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May 31, 2020 (Revised October 15, 2023)

ENGINEER'S LETTER REPORT FOR DRAINAGE DESIGN FOR 33 MIDDLEBUSH, LLC TOWN OF WAPPINGER, NEW YORK

The proposed stormwater management facilities have been designed to provide water quantity controls by detaining, treating, and releasing stormwater runoff at a rate equal to or less than that which existed prior to construction of improvements at the project site.

1.0 PROJECT SUMMARY

The parcel currently contains a masonry building and a limited asphalt parking area. The proposed improvements include reconstruction of a building within the same footprint, asphalt and gravel parking/truck maneuvering area expansion, sidewalk construction, landscaping and utility upgrades. The parcel is currently served by a private water supply well and an underground sanitary sewage disposal system.

The project will involve the removal of existing pervious wooded and grass surfaces for the construction of new impervious surfaces resulting in a net increase in impervious surfaces of approximately 12,630 SF. The project will require the implementation of erosion controls during construction to reduce the impacts of erosion and sedimentation and the installation of permanent stormwater management facilities to control the rate of discharge from the property.

The total disturbance for the project will be 0.9 acres. Therefore, coverage under the NYSDEC General SPDES Permit for Stormwater Discharges from Construction Projects. However, stormwater management facilities have been planned to meet the requirements of the Town of Wappinger.

2.0 SITE DESCRIPTION

This section briefly describes existing and proposed hydrologic and hydraulic conditions at and around the project site as they relate to surface water management planning considerations. Subsequent sections contain a description of the manner in which site runoff will be managed to minimize effects on areas adjacent to the site.

Location

The parcel proposed to be disturbed for this development project comprises approximately 1.75 acres of land on the north side of Middlebush Road, across from Pleasant Lane. The improvements are proposed on Tax Parcels 6157-01-414840 and 396837. The land in the area surrounding the site consists of mixed uses of residential, institutional and commercial.

The watershed that contributes to the Off-Site Discharge Point (ODP) also includes a portion of the Wappingers Central Schools property and single-family residential properties adjacent to the project property.

Topography

The property generally slopes from south to north on the east side of the building and from north to south on the west side of the building. A drainage swale runs along the north side of the building from east to west and drains toward the off-site discharge point consisting of a culvert at the south west corner of the property that transmits flow into the County highway drainage system. Slopes are mostly less than 10% across the site. The adjacent Wappingers Central School property slopes west to east at less than 10% to the wooded area of the project property and adjacent eastern property.

Land Cover

The construction project is on a previously-developed property, consisting of land covers of the building, asphalt parking and wooded/grass areas. The off-site areas that contribute to the ODP are generally paved and grass areas associated with the Wappingers Central School parcel and additional wooded areas.

Soils

According to maps from the National Cooperative Soil Survey for Dutchess County, the on-site soils within the project area are classified into the following mapping unit(s):

Dutchess-Cardigan complex (DwB)
This soil is characterized as silt loam to a depth of 86 inches. Depth to groundwater and bedrock varies. On-site soil test pits indicated a depth to groundwater of approximately 48 inches. The hydrologic soil group is B/C and is characterized with moderate infiltration rates.

Watercourses and Drainage Patterns

No streams are located on the property. The majority of the property drains to the south west corner discharge point. Off-site areas associated with the Wappingers Central School property generally sheet runoff into the wooded area of the project property and eastern property. This area contains isolated wetlands that capture runoff and eventually drains along a ditch on the north side of the project building, and subsequently flows to the 15" RCP culvert at Middlebush. This drainage pattern will be continued.

Regulated Wetlands

ACOE-regulated wetlands are present on the property and adjacent property to the east and are shown on the property survey. An isolated Town-regulated wetland is located in the north east corner of the property. Minor disturbances to these wetlands are proposed.

Floodplains

According to FEMA floodplain mapping, no floodplains are located on or adjacent to the property.

3.0 METHODOLOGY / NYSDEC UNIFORM SIZING CRITERIA

The Environmental Protection Agency, New York State Department of Environmental Conservation and Town of Wappinger require the management of stormwater from construction projects to meet standards for water quantity. The project will result in the disturbance of less than one (1) acre and is therefore not subject to water quality treatment standards. However, water quality treatment will be provided for a portion of the runoff. Maintaining water quality involves the removal or reduction of pollutants including suspended solids, phosphates, nitrates and other chemicals generated by development. The water quantity standards require peak flow attenuation and include parameters designed to protect downstream channels, water bodies and properties from erosion and flooding.

Rainfall Data

Rainfall data utilized in the modeling and analysis was taken from the NYSDEC Stormwater Design Manual:

Table 1 - Precipitation Values

Storm Event *n*	90% Rainfall Event*	1-yr	2-yr	5-yr	10-yr	**25-yr**	50-yr	100-yr
Precipitation $_{24\text{-hr}}P_{n\text{-}yr}$ (inches)	1.4	2.7	-	-	4.9	-	-	9.0

Hydrologic and Hydraulic Analysis

The peak rate of stormwater runoff generated from the proposed improvements during the design storms was calculated to determine the required storage volume of the dry detention basin. The time of concentration (Tc)and runoff curve numbers (CN) were then calculated for each watershed area. A minimum Tc of 0.1 hour was selected due to the small area of the watershed. This data was then entered into the *HydroCAD* computer program for analysis. *HydroCAD*, a Computer-Aided-Design (CAD) program, was used to analyze the hydrologic and hydraulic characteristics of a given watershed and associated stormwater management facilities. It utilizes the latest techniques to predict the consequences of any given storm. *HydroCAD* has the capability of computing hydrographs (which represents discharge rates characteristic of specified watershed conditions, precipitation, and geologic factors) combining hydrographs and routing flows though pipes, streams and ponds. HydroCAD is used to calculate peak runoff flows and to create hydrographs for the various storm events evaluated for both pre-development and post development conditions.

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Watershed Description

Existing (Pre-Development) Watershed Conditions

The study area consists of the portion of the property that will be altered as part of the improvements and the area contributing to the ODP culvert at Middlebush Road. The overall study area is 5.0 acres and the portion impacted by the project is 0.79 acres. All of the effected project area contributes runoff to a 15-inch RCP culvert that transmits flows from the south west corner of the property into the County Highway drainage system. The existing conditions includes an existing 6,700 sf +/- building and 6,100 sf asphalt parking area. The remaining areas are generally wooded/grass areas.

The Off-Site Discharge Point is the 15-inch RCP culvert that accepts runoff from the property and transmits it into the County system along Middlebush Road.

Proposed (Post-Development) Watershed Conditions

The post-development drainage area will be modified by the proposed improvements by converting wooded/grass areas to impervious surfaces related to the parking/truck maneuvering area expansion and sidewalk construction. The net increase in impervious area is 12,630 SF.

The subcatchments are described in the HydroCAD Figure. The subcatchments are generally described:

1 Post: North Parking Area
This area consists of most of the parking area that will sheet flow runoff to catch basins located to the north side of the parking area and building.

2 Post: Area Direct to the Dry Detention Basin
This area consists of the existing building and proposed sidewalk along the west side of the building and area of the basin and immediately adjacent.

3 Post: Remaining Area Direct to the ODP
This area consists of the off-site areas and the portion of the project property not impacted by the proposed construction.

4 Post: South Parking Area
This area consists of the asphalt area adjacent to the east side of the building.

The Off-Site Discharge Point is the 15-inch RCP culvert that accepts runoff from the property and transmits it into the County system along Middlebush Road.

Proposed Water Quantity Controls

Water Quantity

The following table summarizes the stormwater management system performance and discharge point parameters as found in the engineering calculations attached.

Design Point Summary	Pre-Development	Post-Development	Units	Satisfied
Design Point 1				
Contributing Watershed Area	5.0	5.0	AC	
		Peak Discharge		
1-year event	2.2	2.2	cfs	√
10-year event	7.9	7.6	cfs	√
100-year event	20.7	19.5	cfs	√

The off-site discharge point will not be significantly affected by the proposed project. A minor reduction in peak flow rates to the culvert will occur as a result of the proposed on-site detention. The attached figure indicates that the 15" RCP can pass the 1-yr storm event (2.7 inches) with no ponding at the inlet. The 10-yr storm event (4.9 inches) results in a headwater elevation of 150. Runoff will continue to pond on-site within the wetland until drained by the culvert. The 150 contour is generally contained to the site property. Additional storage up to 150 will be provided with the construction of the detention basin.

A review of the 100-year storm (9.0 inches) conditions at the culvert indicates that the storm model may be over estimating flows to the off-site discharge point. Headwater is calculated to be 7.5 ft. This would result in significant flooding of the project property, adjacent properties and Middlebush Road. Historically, storm events approaching 9 inches of rain have occurred without any significant flooding.

Stormwater Management System

The stormwater management system is as follows:

1. Catch Basins

Catch basins will capture runoff from the asphalt and gravel parking/truck maneuvering area. The catch basins will transmit flow to the proposed dry detention basin.

2. Dry Detention Basin

A dry detention basin is proposed on the west side of the building to provide quantity control. The dry detention basin will discharge to the wooded area adjacent to the off-site discharge point.

May 31, 2020 (Revised October 15, 2023)

The proposed construction will not increase the peak discharge rates from the site after development and will meet the Town of Wappinger stormwater requirements.

Sincerely,

Troy A. Wojciekofsky, P. E., LEED-AP
Engineer
Attachments:
Soils Information
HydroCAD Report

Soil Map—Dutchess County, New York
(33 Middlebush, LLC)

Map Scale: 1:483 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 5 10 20 30

Feet
0 20 40 80 120

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Dutchess County, New York
Survey Area Data: Version 16, Sep 16, 2019

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

Date(s) aerial images were photographed: Oct 7, 2013—Feb 26, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DwB	Dutchess-Cardigan complex, undulating, rocky	1.0	100.0%
Totals for Area of Interest		**1.0**	**100.0%**

Dutchess County, New York

DwB—Dutchess-Cardigan complex, undulating, rocky

Map Unit Setting

National map unit symbol: 9rfn
Elevation: 50 to 1,000 feet
Mean annual precipitation: 41 to 47 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 115 to 195 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Dutchess and similar soils: 40 percent
Cardigan and similar soils: 30 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dutchess

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy till derived mainly from phyllite, slate, schist, and shale

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 28 inches: silt loam
H3 - 28 to 86 inches: channery silt loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Cardigan

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy till or colluvium derived from phyllite, slate, shale, and schist

Typical profile

H1 - 0 to 8 inches: channery silt loam
H2 - 8 to 20 inches: channery loam
H3 - 20 to 30 inches: channery silt loam
H4 - 30 to 34 inches: unweathered bedrock

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Georgia

Percent of map unit: 10 percent
Hydric soil rating: No

Massena

Percent of map unit: 9 percent
Hydric soil rating: No

Nassau

Percent of map unit: 9 percent
Hydric soil rating: No

Sun

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

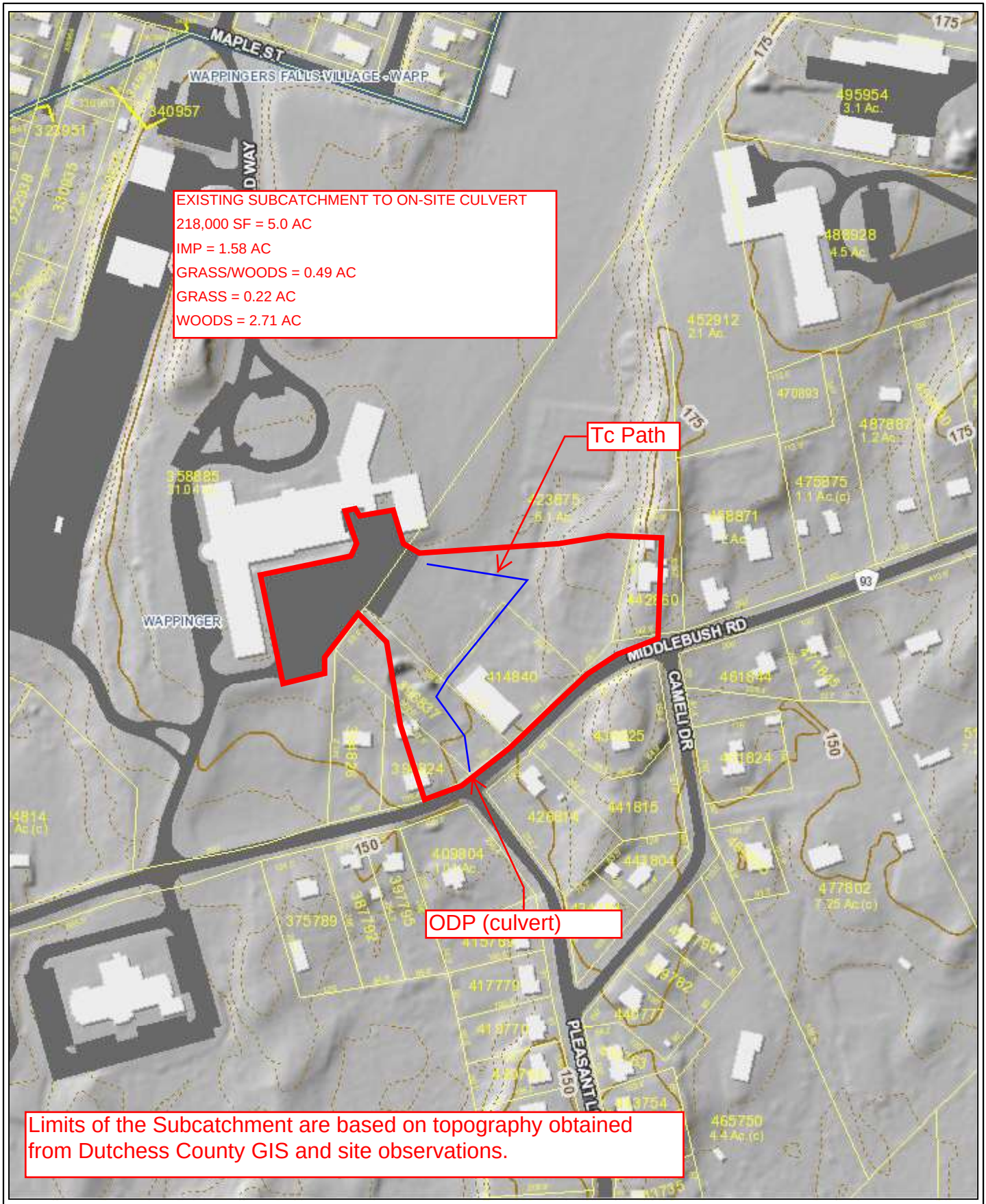
Rock outcrop

Percent of map unit: 1 percent

Hydric soil rating: Unranked

Data Source Information

Soil Survey Area: Dutchess County, New York
Survey Area Data: Version 16, Sep 16, 2019



Dutchess County
New York

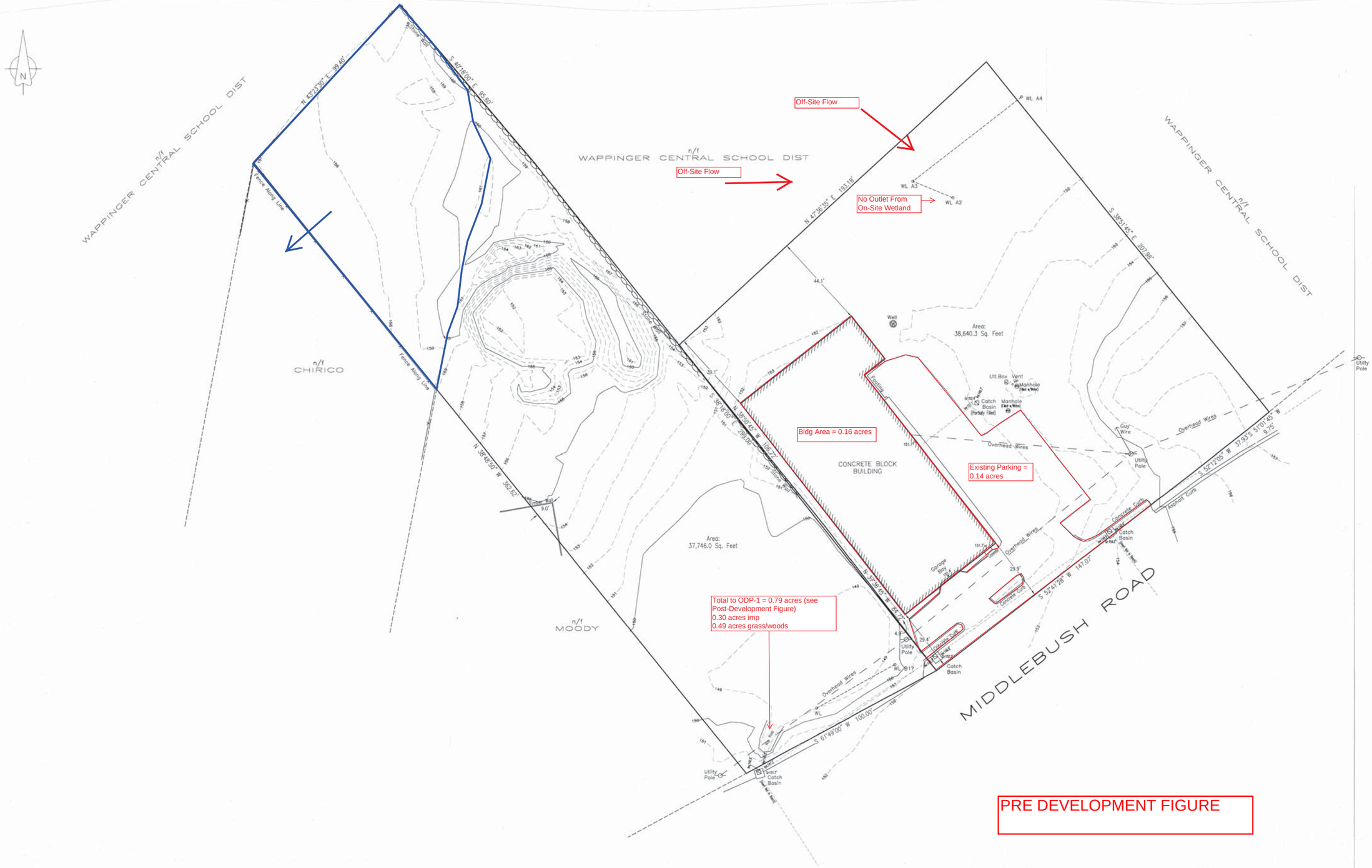
33 Middlebush Road

Dutchess County, NY

Printed by:
ParcelAccess

0 140 280 ft

ParcelAccess
Internet
5/19/2020



PRE DEVELOPMENT FIGURE

EXISTING CONDITIONS SURVEY

SURVEY AS PREPARED BY ROBERT OICLE DATED NOV. 7, 2017

REVISIONS	BY

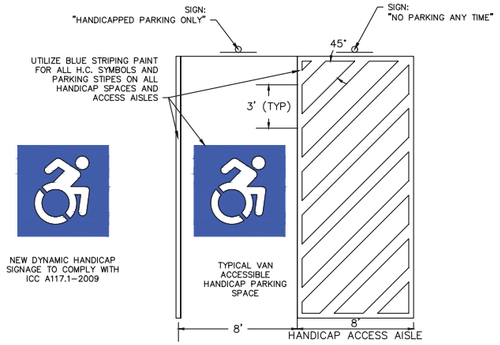
ALFRED A. CAPPELLI Jr., AIA
ARCHITECT
1136 ROUTE 9 WAPPINGERS FALLS, N.Y. 12590
Phone: (845) 632-6500
acappe2102@aol.com

PROPOSED CONTRACTOR STORAGE BUILDING
33 MIDDLEBUSH LLC
33 MIDDLEBUSH ROAD TOWN OF WAPPINGERS, NY

EXISTING CONDITIONS SURVEY

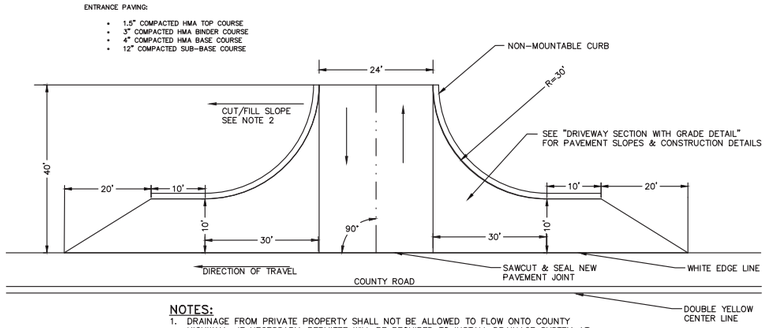
DATE	MAR. 1, 2019
SCALE	1" = 20'
DRAWN	AC
JOB	16-034
SHEET	S-2
OF	SHEETS

CS DIRECT



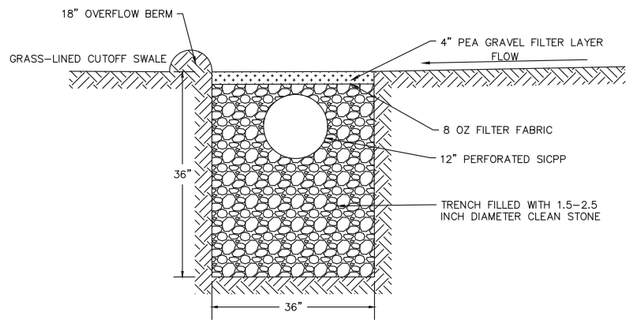
NOTES:
1. ALL PARKING AREAS TO BE RESTRIPED AT LEAST ONCE A YEAR.
2. ALL STRIPING TO BE 4" WIDE UNLESS NOTED OTHERWISE.
3. SEE SIGN DETAILS FOR SIGN MOUNTING AND SIGN HEIGHT REQUIREMENTS.
4. ALL PARKING SPACES SHALL BE MARKED WITH A DOUBLE STRIPED LINE CLOSED AT THE AISLE END. PARKING SPACES SHALL BE MEASURED FROM THE CENTER OF THE DOUBLE STRIPED LINES.

TYPICAL HANDICAP PARKING STRIPING DETAIL

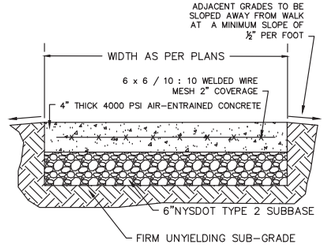


NOTES:
1. DRAINAGE FROM PRIVATE PROPERTY SHALL NOT BE ALLOWED TO FLOW ONTO COUNTY HIGHWAY. IF NECESSARY, PERMITEE WILL BE REQUIRED TO INSTALL DRAINAGE SYSTEM AT PROPOSED DRIVEWAY(S).
2. CUT/FILL SLOPES SHALL BE CONSTRUCTED NO STEEPER THAN 2 HORIZONTAL TO 1 VERTICAL (2:1). DCDPW SHALL EVALUATE CUT/FILL SLOPES FOR ACCEPTABILITY.
3. DIMENSIONS SHOWN ARE TYPICAL. FIELD CONDITIONS MAY REQUIRE ADJUSTMENTS TO MATCH EXISTING CONDITIONS PER DCDPW DIRECTION.

DCDPW LOCAL ROAD/SUBDIVISION ROAD DETAIL
NOT TO SCALE

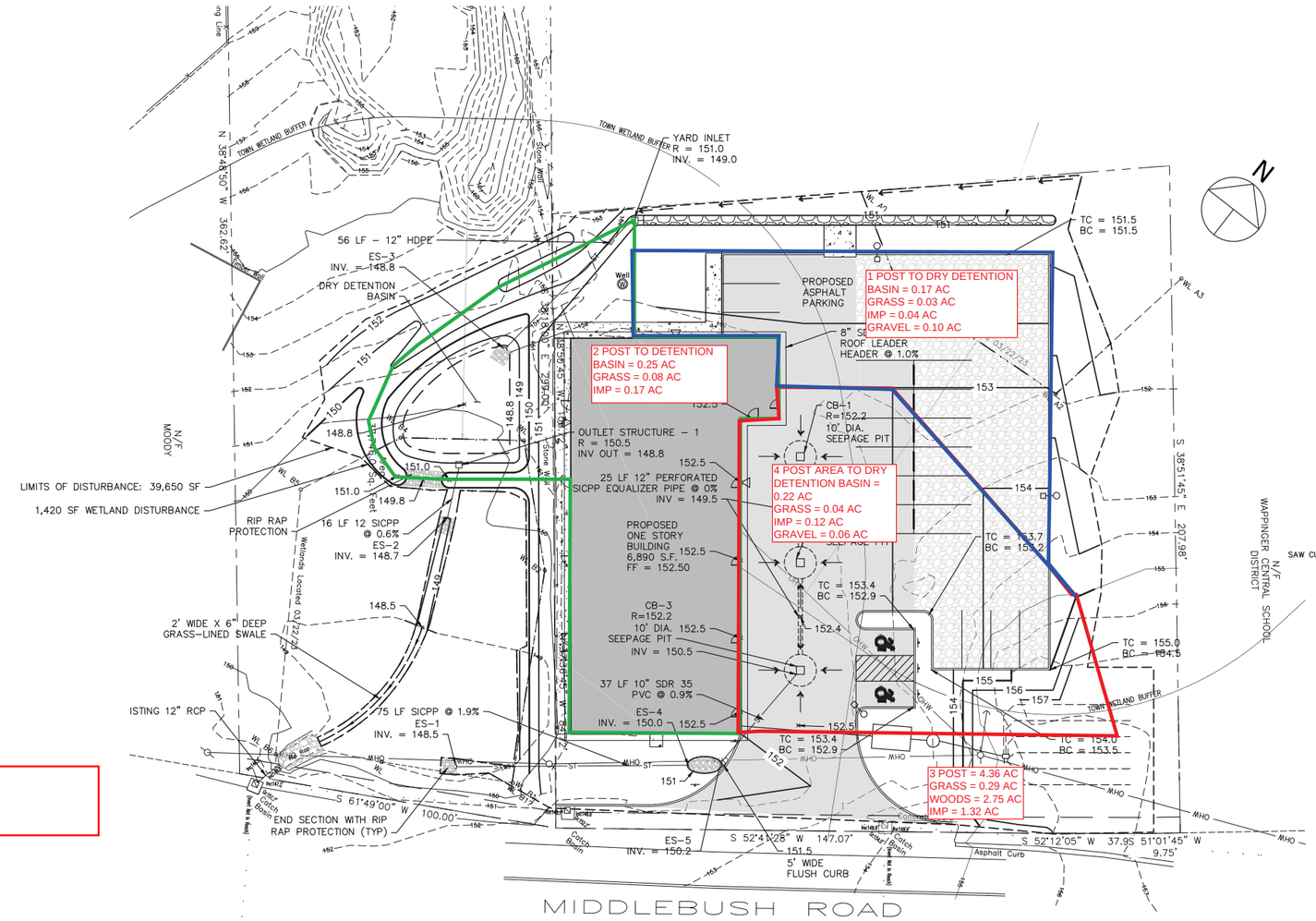


PERF. PIPE IN INFILTRATION TRENCH



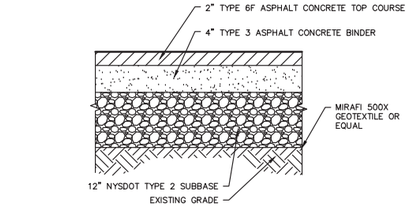
NOTES:
1. EXPANSION JOINTS OF ½" CELLULOSE OR SIMILAR WITH ¼" RADIUS EDGES SHALL BE PLACED ACROSS THE FULL WIDTH OF WALKWAY, AT INTERVALS NOT TO EXCEED 20' ALONG LENGTH OF SIDEWALK.
2. CONTRACTION JOINTS (ACROSS FULL WIDTH OF WALKWAY SHALL BE LOCATED AT A MAXIMUM SPACING OF 5' ON CENTER BETWEEN EXPANSION JOINTS.

SIDEWALK DETAIL

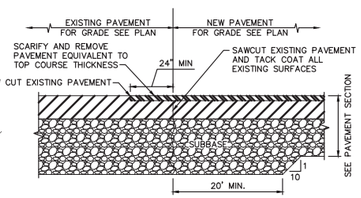


POST-DEVELOPMENT SUBCATHMENT FIGURE

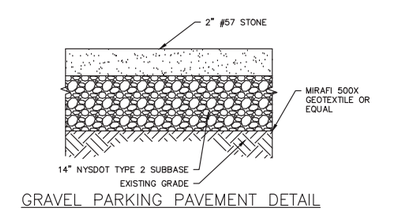
MIDDLEBUSH ROAD
GRADING AND DRAINAGE PLAN
SCALE: 1" = 20'–0"



ASPHALT PARKING PAVEMENT DETAIL



PAVEMENT TRANSITION (SAWCUT)



GRAVEL PARKING PAVEMENT DETAIL

0 20' 40'

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845-594-1529
TROY A. WOJCIEKOFSKY, P.E., LEED - AP
CONSULTING ENGINEER

CONTRACTOR STORAGE BUILDING
33 MIDDLEBUSH LLC
33 MIDDLEBUSH ROAD
TOWN OF WAPPINGER, NEW YORK

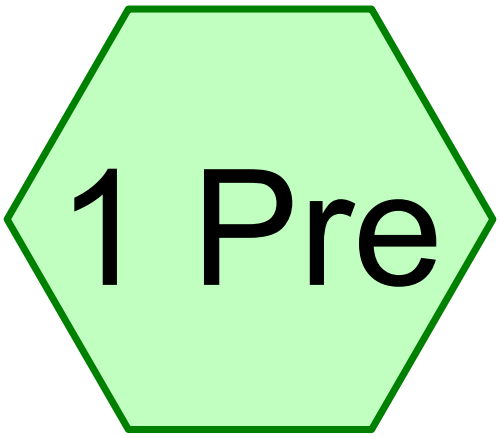
REVISIONS

NO.	DATE	DESCRIPTION
1.	2.07.22	PER CONSULTANT COMMENTS
2	9.06.23	PER CONSULTANT COMMENTS

GRADING & DRAINAGE PLAN

DATE:	2/7/2023
PROJECT NO.	2022-20
SCALE:	1" = 20'
DRAWING NO.	S-4.0

MIDDLEBUSH-PLOT-SHEETS.DWG



Total to ODP-1

Subcat Reach Pond Link

Drainage Diagram for 33 Middlebush LLC 20200531 Pre Dev
Prepared by TW Engineering, P.C. 10/15/2023

Time span=5.00-20.00 hrs, dt=0.01 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1 Pre: Total to ODP-1 Runoff Area=5.000 ac Runoff Depth=0.61"
Flow Length=620' Tc=24.5 min CN=73 Runoff=2.18 cfs 0.253 af

Total Runoff Area = 5.000 ac Runoff Volume = 0.253 af Average Runoff Depth = 0.61"

Subcatchment 1 Pre: Total to ODP-1

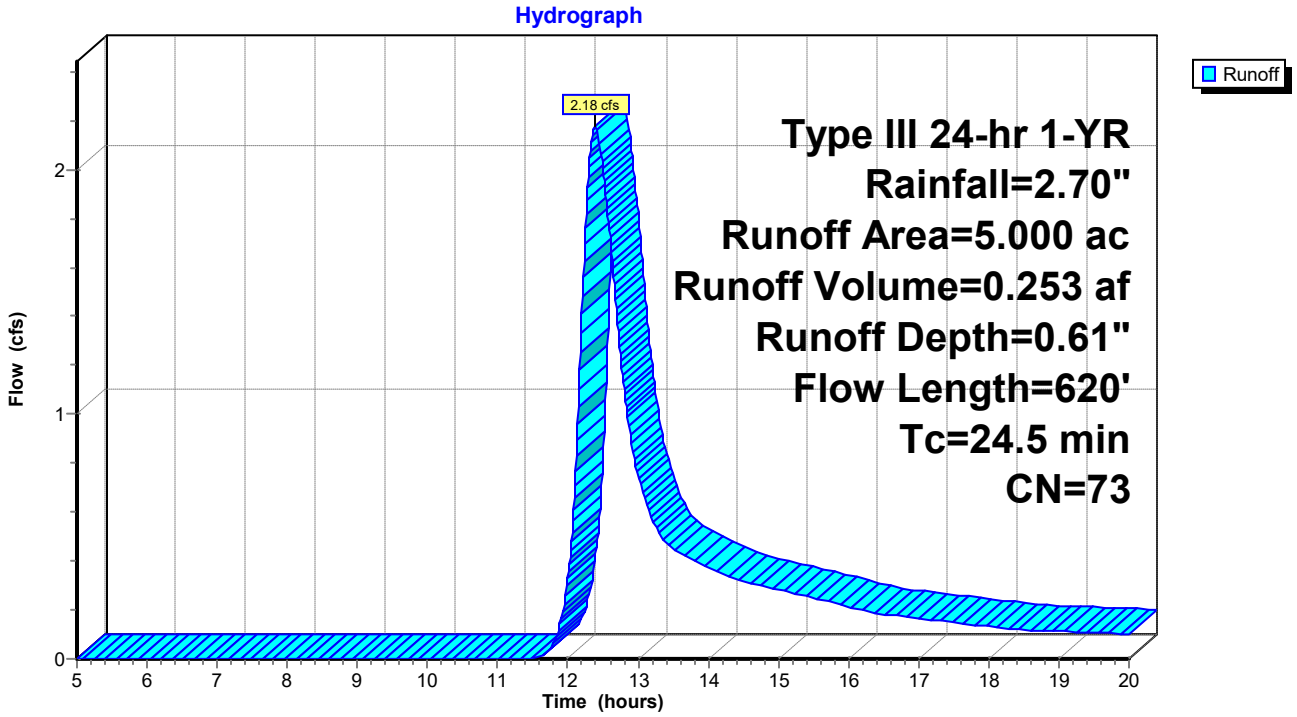
Runoff = 2.18 cfs @ 12.39 hrs, Volume= 0.253 af, Depth= 0.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-YR Rainfall=2.70"

Area (ac)	CN	Description
1.580	98	Paved parking & roofs
0.490	65	Woods/grass comb., Fair, HSG B
0.220	69	50-75% Grass cover, Fair, HSG B
2.710	60	Woods, Fair, HSG B
5.000	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0400	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
17.3	520	0.0100	0.5		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.5	620	Total			

Subcatchment 1 Pre: Total to ODP-1



Time span=5.00-20.00 hrs, dt=0.01 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1 Pre: Total to ODP-1 Runoff Area=5.000 ac Runoff Depth=2.02"
Flow Length=620' Tc=24.5 min CN=73 Runoff=7.89 cfs 0.842 af

Total Runoff Area = 5.000 ac Runoff Volume = 0.842 af Average Runoff Depth = 2.02"

Subcatchment 1 Pre: Total to ODP-1

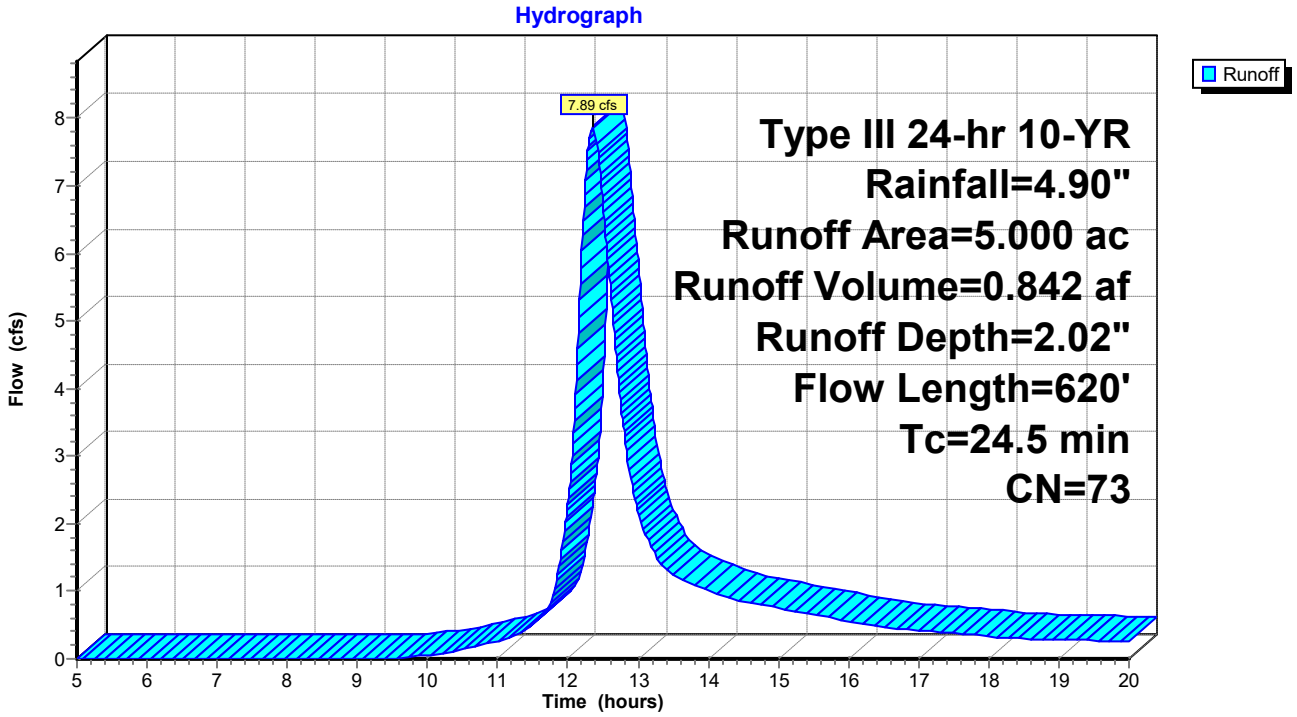
Runoff = 7.89 cfs @ 12.34 hrs, Volume= 0.842 af, Depth= 2.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=4.90"

Area (ac)	CN	Description
1.580	98	Paved parking & roofs
0.490	65	Woods/grass comb., Fair, HSG B
0.220	69	50-75% Grass cover, Fair, HSG B
2.710	60	Woods, Fair, HSG B
5.000	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0400	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
17.3	520	0.0100	0.5		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.5	620	Total			

Subcatchment 1 Pre: Total to ODP-1



Time span=5.00-20.00 hrs, dt=0.01 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1 Pre: Total to ODP-1 Runoff Area=5.000 ac Runoff Depth=5.32"
Flow Length=620' Tc=24.5 min CN=73 Runoff=20.68 cfs 2.215 af

Total Runoff Area = 5.000 ac Runoff Volume = 2.215 af Average Runoff Depth = 5.32"

Subcatchment 1 Pre: Total to ODP-1

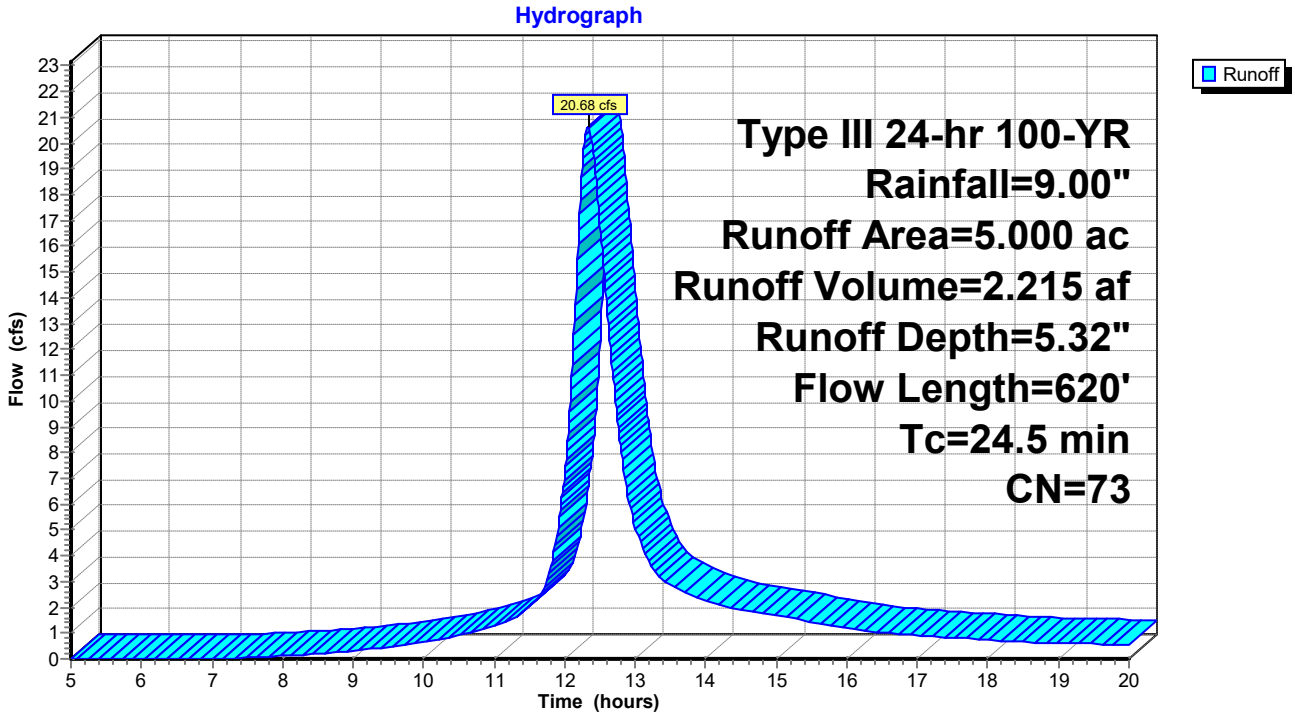
Runoff = 20.68 cfs @ 12.33 hrs, Volume= 2.215 af, Depth= 5.32"

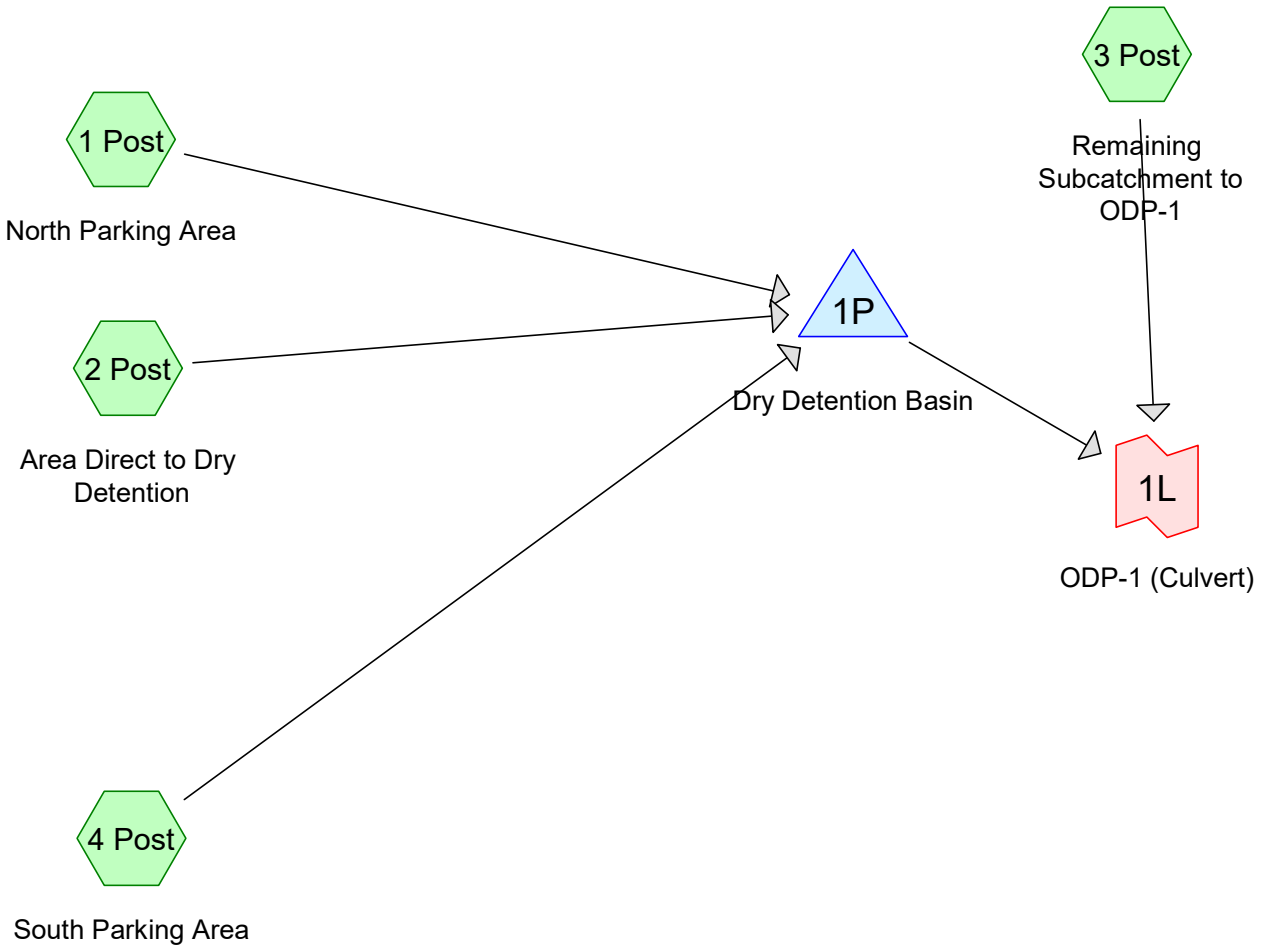
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=9.00"

Area (ac)	CN	Description
1.580	98	Paved parking & roofs
0.490	65	Woods/grass comb., Fair, HSG B
0.220	69	50-75% Grass cover, Fair, HSG B
2.710	60	Woods, Fair, HSG B
5.000	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0400	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
17.3	520	0.0100	0.5		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.5	620	Total			

Subcatchment 1 Pre: Total to ODP-1





Subcat Reach Pond Link

Drainage Diagram for 33 Middlebush LLC 20231006 Post Dev - B
Prepared by TW Engineering, P.C. 10/15/2023

Time span=5.00-20.00 hrs, dt=0.10 hrs, 151 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1 Post: North Parking Area Runoff Area=0.170 ac Runoff Depth=1.24"
Tc=6.0 min CN=85 Runoff=0.25 cfs 0.018 af

Subcatchment 2 Post: Area Direct to Dry Detention Runoff Area=0.250 ac Runoff Depth=1.53"
Tc=6.0 min CN=89 Runoff=0.45 cfs 0.032 af

Subcatchment 3 Post: Remaining Subcatchment to ODP-1 Runoff Area=4.360 ac Runoff Depth=0.57"
Flow Length=620' Tc=24.5 min CN=72 Runoff=1.73 cfs 0.206 af

Subcatchment 4 Post: South Parking Area Runoff Area=0.220 ac Runoff Depth=1.45"
Tc=6.0 min CN=88 Runoff=0.38 cfs 0.027 af

Pond 1P: Dry Detention Basin Peak Elev=149.54' Storage=995 cf Inflow=1.07 cfs 0.076 af
Outflow=0.52 cfs 0.074 af

Link 1L: ODP-1 (Culvert) Inflow=2.18 cfs 0.280 af
Primary=2.18 cfs 0.280 af

Total Runoff Area = 5.000 ac Runoff Volume = 0.282 af Average Runoff Depth = 0.68"

Subcatchment 1 Post: North Parking Area

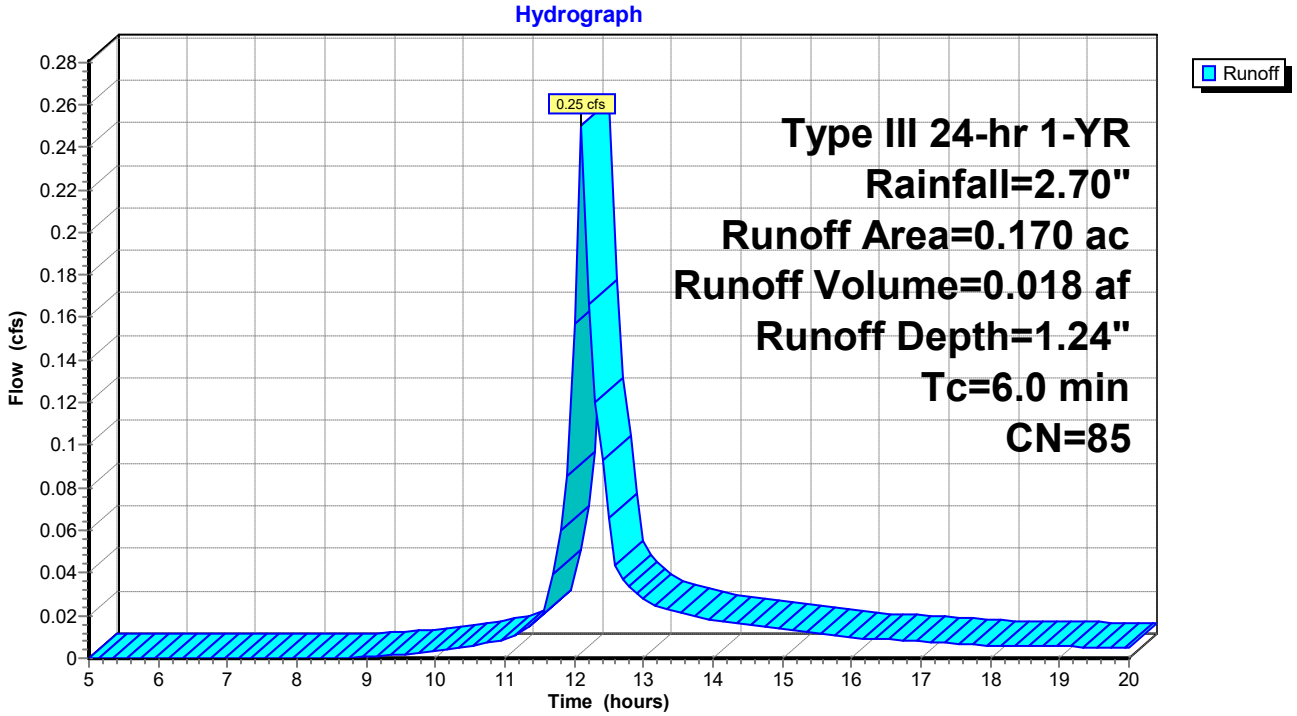
Runoff = 0.25 cfs @ 12.10 hrs, Volume= 0.018 af, Depth= 1.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 1-YR Rainfall=2.70"

Area (ac)	CN	Description
0.040	98	Paved parking & roofs
0.030	65	Woods/grass comb., Fair, HSG B
0.100	85	Gravel roads, HSG B
0.170	85	Weighted Average

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

Subcatchment 1 Post: North Parking Area



Subcatchment 2 Post: Area Direct to Dry Detention

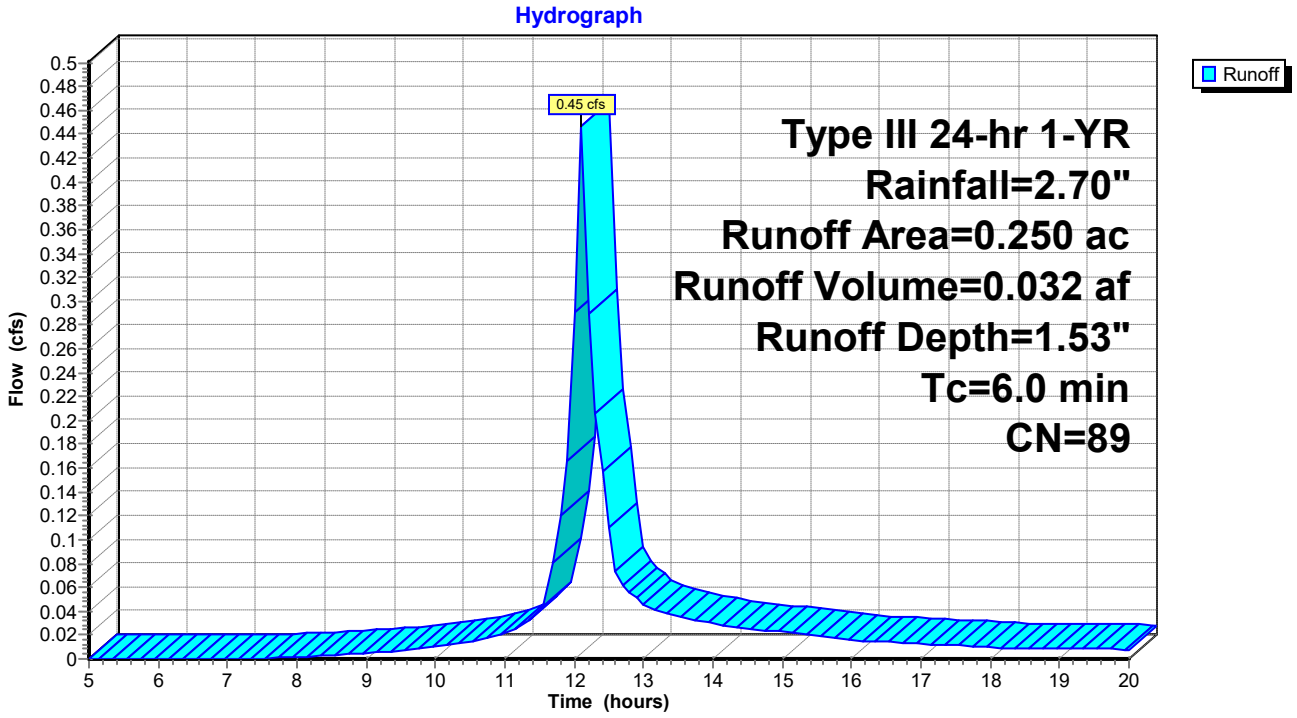
Runoff = 0.45 cfs @ 12.10 hrs, Volume= 0.032 af, Depth= 1.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 1-YR Rainfall=2.70"

Area (ac)	CN	Description
0.170	98	
0.080	69	50-75% Grass cover, Fair, HSG B
0.250	89	Weighted Average

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

Subcatchment 2 Post: Area Direct to Dry Detention



Subcatchment 3 Post: Remaining Subcatchment to ODP-1

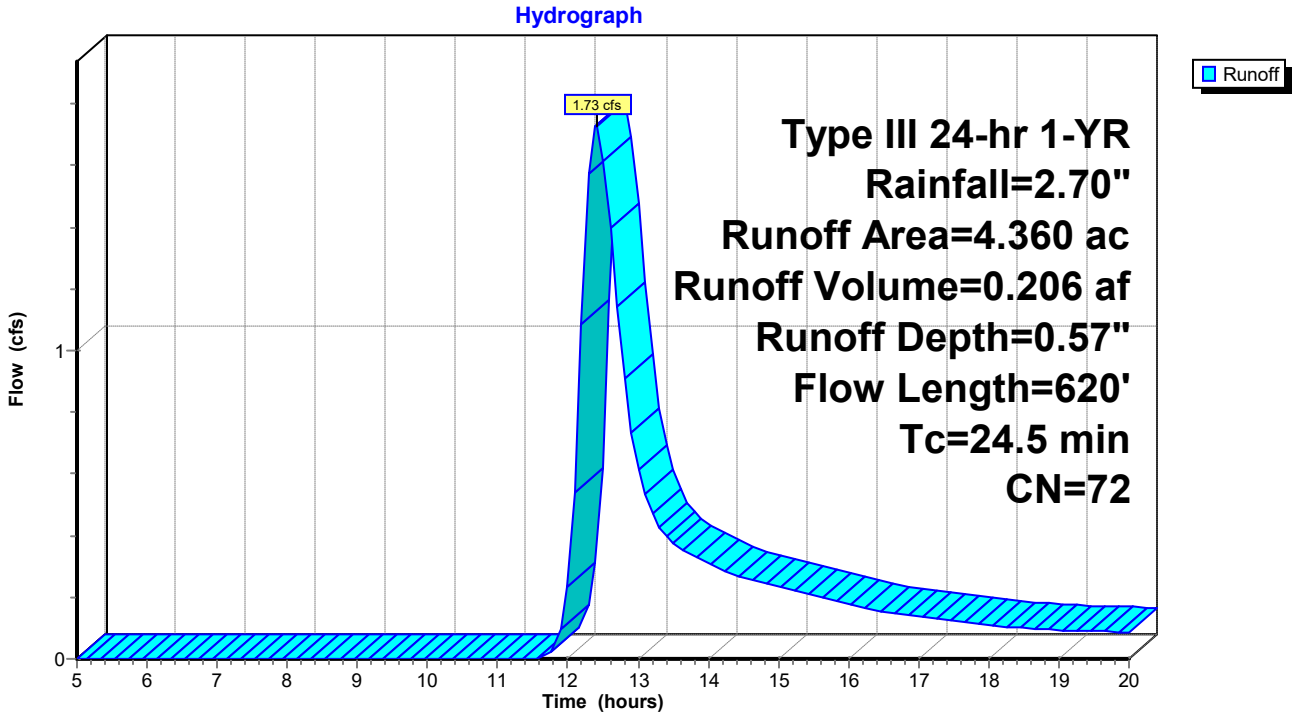
Runoff = 1.73 cfs @ 12.41 hrs, Volume= 0.206 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 1-YR Rainfall=2.70"

Area (ac)	CN	Description
1.320	98	Paved roads w/curbs & sewers
0.220	69	50-75% Grass cover, Fair, HSG B
2.750	60	Woods, Fair, HSG B
0.070	61	>75% Grass cover, Good, HSG B
4.360	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0400	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
17.3	520	0.0100	0.5		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.5	620	Total			

Subcatchment 3 Post: Remaining Subcatchment to ODP-1



Subcatchment 4 Post: South Parking Area

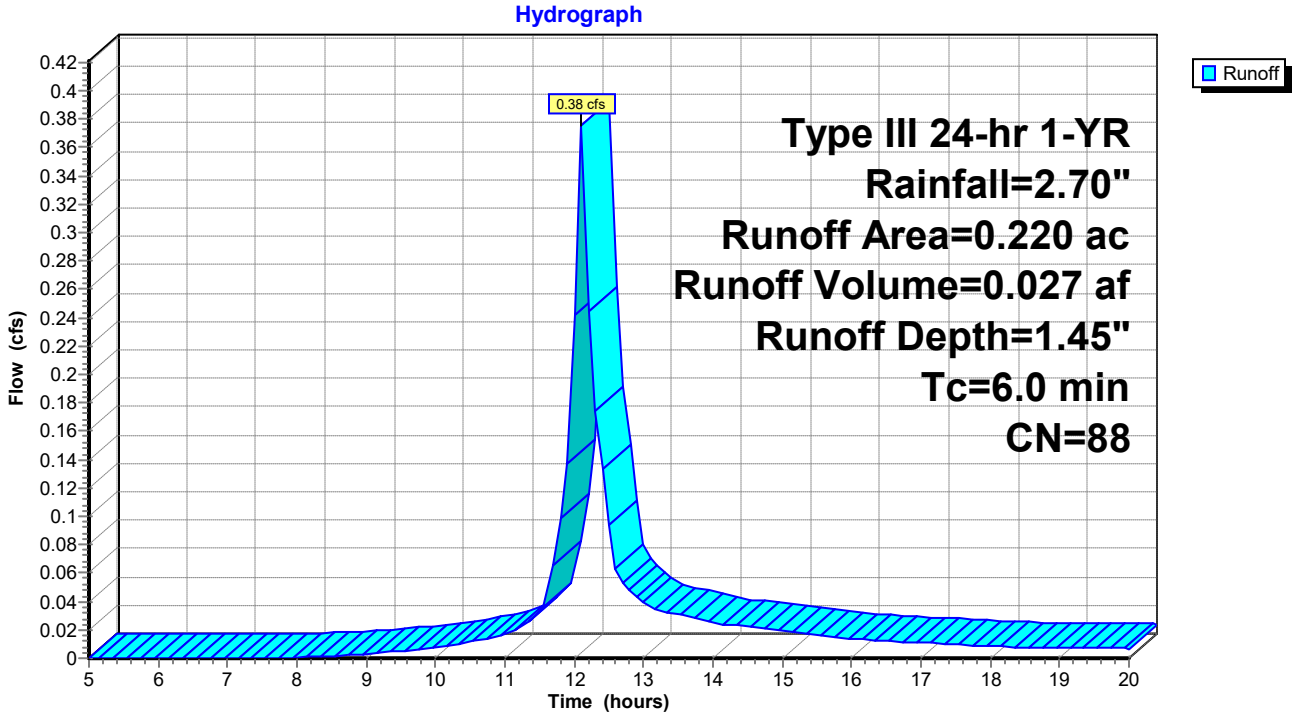
Runoff = 0.38 cfs @ 12.10 hrs, Volume= 0.027 af, Depth= 1.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 1-YR Rainfall=2.70"

Area (ac)	CN	Description
0.120	98	
0.060	85	Gravel roads, HSG B
0.040	61	>75% Grass cover, Good, HSG B
0.220	88	Weighted Average

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

Subcatchment 4 Post: South Parking Area



Pond 1P: Dry Detention Basin

Inflow Area = 0.640 ac, Inflow Depth = 1.43" for 1-YR event
Inflow = 1.07 cfs @ 12.10 hrs, Volume= 0.076 af
Outflow = 0.52 cfs @ 12.33 hrs, Volume= 0.074 af, Atten= 52%, Lag= 13.6 min
Primary = 0.52 cfs @ 12.33 hrs, Volume= 0.074 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Peak Elev= 149.54' @ 12.34 hrs Surf.Area= 1,471 sf Storage= 995 cf
Plug-Flow detention time= 46.1 min calculated for 0.073 af (96% of inflow)
Center-of-Mass det. time= 35.1 min (823.5 - 788.3)

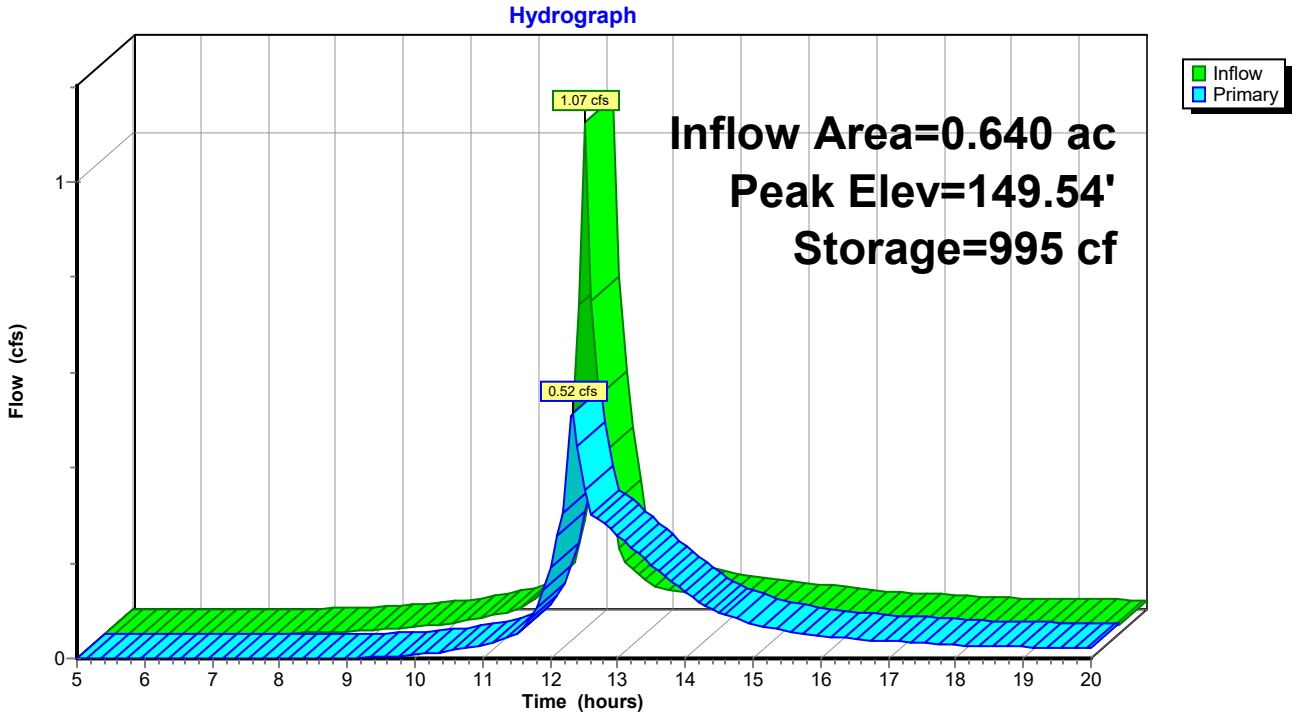
#	Invert	Avail.Storage	Storage Description
1	148.80'	3,635 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
148.80	900	0	0
149.00	1,200	210	210
150.00	1,700	1,450	1,660
151.00	2,250	1,975	3,635

#	Routing	Invert	Outlet Devices
1	Primary	150.10'	**12.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
2	Primary	148.80'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Primary	149.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.48 cfs @ 12.33 hrs HW=149.54' (Free Discharge)
- **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
- **2=Orifice/Grate** (Orifice Controls 0.32 cfs @ 3.6 fps)
- **3=Broad-Crested Rectangular Weir** (Weir Controls 0.17 cfs @ 0.5 fps)

Pond 1P: Dry Detention Basin

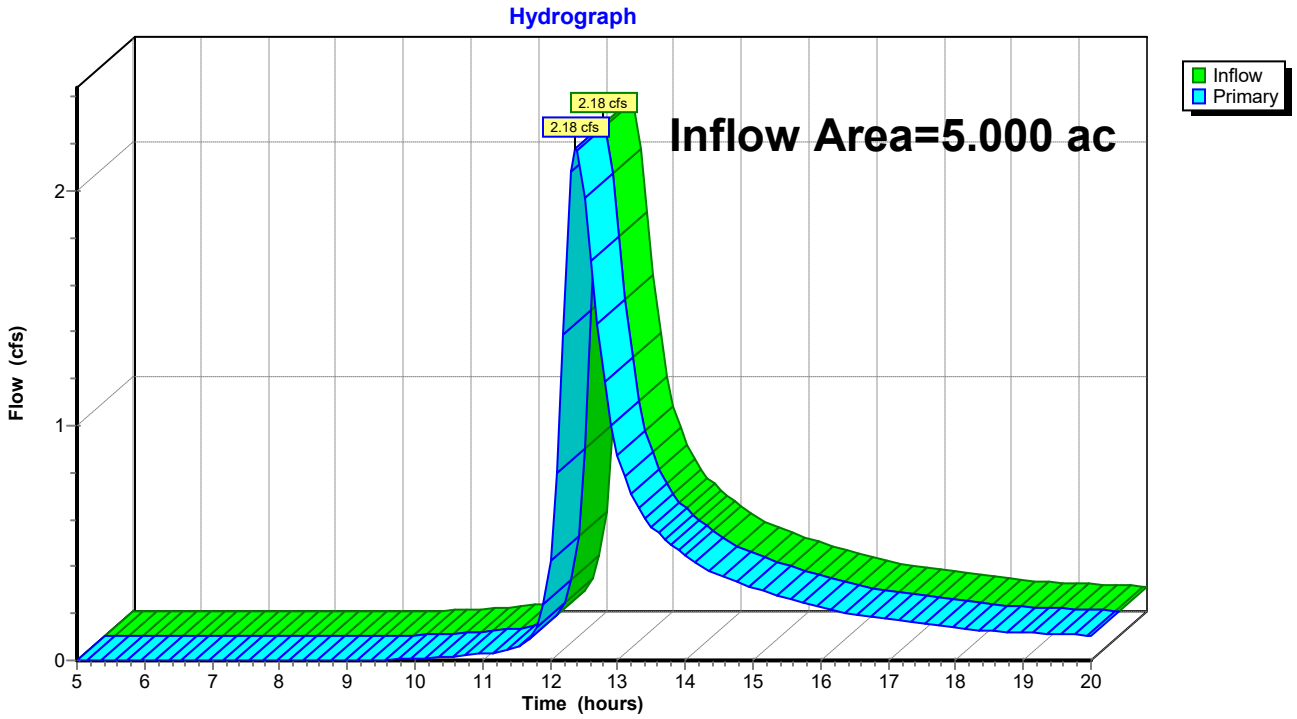


Link 1L: ODP-1 (Culvert)

Inflow Area = 5.000 ac, Inflow Depth = 0.67" for 1-YR event
Inflow = 2.18 cfs @ 12.38 hrs, Volume= 0.280 af
Primary = 2.18 cfs @ 12.38 hrs, Volume= 0.280 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Link 1L: ODP-1 (Culvert)



Time span=5.00-20.00 hrs, dt=0.10 hrs, 151 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1 Post: North Parking Area Runoff Area=0.170 ac Runoff Depth=3.08"
Tc=6.0 min CN=85 Runoff=0.61 cfs 0.044 af

Subcatchment 2 Post: Area Direct to Dry Detention Runoff Area=0.250 ac Runoff Depth=3.47"
Tc=6.0 min CN=89 Runoff=0.98 cfs 0.072 af

Subcatchment 3 Post: Remaining Subcatchment to ODP-1 Runoff Area=4.360 ac Runoff Depth=1.95"
Flow Length=620' Tc=24.5 min CN=72 Runoff=6.52 cfs 0.707 af

Subcatchment 4 Post: South Parking Area Runoff Area=0.220 ac Runoff Depth=3.37"
Tc=6.0 min CN=88 Runoff=0.84 cfs 0.062 af

Pond 1P: Dry Detention Basin Peak Elev=149.69' Storage=1,207 cf Inflow=2.43 cfs 0.178 af
Outflow=2.36 cfs 0.175 af

Link 1L: ODP-1 (Culvert) Inflow=7.56 cfs 0.881 af
Primary=7.56 cfs 0.881 af

Total Runoff Area = 5.000 ac Runoff Volume = 0.885 af Average Runoff Depth = 2.12"

Subcatchment 1 Post: North Parking Area

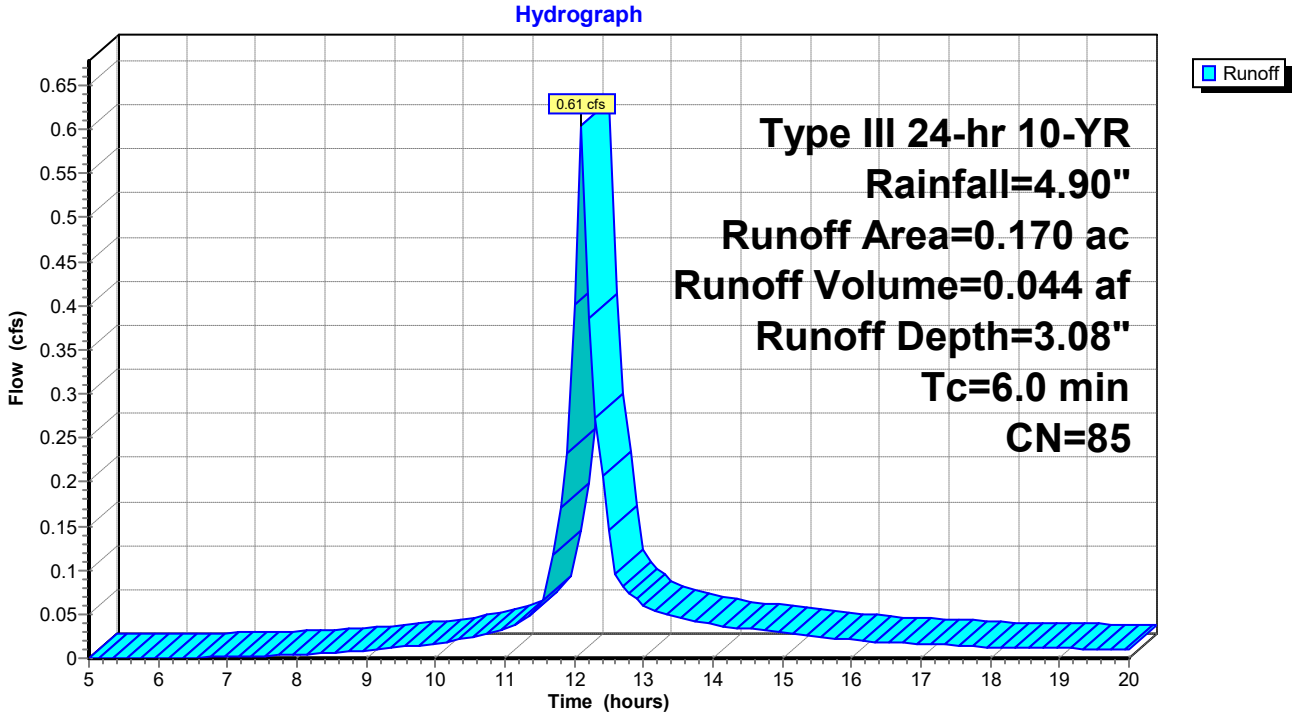
Runoff = 0.61 cfs @ 12.10 hrs, Volume= 0.044 af, Depth= 3.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-YR Rainfall=4.90"

Area (ac)	CN	Description
0.040	98	Paved parking & roofs
0.030	65	Woods/grass comb., Fair, HSG B
0.100	85	Gravel roads, HSG B
0.170	85	Weighted Average

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

Subcatchment 1 Post: North Parking Area



Subcatchment 2 Post: Area Direct to Dry Detention

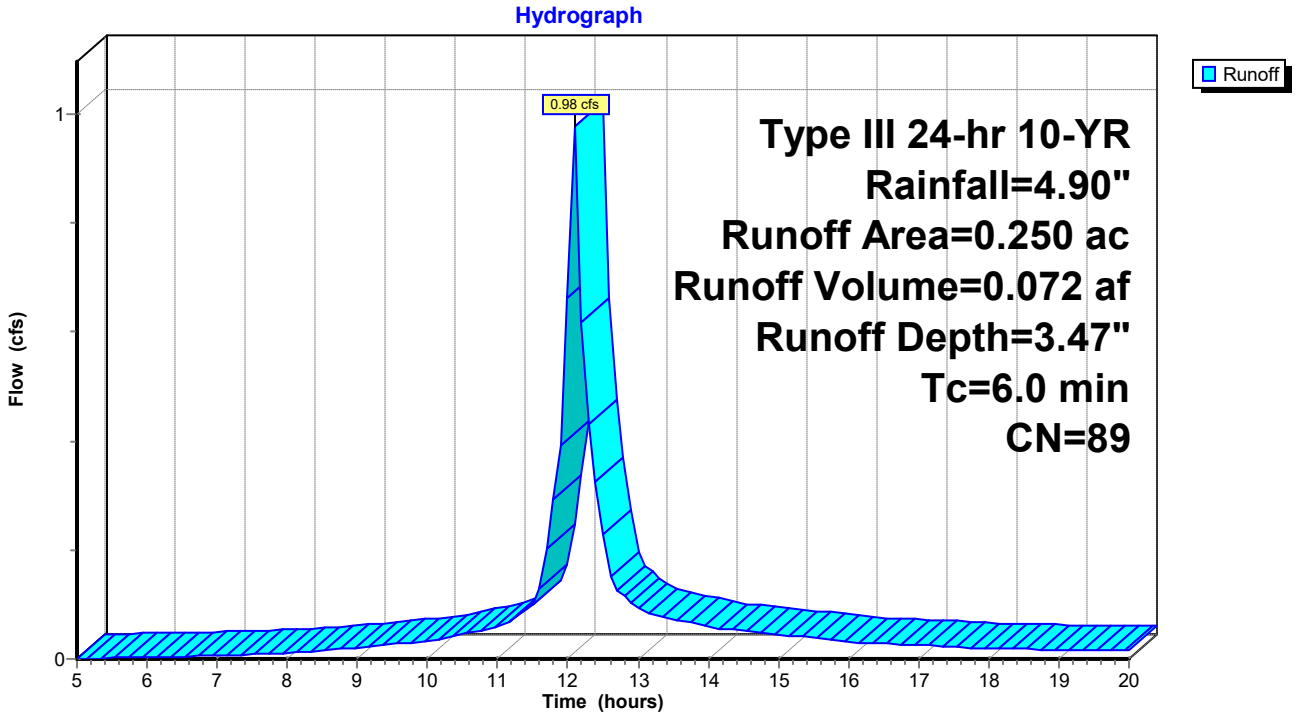
Runoff = 0.98 cfs @ 12.10 hrs, Volume= 0.072 af, Depth= 3.47"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-YR Rainfall=4.90"

Area (ac)	CN	Description
0.170	98	
0.080	69	50-75% Grass cover, Fair, HSG B
0.250	89	Weighted Average

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

Subcatchment 2 Post: Area Direct to Dry Detention



Subcatchment 3 Post: Remaining Subcatchment to ODP-1

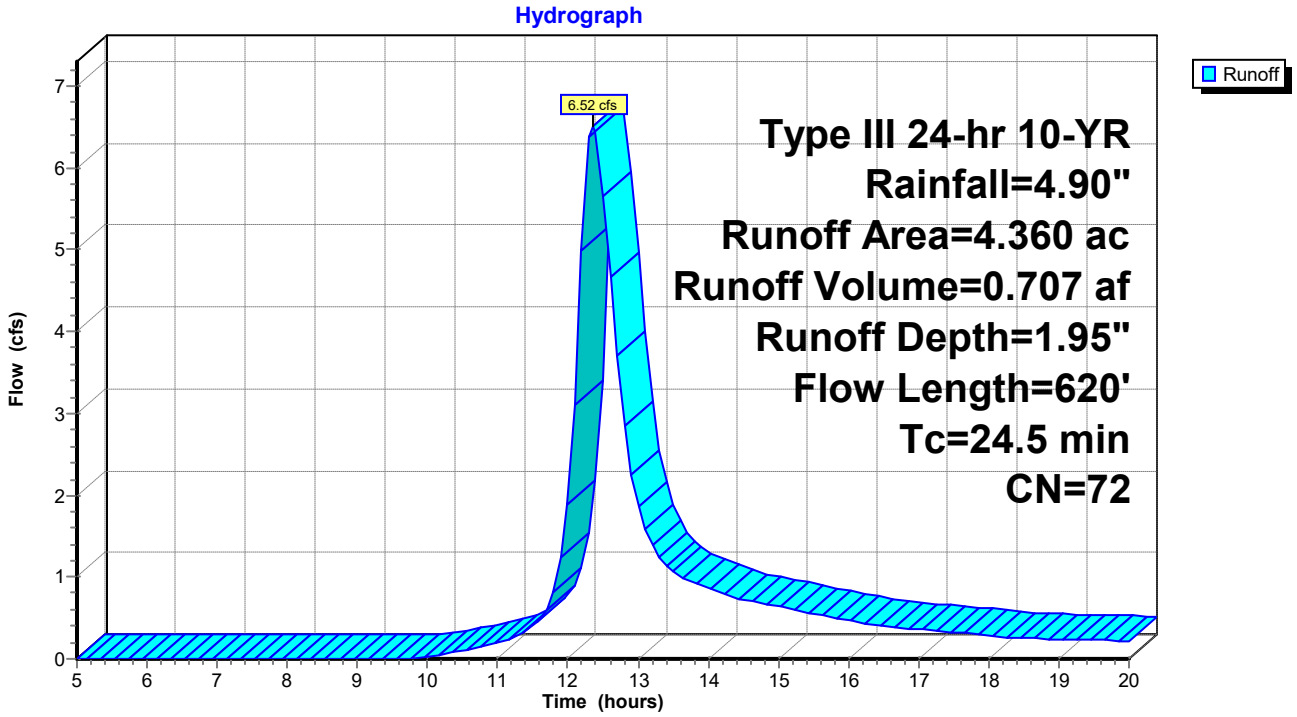
Runoff = 6.52 cfs @ 12.36 hrs, Volume= 0.707 af, Depth= 1.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-YR Rainfall=4.90"

Area (ac)	CN	Description
1.320	98	Paved roads w/curbs & sewers
0.220	69	50-75% Grass cover, Fair, HSG B
2.750	60	Woods, Fair, HSG B
0.070	61	>75% Grass cover, Good, HSG B
4.360	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0400	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
17.3	520	0.0100	0.5		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.5	620	Total			

Subcatchment 3 Post: Remaining Subcatchment to ODP-1



Subcatchment 4 Post: South Parking Area

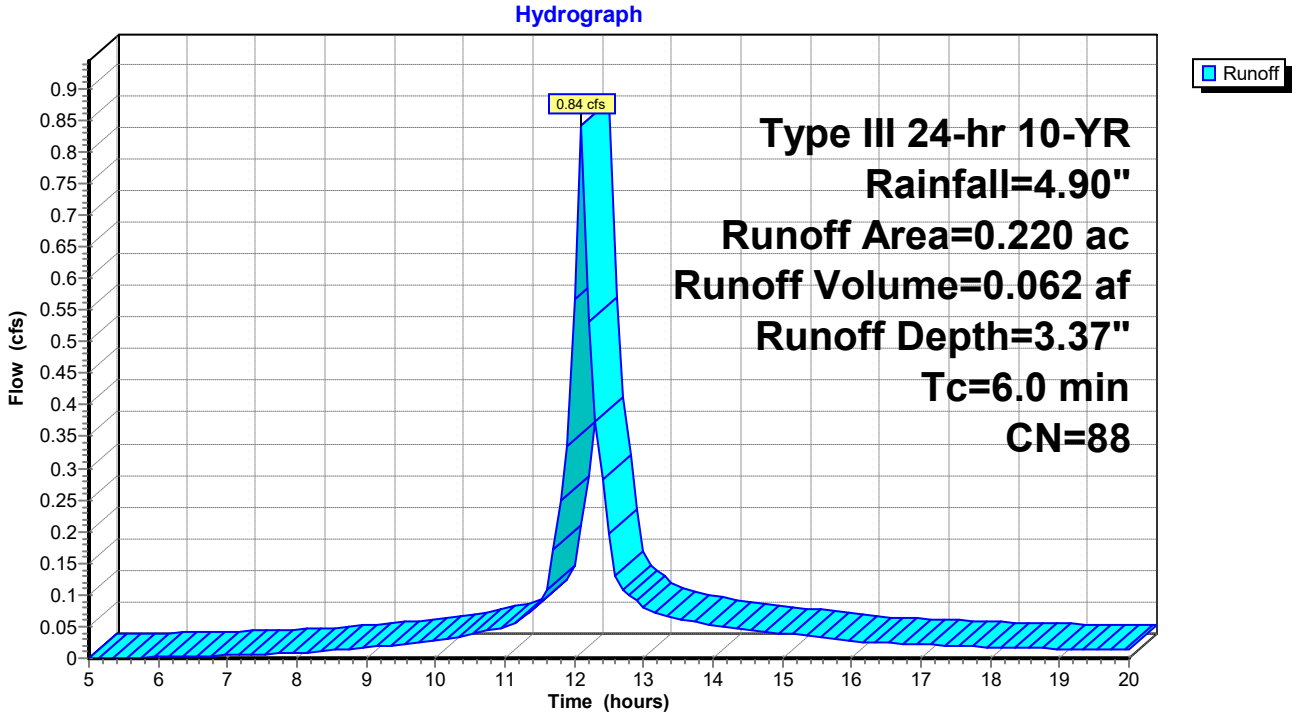
Runoff = 0.84 cfs @ 12.10 hrs, Volume= 0.062 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-YR Rainfall=4.90"

Area (ac)	CN	Description
0.120	98	
0.060	85	Gravel roads, HSG B
0.040	61	>75% Grass cover, Good, HSG B
0.220	88	Weighted Average

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

Subcatchment 4 Post: South Parking Area



Pond 1P: Dry Detention Basin

Inflow Area = 0.640 ac, Inflow Depth = 3.33" for 10-YR event
Inflow = 2.43 cfs @ 12.10 hrs, Volume= 0.178 af
Outflow = 2.36 cfs @ 12.13 hrs, Volume= 0.175 af, Atten= 3%, Lag= 1.7 min
Primary = 2.36 cfs @ 12.13 hrs, Volume= 0.175 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Peak Elev= 149.69' @ 12.13 hrs Surf.Area= 1,544 sf Storage= 1,207 cf
Plug-Flow detention time= 32.9 min calculated for 0.173 af (98% of inflow)
Center-of-Mass det. time= 25.6 min (794.1 - 768.5)

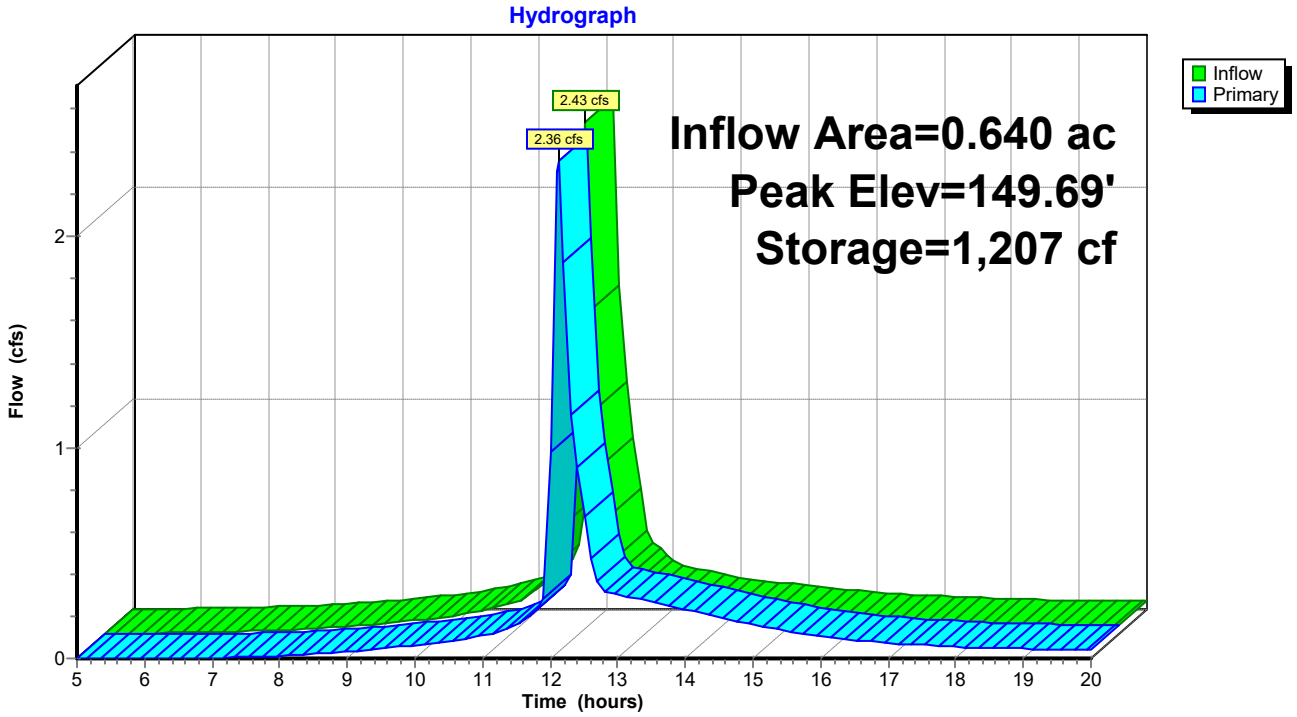
#	Invert	Avail.Storage	Storage Description
1	148.80'	3,635 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
148.80	900	0	0
149.00	1,200	210	210
150.00	1,700	1,450	1,660
151.00	2,250	1,975	3,635

#	Routing	Invert	Outlet Devices
1	Primary	150.10'	**12.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
2	Primary	148.80'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Primary	149.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=2.19 cfs @ 12.13 hrs HW=149.68' (Free Discharge)
- **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
- **2=Orifice/Grate** (Orifice Controls 0.35 cfs @ 4.1 fps)
- **3=Broad-Crested Rectangular Weir** (Weir Controls 1.84 cfs @ 1.0 fps)

Pond 1P: Dry Detention Basin

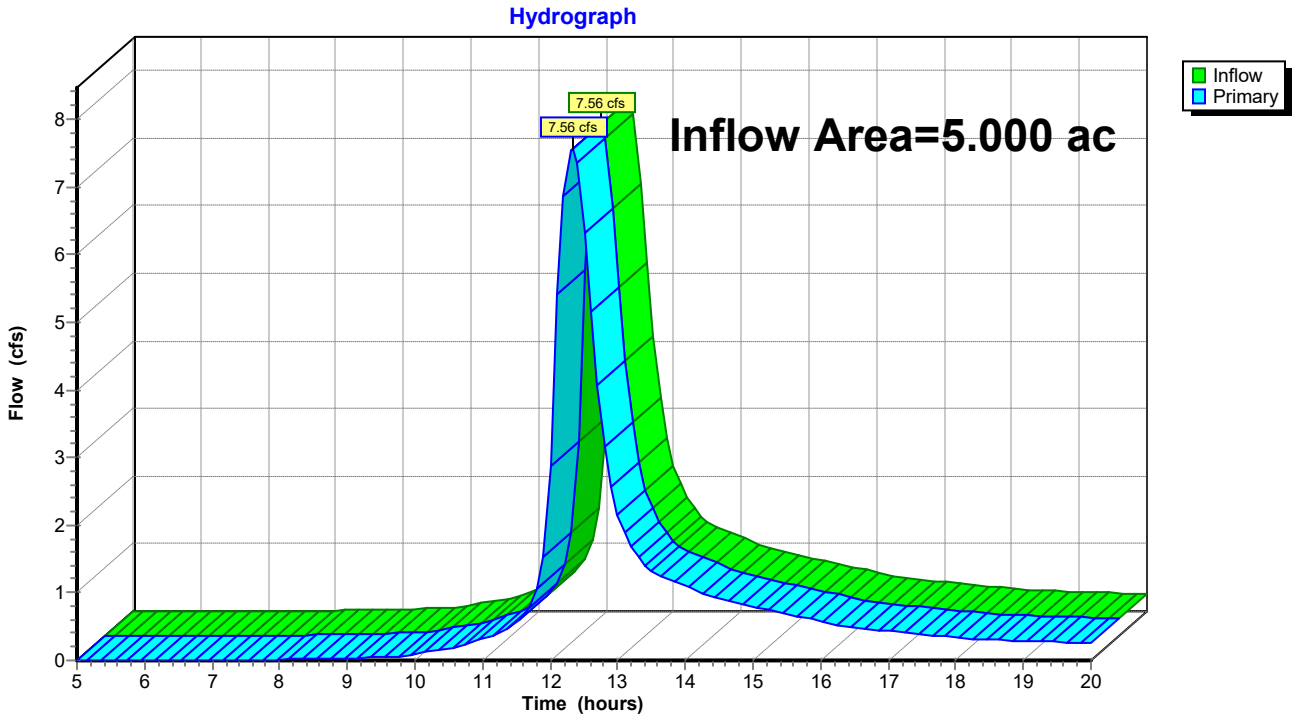


Link 1L: ODP-1 (Culvert)

Inflow Area = 5.000 ac, Inflow Depth = 2.12" for 10-YR event
Inflow = 7.56 cfs @ 12.33 hrs, Volume= 0.881 af
Primary = 7.56 cfs @ 12.33 hrs, Volume= 0.881 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Link 1L: ODP-1 (Culvert)



Time span=5.00-20.00 hrs, dt=0.10 hrs, 151 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1 Post: North Parking Area Runoff Area=0.170 ac Runoff Depth=6.79"
Tc=6.0 min CN=85 Runoff=1.28 cfs 0.096 af

Subcatchment 2 Post: Area Direct to Dry Detention Runoff Area=0.250 ac Runoff Depth=7.24"
Tc=6.0 min CN=89 Runoff=1.96 cfs 0.151 af

Subcatchment 3 Post: Remaining Subcatchment to ODP-1 Runoff Area=4.360 ac Runoff Depth=5.20"
Flow Length=620' Tc=24.5 min CN=72 Runoff=17.54 cfs 1.890 af

Subcatchment 4 Post: South Parking Area Runoff Area=0.220 ac Runoff Depth=7.13"
Tc=6.0 min CN=88 Runoff=1.71 cfs 0.131 af

Pond 1P: Dry Detention Basin Peak Elev=149.81' Storage=1,381 cf Inflow=4.94 cfs 0.378 af
Outflow=4.69 cfs 0.373 af

Link 1L: ODP-1 (Culvert) Inflow=19.48 cfs 2.263 af
Primary=19.48 cfs 2.263 af

Total Runoff Area = 5.000 ac Runoff Volume = 2.268 af Average Runoff Depth = 5.44"

Subcatchment 1 Post: North Parking Area

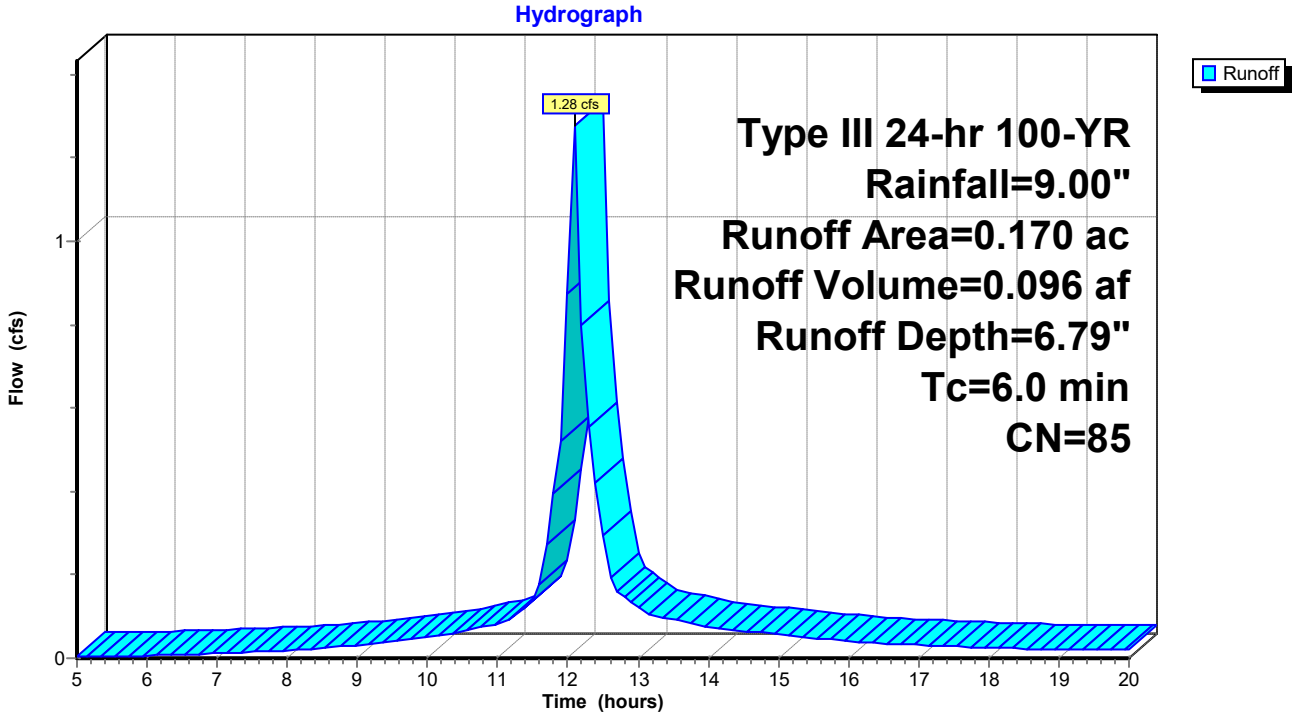
Runoff = 1.28 cfs @ 12.10 hrs, Volume= 0.096 af, Depth= 6.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-YR Rainfall=9.00"

Area (ac)	CN	Description
0.040	98	Paved parking & roofs
0.030	65	Woods/grass comb., Fair, HSG B
0.100	85	Gravel roads, HSG B
0.170	85	Weighted Average

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

Subcatchment 1 Post: North Parking Area



Subcatchment 2 Post: Area Direct to Dry Detention

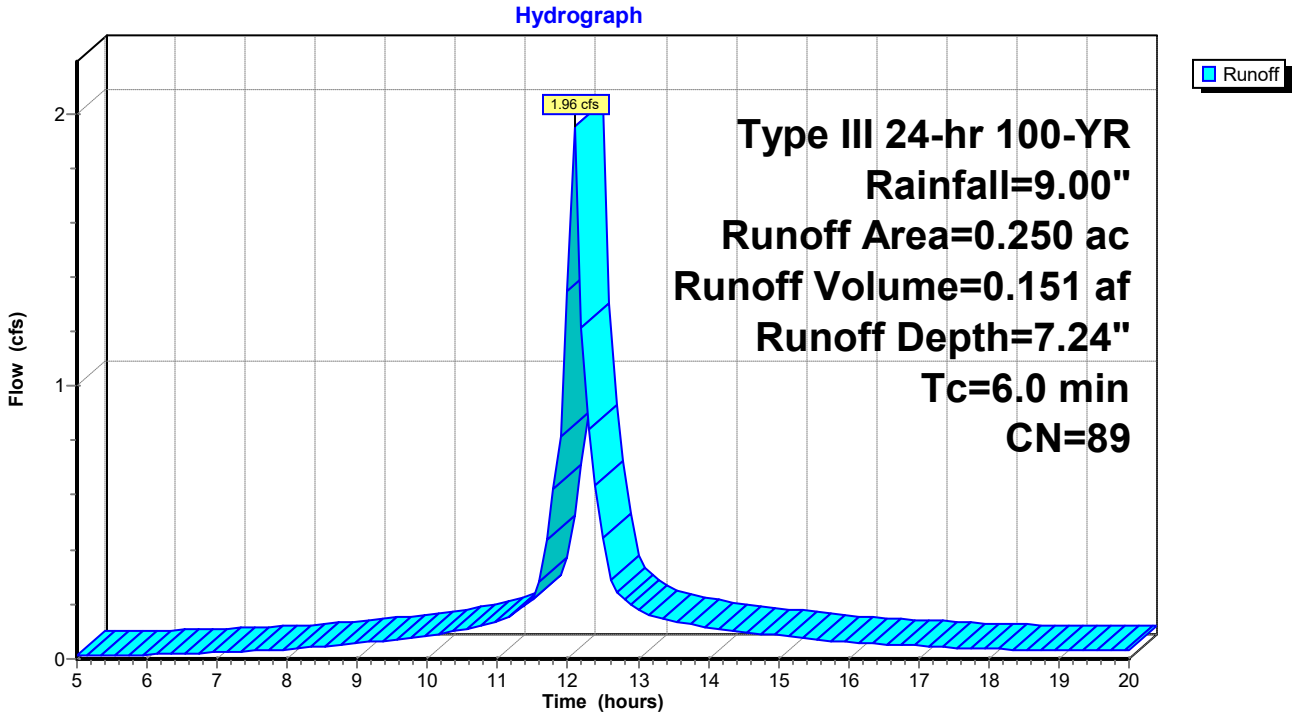
Runoff = 1.96 cfs @ 12.09 hrs, Volume= 0.151 af, Depth= 7.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-YR Rainfall=9.00"

Area (ac)	CN	Description
0.170	98	
0.080	69	50-75% Grass cover, Fair, HSG B
0.250	89	Weighted Average

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

Subcatchment 2 Post: Area Direct to Dry Detention



Subcatchment 3 Post: Remaining Subcatchment to ODP-1

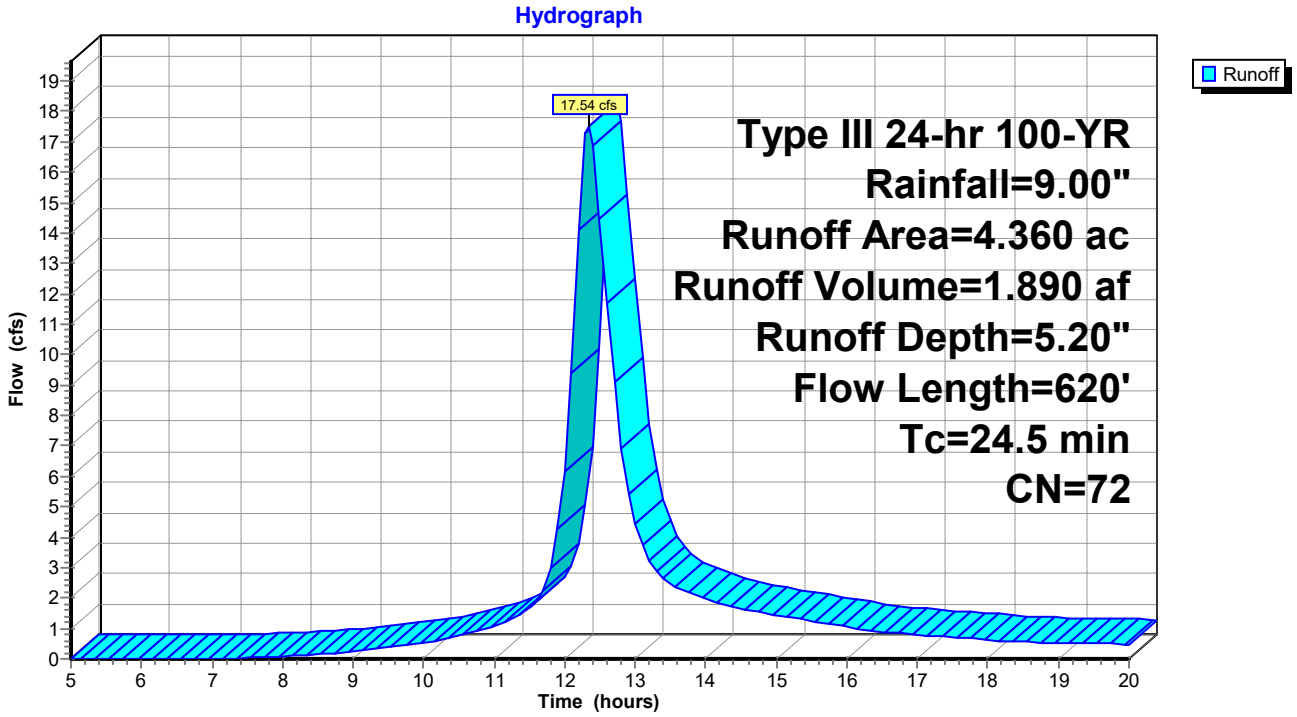
Runoff = 17.54 cfs @ 12.34 hrs, Volume= 1.890 af, Depth= 5.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-YR Rainfall=9.00"

Area (ac)	CN	Description
1.320	98	Paved roads w/curbs & sewers
0.220	69	50-75% Grass cover, Fair, HSG B
2.750	60	Woods, Fair, HSG B
0.070	61	>75% Grass cover, Good, HSG B
4.360	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	100	0.0400	0.2		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
17.3	520	0.0100	0.5		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.5	620	Total			

Subcatchment 3 Post: Remaining Subcatchment to ODP-1



Subcatchment 4 Post: South Parking Area

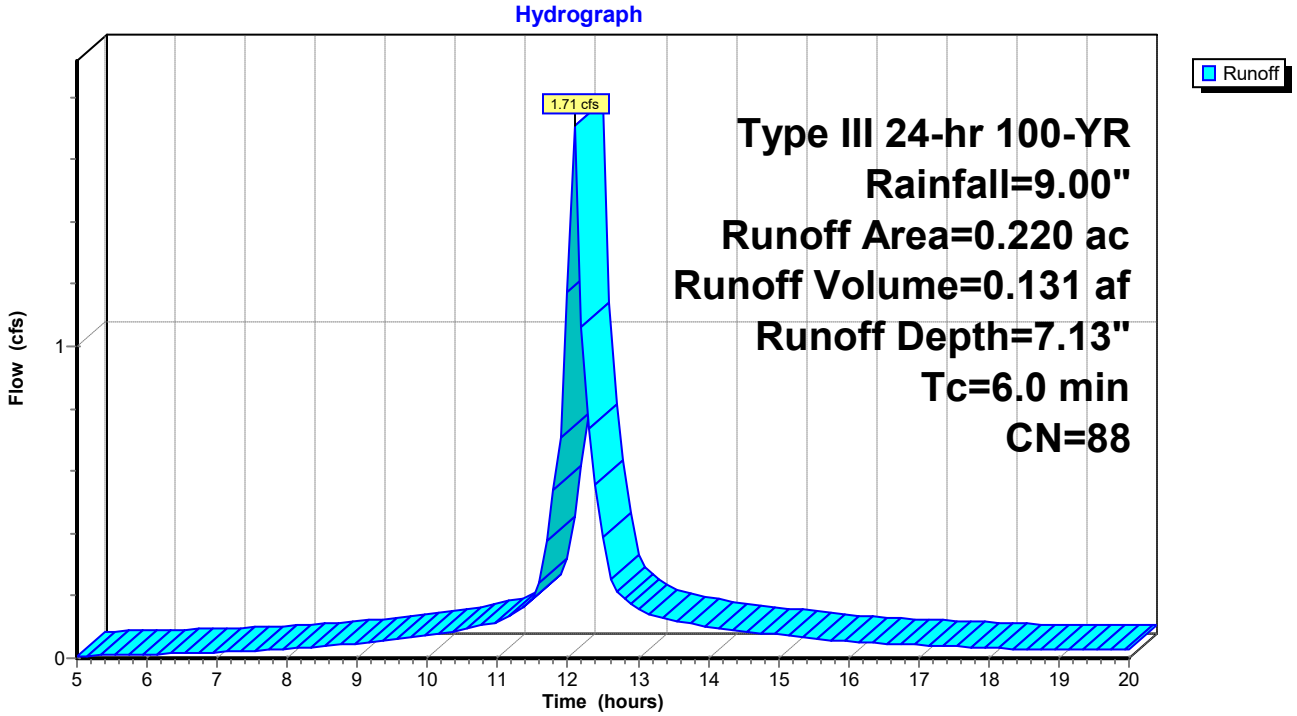
Runoff = 1.71 cfs @ 12.10 hrs, Volume= 0.131 af, Depth= 7.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-YR Rainfall=9.00"

Area (ac)	CN	Description
0.120	98	
0.060	85	Gravel roads, HSG B
0.040	61	>75% Grass cover, Good, HSG B
0.220	88	Weighted Average

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

Subcatchment 4 Post: South Parking Area



Pond 1P: Dry Detention Basin

Inflow Area = 0.640 ac, Inflow Depth = 7.09" for 100-YR event
Inflow = 4.94 cfs @ 12.10 hrs, Volume= 0.378 af
Outflow = 4.69 cfs @ 12.11 hrs, Volume= 0.373 af, Atten= 5%, Lag= 1.1 min
Primary = 4.69 cfs @ 12.11 hrs, Volume= 0.373 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Peak Elev= 149.81' @ 12.11 hrs Surf.Area= 1,604 sf Storage= 1,381 cf
Plug-Flow detention time= 26.2 min calculated for 0.373 af (99% of inflow)
Center-of-Mass det. time= 20.7 min (773.2 - 752.4)

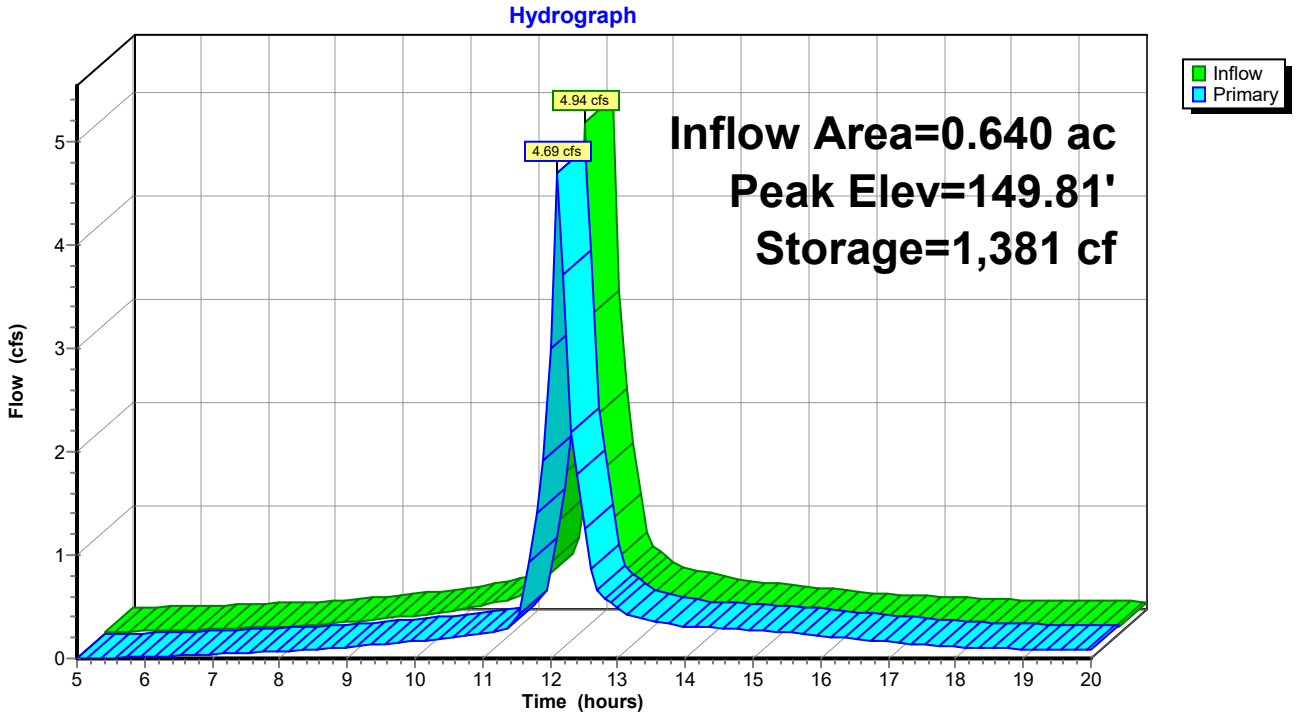
#	Invert	Avail.Storage	Storage Description
1	148.80'	3,635 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
148.80	900	0	0
149.00	1,200	210	210
150.00	1,700	1,450	1,660
151.00	2,250	1,975	3,635

#	Routing	Invert	Outlet Devices
1	Primary	150.10'	**12.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
2	Primary	148.80'	**4.0" Vert. Orifice/Grate** C= 0.600
3	Primary	149.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.53 cfs @ 12.11 hrs HW=149.80' (Free Discharge)
- **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
- **2=Orifice/Grate** (Orifice Controls 0.38 cfs @ 4.4 fps)
- **3=Broad-Crested Rectangular Weir** (Weir Controls 4.15 cfs @ 1.4 fps)

Pond 1P: Dry Detention Basin

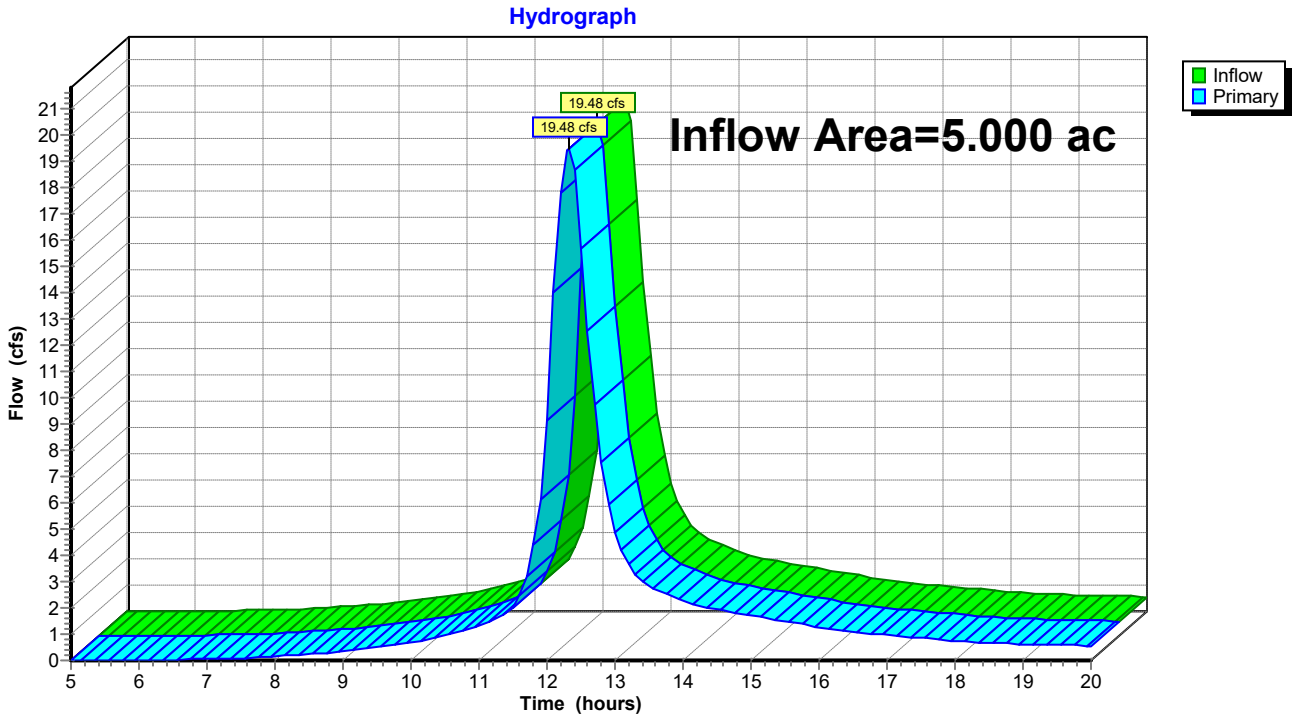


Link 1L: ODP-1 (Culvert)

Inflow Area = 5.000 ac, Inflow Depth = 5.43" for 100-YR event
Inflow = 19.48 cfs @ 12.32 hrs, Volume= 2.263 af
Primary = 19.48 cfs @ 12.32 hrs, Volume= 2.263 af, Atten= 0%, Lag= 0.0 min

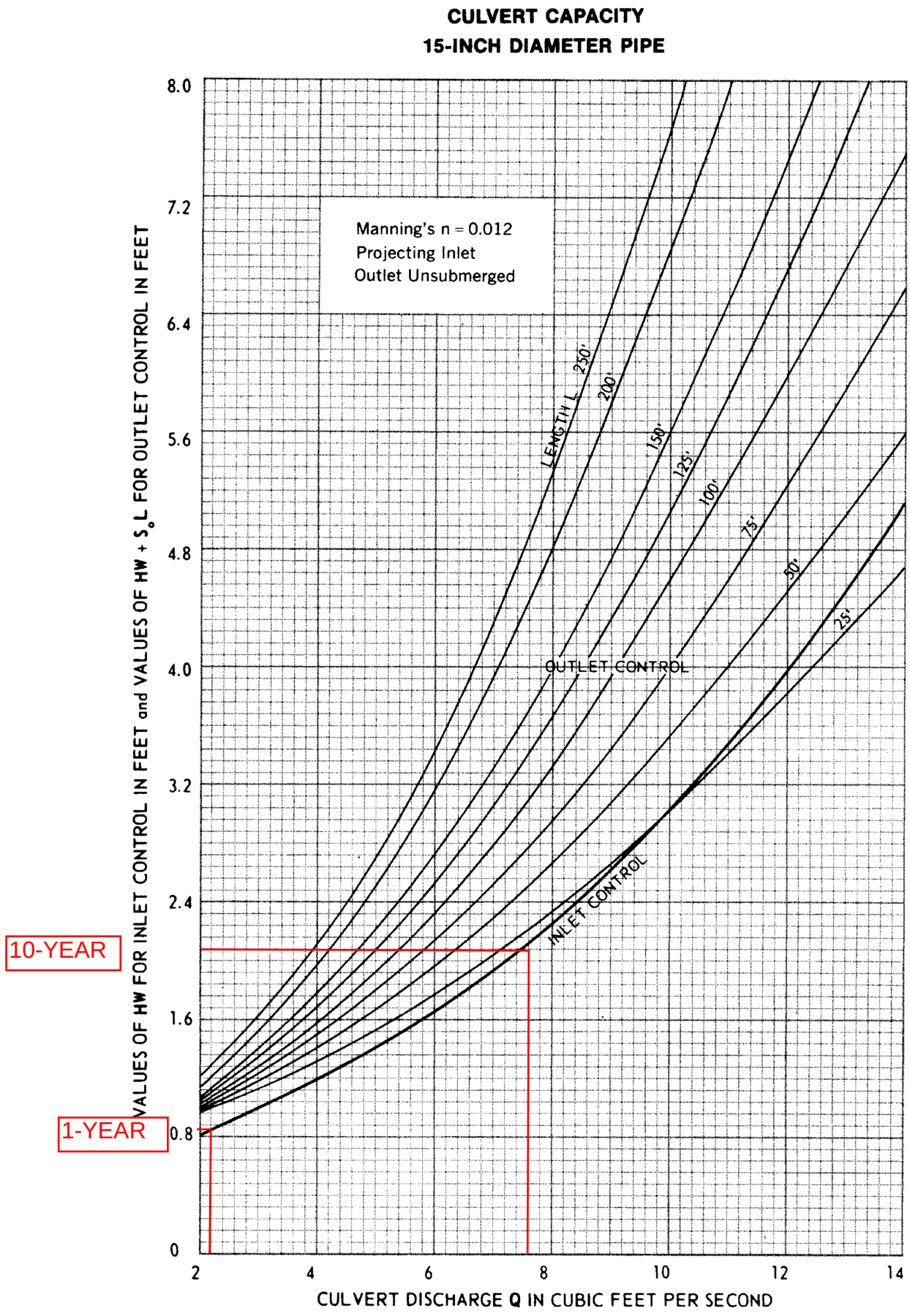
Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Link 1L: ODP-1 (Culvert)



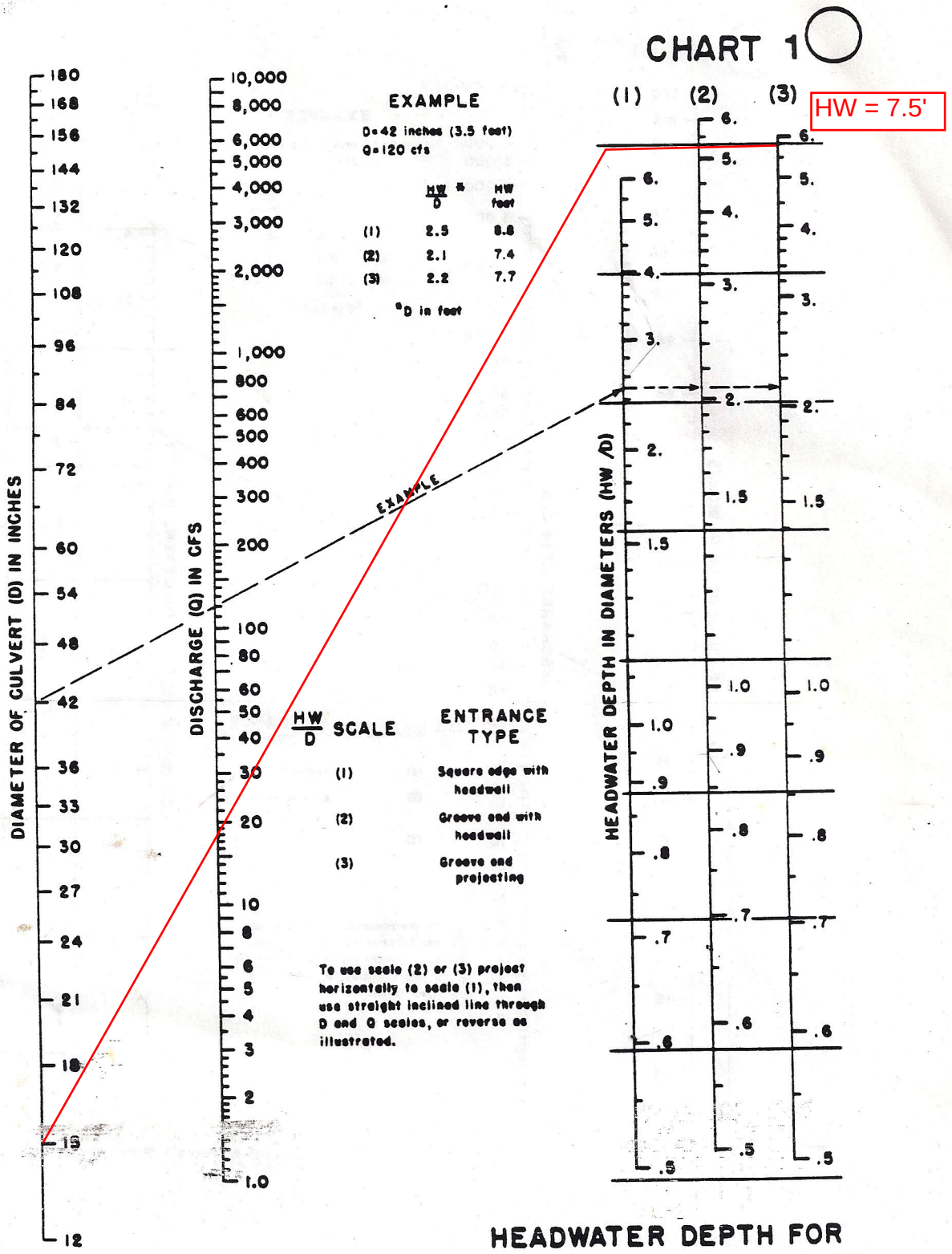
OFF-SITE DICHARGE POINT (EXISTING 15" RCP)

Figure 43



100-YEAR ANALYSIS OF 15" RCP ODP

HW = 7.5'



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL