APPENDIX K

OPERATIONS AND FINAL COVER SURFACE WATER MANAGEMENT SYSTEM DESIGN

APPENDIX K.1

DESIGN OF SURFACE WATER MANAGEMENT SYSTEM FOR OPERATIONAL CONDITIONS

Geosyntec
consultants

COMPUTATION COVER SHEET

Client: Honeywell **Project:** Onondaga Lake SCA Design **Project #:** GJ4299 **Task #:** 17

TITLE OF COMPUTATIONS **DESIGN OF SURFACE WATER MANAGEMENT SYSTEM FOR OPERATIONAL CONDITIONS**

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DESIGN OF SURFACE WATER MANAGEMENT SYSTEM FOR OPERATIONAL CONDITIONS

BACKGROUND & PURPOSE

This package was prepared in support of the design of the Sediment Consolidation Area (SCA) for the Onondaga Lake Bottom Site, which will be constructed on Wastebed 13 (WB-13). Specifically, the package is intended to present the design and analysis of the surface water management system for operational conditions of the SCA.

The package addresses the surface water management system in place during the dewatering of the dredged lake sediment using geotextile tubes (geo-tubes) within the SCA, which is surrounded by a perimeter dike (SCA perimeter dike). For the purposes of the calculations conducted in this package, the SCA has a footprint corresponding to a capacity of up to 2.65 million cubic yards of dredged material. The calculations presented herein are conservative for reduced SCA volumes and interim operational phases. A separate package title Final Cover System Surface Water Management System Design (Appendix K of the SCA Final Design) presents the design analyses for the proposed surface water management system for the final cover system.

KEY CONSIDERATIONS AND LIMITATIONS

This package addresses surface water management within the limits of the SCA perimeter dike and the exterior detention basins (also referred to as stormwater basins) during the period when the geo-tubes are being filled, and does not address how surface water management will be implemented for the final cover. Surface water management outside the limits of the SCA perimeter dike, the detention basins, and the SCA support areas will be addressed as part of the Wastebed 9 through 15 Closure. While this package addresses the general surface water flow and the capacity of the system to convey surface water during operations, additional planning and control measures may be needed depending on geo-tube phasing and settlement patterns. For example, there may be a need to pump water using portable pumps from the top area of the SCA. These operational issues are not addressed in this package.

It is anticipated that the SCA will be used to actively dewater dredged sediment using geo-tubes for approximately four years. Settlement is expected to occur during the four-year period, and continue to occur after the final cover system is constructed. The calculations

performed herein are based on the proposed design elevation of the "Top of the Geo-tubes" of the SCA without considering any calculated settlements that are expected to occur during installation and placement of geo-tubes.

DESIGN CRITERIA

The surface water management system for operational conditions will serve two purposes. During construction and operation of the SCA, the system will convey filtrate and consolidation water from the geo-tubes (i.e., the water generated from dewatering the dredged material in the geo-tubes) to operational pumps located at the temporary perimeter basins/perimeter culverts (i.e., the low spots of the north-south dikes). Specifically, each of the reaches of the temporary perimeter channels will be designed to convey a filtrate and consolidation water flow rate of 6000 gpm (provided to Geosyntec Consultants by Parsons), while maintaining a minimum of six inches of freeboard. The operational pumps will convey the water to the water treatment plant. The exact locations and operation of these pumps will be discussed in more detail in the Sediment Management Intermediate and Final Design.

During rainfall events, the interim surface water management system will convey runoff from the SCA to the operational pumps and the detention basins. For the purposes of the calculations performed in this package, the system is designed to collect and convey runoff from the 25-year, 24-hour design rainfall event, assuming that the SCA will not be operating during this event. Basins and temporary perimeter channels are designed to convey and, combined with the detention basins, contain the calculated peak water elevations from the 25-year, 24-hour design rainfall event while maintaining a minimum of six inches of freeboard.

SURFACE WATER MANAGEMENT SYSTEM COMPONENTS

The surface water management system for operational conditions will include the components listed below. This calculation package will address the design of each of the components, which are shown in Figure 1.

- **Temporary Perimeter Channel and Basins –** The temporary perimeter channel is comprised of four drainage channels located between the SCA perimeter dike and the geo-tubes. These channels capture and convey runoff from the geo-tube side slopes to the perimeter culverts during construction/operation conditions. In addition to providing conveyance, the temporary perimeter channels will provide some

additional storage during high rainfall events when the water surface elevation in the exterior detention basins exceeds the bottom elevations in the temporary perimeter channels. Therefore, they are modeled as both channels and basins.

- **Perimeter Culverts –** Perimeter culverts will be located at two locations beneath the SCA perimeter dike and will convey runoff from the temporary perimeter channels to the detention basins.

- **Detention Basins –** Detention basins will be located west and east of the SCA to provide storage of surface water runoff received from the perimeter culverts.

ANALYSIS METHODOLOGY

Hydraulic and hydrologic analyses are conducted using methods presented in TR-20 (SCS, 1983) and TR-55 (SCS, 1986). Analyses are conducted using the computer program *HydroCAD*^{TM} (HydroCAD, 2005). Computer program analyses are supplemented with other design calculation methods wherever applicable.

MAJOR ASSUMPTIONS

- **Subcatchment Properties –** For the purposes of the analyses conducted herein, the extent of the SCA is divided into 11 subcatchments – four top-deck subcatchments and seven side-slope subcatchments. Tables 1 and 2 summarize the important topographic features of the 11 subcatchments: area, longest travel path, and elevation maxima and minima.

Table 1 – Summary of Top-Deck Subcatchments

	S1A	S2A	S3A	S4A
Area (acres)	7.9	14.4	18.3	9.8
Longest Path (ft)	1051	1536	1658	1159
Max. Elev. (ft)	463.3	468.1	468.1	463.3
Min. Elev. (ft)	429.2	429.2	425.6	425.6

Table 2 – Summary of Side Slope Subcatchments

	S1B	S1C	S2B	S2C	S3B	S3C	S4B
Area (acres)	2.4	1.1	1.1	2.7	2.0	3.0	1.2
Longest Path (ft)	85	85	85	1055	85	1040	85
Max Elev. (ft)	463.3	462.9	468.1	468.1	467.4	468.1	463.3
Min. Elev. (ft)	433.3	432	437.1	429.2	437.1	426.2	433.3

- **Hydrologic Soil Group (HSG) for Cover System** – For the purposes of this calculation, no Hydrologic Soil Group will be applied to the subcatchment surfaces. It is assumed that the synthetic material of the geo-tubes will result in a subcatchment surface that has the highest runoff potential possible, and it will be modeled as a generalized impervious area.

- **Runoff Curve Number (CN)** – It is assumed that the geo-tubes are completely saturated, not allowing infiltration, and the synthetic material behaves like a highly impervious area. Based on these assumptions, a CN = 98 is selected for the subcatchment areas for operational conditions.

- **Rainfall Distribution for Design Storm -** As shown on Attachment 1 (SCS, 1986), the site is located in a region designated under a SCS Type II Rainfall Distribution.

- **Rainfall Depth for Design Storm –** The rainfall depth for 25-year 24-hour design storm event is 4.4 inches and was obtained from Attachment 2 (SCS, 1986).

HYDRAULIC AND HYDROLOGIC MODELING

- **Nodal Network Diagram –** Attachment 3 presents a nodal network diagram showing the connectivity of the subcatchments and the surface water management system components listed below.

    - S1A through S4A – Top Deck Subcatchments
    - S1B through S4B – Side Slope Subcatchments
    - R1B through R4B – Temporary Perimeter Channel Reaches
    - AxB" and CxD" – Perimeter Culverts (do not appear on HydroCAD nodal diagram because they are outfall structures)
    - TB1 and TB2 – Temporary Perimeter Basins

- EDB and WDB – Detention Basins

- **Computer Modeling –** A hydraulic and hydrologic analysis was conducted using the aforementioned assumptions and system components using the computer program *HydroCAD*^{TM}. The results of the modeling are presented in Attachment 4.

DESIGN OF SURFACE WATER MANAGEMENT SYSTEM FOR OPERATIONAL CONDITIONS

- **Temporary Perimeter Channel –** The temporary perimeter channels are shown as R1B, R1C, R2B, R2C, R3B, R3C, and R4B in the HydroCAD nodal diagram and Figure 1. The cross-sectional area of the temporary perimeter channels varies on both the eastern and western half of the SCA. The temporary perimeter channels are designed to collect runoff (i.e., filtrate or surface water) from the side slopes (S1B/C, S2B/C, S3B/C, and S4B) during operations. This runoff is then conveyed to the temporary perimeter basin. During operational conditions the channel reaches were assumed to be *earth, clean and straight* with a corresponding Manning's n value of 0.025, as shown in Attachment 5 (HydroCAD, 2005). Due to the variability in cross-sections throughout the SCA perimeter channel, only the sections with the lowest discharge capacities were evaluated to demonstrate that the target discharge rate (6000 gpm) could be met. The lowest capacity sections are combinations of small cross-sectional areas, relatively large wetted perimeters, and low longitudinal slopes. As a conservative approach, each of these lowest capacity sections was used to represent their entire respective reaches. The four main drainage channels were divided into seven reaches during the subcatchment delineation process, as shown in Figure 1. Using the lowest capacity sections provides a conservative estimate of channel depth during peak flow, which is used to evaluate the freeboard design criteria. The discharge rate for each reach of the temporary perimeter channels with six-inches of freeboard is shown below in Table 3. The minimum freeboard for the 25-year, 24-hour storm is shown below in Table 4. As can be seen in these tables, the discharge capacity with six inches of freeboard meets the target value, and the minimum freeboard during the design storm is greater than six inches.

Table 3 –Discharge Rates with Six Inches of Freeboard for Reaches

Section	R1B	R1C	R2B	R2C	R3B	R3C	R4B
Area (sq. ft)	63.9	62.6	24.5	23.8	58.8	63.3	48.7
Wetted Perimeter (ft)	25.7	24.7	16.8	16.7	24.1	24.7	21.9
Longitudinal Slope (ft/ft)	0.0010	0.0045	0.0002	0.0067	0.0028	0.0079	0.0103
Discharge Capacity (gpm)	100,000	210,000	12,000	66,000	150,000	280,000	230,000

Table 4 – Minimum Freeboard for Reaches of Temporary Perimeter Channels

Reach	R1B	R1C	R2B	R2C	R3B	R3C	R4B
Freeboard (ft)	3.7	4.1	1.9	2.0	3.9	4.1	3.9

- **Temporary Perimeter Basin –** The temporary perimeter basins are shown as TB1 and TB2 in the HydroCAD nodal diagram and Figure 1. There are two temporary perimeter basins available in the temporary perimeter channels. The water flowing to these two basins is divided by the two high points in the temporary perimeter channels (i.e., where R4B and R1B start and where R3B and R2B start). An elevation-storage relationship was developed for each of these temporary perimeter basins by calculating the surface area inside each temporary perimeter channel from the bottom to the top of the channel. This calculation assumes that above 433.3 ft Mean Surface Elevation (MSE) (where R4B and R1B start, which is the highest point in the temporary perimeter channels) the temporary perimeter basins are not connected. These two elevation-storage relationships are summarized below in Table 5. The minimum freeboard in these basins for the 25-year, 24-hour storm is shown below in Table 6.

Table 5 – Elevation-Storage Relationship for Temporary Perimeter Basins

Elevation (ft)	426	427	428	429	430	431	432	433	434
TB1 Storage (acre-ft)	0	0	0	0	0	0.14	0.42	0.90	1.6
TB2 Storage (acre-ft)	0	0.01	0.06	0.16	0.34	0.60	1.0	1.5	2.2

Table 6 – Minimum Freeboard for Temporary Perimeter Basins

Temporary Basin	TB1	TB2
Freeboard (ft)	0.61	0.86

- **Perimeter Culverts –** The perimeter culverts are shown as AxB" and CxD" in Figure 1. As indicated previously, these culverts were modeled as outfall structures for the temporary perimeter basins and therefore do not appear in the HydroCAD nodal diagram. These are culverts in place to convey the water stored in the temporary perimeter basins to the detention basins. These culverts were modeled as outlet structures at the lowest elevations in the detention basins and inlets approximately at the lowest elevations in the temporary perimeter channels. Both culverts, AxB" and CxD", have the same specifications listed below and only vary in length.
    - Pipe Dimensions
        - No. of Pipes = 4
        - Pipe Diameter = 24"
    - Manning's n = 0.013 (Round Concrete Pipe)
        - HDPE pipe is also an option as it typically has a smaller Manning's n value, which results in greater discharge capacity.
    - Longitudinal Slope = 1%

- **Detention Basins –** The detention basins are shown as EDB and WDB in the HydroCAD nodal diagram and Figure 1; the catchment area corresponding to these detention basins is shown as EA and WA. The detention basins on the western and eastern sides on the exterior of the SCA perimeter dike are designed, in combination with the temporary perimeter basins, to store all of the runoff from the side slopes and the top of the geo-tubes during the 25-year, 24-hour design storm. These two elevation-storage relationships are summarized below in Table 7. The minimum freeboard for the 25-year, 24-hour storm is shown below in Table 8.

Table 7 – Elevation-Storage Relationship for Detention Basins

Elevation (ft)	424	425	426	427	428	429	430	431	432	433	434
EDB Storage (acre-ft)	0	0	0	0	0	0.18	0.58	2.1	5.3	9.0	13
WDB Storage (acre-ft)	0	0.10	0.31	0.77	1.5	2.6	4.3	6.4	8.6	11	13

Table 8 – Minimum Freeboard for Detention Basins

Detention Basin	EDB	WDB
Freeboard (ft)	0.61	0.86

CONCLUSION

The components of the surface water management system for operational conditions for the SCA are designed to convey and contain the calculated discharge from a 25-year, 24-hour design storm within the SCA perimeter dike and its detention (i.e., stormwater) basins with a minimum freeboard of six inches. In addition, each reach of the temporary perimeter channels is designed to convey a filtrate and consolidation water flow rate of 6000 gpm while maintaining a minimum of six inches of freeboard.This package addresses surface water management within the limits of the SCA perimeter dike during operational conditions, and does not address how surface water management will be implemented outside the limits of the SCA perimeter dike, which will be addressed separately. Additional planning and control measures may be needed depending on the geo-tube phasing as localized ponding may occur within the SCA during operational conditions, which could require the use of portable pumping units.

REFERENCES

HydroCAD, "HydroCAD™ Storm Water Modeling System, Version 7.1", HydroCAD Software Solutions LLC., Chocorua, New Hampshire, 2005.

SCS, "Computer Program for Project Formulation—Hydrology, Technical Release 20 (TR-20)", United States Department of Agriculture, Soil Conservation Service, Washington, D.C., 1983.

SCS, "Hydrology for Small Watersheds, Technical Release 55 (TR-55)", United States Department of Agriculture, Soil Conservation Service, Washington, D.C., 1986.

Figures

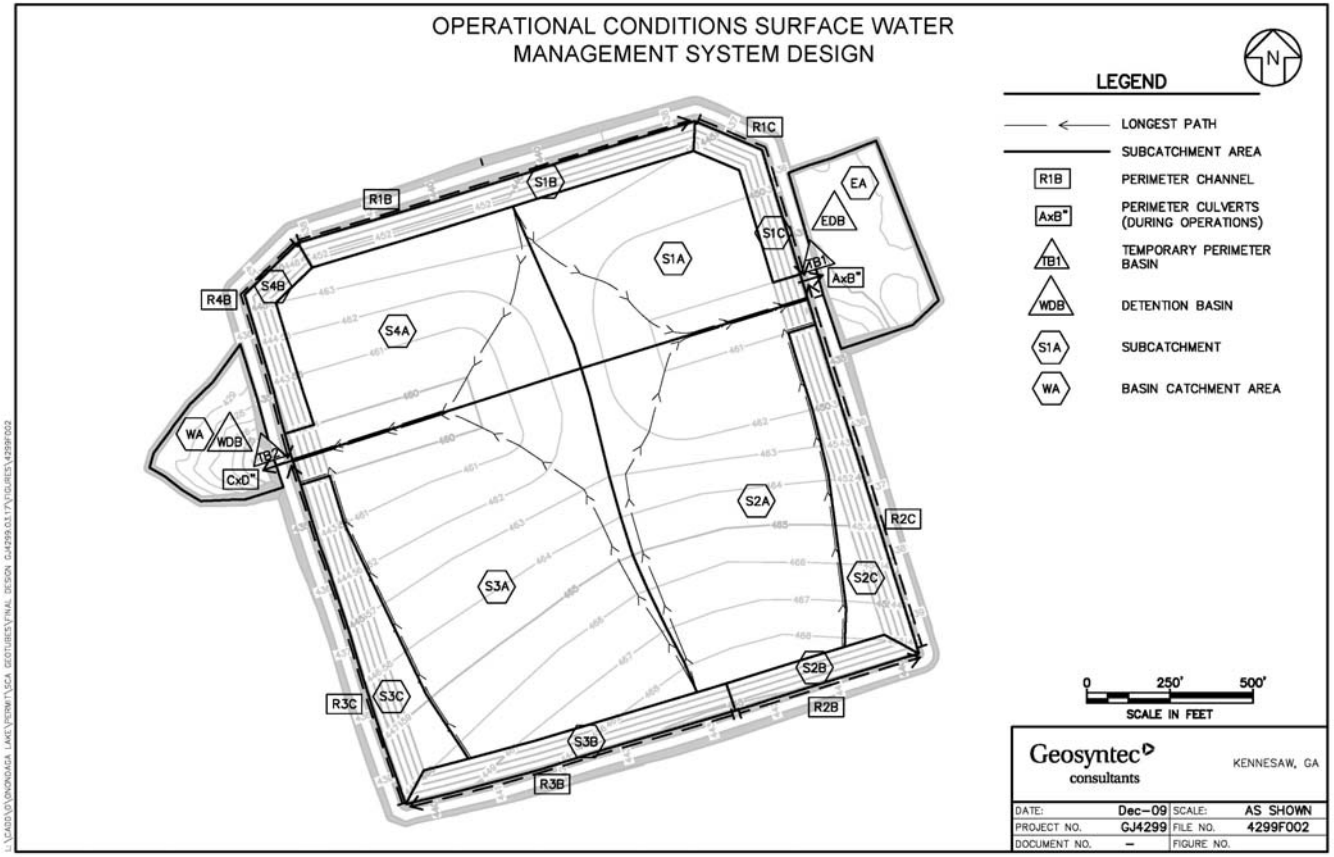


Figure 1: Operational Conditions Surface Water Management System Design

Attachment 1 – Rainfall Distributions

(TR-55, SCS, 1986)

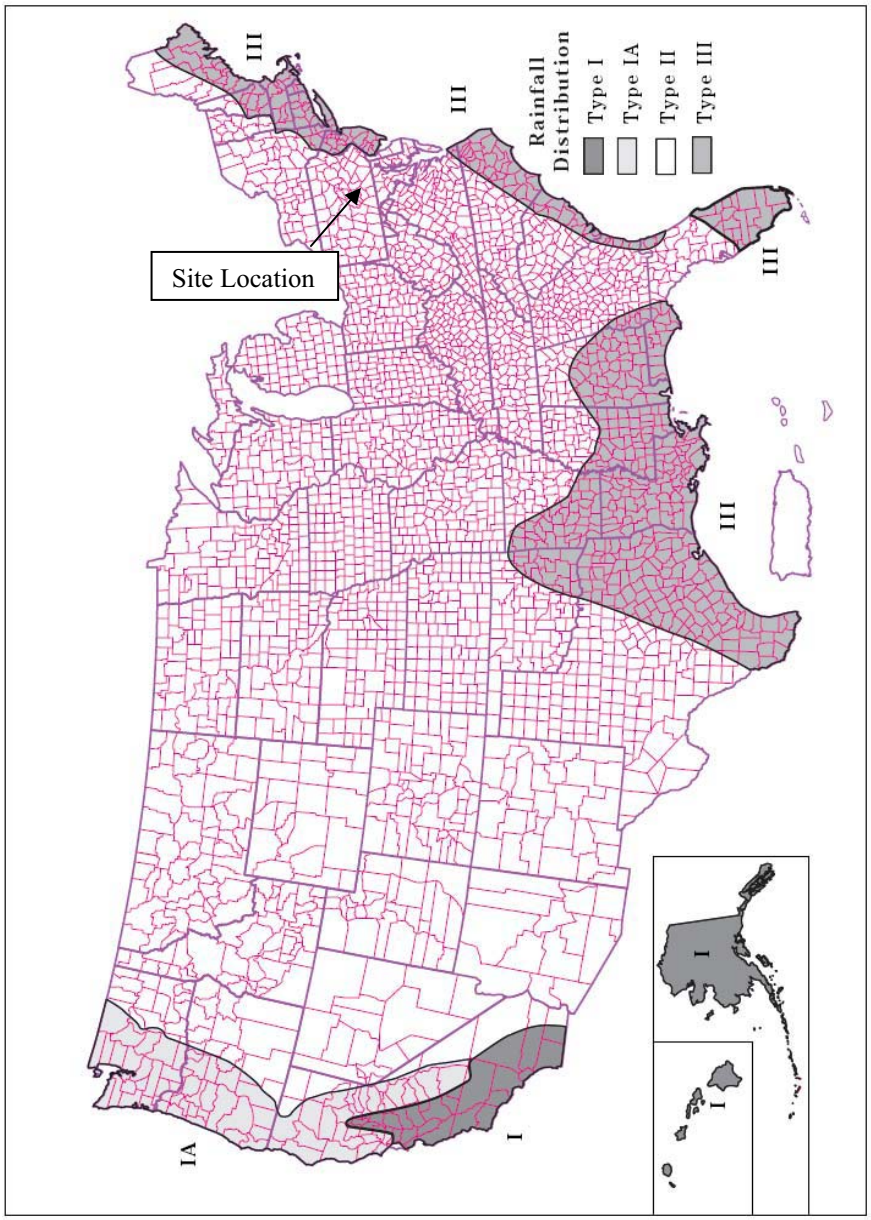
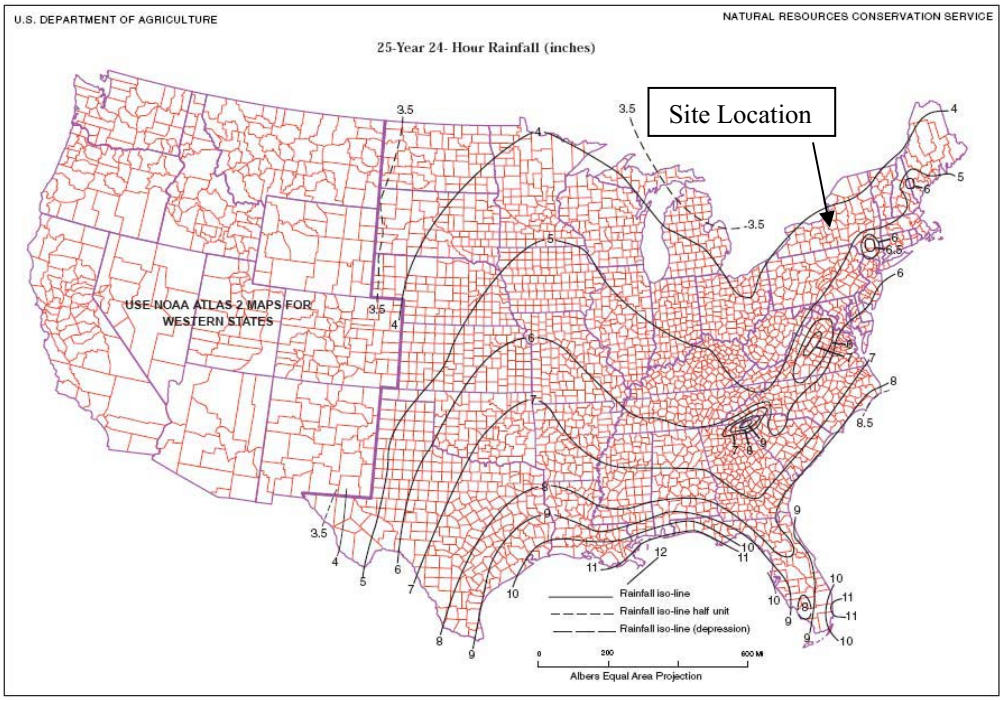


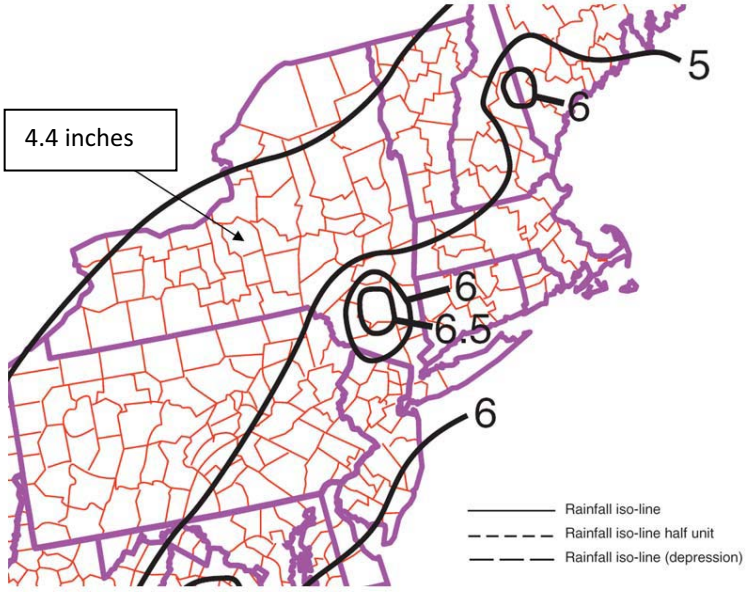
Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions

Attachment 2 – Rainfall Depths

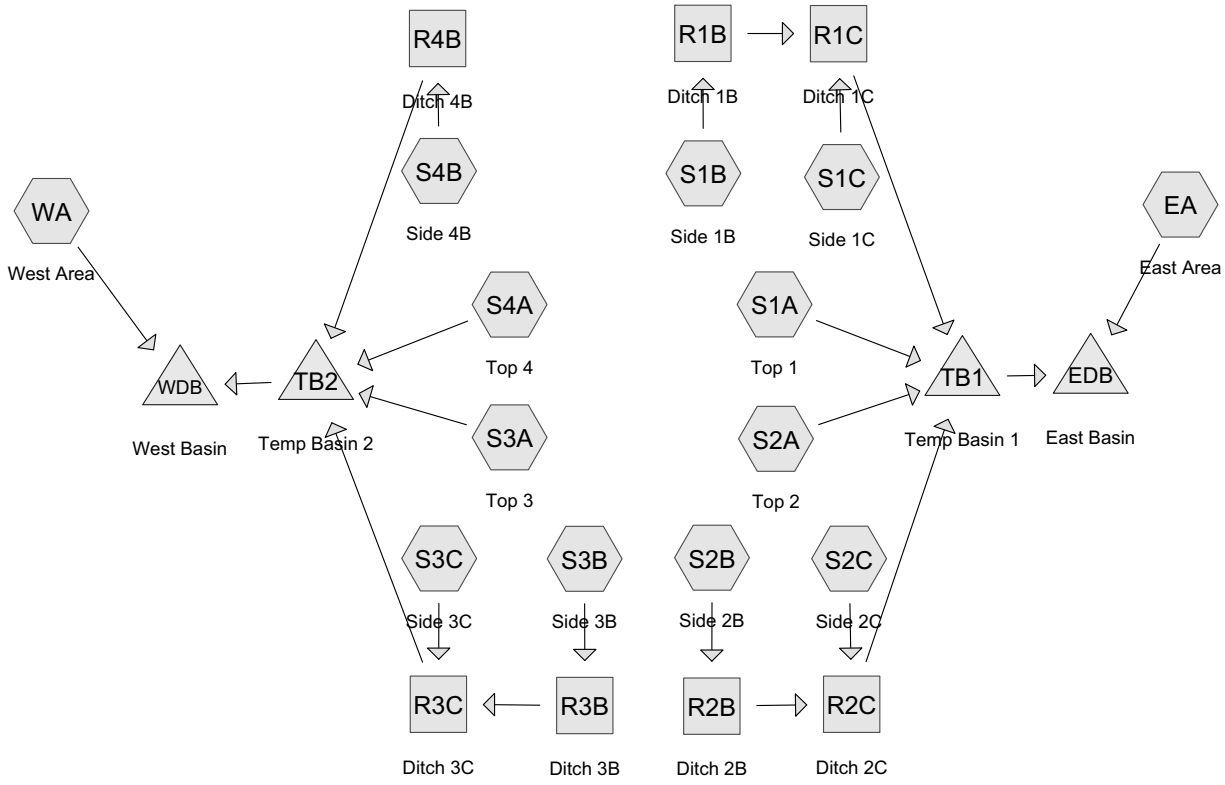
(TR-55, SCS, 1986)

Figure B-6 25-year, 24-hour rainfall





Attachment 3 – Nodal Diagram



Subcat Reach Pond Link

Drainage Diagram for interm_25yr

Prepared by Geosyntec Consultants, Printed 12/17/2009

Attachment 4 – HydroCAD Analysis

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.250	98	(EA, WA)
63.660	98	Geotubes Cover (S1A, S1B, S1C, S2A, S2B, S2C, S3A, S3B, S3C, S4A, S4B)
69.910		**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
69.910	Other	EA, S1A, S1B, S1C, S2A, S2B, S2C, S3A, S3B, S3C, S4A, S4B, WA
69.910		**TOTAL AREA**

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Fill (inches)
1	TB1	429.61	429.00	61.0	0.0100	0.013	24.0	0.0	0.0
2	TB2	424.89	424.00	89.0	0.0100	0.013	24.0	0.0	0.0

Time span=0.00-120.00 hrs, dt=0.01 hrs, 12001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EA: East Area Runoff Area=3.860 ac 100.00% Impervious Runoff Depth=4.16"
Tc=5.0 min CN=98 Runoff=24.92 cfs 1.339 af

Subcatchment S1A: Top 1 Runoff Area=7.910 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=1,051' Tc=20.9 min CN=98 Runoff=31.79 cfs 2.745 af

Subcatchment S1B: Side 1B Runoff Area=2.370 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=85' Tc=5.0 min CN=98 Runoff=15.30 cfs 0.822 af

Subcatchment S1C: Side 1C Runoff Area=1.070 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=85' Tc=5.0 min CN=98 Runoff=6.91 cfs 0.371 af

Subcatchment S2A: Top 2 Runoff Area=14.380 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=1,536' Tc=24.4 min CN=98 Runoff=53.13 cfs 4.990 af

Subcatchment S2B: Side 2B Runoff Area=1.050 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=85' Tc=5.0 min CN=98 Runoff=6.78 cfs 0.364 af

Subcatchment S2C: Side 2C Runoff Area=2.680 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=1,055' Tc=16.2 min CN=98 Runoff=12.25 cfs 0.930 af

Subcatchment S3A: Top 3 Runoff Area=18.290 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=1,658' Tc=24.4 min CN=98 Runoff=67.58 cfs 6.347 af

Subcatchment S3B: Side 3B Runoff Area=1.960 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=85' Tc=5.0 min CN=98 Runoff=12.65 cfs 0.680 af

Subcatchment S3C: Side 3C Runoff Area=3.000 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=1,040' Tc=15.8 min CN=98 Runoff=13.85 cfs 1.041 af

Subcatchment S4A: Top 4 Runoff Area=9.790 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=1,159' Tc=21.2 min CN=98 Runoff=39.12 cfs 3.397 af

Subcatchment S4B: Side 4B Runoff Area=1.160 ac 100.00% Impervious Runoff Depth=4.16"
Flow Length=85' Tc=5.0 min CN=98 Runoff=7.49 cfs 0.403 af

Subcatchment WA: West Area Runoff Area=2.390 ac 100.00% Impervious Runoff Depth=4.16"
Tc=5.0 min CN=98 Runoff=15.43 cfs 0.829 af

Reach R1B: Ditch 1B Avg. Flow Depth=0.66' Max Vel=1.29 fps Inflow=15.30 cfs 0.822 af
n=0.025 L=1,251.0' S=0.0010 '/' Capacity=280.47 cfs Outflow=8.59 cfs 0.822 af

Reach R1C: Ditch 1C Avg. Flow Depth=0.57' Max Vel=2.47 fps Inflow=14.11 cfs 1.194 af
n=0.025 L=638.0' S=0.0045 '/' Capacity=642.07 cfs Outflow=12.67 cfs 1.194 af

Reach R2B: Ditch 2B Avg. Flow Depth=0.73' Max Vel=0.66 fps Inflow=6.78 cfs 0.364 af
n=0.025 L=528.0' S=0.0002 '/' Capacity=40.65 cfs Outflow=4.20 cfs 0.364 af

Reach R2C: Ditch 2C Avg. Flow Depth=0.54' Max Vel=2.90 fps Inflow=16.18 cfs 1.294 af
n=0.025 L=1,175.0' S=0.0067 '/' Capacity=219.74 cfs Outflow=13.83 cfs 1.294 af

Reach R3B: Ditch 3B Avg. Flow Depth=0.66' Max Vel=2.06 fps Inflow=12.65 cfs 0.680 af
n=0.025 L=1,033.0' S=0.0028 '/' Capacity=406.82 cfs Outflow=9.40 cfs 0.680 af

Reach R3C: Ditch 3C Avg. Flow Depth=0.67' Max Vel=3.55 fps Inflow=22.46 cfs 1.721 af
n=0.025 L=1,093.0' S=0.0079 '/' Capacity=834.84 cfs Outflow=20.36 cfs 1.721 af

Reach R4B: Ditch 4B Avg. Flow Depth=0.23' Max Vel=3.43 fps Inflow=7.49 cfs 0.403 af
n=0.025 L=750.0' S=0.0103 '/' Capacity=611.76 cfs Outflow=6.53 cfs 0.403 af

Pond EDB: East Basin Peak Elev=433.39' Storage=10.431 af Inflow=82.79 cfs 10.431 af
Outflow=0.00 cfs 0.000 af

Pond TB1: Temp Basin 1 Peak Elev=433.39' Storage=1.133 af Inflow=107.51 cfs 10.223 af
24.0" Round Culvert x 4.00 n=0.013 L=61.0' S=0.0100 '/' Outflow=79.94 cfs 9.092 af

Pond TB2: Temp Basin 2 Peak Elev=433.14' Storage=1.551 af Inflow=127.80 cfs 11.868 af
24.0" Round Culvert x 4.00 n=0.013 L=89.0' S=0.0100 '/' Outflow=91.95 cfs 10.320 af

Pond WDB: West Basin Peak Elev=433.14' Storage=11.150 af Inflow=93.75 cfs 11.150 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 69.910 ac Runoff Volume = 24.260 af Average Runoff Depth = 4.16"
0.00% Pervious = 0.000 ac 100.00% Impervious = 69.910 ac

Summary for Subcatchment EA: East Area

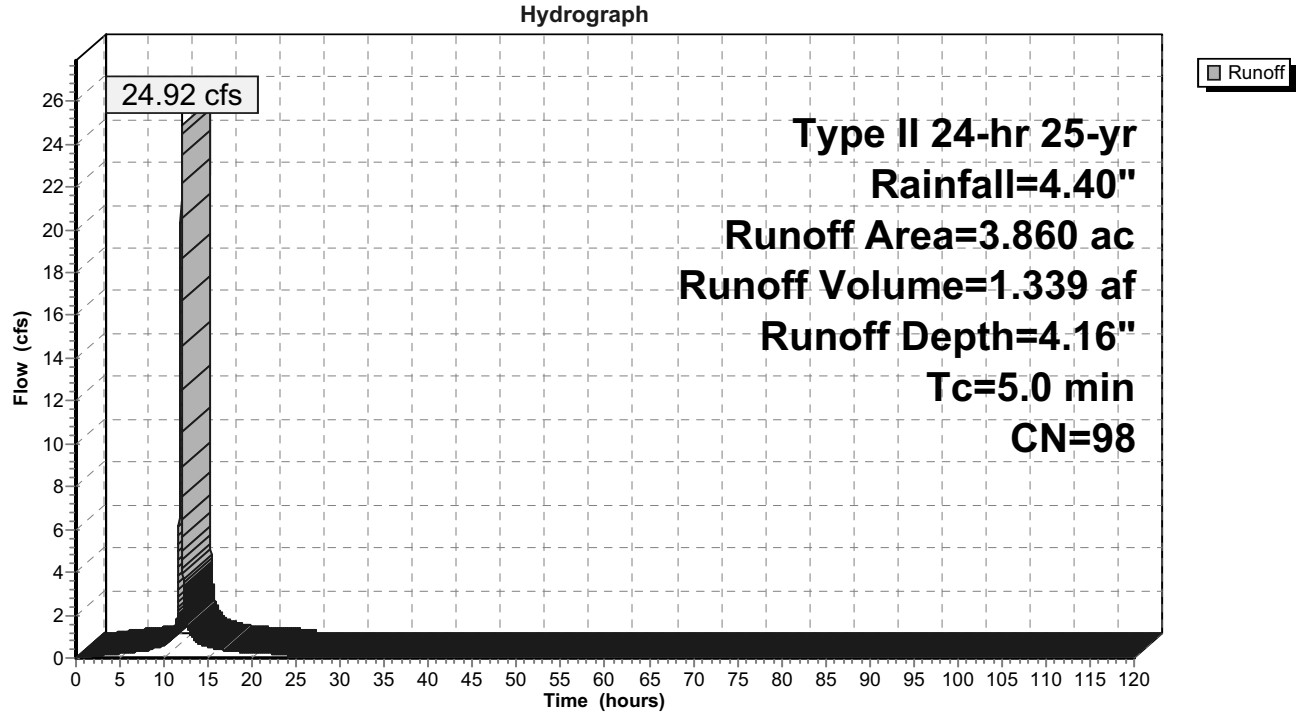
Runoff = 24.92 cfs @ 11.96 hrs, Volume= 1.339 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	3.860	98	
	3.860		100.00% Impervious Area

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

Subcatchment EA: East Area



Summary for Subcatchment S1A: Top 1

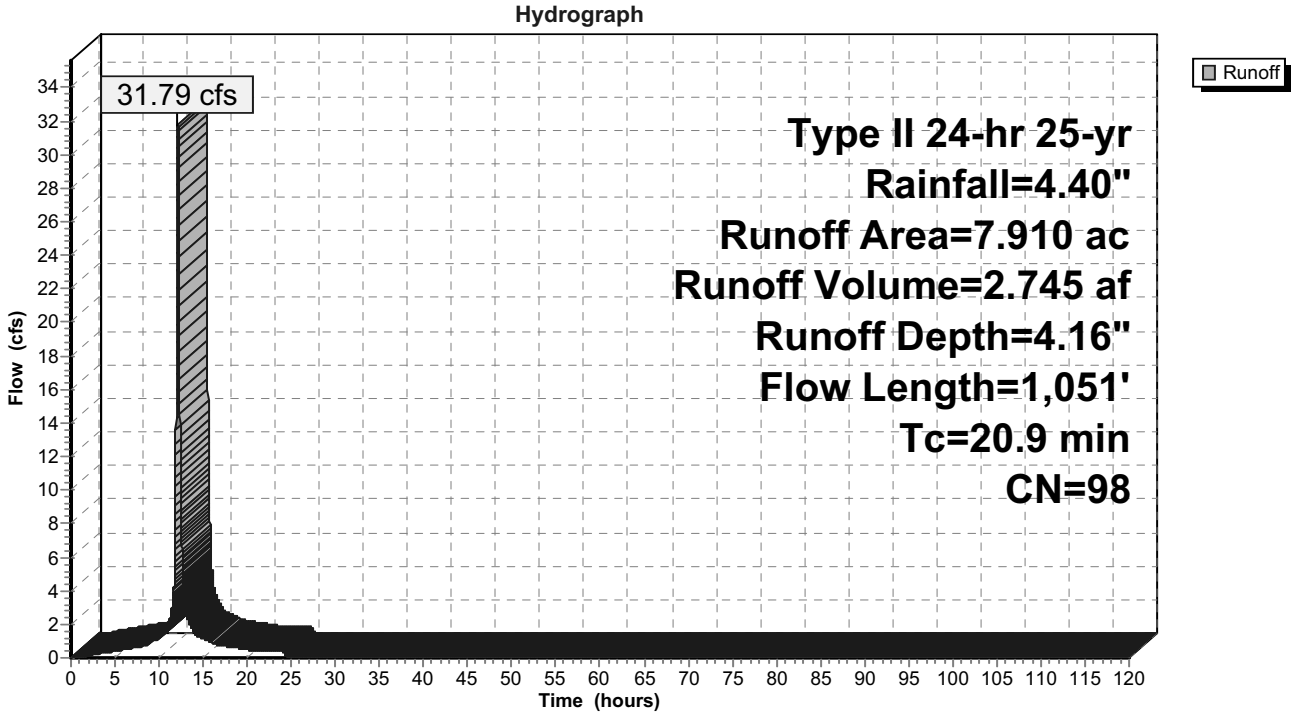
Runoff = 31.79 cfs @ 12.12 hrs, Volume= 2.745 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	7.910	98	Geotubes Cover
	7.910		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	300	0.0038	0.79		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.55"
9.5	666	0.0033	1.17		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
5.0	85		0.28		**Direct Entry, Steps**
20.9	1,051	Total			

Subcatchment S1A: Top 1



Summary for Subcatchment S1B: Side 1B

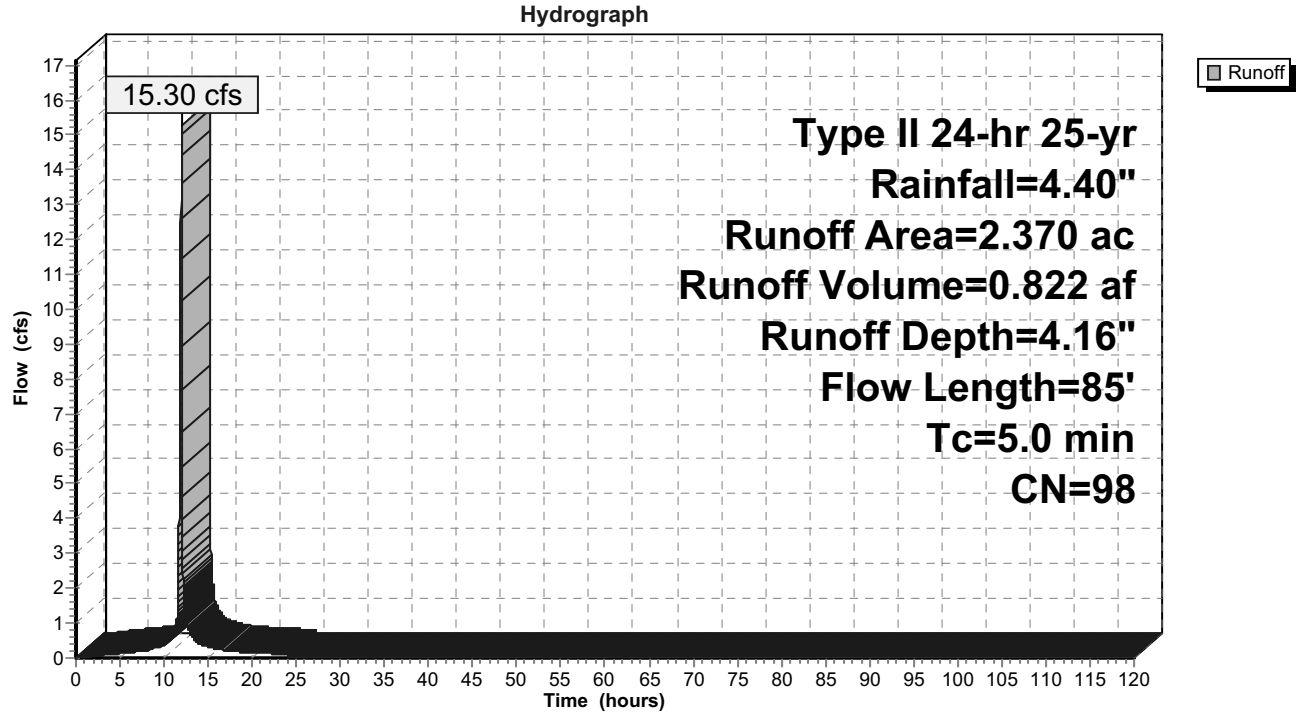
Runoff = 15.30 cfs @ 11.96 hrs, Volume= 0.822 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	2.370	98	Geotubes Cover
	2.370		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	85		0.28		**Direct Entry, Steps**

Subcatchment S1B: Side 1B



Summary for Subcatchment S1C: Side 1C

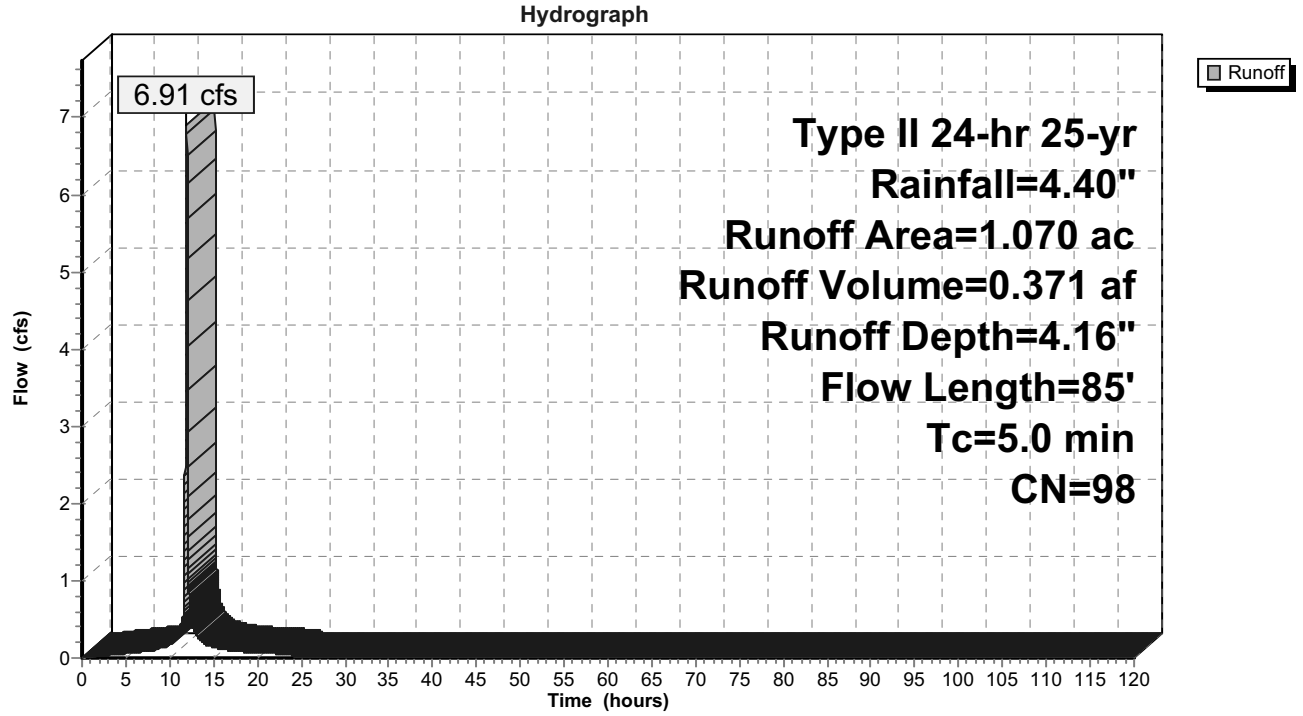
Runoff = 6.91 cfs @ 11.96 hrs, Volume= 0.371 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	1.070	98	Geotubes Cover
	1.070		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	85		0.28		**Direct Entry, Steps**

Subcatchment S1C: Side 1C



Summary for Subcatchment S2A: Top 2

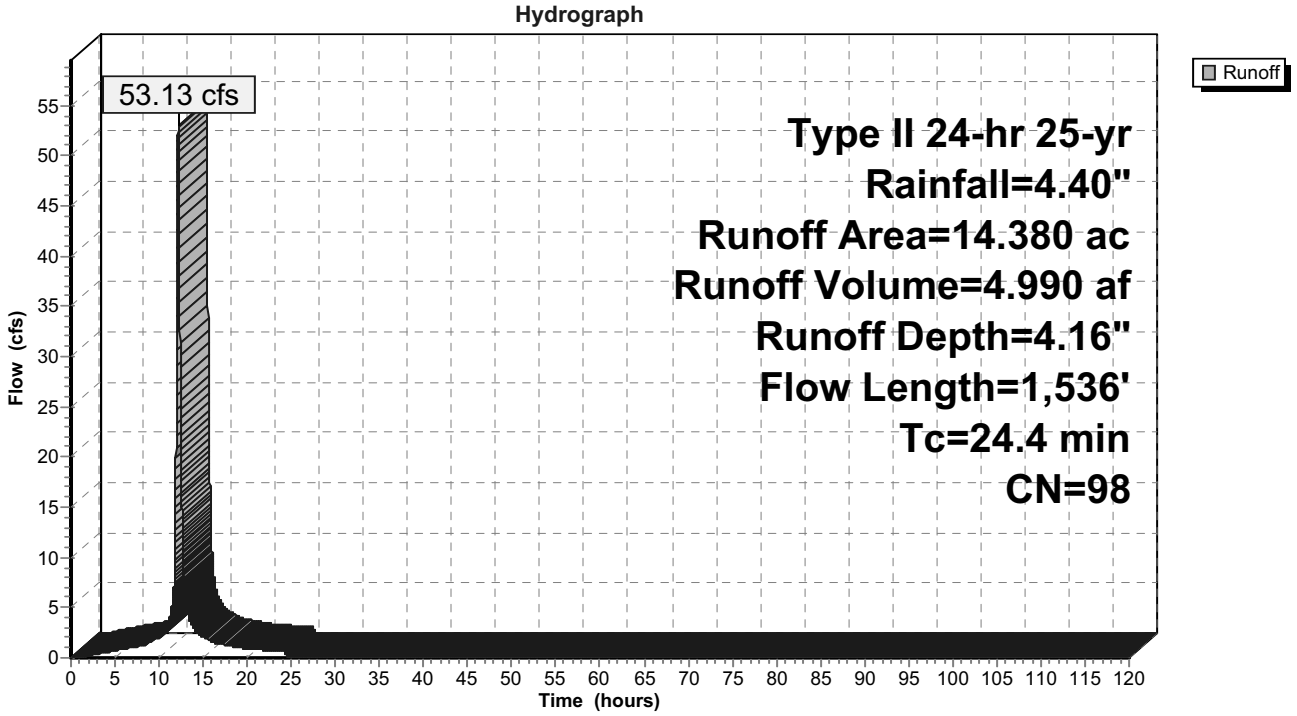
Runoff = 53.13 cfs @ 12.17 hrs, Volume= 4.990 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	14.380	98	Geotubes Cover
	14.380		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	300	0.0062	0.96		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.55"
14.2	1,151	0.0044	1.35		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
5.0	85		0.28		**Direct Entry, Steps**
24.4	1,536	Total			

Subcatchment S2A: Top 2



Summary for Subcatchment S2B: Side 2B

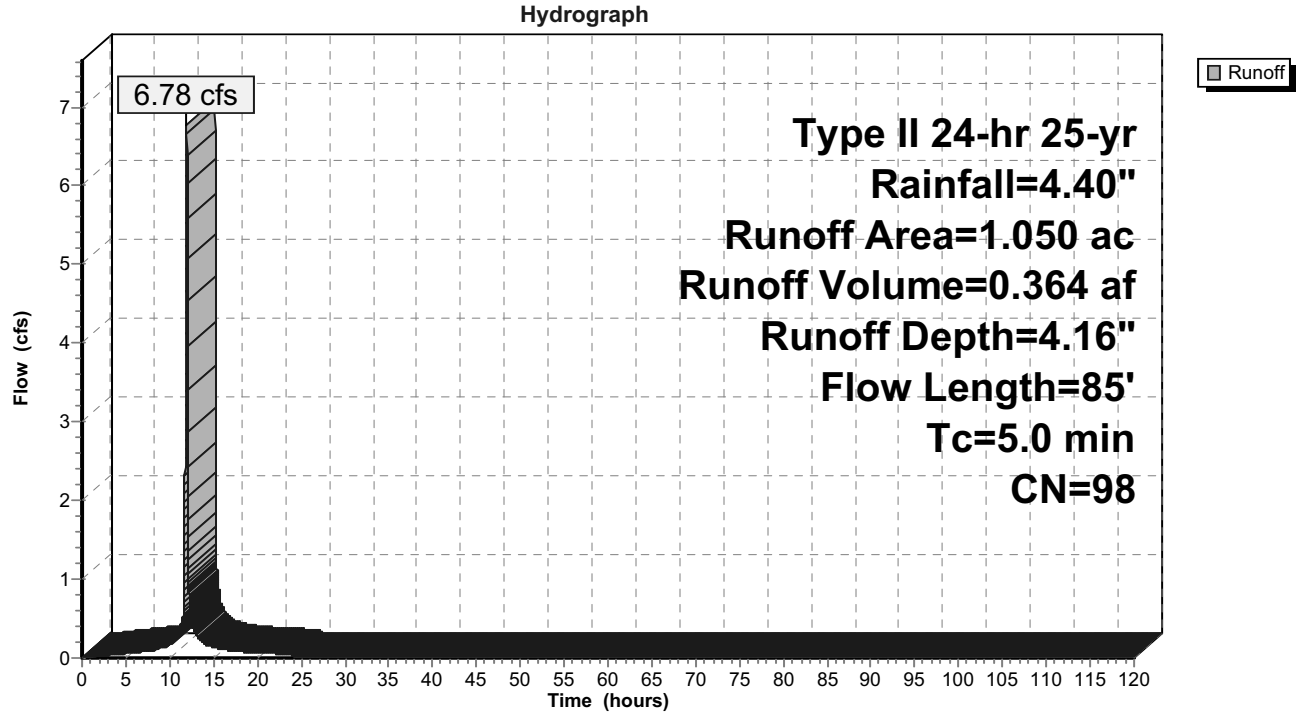
Runoff = 6.78 cfs @ 11.96 hrs, Volume= 0.364 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	1.050	98	Geotubes Cover
	1.050		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	85		0.28		**Direct Entry, Steps**

Subcatchment S2B: Side 2B



Summary for Subcatchment S2C: Side 2C

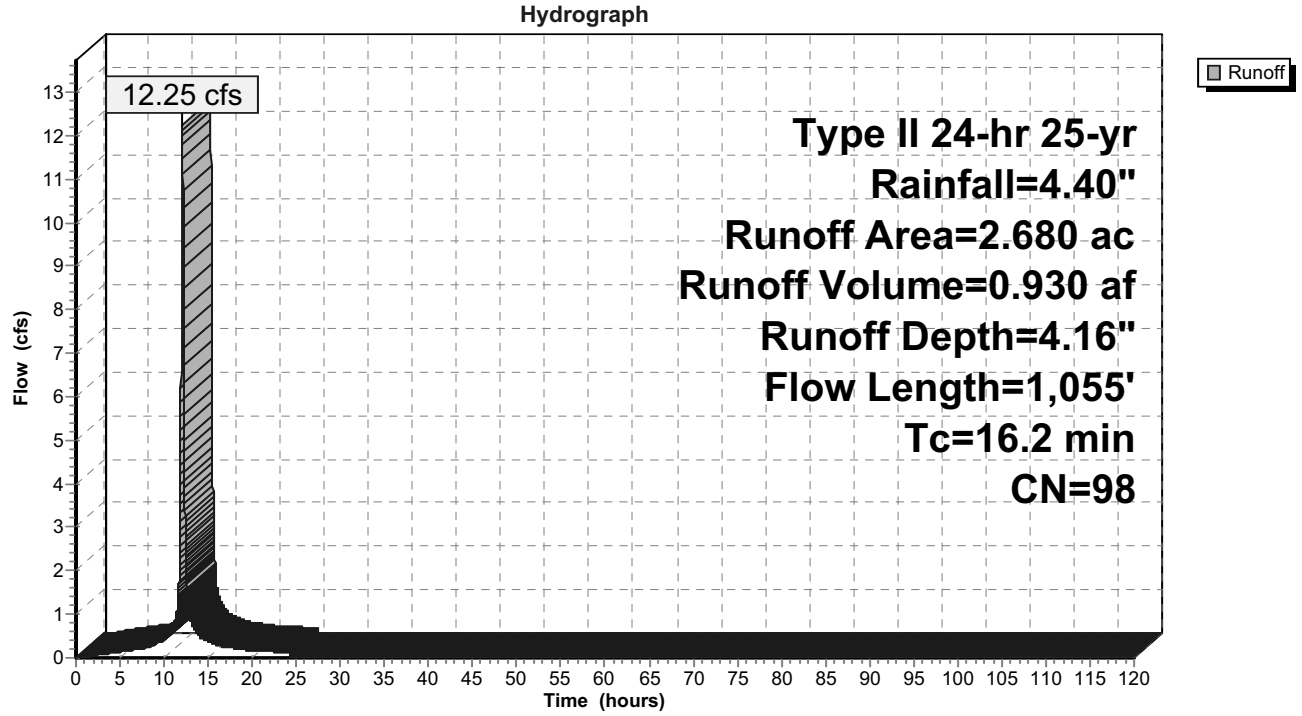
Runoff = 12.25 cfs @ 12.08 hrs, Volume= 0.930 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	2.680	98	Geotubes Cover
	2.680		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	300	0.0083	1.08		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.55"
6.6	670	0.0069	1.69		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
5.0	85		0.28		**Direct Entry, Steps**
16.2	1,055	Total			

Subcatchment S2C: Side 2C



Summary for Subcatchment S3A: Top 3

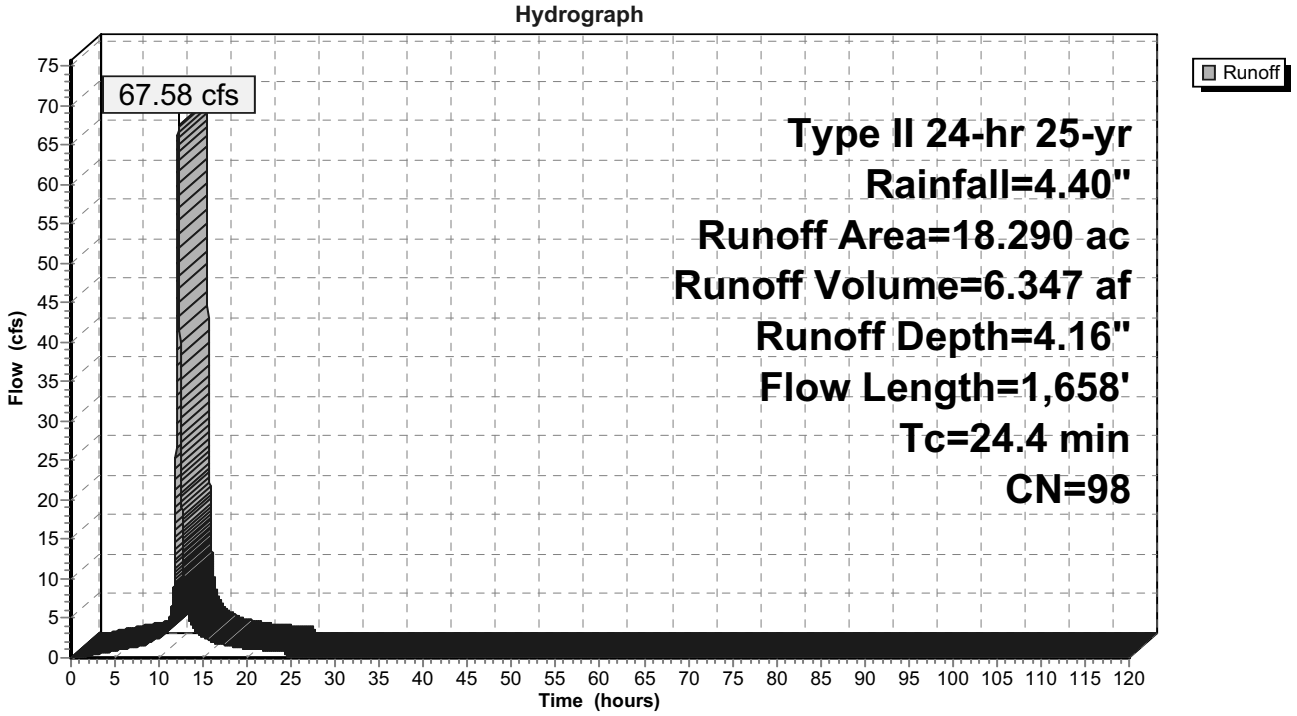
Runoff = 67.58 cfs @ 12.17 hrs, Volume= 6.347 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	18.290	98	Geotubes Cover
	18.290		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	300	0.0061	0.95		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.55"
14.1	1,273	0.0055	1.51		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
5.0	85		0.28		**Direct Entry, Steps**
24.4	1,658	Total			

Subcatchment S3A: Top 3



Summary for Subcatchment S3B: Side 3B

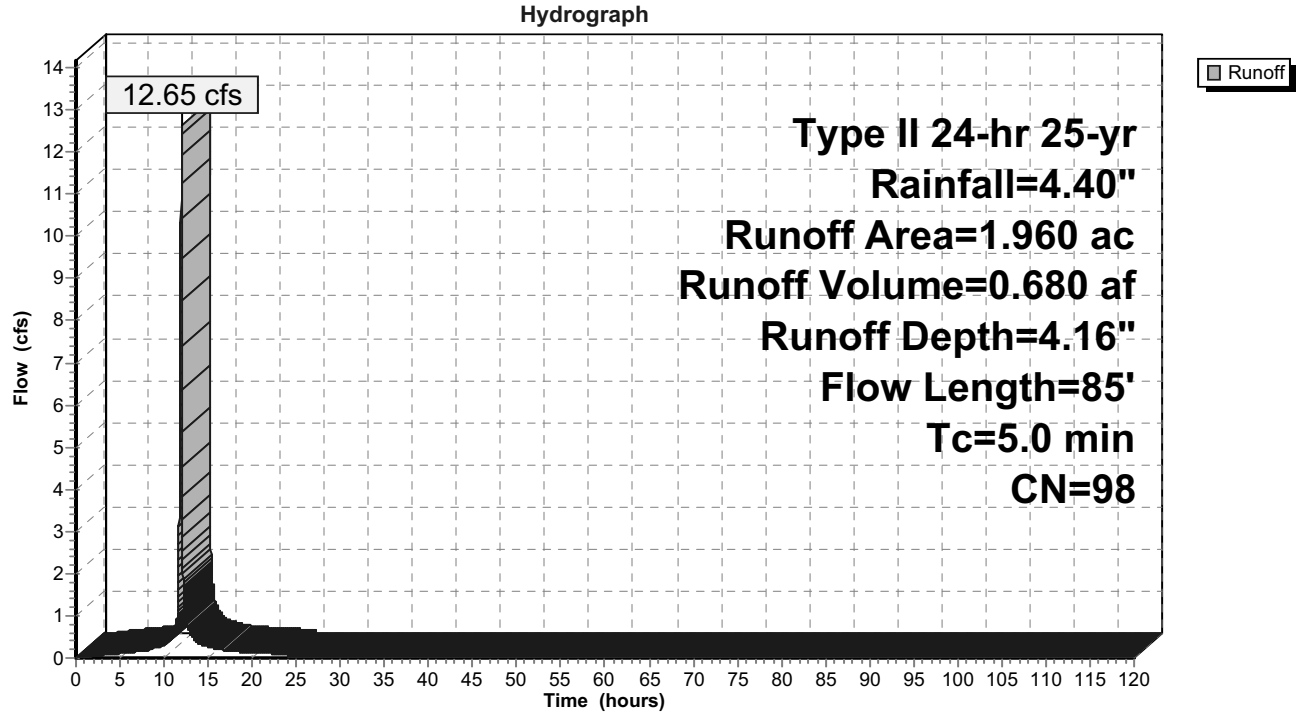
Runoff = 12.65 cfs @ 11.96 hrs, Volume= 0.680 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	1.960	98	Geotubes Cover
	1.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	85		0.28		**Direct Entry, Steps**

Subcatchment S3B: Side 3B



Summary for Subcatchment S3C: Side 3C

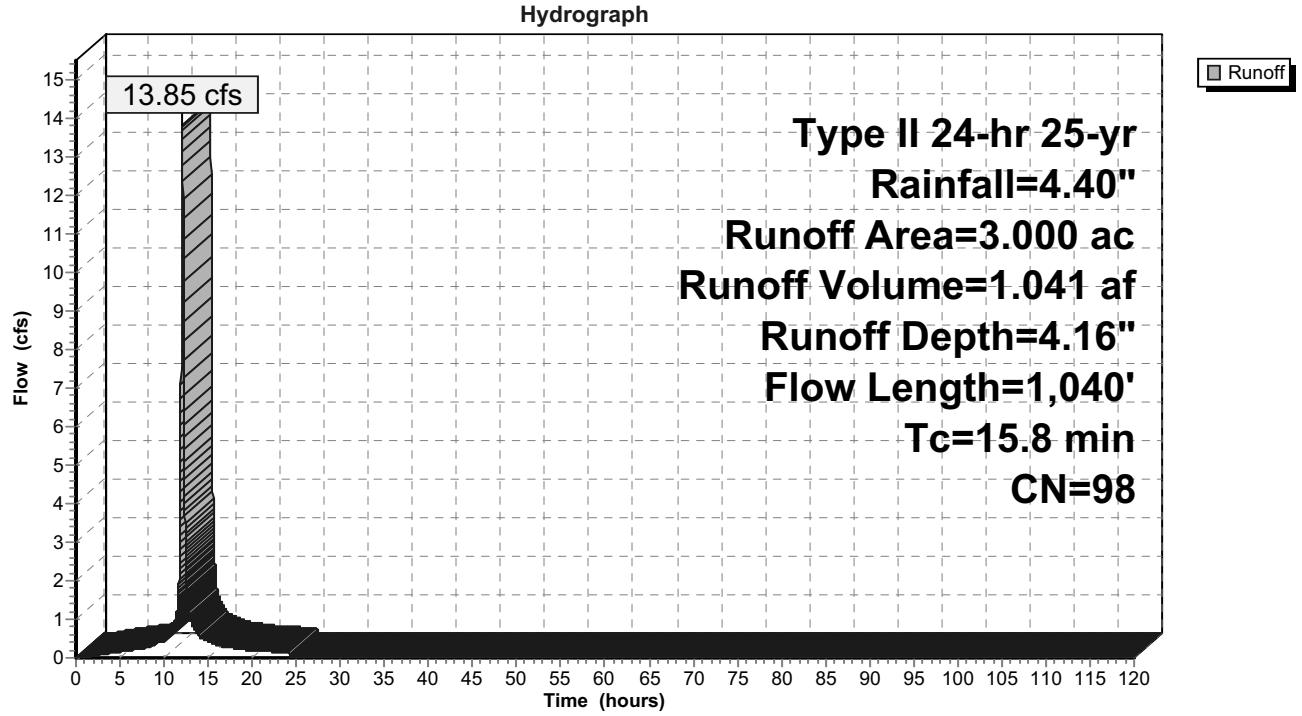
Runoff = 13.85 cfs @ 12.07 hrs, Volume= 1.041 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	3.000	98	Geotubes Cover
	3.000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	300	0.0098	1.15		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.55"
6.5	655	0.0069	1.69		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
5.0	85		0.28		**Direct Entry, Steps**
15.8	1,040	Total			

Subcatchment S3C: Side 3C



Summary for Subcatchment S4A: Top 4

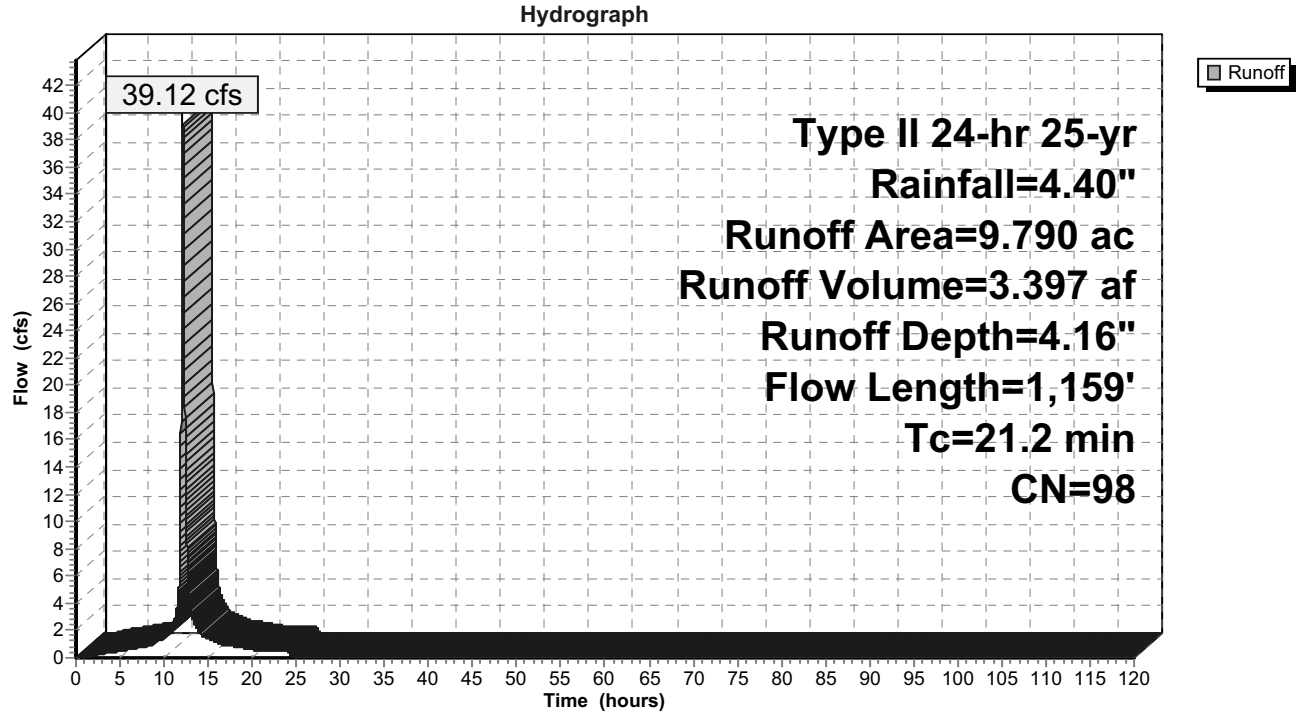
Runoff = 39.12 cfs @ 12.13 hrs, Volume= 3.397 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	9.790	98	Geotubes Cover
	9.790		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	300	0.0043	0.83		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.55"
10.2	774	0.0039	1.27		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
5.0	85		0.28		**Direct Entry, Steps**
21.2	1,159	Total			

Subcatchment S4A: Top 4



Summary for Subcatchment S4B: Side 4B

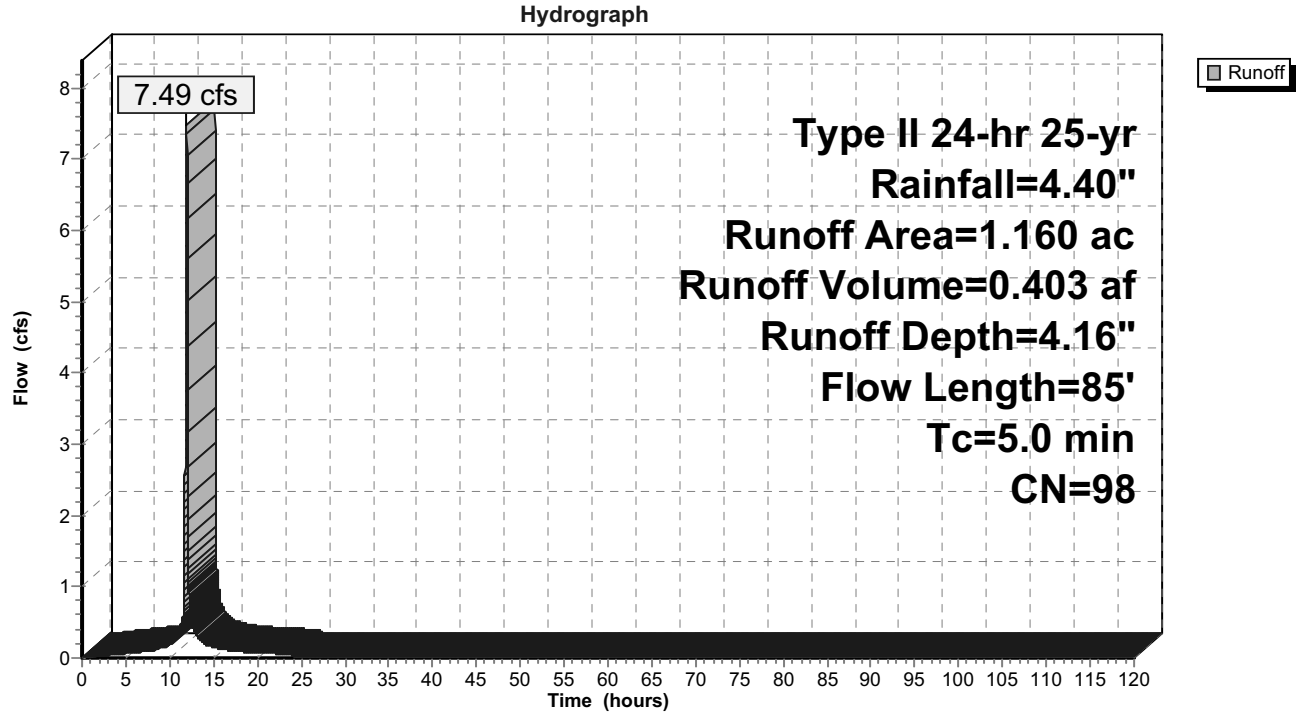
Runoff = 7.49 cfs @ 11.96 hrs, Volume= 0.403 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	1.160	98	Geotubes Cover
	1.160		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	85		0.28		**Direct Entry, Steps**

Subcatchment S4B: Side 4B



Summary for Subcatchment WA: West Area

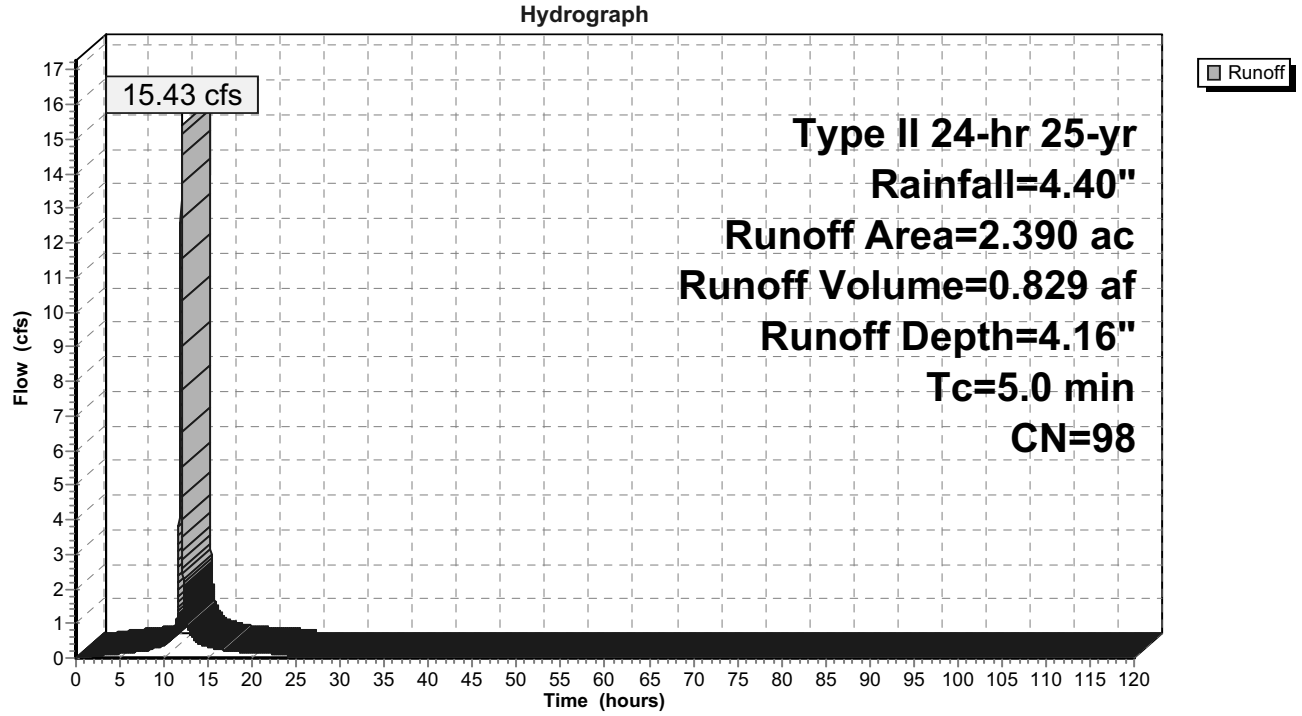
Runoff = 15.43 cfs @ 11.96 hrs, Volume= 0.829 af, Depth= 4.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-yr Rainfall=4.40"

	Area (ac)	CN	Description
*	2.390	98	
	2.390		100.00% Impervious Area

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

Subcatchment WA: West Area



Summary for Reach R1B: Ditch 1B

Inflow Area = 2.370 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 15.30 cfs @ 11.96 hrs, Volume= 0.822 af
Outflow = 8.59 cfs @ 12.03 hrs, Volume= 0.822 af, Atten= 44%, Lag= 4.6 min

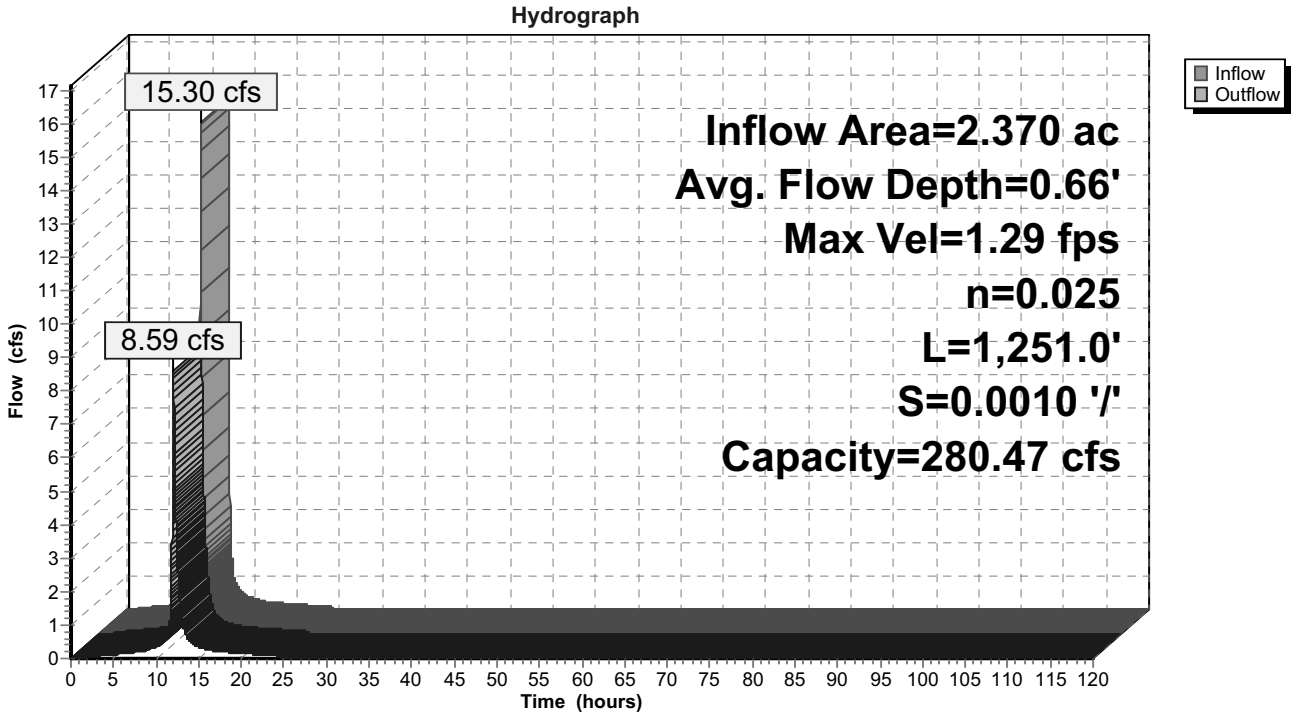
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.29 fps, Min. Travel Time= 16.1 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 19.3 min

Peak Storage= 8,318 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 4.50', Capacity at Bank-Full= 280.47 cfs

Custom stage-perimeter table, n= 0.025
106 Intermediate values determined by Multi-point interpolation
Length= 1,251.0' Slope= 0.0010 '/'
Inlet Invert= 433.30', Outlet Invert= 432.00'

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.50	4.7	11.1	5,896	5.13
1.00	10.9	14.0	13,636	17.68
1.50	18.0	15.9	22,518	37.46
2.00	25.8	17.9	32,276	63.08
2.50	34.3	19.8	42,909	94.80
3.00	43.5	21.8	54,419	132.11
3.50	53.3	23.7	66,678	175.31
4.00	63.9	25.7	79,946	224.75
4.50	75.1	27.6	93,950	280.47

Reach R1B: Ditch 1B



Summary for Reach R1C: Ditch 1C

[61] Hint: Exceeded Reach R1B outlet invert by 0.57' @ 12.03 hrs

Inflow Area = 3.440 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 14.11 cfs @ 11.98 hrs, Volume= 1.194 af
Outflow = 12.67 cfs @ 12.03 hrs, Volume= 1.194 af, Atten= 10%, Lag= 2.8 min

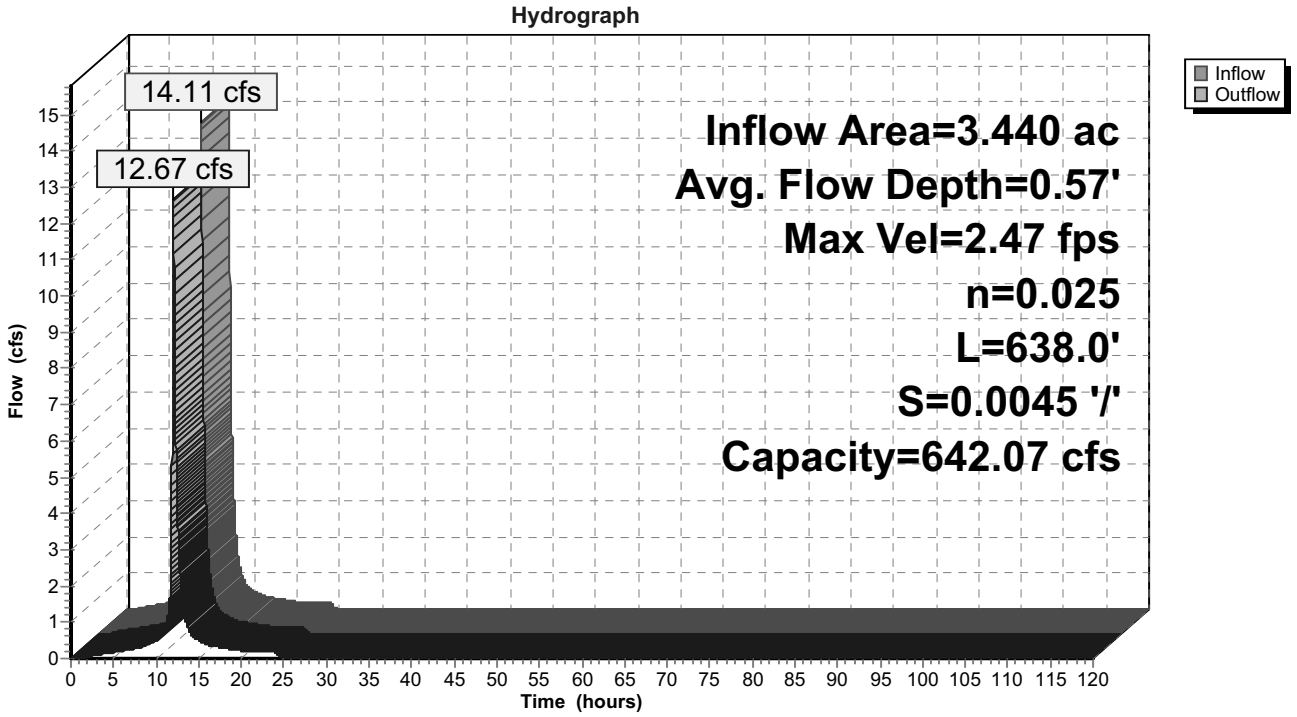
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.47 fps, Min. Travel Time= 4.3 min
Avg. Velocity = 2.25 fps, Avg. Travel Time= 4.7 min

Peak Storage= 3,277 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.57'
Bank-Full Depth= 5.00', Capacity at Bank-Full= 642.07 cfs

Custom stage-perimeter table, n= 0.025
100 Intermediate values determined by Multi-point interpolation
Length= 638.0' Slope= 0.0045 '/'
Inlet Invert= 432.00', Outlet Invert= 429.15'

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.50	4.3	10.1	2,743	9.67
1.00	9.9	12.9	6,316	32.97
1.50	16.4	14.7	10,463	70.08
2.00	23.6	16.6	15,057	118.54
2.50	31.4	18.4	20,033	178.14
3.00	39.8	20.3	25,392	247.68
3.50	48.8	22.1	31,134	328.75
4.00	58.5	23.9	37,323	422.10
4.50	68.8	25.8	43,894	525.60
5.00	79.7	27.6	50,849	642.07

Reach R1C: Ditch 1C



Summary for Reach R2B: Ditch 2B

Inflow Area = 1.050 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 6.78 cfs @ 11.96 hrs, Volume= 0.364 af
Outflow = 4.20 cfs @ 12.03 hrs, Volume= 0.364 af, Atten= 38%, Lag= 4.2 min

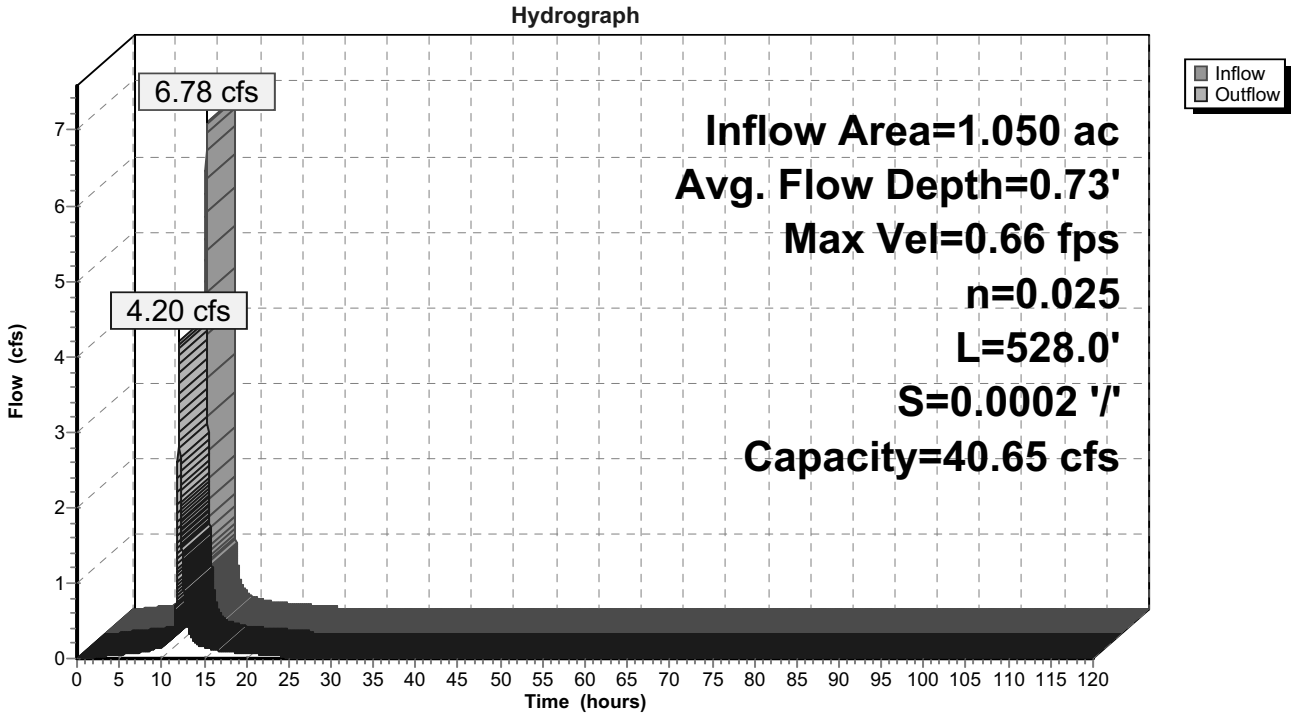
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.66 fps, Min. Travel Time= 13.4 min
Avg. Velocity = 0.52 fps, Avg. Travel Time= 16.9 min

Peak Storage= 3,373 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.73'
Bank-Full Depth= 2.50', Capacity at Bank-Full= 40.65 cfs

Custom stage-perimeter table, n= 0.025
100 Intermediate values determined by Multi-point interpolation
Length= 528.0' Slope= 0.0002 '/'
Inlet Invert= 437.13', Outlet Invert= 437.00'

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.50	3.9	9.4	2,059	2.02
1.00	9.3	12.4	4,910	7.16
1.50	15.8	14.6	8,342	15.53
2.00	22.9	16.4	12,091	26.68
2.50	30.8	18.3	16,262	40.65

Reach R2B: Ditch 2B



Summary for Reach R2C: Ditch 2C

[61] Hint: Exceeded Reach R2B outlet invert by 0.54' @ 12.14 hrs

Inflow Area = 3.730 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 16.18 cfs @ 12.06 hrs, Volume= 1.294 af
Outflow = 13.83 cfs @ 12.14 hrs, Volume= 1.294 af, Atten= 14%, Lag= 4.7 min

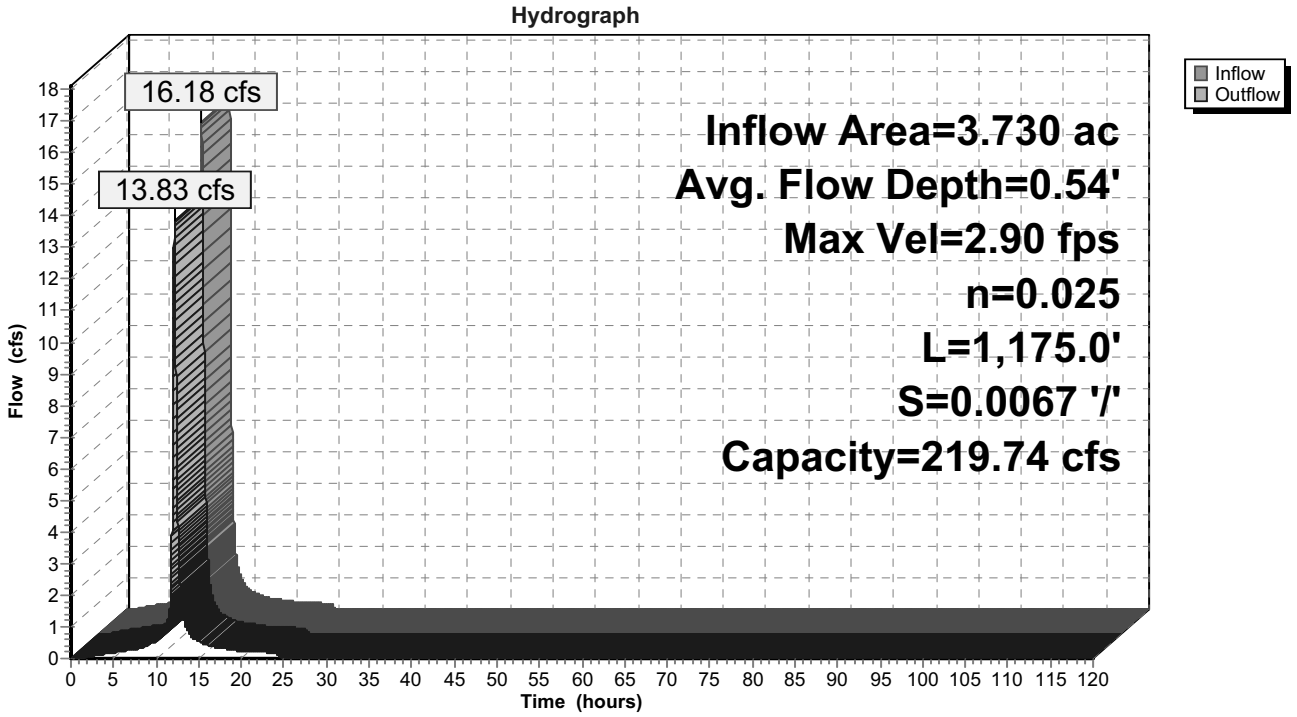
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.90 fps, Min. Travel Time= 6.8 min
Avg. Velocity = 2.75 fps, Avg. Travel Time= 7.1 min

Peak Storage= 5,604 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 2.50', Capacity at Bank-Full= 219.74 cfs

Custom stage-perimeter table, n= 0.025
100 Intermediate values determined by Multi-point interpolation
Length= 1,175.0' Slope= 0.0067 '/'
Inlet Invert= 437.00', Outlet Invert= 429.15'

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.50	4.3	10.1	5,053	11.82
1.00	9.9	13.0	11,633	40.11
1.50	16.6	14.9	19,505	86.67
2.00	23.8	16.7	27,965	146.44
2.50	31.7	18.6	37,248	219.74

Reach R2C: Ditch 2C



Summary for Reach R3B: Ditch 3B

Inflow Area = 1.960 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 12.65 cfs @ 11.96 hrs, Volume= 0.680 af
Outflow = 9.40 cfs @ 12.01 hrs, Volume= 0.680 af, Atten= 26%, Lag= 3.3 min

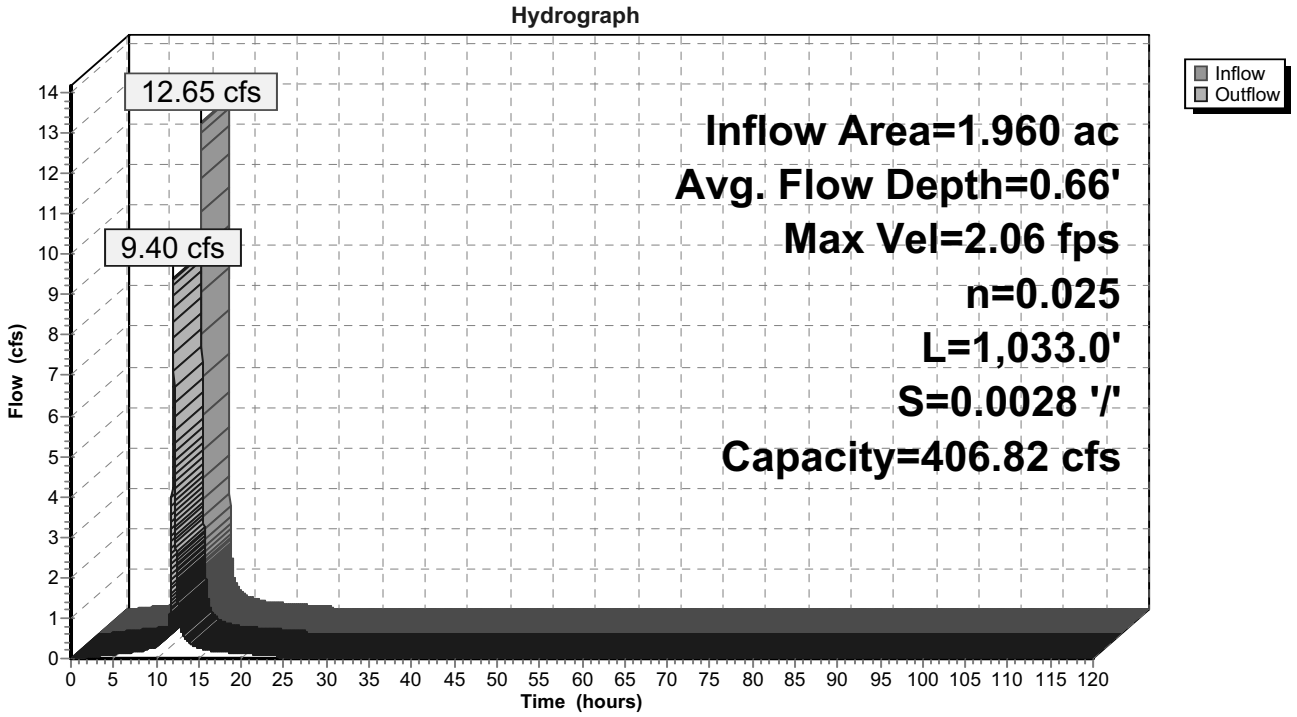
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.06 fps, Min. Travel Time= 8.3 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 10.0 min

Peak Storage= 4,709 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 4.50', Capacity at Bank-Full= 406.82 cfs

Custom stage-perimeter table, n= 0.025
106 Intermediate values determined by Multi-point interpolation
Length= 1,033.0' Slope= 0.0028 '/'
Inlet Invert= 437.13', Outlet Invert= 434.20'

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.50	3.1	7.7	3,215	5.41
1.00	7.6	10.7	7,851	19.15
1.50	13.4	13.6	13,842	42.00
2.00	20.7	16.3	21,383	76.85
2.50	28.7	18.2	29,647	123.09
3.00	37.4	20.0	38,634	179.71
3.50	46.8	21.9	48,344	245.80
4.00	56.8	23.8	58,680	321.17
4.50	67.4	25.6	69,624	406.82

Reach R3B: Ditch 3B



Summary for Reach R3C: Ditch 3C

[62] Hint: Exceeded Reach R3B OUTLET depth by 0.22' @ 12.26 hrs

Inflow Area = 4.960 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 22.46 cfs @ 12.04 hrs, Volume= 1.721 af
Outflow = 20.36 cfs @ 12.10 hrs, Volume= 1.721 af, Atten= 9%, Lag= 3.5 min

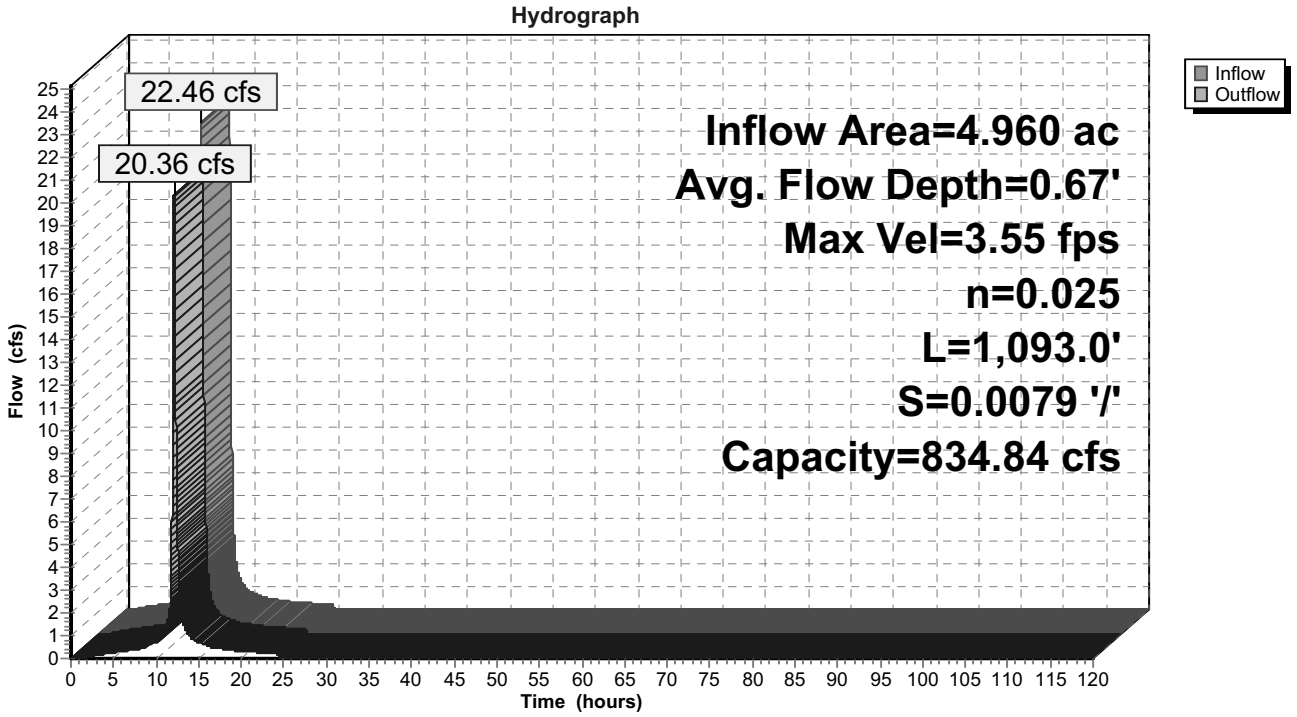
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.55 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 2.94 fps, Avg. Travel Time= 6.2 min

Peak Storage= 6,275 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.67'
Bank-Full Depth= 5.00', Capacity at Bank-Full= 834.84 cfs

Custom stage-perimeter table, n= 0.025
100 Intermediate values determined by Multi-point interpolation
Length= 1,093.0' Slope= 0.0079 '/'
Inlet Invert= 434.20', Outlet Invert= 425.57'

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.50	3.9	9.4	4,263	11.46
1.00	9.2	12.4	10,056	39.82
1.50	15.7	14.4	17,160	87.84
2.00	22.7	16.3	24,811	149.52
2.50	30.4	18.1	33,227	226.87
3.00	38.8	19.9	42,408	319.83
3.50	47.7	21.8	52,136	424.62
4.00	57.3	23.6	62,629	546.71
4.50	67.5	25.5	73,778	682.21
5.00	78.3	27.3	85,582	834.84

Reach R3C: Ditch 3C



Summary for Reach R4B: Ditch 4B

Inflow Area = 1.160 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 7.49 cfs @ 11.96 hrs, Volume= 0.403 af
Outflow = 6.53 cfs @ 11.99 hrs, Volume= 0.403 af, Atten= 13%, Lag= 2.2 min

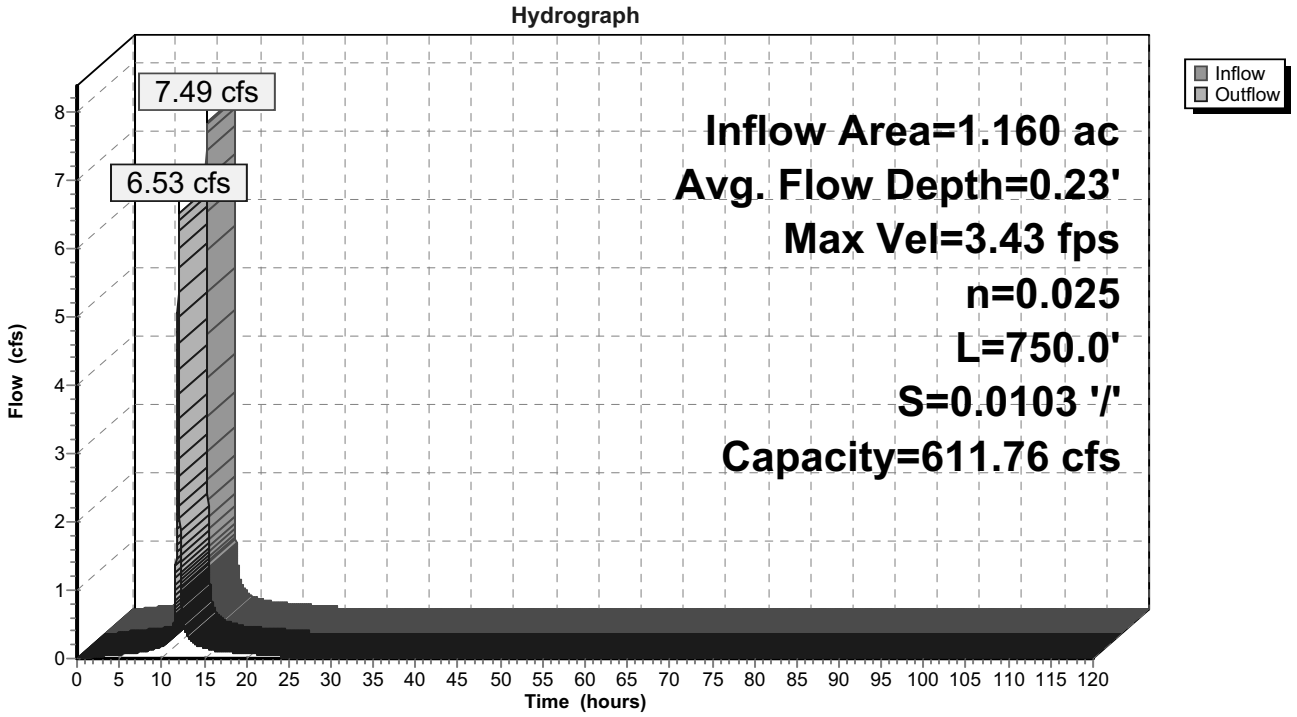
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.43 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 3.43 fps, Avg. Travel Time= 3.6 min

Peak Storage= 1,427 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 611.76 cfs

Custom stage-perimeter table, n= 0.025
104 Intermediate values determined by Multi-point interpolation
Length= 750.0' Slope= 0.0103 '/'
Inlet Invert= 433.30', Outlet Invert= 425.57'

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.0	0	0.00
0.50	4.2	9.8	3,150	14.41
1.00	9.6	12.3	7,200	49.11
1.50	15.8	14.1	11,850	102.86
2.00	22.6	16.0	16,950	171.69
2.50	30.1	17.8	22,575	257.81
3.00	38.2	19.7	28,650	358.45
3.50	46.9	21.5	35,175	476.03
4.00	56.3	23.3	42,225	611.76

Reach R4B: Ditch 4B



Summary for Pond EDB: East Basin

Inflow Area = 33.320 ac,100.00% Impervious, Inflow Depth = 3.76" for 25-yr event
Inflow = 82.79 cfs @ 12.23 hrs, Volume= 10.431 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

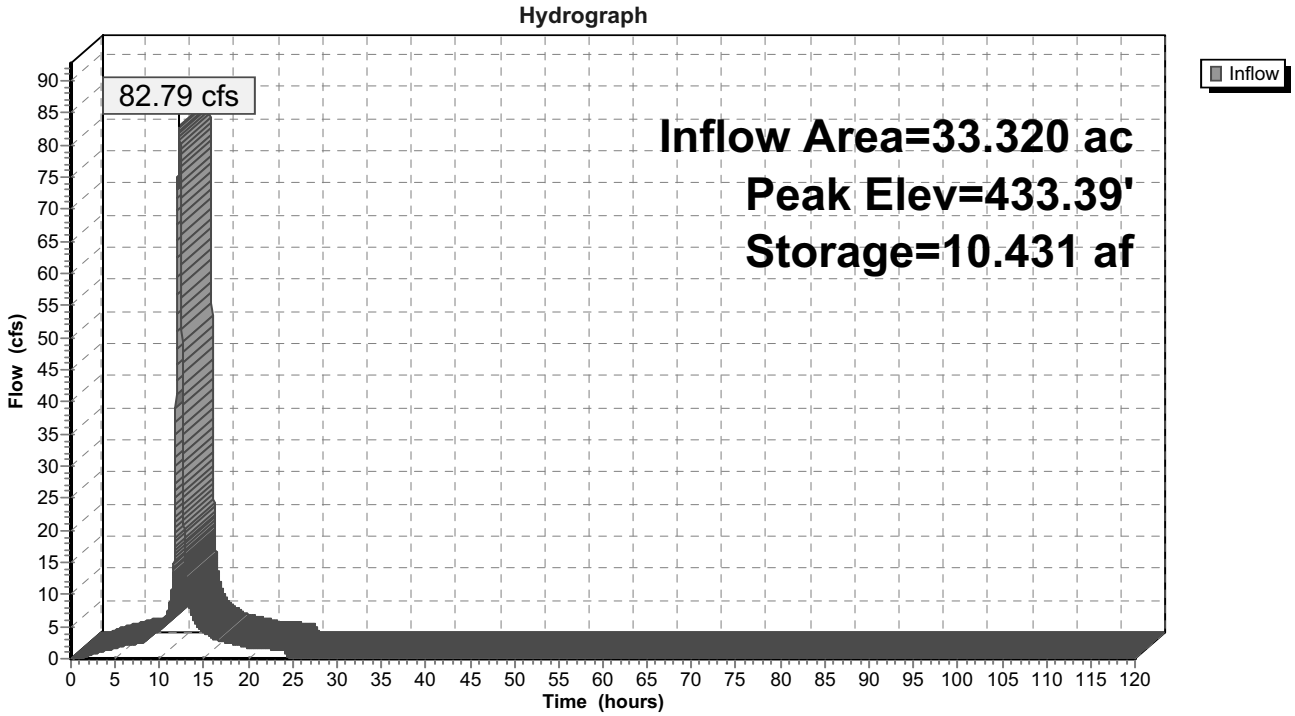
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Peak Elev= 433.39' @ 120.00 hrs Surf.Area= 3.785 ac Storage= 10.431 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	428.00'	12.773 af	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
428.00	0.092	0.000	0.000	0.092
429.00	0.275	0.175	0.175	0.275
430.00	0.559	0.409	0.584	0.559
431.00	2.764	1.522	2.106	2.764
432.00	3.627	3.186	5.292	3.628
433.00	3.740	3.683	8.975	3.746
433.30	3.775	1.127	10.102	3.782
433.50	3.798	0.757	10.860	3.806
434.00	3.856	1.913	12.773	3.866

Pond EDB: East Basin



Summary for Pond TB1: Temp Basin 1

[63] Warning: Exceeded Reach R1C INLET depth by 1.39' @ 26.25 hrs
[62] Hint: Exceeded Reach R2C OUTLET depth by 4.24' @ 26.09 hrs

Inflow Area = 29.460 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 107.51 cfs @ 12.14 hrs, Volume= 10.223 af
Outflow = 79.94 cfs @ 12.23 hrs, Volume= 9.092 af, Atten= 26%, Lag= 5.5 min
Primary = 79.94 cfs @ 12.23 hrs, Volume= 9.092 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Peak Elev= 433.39' @ 26.02 hrs Surf.Area= 0.696 ac Storage= 1.133 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

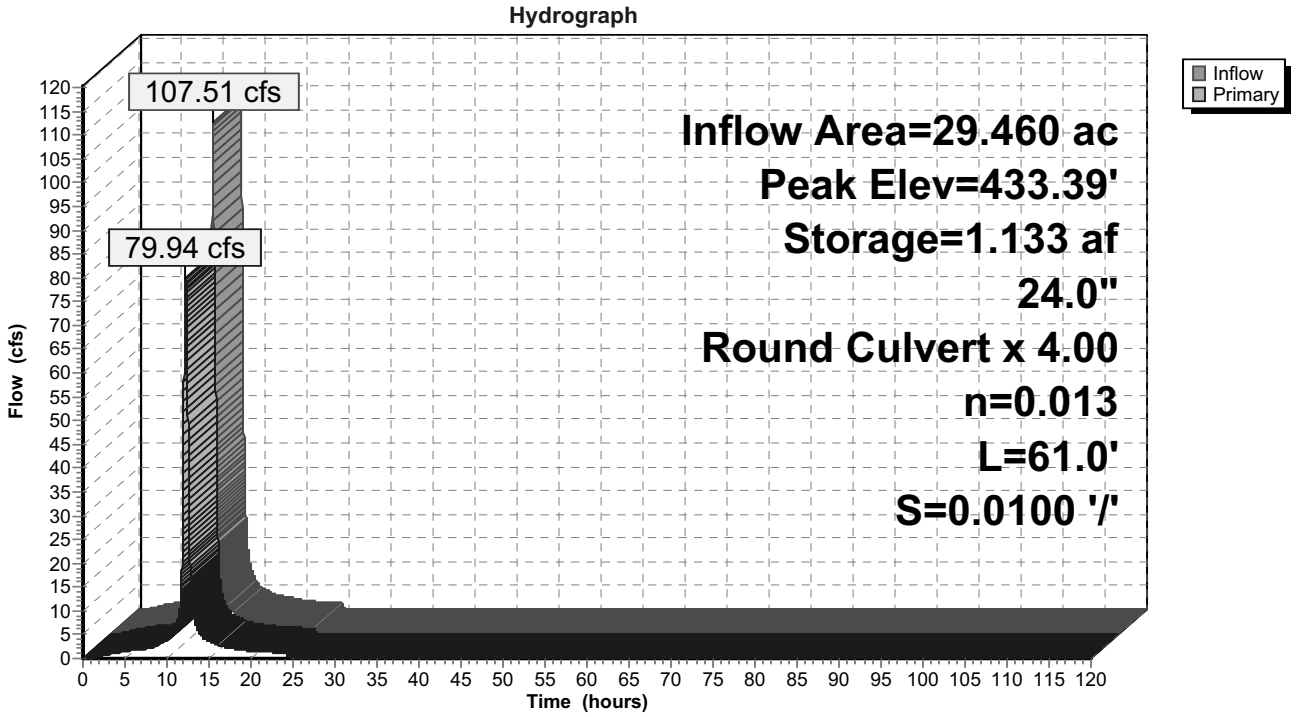
Volume	Invert	Avail.Storage	Storage Description
#1	430.00'	1.633 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
430.00	0.093	0.000	0.000	0.093
431.00	0.204	0.145	0.145	0.204
432.00	0.360	0.278	0.423	0.360
433.00	0.587	0.469	0.892	0.588
433.30	0.638	0.184	1.076	0.639
433.50	0.776	0.141	1.217	0.777
434.00	0.889	0.416	1.633	0.890

Device	Routing	Invert	Outlet Devices
#1	Primary	429.61'	**24.0" Round Culvert X 4.00** L= 61.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 429.61' / 429.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean

Primary OutFlow Max=79.31 cfs @ 12.23 hrs HW=433.17' TW=431.96' (Dynamic Tailwater)
1=Culvert (Outlet Controls 79.31 cfs @ 6.31 fps)

Pond TB1: Temp Basin 1



Summary for Pond TB2: Temp Basin 2

[62] Hint: Exceeded Reach R3C OUTLET depth by 7.57' @ 25.35 hrs
[62] Hint: Exceeded Reach R4B OUTLET depth by 7.57' @ 25.30 hrs

Inflow Area = 34.200 ac,100.00% Impervious, Inflow Depth = 4.16" for 25-yr event
Inflow = 127.80 cfs @ 12.13 hrs, Volume= 11.868 af
Outflow = 91.95 cfs @ 12.22 hrs, Volume= 10.320 af, Atten= 28%, Lag= 5.3 min
Primary = 91.95 cfs @ 12.22 hrs, Volume= 10.320 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Peak Elev= 433.14' @ 25.30 hrs Surf.Area= 0.641 ac Storage= 1.551 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

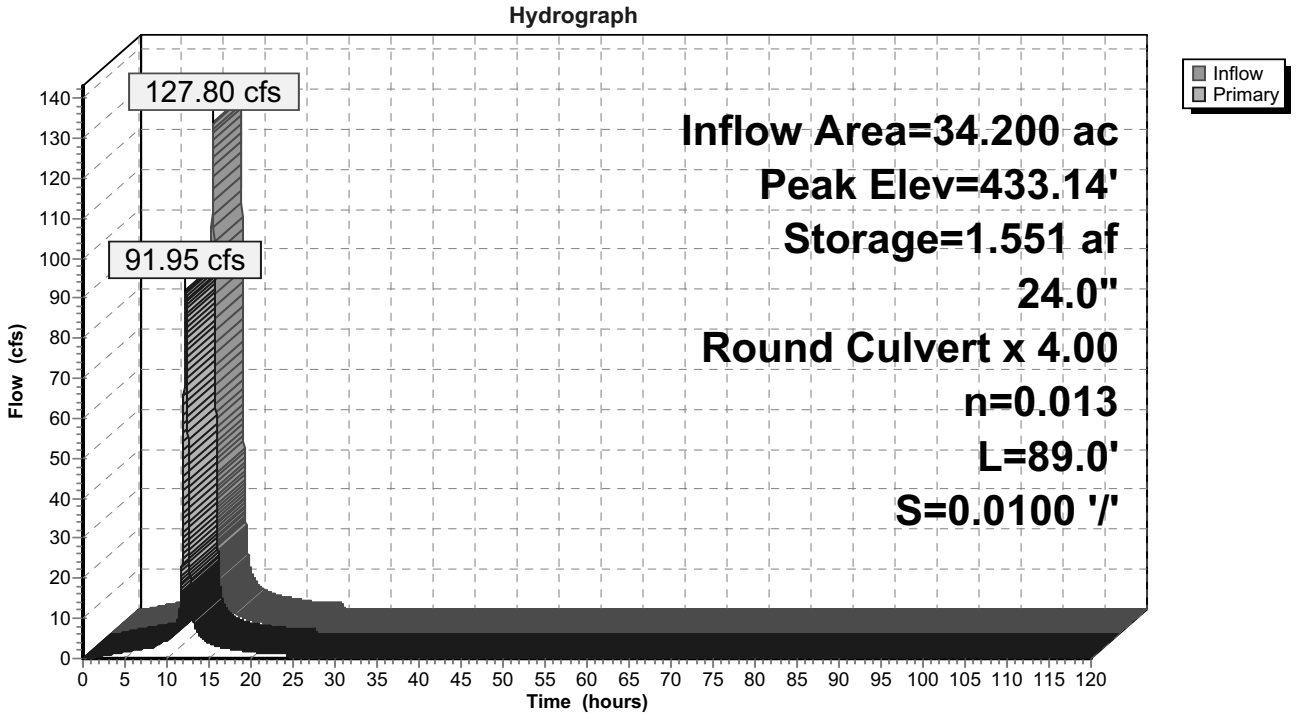
Volume	Invert	Avail.Storage	Storage Description
#1	426.00'	2.184 af	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
426.00	0.003	0.000	0.000	0.003
427.00	0.027	0.013	0.013	0.027
428.00	0.072	0.048	0.061	0.072
429.00	0.135	0.102	0.163	0.135
430.00	0.216	0.174	0.336	0.217
431.00	0.315	0.264	0.600	0.316
432.00	0.417	0.365	0.965	0.419
433.00	0.583	0.498	1.463	0.585
433.30	0.708	0.193	1.656	0.710
433.50	0.725	0.143	1.800	0.727
434.00	0.812	0.384	2.184	0.815

Device	Routing	Invert	Outlet Devices
#1	Primary	424.89'	**24.0" Round Culvert X 4.00** L= 89.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 424.89' / 424.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean

Primary OutFlow Max=91.05 cfs @ 12.22 hrs HW=432.44' TW=430.55' (Dynamic Tailwater)
1=Culvert (Outlet Controls 91.05 cfs @ 7.25 fps)

Pond TB2: Temp Basin 2



Summary for Pond WDB: West Basin

[80] Warning: Exceeded Pond TB2 by 0.01' @ 119.99 hrs (5.13 cfs 29.199 af)

Inflow Area = 36.590 ac,100.00% Impervious, Inflow Depth = 3.66" for 25-yr event
Inflow = 93.75 cfs @ 12.22 hrs, Volume= 11.150 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

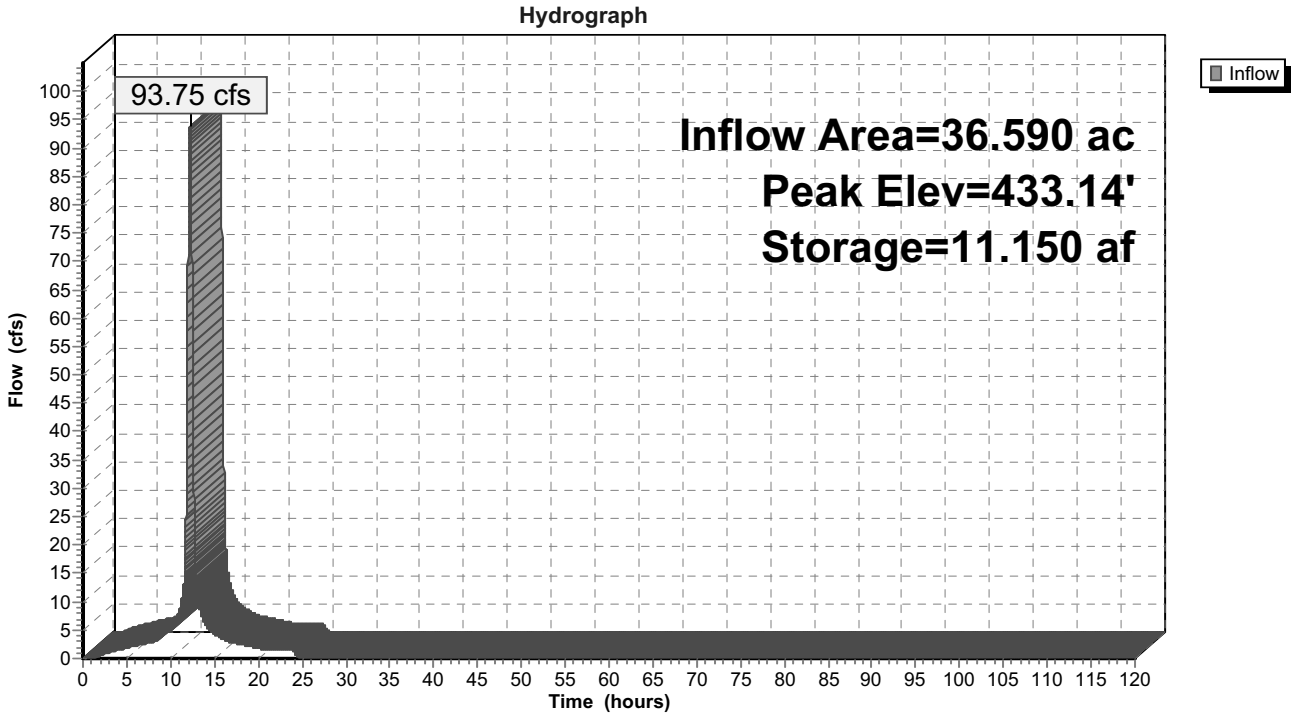
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Peak Elev= 433.14' @ 120.00 hrs Surf.Area= 2.315 ac Storage= 11.150 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	424.00'	13.163 af	**Western Basin Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
424.00	0.020	0.000	0.000	0.020
425.00	0.158	0.078	0.078	0.158
426.00	0.321	0.235	0.313	0.321
427.00	0.601	0.454	0.767	0.602
428.00	0.905	0.748	1.514	0.906
429.00	1.347	1.119	2.633	1.348
430.00	2.036	1.680	4.313	2.038
431.00	2.123	2.079	6.392	2.128
432.00	2.211	2.167	8.559	2.219
433.00	2.302	2.256	10.815	2.314
433.30	2.329	0.695	11.510	2.342
433.50	2.348	0.468	11.978	2.362
434.00	2.394	1.185	13.163	2.410

Pond WDB: West Basin



Attachment 5 – Manning Coefficients

(HydroCAD, 2005)

VALUES OF THE ROUGHNESS COEFFICIENT n
(Boldface figures are values generally recommended in design)

Type of channel and description	Minimum	Normal	Maximum
A. CLOSED CONDUITS FLOWING PARTLY FULL			
A-1. Metal			
a. Brass, smooth	0.009	0.010	0.013
b. Steel			
1. Lockbar and welded	0.010	0.012	0.014
2. Riveted and spiral	0.013	0.016	0.017
c. Cast iron			
1. Coated	0.010	0.013	0.014
2. Uncoated	0.011	0.014	0.016
d. Wrought iron			
1. Black	0.012	0.014	0.015
2. Galvanized	0.013	0.016	0.017
e. Corrugated metal			
1. Subdrain	0.017	0.019	0.021
2. Storm drain	0.021	0.024	0.030
A-2. Nonmetal			
a. Lucite	0.008	0.009	0.010
b. Glass	0.009	0.010	0.013
c. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
d. Concrete			
1. Culvert, straight and free of debris	0.010	0.011	0.013
2. Culvert with bends, connections, and some debris	0.011	0.013	0.014
3. Finished	0.011	0.012	0.014
4. Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
5. Unfinished, steel form	0.012	0.013	0.014
6. Unfinished, smooth wood form	0.012	0.014	0.016
7. Unfinished, rough wood form	0.015	0.017	0.020
e. Wood			
1. Stave	0.010	0.012	0.014
2. Laminated, treated	0.015	0.017	0.020
f. Clay			
1. Common drainage tile	0.011	0.013	0.017
2. Vitrified sewer	0.011	0.014	0.017
3. Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
4. Vitrified subdrain with open joint	0.014	0.016	0.018
g. Brickwork			
1. Glazed	0.011	0.013	0.015
2. Lined with cement mortar	0.012	0.015	0.017
h. Sanitary sewers coated with sewage slimes, with bends and connections	0.012	0.013	0.016
i. Paved invert, sewer, smooth bottom	0.016	0.019	0.020
j. Rubble masonry, cemented	0.018	0.025	0.030

VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
B. LINED OR BUILT-UP CHANNELS			
B-1. Metal			
a. Smooth steel surface			
1. Unpainted	0.011	0.012	0.014
2. Painted	0.012	0.013	0.017
b. Corrugated	0.021	0.025	0.030
B-2. Nonmetal			
a. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
b. Wood			
1. Planed, untreated	0.010	0.012	0.014
2. Planed, creosoted	0.011	0.012	0.015
3. Unplaned	0.011	0.013	0.015
4. Plank with battens	0.012	0.015	0.018
5. Lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. Trowel finish	0.011	0.013	0.015
2. Float finish	0.013	0.015	0.016
3. Finished, with gravel on bottom	0.015	0.017	0.020
4. Unfinished	0.014	0.017	0.020
5. Gunite, good section	0.016	0.019	0.023
6. Gunite, wavy section	0.018	0.022	0.025
7. On good excavated rock	0.017	0.020	
8. On irregular excavated rock	0.022	0.027	
d. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
5. Dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone in mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. Glazed	0.011	0.013	0.015
2. In cement mortar	0.012	0.015	0.018
g. Masonry			
1. Cemented rubble	0.017	0.025	0.030
2. Dry rubble	0.023	0.032	0.035
h. Dressed ashlar	0.013	0.015	0.017
i. Asphalt			
1. Smooth	0.013	0.013	
2. Rough	0.016	0.016	
j. Vegetal lining	0.030	.....	0.500

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

VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Dense willows, summer, straight	0.110	0.150	0.200
2. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.100	0.120	0.160
D-3. Major streams (top width at flood stage >100 ft). The n value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	.....	0.060
b. Irregular and rough section	0.035	.....	0.100

APPENDIX K.2

FINAL COVER SYSTEM SURFACE MANAGEMENT SYSTEM DESIGN

(This appendix will be included in the Closure Design)