Assessment of Dam Safety
Coal Combustion Surface Impoundments (Task 3)
Final Report

American Electric Power

Cardinal Power Plant

Brilliant, Ohio

Prepared for

Lockheed Martin
2890 Woodridge Ave #209
Edison, New Jersey 08837

December 9, 2009

CHA Project No. 20085.1080.1510

I acknowledge that the management units referenced herein:

- Bottom Ash Complex - Bottom Ash Pond
- Bottom Ash Complex - Recirculation Pond
- Fly Ash Reservoir No.1 (Decommissioned)
- Fly Ash Reservoir No.2

Have been assessed on September 1, 2009 and September 2, 2009

Signature: Malcolm D. Hargraves

Malcolm D. Hargraves

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APPENDIX

1.0 INTRODUCTION & PROJECT DESCRIPTION

1.1 Introduction

CHA was contracted by Lockheed Martin (a contractor to the United States Environmental Protection Agency) to perform site assessments of selected coal combustion surface impoundments (Project #0-381 Coal Combustion Surface Impoundments/Dam Safety Inspections). As part of this contract, CHA was assigned to perform a site assessment of American Electric Power's (AEP) Cardinal Power Plant, which is located in Brilliant, Ohio as shown on Figure 1 – Project Location Map.

CHA made a site visit on September 1, 2009 and September 2, 2009 to inventory coal combustion surface impoundments at the facility, perform visual observations of the containment dikes, and collect relevant information regarding the site assessment.

CHA Engineers Malcolm Hargraves, P.E. and Richard M. Loewenstein, P.E. were accompanied by the following individuals:

Company or Organization	**Name and Title**
American Electric Power	Gary Zych, Geotechnical Engineer
American Electric Power	Randy Sims
American Electric Power	Joel Milliken
American Electric Power	Chuck Hewett
American Electric Power	Mohammed Ajlouni, Geotechnical Engineer
American Electric Power	Deanna King, Environmental Specialist
American Electric Power	Jeff Saunders
Ohio Dam Safety	Keith Banachowski (September 1st only)
Ohio Dam Safety	Rodney Tornes (September 2nd only)
Ohio EPA	Brian Queen
Ohio EPA	Caron Farrington

1.2 Project Background

The Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond), Fly Ash Reservoir No.1 (FAR I), and Fly Ash Reservoir No. 2 (FAR II) at the Cardinal Power Plant are under the jurisdiction of the Ohio Department of Natural Resources (DNR) Division of Soil and Water Resources – Dam Safety program. The structures creating the Fly Ash Reservoir No.1 and Fly Ash Reservoir No. 2 impoundments are classified by Ohio DNR as Class I dams, which are likely to cause loss of life in the event of an unexpected breach. The Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond) dikes would be Class II structures in light of the health hazard an industrial waste spill might pose.

1.2.1 State Issued Permits

AEP has received the following state issued permits for the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond), Fly Ash Dam No.1, and Fly Ash Dam No. 2.:

1.2.1.1 Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond)

Ohio State Permit No. 0IB00009 (Federal Application No. OH0012581) has been issued to AEP authorizing discharge under the National Pollutant Discharge Elimination System (NPDES) to the Ohio River in accordance with effluent limitations, monitoring requirements and other conditions set forth in the permit. The permit became effective on August 1, 2008 and will expire on July 31, 2012. (Note this permit also covers the active landfill in the decommissioned Fly Ash Reservoir No.1 and Fly Ash Reservoir No. 2 and surface runoff locations not containing coal combustion waste controlled by AEP on the site.)

1.2.1.2 Fly Ash Dam No. 1

Ohio State Permit No. 0IB00009 (Federal Application No. OH0012581) has been issued to AEP authorizing discharge under the National Pollutant Discharge Elimination System (NPDES) to the Ohio River in accordance with effluent limitations, monitoring requirements and other conditions set forth in the permit. The permit became effective on August 1, 2008 and will expire on July 31, 2012. (Note this permit also covers the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond), Fly Ash Dam No. 2, and other surface runoff locations not containing coal combustion waste controlled by AEP on the site.)

The Ohio Environmental Protection Agency issued Permit No. 06-07993 to install a solid waste landfill over the decommissioned basin and dam in 2007.

1.2.1.3 Fly Ash Dam No. 2

Ohio State Permit No. 0IB00009 (Federal Application No. OH0012581) has been issued to AEP authorizing discharge under the National Pollutant Discharge Elimination System (NPDES) to the Ohio River in accordance with effluent limitations, monitoring requirements and other conditions set forth in the permit. The permit became effective on August 1, 2008 and will expire on July 31, 2012. (Note this permit also covers the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond), Fly Ash Dam No. 2, and other surface runoff locations not containing coal combustion waste controlled by AEP on the site.)

The Ohio Department of Natural Resources – Division of Water issued construction Permit No. 97-264 to raise the dam with roller compacted concrete (RCC) in 1997.

1.3 Site Description and Location

The Cardinal plant currently has three primary process and disposal areas for the coal combustion waste products (CCW). These are located as shown on Figures 2A, 2B, and 2C – Photo Site Plan in the text of this report. The Bottom Ash Complex with two impoundments comprising the Bottom Ash Pond and Recirculation Pond, is located adjacent to the main plant facility along the Ohio River, while the solid waste landfill above the decommissioned Fly Ash No.1 reservoir and the active Fly Ash No. 2 reservoir are located roughly 1 to 2 miles to the north of the plant, on the east and west branches of Blockhouse Run, a tributary of the Ohio River.

The Bottom Ash Complex impoundment receives bottom ash, pyrite, and yard drainage for disposal. It was constructed to its present configuration in 1974, above the general footprint of a previously existing basin so that the current dikes are founded above the original basin dikes or natural prepared subgrade. This original basin was considered to have been built some time earlier when the Cardinal plant was initially completed. Design plans (Figure 4A) and present topographic information (Figure 3A) indicate that the impoundment is partially incised at its southern extremity, where an existing knoll was flattened, and at its northern extremity, where the facility ground surface matches the crest elevation of 670. Earthen dikes up to approximately 20 feet in height form the eastern and western impoundment walls. Typical cross sections of these dikes are depicted in Figure 5A. An interior separator dike spans between the primary eastern and western dikes, creating the Bottom Ash Pond where the CCW is initially discharged, and the Recirculation Pond where the decanted CCW sluicing water is taken up and recycled through the plant to sluice fly ash to the active Fly Ash Reservoir No.2. In 2008, vinyl sheet piling was driven into the bottom of the Recirculation Pond to form a baffle wall and create a separate settling pond in the southern portion of the Recirculation Pond (Figure 4B). At the northern extremity of the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond), adjacent to the incised wall, interior containment dikes on the order of about 5 feet in height have been constructed on the bottom ash delta. These provide a pair of temporary holding basins totaling roughly an acre in surface area for dredged bottom ash material reclaimed from the Bottom Ash Pond. This ash is recycled as construction material, placing in the landfill, or site grading activities at the facilities. In total, the Bottom Ash Complex occupies an area of roughly 25 acres.

Fly Ash Dam No. 1 and the reservoir it formerly impounded, Fly Ash Reservoir No.1, was constructed in the early 1970’s in the western branch of Blockhouse Run. It has been decommissioned as a fly ash basin and has not received sluice ash since 1991. Presently, the old reservoir area and embankment serves as the foundation for a permitted landfill for dry gypsum scrubber waste. The crest of this earth and rock fill embankment dam has been significantly widened in recent years as a result of various grading and miscellaneous spoil stockpiling activities and carries the access road for the landfill operations. Based upon recent topographic mapping (Figure 3B) the crest is effectively on the order of 200 feet wide and has an elevation of 1000 to 1002, placing it approximately 52 to 54 feet above the water surface of the active Fly Ash Reservoir No. 2 impounded against the downstream toe. Information regarding the operating pool elevation when the reservoir was in service was not provided, but presumably it was below about elevation 990, the approximate elevation of the abandoned emergency spillway adjacent to the crest.

Fly Ash Dam No. 2 impounds the active Fly Ash Reservoir No. 2. It is a zoned earth fill dam with a clay core, chimney drain, and a roller compacted concrete (RCC) crest measuring 30 feet wide and 1,400 feet long. The dam was constructed in two major phases, the first of which was permitted in 1985 had a final elevation of 925. The second phase involving the RCC portion was completed in 1998 and established the present crest elevation at 970, creating total height of approximately 230 feet, based upon recent topographic information (Figure 3C) and the available design plans (Figure 4C). At the maximum proposed pool elevation of 960, the dam will create a 138 acre impoundment backing up into the eastern branch of Blockhouse Run and up to the toe of the old Fly Ash Dam No.1. As the dam was being raised and soil for the new downstream face was being placed at the toe extension, a slope failure became evident in the newly placed material. The repair required removing the soil at the toe and replacing it with higher shear strength material in the form of two distinct benches. This repair and final cross section of the dam are highlighted in Figures 5B and 5C.

A map of the region indicating the location of the Cardinal Power Plant Bottom Ash Complex, Fly Ash Reservoir No.1 and Fly Ash Reservoir No. 2 and identifying schools, hospitals, or other critical infrastructure located within approximately 5 miles down gradient of the impoundments is provided as Figure 6.

1.4 Previously Identified Safety Issues

Based on our review of the information provided to CHA and as reported by AEP, there have been no identified safety issues at either the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond) or Fly Ash Dam No. 1 in the last 10 years. According to the AEP 2008 annual inspection report, seepage through a spring along the Morgantown Sandstone outcrop in the hillside adjacent to the west rock groin began to carry ash between February and April of 2004. Since that time the report indicates that the spring has exhibited clear flow. CHA is not aware of any unpermitted release citations as a result of this seepage activity.

1.5 Site Geology

Based on a review of available surficial and bedrock geology maps, and reports by others, the site is in an unglaciated area of Ohio. The local geologic conditions at the Bottom Ash Complex are likely to consist of an alluvial silt, clay and/or sand deposited by the Ohio River floodwaters, and glacial outwash sand and gravel deposits above bedrock categorized as part of the Pennsylvanian Aged Conemaugh Formation comprising interbedded shales, sandstones, coal and limestone. Fly Ash Dam No.1 and Fly Ash Dam No. 2 lie in the upland areas above the Ohio River flood plain and the surficial soils in these locations consist of residuum on flatter hillcrest areas and colluvium at the base of slopes or on hillsides derived from the local bedrock. The mapped bedrock formations include the aforementioned Conemaugh Formation and the

Monongahela Formation in higher elevations. The Monongahela Formation typically contains interbedded coal, shale and sandstone.

1.6 Bibliography

CHA reviewed the following documents provided by AEP in preparing this report:

- *Dam & Dike Inspection Checklists*, dated February 2009 and May 2009, American Electric Power
- *2009 Inspection Report Cardinal Plant Ash Impoundments* [DRAFT], March 20, 2009, BBC&M Engineering, Inc.
- *2008 Inspection Report Fly Ash Dams I, III, and Bottom Ash Complex,* dated January 16, 2009, American Electric Power
- *Monitoring and Emergency Action Plan for the Cardinal Fly Ash Reservoir No.2 (FAR II) Dam ONDR Permit No. 97-264*, June 2005, AEP – Ohio Power Company and Buckeye Power Company
- *Cardinal Generating Plant Bottom Ash Pond Investigation*, August 4, 2009, BBC&M Engineering, Inc.
- *Permit to Install No. 06-07993 Cardinal FAR I Residual Waste Landfill*, May 11, 2007, Ohio Environmental Protection Agency
- *Final Design Report Proposed Earth Fill – Roller Compacted Concrete Dam Raising of Dam for Fly Ash Retention Pond II,* December 1986, American Electric Power Service Corporation – Civil and Mining Engineering Division
- Cardinal Plant Fly Ash Dam No. 2 Slide Repair Modifications in letter to ONDR Division of Water Engineering Group dated April 14, 1998, American Electric Power
- Selected drawings from dam raising at the Fly Ash Dam No. 2
- Graphical Stability Analysis Output of Fly Ash Dam No.1 for Landfill Permit
- Selected original construction drawings of the Bottom Ash Complex

SOURCE: USGS PITTSBURG WEST (PA-OH-WV) QUADRANGLE,
30x60 MIN SERIES

0 5000 10000

Scale in feet

PROJECT LOCATION MAP

CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 1

File: K:\20085\CADD\ACAD\FIGURES\1080 CARD FIGURE 1.DWG Saved: 12/9/2009 12:22:38 PM Plotted: 12/9/2009 12:23:52 PM User: Gray, Timmolyn

IMAGE REFERENCE: GOOGLE EARTH, IMAGE DATED MARCH 2006.

0 1790 3580

Scale in feet

N

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PHOTO SITE PLAN

CARDINAL STEAM PLANT

BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 2A

File: K:\20085\CADD\ACAD\FIGURES\GEO\1080 CARDINAL\1080 CARD PLANS_MAPS.DWG Saved: 10/1/2009 3:33:36 PM Plotted: 10/2/2009 11:55:35 AM User: Filkins, Rebecca

IMAGE REFERENCE: GOOGLE EARTH, IMAGE DATED MARCH 2006.

0 770 1540
Scale in feet

N

CHA

PHOTO SITE PLAN
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 2B

File: K:\20085\CADD\ACAD\FIGURES\GEO\1080 CARDINAL\1080 CARD PLANS_MAPS.DWG Saved: 10/1/2009 3:33:36 PM Plotted: 10/2/2009 12:02:00 PM User: Filkins, Rebecca

IMAGE REFERENCE: GOOGLE EARTH, IMAGE DATED MARCH 2006.

0 325 650
Scale in feet

N

PHOTO SITE PLAN
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 2C

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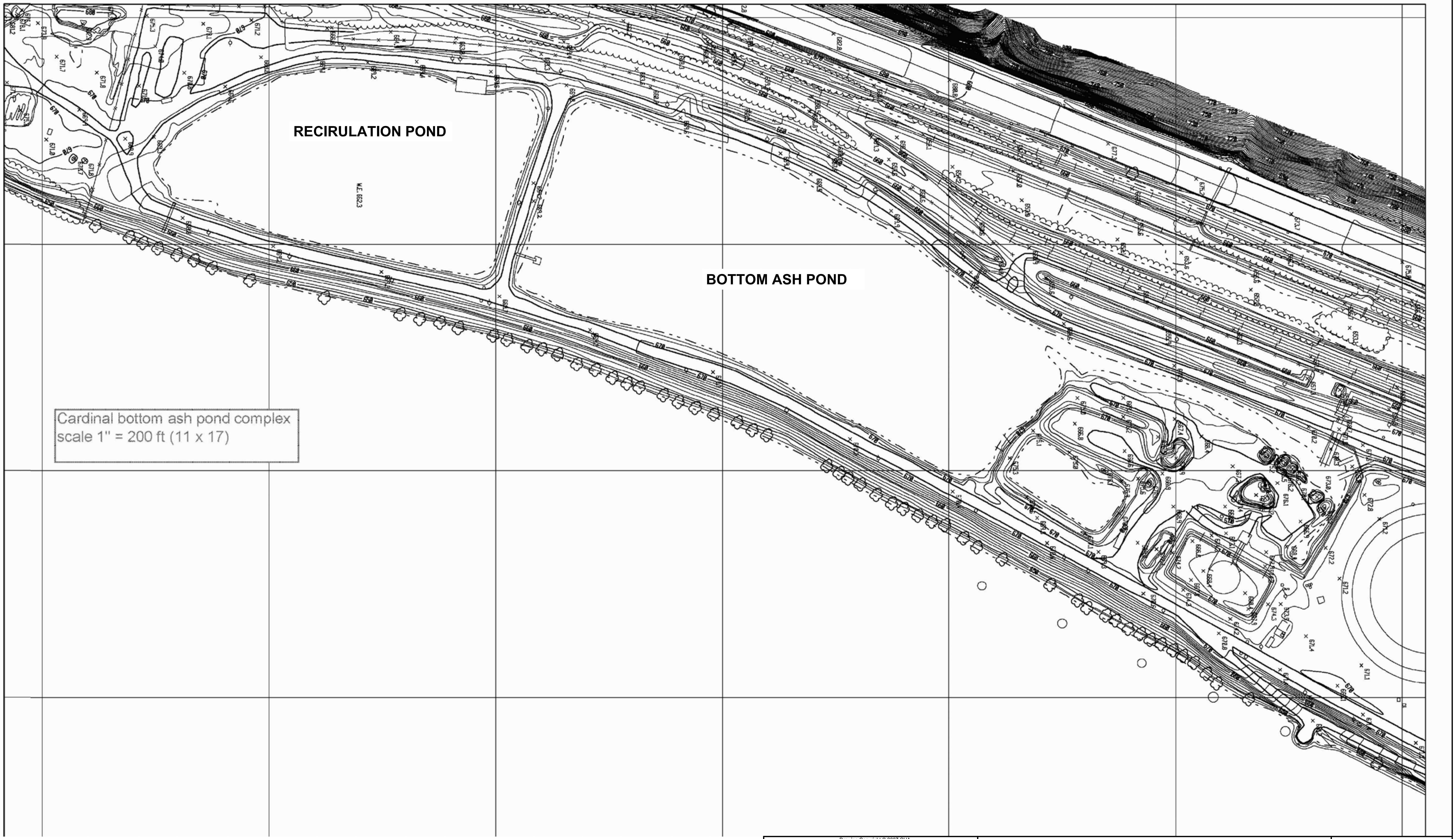

Cardinal bottom ash pond complex
scale 1" = 200 ft (11 x 17)

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: BOTTOM ASH POND TOPOGRAPHIC SURVEY (2005)

CHA

PRESENT TOPOGRAPHIC DATA
BOTTOM ASH COMPLEX
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 3A

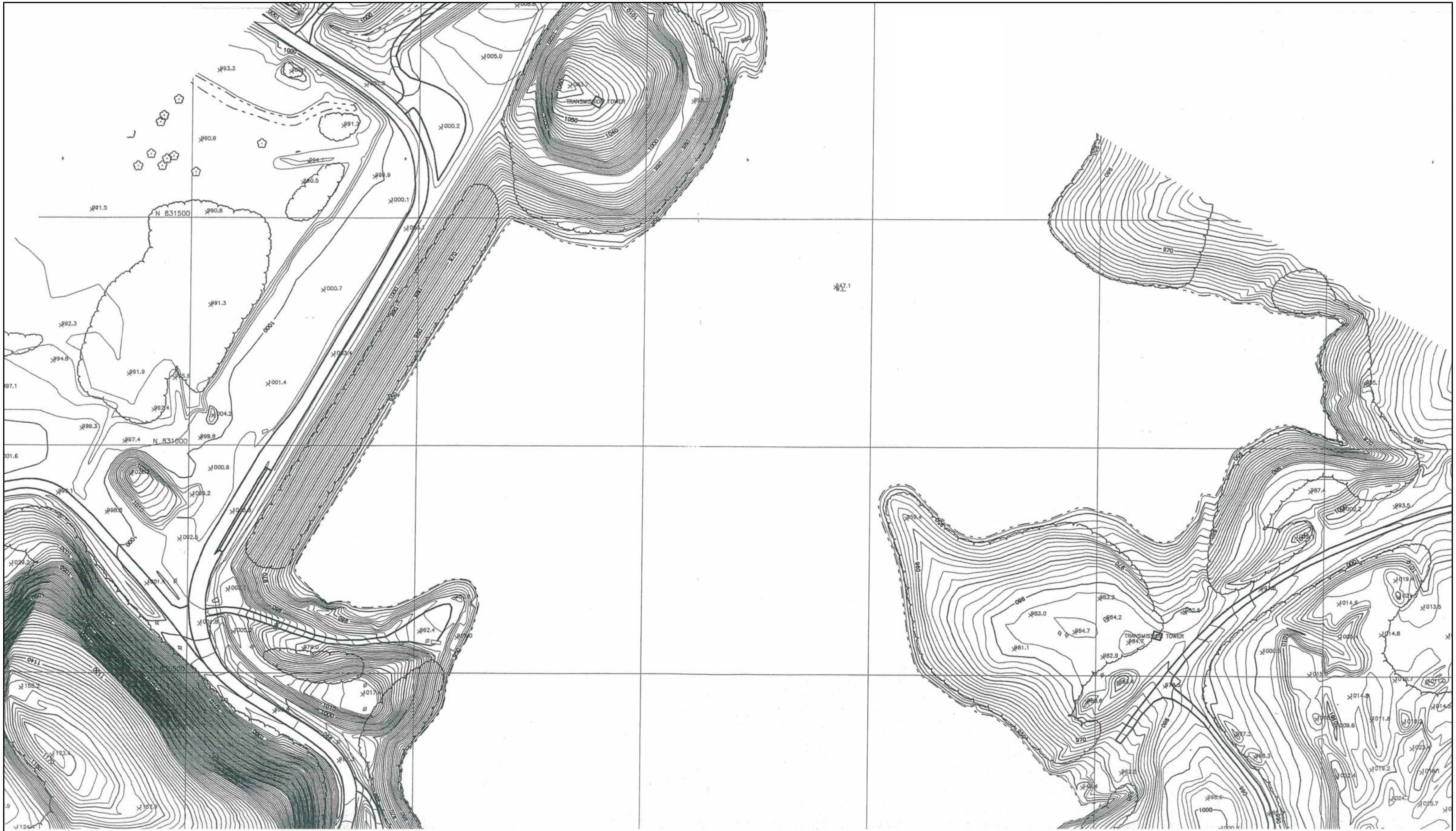

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: FAR I AND FAR II
TOPOGRAPHIC SURVEY (2005)

PRESENT TOPOGRAPHIC DATA
FLY ASH DAM NO. 1
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 3B

File: K:\20085\CADD\ACAD\FIGURES\GEO\1080 CARDINAL\1080 CARD PLANS_MAPS.DWG Saved: 10/2/2009 12:58:16 PM PLotted: 10/2/2009 5:28:37 PM User: Filkins, Rebecca

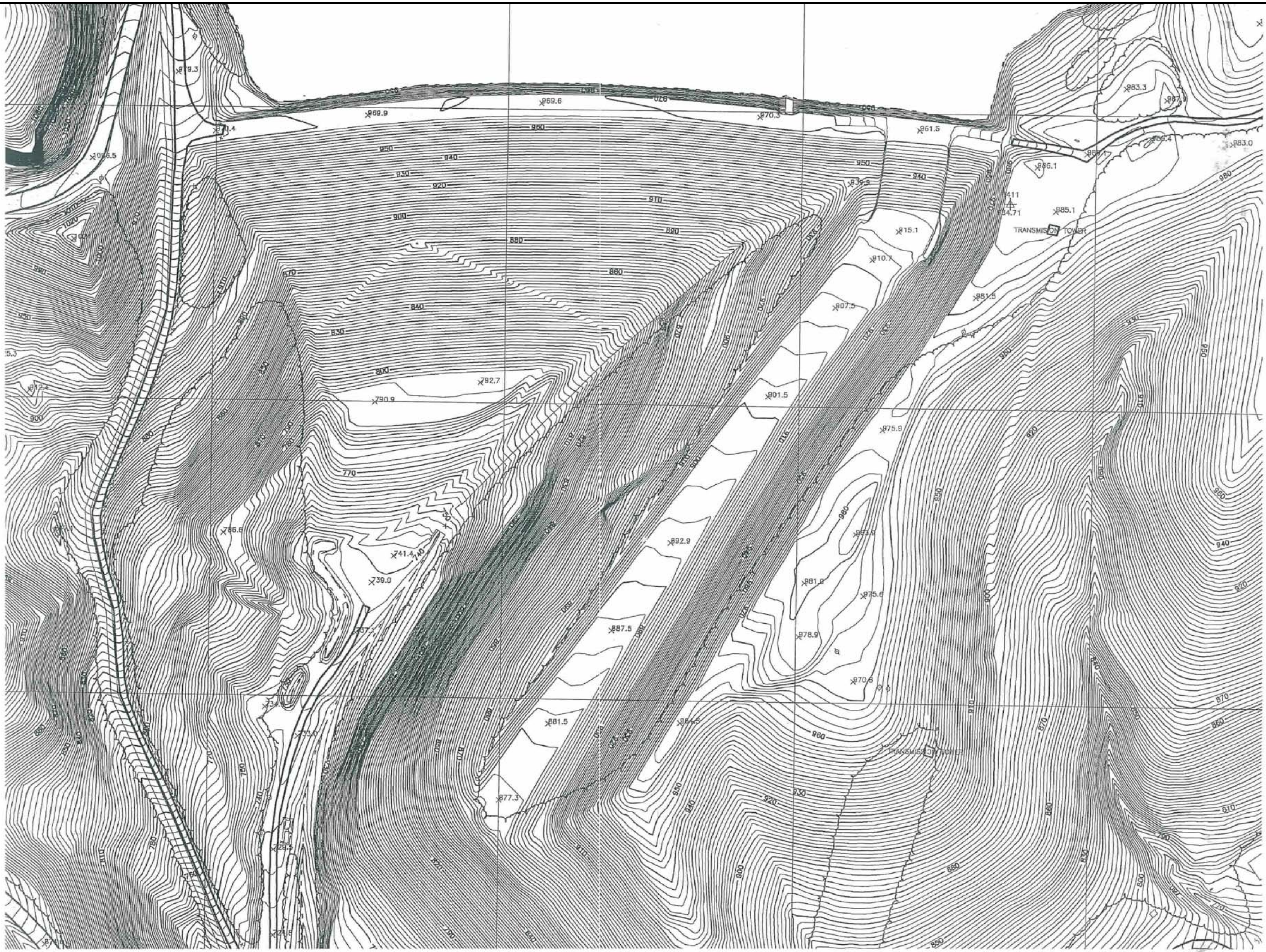

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: FAR I AND FAR II TOPOGRAPHIC SURVEY (2005)

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PRESENT TOPOGRAPHIC DATA
FLY ASH DAM NO. 2
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 3C

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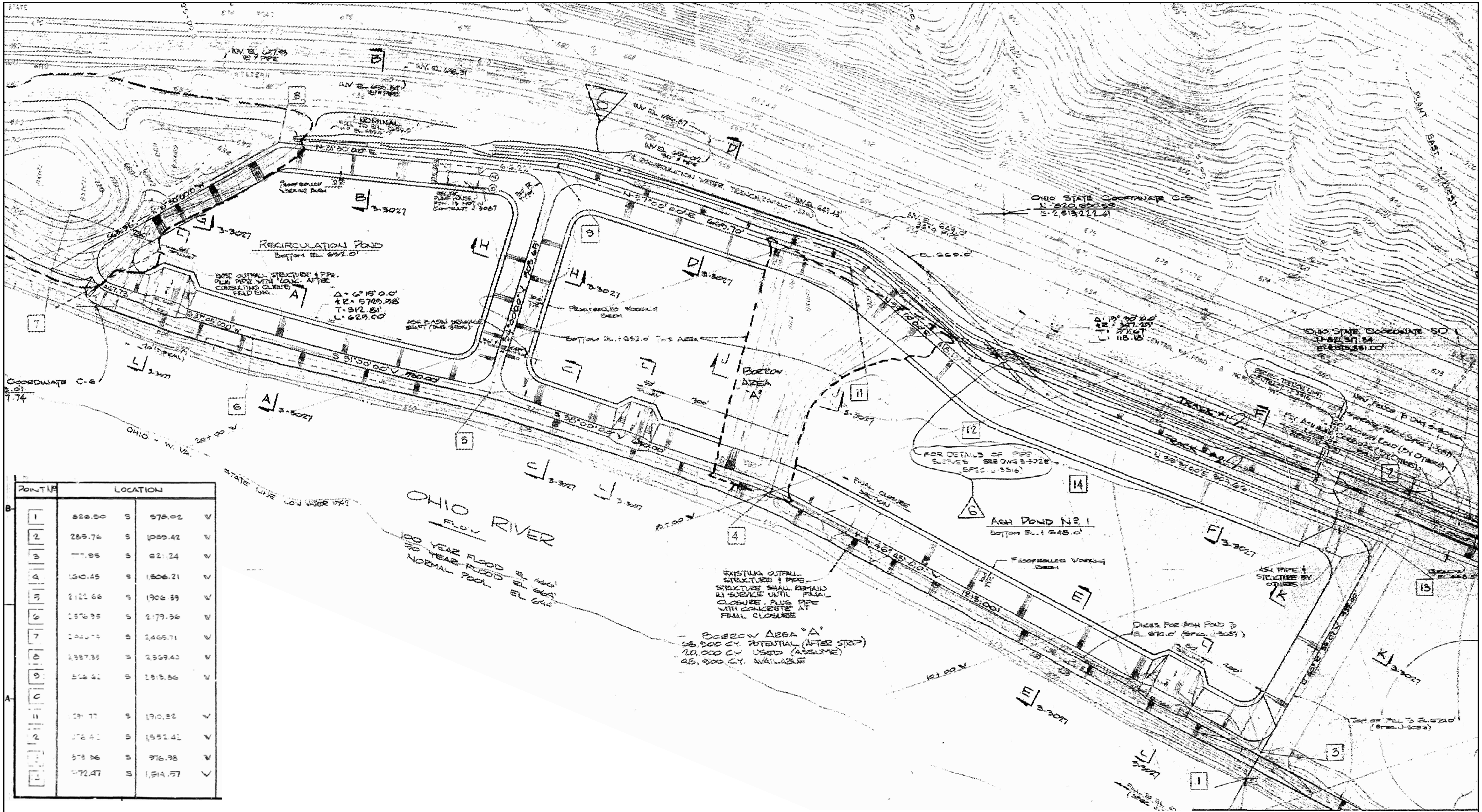

POINT No.	LOCATION			
1	826.50	S	578.02	W
2	285.76	S	1059.42	W
3	77.85	S	621.24	W
4	1310.45	S	1,506.21	W
5	2121.66	S	1906.39	W
6	1576.95	S	2179.36	W
7	[illegible]	S	2,465.71	W
8	2,387.35	S	2,569.43	W
9	516.41	S	2,313.86	W
10				
11	[illegible]	S	1910.82	W
12	372.41	S	1,552.41	W
13	378.36	S	976.98	W
14	972.47	S	1,514.57	W

IMAGE REFERENCE: SITE DEVELOPEMENT PLAN, ASH STORAGE PONDS SHEET 3, DRAWING NO. 3-3017, MARCH 1973.

CHA

DESIGN PLANS
BOTTOM ASH COMPLEX
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 4A

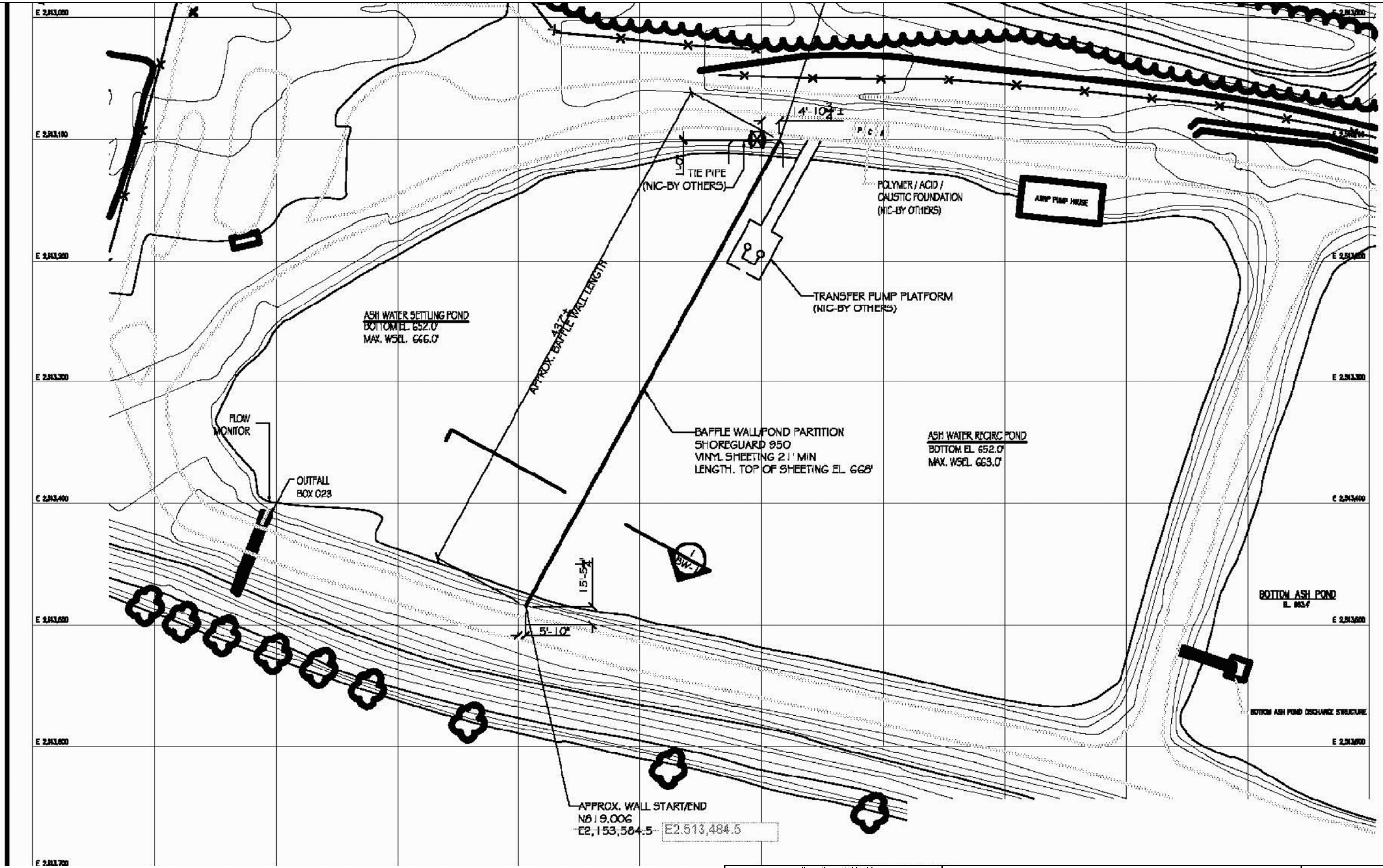

IMAGE REFERENCE: POTENTIAL ENGINEERS PC, AWRP/AWSP POND PARTITION, SHEET NUMBER BW-1, 1-15-06

Z

CHA

DESIGN PLANS
BOTTOM ASH COMPLEX–BAFFLE WALL
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 4B

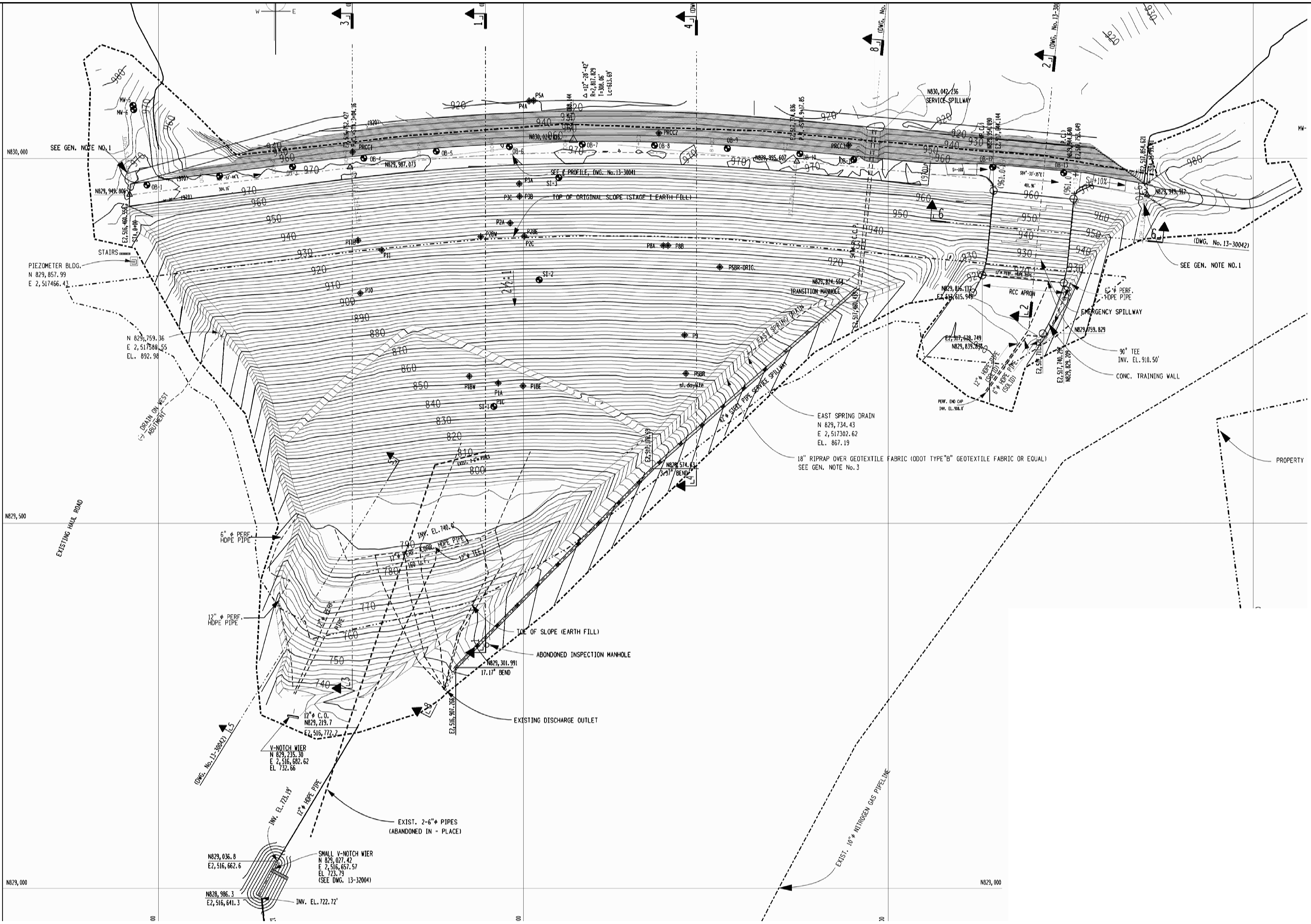

IMAGE REFERENCE: AMERICAN ELECTRIC POWER, FLY ASH DAM II RAISING GRADES & DRAINAGE PLAN, DRAWING NO. 13–30040–5, DATED 4–21–97

DESIGN PLANS
FLY ASH DAM NO. 2
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 4C

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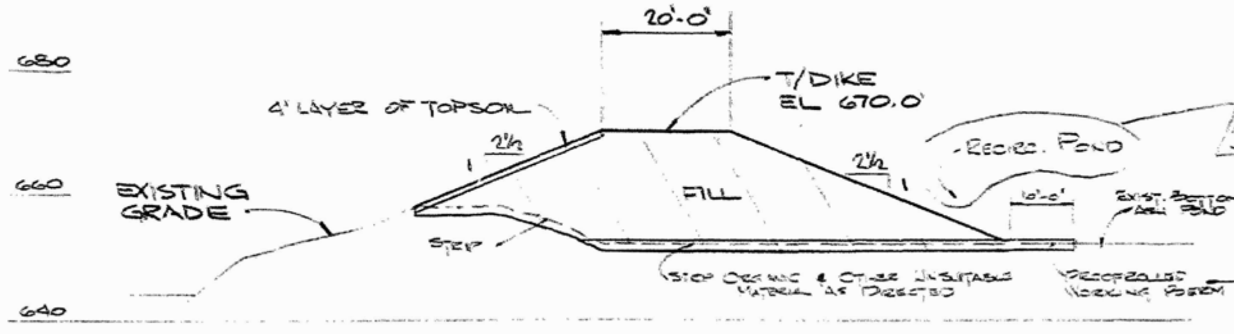

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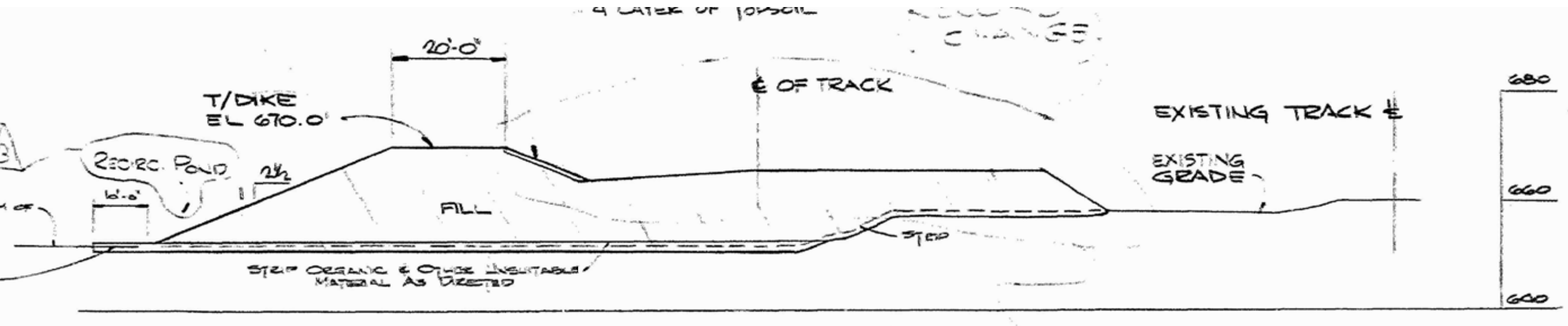
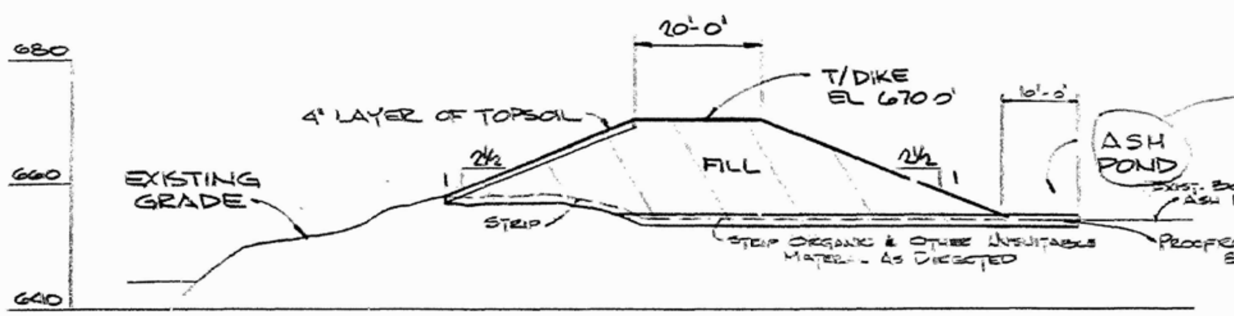


SECTION B-B (3-3017)
SEE NOTE NO. 3



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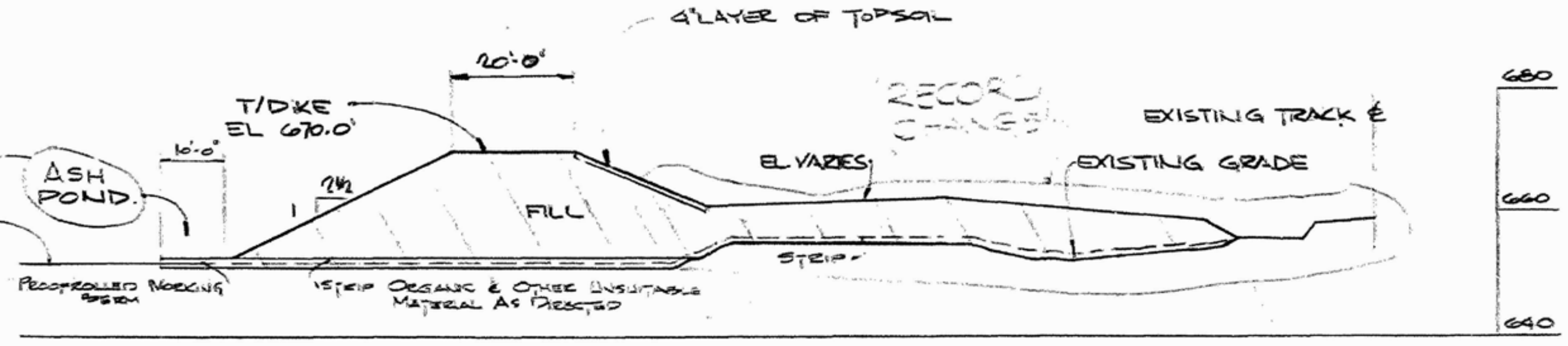

SECTION D-D (3-3017)
SEE NOTE NO. 3

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: SITE DEVELOPMENT ASH STORAGE AREA SECTIONS DRAWING NO. 3-3027-3

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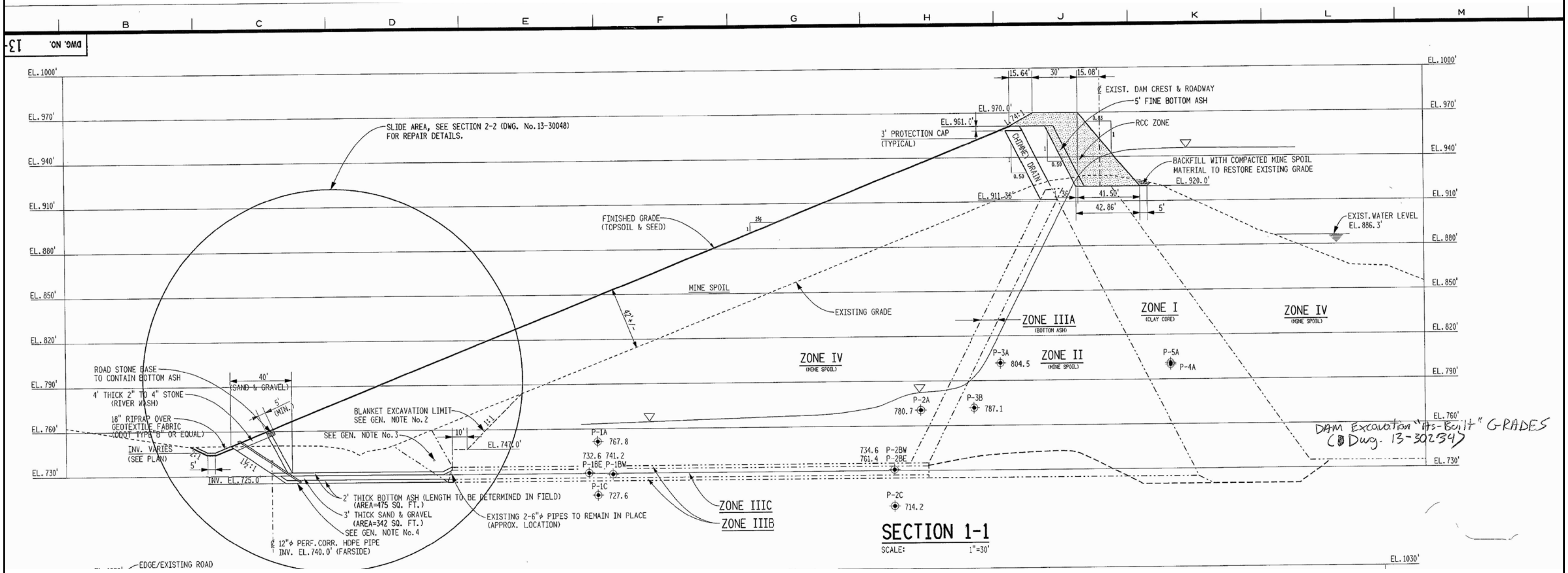
PRIMARY CROSS SECTIONS
BOTTOM ASH COMPLEX
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 5A

File: K:\20085\CADD\ACAD\FIGURES\GEO\1080 CARDINAL\1080 CARD XSECTS.DWG Saved: 10/2/2009 11:09:45 AM PLotted: 10/2/2009 1:47:35 PM User: Filkins, Rebecca



SECTION 1-1

SCALE: 1"=30'

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: FLY ASH DAM RAISING PROFILE AND SECTIONS DRAWING NO. 13-30041-6

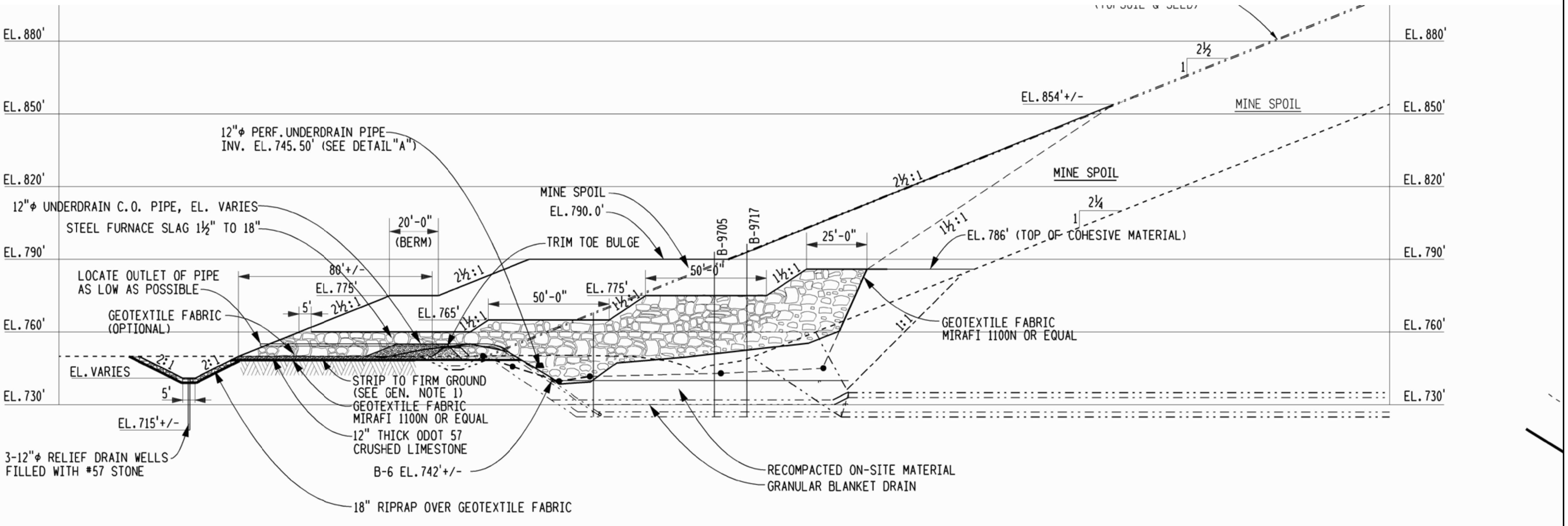
CHA

PRIMARY CROSS SECTIONS
FLY ASH DAM NO.2 SECTION 1-1
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 5B



SECTION 2-2

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: FLY ASH DAM RAISING SLIDE REPAIR SECTIONS AND DETAILS DRAWING NO. 13-30048-3

CHA

PRIMARY CROSS SECTIONS
FLY ASH DAM NO.2 SECTION 2-2
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 5C

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IMAGE REFERENCE: GOOGLE EARTH, IMAGE DATED MARCH 2006.

FLOOD INFORMATION REFERENCE: AMERICAN ELECTRIC POWER: MONITORING AND EMERGENCY ACTION PLAN FOR THE CARDINAL FLY ASH RESERVOIR NO.2 (FAR II) DAM ODNR PERMIT NO. 97-264

LEGEND

CHURCH

SCHOOL

◎ FIRE DEPARTMENT

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CRITICAL INFRASTRUCTURE MAP

CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 6

File: K:\20085\CADD\ACAD\FIGURES\1080 CARDINAL\1080 CARD PLANS_MAPS.DWG Saved: 12/9/2009 12:31:22 PM Plotted: 12/9/2009 12:31:49 PM User: Gray, Timmolyn

2.0 FIELD ASSESSMENT

2.1 Visual Observations

CHA performed visual observations of the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond), Fly Ash No.1 Dam, and Fly Ash No. 2 Dam following the general procedures and considerations contained in FEMA's *Federal Guidelines for Dam Safety* (April 2004), and FERC Part 12 Subpart D to make observations concerning settlement, movement, erosion, seepage, leakage, cracking, and deterioration. A Coal Combustion Dam Inspection Checklist Form, prepared by the US Environmental Protection Agency, was completed on-site during the site visit for each impoundment. A copy of the completed form was submitted via email to a Lockheed Martin representative following the site visit to the Cardinal Plant. Copies of the completed forms are included at the end of Section 2.4. Photo logs and Site Photo Location Maps (Figures 7A, 7B, 7C, and 7D) for the Bottom Ash Pond, Recirculation Pond, Fly Ash No.1 Dam, and Fly Ash No. 2 Dam are also located at the end of Section 2.4.

CHA's visual observations were made on September 1, 2009 and September 2, 2009. The weather was sunny with day time high temperatures of 72 and 74 degrees Fahrenheit and low temperatures of 47 and 48 degrees Fahrenheit. Prior to the days we made our visual observations, the following approximate rainfall amounts occurred (as reported by www.weather.com).

Table 1– Approximate Precipitation Prior to Site Visit

Dates of Site Visits – September 1, 2009 & September 2, 2009		
Day	**Date**	**Precipitation (inches)**
Tuesday	August 25, 2009	0.00
Wednesday	August 26, 2009	0.00
Thursday	August 27, 2009	0.00
Friday	August 28, 2009	0.51
Saturday	August 29, 2009	0.10
Sunday	August 30, 2009	0.00
Monday	August 31, 2009	0.00
Tuesday	September 1, 2009	0.00
Wednesday	September 2, 2009	0.00

Dates of Site Visits – September 1, 2009 & September 2, 2009		
Day	**Date**	**Precipitation (inches)**
Total	**Week Prior to Site Visit**	**0.61**
Total	**Month of August**	**2.95**

2.2 Visual Observation – Bottom Ash Pond

CHA performed visual observations of the Bottom Ash Pond dikes. The dikes, including the separation dike, total approximately 4,155 feet in length, and up to about 20 feet high. Significant vegetation was generally limited to the east dike facing the Ohio River and appeared to be a mixture of weeds, grasses, and small brush up to about 2 feet in height.

2.2.1 Embankments and Crest

In general, the Bottom Ash Pond dike crests do not show signs of an abrupt change in their horizontal alignment. Since the dike crests also serve as operation access drives, they are routinely graded as required. Refer to the following photos showing the dike crest alignment:

- Photo 3 – North Rim
- Photo 8, 14 – West Dike
- Photo 19 – Separator Dike
- Photo 20 – East Dike

2.2.2 West Dike

The west dike is predominantly a granular surfaced structure, and cobble sized rock fragments are often exposed on the slope surface and in some erosion rills. Some of these rills appear to be in less consolidated material pushed toward the upstream and downstream slopes during grading activities. Over the years these activities have gradually widened the crest width from its design shown on the construction drawings at 20 feet to areas CHA measured as wide as 30 to 40 feet.

Photos 9 through 12 show the granular surface and erosion rills at the crest-slope interface and slope surface.

The dike toe area terminates in a drainage swale that also functions as a pipe trace for the recirculation pipes. This drainage swale conveys runoff and other facility surface flow into the site sump located at the north end of the Bottom Ash Pond and pumps that water into the pond. During the site visit, standing water was observed in the drainage swale along approximately 2/3 of the dike length. This water had a reddish brown color in some areas where the pipes had been partially submerged, however it was difficult to determine if the water coloration was due to corrosion or loss of pipe coating. An attempt to probe the toe area in the standing water indicated firm conditions. Given the 30-foot width of the dike and the fairly low head differential of about 5 feet, the water in the swale is not likely hydraulically connected to the pond. However, the grass growth in the swale at that area does suggest that water collects there and stands for a period of time. Photos 12 and 13 show the water collected in this area of the toe swale.

Isolated woody vegetation was observed along the west dike. Photo 15 shows an example of this plant growth.

2.2.3 Separator Dike

The separator dike has a general granular surface and is sparsely vegetated in similar fashion to the west dike as shown in Photos 16 and 34. Erosion features typical of the west dike are evident on this dike which is also about 10 feet wider at the crest than shown in the original site drawings (total measured width of approximately 31 feet). No unusual slumps or bulges were observed in the upstream or downstream slope.

2.2.4 East Dike

The upstream face of east dike is essentially non-vegetated with a fairly coarse granular surface. Erosion from crest runoff has exposed fairly large sized rock fragments in the slope as shown in Photo 21. Beyond the intermittent erosion rills, cracking, slumping, or slough was observed in the upstream face.

The downstream face of the dike was generally vegetated up to within about 3 to 5 feet of the crest as shown in Photos 22 and 23. In areas adjacent to the river a change in vegetation from grasses and weeds to heavier broad leafed plants and woodier brush and trees can be observed. Based upon the available topographic mapping and older design plans, this vegetation change appears to be where the constructed slope transitions to the river bank. Several of the trees were fairly mature on the order of 16 to 24 inches in diameter. Photos 24, 25, 27, and 28, show examples of this vegetation change. Soil conditions in the slope at these vegetation changes were firm to hand probing and did not exhibit excessive moisture.

In some locations where the river bank was visible through the brush, there appeared to have been some larger stone apparently placed as bank stabilization. Photo 26 provides a close-up of this stone. This particular photo was taken adjacent to a large tree growing along the bank. Typically there appeared to be about 3 to 5 feet between the tree line and the river edge.

Downstream slope areas in the northern extremity of the basin adjacent to the incised face of the pond had heavier brush and tree growth as shown in Photo 31. This area of the slope also adjacent to the portion of the pond where a container dike for boiler cleaning chemical tank is located and where interior dikes temporarily store dredged bottom ash intermittently as a part of the plant recycling process. These features are shown in Photos 29 and 32. A paved crest was also observed in this area as shown in Photo 30. Material deposits due to grading activities can also be seen in Photo 30.

2.3 Visual Observation – Recirculation Pond

CHA performed visual observations of the Recirculation Pond dikes which form the southern portion of the Bottom Ash Complex impoundment. The dikes in this location total approximately 1,300 feet in length, and up to about 20 feet high.

2.3.1 Embankments and Crest

In general, the Recirculation Pond dike crests do not show signs of an abrupt change in their horizontal alignment. In a manner similar to the Bottom Ash Pond dikes, the dike crests also serve as operation access drives and are routinely graded as required.

2.3.2 West Dike

The west dike is predominantly a granular surfaced structure with very sparse vegetation and numerous cobble sized rock fragments in the upstream and downstream slope surface. Erosion rills in the crest surface could be observed at the crest slope intersection where sheet flow becomes concentrated. Some areas have had more pronounced erosion than others. Photos 35 through 37 show the slope areas of the dike and Photo 38 is a close up of an erosion rill.

Grading activities have slowly widened the dike crest in this location. While design plans typically referenced 2.5:1 slopes, they are flatter north of the pump house structure and become steeper in the immediate vicinity of the pump house structure where the dike approaches roughly 50 feet in width. In this area, the dike height tapers off as one approaches the incised southern extremity of the pond as shown in Photo 39.

No abrupt changes in the dike alignment were observed during the inspection and indications of slope distress such as sloughing, cracking, or slumping were not evident.

2.3.3 Incised Southern Wall

A recent vinyl sheet pile baffle wall (Photo 40) marks the beginning of the transition to the incised southern extremity of the Recirculation Pond. The inboard wall and crest area are sparsely vegetated with a granular surface, which is typical of the dikes in this impoundment. More pronounced erosion was observed in this area adjacent to where the impoundment transitions to a dike structure, as the large erosion gullies indicate (Photos 41 and 42). Large slope protection stone has been placed in this area, presumably in response to the erosion problem in this area.

2.3.4 East Dike

The crest area of the east dike does not show indications of abrupt changes in horizontal alignment and the slope areas show no obvious signs of slope instability such as scarps or sloughs. Little to no vegetation cover was observed on the upstream face and large slope protection stone has been placed on the slope face in areas adjacent to the outfall. Minor erosion features as a result of concentrated water flow could be observed on the upstream face on most of the dike. Photos 47, 48, and 42 show the typical conditions of the crest and upstream slope.

The downstream face has had a stone slope repair apparently as a result of seepage (Photo 46). This area covers roughly half of the Recirculation Pond dike length and appeared dry during the site visit with no outward signs of seepage. Beyond the slope protection area, the downstream slope is vegetated with the exception of the top few feet at the crest where sight grading activities have affected the vegetation growth (Photos 49 and 50).

2.3.5 Bottom Ash Complex Outlet Control Structures and Discharge Channel

There are two outlet control structures in the Bottom Ash Complex. The Primary Spillway is a drop inlet structure with a floating pond skimmer and concrete pipe beneath the separator dike.

This functions as the initial decanting structure to deliver partially clarified water to the Recirculation Pond. The spillway outlet pipe is normally submerged and was so at the time of the site assessment and could not be observed. Photos 17 and 18 show this outlet control structure. As can be seen in the photos, vegetation had started to establish itself in the skimmer, but does not appear to be fouling the spillway function at this time.

Water that is not used to sluice fly is treated with chemical additives and pumped to a settling basin created with a baffle wall in the Recirculation Pond prior to release to the Ohio River. This outlet structure is a concrete drop inlet connected to a 36-inch diameter corrugated metal pipe. Plans indicate that the maximum operating elevation is at approximately 666 feet. At the time of the site visit, water was approximately 2 to 3 feet below the inlet and not being released through the outlet structure. The downstream outlet channel is the slope of the dike and appears to be well armored with rip-rap protection. Photos 43, 44, and 45 show the outlet structures and slope protection.

2.4 Visual Observations – Fly Ash Dam No.1

CHA performed visual observations of Fly Ash Dam No. 1. The Fly Ash Dam No. 1 is about 1,200 feet long and extends about 55 feet above the water surface of Fly Ash Reservoir No. 2 (Photo 56). Heavy wooded vegetative growth, random rip-rap placement, and locally steep areas inhibited the inspection of this impoundment due to safety concerns.

2.4.1 Embankments and Crest

The alignment of the crest of Fly Ash Dam No.1 does not show signs of change in horizontal alignment. This area is very wide and presently supports a paved haul road with truck scales for the landfill (Photos 53 and 54). The downstream crest of the dam also supports the pipe rack for sluiced CCW being conveyed to the upper reaches of Fly Ash Reservoir No. 2.

The downstream slope is heavily vegetated and armored with large rip rap (Photos 51 and 52). This rip rap has deteriorated over time and the heavy vegetation obscured much of it, giving it the appearance of having been randomly placed (Photos 59 and 60). Heavy vegetation was also observed in the north (left) abutment groin (Photos 57 and 58).

2.4.2 Fly Ash Dam No.1 Abandoned Emergency Spillway

The abandoned emergency spillway for Fly Ash Dam No. 1 is located to the north of the embankment. It now functions as a surface drainage outlet and leachate pipe corridor for the landfill operations in the old Fly Ash Reservoir No.1 basin.

2.5 Visual Observations – Fly Ash Dam No. 2

CHA performed visual observations of Fly Ash Dam No. 2. The Fly Ash Dam No. 2 is about 1,400 feet long and about 230 feet high.

2.5.1 Embankments and Crest

In general, the alignment of the crest of Fly Ash Dam No. 2 does not show signs of change in horizontal alignment, which arches slightly in the upstream direction (Photos 63, 68, and 84). Bedrock exposures can be observed on the east abutment at the emergency spillway (Photo 81).

Weathering effects were also observed in the roller compacted concrete surface during the site assessment. These occurred in the form of edge spalling and isolated erosion (Photos 69 and 72) in the outer surfaces of the material.

Two distinct cracks sealed with caulking were also observed in the crest adjacent to the west (right) abutment and spillway (Photo 78). These cracks apparently occurred during the RCC construction as a result of differential settlement between the RCC crest supported directly on the rock abutment areas and the portion of the RCC crest supported above the original embankment. The seals appeared to be tight during the site visit.

The upstream slope of the roller compacted concrete (RCC) crest is fairly steep and generally appears to be in good condition. Sparse vegetation has slowly started to establish itself (Photos 76 and 77). Due to the nature of the upstream slope, only a limited portion could be directly viewed during the site visit.

The downstream slope areas generally appeared to be well maintained and vegetated with an adequate grass cover as noted in Photos 64, 99, 101, and 105. Much of this cover has grown on the portion of the dam above elevation 925 which is the RCC portion. Isolated grass cover losses were observed in some areas, such as the ones on the upper bench shown in Photos 102 and 103, but these were considered minor. The erosion observed between the upper bench and the west groin is more prominent however, as shown in Photo 100.

Rock lined groins and drainage ditches along the abutment contacts and on the slope face were varied in their conditions. The upper rock groin along the west (right) embankment was generally dry and fairly clear of vegetation (Photo 65). Fairly low vegetation was also evident in the east groin near the toe drain area (Photo 91). This is in contrast to the rock groin in the upper elevation of the east (left) abutment and the downstream slope (Photos 85, 86, and 104). At lower elevations, the abutment groins began to intercept and convey seepage toward the toe drain area (Photos 89, 90, and 106). One of the more prominent seeps on the right abutment is actually drainage from a trench drain in the natural hillside (Photo 88). Another active drain was observed at the east abutment contact. This drain appeared to be conveying flow from the embankment rather than the hillside (Photo 87). Seepage in these areas was clear.

The toe drain is armored with 18-inch diameter rip rap, roughly 5 to 6 vertical feet of which is exposed at the slope toe (Photo 92). This toe terminates in a collection pool where additional drainage pipes actively convey water to the pool (Photos 93 and 94) which in turn empties into a drainage swale. AEP has six weirs in the seepage pool and along the drainage swale to measure volume (Photos 95, 96, and 98). One of these weirs is no longer functional as water is currently by-passing the V-notch (Photo 97). The depth of flow over these weirs is measured and recorded by AEP personnel quarterly.

2.5.2 Fly Ash Dam No. 2 Outlet Control Structure

Fly Ash Dam No. 2 has an inclined Principal Spillway connected to a 54-inch diameter prestressed concrete cylinder pipe through the RCC embankment which transitions to a 42-inch diameter steel pipe. This steel pipe is exposed along the east abutment and outlets at the base of the slope in a concrete energy dissipater (Photos 99 and 107). The inclined spillway was constructed with a diagonal construction joint to allow potential deformation along a crack in the RCC that had formed while the RCC was being placed. Crack deformation gauges have been placed along this joint to track movement (Photo 74 and 75). Shear displacement along this joint was not readily observable.

2.5.3 Fly Ash Dam No. 2 Discharge Channel

Fly Ash Dam No. 2 discharges into the natural stream channel for Blockhouse Run (Photo 107). The stream banks were vegetated at the time of the site visit. Undermining or other signs of bank instability were not readily observed.

2.5.4 Fly Ash Dam No. 2 Emergency Spillway

The Emergency Spillway is constructed out of roller compacted concrete with concrete training walls and will activate once the pool reaches elevation 961 (Photos 80, 82, and 83). It has a designed bottom width of 110 feet. The downstream channel was excavated through rock in the abutment and outlets over the hillside approximately 500 to 600 feet beyond the embankment toe (Photo 79).

2.6 Monitoring Instrumentation

There is monitoring instrumentation installed at both the Bottom Ash Complex and Fly Ash Dam No. 2. The Bottom Ash Complex is currently monitored with five piezometers, three of which were recently installed as part of a geotechnical investigation concerning the stability of the Bottom Ash Complex dikes. Piezometer CD-PZ-BAP-902 was installed at the crest of the Recirculation Pond while piezometers CD-PZ-BAP-904 and CD-PZ-BAP-905 were installed at the crest and toe, respectively, of the Bottom Ash Pond. Two older piezometers, 2N and 3S, are located at the crest of west dike on the Bottom Ash Pond and the east dike of the Recirculation Pond, respectively. Figure 8A shows the approximate locations of these piezometers at the Bottom Ash Pond Complex.

The Fly Ash Dam No. 2 is monitored with slope inclinometers, piezometers, and settlement monuments. Figure 8B shows the approximate locations of this instrumentation at the Fly Ash Dam No. 2. AEP collects data at these instruments and summarizes them in a semiannual report. A more complete discussion of the data collected from the Fly Ash No. 2 instrumentation is contained in Section 3.3.

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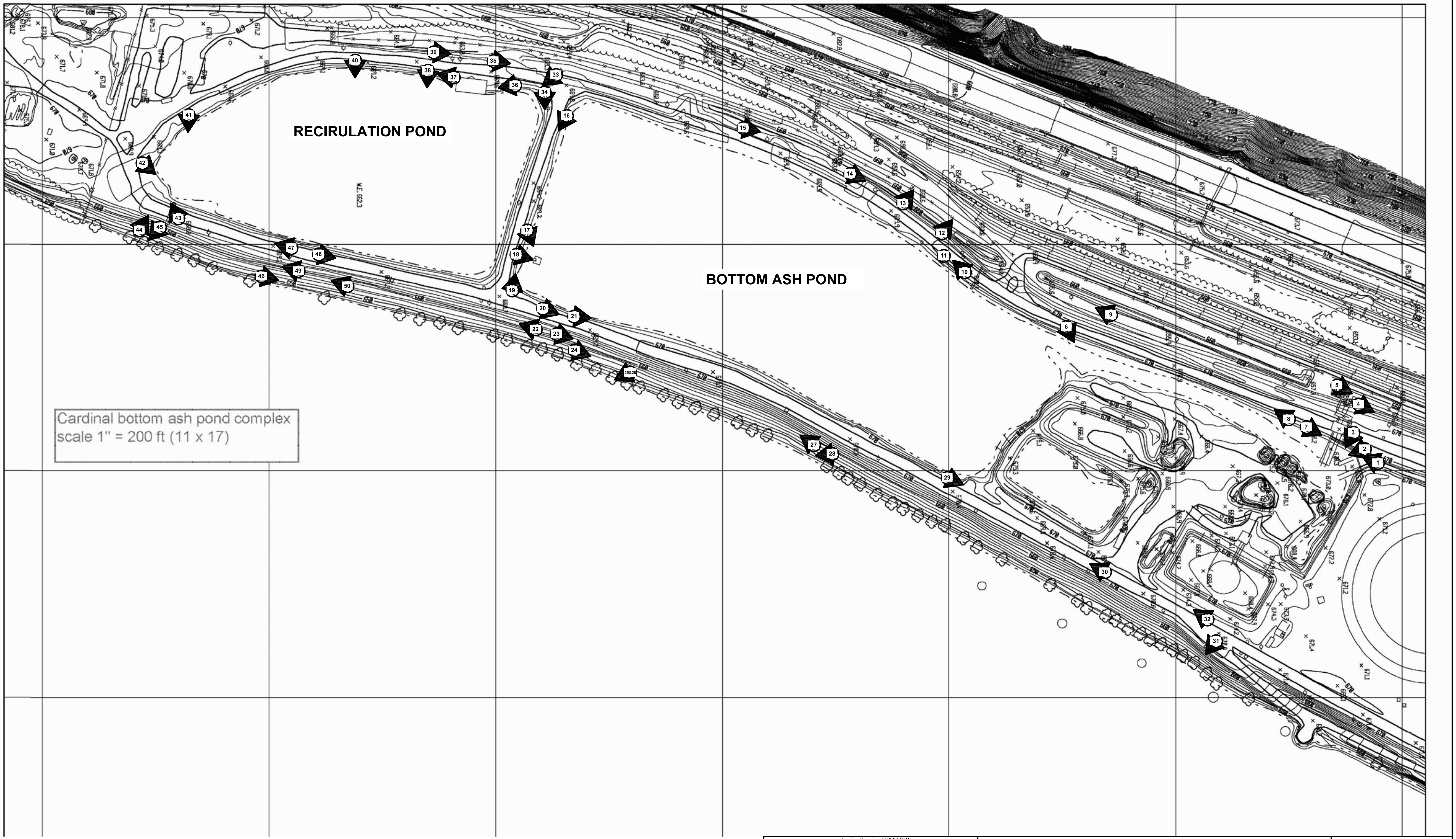

Cardinal bottom ash pond complex
scale 1" = 200 ft (11 x 17)

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: BOTTOM ASH POND
TOPOGRAPHIC SURVEY (2005)

Drawing Copyright © 2007 CHA

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PHOTO LOCATION PLAN
BOTTOM ASH COMPLEX
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO. 20085.1080	
DATE: SEPT 2009	
FIGURE 7A	

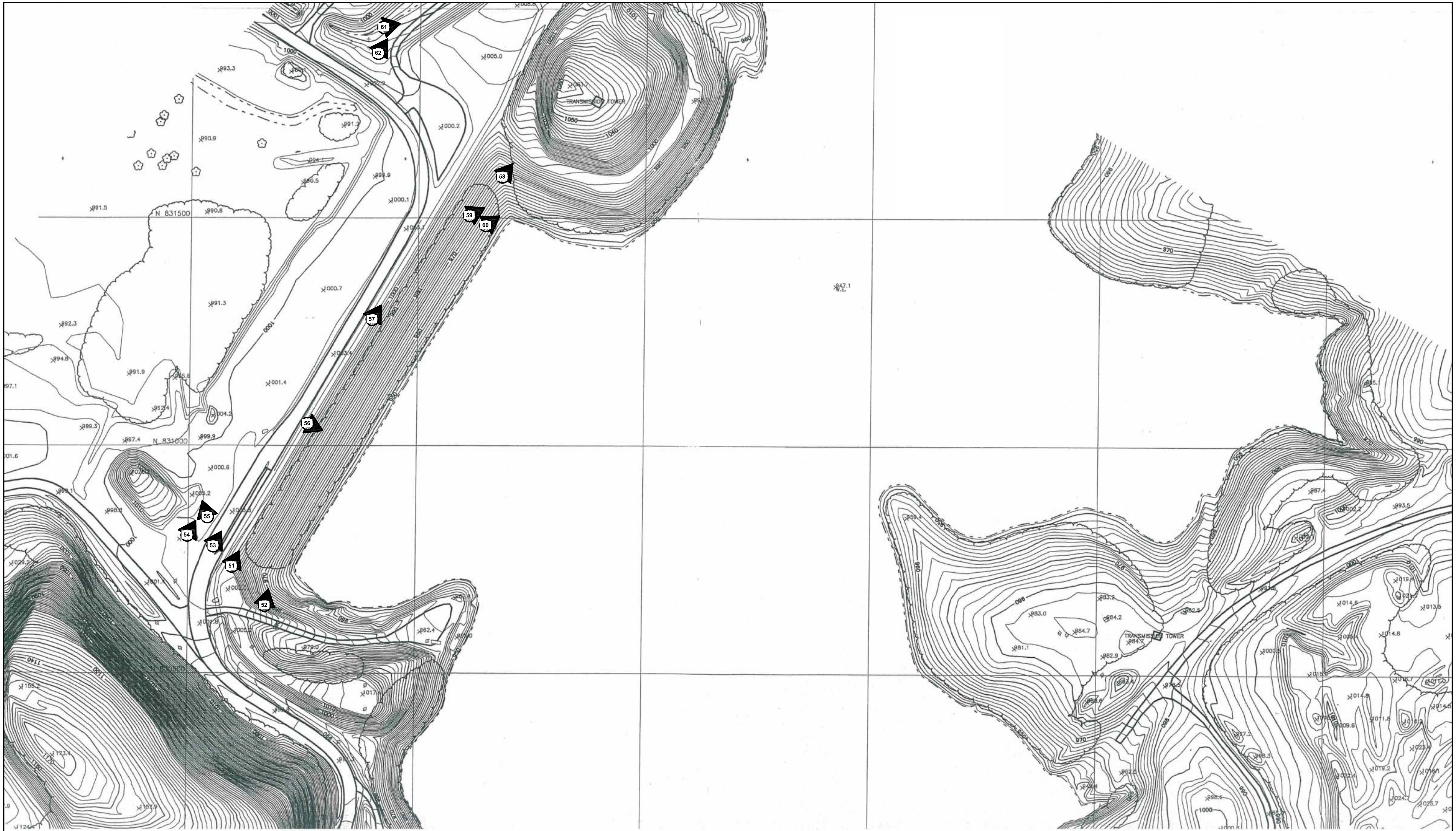

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: FAR I AND FAR II
TOPOGRAPHIC SURVEY (2005)

PHOTO LOCATION PLAN
FLY ASH DAM NO. 1

CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 7B

File: K:\20085\CADD\ACAD\FIGURES\GEO\1080 CARDINAL\1080 CARD PLANS_MAPS.DWG Saved: 10/2/2009 12:58:16 PM PLotted: 10/2/2009 5:31:50 PM User: Filkins, Rebecca

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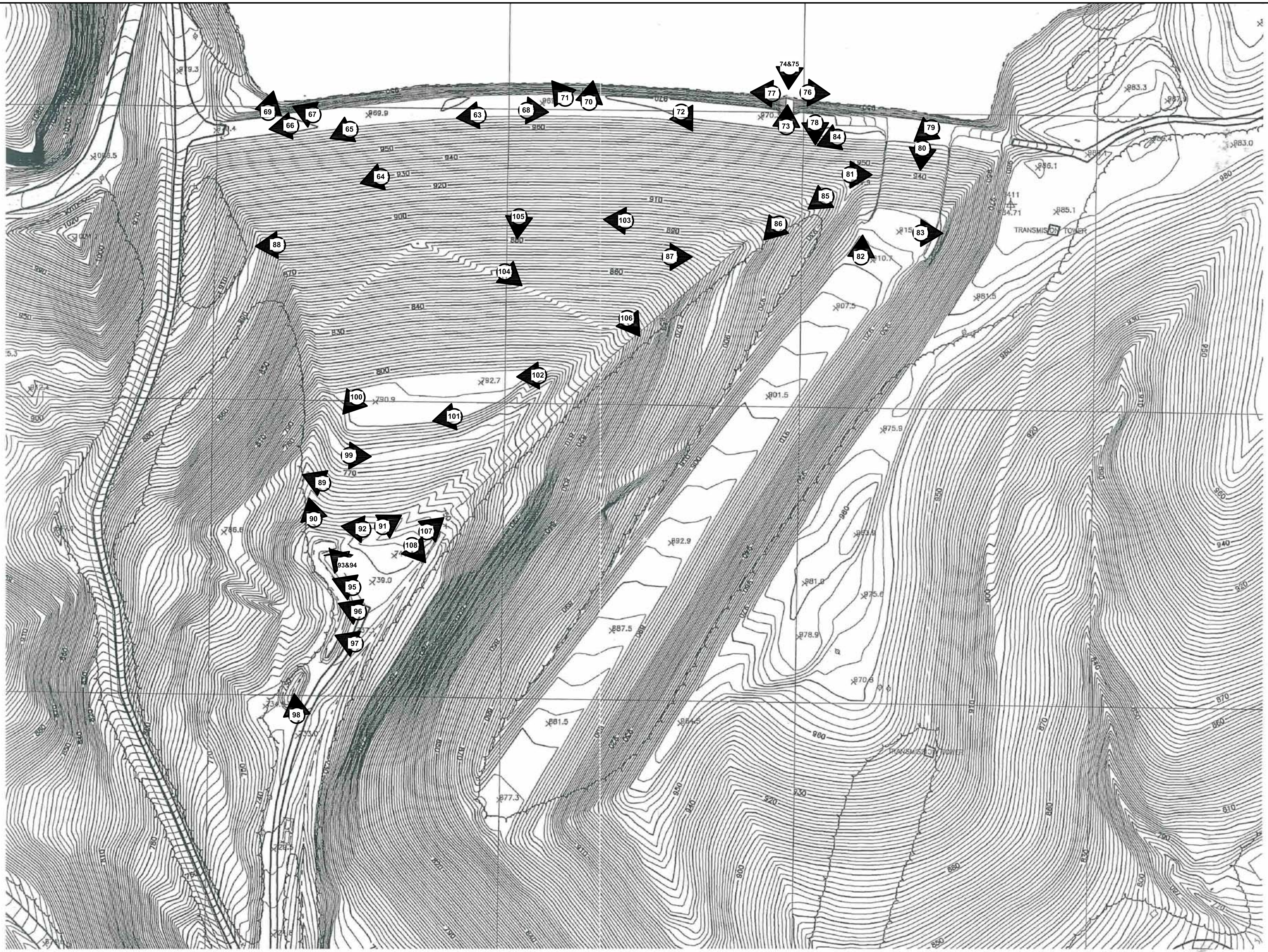

IMAGE REFERENCE: AMERICAN ELECTRIC POWER: FAR I AND FAR II
TOPOGRAPHIC SURVEY (2005)

CHA

PHOTO LOCATION PLAN
FLY ASH DAM NO. 2
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 7C

1

North rim of bottom ash pond at ash lines looking south. Note crane on ash delta platform.

2

View of ash delta working platform from north dike. Note dredge spoil dike in background.

3

Upstream slope of the north rim, looking east.

4

Downstream slope of the west dike, looking north. Note gravel surface and grass in drainage swale.

5

Looking north from the yard sump at the drainage swale along the downstream toe of the west dike.

6

Looking east from west dike at interior dike structure used for temporary bottom ash dredge spoil storage.

7

Upstream slope of west dike looking north.

8

Upstream slope and crest of west dike looking south. Note erosion rills in granular surface

9

Downstream slope of the west dike looking south. Note water collecting around pipes in swale at slope toe which drains to the stormwater/wastewater and drainage sump in Photo # 9.

10

Upstream slope of the west dike, looking south. Note erosion at crest and sparse vegetation in background.

11

Up-close view of erosion noted in Photo #11 showing large rock fragments in dike material.

12

Downstream slope of the west dike, looking west. Note surface erosion and reddish brown water collecting in drainage swale around pipes showing signs of apparent corrosion and loss of coating.

13

Toe of west dike where drainage has collected in pipe swale, looking south. Soil difficult to probe more than a few inches.

14

Downstream slope and crest of west dike, looking north.

15

Wooded vegetation becoming established on downstream slope of west dike, looking north.

16

Upstream slope of separator dike, looking east. Sparse vegetation and erosion rills evident.

17

Pond spillway tower looking north.

18

Closer view of skimmer at spillway tower and vegetation beginning to establish itself.

19

Upstream slope and crest of separator dike, looking west. Note isolated vegetation.

20

Upstream slope and crest alignment of east dike, looking north.

21

Closer view of upstream slope of east dike, looking north.

22

Downstream slope on east dike, looking south showing typical moderate, weedy vegetation cover on the slope face and larger brush with isolated trees at river bank.

CHA

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BOTTOM ASH POND
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23

Downstream slope of east dike, looking north, showing effect of routine grading activities at the crest where vegetation is not established.

24

Downstream toe of east dike showing change in vegetation at slope toe-river bank contact.

25

Close-up of one of the larger trees at the river bank edge along west dike.

26

Close-up of stone at river bank adjacent to tree in Photo #23.

27

Downstream slope of east dike, looking south. Typical loss of vegetation shown at crest and change in vegetation shown adjacent to river bank.

28

Closer view of change to leafy vegetation at river bank. Soils were firm and dry to touch in this area.

29

East dike crest alignment, pond surface, interior dike, chemical tank (in background) looking north.

30

East dike crest alignment, looking south, showing ash build up at road edge due to grading activities.

31

Downstream slope of east dike at northern extent of pond showing heavy vegetation and debris.

32

East dike crest alignment and portion of interior dike, looking south.

33

Pond surface, looking east.

34

Downstream slope of the separator dike on the north side of the pond.
Erosion features noted in separator dike slope.

35

Crest and downstream slope at west dike, looking south where recirculation pipes exit slope. Typical erosion features evident at crest.

36

Upstream slope and crest on west dike adjacent to pump house, looking south. Slope is fairly gentle but steepens adjacent to pump house.

37

Upstream slope and crest of west dike, looking south. Note erosion feature and isolated brush. Vinyl sheet pile wall is in background.

38

Closer look at erosion feature in Photo #36. Note exposed rebar debris in erosion gully.

39

Downstream slope of west dike, looking north. Note fairly low height (about 5 feet tall) at this point.

40

Vinyl sheet pile wall dividing recirculation pond to reduce treated water volume prior to discharge.

41

Inboard face at south wall, looking east. Pond is essentially incised in this location.

42

Looking east at upstream face of east dike. Note large armor stone adjacent to outlet structure and large erosion gullies adjacent to equipment at south wall - east dike interface.

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43

Recirculation pond outlet structure from east dike crest, looking west.

44

36” diameter Recirculation Pond outfall.

45

Slope protection below recirculation pond outfall.

46

Looking north on east dike at stone facing in area of apparent seep.
Seepage was not readily observed during site visit.

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RECIRCULATION POND
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47

Crest and upstream slope of east dike at vinyl wall, looking south.

48

Crest and upstream slope of east dike at vinyl wall, looking north. Note typical erosion and sparse vegetation.

49

Crest and downstream slope of east dike, looking south. Note vertical limit of stone facing.

50

Downstream slope of east dike, looking south showing typical vegetation cover.

51

Downstream slope from right (south) abutment near crest. Note heavy wooded vegetation.

52

Downstream slope from right (south) abutment, closer to Fly Ash Reservoir No. 2 water surface.

53

Looking north at crest area showing landfill truck scales and sluice lines to Fly Ash Reservoir No. 2.

54

Another view of the crest, looking north. Crest is in excess of 100 feet in width.

55

Looking west from crest area into former basin toward active landfill operations.

56

Looking east from crest across Fly Ash Reservoir No. 2 at Fly Ash Dam No. 2.

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CARDINAL POWER PLANT
FLY ASH DAM NO. 1
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57

Looking north at downstream slope and left (north) abutment contact.

58

Left (north) abutment rock groin; heavily vegetated.

59

Downstream slope showing sporadic rip-rap (boulders).

60

Close-up of large rip-rap boulder, visible through vegetation.
.

61

Emergency spillway, looking north from old basin area.

62

Storm runoff and site drainage outlet from landfill operation and old basin surface to emergency spillway.

63

Downstream slope at crest looking west toward right abutment.

64

Downstream slope below crest, looking west towards right abutment. Note rock groin at abutment contact.

65

Closer view of rock groin at right (west) abutment hillside contact from crest.

66

On crest looking at right (west) abutment.

67

On crest looking west at abutment on upstream side.

68

On crest looking east toward left abutment and emergency spillway.

	AMERICAN ELECTRIC POWER **CARDINAL POWER PLANT** **FLY ASH DAM NO. 2** **BRILLIANT, OH**
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69

Close-up at weathered roller compacted concrete (RCC) surface and sealed crack on crest at upstream face.
Note vegetation below crest level.

70

Open observation borehole and deformation monument on crest (typical).

71

Looking north from crest across the reservoir at Fly Ash Dam No. 1.

72

Example of weathering and erosion in RCC material.

73

Inclined spillway from crest.

74

Inclined spillway looking at upstream face. Note diagonal construction deformation joint. Joint was formed to allow for some deformation due to crack in RCC during construction.

75

Close-up of crack gauges on inclined spillway diagonal joint.

76

Upstream slope looking east from spillway.

77

Upstream slope looking west from spillway.

78

Surface expression of sealed crack at crest in RCC that initiated the diagonal joint in the inclined spillway.

79

Emergency spillway, looking south from crest. Note that this spillway is excavated through hillside.

80

Close-up view of emergency spillway showing RCC steps for energy dissipation, vegetation, and weathering.

81

Downstream slope on RCC portion looking toward emergency spillway and left (east) abutment. Bedrock is exposed in far slope.

82

Looking north at dam crest and emergency spillway from downstream channel.

83

Left (east) concrete training wall at emergency spillway outfall channel. Note exposed bedrock.

84

Overall downstream slope showing lower benches looking west from crest adjacent to spillway.

85

Left (east) rock groin at abutment contact. Note moderate to heavy vegetation.

86

Closer view of rock groin at east abutment where spillway outlet transitions to welded steel pipe.

87

Active seepage outlet in left (east) rock groin. Water flowed clear.

88

Active outlet from 12” pipe into west abutment rock groin from trench drain in natural hillside. Appears to supply most of the water flowing in the groin below about elevation 900.

89

Active drain exiting from natural hillside feeding into right (west) groin. Note brush vegetation.

90

Water in right (west) groin adjacent to lower benches flowing toward toe drain.

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91

Looking upslope at left (east) rock groin and 42” diameter spillway outlet from toe drain.

92

Looking west at rock toe and seepage pool in background. Note rip rap placement and vegetation.

93

View of active toe drain discharge, seepage collection pool, and concrete baffles.

94

Closer view of seepage discharge.

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95

Concrete V-notch weir downstream of seepage collection pool.

96

Steel V-Notch weir (typical) noted downstream of concrete weir shown in Photo #93.

97

Ineffective steel V-notch weir where water flows along seepage path around weir.

98

V-notch weir at original (Pre RCC) toe drain.

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CARDINAL POWER PLANT
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99

Downstream slope looking east on lower bench.

100

Erosion feature on downstream slope next to west groin at upper bench.

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101

Downstream slope looking west at crest of upper bench.

102

Sporadic loss of grass cover on upper bench adjacent to left (east) abutment.

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103

Isolated loss of grass cover and possible erosion on upper portion of downstream slope above slope groin.

104

Looking east at slope drainage groin. Vegetation obscures rip rap.

105

Another view of slope groin and general slope grass cover, looking downstream.

106

Area of small seep in left (east) abutment groin at approximate intersection with slope groin.

107

Spillway outfall and energy dissipation structure.

108

Downstream outfall creek channel.

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3.0 DATA EVALUATION

3.1 Design Assumptions

CHA has reviewed the design assumptions related to the design and analysis of the stability and hydraulic adequacy of the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond) and Fly Ash Dam No. 2 available at the time of our site visits and provided to us by AEP. The design assumptions are listed in the following sections.

3.2 Hydrologic and Hydraulic Design

3.2.1 Hydrologic and Hydraulic Design – Bottom Ash Pond Recirculation Pond

The Bottom Ash Complex dikes appear as if they would be classified as Class II dams based on the Ohio Revised Code Chapter 1521 and Administrative Rules Chapter 1501:21 as indicated in the Division of Soil and Water Resources Permit No. 87-159 dated February 19, 1987. This is based on the fact that a sudden breach or failure could release health hazardous industrial waste and impact the Ohio River. As a Class II structure, the dikes are required to safely pass or store the inflow from 50% of the Probable Maximum Flood (PMF). This Chapter also requires a minimum freeboard of 5 feet above maximum operating pool unless otherwise approved by the chief (herein assumed to be the chief dam engineer for the State of Ohio).

The present operating pool elevation is about 665 for the Bottom Ash Pond and 662 to 663 for the Recirculation Pond, with a maximum elevation presently set by the Recirculation Pond outlet at 666. At elevation 665 the Bottom Ash Pond meets the minimum freeboard requirements the design crest elevation at 670. If the Recirculation Pond outlet is utilized at its fixed elevation of 666, the minimum operational freeboard requirement would not be met and would technically require the state dam engineer to grant an exception or lower the dike classification. CHA was not provided documentation concerning such an exception.

AEP was not able to provide CHA with a hydraulic analysis showing the Bottom Ash Complex‘s ability to safely pass the 50% PMF event. However, preliminary analyses performed by CHA suggest there is enough storage capacity at the current operating pool to safely withstand this rainfall event. We recommend AEP perform a complete study to confirm this, and update the study if operating levels of the pond change in the future or the dike system is reclassified.

3.2.2 Hydrologic and Hydraulic Design – Fly Ash Dam No. 2

Fly Ash Dam No. 2 is classified by the Ohio Department of Natural Resources (ODNR) as a Class I dam based on the Ohio Revised Code Chapter 1521 and Administrative Rules Chapter 1501:21 as indicated in the Division of Water Permit No. 87-159 dated February 19, 1987. This classification requires the dam to safely pass or store the inflow from the Probable Maximum Flood (PMF). This classification and design flood is still applicable based upon our review of Chapter 1501:21 as published at http://codes.ohio.gov/oac. This Chapter also requires a minimum freeboard of 5 feet above maximum operating pool.

The dam, as raised in 1998, included the following design assumptions:

Table 2 - Design Assumptions

Condition	Based on 6-hr PMP
Maximum Operating Pool	960
Dam Crest	970
PMP Max Pool	968.1

At the time of the CHA site visit, the operating pool was at approximately elevation 947, 13 feet below the proposed maximum pool elevation and 23 feet below the crest elevation.

The hydrologic and hydraulic evaluations were prepared by AEP engineers and the resulting analyses were reviewed by OH DNR engineers. According to the design report AEP provided, included in these analyses is the design assumption of a fully reclaimed condition of the Fly Ash Reservoir No.1 basin, which is a gently sloping grass covered field. Recent aerial photography shows the construction of the gypsum landfill over the old Fly Ash No.1 Reservoir, which was anticipated in the design. Other development within the drainage basin that could significantly change inflow characteristics used during the design is not indicated. Based on the design report CHA reviewed and the recent aerial photography, it appears that the dam and basin will appropriately handle the design storm event.

3.3 Structural Adequacy & Stability

The Ohio Department of Natural Resources, Division of Soil and Water Resources, Dam Safety Program recognizes "design procedures that have been established by the United States Army Corps of Engineers, the United States Department of Interior, Interior Bureau of Reclamation, the Federal Energy Regulatory Commission, The United States Natural Resources Conservation Service, and others that are generally accepted as sound engineering practice, will be acceptable to the Chief."

In performing an evaluation of the structural adequacy and stability of the Bottom Ash Complex and Fly Ash No. 2 Dam, CHA has compared the computed factor of safety provided in the BBCM Engineering, Inc. report dated August 4, 2009 with minimum required factors of safety as outlined by the U.S. Army Corps of Engineers in EM 1110-2-1902, Table 3-1. The guidance values for minimum factor of safety are provided in Table 3.

Table 3 - Minimum Safety Factors Required

Load Case	Required Minimum Factor of Safety
Steady State Conditions at Present Pool or Maximum Storage Pool Elevation	1.5
Rapid Draw-Down Conditions from Present Pool Elevation	1.3
Maximum Surcharge Pool (Flood) Condition	1.4
Seismic Conditions from Present Pool Elevation	1.0
Liquefaction	1.3

In Sections 3.3.1 and 3.3.2 we discuss our review of the effects of stability analyses and performance of the Bottom Ash Complex (Bottom Ash Pond and Recirculation Pond) and Fly Ash Dam No. 2, respectively.

3.3.1 Bottom Ash Complex

AEP developed a scope of work to perform a geotechnical assessment to provide an indication as to the level of safety provided by the embankment dikes creating the Bottom Ash Complex. A Bottom Ash Pond Investigation Report was prepared by BBCM Engineering, Inc. in August 4, 2009. The scope of work consisted of the following;

- Advancement of a total of seven borings;
- Installation of three monitoring wells;
- Laboratory testing on the recovered samples; and
- Engineering analyses of the existing embankments at the investigated sections with consideration to seepage, steady state slope stability and seismic slope stability.

Static steady state and seismic slope stability analyses were performed on the downstream (outboard) embankment slopes for two cross sections modeling four strata in the foundation soils below the dike structures and two material types for the dike fill. The two different soil types for the dike fill represent the more clayey material encountered at the depths where the original embankment was encountered and the more granular material used to establish the present geometry. According to BBCM's report, the permeability and shear strength parameters used to represent the dike fill material and foundation soils were based on the totality of test data available across the entire site, due to insufficient evidence to justify analyzing specific cross sections at every change encountered in the field and noted in the bore logs.

The shear strength and unit weight values used for the slope stability analyses were reportedly based on a combination of the laboratory index test results, triaxial shear test results, published values and correlations, and judgment and were intended to be representative of long term conditions (drained). To estimate the effective friction angle of the cohesive embankment fill and alluvium layers several correlation methods were examined and laboratory shear strength tests were performed on the embankment fill as well. The properties of the four strata model in the analyses are provided in Table 4 with the seismic analysis design values noted in brackets.

Table 4 - Soil Strength Parameters Used in BBCM August 2009 Investigation Report

Soil Stratum	Unit Weight (pcf)	Friction Angle (φ)	Cohesion (psf)	Description
Newer Embankment Fill	125	31° [31°]	0 [0]	Embankment
Original Embankment Fill	125	30° [22°]	100 [50]	Embankment
Alluvium Silt and Clay	125	30° [30°]	0 [0]	Natural Foundation Subgrade
Organic Clayey Silt	125	30° [24°]	0 [180]	Natural Foundation Subgrade
Very Loose to Loose Glacial Sand and Gravel Outwash	115	29° [29°]	0 [0]	Natural Foundation Subgrade
Medium Dense Sand and Gravel Outwash	120	34° [34°]	0 [0]	Natural Foundation Subgrade

At the time of the topographical survey on March 27, 2009 performed as part of the BBCM investigation, the pool levels in the Bottom Ash Complex were at EL 664.4 feet for the Bottom Ash Pond and EL 663.1 in the Recirculation Pond. The resulting freeboard ranged from 4.3 to 5.1 feet in the Bottom Ash Pond and 5.6 to 5.8 feet in the Recirculation Pond. These conditions were similar to those CHA observed during the September 2009 site visit.

The location of the groundwater table within the embankments was estimated based on groundwater readings taken within the observation wells and conditions encountered during drilling. Results from the seepage analysis performed as part of BBCM's investigation provided pore pressure values within the model to be used in the stability analysis.

Seismic analyses were performed using a pseudo static analysis with a horizontal seismic coefficient of 0.06g This coefficient was determined from the 2008 USGS National Seismic Hazard Maps for the Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years.

Table 5 provides a summary of the calculated factors of safety for the loading conditions outlined by the U.S. Army Corps of Engineers in EM 1110-2-1902, Table 3-1.

Table 5 – Summary of Safety Factors

Load Case	**Required Minimum Factor of Safety**	**Calculated Minimum Factor of Safety**	
		Section B	Section D
Steady State Conditions at Present Pool Elevation (Downstream Slope) (See Figure 9A – Section D)	1.5	1.57	1.52
Rapid Draw-Down Conditions from Present Pool Elevation	1.3	Not Performed as Part of the BBCM Evaluation	
Maximum Surcharge Pool (Flood) Condition	1.4	Not Performed as Part of the BBCM Evaluation	
Seismic Conditions at Present Pool Elevation (Downstream Slope) (See Figure 9B – Section D)	1.0	1.4	1.2
Liquefaction	1.3	Not Performed as Part of the BBCM Evaluation	

Review of the Slide™ outputs and corresponding factors of safety for the various loading conditions, boring logs, laboratory test data and parameter justifications provided in the appendices of the August 2009 investigation report indicate the following;

- The factor of safety for the upstream (inboard) embankment slope of the pond was not evaluated as part of the August 2009 investigation.
- A model was not developed for the maximum surcharge pool (flood) condition as part of the August 2009 investigation.

- The rapid-draw down load case was not evaluated as part of the August 2009 investigation.

- A liquefaction analysis was not performed as part of the August 2009 investigation.

Section 4.10 outlines our recommendations for tasks that should be performed to confirm that the embankments are stable under the loading conditions discussed above.

3.3.2 Fly Ash Dam No. 1

Fly Ash Dam No.1 is decommissioned and is permitted as an active solid waste landfill. CHA was required, however, to observe the structure during the site evaluation of the facility. To this end, CHA requested permit information and the results of the stability analysis for the landfill which includes the dam as a foundation element. A review of this information indicates a static factor of safety equal to 1.576 and a seismic factor of safety equal to 1.029, meeting typical design standards for landfill slope stability.

3.3.3 Fly Ash Dam No. 2

Soil borings, laboratory testing, and available instrumentation data on the original portion of the dam were utilized to prepare the design the RCC raising in 1998. AEP used these data in combination with data collected during the design of the original dam to evaluate the stability of the raised dam. Table 6 summarizes the soil parameters that were used in the evaluation of the raised dam. CHA limited review to the "Steady State" data for this evaluation in light of the fact that the pond has been maintained well above the previous operating level for 10 years.

Table 6 - Soil Strength Parameters Used in the 1998 Dam Raising Evaluation

Material	C (psf)	ϕ (degrees)
Fill Materials		
RCC Zone	14,400	0
Fly Ash	0	0
Upstream Shell	0	30
Clay Core	0	28
Saturated Clay Core	0	28
Transition Zone	0	30
Downstream Shell	0	30
Chimney and Blanket Drain	0	38
Foundation Materials		
Overburden	1700	0
Claystone	1100	22.5
Shale	1100	15

The stability analyses were performed for the maximum storage pool at elevation 960 and the maximum surcharge pool at elevation 968. The current pool elevation is about 13 feet below the design maximum. CHA reviewed piezometer data (Figure 10) provided by AEP and compared the phreatic surface in the dam to the pool level, downstream profile, and approximate design elevation of the chimney and blanket drain and concluded that the drain is working as intended, pulling the phreatic surface down to the design levels.

Table 7 summarizes the minimum factors of safety computed by AEP's design consultant.

Table 7 – Summary of Safety Factors – Fly Ash Dam No.2

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Conditions at Maximum Pool Downstream Slope ▪ Along Face (Shallow Analysis) ▪ Deep Wedge Analysis	1.5	 1.45 1.62
Steady State Conditions at Maximum Pool Upstream Slope	1.5	Not Performed
Rapid Draw-Down Conditions from Present Pool Elevation	1.3	Not Performed
Maximum Surcharge Pool (Flood) Condition (El. 731 feet) ▪ Along Face (Shallow Analysis) ▪ Deep Failure Surface	1.4	 1.45 1.60
Seismic Conditions from Maximum Pool Elevation Downstream Slope ▪ Along Face (Shallow Analysis) ▪ Deep Failure Surface	1.0	 0.99 1.12
Seismic Conditions from Maximum Pool Elevation Upstream Slope	1.0	Not performed
Liquefaction	1.3	Not Performed

During the initial downstream shell construction stages of the RCC raising, slope instability developed in some of the newly placed material, resulting in a slide repair involving the buttressing fill and benches of the present embankment. Table 8 summarizes the soil parameters that were used in the evaluation of the raised dam with the buttressing slag fill.

Table 8 - Soil Strength Parameters - 1998 Dam Raising Repair Buttress Evaluation

Material	C (psf)	ϕ (degrees)
Fill Materials		
RCC Zone	14,400	0
Fly Ash	0	0
Saturated Upstream Shell	0	30
Clay Core	0	28
Saturated Clay Core	0	28
Transition Zone	0	30
Saturated Transition Zone	0	30
Downstream Shell	0	30
Proposed Buttress (Slag)	0	38
Chimney and Blanket Drain	0	38
Foundation Materials		
Overburden	1000	15
Brown Clay	0	*
Claystone	1100	22.5
Shale	1100	15
* Residual shear strength 18 to 22 degrees – Correlation of ϕ w/ PI		

Table 9 summarizes the minimum factors of safety computed by AEP for the buttress repair.

Table 9 – Summary of Safety Factors – Fly Ash Dam No. 2 Repair Buttress

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Conditions Downstream Slope ▪ Specified Failure Surface ▪ Circular Search	1.5	2.73 1.57
Steady State Conditions at Maximum Pool Upstream Slope	1.5	Not Performed
Rapid Draw-Down Conditions from Present Pool Elevation	1.3	Not Performed
Maximum Surcharge Pool (Flood) Condition	1.4	Not Performed
Seismic Conditions from Maximum Pool Elevation Downstream Slope	1.0	Not Performed
Seismic Conditions from Maximum Pool Elevation Upstream Slope	1.0	Not performed
Liquefaction	1.3	Not Performed

AEP did not provide documentation showing that a stability analysis was performed for all of the typical load cases on the Fly Ash Dam No. 2 slope repair configuration. At a minimum the analysis should include the following:

- Verifying that the present steady state factor of safety for the downstream slope was calculated at the maximum storage pool elevation and determining the factor of safety under of the upstream slope for this load case.

- Determining steady state factors of safety on the upstream and downstream slopes at the maximum flood elevation.

- Determining seismic factors of safety on the upstream and downstream slopes at the maximum storage pool.

In addition to the aforementioned analyses, a rapid draw-down analysis should be considered for the upstream face. While CHA understands that rapid drawdown via pumping or other discharge methods may be undesirable for a waste disposal impoundment, CHA suggests that in the event of an emergency at the facility such as unexpected rapid seepage or increased piezometeric levels in the embankment and foundation, rapid drawdown may be more desirable to reduce hydrostatic pressures on the dam, thereby preventing a more catastrophic collapse. There have also been documented case histories where other types of failure (such as a deep stoplog failure above the sluiced ash level) have resulted in rapid drawdown conditions developing which have led to a domino effect and made the situation worse. For these reasons, CHA recommends that a rapid drawdown analysis be performed to develop an understanding of embankment behavior in this scenario.

No liquefaction analysis was performed. Based upon the foundation conditions at this site comprising shale and claystone bedrock, clay overburden, and the original constructed embankment CHA concurs that liquefaction potential is low at the site and a liquefaction analysis is not needed.

The Fly Ash No. 2 Dam is also instrumented with 67 deformation monitoring points and 5 slope inclinometers long with crack gages on the inclined spillway. Data is collected from these instrument points twice a year. CHA reviewed the latest settlement data monitoring summary provided by AEP which included data through November 2008 and a draft report of BBC&M's 2009 site inspection which included a summary of the available slope inclinometer data.

Settlement monitoring points along the crest and downstream slope have shown settlements ranging between from approximately 2.5 to 6 inches since the RCC crest was completed in 1999 (Figure 11). Slope inclinometer data indicates smaller cumulative lateral deformations on the order of 0.5 to 0.8 inches or less over the same time period. These measurements are consistent with the design stability of the dam. AEP should continue to be vigilant in monitoring the instrumentation at this facility as a way of evaluating the performance of the dam.

3.4 Operations & Maintenance

AEP Cardinal Power Plant staff makes quarterly inspections of the Bottom Ash Complex and Fly Ash Dam No. 2. On an annual basis, AEP engineers from the Columbus, Ohio office perform inspections of these facilities and Ohio DNR Dam Safety personnel perform an inspection every 5 years. Piezometer and V-notch weir readings are taken during the quarterly inspections, and the settlement monuments and slope inclinometers at Fly Ash Dam No.2.are surveyed twice a year by AEP's Civil Laboratory Section.

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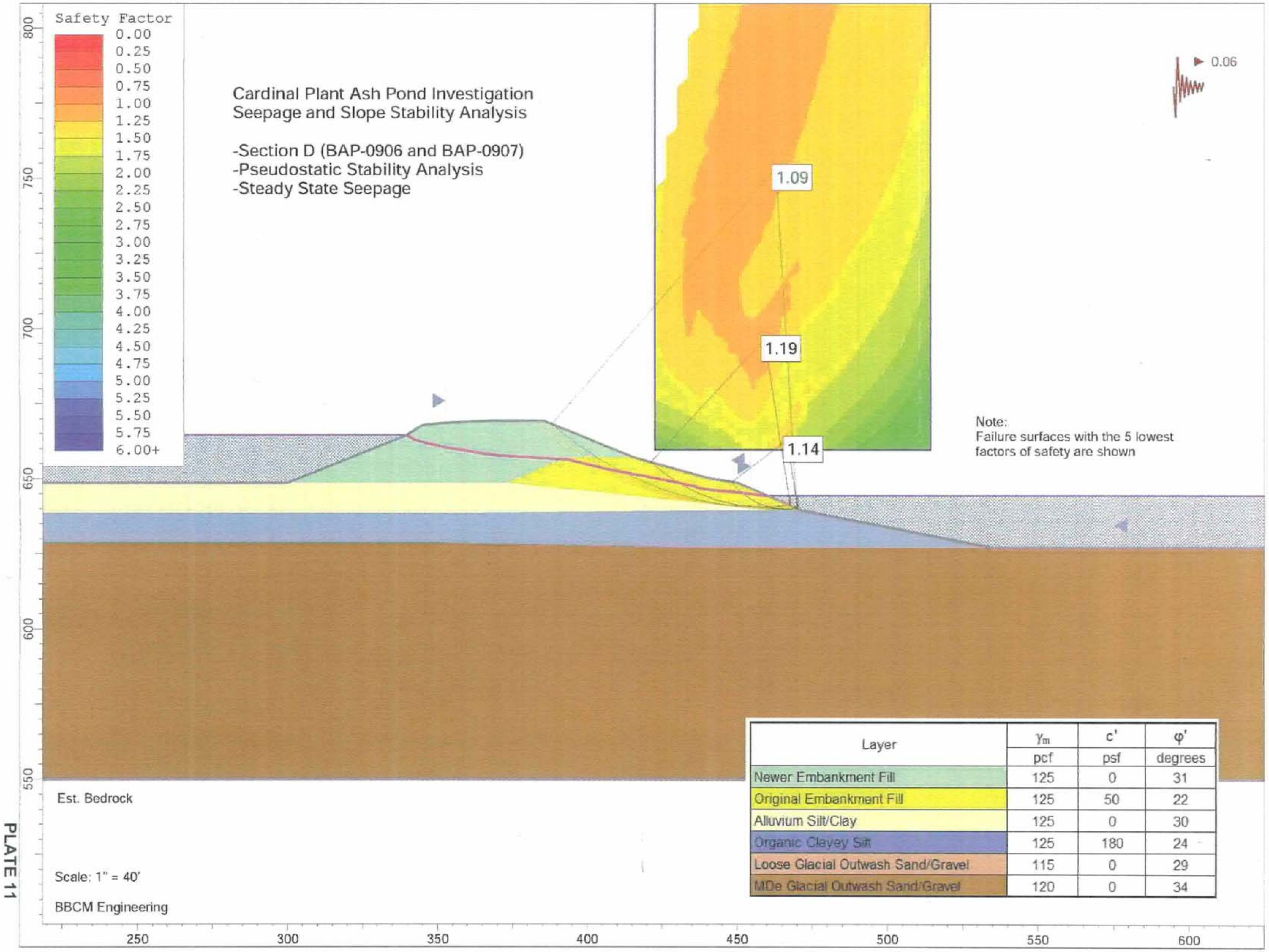


Cardinal Plant Ash Pond Investigation
Seepage and Slope Stability Analysis

-Section D (BAP-0906 and BAP-0907)
-Pseudostatic Stability Analysis
-Steady State Seepage

Note:
Failure surfaces with the 5 lowest factors of safety are shown

Layer	γ_m	c'	φ'
	pcf	psf	degrees
Newer Embankment Fill	125	0	31
Original Embankment Fill	125	50	22
Alluvium Silt/Clay	125	0	30
Organic Clayey Silt	125	180	24
Loose Glacial Outwash Sand/Gravel	115	0	29
MDe Glacial Outwash Sand/Gravel	120	0	34

Scale: 1" = 40'

BBCM Engineering

PLATE 11

AEPCDP-000568

IMAGE REFERENCE: BBC&M, INC.: CARDINAL GENERATING PLANT
BOTTOM ASH POND INVESTIGATION REPORT, AUGUST 2009

Drawing Copyright © 2007 CHA

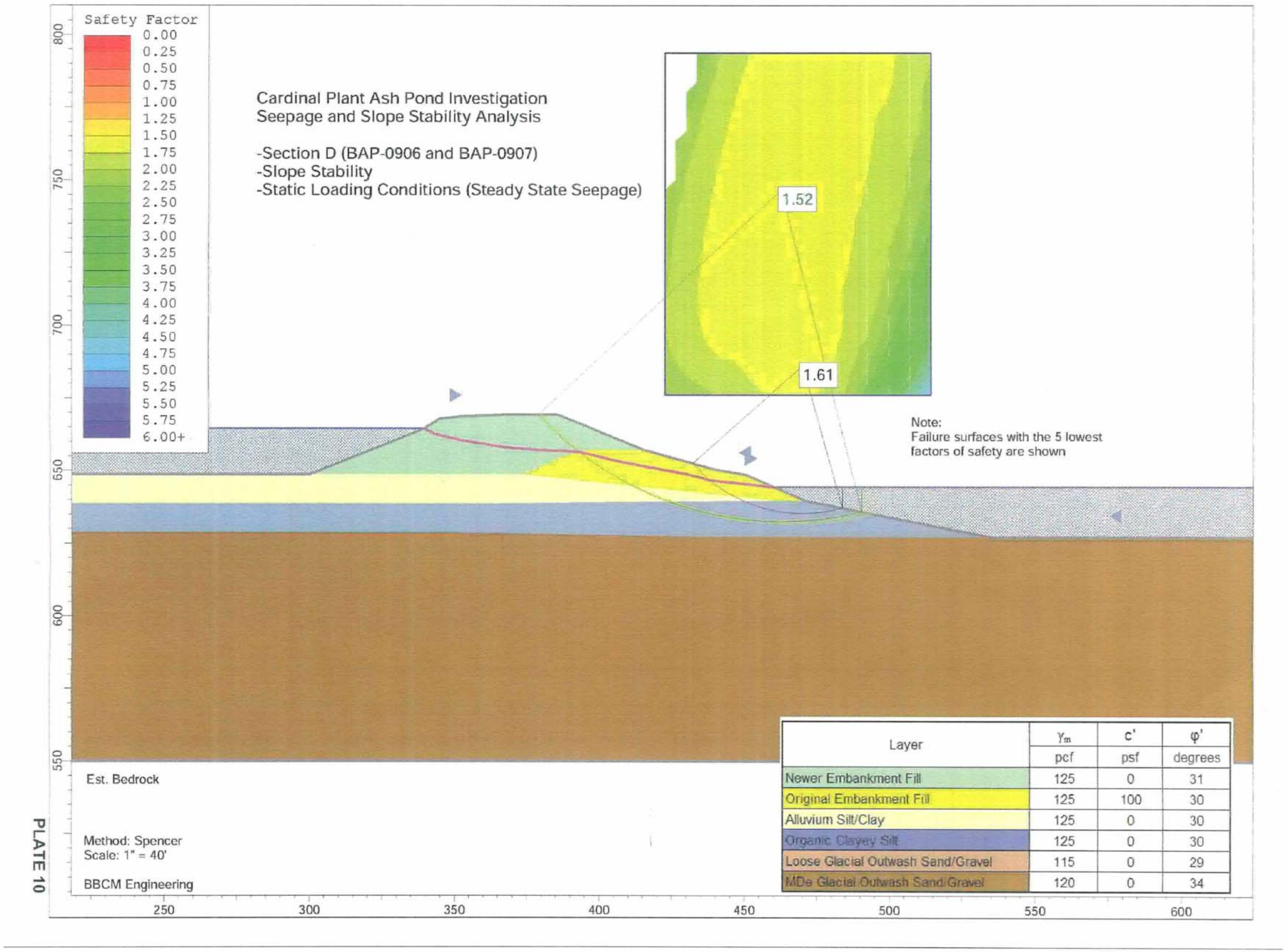
CHA

STABILITY ANALYSIS
BOTTOM ASH COMPLEX
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 9A



Layer	γ_m	c'	φ'
	pcf	psf	degrees
Newer Embankment Fill	125	0	31
Original Embankment Fill	125	100	30
Alluvium Silt/Clay	125	0	30
Organic Clayey Silt	125	0	30
Loose Glacial Outwash Sand/Gravel	115	0	29
MDe Glacial Outwash Sand/Gravel	120	0	34

IMAGE REFERENCE: BBC&M, INC.: CARDINAL GENERATING PLANT
BOTTOM ASH POND INVESTIGATION REPORT, AUGUST 2009

STABILITY ANALYSIS
BOTTOM ASH COMPLEX
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 9B

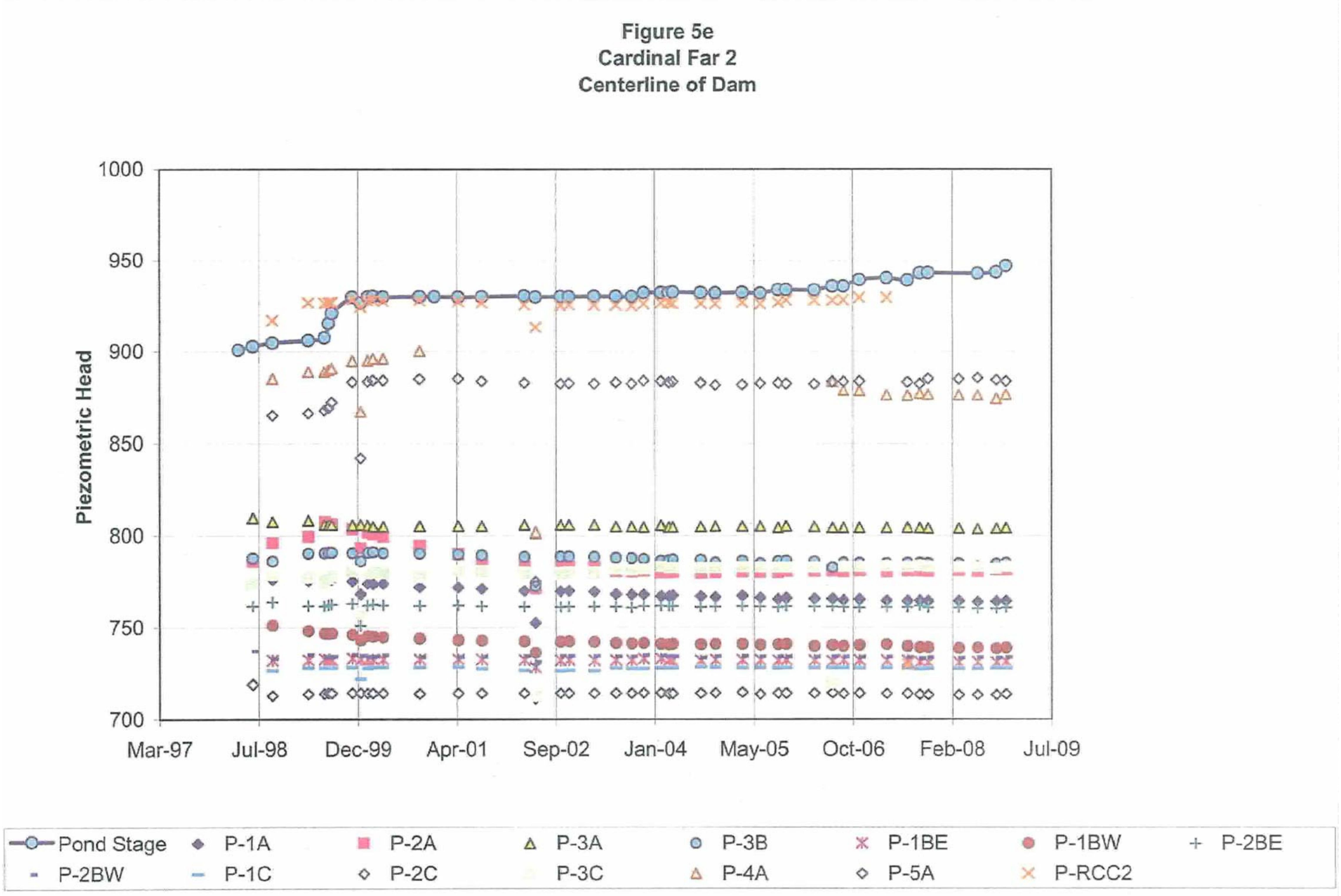


IMAGE REFERENCE: AMERICAN ELECTRIC POWER: 2008 INSPECTION REPORT FLY ASH DAMS I, II, AND BOTTOM ASH COMPLEX

CHA

EXAMPLE OF PIEZOMETER DATA
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 10

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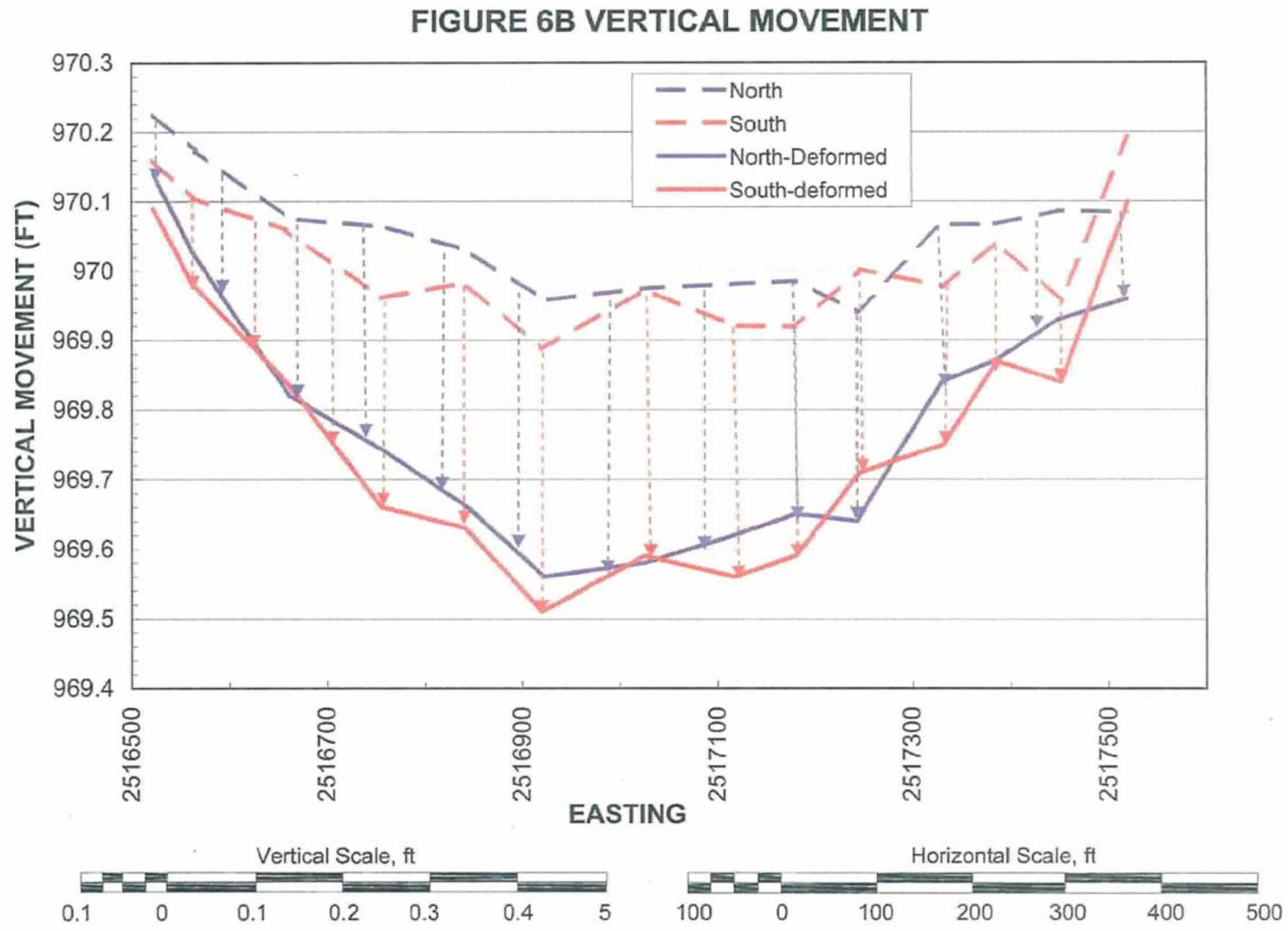


IMAGE REFERENCE: AMERICAN ELECTRIC POWER: 2008 INSPECTION REPORT FLY ASH DAMS I, II, AND BOTTOM ASH COMPLEX

CUMULATIVE SETTLEMENT
CARDINAL STEAM PLANT
BRILLIANT, OHIO

PROJECT NO.
20085.1080

DATE: SEPT 2009

FIGURE 11

4.0 CONCLUSIONS/RECOMMENDATIONS

4.1 Acknowledgement of Management Unit Condition

I acknowledge that the Bottom Ash Pond and Recirculation Pond management units referenced herein was personally inspected by me and was found to be in the following condition: **Fair.** This indicates acceptable performance is expected under required loading conditions in accordance with applicable safety regulatory criteria, however some additional analyses should be performed and documented to verify that these criteria are met.

I acknowledge that the management units (Fly Ash Dam No. 1 and Fly Ash Dam No. 2) referenced herein was personally inspected by me and was found to be in the following condition: **Satisfactory**, with the caveat that additional analyses as outlined in the following sections of this report be performed and included as part of the available documentation for the Fly Ash Dam No. 2 unit. A Satisfactory rating indicates that no existing or potential management unit safety deficiencies are recognized and acceptable performance under required loading conditions in accordance with applicable safety criteria is expected. Minor maintenance items may be required.

Evidence was observed indicating that AEP attempts and maintains proactive maintenance and monitoring program at these facilities. These efforts should be continued.

CHA presents recommendations for maintenance and further studies where applicable to bring these facilities into Satisfactory or maintain their Satisfactory rating in the following sections.

4.2 Maintaining and Controlling Vegetation Growth

The grass cover on Fly Ash Dam No. 2 appeared to be reasonably maintained with only isolated areas of mild cover loss. This practice should continue. Vegetation did, however, become more evident in the rock lined abutment groins and downstream slope ditch line where mowing is not possible. In these areas, herbicide (in accordance with applicable laws/rules) is recommended to control weed growth. Woody plants may require hand removal.

A grass cover on the Bottom Ash Pond and Recirculation Pond dikes will likely be difficult to establish and maintain, due to the granular surface, operations traffic, and routine grading operations. An exception is the east dike facing the Ohio River where vegetation has been able to grow. In this area the plant growth should be cut and reseeded as required. The heavier brush and woody vegetation at the northern extent of the east dike should be cut down and appropriately seeded with grass.

CHA recommends that vegetation be cut prior to each quarterly inspection performed by AEP representatives so that adequate visual inspections can be made.

4.3 Bottom Ash Pond and Recirculation Pond – General Crest Areas and Slopes

These areas typically had intermittent erosion rills, likely exacerbated when grading activities pushed loose material to the crest edge and sheet flow became concentrated during rain events. These erosion rills should be filled in with compacted material and otherwise stabilized. When grading activities push material to the crest edge, a concerted attempt should be made to compact these areas prior to the next rain event.

4.4 Recirculation Pond Outlet Area

Fairly large, deep erosion gullies were observed on the inside slope of the Recirculation Pond adjacent to the outlet approximately where the incised portion of the pond transitions to the east dike. At the time of the site visit, the pool elevation was such that the water was not going into the gullies. This will likely change as the pool elevation rises to its maximum pool. CHA recommends that these gullies be filled in and stabilized. This area should also be graded to direct run off away from this area.

4.5 Bottom Ash Pond – Primary Spillway/Decanting Tower

Vegetation had started to establish itself in the skimmer for this unit. Although it has not become a problem presently, removal is recommended to maintain this area before the vegetation fouls the tower outfall or prevents the skimmer from working effectively.

4.6 Bottom Ash Pond and Recirculation Pond – East Dike

Normal pool of the Ohio River is at about elevation 644 as shown on the design drawings. These drawings also indicate a 100 year flood level at about elevation 664 suggesting that routine high water levels are likely to submerge the downstream toe. During the site visit, slope protection such as rip rap was not observed in this area. CHA recommends an analysis of the flood level water velocities in the area of the downstream slope to determine if rip rap or some similar slope protection is warranted. AEP has indicated that a similar analysis has been performed on another of their facilities along that portion of the Ohio River which suggests the water velocities against the earth structures during flood conditions do not achieve levels at which soil erosion is problematic. In light of this information and CHA field observations, it is not likely that slope protection is necessary, and a site specific analysis, though preferable, should not be considered a critical item at this time.

4.7 Fly Ash Dam No. 2 – Erosion

An erosion rill and subsequent loss of grass cover was observed on the downstream slope between the upper bench and west groin. Thinning and loss of grass cover due to sheet flow was noted in other isolated areas on the downstream slope as well. CHA recommends filling the rill and reseeding the areas.

4.8 Fly Ash Dam No. 2 – Steel Weir Repair

One of the steel V-notch weirs had become undermined so that water does not flow through the notch where it can be measured. CHA recommends replacing the weir or removing it.

4.9 Bottom Ash Pond and Recirculation Pond Hydraulic Analysis

AEP was not able to provide CHA with a hydraulic analysis showing the Bottom Ash Complex's ability to safely pass the 50% PMF event. However, preliminary analyses performed by CHA suggest there is enough storage capacity at the current operating pool to safely withstand this rainfall event. We recommend AEP perform a complete study to confirm this, and update the study if operating levels of the pond change in the future.

4.10 Additional Stability Analyses – Bottom Ash Pond and Recirculation Pond

Based on our review of available information for the Bottom Ash Complex we recommend that the following tasks be performed to confirm that the embankments are indeed stable under the various loading conditions outlined in Section 3.3.

- CHA recommends that a stability analysis model be developed for the maximum surcharge pool (flood) condition.

- CHA recommends modeling the upstream slope stability for seismic and steady state seepage load cases.

- CHA recommends that the rapid draw-down load case be evaluated for the bottom ash complex for reasons explained in section 3.3

- We recommend that a liquefaction analysis be performed in light of some of the loose to very loose alluvial soils encountered during the subsurface investigation for the site.

4.11 Fly Ash Dam No. 2 Recommendations for Additional Stability Analyses

Based on our review of available information for Fly Ash Dam No. 2 we recommend that the following tasks be performed to confirm that the embankment with its present buttessed geometry installed during the 1998 construction repair is indeed stable under the various loading conditions outlined in Section 3.3.

- CHA recommends a maximum surcharge stability evaluation be performed for the steady state conditions on the upstream and downstream slopes.

- CHA recommends modeling the upstream and downstream slope stability for seismic and steady state seepage load cases from the maximum storage pool elevation.

- CHA recommends a rapid drawdown analysis be performed for the current conditions for reasons explained in Section 3.3.

5.0 CLOSING

The information presented in this report is based on visual field observations, review of reports by others and this limited knowledge of the history of the Cardinal Power Plant surface impoundments. The recommendations presented are based, in part, on project information available at the time of this report. No other warranty, expressed or implied is made. Should additional information or changes in field conditions occur, the conclusions and recommendations provided in this report should be re-evaluated by an experienced engineer.

APPENDIX A

Completed EPA Coal Combustion Dam Inspection Checklist Forms

&

Completed EPA Coal Combustion Waste (CCW) Impoundment Inspection Forms

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name: Cardinal Steam Plant

Date: September 1, 2009

Unit Name: Cardinal Bottom Ash Complex

Operator's Name: Ohio AEP/Buckeye Power

Unit I.D.: Bottom Ash Pond

Hazard Potential Classification: High [✓ Significant] Low

Inspector's Name: Rick Lowenstein/Malcolm D. Hargraves

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Quarterly		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	665		19. Major erosion or slope deterioration?	See	Note
3. Decant inlet elevation (operator records)?	665		20. Decant Pipes:	■	■
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	670		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?	D/N/A	
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):	■	■
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	D/N/A		From underdrain?	D/N.A	
9. Trees growing on embankment? (If so, indicate largest diameter below)	X		At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?	D/N/A	
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	X		From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?	Not	Seen	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue # Comments

Note that the Ohio DNR Div. of Water had not established the hazard rating prior to site visit. Rating based on

CHA site assessment. "D/N/A" = Does not apply, "N/A" = Not available.

1. Ohio AEP makes quarterly to annual inspections; piezometer measurements are recorded during inspections

9. Heavy brush, vegetation, small trees (3"- 4") and debris noted in northeast corner of dike; limited inspection submerged.

14., 15. The spillways/outlet servicing the bottom ash pond cannot be observed directly because they are

It appears to function as designed - there is no visible clogging effect.

18. Occasional erosional features are generally superficial and is due to grading activities with granular material.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # OH0012581 INSPECTOR Lowenstein/Hargraves
Date September 1, 2009

Impoundment Name Cardinal Bottom Ash Complex
Impoundment Company Ohio AEP/Buckeye Power Company
EPA Region 5
State Agency (Field Office) Addresss Ohio EPA Southeast District Office
2195 Front Street; Logan, Ohio 43138-8687
Name of Impoundment Cardinal Bottom Ash Pond
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New X Update ____

	Yes	No
Is impoundment currently under construction?		X
Is water or ccw currently being pumped into the impoundment?	X	

IMPOUNDMENT FUNCTION: Bottom Ash, Pyrite, Chemical Washdown Waste

Nearest Downstream Town : Name Beech Bottom, West Virginia
Distance from the impoundment 0.8 miles across Ohio River
Impoundment
Location:

Longitude	80	Degrees	39	Minutes	34.42	Seconds
Latitude	40	Degrees	14	Minutes	16.77	Seconds
State	Ohio	County	Jefferson			

Does a state agency regulate this impoundment? YES X NO ____

If So Which State Agency? ODNR-Division of Water

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

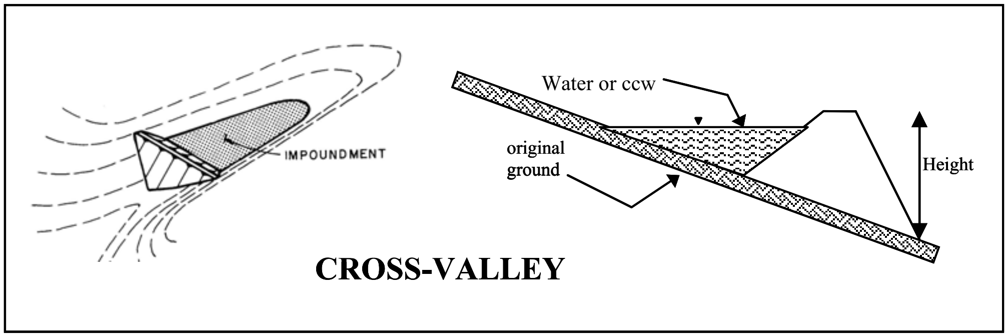
X_____ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

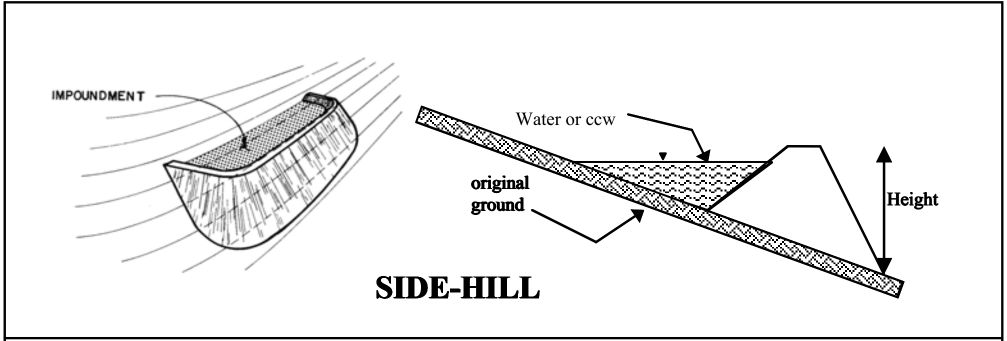
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

In the event of a failure under full pool at elevation 670, the waste would spill into the Ohio River with probable environmental impacts.

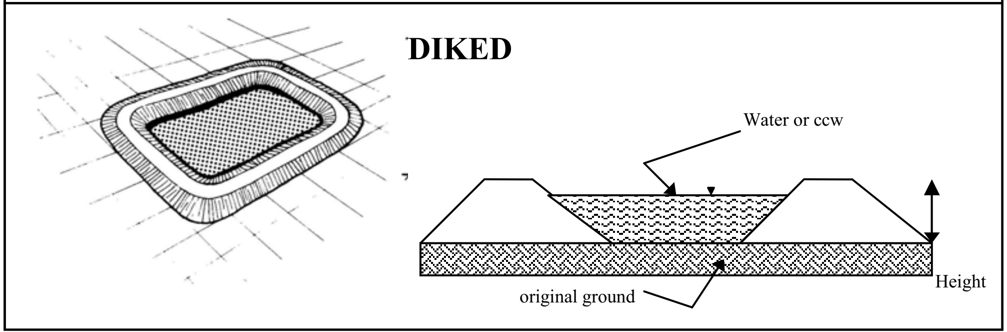
CONFIGURATION:



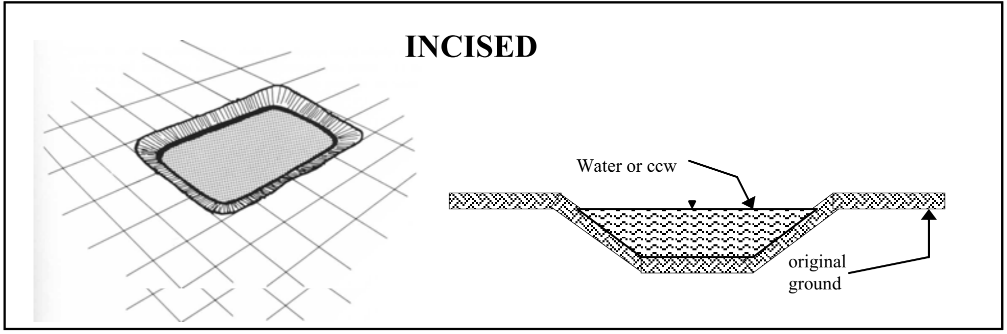
CROSS-VALLEY



SIDE-HILL



DIKED



INCISED

_____ Cross-Valley
_____ Side-Hill
X____ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

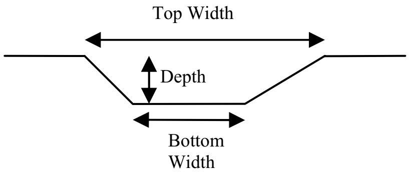
Embankment Height 20 feet Embankment Material Native Borrow
Pool Area 19 acres Liner None
Current Freeboard Approx. 5 feet Liner Permeability D/N/A

TYPE OF OUTLET (Mark all that apply)

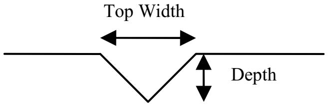
D/N/A **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

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

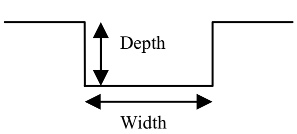
TRAPEZOIDAL



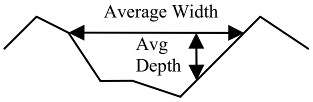
TRIANGULAR



RECTANGULAR

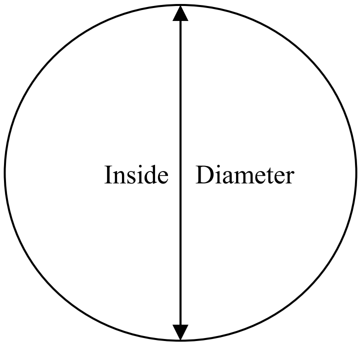


IRREGULAR



X **Outlet**

N/A inside diameter



Material
_____ corrugated metal
_____ welded steel
_____ concrete
_____ plastic (hdpe, pvc, etc.)
N/A other (specify) _____________________

Is water flowing through the outlet? YES X NO _______

_____ **No Outlet**

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

The Impoundment was Designed By Sargent and Lundy

Has there ever been a failure at this site? YES __________ NO X__________

If So When? D/N/A

If So Please Describe :

Has there ever been significant seepages at this site? YES _______ NO X_______

If So When? ___________________________

IF So Please Describe:

Isolated, apparently minor seeps had been noted along the downstream toe adjacent to the Ohio River during routine inspections done in the mid 1990's. A more accurate understanding (time and impact) can be obtained upon review of the quarterly and annual inspection reports CHA requested during the site visit.

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO X

If so, which method (e.g., piezometers, gw pumping,...)? Piezometers (see below)

If so Please Describe :

There have been monitoring wells/piezometers installed at different times (most recently in April) as a part of a proactive monitoring and maintenance program. Water level measurements have been and continue to be recorded periodically at these locations. In addition, AEP has initiated geotechnical investigation with an independent consultant to analyze the stability of the bottom ash complex impoundment. CHA understands that this report was nearing completion at the time of the site assessment.

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name: Cardinal Steam Plant

Date: September 1, 2009

Unit Name: Cardinal Bottom Ash Complex

Operator's Name: Ohio AEP/Buckeye Power

Unit I.D.: Recirculation Pond

Hazard Potential Classification: High [✓ Significant] Low

Inspector's Name: Rick Lowenstein/Malcolm D. Hargraves

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Quarterly		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	662		19. Major erosion or slope deterioration?	See	Note
3. Decant inlet elevation (operator records)?	N/A		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	D/N/A		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	670		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?	D/N/A	
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	D/N/A		From underdrain?	D/N/A	
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?	D/N/A	
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	D/N/A		From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?	Not	Seen	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue # Comments

Note that the Ohio DNR Div. of Water had not established the hazard rating prior to site visit. Rating based on

CHA site assessment. "D/N/A" = Does not apply "N/A" = Not available

1. AEP makes quarterly and annual inspections; monitoring wells measurements are recorded at that time.

14. Water surface of recirculation pond was more than 1 to 2 feet below spillway outlet elevation.

18. Occasional erosional features are generally superficial and is due to grading activities with granular material.

A vinyl sheet pile wall presently divides the recirculation pond into two parts to reduce water treatment volume.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # OH0012581 INSPECTOR Lowenstein/Hargraves
Date September 1, 2009

Impoundment Name Cardinal Bottom Ash Complex
Impoundment Company Ohio AEP/Buckeye Power Company
EPA Region 5
State Agency (Field Office) Addresss Ohio EPA Southeast District Office
2195 Front Street; Logan, Ohio 43138-8687
Name of Impoundment Cardinal Recirculation Pond
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New X Update

	Yes	No
Is impoundment currently under construction?		X
Is water or ccw currently being pumped into the impoundment?	X	

IMPOUNDMENT FUNCTION: Decanted water reservoir for fly ash sluicing

Nearest Downstream Town : Name Beech Bottom, West Virginia
Distance from the impoundment 0.8 miles across Ohio River

Impoundment Location:	Longitude 80	Degrees 39	Minutes 40.6	Seconds		
	Latitude 40	Degrees 14	Minutes 05.5	Seconds		
	State Ohio	County Jefferson				

Does a state agency regulate this impoundment? YES X NO

If So Which State Agency? ODNR-Division of Water

<u>HAZARD POTENTIAL</u> (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

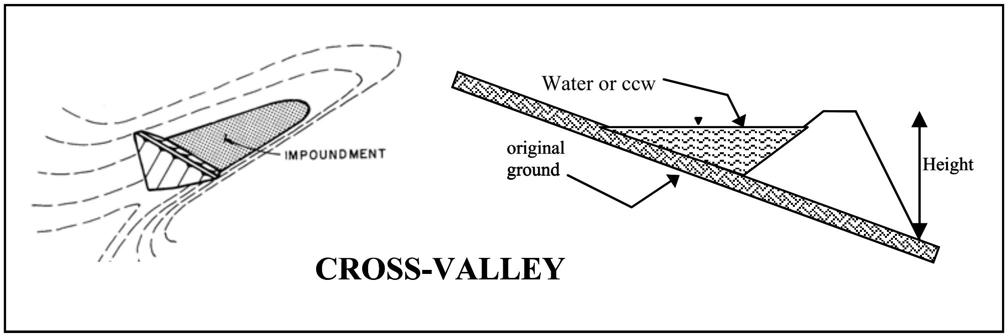
__X__ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

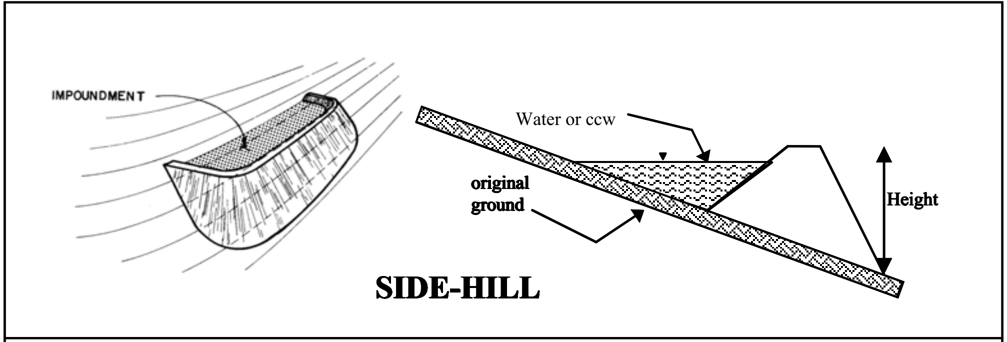
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

In the event of a failure under full pool at elevation 670, the waste would spill into the Ohio River with probable environmental impacts.

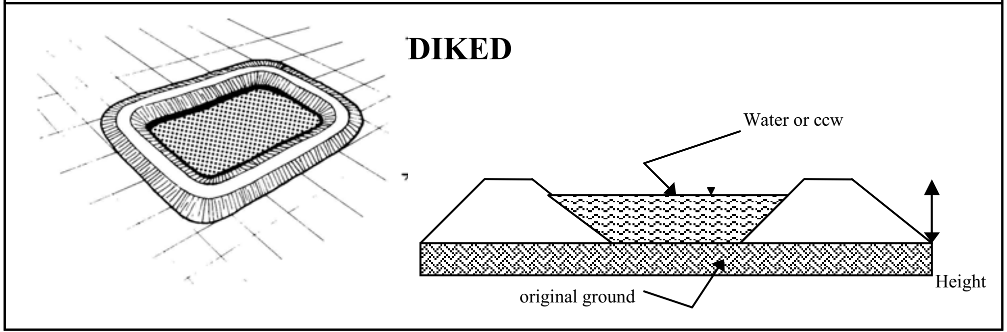
CONFIGURATION:



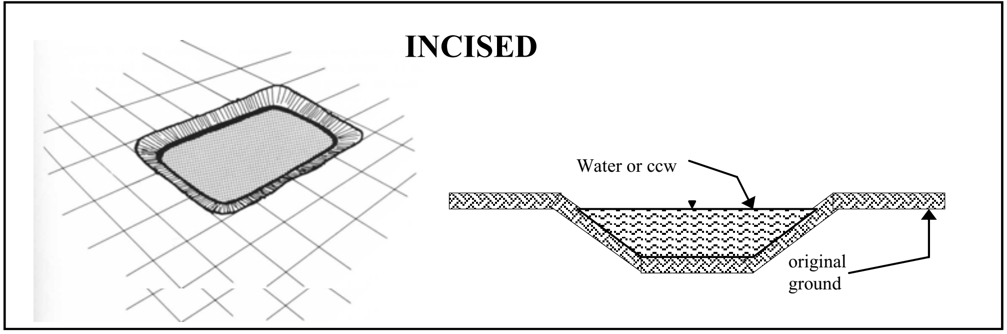
CROSS-VALLEY



SIDE-HILL



DIKED



INCISED

_____ Cross-Valley
_____ Side-Hill
__X__ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

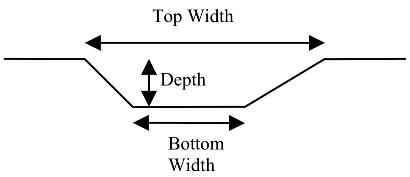
Embankment Height 20 feet Embankment Material Native Borrow
Pool Area 6.5 acres Liner None
Current Freeboard Approx. 8 feet Liner Permeability N/A

TYPE OF OUTLET (Mark all that apply)

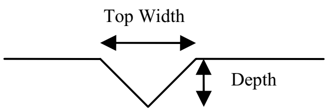
N/A **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

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

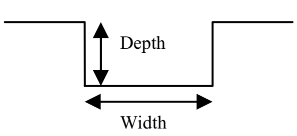
TRAPEZOIDAL



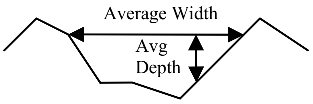
TRIANGULAR



RECTANGULAR

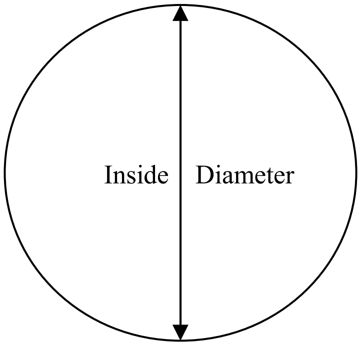


IRREGULAR



X **Outlet**

36 inside diameter



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

Is water flowing through the outlet? YES _______ NO X

_____ **No Outlet**

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

The Impoundment was Designed By Sargent and Lundy

Has there ever been a failure at this site? YES __________ NO X__________

If So When? N/A

If So Please Describe :

Has there ever been significant seepages at this site? YES X NO _______

If So When? Mid 1990's

IF So Please Describe:

A wet area along roughly 350 feet of the downstream slope adjacent to the Ohio River during routine inspections. This area was repaired with a rip rap armor to provide a downstream slope drainage blanket to stabilize any potential softening and sloughing that may have been imminent at the time. This rip rap armoring was visible during the site visit. No seepage was readily observable at that time. A more accurate understanding (time, impact, and repair details) should be available upon review of the quarterly and annual inspection reports CHA requested during the site visit.

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO X

If so, which method (e.g., piezometers, gw pumping,...)? Piezometers (see below)

If so Please Describe :

There have been monitoring wells/piezometers installed at different times (most recently in April) as a part of a proactive monitoring and maintenance program. Water level measurements have been and continue to be recorded periodically at these locations. In addition, AEP has initiated geotechnical investigation with an independent consultant to analyze the stability of the bottom ash complex impoundment. CHA understands that this report was nearing completion at the time of the site assessment.

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name: Cardinal Steam Plant

Date: September 1, 2009

Unit Name: Cardinal Fly Ash Dam No. 1

Operator's Name: Ohio AEP/Buckeye Power

Unit I.D.: FAR I

Hazard Potential Classification: High Significant [✓ Low]

Inspector's Name: Rick Loewenstein/Malcolm D. Hargraves

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Not inspect.		18. Sloughing or bulging on slopes?	See	Note
2. Pool elevation (operator records)?	991		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	D/N/A		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	998		Is water entering inlet, but not exiting outlet?	D/N/A	
5. Lowest dam crest elevation (operator records)?	1003		Is water exiting outlet, but not entering inlet?	D/N/A	
6. If instrumentation is present, are readings recorded (operator records)?	D/N/A		Is water exiting outlet flowing clear?	D/N/A	
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	D/N/A		From underdrain?	D/N/A	
9. Trees growing on embankment? (If so, indicate largest diameter below)	X		At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?	See	Note
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	D/N/A		From downstream foundation area?	D/A/A	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?	D/N/A		"Boils" beneath stream or ponded water?	D/N/A	
14. Clogged spillways, groin or diversion ditches?	X		Around the outside of the decant pipe?	D/N/A	
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?	D/N/A		23. Water against downstream toe?	X	
17. Cracks or scarps on slopes?	See	Note	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments

"D/N/A" = Does not apply. "N/A" = Not available.

1. Dam and impoundment have been decommissioned; AEP does not routinely inspecte as dam.

9., 14. Heavy vegetation and small (less than 4" to 6") trees and shrubs have grown on slope particularly in groin area along south abutment, where wood debris/tree falls and rock/boulder spoil limited inspection.

17.,18.,21. Vegetation and large rip rap/boulder debris limited observation, only gross deformation and high volume seepage would be readily apparent. Such features delineating a major failure were not observed.

22. Water against the downstream toe is the pond surface that Fly Ash Dam No. 2 impounds.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # OH0012581 INSPECTOR Loewenstein/Hargraves

Date September 1, 2009

Impoundment Name Cardinal Fly Ash Reservoir No. 1 (FAR I)

Impoundment Company Ohio AEP/Buckeye Power Company

EPA Region 5

State Agency (Field Office) Addresss Ohio EPA Southeast District Office
2195 Front Street; Logan, Ohio 43138-8687

Name of Impoundment Fly Ash Reservoir No. 1

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update X

	Yes	No
Is impoundment currently under construction?		X
Is water or ccw currently being pumped into the impoundment?		X

IMPOUNDMENT FUNCTION: Decommissioned impoundment; permitted as landfill foundation

Nearest Downstream Town : Name Salt Run, Ohio

Distance from the impoundment 0.9 miles

Impoundment Location:

Longitude 80 Degrees 39 Minutes 05.0 Seconds

Latitude 40 Degrees 16 Minutes 07.7 Seconds

State Ohio County Jefferson

Does a state agency regulate this impoundment? YES X NO ______

If So Which State Agency? ODNR-Division of Water

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

__X__ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

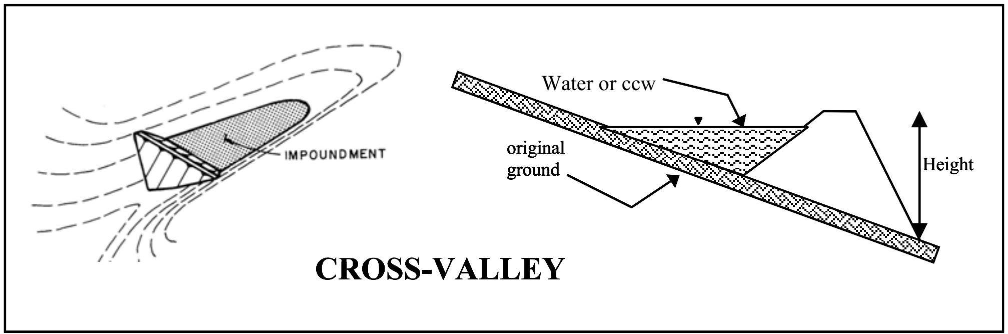
______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

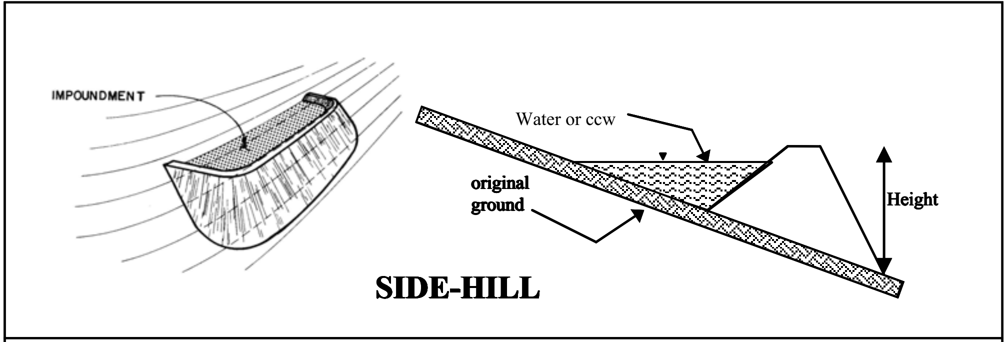
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

Due to its height (60 feet or greater), ODNR regulates the structure as Class I high hazard dam under their classification system. It should noted that the dam no longer impounds water/sluiced ash and has not had CCW discharged to it since 1991. The Ohio EPA has permitted the dry basin and dam structure to be used for the foundation of the landfill operations that have commenced in the upper reaches of the Fly Ash Reservoir No. 1 basin. The crest or dam serves as a haul road to the landfill. The conveyance piping for the sluiced flyash which is deposited in FAR II runs along the crest of the dam.

CONFIGURATION:

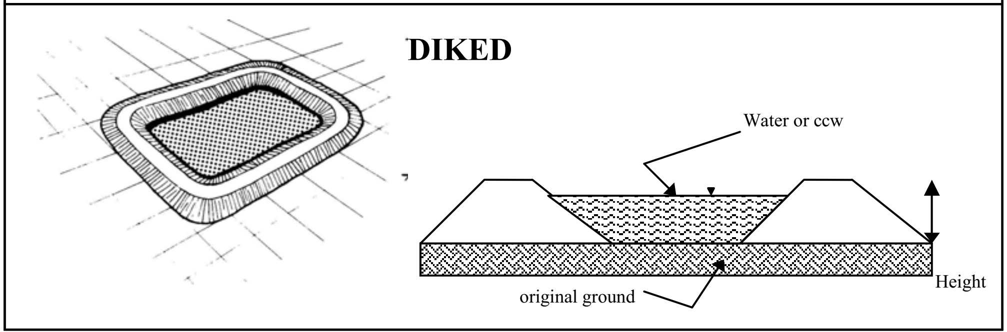


CROSS-VALLEY

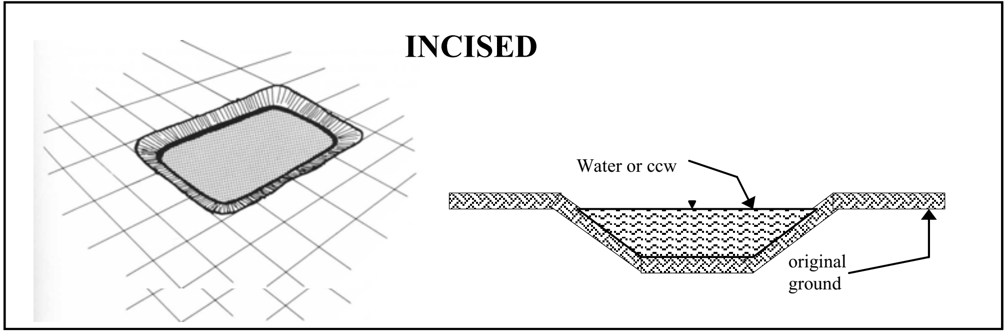


SIDE-HILL

DIKED



INCISED



__X__ Cross-Valley
_____ Side-Hill
_____ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

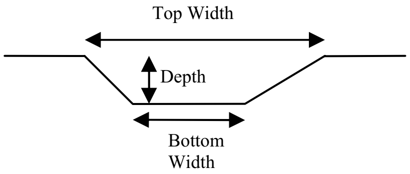
Embankment Height 60 + feet Embankment Material Native Borrow
Pool Area No impounded pool acres Liner None
Current Freeboard Approx. 12 feet Liner Permeability D/N/A

TYPE OF OUTLET (Mark all that apply)

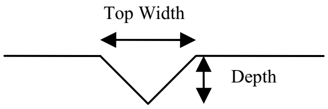
_____ **Open Channel Spillway**
X Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

12' depth
70' bottom (or average) width
120' top width

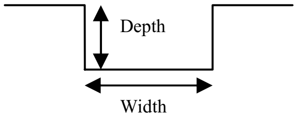
TRAPEZOIDAL



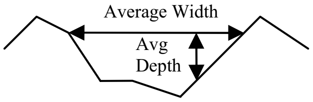
TRIANGULAR



RECTANGULAR

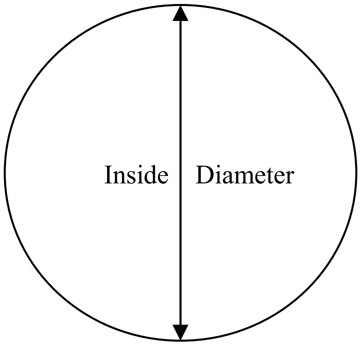


IRREGULAR



D/N/A **Outlet**

_____ inside diameter



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

Is water flowing through the outlet? YES _______ NO X

_____ **No Outlet**

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

The Impoundment was Designed By Ohio AEP

Has there ever been a failure at this site? YES __________ NO X

If So When? D/N/A

If So Please Describe :

Has there ever been significant seepages at this site?   YES _______ NO ___X___

If So When? D/N/A

IF So Please Describe:

Has there ever been any measures undertaken to monitor/lower
Phreatic water table levels based on past seepages or breaches
at this site? YES ________NO __X______

If so, which method (e.g., piezometers, gw pumping,...)? ____________________

If so Please Describe :

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name: Cardinal Steam Plant

Date: September 2, 2009

Unit Name: Cardinal Fly Ash Dam No.2

Operator's Name: Ohio AEP/Buckeye Power

Unit I.D.: FAR II

Hazard Potential Classification: [✓ High] Significant Low

Inspector's Name: Rick Loewenstein/Malcolm D. Hargraves

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Quarterly		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	947		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	947		20. Decant Pipes:	■	■
4. Open channel spillway elevation (operator records)?	D/N/A		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	970		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?	X	
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):	■	■
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	D/N/A		From underdrain?	X	
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?	X		At natural hillside in the embankment area?	X	
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	X		From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?	Not	Seen	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?	X		24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue # Comments

"D/N/A" = Does not apply "N/A" = Not available.

1. AEP makes quarterly and annual inspections; piezometer, seepage volume, and deformations recorded.

9. Occasional vegetation noted in rip rap abutment groins and slope drainage trench.

10., 17. Patched crack noted in roller-compacted concrete crest and in joint of inclined outfall tower. The crack occurred during construction and joint of outfall was designed to accommodate movement and is monitored with crack gages.

21. Weirs measure underdrain and abutment trench drain seepage; seepage more evident from natural hillside.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # OH0012581 INSPECTOR Loewenstein/Hargraves
Date September 2, 2009

Impoundment Name Cardinal Fly Ash Reservoir No. 2 (FAR II)
Impoundment Company Ohio AEP/Buckeye Power Company
EPA Region 5
State Agency (Field Office) Addresss Ohio EPA Southeast District Office
2195 Front Street; Logan, Ohio 43138-8687
Name of Impoundment Fly Ash Reservoir No. 2
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update X

	Yes	No
Is impoundment currently under construction?		X
Is water or ccw currently being pumped into the impoundment?	X	

IMPOUNDMENT FUNCTION: CCW (Sluiced Fly Ash) impoundment

Nearest Downstream Town : Name Salt Run, Ohio
Distance from the impoundment 0.7 miles
Impoundment
Location: Longitude 80 Degrees 38 Minutes 47.7 Seconds
Latitude 40 Degrees 15 Minutes 58.8 Seconds
State Ohio County Jefferson

Does a state agency regulate this impoundment? YES X NO ______

If So Which State Agency? ODNR-Division of Water

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

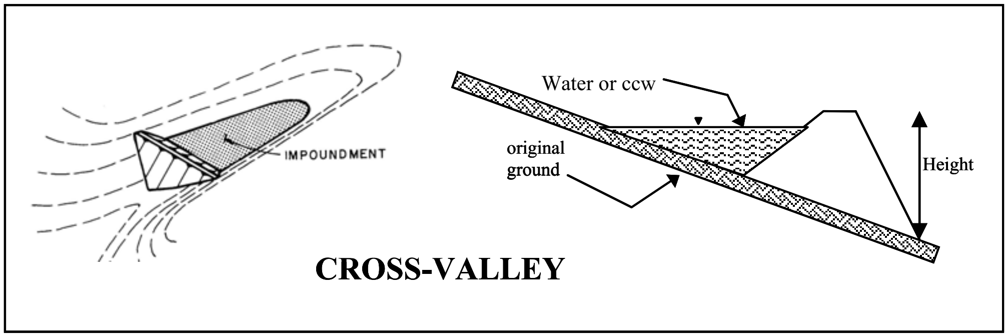
______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

__X__ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

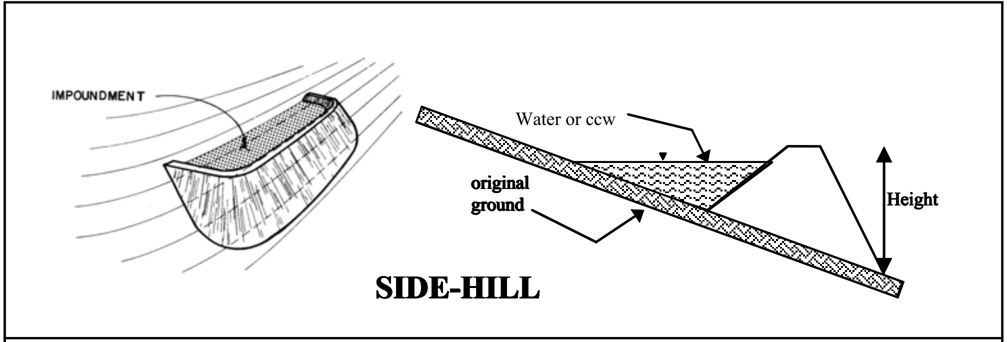
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

In the event of a failure under full pool at elevation 958, the waste would inundate Salt Run, State Route 7, the power plant and eventually spill into the Ohio River with probable loss of life and environmental impacts due to the material volume, dam height (220 feet) and, pollution hazard.

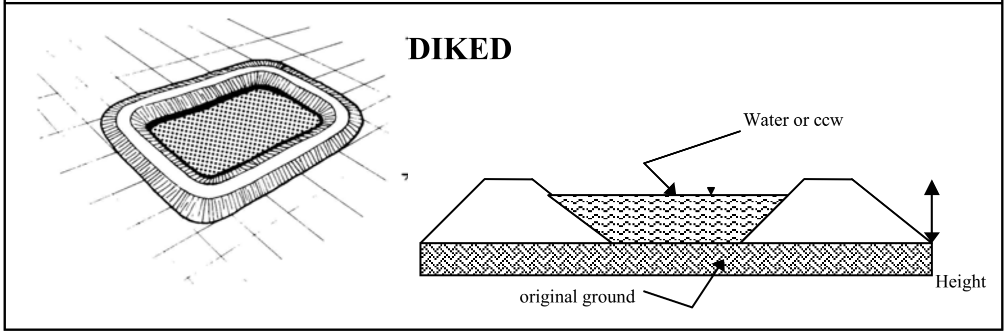
CONFIGURATION:



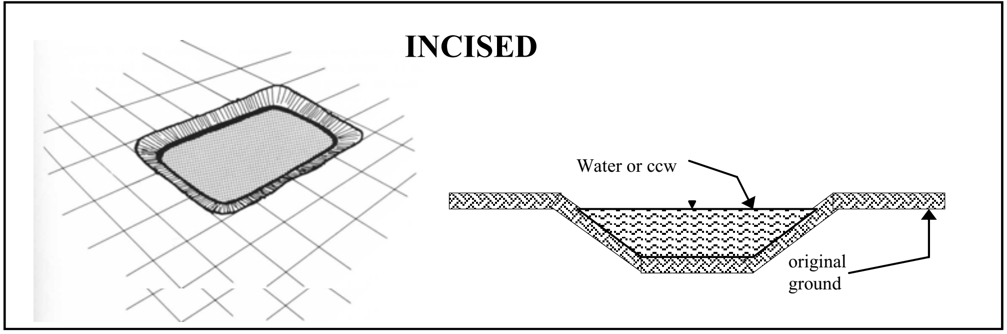
CROSS-VALLEY



SIDE-HILL



DIKED



INCISED

_X____ Cross-Valley
______ Side-Hill
______ Diked
______ Incised (form completion optional)
______ Combination Incised/Diked

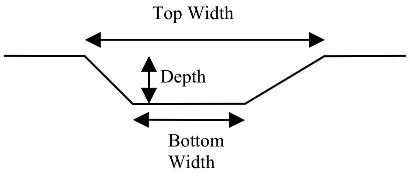
Embankment Height 220 feet
Embankment Material Native Borrow/RCC
Pool Area 139 acres at elev. 960 acres
Liner None
Current Freeboard Approx. 23 feet
Liner Permeability D/N/A

TYPE OF OUTLET (Mark all that apply)

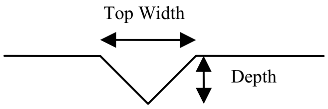
D/N/A **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

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

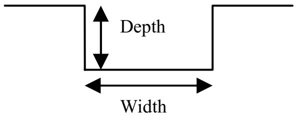
TRAPEZOIDAL



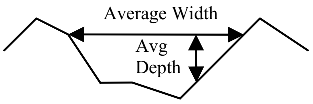
TRIANGULAR



RECTANGULAR

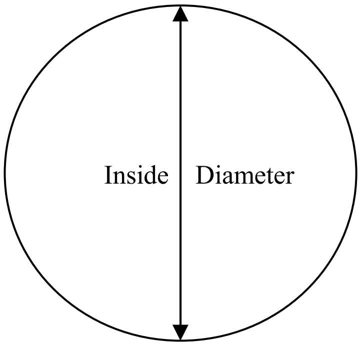


IRREGULAR



X **Outlet**

42 inside diameter



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

Is water flowing through the outlet? YES X NO _______

_____ **No Outlet**

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

The Impoundment was Designed By Ohio AEP

Has there ever been a failure at this site? YES ____X____ NO __________

If So When? 1997

If So Please Describe :

During construction of the dam raising which established the present geometry, additional earth fill placement at the toe of the dam became unstable, damaging the new drainage system that had been installed as part of the foundation preparation. This required removing additional earth fill already in place, reconstructing the drainage system, replacing the fill with more granular earth material, and constructing the present toe berm at the base of the dam. An unpermitted release of impounded CCW did not occur as a result of this incident.

Has there ever been significant seepages at this site? YES _______ NO ___X___

If So When? D/N/A

IF So Please Describe:

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO __X__

If so, which method (e.g., piezometers, gw pumping,...)? Piezometers (see below)

If so Please Describe :

There have been monitoring wells/piezometers and weirs installed as a part of a proactive monitoring and maintenance program. Water level measurements and seepage volumes have been and continue to be recorded periodically at these locations.