

# Assessment of Dam Safety Coal Combustion Surface Impoundments Draft Report

Georgia Power  
Company

Plant Bowen

Cartersville, Georgia



redacted

redacted

Prepared for

**Lockheed Martin**

2890 Woodridge Ave #209  
Edison, New Jersey 08837

July 6, 2009

CHA Project No. 20085.1000.1510



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I acknowledge that the management units referenced herein:

- Plant Bowen Ash Pond

Has been assessed on May 26, 2009 and May 27, 2009.

Signature: \_\_\_\_\_

Malcolm D. Hargraves, P.E.  
Senior Geotechnical Engineer  
Registered in the State of Georgia

Signature: \_\_\_\_\_

Katherine E. Adnams, P.E.  
Senior Geotechnical Engineer

Reviewer: \_\_\_\_\_

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Geotechnical Operating Manager  
Registered in the State of Georgia

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## 1.0 INTRODUCTION & PROJECT DESCRIPTION

### 1.1 Introduction

CHA was contracted by Lockheed Martin 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 Georgia Power Company Plant Bowen, which is located in Cartersville, Georgia as shown on Figure 1 – Project Location Map.

CHA made a site visit on May 26 and 27, 2009 to perform visual observations and to inventory coal combustion surface impoundments at the facility, inspect the containment dikes, and to collect relevant information regarding the site assessment.

CHA engineers, Malcolm Hargraves, P.E. and Katherine Adnams, P.E., were accompanied during the site visit by the following individuals:

<b>Company or Organization</b>	<b>Name and Title</b>
Environmental Protection Agency	Javier Garcia
Georgia Power	Tanya Blalock, Environmental Affairs Manager
Georgia Power Company	Kenneth Duquette, Compliance Team Manager
Georgia Power Company	Nik Budney, Bowen Plant Compliance Manager
Georgia Safe Dams	Carey Anderson, Environmental Engineer
Southern Company	Gary McWhorter, P.E., Environmental Engineering
Southern Company	Hollister Hill
Southern Company	Ron Wood, P.G., Hydro Services
Southern Company	Will McIntyre

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## 1.2 Project Background

The Plant Bowen ash pond is under the jurisdiction of the Georgia Department of Natural Resources Environmental Protection Division (EPD) Safe Dams Program. According to the Natural Inventory of Dams (NID) the Georgia State ID No. for the ash pond is 008-031-04136. According to the Georgia Safe Dams program, the ash pond has been categorized as a "Category II" dam, meaning improper operation or dam failure would not be expected to result in probable loss of human life. Category II facilities are exempt from much of the Georgia dam safety regulations thereby leaving the design, operation, and maintenance standards up to the owner's discretion for best management practices. According to Georgia Safe Dams personnel, as a Category II dam the facility is not held to any state recognized design standards.

The State of Georgia issued Permit No. GA0001449 to the Georgia Power Company authorizing discharge under the National Pollutant Discharge Elimination System to the Euharlee Creek and Etowah River (Coosa River Basin) in accordance with effluent limitations, monitoring requirements and other conditions set forth in the permit. The permit became effective on November 9, 2009 and will expire on June 30, 2012.

On August 1, 2002 Georgia Power provided a written report to the Georgia Department of Natural Resources Environmental Protection Division (EPD) redacted

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redacted

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### 1.3 Site Description and Location

The Plant Bowen management units are shown on Figure 2 – Plant Bowen Site Plan. The main impoundment was created by construction of the main dike, which bounds the impoundment on the south and west sides, and the north dike, which bounds the impoundment on about two thirds of the north side. The remaining portions of the impoundment are contained by natural ground. The main and north dikes were originally constructed in 1968 creating a storage area of about <sup>redacted</sup> acres. In 1992 and again in 2001 Georgia Power developed Ash Stacking Plans to expand the capacity of the facility and transition from wet process disposal to dry disposal. These stacking plans were approved by Georgia Environmental Protection Division (GA EPD). Figures 3 and 4 show cross sections of the main and north dikes, respectively.

This transition to dry disposal was an engineered plan to reduce the impacts of fluctuating water levels in the impoundment from impacting the underlying karst topography, which is more thoroughly discussed in Section 1.5 below. The result of this change in operations is an impoundment with only about <sup>redacted</sup> acres containing liquid and these areas have been lined with geosynthetic clay liners (GCL) or HDPE liners, and/or clay soil liners. The remaining <sup>redacted</sup> acres of the main impoundment contains the dry-stacked ash. The areas where liquid is contained is comprised of two ash dewatering cells, two gypsum settling ponds, and a water recycle pond. Figures 5, 6, and 7 show cross sections of the dikes at the water recycle pond, ash dewatering cells, and gypsum settling ponds, respectively.

The Bowen Power Plant’s recycle water portion of the unit, which contains the largest volume of liquid, is about 2 miles upstream of Euharlee, Georgia by the stream channel. The perimeter ditch drains to the Euharlee Creek, which subsequently discharges into the Etowah River.

A map of the region indicating the location of the Plant Bowen ash pond identifying schools, hospitals, or other critical infrastructure located within approximately 5 miles down gradient of the ash pond is provided as Figure 8.

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### 1.3.1 Other Impoundments

In addition to the coal combustion waste (CCW) disposal area, CHA also observed and/or was made aware of other impoundments at the Plant Bowen site. The largest of these impoundments occupies roughly <sup>redacted</sup> acres and contains water pumped from the Etowah River for use as cooling water in the Plant. Other much smaller impoundments capture and control storm water runoff in the coal pile area and the waste gypsum coal combustion by-product storage facility located to the east of the steam plant and cooling water pond. These impoundments store water intermittently, do not contain CCW and therefore, were not inspected as part of this project. The locations of these areas are shown on Figure 2 – Plant Bowen Site Plan.

### 1.4 Previously Identified Safety Issues

redacted

redacted

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redacted

#### **1.4.2 2008 Release and Revised Stacking Plan**

redacted

#### **1.4.3 2008 Sinkhole at North Dike**

redacted

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## 1.5 Site Geology

A summary of the regional geology was prepared by [redacted]

Section 3.3 – Regional Geology of the report states that “The Plant Bowen ash pond lies within the Valley and Ridge physiographic province about three to four miles north of the Cartersville Fault. The Cartersville Fault separates the late Precambrian-aged metamorphic rocks to the east and south from the Cambrian-aged sedimentary rocks to the north and west. The ash pond lies within an area mapped primarily as Knox Group undifferentiated. The Knox Group produces a characteristic orange to red clayey residuum, often cherty, that ranges in thickness from ten to a hundred feet or more.”

The report summarizes several site-specific subsurface explorations programs that have been conducted in the vicinity of the ash pond since the 1967 plant siting work, including investigations that were performed after the [redacted]. The investigations described in the report include;

- Literature Review (Regional Geology)
- Aerial Photography (Lineament) Studies
- Geophysical Surveys (Resistivity, Self Potential and Electromagnetic)
- Drilling, Sampling, Cone Penetrometer Testing, and Related Laboratory Analysis

Based on the investigations the report provides a description of the soil and rock (Section 3.7). The soils underlying the ash pond and embankment are residual, formed from the in-place weathering of the underlying dolomite and limestone. The soils were noted as varying from a fine, sandy clayey silt to silty clay. Permeability of the material was reported as varying from about  $1 \times 10^{-6}$  to  $1 \times 10^{-8}$  cm/sec. Thickness was also found to vary from about 19 feet to 127 feet at the Plant Bowen site.

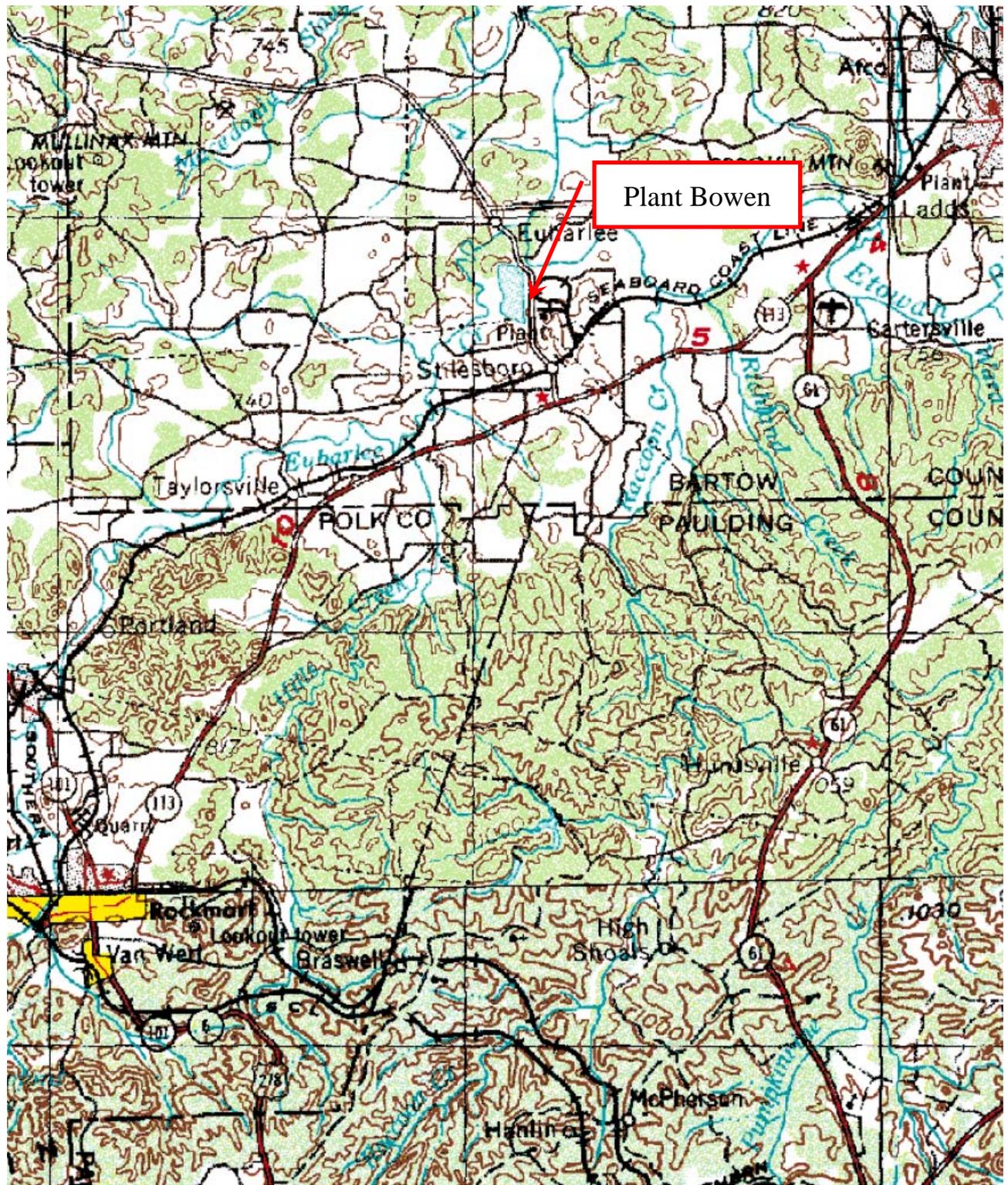
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The report states that the carbonate rocks beneath the ash pond are typical of the Knox Group and that as part of various Plant Bowen studies, karst-controlling features such as lineaments and sinkholes were mapped across the site.

## 1.6 Bibliography

CHA reviewed the following documents provided by Georgia Power in preparing this report.

- Hill, Heather and Franke, Richard M. *Plant Bowen Ash Pond Dike Slope Stability Analysis Report*, Southern Company Services, Inc., December 2003.
- McWhorter, Gary H., Franke, Richard M. et.al. *Georgia Power Company Plant Bowen Final Consent Order EPD-WQ-4075*, Southern Company Services, Inc., May 28, 2004.
- Galt, Joel. *Plant Bowen Dam Safety Surveillance Quarterly Reports*, Southern Company Services, Inc (5/2004 to 4/2009).
- Various *Quarterly Reports on Dam Safety Surveillance* from 2004 to 2009, Southern Company Services, Inc.
- Engineering and Construction Services Calculation - Ash Dewatering Cells Stability, June 25, 2009, Southern Company Services, Inc.
- Gypsum Dewatering Cells Typical Dike Sections, Drawing E23847, October 1, 2007, Southern Company Services, Inc.
- Engineering and Construction Services Calculation - Ash Pond Flood Evaluation, June 30, 2009, Southern Company Services, Inc.



**Figure 1  
Project Location Map**

Scale: 1" = 2 miles

Project No.:  
20085.1000.1510

Georgia Power Company  
Plant Bowen  
Cartersville, Bartow County, Georgia

File: K:\20085\CADD\ACAD\FIGURES\1000 BOWEN PLANT\BOWEN PLANS-MAPS.DWG Saved: 7/6/2009 2:35:49 PM Plotted: 7/6/2009 2:44:23 PM User: Filkins, Rebecca



IMAGE REFERENCE: PLANT BOWEN BOW-API 0036



PLANT SITE PLAN  
 PLANT BOWEN  
 GEORGIA POWER COMPANY  
 CARTERSVILLE, GEORGIA

PROJECT NO.  
 20085.1000  
 DATE: JULY 2009  
 FIGURE 2

# redacted

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN XSECTS1.DWG Saved: 6/26/2009 1:03:52 PM Plotted: 7/6/2009 12:11:17 PM User: Filkins, Rebecca

© Copyright 2002, Southern Company Services, Inc. All Rights Reserved.

IMAGE REFERENCE: STABILITY ANALYSIS, FIGURE 5,  
PLANT BOWEN DIKE STABILITY STUDY, SECTION D-D',  
SOUTH HORSESHOE



CROSS SECTION OF MAIN DIKE  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 3

# redacted

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN XSECTS2.DWG Saved: 7/6/2009 9:51:29 AM Plotted: 7/6/2009 10:24:53 AM User: Filkins, Rebecca

IMAGE REFERENCE: SHEET H-1163 STABILITY ANALYSIS ASH POND DIKES 1969

 <small>Drawing Copyright © 2007 CHA</small>	CROSS SECTION OF NORTH DIKE PLANT BOWEN GEORGIA POWER COMPANY CARTERSVILLE, GEORGIA	PROJECT NO. 20085.1000
		DATE: JULY 2009
		FIGURE 4

# redacted

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN XSECTS1.DWG Saved: 7/6/2009 3:29:04 PM Plotted: 7/6/2009 3:30:39 PM User: Filkins, Rebecca

**NOTE:** THE SLOPE TO THE EAST IS BERM CONSTRUCTED  
ON NATURAL SLOPE WITHOUT A BENCH

IMAGE REFERENCE: BOW-API 0065



CROSS SECTION OF WATER RECYCLE POND  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 5

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# redacted

IMAGE REFERENCE: PLANT BOWEN UNITS 1-4 ASH  
POND DEWATERING CELLS GRADING AND DRAINAGE  
PLAN, SHEET 2, JUNE 2003

 <small>Drawing Copyright © 2007 CHA</small>	CROSS SECTION OF ASH POND DEWATERING CELLS PLANT BOWEN GEORGIA POWER COMPANY CARTERSVILLE, GEORGIA	PROJECT NO. 20085.1000
		DATE: JULY 2009
		FIGURE 6

# redacted

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN XSECTS2.DWG Saved: 7/6/2009 9:51:29 AM Plotted: 7/6/2009 11:27:52 AM User: Filkins, Rebecca

IMAGE REFERENCE: PLANT BOWEN UNITS 1-4, FGD PROJECT, GYPSUM DEWATERING CELLS, TYPICAL DIKE SECTIONS, SHEET 1

 <small>Drawing Copyright © 2007 CHA</small>	<b>GYPSUM DEWATERING CELLS TYPICAL DIKE SECTIONS</b> PLANT BOWEN GEORGIA POWER COMPANY CARTERSVILLE, GEORGIA	PROJECT NO. 20085.1000
		DATE: JULY 2009
		<b>FIGURE 7</b>

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN PLANS-MAPS.DWG Saved: 7/6/2009 2:35:49 PM Plotted: 7/6/2009 3:00:45 PM User: Filkins, Rebecca



IMAGE REFERENCE: GOOGLE EARTH



**CRITICAL INFRASTRUCTURE MAP**  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 8

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## 2.0 FIELD ASSESSMENT

### 2.1 Visual Observations

CHA performed visual observations of the main and north dikes 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 the ash pond. A copy of the completed form was submitted via email to a Lockheed Martin representative approximately three days following the site visit to Plant Bowen. A copy of this completed form is included at the end of Section 2.5. A photo log of photos taken during the site visit and a Site Photo Location Map, Figure 9, are also located at the end of Section 2.5.

CHA's visual observations were made on May 26 and 27, 2009. The weather was cloudy with severe afternoon thunderstorms and temperatures between 64 and 82 degrees Fahrenheit. Prior to and during the days we made our visual observations, the following approximate rainfall amounts occurred (as reported by [www.weather.com](http://www.weather.com)).

**Table 1 - Approximate Precipitation Prior to Site Visit**

<b>Date of Site Visit - May 26, 2009 &amp; May 27, 2009</b>		
<b>Day</b>	<b>Date</b>	<b>Precipitation (inches)</b>
Tuesday	5/19/09	0.00
Wednesday	5/20/09	0.00
Thursday	5/21/09	0.05
Friday	5/22/09	0.00
Saturday	5/23/09	0.05
Sunday	5/24/09	0.00
Monday	5/25/09	0.03
Tuesday	5/26/09	0.94
Wednesday	5/27/09	0.06
<b>Total</b>	<b>Week Prior to Site Visit</b>	<b>1.13</b>
<b>Total</b>	<b>Month of May</b>	<b>7.71</b>

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It should also be noted that localized, isolated thunderstorm activity was evident at the plant Monday mid-afternoon after the initial field walkthrough.

## **2.2 Embankments and Crest**

The main dike is approximately redacted feet long, and the north dike is approximately redacted feet long. Two wet ash disposal ponds are contained within the main impoundment and consist of an exterior berm approximately redacted feet long, and a separator dike between the two ponds approximately redacted feet long. Also included in the main impoundment are two gypsum settling ponds with berms about redacted feet long each. The wet ash and gypsum ponds are lined with geosynthetic liners, and if a breach of one of those were to occur, the release would be contained within the main impoundment. Therefore, CHA performed only a cursory review of these structures.

### **2.2.1 Main Dike**

In general, the main dike does not show signs of changes in horizontal alignment from the proposed alignment. According to Georgia Power personnel, the crest is regraded as needed to fill in tire ruts thereby reducing ponding of storm water on the crest. The embankment is uniform and well covered with appropriate grass cover, which was freshly mowed during our site visit. The main dike was constructed with a downstream slope of redacted.

The southern portion of the main dike along the recycle pond consists of a redacted-foot high dike constructed on top of a redacted foot high natural cut slope. The natural slope throughout this area has several locations where surficial slides have occurred as shown in Photos 1, 2, 5 and 6. Southern Company personnel who redacted indicated these features have been there for at least 6 to 10 years during which time the current staff responsible for redacted have been assigned to this project, and during this time the features have remained unchanged. One feature, as shown in Photo 7, appeared more recent because of relatively new erosion control matting. Southern Company personnel indicated this area had

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been reseeded several times without adequate vegetation growth, so the erosion matting was placed as an additional attempt to establish good grass growth.

In the area where the recycle pond ends and the main dike curves to the north, formerly sluiced or placed ash is level with the crest of the dam as shown in Photos 15, 16, 18, and 20. The design width of the crest was <sup>redacted</sup> feet. This condition continues along the entire length of the main dike from the southwest curve to the north abutment. Although obscuring the upstream slope of the constructed dike and the upstream edge of the main dike crest, CHA did not observe conditions of concern along the crest of the main dike.

### **2.2.2 North Dike**

In general, the north dike does not show signs of changes in horizontal alignment. According to Georgia Power personnel, the crest is re-graded as needed to fill in tire ruts thereby reducing ponding of storm water on the crest. The embankment is uniform and well covered with appropriate grass cover, which was freshly mowed during our site visit. The north dike was constructed with a downstream slope of <sup>redacted</sup>.

The western portion of the north dike is adjacent to the active dry stack area as shown in Photos 24 and 25. These photos also show the configuration of the drainage swale between the north dike and the ash stack. Georgia Power personnel indicated the drainage swale in this area is one of the last areas of water conveying portions of the impoundment to be regraded and lined as part of the work to reduce the facility's impact on the karst topography below. This swale is expected to be lined in 2009 or 2010.

### **2.3 Outlet Control Structure and Discharge Channel**

The only outlet control structure in the main impoundment is in the southeast portion of the impoundment, which is used as a recycle pond. The outlet in this area discharges through a sampling flume into a discharge channel in natural ground (photo 1). The discharge channel

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flows west until it intersects the Euharlee Creek. This channel is relatively clear, although portions of the channel are being choked by soil previously sloughed from the adjacent natural slope as shown in photos 4 through 7.

## 2.4 Monitoring Instrumentation

There are 68 piezometers installed along the main impoundment dikes, recycle pond, and dewatering cell dikes at Plant Bowen. These piezometers are located in the embankments, existing ash, and in the bedrock underlying the site. Because of the karst at the site, selected piezometers are redacted, and redacted

. A new remote reading system is being installed redacted

Figure 10 shows the piezometer layout at the site. Summaries and a review of this data are included in Section 3.4.1.





Coal Combustion Waste (CCW) Impoundment Inspection

Impoundment NPDES Permit # GA 0001449
Date May 26, 2009

INSPECTOR Adnams/Hargraves

Impoundment Name Bowen Power Plant Ash Pond
Impoundment Company Georgia Power
EPA Region 4
State Agency (Field Office) Address

Name of Impoundment Bowen Power Plant Ash Pond
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New Update x

Is impoundment currently under construction?
Is water or ccw currently being pumped into the impoundment?

Yes No
x

IMPOUNDMENT FUNCTION: Dry Ash Stacked Storage, Gypsum Dewatering, Water Recycle

Nearest Downstream Town : Name Euharlee, Georgia

Distance from the impoundment 2 miles

Impoundment

Location: Longitude Degrees Minutes Seconds
Latitude Degrees Minutes Seconds
State County

Does a state agency regulate this impoundment? YES NO x

If So Which State Agency?

**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.

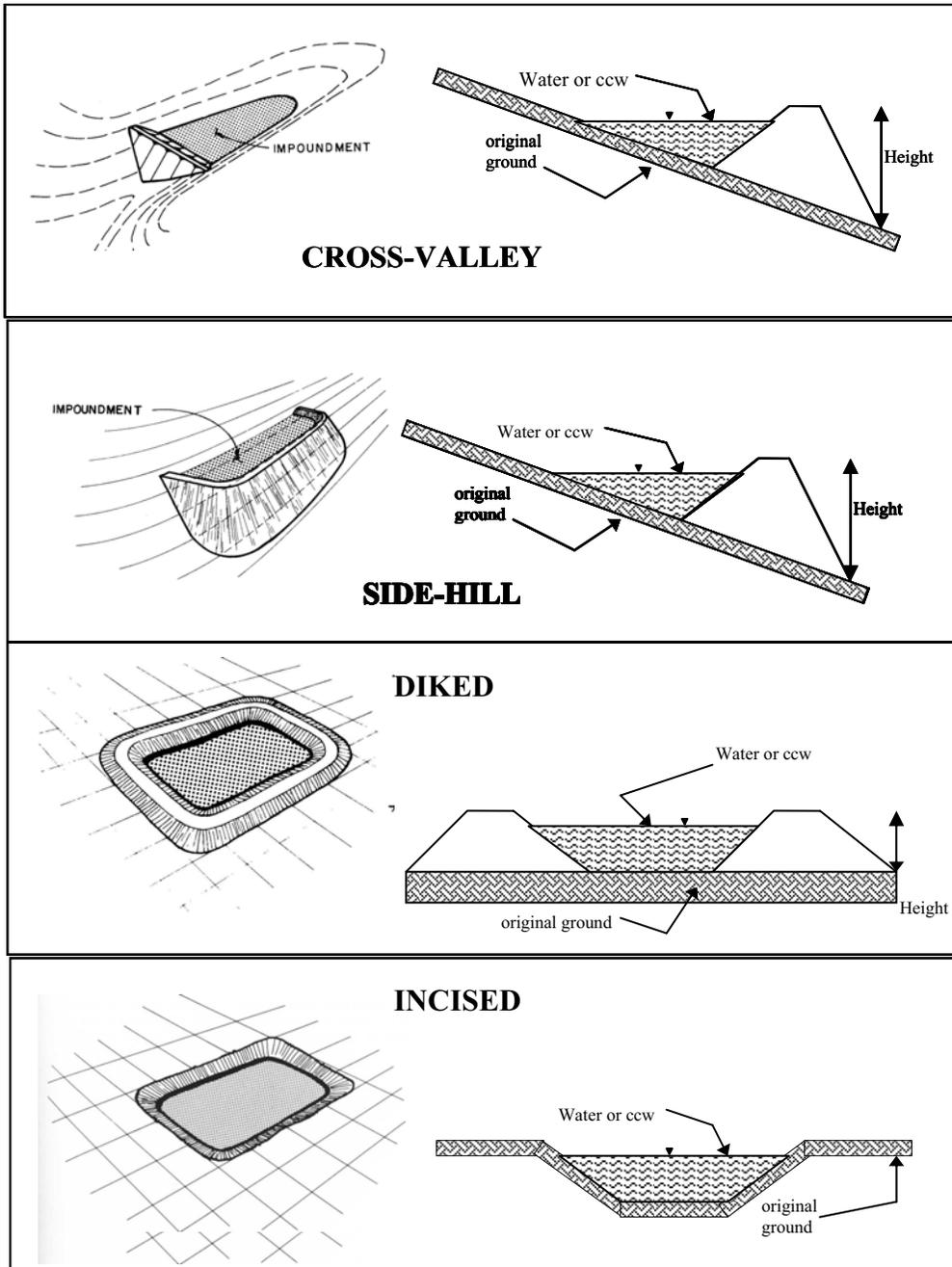
\_\_\_\_\_ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. 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:**

There is essentially little to no water-borne waste being retained in the ash "Pond". Essentially, the term "disposal pond" is misleading with respect to the function of the disposal operations. The hazard potential is primarily related to the karst topography evident below the disposal pond, the feature that eventually led to the change in operation from wet to dry storage/disposal. Any unpermitted releases would primarily be through the bottom of the disposal basin site, via karst solution features that can develop, most probably with notable fluctuations in groundwater table elevations in the bedrock and weathered bedrock formation. As such, any such damage would be environmental, associated with the coal combustion waste chemistry.

**CONFIGURATION:**



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

Embankment Height                      <sup>redacted</sup> feet      Embankment Material Native Borrow

Pool Area                      acres      Liner HDPE (Recycle Pond), GCL, clay/silt

Current Freeboard n/a feet      Liner Permeability

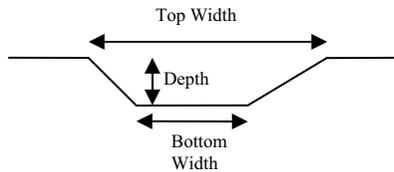
**TYPE OF OUTLET** (Mark all that apply)

n/a **Open Channel Spillway**

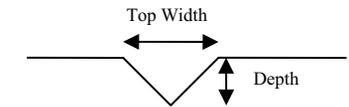
- Trapezoidal
- Triangular
- Rectangular
- Irregular

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

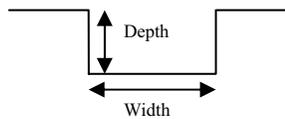
TRAPEZOIDAL



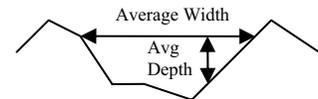
TRIANGULAR



RECTANGULAR



IRREGULAR

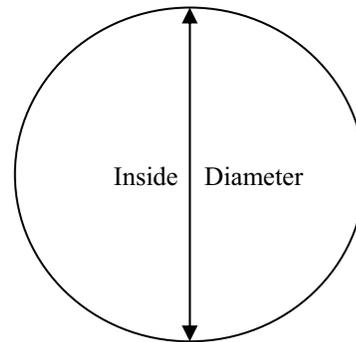


n/a **Outlet**

inside diameter

Material

- corrugated metal
- welded steel
- concrete
- plastic (hdpe, pvc, etc.)
- other (specify) \_\_\_\_\_



Is water flowing through the outlet? YES \_\_\_\_\_ NO \_\_\_\_\_

n/a **No Outlet**

**Other Type of Outlet** (specify) \_\_\_\_\_

The Impoundment was Designed By Southern Companies/Georgia Power





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

If so, which method (e.g., piezometers, gw pumping,...)? piezometers/dry stacking

If so Please Describe :

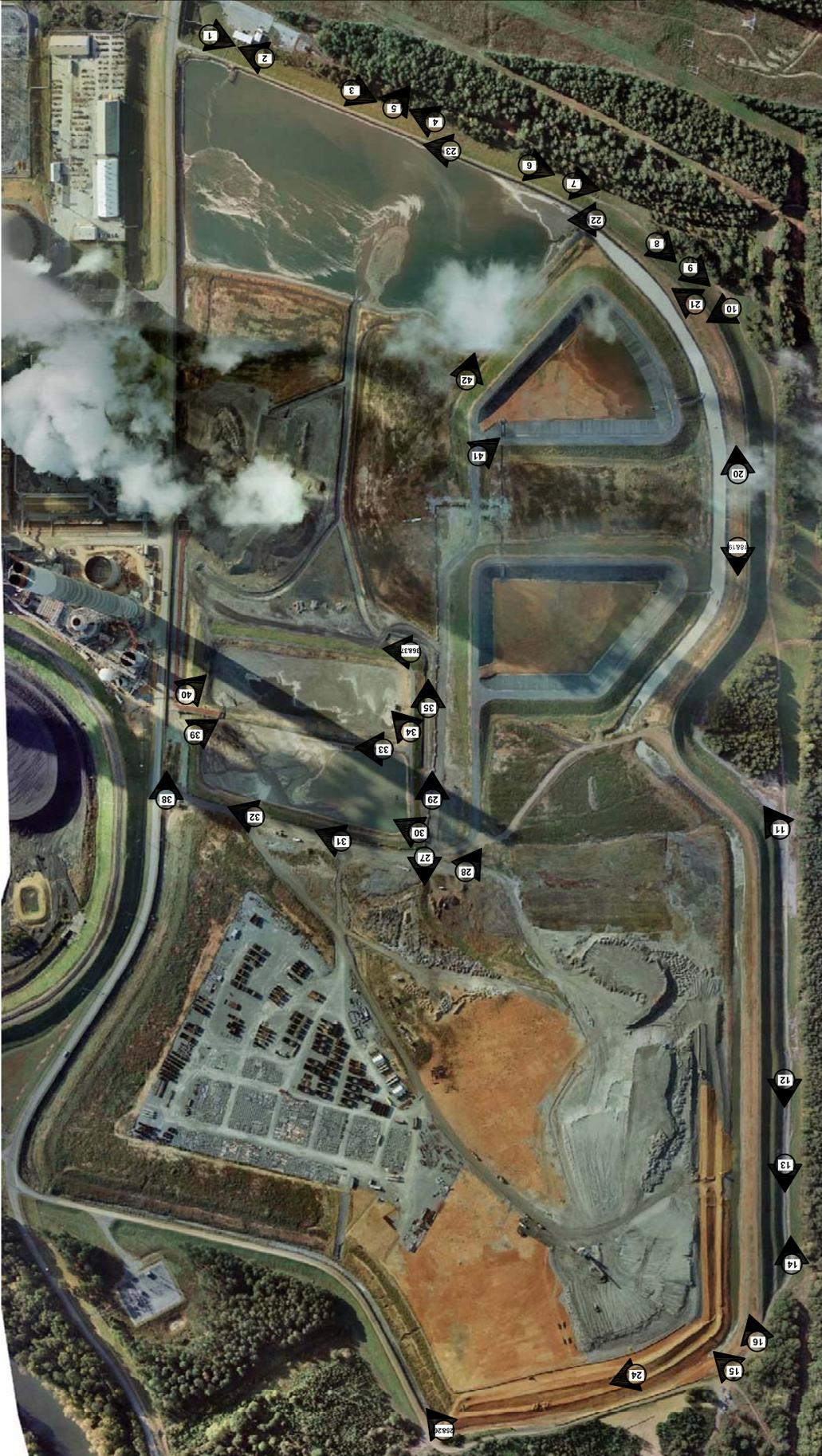
The Bowen Power Plant has lined the recycle pond and the gypsum dewatering basins, and dewateres the CCW before stacking it in a dry state within the disposal area. A remote, automatic piezometer monitoring system is currently being installed and reconfigured as construction and dry stack disposal activities continue in the facility.

IMAGE REFERENCE:  
ASH POND AERIAL  
OCTOBER 2008  
DRAWING BOW-API 0044



SITE PHOTO LOCATION MAP  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000  
DATE: JULY 2009  
FIGURE 9



<sup>1</sup> redacted

<sup>2</sup> redacted

redacted



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

3

# redacted

South end of the main dike, looking west. Note transition between natural cut slope and raised dike.

4

# redacted

redacted



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

5

# redacted

Perimeter ditch at south end of main dike looking west, 180 degree view of previous photo.

6

# redacted

Continuing west on south end of main dike, another slough area in the natural cut slope,  
redacted



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

7

redacted

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has had

8

redacted

South portion of t



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

9

# redacted

South end of the west portion of the Dike.

10

# redacted

South end of the west portion of the Dike. Toe drain outlets are marked with concrete posts. Toe drain outlets located about every 200 feet. No flow noticed, and Georgia Power indicates they have not seen water flowing in the toe drain.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

11

# redacted

Embankment at the "Horseshoe" (looking south). Note the gravel at the toe which was placed during the grouting program to seal karst features below the embankment.

12

# redacted

North end of main embankment (looking north). Note the gravel at the toe which was placed during the grouting program to seal karst features below the embankment.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

13

# redacted

Stone cover at North end of main embankment placed during the grouting program to seal karst features below the embankment. The white numbered concrete posts mark toe drain locations.

14

# redacted

North end of main embankment (looking south).



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

15

redacted

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16

redacted

Drainage swale between dam and dry stacked ash piles.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

17

# redacted

Surficial drainage system draining storm water runoff from ash stacks to the drainage swale.

18

# redacted



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

19

# redacted

Embankment at the "Horseshoe" looking north. Gray coloring at toe of embankment is gravel placed during the grouting program to seal karst features below the embankment.

20

# redacted

Embankment looking from the "Horseshoe" looking south.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

21

# redacted

Reclaim Pond and south end of the embankment crest looking east. Note the Reclaim Pond is lined with and HDPE liner.

22

# redacted

Drainage Swale noted in Photos 15, 16, and 17 discharges into the Reclaim Pond. Note the drainage swale is also HDPE lined. Behind the swale in this photo is one of two gypsum ponds.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

23

# redacted

Crest of south end of main embankment looking east.

24

# redacted

Upstream side of North Dike looking east. Dry Stack ash piles in the right of the photo. Drainage swale in this area is unlined, but lining is planned for the 2009 construction season.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

25

# redacted

Overview of north dike, looking east.

26

# redacted

West end of north dike, looking east.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

27

# redacted

Within the main impoundment looking north toward the dry stack area.

28

# redacted

Within the main impoundment looking south. To the left of photo are the wet ash ponds (2) and to the right of the photo are the gypsum ponds (2).



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

29

redacted

30

redacted

North wet ash pond looking east.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

31

redacted

North embankment of wet ash ponds.

32

redacted

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North embankment of wet ash ponds, looking east.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

33

# redacted

Separator dike between two wet ash ponds.

34

# redacted

South wet ash pond looking east.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

35

# redacted

West embankment of south wet ash pond, looking south.

36

# redacted

South embankment of wet ash ponds, looking East. Note the lined drainage swale in right of photo discharges into the reclaim pond.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

37

# redacted

Upstream slope of south embankment of wet ash ponds, looking east. Note the red clay liner which overlays a liner.

38

# redacted

East slope of wet ash ponds, looking south.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

39

# redacted

Sluiceway into the north wet ash pond.

40

# redacted

East slope of wet ash ponds looking south.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

41

# redacted

Lined gypsum pond.

42

# redacted

Emergency overflow and outlet sluice (via buried outlet pipe) from the gypsum pond into the drainage swale running to the reclaim pond.



**GEORGIA POWER  
BOWEN STEAM PLANT  
ASH DISPOSAL POND  
CATERSVILLE, GA**

---

## 3.0 DATA EVALUATION

### 3.1 Design Assumptions

Design drawings from 1969 show that the dikes were generally homogenous structures comprising low permeability compacted fill supported above the natural soil, with a height ranging from <sup>redacted</sup> feet for the north dike to <sup>redacted</sup> feet for the west dike. The upstream and downstream slopes had <sup>redacted</sup> grades, which was fairly typical of that time period. Most critically, relative to the current condition in the pond, the dikes were to impound liquid borne, completely saturated, coal combustion waste (CCW). The required free board on the dikes would have been based on hydraulic and hydrology analyses for the impoundment. This historical information was not available at the time this report was written and current operating procedures at the site include only a small area of liquid borne CCW and the remaining portions of the site contain ash placed under hydraulic conditions, and stacks of dry ash.

### 3.2 Hydrology and Hydraulics

Georgia EPD classifies the Bowen Ash Pond as a Category II dam based on their criteria that a failure at this impoundment would not be likely to result in a loss of life. As a Category II facility, Georgia regulations exempt the dam from the dam safety regulations.

Despite being exempt from the dam safety regulations, Southern Company provided CHA with an evaluation of the drainage from the Ash Pond site (including the dry stack area, wet process ponds, and gypsum ponds) during a 10-year, 24-hour storm event. The volume of runoff from this storm can be completely stored in the Recycle Pond. This storage ability was based on the normal operating pool elevation of the Recycle Pond.

In addition, there are two methods of discharge from the Recycle Pond. The first discharges to the Etowah River through the NPDES permitted outlet. The second is a former discharge

---

point that is still in place, and discharges to the Euharlee Creek. According to Southern Company this outlet requires manual operation.

In comparison, the same facility in a Category I condition would be required to safely pass or store 50% of the probable maximum flood (PMF).

### 3.3 Structural Adequacy & Stability

The Georgia Department of Natural Resources Environmental Protection Division outlines rules and regulations for dam safety in Standards for the Design and Evaluation of Dams (391-3-8-.09). The regulations state that all dams must be stable under all conditions of construction and/or operation of the impoundment. Analyses using the methods, guidelines and procedures of the agencies listed in the regulations yielding the minimum safety factors shown in Table 2 for earthen embankments can be considered as acceptable stability.

**Table 2 - Minimum Safety Factors Required**

<b>Load Case</b>	<b>Required Minimum Factor of Safety</b>
End of Construction	1.3
Steady State Seepage	1.5
Steady State Seepage with Seismic Loading	1.1
Rapid Drawdown (Upstream)	1.3
Submerged Toe with Rapid Drawdown	1.3

redacted

#### 3.3.1 Main and North Dikes

redacted

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redacted

**Table 3 - 1969 Soil Strength Parameters**

Soil Stratum	Unit Weight (pcf)	Friction Angle ( $\phi$ )	Cohesion (psf)	Description
A	122	redacted	1,000	Embankment
B	128	redacted	500	Natural Subgrade
C	115	redacted	250	Natural Subgrade
C <sub>1</sub>	115	redacted	500	Natural Subgrade (consolidated)
D	120	redacted	1,500	Natural Subgrade
E	120	redacted	1,000	Natural Subgrade

Two of the four strata were modeled below the west dike location while three of the four strata were modeled beneath the north dike. A stability cross-section of the north dike structure (Sta. redacted assuming steady-state conditions and a full hydrostatic head at Elevation redacted is shown in Figure 4.

redacted

redacted

**Table 4 - 2003 Soil Strength Parameters (Steady State)**

Description	Unit Weight (pcf)	Friction Angle ( $\phi$ )	Cohesion (psf)
Embankment		redacted	350
Firm Residual Soil	128	redacted	218
Weak Residual Soil	115	redacted	100
Ash	85	redacted	0

redacted

redacted


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redacted

redacted


### 3.3.2 Wet Ash and Gypsum Dikes

redacted

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redacted

redacted


---

### 3.4 Operations & Maintenance

redacted

Georgia Power began transitioning to dry ash stacking instead of sluicing wet ash into the main impoundment in 1992. Between 1992 and 2002, about 6 to 12 inches of water was maintained on the surface of the ash for dust control purposes. Following the 2002 release of ash through karst below the main dike, Georgia Power changed their process of dust control to include placing moist (but not saturated) CCW, limiting the exposed area of ash, using temporary cover soil, and temporarily sealing exposed areas with a smooth drum roller. redacted

redacted

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### 3.4.1 Piezometers

redacted

redacted

### 3.4.2 Inspections

redacted

# redacted

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IMAGE REFERENCE: PLANT BOWEN ASH POND REMOTE  
AUTOMATIC DATA ACQUISITION SYSTEM  
SITE PLAN WITH PIEZOMETERS  
DRAWING NUMBER H-944-3  
NOVEMBER 10, 2005



**PIEZOMETER LAYOUT PLAN**  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO. 20085.1000
DATE: JULY 2009
<b>FIGURE 10</b>

# redacted

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PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

DATE: JULY 2009

FIGURE 11

# redacted



# redacted

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GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

DATE: JULY 2009

FIGURE 13-2

# redacted

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PLANT BOWEN



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CARTERSVILLE, GEORGIA

20000.1000

DATE: JULY 2009

FIGURE 13-3

# redacted



# redacted

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# redacted

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redacted

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STABILITY ANALYSIS  
ASH POND DEWATERING CELLS  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 15-1

# redacted

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN XSECTS2.DWG Saved: 7/6/2009 9:51:29 AM Plotted: 7/6/2009 11:00:14 AM User: Filkins, Rebecca



STABILITY ANALYSIS  
ASH POND DEWATERING CELLS  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 15-2

# redacted

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN XSECTS2.DWG Saved: 7/6/2009 9:51:29 AM Plotted: 7/6/2009 11:02:29 AM User: Filkins, Rebecca

 <small>Drawing Copyright © 2007 CHA</small>	STABILITY ANALYSIS ASH POND DEWATERING CELLS PLANT BOWEN GEORGIA POWER COMPANY CARTERSVILLE, GEORGIA	PROJECT NO. 20085.1000
		DATE: JULY 2009
		FIGURE 15-3

# redacted



PIEZOMETER READINGS  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO. 20085.1000
DATE: JULY 2009
FIGURE 16-1A

# redacted

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DATE: JULY 2009

FIGURE 16-1B

# redacted

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		DATE: JULY 2009
		FIGURE 16-2A

# redacted

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5/5/2008

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		DATE: JULY 2009
		FIGURE 16-2B

# redacted

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		DATE: JULY 2009
		FIGURE 16-3A

# redacted

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		DATE: JULY 2009
		FIGURE 16-3B

# redacted

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		DATE: JULY 2009
		FIGURE 16-4A

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PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 16-4B

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		DATE: JULY 2009
		FIGURE 16-5A

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		DATE: JULY 2009
		FIGURE 16-5B

# redacted

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PIEZOMETER READINGS  
PLANT BOWEN  
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CARTERSVILLE, GEORGIA

PROJECT NO. 20085.1000
DATE: JULY 2009
FIGURE 16-6A

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		DATE: JULY 2009
		FIGURE 16-6B

# redacted



PIEZOMETER READINGS  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO. 20085.1000
DATE: JULY 2009
FIGURE 16-7A

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PIEZOMETER READINGS  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 16-7B

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PIEZOMETER READINGS  
PLANT BOWEN  
GEORGIA POWER COMPANY  
CARTERSVILLE, GEORGIA

PROJECT NO.  
20085.1000

DATE: JULY 2009

FIGURE 16-8

# redacted

File: K:\20085\CADD\ACAD\FIGURES\GEO\1000 BOWEN PLANT\BOWEN DATA.DWG Saved: 7/6/2009 12:24:27 PM Plotted: 7/6/2009 1:40:14 PM User: Filkins, Rebecca

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	PLANT BOWEN	DATE: JULY 2009
	GEORGIA POWER COMPANY CARTERSVILLE, GEORGIA	FIGURE 16-9

---

## 4.0 CONCLUSIONS/RECOMMENDATIONS

### 4.1 Acknowledgement of Management Unit Condition

I acknowledge that the management unit reference herein was personally inspected by me and was found to be in the following condition: **Satisfactory.**

redacted

### 4.2 Hydrologic and Hydraulic Recommendations

CHA recommends that the hydrology of the site be evaluated and operating procedures developed for a larger storm than the 10-year storm, which can be stored with no discharge in the Recycle Pond. Even though the basin is no longer used for wet ash storage, inundation from storm water runoff and/or breach of wet ash or gypsum ponds is contained within the original impoundment could result in overtopping of the main dikes resulting in embankment failure and a subsequent release of ash. Best Management Practice should be used to consider a reasonable design storm in combination with Georgia Power's tolerance for risk of this type of event occurring. Based on the size of this facility, if development downstream put human life in jeopardy, the Georgia EPD Safe Dam regulations would require the impoundment to contain 33% to 50% (depending on total storage volume and height) of the Probable Maximum Flood (PMF). We suggest that because of potential environmental impacts that could result from an overtopping failure, that this criteria be considered for in storm event planning for the facility.

---

### 4.3 Stability Recommendations

Two stability conditions evaluated by Southern Company produce lower bound factors of safety. The first is under seismic loading, the factor of safety for the main embankment ranges from 0.99 to 1.1 for events ranging from 2% to 10% chance for exceedance in 50 years. The other condition is a Southern Company defined condition of uplift and reduced strength from a seismic event occurring at about the same time, which is a reasonable consideration for the site specific conditions.

CHA recommends that immediately following seismic events resulting in 25% of the peak ground acceleration for a 500-year earthquake (i.e., 10% chance for exceedance in 50 years),  
redacted

### 4.4 Inspection Recommendations

CHA recommends that Georgia Power and Southern Company continue redacted  
that have been implemented for the ash pond. This type of  
redacted, which can reduce the risk of  
damaging releases or failures from occurring.

---

## 5.0 CLOSING

The information presented in this report is based on visual field observations, review of reports prepared by Southern Company Services, Inc. and this limited knowledge of the history of the Plant Bowen ash pond. 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.