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MEMORANDUM

16 October 2016
File No. 40616-108

SUBJECT: Inflow Design Flood Control System Plan
Pond 004
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 004 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 004 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 004 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 and coal pile runoff. CCR reclamation and processing equipment and associated activities also occur at the impoundment. This impoundment is used sparingly as a redundant unit for Pond 003 (meaning it does not receive constant flows and more likely flows on the order of 2 to 3 times a year), primarily during plant outages and when sluice pipes need repair.

Process water and CCR are discharged into the impoundment via pipelines located at the northwestern portion of the impoundment. The discharged water and CCR flow through an open channel to a clear portion of the unit in the southern end. 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 the Mississippi River.

Typically, there are periods (i.e. months) where this impoundment receives nominal or no flow from the plant during typical operating conditions. During times when the plant does discharge into this unit, 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. However, those peak flows are limited, able to be managed, and occur more as instantaneous peaks in a day rather than sustained peak flows. We have modeled two scenarios accordingly.

For modeling purposes, the first model assumes higher operating levels for the impoundment and analysis of the design storm and average monthly flows. The second model assumes operation of the unit at a lower water level under the assumption that staff remove stoplogs when normal conditions exist and also when large storm events or higher plant flows are anticipated. Based on operational considerations, this second model assumes that the peak instantaneous flows are maintained for a 12-hour period (typically those flows are intermittent when occurring and plant ability to manage when those flows occur - so this is a conservative assumption) and then average flows thereafter.

Hydrologic and hydraulic modeling for this Pond 004 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 004 is maintained temporarily at a higher water surface elevation (WSEL) (El. 295.6), the results of the HydroCAD analysis confirm the IDF control system for Pond 004 adequately manage flow into the impoundment during and following the IDF peak storm discharge by containing the flood within the impoundment along with the average process water inflows and discharges. We also evaluated the second scenario of AECI removing stoplogs to lower the initial water surface when a significant rainfall event and/or process water discharge is anticipated (this is the more typical normal operating conditions). 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 to El. 293.6 (more typical operating condition) and to include continuous instantaneous peak process water inflows for a 12-hour period (which is conservative due to ability to manage peak flows and due to limited use of this impoundment). Similarly, Pond 004 adequately manages flow into the impoundment. **Table I** summarizes the results of the IDF peak discharge during temporary operation and a lowered normal stoplog scenario. The output from the two HydroCAD model simulations is provided as **Appendix A**. See **Figure 1** for the Pond 004 existing site plan.

Table I: HydroCAD Output Summary – 1,000 Flood		
	High Operating Conditions	Lower Operating Conditions (Normal)
Peak flood level (ft)	297.2	298.7
Minimum Dike Elevation	301.0	301.0
Minimum freeboard (ft)	3.8	2.3
Peak inflow (cfs)	84.6	104.1

§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 was noted in "Final Report Round 7 Dam Assessment" completed by GZA GeoEnvironmental, Inc. dated 3 June 2011. 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 004 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 004 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 004 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 004 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**.

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

> *<u>§257.3-3(a):</u> 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.*
>
> *<u>§257.3-3(b):</u> 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.*
>
> *<u>§257.3-3(c):</u> 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 004 is subject to the Missouri State Operating Permit issued by the Missouri Department of Natural Resources.

<u>§257.82(c)(1)</u>: 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.

<u>§257.82(c)(2)</u>: 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

<u>§257.82(c)(3)</u>: 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 004 is an existing CCR impoundment.

<u>§257.82(c)(4)</u>: 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.

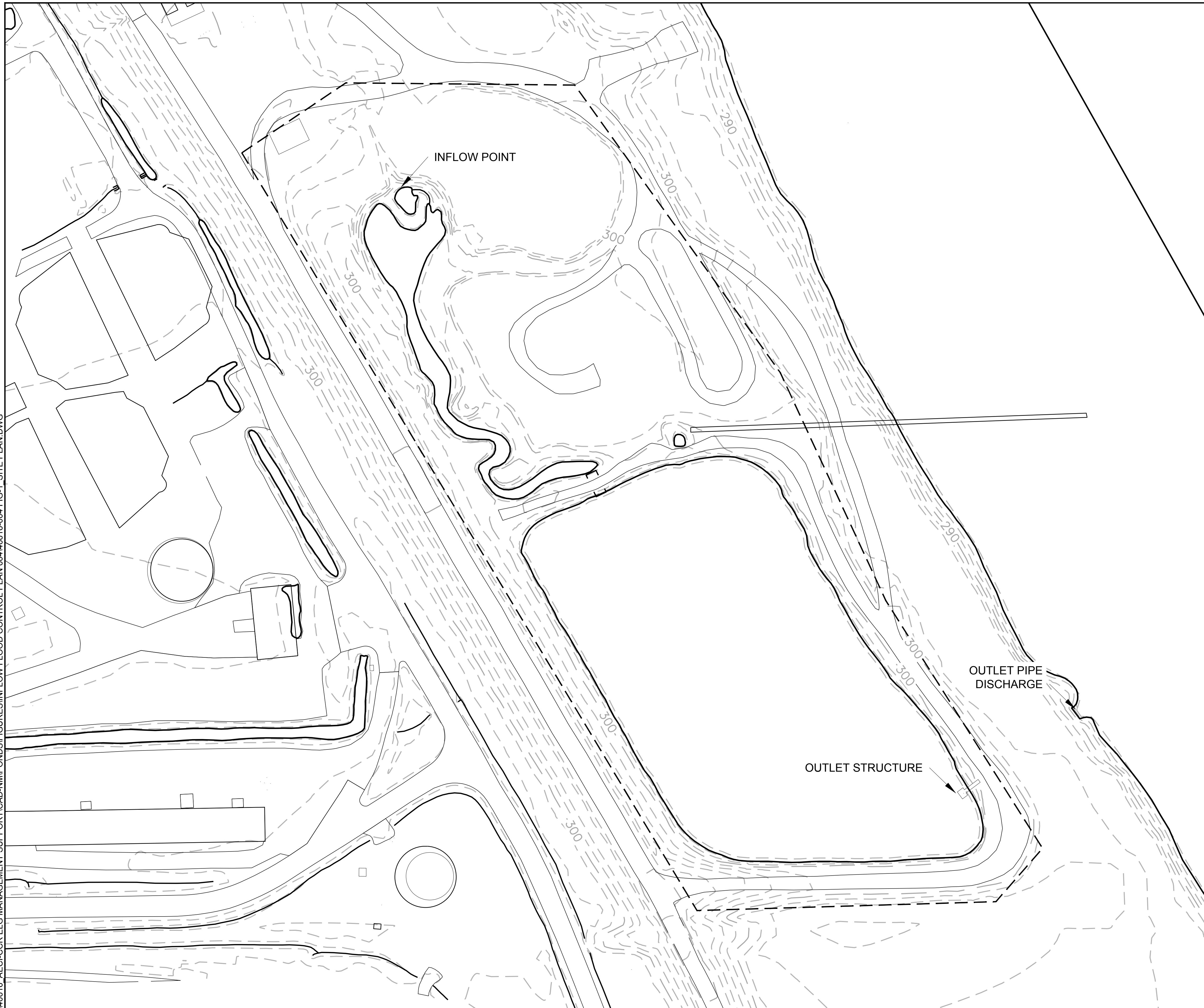
I certify that the design of the flood control system referenced in this Inflow Design Flood Control System Plan for AECI's Pond 004 at the New Madrid Power Plant meets the USEPA's CCR Rule requirements of §257.82.

Signed:________________________________
Consulting 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.

0 120 240
SCALE IN FEET

HALEY ALDRICH

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

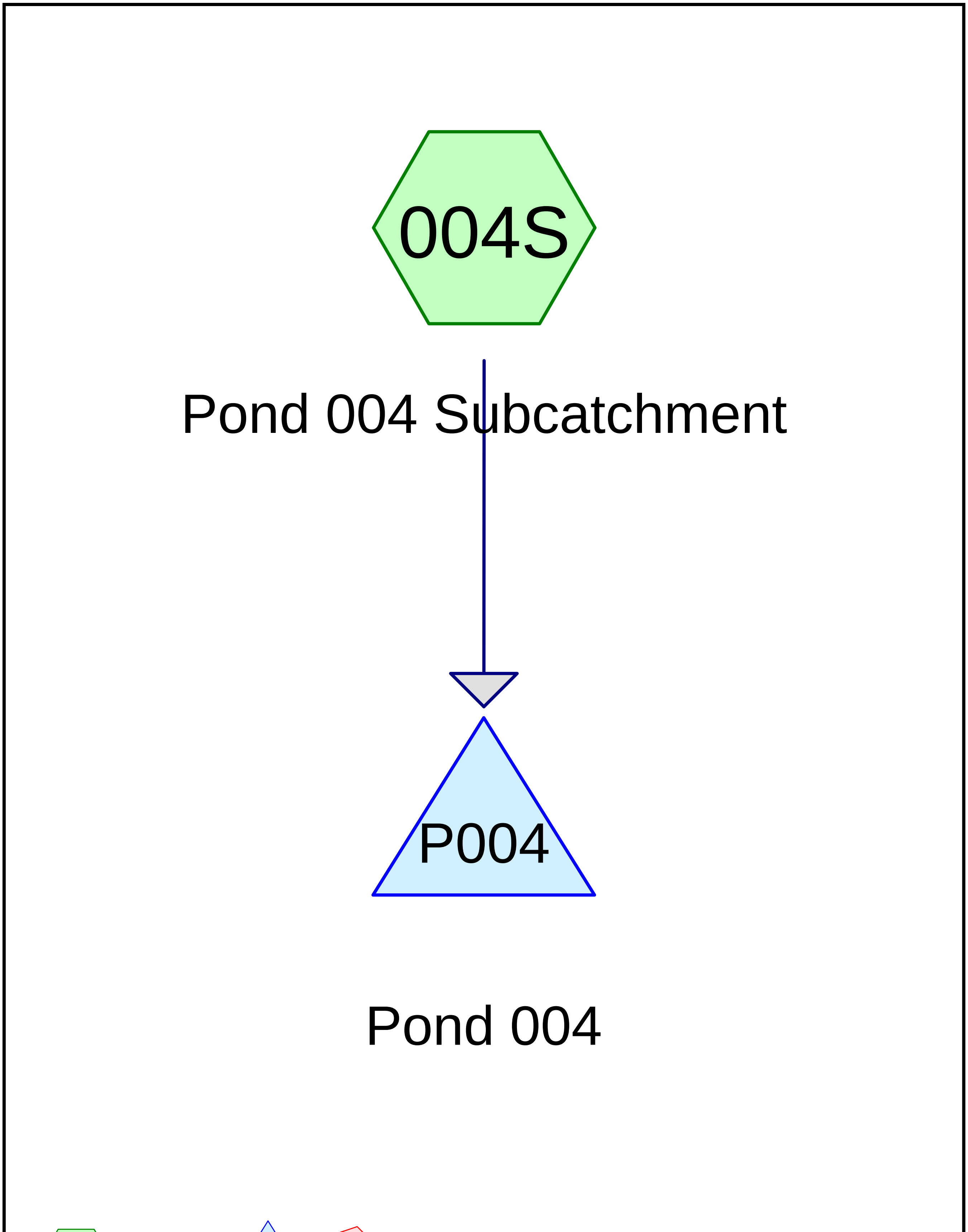
POND 004
SITE PLAN

SCALE: AS SHOWN
OCTOBER 2016

FIGURE 1

LUCAS, ANDY Printed: 9/19/2016 9:54 AM Layout: SITE PLAN
G:\40616_AECI-CCR ELG MANAGEMENT SUPPORT\CAD-NMPONDS\FIGURES\INFLOW FLOOD CONTROL PLAN 004\40616-004 FIG-1_SITE PLAN.DWG

Appendix A



Routing Diagram for AECI_New Madrid_Pond 004_Stormwater_Average Flow
Prepared by {enter your company name here}, Printed 10/14/2016

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.541	84	50-75% Grass cover, Fair, HSG D (004S)
3.431	98	Water Surface, HSG A (004S)
9.972	**89**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
3.431	HSG A	004S
0.000	HSG B	
0.000	HSG C	
6.541	HSG D	004S
0.000	Other	
9.972		**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	6.541	0.000	6.541	50-75% Grass cover, Fair	004S
3.431	0.000	0.000	0.000	0.000	3.431	Water Surface	004S
3.431	**0.000**	**0.000**	**6.541**	**0.000**	**9.972**	**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	P004	289.30	284.00	200.0	0.0265	0.025	18.0	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 004S: Pond 004 Runoff Area=9.972 ac 34.41% Impervious Runoff Depth=10.24"
Flow Length=2,550' Tc=30.8 min CN=89 Runoff=81.83 cfs 8.508 af

Pond P004: Pond 004 Peak Elev=297.16' Storage=12.211 af Inflow=84.62 cfs 41.714 af
Outflow=12.66 cfs 39.764 af

Total Runoff Area = 9.972 ac Runoff Volume = 8.508 af Average Runoff Depth = 10.24"
65.59% Pervious = 6.541 ac 34.41% Impervious = 3.431 ac

Summary for Subcatchment 004S: Pond 004 Subcatchment

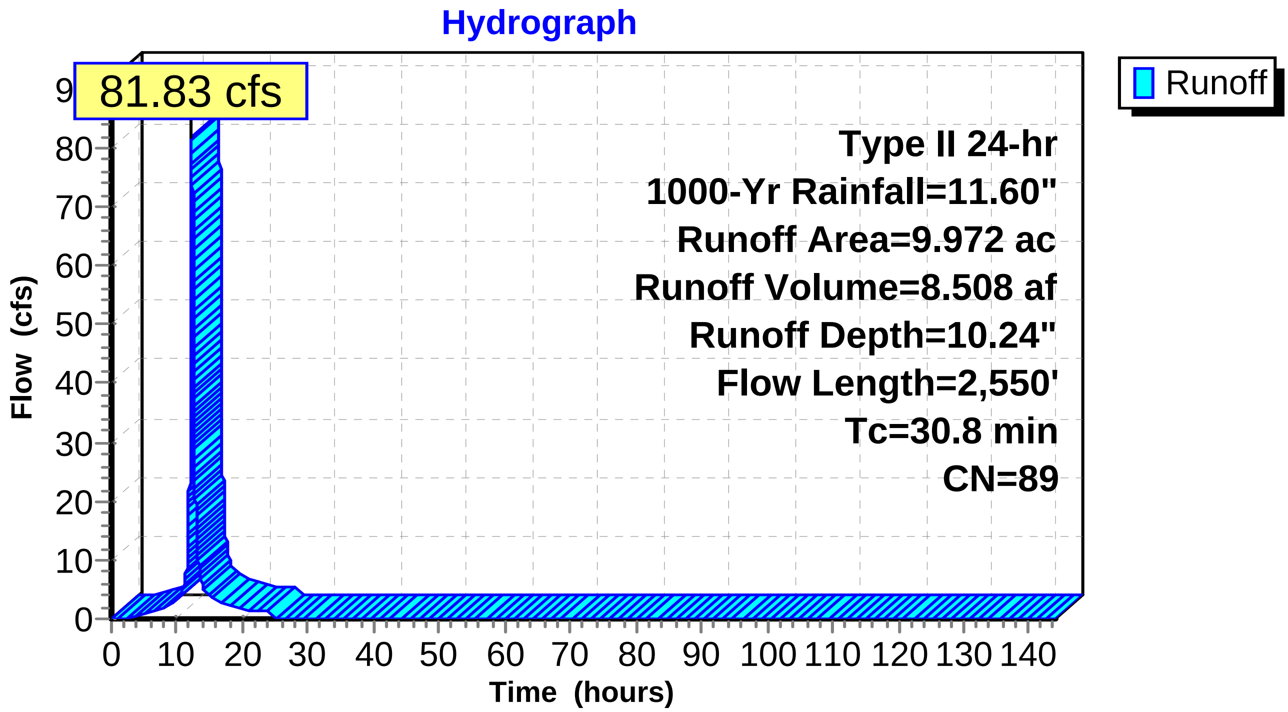
Runoff = 81.83 cfs @ 12.22 hrs, Volume= 8.508 af, Depth=10.24"

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
3.431	98	Water Surface, HSG A
6.541	84	50-75% Grass cover, Fair, HSG D
9.972	89	Weighted Average
6.541		65.59% Pervious Area
3.431		34.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.5	100	0.0100	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
8.5	447	0.0157	0.88		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.8	2,003	0.0010	4.27	558.53	**Channel Flow,** Area= 130.8 sf Perim= 38.2' r= 3.42' n= 0.025 Earth, clean & winding
30.8	2,550	Total			

Subcatchment 004S: Pond 004 Subcatchment



Summary for Pond P004: Pond 004

Inflow Area = 9.972 ac, 34.41% Impervious, Inflow Depth > 50.20" for 1000-Yr event
Inflow = 84.62 cfs @ 12.22 hrs, Volume= 41.714 af, Incl. 2.79 cfs Base Flow
Outflow = 12.66 cfs @ 13.22 hrs, Volume= 39.764 af, Atten= 85%, Lag= 59.9 min
Primary = 12.66 cfs @ 13.22 hrs, Volume= 39.764 af

Routing by Stor-Ind method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Starting Elev= 295.60' Surf.Area= 3.894 ac Storage= 5.847 af
Peak Elev= 297.16' @ 13.22 hrs Surf.Area= 4.218 ac Storage= 12.211 af (6.365 af above start)

Plug-Flow detention time= 1,672.4 min calculated for 33.913 af (81% of inflow)
Center-of-Mass det. time= 218.3 min (3,817.9 - 3,599.6)

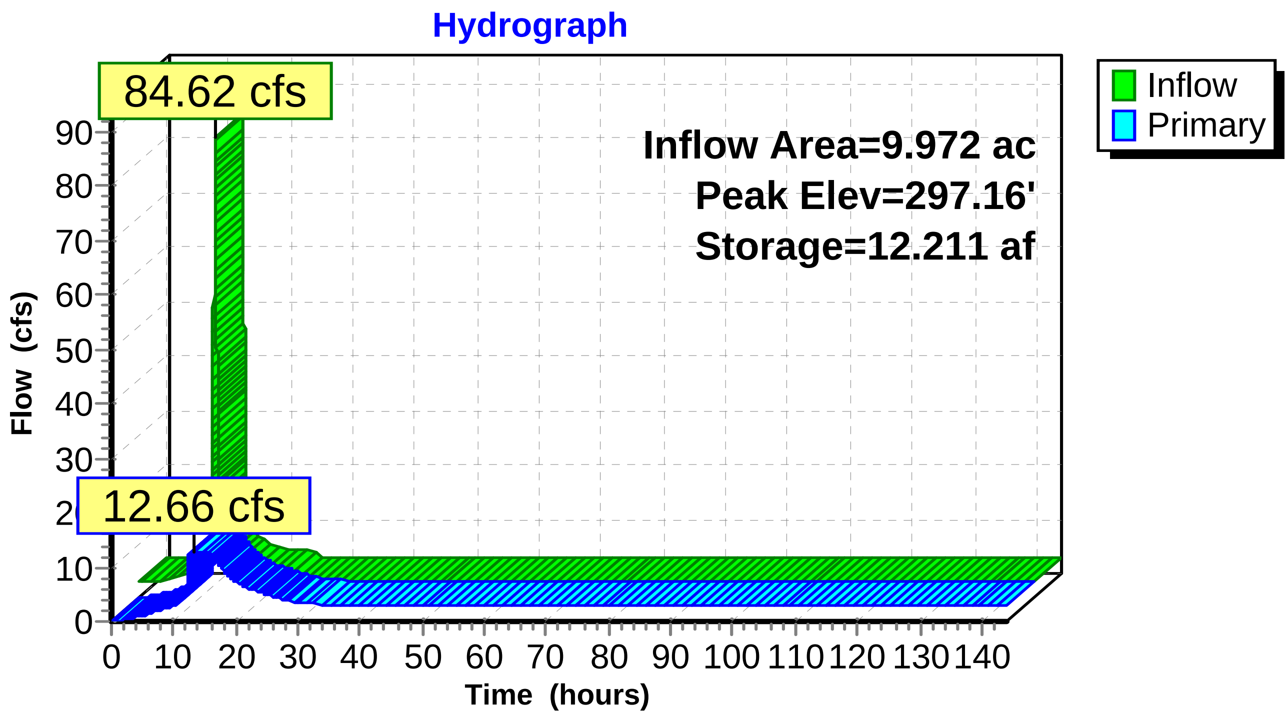
Volume	Invert	Avail.Storage	Storage Description
#1	294.00'	30.306 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

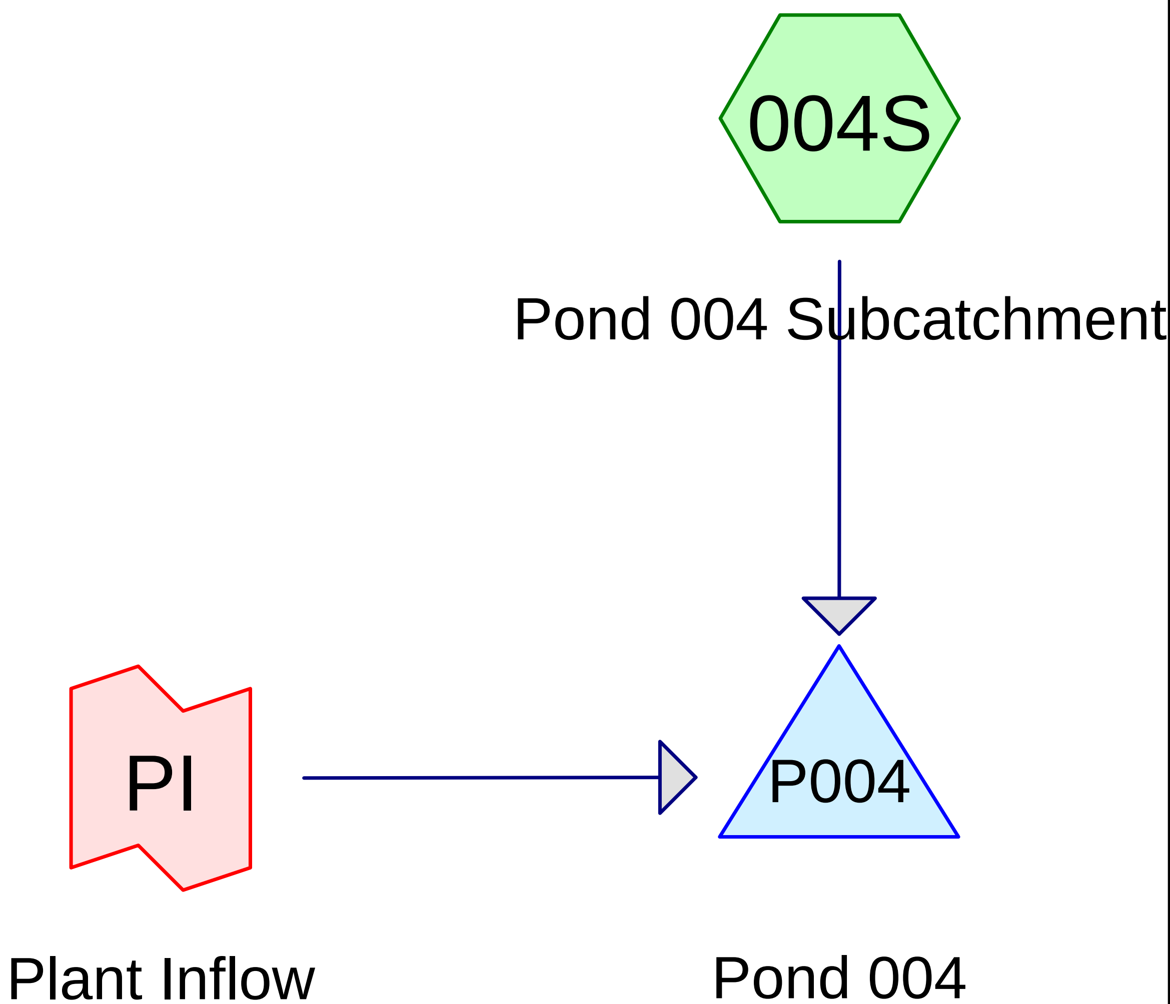
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
294.00	3.431	0.000	0.000
295.00	3.704	3.568	3.568
296.00	4.020	3.862	7.430
297.00	4.191	4.106	11.535
298.00	4.357	4.274	15.809
299.00	4.638	4.497	20.306
300.00	4.986	4.812	25.119
301.00	5.389	5.187	30.306

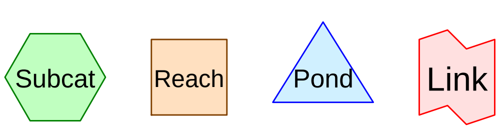
Device	Routing	Invert	Outlet Devices
#1	Primary	289.30'	**18.0" Round Culvert** L= 200.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 289.30' / 284.00' S= 0.0265 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 1.77 sf
#2	Device 1	295.60'	**3.0' long x 1.2' breadth Broad-Crested Rectangular 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) 2.66 2.69 2.71 2.78 2.89 2.99 3.09 3.20 3.21 3.19 3.30 3.32

Primary OutFlow Max=12.66 cfs @ 13.22 hrs HW=297.16' (Free Discharge)
└─**1=Culvert** (Barrel Controls 12.66 cfs @ 7.17 fps)
  └─**2=Broad-Crested Rectangular Weir** (Passes 12.66 cfs of 18.59 cfs potential flow)

Pond P004: Pond 004







Routing Diagram for AECI_New Madrid_Pond 004_Stormwater_Maximum Flow 12-hr
Prepared by {enter your company name here}, Printed 10/14/2016
HydroCAD® 10.00 s/n 08262 © 2013 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.541	84	50-75% Grass cover, Fair, HSG D (004S)
3.431	98	Water Surface, HSG A (004S)
9.972	**89**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
3.431	HSG A	004S
0.000	HSG B	
0.000	HSG C	
6.541	HSG D	004S
0.000	Other	
9.972		**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	6.541	0.000	6.541	50-75% Grass cover, Fair	004S
3.431	0.000	0.000	0.000	0.000	3.431	Water Surface	004S
3.431	**0.000**	**0.000**	**6.541**	**0.000**	**9.972**	**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	P004	289.30	284.00	200.0	0.0265	0.025	18.0	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 004S: Pond 004 Runoff Area=9.972 ac 34.41% Impervious Runoff Depth=10.24"
Flow Length=2,550' Tc=30.8 min CN=89 Runoff=81.83 cfs 8.508 af

Pond P004: Pond 004 Peak Elev=298.66' Storage=34.593 af Inflow=104.11 cfs 46.003 af
Outflow=13.45 cfs 45.986 af

Link PI: Plant Inflow Manual Hydrograph Inflow=22.28 cfs 37.495 af
Primary=22.28 cfs 37.495 af

Total Runoff Area = 9.972 ac Runoff Volume = 8.508 af Average Runoff Depth = 10.24"
65.59% Pervious = 6.541 ac 34.41% Impervious = 3.431 ac

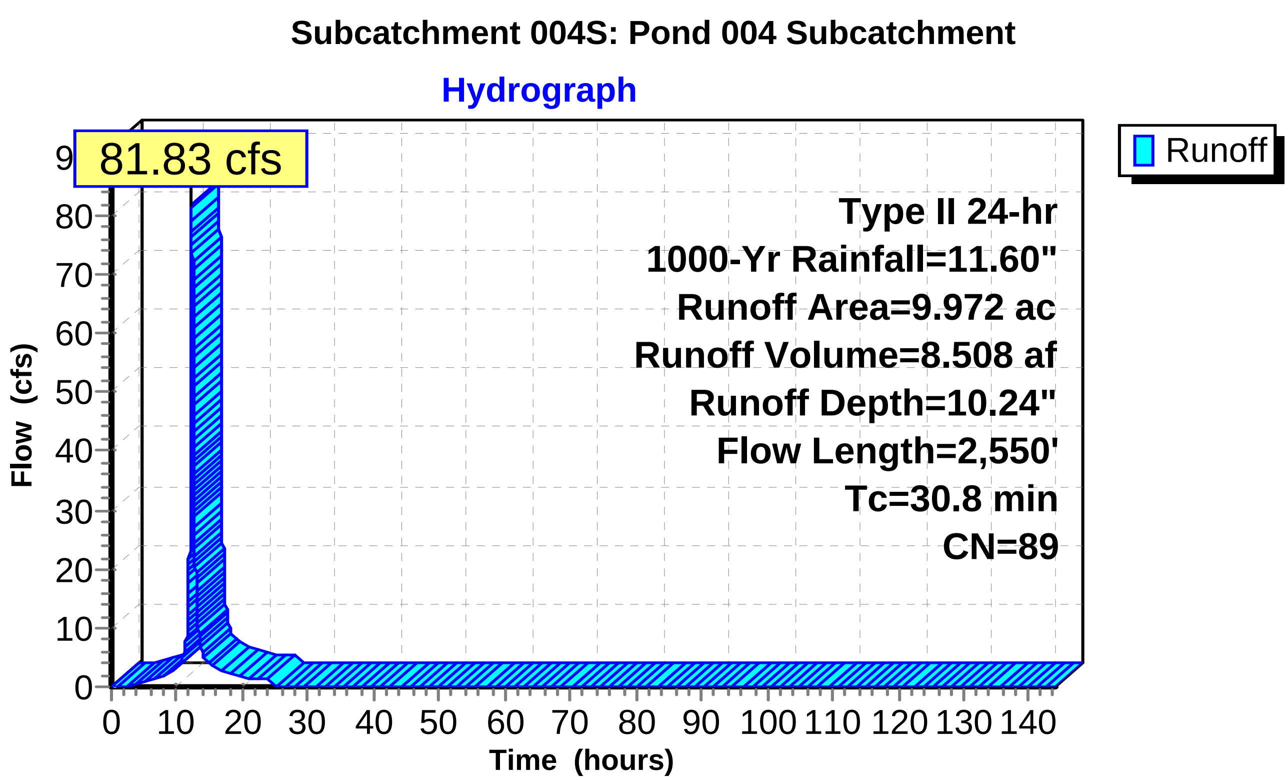
Summary for Subcatchment 004S: Pond 004 Subcatchment

Runoff = 81.83 cfs @ 12.22 hrs, Volume= 8.508 af, Depth=10.24"

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
3.431	98	Water Surface, HSG A
6.541	84	50-75% Grass cover, Fair, HSG D
9.972	89	Weighted Average
6.541		65.59% Pervious Area
3.431		34.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.5	100	0.0100	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.56"
8.5	447	0.0157	0.88		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.8	2,003	0.0010	4.27	558.53	**Channel Flow,** Area= 130.8 sf Perim= 38.2' r= 3.42' n= 0.025 Earth, clean & winding
30.8	2,550	Total			



Summary for Pond P004: Pond 004

Inflow Area = 9.972 ac, 34.41% Impervious, Inflow Depth = 55.36" for 1000-Yr event
Inflow = 104.11 cfs @ 12.22 hrs, Volume= 46.003 af
Outflow = 13.45 cfs @ 18.56 hrs, Volume= 45.986 af, Atten= 87%, Lag= 380.0 min
Primary = 13.45 cfs @ 18.56 hrs, Volume= 45.986 af

Routing by Stor-Ind method, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs
Starting Elev= 293.60' Surf.Area= 3.387 ac Storage= 14.467 af
Peak Elev= 298.66' @ 18.56 hrs Surf.Area= 4.543 ac Storage= 34.593 af (20.126 af above start)

Plug-Flow detention time= 1,696.9 min calculated for 31.518 af (69% of inflow)
Center-of-Mass det. time= 634.4 min (1,884.8 - 1,250.4)

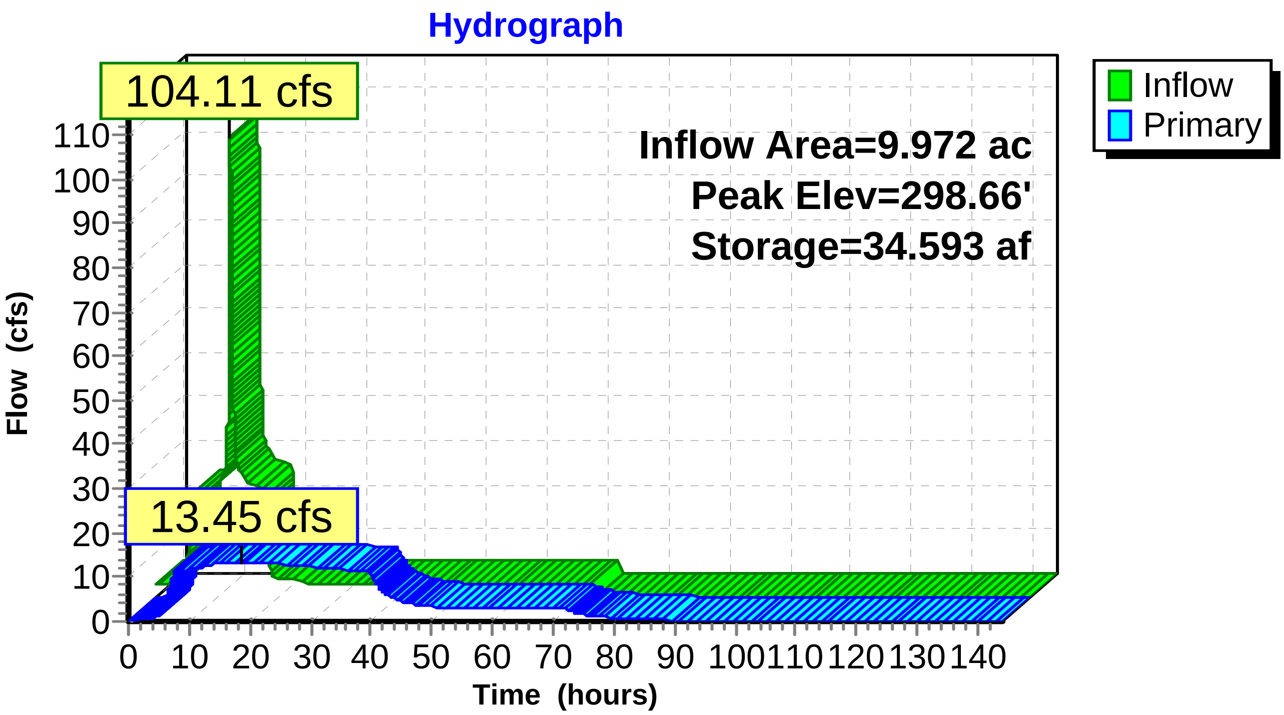
Volume	Invert	Avail.Storage	Storage Description
#1	289.00'	46.137 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
289.00	2.910	0.000	0.000
290.00	3.010	2.960	2.960
291.00	3.110	3.060	6.020
292.00	3.220	3.165	9.185
293.00	3.320	3.270	12.455
294.00	3.431	3.376	15.831
295.00	3.704	3.568	19.398
296.00	4.020	3.862	23.260
297.00	4.191	4.106	27.366
298.00	4.357	4.274	31.640
299.00	4.638	4.497	36.137
300.00	4.986	4.812	40.949
301.00	5.389	5.187	46.137

Device	Routing	Invert	Outlet Devices
#1	Primary	289.30'	**18.0" Round Culvert** L= 200.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 289.30' / 284.00' S= 0.0265 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 1.77 sf
#2	Device 1	293.60'	**3.0' long x 1.2' 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) 2.66 2.69 2.71 2.78 2.89 2.99 3.09 3.20 3.21 3.19 3.30 3.32

Primary OutFlow Max=13.45 cfs @ 18.56 hrs HW=298.66' (Free Discharge)
└─**1=Culvert** (Barrel Controls 13.45 cfs @ 7.61 fps)
  └─**2=Broad-Crested Rectangular Weir** (Passes 13.45 cfs of 113.49 cfs potential flow)

Pond P004: Pond 004



Summary for Link PI: Plant Inflow

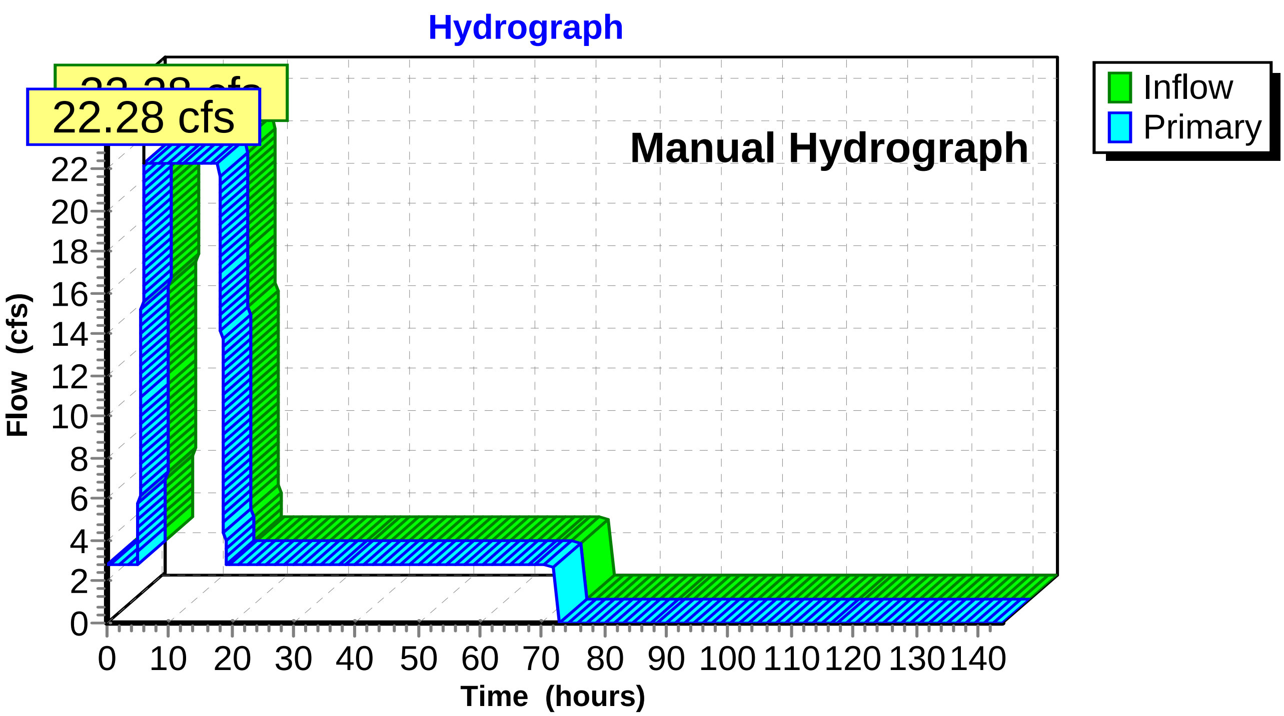
Inflow	=	22.28 cfs @	6.00 hrs, Volume=	37.495 af
Primary	=	22.28 cfs @	6.00 hrs, Volume=	37.495 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-144.00 hrs, dt= 0.01 hrs

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

2.78	2.78	2.78	2.78	2.78	2.78	22.28	22.28	22.28	22.28
22.28	22.28	22.28	22.28	22.28	22.28	22.28	22.28	22.28	2.78
2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78
2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78
2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78
2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78
2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78	2.78
2.78	2.78	2.78							

Link PI: Plant Inflow

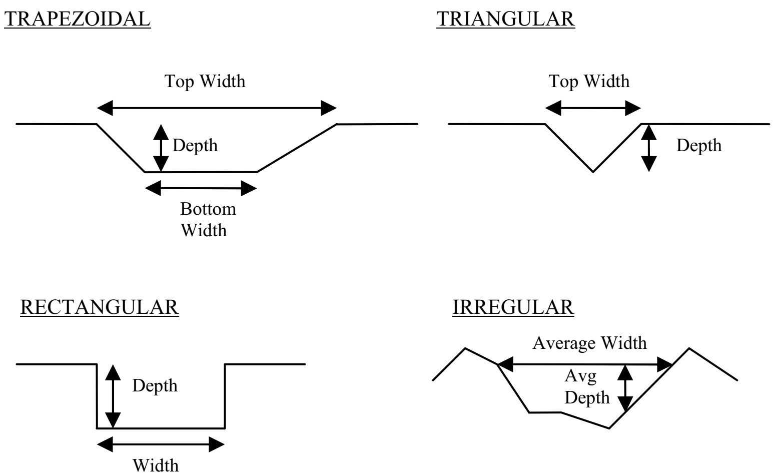


Appendix B

TYPE OF OUTLET (Mark all that apply)

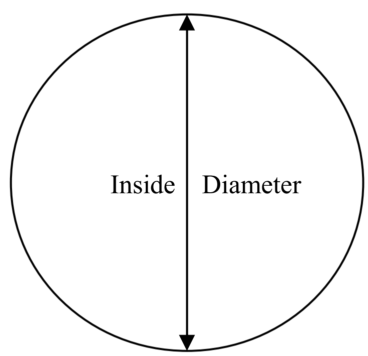
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

_____ depth
_____ bottom (or average) width
_____ top width



x **Outlet**

18" inside diameter



Material
x corrugated metal
_____ welded steel
_____ concrete
_____ plastic (hdpe, pvc, etc.)
_____ other (specify) ____________________

Is water flowing through the outlet? YES x NO _______

_____ **No Outlet**

_____ **Other Type of Outlet** (specify) ______________________________

The Impoundment was Designed By Burns & McDonnell

Appendix C

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NOAA's National Weather Service
Hydrometeorological Design Studies Center
Precipitation Frequency Data Server (PFDS)

Home Site Map News Organization

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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

USA.gov

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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