GZA
GeoEnvironmental, Inc.

Engineers and Scientists

July 27, 2009
GZA File No. 01.0170142.00

Lockheed Martin Services Inc.
REAC Program
GSA Raritan Depot
2890 Woodbridge Avenue
Edison, New Jersey 08837-3679

One Edgewater Drive
Norwood, MA 02062
781-278-3700
FAX 781-278-5701
www.gza.com

Attention: Mr. Dennis Miller, REAC Section Leader

Re: Task 3 Dam Assessment Report
Project #0-381
Clifty Creek Station
West Bottom Ash Pond
Madison, Indiana

Dear Mr. Miller:

In accordance with our proposal 01.P0000018.10, dated May 8, 2009 and Lockheed Martin P.O. 7100051898, dated June 1, 2009, GZA GeoEnvironmental, Inc. (GZA) has completed our inspection of the Clifty Creek Station's, West Bottom Ash Pond Dam, located in Madison, Indiana (site). The site visit was conducted by GZA between June 10 and 11, 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, the dam is currently in **SATISFACTORY** condition, in our opinion, based on the definition provided in Lockheed Martin's RFP. 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.

Walter Kosinski, P.E.
Lead Engineer

Peter H. Baril
Principal-In-Charge

J:\01.0170142.00\Inspections\Clifty Creek, IN\Inspections\West Bottom Ash Pond\Cover letter.doc

Copyright 2009© GZA GeoEnvironmental, Inc.
DRAFT VERSION

PREFACE

The assessment of the general condition of the dam is based 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 realized 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 cases where an impoundment is lowered or 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.

Walter Kosinski, P.E.
Indiana License No.: 10201153

J:\01.0170142.00\Inspections\Clifty Creek, IN\Inspections\West Bottom Ash Pond\Preface.doc

EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report details the results of a visual dam inspection of the Clifty Creek West Bottom Ash Pond Dam, located in Madison, Jefferson County, Indiana. The entrance to the plant is at Clifty Hollow Road, Route 56. The inspection was performed on June 10, 2009 by GZA GeoEnvironmental, Inc (GZA).

For the purposed of this EPA-mandated inspection, the size of the impoundment will be based on U. S. Army Corps of Engineers (COE) criteria. The State of Indiana, Department of Natural Resources (INDNR) Dam Safety Regulations do not explicitly set size criteria for dam and levees under their jurisdiction. Based on an approximate embankment height of 42 feet and a reported storage volume of 3,600 ac-ft, the WBAP would be classified as and **Intermediate** sized structure.

Under both INDNR criteria and the EPA classification system the WBAP dam would be considered as having **Significant Hazard**, due to possible environmental damage and disruption of lifeline facilities if the embankment were to fail.

The dam was judged to be in **SATISFACTORY** condition in GZA's opinion.

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

- Wet areas were observed in several locations near the horizontal berm area between the right abutment and transmission tower. In addition, a seep area continues to exist on the downstream embankment near the left abutment about 150 feet downgradient from the top of the dam.

- Dense scrub vegetation and mature trees cover the majority of the upstream embankment slope; in addition the upstream slope does not appear to have any riprap protection at and above the normal pool level.

- A small sinkhole was a identified above the outlet pipe about 15 feet upgadient from the end of the pipe. IKEC operations staff subsequently backfilled the hole and will monitor the effectiveness of the repair.

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

- Based on our review of existing information, it does not appear that the dam safety section of INDNR has taken jurisdiction of the WBAP Dam. However, they do have jurisdiction, and periodically inspect, IKEC's South Fly Ash Pond Dam also located at the Clifty Creek facility. As both dams are similar is size, volume and hazard classification, this appears to be an inconsistency, in our opinion. GZA recommends that IKEC contact INDNR to formally include this impoundment in their dam safety inventory.

- Based on the above recommendation, the hazard class and magnitude of the spillway design flood (SDF) should be formally established under INDNR rules and regulations. The adequacy of the dam's existing spillway should be confirmed under the regulatory SDF, as may be necessary.

- A subsurface exploration program should be developed and executed to include a limited number of borings and installation of piezometers and other instrumentation to analyze and regularly monitor embankment seepage and stability.

- Based on the results of the subsurface program noted in no. 3 above, a seepage and stability analysis should be conducted for the up and downstream slopes. This should include a seismic stability and liquefaction analysis of the upstream and downstream embankment slopes and foundation.

- Develop a formal, written Emergency Action Plan;

- Enact the proposed inspection program which is to include routine drive by inspections, quarterly checklist completion by IKEC engineering staff.

- Install a staff gage at the intake (or other convenient location) in order to easily and regularly record pond level.

- Monitor repaired sinkhole near the end of the outlet pipe on a monthly basis, at a minimum.

- Repair of grading including minor depressions found on the crest to insure a consistent top of dam at about elevation 470 MSL.

- Investigate seeps at the downstream slope in dry weather, with repairs designed by a professional engineer and construction by a contractor experienced in dam repair.

- The dense vegetation on the upstream slope should be removed; this includes removal of stumps and backfilling and compaction with well draining material, supplemented with loam and seeding in the upper portions of the embankment and riprap placement at the normal fluctuation of the water level.

J:\01.0170142.00\Inspections\Clifty Creek, IN\Inspections\West Bottom Ash Pond\Executive Summary.doc

CLIFTY CREEK STATION
WEST BOTTOM ASH POND DAM
JEFFERSON COUNTY, INDIANA

TABLE OF CONTENTS

1.0 DESCRIPTION OF PROJECT 1
1.1 General 1
1.1.1 Authority 1
1.1.2 Purpose of Work 1
1.1.3 Definitions 1
1.2 Description of Project 1
1.2.1 Location 1
1.2.2 Owner/Caretaker 2
1.2.3 Purpose of the Dam 2
1.2.4 Description of the Dam and Appurtenances 2
1.2.5 Operations and Maintenance 3
1.2.6 Size Classification 4
1.2.7 Hazard Potential Classification 4
1.3 Pertinent Engineering Data 5
1.3.1 Drainage Area 5
1.3.2 Reservoir 5
1.3.3 Discharges at the Dam Site 5
1.3.4 General Elevations 5
1.3.5 Main Spillway Dam 5
1.3.6 Design and Construction Records and History 6
1.3.7 Operating Records 6
1.3.8 Previous Inspection Reports 6
2.0 INSPECTION 6
2.1 Visual Inspection 6
2.1.1 General Findings 7
2.1.2 Upstream Slope 7
2.1.3 Top of Dam 7
2.1.4 Downstream Slope 8
2.1.5 Spillway/Outlet Structure 8
2.2 Caretaker Interview 9
2.3 Operation and Maintenance Procedures 9
2.4 Emergency Warning System 9
2.5 Hydrologic/Hydraulic Data 9
2.6 Structural and Seepage Stability 10
3.0 ASSESSMENTS AND RECOMMENDATIONS 10
3.1 Assessments 10
3.2 Studies and Analyses 11
3.3 Recurrent Operation & Maintenance Recommendations 11
3.4 Repair Recommendations 11
3.5 Remedial Modifications Recommendations 12
3.6 Alternatives 12
4.0 ENGINEER'S CERTIFICATION 12

CLIFTY CREEK STATION
WEST BOTTOM ASH POND DAM
JEFFERSON COUNTY, INDIANA

TABLE OF CONTENTS (Cont'd)

FIGURES

Figure 1	Site Location Map
Figure 2	Orthophoto Location Map
Figure 3	Downstream Area Map
Figure 4	Drainage Area Map
Figure 5	Photo Location Plan
Figure 6	Field Sketch

APPENDICES

Appendix A	Limitations
Appendix B	Photographs
Appendix C	EPA & GZA Inspection Checklists
Appendix D	Definitions

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 Indiana-Kentucky Electric Corporation[1] (IKEC, Owner) Clifty Creek Station, West Bottom Ash Pond (WBAP) Dam in Jefferson County, Indiana. 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[2], and this report is subject to the limitations contained in **Appendix A** and the Terms and Conditions of our Contract Agreement.

1.1.2 Purpose of Work

The purpose of this investigation is to visually inspect and evaluate the present condition of the dam and appurtenant structures (the management unit) to identify conditions that may adversely affect their structural stability and functionality, to note the extent of any deterioration that may be observed, review the status of maintenance and needed repairs, and to evaluate the conformity with current design and construction standards of care.

The investigation 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 with the Owner of available design, inspection, and maintenance data and procedures for the management unit; 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 which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; 5) general; and 6) condition rating.

1.2 Description of Project

1.2.1 Location

The Clifty Creek Generating Plant Coal Ash Retention Dam is located about two miles northeast of Hanover, Indiana, and is part of Jefferson County. The entrance to the plant is at Clifty Hollow Road, Route 56.

---

[1] Parent Company is American Electric Power (AEP)

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

The Clifty Creek Station's WBAP Dam is located at latitude 38°44'16.8" North and longitude - 85°25'8.4" West (WGS 84 datum), as determined from Google Earth. A site locus of the dam is shown in **Figure 1**. An aerial photograph of the dam is provided as **Figure 2**.

1.2.2 Owner/Caretaker

The dam is owned by the Indiana-Kentucky Electric Corporation, Piketon, Ohio.

	Dam Owner	Dam Caretaker
Name	Ohio Valley Electric Corp. Indiana-Kentucky Electric Corp.	Indiana-Kentucky Electric Corp.
Mailing Address	P.O. Box 468, 3932 U.S. Rt. 23	P.O. Box 97 1335 Clifty Hollow Road
Town	Piketon, Ohio 45661	Madison, Indiana 47250
Contact	Donald T. Fulkerson	Paul A de Lamerens
Title	Environmental Affairs Director	Plant Environmental Superintendent
E-Mail	dfulkers@ovec.com	
Daytime Phone	(740) 289-7254	(812) 265-8715
Emergency Phone	911	911

1.2.3 Purpose of the Dam

The WBAP impoundment is currently used to store all sluiced bottom ash from the facility's six generating units. The pond receives upwards of 22 million gallons per day (MGD) of process waters and other discharges including sluiced boiler slag, runoff from coal piles, other process waters, boiler room discharges and natural runoff.

1.2.4 Description of the Dam and Appurtenances

The Clifty Creek WBAP actually consists of two nearly distinct ponds separated by an emerging wetland area. The northern portion of the pond receives boiler slag process waters through discharge pipes located at the northeastern edge of the pond. The southern pond is created by the earthen dam (the subject of this inspection) with a structural height of about 42 feet and total length of approximately 2,500 feet. Based on a 1985 inspection report (Woodward-Clyde Consultants, Inc.), the pond has a maximum storage capacity of approximately 3,600 acre-feet. The dam embankment is orientated in a southwest to northeast direction and the top (i.e. crest) of the dam is approximately 250 feet upgradient from the right bank of the Ohio River.

The WBAP dam was constructed in 1955 at the time of the original development of the first Clifty Creek power plant units. The top (crest) of the dam has been reported to be at about elevation 475 MSL, based on original design drawings and previous inspection reports. However, based on GZA's interpretation of the recent topographic survey mapping supplied to us by IKEC, the low point along the dam crest is at an elevation of approximately 469 MSL. The crest has a width of about 20 feet. The upstream embankment face is set on a slope of about 1.5H:1.0V and is primarily covered with scrub vegetation and numerous large trees. The downstream face has an approximate 2.5H:1V slope with a break in slope at about elevation 446

MSL. Beyond this point (i.e. the toe of the upper portion of the downstream face), the embankment is configured a more gently sloping, near horizontal berm until it then slopes at about 4.5H:1V down to the river. An electrical transmission tower is located on a leveled portion of the downstream embankment about 1,500 feet to the east of the right abutment. The high tension wires traverse the pond in a general north to south direction and cross the Ohio River.

Only limited original design drawings exist for the WBAP although there are a number of engineering memoranda and letters between the design engineers, Arthur and Leo Casagrande of Cambridge, Massachusetts and the owner, American Gas & Electric Service Corporation (AEP). Copies of these materials were provided to GZA as part of the dam inspection. No boring information is available for the WBAP and subsurface and embankment foundation conditions are inferred from the February 1985 inspection report and the various correspondence during the original design.

In general, foundation materials are reportedly characteristic of floodplain deposits having intermixed layers of clay, sand and gravel overlying limestone bedrock. The near surface soils were reportedly primarily silts and/or "hard" clays and were underlain by "soft to medium stiff" clay. As indicated in a November 26, 1952 letter from design engineers Arthur and Leo Casagrande, "… the dikes will be constructed of relatively impervious material, upon a foundation of impervious material…". Although no specific construcation records were identified during GZA's review of available documentation, it appears the WBAP was constructed of clay soils upon a foundation of natural silt or clay soils at the time of plant construction. As the embankment predates operation at this power facility, it is not likely that the embankment foundation was built over wet ash, boiler slag, or other unsuitable materials.

The spillway/outlet structure, a decant-type structure also noted as an "overflow" structure, is located about 70 feet off the right abutment. It consists of an approximately 30 foot reinforced box riser, with interior dimension of about 3.25 ft. by 3.25 feet. The east side of the riser is open and has provisions for accepting concrete stop planks about 4 feet long and with cross-sectional dimension of 3-inches x 3-inches. The stop planks are used to regulate the pond level and releases to the Ohio River. Pond water is conveyed over the stop planks and to a 36-inch diameter reinforced concrete pipe (RCP). The invert of the pipe at the drop inlet is elevation 433 MSL, based on the design drawing[3]. The total outlet pipe length is about 300 feet.

1.2.5 Operations and Maintenance

Sluiced boiler slag from the Station's 6 units is conveyed into the pond. The currently normal operating pool is at elevation 443 ± MSL. This is about 3.5 feet less that the previous operating level in order to expose boiler slag near the headwaters to allow for periodic dredging and reuse of this material. Also, the pool level was lowered to accommodate additional head losses across the pond due the emergent wetland vegetative growth within the mid-point of the pond. The embankments are typically mowed twice per year. Recently, AEP's Geotechnical Engineering Division developed a revised, written inspection and maintenance program[4] detailing routine duties and responsibilities of Plant personnel, Regional Engineering and Services pursuant to AEP's Dam Inspection and Maintenance Program. The revised program for

[3] AEP – IKEC Clifty Creek Plant: "Ash Storage Yard Drainage Shaft, Masonry & Reinforcing", Dwg. # 16-3033-1, April 1954.

[4] Circular Letter (#CL-M-CL-010B), "Dam and Dike Inspection and Maintenance Program", Pedro J. Amaya (Author), revised May 19, 2009.

the WBAP is to include: (a) routine "drive-by" inspections by Plant personnel looking for significant changes in conditions; (b) a formal "check-list type" inspection by Plant or Regional Engineering staff performed on a quarterly basis; (c) inspections performed under the direction of a registered professional engineer (P.E.) at a frequency determined by the dam's risk classification (i.e. 2 year); and (d) non-routine inspections performed by plant personnel after unusual conditions such as heavy precipitation, seismic events, or other situations that could cause a change in the condition of the facility. According to Mr. Pedro Amaya, AEP Geotechnical Engineer, they are currently preparing an Emergency Action Plan (EAP) for the Clifty Creek Station facility.

1.2.6 Size Classification

For the purposed of this EPA-mandated inspection, the size of the impoundment will be based on U. S. Army Corps of Engineers (COE) criteria. The State of Indiana, Department of Natural Resources (INDNR) Dam Safety Regulations do not explicitly set size criteria for dam and levees under their jurisdiction. Based on an approximate embankment height of 42 feet and a reported storage volume of 3,600 ac-ft, the WBAP would be classified as and **Intermediate** sized structure.

1.2.7 Hazard Potential Classification

Based on discussions with AEP engineering staff and IKEC personnel, the INDNR does not currently inspect the WBAP dam nor has it included in the jurisdictional inventory. Thus, an INDNR- developed Hazard Potential Classification does not exist for the WBAP dam. Based on our review of the INDNR Dam Safety Inspection Manual, the WBAP dam would be classified as **Significant Hazard**, based on INDNR criteria, in GZA opinion. This is based on our interpretation of Rule 3 of the Indiana Administrative Code, 312 IAC 10.5-3-1: Consideration of hazard classification, which states, in part:

" If an uncontrolled release of the structures contents due to failure of the structure may result in any of the following, the dam shall be considered significant hazard: …

(D) Damage to important utilities where service would be interrupted for not more that one (1) day, but either of the following may occur: …

(ii) Towers, poles, and above ground lines can be damaged by undermining or debris loading."

Due to the existence of the electrical transmission tower on the downstream face of the embankment, a sudden uncontrolled release of water (i.e. dam break) could undermine the tower and disrupt service.

Under the EPA classification system, as presented on page 2 of the EPA check list (Appendix C) and Definitions section (Appendix D), the WBAP dam would also be considered as having **Significant Hazard**, due to possible environmental damage and disruption of lifeline facilities if the embankment were to fail.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

According to a hydrologic and hydraulic evaluation[5] of the dam performed in 2007 by Fuller, Mossbarger, Scott & May Engineers, Inc. (FMSM), the drainage area has gone under some modification recently due to the recent changes in plant operations. This has resulted in increase to the surrounding drainage area and runoff into the WBAP. As part of the ongoing flue gas desulfurization (FGD) project, the East Bottom Ash Pond has been partially closed, resulting in about 30 cfs of additional boiler slag slurry being now conveyed to the WBAP. In addition, a significant stormwater re-routing program has been recently completed which increases the drainage area to the WBAP. These modifications were performed due to the fly ash landfill being developed to the west of the site. Consequently, based on the FMSM study, the contributing drainage area to the WBAP is approximate 512 acres (0.8 mi^2). The watershed is a mix of wooded and industrial areas of the power plant property. The approximate watershed boundaries for the WBAP dam are presented in **Figure 4**. The impoundment has a current normal operating surface area of approximately 58 acres.

1.3.2 Reservoir

The reservoir has undergone changes in size and storage capacity since original construction due to previous coal ash deposition and the emergence of wetlands in the central area of the pond. Thus, the main pond area is to the southwest, adjacent to the dam embankment. As previously mentioned, the normal pool has been lowered from about 447 to 443.

1.3.3 Discharges at the Dam Site

No records of flow were made available to GZA during our site visit. It is our understanding that plant staff routinely measure and record pond levels, from which discharge could be inferred as needed.

1.3.4 General Elevations (feet – MSL)

Elevations are taken from design drawings, reports, and recent topographic survey provided by AEP. Elevations are based upon the USGS topographic map MSL datum.

A. Top of Dam (minimum)	469.0±
B. Normal Pool	443 ±
C. Upstream Water at Time of Inspection	443.2±
E. Downstream Tail Water at Time of Inspection	424 ± (Ohio River)

1.3.5 Spillway Data

A.	Type	Concrete drop inlet/decant with stop planks
B.	Effective Weir Length	3.0 ft. 3 in. ±
C.	Stop logs typically set at	443 ± ft

[5] *Hydrology and Hydraulic Report*, West Bottom Ash Pond Analysis, Clifty Creek Power Plant, prepared by FMSM Engineers, for AEP, July 25, 2007.

D.	Outlet Conduit	36-inch RCP
E.	Upstream Outlet Invert	433 ft. ±
F.	Downstream Outlet Invert	426 ft. ±

1.3.6 Design and Construction Records and History

The dam was designed by Arthur and Leo Casagrande of Cambridge, Massachusetts in 1952 to 1954. The Casagrande's were also retained during the construction phase and reportedly made a number of visits to the site as the embankment and appurtenances were being built. Only limited design drawings exist for the WBAP dam; however, numerous technical memoranda and letters between the design engineer and owner (AEP) during the design and construction of the plant and other structures on the site do exist and were made available to GZA during our inspection. It should be noted that Arthur Casagrande was considered one of the leading geotechnical engineers in the world at the time, particularly in the subject of earthen dam structures.

1.3.7 Operating Records

No formal operating records for the dam were made available to GZA during the dam. There is no instrumentation or monitoring equipment (i.e. observation wells, piezometers, seepage weirs, etc.) currently installed at the WBAP.

1.3.8 Previous Inspection Reports

Visual inspections of the WBAP dam are typically done by AEP engineering staff on a yearly basis. At GZA's request, AEP provided the latest report[6] prepared in October 2008. An independent consultant inspection reports from 1985 (Woodward-Clyde) was reviewed. A more recent independent inspection report[7] was prepared in May 2009 by Stantec Consulting Services, Inc. of Cincinnati, OH was also reviewed by GZA. Both inspections concluded that the overall condition of the embankment forming the WBAP was in satisfactory condition. Key recommendations from Stantec included:

- Remove trees and brush from interior and exterior embankment slopes;
- Fill in voids (from stump removal operations) with cohesive soils in a controlled manner; and
- Monitor seep on the south-eastern exterior toe of the embankment adjacent to the overgrown central pond section. The excessive vegetation in the seep area should be cut back to assist with visual monitoring.

2.0 INSPECTION

2.1 Visual Inspection

The West Bottom Ash Pond Dam at the Clifty Creek Station was inspected between June 9 and 10, 2009 by Walter Kosinski, P.E. and Peter H. Baril of GZA GeoEnvironmental Inc. At the

[6] *2008 Dam & Dike Inspection Report*, East Bottom Ash Pond, Fly Ash Pond, West Bottom Ash Pond – Clifty Creek Plant, Madison, IN, prepared by Geotechnical Engineering AEP Services Corp., Columbus, Ohio, Inspection Date: Sept. 9, 2008, Approval Date: Nov. 3, 2008; QA/QC Document # GERS-08-014.

[7] *2009 Dam and Dike Inspection Report* – Clifty Creek Power Plant, Madison, IN, prepared by Stantec for AEP, May 14, 2009 (inspection date: April 2, 2009).

time of the inspection, the weather was rainy with temperatures in the in the high 60°'s Fahrenheit. Photographs to document the current conditions of the dam were taken during the inspection and are included in **Appendix B**. The water elevation in the impoundment was approximately 443.2 feet, approximately 2 to 3 inches above the top-most concrete stop plank in the spillway/decant outlet structure. Underwater areas were not inspected, including the inside of the 36-inch diameter outfall culvert, as this level of investigation was beyond of GZA's scope of services. However, AEP did make available a CD copy of a video inspection of this outlet pipe that was conducted in June 2007. GZA's review of that video is provided in Section 2.1.5, below. A copy of the EPA and separate GZA inspection checklists are included in **Appendix C**.

2.1.1 General Findings

In general, the West Bottom Ash Pond Dam was found to be in **SATISFACTORY** condition. The specific concerns are identified in more detail in the sections below. A sketch showing the dam in plan and noting areas of observed deficiencies as well as location and orientation of photographs is contained in **Figure 5**.

2.1.2 Upstream Slope (Photos 4, 11, and 12)

Based on visual observations, the upstream slope was built as designed at slope of about 1.5H:1V. Based on review of the recent topographic survey manuscript, the slope appears to transition to about 2.5H:1.0V at a point about 250 feet to the left (east) of the transmission tower (about 700 feet right of the left abutment). The slope is heavily overgrown with dense scrub vegetation as well as with trees up to one foot diameter breast height. This dense vegetative cover, steep slope, and wet weather made close inspection not possible. A clear path through the vegetation had been made at the location of the stairway in gangway to the spillway structure. Viewing the slope from above the right abutment, it does not appear that the upstream slope contains riprap protection. The metal stairway leading to the spillway inlet was observed to be in good condition. Some minor movement was noted based on the angle of trees within the embankment. Some minor erosion due to surface flow and sloughing of the surface was noted.

2.1.3 Top of Dam (Photos 5, 11, and 15)

The top of the dam runs in a generally straight line parallel to the Ohio River. An approximately 20 foot wide access road in contiguous with the top of the dam and continues as a ring road beyond the left and right abutment. The roadway consists of cinders and boiler slag and is in fair condition. Some minor rutting with shallow ponding of surface runoff was observed primarily at the right abutment area and the right half portion of the embankment. The area of the top of the dam beyond the roadway edge was surfaced with grasses and other herbaceous vegetation, which was noticeably higher on the upstream side. Based on the visual inspection, the vertical alignment of the top of dam appeared to be fairly level. However, as previously discussed, the recent topographic survey and AutoCAD drawing indicates that spot elevations on the crest progress from elevation 472.5 near the right abutment, 471.6 between the abutment and transmission tower, 469.2 at the base of the tower, to 468.8 near the left abutment. These top of dam elevation are significantly lower than the design elevation of 475.

2.1.4 Downstream Slope (Photos 6, 13, and 14)

The downstream slope of the dam consists of an upper section which is the original 2.5H:1V slope, based on review of the recent elevation survey. This portion of the slope is well groomed and was recently mowed. Surficial soils were somewhat saturated, but this was attributed to the heavy rainfall experienced just prior to and during the field inspection. The more gently sloping, nearly horizontal berm was also well maintained an recently mowed. Several large wet areas along this berm, between the right abutment and transmission tower were noted. One of these in particular was staked out to prevent erosion and rutting by the mowing equipment (Photo 13). Another wet/seep area exists on the downstream embankment near the left abutment about 150 feet downgradient from the top of the dam. The approximate location of these wet/seep areas are depicted on **Figure 6**. These seep areas were also noted by Stantec during their April 2009 inspection. Further downgradient from the berm, the fill embankment slopes at about 4.5H:1V until it meets the bank of the Ohio River. Most of this area is covered with mature trees and other dense scrub vegetation. However, this vegetation is located off the main sloping embankment area and is about 200 feet downgradient from the top of the dam.

2.1.5 Spillway/Outlet Structure (Photos 4, 7, 8, 9, and 10)

The water level in the pond is controlled by a square concrete drop inlet structure, which then conveys water to the river via the 36-inch RCP set at about a 2 percent slope. Several concrete stop logs were in-place so that the normal pond level is controlled at or just above elevation 443. The concrete structure appeared intact and was in fair condition. Some surface wear on the exterior portion of the vertical riser was noted in the zone between the existing and formal normal pool water line (El 447). The stop planks had little signs of wear or spalling. A small floating turbidity/trash boom encircles the drop inlet and floating access platform. All of these components appeared to be in good working order.

At a location about 350 feet downgradient from the intake, pond water was discharging from the pipe to the river. Water level at the end of the 36-inch pipe was flowing about 1/3 full and under free discharge with little or no tail water influence. The end of the pipe projects out from the earthen embankment with no headwall structure. Some minor erosion from around the pipe was noted but the discharge area is lined with riprap to assist in energy dissipation of oncoming discharge of pond water.

A small sinkhole was discovered on the ground surface in an area approximate over the crown of the pipe and about 10 to 15 feet upgradeint from the end of the pipe. The depression was about 8-inches in diameter and about 3 feet deep. The hole was dry and not seepage in the area was observed. IKEC maintenance staff subsequently backfilled the hold with quick-setting concrete (Photo 8), and will continue to monitor the repair for future loss of material and subsidence.

It should be noted that an inspection conducted in 1984 discovered separation and about ½-inch of settlement of the last concrete section of pipe. This defect was subsequently repaired by IKEC by: (a) realigning the last two sections of the pipe; (b) reconstructing a concrete cradle at the end of the pipe; and (c) repairing the channel erosion below the pipe outfall including riprap placement. A permit application to conduct Construction in a Floodway was submitted to INDNR by IKEC in May 1996.

While internal inspection of the spillway outlet pipe was beyond our scope of services, we were able to review a video of a 2007 inspection of the pipe. Based on the video, the majority of the pipe appeared to be in good conditions. A few concrete stop planks were in the pipe but, according to IKEC, were subsequently removed. No other obstructions were noted. The pipe slope did not appear to be consistent based on viewing the water line on the interior surfaces of the pipe. A discontinuity in the water stain was noted at the first joint, about 15 feet up from the end of the pipe. The water line was noticeable at a lower level downgradient from this first joint and may be indicative of exfiltration at this location. Given that the sinkhole was discovered at about this point above the crown of the pipe, a possible mechanism for loss of soil and sinkhole creation is postulated.

No other auxiliary spillway or low level outlet exists at the WBAP Dam.

2.2 Caretaker Interview

Maintenance of the dam is the responsibility of the IKEC 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 abut two times per year by a subcontractor. Based on recently developed O&M program, an IKEC representative is to conduct regular drive-by inspections and complete a check list inspection on a quarterly schedule. AEP Geotechnical Engineering staff performs an annual inspection of the dam and appurtenant structures.

2.3 Operation and Maintenance Procedures

See sections 1.2.5 and 2.2 above.

2.4 Emergency Warning System

Currently, there is no written Emergency Action Plan (EAP) developed for the dam. According to AEP Geotechnical Engineering staff, an EAP is under development.

2.5 Hydrologic/Hydraulic Data

GZA did not perform an assessment of the hydraulics and hydrology for the dam as this was beyond our scope of services. However, we did review the 2007 Hydrologic and Hydraulic Report prepared by FMSM that was noted in Section 1.3.1 above. This study was commissioned by AEP due to the increase in drainage area to the pond as a result of certain drainage re-routing primarily associated with the development of dry ash landfill located immediately to the northwest of the WBAP. FMSM developed a rainfall/runoff model for the 0.8 mi^2 contributing drainage area. The spillway design flood was taken to be the 24-hour, 100-year storm having a total rainfall of 6.04 inches. The analysis was run under three separate scenarios for initial water level in the pond and in the Ohio River at the onset of the flood routing simulations. Starting water levels in the pond ranged from elevation 450.2 to 464.2, which is conservative, in GZA's opinion, as the normal pool is elevation 443. Peak 100-year inflow was estimated to be about 1,330 cfs; routed outflow ranged from 50 to 110 cfs. The resultant estimated maximum water surface elevation in the pond due to the 100-year storm ranged from elevation 453 to 466.5. FMSM assumed a top of dam elevation of 470, which is close to the minimum level of 469 noted on the AutoCAD drawing. Thus, the minimum freeboard based on the 100 year flood ranges from about 3.5 to 7.0 feet, which is adequate, in our opinion. Please note that GZA did not review the FMSM routing model for completeness or accuracy.

2.6 Structural and Seepage Stability

GZA did not identify specific structural or seepage analysis within the documentation reviewed. Reference however was made in the November 27, 1952 letter from Arthur and Leo Casagrande to Mr. E.A. Kammer, Chief Design Engineer for AEP, stating:

> *"Design of the Dikes. Since the dikes will be constructed of relatively impervious material, upon a foundation of impervious material, and since the length of period that the dikes will be exposed to high river stages is limited, no special control measures against seepage through and beneath the dikes are required. However, in view of the soft clay foundation and the great difference in elevation between the crest of the dikes and the adjacent deepest excavation, special attention will have to be paid to the question of stability of the dikes, including their foundations. It is noted that in some of the storage areas there is a difference in elevation of 40 to 50 ft between the crest of the dikes and the inside excavation level, with an inside slope of only 1 on 1.75. There is no doubt in my mind that such a steep slope would overstress the soft foundation clay and cause foundation failure of such high dikes."*

Recognizing the soft clay foundation soils referenced by Casagrande above, consolidation over the 50 year history following construction, it is our opinion that the clays have likely gained in strength. However, due to the lack of subsurface soil and water level information in the area of the WBAP embankment, seepage and structural stability analyses would appear to be prudent.

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the overall condition of Clifty Creek Station West Bottom Ash Pond Dam is judged to be **SATISFACTORY**. The dam was found to have the following deficiencies:

1. Wet areas were observed in several locations near the horizontal berm area between the right abutment and transmission tower. In addition, a seep area continues to exist on the downstream embankment near the left abutment about 150 feet downgradient from the top of the dam.

2. Dense scrub vegetation and mature trees cover the majority of the upstream embankment slope; in addition the upstream slope does not appear to have any riprap protection at and above the normal pool level.

3. A small sinkhole was a identified above the outlet pipe about 15 feet upgradient from the end of the pipe. IKEC operations staff subsequently backfilled the hole and will monitor the effectiveness of the repair.

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. 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. Based on our review of existing information, it does not appear that the dam safety section of INDNR has taken jurisdiction of the WBAP Dam. However, they do have jurisdiction, and periodically inspect, IKEC's South Fly Ash Pond Dam also located at the Clifty Creek facility. As both dams are similar is size, volume and hazard classification, this appears to be an inconsistency, in our opinion. GZA recommends that IKEC contact INDNR to formally include this impoundment in their dam safety inventory.

2. Based on the above recommendation, the hazard class and magnitude of the spillway design flood (SDF) should be formally established under INDNR rules and regulations. The adequacy of the dam's existing spillway should be confirmed under the regulatory SDF, as may be necessary.

3. A subsurface exploration program should be developed and executed to include a limited number of borings and installation of piezometers and other instrumentation to analyze and regularly monitor embankment seepage and stability. A seismic stability analysis of the upstream and downstream embankment slopes should be conducted after surveying the actual configuration of the slopes.

4. Based on the results of the subsurface program noted in no. 3 above, a seepage and stability analysis should be conducted for the up and downstream slopes. This should include a seismic stability and liquefaction analysis of the upstream and downstream embankment slopes and foundation.

3.3 Recurrent Operation & Maintenance Recommendations

GZA recommends the following operation and maintenance level activities:

1. Develop a formal, written Emergency Action Plan;

2. Enact the proposed inspection program which is to include routine drive by inspections, quarterly checklist completion by IKEC engineering staff.

3. Install a staff gage at the intake (or other convenient location) in order to easily and regularly record pond level.

4. Monitor repaired sinkhole near the end of the outlet pipe on a monthly basis, at a minimum.

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. Repair of grading including minor depressions found on the crest to insure a consistent top of dam at about elevation 470 MSL.

2. Investigate seeps at the downstream slope in dry weather, with repairs designed by a professional engineer and construction by a contractor experienced in dam repair.

3.5 Remedial Modifications Recommendations

1. The dense vegetation on the upstream slope should be removed; this includes removal of stumps and backfilling and compaction with well draining material, supplemented with loam and seeding in the upper portions of the embankment and riprap placement at the normal fluctuation of the water level.

Additional repairs and/or modifications may be necessary and should be revisited based on the general stability and seismic analyses of the embankment, primarily of the upstream slope, as well as establishment of the regulatory SDF.

3.6 Alternatives

There are no practical alternatives to the repairs itemized above.

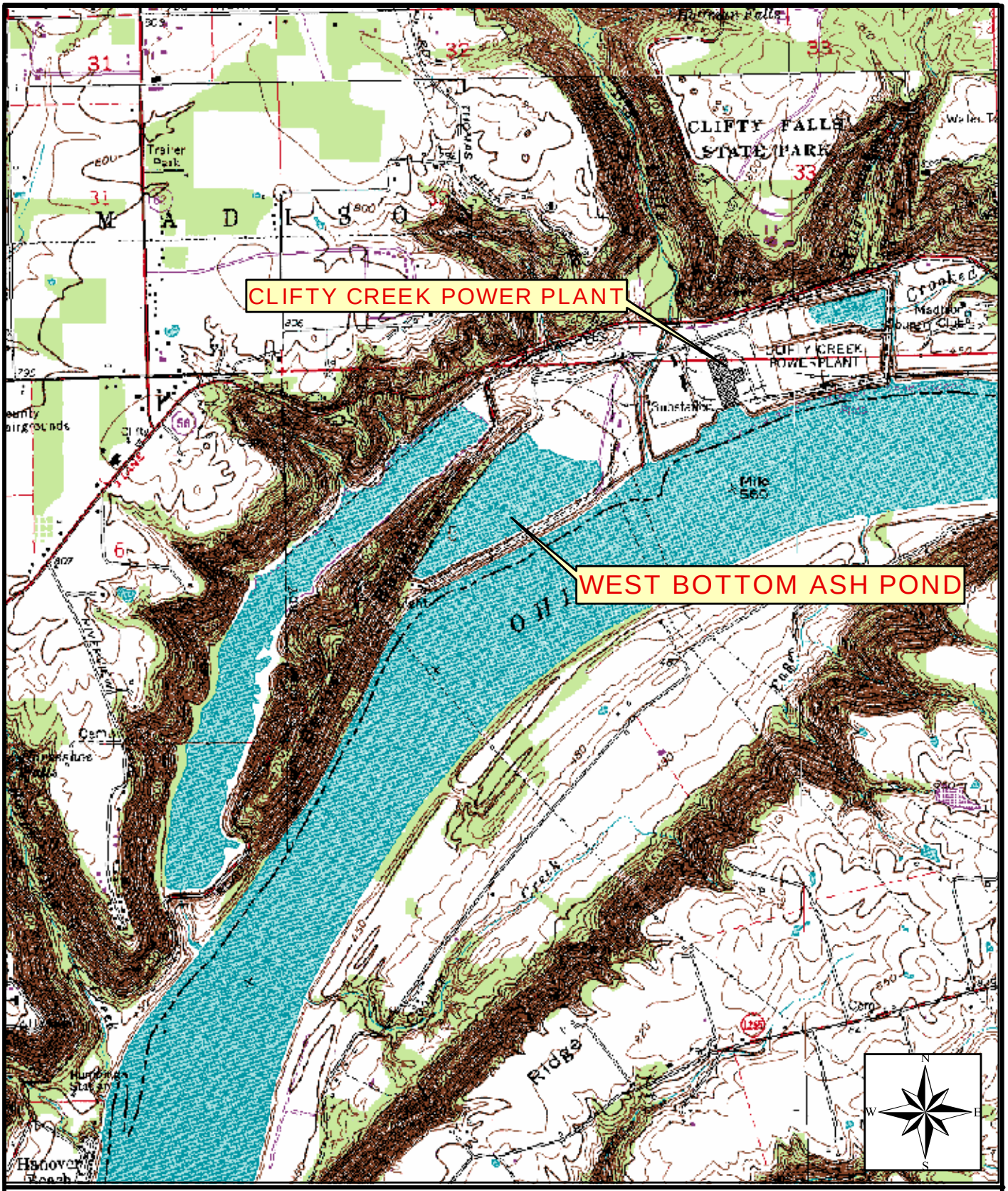
4.0 ENGINEER'S CERTIFICATION

I acknowledge that the management unit referenced herein, the Clifty Creek Station West Bottom Ash Pond Dam, has been assessed on June 9 & 10, 2009.

Walter Kosinski, P.E.	Peter H. Baril
Principal	Consultant/Reviewer

J:\01.0170142.00\Inspections\Clifty Creek, IN\Inspections\West Bottom Ash Pond\Clifty Creek W Bottom Ash Report.doc

FIGURES



SOURCE : SCANNED USGS TOPOGRAPHIC QUADRANGLES SCANNED BY THE INDIANA UNIVERSITY - INDIANA SPACIAL DATA PORTAL (ISDP). DATA ACCESSED JUNE 2009.

Data Supplied by : INDIANA UNIVERSITY

0 1,000 2,000 4,000 Feet

GZA	PROJ. MGR.: JPG DESIGNED BY: GWH REVIEWED BY: PHB OPERATOR: GWH DATE: 09-08-2009	WEST BOTTOM ASH POND USGS QUAD LOCATION MAP	JOB NO. 01.0170142.00
		CLIFTY CREEK POWER PLANT MADISON, INDIANA	FIGURE NO. 1

J:\170,000-179,999\170142\170142-00.JPG\Figures\GIS\Clifty Creek Locus Map.mxd

SOURCE : ORTHOPHOTO IMAGERT PROVIDED BY THE INDIANA UNIVERSITY - INDIANA SPACIAL DATA PORTAL (ISDP). DATA ACCESSED JUNE 2009.

Data Supplied by : INDIANA UNIVERSITY

0 1,000 2,000 4,000 Feet

GZA	PROJ. MGR.: JPG DESIGNED BY: GWH REVIEWED BY: PHB OPERATOR: GWH DATE: 09-16-2009	WEST BOTTOM ASH POND ORTHOPHOTO LOCATION MAP	JOB NO. 01.0170142.00
		CLIFTY CREEK POWER PLANT MADISON, INDIANA	FIGURE NO. 2

J:\170,000-179,999\170142\170142-00.JPG\Figures\GIS\Clifty Creek Locus Map - Ortho.mxd

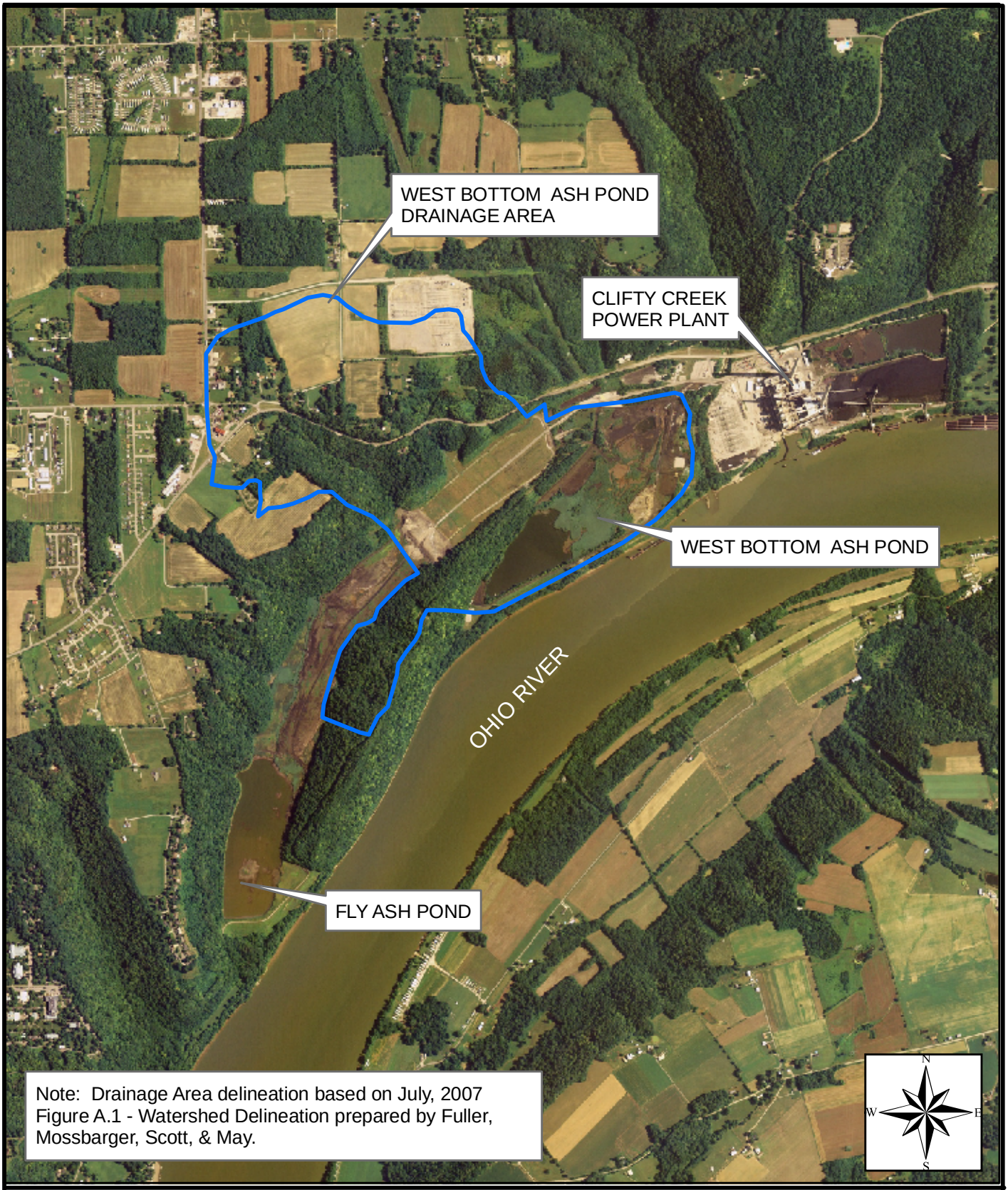
SOURCE : ORTHOPHOTO IMAGERT PROVIDED BY THE INDIANA UNIVERSITY - INDIANA SPACIAL DATA PORTAL (ISDP). DATA ACCESSED JUNE 2009.

Data Supplied by : INDIANA UNIVERSITY

0 2,000 4,000 8,000 Feet

GZA	PROJ. MGR.: JPG DESIGNED BY: GWH REVIEWED BY: PHB OPERATOR: GWH DATE: 09-16-2009	WEST BOTTOM ASH POND DOWNSTREAM AREA MAP	JOB NO. 01.0170142.00
		CLIFTY CREEK POWER PLANT MADISON, INDIANA	FIGURE NO. 3

J:\170,000-179,999\170142\170142-00.JPG\Figures\GIS\Clifty Creek Locus Map.mxd



Note: Drainage Area delineation based on July, 2007
Figure A.1 - Watershed Delineation prepared by Fuller, Mossbarger, Scott, & May.

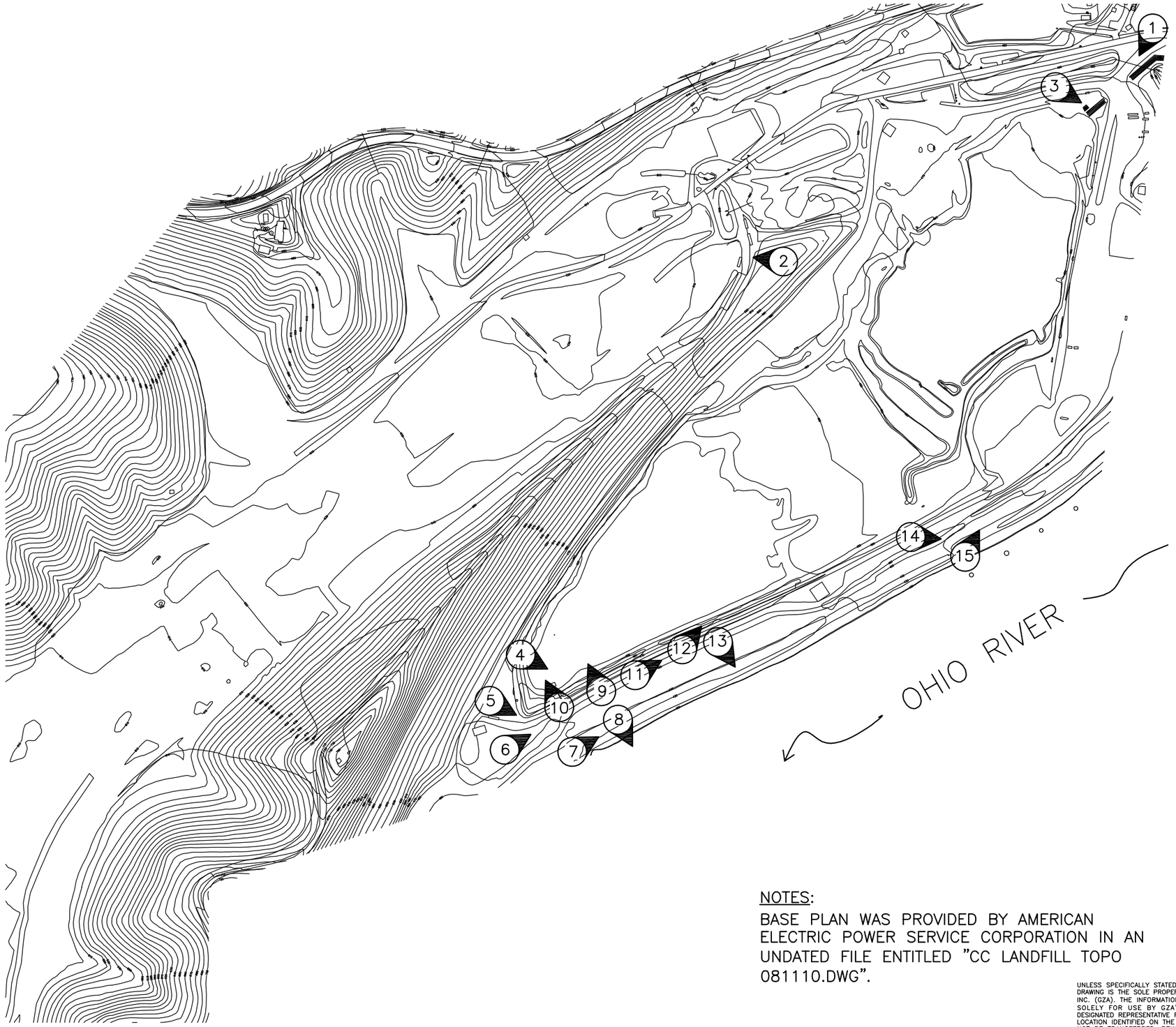
SOURCE : SCANNED USGS TOPOGRAPHIC QUADRANGLES SCANNED BY THE INDIANA UNIVERSITY - INDIANA SPACIAL DATA PORTAL (ISDP). DATA ACCESSED JUNE 2009.

Data Supplied by : INDIANA UNIVERSITY

0 1,000 2,000 4,000 Feet

GZA	PROJ. MGR.: JPG DESIGNED BY: GWH REVIEWED BY: PHB OPERATOR: GWH DATE: 09-17-2009	WEST BOTTOM ASH POND DRAINAGE AREA MAP	JOB NO. 01.0170142.00
		CLIFTY CREEK POWER PLANT MADISON, INDIANA	FIGURE NO. 4

J:\170,000-179,999\170142\170142-00.JPG\Figures\GIS\Clifty Creek Drainage Area Map.mxd



0 250' 500' 1000'

1" = 500'

N

NOTES:

BASE PLAN WAS PROVIDED BY AMERICAN ELECTRIC POWER SERVICE CORPORATION IN AN UNDATED FILE ENTITLED "CC LANDFILL TOPO 081110.DWG".

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.

CLIFTY CREEK POWER PLANT
WEST BOTTOM ASH POND DAM
INDIANA-KENTUCKY ELECTRIC CORP.
MADISON, INDIANA

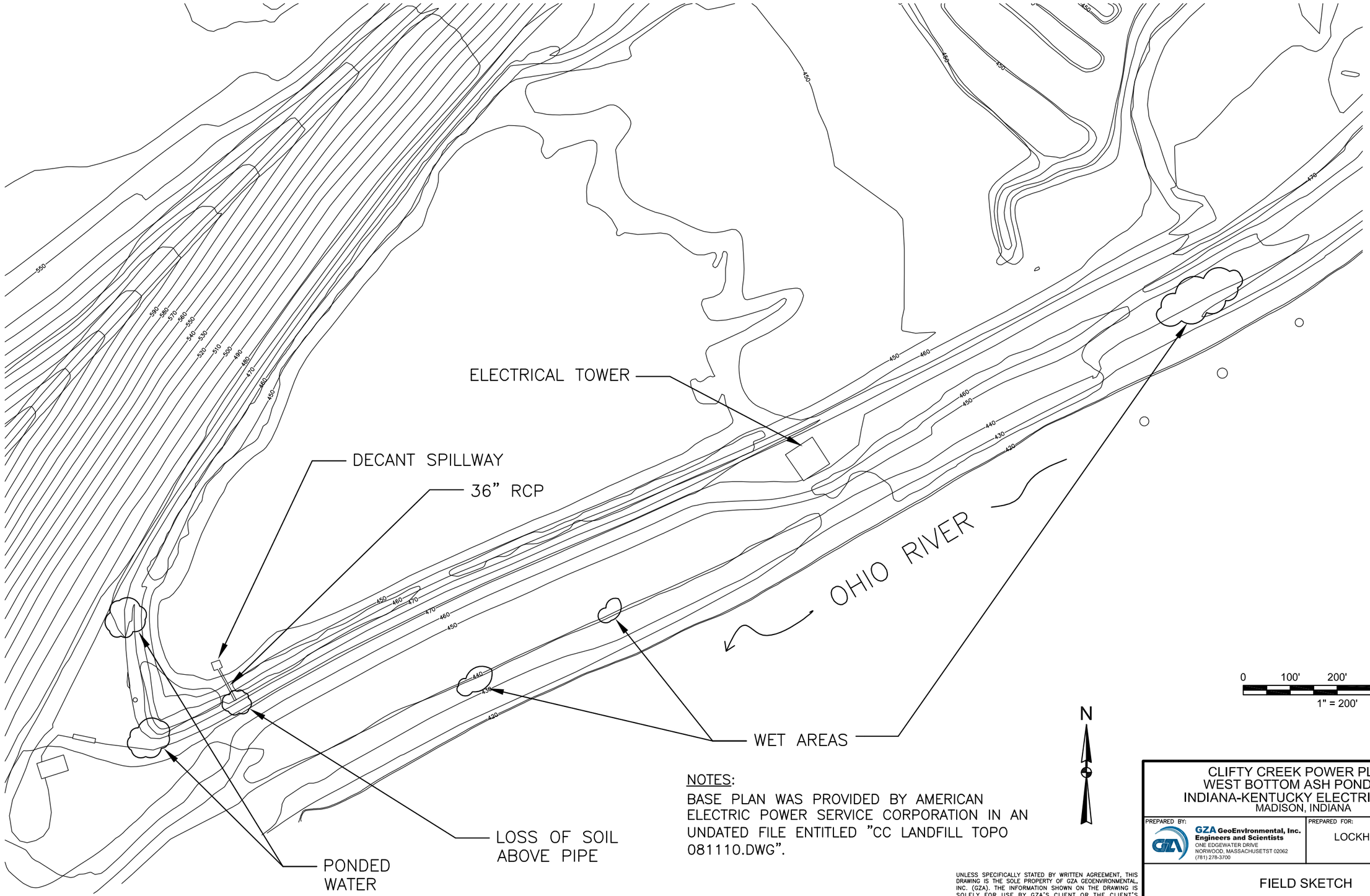
PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
ONE EDGEWATER DRIVE
NORWOOD, MASSACHUSETST 02062
(781) 278-3700

PREPARED FOR:
LOCKHEED MARTIN

PHOTOGRAPH LOCATION PLAN

PROJ MGR: JPG	REVIEWED BY: PHB	CHECKED BY: JPG	FIGURE
DESIGNED BY: LGM	DRAWN BY: LGM	SCALE: 1"=500'	5
DATE: JULY 2009	PROJECT NO. 170142	REVISION NO.	

©2009– GZA GeoEnvironmental, Inc. GZA–J:\170,000–179,999\170142\170142–00.JPG\Figures\CAD\Clifty Creek\Clifty photo location.dwg [Photos] July 27, 2009 – 4:14pm laurie.miller



NOTES:
BASE PLAN WAS PROVIDED BY AMERICAN ELECTRIC POWER SERVICE CORPORATION IN AN UNDATED FILE ENTITLED "CC LANDFILL TOPO 081110.DWG".

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.

CLIFTY CREEK POWER PLANT
WEST BOTTOM ASH POND DAM
INDIANA-KENTUCKY ELECTRIC CORP.
MADISON, INDIANA

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

PREPARED FOR: LOCKHEED MARTIN

FIELD SKETCH

PROJ MGR: JPG	REVIEWED BY: PHB	CHECKED BY: JPG	FIGURE 6
DESIGNED BY: LGM	DRAWN BY: LGM	SCALE: 1"=200'	
DATE: JULY 2009	PROJECT NO. 170142	REVISION NO.	

©2009– GZA GeoEnvironmental, Inc. GZA–J:\170,000–179,999\170142\170142–00.JPG\Figures\CAD\Clifty Creek\Clifty photo location.dwg [fIELD sKETCH] July 27, 2009 – 4:15pm laurie.miller

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 Indiana'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 realized 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 for the dam as this was outside our scope of services. Comments on this subject in the report are referenced from a 2007 analysis performed by Fuller, Mossbarger, Scott & May Engineers, Inc.

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.

APPENDIX B

PHOTOGRAPHS

#1 - Overview of Bottom Ash Pond taken from head water area looking southwest

#2 - Relocated Creek Entering Pond

#3 - Boiler Discharge Lines Into Pond

 # 4 - Decant Spillway and Portion of Upstream Face of Dam Embankment; (note dense tree growth)

#5 - Standing Water on Crest Near Right Abutment

#6 - Upper Slope and Berm of Downstream Face Taken Near Right Abutment

#7 - Sinkhole Above Downstream End of 36" Outlet Pipe

#8 - Repaired Sinkhole & RCP Outlet to Ohio River

#9 - Decant Spillway in Floating Catwalk/Spillway and debris boom

#10 - Surface Wear of Concrete Spillway Riser. EL 447 was Former Normal Pool Level.

#11 - Access Road on Crest with Shallow Ponding in Tire Ruts looking eastward toward left abutment

#12 - Typical Vegetative Growth on Upstream Face of Embankment

#13 - Downstream Face Along Horizontal Berm; Note Wet Area in Middle of Frame

#14 - Lower Slope of Downstream Face at Location of Wet Areas

#15 - Crest and Upstream Face at Left Abutment

APPENDIX C

EPA & GZA INSPECTION CHECKLISTS

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	Clifty Creek	Date:	June 10, 2009
Unit Name:	West Bottom Ash Pond Site 16 (Regn 5)	Operator's Name:	Indiana-Kentucky Electric Corp.
Unit I.D.:		Hazard Potential Classification:	High **Significant** Low
Inspector's Name:	W. Kosinski, P.E., P. Baril (GZA)		

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?	Annual		18. Sloughing or bulging on slopes?		✓
2. Pool elevation (operator records)?	EL 443.75		19. Major erosion or slope deterioration?		✓
3. Decant inlet elevation (operator records)?	Yes		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	No / n/a		Is water entering inlet, but not exiting outlet?		✓
5. Lowest dam crest elevation (operator records)?	475		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?		N/A
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?		✓	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. Annual inspection (by AEP) typical; conducted independent inspection (Stantec) in May, 2009.
8. Embankment dam designed and construction oversight by A. Casagrande
9. Woody vegetation/trees (up to 1 ft brest height diameter) on upstream face
12. No trash rack but does have floating boom at intake (skimmer)
17. Vegetation on u/s slope and steep slope obscured observation of slope.
21. Possible sinkhole above outlet decant pipe approximately 10' up from outlet. Hole filled/repaired subsequently on or about June 12, 2009.
23. Except during flood conditions on Ohio River

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # IN 0001759 (Outfall 002) INSPECTOR Kosinski/Baril (GZA)
Date June 10, 2009

Impoundment Name West Bottom Ash Pond - Clifty Creek, Madison, IN
Impoundment Company Indiana-Kentucky Electric Corp.
EPA Region 5
State Agency (Field Office) Addresss 100 North Senate Avenue
Indianapolis, IN 46204 (317) 232-8603
Name of Impoundment West Bottom Ash Pond
(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: To settle CCW to reclaim boiler slag for beneficial reuse

Nearest Downstream Town : Name Hanover, IN
Distance from the impoundment 2.4 miles
Impoundment Location:
Longitude -85 Degrees 25 Minutes 8.4 Seconds
Latitude +38 Degrees 44 Minutes 16.8 Seconds
State IN County Jefferson

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

If So Which State Agency? IDEM (water quality)

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.

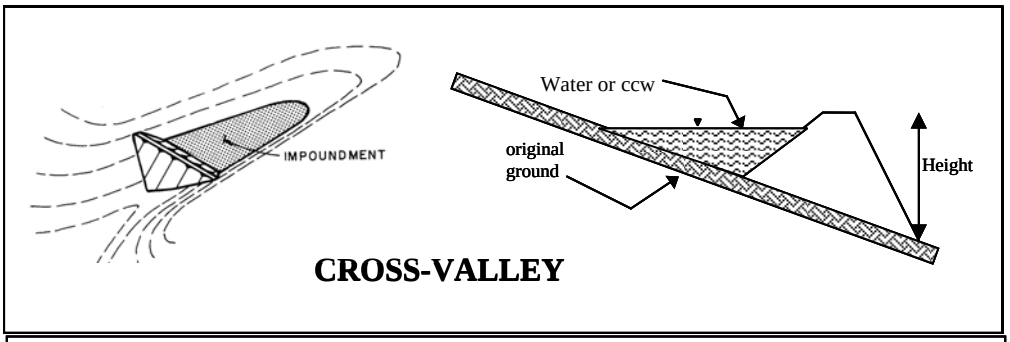
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

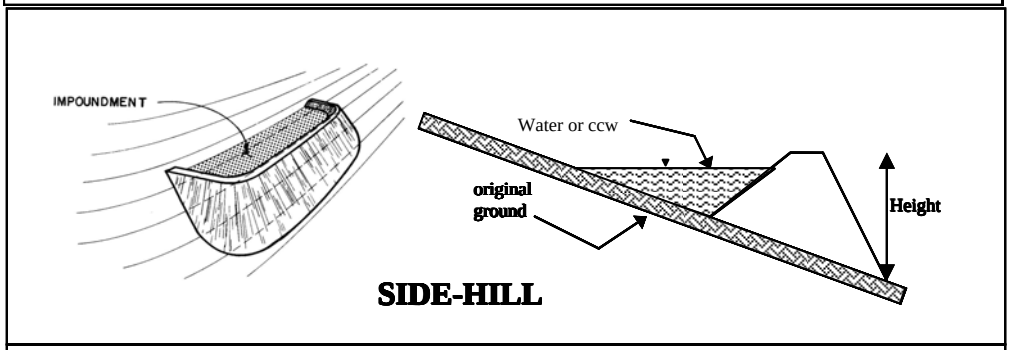
Hazard classification primarily based on potential environmental damage resulting from a dam failure and uncontrolled release of water and bottom ash (slag). Dam is located immediately upgradient from Ohio River.

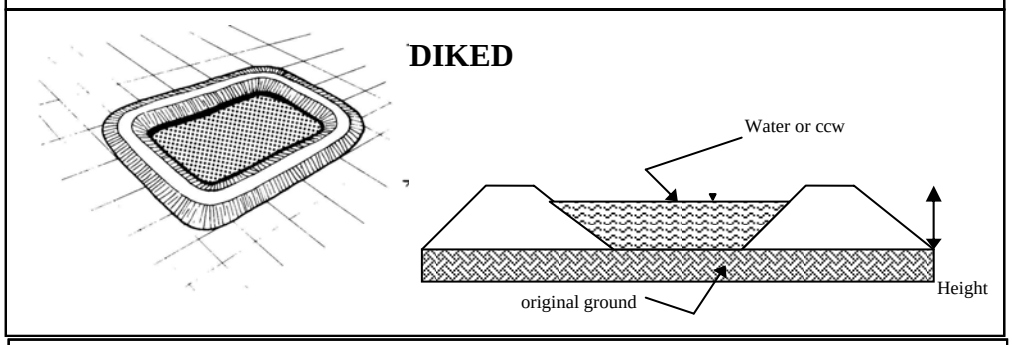
According to Indiana Department of Natural Resources, the dam has a low hazard potential rating.

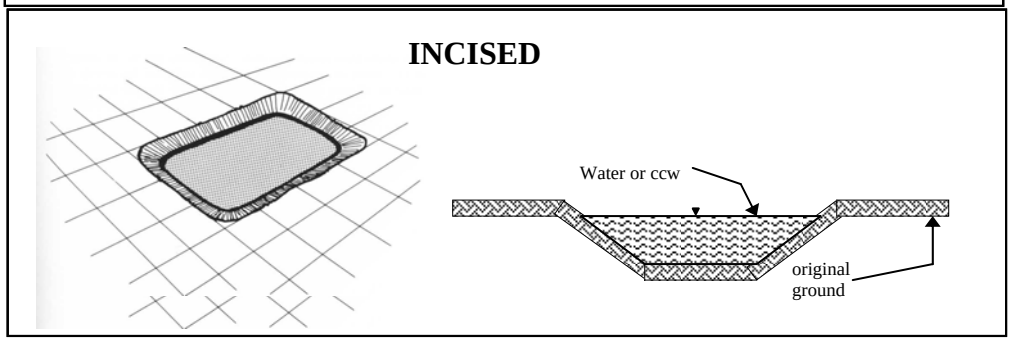
West Bottom Slag

CONFIGURATION:









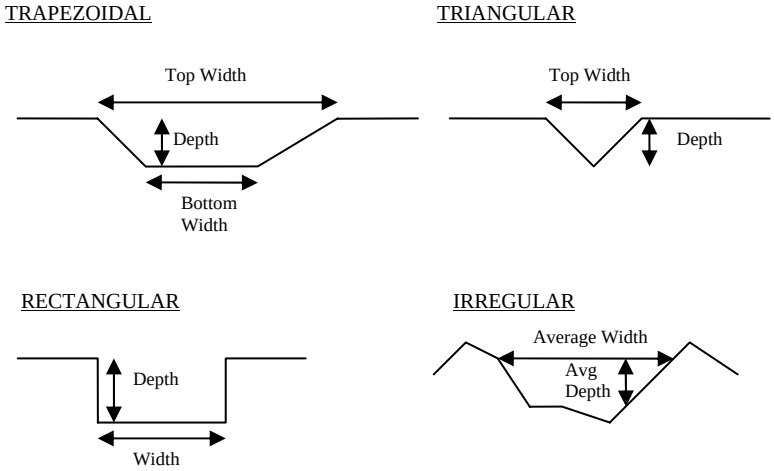
_____ Cross-Valley
__X__ Side-Hill
_____ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

Embankment Height ____35____ feet Embankment Material ____local borrow material (clayey silt)____
Pool Area ____13____ acres Liner ____n/a____
Current Freeboard ____32____ feet Liner Permeability ____n/a____

TYPE OF OUTLET (Mark all that apply)

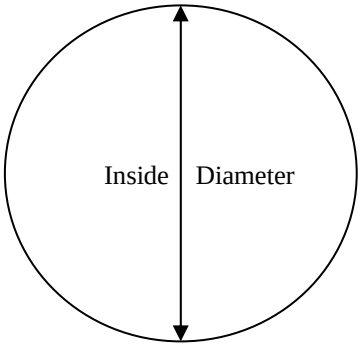
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular N/A
_____ Rectangular
_____ Irregular

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



_____ **Outlet**

36" inside diameter



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

Is water flowing through the outlet? YES X NO _____

_____ **No Outlet**

_____ **Other Type of Outlet** (specify) Drop inlet w/stoplog

The Impoundment was Designed By Prof. Arthur Casagrande

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

If So When? _____

If So Please Describe : _____

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

If So When? _____

IF So Please Describe: _____

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

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

If so Please Describe : _____

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: West Bottom Ash Pond

STATE ID #:

REGISTERED: ☐ YES ☑ NO

NID ID #:

STATE SIZE CLASSIFICATION:

EPA HAZARD CLASSIFICATION: Significant

CHANGE IN HAZARD CLASSIFICATION REQUESTED?: No

DAM LOCATION INFORMATION

CITY/TOWN: Madison, Indiana

COUNTY: Jefferson

DAM LOCATION: Clifty Creek Power Plant
(street address if known)

ALTERNATE DAM NAME: Site 16 (EPA Region 5)

USGS QUAD.: Madison West

LAT.: 38˚44' 04" N

LONG.: 85° 25' 48" W

DRAINAGE BASIN: -

RIVER: Clifty Creek (tributary to Ohio River)

IMPOUNDMENT NAME(S): Same as above

GENERAL DAM INFORMATION

TYPE OF DAM: Earth embankment

OVERALL LENGTH (FT): 2500

PURPOSE OF DAM: Bottom Ash Boiler Slag Storage

NORMAL POOL STORAGE (ACRE-FT): 3600 ±

YEAR BUILT: 1954

MAXIMUM POOL STORAGE (ACRE-FT): 4800±

STRUCTURAL HEIGHT (FT): 35

EL. NORMAL POOL (FT): 443 ± MSL

HYDRAULIC HEIGHT (FT): 37

EL. MAXIMUM POOL (FT): 466.5 (100 year)

FOR INTERNAL MADCR USE ONLY

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO

CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

INSPECTION SUMMARY

DATE OF INSPECTION: June 10, 2009 DATE OF PREVIOUS INSPECTION: April 2, 2009

TEMPERATURE/WEATHER: 60˚s; rain ARMY CORPS PHASE I: ☐ YES ☑ NO If YES, date

CONSULTANT: GZA GeoEnvironmental, Inc. PREVIOUS DCR PHASE I: ☐ YES ☑ NO If YES, date

BENCHMARK/DATUM: NGVD

OVERALL PHYSICAL CONDITION OF DAM: Satisfactory DATE OF LAST REHABILITATION: N/A

SPILLWAY CAPACITY: 110 cfs (+)

EL. POOL DURING INSP.: 443 ± EL. TAILWATER DURING INSP.: Free discharge to Ohio River 424 ±

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING
Walter Kosinski, P.E.	Lead Engineer	GZA GeoEnvironmental, Inc.
Peter Baril	Inspecting Engineer	GZA GeoEnvironmental, Inc.
Pedro J Amaya		American Electric Power
Tim Howdyshell	Principal Coordinator	American Electric Power
Paul de Lamerens	Plant Environment Supint.	Indiana-Kentucky Electric Corporation
Donald T. Fulkerson	Env. Affairs Director	Ohio Valley Electric Corporation/Indiana-Kentucky Elec. Corp.
Matthew W. Smith	Env. Specialist II	Ohio Valley Electric Corporation/Indiana-Kentucky Elec. Corp.
Fred Bartman		U.S. E.P.A.

NAME OF INSPECTING ENGINEER: Walter Kosinski SIGNATURE:

NAME OF DAM: West Bottom Ash Pond

STATE ID #:

INSPECTION DATE: June 10, 2009

NID ID #:

OWNER:		CARETAKER:	
ORGANIZATION	OVEC - IKEC (1)	ORGANIZATION	IKEC
NAME/TITLE	Donald Fulkerson	NAME/TITLE	Paul de Lamerens
STREET	P O Box 468, 3932 U.S. Rt. 23	STREET	P O Box 97, 1335 Clifty Hollow Road
TOWN, STATE, ZIP	Piketon, OH 45661	TOWN, STATE, ZIP	Madison, IN 47250
PHONE	(740) 289-7254	PHONE	(812) 265-8715
EMERGENCY PH. #		EMERGENCY PH. #	
FAX	(740) 289-7253	FAX	(812) 265-8747
EMAIL	dfulkers@ovec.com	EMAIL	
OWNER TYPE	Private		

PRIMARY SPILLWAY TYPE: Concrete Drop Inlet (Decant system)

SPILLWAY LENGTH (FT): Stop plank 3'-3"

SPILLWAY CAPACITY (CFS): 110 (+)

AUXILIARY SPILLWAY TYPE: None

AUX. SPILLWAY CAPACITY (CFS): N/A

NUMBER OF OUTLETS: 1

OUTLET(S) CAPACITY (CFS): N/A

TYPE OF OUTLETS: RCP - 36" diameter

TOTAL DISCHARGE CAPACITY (CFS): 110

DRAINAGE AREA (SQ MI): 0.8 mi²

SPILLWAY DESIGN FLOOD (PERIOD/CFS): 100 year (FMSM)

HAS DAM BEEN BREACHED OR OVERTOPPED ☐ YES ☑ NO IF YES, PROVIDE DATE(S)

FISH LADDER (LIST TYPE IF PRESENT): None

DOES CREST SUPPORT PUBLIC ROAD? ☐ YES ☑ NO IF YES, ROAD NAME:

PUBLIC BRIDGE WITHIN 50' OF DAM? ☐ YES ☑ NO IF YES, ROAD/BRIDGE NAME:

MHD BRIDGE NO. (IF APPLICABLE)

(1) Ohio Valley Electric Corp./Indiana-Kentucky Electric Corp.

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

EMBANKMENT (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Earth with coal ash wearing surface	X		
	2. SURFACE CRACKING	Minor	X		
	3. SINKHOLES, ANIMAL BURROWS	None observed	X		
	4. VERTICAL ALIGNMENT (DEPRESSIONS	Several minor depressions with puddled surface water			X
	5. HORIZONTAL ALIGNMENT	Slight design curvature at each abutment	X		
	6. RUTS AND/OR PUDDLES	Minor tire ruts with shallow puddles			X
	7. VEGETATION (PRESENCE/CONDITION)	Short herbaceous vegetation on edge of gravel/cinder access road	X		
	8. ABUTMENT CONTACT	Good; somewhat indistinct at left end	X		

ADDITIONAL COMMENTS:

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

EMBANKMENT (D/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	Near right abutment near crest (surface ponding) (1)		X	
	2. SEEPAGE	Minor seep area about 130' down from crest (2)		X	X
	3. SLIDE, SLOUGH, SCARP	Minor, mostly due to surface runoff		X	
	4. EMB.-ABUTMENT CONTACT	Good; structural steel laydown area at left abutment	X		
	5. SINKHOLE/ANIMAL BURROWS	None observed	X		
	6. EROSION	Minor, due to surface runoff		X	
	7. UNUSUAL MOVEMENT	None observed	X		
	8. VEGETATION (PRESENCE/CONDITION)	Most of 2½H:1V slope is well maintained; much of horizontal berm and lower slope to	X		
		river's edge contains large trees and other herbaceous vegetation			

ADDITIONAL COMMENTS: Note: Inspection conducted during rainfall conditions. Thus, some observed wetness may have contribution from surface runoff.

(1) Several wet areas on mowed portion of upper slope, between right abutment and high tension electrical tower;
(2) and approximately 750 feet to left of electric tower

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

EMBANKMENT (U/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	Some surficial movement noted; obscured by heavy vegetation			X
	2. SLOPE PROTECTION TYPE AND COND.	Grass and trees; no riprap			X
	3. SINKHOLE/ANIMAL BURROWS	None observed (see Note 1 below)		X	
	4. EMB.-ABUTMENT CONTACT	Good		X	
	5. EROSION	Minor - from surface runoff		X	
	6. UNUSUAL MOVEMENT	None observed		X	
	7. VEGETATION (PRESENCE/CONDITION)	Grass and trees line majority of slope			X

ADDITIONAL COMMENTS: (1) Majority upstream slope nearly 1½H:1V, which, combined with wet weather conditions, did not allow close inspection of most of the slope. Most observations made from crest.

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

INSTRUMENTATION

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS	None			
	2. OBSERVATION WELLS	None			
	3. STAFF GAGE AND RECORDER	None			
	4. WEIRS	None			
	5. INCLINOMETERS	None			
	6. SURVEY MONUMENTS	Unknown; topographic survey conducted November 2008.			
	7. DRAINS	None			
	8. FREQUENCY OF READINGS	None			
	9. LOCATION OF READINGS	None			

ADDITIONAL COMMENTS:

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None observed			
	2. FOUNDATION SEEPAGE	None observed			
	3. SLIDE, SLOUGH, SCARP	None observed			
	4. WEIRS	None			
	5. DRAINAGE SYSTEM	None			
	6. INSTRUMENTATION	None			
	7. VEGETATION	Scrub vegetation and trees on lower slope		X	
	8. ACCESSIBILITY	Only by boat			
	9. DOWNSTREAM HAZARD DESCRIPTION	Significant hazard (EPA definition)			
	10. DATE OF LAST EAP UPDATE	Unknown			

ADDITIONAL COMMENTS: (1) 2½H:1V downstream slope transitions to horizontal berm (L ≈ 100 ft.), then slopes again at 2½H:1V for about length of 60 feet before terminating at bank of Ohio River.

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	7 to 12 feet
	2. RESERVOIR SHORELINE	Vegetation cover or exposed soil
	3. RESERVOIR SLOPES	Shallow to steep
	4. ACCESS ROADS	Gravel ring road on crest
	5. SECURITY DEVICES	Guarded gate at site entrance
	6. VANDALISM OR TRESPASS	☐ YES ☑ NO WHAT:
	7. AVAILABILITY OF PLANS	☑ YES ☐ NO DATE: 1954
	8. AVAILABILITY OF DESIGN CALCS	☐ YES ☑ NO DATE:
	9. AVAILABILITY OF EAP/LAST UPDATE	☐ YES ☐ NO DATE:
	10. AVAILABILITY OF O&M MANUAL	☑ YES ☐ NO DATE: June 2009
	11. CARETAKER/OWNER AVAILABLE	☑ YES ☐ NO DATE:
	12. CONFINED SPACE ENTRY REQUIRED	☐ YES ☑ NO PURPOSE:

ADDITIONAL COMMENTS:

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Concrete, drop inlet/decant	X		
	WEIR TYPE	Removable concrete stop planks (1)	X		
	SPILLWAY CONDITION	Fair; 50+ years old; surface wear at water line		X	
	TRAINING WALLS	N/A	X		
	SPILLWAY CONTROLS AND CONDITION	None observed; turbidity boom encircling weir outlet	X		
	UNUSUAL MOVEMENT	Possible settlement of last section of 36" RCP		X	
	APPROACH AREA	Open water		X	
	DISCHARGE AREA	Drop inlet to 36"diameter RCP to Ohio River	X		
	DEBRIS	None observed	X		
	WATER LEVEL AT TIME OF INSPECTION	EL 443 ±	X		

ADDITIONAL COMMENTS: (1) Dimensions: 4' L x 3" H x 3" D

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	N/A			
	WEIR TYPE				
	SPILLWAY CONDITION				
	TRAINING WALLS				
	SPILLWAY CONTROLS AND CONDITION				
	UNUSUAL MOVEMENT				
	APPROACH AREA				
	DISCHARGE AREA				
	DEBRIS				
	WATER LEVEL AT TIME OF INSPECTION				

ADDITIONAL COMMENTS:

NAME OF DAM: West Bottom Ash Pond STATE ID #:

INSPECTION DATE: June 10, 2009 NID ID #:

OUTLET WORKS (1)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	36-inch diameter RCP		X	
	INTAKE STRUCTURE	At spillway		X	
	TRASHRACK	None - turbidity boom surrounding spillway		X	
	PRIMARY CLOSURE	At spillway (stop planks)	X		
	SECONDARY CLOSURE	None			
	CONDUIT	36-inch RCP		X	
	OUTLET STRUCTURE/HEADWALL	Pipe end projecting out from embankment		X	
	EROSION ALONG TOE OF DAM	Minor - riprap at end of pipe		X	
	SEEPAGE/LEAKAGE	Possible leakage through joint near end of pipe (3)		X	
	DEBRIS/BLOCKAGE	Couple of stop planks in pipe; reportedly removed (3)	X		
	UNUSUAL MOVEMENT	Loss of soil above pipe about 10 ft. upgradient (2) (sinkhole)		X	
	DOWNSTREAM AREA	Ohio River			
	MISCELLANEOUS				

ADDITIONAL COMMENTS: (1) Outlet pipe emanates from drop inlet spillway; there is no separate outlet works.
(2) From end of pipe; subsequently repaired by caretaker.
(3) Based on viewing video inspection conducted in June 2007.

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.

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.