INFLOW DESIGN FLOOD CONTROL PLAN

CFR 257.82

Bottom Ash Pond Complex

Gavin Plant
Cheshire, Ohio

October, 2016

Prepared for: AEP Generation Resources (GENCO) - Gavin Plant

Cheshire, Ohio

Prepared by: American Electric Power Service Corporation

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Document ID: GERS-16-109

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I certify to the best of my knowledge, information, and belief that the information contained in this Inflow Design Flood Control Plan meets the requirements of 40 CFR § 257.82

Table of CONTENTS

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CFR 257.82 for the hydrologic and hydraulic evaluation of CCR surface impoundments.

2.0 DESCRIPTION OF THE CCR UNIT

The Bottom Ash Pond Complex is located adjacent to the Ohio River and Ohio SR 7, north of Gallipolis in Cheshire, Ohio and immediately downstream from the plant. Access to the bottom ash complex is via plant roads. It is owned and operated by AEP Generation Resources (GENCO). The purpose of the Bottom Ash Pond is for the disposal of bottom ash produced at the Gavin Plant.

The Bottom Ash Pond Complex consists of the bottom ash pond and the reclaim pond which are upground reservoirs consisting of continuous earthen dikes on four sides. The total length of the exterior embankment is 6,550 feet and the embankment varies above the exterior grade from 28 to 39 feet. The bottom ash pond and reclaim pond pool levels are operated at approximately Elevations 578 feet and 576 feet, respectively. Storage capacity of the pond is 1,122 acre-feet at the top of the dikes.

Bottom ash slurry is pumped into the bottom ash pond and the water is decanted through a drop inlet structure into a reclaim pond within the diked area and is pumped to the plant for reuse or discharge to the Ohio River via an overflow structure.

List of Main Ponds within the Bottom Ash Complex

Bottom Ash Pond
Reclaim Pond

3.0 INFLOW DESIGN FLOOD 257.82(a)(3)

The facility is classified as a High Hazard Potential Dam. The Inflow Design Flood is the Probable Maximum Flood (PMF). The PMF was calculated using the probable maximum precipitation (PMP). PMP calculations are included in Attachment A.

4.0 FLOOD CONTROL PLAN 257.82(C)

The primary spillway structure at the Bottom Ash Pond is composed of a concrete riser structure that controls the pool elevations with stop logs or large metal plates that are raised and lowered from a hoist. The structure is designed to allow water to flow freely within the structure. The outlet structure at the Reclaim Pond consists of an open concrete channel that discharges into a 30-inch diameter HDPE pipe. The water surface elevation within the pond is controlled by wooden stop logs at the inlet to the concrete channel. The bottom ash and reclaim pool elevations are normally maintained at 578 feet and 576 feet, respectively. The lowest crest elevation of the dike is 585 feet. The available freeboard of 4.8 feet and 7.4 feet was calculated for the bottom ash and reclaim ponds based on the based on the modeling for normal pool with operable spillway during 100% PMP event. Design calculations are included in Attachment A (Bottom Ash Pond Initial Safety Factor Assessment and H&H Analysis, Gavin Plan, prepared by S&ME, dated December 30, 2015).

The calculations show that the facility has the capacity to manage the inflow design flood.

ATTACHMENT A

Bottom Ash Pond
Initial Safety Factor Assessment
and H&H Analysis
General James Gavin Power Plant
Cheshire, Ohio
S&ME Project No. 7217-15-006A

Prepared for:
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December 30, 2015

Table of Contents

List of Figures

List of Tables

Appendices

1.0 Introduction

1.1 Background

In April of 2015, the US EPA formally published national regulations for disposal of coal combustion residuals (CCR) from electric facilities. As part of the rule, the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that aspects of the CCR impoundments are in accordance with the rules. Based on our understanding of the Request for Fee Estimate received from AEP on April 29, 2015, AEP specifically requested P.E. certification to fulfill the requirements of 40 CFR § 257.73(e), *Periodic Safety Factor Assessments*. In the employment of BBC&M Engineering, Inc., the undersigned engineers conducted site investigations at the bottom ash pond in 2009 and 2010. Due to our familiarity with the site, S&ME was selected to perform the Safety Factor Assessment for this facility. Additionally, since the bottom ash pond has not had a recent hydrologic and hydraulic (H&H) analysis performed, S&ME was also tasked to conduct an H&H analysis to fulfill the requirements 40 CFR § 257.73 (d) (1) (v) (B). S&ME understands that certification and/or documentation for other structural integrity criteria will be performed by AEP or other consultants.

1.2 Location and Geologic Conditions

The Gavin Power Plant, as shown in Figure 1-1, is located along the Ohio River, approximately 10 miles north of Gallipolis, Ohio. The bottom ash pond, which was put into service in 1974, is located immediately south of the generating plant and consists of a four-sided upground earthen embankment structure. Within the pond is a smaller, non-structural, embankment separating the main pond from the recirculation pond. The total length of the exterior embankment is 6550 feet and the embankment varies in height, as measured above the exterior grade, from 28 to 39 feet. The pond is completely isolated from exterior surface water inflow. The original construction drawings indicated that the inboard and outboard slopes were designed with 2H:1V slope angles. Survey data taken at the boring locations reveal a range of outboard slope angles from 1.8H:1V to 2.2H:1V. The embankment was constructed as a homogenous dam.

Figure 1-1 – Gavin Plant

The natural soils at the site consist of a layer of alluvium silt, clay and fine sand over glacial outwash deposits of variable thickness overlying the bedrock surface. The alluvium clays and silts were deposited in the backwater of the Ohio River, while the outwash materials typically consist of sand, gravel and silt deposits deposited during the last ice age. Based on available geologic literature, the glacial outwash extends to the bedrock surface, estimated to be roughly 60 feet below the natural ground surface.

1.3 Previous Investigations

In 2009, the undersigned engineers, when in the employment of BBC&M Engineering, Inc., completed a subsurface investigation and geotechnical assessment of the Bottom Ash Pond embankments. This assessment, dated June 16, 2009, concluded that the embankment exhibited adequate factors of safety against slope failure under steady-state seepage and seismic loading conditions relative to typical US Army Corps of Engineers requirements. In 2010, BBC&M Engineering, Inc. performed additional geotechnical analyses. As part of this work, the initial exploration was supplemented with additional borings and laboratory testing, and the updated slope stability analyses were updated and additional failure modes were examined, including rapid drawdown. A report documenting the additional geotechnical analysis, dated April 26, 2010, was submitted as an addendum to the 2009 report.

2.0 Scope of Work

In accordance with AEP's request, the following work items were performed by S&ME:

1. S&ME completed a cursory review of previously conducted assessment work performed by the undersigned engineers, as well as a limited number of construction documents made available by AEP.

2. S&ME visited the site along with personnel from AEP. The site visit was not a formal inspection, but rather served to verify that no significant modifications or changed conditions have taken place since the previous investigations.

3. Hydrologic and Hydraulic (H&H) analysis: An H&H analysis was performed to fulfill the requirements of Part 257.73 (d) (1) (v) (B).

4. Upon completing Tasks 1 through 3, S&ME's determined that there was sufficient information to certify the structural integrity of the surface impoundment in accordance with the requirements of 40 CFR § 257.73(e). A separate letter has been prepared to this effect.

3.0 Information Review and Site Visit

To support the safety factor assessment and hydrology and hydraulic analyses, S&ME conducted a cursory review of previous documents relating to the bottom ash pond and conducted a site visit at the facility. AEP provided S&ME with the following documents:

- Grading and Fence Plan, 1974 (Dr. No. 12-014-9)
- Excavation Plan, Not dated (Dr. No. MHD-SK-012887)
- Sections, 1971 (Dr. No. 12-3015-3)
- Topographic survey data generated from (year) LiDAR information
- Principal Spillway conduit and Impact Basin, 1973 (DWG No. 670 C 205 R1)
- Principal Spillway Plan and Sections, 1973 (DWG No. 670 C 201 R2)
- Principal Spillway Floating Platform and Skimmer, 1973 (DWG No. 670 C206)
- Reclaim Pond Outlet Structure – Plan and Profile, 1994 (DWG No. 12-30408-2)
- Modification of Bottom Ash Complex Pond & Outfall Pipe, 1994 (DWG 12-30401-2)
- Bottom Ash Pond Complex Pond Outfall – Plan and Profile, 1994 (DWG 12-30407-1)
- Bottom Ash Pond Investigation, BBC&M Engineering, Inc., July, 2009
- Assessment of Dam Safety Final Report, Clough Harbour, & Assoc., September, 2009
- Addendum to Bottom Ash Pond Investigation, BBC&M Engineer, Inc. April, 2010

On July 28, 2015, the undersigned S&ME personnel met with Mr. Shah Baig (AEP Civil Engineering) and Mr. Doug Workman (Gavin Plant Manager) at the Gavin Plant and conducted a site visit at the bottom ash pond. The participants discussed and observed the operations of the bottom ash and recirculation ponds, including the hydraulic structures within the ponds. The crest and inboard and outboard slopes were observed and no significant geometry changes appeared to have been made since the 2009 and 2010 assessments. While the site visit was not a formal inspection, visual observations of the bottom ash pond did not reveal any dam safety concerns, and the embankments appear to be in a similar condition as in 2009 and 2010 when our previous investigations were performed.

4.0 Hydrologic and Hydraulic Study

The purpose of this hydrologic and hydraulic study is to satisfy the requirements of 40 CFR § 257.73 (d) (1) (v) (B) published by the EPA in April 2015 for the Gavin Bottom Ash Pond Complex (Main Pond and Reclamation Pond). The Bottom Ash Pond Complex is classified by the Ohio Department of Natural Resources (ODNR) Division of Soil and Water Resources as a Class I Dam. The Bottom Ash Pond Complex is composed of two ponds that are connected by a single hydraulic structure on a shared interior dike. The Main Pond discharges through the shared structure into the Reclamation Pond for final treatment. The Reclamation Pond discharges through an outlet structure to a pipe network that discharges into the Ohio River.

4.1 Records Review and Data Collection

To support our analyses, S&ME requested available data from AEP with respect to the bottom ash pond, and the information received is summarized in Section 3.0 of this report. In particular, S&ME was interested in historical drawings and recent pond survey data (topographic data). An as-built drawing for the Reclamation Pond outlet structural was not available and assumptions were made with regard to structure dimensions based on a plan and profile of the structure (drawing 12-3015-3) and a site visit performed by S&ME on July 28, 2015. Additionally, S&ME was not provided with recent topographic survey data. The stage-storage curve for each pond was developed using the end-area method from the plan view contours within each pond starting at the normal (operating) pool elevation. Please note that the storage curve stops at the lowest elevation of the top of the embankment within each pond (EL. 585.0), not the highest part of the embankment. The contour areas were obtained using AutoCAD Civil 3D 2015 and based on topographic data obtained from Ohio State Imagery program (OSIP) LiDAR dataset (2006).

4.2 Elevation Datum Conversion

Elevations represented in this study refer to the North American Vertical Datum of 1988 (NAVD88) unless otherwise specified. Historical drawings were used to determine structure elevations for critical hydraulic components of this study and these drawings referenced the National Geodetic Vertical Datum of 1929 (NGVD29). The historical elevation data used in this study was converted to the NAVD88 datum using the VERTCON software package developed by the National Oceanic and Atmospheric Association (NOAA) using the best available data near the location of the impoundment. The VERTCON software estimated that the NGVD29 elevation data needs to be lowered by 0.650 feet to approximate the equivalent NAVD88 elevation. The output data from VERTCON is included in Appendix I.

4.3 Hydrologic Routing

The design storm was routed through each drainage area, corresponding to the footprint of each pond in the Bottom Ash Pond Complex, using both of the ODNR PMP distributions to determine the controlling rainfall distribution in accordance with the ODNR PMP guidance. The TR-20 hydrologic routing methodology developed by the Natural Resources Conservation Service (NRCS) was used to calculate the runoff volume for the PMP rainfall event. Following calculation of the hydrologic input parameters, rainfall runoff estimates, and the stage-storage relationship for the sedimentation pond, S&ME modeled the pond and outflow structure using the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) version 4.1, developed by the U.S. Army Corps of Engineers. Input and output data from HEC-HMS is included in Appendix I and a summary of the peak flows and runoff volume is included in table 2 below.

Table 4-1 Hydrologic Routing Summary

Basin	ODNR Distribution	Estimated Peak Inflow (CFS)	Estimated Runoff Volume (AC-FT)
Main Pond	ODNR Type II – 24HR	396.3	131.1
Reclamation Pond	ODNR Type II – 24HR	8.7	2.9

4.4 Hydraulic Routing

Two scenarios were modeled as part of this study. Both scenarios are described below and a summary of the estimated maximum pool elevation within the pond is include in Table 3 below. Input and output data from HEC-HMS is included in Appendix I.

4.4.1 *Scenario 1 - Normal Pool with active spillways during 100% PMP event*

This scenario was calculated using the following assumptions:

1. Pond starting water elevation is normal (operating) pool
2. 100% PMP event
3. Plant pumped inflows and outflows are distributed evenly (hourly) throughout the storm event
4. Spillways are active and operational

Table 4-2 Hydraulic Modeling Summary – Scenario 1

Pond	Estimated Peak Inflow (CFS)	Estimated Peak Outflow (CFS)	Estimated Peak Elevation (ft-msl)	Estimated Freeboard (FT)
Main	398.1	39.2	580.2	4.8
Reclamation	40.1	39.4	577.6	7.4

4.4.2 *Scenario 2 - Normal Pool with inoperable spillways during 100% PMP event*

This scenario was calculated using SCS methodology for various alternatives as described below. The estimated maximum water surface elevation for each pond in Scenario 2 is indicated in Table 6 below. Calculation sheets from the runoff curve number method are included in the Attachments (A.20-A.21).

4.4.2.1 2A - Main Pond

Scenario 2A estimated the total runoff produced from the drainage area to the Main Pond, at both the 24HR rainfall depth and the 6HR rainfall depth, with an inoperable principal spillway.

4.4.2.2 2B - Reclamation Pond

Scenario 2B estimated the total runoff produced from the drainage area to the Reclamation Pond, at both the 24HR rainfall depth and the 6HR rainfall depth, with an inoperable principal spillway and no hydraulic connection to the Main Pond.

4.4.2.3 2C - Pond Complex

Scenario 2C estimated the total runoff produced from the drainage area to the entire pond complex, at both the 24HR rainfall depth and the 6HR rainfall depth, with an inoperable principal spillway and hydraulic connection to the Main Pond.

Table 4-3 Hydraulic Modeling Summary – Scenario 2

Scenario	Pond	Estimated Peak Elevation (ft-msl)[1]	Estimated Freeboard (FT)
2A	Main	582.6	2.4
2C	Reclamation	582.0	3.0

[1]Peak elevation chosen from Table 6 in H&H Technical Report in Appendix I.

4.5 Discussion

S&ME performed a hydrologic and hydraulic study on the bottom ash pond complex at the AEP Gavin Plant and a summary of the results are outlined below:

- The main pond can adequately store and pass the design storm with approximately 4.7 feet of freeboard available.
- The main pond spillway meets the requirements specified in paragraph (d)(1)(v)(A).
- The main pond meets the discharge requirements specified in paragraph (d)(1(v)(B).
- The reclamation pond can adequately store and pass the design storm with approximately 7.4 feet of freeboard available.
- The reclamation pond spillway meets the requirements specified in paragraph (d)(1)(v)(A).
- The reclamation pond meets the discharge requirements specified in paragraph (d)(1(v)(B).

5.0 Safety Factor Assessment

As part of the safety factor assessment, S&ME completed Parts 1 and 2 of Section 257.73(e) of the Final Rules for the Disposal of Coal Combustion Residuals from Electric Utilities published on April 17, 2015 in the Federal Register. In accordance with the Rule, the analysis was performed for the critical cross-sections(s) that are anticipated to be most susceptible of all cross-sections to structural failure based on appropriate engineering considerations. The Rule specified the following loading conditions for analysis:

i. Static Factor of Safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

ii. Calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.50

iii. The calculated seismic factor of safety must equal or exceed 1.00

iv. For dikes constructed of soils susceptible to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

5.1 Limit Equilibrium Analyses

Our 2009 Investigation Report and the 2010 Addendum discuss in detail the subsurface investigation, laboratory testing, parameter justification, seepage analyses and limit equilibrium slope stability analyses that were performed to develop safety factors for the bottom ash pond embankments. In summary, one section on each side of the four-sided pond embankment was studied. Subsurface information for each section was obtained by performing borings through the crest and toe of the embankment. Additionally, four observation wells were installed to obtain groundwater readings within the embankment and foundation. These wells were supplemented with additional groundwater data supplied by AEP, as discussed in more detail in Section 6.0. Based on a review of all four sections explored, two were selected for detailed limit equilibrium stability analysis, one through the west side and one through the south side. The Plan of Borings, geotechnical cross-sections, and soil boring logs from the 2009 investigation are included in Appendix II. A summary of laboratory testing is provided in Appendix III.

Prior to performing the limit equilibrium stability analyses, seepage analyses were performed to develop a better understanding of the likely phreatic surface within the embankment and foundation. The models were calibrated by adding additional total head boundary conditions within the subsurface to best model the groundwater table as observed in the observation wells. The model results, in conjunction with the observation well readings, suggest that much of the seepage emanating from the ponds is moving downward into the more permeable alluvium soils rather than moving laterally through the less permeable embankments. For this reason, it appears that a classically shaped phreatic surface (as might be expected to form within an earth dam constructed on an impermeable foundation, Casagrande 1937) has not developed. In addition, the pool level within the pond is maintained well below the crest for operational purposes. The apparent effect of both of these conditions is a phreatic surface located well within the embankment and far from the outboard slope face.

The shear strength parameters developed for the embankment fill and alluvial layers for use with the pseudo-static seismic analysis were evaluated in consideration of the laboratory testing results. In accordance with NRCS practice, 80 percent of the CU strength values (USACE R-Envelope) were used as recommended for impervious soils, defined by soils exhibiting a coefficient of permeability less than $1x10^{-4}$ cm/sec. Critical failure surfaces were located through a deterministic search, with no limitations on failure depth or failure surface location. The results are based on the pool level recorded at the time of the survey and the groundwater measurements recorded from the observation wells.

Table 5-1 - Shear Strength Parameters

Material Description	γ_{wet} *(pcf)*	*Total*		*Effective*		*Reference*
		ϕ	c (psf)	ϕ'	c' (psf)	
Roadway Fill	125	34°	0	34°	0	NAVFAC
Cohesive Embankment Fill	125	17.3°†	1,430†	32°	100	CU-2 Triaxial Test (BBCM, 2010)
Upper Alluvium	125	11°†	800†	27.9°	470	CU-3 Triaxial Test (BBCM, 2010)
Lower Alluvium	125	18°†	250†	34.5°	0	CU-4 Triaxial Test (BBCM, 2010)
Loose to Med. Dense Glacial Outwash Sand and Gravel	120	32°	0	32°	0	SPT and Grain Size Correlations

† 80% of value used for pseudo-static slope stability analysis

5.2 Liquefaction Potential of Embankment Soils

S&ME evaluated the potential of the embankment soils to liquefy during a seismic event. The embankment material is classified as a fined grained material and the recovered samples with gradation testing were evaluated following guidelines presented in the 2003 NEHRP (National Earthquake Hazards Reduction Program) Recommended Provisions for Seismic Regulations for New Buildings and Other Structures. The provisions in Chapter 7 indicate that liquefaction potential in fine grained soils should be assessed provided the following criteria are met (Seed and Idriss 1982; Seed et al., 1983): the weight of the soil particles finer than 0.005 mm is less than 15 percent of the dry unit weight of a specimen of the soil; the liquid limit of soil is less than 35 percent; and the moisture content of the in-place soil is greater than 0.9 times the liquid limit. If all of these criteria are not met, the soils may be considered non-liquefiable.

Laboratory testing results from 24 samples were available from the 2009 and 2010 investigation for evaluation of the screening criteria. Of the 24 samples, 13 samples contained data to check all three screening criteria, and 11 samples contained data to check two screening criterion. Based on the results of the screening, no sample met all 3 criteria; therefore, these embankment fill can be considered non-liquefiable. A table depicting this evaluation is included in Appendix II.

5.3 Summary of Results

A summary of the computed safety factors for the critical cross-section is provided in Table 5-1. Also included in the table are the minimum values defined in 40 CFR § 257.73(e)(1) subparts (i) through (iv). Graphical output corresponding to the analysis cases are presented in Appendix IV.

Table 5-2 – Safety Factor Summary

Analysis Case	Minimum Safety Factor	Computed Safety Factor
Long-term, maximum storage pool	1.50	1.76
Maximum surcharge pool	1.40	1.75
Pseudo-static seismic loading	1.00	1.39
Embankment Liquefaction	1.20	Non-liquefiable

6.0 Certification

Based on our previous investigations and current assessment of the Bottom Ash Pond facility, S&ME certifies that this assessment meets the requirements of paragraphs (e)(1) and (e)(2) of Part 257.73 for the critical cross-section of the embankment.

We appreciate having been given the opportunity to be of service on this project. If you have any questions, please do not hesitate to contact this office.

Sincerely,

S&ME, Inc.

STATE OF OHIO
MICHAEL T. ROMANELLO
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REGISTERED
PROFESSIONAL ENGINEER
12-30-15

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CALCULATION SHEET

PROJECT NAME		SUBJECT		
AEP Gavin Bottom Ash Pond		Ash Pond H&H Study		
PROJECT NO. 7217-15-006A	**CALC BY** MRM	**REV BY** PLM	**DATE** 9/21/2015	**SHEET NO.** 2 OF 14

TABLE OF CONTENTS

BOTTOM ASH POND HYDROLOGY AND HYDRAULICS

The purpose of this hydrologic and hydraulic study is to satisfy the requirements of 40 CFR § 257.73 (d) (1) (v) (B) published by the EPA in April 2015 for the Gavin Bottom Ash Pond Complex (Main Pond and Reclamation Pond). Section (d)(1)(v)(B) states the following:

(B) *The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:*

(1) *Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or*

(2) *1000-year flood for a significant hazard potential CCR surface impoundment; or*

(3) *100-year flood for a low hazard potential CCR surface impoundment.*

The Bottom Ash Pond Complex is classified by the Ohio Department of Natural Resources (ODNR) Division of Soil and Water Resources as a Class I Dam. The Pond Complex is composed of two ponds that are connected by a single hydraulic structure across a shared interior dike. The Main Pond discharges through this shared structure into the Reclamation Pond for treatment. The Reclamation Pond discharges through an outlet structure to a pipe network that discharges into the Ohio River. A site plan is included in the Attachments (A.1) and the ODNR Dam Inventory Sheet is included in the Attachments (A.10).

HYDROLOGIC STUDY

Elevation Datum Conversion

Elevations represented in this study refer to the North American Vertical Datum of 1988 (NAVD88) unless otherwise specified. Historical drawings were used to determine structure elevations for critical hydraulic components of this study and these drawings referenced the National Geodetic Vertical Datum of 1929 (NGVD29). The historical elevation data used in this study was converted to the NAVD88 datum using the VERTCON software package developed by the National Oceanic and Atmospheric Association (NOAA) using the best available data near the location of the impoundment. The VERTCON software estimated that the NGVD29 elevation data needs to be lowered by 0.650 feet to approximate the equivalent NAVD88 elevation. The output data from VERTCON is included in the Attachments (A.2).

Hydrologic Parameters

Plant Inflows

The Gavin Plant inflows within the Main Pond were provided by AEP in the Water Balance Diagram included in the Attachments (A.3). Table 1 below summarizes the sources of inflows and how the average daily flows were included in the study.

CALCULATION SHEET

PROJECT NAME		SUBJECT		
AEP Gavin Bottom Ash Pond		Ash Pond H&H Study		
PROJECT NO. 7217-15-006A	**CALC BY** MRM	**REV BY** PLM	**DATE** 9/21/2015	**SHEET NO.** 4 OF 14

Table 1 – Plant Inflows and Outflows

Type	Description	Average Daily Flow[1]	Hourly Flow (24HR)[2]	Hourly Flow (6HR)[3]
Inflow – Main Pond	Cooling Tower Blowdown	11.52	1.76 cfs	7.0 cfs
Inflow – Main Pond	Bottom Ash + Pyrites Sluice	7.24		
Inflow – Main Pond	Low Volume Wastewater	8.39		
Inflow – Main Pond	Coal Pile Runoff	0.17		
Inflow – Main Pond	Fly Ash Transfer Building Sumps	0.01		
	MAIN POND INFLOW TOTAL	**27.33**		

[1] Average Daily Flow given in Millions of Gallons per Day (MGD).
[2] Average Daily Flow distributed over 24 hours, given in Cubic Feet per Second (cfs).
[3] Average Daily Flow distributed over 6 hours, given in cfs.

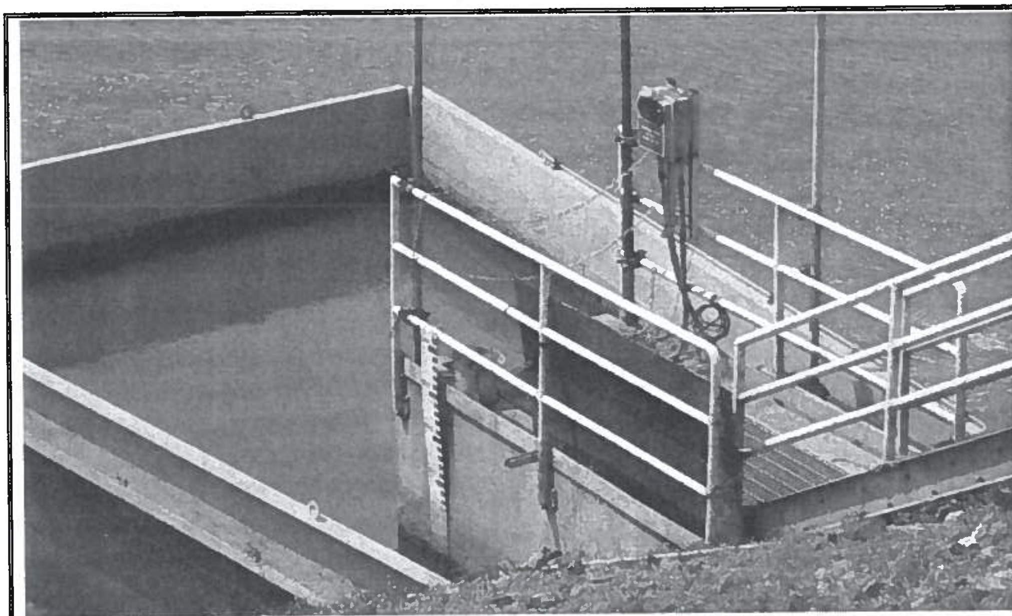
Normal Pool Designation

Normal pool within each pond was based on field observation of staff gages on the outlet structures during a site visit to the AEP Gavin Plant on July 28, 2015. The normal (operating pool) within the Main Pond is approximately 578.0 ft-msl and the operating pool within the Reclamation Pond is approximately 575.0 ft-msl. (see the following photographs).

Date: 7/28/2015

Photographer: MGR/MTR

Location / Orientation	Main Pond Spillway Structure
Remarks	Note that the pond is currently at elevation 578.0



Date: 7/28/2015

Photographer: MGR/MTR

Location / Orientation	Reclamation Pond Spillway Structure
Remarks	Note the pond is currently at elevation 575.0

Drainage Area

The pond is an upground impoundment and the total drainage area is limited to the inboard slope of the four primary embankments. The drainage area for both the main pond and the reclamation pond were estimated using AutoCAD Civil3D 2015 with topographic data obtained from the Ohio State Imagery program (OSIP) LiDAR dataset (2006). The estimated drainage areas for the main pond and reclamation pond are 58.1 Acres and 1.3 Acres respectively. A figure depicting the drainage area delineation is included in the Attachments (A.1).

SCS Runoff Curve Number

The Soil Conservation Service Runoff Curve Number chosen for this study was 98 to reflect a drainage area that is primarily open water with very little exposed vegetated embankment for infiltration to affect the total runoff.

Time of Concentration / Lag Time

Due to the upground nature of the impoundment and the fact that impoundment is predominantly an open water surface, the time of concentration was assumed to be 5 minutes.

Probable Maximum Precipitation Calculation

Based on the Class I classification by the ODNR Division of Soil and Water Resources, the Gavin Bottom Ash Pond is required to pass the 100% of the Probable Maximum Flood (PMF) with a starting water surface elevation at normal pool. The Probable Maximum Precipitation (PMP) was used to estimate the PMF based on revised rainfall depth estimates for the state of Ohio from a statewide PMP study released by ODNR in 2013. Historical PMP values were conservatively high to account for a higher level of uncertainty associated with the predicted values. When the results of the new ODNR study reduced the values, new guidelines were released on the appropriate use of the values in the hydrologic and hydraulic analysis of dams. Specifically, the new guidelines require the evaluation of two separate rainfall distributions: a 24-hour SCS Type II distribution commonly used in the Midwest but modified slightly by ONDR; and a 6-hour PMP distribution developed by ODNR using techniques from Hydrometeorlogical Report No. 52. The distributions are presented in Figures 1 and 2 below. The time step (which influences peak duration and intensity) used in each distribution has been defined by ODNR. The time steps were further modified slightly to accommodate the modeling capabilities of HEC-HMS because a 90 minute and 12 minute time step are not available. The ODNR distributions were interpolated to produce a 60 minute interval across the SCS Type II distribution and a 10 minute interval across the ODNR Dimensionless distribution. The more conservative event (the one resulting in the higher peak water surface elevation) is used as the design event. Maps provided in the Attachments (A.4 – A.5) were used to estimate the total rainfall volumes applied to each of the rainfall distributions below.

Figure 1 - ODNR SCS Type II Distribution

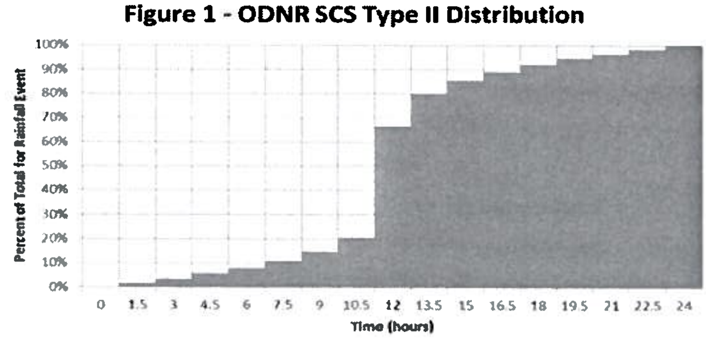
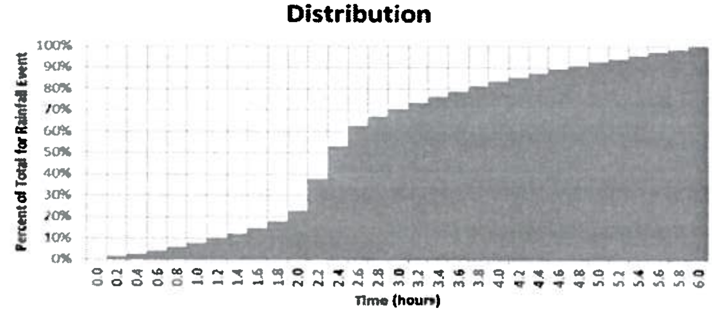


Figure 2 - ODNR, HMR-52 6-Hour PMP Distribution



Elevation Stage Storage Curve

The elevation stage-storage curve for both the main pond and the reclamation pond is included in the attachments (A.6 – A.7). The stage-storage curve was developed using the end-area method from the plan view contours within each pond starting at the normal pool elevation. Please note that the storage curve stops at the lowest elevation of the top of the embankment within each pond, not the highest part of the embankment. The contour areas were obtained using AutoCAD Civil 3D 2015 and based on topographic data obtained from Ohio State Imagery program (OSIP) LiDAR dataset (2006). The LiDAR topographic contours do not provide bathymetric data below the pool level within each pond at the time of the flyover, so the Reclamation pond volume was only available down to elevation 576. S&ME extrapolated down one additional foot to model the operating pool level at elevation 575.

Hydrologic Routing

The design storm was routed through each drainage area, corresponding to the footprint of each pond, using both the ODNR PMP distributions to determine the controlling rainfall distribution in accordance with the ODNR PMP guidance. Hydrologic routing methodology developed by the Natural Resources Conservation Service (NRCS) was used to calculate the runoff volume for the PMP rainfall event. Following calculation of the hydrologic input parameters, rainfall runoff estimates, and the stage-storage relationship for the sedimentation pond, S&ME modeled the pond and outflow structure using the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) version 4.1, developed by the U.S. Army Corps of Engineers. Input and output data from HEC-HMS is included in the Attachments (A.14-A.18) and a summary of the peak flow and runoff volume is included in table 2 below.

Table 2 - Hydrologic Routing Summary

Basin	ODNR Distribution	Estimated Peak Inflow (CFS)	Estimated Runoff Volume (AC-FT)
Run 1 - Main Pond	Type II – 24HR	396.3	131.1
Run 2 - Main Pond	HMR-52 – 6HR	841.2	91.3
Run 1 - Reclamation Pond	Type II – 24HR	8.7	2.9
Run 2 - Reclamation Pond	HMR-52 – 6HR	18.5	2.0

HYDRAULIC STUDY

Hydraulic Structures

Two primary structures control runoff and pumped flow within the main pond, the reclamation pond and between ponds. These structures are outlined below and supporting information including historical drawings is included in the Attachments (A.8 – A.11).

Interior Dike Spillway Structure

The primary spillway structure from the main pond is located within the intermediate dike between the main pond and reclamation pond. The spillway structure is composed of a concrete riser structure that controls the pool elevations with stop logs or large metal plates that are raised and lowered from a hoist. The structure is designed to allow flow to enter from two sides, with each side separated by an interior wall that has large holes to allow water to flow freely within the structure. Each vertical chamber of the structure is approximately 4 feet wide by 4 feet long. The large metal plates act as a weir for the water to flow into the structure and they are approximately 4 feet wide. The weir was modeled using a spillway rating curve developed using the Hydrologic Engineering Circular No. 22 equations for sharp-crested weirs. The calculations used to develop the weir spillway rating curve are included in the Attachments (A.8). The concrete structure discharges into a 42-inch diameter reinforced concrete pipe that runs beneath the interior dike and outlets into the reclamation pond. Characteristics of the outlet pipe are included in Table 3 below.

Table 3 – Main Pond Outlet Pipe Characteristics

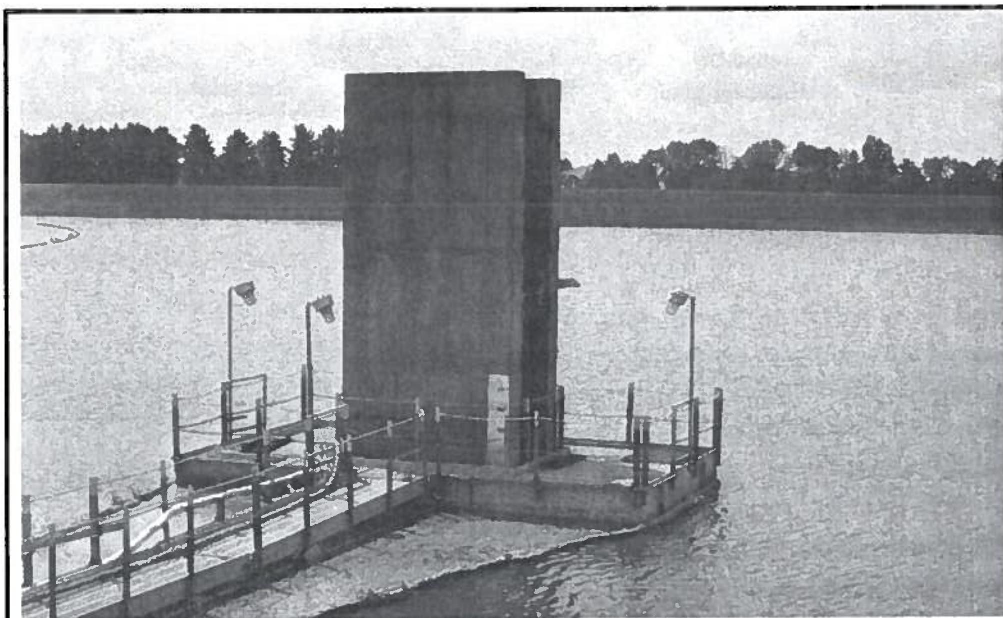
Component	Description	Size / Pipe Diameter (FT)	Length (FT)	Slope (%)	Begin Invert El.	End Invert El.
Pipe 1	Rein. Conc. Pipe	3.5	188	1.0	558.35	556.35

Photos of the main pond spillway structure taken during a site visit on July 28, 2014 are included below.

S&ME

CALCULATION SHEET

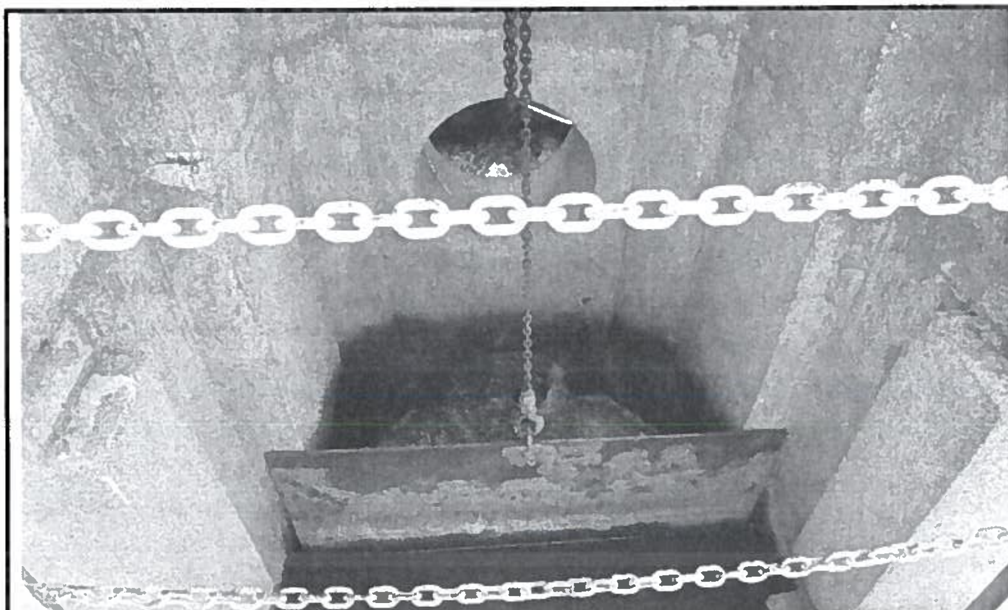
PROJECT NAME		SUBJECT		
AEP Gavin Bottom Ash Pond		Ash Pond H&H Study		
PROJECT NO.	**CALC BY**	**REV BY**	**DATE**	**SHEET NO.**
7217-15-006A	MRM	PLM	9/21/2015	9 OF 14



Date: 7/28/2015

Photographer: MGR/MTR

Location / Orientation	Main Pond Spillway Structure
Remarks	Right side is open, left side is closed currently.



Date: 7/28/2015

Photographer: MGR/MTR

Location / Orientation	Open side of Spillway Structure
Remarks	Note the metal plate used instead of stop logs.

CALCULATION SHEET

PROJECT NAME		SUBJECT		
AEP Gavin Bottom Ash Pond		Ash Pond H&H Study		
PROJECT NO.	**CALC BY**	**REV BY**	**DATE**	**SHEET NO.**
7217-15-006A	MRM	PLM	9/21/2015	10 OF 14

Reclamation Pond Outlet Spillway Structure

The outlet structure in the reclamation pond consists of an open concrete channel that discharges into a 30-inch diameter HDPE Spirolite Pipe. The water surface elevation within the pond is controlled by wooden stop logs at the inlet to the concrete channel. The stop logs can be removed to an invert elevation of 572.33. The concrete channel is 2.5 feet wide and approximately 5 feet tall. The weir was modeled using a spillway rating curve developed using the Hydrologic Engineering Circular No. 22 equations for sharp-crested weirs. The calculations used to develop the weir spillway rating curve are included in the Attachments (A.9).When submerged, the side walls of the concrete channel will begin to perform as a long weir approximately 21.5 feet long at approximately elevation 577.33. The operating pool elevation within the reclamation pond is more or less approximately elevation 575.

Photos of the reclamation pond taken during a site visit on July 28, 2014 are included below.

Date: 7/28/2015

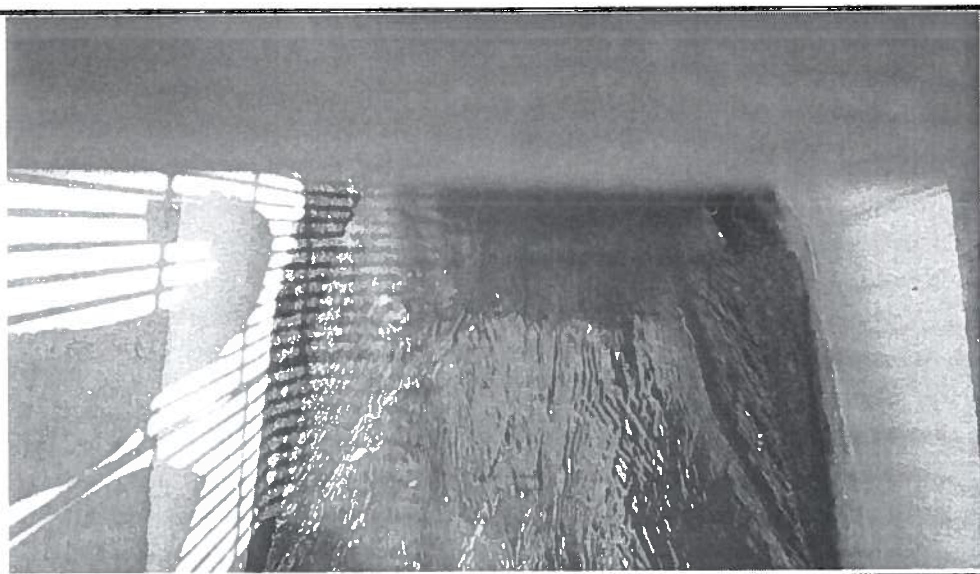
Photographer: MGR/MTR

Location / Orientation	Entrance to concrete channel
Remarks	No stop logs in place at time of visit.

S&ME

CALCULATION SHEET

PROJECT NAME		SUBJECT		
AEP Gavin Bottom Ash Pond		Ash Pond H&H Study		
PROJECT NO. 7217-15-006A	CALC BY MRM	REV BY PLM	DATE 9/21/2015	SHEET NO. 11 OF 14



Date: 7/28/2015

Photographer: MGR/MTR

Location / Orientation	Concrete channel looking through top grating
Remarks	Palmer Bowles Flume within concrete channel used to measure flow volume.

Reclamation Pond Outlet Pipe

The Reclamation pond outlet structure discharges into an outlet pipe network as described in Table 4 below. The characteristics found in the table reflect information obtained from As-built drawing 12-30407-1 included in the Attachments (A.12).

Table 4 – Reclamation Pond Outlet Pipe Network Characteristics

Component	Description	Size / Pipe Diameter (FT)	Length (LF)	Slope (%)	Begin Invert El.	End Invert El.
Pipe 1	Spirolite HDPE	2.5	150	0.37	572.33	571.78
Manhole 1	Concrete	-----	-----	-----	571.78	570.12
Pipe 2.1	Corrugated HDPE	2.5	1,028.4	0.5	570.12	564.35
Pipe 2.2	Spirolite HDPE	2.5	137.53	1.1	564.35	562.81
Manhole 2	Concrete	-----	-----	-----	562.81	562.81
Pipe 3	Spirolite HDPE	2.5	322.36	0.6	562.81	560.92
Manhole 3	Concrete	-----	-----	-----	560.92	560.92
Pipe 4	Corrugated HDPE	2.5	355.31	0.59	560.92	558.84

Manholes identified in this study were not included in the model and assumed to have a negligible effect on head loss across the outlet pipe network.

Modeled Scenarios

Two scenarios were modeled as part of this study. Both scenarios are described below and a summary of the estimated maximum pool elevation within the pond is include in Table 5 below. Input and output data from HEC-HMS is included in the Attachments.

Scenario 1 - Normal Pool with active spillways during PMP event

This scenario was calculated using the following assumptions:

1. Pond starting water elevation is normal (operating) pool
2. 100% PMP event
3. Plant pumped inflows and outflows are distributed evenly (hourly) throughout the event
4. Spillways are active and operational

Table 5: Hydraulic Modeling Summary – Scenario 1

Scenario	Pond	ODNR Distribution	Estimated Peak Inflow (CFS)	Estimated Peak Outflow (CFS)	Estimated Peak Water Surface Elevation (feet-msl)
Scenario 1	Main	Type II – 24HR	398.1	39.2	580.2
Scenario 1	Main	HMR-52 – 6HR	848.2	31.8	579.9
Scenario 1	Reclamation	Type II – 24HR	40.1	39.4	577.6
Scenario 1	Reclamation	HMR-52 – 6HR	33.4	18.1	576.8

Scenario 2 - Normal Pool with inoperable spillways during PMP event

This scenario was calculated using SCS methodology for various alternatives as described below. The estimated maximum water surface elevation for each pond in Scenario 2 is indicated in Table 6 below. Calculation sheets from the runoff curve number method are included in the Attachments (A.19-A.20).

2A - Main Pond

Scenario 2A estimated the total runoff produced from the drainage area to the Main Pond, at both the 24HR rainfall depth and the 6HR rainfall depth, with an inoperable principal spillway.

2B - Reclamation Pond

Scenario 2B estimated the total runoff produced from the drainage area to the Reclamation Pond, at both the 24HR rainfall depth and the 6HR rainfall depth, with an inoperable principal spillway and no hydraulic connection to the Main Pond.

2C - Pond Complex

Scenario 2C estimated the total runoff produced from the drainage area to the entire pond complex, at both the 24HR rainfall depth and the 6HR rainfall depth, with an inoperable principal spillway and hydraulic connection to the Main Pond.

S&ME CALCULATION SHEET

PROJECT NAME AEP Gavin Bottom Ash Pond		SUBJECT Ash Pond H&H Study		
PROJECT NO. 7217-15-006A	CALC BY MRM	REV BY PLM	DATE 9/21/2015	SHEET NO. 13 OF 14

Table 6: Hydraulic Modeling Summary – Scenario 2

Scenario	ODNR Distribution	Estimated Runoff (AC-FT)	Plant Flow Volume (AC-FT)[1]	Total Runoff (AC-FT)	Estimated Peak Water Surface Elevation (feet-msl)
Scenario 2A	Type II – 24HR	132.2	83.9	216.1	582.6
Scenario 2A	HMR-52 – 6HR	92.5	83.9	176.4	581.8
Scenario 2B	Type II – 24HR	3.0	--------	3.0	575.8
Scenario 2B	HMR-52 – 6HR	2.1	--------	2.1	575.6
Scenario 2C	Type II – 24HR	135.1	83.9	49.0	582.0
Scenario 2C	HMR-52 – 6HR	94.5	83.9	178.4	581.2

[1] **Plant Flow Volume calculated as 27.33 MG X (0.1337 CF / 1 gal) X (1 AC / 43560 SF) = 83.9 AC-FT**

DISCUSSION

S&ME performed a hydrologic and hydraulic study on the bottom ash pond complex at the AEP Gavin Plant and a summary of the results are outlined below:

- The main pond can adequately store and pass the design storm without overtopping the embankment.
- The main pond meets the discharge requirements specified in paragraph (d)(1(v)(B).
- The reclamation pond can adequately store and pass the design storm without overtopping the embankment.
- The reclamation pond meets the discharge requirements specified in paragraph (d)(1(v)(B).

REFERENCES

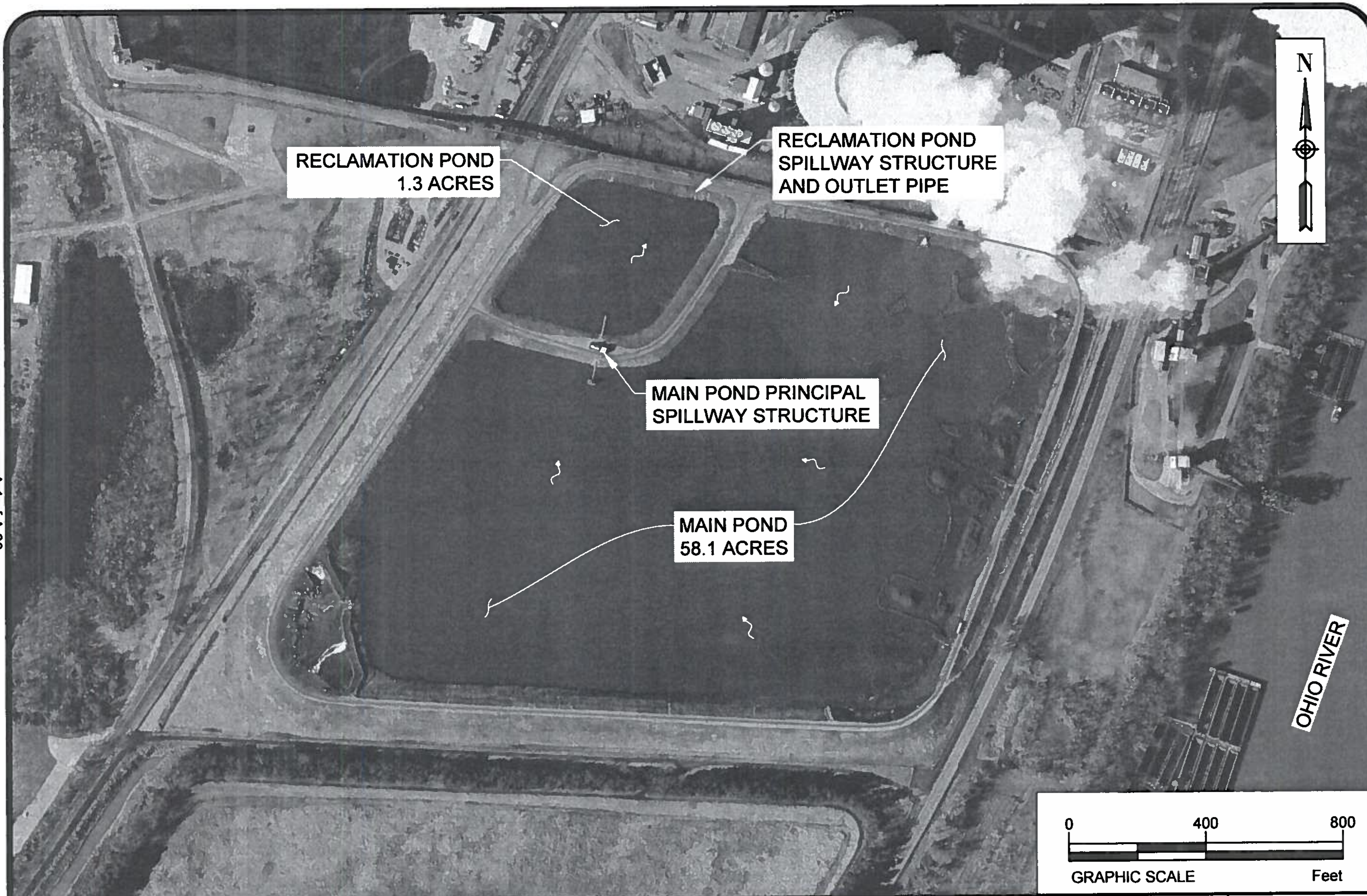
U.S. Army Corps of Engineers Institute for Water Resources, Hydrologic Engineering Center. *HMR52, Probable Maximum Storm (Eastern United States)*. March 1984. Revised April 1987.

CALCULATION SHEET

PROJECT NAME		SUBJECT		
AEP Gavin Bottom Ash Pond		Ash Pond H&H Study		
PROJECT NO.	**CALC BY**	**REV BY**	**DATE**	**SHEET NO.**
7217-15-006A	MRM	PLM	9/21/2015	14 OF 14

ATTACHMENTS

- Site Plan [A.1]
- VERTCON Elevation Adjustment [A.2]
- Plant Water Balance Diagram [A.3]
- PMP Rainfall Estimates [A.4 – A.5]
- Main Pond Stage-Storage Curve [A.6]
- Reclamation Pond Stage-Storage Curve [A.7]
- Main Pond Spillway Rating Curve [A.8]
- Reclamation Pond Spillway Rating Curve [A.9]
- ODNR Dam Inventory Sheet [A.10]
- Drawing 12-30408-2 Reclaim Pond Outlet Structure P&P [A.11]
- Drawing 12-30407-1 Bottom Ash Pond Outfall Pipe P&P [A.12]
- Drawing 12-3015-3 Units 1&2 Bottom Ash Disposal Area Sections [A.13]
- Scenario 1 – HEC-HMS Input / Output Data [A.14 - A.18]
- Runoff Calculation using SCS Methodology [A.19 – A.20]



SITE PLAN AEP GAVIN BOTTOM ASH POND COMPLEX GALLIA COUNTY, CHESHIRE, OHIO	S&ME WWW.SMEINC.COM	SCALE: 1" = 400'	DATE: 9-16-2015
FIGURE NO.		PROJECT NO. 7217-14-006A	DRAWN BY: MRM

Drawing path: Q:\Projects\7217-Civil Columbus\7217-15-006 Gavin\7217-15-006A CCR Certification\Aerial Image.dwg

Questions concerning the VERTCON process may be mailed to NGS

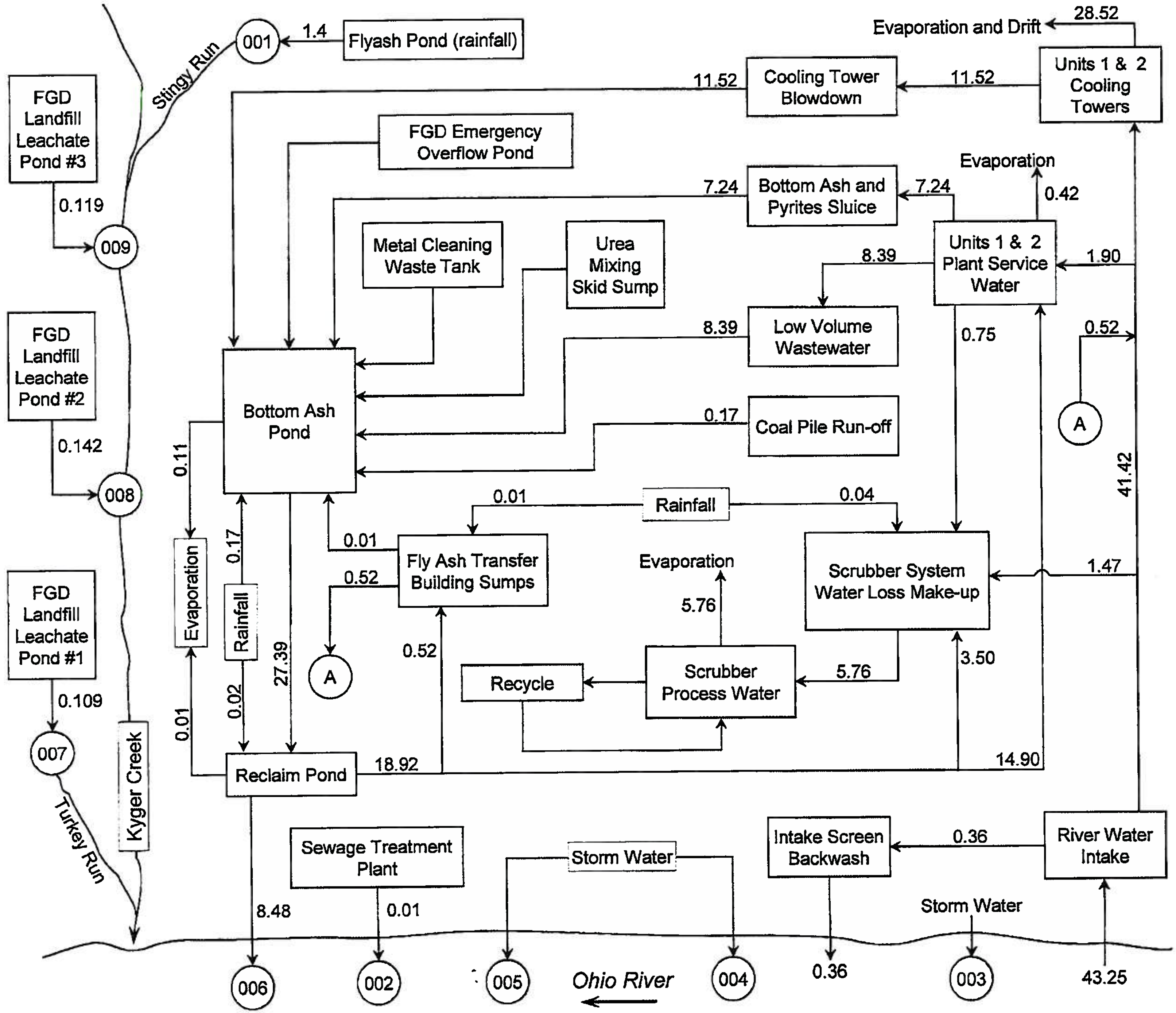
Latitude: 38 55 51.92

Longitude: 082 07 13.15

NGVD 29 height: 600.0 FT

Datum shift(NAVD 88 minus NGVD 29): -0.650 feet

Converted to NAVD 88 height: 599.350 feet



NOTE:
Flows represent average water usage.

(##) Outfall number

05.25.01 GV_water_bal.tif

ALL FLOWS MEASURED IN MILLION GALLONS PER DAY (MGD)

AEP Water & Ecological Resource Services

Ohio Power Company
Gavin Plant

Figure 2: Water Balance Diagram

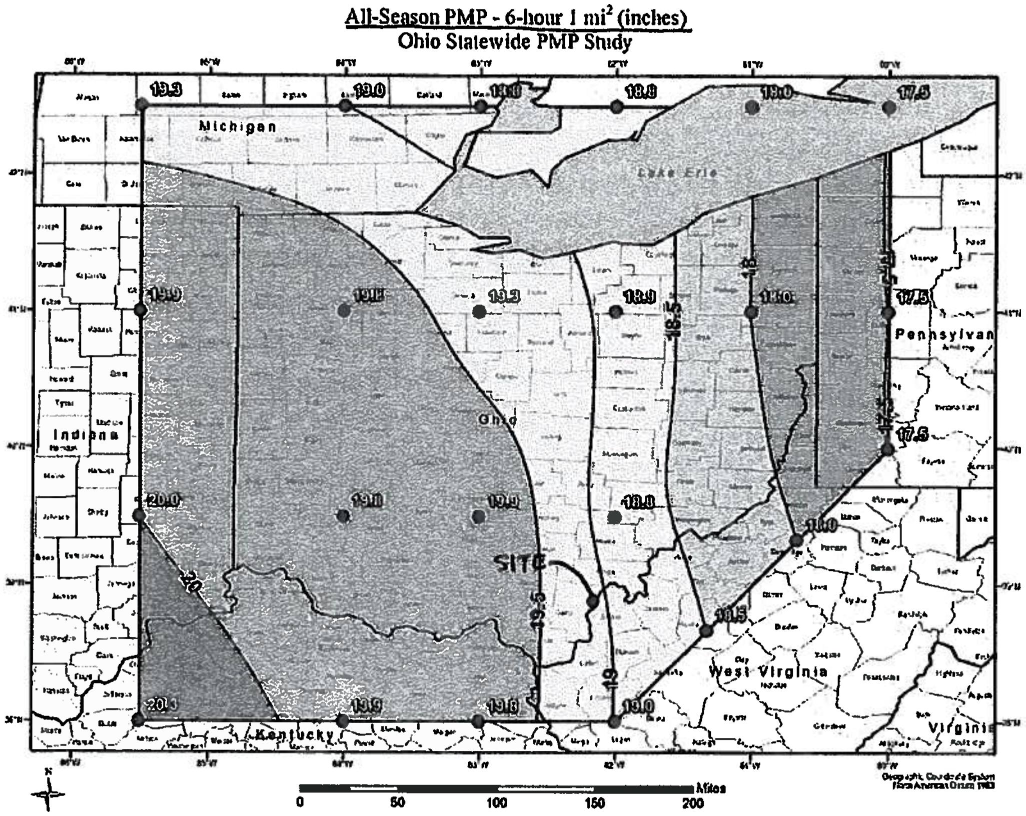


Figure 11.1 All-season PMP (inches) for 6-hour, 1-square mile

USE 19.1 INCHES

6HR PMP

All-Season PMP - 24-hour 1 mi² (inches)
Ohio Statewide PMP Study

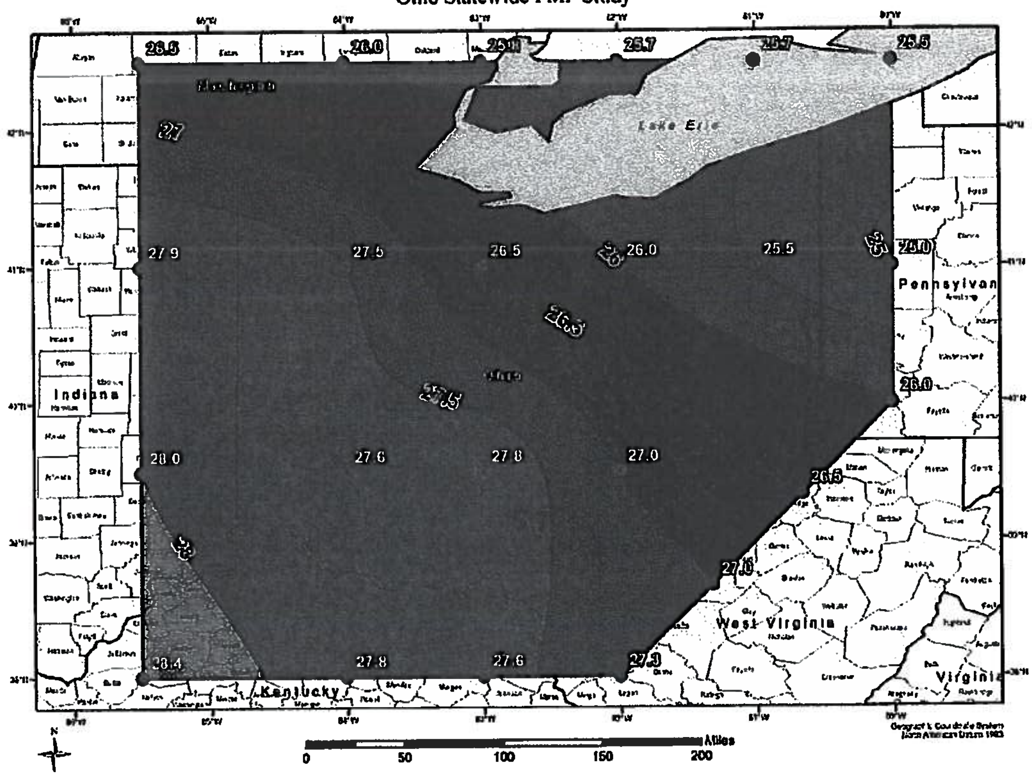


Figure 11.3 All-season PMP (inches) for 24-hour, 1-square mile

USE 27.3 INCHES

24 HR PMP

JOB NAME: AEP Gavin Bottom Ash Pond
SUBJECT: Bottom Ash Pond Stage-Storage Function

CUMPUTED BY: MRM DATE: 9/14/2015
CHECKED BY: PLM DATE: 9/18/2015

☐ TASK: DETERMINE STAGE-STORAGE CURVE FOR GAVIN BOTTOM ASH POND (MAIN POND).
SOURCE: OGRIP LiDAR IMAGERY (2006)

CONTOUR	AREA (SF)	AVG. AREA (SF)	HEIGHT	VOLUME (CF)	CUM. VOL. (CF)	CUM. VOL. (AC-FT)
578	1829710				0	0
		1915287	1	1915287		
579	2000864				1915287	44
		2043994	1	2043994		
580	2087123				3959281	91
		2100397	1	2100397		
581	2113671				6059678	139
		2122728	1	2122728		
582	2131785				8182406	188
		2139903	1	2139903		
583	2148020				10322309	237
		2156991	1	2156991		
584	2165961				12479299	286
		2176221	1	2176221		
585	2186481				14655520	336

JOB NAME: AEP Gavin Bottom Ash Pond
SUBJECT: Bottom Ash Pond Stage-Storage Function

CUMPUTED BY: MRM DATE: 9/14/2015
CHECKED BY: PLM DATE: 9/18/2015

☐ TASK: DETERMINE STAGE-STORAGE CURVE FOR GAVIN BOTTOM ASH POND (RECLAMATION POND).
SOURCE: OGRIP LiDAR IMAGERY (2006)

CONTOUR	AREA (SF)	AVG. AREA (SF)	HEIGHT	VOLUME (CF)	CUM. VOL. (CF)	CUM. VOL. (AC-FT)
576	170584				0	0
		179006	1	179006		
577	187428				179006	4
		190641	1	190641		
578	193855				369647	8
		195709	1	195709		
579	197564				565357	13
		199321	1	199321		
580	201078				764678	18
		202879	1	202879		
581	204679				967557	22
		206628	1	206628		
582	208576				1174184	27
		210855	1	210855		
583	213133				1385039	32
		216287	1	216287		
584	219441				1601326	37

Project: AEP GAVIN BOTTOM ASH POND
Location: GALLIA COUNTY, OHIO
S&ME PROJECT NUMBER: 7217-15-006A

Main Pond - Inlet Weir

Calculated By: MRM **Date:** 9/17/2015

Reviewed By: PLM **Date:** 9/21/2015

Source: Hydraulic Engineering Circular No. 22, Third Editio
Urban Drainage Design Manual (Rev. 2013

Sharp Crested Weirs

Typical sharp crested weirs are illustrated in Figure 8-13. Equation 8-19 provides the discharge relationship for **sharp crested weirs** with no end contractions (illustrated in Figure 8-13a).

$$Q = C_{scw} L H^{1.5} \quad (8\text{-}19)$$

where:

- Q = Discharge, m^3/s (ft^3/s)
- L = Horizontal weir length, m (ft)
- H = Head above weir crest excluding velocity head, m (ft)
- C_{scw} = $1.81 + 0.22 (H/H_c)$ [$3.27 + 0.4 (H/H_c)$ in English units]

As indicated above, the value of the coefficient C_{SCW} is known to vary with the ratio H/H_c (see Figure 8-13c for definition of terms). For values of the ratio H/H_c less than 0.3, a constant C_{SCW} of 1.84 (3.33 in English units) is often used.

Equation 8-20 provides the discharge equation for **sharp-crested weirs with end contractions** (illustrated in Figure 8-13(b)). As indicated above, the value of the coefficient C_{scw} is known to vary with the ratio H/H_c (see Figure 8-13c for definition of terms). For values of the ratio H/H_c less than 0.3, a constant C_{scw} of 1.84 (3.33 in English units) is often used.

$$Q = C_{scw} (L - 0.2 H) H^{1.5} \quad (8\text{-}20)$$

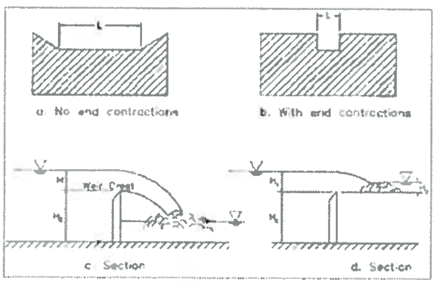


Figure 8-13. Sharp crested weirs.

	Value	Units	Description
Pool Elevation =	578	Feet MSL	Drawing 12-3015-3
Length of Weir =	4.0	Feet	From Site Visit
Height of Weir =	10.0	Feet	Drawing 12-3015-3

Headwater Elevation (FT)	L, Length (feet)	Hc, Feet	H/Hc	Cscw, Coefficient*	Q, Orifice Discharge (CFS) [Use EQ 8-20]**
558.00	4.0	10.00	-2.00	3.33	0
559.00	4.0	10.00	-1.90	3.33	0
560.00	4.0	10.00	-1.80	3.33	0
561.00	4.0	10.00	-1.70	3.33	0
562.00	4.0	10.00	-1.60	3.33	0
563.00	4.0	10.00	-1.50	3.33	0
564.00	4.0	10.00	-1.40	3.33	0
565.00	4.0	10.00	-1.30	3.33	0
566.00	4.0	10.00	-1.20	3.33	0
567.00	4.0	10.00	-1.10	3.33	0
568.00	4.0	10.00	-1.00	3.33	0
569.00	4.0	10.00	-0.90	3.33	0
570.00	4.0	10.00	-0.80	3.33	0
571.00	4.0	10.00	-0.70	3.33	0
572.00	4.0	10.00	-0.60	3.33	0
573.00	4.0	10.00	-0.50	3.33	0
574.00	4.0	10.00	-0.40	3.33	0
575.00	4.0	10.00	-0.30	3.33	0
576.00	4.0	10.00	-0.20	3.33	0
577.00	4.0	10.00	-0.10	3.33	0
578.00	4.0	10.00	0.00	3.33	0.0
579.00	4.0	10.00	0.10	3.33	12.7
580.00	4.0	10.00	0.20	3.33	33.9
581.00	4.0	10.00	0.30	3.39	59.9
582.00	4.0	10.00	0.40	3.43	87.8
583.00	4.0	10.00	0.50	3.47	116.4
584.00	4.0	10.00	0.60	3.51	144.4
585.00	4.0	10.00	0.70	3.55	170.9

* Cscw = 3.33 when H/Hc < 0.3

Project: AEP GAVIN BOTTOM ASH POND
Location: GALLIA COUNTY, OHIO
S&ME PROJECT NUMBER: 7217-15-006A

Reclamation Pond - Inlet Weir

Calculated By: MRM **Date:** 9/17/2015

Reviewed By: PLM **Date:** 9/21/2015

Source: Hydraulic Engineering Circular No. 22, Third Edition
Urban Drainage Design Manual (Rev. 2013)

Sharp Crested Weirs

Typical sharp crested weirs are illustrated in Figure 8-13. Equation 8-19 provides the discharge relationship for **sharp crested weirs** with no end contractions (illustrated in Figure 8-13a).

$$Q = C_{scw} L H^{1.5} \qquad (8\text{-}19)$$

where:

Q	=	Discharge, m^3/s (ft^3/s)
L	=	Horizontal weir length, m (ft)
H	=	Head above weir crest excluding velocity head, m (ft)
C_{scw}	=	$1.81 + 0.22 (H/H_c)$ [$3.27 + 0.4 (H/H_c)$ in English units]

As indicated above, the value of the coefficient C_{scw} is known to vary with the ratio H/H_c (see Figure 8-13c for definition of terms). For values of the ratio H/H_c less than 0.3, a constant C_{scw} of 1.84 (3.33 in English units) is often used.

Equation 8-20 provides the discharge equation for **sharp-crested weirs with end contractions** (illustrated in Figure 8-13(b)). As indicated above, the value of the coefficient C_{scw} is known to vary with the ratio H/H_c (see Figure 8-13c for definition of terms). For values of the ratio H/H_c less than 0.3, a constant C_{scw} of 1.84 (3.33 in English units) is often used.

$$Q = C_{scw} (L - 0.2 H) H^{1.5} \qquad (8\text{-}20)$$

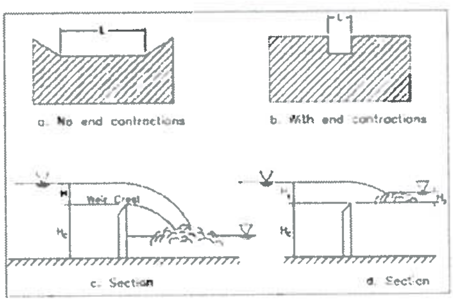


Figure 8-13. Sharp crested weirs.

	Value	Units	Description
Pool Elevation =	575	Feet MSL	Drawing 12-30408-2
Length of Weir =	2.5	Feet	Drawing 12-30408-2
Height of Weir =	5.0	Feet	Drawing 12-30408-2

Headwater Elevation (FT)	L, Length (feet)	Hc, Feet	H/Hc	Cscw, Coefficient*	Q, Orifice Discharge (CFS) [Use EQ 8-20]**
558.00	2.5	5.00	-3.40	3.33	0
559.00	2.5	5.00	-3.20	3.33	0
560.00	2.5	5.00	-3.00	3.33	0
561.00	2.5	5.00	-2.80	3.33	0
562.00	2.5	5.00	-2.60	3.33	0
563.00	2.5	5.00	-2.40	3.33	0
564.00	2.5	5.00	-2.20	3.33	0
565.00	2.5	5.00	-2.00	3.33	0
566.00	2.5	5.00	-1.80	3.33	0
567.00	2.5	5.00	-1.60	3.33	0
568.00	2.5	5.00	-1.40	3.33	0
569.00	2.5	5.00	-1.20	3.33	0
570.00	2.5	5.00	-1.00	3.33	0
571.00	2.5	5.00	-0.80	3.33	0
572.00	2.5	5.00	-0.60	3.33	0
573.00	2.5	5.00	-0.40	3.33	0
574.00	2.5	5.00	-0.20	3.33	0
575.00	2.5	5.00	0.00	3.33	0.0
576.00	2.5	5.00	0.20	3.33	7.7
577.00	2.5	5.00	0.40	3.43	20.4
578.00	2.5	5.00	0.60	3.51	34.7
579.00	2.5	5.00	0.80	3.59	48.8
580.00	2.5	5.00	1.00	3.67	61.5
581.00	2.5	5.00	1.20	3.75	71.6
582.00	2.5	5.00	1.40	3.83	78.0
583.00	2.5	5.00	1.60	3.91	79.6
584.00	2.5	5.00	1.80	3.99	75.4

Dam Inventory Sheet

Name: GAVIN BOTTOM ASH POND
Reservoir:

File No: 8720-003
National #: OH00971
Permit No.:
Class (Ht-Vol): I (III - II)

Owner Information

Owner: AEP Generation Resources Inc.
Address: Gavin Plant
PO Box 271
City: Cheshire
State: OH
Contact: Doug Workman

Owner Type: Utility
Multi-Dams: Yes: 10, Class I:7
Parcel No.:
Zip: 45620
Phone No.: 740-925-3135

Location Information

County: Gallia
Township: Cheshire & Addison
Stream: Kyger Creek - Offstream
USGS Quad.: Cheshire, Oh-wv

Latitude Deg.: 38 **Min.:** 55 **Sec.:** 52
Longitude Deg.: 82 **Min.:** 7 **Sec.:** 14
USGS Basin No.: 05030202

Design/Construction Information

Designed By: Aep With Casagrande Consultants
Constructed By: J.j. Blazer Construction Co.
Completed: 1974 **Plan Available:** YES **At:** AMERICAN ELECTRIC POWER
Failure/Incident/Breach:

Structure Information

Purpose: Waste Retention
Type of Impound.: Upground
Type of Structure: Earthfill
Drainage Area (sq. miles): 0.1 **or (acres):** 62

Embankment Data

Length (ft): 6650
Height (ft): 36.5
Top Width (ft): 30

Upstream Slope: 2H:1V
Downstream Slope: 2H:1V
Volume of Fill (cub. yds.): 723870

Spillway Outlet Works Data

Lake Drain: NONE
Principal: CONCRETE CONTROL TOWER W/ STOPLOGS IN MAIN POND W/ 42-IN RCP
Emergency: 30-INCH HDPE W/CONCRETE FLUME AND SLUICEWAY
Maximum Spillway Discharge (cfs): 320 **Design Flood:** 1.0 **Flood Capacity:** 1.0

Dam Reservoir Data	Elevation (ft-MSL)*	Area (acres)	Storage (acre-feet)
Top of Dam:	594	62.4	1530
Emergency Spillway:	575	59.1	860
Principal Spillway:	574	58.8	470
Streambed:	557.5		
Foundation:			

*Elevations are not necessarily related to a USGS benchmark

Inspection Information

Inspection History:
8/14/2012 WDE
8/20/2007 RAA
12/14/2004 TGL
8/9/1995 JDW

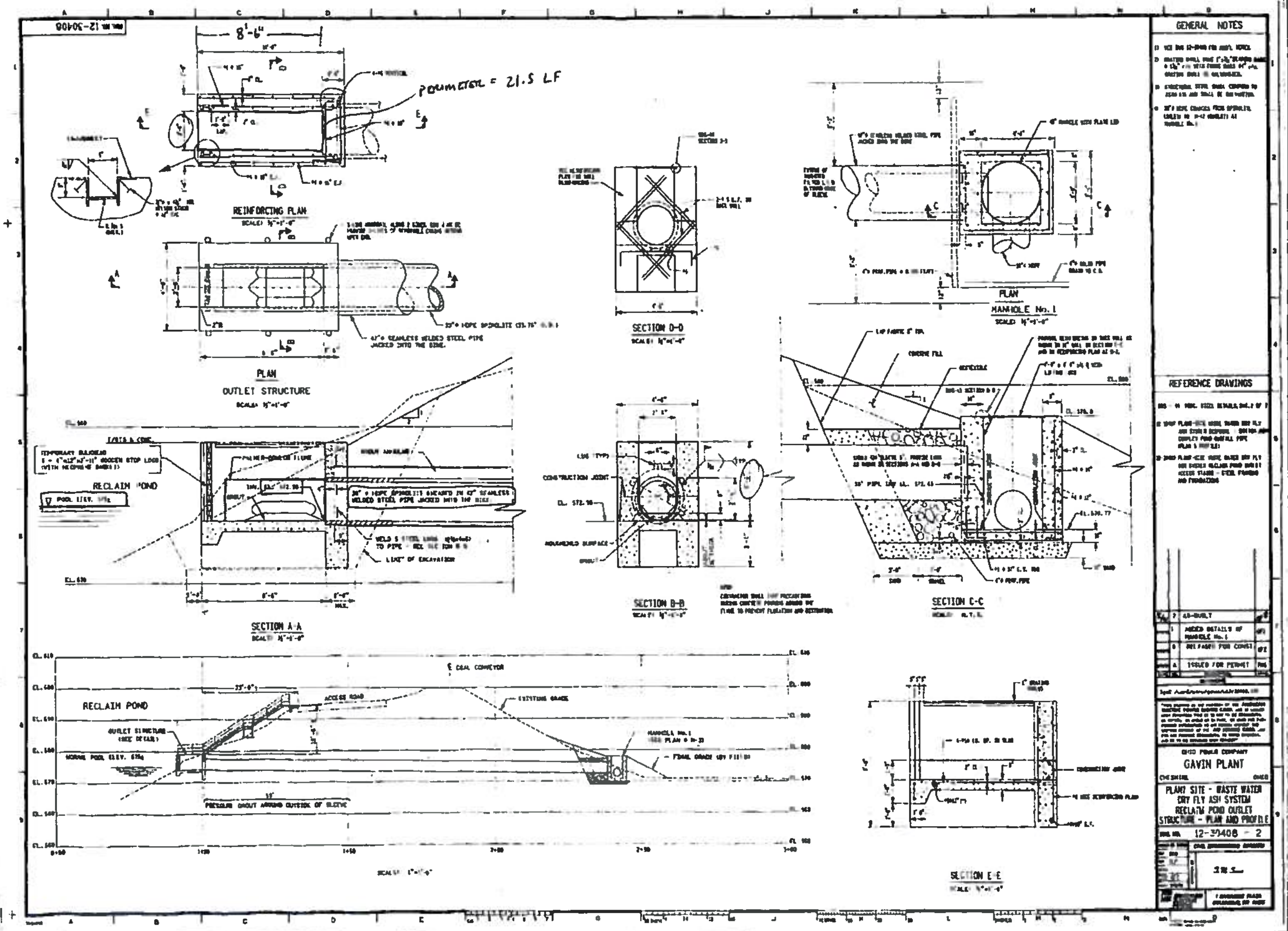
Phase I:
Other Visits:
Inspection Year: E

OPC3

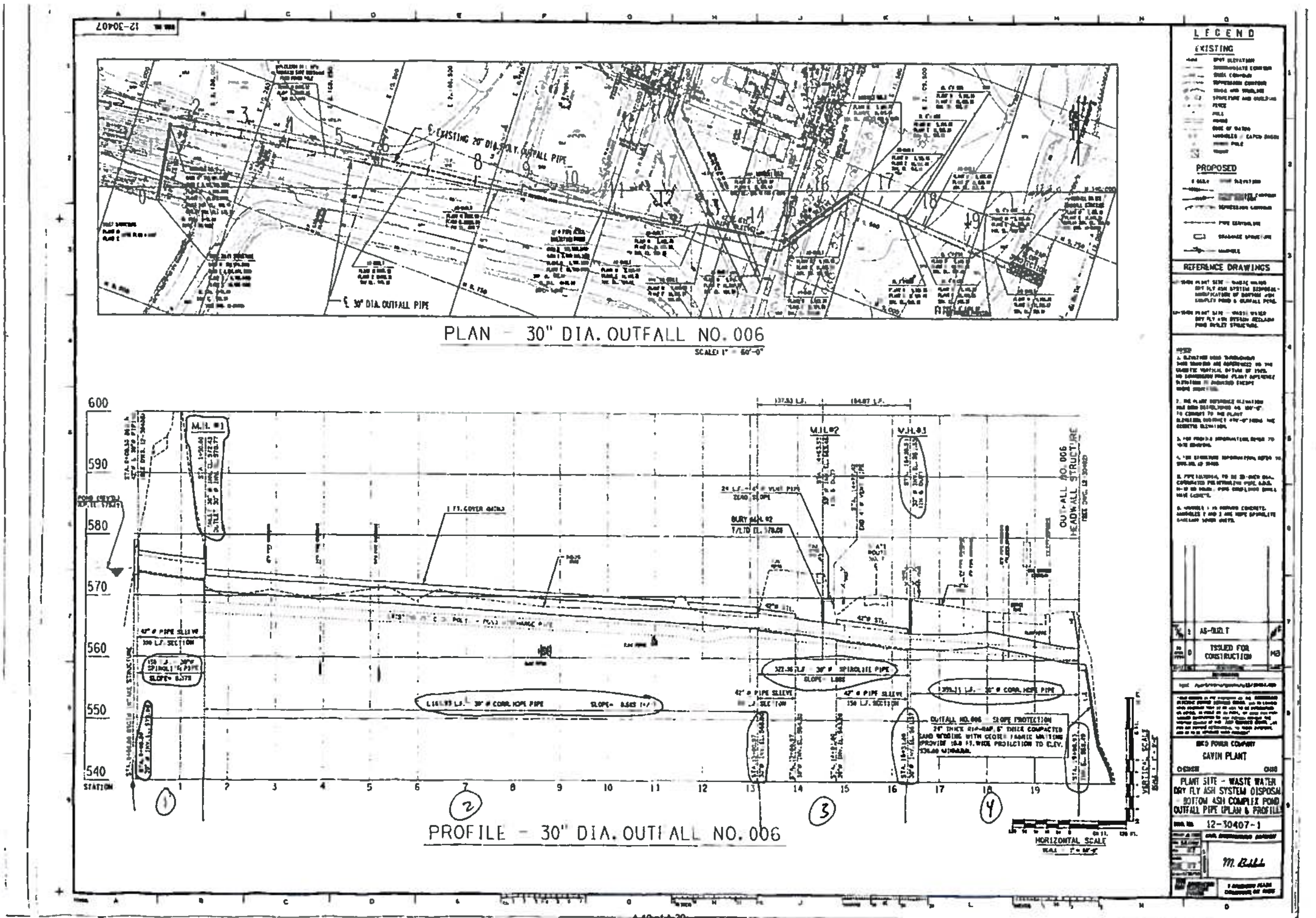
Operation Information/Remarks

Main pond is a bottom ash retent. pond; reclamation pond in nw corner; overflow from main to reclam. pond; principal is overflow in main pond. Emerg. overflow is in reclam. pond. Elev. data is for former design.

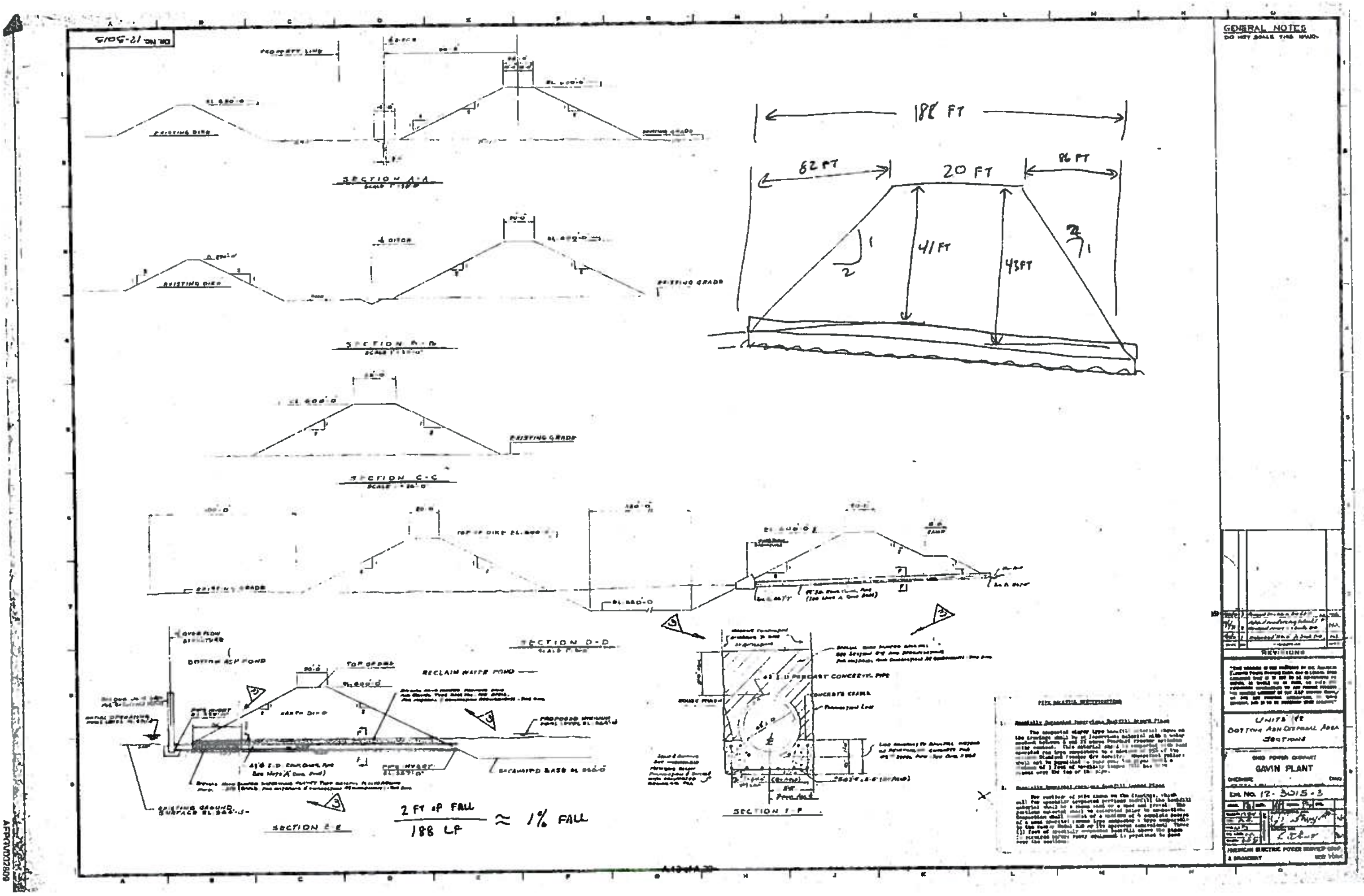
Emergency Action Plan: Approved **Format:** Old **OMI:** Yes-with owner
Last Entry: 4/24/2014



AEPGV002513



12-30407
LEGEND
EXISTING
PROPOSED
REFERENCE DRAWINGS
℄ EXISTING 20" DIA. FLY. OUTFALL PIPE
℄ 30" DIA. OUTFALL PIPE
PLAN - 30" DIA. OUTFALL NO. 006
SCALE: 1" = 60'-0"
M.H. #1
M.H.#2
M.H.#3
1 FT. COVER (MIN.)
24 L.F. - 6" ∅ VENT PIPE
42" ∅ PIPE SLEEVE
42" ∅ STL.
150 L.F. SECTION
30" ∅ SPIROLITE PIPE
30" ∅ CORR. HDPE PIPE
OUTFALL NO. 006 SLOPE PROTECTION
OUTFALL NO. 006 HEADWALL STRUCTURE
HORIZONTAL SCALE
VERTICAL SCALE
STATION
PROFILE - 30" DIA. OUTFALL NO. 006
AS-BUILT
ISSUED FOR CONSTRUCTION
GAVIN PLANT
OHIO
PLANT SITE - WASTE WATER
DRY FLY ASH SYSTEM DISPOSAL
- BOTTOM ASH COMPLEX POND
OUTFALL PIPE (PLAN & PROFILE)
12-30407-1
M. Bill



GENERAL NOTES
DO NOT SCALE THIS DWG.
PROPERTY LINE
EXISTING DIKE
EXISTING GRADE
SECTION A-A
SECTION B-B
EXISTING GRADE
SECTION C-C
TOP OF DIKE
EXISTING GRADE
OVERFLOW STRUCTURE
BOTTOM ASH POND
TOP OF DIKE
RECLAIM WATER POND
EARTH DIKE
PROPOSED MINIMUM POOL LEVEL
RECLAIMED BASE
SECTION D-D
EXISTING GROUND SURFACE
SECTION E-E
PRECAST CONCRETE PIPE
CONCRETE CRADLE
SECTION F-F
PIPE BEDDING SPECIFICATIONS
188 FT
82 FT
20 FT
86 FT
41 FT
43 FT
2
1
2 FT OF FALL / 188 LF ≈ 1% FALL
REVISIONS
UNITS 1&2
BOTTOM ASH DISPOSAL AREA
SECTIONS
OHIO POWER COMPANY
GAVIN PLANT
DR. NO. 12-3015-3
AMERICAN ELECTRIC POWER SERVICE CORP.
NEW YORK

Scenario 1—Main Pond

ODNR Dimensionless 6HR

Summary Results for Subbasin "Main Pond DA"

Project: Dimentionless Simulation Run: Run 2
Subbasin: Main Pond DA

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	01Jan2000, 06:00	Meteorologic Model:	Dimensionless
Compute Time:	18Sep2015, 22:57:48	Control Specifications:	6HR

Volume Units: IN (●) AC-FT

Computed Results

Peak Discharge:	841.2 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 02:20
Precipitation Volume:	92.7 (AC-FT)	Direct Runoff Volume:	91.3 (AC-FT)
Loss Volume:	1.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	91.6 (AC-FT)	Discharge Volume:	91.3 (AC-FT)

Summary Results for Reservoir "Main Pond"

Project: Dimentionless Simulation Run: Run 2
Reservoir: Main Pond

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	01Jan2000, 06:00	Meteorologic Model:	Dimensionless
Compute Time:	18Sep2015, 22:57:48	Control Specifications:	6HR

Volume Units: IN (●) AC-FT

Computed Results

Peak Inflow:	848.2 (CFS)	Date/Time of Peak Inflow:	01Jan2000, 02:20
Peak Discharge:	31.8 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 06:00
Inflow Volume:	94.8 (AC-FT)	Peak Storage:	86.3 (AC-FT)
Discharge Volume:	8.4 (AC-FT)	Peak Elevation:	579.9 (FT)

Scenario 1—Rec Pond

ODNR Dimensionless 6HR

Summary Results for Subbasin "Rec Pond DA"

Project: Dimentionless   Simulation Run: Run 2
Subbasin: Rec Pond DA

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	01Jan2000, 06:00	Meteorologic Model:	Dimensionless
Compute Time:	18Sep2015, 22:57:48	Control Specifications:	6HR

Volume Units: ◯ IN ◉ AC-FT

Computed Results

Peak Discharge:	18.5 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 02:20
Precipitation Volume:	2.0 (AC-FT)	Direct Runoff Volume:	2.0 (AC-FT)
Loss Volume:	0.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2.0 (AC-FT)	Discharge Volume:	2.0 (AC-FT)

Summary Results for Reservoir "Rec Pond"

Project: Dimentionless   Simulation Run: Run 2
Reservoir: Rec Pond

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	01Jan2000, 06:00	Meteorologic Model:	Dimensionless
Compute Time:	18Sep2015, 22:57:48	Control Specifications:	6HR

Volume Units: ◯ IN ◉ AC-FT

Computed Results

Peak Inflow:	33.4 (CFS)	Date/Time of Peak Inflow:	01Jan2000, 05:51
Peak Discharge:	18.1 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 06:00
Inflow Volume:	10.4 (AC-FT)	Peak Storage:	7.3 (AC-FT)
Discharge Volume:	3.1 (AC-FT)	Peak Elevation:	576.8 (FT)

Scenario 1—Main Pond

ODNR SCS Type II 24HR

Summary Results for Subbasin "Main Pond DA"

Project: SCS Simulation Run: Run 1
Subbasin: Main Pond DA

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2000, 00:00	Meteorologic Model:	SCS Type II
Compute Time:	18Sep2015, 22:30:10	Control Specifications:	24HR

Volume Units: ◯ IN ◉ AC-FT

Computed Results

Peak Discharge:	396.3 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 12:00
Precipitation Volume:	132.4 (AC-FT)	Direct Runoff Volume:	131.1 (AC-FT)
Loss Volume:	1.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	131.2 (AC-FT)	Discharge Volume:	131.1 (AC-FT)

Summary Results for Reservoir "Main Pond"

Project: SCS Simulation Run: Run 1
Reservoir: Main Pond

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2000, 00:00	Meteorologic Model:	SCS Type II
Compute Time:	18Sep2015, 22:30:10	Control Specifications:	24HR

Volume Units: ◯ IN ◉ AC-FT

Computed Results

Peak Inflow:	398.1 (CFS)	Date/Time of Peak Inflow:	01Jan2000, 12:00
Peak Discharge:	39.2 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:08
Inflow Volume:	134.5 (AC-FT)	Peak Storage:	100.8 (AC-FT)
Discharge Volume:	41.3 (AC-FT)	Peak Elevation:	580.2 (FT)

Scenario 1—Rec Pond

ODNR SCS Type II 24HR

Summary Results for Subbasin "Rec Pond DA"

Project: SCS Simulation Run: Run 1
Subbasin: Rec Pond DA

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2000, 00:00	Meteorologic Model:	SCS Type II
Compute Time:	18Sep2015, 22:30:10	Control Specifications:	24HR

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge:	8.7 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 12:00
Precipitation Volume:	2.9 (AC-FT)	Direct Runoff Volume:	2.9 (AC-FT)
Loss Volume:	0.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2.9 (AC-FT)	Discharge Volume:	2.9 (AC-FT)

Summary Results for Reservoir "Rec Pond"

Project: SCS Simulation Run: Run 1
Reservoir: Rec Pond

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2000, 00:00	Meteorologic Model:	SCS Type II
Compute Time:	18Sep2015, 22:30:10	Control Specifications:	24HR

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Inflow:	40.1 (CFS)	Date/Time of Peak Inflow:	01Jan2000, 16:01
Peak Discharge:	39.4 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 18:08
Inflow Volume:	44.1 (AC-FT)	Peak Storage:	10.4 (AC-FT)
Discharge Volume:	33.9 (AC-FT)	Peak Elevation:	577.6 (FT)

Scenario 1—Plant Flows

Summary Results for Source "Plant Inflows"

Project: Dimentionless   Simulation Run: Run 2
Source: Plant Inflows

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	01Jan2000, 06:00	Meteorologic Model:	Dimensionless
Compute Time:	18Sep2015, 22:57:48	Control Specifications:	6HR

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge: 7.0 (CFS)   Date/Time of Peak Discharge: 01Jan2000, 00:00
Volume: 3.5 (AC-FT)

Summary Results for Source "Plant Inflows"

Project: SCS   Simulation Run: Run 1
Source: Plant Inflows

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 1
End of Run:	02Jan2000, 00:00	Meteorologic Model:	SCS Type II
Compute Time:	18Sep2015, 22:30:10	Control Specifications:	24HR

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge: 1.8 (CFS)   Date/Time of Peak Discharge: 01Jan2000, 00:00
Volume: 3.5 (AC-FT)

2A - Area of Main Pond - 24HR Storm: $A_M := 58.1\ acre$

$CN := 98 \quad S := \left(\frac{1000}{CN} - 10\right) in \quad I_a := 0.2 \cdot S \quad P := 27.3\ in$

$$Q := \frac{(P - I_a)^2}{(P - I_a) + S}$$

$Q = 27.057\ in$

$\frac{Q}{P} = 99.108\%$ $\qquad Rainfall := P \cdot A_M = 132.178\ acre \cdot ft$

2A - Area of Main Pond - 6HR Storm: $A_M := 58.1\ acre$

$CN := 98 \quad S := \left(\frac{1000}{CN} - 10\right) in \quad I_a := 0.2 \cdot S \quad P := 19.1\ in$

$$Q := \frac{(P - I_a)^2}{(P - I_a) + S}$$

$Q = 18.857\ in$

$\frac{Q}{P} = 98.729\%$ $\qquad Rainfall := P \cdot A_M = 92.476\ acre \cdot ft$

2B - Area of Rec Pond - 24HR Storm: $A_M := 1.3\ acre$

$CN := 98 \quad S := \left(\frac{1000}{CN} - 10\right) in \quad I_a := 0.2 \cdot S \quad P := 27.3\ in$

$$Q := \frac{(P - I_a)^2}{(P - I_a) + S}$$

$Q = 27.057\ in$

$\frac{Q}{P} = 99.108\%$ $\qquad Rainfall := P \cdot A_M = 2.958\ acre \cdot ft$

2B - Area of Rec Pond - 6HR Storm: $A_M := 1.3\ acre$

$CN := 98 \quad S := \left(\frac{1000}{CN} - 10\right) in \quad I_a := 0.2 \cdot S \quad P := 19.1\ in$

$$Q := \frac{(P - I_a)^2}{(P - I_a) + S}$$

$Q = 18.857\ in$

$\frac{Q}{P} = 98.729\%$ $\quad Rainfall := P \cdot A_M = 2.069\ acre \cdot ft$

2C - Area of Pond Complex - 24HR Storm: $A_M := 59.4\ acre$

$CN := 98 \quad S := \left(\frac{1000}{CN} - 10\right) in \quad I_a := 0.2 \cdot S \quad P := 27.3\ in$

$$Q := \frac{(P - I_a)^2}{(P - I_a) + S}$$

$Q = 27.057\ in$

$\frac{Q}{P} = 99.108\%$ $\quad Rainfall := P \cdot A_M = 135.135\ acre \cdot ft$

2C - Area of Pond Complex - 6HR Storm: $A_M := 59.4\ acre$

$CN := 98 \quad S := \left(\frac{1000}{CN} - 10\right) in \quad I_a := 0.2 \cdot S \quad P := 19.1\ in$

$$Q := \frac{(P - I_a)^2}{(P - I_a) + S}$$

$Q = 18.857\ in$

$\frac{Q}{P} = 98.729\%$ $\quad Rainfall := P \cdot A_M = 94.545\ acre \cdot ft$