DRAINAGE CALCULATIONS
AND
STORMWATER MANAGEMENT PLAN

For The

Multi-Use Building

Located at
272 Tremont Street
(Tax Map C12, Block 0, Lot 9)
Melrose, Massachusetts

Submitted to:
City of Melrose
562 Main Street
Melrose, MA 02176

Prepared for:
Eric Kenworthy
49 Marmion Road
Melrose, MA 02176

Prepared by

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

January 15, 2020
REVISED: August 12, 2020

Table of Contents

Executive Summary of Drainage Report
Proposed Multi-Use building
272 Tremont Street
Melrose, MA 02176

Project Description

The project consists of the redevelopment of a single parcel of land comprised of 10,490± S.F. located at 272 Tremont Street (Tax map C12 Block 0 Lot 9). The site is currently occupied by two and a half story residential building with a bituminous concrete driveway and parking area in the rear and some landscaped areas. The project involves the demolition of all existing structures, the construction of the proposed four-story building, bituminous concrete driveway and parking area, utility connections, storm water management system, landscaping and incidental site work. The site abuts residential land to the south, business to the north, railroad tracks to the west and Tremont Street to the east. Access to site will be accessed via Tremont Street.

Site Description

The subject property is currently occupied by a two and a half story building with bituminous concrete driveway, parking area and landscaped areas. The majority of the property is comprised of impervious areas. The topography of the site is relatively flat. The site has well defined drainage patterns consisting of two distinct watershed areas. The western half of the site (EWS-1) drains towards the north-westerly corner offsite (DP-1) while the eastern half of the site (EWS-2) drains to the northeast towards Tremont Street (DP-2).

In the proposed condition, the property will consist of the proposed building, bituminous concrete driveway and landscaped area. Stormwater management facilities will be provided to mitigate the increase in impervious area on the property. The drainage patterns in the proposed condition will mimic those of the existing condition, including two watershed areas draining to the same design points as in the existing condition.

Soils information was obtained from available USDA Soil Conservation Service (SCS) Maps for Middlesex County. The soils on site are classified as Urban land (602). Refer to Figure 5, SCS Soils Map, for a delineation of the boundaries of the soil with respect to the subject parcel and the attached SCS soil description. The Flood Insurance Rate Map for the City of Melrose (Community Panel 25017C0429E with an effective date of June 4, 2010) describes the project as Zone X. Zone X is classified as areas determined to be outside the 0.2% chance floodplain.

All existing conditions information used has been compiled from the plan entitled “Existing Conditions Site Plan of 272 Tremont Street in Melrose, MA,” prepared by P.J.F and Associates and dated March 11, 2018 along with other plans of record obtained from the City of Melrose.

Pre-Development Condition

Technical Release 20 (TR-20) Program for Project Formulation Hydrology developed by the Soil Conservation Service (SCS) was employed to develop pre and post-development peak flows. Drainage calculations were performed for the pre-development condition for the 2, 5, 10, 25, and 100-year type III 24-hour storm events using rainfall data provided by the National Oceanic and Atmospheric Administration (NOAA) for the City of Melrose. Refer to Appendix A and B for computer results, soil characteristics, cover descriptions and times of concentrations calculations. Refer to Appendix E for a summary of the NOAA rainfall data used.

In both the pre-development and post-development stormwater analysis a total of two watershed areas were analyzed. The western half of the site (EWS-1) drains towards the north-westerly corner offsite (DP-1) while the eastern half of the site (EWS-2) drains to the northeast towards Tremont Street (DP-2). Refer to Existing Watershed Plan (EWP) in Appendix A for a

delineation of the watershed areas as well as the location of the design points. The same design points were analyzed in both the pre and post development condition.

A summary of the peak rates of the runoff during the Pre-Development Conditions is as follows:

Pre-Development Condition Peak Discharge Summary (in CFS):

	2-Year Storm (3.29 in)	5-Year Storm (4.32 in)	10-Year Storm (5.18 in)	25-Year Storm (6.35 in)	100-Year Storm (8.17 in)
Design Point #1	0.34	0.46	0.56	0.70	0.91
Design Point #2	0.34	0.48	0.59	0.74	0.97

Proposed Development

The proposed project includes the demolition of all existing structures, the construction of the proposed four-story building, bituminous concrete driveway and parking area, utility connections, storm water management systems, landscaping and incidental site work.

Storm water runoff generated by the proposed building roof will be captured by a series of roof drains and discharged to a subsurface infiltration facility consisting of two (2) rows of six (6) Cultec 330XLHD recharge chambers (P1). Runoff generated from the west side of the driveway, walkways, and landscaped areas will be collected by a water quality inlet (Contech CDS unit with grate inlet) located at a proposed low point in the driveway area. This CDS unit will also discharge stormwater runoff to subsurface infiltration facility P1. Storm water generated on the north and east sides of the site will be collected by two CDS units, each with grate inlets, and ultimately discharged to a second subsurface infiltration facility consisting of one (1) row of four (4) Cultec 330XLHD recharge chambers (P2). All surface runoff will be captured by one of the proposed water quality inlets (Contech CDS units) in an effort to further treat stormwater and reduce total suspended solids. The subsurface facilities have been sized to mitigate peak runoff rates of all storms up to and including the 100-year storm event.

Again, drainage calculations were performed for the post-development condition for the 2, 5, 10, 25, and 100-year type III 24-hour storm events. Refer to Appendix B for computer results, soil characteristics, cover descriptions, times of concentration calculations, and the Proposed Watershed Plans (PWP). A summary of the peak rates of runoff during the Post-Development Condition is as follows:

Post-Development Condition Peak Discharge Summary (in CFS):

	2-Year Storm (3.29 in)	5-Year Storm (4.32 in)	10-Year Storm (5.18 in)	25-Year Storm (6.35 in)	100-Year Storm (8.17 in)
Design Point #1	0.00	0.00	0.00	0.00	0.41
Design Point #2	0.00	0.00	0.00	0.00	0.00

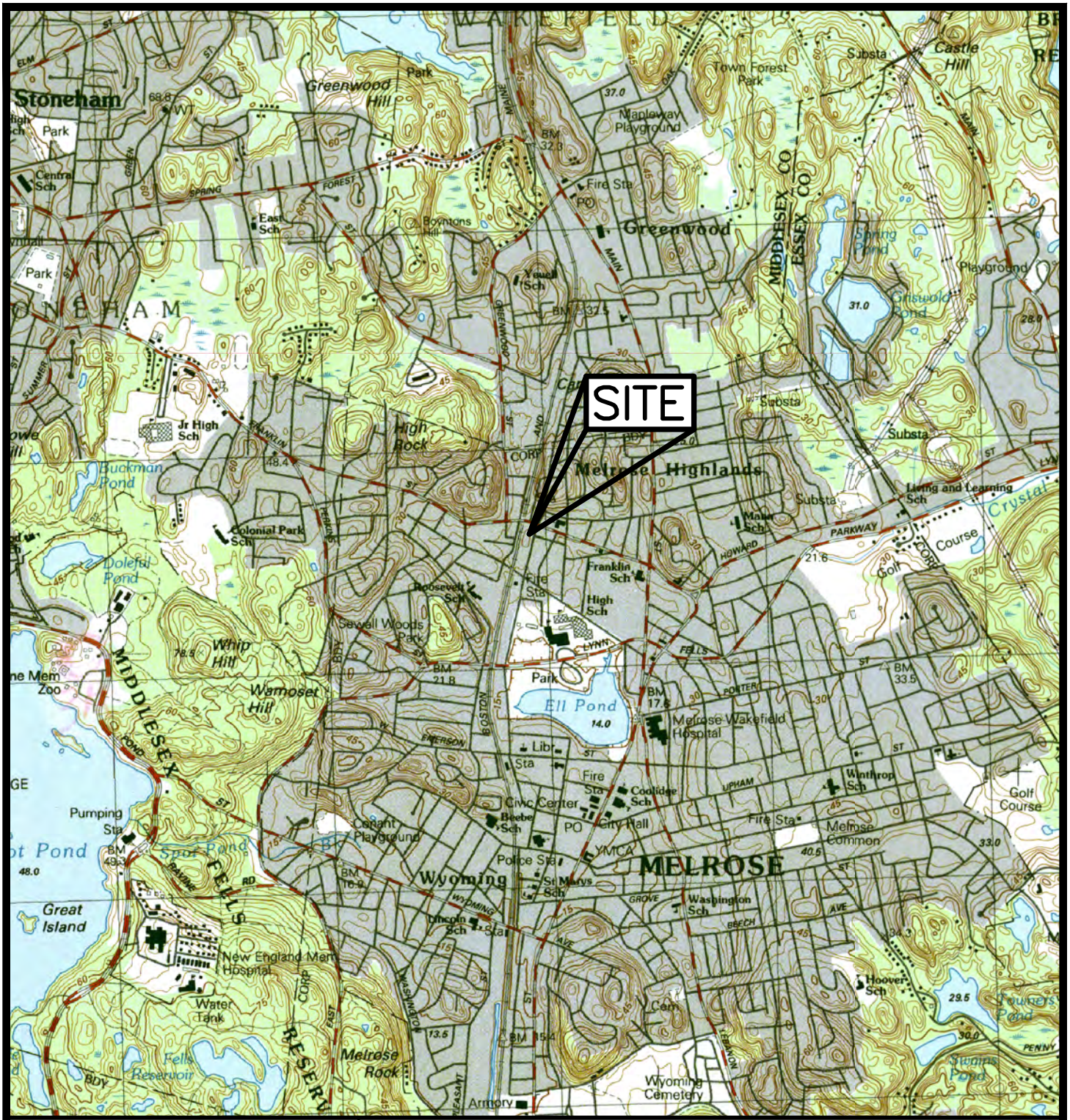
Stormwater Management Facilities

The stormwater facilities were designed to attenuate peak flows generated by all storm events up to and including the 100-year storm event. An infiltration rate of 8.27 in/hr was used based on the Rawls Rate of saturated hydraulic conductivity for a sand soil type. An onsite soils investigation performed by EAI determined that the underlain soils throughout the property were sand to coarse sand material based on USDA soil classification. A percolation test was performed within the sand layer and yielded an infiltration rate of < 2 min/in (30 in/hr). A conservative approach was used by incorporating the 8.27 in/hr based on the Rawls Rate of the sand material. Refer to Appendix A & B for the Stage Storage Curves and TR-20 computer

results for the storage characteristics of the subsurface infiltration facilities. Refer to Appendix F for soil investigation results including the standard Form 11 – Soils Log and Form 12 Percolation Test Log. Refer to the Site Plans (attached) for design details.

Erosion and Siltation Control

Straw bales and silt fence will be placed at the downhill limit of work prior to the commencement of any construction activity. The integrity of the erosion control devices will be maintained by periodic inspection and replacement as necessary. The straw bales and silt fence will remain in place until the first course of pavement has been placed and all side slopes have been loamed and seeded and vegetation has been established.



PREPARED BY:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

PROJECT:

Plan of Land

272 Tremont Street
(Tax Map C11 Block 0 Lot 9)
Melrose, MA 02176

PROJECT: 19-29908	DATE: January 13, 2020
SCALE: 1:25,000	DWG FILE NAME: Figures.dwg
DESIGNED BY: Garrett Anderson	CHECKED BY: Richard A. Salvo, P.E.

DRAWING TITLE:

FIGURE 1 - USGS LOCUS MAP

PREPARED BY:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

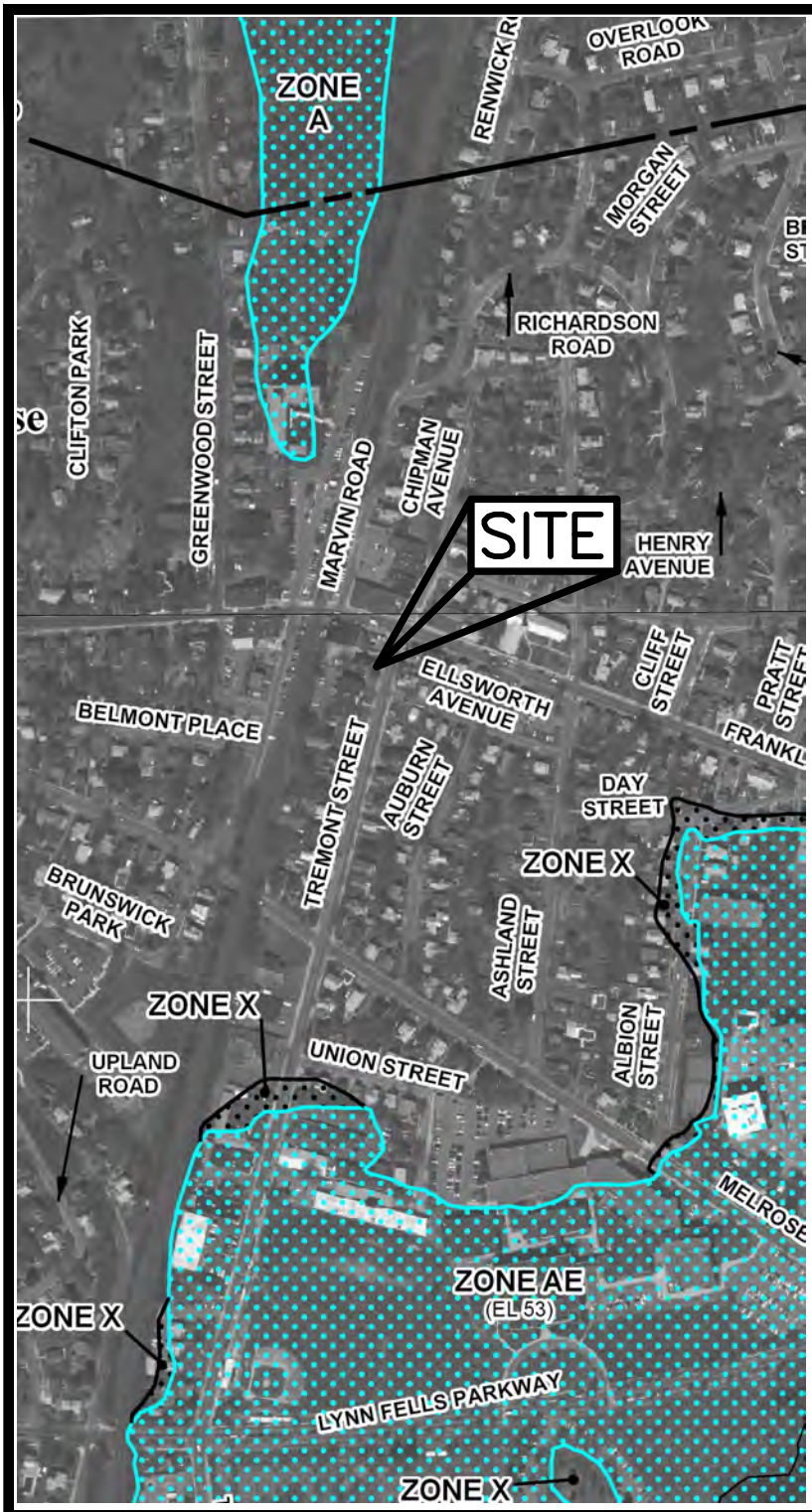
PROJECT:

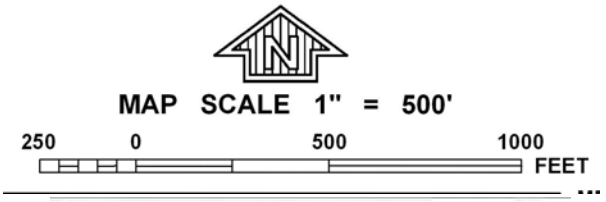
Plan of Land

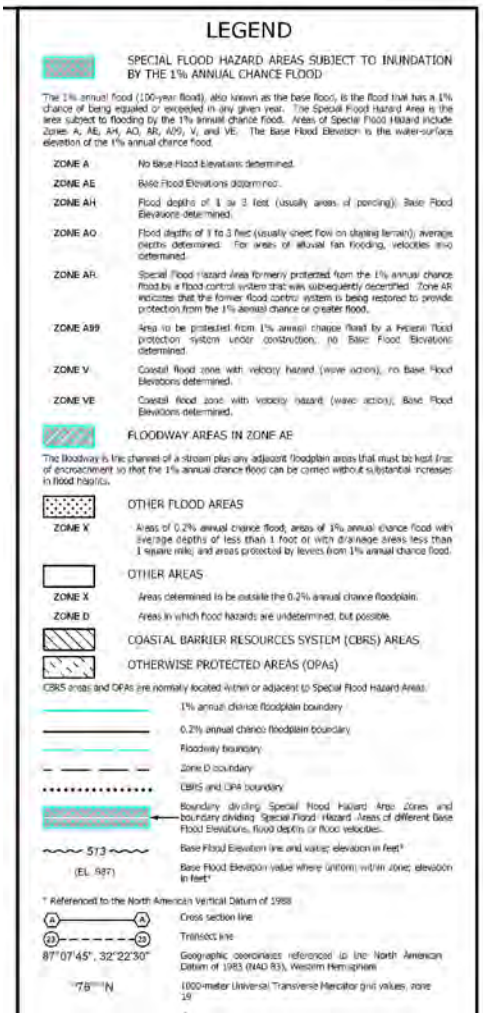
272 Tremont Street
(Tax Map C11 Block 0 Lot 9)
Melrose, MA 02176

PROJECT: 19-29908	DATE: January 13, 2020
SCALE: 1"=200'	DWG FILE NAME: Figures.dwg
DESIGNED BY: Garrett Anderson	CHECKED BY: Richard A. Salvo, P.E.

DRAWING TITLE:
FIGURE 2 - ORTHO PHOTO







NATIONAL FLOOD INSURANCE PROGRAM
MIDDLESEX COUNTY

COMMUNITY PANEL NO: 25017C0429E

EFFECTIVE DATE: June 4, 2010

PREPARED BY:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

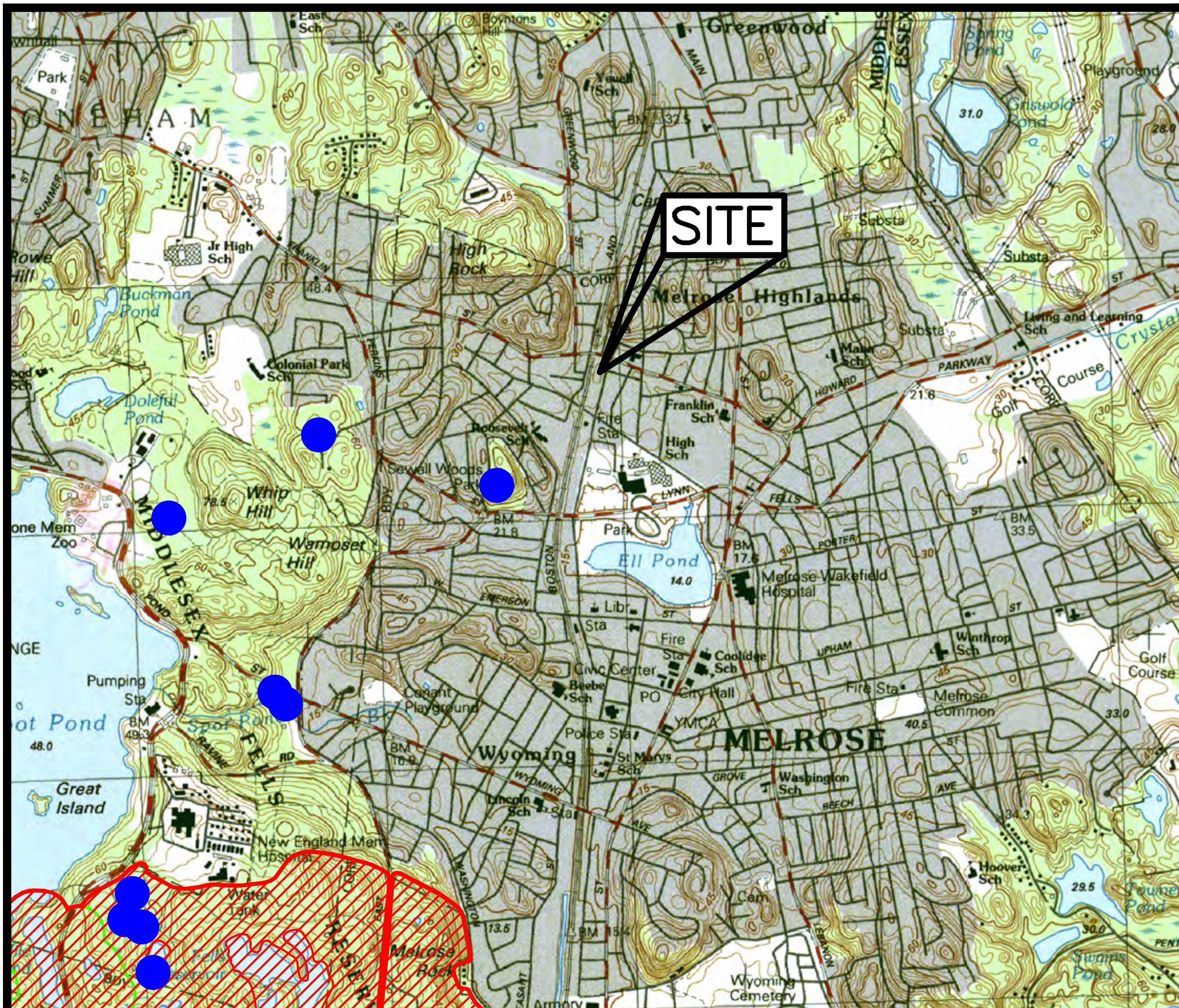
PROJECT:

Plan of Land

272 Tremont Street
(Tax Map C11 Block 0 Lot 9)
Melrose, MA 02176

PROJECT: 19-29908	DATE: January 13, 2020
SCALE: 1"=500'	DWG FILE NAME: Figures.dwg
DESIGNED BY: Garrett Anderson	CHECKED BY: Richard A. Salvo, P.E.

DRAWING TITLE:
FIGURE 3 - FEMA FLOOD MAP



LEGEND:

= NHESP ESTIMATED HABITATS OF RARE SPECIES

= NHESP PRIORITY HABITATS OF RARE SPECIES

= NHESP CERTIFIED VERNAL POOLS

PREPARED BY:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants

194 Central Street	1950 Lafayette Road
Saugus, MA 01906	Portsmouth, NH 03801
Tel: (781) 231-1349	Tel: (603) 610-7100
Fax: (781) 417-0020	Fax: (603) 610-7101

PROJECT:

Plan of Land

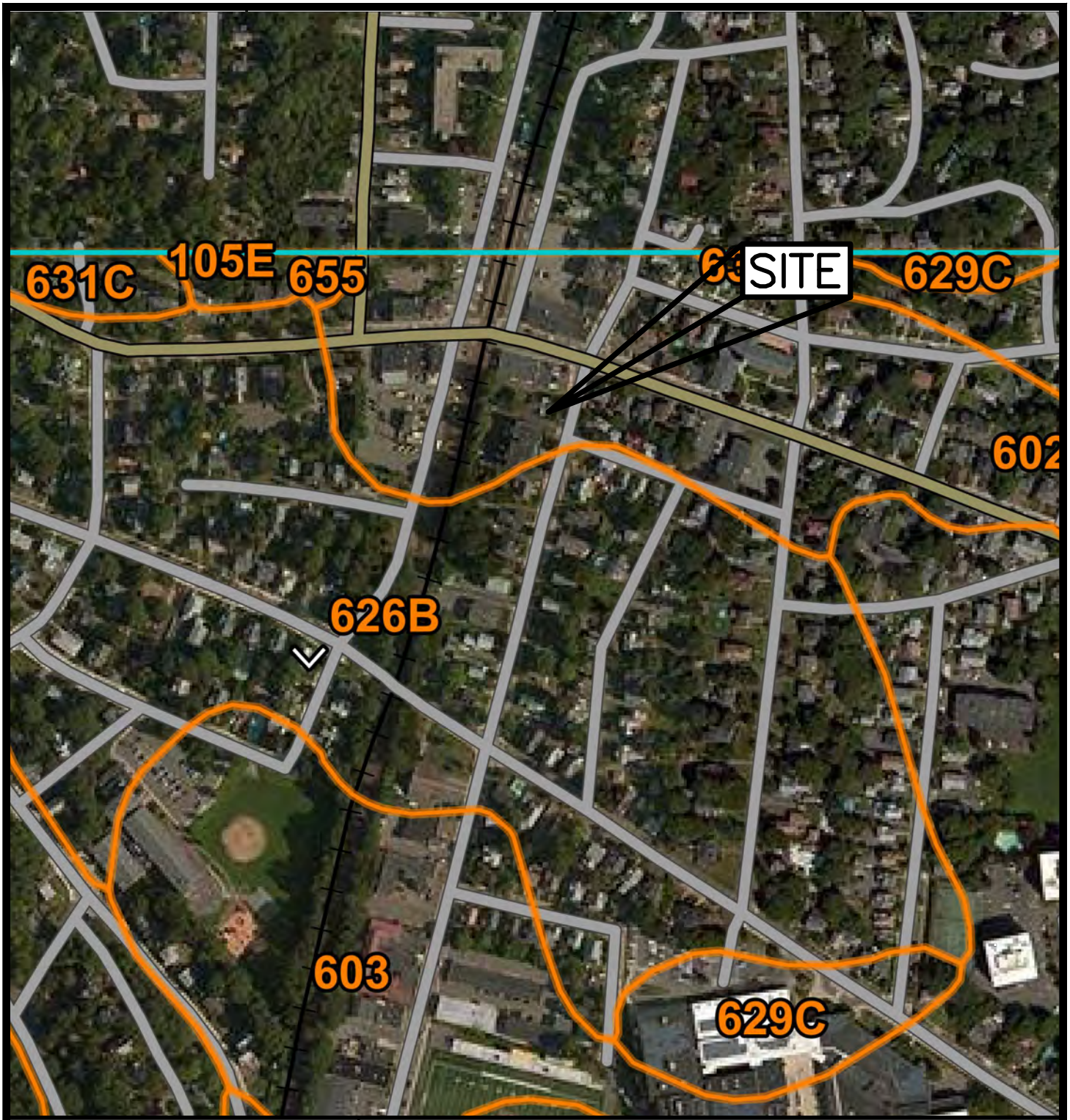
272 Tremont Street
(Tax Map C11 Block 0 Lot 9)
Melrose, MA 02176

PROJECT: 19-29908	DATE: January 13, 2020
SCALE: 1:25,000	DWG FILE NAME: Figures.dwg
DESIGNED BY: Garrett Anderson	CHECKED BY: Richard A. Salvo, P.E.

DRAWING TITLE:

FIGURE 4 - NATURAL HERITAGE MAP

Page #: 4of5



PREPARED BY:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

PROJECT:

Plan of Land

272 Tremont Street
(Tax Map C11 Block 0 Lot 9)
Melrose, MA 02176

PROJECT: 19-29908	DATE: January 13, 2020
SCALE: 1"=300'	DWG FILE NAME: Figures.dwg
DESIGNED BY: Garrett Anderson	CHECKED BY: Richard A. Salvo, P.E.

DRAWING TITLE:

FIGURE 5 - SOILS MAP

602—Urban land

Map Unit Setting

National map unit symbol: 9950
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 110 to 200 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

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Udorthents, wet substratum

Percent of map unit: 5 percent
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave

Udorthents, loamy

Percent of map unit: 5 percent
Hydric soil rating: No

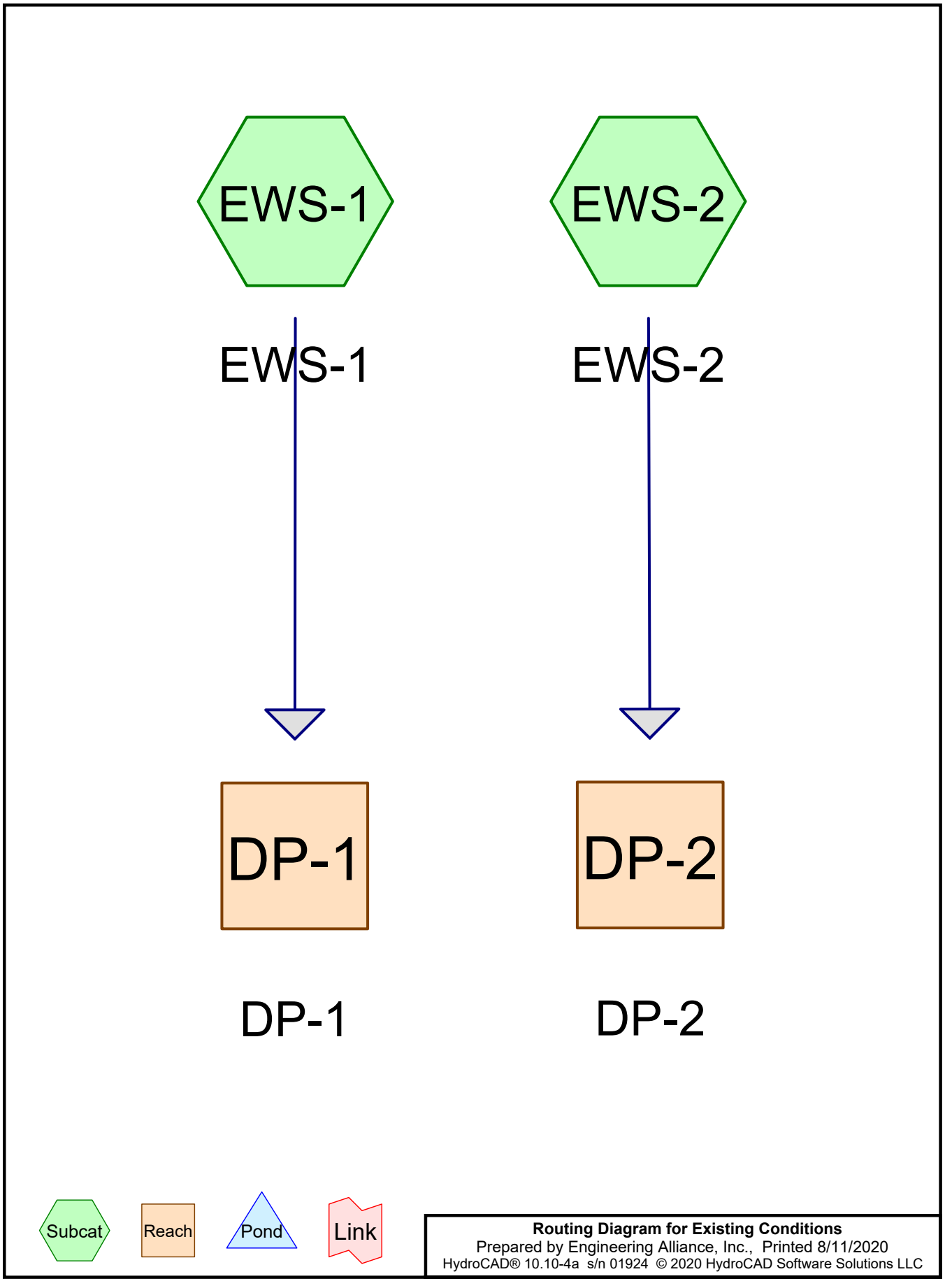
603—Urban land, wet substratum

Map Unit Setting

National map unit symbol: 9951
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 110 to 200 days
Farmland classification: Not prime farmland

APPENDIX A

Existing Conditions Drainage Calculations
Existing Watershed Plan



Routing Diagram for Existing Conditions
Prepared by Engineering Alliance, Inc., Printed 8/11/2020

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type III 24-hr		Default	24.00	1	3.29	2
2	5-year	Type III 24-hr		Default	24.00	1	4.32	2
3	10-year	Type III 24-hr		Default	24.00	1	5.18	2
4	25-year	Type III 24-hr		Default	24.00	1	6.35	2
5	100-year	Type III 24-hr		Default	24.00	1	8.17	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
2,440	74	>75% Grass cover, Good, HSG C (EWS-1, EWS-2)
6,237	98	Paved parking, HSG C (EWS-1, EWS-2)
1,783	98	Roofs, HSG C (EWS-1, EWS-2)
10,460	**92**	**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Sub Num
0	0	2,440	0	0	2,440	>75% Grass cover, Good	
0	0	6,237	0	0	6,237	Paved parking	
0	0	1,783	0	0	1,783	Roofs	
0	**0**	**10,460**	**0**	**0**	**10,460**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWS-1: EWS-1 Runoff Area=4,983 sf 82.42% Impervious Runoff Depth>2.63"
Tc=5.0 min CN=94 Runoff=0.34 cfs 1,092 cf

Subcatchment EWS-2: EWS-2 Runoff Area=5,477 sf 71.44% Impervious Runoff Depth>2.34"
Tc=5.0 min CN=91 Runoff=0.34 cfs 1,069 cf

Reach DP-1: DP-1 Inflow=0.34 cfs 1,092 cf
Outflow=0.34 cfs 1,092 cf

Reach DP-2: DP-2 Inflow=0.34 cfs 1,069 cf
Outflow=0.34 cfs 1,069 cf

Total Runoff Area = 10,460 sf Runoff Volume = 2,161 cf Average Runoff Depth = 2.48"
23.33% Pervious = 2,440 sf 76.67% Impervious = 8,020 sf

Summary for Subcatchment EWS-1: EWS-1

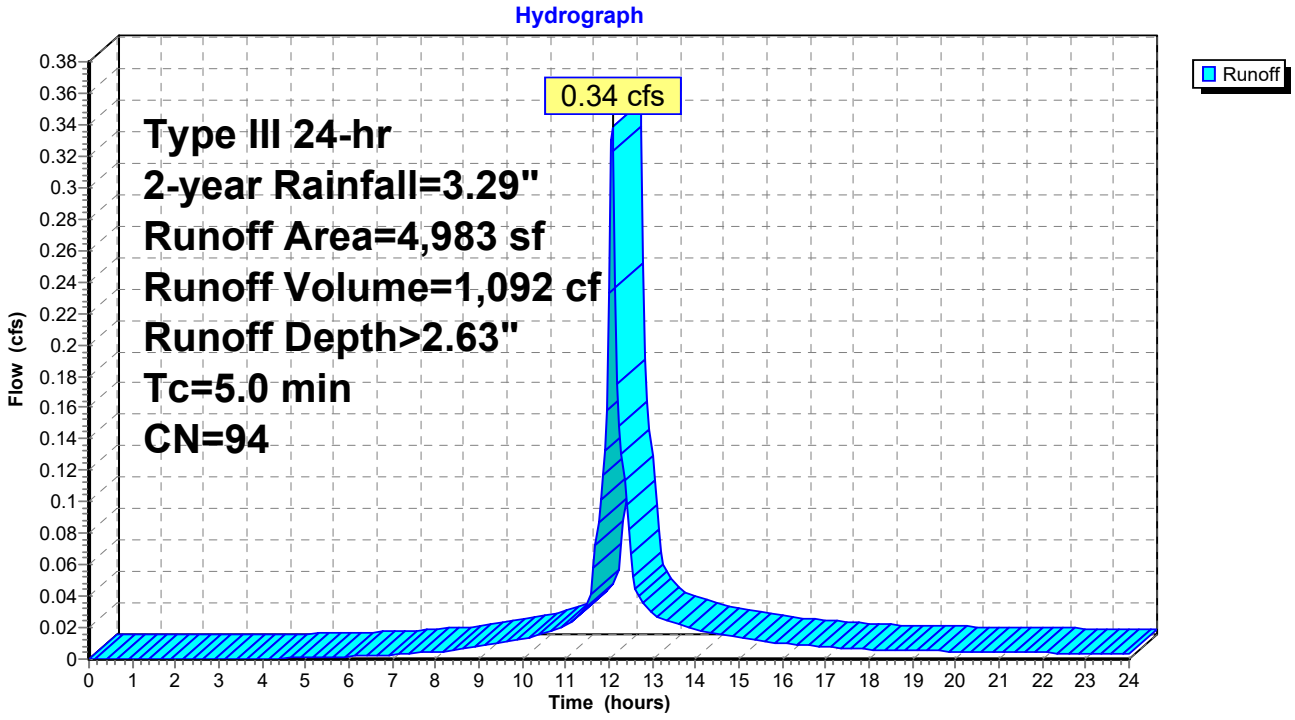
Runoff = 0.34 cfs @ 12.07 hrs, Volume= 1,092 cf, Depth> 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.29"

Area (sf)	CN	Description
3,990	98	Paved parking, HSG C
876	74	>75% Grass cover, Good, HSG C
117	98	Roofs, HSG C
4,983	94	Weighted Average
876		17.58% Pervious Area
4,107		82.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-1: EWS-1



Summary for Subcatchment EWS-2: EWS-2

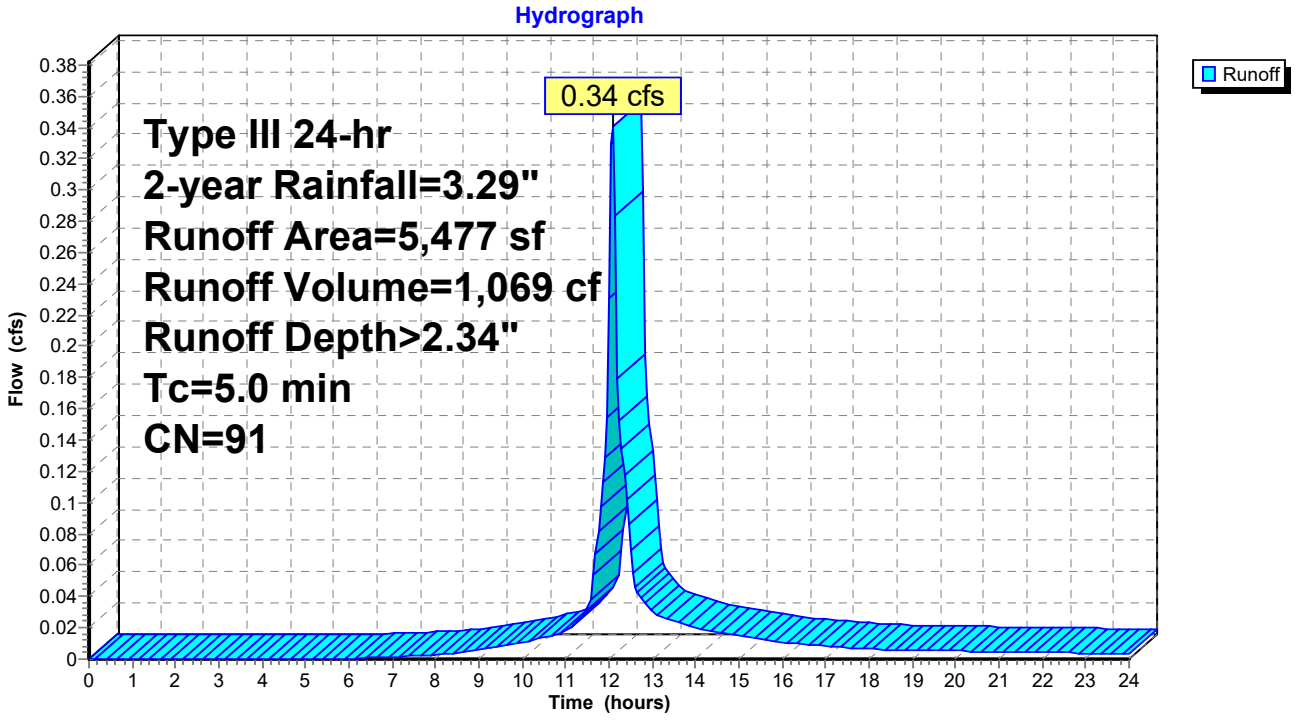
Runoff = 0.34 cfs @ 12.07 hrs, Volume= 1,069 cf, Depth> 2.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.29"

Area (sf)	CN	Description
1,666	98	Roofs, HSG C
1,564	74	>75% Grass cover, Good, HSG C
2,247	98	Paved parking, HSG C
5,477	91	Weighted Average
1,564		28.56% Pervious Area
3,913		71.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-2: EWS-2

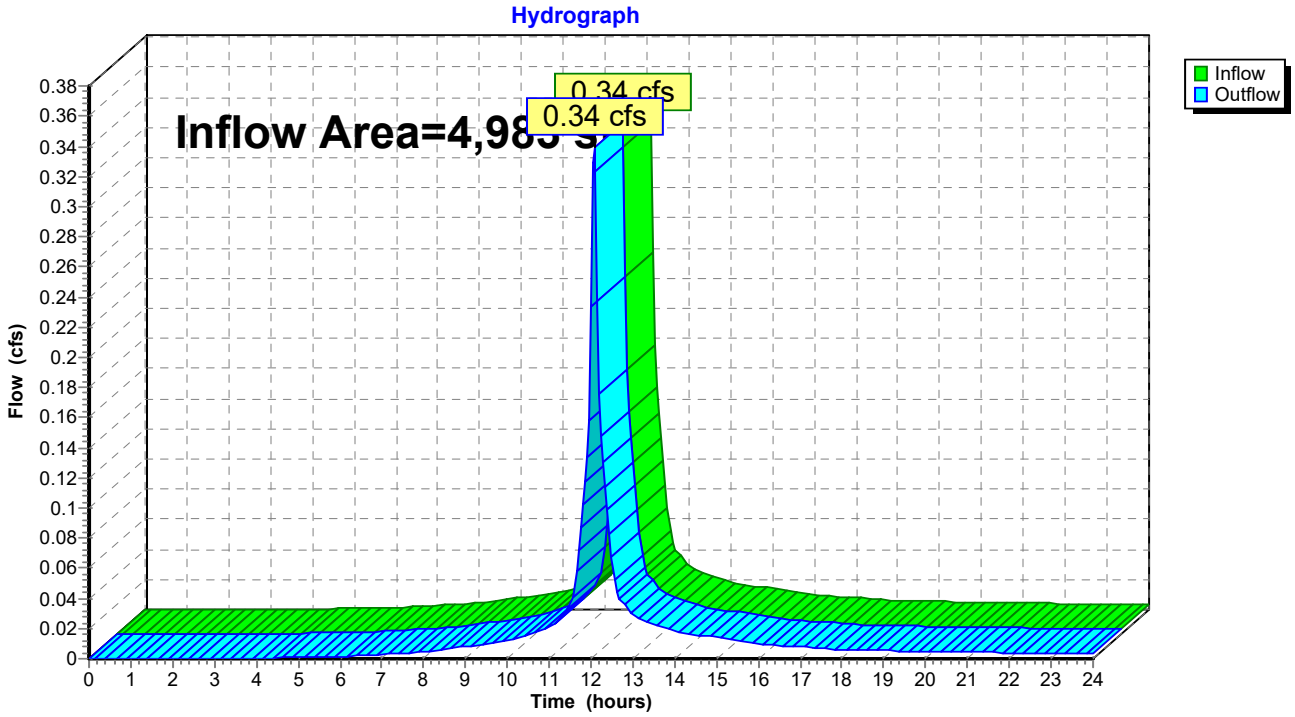


Summary for Reach DP-1: DP-1

Inflow Area = 4,983 sf, 82.42% Impervious, Inflow Depth > 2.63" for 2-year event
Inflow = 0.34 cfs @ 12.07 hrs, Volume= 1,092 cf
Outflow = 0.34 cfs @ 12.07 hrs, Volume= 1,092 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

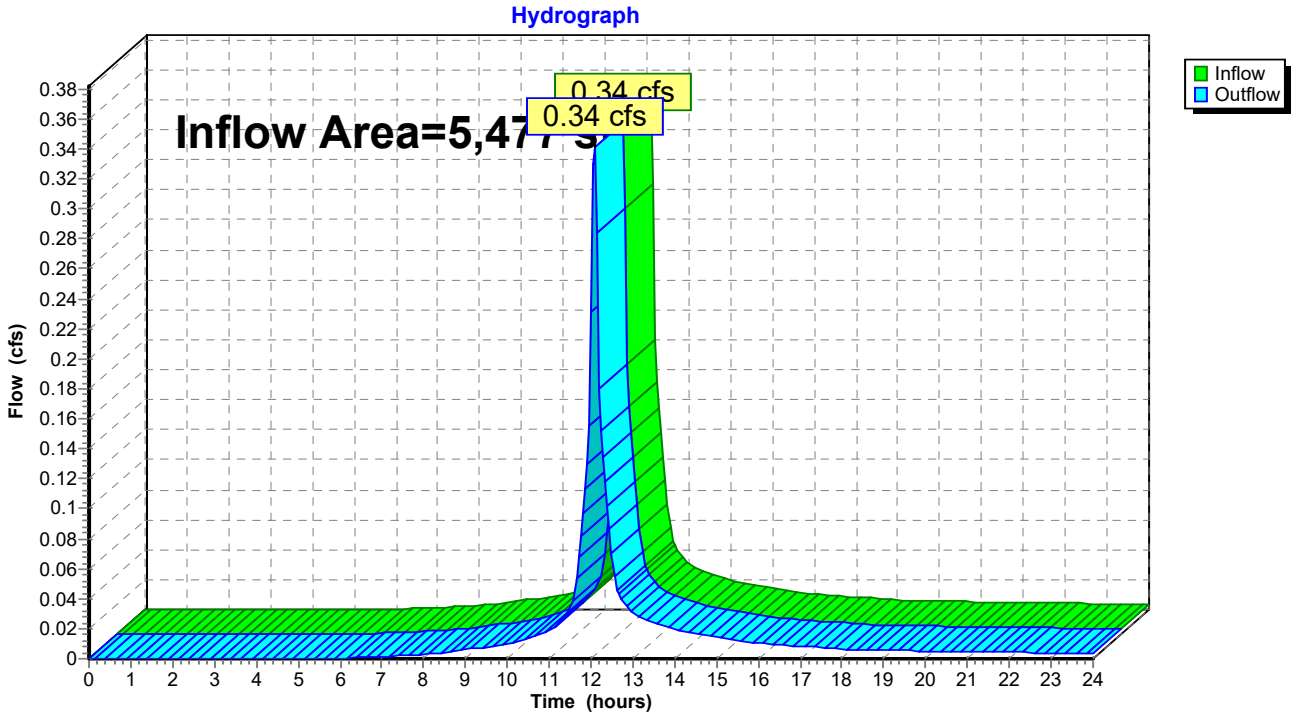


Summary for Reach DP-2: DP-2

Inflow Area = 5,477 sf, 71.44% Impervious, Inflow Depth > 2.34" for 2-year event
Inflow = 0.34 cfs @ 12.07 hrs, Volume= 1,069 cf
Outflow = 0.34 cfs @ 12.07 hrs, Volume= 1,069 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWS-1: EWS-1 Runoff Area=4,983 sf 82.42% Impervious Runoff Depth>3.64"
Tc=5.0 min CN=94 Runoff=0.46 cfs 1,510 cf

Subcatchment EWS-2: EWS-2 Runoff Area=5,477 sf 71.44% Impervious Runoff Depth>3.32"
Tc=5.0 min CN=91 Runoff=0.48 cfs 1,517 cf

Reach DP-1: DP-1 Inflow=0.46 cfs 1,510 cf
Outflow=0.46 cfs 1,510 cf

Reach DP-2: DP-2 Inflow=0.48 cfs 1,517 cf
Outflow=0.48 cfs 1,517 cf

Total Runoff Area = 10,460 sf Runoff Volume = 3,027 cf Average Runoff Depth = 3.47"
23.33% Pervious = 2,440 sf 76.67% Impervious = 8,020 sf

Summary for Subcatchment EWS-1: EWS-1

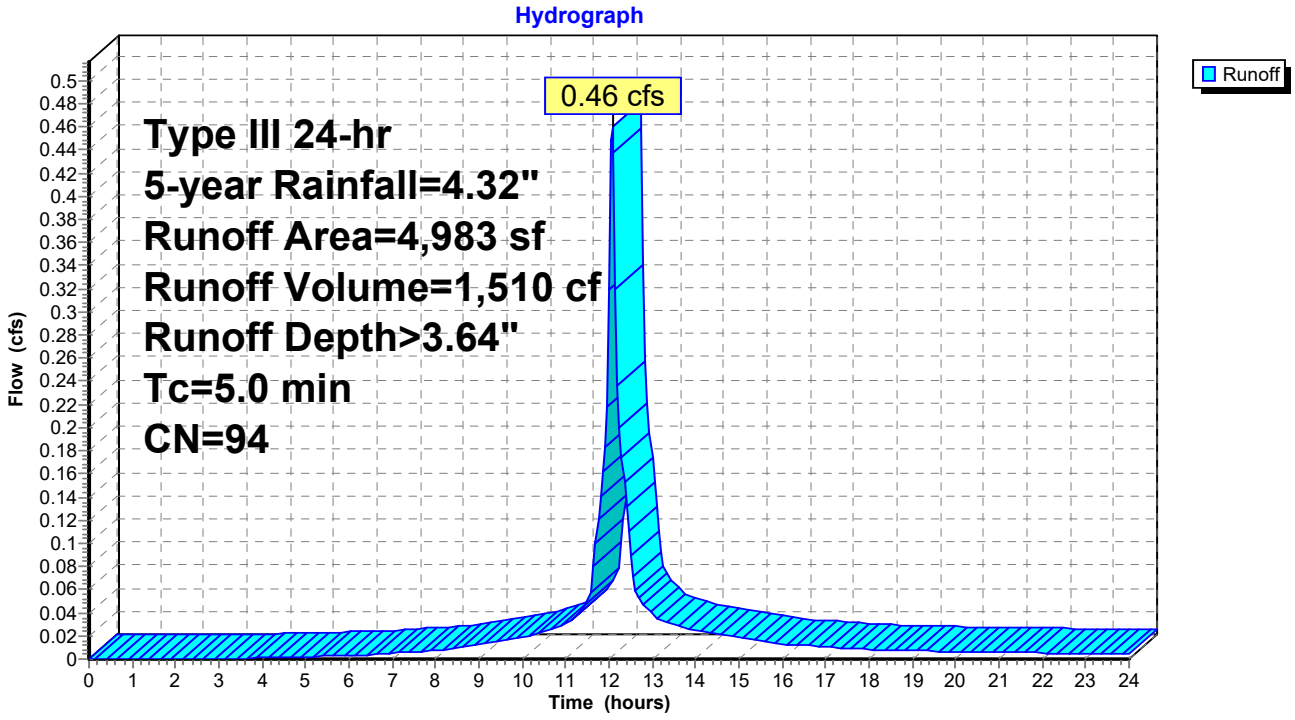
Runoff = 0.46 cfs @ 12.07 hrs, Volume= 1,510 cf, Depth> 3.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 5-year Rainfall=4.32"

Area (sf)	CN	Description
3,990	98	Paved parking, HSG C
876	74	>75% Grass cover, Good, HSG C
117	98	Roofs, HSG C
4,983	94	Weighted Average
876		17.58% Pervious Area
4,107		82.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-1: EWS-1



Summary for Subcatchment EWS-2: EWS-2

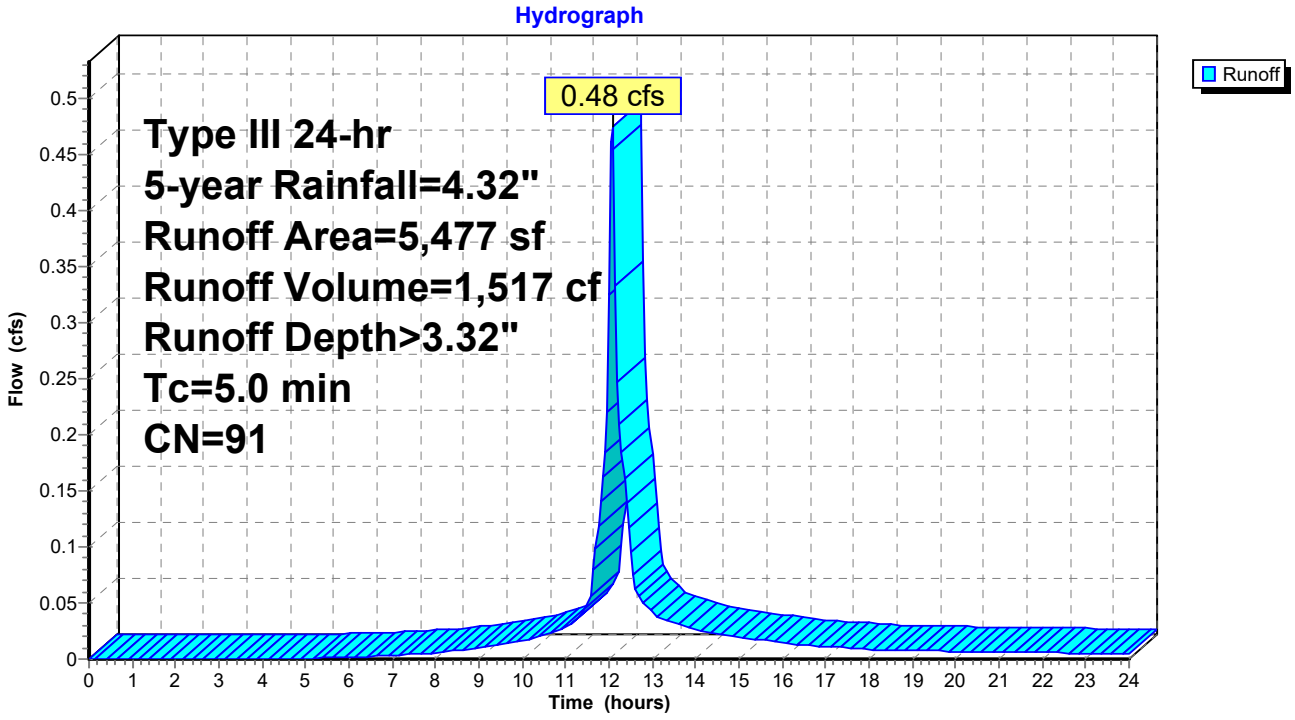
Runoff = 0.48 cfs @ 12.07 hrs, Volume= 1,517 cf, Depth> 3.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 5-year Rainfall=4.32"

Area (sf)	CN	Description
1,666	98	Roofs, HSG C
1,564	74	>75% Grass cover, Good, HSG C
2,247	98	Paved parking, HSG C
5,477	91	Weighted Average
1,564		28.56% Pervious Area
3,913		71.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-2: EWS-2

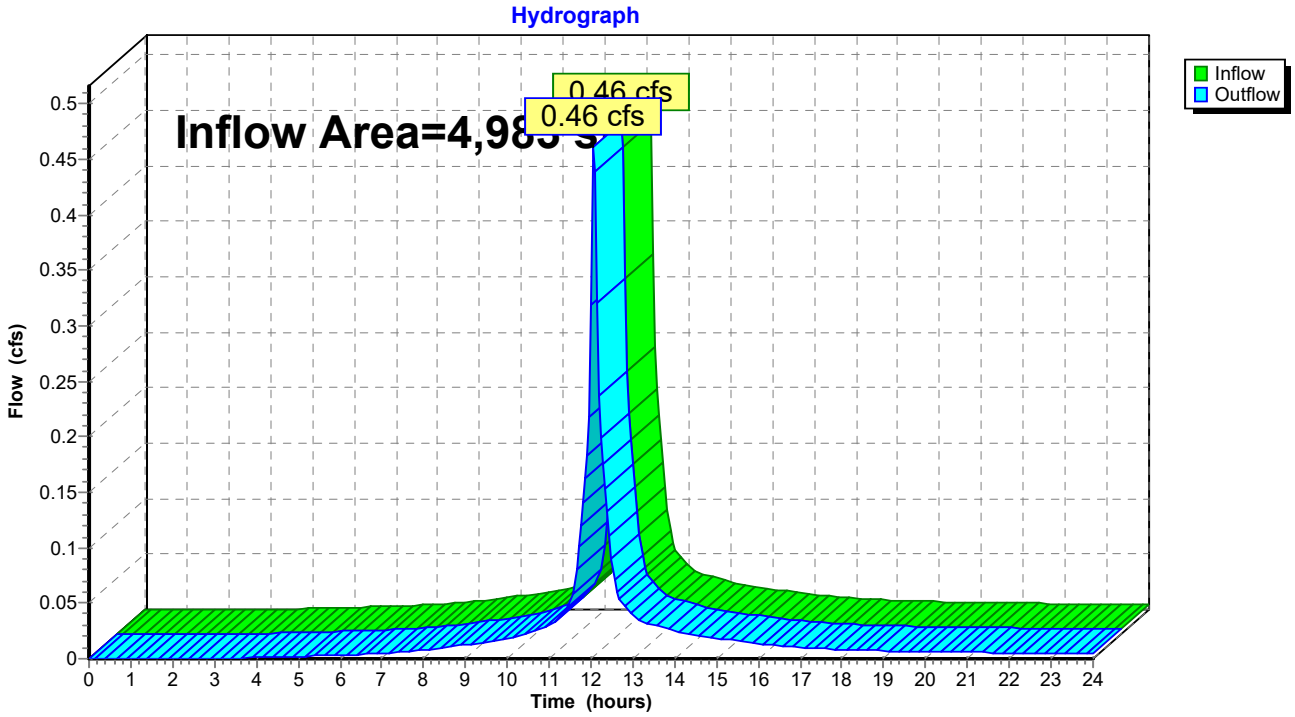


Summary for Reach DP-1: DP-1

Inflow Area = 4,983 sf, 82.42% Impervious, Inflow Depth > 3.64" for 5-year event
Inflow = 0.46 cfs @ 12.07 hrs, Volume= 1,510 cf
Outflow = 0.46 cfs @ 12.07 hrs, Volume= 1,510 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

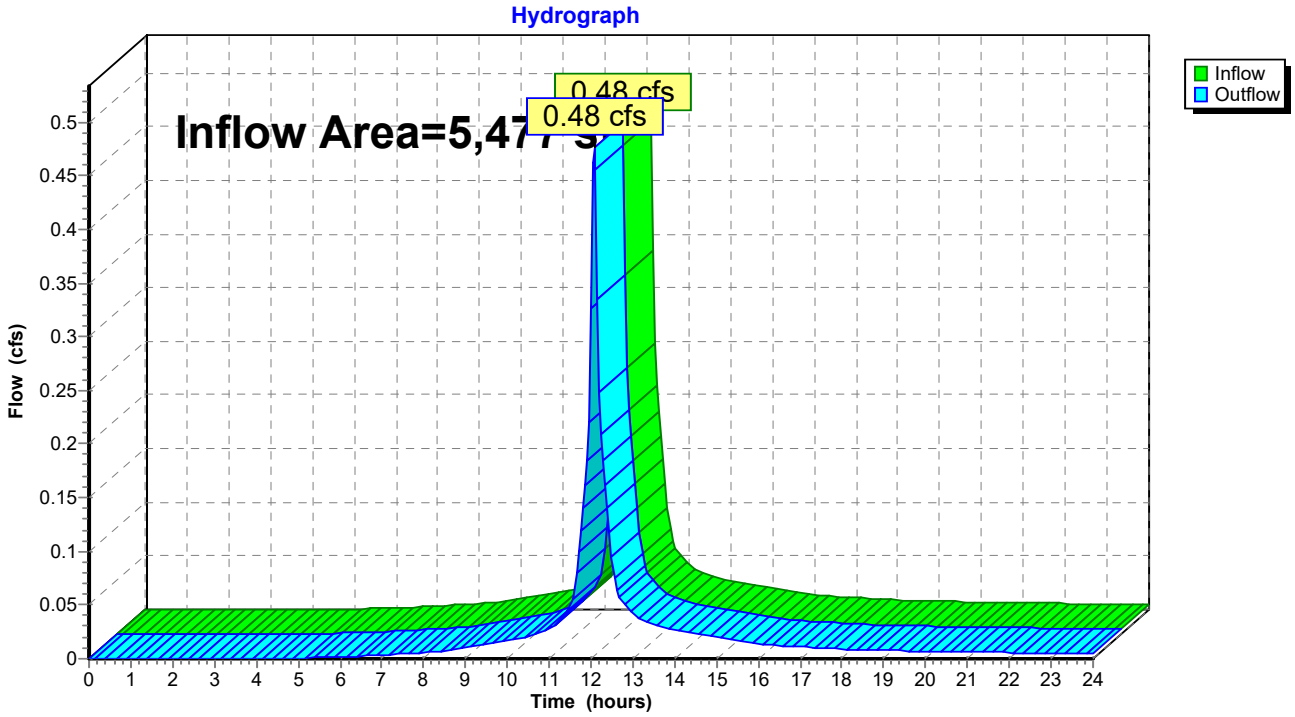


Summary for Reach DP-2: DP-2

Inflow Area = 5,477 sf, 71.44% Impervious, Inflow Depth > 3.32" for 5-year event
Inflow = 0.48 cfs @ 12.07 hrs, Volume= 1,517 cf
Outflow = 0.48 cfs @ 12.07 hrs, Volume= 1,517 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWS-1: EWS-1 Runoff Area=4,983 sf 82.42% Impervious Runoff Depth>4.48"
Tc=5.0 min CN=94 Runoff=0.56 cfs 1,862 cf

Subcatchment EWS-2: EWS-2 Runoff Area=5,477 sf 71.44% Impervious Runoff Depth>4.15"
Tc=5.0 min CN=91 Runoff=0.59 cfs 1,896 cf

Reach DP-1: DP-1 Inflow=0.56 cfs 1,862 cf
Outflow=0.56 cfs 1,862 cf

Reach DP-2: DP-2 Inflow=0.59 cfs 1,896 cf
Outflow=0.59 cfs 1,896 cf

Total Runoff Area = 10,460 sf Runoff Volume = 3,758 cf Average Runoff Depth = 4.31"
23.33% Pervious = 2,440 sf 76.67% Impervious = 8,020 sf

Summary for Subcatchment EWS-1: EWS-1

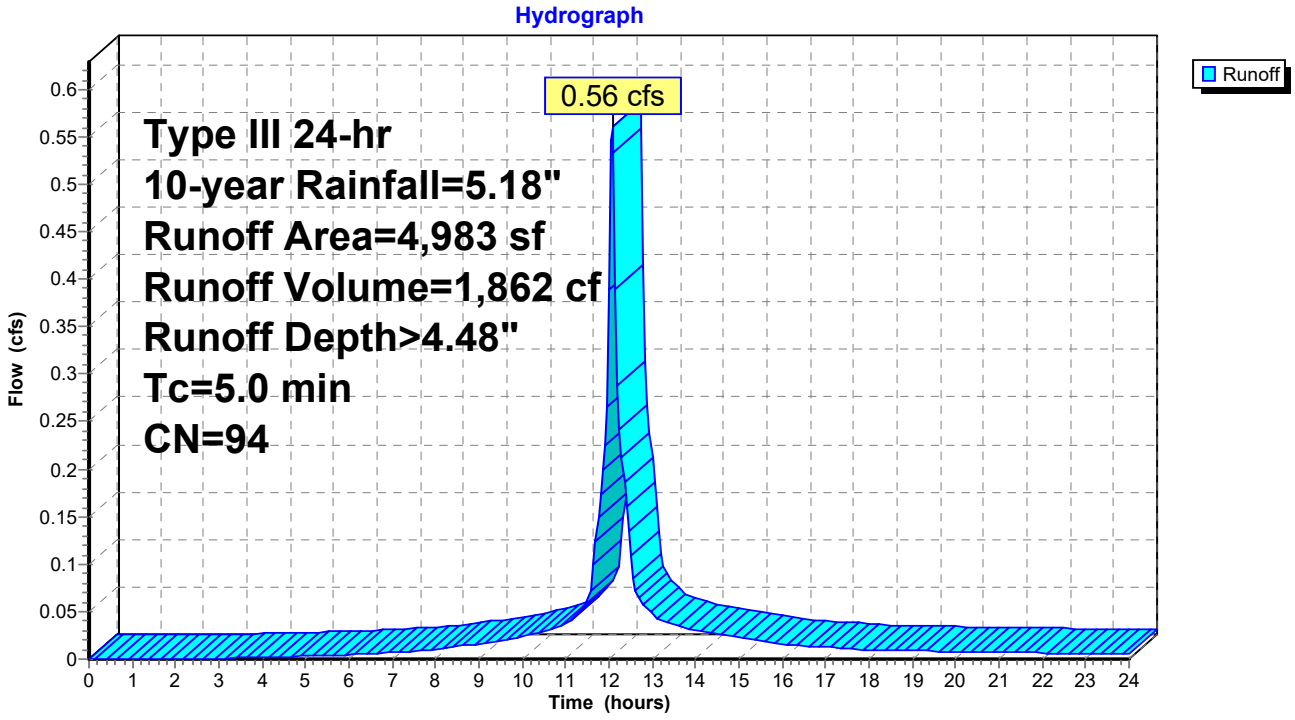
Runoff = 0.56 cfs @ 12.07 hrs, Volume= 1,862 cf, Depth> 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=5.18"

Area (sf)	CN	Description
3,990	98	Paved parking, HSG C
876	74	>75% Grass cover, Good, HSG C
117	98	Roofs, HSG C
4,983	94	Weighted Average
876		17.58% Pervious Area
4,107		82.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-1: EWS-1



Summary for Subcatchment EWS-2: EWS-2

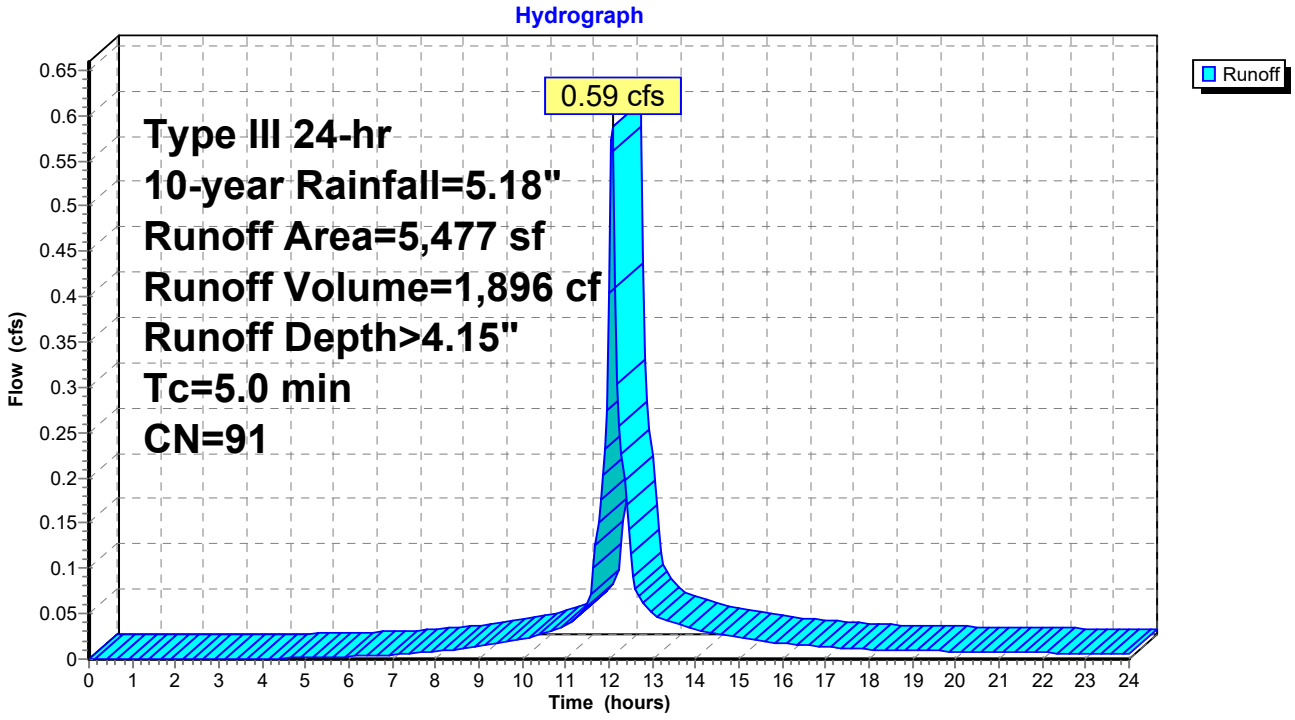
Runoff = 0.59 cfs @ 12.07 hrs, Volume= 1,896 cf, Depth> 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=5.18"

Area (sf)	CN	Description
1,666	98	Roofs, HSG C
1,564	74	>75% Grass cover, Good, HSG C
2,247	98	Paved parking, HSG C
5,477	91	Weighted Average
1,564		28.56% Pervious Area
3,913		71.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-2: EWS-2

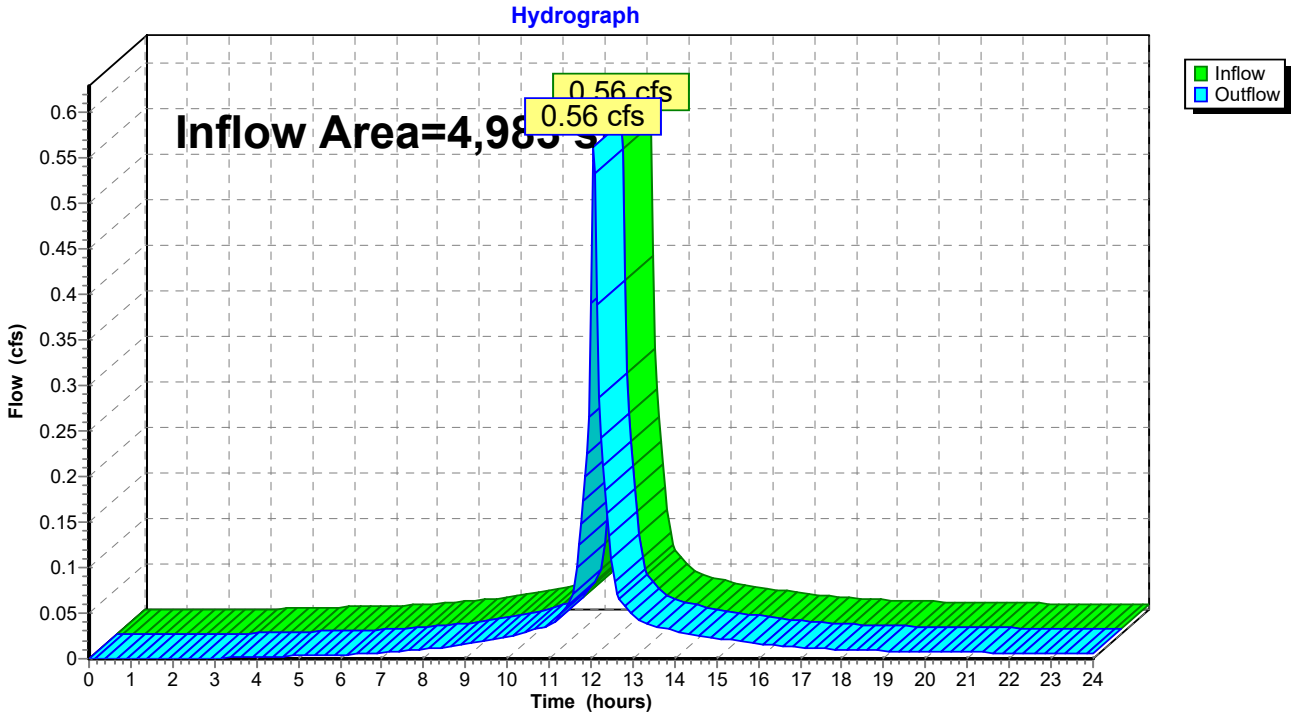


Summary for Reach DP-1: DP-1

Inflow Area = 4,983 sf, 82.42% Impervious, Inflow Depth > 4.48" for 10-year event
Inflow = 0.56 cfs @ 12.07 hrs, Volume= 1,862 cf
Outflow = 0.56 cfs @ 12.07 hrs, Volume= 1,862 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

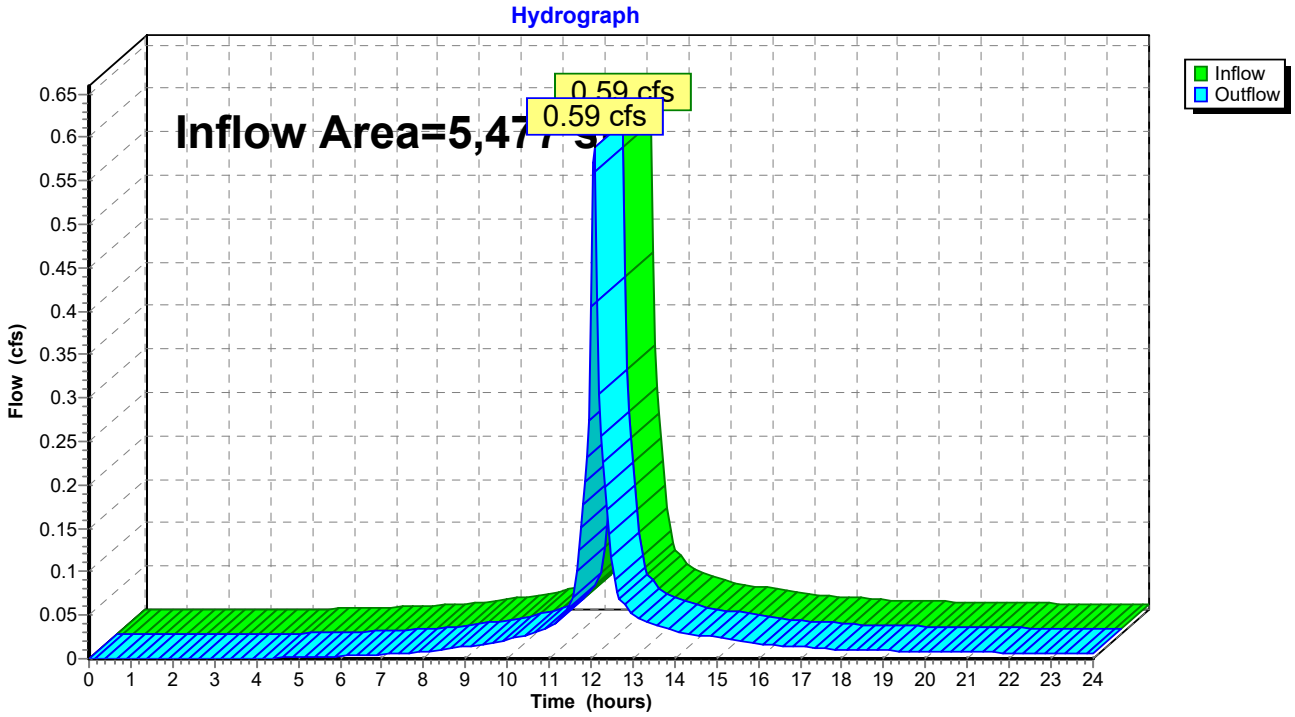


Summary for Reach DP-2: DP-2

Inflow Area = 5,477 sf, 71.44% Impervious, Inflow Depth > 4.15" for 10-year event
Inflow = 0.59 cfs @ 12.07 hrs, Volume= 1,896 cf
Outflow = 0.59 cfs @ 12.07 hrs, Volume= 1,896 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWS-1: EWS-1 Runoff Area=4,983 sf 82.42% Impervious Runoff Depth>5.64"
Tc=5.0 min CN=94 Runoff=0.70 cfs 2,342 cf

Subcatchment EWS-2: EWS-2 Runoff Area=5,477 sf 71.44% Impervious Runoff Depth>5.30"
Tc=5.0 min CN=91 Runoff=0.74 cfs 2,418 cf

Reach DP-1: DP-1 Inflow=0.70 cfs 2,342 cf
Outflow=0.70 cfs 2,342 cf

Reach DP-2: DP-2 Inflow=0.74 cfs 2,418 cf
Outflow=0.74 cfs 2,418 cf

Total Runoff Area = 10,460 sf Runoff Volume = 4,760 cf Average Runoff Depth = 5.46"
23.33% Pervious = 2,440 sf 76.67% Impervious = 8,020 sf

Summary for Subcatchment EWS-1: EWS-1

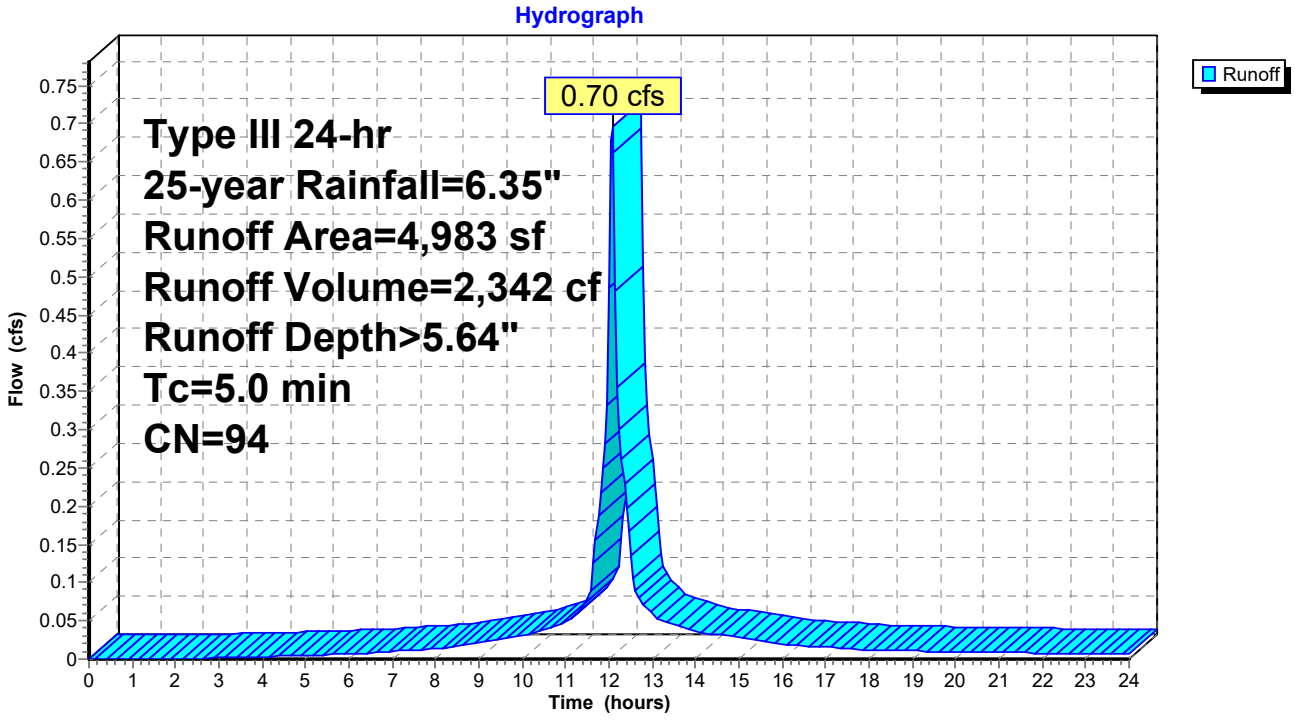
Runoff = 0.70 cfs @ 12.07 hrs, Volume= 2,342 cf, Depth> 5.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=6.35"

Area (sf)	CN	Description
3,990	98	Paved parking, HSG C
876	74	>75% Grass cover, Good, HSG C
117	98	Roofs, HSG C
4,983	94	Weighted Average
876		17.58% Pervious Area
4,107		82.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-1: EWS-1



Summary for Subcatchment EWS-2: EWS-2

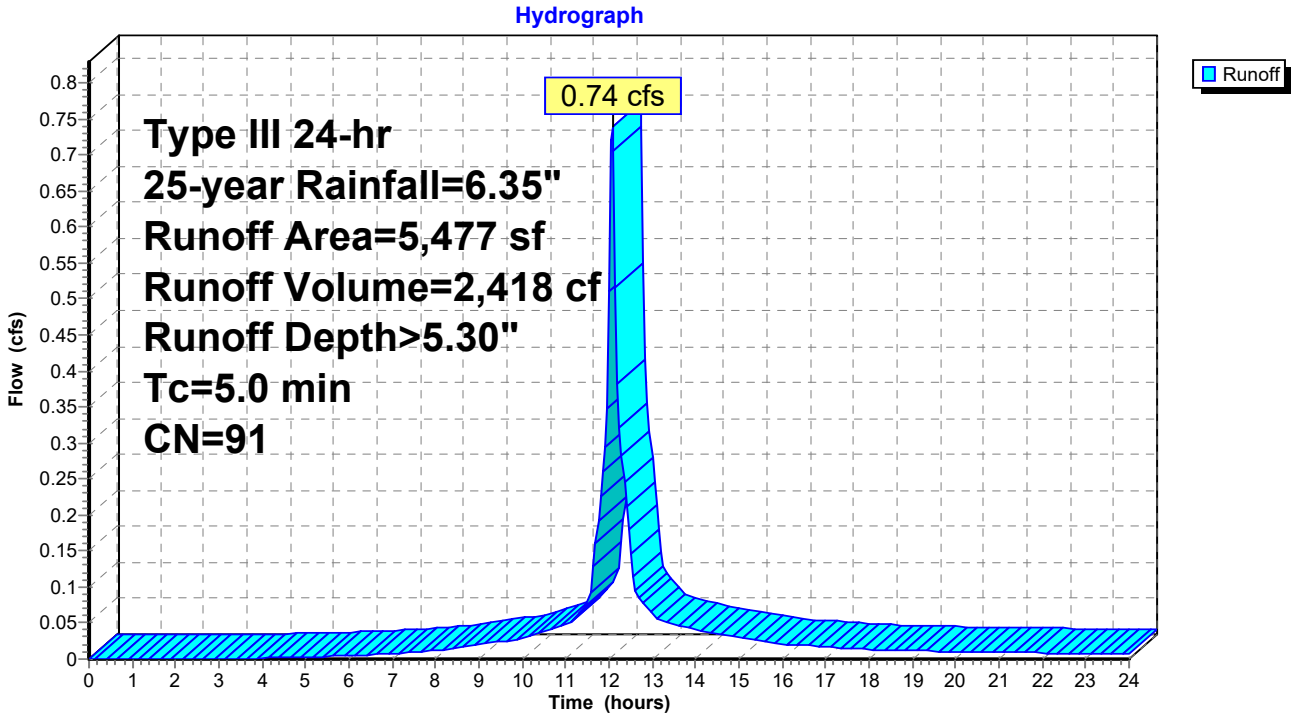
Runoff = 0.74 cfs @ 12.07 hrs, Volume= 2,418 cf, Depth> 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=6.35"

Area (sf)	CN	Description
1,666	98	Roofs, HSG C
1,564	74	>75% Grass cover, Good, HSG C
2,247	98	Paved parking, HSG C
5,477	91	Weighted Average
1,564		28.56% Pervious Area
3,913		71.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-2: EWS-2

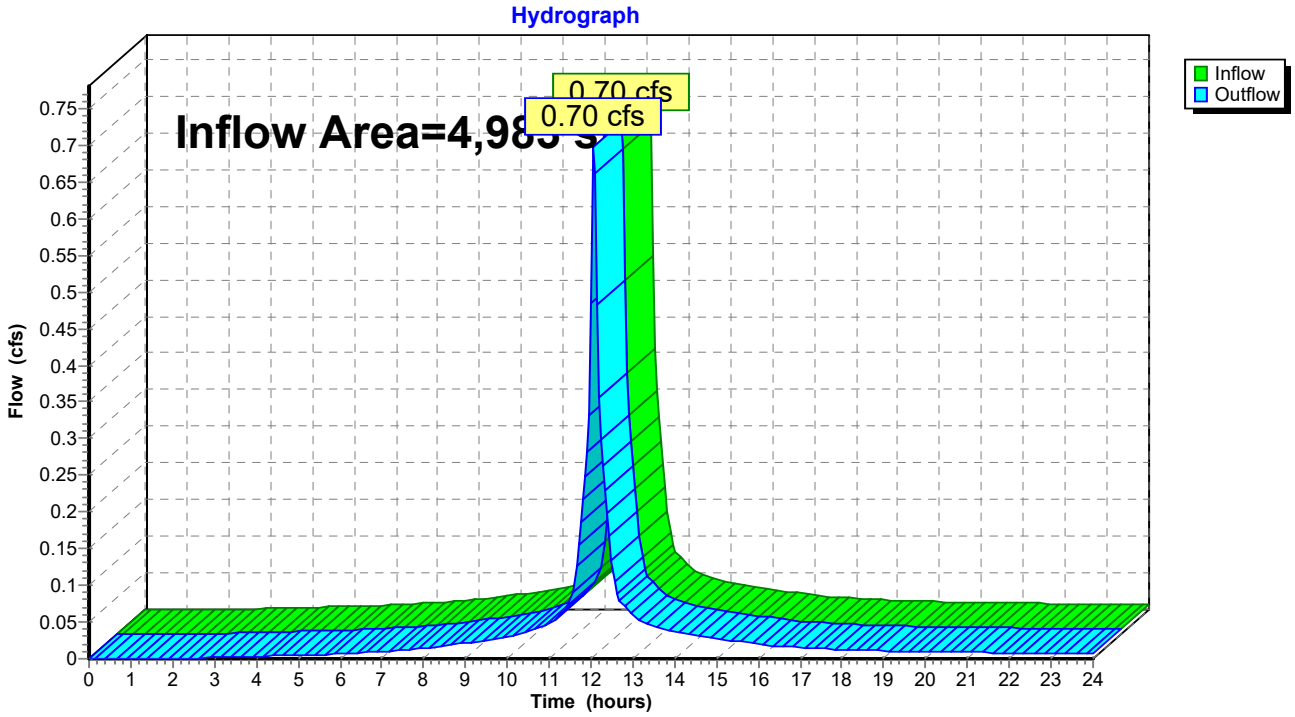


Summary for Reach DP-1: DP-1

Inflow Area = 4,983 sf, 82.42% Impervious, Inflow Depth > 5.64" for 25-year event
Inflow = 0.70 cfs @ 12.07 hrs, Volume= 2,342 cf
Outflow = 0.70 cfs @ 12.07 hrs, Volume= 2,342 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

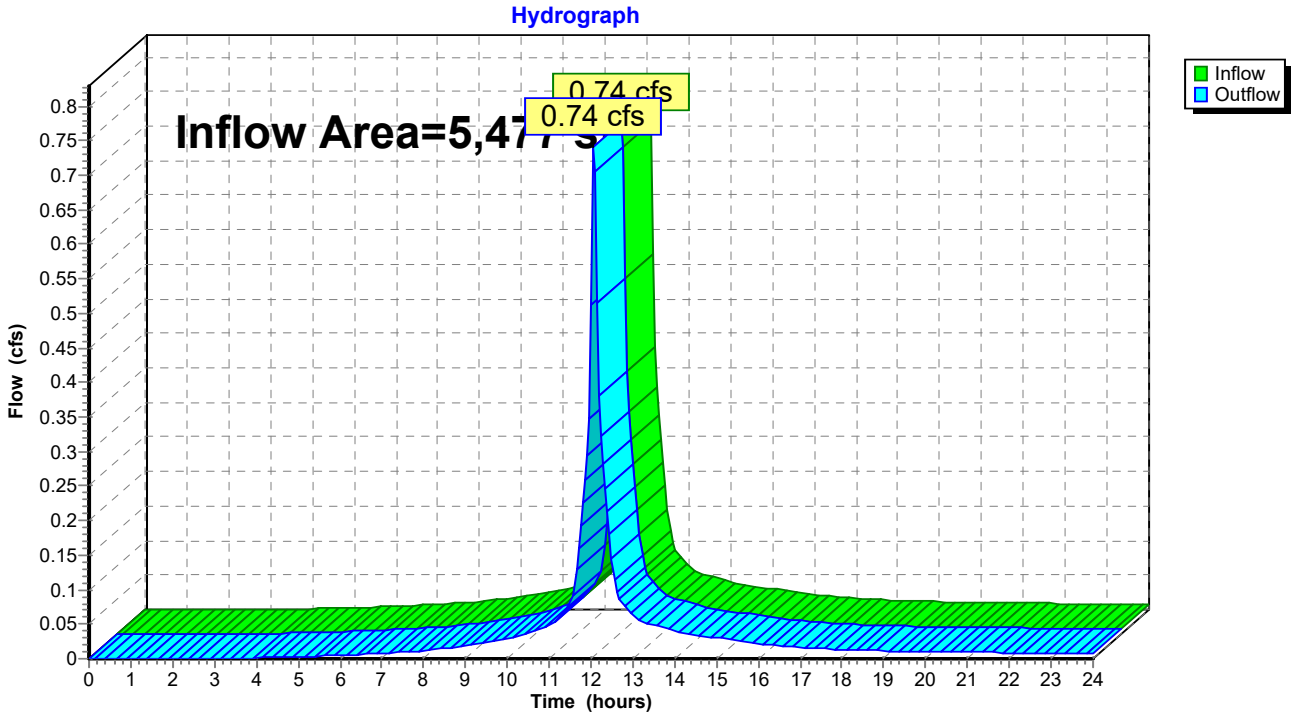


Summary for Reach DP-2: DP-2

Inflow Area = 5,477 sf, 71.44% Impervious, Inflow Depth > 5.30" for 25-year event
Inflow = 0.74 cfs @ 12.07 hrs, Volume= 2,418 cf
Outflow = 0.74 cfs @ 12.07 hrs, Volume= 2,418 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWS-1: EWS-1 Runoff Area=4,983 sf 82.42% Impervious Runoff Depth>7.45"
Tc=5.0 min CN=94 Runoff=0.91 cfs 3,093 cf

Subcatchment EWS-2: EWS-2 Runoff Area=5,477 sf 71.44% Impervious Runoff Depth>7.09"
Tc=5.0 min CN=91 Runoff=0.97 cfs 3,235 cf

Reach DP-1: DP-1 Inflow=0.91 cfs 3,093 cf
Outflow=0.91 cfs 3,093 cf

Reach DP-2: DP-2 Inflow=0.97 cfs 3,235 cf
Outflow=0.97 cfs 3,235 cf

Total Runoff Area = 10,460 sf Runoff Volume = 6,328 cf Average Runoff Depth = 7.26"
23.33% Pervious = 2,440 sf 76.67% Impervious = 8,020 sf

Summary for Subcatchment EWS-1: EWS-1

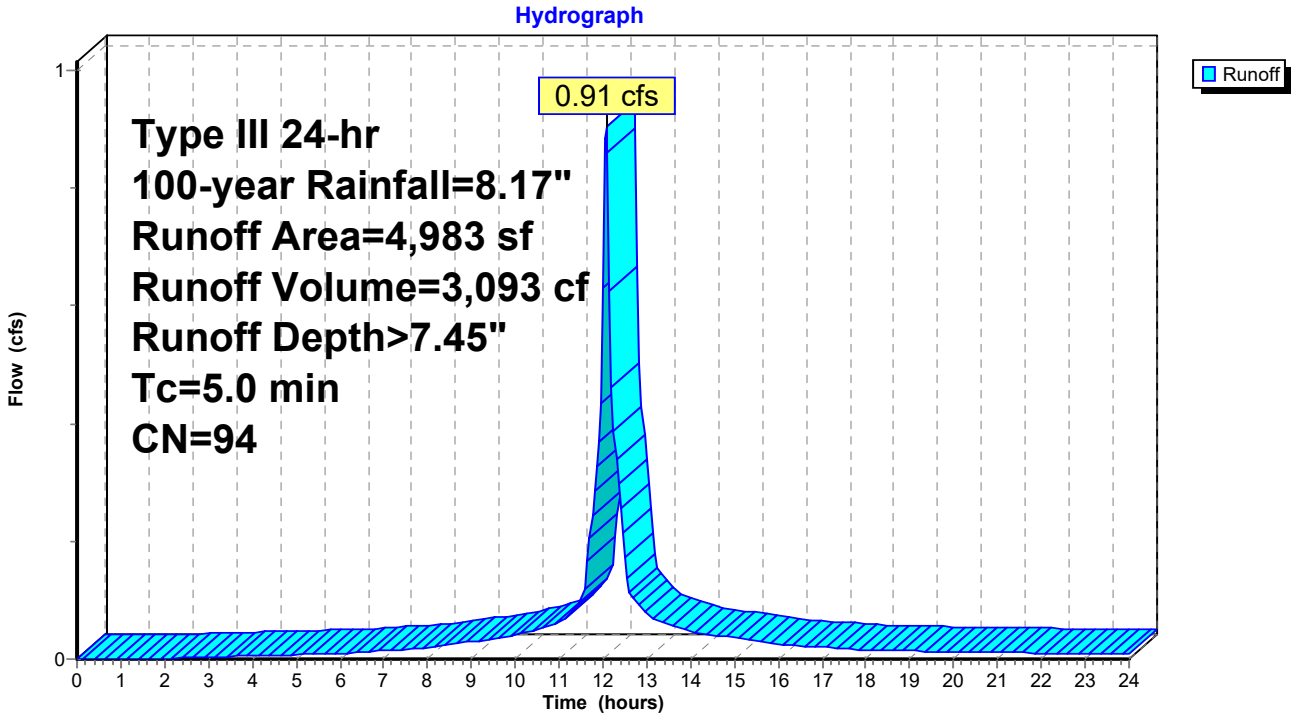
Runoff = 0.91 cfs @ 12.07 hrs, Volume= 3,093 cf, Depth> 7.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=8.17"

Area (sf)	CN	Description
3,990	98	Paved parking, HSG C
876	74	>75% Grass cover, Good, HSG C
117	98	Roofs, HSG C
4,983	94	Weighted Average
876		17.58% Pervious Area
4,107		82.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-1: EWS-1



Summary for Subcatchment EWS-2: EWS-2

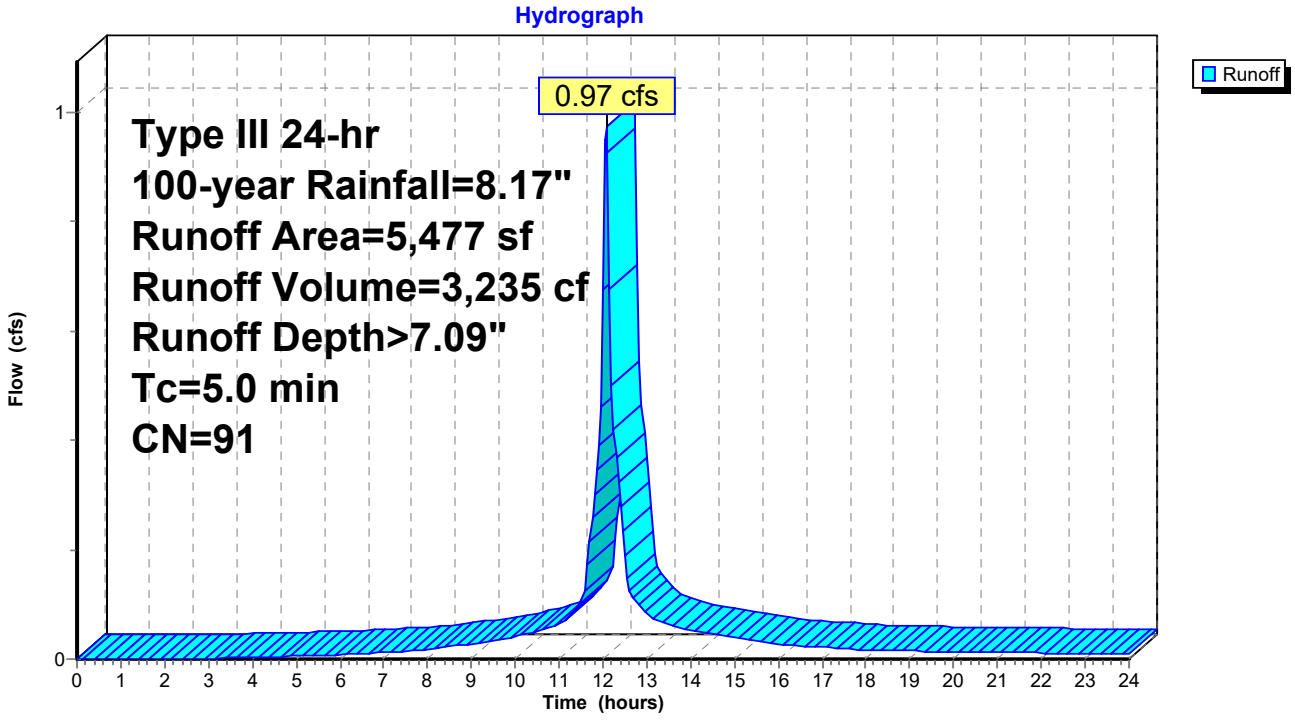
Runoff = 0.97 cfs @ 12.07 hrs, Volume= 3,235 cf, Depth> 7.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=8.17"

Area (sf)	CN	Description
1,666	98	Roofs, HSG C
1,564	74	>75% Grass cover, Good, HSG C
2,247	98	Paved parking, HSG C
5,477	91	Weighted Average
1,564		28.56% Pervious Area
3,913		71.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EWS-2: EWS-2

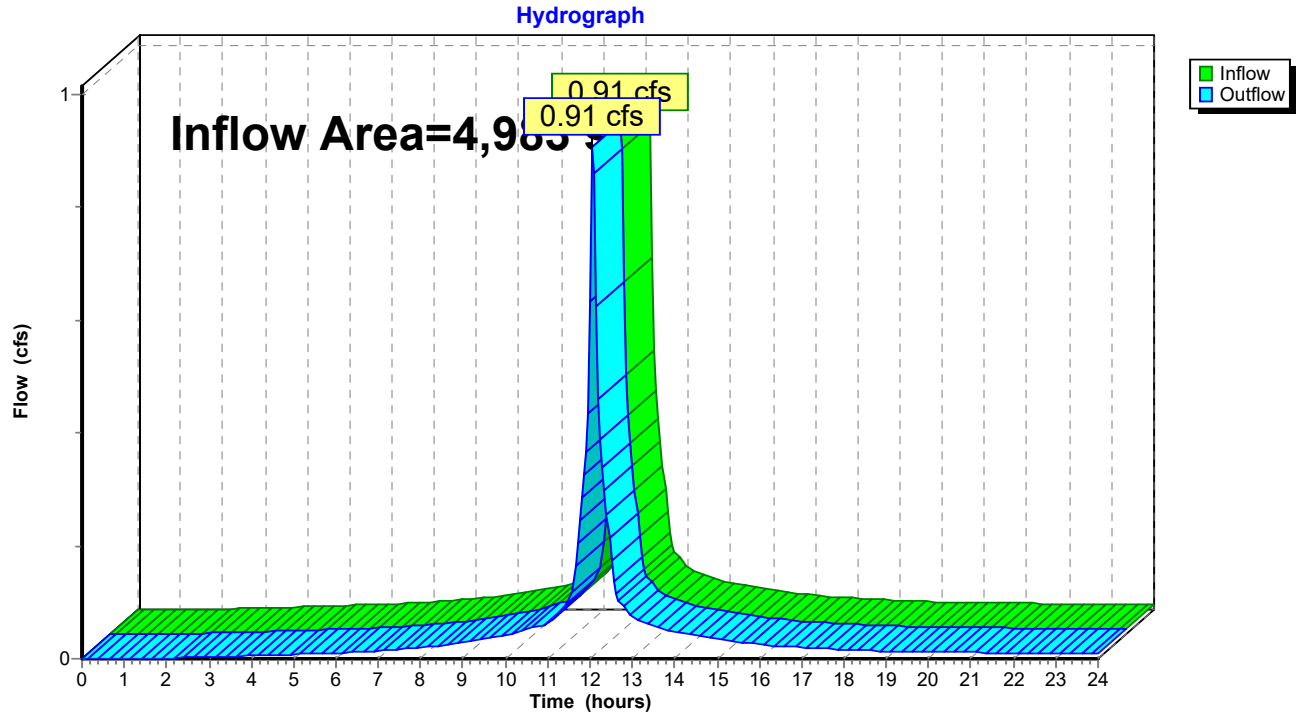


Summary for Reach DP-1: DP-1

Inflow Area = 4,983 sf, 82.42% Impervious, Inflow Depth > 7.45" for 100-year event
Inflow = 0.91 cfs @ 12.07 hrs, Volume= 3,093 cf
Outflow = 0.91 cfs @ 12.07 hrs, Volume= 3,093 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

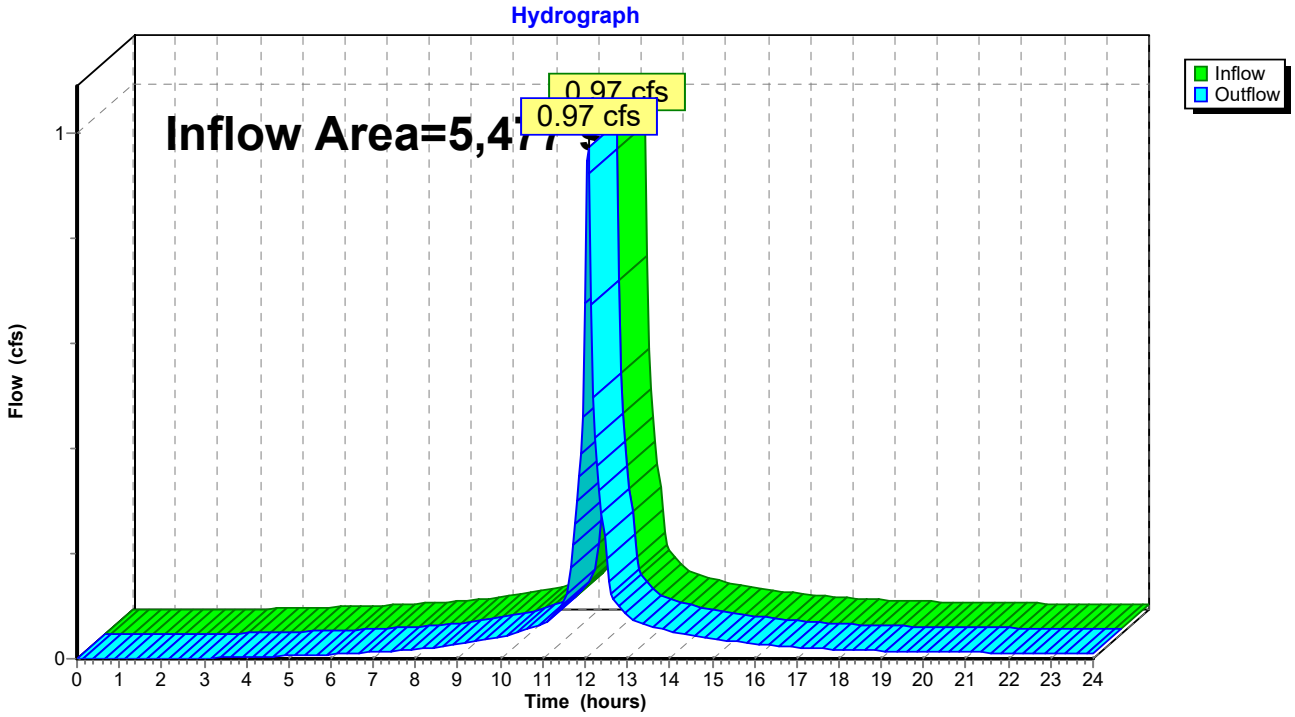


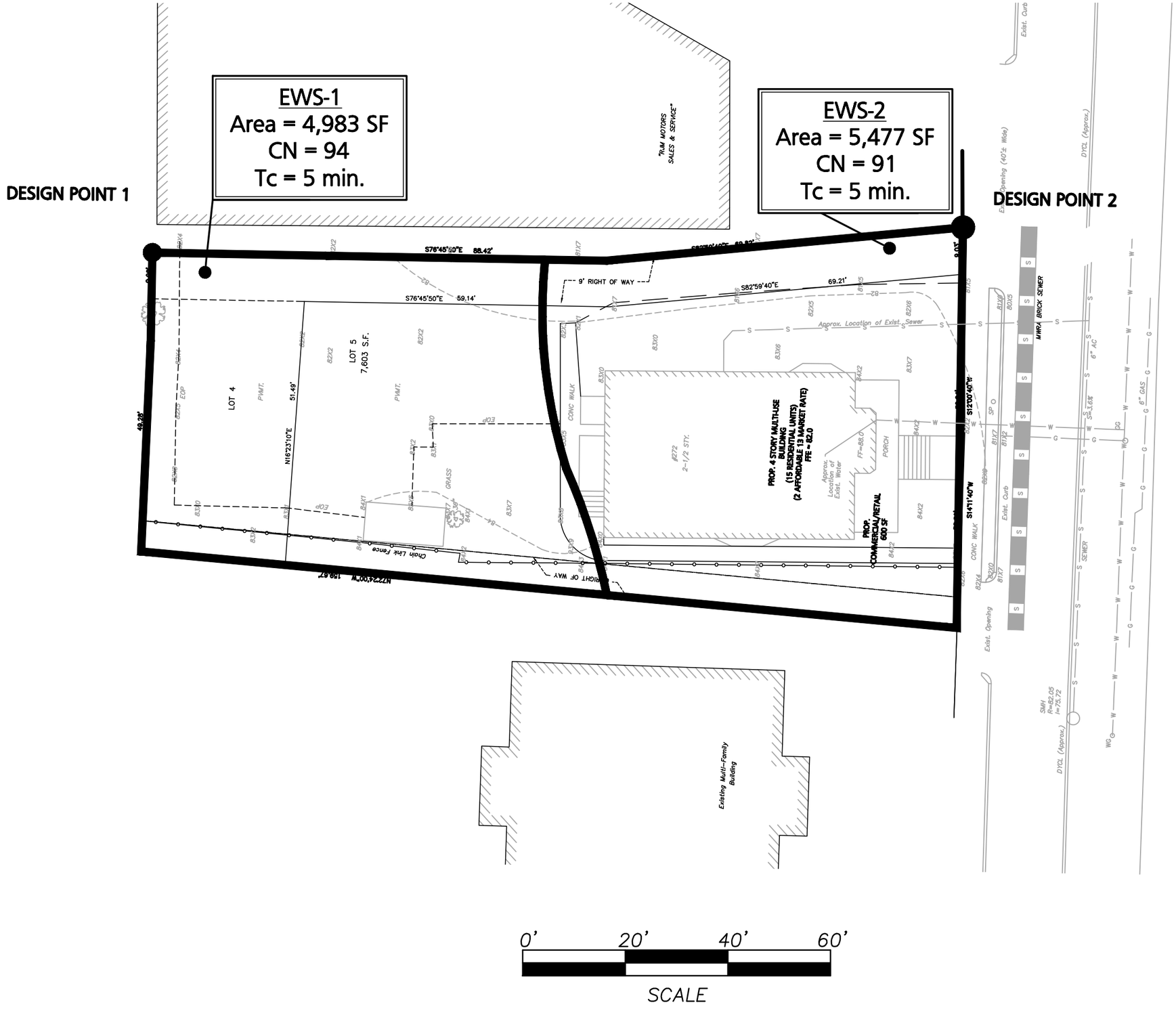
Summary for Reach DP-2: DP-2

Inflow Area = 5,477 sf, 71.44% Impervious, Inflow Depth > 7.09" for 100-year event
Inflow = 0.97 cfs @ 12.07 hrs, Volume= 3,235 cf
Outflow = 0.97 cfs @ 12.07 hrs, Volume= 3,235 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2





DESCRIPTION OF REVISION	DATE

PREPARED BY:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street 1950 Lafayette Road
Saugus, MA 01906 Portsmouth, NH 03801
Tel: (781) 231-1349 Tel: (603) 610-7100
Fax: (781) 417-0220 Fax: (603) 610-7101

PROJECT:

Site Plan

272 Tremont Street
(Tax Map C12 Block 0 Lot 9)
Melrose, Massachusetts 02176

PROJECT #: 19-29908	DATE: January 13, 2020
SCALE: AS NOTED	DWG FILE NAME: 19-29908 REV 1-7-20
DESIGN BY: Garrett Anderson	CHECKED BY: Richard A. Salvo, P.E.

APPLICANT:

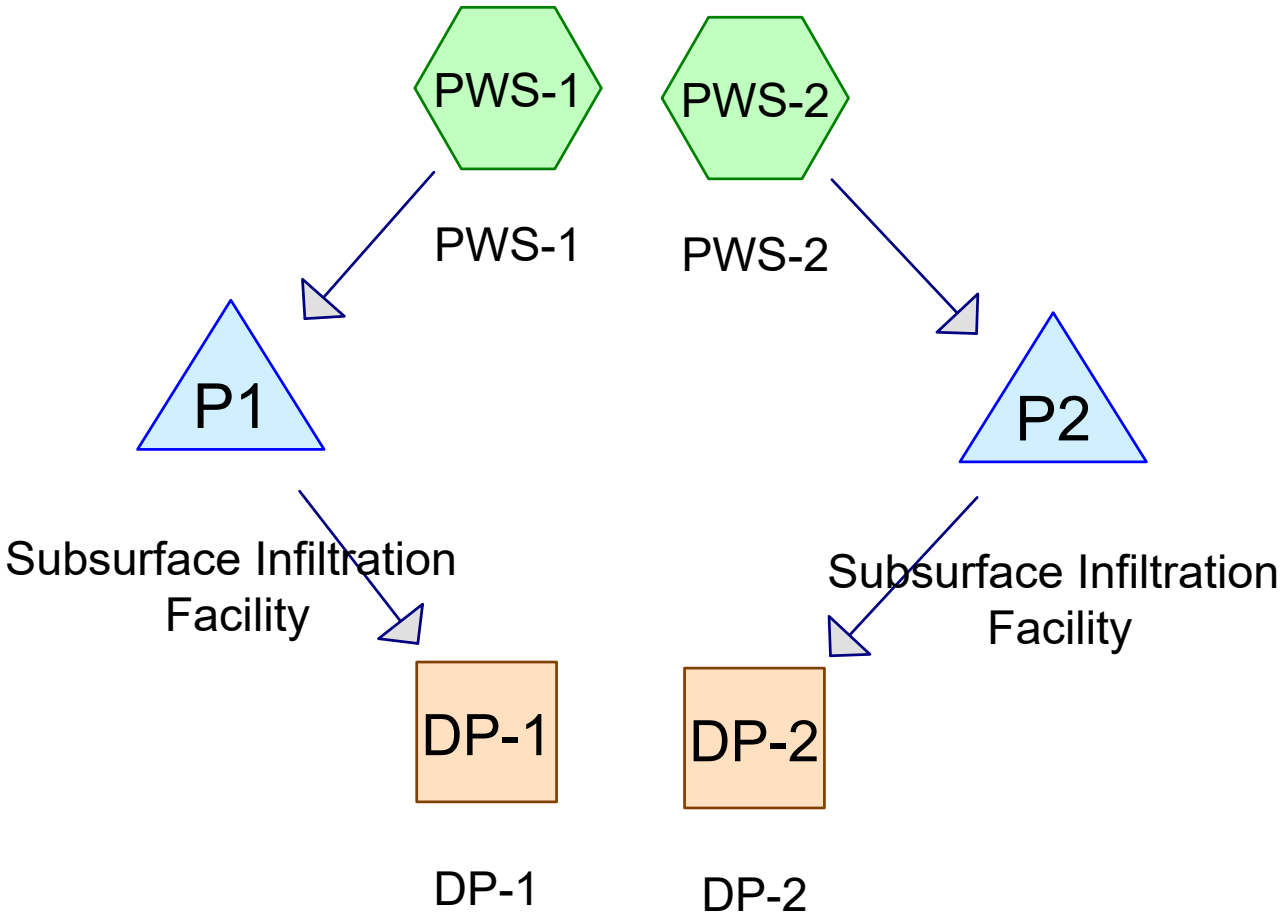
Eric Kenworthy
49 Marmion Road
Melrose, MA 02176

DWG. NO. EWS

DRAWING TITLE: Existing Watershed Plan

APPENDIX B

Proposed Conditions Drainage Calculations
Proposed Watershed Plan



Subcat Reach Pond Link

Routing Diagram for Proposed Conditions
Prepared by Engineering Alliance, Inc., Printed 8/11/2020

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type III 24-hr		Default	24.00	1	3.29	2
2	5-year	Type III 24-hr		Default	24.00	1	4.32	2
3	10-year	Type III 24-hr		Default	24.00	1	5.18	2
4	25-year	Type III 24-hr		Default	24.00	1	6.35	2
5	100-year	Type III 24-hr		Default	24.00	1	8.17	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
718	74	>75% Grass cover, Good, HSG C (PWS-1, PWS-2)
3,758	98	Paved parking, HSG C (PWS-1, PWS-2)
5,984	98	Roofs, HSG C (PWS-1)
10,460	**96**	**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Sub Num
0	0	718	0	0	718	>75% Grass cover, Good	
0	0	3,758	0	0	3,758	Paved parking	
0	0	5,984	0	0	5,984	Roofs	
0	**0**	**10,460**	**0**	**0**	**10,460**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWS-1: PWS-1 Runoff Area=8,193 sf 95.18% Impervious Runoff Depth>2.95"
Tc=0.0 min CN=97 Runoff=0.68 cfs 2,011 cf

Subcatchment PWS-2: PWS-2 Runoff Area=2,267 sf 85.75% Impervious Runoff Depth>2.73"
Tc=5.0 min CN=95 Runoff=0.16 cfs 516 cf

Reach DP-1: DP-1 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Reach DP-2: DP-2 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond P1: Subsurface Infiltration Facility Peak Elev=77.32' Storage=434 cf Inflow=0.68 cfs 2,011 cf
Discarded=0.16 cfs 2,011 cf Primary=0.00 cfs 0 cf Outflow=0.16 cfs 2,011 cf

Pond P2: Subsurface Infiltration Facility Peak Elev=76.81' Storage=87 cf Inflow=0.16 cfs 516 cf
Discarded=0.05 cfs 516 cf Primary=0.00 cfs 0 cf Outflow=0.05 cfs 516 cf

Total Runoff Area = 10,460 sf Runoff Volume = 2,527 cf Average Runoff Depth = 2.90"
6.86% Pervious = 718 sf 93.14% Impervious = 9,742 sf

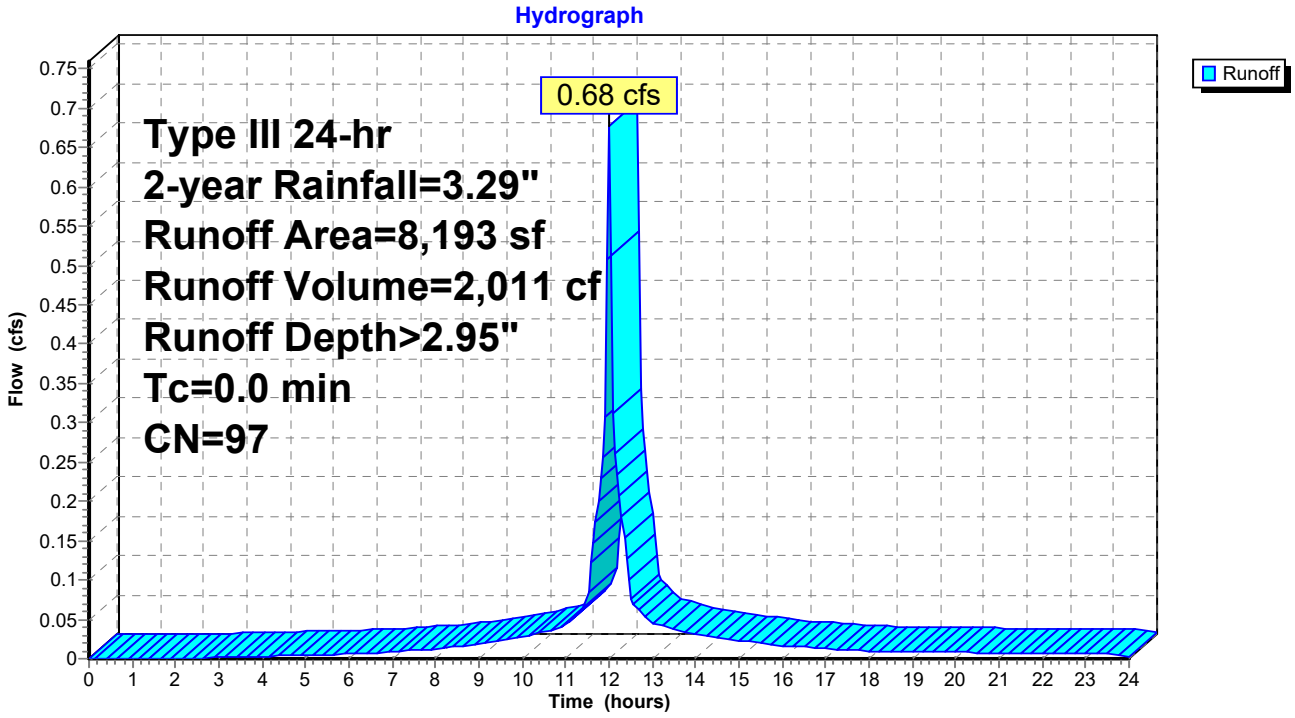
Summary for Subcatchment PWS-1: PWS-1

Runoff = 0.68 cfs @ 12.00 hrs, Volume= 2,011 cf, Depth> 2.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.29"

Area (sf)	CN	Description
395	74	>75% Grass cover, Good, HSG C
1,814	98	Paved parking, HSG C
5,984	98	Roofs, HSG C
8,193	97	Weighted Average
395		4.82% Pervious Area
7,798		95.18% Impervious Area

Subcatchment PWS-1: PWS-1



Summary for Subcatchment PWS-2: PWS-2

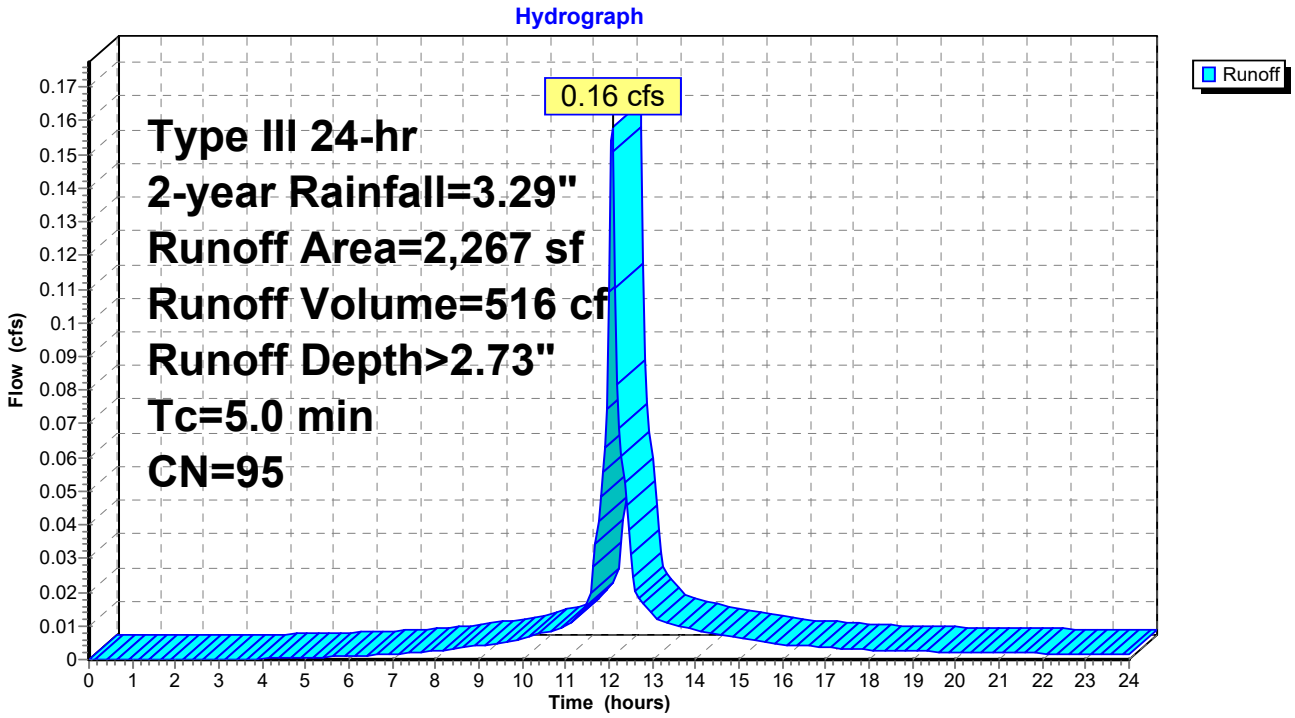
Runoff = 0.16 cfs @ 12.07 hrs, Volume= 516 cf, Depth> 2.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.29"

Area (sf)	CN	Description
323	74	>75% Grass cover, Good, HSG C
1,944	98	Paved parking, HSG C
2,267	95	Weighted Average
323		14.25% Pervious Area
1,944		85.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PWS-2: PWS-2

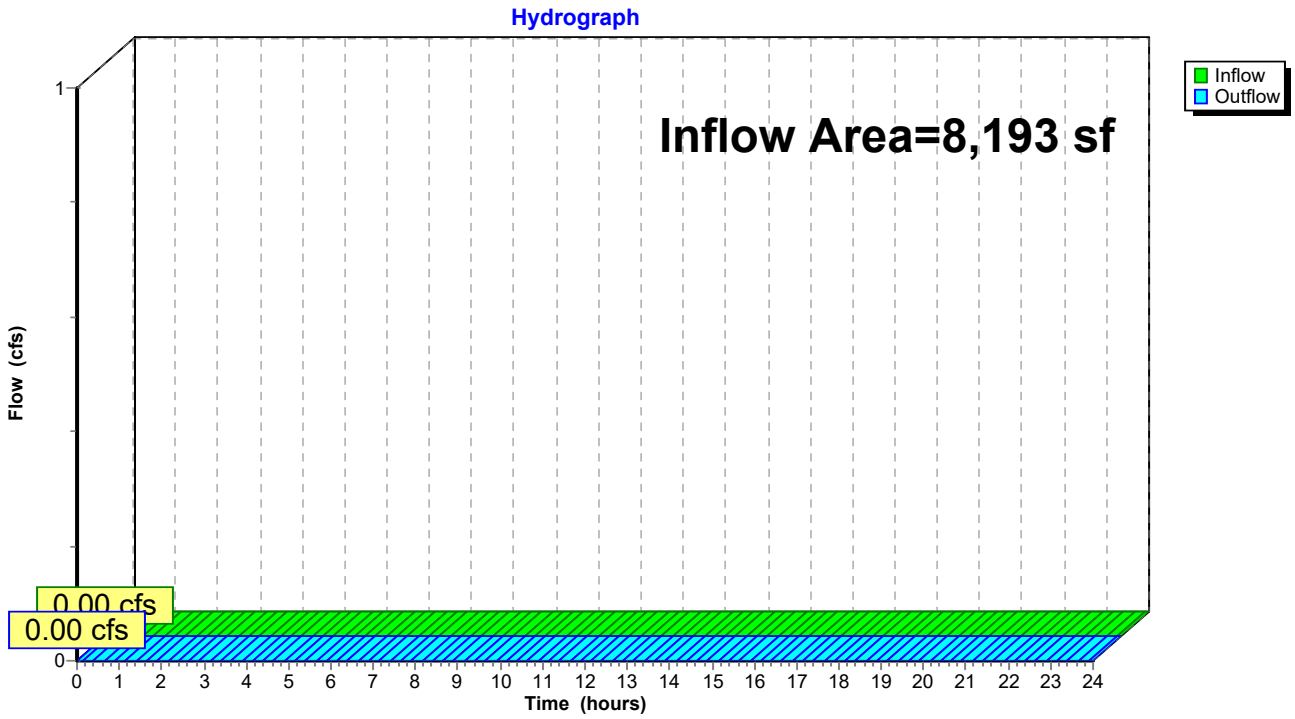


Summary for Reach DP-1: DP-1

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

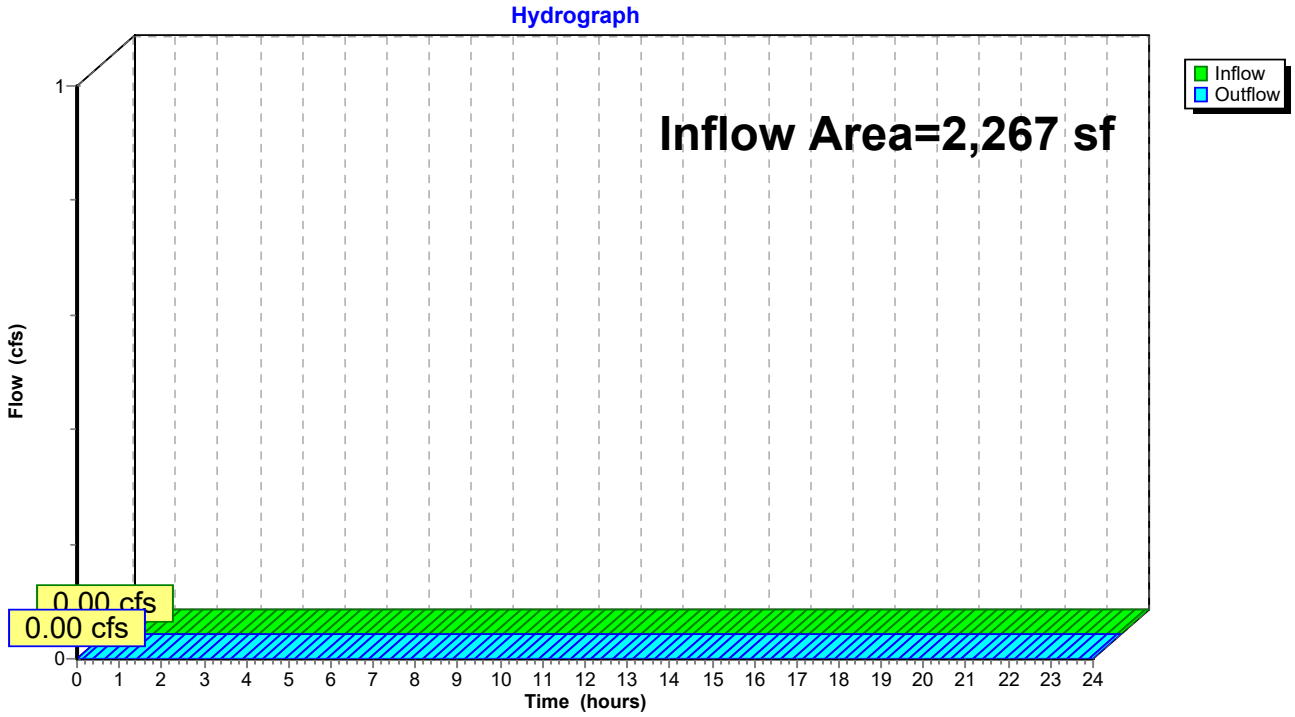


Summary for Reach DP-2: DP-2

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Summary for Pond P1: Subsurface Infiltration Facility

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth > 2.95" for 2-year event
Inflow = 0.68 cfs @ 12.00 hrs, Volume= 2,011 cf
Outflow = 0.16 cfs @ 12.34 hrs, Volume= 2,011 cf, Atten= 76%, Lag= 20.2 min
Discarded = 0.16 cfs @ 12.34 hrs, Volume= 2,011 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 77.32' @ 12.34 hrs Surf.Area= 508 sf Storage= 434 cf

Plug-Flow detention time= 15.7 min calculated for 2,011 cf (100% of inflow)
Center-of-Mass det. time= 15.6 min (775.3 - 759.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	460 cf	**11.17'W x 45.50'L x 3.54'H Field A** 1,799 cf Overall - 648 cf Embedded = 1,151 cf x 40.0% Voids
#2A	76.50'	648 cf	**Cultec R-330XL** x 12 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 2 rows
#3	77.85'	151 cf	**5.00'D x 3.85'H CDS Unit #1 & #2 (Above Invert)**x 2 -Impervious
		1,260 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	81.55'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.16 cfs @ 12.34 hrs HW=77.32' (Free Discharge)
↑**1=Exfiltration** (Controls 0.16 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P1: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 2 rows

52.0" Wide + 6.0" Spacing = 58.0" C-C Row Spacing

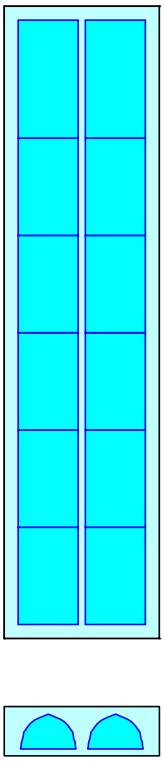
6 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 43.50' Row Length +12.0" End Stone x 2 = 45.50' Base Length
2 Rows x 52.0" Wide + 6.0" Spacing x 1 + 12.0" Side Stone x 2 = 11.17' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

12 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 2 Rows = 648.2 cf Chamber Storage

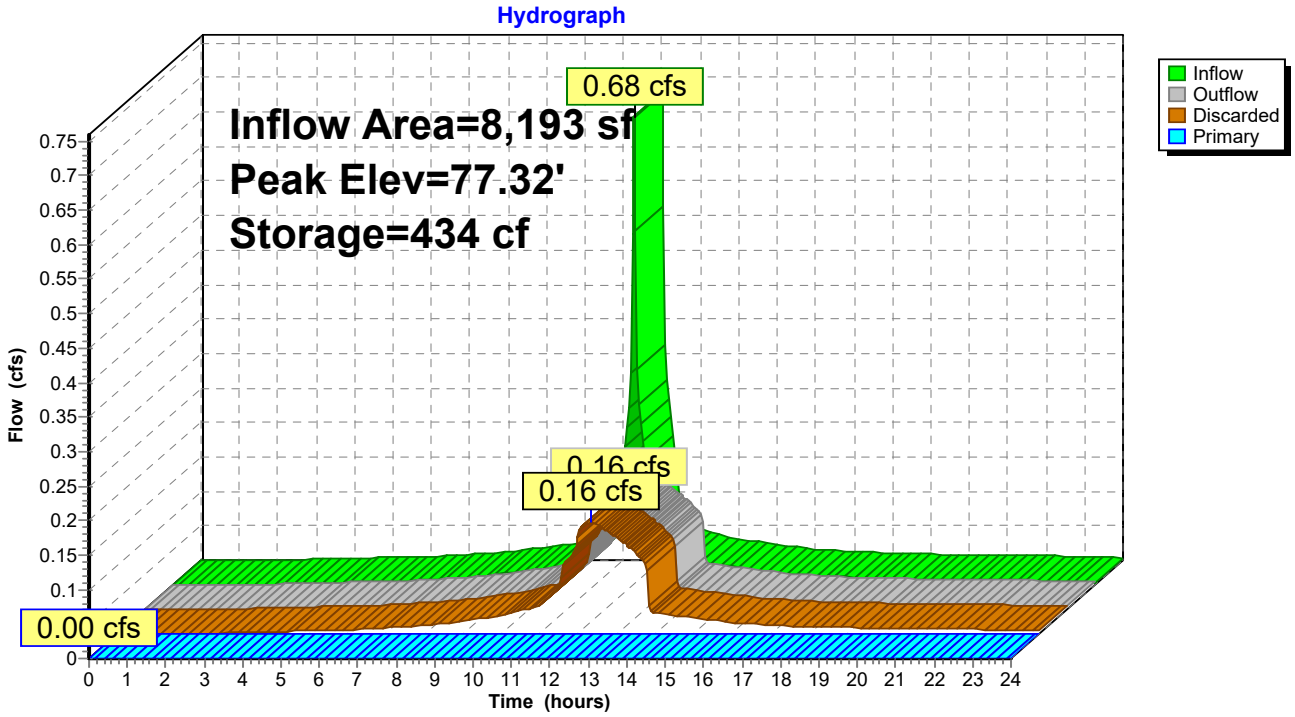
1,799.5 cf Field - 648.2 cf Chambers = 1,151.2 cf Stone x 40.0% Voids = 460.5 cf Stone Storage

Chamber Storage + Stone Storage = 1,108.7 cf = 0.025 af
Overall Storage Efficiency = 61.6%
Overall System Size = 45.50' x 11.17' x 3.54'

12 Chambers
66.6 cy Field
42.6 cy Stone



Pond P1: Subsurface Infiltration Facility



Summary for Pond P2: Subsurface Infiltration Facility

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth > 2.73" for 2-year event
Inflow = 0.16 cfs @ 12.07 hrs, Volume= 516 cf
Outflow = 0.05 cfs @ 12.34 hrs, Volume= 516 cf, Atten= 66%, Lag= 16.4 min
Discarded = 0.05 cfs @ 12.34 hrs, Volume= 516 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 76.81' @ 12.34 hrs Surf.Area= 199 sf Storage= 87 cf

Plug-Flow detention time= 8.8 min calculated for 516 cf (100% of inflow)
Center-of-Mass det. time= 8.6 min (787.4 - 778.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	195 cf	**6.33'W x 31.50'L x 3.54'H Field A** 707 cf Overall - 220 cf Embedded = 487 cf x 40.0% Voids
#2A	76.50'	220 cf	**Cultec R-330XL** x 4 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	77.70'	59 cf	**5.00'D x 3.00'H CDS Unit #3 (Above Invert)** Impervious
		473 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	80.65'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.05 cfs @ 12.34 hrs HW=76.81' (Free Discharge)
↑**1=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P2: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

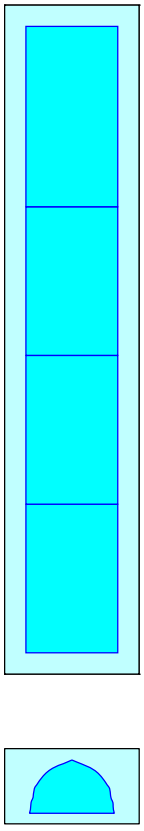
4 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 29.50' Row Length +12.0" End Stone x 2 = 31.50' Base Length
1 Rows x 52.0" Wide + 12.0" Side Stone x 2 = 6.33' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

4 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 219.8 cf Chamber Storage

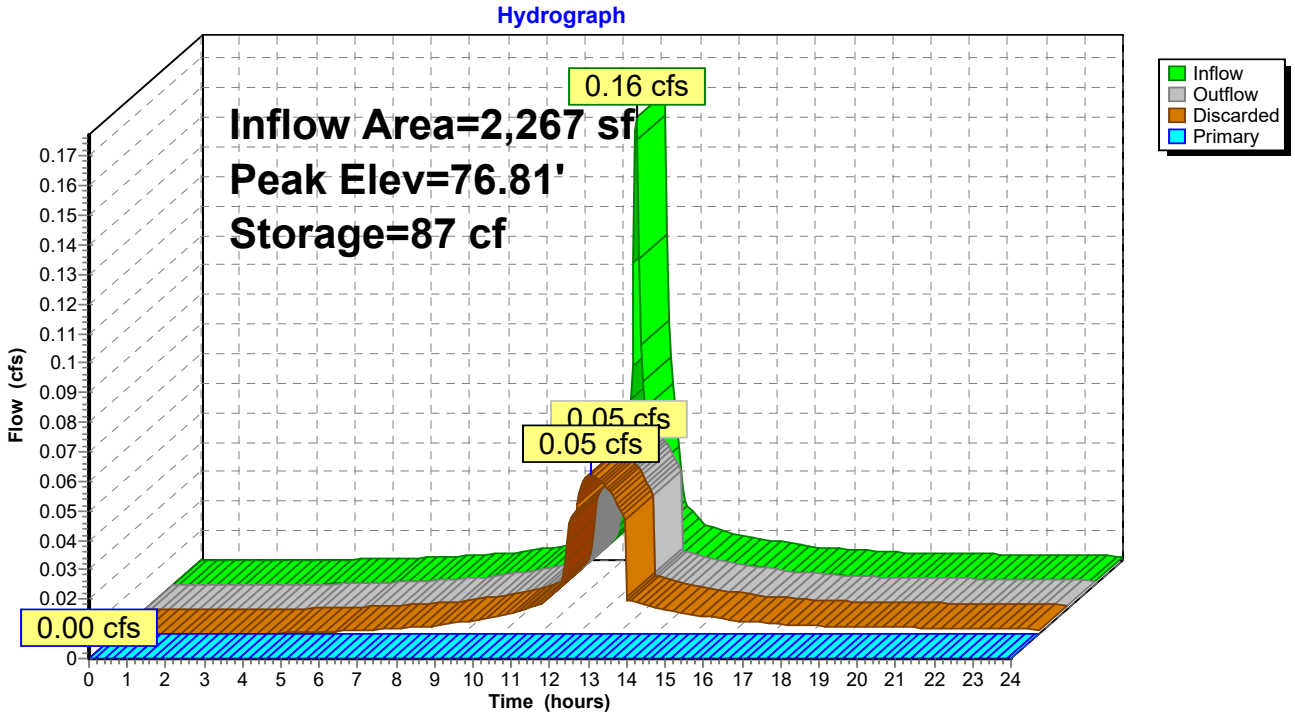
706.6 cf Field - 219.8 cf Chambers = 486.8 cf Stone x 40.0% Voids = 194.7 cf Stone Storage

Chamber Storage + Stone Storage = 414.5 cf = 0.010 af
Overall Storage Efficiency = 58.7%
Overall System Size = 31.50' x 6.33' x 3.54'

4 Chambers
26.2 cy Field
18.0 cy Stone



Pond P2: Subsurface Infiltration Facility



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWS-1: PWS-1 Runoff Area=8,193 sf 95.18% Impervious Runoff Depth>3.97"
Tc=0.0 min CN=97 Runoff=0.90 cfs 2,710 cf

Subcatchment PWS-2: PWS-2 Runoff Area=2,267 sf 85.75% Impervious Runoff Depth>3.74"
Tc=5.0 min CN=95 Runoff=0.21 cfs 707 cf

Reach DP-1: DP-1 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Reach DP-2: DP-2 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond P1: Subsurface Infiltration Facility Peak Elev=77.90' Storage=658 cf Inflow=0.90 cfs 2,710 cf
Discarded=0.19 cfs 2,710 cf Primary=0.00 cfs 0 cf Outflow=0.19 cfs 2,710 cf

Pond P2: Subsurface Infiltration Facility Peak Elev=77.21' Storage=145 cf Inflow=0.21 cfs 707 cf
Discarded=0.06 cfs 707 cf Primary=0.00 cfs 0 cf Outflow=0.06 cfs 707 cf

Total Runoff Area = 10,460 sf Runoff Volume = 3,418 cf Average Runoff Depth = 3.92"
6.86% Pervious = 718 sf 93.14% Impervious = 9,742 sf

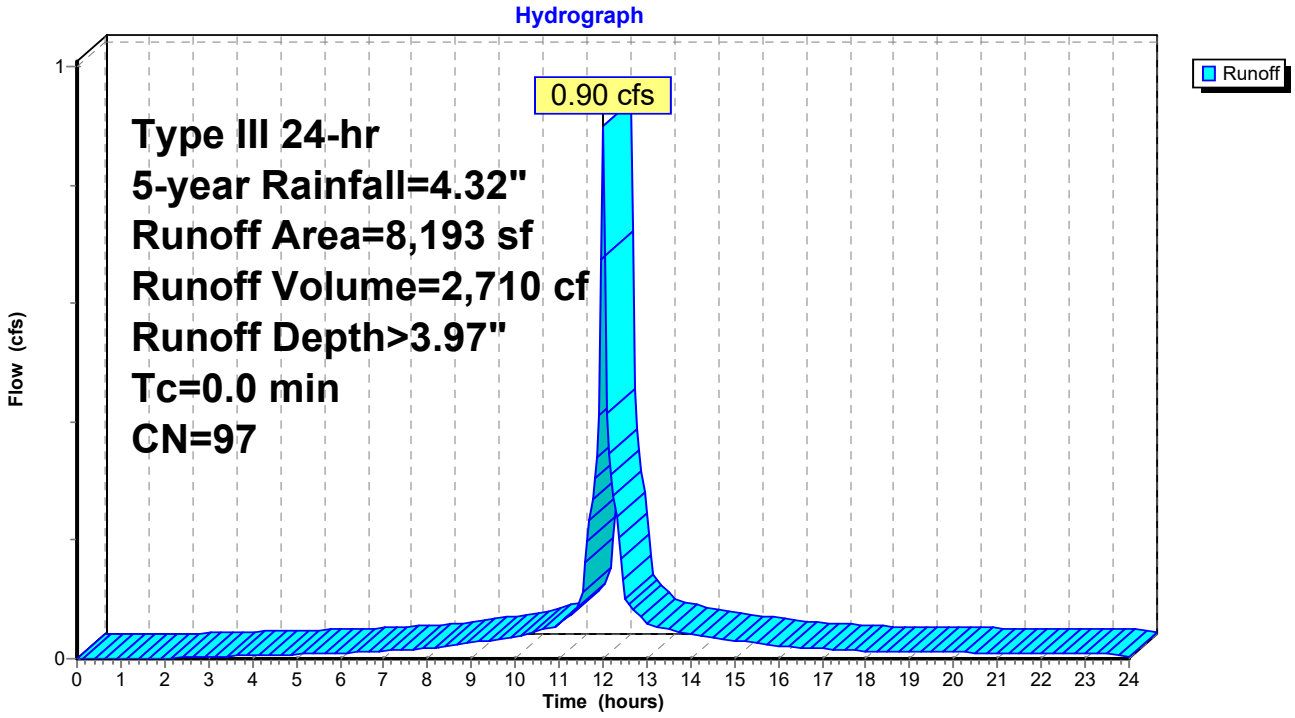
Summary for Subcatchment PWS-1: PWS-1

Runoff = 0.90 cfs @ 12.00 hrs, Volume= 2,710 cf, Depth> 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 5-year Rainfall=4.32"

Area (sf)	CN	Description
395	74	>75% Grass cover, Good, HSG C
1,814	98	Paved parking, HSG C
5,984	98	Roofs, HSG C
8,193	97	Weighted Average
395		4.82% Pervious Area
7,798		95.18% Impervious Area

Subcatchment PWS-1: PWS-1



Summary for Subcatchment PWS-2: PWS-2

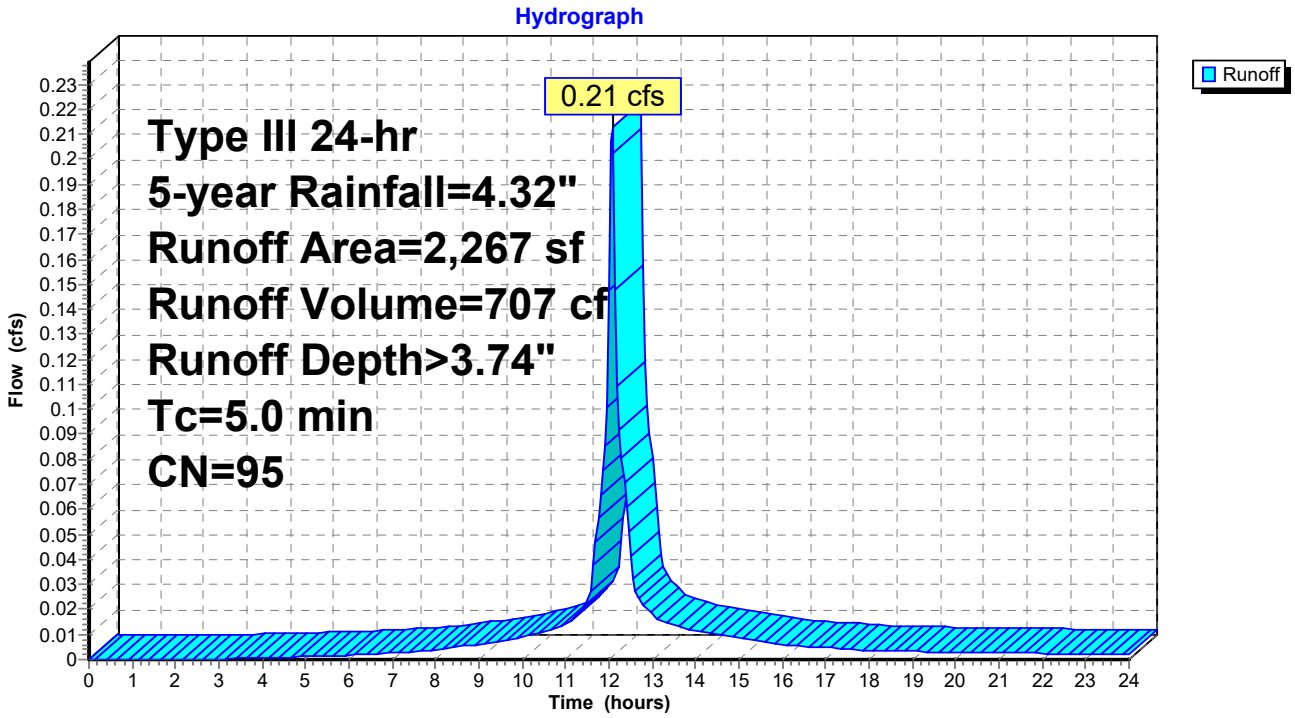
Runoff = 0.21 cfs @ 12.07 hrs, Volume= 707 cf, Depth> 3.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 5-year Rainfall=4.32"

Area (sf)	CN	Description
323	74	>75% Grass cover, Good, HSG C
1,944	98	Paved parking, HSG C
2,267	95	Weighted Average
323		14.25% Pervious Area
1,944		85.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PWS-2: PWS-2

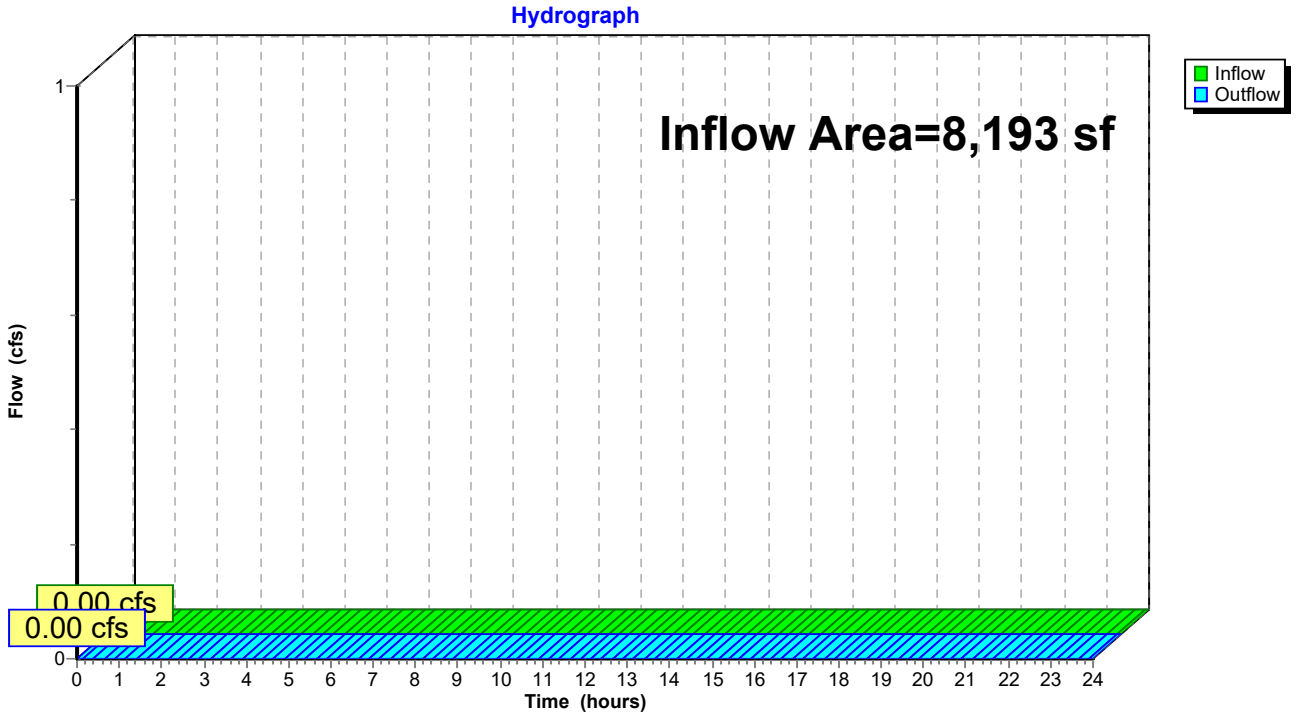


Summary for Reach DP-1: DP-1

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth = 0.00" for 5-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

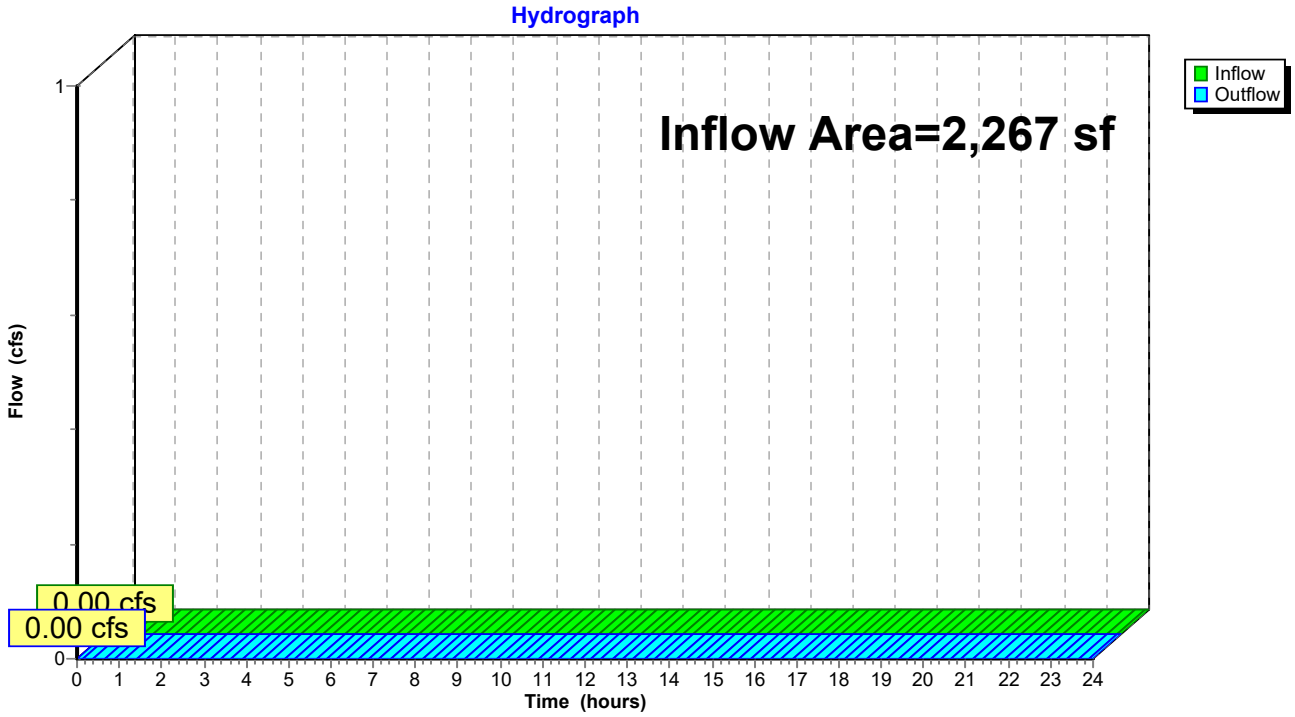


Summary for Reach DP-2: DP-2

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth = 0.00" for 5-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Summary for Pond P1: Subsurface Infiltration Facility

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth > 3.97" for 5-year event
Inflow = 0.90 cfs @ 12.00 hrs, Volume= 2,710 cf
Outflow = 0.19 cfs @ 12.37 hrs, Volume= 2,710 cf, Atten= 79%, Lag= 22.2 min
Discarded = 0.19 cfs @ 12.37 hrs, Volume= 2,710 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 77.90' @ 12.37 hrs Surf.Area= 508 sf Storage= 658 cf

Plug-Flow detention time= 21.7 min calculated for 2,710 cf (100% of inflow)
Center-of-Mass det. time= 21.6 min (775.0 - 753.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	460 cf	**11.17'W x 45.50'L x 3.54'H Field A** 1,799 cf Overall - 648 cf Embedded = 1,151 cf x 40.0% Voids
#2A	76.50'	648 cf	**Cultec R-330XL** x 12 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 2 rows
#3	77.85'	151 cf	**5.00'D x 3.85'H CDS Unit #1 & #2 (Above Invert)**x 2 -Impervious
		1,260 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	81.55'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.19 cfs @ 12.37 hrs HW=77.90' (Free Discharge)
↑**1=Exfiltration** (Controls 0.19 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P1: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 2 rows

52.0" Wide + 6.0" Spacing = 58.0" C-C Row Spacing

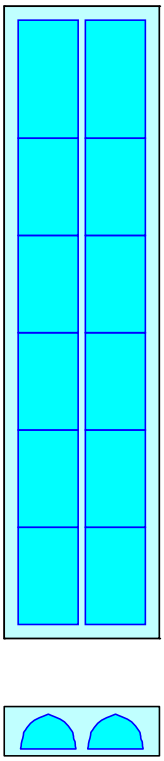
6 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 43.50' Row Length +12.0" End Stone x 2 = 45.50' Base Length
2 Rows x 52.0" Wide + 6.0" Spacing x 1 + 12.0" Side Stone x 2 = 11.17' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

12 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 2 Rows = 648.2 cf Chamber Storage

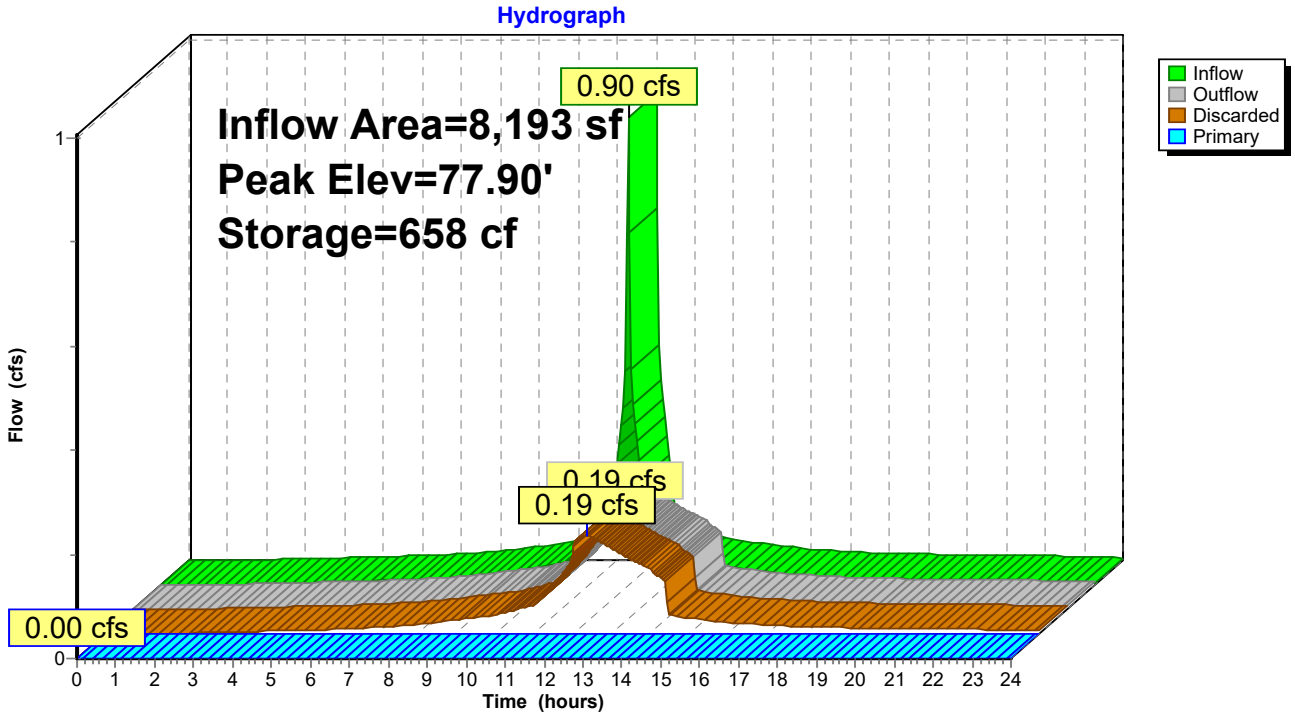
1,799.5 cf Field - 648.2 cf Chambers = 1,151.2 cf Stone x 40.0% Voids = 460.5 cf Stone Storage

Chamber Storage + Stone Storage = 1,108.7 cf = 0.025 af
Overall Storage Efficiency = 61.6%
Overall System Size = 45.50' x 11.17' x 3.54'

12 Chambers
66.6 cy Field
42.6 cy Stone



Pond P1: Subsurface Infiltration Facility



Summary for Pond P2: Subsurface Infiltration Facility

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth > 3.74" for 5-year event
Inflow = 0.21 cfs @ 12.07 hrs, Volume= 707 cf
Outflow = 0.06 cfs @ 12.40 hrs, Volume= 707 cf, Atten= 71%, Lag= 19.6 min
Discarded = 0.06 cfs @ 12.40 hrs, Volume= 707 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 77.21' @ 12.40 hrs Surf.Area= 199 sf Storage= 145 cf

Plug-Flow detention time= 13.5 min calculated for 707 cf (100% of inflow)
Center-of-Mass det. time= 13.4 min (784.3 - 770.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	195 cf	**6.33'W x 31.50'L x 3.54'H Field A** 707 cf Overall - 220 cf Embedded = 487 cf x 40.0% Voids
#2A	76.50'	220 cf	**Cultec R-330XL** x 4 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	77.70'	59 cf	**5.00'D x 3.00'H CDS Unit #3 (Above Invert)** Impervious
		473 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	80.65'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.06 cfs @ 12.40 hrs HW=77.21' (Free Discharge)
↑**1=Exfiltration** (Controls 0.06 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P2: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

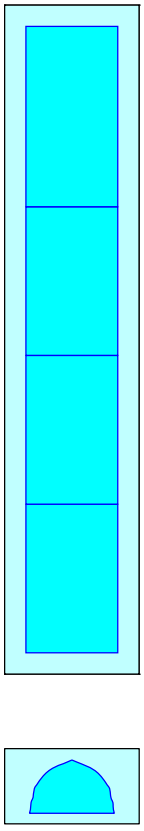
4 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 29.50' Row Length +12.0" End Stone x 2 = 31.50' Base Length
1 Rows x 52.0" Wide + 12.0" Side Stone x 2 = 6.33' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

4 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 219.8 cf Chamber Storage

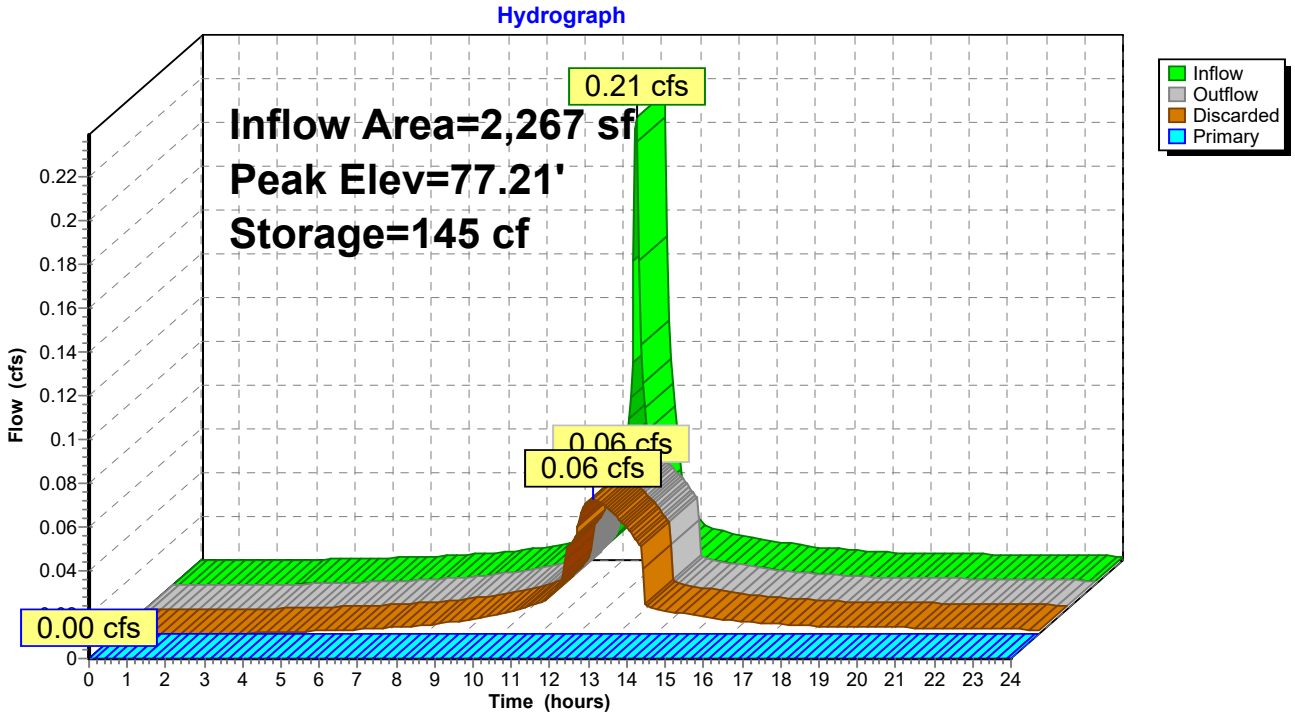
706.6 cf Field - 219.8 cf Chambers = 486.8 cf Stone x 40.0% Voids = 194.7 cf Stone Storage

Chamber Storage + Stone Storage = 414.5 cf = 0.010 af
Overall Storage Efficiency = 58.7%
Overall System Size = 31.50' x 6.33' x 3.54'

4 Chambers
26.2 cy Field
18.0 cy Stone



Pond P2: Subsurface Infiltration Facility



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWS-1: PWS-1 Runoff Area=8,193 sf 95.18% Impervious Runoff Depth>4.83"
Tc=0.0 min CN=97 Runoff=1.08 cfs 3,295 cf

Subcatchment PWS-2: PWS-2 Runoff Area=2,267 sf 85.75% Impervious Runoff Depth>4.60"
Tc=5.0 min CN=95 Runoff=0.26 cfs 868 cf

Reach DP-1: DP-1 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Reach DP-2: DP-2 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond P1: Subsurface Infiltration Facility Peak Elev=78.39' Storage=851 cf Inflow=1.08 cfs 3,295 cf
Discarded=0.21 cfs 3,295 cf Primary=0.00 cfs 0 cf Outflow=0.21 cfs 3,295 cf

Pond P2: Subsurface Infiltration Facility Peak Elev=77.56' Storage=195 cf Inflow=0.26 cfs 868 cf
Discarded=0.07 cfs 868 cf Primary=0.00 cfs 0 cf Outflow=0.07 cfs 868 cf

Total Runoff Area = 10,460 sf Runoff Volume = 4,163 cf Average Runoff Depth = 4.78"
6.86% Pervious = 718 sf 93.14% Impervious = 9,742 sf

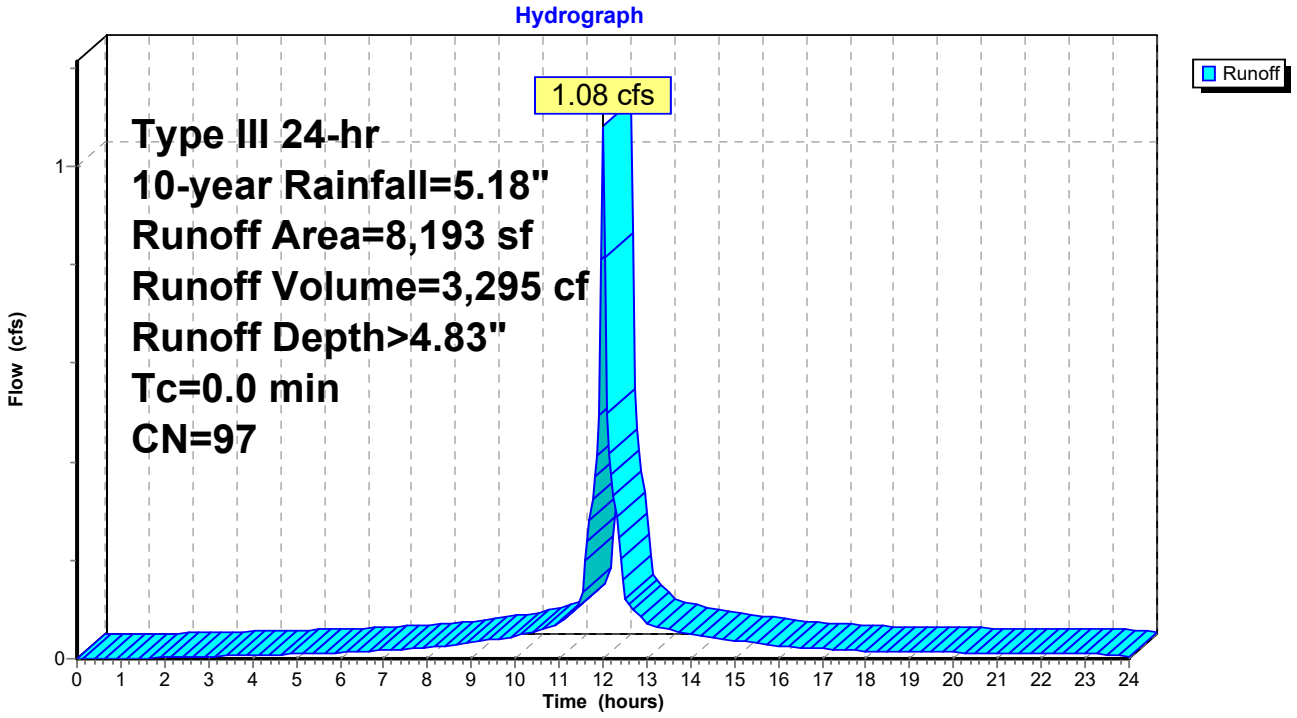
Summary for Subcatchment PWS-1: PWS-1

Runoff = 1.08 cfs @ 12.00 hrs, Volume= 3,295 cf, Depth> 4.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=5.18"

Area (sf)	CN	Description
395	74	>75% Grass cover, Good, HSG C
1,814	98	Paved parking, HSG C
5,984	98	Roofs, HSG C
8,193	97	Weighted Average
395		4.82% Pervious Area
7,798		95.18% Impervious Area

Subcatchment PWS-1: PWS-1



Summary for Subcatchment PWS-2: PWS-2

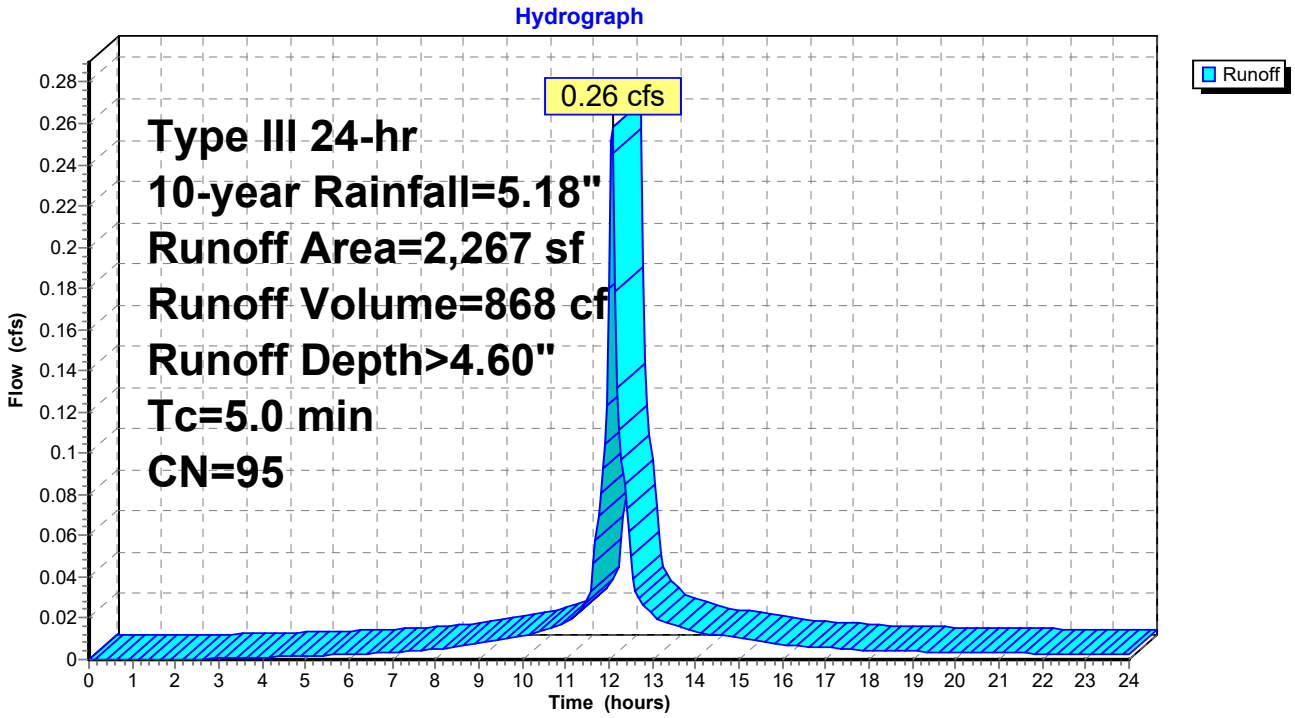
Runoff = 0.26 cfs @ 12.07 hrs, Volume= 868 cf, Depth> 4.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=5.18"

Area (sf)	CN	Description
323	74	>75% Grass cover, Good, HSG C
1,944	98	Paved parking, HSG C
2,267	95	Weighted Average
323		14.25% Pervious Area
1,944		85.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PWS-2: PWS-2

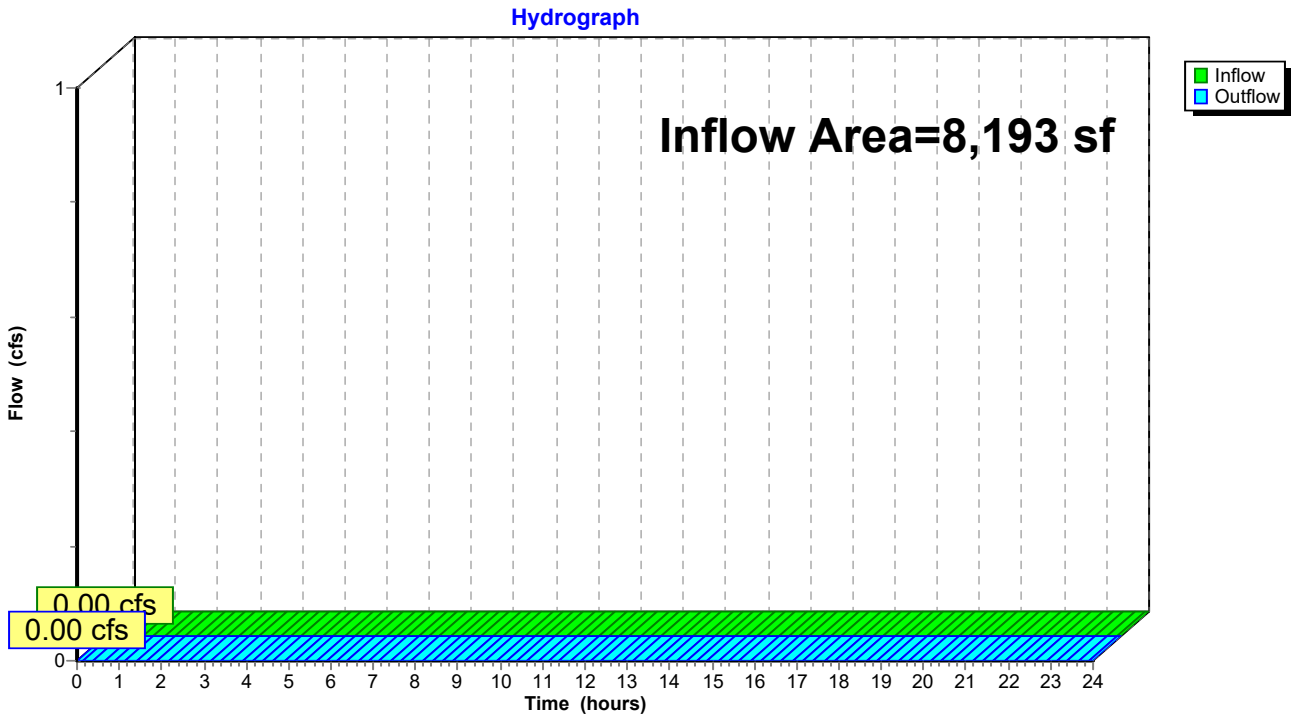


Summary for Reach DP-1: DP-1

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth = 0.00" for 10-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

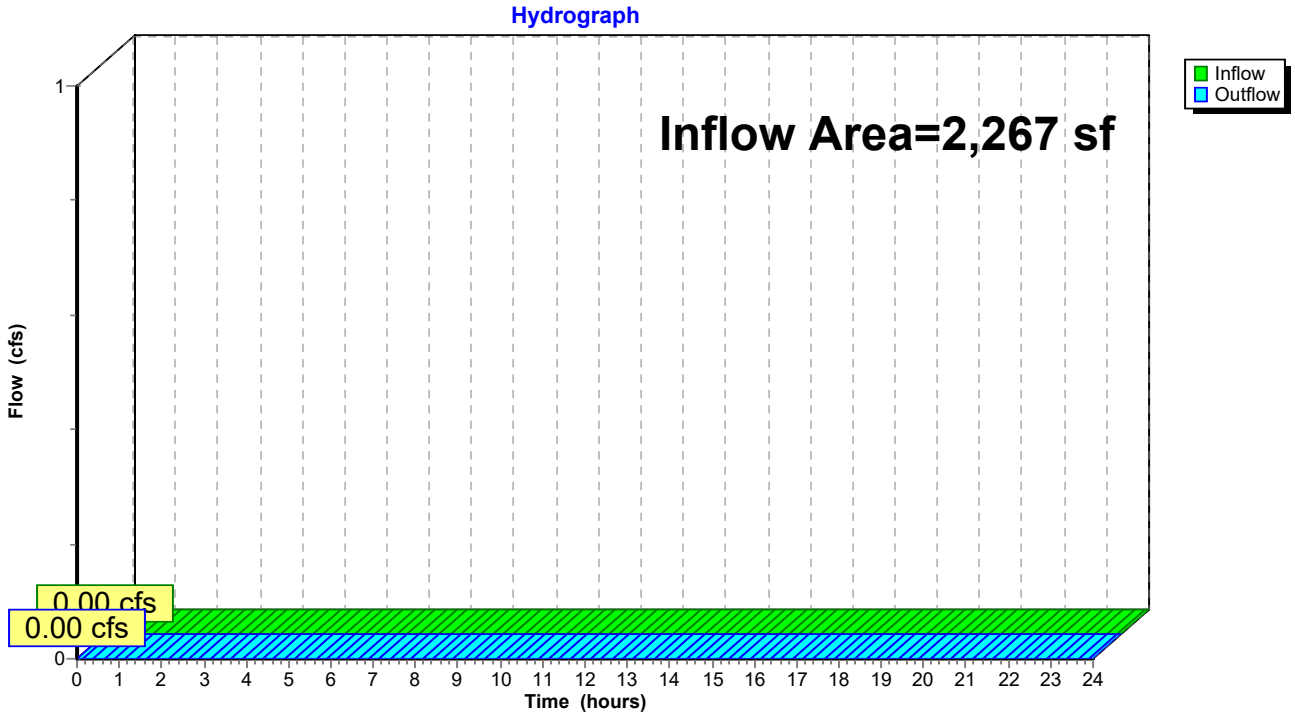


Summary for Reach DP-2: DP-2

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth = 0.00" for 10-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Summary for Pond P1: Subsurface Infiltration Facility

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth > 4.83" for 10-year event
Inflow = 1.08 cfs @ 12.00 hrs, Volume= 3,295 cf
Outflow = 0.21 cfs @ 12.39 hrs, Volume= 3,295 cf, Atten= 80%, Lag= 23.2 min
Discarded = 0.21 cfs @ 12.39 hrs, Volume= 3,295 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 78.39' @ 12.39 hrs Surf.Area= 508 sf Storage= 851 cf

Plug-Flow detention time= 26.3 min calculated for 3,288 cf (100% of inflow)
Center-of-Mass det. time= 26.2 min (775.7 - 749.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	460 cf	**11.17'W x 45.50'L x 3.54'H Field A** 1,799 cf Overall - 648 cf Embedded = 1,151 cf x 40.0% Voids
#2A	76.50'	648 cf	**Cultec R-330XL** x 12 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 2 rows
#3	77.85'	151 cf	**5.00'D x 3.85'H CDS Unit #1 & #2 (Above Invert)**x 2 -Impervious
		1,260 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	81.55'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.21 cfs @ 12.39 hrs HW=78.39' (Free Discharge)
↑**1=Exfiltration** (Controls 0.21 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P1: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 2 rows

52.0" Wide + 6.0" Spacing = 58.0" C-C Row Spacing

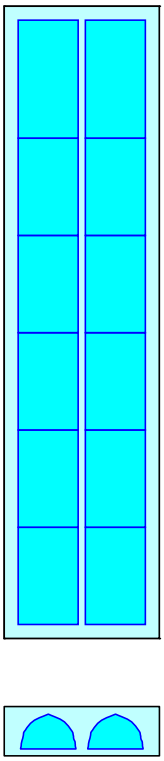
6 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 43.50' Row Length +12.0" End Stone x 2 = 45.50' Base Length
2 Rows x 52.0" Wide + 6.0" Spacing x 1 + 12.0" Side Stone x 2 = 11.17' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

12 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 2 Rows = 648.2 cf Chamber Storage

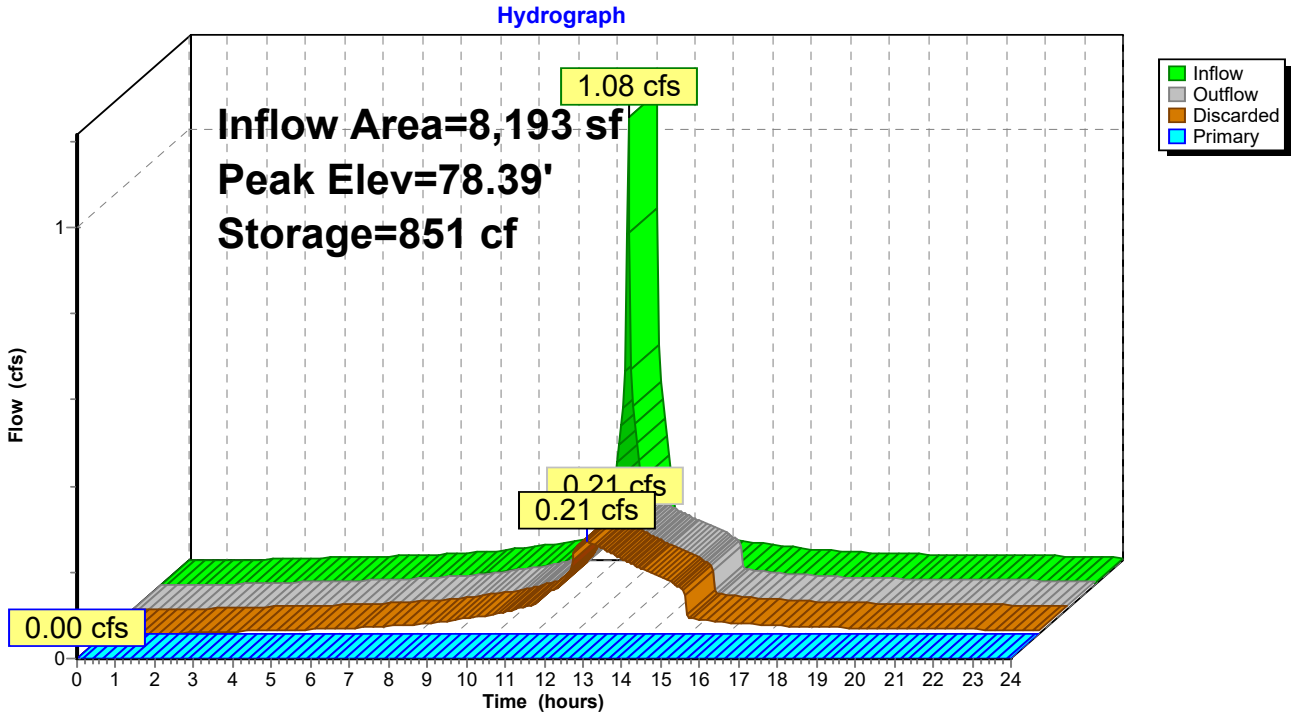
1,799.5 cf Field - 648.2 cf Chambers = 1,151.2 cf Stone x 40.0% Voids = 460.5 cf Stone Storage

Chamber Storage + Stone Storage = 1,108.7 cf = 0.025 af
Overall Storage Efficiency = 61.6%
Overall System Size = 45.50' x 11.17' x 3.54'

12 Chambers
66.6 cy Field
42.6 cy Stone



Pond P1: Subsurface Infiltration Facility



Summary for Pond P2: Subsurface Infiltration Facility

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth > 4.60" for 10-year event
Inflow = 0.26 cfs @ 12.07 hrs, Volume= 868 cf
Outflow = 0.07 cfs @ 12.42 hrs, Volume= 868 cf, Atten= 74%, Lag= 21.1 min
Discarded = 0.07 cfs @ 12.42 hrs, Volume= 868 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 77.56' @ 12.42 hrs Surf.Area= 199 sf Storage= 195 cf

Plug-Flow detention time= 17.3 min calculated for 868 cf (100% of inflow)
Center-of-Mass det. time= 17.1 min (783.1 - 766.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	195 cf	**6.33'W x 31.50'L x 3.54'H Field A** 707 cf Overall - 220 cf Embedded = 487 cf x 40.0% Voids
#2A	76.50'	220 cf	**Cultec R-330XL** x 4 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	77.70'	59 cf	**5.00'D x 3.00'H CDS Unit #3 (Above Invert)** Impervious
		473 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	80.65'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.07 cfs @ 12.42 hrs HW=77.56' (Free Discharge)
↑**1=Exfiltration** (Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P2: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

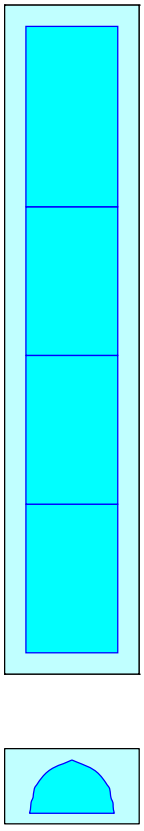
4 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 29.50' Row Length +12.0" End Stone x 2 = 31.50' Base Length
1 Rows x 52.0" Wide + 12.0" Side Stone x 2 = 6.33' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

4 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 219.8 cf Chamber Storage

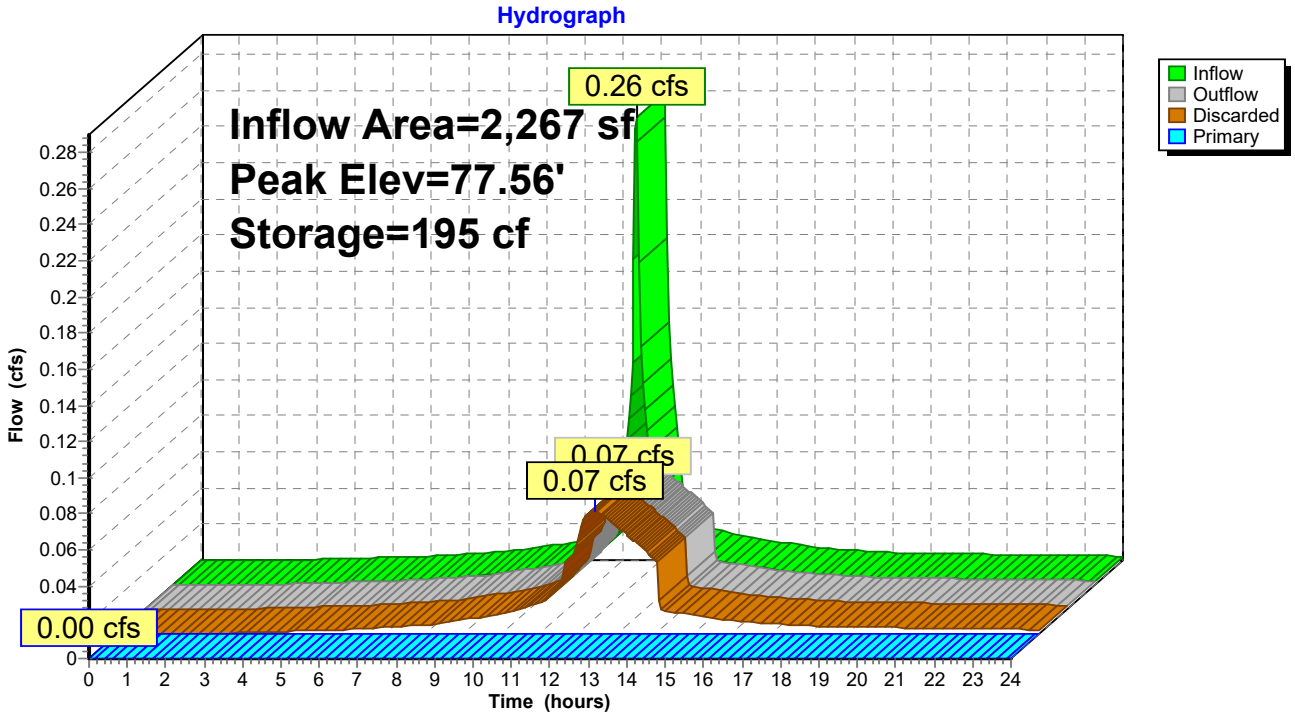
706.6 cf Field - 219.8 cf Chambers = 486.8 cf Stone x 40.0% Voids = 194.7 cf Stone Storage

Chamber Storage + Stone Storage = 414.5 cf = 0.010 af
Overall Storage Efficiency = 58.7%
Overall System Size = 31.50' x 6.33' x 3.54'

4 Chambers
26.2 cy Field
18.0 cy Stone



Pond P2: Subsurface Infiltration Facility



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWS-1: PWS-1 Runoff Area=8,193 sf 95.18% Impervious Runoff Depth>5.99"
Tc=0.0 min CN=97 Runoff=1.33 cfs 4,092 cf

Subcatchment PWS-2: PWS-2 Runoff Area=2,267 sf 85.75% Impervious Runoff Depth>5.76"
Tc=5.0 min CN=95 Runoff=0.32 cfs 1,087 cf

Reach DP-1: DP-1 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Reach DP-2: DP-2 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond P1: Subsurface Infiltration Facility Peak Elev=79.29' Storage=1,115 cf Inflow=1.33 cfs 4,092 cf
Discarded=0.26 cfs 4,091 cf Primary=0.00 cfs 0 cf Outflow=0.26 cfs 4,091 cf

Pond P2: Subsurface Infiltration Facility Peak Elev=78.02' Storage=266 cf Inflow=0.32 cfs 1,087 cf
Discarded=0.08 cfs 1,087 cf Primary=0.00 cfs 0 cf Outflow=0.08 cfs 1,087 cf

Total Runoff Area = 10,460 sf Runoff Volume = 5,179 cf Average Runoff Depth = 5.94"
6.86% Pervious = 718 sf 93.14% Impervious = 9,742 sf

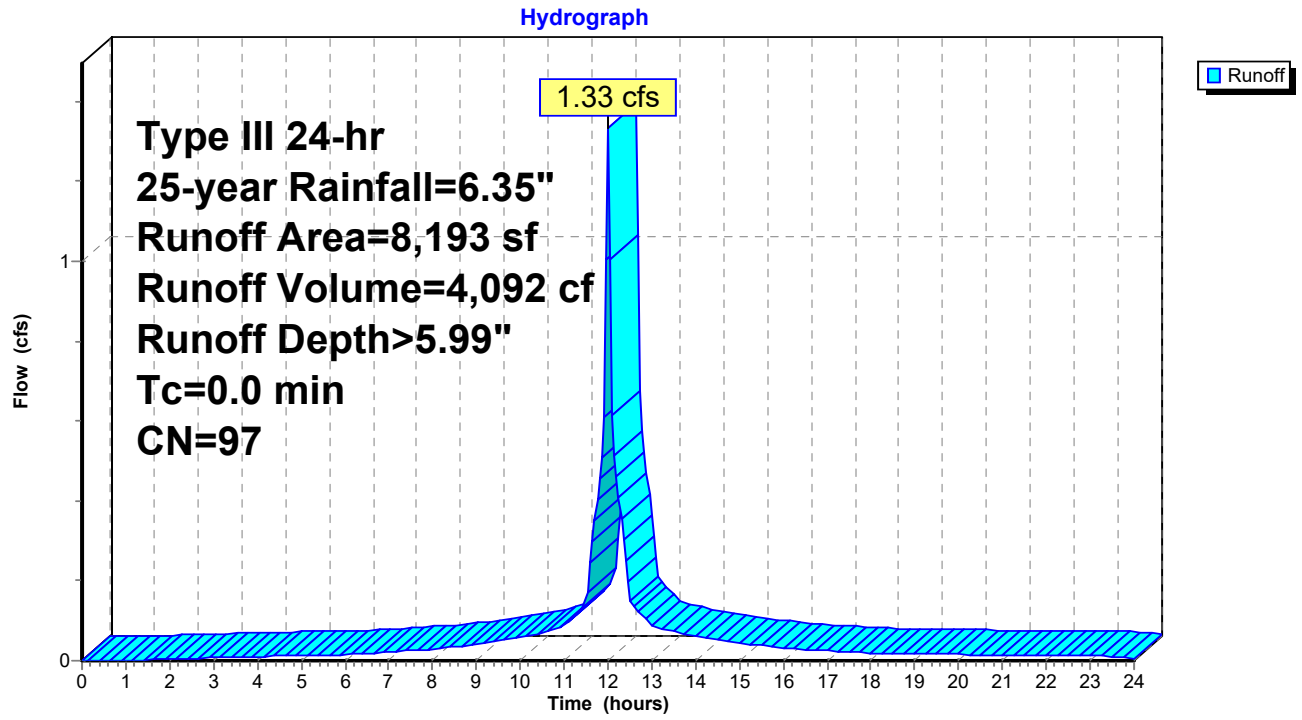
Summary for Subcatchment PWS-1: PWS-1

Runoff = 1.33 cfs @ 12.00 hrs, Volume= 4,092 cf, Depth> 5.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=6.35"

Area (sf)	CN	Description
395	74	>75% Grass cover, Good, HSG C
1,814	98	Paved parking, HSG C
5,984	98	Roofs, HSG C
8,193	97	Weighted Average
395		4.82% Pervious Area
7,798		95.18% Impervious Area

Subcatchment PWS-1: PWS-1



Summary for Subcatchment PWS-2: PWS-2

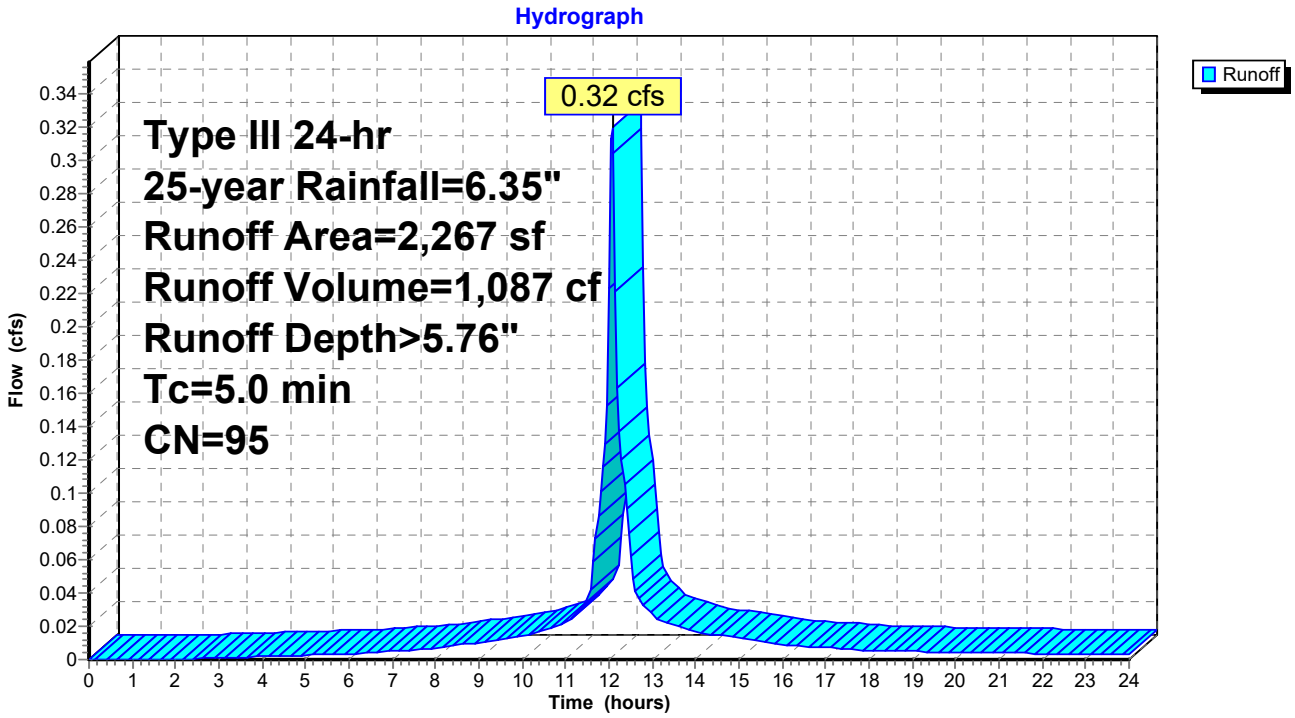
Runoff = 0.32 cfs @ 12.07 hrs, Volume= 1,087 cf, Depth> 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=6.35"

Area (sf)	CN	Description
323	74	>75% Grass cover, Good, HSG C
1,944	98	Paved parking, HSG C
2,267	95	Weighted Average
323		14.25% Pervious Area
1,944		85.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PWS-2: PWS-2

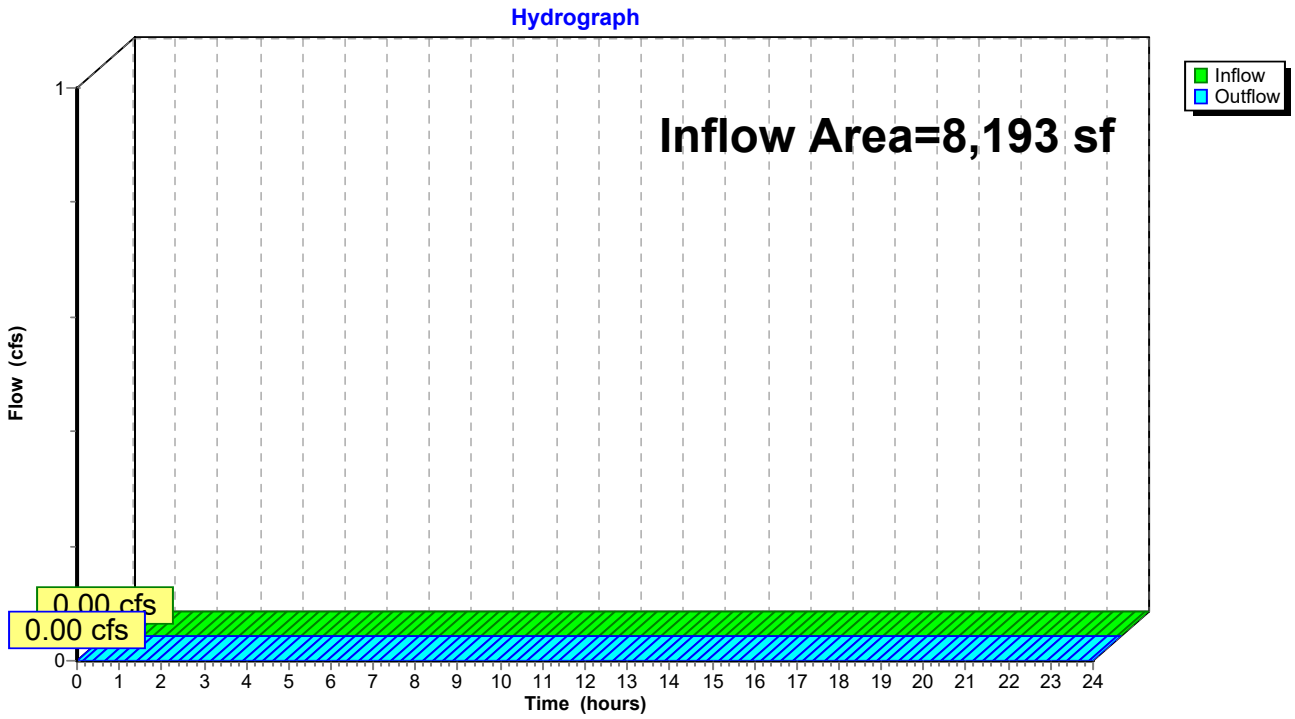


Summary for Reach DP-1: DP-1

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth = 0.00" for 25-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

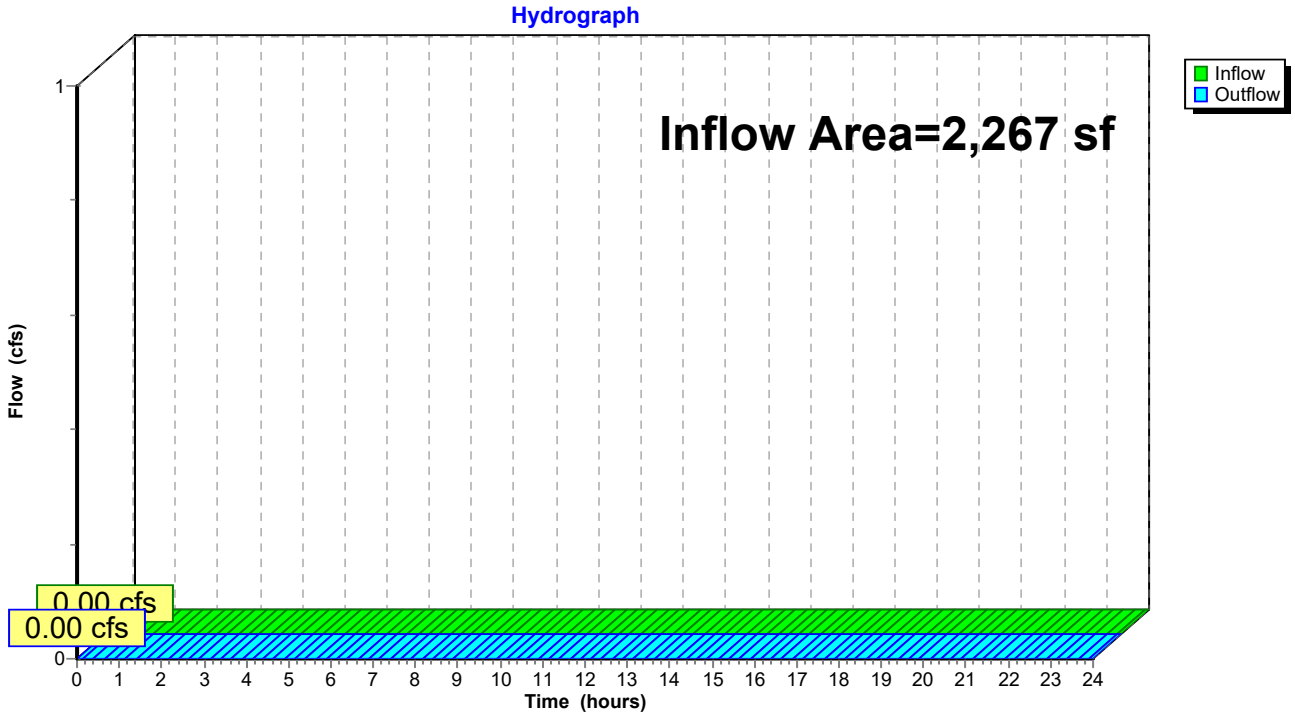


Summary for Reach DP-2: DP-2

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth = 0.00" for 25-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Summary for Pond P1: Subsurface Infiltration Facility

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth > 5.99" for 25-year event
Inflow = 1.33 cfs @ 12.00 hrs, Volume= 4,092 cf
Outflow = 0.26 cfs @ 12.39 hrs, Volume= 4,091 cf, Atten= 81%, Lag= 23.5 min
Discarded = 0.26 cfs @ 12.39 hrs, Volume= 4,091 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 79.29' @ 12.39 hrs Surf.Area= 508 sf Storage= 1,115 cf

Plug-Flow detention time= 31.6 min calculated for 4,083 cf (100% of inflow)
Center-of-Mass det. time= 31.4 min (777.0 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	460 cf	**11.17'W x 45.50'L x 3.54'H Field A** 1,799 cf Overall - 648 cf Embedded = 1,151 cf x 40.0% Voids
#2A	76.50'	648 cf	**Cultec R-330XL** x 12 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 2 rows
#3	77.85'	151 cf	**5.00'D x 3.85'H CDS Unit #1 & #2 (Above Invert)**x 2 -Impervious
		1,260 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	81.55'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.26 cfs @ 12.39 hrs HW=79.29' (Free Discharge)
↑**1=Exfiltration** (Controls 0.26 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P1: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 2 rows

52.0" Wide + 6.0" Spacing = 58.0" C-C Row Spacing

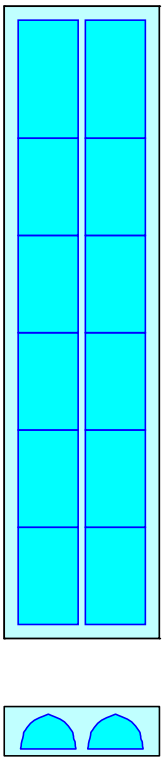
6 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 43.50' Row Length +12.0" End Stone x 2 = 45.50' Base Length
2 Rows x 52.0" Wide + 6.0" Spacing x 1 + 12.0" Side Stone x 2 = 11.17' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

12 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 2 Rows = 648.2 cf Chamber Storage

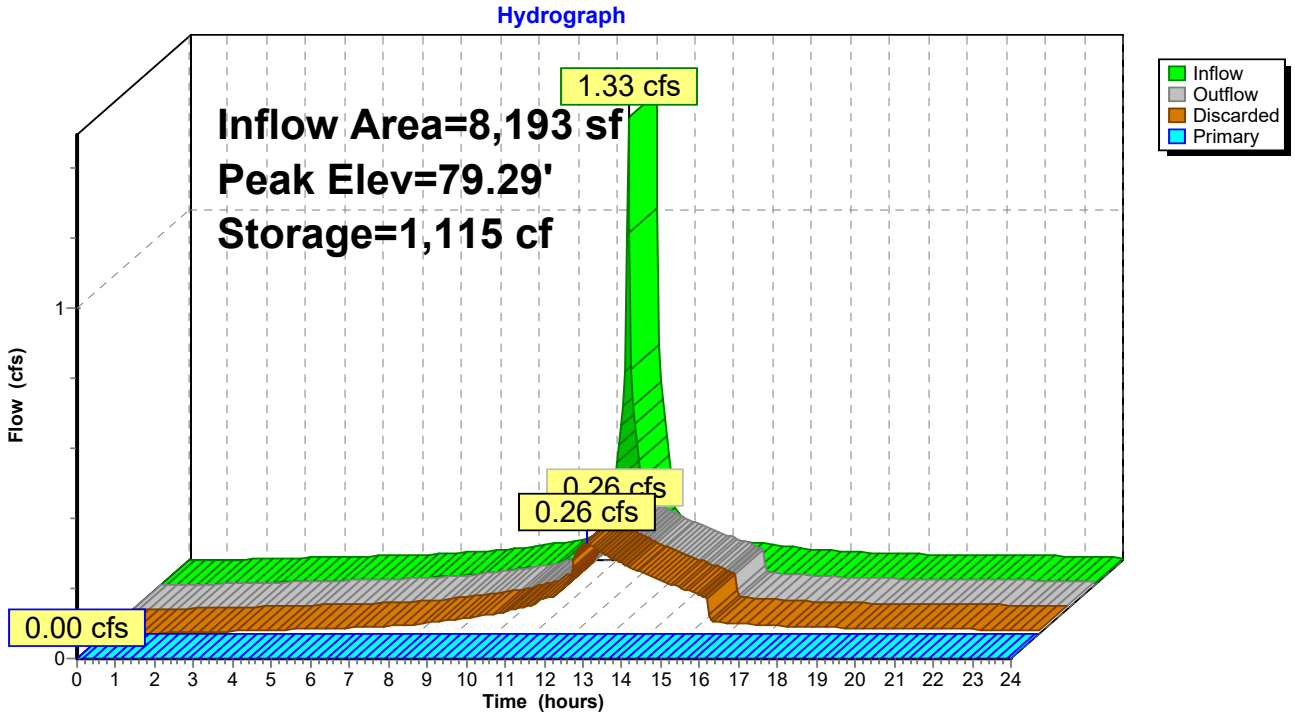
1,799.5 cf Field - 648.2 cf Chambers = 1,151.2 cf Stone x 40.0% Voids = 460.5 cf Stone Storage

Chamber Storage + Stone Storage = 1,108.7 cf = 0.025 af
Overall Storage Efficiency = 61.6%
Overall System Size = 45.50' x 11.17' x 3.54'

12 Chambers
66.6 cy Field
42.6 cy Stone



Pond P1: Subsurface Infiltration Facility



Summary for Pond P2: Subsurface Infiltration Facility

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth > 5.76" for 25-year event
Inflow = 0.32 cfs @ 12.07 hrs, Volume= 1,087 cf
Outflow = 0.08 cfs @ 12.45 hrs, Volume= 1,087 cf, Atten= 76%, Lag= 22.6 min
Discarded = 0.08 cfs @ 12.45 hrs, Volume= 1,087 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 78.02' @ 12.45 hrs Surf.Area= 199 sf Storage= 266 cf

Plug-Flow detention time= 21.9 min calculated for 1,085 cf (100% of inflow)
Center-of-Mass det. time= 21.7 min (782.7 - 761.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	195 cf	**6.33'W x 31.50'L x 3.54'H Field A** 707 cf Overall - 220 cf Embedded = 487 cf x 40.0% Voids
#2A	76.50'	220 cf	**Cultec R-330XL** x 4 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	77.70'	59 cf	**5.00'D x 3.00'H CDS Unit #3 (Above Invert)** Impervious
		473 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	80.65'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.08 cfs @ 12.45 hrs HW=78.02' (Free Discharge)
↑**1=Exfiltration** (Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P2: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

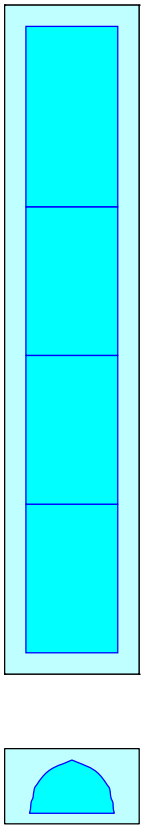
4 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 29.50' Row Length +12.0" End Stone x 2 = 31.50' Base Length
1 Rows x 52.0" Wide + 12.0" Side Stone x 2 = 6.33' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

4 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 219.8 cf Chamber Storage

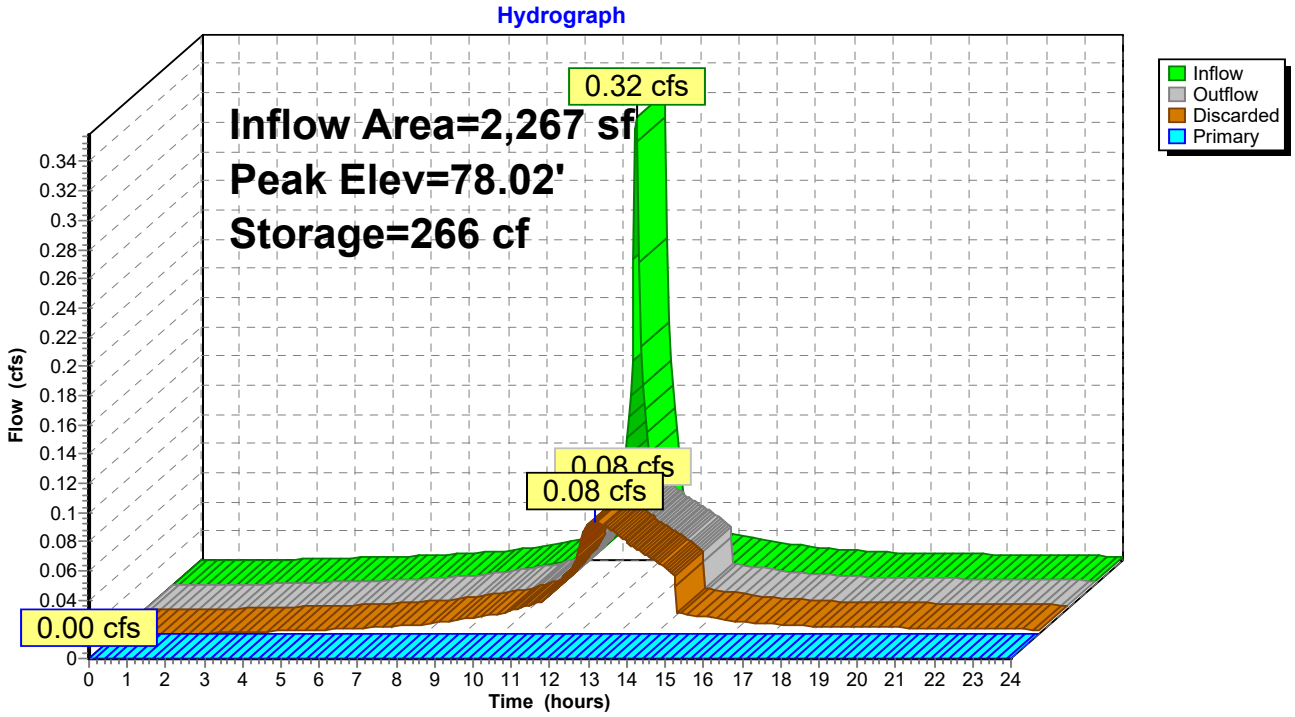
706.6 cf Field - 219.8 cf Chambers = 486.8 cf Stone x 40.0% Voids = 194.7 cf Stone Storage

Chamber Storage + Stone Storage = 414.5 cf = 0.010 af
Overall Storage Efficiency = 58.7%
Overall System Size = 31.50' x 6.33' x 3.54'

4 Chambers
26.2 cy Field
18.0 cy Stone



Pond P2: Subsurface Infiltration Facility



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWS-1: PWS-1 Runoff Area=8,193 sf 95.18% Impervious Runoff Depth>7.81"
Tc=0.0 min CN=97 Runoff=1.72 cfs 5,332 cf

Subcatchment PWS-2: PWS-2 Runoff Area=2,267 sf 85.75% Impervious Runoff Depth>7.57"
Tc=5.0 min CN=95 Runoff=0.42 cfs 1,430 cf

Reach DP-1: DP-1 Inflow=0.41 cfs 215 cf
Outflow=0.41 cfs 215 cf

Reach DP-2: DP-2 Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

Pond P1: Subsurface Infiltration Facility Peak Elev=81.61' Storage=1,256 cf Inflow=1.72 cfs 5,332 cf
Discarded=0.37 cfs 5,116 cf Primary=0.41 cfs 215 cf Outflow=0.79 cfs 5,332 cf

Pond P2: Subsurface Infiltration Facility Peak Elev=78.83' Storage=379 cf Inflow=0.42 cfs 1,430 cf
Discarded=0.09 cfs 1,429 cf Primary=0.00 cfs 0 cf Outflow=0.09 cfs 1,429 cf

Total Runoff Area = 10,460 sf Runoff Volume = 6,762 cf Average Runoff Depth = 7.76"
6.86% Pervious = 718 sf 93.14% Impervious = 9,742 sf

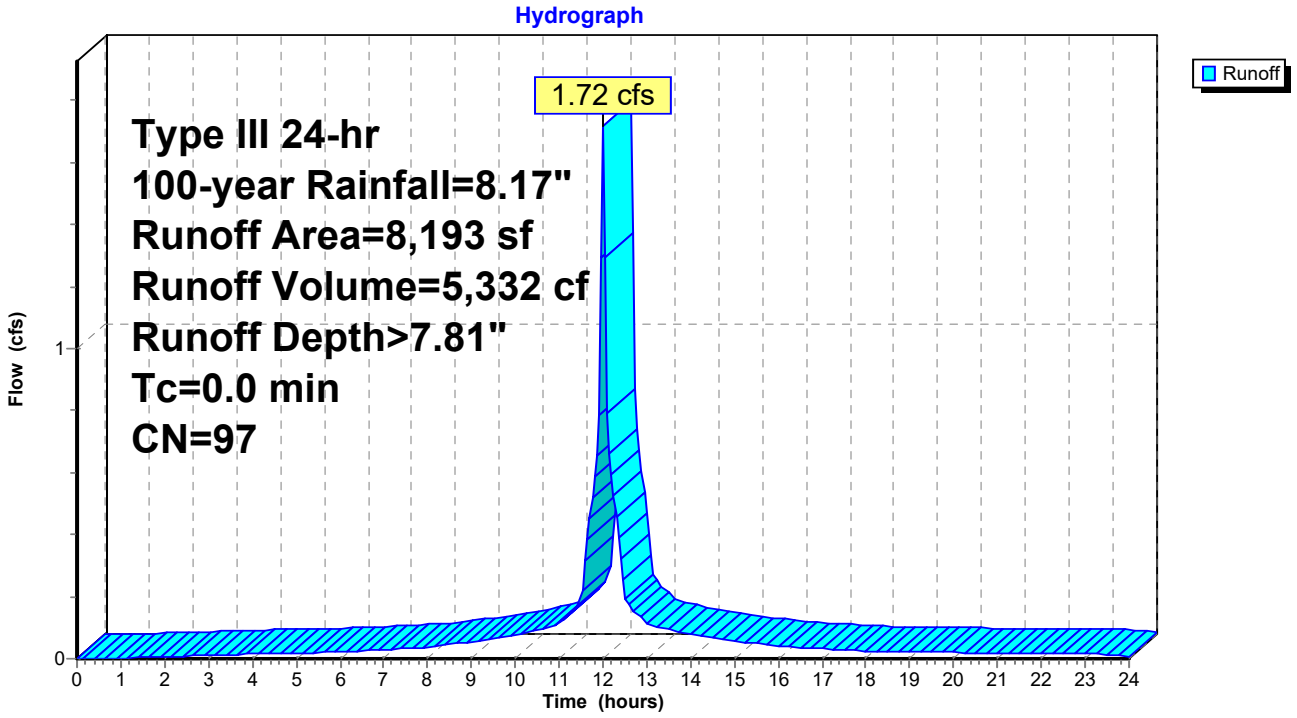
Summary for Subcatchment PWS-1: PWS-1

Runoff = 1.72 cfs @ 12.00 hrs, Volume= 5,332 cf, Depth> 7.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=8.17"

Area (sf)	CN	Description
395	74	>75% Grass cover, Good, HSG C
1,814	98	Paved parking, HSG C
5,984	98	Roofs, HSG C
8,193	97	Weighted Average
395		4.82% Pervious Area
7,798		95.18% Impervious Area

Subcatchment PWS-1: PWS-1



Summary for Subcatchment PWS-2: PWS-2

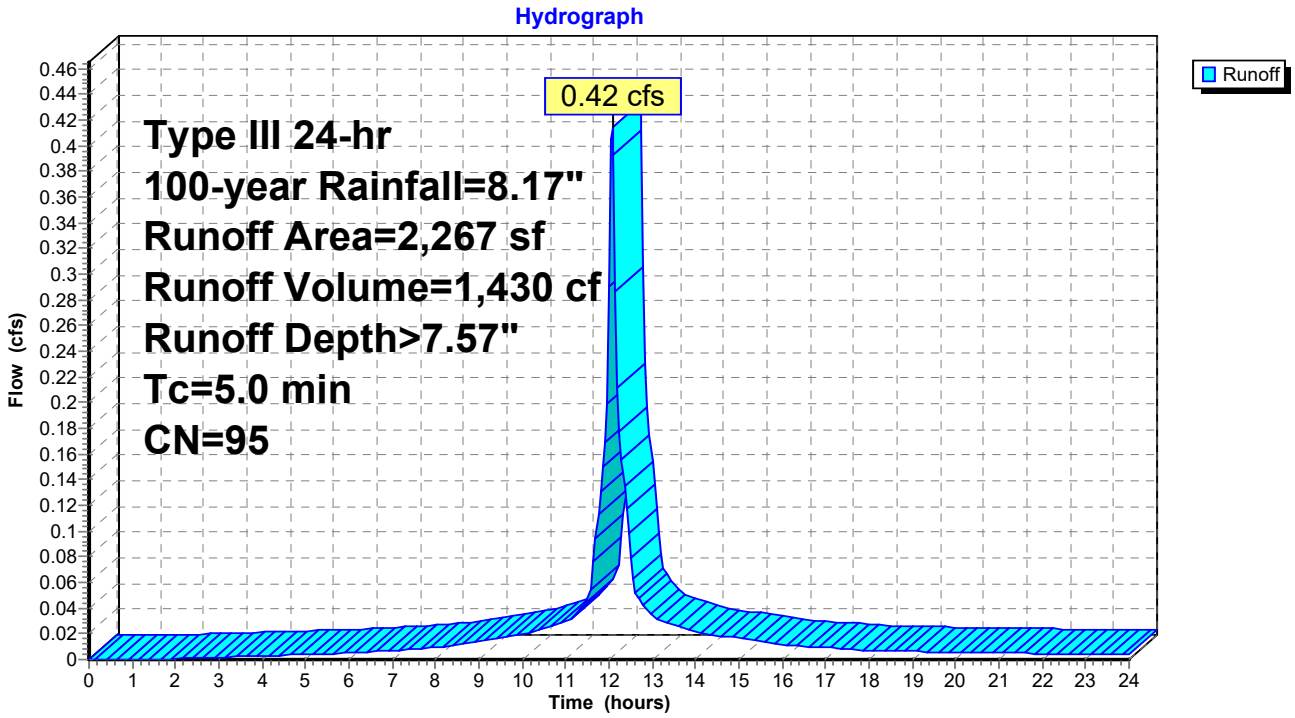
Runoff = 0.42 cfs @ 12.07 hrs, Volume= 1,430 cf, Depth> 7.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=8.17"

Area (sf)	CN	Description
323	74	>75% Grass cover, Good, HSG C
1,944	98	Paved parking, HSG C
2,267	95	Weighted Average
323		14.25% Pervious Area
1,944		85.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PWS-2: PWS-2

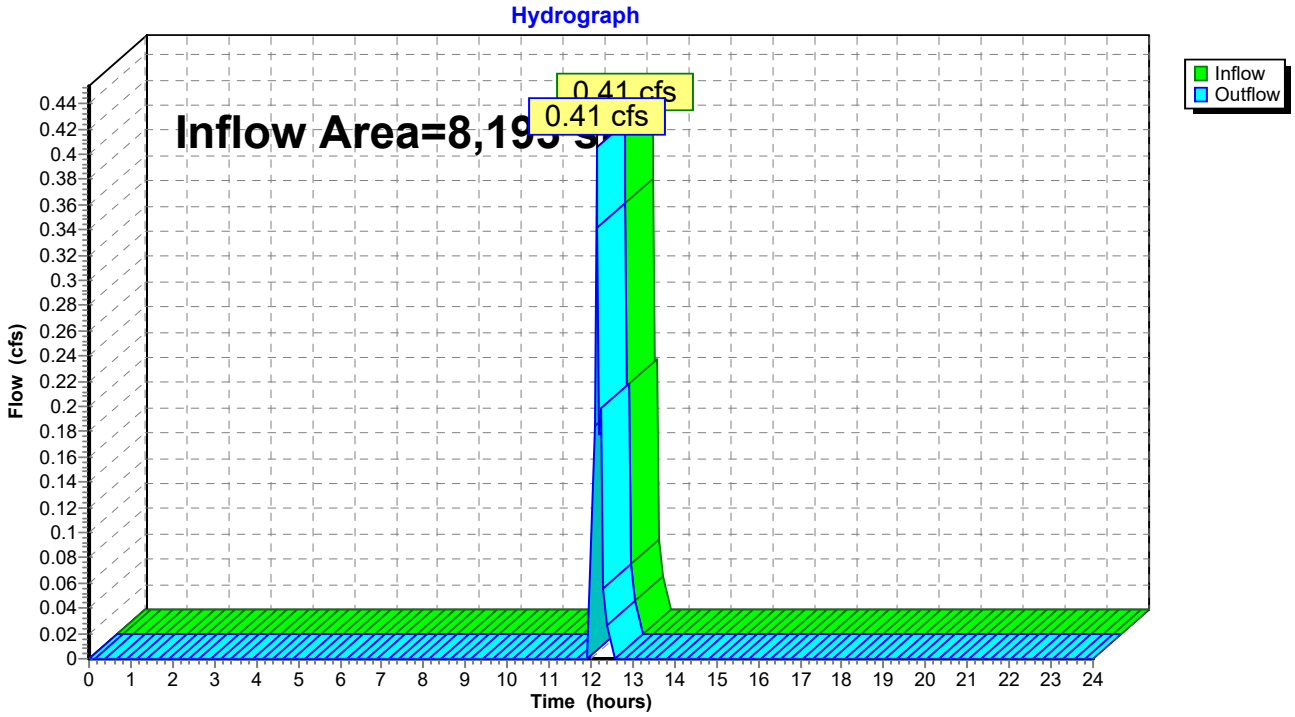


Summary for Reach DP-1: DP-1

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth = 0.32" for 100-year event
Inflow = 0.41 cfs @ 12.12 hrs, Volume= 215 cf
Outflow = 0.41 cfs @ 12.12 hrs, Volume= 215 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: DP-1

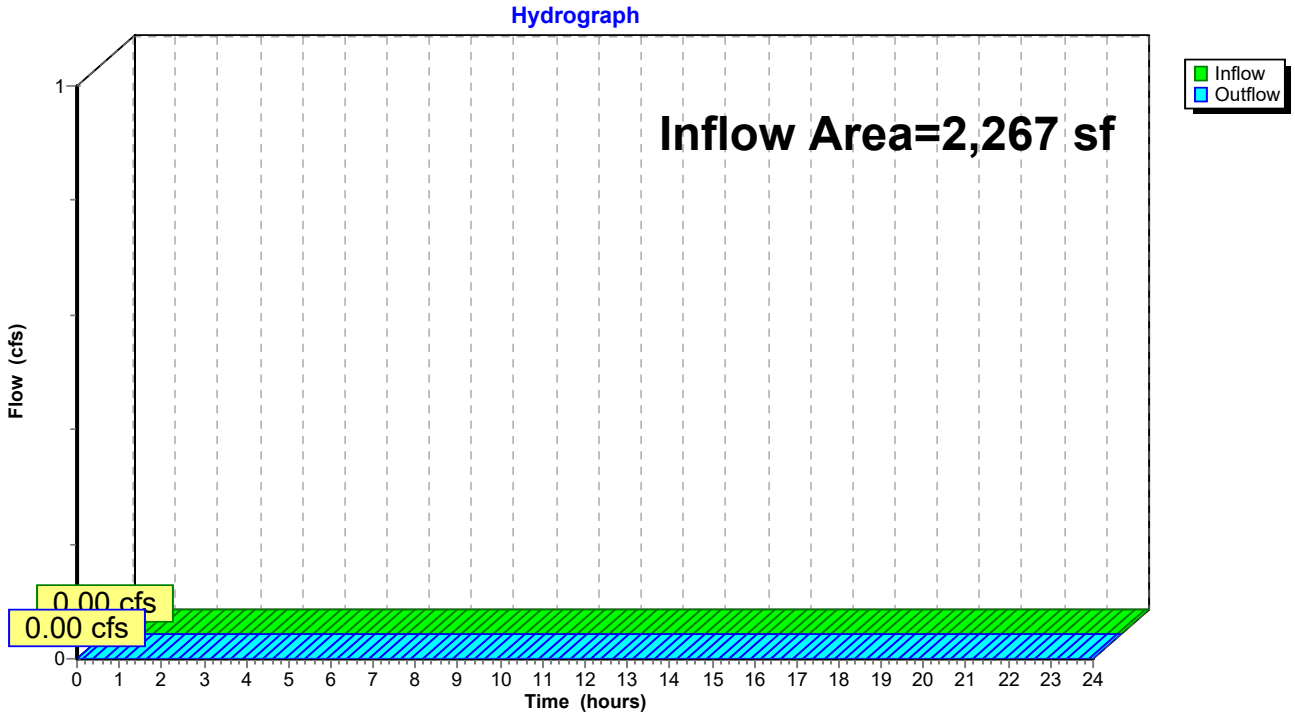


Summary for Reach DP-2: DP-2

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth = 0.00" for 100-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: DP-2



Summary for Pond P1: Subsurface Infiltration Facility

Inflow Area = 8,193 sf, 95.18% Impervious, Inflow Depth > 7.81" for 100-year event
Inflow = 1.72 cfs @ 12.00 hrs, Volume= 5,332 cf
Outflow = 0.79 cfs @ 12.12 hrs, Volume= 5,332 cf, Atten= 54%, Lag= 7.3 min
Discarded = 0.37 cfs @ 12.10 hrs, Volume= 5,116 cf
Primary = 0.41 cfs @ 12.12 hrs, Volume= 215 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 81.61' @ 12.10 hrs Surf.Area= 508 sf Storage= 1,256 cf

Plug-Flow detention time= 31.3 min calculated for 5,332 cf (100% of inflow)
Center-of-Mass det. time= 31.2 min (772.4 - 741.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	460 cf	**11.17'W x 45.50'L x 3.54'H Field A** 1,799 cf Overall - 648 cf Embedded = 1,151 cf x 40.0% Voids
#2A	76.50'	648 cf	**Cultec R-330XL** x 12 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 2 rows
#3	77.85'	151 cf	**5.00'D x 3.85'H CDS Unit #1 & #2 (Above Invert)**x 2 -Impervious
		1,260 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	81.55'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.37 cfs @ 12.10 hrs HW=81.61' (Free Discharge)
↑**1=Exfiltration** (Controls 0.37 cfs)

Primary OutFlow Max=0.33 cfs @ 12.12 hrs HW=81.60' (Free Discharge)
↑**2=Orifice/Grate** (Weir Controls 0.33 cfs @ 0.76 fps)

Pond P1: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 2 rows

52.0" Wide + 6.0" Spacing = 58.0" C-C Row Spacing

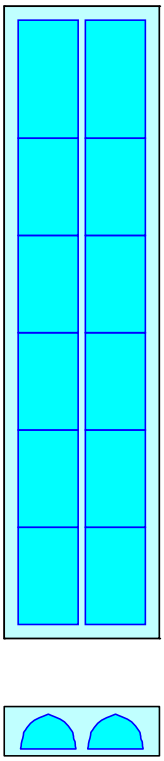
6 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 43.50' Row Length +12.0" End Stone x 2 = 45.50' Base Length
2 Rows x 52.0" Wide + 6.0" Spacing x 1 + 12.0" Side Stone x 2 = 11.17' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

12 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 2 Rows = 648.2 cf Chamber Storage

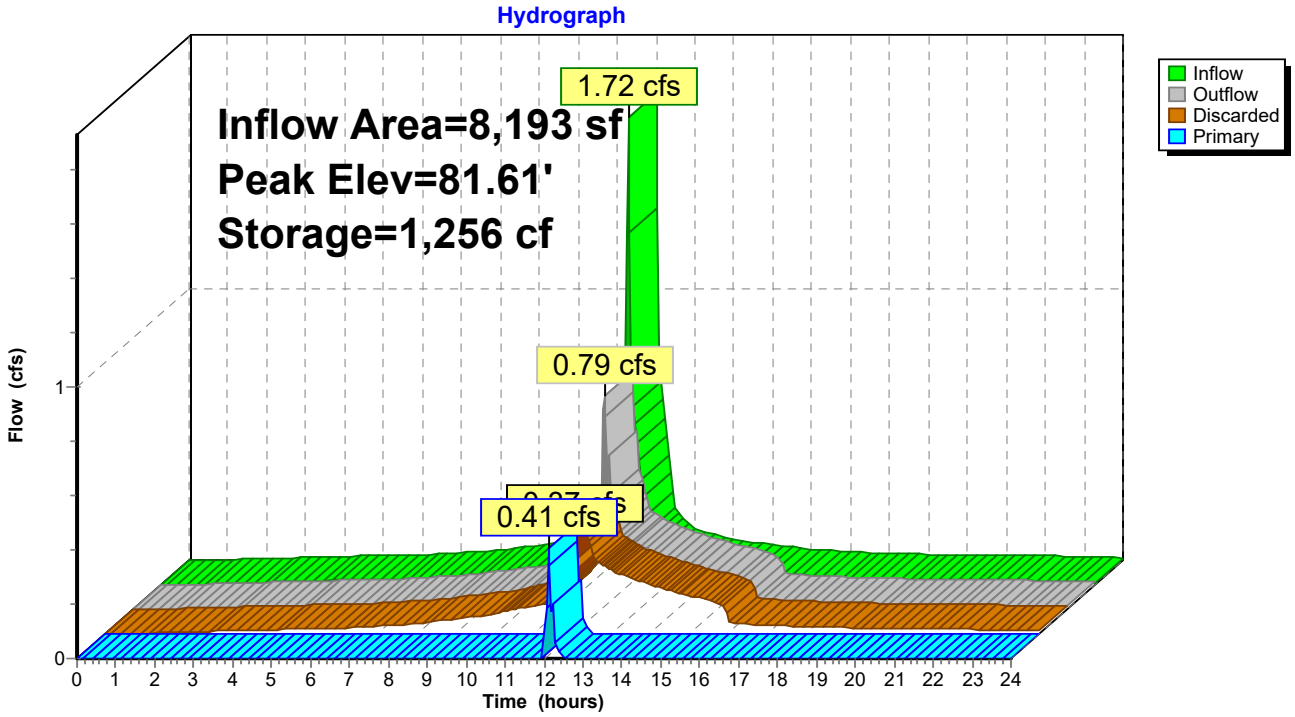
1,799.5 cf Field - 648.2 cf Chambers = 1,151.2 cf Stone x 40.0% Voids = 460.5 cf Stone Storage

Chamber Storage + Stone Storage = 1,108.7 cf = 0.025 af
Overall Storage Efficiency = 61.6%
Overall System Size = 45.50' x 11.17' x 3.54'

12 Chambers
66.6 cy Field
42.6 cy Stone



Pond P1: Subsurface Infiltration Facility



Summary for Pond P2: Subsurface Infiltration Facility

Inflow Area = 2,267 sf, 85.75% Impervious, Inflow Depth > 7.57" for 100-year event
Inflow = 0.42 cfs @ 12.07 hrs, Volume= 1,430 cf
Outflow = 0.09 cfs @ 12.47 hrs, Volume= 1,429 cf, Atten= 78%, Lag= 23.7 min
Discarded = 0.09 cfs @ 12.47 hrs, Volume= 1,429 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 78.83' @ 12.47 hrs Surf.Area= 199 sf Storage= 379 cf

Plug-Flow detention time= 28.3 min calculated for 1,429 cf (100% of inflow)
Center-of-Mass det. time= 28.1 min (783.5 - 755.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	76.00'	195 cf	**6.33'W x 31.50'L x 3.54'H Field A** 707 cf Overall - 220 cf Embedded = 487 cf x 40.0% Voids
#2A	76.50'	220 cf	**Cultec R-330XL** x 4 Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	77.70'	59 cf	**5.00'D x 3.00'H CDS Unit #3 (Above Invert)** Impervious
		473 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 74.00'
#2	Primary	80.65'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.09 cfs @ 12.47 hrs HW=78.83' (Free Discharge)
↑**1=Exfiltration** (Controls 0.09 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=76.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Pond P2: Subsurface Infiltration Facility - Chamber Wizard Field A

Chamber Model = Cultec R-330XL (Cultec Recharger® 330XL - DISCONTINUED, Use R-330XLHD for new designs)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

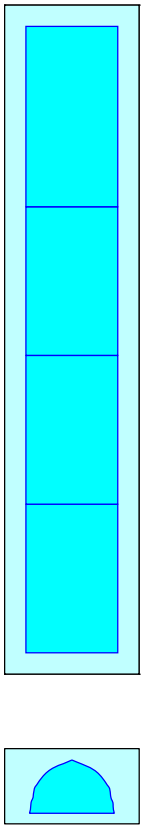
4 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 29.50' Row Length +12.0" End Stone x 2 = 31.50' Base Length
1 Rows x 52.0" Wide + 12.0" Side Stone x 2 = 6.33' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

4 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 219.8 cf Chamber Storage

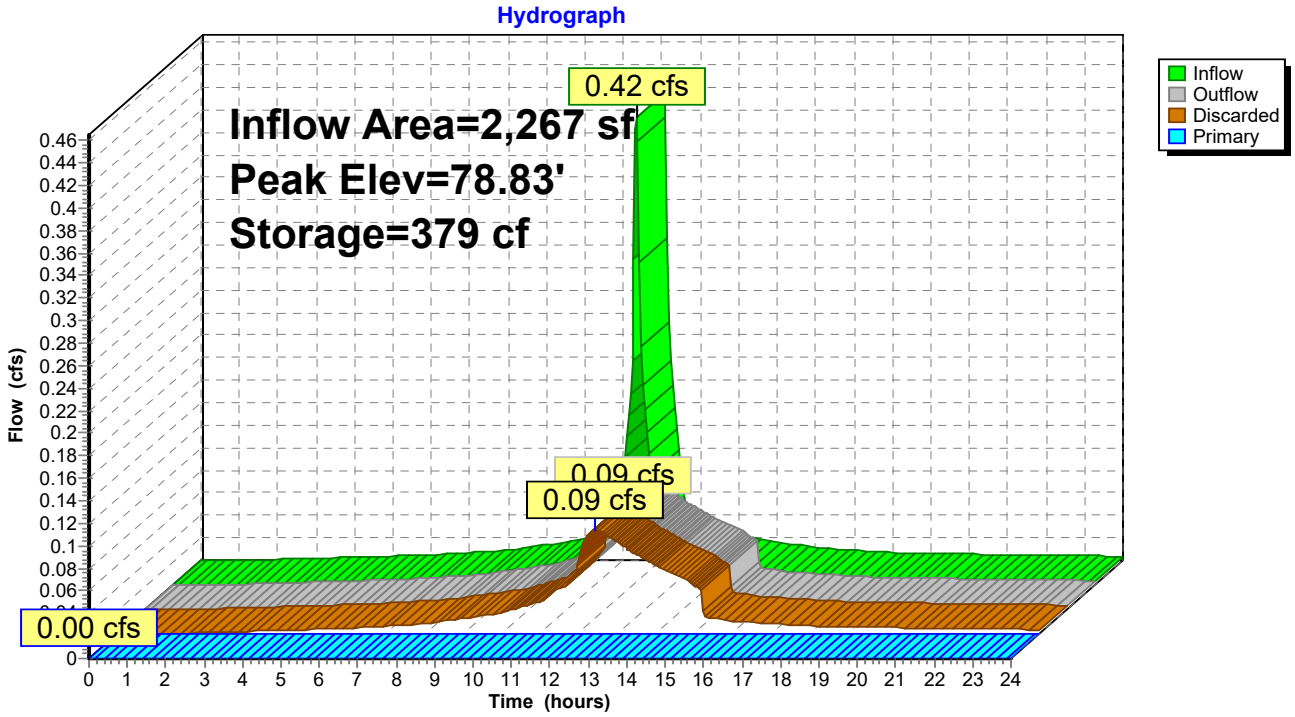
706.6 cf Field - 219.8 cf Chambers = 486.8 cf Stone x 40.0% Voids = 194.7 cf Stone Storage

Chamber Storage + Stone Storage = 414.5 cf = 0.010 af
Overall Storage Efficiency = 58.7%
Overall System Size = 31.50' x 6.33' x 3.54'

4 Chambers
26.2 cy Field
18.0 cy Stone



Pond P2: Subsurface Infiltration Facility

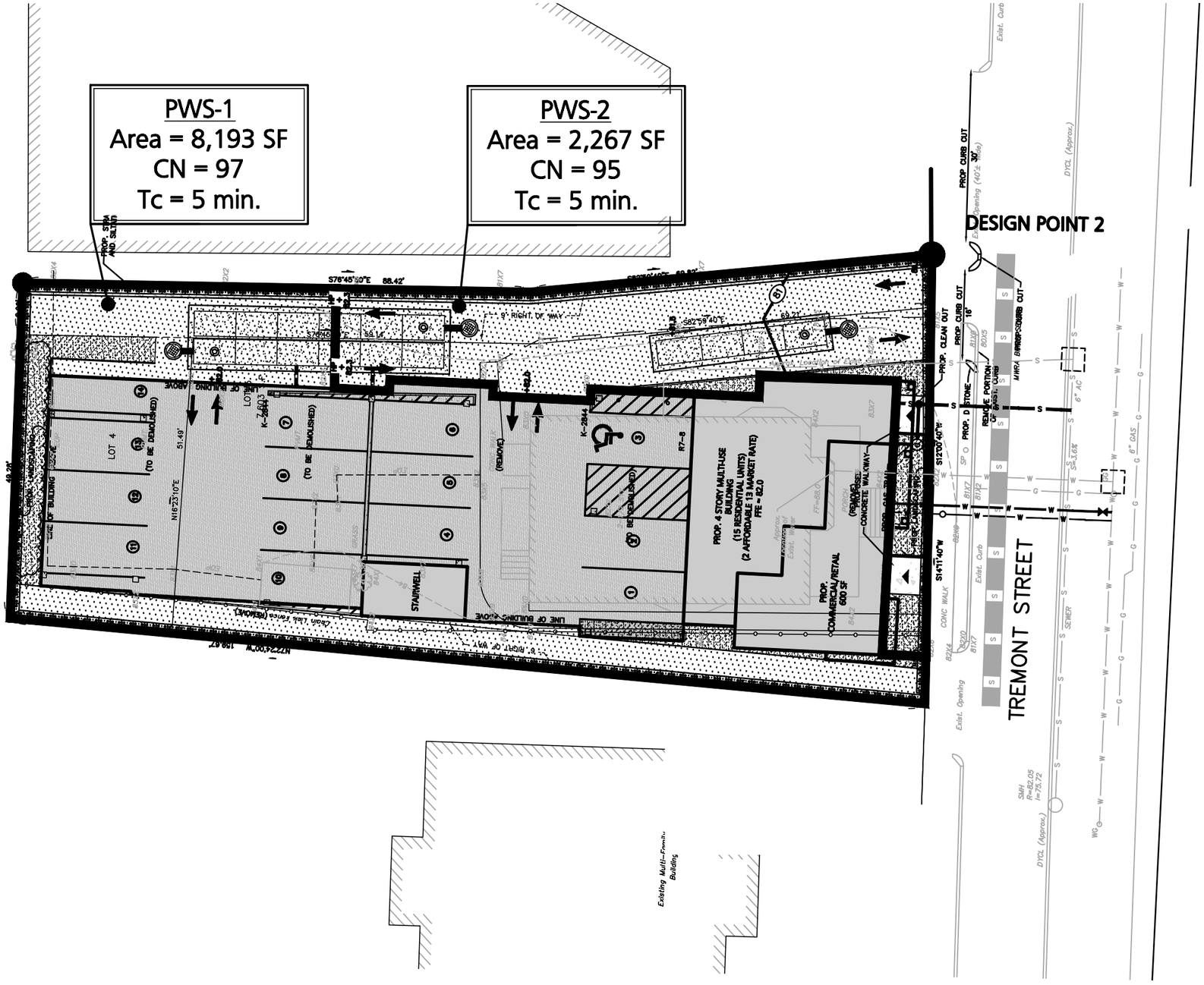


PWS-1
Area = 8,193 SF
CN = 97
Tc = 5 min.

PWS-2
Area = 2,267 SF
CN = 95
Tc = 5 min.

DESIGN POINT 1

DESIGN POINT 2



PREPARED BY:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0220
1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

DESCRIPTION OF REVISION	DATE

PROJECT:

Site Plan
272 Tremont Street
(Tax Map C12 Block 0 Lot 9)
Melrose, Massachusetts 02176

PROJECT #: 19-29908	DATE: January 13, 2020
SCALE: AS NOTED	DWG FILE NAME: 19-29908 REV 1-7-20
DESIGN BY: Garrett Anderson	CHECKED BY: Richard A. Sakey, P.E.

APPLICANT:

Eric Kenworthy
49 Marmion Road
Melrose, MA 02176

DWG. NO.	DRAWING TITLE:
PWS	Proposed Watershed Plan

APPENDIX C

Best Management Practices Maintenance Plan
Best Management Practices Maintenance Log
Contech CDS Maintenance Guidelines
Cultec Recharge Chamber Maintenance Guidelines

BEST MANAGEMENT PRACTICES MAINTENANCE PLAN

For

Proposed Multifamily Dwelling

Located at
272 Tremont Street
(Tax Map C12, Block 0, Lot 9)
Melrose, Massachusetts

Submitted to:
City of Melrose
562 Main Street
Melrose, MA 02176

Prepared for:
Eric Kenworthy
49 Marmion Road
Melrose, MA 02176

Prepared by:

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

January 15, 2020
REVISED: August 12, 2020

BEST MANAGEMENT PRACTICES MANAGEMENT PLAN

An Operations and Maintenance Plan is summarized below and will be incorporated into the construction documents for this project.

In accordance with the Stormwater Management Policy issued by the Department of Environmental Protection (DEP), Engineering Alliance, Inc. has prepared the following operation and maintenance plan for the proposed development located at 272 Tremont Street (Tax Map C12 Block 0 Lot 9) in Melrose, Massachusetts. This plan is broken into two major sections. The first section is construction-related erosion and sedimentation controls. The second section is devoted to a post-development operation and maintenance plan.

Basic Information

Owner: Eric Kenworthy
49 Marmion Road
Melrose, MA 02176

Section 1 Construction Activities

1. Contact the Melrose Planning Department at least three (3) days prior to start of construction.

2. A stabilized construction entrance shall be established prior to construction. Vehicle wash down shall occur on the gravel surface that is adjacent to or part of the stabilized construction entrance.

3. Install straw bales and silt fence around the proposed work zone to prevent sediment from leaving the subject property.

4. The contractor shall only disturb the minimum area necessary.

5. Proper erosion and sediment control must be employed around all material stockpile areas. Regular provisions for dust control must be used, via a water truck or other acceptable method.

6. The entire project area shall be swept upon completion of construction and prior to removal of the erosion control devices.

Section 2 Post-Development Activities

1. Paved Areas - Paved areas shall be swept by street sweepers periodically during dry weather to remove excess sediments, reducing the amount of sediments that the drainage system will have to remove from the runoff. Salt for de-icing on the paved areas during the winter months should be limited as much as possible, as this will reduce the need for removal and treatment. However, difficulties may arise in the enforcement of such restrictions. Sand containing the minimum amount of calcium chloride (or approved equivalent) needed for handling may be applied as part of the routine winter maintenance activities.

2. Water Quality Inlets – Contech CDS units with grate inlets shall be inspected monthly for the initial twelve-month period following the completion of the construction of paved areas. Debris shall be removed from grates and outlet pipes and disposed of in compliance with local, state, and federal guidelines.

   Upon a period beginning twelve months after the completion of the site, all inlets shall be inspected and maintained twice annually, once in April and once in November. Debris shall be removed from grates and outlet pipes and disposed of in compliance with local, state, and federal guidelines.

3. Subsurface Infiltration Facilities – The sub-surface infiltration systems shall be inspected immediately following heavy rain events for the initial twelve-month period following the completion of construction. Should the system or stone surrounding the system become clogged, then the system must be vacuumed and stone must be replaced with washed stone. After the initial twelve-month period following completion of construction, the subsurface infiltration facilities shall be inspected biannually.

4. Pervious Pavers – Pervious paver areas should be maintained periodically to maintain infiltration. Care should be taken to keep sediment off the pavement during and after construction. Yearly cleaning by a vacuum-type street cleaner should be performed when the pavement is dry. Vacuum settings should be adjusted to prevent the uptake of aggregate in the pavement openings and joints. It is important to keep the drainage voids and joints filled with aggregate. Replenishment can be done, if needed, at the time of cleaning.

5. Snow removal and storage - Plowed snow shall be placed in the pervious area located along the roadway, where it can slowly infiltrate. Sediments shall be removed from this area every spring. When the amount of snow exceeds the capacity of the snow storage areas, it shall be removed from the site and disposed of properly immediately after each storm at the owner's expense.

6. Pesticides, Herbicides, and Fertilizers **-** Pesticides and herbicides shall not be used within the limits of the 100-foot buffer zone to any wetland resource areas as defined under 310 CMR 10.00. In addition, fertilizers that are used within this zone should be restricted to the use of organic fertilizers only.

7. Maintenance Responsibilities **-** All post construction maintenance activities should be documented and kept on file and made available upon request. All post construction maintenance activities shall run with the title of the property.

All structural BMP's as identified on the site plans will be owned and maintained by the owner of the property. The owner relinquishes the right to enter and maintain all stormwater systems to the City should they not be maintained properly.

15 Unit Mixed Use Development

272 Tremont Street, Melrose, MA

BMP Maintenance Log

BMP STRUCTURE	INSPECTOR (NAME)	WORK PERFORMED	DATE PERFORMED	COMMENTS
CDS Unit #1				
CDS Unit #2				
Subsurface Infiltration Facility (P1)				
CDS Unit #3				
Subsurface Infiltration Facility (P2)				
Building Roof Drains				
Pervious Pavers				
Other				

Additional Comments:

CONTECH®
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance

CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

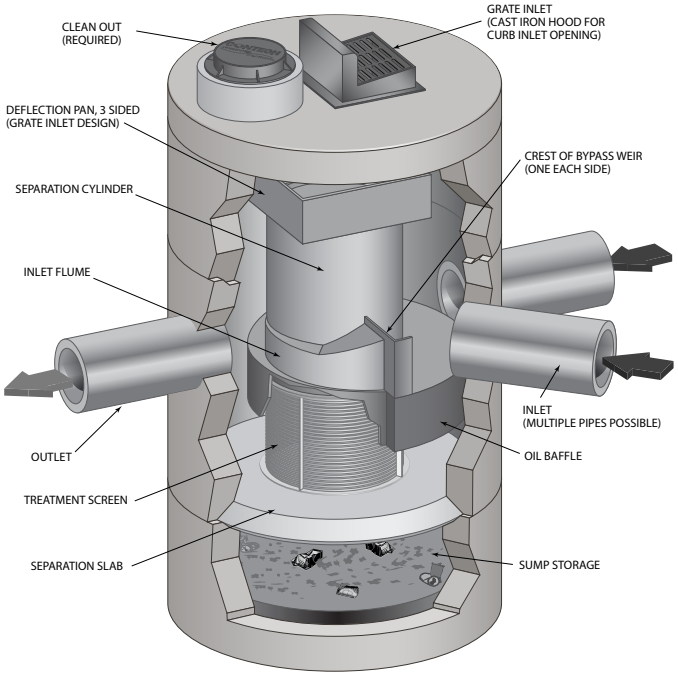
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are

determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

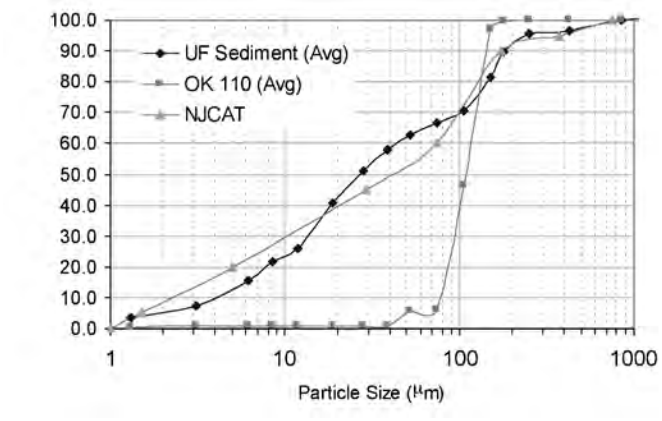


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect

to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

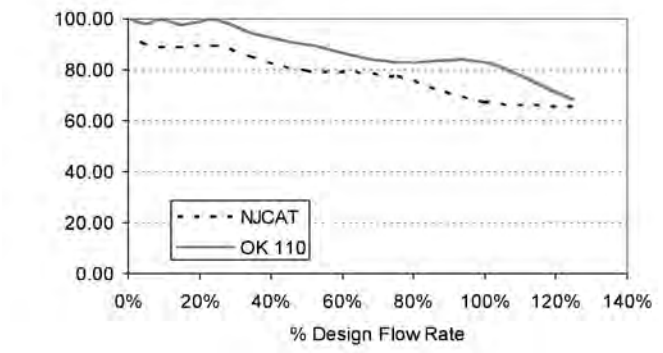


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

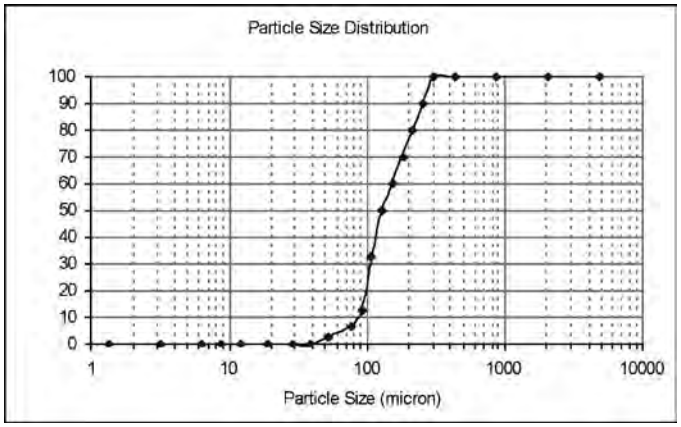


Figure 3. WASDOE PSD

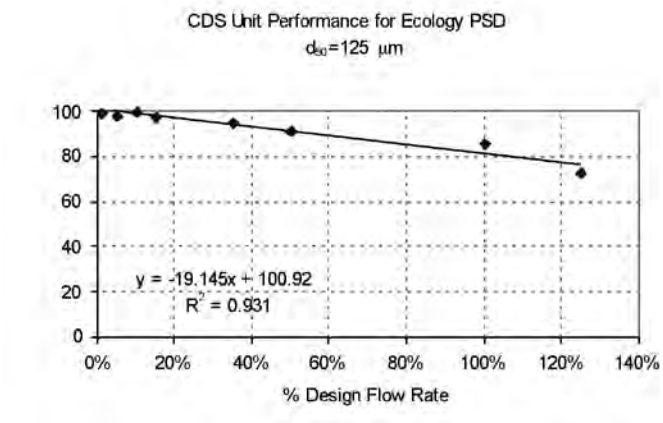


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

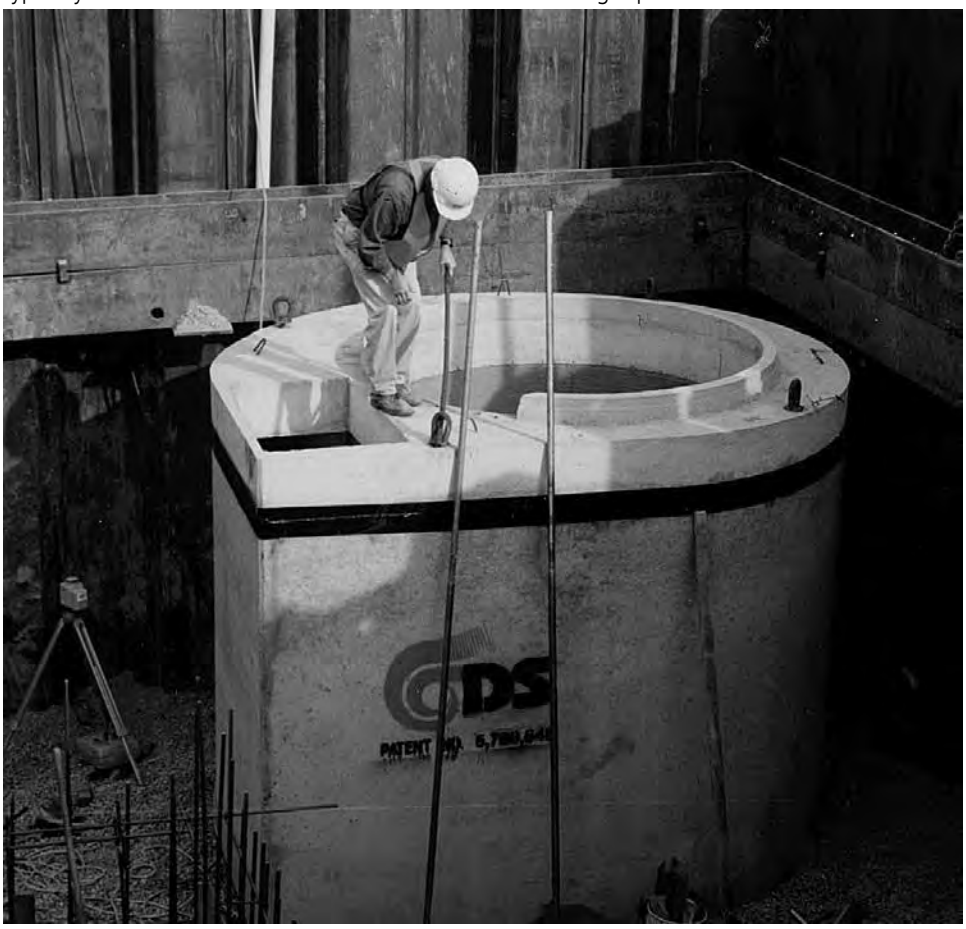
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CONTACTOR® & RECHARGER®

STORMWATER MANAGEMENT SOLUTIONS

OPERATION & MAINTENANCE GUIDELINES

FOR CULTEC STORMWATER MANAGEMENT SYSTEMS

Published by
CULTEC, Inc.
P.O. Box 280
878 Federal Road
Brookfield, Connecticut 06804 USA
www.cultec.com

Disclaimers:
The drawings, photographs and illustrations shown in this document are for illustrative purposes only and are not necessarily to scale.
Actual designs may vary.

CULTEC reserves the right to make design and/or specification changes at any time without notice at CULTEC's sole discretion.

Protected by one or more of the following patents owned by Cultec, Inc.:
U.S. Patents 6,129,482; 6,322,288; 6,854,925; 7,226,241; 7,806,627; 8,366,346; 8,425,148; U.S. Designs D613,819; D638,095; D668,318; Canadian Patent 2,450,565; 2,591,255; Canadian Designs 129144; 135983; 159073; 160977; and/or other U.S. or Foreign Patent(s) or Patent(s) Pending.

Contact Information:
For general information on our other products and services, please contact our offices within the United States at (800)428-5832, (203)775-4416 ext. 202, or e-mail us at custservice@cultec.com.

For technical support, please call (203)775-4416 ext. 203 or e-mail tech@cultec.com.

Visit www.cultec.com/downloads.html for Product Downloads and CAD details.

Doc ID: CLT057 01-20
January 2020

These instructions are for single-layer traffic applications only. For multi-layer applications, contact CULTEC.
All illustrations and photos shown herein are examples of typical situations. Be sure to follow the engineer's drawings.
Actual designs may vary.

This manual contains guidelines recommended by CULTEC, Inc. and may be used in conjunction with, but not to supersede, local regulations or regulatory authorities. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Introduction

The CULTEC Subsurface Stormwater Management System is a high-density polyethylene (HDPE) chamber system arranged in parallel rows surrounded by washed stone. The CULTEC chambers create arch-shaped voids within the washed stone to provide stormwater detention, retention, infiltration, and reclamation. Filter fabric is placed between the native soil and stone interface to prevent the intrusion of fines into the system. In order to minimize the amount of sediment which may enter the CULTEC system, a sediment collection device (stormwater pretreatment device) is recommended upstream from the CULTEC chamber system. Examples of pretreatment devices include, but are not limited to, an appropriately sized catch basin with sump, pretreatment catchment device, oil grit separator, or baffled distribution box. Manufactured pretreatment devices may also be used in accordance with CULTEC chambers. Installation, operation, and maintenance of these devices shall be in accordance with manufacturer's recommendations. Almost all of the sediment entering the stormwater management system will be collected within the pretreatment device.

Best Management Practices allow for the maintenance of the preliminary collection systems prior to feeding the CULTEC chambers. The pretreatment structures shall be inspected for any debris that will restrict inlet flow rates. Outfall structures, if any, such as outlet control must also be inspected for any obstructions that would restrict outlet flow rates. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Operation and Maintenance Requirements

I. Operation

CULTEC stormwater management systems shall be operated to receive only stormwater run-off in accordance with applicable local regulations. CULTEC subsurface stormwater management chambers operate at peak performance when installed in series with pretreatment. Pretreatment of suspended solids is superior to treatment of solids once they have been introduced into the system. The use of pretreatment is adequate as long as the structure is maintained and the site remains stable with finished impervious surfaces such as parking lots, walkways, and pervious areas are properly maintained. If there is to be an unstable condition, such as improvements to buildings or parking areas, all proper silt control measures shall be implemented according to local regulations.

II. Inspection and Maintenance Options

A. The CULTEC system may be equipped with an inspection port located on the inlet row. The inspection port is a circular cast box placed in a rectangular concrete collar. When the lid is removed, a 6-inch (150 mm) pipe with a screw-in plug will be exposed. Remove the plug. This will provide access to the CULTEC Chamber row below. From the surface, through this access, the sediment may be measured at this location. A stadia rod may be used to measure the depth of sediment if any in this row. If the depth of sediment is in excess of 3 inches (76 mm), then this row should be cleaned with high pressure water through a culvert cleaning nozzle. This would be carried out through an upstream manhole or through the CULTEC StormFilter Unit (or other pretreatment device). CCTV inspection of this row can be deployed through this access port to deter mine if any sediment has accumulated in the inlet row.

B. If the CULTEC bed is not equipped with an inspection port, then access to the inlet row will be through an upstream manhole or the CULTEC StormFilter.

1. Manhole Access

This inspection should only be carried out by persons trained in confined space entry and sewer inspection services. After the manhole cover has been removed a gas detector must be lowered into the manhole to ensure that there are not high concentrations of toxic gases present. The inspector should be lowered into the manhole with the proper safety equipment as per OSHA requirements. The inspector may be able to observe sediment from this location. If this is not possible, the inspector will need to deploy a CCTV robot to permit viewing of the sediment.

2. StormFilter Access
Remove the manhole cover to allow access to the unit. Typically a 30-inch (750 mm) pipe is used as a riser from the StormFilter to the surface. As in the case with manhole access, this access point requires a technician trained in confined space entry with proper gas detection equipment. This individual must be equipped with the proper safety equipment for entry into the StormFilter. The technician will be lowered onto the StormFilter unit. The hatch on the unit must be removed. Inside the unit are two filters which may be removed according to StormFilter maintenance guidelines. Once these filters are removed the inspector can enter the StormFilter unit to launch the CCTV camera robot.

C. The inlet row of the CULTEC system is placed on a polyethylene liner to prevent scouring of the washed stone beneath this row. This also facilitates the flushing of this row with high pressure water through a culvert cleaning nozzle. The nozzle is deployed through a manhole or the StormFilter and extended to the end of the row. The water is turned on and the inlet row is back-flushed into the manhole or StormFilter. This water is to be removed from the manhole or StormFilter using a vacuum truck.

III. Maintenance Guidelines

The following guidelines shall be adhered to for the operation and maintenance of the CULTEC stormwater management system:

A. The owner shall keep a maintenance log which shall include details of any events which would have an effect on the system's operational capacity.

B. The operation and maintenance procedure shall be reviewed periodically and changed to meet site conditions.

C. Maintenance of the stormwater management system shall be performed by qualified workers and shall follow applicable occupational health and safety requirements.

D. Debris removed from the stormwater management system shall be disposed of in accordance with applicable laws and regulations.

IV. Suggested Maintenance Schedules

A. Minor Maintenance
The following suggested schedule shall be followed for routine maintenance during the regular operation of the stormwater system:

Frequency	Action
Monthly in first year	Check inlets and outlets for clogging and remove any debris, as required.
Spring and Fall	Check inlets and outlets for clogging and remove any debris, as required.
One year after commissioning and every third year following	Check inlets and outlets for clogging and remove any debris, as required.

B. Major Maintenance
The following suggested maintenance schedule shall be followed to maintain the performance of the CULTEC stormwater management chambers. Additional work may be necessary due to insufficient performance and other issues that might be found during the inspection of the stormwater management chambers. (See table on next page)

	Frequency	Action
Inlets and Outlets	Every 3 years	• Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
	Spring and Fall	• Check inlet and outlets for clogging and remove any debris as required.
CULTEC Stormwater Chambers	2 years after commissioning	• Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
	9 years after commissioning every 9 years following	• Clean stormwater management chambers and feed connectors of any debris. • Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
	45 years after commissioning	• Clean stormwater management chambers and feed connectors of any debris. • Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. • Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. • Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. • Attain the appropriate approvals as required. • Establish a new operation and maintenance schedule.
Surrounding Site	Monthly in 1st year	• Check for depressions in areas over and surrounding the stormwater management system.
	Spring and Fall	• Check for depressions in areas over and surrounding the stormwater management system.
	Yearly	• Confirm that no unauthorized modifications have been performed to the site.

For additional information concerning the maintenance of CULTEC Subsurface Stormwater Management Chambers, please contact CULTEC, Inc. at 1-800-428-5832.

APPENDIX D

Water Quality Volume Calculations

Project: Proposed Mixed Use Development
Client: Eric Kenworthy
Project Number: 19-29908

Prepared By: EJB
Checked By: RAS
Date: 08/10/20

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

WATER QUALITY - Cultec 330XLHD (System #P1)

WATER QUALITY TREATMENT VOLUME

V_{WQ} = (D_{WQ} in. / 12 inches/foot) x (A_{IMP} x 43,560 square feet/acre)

V_{WQ}	=	Required Water Quality Volume (in cubic feet)
D_{WQ}	=	Water Quality Depth
A_{IMP}	=	Impervious Area (in acres)

V_{WQ} = (1.0 in. / 12 inches/foot) x (0.18 x 43,560 square feet/acre) = **653 CF**

Stormwater BMP	Volume
Cultec 330 XL System	1,109
Total	**1,109**

NOTES:

1. Storage volume for the stormwater BMPs obtained from the hydrologic model created in HydroCAD

CONCLUSION:

1. The storage volume provided by the proposed BMPs is greater than the required water quality treatment volume. 1,109 CF > 653 CF

Project: Proposed Mixed Use Development
Client: Eric Kenworthy
Project Number: 19-29908

Prepared By: EJB
Checked By: RAS
Date: 08/10/20

Engineering Alliance, Inc.
Civil Engineering & Land Planning Consultants
194 Central Street
Saugus, MA 01906
Tel: (781) 231-1349
Fax: (781) 417-0020

1950 Lafayette Road
Portsmouth, NH 03801
Tel: (603) 610-7100
Fax: (603) 610-7101

WATER QUALITY - Cultec 330XLHD (System #P2)

WATER QUALITY TREATMENT VOLUME

$V_{WQ} = (D_{WQ}\ in. / 12\ inches/foot) \times (A_{IMP} \times 43{,}560\ square\ feet/acre)$

V_{WQ}	=	Required Water Quality Volume (in cubic feet)
D_{WQ}	=	Water Quality Depth
A_{IMP}	=	Impervious Area (in acres)

V_{WQ} = (1.0 in. / 12 inches/foot) x (0.04 x 43,560 square feet/acre) = **145 CF**

Stormwater BMP	Volume
Cultec 330 XL System	414
Total	**414**

NOTES:

1. Storage volume for the stormwater BMPs obtained from the hydrologic model created in HydroCAD

CONCLUSION:

1. The storage volume provided by the proposed BMPs is greater than the required water quality treatment volume. 414 CF > 145 CF

APPENDIX E

NOAA Rainfall Data

NOAA Atlas 14, Volume 10, Version 3
Location name: Melrose, Massachusetts, USA*
Latitude: 42.4684°, Longitude: -71.0681°
Elevation: 76.72 ft**
* source: ESRI Maps
** source: USGS

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)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.306 (0.235-0.390)	0.372 (0.285-0.474)	0.479 (0.367-0.614)	0.567 (0.431-0.730)	0.689 (0.510-0.934)	0.779 (0.567-1.08)	0.877 (0.625-1.27)	0.995 (0.667-1.47)	1.18 (0.760-1.80)	1.33 (0.842-2.07)
10-min	0.434 (0.333-0.553)	0.527 (0.404-0.672)	0.678 (0.518-0.868)	0.803 (0.611-1.04)	0.976 (0.723-1.32)	1.10 (0.805-1.54)	1.24 (0.885-1.80)	1.41 (0.945-2.08)	1.67 (1.08-2.54)	1.88 (1.19-2.94)
15-min	0.511 (0.392-0.650)	0.619 (0.475-0.790)	0.797 (0.610-1.02)	0.944 (0.719-1.22)	1.15 (0.851-1.56)	1.30 (0.946-1.81)	1.46 (1.04-2.12)	1.66 (1.11-2.44)	1.96 (1.27-2.99)	2.22 (1.40-3.46)
30-min	0.702 (0.539-0.894)	0.852 (0.653-1.09)	1.10 (0.839-1.41)	1.30 (0.989-1.68)	1.58 (1.17-2.14)	1.79 (1.30-2.49)	2.01 (1.44-2.93)	2.29 (1.53-3.37)	2.71 (1.75-4.13)	3.07 (1.94-4.78)
60-min	0.894 (0.686-1.14)	1.09 (0.832-1.38)	1.40 (1.07-1.79)	1.66 (1.26-2.13)	2.01 (1.49-2.73)	2.28 (1.66-3.17)	2.56 (1.83-3.73)	2.91 (1.95-4.29)	3.45 (2.23-5.27)	3.91 (2.48-6.10)
2-hr	1.15 (0.888-1.45)	1.41 (1.09-1.78)	1.83 (1.41-2.33)	2.19 (1.67-2.80)	2.67 (1.99-3.60)	3.03 (2.22-4.19)	3.42 (2.46-4.95)	3.91 (2.63-5.71)	4.68 (3.03-7.08)	5.35 (3.39-8.25)
3-hr	1.33 (1.03-1.68)	1.64 (1.27-2.07)	2.14 (1.65-2.71)	2.56 (1.96-3.26)	3.13 (2.34-4.20)	3.55 (2.62-4.89)	4.01 (2.90-5.79)	4.59 (3.09-6.67)	5.51 (3.58-8.29)	6.31 (4.01-9.68)
6-hr	1.73 (1.35-2.16)	2.12 (1.66-2.66)	2.77 (2.15-3.48)	3.30 (2.56-4.18)	4.04 (3.05-5.39)	4.58 (3.40-6.26)	5.18 (3.76-7.40)	5.92 (4.01-8.52)	7.09 (4.62-10.6)	8.10 (5.17-12.3)
12-hr	2.21 (1.74-2.75)	2.71 (2.13-3.37)	3.52 (2.76-4.40)	4.19 (3.27-5.27)	5.12 (3.88-6.76)	5.81 (4.32-7.85)	6.55 (4.76-9.25)	7.47 (5.08-10.6)	8.88 (5.81-13.1)	10.1 (6.46-15.2)
24-hr	2.66 (2.11-3.29)	3.29 (2.61-4.07)	4.32 (3.41-5.36)	5.18 (4.07-6.46)	6.35 (4.85-8.34)	7.22 (5.41-9.70)	8.17 (5.98-11.5)	9.35 (6.38-13.2)	11.2 (7.34-16.3)	12.8 (8.20-19.0)
2-day	3.02 (2.41-3.70)	3.80 (3.04-4.67)	5.09 (4.05-6.27)	6.16 (4.87-7.63)	7.63 (5.87-9.96)	8.70 (6.58-11.7)	9.89 (7.33-13.9)	11.4 (7.83-16.0)	13.9 (9.15-20.1)	16.1 (10.3-23.6)
3-day	3.29 (2.65-4.02)	4.14 (3.32-5.06)	5.52 (4.41-6.78)	6.67 (5.30-8.23)	8.25 (6.38-10.7)	9.40 (7.14-12.5)	10.7 (7.95-14.9)	12.4 (8.48-17.2)	15.0 (9.92-21.6)	17.4 (11.2-25.5)
4-day	3.56 (2.87-4.34)	4.44 (3.57-5.41)	5.86 (4.70-7.17)	7.05 (5.61-8.66)	8.68 (6.72-11.2)	9.86 (7.51-13.1)	11.2 (8.34-15.6)	12.9 (8.88-17.9)	15.7 (10.4-22.4)	18.1 (11.7-26.4)
7-day	4.33 (3.50-5.24)	5.24 (4.24-6.35)	6.72 (5.42-8.18)	7.96 (6.38-9.73)	9.66 (7.52-12.4)	10.9 (8.32-14.3)	12.3 (9.15-16.9)	14.0 (9.69-19.3)	16.8 (11.2-23.9)	19.3 (12.5-27.8)
10-day	5.02 (4.08-6.06)	5.96 (4.84-7.20)	7.50 (6.07-9.08)	8.77 (7.05-10.7)	10.5 (8.21-13.4)	11.8 (9.03-15.4)	13.2 (9.85-18.0)	15.0 (10.4-20.5)	17.7 (11.8-25.0)	20.1 (13.0-28.9)
20-day	7.00 (5.73-8.38)	8.03 (6.57-9.63)	9.72 (7.93-11.7)	11.1 (9.01-13.4)	13.1 (10.2-16.4)	14.5 (11.1-18.6)	16.0 (11.9-21.2)	17.8 (12.4-24.0)	20.3 (13.5-28.2)	22.3 (14.5-31.7)
30-day	8.64 (7.11-10.3)	9.74 (8.01-11.6)	11.6 (9.46-13.8)	13.1 (10.6-15.7)	15.1 (11.8-18.8)	16.7 (12.8-21.2)	18.3 (13.5-23.9)	20.0 (14.0-26.8)	22.3 (15.0-30.9)	24.2 (15.7-34.1)
45-day	10.7 (8.88-12.8)	11.9 (9.84-14.2)	13.8 (11.4-16.5)	15.4 (12.6-18.5)	17.7 (13.9-21.8)	19.4 (14.8-24.3)	21.1 (15.5-27.1)	22.7 (16.0-30.3)	24.9 (16.7-34.2)	26.4 (17.2-37.0)
60-day	12.5 (10.4-14.8)	13.8 (11.4-16.3)	15.8 (13.0-18.8)	17.5 (14.3-20.9)	19.8 (15.6-24.3)	21.6 (16.5-26.9)	23.3 (17.1-29.8)	24.9 (17.6-33.1)	27.0 (18.2-36.9)	28.3 (18.5-39.6)

[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

APPENDIX F

Form 11 – Soil Suitability Assessment
Form 12 – Percolation Test

Commonwealth of Massachusetts
City/Town of Melrose

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-1 (Hole #) | 7/31/2020 (Date) | 1:45 p.m. (Time) | Clear Skies (Weather) | _____ (Latitude) | _____ (Longitude:)

1. Land Use: Residential (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | N/A (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 1-5% (Slope (%))

Description of Location: _____

2. Soil Parent Material: _____ | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body _____ feet | Drainage Way _____ feet | Wetlands _____ feet | Property Line _____ feet | Drinking Water Well _____ feet | Other _____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-14"	A	Sandy Loam	10 YR 3/3	-	-	-	-	-	Granular	Very Friable	
14-36"	Bw	Loamy Fine Sand	10 YR 4/6	-	-	-	5%	-	Massive	Very Friable	
36"-96"	C	Sand	10 YR 5/4	-	-	-	15%	10%	Single Graine	Loose	

Additional Notes:
1. No weeping, no mottles, no standing water observed. 2. Roots at approx. 36" depth.

Commonwealth of Massachusetts
City/Town of Melrose

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-2 (Hole #) | 7/31/20 (Date) | 2:40 p.m. (Time) | Clear Skies (Weather) | _____ (Latitude) | _____ (Longitude:)

1. Land Use: Residential (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | N/a (Surface Stones (e.g., cobbles, stones, boulders, etc.) | 1-5% (Slope (%)

Description of Location: _____

2. Soil Parent Material: _____ | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body _____ feet | Drainage Way _____ feet | Wetlands _____ feet
Property Line _____ feet | Drinking Water Well _____ feet | Other _____ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

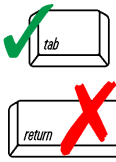
Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-8"	Fill	Fine Sandy Loam	10 YR 3/3	-	-	-	-	-	Granular	Very Friable	
8-14"	Ab	Fine Sandy Loam	10 YR 3/3	-	-	-	-	-	Granular	Very Friable	
14-24"	Bw	Loamy Sand	10 YR 4/6	-	-	-	-	-	Massive	Very Friable	
24"-96"	C	Coarse Sand	10 YR 5/4	-	-	-	10%	10%	Single Grain	Loose	

Additional Notes:
1. Right side of pit shows concentrations at 24" depth, possible trapped water between Loamy Sand/Sand. 2. No weeping, standing water.

Commonwealth of Massachusetts
City/Town of Melrose
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A. Site Information

Eric Kenworthy
Owner Name

272 Tremont Street
Street Address or Lot #

Melrose	MA	02176
City/Town	State	Zip Code

Eric Bradanese, P.E.	781-231-1349
Contact Person (if different from Owner)	Telephone Number

B. Test Results

	7/31/2020 Date	2:00 p.m. Time	Date	Time
Observation Hole #	TP-1			
Depth of Perc	54"			
Start Pre-Soak	2:05 p.m.			
End Pre-Soak	2:20 p.m.			
Time at 12”	2:20 p.m.			
Time at 9”	2:24 p.m.			
Time at 6”	2:28 p.m.			
Time (9”-6”)	4 mins			
Rate (Min./Inch)	< 2 min/in			
	Test Passed: ☒ Test Failed: ☐		Test Passed: ☐ Test Failed: ☐	

Eric Bradanese, P.E. SE#13860
Test Performed By:

Board of Health Witness

Comments: