Report of
Dam Safety Assessment of Coal Combustion Surface Impoundments

Kentucky Utilities,
a wholly owned subsidiary of LG&E and KU Energy LLC

Tyrone Generating Station, Tyrone, KY

AMEC Project No. 3-2106-0177.0004

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I certify that the management units referenced herein:

Kentucky Utilities, a wholly owned subsidiary of LG&E and KU Energy LLC, Tyrone Generating Station: Tyrone Ash Pond and the Former Secondary Pond were assessed on August 3, 2010.

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TABLE OF CONTENTS

SECTION **PAGE NO.**

1.0 INTRODUCTION AND PROJECT DESCRIPTION 1

1.1 Introduction 1
1.2 Project Background 1
1.2.1 State Issued Permits 3
1.3 Site Description and Location 3
1.4 Process Ponds 4
1.4.1 Ash Handling and Flow Summary 4
1.4.2 Tyrone Ash Pond 4
1.4.3 Former Secondary Pond 5
1.5 Previously Identified Safety Issues 6
1.6 Site Geology 6
1.7 Inventory of Provided Materials 6

2.0 FIELD ASSESSMENT 7

2.1 Visual Observations 7
2.2 Visual Observations - Tyrone Ash Pond 7
2.2.1 Tyrone Ash Pond - Embankments and Crest 7
2.2.2 Tyrone Ash Pond - Outlet Control Structure 8
2.3 Visual Observations - Former Secondary Pond 8
2.4 Monitoring Instrumentation 8

3.0 DATA EVALUATION 9

3.1 Design Assumptions 9
3.2 Hydrologic and Hydraulic Design 9
3.2.1 Tyrone Ash Pond 12
3.2.2 Former Secondary Pond 16
3.3 Structural Adequacy & Stability 16
3.3.1 Tyrone Ash Pond - Structural Adequacy & Stability 17
3.3.2 Former Secondary Pond - Structural Adequacy & Stability 20
3.4 Foundation Conditions 20
3.5 Operations and Maintenance 20
3.5.1 Instrumentation 21
3.5.2 Inspections 21

4.0 COMMENTS AND RECOMMENDATIONS 28

4.1 Acknowledgement of Management Unit Conditions 28
4.2 Tyrone Ash Pond 29
4.2.1 Hydrologic and Hydraulic Recommendations 29
4.2.2 Geotechnical and Stability Recommendations 30
4.2.3 Monitoring and Instrumentation Recommendations 31
4.2.4 Inspection Recommendations 32
4.3 Former Secondary Pond 32

5.0 CLOSING 33

TABLES

Table 1. Site Visit Attendees 1
Table 2. MSHA* Minimum Long Term Hydrologic Design Criteria 11
Table 3. Summary of 1998 DAMS2 Analysis 13
Table 4. Minimum Required Dam Safety Factors 17
Table 5. Soil Parameters 18
Table 6. Slope Stability Analyses Calculated Safety Factors 19
Table 7. Piezometer Information 21

FIGURES

Site Location & Vicinity Map ..... Figure 1
Site Plan ..... Figure 2
Critical Infrastructure Map ..... Figure 3
Topographic Map ..... Figure 4
Tyrone Ash Pond Plan View ..... Figure 5
Tyrone Ash Pond Typical Cross-Sections ..... Figure 6
Tyrone Ash Pond Piezometer Locations and 2010 Stability Analysis Cross-Sections ..... Figure 7

APPENDICES

EPA Coal Combustion Dam Inspection Checklists and Coal Combustion
Waste Impoundment Inspection Forms - August 2010 ..... Appendix A
Site Photo Log Maps and Site Photos ..... Appendix B
Inventory of Provided Materials ..... Appendix C

1.0 INTRODUCTION AND PROJECT DESCRIPTION

1.1 Introduction

AMEC was contracted by the United States Environmental Protection Agency (EPA), via contract BPA EP09W001702, to perform site assessments of selected coal combustion byproducts surface impoundments. AMEC was directed by EPA, through the provided scope of work and verbal communications, to utilize the following resources and guidelines to conduct a site assessment and produce a written assessment report for the coal combustion waste facilities and impoundments.

- Coal Combustion Waste (CCW) Impoundment Inspection forms (hazard rating, found in Report Appendix A)
- Coal Combustion Dam Inspection Checklist (found in Report Appendix A)
- Impoundment Design Guidelines of the Mining Safety and Health Administration (MSHA) Coal Mine Impoundment Inspection and Plan Review Handbook (hydrologic, hydraulic, and stability conditions)
- National Dam Safety Review Board Condition Assessment Definitions (condition rating)

As part of this contract with EPA, AMEC was assigned to perform a site assessment of Kentucky Utilities (a wholly owned subsidiary of LG&E and KU Energy LLC, formerly E.ON U.S.) Tyrone Generating Station, which is located in Woodford County, Kentucky, approximately 7 miles west of Versailles, Kentucky. A Project Location Map is provided as Figure 1.

A site visit to Tyrone Generating Station was made by AMEC on August 3, 2010. The purpose of the visit was to perform visual observations, to inventory coal combustion waste (CCW) surface impoundments, assess the containment dikes, and to collect relevant historical impoundment documentation.

AMEC engineers, James Black, PE and Mary Swiderski, EIT were accompanied during the site visit by the following individuals:

Table 1. Site Visit Attendees

Company or Organization	Name and Title
Kentucky Utilities	Barry Currens, Manager Tyrone Operations
LG&E and KU Energy Environmental Affairs	Roger J. Medina, Senior Chemical Engineer
LG&E and KU Energy Generation Engineering	David J. Millay, P.E., Civil Engineer

1.2 Project Background

CCW results from the power production processes at coal fired power plants like Kentucky Utilities (KU) Tyrone Generating Station. Impoundments (dams) are designed and constructed to provide storage and disposal for the CCW that are produced. KU refers to the two CCW impoundments at the Tyrone Generating Station as “Tyrone (or Main) Ash Pond” and the “Former Secondary Pond”.

The National Inventory of Dams (NID), administered by the U.S. Army Corps of Engineers (USACE), provides a list of many dams within the United States, as well as hazard potentials related to the listed dams. The Tyrone Ash Pond and Former Secondary Pond are not listed in the database.

Kentucky Revised Statute (KRS) 151.100 defines the word dam to mean any artificial barrier, including appurtenant works, which does or can impound or divert water and which either: (a) is or will be twenty-five (25) feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier; or (b) has or will have an impounding capacity at maximum water storage elevation of 50 acre-feet or more. The Kentucky Department for Natural Resources and Environmental Protection's (KDEP) Division of Water (KDOW) regulates dam design, construction and repair. The Kentucky Department for Natural Resources and Environmental Protection's (KDEP) Division of Water (KDOW) regulates dam design, construction and repair. KDOW also evaluates a dam's structure and various other criteria related to the effects of dam failure to determine and assign a dam hazard classification to each structure. KDOW's Engineering Memorandum No. 5 provides minimum hydrologic and hydraulics related design criteria, as well as hazard classification definitions for dam structures. Dam hazard classifications, outlined in KDOW's Engineering Memorandum No. 5, include Low Hazard (A), Moderate Hazard (B), and High Hazard (C).

- A Low Hazard (A) classification is assigned to structures "located such that failure would cause loss of the structure itself but little or no additional damage to other property."

- A Moderate Hazard (B) classification is assigned to structures that "are located such that failure may cause significant damage to property and project operation, but loss of human life is not envisioned."

- A High Hazard (C) classification is assigned to "structures located such that failure may cause loss of life or serious damage to houses, industrial or commercial buildings, important public utilities, main highways or major railroads."

According to KDOW, state inspections for dams with high (Class C) and moderate (Class B) hazard classifications occur every two years, while dams with a low (Class A) hazard classification are inspected every five years. A Certification of Inspection is issued to the dam owner if, upon inspection, it is determined that the as-built structure meets all the necessary requirements as outlined in KDOW's Engineering Memorandum No. 5. Following successful construction completion and inspection, the owner is given permission to impound water and the dam is placed on the KDOW inventory of dams.

KDOW has classified Tyrone Ash Pond (ID 956) as a low hazard dam (Class A). However, according to the KDOW inspection on June 9, 2005, the Former Secondary Pond "does not meet the regulatory requirements and definition attributed to a „dam'. Due to location, ash settlement and flow characteristics, operational methods of ash handling and lack of downstream development, it does not appear that overtopping of this lower impoundment would feasibly create any hydraulic (flooding) hazard downstream."

As part of the observations and evaluations performed at Tyrone Generating Station, AMEC completed EPA's Coal Combustion Dam Inspection Checklists and Coal Combustion Waste (CCW) Impoundment Inspection Forms for the Tyrone Ash Pond and Former Secondary Pond. Copies of the CCW Impoundment Inspection Forms are provided in Appendix A. The CCW Impoundment Inspection Forms include a section that assigns a "Hazard Potential" that is used

to indicate what would occur following failure of an impoundment. "Hazard Potential" choices include "Less than Low," "Low," "Significant," and "High." Based on the site visit evaluation of the impoundments, AMEC engineers assigned a "Significant Hazard Potential" classification to the Tyrone Ash Pond. As defined on the Inspection Form, dams assigned a "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. No classification was assigned to the Former Secondary Pond since the dikes of this pond have been de-graded and the contained material has been removed.

EPA received Draft Report[1] response comments from KU (January 26, 2011) and KDOW (January 31, 2011). Both parties take exception to (1) the assignment of an independent hazard potential rating to the Tyrone Ash Pond (considered to be a low hazard structure by Kentucky regulations) and (2) criteria for assignment of the rating. AMEC utilized the resources and guidelines provided by EPA for this work.

1.2.1 State Issued Permits

KDOW has issued Kentucky Pollutant Discharge Elimination System (KPDES) Permit No. KY 0001899 to Kentucky Utilities Company. The most recent permit provided by KDOW authorizes Kentucky Utilities Company to discharge from Tyrone Generating Station to the Kentucky River at mile point 82.9 and 83.1. The permit became effective on February 1, 2002 and expired on February 1, 2007. At the time of writing this report, KDOW stated the KPDES permit for Tyrone Generating Station was under review. However, under applicable state regulations, the permit will remain in effect during the review process.

KDOW issues construction permits for proposed ash ponds. Construction permit number 1502 dated April 21, 1978 for the "new ash pond at site of existing ash pond" was provided; however, the pond location could not be confirmed based on the latitude and longitude coordinates listed on the permit.

1.3 Site Description and Location

Kentucky Utilities Tyrone Generating Station is located approximately 7 miles west of Versailles, Kentucky. The area surrounding the plant boundary is primarily rural. The Site Location and Vicinity Map, included as Figure 1, illustrates the location of Tyrone Generating Station relative to Versailles. The Kentucky River is located to the west of the plant facilities. The Site Plan, included as Figure 2, shows the location of the Ash Ponds and their proximity to the Kentucky River. The distances between the closest point of the ash ponds and the Kentucky River are approximately 200 feet and 225 feet for the Tyrone Ash Pond and Former Secondary Pond, respectively.

An aerial photograph of the region indicating the location of Tyrone Generating Station ash ponds in relation to schools, hospitals, and other critical infrastructure located within approximately 5 miles down gradient of the structures is included as Figure 3, the Critical Infrastructure Map. A table that provides names and coordinate data for the infrastructure is included on the map.

[1] Draft Report submitted to EPA by AMEC in September 2010

1.4 Process Ponds

1.4.1 Ash Handling and Flow Summary

Tyrone Generating Station utilizes coal in the production of electricity. In this process, two types of CCW ash are generated: bottom ash and fly ash. The Tyrone Ash Pond is an active ash pond that receives process flows discharged from Unit 3 and rainfall runoff. Discharge from the Ash Pond is via a concrete decant structure to a KPDES monitoring and sampling point. From this monitoring/sampling point, discharge is conveyed to a rip-rap lined channel which directs the discharge to the Kentucky River via KPDES permitted outfalls.

Historically, the Former Secondary Pond received discharge from the main pond. At present, this pond no longer receives liquid-borne material; the dikes of this pond have been graded; and, the contained material has been removed.

1.4.2 Tyrone Ash Pond

Current Pond Conditions

The Tyrone Ash Pond was commissioned circa 1977 with a 13-acre surface area and a maximum embankment height of 19.6 feet. Information provided in response to the EPA Request for Information under Section 104(e) dated March 25, 2009 indicated that KU was unable to determine the total storage capacity and volume of materials stored in the ash pond. Design drawings indicate the pond storage capacity is approximately 162,000 cubic yards. Drawings indicate a design embankment crest width of 12 feet and exterior and interior slopes of 2.5:1 (H:V). A drainage ditch is located 10 feet from the toe of the downstream slope on the north and south embankments and was designed to provide drainage for non-pond site surface runoff. KU was unable to determine if the dam was constructed under the supervision of a professional engineer; however, documentation indicates the dam was designed and is currently inspected by a professional engineer. A topographic plan view of the Tyrone Ash Pond is included as Figure 4. This figure is based on a ground control survey dated December 23, 2009 completed by Kimball Associates, Inc to provide KU with more accurate embankment elevations and other useful information regarding the facilities. Figures 5 and 6 illustrate the Tyrone Ash Pond Plan View and Typical Cross Sections.

Process flows to the ash basin primarily result from the operation of Unit 3 and management of residuals formed by the combustion of coal including the following:

- Fly ash and bottom ash sluicing flows;
- Coal mill rejects and pyrites;
- Boiler blowdown flows;
- Water demineralizer regeneration wastes and reverse osmosis system reject water flows;
- Miscellaneous filter backwash and floor drain flows (from plant sumps);
- Sewage treatment plant effluent flows;
- Miscellaneous once-thru cooling water flows;
- Plant substation runoff flows pumped to ash basin; and,
- Coal pile runoff flows.

The basin receives process flows from the plant operations and rainfall flow from several areas. The rainfall runoff areas to the ash basin include:

- Two substations immediately to the east of the boiler-turbine building;
- The coal pile runoff area (runoff is collected in an approximately 1 acre pond and pumped to the ash basin); and
- Rainfall runoff flows associated with the watershed basin of the pond including runoff from stockpiled ash directly uphill (east) of the basin.

Material from the ash pond is periodically excavated based on beneficial reuse and operational need. From year 2000 to 2008, the pond was excavated twice per year. Tyrone Generating Station was placed on reserve shutdown in February 2009 and returned to service in June of 2010. From 2009 to August 2010, the pond was not excavated. When dredging occurs, the dredged ash is placed in an ash stack located immediately adjacent to the eastern portion of the pond. In accordance with communication with KPDES permit writers, KU stockpiles ash within the drainage area of the Tyrone Ash Pond. The purpose of the stockpile is to have readily marketable material for beneficial reuse projects.

Previous Pond Issues

During a February 2009 site inspection, ATC Associates, Inc. noted seeps below the west embankment and recommended an evaluation of the area as a High priority item (see Section 3.5.2). KU commissioned ATC to perform an investigation. ATC's report, entitled *Ash Pond Seep Evaluation Report Tyrone Power Station* dated September 11, 2009, discussed the water seeps and slope erosion of the earth slopes between the cooling water canal and the west embankment of the Tyrone Ash Pond. The report also addressed the dry stacking of ash and the excavation of ash from the pond. KU did not provide the entire ATC report to AMEC; therefore, AMEC's comments regarding these issues are limited.

The study scope included drilling four soil test borings, installing three temporary piezometers, pressure testing of the rock in the boreholes, water level readings, limited water quality testing and an electrical resistivity survey. ATC determined that the "seepage areas noted in the cooling water canal most likely reflect seepage of groundwater rather than seepage from the Main Ash Pond and at this time do not appear to represent a significant threat to the integrity of the Main Ash Pond". Referring to the seepage and bank erosion, the report recommends "future site assessments include monitoring of these areas".

1.4.3 Former Secondary Pond

According to provided documentation from KU's response to EPA, the Former Secondary Pond was commissioned in 1977 (estimated) with a total storage area of 0.5 acres. Documentation indicated that Kentucky Utilities was unable to determine the pond height or volume of materials stored in the ash pond. The pond was located to the north of the Tyrone Ash Pond and previously served as a finishing pond. Discharge from the Tyrone Ash Pond entered the Secondary Pond at its southeast corner. The principal spillway for the Secondary Pond was located on the northwest corner. Documentation could not be located to indicate whether the dam was designed and constructed under the supervision of a Professional Engineer. Prior to removal, the Former Secondary Pond was inspected by a professional engineer.

During April to May 2010, the pond was taken out of service, material was excavated, and the embankments were re-graded. Following the Former Secondary Pond's removal from service,

decanted flow from the Ash Pond was routed north through a rock lined channel to a natural ravine that discharges to the Kentucky River.

1.5 Previously Identified Safety Issues

Discussions with plant personnel and review of provided documentation indicate that except for the seepage and erosion issue previously mentioned, there are no other current or previously identified safety issues, from the previous 5 years, at Tyrone Generating Station.

1.6 Site Geology

FMSM Engineers completed an Ash Pond Modification Study, dated April 1998. Within the report the site geology was described as follows;

> *The geologic map of the Tyrone Quadrangle, Anderson and Woodford Counties, Kentucky (USGS 1964) indicates the site is partially underlain by alluvial deposits representing the Pleistocene geologic period. The alluvium consists of sand, silt, clay and gravel material deposited by the Kentucky River, and varies in thickness from 10 to 70 feet in the area.*

The report further describes the irregularity of the bedrock formation. The report states that:

> *Underlying the alluvium in the project area is bedrock associated with the Tyrone Limestone Formation. This bedrock was deposited during the Middle Ordovician geologic period and consists of limestone. The limestone is described as light brownish gray, thin to thick bedded with some interbeds of yellowish-white limestone and shaley limestone.*
>
> *Structural controls drawn on the base of the Brannon Limestone Member of Cynthiana Formation indicate a rock strata dip of 30 feet per mile to the west. The Brannon Limestone is located topographically above the Tyrone Limestone Formation. The mapping shows no faults or other structural features in the immediate vicinity of the site.*

1.7 Inventory of Provided Materials

Kentucky Utilities provided AMEC with numerous documents pertaining to the design and operation of Tyrone Generating Station. These documents were used in the preparation of this report and are listed in Appendix C, Inventory of Provided Materials.

2.0 FIELD ASSESSMENT

2.1 Visual Observations

AMEC performed visual assessments of Plant Tyrone's two ash pond units on August 3, 2010. Assessment of the ash ponds was completed in general accordance with *FEMA's Federal Guidelines for Dam Safety, Hazard Potential Classification System for Dams, April 2004*. The EPA Coal Combustion Dam Inspection Checklist and Coal Combustion Waste (CCW) Impoundment Inspection Forms were completed for each ash pond during the site visit. The completed forms were provided to the EPA via email four business days following the site visit. Copies of the completed checklists are included in Appendix A. In addition to completing the checklist and assessment forms, photographs were taken of each impoundment during the site visit. Photo site location maps and descriptive photos are included in Appendix B.

2.2 Visual Observations - Tyrone Ash Pond

The Tyrone Ash Pond is currently active and receives/contains fly ash, bottom ash, and other low volume wastes including coal fines, process water drainage, pyrites, and treated sanitary wastewater. The area to the east of the pond was being used to stack ash (photos 1-17, 1-18, 1-19, and 1-21) which is dredged from the active pond periodically based on beneficial reuse opportunities and operational needs. The ash pond receives storm water drainage from the ash stack, coal pile, two substations located to the east of the boiler-turbine building, and from farmland located to the east of the pond.

2.2.1 Tyrone Ash Pond - Embankments and Crest

The ash pond has a side-hill configuration, with the north, south and west dikes consisting of construction embankments. A freeboard of approximately 3 to 4 feet between the top of water and top of dike was observed at the outlet structure during the site visit (photo 1-10). Freeboard based on reported water elevation (532.3 feet) and the lowest dam crest elevation in the area of the outlet structure obtained from recent survey data dated 2010 (533.5 feet) was 1.2 feet. Photo 1-10 clearly shows one of these elevations to be incorrect. The crest of the dam was primarily surfaced with grass, however sections along the western dike were covered with crushed stone (photos 1-16, 1-18 and 1-20). The surface of the downstream embankment was covered with grass (photos 1-4, 1-5, 1-9, and 1-14). The dikes appeared to be maintained and were mowed at the time of the site visit. The upstream slopes were covered with grass and vegetation (photos 1-3, 1-17 and 1-19). Slopes thought to be over-steepened and/or uneven were noted on the downstream slope areas of the southwest and northern dikes (photos 1-4, 1-9 and 1-12). A low and sloping crest was noted in the center area of the west dike (photo 1-8). A cut was noted at the bottom of the downstream toe of the north dike (photo 1-9). Repaired surface areas on the downstream embankment were observed on the southwest, north and south dikes (photos 1-2, 1-5, and 1-14). A seep is located at the toe of the natural slope and above the cooling water canal below the toe of the center area of the west dike (photo 1-6). An ATC report dated September 2009 determined the seep was due to groundwater. KU has installed a monitoring and sampling point at the seep and has placed large rock in the channel above the seep (photo 1-7).

Information submitted in KU's January 2011 response to the September 2010 Draft Report describes the freeboard being measured in January 2011 "as 4.26 feet using differential leveling techniques". Additionally provided information indicates "the lowest crest elevation was

measured at 533.08 feet. Additional information was provided to support a reduction in operating water surface elevation to within the elevation range of 529.0 to 530.0 feet.

2.2.2 Tyrone Ash Pond - Outlet Control Structure

The primary outlet for the Tyrone Ash Pond is a concrete structure connected to a 18-inch diameter corrugated metal discharge pipe (photo 1-10). The concrete structure supports an adjustable skimmer and stop log unit which allows the water level/discharge rate to be adjusted by facility personnel as operations require (photo 1-11). The inlet is located along the northern edge of the pond. Flow from this primary outlet structure is conveyed through the discharge point which is located at the toe of the downstream embankment (photos 1-12 and 1-13). The discharge channel is lined with a geotextile fabric beneath 12 inches of crushed limestone that is four to six inches in diameter. The channel connects to a natural ravine, which routes flow into the Kentucky River (photo 1-15).

2.3 Visual Observations - Former Secondary Pond

The Former Secondary Pond was located to the north of the Tyrone Ash Pond. During April and May 2010 the pond was taken out of service, material was excavated, and embankments were re-graded. At the time of the site visit, the pond dikes had been removed (re-graded) and the area was sparsely covered with grass (photos 1-9 and 1-14).

2.4 Monitoring Instrumentation

Historically, impoundment embankment monitoring equipment has not been used at the Tyrone Generating Station. However, MACTEC Engineering installed three piezometers in the Tyrone Ash Pond in support of the August 2010 slope stability analyses (subsequent to AMEC's site inspection).

Additionally, the pond was designed and constructed with a weirbox structure and metal plate v-notch weir at the pond flow measurement structure.

3.0 DATA EVALUATION

3.1 Design Assumptions

This section provides a summary of accepted minimum design criteria for dams and impoundments with respect to hydrologic, hydraulic and stability design of those structures. The relevant, methodology, design criteria, data, and analyses information that was provided for the particular project impoundments concerning hydrologic and hydraulic issues, as well as for structural adequacy and stability issues, is then presented and compared to the accepted minimum industry criteria.

3.2 Hydrologic and Hydraulic Design

KDOW

The Kentucky Department for Natural Resources and Environmental Protection, Division of Water, Engineering Memorandum No. 5 (EM No. 5), Section C, provides minimum hydrologic design criteria for all dams, as defined by KRS 151.100, and all other impounding obstructions which might create a hazard to life or property, that are constructed within the state of Kentucky. EM No. 5 provides equations to determine the minimum hydrologic criteria to be used in the development of emergency spillway and freeboard hydrographs for the structures. Definitions provided in EM No. 5 for these hydrographs are as follows:

> "The emergency-spillway hydrograph is that hydrograph used to establish the minimum design dimensions of the emergency spillway."
>
> "The freeboard hydrograph is the hydrograph used to establish the minimum elevation of the top of the dam."

Precipitation values to be used in determination of the emergency and freeboard hydrographs for low, moderate, and high hazard class dams are provided by EM No. 5 and are as follows.

Emergency Spillway Hydrograph

Class (A) Low Hazard Structure	$P_A = P_{100}$	(1)
Class (B) Moderate Hazard Structure	$P_B = P_{100} + [0.12 \times (PMP - P_{100})]$	(2)
Class (C) High Hazard Structure	$P_c = P_{100} + [0.26 \times (PMP - P_{100})]$	(3)

Freeboard Hydrograph

Class (A) Low Hazard Structure	$P_A = P_{100} + [0.12 \times (PMP - P_{100})]$	(4)
Class (B) Moderate Hazard Structure	$P_B = P_{100} + [0.40 \times (PMP - P_{100})]$	(5)
Class (C) High Hazard Structure	$P_c = PMP$	(6)

where, P refers to 6-hour precipitation, P_{100} refers to 6-hour, 100-year precipitation, and PMP refers to 6-hour Probable Maximum Precipitation.

According to EM No. 5, the freeboard hydrograph rainfall depth established by the equation "does not eliminate the need for sound engineering judgment but only establishes the lowest limit of design considered acceptable." Several sources are provided in EM No. 5 regarding where to obtain rainfall values to use in the equations. Engineering Memorandum No. 2 (EM No. 2), issued by KDOW and last revised on June 1, 1979, is entitled "Rainfall Frequency Values for Kentucky", and is noted as an acceptable data source for rainfall data for locations in Kentucky.

With respect to the principal spillway, EM No. 5 states that "It is desirable that the retarding pool be emptied in ten (10) days or less. It may be assumed that this requirement has been met if eighty (80) percent of the maximum volume of retarding storage has been evacuated in the ten (10) day period." KDOW defines retarding pool at "the reservoir space allotted to the temporary impoundment of floodwater. Its upper limit is the elevation of the crest of the emergency spillway." According to discussions with KDOW Dam Safety personnel, in the absence of an emergency spillway, the upper limit would be considered to be the crest of the dam.

Emergency spillway hydrographs are to be routed "through the reservoirs beginning at the water surface elevation of the principal spillway or the water surface elevation after 10 days drawdown, whichever is greater." Class (A) and (B) structures shall have freeboard "routed through the structure beginning at the same water surface elevation as for the emergency spillway hydrograph." The crest of the principal spillway shall be the starting point for routing hydrographs for Class (C) structures.

Additional discussions with the Dam Safety Division of KDOW indicate that in that absence of an emergency spillway, the crest of the dam is considered the uppermost elevation. A temporary water surface may exist within an impoundment as a result of the design storm occurrence; however, the discharge structure must be shown to be capable of returning the water surface elevation to normal levels within 10 days following the storm. Routing hydrographs are necessary to show the discharge capabilities of the principal spillway within the structure. Stability analyses that reflect adequate stability for the "pond full" condition are also important.

<u>Mine Safety and Health Administration</u>

Chapter 8 - Impoundment Design Guidelines of the Mining Safety and Health Administration (MSHA) Coal Mine Impoundment Inspection and Plan Review Handbook (Number PH07-01) published by the U.S. Department of Labor, Mine Safety and Health Administration, Coal Mine Safety and Health, October 2007 provides another source for minimum hydrologic design criteria.

When detailing impoundment design storm criteria, MSHA states that dams need "to be able to safely accommodate the inflow from a storm event that is appropriate for the size of the impoundment and the hazard potential in the event of failure of the dam." Additionally, MSHA notes that sufficient freeboard, adequate factors of safety for embankment stability, and the prevention of significant erosion to discharge facilities, are all design elements that are required for dam structures under their review. Additional impoundment and design storm criteria are as shown in Table 2, MSHA Minimum Long Term Hydrologic Design Criteria.

Table 2. MSHA* Minimum Long Term Hydrologic Design Criteria

Hazard Potential	Impoundment Size	
	< 1000 acre-feet < 40 feet deep	≥ 1000 acre-feet ≥ 40 feet deep
Low - Impoundments located where failure of the dam would result in no probable loss of human life and low economic and/or environmental losses.	100 - year rainfall**	½ PMF
Significant/Moderate - Impoundments located where failure of the dam would result in no probably loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities.	½ PMF	PMF
High - Facilities located where failure of the dam will probably cause loss of human life.	PMF	PMF

*Mining Safety and Health Administration (MSHA) Coal Mine Impoundment Inspection and Plan Review Handbook (Number PH07-01) published by the U.S. Department of Labor, Mine Safety and Health Administration, Coal Mine Safety and Health, October 2007

**Per MSHA, the 24-hour duration shall be used with the 100-year frequency rainfall.

Probable maximum flood (PMF) is, per MSHA, "the maximum runoff condition resulting from the most severe combination of hydrologic and meteorological conditions that are considered reasonably possible for the drainage area." Additionally, MSHA notes the designer should consider several components of the PMF that are site specific. These components are said to include: "antecedent storm; principal storm; subsequent storm; time and spatial distribution of the rainfall and snowmelt; and runoff conditions." Basic agreement, it was noted, exists between dam safety authorities regarding "combinations of conditions and events that comprise the PMF;" however, there are "differences in the individual components that are used." MSHA provided the following as a "reasonable set of conditions for the PMF:

- Antecedent Storm: 100-year frequency, 24 hour duration, with antecedent moisture condition II (AMC II), occurring 5 days prior to the principal storm.

- Principal Storm: Probable maximum precipitation (PMP), with AMC III. The principal storm rainfall must be distributed spatially and temporally to produce the most sever conditions with respect to impoundment freeboard and spillway discharge.

- Subsequent Storm: A subsequent storm is considered to be handled by meeting the "storm inflow drawdown criteria," as described subsequently in the document.

With regard to storm inflow drawdown criteria, MSHA Impoundment Design Guidelines noted that:

> *Impoundments must be capable of handling the design storms that occur in close succession. To accomplish this, the discharge facilities must be able to discharge, within 10 days, at least 90 percent of the volume of water stored during the design storm above the allowable normal operating water level. The*

> *10-day drawdown criterion begins at the time the water surface reaches the maximum elevation attainable for the design storm. Alternatively, plans can provide for sufficient reservoir capacity to store the runoff from two design storms, while specifying means to evacuate the storage from both storms in a reasonable period of time - generally taken to be at a discharge rate that removes at least 90% of the second storm inflow volume within 30 days……When storms are stored, the potential for an elevated saturation level to affect the stability of the embankment needs to be taken into account.*

In Mineral Resources Department of Labor Mine Safety and Health Administration Title *30 CFR § 77.216-2 Water, sediment, or slurry impoundments and impounding structures; minimum plan requirements; changes or modifications, certification*, information relevant to the duration of the probable maximum precipitation is given. Sub-section *(10)* of *77.216-2* states that a "statement of the runoff attributable to the probable maximum precipitation of 6-hour duration and the calculations used in determining such runoff" shall be provided at minimum in submitted plans for water, sediment or slurry impoundments and impounding structures.

The definition of design freeboard, according to the MSHA Guidelines, is "the vertical distance between the lowest point on the crest of the embankment and the maximum water surface elevation resulting from the design storm." Additionally, the Handbook states that "Sufficient documentation should be provided in impoundment plans to verify the adequacy of the freeboard." Recommended items to consider when determining freeboard include "potential wave run-up on the upstream slope, ability of the embankment to resist erosion, and potential for embankment foundation settlement." Lastly, the Handbook states, "Without documentation, and absent unusual conditions, a minimum freeboard of 3 feet is generally accepted for impoundments with a fetch of less than 1 mile."

3.2.1 Tyrone Ash Pond

1998 Hydrologic Study

FMSM Engineers completed a hydrologic analysis of the Tyrone Ash Pond as part of their April 1998 report entitled *Ash Pond Modification Study Tyrone Generating Station Woodford County, Kentucky*. In order to provide KU with an additional 5 to 8 years of capacity, FMSM proposed two options for expansion of the east dike of the pond. Hydrologic analyses were completed for both the existing condition, as well as for both proposed option conditions. On-site observations by AMEC and correspondence with personnel indicate that neither of FMSM's options was pursued. As such, with the exception of an ash stack which is currently present and located to the east of the pond, current pond and tributary area conditions today are the same as the „existing conditions' in FMSM's hydrologic analysis. The ash stack is graded to direct flow to the ash pond and is not expected to contribute a significant amount of runoff to the pond.

According to the FMSM report, existing conditions were hydrologically analyzed using the DAMS2 computer program. FMSM made note of the fact that additional resources used in the analysis included construction plans provided by KU, available topographic mapping, as well as field observations made by FMSM. Curve numbers and times of concentration were developed to characterize the watershed. The report continued by noting that:

> *Because the dam is „Class A', current regulations dictate it be designed to safely pass both emergency spillway (100-year, 6-hour rainfall) and freeboard (7.2 inches of rainfall) hydrographs in accordance with DOW Engineering*

Memorandum No. 5…The emergency spillway hydrograph was analyzed, even though this structure does not have an emergency spillway, in order to evaluate the performance of the existing principal spillway pipe. It is FMSM's experience that DOW will permit facilities such as this, with relatively small watersheds, to operate without an emergency spillway, provided the principal spillway is adequate to safely pass both hydrographs without overtopping the pond. It should be noted that the above statement is based only on FMSM's experience and is subject to interpretation by the DOW.

The DAMS2 program provides the option of routing a storm distribution through an outlet structure located within a defined stage storage impoundment relationship. FMSM routed the design storm though the vertical discharge riser and pipe structure to determine the maximum water surface elevation that would result from each calculated hydrograph precipitation amount, as well as the rate that the outlet structure could discharge the design storm and return the water surface elevation to normal operating levels. Table 3, shown below, provides a summary of the DAMS2 hydrological analysis input and output values for the existing conditions at the Tyrone Generating Station.

Table 3. Summary of 1998 DAMS2 Analysis

	EMERGENCY SPILLWAY HYDROGRAPH	FREEBOARD HYDROGRAPH
	EXISTING CONDITIONS	
Normal Pool Elevation (feet)	534	534
Watershed Area (acres)	61.9	61.9
Reservoir Area (acres)	10.0	10.0
Runoff Curve Number	73	73
Volume at Normal Pool (acre/feet)	81.0	81.0
Precipitation (inches)	4.4	7.2
Time of Concentration (hours)	0.14	0.14
Runoff (inches)	1.82	4.11
Peak Inflow (cfs)	96.5	225.2
Peak Outflow (cfs)	17.2	25.2
Maximum Water Surface Elevation (feet)	534.54	535.40

Table 3 indicates the results of routing the freeboard design hydrograph precipitation of 7.2 inches, calculated from KDOW freeboard hydrograph equation (4). Freeboard hydrograph precipitation would produce a peak water surface elevation of 535.4 feet in the Tyrone Ash Pond. That is 1.40 feet greater than the normal water surface elevation of 534.0 feet, and results in a freeboard (non-inundated depth between design rainfall event water surface elevation and dam crest elevation) of 0.6 feet using the design crest elevation of 536.0 feet. Additionally, the DAMS2 analysis of this design storm indicated that the principal spillway structure would be capable of discharging the runoff volume within approximately 16 hours.

The Ash Pond at the Tyrone Generating Station does not have an emergency spillway. However, Table 3 indicates the results of routing the emergency hydrograph precipitation from KDOW emergency hydrograph equation (1) produces a water surface elevation 0.54 feet above the normal operating elevation of 534.0 feet. The routing results indicated runoff volumes

resulting from the emergency hydrograph would pass through the pond in approximately 12 hours.

The Tyrone Generating Station discharges at river mile 82.9 and 83.1, the facility is in close proximity to Kentucky River Lock Number 5, which is located at mile point 82.2. The Kentucky River Navigation Charts indicate the typical river level at Lock No. 5 varies from 470 feet along the lower section to 485 feet at the upper section. A maximum high water elevation of 523 feet was observed in 1937. A topographic study, noted performed in January 2010, indicates crest elevations of 533.5 feet at the south portion of the west dike to 535.4 feet at the west portion of the south dike.

It is AMEC's position that hydrologic design or assessment of an impounding dam or structure, including the determination of an acceptable freeboard, should be heavily influenced by the minimum criteria set forth in Chapter 8 - Impoundment Design Guidelines of the Mining Safety and Health Administration (MSHA) Coal Mine Impoundment Inspection and Plan Review Handbook (Number PH07-01) published by the U.S. Department of Labor, Mine Safety and Health Administration, Coal Mine Safety and Health, October 2007, as described previously in Section 3.2.

Although according to KDOW the Tyrone Ash Pond is currently considered a low hazard dam, AMEC assigned a "Significant Hazard" classification to the Tyrone Ash Pond on EPA's CCW Impoundment Inspection form that was completed during the August 3, 2010 facility site visit. The "Significant Hazard" classification was chosen for the Ash Pond due to its proximity to the Kentucky River and the potential for environmental damages in the event of a dam failure, per Coal Combustion Waste (CCW) Impoundment Inspection forms provided by EPA for assessment purposes.

With respect to minimum hydrologic criteria, MSHA requires that an impoundment must be able to "safely accommodate the inflow from a storm event that is appropriate for the size of the impoundment and the hazard potential in the event of failure of the dam." According to Table 2, MSHA specifies a design storm equal to ½ PMF (Peak Maximum Flood) for dams assigned a significant hazard classification and crest heights less than 40 feet and impoundment volumes less than 1,000 acre-feet. Details regarding what MSHA specifies as acceptable criteria for use in determining the PMF were provided previously in Section 3.2 of this Assessment Report. Time required to pass the design storm through the impoundment is also important and is described within MSHA documents.

January 2011 Hydrologic Study

Subsequent to the September 2010 Draft Report, KU authored additional information and submitted this information in a report entitled *KU Tyrone Ash Pond: Hydrologic and Hydraulic Assessment*, dated January 20, 2011. The Assessment was developed to investigate the performance of the pond's principal spillway structure and KU noted the spillway consists of a "concrete riser box structure connected to a 15-inch corrugated metal pipe set at a one percent slope." A stage-storage curve was developed based on original design drawings. A stage-discharge curve, for elevations of greater than or equal to 529 (NAVD88), was developed based on weir, orifice, or pipe flow. AMEC believes, after reading the January 2011 Hydrologic Study, the stage- discharge storage curve was meant to be developed for elevations greater than or equal to elevation 529.9 (NAVD88). Table 4 summarizes the hydrologic criteria that were used in the Assessment.

Table 4. Summary of Hydrologic Criteria

Hydrograph	Frequency	Duration	Precipitation (inches)
Principal Spillway	100-Year	24-Hour	6.2
Emergency Spillway	100-Year	6-Hour	4.4
Freeboard	100-Year	6-Hour	7.24*

*Calculated according to KDOW Memo No. 5 Class (A) dam criteria.

It should be noted that the pond's tributary watershed area was identified as 61.9 acres in the 1998 FMSM study. However, the January 2011 study authored by KU indicates the tributary area to be 19.05 acres. The Ash Pond Drainage Area Map that was provided with the 2011 study presents topography and an outlined area (A1) that is tributary to the ash pond. The map supports the area of 19.05 acres as a more accurate representation of current conditions, assuming a roadway at the southwest corner of the area diverts flow from upstream locations away from the ash pond. Also, the removal of the former Secondary Pond in spring 2010 would result in a reduction of the total tributary area to holding facilities. This said, AMEC was not provided with definitive information regarding the reduction in tributary watershed area.

KU notes that, "Although the Tyrone Ash Pond does not have an emergency spillway, an emergency spillway hydrograph was developed in order to evaluate the performance of the principal spillway structure." The Emergency spillway and Freeboard Hydrograph precipitation values were calculated using equations from the KDOW Engineering Memorandum No. 5, as shown previously in Section 3.2 of this report. Further, KU lists NRCS National Engineering Handbook, Section 4 "Hydrology" (NEH-4) as the source for all design parameter calculations. KU utilized the United States Army Corps of Engineers HEC-HMS 3.5 program to develop the routing hydrographs that are summarized below in Table 5. Although provided documentation stated that a stage-discharge curve was created for elevations equal or greater to elevation 529 (NAVD**), KU reported an operating pool elevation, as shown in Table 5, of 529.9 feet. The minimum embankment crest elevation was reported to be "approximately 535.5 (NAVD88)".

Table 5. Summary of HEC-HMS 3.5 Analysis

	Principal Spillway Hydrograph	Emergency Spillway Hydrograph	Freeboard Hydrograph
Pool Elevation (feet)*	529.9	529.9	529.9
Peak Inflow (cfs)	97.0	37.2	76.9
Peak Outflow (cfs)	10.7	10.3	12.2
Peak Elevation (feet)*	530.2	530.1	530.5
Reported Freeboard (feet)	3.3	3.4	3.0
Adjusted** Freeboard (feet)*	2.88	2.98	2.58

*Elevations listed reference NAVD88.
**Freeboard added to table and adjusted by AMEC based on lowest surveyed crest elevation of 533.08 feet as reported in January 2011 KU Comments to September 2010 Draft Report-clerical and technical corrections to 2010 Draft Report

The results of the Assessment indicate that with respect to a minimum crest elevation of 533.08 feet (NAVD88), as corrected and reported most recently by KU in their January 2011 Draft Report comments, a minimum freeboard of approximately 2.6 feet will occur as the result of the freeboard hydrograph rainfall of 7.24 inches. KU notes that "the ash pond can effectively operated at or below a pool elevation of 529.9 feet and continue to maintain a minimum freeboard of 3 feet or more." Based on the recently reported adjusted minimum crest elevation of 533.08 feet, the maximum operating water surface elevation should be lowered to a maximum of 529.5 feet to maintain a freeboard of 3 feet with respect to the EM No. 2 freeboard hydrograph rainfall.

The freeboard hydrograph rainfall value of 7.24 inches is greater than the 100-Year 24-Hour rainfall of 6.2 inches but is much less than the ½ PMF rainfall event suggested by MSHA guidelines as appropriate for a dam identified as a Significant Hazard Potential. AMEC extrapolated the return period precipitation values listed in EM No. 2. to estimate the corresponding return rainfall event for the calculated freeboard hydrograph precipitation depth of 7.24 inches. It was determined that a 24-Hour rainfall of 7.24 inches would equate to a 250-Year precipitation event.

Provided documentation indicates that the crest of the Tyrone Ash Pond is not uniform. Construction and repair of the dam crest with the goal of increasing the elevation to closer to that of the design intent, in conjunction with implementation of the lower water surface operating level to a maximum of 529.5 feet, would work to increase available freeboard to closer to that necessary to pass a rainfall event like the ½ PMF, and maintain a more conservatively and more widely defined "freeboard" depth (non-inundated depth between design rainfall event water surface elevation and crest of dam). In addition, a field measurement taken by David Millay with LG&E-KU on March 3, 2011 confirms the 18-inch diameter of the principal spillway CMP pipe as shown on Tyrone Drawing TY-C-000009 and reported in AMEC's assessment. The existing size of the pipe is larger than the size considered in the hydrologic and hydraulic study and would also work to increase available freeboard over what was calculated and reported for a 15-inch pipe.

3.2.2 Former Secondary Pond

There was no information provided regarding hydrologic and hydraulic design of the Former Secondary Pond.

It is AMEC's position that the Former Secondary Pond does not require a hydrologic evaluation based on its current removed condition and inability to store storm runoff.

3.3 Structural Adequacy & Stability

The Commonwealth of Kentucky Department of Natural Resources Environmental Protection, Bureau of Environmental Protection, Division of Water, provided the June 1, 1980 document entitled, *Guidelines for the Geotechnical Investigation and Analysis of Existing Earth Dams*. The guidelines were written pursuant to the provisions set forth in KRS 151.125(2). Earthen dams, when analyzed to determine safety factors using the methods, guidelines, and procedures of the agencies listed in the guidelines may be considered, by the State of Kentucky, to have acceptable stability if the analyses yield at least the minimum safety factors shown in Table 6.

Two well regarded sources for embankment design and evaluation criteria include The United States Army Corps of Engineers (USACE) and the United States Mine Safety and Health Administration (MHSA). Minimum recommended factors of safety for various loading conditions can be found in those agency publications, as shown in Table 6 below.

Table 6. Minimum Recommended Dam Safety Factors

LOAD CASE	KDOW[1]	MSHA CRITERIA[2]	USACE[3]
Rapid Drawdown	1.2	1.3	1.1[4]-1.3[5]
Long- Term Steady State Seepage	1.5	1.5	1.5
Earthquake Loading	1.0	1.2	---[6]

[1] **Guidelines for the Geotechnical Investigation and Analysis of Existing Earth Dams, 1980, Kentucky Division of Water**
[2] Coal Mine Impoundment Inspection and Plan Review Handbook, 2007, US Mine Safety and Health Administration
[3] Slope Stability Publication, EM1110-2-1902, 2003, US Army Corps of Engineers, Table 3-1: New Earth and Rock-Fill Dams
[4] Applies to drawdown from maximum surcharge pool
[5] Applies to drawdown from maximum storage pool
[6] Referred to USACE Engineer Circular "Dynamic Analysis of Embankment Dams" document that is still in preparation

AMEC reviewed the August 27, 2010 report entitled *Geotechnical Exploration and Slope Stability Analyses Data Package for the Tyrone Ash Pond* prepared by MACTEC Engineering and Consulting, Inc. The recently completed stability analysis is summarized in Section 3.3.1. To analyze the structural adequacy and stability of the Tyrone Ash Pond at Tyrone Generating Station, AMEC reviewed the material provided by Kentucky Utilities with respect to the load cases shown in Table 6. Factors of safety documented in the provided material were compared with those factors outlined in Table 6 to help determine whether the impoundments meet requirements for acceptable stability.

3.3.1 Tyrone Ash Pond - Structural Adequacy & Stability

August 2010 Stability Analysis

MACTEC Engineering and Consulting, Inc developed a geotechnical exploratory drilling program, piezometer installation program and a geotechnical laboratory testing program. The geotechnical exploration program was conducted in August, 2010 and included a total of 12 borings at six cross-sections along the dam in areas judged to be "critical" based on the topography and nature of the exposed slope. Figure 7 illustrates the location of the six cross sections. Six of the borings were located along the embankment crest and were extended to a depth of up to 50 feet. The remaining six borings were located at corresponding locations along the toe of the embankment, and were extended to depths of up to 20 feet. A total of three piezometers were installed in crest Borings B-1, B-3, and B-5 to monitor pieziometeric levels within the dam.

The geotechnical laboratory testing program consisted of classification tests including Atterberg limits, grain-size analyses, specific gravity and unit weight determinations. Consolidated undrained triaxial shear tests with pore pressure measurements were performed on undisturbed samples in order to determine total stress and effective stress parameters. Additional strength testing was ongoing at the time this report was written. In addition to laboratory testing, Standard Penetration Test results were statistically analyzed to *"delineate the general*

subsurface conditions and estimate anticipated soil properties based on correlations and published data." Regarding soil conditions and strength parameters, MACTEC stated:

> *In general, the dike was constructed of silty to sandy clay fill reportedly excavated from the incised portion of the pond. The clay fill was placed overlying existing alluvial soils comprised of clay and sandy soils. Soil parameters selected for the slope stability analyses were based on various resources including the preliminary results of the extensive laboratory testing described above, field testing and observations, published information on similar soil types and our experience on similar projects.*

Soil parameters selected by MACTEC for the analyses are shown in Table7.

Table 7. Soil Parameters

SOIL TYPE NO.	SOIL DESCRIPTION	UNIT WEIGHT		EFFECTIVE STRESS	
		TOTAL (PCF)	SATURATED (PCF)	COHESION C' (PSF)	FRICTION ANGLE Φ' (DEGREES)
1	SC (fill)	134	139	100	32
2	CL (fill)	130	135	160	30
3	SC (alluvium)	130	135	100	30
4	CL (alluvium)	120	125	300	28
5	ML (alluvium)	118	123	200	28
6	CCW	90	95	0	30

Slope stability analyses were conducted using the computer program PCSTABL, developed by Purdue University. The program utilizes a "*two-dimensional limit equilibrium method of analysis and calculates the factor of safety based on the Modified Bishop Method of Slice*s." The stability of the existing dike was analyzed under steady-state/maximum flooding conditions, rapid drawdown and seismic (dynamic) conditions. Two of the six cross-section locations (sections 5 and 6) located along the north and east sides of the dike had been analyzed at the time of writing this report; however, the remaining four cross-section slope stability analyses (cross sections 1 through 4) and corresponding laboratory testing is currently ongoing. Cross-sections 5 and 6 were selected as the most critical based on the length of the exterior slopes.

The geometry used in the analyses was based on construction drawings provided by KU and a topographic survey map dated December 2009. The report noted that:

> *The upstream slopes for Sections 5 and 6 were observed to range from 2.2H:1V to 2.4H:1V and the downstream slopes ranged from 1.6H:1V to 2.2H:1V. The upstream slopes below the current water or ash levels were projected from the topographic data obtained in the field at each cross-section location from the portion of the upstream slope above the water/CCW level. Seismic conditions for this site were modeled under dynamic loading conditions using a peak ground accelerating value of 0.060 g (horizontally) for a 2 percent probability of exceedance in 50 years. The value was obtained from published guidance based on the site location.*

The maximum pool level was modeled as the top of the surveyed crest. Based on topographic mapping, the crest elevation ranged from 533.0 to 534.7 feet National Geodetic Vertical Datum. Water level readings were obtained at the time of drilling and from piezometers installed in the crest borings.

MACTEC's report stated *"our analysis, performed using the parameters and geometry described above, indicated that the cross-sections analyzed to date provide factors of safety that exceed the published factors of safety for the cases analyzed."* MACTEC commented that *"based on our initial review of the data, the material properties and embankment characteristics, it is expected that further analysis will result in factors of safety that meet regulatory guidelines."*

Results of the slope stability analyses are presented in Table 8.

Table 8. Slope Stability Analyses Calculated Safety Factors

CRITICAL SECTION	UPSTREAM SLOPE (H:V)	DOWNSTREAM SLOPE (H:V)	LONG-TERM STEADY STATE/MAX SURCHARGE POOL		RAPID DRAWDOWN		SEISMIC	
			TARGET FOS	FOS	TARGET FOS	FOS	TARGET FOS	FOS
5 Upstream	2.2 : 1.0	-	1.5	2.9	1.2	1.6	1.2	2.2
5 Downstream	-	2.2 : 1.0	1.5	2.2	1.2	2.2	1.2	1.9
6 Upstream	2.4: 1.0	-	1.5	3.6	1.2	1.9	1.2	2.6
6 Downstream	-	1.6: 1.0	1.5	2.1	1.2	2.1	1.2	1.8

* Target Factor of Safety References: Design Criteria for Dams & Associated Structures (401 KAR 4:030, KAR 4:040)
USACE EM 1110-2-1902: Slope Stability
MSHA Engineering and Design Manual

September 2010 Stability Analysis

As part of the comments to the September 2010 Draft Report , KU provided additional geotechnical stability information in a report entitled Report of Geotechnical Exploration and Slope Stability Analyses Kentucky Utilities (KU) Tyrone Power Station Ash Pond Tyrone, Woodford County, Kentucky, dated September 29, 2010, by Mactec Engineering Consulting, Inc. An addendum to this report, dated January 19, 2011 and entitled Addendum A, was issued by Mactec as well.

The September 2010 report by MACTEC included additional stability analyses for sections 1 through 4. Properties and strength parameters were expanded to include a silty sand fill and silty sand alluvium soil and bedrock. The results of the analyses indicate the calculated factors of safety exceed the minimum recommended factors of safety for all sections and cases.

The January 2011 addendum to the stability analyses report included additional piezometer readings, updated stability analyses data, and responses and clarifications to stability comments provided in AMEC's September Draft Report. Two additional sets of piezometer readings were provided in the addendum as well. The data noted the piezometer in B-3C had been damaged and no additional readings could be obtained. AMEC requested information from KU regarding

the damage. David Millay with LG&E-KU quickly responded and reported on March 8, 2010 that the piezometer:

> *was inadvertently damaged in September 2010 by Tyrone maintenance personnel while conducting routine grading work on the embankment crest. While using a tracked dozer, the blade dislodged the piezometer's protective concrete pad and manhole. The dislodging force caused the upper five foot pipe section to become separated from the lower portion. The connecting threads of the five foot pipe section were damaged and debris filled the open hole rendering piezometer B-3C inoperable. KU has instructed MACTEC to decommission the damaged piezometer B-3C and install a replacement near the original. MACTEC expects to complete this work by the end of this week.*

The reported additional piezometer readings are abnormal in the December 2010 reading as the water level dropped in B-1C and rose in B-5C. The readings in B-1C dropped with successive readings. Since no river or pond levels or rain data were provided, no further analysis of the readings can be performed.

Stability analyses data was updated in the addendum to include the long-term case of maximum solids (pond full of ash) and maximum surcharge pool condition for the downstream slopes. The calculated factors of safety exceed the minimum recommended factor of safety for all sections analyzed.

MACTEC's responses and clarifications to stability comments provided by AMEC in the September 2010 Draft Report noted MACTEC errors, additional data and studies. A comment notes the revised minimum factors of safety presented in the addendum are in accordance with Kentucky regulations.

3.3.2 Former Secondary Pond - Structural Adequacy & Stability

Information regarding structural adequacy and stability was not provided for the Former Secondary Pond.

3.4 Foundation Conditions

Geotechnical borings performed in 1998 by FMSM indicate the natural soils on the east dike consist primarily of fat clays with sand. The 2009 ATC seep evaluation report included two historic borings designated KU-11 and KU-12. These borings indicated the foundation materials consisted of "sandy soil" to "clay" overlying alluvial "sand and gravel".

MACTEC's report entitled *Geotechnical Exploration and Slope Stability Analyses Data Package for the Tyrone Ash Pond* prepared by MACTEC Engineering and Consulting, Inc dated August 27, 2010 briefly describes foundation conditions. The report states, "In general, the dike was constructed of silty to sandy clay fill reportedly excavated from the incised portion of the pond. The clay fill was placed overlying existing alluvial soils comprised of clay and sandy soils."

3.5 Operations and Maintenance

Kentucky Utilities personnel perform daily safety and surveillance inspections for the ash ponds at the Tyrone Generating Station. Inspections are documented during the times the plant is out-of-service; however, they are not documented when the plant is in service. No record of

inspection dates or observations were provided. Furthermore, no information was provided to indicate the general inspection procedures or extent of the inspected area(s).

ATC Associates performed inspections on the ash ponds in February 2009, and January 2010. The reports indicate areas of surface erosion, animal burrows, ash build-up on crest, low areas on crest, steep slopes, and un-vegetated areas. Additional details regarding the ATC inspections are provided in Section 3.5.2. Although several of the issues noted in the 2010 ATC inspection report appeared to be addressed at the time of AMEC's site visit, no documentation was provided to indicate KU had proceeded with ATC's recommendations. No safety issues were noted in the reports that were reviewed by AMEC.

In January 2011, following AMEC's submittal of the September 2010 Draft Report, ATC conducted a visual site assessment and inspection of the Tyrone facility. The resulting report is summarized in Section 3.5.2 Inspections.

3.5.1 Instrumentation

Historically, impoundment embankment monitoring equipment has not been used at the Tyrone Generating Station. However, MACTEC Engineering installed three piezometers in support of the August 2010 slope stability analyses (subsequent to AMEC's site inspection). The piezometers were installed in crest Borings B-1C, B-3C, and B-5C. Each piezometer contained a 10-foot well screen that was placed from 20 feet to 30 feet below ground surface in Boring B-1C, and from 25 feet to 35 feet in Borings B-3C and B-5C. Piezometer information was summarized by AMEC and is provided in Table 9.

Table 9. Piezometer Information

PIEZOMETER ID	BORING ELEVATION	BOTTOM OF BOREHOLE	DEPTH (FEET) WATER ELEVATION (FEET)		
			8/25/10	12/8/10*	1/7/11*
B-1C	534.7	502.7	14.7 520.0	20.7 514.0	21.5 513.2
B-3C	534.3	499.3	28.9 505.4	n/a** n/a	n/a** n/a
B-5C	534.4	488.9	n/a Dry	34.3 500.1	Dry n/a

*12/8/10 and 1/7/11 readings were not part of the September 2010 Draft Report submitted to EPA. This data was reported by KU in their January 26 Comments to the September 2010 Draft Report.
**Piezometer B-3C was reported, by KU in their Comments to the September 2010 Draft Report, as damaged following the 8/25/10 reading and subsequent readings were not possible.

A discussion of these piezometers readings was provided in Section 3.1. In summary, the piezometer broken by maintenance operations at B-3C is reported to be replaced soon. The readings in December 2010 are abnormal as the water level is lower in B-1C and higher in B-5C. The readings in B-1C dropped with successive readings. The absence of pond and river water elevations or recent rainfall data prohibit further analyses of the readings.

KU provided comments, subsequent to submittal of the the September 2010 Draft Report, that noted they are continuing "to periodically monitor instrumentation including piezometers and the principal spillway weir at the Tryone Ash Pond."

3.5.2 Inspections

State Inspections

The Tyrone Ash Pond is classified as a Low Hazard, or Class (A), dam by the KDOW, which means that, according to state regulations, the dam should be scheduled for inspected every 5 years. As of September 2010, the most recent inspection performed by KDOW at Tyrone Generating Station was June 9, 2005. Review of the inspection indicates the following items for the Former Secondary Pond were to be addressed: removal of saplings, protection of the concrete apron below the outlet, filling in of low areas and re-grading the crest. Additionally, mowing of the downstream slope of the Tyrone Ash Pond was necessary. A February 2009 inspection report prepared by ATC Associates Inc. lists previous inspections completed by KDOW in January 1983, June 1988, July 1993, and December 1999. Previous inspection deficiencies to be addressed included mowing, filling animal burrows, and removal of vegetation.

Following submittal of the September 2010 Draft Report, KDOW completed an inspection of the Tyrone Generating Station in early January 2011. Two deficiencies, as identified below, were noted as needing to be corrected.

1. *Update reservoir storage capacity by providing stage-storage and stage-area data and all hydrologic data to perform a reservoir routing analysis (SITES) to determine structure's current storage capacity to pass the regulatory rainfall criteria for a low hazard dam without overtopping. Current pond area and natural drainage area to the pond will be included in the analysis. OR*

2. *Submit past hydrologic analysis (DAMS2) April 1998 report by FMSM entitled, "Ash Pond Modification Study Tyrone Generating Station Woodford County, KY".*

In AMEC's opinion, it is unclear how the second item requested by KDOW can address the deficiency considering the discrepancies noted in the report. AMEC noted that the KDOW Certificate of Inspection for Dam and Appurtenant Works, issued with the January 2011 inspection summary letter, identified the Normal Pool, Current Pool, and Top of Dam Elevations (in feet) as 534.0, 534.1, and 536.0, respectively. Information provided by KU in the same month indicates that these elevations may have been intended by design, but that the dam is not currently operated at these levels, nor has the originally intended crest elevation been maintained. Low points on the crest were surveyed at elevation 533.08 feet in January 2011 and the operating water surface elevation, at the time of KDOW's January 2011 inspection, was well below the elevation of 534.1 feet reported in the Certificate of Inspection.

2009 Consultant Inspection

ATC Associates Inc. completed an assessment of the Tyrone Ash Pond and Former Secondary Pond in February 2009. ATC rated the overall condition of the Tyrone Ash Pond as conditionally poor, which is defined as:

> *A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. This designation may also be used when uncertainties exist as to critical*

analysis parameters which identify a potential dam safety deficiency; further investigation and studies are necessary.

The assessing professional engineer's comments concerning the overall condition of the pond included:

> *Current ash excavation practices and presence of seepage below toe of natural slope present hazard to loss of embankment particularly during plant operations when water level in pond would be elevated. Several minor conditions observed with embankments as described above. Inlet pipes to pond not encased and are buried in embankment without protection. Previous leaks in pipes have caused damage to embankment slopes.*

The report noted a total of nine action items. Three items were regarded as „high' importance, which indicates the action item should be addressed as soon as possible. The „high' importance items included:

1. *Evaluate seepage and bank erosion above the cooling water outflow canal, below toe of the west embankment;*

2. *Monitor seepage area above cooling water outflow channel for increased flow, soil fines in flow or erosion or natural slope above seepage; and,*

3. *Evaluate the current ash excavation operations to avoid removing limestone boulders and clay soil from the pond bottom.*

The remaining six maintenance items were given a „normal' rating indicating the action item should be addressed as part of the ongoing maintenance of the structure. The „normal' items included:

4. Monitor areas of surface erosion, west and north embankments, repair if vegetative cover damaged;

5. Repair animal burrows below west embankment crest on upstream slope near north end;

6. Remove ash build-up on crest from ash excavation operations, re-establish stable road base;

7. Monitor wet area below south embankment for seepage;

8. Evaluate and modify dry stacking of excavated ash east of pond; evaluate stability and prevent water ponding; and,

9. Evaluate need for concrete cradle below pipes crossing through south embankment.

The September 11, 2009 report prepared by ATC entitled *Ash Pond Seep Evaluation Report Tyrone Power Station* states that, based on their evaluations, they consider recommendation items 1, 3, 6, and 8 above to be cleared.

2010 Consultant Inspection

ATC Associates Inc. completed an assessment of the Tyrone Ash Pond and Former Secondary Pond in January 2010 (field date October 2009). ATC rated the overall condition of the Tyrone Ash Pond as fair, which is defined as:

> *No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.*

The assessing professional engineer's comments concerning the overall condition of the pond included:

> *Plant offline at time of inspection and minimal water in pond. Item numbers 1 to 4 in the attached findings and recommendations should be implemented prior to placing the station back on line.*

The report noted a total of fourteen action items. Two items were regarded as „high' importance, which indicates that the action(s) should be addressed as soon as possible. The two „high' importance items included:

1. *Record flow rate before water added to Main pond and one week after as per ATC Sept. 11, 2009 Report; and,*

2. *Perform analytical and physical testing of pond and seep water as per ATC Sept. 11, 2009 Report.*

Of the fourteen action items, nine items were considered of „moderate' importance, which indicates the action(s) should be addressed during the next construction season. The nine „moderate' importance items included:

3. *Modify ash excavation procedures as per ATC Sept. 11, 2009 Report;*

4. *Install seep collection and monitoring system at outfall as per ATC Sept. 11, 2009 Report;*

5. *Perform elevation survey of dam crest and fill low areas to maintain consistent crest elevation and freeboard;*

6. *Repair erosion gullies along downstream slope of north embankment on east and west sides of principal spillway outlet;*

7. *Place fill against toe of slope in area of finishing pond to restore consistent slope angle;*

8. *Mow vegetation along north embankment west of principal spillway;*

9. *Place fill material to flatten slope to 2.5H:1V in area east of ramp to crest;*

10. *Repair animal burrow on west embankment, survey stake with flagging driven at burrow; and,*

11. *Re-establish vegetation on exterior slope where damaged by mowing.*

The remaining three recommended action items were rated as a „normal' priority, which indicates the action(s) should be completed as part of ongoing maintenance of the structure. The three „normal' priority items included:

12. *Add crushed stone to existing ravines at referenced points;*

13. *Evaluate need for concrete pipe cradle to contain pipe penetrations through slope; and,*

14. *Grout or remove abandoned pipe penetrating embankment @NE abutment.*

While onsite at the Tyrone Ash Pond in October 2009, ATC performed field measurements to determine crest width, upstream and downstream slopes, dam height, and free board at various locations along the pond. Crest width measurements ranged from 13 to 20.5 feet. Upstream slopes varied from 1.5:1 to 3.6:1. Downstream slopes ranged from 1.3:1 to 2.9:1. Dam height was determined at one location and was found to be 19.6 feet. Freeboard varied from 10.6 to 11.4 feet.

AMEC was not provided with documentation to verify that items 1 to 4 listed previously for the 2010 ATC inspection were addressed before placing the station back on line in June of 2010.

In addition to inspecting the Tyrone Ash Pond in October 2009, ATC inspected the Former Secondary Pond; however, the pond was emptied and re-graded during April and May of 2010. Therefore, it will not be discussed.

2011 Consultant Inspection

KU provided, as part of their comments to the September 2010 Draft Report, additional documentation regarding an inspection that was conducted by ATC at the Tyrone facility in January 2011. The inspection report is entitled *2011 Pond Inspections Visual Site Assessment Report Six Impoundment Facilities. As the report title suggest,* ATC also performed visual assessments and inspections of other KU facilities at the time that the Tyrone work was conducted. As a result of that work, ATC was able to develop four general recommendations, described below, that were noted to apply to CCW containing ponds at all of the facilities, including Tyrone.

1. *Prepare or update an Operation and Maintenance Manual for the facility. (Normal Priority);*

2. *Continue regular facility inspections and provide training to personnel who will conduct the inspections. The training should include proper inspection techniques, the specific items that should be inspected, the frequency of inspections, and the documentation that is required. Part of the inspection process should include a yearly assessment by either outside consultants or LG&E or KU corporate personnel not routinely assigned to a power station. (High Priority);*

3. *Determine (for each pond) the maximum pool level that can be safely maintained to provide adequate freeboard capacity with the existing spillway*

configurations. The maximum elevation should then be surveyed and marked on each spillway inlet and documentation of the maximum water surface elevation should be included in the Operation and Maintenance manual. (High Importance); and,

4. *Evaluate each pond facility with an embankment to determine whether a redundant method to prevent or safely control impounded water from overtopping the embankment crest is needed.*

Conclusions contained in the 2011 Report, specific to the Tyrone facility, are summarized below.

ATC again rated the overall condition of the facility as fair, which ATC defines as:

> *No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.*

In comments assessing the overall condition of the pond, the assessing professional engineer noted that "substantial improvements [were] made since the last ATC inspection."

However, the 2011 Report noted a total of fourteen action items. One item was regarded by ATC as having „high' importance, which indicates that the action(s) should be addressed as soon as possible. The „high' importance item was noted to be:

1. *Clearly mark highest allowable stoplog elevation on principal spillway. Elevation determined by others. Include instruction in Operation manual for pond.*

Of the fourteen action items, ten items were considered of „moderate' importance, which indicates the action(s) should be addressed during the next construction season. These ten „moderate' importance items included:

2. *Rework spillway skimmer and stop logs to minimize joint leakage and prevent blockage of spillway inlet;*

3. *Perform elevation survey of dam crest. Fill low areas to maintain consistent freeboard requirements of pond hydraulic study;*

4. *Repair erosion gullies along downstream slope of north embankment on east and west sides of principal spillway outlet;*

5. *Place fill along exterior toe of north embankment to restore consistent slope angle;*

6. *Cut vegetation along north embankment west of principle spillway;*

7. *Re-establish vegetation on exterior slope, numerous locations;*

8. *Establish erosion protection on interior slopes from crest to below waterline, interior slopes on south end of west embankment are bare earth;*

9. *Monitor all slopes below pond embankments for sloughs and scarps, several new scarps observed during January site walkover;*

10. *Cut woody vegetation at toe of downstream slope and extend 10 feet below toe; and,*

11. *Seal off water flowing below monitoring pipe installed May 2010.* (This pipe is for what has been determined as a groundwater seep located above the canal below the west embankment.)

The remaining three recommended action items were rated as a „normal' priority, which indicates the action(s) should be completed as part of ongoing maintenance of the structure. These three „normal' priority items included:

12. *Add rip rap erosion protection to existing ravines below west pond embankment toe, monitor groundwater seep near south end of canal for changes;*

13. *Evaluate need for pipe cradle to contain pipe penetrations through slope and protect integrity of slope should a discharge line rupture; and,*

14. *Grout of remove abandoned pipe penetrating embankment at NE abutment.*

ATC noted in the 2011 Report that:

> *The scope of these assessments was limited to an examination of readily observable surficial features of the ponds and a review of information provided to us…….Our assessments did not include any test drilling, material testing, precise physical measurements of pond features, detailed calculations……*

The interior (upstream) slopes noted in the 2011 Report were less than those reported in the 2010 Report at 1.5 to 2.3:1 (H:V) versus 1.5 to 3.6:1 (H:V). KU noted in comments to the Draft Report, regarding ATC's 2011 inspection, that they are "developing plans to address the priority maintenance items in 2011."

4.0 COMMENTS AND RECOMMENDATIONS

Condition assessment definitions, as accepted by the National Dam Safety Review Board, are as follows:

SATISFACTORY

No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.

FAIR

No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.

POOR

A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.

UNSATISFACTORY

A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

NOT RATED

The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.

EPA received Draft Report response comments from KU (January 26, 2011) and KDOW (January 31, 2011). Both parties take exception to (1) the assignment of a condition assessment rating to this pond ((considered to be of low hazard potential by Kentucky regulations) and (2) criteria for assignment of the rating. AMEC utilized the resources and guidelines provided by EPA for this work.

4.1 Acknowledgement of Management Unit Conditions

I certify that the management units referenced herein (Tyrone Ash Pond and the Former Secondary Pond) were personally assessed by me and were found to be in the following condition:

Tyrone Ash Pond: Fair

The Tyrone Ash Pond was rated poor in the Draft Report because, in AMEC's opinion, further critical studies or investigations (detailed below) were needed to identify any potential dam safety deficiencies.

Based upon the additional information, data, studies and subsequent action to be taken by KU contained in Draft report comments provided by Kentucky Utilities on January 26, 2011, in AMEC's opinion, the pond is now rated Fair because no existing dam safety deficiencies are recognized for normal loading conditions, but rare or extreme hydrologic events may result in a dam safety deficiency. Risk may be in the range to take further action.

Former Secondary Pond: Not Rated

The Former Secondary Pond is not rated because it was removed in April and May, 2010.

4.2 Tyrone Ash Pond

4.2.1 Hydrologic and Hydraulic Recommendations

September 2010 Draft Report

The current ash pond configuration with lower crest heights and steepened slopes are not as designed. The recent topographic mapping of the site indicates crest elevations on the Tyrone Ash Pond range from 533.5 feet at south portion of west dike to 535.4 feet at the west portion of the south dike. The mapping shows crest elevations below 534 feet on the north and west dikes. Although FMSM performed a hydrologic study of existing conditions in their 1998 report, the results cannot be considered valid since they used a crest elevation of 536 feet and a water elevation of 534 feet. In order to confirm that the impoundment will not be overtopped during a design storm event, as well as determine whether acceptable freeboard conditions exist, the appropriate design storm rainfall (per MSHA guidelines), or ½ PMF, should be applied to the impoundment's entire tributary watershed to determine the resulting water surface elevation in the pond. Accurate impoundment volumes and embankment elevations must be utilized in any model that is used to determine the structure's storage and/or routing capabilities.

Final Report

In comments included in the January 26, 2011 response to the draft report by Kentucky Utilities and comments from Kentucky Department of Water to EPA dated January 31, 2011 both parties take exception to the use of MSHA guidelines to evaluate CCW impoundments. AMEC followed the guidelines presented in our scope of work for assessment of CCW impoundments which was provided by EPA.

Although the January 2011 hydrologic and hydraulic information supplied by KU addressed more current conditions, some inadequacies remain. MSHA guidelines for dams assigned a Significant Hazard classification, applied to the dam by AMEC in this assessment as a result of its proximity to the Kentucky River, suggest that structure should be capable of passing the ½ PMF precipitation event while maintaining a minimum freeboard of 3 feet. As noted in Section 3.2.1, construction to raise the crest elevation from the current degraded minimum of 533.1 feet to at least 534 feet, preferably 534.5 feet (NAVD88), in conjunction with application of a maximum operating water surface elevation of 529.5 feet, would increase available freeboard

for lesser design storms. The rating of fair given to the Tyrone Ash Pond signifies the fact that, although no existing dam safety deficiencies are recognized for normal hydrologic loading conditions (100-year 24-hour rainfall event), rare or extreme hydrologic events (½ PMF) may result in a dam deficiency.

Additionally, although the 2011 Hydrologic and Hydraulic Assessment (Attachment 3 of KU's Draft Report comments) and design documents indicate the Tryone Ash Pond principal spillway discharge pipe diameter is 15-inches, plant personnel have confirmed the pipe is 18-inches in diameter. Hydraulics associated with the existing larger pipe would provide additional freeboard compared to values shown in the calculations/assessment. The correct pipe size should be used in all future hydrologic and hydraulic calculations that are performed for the structure.

4.2.2 Geotechnical and Stability Recommendations

September 2010 Draft Report

In the opinion of the assessing professional engineer, the criteria for minimum safety factors should be in accordance with USACE EM 1110-2-1902 with a minimum seismic safety factor of 1.2 as recommended by 2007 *MSHA Coal Mine Impoundment Inspection and Plan Review Handbook*, page 88. Likewise, if the dam does not meet the above seismic factor of safety, then the stability of the embankment should be analyzed and the amount of embankment deformation or settlement that may occur should be evaluated to assure that sufficient section of the crest will remain intact to prevent a release from the impoundment.

The provided stability analysis by MACTEC dated August 27, 2010 analyzed two cross-sections, one on the northwest corner and one on the north dike. The stability analyses were performed using the existing over-steepened slopes, existing loading conditions, and a seismic acceleration. The minimum safety factors are generally in line with the recommended criteria as stated above. The results generally indicate safety factors well above the minimum target values. However, in the opinion of the assessing professional engineer, the analyses should be revised in accordance with the following recommendations. The analysis should consider all critical stages over the life of the pond including pond full conditions. These conditions would need to be determined in conjunction with the hydrologic and hydraulic recommendations above. The hydrologic and hydraulic analysis will provide a phreatic surface through the embankment. The almost vertical phreatic surfaces shown in the analysis are not typical.

The friction angle value of 30 degrees used for the CCW (ash) in the analysis appears high for loose, saturated ash. More typical ash friction values are 28 degrees for compacted, 24 degrees for loosely compacted, and 11 degrees for uncompacted material. Consideration should be given for lowering strength values to account for exhibited lower strengths or inconsistencies within the fill or foundation materials. Lowering the friction value, by one or two degrees, or more for weaker soils would be conservative and more appropriate. More layering of the embankment materials is needed to model lower strength materials, such as the low strength material encountered in Boring 6T. In addition, it appears odd that the moisture content at a depth of about 5 feet in Boring 6T is 79.9 percent, this soil and the material below is described as wet, and yet no water was encountered in the boring. Consideration should also be given to allowing some time for water levels in the piezometers to develop and stabilize.

Some of the analyses presented appear limited to a circular surface; different types of failure surfaces should be analyzed and optimized. We understand additional laboratory results and analyses of other sections are to be performed as part of this study. Considerations at other

sections include elevated water levels and soft foundation soils encountered at Section 1 and steep natural slope conditions below the sections on the west dike. The study should be revised to address the recommendations in this report and reviewed when complete. The completed analyses should include data sheets to show all input parameters, discussion on how each parameter was derived and preferably an AutoCAD (or equivalent) section to facilitate review.

Final Report

In comments included in the January 26, 2011 response to the draft report by Kentucky Utilities and comments from Kentucky Department of Water to EPA dated January 31, 2011 both parties take exception to the use of MSHA guidelines to evaluate CCW impoundments. AMEC followed the guidelines presented in our scope of work for assessment of CCW impoundments which was provided by EPA.

In the assessing engineer's opinion, the calculated factors of safety presented in the most recent stability analyses are not conservative. The results show factors of safety for 1.3:1 and 1.6:1 downstream slopes at sections 1 and 6 to be greater than 2. In the assessing engineer's opinion, the downstream slope at section 6 is marginally stable. In addition, it is recommended that the downstream slopes adjacent to the west and northwest sides of the pond be analyzed. The "groundwater" seep in the area below section 3 and the new scarps occurring on the slopes below the impoundment indicate instability and warrant study, stability analyses, repair as needed, and diligent monitoring of the area to protect the stability of the above ash pond embankments.

4.2.3 Monitoring and Instrumentation Recommendations

September 2010 Draft Report

Three piezometers were installed as part of the stability analysis investigation in August 2010. It would be prudent for the Tyrone Generating Station to maintain and protect these instruments, and document monitoring frequently until base line phreatic readings are apparent. After that time, a regular monitoring frequency should be maintained and the results evaluated by an engineer. Monitoring should include pond and river levels and should include additional readings and evaluation in response to elevated pond levels or specific rainfall events. AMEC recommends that, at minimum, additional instrumentation be installed at the crest and toe of critical slopes. Installation should occur as budgets allow, or immediately upon development of future problems.

Final Report

As indicated in their comments to the Draft Report, "KU continues to periodically monitor instrumentation including piezometers and the principal spillway weir at the Tyrone Ash Pond." KU has stated the piezometers in B-3C will be replaced soon. As stated in the draft report, AMEC recommends the monitoring of the piezometers to include pond and river levels and additional readings for significant rain events. Documentation for recent and/or significant rain events should be included in the monitoring data. The recent appearance of scarps on the hillside slopes below the ash pond, indicate KU should evaluate performing a geotechnical study including the installation of piezometers on these slopes.

In addition to the monitoring and instrumentation recommendations provided by AMEC in the Draft Report, AMEC recommends that each recommendation provided in the January 2011 ATC Assessment and Inspection Report be incorporated by KU for the Tyrone facility.

4.2.4 Inspection Recommendations

September 2010 Draft Report

Kentucky Utilities stated that plant personnel perform daily safety and surveillance inspections for the ash pond at the Tyrone Generating Station. Inspections are documented during the times the plant is out-of-service; however, they are not documented when the plant is in service. No documentation of the inspections was provided. Furthermore, no information was provided to indicate the general procedure or extent of the inspection area(s). AMEC recommends that the current inspection program by the plant be expanded to include at least monthly documented inspections which identify potential problems, areas inspected, instrumentation monitoring, and pond and river levels.

AMEC has reviewed the 2009 and 2010 annual inspection reports and determined KU has adequate annual inspections by a Profession Engineer. We recommend this type of annual inspection program and report by a Professional Engineer be continued at least yearly, in addition to the recommended monthly inspections by facility personnel.

Final Report

As described in the most recent ATC assessment and inspection comments (completed in January 2011 subsequent to submittal of the September 2010 Draft Report), KU is, as was also noted in their comments to the Draft Report, “developing plans to address the priority maintenance items in 2011.” AMEC recommends that KU continue the current annual inspection program at the Tyrone facility that is conducted by an independent engineering consultant and incorporate corrective actions as necessary. Documented monthly inspections by facility personnel should begin as outlined in the above paragraph.

4.3 Former Secondary Pond

The Former Secondary Pond has been removed.

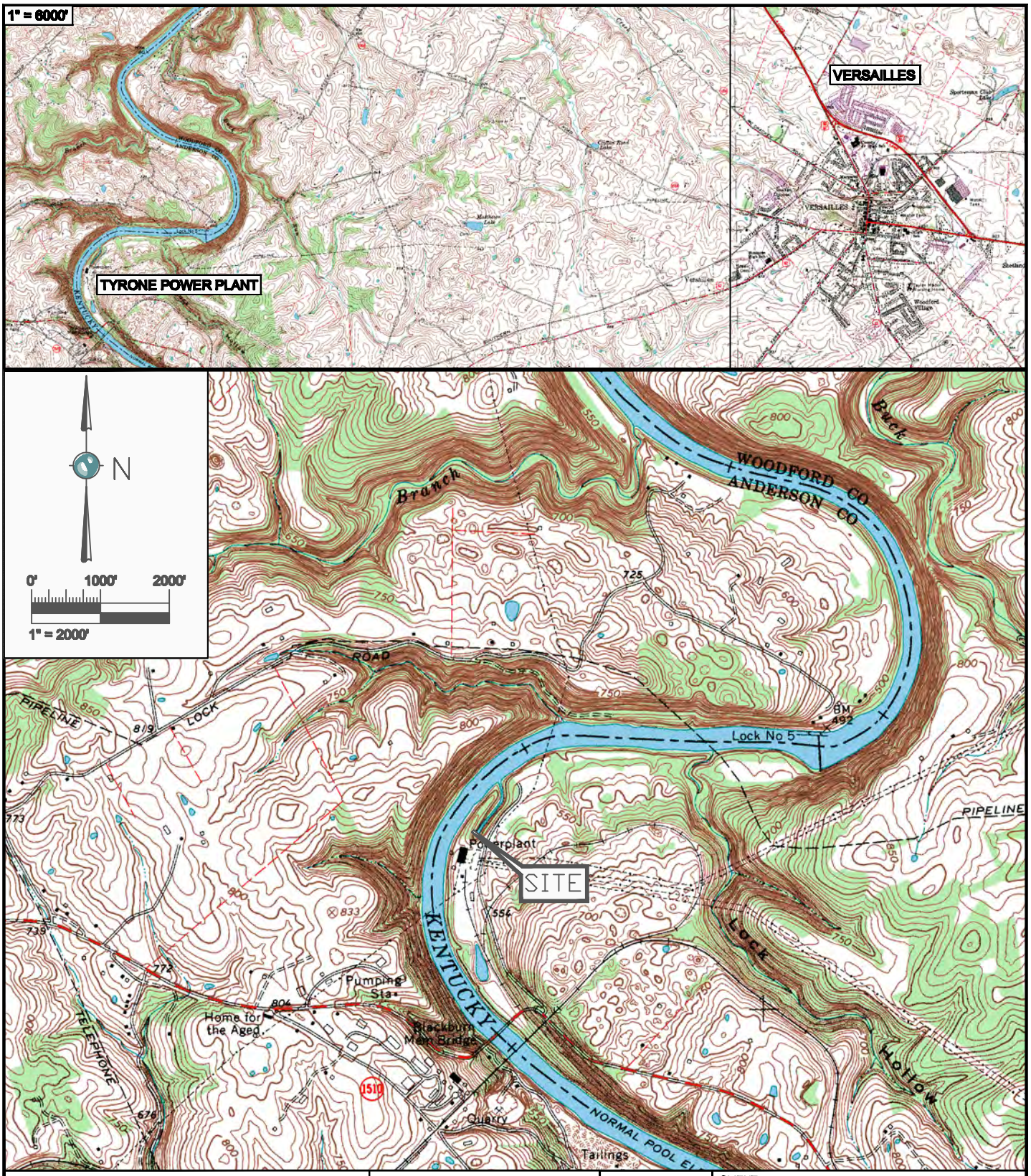
5.0 CLOSING

This report is prepared for the exclusive use of the Environmental Protection Agency for the site and criteria stipulated herein. This report does not address regulatory issues associated with storm water runoff, the identification and modification of regulated wetlands, or ground water recharge areas. Further, this report does not include review or analysis of environmental or regional geo-hydrologic aspects of the site, except as noted herein. Questions or interpretation regarding any portion of the report should be addressed directly by the geotechnical engineer.

Any use, reliance on, or decisions to be made based on this report by a third party are the responsibility of such third parties. AMEC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The conclusions and recommendations given in this report are based on visual observations, our partial knowledge of the history of Tyrone Generating Station impoundments, and information provided to us by others. This report has been prepared in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

FIGURES



AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 8/16/10
TITLE KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY SITE LOCATION & VICINITY MAP		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
		PROJECTION:	SCALE:	PAGE NO.. 1

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

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DWN BY:	DJC
CKD BY:	MS
Datum:	NAD 83
Projection:	Albers
Scale:	As Shown

ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S
TYRONE GENERATING STATION, TYRONE, KY
TYRONE ASH POND & FORMER SECONDARY POND
SITE PLAN

REV. No.:	A
Date:	8-19-10
Project No:	3-2106-0177-0004
Figure No:	2

Critical Infrastructure	ID Number	Latitude	Longitude
Margaret Hall	1	38.057298	-84.731335
Millville School	2	38.12063	-84.826893
Simmons High School	3	38.048132	-84.744947
Alton Church	4	38.080351	-84.926896
Glens Creek Church	5	38.095908	-84.792448
Griers Creek Church	6	38.03452	-84.793837
Macedonia Church	7	38.129518	-84.848839
Victory Chapel	8	38.124518	-84.886339
Blugrass Community Hospital	9	38.05511	-84.723759

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DRAWN BY: DJC
CHK'D BY: MS
DATUM: NAD83
PROJECTION: Albers
SCALE: AS SHOWN
DATE: 8/19/2010

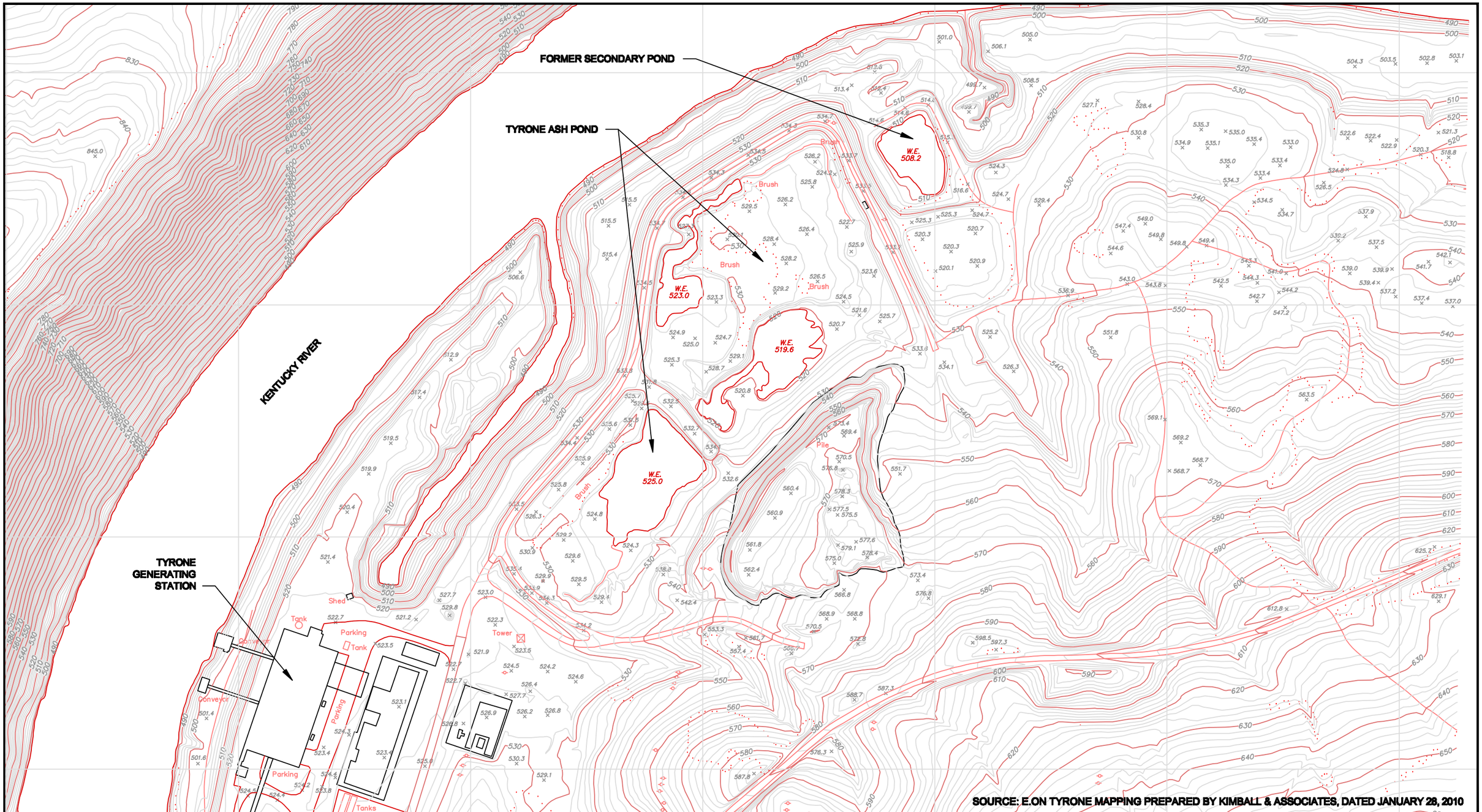
ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S
TYRONE GENERATING STATION, TYRONE, KY
CRITICAL INFRASTRUCTURE

N
0 1 Miles
0 1 Kilometers

Notes: Critical infrastructure data provided by ESRI

FIGURE 3



SOURCE: E.ON TYRONE MAPPING PREPARED BY KIMBALL & ASSOCIATES, DATED JANUARY 28, 2010

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

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DATUM:	
PROJECTION:	
SCALE:	AS SHOWN

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S.
TYRONE GENERATING STATION, TYRONE, KY
TOPOGRAPHIC MAP

DATE:	8/16/10
PROJECT NO:	3-2106-1077.0004
REV. NO.:	
FIGURE No.	4

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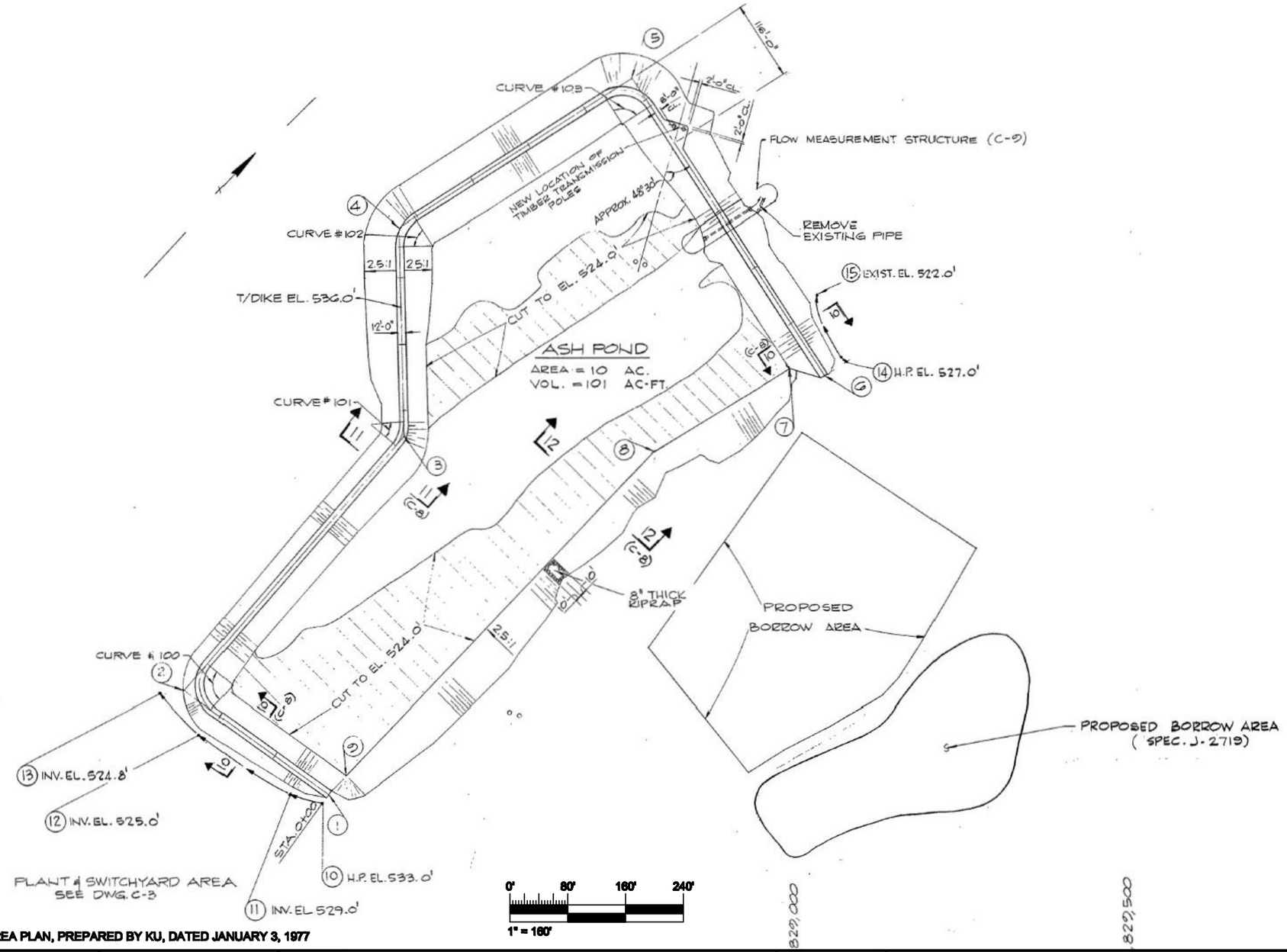

SOURCE: (TY-C-00001) PLANT & ASH POND AREA PLAN, PREPARED BY KU, DATED JANUARY 3, 1977

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

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PROJECTION:	
SCALE:	AS SHOWN

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S.
TYRONE GENERATING STATION, TYRONE, KY
TYRONE ASH POND PLAN VIEW

DATE:	8/16/10
PROJECT NO:	3-2106-1077.0004
REV. NO.:	
FIGURE No.	5

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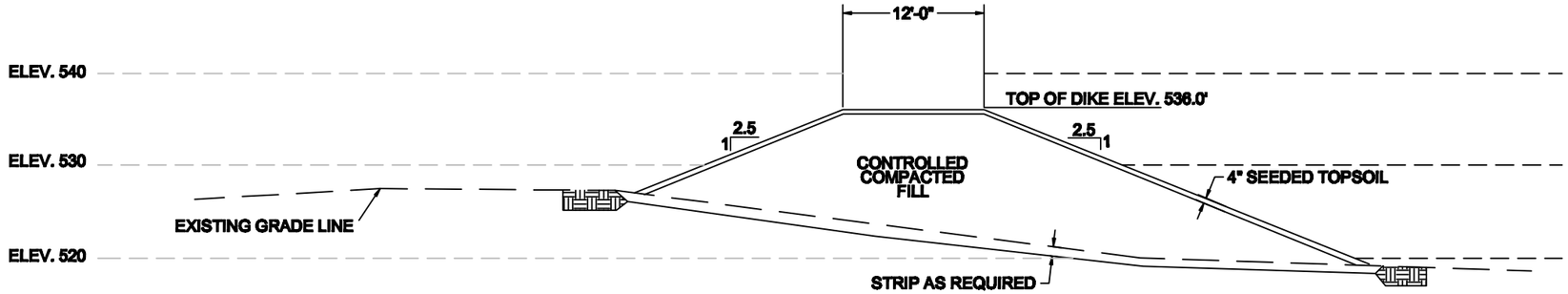
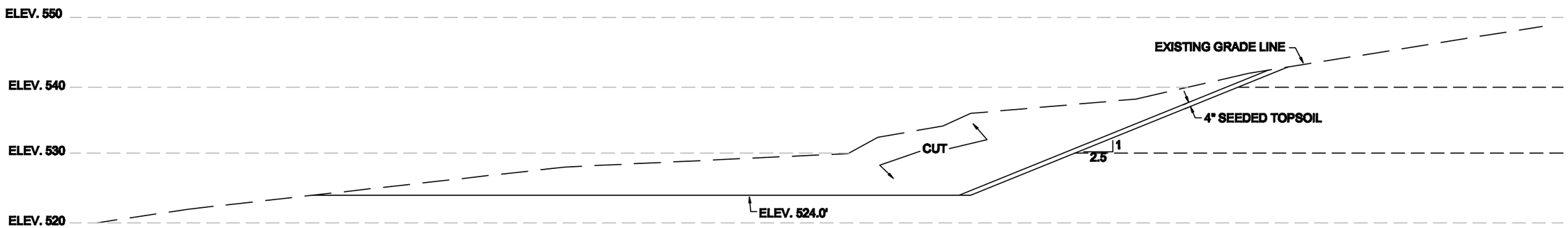
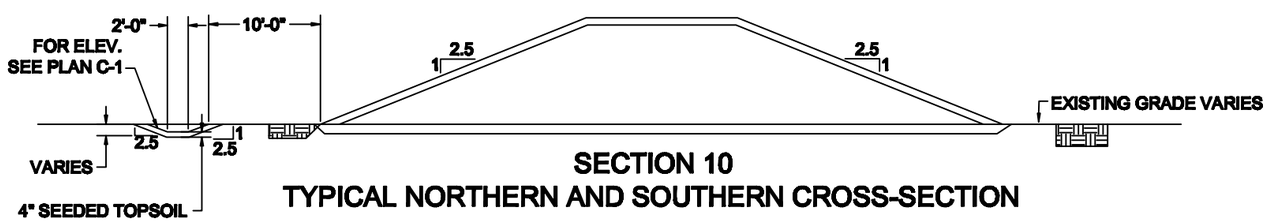


SECTION 11
TYPICAL WESTERN CROSS-SECTION



SECTION 12
TYPICAL EASTERN CROSS-SECTION



SECTION 10
TYPICAL NORTHERN AND SOUTHERN CROSS-SECTION

SOURCE: (TY-C-00008) ASH POND AREA - SECTION & DETAILS, PREPARED BY KU DATED JANUARY 3, 1977

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

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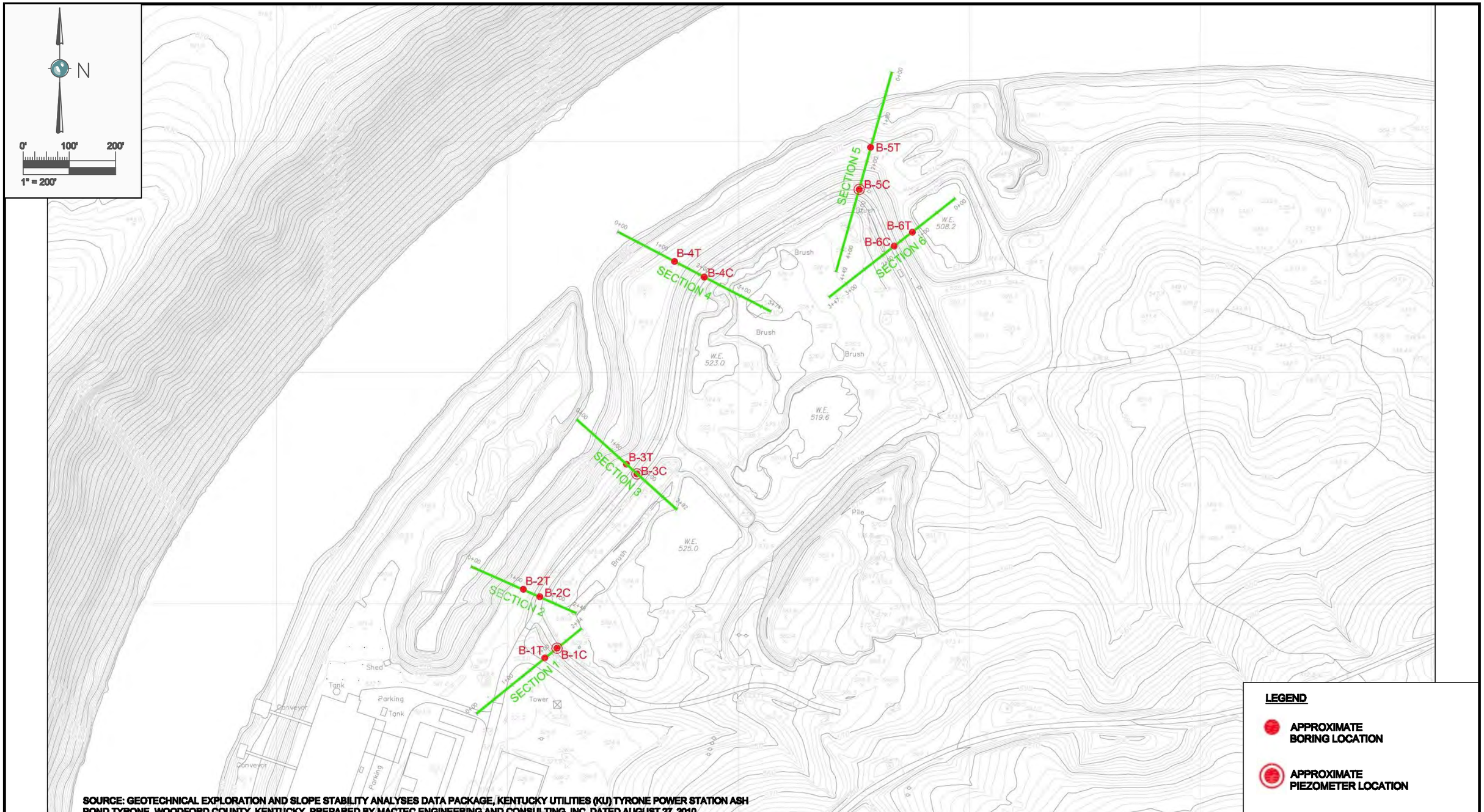
DATUM:	
PROJECTION:	
SCALE:	AS SHOWN

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S.
TYRONE GENERATING STATION, TYRONE, KY
TYRONE ASH POND TYPICAL CROSS-SECTIONS

DATE:	8/16/10
PROJECT NO:	3-2106-1077.0004
REV. NO.:	
FIGURE No.	6

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\EPA CCW June Round 6\KU E-ON Tyrone\CAD and GIS\TYRONEFIG6.dwg – Layout1 – Aug. 18, 2010 7:53am – chris.eger



SOURCE: GEOTECHNICAL EXPLORATION AND SLOPE STABILITY ANALYSES DATA PACKAGE, KENTUCKY UTILITIES (KU) TYRONE POWER STATION ASH POND TYRONE, WOODFORD COUNTY, KENTUCKY. PREPARED BY MACTEC ENGINEERING AND CONSULTING, INC. DATED AUGUST 27, 2010

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

CLIENT LOGO

CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

DWN BY:	CAE
CHK'D BY:	MGS
DATUM:	
PROJECTION:	
SCALE:	AS SHOWN

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S.
TYRONE GENERATING STATION, TYRONE, KY
TYRONE ASH POND PIEZOMETER LOCATIONS AND 2010 STABILITY ANALYSIS CROSS-SECTIONS

DATE:	8/30/10
PROJECT NO:	3-2106-1077.0004
REV. NO.:	
FIGURE No.	7

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\EPA CCW June Round 6\KU E-ON Tyrone\CAD and GIS\TYRONEFIG7.dwg – Layout2 – Aug. 30, 2010 11:13am – chris.eger

APPENDICES

APPENDIX A
Waste Impoundment Inspection Forms

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Tyrone Generating Station	Date: August 3, 2010
Unit Name: Tyrone Ash Pond	Operator's Name: KU (Subsidiary of EON)
Unit I.D.: Tyrone Ash Pond	Hazard Potential Classification: High **Significant** Low
Inspector's Name: James Black, Mary Swiderski	

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?	Daily		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	532.3'		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	Varies		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	533.5'		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?	X	
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?		X	From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?		X	From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

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

Inspection Issue #	Comments
1	Daily inspection around pond, inspection is documented if the plant is out of service, not documented when plant is running. Two semi annual inspections were conducted in 2009.
3	Outlet controlled by stop logs, bottom elevation of structure is 520.5', top is 536'
6	Weir at outlet is only instrumentation
12	Skimmer present

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # KY 0001899 INSPECTOR Black/Swiderski

Date August 3, 2010

Impoundment Name Tyrone Generating Station – Tyrone Ash Pond
Impoundment Company Kentucky Utilities (KU) Company (A Subsidiary of EON-US)
EPA Region 4
State Agency (Field Office) Address
200 Fair Oaks Lane
Frankfort, KY 40601

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

New X Update _____

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

IMPOUNDMENT FUNCTION: Storage and management of coal combustion byproducts

Nearest Downstream Town : Name Frankfort, KY
Distance from the impoundment Approximately 14 miles
Impoundment
Location: Longitude -84 Degrees 50 Minutes 43 Seconds
Latitude 38 Degrees 2 Minutes 59 Seconds
State KY County Woodford

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

If So Which State Agency? KY Division of Water

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

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

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

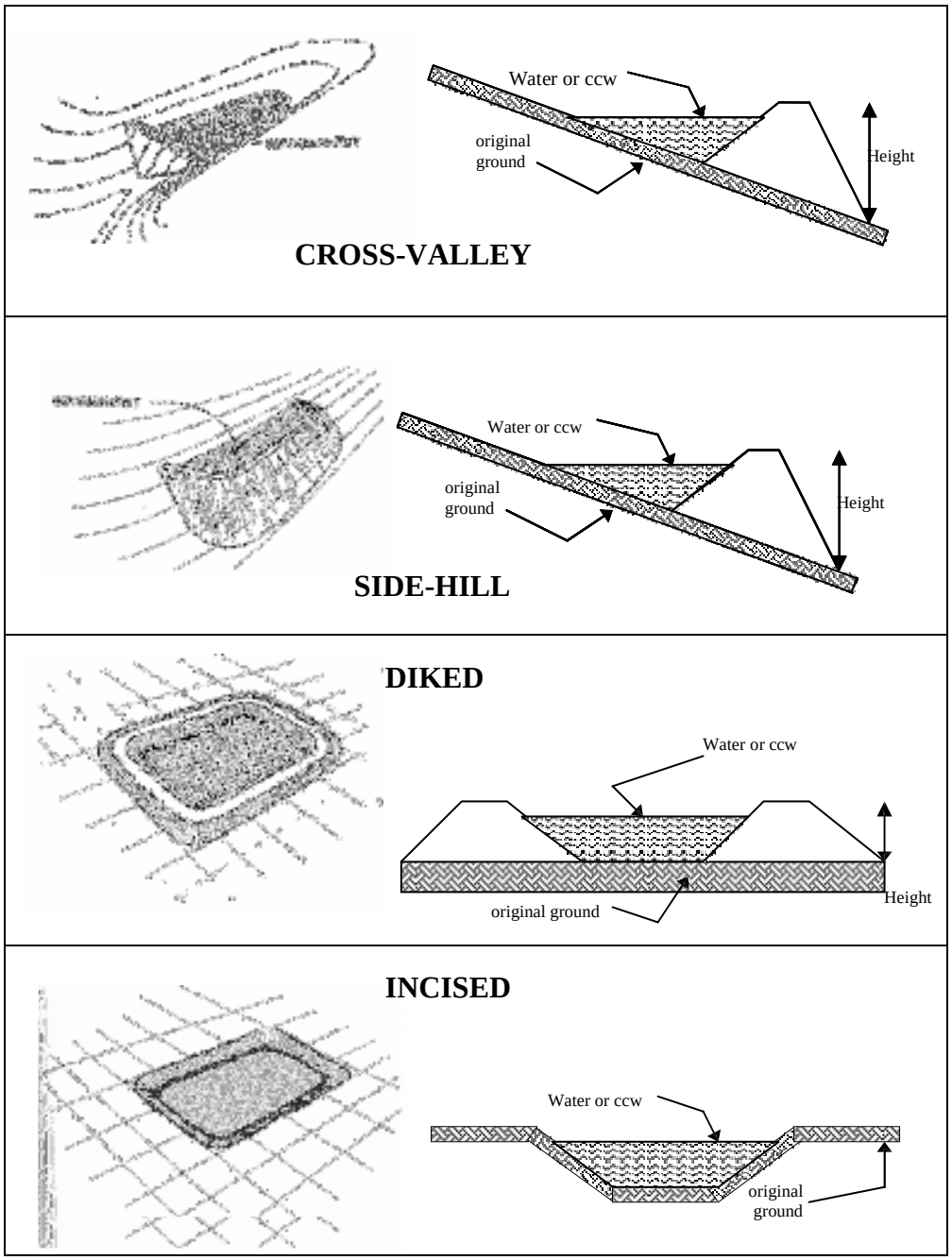
__X__**SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

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

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

Failure may reach Kentucky River
Water Intakes are located downstream
Failure would not result in shutdown of Power Plant

CONFIGURATION:



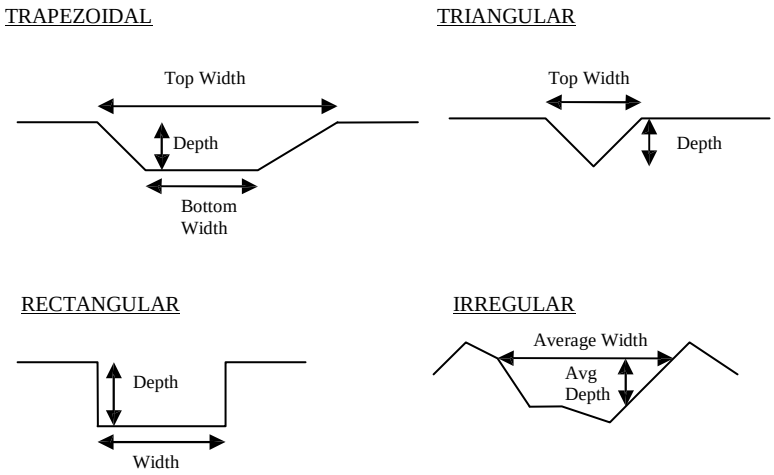
_____Cross-Valley
___X__Side-Hill
_____Diked
_____Incised (form completion optional)
_____Combination Incised/Diked

Embankment Height __19.6_____feet Embankment Material_Earthen Fill_____
Pool Area _____13_____ acres Liner _N/A_____
Current Freeboard ___3-4_____ feet Liner Permeability _N/A_____

TYPE OF OUTLET (Mark all that apply)

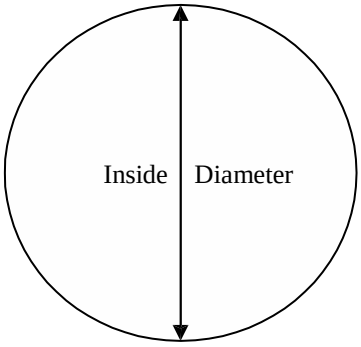
_N/A_ Open Channel Spillway
_____Trapezoidal
_____Triangular
_____Rectangular
_____Irregular

_____depth
_____bottom (or average) width
_____top width
_____



_X_ Outlet

_18”_ inside diameter



Material
_X_ corrugated metal
_____welded steel
_____concrete
_____plastic (hdpe, pvc, etc.)
_____other (specify) _____

_____
Is water flowing through the outlet? YES _X_____ NO _____

_____No Outlet

_____
_____Other Type of Outlet (specify) _____

The Impoundment was Designed By Sargent and Lundy – J.M McLaughlin KY # 9039

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_____

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

If so Please Describe : _____

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Tyrone Generating Station	Date: August 3, 2010
Unit Name: Tyrone Secondary Ash Pond	Operator's Name: KU (Subsidiary of EON)
Unit I.D.:	Hazard Potential Classification: **N/A**
Inspector's Name: James Black, Mary Swiderski	

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

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

Comments: Decommissioned (removed ash and berms) Secondary Pond (Polish Pond) in May 2009, previously contained CCW material from Tyrone Ash Pond.

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # KY 0001899 INSPECTOR Black/Swiderski

Date August 3, 2010

Impoundment Name Tyrone Generating Station – Secondary Ash Pond

Impoundment Company Kentucky Utilities (KU) Company (A Subsidiary of EON-US)

EPA Region 4

State Agency (Field Office) Address

200 Fair Oaks Lane

Frankfort, KY 40601

Name of Impoundment Secondary Ash Pond

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

New X Update _____

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

IMPOUNDMENT FUNCTION: Decommissioned Secondary Pond (Polish Pond) in May 2009, previously contained CCW material from Tyrone Ash Pond.

Nearest Downstream Town : Name Frankfort, KY

Distance from the impoundment Approximately 14 miles

Impoundment Location:

Longitude -84 Degrees 50 Minutes 37 Seconds

Latitude 38 Degrees 3 Minutes 5 Seconds

State KY County Woodford

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

If So Which State Agency? -

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur): **See comments below.**

_____**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.

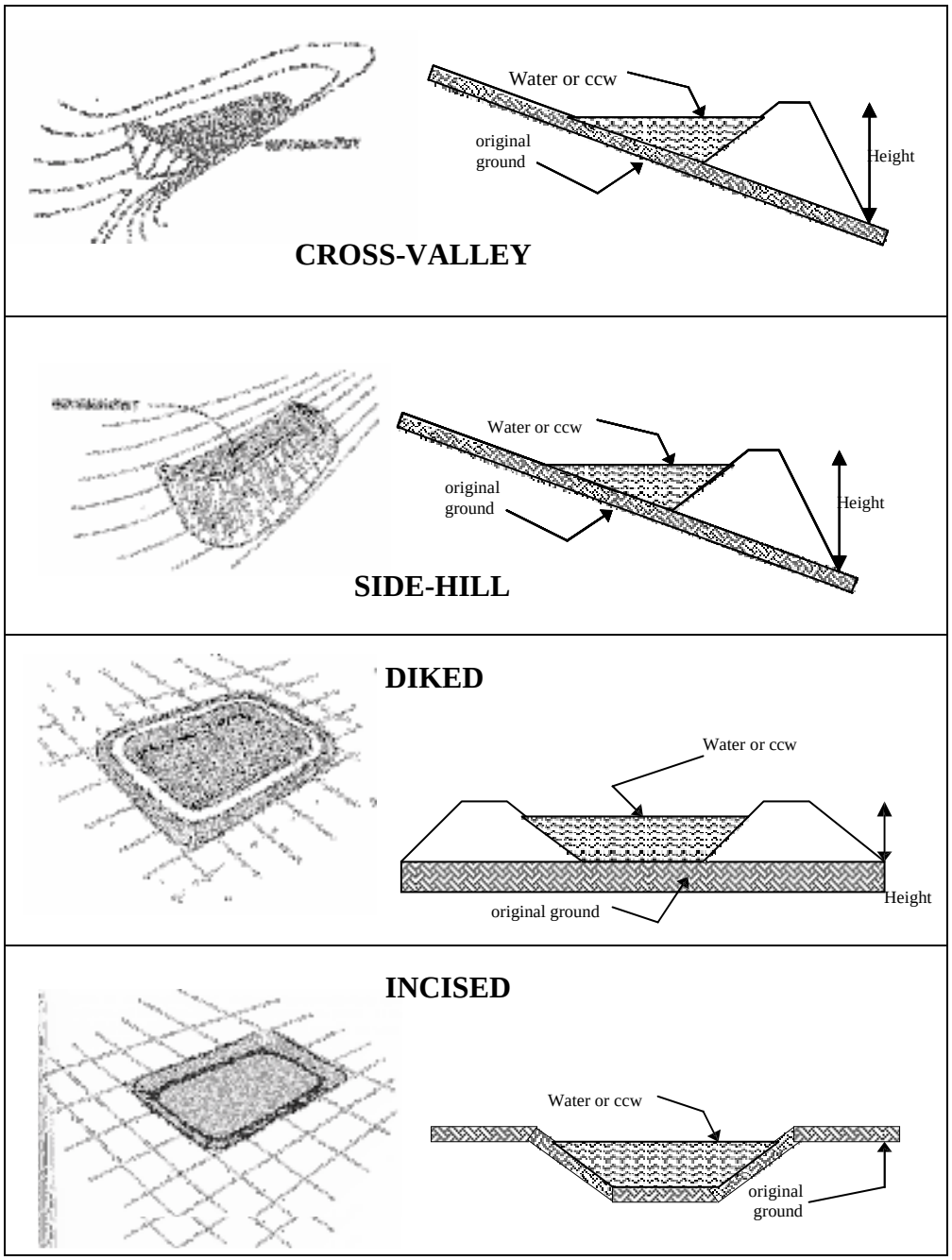
_____**SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

- Ash Pond dikes have been removed and graded across pond site
- Previously contained CCW material has been removed and placed in Tyrone Ash Pond

CONFIGURATION:



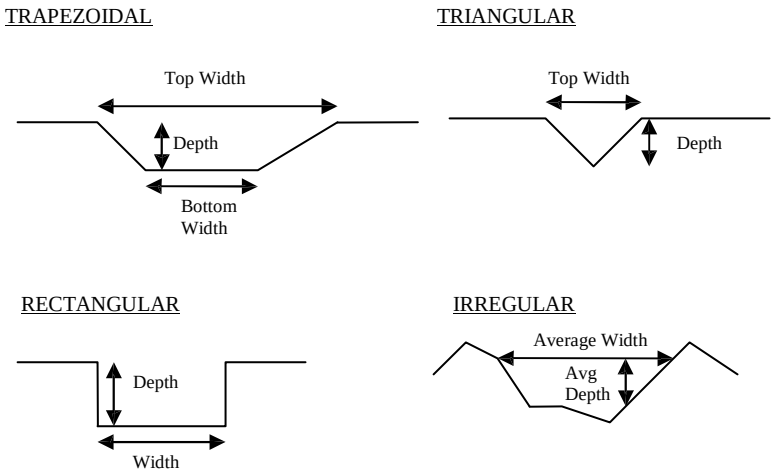
_____Cross-Valley
_____Side-Hill
_____Diked
_____Incised (form completion optional)
_____Combination Incised/Diked

Embankment Height __N/A_____feet Embankment Material_N/A_____
Pool Area _____N/A_____ acres Liner _N/A_____
Current Freeboard ___N/A_____ feet Liner Permeability _N/A_____

TYPE OF OUTLET (Mark all that apply)

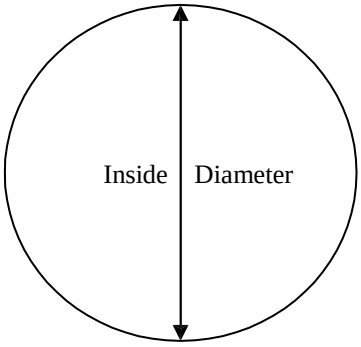
_N/A_ Open Channel Spillway
_____Trapezoidal
_____Triangular
_____Rectangular
_____Irregular

_____depth
_____bottom (or average) width
_____top width
_____



____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 _____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_____

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

If so Please Describe : _____

APPENDIX B
Site Photo Log Map and Site Photos

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

AMEC Earth & Environmental
690 Commonwealth Business Center
11003 Bluegrass Parkway
Louisville, KY 40299

DWN BY:	DJC
CKD BY:	MS
Datum:	NAD 83
Projection:	Albers
Scale:	As Shown

ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S
TYRONE GENERATING STATION, TYRONE, KY
TYRONE ASH POND & FORMER SECONDARY POND
PHOTO LOCATION MAP

REV. No.:	A
Date:	8-19-10
Project No:	3-2106-0177-0004
Figure No:	B-1

SITE PHOTOS

1-1

OIL AND WATER SEPARATOR, STEAM RELEASE, LOCATED 200 FEET SOUTHWEST OF ASH POND

1-2

RESEEDED AREA ALONG SOUTH DOWNSTREAM DIKE SLOPE

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
		PROJECTION:	SCALE:	PAGE NO.. B-2

1-3

INLET PIPES FROM UNIT 3, COAL PILE RUNOFF POND AND LIFT STATION

1-4

STEEP EMBANKMENTS ALONG SOUTHWESTERN DIKE

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
		PROJECTION:	SCALE:	PAGE NO.. B-3

1-5

RESEEDED AREA ALONG WESTERN DIKE

1-6

AREA OF 2009 EARTH SLOPE REPAIR BETWEEN THE PLANT COOLING WATER CANAL AND THE TOE OF THE WESTERN DIKE OF THE ASH POND

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
		PROJECTION:	SCALE:	PAGE NO.. B-4

1-7

AREA OF 2009 EARTH SLOPE REPAIR BETWEEN THE PLANT COOLING WATER CANAL AND THE TOE OF THE WESTERN DIKE OF THE ASH POND

1-8

STANDING IN LOW AREA OF WEST DIKE LOOKING EAST AT WORKING PLATFORM DIVIDING DIKE

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(502) 267-0700

CLIENT LOGO	CLIENT		
	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
	PROJECTION:	SCALE:	PAGE NO.: B-5

1-9

LOOKING NORTHEAST AT LOCATION OF FORMER SECONDARY POND, RIGHT IS DOWNSTREAM SLOPE (UNEVEN) OF NORTH DIKE, CUT AT TOE OF SLOPE

1-10

PRIMARY OUTLET STRUCTURE

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO

CLIENT
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
	PROJECTION:	SCALE:	PAGE NO.: B-6

1-11

SKIMMER ON OUTLET STRUCTURE

1-12

PRIMARY OUTLET/MONITORING POINT OF ASH POND AT TOE OF NORTHERN DIKE, NOTE STEEP/ERODED AREA TO RIGHT

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

amec

CLIENT LOGO

CLIENT
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
	PROJECTION:	SCALE:	PAGE NO.: B-7

1-13

PRIMARY OUTLET/MONITORING POINT OF ASH POND ALONG NORTHERN DIKE

1-14

LOOKING SOUTH FROM LOCATION OF FORMER SECONDARY POND, DOWNSTREAM SLOPE OF NORTH DIKE IN BACKGROUND

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
	PROJECTION:	SCALE:	PAGE NO.: B-8

1-15

DISCHARGE POINT TO KENTUCKY RIVER

1-16

VIEW FROM NORTHERN DIKE LOOKING EAST, BACKGROUND AREA IS NORTH OF ASH STACK

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
		PROJECTION:	SCALE:	PAGE NO.. B-9

1-17

VIEW FROM NORTHERN DIKE LOOKING SOUTHEAST TOWARDS ASH STACK

1-18

VIEW ALONG WESTERN DIKE AT TOE OF ASH STACK NOTE DRAINAGE DITCH ALONG BASE OF STACK

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

amec

CLIENT LOGO

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE: KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS	CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
	PROJECTION:	SCALE:	PAGE NO.: B-10

1-19

VIEW ALONG WESTERN DIKE LOOKING SOUTH TOWARDS POWER PLANT

1-20

VIEW FROM SOUTHERN DIKE LOOKING EAST ACROSS CREST TO TIE-IN TO ORIGINAL GROUND, BACKGROUND IS AREA SOUTH OF ASH STACK

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS		DWN BY: CAE	DATUM:	DATE: 8/4/10
TITLE KENTUCKY UTILITIES, SUBSIDIARY OF E.ON U.S. TYRONE GENERATING STATION, TYRONE, KY ASH POND SITE PHOTOS		CHK'D BY: MGS	REV. NO.:	PROJECT NO: 3-2106-0177-0004
		PROJECTION:	SCALE:	PAGE NO.. B-11

1-21

VIEW FROM SOUTHERN DIKE LOOKING NORTHEAST TOWARDS ASH STACK

AMEC Earth & Environmental
690 Commonwealth Center
11003 Bluegrass Parkway
Louisville, Ky 40299
(502) 267-0700

CLIENT LOGO	CLIENT		
	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 8/4/10
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	PROJECTION:	SCALE:	PAGE NO.: B-12

APPENDIX C
Inventory of Provided Materials

Generation Engineering
220 West Main Street
Louisville, Kentucky 40202
T 1-502-627-2985

TRANSMITTAL LETTER

Date: August 11, 2010

To: James Black, AMEC Earth and Environmental
Mary Swiderski, AMEC Earth and Environmental

Re: Requested information for Tyrone Generating Station and Pineville Station

The following information you have requested has been provided on the CD included with this letter:

TYRONE

Item	Description/File Name
1	TY-C-00001 – Plant and Ash Pond Area Plan – Rev D.pdf *(included in July 30 2010 email transmittal)*
2	TY-C-00008 – Ash Pond Area Sections and Details – Rev C.pdf *(included in July 30 2010 email transmittal)*
3	TY-C-00009 – Flow Measurement Structure – Plan and Section – Rev D.pdf *(included in July 30 2010 email transmittal)*
4	Tyrone-MAP.dwg *(included in July 30 2010 email transmittal)*
5	TY-S-00017 – Ash Pond Outlet Structures – Rev D.pdf *(included in July 30 2010 email transmittal)*
6	Aerial Tyrone1 2009.pdf
7	Partial Tyrone Seep Report Sep 2009.pdf
8	Appendix F Tyrone.pdf – appendix from the 2009 Growing Season Visual Site Assessment Report, prepared by *ATC Associates Inc.*, March 19, 2010
9	Partial ATC Low Hazard Dams Assessment Report signed 20090319.pdf – portion of the Low Hazard Dams Assessment Report, prepared by *ATC Associates Inc.*, March 19, 2009
10	Folder contains 5 years of Discharge Monitoring Reports (DMRs) from 2006 through 2010
11	TY FMSM 1998 Ash Pond Modification Study.pdf – report was prepared by *FMSM Engineers*, April 1998

Generation Engineering
220 West Main Street
Louisville, Kentucky 40202
T 1-502-627-2985

TRANSMITTAL LETTER

Date: August 17, 2010

To: James Black, AMEC Earth and Environmental
Mary Swiderski, AMEC Earth and Environmental

Re: Additional information for Tyrone Generating Station and Pineville Station

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The following additional information has been provided on the CD included with this letter:

TYRONE

Item	Description/File Name
1	KU-Tyrone WB Diag-1-KPDES.jpg – Water Balance Diagram, 1-Day Max Rainfall
2	KU-Tyrone WB Diag-AVG-KPDES – Water Balance Diagram, Average Rainfall
3	Tyrone Process Flows Narrative.pdf - August 2010

PINEVILLE

Item	Description/File Name
1	B-66.pdf – Location Plan & Sections of Test Borings Unit No. 3
2	KU-Pineville WB Diagram.pdf – Water Balance Diagram, 30 Day Peak Monthly Average Process and 1-Day Max Rainfall Conditions
3	Pineville Process Flows Narrative.pdf – August 2010

If you have any questions, please call me.

David Millay
Civil Engineer
T 502-627-2468

Generation Engineering
220 West Main Street
Louisville, Kentucky 40202
T 1-502-627-2985

TRANSMITTAL LETTER

Date: August 27, 2010

To: James Black, AMEC Earth and Environmental
Mary Swiderski, AMEC Earth and Environmental

Re: Information for Tyrone Generating Station

The following additional information has been provided on the CD included with this letter:

GREEN RIVER

Item	Description/File Name
1	2010-08-27 Tyrone Data Package.pdf

If you have any questions, please call me.

David Millay
Civil Engineer
T 502-627-2468

Additional Provided Documents (provided as a response to September 2010 Tyrone Generating Station Draft Report to EPA)

1. Kentucky Utilities Comments on DRAFT Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments Kentucky Utilities, A Subsidiary of E.ON U.S. Tyrone Generating Station, Tyrone, Kentucky, dated January 26, 2011, including following Attachments 1 through 4:

Attachment 1 – KU's Comments - clerical and technical corrections to *DRAFT Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments Kentucky Utilities, a Subsidiary of E.ON U.S. Tyrone Generating Station, Tyrone, Kentucky*

Attachment 2 - *Report of Geotechnical Exploration and Slope Stability Analyses Kentucky Utilities (KU) Tyrone Power Station Ash Pond Tyrone, Woodford County, Kentucky,* September 29, 2010, Mactec Engineering and Consulting, Inc.

Addendum A, Report of Geotechnical Exploration and Slope Stability Analyses Kentucky Utilities (KU) Tyrone Power Station Ash Pond Tyrone, Woodford County, Kentucky, January 19, 2011, Mactec Engineering and Consulting, Inc.

Attachment 3 – *KU Tyrone Ash Pond: Hydrologic and Hydraulic Assessment,* January 20, 2011, LG&E and KU Services Company

Attachment 4 – Cover pages, cover letter, appendices A and D of *2011 Pond Inspections Visual Site Assessment Report Six Impoundment Facilities*, January 25, 2011, ATC Associates, Inc.

2. KDEP Comments DRAFT Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments Kentucky Utilities, A Subsidiary of E.ON U.S., Green River Station, Central City, Tyrone, and Pineville KY AMEC Project No. 3-2106-0177-0002, dated January 31, 2011

3. Kentucky Energy and Environment Cabinet Department for Environmental Protection Division of Water Cover Letter, dated January 27, 2011 and Certificate of Inspection for Dam and Appurtenant Works for Tyrone Generating Station Coal Ash Pond, inspection date January 5, 2011