APPENDIX VI-G

STORMWATER MANAGEMENT SYSTEM CALCULATIONS

APPENDIX VI-G.1

SELECTION OF POST-DEVELOPMENT HYDROLOGIC PARAMETERS

Geosyntec consultants

COMPUTATION COVER SHEET

Client: DRPI **Project:** Landfill Vertical Expansion **Project #:** ME1571 **Phase #:** 04

TITLE OF COMPUTATIONS: SELECTION OF POST-DEVELOPMENT HYDROLOGIC PARAMETERS

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APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL
1	Graded revised near southeast corner	3/25/2019	ZL	Carrie Pendleton	Carrie Pendleton

SELECTION OF POST-DEVELOPMENT HYDROLOGIC PARAMETERS

PURPOSE

The purpose of this calculation package is to select watershed and subcatchment hydrologic parameters used for watershed analysis of the post-development conditions of the Delaware Recyclable Products, Inc. (DRPI) Landfill Vertical Expansion project, as well as to present the "*HydroCAD® Stormwater Modeling System*", version 10.00 [HydroCAD Software Solutions LLC, 2016] (HydroCAD®) computer output files for the design of the various components of the stormwater management conveyance features of the DRPI Landfill.

The input parameters described in this calculation are integral to estimating the peak discharge associated with each subcatchment area of the landfill. In turn, the peak discharge is a design input for each of the stormwater management features for the project, including: (i) sideslope terraces; (ii) downchutes; (iii) drainage channels; (iv) culverts; (v) plateau edge diversion berms; and (vi) sediment basins.

METHOD

HydroCAD® routes stormwater runoff through the defined model using the procedures defined in "*Urban Hydrology for Small Watersheds, Technical Release 55*", [USDA-SCS, 1986] and "*Computer Program for Project Formulation Hydrology, Technical Release 20*", [USDA –SCS, 1982].

This calculation is prepared in accordance with the following regulations:

- 5101 Delaware Sediment and Stormwater Regulations (Section 10.3.4.1, Title 7 DNREC, 5000 Division of Watershed Stewardship), requires a three-step approval purpose: (i) project application meeting; (ii) preliminary Sediment and Stormwater Management Plan; and (iii) Sediment and Stormwater Management Plan. The regulations also list the performance criteria for post construction stormwater management (Section 5.0) which requires that the following events be met: (i) the Resource Protection Event Volume (RPv) or 1-year, 24-hour rainfall event; (ii) the Conveyance Event Criteria (Cv) or 10-year, 24-hour rainfall event; and (iii) the Flooding Event Volume (Fv) or the 100-year, 24-hour rainfall event.
- Natural Resources Conservation Service (NRCS) Conservation Practice Standard, Pond Code 378 [NRCS 2015], which requires that the auxiliary spillway for a pond must pass the 24-hour, 25-year design storm. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2-ft and shall have at least a minimum of 1-ft of freeboard between design high-water-

flow elevation in the auxiliary spillway and the top of the settled embankment.

- Delaware Solid Waste Regulations for industrial landfills (Section 6.6.2.1, Title 7 DNREC, 1300 Solid and Hazardous Waste Management Section, 1301 Regulations Governing Solid Waste), which requires that stormwater management features pass the 2-hour, 10-year storm event (the 25-year, 24-hour design storm is conservatively selected for design of landfill conveyance features).
- Delaware Erosion and Sediment Control Handbook (April 2016), which requires that stormwater structures be designed according to either local, state or NRCS standards, whichever is more stringent. No freeboard is required where good vegetation can be grown and is maintained. The minimum freeboard for lined channels shall be 0.25 feet above the design high water in areas where erosion resistant vegetation cannot be grown adjacent to the lining on the side slopes.

Based on the discussion above, the 25-year, 24-hour design storm is conservatively selected for design of landfill conveyance features.

CALCULATION PARAMETERS

The following section summarizes the selection of the various hydrologic parameters used for the watershed analysis.

- **Design Rainfall Depth and Distribution: Figure 1**, from the DNREC Sediment and Stormwater Management program requirements, lists the following NRCS Type II, 24-Hour Duration design storm depths applicable to the DRPI landfill (located in New Castle County, Delaware, effective date 1 January 2014):
  - 1-year storm: 2.7 inches
  - 2-year storm: 3.2 inches
  - 10-year storm: 4.8 inches
  - 25-year storm: 6.0 inches
  - 100-year storm: 8.0 inches
- **Hydrologic Soil Groups:** It is expected that the soil used to construct the final cover system will come from offsite sources, which, in addition to natural soil, may include manufactured or processed soils. In general, the final cover soil is anticipated to exhibit characteristics of Hydrologic Soils Group C.
- **Curve Number (CN):** The CN value for the post-development condition for Hydrologic Soil Group C is obtained from **Figure 2**, which is taken from TR-55. The final cover system of the landfill will be treated as "Open Spaces in Good Condition" (grass cover greater than 75 percent), with a CN value of 74.

- **Time of Concentration *Tc:*** The various parameters used to calculate the *Tc* for each subarea are summarized in the HydroCAD result report in Attachment 1. The *Tc* value represents the total time for stormwater runoff to travel from the hydraulically most distant point of a watershed or drainage area, to a point of interest. Factors affecting *Tc* include surface roughness, channel shape and flow patterns, and slope. The calculation of *Tc* includes analysis of three different types of stormwater runoff flow:

  - **sheet flow** – flow over plane surfaces, which is limited to a maximum length of 100 ft.;
  - **shallow concentrated flow** – after 100 ft., sheet flow will begin to concentrate, but not necessarily defined in a specific channel; and
  - **open channel flow** – flow that is confined to a defined channel.

  The *Tc* value for a drainage area is the sum of the individual various travel time (*Tt*) values of the above flow types. The equations for calculating the *Tt* are presented below:

  - **sheet flow:** $$Tt = \frac{0.007\,(nL)^{0.8}}{(P2)^{0.5}\,s^{0.4}}$$

  - **shallow concentrated flow:** $$Tt = \frac{L}{3{,}600\,V}$$

  - **open channel flow:** $$Tt = \frac{nL}{3{,}600\,(1.49)\,r^{2/3}\,s^{1/2}}$$

  where:
  - *Tt* = travel time, hours
  - *n* = Manning's roughness coefficient (dimensionless);
    - n = 0.15 for sheet flow (conservatively assumed "grass range, short")
  - *L* = length of flow, ft
  - *P2* = rainfall from a 2-year, 24-hour storm, in
  - *s* = Bed or surface slope in the flow direction, ft/ft
  - *V* = velocity, ft/sec
  - *r* = hydraulic radius, ft

  TR-55 provides a graphical solution for *Tt* for shallow concentrated flow over "paved" and "unpaved areas". Alternatively, the "*National Engineering Handbook, Section 4 Hydrology (NEH-4)*", [SCS, 1985] provides the following equation for *V*:

$$V = K_V \sqrt{s}$$

Where *Kv* is a velocity factor based on various surface conditions (i.e., paved, unpaved, grassed waterway, short grass pasture) and *s* is the slope of the land surface. "*HydroCAD® Stormwater Modeling System*", version 10.0 [Applied Microcomputer Systems, 2016] (HydroCAD®) provides a table of velocity factors (*Kv*), which are used to calculate *V* in the above equation.

For this design, a *Kv* value of 7 ft/sec (corresponding to "Short Grass Pasture") is selected. The computations for *Tc* and *Tt* are completed in the HydroCAD® model.

- **Final Cover Drainage Areas:** The delineated drainage areas for the stormwater management plan for the final phase of the vertical expansion of the landfill is presented as **Figure 3**. This plan presents the boundaries of the landfill drainage areas and the stormwater runoff flow path within each modeled drainage area. In general, subcatchment drainage areas of the final cover system are defined by sideslope terraces, downchutes, perimeter channels, and access roads.

In addition to the hydrologic design parameters described above, existing channels and culverts are also modeled. Cross section, slope and lining for existing channels have been obtained from previously permitted design drawings, or from as-built drawings. The specific parameters obtained from these drawings are defined below:

- *b* = channel bottom width, ft
- *d* = maximum flow depth in channel, ft
- *z* = inclination of channel slope (dimensionless)

RESULTS

The site-specific parameters along with site drainage area details shown in Figure 3 used as input were compiled into the computer program HydroCAD®. Configuration of East and West Sediment Basins (East Pond and West Pond in Figure 3) was obtained from the as-built drawings dated 11 January 2017, included in **Appendix VI-G.3**. The proposed final design grade of the landfill and the channel elevations were estimated as shown in Figure 3. Basin outlet structures and existing perimeter channels were obtained from available drawings. Proposed revisions were made when the capacity did not meet the requirements.

The existing two basins were considered in the model. When basin inlets are submerged, the tailwater in the basin will back up the discharge through the basin inlets, which will potentially raise the water level in the perimeter channels. The existing basin inlet structures cannot meet the drainage requirements and the proposed revisions, as discussed below, were modeled in the

analysis:

- The upgrades to East Basin include:
  - Replacing existing one 36”-diameter RCP with proposed four 54”-diameter RCPs with headwall and Endwall.

- The upgrades to West Basin include:
  - Replacing existing two 54”-diameter CMPs with proposed three 54”-diameter RCPs with headwall and Endwall.

The results of the HydroCAD output file are presented in **Attachment 1** and will be used to verify the geometric sizing and select appropriate lining for erosion resistance of the stormwater management conveyance features.

It is notable that the inputs and assumptions are based the available data from historical drawings and communication with DRPI. Should there be any difference between inputs and the actual conditions, the Engineer should be informed and the analysis may be revised as necessary.

REFERENCES

HydroCAD Software Solutions LLC, “*HydroCAD® Stormwater Modeling System*”, Version 10.00, Chocorua, New Hampshire 2016.

United States Department of Agriculture, Soil Conservation Service, “*Computer Program for Project Formulation Hydrology, Technical Release 20*”, Washington D.C., 1982.

United States Department of Agriculture, Soil Conservation Service, *“National Engineering Handbook, Section 4 Hydrology (NEH-4)”*, National Technical Information Service, 1985.

United States Department of Agriculture, Soil Conservation Service, “*Urban Hydrology for Small Watersheds, Technical Release 55*”, 2nd ed., Washington, D.C., 1986.

FIGURES

Rainfall Depths for Delaware*

(NRCS Type II, 24-Hour Duration)

Storm Event	County		
	New Castle	Kent	Sussex
Latitude	39.547 N	39.070 N	38.673 N
Longitude	75.681 W	75.602 W	75.417 W
6-MO (WQ)	2.0	2.0	2.0
1-YR (RPv)	2.7	2.7	2.7
2-YR	3.2	3.3	3.4
5-YR	4.1	4.3	4.4
10-YR (Cv)	4.8	5.2	5.3
25-YR	6.0	6.5	6.7
50-YR	6.9	7.6	7.9
100-YR (Fv)	8.0	8.9	9.2
500-YR	10.9	12.6	13.0

* Ref: NOAA Atlas 14 Volume 2, Version 3

EFFECTIVE DATE: January 1, 2014

01/14

RAINFALL DEPTH FOR DELAWARE
Stormwater Management System Plan
DRPI Vertical Expansion

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Figure VI-G.1-1

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

CURVE NUMBERS FROM TR-55 MANUAL
Stormwater Management System Plan
DRPI Vertical Expansion

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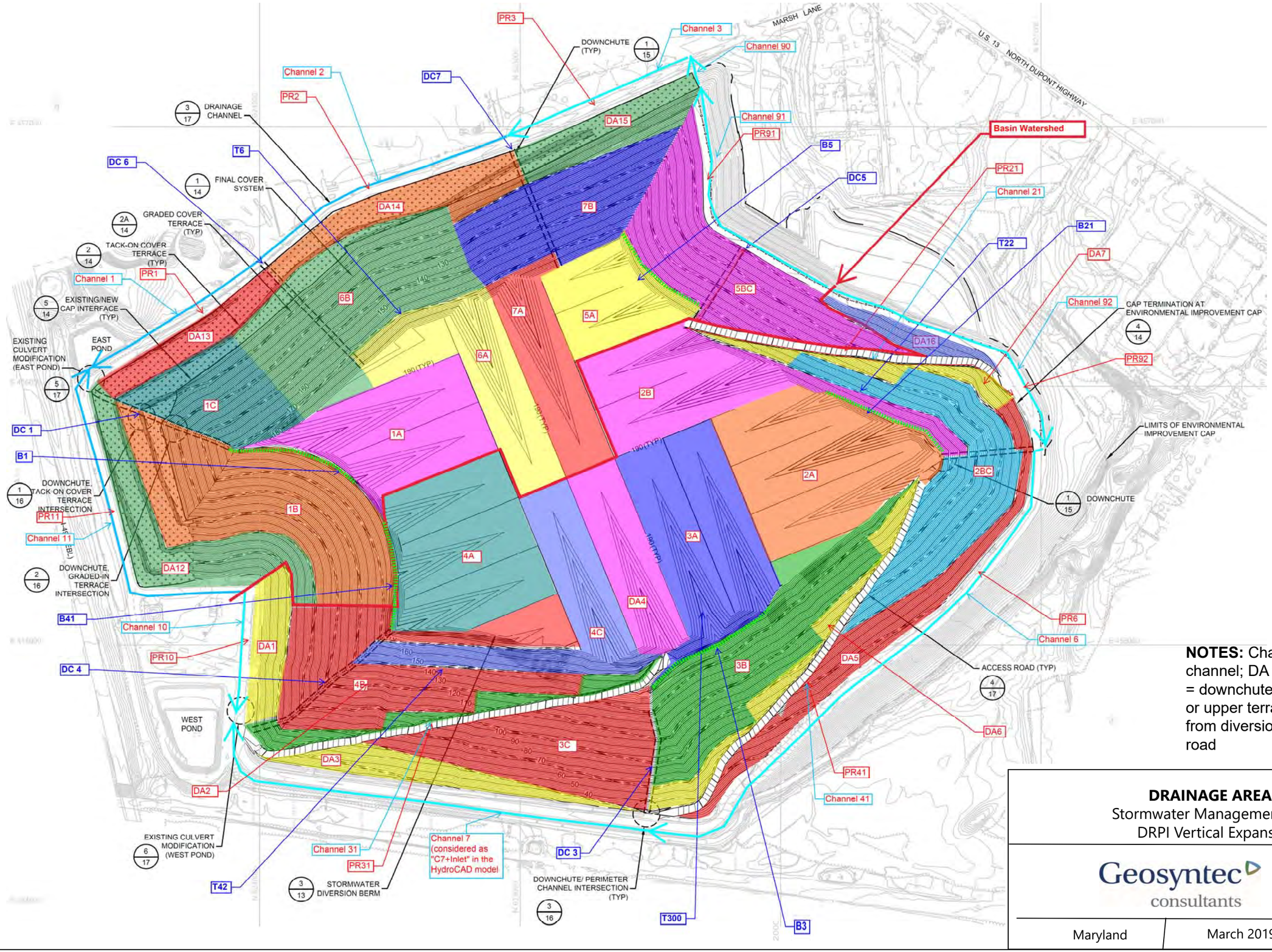
Figure VI-G.1-2



NOTES: Channel = perimeter channel; DA = drainage area; DC = downchute; T = diversion berm or upper terrace that directed from diversion berm; PR = paved road

DRAINAGE AREAS
Stormwater Management Plan
DRPI Vertical Expansion

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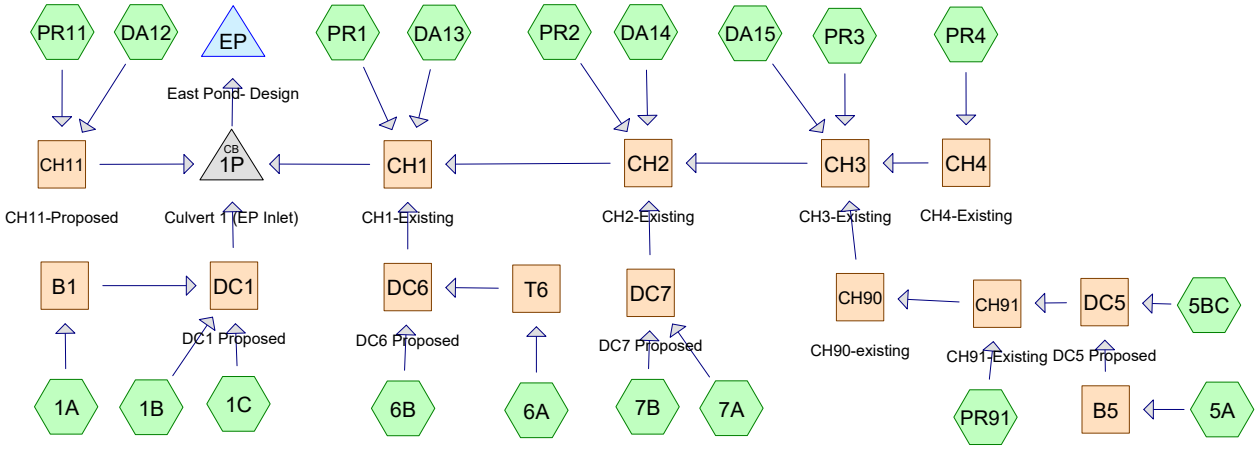
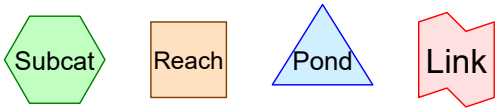
Figure VI-G.1-3

ATTACHMENT 1

HYDROCARD OUTPUT

EAST BASIN WATERSHED





Routing Diagram for Final Cover of 20180420 version SW Model20190325
Prepared by SCCM-01, Printed 3/25/2019
HydroCAD® 10.00-18 s/n 00663 © 2016 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
64.347	74	>75% Grass cover, Good, HSG C (1A, 1B, 1C, 5A, 5BC, 6A, 6B, 7A, 7B, DA12, DA13, DA14, DA15)
4.951	98	Paved parking, HSG C (PR1, PR11, PR2, PR3, PR4, PR91)
69.298	**76**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
69.298	HSG C	1A, 1B, 1C, 5A, 5BC, 6A, 6B, 7A, 7B, DA12, DA13, DA14, DA15, PR1, PR11, PR2, PR3, PR4, PR91
0.000	HSG D	
0.000	Other	
69.298		**TOTAL AREA**

Ground Covers (selected 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	64.347	0.000	0.000	64.347	>75% Grass cover, Good	1A, 1B, 1C, 5A, 5BC, 6A, 6B, 7A, 7B, DA12, DA13, DA14, DA15
0.000	0.000	4.951	0.000	0.000	4.951	Paved parking	PR1, PR11, PR2, PR3, PR4, PR91
0.000	**0.000**	**69.298**	**0.000**	**0.000**	**69.298**	**TOTAL AREA**	

Pipe Listing (selected 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	1P	20.00	9.69	70.0	0.1473	0.012	54.0	0.0	0.0
2	EP	10.45	9.86	59.0	0.0100	0.012	48.0	0.0	0.0

Time span=0.00-54.00 hrs, dt=0.01 hrs, 5401 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 1A: Runoff Area=255,100 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=275' Tc=6.7 min CN=74 Runoff=32.37 cfs 1.554 af

Subcatchment 1B: Runoff Area=403,635 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=1,010' Tc=4.6 min CN=74 Runoff=55.27 cfs 2.459 af

Subcatchment 1C: Runoff Area=162,917 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=290' Tc=2.7 min CN=74 Runoff=23.87 cfs 0.993 af

Subcatchment 5A: Runoff Area=159,041 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=420' Tc=9.1 min CN=74 Runoff=18.49 cfs 0.969 af

Subcatchment 5BC: Runoff Area=296,590 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=620' Tc=3.8 min CN=74 Runoff=41.80 cfs 1.807 af

Subcatchment 6A: Runoff Area=236,072 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=275' Tc=6.7 min CN=74 Runoff=29.96 cfs 1.438 af

Subcatchment 6B: Runoff Area=372,947 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=520' Tc=3.3 min CN=74 Runoff=53.51 cfs 2.272 af

Subcatchment 7A: Runoff Area=167,171 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=450' Tc=7.2 min CN=74 Runoff=20.83 cfs 1.019 af

Subcatchment 7B: Runoff Area=234,237 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=510' Tc=3.3 min CN=74 Runoff=33.61 cfs 1.427 af

Subcatchment DA12: Runoff Area=195,785 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=70' Slope=0.3333 '/' Tc=2.4 min CN=74 Runoff=29.00 cfs 1.193 af

Subcatchment DA13: Runoff Area=85,256 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=70' Slope=0.3333 '/' Tc=2.4 min CN=74 Runoff=12.63 cfs 0.519 af

Subcatchment DA14: Runoff Area=124,622 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=70' Slope=0.3333 '/' Tc=2.4 min CN=74 Runoff=18.46 cfs 0.759 af

Subcatchment DA15: Runoff Area=109,590 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=70' Slope=0.3333 '/' Tc=2.4 min CN=74 Runoff=16.23 cfs 0.668 af

Subcatchment PR1: Runoff Area=23,550 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=5.44 cfs 0.260 af

Subcatchment PR11: Runoff Area=40,350 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=9.32 cfs 0.445 af

Subcatchment PR2: Runoff Area=31,620 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=7.30 cfs 0.349 af

Subcatchment PR3: Runoff Area=48,900 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=11.29 cfs 0.539 af

Subcatchment PR4: Runoff Area=40,500 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=9.35 cfs 0.446 af

Subcatchment PR91: Runoff Area=30,750 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=7.10 cfs 0.339 af

Reach B1: Avg. Flow Depth=1.40' Max Vel=5.38 fps Inflow=32.37 cfs 1.554 af
n=0.030 L=490.0' S=0.0204 '/' Capacity=81.98 cfs Outflow=31.54 cfs 1.554 af

Reach B5: Avg. Flow Depth=1.14' Max Vel=4.64 fps Inflow=18.49 cfs 0.969 af
n=0.030 L=500.0' S=0.0200 '/' Capacity=81.16 cfs Outflow=17.98 cfs 0.969 af

Reach CH1: CH1-Existing Avg. Flow Depth=2.57' Max Vel=9.75 fps Inflow=220.79 cfs 12.812 af
n=0.030 L=785.0' S=0.0229 '/' Capacity=574.88 cfs Outflow=217.04 cfs 12.812 af

Reach CH11: CH11-Proposed Avg. Flow Depth=1.61' Max Vel=3.36 fps Inflow=36.89 cfs 1.638 af
n=0.030 L=1,345.0' S=0.0052 '/' Capacity=45.60 cfs Outflow=28.12 cfs 1.638 af

Reach CH2: CH2-Existing Avg. Flow Depth=2.53' Max Vel=6.22 fps Inflow=143.88 cfs 8.322 af
n=0.030 L=1,054.0' S=0.0095 '/' Capacity=369.79 cfs Outflow=134.91 cfs 8.322 af

Reach CH3: CH3-Existing Avg. Flow Depth=1.98' Max Vel=4.99 fps Inflow=77.22 cfs 4.768 af
n=0.030 L=750.0' S=0.0080 '/' Capacity=339.56 cfs Outflow=73.95 cfs 4.768 af

Reach CH4: CH4-Existing Avg. Flow Depth=0.57' Max Vel=2.45 fps Inflow=9.35 cfs 0.446 af
n=0.030 L=1,350.0' S=0.0074 '/' Capacity=326.74 cfs Outflow=6.46 cfs 0.446 af

Reach CH90: CH90-existing Avg. Flow Depth=0.78' Max Vel=13.55 fps Inflow=53.58 cfs 3.115 af
n=0.030 L=150.0' S=0.1600 '/' Capacity=1,518.56 cfs Outflow=53.57 cfs 3.115 af

Reach CH91: CH91-Existing Avg. Flow Depth=1.61' Max Vel=4.94 fps Inflow=58.87 cfs 3.115 af
n=0.030 L=1,025.0' S=0.0098 '/' Capacity=374.98 cfs Outflow=53.58 cfs 3.115 af

Reach DC1: DC1 Proposed Avg. Flow Depth=0.55' Max Vel=15.91 fps Inflow=105.01 cfs 5.006 af
n=0.030 L=580.0' S=0.2586 '/' Capacity=272.76 cfs Outflow=104.65 cfs 5.006 af

Reach DC5: DC5 Proposed Avg. Flow Depth=0.38' Max Vel=12.13 fps Inflow=54.95 cfs 2.776 af
n=0.030 L=335.0' S=0.2388 '/' Capacity=262.10 cfs Outflow=54.84 cfs 2.776 af

Reach DC6: DC6 Proposed Avg. Flow Depth=0.44' Max Vel=14.60 fps Inflow=77.66 cfs 3.711 af
n=0.030 L=440.0' S=0.2841 '/' Capacity=285.88 cfs Outflow=77.45 cfs 3.711 af

Reach DC7: DC7 Proposed Avg. Flow Depth=0.35' Max Vel=12.19 fps Inflow=52.09 cfs 2.446 af
n=0.030 L=480.0' S=0.2604 '/' Capacity=273.70 cfs Outflow=51.86 cfs 2.446 af

Reach T6: Avg. Flow Depth=1.23' Max Vel=5.51 fps Inflow=29.96 cfs 1.438 af
n=0.030 L=500.0' S=0.0250 '/' Capacity=49.57 cfs Outflow=29.19 cfs 1.438 af

Pond 1P: Culvert 1 (EP Inlet) Peak Elev=23.56' Inflow=347.19 cfs 19.455 af
54.0" Round Culvert x 4.00 n=0.012 L=70.0' S=0.1473 '/' Outflow=347.19 cfs 19.455 af

Pond EP: East Pond- Design Peak Elev=22.13' Storage=295,843 cf Inflow=347.19 cfs 19.455 af
Primary=158.07 cfs 17.215 af Secondary=51.25 cfs 0.513 af Outflow=209.32 cfs 17.728 af

Total Runoff Area = 69.298 ac Runoff Volume = 19.455 af Average Runoff Depth = 3.37"
92.86% Pervious = 64.347 ac 7.14% Impervious = 4.951 ac

Summary for Subcatchment 1A:

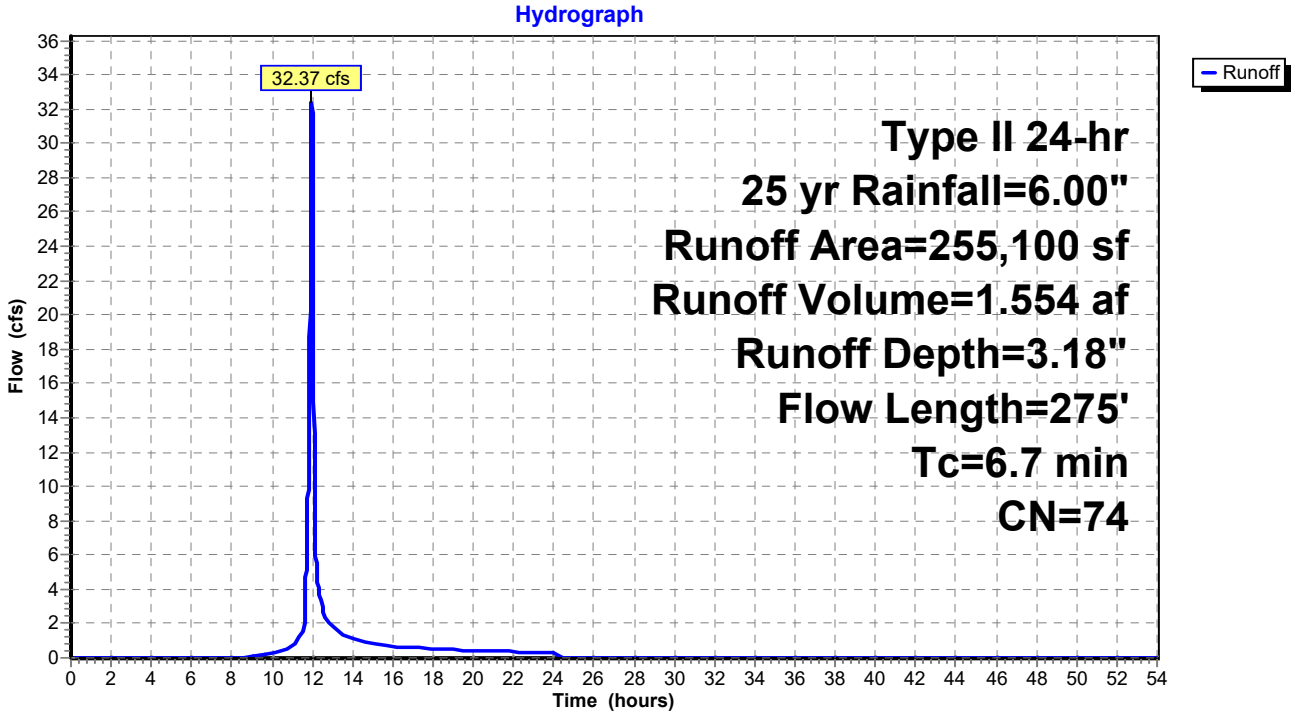
Runoff = 32.37 cfs @ 11.98 hrs, Volume= 1.554 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
255,100	74	>75% Grass cover, Good, HSG C
255,100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	75	0.1670	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.7	275	Total			

Subcatchment 1A:



Summary for Subcatchment 1B:

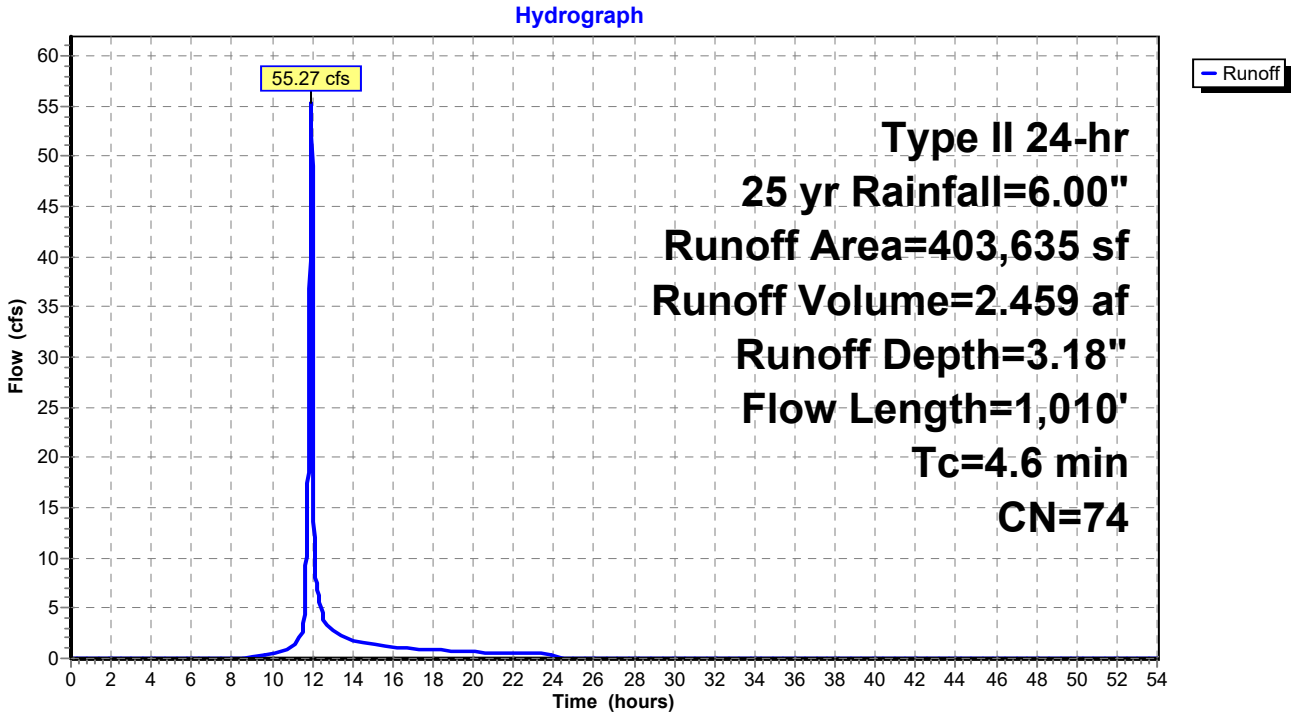
Runoff = 55.27 cfs @ 11.96 hrs, Volume= 2.459 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
403,635	74	>75% Grass cover, Good, HSG C
403,635		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	60	0.3333	0.47		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.5	950	0.0250	6.32	49.92	**Channel Flow,** Area= 7.9 sf Perim= 10.9' r= 0.72' n= 0.030 Earth, grassed & winding
4.6	1,010	Total			

Subcatchment 1B:



Summary for Subcatchment 1C:

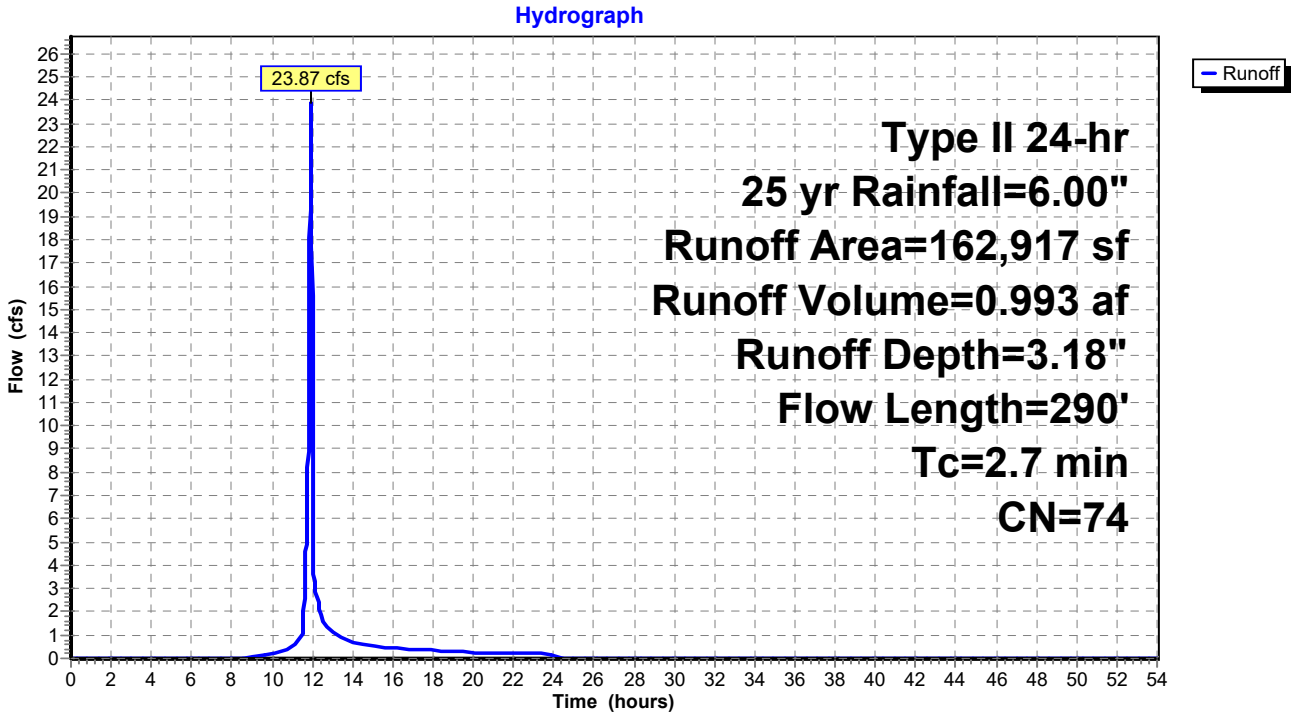
Runoff = 23.87 cfs @ 11.93 hrs, Volume= 0.993 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
162,917	74	>75% Grass cover, Good, HSG C
162,917		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	60	0.3333	0.47		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.6	230	0.0250	6.32	49.92	**Channel Flow,** Area= 7.9 sf Perim= 10.9' r= 0.72' n= 0.030 Earth, grassed & winding
2.7	290	Total			

Subcatchment 1C:



Summary for Subcatchment 5A:

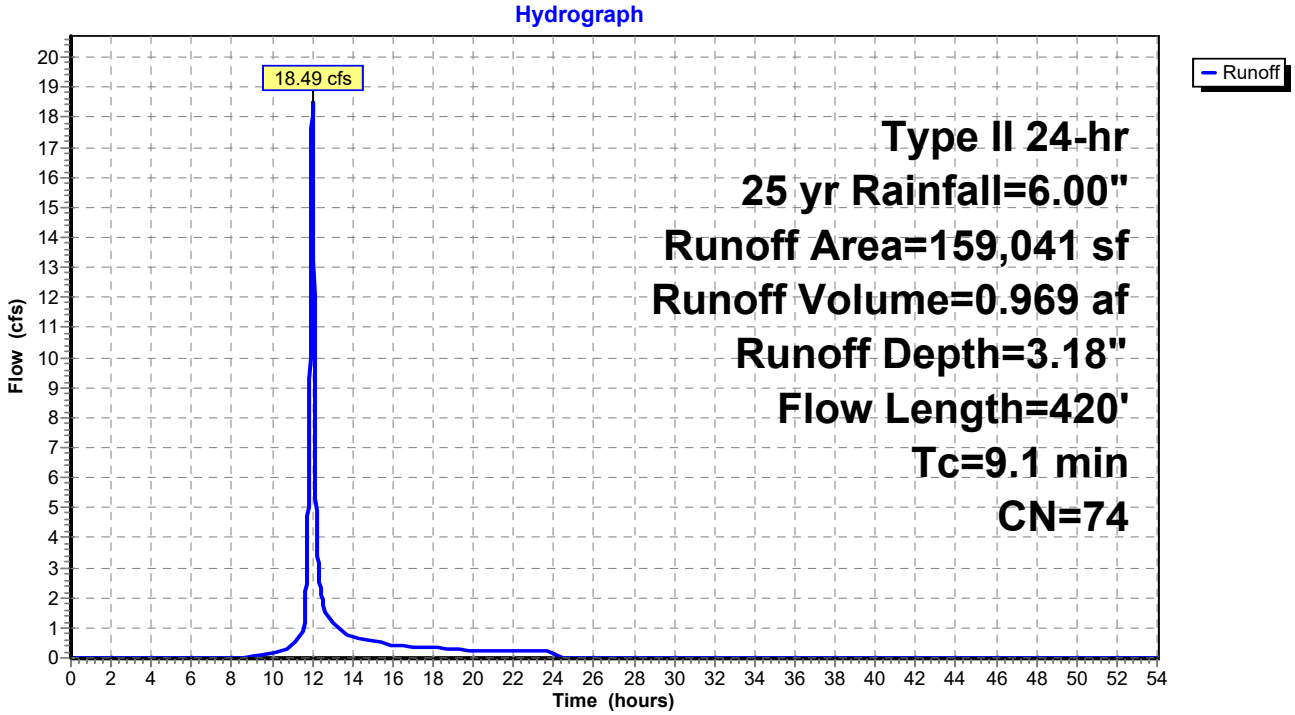
Runoff = 18.49 cfs @ 12.01 hrs, Volume= 0.969 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
159,041	74	>75% Grass cover, Good, HSG C
159,041		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	70	0.1670	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
5.9	350	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.1	420	Total			

Subcatchment 5A:



Summary for Subcatchment 5BC:

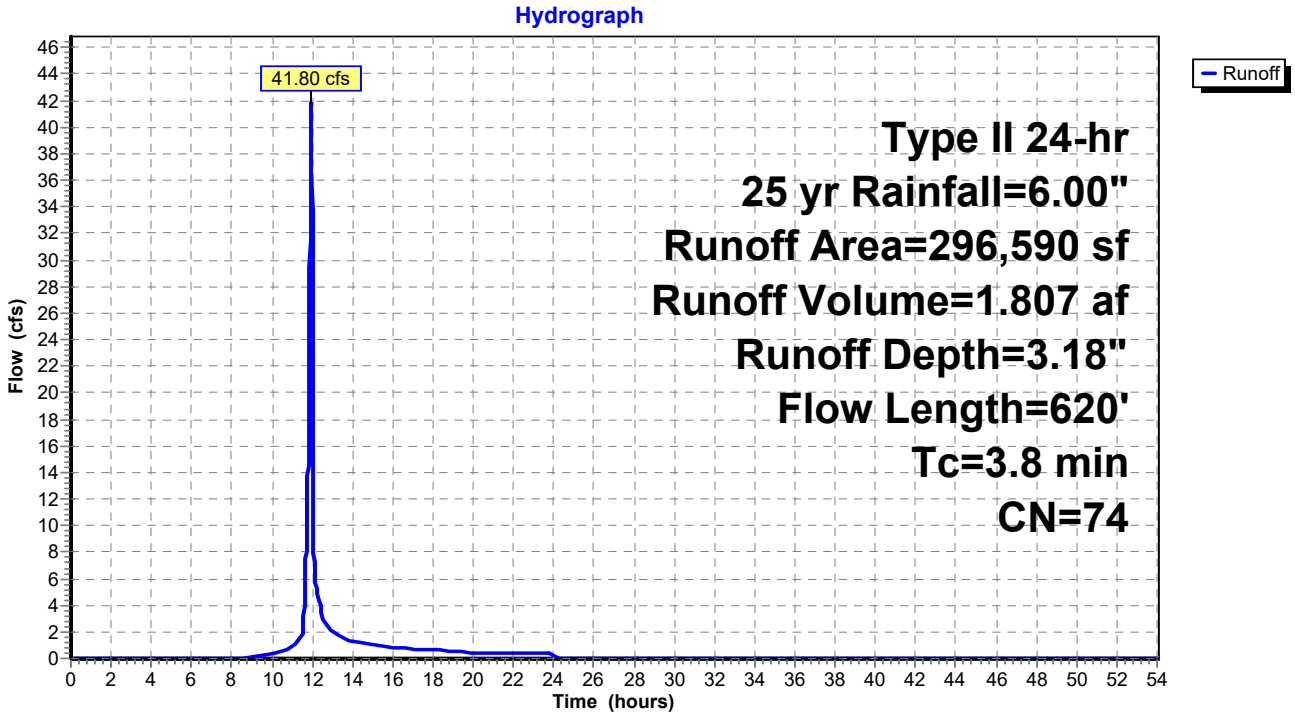
Runoff = 41.80 cfs @ 11.95 hrs, Volume= 1.807 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
296,590	74	>75% Grass cover, Good, HSG C
296,590		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.4	550	0.0250	6.33	63.93	**Channel Flow,** Area= 10.1 sf Perim= 13.9' r= 0.73' n= 0.030 Earth, grassed & winding
3.8	620	Total			

Subcatchment 5BC:



Summary for Subcatchment 6A:

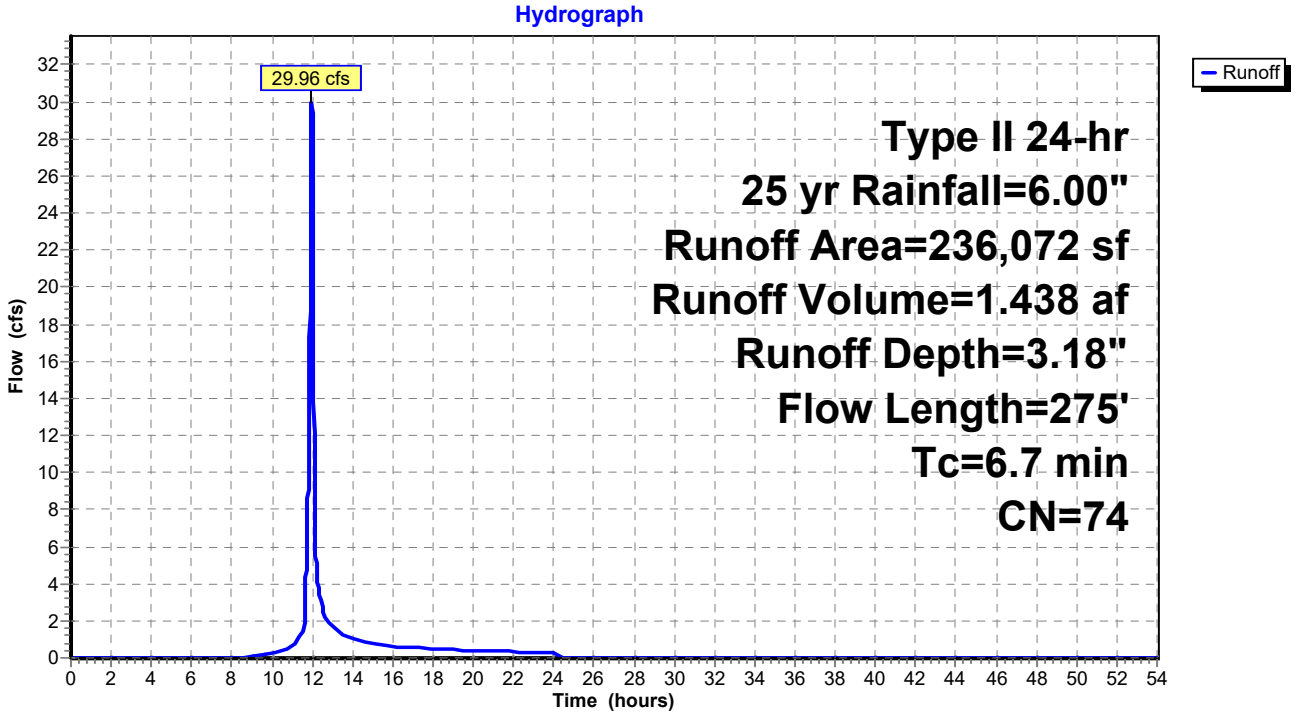
Runoff = 29.96 cfs @ 11.98 hrs, Volume= 1.438 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
236,072	74	>75% Grass cover, Good, HSG C
236,072		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	75	0.1670	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.7	275	Total			

Subcatchment 6A:



Summary for Subcatchment 6B:

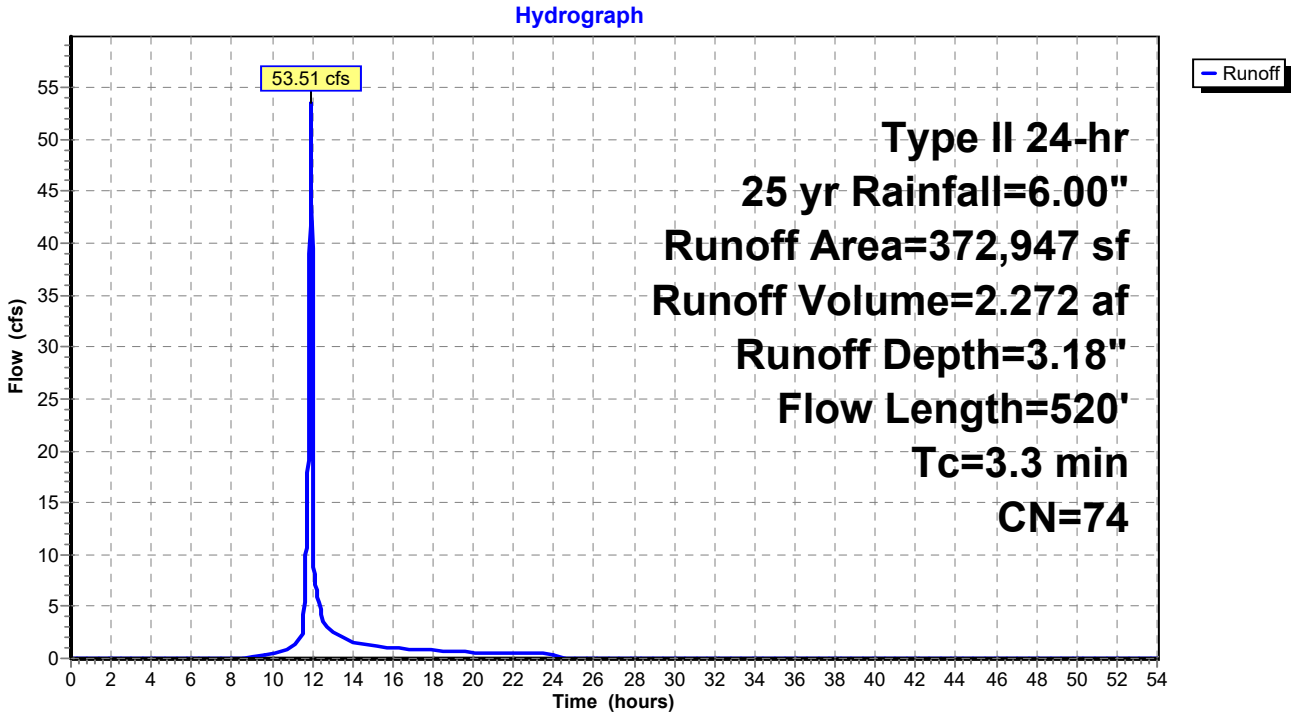
Runoff = 53.51 cfs @ 11.94 hrs, Volume= 2.272 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
372,947	74	>75% Grass cover, Good, HSG C
372,947		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	60	0.3333	0.47		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.2	460	0.0250	6.32	49.92	**Channel Flow,** Area= 7.9 sf Perim= 10.9' r= 0.72' n= 0.030 Earth, grassed & winding
3.3	520	Total			

Subcatchment 6B:



Summary for Subcatchment 7A:

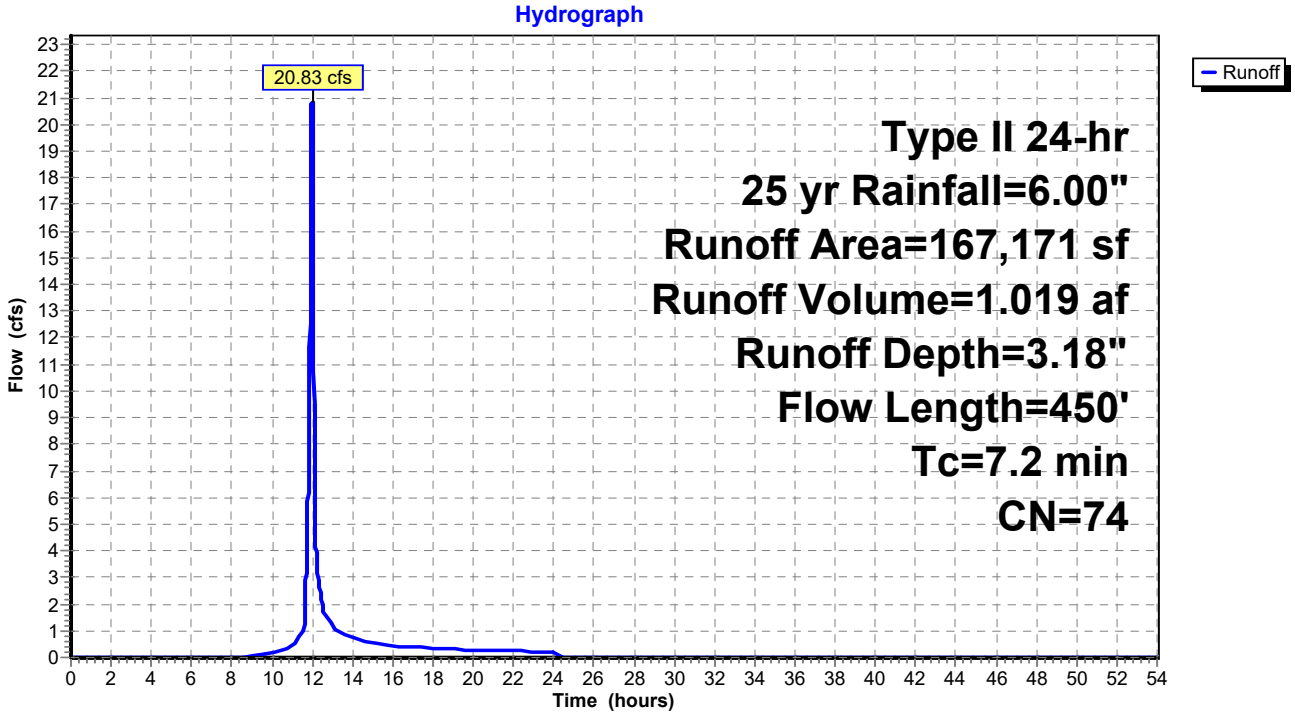
Runoff = 20.83 cfs @ 11.99 hrs, Volume= 1.019 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
167,171	74	>75% Grass cover, Good, HSG C
167,171		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	75	0.1670	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	175	0.0250	6.30	49.57	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 4.0 '/' Top.W=10.50' n= 0.030 Earth, grassed & winding
7.2	450	Total			

Subcatchment 7A:



Summary for Subcatchment 7B:

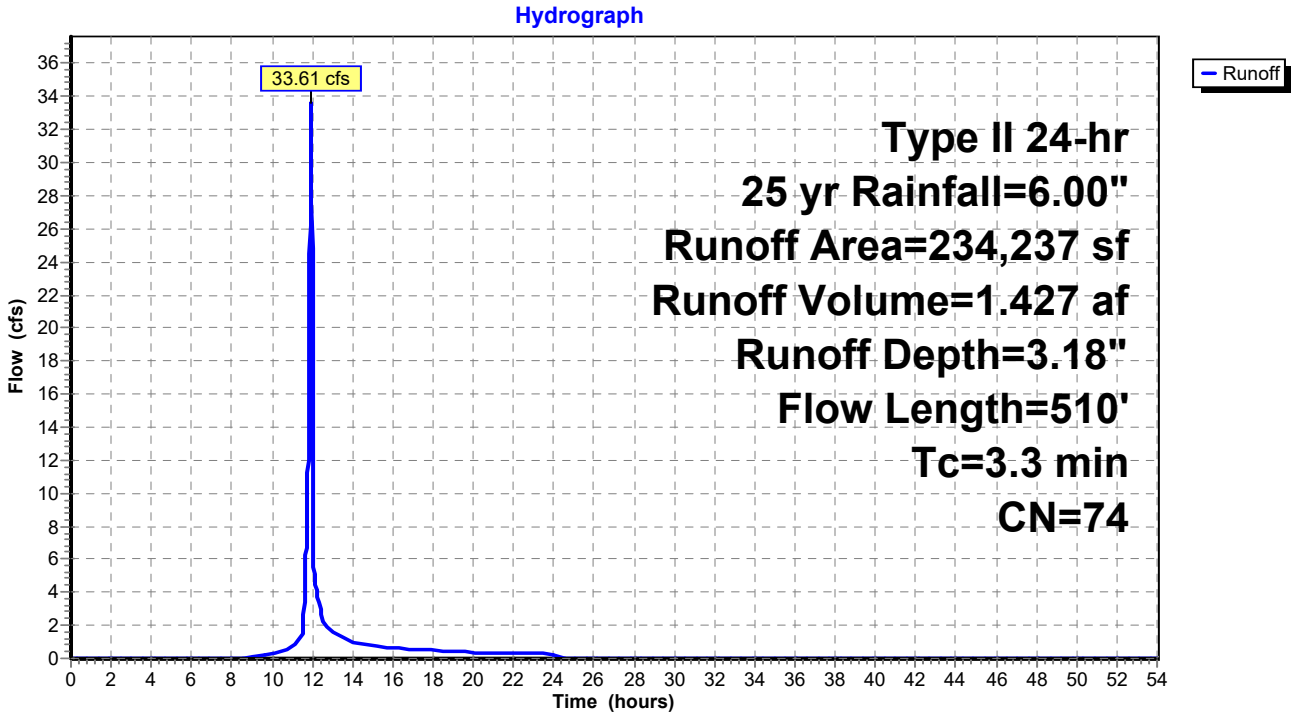
Runoff = 33.61 cfs @ 11.94 hrs, Volume= 1.427 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
234,237	74	>75% Grass cover, Good, HSG C
234,237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	60	0.3333	0.47		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.2	450	0.0250	6.32	49.92	**Channel Flow,** Area= 7.9 sf Perim= 10.9' r= 0.72' n= 0.030 Earth, grassed & winding
3.3	510	Total			

Subcatchment 7B:



Summary for Subcatchment DA12:

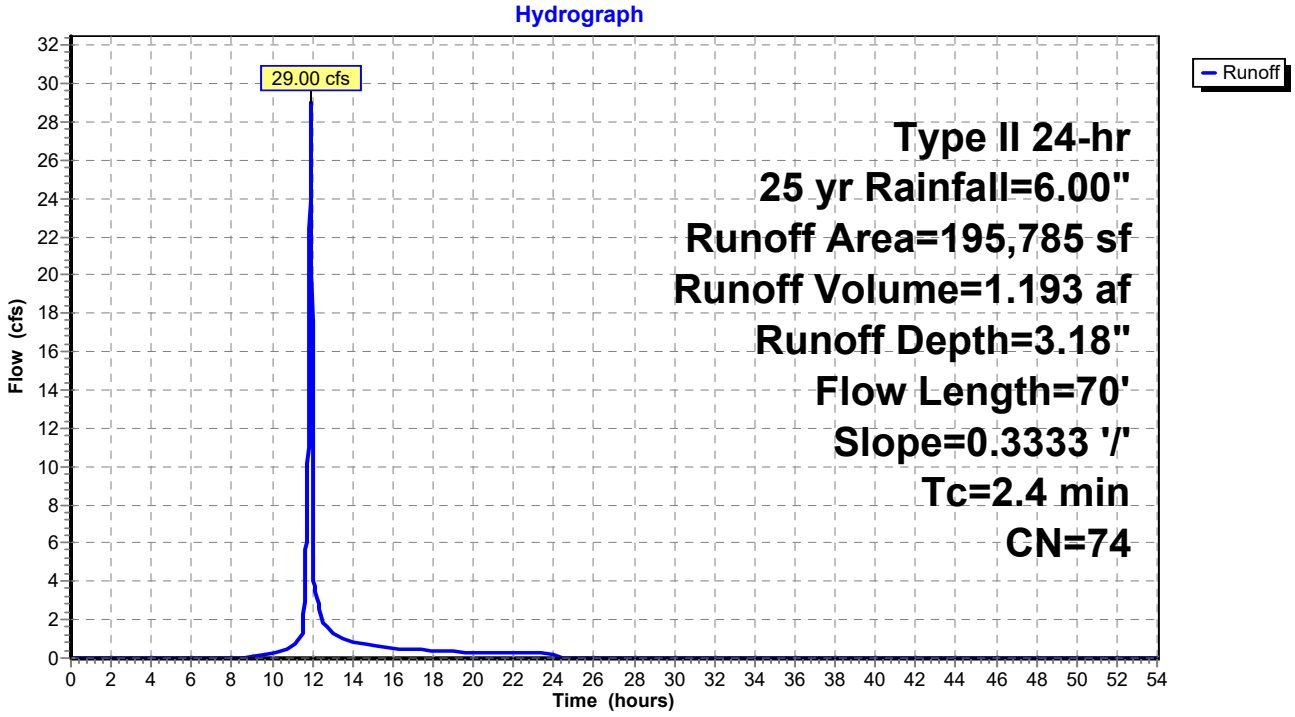
Runoff = 29.00 cfs @ 11.93 hrs, Volume= 1.193 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
195,785	74	>75% Grass cover, Good, HSG C
195,785		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA12:



Summary for Subcatchment DA13:

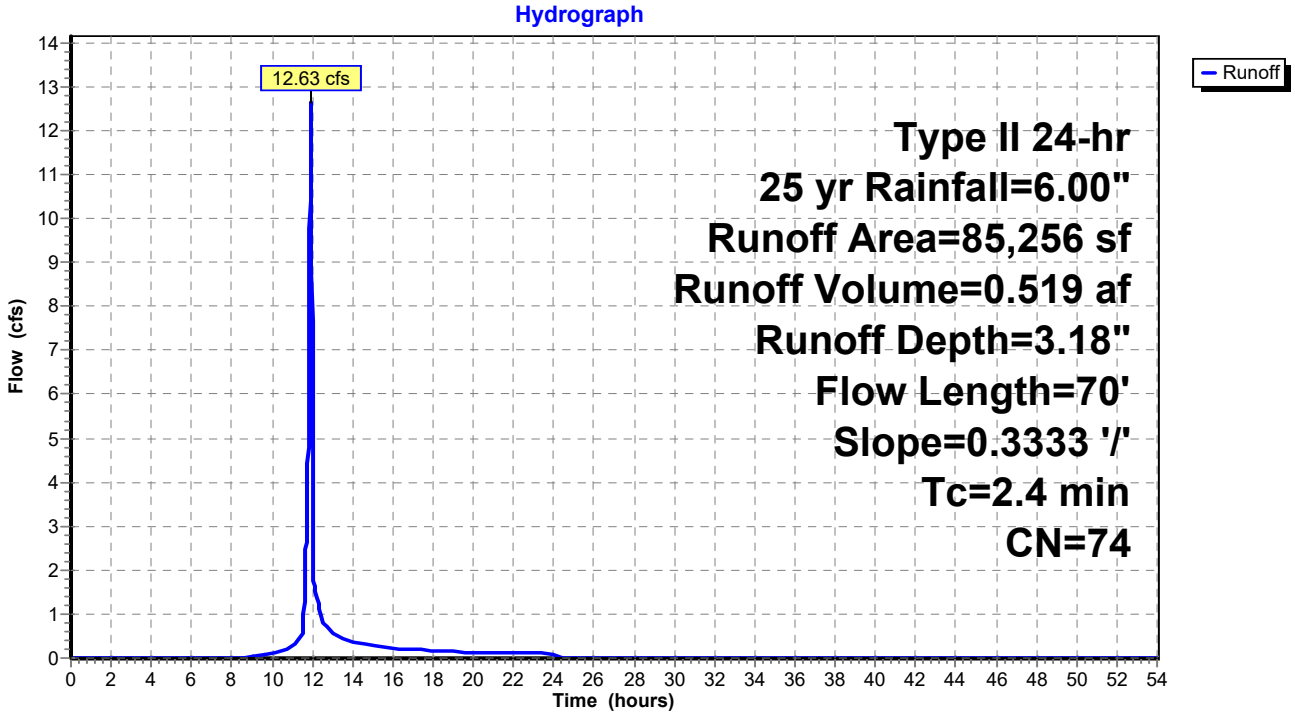
Runoff = 12.63 cfs @ 11.93 hrs, Volume= 0.519 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
85,256	74	>75% Grass cover, Good, HSG C
85,256		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA13:



Summary for Subcatchment DA14:

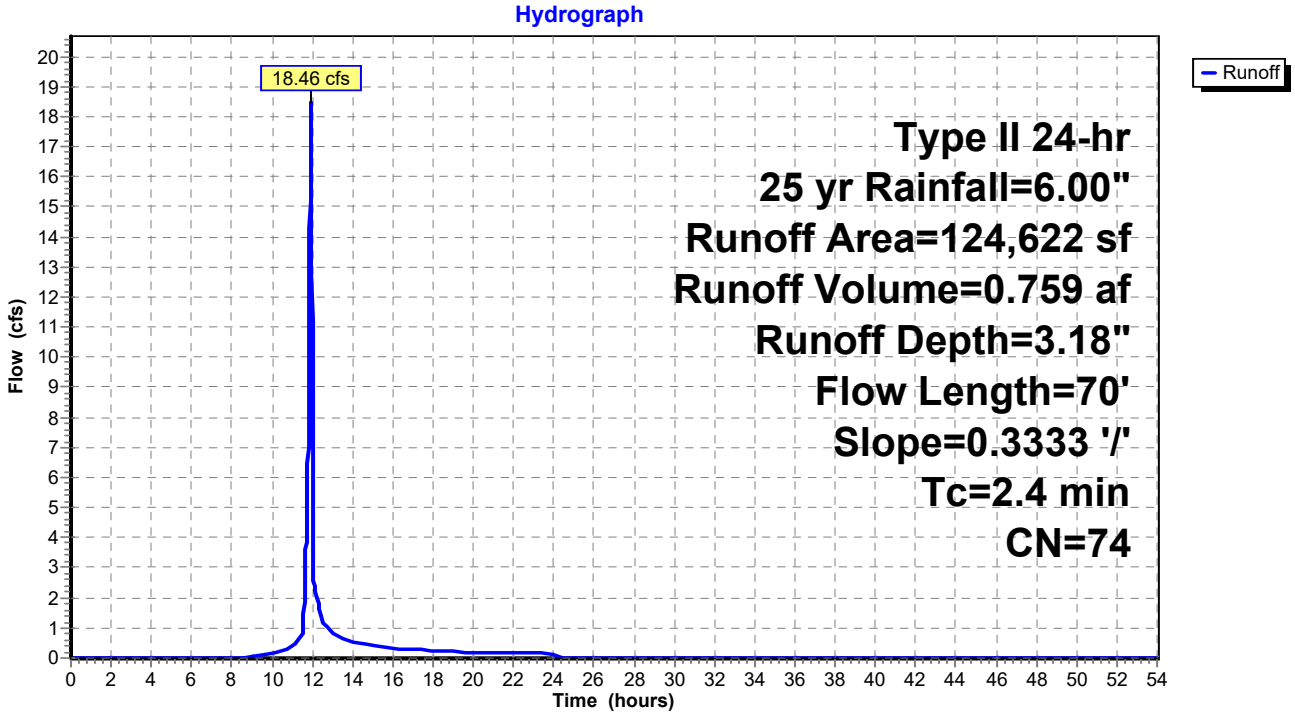
Runoff = 18.46 cfs @ 11.93 hrs, Volume= 0.759 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
124,622	74	>75% Grass cover, Good, HSG C
124,622		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA14:



Summary for Subcatchment DA15:

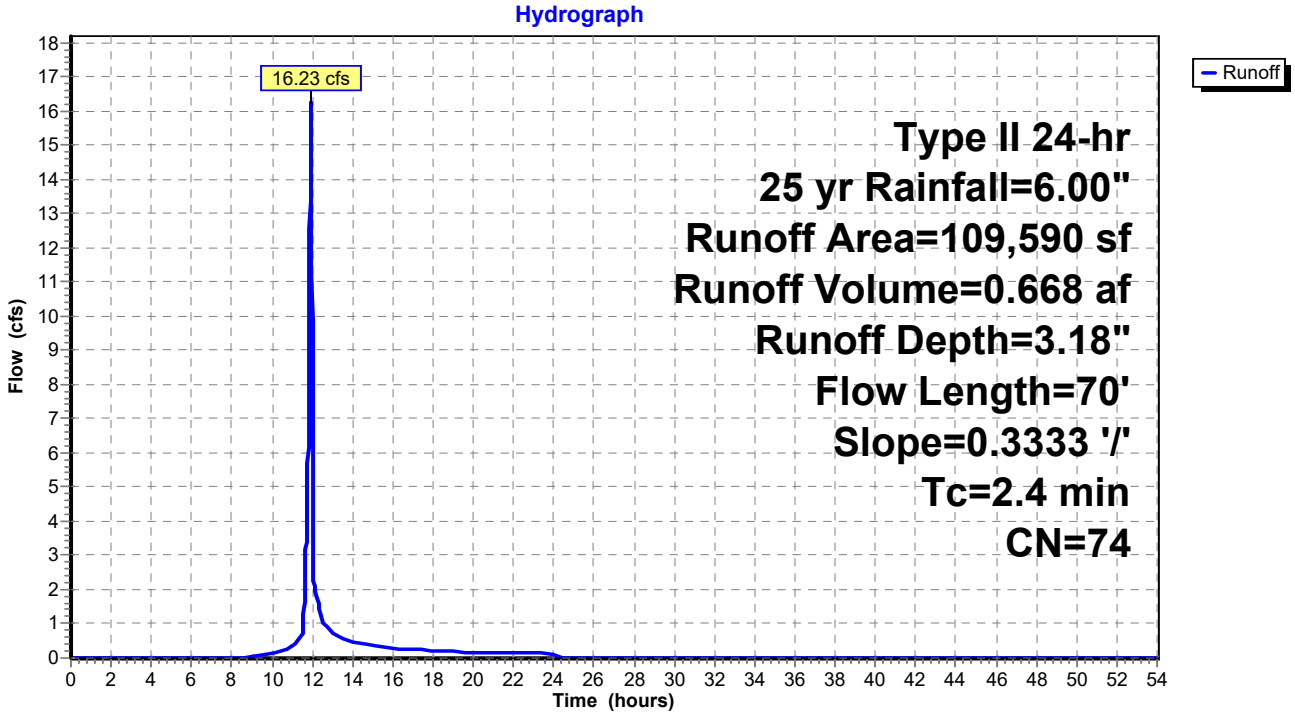
Runoff = 16.23 cfs @ 11.93 hrs, Volume= 0.668 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
109,590	74	>75% Grass cover, Good, HSG C
109,590		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA15:



Summary for Subcatchment PR1:

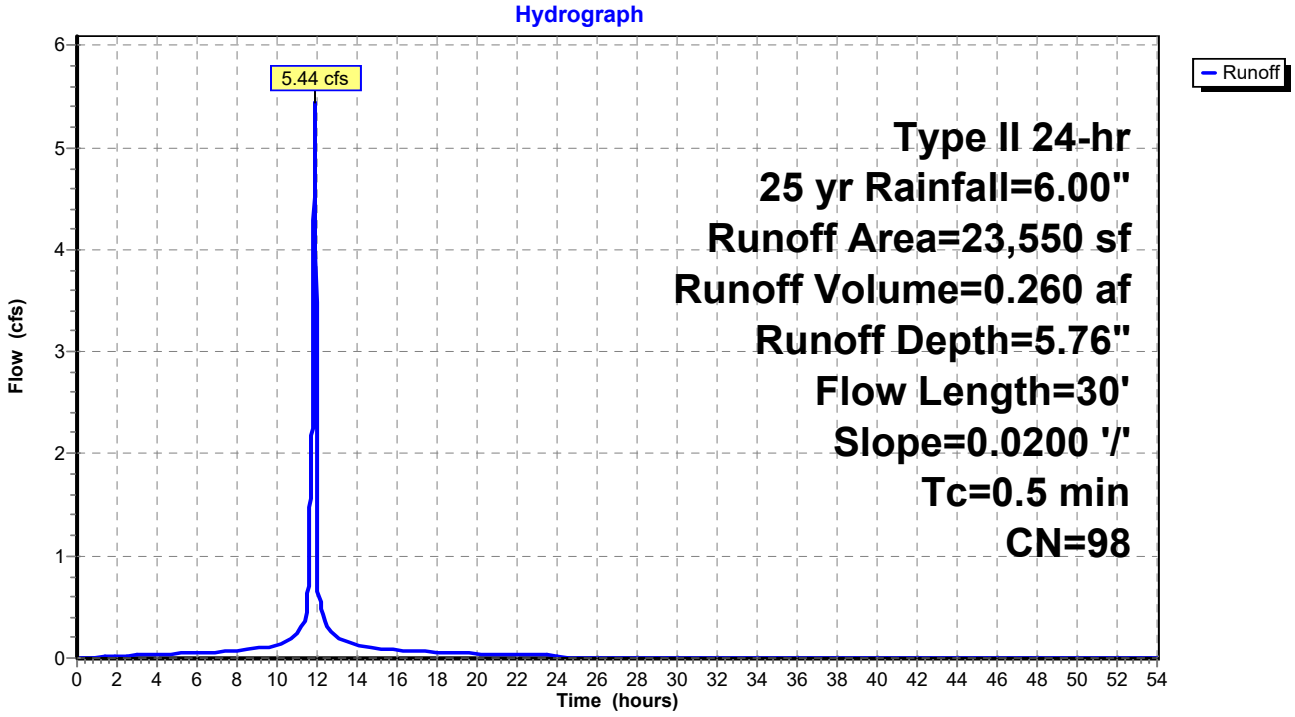
Runoff = 5.44 cfs @ 11.91 hrs, Volume= 0.260 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
23,550	98	Paved parking, HSG C
23,550		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR1:



Summary for Subcatchment PR11:

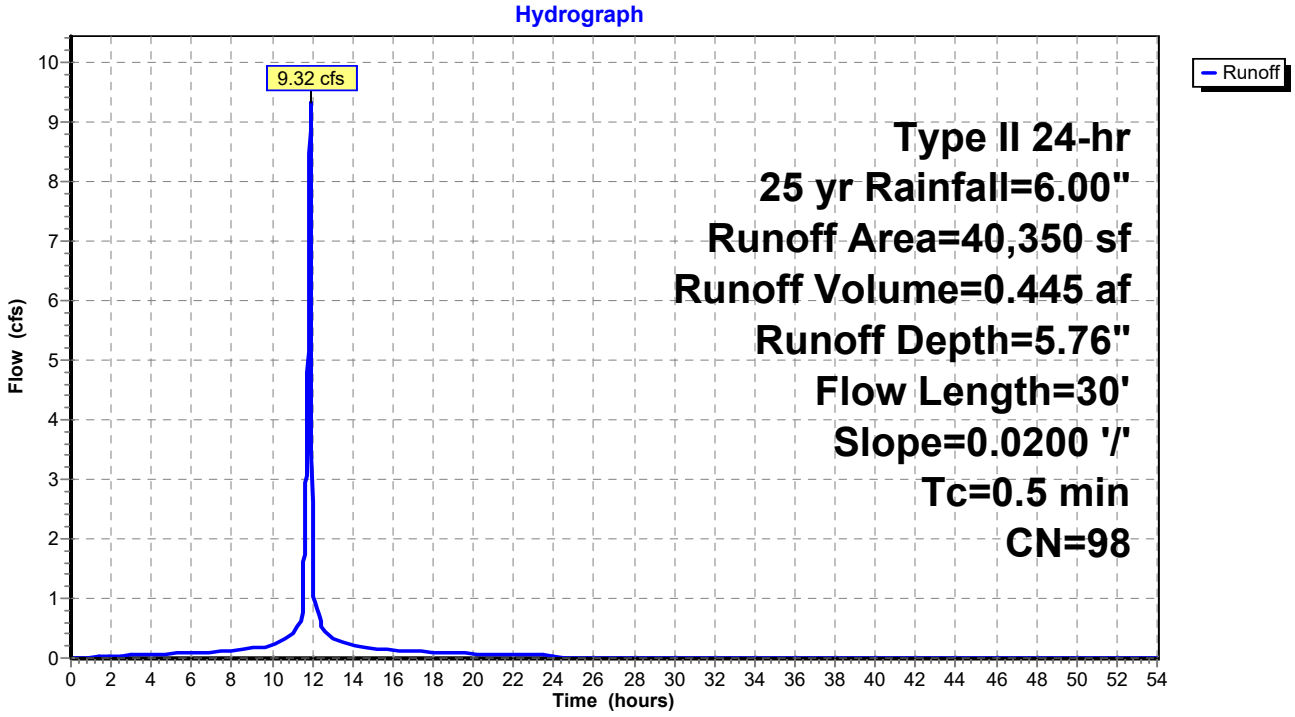
Runoff = 9.32 cfs @ 11.91 hrs, Volume= 0.445 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
40,350	98	Paved parking, HSG C
40,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR11:



Summary for Subcatchment PR2:

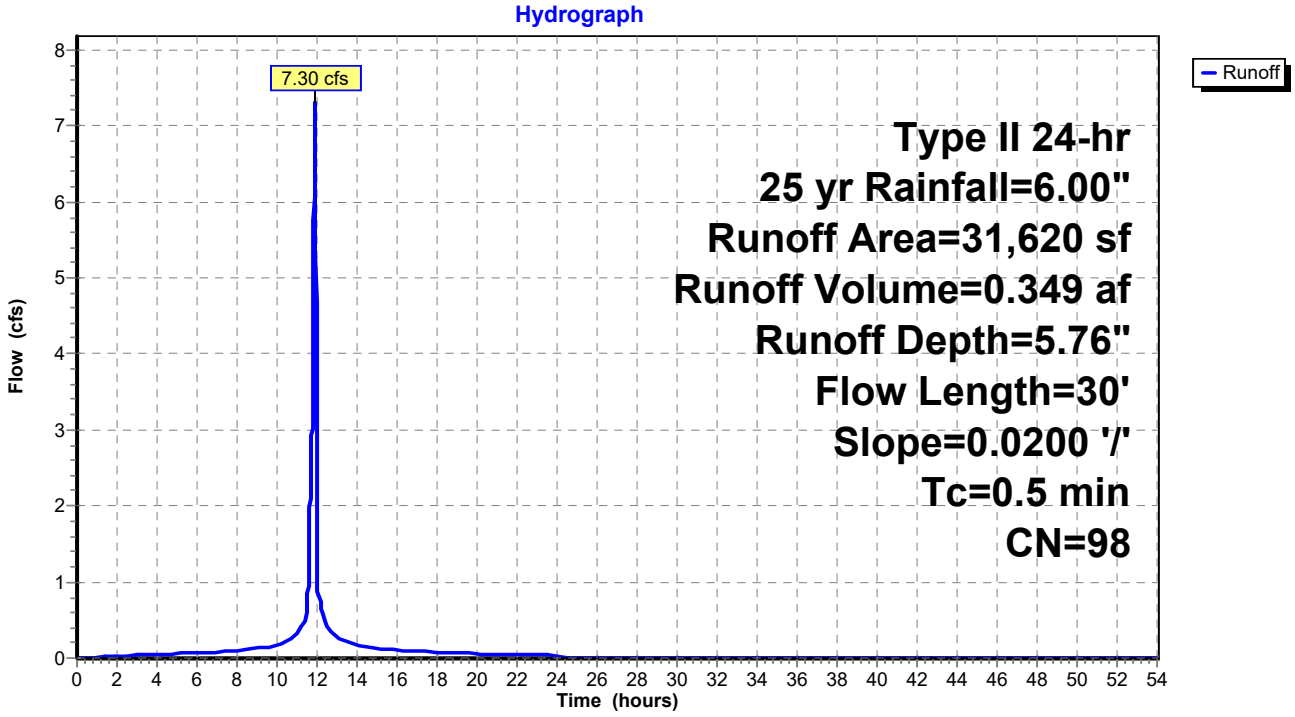
Runoff = 7.30 cfs @ 11.91 hrs, Volume= 0.349 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
31,620	98	Paved parking, HSG C
31,620		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR2:



Summary for Subcatchment PR3:

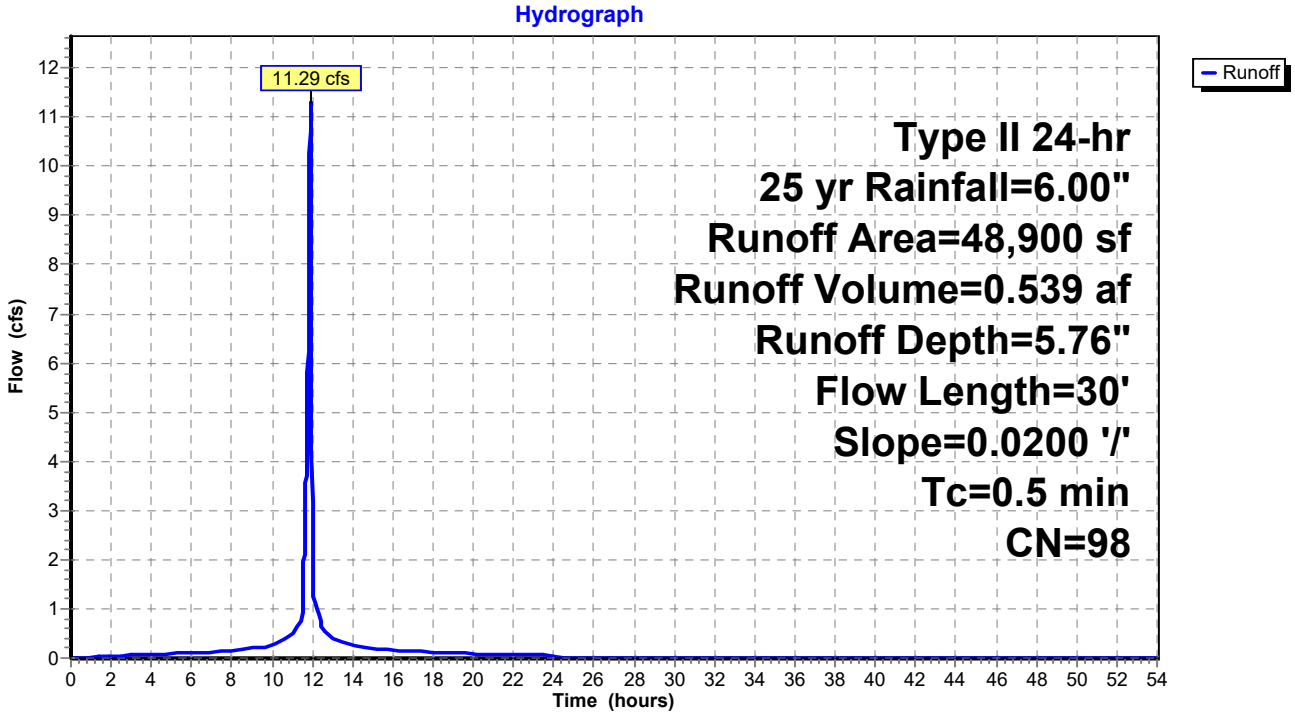
Runoff = 11.29 cfs @ 11.91 hrs, Volume= 0.539 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
48,900	98	Paved parking, HSG C
48,900		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR3:



Summary for Subcatchment PR4:

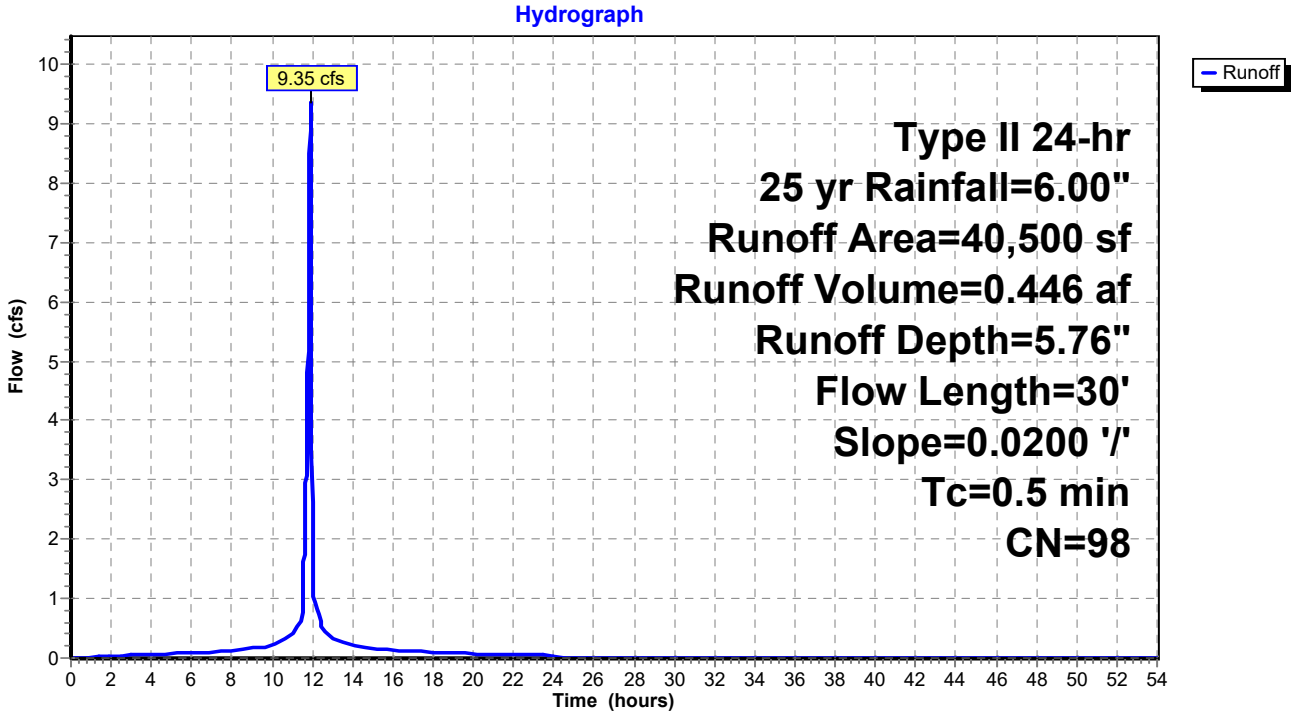
Runoff = 9.35 cfs @ 11.91 hrs, Volume= 0.446 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
40,500	98	Paved parking, HSG C
40,500		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR4:



Summary for Subcatchment PR91:

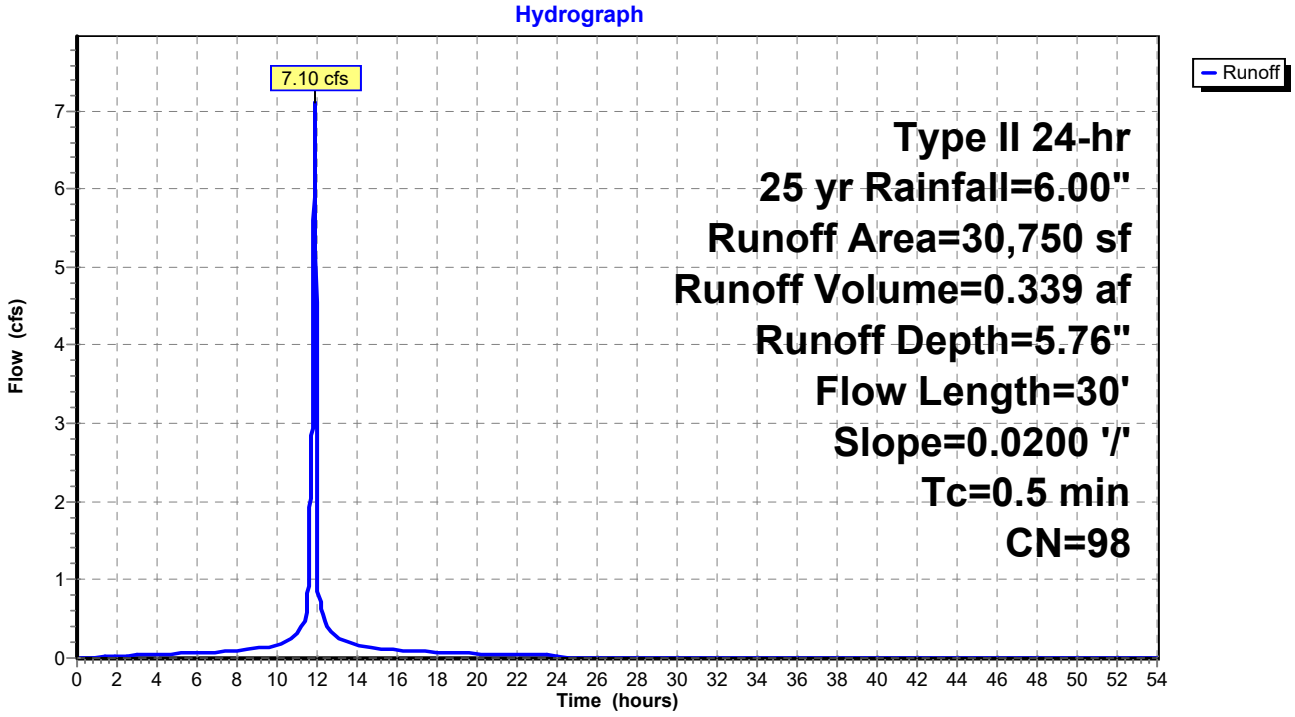
Runoff = 7.10 cfs @ 11.91 hrs, Volume= 0.339 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
30,750	98	Paved parking, HSG C
30,750		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR91:



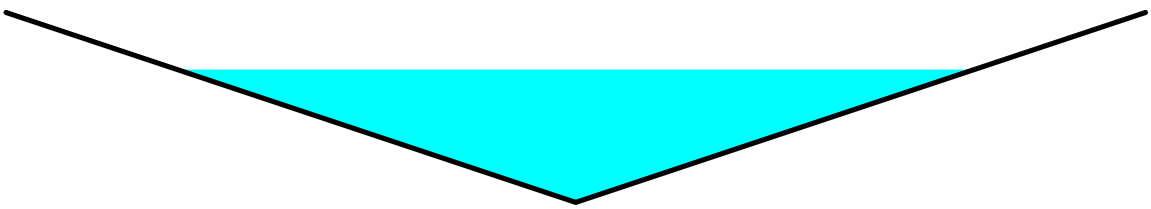
Summary for Reach B1:

Inflow Area = 5.856 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 32.37 cfs @ 11.98 hrs, Volume= 1.554 af
Outflow = 31.54 cfs @ 12.00 hrs, Volume= 1.554 af, Atten= 3%, Lag= 1.0 min

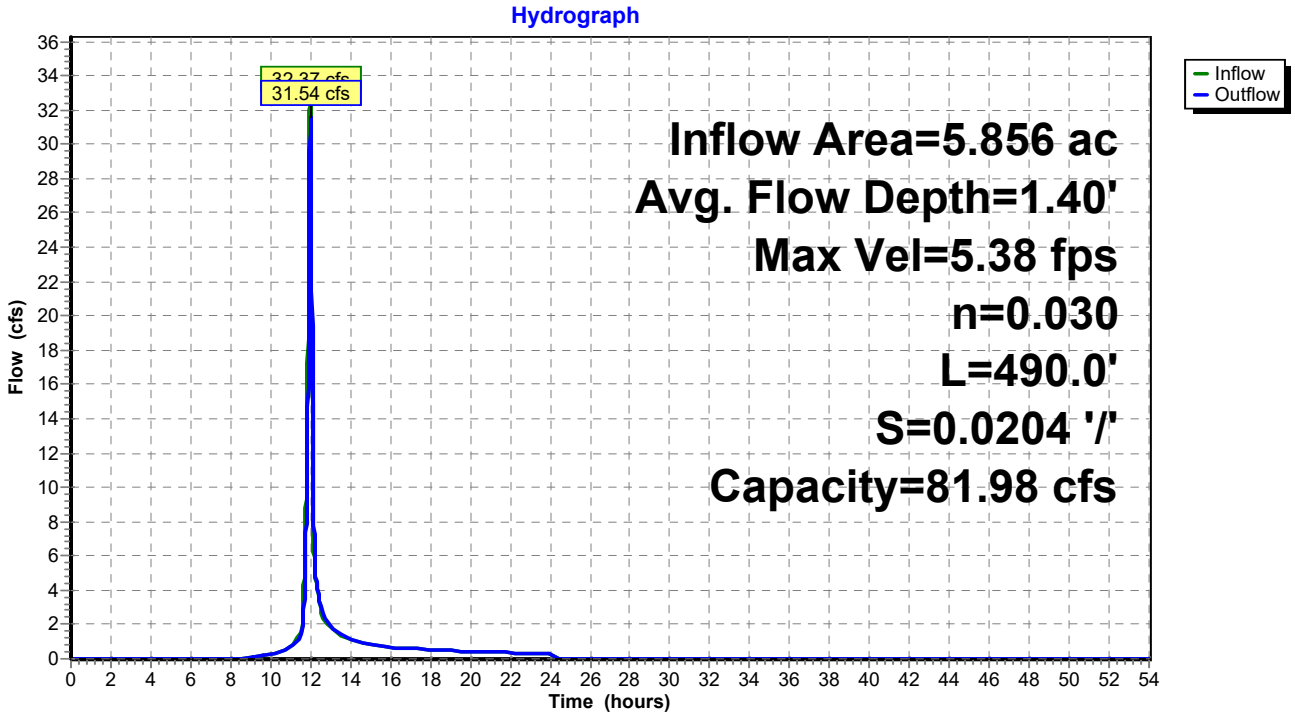
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.38 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.82 fps, Avg. Travel Time= 4.5 min

Peak Storage= 2,872 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.40'
Defined Flood Depth= 2.00' Flow Area= 12.0 sf, Capacity= 81.98 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 81.98 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 490.0' Slope= 0.0204 '/'
Inlet Invert= 180.00', Outlet Invert= 170.00'



Reach B1:



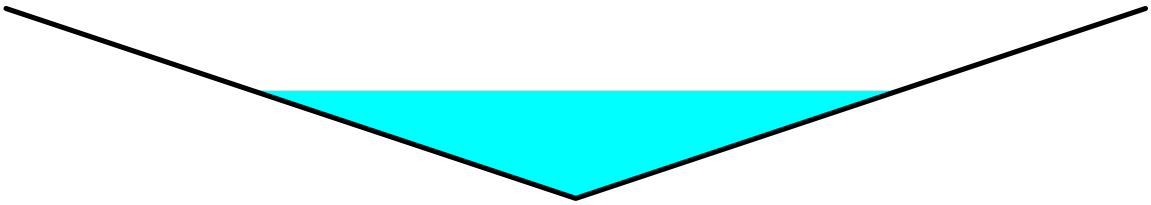
Summary for Reach B5:

Inflow Area = 3.651 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 18.49 cfs @ 12.01 hrs, Volume= 0.969 af
Outflow = 17.98 cfs @ 12.03 hrs, Volume= 0.969 af, Atten= 3%, Lag= 1.3 min

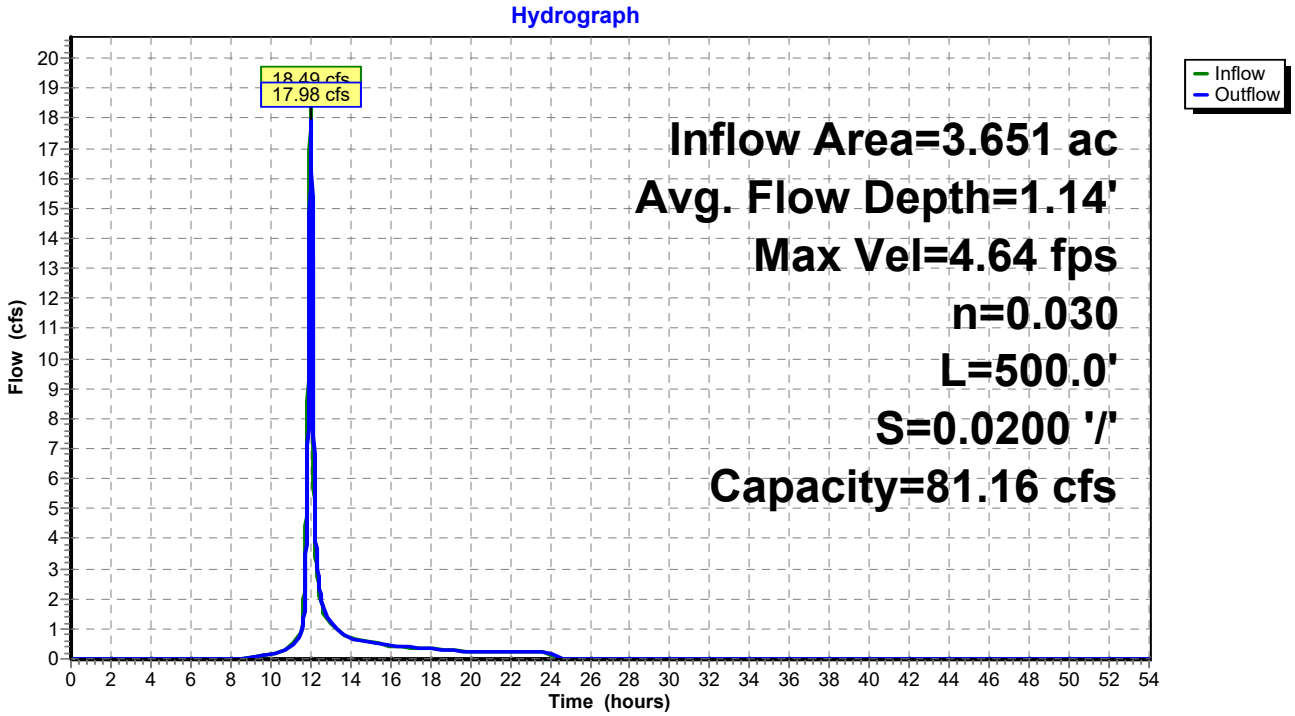
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.64 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.61 fps, Avg. Travel Time= 5.2 min

Peak Storage= 1,937 cf @ 12.03 hrs
Average Depth at Peak Storage= 1.14'
Defined Flood Depth= 1.75' Flow Area= 9.2 sf, Capacity= 56.85 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 81.16 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 500.0' Slope= 0.0200 '/'
Inlet Invert= 180.00', Outlet Invert= 170.00'



Reach B5:



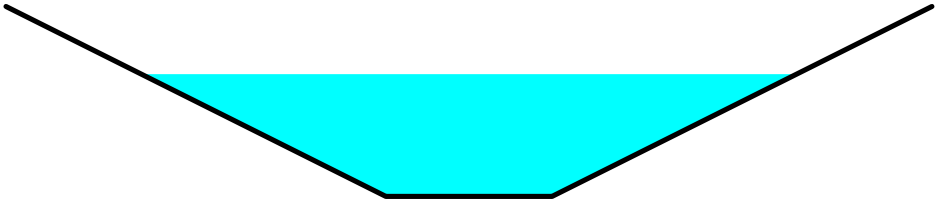
Summary for Reach CH1: CH1-Existing

Inflow Area = 45.015 ac, 8.94% Impervious, Inflow Depth = 3.42" for 25 yr event
Inflow = 220.79 cfs @ 11.97 hrs, Volume= 12.812 af
Outflow = 217.04 cfs @ 11.99 hrs, Volume= 12.812 af, Atten= 2%, Lag= 1.0 min

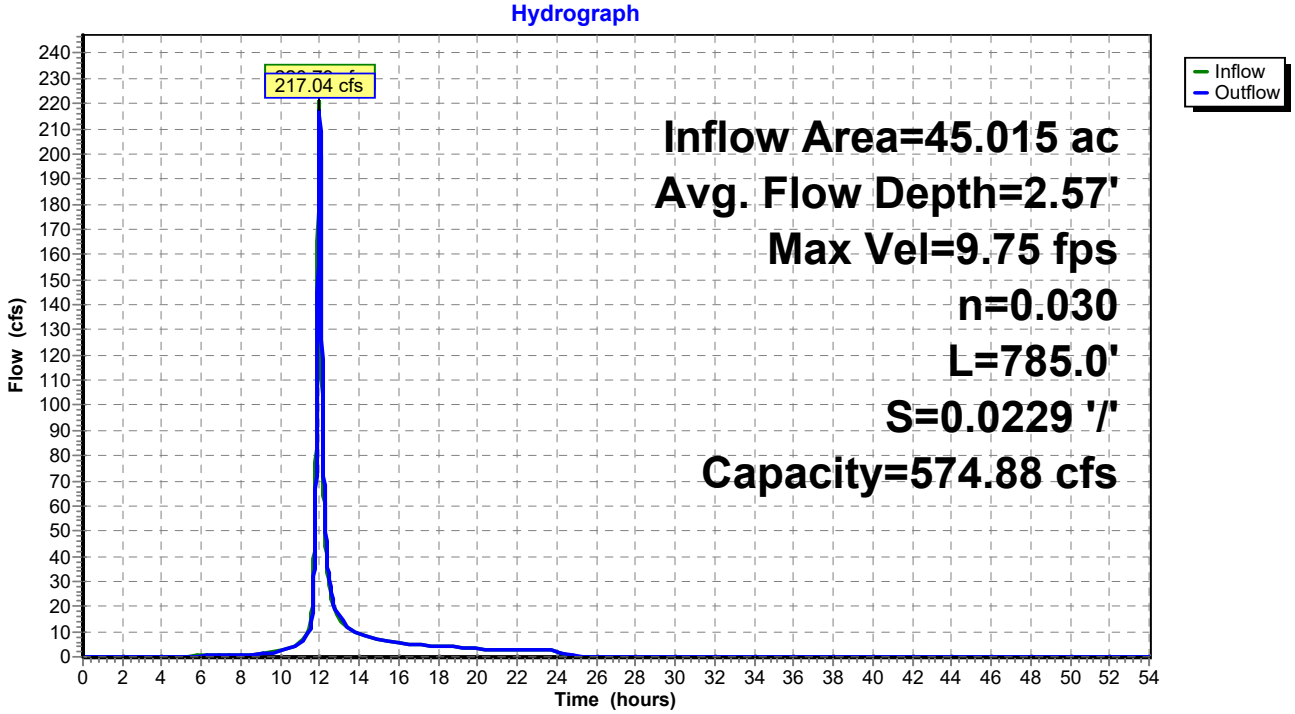
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.75 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 2.27 fps, Avg. Travel Time= 5.8 min

Peak Storage= 17,469 cf @ 11.99 hrs
Average Depth at Peak Storage= 2.57'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 496.87 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 574.88 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 785.0' Slope= 0.0229 '/'
Inlet Invert= 40.00', Outlet Invert= 22.00'



Reach CH1: CH1-Existing



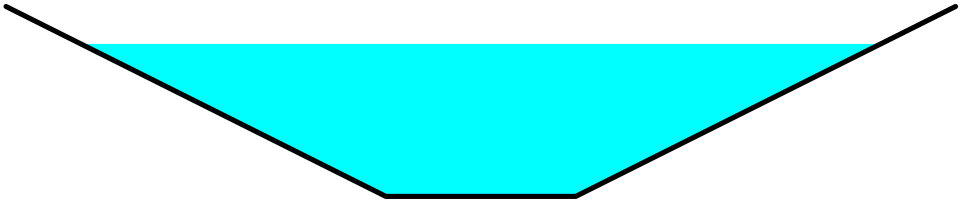
Summary for Reach CH11: CH11-Proposed

Inflow Area = 5.421 ac, 17.09% Impervious, Inflow Depth = 3.63" for 25 yr event
Inflow = 36.89 cfs @ 11.92 hrs, Volume= 1.638 af
Outflow = 28.12 cfs @ 11.97 hrs, Volume= 1.638 af, Atten= 24%, Lag= 2.7 min

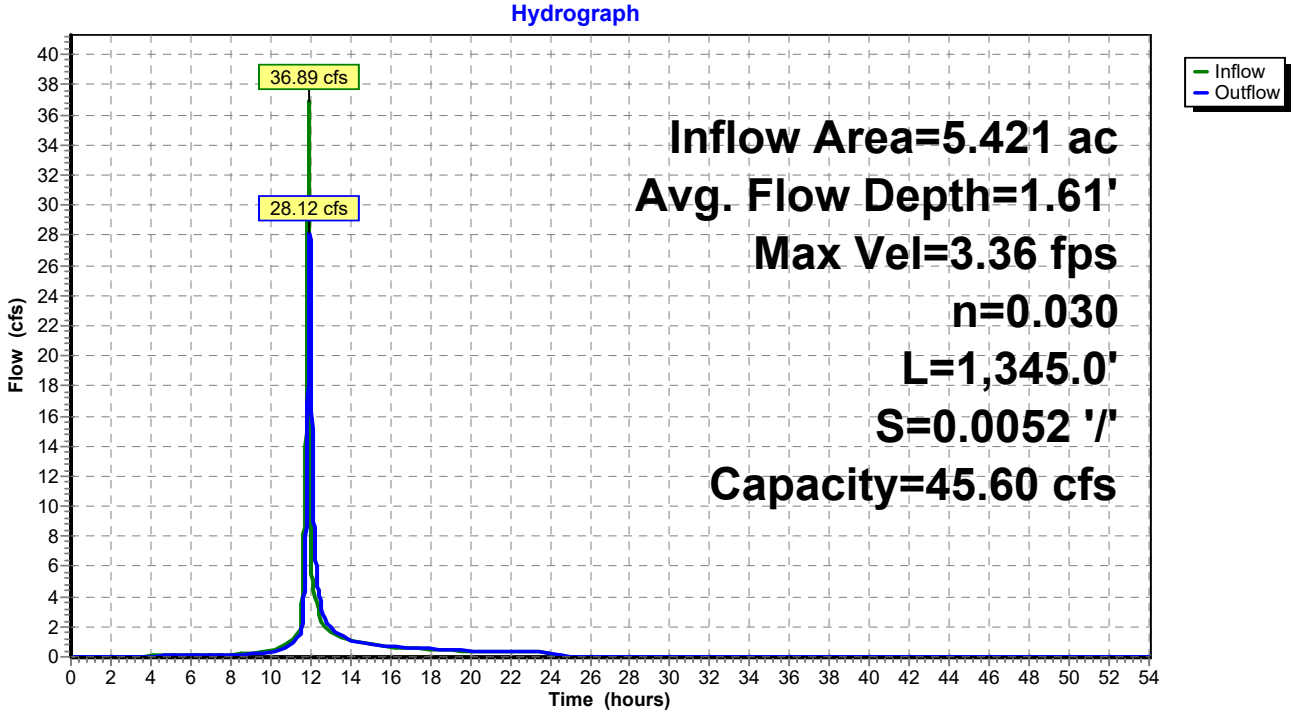
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.36 fps, Min. Travel Time= 6.7 min
Avg. Velocity = 0.75 fps, Avg. Travel Time= 29.8 min

Peak Storage= 11,257 cf @ 11.97 hrs
Average Depth at Peak Storage= 1.61'
Defined Flood Depth= 1.75' Flow Area= 9.6 sf, Capacity= 33.92 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 45.60 cfs

2.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,345.0' Slope= 0.0052 '/'
Inlet Invert= 30.00', Outlet Invert= 23.00'



Reach CH11: CH11-Proposed



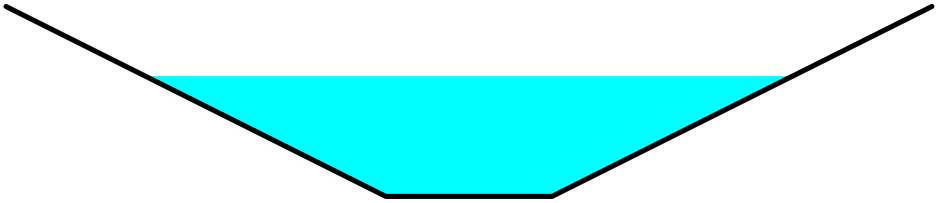
Summary for Reach CH2: CH2-Existing

Inflow Area = 28.536 ac, 12.21% Impervious, Inflow Depth = 3.50" for 25 yr event
Inflow = 143.88 cfs @ 11.96 hrs, Volume= 8.322 af
Outflow = 134.91 cfs @ 11.99 hrs, Volume= 8.322 af, Atten= 6%, Lag= 1.9 min

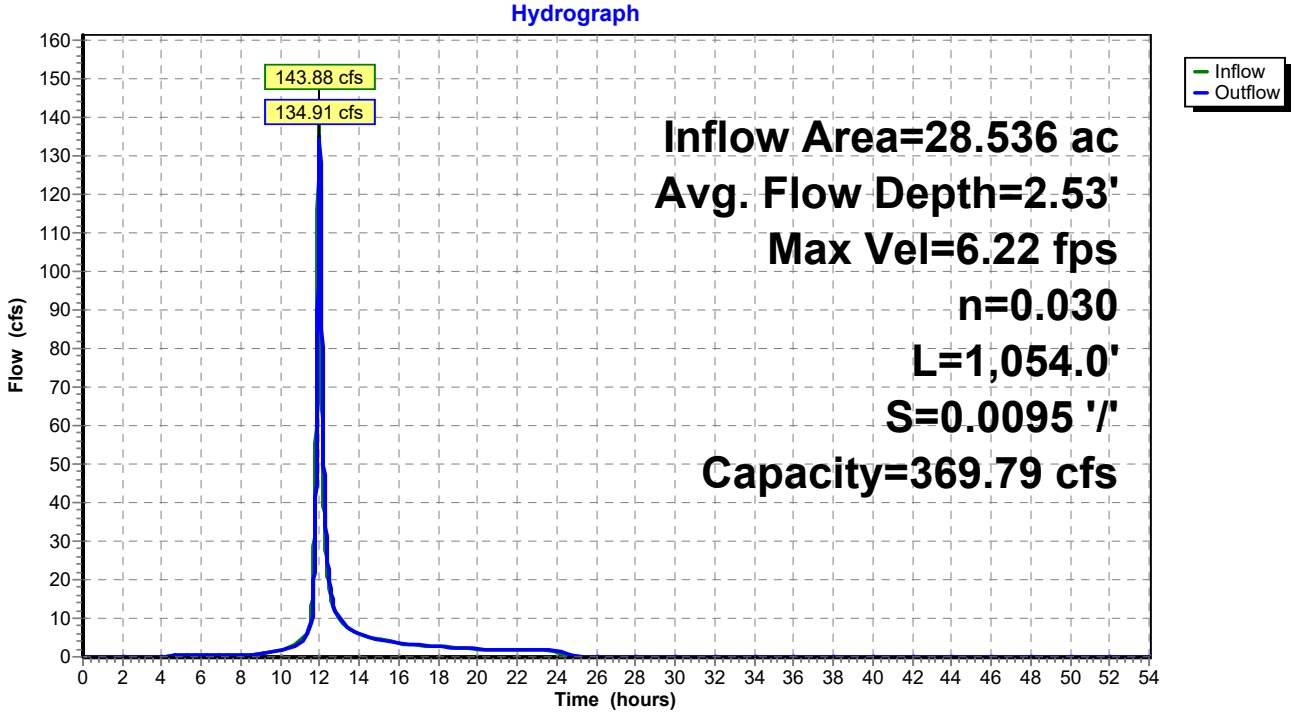
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.22 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 11.8 min

Peak Storage= 22,866 cf @ 11.99 hrs
Average Depth at Peak Storage= 2.53'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 319.61 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 369.79 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 1,054.0' Slope= 0.0095 '/'
Inlet Invert= 50.00', Outlet Invert= 40.00'



Reach CH2: CH2-Existing



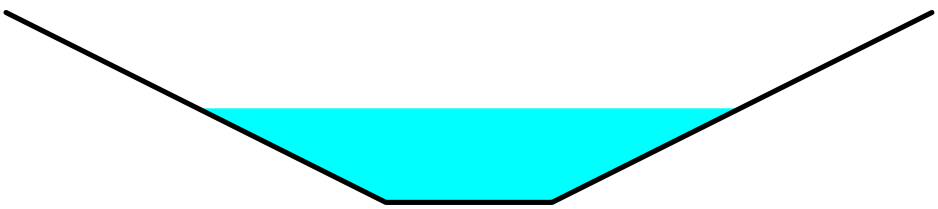
Summary for Reach CH3: CH3-Existing

Inflow Area = 15.734 ac, 17.53% Impervious, Inflow Depth = 3.64" for 25 yr event
Inflow = 77.22 cfs @ 11.95 hrs, Volume= 4.768 af
Outflow = 73.95 cfs @ 11.98 hrs, Volume= 4.768 af, Atten= 4%, Lag= 1.8 min

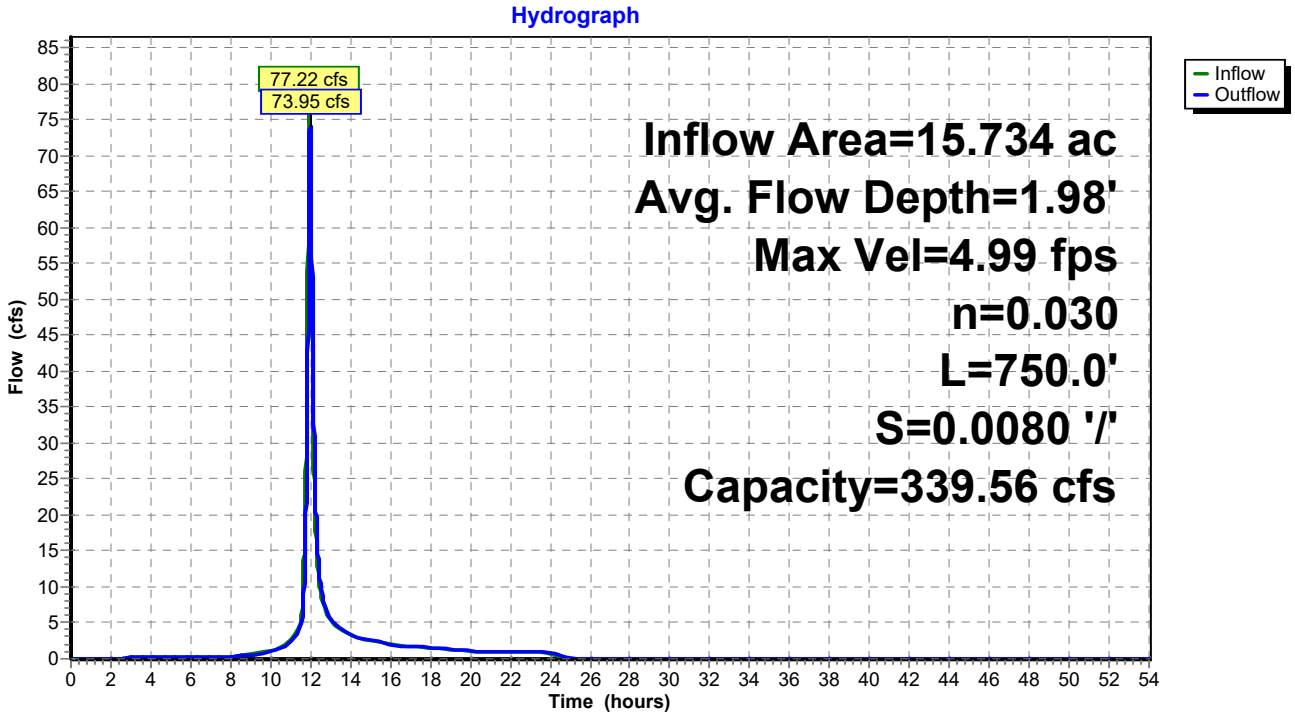
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.99 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 10.2 min

Peak Storage= 11,104 cf @ 11.98 hrs
Average Depth at Peak Storage= 1.98'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 293.49 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 339.56 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 750.0' Slope= 0.0080 '/'
Inlet Invert= 56.00', Outlet Invert= 50.00'



Reach CH3: CH3-Existing



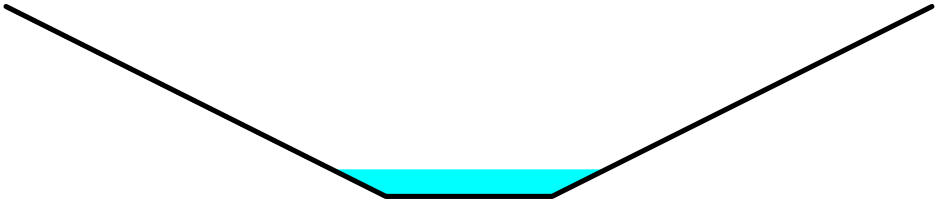
Summary for Reach CH4: CH4-Existing

Inflow Area = 0.930 ac,100.00% Impervious, Inflow Depth = 5.76" for 25 yr event
Inflow = 9.35 cfs @ 11.91 hrs, Volume= 0.446 af
Outflow = 6.46 cfs @ 11.94 hrs, Volume= 0.446 af, Atten= 31%, Lag= 2.4 min

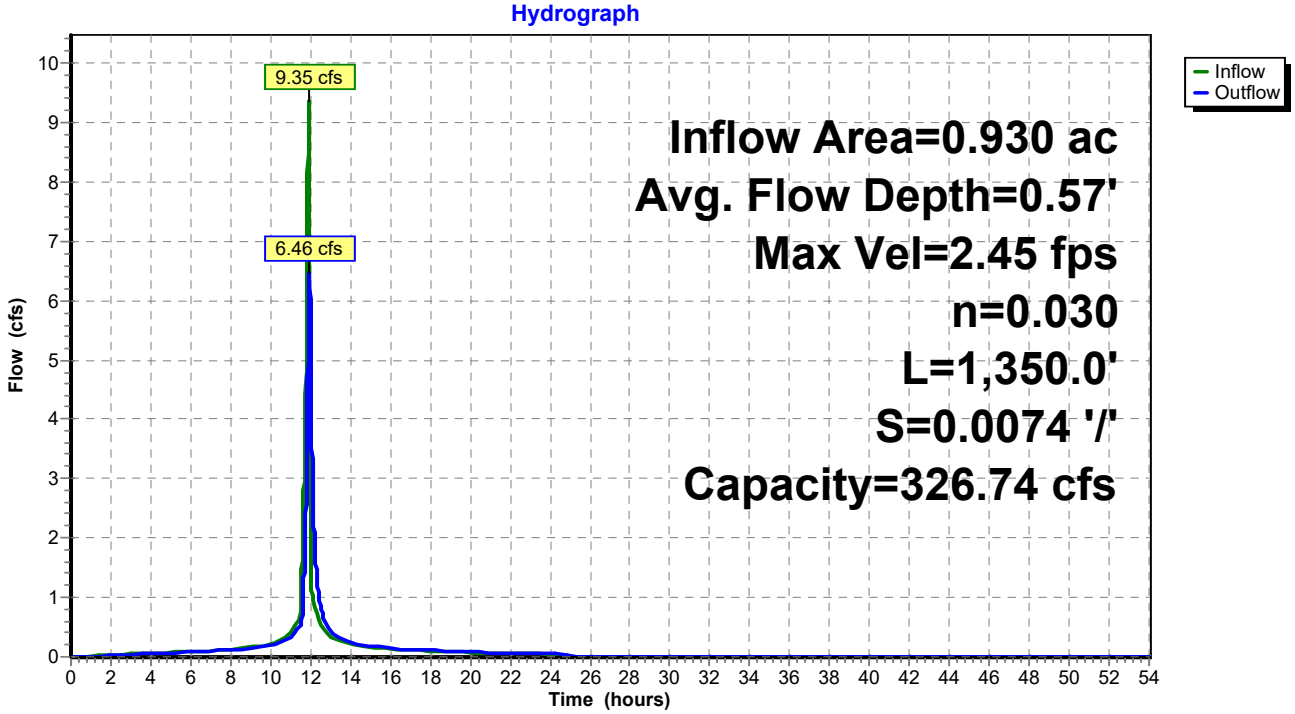
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.45 fps, Min. Travel Time= 9.2 min
Avg. Velocity = 0.63 fps, Avg. Travel Time= 35.9 min

Peak Storage= 3,555 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.57'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 282.41 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 326.74 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 1,350.0' Slope= 0.0074 '/'
Inlet Invert= 70.00', Outlet Invert= 60.00'



Reach CH4: CH4-Existing



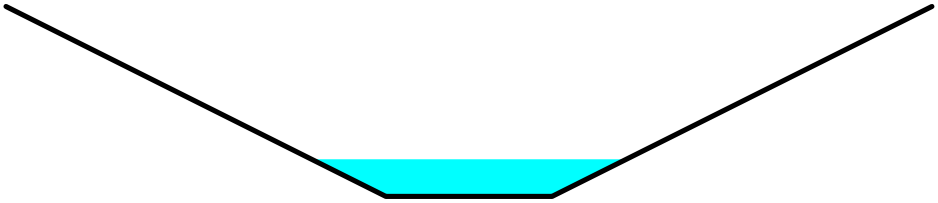
Summary for Reach CH90: CH90-existing

Inflow Area = 11.166 ac, 6.32% Impervious, Inflow Depth = 3.35" for 25 yr event
Inflow = 53.58 cfs @ 11.99 hrs, Volume= 3.115 af
Outflow = 53.57 cfs @ 11.99 hrs, Volume= 3.115 af, Atten= 0%, Lag= 0.1 min

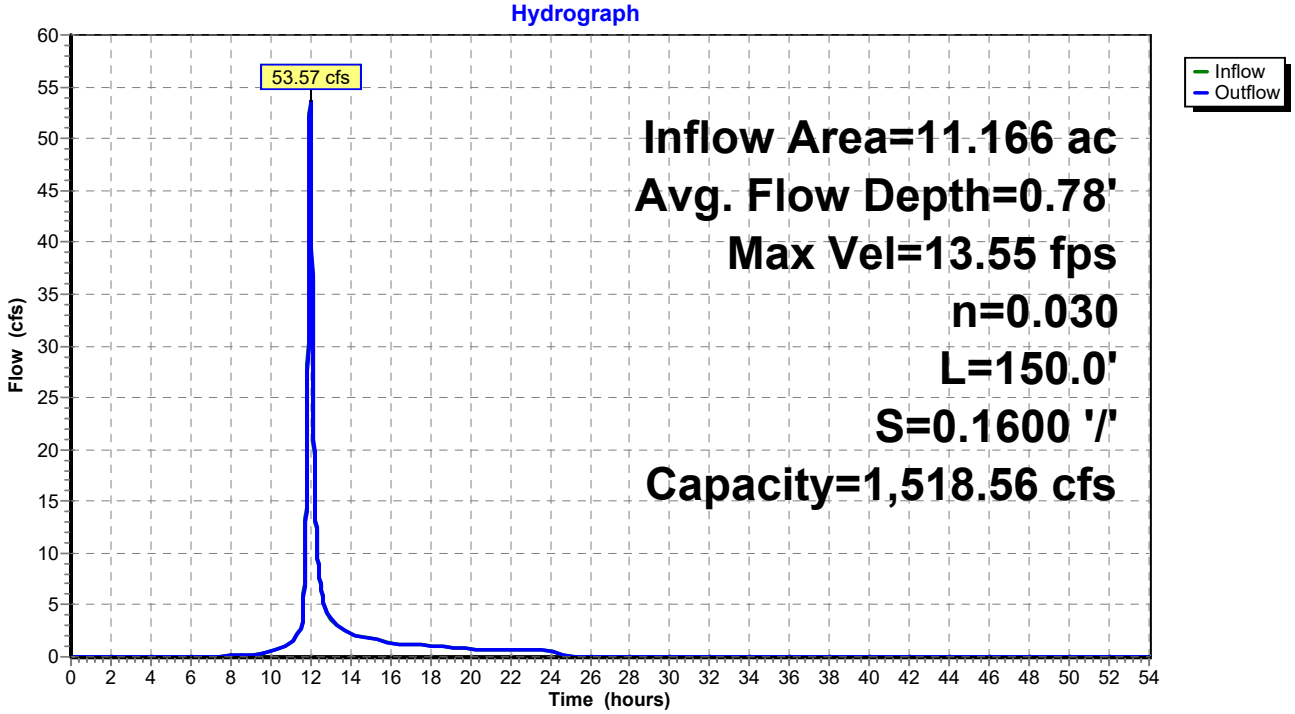
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.55 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.28 fps, Avg. Travel Time= 0.8 min

Peak Storage= 593 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.78'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 1,312.51 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 1,518.56 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 150.0' Slope= 0.1600 '/'
Inlet Invert= 80.00', Outlet Invert= 56.00'



Reach CH90: CH90-existing



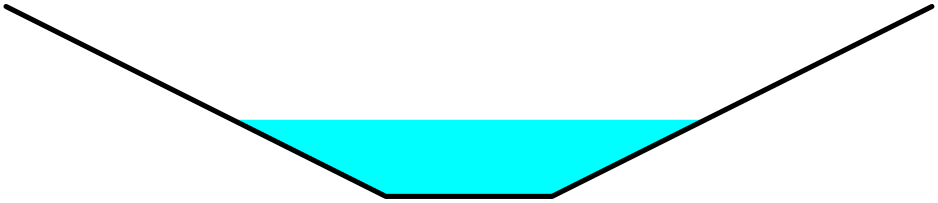
Summary for Reach CH91: CH91-Existing

Inflow Area = 11.166 ac, 6.32% Impervious, Inflow Depth = 3.35" for 25 yr event
Inflow = 58.87 cfs @ 11.95 hrs, Volume= 3.115 af
Outflow = 53.58 cfs @ 11.99 hrs, Volume= 3.115 af, Atten= 9%, Lag= 2.0 min

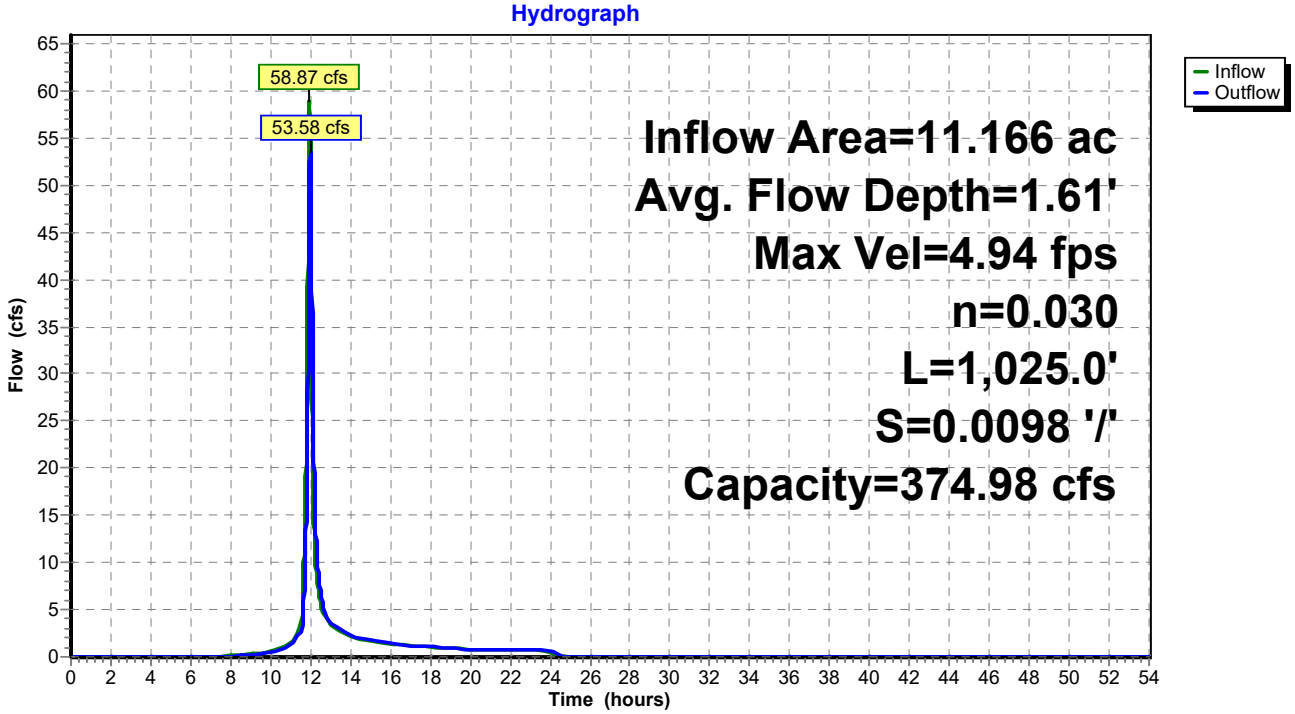
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.94 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 1.16 fps, Avg. Travel Time= 14.8 min

Peak Storage= 11,128 cf @ 11.99 hrs
Average Depth at Peak Storage= 1.61'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 324.10 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 374.98 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 1,025.0' Slope= 0.0098 '/'
Inlet Invert= 90.00', Outlet Invert= 80.00'



Reach CH91: CH91-Existing



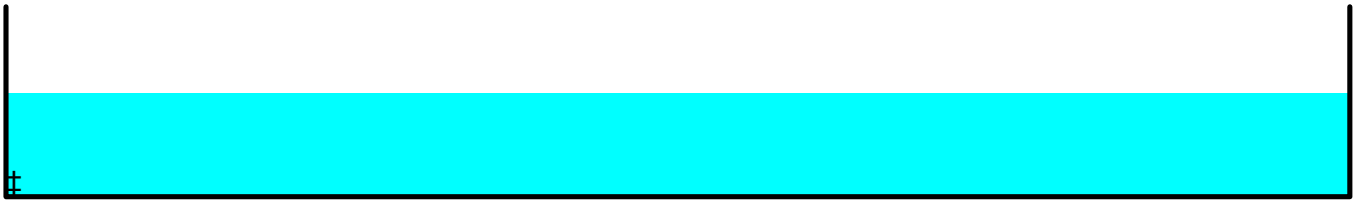
Summary for Reach DC1: DC1 Proposed

Inflow Area = 18.863 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 105.01 cfs @ 11.96 hrs, Volume= 5.006 af
Outflow = 104.65 cfs @ 11.96 hrs, Volume= 5.006 af, Atten= 0%, Lag= 0.4 min

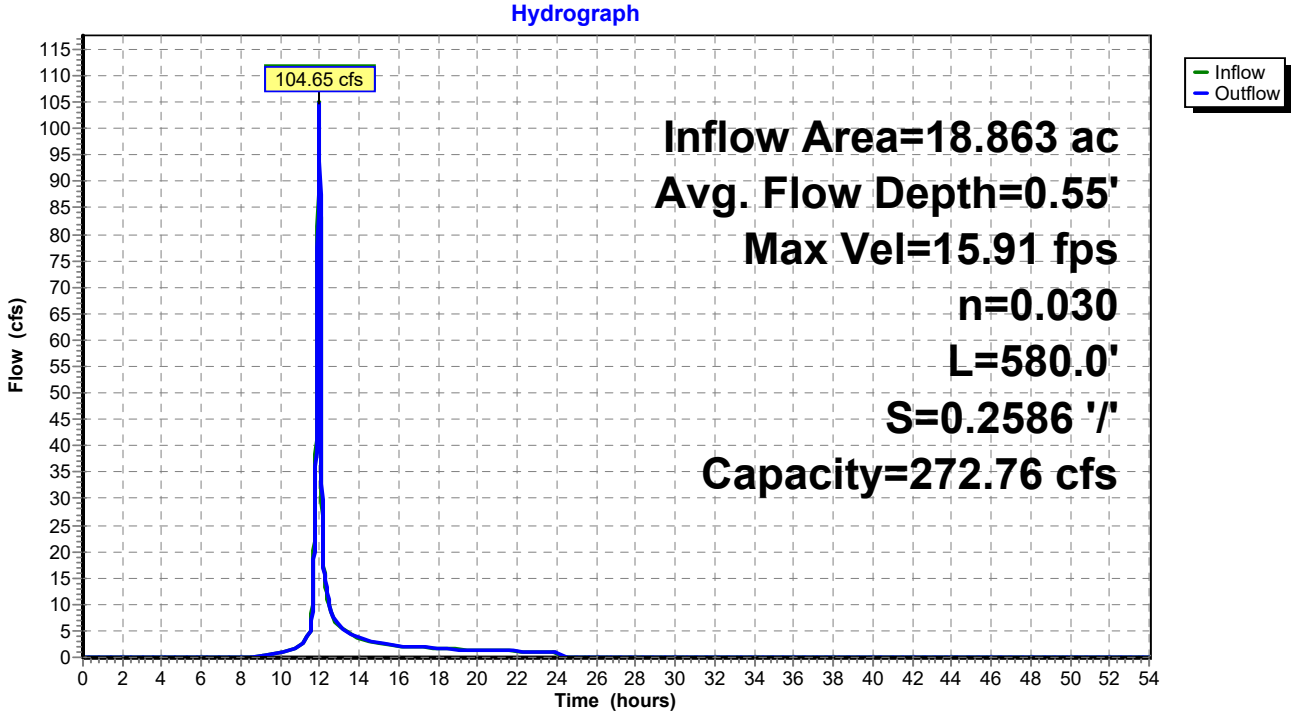
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 15.91 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 3.26 fps, Avg. Travel Time= 3.0 min

Peak Storage= 3,814 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.55'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 173.01 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 272.76 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 580.0' Slope= 0.2586 '/'
Inlet Invert= 180.00', Outlet Invert= 30.00'



Reach DC1: DC1 Proposed



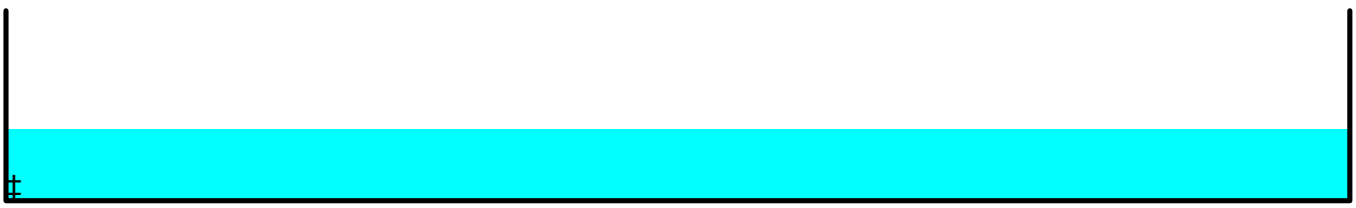
Summary for Reach DC5: DC5 Proposed

Inflow Area = 10.460 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 54.95 cfs @ 11.96 hrs, Volume= 2.776 af
Outflow = 54.84 cfs @ 11.96 hrs, Volume= 2.776 af, Atten= 0%, Lag= 0.3 min

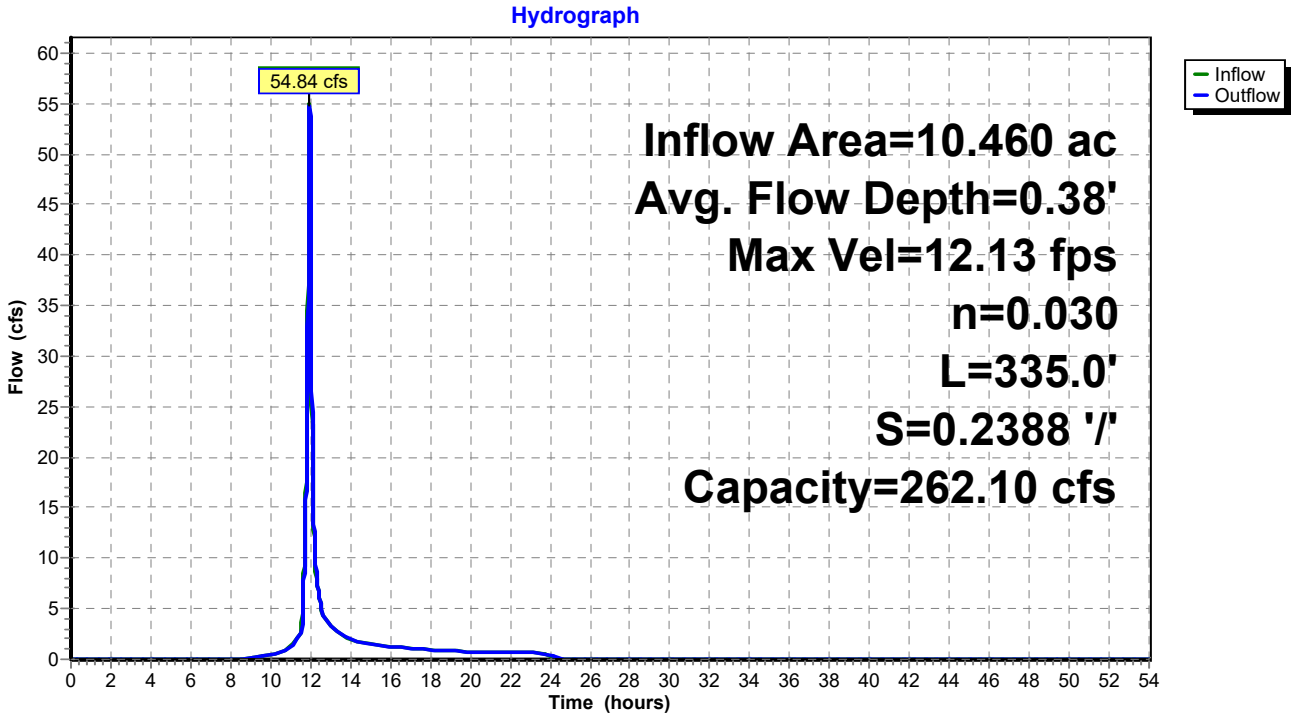
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.13 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 2.56 fps, Avg. Travel Time= 2.2 min

Peak Storage= 1,515 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.38'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 166.25 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 262.10 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 335.0' Slope= 0.2388 '/'
Inlet Invert= 170.00', Outlet Invert= 90.00'



Reach DC5: DC5 Proposed



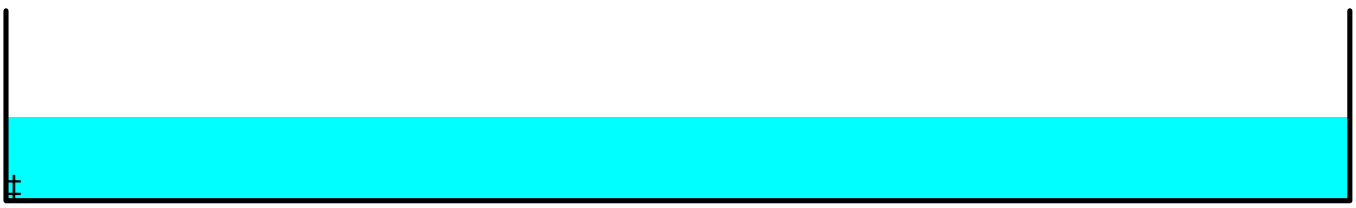
Summary for Reach DC6: DC6 Proposed

Inflow Area = 13.981 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 77.66 cfs @ 11.95 hrs, Volume= 3.711 af
Outflow = 77.45 cfs @ 11.96 hrs, Volume= 3.711 af, Atten= 0%, Lag= 0.3 min

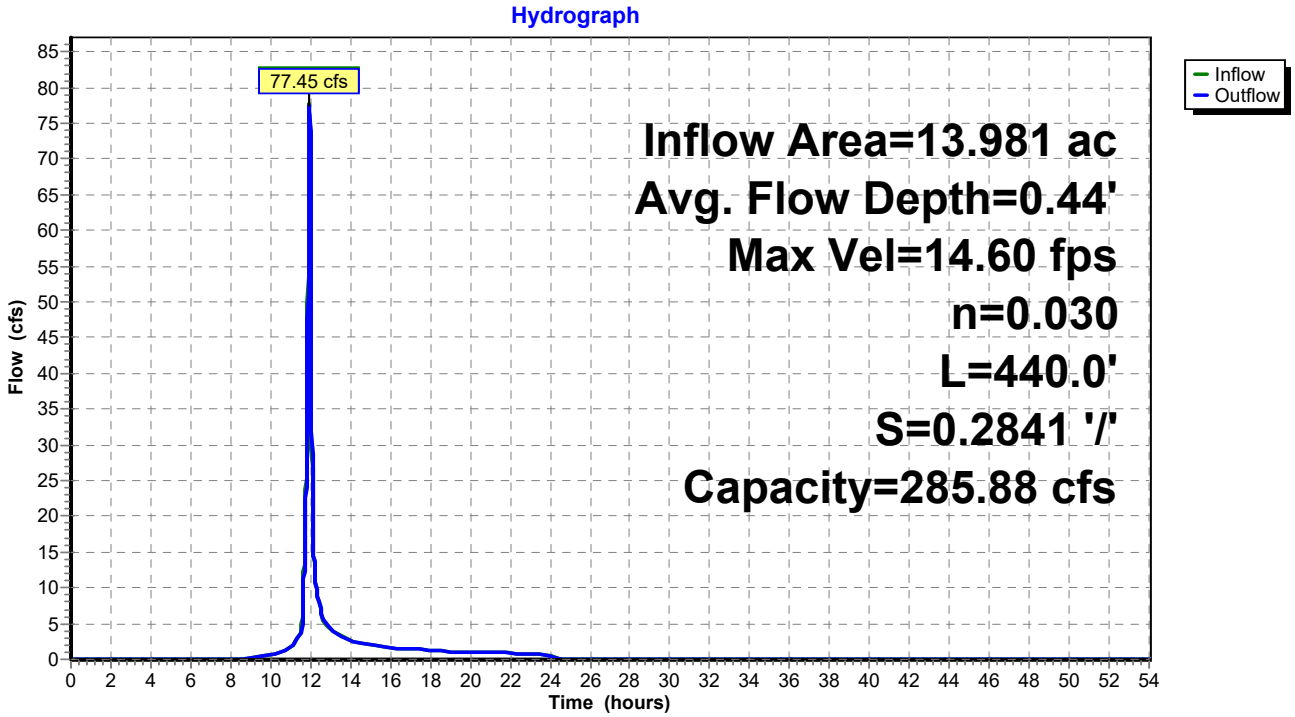
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 14.60 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.02 fps, Avg. Travel Time= 2.4 min

Peak Storage= 2,333 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.44'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 181.33 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 285.88 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 440.0' Slope= 0.2841 '/'
Inlet Invert= 170.00', Outlet Invert= 45.00'



Reach DC6: DC6 Proposed



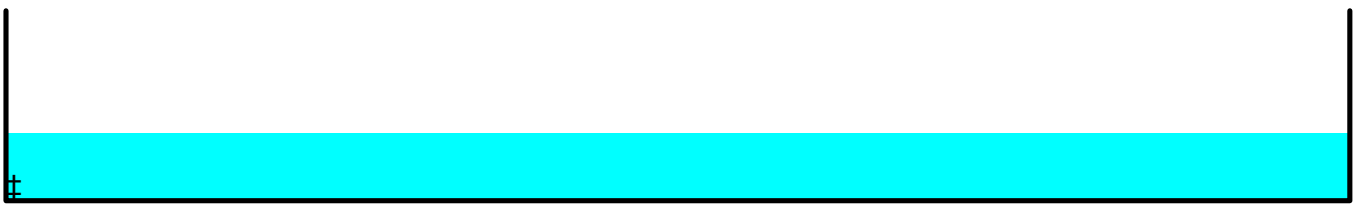
Summary for Reach DC7: DC7 Proposed

Inflow Area = 9.215 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 52.09 cfs @ 11.95 hrs, Volume= 2.446 af
Outflow = 51.86 cfs @ 11.96 hrs, Volume= 2.446 af, Atten= 0%, Lag= 0.4 min

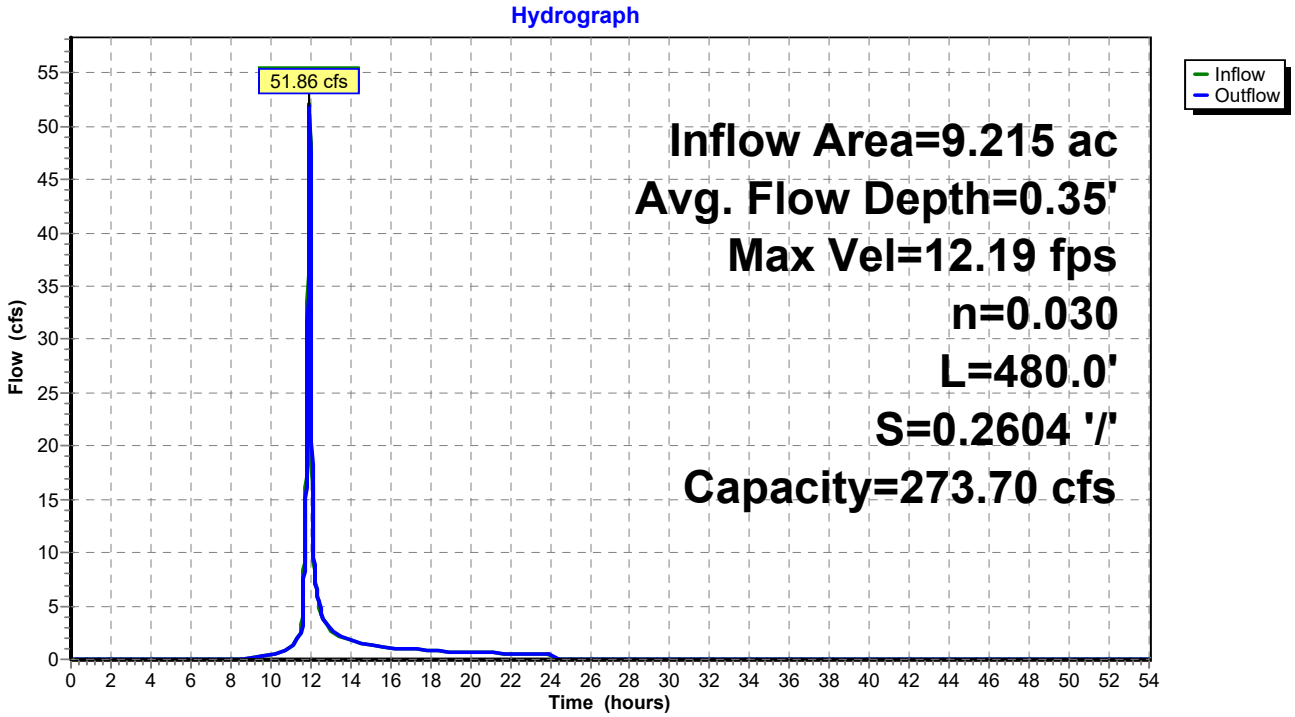
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.19 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 2.58 fps, Avg. Travel Time= 3.1 min

Peak Storage= 2,042 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.35'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 173.61 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 273.70 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 480.0' Slope= 0.2604 '/'
Inlet Invert= 180.00', Outlet Invert= 55.00'



Reach DC7: DC7 Proposed



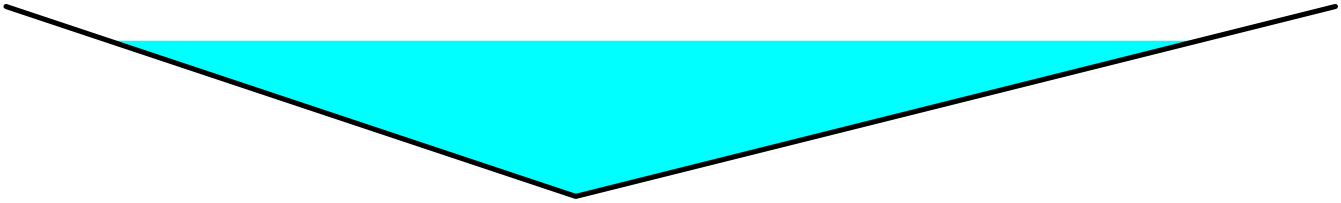
Summary for Reach T6:

Inflow Area = 5.419 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 29.96 cfs @ 11.98 hrs, Volume= 1.438 af
Outflow = 29.19 cfs @ 12.00 hrs, Volume= 1.438 af, Atten= 3%, Lag= 1.0 min

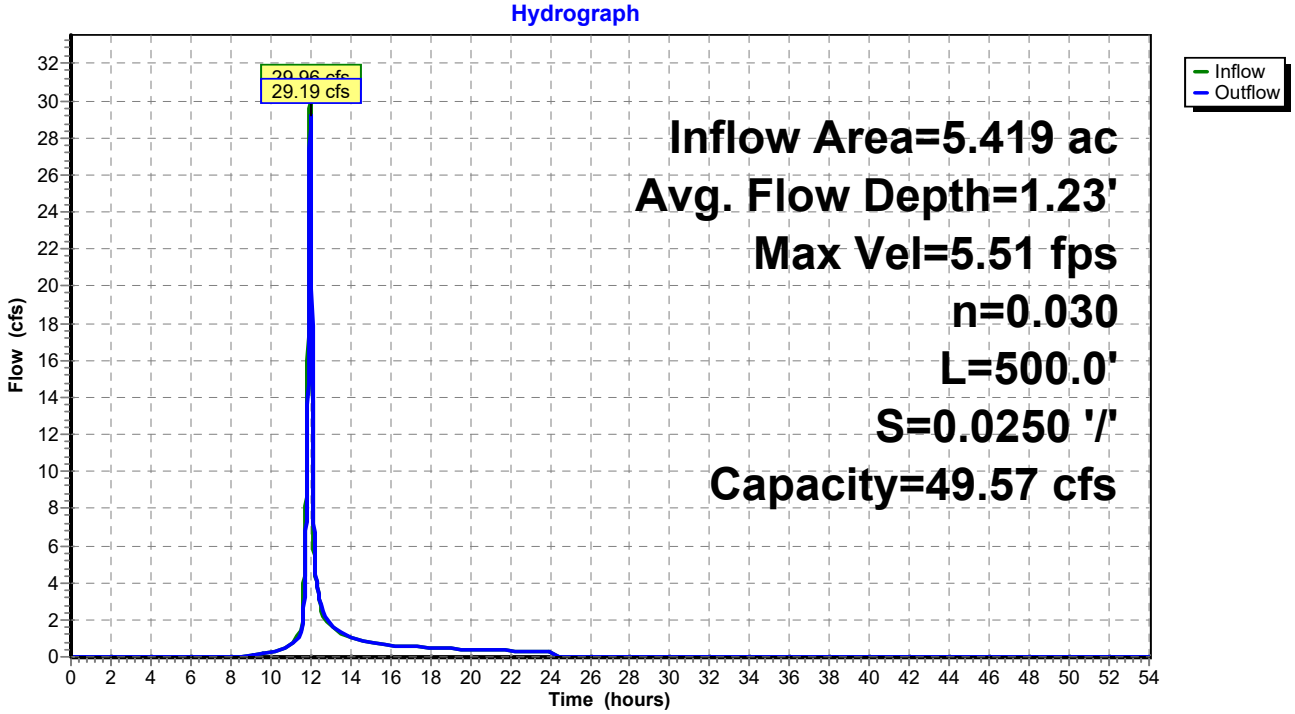
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.51 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.86 fps, Avg. Travel Time= 4.5 min

Peak Storage= 2,647 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.23'
Defined Flood Depth= 1.50' Flow Area= 7.9 sf, Capacity= 49.57 cfs
Bank-Full Depth= 1.50' Flow Area= 7.9 sf, Capacity= 49.57 cfs

0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 4.0 '/' Top Width= 10.50'
Length= 500.0' Slope= 0.0250 '/'
Inlet Invert= 180.00', Outlet Invert= 167.50'



Reach T6:



Summary for Pond 1P: Culvert 1 (EP Inlet)

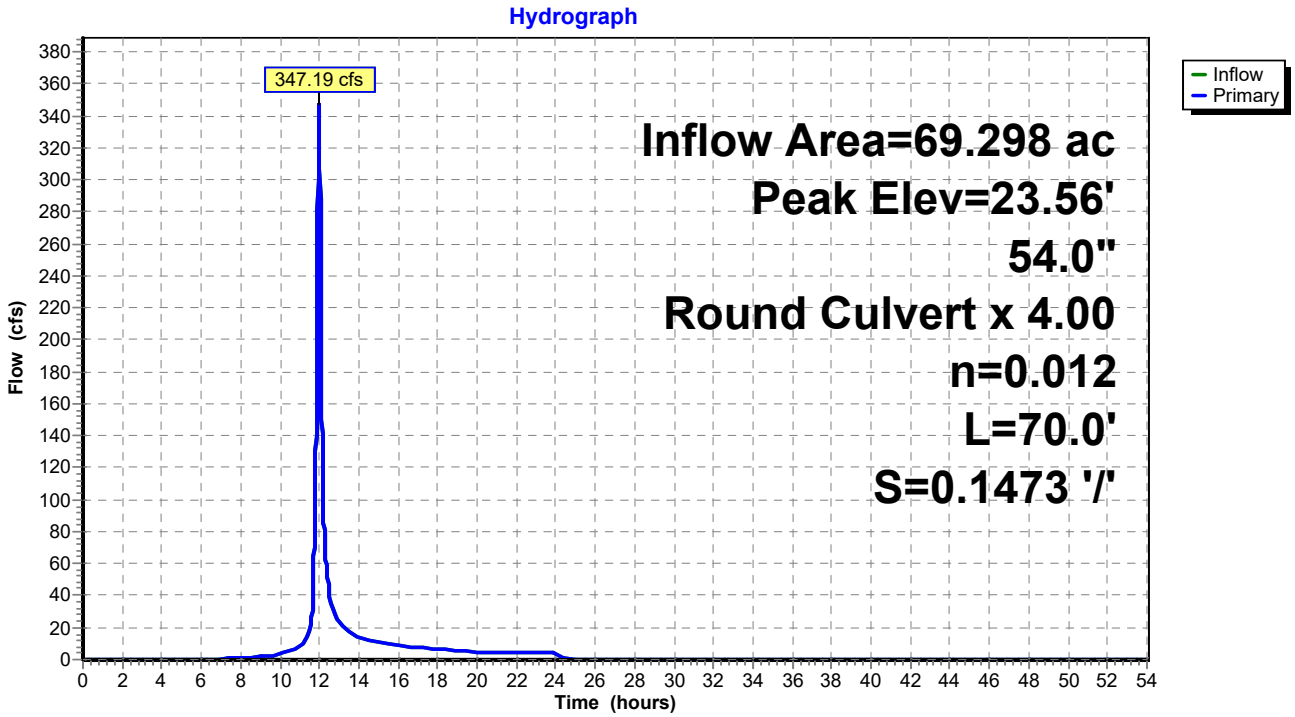
Inflow Area = 69.298 ac, 7.14% Impervious, Inflow Depth = 3.37" for 25 yr event
Inflow = 347.19 cfs @ 11.98 hrs, Volume= 19.455 af
Outflow = 347.19 cfs @ 11.98 hrs, Volume= 19.455 af, Atten= 0%, Lag= 0.0 min
Primary = 347.19 cfs @ 11.98 hrs, Volume= 19.455 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Peak Elev= 23.56' @ 11.98 hrs
Flood Elev= 24.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	20.00'	**54.0" Round Culvert X 4.00** L= 70.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 20.00' / 9.69' S= 0.1473 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 15.90 sf

Primary OutFlow Max=346.63 cfs @ 11.98 hrs HW=23.56' TW=20.69' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 346.63 cfs @ 6.42 fps)

Pond 1P: Culvert 1 (EP Inlet)



Summary for Pond EP: East Pond- Design

Inflow Area = 69.298 ac, 7.14% Impervious, Inflow Depth = 3.37" for 25 yr event
Inflow = 347.19 cfs @ 11.98 hrs, Volume= 19.455 af
Outflow = 209.32 cfs @ 12.07 hrs, Volume= 17.728 af, Atten= 40%, Lag= 5.9 min
Primary = 158.07 cfs @ 12.07 hrs, Volume= 17.215 af
Secondary = 51.25 cfs @ 12.07 hrs, Volume= 0.513 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Peak Elev= 22.13' @ 12.07 hrs Surf.Area= 0 sf Storage= 295,843 cf
Flood Elev= 24.00' Surf.Area= 0 sf Storage= 360,454 cf

Plug-Flow detention time= 283.3 min calculated for 17.728 af (91% of inflow)
Center-of-Mass det. time= 235.6 min (1,059.6 - 823.9)

Volume	Invert	Avail.Storage	Storage Description
#1	8.00'	360,454 cf	**Custom Stage Data** Listed below

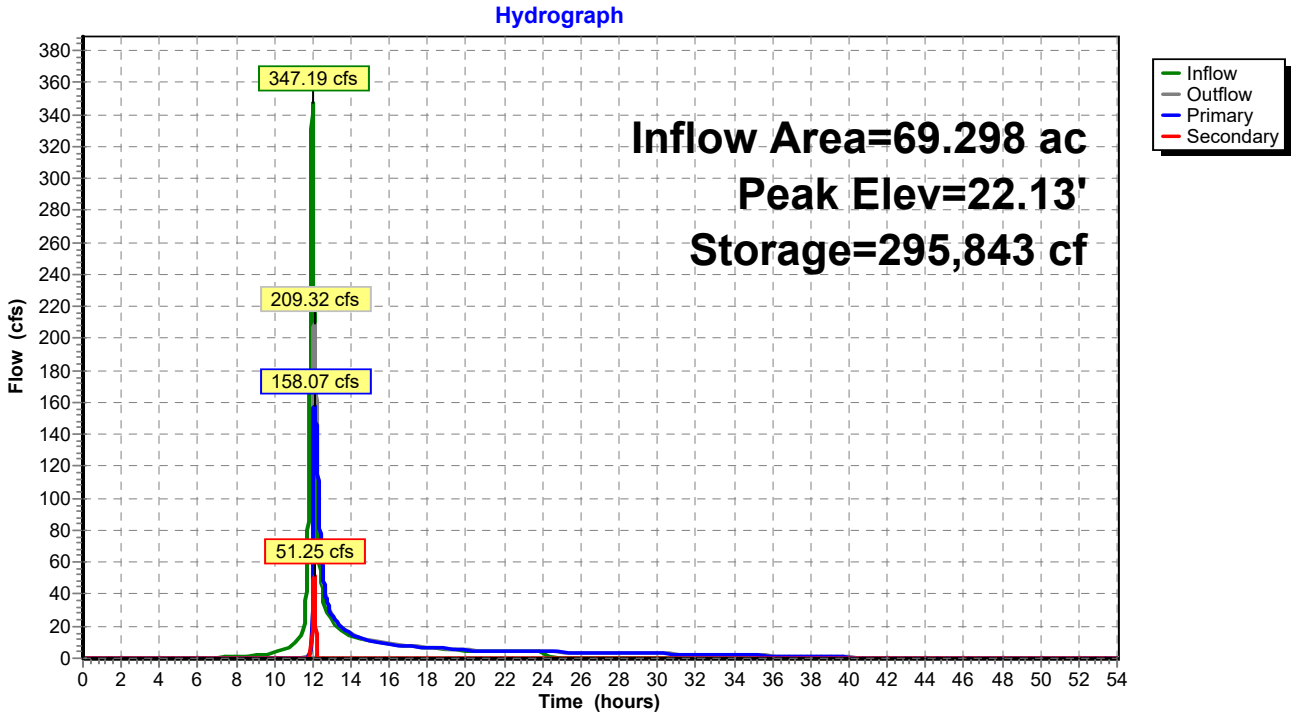
Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.00	0	0
9.00	3,863	3,863
10.00	7,603	11,466
11.00	14,709	26,175
12.00	16,936	43,111
13.00	18,414	61,525
14.00	19,786	81,311
15.00	21,123	102,434
16.00	22,487	124,921
17.00	23,894	148,815
18.00	25,334	174,149
19.00	26,831	200,980
20.00	28,447	229,427
22.00	61,999	291,426
24.00	69,028	360,454

Device	Routing	Invert	Outlet Devices
#1	Primary	10.45'	**48.0" Round Culvert** L= 59.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 10.45' / 9.86' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 12.57 sf
#2	Device 1	13.60'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	19.50'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	21.40'	**31.0' long x 21.0' 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) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

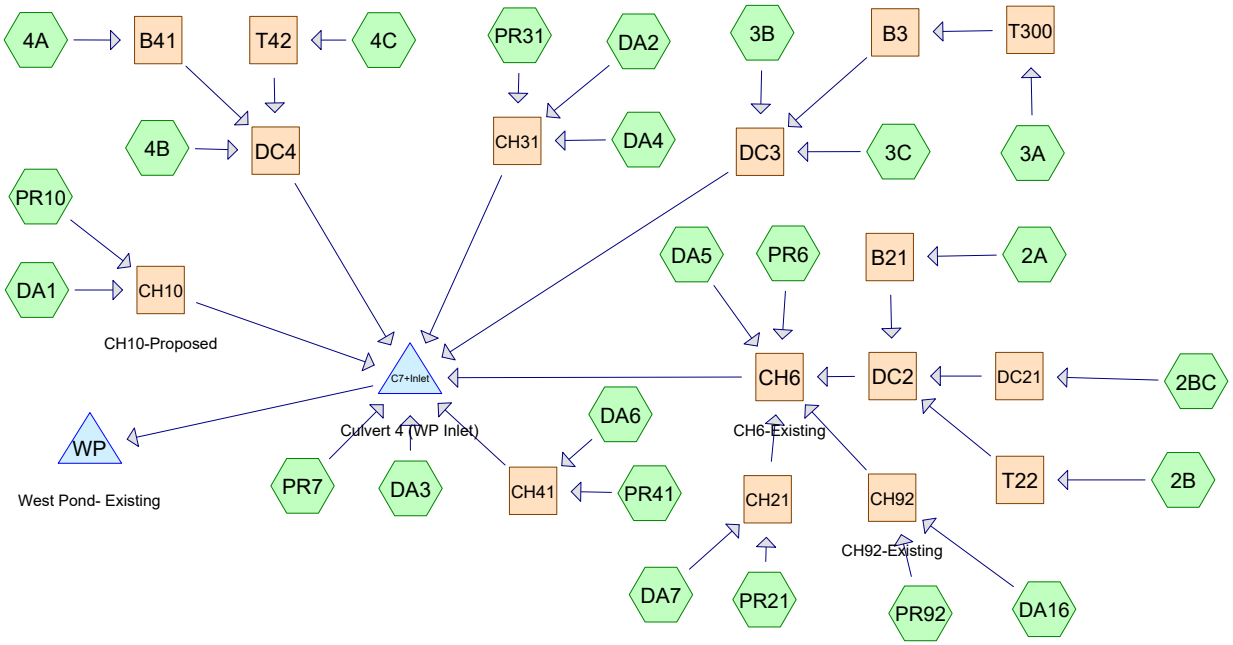
Primary OutFlow Max=158.01 cfs @ 12.07 hrs HW=22.13' (Free Discharge)
└─**1=Culvert** (Passes 158.01 cfs of 188.21 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 4.81 cfs @ 13.78 fps)
  └─**3=Orifice/Grate** (Orifice Controls 153.20 cfs @ 7.80 fps)

Secondary OutFlow Max=51.04 cfs @ 12.07 hrs HW=22.13' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Weir Controls 51.04 cfs @ 2.27 fps)

Pond EP: East Pond- Design



WEST BASIN WATERSHED



Subcat Reach Pond Link

Routing Diagram for Final Cover of 20180420 version SW Model20190325
Prepared by SCCM-01, Printed 3/25/2019
HydroCAD® 10.00-18 s/n 00663 © 2016 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
79.694	74	>75% Grass cover, Good, HSG C (2A, 2B, 2BC, 3A, 3B, 3C, 4A, 4B, 4C, DA1, DA16, DA2, DA3, DA4, DA5, DA6, DA7)
7.165	98	Paved parking, HSG C (PR10, PR21, PR31, PR41, PR6, PR7, PR92)
86.859	**76**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
86.859	HSG C	2A, 2B, 2BC, 3A, 3B, 3C, 4A, 4B, 4C, DA1, DA16, DA2, DA3, DA4, DA5, DA6, DA7, PR10, PR21, PR31, PR41, PR6, PR7, PR92
0.000	HSG D	
0.000	Other	
86.859		**TOTAL AREA**

Ground Covers (selected 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	79.694	0.000	0.000	79.694	>75% Grass cover, Good	2A, 2B, 2BC, 3A, 3B, 3C, 4A, 4B, 4C, DA1, DA16, DA2, DA3, DA4, DA5, DA6, DA7
0.000	0.000	7.165	0.000	0.000	7.165	Paved parking	PR10, PR21, PR31, PR41, PR6, PR7, PR92
0.000	**0.000**	**86.859**	**0.000**	**0.000**	**86.859**	**TOTAL AREA**	

Pipe Listing (selected 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	C7+Inlet	24.00	14.25	105.0	0.0929	0.012	54.0	0.0	0.0
2	WP	13.20	11.98	76.0	0.0161	0.012	48.0	0.0	0.0

Time span=0.00-54.00 hrs, dt=0.01 hrs, 5401 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

Subcatchment2A: Runoff Area=362,563 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=275' Tc=6.7 min CN=74 Runoff=46.01 cfs 2.209 af

Subcatchment2B: Runoff Area=280,801 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=275' Slope=0.0200 '/' Tc=11.2 min CN=74 Runoff=30.31 cfs 1.711 af

Subcatchment2BC: Runoff Area=275,809 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=720' Tc=4.1 min CN=74 Runoff=38.45 cfs 1.680 af

Subcatchment3A: Runoff Area=321,456 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=250' Tc=5.8 min CN=74 Runoff=42.14 cfs 1.959 af

Subcatchment3B: Runoff Area=315,456 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=620' Tc=3.8 min CN=74 Runoff=44.46 cfs 1.922 af

Subcatchment3C: Runoff Area=269,406 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=620' Tc=3.8 min CN=74 Runoff=37.97 cfs 1.641 af

Subcatchment4A: Runoff Area=328,729 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=450' Tc=10.1 min CN=74 Runoff=36.90 cfs 2.003 af

Subcatchment4B: Runoff Area=338,456 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=720' Tc=4.1 min CN=74 Runoff=47.18 cfs 2.062 af

Subcatchment4C: Runoff Area=228,724 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=275' Tc=6.7 min CN=74 Runoff=29.02 cfs 1.394 af

SubcatchmentDA1: Runoff Area=76,359 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=70' Slope=0.3333 '/' Tc=2.4 min CN=74 Runoff=11.31 cfs 0.465 af

SubcatchmentDA16: Runoff Area=42,043 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=70' Slope=0.3333 '/' Tc=2.4 min CN=74 Runoff=6.23 cfs 0.256 af

SubcatchmentDA2: Runoff Area=77,473 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=50' Slope=0.3300 '/' Tc=1.8 min CN=74 Runoff=11.71 cfs 0.472 af

SubcatchmentDA3: Runoff Area=93,767 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=100' Slope=0.3333 '/' Tc=3.2 min CN=74 Runoff=13.50 cfs 0.571 af

SubcatchmentDA4: Runoff Area=151,013 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=275' Tc=6.7 min CN=74 Runoff=19.16 cfs 0.920 af

SubcatchmentDA5: Runoff Area=171,094 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=50' Slope=0.3333 '/' Tc=1.8 min CN=74 Runoff=25.86 cfs 1.042 af

SubcatchmentDA6: Runoff Area=85,640 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=40' Slope=0.3300 '/' Tc=1.5 min CN=74 Runoff=13.09 cfs 0.522 af

Subcatchment DA7: Runoff Area=52,686 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=50' Slope=0.3300 '/' Tc=1.8 min CN=74 Runoff=7.96 cfs 0.321 af

Subcatchment PR10: Runoff Area=15,360 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=3.55 cfs 0.169 af

Subcatchment PR21: Runoff Area=39,450 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=9.11 cfs 0.435 af

Subcatchment PR31: Runoff Area=52,800 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=12.19 cfs 0.582 af

Subcatchment PR41: Runoff Area=50,310 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=11.62 cfs 0.555 af

Subcatchment PR6: Runoff Area=69,000 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=15.93 cfs 0.761 af

Subcatchment PR7: Runoff Area=51,900 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=11.99 cfs 0.572 af

Subcatchment PR92: Runoff Area=33,300 sf 100.00% Impervious Runoff Depth=5.76"
Flow Length=30' Slope=0.0200 '/' Tc=0.5 min CN=98 Runoff=7.69 cfs 0.367 af

Reach B21: Avg. Flow Depth=1.59' Max Vel=5.91 fps Inflow=46.01 cfs 2.209 af
n=0.030 L=578.0' S=0.0208 '/' Capacity=82.69 cfs Outflow=44.67 cfs 2.209 af

Reach B3: Avg. Flow Depth=1.51' Max Vel=5.92 fps Inflow=41.61 cfs 1.959 af
n=0.030 L=495.0' S=0.0222 '/' Capacity=85.55 cfs Outflow=40.64 cfs 1.959 af

Reach B41: Avg. Flow Depth=1.47' Max Vel=5.59 fps Inflow=36.90 cfs 2.003 af
n=0.030 L=390.0' S=0.0205 '/' Capacity=82.19 cfs Outflow=36.45 cfs 2.003 af

Reach CH10: CH10-Proposed Avg. Flow Depth=1.36' Max Vel=1.88 fps Inflow=14.31 cfs 0.635 af
n=0.030 L=512.0' S=0.0020 '/' Capacity=27.93 cfs Outflow=12.06 cfs 0.635 af

Reach CH21: Avg. Flow Depth=0.75' Max Vel=8.14 fps Inflow=16.69 cfs 0.756 af
n=0.030 L=1,315.0' S=0.0837 '/' Capacity=143.80 cfs Outflow=15.11 cfs 0.756 af

Reach CH31: Avg. Flow Depth=1.09' Max Vel=10.09 fps Inflow=37.62 cfs 1.974 af
n=0.030 L=1,760.0' S=0.0841 '/' Capacity=144.18 cfs Outflow=34.78 cfs 1.974 af

Reach CH41: Avg. Flow Depth=0.87' Max Vel=9.02 fps Inflow=24.28 cfs 1.076 af
n=0.030 L=1,677.0' S=0.0865 '/' Capacity=146.20 cfs Outflow=21.50 cfs 1.076 af

Reach CH6: CH6-Existing Avg. Flow Depth=2.16' Max Vel=7.63 fps Inflow=148.74 cfs 8.783 af
n=0.030 L=2,300.0' S=0.0170 '/' Capacity=494.36 cfs Outflow=129.26 cfs 8.783 af

Reach CH92: CH92-Existing Avg. Flow Depth=0.65' Max Vel=3.55 fps Inflow=13.42 cfs 0.623 af
n=0.030 L=1,110.0' S=0.0135 '/' Capacity=441.32 cfs Outflow=11.02 cfs 0.623 af

Reach DC2: Avg. Flow Depth=0.50' Max Vel=16.38 fps Inflow=98.14 cfs 5.600 af
n=0.030 L=270.0' S=0.3074 '/' Capacity=297.38 cfs Outflow=98.09 cfs 5.600 af

Reach DC21: Avg. Flow Depth=0.28' Max Vel=11.33 fps Inflow=38.45 cfs 1.680 af
n=0.030 L=100.0' S=0.3000 '/' Capacity=293.77 cfs Outflow=38.44 cfs 1.680 af

Reach DC3: Avg. Flow Depth=0.58' Max Vel=16.71 fps Inflow=116.99 cfs 5.522 af
n=0.030 L=490.0' S=0.2653 '/' Capacity=276.26 cfs Outflow=116.72 cfs 5.522 af

Reach DC4: Avg. Flow Depth=0.53' Max Vel=15.40 fps Inflow=98.98 cfs 5.459 af
n=0.030 L=500.0' S=0.2500 '/' Capacity=268.17 cfs Outflow=98.81 cfs 5.459 af

Reach T22: Avg. Flow Depth=1.21' Max Vel=5.38 fps Inflow=30.31 cfs 1.711 af
n=0.030 L=1,240.0' S=0.0242 '/' Capacity=48.77 cfs Outflow=27.73 cfs 1.711 af

Reach T300: Avg. Flow Depth=1.07' Max Vel=6.01 fps Inflow=42.14 cfs 1.959 af
n=0.030 L=350.0' S=0.0343 '/' Capacity=218.12 cfs Outflow=41.61 cfs 1.959 af

Reach T42: Avg. Flow Depth=1.19' Max Vel=5.42 fps Inflow=29.02 cfs 1.394 af
n=0.030 L=990.0' S=0.0253 '/' Capacity=49.82 cfs Outflow=26.75 cfs 1.394 af

Pond C7+Inlet: Culvert 4 (WP Inlet) Peak Elev=28.78' Storage=53,281 cf Inflow=420.38 cfs 24.592 af
54.0" Round Culvert x 3.00 n=0.012 L=105.0' S=0.0929 '/' Outflow=365.64 cfs 24.592 af

Pond WP: West Pond- Existing Peak Elev=25.24' Storage=533,662 cf Inflow=365.64 cfs 24.592 af
Outflow=65.05 cfs 20.836 af

Total Runoff Area = 86.859 ac Runoff Volume = 24.592 af Average Runoff Depth = 3.40"
91.75% Pervious = 79.694 ac 8.25% Impervious = 7.165 ac

Summary for Subcatchment 2A:

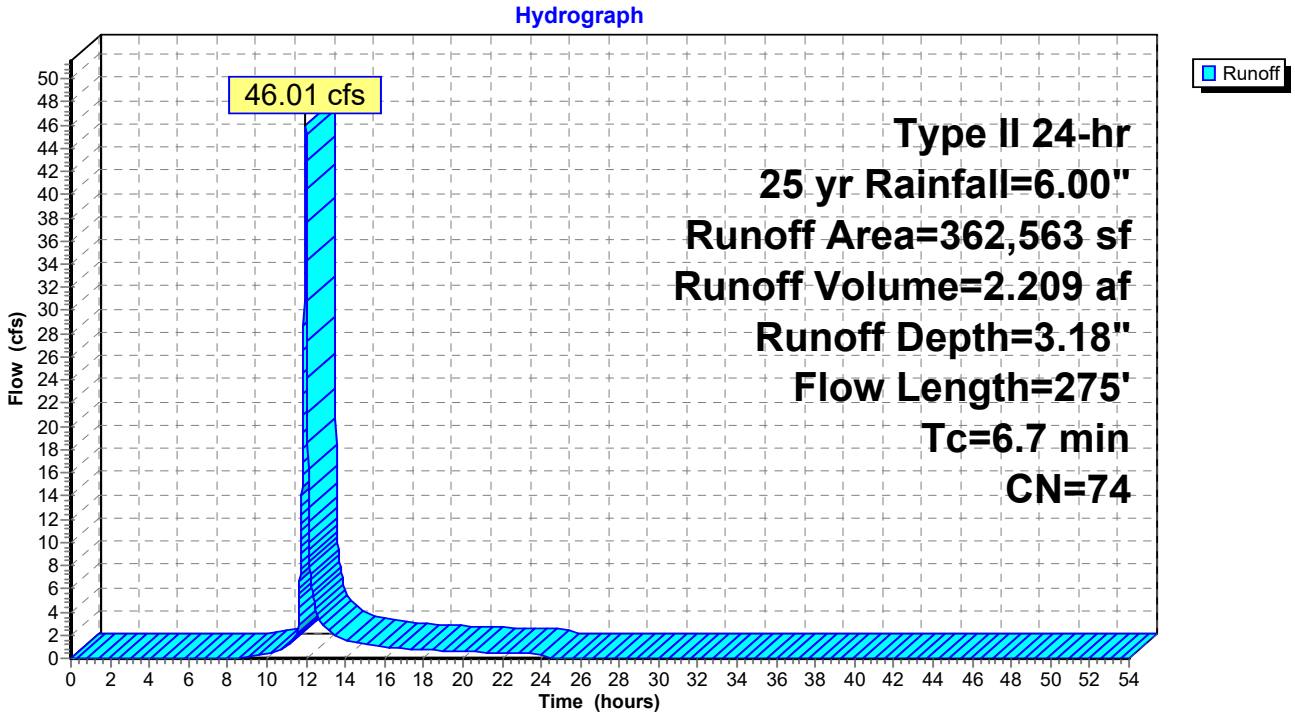
Runoff = 46.01 cfs @ 11.98 hrs, Volume= 2.209 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
362,563	74	>75% Grass cover, Good, HSG C
362,563		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	75	0.1670	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.7	275	Total			

Subcatchment 2A:



Summary for Subcatchment 2B:

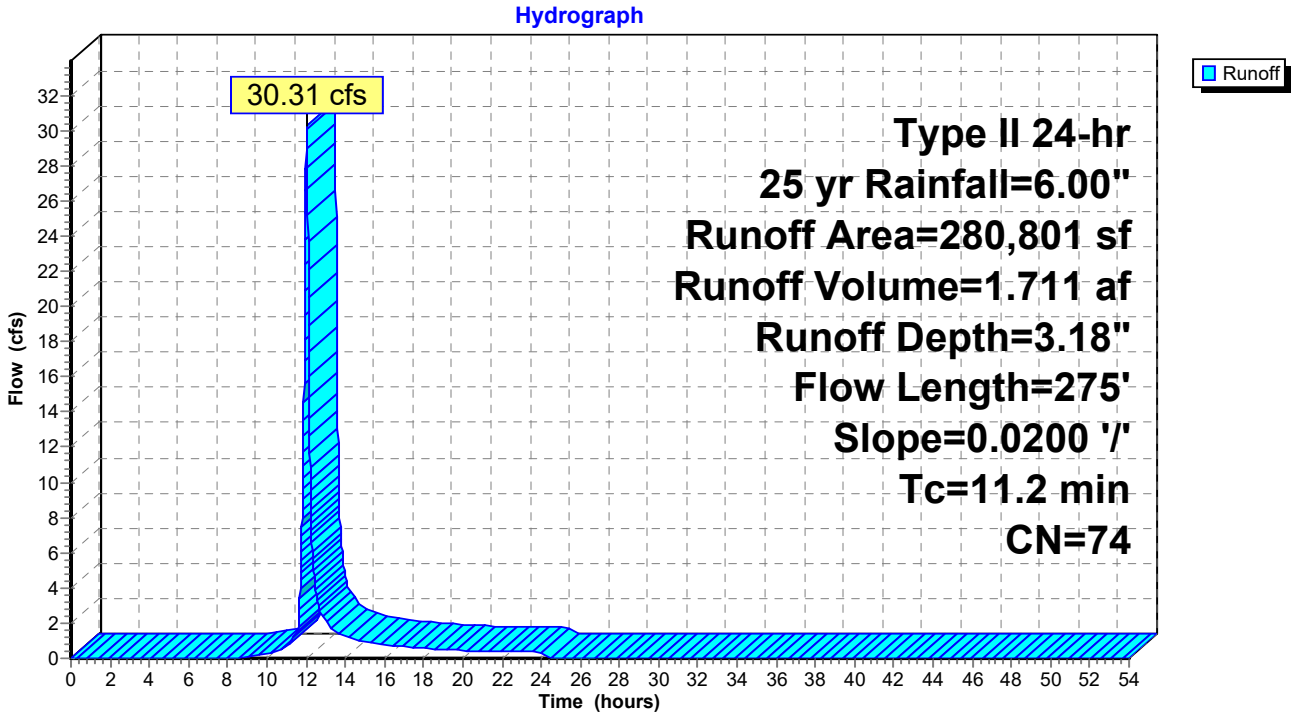
Runoff = 30.31 cfs @ 12.03 hrs, Volume= 1.711 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
280,801	74	>75% Grass cover, Good, HSG C
280,801		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	75	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.2	275	Total			

Subcatchment 2B:



Summary for Subcatchment 2BC:

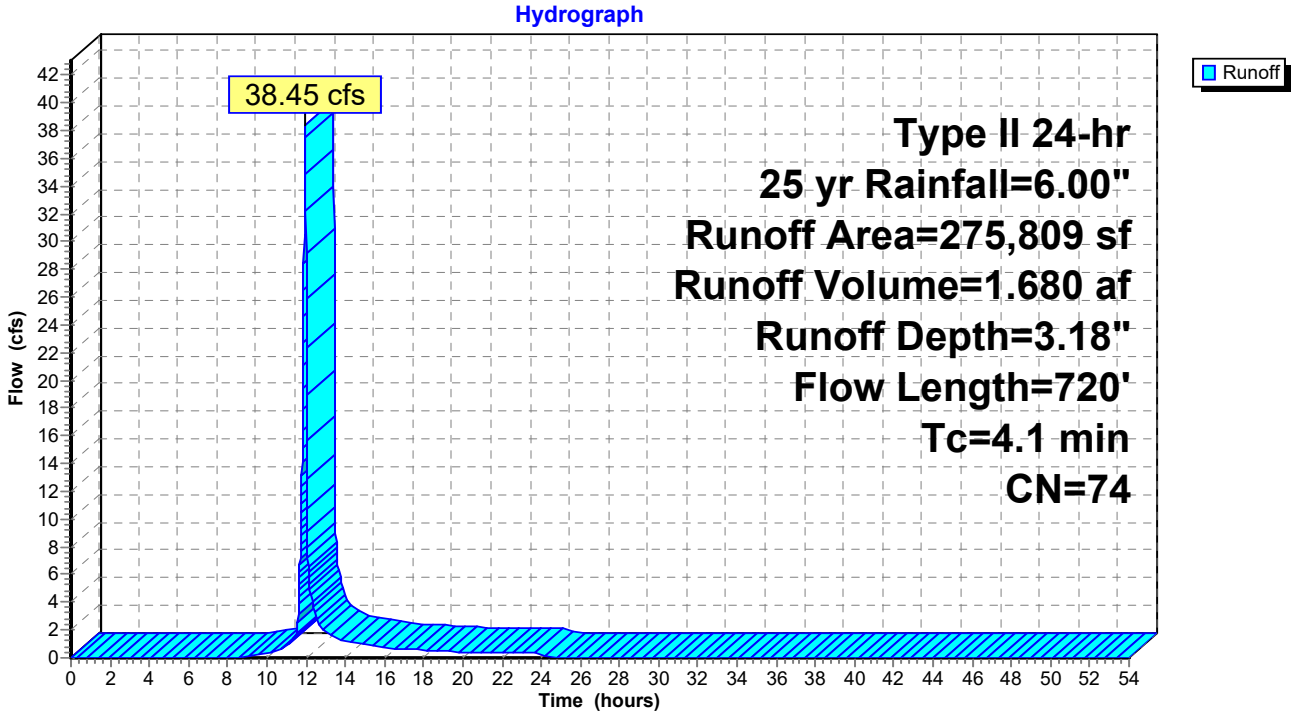
Runoff = 38.45 cfs @ 11.95 hrs, Volume= 1.680 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
275,809	74	>75% Grass cover, Good, HSG C
275,809		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.7	650	0.0250	6.33	63.93	**Channel Flow,** Area= 10.1 sf Perim= 13.9' r= 0.73' n= 0.030 Earth, grassed & winding
4.1	720	Total			

Subcatchment 2BC:



Summary for Subcatchment 3A:

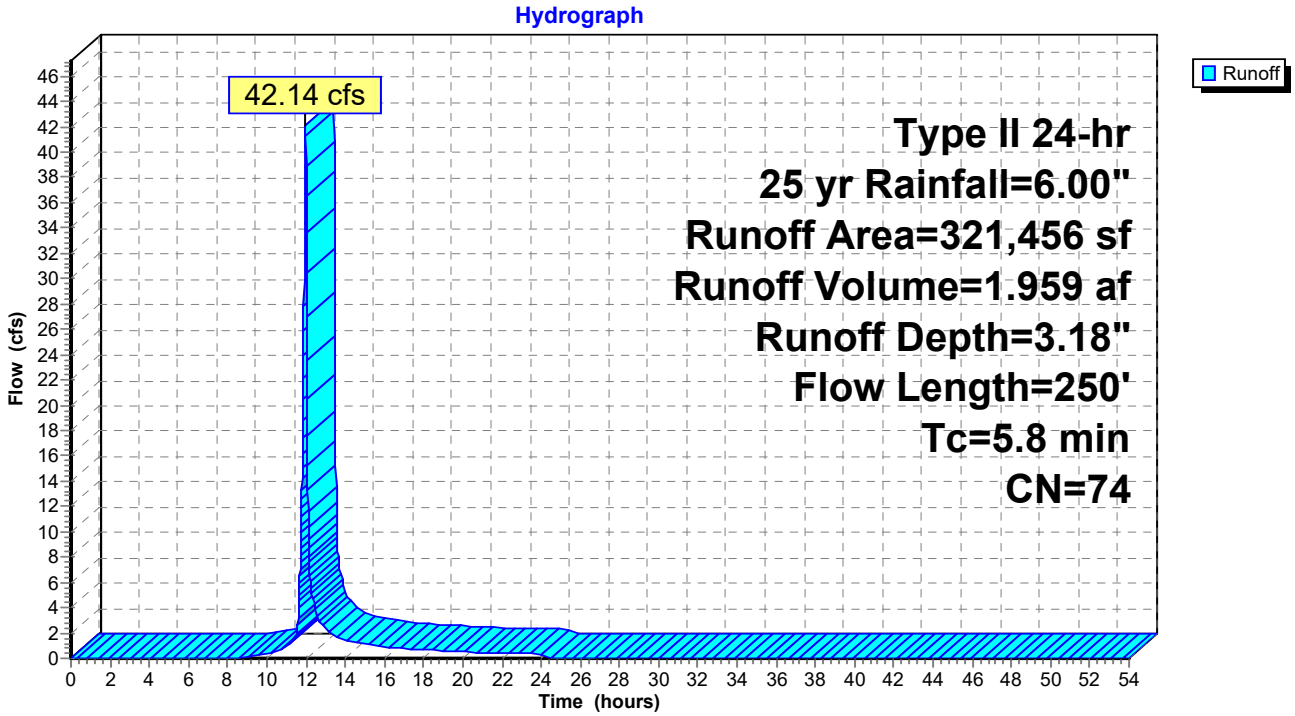
Runoff = 42.14 cfs @ 11.97 hrs, Volume= 1.959 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
321,456	74	>75% Grass cover, Good, HSG C
321,456		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	50	0.1670	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.8	250	Total			

Subcatchment 3A:



Summary for Subcatchment 3B:

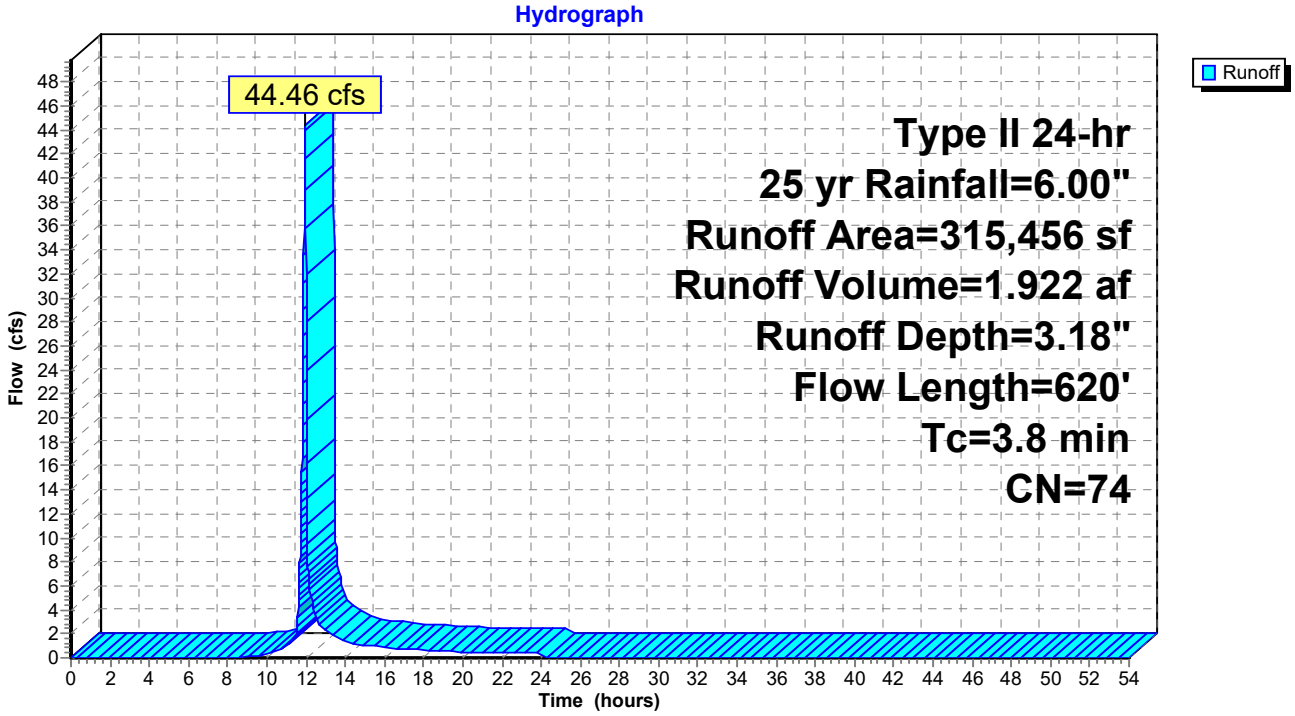
Runoff = 44.46 cfs @ 11.95 hrs, Volume= 1.922 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
315,456	74	>75% Grass cover, Good, HSG C
315,456		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.4	550	0.0250	6.33	63.93	**Channel Flow,** Area= 10.1 sf Perim= 13.9' r= 0.73' n= 0.030 Earth, grassed & winding
3.8	620	Total			

Subcatchment 3B:



Summary for Subcatchment 3C:

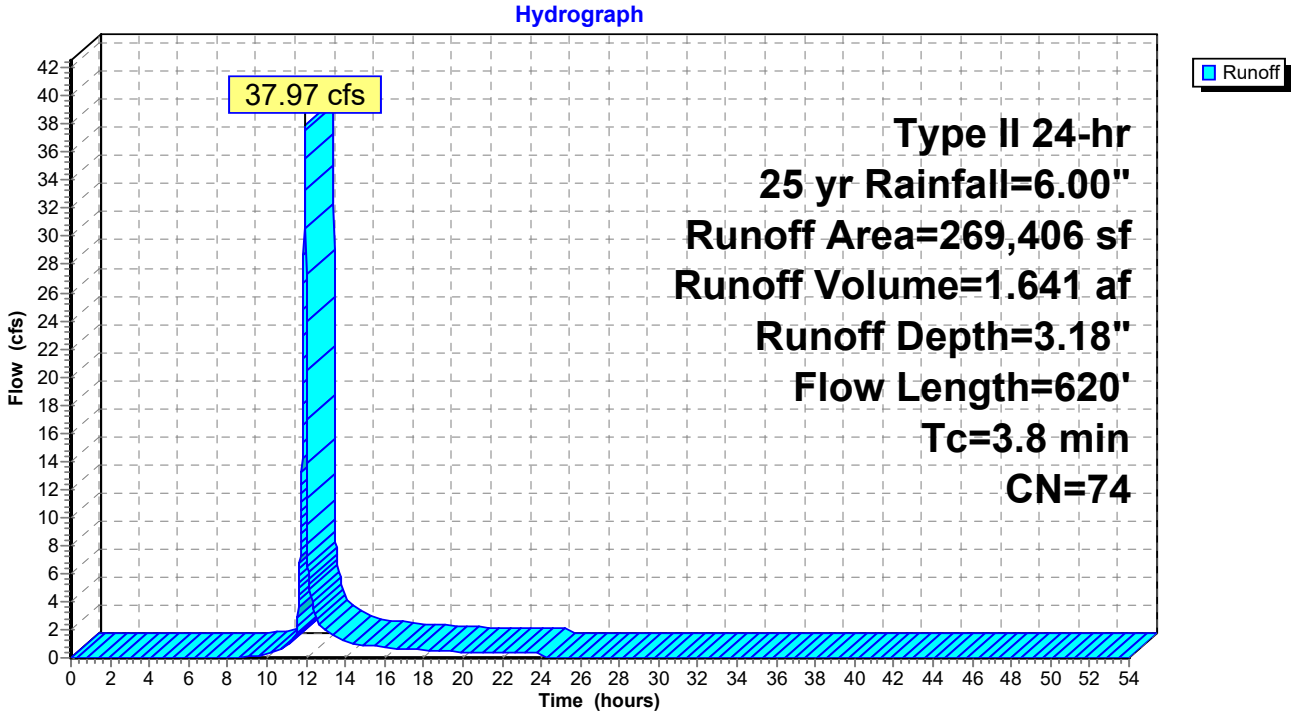
Runoff = 37.97 cfs @ 11.95 hrs, Volume= 1.641 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
269,406	74	>75% Grass cover, Good, HSG C
269,406		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.4	550	0.0250	6.33	63.93	**Channel Flow,** Area= 10.1 sf Perim= 13.9' r= 0.73' n= 0.030 Earth, grassed & winding
3.8	620	Total			

Subcatchment 3C:



Summary for Subcatchment 4A:

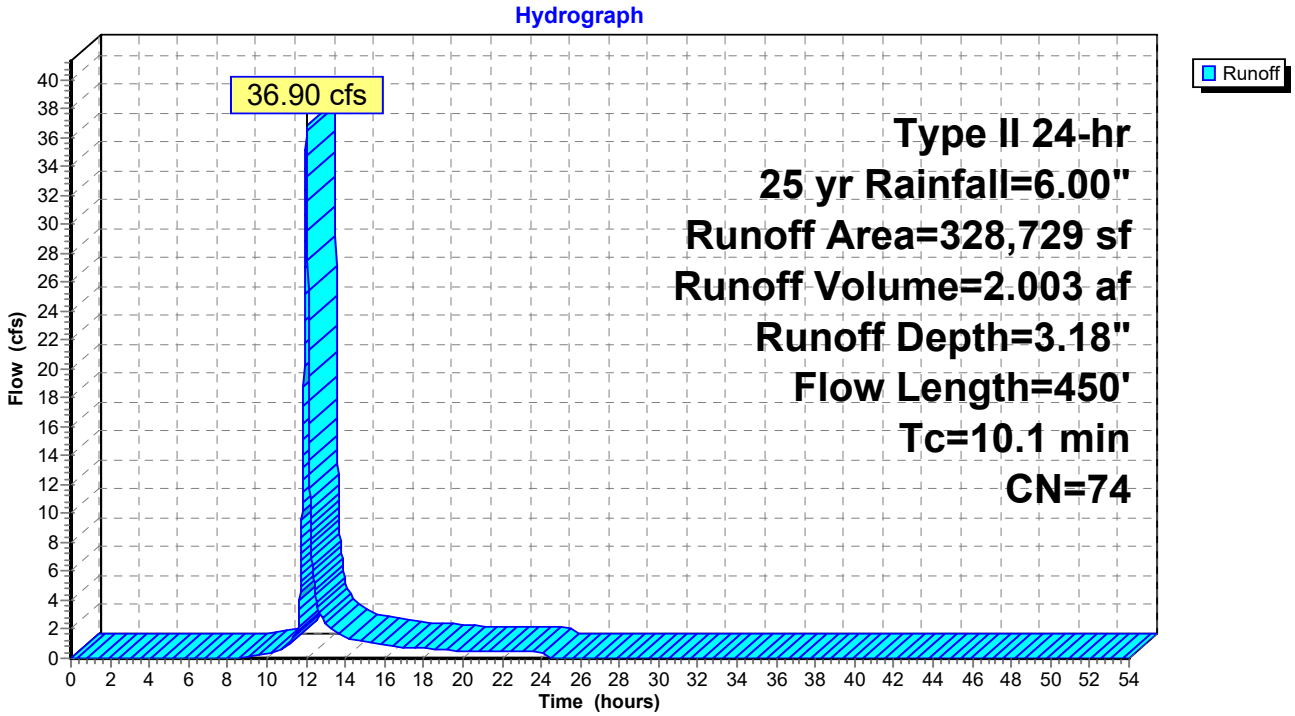
Runoff = 36.90 cfs @ 12.02 hrs, Volume= 2.003 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
328,729	74	>75% Grass cover, Good, HSG C
328,729		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1670	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
5.9	350	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.1	450	Total			

Subcatchment 4A:



Summary for Subcatchment 4B:

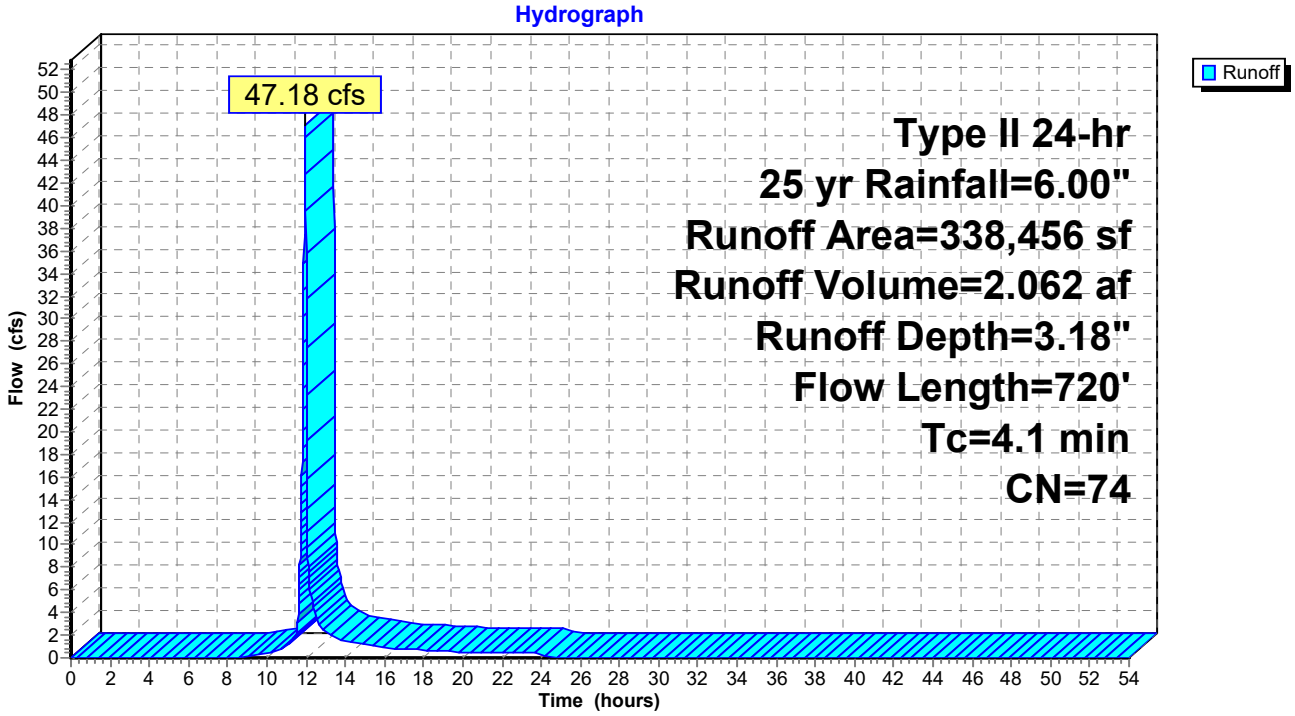
Runoff = 47.18 cfs @ 11.95 hrs, Volume= 2.062 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
338,456	74	>75% Grass cover, Good, HSG C
338,456		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
1.7	650	0.0250	6.33	63.93	**Channel Flow,** Area= 10.1 sf Perim= 13.9' r= 0.73' n= 0.030 Earth, grassed & winding
4.1	720	Total			

Subcatchment 4B:



Summary for Subcatchment 4C:

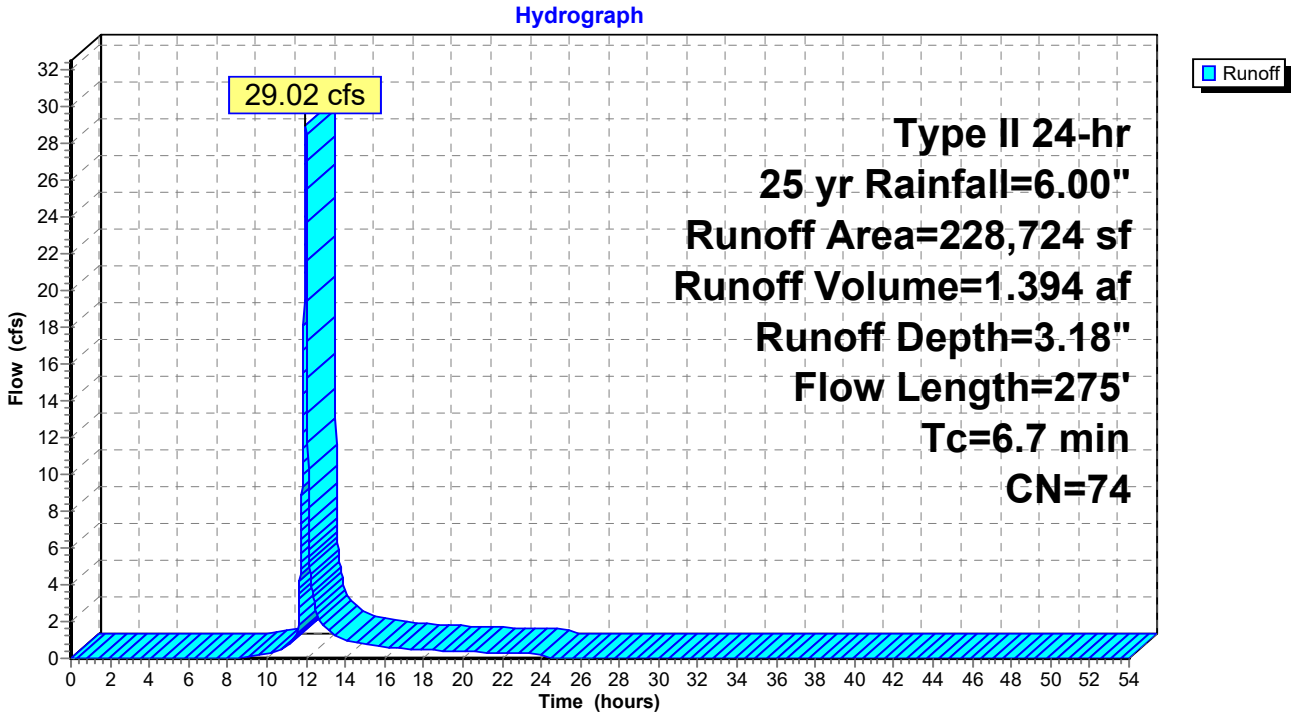
Runoff = 29.02 cfs @ 11.98 hrs, Volume= 1.394 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
228,724	74	>75% Grass cover, Good, HSG C
228,724		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	75	0.1670	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.7	275	Total			

Subcatchment 4C:



Summary for Subcatchment DA1:

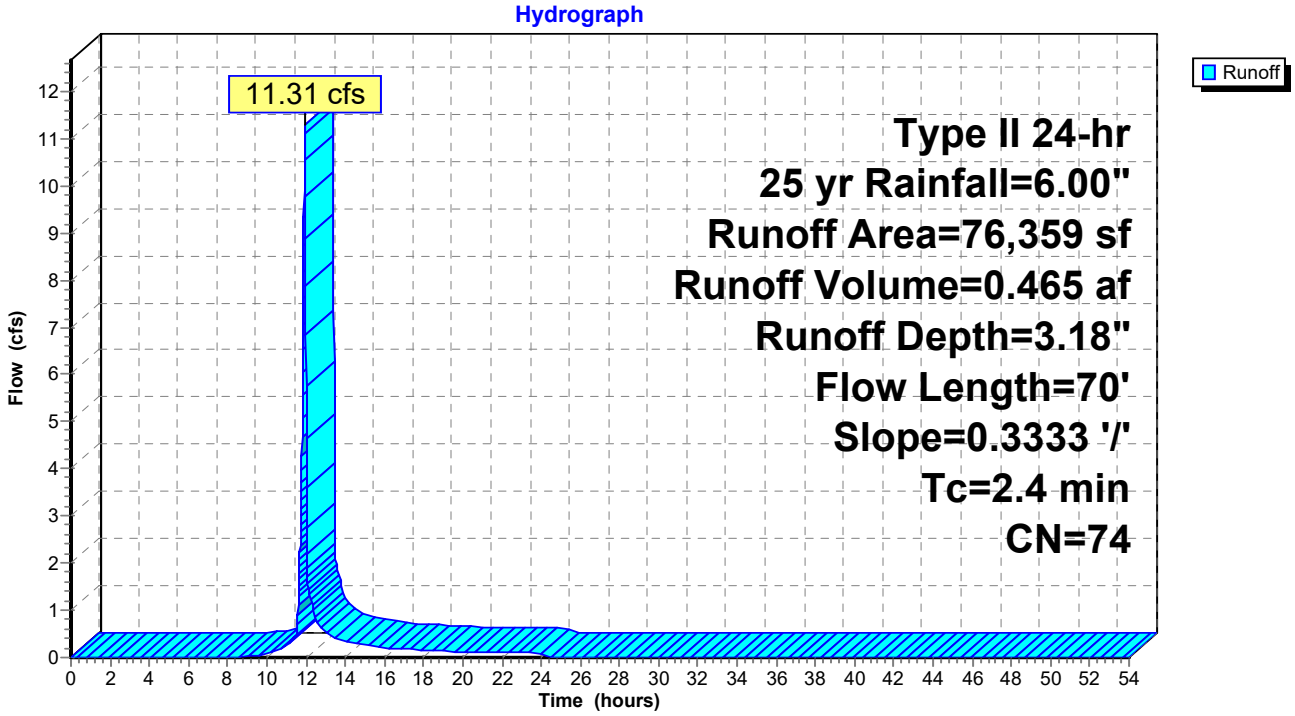
Runoff = 11.31 cfs @ 11.93 hrs, Volume= 0.465 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
76,359	74	>75% Grass cover, Good, HSG C
76,359		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA1:



Summary for Subcatchment DA16:

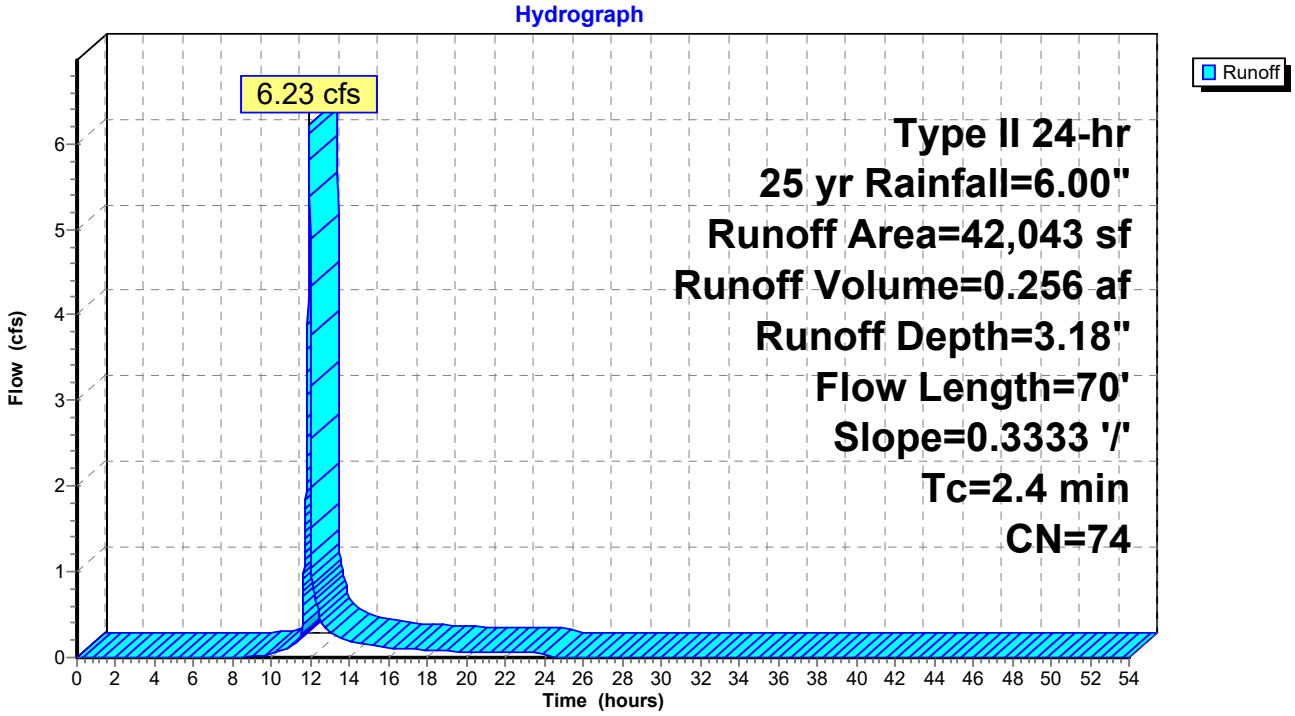
Runoff = 6.23 cfs @ 11.93 hrs, Volume= 0.256 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
42,043	74	>75% Grass cover, Good, HSG C
42,043		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	70	0.3333	0.49		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA16:



Summary for Subcatchment DA2:

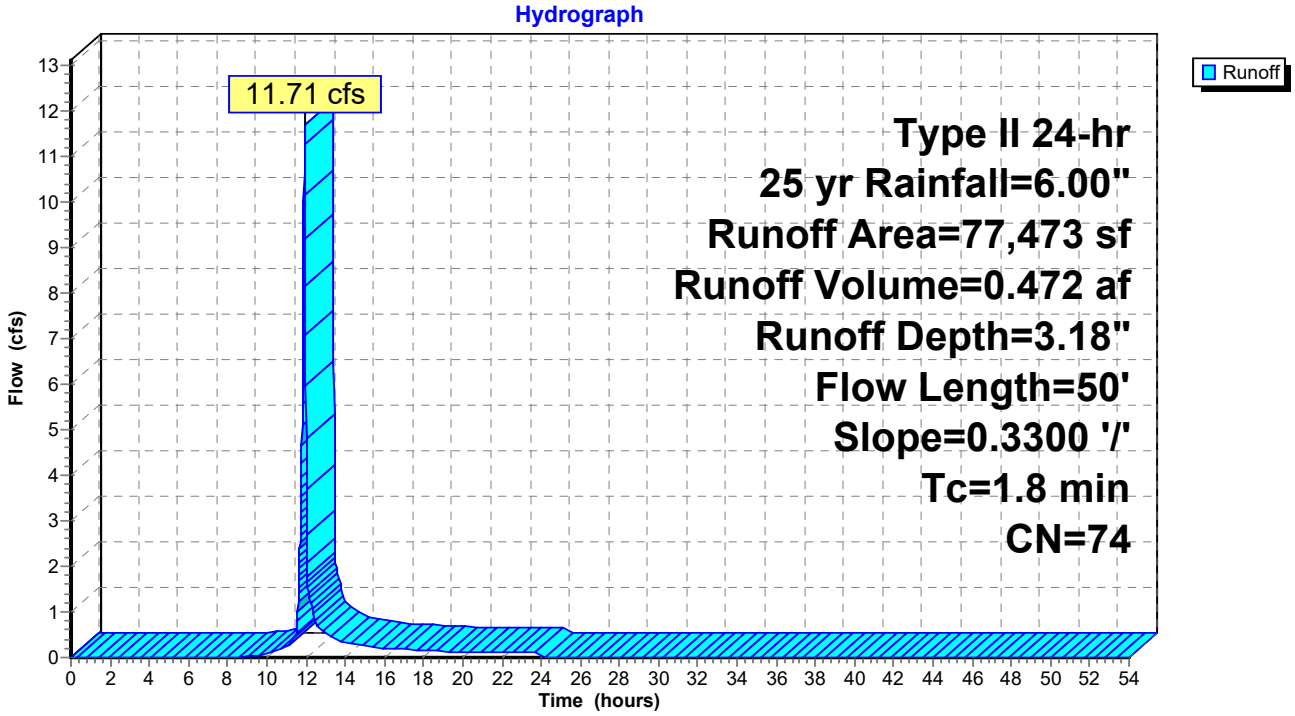
Runoff = 11.71 cfs @ 11.92 hrs, Volume= 0.472 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
77,473	74	>75% Grass cover, Good, HSG C
77,473		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	50	0.3300	0.45		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA2:



Summary for Subcatchment DA3:

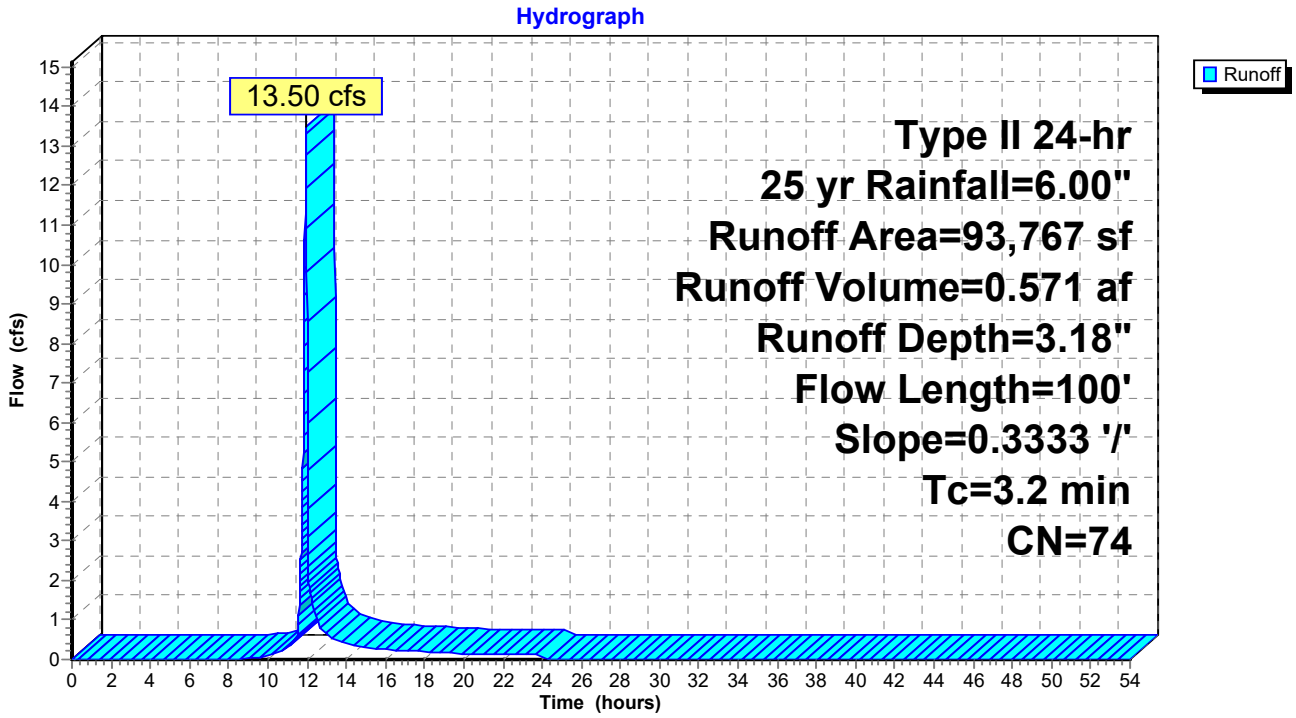
Runoff = 13.50 cfs @ 11.94 hrs, Volume= 0.571 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
93,767	74	>75% Grass cover, Good, HSG C
93,767		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	100	0.3333	0.52		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA3:



Summary for Subcatchment DA4:

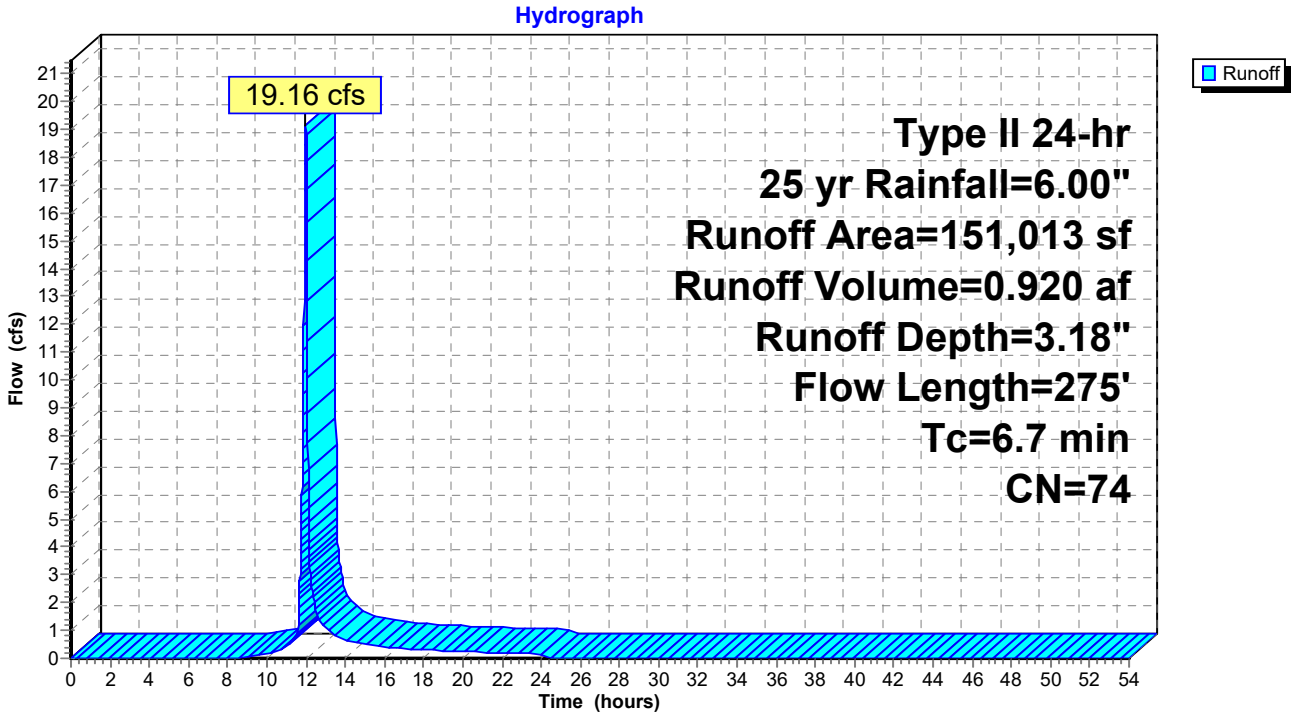
Runoff = 19.16 cfs @ 11.98 hrs, Volume= 0.920 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
151,013	74	>75% Grass cover, Good, HSG C
151,013		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	75	0.1670	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
3.4	200	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.7	275	Total			

Subcatchment DA4:



Summary for Subcatchment DA5:

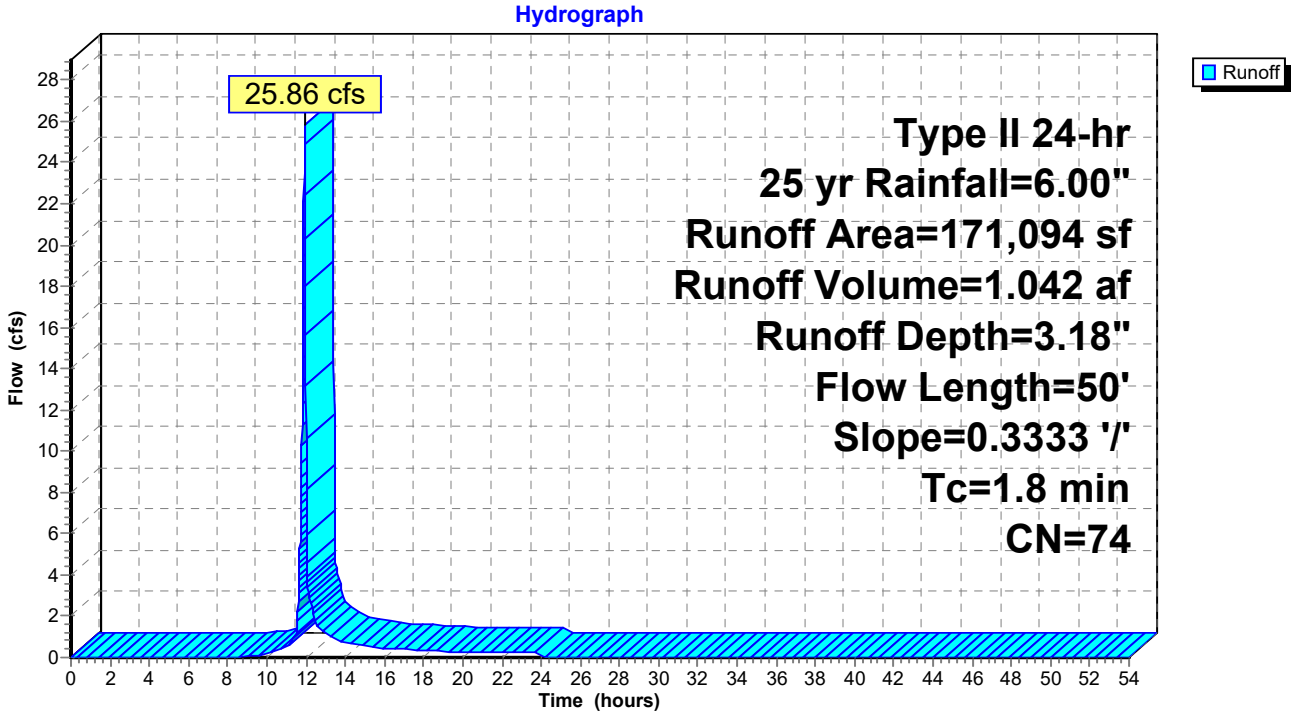
Runoff = 25.86 cfs @ 11.92 hrs, Volume= 1.042 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
171,094	74	>75% Grass cover, Good, HSG C
171,094		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	50	0.3333	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA5:



Summary for Subcatchment DA6:

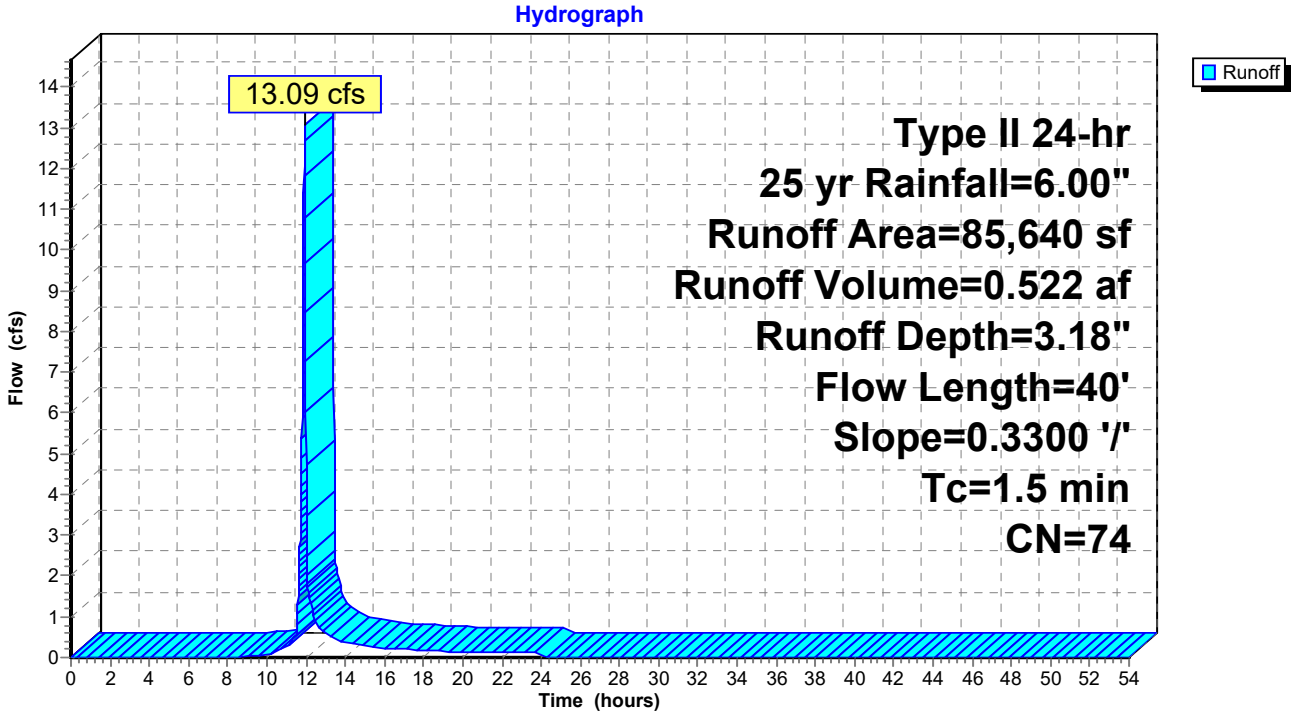
Runoff = 13.09 cfs @ 11.92 hrs, Volume= 0.522 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
85,640	74	>75% Grass cover, Good, HSG C
85,640		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	40	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA6:



Summary for Subcatchment DA7:

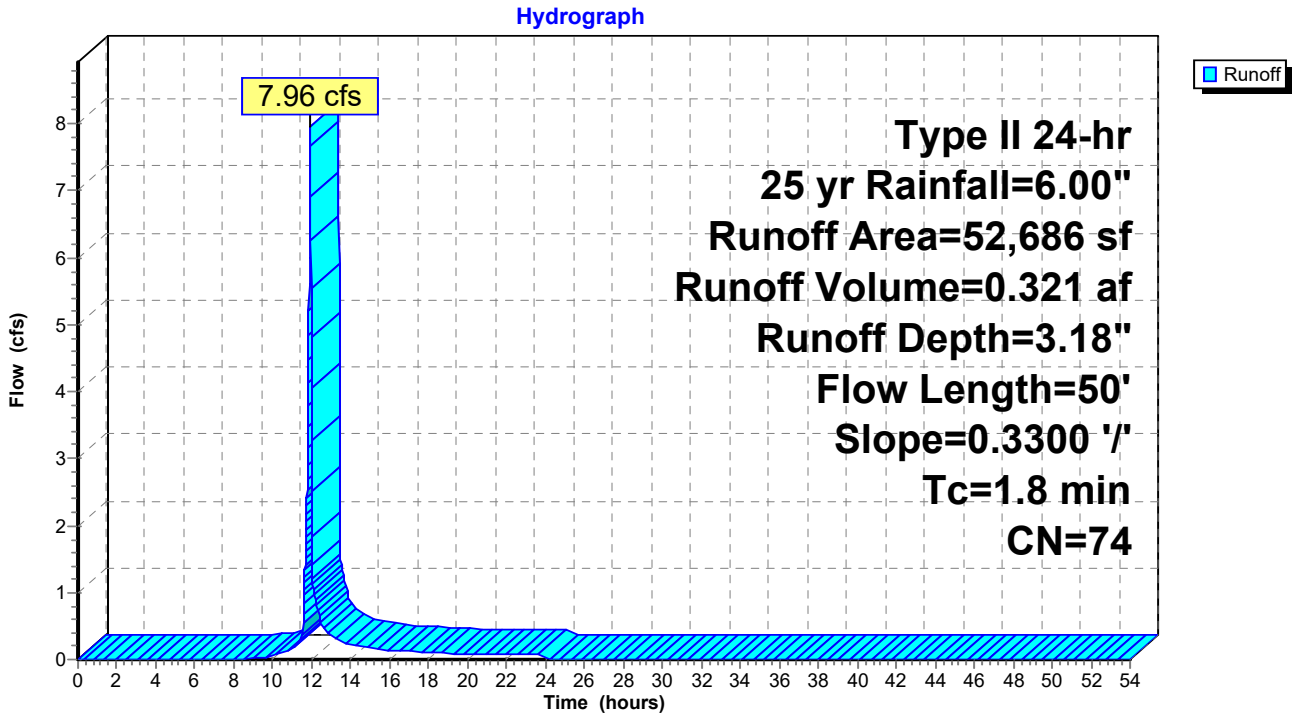
Runoff = 7.96 cfs @ 11.92 hrs, Volume= 0.321 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
52,686	74	>75% Grass cover, Good, HSG C
52,686		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	50	0.3300	0.45		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"

Subcatchment DA7:



Summary for Subcatchment PR10:

[49] Hint: Tc<2dt may require smaller dt

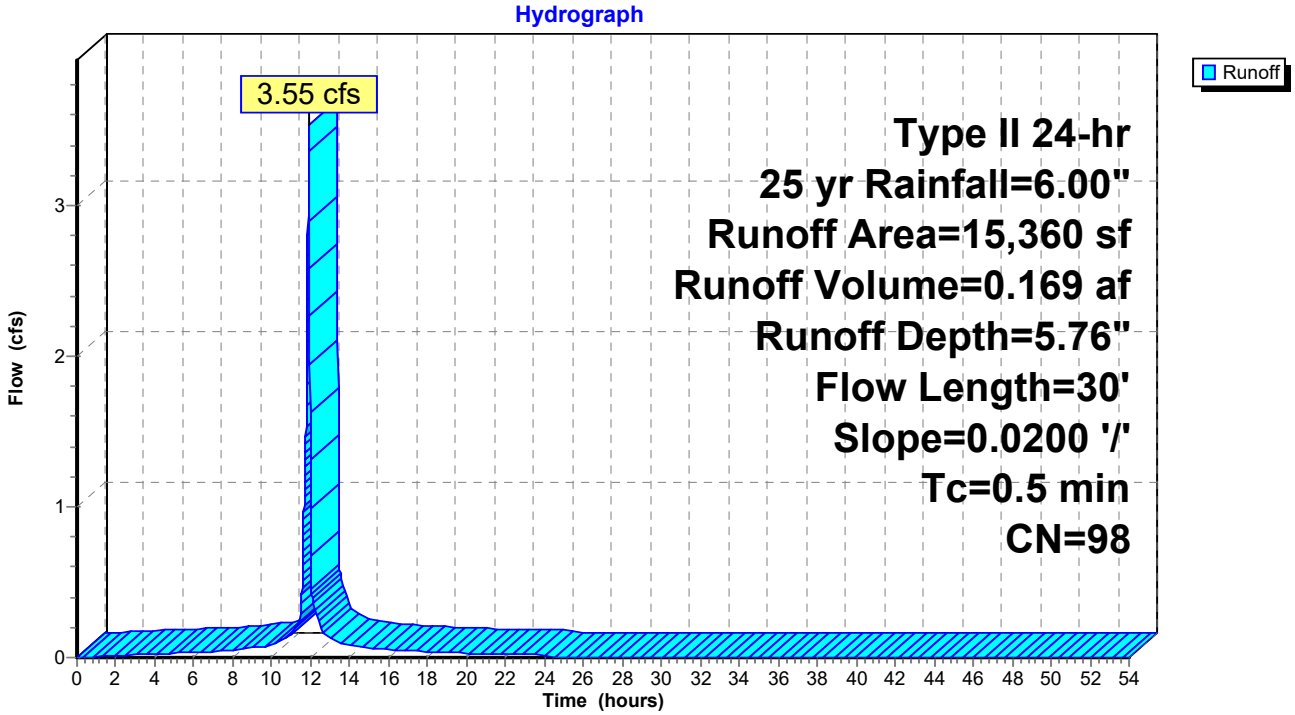
Runoff = 3.55 cfs @ 11.91 hrs, Volume= 0.169 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
15,360	98	Paved parking, HSG C
15,360		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR10:



Summary for Subcatchment PR21:

[49] Hint: Tc<2dt may require smaller dt

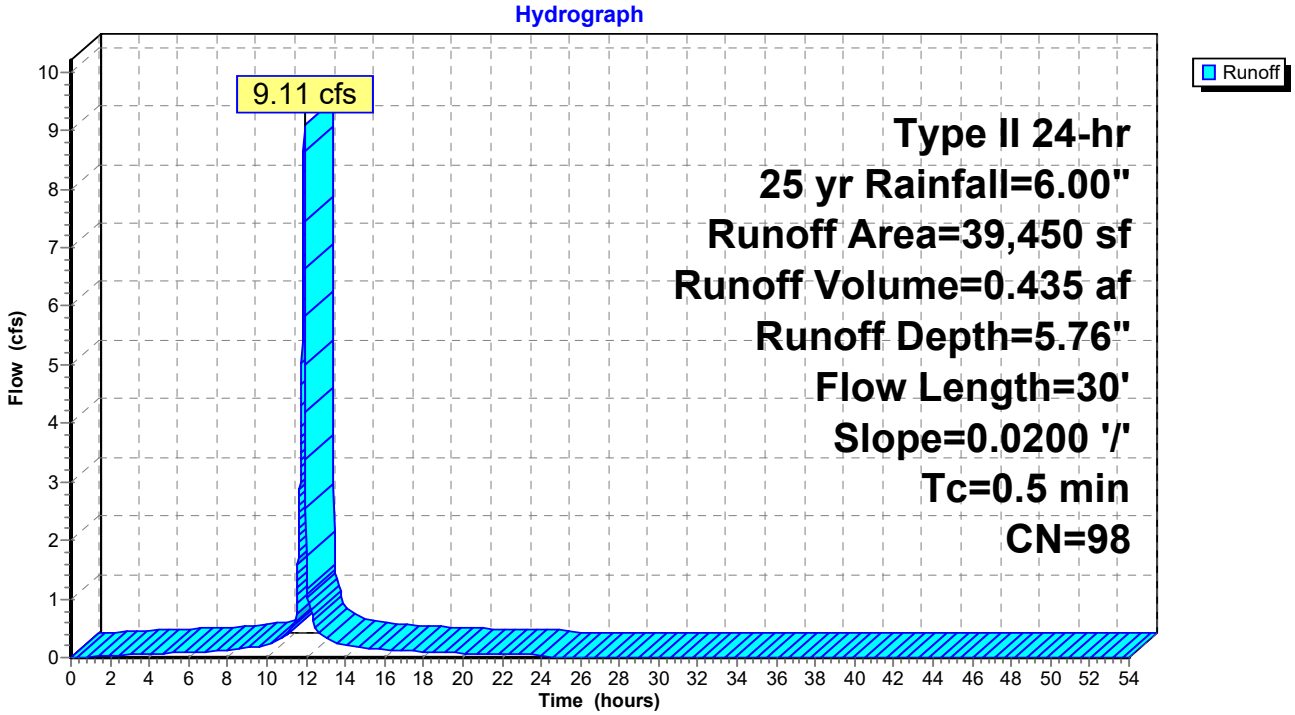
Runoff = 9.11 cfs @ 11.91 hrs, Volume= 0.435 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
39,450	98	Paved parking, HSG C
39,450		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR21:



Summary for Subcatchment PR31:

[49] Hint: Tc<2dt may require smaller dt

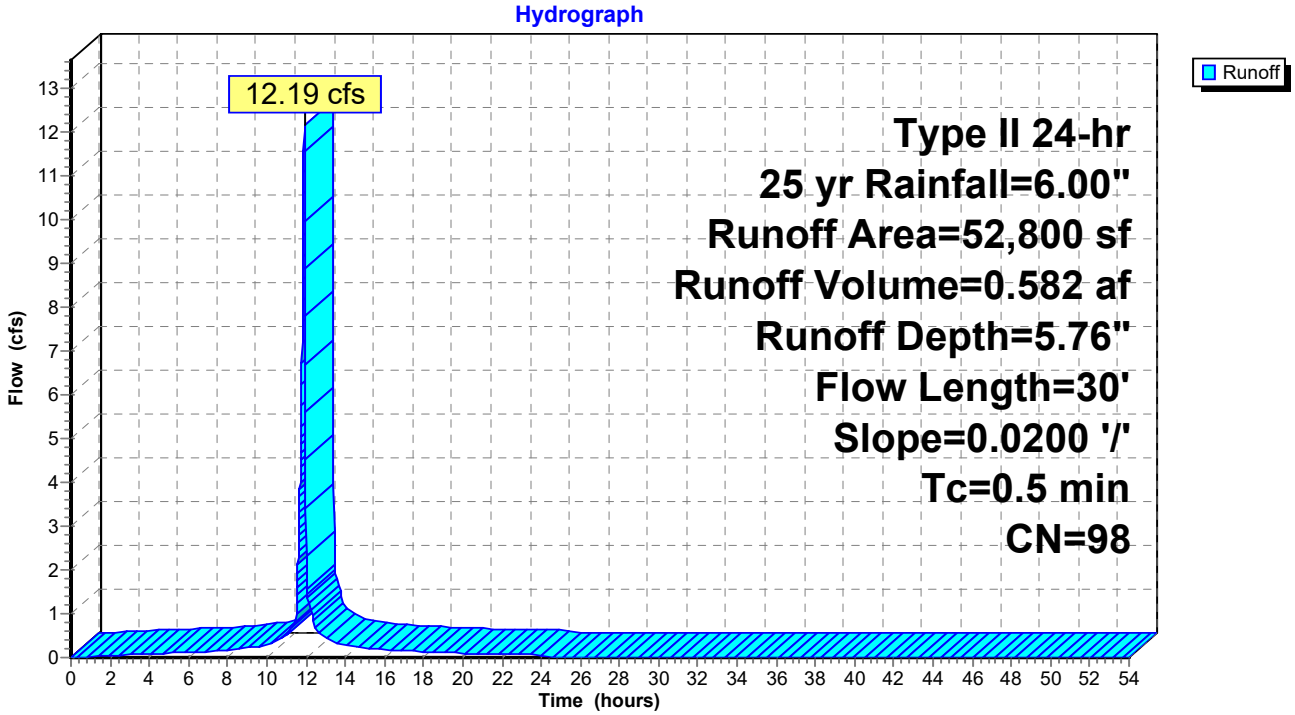
Runoff = 12.19 cfs @ 11.91 hrs, Volume= 0.582 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
52,800	98	Paved parking, HSG C
52,800		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR31:



Summary for Subcatchment PR41:

[49] Hint: Tc<2dt may require smaller dt

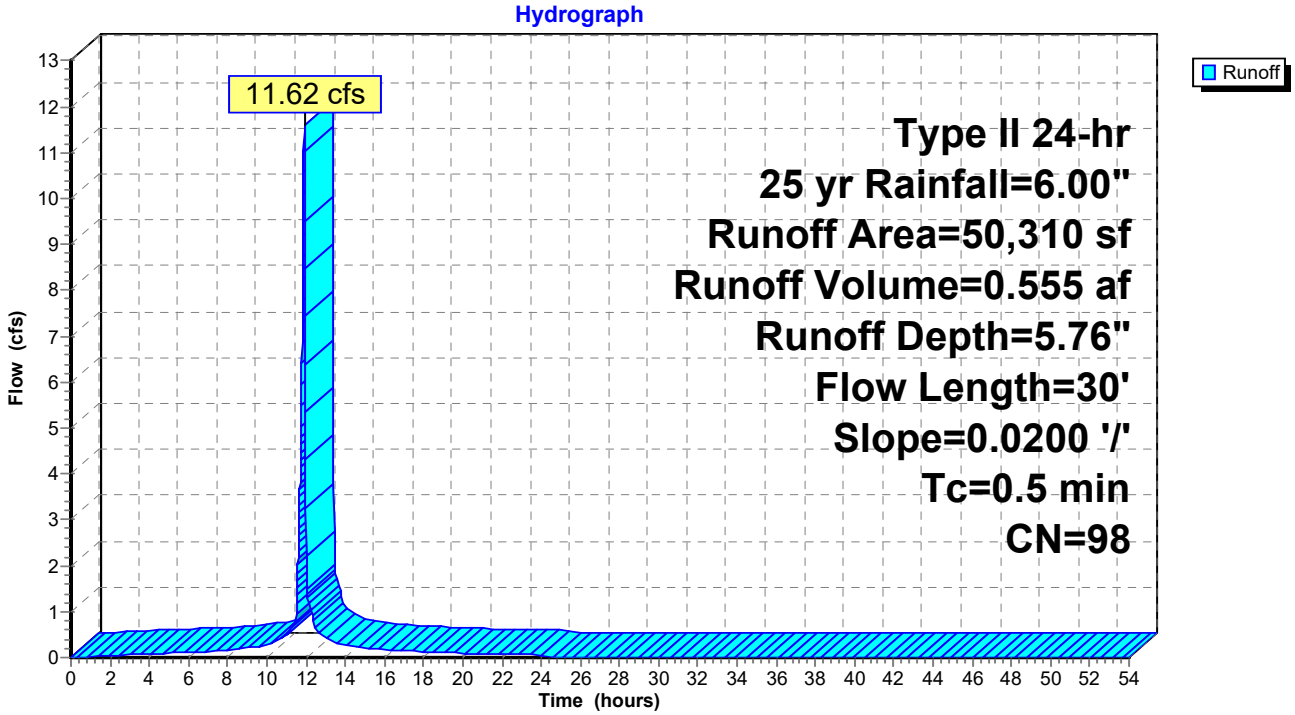
Runoff = 11.62 cfs @ 11.91 hrs, Volume= 0.555 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
50,310	98	Paved parking, HSG C
50,310		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR41:



Summary for Subcatchment PR6:

[49] Hint: Tc<2dt may require smaller dt

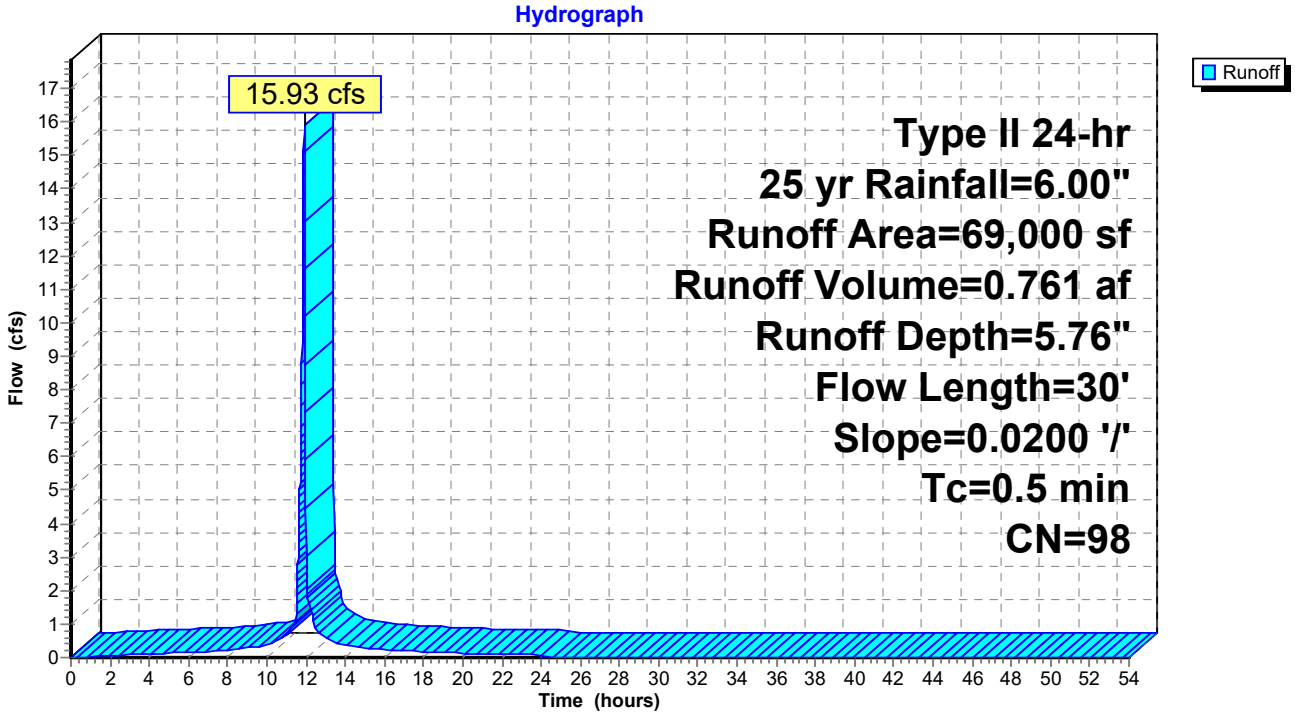
Runoff = 15.93 cfs @ 11.91 hrs, Volume= 0.761 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
69,000	98	Paved parking, HSG C
69,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR6:



Summary for Subcatchment PR7:

[49] Hint: Tc<2dt may require smaller dt

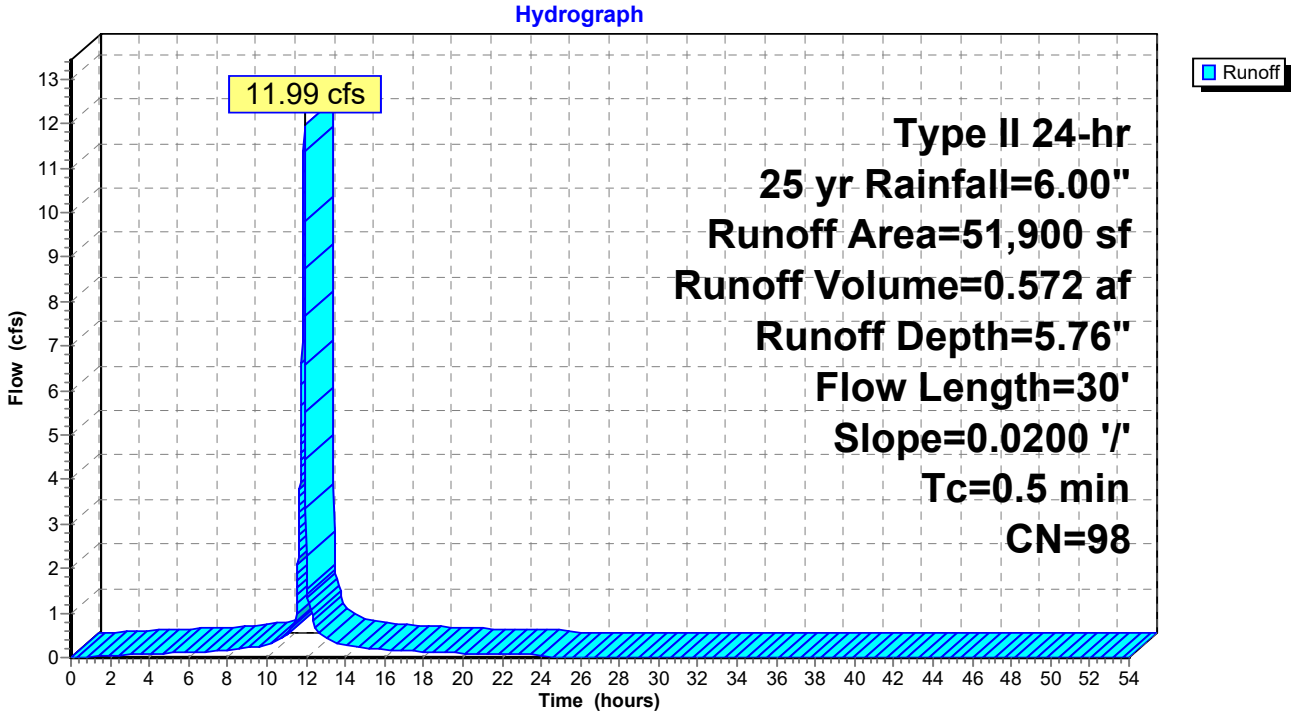
Runoff = 11.99 cfs @ 11.91 hrs, Volume= 0.572 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
51,900	98	Paved parking, HSG C
51,900		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR7:



Summary for Subcatchment PR92:

[49] Hint: Tc<2dt may require smaller dt

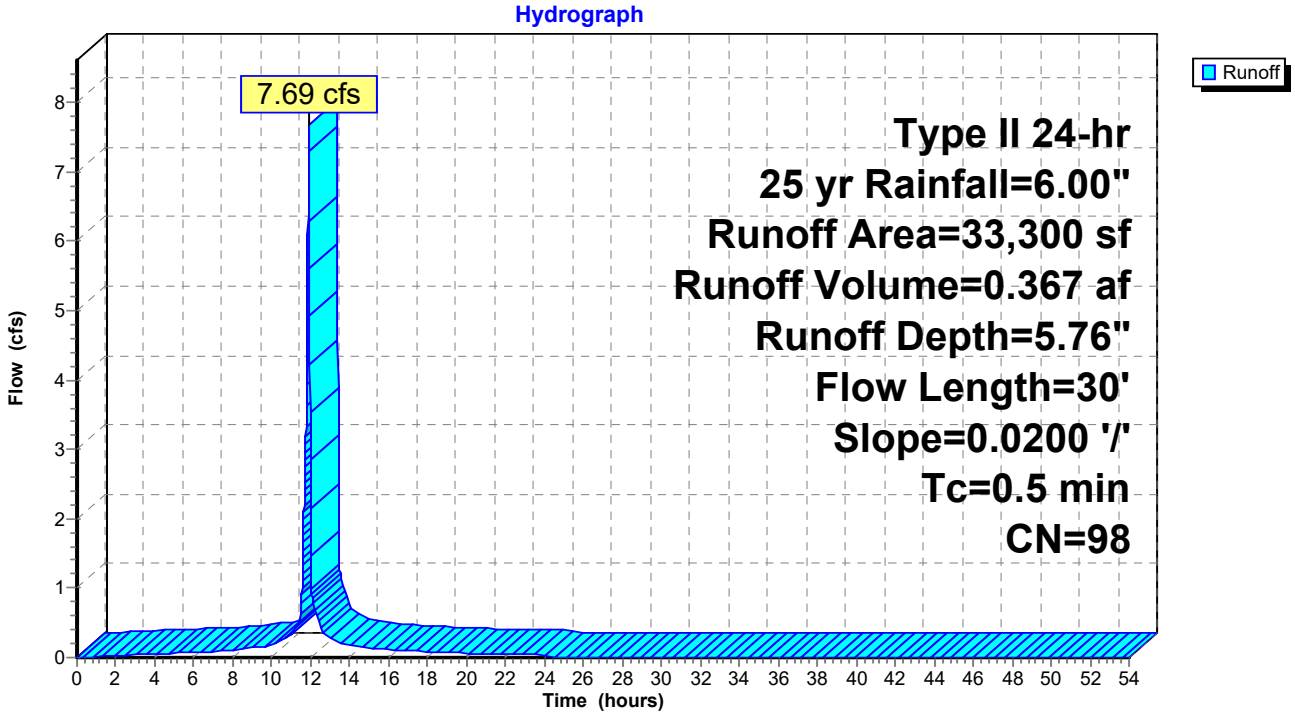
Runoff = 7.69 cfs @ 11.91 hrs, Volume= 0.367 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

Area (sf)	CN	Description
33,300	98	Paved parking, HSG C
33,300		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	30	0.0200	1.08		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"

Subcatchment PR92:



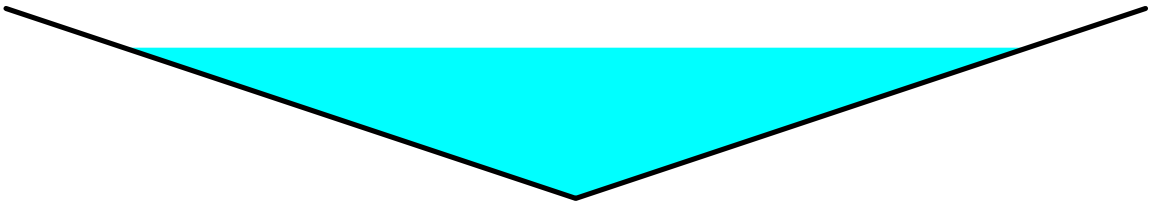
Summary for Reach B21:

Inflow Area = 8.323 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 46.01 cfs @ 11.98 hrs, Volume= 2.209 af
Outflow = 44.67 cfs @ 12.00 hrs, Volume= 2.209 af, Atten= 3%, Lag= 1.1 min

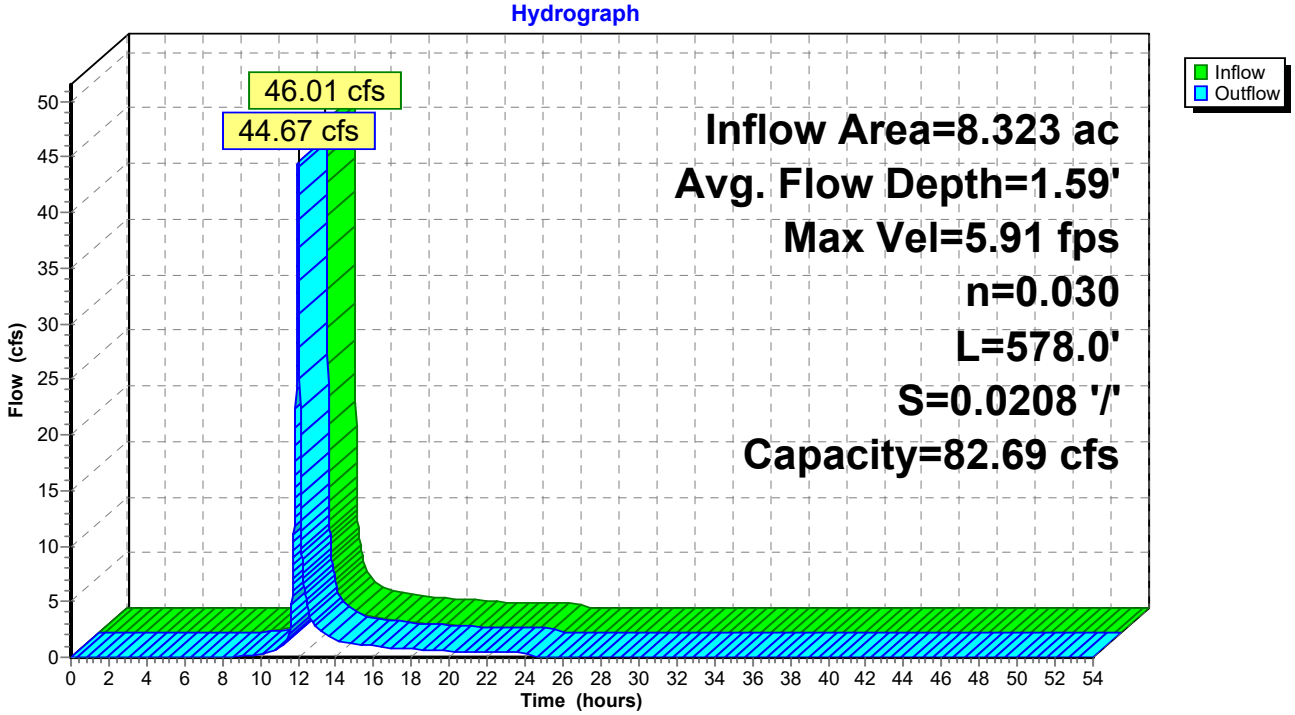
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.91 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 4.9 min

Peak Storage= 4,370 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.59'
Defined Flood Depth= 2.00' Flow Area= 12.0 sf, Capacity= 82.69 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 82.69 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 578.0' Slope= 0.0208 '/'
Inlet Invert= 180.00', Outlet Invert= 168.00'



Reach B21:



Summary for Reach B3:

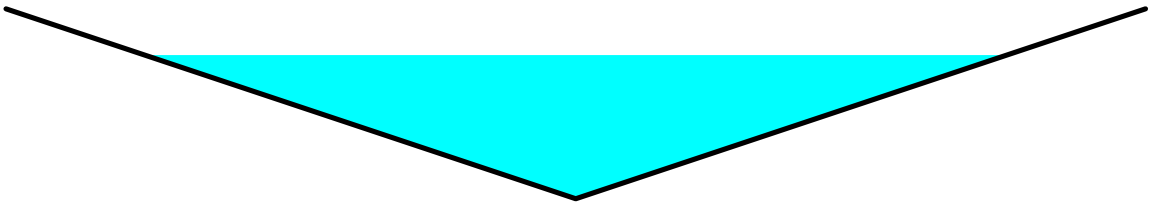
[62] Hint: Exceeded Reach T300 OUTLET depth by 0.47' @ 12.04 hrs

Inflow Area = 7.380 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 41.61 cfs @ 11.98 hrs, Volume= 1.959 af
Outflow = 40.64 cfs @ 12.00 hrs, Volume= 1.959 af, Atten= 2%, Lag= 1.0 min

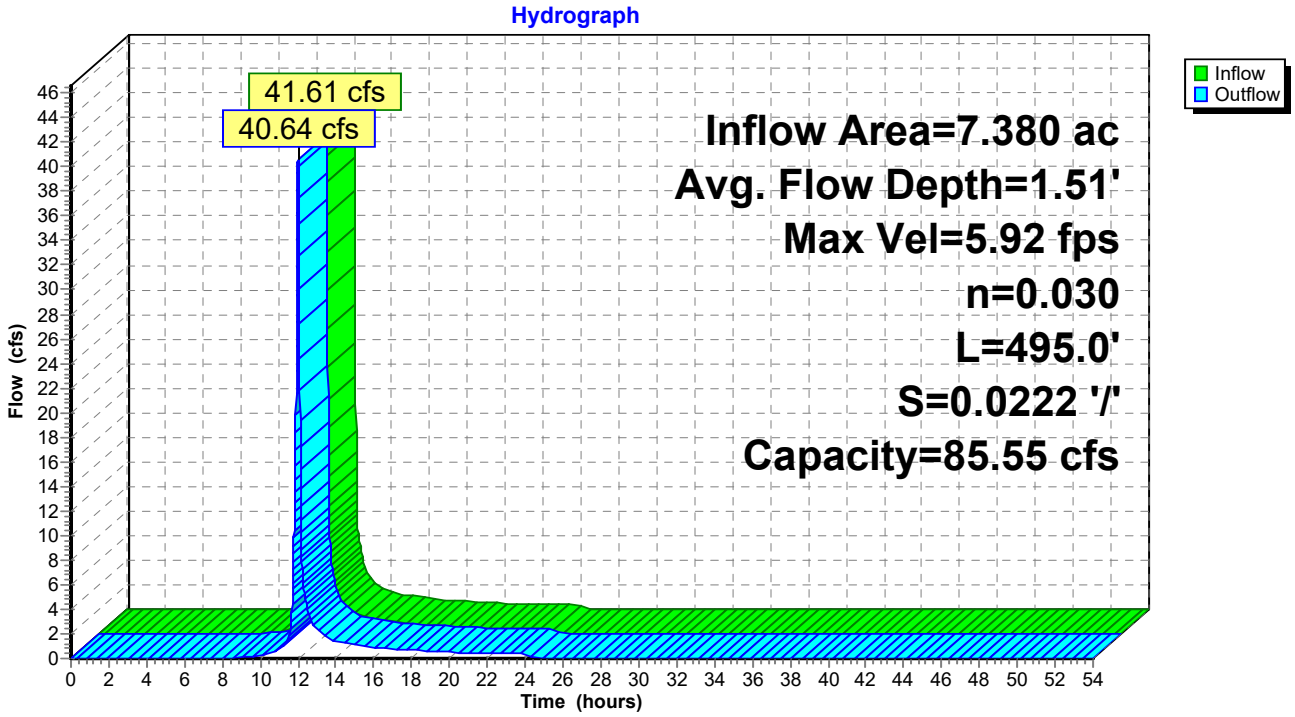
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.92 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 4.2 min

Peak Storage= 3,399 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.51'
Defined Flood Depth= 2.00' Flow Area= 12.0 sf, Capacity= 85.55 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 85.55 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 495.0' Slope= 0.0222 '/'
Inlet Invert= 176.00', Outlet Invert= 165.00'



Reach B3:


Hydrograph
41.61 cfs
40.64 cfs
Inflow Area=7.380 ac
Avg. Flow Depth=1.51'
Max Vel=5.92 fps
n=0.030
L=495.0'
S=0.0222 '/'
Capacity=85.55 cfs
Inflow
Outflow
Flow (cfs)
Time (hours)

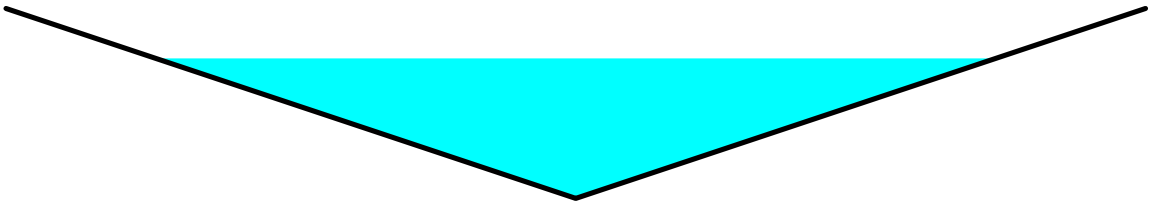
Summary for Reach B41:

Inflow Area = 7.547 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 36.90 cfs @ 12.02 hrs, Volume= 2.003 af
Outflow = 36.45 cfs @ 12.03 hrs, Volume= 2.003 af, Atten= 1%, Lag= 0.8 min

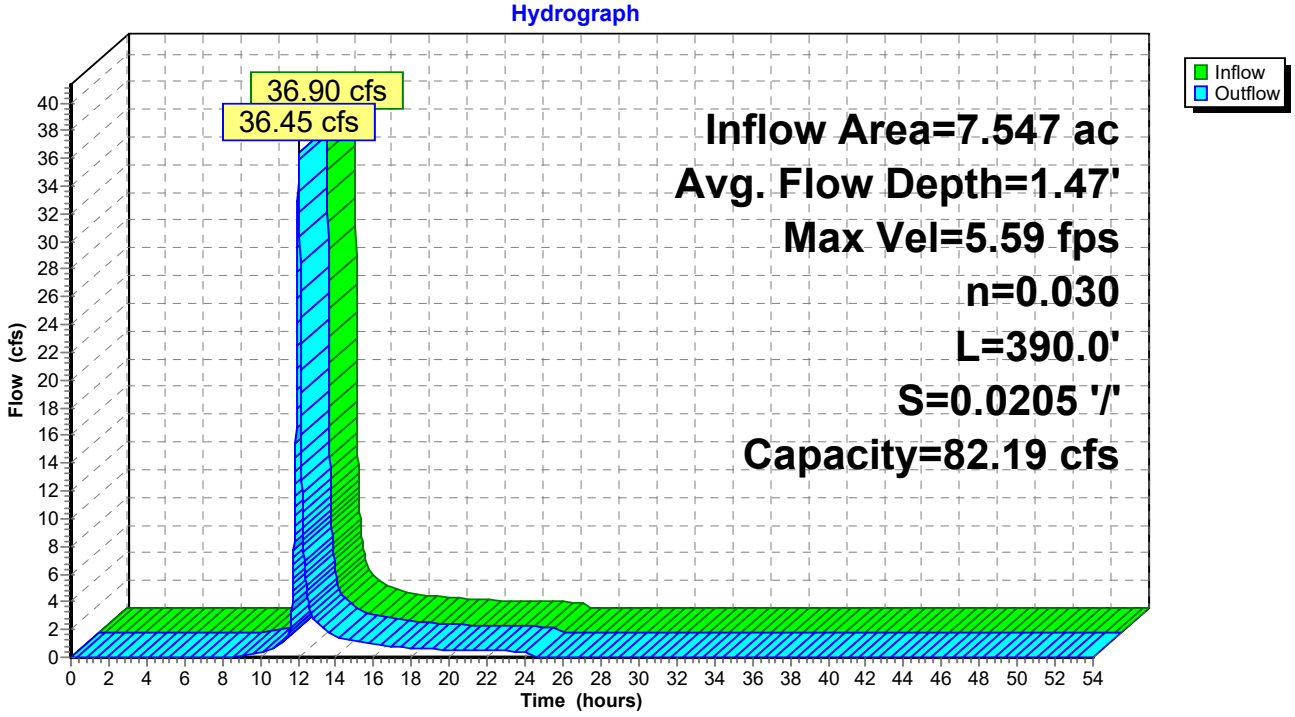
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.59 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 3.3 min

Peak Storage= 2,543 cf @ 12.03 hrs
Average Depth at Peak Storage= 1.47'
Defined Flood Depth= 2.00' Flow Area= 12.0 sf, Capacity= 82.19 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 82.19 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 390.0' Slope= 0.0205 '/'
Inlet Invert= 180.00', Outlet Invert= 172.00'



Reach B41:



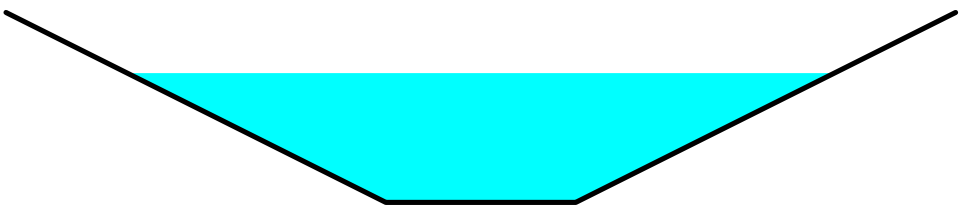
Summary for Reach CH10: CH10-Proposed

Inflow Area = 2.106 ac, 16.75% Impervious, Inflow Depth = 3.62" for 25 yr event
Inflow = 14.31 cfs @ 11.92 hrs, Volume= 0.635 af
Outflow = 12.06 cfs @ 11.96 hrs, Volume= 0.635 af, Atten= 16%, Lag= 2.1 min

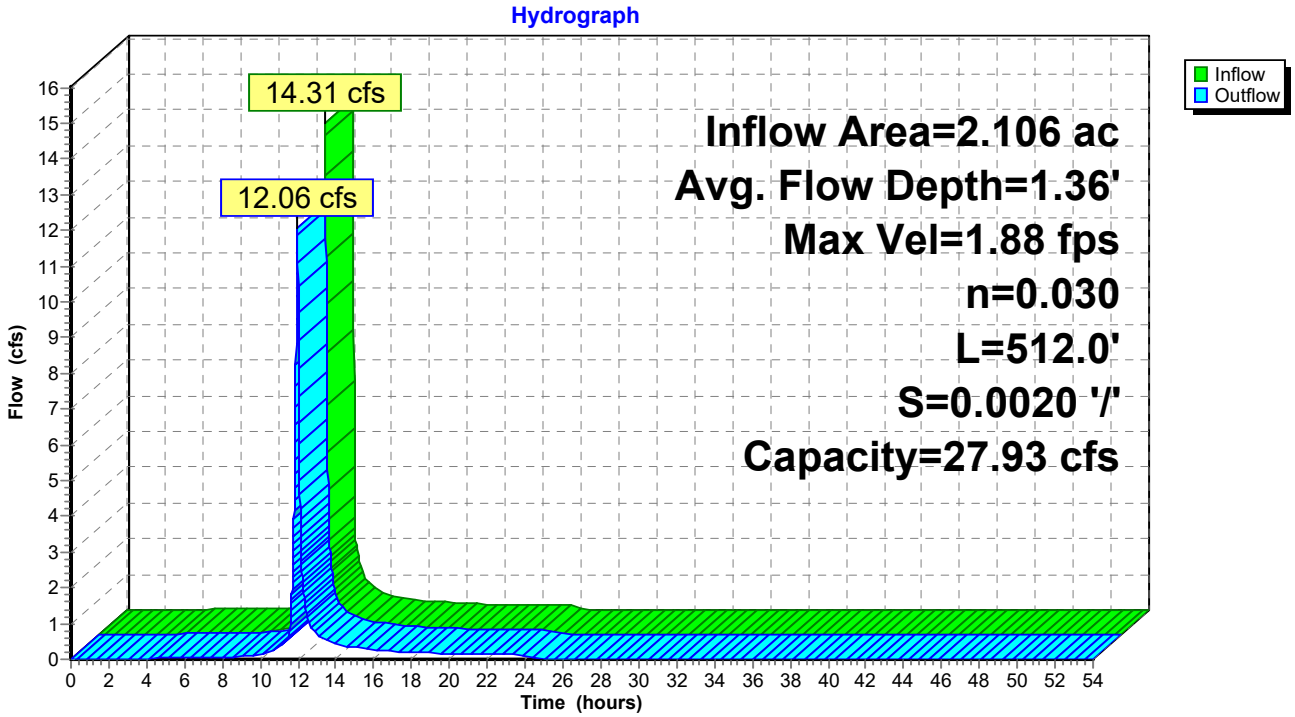
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.88 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 0.43 fps, Avg. Travel Time= 19.7 min

Peak Storage= 3,289 cf @ 11.96 hrs
Average Depth at Peak Storage= 1.36'
Defined Flood Depth= 1.75' Flow Area= 9.6 sf, Capacity= 20.78 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 27.93 cfs

2.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 512.0' Slope= 0.0020 '/'
Inlet Invert= 28.00', Outlet Invert= 27.00'



Reach CH10: CH10-Proposed



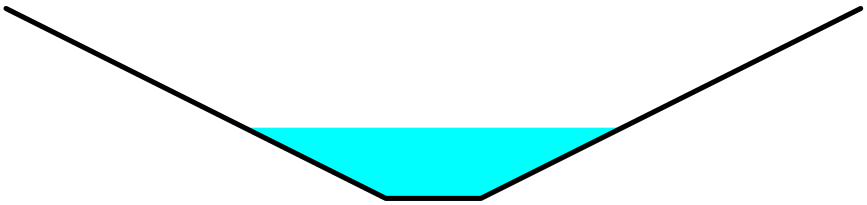
Summary for Reach CH21:

Inflow Area = 2.115 ac, 42.82% Impervious, Inflow Depth = 4.29" for 25 yr event
Inflow = 16.69 cfs @ 11.91 hrs, Volume= 0.756 af
Outflow = 15.11 cfs @ 11.93 hrs, Volume= 0.756 af, Atten= 9%, Lag= 1.3 min

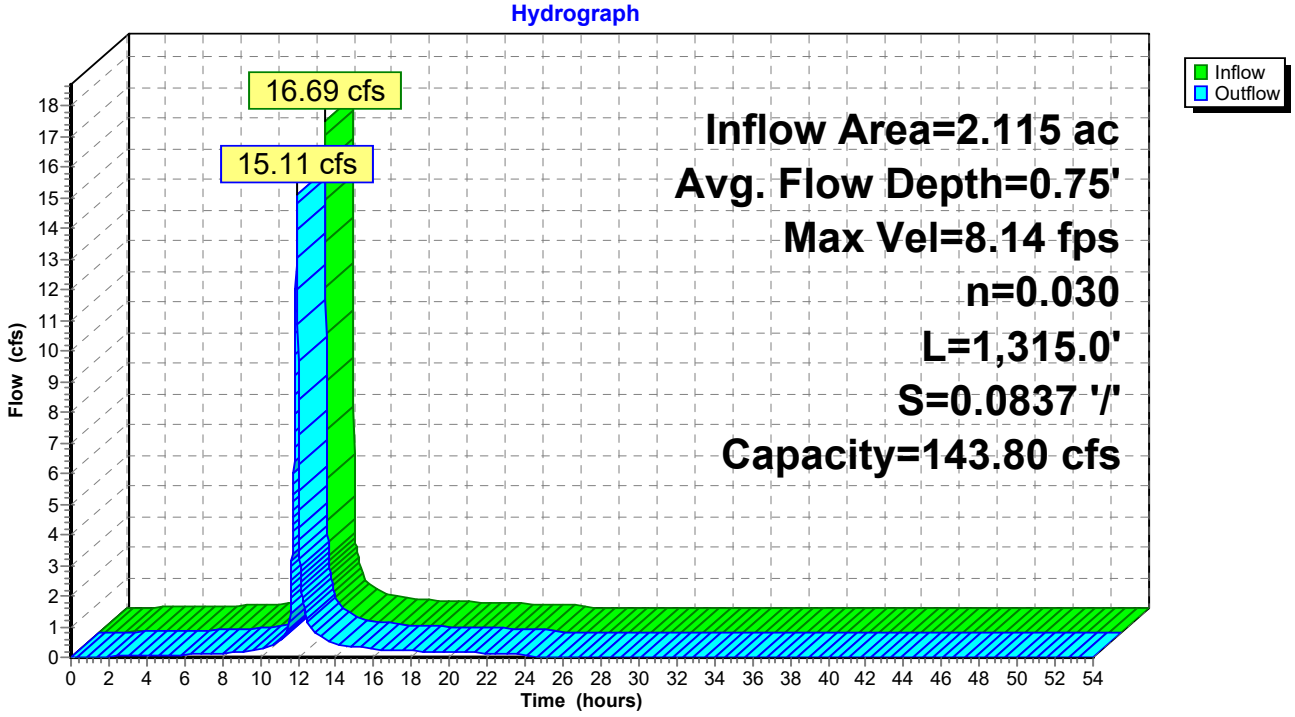
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.14 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 2.20 fps, Avg. Travel Time= 9.9 min

Peak Storage= 2,441 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.75'
Defined Flood Depth= 1.75' Flow Area= 7.9 sf, Capacity= 104.57 cfs
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 143.80 cfs

1.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 1,315.0' Slope= 0.0837 '/'
Inlet Invert= 180.00', Outlet Invert= 70.00'



Reach CH21:



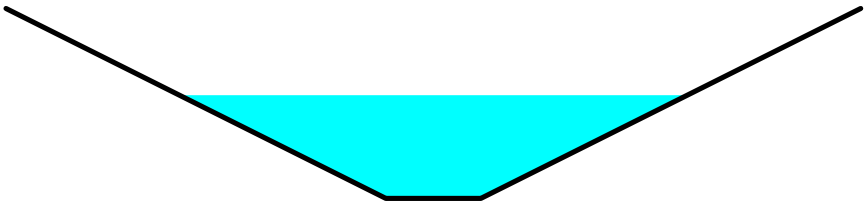
Summary for Reach CH31:

Inflow Area = 6.457 ac, 18.77% Impervious, Inflow Depth = 3.67" for 25 yr event
Inflow = 37.62 cfs @ 11.92 hrs, Volume= 1.974 af
Outflow = 34.78 cfs @ 11.96 hrs, Volume= 1.974 af, Atten= 8%, Lag= 2.1 min

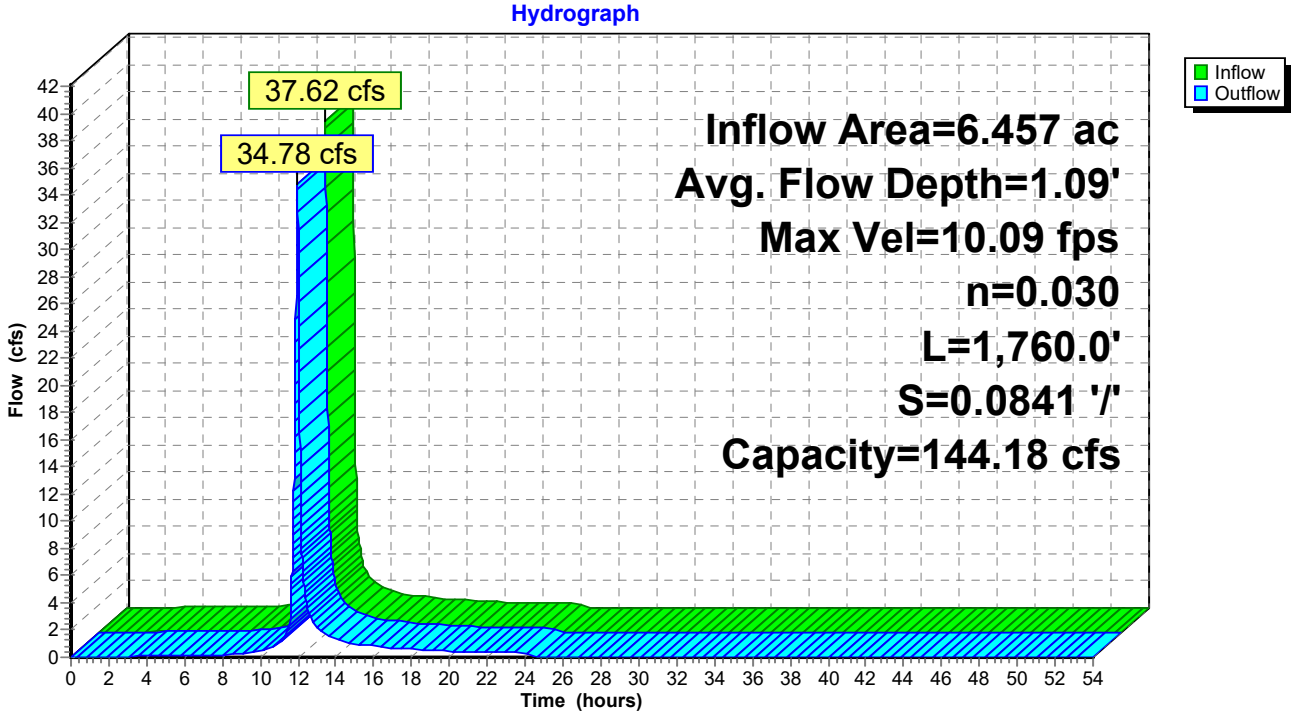
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.09 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 2.79 fps, Avg. Travel Time= 10.5 min

Peak Storage= 6,068 cf @ 11.96 hrs
Average Depth at Peak Storage= 1.09'
Defined Flood Depth= 1.75' Flow Area= 7.9 sf, Capacity= 104.84 cfs
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 144.18 cfs

1.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 1,760.0' Slope= 0.0841 '/'
Inlet Invert= 180.00', Outlet Invert= 32.00'



Reach CH31:



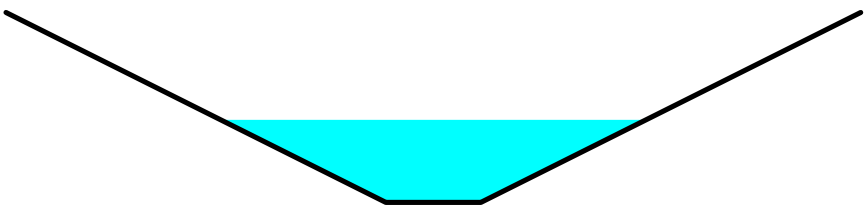
Summary for Reach CH41:

Inflow Area = 3.121 ac, 37.01% Impervious, Inflow Depth = 4.14" for 25 yr event
Inflow = 24.28 cfs @ 11.91 hrs, Volume= 1.076 af
Outflow = 21.50 cfs @ 11.93 hrs, Volume= 1.076 af, Atten= 11%, Lag= 1.4 min

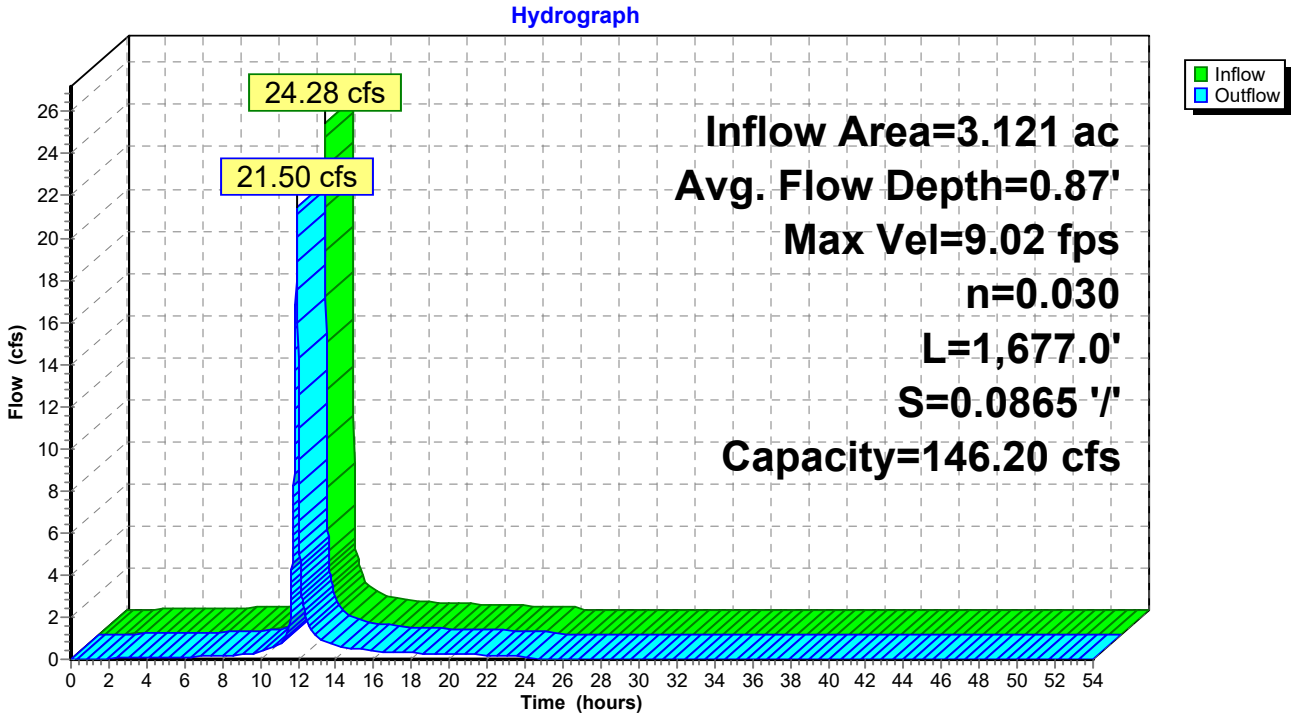
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.02 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 2.44 fps, Avg. Travel Time= 11.5 min

Peak Storage= 3,996 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.87'
Defined Flood Depth= 1.75' Flow Area= 7.9 sf, Capacity= 106.31 cfs
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 146.20 cfs

1.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 1,677.0' Slope= 0.0865 '/'
Inlet Invert= 175.00', Outlet Invert= 30.00'



Reach CH41:



Summary for Reach CH6: CH6-Existing

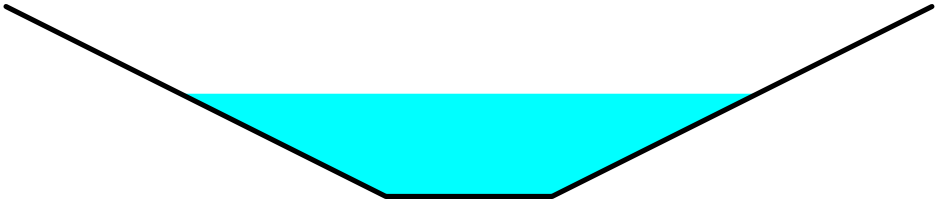
[62] Hint: Exceeded Reach CH92 OUTLET depth by 1.63' @ 12.04 hrs
[61] Hint: Exceeded Reach DC2 outlet invert by 0.16' @ 12.00 hrs

Inflow Area = 30.458 ac, 10.68% Impervious, Inflow Depth = 3.46" for 25 yr event
Inflow = 148.74 cfs @ 11.95 hrs, Volume= 8.783 af
Outflow = 129.26 cfs @ 12.00 hrs, Volume= 8.783 af, Atten= 13%, Lag= 3.0 min

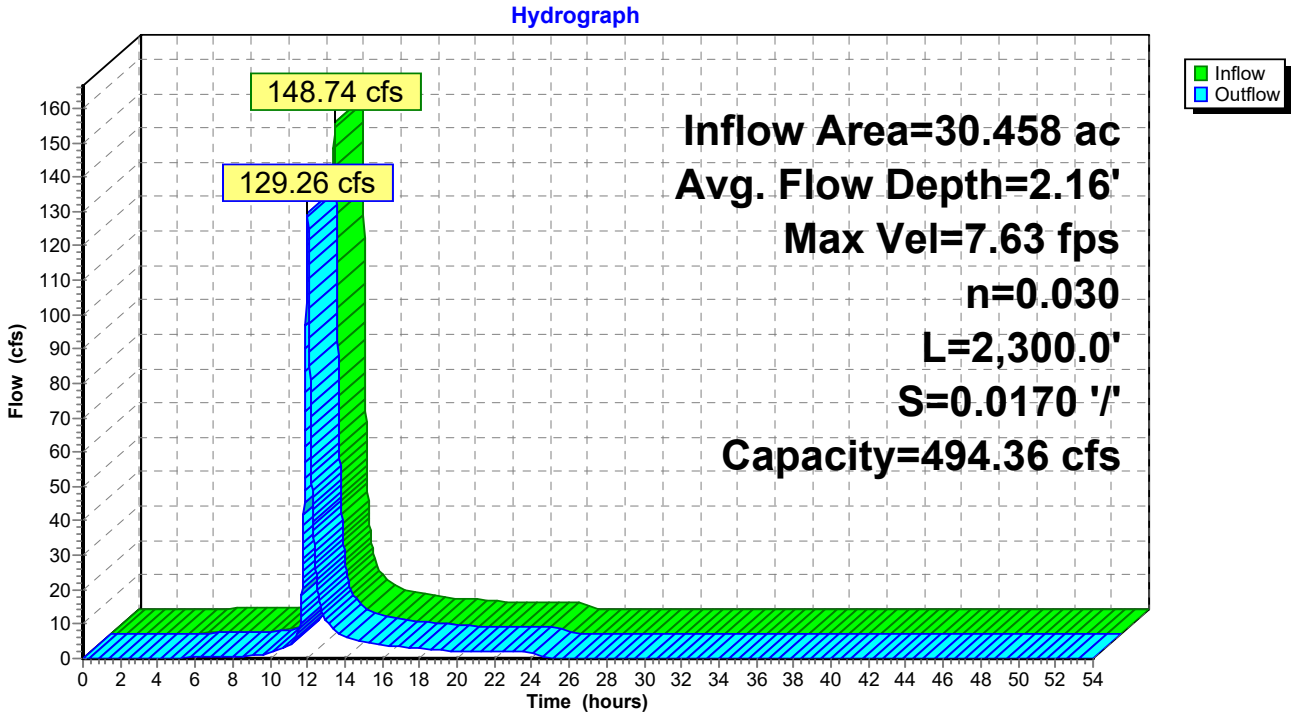
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.63 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 1.82 fps, Avg. Travel Time= 21.1 min

Peak Storage= 38,979 cf @ 12.00 hrs
Average Depth at Peak Storage= 2.16'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 427.28 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 494.36 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 2,300.0' Slope= 0.0170 '/'
Inlet Invert= 65.00', Outlet Invert= 26.00'



Reach CH6: CH6-Existing



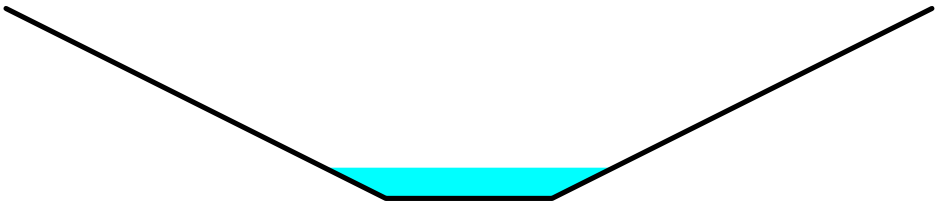
Summary for Reach CH92: CH92-Existing

Inflow Area = 1.730 ac, 44.20% Impervious, Inflow Depth = 4.32" for 25 yr event
Inflow = 13.42 cfs @ 11.91 hrs, Volume= 0.623 af
Outflow = 11.02 cfs @ 11.95 hrs, Volume= 0.623 af, Atten= 18%, Lag= 2.2 min

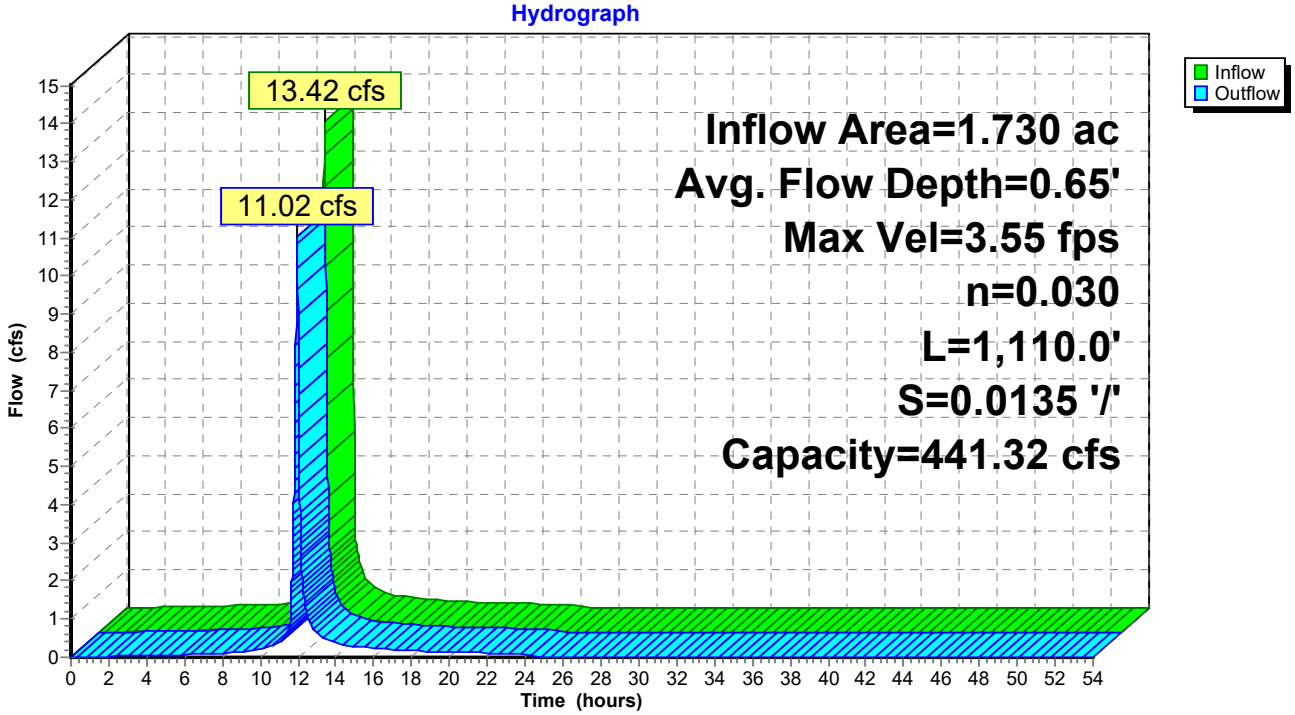
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.55 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 21.4 min

Peak Storage= 3,440 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.65'
Defined Flood Depth= 3.75' Flow Area= 41.3 sf, Capacity= 381.44 cfs
Bank-Full Depth= 4.00' Flow Area= 46.0 sf, Capacity= 441.32 cfs

3.50' x 4.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 19.50'
Length= 1,110.0' Slope= 0.0135 '/'
Inlet Invert= 80.00', Outlet Invert= 65.00'



Reach CH92: CH92-Existing



Summary for Reach DC2:

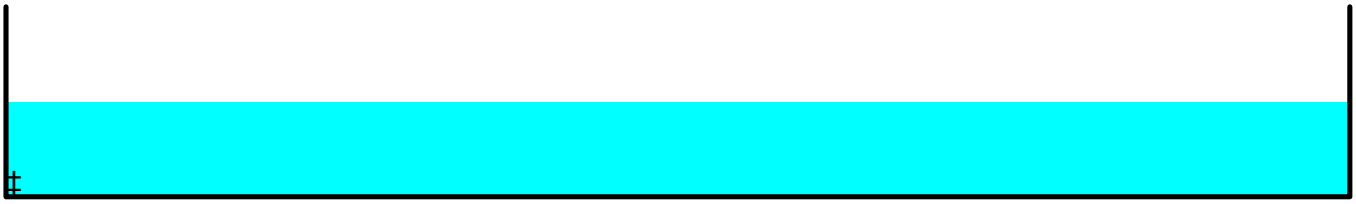
[62] Hint: Exceeded Reach DC21 OUTLET depth by 0.29' @ 12.05 hrs
[61] Hint: Exceeded Reach T22 outlet invert by 0.50' @ 11.99 hrs

Inflow Area = 21.101 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 98.14 cfs @ 11.98 hrs, Volume= 5.600 af
Outflow = 98.09 cfs @ 11.99 hrs, Volume= 5.600 af, Atten= 0%, Lag= 0.2 min

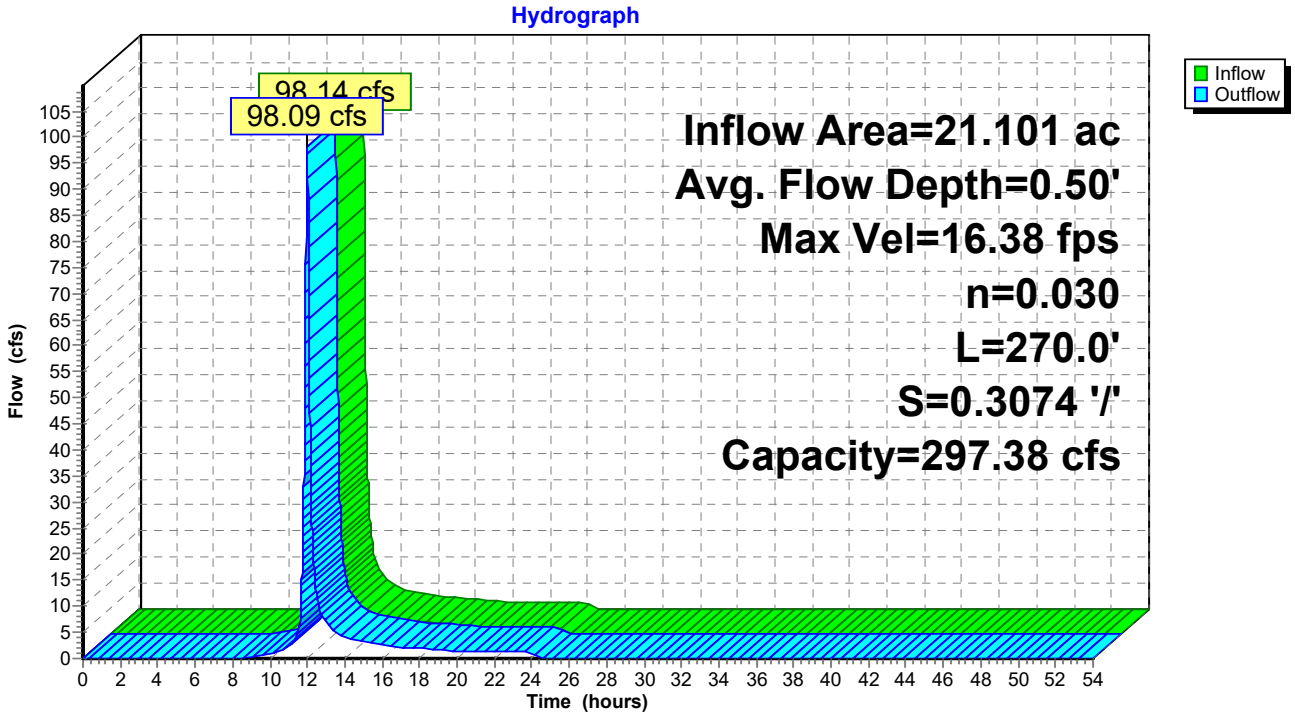
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 16.38 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.37 fps, Avg. Travel Time= 1.3 min

Peak Storage= 1,617 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.50'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 188.63 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 297.38 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 270.0' Slope= 0.3074 '/'
Inlet Invert= 150.00', Outlet Invert= 67.00'



Reach DC2:


Hydrograph
98.14 cfs
98.09 cfs
Inflow Area=21.101 ac
Avg. Flow Depth=0.50'
Max Vel=16.38 fps
n=0.030
L=270.0'
S=0.3074 '/'
Capacity=297.38 cfs
Inflow
Outflow
Flow (cfs)
Time (hours)

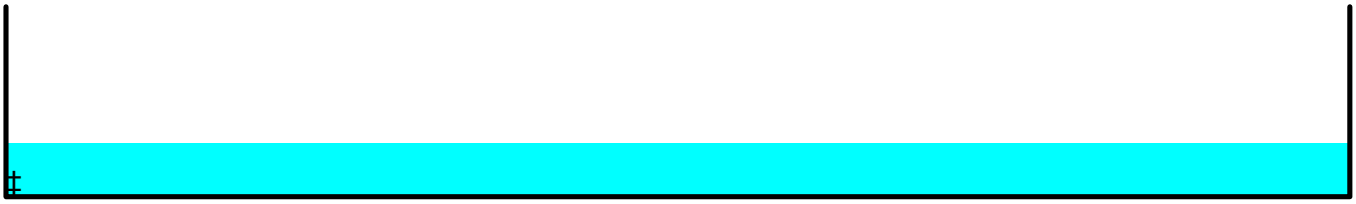
Summary for Reach DC21:

Inflow Area = 6.332 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 38.45 cfs @ 11.95 hrs, Volume= 1.680 af
Outflow = 38.44 cfs @ 11.95 hrs, Volume= 1.680 af, Atten= 0%, Lag= 0.1 min

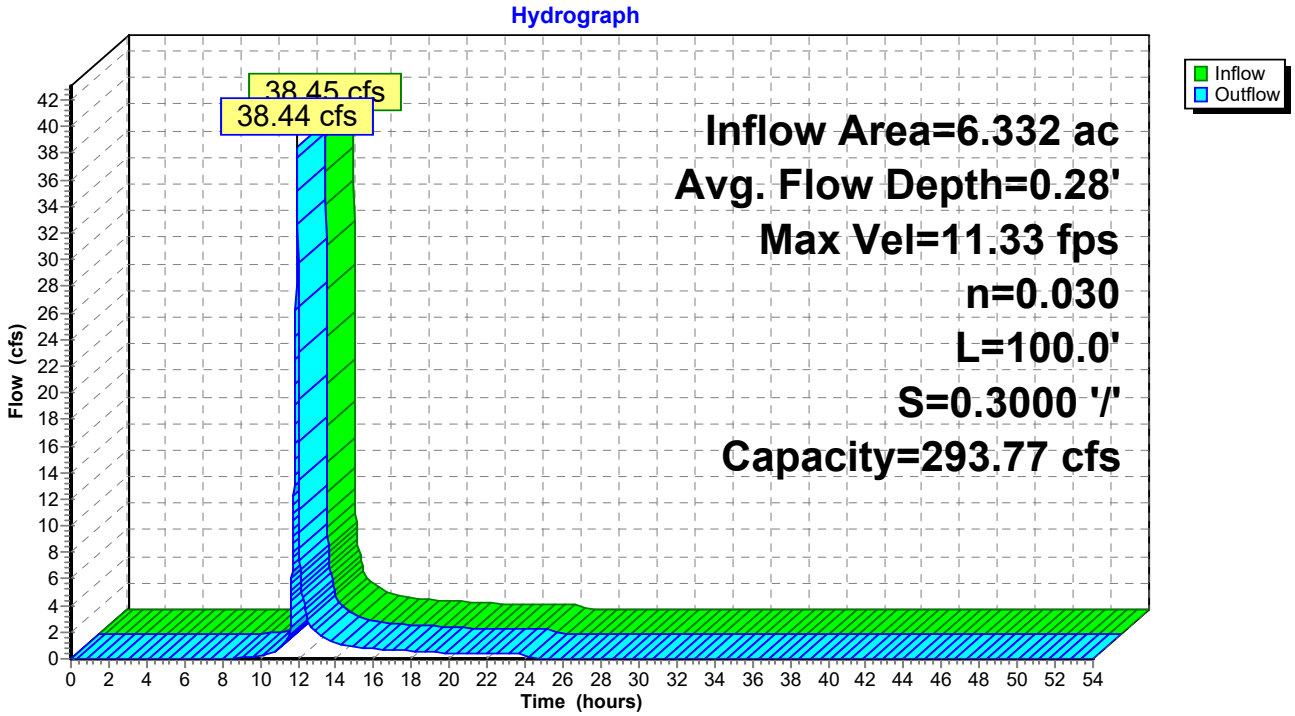
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.33 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.39 fps, Avg. Travel Time= 0.7 min

Peak Storage= 339 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.28'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 186.34 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 293.77 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 100.0' Slope= 0.3000 '/'
Inlet Invert= 180.00', Outlet Invert= 150.00'



Reach DC21:



Summary for Reach DC3:

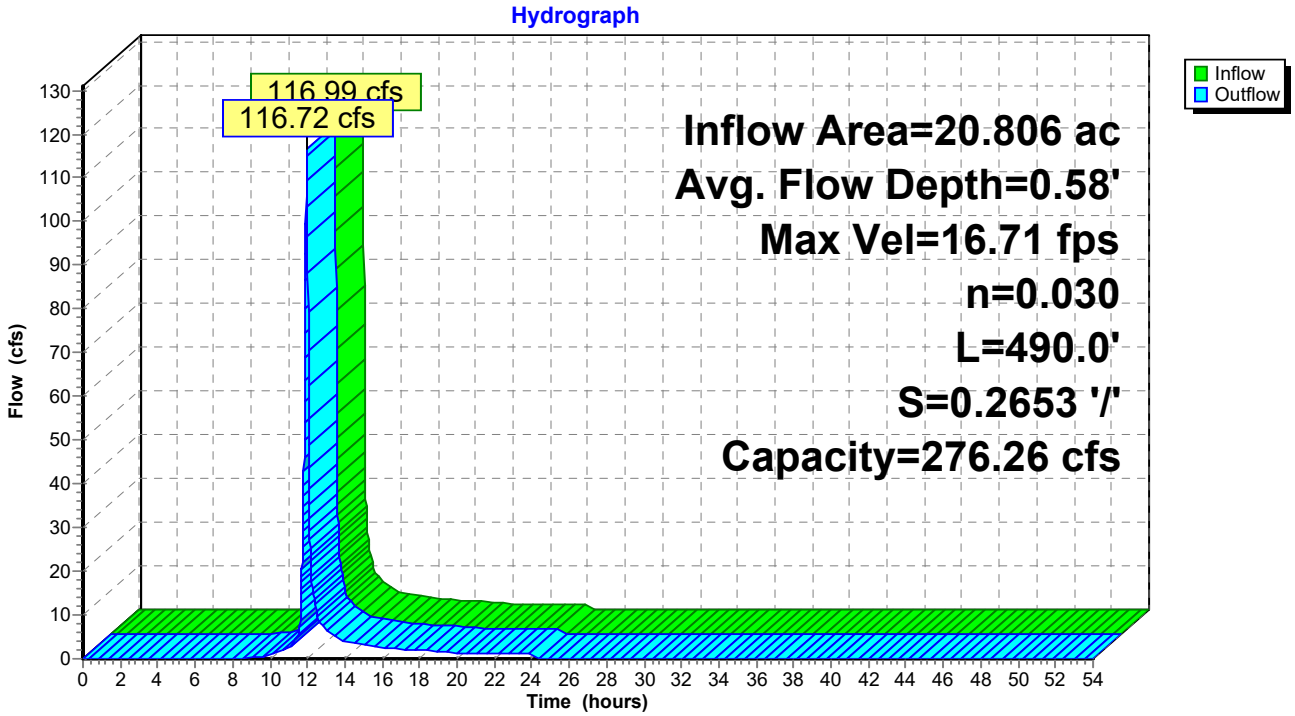
Inflow Area = 20.806 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 116.99 cfs @ 11.96 hrs, Volume= 5.522 af
Outflow = 116.72 cfs @ 11.96 hrs, Volume= 5.522 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 16.71 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.39 fps, Avg. Travel Time= 2.4 min

Peak Storage= 3,421 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.58'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 175.23 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 276.26 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 490.0' Slope= 0.2653 '/'
Inlet Invert= 160.00', Outlet Invert= 30.00'

Reach DC3:



Summary for Reach DC4:

[61] Hint: Exceeded Reach T42 outlet invert by 0.53' @ 11.98 hrs

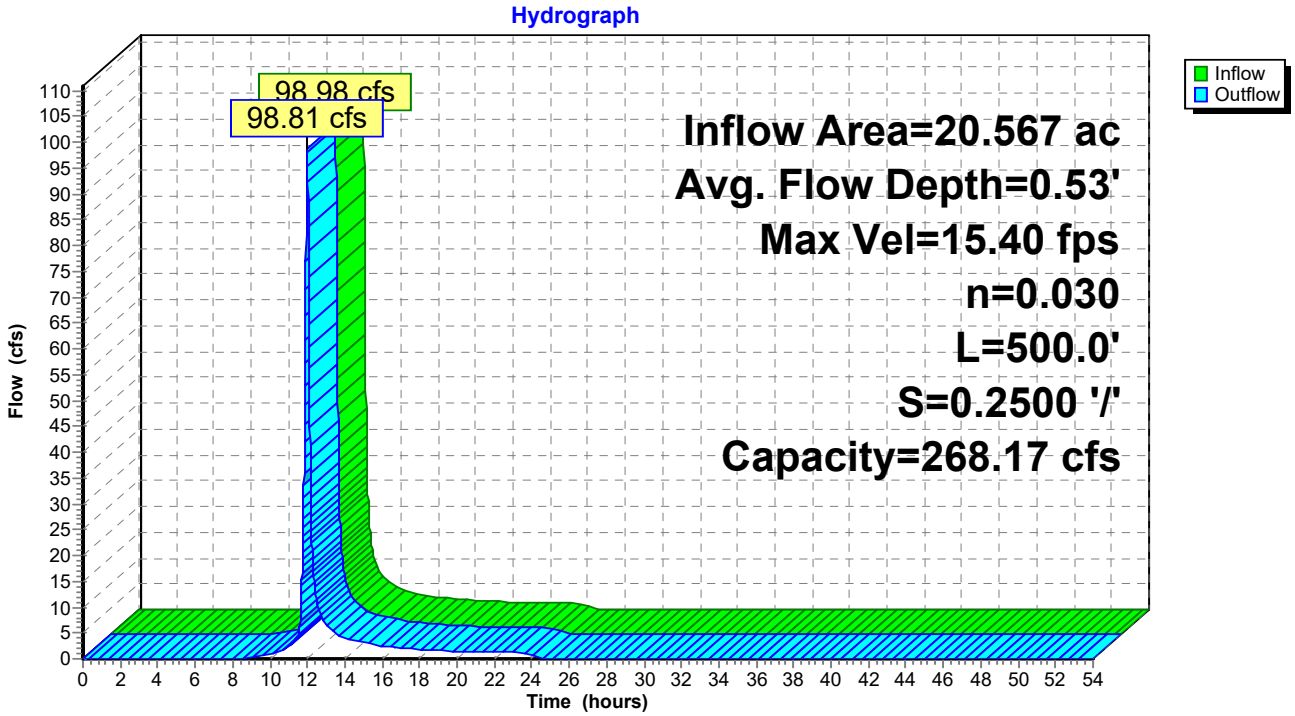
Inflow Area = 20.567 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 98.98 cfs @ 11.98 hrs, Volume= 5.459 af
Outflow = 98.81 cfs @ 11.98 hrs, Volume= 5.459 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 15.40 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.19 fps, Avg. Travel Time= 2.6 min

Peak Storage= 3,206 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.53'
Defined Flood Depth= 0.75' Flow Area= 9.0 sf, Capacity= 170.10 cfs
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 268.17 cfs

12.00' x 1.00' deep channel, n= 0.030
Length= 500.0' Slope= 0.2500 '/'
Inlet Invert= 155.00', Outlet Invert= 30.00'

Reach DC4:



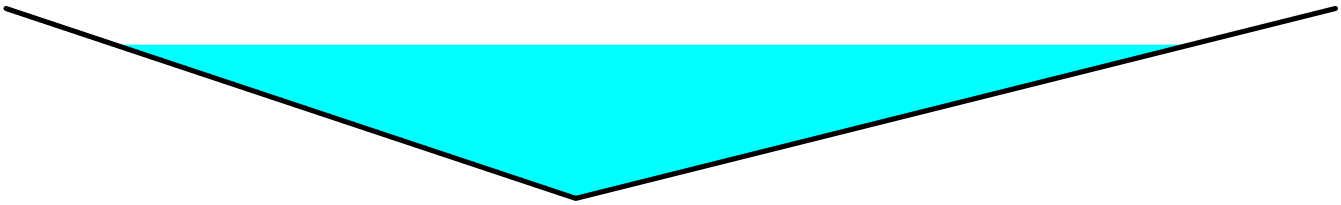
Summary for Reach T22:

Inflow Area = 6.446 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 30.31 cfs @ 12.03 hrs, Volume= 1.711 af
Outflow = 27.73 cfs @ 12.07 hrs, Volume= 1.711 af, Atten= 8%, Lag= 2.5 min

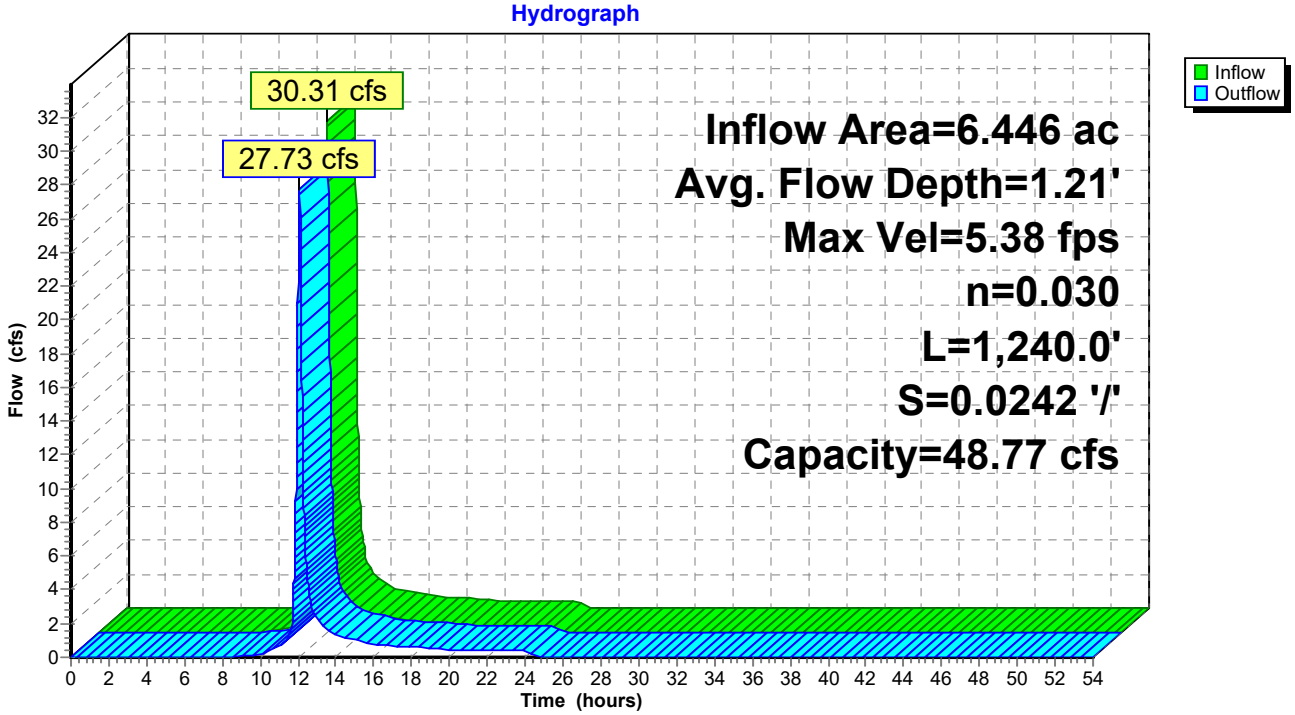
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.38 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 1.70 fps, Avg. Travel Time= 12.2 min

Peak Storage= 6,395 cf @ 12.07 hrs
Average Depth at Peak Storage= 1.21'
Defined Flood Depth= 1.50' Flow Area= 7.9 sf, Capacity= 48.77 cfs
Bank-Full Depth= 1.50' Flow Area= 7.9 sf, Capacity= 48.77 cfs

0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 4.0 '/' Top Width= 10.50'
Length= 1,240.0' Slope= 0.0242 '/'
Inlet Invert= 180.00', Outlet Invert= 150.00'



Reach T22:



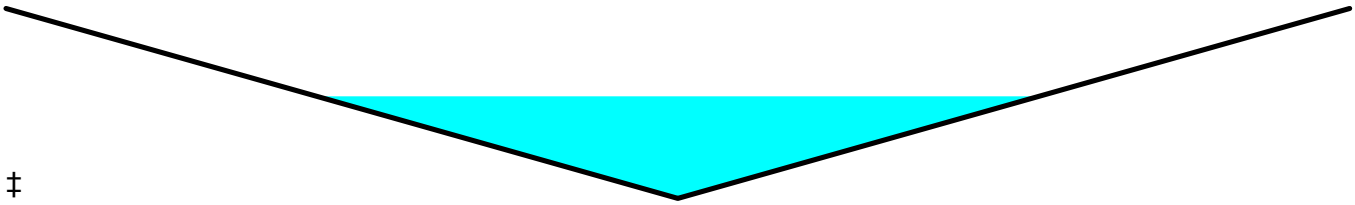
Summary for Reach T300:

Inflow Area = 7.380 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 42.14 cfs @ 11.97 hrs, Volume= 1.959 af
Outflow = 41.61 cfs @ 11.98 hrs, Volume= 1.959 af, Atten= 1%, Lag= 0.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.01 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 2.08 fps, Avg. Travel Time= 2.8 min

Peak Storage= 2,424 cf @ 11.98 hrs
Average Depth at Peak Storage= 1.07'
Defined Flood Depth= 2.00' Flow Area= 24.0 sf, Capacity= 218.12 cfs
Bank-Full Depth= 2.00' Flow Area= 24.0 sf, Capacity= 218.12 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 6.0 '/' Top Width= 24.00'
Length= 350.0' Slope= 0.0343 '/'
Inlet Invert= 188.00', Outlet Invert= 176.00'



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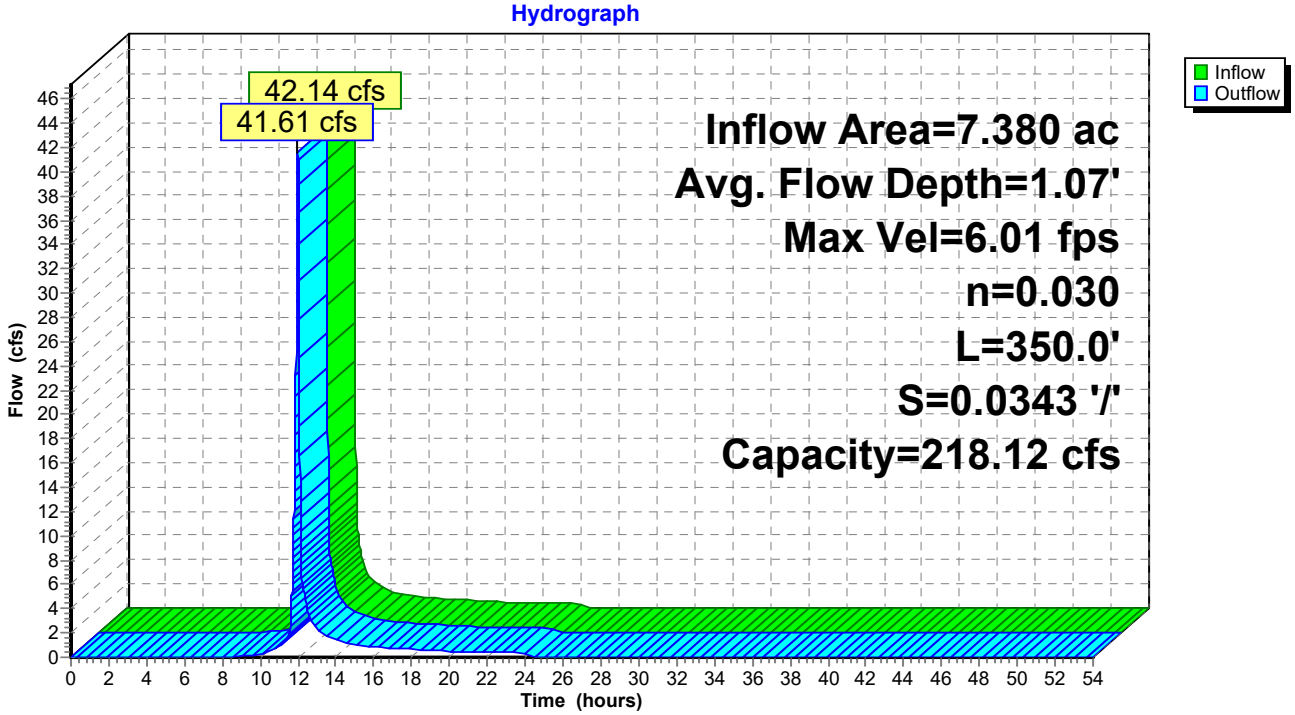
Reach T300:



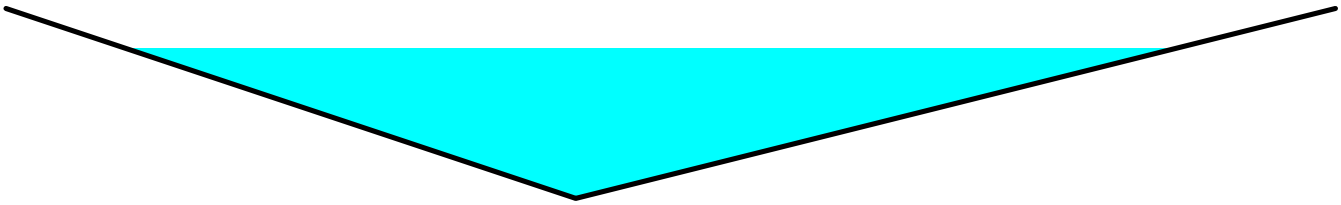
Summary for Reach T42:

Inflow Area = 5.251 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25 yr event
Inflow = 29.02 cfs @ 11.98 hrs, Volume= 1.394 af
Outflow = 26.75 cfs @ 12.01 hrs, Volume= 1.394 af, Atten= 8%, Lag= 1.9 min

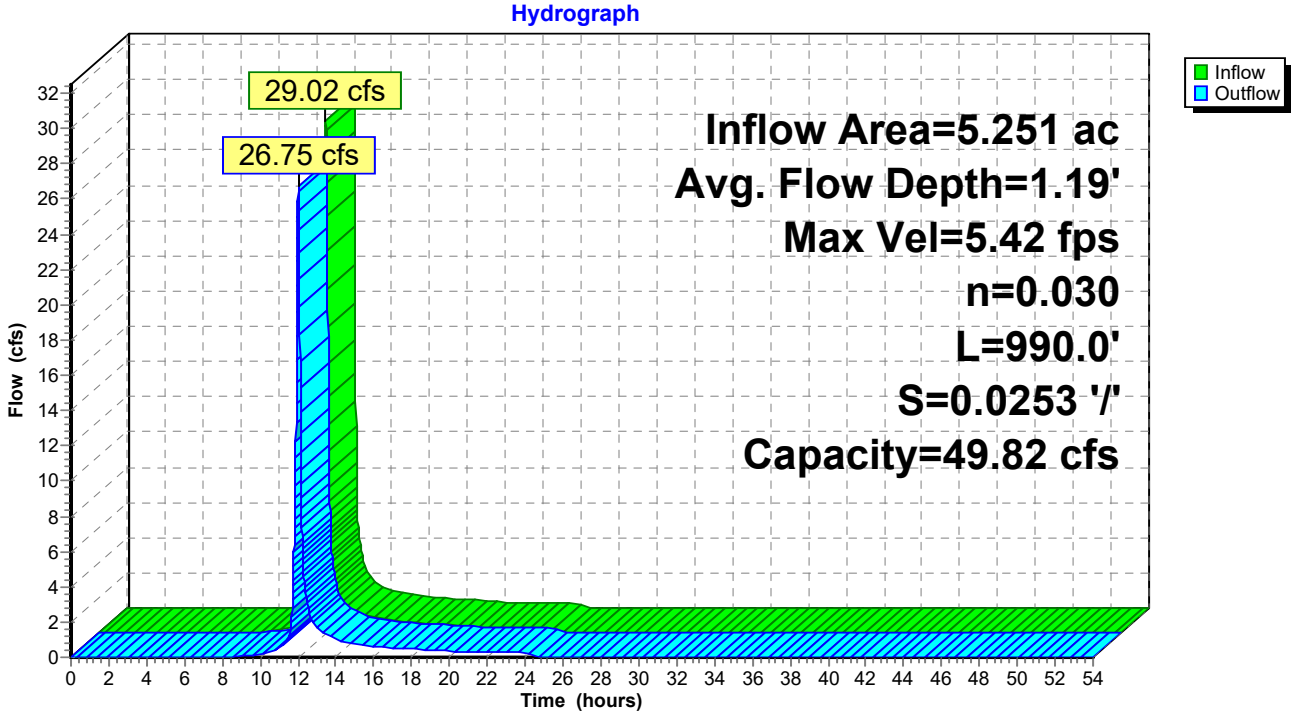
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.42 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 9.6 min

Peak Storage= 4,889 cf @ 12.01 hrs
Average Depth at Peak Storage= 1.19'
Defined Flood Depth= 1.50' Flow Area= 7.9 sf, Capacity= 49.82 cfs
Bank-Full Depth= 1.50' Flow Area= 7.9 sf, Capacity= 49.82 cfs

0.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 4.0 '/' Top Width= 10.50'
Length= 990.0' Slope= 0.0253 '/'
Inlet Invert= 180.00', Outlet Invert= 155.00'



Reach T42:



Summary for Pond C7+Inlet: Culvert 4 (WP Inlet)

[62] Hint: Exceeded Reach CH10 OUTLET depth by 0.65' @ 12.04 hrs
[62] Hint: Exceeded Reach CH6 OUTLET depth by 0.64' @ 12.03 hrs

Inflow Area =	86.859 ac,	8.25% Impervious,	Inflow Depth =	3.40"	for 25 yr event
Inflow =	420.38 cfs @	11.97 hrs,	Volume=	24.592 af	
Outflow =	365.64 cfs @	12.02 hrs,	Volume=	24.592 af,	Atten= 13%, Lag= 3.0 min
Primary =	365.64 cfs @	12.02 hrs,	Volume=	24.592 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Peak Elev= 28.78' @ 12.02 hrs Surf.Area= 25,607 sf Storage= 53,281 cf
Flood Elev= 29.00' Surf.Area= 27,125 sf Storage= 59,000 cf

Plug-Flow detention time= 2.9 min calculated for 24.587 af (100% of inflow)
Center-of-Mass det. time= 2.9 min (823.4 - 820.5)

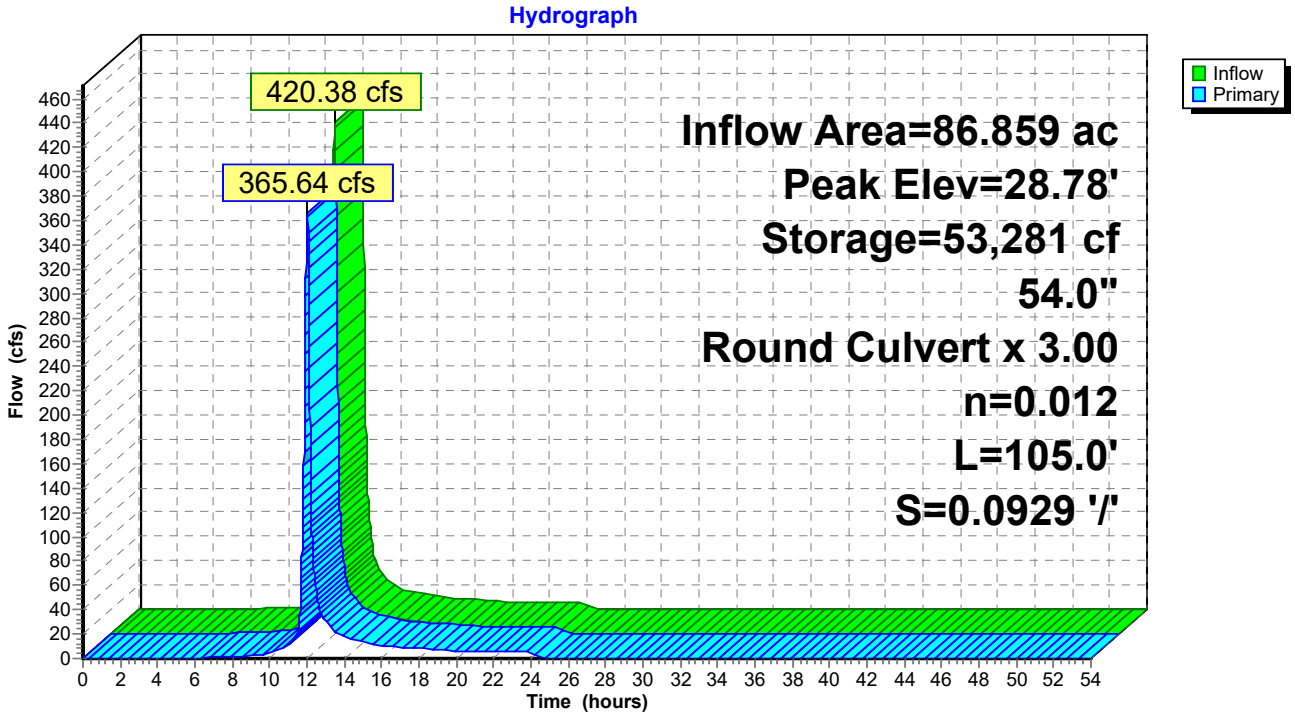
Volume	Invert	Avail.Storage	Storage Description
#1	24.00'	59,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
24.00	3,000	0	0
26.00	6,125	9,125	9,125
29.00	27,125	49,875	59,000

Device	Routing	Invert	Outlet Devices
#1	Primary	24.00'	**54.0" Round Culvert X 3.00** L= 105.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 24.00' / 14.25' S= 0.0929 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 15.90 sf

Primary OutFlow Max=365.53 cfs @ 12.02 hrs HW=28.78' TW=22.33' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 365.53 cfs @ 7.66 fps)

Pond C7+Inlet: Culvert 4 (WP Inlet)



Summary for Pond WP: West Pond- Existing

Inflow Area = 86.859 ac, 8.25% Impervious, Inflow Depth = 3.40" for 25 yr event
Inflow = 365.64 cfs @ 12.02 hrs, Volume= 24.592 af
Outflow = 65.05 cfs @ 12.42 hrs, Volume= 20.836 af, Atten= 82%, Lag= 23.9 min
Primary = 65.05 cfs @ 12.42 hrs, Volume= 20.836 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Peak Elev= 25.24' @ 12.42 hrs Surf.Area= 0 sf Storage= 533,662 cf
Flood Elev= 28.00' Surf.Area= 0 sf Storage= 729,969 cf

Plug-Flow detention time= 510.7 min calculated for 20.833 af (85% of inflow)
Center-of-Mass det. time= 439.1 min (1,262.5 - 823.4)

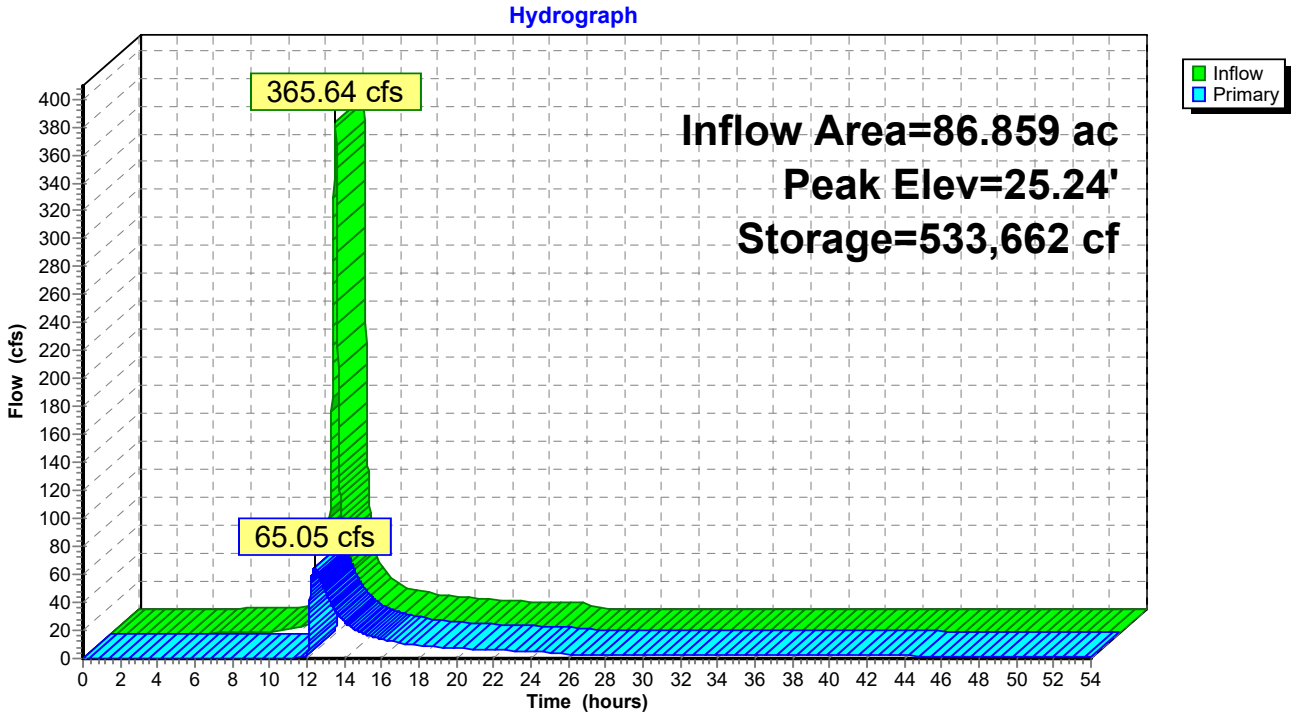
Volume	Invert	Avail.Storage	Storage Description
#1	12.00'	807,221 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
12.00	0
13.00	1,798
14.00	13,267
15.00	42,409
16.00	74,695
17.00	108,829
18.00	144,837
19.00	182,750
20.00	222,636
21.00	268,277
22.00	323,549
24.00	449,520
26.00	584,973
28.00	729,969
29.00	807,221

Device	Routing	Invert	Outlet Devices
#1	Primary	13.20'	**48.0" Round Culvert** L= 76.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.20' / 11.98' S= 0.0161 '/' Cc= 0.900 n= 0.012, Flow Area= 12.57 sf
#2	Device 1	16.00'	**6.0" Horiz. Orifice/Grate** C= 0.600
#3	Device 1	22.50'	**60.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=65.05 cfs @ 12.42 hrs HW=25.24' (Free Discharge)
└─**1=Culvert** (Passes 65.05 cfs of 191.74 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 2.87 cfs @ 14.64 fps)
  └─**3=Orifice/Grate** (Orifice Controls 62.17 cfs @ 5.64 fps)

Pond WP: West Pond- Existing



APPENDIX VI-G.2

DESIGN OF STORMWATER FEATURES

Geosyntec consultants

COMPUTATION COVER SHEET

Client: DRPI **Project:** Landfill Vertical Expansion **Project #:** ME1571 **Phase #:** 04

TITLE OF COMPUTATIONS: DESIGN OF STORMWATER MANAGEMENT FEATURES

COMPUTATIONS BY:
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Signature: Zichang Li — DATE: 07/09/2018
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APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL
1	Graded revised near southeast corner	3/25/2019	ZL	Carrie Pendleton	Carrie Pendleton

DESIGN OF STORMWATER MANAGEMENT FEATURES

PURPOSE

The purpose of this calculation package is to: (i) verify that the proposed geometry of the various stormwater management features of the Delaware Recyclable Products Inc., (DRPI) Landfill final cover system are sufficiently sized to convey the design discharge; and (ii) select the appropriate lining material of these features. The stormwater management features to be designed include: (i) plateau edge diversion berms, (ii) sideslope terraces (SST), (iii) sideslope downchutes, and (iv) perimeter drainage channels. Each of these features will be designed to convey the peak discharge and withstand the erosive forces from the peak discharge of the 25- year, 24-hour design storm.

METHOD

The peak discharge values for the 25-year, 24-hour design storm for the various stormwater management features are provided in Appendix VI-G.1 of the *Selection of Post-Development Hydrologic Parameters*. The peak discharge values were calculated using *HydroCAD® Stormwater Modeling System*", version 10.00 [HydroCAD Software Solutions LLC, 2016] (HydroCAD®).

Each of the final cover system stormwater management features is designed as either a triangular trapezoidal, or rectangular cross section. The allowable discharge in each feature was calculated using Manning's equation [Chow, 1959] expressed as:

$$Q = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}} \qquad (1)$$

where: Q = discharge, ft^3/sec
n = Manning's roughness coefficient (dimensionless)
A = area of cross-section of flow, ft^2
R = hydraulic radius = $\frac{A}{P}$
P = wetted perimeter, ft
S = longitudinal slope of the channel, ft/ft

The velocity (V) of the flow in a channel is calculated as follows:

$$V = \frac{Q}{A} \qquad (2)$$

The erosive force in the channels is related to the tractive stresses imposed by the force of the flowing water. The tractive force in the channel at normal flow depth was calculated using the following equation [Chow, 1959].

$$\tau = \gamma RS \tag{3}$$

where: τ = tractive stress (lb/ft^2);
γ = unit weight of water = 62.4 (lb/ft^3);
R = hydraulic radius of flow cross-section (ft); and
S = longitudinal slope of the channel (ft/ft).

The calculated tractive stress and velocity are then used to determine the appropriate channel lining material by comparing to the following values (DE Erosion and Sediment Control Handbook and DelDOT Road Design Manual):

- $V < 4$ ft/s and $\tau < 1.65$ lb/ft^2 permanent vegetation;
- $V > 4$ ft/s and $\tau < 1.65$ lb/ft^2 SSM II (e.g. North American Green S150);
- 2.1 lb/ft^2 $< \tau < 5.9$ lb/ft^2 TRM-II (e.g. Landlok TRM 1060/1061B);
- 6 lb/ft^2 $< \tau < 8$ lb/ft^2 TRM-III (e.g. North American Green P550).

All channels will have permanent vegetation installed. According to the Delaware Erosion and Sediment Control Handbook, no freeboard is required where "good vegetation can be grown and is maintained." However, perimeter channels are conservatively designed with minimum 0.5-ft freeboard under the 25-year, 24-hour design storm.

CALCULATION PARAMETERS

The individual calculation parameters used for analysis of each stormwater feature are summarized in Table 1. Design discharges, average channel slopes and depths are obtained from Appendix VI-G.1. For post-development conditions, the Manning roughness coefficient is based on vegetated erosion control mat, n = 0.03 (see Figure 1).

Channels CH1, CH2, CH3, CH4, CH6, CH90, CH91, and CH92 are existing and their configurations are used and validated in the HydroCAD model. Portion of Channel CH4 has a bottom width of either 4 ft or 3.5 ft and the entire CH4 is conservatively assumed as 3.5 ft wide. Proposed channel CH7 is simulated as a pond area before discharging in the West Sediment Basin.

Diversion berms are to be constructed along the top deck edges and directly connect to downchutes or upper-most drainage terraces to divert water from the top deck to the bottom of the landfill. As the configurations for the all plateau edge diversion berms are the same, only critical diversion berms (either largest drainage area or longest drainage length) are evaluated.

CALCULATION

The proposed geometry and freeboard of the various stormwater management features are validated. The selection of channel lining material is based on: (i) the peak discharge flow velocity resulting from the 25-year, 24-hour design storm, calculated using Equation 2; and (ii) the tractive stresses calculated for the 25-year, 24-hour design storm using Equation 3.

RESULTS

Table 2 summarizes the peak discharge, flow depth, flow velocity, and tractive stress for the respective stormwater management features. Selection of the channel lining is based on the calculated tractive stress and velocity in each channel and other stormwater features, meeting the requirements specified in Delaware Erosion and Sediment Control Handbook and DelDOT Road Design Manual. The configurations of the stormwater features are summarized in Table 1.

REFERENCES

HydroCAD Software Solutions LLC, "*HydroCAD® Stormwater Modeling System*", Version 10.00, Chocorua, New Hampshire 2016.

Chow, V.T., *Open Channel-Hydraulics*. New York: McGraw-Hill, 1959.

Delaware Department of Natural Resources, *Delaware Erosion and Sediment Control Handbook*, Dover, Delaware, 2003.

Delaware Department of Transportation (DelDOT), *DelDOT Road Design Manual*, July 2008.

FIGURES

This table reprinted from OPEN CHANNEL HYDRAULICS by Ven Te Chow. Copyright 1959 by McGraw-Hill, with the permission of the publisher.

VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
C. EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140
D. NATURAL STREAMS			
D-1. Minor streams (top width at flood stage <100 ft)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

ROUGHNESS COEFFICIENT REFERENCE
Stormwater Management System Plan
DRPI Vertical Expansion

Geosyntec consultants

Figure VI-G.2-1

Maryland | May 2018

TABLES

TABLE 1
CALCULATION PARAMETERS FOR DESIGN OF CHANNELS

ID[1,2,3]	Average Slope of Channel S_o (ft/ft)	Manning's Roughness n	Channel Cross-section			Available Depth D (ft)	Flow Depth (25-yr, 24-hr design storm) (ft)
			Bottom Width b (ft)	Side Slope z (H: 1V)	Side Slope z (H: 1V)		
CH1-Existing	**0.0229**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**2.57**
CH2-Existing	**0.0095**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**2.53**
CH3-Existing	**0.0080**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**1.98**
CH4-Existing	**0.0074**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**0.57**
CH6-Existing	**0.0170**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**2.16**
CH90-Existing	**0.1600**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**0.78**
CH91-Existing	**0.0098**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**1.61**
CH92-Existing	**0.0135**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**0.65**
CH7[5]	**0.0023**	**0.03**	**3.5**	**2.0**	**2.0**	**4.0**	**3.29**
CH10	**0.0020**	**0.03**	**2.0**	**2.0**	**2.0**	**2.0**	**1.36**
CH11	**0.0052**	**0.03**	**2.0**	**2.0**	**2.0**	**3.0**	**1.61**
CH21	**0.0837**	**0.03**	**1.0**	**2.0**	**3.0**	**2.0**	**0.75**
CH31	**0.0841**	**0.03**	**1.0**	**2.0**	**3.0**	**2.0**	**1.09**
CH41	**0.0865**	**0.03**	**1.0**	**2.0**	**3.0**	**2.0**	**2.57**
SST (Typ)[6]	**0.0250**	**0.03**	**0.0**	**3.0**	**4.0**	**1.5**	**1.23**
DC1	**0.2586**	**0.03**	**12.0**	**0.0**	**0.0**	**1.0**	**0.55**
DC2 (DC-21)	**0.3074**	**0.03**	**12.0**	**0.0**	**0.0**	**1.0**	**0.50**
DC3	**0.2653**	**0.03**	**12.0**	**0.0**	**0.0**	**1.0**	**0.58**
DC4	**0.2500**	**0.03**	**12.0**	**0.0**	**0.0**	**1.0**	**0.53**
DC5	**0.2388**	**0.03**	**12.0**	**0.0**	**0.0**	**1.0**	**0.38**
DC6	**0.2841**	**0.03**	**12.0**	**0.0**	**0.0**	**1.0**	**0.44**
DC7	**0.2604**	**0.03**	**12.0**	**0.0**	**0.0**	**1.0**	**0.35**
Diversion Berm (Typ)[6]	**0.020**	**0.03**	**0.0**	**3.0**	**3.0**	**2.0**	**1.59**

NOTES

1. Designation of the stormwater features on Schematic Plan presented in Appendix VI-G.1.
2. CH = channel; SST = sideslope terraces; DC = downchutes.
3. Not all SSTs are simulated as a "Reach". Instead, the flow in the non-critical SSTs to downchutes is considered in Tc as “channel flow”. Only critical SSTs and diversion berms are simulated as “Reach” in the analysis.
4. Portion of Channel CH4 has a bottom width of 4 ft or 3.5 ft and the entire CH4 is conservatively assumed as 3.5 ft wide.
5. CH7 is simulated as temporary storage area before draining to pond basin; the feature configurations are similar to CH6.
6. Most critical sections of SSTs (T6) and diversion berms (B21) are considered in the analysis.

TABLE 2
ANALYSIS OF CHANNEL LINING TRACTIVE STRESS AND VELOCITY

ID[1]	Average Slope of Channel S_o (ft/ft)	Peak Discharge[2] Q_{25} (ft^3/sec)	Available Depth D (ft)	Depth of Flow at Peak[3] $Y = Q_{25}/A$ (ft)	Peak Velocity[4] V (ft/s)	Max Tractive Stress[5] τ (lb/ft^2)	Channel Lining[6]
CH1-Existing	**0.0229**	**217.04**	4.0	2.57	9.8	21.4	TRM-III
CH2-Existing	**0.0095**	**134.91**	4.0	2.53	6.2	8.8	TRM-III
CH3-Existing	**0.0080**	**73.95**	4.0	1.98	5.0	6.2	TRM-III
CH4-Existing	**0.0074**	**6.46**	4.0	0.57	2.4	2.8	TRM-II
CH6-Existing	**0.0170**	**129.26**	4.0	2.16	7.7	14.0	TRM-III
CH90-Existing	**0.1600**	**53.57**	4.0	0.78	13.6	69.8	TRM-III
CH91-Existing	**0.0098**	**53.58**	4.0	1.61	5.0	6.5	TRM-III
CH92-Existing	**0.0135**	**11.02**	4.0	0.65	3.5	5.4	TRM-II
CH7 [7]	**0.0023**	**365.64**	4.0	3.29	11.0	2.6	TRM-II
CH10	**0.0020**	**12.06**	2.0	1.36	1.9	1.0	Vegetation
CH11	**0.0052**	**28.12**	3.0	1.61	3.3	3.0	TRM-II
CH21	**0.0837**	**15.11**	2.0	0.75	7.0	26.4	TRM-III
CH31	**0.0841**	**34.78**	2.0	1.09	8.6	36.1	TRM-III
CH41	**0.0865**	**21.50**	2.0	0.87	7.8	30.7	TRM-III
SST (Typ) [8]	**0.0250**	**29.19**	1.5	1.23	5.5	14.0	TRM-III
DC1	**0.2586**	**104.65**	1.0	0.55	15.9	211.4	Gabion
DC2 (DC-21)	**0.3074**	**98.09**	1.0	0.50	16.3	249.4	Gabion
DC3	**0.2653**	**116.72**	1.0	0.58	16.8	217.9	Gabion
DC4	**0.2500**	**98.81**	1.0	0.53	15.5	203.7	Gabion
DC5	**0.2388**	**54.84**	1.0	0.38	12.0	190.1	Gabion
DC6	**0.2841**	**77.45**	1.0	0.44	14.7	228.3	Gabion
DC7	**0.2604**	**51.86**	1.0	0.35	12.3	206.4	Gabion
Diversion Berm (Typ) [8]	0.020	**44.67**	2.0	1.59	5.9	12.5	TRM-III

NOTES
1. Designation of the channel on Schematic Plan presented in Figure 3 of **Appendix VI-G.1**.
2. Peak discharge obtained from HydroCAD outputs.
3. Y is a function of the cross sectional flow area, A, defined by solution to Equation 1.
4. From Equation 2.
5. From Equation 3.
6. Channel lining defined in DNREC Erosion and Sediment Control Manual.
7. CH7 is simulated as temporary storage before draining to pond basin; the feature configurations are similar to CH6.
8. Most critical sections of SSTs (T6) and diversion berms (B21) are considered in the analysis. The design configurations are the same for SSTs or diversion berms.

APPENDIX VI-G.3

STORMWATER MANAGEMENT BASIN ANALYSIS

Geosyntec consultants

COMPUTATION COVER SHEET

Client: DRPI **Project:** Landfill Vertical Expansion **Project #:** ME1571 **Phase #:** 04

TITLE OF COMPUTATIONS: STORMWATER BASIN ANALYSIS

COMPUTATIONS BY:
Signature: Zichang Li — DATE: 05/14/2018
Printed Name and Title: Zichang Li, Senior Staff Professional

ASSUMPTIONS AND PROCEDURES CHECKED BY: (Peer Reviewer)
Signature: Sean O'Donnell — DATE: 05/15/2018
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COMPUTATIONS CHECKED BY:
Signature: Sean O'Donnell — DATE: 05/15/2018
Printed Name and Title: Sean O'Donnell, Senior Staff Professional

COMPUTATIONS BACKCHECKED BY: (Originator)
Signature: Zichang Li — DATE: 07/12/2018
Printed Name and Title: Zichang Li, Senior Staff Professional

COMPUTATIONS (PM or Designate)
Signature: William M. Steier — DATE: 07/12/2018
Printed Name and Title: William M. Steier, Senior Engineer

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL
1	Graded revised near southeast corner	3/25/2019	ZL	Carrie Pendleton	Carrie Pendleton

STORMWATER BASIN ANALYSIS

PURPOSE

The purposes of this calculation package are: (i) to verify the hydraulic function of the East and West Stormwater / Sediment Basins at the Delaware Recyclable Products, Inc. (DRPI) Landfill; and (ii) to verify that both basins meet the water quality routing requirements. Currently there are two sediment basins at the site, identified as the East and West Sediment Basins, and the engineered wetland downstream of East Sediment Basin, which ultimately discharges to the Christina River. The existing East and West Sediment Basins provide detention and controlled release of stormwater to the tidally influenced areas of the Christina River. Attachment 1 presents the as-built survey of the two sediment basins conducted dated 11 January 2017.

HYDRAULIC FUNCTION

As required by the Natural Resources Conservation Service (NRCS) Conservation Practice Standard Pond No. Code 378 [NRCS September 2015], stormwater sediment basins are sized to convey the 24-hour, 25-year design storm for auxiliary spillway. The existing sediment basin (e.g., East Sediment Basin) is also required to pass the 24-hour, 25-year design storm with a minimum of 1-ft of freeboard between the design water surface elevation and the crest of the embankment for the dams with a drainage area greater than 20 acres. In addition, the primary outlet elevation must be at least one foot below the crest elevation of the emergency spillway for dams with a drainage area greater than 20 acres. If there is no emergency spillway (e.g., West Sediment Basin), the required freeboard is 2 ft. An emergency spillway is required if the sediment basin cannot pass the peak flow expected from the design storm.

Method

Inflow hydrographs used in this calculation are computed using procedures defined in "*Urban Hydrology for Small Watersheds, Technical Release 55*", [USDA-SCS, 1986] and "*Computer Program for Project Formulation Hydrology, Technical Release 20*", [USDA-SCS, 1982]. Computation for inflow hydrographs are performed using the computer program "*HydroCAD® Stormwater Modeling System*", version 10.00 [Applied Microcomputer Systems, 2016] (HydroCAD®).

Basin routing computations described in this calculation are performed using the Storage-Indication Routing method [Ponce, 1989]:

$$I - O = \frac{\Delta S}{\Delta t}$$

where: I = inflow rate into the structure (ft^3/sec);
O = outflow rate from the structure (ft^3/sec);
ΔS = change in storage (ft^3); and
Δt = time change increment (hr).

Freeboard

Freeboard within each basin is calculated using the following equation:

$$FB = Berm_{elev} - WSE$$

where: FB = freeboard height (ft);
$Bermele$ = minimum berm elevation (ft); and
WSE = water surface elevation at design storm (ft).

As required by NRCS No. Code 378 [NRCS, NHCP September 2015], the minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

Parameters

The basins modeled for this calculation incorporate features with multiple stage-risers, dewatering devices, and emergency spillways. Analysis of the existing basin features are based on geometry and material specifications obtained previously from the permitted design drawings by Geosyntec (2004, 2013) and Golder (2015), the as-built survey in Attachment 1 (Vandemark & Lynch, Inc., 2017), or as modified for this analysis.

The storage indication method requires preparation of stage-storage and stage-discharge curves for each basin. Using elevation and plan area data based on design and as-built basin grading plans, HydroCAD® computes stage-storage curves for analysis. A summary of the elevation and area data for each basin watershed are presented in **Appendix VI-G.1**, Attachment VI-G.1-1. The stage-storage and stage-discharge curves can be found in Attachment 2.

Calculation

HydroCAD® performs detailed routing computations of the maximum height of water within each basin, and the peak discharge. HydroCAD® results for each basin and outlet structure for the 24-hour, 25-year design storms are presented in **Appendix VI-G.1**.

Results

Results of the maximum water surface elevations, discharge and flow velocity under 24-hour, 25-year design storm are as follows.

East Sediment Basin:

- Discharge Q = 158.01 cfs (Primary Spillway)
- Velocity V = 12.58 fps (Primary Spillway)
- Discharge Q = 51.04 cfs (Emergency Spillway)
- Velocity V = 2.27 fps (Emergency Spillway)
- Water surface elevation WSE = 22.13 ft

West Sediment Basin:

- Discharge Q = 65.05 cfs
- Velocity V = 5.18 fps
- Water surface elevation WSE = 25.24 ft

The freeboard within each basin is calculated below. The freeboard for the East Sediment Basin is greater than the required 1 ft between design high-water-flow elevation in the auxiliary spillway and the top of the settled embankment under the 24-hour, 25-year design storm. The freeboard for West Sediment Basin is greater than the required 2 ft between design high-water-flow elevation and the top of the settled embankment under the 24-hour, 25-year design storm.

Design Storm	Pond	Emergency Spillway Elevation (ft-msl)	Peak Flow Elevation (ft)	Embankment Crest Elevation (ft)	Distance between Spillway and Crest (ft)	Freeboard to Crest (ft)
24-hour, 25-year	East Sediment Basin	21.0	22.13	24.0	3.0	1.87 (≥1 ft)
	West Sediment Basin	None	25.24	28.0	Not Applicable	2.76 (≥2 ft, no emergency spillway)

WATER QUALITY ROUTING

The water quality function of the stormwater management basins is to control the discharge rate. According to the DNREC 3.06.2.10 [DNREC, effective April 2016], "detention practices must be sized to store a volume equivalent to the Resource Protection storm (i.e., the runoff volume from the 1-year 2.7" Type II storm event)" and "must be sized to detain the RPv for a minimum period of 24 hours, not to exceed 48 hours". Other design requirements are: (i) store volume equivalent to RPv; (ii) forebays sized for 10% of RPv; and (iii) include an orifice to drain the RPv over 12- to 24-hours for extended detention (e.g., East Sediment Basin).

Method

The routing is performed to demonstrate that discharge through the low flow orifice outlet in each basin occurs over a period of at least 24-hours. Water quality computations are completed using "*HydroCAD® Stormwater Modeling System*", version 10.00 [HydroCAD Software Solutions LLC, 2016] (HydroCAD®) for routing of the 2.7-in, 24-hour design storm. HydroCAD® routes stormwater runoff using the procedures defined in "*Urban Hydrology for Small Watersheds, Technical Release 55*", [USDA-SCS, 1986] and "*Computer Program for Project Formulation Hydrology, Technical Release 20*", [USDA –SCS, 1982].

Calculation

Input parameters to the HydroCAD model are described in **Appendix VI-G.1**. The results of the HydroCAD outputs are provided in Attachment VI-G.1-1 and summarized below.

East Sediment Basin
RPv = 130,223 cf (forebay size of approximately 13,100 cf estimated from as-built)
Discharge Starts – 2.38 cfs at 14 hrs
Peak Discharge – 2.54 cfs at 16 hrs
Discharge Duration – Greater than 24 hours (at 36 hrs Q= 0.12 cfs)

West Sediment Basin
RPv = 200,357 cf (forebay size of approximately 13,900 cf estimated from as-built)
Discharge Starts – 1.52 cfs at 14 hrs
Peak Discharge – 1.75 cfs at 22 hrs
Discharge Duration – Greater than 24 hours (at 36 hrs Q= 1.27 cfs)

Results

Based on the analysis in this calculation package, the required water quality routing is completed with the proposed Stormwater Management Basin design plans. The peak discharge at the East and

West Sediment Basins both occurs between 12 and 36 hours as required, with peak discharge at 16 and 22 hours for East and West Sediment Basins, respectively. The estimated size of the forebay for West Sediment Basin is less than 10 percent of the RPv; therefore, the forebay should be maintained and excess sediments removed. The East Sediment Basin is an extended detention and an orifice at elevation is used to drain the RPv as required for conveyance.

SUMMARY

As discussed above, existing East and West Sediment Basins are capable of conveying the 24-hour, 25-year design storm and exceed the freeboard requirements. Both basins meet the water quality routing requirements.

It is notable that the existing basin inlets cannot meet the design requirement and proposed inlet upgrades, modeled in the analysis, can be found in Appendix VI-G.1. Both East and West Sediment Basins meets the water quality requirements and the forebays are required to be maintained.

REFERENCES

Applied Microcomputer Systems, "*HydroCAD® Stormwater Modeling System*", Version 10.00, Chocorua, New Hampshire 2012.

GeoEnvironmental, Inc. (GZA), "*Design Plans, Application to Construct a Solid Waste Facility (Industrial Landfill) Cell 4 – Delware Recyclable Products, Inc., New Castle County, Delaware*". Dated 25 October 1994.

GeoEnvironmental, Inc. (GZA), "*Design Plans, Application to Construct a Solid Waste Facility (Industrial Landfill) Cell 5 – Delaware Recyclable Products, Inc., New Castle County, Delaware*". Dated 19 February 1998.

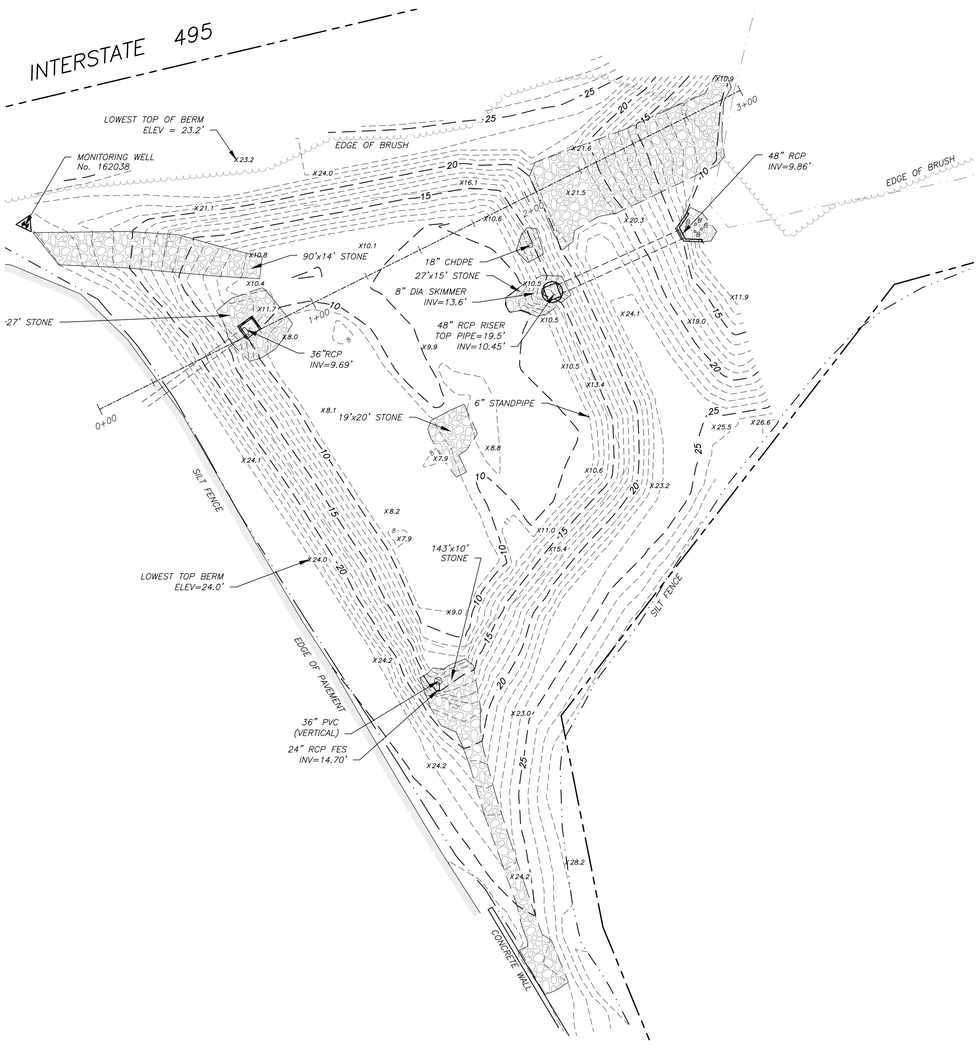
Ponce, Victor, Engineering Hydrology Principles and Practice. Prentice Hall, Englewood, New Jersey 1989.

United States Department of Agriculture, Soil Conservation Service, "Computer Program for Project Formulation Hydrology, Technical Release 20", Washington, D.C., 1982.

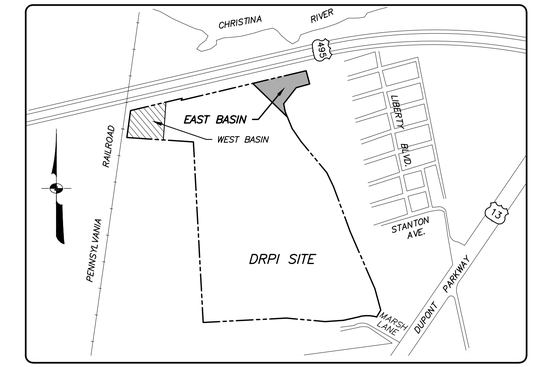
United States Department of Agriculture, Soil Conservation Service, "Urban Hydrology for Small Watersheds, Technical Release 55", 2nd ed., Washington, D.C., 1986.

ATTACHMENT VI-G.3-1
Basin As-built Drawings [2017]

As-built East Sediment Basin



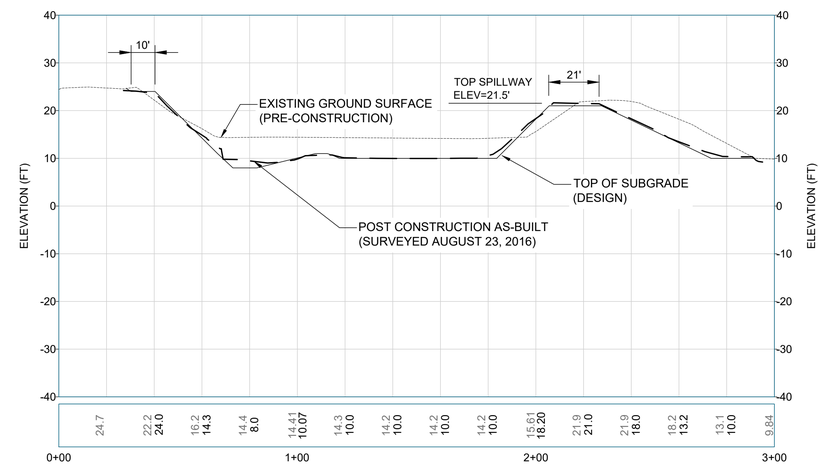
Elevation	Incremental Storage (CF)	Cumulative Storage Volume (CF)
8		-
9	3,863	3,863
10	7,603	11,466
11	14,709	26,175
12	16,936	43,111
13	18,414	61,525
14	19,786	81,311
15	21,123	102,434
16	22,487	124,921
17	23,894	148,815
18	25,334	174,149
19	26,831	200,980
19.5	14,010	214,990



LOCATION PLAN SCALE: 1" = 800'

LEGEND

x 12.2	SPOT ELEVATIONS
	CONTOURS
	SILT FENCE
	RIP-RAP
B	BOLLARD



EAST BASIN PROFILE

HORIZONTAL SCALE: 1" = 30'

VERTICAL SCALE: 1" = 15'

NOTES:

1. Date of Field Survey: July 20 and 25, 2016 and January 11, 2017
2. Horizontal Datum: Delaware State Grid (NAD '27)
3. Vertical Datum: National Geodetic Vertical Datum, 1929
4. This plan was prepared without the benefit of a title search, commitment or a bringdown and is subject to easements, validity of chain of title, etc., that a subsequent search may disclose.
5. The purpose of this plan plan is to show the final grades within the East Sediment Basin, as requested by Delaware Recyclable Products, Inc.

POST CONSTRUCTION VERIFICATION DOCUMENT

EAST SEDIMENT BASIN

PREPARED FOR

DELAWARE RECYCLABLE PRODUCTS, INC.

A SUBSIDIARY OF

WASTE MANAGEMENT, INC.

246 MARSH LANE

NEW CASTLE HUNDRED – NEW CASTLE COUNTY

DELAWARE

SCALE: 1"=30' JANUARY 11, 2017

30 0 15 30 60 120

GRAPHIC SCALE (FEET)

NO.	DATE	REVISION	BY	APPROVED

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VANDEMARK & LYNCH, INC.

ENGINEERS – PLANNERS – SURVEYORS

4305 MILLER RD./PO BOX 2047
WILMINGTON, DE 19899/(302) 764-7635

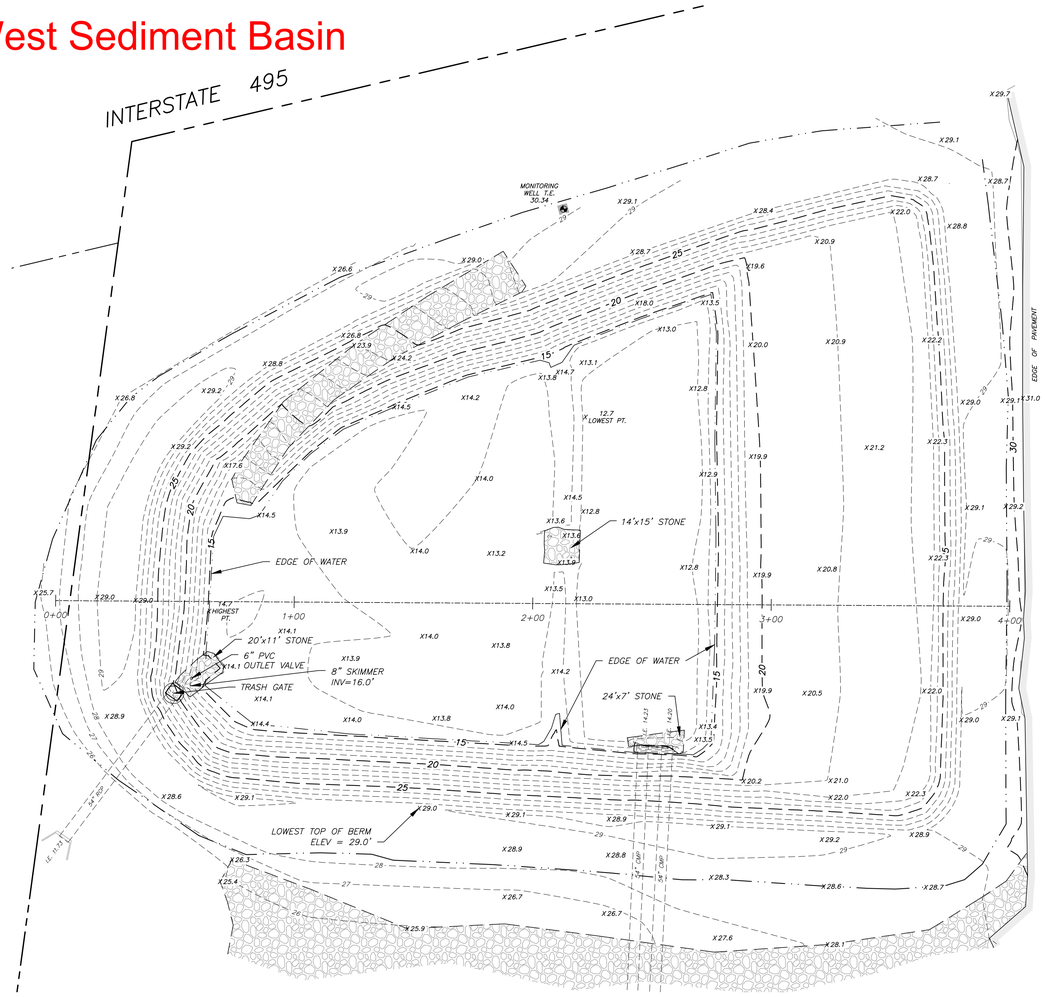
PERMANENT FILE	QA REVIEW	APPROVED BY
102/350		

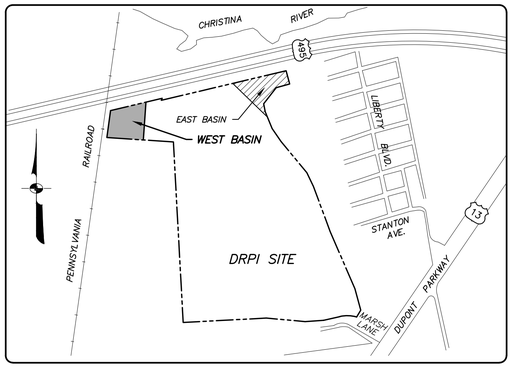
SURVEYED BY	PROJECT MANAGER	REFERENCE DRAWINGS	
T. MASKE	K. GOLDSTONE		
COMPUTED BY	DRAWN BY	A. KATHY GOLDSTONE, DE. P.L.S. 631	DATE
K. GOLDSTONE	K. GOLDSTONE		

PROJECT NO.	FILE NO.	SHEET		REVISION
18553.60	TOPO-02	1 OF 2		

P:\Land Projects\18553 De Recycl Prod_Plan Production\18553.60-TOPO-02.dwg, 1/13/2017 10:43:36 AM, Kathy Goldstone, VanDemark & Lynch, Inc.

As-built West Sediment Basin





LOCATION PLAN SCALE: 1" = 800'

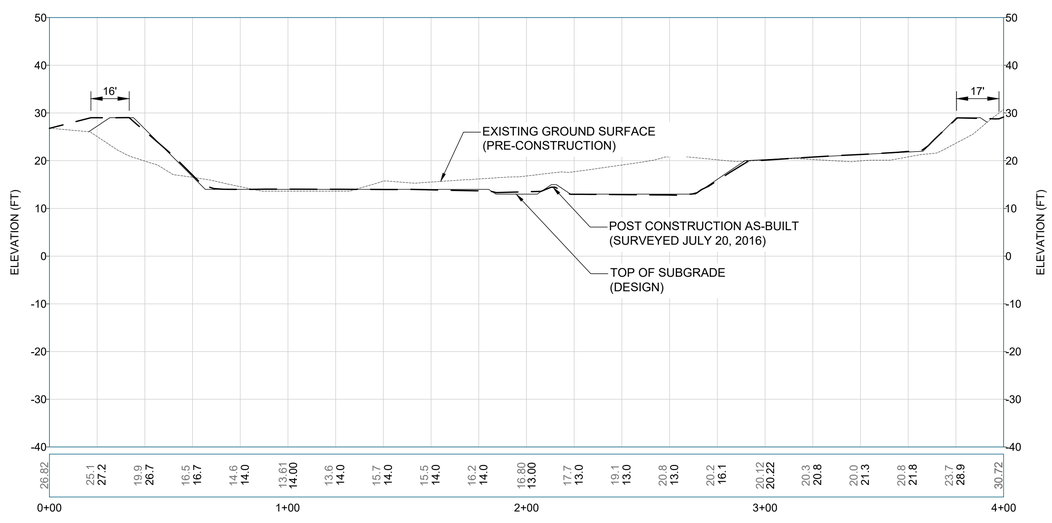
Elevation	Incremental Storage (CF)	Cumulative Storage Volume (CF)
12		-
13	1,798	1,798
14	11,469	13,267
15	29,142	42,409
16	32,286	74,695
17	34,134	108,829
18	36,008	144,837
19	37,913	182,750
20	39,886	222,636
21	45,641	268,277
22	55,272	323,549
22.5	30,472	354,021

LEGEND

- X 12.2 — SPOT ELEVATIONS
- CONTOURS
- EDGE OF WATER
- RIP–RAP

NOTES:

1. Date of Field Survey: July 20 and 25, 2016 and January 11, 2017
2. Horizontal Datum: Delaware State Grid (NAD '27)
3. Vertical Datum: National Geodetic Vertical Datum, 1929
4. This plan was prepared without the benefit of a title search, commitment or a bringdown and is subject to easements, validity of chain of title, etc., that a subsequent search may disclose.
5. The purpose of this plan is to show the as–built grades within the West Sediment Basin, as requested by Delaware Recyclable Products, Inc.



WEST BASIN PROFILE

HORIZONTAL SCALE: 1" = 30'

VERTICAL SCALE: 1" = 15'

POST CONSTRUCTION VERIFICATION DOCUMENT

WEST SEDIMENT BASIN

PREPARED FOR

DELAWARE RECYCLABLE PRODUCTS, INC.

A SUBSIDIARY OF

WASTE MANAGEMENT, INC.

246 MARSH LANE

NEW CASTLE HUNDRED – NEW CASTLE COUNTY

DELAWARE

SCALE: 1"=30' JULY 25, 2016

30 0 15 30 60 120

GRAPHIC SCALE (FEET)

NO.	DATE	REVISION	BY	APPROVED

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PERMANENT FILE	QA REVIEW	APPROVED BY
102/350		

SURVEYED BY	PROJECT MANAGER	REFERENCE DRAWINGS
T. MASKE	K. GOLDSTONE	
COMPUTED BY	DRAWN BY	A. KATHY GOLDSTONE, DE. P.L.S. 631 — DATE
K. GOLDSTONE	K. GOLDSTONE	

PROJECT NO.	FILE NO.	SHEET	REVISION
18553.60	TOPO–02	2 OF 2	

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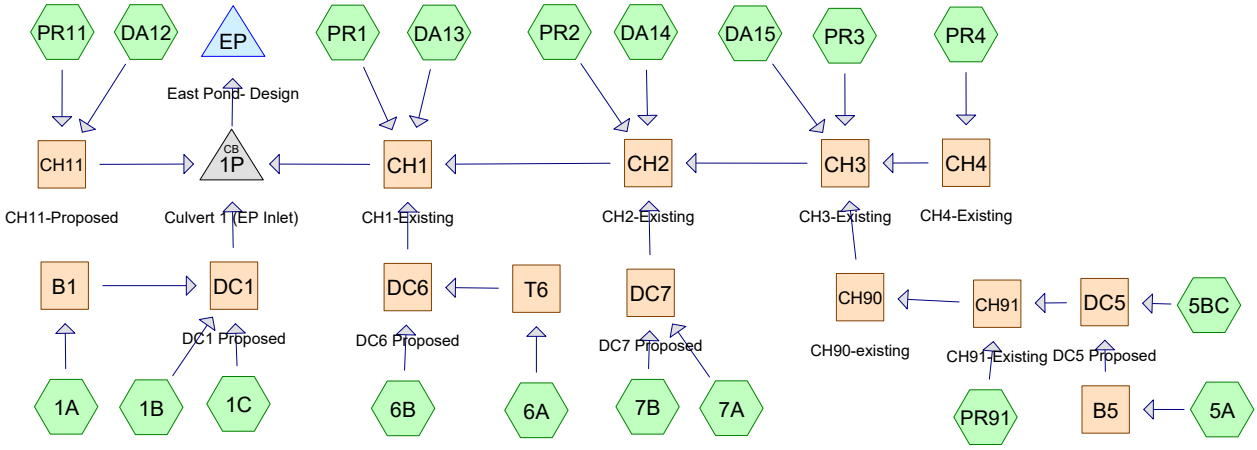
ATTACHMENT VI-G.3-2
2-inch 24-hour Design Storm
Analysis

EAST BASIN, 2.7-INCH 24-HOUR DESIGN STORM



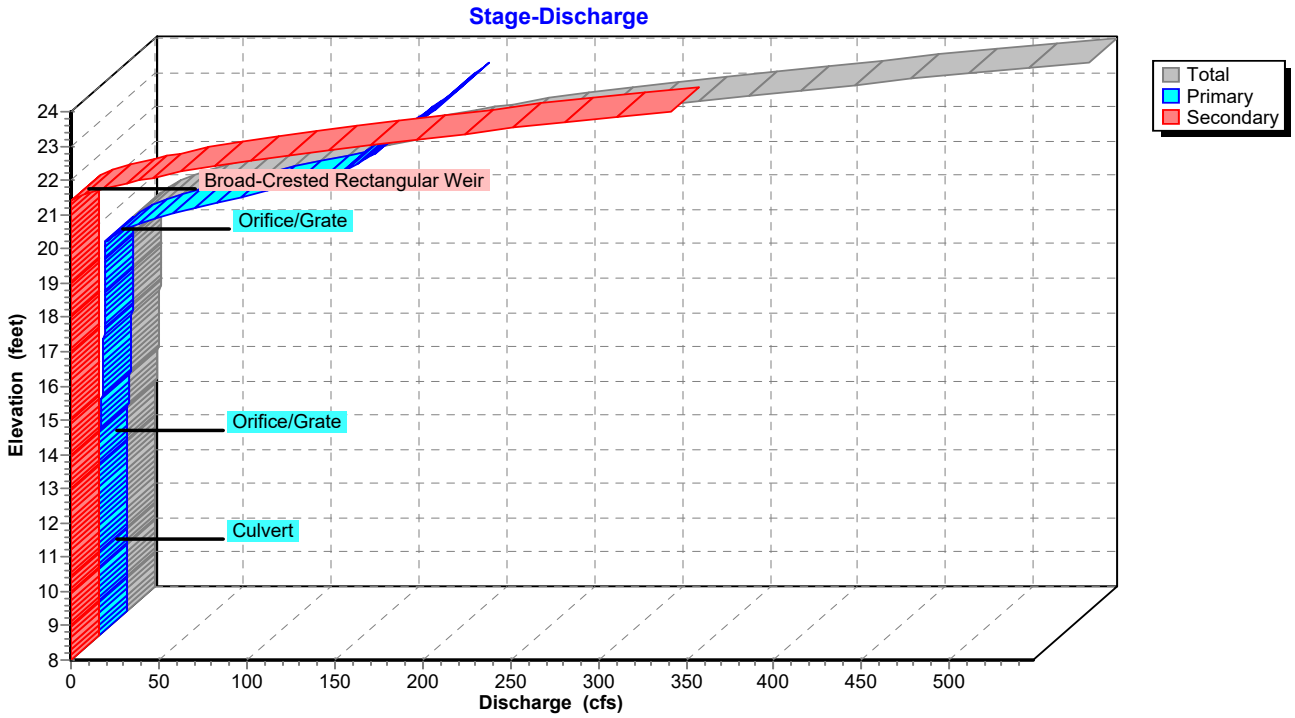
Subcat Reach Pond Link

Routing Diagram for Final Cover of 20180420 version SW Model20190325
Prepared by SCCM-01, Printed 3/25/2019
HydroCAD® 10.00-18 s/n 00663 © 2016 HydroCAD Software Solutions LLC

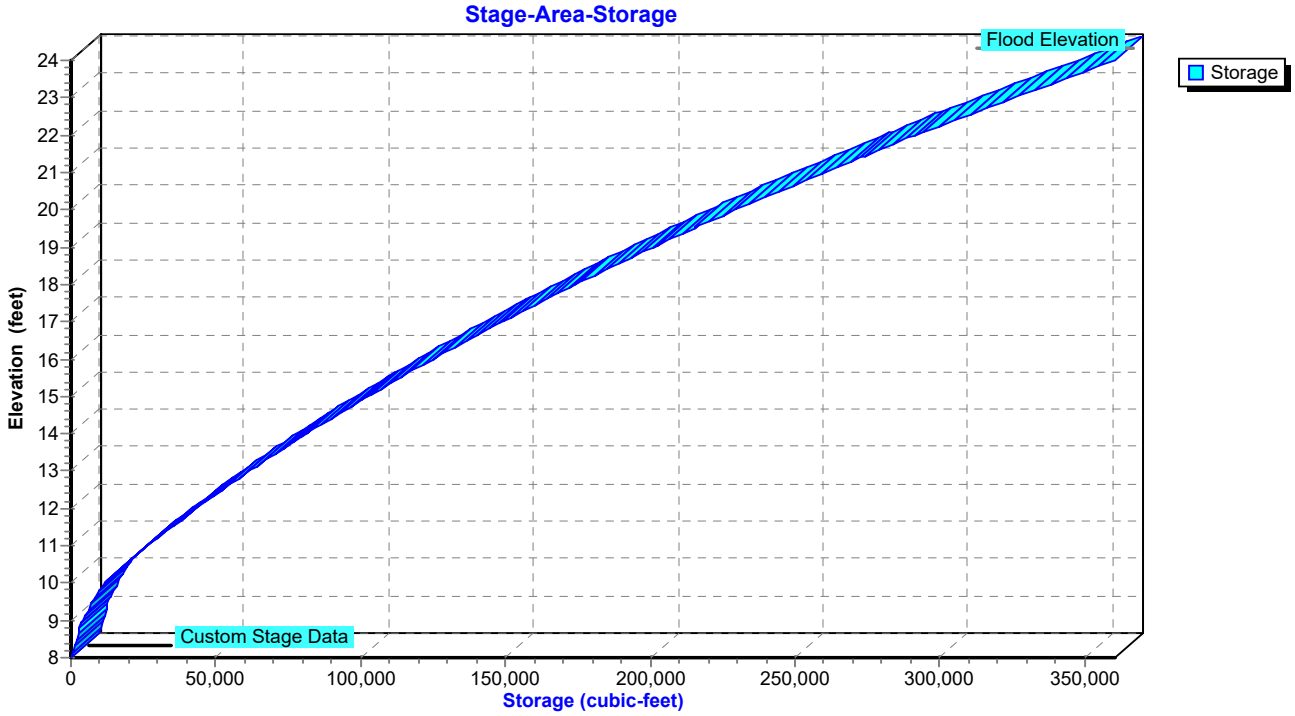
Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	EP	10.45	9.86	59.0	0.0100	0.012	48.0	0.0	0.0

Pond EP: East Pond- Design



Pond EP: East Pond- Design



Summary for Pond EP: East Pond- Design

Inflow Area = 69.298 ac, 7.14% Impervious, Inflow Depth = 0.85" for 2.7-in event
Inflow = 72.81 cfs @ 11.99 hrs, Volume= 4.901 af
Outflow = 2.54 cfs @ 16.28 hrs, Volume= 3.189 af, Atten= 97%, Lag= 257.0 min
Primary = 2.54 cfs @ 16.28 hrs, Volume= 3.189 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Peak Elev= 16.22' @ 16.28 hrs Surf.Area= 0 sf Storage= 130,223 cf
Flood Elev= 24.00' Surf.Area= 0 sf Storage= 360,454 cf

Plug-Flow detention time= 533.5 min calculated for 3.189 af (65% of inflow)
Center-of-Mass det. time= 404.9 min (1,266.8 - 861.9)

Volume	Invert	Avail.Storage	Storage Description
#1	8.00'	360,454 cf	**Custom Stage Data** Listed below

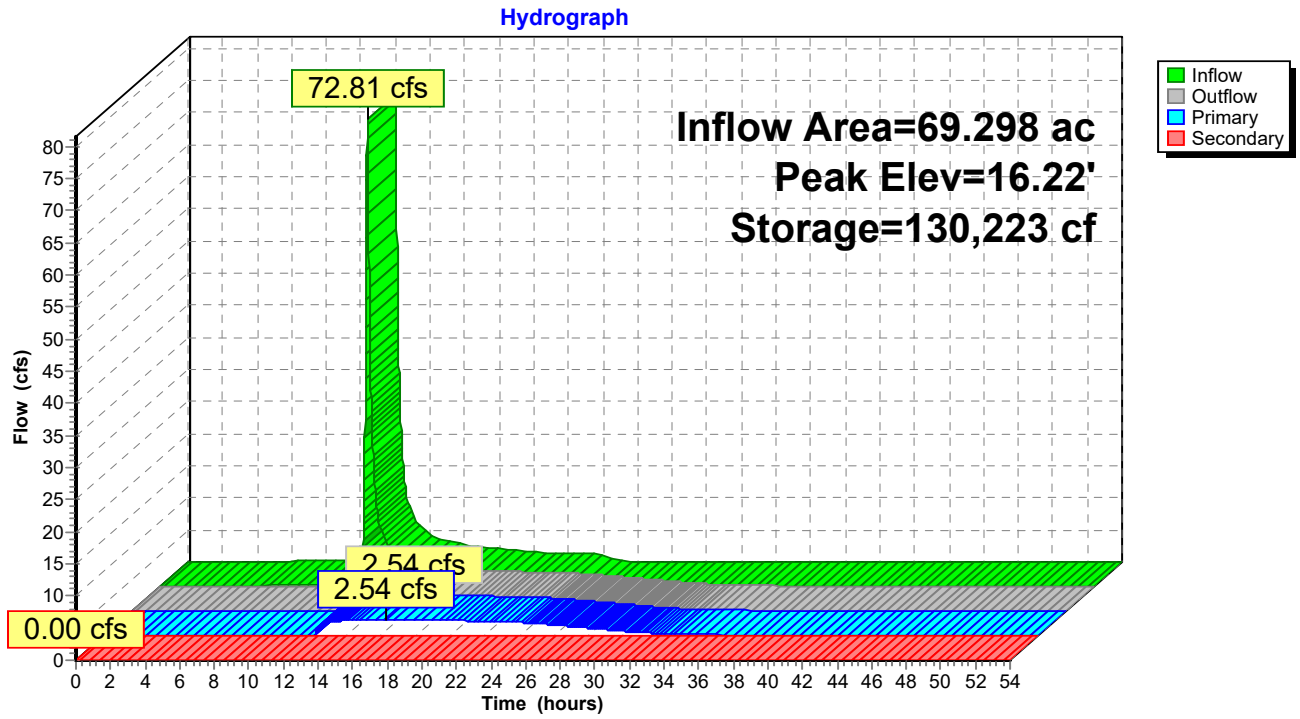
Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
8.00	0	0
9.00	3,863	3,863
10.00	7,603	11,466
11.00	14,709	26,175
12.00	16,936	43,111
13.00	18,414	61,525
14.00	19,786	81,311
15.00	21,123	102,434
16.00	22,487	124,921
17.00	23,894	148,815
18.00	25,334	174,149
19.00	26,831	200,980
20.00	28,447	229,427
22.00	61,999	291,426
24.00	69,028	360,454

Device	Routing	Invert	Outlet Devices
#1	Primary	10.45'	**48.0" Round Culvert** L= 59.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 10.45' / 9.86' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 12.57 sf
#2	Device 1	13.60'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	19.50'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	21.40'	**31.0' long x 21.0' 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) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

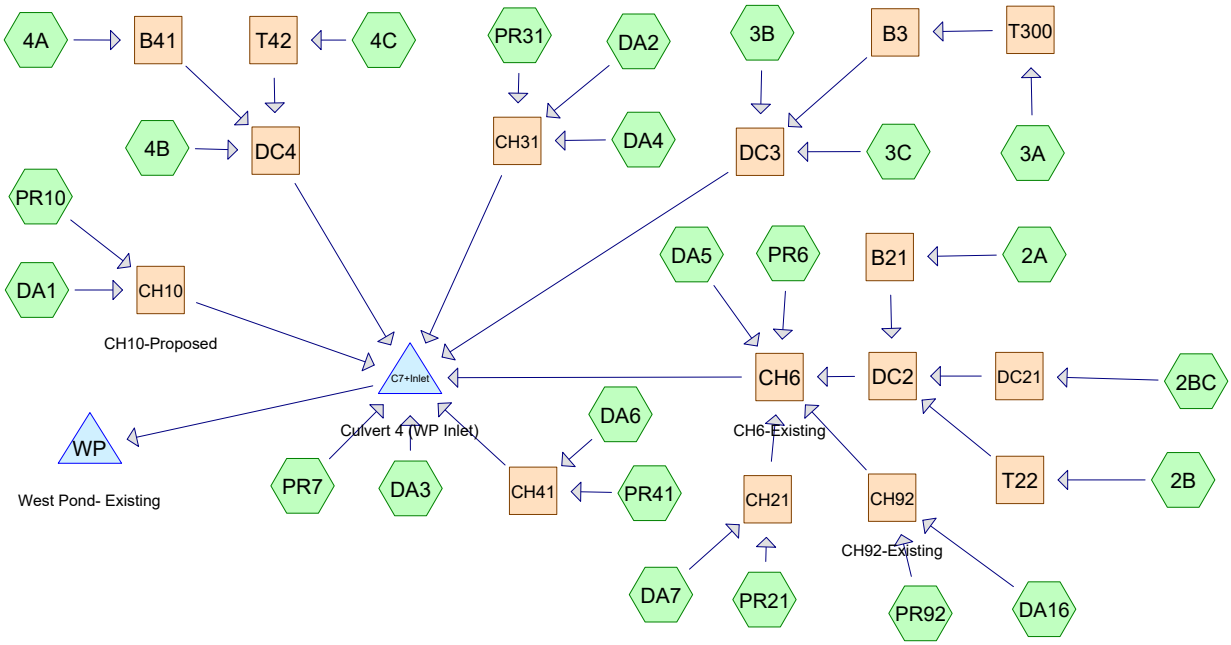
Primary OutFlow Max=2.54 cfs @ 16.28 hrs HW=16.22' (Free Discharge)
└─**1=Culvert** (Passes 2.54 cfs of 117.20 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 2.54 cfs @ 7.28 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=8.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond EP: East Pond- Design



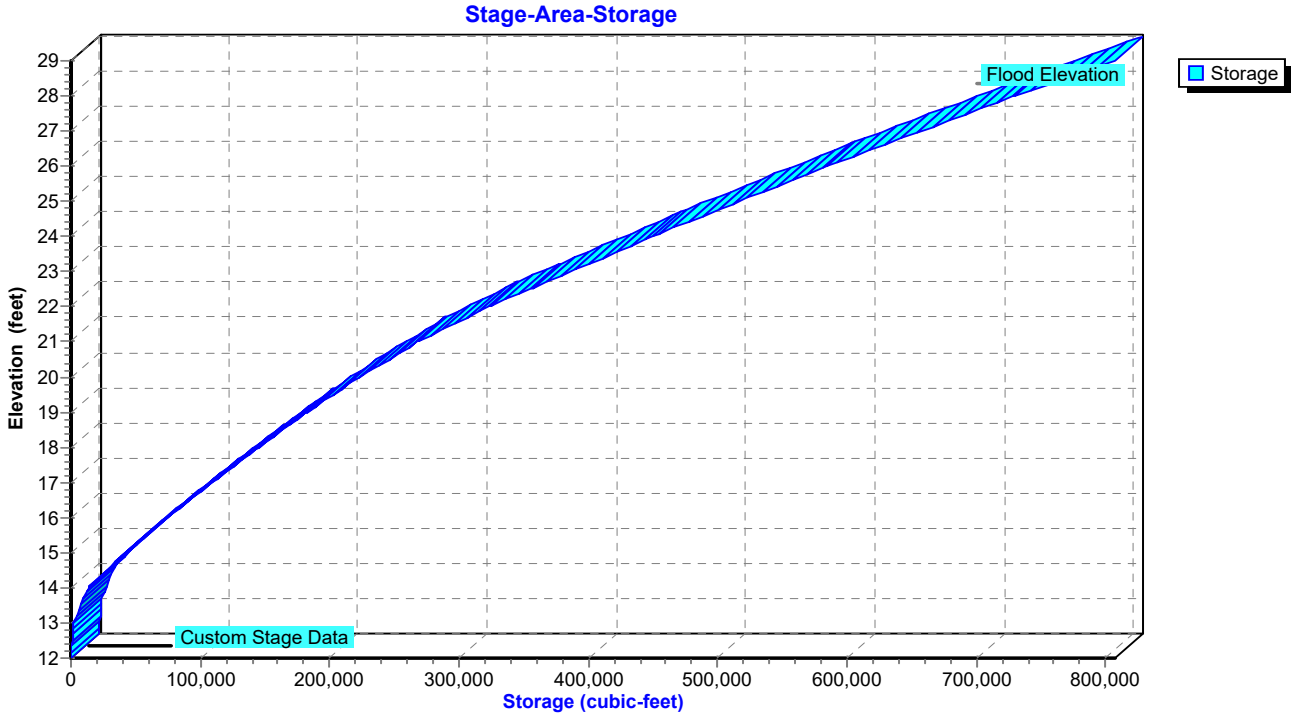
WEST BASIN, 2.7-INCH 24-HOUR DESIGN STORM



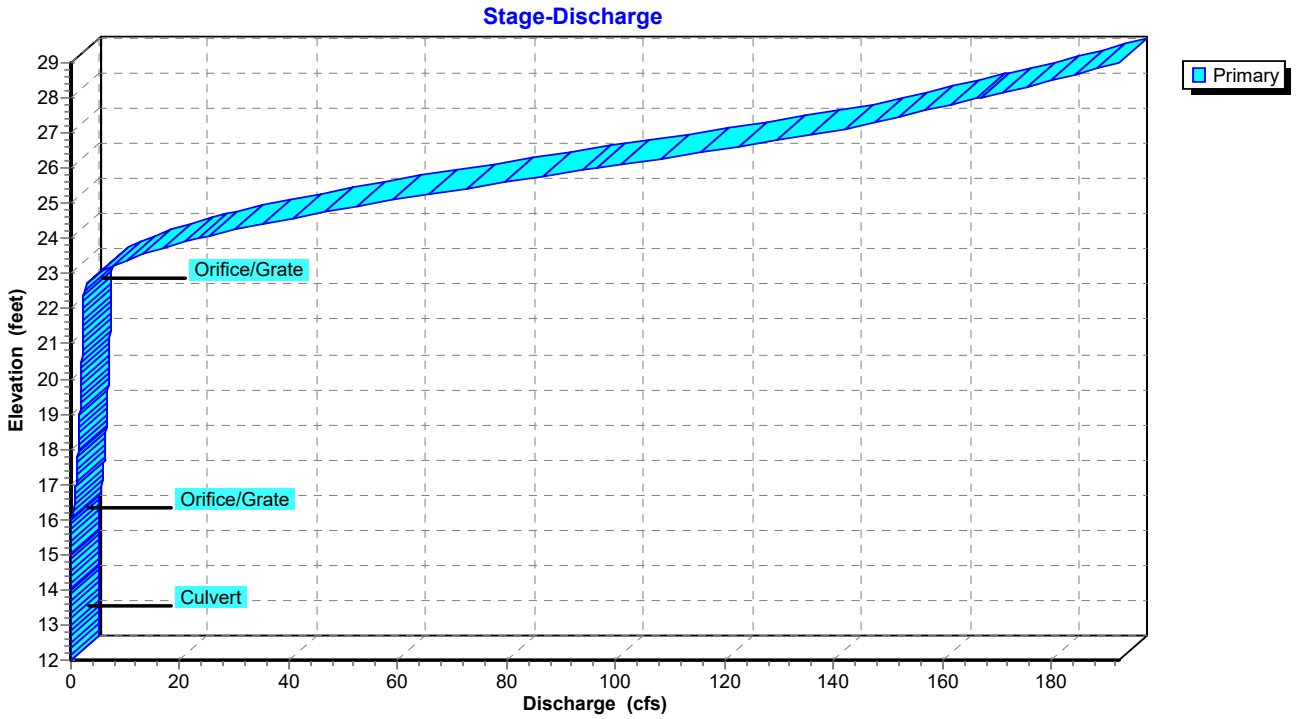
Subcat Reach Pond Link

Routing Diagram for Final Cover of 20180420 version SW Model20190325
Prepared by SCCM-01, Printed 3/25/2019
HydroCAD® 10.00-18 s/n 00663 © 2016 HydroCAD Software Solutions LLC

Pond WP: West Pond- Existing



Pond WP: West Pond- Existing



Summary for Pond WP: West Pond- Existing

Inflow Area = 86.859 ac, 8.25% Impervious, Inflow Depth = 0.87" for 2.7-in event
Inflow = 88.55 cfs @ 12.00 hrs, Volume= 6.282 af
Outflow = 1.75 cfs @ 22.37 hrs, Volume= 4.401 af, Atten= 98%, Lag= 622.2 min
Primary = 1.75 cfs @ 22.37 hrs, Volume= 4.401 af

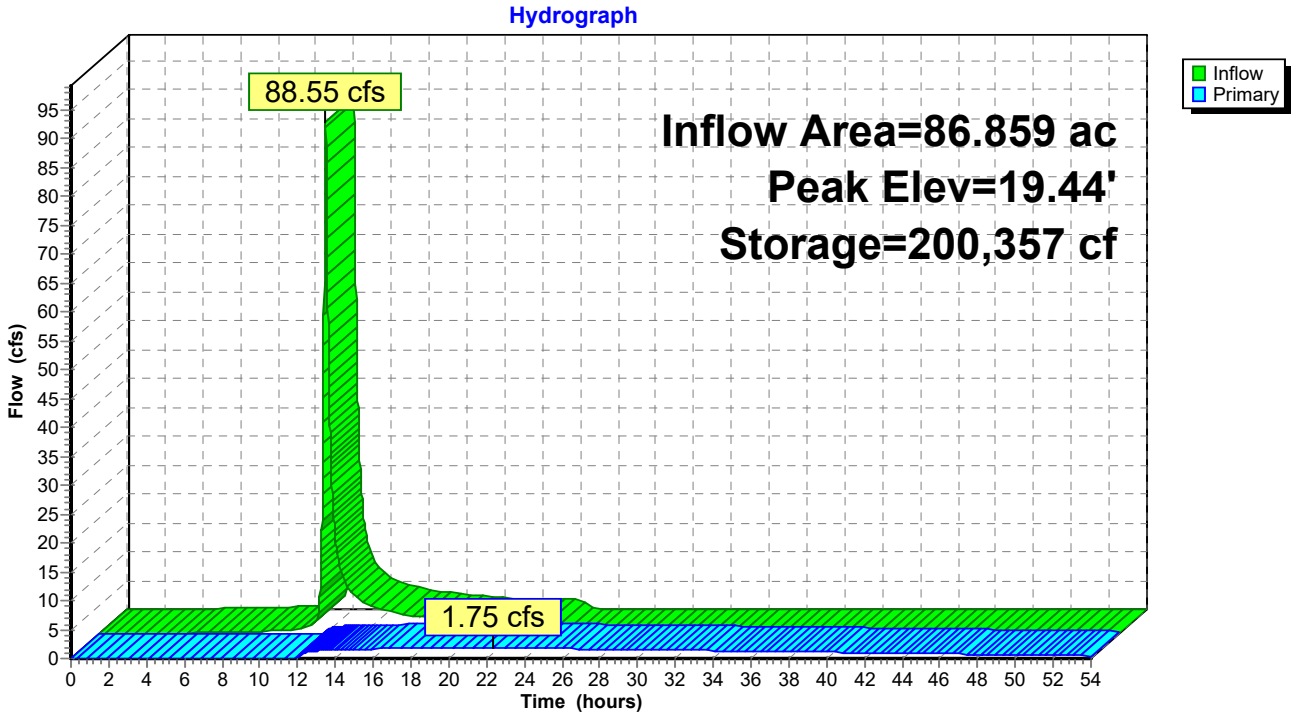
Routing by Dyn-Stor-Ind method, Time Span= 0.00-54.00 hrs, dt= 0.01 hrs
Peak Elev= 19.44' @ 22.37 hrs Surf.Area= 0 sf Storage= 200,357 cf
Flood Elev= 28.00' Surf.Area= 0 sf Storage= 729,969 cf

Plug-Flow detention time= 1,031.0 min calculated for 4.400 af (70% of inflow)
Center-of-Mass det. time= 912.5 min (1,771.4 - 858.9)

Volume	Invert	Avail.Storage	Storage Description
#1	12.00'	807,221 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
12.00	0
13.00	1,798
14.00	13,267
15.00	42,409
16.00	74,695
17.00	108,829
18.00	144,837
19.00	182,750
20.00	222,636
21.00	268,277
22.00	323,549
24.00	449,520
26.00	584,973
28.00	729,969
29.00	807,221

Device	Routing	Invert	Outlet Devices
#1	Primary	13.20'	**48.0" Round Culvert** L= 76.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.20' / 11.98' S= 0.0161 '/' Cc= 0.900 n= 0.012, Flow Area= 12.57 sf
#2	Device 1	16.00'	**6.0" Horiz. Orifice/Grate** C= 0.600
#3	Device 1	22.50'	**60.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.75 cfs @ 22.37 hrs HW=19.44' (Free Discharge)
└─**1=Culvert** (Passes 1.75 cfs of 124.61 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.75 cfs @ 8.93 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Pond WP: West Pond- Existing