



Stormwater Management Report

Prepared For:

Proposed Washville Car Wash
991 – 995 W. Main Road
Middletown, RI 02842

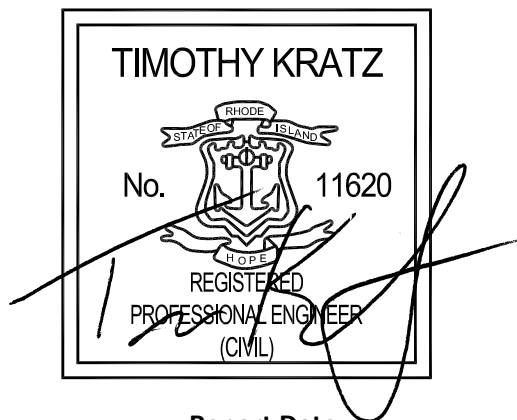
Owner/Developer:

SITEology
3025 Highland Pkwy, Suite 850
Downers Grove, IL 60515

Prepared by:

Sevan Engineering, P.C.
3025 Highland Pkwy, Suite 850
Downers Grove, IL 60515
Tim Kratz, P.E.

Professional Certification: I hereby certify that these documents, applications, calculations, and drawings were prepared by me or under my direct supervision and approved by me, and that I am a duly licensed professional engineer in the State of Rhode Island.



Report Date:

Prepared: March 18, 2022
Revised: June 30, 2022
Revised: August 5, 2022
Revised: August 25, 2022



Table of Contents

Purpose of Report	3
Existing Conditions	3
Site Soils.....	3
Rainfall Data.....	4
Proposed Improvements	4
Hydrologic Analysis	5
Soil Erosion Control	5
Rhode Island Stormwater Design and Installation Standards Manual Minimum Standards	6
Conclusion.....	8

Appendices

- A. Location Map
- B. Existing Drainage Patterns
- C. NRCS Soils Map and Classification
- D. Geotechnical Report
- E. NOAA Local Rainfall Data
- F. Proposed Drainage Patterns
- G. Hydraflow Hydrographs – 1, 2, 10, 25 and 100-yr storms
- H. Hydraflow Hydrographs – 1.2” Storm
- I. Contech CCS Sizing Areas Exhibit
- J. Hydraflow Hydrographs – CCS sizing with modified CN
- K. Water Quality Calculations Sheets
- L. RIDEM Contech Cascade Separator Certification Letter



Purpose of Report

This stormwater management report and associated plan drawings were prepared in accordance with the stormwater management requirements of the Rhode Island Stormwater Design and Installation Standards Manual (RISDISM). This report summarizes the predevelopment site conditions, post development site conditions, stormwater storage/conveyance, erosion control, and operation and maintenance procedures associated with the proposed re-development of the parcel of land located at 991-995 W. Main Road in the Town of Middletown, Newport County, RI, 02842.

The site currently consists of two existing residential driveways that used to serve two existing residential buildings that have been demolished. The site will be re-developed into a Washville branded car wash with associated vacuum stalls and pavement areas. The practices described in this report are designed to manage the effects of the redevelopment by decreasing stormwater runoff from the development, reducing soil erosion, minimizing pollutants in runoff, and protecting public safety through the proper design and operation of stormwater facilities, in order to comply with the RISDISM. Although this parcel was previously developed, it does not qualify as a Redevelopment under the RISDISM and will be designed to meet all of the RISDISM Minimum Standards.

A location map is included in the *Appendix A* of this report.

Existing Conditions

The site is located at 991-995 W. Main Road in the Town of Middletown, Newport County, RI, 02842 with approximate coordinates of; Latitude 41.5287 North, Longitude 71.2950 West. The site is approximately 1.08 Acres in total size and is bounded by W. Main Road to the West, existing commercial to the North and South and multi-family residential to the East. In its current existing conditions, the site currently consists of two existing residential driveways that used to serve two existing residential buildings that have been demolished as noted in *Appendix B "Existing Drainage Patterns"*.

As noted on *Appendix B "Existing Drainage Patterns"* The site can be broken down into a single watershed area consisting of 6.48% impervious surface and runoff currently drains undetained in a southwesterly direction towards Main Road. There do not appear to be any existing storm structures, storm pipe, retention/detention basins, infiltration basins or depressional storage areas on the parcel so the entirety of the site runoff is collected by the existing storm sewer structures along Main Road.

Site Soils

Site soil types were obtained from the NRCS website. Soil mapping generated from the NRCS website is provided in *Appendix C*. The mapping shows site soils are comprised mostly of Pittstown Silt Loam. This soil is classified as a Type C soil and that classification will be used for all calculations.

The following runoff curve numbers were used for the land cover characteristics as noted:



<u>Land Cover</u>	<u>Runoff Curve Number</u>
Roofs	98
Paved Parking	98
Grass Cover, Fair – HSG A	79
Grass Cover, Good – HSG A	70

Design Modeling Methodology

Runoff and routing calculations have been performed for the watershed areas affected by the proposed development under existing and proposed development conditions scenarios. Time of concentration and runoff curve number calculations have been performed using the method described in NRCS Technical Release 55 – Urban Hydrology for Small Watersheds. The TR-20 based Hydraflow Hydrograph modeling software has been utilized to perform the more complex runoff and routing calculations which are beyond the scope and capabilities of the TR-55 method.

Design rainfall events have been modeled using the Soil Conservation Service (SCS) Type III hydrograph for 24-hour duration storms. The rainfall depth for each return period is taken from the RISDISM. This guidance document splits the state into five regions for rainfall frequency based on county. The project site is located in the Newport County region defined in the RISDISM. The rainfall frequency values recommended by RIDEM and used in this drainage analysis are listed in the table below.

Rainfall Frequency Values for Newport County Rhode Island with 24-Hour Storm Duration					
RIDEM Stormwater Design and Installation Standards manual 3/15					
Frequency	1-Yr	2-Yr	10-Yr	25-Yr	100-Yr
Inches of Rainfall	2.8	3.3	4.9	6.1	8.6

The existing and proposed conditions runoff calculations were analyzed and the proposed stormwater systems were sized to mitigate the peak runoff for the 1, 2, 10, 25, and 100-year 24-hour design storms. The 1, 10 and 100 year storm requirements are mandated by the RISDISM, while mitigation of the 2 and 25 year storms are also required by the municipality. The resulting stormwater management devices were designed to effectively capture, detain, and treat runoff from developed areas of the site before allowing it to discharge in a non-erosive manner to downstream areas in accordance with the RISDISM.

Proposed Improvements

The proposed improvements will consist of a 4,201 gross square foot Car Wash building with a 110' long wash tunnel and associated vacuum parking lot, access drives, pay stations and pervious areas. Stormwater runoff will be collected by a proposed on-site storm sewer system and diverted to a proposed underground lined and sub-drained sand filter system where it will be detained and then slowly released into the existing roadway storm sewer system through the proposed restrictor.



As noted on *Appendix F “Proposed Drainage Patterns”* the proposed site improvements can be broken down into two separate watershed areas. A portion of the site at the access drives needs to be undetained while the larger overall watershed is captured by the proposed storm sewer and sand filter system.

A comparison of Existing Conditions and Proposed Conditions reveals that under proposed conditions, the sites total impervious area will be increased from 0.07 acres to 0.7 acres.

Hydrologic Analysis

The drainage analysis, including peak flows, for the existing development and proposed conditions was completed using Autodesk Hydraflow Hydrographs Extension Software (Hydraflow). Hydraflow uses TR-55 and TR-20 methodology as developed by the USDA Natural Resources Conservation Services. Runoff Curve Numbers (CN) and Times of Concentration were determined based on the soil types indicated previously, existing and proposed ground cover conditions.

Peak flows for the 1-, 2-, 10-, 25-, and 100-year frequency storm events were determined by using a 24-hour type III storm, standard for the New England area. Existing and proposed hydrologic models are included in *Appendix G*.

Drainage Runoff Summaries:

Existing Conditions Runoff Rates

Subarea	Area (ac)	1-year (cfs)	2-year (cfs)	10-year (cfs)	25-year (cfs)	100-year (cfs)
EX1	1.08	1.024	1.460	3.013	4.261	6.940

Proposed Conditions Controlled Runoff Rates

Subarea	Area (ac)	1-year (cfs)	2-year (cfs)	10-year (cfs)	25-year (cfs)	100-year (cfs)
PUN1	0.13	0.141	0.196	0.389	0.541	0.866
PR1	0.95	0.463	0.806	2.318	3.197	5.468
Combined	1.08	0.503	0.880	2.554	3.583	6.087

As noted on the above chart, the proposed sand filter/detention system has been designed to collect, convey, store and release all design storms up to and including the 100-year event to a release rate less than under existing conditions. As a result the runoff for the proposed development areas will be significantly reduced from existing conditions and result in a net benefit for the overall watershed.

Soil Erosion Control

Soil Erosion and sedimentation controls will be installed prior to the start of construction. Erosion and sedimentation control (E&S) details and narratives for construction activities are provided on the Site Plans. E&S details and procedures are in accordance with the Rhode Island Department of Environmental



Management 'RIDEM' requirements. E&S will be maintained for the duration of the project until disturbed slopes have been fully stabilized.

Rhode Island Stormwater Design and Installation Standards Manual Minimum Standards

The proposed development is not considered a redevelopment under Section 3.2.6 "Minimum Standard 6: Redevelopment and Infill Projects" of the Rhode Island Stormwater Design and Installation Standards Manual (RISDISM) and has therefore been designed to meet the all the requirements of the RISDISM where applicable

Minimum Standard 1: LID Site Planning and Design Strategies

As required in The Manual, Low Impact Development (LID) measures were considered with the proposed site redevelopment to enhance stormwater quality. The project has been designed to minimize impervious areas to the maximum extent possible. LID measures include:

- Proposed impervious surfaces have been minimized and new pervious areas have been maximized.
- During construction, stormwater collection structures indicated on the site plans will be fitted with filter fabric inserts to remove sediments from the stormwater run-off prior to entering the receiving drainage systems.
- The proposed pretreatment Contech Cascade Separators and sand filter/detention system will be installed on the site to improve water quality from the parking and building areas, attenuate peak flows, and remove pollutants from the runoff.

Minimum Standard 2: Groundwater Recharge

Groundwater is to be recharged based on impervious area coverage in accordance with section 3.2.2 of RISDISM. The soils report however found indications that there is a shallow groundwater table on the site. A prior Class IV soil evaluation that was performed by a third party revealed that there is a seasonal groundwater table located approximately 18" below the surface, with no fill layer. Given this extremely shallow water table, no groundwater recharge is possible on this site. It is requested that this criteria be waived for this development.

Minimum Standard 3: Water Quality

Per the RISDISM, the stormwater system is required to treat the impervious areas of the proposed development to provide stormwater runoff water quality. The ultimate receiving water body for drainage from the development is Bailey's Brook which is an impaired waterway. Bailey's Brook is impaired for Enterococcus, Phosphorus, Total Lead and the brook has a TMDL.

Based on the calculations provided in *Appendix K*, because of the proximity to Bailey's Brook, the site has to provide for a minimum water quality treatment area of 1.3 acres. This results in a required water quality volume of 4,719 c.f. The proposed improvements will consist of two Contech Cascade Model #CS-4 Separators that will provide pretreatment for the runoff prior to it entering a proposed lined sub-drained sand filter system. The Contech Cascade separators have been designed to handle and remove pollutants



from the 1.2" storm while bypassing larger storms directly into the sand filter where runoff would be further filtered prior to being released into the existing roadway storm sewer system.

The sand filter has been properly sized for total system volume and surface area. The minimum required filter bed area as calculated using the equation in section 8.23 of the RIDEM Stormwater Management, Design and Installation Rules is: $A_f = (WQ_v) (df) / [(k) (hf + df) (tf)] = (4,719) (1.5) / [(3.5) (2.5+1.5) (2)] = 252$ sf. As designed, the sand filter provides a filter bed area of 2,364 sf and therefore meets the requirements.

Because the ultimate receiving water body for drainage from the development is the impaired Bailey's Brook waterway, the stormwater system is required to remove pollutants in order to comply with the Brook's TMDL requirements. The Contech Cascade Separators will provide pretreatment of the runoff by removing TSS, oil and other pollutants from the runoff. As noted in the RIDEM Contech Cascade Separator Certification Letter located in *Appendix L*, the CCS structures are approved as a 50% removal system. Furthermore, manufacture studies have shown that the proposed CCS units can remove up to 75% of TSS and other pollutants from the first flush storm event (1.2" storm) this is significantly higher than the required 25% pretreatment removal. The runoff would then enter the sand filter where the remaining pollutants would be removed from the runoff as it passes through the sand medium.

Minimum Standard 4: Conveyance and Natural Channel Protection

Drainage Network Design Parameters:

A. Pipes:

1. All drainage pipes are HDPE or equivalent unless otherwise noted.
2. Manning's coefficient = 0.012 for HDPE Pipe.
3. Diameters and lengths as specified.
4. The 100-year design storm is utilized for the drainage pipe design to ensure that the drainage system contains and channels water to the CDS units and the sand filter/detention system.

B. Structures:

1. Storm structures will be concrete manholes with diameters as specified.

Channel Protection Volume:

The sand filter system has been designed to release the 1-year storm volume over a 24 hour time span in accordance with Section 3.2.4 of the RISDISM. This hold and release time span can be seen in the hydrograph for the 1-year storm event located in *Appendix G (Page 10 of the output)*. As can be seen on that hydrograph, the system peaks at hour 12.43 and is empty by the 24-hour mark. The channel protection requirement has been met.

Minimum Standard 5: Overbank Flood Protection and Downstream Analysis

The proposed sand filter system will be a subsurface system and will not have an emergency overbank that requires protection.



As noted previously, there will be no net increase in stormwater runoff from pre-development to post-development conditions from the 1-year to through the 100-year storm event. Due to the reduction in stormwater flow from pre to post development and stable surrounding drainage conditions, a downstream analysis is not required per the rules of section 3.3.6 in the RIDEM checklist.

Minimum Standard 6: Redevelopment and Infill Projects.

The site is not classified as a redevelopment or infill project.

Minimum Standard 7: Pollution Prevention

A Soil Erosion and Sediment Control Plan (SESC) for this development can be found in the plans submitted under separate cover. The SESC contains information for construction pollution prevention.

Minimum Standard 8: Land Uses with High Potential Pollutant Loads (LUHPPI's)

This site is not considered LUHHPL.

Minimum Standard 9: Illicit Discharges

There are no proposed Illicit Discharges on site. The site will be serviced by public water and sewer.

Minimum Standard 10: Construction Activity Soil Erosion, Runoff and Sedimentation and Pollution Prevention Control Measure Requirements

A Soil Erosion and Sediment Control Plan (SESC) for this development can be found in the plans submitted under separate cover. The SESC contains information for construction pollution prevention.

Minimum Standard 11: Stormwater Management System Operation and Maintenance

A Stormwater Management System Operation and Maintenance (SWMS O&M) plan will be developed for the development of the site and will be added to this document as soon as the proposed improvements and stormwater management items have been accepted by the authorities having jurisdiction over the proposed development. The owner shall be responsible for construction operation and maintenance of the site.

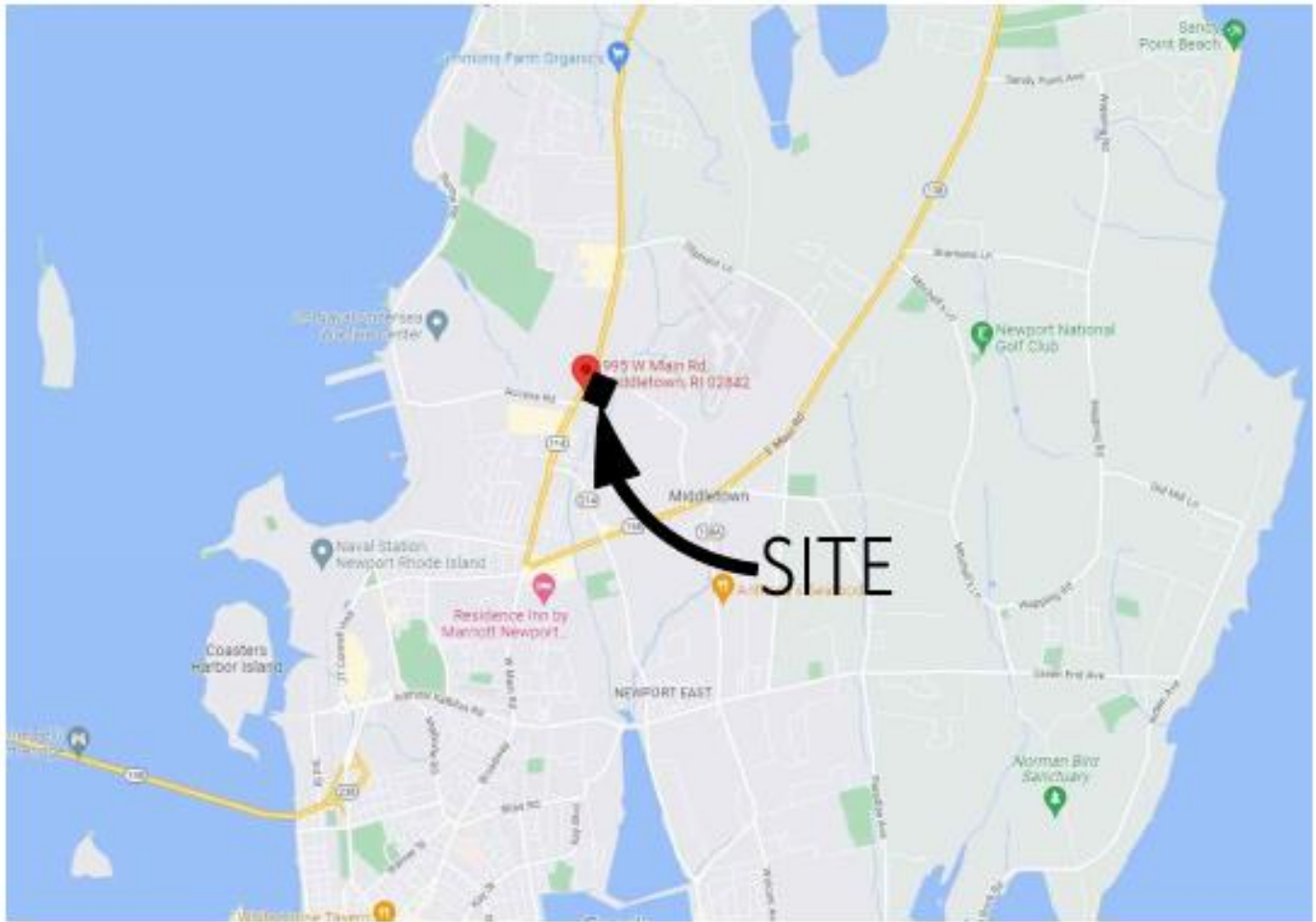
Conclusion

It is our professional opinion that with the incorporation of the above-mentioned stormwater management methodology, the proposed development plan for this site will be able to adequately manage the runoff across the site in accordance with the current requirements of RISDISM and will present no detrimental impacts to the downstream wetlands or to adjacent properties and should be granted approval.



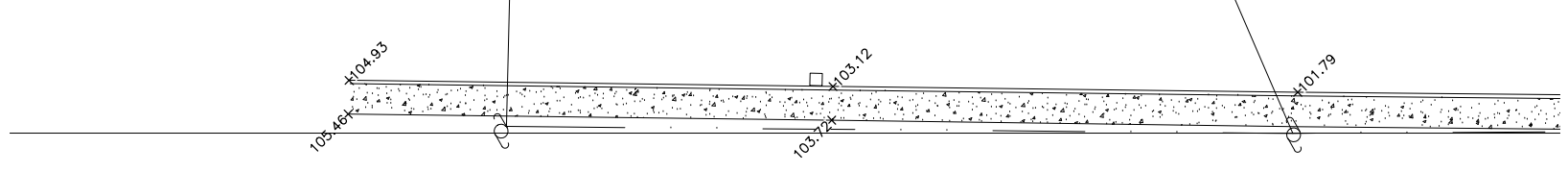
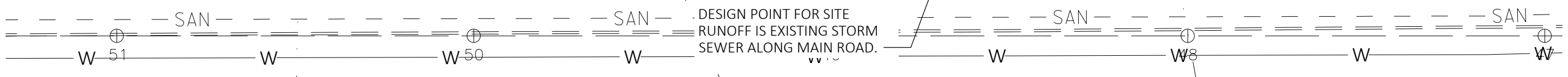
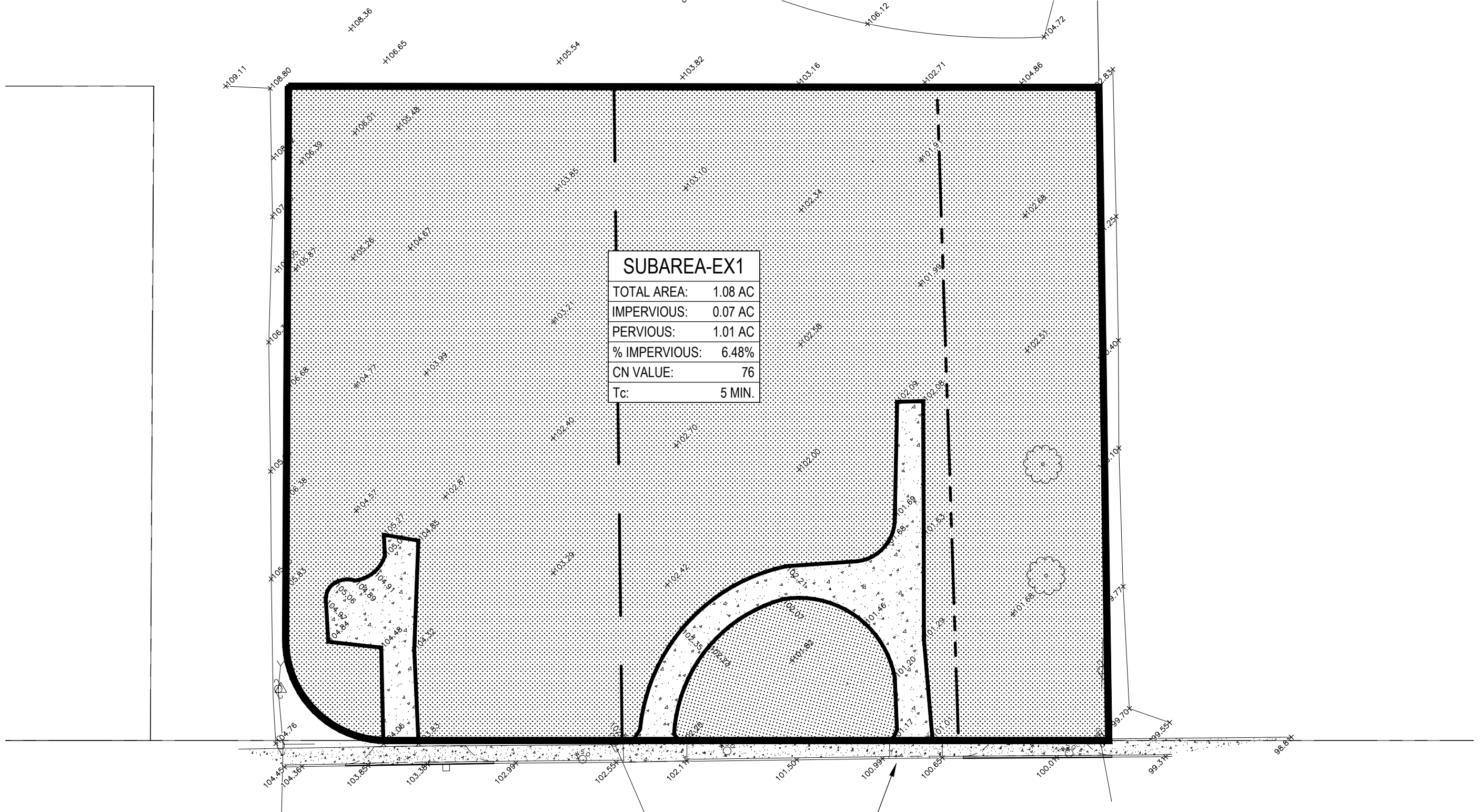
Appendix A

Location Map





Appendix B
Existing Drainage Patterns



sevan
ENGINEERING

Regional Office:
37704 Hills Tech Drive
Farmington Hills, MI 48331
734.367.4445 Telephone
info@sevanengineering.com www.sevanengineering.com

Corporate Office:
3025 Highland Parkway, Suite 850
Downers Grove, IL 60515
info@sevanengineering.com www.sevanengineering.com

INTEGRITY | RESPECT | TEAMWORK | EXCELLENCE | CHARITY

CUSTOMER

Washville
Your Hometown Car Wash

PROJECT LOCATION

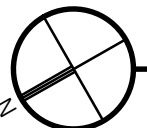
991-995 W. MAIN ROAD
MIDDLETOWN, RI 02842
(NEWPORT COUNTY)

SHEET MANAGEMENT	
PROJECT NO.:	MIDDLETOWN
DATE:	06.30.2022
CRITERIA:	
PROJECT MANAGER:	T. KRATZ

THIS DOCUMENT IS AND SHALL REMAIN THE PROPERTY OF SEVAN MULTI-SITE SOLUTIONS, INC.
REPRODUCTION OR ALTERATION OF THIS DOCUMENT WITHOUT THE EXPRESSED WRITTEN PERMISSION OF SEVAN MULTI-SITE SOLUTIONS, INC. IS PROHIBITED.
(NOT PUBLISHED: ALL RIGHTS RESERVED.)
COPYRIGHT BY SEVAN MULTI-SITE SOLUTIONS, INC. 2022

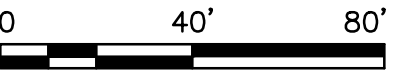
REVISIONS		
NO.	DATE	DESCRIPTION

SHEET TITLE	
EXISTING DRAINAGE PATTERNS	
SHEET NUMBER	
EDP	



EXISTING DRAINAGE PATTERNS

SCALE: 1" = 40'-0"





Appendix C

NRCS Soils Map and Classification



United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

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

Custom Soil Resource Report for State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties



Soil Map

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

Custom Soil Resource Report Soil Map




Soil Map may not be valid at this scale.

Map Scale: 1:691 if printed on A portrait (8.5" x 11") sheet.



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)




















Soils







 Soil Map Unit Polygons

 Soil Map Unit Lines


 Soil Map Unit Points

Special Point Features






-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot

-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features

Water Features

 Streams and Canals

Transportation

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

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
 Survey Area Data: Version 21, Sep 3, 2021

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

Date(s) aerial images were photographed: May 6, 2015—Sep 12, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
PmB	Pittstown silt loam, 3 to 8 percent slopes	1.0	89.0%
UD	Udorthents-Urban land complex	0.1	7.3%
Ur	Urban land	0.0	3.6%
Totals for Area of Interest		1.1	100.0%

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the

Custom Soil Resource Report

development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

PmB—Pittstown silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 9lw
Elevation: 0 to 250 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 185 to 211 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Pittstown and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pittstown

Setting

Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Loamy lodgment till derived from metamorphic and sedimentary rock

Typical profile

A - 0 to 8 inches: very stony silt loam
Bw - 8 to 28 inches: silt loam
Cd - 28 to 60 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F144AY037MA - Moist Dense Till Uplands
Hydric soil rating: No

Minor Components

Newport

Percent of map unit: 5 percent

Custom Soil Resource Report

Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Stissing

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

UD—Udorthents-Urban land complex

Map Unit Setting

National map unit symbol: 9lxj
Elevation: 0 to 670 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 120 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 70 percent
Urban land: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Human transported material

Typical profile

A - 0 to 12 inches: sandy loam
C1 - 12 to 25 inches: sandy loam
C2 - 25 to 60 inches: stratified sand to very gravelly coarse sand

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: About 42 to 54 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Description of Urban Land

Setting

Parent material: Human transported material

Typical profile

R - 0 to 6 inches: variable

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8s

Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 5 percent

Landform: Terraces, outwash plains, kames

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Quonset

Percent of map unit: 5 percent

Landform: Outwash plains, terraces, outwash terraces, eskers

Down-slope shape: Convex

Across-slope shape: Convex

Hydric soil rating: No

Ur—Urban land

Map Unit Setting

National map unit symbol: 9lxx

Elevation: 0 to 810 feet

Mean annual precipitation: 44 to 50 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 100 to 211 days

Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Human transported material

Minor Components

Udorthents

Percent of map unit: 5 percent
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Pittstown

Percent of map unit: 2 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Charlton

Percent of map unit: 2 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Canton

Percent of map unit: 2 percent
Landform: Hills
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Sutton

Percent of map unit: 1 percent
Landform: Drainageways, depressions
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: No

Newport

Percent of map unit: 1 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Sudbury

Percent of map unit: 1 percent
Landform: Terraces, outwash plains
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Merrimac

Percent of map unit: 1 percent
Landform: Terraces, outwash plains, kames
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Custom Soil Resource Report

References

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

Custom Soil Resource Report

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

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

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



Appendix D
Geotechnical Report

REPORT OF GEOTECHNICAL INVESTIGATION

**PROPOSED WASHVILLE CAR WASH
991 - 995 WEST MAIN ROAD
PLAT 106, LOTS 115 & 116
MIDDLETOWN, NEWPORT COUNTY, RHODE ISLAND**



Prepared for:

**SEVAN MULTI-SITE SOLUTIONS
3025 Highland Parkway
Suite 850
Downers Grove, Illinois 60515**

Prepared by:

**WHITESTONE ASSOCIATES, INC.
352 Turnpike Road
Suite 320
Southborough, Massachusetts 06067**

**Richard W.M. McLaren, P.E.
Senior Consultant**

**Ryan R. Roy, P.E.
Vice President**

**Whitestone Project No.: GM2218968.000
April 26, 2022**

Other Office Locations:

WARREN, NJ
908.668.7777

CHALFONT, PA
215.712.2700

ROCKY HILL, CT
860.726.7889

WALL, NJ
732.592.2101

PHILADELPHIA, PA
215.848.2323

BEDFORD, NH
603.514.2230

TAMPA, FL
813.851.0690



352 TURNPIKE ROAD
SUITE 320
SOUTHBOROUGH, MA 01772
508.485.0755
whitestoneassoc.com

April 26, 2022

via email

SEVAN MULTI-SITE SOLUTIONS

3025 Highland Parkway
Suite 850
Downers Grove, Illinois 60515

Attention: Mr. Brady Carlucci
Project Manager

**Regarding: REPORT OF GEOTECHNICAL INVESTIGATION
PROPOSED WASHVILLE CAR WASH
991 - 995 WEST MAIN ROAD
PLAT 106, LOTS 115 & 116
MIDDLETOWN, NEWPORT COUNTY, RHODE ISLAND
WHITESTONE PROJECT NO.: GM2218968.000**

Dear Mr. Carlucci:

Whitestone Associates, Inc. (Whitestone) is pleased to submit the *Report of Geotechnical Investigation* for the above-referenced project. The report presents the results of Whitestone's subsurface exploration and includes design recommendations for the foundations, slab, pavements, and related earthwork associated with the proposed Washville car wash.

Whitestone appreciates the opportunity to be of service to Sevan Multi-Site Solutions. Should you have questions regarding the enclosed report, contact us at (508) 485-0755.

Sincerely,

WHITESTONE ASSOCIATES, INC.

Richard W.M. McLaren, P.E.
Senior Consultant

Ryan R. Roy, P.E.
Vice President

RWM/ri N:\Job Folders\2022\2218968GM\Reports and Submittals\Sevan Car Wash GM2218968 Middletown RI ROGI 4-26-22.docx
Enclosures
Copy: Jeffrey T. Bauer, P.G., Whitestone Associates, Inc.

Other Office Locations:

WARREN, NJ
908.668.7777

CHALFONT, PA
215.712.2700

ROCKY HILL, CT
860.726.7889

WALL, NJ
732.592.2101

PHILADELPHIA, PA
215.848.2323

BEDFORD, NH
603.514.2230

TAMPA, FL
813.851.0690

Environmental & Geotechnical Engineers & Consultants

**REPORT OF
 GEOTECHNICAL INVESTIGATION
 PROPOSED WASHVILLE CAR WASH
 991-995 West Main Road
 Plat 106, Lots 115 & 116
 Middletown, Newport County, Rhode Island**

TABLE OF CONTENTS

SECTION 1.0 SUMMARY OF FINDINGS 1

SECTION 2.0 INTRODUCTION 2

 2.1 AUTHORIZATION..... 2

 2.2 PURPOSE..... 2

 2.3 SCOPE..... 2

 2.3.1 Field Exploration 2

 2.3.2 Laboratory Testing..... 3

SECTION 3.0 SITE DESCRIPTION..... 4

 3.1 LOCATION AND DESCRIPTION 4

 3.2 EXISTING CONDITIONS..... 4

 3.3 SITE GEOLOGY..... 4

 3.4 PROPOSED CONSTRUCTION 5

SECTION 4.0 SUBSURFACE CONDITIONS..... 6

 4.1 SUBSURFACE SOIL CONDITIONS 6

 4.2 GROUNDWATER 6

SECTION 5.0 CONCLUSIONS AND RECOMMENDATIONS..... 7

 5.1 GENERAL..... 7

 5.2 SITE PREPARATION AND EARTHWORK 7

 5.3 STRUCTURAL FILL AND BACKFILL..... 8

 5.4 GROUNDWATER CONTROL 9

 5.5 FOUNDATIONS 9

 5.6 SLABS..... 10

 5.7 PAVEMENT DESIGN CRITERIA..... 11

 5.8 RETAINING WALLS/LATERAL EARTH PRESSURES 13

 5.9 SEISMIC AND LIQUEFACTION CONSIDERATIONS 13

 5.10 EXCAVATIONS 14

 5.11 SUPPLEMENTAL POST INVESTIGATION SERVICES 14

SECTION 6.0 GENERAL COMMENTS..... 15

**REPORT OF
GEOTECHNICAL INVESTIGATION
PROPOSED WASHVILLE CAR WASH
991-995 West Main Road
Plat 106, Lots 115 & 116
Middletown, Newport County, Rhode Island**

**TABLE OF CONTENTS
(Continued)**

FIGURES

FIGURE 1 Boring Location Plan

APPENDICES

APPENDIX A Records of Subsurface Exploration (Borings B-1 through B-6)

APPENDIX B Laboratory Test Results

APPENDIX C Supplemental Information (USCS, Terms & Symbols)

SECTION 1.0

Summary of Findings

Whitestone has completed an exploration and evaluation of the subsurface conditions at the site of the proposed Washville car wash located at 991 - 995 West Main Road in the Town of Middletown, Newport County, Rhode Island. Based on a December 3, 2021 *Concept Site Plan Option 1* prepared by Sevan Engineering (Sevan) of Downers Grove, Illinois, the project consists of the construction of a car wash with a footprint of 4,201 square feet on the eastern side of the site. The proposed building will be constructed close to existing site grade to match the adjacent roadway. No stormwater detention systems or new retaining walls are shown on the *Concept Site Plan Option 1*.

The geotechnical investigation included conducting a reconnaissance of the project site, advancing six soil borings, and collecting soil samples for laboratory testing and characterization. Site subsurface conditions generally consisted of topsoil/subsoil over intermittent existing fill underlain by glacial till, which is underlain by weathered shale bedrock. Water was encountered in the explorations during field activities at depths ranging from two feet below ground surface (fbgs) to 15 fbgs.

The results of the investigation indicate that the proposed structure may be supported on conventional spread footings designed to bear on the glacial till or structural fill placed over the glacial till. Existing fill was encountered in two borings to a depth of two fbgs, however, is expected to be about seven to eight feet deep within previously developed areas of the site. Subsoil with roots was encountered up to 2.5 fbgs. However, deeper existing fill/subsoil may be encountered between the widely spaced borings. Overexcavation of existing fill/subsoil and replacement with structural fill may be required under footings within a portion of the proposed building footprint. Slabs may be supported on the properly inspected and approved glacial till or existing fill, and/or structural fill placed over these materials. Additionally, the site conditions support the use of typical pavement sections using standard Rhode Island Department of Transportation (RIDOT) specified materials.

The above summary is intended to provide an overview of the geotechnical findings and recommendations and is not fully developed. Greater detail is presented in the following sections. The entire report must be read for comprehensive understanding of the information contained herein.

SECTION 2.0

Introduction

2.1 AUTHORIZATION

Mr. Brady Carlucci, Project Manager at Sevan Multi-Site Solutions, issued authorization to Whitestone to conduct a geotechnical investigation on this site relevant to the construction of a proposed Washville car wash located at 991 - 995 West Main Road in the Town of Middletown, Newport County, Rhode Island. The geotechnical investigation was conducted in general accordance with Whitestone's December 13, 2021 proposal.

2.2 PURPOSE

The purpose of this exploration and analysis was to:

- ▶ ascertain the various soil profile components at test locations;
- ▶ estimate the engineering characteristics of the proposed foundation bearing and subgrade materials;
- ▶ provide geotechnical criteria for use by the design engineers in preparing the foundation, slab, and pavement design;
- ▶ provide recommendations for required earthwork and subgrade preparation;
- ▶ record groundwater levels (if encountered) at the time of the investigation and discuss the potential impact on the proposed construction; and
- ▶ recommend additional investigation and/or analysis, if warranted.

2.3 SCOPE

The scope of the exploration and analysis included the subsurface exploration, field testing and sampling, laboratory testing, evaluation of the subsurface materials, and a geotechnical engineering analysis. This *Report of Geotechnical Investigation* is limited to addressing the site conditions related to the physical support of the proposed construction. Whitestone completed a *Phase I Environmental Site Assessment* concurrently with the geotechnical investigation, the report for which was issued under separate cover.

2.3.1 Field Exploration

Field exploration of the project site was conducted by means of six soil borings, identified as B-1 through B-6, advanced with a truck-mounted CME 55 drill rig equipped with hollow stem augers to termination depths that ranged from approximately 6.9 fbg to 17 fbg. Soil borings were backfilled with excavated soils generated from the investigation. The *Records of Subsurface Exploration* for the borings are included in Appendix A. Test locations are shown on the *Boring Location Plan* included as Figure 1.

Test locations were based on project information provided to Whitestone at the time of the investigation, including the December 3, 2021 *Concept Site Plan Option 1* prepared by Sevan. The subsurface tests were conducted in the presence of a Whitestone field engineer, who conducted field tests, recorded visual classifications, and collected samples of the various strata encountered. Test locations were established in the field using normal taping procedures and estimated right angles. These locations are presumed to be accurate to the degree implied by the method used.

Soil borings and Standard Penetration Tests (SPTs) were conducted in general accordance with ASTM International (ASTM) designation D1586. The Standard Penetration Resistance value (N) can be used as an indicator of the consistency of fine-grained soils and the relative density of coarse-grained soils. The N-value for various soil types can be correlated with the engineering behavior of earthworks and foundations.

Groundwater level observations, where encountered, were recorded during and immediately following the completion of the testing operations within the soil borings. Seasonal variations, temperature effects, and recent rainfall conditions may influence the levels of the groundwater, and the observed levels will depend on the permeability of the soils. Groundwater elevations derived from sources other than seasonally observed groundwater monitoring wells may not be representative of true groundwater levels.

2.3.2 Laboratory Testing

In addition to the field investigation, laboratory testing was conducted to determine additional, pertinent engineering characteristics of representative samples of on-site soils. The laboratory testing was conducted in general accordance with applicable ASTM standard test methods and included physical testing of the glacial till.

Physical/Textural Analysis: Two representative samples of the site soils were subjected to laboratory testing that included moisture content determination (ASTM D2216) and washed gradation analyses (ASTM D422) in order to conduct supplementary engineering soil classifications and/or to assess possible re-use of the site soils as structural fill. The results of the laboratory testing are summarized in the following table:

LABORATORY TESTING SUMMARY					
Boring	Sample Number	Depth (fbgs)	Moisture Content (%)	Passing No. 200 Sieve (%)	USCS Classification
B-1	S-2	2.0 - 4.0	9.5	36.3	SM
B-4	S-3	5.0 - 7.0	10.3	36.3	SM

The engineering classifications are useful when considered in conjunction with the additional site data to estimate properties of the soil types encountered and to predict soil behavior under construction and service loads. Laboratory test results are provided in Appendix B.

SECTION 3.0 Site Description

3.1 LOCATION AND DESCRIPTION

The subject site is located at 991 - 995 West Main Road in the Town of Middletown, Newport County, Rhode Island, Latitude 41.5288 North, Longitude 71.2947 West. The approximately 0.9-acre site, which is identified further as Plat 106, Lots 115 and 116, is vacant.

The rectangular site is bounded to the northwest by West Main Road, to the northeast by a strip mall, to the southeast by three-story apartment buildings, and to the southwest by a single story retail building. Access to the site is from West Main Road. The site of the proposed construction is shown on the *Boring Location Plan* included as Figure 1.

3.2 EXISTING CONDITIONS

Existing Development: The subject site, which is vacant, was previously developed with two residences, which have been razed. Remnant foundations appear to have been left in place and the basements appear to have been filled. Indications of settlement were observed within the former building footprints.

Topography: Based on a review of the *USGS 7.5 Minute Series Prudence Island Quadrangle, Rhode Island (2021)* and Whitestone's visual observations, the site generally slopes down to the southeast from approximately elevation 105 feet above National American Vertical Datum of 1988 (NAVD) to 100 feet above NAVD.

Utilities: The site was previously serviced by electrical and telecommunication utilities, which may have extended underground from an overhead power line along West Main Road. The site is connected to municipal water and sewer. The utility information contained in this report is presented for general discussion only and is not intended for construction purposes.

Site Drainage: Surface run-off will follow site topography and flow to southeast towards the rear of the site.

3.3 SITE GEOLOGY

Based on a review of the Rhode Island Department of Environmental Management (RIDEM) *Geology and Soils* data, the site is underlain by glacial till. The *Bedrock Geologic Map of Rhode Island (1994)* indicates that the subject property is underlain by the Pennsylvanian-age Narragansett Bay Group - Rhode

Island Formation, consisting of quartz arenite, litharenite, shale, and conglomerate with incidental anthracite, part of the Esmond-Dedham Subterrane.

3.4 PROPOSED CONSTRUCTION

Based on the aforementioned Sevan *Concept Site Plan Option 1*, the project consists of the construction of a car wash with a footprint of 4,201 square feet on the eastern side of the site. The proposed building will be constructed close to existing site grade to match the adjacent roadway. No stormwater detention systems or new retaining walls are shown on the *Concept Site Plan Option 1*.

Whitestone anticipates the proposed building will be a single-story, masonry and metal-framed structure constructed with a ground-supported concrete slab and a crawl space for piping. Maximum wall and floor loads are expected to be on the order of:

- ▶ load bearing walls - 2.0 kips per linear foot; and
- ▶ slab - 150 pounds per square foot.

The scope of Whitestone's investigation and the professional advice contained in this report were generated based on the project details and loading noted herein. Revisions or additions to the design details enumerated in this report should be brought to the attention of Whitestone for additional evaluation as warranted.

SECTION 4.0 Subsurface Conditions

Details of the subsurface materials encountered are presented on the *Records of Subsurface Exploration* presented in Appendix A of this report. The subsurface soil conditions encountered in the test locations consisted of the following generalized strata in order of increasing depth.

4.1 SUBSURFACE SOIL CONDITIONS

Surface Cover Materials: The borings encountered two inches to 12 inches (typically 12 inches) of topsoil at the ground surface with six inches to 18 inches of subsoil with roots.

Existing Fill (intermittent): Beneath the surface cover materials, borings B-2 and B-3 encountered existing fill, consisting of brown, loose, silty sand with gravel. SPT N-values recorded within the existing fill were six blows per foot (bpf) and eight fbgs. The existing fill extended to a depth of two fbgs.

Although not noted in borings, basements of the former buildings appear to have been filled. As such, existing fill is expected to extend to depths of approximately seven to eight fbgs in the vicinity of the former buildings.

Glacial Till: Beneath the surface cover materials or existing fill, the borings encountered glacial till, consisting of gray-brown, medium dense to dense (occasionally very dense), silty sand with gravel, occasional cobbles (USCS: SM). SPT N-values recorded within the glacial till were variable, ranging from 14 bpf to 84 bpf. The borings, except B-2 and B-4, terminated in the glacial till at depths of 6.9 fbgs to 17 fbgs.

Weathered Bedrock: Beneath the glacial till, borings B-2 and B-4 encountered weathered shale bedrock at a depth of 16 fbgs. Borings B-2 and B-4 terminated in the weathered bedrock at a depth of 17 fbgs.

4.2 GROUNDWATER

Water was encountered in two borings (B-5 and B-6) at two fbgs. Static and perched/trapped water conditions generally will fluctuate seasonally and following periods of precipitation.

SECTION 5.0

Conclusions and Recommendations

5.1 GENERAL

The results of the investigation indicate that the proposed structure may be supported on conventional spread footings designed to bear on the natural glacial till or structural fill placed on the glacial till. Existing fill was encountered in two borings to a depth of two fbs. Subsoil with roots was encountered up to 2.5 fbs. However, deeper existing fill/subsoil may be encountered between the widely spaced borings. Overexcavation of existing fill/subsoil and replacement with structural fill may be required under footings within a portion of the proposed building footprint. The results also indicate that the site is suitable for a ground-supported slab bearing on the compacted, approved, and improved existing fill or glacial till, and/or structural fill. Additionally, the site conditions support the use of typical pavement sections using RIDOT specified materials.

5.2 SITE PREPARATION AND EARTHWORK

Surface Cover Stripping: Prior to stripping operations, utilities should be identified and secured. Vegetation, topsoil, and any organic matter should also be removed from within and at least five feet beyond the limits of the proposed building, slab, and pavement areas, as well as any other area that will require controlled structural fill placement. Existing foundations, where encountered, should be removed completely from below building foundations and site appurtenances, within two feet of the proposed finished grade below pavement, and deeper where in conflict with utilities. The contractor should be required to conduct earthwork in accordance with the recommendations in this report, including backfilling any excavation, etc. with structural fill. Fill or backfill placed within the proposed building and slab areas should be placed as structural fill in accordance with Section 5.2 and 5.3 of this report.

Surface Preparation/Proofrolling: Prior to placing fill or base materials to raise or restore grades to the desired subgrade elevations, the existing exposed soils should be compacted to a firm surface with several passes in two perpendicular directions of a minimum 10-ton vibratory roller. The surface should then be proofrolled with a loaded tandem axle truck in the presence of the geotechnical engineer to help identify soft or loose pockets that may require removal and replacement or further investigation. Proofrolling should be conducted after a suitable period of dry and non-freezing weather to reduce the likelihood of degrading an otherwise stable subgrade. If construction is started during the winter months, Whitestone should be contacted for alternate surface preparation procedures. Fill or backfill should be placed and compacted in accordance with Section 5.3.

Weather Performance Criteria: The site soils are moisture sensitive and will soften when exposed to water, every effort should be made to maintain drainage of surface water runoff away from construction areas by grading and limiting the exposure of excavations and prepared subgrades to rainfall. Accordingly, excavation and fill placement procedures should be conducted during favorable weather

conditions. Overexcavation of wet or disturbed soils and replacement with controlled structural fill per Section 5.3 of this report may be required prior to resuming work on subgrade soils.

Subgrade Protection and Maintenance: The site soils are moisture sensitive and will degrade if exposed to inclement weather, freeze-thaw cycles, or repeated construction traffic. However, if properly protected and maintained as recommended herein, the site soils will provide adequate support for the proposed construction. The site contractors should employ appropriate means and methods to protect the subgrade including, but not limited to the following:

- ▶ sealing exposed subgrade soils on a daily basis with a smooth drum roller operated in static mode;
- ▶ regrading the site as needed to maintain positive drainage away from open earthwork construction areas and to prevent standing water;
- ▶ removing wet surficial soils and ruts immediately; and
- ▶ limiting exposure to construction traffic and precipitation especially following inclement weather and subgrade thawing.

5.3 STRUCTURAL FILL AND BACKFILL

Imported Fill Material: Imported material placed as structural fill or backfill to raise elevations or restore design grades should consist of clean, relatively well graded sand or gravel with a maximum particle size of three inches and up to 15 percent of material finer than a #200 sieve. Imported material should be free of silt, clay, organics, and deleterious material.

On-Site Material/Reuse: Whitestone anticipates that portions of the glacial till and existing fill will generally be suitable for selective reuse as structural fill/backfill material, provided that soil moisture contents are controlled within three percent of optimum moisture level, particles larger than three inches in diameter are either removed or crushed, and objectionable portions, such as organics if encountered, are segregated. The glacial till has a relatively high fines content and may require drying and/or mixing with more granular material before reuse. In addition, reuse of the glacial till should not be attempted during inclement weather or in damp conditions. Immediate reuse of the glacial till should not be expected. Reuse of the site soils will be contingent on careful review in the field by the owner's geotechnical engineer by visual observation during construction as recommended herein.

Compaction and Placement Requirements: Fill and backfill should be placed in maximum eight-inch loose lifts and compacted using a vibratory drum roller during mass grading activities or a small hand-held vibratory compactor within excavations. Structural fill and backfill should be compacted to at least 95 percent of the maximum dry density within three percent of the optimum moisture content, as determined by ASTM D1557 (Modified Proctor).

Structural Fill Testing: A sample of the imported fill material or on-site material proposed for re-use as structural fill or backfill should be submitted to the owner's geotechnical engineer for analysis and approval at least one week prior to its use. The placement of fill and backfill should be monitored by a

qualified engineering technician, so that the specified material and lift thicknesses are properly installed. A sufficient number of in-place density tests should be conducted to check that the specified compaction is achieved throughout the height of the fill or backfill.

5.4 GROUNDWATER CONTROL

Static groundwater was encountered during this investigation at depths that are unlikely to impact excavation for foundations or utility installation. However, perched/trapped water, which was observed at a depth of two fbg's in two borings, may be encountered above non-permeable strata elsewhere on the site during construction. As such, construction phase dewatering will likely consist of removing surface water runoff, infiltrating water, or trapped water at this site. Whitestone anticipates that construction phase dewatering, if required, would include installing temporary sump pits and filtered pumps within trenches and excavations.

Proper grading and drainage should be incorporated into the site design and construction phase grading to discourage ponding of surface runoff. Every effort should be made to maintain drainage of surface runoff away from construction areas by grading. The contractor should limit exposure of excavations and prepared subgrades to rainfall. Overexcavation of wet soils and replacement with controlled structural fill per Section 5.3 of this report may be required prior to resuming work on disturbed subgrade soils.

5.5 FOUNDATIONS

Shallow Foundation Design Criteria: Whitestone considers that the proposed structure may be supported on conventional spread and continuous wall footings designed to bear on the natural glacial till, after thorough surface compaction, or structural fill placed on the glacial till, provided these materials are properly evaluated, placed, and compacted in accordance with Sections 5.2, 5.3, and 5.11 of this report. Existing fill was encountered in two borings to a depth of two fbg's. Subsoil with roots was encountered up to 2.5 fbg's. However, deeper existing fill/subsoil may be encountered between the widely spaced borings. Overexcavation of existing fill/subsoil and replacement with structural fill may be required under footings within a portion of the proposed building footprint. Following in-trench compaction of foundation subgrades, foundations bearing within these materials may be designed to impart a maximum net allowable bearing pressure of 3,000 pounds per square foot.

Foundation subgrades should be compacted in the presence of the geotechnical engineer to densify loose upper soils and disturbed soils. Regardless of loading conditions, new foundations should be sized no less than minimum dimensions of 24 inches for continuous wall footings and 36 inches for isolated column footings.

Footings should be designed such that the maximum toe pressure due to the combined effect of vertical loads (including soil weight) and overturning moment does not exceed the recommended maximum allowable bearing pressure. In addition, positive contact pressure should be maintained throughout the

base of the footings, such that no uplift or tension exists between the base of the footings and the supporting soil. Uplift loads should be resisted by the weight of the concrete footing and the weight of the soil above the footing. Side friction should be neglected when proportioning the footings, so that lateral resistance is provided by friction resistance at the base of the footings. A coefficient of friction against sliding of 0.4 is recommended for use in the design of the foundations bearing within the site soils or imported structural fill.

Foundation Inspection/Overexcavation Criteria: Whitestone recommends that the suitability of the bearing materials along new footing bottoms be reviewed by a Whitestone geotechnical engineer prior to placing concrete for the footings. Following review by the owner's geotechnical engineer, the exposed subgrade may be compacted. Special attention should be given to areas of the site underlain by any soft/loose conditions. In the event that isolated areas of unsuitable materials are encountered in footing excavations, overexcavation and replacement of the materials or deeper foundation embedment may be necessary to provide a suitable footing subgrade. Overexcavation to be restored with structural fill will need to extend at least one foot laterally beyond footing edges for each vertical foot of overexcavation. Lateral overexcavation may be eliminated if grade is restored with lean concrete.

Settlement: Whitestone estimates post-construction settlements of building foundations will be on the order of less than one inch, if the recommendations outlined in this report are properly implemented. Differential settlements of building foundations should be less than 0.5-inch.

Frost Coverage: Footings subject to frost action should be placed at least 40 inches below adjacent exterior grades, in accordance with the Rhode Island *State Building Code*, to provide protection from frost penetration. Interior footings not subject to frost action may be placed at a minimum depth of 18 inches below the slab subgrade, but should not be placed on existing fill.

5.6 SLABS

Following surficial compaction and proofrolling to densify any upper loose zones, Whitestone anticipates that inspected, approved glacial till or existing fill, and/or compacted structural fill will be suitable for support of the proposed slab provided these materials are properly compacted and proofrolled in accordance with Sections 5.2, 5.3, and 5.11 of this report during favorable weather conditions. Areas of overexcavation should be anticipated if the subgrades are exposed to precipitation. Areas of soil that are, or become, softened or disturbed as a result of wetting and/or repeated exposure to construction traffic should be removed and replaced with compacted structural fill. The properly prepared on-site soils are expected to yield a minimum subgrade modulus (k) of 150 psi/in.

A minimum 12-inch thick layer of RIDOT *304.02 Select Leveling & Filler Aggregate* (or approved equivalent) should be placed below slabs to provide a uniform granular base. If a slab has a moisture-

sensitive covering and/or supports moisture-sensitive equipment, a moisture vapor barrier should be installed beneath the slab in accordance with flooring manufacturer’s recommendations.

5.7 PAVEMENT DESIGN CRITERIA

General: Ideally, existing fill would be removed from below proposed pavements, however, this is likely not cost effective and may not be necessary provided the owner is able to accept some risk of pavement settlement. Whitestone anticipates that the properly inspected, approved, and improved existing fill (after thorough surface compaction), glacial till, and/or compacted structural fill and/or backfill placed to raise or restore design elevations will be suitable for support of the proposed pavements, provided these materials are properly evaluated, compacted, and proofrolled in accordance with Sections 5.2, 5.3, and 5.11 of this report during favorable weather conditions. However, there is some risk of increased maintenance unless all the underlying existing fill materials are removed under pavement areas. If existing fill is left in place, Whitestone anticipates that shimming to re-level the asphaltic concrete surface will be required during the design life of the pavement.

Design Criteria: A California Bearing Ratio value of eight has been assigned to the properly prepared subgrade soils for pavement design purposes. This value was correlated with pertinent soil support values and assumed traffic loads to prepare flexible and rigid pavement designs per the AASHTO *Guide for the Design of Pavement Structures*.

Design traffic loads were assumed based on typical volumes for similar facilities and correlated with 18-kip equivalent single axle loads (ESAL) for a 20-year life. Estimated maximum pavement loads of 15,000 ESALs and 75,000 ESALs were used for the standard-duty and heavy-duty pavement areas, respectively. These values assume the pavements primarily will accommodate both automobile and limited heavier truck traffic, with the heavier truck traffic designated to the main drive lanes. Actual loading experienced is anticipated to be less than these values.

Pavement Sections: Pavement components should meet material specifications from RIDOT *Standard Specifications* specified below. The recommended flexible pavement sections are tabulated below:

FLEXIBLE PAVEMENT SECTION			
Layer	Material	Standard-Duty Thickness (inches)	Heavy-Duty Thickness (inches)
Asphalt Surface Course	RIDOT M.03.02 Class I-1; PG 64-28	1.5	1.5
Asphalt Binder Course	RIDOT M.03.02 Binder Course; PG 64-28	1.5	2.5
Granular Base	RIDOT 304.02 Select Leveling & Filler Aggregate	6.0	6.0

FLEXIBLE PAVEMENT SECTION			
Layer	Material	Standard-Duty Thickness (inches)	Heavy-Duty Thickness (inches)
Granular Subbase	RIDOT M.01.02.1 Bank Run or Plant-Processed Sand and Gravel; M.01.09, Table I, Column Ia	6.0	6.0

A rigid concrete pavement should be used to provide suitable support at areas of high traffic or severe turns, such as ingress/egress locations and at the trash enclosure. The recommended rigid pavement is tabulated below:

RIGID PAVEMENT SECTION		
Layer	Material	Thickness (inches)
Surface	4,000 psi Air-Entrained Concrete	6.0 ¹
Granular Base	RIDOT 304.02 Select Leveling & Filler Aggregate	6.0
Granular Subbase	RIDOT M.01.02.1 Bank Run or Plant-Processed Sand and Gravel; M.01.09, Table I, Column Ia	6.0

¹ The outer edges of concrete pavements are susceptible to damage as trucks move from rigid pavement to adjacent flexible pavement. Therefore, the thickness at the outer two feet of the rigid concrete pavement should be 12 inches. The concrete should be reinforced with at least one layer of six-inch by six-inch W5.4/W5.4 welded wire fabric (ASTM A185).

Additional Design Considerations: The pavement section thickness designs presented in this report are based on the design parameters detailed herein and are contingent on proper construction, inspection, and maintenance. Additional pavement thickness may be required by local code. The designs are contingent on achieving the minimum soil support value in the field. To accomplish this requirement, subgrade soil and supporting fill or backfill must be placed, compacted, and evaluated in accordance with Sections 5.2, 5.3, and 5.11 of this report. Proper drainage should be provided for the pavement structure, including appropriate grading and surface water control.

The performance of the pavement also will depend on the quality of materials and workmanship. Whitestone recommends that RIDOT standards for materials, workmanship, and maintenance be applied to this site. Project specifications should include verifying that the installed asphaltic concrete material composition is within tolerance for the specified materials and that the percentage of air voids of the installed pavement is within specified ranges for the respective materials. Rigid concrete pavements should be suitably air-entrained, jointed, and reinforced in general accordance with ACI 330R-08 *Guide for the Design and Construction of Concrete Parking Lots*.

5.8 RETAINING WALLS/LATERAL EARTH PRESSURES

General: The following parameters may be used for design of any below-grade walls, retaining walls, and other structures reliant on granular materials to provide adequate drainage.

Lateral Earth Pressures: Retaining/below-grade walls should be capable of withstanding active and at-rest earth pressures. With an active earth pressure coefficient (K_a) of 0.33, a level backfill, and an assumed maximum backfill soil unit weight of 140 pounds per cubic foot (pcf), an equivalent fluid pressure of 46 psf per foot of wall height should be used in design of retaining/below-grade walls which are free to rotate.

Retaining/below-grade walls and wall corners that are restrained from lateral movement should be designed using at-rest earth pressures. A coefficient of at-rest earth pressure (K_o) of 0.5, for a level backfill, is recommended for retaining/below-grade walls designed to resist at-rest earth pressures, which assume no lateral movement. With an assumed maximum total unit weight of backfill of approximately 140 pcf, an equivalent fluid pressure of 70 pounds per square foot per foot of wall height should be used in design of restrained retaining/below-grade wall and wall corners. A coefficient of friction of 0.4 against sliding can be used for concrete on the existing site soils. Additional lateral earth pressures from a sloped backfill or any temporary or long-term surcharge loads also should be included in the design. Retaining wall design should include a global stability analysis.

Backfill Criteria: Whitestone recommends that granular soils be used to backfill behind retaining walls. The granular backfill materials should consist of clean, relatively well graded sand or gravel.

Whitestone recommends that backfill directly behind any walls be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within a zone of influence measured at a 45-degree angle from the base of the walls during backfilling to avoid developing excessive temporary or long-term lateral soil pressures.

Positive drainage should be provided at the base of the below-grade walls. Where wall drainage is not provided, the wall should be designed to withstand full hydrostatic pressure.

Whitestone should be notified if any other retaining structures or design considerations requiring lateral earth pressure estimations are proposed. Specific recommendations for temporary retaining structures are beyond Whitestone's scope of work.

5.9 SEISMIC AND LIQUEFACTION CONSIDERATIONS

The subsurface conditions are most consistent with a Site Class D, as defined by the *State of Rhode Island Building Code*. The site soils are not susceptible to earthquake induced liquefaction.

5.10 EXCAVATIONS

The existing fill and glacial till encountered during this investigation typically are, at a minimum, consistent with Type C Soil Conditions as defined by 29 CFR Part 991-9956 (OSHA) that require a maximum unbraced excavation angle of 1.5:1 (horizontal: vertical). Actual conditions encountered during construction should be evaluated by a competent person (as defined by OSHA), so that safe excavation methods and/or shoring and bracing requirements are implemented.

5.11 SUPPLEMENTAL POST INVESTIGATION SERVICES

Construction Phase Evaluation of Existing Fill: Whitestone recommends further reviewing the condition of the site soils for pavement and site appurtenance support, and/or re-use as structural fill by means of supplemental test pit evaluation either prior to or during the early stages of construction to further explore former basement areas and to identify areas requiring removal and possible uncontrolled conditions or deleterious materials not disclosed by the soil borings conducted during this exploration.

Construction Inspection and Monitoring: Earthwork inspections, testing, and consultation should be conducted during construction as described in previous sections of this report. Monitoring and testing should also be conducted to confirm that any encountered underground structures, such as the foundations of the razed buildings, are properly backfilled, the existing surface cover materials are properly removed, and suitable materials, used for controlled fill, are properly placed and compacted over suitable subgrade soils. Overexcavation of any existing fill materials beneath proposed foundations and proofrolling of all subgrades prior to foundation, slab, and pavement support should be witnessed and documented by the owner's geotechnical engineer to confirm earthwork is conducted in accordance with the recommendations herein.

SECTION 6.0

General Comments

Supplemental recommendations may be required upon finalization of construction plans or if significant changes are made in the characteristics or location of the proposed structure. Soil bearing conditions should be checked at the appropriate time for consistency with those conditions encountered during Whitestone's geotechnical investigation.

The recommendations presented herein should be utilized by a qualified engineer in preparing the project plans and specifications. The engineer should consider these recommendations as minimum physical standards which may be superseded by local and regional building codes and structural considerations. These recommendations are prepared for the sole use of Sevan Multi-Site Solutions for the specific project detailed and should not be used by any third party. These recommendations are relevant to the design phase and should not be substituted for construction specifications.

The possibility exists that conditions between borings may differ from those at specific test locations, and conditions may not be as anticipated by the designers or contractors. In addition, the construction process may alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered.

Whitestone assumes that a qualified contractor will be employed to conduct the construction work, and that the contractor will be required to exercise care to ensure all excavations are conducted in accordance with applicable regulations and good practice. Particular attention should be paid to avoiding damaging or undermining adjacent properties and maintaining slope stability.

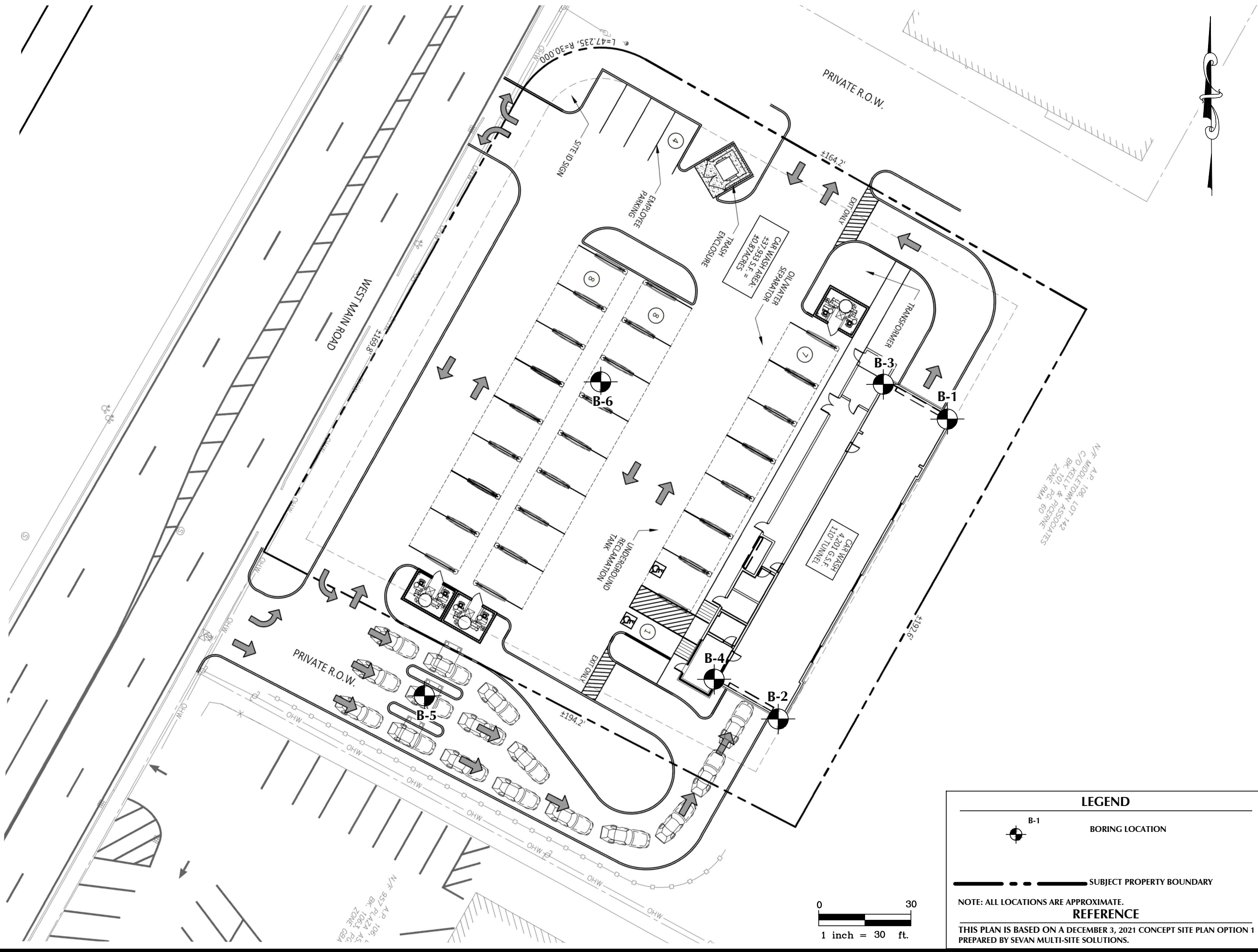
Whitestone recommends that the services of the geotechnical engineer be engaged to test and evaluate the soils in the footing excavations prior to concreting in order to determine that the soils will support the bearing capacities. Monitoring and testing also should be conducted to verify that suitable materials are used for controlled fills and that they are properly placed and compacted over suitable subgrade soils.

The exploration and analysis of the foundation conditions reported herein are considered sufficient in detail and scope to form a reasonable basis for the foundation design. The recommendations submitted for the proposed construction are based on the available soil information and the design details furnished by Sevan Multi-Site Solutions. Deviations from the noted subsurface conditions encountered during construction should be brought to the attention of the geotechnical engineer.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been promulgated after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics, and engineering geology. No other warranties, express or implied, are made.

FIGURE 1
Boring Location Plan

N:\Job Folders\2022\2218968GM\Drawings and Plans\CAD\GM2218968.000.dwg



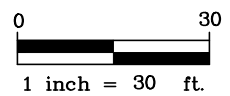
LEGEND

B-1
BORING LOCATION

SUBJECT PROPERTY BOUNDARY

NOTE: ALL LOCATIONS ARE APPROXIMATE.
REFERENCE

THIS PLAN IS BASED ON A DECEMBER 3, 2021 CONCEPT SITE PLAN OPTION 1 PREPARED BY SEVAN MULTI-SITE SOLUTIONS.



WHITESTONE
An Employee-Owned Company

16 OLD FORGE ROAD, SUITE A, ROCKY HILL, CT 06067
860.726.7889 WHITESTONEASSOC.COM



DRAWING TITLE: BORING LOCATION PLAN	
CLIENT: SEVAN MULTI-SITE SOLUTIONS	
PROJECT: PROPOSED WASHVILLE CARWASH 991-995 WEST MAIN ROAD MIDDLETOWN, NEWPORT COUNTY, RHODE ISLAND	

PROJECT #: GM2218968.000	
DESIGNED BY: MR	PROJ. MGR.: RR
DATE: 4/26/22	FIGURE: 1
SCALE: 1" = 30'	

APPENDIX A
Records of Subsurface Exploration

RECORD OF SUBSURFACE EXPLORATION

Project: Proposed Washville Car Wash		WAI Project No.: GM2218968.000	
Location: 991-995 West Main Road, Middletown, Newport County, Rhode Island		Client: Sevan Multi-Site Solutions	
Surface Elevation: ± NS feet above NAVD88	Date Started: 4/12/2022	Water Depth Elevation (feet bgs) (ft NAVD88)	Cave-In Depth Elevation (feet bgs) (ft NAVD88)
Termination Depth: 17.0 feet bgs	Date Completed: 4/12/2022	During: 14.0 -- ▾	At Completion: -- -- ▾
Proposed Location: Building	Logged By: RK	24 Hours: -- -- ▾	At Completion: -- -- ▾
Drill / Test Method: HSA / SPT	Contractor: DE		24 Hours: -- -- ▾
	Equipment: CME 55		

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
						0.0			
0 - 2	S-1	X	3 - 3 - 4 - 9	14	7		TS 	12" Topsoil	
							SUBSOIL 	6" Subsoil, Roots	
2 - 4	S-2	X	11 - 15 - 15 - 17	20	30			Gray-Brown, Medium Dense to Dense, Silty Sand with Gravel (SM)	
						5.0		As Above (SM)	
5 - 7	S-3	X	9 - 8 - 8 - 9	20	16			As Above (SM)	
7 - 9	S-4	X	9 - 9 - 9 - 9	20	18			As Above (SM)	
						10.0	GLACIAL TILL		
10 - 12	S-5	X	6 - 8 - 9 - 9	20	17			As Above (SM)	
						15.0			
15 - 17	S-6	X	11 - 13 - 13 - 14	14	26			As Above (SM)	
						20.0			
						25.0			
								Boring Log B-1 Terminated at Depth of 17 feet below ground surface.	

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

RECORD OF SUBSURFACE EXPLORATION

Project: Proposed Washville Car Wash		WAI Project No.: GM2218968.000	
Location: 991-995 West Main Road, Middletown, Newport County, Rhode Island		Client: Sevan Multi-Site Solutions	
Surface Elevation: ± NS feet above NAVD88	Date Started: 4/12/2022	Water Depth Elevation (feet bgs) (ft NAVD88)	Cave-In Depth Elevation (feet bgs) (ft NAVD88)
Termination Depth: 17.0 feet bgs	Date Completed: 4/12/2022	During: 14.5 -- ▾	At Completion: -- -- ▾
Proposed Location: Building	Logged By: RK	24 Hours: -- -- ▾	At Completion: -- -- ▾
Drill / Test Method: HSA / SPT	Contractor: DE		24 Hours: -- -- ▾
	Equipment: CME 55		

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
						0.0			
0 - 2	S-1	X	3 - 2 - 6 - 7	18	8		TS	3" Topsoil	
							SUBSOIL	8" Subsoil, Roots	
							EXISTING FILL	Brown, Loose, Silty Sand with Gravel (FILL)	
2 - 4	S-2	X	10 - 11 - 10 - 11	18	21				
5 - 7	S-3	X	7 - 11 - 16 - 20	18	27			As Above (SM)	
7 - 9	S-4	X	15 - 10 - 11 - 12	16	21			As Above (SM)	
							GLACIAL TILL		
10 - 12	S-5	X	10 - 9 - 10 - 12	20	19			As Above (SM)	
15 - 17	S-6	X	8 - 13 - 14 - 12	20	27			As Above (SM)	
								Boring Log B-2 Terminated at Depth of 17 feet below ground surface.	
						20.0			
						25.0			

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

RECORD OF SUBSURFACE EXPLORATION

Project: Proposed Washville Car Wash		WAI Project No.: GM2218968.000	
Location: 991-995 West Main Road, Middletown, Newport County, Rhode Island		Client: Sevan Multi-Site Solutions	
Surface Elevation: ± NS feet above NAVD88	Date Started: 4/12/2022	Water Depth Elevation (feet bgs) (ft NAVD88)	Cave-In Depth Elevation (feet bgs) (ft NAVD88)
Termination Depth: 17.0 feet bgs	Date Completed: 4/12/2022	During: 15.0 -- ▼	At Completion: -- -- ▼
Proposed Location: Building	Logged By: RK	24 Hours: -- -- ▼	At Completion: -- -- ▼
Drill / Test Method: HSA / SPT	Contractor: DE		24 Hours: -- -- ▼
	Equipment: CME 55		

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
0 - 2	S-1	X	7 - 4 - 2 - 8	8	6	0.0	TS	2" Topsoil	
							SUBSOIL	10" Subsoil, Roots	
						2.0	EXISTING FILL	Brown, Loose, Silty Sand with Gravel (FILL)	
2 - 4	S-2	X	12 - 13 - 11 - 12	14	24			Gray-Brown, Medium Dense, Silty Sand with Gravel (SM)	
5 - 7	S-3	X	8 - 9 - 8 - 8	16	17			As Above (SM)	
7 - 9	S-4	X	10 - 8 - 10 - 9	12	18			As Above (SM)	
						10.0	GLACIAL TILL		
10 - 12	S-5	X	8 - 9 - 11 - 11	20	20			As Above (SM)	
						15.0			
15 - 17	S-6	X	12 - 15 - 16 - 15	18	31			As Above, Dense (SM)	
								Boring Log B-3 Terminated at Depth of 17 feet below ground surface.	
						20.0			
						25.0			

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

RECORD OF SUBSURFACE EXPLORATION

Project: Proposed Washville Car Wash		WAI Project No.: GM2218968.000	
Location: 991-995 West Main Road, Middletown, Newport County, Rhode Island		Client: Sevan Multi-Site Solutions	
Surface Elevation: ± NS feet above NAVD88	Date Started: 4/12/2022	Water Depth Elevation (feet bgs) (ft NAVD88)	Cave-In Depth Elevation (feet bgs) (ft NAVD88)
Termination Depth: 17.0 feet bgs	Date Completed: 4/12/2022	During: 14.0 -- ▾	At Completion: -- -- ▾
Proposed Location: Building	Logged By: RK	24 Hours: -- -- ▾	At Completion: -- -- ▾
Drill / Test Method: HSA / SPT	Contractor: DE		24 Hours: -- -- ▾
	Equipment: CME 55		

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
0 - 2	S-1	X	1 - 2 - 2 - 3	14	4	0.0	TS	12" Topsoil	
							SUBSOIL	18" Subsoil, Roots	
2 - 4	S-2	X	3 - 7 - 7 - 7	16	14			Gray-Brown, Medium Dense, Silty Sand with Gravel (SM)	
						5.0		As Above (SM)	
5 - 7	S-3	X	8 - 9 - 10 - 12	16	19			As Above (SM)	
7 - 9	S-4	X	9 - 12 - 13 - 14	16	25			As Above (SM)	
						10.0	GLACIAL TILL		
10 - 12	S-5	X	11 - 13 - 18 - 28	18	31			As Above, Dense (SM)	
						15.0			
15 - 17	S-6	X	14 - 18 - 22 - 27	18	40			As Above (SM)	
						20.0			
						25.0			
								Boring Log B-4 Terminated at Depth of 17 feet below ground surface.	

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

RECORD OF SUBSURFACE EXPLORATION








Project: Proposed Washville Car Wash		WAI Project No.: GM2218968.000	
Location: 991-995 West Main Road, Middletown, Newport County, Rhode Island		Client: Sevan Multi-Site Solutions	
Surface Elevation: ± NS feet above NAVD88	Date Started: 4/12/2022	Water Depth Elevation (feet bgs) (ft NAVD88)	Cave-In Depth Elevation (feet bgs) (ft NAVD88)
Termination Depth: 6.9 feet bgs	Date Completed: 4/12/2022	During: 2.0 (P) --	At Completion: -- --
Proposed Location: Building	Logged By: RK	24 Hours: -- --	At Completion: -- --
Drill / Test Method: HSA / SPT	Contractor: DE		24 Hours: -- --
	Equipment: CME 55		

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
						0.0			
0 - 2	S-1	X	5 - 4 - 3 - 3	12	7		TS	12" Topsoil	
							▽	SUBSOIL	18" Subsoil, Roots
2 - 4	S-2	X	9 - 14 - 18 - 21	18	32			Gray-Brown, Dense, Silty Sand with Gravel (SM)	Perched water observed
						5.0	GLACIAL TILL	As Above, Very Dense (SM)	
5 - 6.9	S-3	X	24 - 38 - 46 - 50/5"	12	84				Cobbles
Boring Log B-5 Terminated at Depth of 6.9 feet below ground surface.									
						10.0			
						15.0			
						20.0			
						25.0			

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

RECORD OF SUBSURFACE EXPLORATION

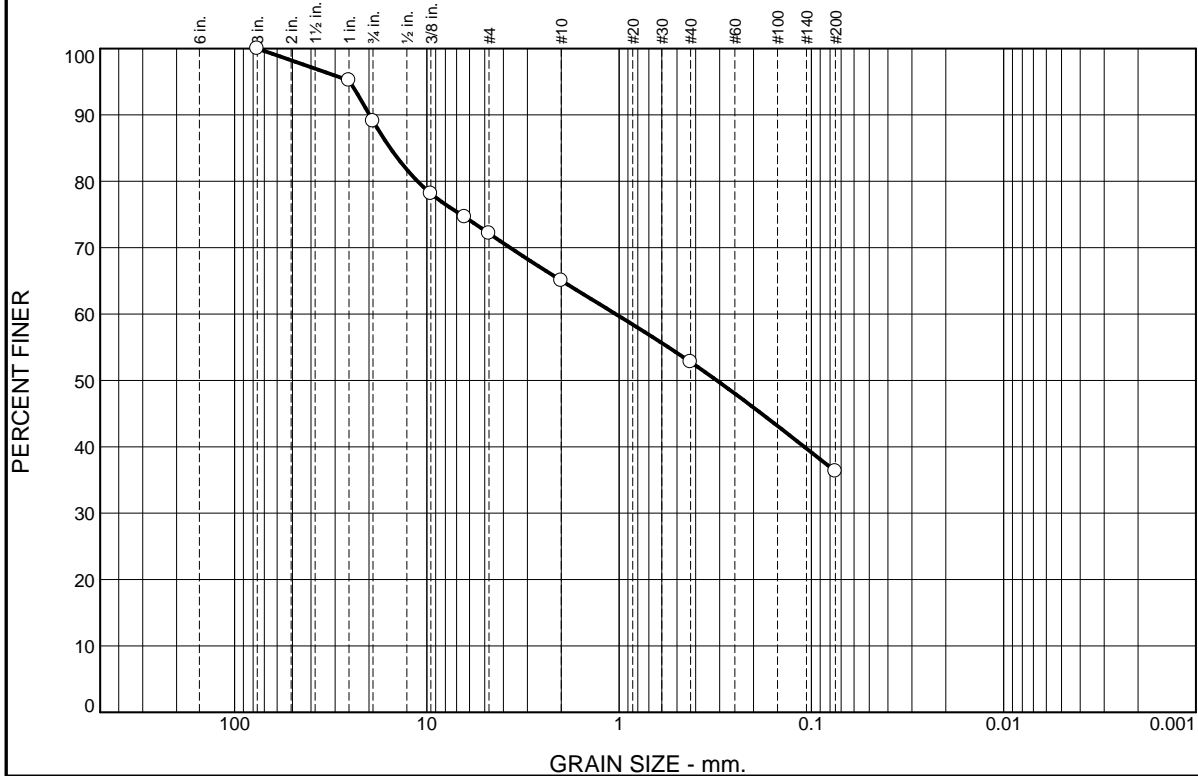
Project: Proposed Washville Car Wash		WAI Project No.: GM2218968.000	
Location: 991-995 West Main Road, Middletown, Newport County, Rhode Island		Client: Sevan Multi-Site Solutions	
Surface Elevation: ± <u>NS</u> feet above NAVD88	Date Started: <u>4/12/2022</u>	Water Depth Elevation (feet bgs) (ft NAVD88)	Cave-In Depth Elevation (feet bgs) (ft NAVD88)
Termination Depth: <u>9.0</u> feet bgs	Date Completed: <u>4/12/2022</u>	During: <u>2.0 (P)</u> -- ▾	At Completion: -- -- ▾
Proposed Location: <u>Building</u>	Logged By: <u>RK</u>	24 Hours: -- -- ▾	At Completion: -- -- ▾
Drill / Test Method: <u>HSA / SPT</u>	Contractor: <u>DE</u>		24 Hours: -- -- ▾
	Equipment: <u>CME 55</u>		

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
						0.0			
0 - 2	S-1		5 - 5 - 2 - 2	10	7		TS 	12" Topsoil	Perched water observed
							SUBSOIL 	12" Subsoil, Roots	
2 - 4	S-2		3 - 8 - 9 - 9	16	17			Gray-Brown, Medium Dense, Silty Sand with Gravel (SM)	
						5.0	GLACIAL TILL 	As Above (SM)	
5 - 7	S-3		9 - 12 - 11 - 10	20	23			As Above (SM)	
7 - 9	S-4		18 - 15 - 13 - 12	12	28			As Above (SM)	
						10.0		Boring Log B-6 Terminated at Depth of 9 feet below ground surface.	
						15.0			
						20.0			
						25.0			

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

APPENDIX B
Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.9	17.0	7.0	12.3	16.5	36.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0	100.0	
1"	95.2		
3/4"	89.1		
3/8"	78.1		
1/4"	74.6		
#4	72.1		
#10	65.1		
#40	52.8		
#200	36.3	0.0 - 15.0	X

Material Description

Silty Sand with Gravel

Atterberg Limits

PL= NP LL= NP PI= NV

Coefficients

D₉₀= 19.8780 D₈₅= 15.4888 D₆₀= 1.0416
D₅₀= 0.3104 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Moisture Content = 10.3%
Gradation Unsuitable for Whitestone Structural Fill Spec

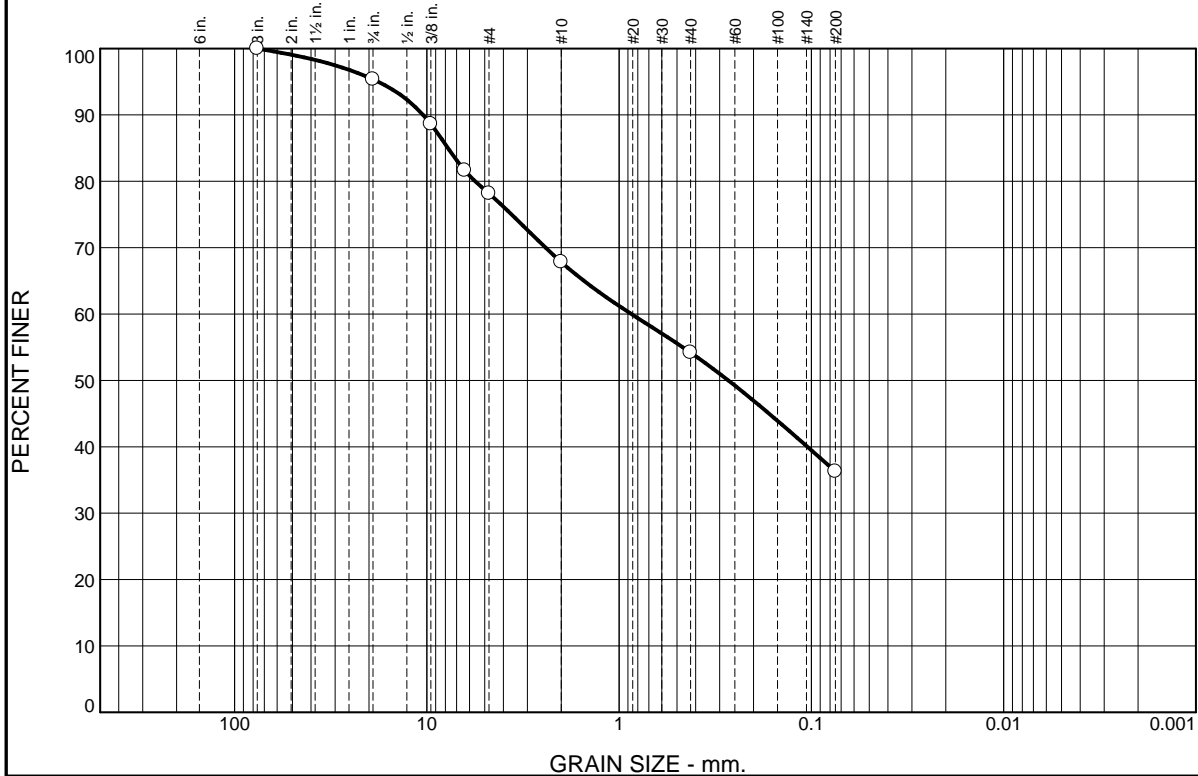
* Whitestone Structural Fill

Location: Boring B-4 **Depth:** 5'-7' **Date:** 4/20/2022
Sample Number: S-3

WHITESTONE	Client: Sevan Multi-Site Solutions
	Project: Proposed Washville Car Wash 991-995 West Main Rd, Middletown, Newport County, RI
	Project No: GM2218968.000 Figure S-2

Tested By: JM **Checked By:** RWM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.6	17.2	10.4	13.6	17.9	36.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0	100.0	
3/4"	95.4		
3/8"	88.6		
1/4"	81.6		
#4	78.2		
#10	67.8		
#40	54.2		
#200	36.3	0.0 - 15.0	X

Material Description

Silty Sand with Gravel

Atterberg Limits

PL= NP LL= NP PI= NV

Coefficients

D₉₀= 10.4547 D₈₅= 7.7564 D₆₀= 0.8624
D₅₀= 0.2705 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Moisture Content = 9.5%
Gradation Unsuitable for Whitestone Structural Fill Spec

* Whitestone Structural Fill

Location: Boring B-1 Depth: 2'-4' Date: 4/20/2022
Sample Number: S-2

WHITESTONE	Client: Sevan Multi-Site Solutions
	Project: Proposed Washville Car Wash 991-995 West Main Rd, Middletown, Newport County, RI
	Project No: GM2218968.000 Figure S-1

Tested By: JM Checked By: RWM

APPENDIX C
Supplemental Information
(USCS, Terms & Symbols)

UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION <u>RETAINED</u> ON NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF MATERIAL IS <u>LARGER</u> THAN NO. 200 SIEVE SIZE	MORE THAN 50% OF COARSE FRACTION <u>PASSING</u> NO. 4 SIEVE	SM	SILTY SANDS, SAND-SILT MIXTURES	
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMITS <u>LESS</u> THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	SILTS AND CLAYS	LIQUID LIMITS <u>GREATER</u> THAN 50	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
	SILTS AND CLAYS	LIQUID LIMITS <u>GREATER</u> THAN 50	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS FOR SAMPLES WITH 5% TO 12% FINES

GRADATION*

% FINER BY WEIGHT

TRACE..... 1% TO 10%
LITTLE..... 10% TO 20%
SOME..... 20% TO 35%
AND..... 35% TO 50%

COMPACTNESS*

Sand and/or Gravel

RELATIVE DENSITY

LOOSE..... 0% TO 40%
MEDIUM DENSE.... 40% TO 70%
DENSE..... 70% TO 90%
VERY DENSE..... 90% TO 100%

CONSISTENCY*

Clay and/or Silt

RANGE OF SHEARING STRENGTH IN POUNDS PER SQUARE FOOT

VERY SOFT..... LESS THAN 250
SOFT..... 250 TO 500
MEDIUM..... 500 TO 1000
STIFF..... 1000 TO 2000
VERY STIFF..... 2000 TO 4000
HARD..... GREATER THAN 4000

* VALUES ARE FROM LABORATORY OR FIELD TEST DATA, WHERE APPLICABLE. WHEN NO TESTING WAS PERFORMED, VALUES ARE ESTIMATED.

L:\Geotechnical Forms and References\Reports\USCSTRMSSYM MA.docx

Other Office Locations:

WARREN, NJ
908.668.7777

CHALFONT, PA
215.712.2700

ROCKY HILL, CT
860.726.7889

WALL, NJ
732.592.2101

PHILADELPHIA, PA
215.848.2323

BEDFORD, NH
603.514.2230

TAMPA, FL
813.851.0690

GEOTECHNICAL TERMS AND SYMBOLS

SAMPLE IDENTIFICATION

The Unified Soil Classification System is used to identify the soil unless otherwise noted.

SOIL PROPERTY SYMBOLS

- N: Standard Penetration Value: Blows per ft. of a 140 lb. hammer falling 30" on a 2" O.D. split-spoon.
 Qu: Unconfined compressive strength, TSF.
 Qp: Penetrometer value, unconfined compressive strength, TSF.
 Mc: Moisture content, %.
 LL: Liquid limit, %.
 PI: Plasticity index, %.
 δd: Natural dry density, PCF.
 ▽: Apparent groundwater level at time noted after completion of boring.

DRILLING AND SAMPLING SYMBOLS

- NE: Not Encountered (Groundwater was not encountered).
 SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
 ST: Shelby Tube - 3" O.D., except where noted.
 AU: Auger Sample.
 OB: Diamond Bit.
 CB: Carbide Bit
 WS: Washed Sample.

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

Term (Non-Cohesive Soils)

Standard Penetration Resistance

Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Term (Cohesive Soils)

Qu (TSF)

Very Soft	0 - 0.25
Soft	0.25 - 0.50
Firm (Medium)	0.50 - 1.00
Stiff	1.00 - 2.00
Very Stiff	2.00 - 4.00
Hard	4.00+

PARTICLE SIZE

Boulders	8 in.+	Coarse Sand	5mm-0.6mm	Silt	0.074mm-0.005mm
Cobbles	8 in.-3 in.	Medium Sand	0.6mm-0.2mm	Clay	-0.005mm
Gravel	3 in.-5mm	Fine Sand	0.2mm-0.074mm		

L:\Geotechnical Forms and References\Reports\USCSTRMSSYM MA.docx

Other Office Locations:

WARREN, NJ
908.668.7777

CHALFONT, PA
215.712.2700

ROCKY HILL, CT
860.726.7889

WALL, NJ
732.592.2101

PHILADELPHIA, PA
215.848.2323

BEDFORD, NH
603.514.2230

TAMPA, FL
813.851.0690



Appendix E
NOAA Local Rainfall Data



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aerials](#)

PF tabular

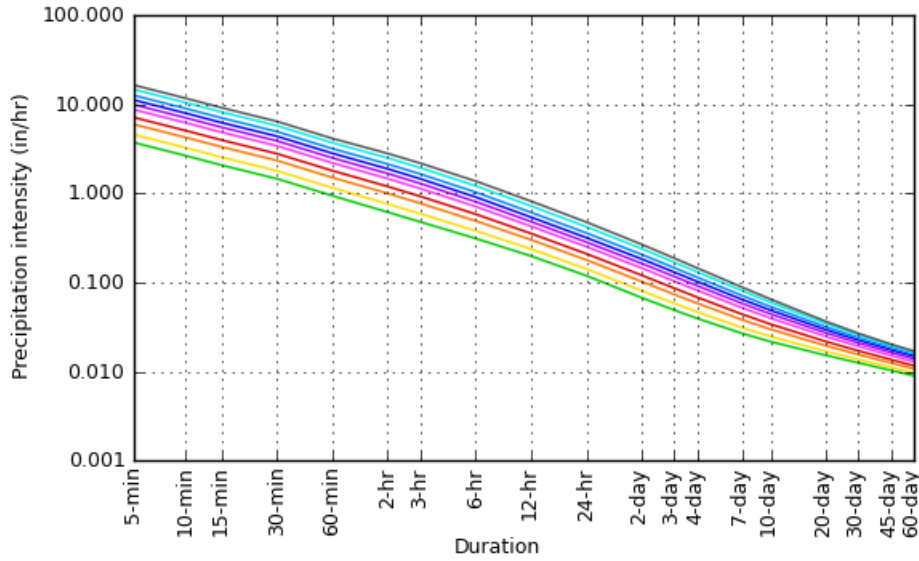
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	3.73 (3.00-4.63)	4.58 (3.67-5.70)	5.98 (4.76-7.45)	7.14 (5.66-8.95)	8.74 (6.68-11.4)	9.94 (7.43-13.2)	11.2 (8.10-15.4)	12.6 (8.58-17.7)	14.7 (9.58-21.3)	16.5 (10.4-24.2)
10-min	2.65 (2.12-3.28)	3.25 (2.60-4.04)	4.24 (3.38-5.29)	5.06 (4.01-6.34)	6.19 (4.73-8.08)	7.04 (5.26-9.37)	7.93 (5.74-10.9)	8.95 (6.08-12.5)	10.4 (6.79-15.1)	11.7 (7.38-17.1)
15-min	2.07 (1.66-2.57)	2.55 (2.04-3.17)	3.32 (2.66-4.14)	3.97 (3.15-4.98)	4.86 (3.71-6.34)	5.52 (4.12-7.34)	6.22 (4.50-8.58)	7.02 (4.77-9.83)	8.18 (5.32-11.8)	9.15 (5.79-13.4)
30-min	1.46 (1.17-1.81)	1.79 (1.44-2.23)	2.34 (1.87-2.91)	2.79 (2.21-3.49)	3.41 (2.61-4.45)	3.88 (2.90-5.16)	4.37 (3.16-6.02)	4.93 (3.35-6.91)	5.75 (3.74-8.30)	6.42 (4.06-9.44)
60-min	0.941 (0.755-1.17)	1.16 (0.926-1.44)	1.51 (1.20-1.88)	1.80 (1.43-2.25)	2.20 (1.68-2.87)	2.50 (1.87-3.33)	2.82 (2.04-3.88)	3.18 (2.16-4.45)	3.70 (2.40-5.34)	4.13 (2.62-6.08)
2-hr	0.616 (0.498-0.760)	0.760 (0.614-0.939)	0.998 (0.802-1.24)	1.19 (0.954-1.49)	1.47 (1.13-1.90)	1.67 (1.26-2.21)	1.88 (1.38-2.58)	2.13 (1.46-2.96)	2.50 (1.64-3.57)	2.80 (1.79-4.07)
3-hr	0.479 (0.388-0.588)	0.591 (0.479-0.727)	0.774 (0.624-0.954)	0.926 (0.742-1.15)	1.14 (0.878-1.47)	1.29 (0.977-1.70)	1.46 (1.07-1.99)	1.65 (1.14-2.28)	1.94 (1.28-2.76)	2.18 (1.40-3.15)
6-hr	0.312 (0.255-0.381)	0.380 (0.310-0.465)	0.492 (0.400-0.603)	0.585 (0.472-0.720)	0.712 (0.556-0.914)	0.807 (0.617-1.06)	0.909 (0.675-1.23)	1.03 (0.716-1.41)	1.22 (0.809-1.71)	1.37 (0.891-1.96)
12-hr	0.198 (0.163-0.240)	0.237 (0.195-0.288)	0.301 (0.246-0.366)	0.354 (0.288-0.433)	0.427 (0.336-0.544)	0.481 (0.371-0.625)	0.540 (0.405-0.727)	0.612 (0.428-0.827)	0.722 (0.485-1.00)	0.817 (0.535-1.15)
24-hr	0.119 (0.099-0.143)	0.142 (0.117-0.171)	0.179 (0.147-0.216)	0.210 (0.172-0.255)	0.252 (0.200-0.318)	0.284 (0.220-0.365)	0.318 (0.240-0.423)	0.359 (0.254-0.480)	0.421 (0.286-0.579)	0.475 (0.314-0.663)
2-day	0.067 (0.056-0.080)	0.081 (0.067-0.096)	0.102 (0.085-0.123)	0.120 (0.099-0.145)	0.145 (0.115-0.181)	0.163 (0.127-0.207)	0.183 (0.139-0.240)	0.206 (0.147-0.272)	0.239 (0.164-0.325)	0.267 (0.179-0.369)
3-day	0.049 (0.041-0.058)	0.058 (0.049-0.069)	0.073 (0.061-0.088)	0.086 (0.071-0.103)	0.104 (0.083-0.129)	0.117 (0.091-0.147)	0.130 (0.099-0.169)	0.146 (0.105-0.192)	0.169 (0.116-0.228)	0.187 (0.126-0.257)
4-day	0.039 (0.033-0.047)	0.047 (0.039-0.055)	0.058 (0.049-0.070)	0.068 (0.057-0.082)	0.082 (0.065-0.101)	0.092 (0.072-0.115)	0.102 (0.078-0.132)	0.114 (0.082-0.149)	0.131 (0.091-0.176)	0.145 (0.098-0.198)
7-day	0.027 (0.023-0.032)	0.031 (0.026-0.037)	0.038 (0.032-0.045)	0.044 (0.037-0.052)	0.052 (0.042-0.064)	0.058 (0.046-0.072)	0.064 (0.049-0.082)	0.071 (0.052-0.093)	0.081 (0.056-0.108)	0.088 (0.060-0.120)
10-day	0.022 (0.018-0.025)	0.025 (0.021-0.029)	0.030 (0.025-0.035)	0.034 (0.028-0.040)	0.040 (0.032-0.048)	0.044 (0.035-0.055)	0.049 (0.037-0.062)	0.053 (0.039-0.069)	0.060 (0.042-0.079)	0.065 (0.044-0.087)
20-day	0.015 (0.013-0.018)	0.017 (0.014-0.020)	0.019 (0.017-0.023)	0.022 (0.018-0.026)	0.025 (0.020-0.030)	0.027 (0.022-0.033)	0.029 (0.023-0.037)	0.032 (0.023-0.040)	0.034 (0.024-0.045)	0.036 (0.025-0.048)
30-day	0.013 (0.011-0.015)	0.014 (0.012-0.016)	0.016 (0.013-0.018)	0.017 (0.014-0.020)	0.019 (0.016-0.023)	0.021 (0.017-0.025)	0.023 (0.017-0.028)	0.024 (0.018-0.030)	0.026 (0.018-0.033)	0.027 (0.019-0.035)
45-day	0.010 (0.009-0.012)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.014 (0.012-0.016)	0.015 (0.012-0.018)	0.016 (0.013-0.020)	0.018 (0.014-0.021)	0.019 (0.014-0.023)	0.020 (0.014-0.025)	0.020 (0.014-0.027)
60-day	0.009 (0.008-0.010)	0.010 (0.008-0.011)	0.011 (0.009-0.012)	0.012 (0.010-0.014)	0.013 (0.011-0.015)	0.014 (0.011-0.017)	0.015 (0.011-0.018)	0.016 (0.012-0.020)	0.016 (0.012-0.021)	0.017 (0.012-0.022)

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

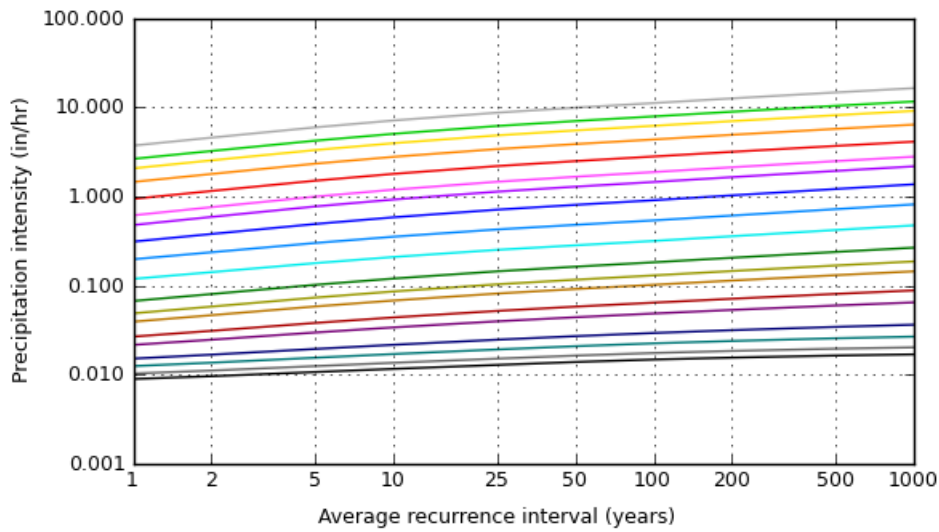
[Back to Top](#)

PF graphical

PDS-based intensity-duration-frequency (IDF) curves
 Latitude: 41.5287°, Longitude: -71.2950°



Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000



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

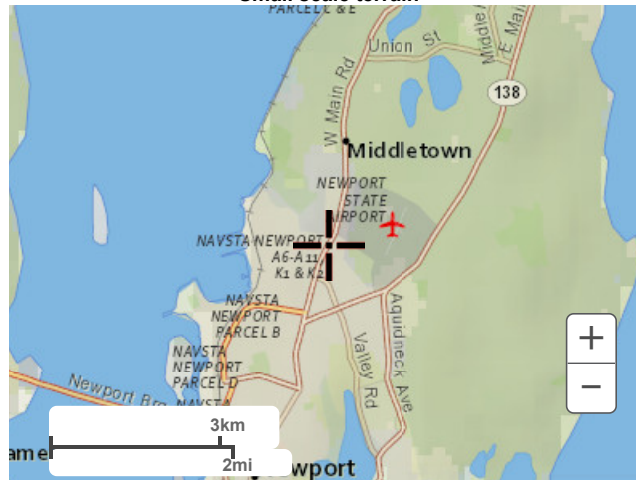
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Thu Mar 17 18:32:04 2022

[Back to Top](#)

Maps & aerials

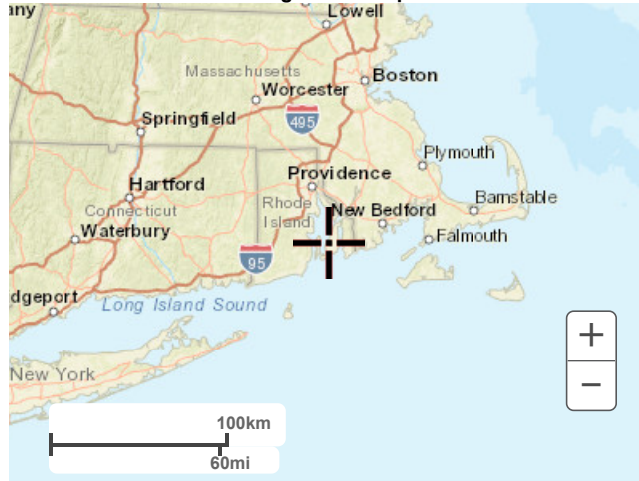
Small scale terrain



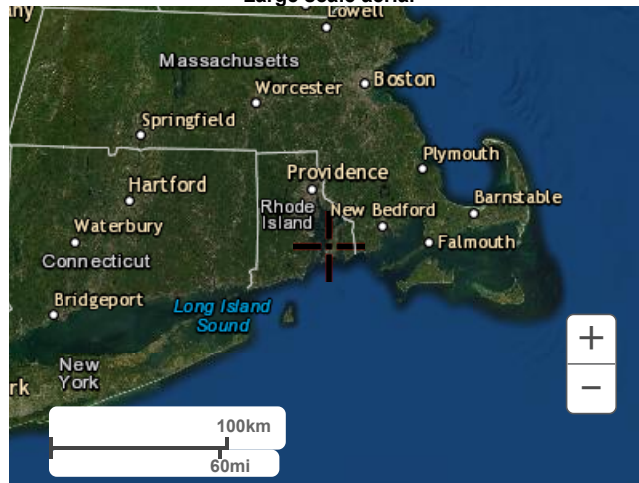
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

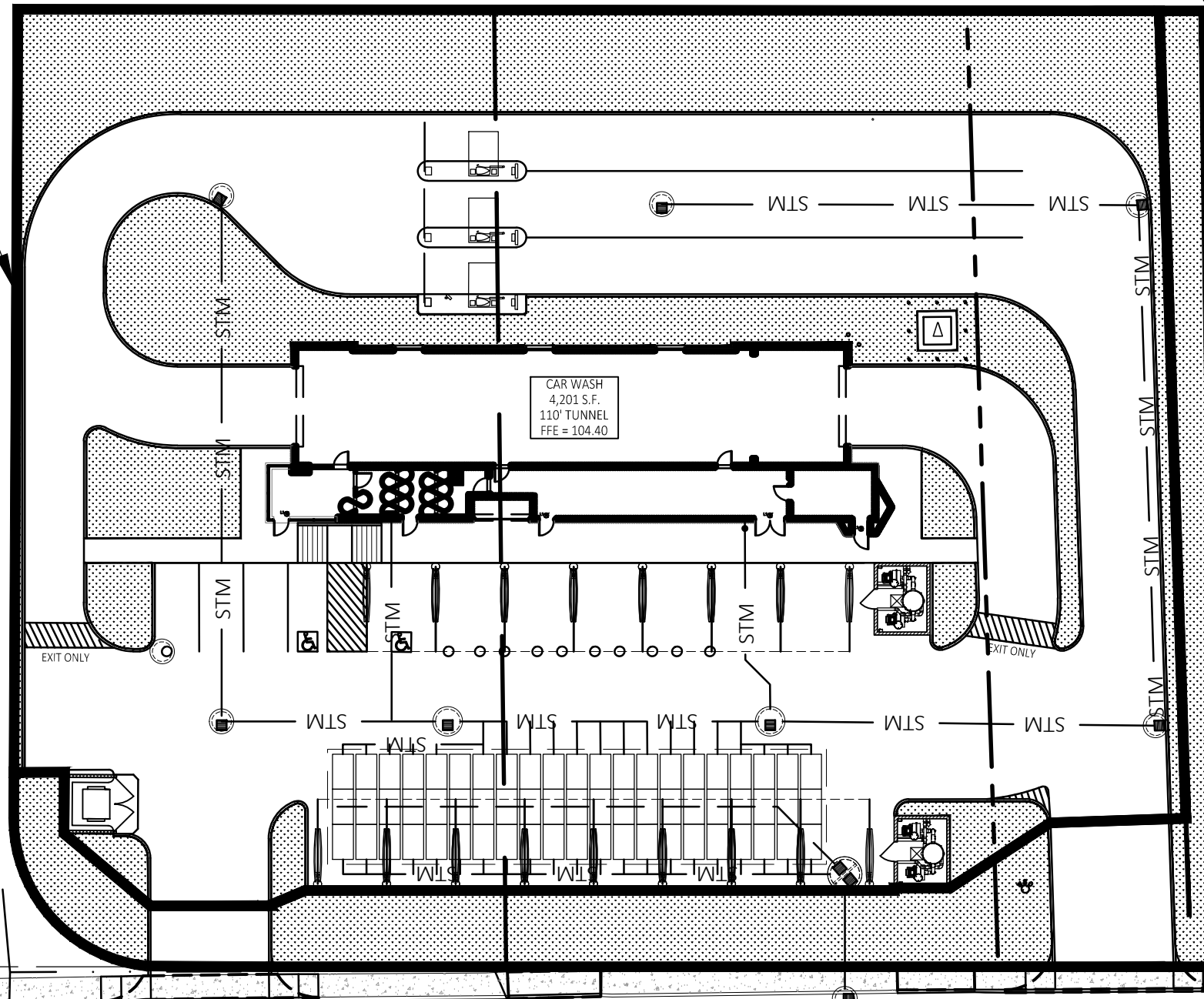
[US Department of Commerce](#)
[National Oceanic and Atmospheric Administration](#)
[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)



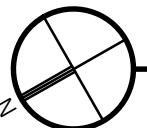
Appendix F
Proposed Drainage Patterns

SUBAREA-PR1	
TOTAL AREA:	0.95 AC
IMPERVIOUS:	0.716 AC
PERVIOUS:	0.234 AC
% IMPERVIOUS:	75.37%
CN VALUE:	92
Tc:	5 MIN.



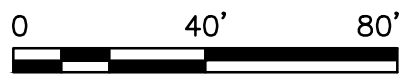
SUBAREA-PUN1	
TOTAL AREA:	0.13 AC
IMPERVIOUS:	0.024 AC
PERVIOUS:	0.106 AC
% IMPERVIOUS:	18.46%
CN VALUE:	78
Tc:	5 MIN.

DESIGN POINT FOR SITE RUNOFF IS EXISTING STORM SEWER ALONG MAIN ROAD.



PROPOSED DRAINAGE PATTERNS

SCALE: 1" = 40'-0"



sevan
ENGINEERING

Regional Office:
37704 Hills Tech Drive
Farmington Hills, MI 48331
734.367.4445 Telephone

Corporate Office:
3025 Highland Parkway, Suite 850
Downers Grove, IL 60515
info@sevansolutions.com www.sevansolutions.com

INTEGRITY | RESPECT | TEAMWORK | EXCELLENCE | CHARITY

CUSTOMER



PROJECT LOCATION

991-995 W. MAIN ROAD
MIDDLETOWN, RI 02842
(NEWPORT COUNTY)

SHEET MANAGEMENT

PROJECT NO.:	MIDDLETOWN
DATE:	06.30.2022
CRITERIA:	
PROJECT MANAGER:	T. KRATZ

THIS DOCUMENT IS AND SHALL REMAIN THE PROPERTY OF SEVAN MULTI-SITE SOLUTIONS, INC.
REPRODUCTION OR ALTERATION OF THIS DOCUMENT WITHOUT THE EXPRESSED WRITTEN PERMISSION OF SEVAN MULTI-SITE SOLUTIONS, INC. IS PROHIBITED.
(NOT PUBLISHED: ALL RIGHTS RESERVED.)
COPYRIGHT BY SEVAN MULTI-SITE SOLUTIONS, INC. 2022

REVISIONS

NO.	DATE	DESCRIPTION

SHEET TITLE

PROPOSED DRAINAGE PATTERNS

SHEET NUMBER

PDP



Appendix G

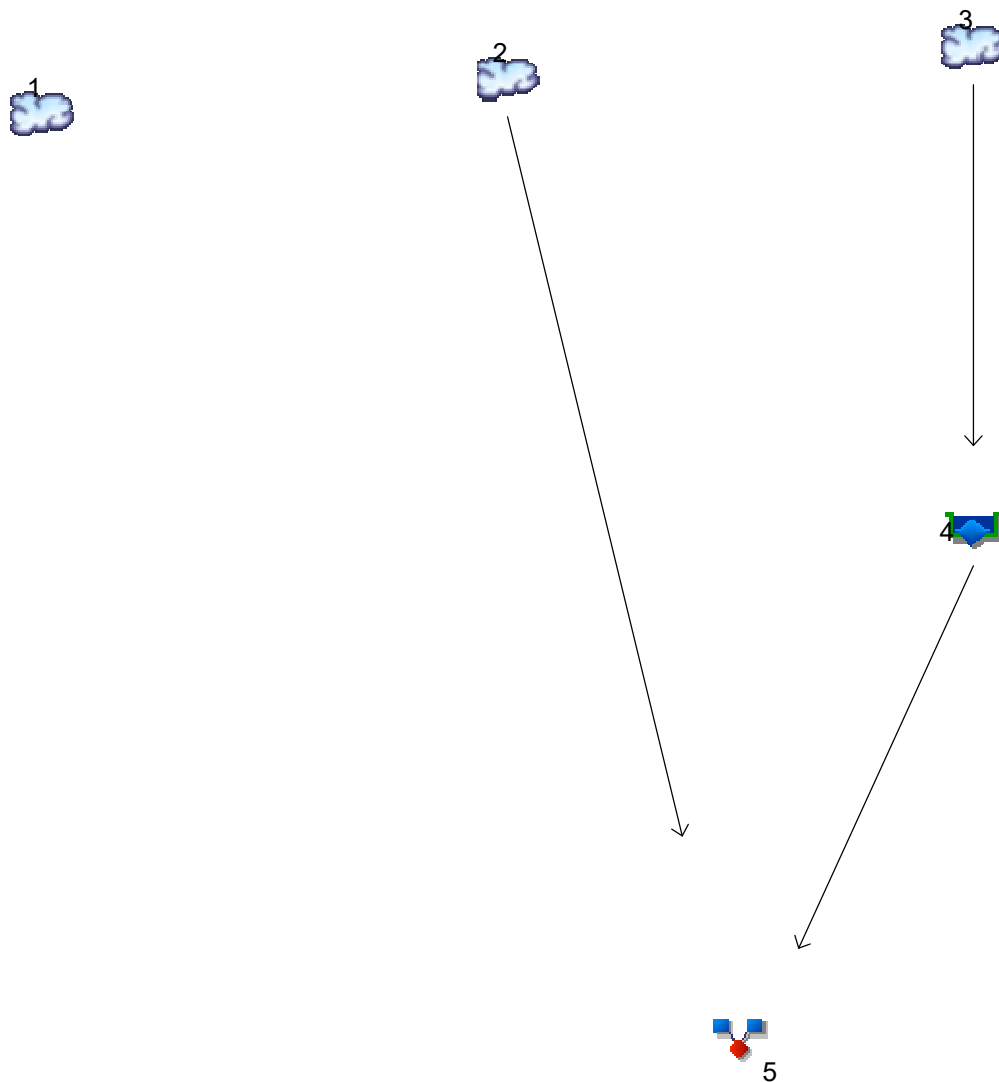
Hydraflow Hydrographs – 1, 2, 10, 25 and 100-yr storms

Watershed Model Schematic.....	1
Hydrograph Return Period Recap.....	2
1 - Year	
Summary Report.....	3
Hydrograph Reports.....	4
Hydrograph No. 1, SCS Runoff, SUBAREA-EX1.....	4
Hydrograph No. 2, SCS Runoff, SUBAREA-PUN1.....	5
Hydrograph No. 3, SCS Runoff, SUBAREA-PR1.....	6
Hydrograph No. 4, Reservoir, ControlledRunoff.....	7
Pond Report - Sand Filter.....	8
Hydrograph No. 5, Combine, Proposed Combined.....	10
2 - Year	
Summary Report.....	11
Hydrograph Reports.....	12
Hydrograph No. 1, SCS Runoff, SUBAREA-EX1.....	12
Hydrograph No. 2, SCS Runoff, SUBAREA-PUN1.....	13
Hydrograph No. 3, SCS Runoff, SUBAREA-PR1.....	14
Hydrograph No. 4, Reservoir, ControlledRunoff.....	15
Hydrograph No. 5, Combine, Proposed Combined.....	16
10 - Year	
Summary Report.....	17
Hydrograph Reports.....	18
Hydrograph No. 1, SCS Runoff, SUBAREA-EX1.....	18
Hydrograph No. 2, SCS Runoff, SUBAREA-PUN1.....	19
Hydrograph No. 3, SCS Runoff, SUBAREA-PR1.....	20
Hydrograph No. 4, Reservoir, ControlledRunoff.....	21
Hydrograph No. 5, Combine, Proposed Combined.....	22
25 - Year	
Summary Report.....	23
Hydrograph Reports.....	24
Hydrograph No. 1, SCS Runoff, SUBAREA-EX1.....	24
Hydrograph No. 2, SCS Runoff, SUBAREA-PUN1.....	25
Hydrograph No. 3, SCS Runoff, SUBAREA-PR1.....	26
Hydrograph No. 4, Reservoir, ControlledRunoff.....	27
Hydrograph No. 5, Combine, Proposed Combined.....	28
100 - Year	
Summary Report.....	29
Hydrograph Reports.....	30
Hydrograph No. 1, SCS Runoff, SUBAREA-EX1.....	30
Hydrograph No. 2, SCS Runoff, SUBAREA-PUN1.....	31
Hydrograph No. 3, SCS Runoff, SUBAREA-PR1.....	32
Hydrograph No. 4, Reservoir, ControlledRunoff.....	33

Hydrograph No. 5, Combine, Proposed Combined.....	34
---	----

Watershed Model Schematic

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



Legend

<u>Hyd. Origin</u>	<u>Description</u>
1	SCS Runoff SUBAREA-EX1
2	SCS Runoff SUBAREA-PUN1
3	SCS Runoff SUBAREA-PR1
4	Reservoir ControlledRunoff
5	Combine Proposed Combined

Hydrograph Return Period Recap

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

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	-----	1.024	1.460	-----	-----	3.013	4.261	-----	6.940	SUBAREA-EX1
2	SCS Runoff	-----	0.141	0.196	-----	-----	0.389	0.541	-----	0.866	SUBAREA-PUN1
3	SCS Runoff	-----	2.092	2.568	-----	-----	4.081	5.203	-----	7.516	SUBAREA-PR1
4	Reservoir	3	0.463	0.806	-----	-----	2.318	3.197	-----	5.468	ControlledRunoff
5	Combine	2, 4	0.503	0.880	-----	-----	2.554	3.583	-----	6.087	Proposed Combined

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	1.024	2	724	3,245	-----	-----	-----	SUBAREA-EX1	
2	SCS Runoff	0.141	2	724	437	-----	-----	-----	SUBAREA-PUN1	
3	SCS Runoff	2.092	2	724	6,378	-----	-----	-----	SUBAREA-PR1	
4	Reservoir	0.463	2	748	6,378	3	99.88	2,307	ControlledRunoff	
5	Combine	0.503	2	746	6,815	2, 4	-----	-----	Proposed Combined	
Washville_Middletown_RI_Storm_rev1.gpw					Return Period: 1 Year			Friday, 07 / 1 / 2022		

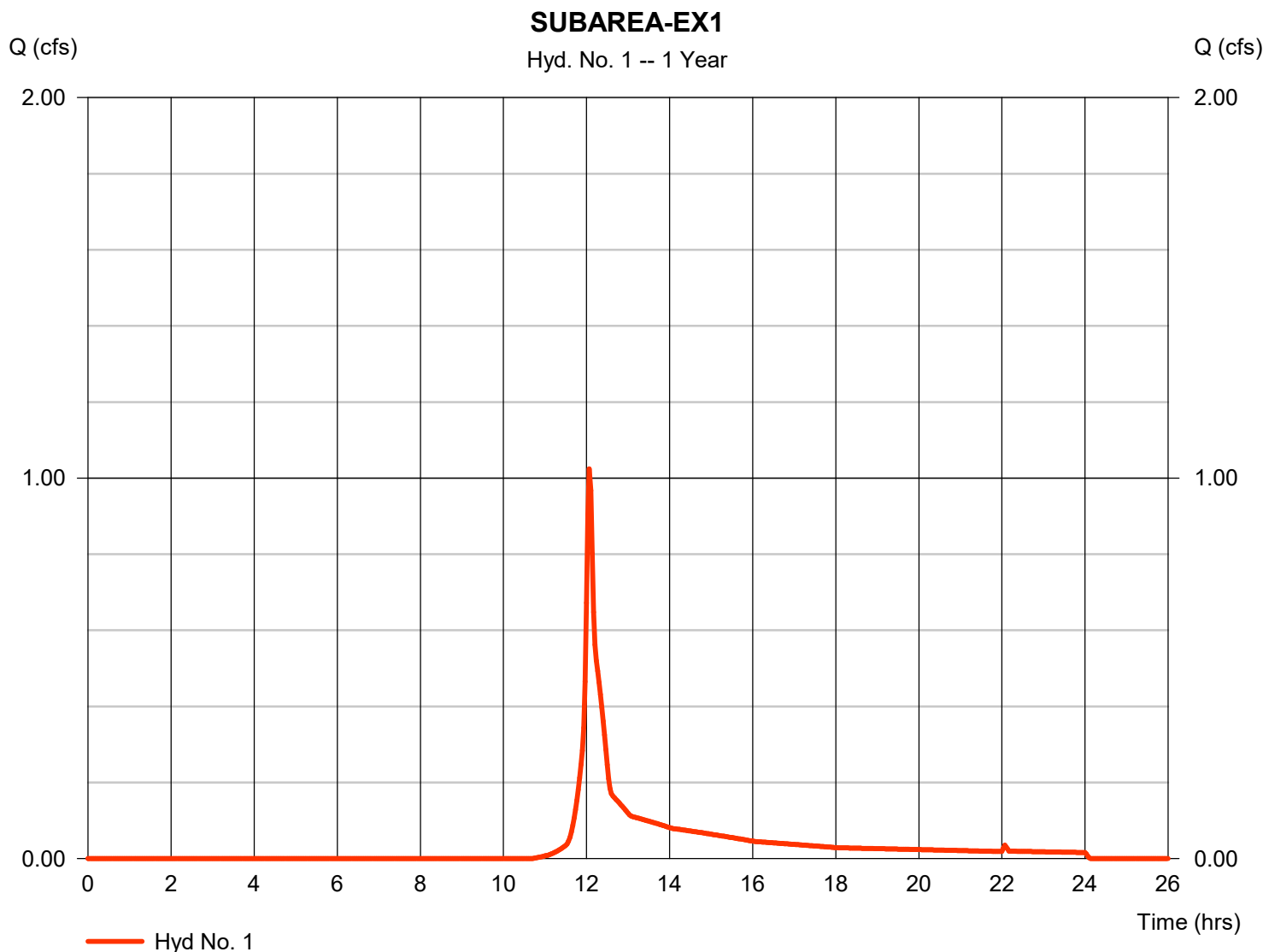
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.024 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 3,245 cuft
Drainage area	= 1.080 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.80 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 98) + (1.010 x 74)] / 1.080



Hydrograph Report

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

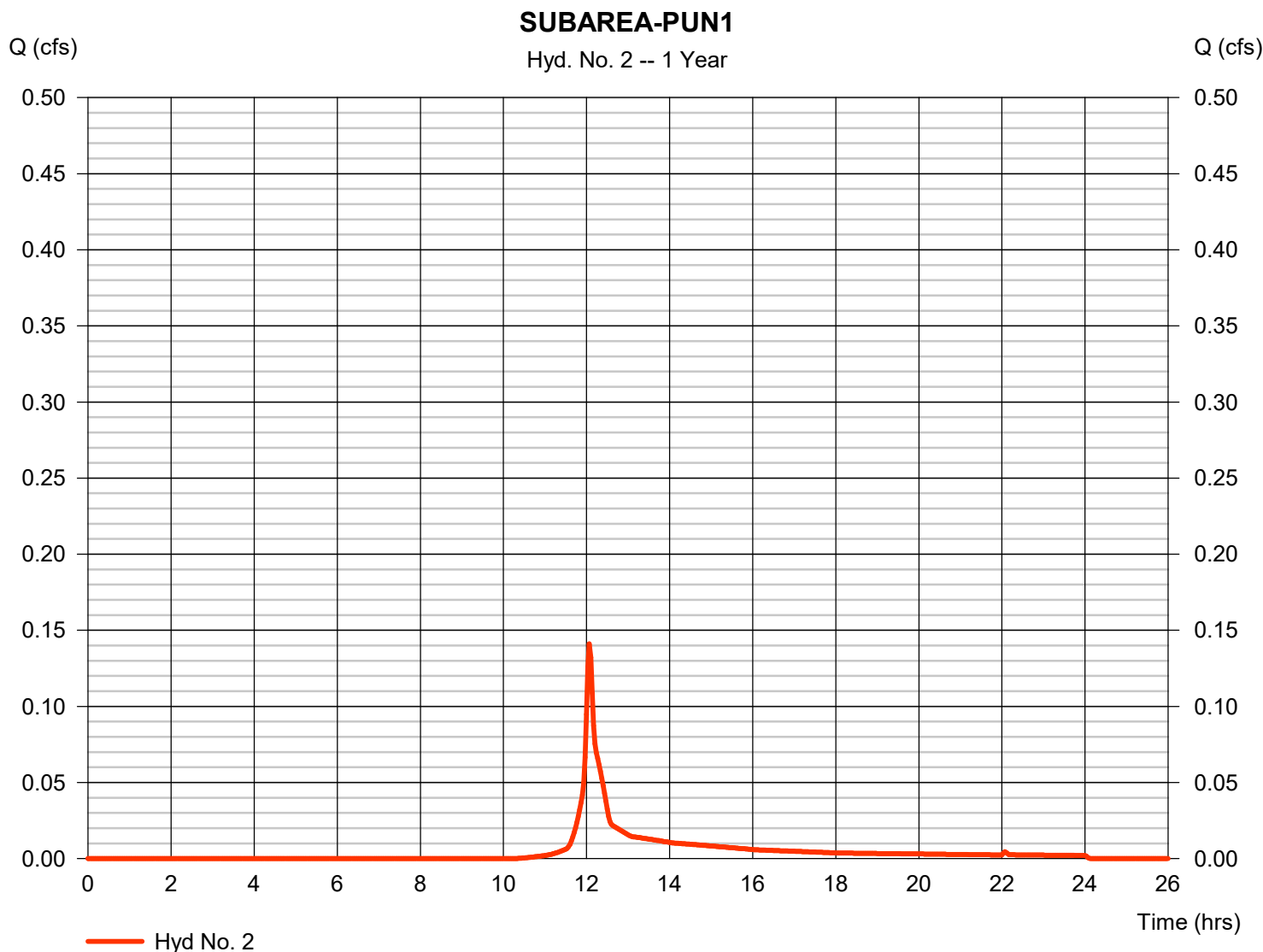
Friday, 07 / 1 / 2022

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.141 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 437 cuft
Drainage area	= 0.130 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.80 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.024 x 98) + (0.106 x 74)] / 0.130



Hydrograph Report

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

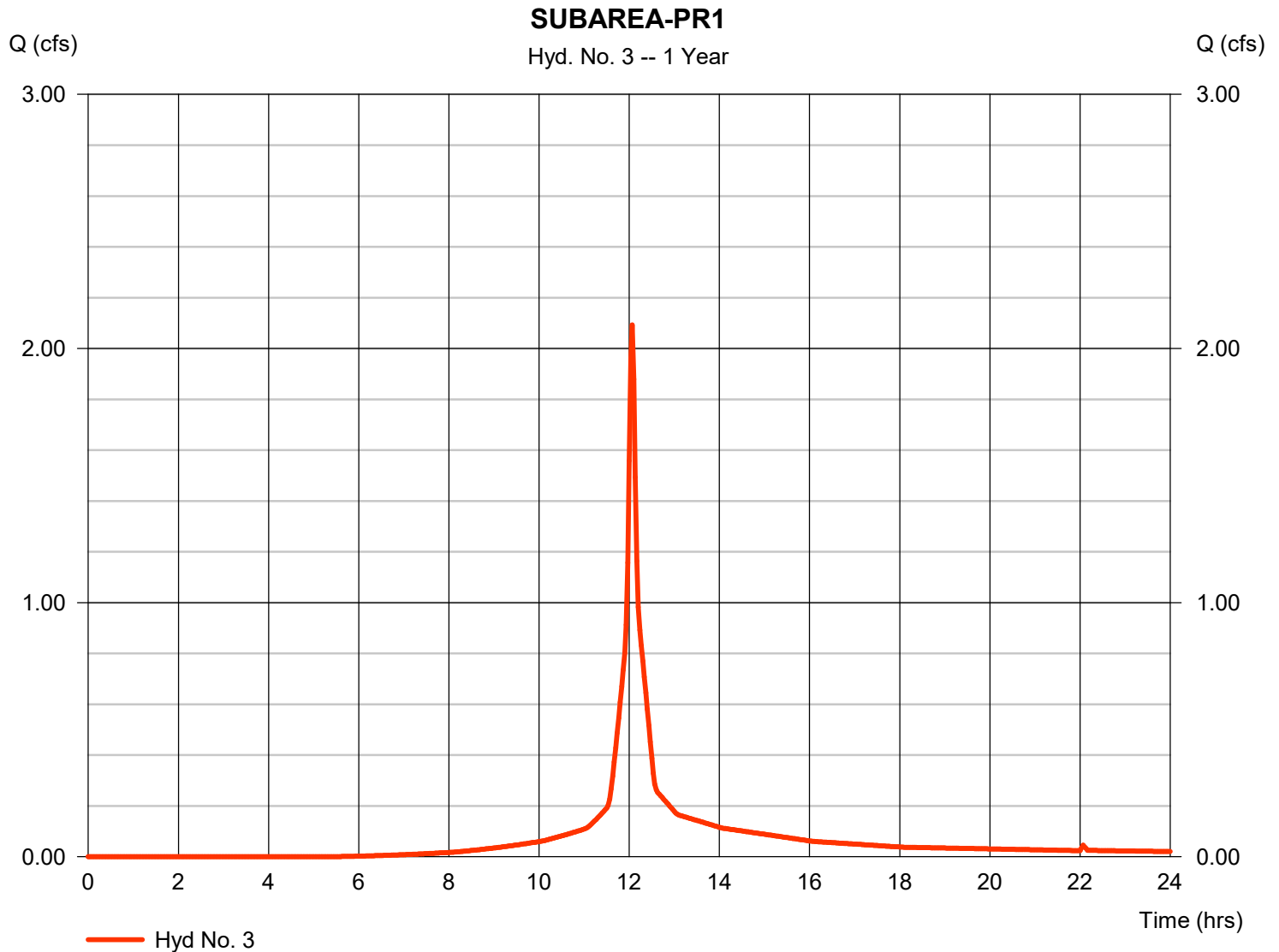
Friday, 07 / 1 / 2022

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.092 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 6,378 cuft
Drainage area	= 0.950 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.80 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.716 x 98) + (0.234 x 74)] / 0.950



Hydrograph Report

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

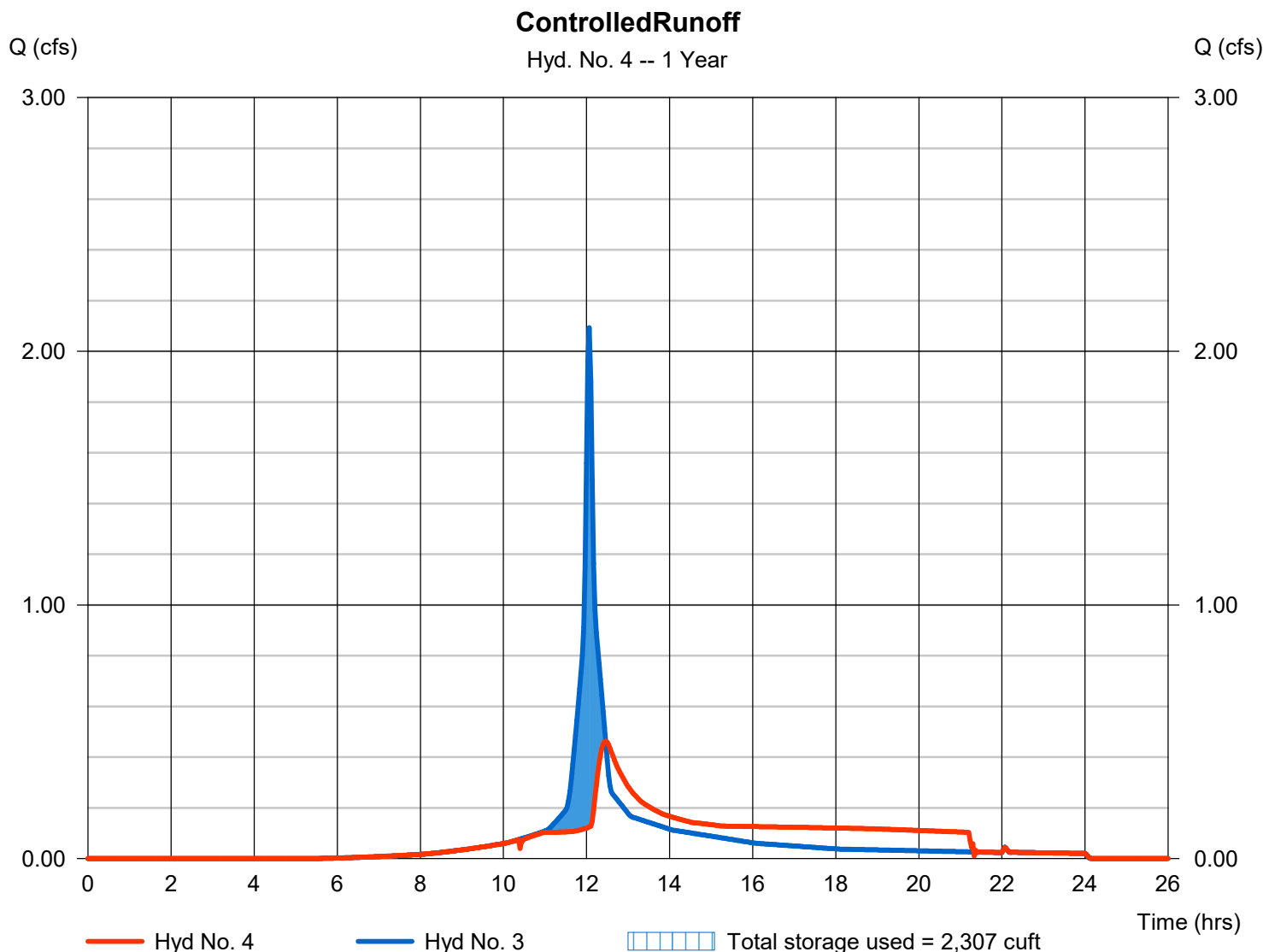
Friday, 07 / 1 / 2022

Hyd. No. 4

ControlledRunoff

Hydrograph type	= Reservoir	Peak discharge	= 0.463 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 6,378 cuft
Inflow hyd. No.	= 3 - SUBAREA-PR1	Max. Elevation	= 99.88 ft
Reservoir name	= Sand Filter	Max. Storage	= 2,307 cuft

Storage Indication method used.



Pond Report

Pond No. 2 - Sand Filter

Pond Data

UG Chambers -Invert elev. = 99.00 ft, Rise x Span = 2.50 x 4.25 ft, Barrel Len = 21.35 ft, No. Barrels = 21, Slope = 0.00%, Headers = Yes
Encasement -Invert elev. = 97.00 ft, Width = 4.25 ft, Height = 4.50 ft, Voids = 0.33%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	97.00	n/a	0	0
0.45	97.45	n/a	4	4
0.90	97.90	n/a	4	8
1.35	98.35	n/a	4	12
1.80	98.80	n/a	4	16
2.25	99.25	n/a	667	683
2.70	99.70	n/a	1,176	1,858
3.15	100.15	n/a	1,112	2,970
3.60	100.60	n/a	999	3,970
4.05	101.05	n/a	816	4,785
4.50	101.50	n/a	469	5,254

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 3.00	8.00	12.00	0.00
Span (in)	= 3.00	8.00	12.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 97.00	100.83	99.60	0.00
Length (ft)	= 107.00	107.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

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

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

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	97.00	0.00	0.00	0.00	---	---	---	---	---	---	---	0.000
0.05	0	97.04	0.00 ic	0.00	0.00	---	---	---	---	---	---	---	0.004
0.09	1	97.09	0.02 ic	0.00	0.00	---	---	---	---	---	---	---	0.016
0.14	1	97.13	0.03 ic	0.00	0.00	---	---	---	---	---	---	---	0.034
0.18	2	97.18	0.05 ic	0.00	0.00	---	---	---	---	---	---	---	0.055
0.22	2	97.22	0.08 ic	0.00	0.00	---	---	---	---	---	---	---	0.075
0.27	2	97.27	0.01 oc	0.00	0.00	---	---	---	---	---	---	---	0.012
0.31	3	97.31	0.02 oc	0.00	0.00	---	---	---	---	---	---	---	0.021
0.36	3	97.36	0.03 oc	0.00	0.00	---	---	---	---	---	---	---	0.028
0.40	4	97.40	0.03 oc	0.00	0.00	---	---	---	---	---	---	---	0.033
0.45	4	97.45	0.04 oc	0.00	0.00	---	---	---	---	---	---	---	0.037
0.50	4	97.50	0.04 oc	0.00	0.00	---	---	---	---	---	---	---	0.041
0.54	5	97.54	0.04 oc	0.00	0.00	---	---	---	---	---	---	---	0.045
0.58	5	97.58	0.05 oc	0.00	0.00	---	---	---	---	---	---	---	0.048
0.63	6	97.63	0.05 oc	0.00	0.00	---	---	---	---	---	---	---	0.051
0.68	6	97.67	0.05 oc	0.00	0.00	---	---	---	---	---	---	---	0.054
0.72	6	97.72	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.057
0.76	7	97.76	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.060
0.81	7	97.81	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.062
0.86	8	97.85	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.065
0.90	8	97.90	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.067
0.94	8	97.94	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.069
0.99	9	97.99	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.072
1.03	9	98.04	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.074
1.08	9	98.08	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.076
1.13	10	98.12	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.078
1.17	10	98.17	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.080
1.22	11	98.21	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.082
1.26	11	98.26	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.084
1.30	11	98.30	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.085
1.35	12	98.35	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.087
1.39	12	98.39	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.089

Continues on next page...

Sand Filter

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.44	13	98.44	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.091
1.49	13	98.48	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.092
1.53	13	98.53	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.094
1.58	14	98.57	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.096
1.62	14	98.62	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.097
1.66	15	98.66	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.099
1.71	15	98.71	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.100
1.75	15	98.75	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.102
1.80	16	98.80	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.103
1.85	83	98.85	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.105
1.89	149	98.89	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.106
1.93	216	98.93	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.108
1.98	283	98.98	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.109
2.03	349	99.02	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.111
2.07	416	99.07	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.112
2.12	483	99.11	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.114
2.16	549	99.16	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.115
2.20	616	99.20	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.116
2.25	683	99.25	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.118
2.30	800	99.29	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.119
2.34	918	99.34	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.120
2.38	1,035	99.38	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.121
2.43	1,153	99.43	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.123
2.47	1,270	99.47	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.124
2.52	1,388	99.52	0.13 oc	0.00	0.00	---	---	---	---	---	---	---	0.125
2.57	1,505	99.56	0.13 oc	0.00	0.00	---	---	---	---	---	---	---	0.126
2.61	1,623	99.61	0.13 oc	0.00	0.00 ic	---	---	---	---	---	---	---	0.128
2.66	1,741	99.65	0.13 oc	0.00	0.01 ic	---	---	---	---	---	---	---	0.142
2.70	1,858	99.70	0.13 oc	0.00	0.04 ic	---	---	---	---	---	---	---	0.174
2.74	1,969	99.75	0.13 oc	0.00	0.09 ic	---	---	---	---	---	---	---	0.223
2.79	2,081	99.79	0.13 oc	0.00	0.15 ic	---	---	---	---	---	---	---	0.287
2.84	2,192	99.83	0.13 oc	0.00	0.23 ic	---	---	---	---	---	---	---	0.366
2.88	2,303	99.88	0.13 oc	0.00	0.32 ic	---	---	---	---	---	---	---	0.459
2.92	2,414	99.92	0.14 oc	0.00	0.43 ic	---	---	---	---	---	---	---	0.566
2.97	2,525	99.97	0.14 oc	0.00	0.55 ic	---	---	---	---	---	---	---	0.685
3.02	2,637	100.01	0.14 oc	0.00	0.68 ic	---	---	---	---	---	---	---	0.815
3.06	2,748	100.06	0.14 oc	0.00	0.81 ic	---	---	---	---	---	---	---	0.954
3.11	2,859	100.11	0.14 oc	0.00	0.96 ic	---	---	---	---	---	---	---	1.104
3.15	2,970	100.15	0.14 oc	0.00	1.12 ic	---	---	---	---	---	---	---	1.260
3.19	3,070	100.19	0.14 oc	0.00	1.28 ic	---	---	---	---	---	---	---	1.423
3.24	3,170	100.24	0.14 oc	0.00	1.45 ic	---	---	---	---	---	---	---	1.590
3.29	3,270	100.29	0.14 oc	0.00	1.62 ic	---	---	---	---	---	---	---	1.762
3.33	3,370	100.33	0.15 oc	0.00	1.79 ic	---	---	---	---	---	---	---	1.934
3.38	3,470	100.38	0.15 oc	0.00	1.96 ic	---	---	---	---	---	---	---	2.105
3.42	3,570	100.42	0.15 oc	0.00	2.13 ic	---	---	---	---	---	---	---	2.274
3.47	3,670	100.46	0.15 oc	0.00	2.29 ic	---	---	---	---	---	---	---	2.435
3.51	3,770	100.51	0.15 oc	0.00	2.44 ic	---	---	---	---	---	---	---	2.588
3.56	3,870	100.56	0.15 oc	0.00	2.57 ic	---	---	---	---	---	---	---	2.723
3.60	3,970	100.60	0.15 oc	0.00	2.67 ic	---	---	---	---	---	---	---	2.826
3.64	4,051	100.64	0.15 oc	0.00	2.79 ic	---	---	---	---	---	---	---	2.945
3.69	4,133	100.69	0.15 oc	0.00	2.90 ic	---	---	---	---	---	---	---	3.059
3.73	4,214	100.74	0.16 oc	0.00	3.01 ic	---	---	---	---	---	---	---	3.168
3.78	4,296	100.78	0.16 oc	0.00	3.12 ic	---	---	---	---	---	---	---	3.274
3.83	4,377	100.82	0.16 oc	0.00	3.22 ic	---	---	---	---	---	---	---	3.377
3.87	4,459	100.87	0.16 oc	0.01 ic	3.32 ic	---	---	---	---	---	---	---	3.482
3.92	4,540	100.92	0.16 oc	0.03 ic	3.41 ic	---	---	---	---	---	---	---	3.598
3.96	4,622	100.96	0.16 oc	0.06 ic	3.51 ic	---	---	---	---	---	---	---	3.726
4.01	4,704	101.00	0.16 oc	0.10 ic	3.60 ic	---	---	---	---	---	---	---	3.862
4.05	4,785	101.05	0.16 oc	0.16 ic	3.69 ic	---	---	---	---	---	---	---	4.008
4.09	4,832	101.10	0.16 oc	0.23 ic	3.77 ic	---	---	---	---	---	---	---	4.162
4.14	4,879	101.14	0.16 oc	0.30 ic	3.86 ic	---	---	---	---	---	---	---	4.322
4.18	4,926	101.18	0.16 oc	0.38 ic	3.94 ic	---	---	---	---	---	---	---	4.487
4.23	4,973	101.23	0.17 oc	0.47 ic	4.02 ic	---	---	---	---	---	---	---	4.657
4.28	5,020	101.28	0.17 oc	0.56 ic	4.10 ic	---	---	---	---	---	---	---	4.828
4.32	5,066	101.32	0.17 oc	0.66 ic	4.18 ic	---	---	---	---	---	---	---	5.000
4.37	5,113	101.36	0.17 oc	0.75 ic	4.25 ic	---	---	---	---	---	---	---	5.169
4.41	5,160	101.41	0.17 oc	0.84 ic	4.33 ic	---	---	---	---	---	---	---	5.334
4.46	5,207	101.46	0.17 oc	0.92 ic	4.40 ic	---	---	---	---	---	---	---	5.487
4.50	5,254	101.50	0.17 oc	0.06 oc	4.47 ic	---	---	---	---	---	---	---	4.706

...End

Hydrograph Report

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

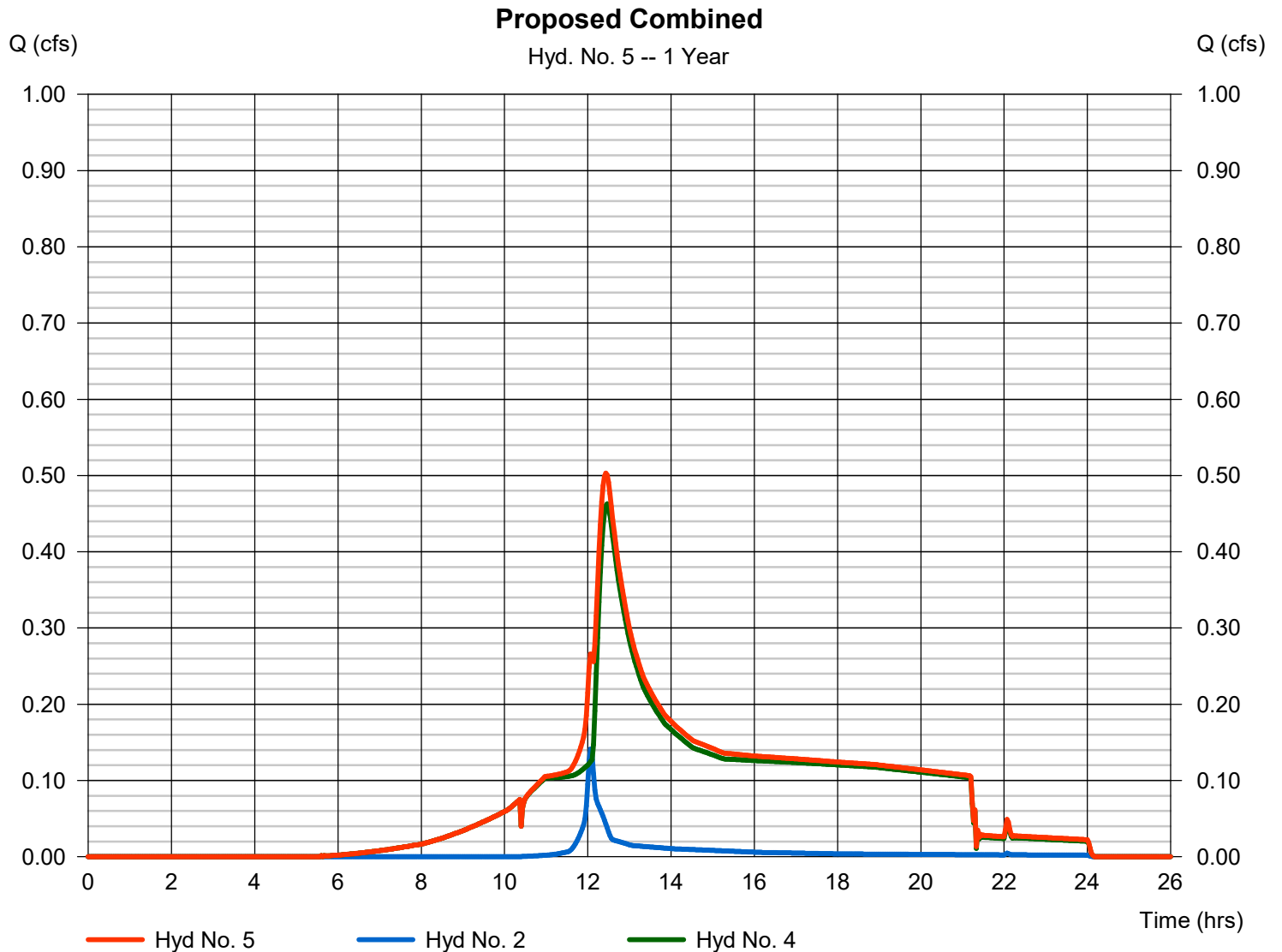
Friday, 07 / 1 / 2022

Hyd. No. 5

Proposed Combined

Hydrograph type = Combine
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyds. = 2, 4

Peak discharge = 0.503 cfs
Time to peak = 12.43 hrs
Hyd. volume = 6,815 cuft
Contrib. drain. area = 0.130 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	1.460	2	724	4,492	-----	-----	-----	SUBAREA-EX1	
2	SCS Runoff	0.196	2	724	596	-----	-----	-----	SUBAREA-PUN1	
3	SCS Runoff	2.568	2	724	7,907	-----	-----	-----	SUBAREA-PR1	
4	Reservoir	0.806	2	742	7,907	3	100.01	2,629	ControlledRunoff	
5	Combine	0.880	2	740	8,503	2, 4	-----	-----	Proposed Combined	
Washville_Middletown_RI_Storm_rev1.gpw					Return Period: 2 Year			Friday, 07 / 1 / 2022		

Hydrograph Report

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

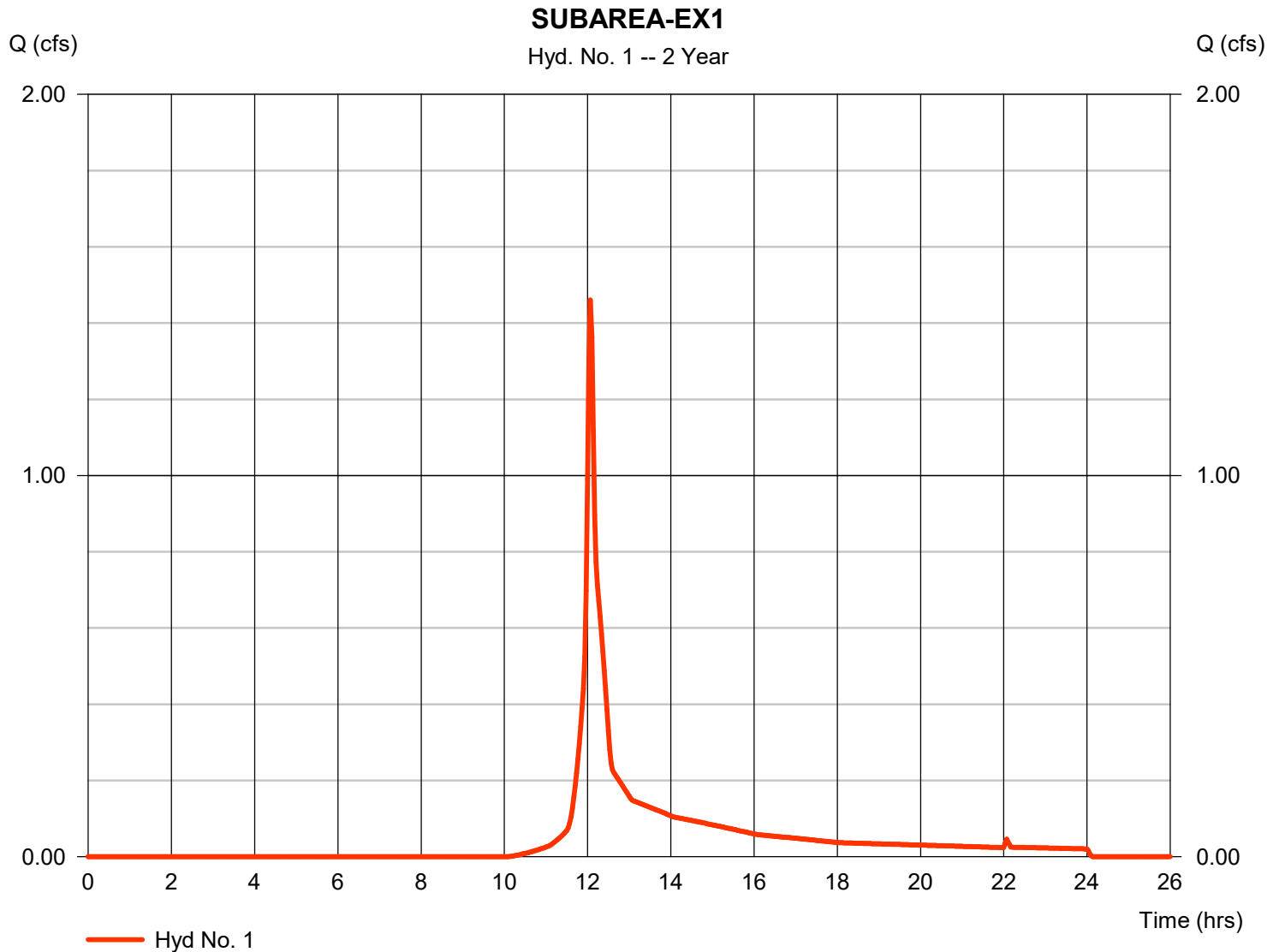
Friday, 07 / 1 / 2022

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.460 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 4,492 cuft
Drainage area	= 1.080 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 98) + (1.010 x 74)] / 1.080



Hydrograph Report

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

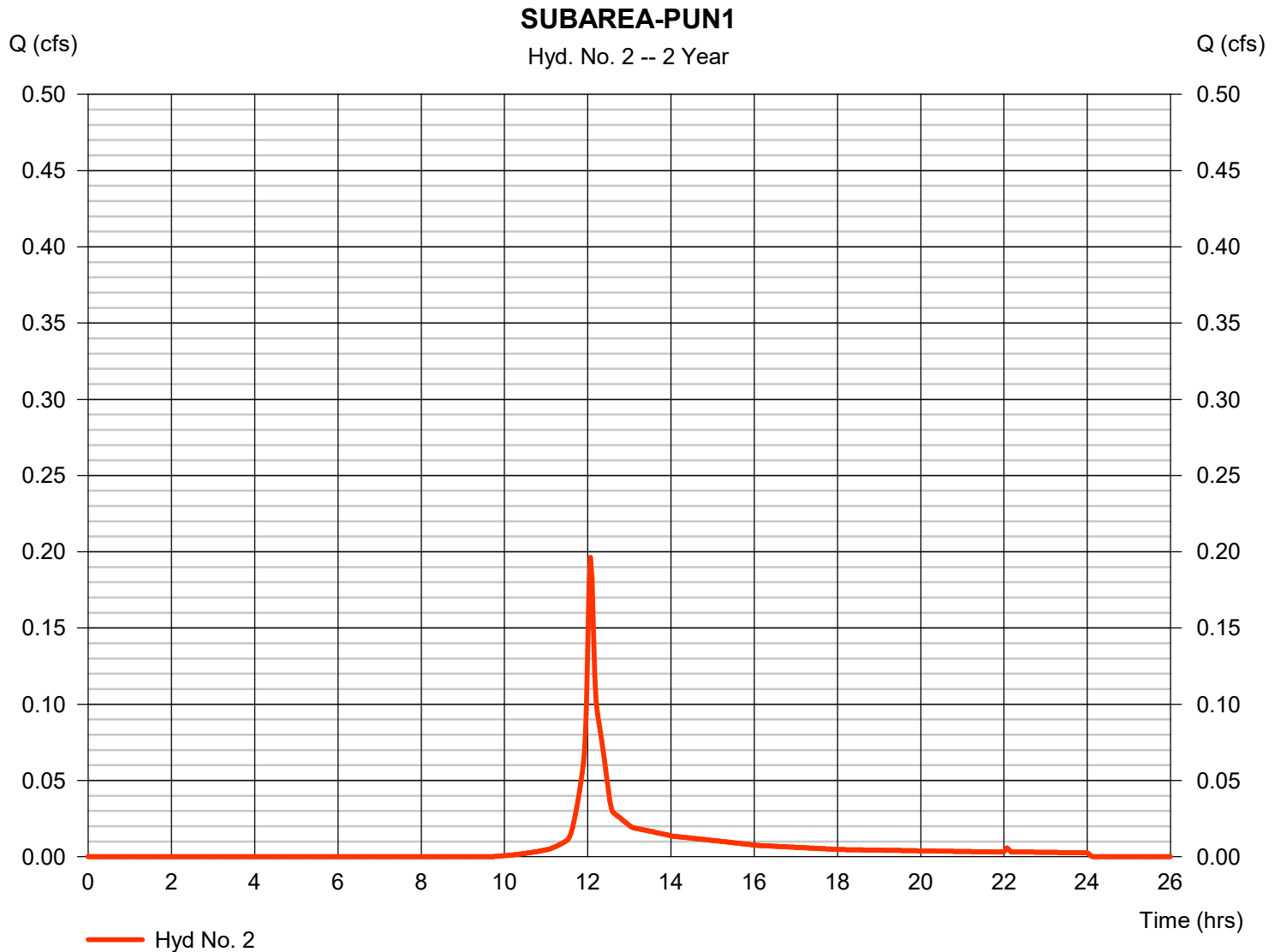
Friday, 07 / 1 / 2022

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.196 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 596 cuft
Drainage area	= 0.130 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.024 x 98) + (0.106 x 74)] / 0.130



Hydrograph Report

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

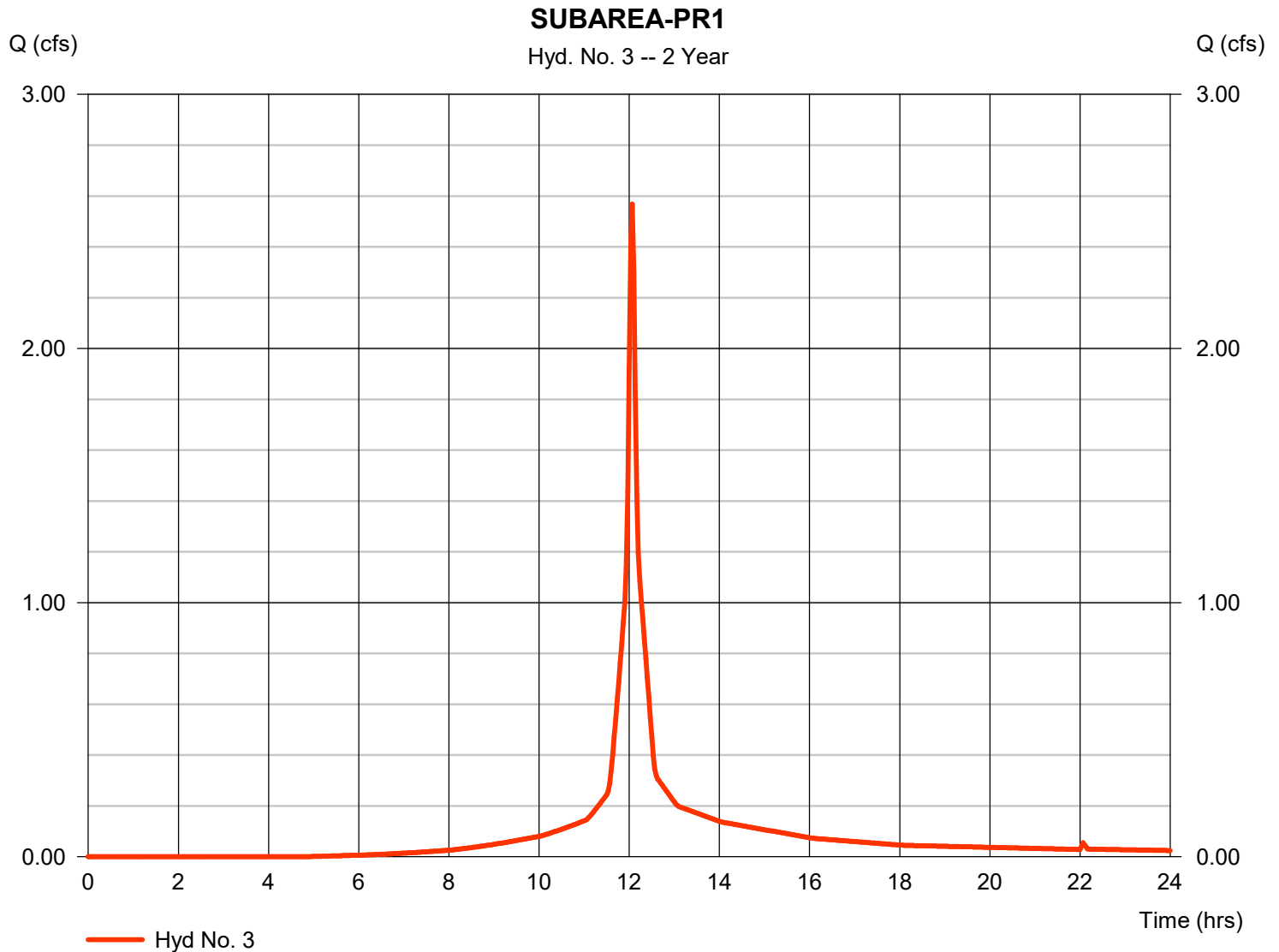
Friday, 07 / 1 / 2022

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.568 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 7,907 cuft
Drainage area	= 0.950 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.716 x 98) + (0.234 x 74)] / 0.950



Hydrograph Report

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

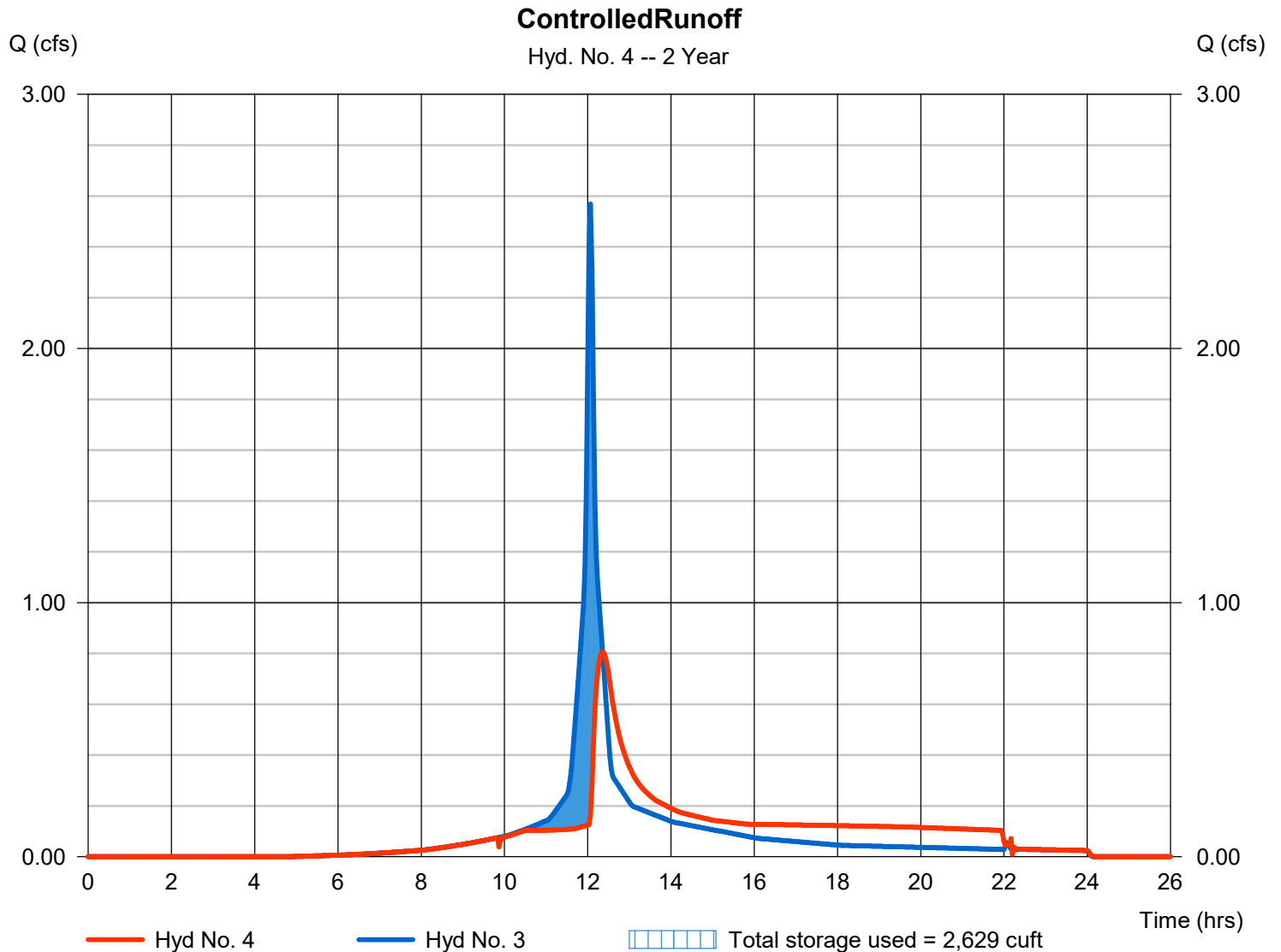
Friday, 07 / 1 / 2022

Hyd. No. 4

ControlledRunoff

Hydrograph type	= Reservoir	Peak discharge	= 0.806 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 7,907 cuft
Inflow hyd. No.	= 3 - SUBAREA-PR1	Max. Elevation	= 100.01 ft
Reservoir name	= Sand Filter	Max. Storage	= 2,629 cuft

Storage Indication method used.



Hydrograph Report

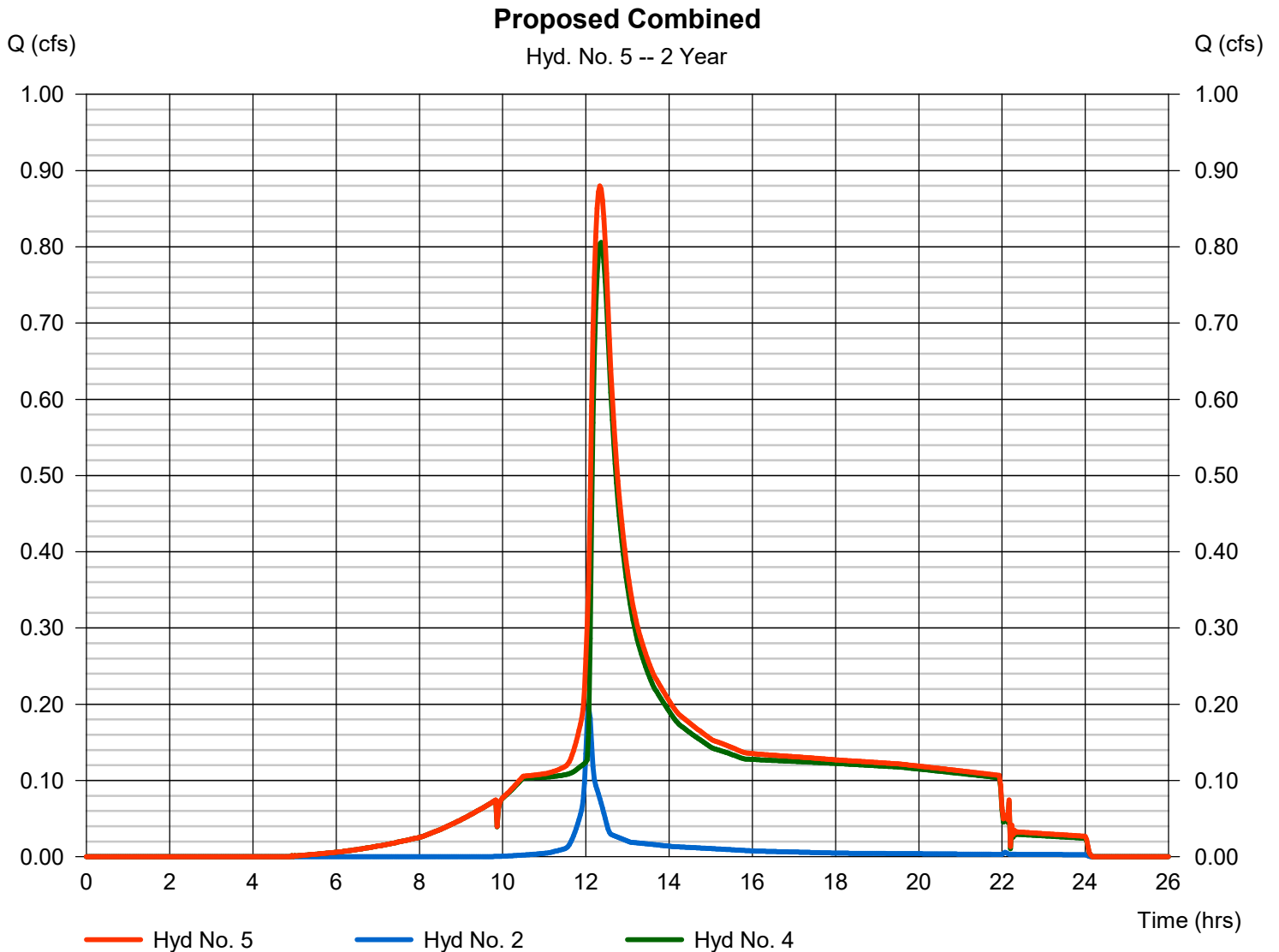
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Friday, 07 / 1 / 2022

Hyd. No. 5

Proposed Combined

Hydrograph type	= Combine	Peak discharge	= 0.880 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.33 hrs
Time interval	= 2 min	Hyd. volume	= 8,503 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 0.130 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	3.013	2	724	9,017	-----	-----	-----	SUBAREA-EX1	
2	SCS Runoff	0.389	2	724	1,162	-----	-----	-----	SUBAREA-PUN1	
3	SCS Runoff	4.081	2	724	12,905	-----	-----	-----	SUBAREA-PR1	
4	Reservoir	2.318	2	730	12,906	3	100.43	3,597	ControlledRunoff	
5	Combine	2.554	2	728	14,068	2, 4	-----	-----	Proposed Combined	
Washville_Middletown_RI_Storm_rev1.gpw					Return Period: 10 Year			Friday, 07 / 1 / 2022		

Hydrograph Report

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

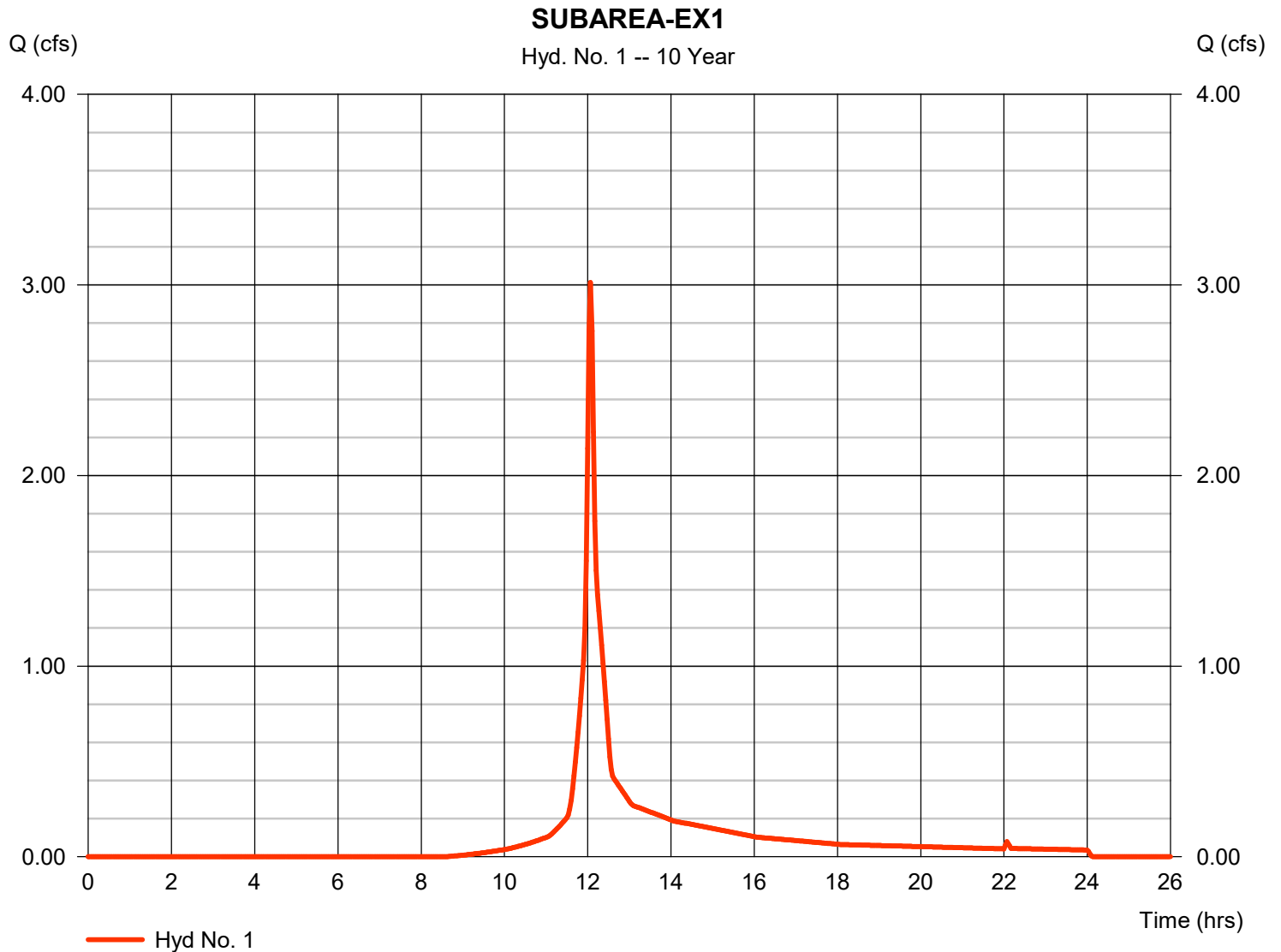
Friday, 07 / 1 / 2022

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	= SCS Runoff	Peak discharge	= 3.013 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 9,017 cuft
Drainage area	= 1.080 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.90 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 98) + (1.010 x 74)] / 1.080



Hydrograph Report

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

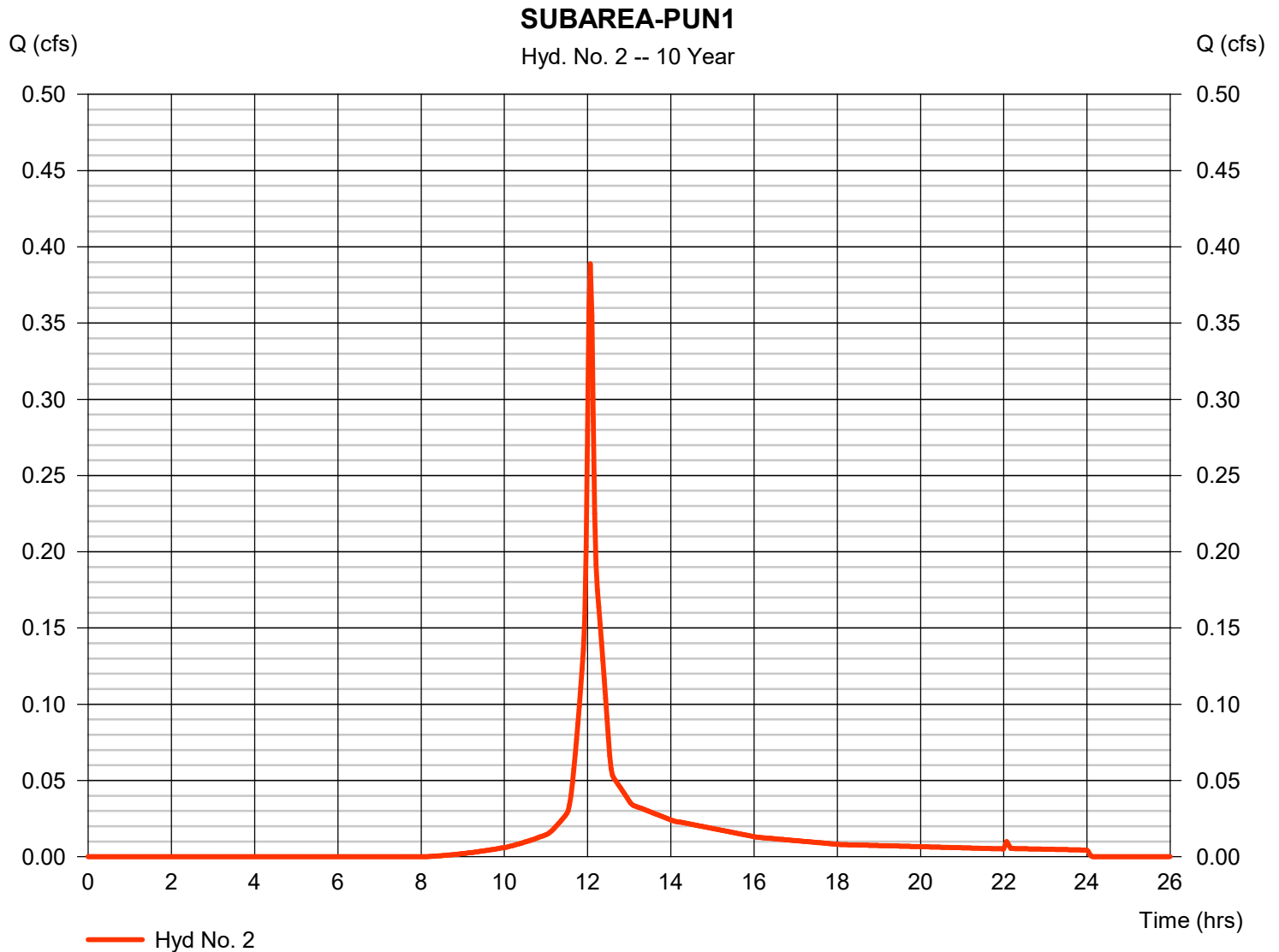
Friday, 07 / 1 / 2022

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.389 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 1,162 cuft
Drainage area	= 0.130 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.90 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.024 x 98) + (0.106 x 74)] / 0.130



Hydrograph Report

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

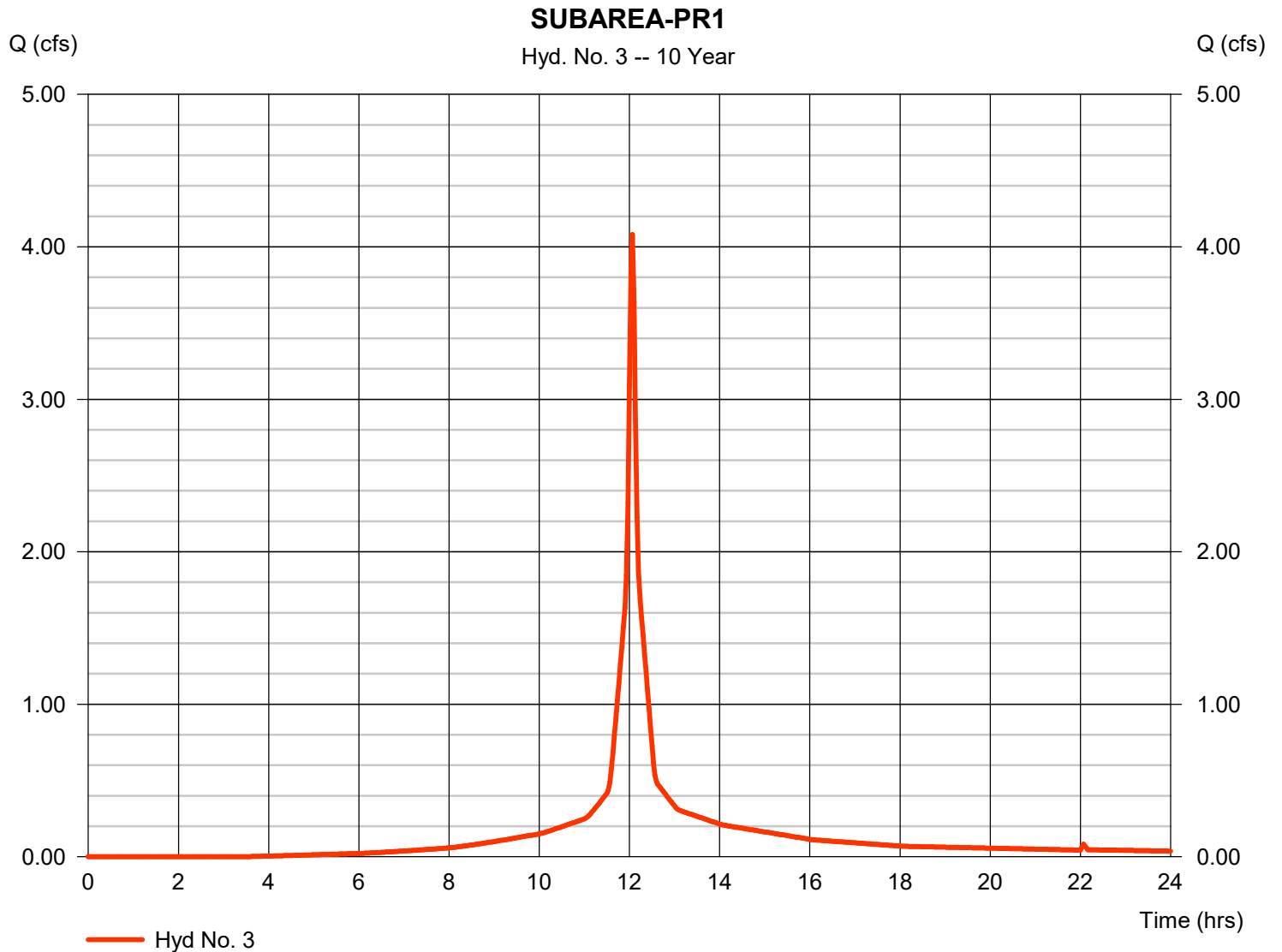
Friday, 07 / 1 / 2022

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.081 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 12,905 cuft
Drainage area	= 0.950 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.90 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.716 x 98) + (0.234 x 74)] / 0.950



Hydrograph Report

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

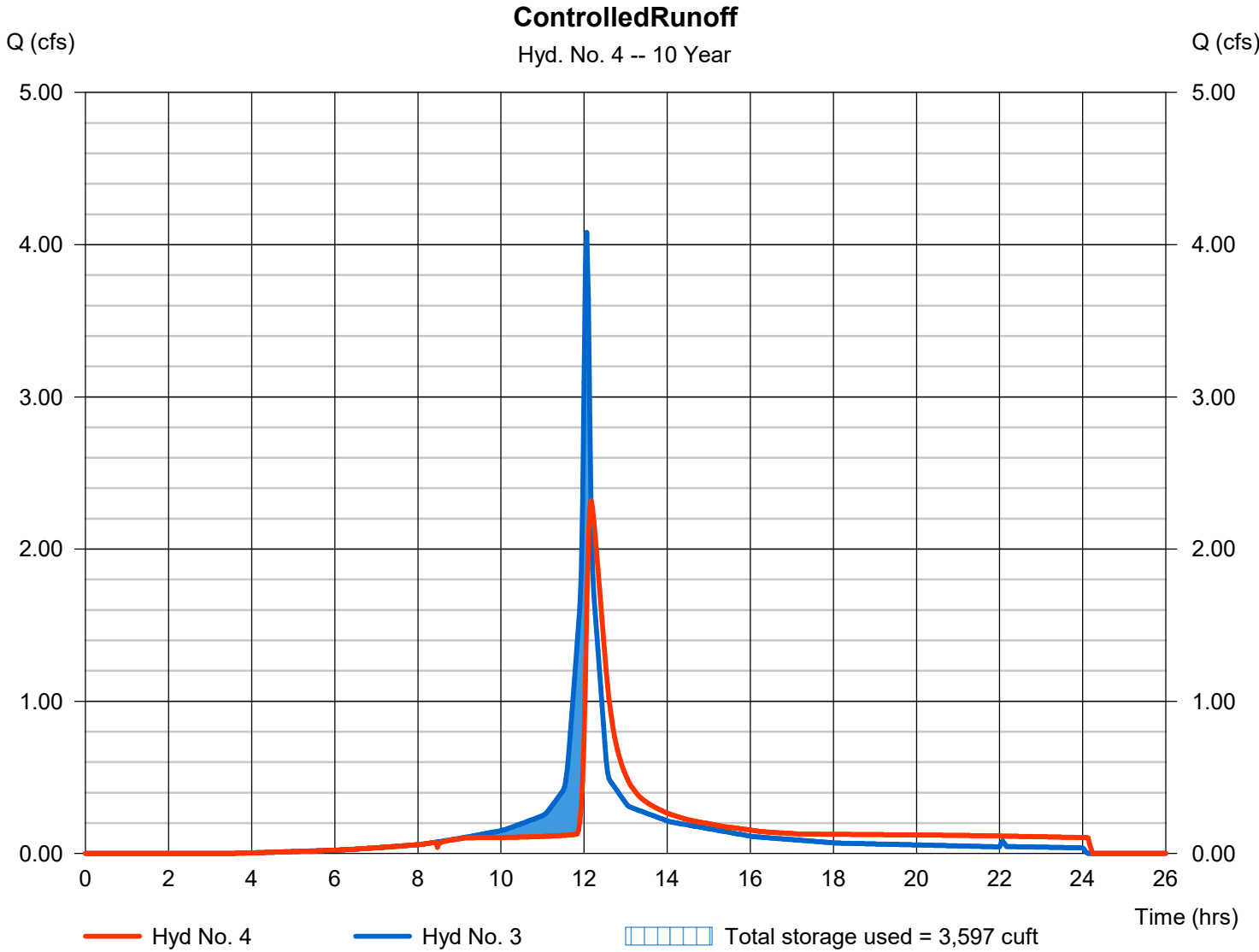
Friday, 07 / 1 / 2022

Hyd. No. 4

ControlledRunoff

Hydrograph type	= Reservoir	Peak discharge	= 2.318 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 12,906 cuft
Inflow hyd. No.	= 3 - SUBAREA-PR1	Max. Elevation	= 100.43 ft
Reservoir name	= Sand Filter	Max. Storage	= 3,597 cuft

Storage Indication method used.



Hydrograph Report

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

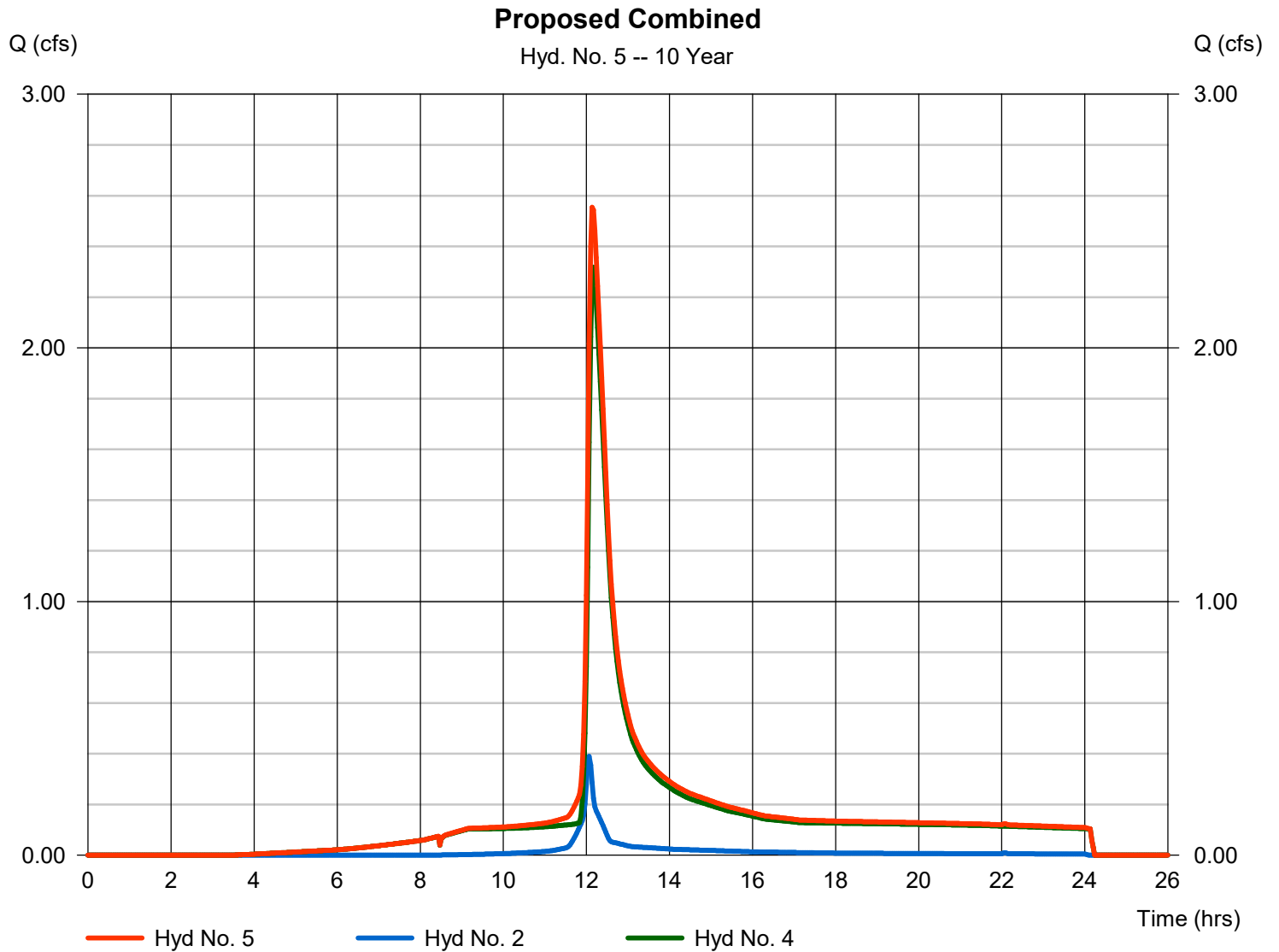
Friday, 07 / 1 / 2022

Hyd. No. 5

Proposed Combined

Hydrograph type = Combine
Storm frequency = 10 yrs
Time interval = 2 min
Inflow hyds. = 2, 4

Peak discharge = 2.554 cfs
Time to peak = 12.13 hrs
Hyd. volume = 14,068 cuft
Contrib. drain. area = 0.130 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	4.261	2	724	12,741	-----	-----	-----	SUBAREA-EX1	
2	SCS Runoff	0.541	2	724	1,622	-----	-----	-----	SUBAREA-PUN1	
3	SCS Runoff	5.203	2	724	16,707	-----	-----	-----	SUBAREA-PR1	
4	Reservoir	3.197	2	730	16,708	3	100.75	4,236	ControlledRunoff	
5	Combine	3.583	2	728	18,330	2, 4	-----	-----	Proposed Combined	
Washville_Middletown_RI_Storm_rev1.gpw					Return Period: 25 Year			Friday, 07 / 1 / 2022		

Hydrograph Report

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

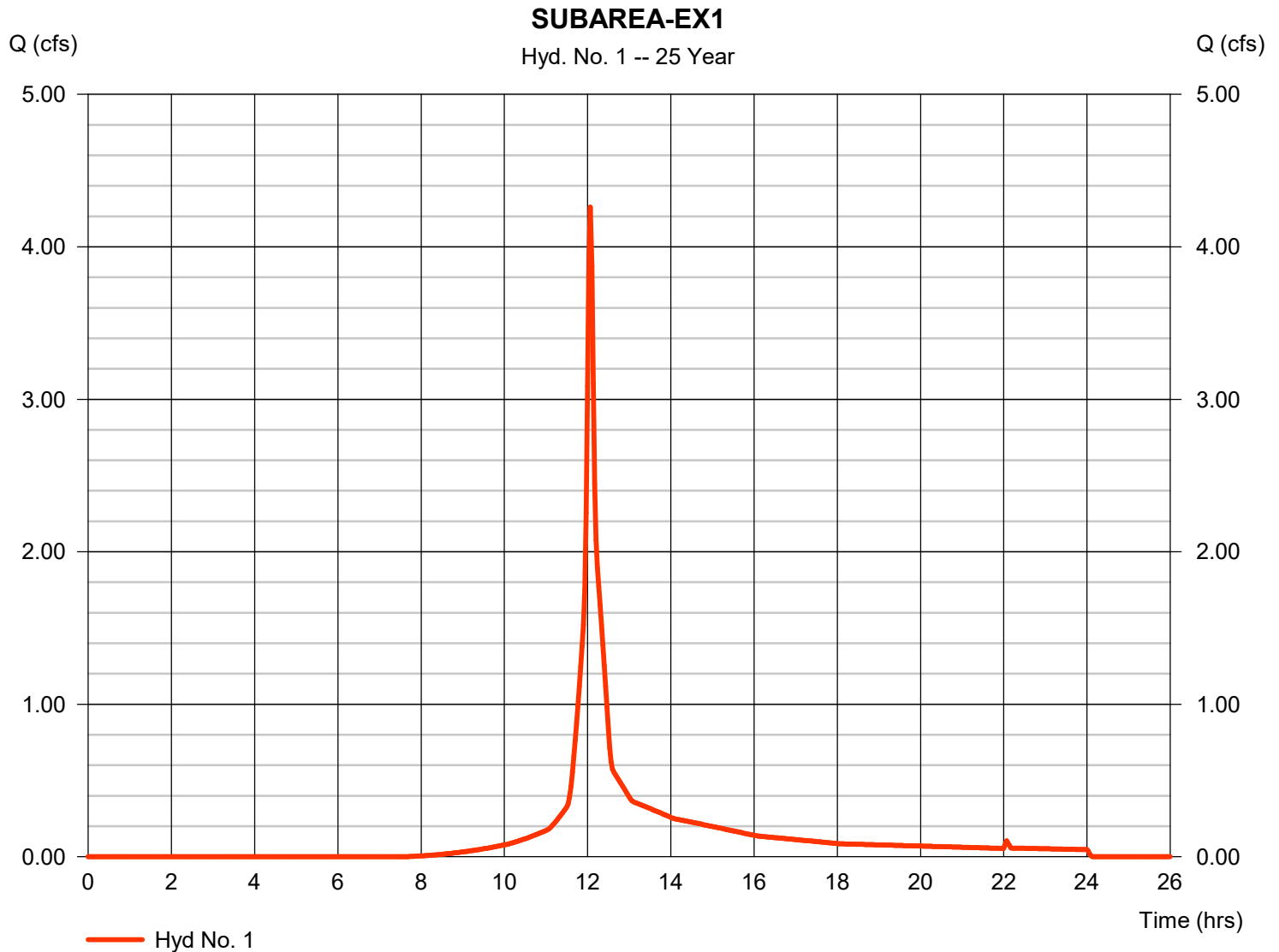
Friday, 07 / 1 / 2022

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.261 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 12,741 cuft
Drainage area	= 1.080 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 98) + (1.010 x 74)] / 1.080



Hydrograph Report

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

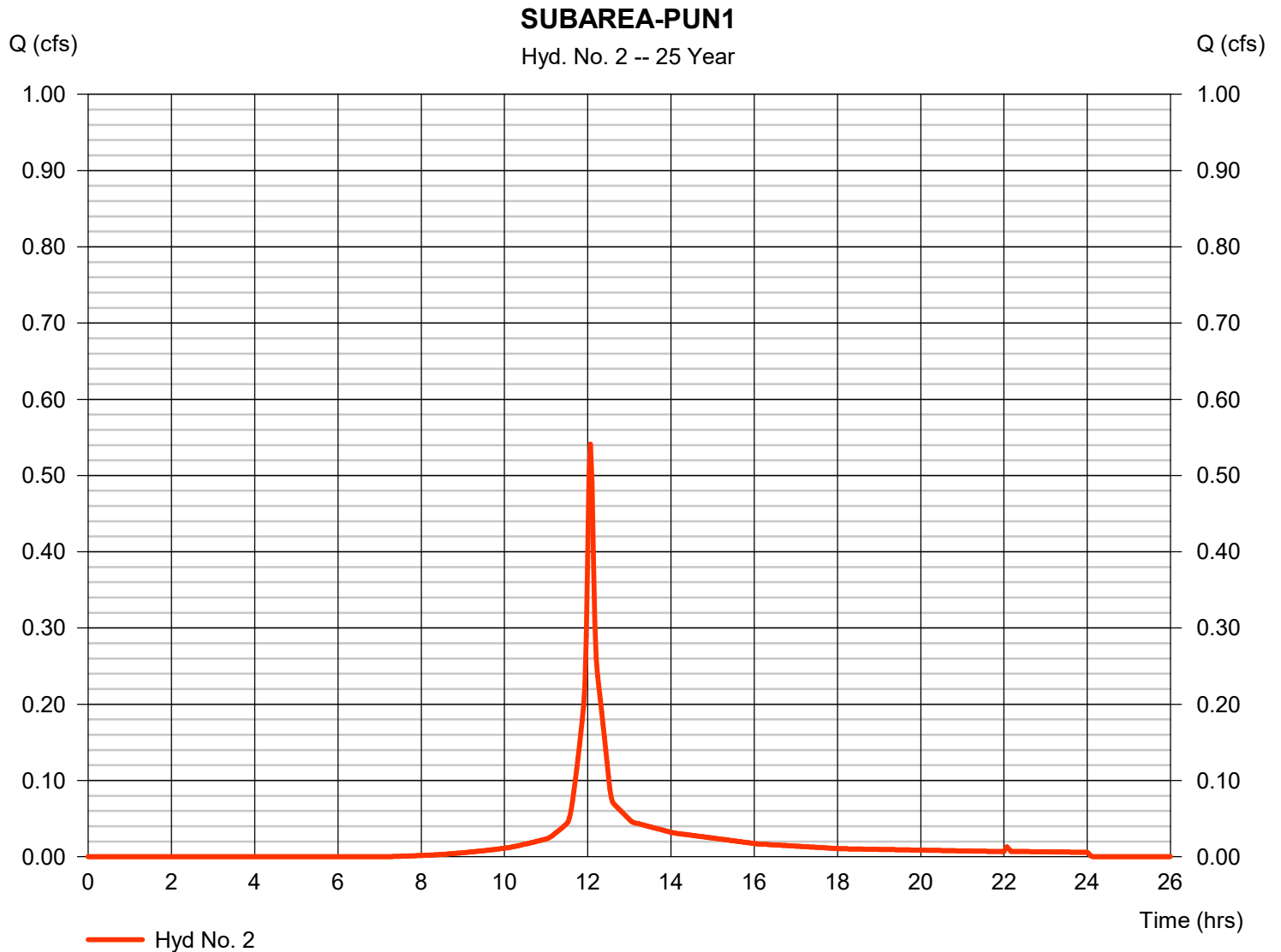
Friday, 07 / 1 / 2022

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.541 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 1,622 cuft
Drainage area	= 0.130 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.024 x 98) + (0.106 x 74)] / 0.130



Hydrograph Report

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

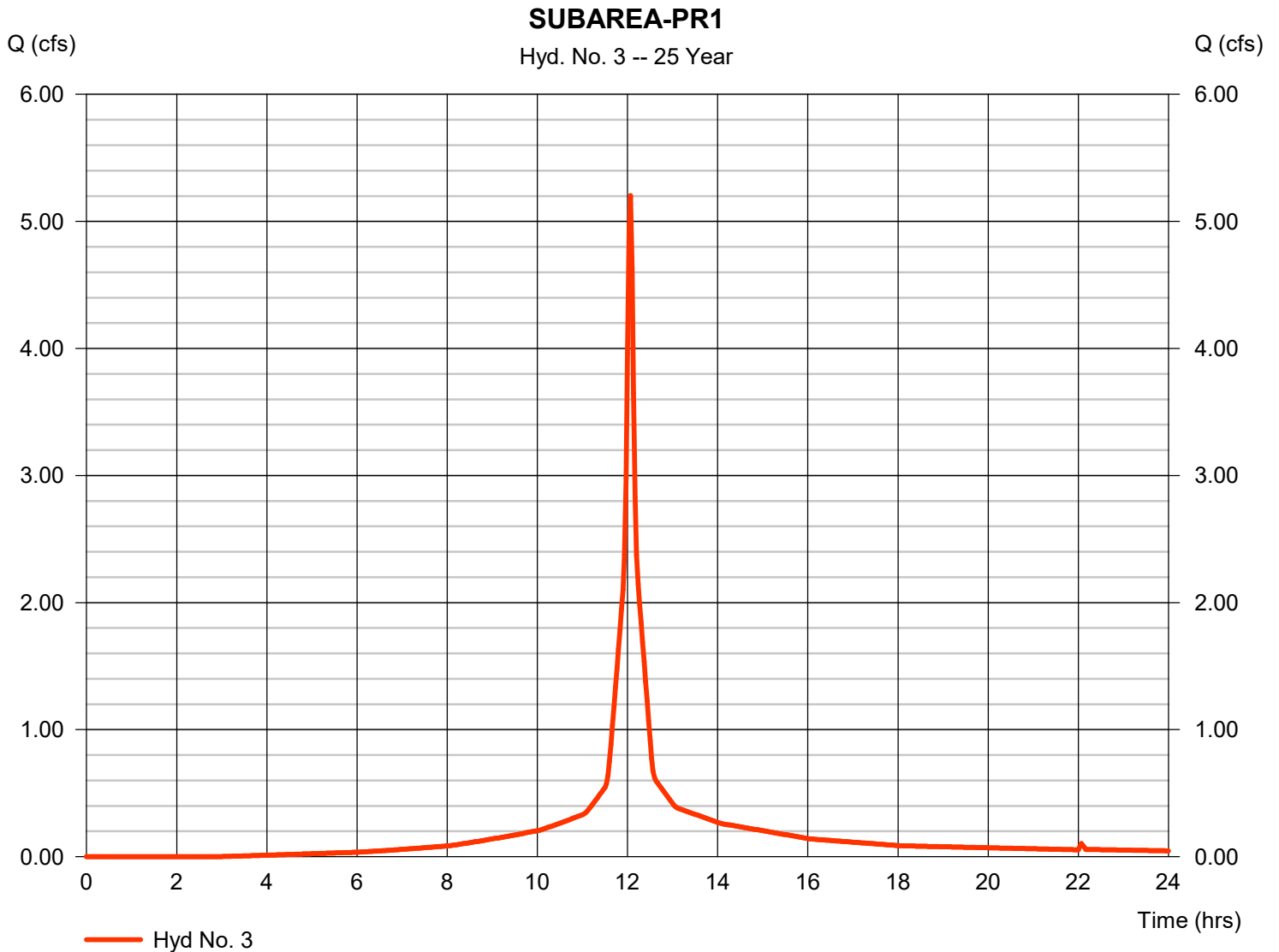
Friday, 07 / 1 / 2022

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	= SCS Runoff	Peak discharge	= 5.203 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 16,707 cuft
Drainage area	= 0.950 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.716 x 98) + (0.234 x 74)] / 0.950



Hydrograph Report

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

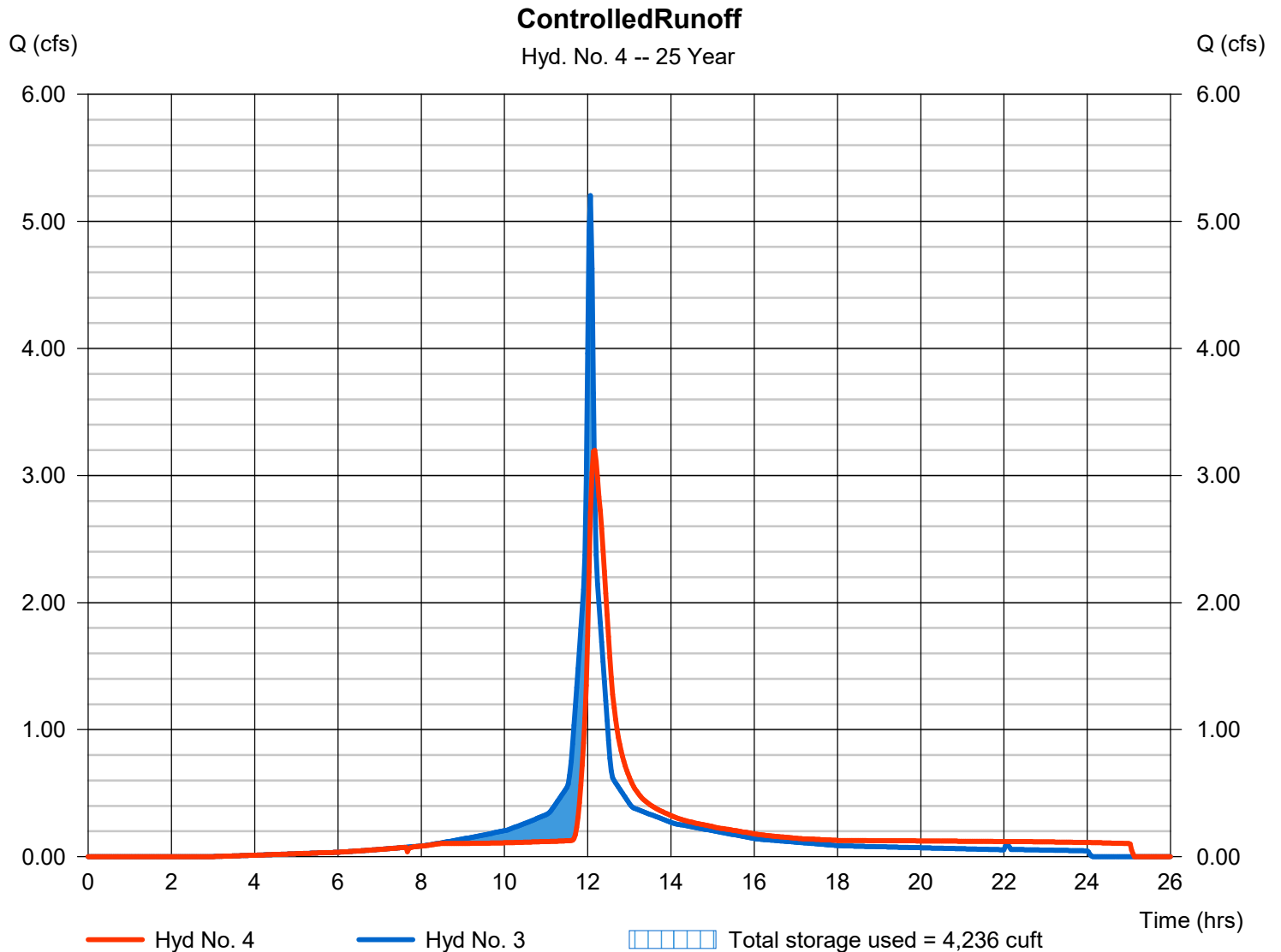
Friday, 07 / 1 / 2022

Hyd. No. 4

ControlledRunoff

Hydrograph type	= Reservoir	Peak discharge	= 3.197 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 16,708 cuft
Inflow hyd. No.	= 3 - SUBAREA-PR1	Max. Elevation	= 100.75 ft
Reservoir name	= Sand Filter	Max. Storage	= 4,236 cuft

Storage Indication method used.



Hydrograph Report

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

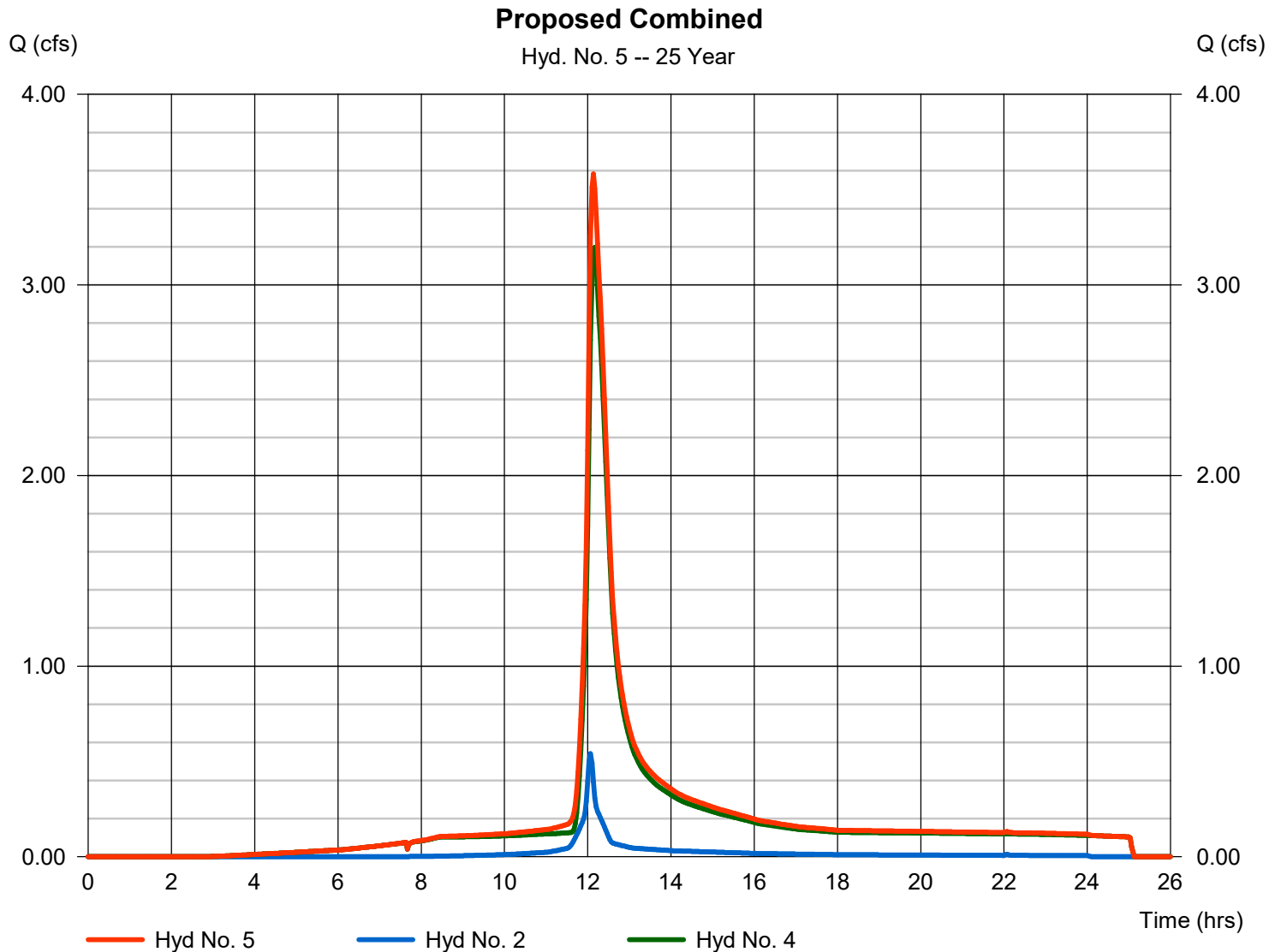
Friday, 07 / 1 / 2022

Hyd. No. 5

Proposed Combined

Hydrograph type = Combine
Storm frequency = 25 yrs
Time interval = 2 min
Inflow hyds. = 2, 4

Peak discharge = 3.583 cfs
Time to peak = 12.13 hrs
Hyd. volume = 18,330 cuft
Contrib. drain. area = 0.130 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	6.940	2	724	20,975	-----	-----	-----	SUBAREA-EX1	
2	SCS Runoff	0.866	2	724	2,632	-----	-----	-----	SUBAREA-PUN1	
3	SCS Runoff	7.516	2	724	24,693	-----	-----	-----	SUBAREA-PR1	
4	Reservoir	5.468	2	728	24,695	3	101.45	5,201	ControlledRunoff	
5	Combine	6.087	2	728	27,326	2, 4	-----	-----	Proposed Combined	
Washville_Middletown_RI_Storm_rev1.gpw					Return Period: 100 Year			Friday, 07 / 1 / 2022		

Hydrograph Report

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

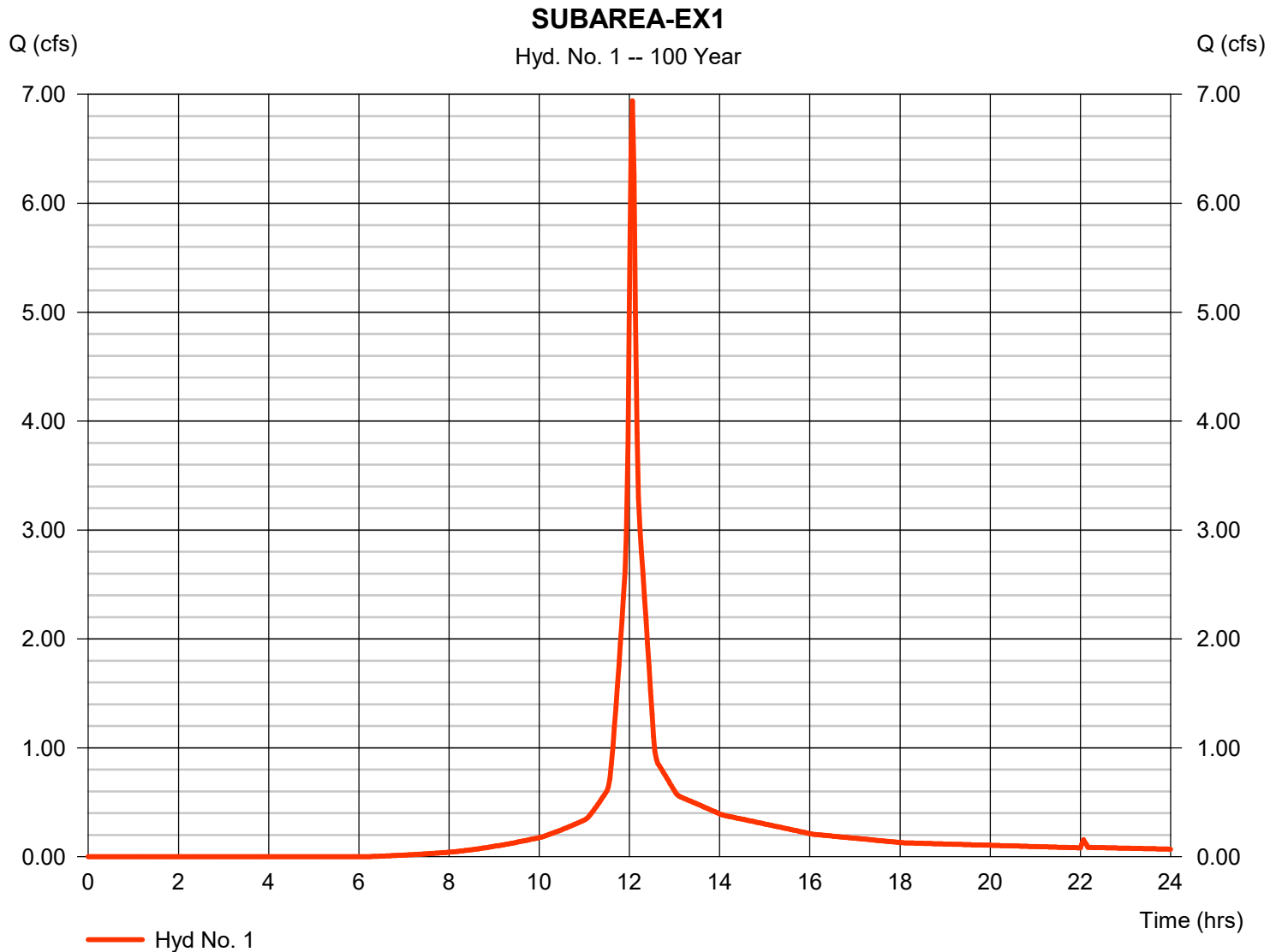
Friday, 07 / 1 / 2022

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	= SCS Runoff	Peak discharge	= 6.940 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 20,975 cuft
Drainage area	= 1.080 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 98) + (1.010 x 74)] / 1.080



Hydrograph Report

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

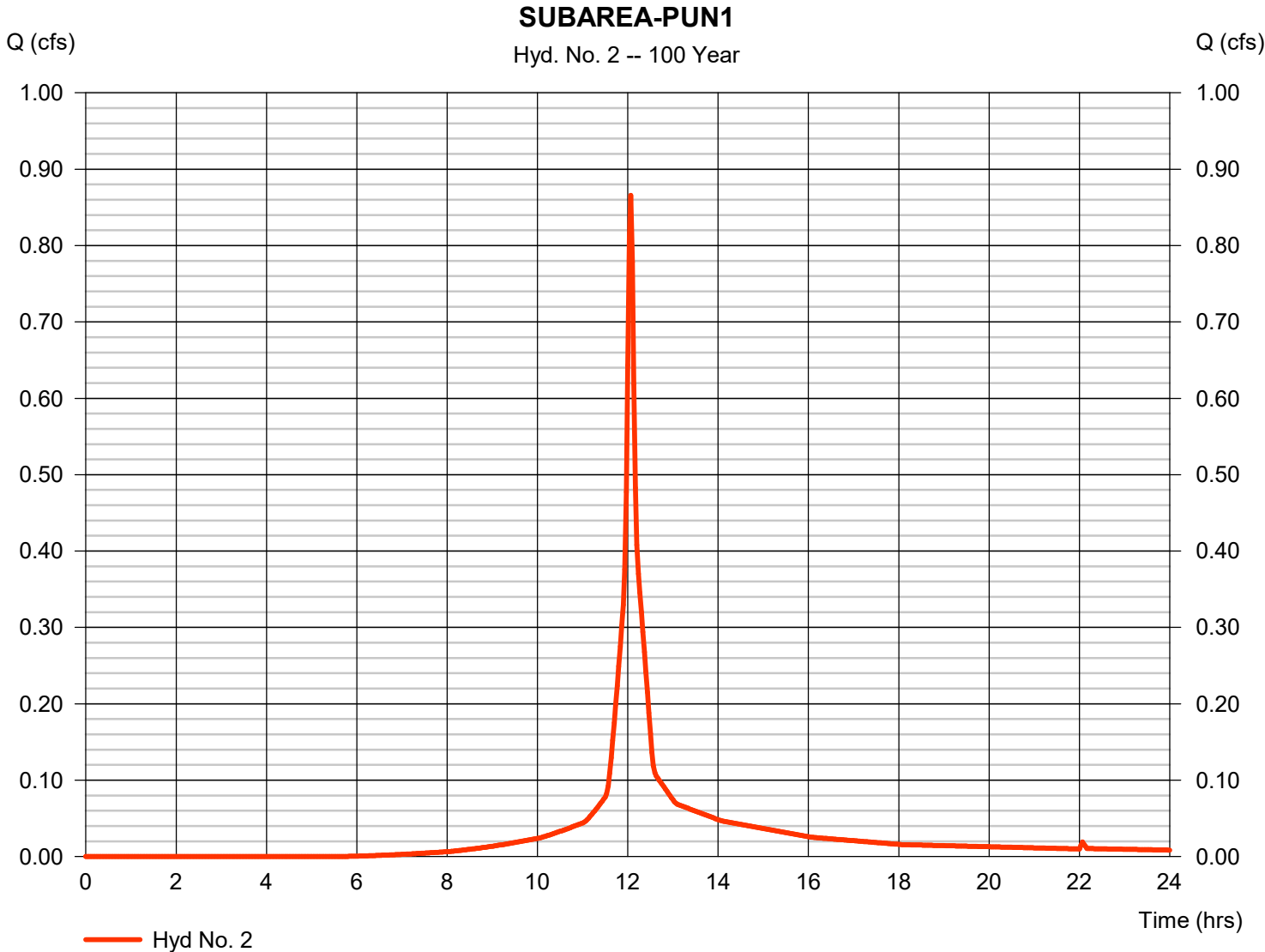
Friday, 07 / 1 / 2022

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.866 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 2,632 cuft
Drainage area	= 0.130 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.024 x 98) + (0.106 x 74)] / 0.130



Hydrograph Report

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

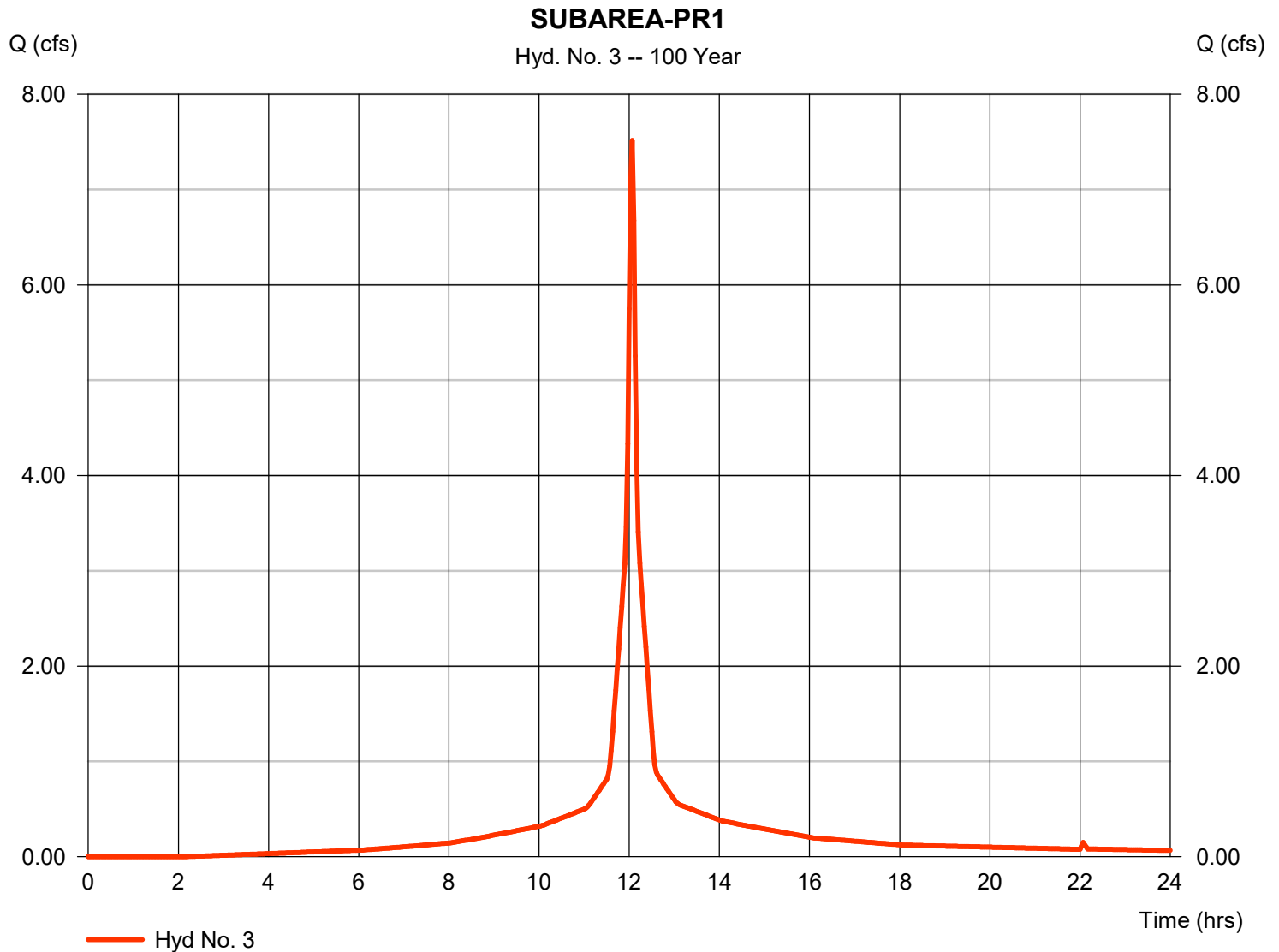
Friday, 07 / 1 / 2022

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	= SCS Runoff	Peak discharge	= 7.516 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 24,693 cuft
Drainage area	= 0.950 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.716 x 98) + (0.234 x 74)] / 0.950



Hydrograph Report

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

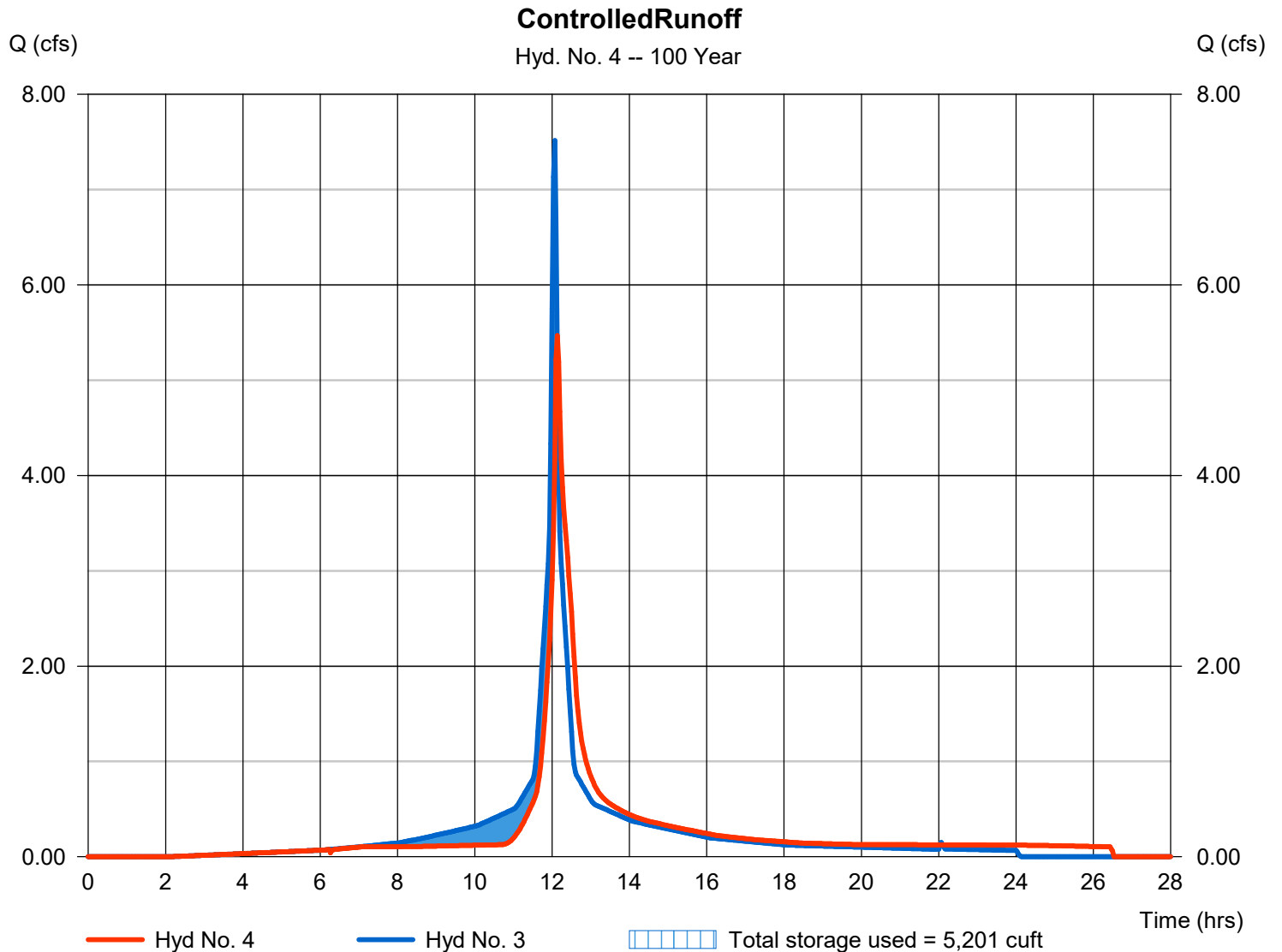
Friday, 07 / 1 / 2022

Hyd. No. 4

ControlledRunoff

Hydrograph type	= Reservoir	Peak discharge	= 5.468 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 24,695 cuft
Inflow hyd. No.	= 3 - SUBAREA-PR1	Max. Elevation	= 101.45 ft
Reservoir name	= Sand Filter	Max. Storage	= 5,201 cuft

Storage Indication method used.



Hydrograph Report

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

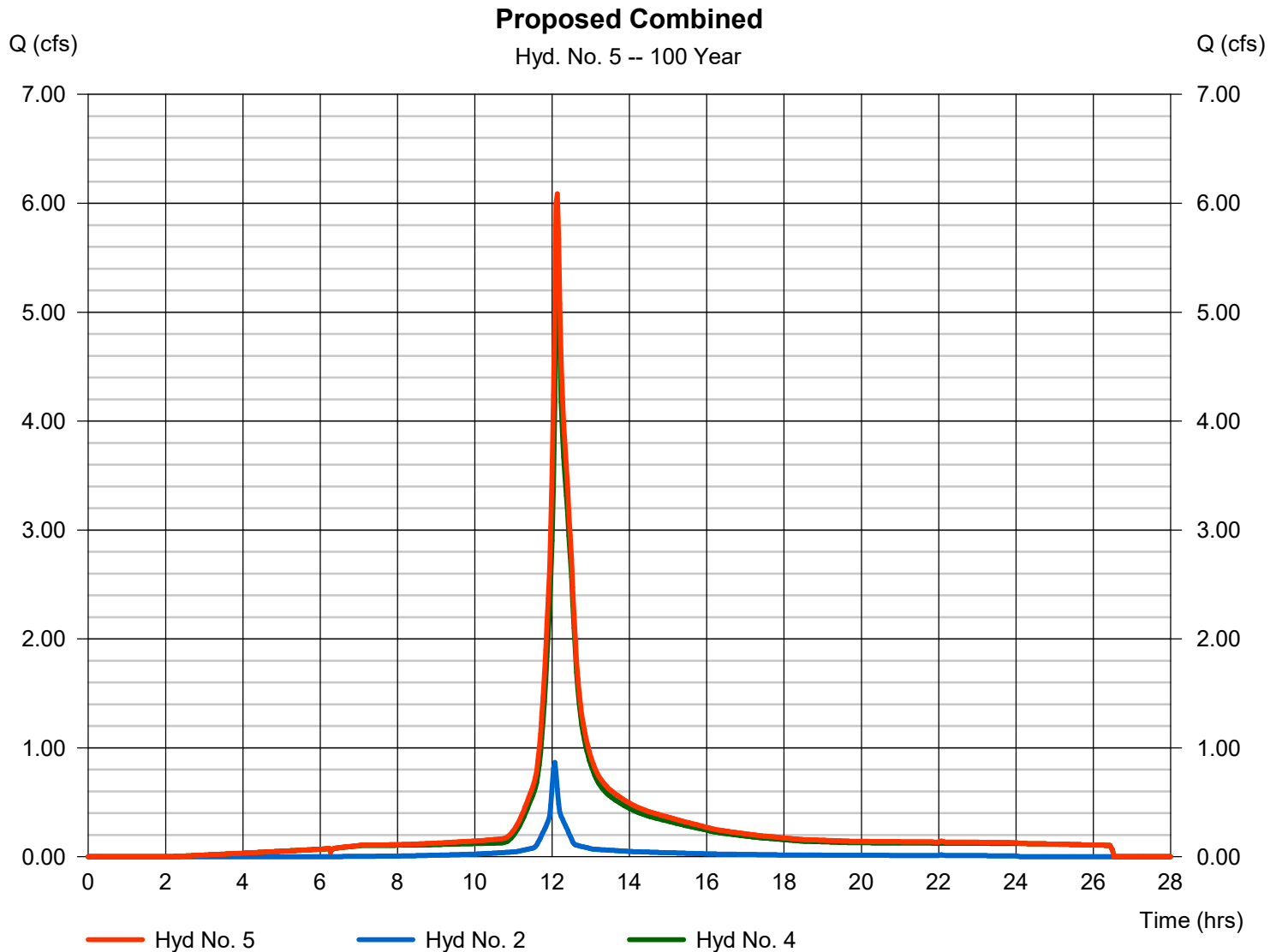
Friday, 07 / 1 / 2022

Hyd. No. 5

Proposed Combined

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 2, 4

Peak discharge = 6.087 cfs
Time to peak = 12.13 hrs
Hyd. volume = 27,326 cuft
Contrib. drain. area = 0.130 ac





Appendix H
Hydraflow Hydrographs – 1.2” Storm

Watershed Model Schematic..... 1

Hydrograph Return Period Recap..... 2

1.2" Storm

Summary Report..... 3

Hydrograph Reports..... 4

 Hydrograph No. 1, SCS Runoff, SUBAREA-EX1..... 4

 Hydrograph No. 2, SCS Runoff, SUBAREA-PUN1..... 5

 Hydrograph No. 3, SCS Runoff, SUBAREA-PR1..... 6

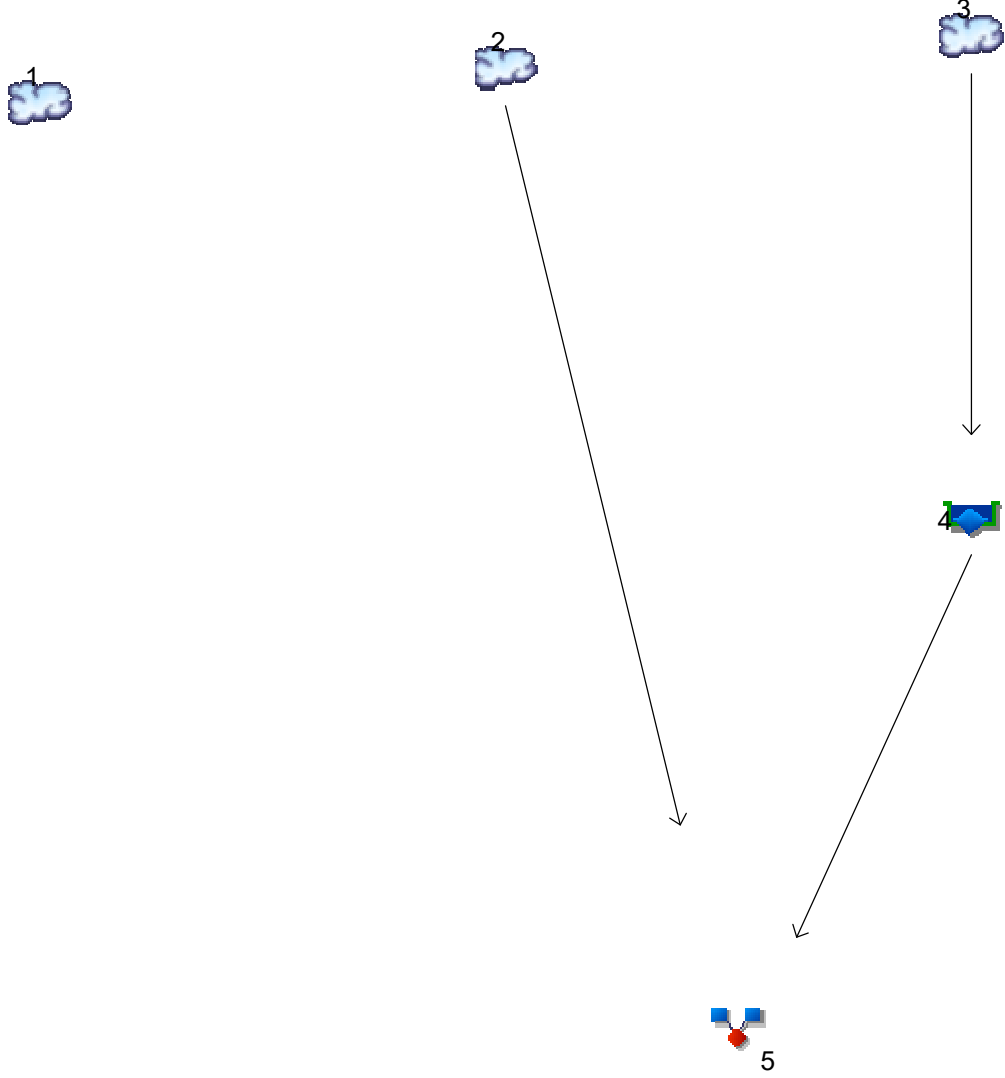
 Hydrograph No. 4, Reservoir, ControlledRunoff..... 7

 Pond Report - Sand Filter..... 8

 Hydrograph No. 5, Combine, Proposed Combined..... 10

Watershed Model Schematic

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



Legend

Hyd. Origin	Description
1	SCS Runoff SUBAREA-EX1
2	SCS Runoff SUBAREA-PUN1
3	SCS Runoff SUBAREA-PR1
4	Reservoir ControlledRunoff
5	Combine Proposed Combined

Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	1.2"St	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	0.034	-----	-----	-----	-----	-----	SUBAREA-EX1
2	SCS Runoff	-----	-----	-----	0.007	-----	-----	-----	-----	-----	SUBAREA-PUN1
3	SCS Runoff	-----	-----	-----	1.017	-----	-----	-----	-----	-----	SUBAREA-PR1
4	Reservoir	3	-----	-----	0.122	-----	-----	-----	-----	-----	ControlledRunoff
5	Combine	2, 4	-----	-----	0.127	-----	-----	-----	-----	-----	Proposed Combined

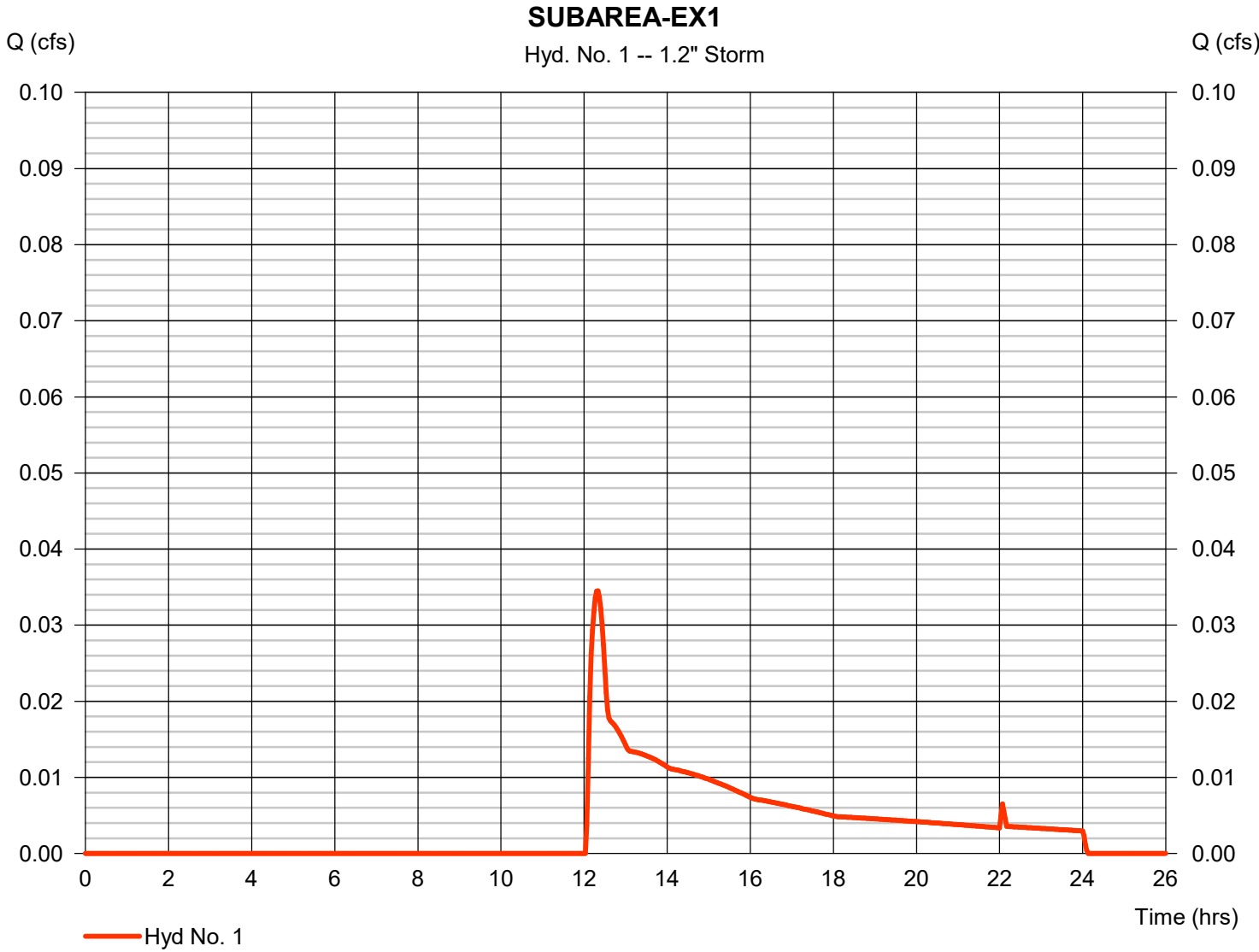
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.034 cfs
Storm frequency	= 1.2"Storm	Time to peak	= 12.33 hrs
Time interval	= 2 min	Hyd. volume	= 319 cuft
Drainage area	= 1.080 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 98) + (1.010 x 74)] / 1.080



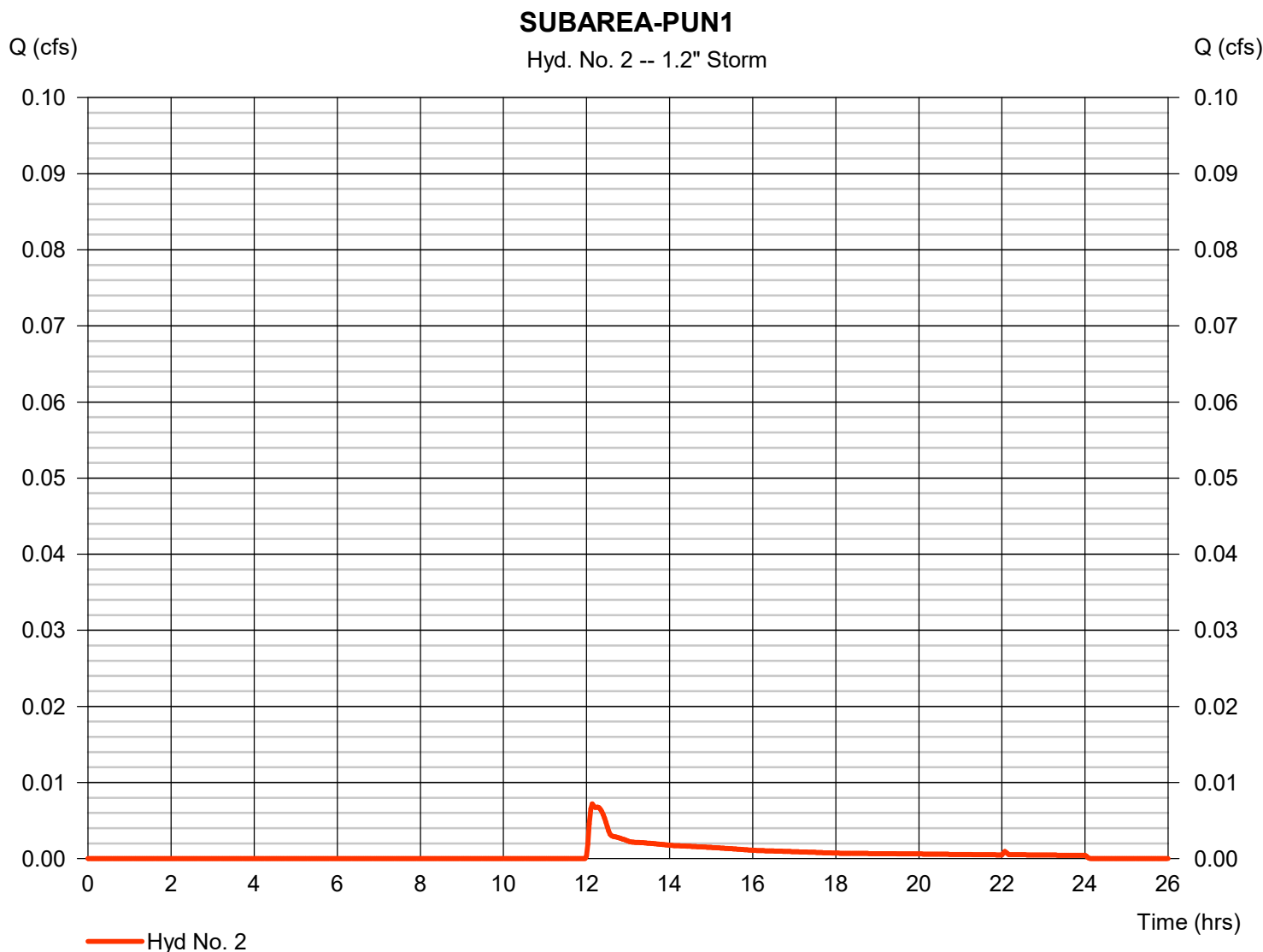
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.007 cfs
Storm frequency	= 1.2" Storm	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 52 cuft
Drainage area	= 0.130 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.024 x 98) + (0.106 x 74)] / 0.130



Hydrograph Report

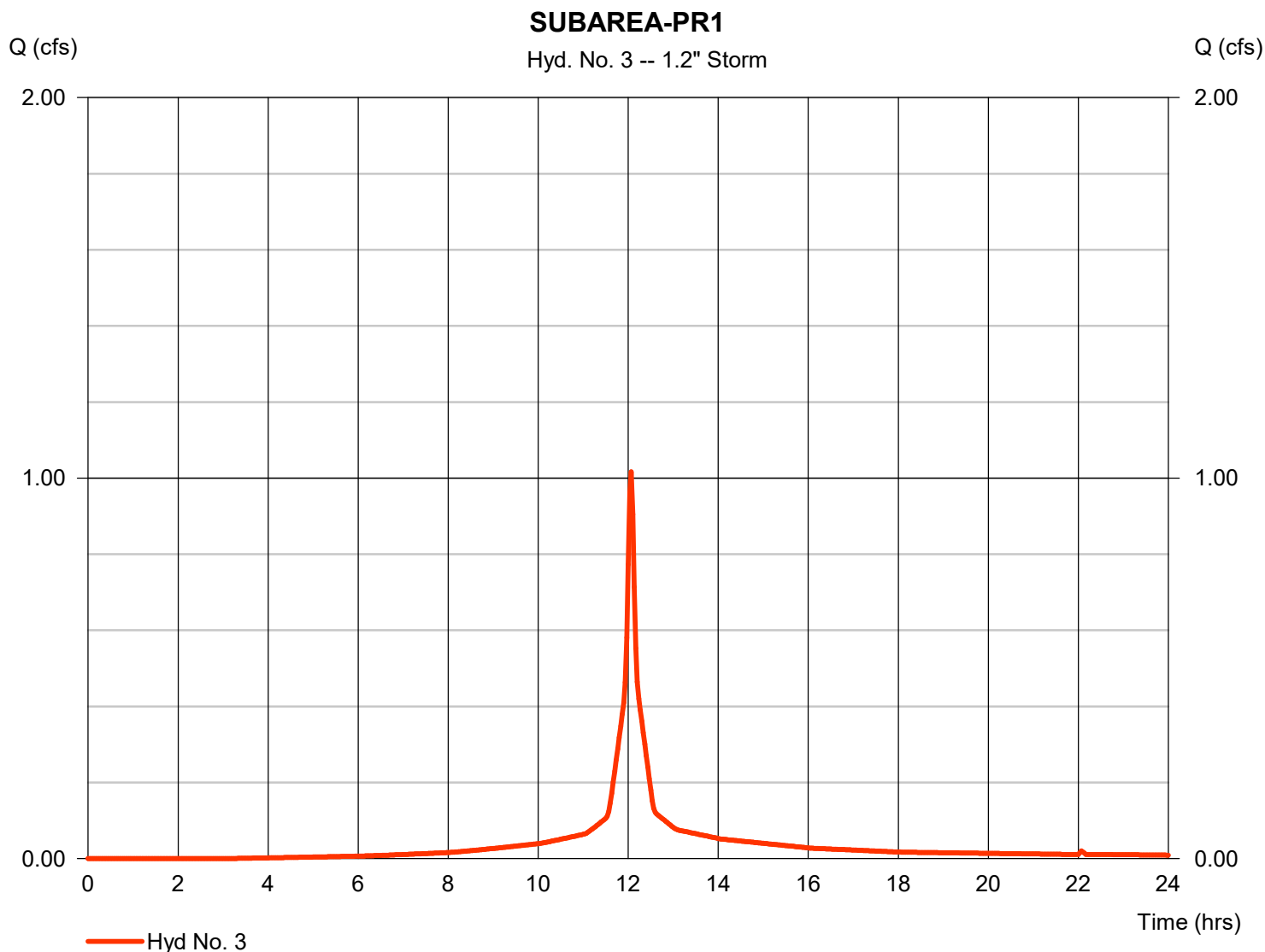
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Friday, 07 / 1 / 2022

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.017 cfs
Storm frequency	= 1.2" Storm	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 3,249 cuft
Drainage area	= 0.950 ac	Curve number	= 98.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

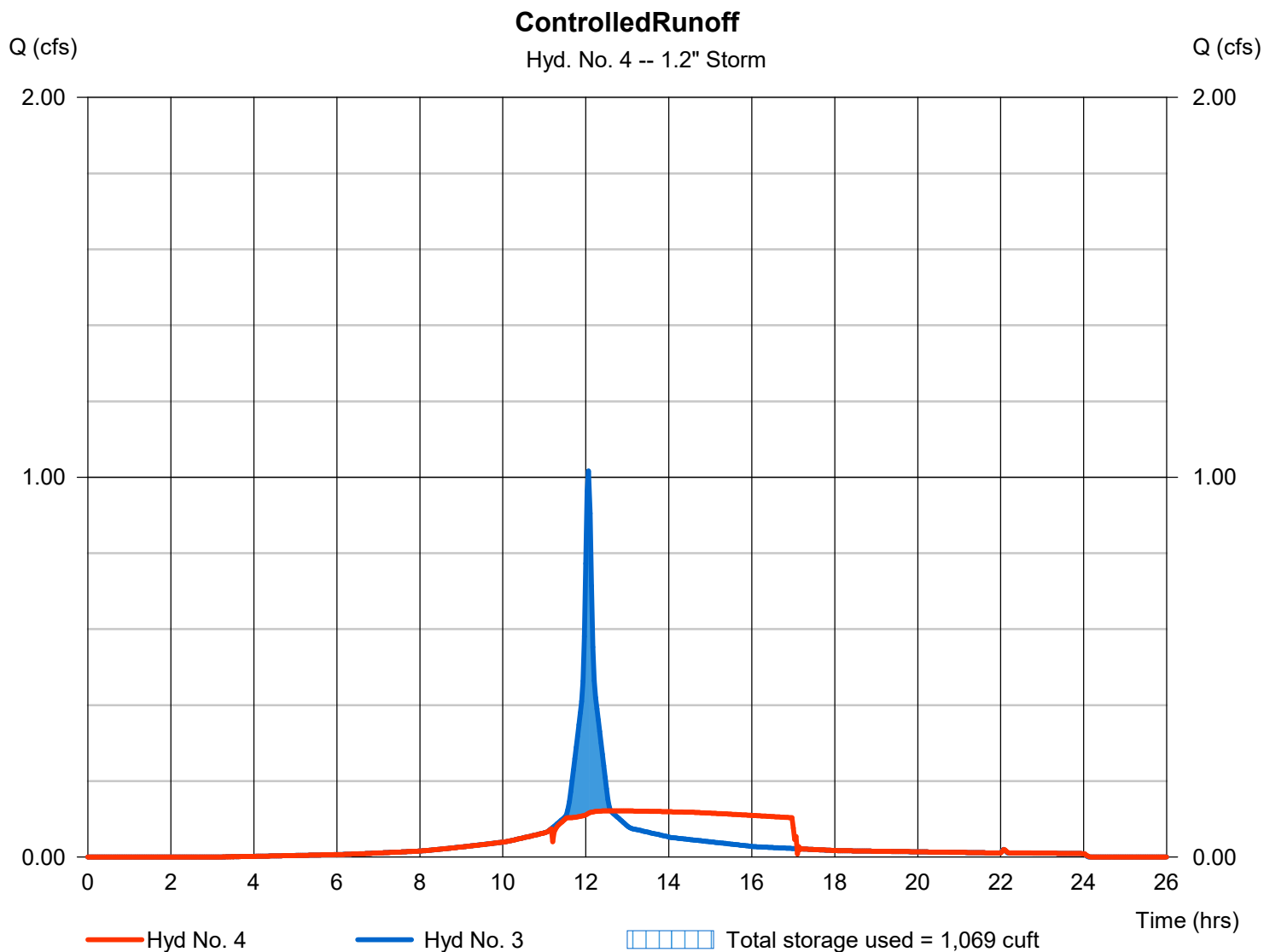
Friday, 07 / 1 / 2022

Hyd. No. 4

ControlledRunoff

Hydrograph type	= Reservoir	Peak discharge	= 0.122 cfs
Storm frequency	= 1.2" Storm	Time to peak	= 12.60 hrs
Time interval	= 2 min	Hyd. volume	= 3,249 cuft
Inflow hyd. No.	= 3 - SUBAREA-PR1	Max. Elevation	= 99.40 ft
Reservoir name	= Sand Filter	Max. Storage	= 1,069 cuft

Storage Indication method used.



Pond No. 2 - Sand Filter

Pond Data

UG Chambers -Invert elev. = 99.00 ft, Rise x Span = 2.50 x 4.25 ft, Barrel Len = 21.35 ft, No. Barrels = 21, Slope = 0.00%, Headers = Yes
Encasement -Invert elev. = 97.00 ft, Width = 4.25 ft, Height = 4.50 ft, Voids = 0.33%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	97.00	n/a	0	0
0.45	97.45	n/a	4	4
0.90	97.90	n/a	4	8
1.35	98.35	n/a	4	12
1.80	98.80	n/a	4	16
2.25	99.25	n/a	667	683
2.70	99.70	n/a	1,176	1,858
3.15	100.15	n/a	1,112	2,970
3.60	100.60	n/a	999	3,970
4.05	101.05	n/a	816	4,785
4.50	101.50	n/a	469	5,254

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 3.00	8.00	12.00	0.00
Span (in)	= 3.00	8.00	12.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 97.00	100.83	99.60	0.00
Length (ft)	= 107.00	107.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

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

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

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	97.00	0.00	0.00	0.00	---	---	---	---	---	---	---	0.000
0.04	0	97.04	0.00 ic	0.00	0.00	---	---	---	---	---	---	---	0.004
0.09	1	97.09	0.02 ic	0.00	0.00	---	---	---	---	---	---	---	0.016
0.13	1	97.13	0.03 ic	0.00	0.00	---	---	---	---	---	---	---	0.034
0.18	2	97.18	0.05 ic	0.00	0.00	---	---	---	---	---	---	---	0.055
0.22	2	97.22	0.08 ic	0.00	0.00	---	---	---	---	---	---	---	0.075
0.27	2	97.27	0.01 oc	0.00	0.00	---	---	---	---	---	---	---	0.012
0.31	3	97.31	0.02 oc	0.00	0.00	---	---	---	---	---	---	---	0.021
0.36	3	97.36	0.03 oc	0.00	0.00	---	---	---	---	---	---	---	0.028
0.40	4	97.40	0.03 oc	0.00	0.00	---	---	---	---	---	---	---	0.033
0.45	4	97.45	0.04 oc	0.00	0.00	---	---	---	---	---	---	---	0.037
0.49	4	97.49	0.04 oc	0.00	0.00	---	---	---	---	---	---	---	0.041
0.54	5	97.54	0.04 oc	0.00	0.00	---	---	---	---	---	---	---	0.045
0.58	5	97.58	0.05 oc	0.00	0.00	---	---	---	---	---	---	---	0.048
0.63	6	97.63	0.05 oc	0.00	0.00	---	---	---	---	---	---	---	0.051
0.68	6	97.67	0.05 oc	0.00	0.00	---	---	---	---	---	---	---	0.054
0.72	6	97.72	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.057
0.77	7	97.76	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.060
0.81	7	97.81	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.062
0.86	8	97.85	0.06 oc	0.00	0.00	---	---	---	---	---	---	---	0.065
0.90	8	97.90	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.067
0.94	8	97.94	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.069
0.99	9	97.99	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.072
1.03	9	98.03	0.07 oc	0.00	0.00	---	---	---	---	---	---	---	0.074
1.08	9	98.08	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.076
1.12	10	98.12	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.078
1.17	10	98.17	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.080
1.21	11	98.21	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.082
1.26	11	98.26	0.08 oc	0.00	0.00	---	---	---	---	---	---	---	0.084
1.30	11	98.30	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.085
1.35	12	98.35	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.087
1.39	12	98.39	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.089

Continues on next page...

Sand Filter

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.44	13	98.44	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.091
1.48	13	98.48	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.092
1.53	13	98.53	0.09 oc	0.00	0.00	---	---	---	---	---	---	---	0.094
1.57	14	98.57	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.096
1.62	14	98.62	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.097
1.66	15	98.66	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.099
1.71	15	98.71	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.100
1.75	15	98.75	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.102
1.80	16	98.80	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.103
1.85	83	98.85	0.10 oc	0.00	0.00	---	---	---	---	---	---	---	0.105
1.89	149	98.89	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.106
1.93	216	98.93	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.108
1.98	283	98.98	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.109
2.02	349	99.02	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.111
2.07	416	99.07	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.112
2.12	483	99.11	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.114
2.16	549	99.16	0.11 oc	0.00	0.00	---	---	---	---	---	---	---	0.115
2.21	616	99.20	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.116
2.25	683	99.25	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.118
2.30	800	99.29	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.119
2.34	918	99.34	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.120
2.39	1,035	99.38	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.121
2.43	1,153	99.43	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.123
2.48	1,270	99.47	0.12 oc	0.00	0.00	---	---	---	---	---	---	---	0.124
2.52	1,388	99.52	0.13 oc	0.00	0.00	---	---	---	---	---	---	---	0.125
2.57	1,505	99.56	0.13 oc	0.00	0.00	---	---	---	---	---	---	---	0.126
2.61	1,623	99.61	0.13 oc	0.00	0.00 ic	---	---	---	---	---	---	---	0.128
2.66	1,741	99.65	0.13 oc	0.00	0.01 ic	---	---	---	---	---	---	---	0.142
2.70	1,858	99.70	0.13 oc	0.00	0.04 ic	---	---	---	---	---	---	---	0.174
2.75	1,969	99.74	0.13 oc	0.00	0.09 ic	---	---	---	---	---	---	---	0.223
2.79	2,081	99.79	0.13 oc	0.00	0.15 ic	---	---	---	---	---	---	---	0.287
2.84	2,192	99.83	0.13 oc	0.00	0.23 ic	---	---	---	---	---	---	---	0.366
2.88	2,303	99.88	0.13 oc	0.00	0.32 ic	---	---	---	---	---	---	---	0.459
2.93	2,414	99.92	0.14 oc	0.00	0.43 ic	---	---	---	---	---	---	---	0.566
2.97	2,525	99.97	0.14 oc	0.00	0.55 ic	---	---	---	---	---	---	---	0.685
3.02	2,637	100.01	0.14 oc	0.00	0.68 ic	---	---	---	---	---	---	---	0.815
3.06	2,748	100.06	0.14 oc	0.00	0.81 ic	---	---	---	---	---	---	---	0.954
3.11	2,859	100.10	0.14 oc	0.00	0.96 ic	---	---	---	---	---	---	---	1.104
3.15	2,970	100.15	0.14 oc	0.00	1.12 ic	---	---	---	---	---	---	---	1.260
3.20	3,070	100.19	0.14 oc	0.00	1.28 ic	---	---	---	---	---	---	---	1.423
3.24	3,170	100.24	0.14 oc	0.00	1.45 ic	---	---	---	---	---	---	---	1.590
3.29	3,270	100.28	0.14 oc	0.00	1.62 ic	---	---	---	---	---	---	---	1.762
3.33	3,370	100.33	0.15 oc	0.00	1.79 ic	---	---	---	---	---	---	---	1.934
3.38	3,470	100.37	0.15 oc	0.00	1.96 ic	---	---	---	---	---	---	---	2.105
3.42	3,570	100.42	0.15 oc	0.00	2.13 ic	---	---	---	---	---	---	---	2.274
3.47	3,670	100.46	0.15 oc	0.00	2.29 ic	---	---	---	---	---	---	---	2.435
3.51	3,770	100.51	0.15 oc	0.00	2.44 ic	---	---	---	---	---	---	---	2.588
3.56	3,870	100.55	0.15 oc	0.00	2.57 ic	---	---	---	---	---	---	---	2.723
3.60	3,970	100.60	0.15 oc	0.00	2.67 ic	---	---	---	---	---	---	---	2.826
3.65	4,051	100.64	0.15 oc	0.00	2.79 ic	---	---	---	---	---	---	---	2.945
3.69	4,133	100.69	0.15 oc	0.00	2.90 ic	---	---	---	---	---	---	---	3.059
3.74	4,214	100.73	0.16 oc	0.00	3.01 ic	---	---	---	---	---	---	---	3.168
3.78	4,296	100.78	0.16 oc	0.00	3.12 ic	---	---	---	---	---	---	---	3.274
3.83	4,377	100.82	0.16 oc	0.00	3.22 ic	---	---	---	---	---	---	---	3.377
3.87	4,459	100.87	0.16 oc	0.01 ic	3.32 ic	---	---	---	---	---	---	---	3.482
3.92	4,540	100.91	0.16 oc	0.03 ic	3.41 ic	---	---	---	---	---	---	---	3.598
3.96	4,622	100.96	0.16 oc	0.06 ic	3.51 ic	---	---	---	---	---	---	---	3.726
4.01	4,704	101.00	0.16 oc	0.10 ic	3.60 ic	---	---	---	---	---	---	---	3.862
4.05	4,785	101.05	0.16 oc	0.16 ic	3.69 ic	---	---	---	---	---	---	---	4.008
4.10	4,832	101.10	0.16 oc	0.23 ic	3.77 ic	---	---	---	---	---	---	---	4.162
4.14	4,879	101.14	0.16 oc	0.30 ic	3.86 ic	---	---	---	---	---	---	---	4.322
4.19	4,926	101.18	0.16 oc	0.38 ic	3.94 ic	---	---	---	---	---	---	---	4.487
4.23	4,973	101.23	0.17 oc	0.47 ic	4.02 ic	---	---	---	---	---	---	---	4.657
4.28	5,020	101.27	0.17 oc	0.56 ic	4.10 ic	---	---	---	---	---	---	---	4.828
4.32	5,066	101.32	0.17 oc	0.66 ic	4.18 ic	---	---	---	---	---	---	---	5.000
4.37	5,113	101.36	0.17 oc	0.75 ic	4.25 ic	---	---	---	---	---	---	---	5.169
4.41	5,160	101.41	0.17 oc	0.84 ic	4.33 ic	---	---	---	---	---	---	---	5.334
4.46	5,207	101.45	0.17 oc	0.92 ic	4.40 ic	---	---	---	---	---	---	---	5.487
4.50	5,254	101.50	0.17 oc	0.06 oc	4.47 ic	---	---	---	---	---	---	---	4.706

...End

Hydrograph Report

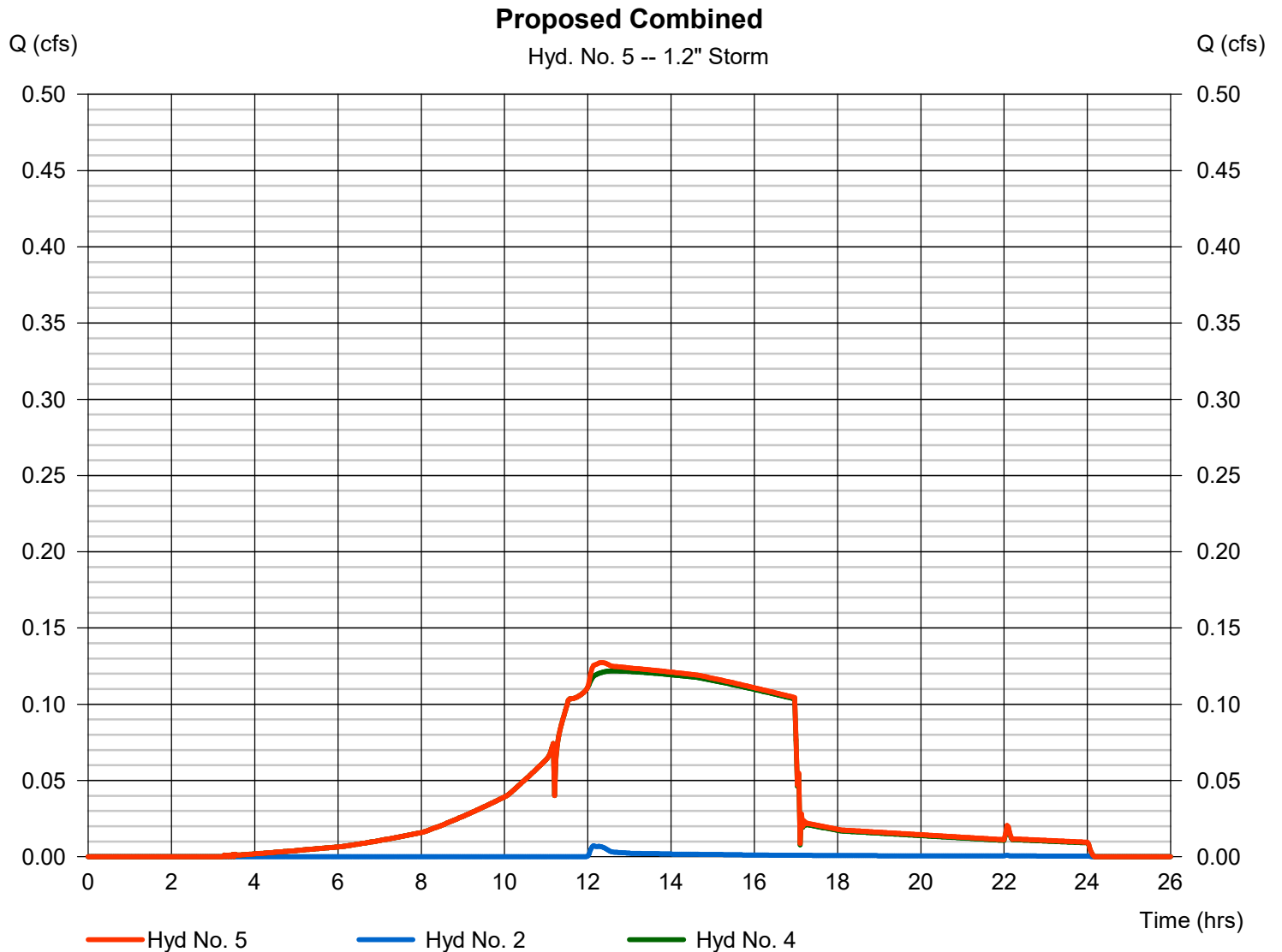
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Friday, 07 / 1 / 2022

Hyd. No. 5

Proposed Combined

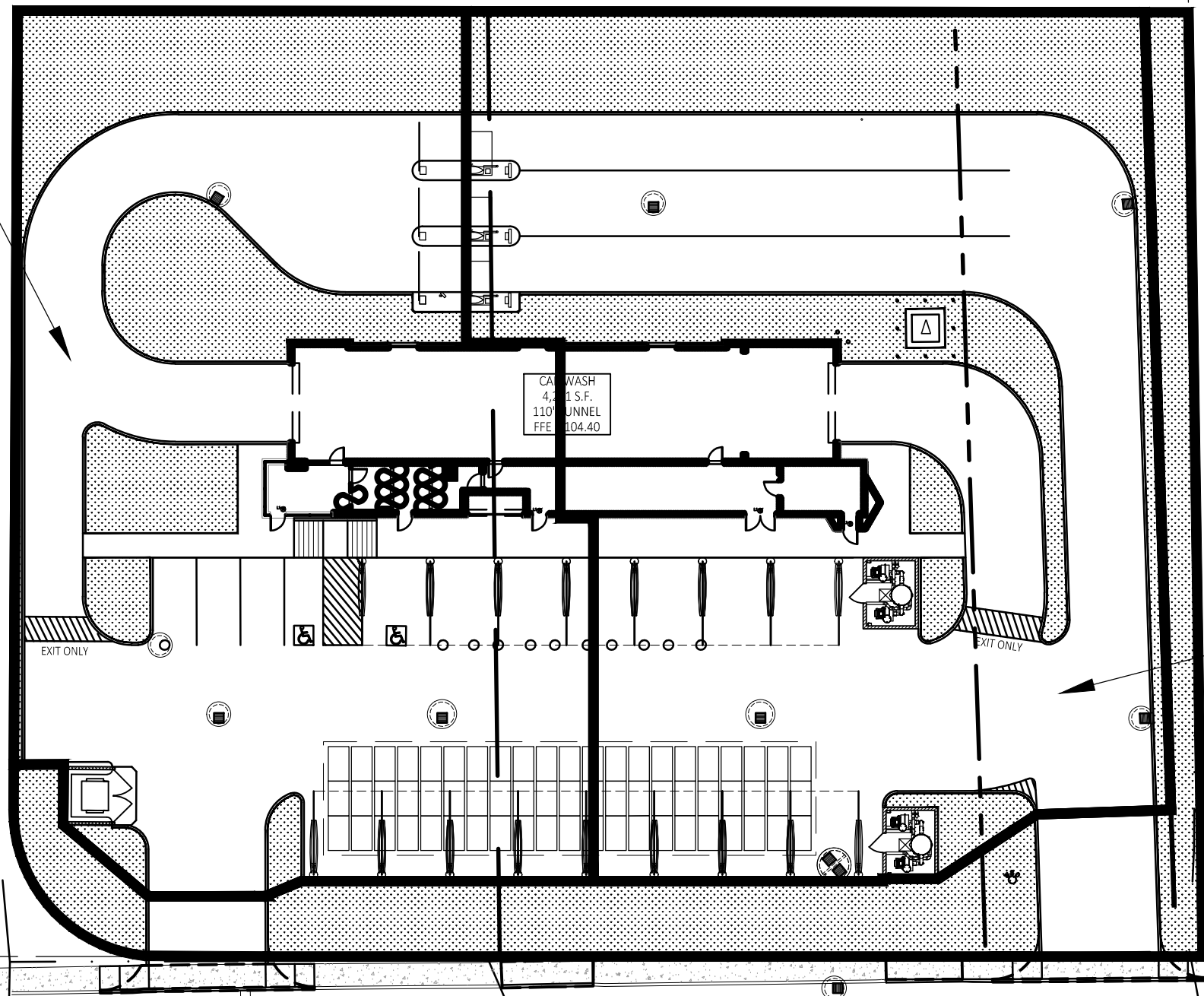
Hydrograph type	= Combine	Peak discharge	= 0.127 cfs
Storm frequency	= 1.2" Storm	Time to peak	= 12.33 hrs
Time interval	= 2 min	Hyd. volume	= 3,301 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 0.130 ac





Appendix I
Contech CCS Sizing Areas Exhibit

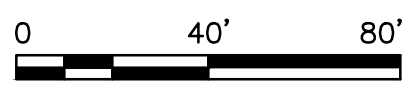
SUBAREA-CCS1	
TOTAL AREA:	0.44 AC
IMPERVIOUS:	0.33 AC
PERVIOUS:	0.11 AC
% IMPERVIOUS:	75.00%
CN VALUE:	98.23
Tc:	5 MIN.



SUBAREA-CCS2	
TOTAL AREA:	0.51 AC
IMPERVIOUS:	0.39 AC
PERVIOUS:	0.12 AC
% IMPERVIOUS:	76.47%
CN VALUE:	98.23
Tc:	5 MIN.

CDS SIZING AREAS

SCALE: 1" = 40'-0"



sevan
ENGINEERING

Regional Office:
37704 Hills Tech Drive
Farmington Hills, MI 48331
734.367.4445 Telephone

Corporate Office:
3025 Highland Parkway, Suite 850
Downers Grove, IL 60515
info@sevansolutions.com www.sevansolutions.com

INTEGRITY | RESPECT | TEAMWORK | EXCELLENCE | CHARITY

CUSTOMER

Washville
Your Hometown Car Wash

PROJECT LOCATION

991-995 W. MAIN ROAD
MIDDLETOWN, RI 02842
(NEWPORT COUNTY)

SHEET MANAGEMENT	
PROJECT NO.:	MIDDLETOWN
DATE:	06.30.2022
CRITERIA:	
PROJECT MANAGER:	T. KRATZ
THIS DOCUMENT IS AND SHALL REMAIN THE PROPERTY OF SEVAN MULTI-SITE SOLUTIONS, INC. REPRODUCTION OR ALTERATION OF THIS DOCUMENT WITHOUT THE EXPRESSED WRITTEN PERMISSION OF SEVAN MULTI-SITE SOLUTIONS, INC. IS PROHIBITED. (NOT PUBLISHED: ALL RIGHTS RESERVED.) COPYRIGHT BY SEVAN MULTI-SITE SOLUTIONS, INC. 2022	

REVISIONS		
NO.	DATE	DESCRIPTION

SHEET TITLE	
CCS SIZING AREAS	
SHEET NUMBER	
CCSSA	



Appendix J

Hydraflow Hydrographs – CCS Sizing with Modified CN

Watershed Model Schematic.....	1
Hydrograph Return Period Recap.....	2
1.2" Storm	
Summary Report.....	3
Hydrograph Reports.....	4
Hydrograph No. 1, SCS Runoff, SUBAREA-CCS1.....	4
Hydrograph No. 2, SCS Runoff, SUBAREA-CCS2.....	5
100 - Year	
Summary Report.....	6
Hydrograph Reports.....	7
Hydrograph No. 1, SCS Runoff, SUBAREA-CCS1.....	7
Hydrograph No. 2, SCS Runoff, SUBAREA-CCS2.....	8

Watershed Model Schematic

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



Legend

<u>Hyd.</u>	<u>Origin</u>	<u>Description</u>
1	SCS Runoff	SUBAREA-CCS1
2	SCS Runoff	SUBAREA-CCS2

Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	1.2" St	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	0.471	-----	-----	-----	-----	3.583	SUBAREA-CCS1
2	SCS Runoff	-----	-----	-----	0.546	-----	-----	-----	-----	4.153	SUBAREA-CCS2

Hydrograph Summary Report

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

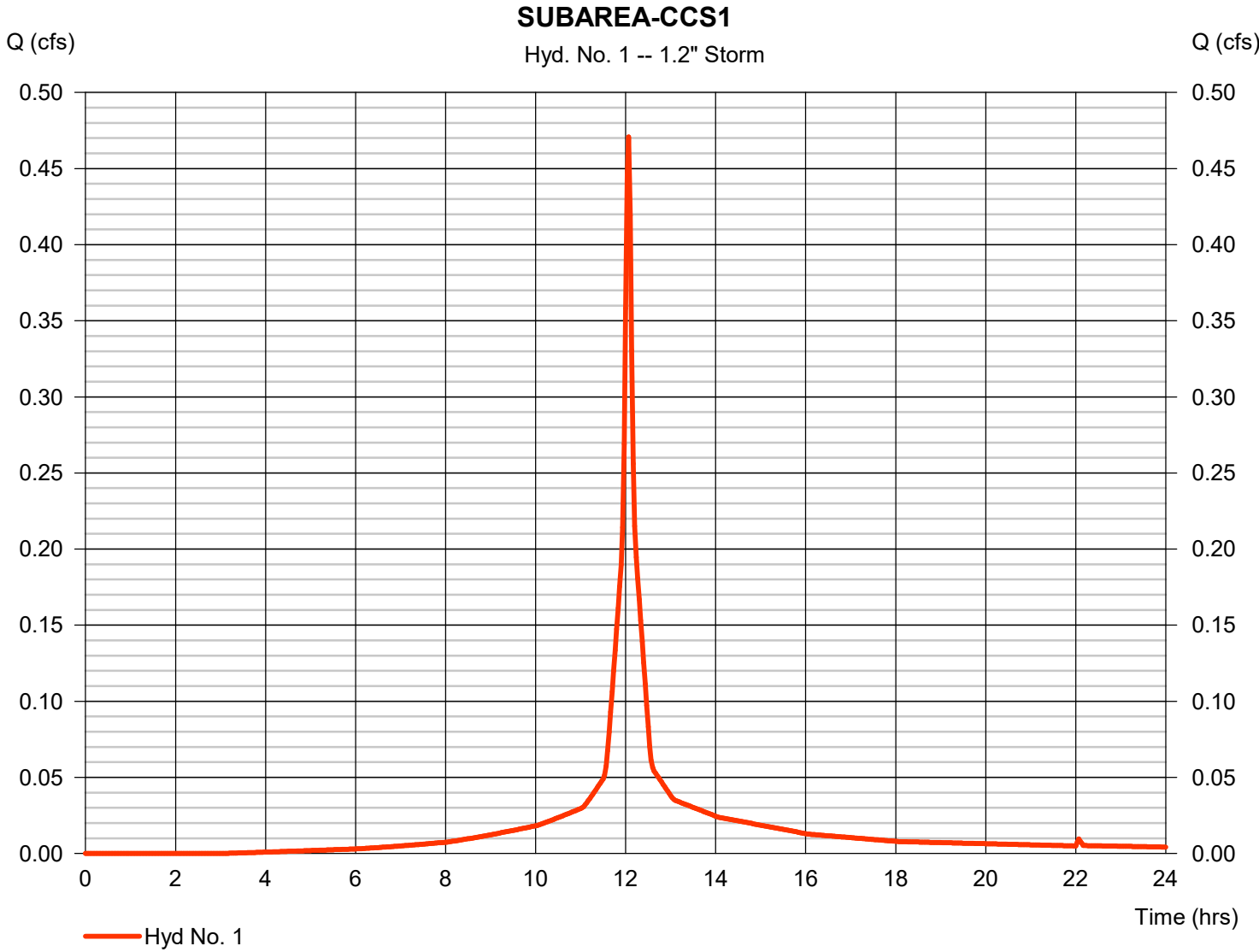
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.471	2	724	1,505	-----	-----	-----	SUBAREA-CCS1
2	SCS Runoff	0.546	2	724	1,744	-----	-----	-----	SUBAREA-CCS2
Washville_Middletown_RI_Storm_CCSSizing.gpr Return Period: 1.2" Storm									Friday, 07 / 1 / 2022

Hydrograph Report

Hyd. No. 1

SUBAREA-CCS1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.471 cfs
Storm frequency	= 1.2" Storm	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 1,505 cuft
Drainage area	= 0.440 ac	Curve number	= 98.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

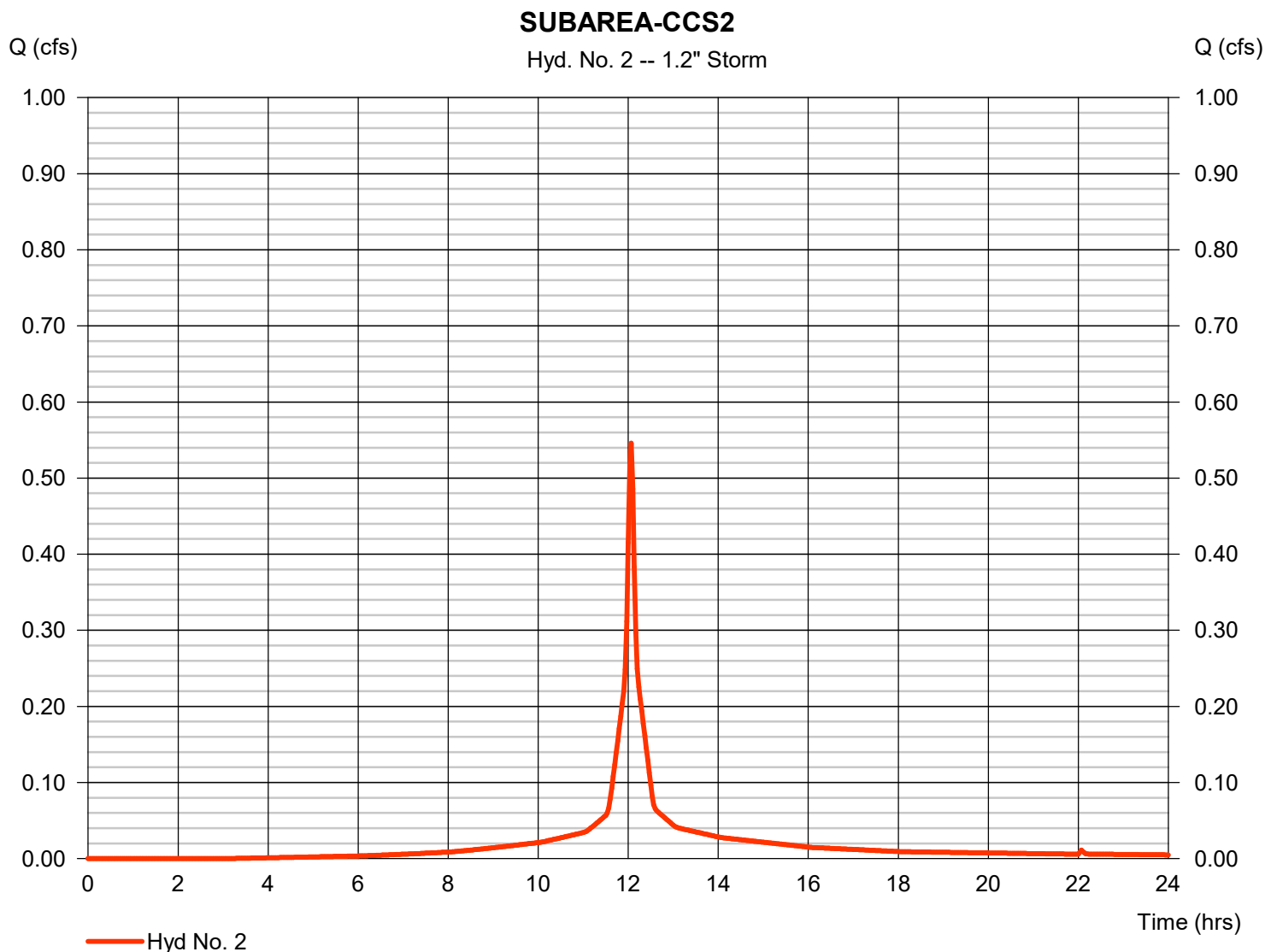
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Friday, 07 / 1 / 2022

Hyd. No. 2

SUBAREA-CCS2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.546 cfs
Storm frequency	= 1.2" Storm	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 1,744 cuft
Drainage area	= 0.510 ac	Curve number	= 98.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

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

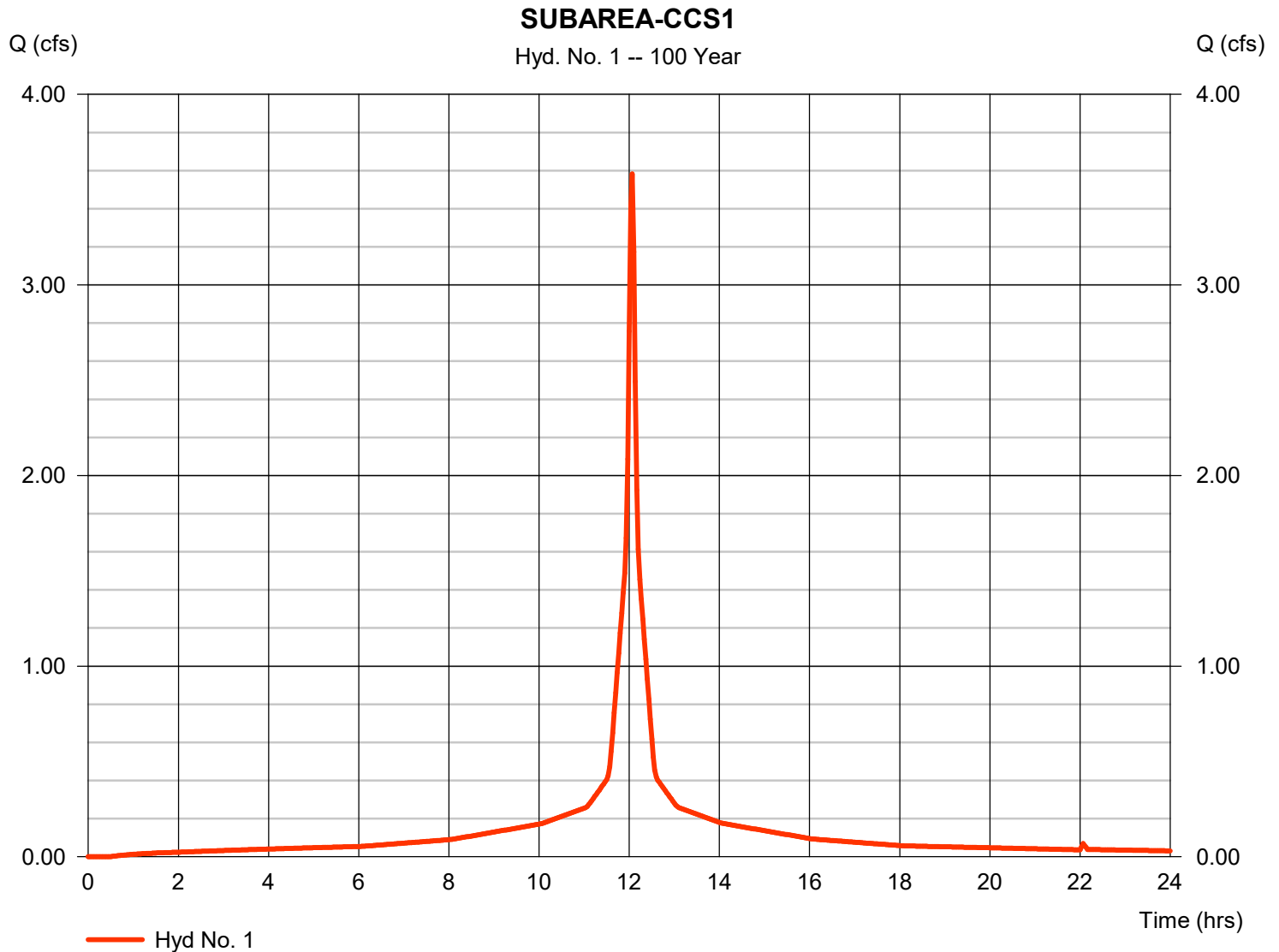
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.583	2	724	12,554	-----	-----	-----	SUBAREA-CCS1
2	SCS Runoff	4.153	2	724	14,551	-----	-----	-----	SUBAREA-CCS2
Washville_Middletown_RI_Storm_CCSSizing.gpr						Return Period: 100 Year			Friday, 07 / 1 / 2022

Hydrograph Report

Hyd. No. 1

SUBAREA-CCS1

Hydrograph type	= SCS Runoff	Peak discharge	= 3.583 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 12,554 cuft
Drainage area	= 0.440 ac	Curve number	= 98.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

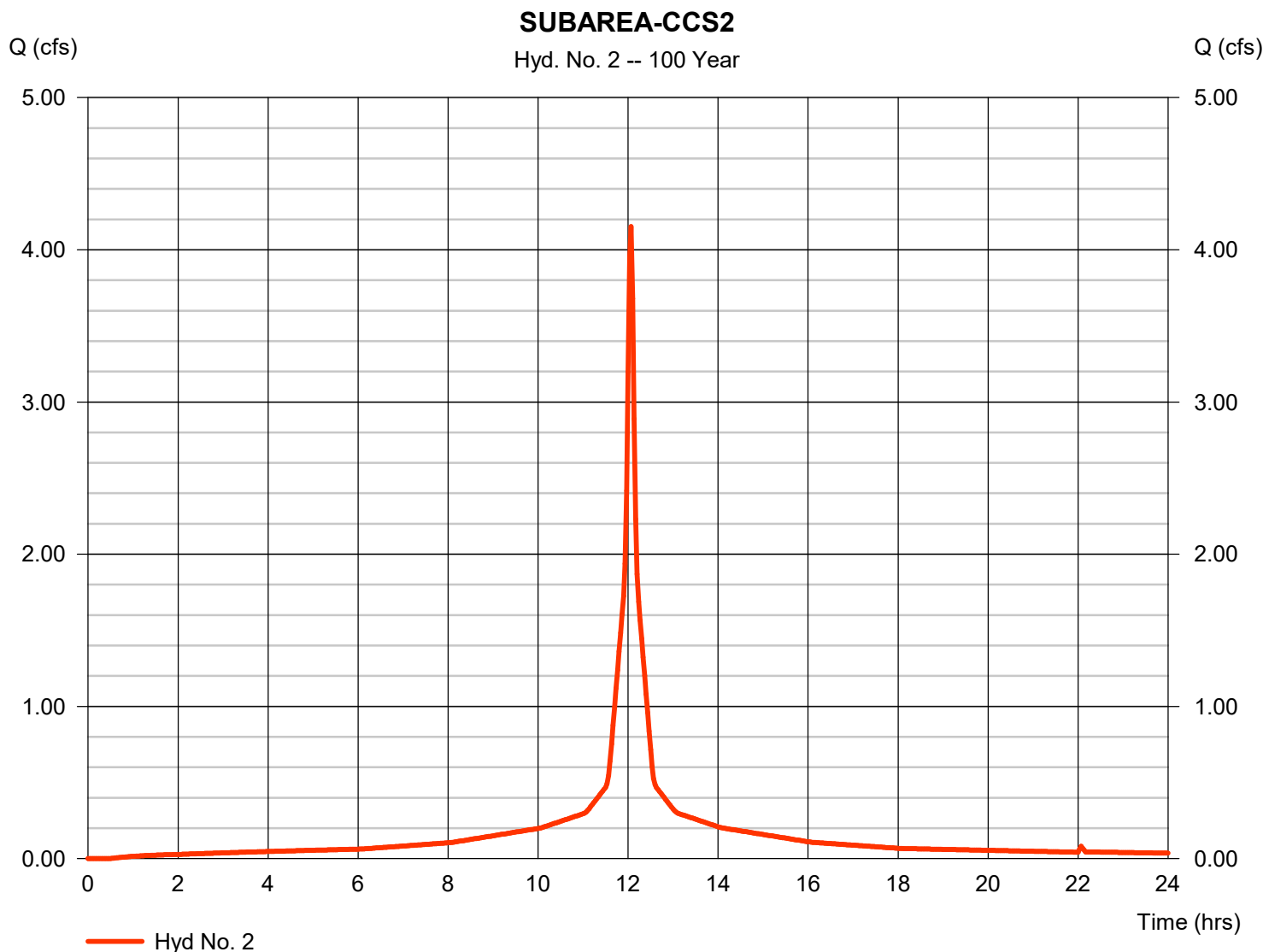
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Friday, 07 / 1 / 2022

Hyd. No. 2

SUBAREA-CCS2

Hydrograph type	= SCS Runoff	Peak discharge	= 4.153 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 14,551 cuft
Drainage area	= 0.510 ac	Curve number	= 98.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484





Appendix K
Water Quality Calculations Sheets

Water Quality Volume Calculation WorkSheet

This worksheet is designed to assist the project engineer with a determination of the required water quality treatment area. The worksheet leads the designer through redevelopment applicability first and then receiving water requirements. This tool is intended to compliment to the Redevelopment Criteria Guidance and the Water Quality Guidance and assist both the designer and the permit application reviewer towards consistent results. Enter information into only the **YELLOW** Boxes.

[Redevelopment Criteria Guidance](#)

[Water Quality Goals "Stormwater Compensation Method"](#)

Step 1 - Determine which office in OWR you are applying to: [Application Guidance](#)

Step 2 - Site Information value/calculation units

Total Site Area (total area of project parcels)	TS	1.08	acres
Total Jurisdictional Wetlands and/or floodplain within the above TSA	JW1	0.00	acres
Existing impervious also within the Jurisdictional Wetlands	-JW2	0.00	acres
Conservation Land within the TSA		0.00	acres
Site Size = (TSA)-(JW1-JW2)-CL	SS=	1.08	acres

Step 3 - Redevelopment Applicability

Total Impervious Area (pre-construction)	TIA=	0.07	acres
% Impervious (if ≥40% - redevelopment standard 3.2.6 applies)		0.06	

REPEAT IF NECESSARY Steps 4, 5 and 6 for EACH Waterbody ID (RIVER-ID as found in the GIS Map Server)

Step 4 - Receiving waterbody information

Waterbody ID or RIVER ID from GIS Map Server	
Waterbody Name from GIS Map Server	
Name the sub-watersheds (design-points) contributing to this Waterbody ID	
Is this Waterbody Impaired/TMDL for any Phosphorus, Metals or Bacteria?	YES
Is this Waterbody Impaired for Nitrogen?	NO

Step 5 - Pre-Post Construction Conditions to the Waterbody

Total Pre-Construction Impervious Surface to this Waterbody ID	0.07	acres
Total Disturbed Existing Impervious (DI)	0.07	acres
Total Post-Construction Impervious to this Waterbody ID	0.74	acres
Net Increased Impervious (NII)	0.67	acres

Step 6 - Infiltration and BMP information - Note: Increasing infiltration will likely decrease stormwater treatment area for Metals, Bacteria and Phosphorus

I am proposing to infiltrate this percentage WQv to this WBID	0%	%
I am proposing this number of BMP's	2	#

RESULTS - Select the Larger Number of the 2 numbers provided

Applicable Condition	Min Water Quality Treatment Area	Min Treatment w/o WQ consideration
No Impairment or TMDL - New Development		
No Impairment or TMDL - Redevelopment		
Only Phosphorus, Metals or Bacteria Impairment - New Development	1.34	0.74
Only Phosphorus, Metals or Bacteria Impairment - Redevelopment		
Nitrogen Impairment - New Development		
Nitrogen Impairment - Redevelopment		
REQUIRED STORMWATER TREATMENT AREA	1.3	acres

* Enter the name of the STP (both type and label) which has been designed to treat this particular Rev or Rea.

RHODE ISLAND STORMWATER DESIGN AND INSTALLATION STANDARDS MANUAL

WATER QUALITY CALCULATIONS

TOTAL REQUIRED WATER QUALITY FOR THE SITE

90% Rainfall Event Number	P=	1.2 in
Rainfall Intensity	I=	1.0 in
Impervious Area to be Treated	Ai=	1.3 Ac
Water Quality Volume Required	Wqv=	4719 c.f.

WATER QUALITY PEAK FLOW CALCULATION

90% Rainfall Event Number	P=	1.2 in
Area	A=	1.3 Ac
Water Quality Volume	Wqv=	4719 c.f.
Runoff Volume	Q=	1.01 in
Curve Number	CN=	98.23
Ia = (200/CN) - 2	Ia=	0.04 in
R = Ia/P	R=	0.03
qu (From Exhibits 4-I to 4-III)	qu=	500
Qp = qu*A*WQv	P=	1.02 cfs



Appendix L

RIDEM Contech Cascade Separator Certification Letter



Rhode Island Department of Environmental Management
Office of Water Resources – Stormwater Technology Review Committee
235 Promenade St. Providence, RI 02908 Ph: 401-222-4700

Alternative Stormwater Technology Certification

Vendor Contact:

Mr. Derek M. Berg
Director of Stormwater Management - East
Contech Engineered Solutions, LLC
71 US Route 1, Suite F
Derek.berg@contechllc.com
www.conteches.com
Ph: 207-885-6174

Technology Name:

Cascade Separator®

Approval Type:

Pretreatment/Retrofits

Certification Dates:

Issued: October 12, 2021
Expires: October 12, 2026

CERTIFICATION:

The Rhode Island Stormwater Technology Review Committee which consists of members from the Department of Environmental Management (DEM), Department of Transportation (DOT) and the Coastal Resources Management Council (CRMC) have reviewed the **Cascade Separator®** application for certification of its Technology Approval and accepted use for Stormwater Treatment in the State of Rhode Island.

In accordance with Stormwater Rule 250-RICR-150-10-8.9B, **Contech Engineered Solutions, LLC** has petitioned the permitting agencies to certify the **Cascade Separator®** as an acceptable structural stormwater control described in Stormwater Rule 250-RICR-150-10-8.31. They have submitted monitoring results and supporting information developed in accordance with the provisions of the Technology Assessment Protocol (TAP) for Innovative and Emerging Technologies as described in Stormwater Rule 250-RICR-150-10 Sections 8.39 and 8.40.

The **Cascade Separator®** is granted reciprocity in Rhode Island as a proprietary stormwater treatment technology, given that it has been issued an MTD (manufactured treatment device) Lab Certification from the New Jersey Department of Environmental Protection (NJDEP) effective October 1, 2019 as a result of the *NJCAT Technology Verification – Cascade Separator®* study from April 2019, performed by Contech's laboratory in Portland, Oregon, with independent third-party observation provided by Dr. Scott Wells and Dr. Chris Berger from Portland State University. The study was conducted in accordance with the NJDEP "Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" from January 2013. This NJDEP MTD Lab Certification recognizes the **Cascade Separator®** as a stormwater treatment technology which provides 50% removal of total suspended solids when operating at the maximum treatment flow rate for each device specified in the attached *Table 1: RIDEM Approved Cascade Separator Sizing Table for 50% TSS Removal*. The State of New Jersey is a member of the Technology Acceptance Reciprocity Partnership (TARP), which allows for reciprocity consideration in Rhode Island.

The **Cascade Separator®** is a pre-treatment or retrofit device that captures both TSS and free oil (TPH) from stormwater runoff as described in Stormwater Rule 250-RICR-150-10-8.31. It is a vertically oriented cylindrical structure manufactured from pre-cast reinforced concrete and fiber reinforced plastic, designed to remove trash, hydrocarbons, and sediment from stormwater. This product was developed by **Contech Engineered Solutions, LLC**. The **Cascade Separator®** is approved for online and off-line use.

The manufacturer has demonstrated that this product meets the minimum water quality standards for pretreatment as described in Stormwater Rule 250-RICR-150-10-8.31. The **Cascade Separator®** is approved for **50%** removal of total suspended solids (TSS) when designed using flow rates specified in the attached *Table 1: RIDEM Approved Sizing for Cascade Separator®*. The **Cascade Separator®** is NOT recognized for removal of

Pathogens, Total Phosphorus or Nitrogen. This device may be used as an **Oil and Grit Separator** for use on **LUHPPL sites** in accordance with Stormwater Rule 250-RICR-150-10-8.14 provided that the design, installation, and maintenance are conducted in accordance with the following terms and conditions:

I. GENERAL CERTIFICATION REQUIREMENTS

1. The system must be designed and installed to adhere to the manufacturer's specifications titled "Cascade Separator General Specification" which can be found on at: <https://www.conteches.com/technical-guides/search?filter=QL31JT8LA0>
2. The **Cascade Separator®** is **certified as a pretreatment** device in accordance with Stormwater Rule 250-RICR-150-10-8.31, provided the device treats the flow of the first inch of runoff from the capture area, unless waived by the state permitting agency.
3. The CS-8 or greater models meet (**LUHPPL**) minimum requirements for sites that are classified as **LUHPPLs or MSGPs** that are required to have an oil water separator. These models meet the minimum 500 gallon hydrocarbon storage capacity required for pretreatment. Models that do not typically meet the minimum 500 gallon hydrocarbon storage capacity requirement may be modified to do so by adding additional hydrocarbon storage capacity; however modified units must receive engineering approval by the manufacturer and are subject to review by the state permitting agency on a case-by-case basis for approval.
4. The applicant must provide the RI specific manufacturers design sheet for Departmental review or provide the manufacturer's review approval. All units that capture greater than one acre of impervious cover must be reviewed by the manufacturer.
5. This device is **certified as a retrofit device** in accordance with Stormwater Rule 250-RICR-150-10-8.6A. Retrofits are allowed flexibility with regards to the eleven minimum standards described in Sections 8.6 through 8.17 of Stormwater Rule 250-RICR-150-10, but in general they are considered effective if they capture at least 50% of the catchment and meet the target water quality treatment of at least the first 0.5 inches of the water quality volume.
6. The approved devices shall be located such that they are accessible for maintenance and/or emergency removal of oil or chemical spills.
7. The device cannot be used in series with another Hydrodynamic separator to achieve enhanced removal rates for TSS.

II. MAINTENANCE REQUIREMENTS

1. The device must be maintained in accordance with the manufacturer's specifications provided in the **Cascade Separator®** Inspection and Maintenance Guide.
2. The device must be maintained in accordance with the requirements for proprietary pre-treatment devices, as stated in Stormwater Rule 250-RICR-150-10-8.31-C, which requires that the device be inspected a minimum of 2 times per year. Additionally, the device must be cleaned out when either pollutant removal capacity is reduced by 50% or more, or when 50% or more of the pollutant storage capacity is filled or displaced.
3. All material removed from the unit must be properly disposed of and is the responsibility of the owner.

4. The applicant must provide evidence of a maintenance contract which extends for a minimum of two years. The contracted maintenance provider must receive training by **Contech Engineered Solutions, LLC** on how to properly maintain **Cascade Separator®** devices. This requirement excludes maintenance providers recognized by the RIDEM to be qualified in maintenance of **Cascade Separator®** devices.
5. The applicant must include a copy of the **Cascade Separator®** Inspection and Maintenance Guide in their project specific long term operation and maintenance plan.

III. REPORTING REQUIREMENTS

1. Upon request from the owner of any Cascade Separator system installed in the State of Rhode Island, the vendor shall provide the owner with a recommended maintenance schedule after the first year of operation. If a recommended maintenance schedule is requested by the owner after the first year of the device's operation, then the owner is responsible for notifying the vendor of any additional pollutant loads on sites where contributing drainage areas may be subject to further development.
2. The Vendor shall provide a listing to the RIDEM Office of Water Resources of all systems installed within the State of Rhode Island on an annual basis.
3. The Vendor shall provide an annual listing to the RIDEM Office of Water Resources of all Rhode Island maintenance providers that they trained in **Cascade Separator®** maintenance.
4. The Vendor shall immediately notify the RIDEM Office of Water Resources if and when any changes are made to the model name or number of any **Cascade Separator®** device for all models applicable to this certification.
5. The Vendor shall immediately notify the RIDEM Office of Water Resources if and when any revisions are made to the design, installation operation and maintenance manuals for all models applicable to this certification. Revisions deemed by the RIDEM to be substantial, may require re-application to the Alternative Stormwater Technology Program.
6. The Vendor shall notify the RIDEM at least thirty (30) days following any proposed transfer of ownership of the Component technology. Notification shall include the name and address of the new owner and a written agreement between the existing and new owner specifying a date for transfer of ownership, responsibility, and liability for the Component. All provisions of this Certification shall be applicable to any new owners.

IV. RIGHTS OF THE RIDEM AND CRMC

1. The RIDEM may suspend, modify, or revoke this approval for cause, including but not limited to non-compliance with any of the conditions or provisions of this approval, mis-representation, or failure to fully disclose all relevant data, or receipt of new information indicating that the use of the **Cascade Separator®** system is contrary to the public interest, public health, or the environment.
2. This approval does not represent an endorsement of the **Cascade Separator®** system by the RIDEM, RIDOT or CRMC. This letter of approval may be reproduced only in its entirety.
3. The **Cascade Separator®** General Specification and **Cascade Separator®** Inspection and Maintenance Guide referenced herein are approved upon the date of approval of this Certification.

4. The RIDEM reserves the right to suspend or revoke this Certification if updated design, installation, and O&M manuals are not provided to the RIDEM within thirty (30) days of RIDEM request or one hundred and eighty (180) days prior to the expiration date of this Certification. All revisions must be reviewed and approved by the RIDEM prior to re-certification.

Eric A. Beck, P.E.
 Administrator of Groundwater and Wetlands Protection
 RIDEM

Date

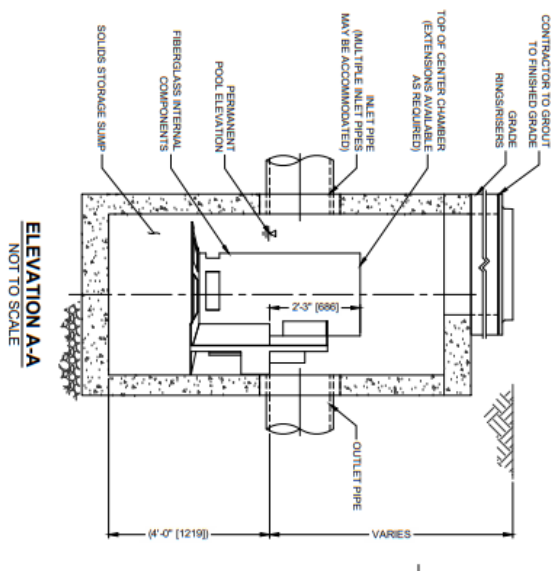
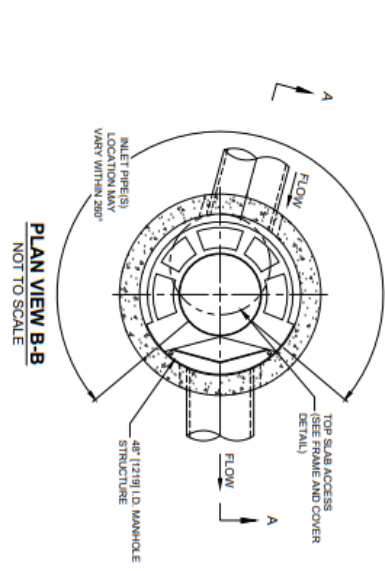
ATTACHMENTS

Table 1: RIDEM Approved Cascade Separator Sizing Table for 50% TSS Removal

Model #	Water Quality Flow Rate (cfs)	Approximate Impervious Treatment Area (acres)
CS-3	1.02	0.93
CS-4	1.80	1.68
CS-5	2.81	2.63
CS-6	4.05	3.78
CS-8	7.20	6.73
CS-10	11.3	10.56
CS-12	16.2	15.14

Table 2: Standard Hydrocarbon & Sediment Storage Capacity of Cascade Separator® Devices

Model #	Structure Inside Diameter (ft)	Oil Spill Volume (gal)	Sediment Storage Volume (ft ³)
CS-4	4	141	18.9
CS-5	5	269.3	29.4
CS-6	6	475.9	42.4
CS-8	8	1128	75.3
CS-10	10	2203.2	117.7
CS-12	12	3807.1	169.6



CASCADE
separators

CASCADE SEPARATOR DESIGN NOTES

THE STANDARD CS-4 CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION

- GRADED INLET ONLY (NO INLET PIPE)
- GRADED INLET WITH INLET PIPE OR PRESS
- CURB INLET ONLY (NO INLET PIPE)
- CURB INLET WITH INLET PIPE OR PRESS

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (G5 L5d)	
PEAK FLOW RATE (G5 L5d)	
RETURNS PERIOD OF PEAK FLOW (hrs)	
RIM ELEVATION	
PIPE DATA	
INLET PIPE 1	
INLET PIPE 2	
OUTLET PIPE	



FRAME AND COVER
 (DIAMETER VARIES)
 NOT TO SCALE

GENERAL NOTES

1. CONTRACTOR TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
 2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechs.com
 3. CASCADE SEPARATOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN CONTECH ENGINEERED SOLUTIONS LLC DRAWINGS AND SPECIFICATIONS.
 4. CASCADE SEPARATOR STRUCTURE SHALL MEET ASHTO H501 LOAD RATING ASSUMING EARTH COVER OF 0' - 2' @ 101, AND GROUNDWATER ELEVATION AT OR BELOW THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET ASHTO M309 AND BE CAST WITH THE CONTECH LOGO.
 5. CASCADE SEPARATOR STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C919 AND ASHTO LOAD FACTOR DESIGN.
 6. ALTERNATE UNITS ARE SHOWN IN MILLIMETERS [mm].
- INSTALLATION NOTES**
- A. INSTALLATION SHALL BE PERFORMED IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN CONTECH ENGINEERED SOLUTIONS LLC DRAWINGS AND SPECIFICATIONS.
 - B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CASCADE SEPARATOR MANHOLE STRUCTURE.
 - C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLY STRUCTURE.
 - D. CONTRACTOR TO PROVIDE APPROPRIATE CENTERLINE (AND OUTLET PIPES), MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
 - E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT. HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH
 ENGINEERED SOLUTIONS LLC
www.contechs.com
 8025 Century Parkway Dr. Suite 400, Walnut Creek, CA 94598
 925.338.1122 513.465.7000 513.465.7000 FAX

CS-4
CASCADE SEPARATOR
 STANDARD DETAIL