

ARDEN CONSULTING ENGINEERS, PLLC

November 19, 2018

Mr. Jay Sheers
Planning Board Chairman
City of Beacon
1 Municipal Plaza
Beacon, NY 12508

**Re: Dellaportas Enterprises I Subdivision
Dennings Avenue - City of Beacon
Tax Map No. 5954-50-687603**

Drainage Study

Dear Mr. Sheers:

Arden Consulting Engineers, PLLC is submitting this Drainage Study letter report regarding the referenced project in response to comment #2 & #3 in the review letter prepared by Lanc & Tully, P.C. dated 1/7/16.

The purpose of the study is to quantify the runoff within the watershed and whether the catch basins and piping that have been previously installed have adequate capacity to convey this runoff. The following paragraphs provide a summary of the drainage study while the hydrologic model attached to this letter provides supporting calculations.

Watershed Boundary

The watershed boundary was determined using Dutchess County GIS information as shown in the attached Drainage Subcatchment map. South Avenue to the east, changes in topography to the north and south and the entrance to the subject parcel form the 2.7 acre watershed boundary. The existing catch basins create three different sub catchments as shown in the attached Drainage Analysis Map. Separate Time of Concentrations (Tc) were calculated for each watershed in order to develop a hydrologic model.

HydroCad Model

A HydroCad model of the watershed was created to quantify the runoff and determine flow through the piping and catch basins using the SCS TR-20 method. The site is characterized by a westerly sloping topography that ranges from elevation 100.0 at the rear of the property to elevation 50.0 by Dennings Avenue.

A majority of the soils within the watershed consist of the Dutchess-Cardigan (DwB) complex, which are classified as hydrologic group C soil. A small portion of the soils on the far eastern portion of the site consist of Hudson and Vergennes soils (HvD) which are classified as hydrologic group B soil.

Northeast Regional Climate Center data for a Type III, 25-year storm event with a runoff depth of 5-inches was utilized in the analysis. It is typical to use a 25-year storm to

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determine the stormwater runoff for this type of drainage system constructed on a residential parcel with a watershed of this size.

During a previous site visit on April 2, 2014 by Mr. John Russo, P.E., it was noted that the eastern portion of the site was wet and water was observed percolating out of the ground. To recreate the various site conditions in the HydroCad model, the Antecedent Moisture Content (AMC) was set to 2 for normal conditions, 3 for very wet site conditions, and 4 for saturated or frozen conditions. Table 1 Below summarizes the runoff for the various AMC conditions.

Table 1
AMC Runoff Conditions for a Type III, 25 Year Storm

Antecedent Moisture Content	Runoff (cfs)
2	6.34
3	8.94
4	10.04

The results of the HydroCad model show that the existing drainage system is adequate to convey the runoff from a Type III, 25-year storm event under the various AMC conditions.

Please do not hesitate to contact us if you have any questions or concerns.

Sincerely,

Arden Consulting Engineers, PLLC



Michael A. Morgante, P.E.

C:\JOBS\14-006 Dellaportas\Drainage\Drainage Letter Report 1-14-16.doc

Cc: John Russo, P.E.
Tim Dexter, Building Inspector

Soil Map—Dutchess County, New York
(Dellaportas Enterprises I Subdivision)



Map Scale: 1:979 if printed on A landscape (11" x 8.5") sheet.

0 10 20 40 60 Meters

0 45 90 180 270 Feet

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



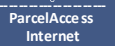
Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

1/14/2016
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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: <http://websoilsurvey.nrcs.usda.gov>
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 12, Sep 23, 2015

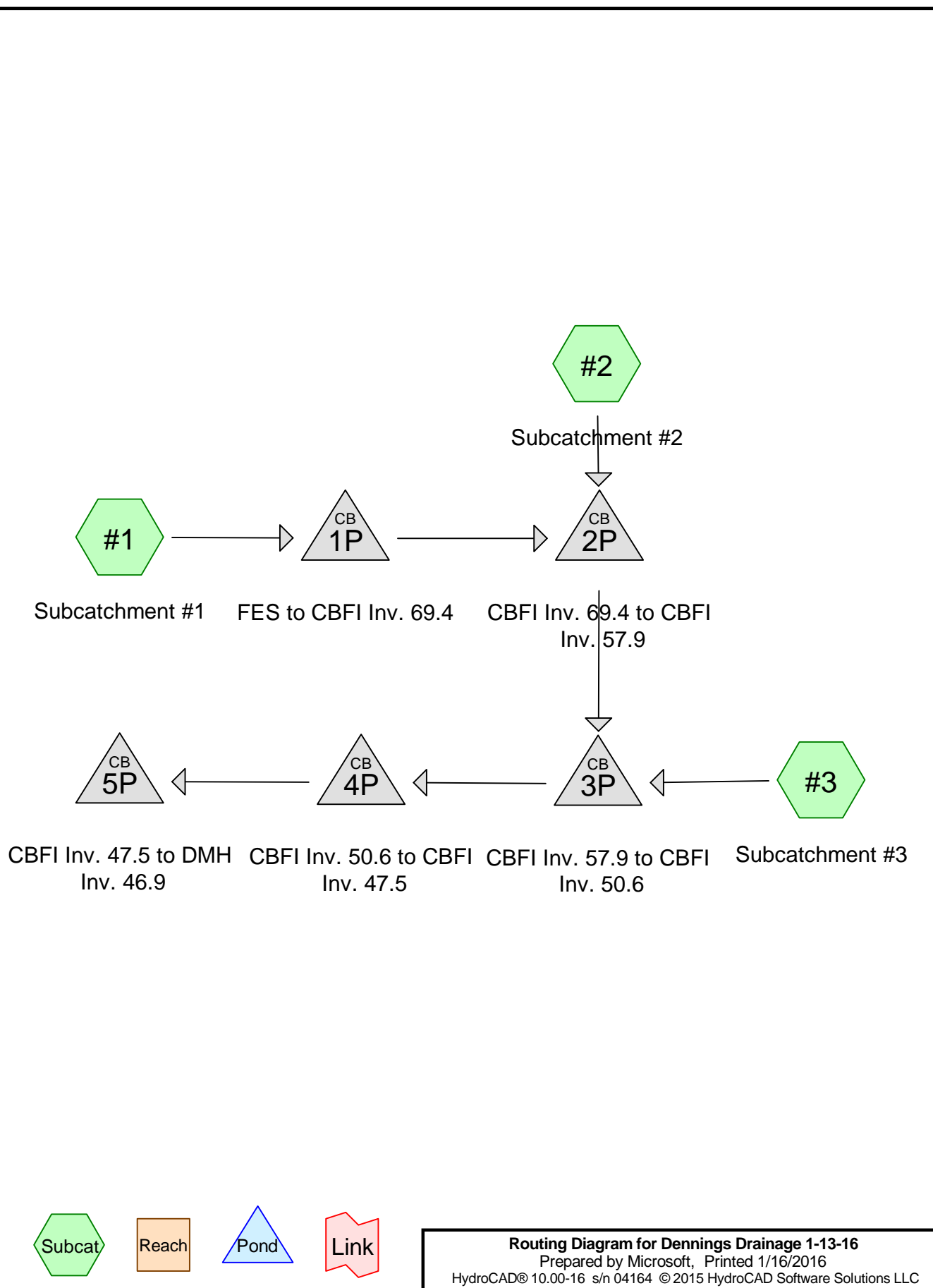
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Apr 16, 2012

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

Dutchess County, New York (NY027)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DwB	Dutchess-Cardigan complex, undulating, rocky	0.4	16.8%
HvD	Hudson and Vergennes soils, hilly	2.0	83.2%
Totals for Area of Interest		2.4	100.0%



Dennings Drainage 1-13-16

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.922	74	>75% Grass cover, Good, HSG C (#1, #2, #3)
0.319	98	Paved parking, HSG C (#1, #2, #3)
2.241	77	TOTAL AREA

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
2.241	HSG C	#1, #2, #3
0.000	HSG D	
0.000	Other	
2.241		TOTAL AREA

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	1.922	0.000	0.000	1.922	>75% Grass cover, Good	#1, #2, #3
0.000	0.000	0.319	0.000	0.000	0.319	Paved parking	#1, #2, #3
0.000	0.000	2.241	0.000	0.000	2.241	TOTAL AREA	

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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	#1	0.00	0.00	30.0	0.2000	0.013	24.0	0.0	0.0
2	1P	75.50	69.40	30.0	0.2033	0.013	24.0	0.0	0.0
3	2P	69.40	57.90	160.0	0.0719	0.013	24.0	0.0	0.0
4	3P	57.90	50.60	70.0	0.1043	0.013	24.0	0.0	0.0
5	4P	50.60	47.50	67.0	0.0463	0.013	24.0	0.0	0.0
6	5P	47.50	46.90	41.0	0.0146	0.013	18.0	0.0	0.0

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Type III 24-hr 25 Year Rainfall=5.00", AMC=4

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Time span=1.00-24.00 hrs, dt=0.01 hrs, 2301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment #1: Subcatchment #1 Runoff Area=51,401 sf 8.95% Impervious Runoff Depth>4.76"
Flow Length=370' Tc=6.6 min AMC Adjusted CN=98 Runoff=5.66 cfs 0.468 af

Subcatchment #2: Subcatchment #2 Runoff Area=32,272 sf 21.38% Impervious Runoff Depth>4.76"
Flow Length=440' Tc=9.7 min AMC Adjusted CN=98 Runoff=3.21 cfs 0.294 af

Subcatchment #3: Subcatchment #3 Runoff Area=13,939 sf 17.22% Impervious Runoff Depth>4.76"
Flow Length=260' Tc=9.7 min AMC Adjusted CN=98 Runoff=1.39 cfs 0.127 af

Pond 1P: FES to CBFI Inv. 69.4 Peak Elev=76.53' Inflow=5.66 cfs 0.468 af
24.0" Round Culvert n=0.013 L=30.0' S=0.2033 '/' Outflow=5.66 cfs 0.468 af

Pond 2P: CBFI Inv. 69.4 to CBFI Inv. 57.9 Peak Elev=70.73' Inflow=8.70 cfs 0.762 af
24.0" Round Culvert n=0.013 L=160.0' S=0.0719 '/' Outflow=8.70 cfs 0.762 af

Pond 3P: CBFI Inv. 57.9 to CBFI Inv. 50.6 Peak Elev=59.35' Inflow=10.04 cfs 0.888 af
24.0" Round Culvert n=0.013 L=70.0' S=0.1043 '/' Outflow=10.04 cfs 0.888 af

Pond 4P: CBFI Inv. 50.6 to CBFI Inv. 47.5 Peak Elev=52.05' Inflow=10.04 cfs 0.888 af
24.0" Round Culvert n=0.013 L=67.0' S=0.0463 '/' Outflow=10.04 cfs 0.888 af

Pond 5P: CBFI Inv. 47.5 to DMH Inv. 46.9 Peak Elev=49.64' Inflow=10.04 cfs 0.888 af
18.0" Round Culvert n=0.013 L=41.0' S=0.0146 '/' Outflow=10.04 cfs 0.888 af

Total Runoff Area = 2.241 ac Runoff Volume = 0.888 af Average Runoff Depth = 4.76"
85.76% Pervious = 1.922 ac 14.24% Impervious = 0.319 ac

Dennings Drainage 1-13-16

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Type III 24-hr 25 Year Rainfall=5.00", AMC=4

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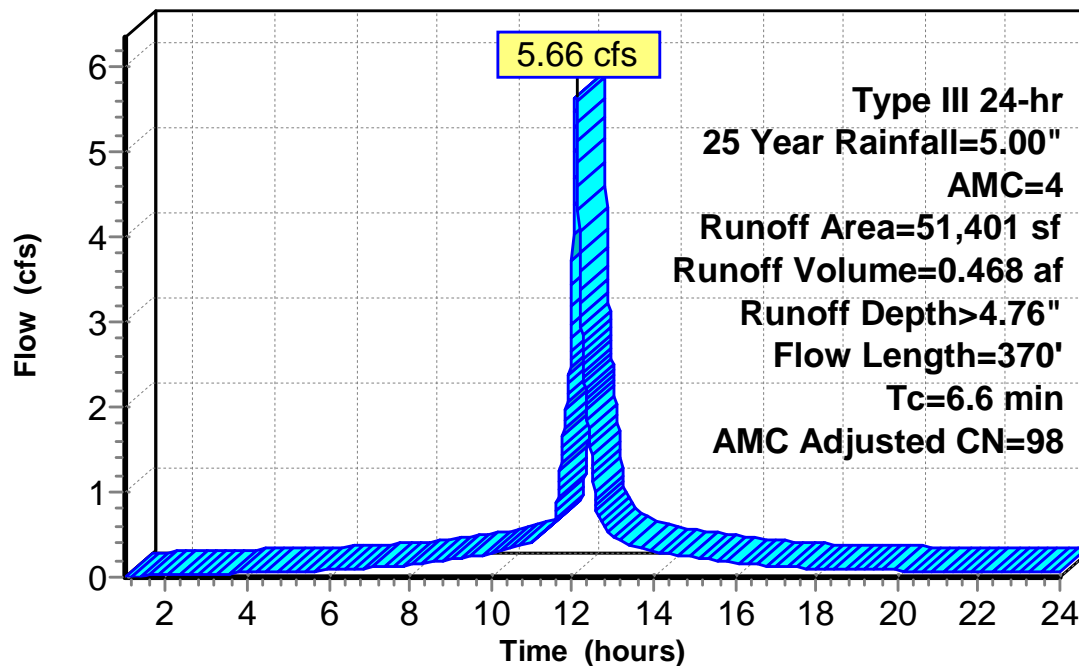
Summary for Subcatchment #1: Subcatchment #1

Runoff = 5.66 cfs @ 12.09 hrs, Volume= 0.468 af, Depth> 4.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Rainfall=5.00", AMC=4

Area (sf)	CN	Adj	Description
46,801	74		>75% Grass cover, Good, HSG C
4,600	98		Paved parking, HSG C
51,401	76	98	Weighted Average, AMC Adjusted
46,801			91.05% Pervious Area
4,600			8.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0670	0.22		Sheet Flow, Sheet Flow
					Grass: Short n= 0.150 P2= 2.75"
2.9	290	0.0550	1.64		Shallow Concentrated Flow, Shallow Flow from Edge of South Ave. t
					Short Grass Pasture Kv= 7.0 fps
0.0	30	0.2000	32.20	101.17	Pipe Channel, PIPE FLOW TO CBF1 INV. 75.5
					24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50'
					n= 0.013
6.6	370	Total			

Subcatchment #1: Subcatchment #1**Hydrograph**

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Type III 24-hr 25 Year Rainfall=5.00", AMC=4

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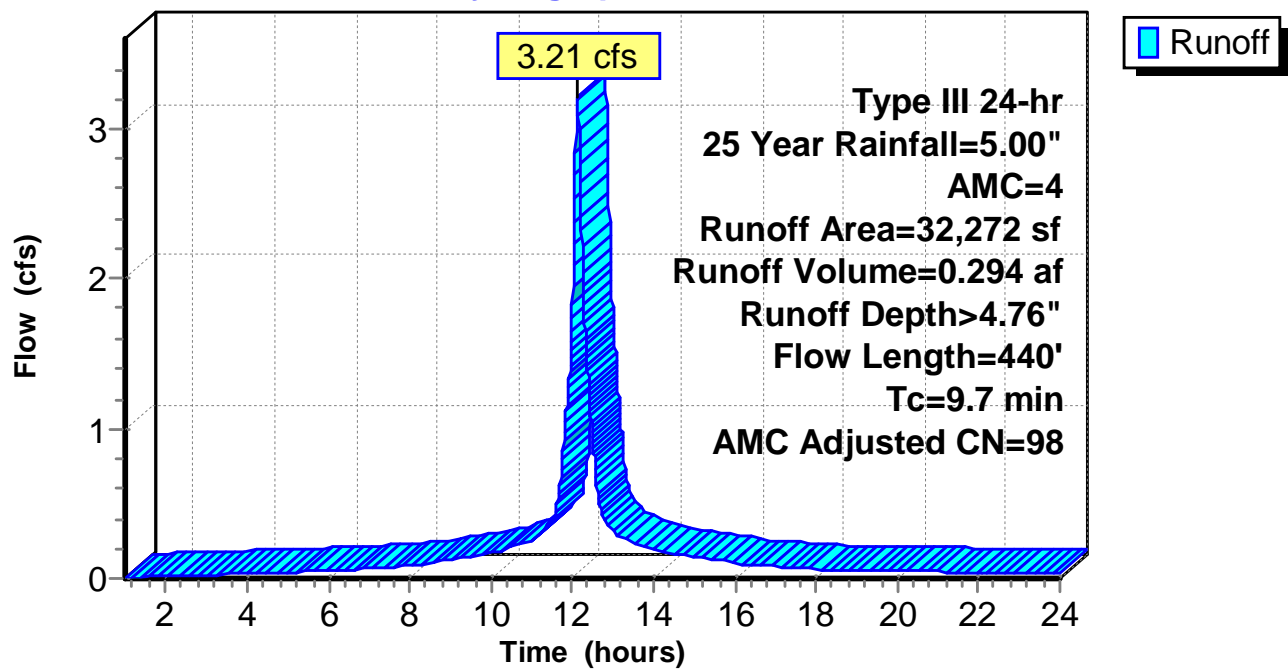
Summary for Subcatchment #2: Subcatchment #2

Runoff = 3.21 cfs @ 12.13 hrs, Volume= 0.294 af, Depth> 4.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Rainfall=5.00", AMC=4

Area (sf)	CN	Adj	Description
25,372	74		>75% Grass cover, Good, HSG C
6,900	98		Paved parking, HSG C
32,272	79	98	Weighted Average, AMC Adjusted
25,372			78.62% Pervious Area
6,900			21.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	100	0.0800	0.27		Sheet Flow, SHEET FLOW
					Grass: Short n= 0.150 P2= 2.75"
3.6	340	0.0500	1.57		Shallow Concentrated Flow, SHALLOW FLOW TO CBFI INV. 57.9
					Short Grass Pasture Kv= 7.0 fps
9.7	440	Total			

Subcatchment #2: Subcatchment #2**Hydrograph**

Dennings Drainage 1-13-16

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Type III 24-hr 25 Year Rainfall=5.00", AMC=4

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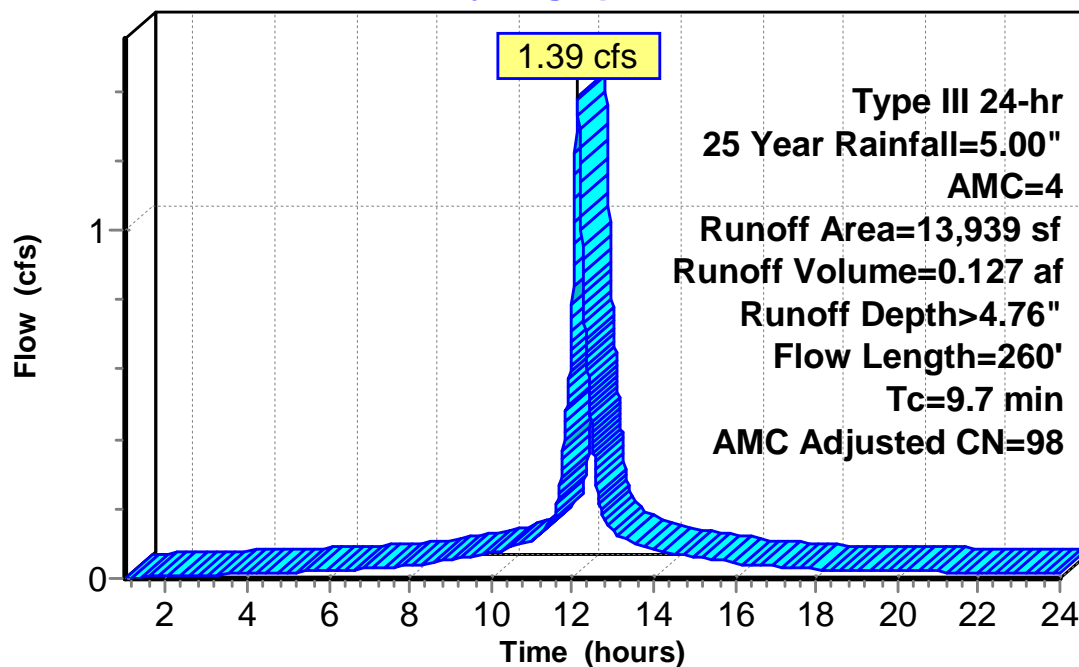
Summary for Subcatchment #3: Subcatchment #3

Runoff = 1.39 cfs @ 12.13 hrs, Volume= 0.127 af, Depth> 4.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Year Rainfall=5.00", AMC=4

Area (sf)	CN	Adj	Description
11,539	74		>75% Grass cover, Good, HSG C
2,400	98		Paved parking, HSG C
13,939	78	98	Weighted Average, AMC Adjusted
11,539			82.78% Pervious Area
2,400			17.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	100	0.0400	0.21		Sheet Flow, SHEET FLOW
					Grass: Short n= 0.150 P2= 2.75"
1.7	160	0.0500	1.57		Shallow Concentrated Flow, SHALLOW FLOW TO CBFI INV. 47.5 (DP
					Short Grass Pasture Kv= 7.0 fps
9.7	260	Total			

Subcatchment #3: Subcatchment #3**Hydrograph**

Dennings Drainage 1-13-16

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Type III 24-hr 25 Year Rainfall=5.00", AMC=4

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Summary for Pond 1P: FES to CBF1 Inv. 69.4

Inflow Area = 1.180 ac, 8.95% Impervious, Inflow Depth > 4.76" for 25 Year event
Inflow = 5.66 cfs @ 12.09 hrs, Volume= 0.468 af
Outflow = 5.66 cfs @ 12.09 hrs, Volume= 0.468 af, Atten= 0%, Lag= 0.0 min
Primary = 5.66 cfs @ 12.09 hrs, Volume= 0.468 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

Peak Elev= 76.53' @ 12.09 hrs

Flood Elev= 77.50'

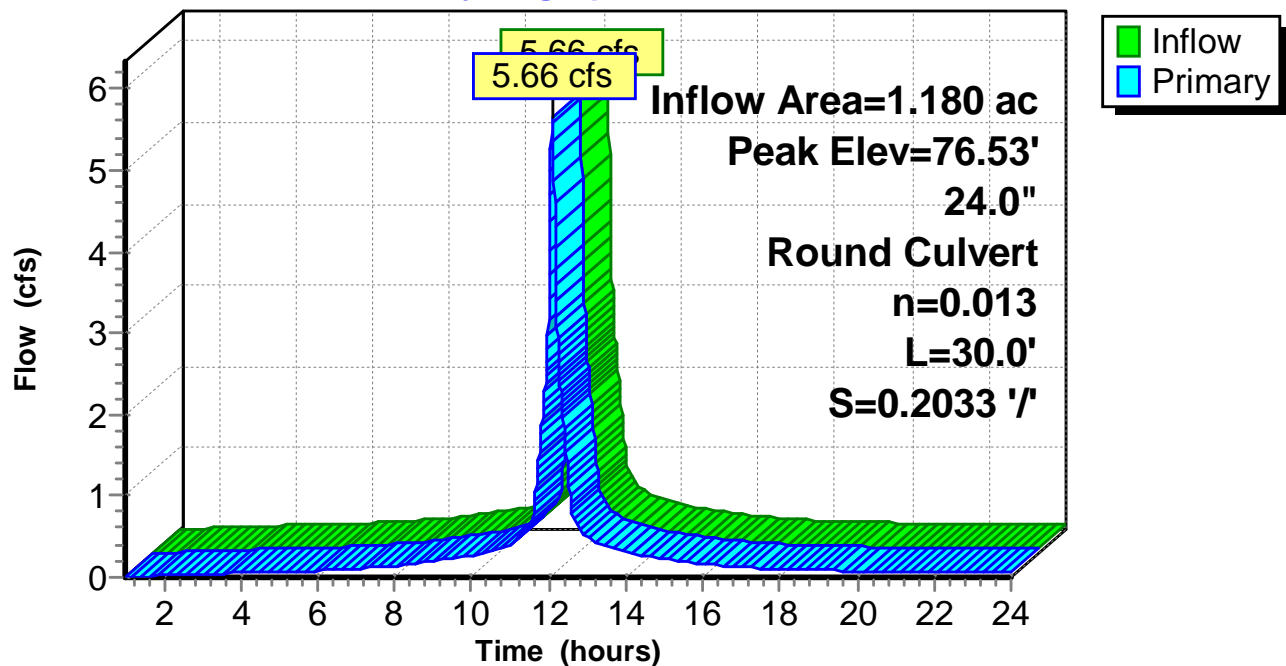
Device	Routing	Invert	Outlet Devices
#1	Primary	75.50'	24.0" Round Culvert L= 30.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 75.50' / 69.40' S= 0.2033 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf

Primary OutFlow Max=5.65 cfs @ 12.09 hrs HW=76.53' TW=70.72' (Dynamic Tailwater)

↑ **1=Culvert** (Inlet Controls 5.65 cfs @ 3.46 fps)

Pond 1P: FES to CBF1 Inv. 69.4

Hydrograph



Summary for Pond 2P: CBF1 Inv. 69.4 to CBF1 Inv. 57.9

Inflow Area = 1.921 ac, 13.74% Impervious, Inflow Depth > 4.76" for 25 Year event
 Inflow = 8.70 cfs @ 12.10 hrs, Volume= 0.762 af
 Outflow = 8.70 cfs @ 12.10 hrs, Volume= 0.762 af, Atten= 0%, Lag= 0.0 min
 Primary = 8.70 cfs @ 12.10 hrs, Volume= 0.762 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

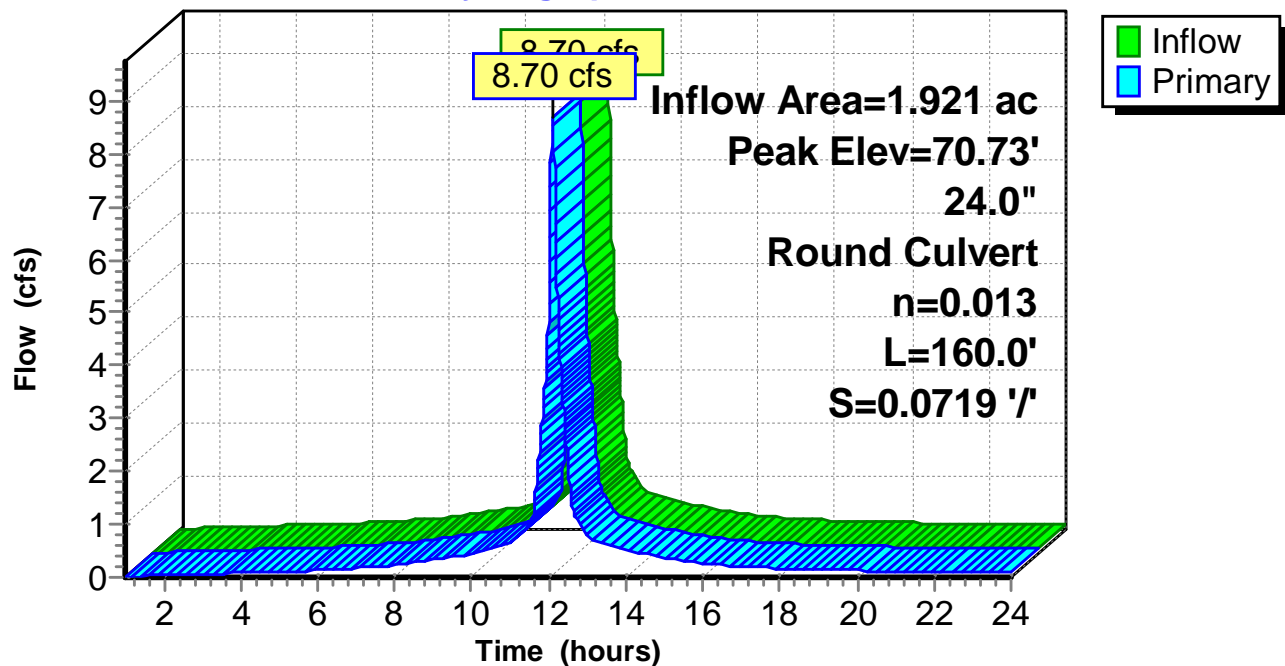
Peak Elev= 70.73' @ 12.10 hrs

Flood Elev= 73.10'

Device	Routing	Invert	Outlet Devices
#1	Primary	69.40'	24.0" Round Culvert L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 69.40' / 57.90' S= 0.0719 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf

Primary OutFlow Max=8.69 cfs @ 12.10 hrs HW=70.73' TW=59.35' (Dynamic Tailwater)

↑ **1=Culvert** (Inlet Controls 8.69 cfs @ 3.92 fps)

Pond 2P: CBF1 Inv. 69.4 to CBF1 Inv. 57.9**Hydrograph**

Summary for Pond 3P: CBFI Inv. 57.9 to CBFI Inv. 50.6

Inflow Area = 2.241 ac, 14.24% Impervious, Inflow Depth > 4.76" for 25 Year event
 Inflow = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af
 Outflow = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af, Atten= 0%, Lag= 0.0 min
 Primary = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

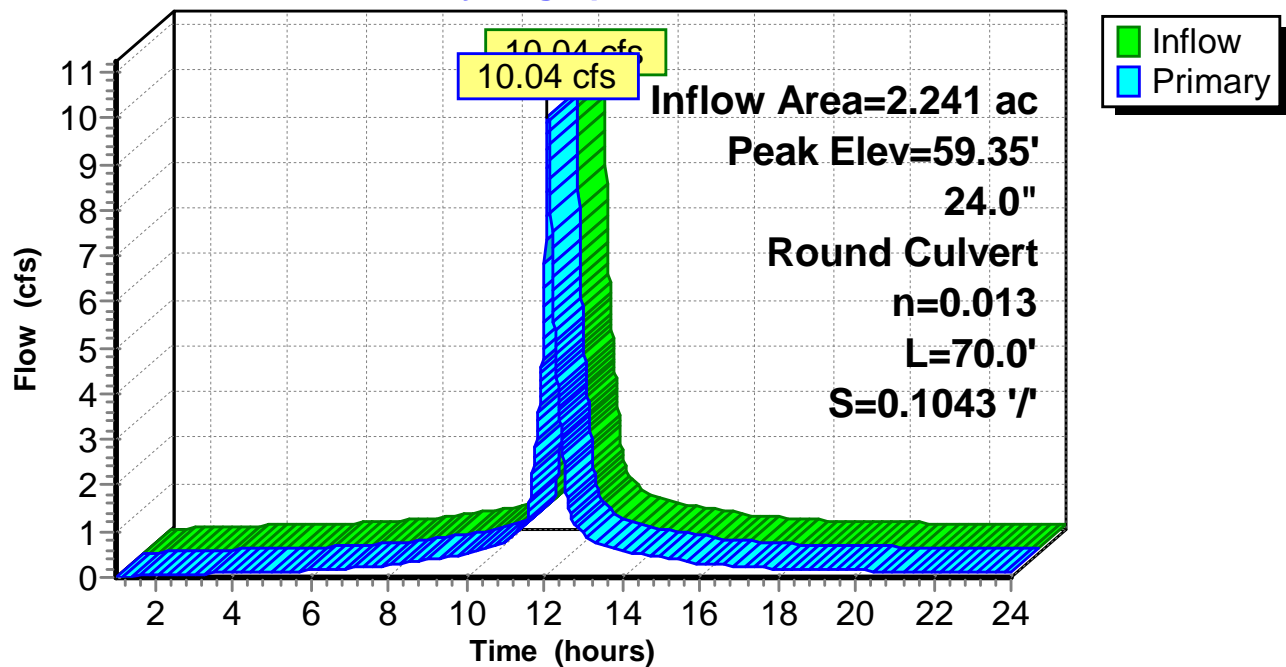
Peak Elev= 59.35' @ 12.11 hrs

Flood Elev= 61.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	57.90'	24.0" Round Culvert L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 57.90' / 50.60' S= 0.1043 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf

Primary OutFlow Max=10.03 cfs @ 12.11 hrs HW=59.35' TW=52.05' (Dynamic Tailwater)

↑ **1=Culvert** (Inlet Controls 10.03 cfs @ 4.10 fps)

Pond 3P: CBFI Inv. 57.9 to CBFI Inv. 50.6**Hydrograph**

Summary for Pond 4P: CBF1 Inv. 50.6 to CBF1 Inv. 47.5

Inflow Area = 2.241 ac, 14.24% Impervious, Inflow Depth > 4.76" for 25 Year event
 Inflow = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af
 Outflow = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af, Atten= 0%, Lag= 0.0 min
 Primary = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

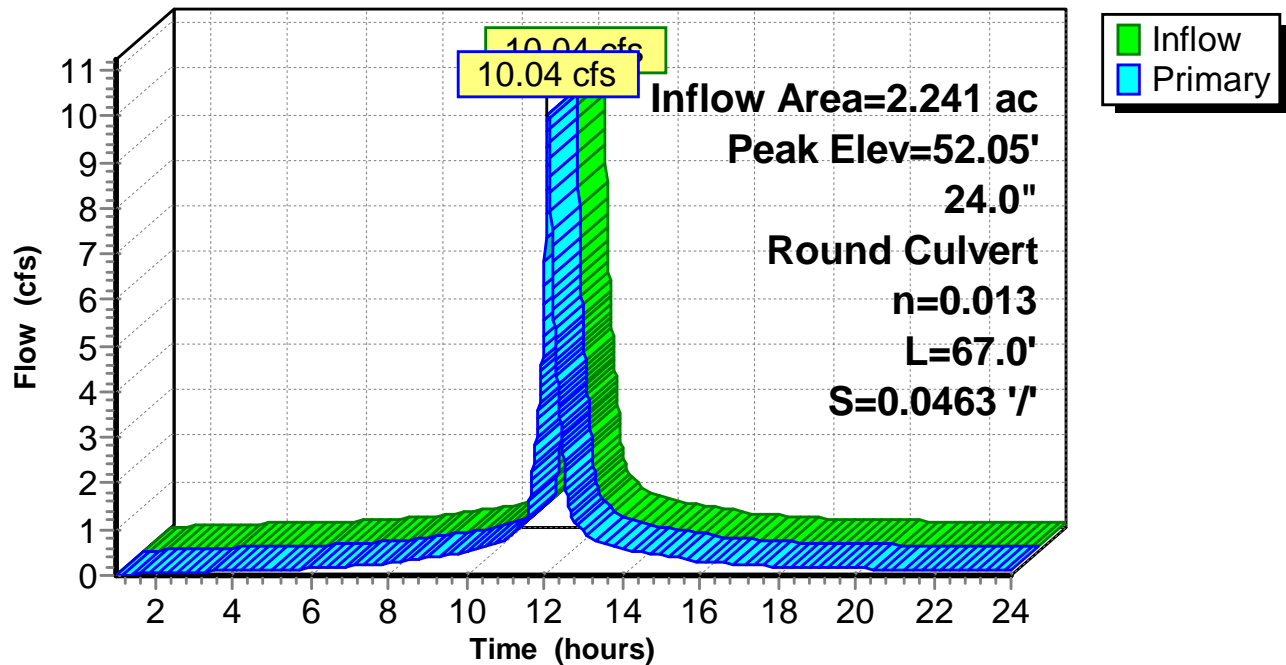
Peak Elev= 52.05' @ 12.11 hrs

Flood Elev= 53.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	50.60'	24.0" Round Culvert L= 67.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 50.60' / 47.50' S= 0.0463 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf

Primary OutFlow Max=10.03 cfs @ 12.11 hrs HW=52.05' TW=49.64' (Dynamic Tailwater)

↑ **1=Culvert** (Inlet Controls 10.03 cfs @ 4.10 fps)

Pond 4P: CBF1 Inv. 50.6 to CBF1 Inv. 47.5**Hydrograph**

Summary for Pond 5P: CBF1 Inv. 47.5 to DMH Inv. 46.9

Inflow Area = 2.241 ac, 14.24% Impervious, Inflow Depth > 4.76" for 25 Year event
 Inflow = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af
 Outflow = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af, Atten= 0%, Lag= 0.0 min
 Primary = 10.04 cfs @ 12.11 hrs, Volume= 0.888 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

Peak Elev= 49.64' @ 12.11 hrs

Flood Elev= 50.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	47.50'	18.0" Round Culvert L= 41.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.50' / 46.90' S= 0.0146 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=10.03 cfs @ 12.11 hrs HW=49.64' (Free Discharge)

↑ **1=Culvert** (Inlet Controls 10.03 cfs @ 5.67 fps)

Pond 5P: CBF1 Inv. 47.5 to DMH Inv. 46.9**Hydrograph**