COMMERCIAL SITE DESIGN

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Stormwater Management & Sediment/Erosion Control Report

Submitted to:
Town of Zebulon, NC & Wake County, NC

Prepared for:
COOKOUT
1200 N Arendell Avenue
Zebulon, NC 27597

CSD Project No: OUT-1502

VICINITY MAP
NTS

Prepared by:
COMMERCIAL SITE DESIGN, PLLC
8312 Creedmoor Road
Raleigh, North Carolina 27613

Date: 10/24/2022
Rev. 7/21/2023
Rev. 11/6/2023

SAMBATEK NC P.C. REGISTERED CORPORATION C-4993 NORTH CAROLINA RALEIGH, NORTH CAROLINA

NORTH CAROLINA PROFESSIONAL SEAL 041458 ENGINEER JUSTIN W. ROHDE
11/06/2023

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List of Appendices:

Project Narrative

This report addresses stormwater runoff quantity volume control, water quality treatment and peak flow reduction for site improvements of an existing site in Zebulon, NC. The property is located on N. Arendell Ave. +/-900LF northeast of US-64. The property coordinates are 35° 50' 12.336" N; 78° 19' 18.876" W. The existing property is an undeveloped open space area. The proposed development of this site includes the construction of a 4,625 SF single-story fast-food restaurant with associated parking. The total site area is 83,368 SF with 0 SF of existing impervious area. After proposed development the site consists of 48,983 SF of impervious area.

Adjacent Areas

The site is bounded by commercial development. Limits of disturbance for this project remain on-site with the exception of utility connections.

Existing Conditions

The on-site runoff sheet flows from the center of the property and sheet flows off-site. Proposed development maintains existent drainage patterns.

Site Area = 83,368 SF
Existing Open Space = 83,368 SF
Existing Impervious = 0 SF

The USDA Soils Survey mapping included in Appendix A shows that the soils on-site are primarily Ur – Urban Land and WeB – Wedowee sandy loam, 2 to 6 percent slopes, both belonging to Hydrologic Soil Group D.

Proposed Conditions

The proposed development consist of a single-story 4,625 SF building with curb islands and associated parking. The development will result in 48,983 SF of impervious surface area being added to the site. In the post-development condition, stormwater runoff enters a proposed stormwater conveyance system then flows into an underground detention system. A portion of the detained runoff is directed through a Contech StormFilter water quality device, prior to exiting the site. Runoff volumes in excess of the water quality volume are detained and released at or below pre-development flow rates via the use of a multistage outlet control structure. The outlet pipe from the outlet control structure daylights in the rear of property along Jones Street.

Site Area = 83,368 SF
Proposed Open Space = 34,385 SF
Proposed Impervious = 48,983 SF

Critical Erosion Areas

The most critical erosion area will be the surface of the working areas during construction operations. If grass is not established on dormant denuded areas then there is a significant potential for the covered areas to be eroded and for sediment to be carried in the runoff. To minimize the potential for erosion, covered areas that are temporarily inactive will be seeded within 14 working days after placement of the soil cover.

Erosion and Sediment Control Measures

All vegetative practices and erosion and sediment control features shall be designed, constructed, and maintained in accordance with the NCDEQ Erosion and Sediment Control and Wake County requirements. The erosion and sediment control plan shall be kept on site in a mailbox type structure located immediately adjacent to the posted permits if needed. Sediment shall be removed from the sediment control structures as necessary, but at a minimum of when the design capacity of each structure is reduced by 50%. Plan-view drawings with details and these same requirements are provided.

Silt Fence

Sediment fences will be provided down gradient of the proposed site grading at the locations shown on the drawings. Silt fences are not to be used across channels or in areas of concentrated flows.

Vegetative Stabilization

Vegetative cover shall be re-established within 14 calendar days after completion of the activity. Refer to plans for temporary and permanent seeding schedule and specifications.

Temporary Stabilization

Disturbed areas will be vegetated in accordance with NCDEQ Erosion and Sediment Control and Wake County requirements. Temporary control features will remain in place and will be maintained until the up-gradient disturbed area has been stabilized with vegetative cover.

Construction Sequence

The contractor is responsible for ensuring that erosion is minimized and that compliance with all applicable federal, state, and local laws, regulations, and ordinances are maintained throughout execution of this project.

Phase 1:

1. Obtain a land disturbing permit. Schedule a pre-construction meeting.
2. Install gravel construction pad, temporary diversions, silt fence, or other measures as shown on the approved plan. Clear only as necessary to install these devices. Seed temporary diversions and berms immediately after construction. See detail on seeding schedule. Contractor shall begin with sediment fencing and all other sediment containment devices followed by all diversion and by-pass ditches/berms and approved inlet protection devices.
3. Contact Karyn Pageu @ 919-786-8769 for a compliance inspection immediately following installation of the temporary sediment control devices and prior to mass grading of the site.

Phase 2:

1. Begin clearing/grubbing and general excavation on site. It is the responsibility of the contractor to phase/stage erosion control to allow for construction.

   Note: Contractor shall inspect and repair all erosion devices at least once a week and after every rainfall. Grading activity shall be prohibited in the areas of the sediment control devices until the areas upstream of these devices have been stabilized and approved.

2. Begin installing upstream storm drainage system. Install approved inlet protection. Additional measures may be required by the inspector due to the routing of the storm drainage system and actual field conditions.

   Note: the contractor shall ensure that the erosion control devices remain undisturbed during construction of the building pads and associated parking/drive areas adjacent to these devices until the contributing upstream areas have been stabilized and approved. Erosion control measures shall not be removed until approval from the environmental inspector.
3. Stabilize site as areas are brought up to finish grade with vegetation, paving, ditch linings, etc. Seed and mulch denuded areas within 14 working days or 30 calendar days after completion of any phase of construction, whichever period is stabilized. All areas shall be stabilized within 30 days.

   Note: the contractor shall ensure that the erosion control devices remain undisturbed during construction of the building pads and associated parking/drive areas adjacent to these devices until the contributing upstream areas have been stabilized and approved.

Phase 3:

1. When construction is complete and all areas are stabilized completely, call for inspection by environmental inspector. When site is approved, remove silt fencing, inlet protection, etc. and seed or pave any resulting bare areas. All remaining permanent erosion control devices, such as outlet protection and permanent swale vegetation, should now be installed or brought online.
2. When vegetation has become established, call for a final site inspection by the environmental inspector. Obtain a certificate of completion.

Temporary Erosion and Sediment Control Maintenance

All erosion and sediment control measures will be checked for stability and operation following every runoff-producing rainfall but in no case less than twice every week, at least 72 hours apart. Any needed repairs will be made immediately to maintain all measures as designed.

Sediment fences and inlet protection shall be inspected at least twice every week, at least 72 hours apart. Repairs shall be made immediately. Sediment deposits shall be removed as needed to provide adequate storage volume for the next rainfall event, and to reduce pressure on the fence. Fencing materials and sediment deposits shall be removed, and the area brought to grade following stabilization of up gradient disturbed areas.

Proposed Stormwater Management Requirements

The stormwater management controls proposed provide water quantity volume control, peak flow reduction and water quality treatment. The Appendices of this report provide detailed information regarding the hydrology and water quality improvements for the pre- and post-development conditions for the site.

Water Quantity Control Requirements and Compliance Methods

This project is located within the City of Zebulon city limits and is subject to the City of Zebulon Code of Ordinances Chapter 151 – Stormwater. Per Chapter 151.35, high-density projects shall control and treat runoff from the first inch of rainfall, and shall feature BMPs designed to ensure no net increase in peak flow rates leaving the site from the pre-development conditions for the one-year, 24-hour storm. Additionally, per Chapter 151.36 (A), a downstream impact analysis shall be performed to ensure the project will not cause any negative impacts on flooding or channel degradation downstream of the project site.

In order to address these water quantity control requirements, this project proposes to install an underground detention system with a multi-stage outlet control structure. Stormwater flows have been modeled for on-site and off-site pre- and post-development flow rates to ensure compliance with the above stated regulations. In the post-development conditions, the 1-year and 10-year 24-hour flow rates are controlled to below the pre-development conditions at each respective analysis point, as indicated on the Downstream Drainage Analysis Map within Appendix F. Please see Appendix B for supporting on and off-site water quantity calculations and further information.

Water Quality Treatment Requirements

The project is located within the Neuse River watershed basin and is subject to water quality treatment requirements listed in the City of Zebulon Code of Ordinances, Chapter 151.35 (D) consisting of treatment to remove 85% TSS from the first 1.0" of rainfall on-site. Post-construction runoff will be treated with a primary SCM (Contech StormFilter) which will provide the TSS treatment requirements per the City of Zebulon Ordinances. The StormFilter will be designed and sized in accordance with NCDEQ minimum design criteria listed in the NCDEQ Stormwater Design Manual, chapter D-1. See Appendix C and D for details.

Downstream Impact Analysis

A downstream impact analysis was performed in accordance with section 151.36 of the Zebulon Code of Ordinances to ensure there are no impacts on flooding or channel degradation downstream as a result of this project. Topographic mapping of the site as well as the downstream drainage areas was reviewed during the preparation of this analysis. Two downstream drainage areas and analysis points were identified and modeled using Hydraflows Hydrographs and the NRCS SCS-Method. Pre-development and post-development hydrograph models were prepared and used to confirm there were no increases in the 10-year, 24-hour storm flow rates at the site boundaries nor at the downstream analysis points. Please see the summary of findings below, as well as the attached Hydraflows Hydrograph calculations (Appendix B) and Downstream Impact Analysis exhibit figure (Appendix F).

10-Year, 24-Hour Storm Peak Flow Summary Table:				
Analysis Point:	DA-1 (On-Site)	DA-1 (Downstream)	DA-2 (On-Site)	DA-2 (Downstream)
Pre-Development	3.48 CFS	15.88 CFS	4.82 CFS	32.71 CFS
Post-Development	1.12 CFS	14.35 CFS	2.56 CFS	32.71 CFS

Calculation Methodology

- The rainfall data was taken from NOAA Atlas 14. This rainfall depth was then input into Hydraflow 2017 along with a CN using the SCS method for pre- and post-development flow rates. Please reference the Appendix B within this report for additional information.
- Soils data for the site was taken from the NRCS USDA web soil survey website (http://websoilsurvey.nrcs.usda.gov/). Please reference the miscellaneous site data section within this report for additional information.
- The on- and off-site topography used in the analysis is from a field survey by Commercial Site Design.

Stormwater SCM Maintenance

Frequent, thorough, and consistent inspections and maintenance are critical to the successful operation of the stormwater control measures. Inspections reveal the operational status of the system and identify needed maintenance actions. Therefore, the individuals responsible for inspecting and maintaining the SCM should thoroughly understand the stormwater control measures and processes. The type and frequency of maintenance for a specific stormwater system is determined by inspection results and the maintenance schedule for each stormwater device being proposed. Maintenance should be performed in accordance with system design information and safety procedures provided in Appendices. Performing timely maintenance is important in preventing system failure and will be less expensive in the long-term.

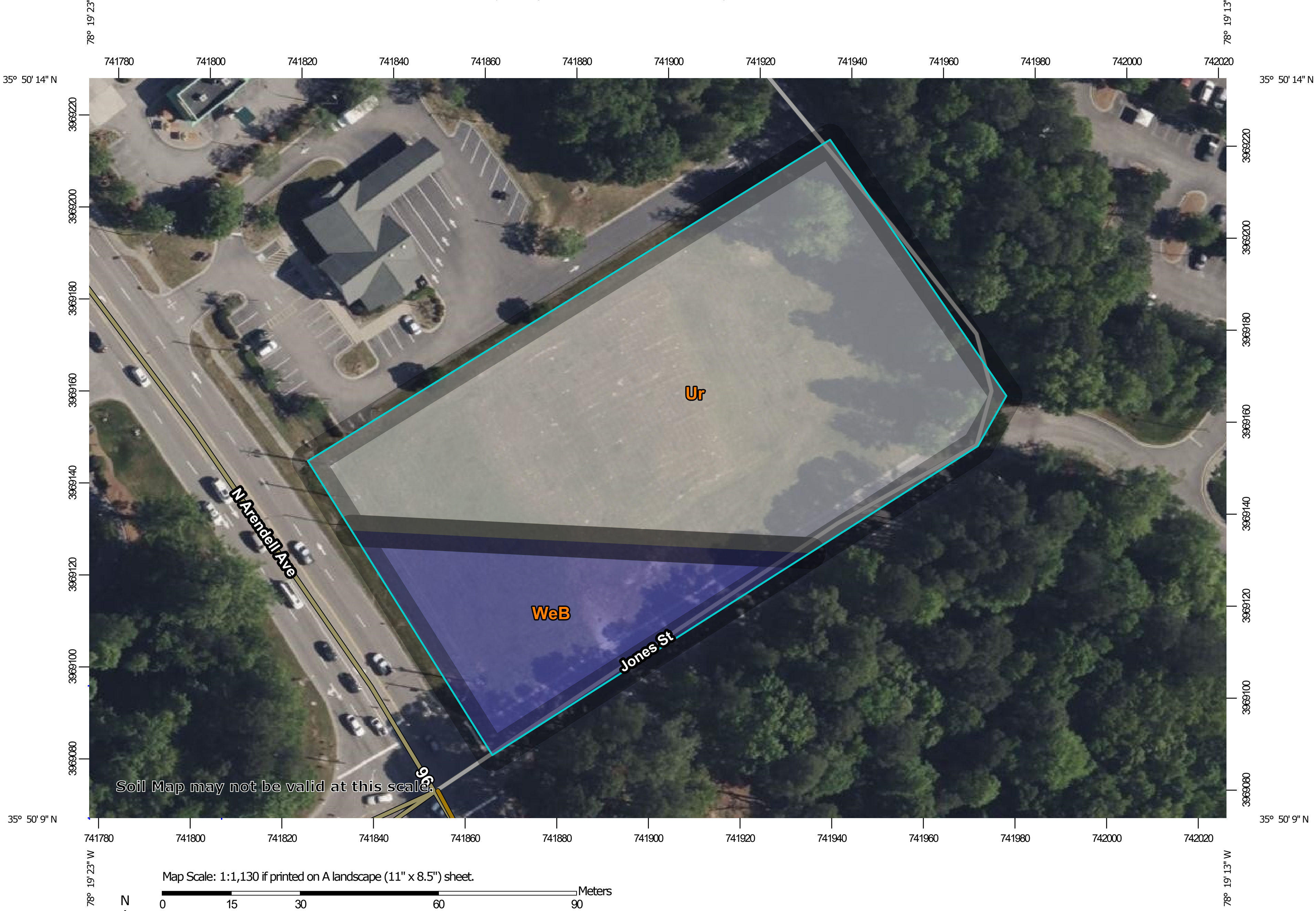
<u>Construction Maintenance</u>
During construction, the project site owner must implement a self-monitoring program that includes a written site evaluation of all erosion control measures and SCMs after each measurable storm event, and at least one time per week, in accordance with the requirements in the stormwater manual. All measures and controls must be repaired and maintained in proper operating condition.

<u>Post-Construction Maintenance</u>
After all construction activity has been completed, SCM maintenance is the responsibility of the property owner.

APPENDIX A

COOK OUT
1200 N. ARENDELL AVE.
ZEBULON, NC 27597
OUT-1502

Hydrologic Soil Group—Wake County, North Carolina



Map Scale: 1:1,130 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 15, 30, 60, 90

Feet: 0, 50, 100, 200, 300

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N 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: Wake County, North Carolina
Survey Area Data: Version 25, Oct 2, 2023

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

Date(s) aerial images were photographed: Apr 24, 2022—May 9, 2022

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
Ur	Urban land		1.9	76.5%
WeB	Wedowee sandy loam, 2 to 6 percent slopes	B	0.6	23.5%
Totals for Area of Interest			**2.5**	**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

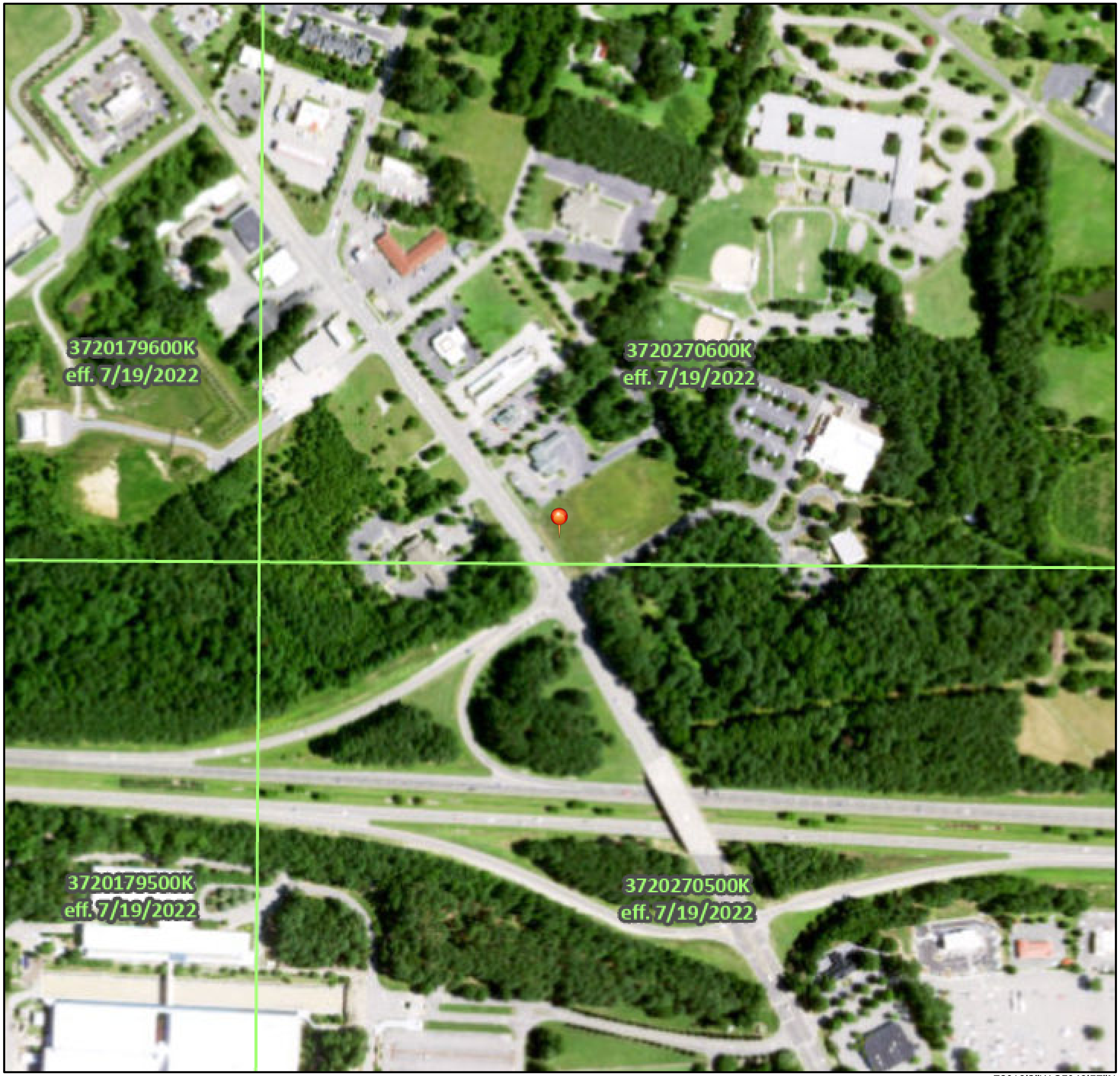
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette

FEMA

78°19'39"W 35°50'26"N



78°19'2"W 35°49'57"N

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

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
- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 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 10/17/2023 at 2:48 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.

USGS
science for a changing world

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
US Topo

ZEBULON QUADRANGLE
NORTH CAROLINA
7.5-MINUTE SERIES

Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid:Universal Transverse Mercator, Zone 17S

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery..........NAIP, May 2016 - November 2016
Roads..........U.S. Census Bureau, 2016
Names..........GNIS, 1980 - 2019
Hydrography..........National Hydrography Dataset, 1899 - 2018
Contours..........National Elevation Dataset, 2008
Boundaries..........Multiple sources; see metadata file 2017 - 2018

Wetlands..........FWS National Wetlands Inventory 1983

MN
GN
9°31′ 169 MILS
1°34′ 28 MILS

UTM GRID AND 2019 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000 - m Square ID
QV
Grid Zone Designation 17S

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1 MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the
National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.18

NORTH CAROLINA
QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES

1 Rolesville
2 Bunn West
3 Bunn East
4 Knightdale
5 Middlesex
6 Clayton
7 Flowers
8 Stancils Chapel

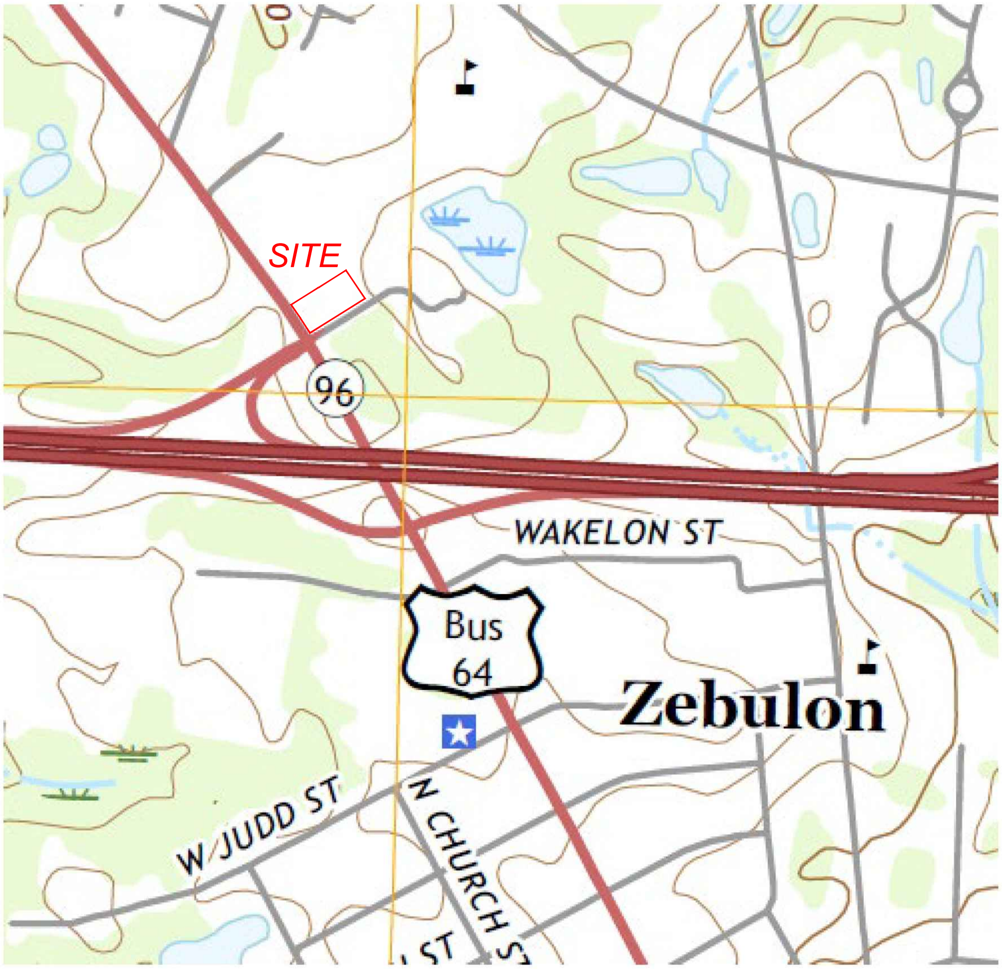
ROAD CLASSIFICATION

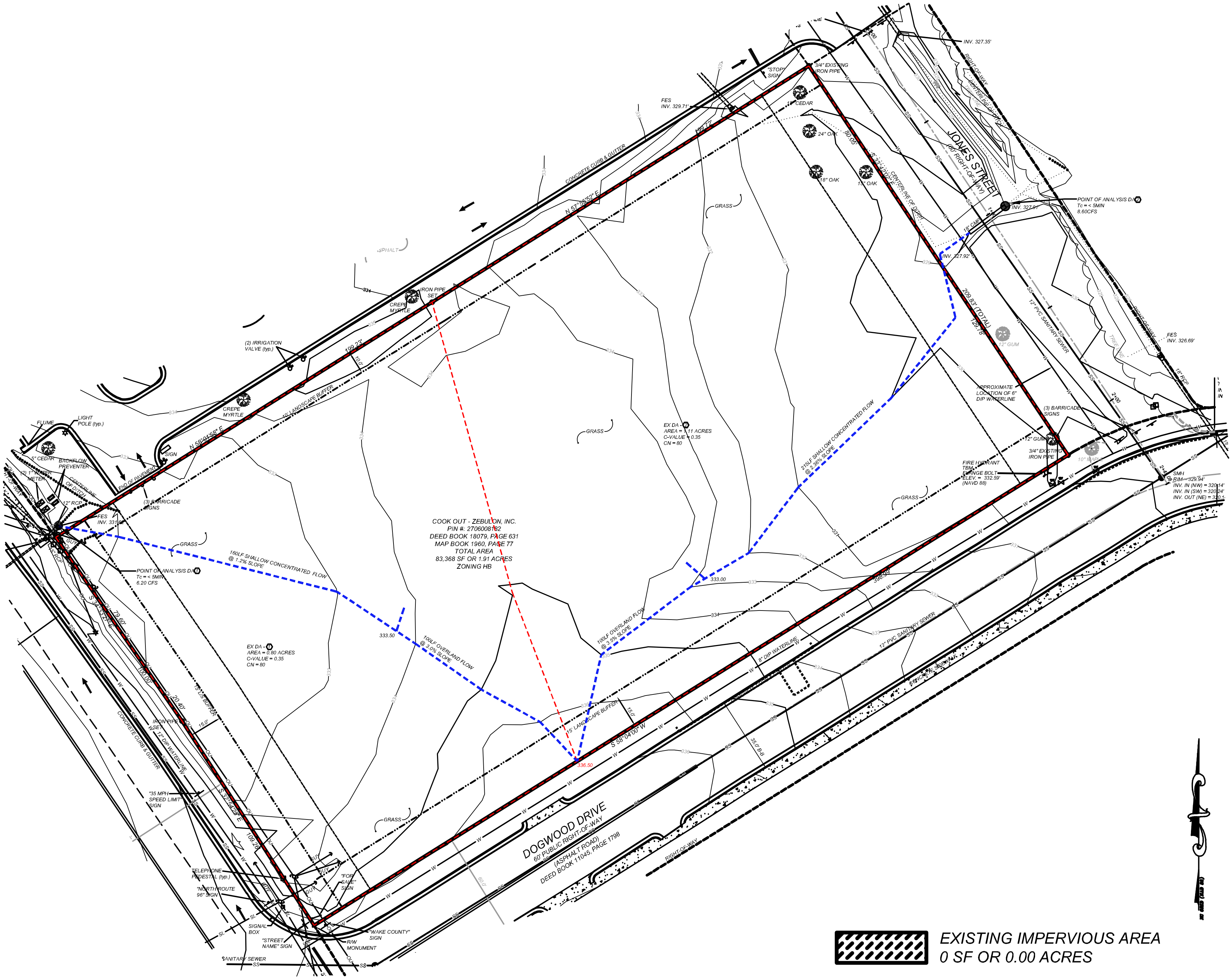
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route

ZEBULON, NC
2019

NSN. 7643016379377
NGA REF NO. USGSX24K72128

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY





EXISTING IMPERVIOUS AREA
0 SF OR 0.00 ACRES

PRE-DEVELOPMENT IMPERVIOUS MAP

COOKOUT ZEBULON
1200 N ARENDELL AVE
ZEBULON, NC

COMMERCIAL SITE DESIGN
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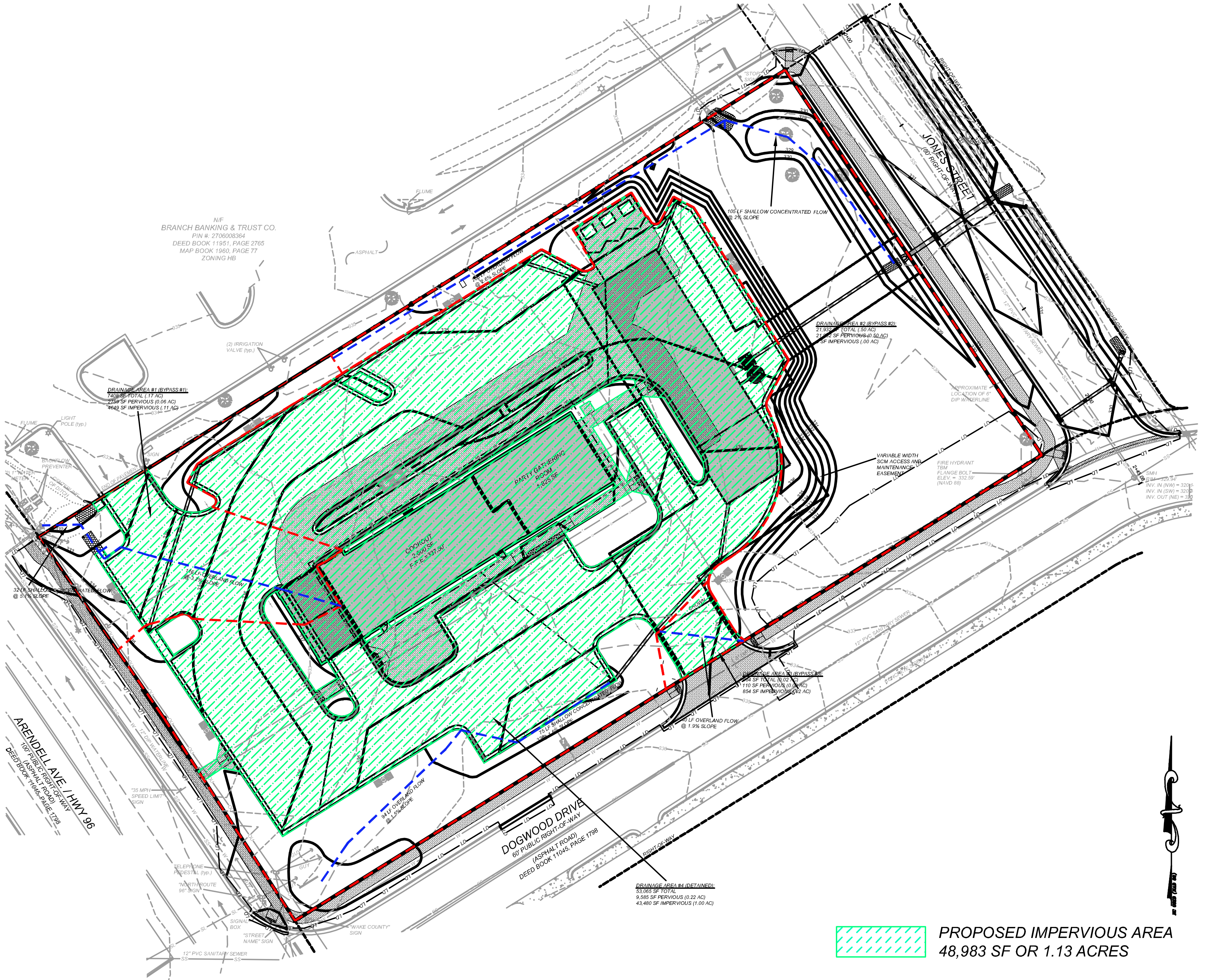
WWW.CSITEDESIGN.COM

PROJECT NO. OUT-1502
FILENAME: OUT1502-EXA
SCALE: 1"= 60'
DATE: 10/17/2023



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POST-DEVELOPMENT IMPERVIOUS MAP

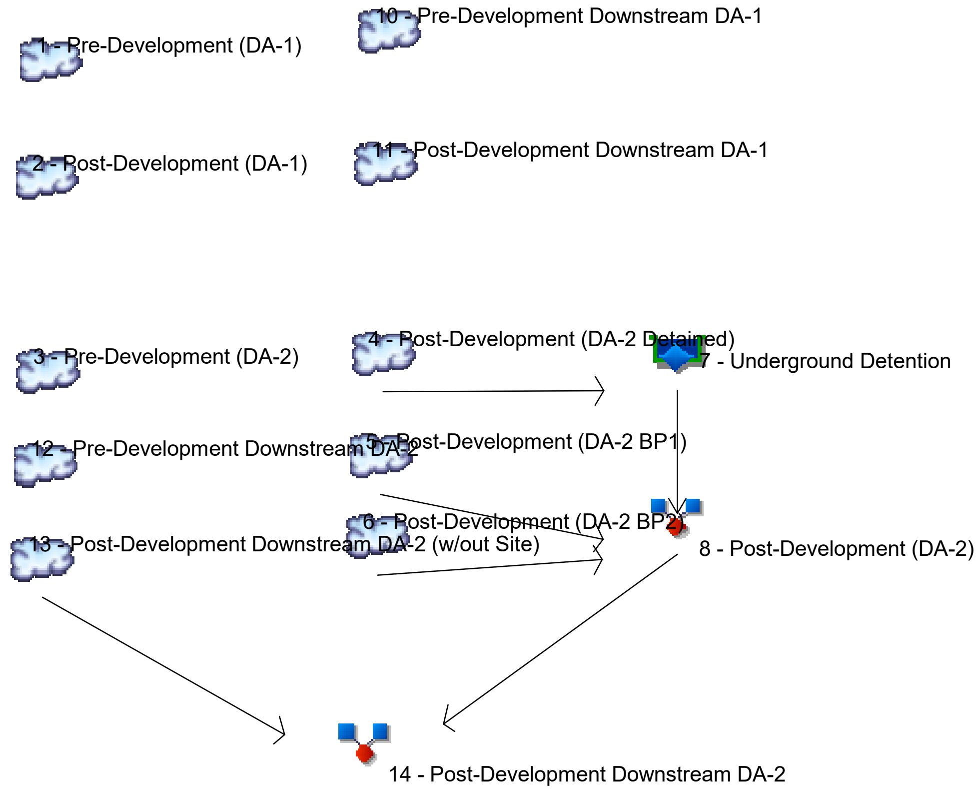
COOK OUT ZEBULON
1200 N ARENDELL AVE
ZEBULON, NC

PROJECT NO.: OUT-1502
FILENAME: OUT1502-EXB
SCALE: 1"= 60'
DATE: 10/17/2023

APPENDIX B

COOK OUT
1200 N. ARENDELL AVE.
ZEBULON, NC 27597
OUT-1502

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Pre-Development (DA-1)
2	SCS Runoff	Post-Development (DA-1)
3	SCS Runoff	Pre-Development (DA-2)
4	SCS Runoff	Post-Development (DA-2 Detained)
5	SCS Runoff	Post-Development (DA-2 BP1)
6	SCS Runoff	Post-Development (DA-2 BP2)
7	Reservoir	Underground Detention
8	Combine	Post-Development (DA-2)
10	SCS Runoff	Pre-Development Downstream DA-1
11	SCS Runoff	Post-Development Downstream DA-1
12	SCS Runoff	Pre-Development Downstream DA-2
13	SCS Runoff	Post-Development Downstream DA-2 (w/out Site)
14	Combine	Post-Development Downstream DA-2

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	1.300	-------	-------	-------	3.476	-------	-------	6.368	Pre-Development (DA-1)
2	SCS Runoff	------	0.558	-------	-------	-------	1.115	-------	-------	1.800	Post-Development (DA-1)
3	SCS Runoff	------	1.803	-------	-------	-------	4.823	-------	-------	8.836	Pre-Development (DA-2)
4	SCS Runoff	------	4.393	-------	-------	-------	8.324	-------	-------	13.16	Post-Development (DA-2 Detained)
5	SCS Runoff	------	0.594	-------	-------	-------	1.614	-------	-------	2.978	Post-Development (DA-2 BP1)
6	SCS Runoff	------	0.077	-------	-------	-------	0.140	-------	-------	0.218	Post-Development (DA-2 BP2)
7	Reservoir	4	0.433	-------	-------	-------	0.932	-------	-------	12.95	Underground Detention
8	Combine	5, 6, 7	1.029	-------	-------	-------	2.563	-------	-------	15.34	Post-Development (DA-2)
10	SCS Runoff	------	6.955	-------	-------	-------	15.88	-------	-------	27.13	Pre-Development Downstream DA-1
11	SCS Runoff	------	6.438	-------	-------	-------	14.35	-------	-------	24.26	Post-Development Downstream DA-1
12	SCS Runoff	------	13.97	-------	-------	-------	32.71	-------	-------	56.56	Pre-Development Downstream DA-2
13	SCS Runoff	------	13.56	-------	-------	-------	31.00	-------	-------	53.02	Post-Development Downstream DA-2
14	Combine	8, 13	14.29	-------	-------	-------	32.71	-------	-------	55.83	Post-Development Downstream DA-2

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	1.300	2	722	3,410	------	------	------	Pre-Development (DA-1)
2	SCS Runoff	0.558	2	716	1,169	------	------	------	Post-Development (DA-1)
3	SCS Runoff	1.803	2	722	4,731	------	------	------	Pre-Development (DA-2)
4	SCS Runoff	4.393	2	716	9,562	------	------	------	Post-Development (DA-2 Detained)
5	SCS Runoff	0.594	2	728	2,104	------	------	------	Post-Development (DA-2 BP1)
6	SCS Runoff	0.077	2	716	178	------	------	------	Post-Development (DA-2 BP2)
7	Reservoir	0.433	2	740	9,558	4	331.87	5,095	Underground Detention
8	Combine	1.029	2	728	11,840	5, 6, 7	------	------	Post-Development (DA-2)
10	SCS Runoff	6.955	2	736	33,756	------	------	------	Pre-Development Downstream DA-1
11	SCS Runoff	6.438	2	736	31,203	------	------	------	Post-Development Downstream DA-1
12	SCS Runoff	13.97	2	744	79,332	------	------	------	Pre-Development Downstream DA-2
13	SCS Runoff	13.56	2	744	76,855	------	------	------	Post-Development Downstream DA-2
14	Combine	14.29	2	742	88,695	8, 13	------	------	Post-Development Downstream DA-2

OUT-1502 Model.gpw	Return Period: 1 Year	Thursday, 11 / 2 / 2023

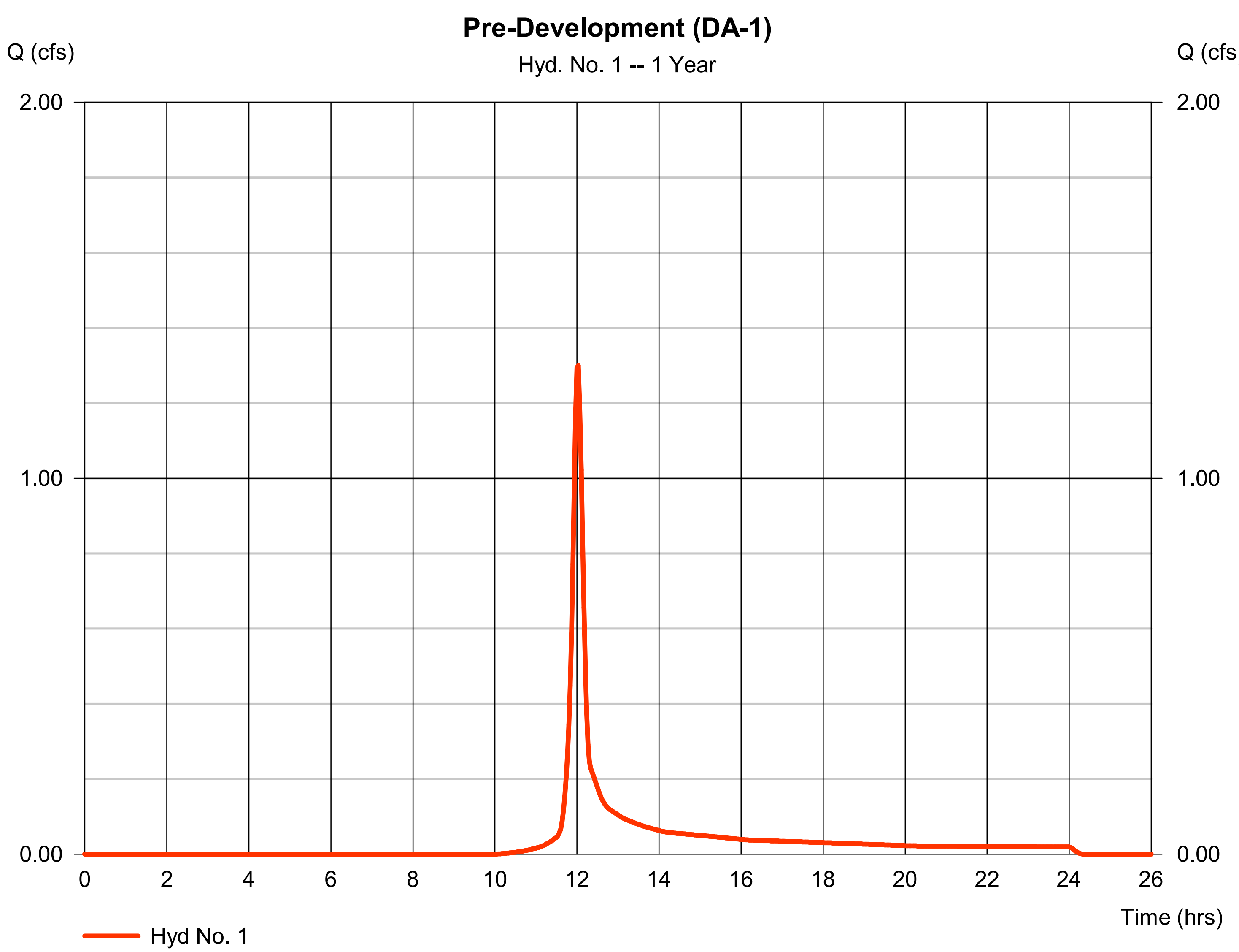
Hydrograph Report

Hyd. No. 1

Pre-Development (DA-1)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.300 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 3,410 cuft
Drainage area	= 0.800 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.20 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.800 x 80)] / 0.800



TR55 Tc Worksheet

Hyd. No. 1

Pre-Development (DA-1)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.240		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.46		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 11.67**	**+**	**0.00**	**+**	**0.00**	**=**	**11.67**
Shallow Concentrated Flow							
Flow length (ft)	= 160.00		0.00		0.00		
Watercourse slope (%)	= 1.20		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.77		0.00		0.00		
Travel Time (min)	**= 1.51**	**+**	**0.00**	**+**	**0.00**	**=**	**1.51**
Channel Flow							
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		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 13.20 min

Hydrograph Report

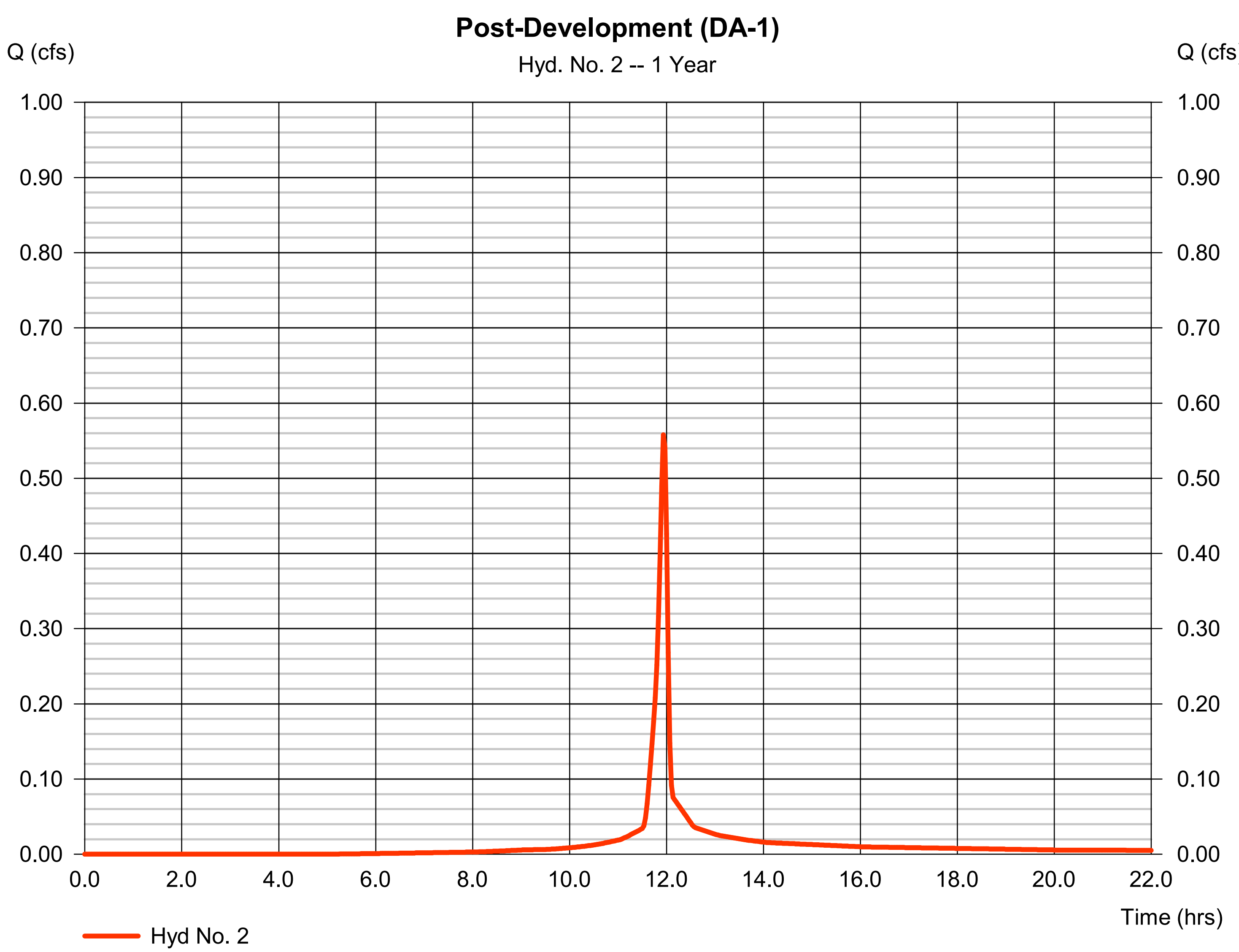
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 — Thursday, 11 / 2 / 2023

Hyd. No. 2

Post-Development (DA-1)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.558 cfs
Storm frequency	= 1 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 1,169 cuft
Drainage area	= 0.170 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.110 x 98) + (0.060 x 80)] / 0.170



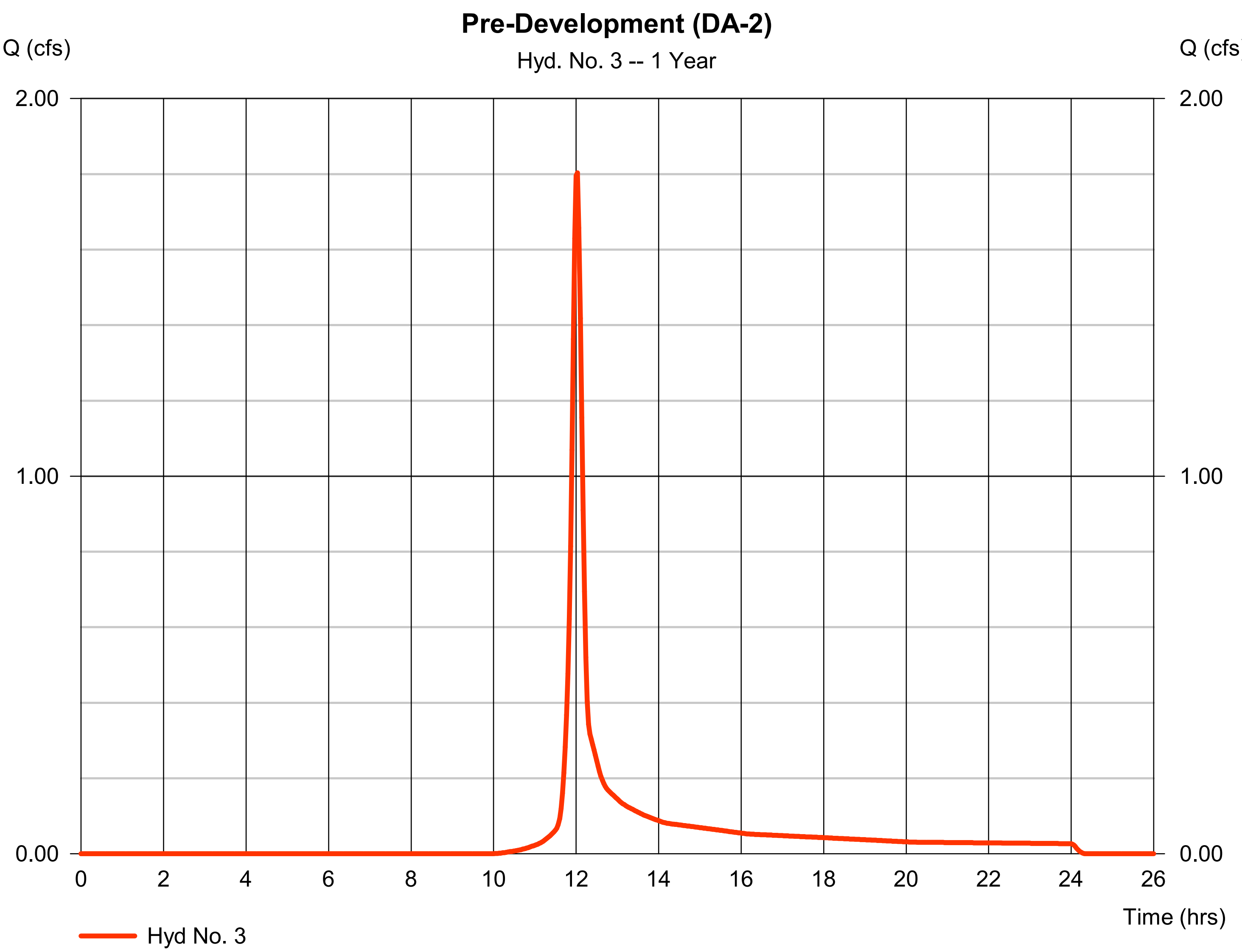
Hydrograph Report

Hyd. No. 3

Pre-Development (DA-2)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.803 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 4,731 cuft
Drainage area	= 1.110 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.40 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (1.110 x 80)] / 1.110



TR55 Tc Worksheet

Hyd. No. 3

Pre-Development (DA-2)

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.46		0.00		0.00		
Land slope (%)	=	3.50		0.00		0.00		
Travel Time (min)	**=**	**10.97**	**+**	**0.00**	**+**	**0.00**	**=**	**10.97**
Shallow Concentrated Flow								
Flow length (ft)	=	215.00		0.00		0.00		
Watercourse slope (%)	=	2.36		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.48			0.00		0.00		
Travel Time (min)	**=**	**1.45**	**+**	**0.00**	**+**	**0.00**	**=**	**1.45**
Channel Flow								
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		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 12.40 min

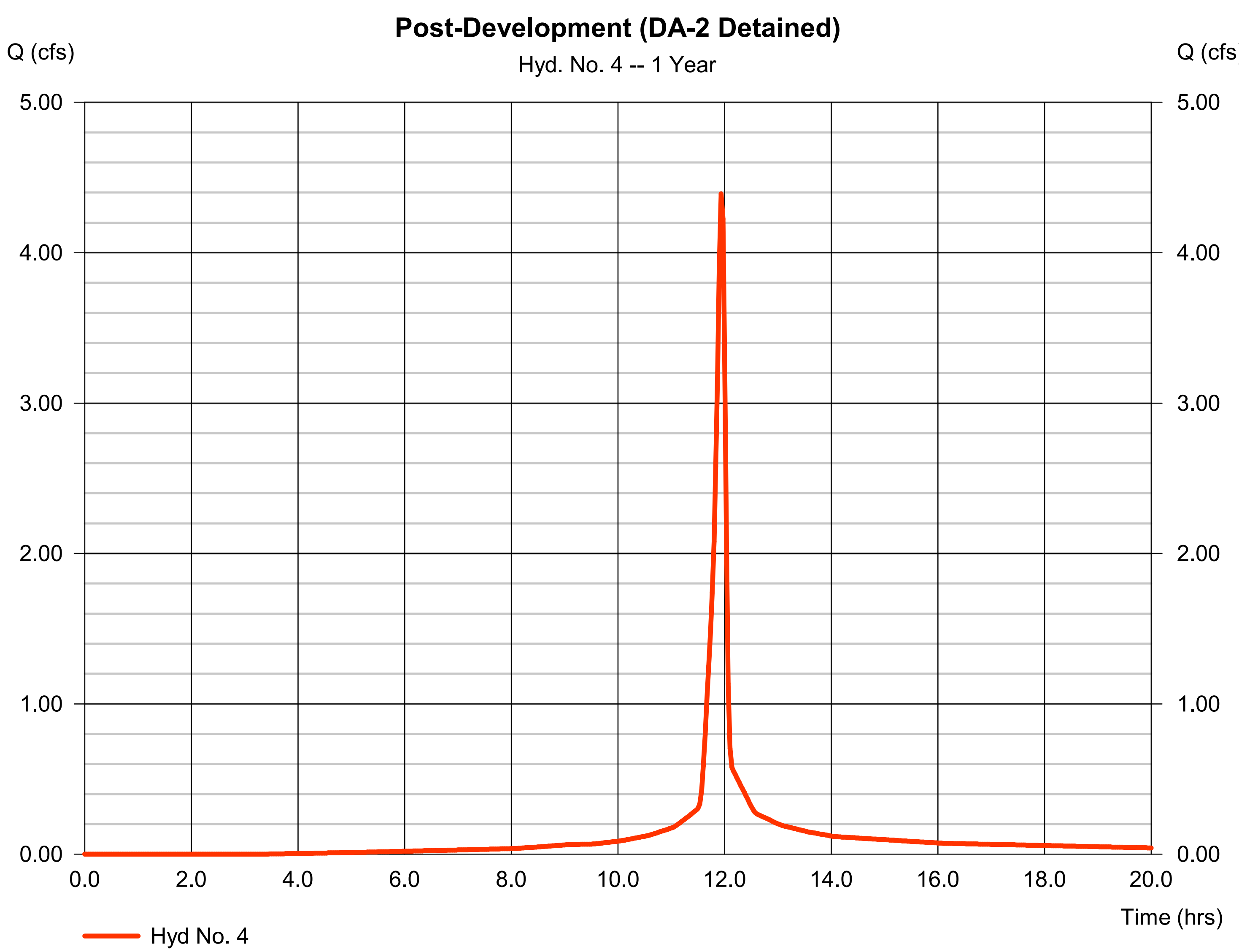
Hydrograph Report

Hyd. No. 4

Post-Development (DA-2 Detained)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.393 cfs
Storm frequency	= 1 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 9,562 cuft
Drainage area	= 1.220 ac	Curve number	= 95*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.220 x 80)] / 1.220



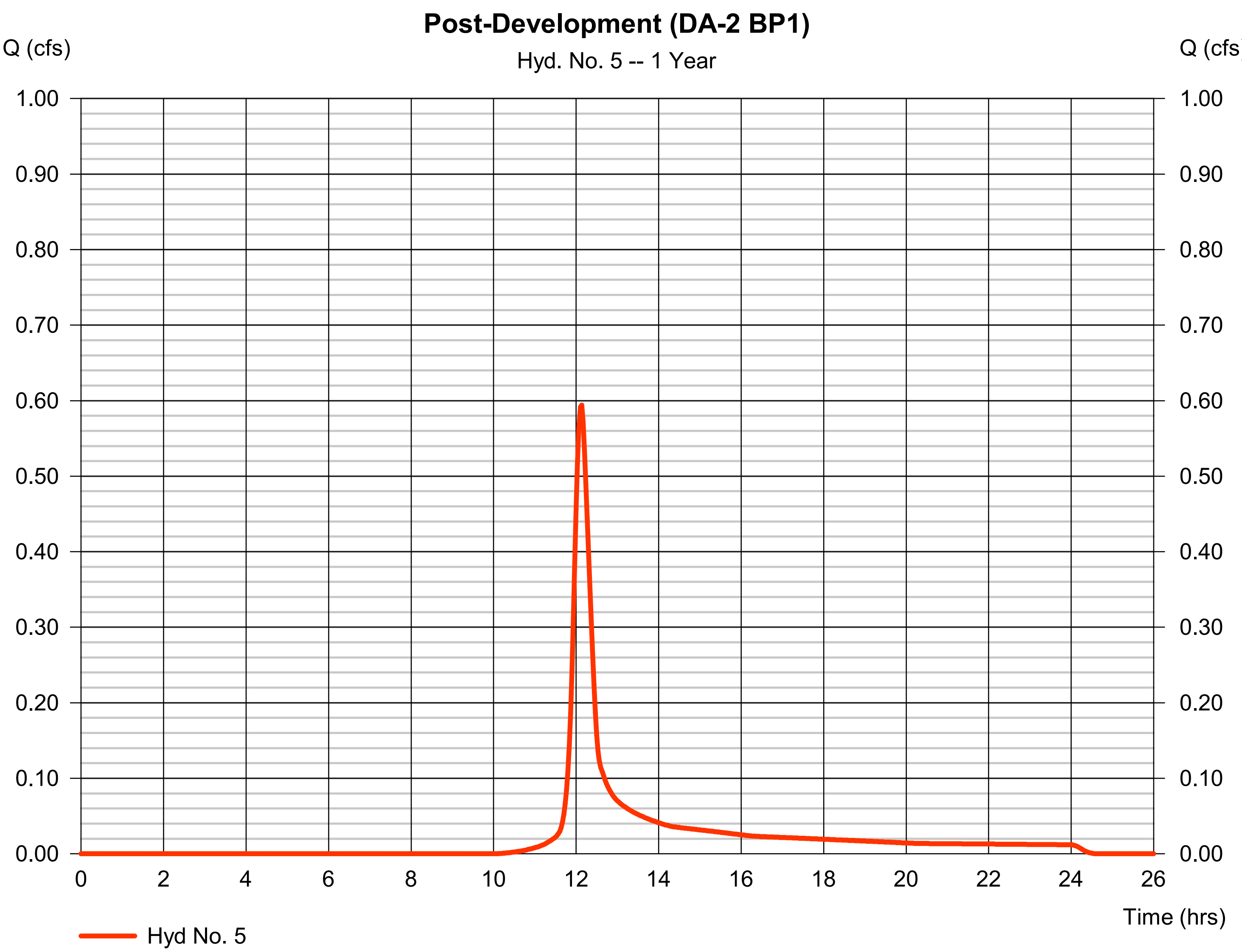
Hydrograph Report

Hyd. No. 5

Post-Development (DA-2 BP1)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.594 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 2,104 cuft
Drainage area	= 0.500 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.00 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.500 x 80)] / 0.500



TR55 Tc Worksheet

Hyd. No. 5

Post-Development (DA-2 BP1)

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		0.011		0.011		
Flow length (ft)	=	208.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.46		0.00		0.00		
Land slope (%)	=	2.60		0.00		0.00		
Travel Time (min)	**=**	**22.20**	**+**	**0.00**	**+**	**0.00**	**=**	**22.20**
Shallow Concentrated Flow								
Flow length (ft)	=	105.00		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)	**=**	**0.77**	**+**	**0.00**	**+**	**0.00**	**=**	**0.77**
Channel Flow								
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		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **23.00 min**

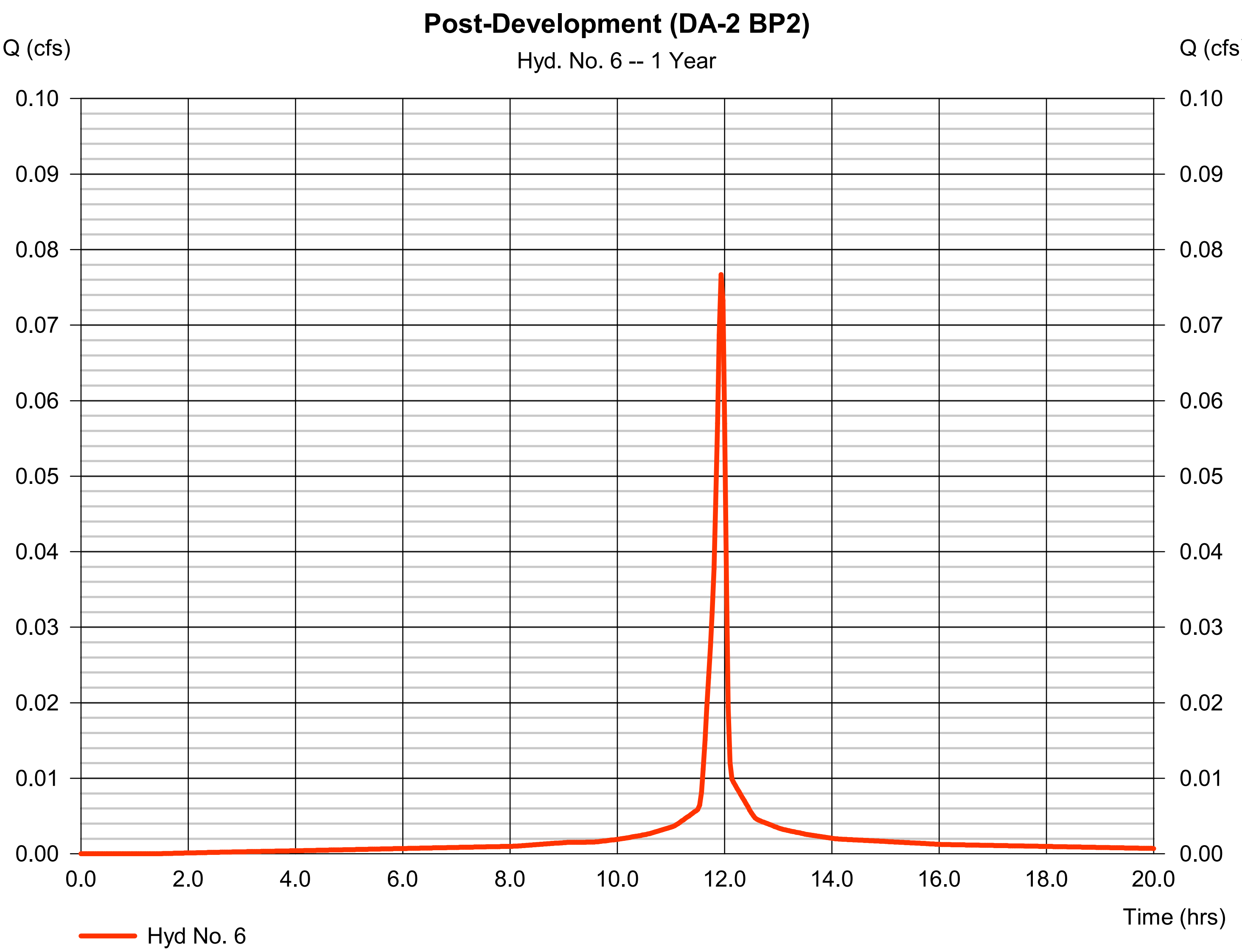
Hydrograph Report

Hyd. No. 6

Post-Development (DA-2 BP2)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.077 cfs
Storm frequency	= 1 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 178 cuft
Drainage area	= 0.020 ac	Curve number	= 98*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98)] / 0.020



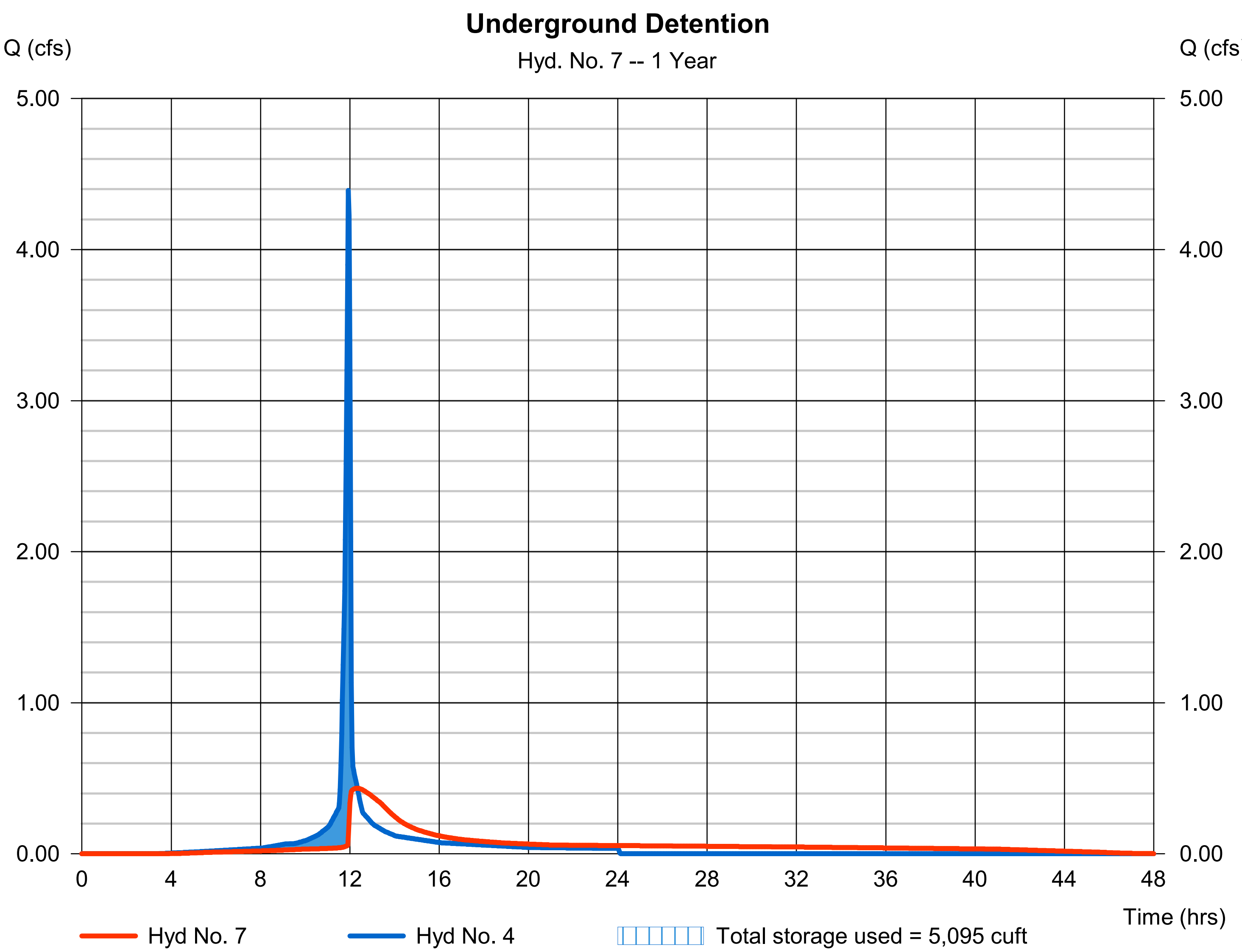
Hydrograph Report

Hyd. No. 7

Underground Detention

Hydrograph type	= Reservoir	Peak discharge	= 0.433 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.33 hrs
Time interval	= 2 min	Hyd. volume	= 9,558 cuft
Inflow hyd. No.	= 4 - Post-Development (DA-2 Detained)	Max. Elevation	= 331.87 ft
Reservoir name	= UG Detention System	Max. Storage	= 5,095 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 — Thursday, 11 / 2 / 2023

Pond No. 1 - UG Detention System

Pond Data

UG Chambers -Invert elev. = 330.00 ft, Rise x Span = 4.00 x 4.00 ft, Barrel Len = 123.00 ft, No. Barrels = 8, Slope = 0.25%, Headers = No

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	330.00	n/a	0	0
0.43	330.43	n/a	389	389
0.86	330.86	n/a	1,096	1,485
1.29	331.29	n/a	1,420	2,905
1.72	331.72	n/a	1,600	4,505
2.15	332.15	n/a	1,680	6,185
2.58	332.58	n/a	1,680	7,866
3.02	333.02	n/a	1,600	9,466
3.45	333.45	n/a	1,419	10,885
3.88	333.88	n/a	1,095	11,980
4.31	334.31	n/a	387	12,368

Culvert / Orifice Structures

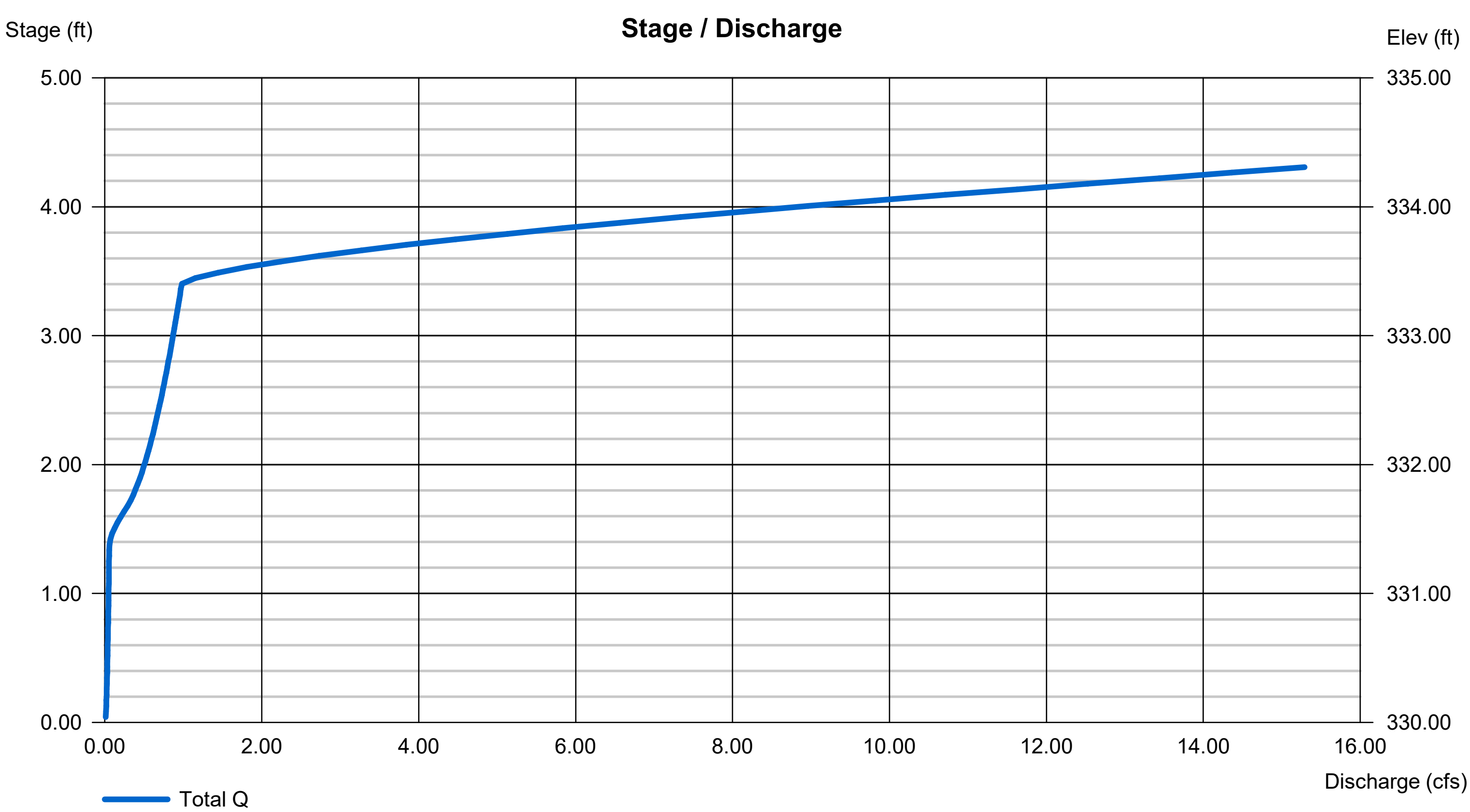
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	1.33	5.00	0.00
Span (in)	= 18.00	1.33	5.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 328.70	328.70	331.35	0.00
Length (ft)	= 40.00	0.50	0.50	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.61	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 20.00	5.00	Inactive	0.00
Crest El. (ft)	= 336.00	333.40	333.20	0.00
Weir Coeff.	= 3.33	3.33	1.05	3.33
Weir Type	= 1	Rect	45 degV	---
Multi-Stage	= Yes	Yes	Yes	No

Exfil.(in/hr) = 0.000 (by Contour)
TW Elev. (ft) = 0.00

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

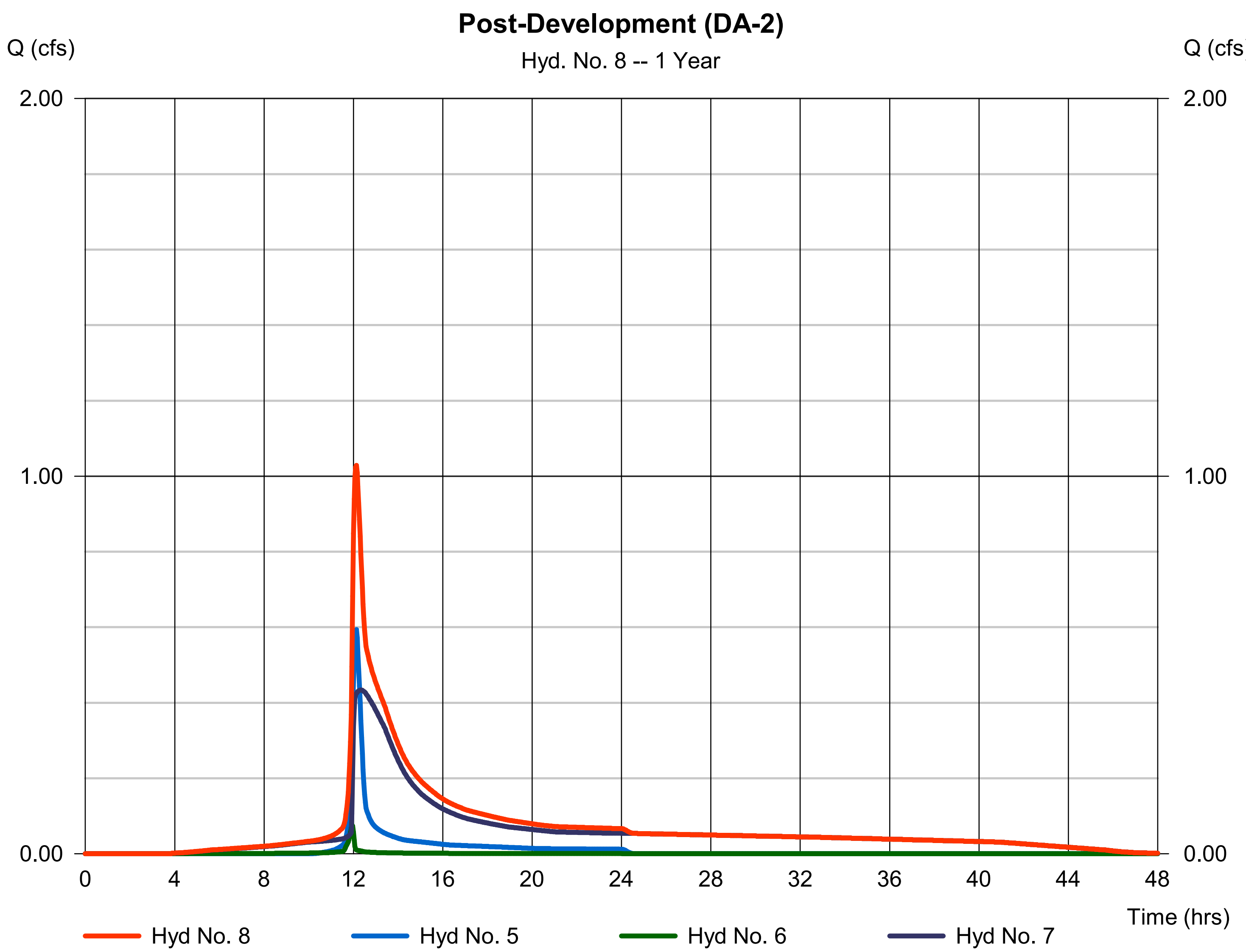


Hydrograph Report

Hyd. No. 8

Post-Development (DA-2)

Hydrograph type	= Combine	Peak discharge	= 1.029 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 11,840 cuft
Inflow hyds.	= 5, 6, 7	Contrib. drain. area	= 0.520 ac



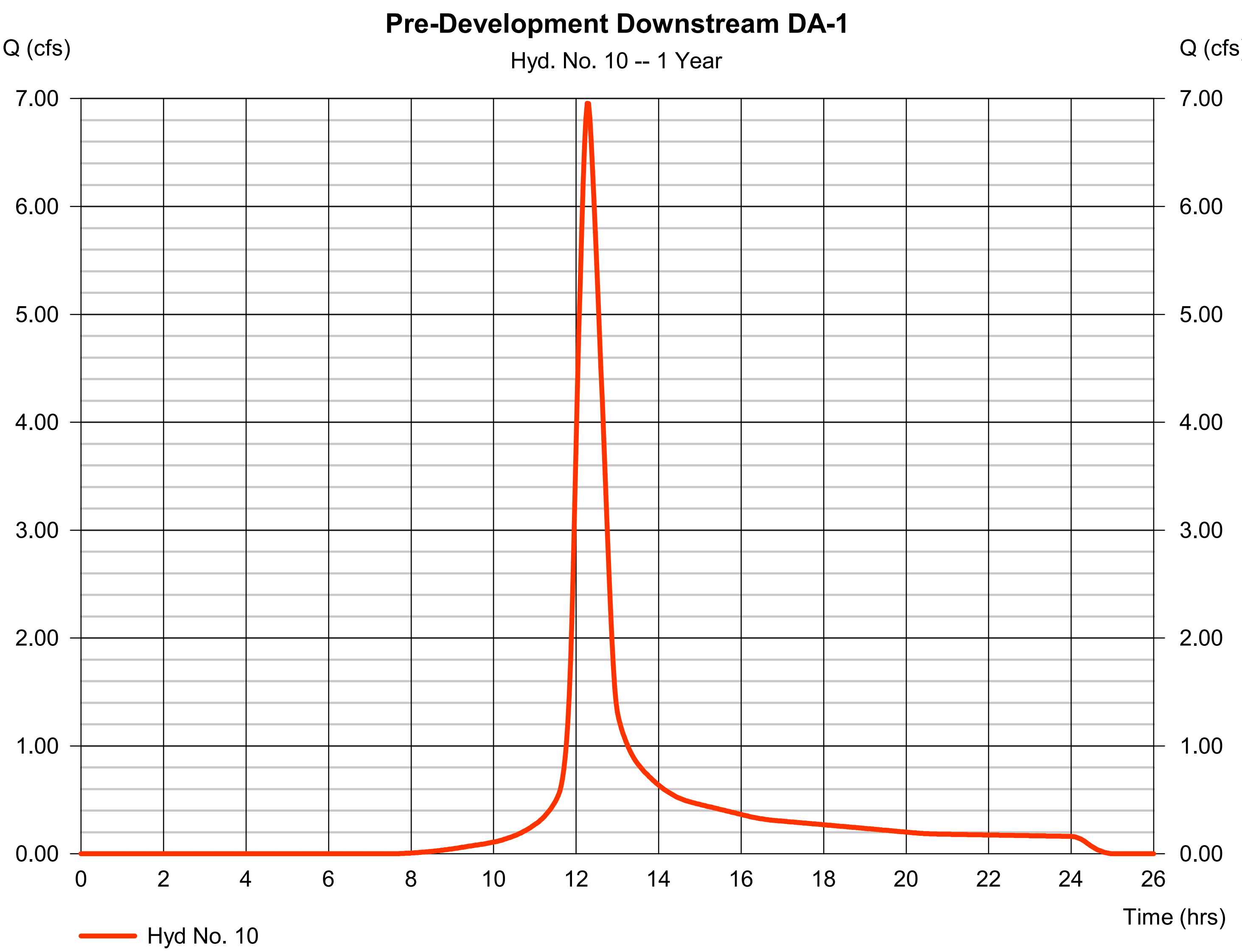
Hydrograph Report

Hyd. No. 10

Pre-Development Downstream DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 6.955 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 33,756 cuft
Drainage area	= 5.780 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 40.10 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.180 x 98) + (3.600 x 80)] / 5.780



TR55 Tc Worksheet

Hyd. No. 10

Pre-Development Downstream DA-1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.011		0.011		
Flow length (ft)	=	200.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.46		0.00		0.00		
Land slope (%)	=	1.75		0.00		0.00		
Travel Time (min)	**=**	**37.93**	**+**	**0.00**	**+**	**0.00**	**=**	**37.93**
Shallow Concentrated Flow								
Flow length (ft)	=	380.00		0.00		0.00		
Watercourse slope (%)	=	3.42		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)		=2.98		0.00		0.00		
Travel Time (min)	**=**	**2.12**	**+**	**0.00**	**+**	**0.00**	**=**	**2.12**
Channel Flow								
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		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 40.10 min

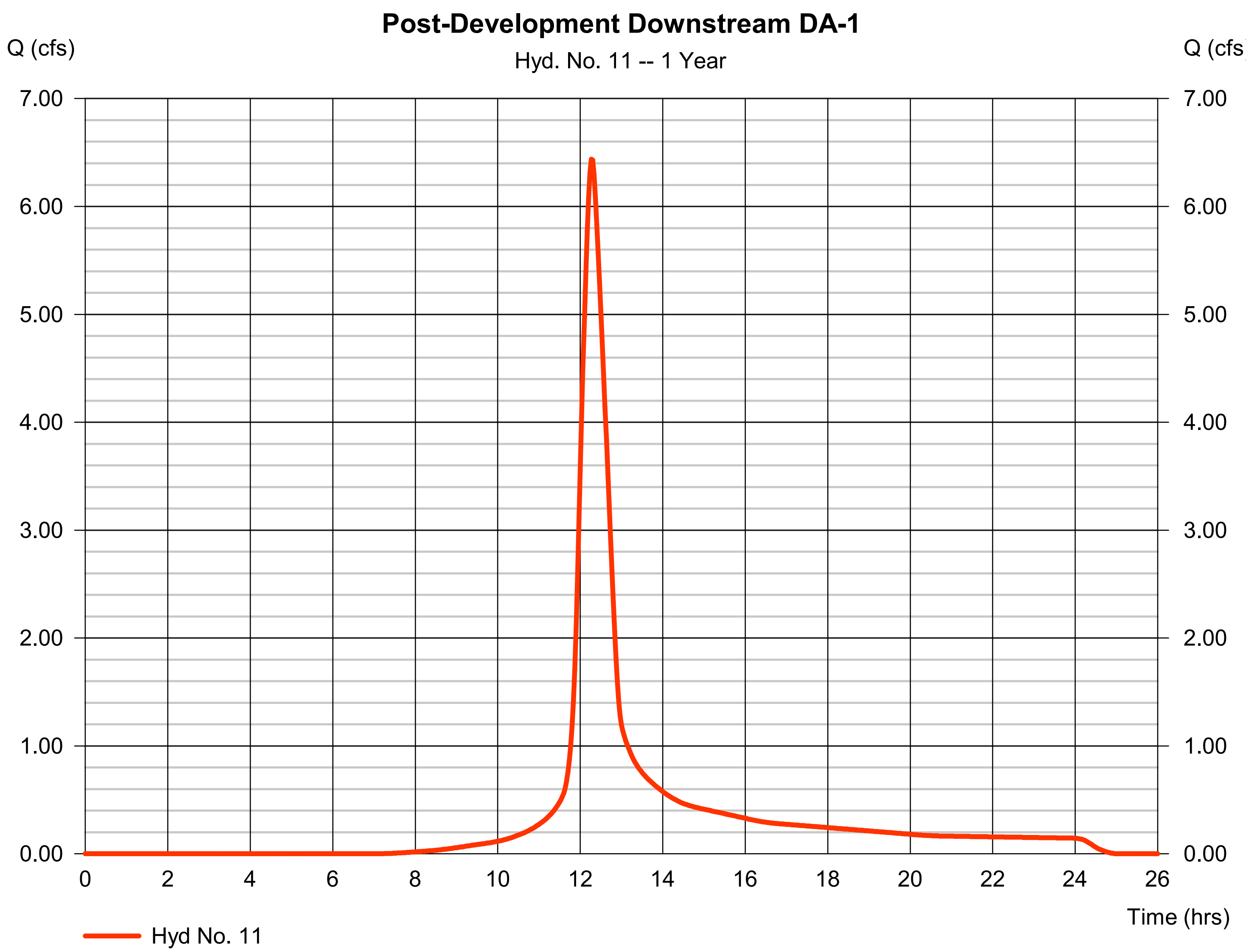
Hydrograph Report

Hyd. No. 11

Post-Development Downstream DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 6.438 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 31,203 cuft
Drainage area	= 5.100 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 40.10 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.320 x 98) + (2.780 x 80)] / 5.100



TR55 Tc Worksheet

Hyd. No. 11

Post-Development Downstream DA-1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.011		0.011		
Flow length (ft)	=	200.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.46		0.00		0.00		
Land slope (%)	=	1.75		0.00		0.00		
Travel Time (min)	**=**	**37.93**	**+**	**0.00**	**+**	**0.00**	**=**	**37.93**
Shallow Concentrated Flow								
Flow length (ft)	=	380.00		0.00		0.00		
Watercourse slope (%)	=	3.42		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.98			0.00		0.00		
Travel Time (min)	**=**	**2.12**	**+**	**0.00**	**+**	**0.00**	**=**	**2.12**
Channel Flow								
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		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Total Travel Time, Tc								**40.10 min**

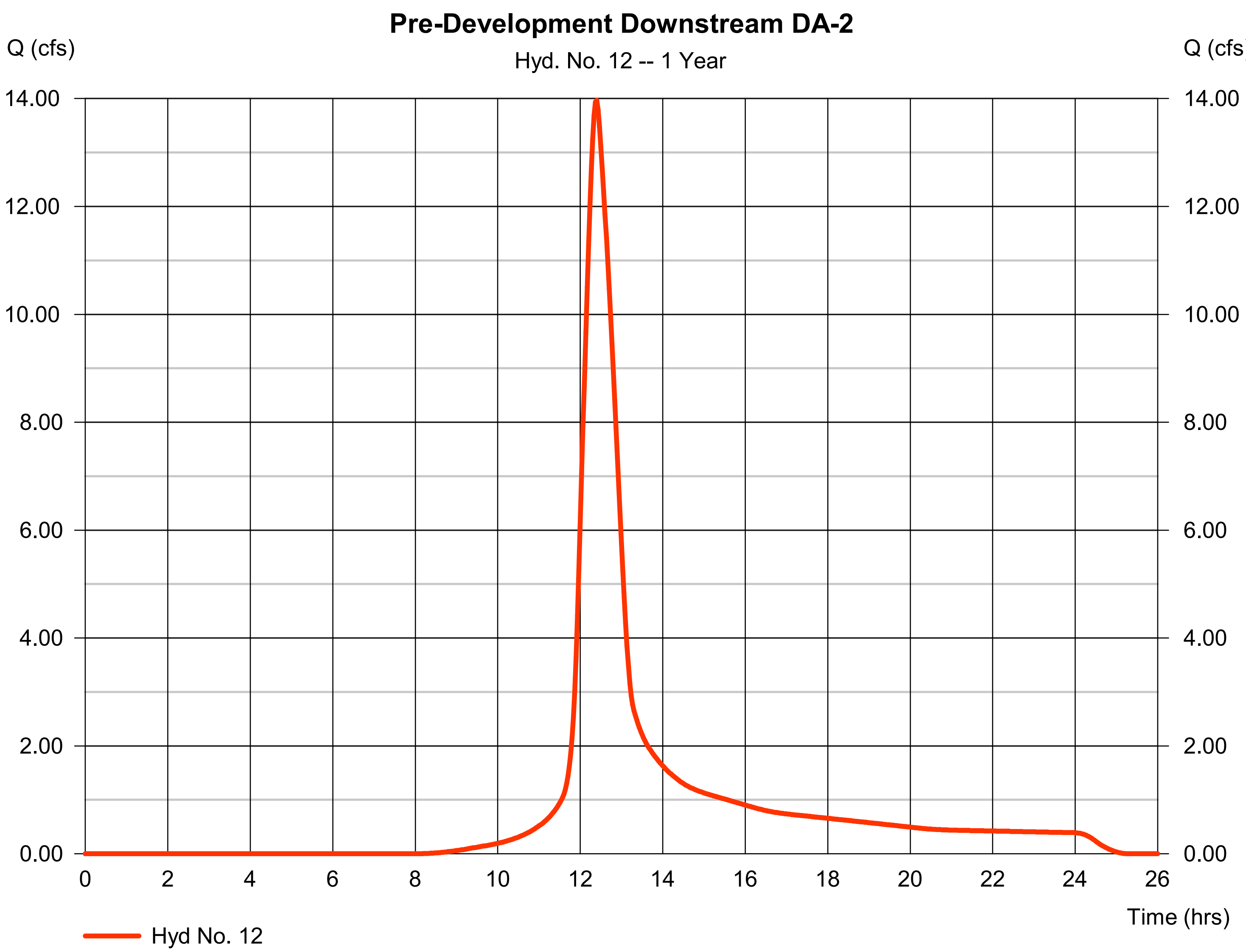
Hydrograph Report

Hyd. No. 12

Pre-Development Downstream DA-2

Hydrograph type	= SCS Runoff	Peak discharge	= 13.97 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 79,332 cuft
Drainage area	= 14.240 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 49.10 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.930 x 98) + (9.310 x 80)] / 14.240



TR55 Tc Worksheet

Hyd. No. 12

Pre-Development Downstream DA-2

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.400		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.46		0.00		0.00		
Land slope (%)	= 3.50		0.00		0.00		
Travel Time (min)	**= 39.76**	**+**	**0.00**	**+**	**0.00**	**=**	**39.76**
Shallow Concentrated Flow							
Flow length (ft)	= 785.00		0.00		0.00		
Watercourse slope (%)	= 0.76		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.41		0.00		0.00		
Travel Time (min)	**= 9.30**	**+**	**0.00**	**+**	**0.00**	**=**	**9.30**
Channel Flow							
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		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 49.10 min

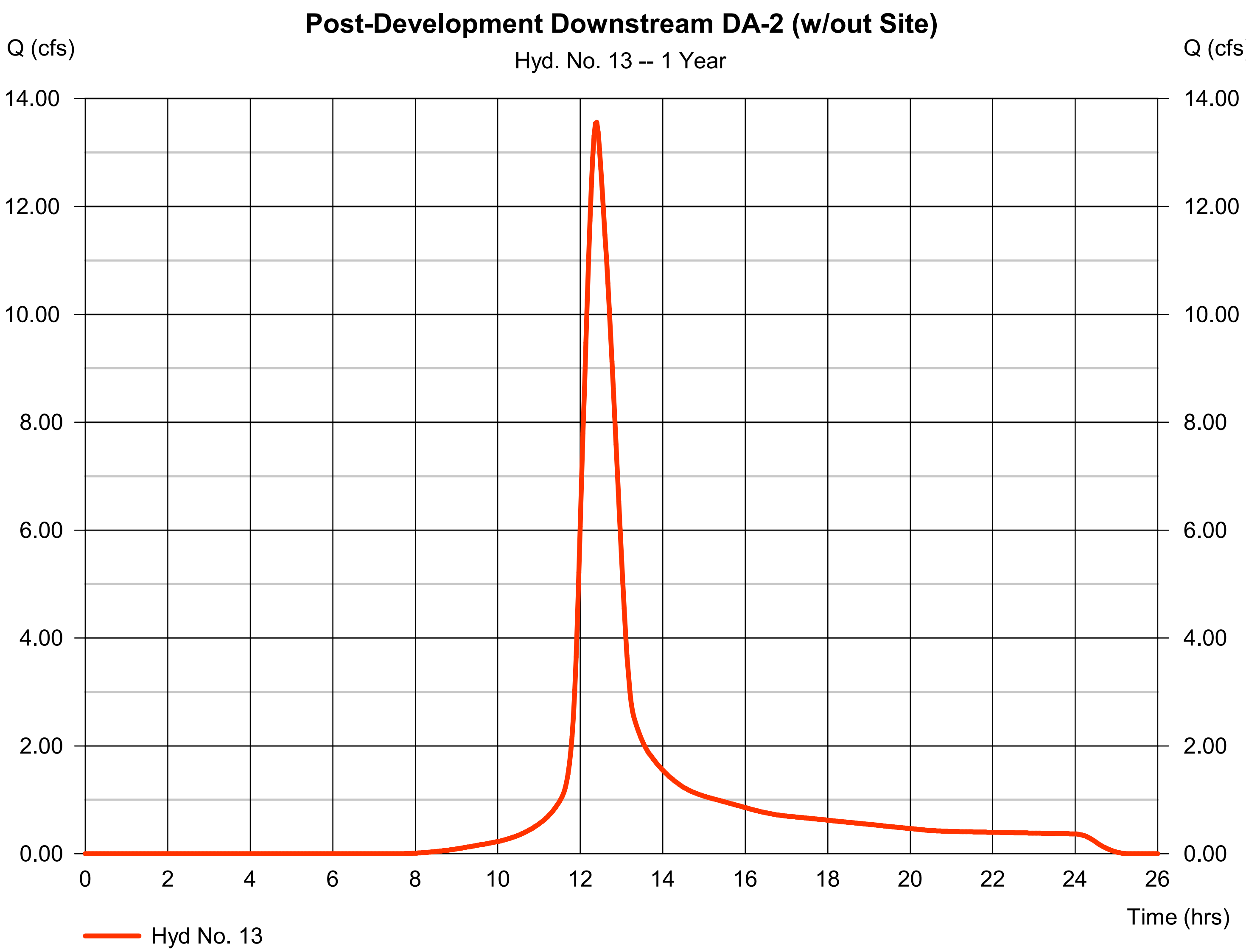
Hydrograph Report

Hyd. No. 13

Post-Development Downstream DA-2 (w/out Site)

Hydrograph type	= SCS Runoff	Peak discharge	= 13.56 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 76,855 cuft
Drainage area	= 13.160 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 49.06 min
Total precip.	= 2.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.220 x 98) + (7.940 x 80)] / 13.160



TR55 Tc Worksheet

Hyd. No. 13

Post-Development Downstream DA-2 (w/out Site)

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.46		0.00		0.00		
Land slope (%)	=	3.50		0.00		0.00		
Travel Time (min)	**=**	**39.76**	**+**	**0.00**	**+**	**0.00**	**=**	**39.76**
Shallow Concentrated Flow								
Flow length (ft)	=	785.00		0.00		0.00		
Watercourse slope (%)	=	0.76		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.41		0.00		0.00		
Travel Time (min)	**=**	**9.30**	**+**	**0.00**	**+**	**0.00**	**=**	**9.30**
Channel Flow								
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		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

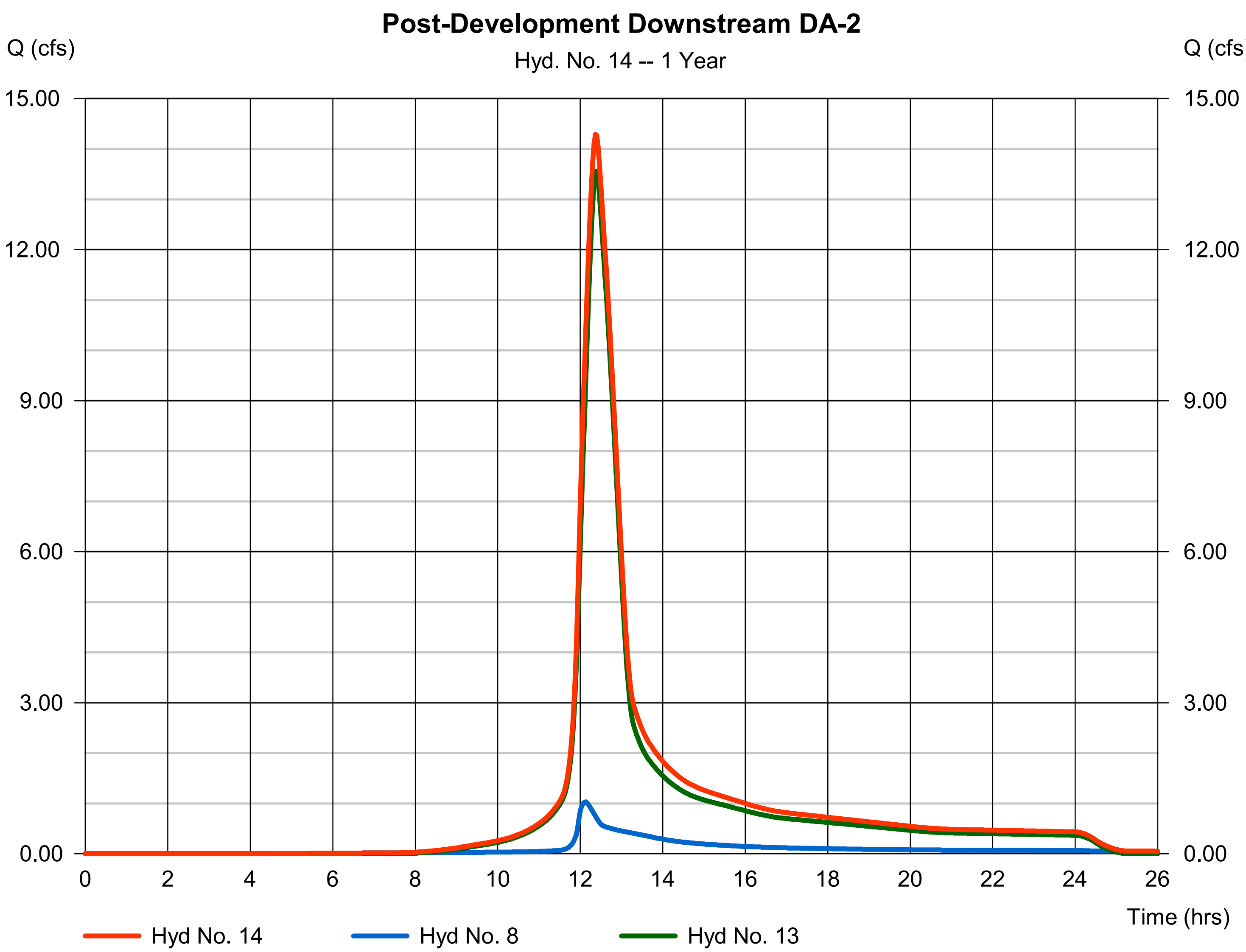
Total Travel Time, Tc .... 49.06 min

Hydrograph Report

Hyd. No. 14

Post-Development Downstream DA-2

Hydrograph type	= Combine	Peak discharge	= 14.29 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 88,695 cuft
Inflow hyds.	= 8, 13	Contrib. drain. area	= 13.160 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	3.476	2	720	9,030	------	------	------	Pre-Development (DA-1)
2	SCS Runoff	1.115	2	716	2,445	------	------	------	Post-Development (DA-1)
3	SCS Runoff	4.823	2	720	12,529	------	------	------	Pre-Development (DA-2)
4	SCS Runoff	8.324	2	716	18,925	------	------	------	Post-Development (DA-2 Detained)
5	SCS Runoff	1.614	2	726	5,571	------	------	------	Post-Development (DA-2 BP1)
6	SCS Runoff	0.140	2	716	334	------	------	------	Post-Development (DA-2 BP2)
7	Reservoir	0.932	2	734	18,921	4	333.22	10,157	Underground Detention
8	Combine	2.563	2	726	24,825	5, 6, 7	------	------	Post-Development (DA-2)
10	SCS Runoff	15.88	2	736	77,617	------	------	------	Pre-Development Downstream DA-1
11	SCS Runoff	14.35	2	736	70,388	------	------	------	Post-Development Downstream DA-1
12	SCS Runoff	32.71	2	742	185,978	------	------	------	Pre-Development Downstream DA-2
13	SCS Runoff	31.00	2	742	176,720	------	------	------	Post-Development Downstream DA-2
14	Combine	32.71	2	742	201,545	8, 13	------	------	Post-Development Downstream DA-2

OUT-1502 Model.gpw	Return Period: 10 Year	Thursday, 11 / 2 / 2023

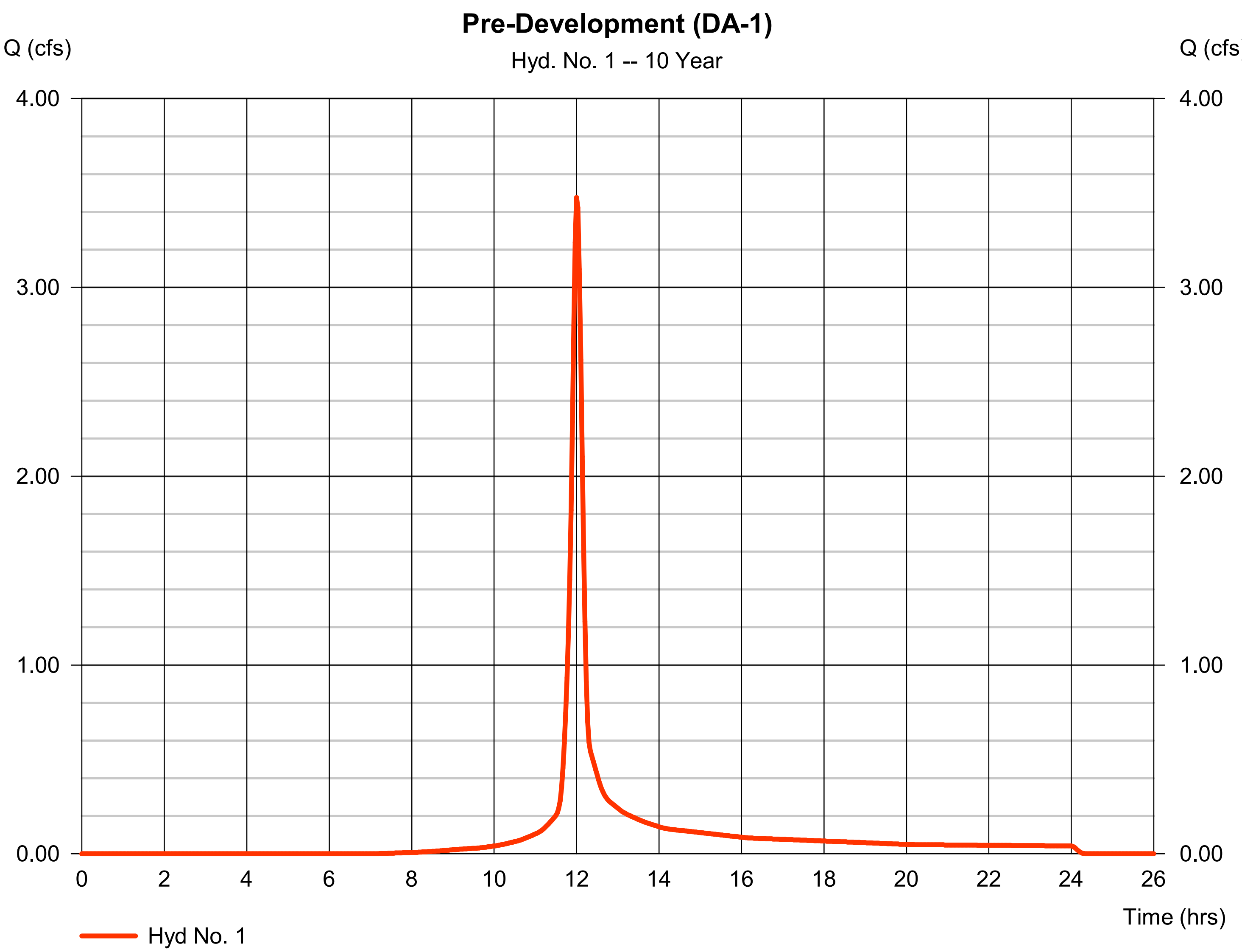
Hydrograph Report

Hyd. No. 1

Pre-Development (DA-1)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.476 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 9,030 cuft
Drainage area	= 0.800 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.20 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.800 x 80)] / 0.800



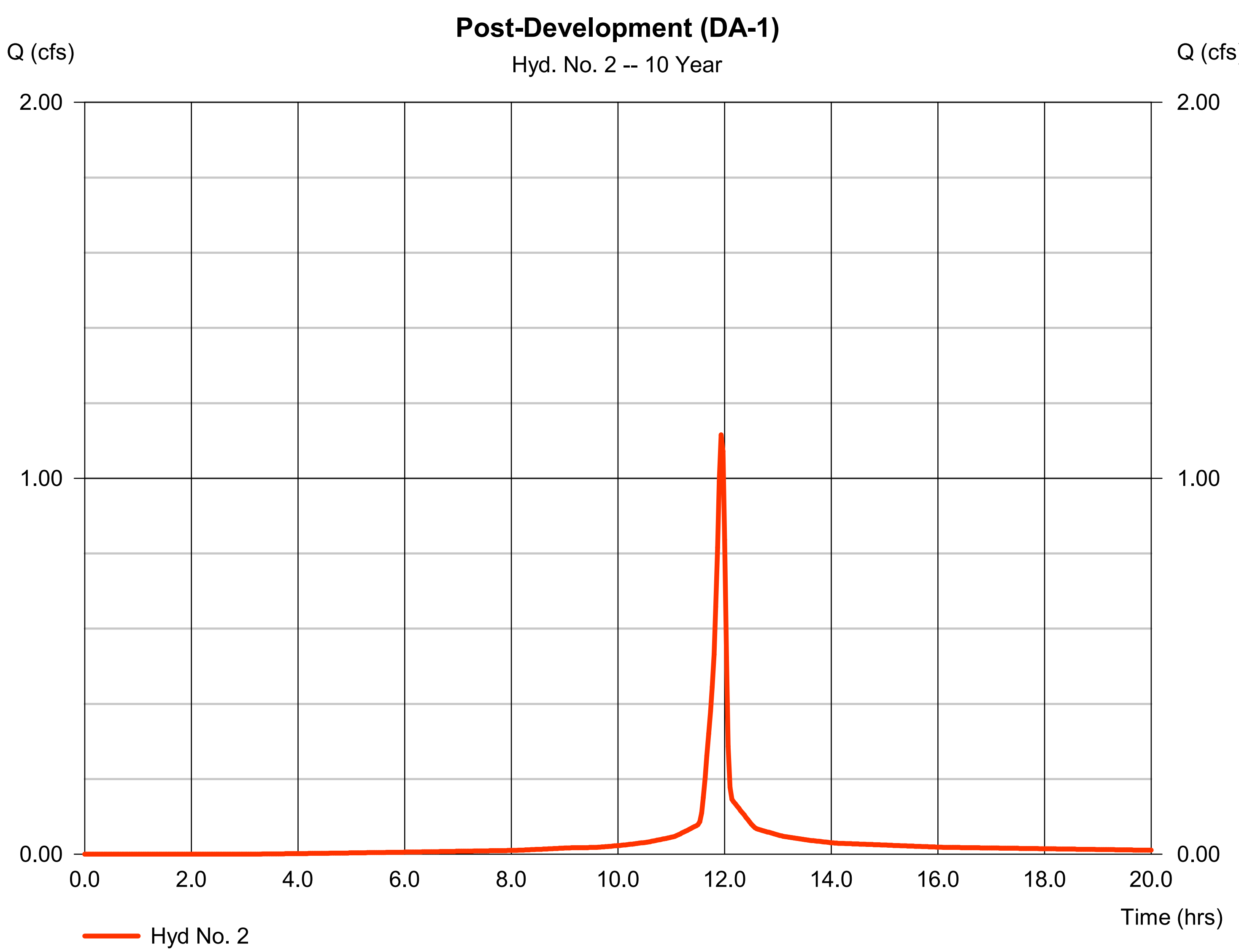
Hydrograph Report

Hyd. No. 2

Post-Development (DA-1)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.115 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 2,445 cuft
Drainage area	= 0.170 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.110 x 98) + (0.060 x 80)] / 0.170



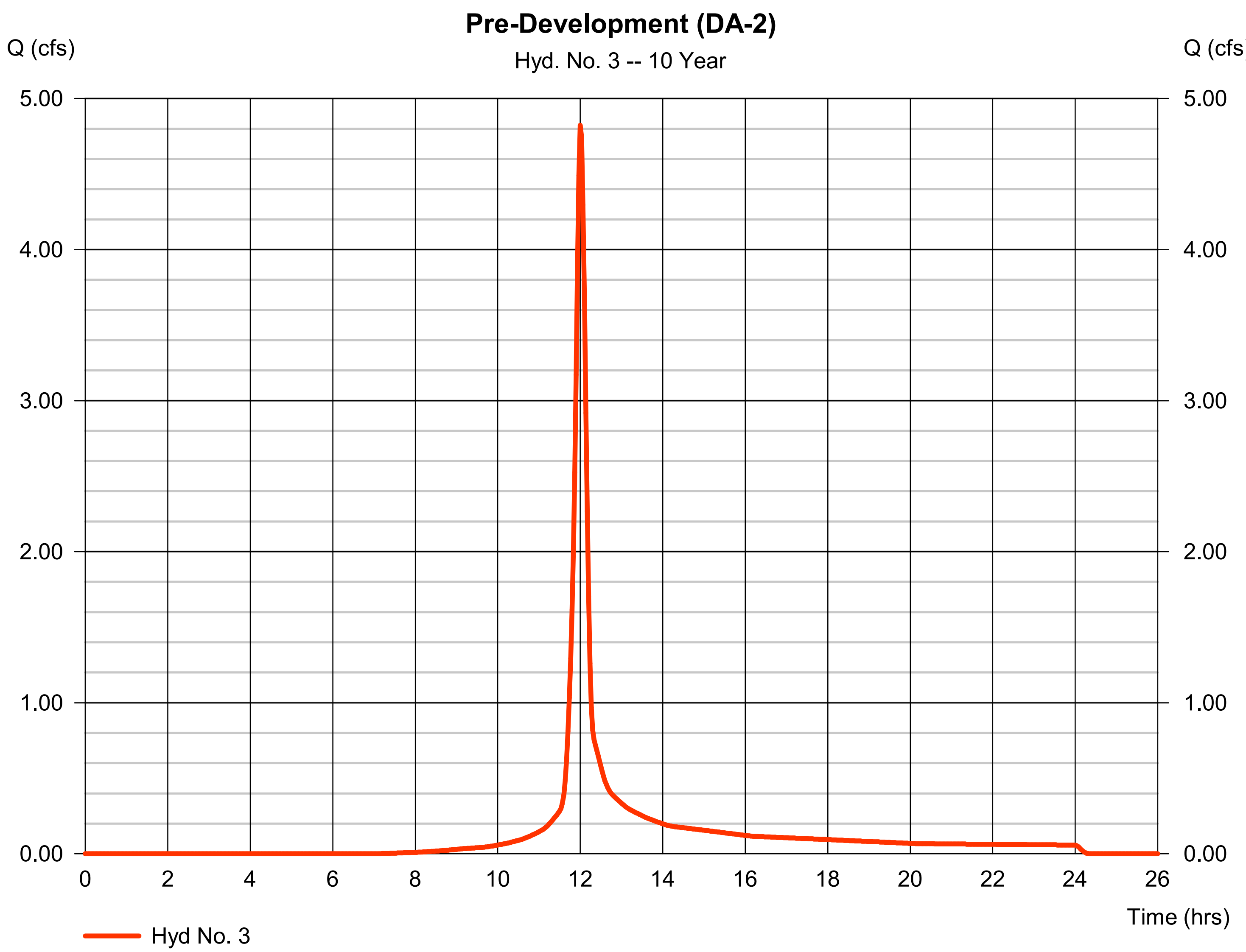
Hydrograph Report

Hyd. No. 3

Pre-Development (DA-2)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.823 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 12,529 cuft
Drainage area	= 1.110 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.40 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (1.110 x 80)] / 1.110



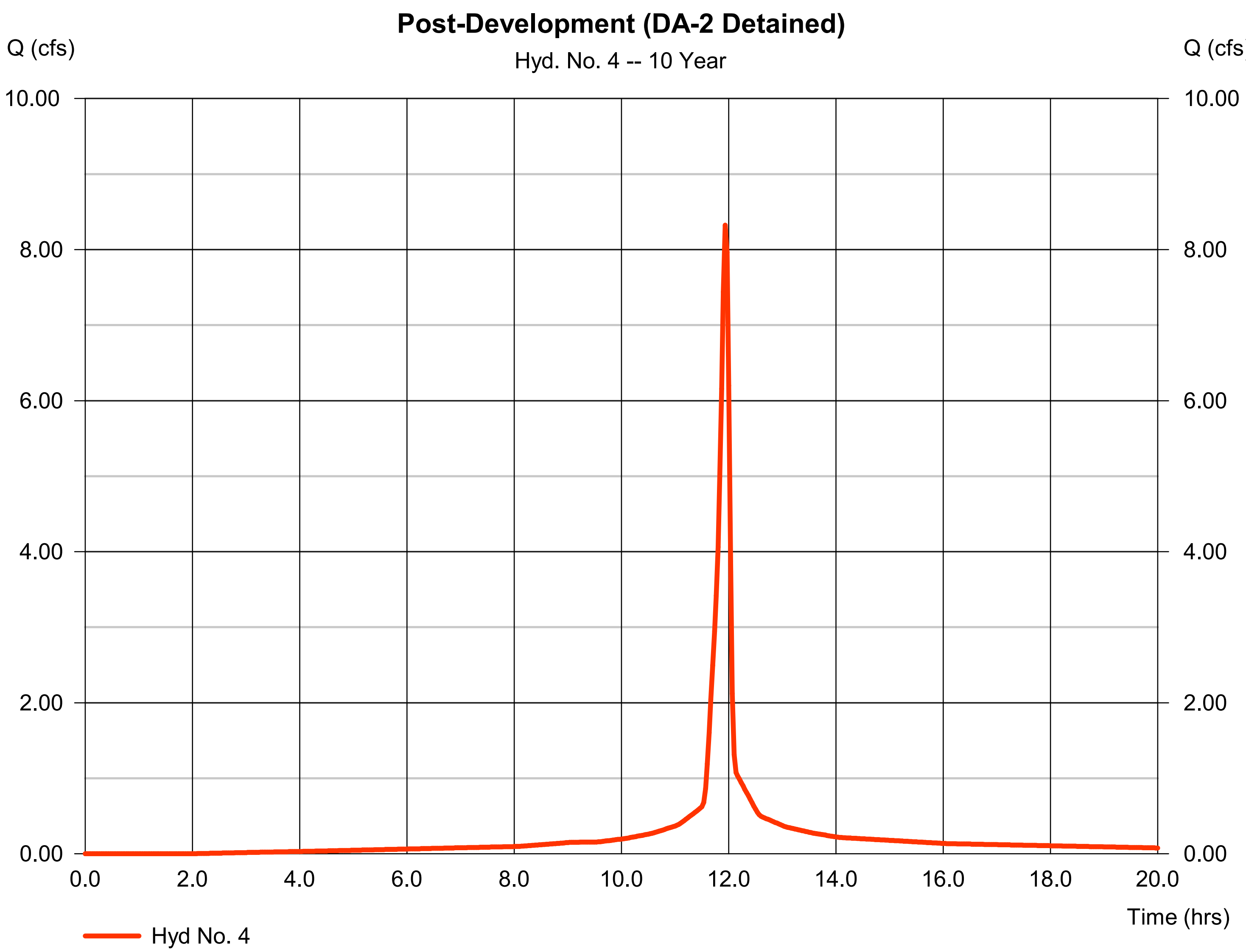
Hydrograph Report

Hyd. No. 4

Post-Development (DA-2 Detained)

Hydrograph type	= SCS Runoff	Peak discharge	= 8.324 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 18,925 cuft
Drainage area	= 1.220 ac	Curve number	= 95*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.220 x 80)] / 1.220



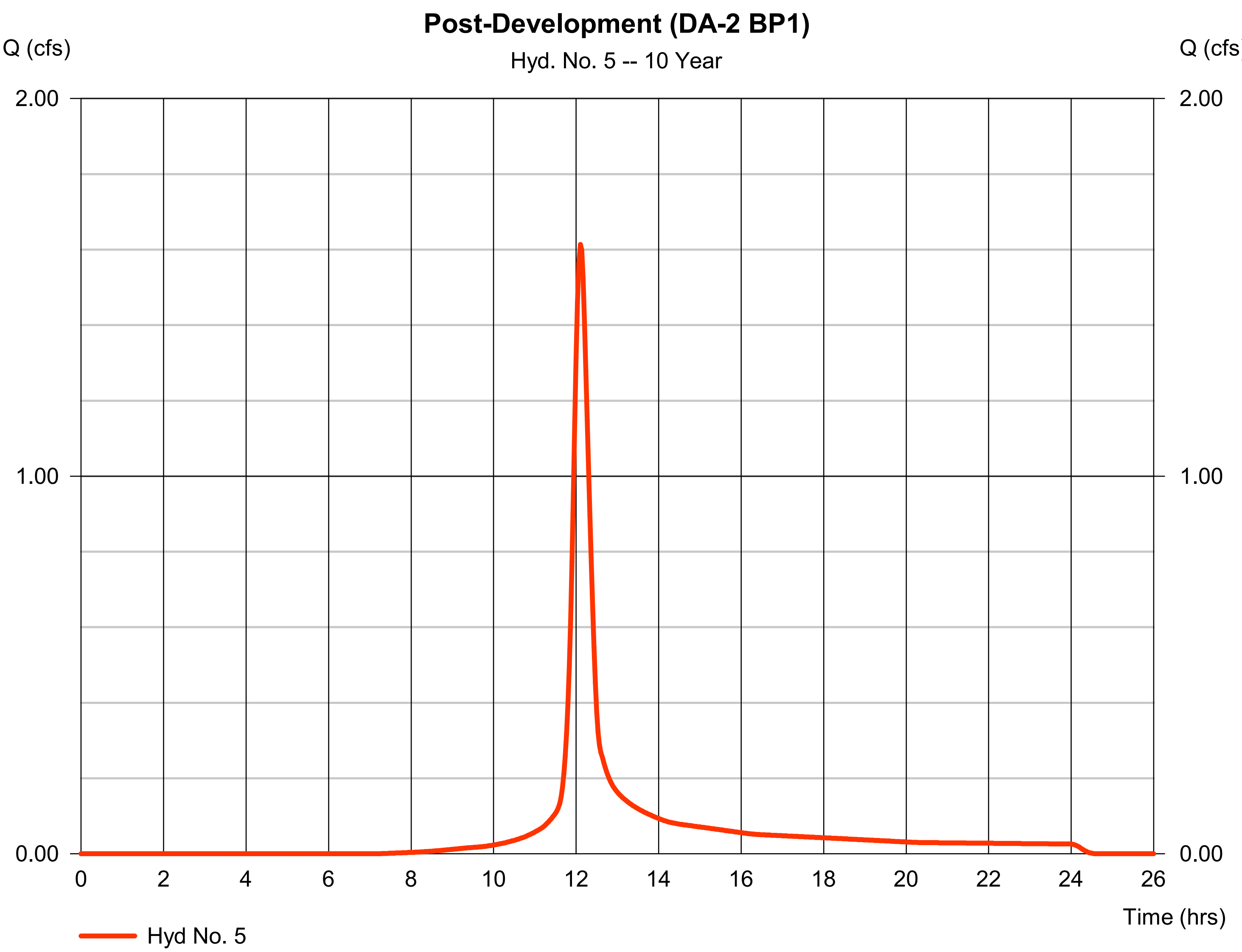
Hydrograph Report

Hyd. No. 5

Post-Development (DA-2 BP1)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.614 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 5,571 cuft
Drainage area	= 0.500 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.00 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.500 x 80)] / 0.500



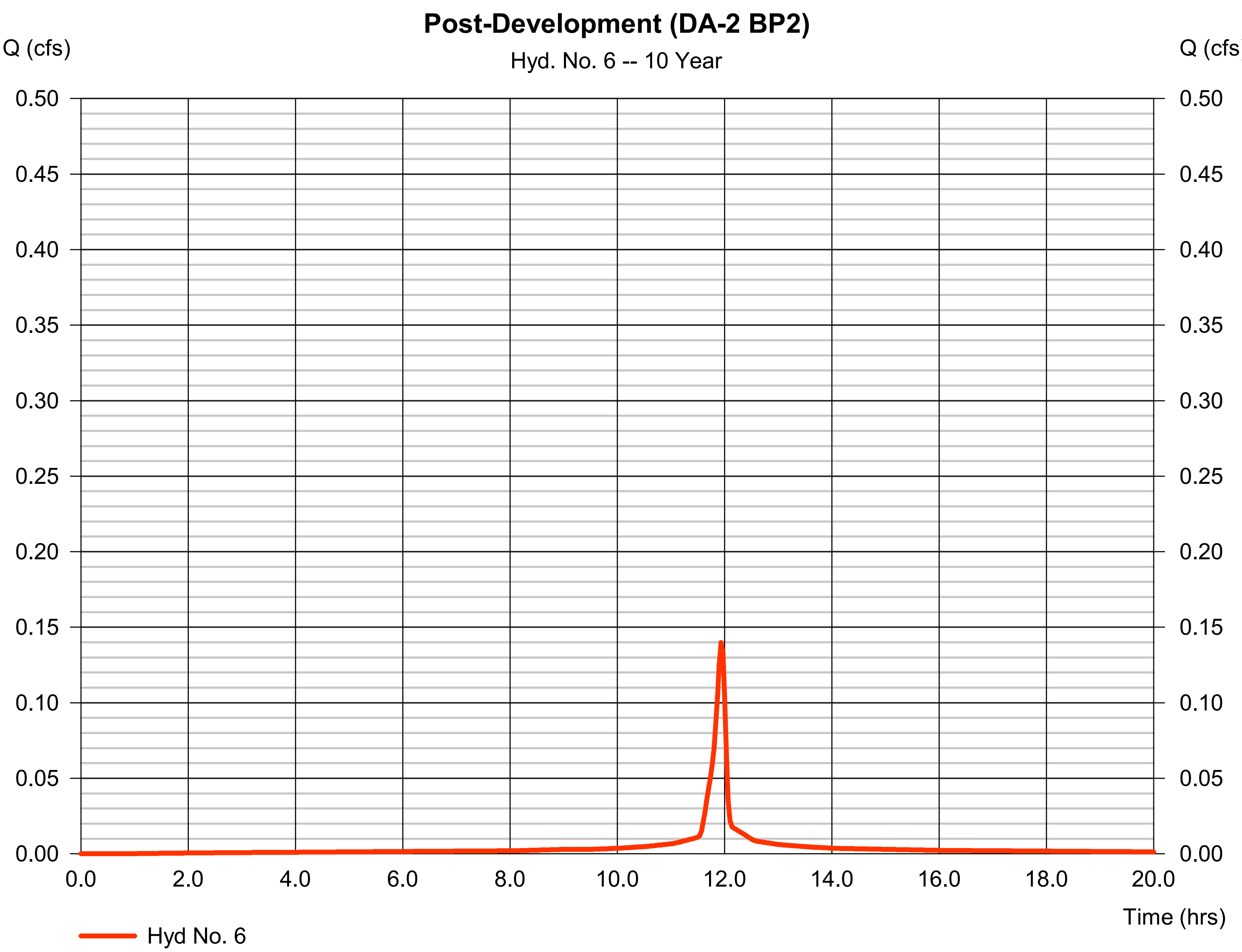
Hydrograph Report

Hyd. No. 6

Post-Development (DA-2 BP2)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.140 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 334 cuft
Drainage area	= 0.020 ac	Curve number	= 98*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98)] / 0.020



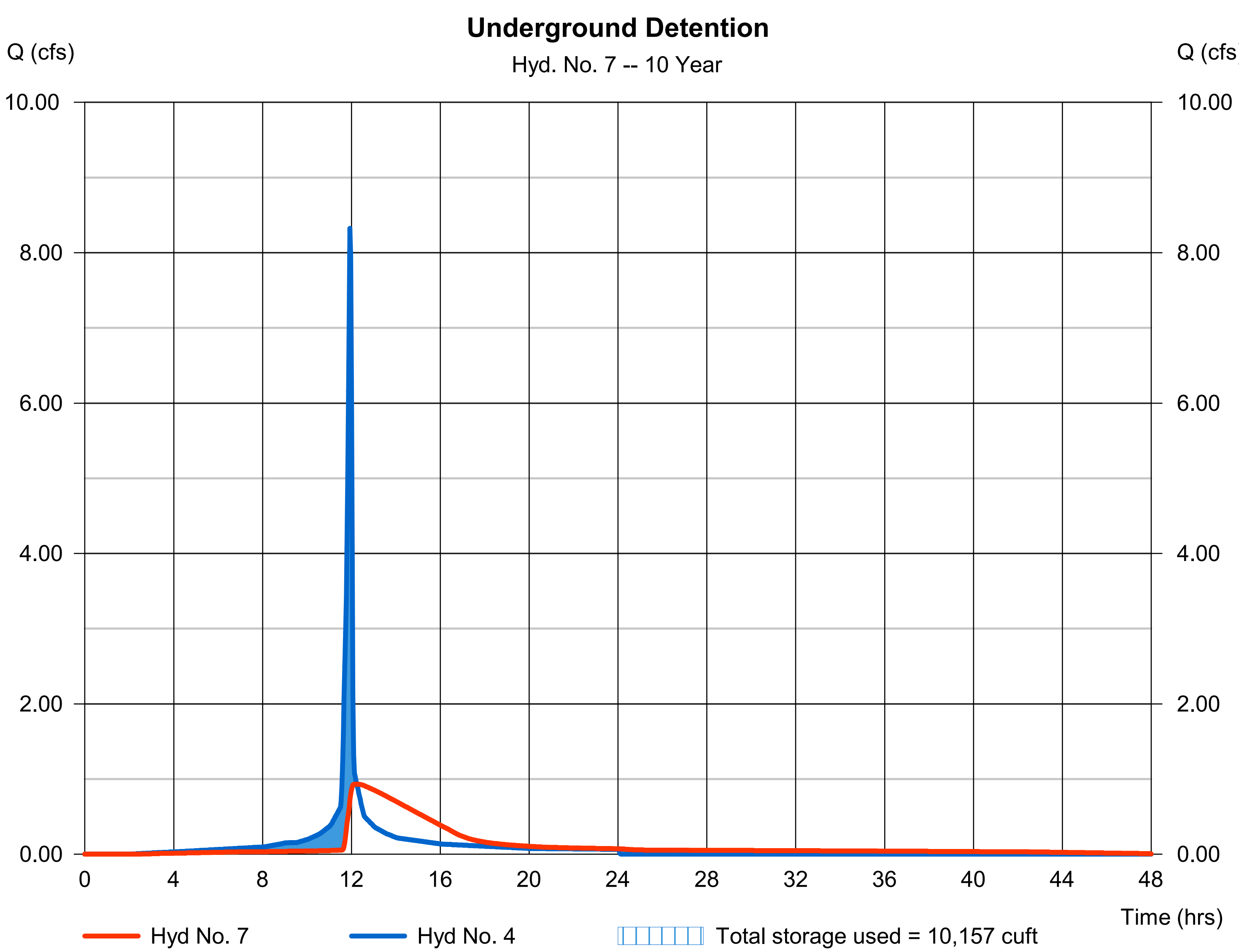
Hydrograph Report

Hyd. No. 7

Underground Detention

Hydrograph type	= Reservoir	Peak discharge	= 0.932 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 18,921 cuft
Inflow hyd. No.	= 4 - Post-Development (DA-2 Detained)	Max. Elevation	= 333.22 ft
Reservoir name	= UG Detention System	Max. Storage	= 10,157 cuft

Storage Indication method used.



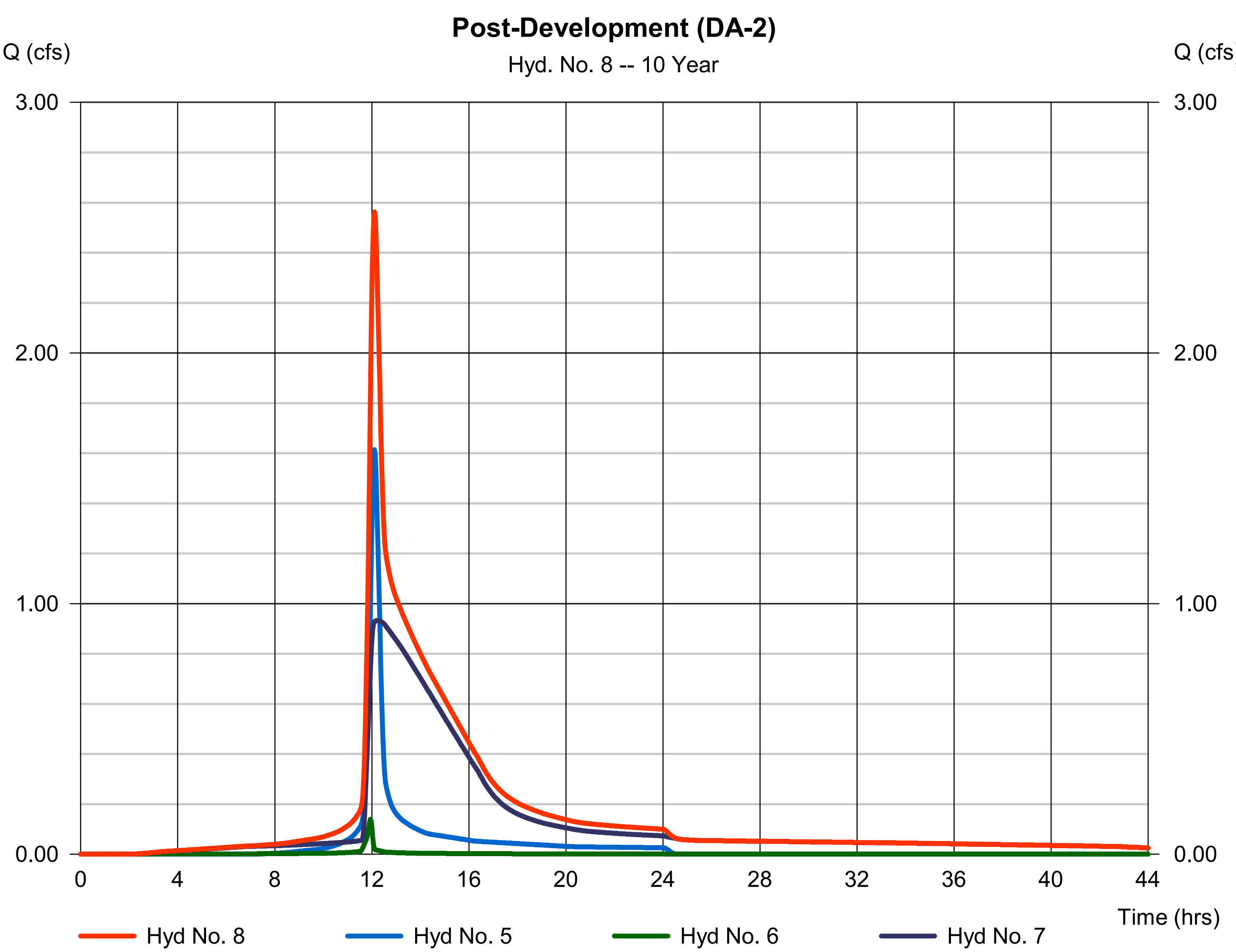
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 11 / 2 / 2023

Hyd. No. 8

Post-Development (DA-2)

Hydrograph type	= Combine	Peak discharge	= 2.563 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 24,825 cuft
Inflow hyds.	= 5, 6, 7	Contrib. drain. area	= 0.520 ac



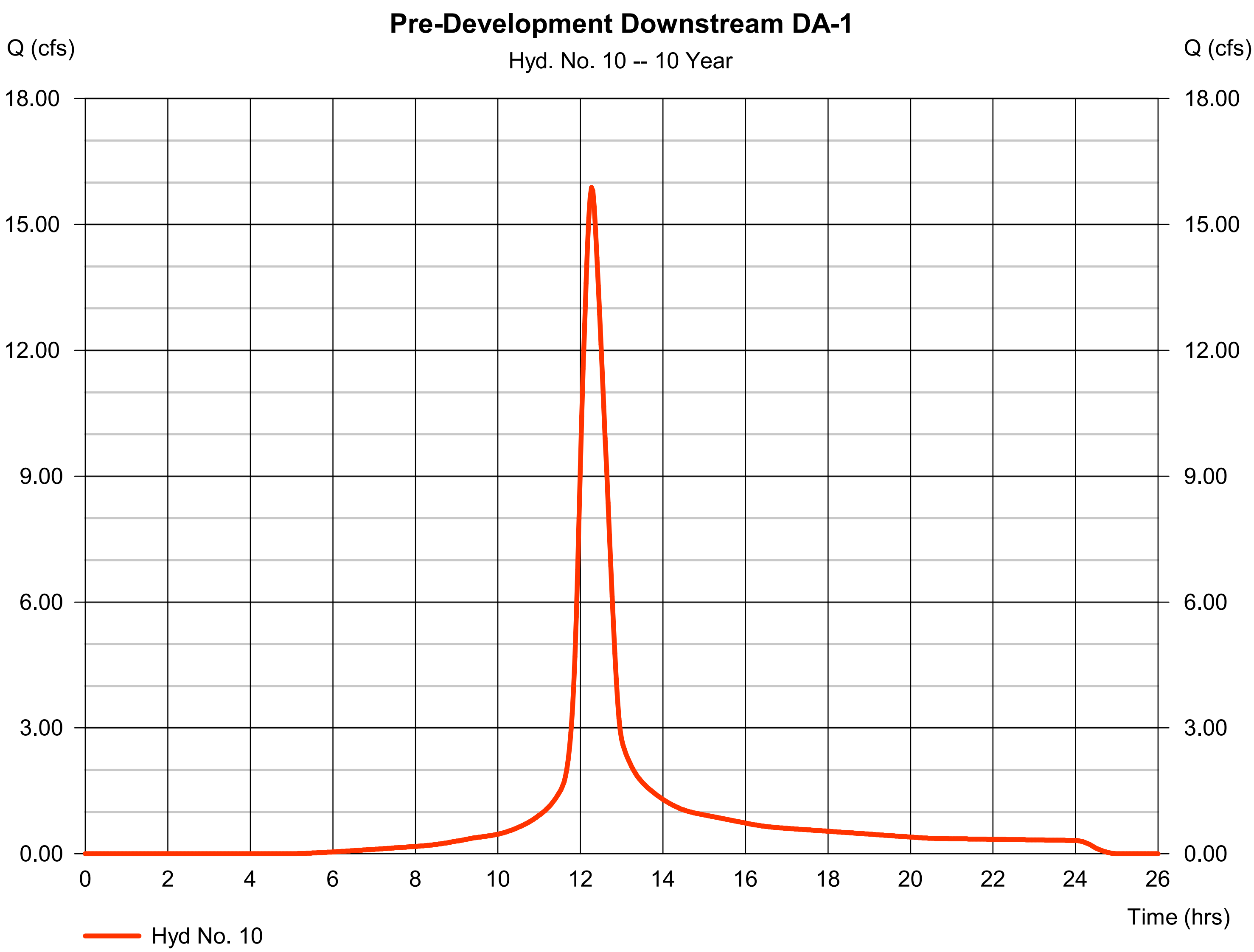
Hydrograph Report

Hyd. No. 10

Pre-Development Downstream DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 15.88 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 77,617 cuft
Drainage area	= 5.780 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 40.10 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.180 x 98) + (3.600 x 80)] / 5.780



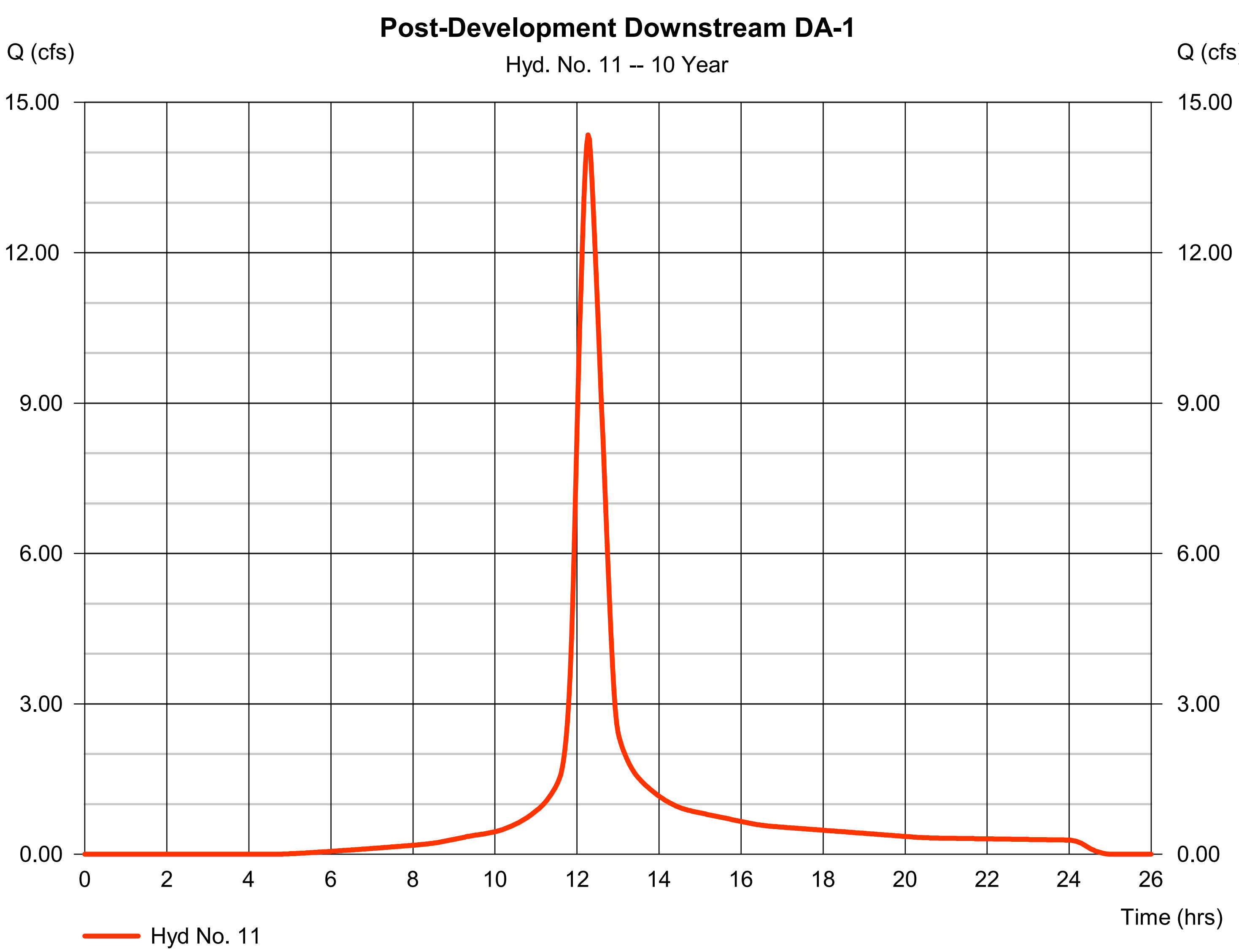
Hydrograph Report

Hyd. No. 11

Post-Development Downstream DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 14.35 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 70,388 cuft
Drainage area	= 5.100 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 40.10 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.320 x 98) + (2.780 x 80)] / 5.100



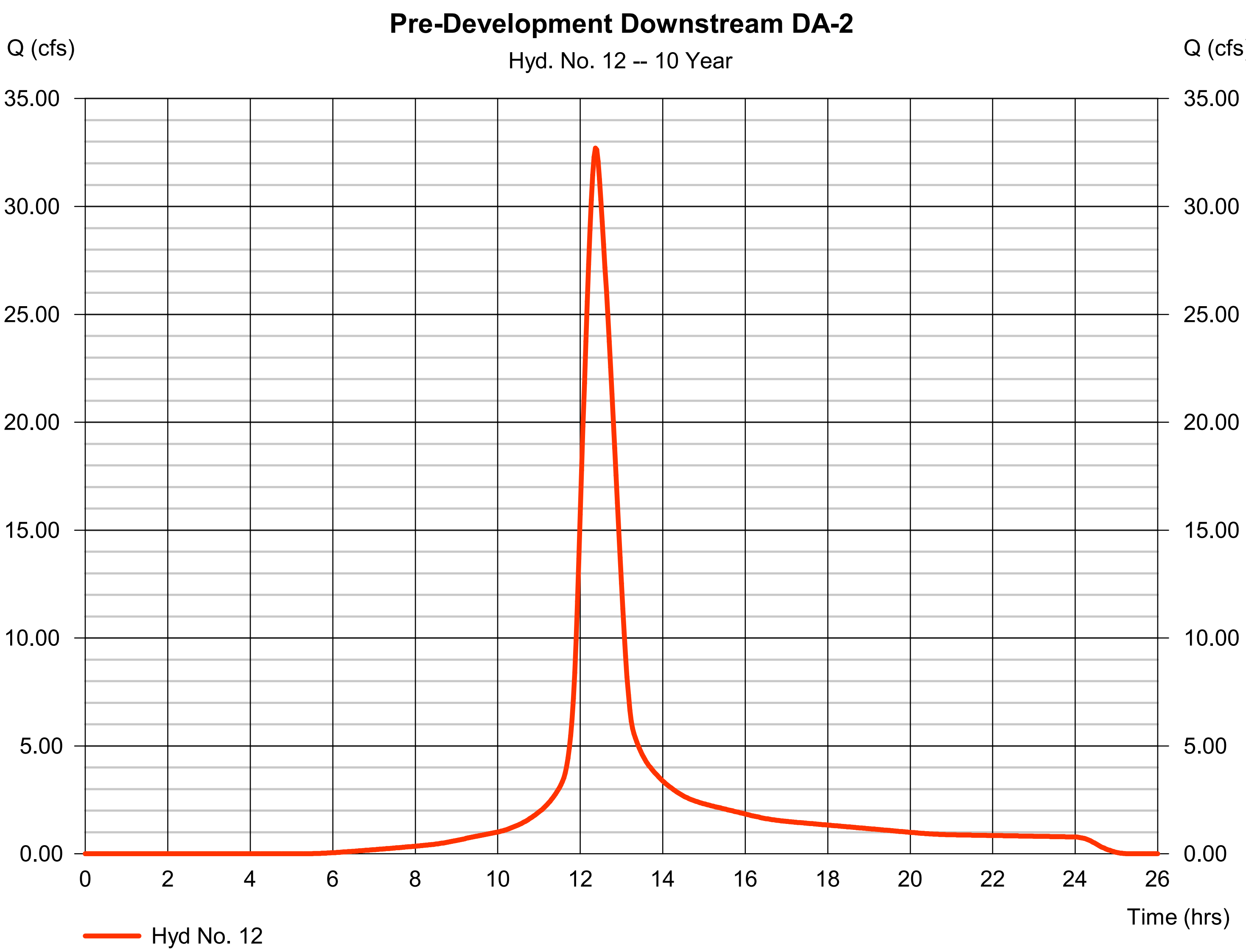
Hydrograph Report

Hyd. No. 12

Pre-Development Downstream DA-2

Hydrograph type	= SCS Runoff	Peak discharge	= 32.71 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 185,978 cuft
Drainage area	= 14.240 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 49.10 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.930 x 98) + (9.310 x 80)] / 14.240



Hydrograph Report

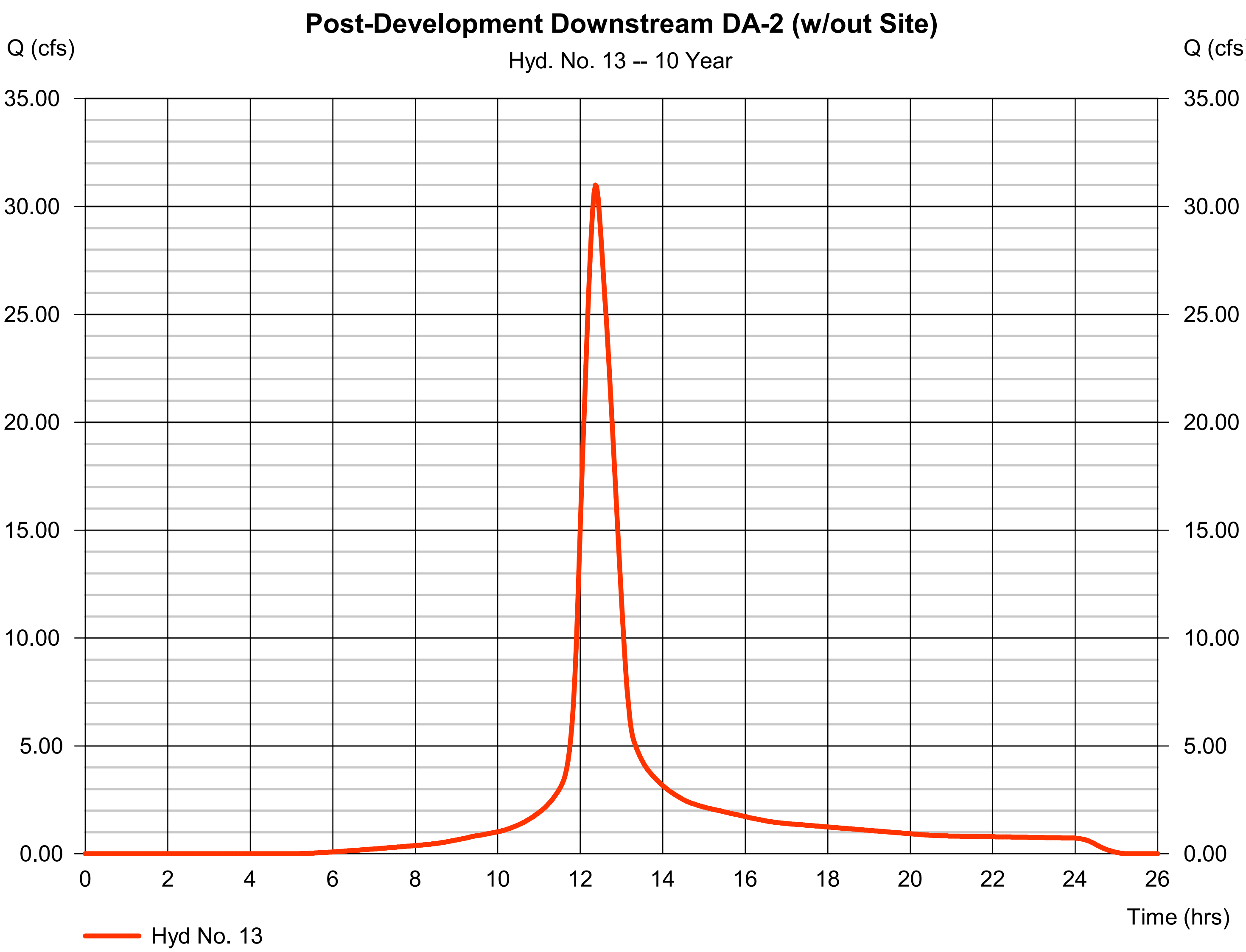
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 11 / 2 / 2023

Hyd. No. 13

Post-Development Downstream DA-2 (w/out Site)

Hydrograph type	= SCS Runoff	Peak discharge	= 31.00 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 176,720 cuft
Drainage area	= 13.160 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 49.06 min
Total precip.	= 5.14 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.220 x 98) + (7.940 x 80)] / 13.160

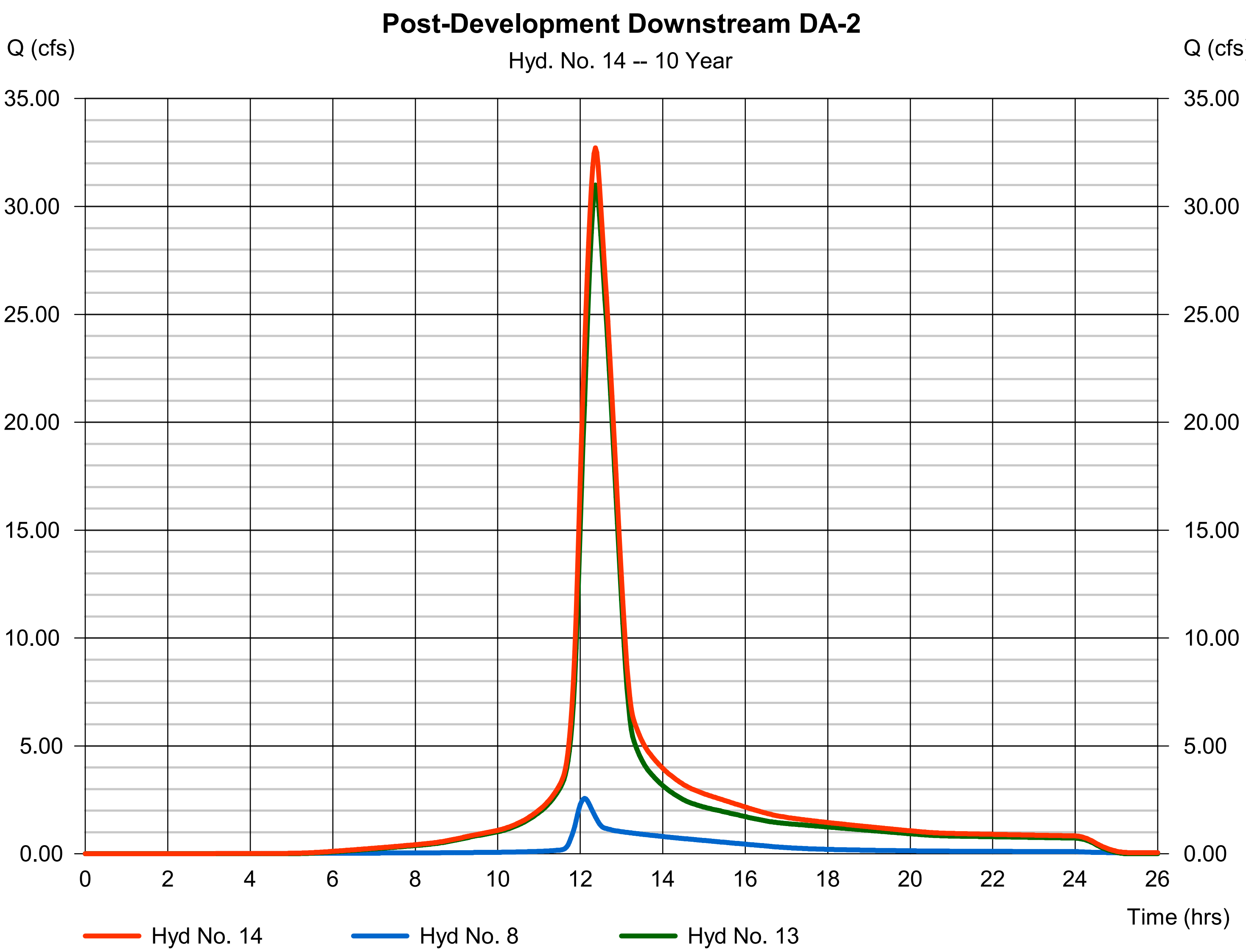


Hydrograph Report

Hyd. No. 14

Post-Development Downstream DA-2

Hydrograph type	= Combine	Peak discharge	= 32.71 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 201,545 cuft
Inflow hyds.	= 8, 13	Contrib. drain. area	= 13.160 ac



Hydrograph Summary Report

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	6.368	2	720	16,845	------	------	------	Pre-Development (DA-1)
2	SCS Runoff	1.800	2	716	4,075	------	------	------	Post-Development (DA-1)
3	SCS Runoff	8.836	2	720	23,373	------	------	------	Pre-Development (DA-2)
4	SCS Runoff	13.16	2	716	30,729	------	------	------	Post-Development (DA-2 Detained)
5	SCS Runoff	2.978	2	726	10,392	------	------	------	Post-Development (DA-2 BP1)
6	SCS Runoff	0.218	2	716	528	------	------	------	Post-Development (DA-2 BP2)
7	Reservoir	12.95	2	718	30,725	4	334.20	12,269	Underground Detention
8	Combine	15.34	2	718	41,645	5, 6, 7	------	------	Post-Development (DA-2)
10	SCS Runoff	27.13	2	736	135,324	------	------	------	Pre-Development Downstream DA-1
11	SCS Runoff	24.26	2	736	121,597	------	------	------	Post-Development Downstream DA-1
12	SCS Runoff	56.56	2	742	327,277	------	------	------	Pre-Development Downstream DA-2
13	SCS Runoff	53.02	2	742	308,108	------	------	------	Post-Development Downstream DA-2
14	Combine	55.83	2	742	349,753	8, 13	------	------	Post-Development Downstream DA-2

OUT-1502 Model.gpw	Return Period: 100 Year	Thursday, 11 / 2 / 2023

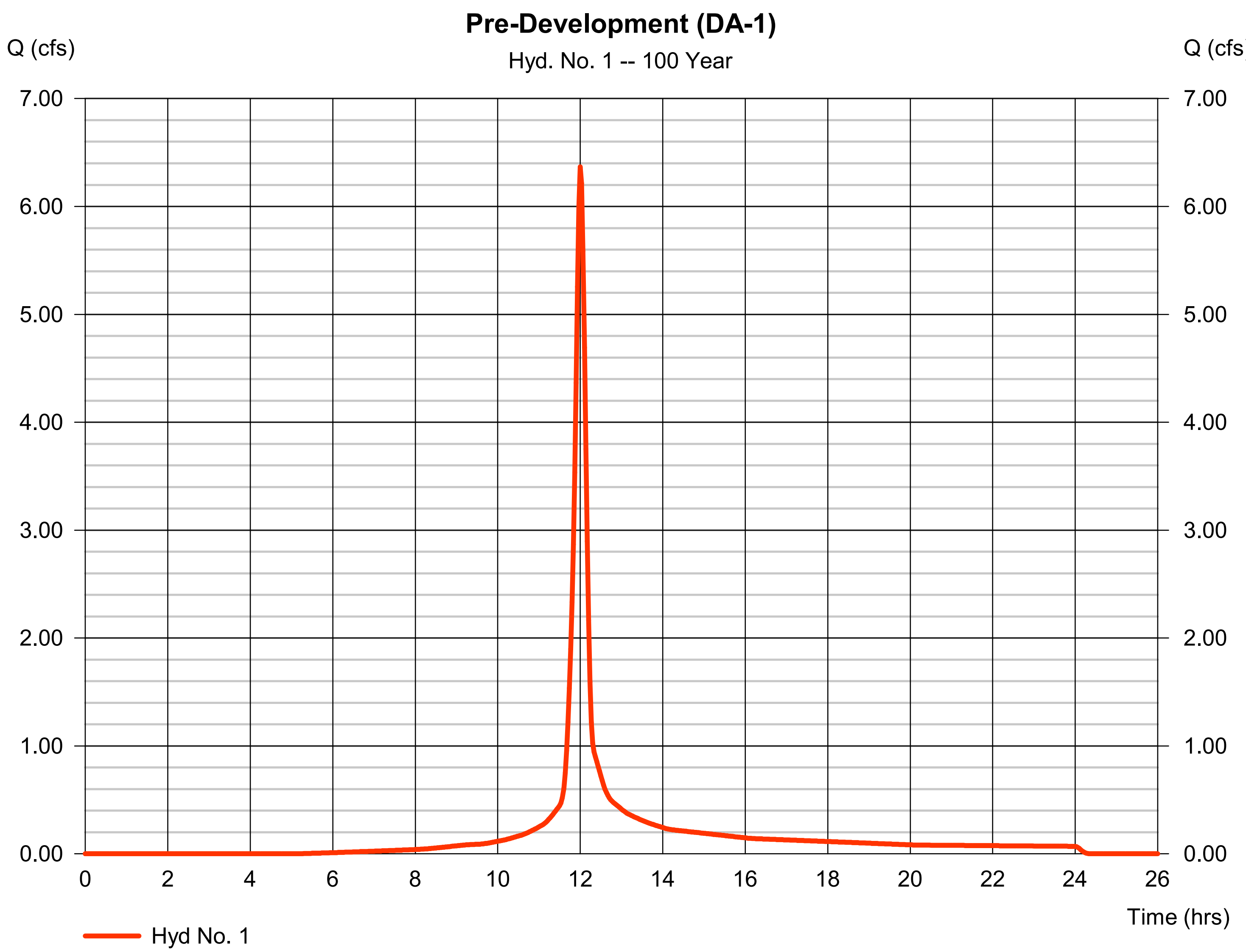
Hydrograph Report

Hyd. No. 1

Pre-Development (DA-1)

Hydrograph type	= SCS Runoff	Peak discharge	= 6.368 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 16,845 cuft
Drainage area	= 0.800 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.20 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.800 x 80)] / 0.800



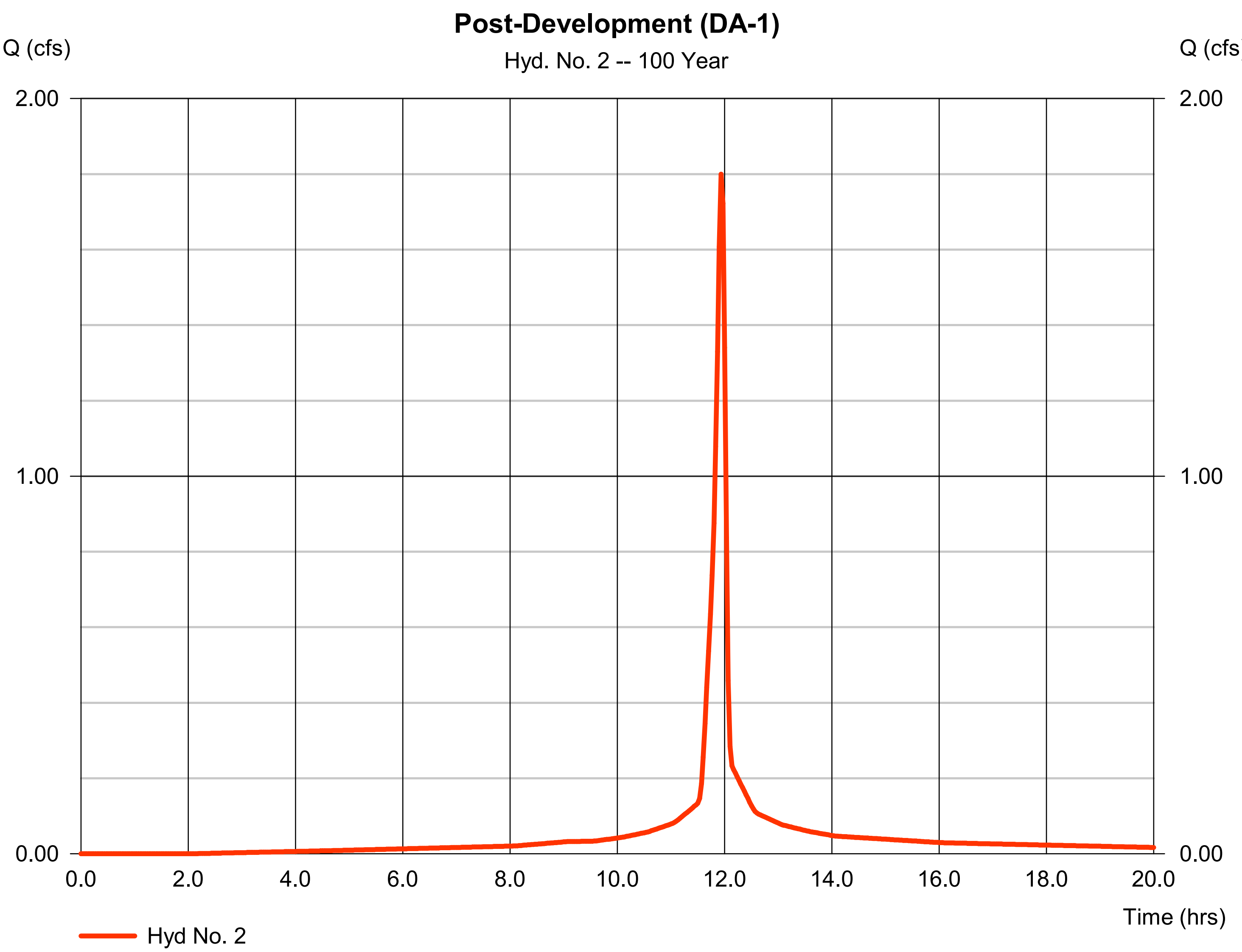
Hydrograph Report

Hyd. No. 2

Post-Development (DA-1)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.800 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 4,075 cuft
Drainage area	= 0.170 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.110 x 98) + (0.060 x 80)] / 0.170



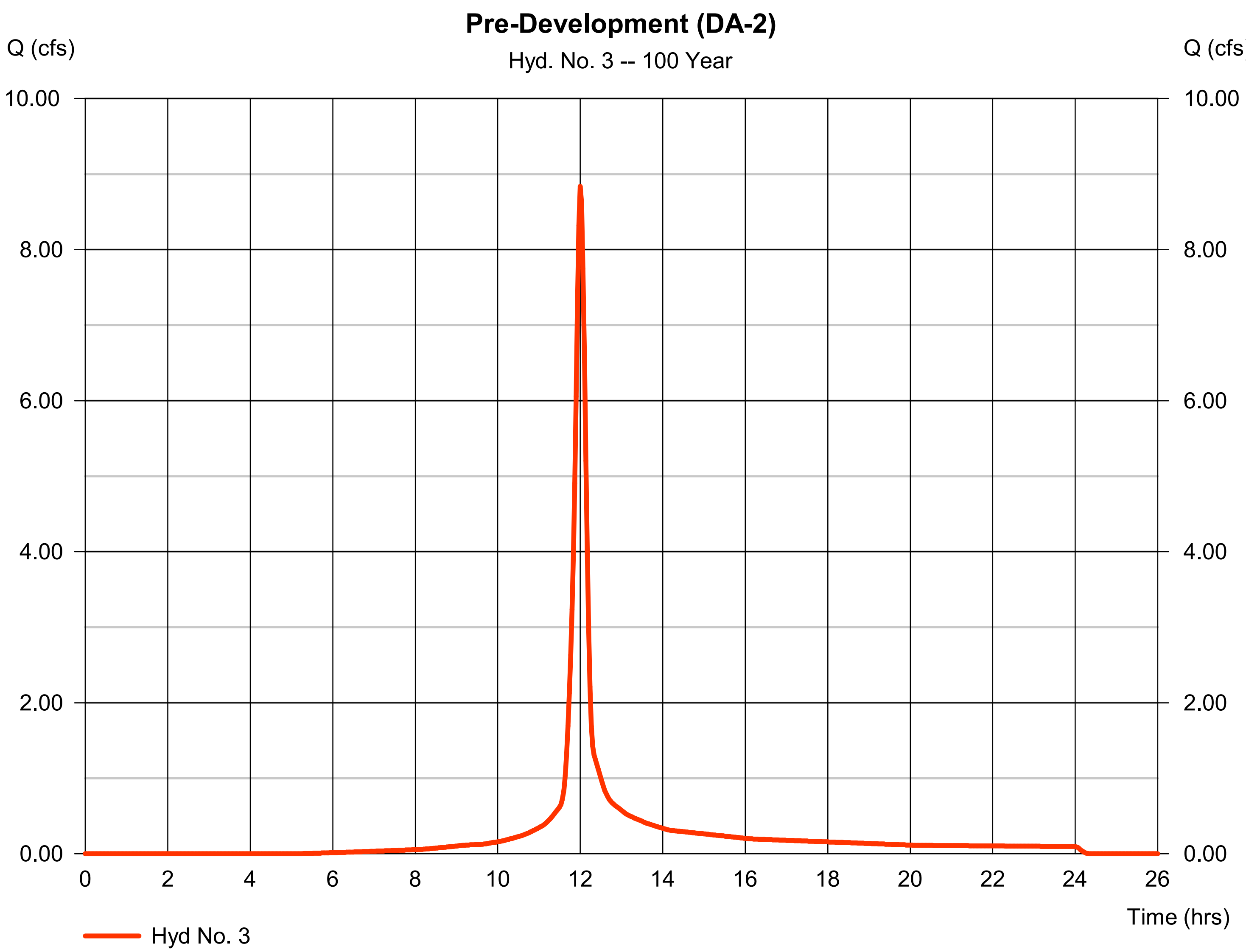
Hydrograph Report

Hyd. No. 3

Pre-Development (DA-2)

Hydrograph type	= SCS Runoff	Peak discharge	= 8.836 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 23,373 cuft
Drainage area	= 1.110 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.40 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (1.110 x 80)] / 1.110



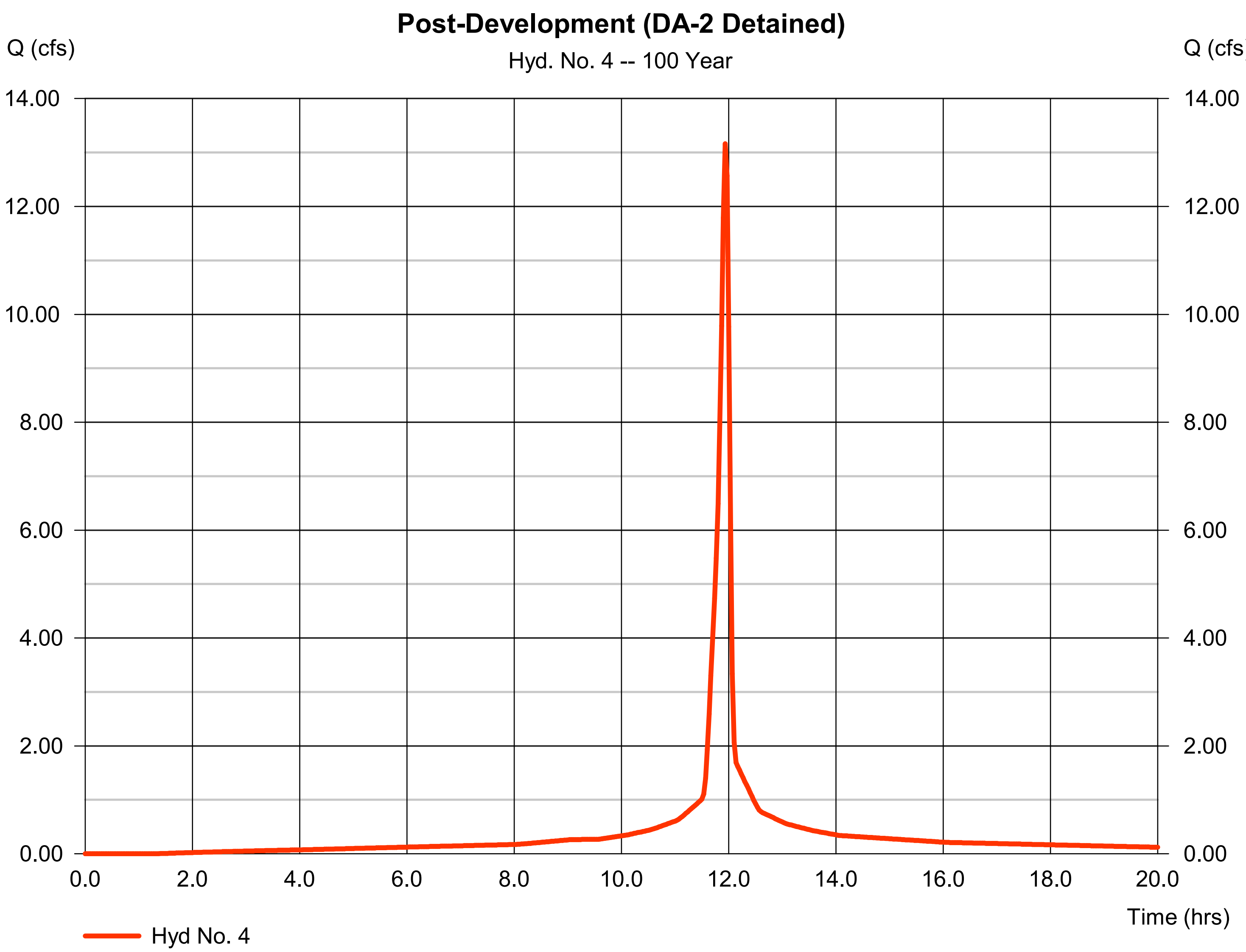
Hydrograph Report

Hyd. No. 4

Post-Development (DA-2 Detained)

Hydrograph type	= SCS Runoff	Peak discharge	= 13.16 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 30,729 cuft
Drainage area	= 1.220 ac	Curve number	= 95*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.000 x 98) + (0.220 x 80)] / 1.220



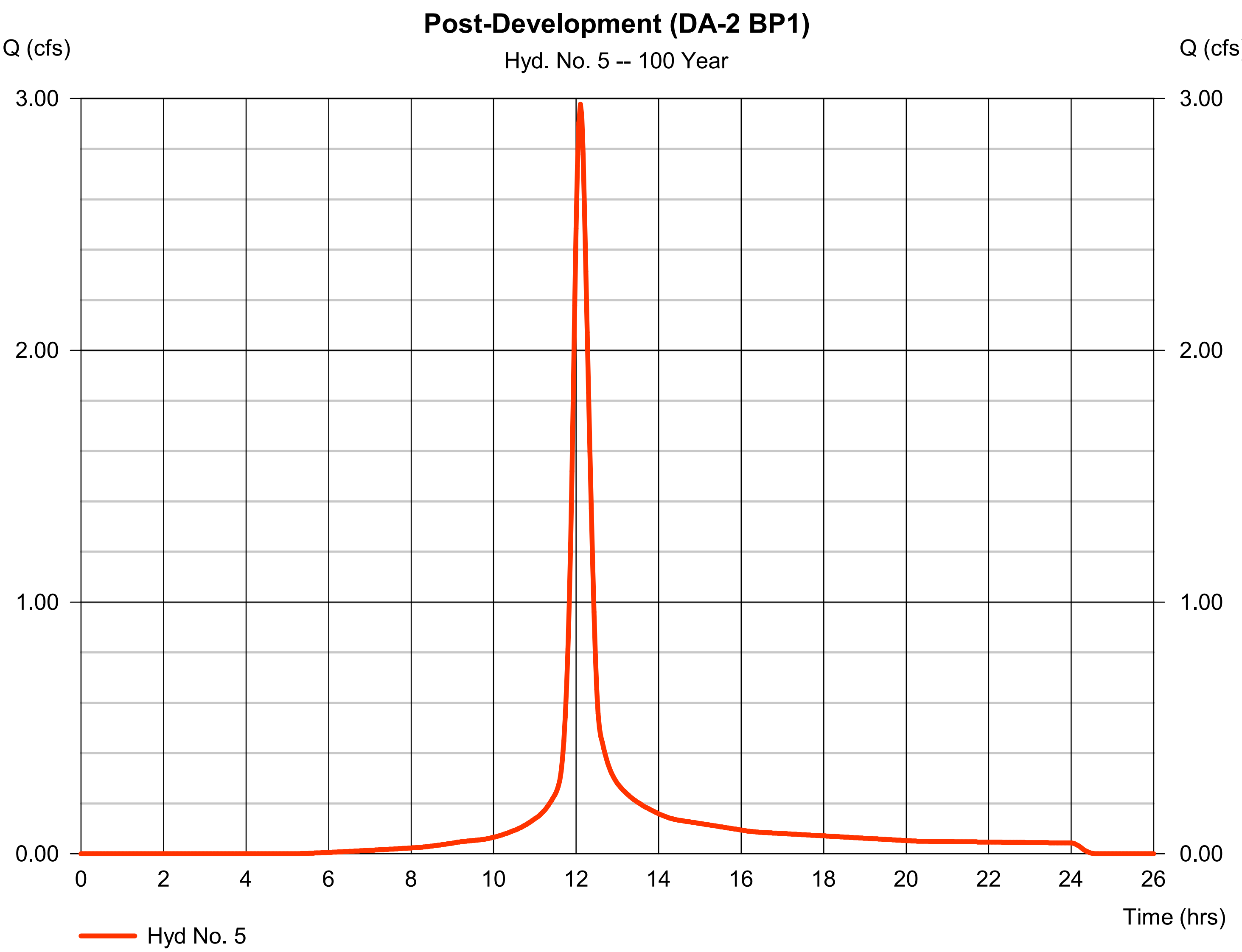
Hydrograph Report

Hyd. No. 5

Post-Development (DA-2 BP1)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.978 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 10,392 cuft
Drainage area	= 0.500 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 23.00 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.500 x 80)] / 0.500



Hydrograph Report

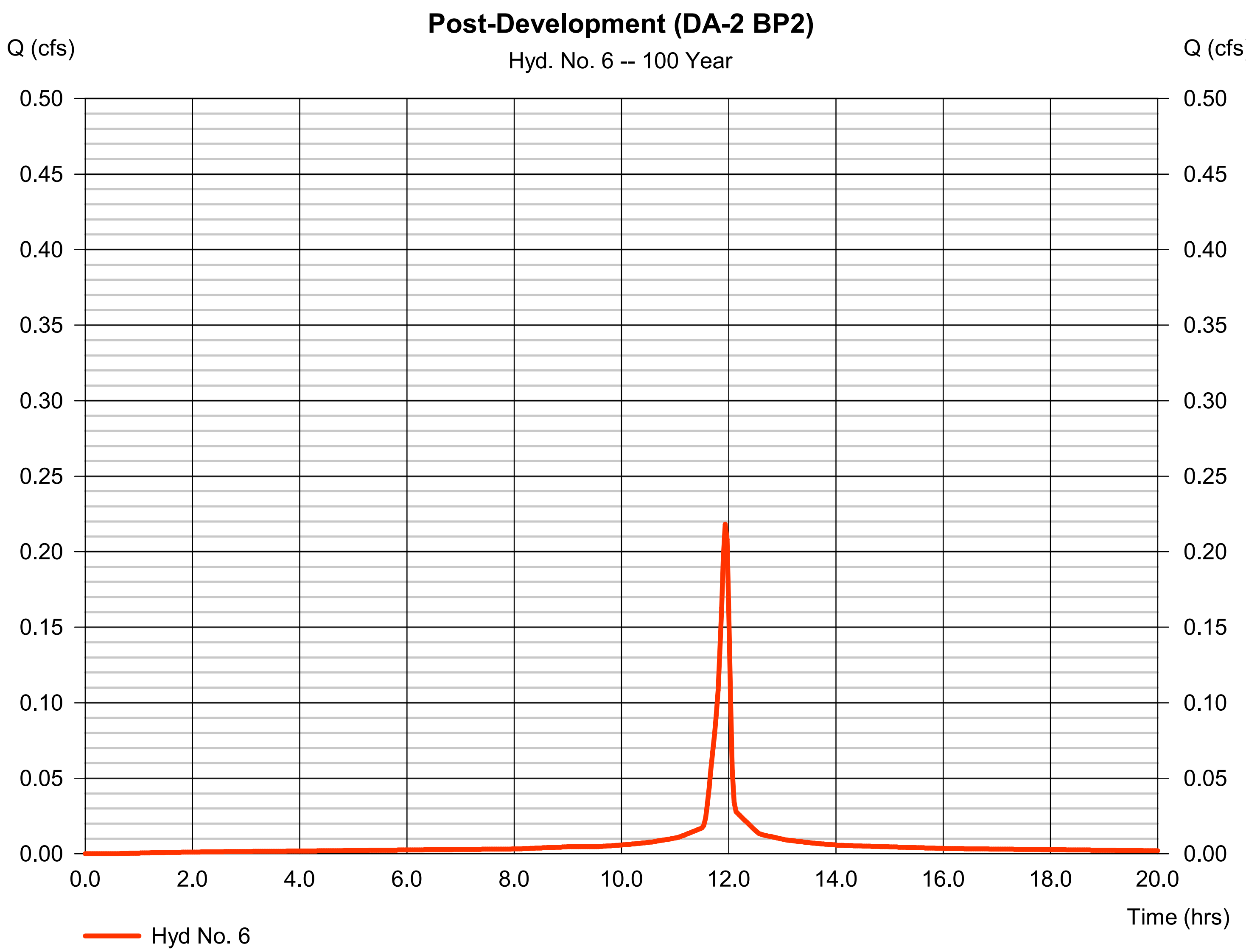
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 11 / 2 / 2023

Hyd. No. 6

Post-Development (DA-2 BP2)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.218 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 528 cuft
Drainage area	= 0.020 ac	Curve number	= 98*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.020 x 98)] / 0.020



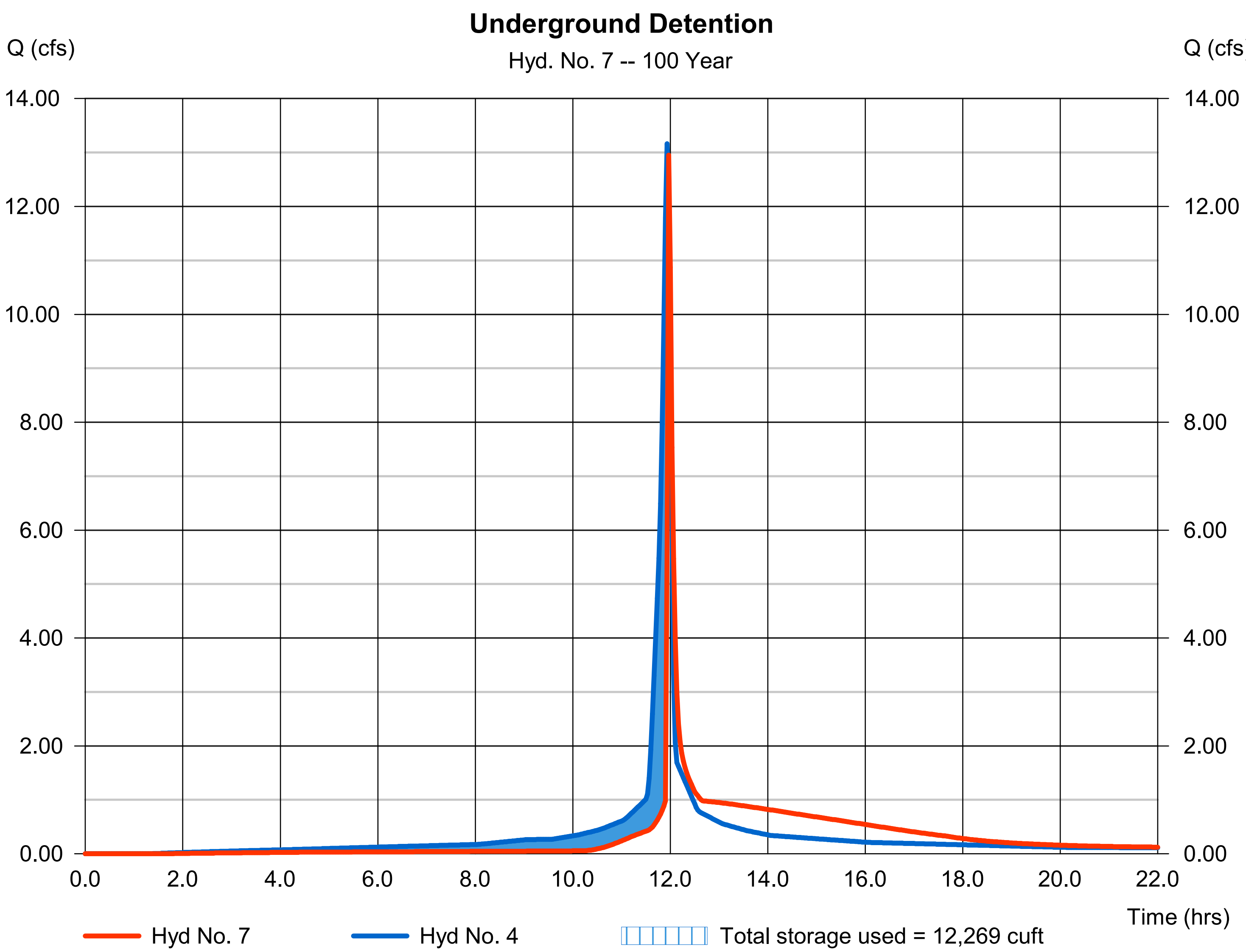
Hydrograph Report

Hyd. No. 7

Underground Detention

Hydrograph type	= Reservoir	Peak discharge	= 12.95 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.97 hrs
Time interval	= 2 min	Hyd. volume	= 30,725 cuft
Inflow hyd. No.	= 4 - Post-Development (DA-2 Detained)	Max. Elevation	= 334.20 ft
Reservoir name	= UG Detention System	Max. Storage	= 12,269 cuft

Storage Indication method used.

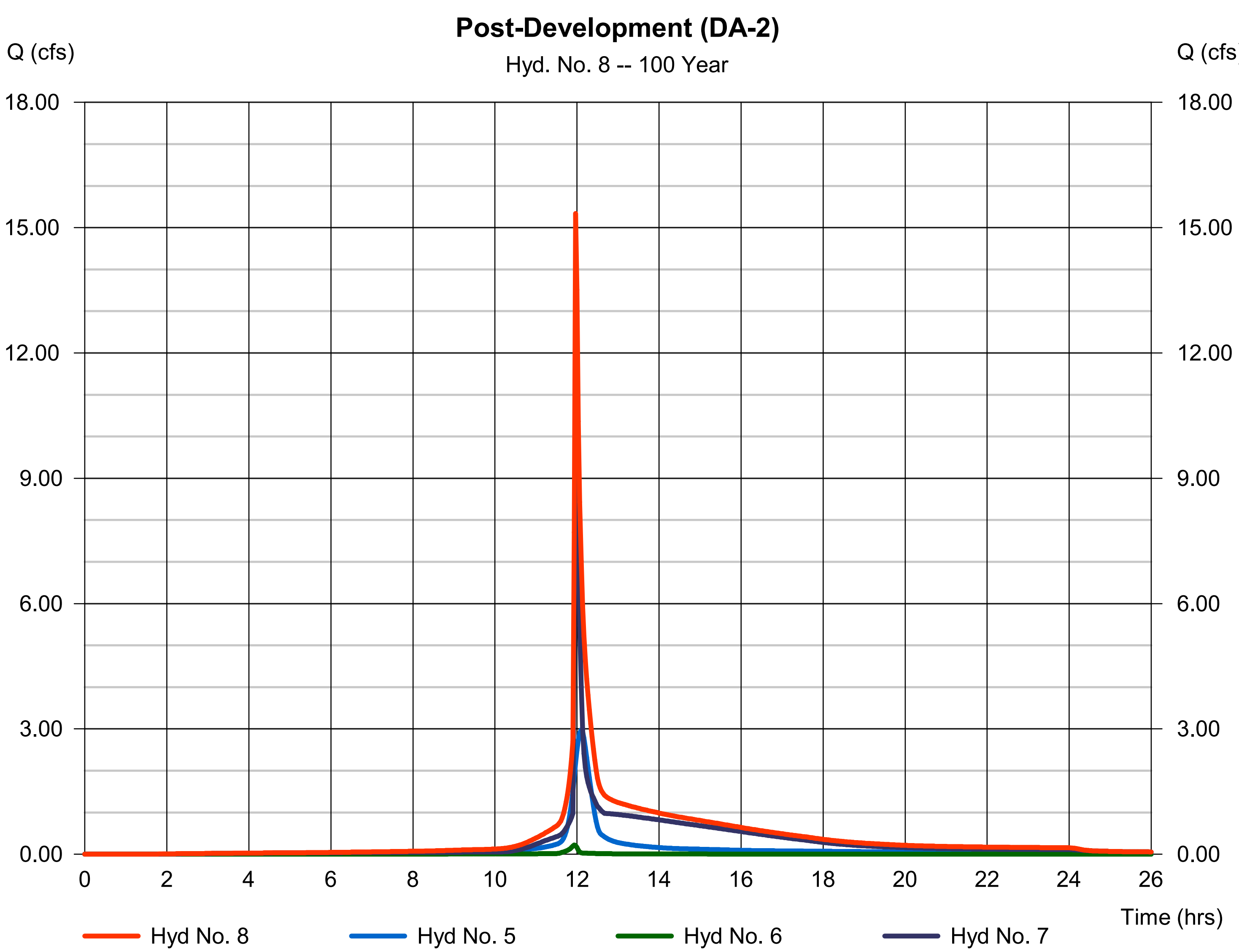


Hydrograph Report

Hyd. No. 8

Post-Development (DA-2)

Hydrograph type	= Combine	Peak discharge	= 15.34 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.97 hrs
Time interval	= 2 min	Hyd. volume	= 41,645 cuft
Inflow hyds.	= 5, 6, 7	Contrib. drain. area	= 0.520 ac



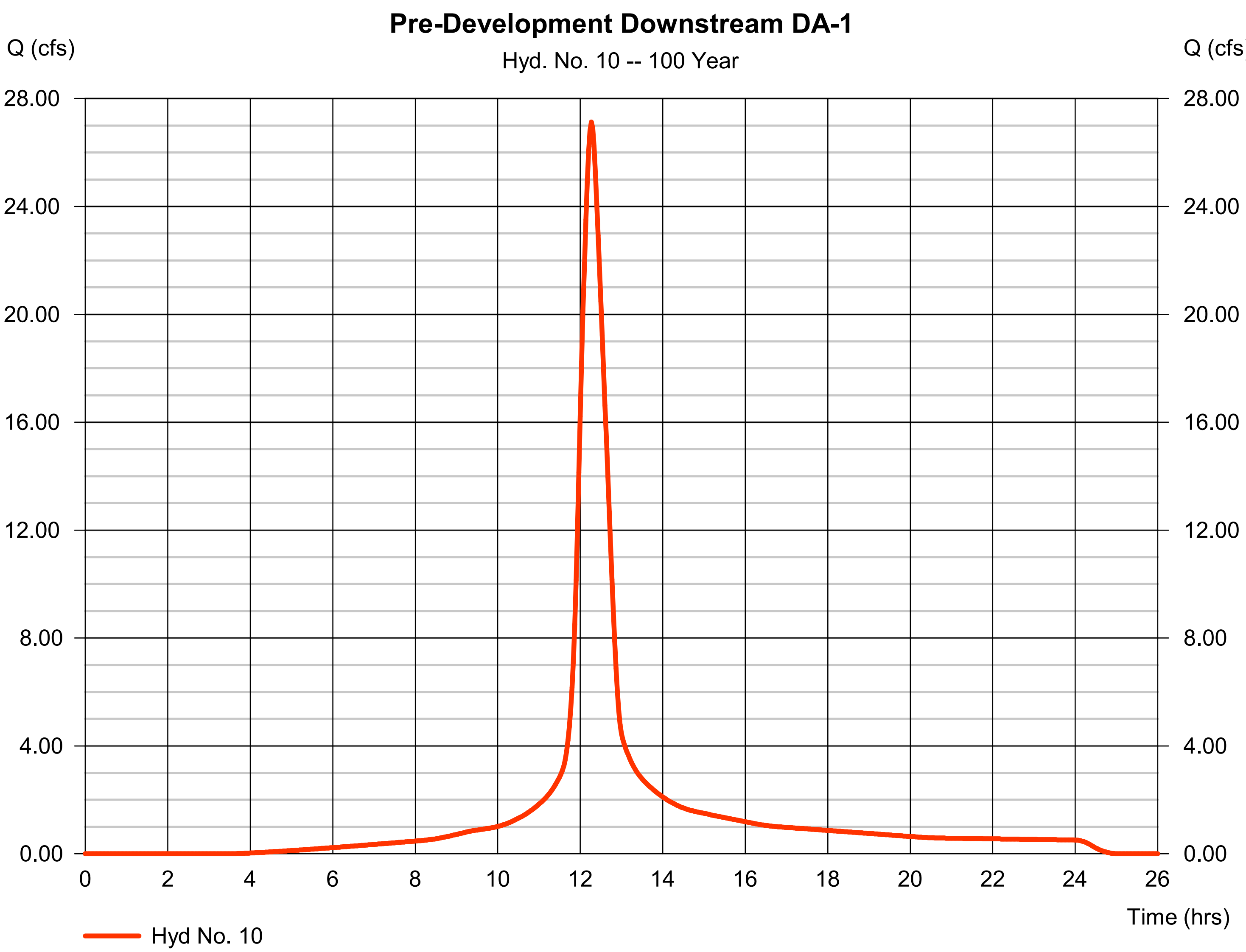
Hydrograph Report

Hyd. No. 10

Pre-Development Downstream DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 27.13 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 135,324 cuft
Drainage area	= 5.780 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 40.10 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.180 x 98) + (3.600 x 80)] / 5.780



Hydrograph Report

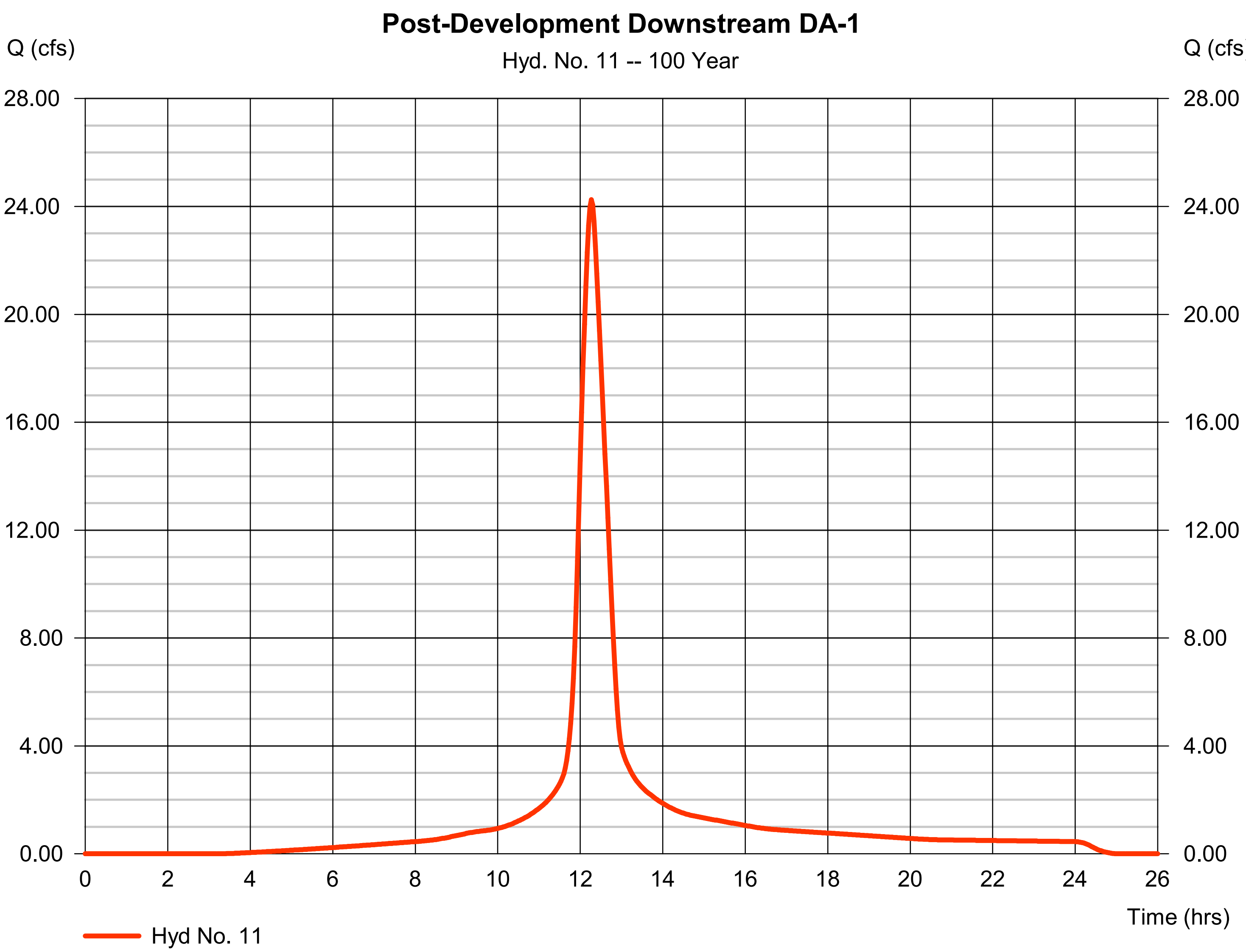
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 11 / 2 / 2023

Hyd. No. 11

Post-Development Downstream DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 24.26 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 121,597 cuft
Drainage area	= 5.100 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 40.10 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.320 x 98) + (2.780 x 80)] / 5.100



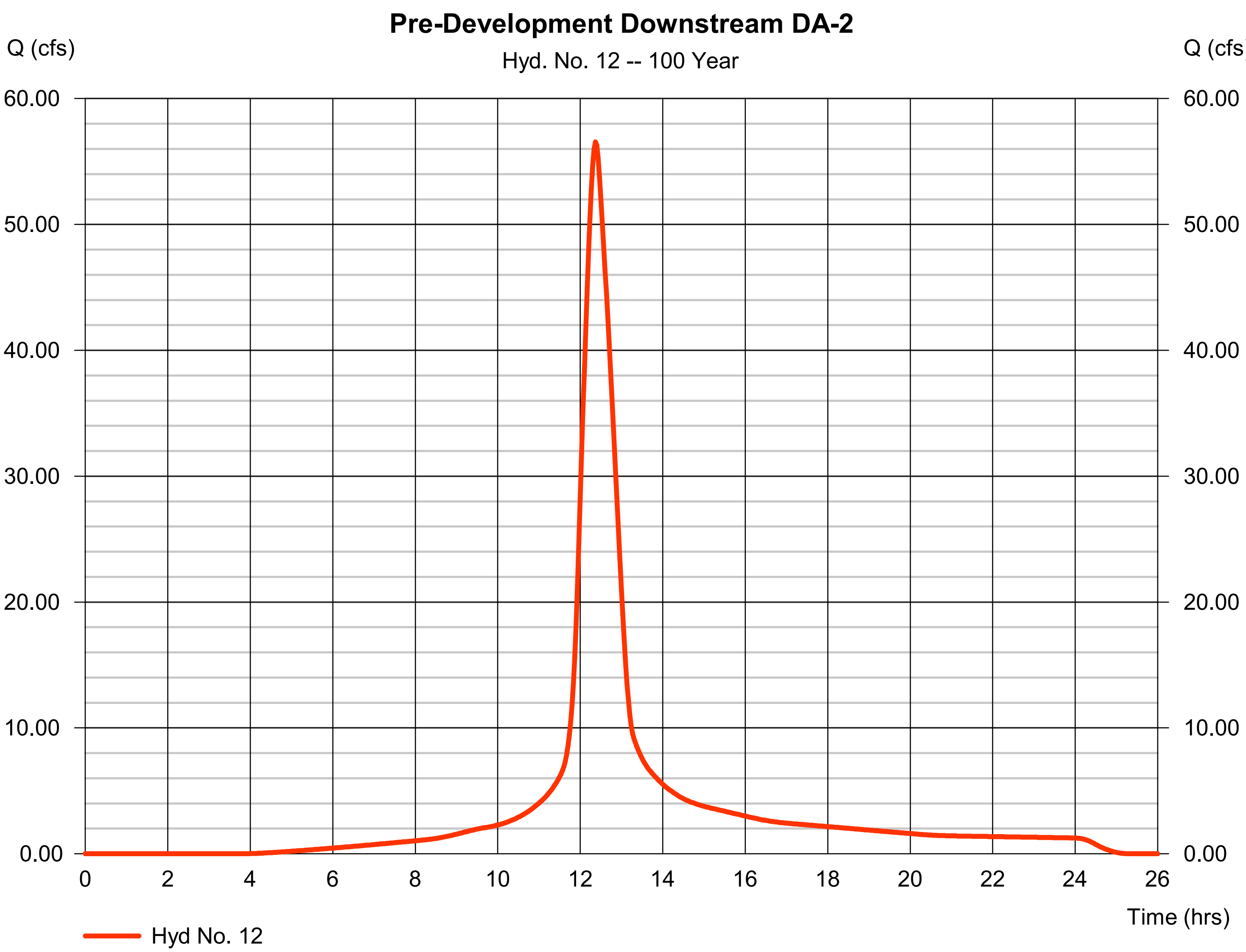
Hydrograph Report

Hyd. No. 12

Pre-Development Downstream DA-2

Hydrograph type	= SCS Runoff	Peak discharge	= 56.56 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 327,277 cuft
Drainage area	= 14.240 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 49.10 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.930 x 98) + (9.310 x 80)] / 14.240



Hydrograph Report

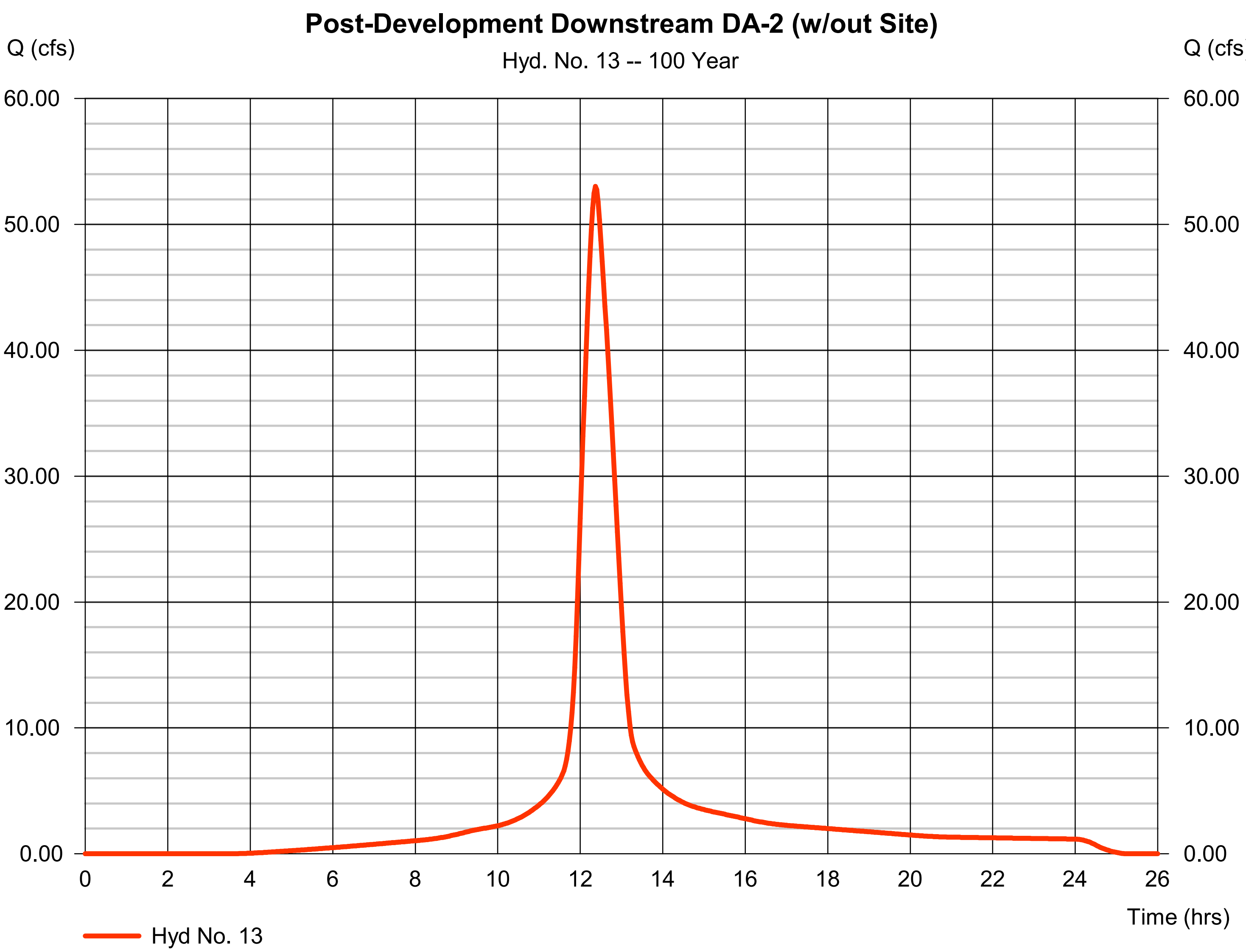
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Thursday, 11 / 2 / 2023

Hyd. No. 13

Post-Development Downstream DA-2 (w/out Site)

Hydrograph type	= SCS Runoff	Peak discharge	= 53.02 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 308,108 cuft
Drainage area	= 13.160 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 49.06 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.220 x 98) + (7.940 x 80)] / 13.160

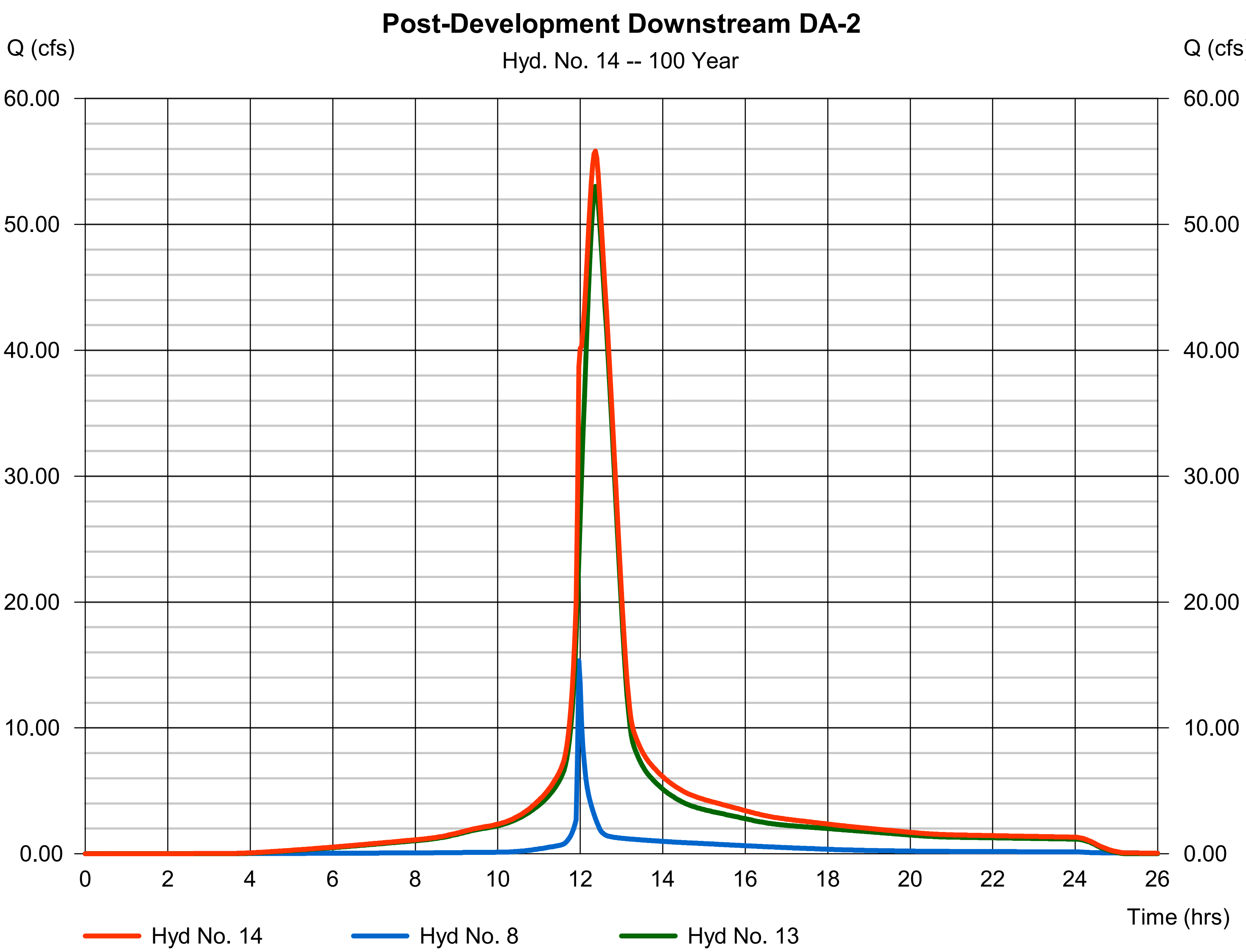


Hydrograph Report

Hyd. No. 14

Post-Development Downstream DA-2

Hydrograph type	= Combine	Peak discharge	= 55.83 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 349,753 cuft
Inflow hyds.	= 8, 13	Contrib. drain. area	= 13.160 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	65.1130	13.0000	0.8983	--------
2	71.2172	12.9000	0.8806	--------
3	0.0000	0.0000	0.0000	--------
5	68.0041	12.5000	0.8280	--------
10	71.4662	12.4000	0.8035	--------
25	63.2015	11.1000	0.7421	--------
50	56.4878	9.9000	0.6912	--------
100	54.2579	9.3000	0.6606	--------

File name: OUT-1502 IDF.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.85	3.89	3.26	2.82	2.48	2.22	2.01	1.84	1.70	1.58	1.47	1.38
2	5.61	4.52	3.80	3.28	2.90	2.60	2.36	2.16	2.00	1.86	1.74	1.63
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.36	5.16	4.37	3.81	3.38	3.05	2.78	2.56	2.37	2.22	2.08	1.96
10	7.20	5.88	5.00	4.37	3.89	3.52	3.22	2.97	2.76	2.58	2.43	2.29
25	8.04	6.58	5.62	4.93	4.42	4.01	3.68	3.41	3.18	2.99	2.82	2.67
50	8.73	7.15	6.12	5.40	4.85	4.42	4.07	3.79	3.55	3.34	3.16	3.00
100	9.36	7.68	6.59	5.83	5.25	4.80	4.43	4.13	3.88	3.66	3.47	3.30

Tc = time in minutes. Values may exceed 60.

e: X:\OUT - Cookout\1500 Sites\1502 - Zebulon, NC\Engineering\Stormwater\Stormwater Model\OUT-1502 Evt Mgr.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.85	3.46	0.00	4.38	5.14	6.20	7.07	8.00
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WQV DRAWDOWN CALCULATIONS

WATER QUALITY VOLUME

WQv = 3630 * Rd * Rv * A

where,

WQv = Water quality volume (acre-feet)
Rv = 0.05 + 0.009 x I
I = Percent impervious
A = Area (acres)
P = Rainfall (inches)

Total area to UG Detention, A =	1.22	acres
Impervious area to UG Detention =	1.00	acres
Percent impervious, I =	81.97	%
Runoff coefficient, Rv =	0.79	
Rainfall for WQ storm, Rd =	1.00	inches
Water quality volume, WQv =	**3488**	**cf**
75% WQv =	**2616**	**cf**

WATER QUALITY VOLUME DRAWDOWN

T = WQv / Q / 86400 (sec/day)

where,

T = Drawdown Time (days)
WQv = Water Quality Volume (cf)
Q = Cd * A * (2gh)^(1/2)

Diameter of orifice, D =	1.33	inches
Cross sectional area of orifice, A =	0.002	sf
Orifice invert elevation =	328.70	ft
WQv elevation =	331.08	ft
Orifice coefficient =	0.61	
Driving head on orifice @WQv, h =	2.38	
Orifice flowrate, Q =	0.0061	
Drawdown time, T =	**4.99**	**days**
	119.70	**hours**

Determining Number of Cartridges for Volume-Based Design in NC

Design Engineer:	**lrs**		**Blue Cells = Input**
Date	**10/30/2023**		**Black Cells = Calculation**

Site Information

Project Name	**Cook Out REV1**		
Project State	**NC**		
Project Location	**Zebulon**		
Drainage Area, Ad	**1.22**	ac	
Impervious Area, Ai	**1.00**	ac	
Pervious Area, Ap	**0.22**		
% Impervious	**82%**		
Runoff Coefficient, Rv	**0.79**		=0.05+0.9*(Ai/Ad)

Water Quality Volume Calculations

Design storm rainfall depth, Rd	**1.0**	in	
Water quality volume, WQV	**3488.4**	ft^3	=Ad*Rv*Rd*(43560/12)

Storage Component Calculations

Capture 75% of WQV	**2616.3**	ft^3	=0.75*WQV
Pretreatment credit (estimated or calculated), %pre	**30%**		

Mass loading calculations

Mean Annual Rainfall, P	45	in	
Agency required % removal	**85%**		
Percent Runoff Capture (% capture)	**90%**		
Mean Annual Runoff, V_t	**142,286**	ft^3	=P*Ad*Rv*(43560/12)*%capture
Event Mean Concentration of Pollutant, EMC	**70.0**	mg/l	(Suggestion: Use 60 for residential, 70 for Commercial, 100 for Industrial)
Annual Mass Load, M_{total}	**621.41**	lbs	=EMC*Vt*(28.3)*(0.000001)*(2.2046)

Filter System

Filtration brand	**StormFilter**		
Cartridge height	**18**	in	

Cartridge Quantity Calculation

Mass removed by pretreatment system, M_{pre}	**186**	lbs	=Mtotal * %removal
Mass load to filters after pretreatment, M_{pass1}	**435**	lbs	=Mtotal - Mpre
Estimate the required filter efficiency, E_{filter}	**79%**		=1+(%removal - 1)/(1 - %pre)
Mass to be captured by filters, M_{filter}	**342**	lbs	=Mpass1 * Efilter
Maximum Cartridge Flow rate, Q_{cart}	**7.5**	gpm	=q * (7.5 ft2/cartridge)
Mass load per cartridge, M_{cart} (lbs)	**36**	lbs	=lookup mass load per cartridge
Number of Cartridges required, N_{mass}	**10**		=ROUNDUP(Mfilter/Mcart,0)
Maximum Treatment Capacity	**0.17**		=Nmass*(Qcart/449)

SUMMARY

Maximum Treatment Flow Rate, cfs	0.17
Cartridge Flow Rate, gpm	7.5
Number of Cartridges	10
Stormfilter Size	96" MH

Target Pollutant(s):	TSS, N&P
Media:	Phosphosorb

2022-10-20_County Response to Comments Letter

APPENDIX C

COOK OUT
1200 N. ARENDELL AVE.
ZEBULON, NC 27597
OUT-1502

Weir Report

Flume #1

Rectangular Weir

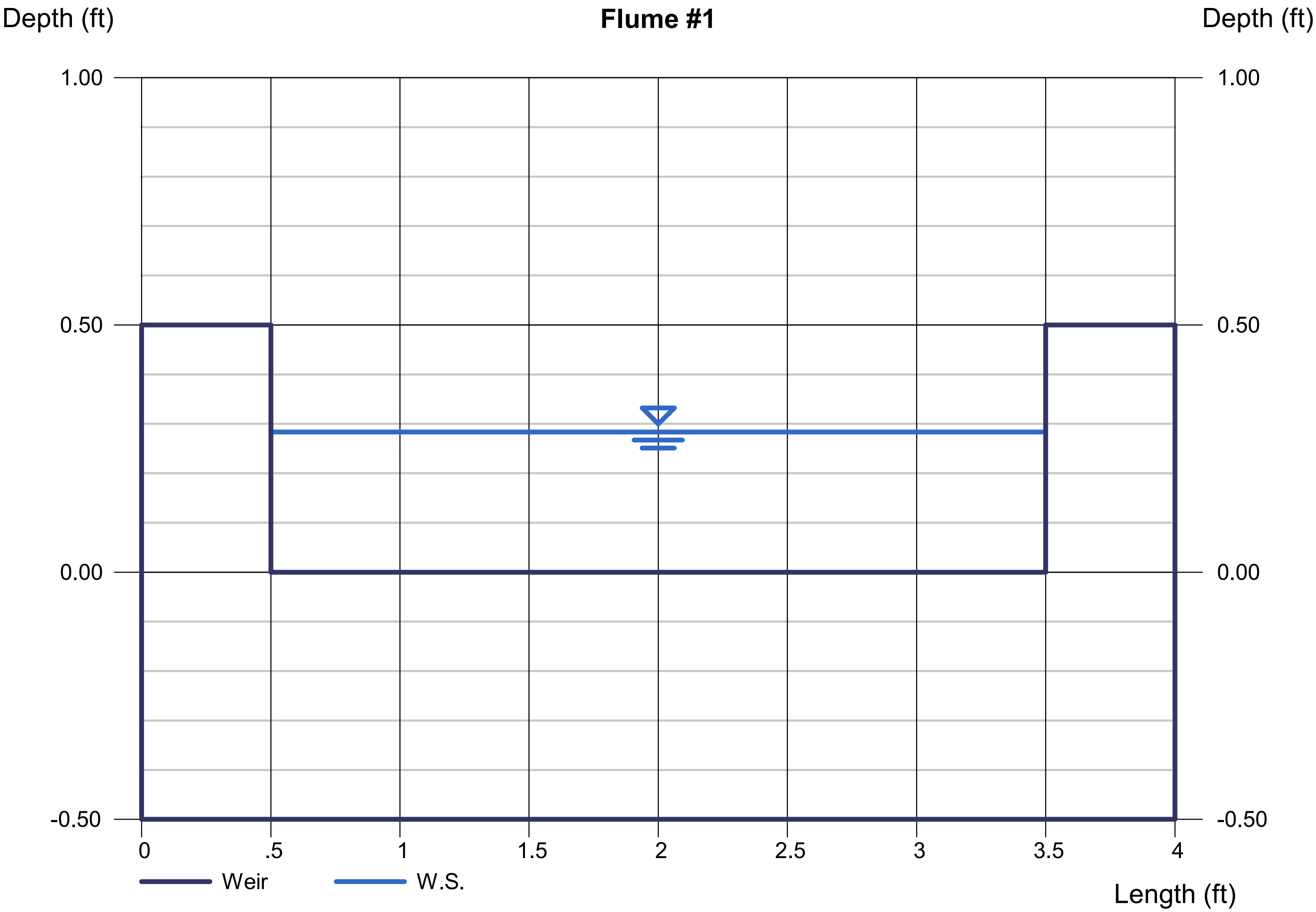
Crest	= Sharp
Bottom Length (ft)	= 3.00
Total Depth (ft)	= 0.50

Calculations

Weir Coeff. Cw	= 3.33
Compute by:	Known Q
Known Q (cfs)	= 1.51

Highlighted

Depth (ft)	= 0.28
Q (cfs)	= 1.510
Area (sqft)	= 0.85
Velocity (ft/s)	= 1.77
Top Width (ft)	= 3.00



DESIGN OF RIPRAP OUTLET PROTECTION

New York DOT Dissipator Method For Use in Defined Chann

(Source: "Bank and channel lining procedures", New York Department of Transportation, Division of Design and Construction, 1971.)

Guide to Color Key:	User Input Data	Calculated Value

Designed By:	JAS	**Date:**
Checked By:		**Date:**
Company:	Sambatek	
Project Name:	Cookout Zebulon	
Project No.:	OUT-1502	

Site Location (City/Town)	Zebulon
Culvert Id.	Flume #1

Estimation of Stone Size and Dimensions For Culvert Aprons

Step 1) Compute flow velocity V_o at culvert or paved channel outlet.

Step 2) For pipe culverts D_o is diameter.
For pipe arch, arch and box culverts, and paved channel outlets, $D_o = A_o$ where A. = cross-sectional area of flow at outlet.

For multiple culverts, use $D_o = 1.25 \times D_o$ of single culvert.

Velocity (ft/s)	1.77
Opening type	Paved Channel Outlet
Single or multiple openings?	Single
Outlet pipe diameter, D_o (ft)	0.85

NOTE 1: If opening type is anything other than "Pipe Culvert", D_o=A_o (Cross-sectional area of flow at outlet).

NOTE 2: If multiple openings, D_o=1.25 x D_o of single culvert.

Step 3) For apron grades of 10% or steeper, use recommendations
For next higher zone. (Zones 1 through 6).

Zone	1	Figure 8.06c
Will apron have >/=10% grade?	No	

NOTE: For apron slopes equal to or greater than 10%, use next higher Zone in Figure 8.06d to determine apron length.

Apron length (ft)	10	Figure 8.06d

Determination of Stone Sizes For Dumped Stone Channel Linings and Revetments

Step 1. Use figure 8.06.e to determine maximum stone size (e.g. for 12 Fps = 20" or 550 lbs.

Max. stone size (in.)	5	Figure 8.06e

Step 2. Use figure 8.06.f to determine acceptable size range for stone (for 12 FPS it is 125-500 lbs. for 75% of stone, and the maximum and minimum range in weight should be 25-500 lbs.).

NOTE: In determining channel velocities for stone linings and revetment, use the following coefficients of roughness:

	Diameter (inches)	Manning's "n"	Min. thickness of lining	(inches)
Fine	3	0.031	9	12
Light	6	0.035	12	18
Medium	13	0.040	18	24
Heavy	23	0.044	30	36
			(Channels)	(Dissapators)

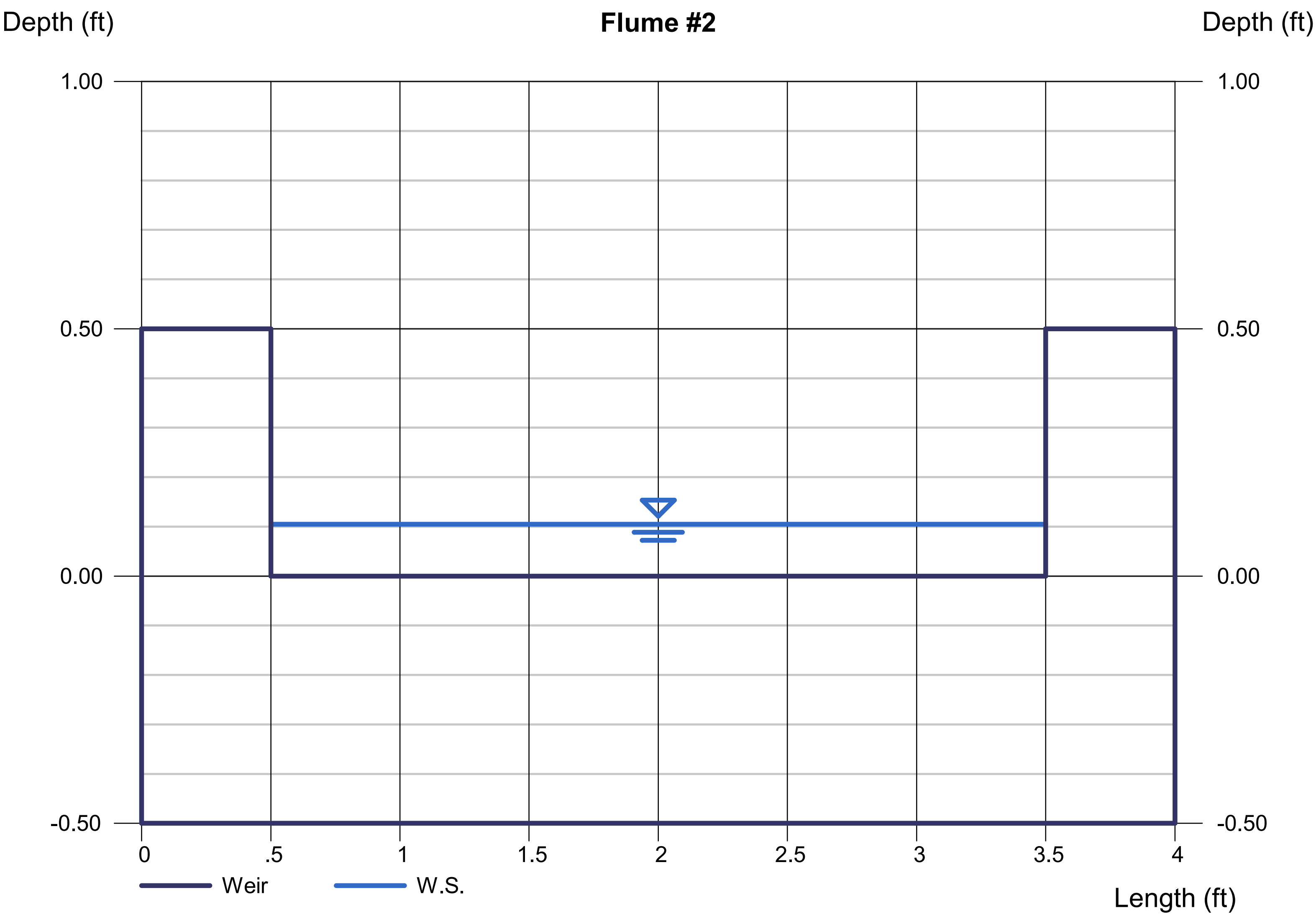
Min. & max range of stones (lbs)	5-25	Figure 8.05f
Weight range of 75% of stones (lbs)	5-25	Figure 8.05f

Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Oct 3 2023

Flume #2

Rectangular Weir		**Highlighted**	
Crest	= Sharp	Depth (ft)	= 0.10
Bottom Length (ft)	= 3.00	Q (cfs)	= 0.340
Total Depth (ft)	= 0.50	Area (sqft)	= 0.31
		Velocity (ft/s)	= 1.08
Calculations		Top Width (ft)	= 3.00
Weir Coeff. Cw	= 3.33		
Compute by:	Known Q		
Known Q (cfs)	= 0.34		



DESIGN OF RIPRAP OUTLET PROTECTION

New York DOT Dissipator Method For Use in Defined Chann

(Source: "Bank and channel lining procedures", New York Department of Transportation, Division of Design and Construction, 1971.)

Guide to Color Key:	User Input Data	Calculated Value

Designed By:	JAS	**Date:**	
Checked By:		**Date:**	
Company:	Sambatek		
Project Name:	Cookout Zebulon		
Project No.:	OUT-1502		

Site Location (City/Town)	Zebulon
Culvert Id.	Flume #1

Estimation of Stone Size and Dimensions For Culvert Aprons

Step 1) Compute flow velocity V_o at culvert or paved channel outlet.

Step 2) For pipe culverts D_o is diameter.
For pipe arch, arch and box culverts, and paved channel outlets, $D_o = A_o$ where A. = cross-sectional area of flow at outlet.

For multiple culverts, use $D_o = 1.25 \times D_o$ of single culvert.

Velocity (ft/s)	1.08
Opening type	Paved Channel Outlet
Single or multiple openings?	Single
Outlet pipe diameter, D_o (ft)	0.31

NOTE 1: If opening type is anything other than "Pipe Culvert", D_o=A_o (Cross-sectional area of flow at outlet).

NOTE 2: If multiple openings, D_o=1.25 x D_o of single culvert.

Step 3) For apron grades of 10% or steeper, use recommendations
For next higher zone. (Zones 1 through 6).

Zone	1	Figure 8.06c
Will apron have >/=10% grade?	No	

NOTE: For apron slopes equal to or greater than 10%, use next higher Zone in Figure 8.06d to determine apron length.

Apron length (ft)	10	Figure 8.06d

Determination of Stone Sizes For Dumped Stone Channel Linings and Revetments

Step 1. Use figure 8.06.e to determine maximum stone size (e.g. for 12 Fps = 20" or 550 lbs.

Max. stone size (in.)	5	Figure 8.06e

Step 2. Use figure 8.06.f to determine acceptable size range for stone (for 12 FPS it is 125-500 lbs. for 75% of stone, and the maximum and minimum range in weight should be 25-500 lbs.).

NOTE: In determining channel velocities for stone linings and revetment, use the following coefficients of roughness:

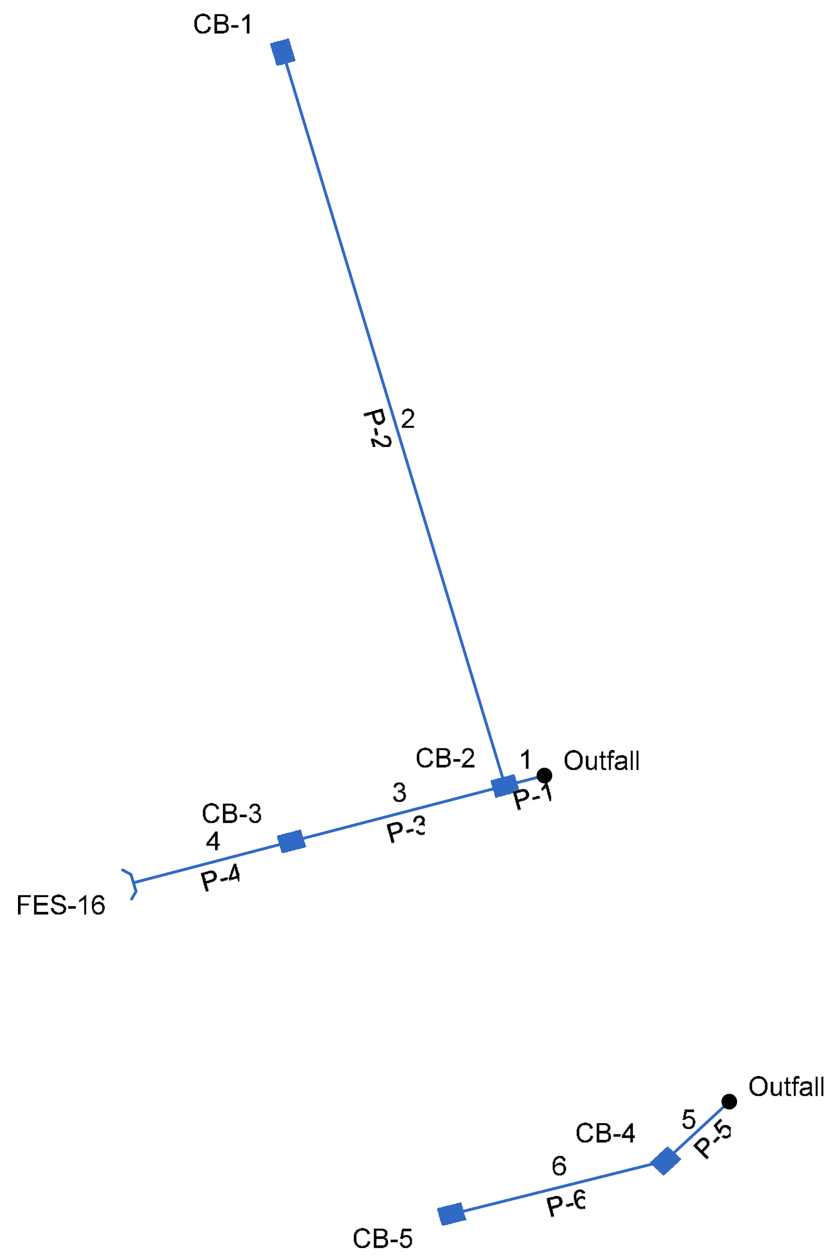
	Diameter (inches)	Manning's "n"	Min. thickness of lining	(inches)
Fine	3	0.031	9	12
Light	6	0.035	12	18
Medium	13	0.040	18	24
Heavy	23	0.044	30	36
			(Channels)	(Dissapators)

Min. & max range of stones (lbs)	5-25	Figure 8.05f
Weight range of 75% of stones (lbs)	5-25	Figure 8.05f

APPENDIX D

COOK OUT
1200 N. ARENDELL AVE.
ZEBULON, NC 27597
OUT-1502

OUT-1502 Storm Sewer Model



Project File: OUT-1502 Storm Sewer-Gutter Spread.stm	Number of lines: 6	Date: 10/18/2023

Storm Sewers v2022.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	5.000	164.292	Comb	0.00	0.03	0.95	5.0	326.55	3.00	326.70	24	Cir	0.013	1.50	331.15	P-1
2	1	100.000	90.000	Comb	0.00	0.40	0.95	5.0	326.90	0.50	327.40	18	Cir	0.013	1.00	331.90	P-2
3	1	27.000	0.000	Comb	0.00	0.03	0.95	5.0	326.90	0.93	327.15	18	Cir	0.013	0.50	331.15	P-3
4	3	20.000	0.000	Hdwl	5.24	1.25	0.55	0.0	327.25	1.25	327.50	24	Cir	0.013	1.00	330.00	P-4
5	End	11.000	135.000	Comb	0.00	0.02	0.95	5.0	327.00	0.91	327.10	18	Cir	0.013	0.83	330.50	P-5
6	5	27.000	30.000	Comb	0.00	0.02	0.95	5.0	327.10	0.56	327.25	18	Cir	0.013	1.00	330.50	P-6

OUT-1502 Storm Sewer Model | Number of lines: 6 | Date: 10/18/2023

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	CB-2	Combination	331.15	Rect	3.00	2.33	24	Cir	326.70	18 18	Cir Cir	326.90 326.90
2	CB-1	Combination	331.90	Rect	3.00	2.33	18	Cir	327.40			
3	CB-3	Combination	331.15	Rect	3.00	2.33	18	Cir	327.15	24	Cir	327.25
4	FES-16	OpenHeadwall	330.00	n/a	n/a	n/a	24	Cir	327.50			
5	CB-4	Combination	330.50	Rect	3.00	2.33	18	Cir	327.10	18	Cir	327.10
6	CB-5	Combination	330.50	Rect	3.00	2.33	18	Cir	327.25			

OUT-1502 Storm Sewer Model	Number of Structures: 6	Run Date: 10/18/2023

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P-1	9.74	24	Cir	5.000	326.55	326.70	3.000	327.98	327.81	0.68	327.81	End	Combination
2	P-2	1.52	18	Cir	100.000	326.90	327.40	0.500	327.81	327.86	n/a	327.86	1	Combination
3	P-3	8.10	18	Cir	27.000	326.90	327.15	0.926	327.92	328.25	0.26	328.25	1	Combination
4	P-4	5.24	24	Cir	20.000	327.25	327.50	1.250	328.25	328.31	n/a	328.31 j	3	OpenHeadwall
5	P-5	0.15	18	Cir	11.000	327.00	327.10	0.909	327.17	327.24	n/a	327.24 j	End	Combination
6	P-6	0.08	18	Cir	27.000	327.10	327.25	0.556	327.24	327.35	0.03	327.39	5	Combination

OUT-1502 Storm Sewer Model	Number of lines: 6	Run Date: 10/18/2023

NOTES: Return period = 10 Yrs. ; j - Line contains hyd. jump.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	CB-2	0.11	0.00	0.11	0.00	Comb	4.0	3.00	3.00	2.00	3.00	Sag	2.00	0.050	0.020	0.000	0.07	1.44	0.07	1.44	0.0	Off
2	CB-1	1.52	0.00	1.52	0.00	Comb	4.0	3.00	3.00	2.00	3.00	Sag	2.00	0.050	0.020	0.000	0.18	5.88	0.18	5.88	0.0	Off
3	CB-3	0.11	0.00	0.11	0.00	Comb	4.0	3.00	3.00	2.00	3.00	Sag	2.00	0.050	0.020	0.000	0.07	1.44	0.07	1.44	0.0	Off
4	FES-16	5.24*	0.00	5.24	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
5	CB-4	0.08	0.00	0.08	0.00	Comb	4.0	3.00	0.00	2.00	3.00	0.020	2.00	0.050	0.020	0.013	0.06	1.26	0.00	0.00	0.0	Off
6	CB-5	0.08	0.00	0.08	0.00	Comb	4.0	3.00	0.00	2.00	3.00	0.020	2.00	0.050	0.020	0.013	0.06	1.26	0.00	0.00	0.0	Off

OUT-1502 Storm Sewer Model	Number of lines: 6	Run Date: 10/18/2023

NOTES: Inlet N-Values = 0.016; Intensity = 4.00 / (Inlet time + 0.00) ^ 0.00; Return period = 10 Yrs. ; * Indicates Known Q added. All curb inlets are Inclined throat.

Storm Sewer Inlet Time Tabulation

Line	Line ID	Tc	Sheet Flow					Shallow Concentrated Flow					Channel Flow							Total
No.		Method	n-Value	flow Length (ft)	2-yr 24h P (in)	Land Slope (%)	Travel Time (min)	flow Length (ft)	Water Slope (%)	Surf Descr	Ave Vel (ft/s)	Travel Time (min)	X-sec Area (sqft)	Wetted Perim (ft)	Chan Slope (%)	n-Value	Vel	flow Length (ft)	Travel Time (min)	Travel Time (min)
1	P-1	User																		5.00
2	P-2	User																		5.00
3	P-3	User																		5.00
4	P-4	User																		0.00
5	P-5	User																		5.00
6	P-6	User																		5.00

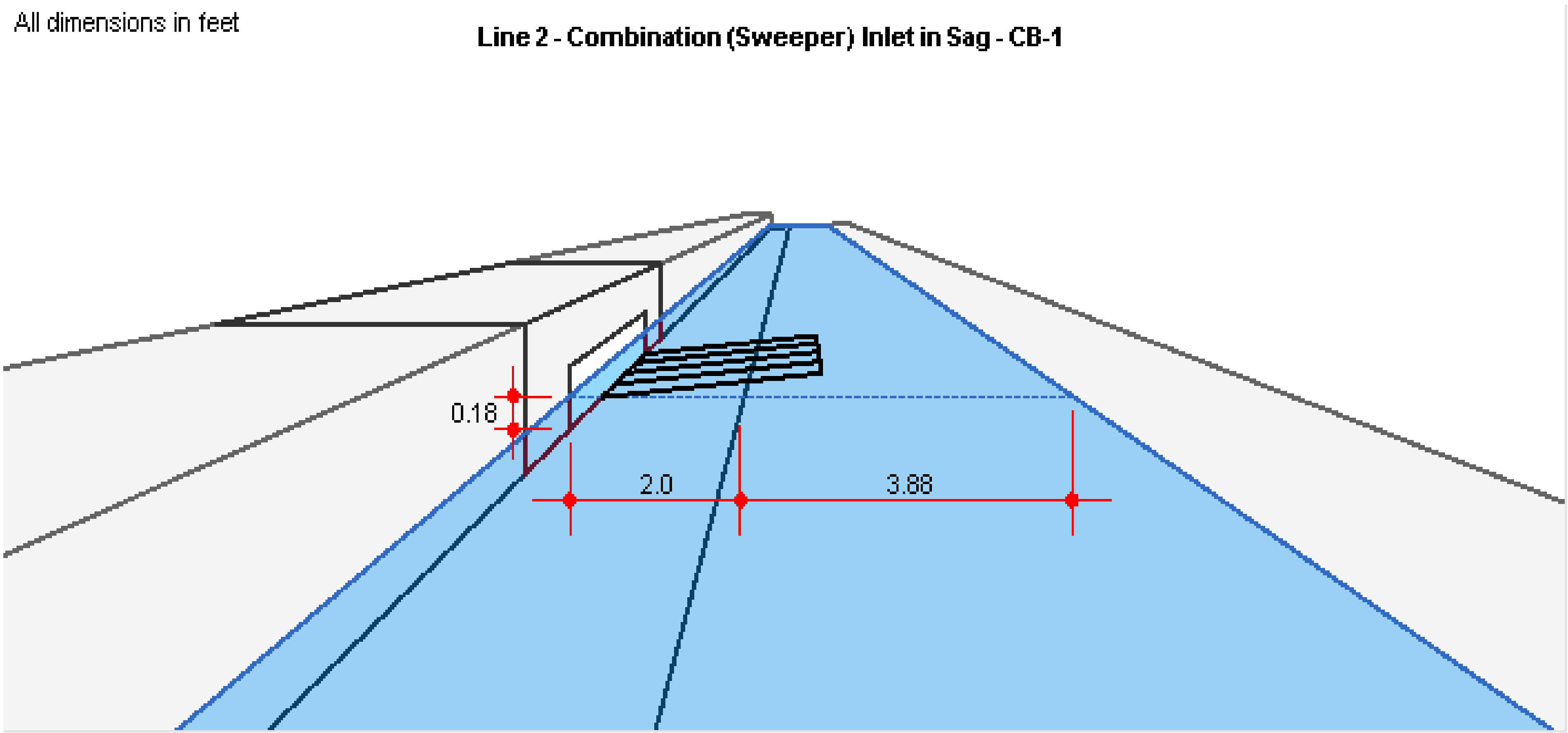
Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
1	24	9.74	326.55	327.98	1.43	1.80	4.05	0.45	328.44	0.000	5.000	326.70	327.81	1.11**	1.80	5.41	0.45	328.27	0.000	0.000	n/a	1.50	0.68
2	18	1.52	326.90	327.81	0.91	0.46	1.35	0.17	327.98	0.000	100.000	327.40	327.86	0.46**	0.46	3.28	0.17	328.03	0.000	0.000	n/a	1.00	n/a
3	18	8.10	326.90	327.92	1.02*	1.28	6.36	0.53	328.44	0.000	27.000	327.15	328.25	1.10**	1.39	5.83	0.53	328.78	0.000	0.000	n/a	0.50	0.26
4	24	5.24	327.25	328.25	1.00	1.19	3.33	0.30	328.56	0.000	20.000	327.50	328.31 j	0.81**	1.19	4.42	0.30	328.61	0.000	0.000	n/a	1.00	0.30
5	18	0.15	327.00	327.17	0.17	0.09	1.38	0.05	327.22	0.000	11.000	327.10	327.24 j	0.14**	0.09	1.77	0.05	327.29	0.000	0.000	n/a	0.83	n/a
6	18	0.08	327.10	327.24	0.14	0.05	0.89	0.01	327.26	0.147	27.000	327.25	327.35	0.10**	0.05	1.44	0.03	327.39	0.596	0.371	0.100	1.00	0.03

OUT-1502 Storm Sewer Model	Number of lines: 6	Run Date: 10/18/2023

Notes: * Normal depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

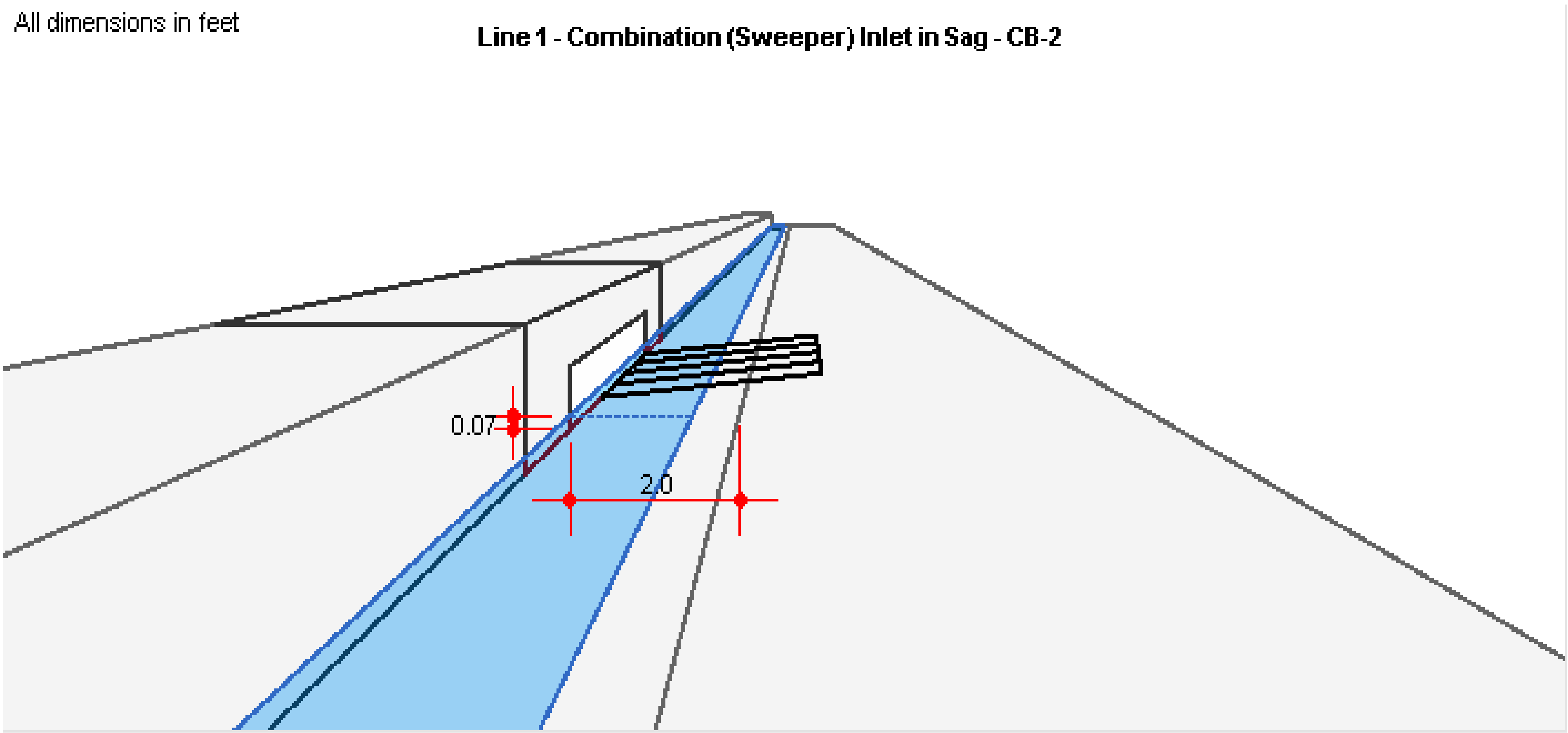
Inlet Section (Line 2 - Combination Inlet) - CB-1



Line #	Q				Inlet			Gutter				Depth		Spread		Byp
	Catch (cfs)	Carry (cfs)	Capt (cfs)	Byp (cfs)	Length (ft)	Depr (in)	Throat (in)	Width (ft)	Slope (ft/ft)	Sw (ft/ft)	Sx (ft/ft)	Gutter (ft)	Inlet (ft)	Gutter (ft)	Inlet (ft)	Line (ft)
2	1.52	0.00	1.52	0.00	Sweep	0.0	4.0	2.00	Sag	0.050	0.020	0.18	5.88	n/a	n/a	Sag

OUT-1502 Storm Sewer Model	No. Lines: 6	Run Date: 10/18/2023

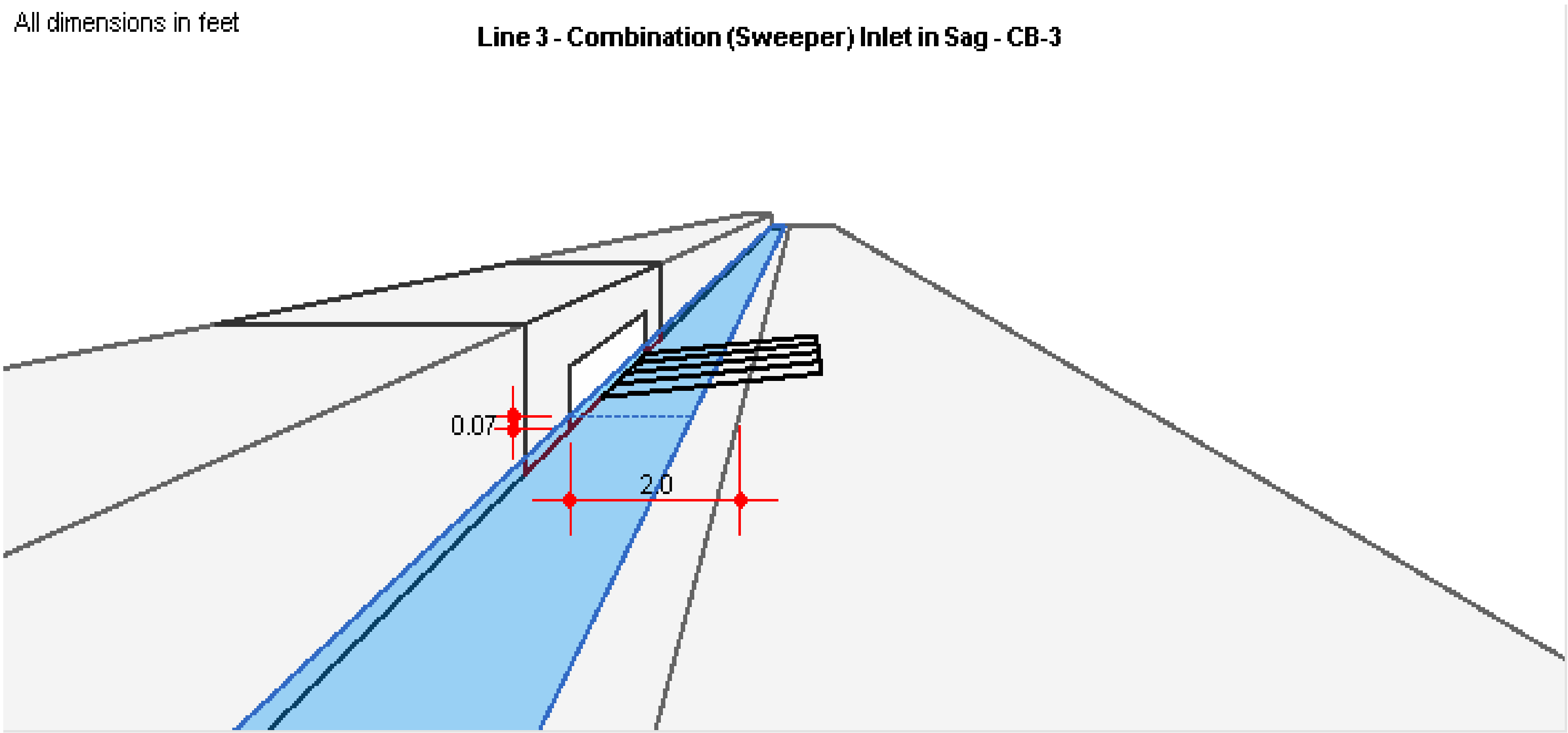
Inlet Section (Line 1 - Combination Inlet) - CB-2



Line #	Q				Inlet			Gutter				Depth		Spread		Byp
	Catch (cfs)	Carry (cfs)	Capt (cfs)	Byp (cfs)	Length (ft)	Depr (in)	Throat (in)	Width (ft)	Slope (ft/ft)	Sw (ft/ft)	Sx (ft/ft)	Gutter (ft)	Inlet (ft)	Gutter (ft)	Inlet (ft)	Line (ft)
1	0.11	0.00	0.11	0.00	Sweep	0.0	4.0	2.00	Sag	0.050	0.020	0.07	1.44	n/a	n/a	Sag

OUT-1502 Storm Sewer Model	No. Lines: 6	Run Date: 10/18/2023

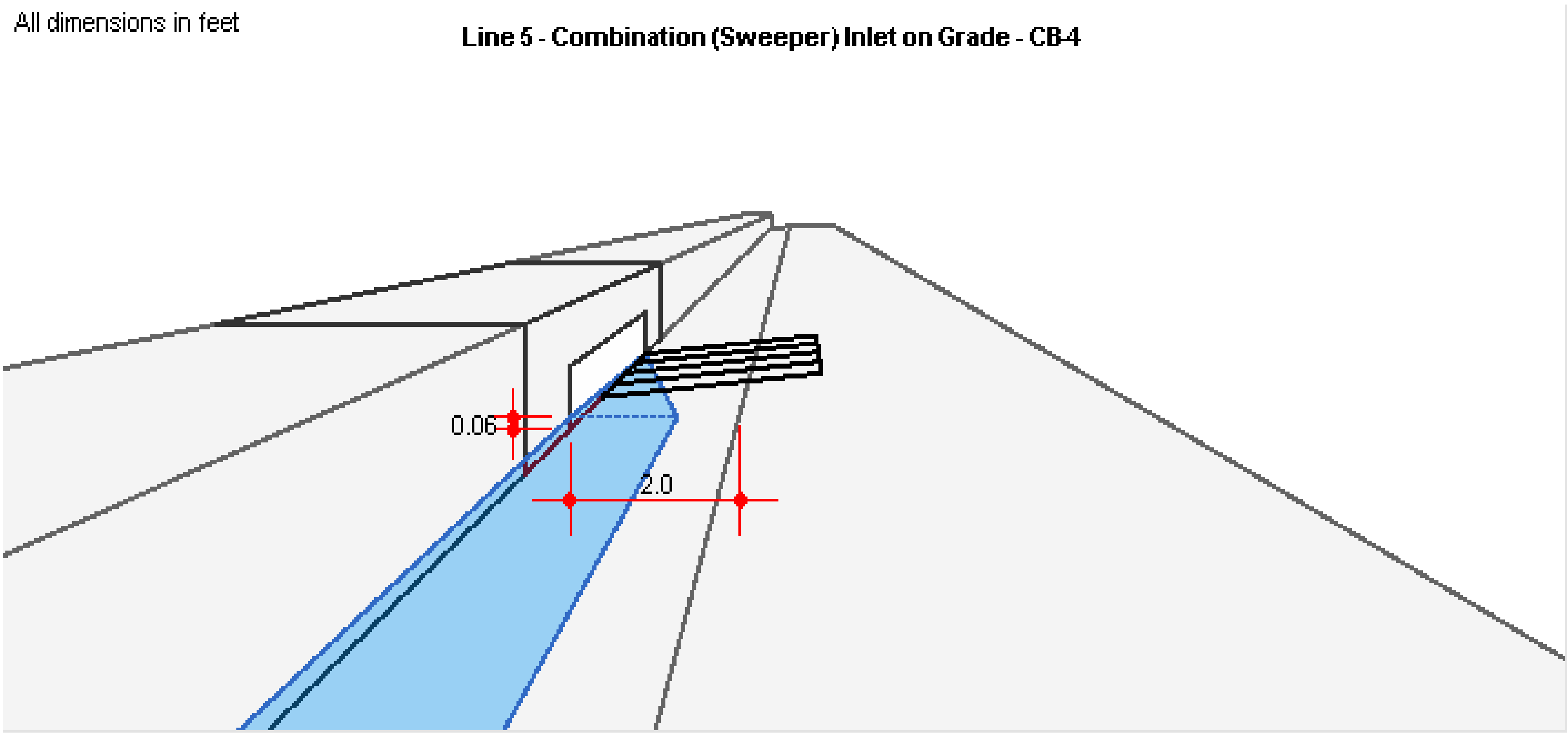
Inlet Section (Line 3 - Combination Inlet) - CB-3



Line #	Q				Inlet			Gutter				Depth		Spread		Byp
	Catch (cfs)	Carry (cfs)	Capt (cfs)	Byp (cfs)	Length (ft)	Depr (in)	Throat (in)	Width (ft)	Slope (ft/ft)	Sw (ft/ft)	Sx (ft/ft)	Gutter (ft)	Inlet (ft)	Gutter (ft)	Inlet (ft)	Line (ft)
3	0.11	0.00	0.11	0.00	Sweep	0.0	4.0	2.00	Sag	0.050	0.020	0.07	1.44	n/a	n/a	Sag

OUT-1502 Storm Sewer Model | No. Lines: 6 | Run Date: 10/18/2023

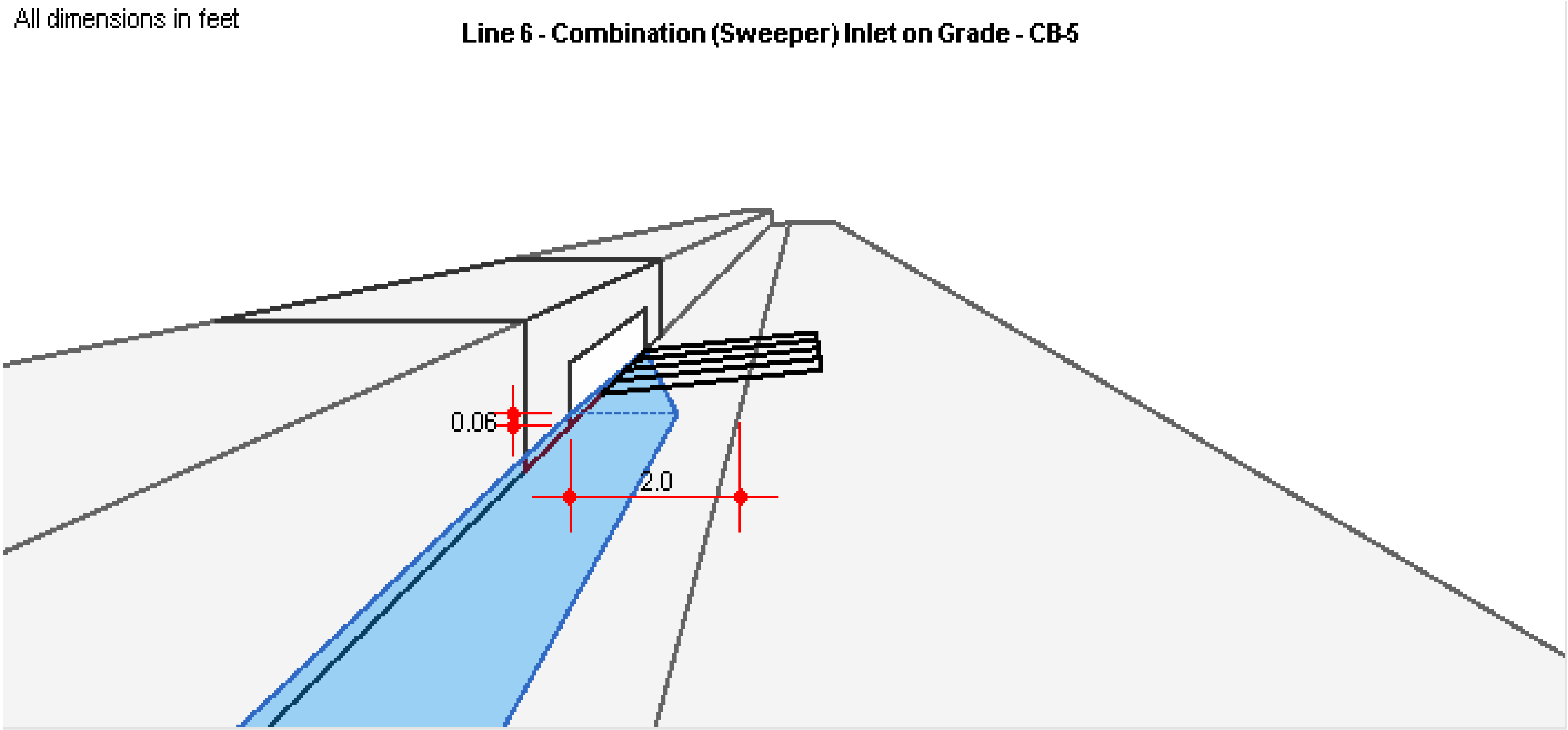
Inlet Section (Line 5 - Combination Inlet) - CB-4



Line #	Q				Inlet			Gutter				Depth		Spread		Byp
	Catch (cfs)	Carry (cfs)	Capt (cfs)	Byp (cfs)	Length (ft)	Depr (in)	Throat (in)	Width (ft)	Slope (ft/ft)	Sw (ft/ft)	Sx (ft/ft)	Gutter (ft)	Inlet (ft)	Gutter (ft)	Inlet (ft)	Line (ft)
5	0.08	0.00	0.08	0.00	Sweep	0.0	4.0	2.00	0.020	0.050	0.020	0.06	1.26	0.00	0.00	Offsite

OUT-1502 Storm Sewer Model	No. Lines: 6	Run Date: 10/18/2023

Inlet Section (Line 6 - Combination Inlet) - CB-5



Line #	Q				Inlet			Gutter				Depth		Spread		Byp
	Catch (cfs)	Carry (cfs)	Capt (cfs)	Byp (cfs)	Length (ft)	Depr (in)	Throat (in)	Width (ft)	Slope (ft/ft)	Sw (ft/ft)	Sx (ft/ft)	Gutter (ft)	Inlet (ft)	Gutter (ft)	Inlet (ft)	Line (ft)
6	0.08	0.00	0.08	0.00	Sweep	0.0	4.0	2.00	0.020	0.050	0.020	0.06	1.26	0.00	0.00	Offsite

OUT-1502 Storm Sewer Model	No. Lines: 6	Run Date: 10/18/2023

APPENDIX E

COOK OUT
1200 N. ARENDELL AVE.
ZEBULON, NC 27597
OUT-1502

STATE OF NORTH CAROLINA
WAKE COUNTY

STORMWATER AGREEMENT

THIS AGREEMENT, made and entered into this the _____ day of __________, _________, by and between Wake County, hereinafter referred to as County, and ____________________________, hereinafter referred to as Owner;

WITNESSETH

THAT WHEREAS, Owner is this day accepting responsibility for the stormwater device(s) installed on that certain real property known as_____________________________________, Permit Number ________________as shown on the plat thereof recorded in the Book of Maps _______, Page _______, Wake County Registry; and

WHEREAS, as a part of the construction of the residence/development the Wake County Environmental Services – Watershed Management Section required that a stormwater device(s) be constructed; and

WHEREAS, the Owner accepts responsibility for the maintenance of the stormwater device(s) as prescribed in the Maintenance Agreement signed and notarized, dated ________________, 20____; and

WHEREAS, the Owner grants access to Wake County to inspect the stormwater device(s); and

WHEREAS, the Owner understands that this Agreement shall endure to the benefit of his successors in title, whomsoever they may be in the future.

NOW, THEREFORE, it is understood and agreed by and between the parties:

1. The maintenance of the stormwater device(s) shall be the sole responsibility of the Owner.
2. The responsibility for the maintenance of the stormwater device shall pass in the chain of title to the Owner's successor in interest.
3. Access is granted to Wake County to inspect the stormwater device(s).
4. Annually, the Owner shall provide an inspection report by ~~June~~ 30th.

The report should be uploaded to the Permit Portal at Wakegov.com. You will need to Register in the Permit Portal and contact Watershed Management at watershedmanagement@wakegov.com to request access to your permit case files. (Subject Line: Add Case Contact)

Owner: __________________________

Date: _________________________

I, ______________________________ THE UNDERSIGNED notary Public of the County and State aforesaid, certify that ___________________ personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

WITNESS my hand and notarial seal, this the ________ day of ____________, ________.

____
Notary Public

My Comm. Exp. ______________

After recording return to:
Watershed Management Section
336 Fayetteville St. PO Box 550
Raleigh, NC 27602

SITE DATA

Project Information		
	Project Name:	**OUT-1502 Cookout Zebulon**
	Applicant:	Cook Out
	Applicant Contact Name:	Michael Hicks
	Applicant Contact Number:	919.848.6121
	Contact Email:	mhicks@sambatek.com
	Municipal Jurisdiction (Select from dropdown menu):	Zebulon
	Last Updated:	Wednesday, October 18, 2023
Site Data:		
	Total Site Area (Ac):	1.91
	Existing Lake/Pond Area (Ac):	0.00
	Proposed Disturbed Area (Ac):	2.20
	Impervious Surface Area (acre):	1.13
	Type of Development (Select from Dropdown menu):	Non-Residential
	Percent Built Upon Area (BUA):	59%
	Project Density:	High
	Is the proposed project a site expansion?	No
	Number of Drainage Areas on Site:	1
NOAA	**1-Year, 24-Hour Storm (inches) (See NOAA Website):**	2.85
	2-Year, 24-Hour Storm (inches) (See NOAA Website):	3.46
	10-Year, 24-Hour Storm (inches) (See NOAA Website):	5.14
Lot Data (if applicable):		
	Total Acreage in Lots:	1.91
	Number of Lots:	1
	Average Lot Size (SF):	83368.00
	Total Impervious Surface Area on Lots (SF):	48702.00
	Average Impervious Surface Area Per Lot (SF):	48702.00
Stormwater Narrative (limit to 1,200 characters - attach additional pages with submittal if necessary):		

This project consists of the development of a Cook Out restaurant with drive thru for commerical usage. The post-construction stormwater improvements include stormwater runoff collection infrastructure that drains to an underground detention system. Water quality treatment is completed using a primary SCM (Contech Filterra) and water quantity control is achieved via the underground detention sytem and a multi stage outlet control structure which detains design storm runoff and releases it at the edge of the property at or below pre-development flow rates.

Project Name: OUT-1502 Cookout Zebulon

DRAINAGE AREA 1
STORMWATER PRE-POST CALCULATIONS

LAND USE & SITE DATA	PRE-DEVELOPMENT				POST-DEVELOPMENT			
Drainage Area (Acres)=	1.91				1.91			
Site Acreage within Drainage=	1.91				1.91			
One-year, 24-hour rainfall (in)=	2.85							
Two-year, 24-hour rainfall (in)=	3.46							
Ten-year, 24-hour storm (in)=	5.14							
Total Lake/Pond Area (Acres)=	0.00				0.00			
Lake/Pond Area not in the Tc flow path (Acres)=	0.00				0.00			
Site Land Use (acres):	A	B	C	D	A	B	C	D
Pasture								
Woods, Poor Condition								
Woods, Fair Condition								
Woods, Good Condition								
Open Space, Poor Condition								
Open Space, Fair condition								
Open Space, Good Condition				1.91				0.78
Reforestation (in dedicated OS)								
Connected Impervious								1.13
Disconnected Impervious								

SITE FLOW	PRE-DEVELOPMENT T_c	POST-DEVELOPMENT Tc
Sheet Flow		
Length (ft)=	100.00	208.00
Slope (ft/ft)=	0.030	0.026
Surface Cover:	Grass	Grass
n-value=	0.240	0.240
T_t (hrs)=	0.214	0.408
Shallow Flow		
Length (ft)=	160.00	105.00
Slope (ft/ft)=	0.012	0.020
Surface Cover:	Unpaved	Unpaved
Average Velocity (ft/sec)=	1.77	2.28
T_t (hrs)=	0.03	0.01
Channel Flow 1		
Length (ft)=		
Slope (ft/ft)=		
Cross Sectional Flow Area (ft^2)=		
Wetted Perimeter (ft)=		
Channel Lining:		
n-value=		
Hydraulic Radius (ft)=		
Average Velocity (ft/sec)=		
T_t (hrs)=		

Project Name: OUT-1502 Cookout Zebulon

DRAINAGE AREA 1
STORMWATER PRE-POST CALCULATIONS

Channel Flow 2		
Length (ft)=		
Slope (ft/ft)=		
Cross Sectional Flow Area (ft^2)=		
Wetted Perimeter (ft)=		
Channel Lining:		
n-value=		
Hydraulic Radius (ft)=		
Average Velocity (ft/sec)=		
T_t (hrs)=		
Channel Flow 3		
Length (ft)=		
Slope (ft/ft)=		
Cross Sectional Flow Area (ft^2)=		
Wetted Perimeter (ft)=		
Channel Lining:		
n-value=		
Hydraulic Radius (ft)=		
Average Velocity (ft/sec)=		
T_t (hrs)=		
Tc (hrs)=	0.24	0.10
RESULTS	**PRE-DEVELOPMENT**	**POST-DEVELOPMENT**
Composite Curve Number=	80	91
Disconnected Impervious Adjustment		
Disconnected impervious area (acre) =		
$CN_{adjusted\ (1\text{-}year)}$=	**91**	
High Density Only		
Volume of runoff from 1" rainfall for DA HIGH DENSITY REQUIREMENT = (ft^3) =	4,038	
1-year, 24-hour storm (Peak Flow)		
Runoff (inches) = $Q^*_{1\text{-}year}$=	1.14	1.90
Volume of runoff (ft^3) =	7,895	13,185
Volume change (ft^3) =	5,290	
Peak Discharge (cfs)= $Q_{1\text{-}year}$=	2.510	5.732
2-year, 24-hour storm (LID)		
Runoff (inches) = $Q^*_{2\text{-}year}$=	1.60	2.47
Volume of runoff (ft^3) =	11,126	17,129
Peak Discharge (cfs)= $Q_{2\text{-}year}$=	3.538	7.447
10-year, 24-hour storm (DIA)		
Runoff (inches) = $Q^*_{10\text{-}year}$=	3.02	4.08
Volume of runoff (ft^3) =	20,906	28,292
Peak Discharge (cfs)= $Q_{10\text{-}year}$=	6.648	12.300

Project Name:

DA SITE SUMMARY
STORMWATER PRE-POST CALCULATIONS

SITE SUMMARY										
DRAINAGE AREA SUMMARIES										
DRAINAGE AREA:	DA1	DA2	DA3	DA4	DA5	DA6	DA7	DA8	DA9	DA10
Pre-Development (1-year, 24-hour storm)										
Runoff (in) = $Q_{pre,1\text{-}year}$ =	1.14									
Peak Flow (cfs)=$Q_{1\text{-}year}$ =	2.510									
Post-Development (1-year, 24-hour storm)										
Proposed Impervious Surface (acre) =	1.13									
Runoff (in)=$Q_{1\text{-}year}$ =	1.90									
Peak Flow (cfs)=$Q_{1\text{-}year}$ =	5.732									
Increase in volume per DA (ft^3)_1-yr storm=	5,290									
Minimum Volume to be Managed for DA HIGH DENSITY REQUIREMENT = (ft^3) =	4,038									

TARGET CURVE NUMBER (TCN)

Site Data

SITE \SOIL COMPOSITION

HYDROLOGIC SOIL GROUP	Site Area	%	Target CN
A	0.00	0%	N/A
B	0.00	0%	N/A
C	0.00	0%	N/A
D	1.91	100%	N/A

Total Site Area (acres) =	1.91
Percent BUA (Includes Existing Lakes/Pond Areas) =	59%
Project Density =	High
Target Curve Number (TCN) =	N/A
$CN_{adjusted\ (1\text{-}year)}$=	91
Minimum Volume to be Managed (Total Site) Per TCN Requirement= ft^3 =	N/A

Site Nitrogen Loading Data

HSG	TN export coefficient (lbs/ac/yr)	Site Acreage	N Export
Pasture	1.2	0.00	0.00
Woods, Poor Condition	1.6	0.00	0.00
Woods, Fair Condition	1.2	0.00	0.00
Woods, Good Condition	0.8	0.00	0.00
Open Space, Poor Condition	1.0	0.00	0.00
Open Space, Fair Condition	0.8	0.00	0.00
Open Space, Good Condition	0.6	0.78	0.47
Reforestation (in dedicated OS)	0.6	0.00	0.00
Impervious	21.2	1.13	23.96
SITE NITROGEN LOADING RATE (lbs/ac/yr)=	12.79		
Nitrogen Load (lbs/yr)=	24.42		
TOTAL SITE NITROGEN TO MITIGATE (lbs/yr)_Wendell Only=	17.55		

Site Nitrogen Loading Data For Expansions Only

	Existing	New
Impervious(acres)=	NA	NA
"Expansion Area" (acres=)		
Nitrogen Load (lbs/yr)=	NA	NA
SITE NITROGEN LOADING RATE (lbs/ac/yr)=	NA	NA
Total Site loading rate (lbs/ac/yr)		
TOTAL SITE NITROGEN TO MITIGATE (lbs/yr)=	NA	

Project Name:

DRAINAGE AREA 1
BMP CALCULATIONS

DRAINAGE AREA 1 - BMP DEVICES AND ADJUSTMENTS				
DA1 Site Acreage=	1.91			
DA1 Off-Site Acreage=				
Total Required Storage Volume for Site TCN Requirement (ft^3)=	N/A			
Total Required Storage Volume for DA1 1" Rainfall for High Density (ft^3)=	4,038			
Will site use underground detention/cistern?	Yes	Enter % of the year water will be reused=	0%	Note: Supporting information/details should be submitted to demonstrate water usage.

ENTER ACREAGE FOR ALL SUB-DRAINAGE AREAS IN DA

HSG	Sub-DA1(a) (Ac)		Sub-DA1(b) (Ac)		Sub-DA1(c) (Ac)		Sub-DA1(d) (Ac)		Sub-DA1(e) (Ac)	
	Site	Off-site	Site	Off-site	Site	Off-site	Site	Off-site	Site	Off-site
Pasture										
Woods, Poor Condition										
Woods, Fair Condition										
Woods, Good Condition										
Open Space, Poor Condition										
Open Space, Fair Condition										
Open Space, Good Condition	0.22		0.56							
Reforestation (in dedicated OS)										
Impervious	1.00		0.13							

Sub-DA1(a) BMP(s)

Device Name (As Shown on Plan)	Device Type	Water Quality Volume for Sub-DA (ft^3)	Provided Volume that will drawdown 2-5 days (ft^3)	Nitrogen Removal Efficiency	Sub-DA Nitrogen (lbs)	Nitrogen Removed (lbs)	Drawdown Time (hours)
Underground Chambers w/ StormFilter	Bioretention with IWS	2,308	3,065	40%	21.33	8.53	
@ 85% TSS & 50% Nitrogen removal				0%	12.80	0.00	
				0%	12.80	0.00	
				0%	12.80	0.00	
				0%	12.80	0.00	
Total Nitrogen remaining leaving the subbasin (lbs):		**12.80**					

Sub-DA1(b) BMP(s)

Device Name (As Shown on Plan)	Device Type	Water Quality Volume for Sub-DA (ft^3)	Provided Volume that will drawdown 2-5 days (ft^3)	Nitrogen Removal Efficiency	Sub-DA Nitrogen (lbs)	Nitrogen Removed (lbs)	Drawdown Time (hours)
If Sub-DA1(b) is connected to upstream subbasin(s), enter the nitrogen leaving the most upstream subbasin(lbs):							
BYPASS		279	0	0%	3.09	0.00	
				0%	3.09	0.00	
				0%	3.09	0.00	
				0%	3.09	0.00	
				0%	3.09	0.00	
Total Nitrogen remaining leaving the subbasin (lbs):		**3.09**					

Sub-DA1 (c) BMP(s)

Device Name (As Shown on Plan)	Device Type	Water Quality Volume for Sub-DA (ft^3)	Provided Volume that will drawdown 2-5 days (ft^3)	Nitrogen Removal Efficiency	Sub-DA Nitrogen (lbs)	Nitrogen Removed (lbs)	Drawdown Time (hours)
If Sub-DA1(c) is connected to upstream subbasin(s), enter the nitrogen leaving the most upstream subbasin(lbs):							
				0%	0.00	0.00	
				0%	0.00	0.00	
				0%	0.00	0.00	
				0%	0.00	0.00	
				0%	0.00	0.00	
Total Nitrogen remaining leaving the subbasin (lbs):							

Project Name:

DRAINAGE AREA 1
BMP CALCULATIONS

Sub-DA1(d) BMP(s)							
If Sub-DA1(d) is connected to upstream subbasin(s), enter the nitrogen leaving the most upstream subbasin(lbs):							
Device Name (As Shown on Plan)	Device Type	Water Quality Volume for Sub-DA (ft^3)	Provided Volume that will drawdown 2-5 days (ft^3)	Nitrogen Removal Efficiency	Sub-DA Nitrogen (lbs)	Nitrogen Removed (lbs)	Drawdown Time (hours)
				0%	0.00	0.00	
				0%	0.00	0.00	50
				0%	0.00	0.00	
				0%	0.00	0.00	
				0%	0.00	0.00	
Total Nitrogen remaining leaving the subbasin (lbs):							

Sub-DA1(e) BMP(s)							
If Sub-DA1(e) is connected to upstream subbasin(s), enter the nitrogen leaving the most upstream subbasin(lbs):							
Device Name (As Shown on Plan)	Device Type	Water Quality Volume for Sub-DA (ft^3)	Provided Volume that will drawdown 2-5 days (ft^3)	Nitrogen Removal Efficiency	Sub-DA Nitrogen (lbs)	Nitrogen Removed (lbs)	Drawdown Time (hours)
				0%	0.00	0.00	
				0%	0.00	0.00	
				0%	0.00	0.00	
				0%	0.00	0.00	
				0%	0.00	0.00	
Total Nitrogen remaining leaving the subbasin (lbs):							

DA1 BMP SUMMARY	
Total Volume Treated (ft^3)=	3,065
Nitrogen Mitigated(lbs)=	8.53
1-year, 24-hour storm	
Post BMP Volume of Runoff $(ft^3)_{(1\text{-year})}$=	10,120
Post BMP Runoff (inches) = $Q^*_{(1\text{-year})}$=	1.46
Post BMP $CN_{(1\text{-year})}$=	84
Post BMP Peak Discharge (cfs)= $Q_{1\text{-year}}$=	1.708
2-year, 24-hour storm (LID)	
Post BMP Volume of Runoff $(ft3)_{(2\text{-year})}$=	14,064
Post BMP Runoff (inches) = $Q^*_{(2\text{-year})}$=	2.03
Post BMP $CN_{(2\text{-year})}$=	85
Post BMP Peak Discharge (cfs)= $Q_{(2\text{-year})}$=	2.952
10-year, 24-hour storm (DIA)	
Post BMP Volume of Runoff $(ft^3)_{(10\text{-year})}$=	25,227
Post BMP Runoff (inches) = $Q^*_{(10\text{-year})}$=	3.64
Post BMP CN($_{10\text{-year}}$)=	98
Post BMP Peak Discharge (cfs)= $Q_{(10\text{-year})}$=	5.315

WAKE COUNTY
NORTH CAROLINA

Project Name:

DA SITE SUMMARY
BMP CALCULATIONS

BMP SUMMARY										
DRAINAGE AREA SUMMARIES										
DRAINAGE AREA:	DA1	DA2	DA3	DA4	DA5	DA6	DA7	DA8	DA9	DA10
Pre-Development (1-year, 24-hour storm)										
Runoff (in)=$Q^*_{1\text{-year}}$ =	1.14									
Peak Flow (cfs)=$Q_{1\text{-year}}$ =	2.510									
Post-Development (1-year, 24-hour storm)										
Target Curve Number (TCN) =	NA									
Post BMP Runoff (inches) = $Q^*_{(1\text{-year})}$=	1.46									
Post BMP Peak Discharge (cfs)= $Q_{1\text{-year}}$=	1.708									
Post BMP $CN_{(1\text{-year})}$=	84									
Post-BMP Nitrogen Loading										
TOTAL SITE NITROGEN MITIGATED (lbs)=	8.53									
SITE NITROGEN LOADING RATE (lbs/ac/yr)=	8.32									
TOTAL SITE NITROGEN LEFT TO MITIGATE_Wendell Only (lbs)=	**9.02**									

Project Name:	

WAKE COUNTY NORTH CAROLINA

LOW IMPACT DEVELOPMENT SUMMARY

DRAINAGE AREA SUMMARIES										
DRAINAGE AREA:	DA1	DA2	DA3	DA4	DA5	DA6	DA7	DA8	DA9	DA10
Pre-Development										
Runoff (in) = $Q_{pre\_2\text{-}year}$ =	1.60									
Total Runoff Volume (ft^3)=	11,126									
Peak Flow (cfs)=$Q_{2\text{-}year}$ =	3.538									
Post-Development										
2-year, 24-hour storm (LID)										
Post BMP Runoff (inches) = $Q^*_{(2\text{-}year)}$=	2.03									
Post BMP Peak Discharge (cfs)= $Q_{(2\text{-}year)}$=	2.952									
Post BMP Volume of Runoff $(ft3)_{(2\text{-}year)}$=	14,064									
Does Runoff meet LID requirements?	No									
Does Peak Flow meet LID requirements?	Yes									
Does Runoff Volume meet LID requirements?	No									

SITE SUMMARY	
Site Data	
Target CN =	N/A
Post-Development CN =	85
Does CN meet LID requirements?	

LID CHECKLIST
Complete the below checklist if all requirements have been met above:

LID Narrative (limit to 600 characters - attach additional pages with submittal if necessary):
Describe in detail how the proposed development has utilized "Natural Site Design". Narrative should include the location of site buildings, roads and other land disturbances in the least environmentally-sensitive areas, preservation of steep slopes, and preservation of naturally well draining soils and other hydrologically valuable features.

LID Techniques (check all that apply)
At least **one** of the following techniques must be used to achieve LID classification:

☐	Bioretention
☐	On-site infiltration

Additional LID Techniques (check all that apply)
At least **two** (**one for Wendell**) of the following techniques must be used to achieve LID classification:

☐	Retention of 50% of vegetated area, including open space, landscaping or forests
☐	Use of permeable pavement for <u>all</u> private driveways, private roads, sidewalks and parking areas
☐	Installation of one rain cistern per lot or three rain barrels per lot
☐	Installation of vegetative roofs
☐	Increasing all buffers in the Riparian buffer zone or the Flood Protection Zone, whichever is greater, by 50 feet
☐	Use of reclaimed water for all buildings
☐	Use of innovative LID techniques subject to approval

Project Name:	

DOWNSTREAM IMPACT ANALYSIS SITE SUMMARY

DRAINAGE AREA SUMMARIES										
DRAINAGE AREA:	DA1	DA2	DA3	DA4	DA5	DA6	DA7	DA8	DA9	DA10
Pre-Development										
Peak Discharge (cfs)= $Q_{10\text{-year}}$ =	6.65									
Volume of Runoff $(ft^3)_{(10\text{-year})}$ =	20,906									
Post-Development										
10-year, 24-hour storm (DIA)										
Post BMP Peak Discharge (cfs)= $Q_{(10\text{-year})}$=	5.32									
Post BMP Volume of Runoff $(ft^3)_{(10\text{-year})}$=	25,227									

CALCULATIONS AND REFERENCE

TARGET CURVE NUMBER

MAXIMUM CURVE NUMBER AFTER DEVELOPMENT

PROJECT DENSITY	A	B	C	D
Ultra-Low	43	63	76	81
Low	48	66	78	83
High	N/A	N/A	N/A	N/A

WEIGHTED CURVE NUMBER

RUNOFF CURVE NUMBERS FOR URBAN AREAS

LAND USE	A	B	C	D
Pasture	39	61	74	80
Woods, Poor Condition[1]	45	66	77	83
Woods, Fair Condition[2]	36	60	73	79
Woods, Good Condition[3]	30	55	70	77
Open Space, Poor Condition[4]	68	79	86	89
Open Space, Fair Condition[5]	49	69	79	84
Open Space, Good Condition[6]	39	61	74	80
Reforestation (in dedicated OS)[7]	30	55	70	77
Impervious[8]	98	98	98	98

Notes:
[1] Poor Condition = Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
[2] Fair Condition = Woods are grazed but not burned, and some forest litter covers the soil.
[3] Good Condition = Woods that are protected from grazing, litter, and brush adequately cover the soil
[4] Poor Condition = Grass Cover <50% (lawns, parks, golf courses, cemeteries, etc.)
[5] Fair Condition = Grass Cover = 50% - 75% (lawns, parks, golf courses, cemeteries, etc.)
[6] Good Condition = Grass Cover >75% (lawns, parks, golf courses, cemeteries, etc.)
[7] Includes paved/gravel/compacted soil driveways and roads, roofs, etc.
[8] Includes paved/gravel/compacted soil driveways and roads, roofs, etc.

SCS RUNOFF METHOD

$$Q^* = (P - .2S)^2/(P + .8S)$$

Where:
Q*= Runoff (in)
P= Precipitation (in)
S= Potential max retention after runoff begins (in) = (1000/CN)-10

Notes:
Calculations used on Drainage Area Sheets

DISCRETE RUNOFF METHOD (HIGH DENSITY ONLY)

$$Q^*_{High} = Q^*_{(imp)} \times DA_{(imp)} + Q^*_{(pervious)} \times DA_{(pervious)}$$

$Q^*_{(imp)}$ = Runoff from Impervious Area (in)
$DA_{(imp)}$ = Drainage from impervious area (acre)
$Q^*_{(pervious)}$ = Runoff from pervious area (in)
$DA_{(pervious)}$ = Drainage from pervious area (acre)

PEAK FLOW

Method: TR-55 Graphical Peak Discharge Method for Type II Distribution

$$Q_p = q_u A m Q^* Fp$$

Where:
Q_p = Peak Discharge (cfs)
q_u = Unit peak discharge (csm/in) *TR-55 Appendix F*
A_m = Drainage Area (mi^2)
Q* = runoff (inches)
F_p = pond adjustment factor

$$\log(q_u) = C_o + C_1 \log(Tc) + C_2[\log(Tc)]^2$$

Where:
C_o, C_1, C_2 = coefficient from Table F-1
T_c = time of concentration (hr)

Limitations:
The watershed must be hydrologically homogeneous
The watershed may have only one main stream or, if more than one, the branches must have nearly equal T_c's.
The Fp factor can be applied only for ponds or swamps that are not in the T_c flow path
This method should be used only if the weighted CN is greater than 40.
When this method is used to develop estimates of peak discharge for both pre and post development, use the same procedure for estimating Tc.
T_c values with this method may range from 0.1 to 10 hours.

TIME OF CONCENTRATION

$$T_t = \frac{L}{3600V}$$

T_t =travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours

T_c = sum of T_t values for consecutive flow segments

$T_c = T_1 + T_2 + T_3 + ...T_m$

T_c = time of concentration (hr)
m = # of flow segments

Note: Minimal 5 minute Tc

SHEET FLOW (FOR FLOW LESS THAN 300 FEET)

$$T_t = \frac{0.0007(nL)^{0.8}}{(P_2)^{0.5}s^{0.4}}$$

T_t =travel time (hr)
n = Manning's roughness coefficient (Table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

SHALLOW FLOW

Surface Cover

Unpaved: $V = 16.1345(s)^{0.5}$

Paved: $V = 20.3282(s)^{0.6}$

V=Average Velocity (ft/s)
s = slope of hydraulic grade line (watercourse slope, ft/ft)

$$T_t = \frac{L}{3600V}$$

T_t =travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours

Modified Table 3-1 for Stormwater Tool

SURFACE DESCRIPTION	n
Paved, Gravel, or Bare Soil	0.011
Grass	0.24
Woods	0.40

OPEN CHANNEL FLOW

$$V = \frac{1.49r^{2/3}s^{1/2}}{n}$$

V=Average Velocity (ft/s)
r = hydraulic radius (ft)
s = slope of hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow

$$r = \frac{a}{p_w} \qquad T_t = \frac{L}{3600V}$$

a = cross sectional flow area (ft2)
p_w=wetted perimeter (ft)

T_t =travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor (sec-hrs)

TABLE 4-1, TR-55
I_a values for runoff curve numbers

CN	I_a (in)	CN	I_a (in)	CN	I_a (in)
40	3.000	60	1.333	80	0.500
41	2.878	61	1.279	81	0.469
42	2.762	62	1.226	82	0.439
43	2.651	63	1.175	83	0.410
44	2.545	64	1.125	84	0.381
45	2.444	65	1.077	85	0.353
46	2.348	66	1.030	86	0.326
47	2.255	67	0.985	87	0.299
48	2.167	68	0.941	88	0.273
49	2.082	69	0.899	89	0.247
50	2.000	70	0.857	90	0.222
51	1.922	71	0.817	91	0.198
52	1.846	72	0.778	92	0.174
53	1.774	73	0.740	93	0.151
54	1.704	74	0.703	94	0.128
55	1.636	75	0.667	95	0.105
56	1.571	76	0.632	96	0.083
57	1.509	77	0.597	97	0.062
58	1.448	78	0.564	98	0.041
59	1.390	79	0.532		

TABLE 3-9, TR-55
Rational Runoff Coefficients

CHANNEL LINING	n
Asphalt	0.016
Concrete, finished	0.012
Concrete, unfinished	0.014
Grass	0.035
Gravel Bottom/riprap sides	0.033
Weeds	0.040

DISCONNECTED IMPERVIOUS CALCULATION

$CN_{adjusted} = CN_p + [(P_{imp}/100)*(98-CN_p)*(1-(0.5*R))]$

Where:

$CN_{adjusted}$ = Composite Curve Number

CN_p = Pervious runoff curve number =(PostCN - (Pimp/100)*98)/(1 -(Pimp/100))

P_{imp} = Percent Imperviousness

R = ratio of unconnected impervious area to total impervious area

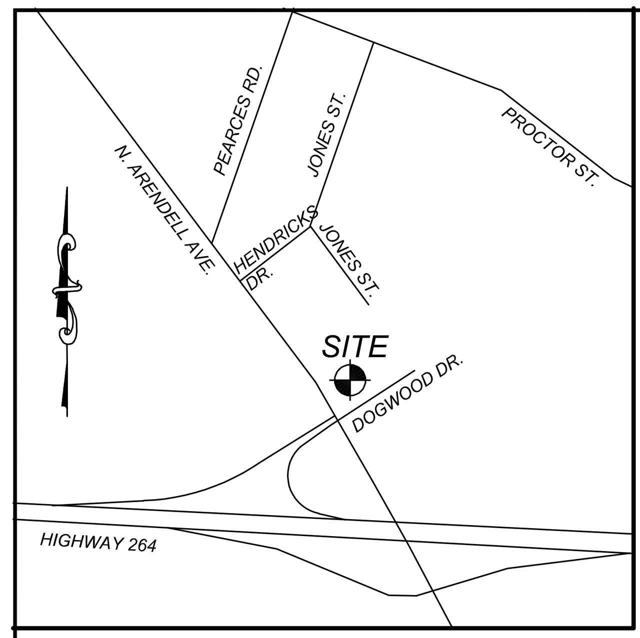
TABLE 4-1, SW BMP MANUAL
BMP ABILITY FOR
SW QUANTITY CONTROL

BMP	TSS	TN
Bioretention without IWS	**85%**	**35%**
Bioretention with IWS	**85%**	**40%**
Stormwater Wetlands	**85%**	**40%**
Wet Detention Basin	**85%**	**25%**
Sand Filter	**85%**	**35%**
Filter Strip	**25-40%**	**20%**
Grass Swale	**35%**	**20%**
Restored Riparian Buffer	**60%**	**30%**
Infiltration Device	**85%**	**30%**
Dry Extended Detention Basin	**50%**	**10%**
Permeable Pavement	**0%**	**0%**
Rooftop Runoff Management (Excluding Cisterns)	**0%**	**0%**
Cistern/Underground Detention	**See Note**	**100%**

[1] Use of underground detention reduces total volume required for storage as well total nitrogen load. To receive total reduction,

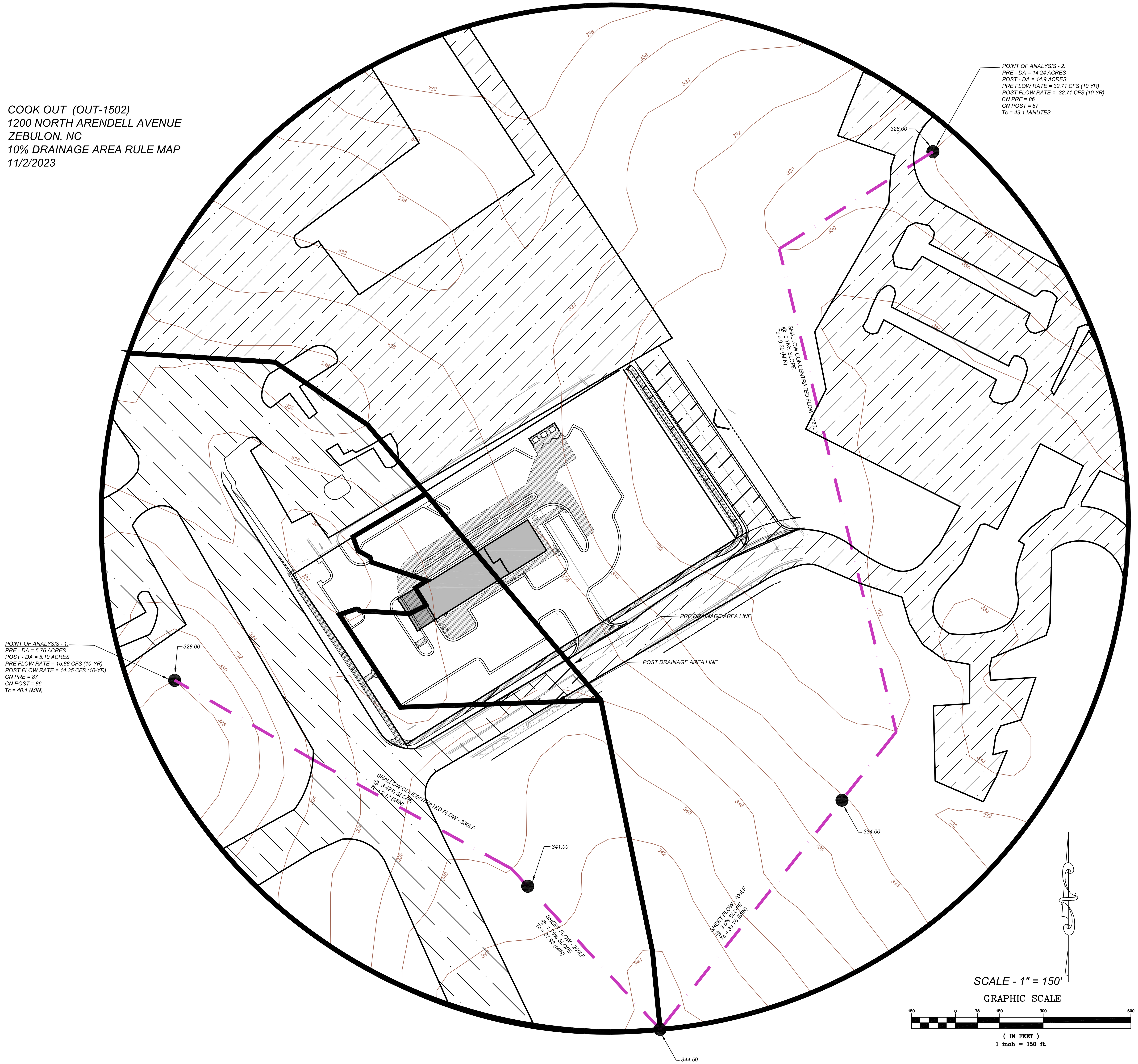
APPENDIX F

COOK OUT
1200 N. ARENDELL AVE.
ZEBULON, NC 27597
OUT-1502



N.T.S

COOK OUT (OUT-1502)
1200 NORTH ARENDELL AVENUE
ZEBULON, NC
10% DRAINAGE AREA RULE MAP
11/2/2023



SCALE - 1" = 150'

GRAPHIC SCALE

150 0 75 150 300 600

(IN FEET)
1 inch = 150 ft.

REVISIONS

NO.	DATE	DESCRIPTION	BY

COMMERCIAL SITE DESIGN
A Sambatek Company
8312 CREEDMOOR ROAD
RALEIGH, NORTH CAROLINA 27613
(919) 848-6121, FAX: (919) 848-3741
WWW.CSITEDESIGN.COM

CLIENT/OWNER:
COOK OUT
15 LAURA LANE, SUITE 300
THOMASVILLE, NC 27360
TELEPHONE: (336) 215-7025
FAX: (336) 474-1849

COOK OUT FRESH HAMBURGERS

1200 NORTH ARENDELL AVENUE
ZEBULON, NORTH CAROLINA

DOWNSTREAM ANALYSIS 10% MAP

OUT1502
OUT1502-POSTDSA
OUT-1502
1" =150'
10-09-2023

DIA