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GZA
GeoEnvironmental, Inc.

Engineers and Scientists

September 16, 2009
GZA File No. 01.0170142.00

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Attention: Dr. Dennis Miller

Re: Task 3 Dam Assessment Report
Project #0-381
Allen Steam Station Coal Ash Retention Dam
Belmont, North Carolina

Dear Dr. Miller:

In accordance with our proposal 01.P0000018.10, dated May 8, 2009, GZA GeoEnvironmental, Inc. (GZA) has completed our inspection of the Allen Steam Station Coal Ash Retention Dam, located in Belmont, North Carolina. The site visit was conducted on June 12, 2009. The purpose of our efforts was to provide Lockheed Martin and the U.S. Environmental Protection Agency (EPA) with a site specific inspection of the dam to assist EPA in assessing the structural stability of the dam under the authority of the Comprehensive Environmental response, Compensation, and Liability Act (CERCLA) Section 104(e). We will submit one hard copy and one CD-ROM copy of this report directly to Lockheed Martin and EPA.

Based on our visual inspection, and in accordance with EPA's criteria, the dam is currently in **SATISFACTORY** condition, in our opinion. A further discussion of our evaluation and recommended actions are presented in the Task 3 Dam Assessment Report. The report includes a: (a) completed Coal Combustion Dam Inspection Checklist Form; (b) field sketch; and (c) selected photographs with captions. Our services and report are subject to the Limitations found in **Appendix A** and the Terms and Conditions of our contract agreement.

We are happy to have been able to assist you with this inspection and appreciate the opportunity to continue to provide you with dam engineering consulting services. Please contact the undersigned if you have any questions or comments regarding the content of this Task 3 Dam Assessment Report.

Sincerely,

GZA GeoEnvironmental, Inc.

Robert J. Palermo, P.E.
Senior Principal

Peter H, Baril
Project Director

William H. Hover
Consultant/Reviewer

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FINAL REPORT

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EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report presents the results of a visual dam inspection of the Allen Steam Station Coal Active Ash Basin North and East Dikes located off State Highway 273 in Belmont, North Carolina. The inspection was performed on June 11 and June 12, 2009 by representatives of GZA GeoEnvironmental, Inc (GZA).

The Allen Steam Station Coal Ash Retention East Dike has a maximum structural height of dam of approximately 75 feet, while the North Dike has a maximum structural height of 65 feet. In accordance with the U.S. Army Corps of Engineers (COE) guidelines, these structures are **Intermediate** size. However, under criteria listed in the North Carolina Dam Safety Regulations, they would be classified as **Large** size structures.

The Hazard Potential Classification for the Allen Steam Station Coal Ash Retention Dikes was **High** under the State of North Carolina criteria. It is our understanding that this classification designation was due to potential environmental damage due to sudden release of water from behind the dike. Under this inspection contract, the EPA's hazard classification sets potential environmental damage as a result of dam/dike failure as Significant Hazard. The High Hazard designation is for probable loss of human life and does not address environmental damage issues. Thus, by current EPA definition, the East and North Dikes have **SIGNIFICANT** hazard potential.

The dam was judged to be in **SATISFACTORY** condition, based on EPA criteria, in GZA's opinion.

The deficiencies at the dam that were noted during the current visual inspection include:

- Several historical scarps were observed on the upper downstream slope near the crest. These should be monitored and addressed by maintenance measures, including maintaining positive slope vegetation.

- Seepage was observed in several locations along the downstream slopes of both dikes. Standing water was observed near the 42-inch outlet pipe. Because of recent heavy rainfall at the time of the inspection, it is difficult to determine whether the standing water was from uncontrolled seepage through the dike or surface water flowing down the dike slope. Seepage should be monitored.

- Vegetation including low shrubs was observed in riprap and rock fill, and should be removed.

- Recent construction activity caused rutting in the embankment at Cell 1 should be repaired.

GZA recommends that the owner arrange for the following actions to be performed at the dam:

- A seismic stability and liquefaction analysis of the upstream and downstream embankment slopes and foundation should be conducted after surveying the actual configuration of the slopes. This is similar to a recommendation previously made to Duke Energy by S&ME, Inc. in their Seventh, Five-Year Independent Consultant Inspection Report, dated September 12, 2008.

- Engineered maintenance repairs of the scarps should be undertaken and a monitoring program implemented to detect potential stability or seepage issues.

- The piezometer data from all instruments should be collected, plotted, and evaluated. This includes piezometer and observation wells. In conjunction with this recommendation, an updated monitoring program should be developed.

- Observations of the upper downstream toe should be made during periods of low rainfall to determine whether the standing water observed at the toe was due to surface water runoff or internal seepage. Seepage conditions should be monitored regularly

- Regrading of the embankment near Cell 1 should be undertaken to repair damage to the dike due to ongoing construction activity. The embankment should be revegetated after construction is complete.

With respect to the Environmental Protection Agency's (EPA's) inquiry concerning whether any portion of the embankment was constructed upon coal ash slimes (known to GZA as TDF-5 and containing three specific questions), GZA provides the following response:

Question 1. "Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? - The east dike is built on natural ground or earth fill. The initial construction of the north dike was built on natural ground or earth fill. Overtime as the facility expanded ash was deposited such that it built up against the embankment geometry. To allow for additional ash storage, the north dike was raised and widened over several iterations. During the widening/raising(s) earth was placed over ash which prior to the widening/raising(s) had built up against the previous embankment geometry. Details of the raising/widening efforts are depicted on Drawing A-3350-1A which was provided by Duke Energy and reviewed by GZA. Typical cross sections of the East and North Dikes are depicted on the Law Engineering Testing Co. Figure 4 that has been included in the Figures section of GZA's inspection report.

Question 2. "Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?" - The inspection team did not meet with the original designer Law Engineering. In fact Law Engineering no longer exists. GZA did review several design level drawings provided to us by Duke Energy, but said drawing do not reference the firm that produced them.

Question 3. "From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?" - The central and western portions of the north dike experienced a failure during initial ash filling (circa 1982). This issue was remedied by the addition of stabilization berms and drainage blankets. Remediation work was also implemented at the east dike apparently because the results of borings and calculations undertaken to assess the north failure also indicated other potential stability problems and less than acceptable factors of safety. The geometry of the berms at both structures therefore was augmented as appropriate such that potential critical failure arcs where forced up the embankment to less critical areas between the top of the stability berm and the crest. It was reasoned that minor sloughing in these zones could be handled as routine maintenance.

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PREFACE

The assessment of the general condition of the dam is based solely upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

In reviewing this report, it should be noted that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team. In the case of cells 1-3, where an impoundment is lowered or fully or partially drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions, which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Prepared by:

GZA GeoEnvironmental, Inc.

NORTH CAROLINA PROFESSIONAL SEAL 26143 ENGINEER ROBERT J. PALERMO

9/15/09

Robert J. Palermo, P.E.
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ALLEN STEAM STATION COAL ASH RETENTION DAM
BELMONT, NORTH CAROLINA

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ALLEN STEAM STATION COAL ASH RETENTION DAM
GASTON COUNTY, NORTH CAROLINA

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1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The United States Environmental Protection Agency (EPA), through Lockheed Martin Corporation (LM), has retained GZA GeoEnvironmental, Inc. (GZA) to perform a visual inspection and develop a report of conditions for the Duke Energy Company (Owner) Allen Steam Station Coal Ash Retention Dam in Gaston County, North Carolina. This inspection and report were performed in accordance with Task 3 of Lockheed Martin Competitive RFP for Assessment of Dam Safety of Coal Combustion Surface Impoundments, EAC-0381, dated March 17, 2008. The inspection generally conformed to the requirements of the Federal Guidelines for Dam Safety[1], and this report is subject to the limitations contained in **Appendix A** and the Terms and Conditions of our Contract Agreement.

1.1.2 Scope of Work

The scope of our work that is described in this report includes a visual inspection and evaluation of the present condition of the dikes and appurtenant structures to:

- identify conditions that may adversely affect their structural stability and functionality
- note the extent of any deterioration that may be observed
- review the status of maintenance and needed repairs, and
- evaluate the conformity with current normally accepted design and construction practices.

The work was divided into four parts:

1. obtain and review available reports, investigations, and data previously submitted to the Owner pertaining to the dikes and appurtenant structures;
2. perform an on-site review of available design, inspection, and maintenance data and procedures for the management unit with the Owner;
3. perform a visual inspection of the site; and
4. prepare and submit a final report presenting the evaluation of the structure, including recommendations and proposed remedial actions.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in **Appendix D**. Many of these terms may be included in this report. The terms are presented under common categories associated with dams

[1] FEMA/ICODS, April 2004: http://www.ferc.gov/industries/hydropower/safety/guidelines/fema-93.pdf

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which include orientation, dam components, size classification, hazard classification, general and condition rating.

1.2 Description of Project

1.2.1 Location

The 1200 MW Allen Steam Station is located in Gaston County, North Carolina, about 4.5 miles southeast of Belmont. The site can be reached from Interstate 85 by taking exit 27 for North Carolina Highway 273 South. The entrance to the Allen Steam Station is at Plant Allen Road, approximately 6 miles south of I-85 on Highway 273. The location of Allen Steam Station Coal Ash Retention impoundment is shown in **Figure 1**. An aerial photograph of the dikes is provided as **Figure 2.** The general area downstream of the site is depicted in **Figure 3. As** discussed in Section 1.3.1, the approximate limits of the drainage area to the active basin are presented in **Figure 4.**

Allen Steam Station Coal Ash Retention "active" impoundment includes two dikes that are referred to on existing documents and throughout this report as the East Dike and the North Dike. Within the confines of these two dikes, there are four cells, subdivided by intermediate dikes/berms, as shown on **Figure 5**. Intermediate structures between Cells 1, 2, and 3, and the Polishing cell were constructed in 1995, but do not qualify as management units according to the definition presented in the Lockheed Martin LFP since these structures are located within the impoundments of the North and East Dikes.

The impoundment area is located approximately at latitude 35°10'34.7" North and longitude -81°00'34.3" West, as determined from Google Earth.

An inactive impoundment is located between the North Dike and the coal stockpile, as shown on **Figure 5**. This impoundment was being converted to a landfill for ash removed from the active impoundment area to the south of the North Dike.

1.2.2 Owner/Caretaker

The dam owner and caretaker are listed below:

	Dam Owner	Dam Caretaker
Name	Duke Energy Carolinas, LLC Fossil and Hydro Generation Dept.	Allen Steam Station
Mailing Address	PO Box 1006	253 Plant Allen Road
Town	Charlotte, NC 28201-1006	Belmont, NC 28012
Daytime Phone	(800) 777-9898	(704) 829-2800

1.2.3 Purpose of the Dam and Dikes

The active Allen Steam Station Coal Ash Retention impoundment is a retention pond for the disposal of coal ash, a by-product of the burning of coal for the generation of electricity. In the past, the coal ash was mixed with water and sluiced from the plant to the Coal Ash Retention Ponds. Currently, the plant employs a dry ash handling system, in which the ash is

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trucked to silos, where it is temporarily stored before either being landfilled or recycled. The pond contains residual ash from historic sluicing operations and some wet disposal into Cell 2 from yard drainage and occasional start-up operations after maintenance shut-downs.

1.2.4 Description of the Dam and Appurtenances

The basin is impounded to the east by the East Dike, which is approximately parallel to the Lake Wylie (formerly Catawba River) in a northerly-southerly orientation, and to the north by the North Dike, which has a generally east-west orientation. The crest of both dikes is at approximately elevation 645 MSL.

The East Dike is an approximately 3,200-foot long earthen structure that was originally built in 1973. An earthen berm was added to the downstream slope in 1982, based on static slope stability analyses, in order to improve the factor of safety against deep-seated slope instability. The width of the crest is approximately 15 feet. The slopes were constructed on an about 2H:1V (horizontal:vertical) grade. The 20-foot wide stability berm is at a 2.5H:1V slope with a crest at approximate elevation 620 feet. Based on the crest elevation of 645 feet MSL and the spillway outlet invert of 570 feet MSL, the structural height of the dam is 75 feet. Based on our review of a design drawing[2] for the East Dike, dated 1973, the dike foundation does not appear to have been constructed over wet ash, slag, or other unsuitable materials.

The North Dike was originally constructed in 1965 as an approximately 2400-foot long earthen embankment, to impound coal ash slurry in what is now a landfill to the north of the dike. The crest elevation was initially at 610 feet MSL, but was subsequently raised to 625 feet MSL and 645 feet MSL in 1968 and 1973, respectively, as the pond level was raised. The North Dike now serves as the north side of the "active" basin to the south. Like the East Dike, the North Dike has a crest width of about 15 feet, except along Cell 3, where the width is temporarily greater due to ongoing construction associated with removing coal ash for use as structural fill in the abutting landfills. The upstream slope is about 2H:1V and the downstream slope is about 3H:1V. The height of the North dike is about 65 feet, based on the elevation of the lowest point along the dam (580 feet MSL). Two berms were added to the North Dike in 1982-1983. They were constructed to address stability issues within the embankment. The upper berm is 15-foot wide with a top elevation of 630 feet and a 2.5H:1V slope. The lower berm's top elevation is 625 feet and is 25 feet wide. The slope of the downstream side (above, below, and between the berms) is 3H:1V. The slopes are grassed with occasional low shrubs along the dam. Our review of the design drawing[3] supplied by the operator, suggests that the North Dike current embankment configuration, as developed during Stage II construction, may have a portion of the foundation built over pre-existing coal ash. The geometry of the dike during its three stages of construction is shown on the Law Engineering Figure 4, that is included in the Figure section of this report.

The outlet/spillway structure is a drop inlet spillway with concrete stoplogs located at the southeast part of the reservoir. Flow is conveyed downstream by a 42-inch concrete pipe through the embankment that terminates on the shores of the Lake Wylie. Coal Ash slurry

[2] Duke Energy Co. – Plant Allen: "Ash Storage Basin Alterations – Sections & Details", Dwg. # A-3350-2, February 27, 1973.
[3] Duke Energy Co. – Plant Allen: "Ash Storage Basin Alterations – General Plan & Sections", Dwg. # A-3350 [Section E-E], dated October 1965.

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currently enters the reservoir through the Waste Water Sump Discharge pipes located at the northeast part of the reservoir, and from inflow pipes that flow directly into Cell 2.

1.2.5 Operations and Maintenance

Historically, sluiced ash from the Steam Station was deposited into the active ash basin. The water levels in the basin changed over time as the ash was dredged from the basin and disposed of off-site.

The Steam Station recently converted to a dry ash process. Therefore, inflow to the impoundment is limited to rainfall and a the relatively small amount of slurry resulting from cleaning of system residue in addition to bottom ash and pyrites, as well as residue from yard drainage. During periods when the dry process cannot be employed, wet sluicing procedures are temporarily utilized. The dry ash is currently being used in the landfill construction immediately to the north of the North Dike.

No written operations and maintenance plan for the dam was provided by Duke Energy. Operations and maintenance of the dam is performed by the Allen Steam Station operating personnel, who perform regular weekly drive-by inspections. The groundwater levels in existing observation wells are measured monthly by plant personnel. A Duke Energy Company registered professional engineer or consultant performs a yearly inspection, and an independent consultant performs the 5-year inspection of the dam and appurtenant structures required by the North Carolina Utility Commission (NCUC). The last annual inspection was performed in December and the last 5-year inspection was performed in September 2008.

1.2.6 Size Classification

According to previous reports, the East Dike has a maximum structural height of dam of approximately 75 feet and the North Dike has a maximum structural height of 65 feet. In accordance with the U.S. Army Corps of Engineers (COE) guidelines, these structures are **Intermediate** size. However, under criteria listed in the North Carolina Dam Safety Regulations, both dikes would be classified as **Large** size structures.

1.2.7 Hazard Potential Classification

The Hazard Potential Classification for the Allen Steam Station East and North Dikes was **High** under the State of North Carolina criteria. It is our understanding that this classification designation was due to potential environmental impacts associated with a sudden release of water and coal ash from behind the dikes. Under this inspection contract, the EPA's hazard classification sets potential environmental damage as a result of dam/dike failure as **Significant Hazard**. The High Hazard designation is for probable loss of human life and does not address environmental impacts. Thus, by current EPA definition, the East and North Dikes have **SIGNIFICANT** hazard potential.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

Based on our review of previous Five-Year Independent Consultant Inspection Reports, the contributing drainage area to the Allen Ash Storage Basins is just under 300 acres. The majority of the watershed to the basins is located on Duke Energy property. The watershed is

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generally industrial areas of the power plant property. The approximate watershed boundaries for the dam are presented in **Figure 4**. According to the most recent Five Year Inspection (2008) the surface area of the active ash basin is on the order of 160 acres at the crest elevation of 645 feet MSL.

1.3.2 Reservoir

The reservoir has undergone changes in size and storage capacity since original construction due to previous coal ash deposition. The reservoir currently consists of three cells that have generally rectangular shapes with the long sides running parallel to Lake Wylie.

Hydrologic and Hydraulic analyses conducted in 1983, and referenced in the 1987 inspection report, indicate that the spillway design pool for the ¾ PMP (Probable Maximum Precipitation) is 643.07, some 1.9 feet below the crest of the dike.

1.3.3 Discharges at the Dam Site

No records of flow are kept at the dam.

1.3.4 General Elevations

All elevations are taken from design drawings and reports provided by Duke Energy. Elevations are based upon the USGS topographic map MSL datum.

A.	Top of East Dike and North Dike	645.0±
B.	East Dike Spillway Crest	642.0±
C.	Normal Pool	642.0±
D.	Upstream Water at Time of Inspection	640-642± at north cell 635± at final treatment cell
E.	Downstream Water at Time of Inspection	Coincident with Lake Wylie

1.3.5 Main Spillway Data

A.	Type	Drop inlet with stoplogs
B.	Weir Length	two 4.5 ft weirs
C.	Stop logs typically set at	635 ± ft
C.	Upstream Outlet Invert	603.0 ft
C.	Downstream Outlet Invert	570.0 ft

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1.3.6 Design and Construction Records and History

Construction of the East Dike was completed by Burns and Spangler in 1973, and the downstream stabilizing berm was added in 1982. The East Dike is built on natural ground or earth fill. In 1983, sloughing of the upper portion of the upstream slope of the East Dike occurred in several areas, and rip-rap was installed as a remedial measure. Shallow sloughing of the upper portion of the downstream slope occurred at the south end of the east Dike in 1984, 1987 and 1990. Areas of instability and remedial work are indicated on drawing A-3350-1A prepared by Duke Power Company (Rev 12).

Remediation work was also implemented at the East dike apparently because the results of borings and calculations undertaken to assess the north failure also indicated other potential stability problems and less than acceptable factors of safety. The geometry of the berms at both structures therefore was augmented as appropriate such that potential critical failure arcs where forced up the embankment to less critical areas between the top of the stability berm and the crest. It was reasoned that minor sloughing in these zones could be handled as routine maintenance.

The initial construction of the North Dike was built on natural ground or earth fill. Overtime as the facility expanded ash was deposited such that it built up against the embankment geometry. To allow for additional ash storage, the North Dike was raised and widened over several iterations. During the widening/raising(s) earth was placed over ash which prior to the widening/raising(s) had built up against the previous embankment geometry. Details of the raising/widening efforts are depicted on Drawing A-3350-1A which was provided by Duke Energy and reviewed by GZA. Typical cross sections of the East and North Dikes are depicted on the Law Engineering Figure 4 that has been included in the Figures section of GZA's inspection report.

Emergency repairs were conducted in early 1982 involving the construction of stabilizing berms in the area of a slope failure of the downstream slope on the western part of the North Dike. A report issued in April 1982 by Law Engineering, concluded that the slope failure was likely caused by the build-up of "excessive pore pressures in a thin layer of permeable ash in contact with a permeable foundation and confined beneath the downstream slope of the dike". This failure had occurred after the water level had been raised to within two feet of the full pond level.

With respect to whether GZA's dam assessors met with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation, we offer the following:

- The inspection team did not meet with the original designer Law Engineering. In fact Law Engineering no longer exists as an independent company.
- GZA did review several design level drawings provided by Duke Energy. These drawings did not indicate the firm that produced them.

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1.3.7 Operating Records

There are no operating records for the impoundment. Fourteen monitoring wells (2 inoperable) are located within the dikes. Piezometers are located within the East Dike. These wells are read monthly according to Duke personnel.

1.3.8 Previous Inspection Reports

Independent consultant Inspection Reports from 1982 and 1987 were reviewed. The most recent 5-year Inspection Report was prepared in September 2008 by S&ME, Inc. of Arden, NC. S&ME concluded that the Dikes ***"… are currently operating in a satisfactory condition relative to immediate site and public safety."*** Maintenance activities were recommended to contribute to the long-term safety of the dikes. Additionally, engineering reports were recommended to find the source of seepage at the North Dike and to evaluate the stability of both embankments.

2.0 INSPECTION

2.1 Visual Inspection

The Allen Steam Station East and North Dikes were inspected on June 11 and 12, 2009 by Robert J. Palermo, P.E. and William H. Hover of GZA GeoEnvironmental, Inc. Also attending were Davy Simonson of EPA; Don Scruggs of Duke Power; Jen Laino, Allen Stowe, Stephen Immel, P.E., and Gary Blevins, P.E. of Duke Energy; and Larry Frost and A. Scott Harrell, P.E. of NCDENR.

At the time of the inspection, the weather was clear and sunny with temperatures in the in the high 70°'s Fahrenheit. Up to 3-4 inches of rain had fallen during the week prior to the inspection. Therefore, flow over the stoplogs was estimated to be higher than normal. The water elevation in the impoundment was approximately 640 to 642 feet in the northern cell and 635 feet at the polishing cell. Also, landfill Cells 1 and 2 were under construction; coal ash was being excavated from the north end of Cell 3 to provide structural fill for the landfill work; and Cell 2 was receiving coal ash slurry. The grass along the downstream slope of the entire East Dike and all but the west end of the North Dike was mowed within a few days of the inspection. We understand that the grass is mowed at least two times per year. Refer to **Figure 5** (Site Plan) for a more complete list of existing conditions at the time of GZA's inspection.

Photographs to document the current conditions of the North and East Dikes were taken during the inspection and are included in **Appendix B**. Locations of photos and observed deficiencies are shown in **Figures 6 and 7**. Some of the conditions noted at the time of the inspection are also noted on **Figures 5, 6 and 7.**

Underwater areas were not inspected, including the inside of the submerged outfall culvert, as this level of work is beyond GZA's scope of services. The inspection checklists prepared by GZA representatives based on observations during the site visit are included in **Appendix C**.

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2.1.1 General Findings

In general, Allen Steam Station Coal Ash Impoundment East and North Dikes were found to be in **SATISFACTORY** condition, based on EPA criteria noted in the attached Checklist (Appendix C). However, specific concerns are identified in the sections below.

2.1.2 East Dike

- Upstream Slope (Photos 2, 3, 5, 14 and 15)

  The upstream slope has a design slope of 2H:1V and has riprap to about 2 feet below the top of embankment. Shrubs and vegetation were observed around growing through the riprap around the waterline. The footbridge leading to the drop inlet was observed to be in satisfactory condition.

- Crest (Photos 1, 3, 5, 6, 9, 11, 12, 14, and 15)

  The crest of the dam runs in a generally straight alignment beginning at the east end of the North Dike and ending with a turn to the west in the area of the drop inlet spillway. The crest is approximately 15 feet wide and is surfaced with a gravel roadway.

- Downstream Slope (Photos 1, 4, 6-13, 16, 17, 21-28, and 30-40)

  The downstream slope of the dike consists of an upper section with a 2H:1V slope and a low section (stability berm) having a slope of 2.5H:1V. There is a 20-foot wide stability berm at elevation 620 feet. The slopes are grassed with occasional low shrubs along the dam. The toe of the embankment is of rockfill constituting the day lighted section of the blanket/toe drain that was constructed when the berm was added. The riprap was observed to be in good condition; clear seepage with a flow rate of less than one gallon per minute was observed at several areas along the rock toe drain. Ponded surface water was observed east of the downstream toe near the outlet and locally on the berm; this water is attributed to the recent heavy rains.

  Minor scarps have occurred on the upper part of the downstream slope. These scarps are located several feet below the crest and are attributed to shallow slip failures within the upper layers of soil. The scarps remain on the embankment, and appear to have caused minor bulging in the lower section of the 2H:1V slope (above the stability berm). They are reportedly periodically addressed as maintenance items.

2.1.3 North Dike

- Upstream Slope (Photos 58-60, 62, 63, 66, 73, and 74)

  The surficial conditions of the upstream slope of the North Dike vary due to the ongoing earthwork activities in the active Cells nos. 1, 2, and 3. The majority of the dike's upstream slope coincident with Cell 1 consists of primarily exposed ash

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with notable minor erosion due to surface runoff. Some short grass vegetation exists near the top of the slope. The upstream slope coincident with Cell 2 also exhibits minor surface erosion, but has more light vegetation taking hold on the slope. The slope at Cell 3 has recently been reworked and is devoid of any stabilizing vegetation treatment. As a result, a significant amount of surface erosion in the ash fill was observed. The upstream slope of the North Dike, in all cells, was set at an approximate slope of 2H:1V.

- Crest (50, 51, 56, 62, 65, 66, and 71)

  The top of the dam runs generally perpendicular to the Lake Wylie and abuts the East Dike at its eastern end. The embankment jogs to the south adjacent to Cell 1. The crest varies from approximately 15 to 35 feet wide due to ongoing construction activity consisting of excavation of coal ash from Cells 1 and 2.

- Downstream Slope (Photos 19, 20, 43-47, 52-54, 61, 62, 67-70, 72, 75, and 76)

  The downstream slope of the dam consists of an upper section which is the original 2H:1V slope, along with two stability berms that were constructed subsequently. The slope is grassed.

  Minor scarps have historically been observed on the upper part of the downstream slope. These scarps are located several feet below the crest and are attributed to shallow slip failures within the upper layers of soil. The scarps remain on the embankment, and appear to have caused minor bulging in the lower section of the 2H:1V slope (above the stability berm). The ongoing construction activity in Cell 1 has also created ruts on the downstream slope at the western end of the North Dike.

2.1.4 Appurtenant Structures (Photos 3, 29, and 31)

The water level in the polishing cell is controlled by a square concrete drop inlet structure that has two 4.5-foot long stoplog-controlled weirs. This structure was observed to be in good condition. The stoplog-controlled weirs are on the north and south (left and right) side of the drop inlet, and can accommodate precast concrete stop logs on two sides. The concrete appeared intact, and the stop logs had little signs of wear or spalling. The 42-inch discharge pipe to Lake Wylie could not be visually inspected, as water was discharging during the inspection.

2.2 Caretaker Interview

Maintenance of the dam is the responsibility of the Duke Energy operating plant personnel. Regular maintenance activity at the dam consists of periodic adjustment of the stoplogs to control the water quality in the pond, and mowing is performed two times per year by a subcontractor. A Duke Energy Company representative conducts regular weekly drive-by inspections of the dikes, and an independent consultant performs the 5-year inspection of the dam and appurtenant structures required by the North Carolina Utilities Commission (NCUC). In-house inspections are conducted on an annual basis and water level readings in observation wells are taken at approximately monthly intervals.

US EPA ARCHIVE DOCUMENT

2.3 Operation and Maintenance Procedures

No formal records of operation and maintenance procedure were available at the time of the inspection and were not necessary to undertake the current inspection.

2.4 Emergency Warning System

There is no Emergency Action Plan (EAP) developed for the dam. Given the dam's size and potential for adverse environmental consequences in the event of a partial/full breach, GZA recommends that an EAP be developed.

2.5 Hydrologic/Hydraulic Data

GZA did not perform an independent assessment of the hydraulics and hydrology for the dam as this was outside our contractual scope of work. An analysis from 1983 was provided from Duke's files. According to the 1983 report the maximum water surface elevation under the ¾ PMP (Probable Maximum Precipitation) is 643.07 feet. This results in a minimum freeboard of approximately 1.9 feet.

2.6 Structural and Seepage Stability

2.6.1 Structural Stability

Results of structural slope stability analyses have been summarized in previous inspection reports made available for the dikes from the Duke Energy files. The 2008 report indicated that adequate factors of safety against slope stability failure were found for static inundation. Seismic loading conditions have not been analyzed for either dike. The downstream berms were added to the original dikes to help increase the stability of the embankments after shallow failures had been observed. GZA recommends that liquefaction and seismic analyses be undertaken to evaluate the factor of safety against stability failure under extreme loads. Such evaluations were recommended in several previous 5-year inspection reports. Stability analyses should also consider the presence of coal ash below the North Dike, and the "lessons learned" from the recent TVA failure. GZA did not independently conduct structural stability or liquefaction analyses of these dikes.

2.6.2 Seepage Stability

During the visual inspection, potential seepage was observed as part of the downstream blanket drain system along the toe of the North Dike Berm and near the maximum section for the East Dike.

US EPA ARCHIVE DOCUMENT

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the overall condition of Allen Steam Station East and North Dikes is judged to be **SATISFACTORY**, based on EPA criteria. The dam was found to have the following deficiencies:

1. Several historical scarps were observed on the upper downstream slope near the crest. These should be monitored and addressed by maintenance measures, including maintaining positive slope vegetation.

2. Seepage was observed in several locations along the downstream slopes of both dikes. Standing water was also observed near the 42-inch outlet pipe. Because of recent heavy rainfall at the time of the inspection, it was not possible to assess whether the standing water was from uncontrolled seepage through the dike or surface water flowing down the dike slope. Seepage should be monitored during future weekly and annual inspections.

3. Ruts and gullies observed on the embankment of the North Dike along Cell 1, due to recent construction activity should be repaired.

4. Vegetation including low shrubs was observed in riprap and rock fill, and should be removed.

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dikes. Prior to undertaking recommended maintenance, repairs, or remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of the appropriate regulatory agencies.

3.2 Studies and Analyses

1. A seismic stability and liquefaction analysis of the upstream and downstream embankment slopes and foundation should be conducted after surveying the actual configuration of the slopes.

2. Engineered maintenance repairs of the scarps should be undertaken and a monitoring program implemented to detect potential stability or seepage issues.

3. The piezometer data from all instruments should be collected, plotted, and evaluated. This includes piezometer and observation wells. An updated monitoring program should be developed based on conditions observed during this inspection and performance history of the dikes during and after construction.

4. Observations of the upper downstream toe of the East Dike should be made during periods of low rainfall to determine whether the standing water observed at the toe was due to surface water runoff or internal seepage. Seepage conditions should be monitored regularly

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5. Since a portion of the North Dike is underlain with coal ash, slope stability analysis should be under taken if the site operator plans to proceed with land filling in Cells 1, 2 and 3.

3.3 Recurrent Maintenance Recommendations

GZA recommends no recurrent maintenance level activities that should be undertaken by the dam owner at this time.

3.4 Repair Recommendations

GZA recommends the following minor repairs which may improve the overall condition of the dam, but do not alter the current design of the dam. The recommendations may require design by a professional engineer and construction contractor experienced in dam construction.

1. Regrading of the ruts associated with the construction on the embankment near Cell 1 should be undertaken. The embankment should be revegetated after construction is complete.

3.5 Alternatives

There are no practical alternatives to the repairs itemized above.

4.0 ENGINEER'S CERTIFICATION

I acknowledge that the management unit referenced herein, the Allen Steam Station Coal Ash Impoundment East and North Dikes has been assessed on June 11 and 12, 2009.

Robert J. Palermo, P.E.
Senior Principal

William H. Hover
Senior Principal

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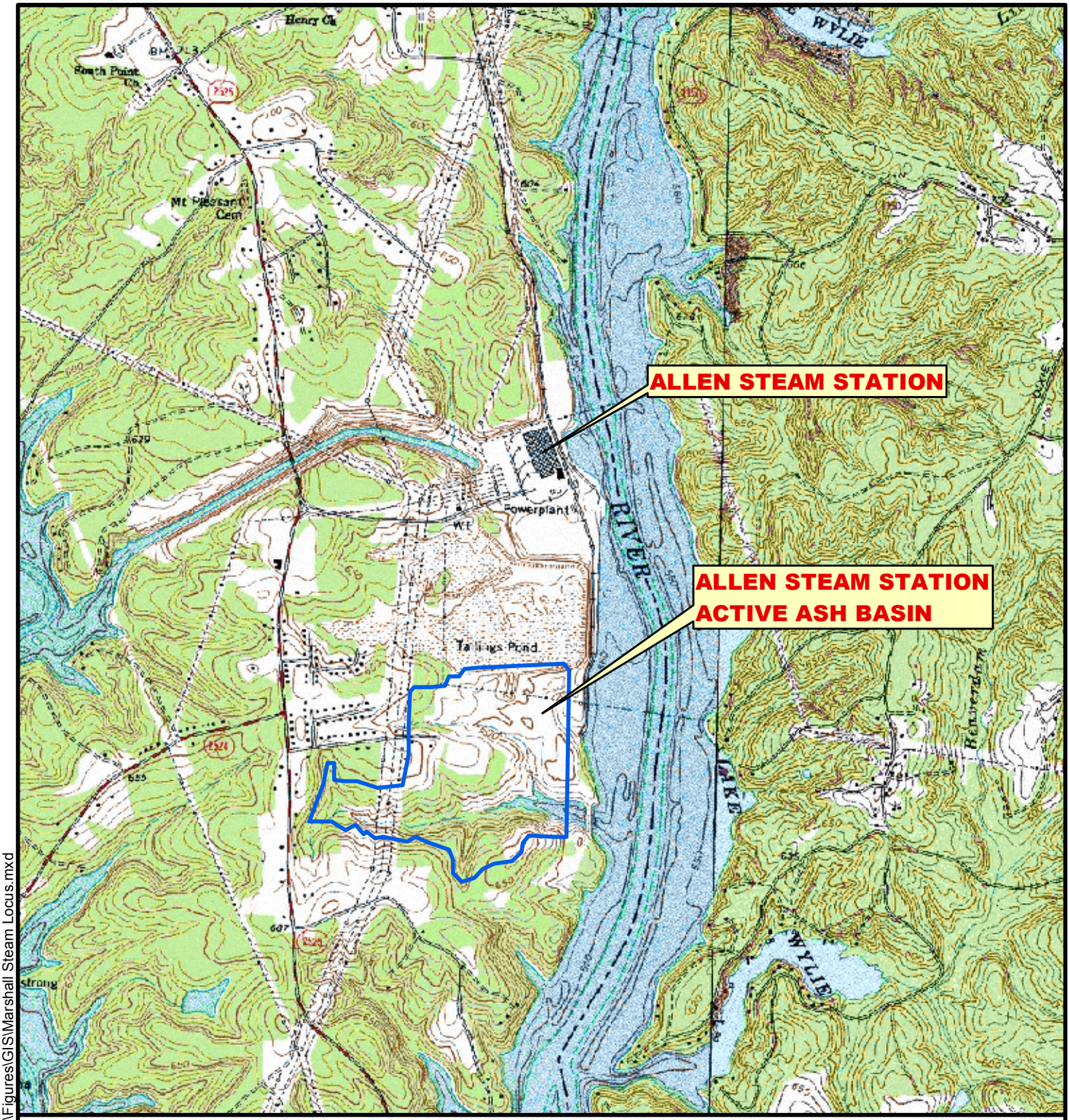
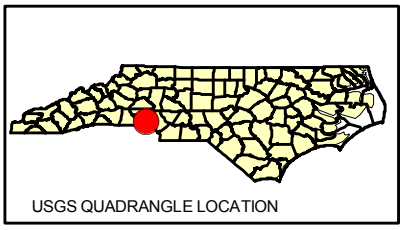
US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

FIGURES





SOURCE : SCANNED USGS TOPOGRAPHIC QUADRANGLES PROVIDED BY THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT).

0 1,000 2,000 4,000 Feet

N W E S

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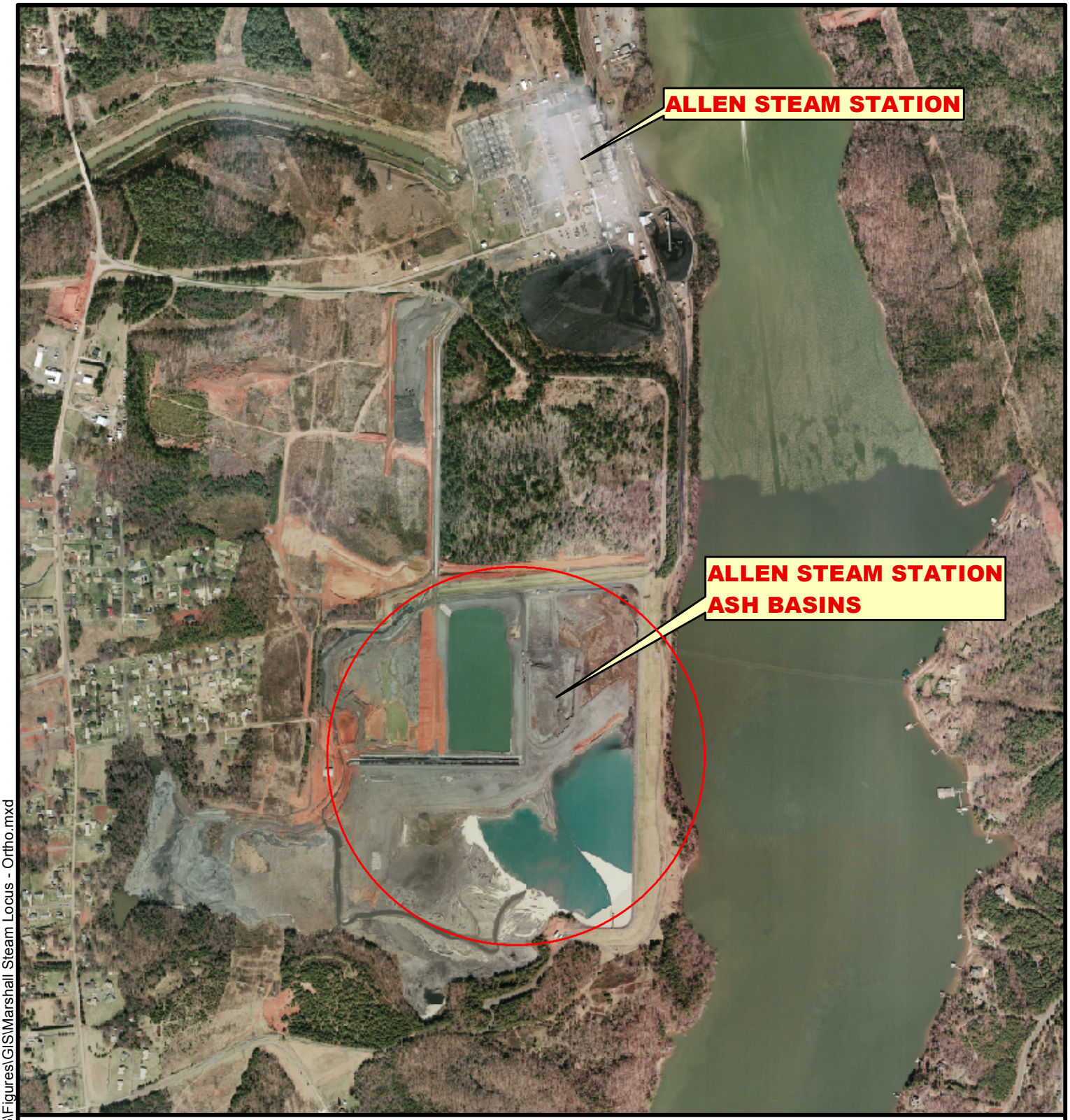
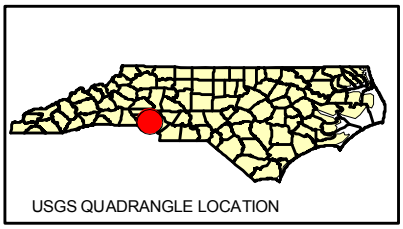
GZA	PROJ. MGR.: ABB DESIGNED BY: GAS REVIEWED BY: ABB OPERATOR: GAS DATE: 06-15-2009	USGS QUAD LOCATION MAP	JOB NO. 01.0170142.00
		ALLEN STEAM STATION GASTON COUNTY, NORTH CAROLINA	FIGURE NO. **1**





SOURCE : Centralina Council of Governments (CCOG), and Catawba County GIS Department, 20060626, Natural Color Orthophotography for Catawba County, NC: EarthData International, Inc, Frederick, MD 21704

0 500 1,000 2,000 Feet

N W E S

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GZA

PROJ. MGR.: ABB
DESIGNED BY: GAS
REVIEWED BY: ABB
OPERATOR: GAS

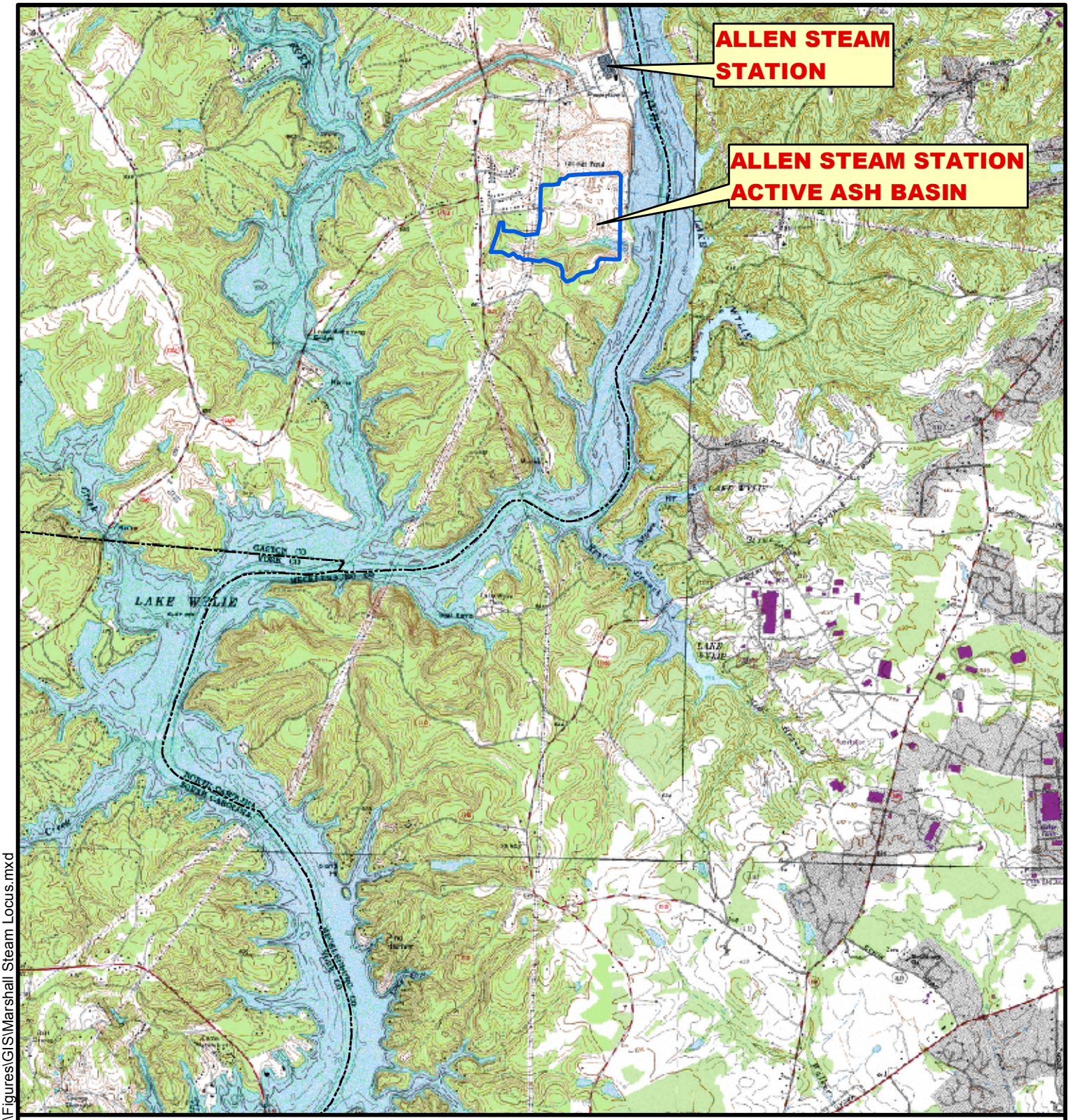
DATE: 06-15-2009

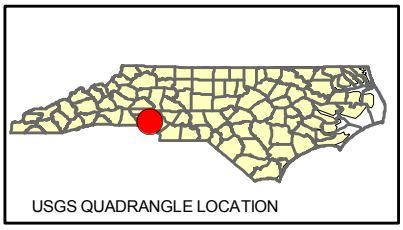
ORTHOPHOTO LOCATION MAP

ALLEN STEAM STATION
GASTON COUNTY, NORTH CAROLINA

JOB NO.
01.0170142.00

FIGURE NO.
2





SOURCE : SCANNED USGS TOPOGRAPHIC QUADRANGLES PROVIDED BY THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT).

0 2,000 4,000 8,000 Feet

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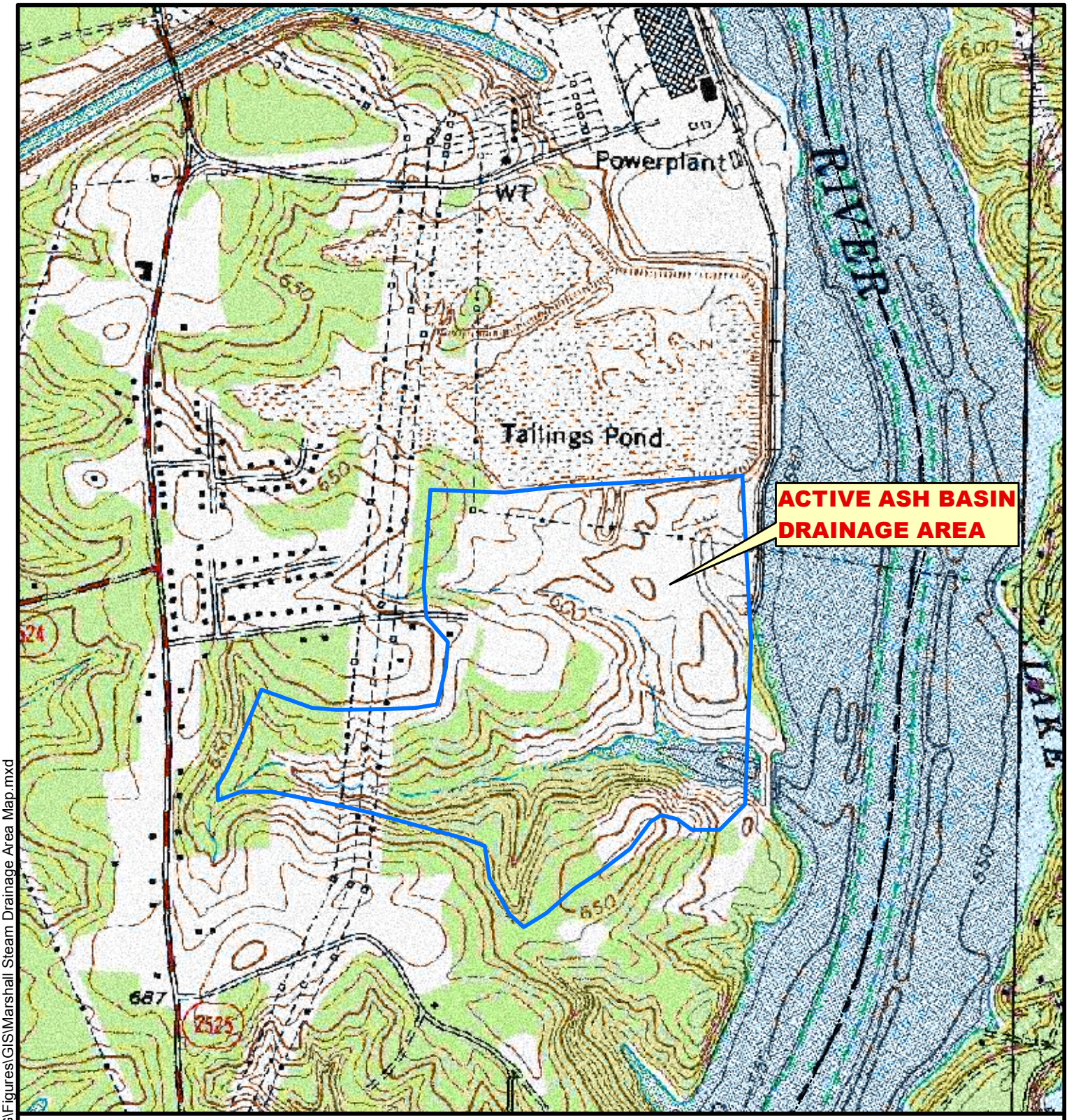
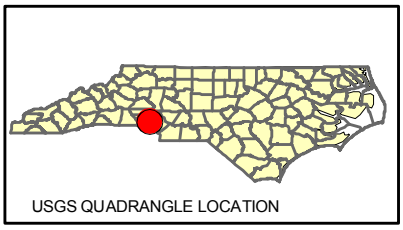
GZA	PROJ. MGR.: ABB DESIGNED BY: GAS REVIEWED BY: ABB OPERATOR: GAS DATE: 06-15-2009	DOWNSTREAM AREA MAP	JOB NO. 01.0170142.00
		ALLEN STEAM STATION GASTON COUNTY, NORTH CAROLINA	FIGURE NO. **3**





SOURCE : SCANNED USGS TOPOGRAPHIC QUADRANGLES
PROVIDED BY THE NORTH CAROLINA DEPARTMENT
OF TRANSPORTATION (NCDOT).

0 500 1,000 2,000 Feet

N W E S

GZA

PROJ. MGR.: ABB
DESIGNED BY: GAS
REVIEWED BY: ABB
OPERATOR: GAS

DATE: 06-17-2009

APPROXIMATE ACTIVE ASH BASIN
DRAINAGE AREA MAP

ALLEN STEAM STATION
GASTON COUNTY, NORTH CAROLINA

JOB NO.
01.0170142.00

FIGURE NO.
4

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US EPA ARCHIVE DOCUMENT

Conditions Noted at time of Site Visit:

1. Landfill Phase 1; Cells 1 and 2 under construction.
2. Coal ash was being excavated from North end of Cell 3 to provide structural fill for landfill construction.
3. Cell 2 was active and receiving coal ash slurry.
4. The pond level in Cell 1 was being lowered to perform survey/remedial work. Coal ash removed to approx.10 -15 feet below crest level at North end of cell.
5. Coal ash at north end of Cell 3 within 3-5 feet of embankment crest. Crest Elevation approx. 645.
6. Pond level in Polishing Cell at approx. Elevation 635.

Note: This Figure indicates the location of the East Dike and North Dike observed on June 11 and 12, 2009 and shows the designation of the cells used by the operator as part of the coal ash processing.

NOTE: AERIAL PHOTO DATE MARCH 2009.

0 175' 350' 700'

APPROXIMATE SCALE IN FEET

UNLESS SPECIFICALLY STATED BY WRITTEN AGREEMENT, THIS DRAWING IS THE SOLE PROPERTY OF GZA GEOENVIRONMENTAL, INC. (GZA). THE INFORMATION SHOWN ON THE DRAWING IS SOLELY FOR USE BY GZA'S CLIENT OR THE CLIENT'S DESIGNATED REPRESENTATIVE FOR THE SPECIFIC PROJECT AND LOCATION IDENTIFIED ON THE DRAWING. THE DRAWING SHALL NOT BE TRANSFERRED, REUSED, COPIED, OR MODIFIED IN WHOLE OR IN PART FOR ANY OTHER PURPOSE OR PROJECT. ANY TRANSFER, REUSE, OR MODIFICATION TO THE DRAWING SHALL BE AT THE USER'S OR SUCH OTHER PARTIES' SOLE RISK AND WITHOUT ANY RISK OR LIABILITY TO GZA.

ALLEN STEAM STATION

GASTON COUNTY, NORTH CAROLINA

OVERALL SITE PLAN

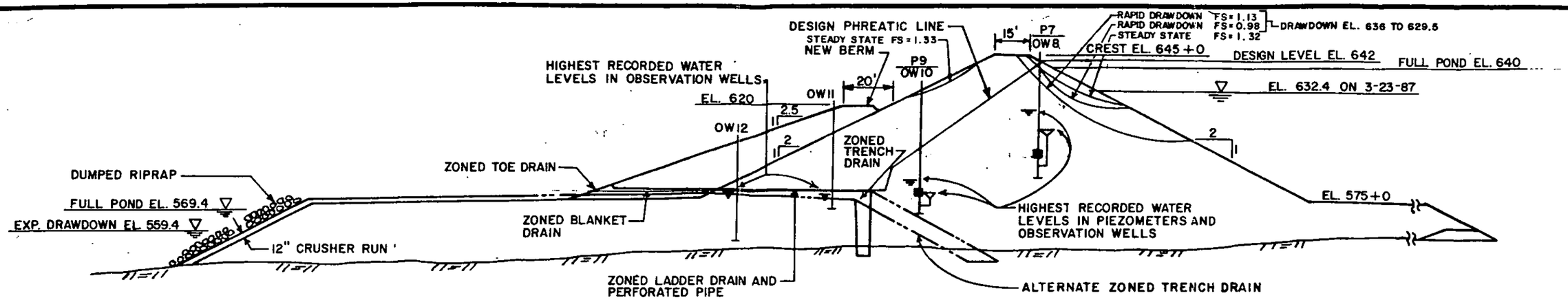
PREPARED BY:
GZA GeoEnvironmental, Inc. Engineers and Scientists
ONE EDGEWATER DRIVE
NORWOOD, MASSACHUSETTS 02062
(781) 278-3700

PREPARED FOR:

PROJ. MGR: JPG	REVIEWED BY: RBP	CHECKED BY: JPG	FIGURE
DESIGNED BY: GH	DRAWN BY: EMD	SCALE: AS NOTED	5
DATE: 06-26-2009	PROJECT NO. 01.0170142.00	REVISION NO.	

US EPA ARCHIVE DOCUMENT

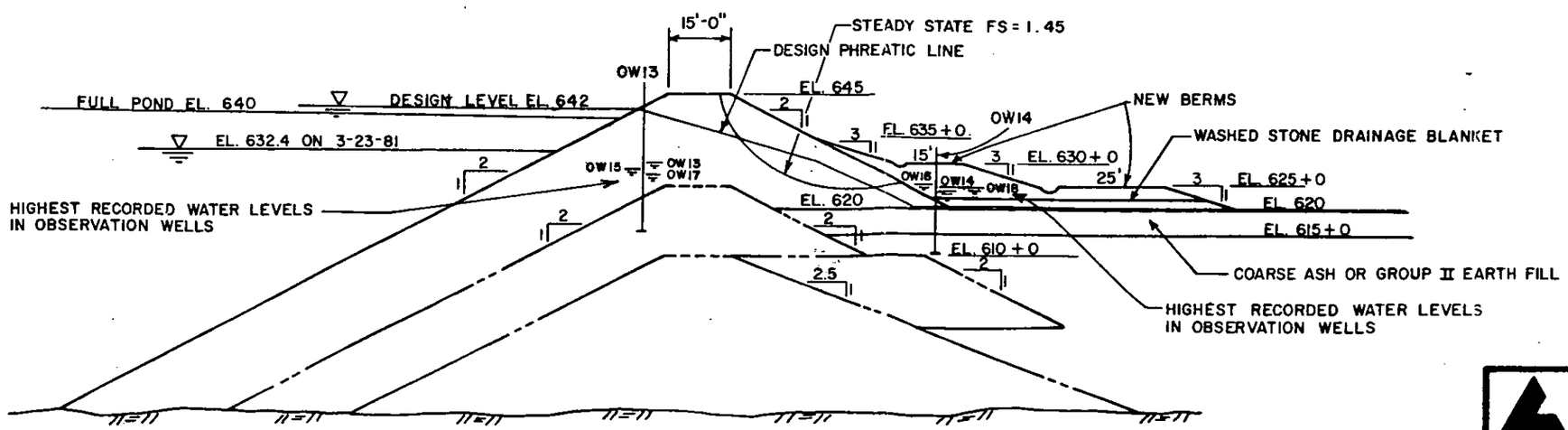
US EPA ARCHIVE DOCUMENT



SECTION A-A

EAST DIKE

SCALE: 1" = 50'



SECTION B-B

NORTH DIKE

SCALE: 1" = 30'

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

CROSS SECTIONS
NORTH AND SOUTH DIKES OF PRIMARY BASIN
ALLEN STEAM STATION
GASTON COUNTY, NORTH CAROLINA

JOB NO. CHW 5825 | FIGURE 4

US EPA ARCHIVE DOCUMENT

APPENDIX A

LIMITATIONS

DAM ENGINEERING & VISUAL INSPECTION LIMITATIONS

1. The observations described in this report were made under the conditions stated herein. The conclusions presented in the report were based solely on the services described therein, and not on scientific tasks or procedures beyond the scope of described services or the time and budgetary constraints imposed by Lockheed Martin.

2. In preparing this report, GZA GeoEnvironmental, Inc. (GZA) has relied on certain information provided by Lockheed Martin, Duke Energy Corporation (and their affiliates) as well as Federal, state, and local officials and other parties referenced therein. GZA has also relied on certain information contained on the State of North Carolina's Dam Safety Program website as well as Federal, state, and local officials and other parties which were available to GZA at the time of the inspection. Although there may have been some degree of overlap in the information provided by these various sources, GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this work.

3. In reviewing this Report, it should be noted that the reported condition of the dam is based on observations of field conditions during the course of this study along with data made available to GZA. The observations of conditions at the dam reflect only the situation present at the specific moment in time the observations were made, under the specific conditions present. It may be necessary to reevaluate the recommendations of this report when subsequent phases of evaluation or repair and improvement provide more data.

4. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions may be detected.

5. Water level readings have been reviewed and interpretations have been made in the text of this report. Fluctuations in the level of the groundwater and surface water may occur due to variations in rainfall, temperature, and other factors different than at the time measurements were made.

6. GZA did not perform an assessment of the hydraulics and hydrology or embankment stability for the dam as these were outside our scope of services. Comments on this subject in the report are referenced from an uncredited analysis located in Duke Energy's internal files.

7. This report has been prepared for the exclusive use of Lockheed Martin for specific application to the existing dam facilities, in accordance with generally accepted dam engineering practices. No other warranty, express or implied, is made.

8. This dam inspection verification report has been prepared for this project by GZA. This report is for broad evaluation and management purposes only and is not sufficient, in and of itself, to prepare construction documents or an accurate bid.

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US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

APPENDIX B

PHOTOGRAPHS

US EPA ARCHIVE DOCUMENT

 # 1 Southern Crest & Downstream Slope of East Dike – Local Reseeded Area

#2 Overview of Polishing Cell

#3 Upstream Slope & Bridge to Drop Inlet Structure

US EPA ARCHIVE DOCUMENT

#4 Local Erosion on Top of Downstream Stability Berm – Southern Portion of East Dike

#5 Overview of Crest & Upstream Slope of East Dike – Polishing Cell

#6 Crest & Downstream Slope of East Dike

US EPA ARCHIVE DOCUMENT

#7 Downstream Berm & Toe Area of East Dike – Southern Portion Lake Wylie at Downstream Toe

#9 Southern Portion of Crest & Downstream Slope of East Dike – Note Ponded Water on Berm

#8 Ponded Water on Bench of Downstream Stability Berm of East Dike

#10 Southern Downstream Slope of East Dike - Note Local Scarps in Upper Slope

US EPA ARCHIVE DOCUMENT

#11 Maximum Section Portion of East Dike –
Note Wet Area at Toe and Local Berm Erosion

#13 Eroded Area of Downstream Toe Road from Operations due to Installation of Chain Link Fencing and Mowing

#12 North End of East Dike: Cell No. 3
Note Cell is Full to Design Grade – Elev. 640 or above

#14 Northern Ash Retention Cell 3

US EPA ARCHIVE DOCUMENT

#15 Crest of East Dike Looking South - Satisfactory Alignment

#17 Northern Portion of Downstream Slope of East Dike

#16 Wastewater Sump Discharge Pipes @ Cell 3

#18 New Ash Landfill Construction

US EPA ARCHIVE DOCUMENT

#19 Overview of Crest & Downstream Slope of North Dike

#20 Overview of Central Portion of North Dike

#21 Stability Berm at North End of East Dike

#22 Stability Berm and Downstream Slope of East Dike

US EPA ARCHIVE DOCUMENT

#23 Northern End of East Dike - Note Stability Berm Extends Over Transmission Tower

#25 Scarp on Upper Portion of Downstream Slope of East Dike

#24 Note Seepage/Ponded Surface Water at Downstream Toe of North Dike

#26 Piezometers and Observation Wells Along Toe Stability Berm at South End of East Dike. (Note Standing Water at Toe)

US EPA ARCHIVE DOCUMENT

#27 Note Minor Bulging of Lower Portions – Upper Slope Above Stability Berm of East Dike

#29 Drop Inlet Structure - Note Concrete Stop Logs and Crane

#28 Riprap at Downstream Toe of East Dike - Southern Portion

#30 Overview of Downstream Toe of East Dike Near Maximum Section

US EPA ARCHIVE DOCUMENT

#31 Discharge at Outlet Pipe

#33 Overview of Downstream Slope of East Dike – Maximum Section

#32 Ponded Surface Water East of Downstream Toe Near Outlet

#34 Minor Local Clear Seepage Discharges from Downstream Rock Toe at South End of East Dike

US EPA ARCHIVE DOCUMENT

#35 Seepage Collection Area Near Maximum Section of Downstream Toe of East Dike

#36 Local Minor Seepage & Standing Drainage Flow at Downstream Toe of South End at East Dike

#37 Seepage Area Near Maximum Section of East Dike

US EPA ARCHIVE DOCUMENT

#38 Downstream Toe of East Dike Access Road – Rutting from Construction Equipment

#39 Local Erosion / Rutting of Downstream Toe Road. Near Central Portion of East Dike

#40 Downstream Toe Road at North End of East Dike - Erosion

US EPA ARCHIVE DOCUMENT

#41 Shoreline on Opposite Bank of Tailwater Impoundment – Lake Wylie – Note Development

#43 Stabilizing Berm from Crest

#42 Shoreline on Opposite Bank of Tailwater Impoundment – Lake Wylie

#44 Upper Berm of North Dike - 15 Feet Wide @ Elev. 630

US EPA ARCHIVE DOCUMENT

#45 Downstream Toe of North Dike

#47 Lower Berm of North Dike – 25-Foot-Wide Berm @ Elev. 625

#46 Local Erosion @ Toe of Crushed Stone Drainage Material

#48 Inlets of Sluice Pipes - Pool Elev. 635 +/- in Cell 2

US EPA ARCHIVE DOCUMENT

#49 Pool at Elev. 635 in Cell 2

#51 Widened Crest in Cell 3 to Create Haul Road.
Width Increased from 15 to about 45 Feet.

#50 Pipes Used for Sluicing

#52 Overview of Downstream Slope from a Point Near Construction Ramp

US EPA ARCHIVE DOCUMENT

#53 Downstream Slope of North Dike (Central Area)

#55 Drop Inlet for Retained Ash Basin

#54 Downstream Slope of North Dike (Note Evidence of Prior Scarps)

#56 Widened Upstream Crest (to 45 Feet) to Create Haul Road

US EPA ARCHIVE DOCUMENT

#57 Cell 3 Excavated to About 20-Foot Depth. No Water Impounded Due to Dewatering by Pumping.

#58 Upstream Slope of Cell 3. Ash Excavated to Depth of About 20 Feet. No Water Impoundment

#59 Erosion in Ashfill in Upstream Excavated Slope of Cell 3

US EPA ARCHIVE DOCUMENT

#60 Dewatered Cell 3, Ash Excavated to up to 20-Foot Depth

#62 Crest of Western Portion of North Dike

#61 Overview of Central Portion of North Dike

#63 Western Bend in North Dike at Cell 1 - Note Erosion in Upstream Slope of Ashfill

US EPA ARCHIVE DOCUMENT

#64 Cell 1 Dewatering

#66 Local Erosion Near Crest of North Dike

#65 Overview Crest of North Dike at West End

#67 Erosion at Downstream Slope of North Dike

US EPA ARCHIVE DOCUMENT

#68 Ponded Water Near Downstream Toe of North Dike

#70 Downstream Slope Near Western Limit of North Dike

#69 Ponded Surface Drainage & Seepage Near Transmission Tower at West End of North Dike

#71 Rutting in Crest at West End of North Dike

US EPA ARCHIVE DOCUMENT

#72 Area to Improve Drainage at West End of North Dike

#74 Excavated Ash & Pool Elev. 635 in Cell 1

#73 Cell 1 Partially Excavated Ash on Upstream Side of Dike – Note Surface Erosion on Dike Slope

#75 Cut Into Downstream Toe of North Dike For Pipe Installation

US EPA ARCHIVE DOCUMENT

#76 Erosion Adjacent to Road Along Downstream Toe of North Dike

US EPA ARCHIVE DOCUMENT

APPENDIX C

EPA INSPECTION CHECKLISTS

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	Allen Steam Station	Date:	June 12, 2009
Unit Name:	East Dike	Operator's Name:	Duke Energy Carolinas LLC
Unit I.D.:	Active Ash Basin	Hazard Potential Classification:	High Significant Low
Inspector's Name:	Robert J. Palermo, P.E., and William H. Hover		

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?	Yes		18. Sloughing or bulging on slopes?	✓	
2. Pool elevation (operator records)?	Yes		19. Major erosion or slope deterioration?		✓
3. Decant inlet elevation (operator records)?	Yes		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		✓
5. Lowest dam crest elevation (operator records)?	Yes		Is water exiting outlet, but not entering inlet?		✓
6. If instrumentation is present, are readings recorded (operator records)?	✓		Is water exiting outlet flowing clear?	✓	
7. Is the embankment currently under construction?		✓	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)?		✓	From underdrain?	✓	
9. Trees growing on embankment? (If so, indicate largest diameter below)		✓	At isolated points on embankment slopes?	✓	
10. Cracks or scarps on crest?		✓	At natural hillside in the embankment area?		✓
11. Is there significant settlement along the crest?		✓	Over widespread areas?		✓
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?		✓
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		✓	"Boils" beneath stream or ponded water?		✓
14. Clogged spillways, groin or diversion ditches?		✓	Around the outside of the decant pipe?		✓
15. Are spillway or ditch linings deteriorated?		✓	22. Surface movements in valley bottom or on hillside?		✓
16. Are outlets of decant or underdrains blocked?		✓	23. Water against downstream toe?		✓
17. Cracks or scarps on slopes?	✓		24. Were Photos taken during the dam inspection?	✓	

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

1. Inspection by plant personnel frequently by drive-by methods. Inspections every 5 years by independent consultant per NCUC requirements
2. Pool at Elev. 635 in final treatment cell; ash at Elev. 640-642 (design) in north cell where pool is at ash surface or slightly above.
3. Drop inlet in south final finishing cell, hydraulic control by concrete stop logs. 42-inch discharge pipe to Lake Wylie/Catawba River.
4. No open channel spillway structure.
5. Constructed to Elev. 645 originally in 1973.
6. Instrumentation - observation wells and piezometers - recorded monthly by plant personnel.
9. No trees on embankment. Mowed two times per year.
12. No decant trashracks observed.
17. Minor scarps at several locations that appear to have been in place for years based on prior inspection reports. Located several feet below crest in upper downstream slopes, apparently due to shallow slip surfaces in 2H:1V slopes.
Stability berms (top elev. 620) constructed in 1983 to improve factor of safety against deep-seated instability, along with internal drainage comprised of a zoned drainage blanket beneath the berm and rock toe drain. Slope below 20-foot-wide berm was 2.5H:1V slope vs original 2H;1V slope.
18. Pre-existing scarps in upper downstream slopes resulted in minor bulging of the lower slopes, 2H:1V above the stability berm. Previous owner decision to address shallow slope sloughing above stability berm and below crest by ongoing maintenance.
21. Quantity of clear seepage observed at downstream toe in several areas, primarily near maximum section, estimated less than 1 gallon per minute (gpm)
Appears to emanate from base of riprap toe and drainage blanket under stability berm.
Isolated seepage at intersection of stability berm and upper slope < 0.1 gpm.
Some standing surface water locally on berm and downstream toe area likely due to recent heavy rains.
24. Refer to photographs for illustrations of observed surficial conditions during visual inspection on June 11, 2009.
NOTE: Recommendations of 9/12/08 Five Year Report of S&ME should be addressed, including liquefaction analyses.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # NC 0004979 INSPECTOR R. Palermo, P.E. & W. Hover

Date June 11, 2009

Impoundment Name Allen Steam Station - East Dike - Active Ash Basin

Impoundment Company Duke Energy Carolinas LLC

EPA Region 4

State Agency (Field Office) Addresss North Carolina Utilities Commission (NCUC)

Name of Impoundment Allen Steam Station - East Dike - Active Ash Basin

(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: Ash Retention Dam/Basin

Nearest Downstream Town : Name Charlotte

Distance from the impoundment 1 mile (residential area)

Impoundment Location:

Longitude 81 Degrees 00 Minutes 34.3 Seconds

Latitude 35 Degrees 10 Minutes 45.7 Seconds

State NC County Gaston

Middle of E. Dike Impoundment

Does a state agency regulate this impoundment? YES x NO _____

If So Which State Agency? North Carolina Utility Commission

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.

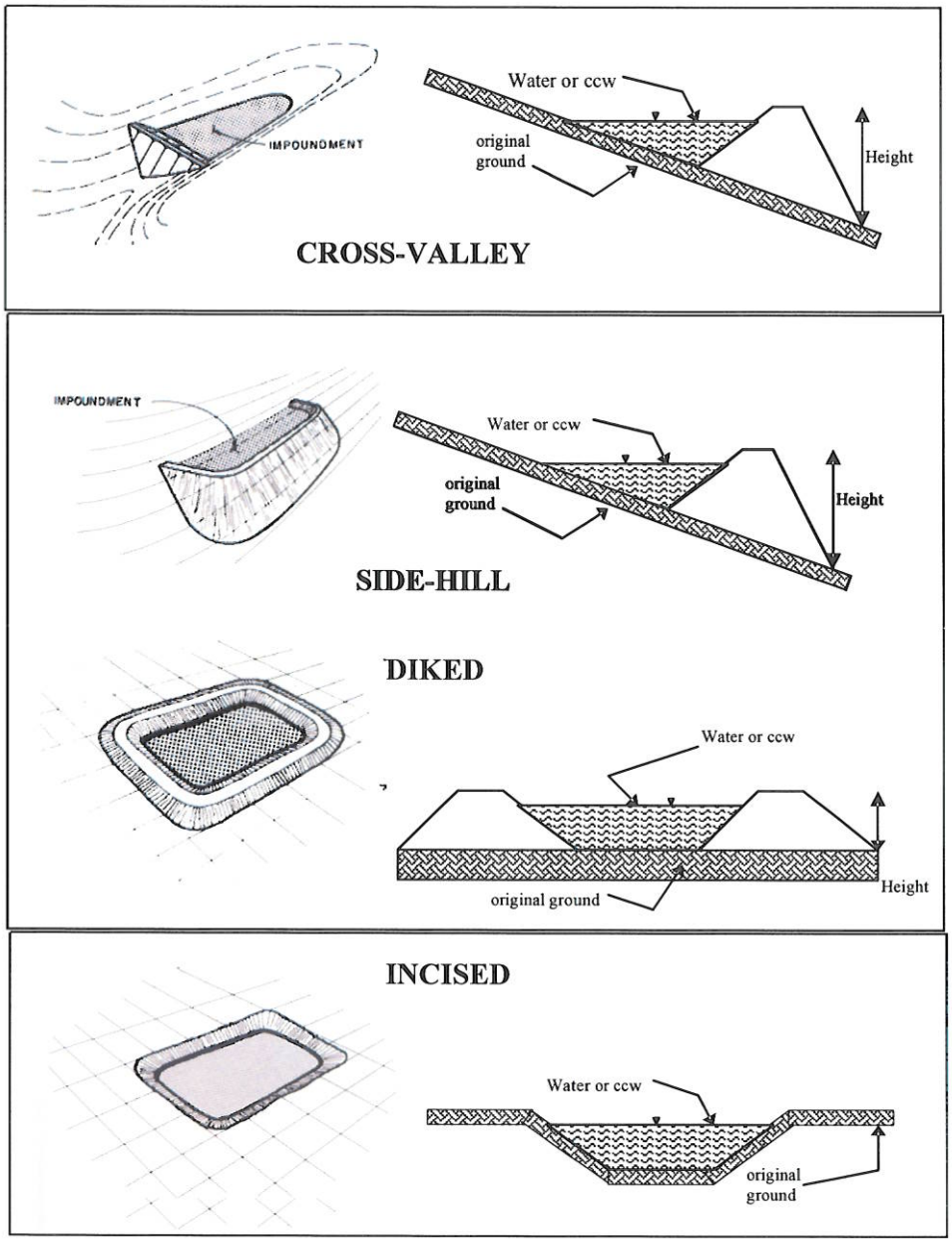
_____ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

Dam classified by North Carolina Department of Environmental and Natural Resources (NCDENR) as "low hazard potential" from a structural perspective and "high hazard" from an environmental damage perspective.

Given the above criteria for hazard potential, and in consideration of NCDENR's hazard classification, it appears that "significant hazard potential" would be consistent for the purposes of this visual inspection.

CONFIGURATION:



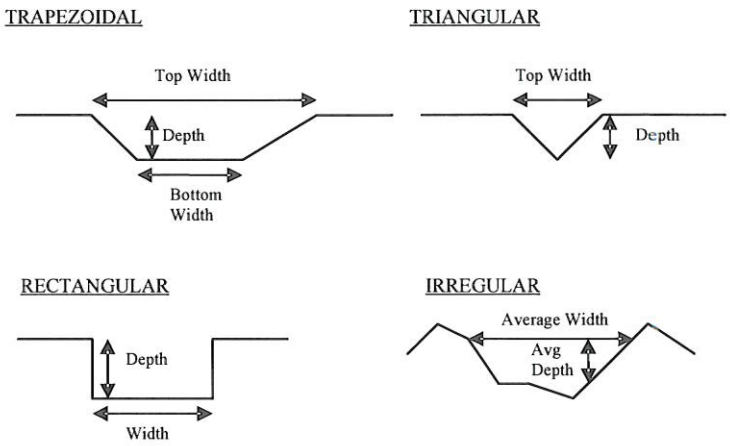
__x__ Cross-Valley
_____ Side-Hill
_____ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

Embankment Height 75 feet Embankment Material compacted earth
Pool Area 160 Acres at El. 645 acres Liner None
Current Freeboard 3 to 25 feet Liner Permeability N/A

TYPE OF OUTLET (Mark all that apply)

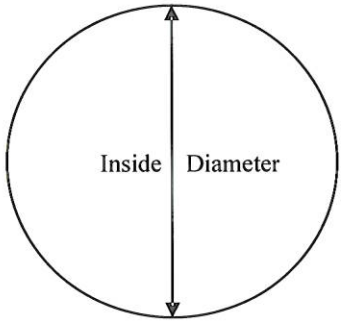
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

_____ depth
_____ bottom (or average) width
_____ top width
X drop inlet w/stop logs



X **Outlet**

42 in. inside diameter



Material
_____ corrugated metal
_____ welded steel
_____ concrete
_____ plastic (hdpe, pvc, etc.)
X other (specify) reinforced concrete
Inv. elev. 570

_____

Is water flowing through the outlet? YES X NO _____

X **No Outlet**

_____

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

The Impoundment was Designed By Unknown

Has there ever been a failure at this site? YES x NO _____

If So When? 1982 - 1983

If So Please Describe :

* Based on review of 5 year independent inspection reports, which are required by North Carolina Utility Commission, there was a relatively shallow failure of a 300-foot-long section of the upstream slope of the East Dike between Stations 54 and 25 and 57 and 25 in December 1982, or January 1983. The failure was believed to be triggered by loss of soil support due to wave erosion. Between summer 1983 and 1985, the upstream slope was blanketed with riprap underlain by washed stone and then filter fabric.

* Shallow slumps in the upper downstream slope at and near the bend of the south end were repaired in 1983-1984.

* Based on engineering stability analyses in 1982, a 20-foot-wide stabilizing berm was constructed on the downstream slope of the East Dike in 1982-1983. The berm slope was constructed at 2.5H:1V, flatter than the original 2H:1V slope. A zoned blanket drain with toe drain was constructed under the East Dike berm.

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

If So When? _____

IF So Please Describe: _____

Based on review of 5 year inspection reports, 1982-2008 observed seepage has been clear and of low quantities. This was confirmed by Messrs. Scruggs and Blevins of Duke Energy.

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

If so, which method (e.g., piezometers, gw pumping,...)? Piezometers, Obs. Wells, Blanket and Toe Drain

If so Please Describe :

* A blanket and toe drain was constructed as part of the 1982-1983 stability berm construction (see P. 5).

* In 1986, observation wells and piezometers were installed for long-term monitoring of water levels in the East Dike. Locations were within the areas of historical slope stability issues mentioned on P. 5.

* Monitoring of these instruments is ongoing by Duke and data is plotted and summarized periodically.

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	Allen Steam Station	Date:	June 12, 2009
Unit Name:	North Dike	Operator's Name:	Duke Energy Carolinas LLC
Unit I.D.:	Active Ash Basin	Hazard Potential Classification:	High Significant Low
Inspector's Name:	Robert J. Palermo, P.E., and William H. Hover		

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?	Yes		18. Sloughing or bulging on slopes?	✓	
2. Pool elevation (operator records)?	Yes		19. Major erosion or slope deterioration?		✓
3. Decant inlet elevation (operator records)?	Yes		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		✓
5. Lowest dam crest elevation (operator records)?	Yes		Is water exiting outlet, but not entering inlet?		✓
6. If instrumentation is present, are readings recorded (operator records)?	✓		Is water exiting outlet flowing clear?	✓	
7. Is the embankment currently under construction?		✓	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)?		✓	From underdrain?	✓	
9. Trees growing on embankment? (If so, indicate largest diameter below)		✓	At isolated points on embankment slopes?	✓	
10. Cracks or scarps on crest?		✓	At natural hillside in the embankment area?		✓
11. Is there significant settlement along the crest?		✓	Over widespread areas?		✓
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?		✓
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		✓	"Boils" beneath stream or ponded water?		✓
14. Clogged spillways, groin or diversion ditches?		✓	Around the outside of the decant pipe?		✓
15. Are spillway or ditch linings deteriorated?		✓	22. Surface movements in valley bottom or on hillside?		✓
16. Are outlets of decant or underdrains blocked?		✓	23. Water against downstream toe?		✓
17. Cracks or scarps on slopes?	✓		24. Were Photos taken during the dam inspection?	✓	

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

1. Inspections by plant personnel using drive-by methods, regularly. Inspections every 5 years by independent consultant, per NCUC requirements.
2. Cells 1 and 3 dewatered and excavating ash for re-use as structural fill at new landfill. Cell 2 receiving tailings - estimated tailings pool at Elev. 635. Filled with ash along North Dike.
3. Decant inlet estimated at Elev. 635.
4. No open channel spillway structure.
5. North Dike constructed in 3 phases - crest Elev. 610 in 1965 to 645 in 1973 with stabilizing berms. Served formerly as south dike for Retired Ash Basin.
6. Instrumentation observation wells and piezometers recorded monthly by plant personnel.
9. No trees on embankment. Mowed two times per year.
17. Minor scarps in upper portions of downstream slope that appear to have been in place for years based on review of prior inspection reports. Located several feet below crest, apparently due to shallow slip surfaces and sloughing of upper portions of slope locally.
Two stability berms (top elevs. 630 and 625) constructed in 1982-1983 to improve factor of safety against deep-seated instability. The width of the upper berm is 15 ft. and of the lower berm is 25 ft. with slopes flattened to 3H:1V between the berms and extending up from the upper berm and down from the lower berm also at 3H:1V. Internal drainage was provided under the berm, including a filter fabric wrapped blanket drain of washed stone under the berm.
18. Pre-existing scarps in upper downstream slopes resulted in minor bulging of the lower slopes, 2H:1V above the upper stability berm at Elev. 630. Previous owner decision to address shallow slope failures/sloughing above upper stability berm and below crest by ongoing maintenance. Substantial erosion on crest and upstream slope near transmission tower due to ash excavation operations. Also downstream toe erosion this area.
21. Minor clear seepage existing blanket drain at downstream toe. Clear seepage and standing water near transmission tower may be addressed by toe drainage and swale discharging beneath road.
24. Refer to photographs for illustration of observed conditions during visual inspection on June 11-12, 2009.
Note: Recommendations of 9/12/08 Five Year Report of S&ME should be addressed, including liquefaction analysis.
Note: Top of dike rutted due to recent construction activity along Cells 1 and 2.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # NC0004979 INSPECTOR W. Hover & R. Palermo, P.E.

Date June 12, 2009

Impoundment Name Allen Steam Station - North Dike - Active Ash Basin

Impoundment Company Duke Energy Carolinas LLC

EPA Region 4

State Agency (Field Office) Addresss North Carolina Utilities Commission (NCUC)

Name of Impoundment Allen Steam Station - North Dike - Active Ash Basin

(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: Ash Retention Dike/Basin

Nearest Downstream Town : Name Charlotte

Distance from the impoundment 1 mile (residential area)

Impoundment Location:

Longitude 81 Degrees 00 Minutes 34.3 Seconds Middle of Impoundment

Latitude 35 Degrees 10 Minutes 45.7 Seconds

State NC County Gaston

Does a state agency regulate this impoundment? YES x NO _____

If So Which State Agency? North Carolina Utility Commission

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.

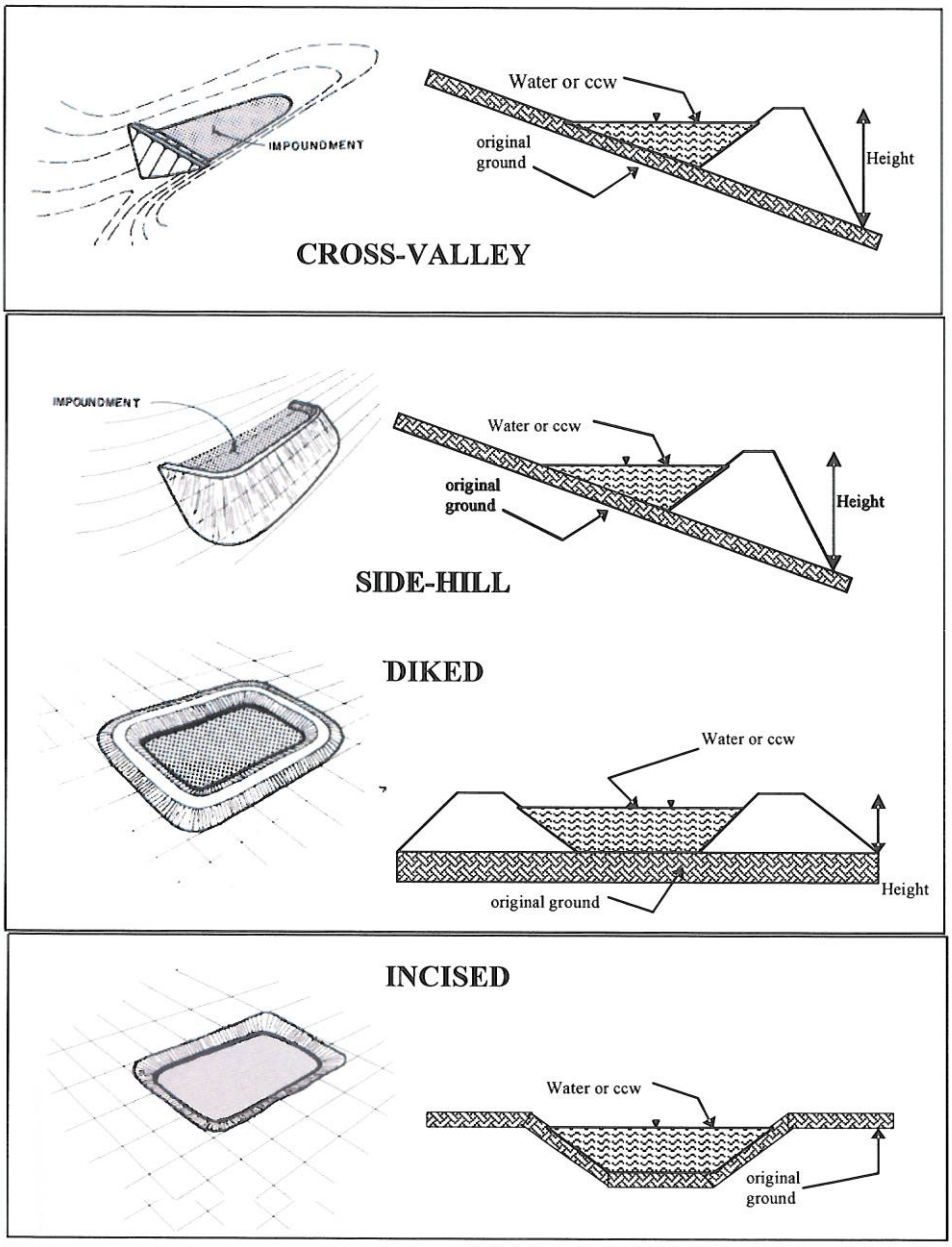
_____ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

Dam classified by North Carolina Department of Environmental and Natural Resources (NCDENR) as "low hazard potential" from a structural perspective and "high hazard" from an environmental damage perspective.

Given the above criteria for hazard potential, and in consideration of NCDENR's hazard classification, it appears that "significant hazard potential" would be consistent for the purposes of this visual inspection.

CONFIGURATION:



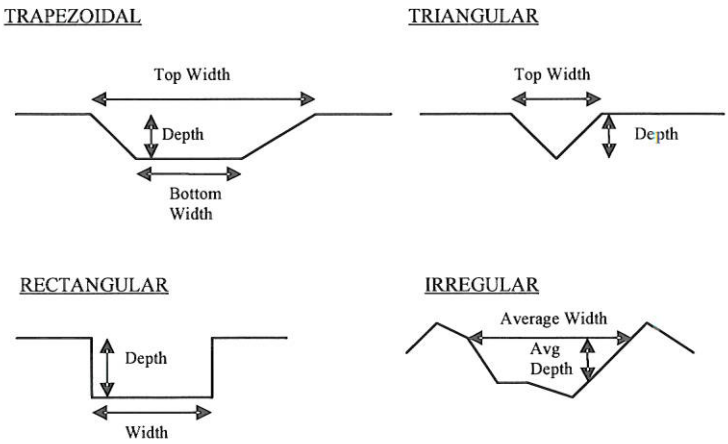
_____ Cross-Valley
_____ Side-Hill
__X__ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

Embankment Height __65__ feet Embankment Material compacted earth and sluiced ash fill
Pool Area 160 Acres @ El.645 acres Liner _____
Current Freeboard Cell 3 up to 25 feet Liner Permeability __N/A__
Cells 1/2 - 5 ft to 10 ft

TYPE OF OUTLET (Mark all that apply)

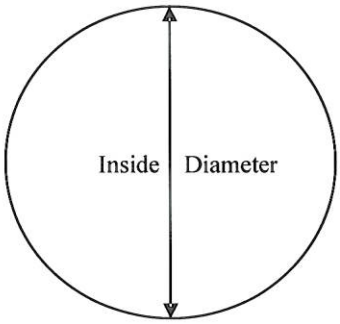
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

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



_____ **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 __Unknown__

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

If So When? 1982

If So Please Describe :

* Based on review of 5 year independent inspection reports, which are required by North Carolina Utility Commission, the North Dike was raised to its present Elevation 645 by 1973 to form the Active Ash Basin. In early March 1982, there was a failure of the downstream slope in the western part of the North Dike (intermediate dike) requiring emergency repairs with stabilizing berms in area of failure. The cause was believed to be due to excessive porewater pressures in a thin layer of permeable ash in contact with a permeable foundation and confined beneath the downstream slope of the dike, after the Primary Basin water level had been raised to Elev. 638 (2 ft. below full pond).

* Based on engineering stability analyses in 1982, stabilizing berms were designed for the downstream sides of the North Dike; one 15-feet wide at Elev. 630, and the other 25-feet wide at Elev. 625 with 3H:1V slopes between the berms and extending up from the upper berm and down from the lower berm. The original downstream slope was 2H:1V. Berms constructed 1982-1983.

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

If So When? _____

IF So Please Describe: _____

Based on review of 5 year inspection reports, 1982-2008 observed seepage has been clear and of low quantities. This was confirmed by Messrs. Scruggs and Blevins of Duke Energy.

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

If so, which method (e.g., piezometers, gw pumping,...)? Piezometers, Obs. Wells, Blanket Drain

If so Please Describe :

* When stabilizing berms were constructed in 1982, the design included a filter fabric wrapped blanket drain of washed stone under the stability berm at the North Dike.

* In 1986, observation wells and piezometers were installed for long-term monitoring of water levels in the North Dike. Locations were within areas of historical slope stability issues mentioned on P. 5.

* Monitoring of these instruments is ongoing by Duke Energy engineers and data is plotted and summarized periodically.

US EPA ARCHIVE DOCUMENT

APPENDIX D

DEFINITIONS

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to references published by the U.S. Army Corps of Engineers, the Federal Energy Regulatory Commission, the Department of the Interior Bureau of Reclamation, or the Federal Emergency Management Agency.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate there from, including but not be limited to, spillways; reservoirs and their rims; low level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

General

EAP – Emergency Action Plan - Shall mean a predetermined plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam break.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre feet.

US EPA ARCHIVE DOCUMENT

Height of Dam – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Condition Rating

SATISFACTORY - No existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria. Minor maintenance items may be required.

FAIR - Acceptable performance is expected under all required loading conditions (static, hydrologic, seismic) in accordance with the applicable safety regulatory criteria. Minor deficiencies may exist that require remedial action and/or secondary studies or investigations.

POOR - A management unit safety deficiency is recognized for any required loading condition (static, hydrologic, seismic) in accordance with the applicable dam safety regulatory criteria. Remedial action is necessary. POOR also applies when further critical studies or investigations are needed to identify any potential dam safety deficiencies.

UNSATISFACTORY - Considered unsafe. A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution. Reservoir restrictions may be necessary.

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.

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

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