Stantec

**Stantec Consulting Services Inc.**
10509 Timberwood Circle Ste. 100 Louisville, Kentucky 40223-5308

October 6, 2016
File: rpt_002_let_175555008
Revision 0

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

**RE: Initial Inflow Design Flood Control System Plan**
**Active Ash Pond 2**
**EPA Final Coal Combustion Residuals (CCR) Rule**
**TVA Johnsonville Fossil Plant**
**New Johnsonville, Tennessee**

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## 1.0 PURPOSE

This letter documents Stantec's certification of the initial inflow design flood control system plan for the TVA Johnsonville Fossil Plant's Active Ash Pond 2. Based on the assessment, the Active Ash Pond 2 complies with the inflow design flood control requirements in the EPA Final CCR Rule at 40 CFR 257.82.

## 2.0 INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

As described in 40 CFR 257.82(c), an inflow design flood control system plan must be prepared to document how the inflow design flood control system has been designed and constructed to manage the design storm required by the hazard classification. Stantec has assigned the Active Ash Pond 2 a significant hazard potential classification rating. Thus, the inflow design storm event was selected from §257.82(a)(3) as the 1000-year flood event based upon a hazard potential classification of "significant".

## 3.0 SUMMARY OF FINDINGS

The attached plan presents the analysis of the inflow design flood control system for Active Ash Pond 2. The resulting water surface elevations are shown in the following table. The plan and results show that the impoundment meets the requirements set forth in 40 CFR 257.82(a) and (b).

| Plant | Facility | Inflow Design Storm | Water Surface Elevation (feet) | Minimum Embankment Elevation (feet) |
|---|---|---|---|---|
| JOF | Active Ash Pond 2 | 1000-year storm | 385.9 | 390.0 |

Re: **Initial Inflow Design Flood Control System Plan**
**Active Ash Pond 2**
**EPA Final Coal Combustion Residuals (CCR) Rule**
**TVA Johnsonville Fossil Plant**
**New Johnsonville, Tennessee**

## 4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stephen H. Bickel, being a Professional Engineer in good standing in the State of Tennessee do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the inflow design flood control system plan for the TVA Johnsonville Fossil Plant's Active Ash Pond 2 meets the requirements specified in 40 CFR 257.82(a), (b), and (c)(1).

SIGNATURE ____________________ DATE 10/6/2016


ADDRESS: Stantec Consulting Services Inc.
10509 Timberwood Circle, Suite 100
Louisville, Kentucky 40223-5308

TELEPHONE: (502) 212-5075

ATTACHMENTS: Inflow Design Flood Control System Plan

**Initial Inflow Design Flood Control System Plan**

Johnsonville Fossil Plant– Active Ash Pond 2
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

October 6, 2016
Revision 0

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## LIST OF APPENDICES

# 1.0 BACKGROUND

On April 17, 2015 the Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (RIN-2050-AE81;FRL-9149-4) (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services Inc. (Stantec) was contracted by the Tennessee Valley Authority (TVA) to analyze the inflow design flood for Johnsonville Fossil Plant's (JOF) Active Ash Pond 2 (referred to herein as the "Ash Pond") CCR surface impoundment and evaluate compliance with section §257.82 of the EPA Final CCR Rule.

JOF is a coal-fired, electric generating plant located in Humphreys County, Tennessee approximately 70 miles west of Nashville. The plant is located on the eastern bank of the Kentucky Lake at Tennessee River Mile 100. The Ash Pond is the only active CCR unit at JOF, and its location is shown in Figure 1. A map showing the location of JOF in relation to the surrounding hydrologic features is included as Appendix A.


**Figure 1 Johnsonville Fossil Plant**

# 2.0 EXISTING CONDITIONS

Fly ash and bottom ash are wet-sluiced through pipes running along the causeway to a sluice channel that begins at the east side of the Ash Pond. Dewatered ash is reclaimed from the sluice channel and stacked within the Ash Pond footprint. The Ash Pond's perimeter dike is approximately two miles in length and its crest elevation is approximately 390 feet.

A perimeter embankment, having a gravel road along its crest and grass-covered slopes, surrounds the Ash Pond. The northern portion of the Ash Pond mostly contains dewatered, stacked ash. The southern portion contains three separate settling ponds and interior bottom ash divider embankments.

Water from the ponds discharges through a spillway structure located on the southwest dike. The spillway consists of six precast concrete box structures, each having a 7 foot weir inlet and a 30 inch diameter HDPE outlet pipe. The outlet pipes discharge through a headwall at an NPDES permitted outfall (NPDES permit number: TN0005444) on Kentucky Lake.

The precast concrete boxes are rectangular with inside dimensions of 4 feet by 8 feet. The inlet weir is controlled by fiberglass stoplogs that maintain the normal pool elevation at 384.3 feet. At normal pool the three ponds display a total area of approximately 25 acres. The spillway structures were installed as part of the Spillway Replacement Project completed in 2009 (See Appendix E for pertinent record drawings).

Note that elevations included in this document and appendices are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

# 3.0 METHODS / DESIGN CRITERIA

This Inflow Design Flood Control System Plan has been developed to document how the inflow design flood control system has been designed and constructed to meet the requirements of §257.82. The Ash Pond was classified as a Significant Hazard structure in September, 2013 and was confirmed to be a Significant Hazard structure based on the report from Stantec to TVA dated September 30, 2016. Therefore, the following EPA Final CCR Rule criteria apply:

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. (Ref. §257.82(a)(1)),
2. The inflow design flood control system must collect and control flow from the CCR unit during and following the peak discharge of the inflow design flood. (Ref. §257.82(a)(2)),
3. The inflow design flood for a Significant Hazard potential CCR surface impoundment is the 1,000 year flood. (Ref. §257.82(a)(3)(ii)),
4. Discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.
5. The owner or operator must prepare an initial inflow design flood control system plan for its existing surface impoundments by October 17, 2016. (Ref. §257.82(c)(3)(i)),
6. The plan must be revised every 5 years, and amendments must be made whenever there is a change in condition(s) that would substantially affect the written plan in effect. (Ref. §257.82)(c)(4) & (2)),
7. This plan will be considered complete upon its placement in the facility's operating record. (Ref. §257.82(c)(1)),
8. 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 §257.82.

Hydrological calculations were performed based on Soil Conservation Service Technical Release 55 (TR-55) methods in U.S. Army Corps of Engineers' Hydrologic Engineering Center-Hydrological Modeling System (HEC-HMS) software to analyze the performance of the impoundment for the 1000 year flood. EPA's Final CCR Rule does not specify the storm duration for the inflow design flood; therefore, a 6 hour storm duration was used.

The following sections describe the hydrologic parameter inputs to the HEC-HMS model, including curve number and lag times.

## 3.1 MODELING ASSUMPTIONS

1. The study represents existing conditions as of March, 2016 except for adjustments to account for future ash stacking as noted below.
2. The stacking in the Ash Pond corresponds with Stage 1 of the "Ash Disposal Area Stacking Plan" dated October 19, 2015. This plan was used to adjust the stage-storage relationship for the pond so that available flood storage shown on the 2015 mapping within the stacking limits would not be included in the stage-storage calculations.
3. The tailwater is elevation 375.1 feet. This is the 100 year peak elevation of Kentucky Lake from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) dated September 25, 2009 for Humphreys County, Tennessee (converted from NAVD88 to NGVD29).
4. The Ash Pond is receiving a constant inflow of 44.7 million gallons per day (69.1 cfs). This inflow includes:
   - peak discharge from the Coal Yard Runoff Pond (3,720 gallons per minute - estimated in the "Pump Evaluation for Force Main Extension" report dated September 24, 2010),
   - peak discharge from the station sumps (10,000 gallons per minute – estimated in the Basis of Design Report for the Station Sump Discharge Relocation dated January 6, 2012),
   - and other plant process flows shown on the NPDES Permit No. TN0005444 wastewater flow schematic.
5. Spillway pipes are free from obstructions to flow.

## 3.2 HYDROLOGY INPUTS

### 3.2.1 Watershed Parameters

Subwatersheds were delineated in ArcMap version 10.1. The watershed delineations were based on topographic data provided by TVA dated April 11, 2015. The estimated watershed parameters are summarized in Table 1. A figure showing the watershed delineations is included in Appendix B.

**Table 1 Watershed Parameters**

| Watershed | Drainage Area (Acres) | Composite Curve Number | Lag Time (minutes) |
|---|---|---|---|
| 1 | 50.2 | 91 | 3.8 |
| 2 | 33.7 | 96 | 3.5* |

*Note that the HEC-HMS model uses minimum lag time of 3.5 minutes.

### 3.2.1.1 Curve Number (CN)

The land use cover on the Ash Pond and contributing watersheds includes water, grass, bottom and fly ash, and gravel.

TVA report "Hydrogeologic Evaluation of Coal-Combustion Byproduct Disposal Facility Expansion," Kingston Fossil Plant, dated November 2004 was utilized to determine the CN for the exposed Bottom Ash (86) and Fly Ash (91). Because fly ash comprises about 80% of the JOF ash and the two ash streams are comingled, a CN of 91 was assigned for all exposed ash areas.

Areas of vegetation were assumed to be in "good condition" with a Hydrologic Soil Group (HSG) of C (CN 80). Gravel areas were assumed to have a HSG of D (CN 91). Surface water areas were assigned a CN of 100.

A summary of curve number calculations and a map showing the curve numbers for each sub-area is included in Appendix C.

### 3.2.1.2 Lag Time

The time of concentration for each subwatershed was calculated using the NRCS segmental approach described in TR-55. The longest hydraulic flow path in each subwatershed was delineated using topographic data and aerial imagery data (dated April 11, 2015 and March 23, 2015, respectively). The flowpaths were subdivided into sheet, shallow-concentrated and open-channel flow components. The following methods were used to calculate flow velocities (time of concentration was then found by dividing flow length by velocity) for each flow component:

- Sheet Flow: Sheet flow velocity was computed based on methodology presented in TR-55. This equation calculates time of concentration based on Manning's roughness coefficient for sheet flow, flow length (up to a maximum distance of 100 feet) slope, and the 2 year, 24 hour rainfall depth.
- Shallow Concentrated Flow: Shallow concentrated flow velocity was calculated based on methodology presented in TR-55. This equation calculates average velocity based on the slope and surface of the watercourse.
- Open Channel Flow: Open channel flow velocities were calculated based on an assumed depth and channel geometry.

Lag time calculations are included in Appendix D.

### 3.2.2 Spillway Data

Flow from the Ash Pond is conveyed to Kentucky Lake. As described in Section 2, there are six spillways within the Ash Pond. Dimensions and elevations for the six spillway structures were obtained from drawing 10W502-05, "Spillway Replacement Project" by Stantec (Rev 1 Record Drawing). These drawings are included in Appendix E.

A schematic showing the geometry of the outlet pipes is shown in Figure 2. Geometry data for the Ash Pond spillway structures is summarized in Table 2.

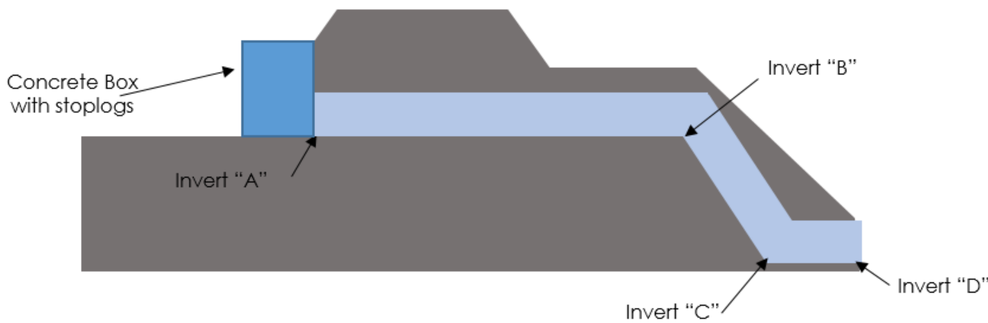


**Figure 2 Spillway Schematic**

**Table 2 Ash Pond Spillway Data**

| Weir/Box Structure | Inner Box Dimensions (feet) | Stop Log Crest Elevation (feet) | Outlet Pipe Inside Diameter (inches) | Pipe Inlet Invert "A" Elevation (feet) | Pipe Invert "B" Elevation (feet) | Pipe Invert "C" Elevation (feet) | Pipe Outlet Invert "D" Elevation (feet) | Total Pipe Length (feet) |
|---|---|---|---|---|---|---|---|---|
| Spillway 1 | 4 x 8 | 384.11 | 27 | 381.43 | 379.89 | 365.68 | 365.29 | 96 |
| Spillway 2 | 4 x 8 | 384.12 | 27 | 381.43 | 379.54 | 365.66 | 365.27 | 96 |
| Spillway 3 | 4 x 8 | 384.07 | 27 | 381.40 | 379.89 | 365.67 | 365.28 | 96 |
| Spillway 4 | 4 x 8 | 384.15 | 27 | 381.42 | 379.86 | 365.71 | 365.32 | 96 |
| Spillway 5 | 4 x 8 | 384.12 | 27 | 381.39 | 379.80 | 365.71 | 365.32 | 96 |
| Spillway 6 | 4 x 8 | 384.16 | 27 | 381.42 | 379.90 | 365.73 | 365.34 | 96 |

Each spillway consists of a precast concrete box and an outlet pipe that penetrates the embankment. Depending on the headwater elevation, these structures are controlled by weir or orifice flow through the box, or by orifice or open-channel flow through the outlet pipe.

In developing a hydraulic rating curve for these structures, these four flow conditions were computed for a range of headwater elevations and the limiting flow is used. The methods used to estimate the discharge for each of these components are described below.

Stoplog and Box – Weir flow

Flow just above the stoplog crest or just above the box crest behaves as weir flow and was computed using:

$$Q = C_w L H^{\frac{3}{2}}$$ **Eqn. 1**

Where: Q = discharge (cubic feet per second); $C_w$ = weir coefficient; L = weir length (feet); and H = head above the stoplog or box crest (feet). The stoplog and box were assumed to behave as a sharp-crested weirs with a weir coefficient of 3.27 (Chow 1959).

Box – Orifice flow

As head develops above the box crest, orifice flow in the box may limit flow through the spillway system. Orifice flow in the box was computed as:

$$Q = C_0 A(2gH)^{0.5}$$ **Eqn. 2**

Where $C_0$ = orifice discharge coefficient, A = cross sectional area of the box, g = gravitational constant, and H = head above the box crest. The orifice discharge coefficient is 0.6 (Brater and King 1976).

Outlet Pipe – Orifice flow

Orifice flow in the outlet pipe was computed for the range of hydraulic conditions using:

$$Q = C_0 A[2g(H_C)]^{0.5}$$ **Eqn. 3**

Where $H_c$ = head above the centerline of the outlet pipe (at upstream end), A = cross sectional area of the outlet pipe.

Outlet Pipe – Open-channel/submerged inlet flow

Open-channel and submerged inlet flow in the outlet pipe was computed using the HY-8 Culvert Hydraulic Analysis Program developed by the US Department of Transportation Federal Highway Administration (FHWA).

Computed rating curves for the structures are included in Appendix F.

### 3.2.3 Precipitation Data

The rainfall depth for the 1000 year, 6 hour storm is 7 to 8 inches at JOF based on Figure J-3 from the TVA Basin Point Precipitation Analysis. An 8 inch rainfall depth was used for this analysis. "Early", "Middle" and "Late Peak" hyetographs were obtained from HydroCAD for a 6 hour storm duration assuming an SCS Type II shape. The modeled distributions are included in Appendix G.

### 3.2.4 Stage-Storage Data

Storage volumes were computed at one foot increments for the Ash Pond using AutoCAD Civil3D and are included as Appendix H. A surface was created to represent the bottom of the impoundments using existing topographic data (dated April, 2015) provided by TVA. The area denoted as "stacking limits" on the stacking plan (10W537-02) was assigned an elevation of 394 feet and added to the existing topographic data surface so that storage within this area would not be included when determining the available storage volume.

The elevation of the top of embankment for the Ash Pond is approximately 390.0 feet based on the existing topographic data.

### 3.2.5 Plant Process Flow

A flow schematic (dated March 2013 and provided by TVA), shows the average daily process flow into the Ash Pond is 31.0 million gallons per day and was applied to Watershed 1.

### 3.2.6 Starting Water Surface Elevations

The starting water surface elevation for the Ash Pond was set to elevation 384.3 feet, which is the normal pool elevation of the Ash Pond based on the April, 2015 topographic data.

## 3.3 HYDROLOGIC AND HYDRAULIC MODELING

Hydrologic and hydraulic modeling was performed using HEC-HMS 4.0 based on the model inputs summarized in Section 3.2. A model schematic is included in Figure 3.

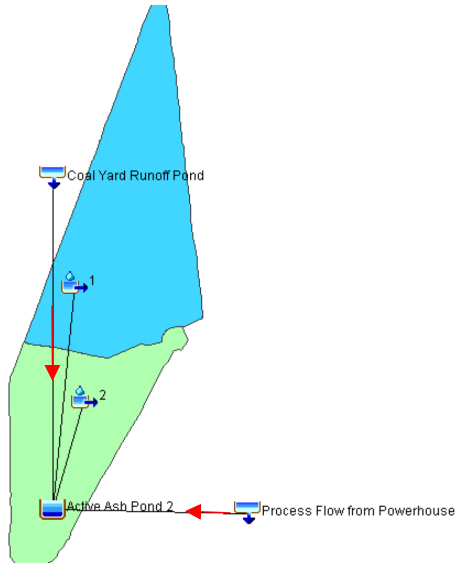


**Figure 3 HEC-HMS Model Schematic**

# 4.0 CALCULATION RESULTS

The hydrologic modeling results were used to determine the performance of the Ash Pond for the 1000 year, 6 hour storm for the three precipitation events described in Section 3.2.3.

## 4.1 CAPACITY AND FREEBOARD RESULTS

The peak pool elevation, inflow and outflow for each pond is summarized in Table 3. The results showed that the Ash Pond can convey the flow from the 1000 year 6 hour storm without overtopping.

**Table 3 Hydrologic and Hydraulic Modeling Results**

| Scenario | Storm | Peak Water Surface Elevation (feet) | Peak Inflow (cubic feet per second) | Peak Outflow (cubic feet per second) | Minimum Embankment Crest Elevation (feet) | Freeboard (feet) |
|---|---|---|---|---|---|---|
| 1 | SCS Type II "Early Peak" | 385.1 | 676 | 127 | 390.0 | 4.9 |
| 2 | SCS Type II "Middle Peak" | 385.8 | 1231 | 198 | 390.0 | 4.2 |
| 3 | SCS Type II "Late Peak" | 385.9 | 1255 | 200 | 390.0 | 4.1 |

# 5.0 CONCLUSIONS

The calculations included in this report demonstrate that the inflow design flood control system adequately manages flow into and from the CCR unit during and following the peak discharge of the inflow design flood (1000-year flood). In addition, the CCR unit discharges through a NPDES permitted outfall, and is therefore handled in accordance with the surface water requirements under §257.3-3. Therefore the Ash Pond meets the requirements of Section §257.82 of the EPA Final CCR Rule.

# 6.0 REFERENCES

1. Boggs, Mark J. and Julian, Hank, E., "Hydrogeologic Evaluation of Coal-Combustion Byproduct Disposal Facility Expansion", Kingston Fossil Plant, Tennessee Valley Authority, November 2004.

2. Schaeffer, Mel G., TVA Basin Point Precipitation Analysis, RSOGENROGCDX0003262015, March 2, 2015.

3. Bonnin G. M. et all, NOAA Atlas 14, Precipitation Frequency Atlas of the United States, Volume 2, Version 3, 2006.

4. "Johnsonville 2015 Mapping.dwg" Provided by Tennessee Valley Authority, April 11, 2015.

5. Site aerial imagery prepared for Tennessee Valley Authority, March 23, 2015.

6. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (RIN-2050-AE81; FRL-9149-4) (EPA Final CCR Rule), April 2015.

7. United States Department of Agriculture (1986). "Urban Hydrology for Small Watersheds, TR-55."June, 1986.

8. Tennessee Valley Authority, Flow Schematic, TVA Johnsonville Fossil Plant, NPDES Permit No. TN0005444, March, 2013.

9. Brater, E.F. and H.W. King (1976), Handbook of Hydraulics, McGraw-Hill, New York.

10. Chow, V.T. (1959), Open-Channel Hydraulics, McGraw-Hill, 680 p.

11. Federal Highway Administration, HY-8 Culvert Hydraulic Analysis Program, Version 7.3, January 17, 2012.

12. United States Army Corps of Engineers, Hydrologic Modeling System (HEC-HMS), Version 4.0, December 31, 2013.

13. Stantec Consulting Services Inc., "Record Drawings – Spillway Replacement Project – Ash Disposal Area No. 2 – Work Plan 3 (JOF-090515-WP-3", April 16, 2010.

14. Stantec Consulting Services Inc., "Record Drawings – TVA Project No. 610457 – Ash Disposal Area No. 2 Stacking Plan", October 19, 2015.

15. Stantec Consulting Services Inc., "Addendum to Dam Safety Hazard Classification Review Ash Disposal Area 2", Prepared for Tennessee Valley Authority, September 27, 2013.

16. Stantec Consulting Services Inc., "Initial, Hazard Potential Classification Assessment Active Ash Pond 2", September 30, 2016.

17. Stantec Consulting Services Inc., "Station Sump Discharge Relocation, Johnsonville Fossil Plant". January 6, 2012.

18. Stantec Consulting Services Inc. "Pump Evaluation for Force Main Extension – Coal Yard Drainage Basin." September 24, 2010

# APPENDIX A
# HYDROLOGIC OVERVIEW MAP


Figure No.
**1**

Title
## HYDROLOGIC OVERVIEW MAP
## ACTIVE ASH POND 2 - JOF

Client/Project
Tennessee Valley Authority
Inflow Design Flood Control Plan
175555008

Project Location:
Humphreys County, TN

Prepared by mmm on 02-08-16
Technical Review by tgc on 02-29-16
Independent Review by mah on 03-02-16

175555008

0 2,000 4,000 Feet
1:24,000 (At Original document size of 11x17)

**Legend**

Flow Direction

Active Ash Pond 2 Approximate Boundary

**Notes**
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Source: ESRI

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# APPENDIX B
# WATERSHED MAP


Figure No.
**2**

Title
# WATERSHED MAP
# ACTIVE ASH POND 2 - JOF

Client/Project
Tennessee Valley Authority
Inflow Design Flood Control Plan
175555008

Project Location:
Humphreys County, TN

Prepared by mmm on 2-08-16
Technical Review by tgc on 2-29-16
Independent Review by mah on 3-02-16

175553008

0 500 1,000 Feet
1:6,000 (At Original document size of 11x17)

| Watershed Name | Area (Acres) |
|---|---|
| 1 | 50.2 |
| 2 | 33.7 |

## Legend

Flow Paths
Topographic Mapping

**Sub-Watersheds**
1
2

**Notes**
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Aerial Imagery dated March 23, 2015
3. Topographic Data dated April 11, 2015

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# APPENDIX C
# CURVE NUMBER MAP AND CALCULATIONS


Figure No.
**3**

Title
## CURVE NUMBER MAP
## ACTIVE ASH POND 2 - JOF

Client/Project
Tennessee Valley Authority
Inflow Design Flood Control Plan
175555008

Project Location:
Humphreys County, TN

Prepared by mmm on 02-08-16
Technical Review by tgc on 02-29-16
Independent Review by mah on 03-02-16

175555008

0 500 1,000 Feet

1:6,000 (At Original document size of 11x17)

| Watershed Name | Area (Acres) | Composite Curve Number | Estimated Lag Time (min) |
|---|---|---|---|
| 1 | 50.2 | 91 | 3.8 |
| 2 | 33.7 | 96 | 3.5 |

### Legend

- Flow Paths
- Topographic Mapping
- subwatersheds

### Curve Number

- Ash (91)
- Grass (80)
- Gravel (91)
- Open Water (100)

**Notes**

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Aerial Imagery dated March 23, 2015
3. Topographic Data dated April 11, 2015

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**Curve Number Calculation**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 1755553008
Calculation Performed by: MMM Calculation Date: 2/8/2016
Checked by: TGC Checked By Date: 2/29/2016

| Watershed | Type | Subbasin Curve Number | Subbasin Area, Acre | Area Weighted Curve Number | Composite Curve Number |
|---|---|---|---|---|---|
| 1 | Ash | 91 | 38.2117 | 3477.27 | |
| | Open Water | 100 | 3.0141 | 301.41 | |
| | Open Water | 100 | 0.5399 | 53.99 | |
| | Open Water | 100 | 0.2798 | 27.98 | |
| | Gravel | 91 | 0.4634 | 42.17 | |
| | Grass | 80 | 0.8699 | 69.59 | |
| | Grass | 80 | 0.0241 | 1.92 | |
| | Grass | 80 | 0.1910 | 15.28 | |
| | Open Water | 100 | 1.2085 | 120.85 | |
| | Open Water | 100 | 0.2338 | 23.38 | |
| | Gravel | 91 | 0.6506 | 59.20 | |
| | Grass | 80 | 4.3063 | 344.51 | |
| | Gravel | 91 | 0.0708 | 6.44 | |
| | Ash | 91 | 0.0000 | 0.00 | |
| | Gravel | 91 | 0.0000 | 0.00 | |
| | Grass | 80 | 0.0051 | 0.41 | |
| | Gravel | 91 | 0.1233 | 11.22 | |
| | | sum | 50.2 | 4555.6 | 91 |
| 2 | Open Water | 100 | 24.4635 | 2446.35 | |
| | Gravel | 91 | 0.2211 | 20.12 | |
| | Gravel | 91 | 1.2154 | 110.60 | |
| | Grass | 80 | 2.3787 | 190.30 | |
| | Grass | 80 | 1.1609 | 92.87 | |
| | Open Water | 100 | 0.7889 | 78.89 | |
| | Grass | 80 | 0.0768 | 6.15 | |
| | Gravel | 91 | 0.8039 | 73.16 | |
| | Grass | 80 | 0.6877 | 55.01 | |
| | Grass | 80 | 1.7112 | 136.89 | |
| | Ash | 91 | 0.0000 | 0.00 | |
| | Gravel | 91 | 0.0000 | 0.00 | |
| | Gravel | 91 | 0.0699 | 6.36 | |
| | Ash | 91 | 0.0634 | 5.77 | |
| | Grass | 80 | 0.0003 | 0.02 | |
| | Grass | 80 | 0.0016 | 0.13 | |
| | Open Water | 100 | 0.0092 | 0.92 | |
| | | sum | 33.7 | 3223.5 | 96 |

| | | |
|---|---|---|
| Curve Number Key: | CN - Grass over Ash | 80 |
| | CN - Bottom Ash | 86 |
| | CN- Fly Ash | 91 |
| | CN - Riprap | 89 |
| | CN- Gravel road | 91 |
| | CN- Water | 100 |
| | CN - Paved road | 98 |
| | CN- Coal pile | 89 |

# APPENDIX D
# LAG TIME CALCULATIONS

**Lag Time Calculation**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/8/2016
Checked by: TBC Checked By Date: 2/29/2016

Watershed ID: 1

| Sheet Flow | Unit | Segment ID | | Total |
|---|---|---|---|---|
| 1. Surface description | | | | |
| 2. Manning's roughness coef., n | | | | |
| 3. Flow length, L (Total L less than 300/100 f | ft | | | |
| 4. Two-year, 24-hour Rainfall, P2 | in | | | |
| 5a. Upstream elevation | ft | | | |
| 5b. Downstream elevation | ft | | | |
| 5. Land slope, S | ft / ft | | | |
| 6. Tt = $[0.007(nL)^{0.8}]/[\text{sqrt}(P2)\ S^{0.4}]$ | hr | | = | 0.00 hr |

| Shallow Concentrated Flow | Unit | Segment ID | | Total |
|---|---|---|---|---|
| 7. Surface description (paved or unpaved) | | | | |
| 8. Flow length, L | ft | | | |
| 9a. Upstream elevation | ft | | | |
| 9b. Downstream elevation | ft | | | |
| 9. Watercourse slope, S | ft / ft | | | |
| 10. Average velocity, V | ft / s | | | |
| 11. Tt = L / 3600V | hr | | = | 0.00 hr |

| Open Channel Flow | Unit | Segment ID: 1A | | Total |
|---|---|---|---|---|
| 12. Pipe or Open Channel | | Open-channel | | |
| 13. Diam (pipe) or depth (open) | ft | 2 | | |
| 14. Base width (open) | ft | 30 | | |
| 15. Channel side slope | XH:1V | 3 | | |
| 16. Cross sectional flow area | ft2 | 72.00 | | |
| 17. Wetted perimeter, Pw | ft | 42.65 | | |
| 18. Hydraulic radius, r = a/Pw | ft | 1.69 | | |
| 19a. Upstream elevation | ft | 391 | | |
| 19b. Downstream elevation | ft | 386 | | |
| 19. Channel slope, S | ft / ft | 0.002 | | |
| 20. Runoff surface / pipe material | | earth, straight | | |
| 21. Manning's roughness coef., n | | 0.02 | | |
| 22. V= (1.49 r2/3 S1/2 / n) | ft / s | 5.28 | | |
| 23. Flow length, L | ft | 2004 | | |
| 24. Tt = L / 3600V | hr | 0.11 | = | 0.11 hr |

25. Watershed Tc (sum Tt from 6, 11, 24) 0.11 hr

26. Watershed lag time, TL (=0.6 x Tc) 0.063 hr

**Lag Time Calculation**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/8/2016
Checked by: TBC Checked By Date: 2/29/2016

Watershed ID: 2

| | | | | | |
|---|---|---|---|---|---|
| Sheet Flow | Segment ID | 2A | | | |
| 1. Surface description | | Smooth surfaces (concrete, asphalt, gravel, bare soil) | | | |
| 2. Manning's roughness coef., n | | 0.011 | | | |
| 3. Flow length, L (Total L less than 300/100 f | ft | 100 | | | |
| 4. Two-year, 24-hour Rainfall, P2 | in | 3.76 | | | |
| 5a. Upstream elevation | ft | 396 | | | |
| 5b. Downstream elevation | ft | 392 | | | |
| 5. Land slope, S | ft / ft | 0.040 | | | |
| 6. Tt = $[0.007(nL)^{0.8}]/[sqrt(P2)\ S^{0.4}]$ | hr | 0.01 | | = | 0.01 hr |

| | | | | | |
|---|---|---|---|---|---|
| Shallow Concentrated Flow | Segment ID | 2B | | | |
| 7. Surface description (paved or unpaved) | | Unpaved | | | |
| 8. Flow length, L | ft | 107 | | | |
| 9a. Upstream elevation | ft | 392 | | | |
| 9b. Downstream elevation | ft | 389 | | | |
| 9. Watercourse slope, S | ft / ft | 0.028 | | | |
| 10. Average velocity, V | ft / s | 2.7 | | | |
| 11. Tt = L / 3600V | hr | 0.01 | | = | 0.01 hr |

| | | | | | |
|---|---|---|---|---|---|
| Open Channel Flow | Segment ID | | | | |
| 12. Pipe or Open Channel | | | | | |
| 13. Diam (pipe) or depth (open) | ft | | | | |
| 14. Base width (open) | ft | | | | |
| 15. Channel side slope | XH:1V | | | | |
| 16. Cross sectional flow area | ft2 | | | | |
| 17. Wetted perimeter, Pw | ft | | | | |
| 18. Hydraulic radius, r = a/Pw | ft | | | | |
| 19a. Upstream elevation | ft | | | | |
| 19b. Downstream elevation | ft | | | | |
| 19. Channel slope, S | ft / ft | | | | |
| 20. Runoff surface / pipe material | | earth, winding, grass weeds | | | |
| 21. Manning's roughness coef., n | | | | | |
| 22. V= (1.49 r2/3 S1/2 / n) | ft / s | | | | |
| 23. Flow length, L | ft | | | | |
| 24. Tt = L / 3600V | hr | | | = | 0.00 hr |

| | |
|---|---|
| 25. Watershed Tc (sum Tt from 6, 11, 24) | 0.03 hr |
| 26. Watershed lag time, TL (=0.6 x Tc) | 0.015 hr |

Stantec

**Lag Time Calculation**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/8/2016
Checked by: TBC Checked By Date: 2/29/2016

| Lag Time Summary | | | |
|---|---|---|---|
| Watershed | $T_L$(hr) | $T_L$(hr) Used | $T_L$(min) Used* |
| 1 | 0.063 | 0.063 | 3.8 |
| 2 | 0.015 | 0.058 | 3.5 |

*HEC-HMS model uses minimum lag time of 3.5 minutes. Therefore, any time less than 3.5 minutes will be modified to 3.5 minutes.

# POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

**WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION**
**NOAA Atlas 14, Volume 2, Version 3**

**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 | **0.406** (0.368-0.451) | **0.476** (0.433-0.530) | **0.547** (0.496-0.608) | **0.604** (0.548-0.669) | **0.675** (0.609-0.747) | **0.727** (0.654-0.804) | **0.781** (0.698-0.862) | **0.831** (0.741-0.917) | **0.897** (0.792-0.990) | **0.947** (0.832-1.04) |
| 10-min | **0.648** (0.588-0.720) | **0.761** (0.693-0.847) | **0.877** (0.795-0.973) | **0.965** (0.876-1.07) | **1.08** (0.971-1.19) | **1.16** (1.04-1.28) | **1.24** (1.11-1.37) | **1.32** (1.17-1.45) | **1.42** (1.25-1.56) | **1.49** (1.31-1.65) |
| 15-min | **0.810** (0.735-0.900) | **0.957** (0.871-1.06) | **1.11** (1.00-1.23) | **1.22** (1.11-1.35) | **1.36** (1.23-1.51) | **1.47** (1.32-1.62) | **1.57** (1.40-1.73) | **1.66** (1.48-1.83) | **1.78** (1.58-1.97) | **1.87** (1.64-2.07) |
| 30-min | **1.11** (1.01-1.23) | **1.32** (1.20-1.47) | **1.58** (1.43-1.75) | **1.77** (1.60-1.96) | **2.02** (1.82-2.24) | **2.21** (1.99-2.44) | **2.40** (2.15-2.65) | **2.59** (2.31-2.86) | **2.84** (2.51-3.13) | **3.03** (2.66-3.35) |
| 60-min | **1.38** (1.26-1.54) | **1.66** (1.51-1.85) | **2.02** (1.83-2.24) | **2.30** (2.09-2.55) | **2.69** (2.43-2.98) | **2.99** (2.69-3.31) | **3.31** (2.96-3.65) | **3.63** (3.23-4.01) | **4.08** (3.60-4.50) | **4.43** (3.89-4.88) |
| 2-hr | **1.59** (1.44-1.77) | **1.91** (1.73-2.12) | **2.34** (2.11-2.59) | **2.69** (2.43-2.99) | **3.20** (2.87-3.54) | **3.61** (3.22-3.99) | **4.04** (3.60-4.47) | **4.50** (3.99-4.99) | **5.16** (4.53-5.72) | **5.69** (4.96-6.32) |
| 3-hr | **1.72** (1.57-1.90) | **2.06** (1.87-2.27) | **2.52** (2.29-2.78) | **2.91** (2.64-3.21) | **3.46** (3.12-3.81) | **3.91** (3.52-4.31) | **4.40** (3.94-4.84) | **4.92** (4.38-5.41) | **5.65** (4.99-6.23) | **6.26** (5.48-6.91) |
| 6-hr | **2.13** (1.93-2.36) | **2.54** (2.30-2.81) | **3.10** (2.82-3.44) | **3.58** (3.25-3.96) | **4.27** (3.84-4.71) | **4.84** (4.33-5.33) | **5.45** (4.86-6.00) | **6.10** (5.41-6.72) | **7.03** (6.18-7.75) | **7.80** (6.80-8.61) |
| 12-hr | **2.58** (2.36-2.86) | **3.08** (2.83-3.42) | **3.80** (3.47-4.20) | **4.39** (4.00-4.84) | **5.23** (4.75-5.77) | **5.94** (5.35-6.54) | **6.68** (5.98-7.35) | **7.49** (6.67-8.24) | **8.63** (7.61-9.50) | **9.58** (8.39-10.5) |
| 24-hr | **3.13** (2.87-3.43) | **3.76** (3.45-4.11) | **4.65** (4.26-5.09) | **5.38** (4.92-5.89) | **6.41** (5.84-7.01) | **7.27** (6.59-7.93) | **8.17** (7.37-8.91) | **9.14** (8.18-9.96) | **10.5** (9.30-11.5) | **11.6** (10.2-12.7) |
| 2-day | **3.75** (3.45-4.10) | **4.49** (4.13-4.93) | **5.53** (5.08-6.05) | **6.36** (5.84-6.95) | **7.52** (6.88-8.21) | **8.46** (7.70-9.22) | **9.44** (8.54-10.3) | **10.5** (9.41-11.4) | **11.9** (10.6-13.0) | **13.0** (11.5-14.3) |
| 3-day | **4.00** (3.68-4.37) | **4.80** (4.41-5.25) | **5.90** (5.42-6.44) | **6.77** (6.22-7.39) | **7.99** (7.30-8.71) | **8.96** (8.15-9.77) | **9.97** (9.02-10.9) | **11.0** (9.91-12.0) | **12.5** (11.1-13.7) | **13.6** (12.0-15.0) |
| 4-day | **4.25** (3.92-4.64) | **5.10** (4.69-5.57) | **6.26** (5.75-6.83) | **7.19** (6.59-7.83) | **8.45** (7.73-9.20) | **9.46** (8.61-10.3) | **10.5** (9.51-11.5) | **11.6** (10.4-12.7) | **13.0** (11.6-14.3) | **14.2** (12.6-15.6) |
| 7-day | **5.05** (4.64-5.49) | **6.05** (5.56-6.59) | **7.43** (6.82-8.08) | **8.53** (7.80-9.27) | **10.0** (9.16-10.9) | **11.3** (10.2-12.3) | **12.5** (11.3-13.7) | **13.9** (12.4-15.1) | **15.7** (14.0-17.2) | **17.1** (15.1-18.8) |
| 10-day | **5.75** (5.32-6.21) | **6.88** (6.36-7.44) | **8.38** (7.74-9.05) | **9.54** (8.79-10.3) | **11.1** (10.2-12.0) | **12.3** (11.3-13.3) | **13.6** (12.4-14.7) | **14.9** (13.5-16.1) | **16.6** (14.9-18.0) | **17.9** (16.0-19.6) |
| 20-day | **7.86** (7.31-8.45) | **9.33** (8.69-10.1) | **11.1** (10.3-12.0) | **12.4** (11.6-13.4) | **14.2** (13.1-15.3) | **15.5** (14.3-16.7) | **16.8** (15.5-18.1) | **18.0** (16.6-19.4) | **19.6** (17.9-21.2) | **20.8** (18.9-22.6) |
| 30-day | **9.58** (8.94-10.3) | **11.4** (10.6-12.2) | **13.4** (12.5-14.3) | **14.9** (13.9-16.0) | **16.9** (15.7-18.1) | **18.4** (17.1-19.7) | **19.9** (18.4-21.3) | **21.3** (19.6-22.9) | **23.1** (21.2-24.8) | **24.5** (22.3-26.3) |
| 45-day | **12.0** (11.2-12.8) | **14.2** (13.3-15.2) | **16.7** (15.6-17.8) | **18.5** (17.2-19.7) | **20.7** (19.3-22.1) | **22.4** (20.8-24.0) | **24.0** (22.3-25.7) | **25.6** (23.6-27.4) | **27.5** (25.3-29.5) | **28.9** (26.5-31.1) |
| 60-day | **14.4** (13.5-15.3) | **17.0** (15.9-18.1) | **19.8** (18.5-21.1) | **21.8** (20.4-23.2) | **24.3** (22.7-25.9) | **26.1** (24.3-27.9) | **27.8** (25.9-29.8) | **29.5** (27.3-31.5) | **31.5** (29.0-33.7) | **32.9** (30.2-35.3) |

[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

# APPENDIX E
# REFERENCE DRAWINGS


PLAN – SPILLWAY SIPHON AND PERMANENT SPILLWAY SYSTEM
SCALE: 1" = 20'

GRAPHIC SCALE: 1" = 20'
CONTOUR INTERVAL = 1'

**RECORD DRAWING**

REFERENCE KEY
Section or Detail No.
Sheet Where Shown

For Supporting Design Calculations see FPGJOFFESCDX00000020100005

| REV. NO. | DATE | DSGN | DRWN | CHKD | SUPV | RVWD | APPD | ISSD | PROJECT ID | AS CONST | REV CD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R 1 | 04/16/10 | JK | RP | SHB | SHB | SHB | SHB | TJ | – | – | – |
| RECORD DRAWING | | | | | | | | | | | |
| R 0 | 04/16/10 | JK | RP | SHB | SHB | SHB | SHB | TJ | – | – | – |
| ISSUED FOR CONSTRUCTION | | | | | | | | | | | |

DISCIPLINE INTERFACE 1 2 3 4

SCALE: 1"=20' EXCEPT AS NOTED

YARD
ASH DISPOSAL AREA NO. 2

SPILLWAY REPLACEMENT PROJECT
SPILLWAY & SIPHON PLAN
WORK PLAN 3 (JOF–090515–WP–3)

STEPHEN H. BICKEL REGISTERED ENGINEER AGRICULTURE COMMERCE No. 113134 STATE OF TENNESSEE
4/16/2010

| DESIGNED BY: | DRAWN BY: | CHECKED BY: | SUPERVISED BY: | REVIEWED BY: | APPROVED BY: | ISSUED BY: |
|---|---|---|---|---|---|---|
| J. KOPP | R. PETTY | S. BICKEL | S. BICKEL | S. BICKEL | S. BICKEL | T. JOHNSON |


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Fax 502.212.5055
www.stantec.com


JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | DATE 04/16/10 | 30 | C | 10W502–03 | R 1

STANTEC | 1
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

30 C 10W502-03


| Spillway | Invert Location (MSL) | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 1 | 384.11 | 381.43 | 379.89 | 365.29 |
| 2 | 384.12 | 381.43 | 379.54 | 365.27 |
| 3 | 384.07 | 381.40 | 379.89 | 365.28 |
| 4 | 384.15 | 381.42 | 379.86 | 365.32 |
| 5 | 384.12 | 381.39 | 379.80 | 365.32 |
| 6 | 384.16 | 381.42 | 379.90 | 365.34 |

For Supporting Design Calculations see FPGJOFFESCDX00000020100005

| REV. NO. | DATE | DSGN | DRWN | CHKD | SUPV | RVWD | APPD | ISSD | PROJECT | AS CONST |
|---|---|---|---|---|---|---|---|---|---|---|
| R 1 | 04/16/10 | JK | RP | SHB | SHB | SHB | SHB | TJ | – | – |
| RECORD DRAWING | | | | | | | | | | |
| R 0 | 04/16/10 | JK | RP | SHB | SHB | SHB | SHB | TJ | – | – |
| ISSUED FOR CONSTRUCTION | | | | | | | | | | |

SCALE: AS SHOWN EXCEPT AS NOTED

YARD
ASH DISPOSAL AREA NO. 2

# SPILLWAY REPLACEMENT PROJECT
# SPILLWAY PROFILE & DETAILS
# WORK PLAN 3 (JOF-090515-WP-3)

STEPHEN H. BICKEL REGISTERED ENGINEER AGRICULTURE COMMERCE No. 113134 STATE OF TENNESSEE 4/16/2010

| DESIGNED BY: | DRAWN BY: | CHECKED BY: | SUPERVISED BY: | REVIEWED BY: | APPROVED BY: | ISSUED BY: |
|---|---|---|---|---|---|---|
| J. KOPP | R. PETTY | S. BICKEL | S. BICKEL | S. BICKEL | S. BICKEL | T. JOHNSON |

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www.stantec.com

JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2000 | DATE 04/16/10 | 30 | C | 10W502-05 | R 1

STANTEC | 1
TASK COMPLETED BY: | REV NO.

PLOT FACTOR:XX W_TVA
C.A.D. DRAWING DO NOT ALTER MANUALLY

# APPENDIX F
# RATING CURVES

**Rating Curve Inputs**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/05/2016
Checked by: TGC Checked By Date: 2/29/2016

**Active Ash Pond 2 Outlet Structures**

| Spillway 1 | | Spillway 2 | | Spillway 3 | | Notes |
|---|---|---|---|---|---|---|
| Stop Log Inv. Elev= | 384.11 feet (NGVD29) | Stop Log Inv. Elev= | 384.12 feet (NGVD29) | Stop Log Inv. Elev= | 384.07 feet (NGVD29) | |
| Stop Log L= | 7 feet | Stop Log L= | 7 feet | Stop Log L= | 7 feet | |
| Riser Length= | 8 feet | Riser Length= | 8 feet | Riser Length= | 8 feet | |
| Riser Width= | 4 feet | Riser Width= | 4 feet | Riser Width= | 4 feet | |
| Riser Elev= | 386.67 feet | Riser Elev= | 386.67 feet | Riser Elev= | 386.67 feet | |
| Pipe Inlet= | 381.43 feet (NGVD29) | Pipe Inlet= | 381.43 feet (NGVD29) | Pipe Inlet= | 381.4 feet (NGVD29) | |
| Pipe Outlet= | 379.89 feet (NGVD29) | Pipe Outlet= | 379.54 feet (NGVD29) | Pipe Outlet= | 379.89 feet (NGVD29) | |
| Pipe ID= | 27 in | Pipe ID= | 27 in | Pipe ID= | 27 in | |
| Length= | 50 feet | Length= | 50 feet | Length= | 50 feet | |
| C= | 3.27 | C= | 3.27 | C= | 3.27 | Assumed to behave as sharp crested weir |
| $C_0$= | 0.6 | $C_0$= | 0.6 | $C_0$= | 0.6 | Based on Brater and King 1976 |
| Computed Values | | Computed Values | | Computed Values | | Equation |
| Stoplog $L_{weir}$= | 7 ft | $L_{weir}$= | 7 ft | $L_{weir}$= | 7 ft | |
| Riser $L_{weir}$= | 16 ft | Riser $L_{weir}$= | 16 ft | Riser $L_{weir}$= | 16 ft | |
| $A_{riser}$= | 32 sq. ft. | $A_{riser}$= | 32 sq. ft. | $A_{riser}$= | 32 sq. ft. | Area = Length*Width |
| $A_{pipe}$= | 3.976078 sq. ft. | $A_{pipe}$= | 3.976078 sq. ft. | $A_{pipe}$= | 3.976078 sq. ft. | Area = PI*$D^2$/4 |
| Elev C*= | 382.555 feet (NGVD29) | Elev C*= | 382.555 feet (NGVD29) | Elev C*= | 382.525 feet (NGVD29) | |

*C is the elevation of centerline of the outlet pipe inlet

| Spillway 4 | | Spillway 5 | | Spillway 6 | | Notes |
|---|---|---|---|---|---|---|
| Stop Log Inv. Elev= | 384.15 feet (NGVD29) | Stop Log Inv. Elev= | 384.12 feet (NGVD29) | Stop Log Inv. Elev= | 384.16 feet (NGVD29) | |
| Stop Log L= | 7 feet | Stop Log L= | 7 feet | Stop Log L= | 7 feet | |
| Riser Length= | 8 feet | Riser Length= | 8 feet | Riser Length= | 8 feet | |
| Riser Width= | 4 feet | Riser Width= | 4 feet | Riser Width= | 4 feet | |
| Riser Elev= | 386.67 feet | Riser Elev= | 386.67 feet | Riser Elev= | 386.67 feet | |
| Pipe Inlet= | 381.42 feet (NGVD29) | Pipe Inlet= | 381.39 feet (NGVD29) | Pipe Inlet= | 381.42 feet (NGVD29) | |
| Pipe Outlet= | 379.86 feet (NGVD29) | Pipe Outlet= | 379.8 feet (NGVD29) | Pipe Outlet= | 379.9 feet (NGVD29) | |
| Pipe ID= | 27 in | Pipe ID= | 27 in | Pipe ID= | 27 in | |
| Length= | 50 feet | Length= | 50 feet | Length= | 50 feet | |
| C= | 3.27 | C= | 3.27 | C= | 3.27 | Assumed to behave as sharp crested weir |
| $C_0$= | 0.6 | $C_0$= | 0.6 | $C_0$= | 0.6 | Based on Brater and King 1976 |
| Computed Values | | Computed Values | | Computed Values | | Equation |
| $L_{weir}$= | 7 ft | $L_{weir}$= | 7 ft | $L_{weir}$= | 7 ft | |
| Riser $L_{weir}$= | 16 ft | Riser $L_{weir}$= | 16 ft | Riser $L_{weir}$= | 16 ft | |
| $A_{riser}$= | 32 sq. ft. | $A_{riser}$= | 32 sq. ft. | $A_{riser}$= | 32 sq. ft. | Area = Length*Width |
| $A_{pipe}$= | 3.976078 sq. ft. | $A_{pipe}$= | 3.976078 sq. ft. | $A_{pipe}$= | 3.976078 sq. ft. | Area = PI*$D^2$/4 |
| Elev C*= | 382.545 feet (NGVD29) | Elev C*= | 382.515 feet (NGVD29) | Elev C*= | 382.545 feet (NGVD29) | |

**References:**

1 "Spillway Rating Curve Development" \\us1243-f01\workgroup\1755\active\175565240\geotechnical\analysis\H&H\rating_curve_methodology.doc:
2 Spillway Replacement Project Work Plan 3 \\us1243-f01\workgroup\1755\active\175565240\geotechnical\analysis\H&H\JOF_Hydrologic_Modeling\Report\Appendices\Appendix F - Reference Drawings\10W502-01-09-R1.pc

**Rating Curve Development: Active Ash Pond 2**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/5/2016
Checked by: TGC Checked By Date: 2/29/2016

Indicates Controlling Flow

## Spillway 1

| Elevation | Weir Flow (Stoplog) | | Weir Flow (Box) | | Combined Weir Flow | Orifice Flow | | Pipe Orifice Flow | | Outlet Pipe Flow (from HY-8) | | Rating Curve for HEC-HMS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H (ft) | $Q=CLH^{1.5}$ (cfs) | H (ft) | $Q=CLH^{1.5}$ (cfs) | Q (cfs) | H (ft) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft)[1] | $Q=C_0A(2gH_c)^{0.5}$ (cfs) | Assumed TW (ft) | Q (cfs) | HW Elevation (ft) | Q (cfs) |
| 368.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 0.00 | 368.00 | 0.00 |
| 382.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 3.93 | 382.00 | 0.00 |
| 383.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 | 12.77 | 375.1 | 11.82 | 383.00 | 0.00 |
| 384.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.44 | 23.01 | 375.1 | 21.90 | 384.00 | 0.00 |
| 385.00 | 0.89 | 19.22 | 0.00 | 0.00 | 19.22 | 0.89 | 145.36 | 2.44 | 29.94 | 375.1 | 29.69 | 385.00 | 19.22 |
| 386.00 | 1.89 | 59.48 | 0.00 | 0.00 | 59.48 | 1.89 | 211.82 | 3.44 | 35.53 | 375.1 | 35.84 | 386.00 | 35.53 |
| 387.00 | 2.89 | 112.46 | 0.33 | 9.92 | 122.38 | 2.89 | 261.93 | 4.44 | 40.36 | 375.1 | 41.12 | 387.00 | 40.36 |
| 388.00 | 3.89 | 175.62 | 1.33 | 80.25 | 255.87 | 3.89 | 303.89 | 5.44 | 44.67 | 375.1 | 45.48 | 388.00 | 44.67 |
| 389.00 | 4.89 | 247.52 | 2.33 | 186.08 | 433.60 | 4.89 | 340.72 | 6.44 | 48.60 | 375.1 | 49.74 | 389.00 | 48.60 |
| 390.00 | 5.89 | 327.20 | 3.33 | 317.93 | 645.14 | 5.89 | 373.94 | 7.44 | 52.24 | 375.1 | 53.44 | 390.00 | 52.24 |

[1] Pipe Orifice flow computed without consideration of tailwater. Tailwater was considered in "Outlet Pipe Flow" computation.

## Spillway 2

| Elevation | Weir Flow (Stoplog) | | Weir Flow (Box) | | Combined Weir Flow | Orifice Flow | | Pipe Orifice Flow | | Outlet Pipe Flow (from HY-8) | | Rating Curve for HEC-HMS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H (ft) | $Q=CLH^{1.5}$ (cfs) | H (ft) | $Q=CLH^{1.5}$ (cfs) | Q (cfs) | H (ft) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft)[1] | $Q=C_0A(2gH_c)^{0.5}$ (cfs) | Assumed TW (ft) | Q (cfs) | HW Elevation (ft) | Q (cfs) |
| 368.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 0.00 | 368.00 | 0.00 |
| 382.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 3.93 | 382.00 | 0.00 |
| 383.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 | 12.77 | 375.1 | 11.82 | 383.00 | 0.00 |
| 384.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.44 | 23.01 | 375.1 | 21.90 | 384.00 | 0.00 |
| 385.00 | 0.88 | 18.90 | 0.00 | 0.00 | 18.90 | 0.88 | 144.54 | 2.44 | 29.94 | 375.1 | 29.69 | 385.00 | 18.90 |
| 386.00 | 1.88 | 59.00 | 0.00 | 0.00 | 59.00 | 1.88 | 211.26 | 3.44 | 35.53 | 375.1 | 35.84 | 386.00 | 35.53 |
| 387.00 | 2.88 | 111.88 | 0.33 | 9.92 | 121.79 | 2.88 | 261.48 | 4.44 | 40.36 | 375.1 | 41.12 | 387.00 | 40.36 |
| 388.00 | 3.88 | 174.94 | 1.33 | 80.25 | 255.19 | 3.88 | 303.50 | 5.44 | 44.67 | 375.1 | 45.48 | 388.00 | 44.67 |
| 389.00 | 4.88 | 246.76 | 2.33 | 186.08 | 432.84 | 4.88 | 340.37 | 6.44 | 48.60 | 375.1 | 49.74 | 389.00 | 48.60 |
| 390.00 | 5.88 | 326.37 | 3.33 | 317.93 | 644.30 | 5.88 | 373.62 | 7.44 | 52.24 | 375.1 | 53.44 | 390.00 | 52.24 |

[1] Pipe Orifice flow computed without consideration of tailwater. Tailwater was considered in "Outlet Pipe Flow" computation.

**Rating Curve Development: Active Ash Pond 2**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/5/2016
Checked by: TGC Checked By Date: 2/29/2016

Indicates Controlling Flow

## Spillway 3

| Elevation | Weir Flow (Stoplog) | | Weir Flow (Box) | | Combined Weir Flow | Orifice Flow | | Pipe Orifice Flow | | Outlet Pipe Flow (from HY-8) | | Rating Curve for HEC-HMS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H (ft) | $Q=CLH^{1.5}$ (cfs) | H (ft) | $Q=CLH^{1.5}$ (cfs) | Q (cfs) | H (ft) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft)[1] | $Q=C_0A(2gH_c)^{0.5}$ (cfs) | Assumed TW (ft) | Q (cfs) | HW Elevation (ft) | Q (cfs) |
| 368.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 0.00 | 368.00 | 0.00 |
| 382.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 4.07 | 382.00 | 0.00 |
| 383.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.48 | 13.19 | 375.1 | 12.12 | 383.00 | 0.00 |
| 384.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.48 | 23.25 | 375.1 | 22.18 | 384.00 | 0.00 |
| 385.00 | 0.93 | 20.53 | 0.00 | 0.00 | **20.53** | 0.93 | 148.59 | 2.48 | 30.12 | 375.1 | 29.90 | 385.00 | 20.53 |
| 386.00 | 1.93 | 61.37 | 0.00 | 0.00 | 61.37 | 1.93 | 214.05 | 3.48 | 35.69 | 375.1 | **36.01** | 386.00 | 35.69 |
| 387.00 | 2.93 | 114.80 | 0.33 | 9.92 | 124.72 | 2.93 | 263.74 | 4.48 | 40.50 | 375.1 | **41.27** | 387.00 | 40.50 |
| 388.00 | 3.93 | 178.33 | 1.33 | 80.25 | 258.58 | 3.93 | 305.45 | 5.48 | **44.80** | 375.1 | 45.60 | 388.00 | 44.80 |
| 389.00 | 4.93 | 250.56 | 2.33 | 186.08 | 436.64 | 4.93 | 342.11 | 6.48 | **48.72** | 375.1 | 49.85 | 389.00 | 48.72 |
| 390.00 | 5.93 | 330.54 | 3.33 | 317.93 | 648.47 | 5.93 | 375.21 | 7.48 | **52.34** | 375.1 | 53.54 | 390.00 | 52.34 |

[1] Pipe Orifice flow computed without consideration of tailwater. Tailwater was considered in "Outlet Pipe Flow" computation.

## Spillway 4

| Elevation | Weir Flow (Stoplog) | | Weir Flow (Box) | | Combined Weir Flow | Orifice Flow | | Pipe Orifice Flow | | Outlet Pipe Flow (from HY-8) | | Rating Curve for HEC-HMS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H (ft) | $Q=CLH^{1.5}$ (cfs) | H (ft) | $Q=CLH^{1.5}$ (cfs) | Q (cfs) | H (ft) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft)[1] | $Q=C_0A(2gH_c)^{0.5}$ (cfs) | Assumed TW (ft) | Q (cfs) | HW Elevation (ft) | Q (cfs) |
| 368.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 0.00 | 368.00 | 0.00 |
| 382.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 3.98 | 382.00 | 0.00 |
| 383.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 12.91 | 375.1 | 11.92 | 383.00 | 0.00 |
| 384.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.45 | 23.09 | 375.1 | 21.99 | 384.00 | 0.00 |
| 385.00 | 0.85 | 17.94 | 0.00 | 0.00 | **17.94** | 0.85 | 142.05 | 2.45 | 30.00 | 375.1 | 29.76 | 385.00 | 17.94 |
| 386.00 | 1.85 | 57.60 | 0.00 | 0.00 | 57.60 | 1.85 | 209.57 | 3.45 | 35.59 | 375.1 | **35.89** | 386.00 | 35.59 |
| 387.00 | 2.85 | 110.13 | 0.33 | 9.92 | 120.05 | 2.85 | 260.12 | 4.45 | 40.41 | 375.1 | **41.16** | 387.00 | 40.41 |
| 388.00 | 3.85 | 172.92 | 1.33 | 80.25 | 253.17 | 3.85 | 302.33 | 5.45 | **44.71** | 375.1 | 45.51 | 388.00 | 44.71 |
| 389.00 | 4.85 | 244.49 | 2.33 | 186.08 | 430.57 | 4.85 | 339.32 | 6.45 | **48.64** | 375.1 | 49.77 | 389.00 | 48.64 |
| 390.00 | 5.85 | 323.88 | 3.33 | 317.93 | 641.81 | 5.85 | 372.67 | 7.45 | **52.27** | 375.1 | 53.47 | 390.00 | 52.27 |

[1] Pipe Orifice flow computed without consideration of tailwater. Tailwater was considered in "Outlet Pipe Flow" computation.

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**Rating Curve Development: Active Ash Pond 2**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/5/2016
Checked by: TGC Checked By Date: 2/29/2016

(yellow) Indicates Controlling Flow

**Spillway 5**

| Elevation | Weir Flow (Stoplog) | | Weir Flow (Box) | | Combined Weir Flow | Orifice Flow | | Pipe Orifice Flow | | Outlet Pipe Flow (from HY-8) | | Rating Curve for HEC-HMS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H (ft) | $Q=CLH^{1.5}$ (cfs) | H (ft) | $Q=CLH^{1.5}$ (cfs) | Q (cfs) | H (ft) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft)[1] | $Q=C_0A(2gH_c)^{0.5}$ (cfs) | Assumed TW (ft) | Q (cfs) | HW Elevation (ft) | Q (cfs) |
| 368.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 0.00 | 368.00 | 0.00 |
| 382.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 4.11 | 382.00 | 0.00 |
| 383.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 13.33 | 375.1 | 12.21 | 383.00 | 0.00 |
| 384.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.49 | 23.33 | 375.1 | 22.26 | 384.00 | 0.00 |
| 385.00 | 0.88 | 18.90 | 0.00 | 0.00 | 18.90 | 0.88 | 144.54 | 2.49 | 30.18 | 375.1 | 29.96 | 385.00 | 18.90 |
| 386.00 | 1.88 | 59.00 | 0.00 | 0.00 | 59.00 | 1.88 | 211.26 | 3.49 | 35.74 | 375.1 | 36.05 | 386.00 | 35.74 |
| 387.00 | 2.88 | 111.88 | 0.33 | 9.92 | 121.79 | 2.88 | 261.48 | 4.49 | 40.54 | 375.1 | 41.31 | 387.00 | 40.54 |
| 388.00 | 3.88 | 174.94 | 1.33 | 80.25 | 255.19 | 3.88 | 303.50 | 5.49 | 44.84 | 375.1 | 45.64 | 388.00 | 44.84 |
| 389.00 | 4.88 | 246.76 | 2.33 | 186.08 | 432.84 | 4.88 | 340.37 | 6.49 | 48.75 | 375.1 | 49.88 | 389.00 | 48.75 |
| 390.00 | 5.88 | 326.37 | 3.33 | 317.93 | 644.30 | 5.88 | 373.62 | 7.49 | 52.38 | 375.1 | 53.58 | 390.00 | 52.38 |

[1] Pipe Orifice flow computed without consideration of tailwater. Tailwater was considered in "Outlet Pipe Flow" computation.

**Spillway 6**

| Elevation | Weir Flow (Stoplog) | | Weir Flow (Box) | | Combined Weir Flow | Orifice Flow | | Pipe Orifice Flow | | Outlet Pipe Flow (from HY-8) | | Rating Curve for HEC-HMS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H (ft) | $Q=CLH^{1.5}$ (cfs) | H (ft) | $Q=CLH^{1.5}$ (cfs) | Q (cfs) | H (ft) | $Q=C_0A(2gH)^{0.5}$ (cfs) | $H_c$ (ft)[1] | $Q=C_0A(2gH_c)^{0.5}$ (cfs) | Assumed TW (ft) | Q (cfs) | HW Elevation (ft) | Q (cfs) |
| 368.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 0.00 | 368.00 | 0.00 |
| 382.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 375.1 | 3.97 | 382.00 | 0.00 |
| 383.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 12.91 | 375.1 | 11.91 | 383.00 | 0.00 |
| 384.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.45 | 23.09 | 375.1 | 21.98 | 384.00 | 0.00 |
| 385.00 | 0.84 | 17.62 | 0.00 | 0.00 | 17.62 | 0.84 | 141.22 | 2.45 | 30.00 | 375.1 | 29.76 | 385.00 | 17.62 |
| 386.00 | 1.84 | 57.13 | 0.00 | 0.00 | 57.13 | 1.84 | 209.00 | 3.45 | 35.59 | 375.1 | 35.89 | 386.00 | 35.59 |
| 387.00 | 2.84 | 109.55 | 0.33 | 9.92 | 119.47 | 2.84 | 259.66 | 4.45 | 40.41 | 375.1 | 41.16 | 387.00 | 40.41 |
| 388.00 | 3.84 | 172.24 | 1.33 | 80.25 | 252.49 | 3.84 | 301.93 | 5.45 | 44.71 | 375.1 | 45.51 | 388.00 | 44.71 |
| 389.00 | 4.84 | 243.73 | 2.33 | 186.08 | 429.81 | 4.84 | 338.97 | 6.45 | 48.64 | 375.1 | 49.77 | 389.00 | 48.64 |
| 390.00 | 5.84 | 323.05 | 3.33 | 317.93 | 640.98 | 5.84 | 372.35 | 7.45 | 52.27 | 375.1 | 53.47 | 390.00 | 52.27 |

[1] Pipe Orifice flow computed without consideration of tailwater. Tailwater was considered in "Outlet Pipe Flow" computation.

**Rating Curves - HY-8 Output, Active Ash Pond 2**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/6/2016
Checked by: TGC Checked By Date: 2/29/2016

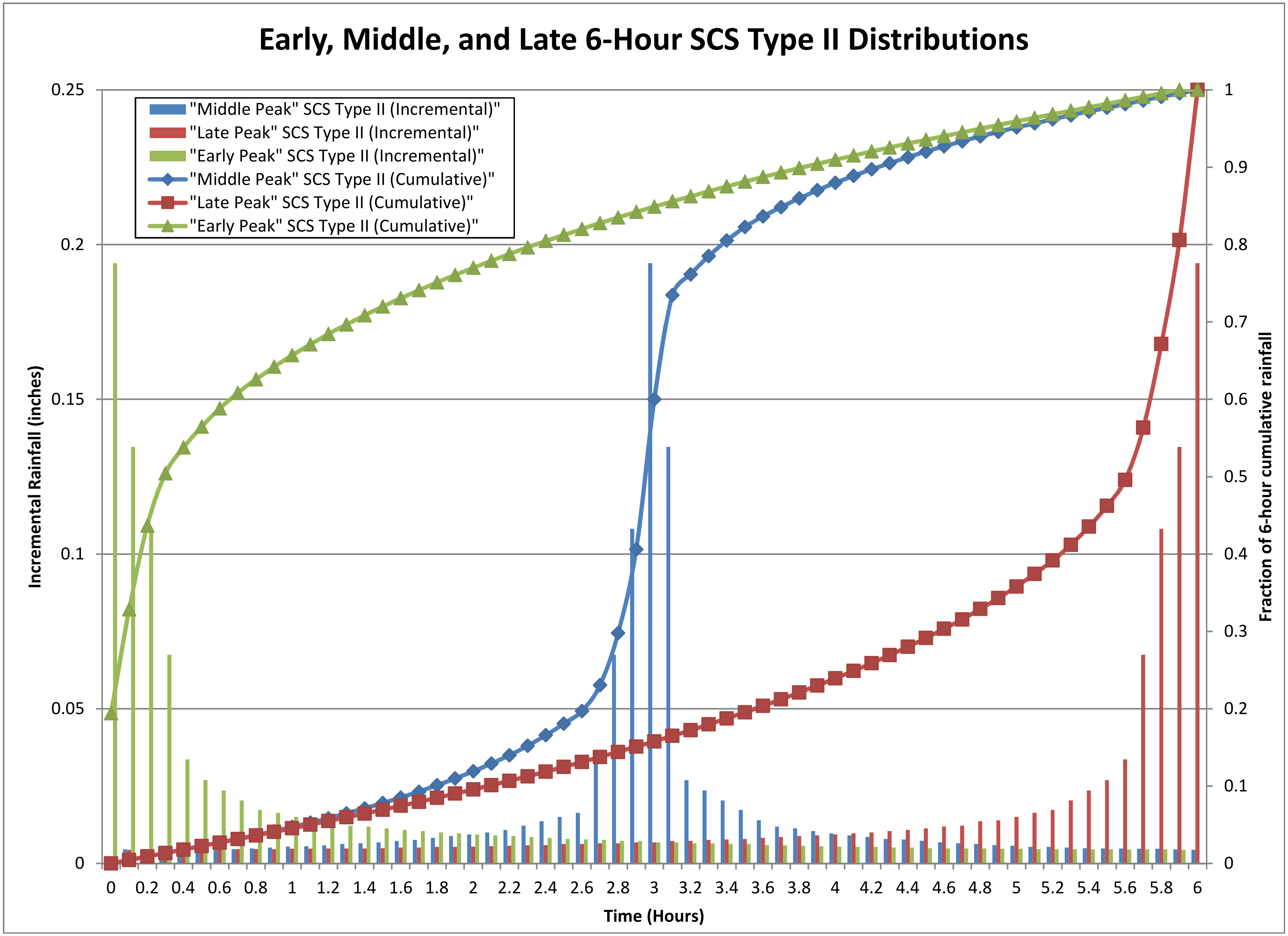
HY-8 Output

| | Spillway 1 | Spillway 2 | Spillway 3 | Spillway 4 | Spillway 5 | Spillway 6 | Total |
|---|---|---|---|---|---|---|---|
| Headwater (ft) | Q (cfs) | Q (cfs) | Q (cfs) | Q (cfs) | Q (cfs) | Q (cfs) | |
| 381.39 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 382.66 | 8.19 | 8.19 | 8.47 | 8.28 | 8.55 | 8.27 | 50.0 |
| 383.44 | 16.51 | 16.51 | 16.84 | 16.62 | 16.94 | 16.61 | 100.0 |
| 384.31 | 24.88 | 24.88 | 25.13 | 24.96 | 25.2 | 24.96 | 150.0 |
| 385.51 | 33.25 | 33.25 | 33.43 | 33.3 | 33.48 | 33.3 | 200.0 |
| 387.09 | 41.6 | 41.6 | 41.74 | 41.64 | 41.78 | 41.64 | 250.0 |
| 389.05 | 49.95 | 49.95 | 50.06 | 49.98 | 50.09 | 49.98 | 300.0 |
| 390.21 | 54.21 | 54.21 | 54.31 | 54.24 | 54.35 | 54.24 | 325.6 |
| 390.41 | 54.93 | 54.93 | 55.03 | 54.96 | 55.07 | 54.96 | 329.9 |
| 390.57 | 55.48 | 55.49 | 55.59 | 55.52 | 55.62 | 55.52 | 333.2 |
| 390.71 | 55.96 | 55.96 | 56.06 | 56 | 56.1 | 55.99 | 336.1 |

**Rating Curves - HEC-HMS Input, Active Ash Pond 2**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/8/2016
Checked by: TGC Checked By Date: 2/29/2016

| Elevation | Discharge (cfs) | Storage (acre-ft) |
|---|---|---|
| 368 | 0.00 | 0.00 |
| 370 | 0.00 | 0.05 |
| 372 | 0.00 | 4.15 |
| 374 | 0.00 | 16.87 |
| 376 | 0.00 | 36.90 |
| 378 | 0.00 | 62.31 |
| 380 | 0.00 | 93.11 |
| 382 | 0.00 | 128.55 |
| 383 | 0.00 | 148.85 |
| 384 | 0.00 | 169.15 |
| 385 | 113.10 | 193.32 |
| 386 | 213.67 | 217.48 |
| 387 | 242.59 | 248.57 |
| 388 | 268.41 | 279.66 |
| 389 | 291.96 | 316.45 |
| 390 | 313.74 | 353.25 |

# APPENDIX G
# RAINFALL DISTRIBUTIONS


Early, Middle, and Late 6-Hour SCS Type II Distributions
"Middle Peak" SCS Type II (Incremental)"
"Late Peak" SCS Type II (Incremental)"
"Early Peak" SCS Type II (Incremental)"
"Middle Peak" SCS Type II (Cumulative)"
"Late Peak" SCS Type II (Cumulative)"
"Early Peak" SCS Type II (Cumulative)"
Incremental Rainfall (inches)
Fraction of 6-hour cumulative rainfall
Time (Hours)
0.25
0.2
0.15
0.1
0.05
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 4.6 4.8 5 5.2 5.4 5.6 5.8 6

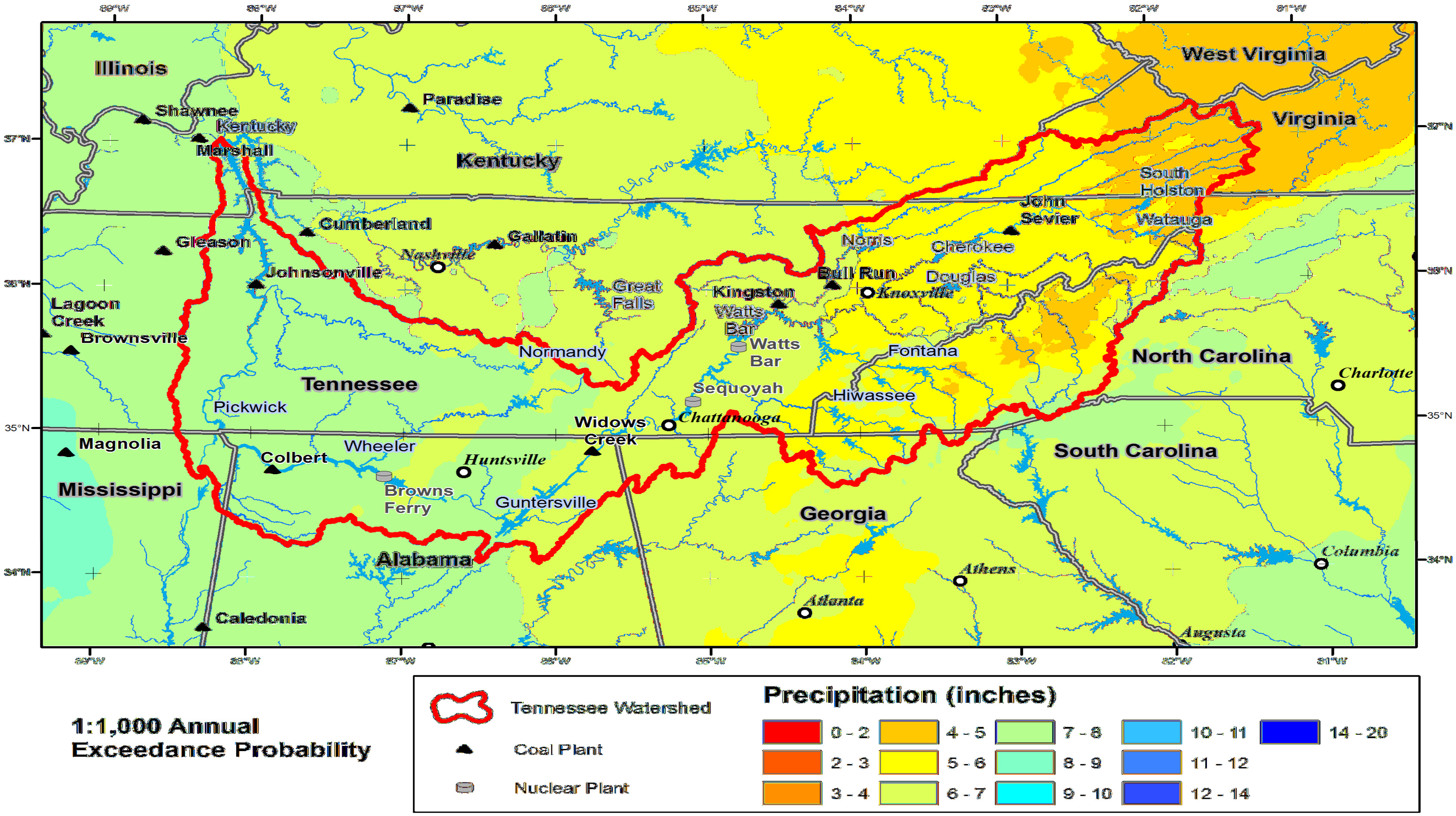
Stantec

**Rainfall Distribution**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/06/2016
Checked by: TGC Checked By Date: 3/08/2016

1000-year 6-hour Rainfall Depth 8 inches
From Isopluvial Map (TVA Basin Point Precipitation Analysis)

| 1000-year 6-hour SCS Type II "Late Peak" Hydrograph | | | 1000-year 6-hour SCS Type II "Middle Peak" Hydrograph | | | 1000-year 6-hour SCS Type II "Early Peak" Hydrograph | | |
|---|---|---|---|---|---|---|---|---|
| Time | Incremental Depth | Cumulative Depth | Time | Incremental Depth | Cumulative Depth | Time | Incremental Depth | Cumulative Depth |
| 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 1.55 | 1.55 |
| 0.1 | 0.04 | 0.04 | 0.1 | 0.04 | 0.04 | 0.1 | 1.08 | 2.63 |
| 0.2 | 0.04 | 0.07 | 0.2 | 0.04 | 0.07 | 0.2 | 0.86 | 3.49 |
| 0.3 | 0.04 | 0.11 | 0.3 | 0.04 | 0.11 | 0.3 | 0.54 | 4.03 |
| 0.4 | 0.04 | 0.14 | 0.4 | 0.04 | 0.14 | 0.4 | 0.27 | 4.30 |
| 0.5 | 0.04 | 0.18 | 0.5 | 0.04 | 0.18 | 0.5 | 0.22 | 4.52 |
| 0.6 | 0.04 | 0.22 | 0.6 | 0.04 | 0.22 | 0.6 | 0.19 | 4.70 |
| 0.7 | 0.04 | 0.25 | 0.7 | 0.04 | 0.25 | 0.7 | 0.16 | 4.87 |
| 0.8 | 0.04 | 0.29 | 0.8 | 0.04 | 0.29 | 0.8 | 0.14 | 5.01 |
| 0.9 | 0.04 | 0.33 | 0.9 | 0.04 | 0.33 | 0.9 | 0.13 | 5.14 |
| 1 | 0.04 | 0.36 | 1 | 0.04 | 0.38 | 1 | 0.12 | 5.26 |
| 1.1 | 0.04 | 0.40 | 1.1 | 0.04 | 0.42 | 1.1 | 0.11 | 5.37 |
| 1.2 | 0.04 | 0.44 | 1.2 | 0.05 | 0.47 | 1.2 | 0.11 | 5.48 |
| 1.3 | 0.04 | 0.48 | 1.3 | 0.05 | 0.52 | 1.3 | 0.10 | 5.57 |
| 1.4 | 0.04 | 0.52 | 1.4 | 0.05 | 0.57 | 1.4 | 0.10 | 5.67 |
| 1.5 | 0.04 | 0.56 | 1.5 | 0.05 | 0.62 | 1.5 | 0.09 | 5.76 |
| 1.6 | 0.04 | 0.60 | 1.6 | 0.06 | 0.68 | 1.6 | 0.09 | 5.85 |
| 1.7 | 0.04 | 0.64 | 1.7 | 0.06 | 0.74 | 1.7 | 0.08 | 5.93 |
| 1.8 | 0.04 | 0.68 | 1.8 | 0.07 | 0.81 | 1.8 | 0.08 | 6.01 |
| 1.9 | 0.04 | 0.72 | 1.9 | 0.07 | 0.88 | 1.9 | 0.08 | 6.09 |
| 2 | 0.04 | 0.76 | 2 | 0.07 | 0.95 | 2 | 0.07 | 6.16 |
| 2.1 | 0.04 | 0.81 | 2.1 | 0.08 | 1.03 | 2.1 | 0.07 | 6.23 |
| 2.2 | 0.05 | 0.85 | 2.2 | 0.09 | 1.12 | 2.2 | 0.07 | 6.30 |
| 2.3 | 0.05 | 0.90 | 2.3 | 0.10 | 1.22 | 2.3 | 0.07 | 6.37 |
| 2.4 | 0.05 | 0.95 | 2.4 | 0.11 | 1.33 | 2.4 | 0.07 | 6.44 |
| 2.5 | 0.05 | 1.00 | 2.5 | 0.12 | 1.45 | 2.5 | 0.06 | 6.50 |
| 2.6 | 0.05 | 1.05 | 2.6 | 0.13 | 1.58 | 2.6 | 0.06 | 6.56 |
| 2.7 | 0.05 | 1.10 | 2.7 | 0.27 | 1.84 | 2.7 | 0.06 | 6.62 |
| 2.8 | 0.05 | 1.15 | 2.8 | 0.54 | 2.38 | 2.8 | 0.06 | 6.68 |
| 2.9 | 0.05 | 1.21 | 2.9 | 0.86 | 3.25 | 2.9 | 0.06 | 6.74 |
| 3 | 0.05 | 1.26 | 3 | 1.55 | 4.80 | 3 | 0.05 | 6.79 |
| 3.1 | 0.06 | 1.32 | 3.1 | 1.08 | 5.88 | 3.1 | 0.05 | 6.85 |
| 3.2 | 0.06 | 1.38 | 3.2 | 0.22 | 6.09 | 3.2 | 0.05 | 6.90 |
| 3.3 | 0.06 | 1.44 | 3.3 | 0.19 | 6.28 | 3.3 | 0.05 | 6.95 |
| 3.4 | 0.06 | 1.50 | 3.4 | 0.16 | 6.44 | 3.4 | 0.05 | 7.00 |
| 3.5 | 0.06 | 1.56 | 3.5 | 0.14 | 6.58 | 3.5 | 0.05 | 7.05 |
| 3.6 | 0.07 | 1.63 | 3.6 | 0.11 | 6.69 | 3.6 | 0.05 | 7.10 |
| 3.7 | 0.07 | 1.70 | 3.7 | 0.10 | 6.79 | 3.7 | 0.05 | 7.15 |
| 3.8 | 0.07 | 1.77 | 3.8 | 0.09 | 6.88 | 3.8 | 0.05 | 7.19 |
| 3.9 | 0.07 | 1.84 | 3.9 | 0.08 | 6.96 | 3.9 | 0.04 | 7.24 |
| 4 | 0.07 | 1.91 | 4 | 0.08 | 7.04 | 4 | 0.04 | 7.28 |
| 4.1 | 0.08 | 1.99 | 4.1 | 0.07 | 7.11 | 4.1 | 0.04 | 7.32 |
| 4.2 | 0.08 | 2.07 | 4.2 | 0.07 | 7.18 | 4.2 | 0.04 | 7.36 |
| 4.3 | 0.08 | 2.15 | 4.3 | 0.06 | 7.24 | 4.3 | 0.04 | 7.40 |
| 4.4 | 0.09 | 2.24 | 4.4 | 0.06 | 7.30 | 4.4 | 0.04 | 7.44 |
| 4.5 | 0.09 | 2.33 | 4.5 | 0.06 | 7.36 | 4.5 | 0.04 | 7.48 |
| 4.6 | 0.10 | 2.43 | 4.6 | 0.05 | 7.42 | 4.6 | 0.04 | 7.52 |
| 4.7 | 0.10 | 2.52 | 4.7 | 0.05 | 7.47 | 4.7 | 0.04 | 7.56 |
| 4.8 | 0.11 | 2.63 | 4.8 | 0.05 | 7.52 | 4.8 | 0.04 | 7.60 |
| 4.9 | 0.11 | 2.74 | 4.9 | 0.05 | 7.57 | 4.9 | 0.04 | 7.64 |
| 5 | 0.12 | 2.86 | 5 | 0.05 | 7.61 | 5 | 0.04 | 7.67 |
| 5.1 | 0.13 | 2.99 | 5.1 | 0.04 | 7.65 | 5.1 | 0.04 | 7.71 |
| 5.2 | 0.14 | 3.13 | 5.2 | 0.04 | 7.70 | 5.2 | 0.04 | 7.75 |
| 5.3 | 0.16 | 3.30 | 5.3 | 0.04 | 7.74 | 5.3 | 0.04 | 7.78 |
| 5.4 | 0.19 | 3.48 | 5.4 | 0.04 | 7.78 | 5.4 | 0.04 | 7.82 |
| 5.5 | 0.22 | 3.70 | 5.5 | 0.04 | 7.82 | 5.5 | 0.04 | 7.86 |
| 5.6 | 0.27 | 3.97 | 5.6 | 0.04 | 7.85 | 5.6 | 0.04 | 7.89 |
| 5.7 | 0.54 | 4.51 | 5.7 | 0.04 | 7.89 | 5.7 | 0.04 | 7.93 |
| 5.8 | 0.86 | 5.37 | 5.8 | 0.04 | 7.93 | 5.8 | 0.04 | 7.96 |
| 5.9 | 1.08 | 6.45 | 5.9 | 0.04 | 7.96 | 5.9 | 0.04 | 8.00 |
| 6 | 1.55 | 8.00 | 6 | 0.04 | 8.00 | 6 | 0.00 | 8.00 |

## 6 Hour Precipitation for Mesoscale Storms with Embedded Convection




**1:1,000 Annual Exceedance Probability**

# APPENDIX H
# STAGE-STORAGE DATA

**Stage -Storage Data**
Inflow Design Flow Control System Plan
Active Ash Pond 2, Johnsonville Fossil Plant
Project Number: 175555008
Calculation Performed by: MMM Calculation Date: 2/5/2016
Checked by: TGC Checked By Date: 2/29/2016

## Active Ash Pond 2 Stage-Storage

| Item No. | Basin Elevation (ft) (1) | Height (ft) | Cumulative Storage (ac-ft) | Cumulative Storage (cu. yds) | Cumulative Storage (cu. ft) |
|---|---|---|---|---|---|
| 1 | 368.0 | 0.0 | 0.00 | 0 | 0 |
| 2 | 370.0 | 2.0 | 0.05 | 75 | 2020 |
| 3 | 372.0 | 4.0 | 4.15 | 6696 | 180779 |
| 4 | 374.0 | 6.0 | 16.87 | 27214 | 734790 |
| 5 | 376.0 | 8.0 | 36.90 | 59537 | 1607506 |
| 6 | 378.0 | 10.0 | 62.31 | 100521 | 2714061 |
| 7 | 380.0 | 12.0 | 93.11 | 150218 | 4055880 |
| 8 | 382.0 | 14.0 | 128.55 | 207392 | 5599576 |
| 9 | 384.0 | 16.0 | 169.15 | 272902 | 7368347 |
| 10 | 386.0 | 18.0 | 217.48 | 350875 | 9473623 |
| 11 | 388.0 | 20.0 | 279.66 | 451185 | 12182001 |
| 12 | 390.0 | 22.0 | 353.25 | 569908 | 15387517 |

ft = feet; sf = square feet; ac = acre, ac-ft = acre feet; CB = calculation brief.