Big Rivers
ELECTRIC CORPORATION

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Green Station CCR Surface Impoundment

Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule
Hydrologic and Hydraulic Capacity Assessment and
Initial Inflow Design Flood Control System Plan

October 11, 2016

Prepared By:

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

Project ID: 160028B

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CCR Surface Impoundment Information

Name:	Green Station CCR Surface Impoundment
Operator:	Sebree Generating Station
Address:	9000 Highway 2096 Robards, Kentucky 42452
CCR Unit Identification Number:	Kentucky State Dam Inventory System ID No. 0855

Qualified Professional Engineer

Name:	David A. Lamb
Company:	Associated Engineers, Inc.
Kentucky P.E. Number:	17822

Regulatory Applicability

As part of the § 257.82 Hydrologic and hydraulic capacity requirements for CCR surface impoundments, an owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified below. The owner or operator of the CCR unit must prepare the initial inflow design flood control system plan no later than October 17, 2016. The hazard potential classification definitions (from: VI. Development of the Final Rule - Technical Requirements) that must be considered follow:

- High hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation will probably cause loss of human life

- Significant hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

- Low hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment's owner's property.

1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in item 3) of this section.

2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified item 3) of this section.

3) The inflow design flood is:

   (i) For a high hazard potential CCR surface impoundment the inflow design flood is the probable maximum flood;

   (ii) For a significant hazard potential CCR surface impoundment the inflow design flood is the 1,000-year flood;

   (iii) For a low hazard potential CCR surface impoundment the inflow design flood is the 100-year flood;

   (iv) For an incised CCR surface impoundment the inflow design flood is the 25-year flood.

Discharge from the CCR unit must be handled in accordance with the surface water requirements under § 257.3-3 (Part 257 - Criteria for Classification of Solid Waste Disposal Facilities and Practices Subpart A - Classification of Solid Waste Disposal Facilities and Practices Section 257.3-3 - Surface water).

Inflow design flood control system Plan:

1) *Content of the plan.* The owner or operator must prepare an initial inflow design flood control system plan that must document how the inflow design flood control system has been designed and constructed to meet the requirements of this section. Each plan must be supported by appropriate engineering calculations.

2) *Amendment of the plan.* The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record. The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

Description of Impoundment

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years and is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 54.13 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The Green River is located approximately 400 feet east of the structure. Due to surface relief, only the toe area of the south dike is potentially subject to flooding. The predominant features were small stream valleys draining eastward to the Green River. Most of the central portion of the south dike was constructed on a subdued ridge. The toe of the outboard slope intersected a lower drainage area. Underlying preconstruction soils consisted of Loring-Grenada, Loring-Zanesville-Wellston (Henderson County) and Loring-Wellston-Zanesville (Webster County) soil associations which are generally characterized as well drained to moderately well drained soils on nearly level to sloping uplands.

The west dike is generally less than five feet in height and the south dike reaches a maximum height of 19.5 feet. The east dike reaches a maximum height of approximately eight feet and is buttressed with a secondary parallel embankment that serves as a 40-foot wide roadway. The Burns and Roe, Inc. Engineering and Consultants June 30, 1978 site grading plans show the original construction layout and ground contours for the impoundment site. Bottom ash has been placed above the normal pool along the inboard side, essentially creating reclaimed land

Depth of impounded water and CCR is 16 feet and 46 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 394 feet and 408 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 172,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 981,000 cubic yards (approximate water volume is 172,000 cubic yards and approximate CCR volume is 809,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.

The impoundment discharge consists of two corrugated steel pipes, each 30 inches in diameter. The pipe intakes are through a concrete common headwall collection structure with a variable height steel debris deflector on each pipe intake.

Inflow Design Flood Control System Plan

The initial inflow design flood control system plan documents that the inflow design flood control system has been designed and constructed to meet the storm generated discharge requirements for a Significant hazard potential CCR surface impoundment which means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. The inflow design flood for a Significant hazard potential CCR surface impoundment is the 1,000-year flood.

Analysis via HydroCAD Stormwater Modeling software of the of the Green CCR impoundment site drainage demonstrates that the design flood control system adequately manages inflow and discharge out of the CCR unit during and following the specified 1,000-year/24-hour storm event. HydroCAD Stormwater Modeling by HydroCAD Software Solutions, LLC is a widely recognized comprehensive hydrology and hydraulics software for use by Civil Engineers, useful for runoff and sediment control design calculations. The HydroCAD modeling results for the Green CCR impoundment are attached to this report.

The operating facility has verified that discharge from the Green CCR impoundment is handled in accordance with the surface water requirements under § 257.3-3 (Part 257 - Criteria for Classification of Solid Waste Disposal Facilities and Practices Subpart A - Classification of Solid Waste Disposal Facilities and Practices Section 257.3-3 - Surface water).

Sources of Information

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

Professional Engineer Certification [Per 40 CFR § 257.82]
Green CCR Impoundment Initial Inflow Design Flood Control System Plan

I hereby certify that myself or an agent under my review has prepared this Initial Inflow Design Flood Control System Plan (Plan), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Plan has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.82. To the best of my knowledge and belief, the information contained in this Plan is true, complete, and accurate.

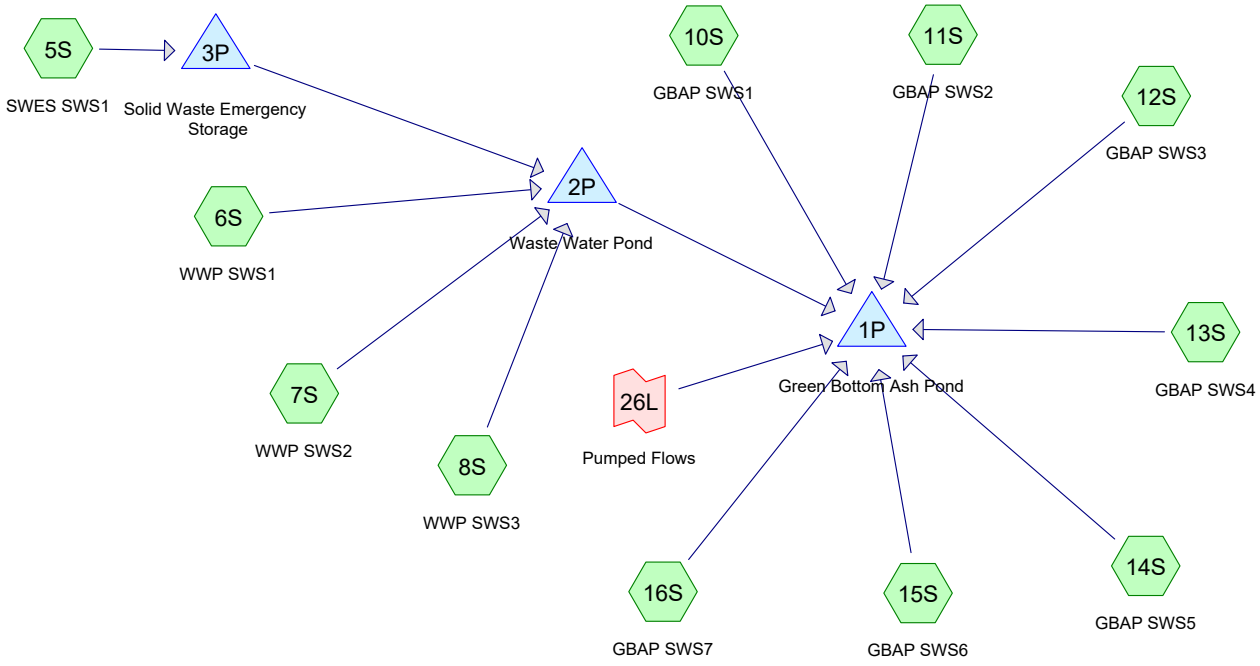
David A. Lamb P.E.

State of Kentucky License No. 17822

Date: 10/11/16

Attachment A. Aerial Photo of the Green CCR Surface Impoundment

Attachment B. Topographic Map showing the Green CCR Surface Impoundment



Subcat Reach Pond Link

Routing Diagram for Green Impoundment NO REACHES
Prepared by Associated Engineers, Inc., Printed 10/7/2016

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.860	91	(5S)
20.620	98	(6S, 10S, 11S, 12S, 13S)
2.230	74	(7S)
1.150	94	(8S)
0.830	86	(14S)
6.380	88	(15S)
22.060	99	(16S)
54.130	**96**	**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 5S: SWES SWS1 Runoff Area=0.860 ac 0.00% Impervious Runoff Depth=9.20"
Flow Length=39' Slope=0.0513 '/' Tc=5.0 min CN=91 Runoff=12.76 cfs 0.659 af

Subcatchment 6S: WWP SWS1 Runoff Area=1.690 ac 100.00% Impervious Runoff Depth=10.06"
Flow Length=741' Slope=0.0027 '/' Tc=14.8 min CN=98 Runoff=18.93 cfs 1.417 af

Subcatchment 7S: WWP SWS2 Runoff Area=2.230 ac 0.00% Impervious Runoff Depth=7.03"
Flow Length=432' Slope=0.0046 '/' Tc=7.1 min CN=74 Runoff=25.99 cfs 1.306 af

Subcatchment 8S: WWP SWS3 Runoff Area=1.150 ac 0.00% Impervious Runoff Depth=9.57"
Flow Length=500' Tc=5.0 min CN=94 Runoff=17.30 cfs 0.917 af

Subcatchment 10S: GBAP SWS1 Runoff Area=10.390 ac 100.00% Impervious Runoff Depth=10.06"
Flow Length=1,031' Tc=8.0 min CN=98 Runoff=143.60 cfs 8.709 af

Subcatchment 11S: GBAP SWS2 Runoff Area=2.400 ac 100.00% Impervious Runoff Depth=10.06"
Flow Length=553' Slope=0.0253 '/' Tc=5.0 min CN=98 Runoff=36.46 cfs 2.012 af

Subcatchment 12S: GBAP SWS3 Runoff Area=4.500 ac 100.00% Impervious Runoff Depth=10.06"
Flow Length=460' Slope=0.0130 '/' Tc=5.0 min CN=98 Runoff=68.36 cfs 3.772 af

Subcatchment 13S: GBAP SWS4 Runoff Area=1.640 ac 100.00% Impervious Runoff Depth=10.06"
Flow Length=782' Slope=0.0077 '/' Tc=9.2 min CN=98 Runoff=21.80 cfs 1.375 af

Subcatchment 14S: GBAP SWS5 Runoff Area=0.830 ac 0.00% Impervious Runoff Depth=8.57"
Flow Length=761' Slope=0.0079 '/' Tc=9.5 min CN=86 Runoff=10.29 cfs 0.593 af

Subcatchment 15S: GBAP SWS6 Runoff Area=6.380 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=401' Slope=0.0324 '/' Tc=5.0 min CN=88 Runoff=92.91 cfs 4.693 af

Subcatchment 16S: GBAP SWS7 Runoff Area=22.060 ac 100.00% Impervious Runoff Depth=10.18"
Flow Length=500' Tc=5.0 min CN=99 Runoff=335.43 cfs 18.714 af

Pond 1P: Green Bottom Ash Pond Peak Elev=395.48' Storage=44.325 af Inflow=711.21 cfs 79.622 af
Outflow=24.86 cfs 42.278 af

Pond 2P: Waste Water Pond Peak Elev=394.08' Storage=3.155 af Inflow=59.13 cfs 4.081 af
Outflow=1.44 cfs 1.363 af

Pond 3P: Solid Waste Emergency Storage Peak Elev=396.18' Storage=0.389 af Inflow=12.76 cfs 0.659 af
Outflow=2.49 cfs 0.442 af

Link 26L: Pumped Flows Manual Hydrograph Inflow=12.90 cfs 38.391 af
Primary=12.90 cfs 38.391 af

Total Runoff Area = 54.130 ac Runoff Volume = 44.167 af Average Runoff Depth = 9.79"
21.15% Pervious = 11.450 ac 78.85% Impervious = 42.680 ac

Summary for Subcatchment 5S: SWES SWS1

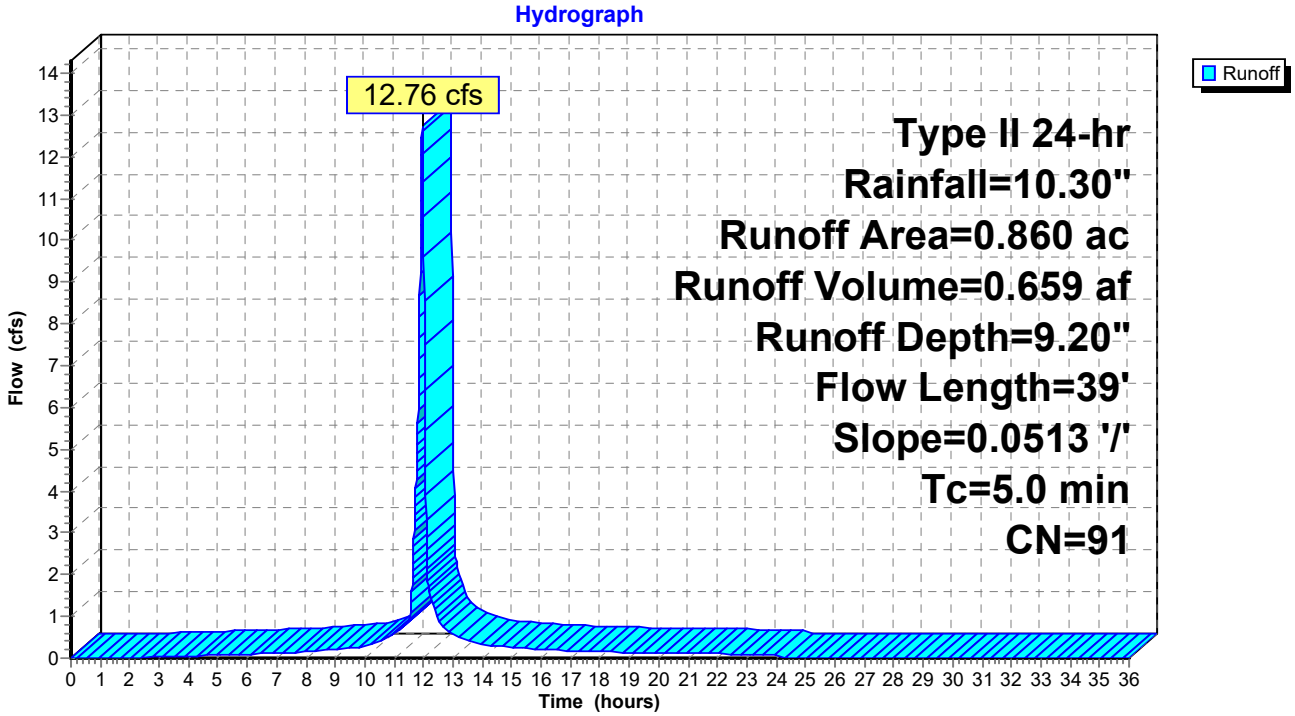
Runoff = 12.76 cfs @ 11.96 hrs, Volume= 0.659 af, Depth= 9.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	0.860	91	
	0.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	39	0.0513	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.28"
3.1	39	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 5S: SWES SWS1



Summary for Subcatchment 6S: WWP SWS1

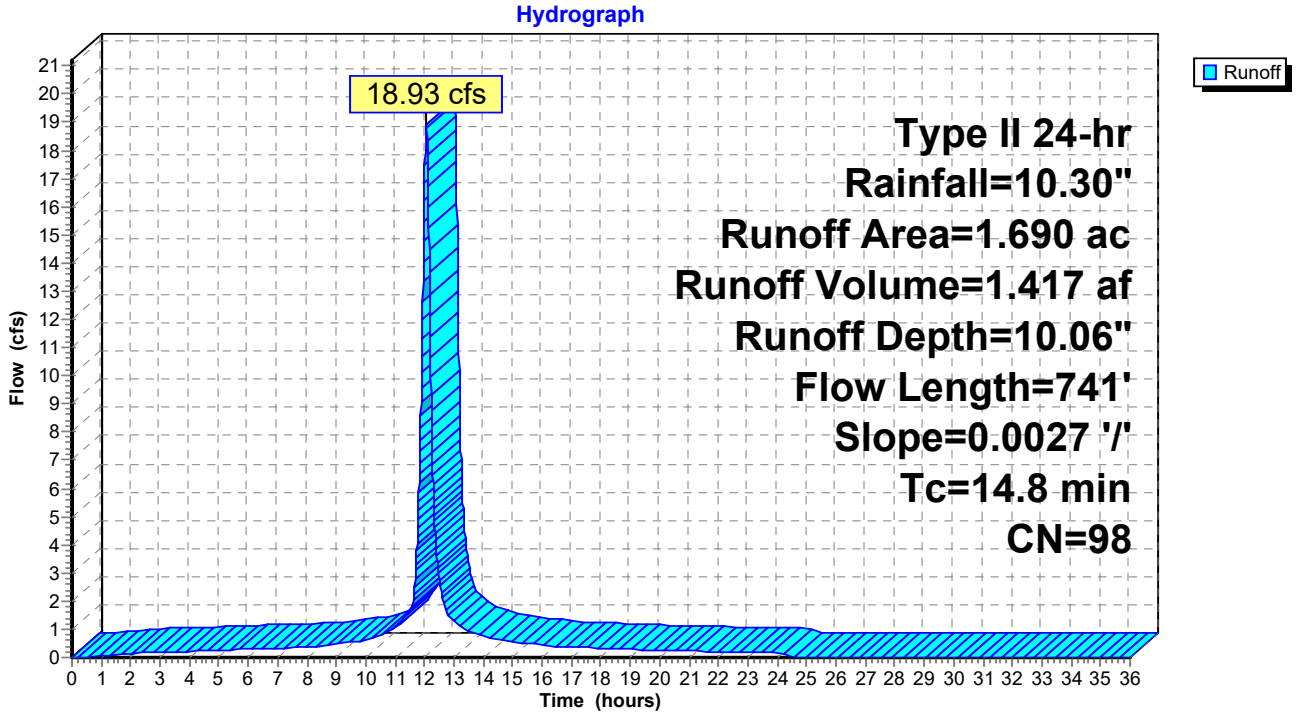
Runoff = 18.93 cfs @ 12.06 hrs, Volume= 1.417 af, Depth=10.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	1.690	98	
	1.690		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	741	0.0027	0.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps

Subcatchment 6S: WWP SWS1



Summary for Subcatchment 7S: WWP SWS2

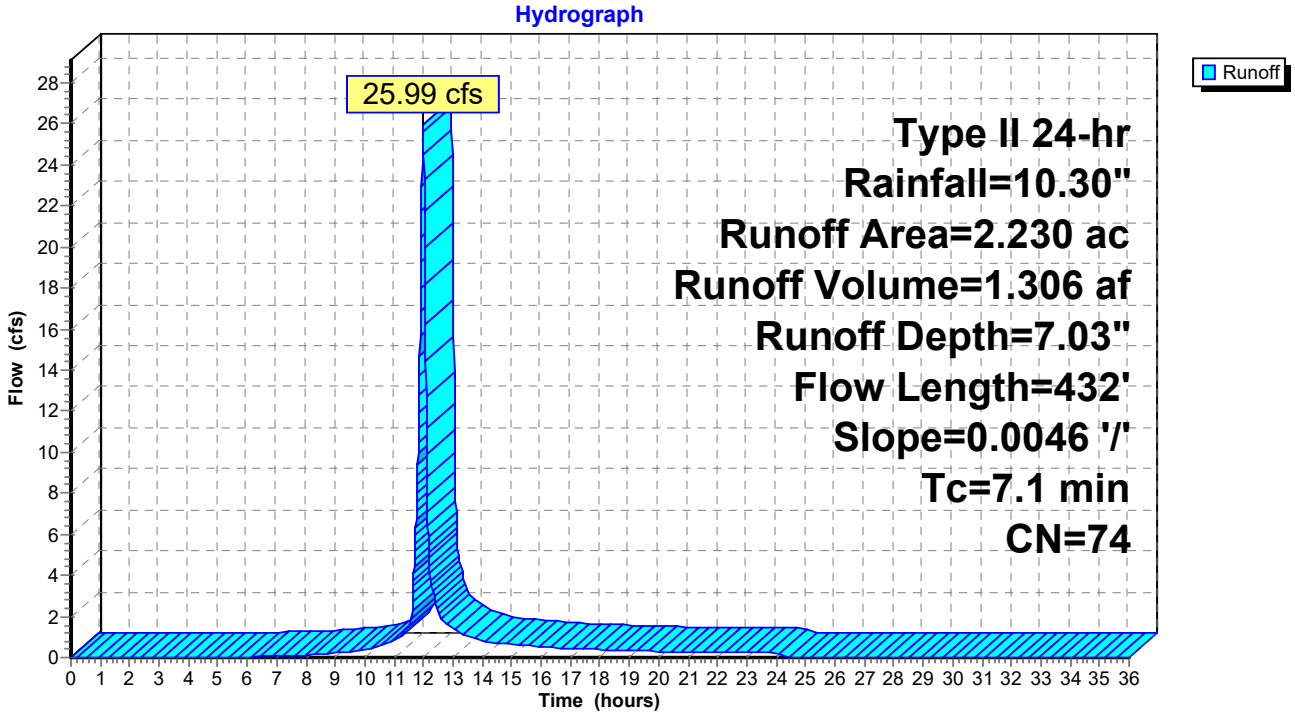
Runoff = 25.99 cfs @ 11.98 hrs, Volume= 1.306 af, Depth= 7.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	2.230	74	
	2.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	432	0.0046	1.02		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps

Subcatchment 7S: WWP SWS2



Summary for Subcatchment 8S: WWP SWS3

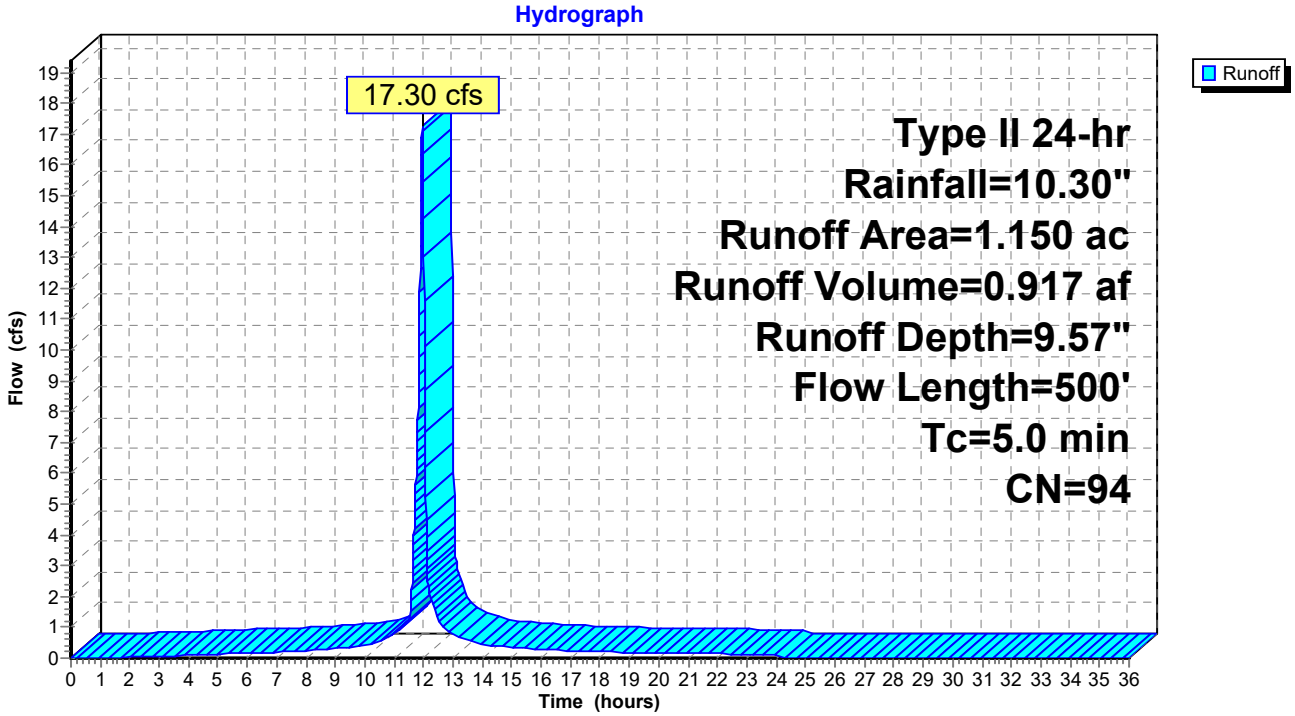
Runoff = 17.30 cfs @ 11.96 hrs, Volume= 0.917 af, Depth= 9.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	1.150	94	
	1.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	500		5.67		**Lake or Reservoir,** Mean Depth= 1.00'
1.5	500	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 8S: WWP SWS3



Summary for Subcatchment 10S: GBAP SWS1

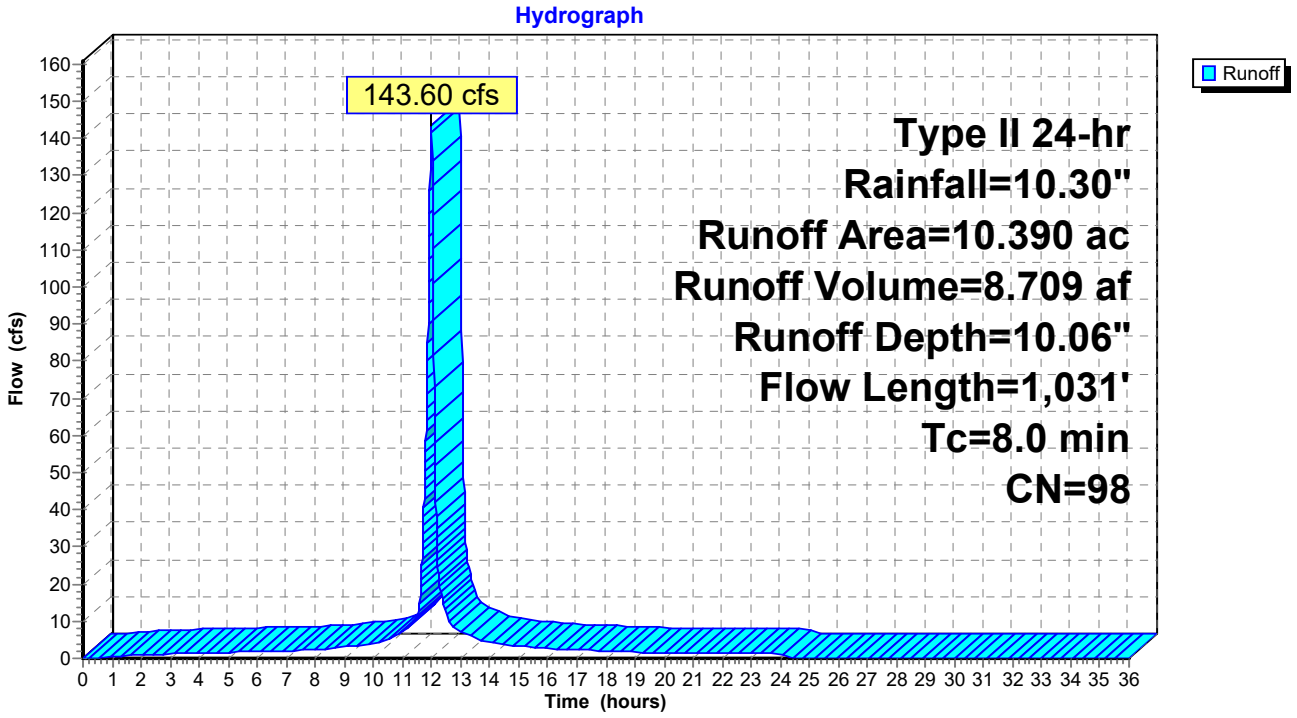
Runoff = 143.60 cfs @ 11.99 hrs, Volume= 8.709 af, Depth=10.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	10.390	98	
	10.390		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	493	0.0345	2.99		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.3	538	0.0112	1.70		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.0	1,031	Total			

Subcatchment 10S: GBAP SWS1



Summary for Subcatchment 11S: GBAP SWS2

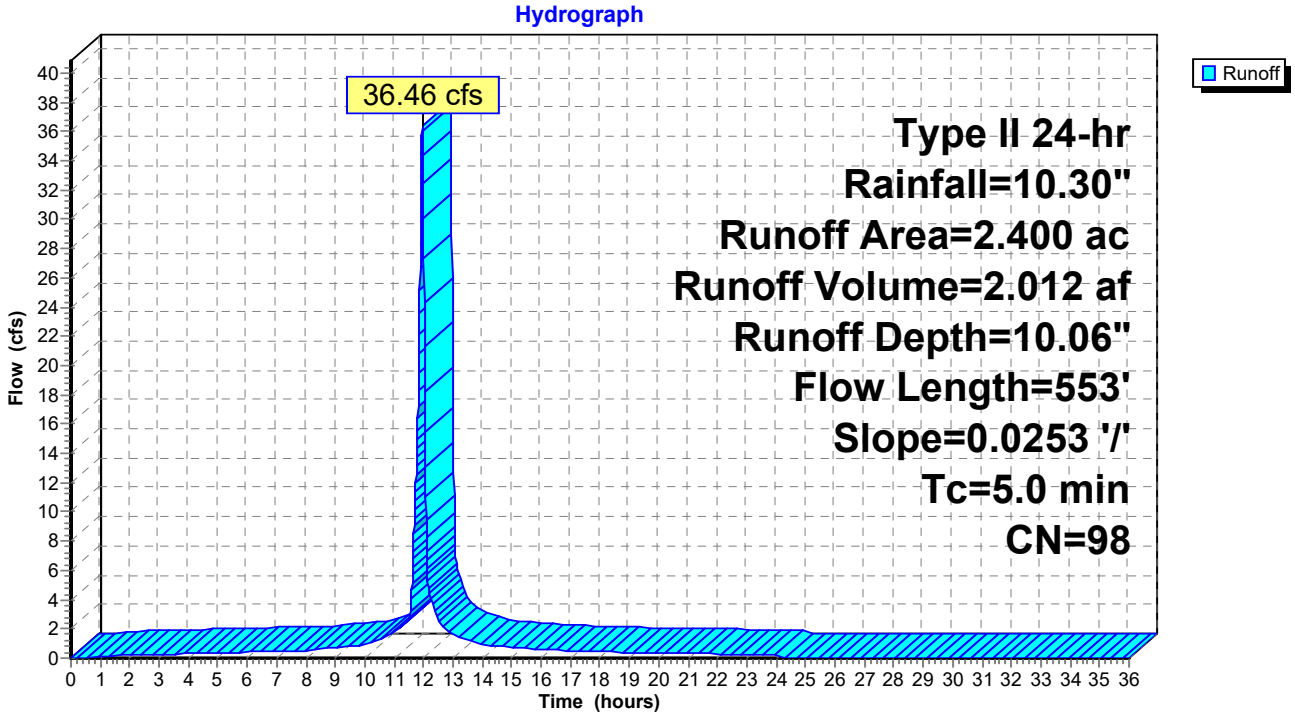
Runoff = 36.46 cfs @ 11.96 hrs, Volume= 2.012 af, Depth=10.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	2.400	98	
	2.400		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	553	0.0253	2.56		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.6	553	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 11S: GBAP SWS2



Summary for Subcatchment 12S: GBAP SWS3

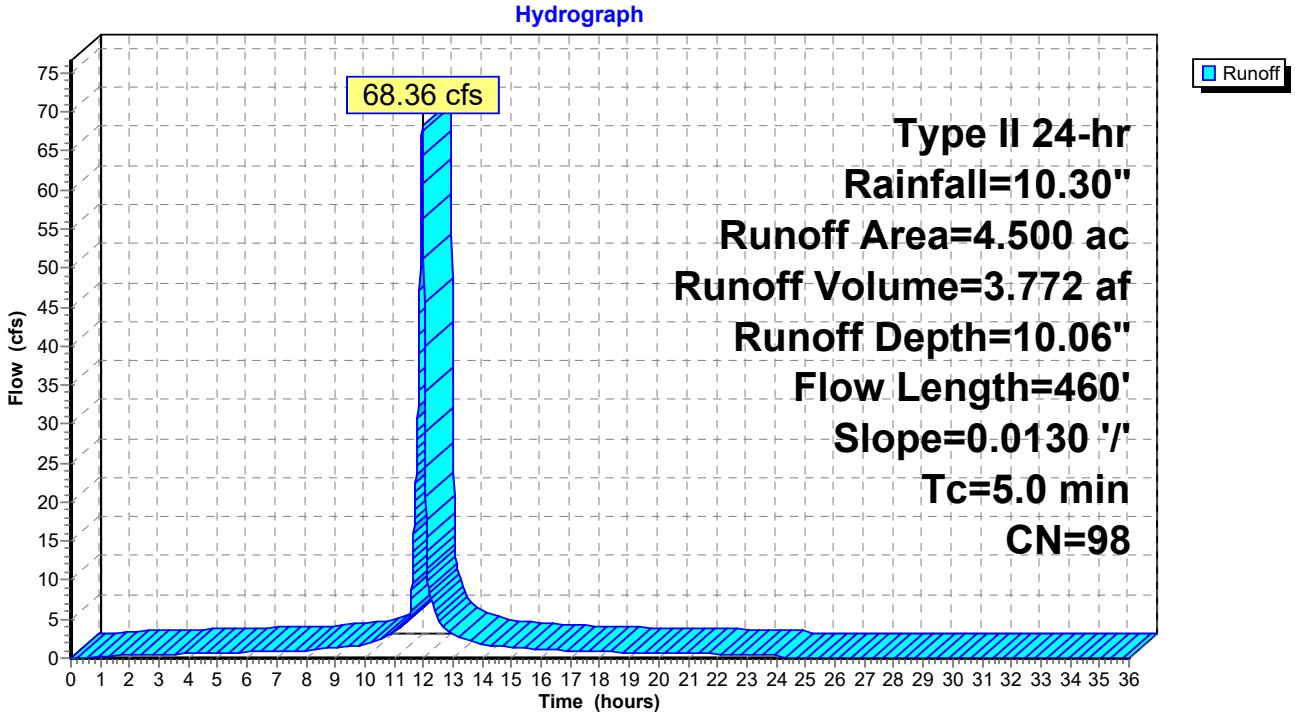
Runoff = 68.36 cfs @ 11.96 hrs, Volume= 3.772 af, Depth=10.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	4.500	98	
	4.500		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	460	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	460	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 12S: GBAP SWS3



Summary for Subcatchment 13S: GBAP SWS4

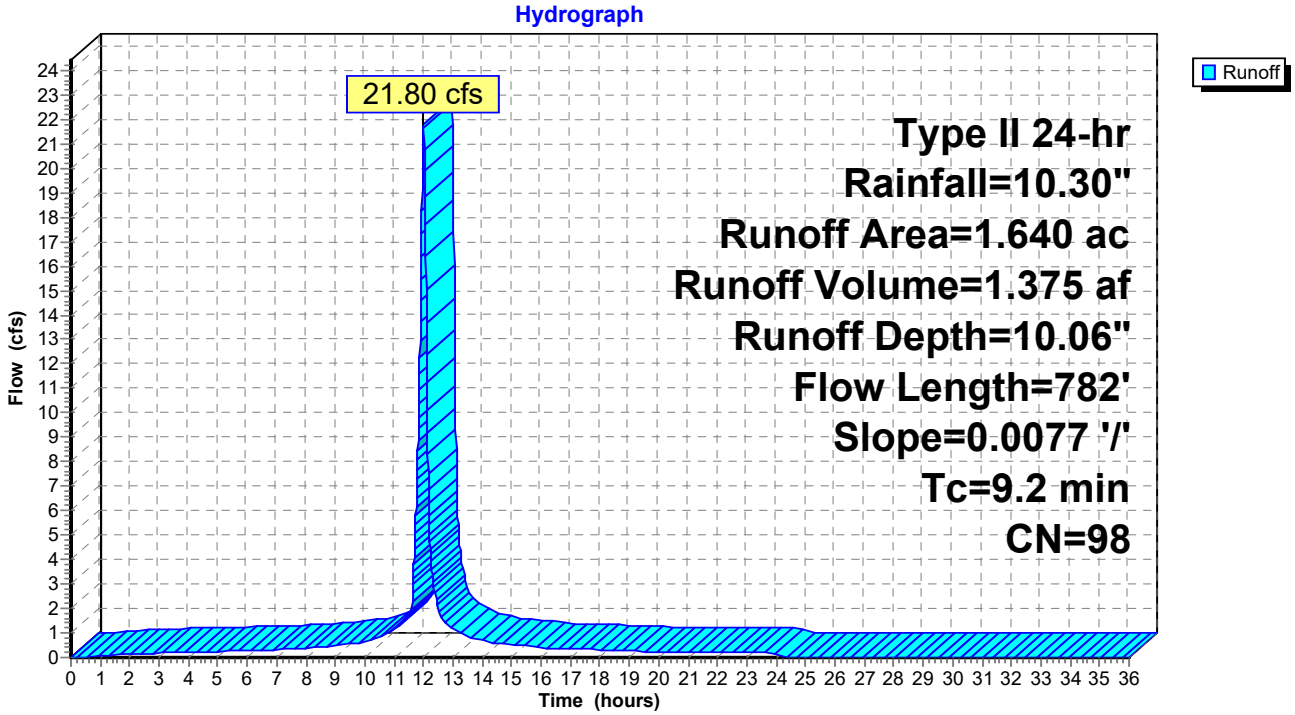
Runoff = 21.80 cfs @ 12.00 hrs, Volume= 1.375 af, Depth=10.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	1.640	98	
	1.640		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	782	0.0077	1.41		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps

Subcatchment 13S: GBAP SWS4



Summary for Subcatchment 14S: GBAP SWS5

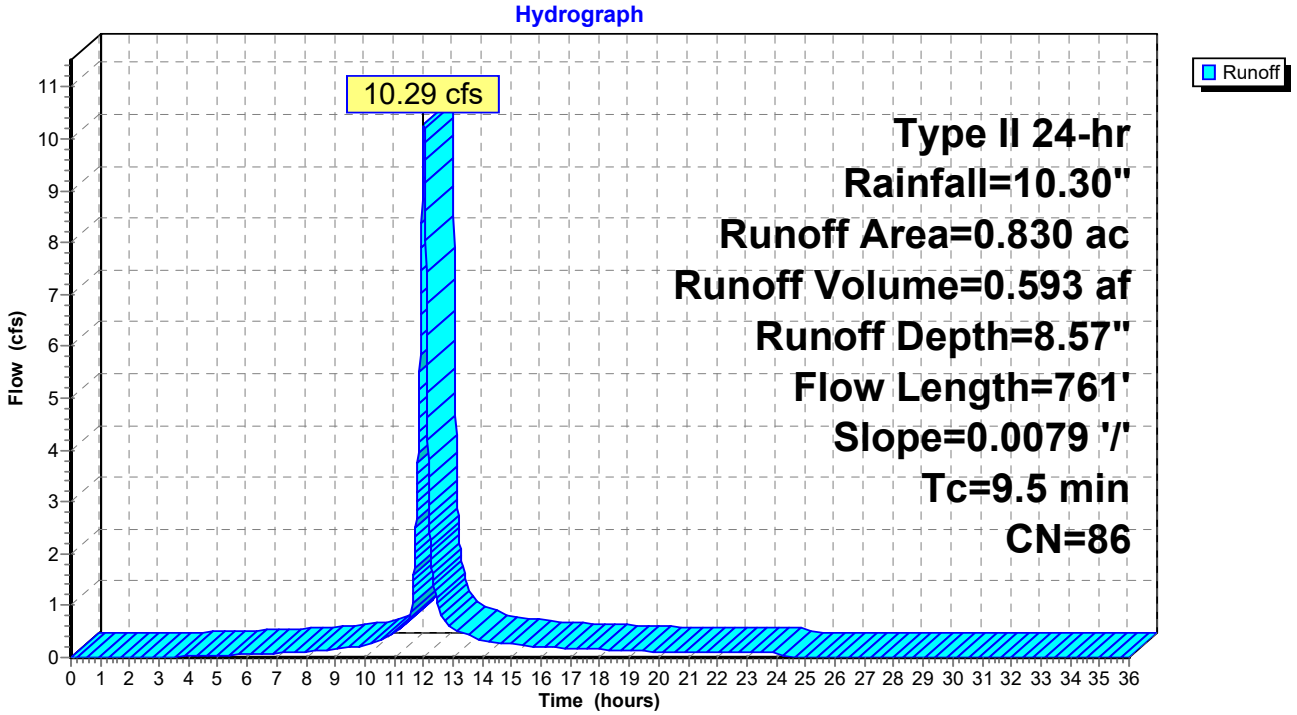
Runoff = 10.29 cfs @ 12.00 hrs, Volume= 0.593 af, Depth= 8.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	0.830	86	
	0.830		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	761	0.0079	1.33		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps

Subcatchment 14S: GBAP SWS5



Summary for Subcatchment 15S: GBAP SWS6

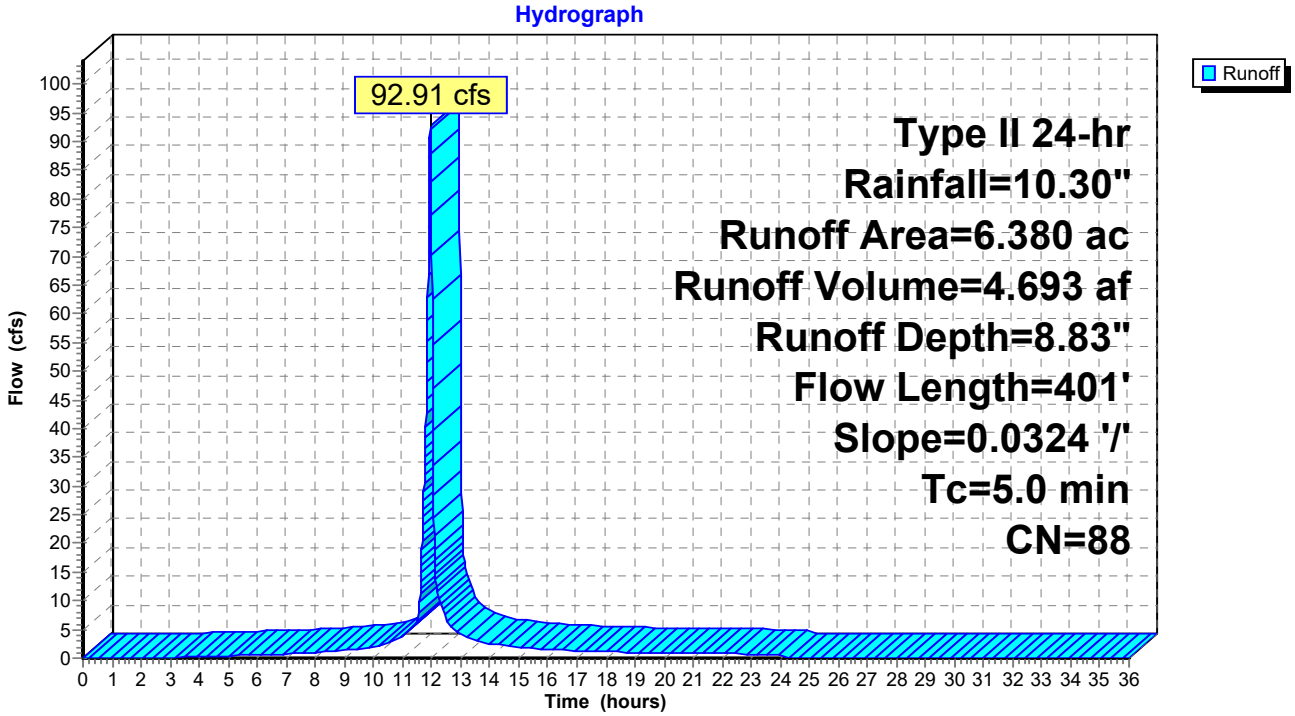
Runoff = 92.91 cfs @ 11.96 hrs, Volume= 4.693 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	6.380	88	
	6.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	401	0.0324	2.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.3	401	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 15S: GBAP SWS6



Summary for Subcatchment 16S: GBAP SWS7

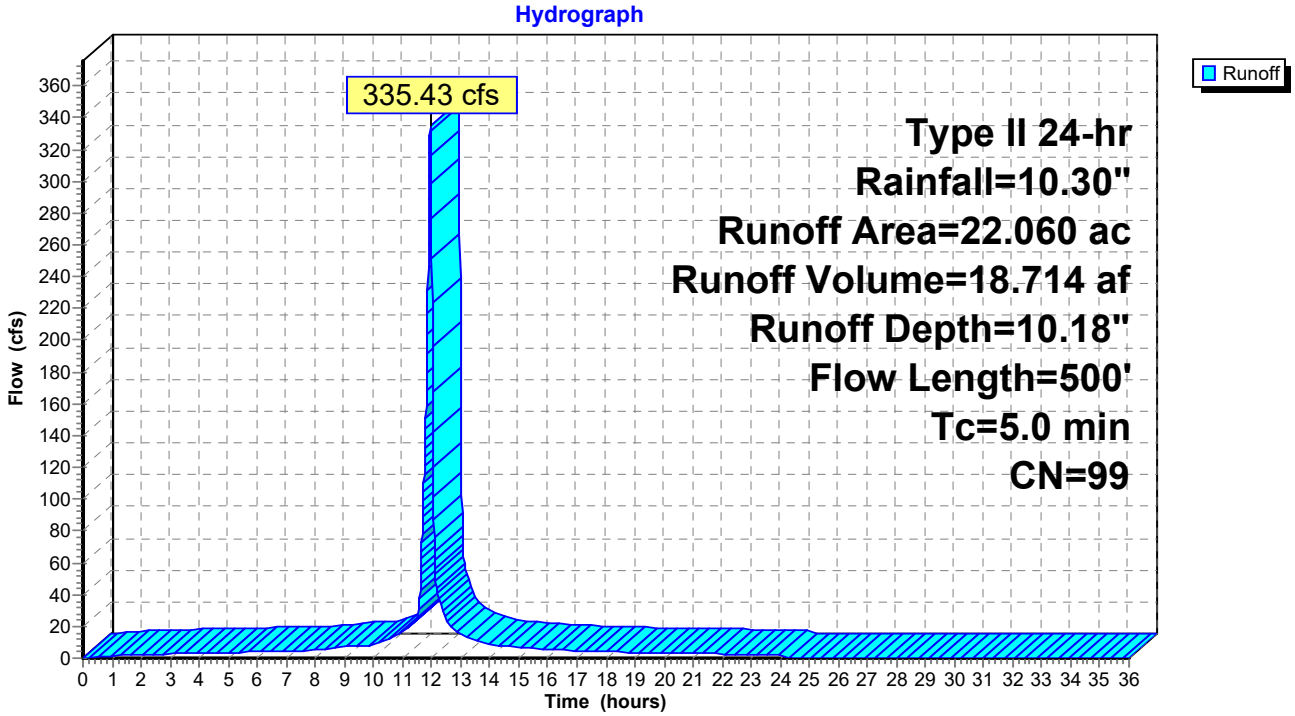
Runoff = 335.43 cfs @ 11.96 hrs, Volume= 18.714 af, Depth=10.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	22.060	99	
	22.060		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	500		5.67		**Lake or Reservoir,** Mean Depth= 1.00'
1.5	500	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 16S: GBAP SWS7



Summary for Pond 1P: Green Bottom Ash Pond

[81] Warning: Exceeded Pond 2P by 3.40' @ 8.77 hrs

Inflow Area = 54.130 ac, 78.85% Impervious, Inflow Depth > 17.65"
Inflow = 711.21 cfs @ 11.96 hrs, Volume= 79.622 af
Outflow = 24.86 cfs @ 16.85 hrs, Volume= 42.278 af, Atten= 97%, Lag= 293.1 min
Primary = 24.86 cfs @ 16.85 hrs, Volume= 42.278 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 395.48' @ 16.85 hrs Surf.Area= 19.053 ac Storage= 44.325 af

Plug-Flow detention time= 828.3 min calculated for 42.261 af (53% of inflow)
Center-of-Mass det. time= 474.1 min (1,384.9 - 910.8)

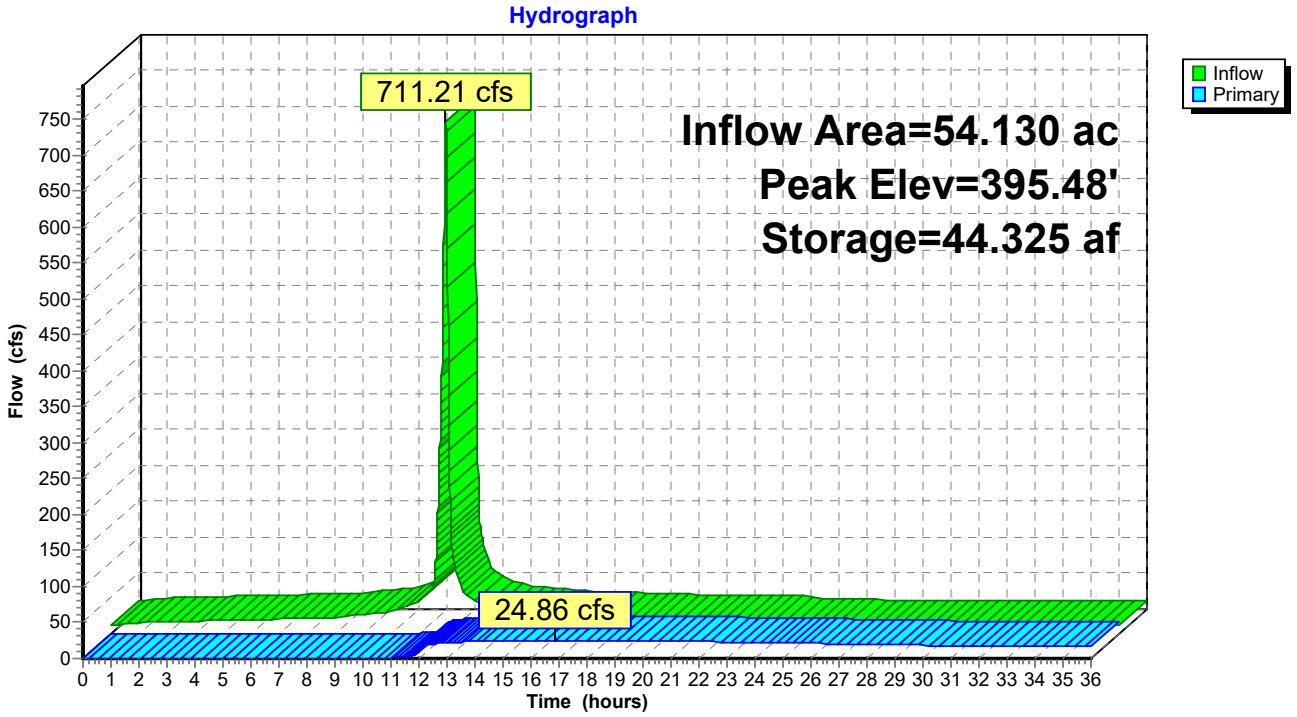
Volume	Invert	Avail.Storage	Storage Description
#1	393.00'	54.290 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
393.00	16.360	0.000	0.000
394.00	17.680	17.020	17.020
395.00	18.730	18.205	35.225
396.00	19.400	19.065	54.290

Device	Routing	Invert	Outlet Devices
#1	Primary	393.03'	**30.0" Round Culvert** L= 40.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 393.03' / 380.89' S= 0.3035 '/' Cc= 0.900 n= 0.024, Flow Area= 4.91 sf
#2	Device 1	393.87'	**30.0" Round Culvert** L= 42.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 393.87' / 393.03' S= 0.0200 '/' Cc= 0.900 n= 0.024, Flow Area= 4.91 sf
#3	Primary	393.03'	**30.0" Round Culvert** L= 40.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 393.03' / 381.19' S= 0.2960 '/' Cc= 0.900 n= 0.024, Flow Area= 4.91 sf
#4	Device 3	393.87'	**30.0" Round Culvert** L= 42.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 393.87' / 393.03' S= 0.0200 '/' Cc= 0.900 n= 0.024, Flow Area= 4.91 sf

Primary OutFlow Max=24.86 cfs @ 16.85 hrs HW=395.48' (Free Discharge)
- **1=Culvert** (Passes 12.43 cfs of 22.99 cfs potential flow)
  - **2=Culvert** (Barrel Controls 12.43 cfs @ 5.29 fps)
- **3=Culvert** (Passes 12.43 cfs of 22.99 cfs potential flow)
  - **4=Culvert** (Barrel Controls 12.43 cfs @ 5.29 fps)

Pond 1P: Green Bottom Ash Pond



Summary for Pond 2P: Waste Water Pond

Inflow Area = 5.930 ac, 28.50% Impervious, Inflow Depth > 8.26"
Inflow = 59.13 cfs @ 11.98 hrs, Volume= 4.081 af
Outflow = 1.44 cfs @ 16.29 hrs, Volume= 1.363 af, Atten= 98%, Lag= 258.2 min
Primary = 1.44 cfs @ 16.29 hrs, Volume= 1.363 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 394.08' @ 16.29 hrs Surf.Area= 0.939 ac Storage= 3.155 af

Plug-Flow detention time= 635.6 min calculated for 1.363 af (33% of inflow)
Center-of-Mass det. time= 463.6 min (1,250.8 - 787.2)

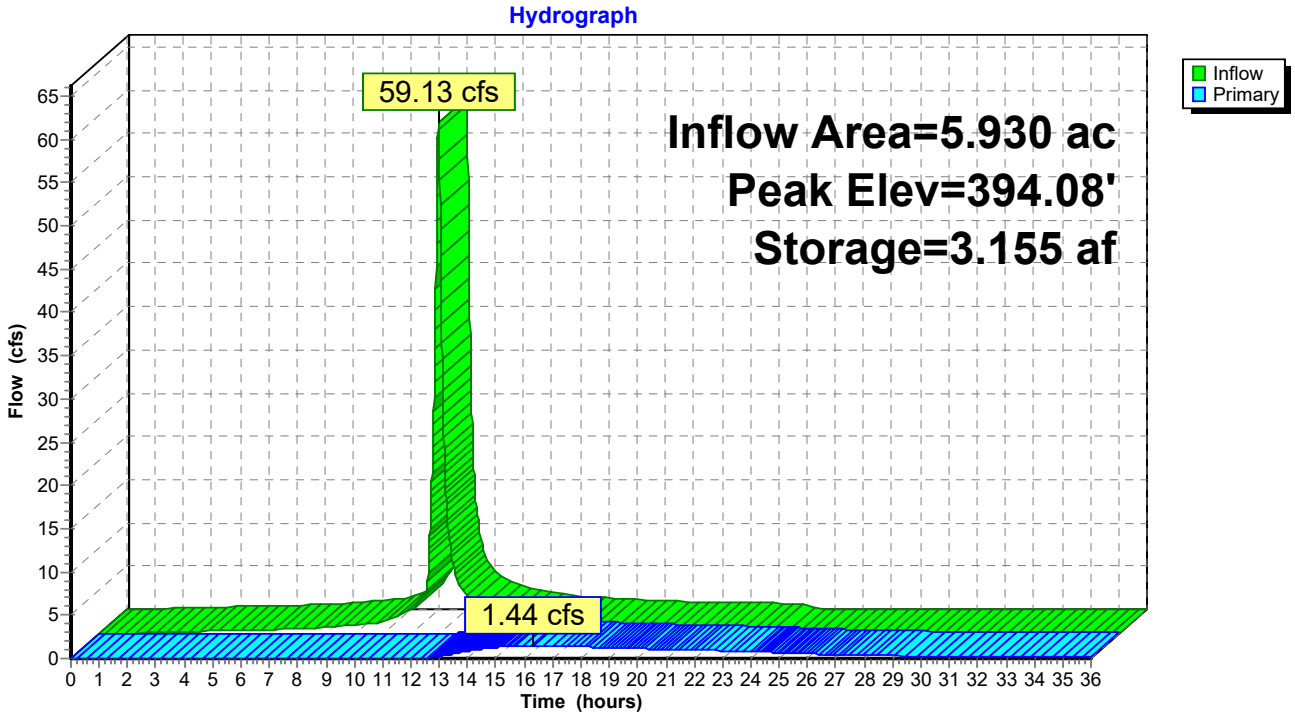
Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	5.160 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
390.00	0.610	0.000	0.000
392.00	0.770	1.380	1.380
394.00	0.930	1.700	3.080
396.00	1.150	2.080	5.160

Device	Routing	Invert	Outlet Devices
#1	Primary	393.35'	**12.0" Round Culvert** L= 29.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 393.35' / 393.27' S= 0.0028 '/' Cc= 0.900 n= 0.014, Flow Area= 0.79 sf
#2	Primary	393.74'	**12.0" Round Culvert** L= 28.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 393.74' / 393.11' S= 0.0225 '/' Cc= 0.900 n= 0.014, Flow Area= 0.79 sf

Primary OutFlow Max=1.44 cfs @ 16.29 hrs HW=394.08' (Free Discharge)
1=Culvert (Barrel Controls 1.07 cfs @ 2.42 fps)
2=Culvert (Inlet Controls 0.37 cfs @ 1.57 fps)

Pond 2P: Waste Water Pond



Summary for Pond 3P: Solid Waste Emergency Storage

Inflow Area = 0.860 ac, 0.00% Impervious, Inflow Depth = 9.20"
Inflow = 12.76 cfs @ 11.96 hrs, Volume= 0.659 af
Outflow = 2.49 cfs @ 12.10 hrs, Volume= 0.442 af, Atten= 80%, Lag= 8.9 min
Primary = 2.49 cfs @ 12.10 hrs, Volume= 0.442 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 396.18' @ 12.10 hrs Surf.Area= 0.612 ac Storage= 0.389 af

Plug-Flow detention time= 295.0 min calculated for 0.442 af (67% of inflow)
Center-of-Mass det. time= 195.9 min (957.1 - 761.3)

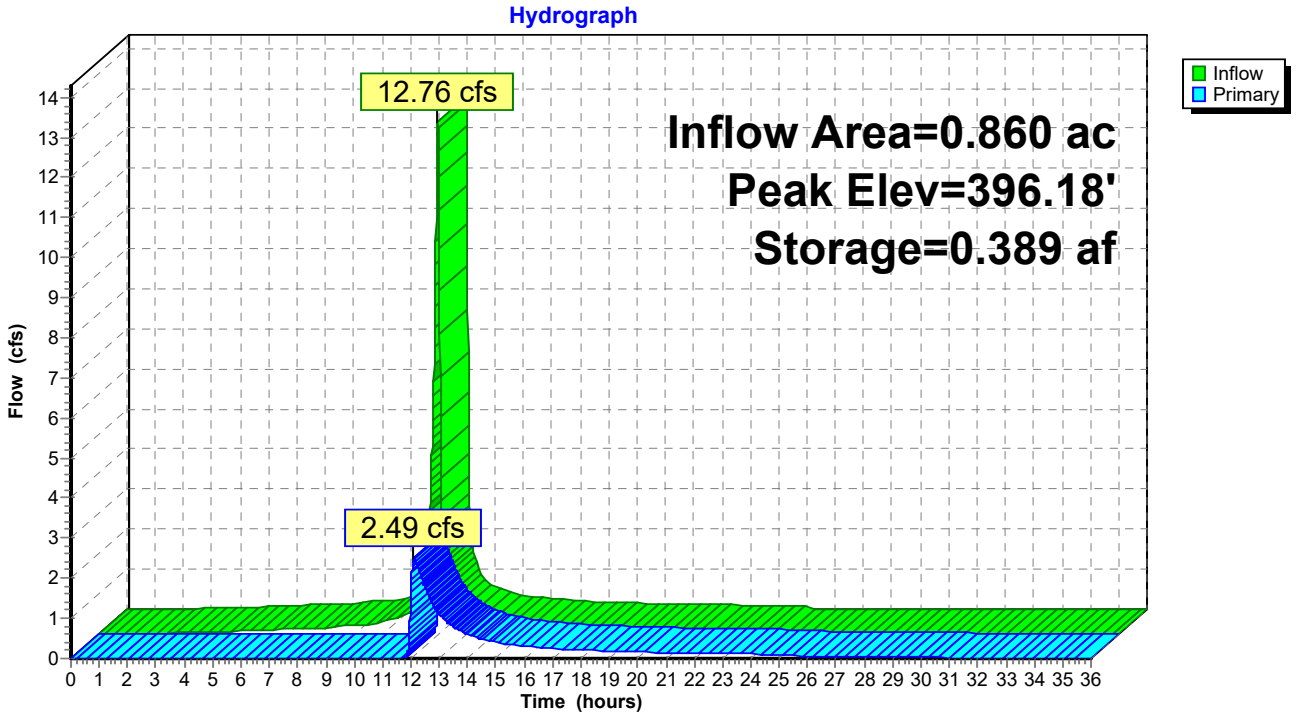
Volume	Invert	Avail.Storage	Storage Description
#1	395.50'	0.590 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
395.50	0.530	0.000	0.000
396.00	0.590	0.280	0.280
396.50	0.650	0.310	0.590

Device	Routing	Invert	Outlet Devices
#1	Primary	395.86'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.64 Width (feet) 0.10 20.48

Primary OutFlow Max=2.49 cfs @ 12.10 hrs HW=396.18' (Free Discharge)
↑**1=Custom Weir/Orifice** (Weir Controls 2.49 cfs @ 1.49 fps)

Pond 3P: Solid Waste Emergency Storage



Summary for Link 26L: Pumped Flows

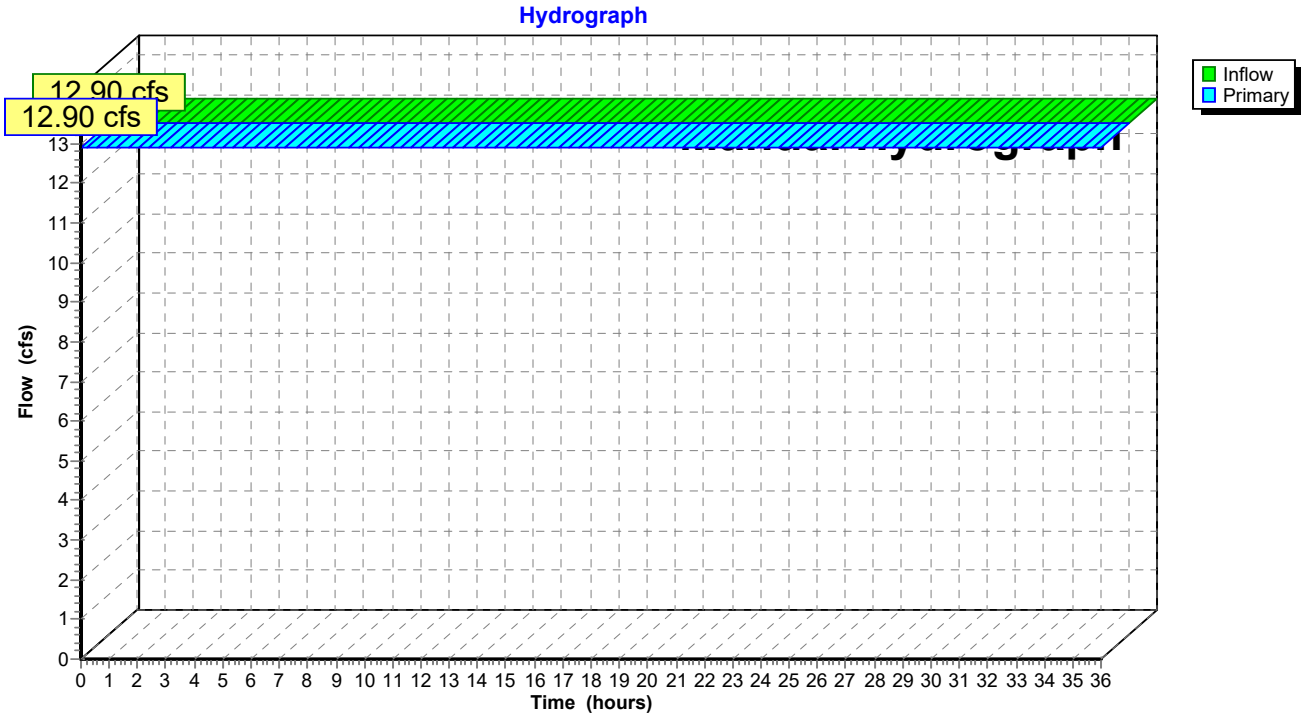
Inflow = 12.90 cfs @ 0.00 hrs, Volume= 38.391 af
Primary = 12.90 cfs @ 0.00 hrs, Volume= 38.391 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

37 Point manual hydrograph, To= 0.00 hrs, dt= 1.00 hrs, cfs =

12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90
12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90
12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90	12.90
12.90	12.90	12.90	12.90	12.90	12.90	12.90			

Link 26L: Pumped Flows



Big Rivers
ELECTRIC CORPORATION

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Reid/HMPL Station CCR Surface Impoundment

Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule
Hydrologic and Hydraulic Capacity Assessment and
Initial Inflow Design Flood Control System Plan

October 11, 2016

Prepared By:

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

Project ID: 160027B

Big Rivers Electric Corporation
Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule
Hydrologic and Hydraulic Capacity Assessment and
Initial Inflow Design Flood Control System Plan

CCR Surface Impoundment Information

Name:	Reid/HMPL Station CCR Surface Impoundment
Operator:	Sebree Generating Station
Address:	9000 Highway 2096 Robards, Kentucky 42452
CCR Unit Identification Number:	Kentucky State Dam Inventory System ID No. 0855

Qualified Professional Engineer

Name:	David A. Lamb
Company:	Associated Engineers, Inc.
Kentucky P.E. Number:	17822

Regulatory Applicability

As part of the § 257.82 Hydrologic and hydraulic capacity requirements for CCR surface impoundments, an owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified below. The owner or operator of the CCR unit must prepare the initial inflow design flood control system plan no later than October 17, 2016. The hazard potential classification definitions (from: VI. Development of the Final Rule - Technical Requirements) that must be considered follow:

- High hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation will probably cause loss of human life

- Significant hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

- Low hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment's owner's property.

1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in item 3) of this section.

2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified item 3) of this section.

3) The inflow design flood is:

   (i) For a high hazard potential CCR surface impoundment the inflow design flood is the probable maximum flood;

   (ii) For a significant hazard potential CCR surface impoundment the inflow design flood is the 1,000-year flood;

   (iii) For a low hazard potential CCR surface impoundment the inflow design flood is the 100-year flood;

   (iv) For an incised CCR surface impoundment the inflow design flood is the 25-year flood.

Discharge from the CCR unit must be handled in accordance with the surface water requirements under § 257.3-3 (Part 257 - Criteria for Classification of Solid Waste Disposal Facilities and Practices Subpart A - Classification of Solid Waste Disposal Facilities and Practices Section 257.3-3 - Surface water).

Inflow design flood control system Plan:

1) *Content of the plan.* The owner or operator must prepare an initial inflow design flood control system plan that must document how the inflow design flood control system has been designed and constructed to meet the requirements of this section. Each plan must be supported by appropriate engineering calculations.

2) *Amendment of the plan.* The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record. The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

Description of Impoundment

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years and is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 25.45 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The original terrain on which the pond was constructed generally sloped toward the west. Although the Green River is located less than 0.5 miles from the site, the structure does not extend significantly into the floodplain. Underlying preconstruction soils consisted of Loring-Grenada, Loring-Zanesville-Wellston (Henderson County) and Loring-Wellston-Zanesville (Webster County) soil associations which are generally characterized as well drained to moderately well drained soils on nearly level to sloping uplands.

The embankment reaches its greatest relief of approximately 42 feet on the west side. The Burns & McDonnell Engineering Co. October 8, 1971 design drawings show the inboard slope and central core portion of the dike to be constructed of compacted soil fill and the outboard slope to be consisted of sand fill. A sand blanket drain was designed for the outboard third of the base of the dike for the majority of the length and the plans show a crushed limestone drainage layer with a minimum thickness of 18 inches topped with a minimum six inches thick sand layer which extends across the entire width of the dike cross section in the southwest corner. The plans also show a cut-off trench in the original ground below dike crest and extending for the entire length of the dike.

Depth of impounded water and CCR is 16 feet and 39 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 426 feet and 440 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 85,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 767,000 cubic yards (approximate water volume is 85,000 cubic yards and approximate CCR volume is 682,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.

The impoundment discharge consists of a rectangular concrete drop structure with a variable height steel debris skimmer. The pool elevation can be controlled by adding or removing stop logs. The discharge structure connects to a 24-inch diameter smooth walled metal pipe underground conveyance.

Inflow Design Flood Control System Plan

The initial inflow design flood control system plan documents that the inflow design flood control system has been designed and constructed to meet the storm generated discharge requirements for a Significant hazard potential CCR surface impoundment which means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. The inflow design flood for a Significant hazard potential CCR surface impoundment is the 1,000-year flood.

Analysis via HydroCAD Stormwater Modeling software of the of the Reid/HMPL CCR impoundment site drainage demonstrates that the design flood control system adequately manages inflow and discharge out of the CCR unit during and following the specified 1,000-year/24-hour storm event. HydroCAD Stormwater Modeling by HydroCAD Software Solutions, LLC is a widely recognized comprehensive hydrology and hydraulics software for use by Civil Engineers, useful for runoff and sediment control design calculations. The HydroCAD modeling results for the Reid/HMPL CCR impoundment are attached to this report.

The operating facility has verified that discharge from the Reid/HMPL CCR impoundment is handled in accordance with the surface water requirements under § 257.3-3 (Part 257 - Criteria for Classification of Solid Waste Disposal Facilities and Practices Subpart A - Classification of Solid Waste Disposal Facilities and Practices Section 257.3-3 - Surface water).

Sources of Information

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

Professional Engineer Certification [Per 40 CFR § 257.82]
Reid/HMPL CCR Impoundment Initial Inflow Design Flood Control System Plan

I hereby certify that myself or an agent under my review has prepared this Initial Inflow Design Flood Control System Plan (Plan), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Plan has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.82. To the best of my knowledge and belief, the information contained in this Plan is true, complete, and accurate.

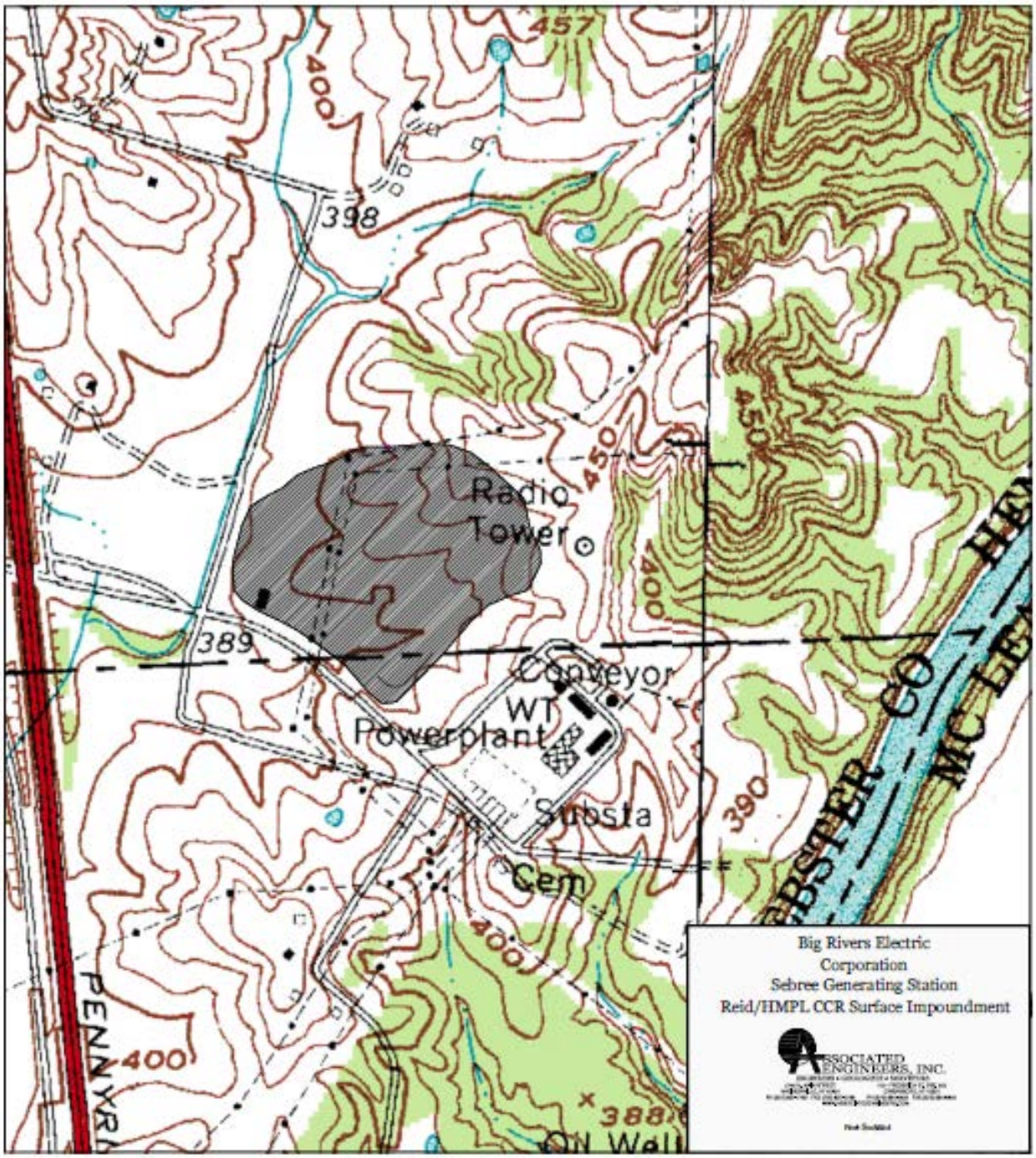
David A. Lamb P.E.

State of Kentucky License No. 17822

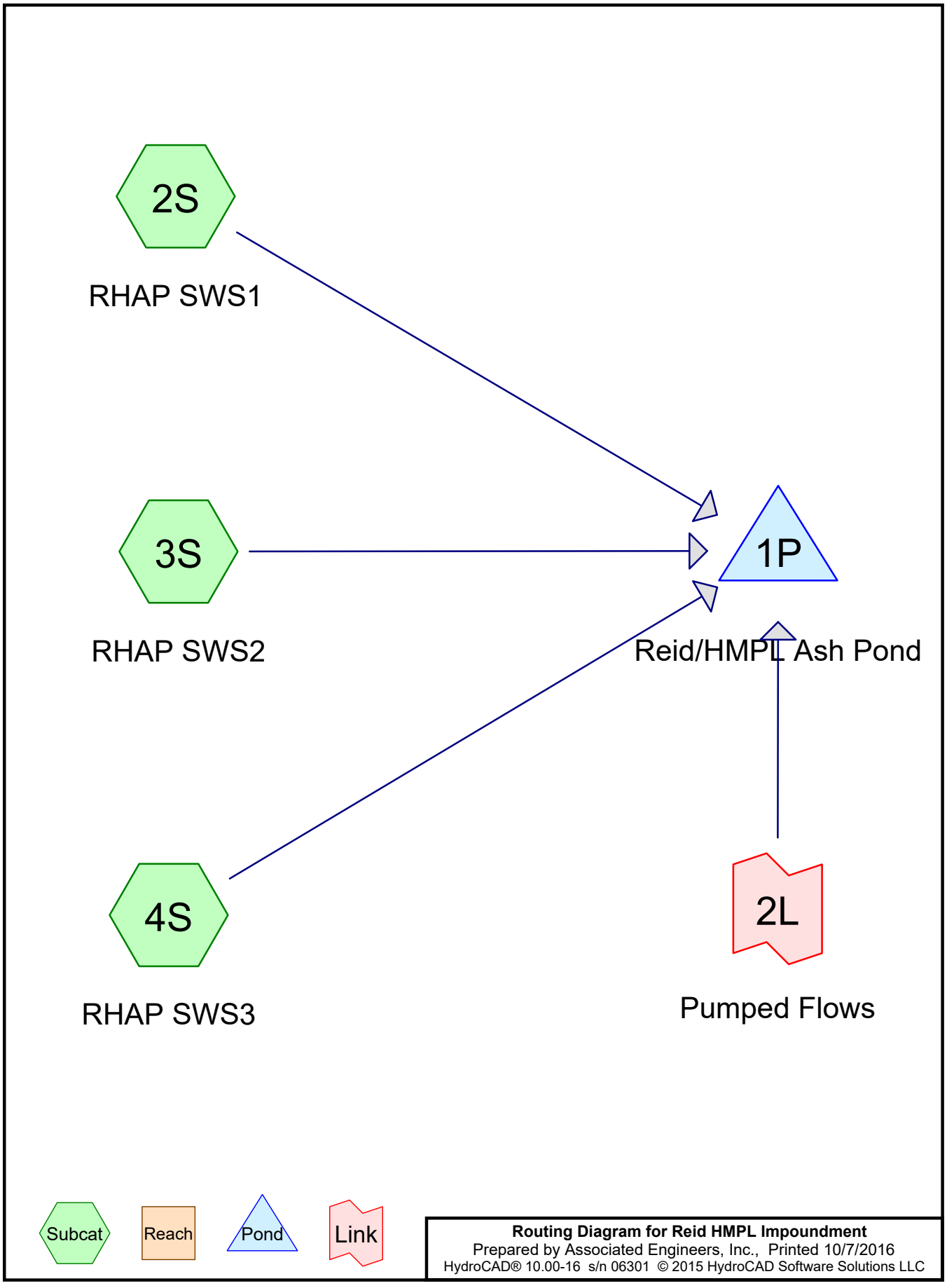
STATE OF KENTUCKY
DAVID A. LAMB
17822
LICENSED PROFESSIONAL ENGINEER

Date: 10/11/16

Attachment A. Aerial Photo of the Reid/HMPL CCR Surface Impoundment



Attachment B. Topographic Map showing the Reid/HMPL CCR Surface Impoundment



Routing Diagram for Reid HMPL Impoundment
Prepared by Associated Engineers, Inc., Printed 10/7/2016

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.050	79	(2S)
9.650	86	(3S)
12.750	99	(4S)
25.450	**92**	**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: RHAP SWS1 Runoff Area=3.050 ac 0.00% Impervious Runoff Depth=7.68"
Flow Length=392' Slope=0.0510 '/' Tc=16.4 min CN=79 Runoff=28.25 cfs 1.952 af

Subcatchment 3S: RHAP SWS2 Runoff Area=9.650 ac 0.00% Impervious Runoff Depth=8.57"
Flow Length=38' Slope=0.2368 '/' Tc=5.0 min CN=86 Runoff=138.43 cfs 6.896 af

Subcatchment 4S: RHAP SWS3 Runoff Area=12.750 ac 100.00% Impervious Runoff Depth=10.18"
Flow Length=500' Tc=5.0 min CN=99 Runoff=193.87 cfs 10.816 af

Pond 1P: Reid/HMPL Ash Pond Peak Elev=427.61' Storage=26.788 af Inflow=358.90 cfs 43.859 af
Outflow=27.32 cfs 43.388 af

Link 2L: Pumped Flows Manual Hydrograph Inflow=8.13 cfs 24.195 af
Primary=8.13 cfs 24.195 af

Total Runoff Area = 25.450 ac Runoff Volume = 19.663 af Average Runoff Depth = 9.27"
49.90% Pervious = 12.700 ac 50.10% Impervious = 12.750 ac

Summary for Subcatchment 2S: RHAP SWS1

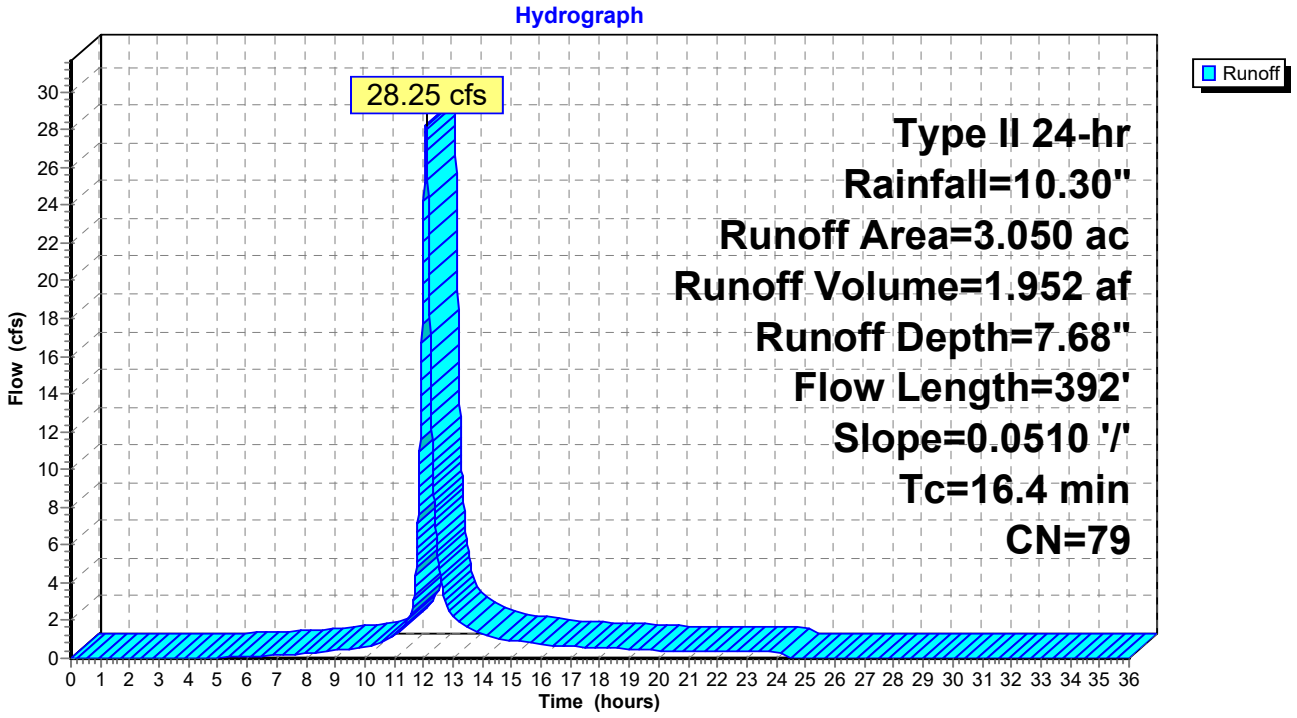
Runoff = 28.25 cfs @ 12.08 hrs, Volume= 1.952 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	3.050	79	
	3.050		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0	300	0.0510	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.28"
0.4	92	0.0510	3.64		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
16.4	392	Total			

Subcatchment 2S: RHAP SWS1



Summary for Subcatchment 3S: RHAP SWS2

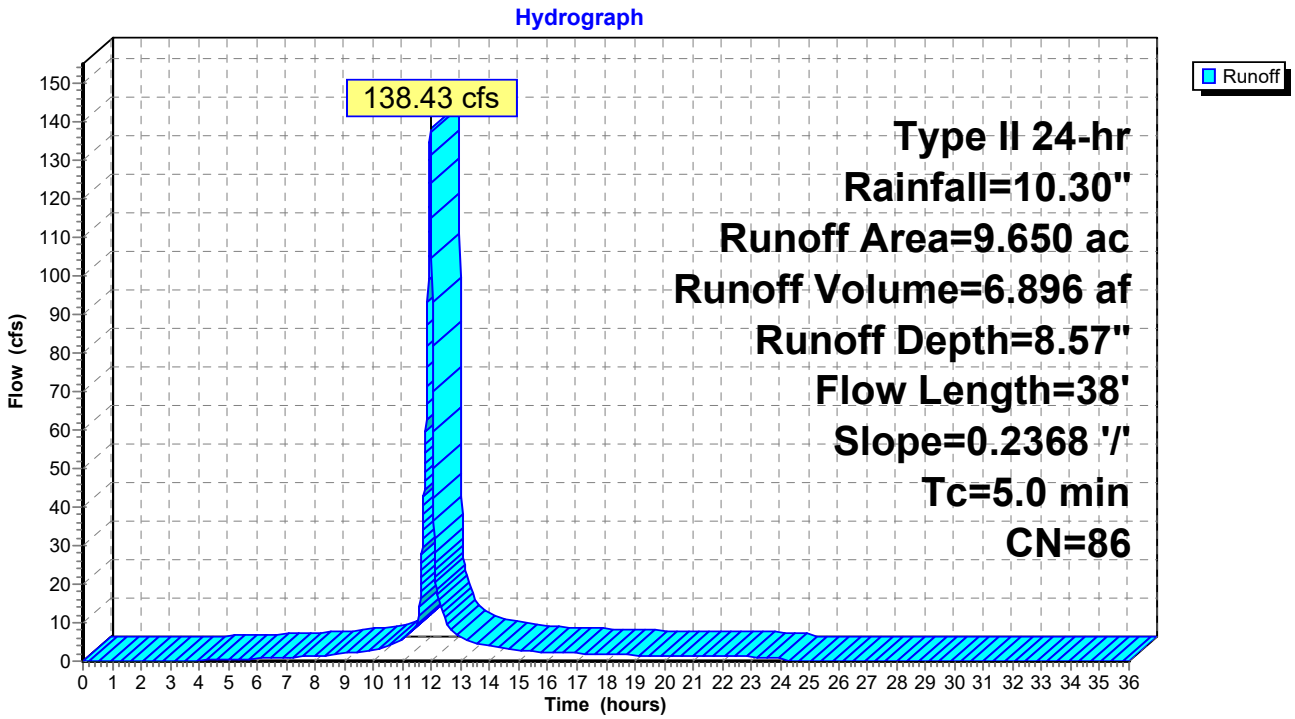
Runoff = 138.43 cfs @ 11.96 hrs, Volume= 6.896 af, Depth= 8.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	9.650	86	
	9.650		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	38	0.2368	7.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	38	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 3S: RHAP SWS2



Summary for Subcatchment 4S: RHAP SWS3

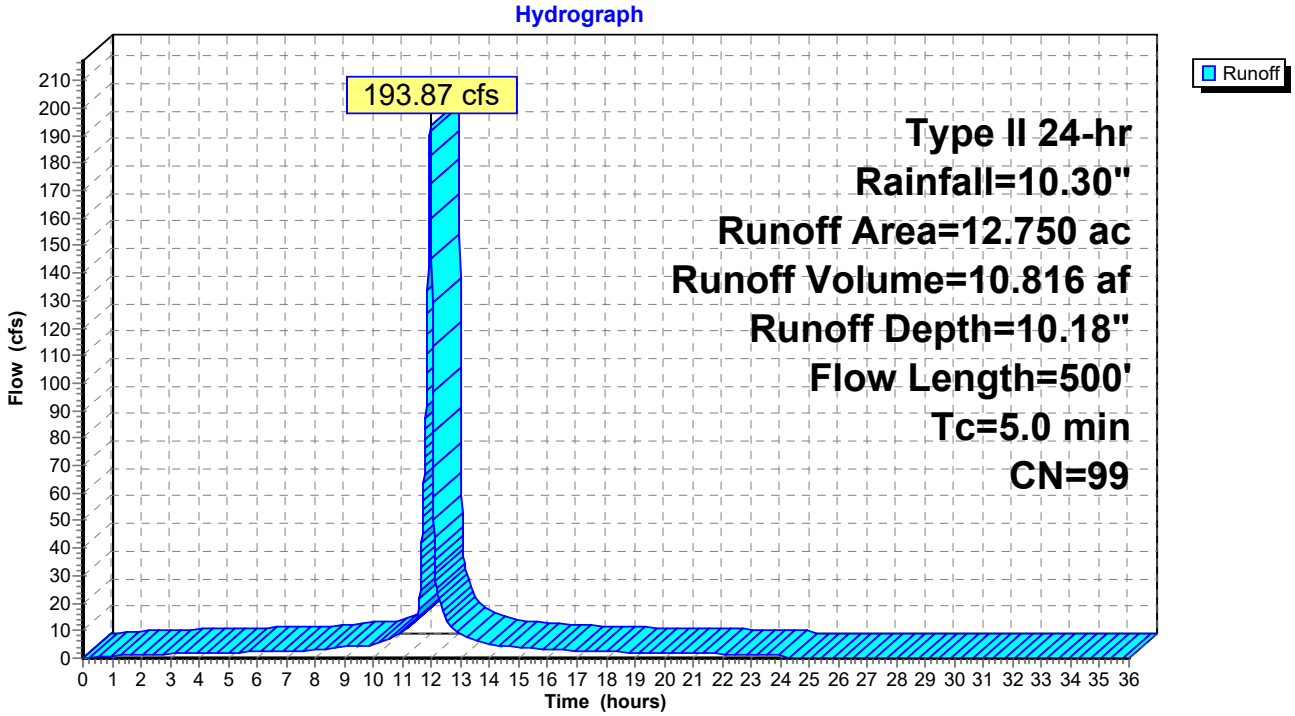
Runoff = 193.87 cfs @ 11.96 hrs, Volume= 10.816 af, Depth=10.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=10.30"

	Area (ac)	CN	Description
*	12.750	99	
	12.750		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	500		5.67		**Lake or Reservoir,** Mean Depth= 1.00'
1.5	500	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 4S: RHAP SWS3



Summary for Pond 1P: Reid/HMPL Ash Pond

Inflow Area = 25.450 ac, 50.10% Impervious, Inflow Depth > 20.68"
Inflow = 358.90 cfs @ 11.96 hrs, Volume= 43.859 af
Outflow = 27.32 cfs @ 12.85 hrs, Volume= 43.388 af, Atten= 92%, Lag= 53.6 min
Primary = 27.32 cfs @ 12.85 hrs, Volume= 43.388 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Starting Elev= 426.67' Surf.Area= 11.351 ac Storage= 15.583 af
Peak Elev= 427.61' @ 12.85 hrs Surf.Area= 12.373 ac Storage= 26.788 af (11.204 af above start)

Plug-Flow detention time= 766.1 min calculated for 27.802 af (63% of inflow)
Center-of-Mass det. time= 142.3 min (1,075.1 - 932.8)

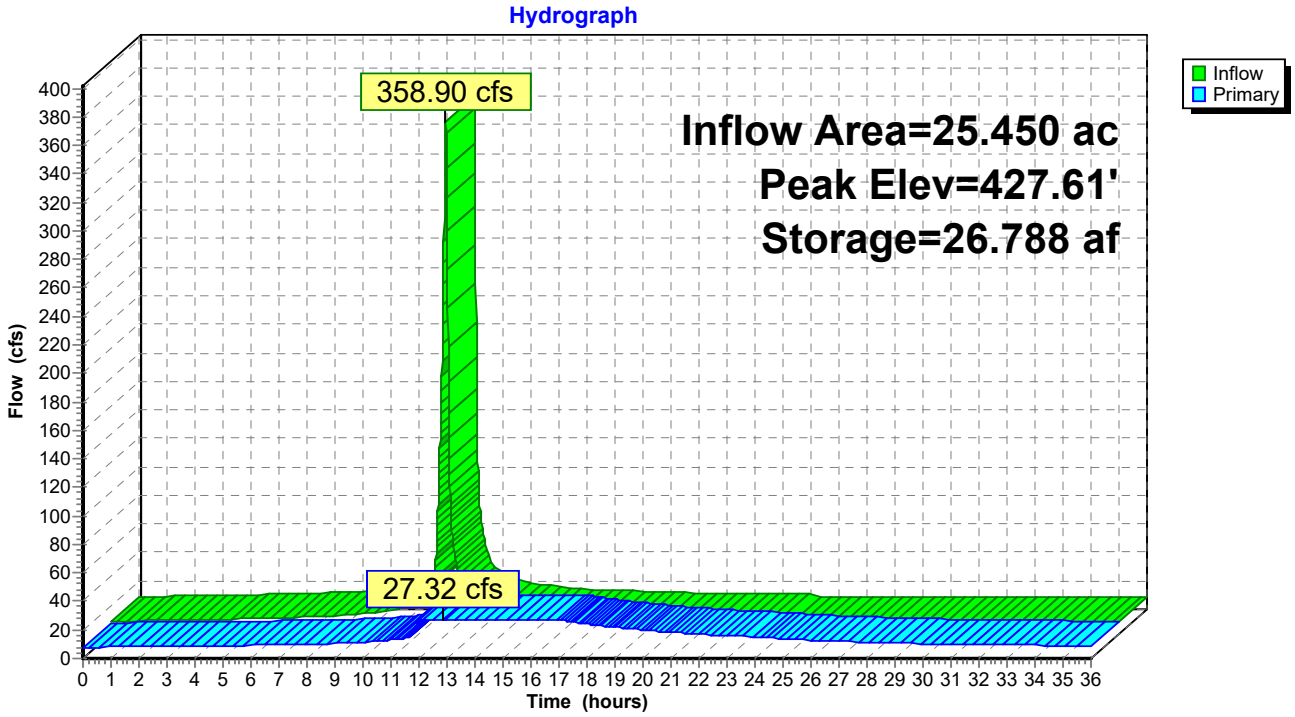
Volume	Invert	Avail.Storage	Storage Description
#1	425.00'	31.665 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
425.00	6.060	0.000	0.000
426.00	10.480	8.270	8.270
427.00	11.780	11.130	19.400
428.00	12.750	12.265	31.665

Device	Routing	Invert	Outlet Devices
#1	Primary	419.95'	**24.0" Round Culvert** L= 1,760.0' CMP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 419.95' / 401.90' S= 0.0103 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 3.14 sf
#2	Device 1	426.08'	**6.0' long x 0.7' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32

Primary OutFlow Max=27.32 cfs @ 12.85 hrs HW=427.61' (Free Discharge)
└**1=Culvert** (Barrel Controls 27.32 cfs @ 8.70 fps)
└**2=Broad-Crested Rectangular Weir** (Passes 27.32 cfs of 37.42 cfs potential flow)

Pond 1P: Reid/HMPL Ash Pond



Summary for Link 2L: Pumped Flows

Inflow = 8.13 cfs @ 0.00 hrs, Volume= 24.195 af
Primary = 8.13 cfs @ 0.00 hrs, Volume= 24.195 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

37 Point manual hydrograph, To= 0.00 hrs, dt= 1.00 hrs, cfs =

8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13
8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13
8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13
8.13	8.13	8.13	8.13	8.13	8.13	8.13			

Link 2L: Pumped Flows