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Cleveland, OH 44131
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MEMORANDUM

16 October 2016
File No. 40616-108

SUBJECT: Inflow Design Flood Control System Plan
Pond 003
Associated Electric Cooperative, Inc.
New Madrid Power Plant
New Madrid, Missouri

Haley & Aldrich, Inc. (Haley & Aldrich) has developed this Inflow Design Flood (IDF) Control System Plan (Plan) on behalf of Associated Electric Cooperative, Inc. (AECI) for the existing coal combustion residuals (CCR) surface impoundment referred to as Pond 003 at the New Madrid Power Plant in New Madrid, Missouri. This has been completed based on requirements of the Environmental Protection Agency (EPA) 40 CFR Parts 257 and 261, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities" (CCR Rule), specifically section §257.82. The Pond 003 existing conditions and supporting documentation has been reviewed and associated stormwater modeling and analysis performed to satisfy the Inflow Design Flood Control System Plan requirements of CCR Rule section §257.82 as described below.

§257.82(a): The 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 in paragraphs (a)(1) and (a)(2) of this section.

§257.82(a)(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 paragraph (a)(3) of this section.

Pond 003 is a coal combustion residuals (CCR) surface impoundment used for settling and temporary wet storage of bottom ash and boiler slag sluiced from the NMPP. This impoundment also manages plant process water, coal pile runoff, and minor amounts of fly ash. CCR reclamation and processing equipment and activity are also located in the northern portion of the unit. Process water and CCR are discharged into the impoundment via two sets of pipelines located at the northern end of the impoundment. The discharged water and CCR flow through an open channel to a clear portion of the unit in the southeast corner. Decant water discharges from the impoundment flow to a concrete drop inlet structure with concrete stoplogs used to manage water elevation. A discharge pipe directs water through the dike and into a discharge channel which flows towards the Mississippi River. The discharge channel has also been modeled for tailwater effects.

Process water flows from the plant to this impoundment include typical average monthly flows along with specific flow types that have peak instantaneous or daily flows based on plant operations as stated in the plant NDPES permit. To be conservative, the model includes the 1,000 storm event along with a continuous peak inflow from the plant. It should be noted that this process water discharge assuming all peak flows occurring simultaneously is highly unlikely to occur based on the plant's ability to regulate flows from different sources and since some peak flows only occur at infrequent times associated certain operational and maintenance activities which the plant has the ability to schedule.

Hydrologic and hydraulic modeling for this Pond 003 IDF Control System Plan was performed using HydroCAD Stormwater Modeling System, version 10.00-12 (HydroCAD) in conjunction with the appropriate IDF as determined per the Hazard Potential Classification Assessment performed under separate cover.

When Pond 003 is maintained at its normal water surface elevation (WSEL) (El. 299.0), the results of the HydroCAD analysis confirm the IDF control system for Pond 003 adequately manage flow into the impoundment during and following the IDF peak storm discharge by containing the flood within the impoundment along with the continuous peak process water inflows and discharges. We also evaluated the more likely scenario of AECI removing stoplogs to lower the initial water surface when a significant rainfall event or process water discharge is anticipated. This second scenario includes removing two (2) stoplogs (24-in. total) from the decant structure to decrease the peak water surface elevation in the unit. **Table I** summarizes the effects of the IDF peak discharge during normal operation of the impoundment. The output from the two HydroCAD model simulations is provided as **Appendix A**. See **Figure 1** for the Pond 003 existing site plan.

Table I: HydroCAD Output Summary – 1,000 Flood

	Normal Operating Conditions	Lower Operating Conditions
Peak flood level (ft)	305.8	305.3
Minimum Dike Elevation	307.0	307.0
Minimum freeboard (ft)	1.2	1.7
Peak inflow (cfs)	1,066	1,066

§257.82(a)(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 in paragraph (a)(3) of this section.

The outlet control structure is detailed in the Burns & McDonnell Ash Retaining Dike Grading and Drainage Plan dated 26 October 1977. Pertinent pages providing the required information

have been provided as **Appendix B**. Supplemental hand measurements of the structure were also made by AECI. Based on the HydroCAD analysis, the IDF control system for Pond 003 was determined to adequately manage flow from the impoundment by collecting and controlling the IDF peak discharge. The peak level and resulting freeboard in Pond 003 during the 1,000-year flood is noted in Table I (above). The HydroCAD model simulation output is provided as **Appendix A**.

§257.82(a)(3): The inflow design flood is:

i. *For a high hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the probable maximum flood;*
ii. *For a significant hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the 1,000-year flood;*
iii. *For a low hazard potential CCR surface impoundment, as determined under § 257.73(a)(2) or § 257.74(a)(2), the 100-year flood; or*
iv. *For an incised CCR surface impoundment, the 25-year flood.*

Pond 003 was determined to be significant hazard potential; therefore, the design event is the 1,000-year, 24-hour storm. The basis of the determination is discussed in Initial Hazard Potential Classification Assessment, Pond 003 dated October 2016. The 1,000-year storm characteristics were detailed in the NOAA Atlas 14 Point Precipitation Frequency Estimates dated 15 September 2016 and prepared by the National Weather Service. Pertinent pages providing the required information have been provided as **Appendix C**.

§257.82(b): Discharge from the CCR unit must be handled in accordance with the surface water requirements under § 257.3–3.

§257.3-3(a): For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act, as amended.

§257.3-3(b): For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under section 404 of the Clean Water Act, as amended.

§257.3-3(c): A facility or practice shall not cause non-point source pollution of waters of the United States that violates applicable legal requirements implementing an areawide or Statewide water quality management plan that has been approved by the Administrator under section 208 of the Clean Water Act, as amended.

Discharge from the Pond 003 is subject to the Missouri State Operating Permit issued by the Missouri Department of Natural Resources.

§257.82(c)(1): Content of the plan. The owner or operator must prepare initial and periodic inflow design flood control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (4) of this section. These plans 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. The owner or operator of the CCR unit has completed the inflow design flood control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(4).

This document and all attachments serve as the initial IDF Plan. Periodic inflow design flood control system plans will be prepared and placed in the facility operating record at 5-year increments or whenever there is a change in conditions that would affect the Plan.

§257.82(c)(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 as required by § 257.105(g)(4). 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.

The IDF Plan will be amended at least 60 days prior to a planned change in the operation of the facility or the CCR impoundment, or no later than 60 days after an unanticipated event requires the need to revise the IDF Plan. If the Plan needs to be revised after closure activities have commenced, the Plan will be revised no later than 30 days following the triggering event.

Any amendments to the Plan will include written certification from a qualified professional engineer that the initial and any amendments to the IDF Plan meet the requirements of the CCR Rule.

A record of amendments to the Plan will be tracked below. The latest version of the IDF Plan will be noted on the front cover of the Plan.

Version	Date	Description of Changes Made
1	16 October 2016	Initial Issuance

§257.82(c)(3): Timeframes for preparing the initial plan

i. Existing CCR surface impoundments. The owner or operator of the CCR unit must prepare the initial inflow design flood control system plan no later than October 17, 2016.

This IDF control system plan has been prepared within the specified timeframe.

ii. New CCR surface impoundments and any lateral expansion of a CCR surface impoundment. The owner or operator must prepare the initial inflow design flood control system plan no later than the date of initial receipt of CCR in the CCR unit.

N/A – Pond 003 is an existing CCR impoundment.

§257.82(c)(4): Frequency for revising the plan. The owner or operator must prepare periodic inflow design flood control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first periodic plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed an inflow design flood control system plan when the plan has been placed in the facility's operating record as required by § 257.105(g)(4).

This IDF Plan or any subsequent IDF Plan will be assessed and amended whenever there is a change in operation of the CCR impoundment that would substantially affect the IDF Plan or when unanticipated events necessitate a revision of the Plan either before or after closure activities have commenced.

§257.82(c)(5): The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic inflow design flood control system plans meet the requirements of this section.

I certify that the design of the flood control system referenced in this Inflow Design Flood Control System Plan for AECI's Pond 003 at the New Madrid Power Plant meets the USEPA's CCR Rule requirements of §257.82.

Signed:_____
Certifying Engineer

Print Name:	Steven F. Putrich
Missouri License No.:	2014035813
Title:	Project Principal
Company:	Haley & Aldrich, Inc.

Professional Engineer's Seal and date:

Cc: Jenny Burns-AECI; Jason Pokorny-Haley & Aldrich

LEGEND

- EXISTING MINOR CONTOUR
- 300 EXISTING MAJOR CONTOUR
- APPROXIMATE IMPOUNDMENT BOUNDARY
- ROAD
- WATER

NOTES

1. EXISTING TOPOGRAPHY BASED ON LIDAR DATA RECEIVED FROM AECI CONDUCTED BY PICTOMETRY INTERNATIONAL CORP. AERIAL SURVEY CONDUCTED BETWEEN 4-8 OCTOBER 2014.

N

0 300 600
SCALE IN FEET

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
NEW MADRID, MO

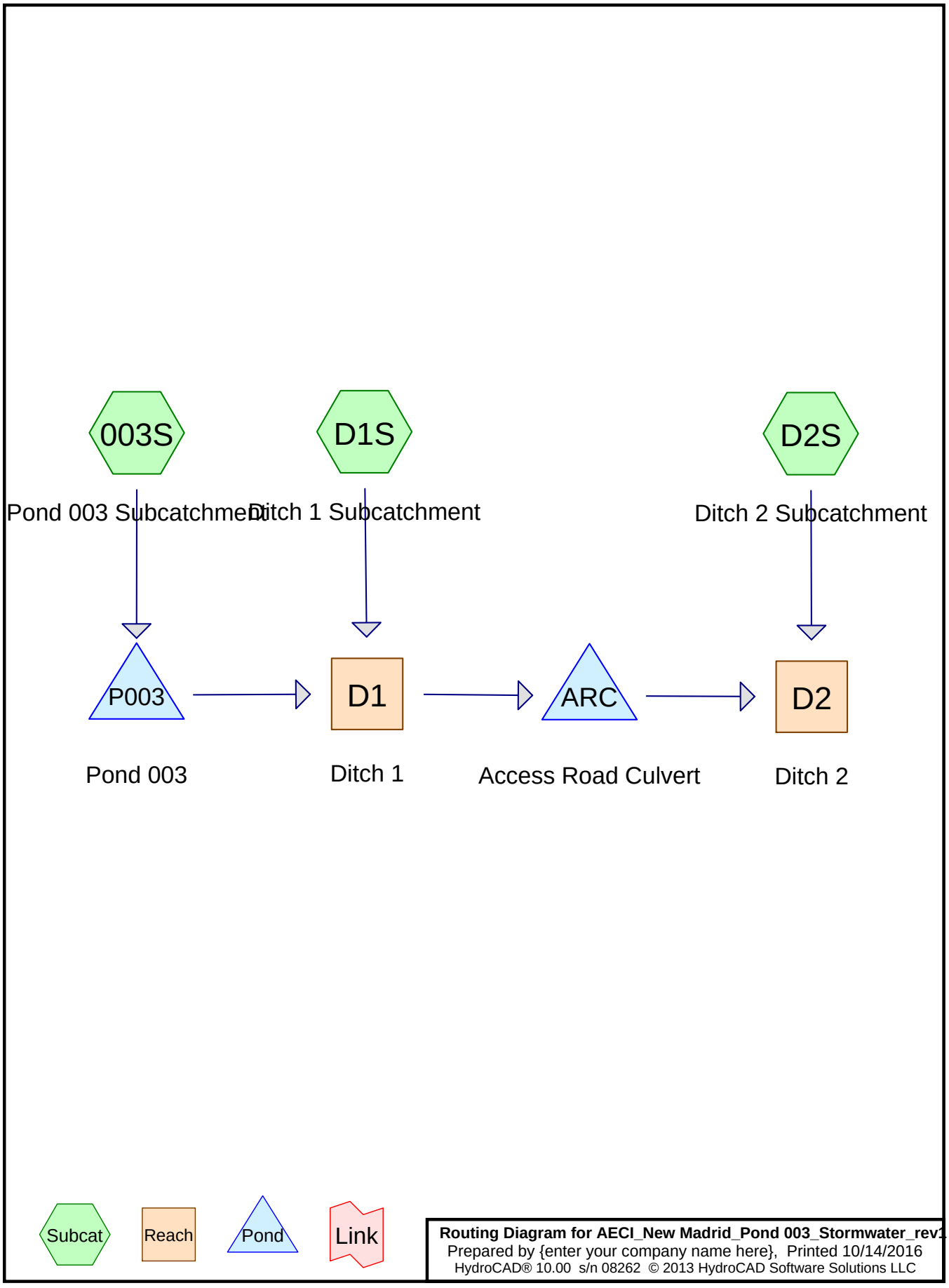
POND 003
SITE PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 1

LUCAS, ANDY Printed: 9/19/2016 9:52 AM Layout: SITE PLAN
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-NM\PONDS\FIGURES\INFLOWFLOOD CONTROL PLAN 003\40616-003 FIG-1_SITE PLAN.DWG

Appendix A



Routing Diagram for AECI_New Madrid_Pond 003_Stormwater_rev1
Prepared by {enter your company name here}, Printed 10/14/2016

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
121.454	84	50-75% Grass cover, Fair, HSG D (003S, D1S, D2S)
12.131	98	Water Surface, HSG A (003S, D1S, D2S)
133.585	**85**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
12.131	HSG A	003S, D1S, D2S
0.000	HSG B	
0.000	HSG C	
121.454	HSG D	003S, D1S, D2S
0.000	Other	
133.585		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	121.454	0.000	121.454	50-75% Grass cover, Fair	003S, D1S, D2S
12.131	0.000	0.000	0.000	0.000	12.131	Water Surface	003S, D1S, D2S
12.131	**0.000**	**0.000**	**121.454**	**0.000**	**133.585**	**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)	Inside-Fill (inches)
1	ARC	281.83	281.70	100.0	0.0013	0.012	30.0	0.0	0.0
2	P003	282.80	281.13	170.0	0.0098	0.013	24.0	0.0	0.0

Time span=0.00-144.00 hrs, dt=0.01 hrs, 14401 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 003S: Pond 003 Runoff Area=111.421 ac 9.96% Impervious Runoff Depth=9.72"
Flow Length=2,189' Tc=24.8 min CN=85 Runoff=1,008.79 cfs 90.267 af

Subcatchment D1S: Ditch 1 Subcatchment Runoff Area=21.833 ac 4.50% Impervious Runoff Depth=9.72"
Flow Length=1,416' Tc=62.0 min CN=85 Runoff=107.80 cfs 17.688 af

Subcatchment D2S: Ditch 2 Subcatchment Runoff Area=0.331 ac 14.80% Impervious Runoff Depth=9.85"
Flow Length=116' Tc=8.9 min CN=86 Runoff=4.76 cfs 0.272 af

Reach D1: Ditch 1 Avg. Flow Depth=2.47' Max Vel=3.93 fps Inflow=170.56 cfs 731.124 af
n=0.022 L=1,180.0' S=0.0017 '/' Capacity=6,424.73 cfs Outflow=168.96 cfs 730.142 af

Reach D2: Ditch 2 Avg. Flow Depth=1.06' Max Vel=5.28 fps Inflow=74.12 cfs 721.785 af
n=0.022 L=130.0' S=0.0077 '/' Capacity=4,384.71 cfs Outflow=74.12 cfs 721.714 af

Pond ARC: Access Road Culvert Peak Elev=290.87' Storage=17.735 af Inflow=168.96 cfs 730.142 af
30.0" Round Culvert n=0.012 L=100.0' S=0.0013 '/' Outflow=74.00 cfs 721.513 af

Pond P003: Pond 003 Peak Elev=305.77' Storage=119.519 af Inflow=1,065.93 cfs 770.327 af
Outflow=64.05 cfs 713.436 af

Total Runoff Area = 133.585 ac Runoff Volume = 108.226 af Average Runoff Depth = 9.72"
90.92% Pervious = 121.454 ac 9.08% Impervious = 12.131 ac

Summary for Subcatchment 003S: Pond 003 Subcatchment

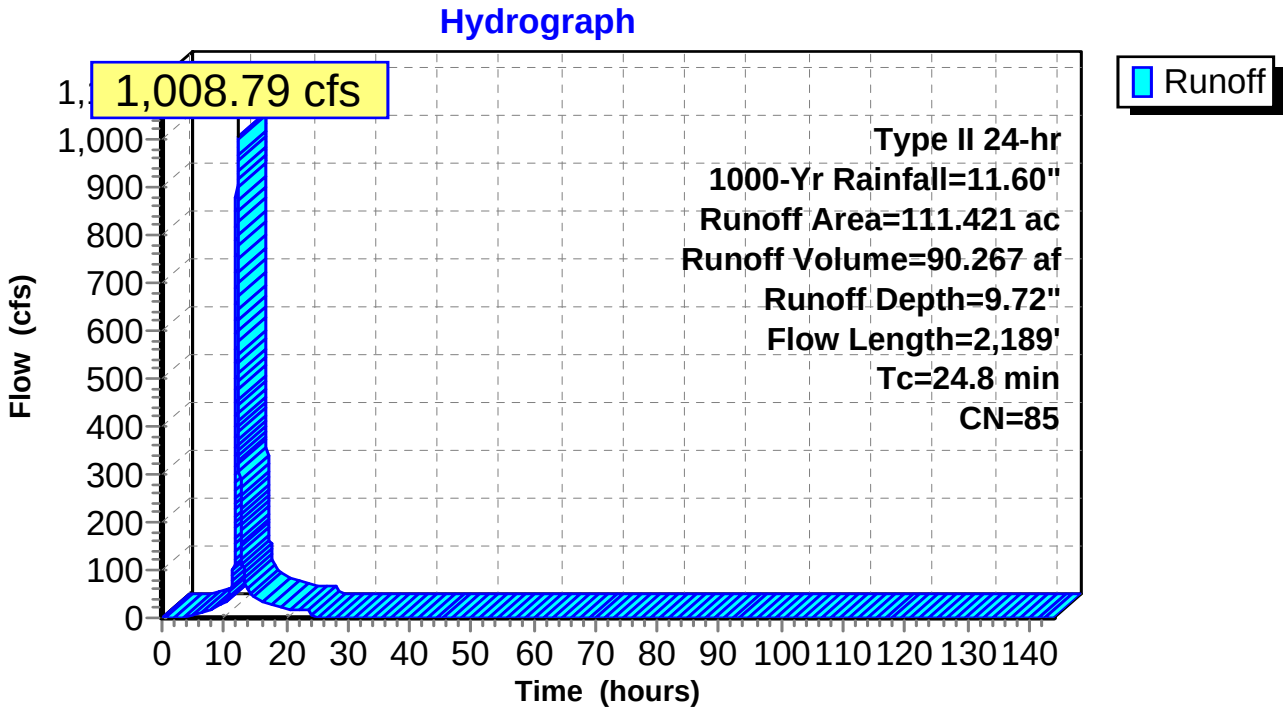
Runoff = 1,008.79 cfs @ 12.17 hrs, Volume= 90.267 af, Depth= 9.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 1000-Yr Rainfall=11.60"

Area (ac)	CN	Description
11.099	98	Water Surface, HSG A
100.322	84	50-75% Grass cover, Fair, HSG D
111.421	85	Weighted Average
100.322		90.04% Pervious Area
11.099		9.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	100	0.0110	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
2.0	86	0.0105	0.72		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.9	2,003	0.0030	3.77	234.54	**Channel Flow,** Area= 62.2 sf Perim= 49.9' r= 1.25' n= 0.025 Earth, clean & winding
24.8	2,189	Total			

Subcatchment 003S: Pond 003 Subcatchment



Summary for Subcatchment D1S: Ditch 1 Subcatchment

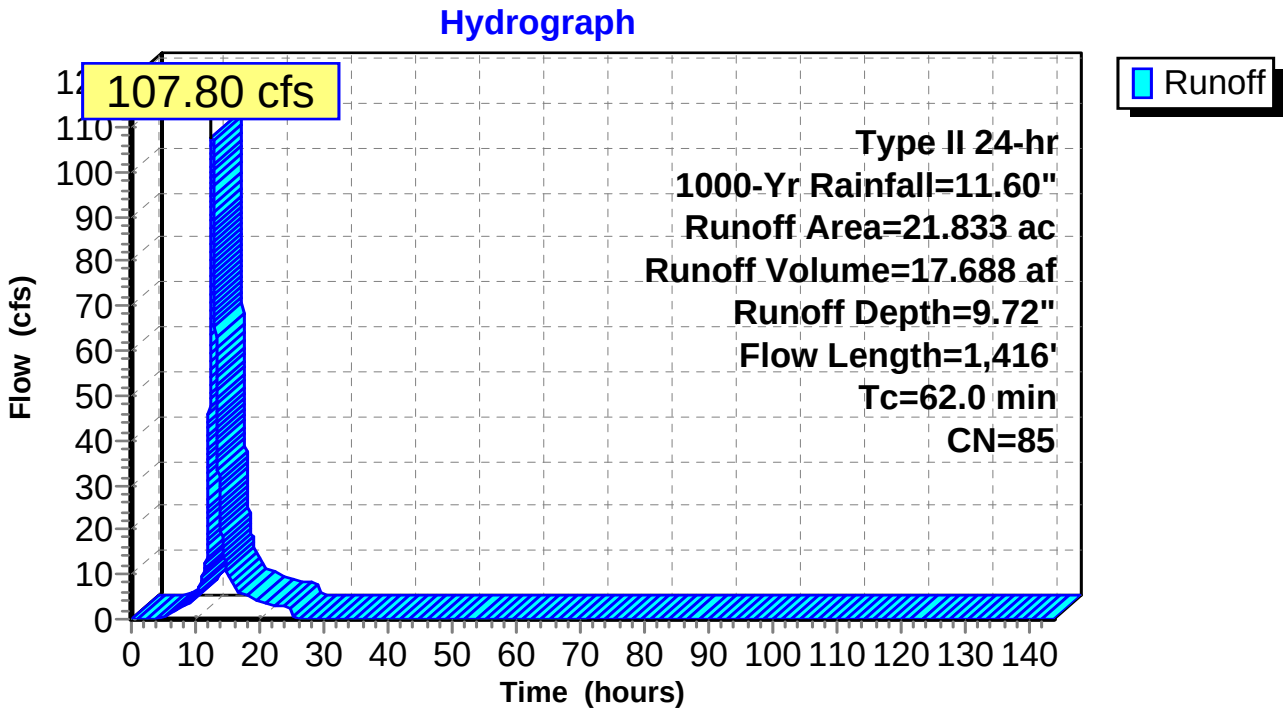
Runoff = 107.80 cfs @ 12.61 hrs, Volume= 17.688 af, Depth= 9.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 1000-Yr Rainfall=11.60"

Area (ac)	CN	Description
0.983	98	Water Surface, HSG A
20.850	84	50-75% Grass cover, Fair, HSG D
21.833	85	Weighted Average
20.850		95.50% Pervious Area
0.983		4.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.9	100	0.0040	0.08		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
41.1	1,316	0.0058	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
62.0	1,416	Total			

Subcatchment D1S: Ditch 1 Subcatchment



Summary for Subcatchment D2S: Ditch 2 Subcatchment

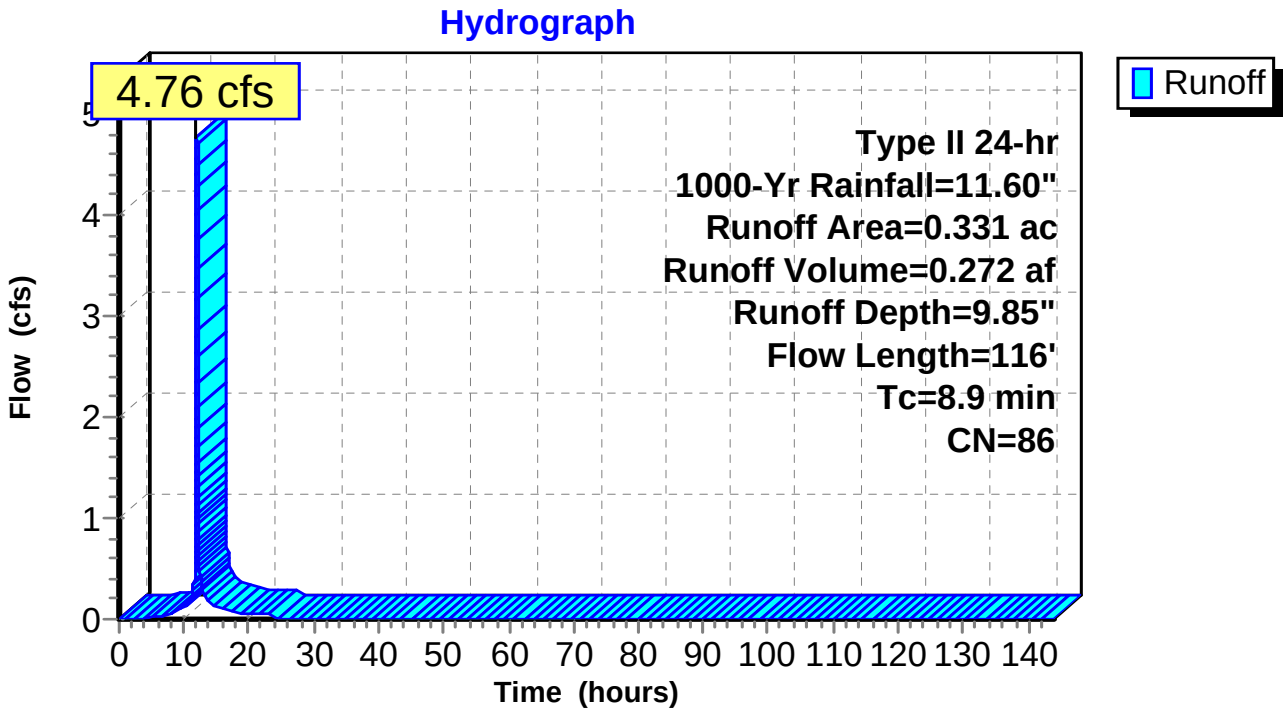
Runoff = 4.76 cfs @ 12.00 hrs, Volume= 0.272 af, Depth= 9.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 1000-Yr Rainfall=11.60"

Area (ac)	CN	Description
0.049	98	Water Surface, HSG A
0.282	84	50-75% Grass cover, Fair, HSG D
0.331	86	Weighted Average
0.282		85.20% Pervious Area
0.049		14.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	100	0.0350	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
0.1	16	0.4062	4.46		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.9	116	Total			

Subcatchment D2S: Ditch 2 Subcatchment



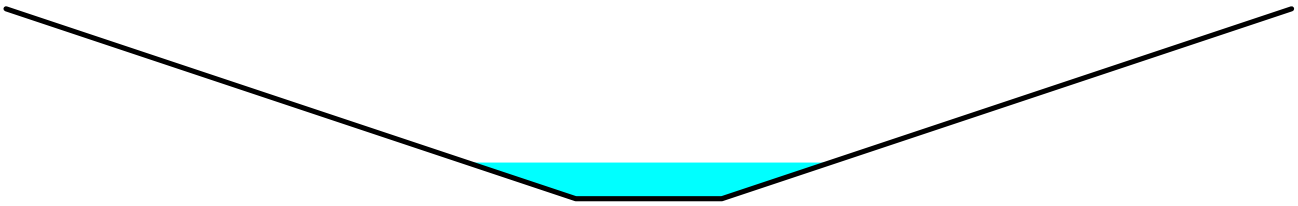
Summary for Reach D1: Ditch 1

Inflow Area = 133.254 ac, 9.07% Impervious, Inflow Depth > 65.84" for 1000-Yr event
Inflow = 170.56 cfs @ 12.61 hrs, Volume= 731.124 af
Outflow = 168.96 cfs @ 12.77 hrs, Volume= 730.142 af, Atten= 1%, Lag= 9.5 min

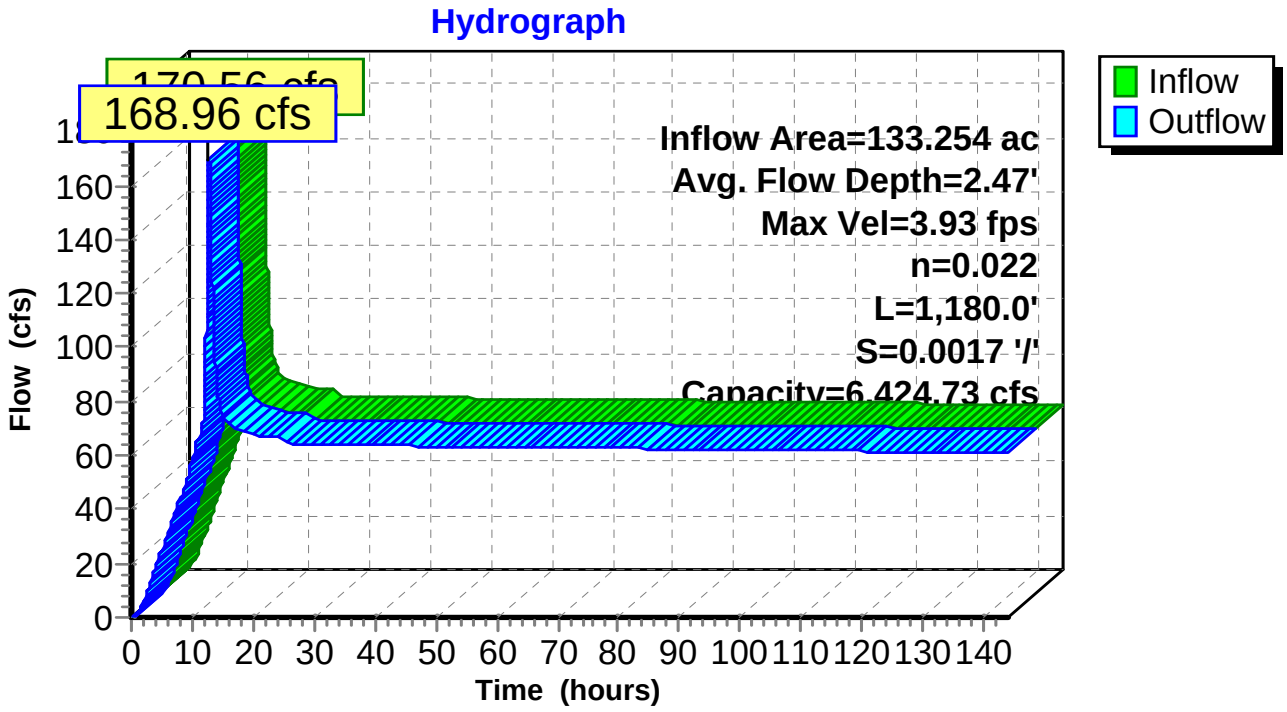
Routing by Stor-Ind+Trans method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.93 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 2.91 fps, Avg. Travel Time= 6.8 min

Peak Storage= 50,760 cf @ 12.69 hrs
Average Depth at Peak Storage= 2.47'
Bank-Full Depth= 13.00' Flow Area= 637.0 sf, Capacity= 6,424.73 cfs

10.00' x 13.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 88.00'
Length= 1,180.0' Slope= 0.0017 '/'
Inlet Invert= 279.00', Outlet Invert= 277.00'



Reach D1: Ditch 1



Summary for Reach D2: Ditch 2

Inflow Area = 133.585 ac, 9.08% Impervious, Inflow Depth > 64.84" for 1000-Yr event
Inflow = 74.12 cfs @ 15.04 hrs, Volume= 721.785 af
Outflow = 74.12 cfs @ 15.05 hrs, Volume= 721.714 af, Atten= 0%, Lag= 0.6 min

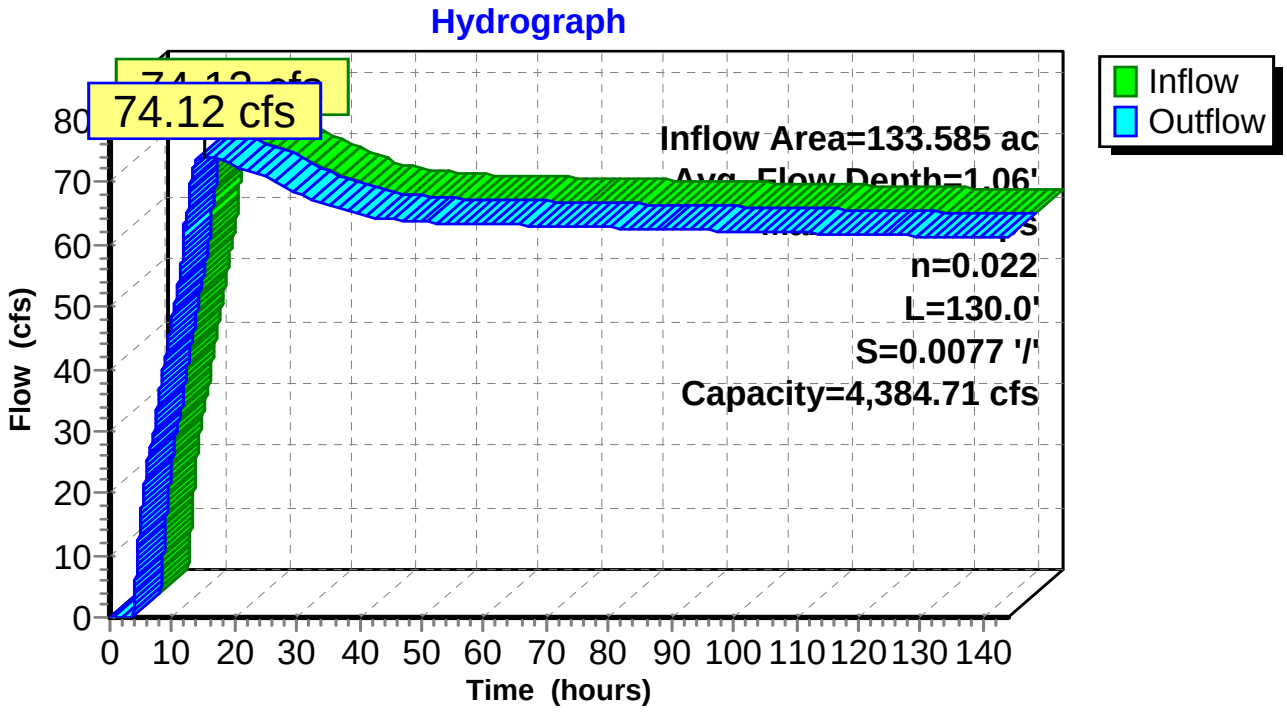
Routing by Stor-Ind+Trans method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.28 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 4.94 fps, Avg. Travel Time= 0.4 min

Peak Storage= 1,827 cf @ 15.04 hrs
Average Depth at Peak Storage= 1.06'
Bank-Full Depth= 8.00' Flow Area= 272.0 sf, Capacity= 4,384.71 cfs

10.00' x 8.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 58.00'
Length= 130.0' Slope= 0.0077 '/'
Inlet Invert= 276.00', Outlet Invert= 275.00'

‡

Reach D2: Ditch 2



Summary for Pond ARC: Access Road Culvert

[63] Warning: Exceeded Reach D1 INLET depth by 10.28' @ 15.71 hrs

Inflow Area = 133.254 ac, 9.07% Impervious, Inflow Depth > 65.75" for 1000-Yr event
Inflow = 168.96 cfs @ 12.77 hrs, Volume= 730.142 af
Outflow = 74.00 cfs @ 15.12 hrs, Volume= 721.513 af, Atten= 56%, Lag= 140.9 min
Primary = 74.00 cfs @ 15.12 hrs, Volume= 721.513 af

Routing by Stor-Ind method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Peak Elev= 290.87' @ 15.12 hrs Surf.Area= 6.887 ac Storage= 17.735 af

Plug-Flow detention time= 112.3 min calculated for 721.513 af (99% of inflow)
Center-of-Mass det. time= 62.0 min (4,449.7 - 4,387.7)

Volume	Invert	Avail.Storage	Storage Description
#1	277.00'	18.677 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

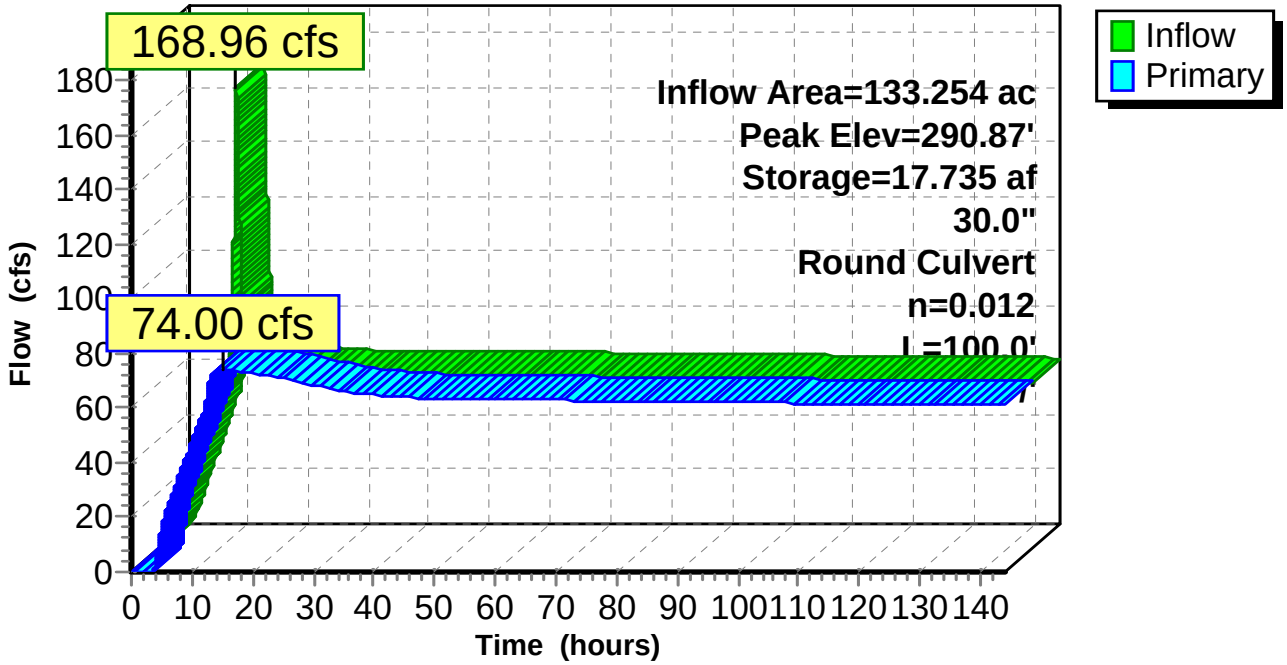
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
277.00	0.026	0.000	0.000
278.00	0.145	0.085	0.085
279.00	0.265	0.205	0.290
280.00	0.385	0.325	0.615
281.00	0.505	0.445	1.060
282.00	0.624	0.564	1.625
283.00	0.744	0.684	2.309
284.00	0.864	0.804	3.113
285.00	0.983	0.924	4.036
286.00	1.103	1.043	5.080
287.00	1.224	1.163	6.243
288.00	1.371	1.298	7.541
289.00	1.718	1.544	9.085
290.00	5.155	3.436	12.522
291.00	7.155	6.155	18.677

Device	Routing	Invert	Outlet Devices
#1	Primary	281.83'	**30.0" Round Culvert** L= 100.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 281.83' / 281.70' S= 0.0013 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf

Primary OutFlow Max=74.00 cfs @ 15.12 hrs HW=290.87' (Free Discharge)
1=Culvert (Barrel Controls 74.00 cfs @ 15.08 fps)

Pond ARC: Access Road Culvert

Hydrograph



Summary for Pond P003: Pond 003

Inflow Area = 111.421 ac, 9.96% Impervious, Inflow Depth > 82.96" for 1000-Yr event
Inflow = 1,065.93 cfs @ 12.17 hrs, Volume= 770.327 af, Incl. 57.14 cfs Base Flow
Outflow = 64.05 cfs @ 24.36 hrs, Volume= 713.436 af, Atten= 94%, Lag= 731.4 min
Primary = 64.05 cfs @ 24.36 hrs, Volume= 713.436 af

Routing by Stor-Ind method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Starting Elev= 299.00' Surf.Area= 9.955 ac Storage= 9.669 af
Peak Elev= 305.77' @ 24.36 hrs Surf.Area= 36.357 ac Storage= 119.519 af (109.850 af above start)

Plug-Flow detention time= 1,028.6 min calculated for 703.744 af (91% of inflow)
Center-of-Mass det. time= 563.2 min (4,469.9 - 3,906.7)

Volume	Invert	Avail.Storage	Storage Description
#1	298.00'	169.675 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

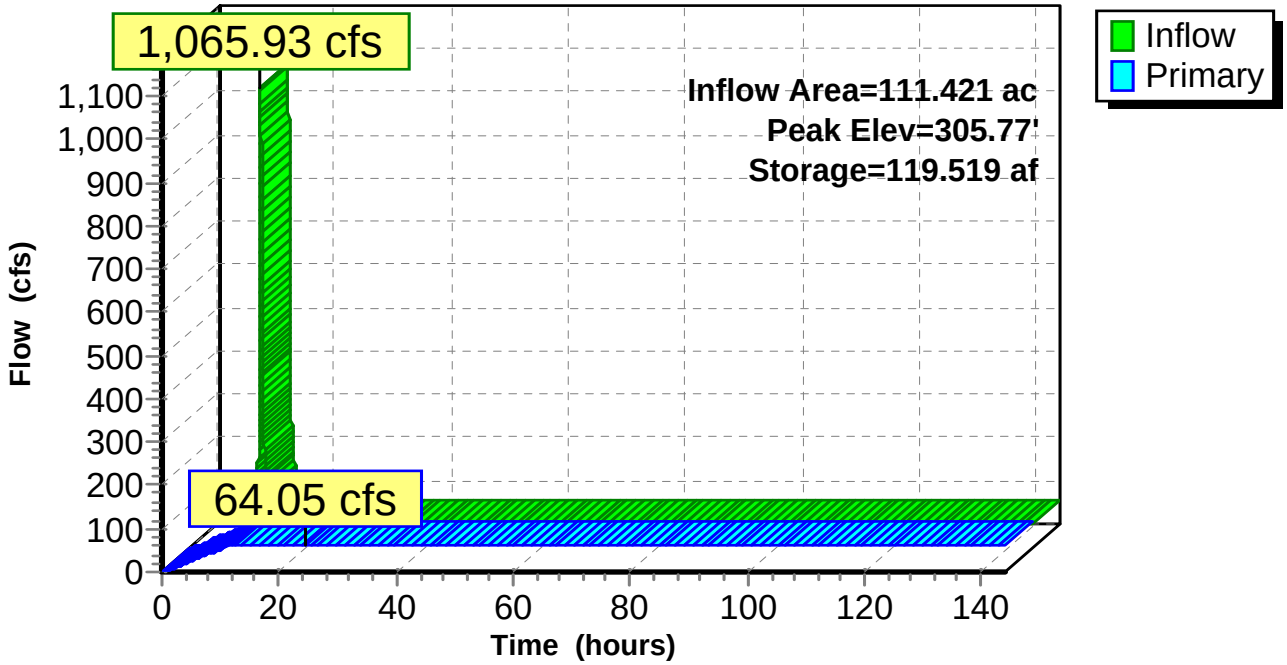
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
298.00	9.383	0.000	0.000
299.00	9.955	9.669	9.669
300.00	10.527	10.241	19.910
301.00	11.099	10.813	30.723
302.00	11.671	11.385	42.108
303.00	12.790	12.231	54.338
304.00	20.086	16.438	70.776
305.00	27.797	23.942	94.718
306.00	38.868	33.333	128.051
307.00	44.381	41.625	169.675

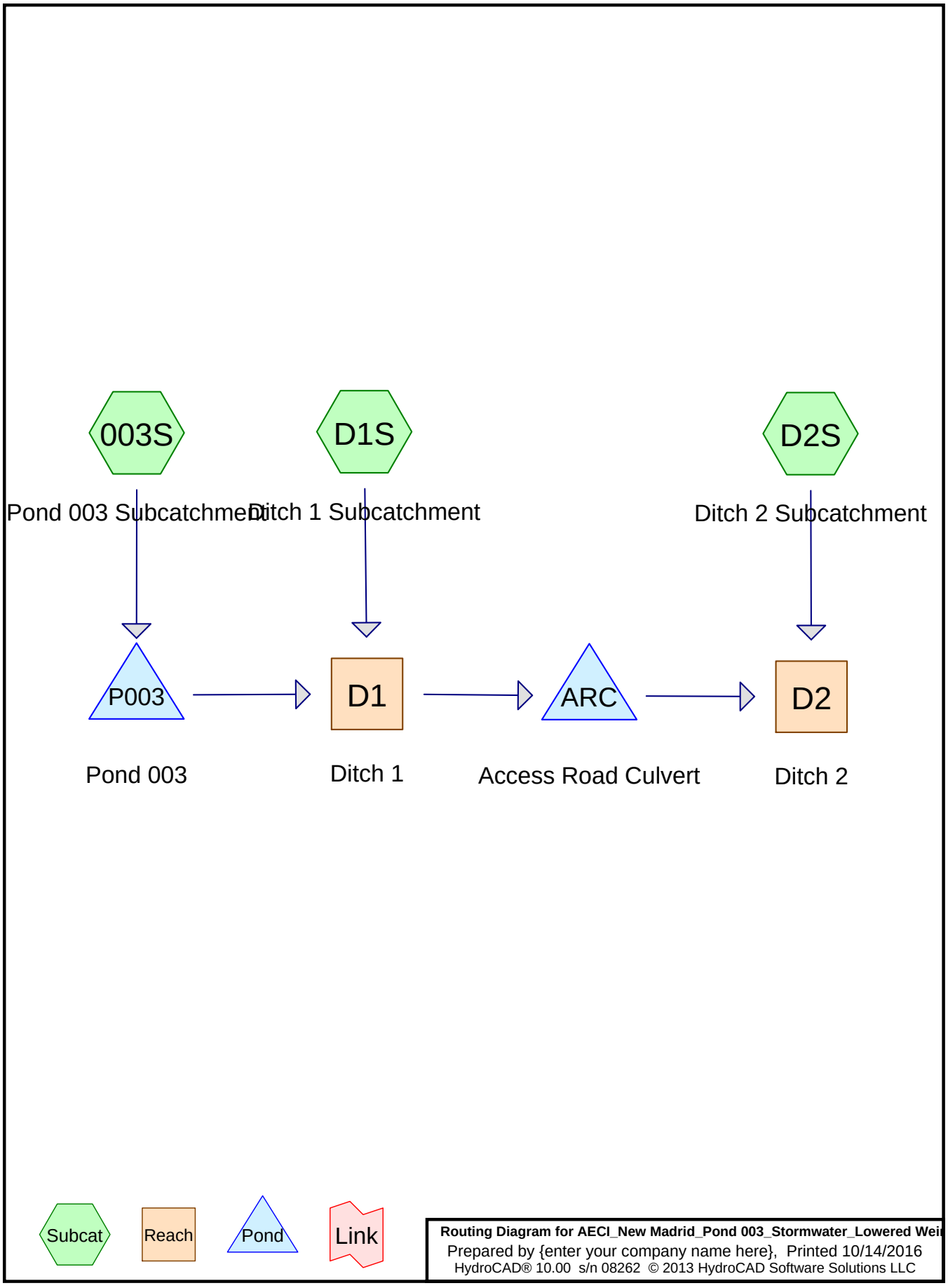
Device	Routing	Invert	Outlet Devices
#1	Primary	282.80'	**24.0" Round Culvert** L= 170.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 282.80' / 281.13' S= 0.0098 '/' Cc= 0.900 n= 0.013 Clay tile, Flow Area= 3.14 sf
#2	Device 1	299.00'	**3.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=64.05 cfs @ 24.36 hrs HW=305.77' TW=285.00' (Fixed TW Elev= 285.00')
↑└**1=Culvert** (Outlet Controls 64.05 cfs @ 20.39 fps)
↑└**2=Broad-Crested Rectangular Weir** (Passes 64.05 cfs of 175.57 cfs potential flow)

Pond P003: Pond 003

Hydrograph





Routing Diagram for AECI_New Madrid_Pond 003_Stormwater_Lowered Wei

Prepared by {enter your company name here}, Printed 10/14/2016

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
121.454	84	50-75% Grass cover, Fair, HSG D (003S, D1S, D2S)
12.131	98	Water Surface, HSG A (003S, D1S, D2S)
133.585	**85**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
12.131	HSG A	003S, D1S, D2S
0.000	HSG B	
0.000	HSG C	
121.454	HSG D	003S, D1S, D2S
0.000	Other	
133.585		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	121.454	0.000	121.454	50-75% Grass cover, Fair	003S, D1S, D2S
12.131	0.000	0.000	0.000	0.000	12.131	Water Surface	003S, D1S, D2S
12.131	**0.000**	**0.000**	**121.454**	**0.000**	**133.585**	**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)	Inside-Fill (inches)
1	ARC	281.83	281.70	100.0	0.0013	0.012	30.0	0.0	0.0
2	P003	282.80	281.13	170.0	0.0098	0.013	24.0	0.0	0.0

Time span=0.00-144.00 hrs, dt=0.01 hrs, 14401 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 003S: Pond 003 Runoff Area=111.421 ac 9.96% Impervious Runoff Depth=9.72"
Flow Length=2,189' Tc=24.8 min CN=85 Runoff=1,008.79 cfs 90.267 af

Subcatchment D1S: Ditch 1 Subcatchment Runoff Area=21.833 ac 4.50% Impervious Runoff Depth=9.72"
Flow Length=1,416' Tc=62.0 min CN=85 Runoff=107.80 cfs 17.688 af

Subcatchment D2S: Ditch 2 Subcatchment Runoff Area=0.331 ac 14.80% Impervious Runoff Depth=9.85"
Flow Length=116' Tc=8.9 min CN=86 Runoff=4.76 cfs 0.272 af

Reach D1: Ditch 1 Avg. Flow Depth=2.46' Max Vel=3.92 fps Inflow=169.50 cfs 739.231 af
n=0.022 L=1,180.0' S=0.0017 '/' Capacity=6,424.73 cfs Outflow=167.90 cfs 738.247 af

Reach D2: Ditch 2 Avg. Flow Depth=1.06' Max Vel=5.28 fps Inflow=74.14 cfs 730.078 af
n=0.022 L=130.0' S=0.0077 '/' Capacity=4,384.71 cfs Outflow=74.14 cfs 730.008 af

Pond ARC: Access Road Culvert Peak Elev=290.87' Storage=17.752 af Inflow=167.90 cfs 738.247 af
30.0" Round Culvert n=0.012 L=100.0' S=0.0013 '/' Outflow=74.02 cfs 729.806 af

Pond P003: Pond 003 Peak Elev=305.31' Storage=103.751 af Inflow=1,065.93 cfs 770.327 af
Outflow=63.32 cfs 721.543 af

Total Runoff Area = 133.585 ac Runoff Volume = 108.226 af Average Runoff Depth = 9.72"
90.92% Pervious = 121.454 ac 9.08% Impervious = 12.131 ac

Summary for Subcatchment 003S: Pond 003 Subcatchment

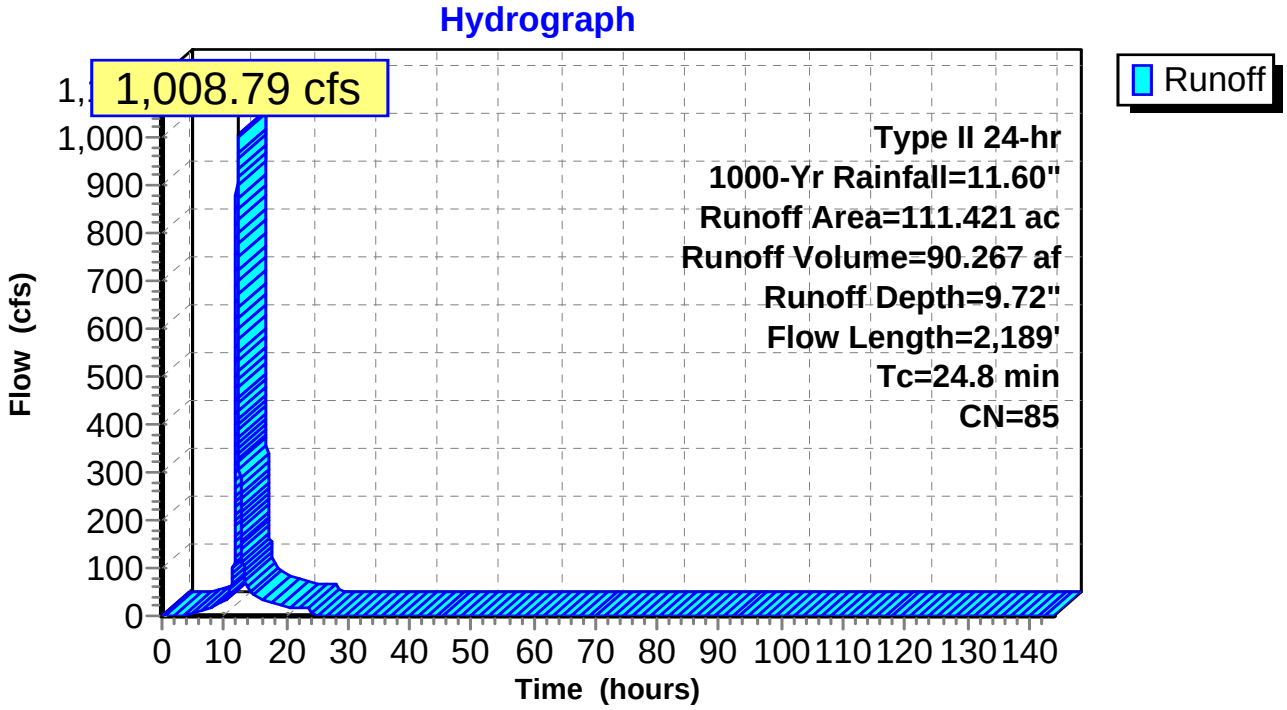
Runoff = 1,008.79 cfs @ 12.17 hrs, Volume= 90.267 af, Depth= 9.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 1000-Yr Rainfall=11.60"

Area (ac)	CN	Description
11.099	98	Water Surface, HSG A
100.322	84	50-75% Grass cover, Fair, HSG D
111.421	85	Weighted Average
100.322		90.04% Pervious Area
11.099		9.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	100	0.0110	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
2.0	86	0.0105	0.72		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.9	2,003	0.0030	3.77	234.54	**Channel Flow,** Area= 62.2 sf Perim= 49.9' r= 1.25' n= 0.025 Earth, clean & winding
24.8	2,189	Total			

Subcatchment 003S: Pond 003 Subcatchment



Summary for Subcatchment D1S: Ditch 1 Subcatchment

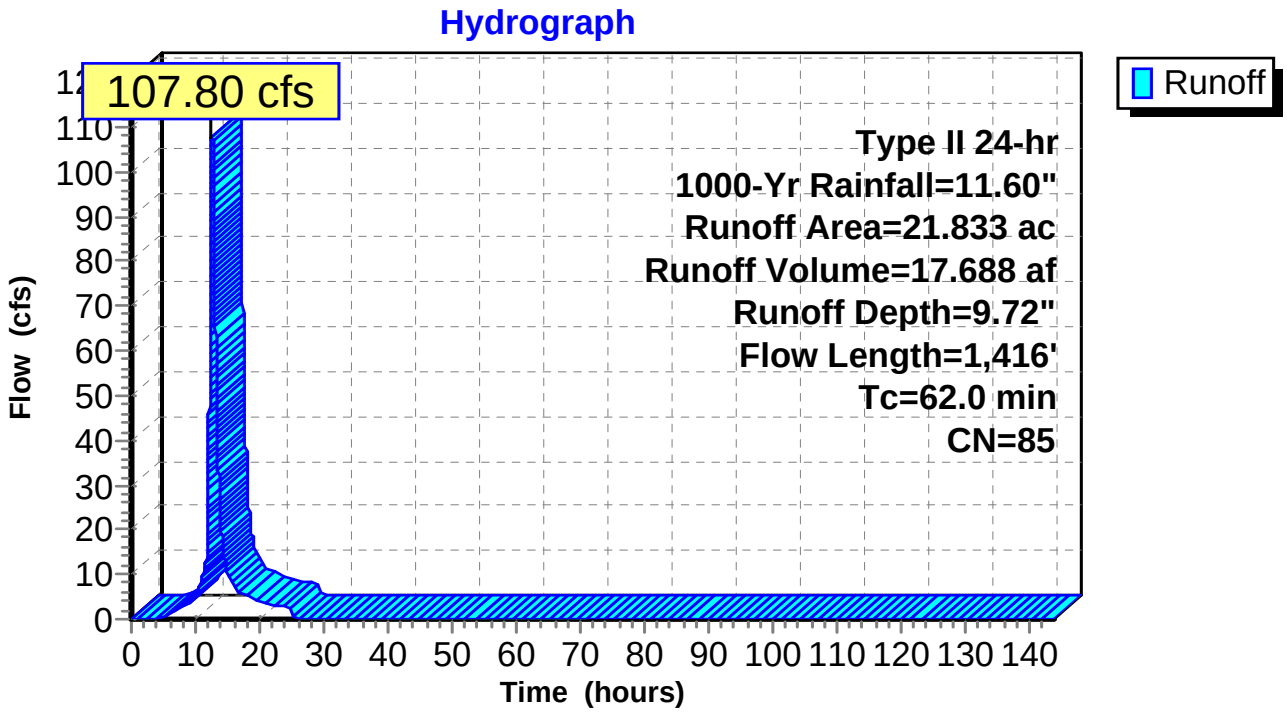
Runoff = 107.80 cfs @ 12.61 hrs, Volume= 17.688 af, Depth= 9.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 1000-Yr Rainfall=11.60"

Area (ac)	CN	Description
0.983	98	Water Surface, HSG A
20.850	84	50-75% Grass cover, Fair, HSG D
21.833	85	Weighted Average
20.850		95.50% Pervious Area
0.983		4.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.9	100	0.0040	0.08		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
41.1	1,316	0.0058	0.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
62.0	1,416	Total			

Subcatchment D1S: Ditch 1 Subcatchment



Summary for Subcatchment D2S: Ditch 2 Subcatchment

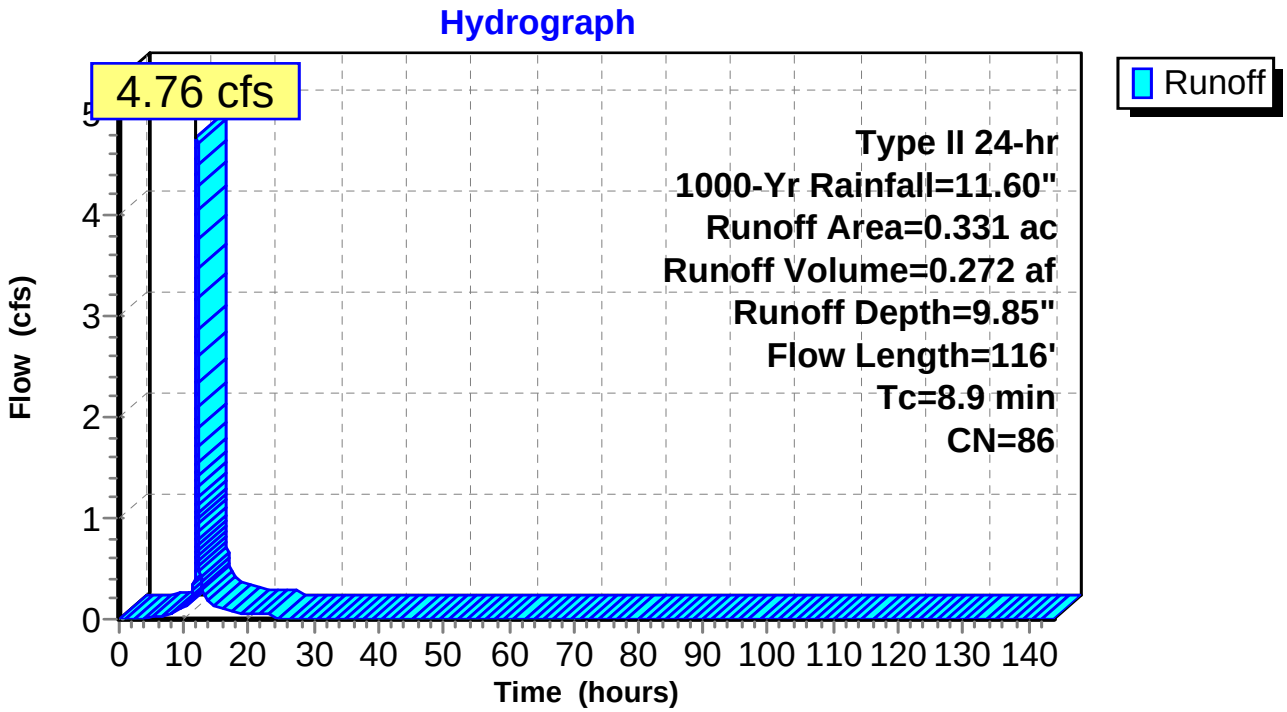
Runoff = 4.76 cfs @ 12.00 hrs, Volume= 0.272 af, Depth= 9.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Type II 24-hr 1000-Yr Rainfall=11.60"

Area (ac)	CN	Description
0.049	98	Water Surface, HSG A
0.282	84	50-75% Grass cover, Fair, HSG D
0.331	86	Weighted Average
0.282		85.20% Pervious Area
0.049		14.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	100	0.0350	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
0.1	16	0.4062	4.46		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.9	116	Total			

Subcatchment D2S: Ditch 2 Subcatchment



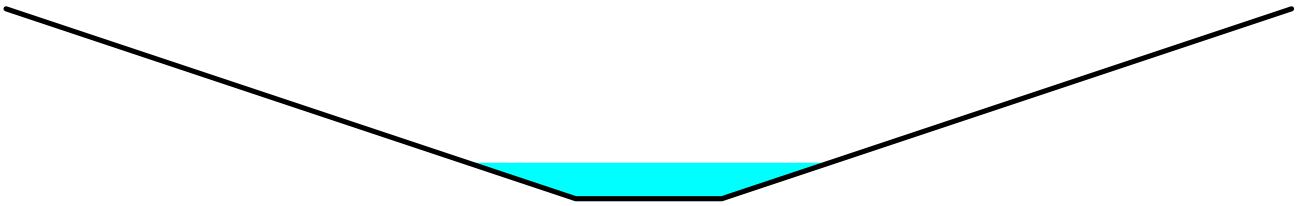
Summary for Reach D1: Ditch 1

Inflow Area = 133.254 ac, 9.07% Impervious, Inflow Depth > 66.57" for 1000-Yr event
Inflow = 169.50 cfs @ 12.61 hrs, Volume= 739.231 af
Outflow = 167.90 cfs @ 12.77 hrs, Volume= 738.247 af, Atten= 1%, Lag= 9.6 min

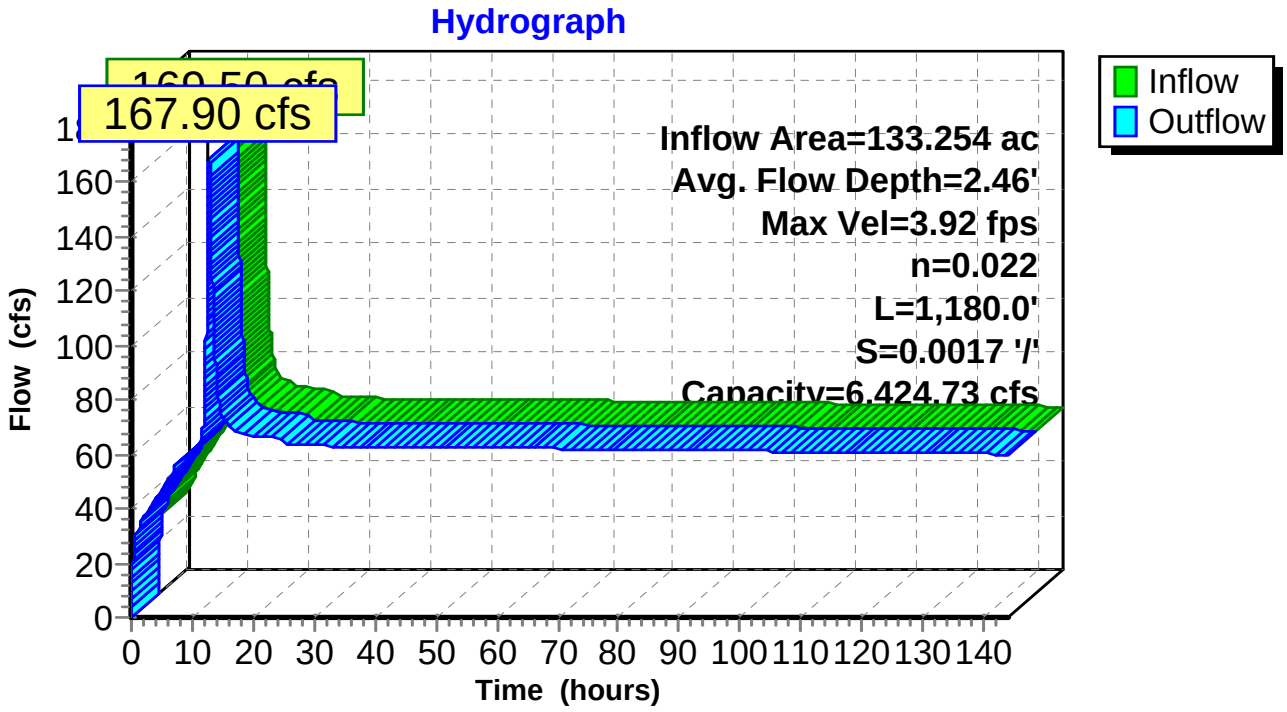
Routing by Stor-Ind+Trans method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.92 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 2.94 fps, Avg. Travel Time= 6.7 min

Peak Storage= 50,527 cf @ 12.69 hrs
Average Depth at Peak Storage= 2.46'
Bank-Full Depth= 13.00' Flow Area= 637.0 sf, Capacity= 6,424.73 cfs

10.00' x 13.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 88.00'
Length= 1,180.0' Slope= 0.0017 '/'
Inlet Invert= 279.00', Outlet Invert= 277.00'



Reach D1: Ditch 1



Summary for Reach D2: Ditch 2

Inflow Area = 133.585 ac, 9.08% Impervious, Inflow Depth > 65.58" for 1000-Yr event
Inflow = 74.14 cfs @ 14.88 hrs, Volume= 730.078 af
Outflow = 74.14 cfs @ 14.90 hrs, Volume= 730.008 af, Atten= 0%, Lag= 1.0 min

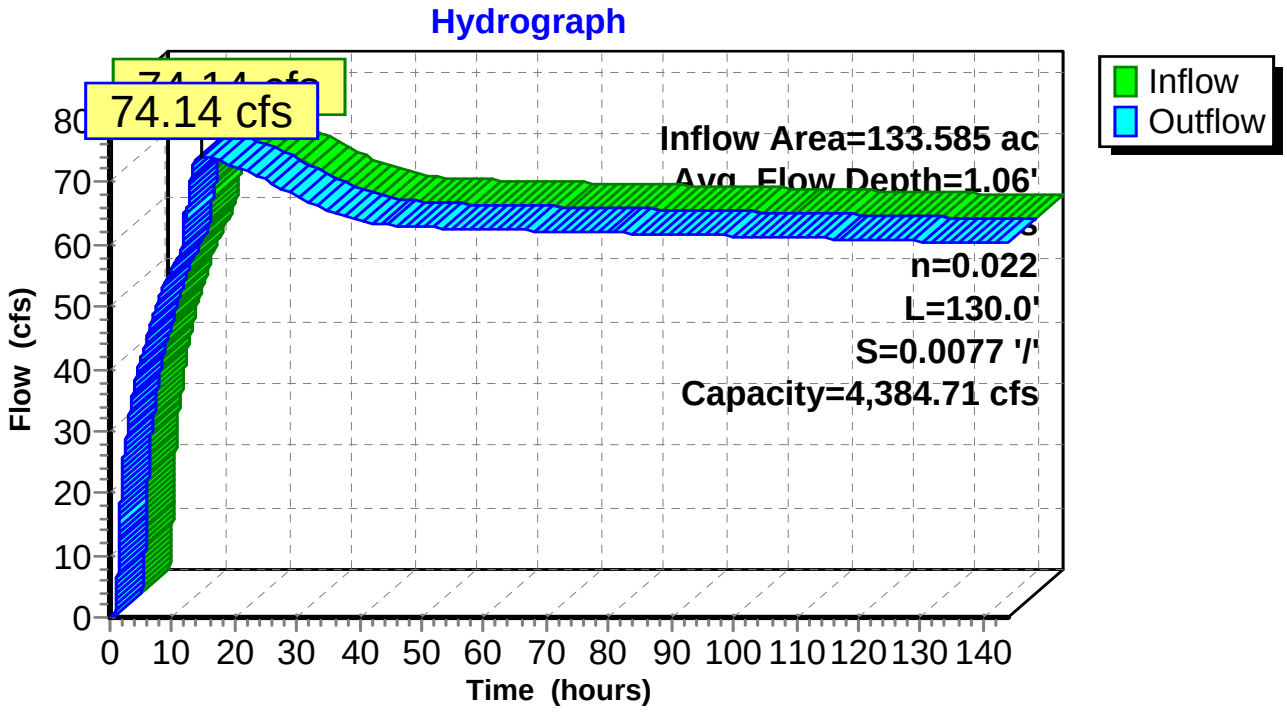
Routing by Stor-Ind+Trans method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.28 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 4.96 fps, Avg. Travel Time= 0.4 min

Peak Storage= 1,827 cf @ 14.89 hrs
Average Depth at Peak Storage= 1.06'
Bank-Full Depth= 8.00' Flow Area= 272.0 sf, Capacity= 4,384.71 cfs

10.00' x 8.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 58.00'
Length= 130.0' Slope= 0.0077 '/'
Inlet Invert= 276.00', Outlet Invert= 275.00'

‡

Reach D2: Ditch 2



Summary for Pond ARC: Access Road Culvert

[63] Warning: Exceeded Reach D1 INLET depth by 10.28' @ 15.50 hrs

Inflow Area = 133.254 ac, 9.07% Impervious, Inflow Depth > 66.48" for 1000-Yr event
Inflow = 167.90 cfs @ 12.77 hrs, Volume= 738.247 af
Outflow = 74.02 cfs @ 14.95 hrs, Volume= 729.806 af, Atten= 56%, Lag= 130.9 min
Primary = 74.02 cfs @ 14.95 hrs, Volume= 729.806 af

Routing by Stor-Ind method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Peak Elev= 290.87' @ 14.95 hrs Surf.Area= 6.892 ac Storage= 17.752 af

Plug-Flow detention time= 110.4 min calculated for 729.756 af (99% of inflow)
Center-of-Mass det. time= 60.7 min (4,351.3 - 4,290.6)

Volume	Invert	Avail.Storage	Storage Description
#1	277.00'	18.677 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

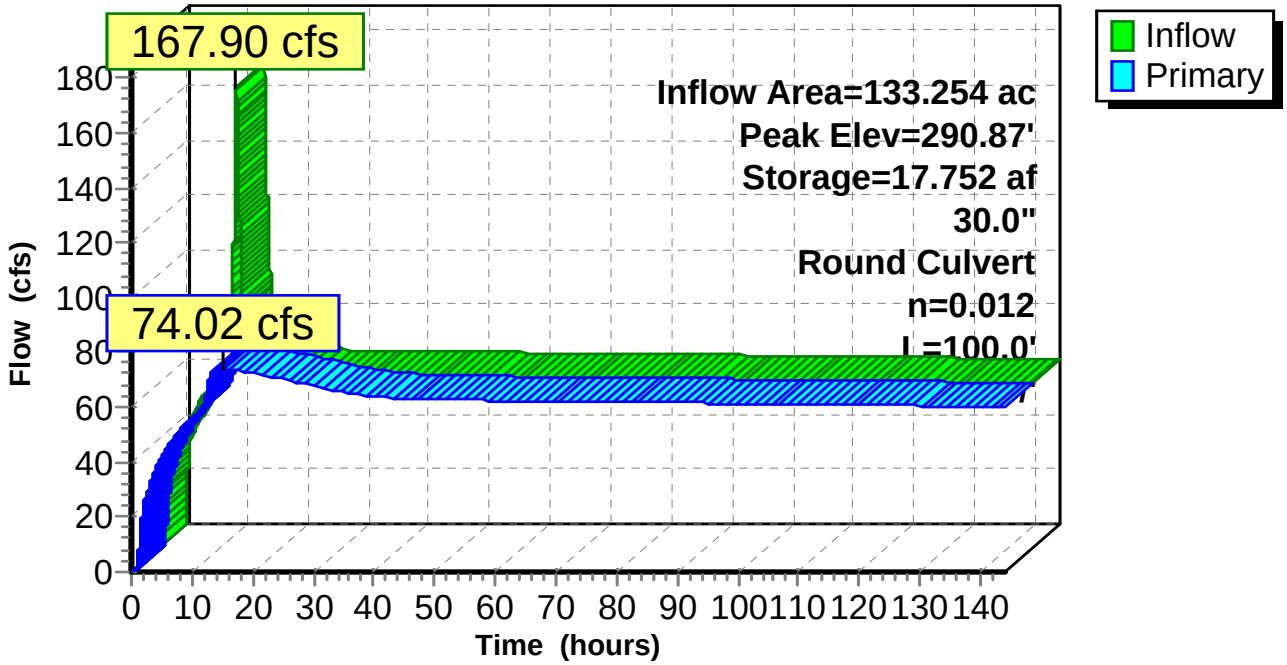
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
277.00	0.026	0.000	0.000
278.00	0.145	0.085	0.085
279.00	0.265	0.205	0.290
280.00	0.385	0.325	0.615
281.00	0.505	0.445	1.060
282.00	0.624	0.564	1.625
283.00	0.744	0.684	2.309
284.00	0.864	0.804	3.113
285.00	0.983	0.924	4.036
286.00	1.103	1.043	5.080
287.00	1.224	1.163	6.243
288.00	1.371	1.298	7.541
289.00	1.718	1.544	9.085
290.00	5.155	3.436	12.522
291.00	7.155	6.155	18.677

Device	Routing	Invert	Outlet Devices
#1	Primary	281.83'	**30.0" Round Culvert** L= 100.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 281.83' / 281.70' S= 0.0013 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf

Primary OutFlow Max=74.02 cfs @ 14.95 hrs HW=290.87' (Free Discharge)
1=Culvert (Barrel Controls 74.02 cfs @ 15.08 fps)

Pond ARC: Access Road Culvert

Hydrograph



Summary for Pond P003: Pond 003

Inflow Area = 111.421 ac, 9.96% Impervious, Inflow Depth > 82.96" for 1000-Yr event
Inflow = 1,065.93 cfs @ 12.17 hrs, Volume= 770.327 af, Incl. 57.14 cfs Base Flow
Outflow = 63.32 cfs @ 24.38 hrs, Volume= 721.543 af, Atten= 94%, Lag= 732.6 min
Primary = 63.32 cfs @ 24.38 hrs, Volume= 721.543 af

Routing by Stor-Ind method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Starting Elev= 299.00' Surf.Area= 9.955 ac Storage= 9.669 af
Peak Elev= 305.31' @ 24.38 hrs Surf.Area= 31.188 ac Storage= 103.751 af (94.082 af above start)

Plug-Flow detention time= 879.0 min calculated for 711.851 af (92% of inflow)
Center-of-Mass det. time= 462.6 min (4,369.3 - 3,906.7)

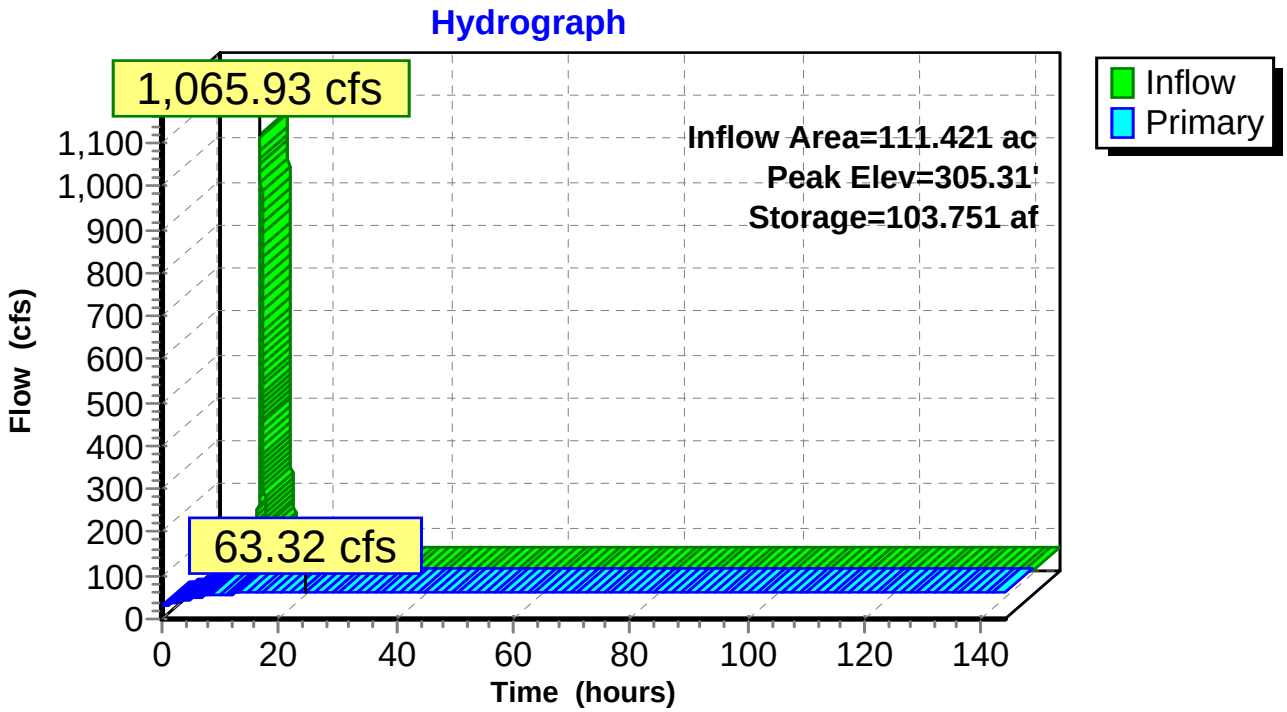
Volume	Invert	Avail.Storage	Storage Description
#1	298.00'	169.675 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
298.00	9.383	0.000	0.000
299.00	9.955	9.669	9.669
300.00	10.527	10.241	19.910
301.00	11.099	10.813	30.723
302.00	11.671	11.385	42.108
303.00	12.790	12.231	54.338
304.00	20.086	16.438	70.776
305.00	27.797	23.942	94.718
306.00	38.868	33.333	128.051
307.00	44.381	41.625	169.675

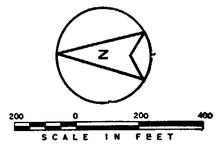
Device	Routing	Invert	Outlet Devices
#1	Primary	282.80'	**24.0" Round Culvert** L= 170.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 282.80' / 281.13' S= 0.0098 '/' Cc= 0.900 n= 0.013 Clay tile, Flow Area= 3.14 sf
#2	Device 1	297.00'	**3.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=63.32 cfs @ 24.38 hrs HW=305.31' TW=285.00' (Fixed TW Elev= 285.00')
↑└**1=Culvert** (Outlet Controls 63.32 cfs @ 20.16 fps)
↑└**2=Broad-Crested Rectangular Weir** (Passes 63.32 cfs of 238.43 cfs potential flow)

Pond P003: Pond 003

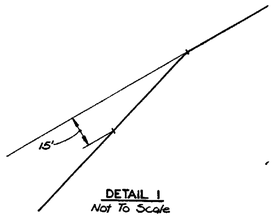


Appendix B

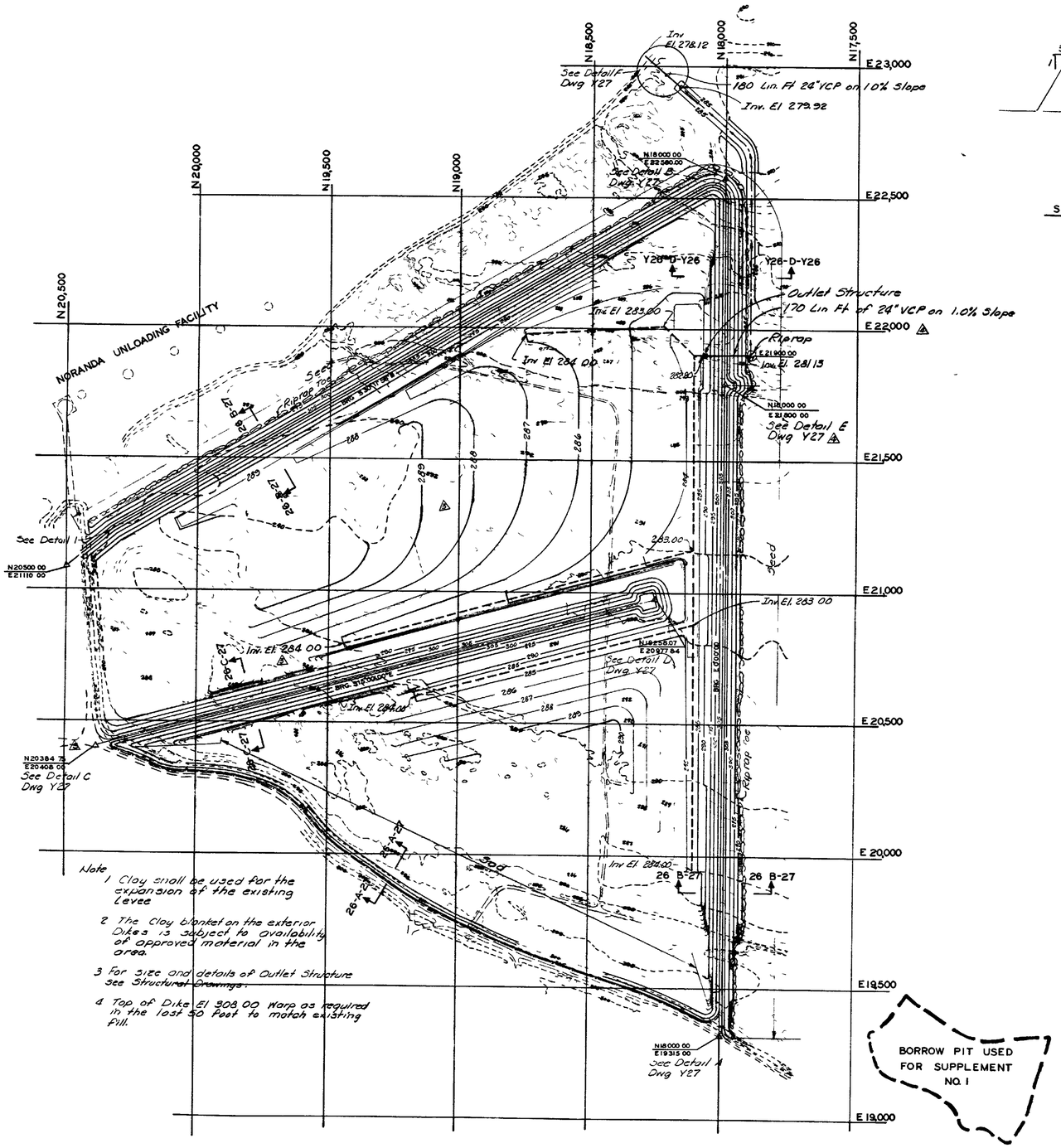


LEGEND

- 290 Existing Contour
- 290 Finish Contour
- Guardrail
- Culvert or Pipe
- Subdrain

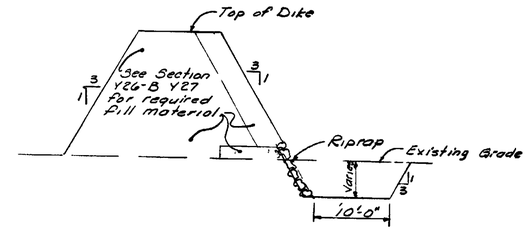


DETAIL 1
Not To Scale



Note

1. Clay shall be used for the expansion of the existing Levee
2. The Clay blanket on the exterior Dikes is subject to availability of approved material in the area.
3. For size and details of Outlet Structure See Structural Drawings.
4. Top of Dike El 308.00 Warp as required in the last 50 Feet to match existing Fill.



SECTION Y26-D-Y26
Not to Scale △4

NO	DATE	BY	REVISION
△1	2-3-71	RZ	Increased 18"VCP to 24"VCP @ Outlet Structure Revised Sub Drain @ Outlet Structure Added Riprap @ the Outlet Struct. Pipe
△2	4-23-71	RZ	Revised existing topography per new Survey Regraded as required
△3	6-29-71	RZ	Lowered Inv. Elevs on Subdrain, Regraded area within I/E Dike
4	7-14-71	RZ	Relocated Outlet Structure & Turn around Added Section Y26-D Y26
△5	10-26-71	TDW	

CONFORMING TO CONSTRUCTION RECORDS

BORROW PIT USED FOR SUPPLEMENT NO. 1

RICHARD D. WINDS NUMBER E-10690 REGISTERED PROFESSIONAL ENGINEER STATE OF MISSOURI

CONTRACT NO 150
SUPPLEMENT 14
STEAM GENERATING STATION-UNIT 1
CITY OF NEW MADRID
NEW MADRID, MISSOURI
ASH RETAINING DIKE
GRADING AND DRAINAGE PLAN

BURNS & McDONNELL ENGINEERING CO
KANSAS CITY MISSOURI

DATE DEC 7 1970	DRAWING NO REV Y26 -5
DESIGNED RZ	
DETAILED RZ	PROJECT 67 51D
CHECKED	SHEET 26 OF 68 SHEETS

6231 9/1/68

Appendix C

General Info
Homepage
Current Projects
FAQ
Glossary

Precipitation Frequency (PF)
PF Data Server
PF in GIS Format
PF Maps
Temporal Distr.
Time Series Data
PFDS Perform.
PF Documents

Probable Maximum Precipitation (PMP)
PMP Documents

Miscellaneous
Publications
AEP Storm Analysis
Record Precipitation

Contact Us
Inquiries
List-server

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: TN

Data description

Data type: Precipitation depth **Units:** English **Time series type:** Partial duration

Select location

1) Manually:

a) By location

Decimal degrees Degrees, decimal minutes Degrees, minutes, seconds

Latitude: 36.5072° N Longitude: -89.5571° E Submit

b) By station

Click here for a list of stations used in frequency analysis for TN:

Select station

c) By address

Search

2) Use map:

a) Select location

Move crosshair or double click

b) Click on station icon

Show stations on map

Location information:

Name: Tiptonville, Tennessee, US
Latitude: 36.5072° N
Longitude: -89.5571° E
Elevation: 305.11 ft **

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 8, Version 2

PF tabular PF graphical Supplementary information Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.411** (0.330-0.515)	**0.476** (0.382-0.596)	**0.581** (0.465-0.730)	**0.669** (0.533-0.843)	**0.792** (0.611-1.02)	**0.886** (0.670-1.15)	**0.982** (0.719-1.30)	**1.08** (0.761-1.45)	**1.21** (0.823-1.66)	**1.31** (0.870-1.82)
10-min	**0.602** (0.484-0.754)	**0.696** (0.559-0.873)	**0.851** (0.681-1.07)	**0.980** (0.780-1.23)	**1.16** (0.894-1.49)	**1.30** (0.981-1.69)	**1.44** (1.05-1.90)	**1.58** (1.11-2.13)	**1.77** (1.21-2.43)	**1.92** (1.27-2.66)
15-min	**0.735** (0.590-0.920)	**0.849** (0.681-1.06)	**1.04** (0.830-1.30)	**1.20** (0.951-1.50)	**1.41** (1.09-1.82)	**1.58** (1.20-2.06)	**1.75** (1.28-2.32)	**1.93** (1.36-2.59)	**2.16** (1.47-2.96)	**2.33** (1.55-3.24)

30-min	**1.05** (0.846-1.32)	**1.22** (0.981-1.53)	**1.50** (1.20-1.88)	**1.73** (1.38-2.18)	**2.05** (1.58-2.63)	**2.29** (1.73-2.98)	**2.54** (1.86-3.35)	**2.79** (1.97-3.75)	**3.12** (2.13-4.28)	**3.37** (2.25-4.68)
60-min	**1.39** (1.12-1.74)	**1.61** (1.29-2.01)	**1.96** (1.57-2.46)	**2.27** (1.80-2.85)	**2.69** (2.08-3.48)	**3.03** (2.29-3.95)	**3.38** (2.48-4.47)	**3.73** (2.64-5.04)	**4.22** (2.88-5.80)	**4.59** (3.05-6.38)
2-hr	**1.73** (1.41-2.14)	**1.99** (1.61-2.46)	**2.43** (1.97-3.01)	**2.81** (2.26-3.49)	**3.34** (2.62-4.27)	**3.77** (2.89-4.86)	**4.22** (3.13-5.52)	**4.68** (3.35-6.25)	**5.31** (3.67-7.23)	**5.81** (3.91-7.98)
3-hr	**1.96** (1.60-2.40)	**2.24** (1.83-2.75)	**2.73** (2.22-3.35)	**3.15** (2.56-3.89)	**3.77** (2.98-4.78)	**4.26** (3.29-5.46)	**4.78** (3.58-6.24)	**5.33** (3.85-7.09)	**6.09** (4.24-8.26)	**6.69** (4.54-9.14)
6-hr	**2.39** (1.98-2.90)	**2.72** (2.25-3.30)	**3.31** (2.73-4.02)	**3.82** (3.14-4.66)	**4.58** (3.67-5.75)	**5.20** (4.07-6.59)	**5.85** (4.44-7.54)	**6.54** (4.78-8.61)	**7.51** (5.29-10.1)	**8.29** (5.68-11.2)
12-hr	**2.88** (2.42-3.44)	**3.29** (2.76-3.94)	**4.00** (3.34-4.80)	**4.62** (3.84-5.56)	**5.53** (4.48-6.86)	**6.27** (4.97-7.84)	**7.05** (5.41-8.97)	**7.87** (5.81-10.2)	**9.01** (6.42-11.9)	**9.92** (6.88-13.3)
24-hr	**3.41** (2.90-4.03)	**3.93** (3.33-4.64)	**4.80** (4.06-5.68)	**5.55** (4.67-6.59)	**6.63** (5.42-8.09)	**7.49** (5.99-9.23)	**8.37** (6.50-10.5)	**9.30** (6.94-11.9)	**10.6** (7.61-13.8)	**11.6** (8.12-15.3)
2-day	**3.98** (3.43-4.64)	**4.62** (3.97-5.39)	**5.68** (4.87-6.64)	**6.58** (5.60-7.70)	**7.83** (6.47-9.40)	**8.81** (7.13-10.7)	**9.80** (7.68-12.1)	**10.8** (8.17-13.7)	**12.2** (8.88-15.7)	**13.3** (9.42-17.3)
3-day	**4.38** (3.79-5.05)	**5.07** (4.38-5.86)	**6.21** (5.36-7.20)	**7.18** (6.16-8.34)	**8.53** (7.10-10.2)	**9.59** (7.81-11.6)	**10.7** (8.42-13.1)	**11.8** (8.94-14.8)	**13.3** (9.72-17.0)	**14.4** (10.3-18.7)
4-day	**4.68** (4.08-5.38)	**5.41** (4.71-6.21)	**6.61** (5.74-7.62)	**7.63** (6.59-8.82)	**9.07** (7.59-10.8)	**10.2** (8.36-12.2)	**11.3** (9.01-13.9)	**12.5** (9.58-15.7)	**14.1** (10.4-18.1)	**15.4** (11.1-19.9)
7-day	**5.41** (4.76-6.14)	**6.21** (5.46-7.06)	**7.55** (6.62-8.61)	**8.71** (7.59-9.95)	**10.3** (8.77-12.2)	**11.6** (9.65-13.8)	**13.0** (10.4-15.7)	**14.4** (11.1-17.8)	**16.3** (12.1-20.6)	**17.8** (12.9-22.7)
10-day	**6.08** (5.39-6.86)	**6.93** (6.14-7.83)	**8.37** (7.39-9.47)	**9.61** (8.43-10.9)	**11.4** (9.70-13.3)	**12.8** (10.7-15.1)	**14.2** (11.5-17.1)	**15.7** (12.2-19.3)	**17.8** (13.3-22.3)	**19.4** (14.2-24.6)
20-day	**8.19** (7.35-9.10)	**9.17** (8.23-10.2)	**10.8** (9.66-12.0)	**12.2** (10.8-13.6)	**14.1** (12.2-16.2)	**15.6** (13.2-18.1)	**17.1** (14.0-20.3)	**18.7** (14.7-22.7)	**20.8** (15.8-25.8)	**22.4** (16.6-28.2)
30-day	**10.0** (9.05-11.0)	**11.1** (10.1-12.3)	**13.0** (11.7-14.3)	**14.5** (13.0-16.1)	**16.5** (14.3-18.7)	**18.1** (15.4-20.8)	**19.6** (16.2-23.0)	**21.2** (16.8-25.5)	**23.2** (17.8-28.6)	**24.8** (18.5-31.0)
45-day	**12.3** (11.2-13.5)	**13.7** (12.5-15.0)	**15.8** (14.4-17.4)	**17.6** (15.9-19.3)	**19.8** (17.3-22.3)	**21.5** (18.4-24.5)	**23.1** (19.2-26.9)	**24.7** (19.7-29.4)	**26.7** (20.5-32.5)	**28.1** (21.1-34.9)
60-day	**14.3** (13.1-15.5)	**15.9** (14.6-17.3)	**18.4** (16.8-20.0)	**20.3** (18.5-22.3)	**22.9** (20.0-25.4)	**24.7** (21.2-27.9)	**26.4** (22.0-30.4)	**28.0** (22.4-33.1)	**30.0** (23.1-36.2)	**31.3** (23.7-38.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates ▾ Submit

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