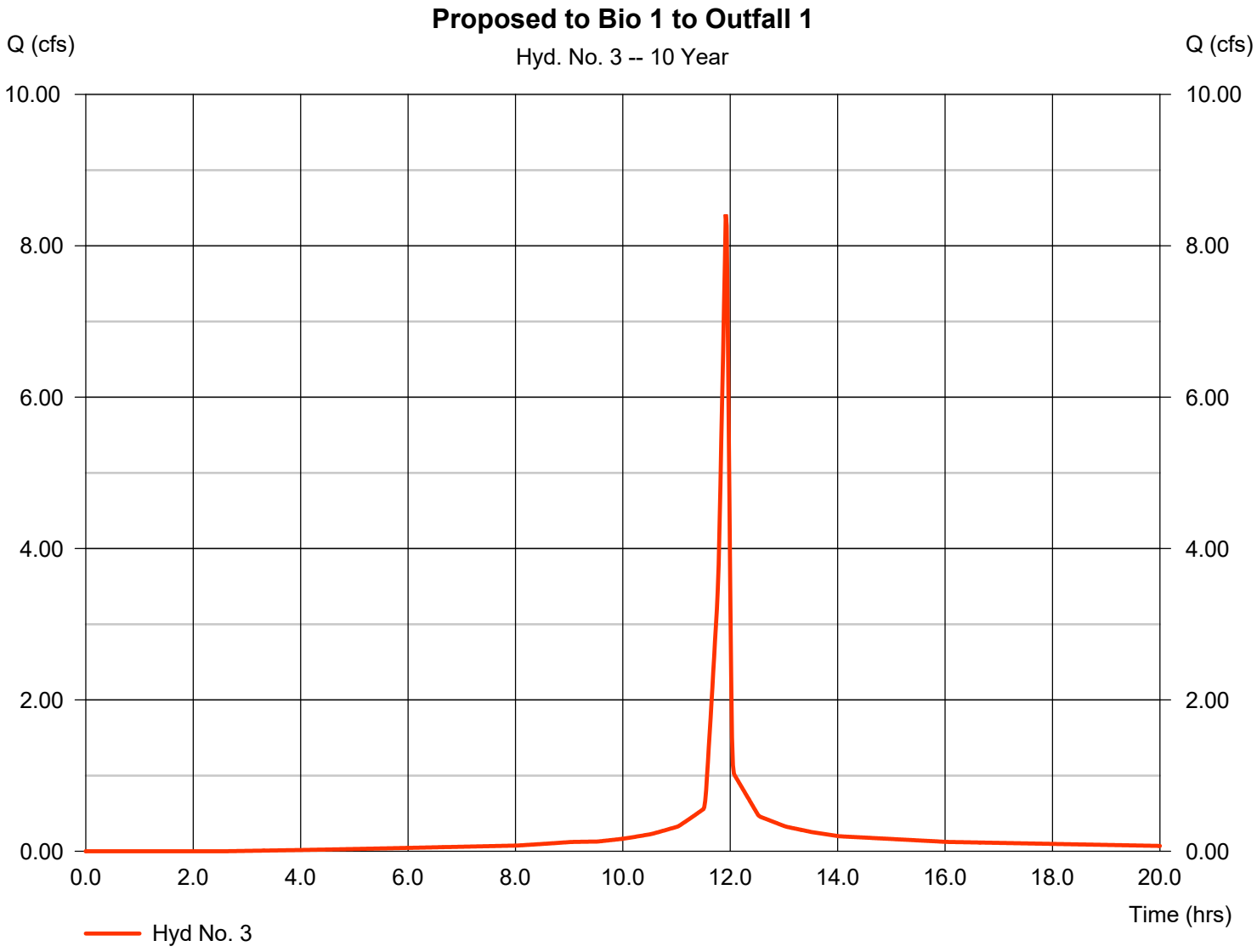
Hydrograph Report

Hyd. No. 3

Proposed to Bio 1 to Outfall 1

Hydrograph type	= SCS Runoff	Peak discharge	= 8.413 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 16,711 cuft
Drainage area	= 1.110 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.10 min
Total precip.	= 5.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.009 x 68) + (0.100 x 49)] / 1.110



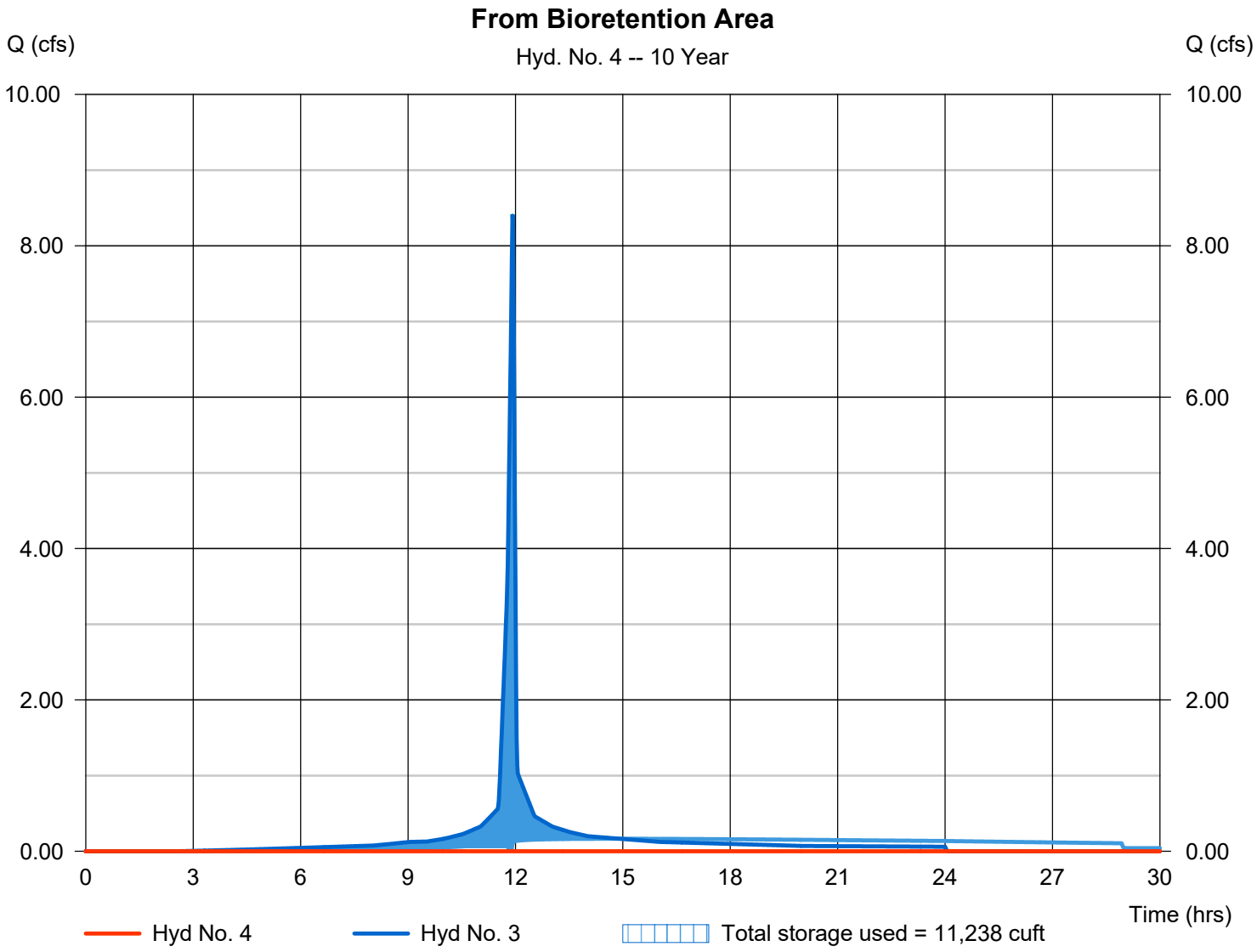
Hydrograph Report

Hyd. No. 4

From Bioretention Area

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	3 - Proposed to Bio 1 to Outfall	Max. Elevation	=	406.09 ft
Reservoir name	=	Bioretention Area	Max. Storage	=	11,238 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	4.044	1	723	11,578	------	------	------	Existing to Outfall 1
3	SCS Runoff	10.03	1	715	20,174	------	------	------	Proposed to Bio 1 to Outfall 1
4	Reservoir	0.497	1	747	2,229	3	406.35	12,108	From Bioretention Area

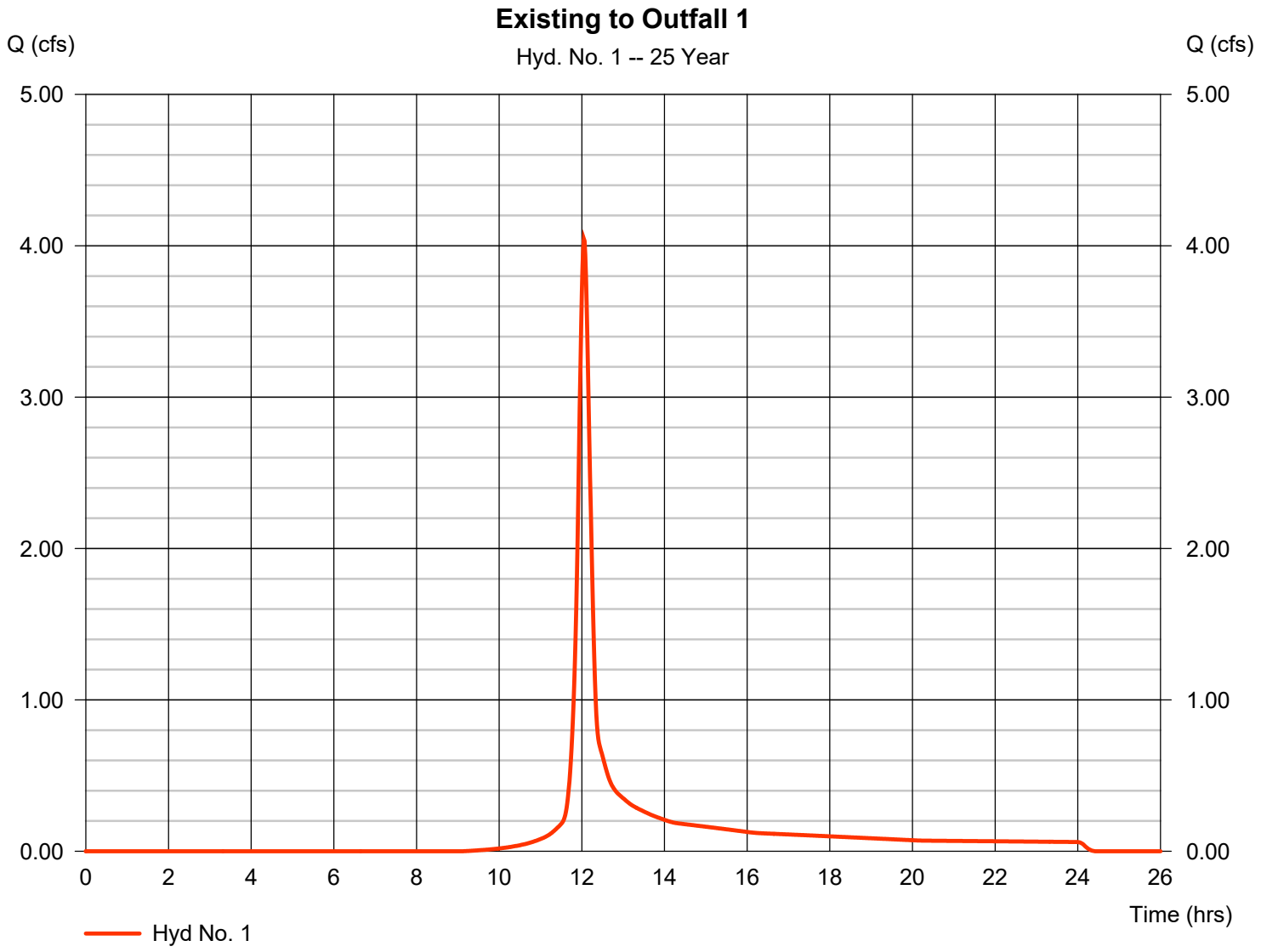
Hydrograph Report

Hyd. No. 1

Existing to Outfall 1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.044 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.05 hrs
Time interval	= 1 min	Hyd. volume	= 11,578 cuft
Drainage area	= 1.110 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.10 min
Total precip.	= 6.16 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98) + (1.090 x 68)] / 1.110



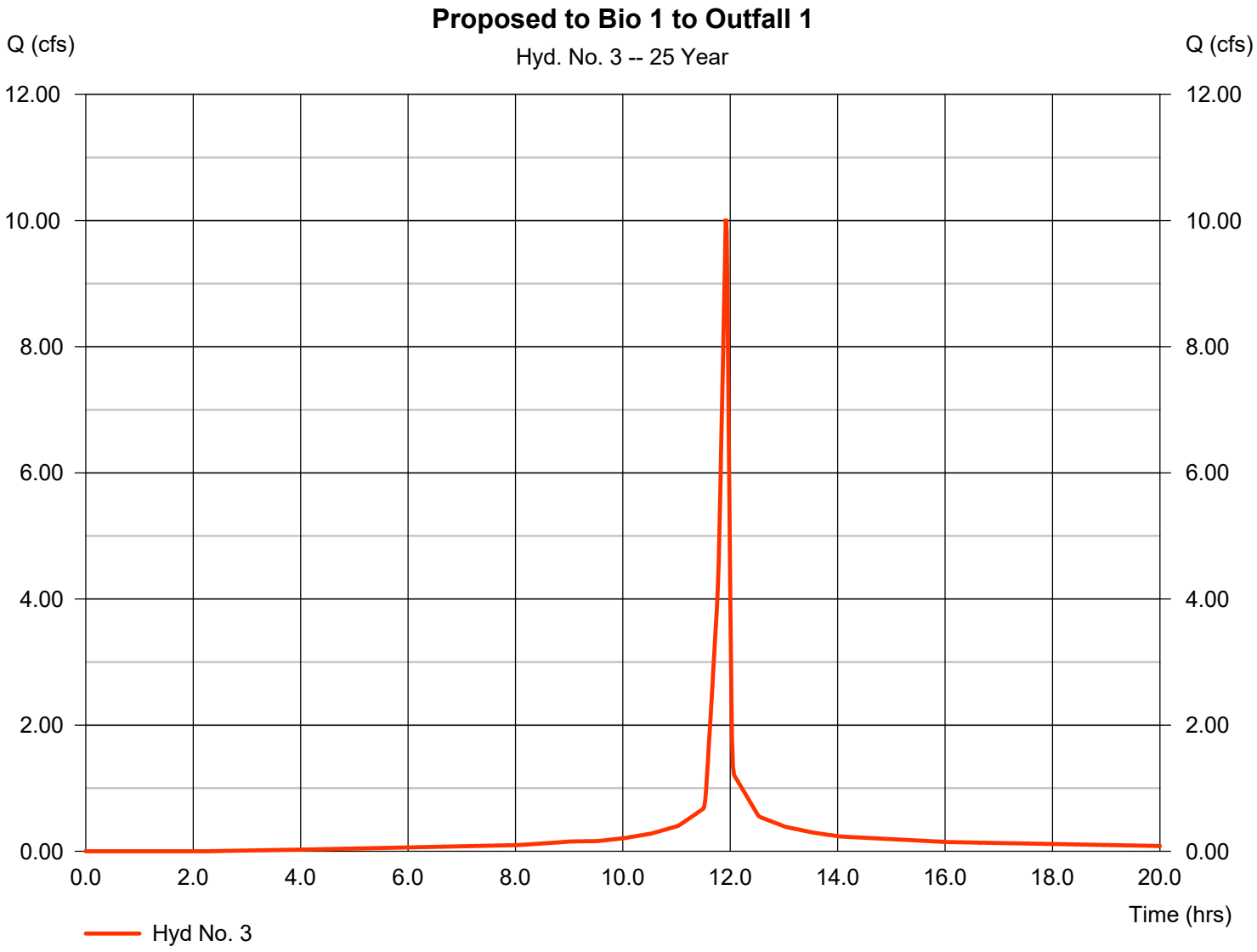
Hydrograph Report

Hyd. No. 3

Proposed to Bio 1 to Outfall 1

Hydrograph type	= SCS Runoff	Peak discharge	= 10.03 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 20,174 cuft
Drainage area	= 1.110 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.10 min
Total precip.	= 6.16 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.009 x 68) + (0.100 x 49)] / 1.110



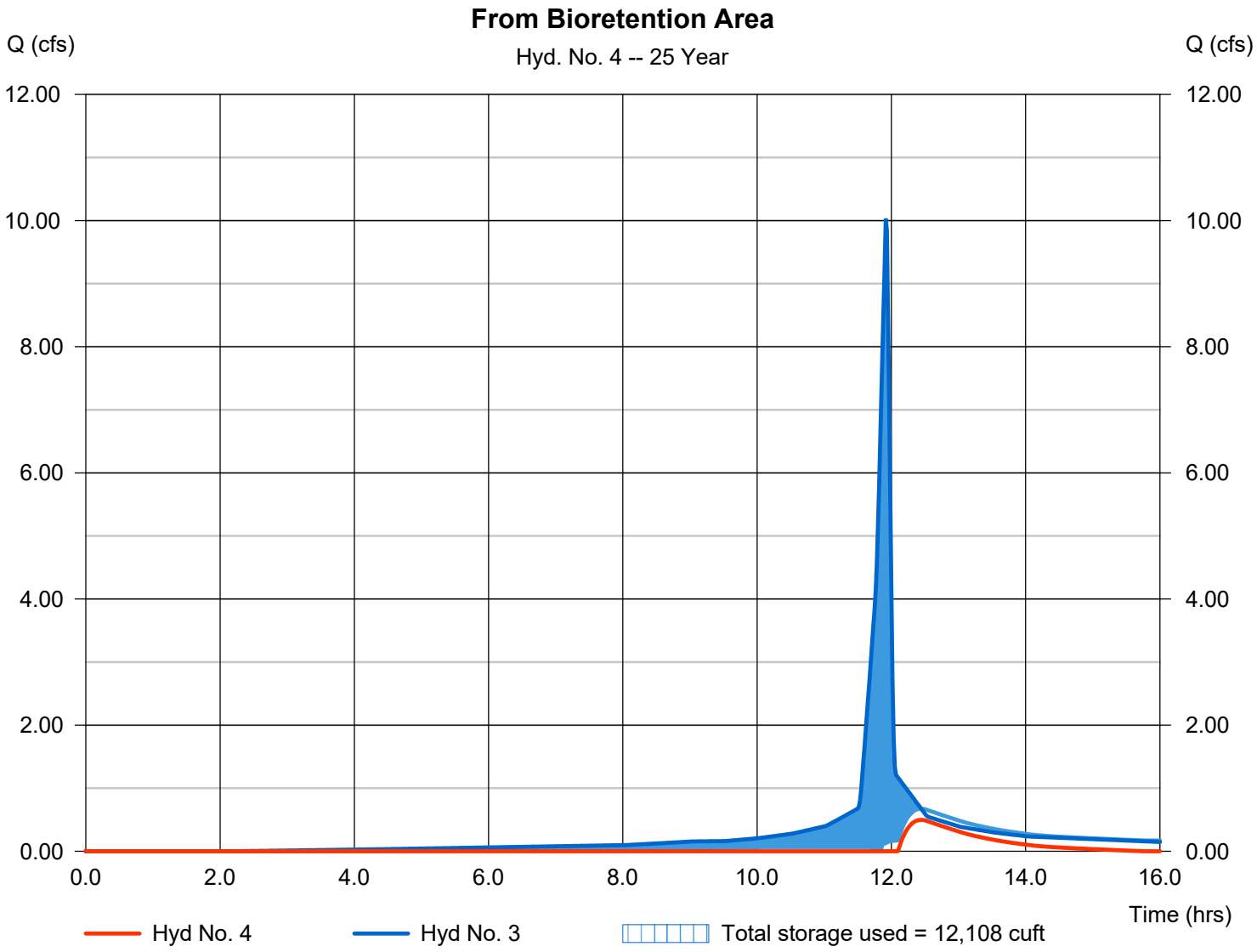
Hydrograph Report

Hyd. No. 4

From Bioretention Area

Hydrograph type	=	Reservoir	Peak discharge	=	0.497 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.45 hrs
Time interval	=	1 min	Hyd. volume	=	2,229 cuft
Inflow hyd. No.	=	3 - Proposed to Bio 1 to Outfall	Max. Elevation	=	406.35 ft
Reservoir name	=	Bioretention Area	Max. Storage	=	12,108 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	4.848	1	723	13,836	------	------	------	Existing to Outfall 1
3	SCS Runoff	11.22	1	715	22,751	------	------	------	Proposed to Bio 1 to Outfall 1
4	Reservoir	2.013	1	722	4,315	3	406.50	12,591	From Bioretention Area

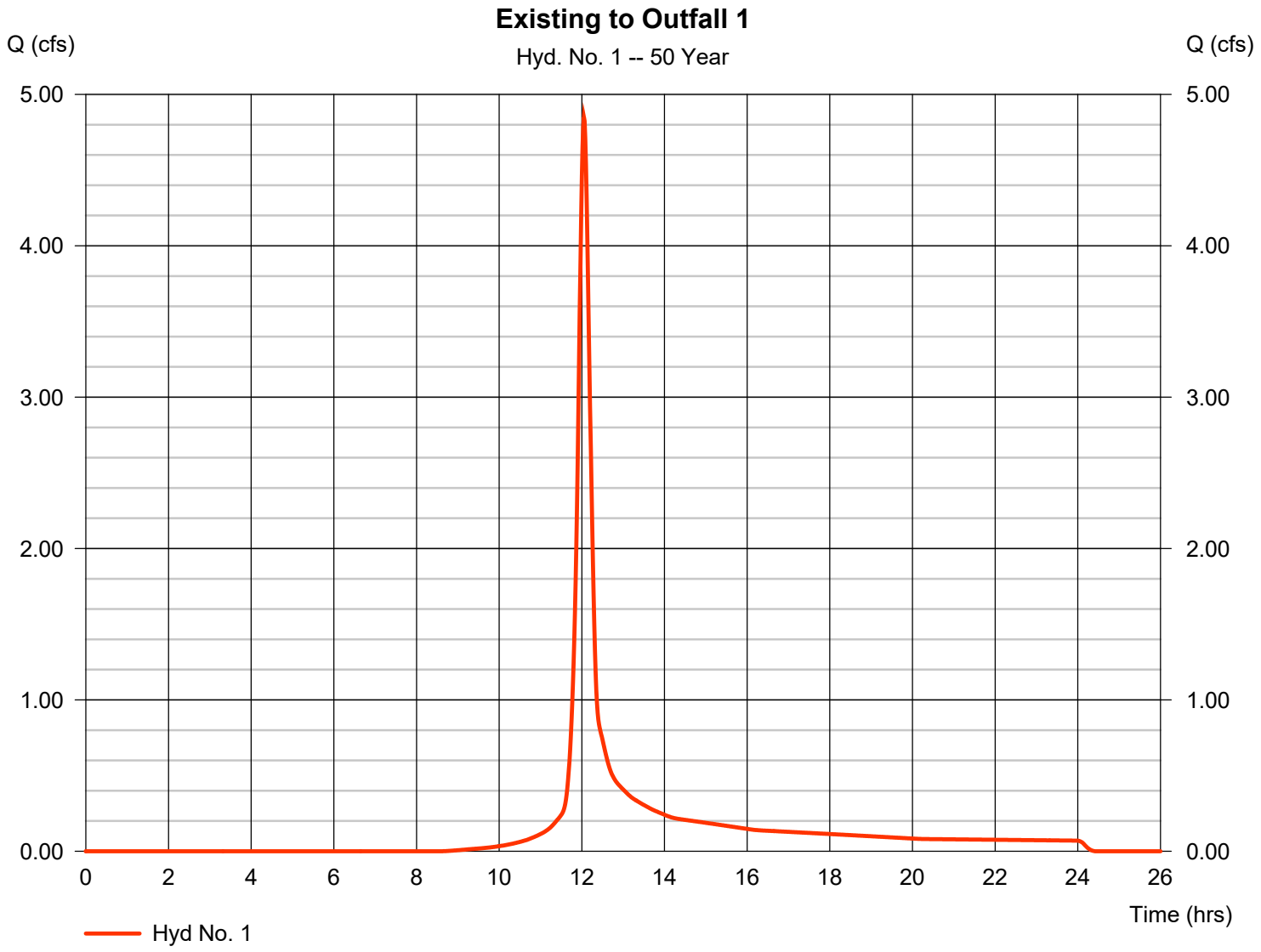
Hydrograph Report

Hyd. No. 1

Existing to Outfall 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.848 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.05 hrs
Time interval	=	1 min	Hyd. volume	=	13,836 cuft
Drainage area	=	1.110 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.10 min
Total precip.	=	6.85 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.020 x 98) + (1.090 x 68)] / 1.110



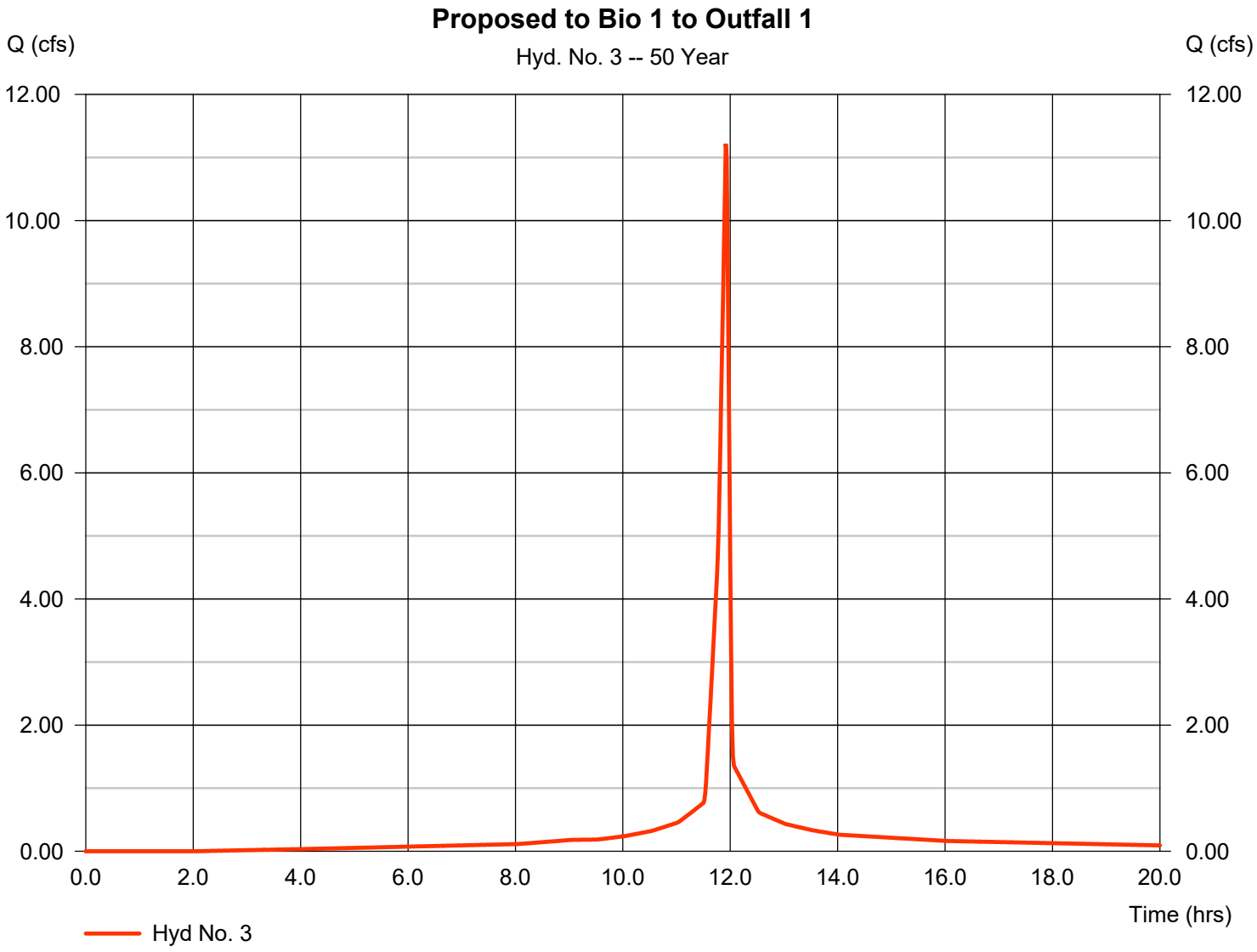
Hydrograph Report

Hyd. No. 3

Proposed to Bio 1 to Outfall 1

Hydrograph type	= SCS Runoff	Peak discharge	= 11.22 cfs
Storm frequency	= 50 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 22,751 cuft
Drainage area	= 1.110 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.10 min
Total precip.	= 6.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.009 x 68) + (0.100 x 49)] / 1.110



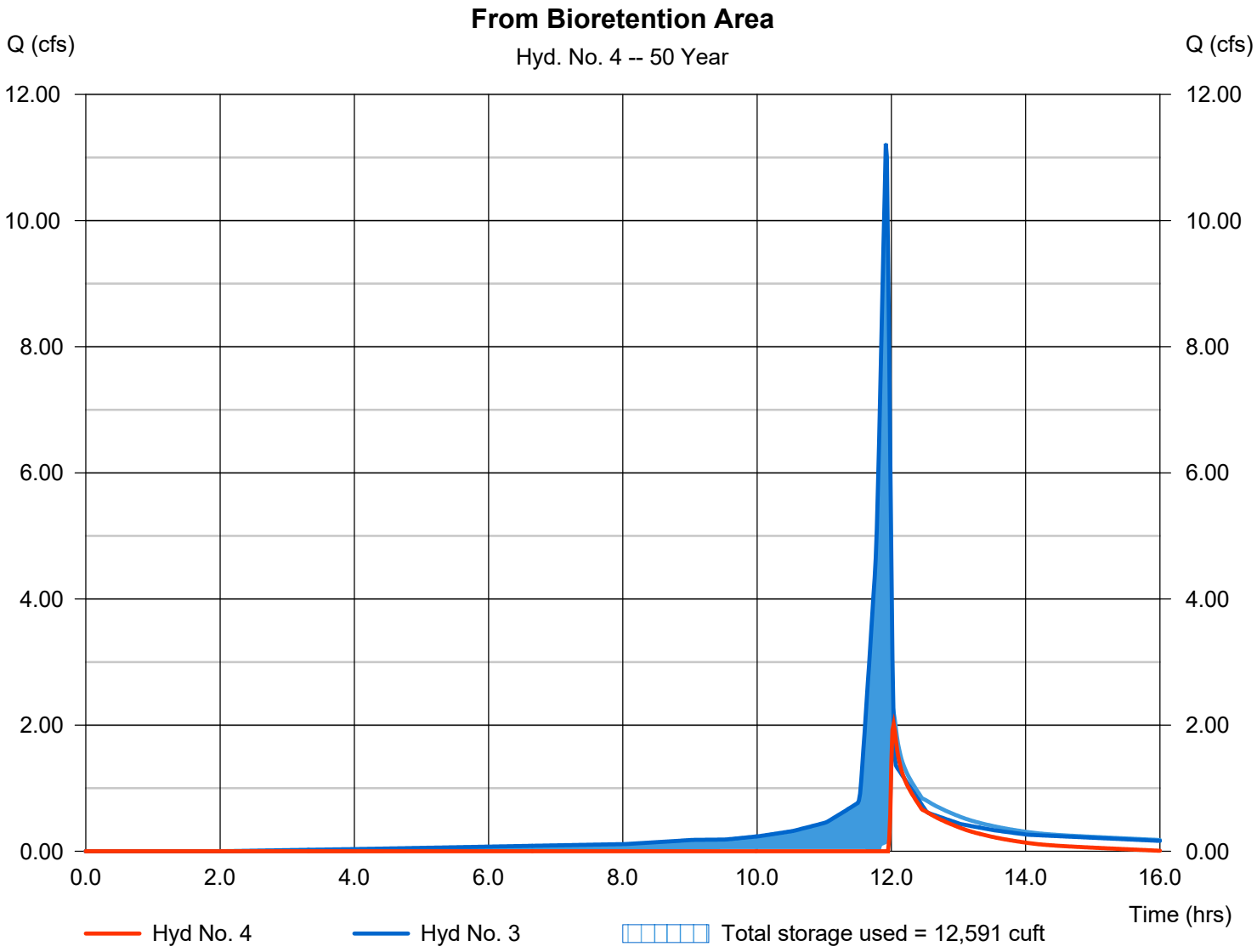
Hydrograph Report

Hyd. No. 4

From Bioretention Area

Hydrograph type	=	Reservoir	Peak discharge	=	2.013 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.03 hrs
Time interval	=	1 min	Hyd. volume	=	4,315 cuft
Inflow hyd. No.	=	3 - Proposed to Bio 1 to Outfall	Max. Elevation	=	406.50 ft
Reservoir name	=	Bioretention Area	Max. Storage	=	12,591 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	5.658	1	723	16,128	------	------	------	Existing to Outfall 1
3	SCS Runoff	12.39	1	715	25,296	------	------	------	Proposed to Bio 1 to Outfall 1
4	Reservoir	5.208	1	720	6,428	3	406.69	13,223	From Bioretention Area

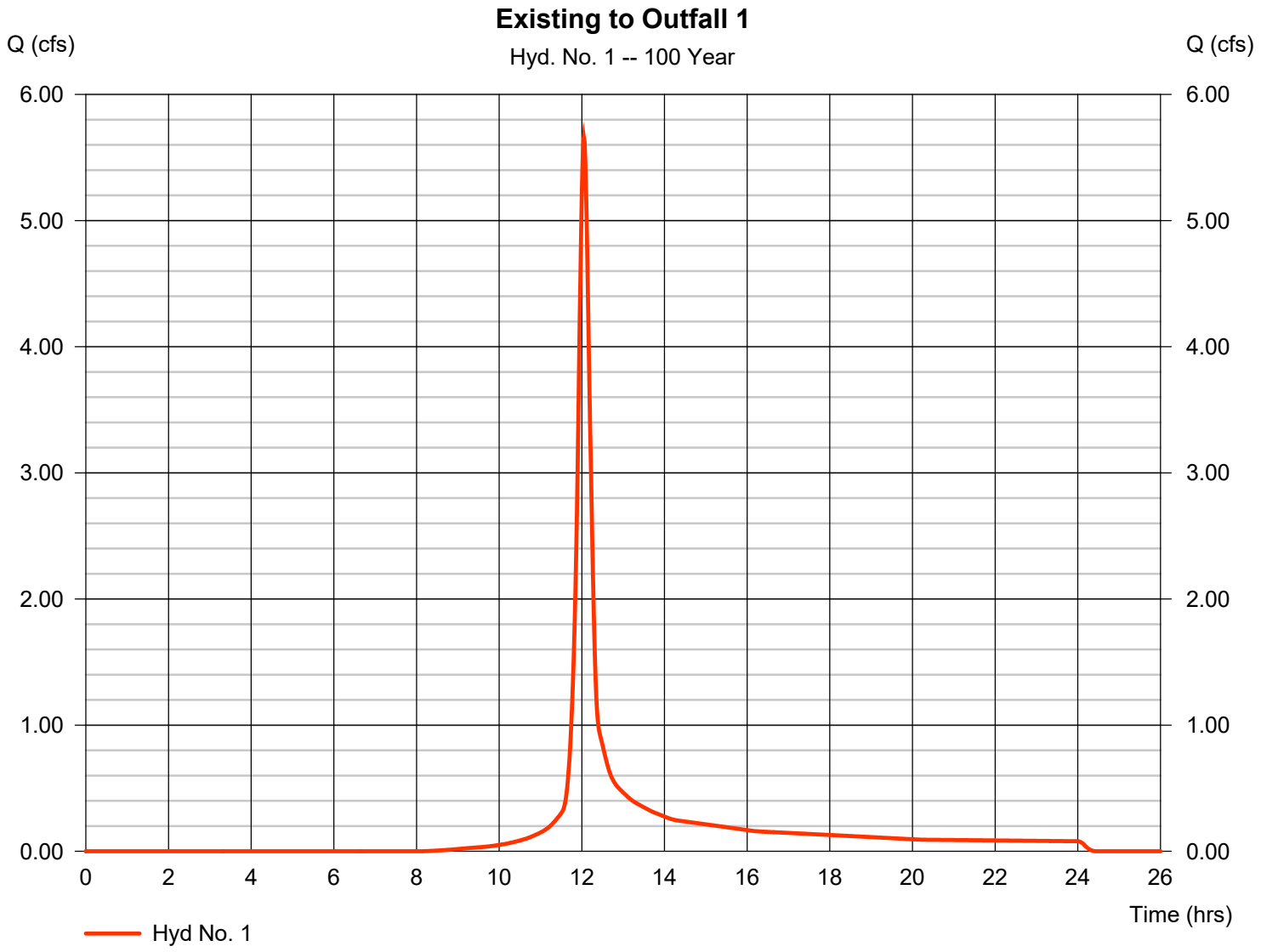
Hydrograph Report

Hyd. No. 1

Existing to Outfall 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.658 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.05 hrs
Time interval	=	1 min	Hyd. volume	=	16,128 cuft
Drainage area	=	1.110 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.10 min
Total precip.	=	7.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.020 x 98) + (1.090 x 68)] / 1.110



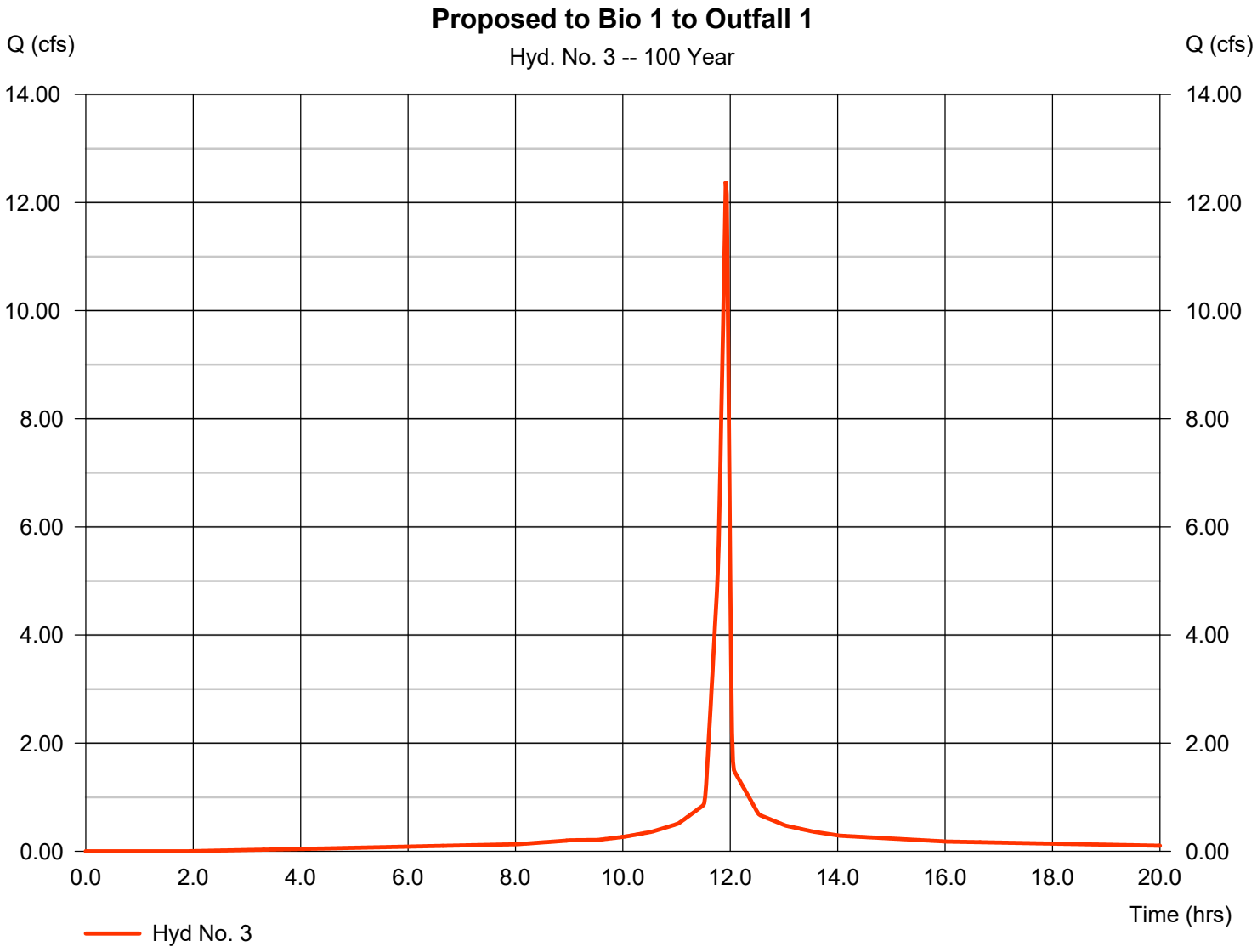
Hydrograph Report

Hyd. No. 3

Proposed to Bio 1 to Outfall 1

Hydrograph type	= SCS Runoff	Peak discharge	= 12.39 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 25,296 cuft
Drainage area	= 1.110 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.10 min
Total precip.	= 7.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.009 x 68) + (0.100 x 49)] / 1.110



Hydrograph Report

Hyd. No. 4

From Bioretention Area

Hydrograph type	=	Reservoir	Peak discharge	=	5.208 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.00 hrs
Time interval	=	1 min	Hyd. volume	=	6,428 cuft
Inflow hyd. No.	=	3 - Proposed to Bio 1 to Outfall	Max. Elevation	=	406.69 ft
Reservoir name	=	Bioretention Area	Max. Storage	=	13,223 cuft

Storage Indication method used. Exfiltration extracted from Outflow.