No hydrologic or hydraulic design criteria or calculations were provided for Ash Pond 3.

EAST KENTUCKY POWER COOPERATIVE

January 12, 2011

Mr. Stephen Hoffman
US Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Subject: Comments on Draft, *Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments East Kentucky Power Cooperative William C. Dale Power Station, Winchester, KY.* (AMEC Project Number 3-2106-0177.0001)

Dear Sir,

The following comments are being submitted by East Kentucky Power Cooperative (EKPC) on the draft *Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments East Kentucky Power Cooperative William C. Dale Power Station, Winchester, KY* prepared by AMEC Earth and Environmental, Inc. EKPC has also attached comments provided by an engineering firm, S&ME, that recently performed studies on the ash ponds at Dale Station.

In its report AMEC recommended that EPA rate the three ash ponds at Dale Station as poor because (1) further critical studies or investigations are needed to identify potential dam safety deficiencies and (2) in the case of Ash Pond 4 repairs are ongoing. As detailed in these comments and supporting studies, Dale Station's ash ponds are safe with a very small possibility of failure. EKPC has performed extensive studies and assessments of these ponds and performed all necessary corrective measures and on-going maintenance. These corrective measures and maintenance continue on a daily basis, along EKPC's inspection program. No further critical studies or investigations are needed beyond those that EKPC has and continues to perform.

EKPC appreciates EPA granting additional time for EKPC to prepare these comments.

Background

EKPC is a not-for-profit member-owned rural generation and transmission utility founded in 1941 whose headquarters are located in Winchester, Ky. Today, EKPC provides wholesale energy and services to 16 member distribution cooperatives through power plants, peaking units, hydro power and more than 2,900 miles of transmission lines. EKPC's purpose is to provide, transmit, and distribute electricity to its rural member systems. EKPC's distribution cooperative members supply energy to approximately 519,000 Kentucky homes, farms, businesses and industries across 87 counties.

William C. Dale Power Station is owned and operated by EKPC and is located in Clark County, Kentucky. The Station began operation in 1954. Four steam generating units produce 195 MW

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(net) and annually produce approximately 30,000-40,000 tons of coal combustion residuals (CCRs). Throughout its history, the Station has sluiced these CCRs to one of four onsite impoundments. Two of these impoundments, Ash Ponds 1 & 2, have been combined to form one impoundment by removing a dike separating them. The resulting pond, Ash Pond 2, is currently in service. Another impoundment, Ash Pond 3, is used for dry storage and has not received sluiced ash for over 30 years. The final impoundment, Ash Pond 4, is currently empty and out of service awaiting a repair. Periodically, CCRs are removed from Ash Pond 2 and Ash Pond 4 and moved to a permitted off-site landfill.

EKPC has a long history of successfully operating these impoundments. Leaks or spills have been reported to the Kentucky Division of Environmental Protection and promptly repaired. In the case of Ash Pond 3, the impoundment was permanently removed from service as a wet pond after a breach was repaired and is only used for dry storage.

General Comments

First of all, EKPC would like to thank EPA for the opportunity to comment on this draft report. It is our hope that these comments will add clarity and perspective.

It is of interest to EKPC that during their site visit AMEC personnel commented on our preparation for the visit. AMEC stated that Dale Station was the best prepared and most cooperative of any site they had visited to date. While this does not affect the operation of the impoundments at the Station, it does indicate that EKPC understands the seriousness of agency requests and demonstrates a continued proactive attitude in the operation of Dale Station. Nowhere in the report does AMEC acknowledge EKPC's cooperation or responsiveness.

Throughout its narrative, AMEC continually references numerous studies EKPC has had performed by various engineering firms on Dale Station's impoundments. These studies show a continued commitment by EKPC to their safe and efficient operation.

Specific Comments

Page 2, 1.2 (Paragraph 5), AMEC assigned the "Significant Hazard Potential" classification to the impoundments at Dale Station based on the proximity to the Kentucky River.

The hazard potential was based solely on the proximity to the Kentucky River. The condition or operation of the impoundments was not considered in assigning the classification.

Page 4, 1.4.2 (Paragraph 2), AMEC notes that EKPC made repairs in response to a Stantec Report dated August 13, 1992.

EKPC responded to the Stantec inspection by making recommended repairs to Ash Pond 2. These continual studies and corresponding improvements to Dale Station's impoundments indicate a continued commitment to their safe operation.

Page 5, 1.4.2 (Paragraph 1), AMEC states that Stantec notes the dike is approximately 23 ft high which contradicts information provided by EKPC.

AMEC was provided with the referenced Stantec report during its visit to Dale Station. EKPC could not find any conflicting information in the RRFI submitted to AMEC that supports this claim. S&ME's report confirms the 26' design height, however, it does note that the actual minimum dam elevation is 2.2 feet below design. This results in an approximate 23.8 ft high dam elevation.

Page 7, 1.4.2 (Paragraph 1), AMEC implies that EKPC only responded to 2 of the 8 recommendations from the Stantec 2009 report.

The Re-grade design plans for Pond #3 and LIDAR survey performed Dec 2009 are in the RRFI submitted to AMEC. AMEC was also advised that an Emergency Action Plan has been authorized and was provided a copy of the Purchase Order noting this work. The remaining items deal with inspections and monitoring that are incorporated in the standard operation of the Dale Station Coal Yard. EKPC has addressed all of the recommendations in the report.

Page 9, 1.4.4, AMEC refers to a Fuller, Mossbargar, Scott, and May Engineering, Inc. (FMSM) report noting that FMSM was providing services to stop the leakage that had been occurring for at least five years through the east side of the ash pond.

This is reiterated on pages 10 and 15. The FMSM report does not state the leakage as a matter of fact, but as "their understanding". EKPC does not believe that FMSM's intent was to say that the No.4 pond had been leaking continuously for the past five years, but that five years ago leakage had occurred at that location that was corrected upon discovery. EKPC's intent for this engineering investigation was to look at a permanent fix to ensure the leakage did not recur in the future.

Page 9, 1.4.4, AMEC states that FMSM was directed by EKPC to focus on the east side despite their recommendations to apply corrective action to the entire pond.

The FMSM report does note that EKPC asked them to focus on the east side where the pond had leaked, which was an obvious first course of action. They also note that because of the karst features under the pond, the measures needed to be applied to the entire pond; otherwise the potential for leakage to occur will not be eliminated. AMEC appears to imply that EKPC influenced the outcome of the report. EKPC vigorously denies this. FMSM was hired as a professional engineering firm to evaluate corrective measures for this pond. Their report makes three recommendations, notes pros and cons and outlines the risks.

Page 32, 3.3.3 (Paragraph 3), AMEC states that they do not agree with the storm event, loading conditions and high strength values used in the 1975 Bowser-Morner report.

AMEC is not specific regarding their disagreement. EKPC assumes that they disagree with the prevailing dam design criteria (USACE & KDOW) in use at the time and are suggesting a more stringent criterion from MSHA (US Mine Safety and Health) should be used.

MSHA is not the regulatory agency with jurisdiction over the two EKPC surface impoundments in Kentucky. The Kentucky Division of Water is the regulatory agency under which these impoundments were built and operated for numerous years. The impoundments were designed and built pursuant to the design criteria required by KDOW. Should EPA want to apply new design criteria or to become the regulatory agency with jurisdiction over the impoundments, then the EPA should implement rulemaking to do so.

Page 37, 4.2.1 (Paragraph 3), AMEC implies that the 2010 S&ME hydraulic study at Dale is not adequate and recommends another hydraulic study on the No. 2 pond in accordance with MSHA guidelines.

The study performed was in accordance with current applicable engineering design standards and prudent engineering practice. AMEC did not provide any evidence or supporting data to justify the application of the MSHA design criteria, especially since EKPC is required by Kentucky regulations to use the dam design criteria specified by the KDOW. EKPC also questions retroactive increases in design criteria, even if there is justification to support an increase. The new criteria will result in significant costs to upgrade these facilities.

MSHA is not the regulatory agency with jurisdiction over the two EKPC surface impoundments in Kentucky. The Kentucky Division of Water is the regulatory agency under which these impoundments were built and operated for numerous years. The impoundments were designed and built pursuant to the design criteria required by KDOW. Should EPA want to apply new design criteria or to become the regulatory agency with jurisdiction over the impoundments, then the EPA should implement rulemaking to do so.

Pages 37 & 38, 4.2.2, AMEC implies that the 2010 S&ME Engineering Study at Dale is not adequate and recommends another stability analysis be performed on the No. 2 pond in accordance with MSHA guidelines. They also state that the strength factors that S&ME uses are inadequate.

The study performed was in accordance with current applicable engineering design standards and prudent engineering practice. AMEC did not provide any evidence or supporting data to justify an increase in design criteria. EKPC also questions retroactive increases in design criteria, even if there is justification to support an increase. The new criteria will result in significant costs to upgrade these facilities.

MSHA is not the regulatory agency with jurisdiction over the two EKPC surface impoundments in Kentucky. The Kentucky Division of Water is the regulatory agency under which these impoundments were built and operated for numerous years. The impoundments were designed and built pursuant to the design criteria required by KDOW. Should EPA want to apply new design criteria or to become the regulatory agency with jurisdiction over the impoundments, then the EPA should implement rulemaking to do so.

Page 39, 4.3.3 (Paragraph 2), AMEC recommends "at least piezometer instrumentation be installed" for the dam on Ash Pond 3.

Ash Pond 3 is used for dry storage of compacted ash. It is unclear what useful information such instrumentation would provide.

Page 39, 4.4.1 (Paragraph 5), AMEC implies that the 2010 S&ME hydraulic study at Dale is not adequate and recommends another hydraulic study on the No. 4 pond in accordance with MSHA guidelines.

The study performed was in accordance with current applicable engineering design standards and prudent engineering practice. AMEC did not provide any evidence or supporting data to justify an increase in design criteria. EKPC also questions retroactive increases in design criteria, even if there is justification to support an increase. The new criteria will result in significant costs to upgrade these facilities.

MSHA is not the regulatory agency with jurisdiction over the two EKPC surface impoundments in Kentucky. The Kentucky Division of Water is the regulatory agency under which these impoundments were built and operated for numerous years. The impoundments were designed and built pursuant to the design criteria required by KDOW. Should EPA want to apply new design criteria or to become the regulatory agency with jurisdiction over the impoundments, then the EPA should implement rulemaking to do so.

Page 40, Section 4.4.2 (Paragraph 2), AMEC states that a recent stability analysis was not performed for Ash Pond 4 and EKPC has only had one from 1975.

The stability study in 1975 was performed under applicable engineering standards Unless physical changes are made to the pond, such as reducing slopes, etc., the stability study remains valid and a new study is not needed. Stability analysis was performed for areas of concern on Ash Pond 4 by S&ME in 2010. AMEC acknowledges Ash Pond 4 exceeds computed factors of safety for seismic minimums according to USACE and MSHA standards.

Page 40, Section 4.4.2, AMEC states that the "30 year old design stability study" does not accurately represent the as-built structure and also needs to be re-done in accordance with AMEC's recommendation to use the MSHA criteria.

The original Bowser – Morner report extensively analyized the stability of the embankment under various loading conditions, S&ME performed a recent stability analysis in the slide area, and the service life under known worst case loading conditions over 30 years have proven structural stability of the slopes however, analysis were not per recommended MSHA criteria. Again, no evidence or support for increasing design standards and re-engineering an existing facility under new criteria.

MSHA is not the regulatory agency with jurisdiction over the two EKPC surface impoundments in Kentucky. The Kentucky Division of Water is the regulatory agency under which these impoundments were built and operated for numerous years. The impoundments were designed

and built pursuant to the design criteria required by KDOW. Should EPA want to apply new design criteria or to become the regulatory agency with jurisdiction over the impoundments, then the EPA should implement rulemaking to do so.

Page 44, Site Location Map, The facilities noted on the map are incorrectly labeled.

The Site is marked correctly. However, the Dale Generating Plant label is incorrectly marking a quarry approximately two miles from the actual location of the Station. From the map, it appears that ash is sluiced over a great distance.

Summary

EKPC has had a long history of safely and effectively operating its impoundments at Dale Power Station. Good engineering practices have been and will continue to be employed by the facility. Leaks and spills, although rare in these impoundments, have been managed quickly and safely. The Station has consistently notified the Kentucky Division of Water in a timely fashion should an ash spill event occur. EKPC has always taken immediate corrective action.

The commitment of EKPC to the safe operation of the impoundment at Dale Station is demonstrated by the numerous studies that have been performed to improve their safety and effectiveness and our prompt action in correcting any issues that have occurred. As noted by the reports discuss by AMEC, that commitment is on-going and involves continuing actions to ensure the stability and safe operation of these impoundments.

We appreciate the opportunity to provide comments and participate in the EPA's public process. Please incorporate our comments as well as the enclosed S&ME report dated January 12, 2011 into the final report. We appreciate the EPA's consideration and the evaluation of the AMEC report. EKPC will continue to evaluate the recommendations in the report and those of other engineering studies performed at Dale Power Station to ensure safe operation of the surface impoundments.

Sincerely,

Jerry Purvis
Manager, Environmental Affairs
East Kentucky Power Cooperative, Inc.

Enclosure:

C: Jim Kohler, P.E.
Brad Condley

Mr. Mark Brewer, P.E.
East Kentucky Power Cooperative
P.O. Box 707
Winchester, Kentucky 40392-0707

January 12, 2011

Subject: **Response to Dam Safety Assessment**
Of Coal Combustion Surface Impoundments
WILLIAM C. DALE POWER STATION
Winchester, Kentucky
S&ME Project Number 1831-10-5580

Dear Mr. Brewer,

At your request, the Lexington, Kentucky office of S&ME, Inc. (formerly QORE) has drafted a response to the comments and recommendations presented in the draft Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments, dated September 2010, prepared by AMEC Earth & Environmental, Inc.

The AMEC report rated Dale Ash Pond 2, Ash Pond 3, and Ash Pond 4 as POOR because "further critical studies or investigations are needed to identify potential dam safety deficiencies." Those critical studies are largely associated with the Hydrologic and Hydraulic Studies and the Geotechnical and Stability aspects of the impoundments. Following are the response to the major issues raised in the AMEC report.

HYDROLOGIC AND HYDRAULIC RECOMMENDATIONS

SECTION 3.2 – 3.2.3

1. It should be noted that the hazard rating for Ash Pond No. 2 as "Class (A) - Low Hazard Structure" is incorrect in the S&ME report submitted to EKPC. This pond was not listed in the Kentucky Division Water's (KDOW) database. This section of the report will be corrected and re-submitted to EKPC.

2. It should be noted that the hazard rating for Ash Pond No. 4 as not rated is incorrect in the submitted report to EKPC. This pond is listed in the KDOW database as "Class (A) – Low Hazard Structure" ID No. 660. This section of the report will be corrected and re-submitted to EKPC.

3. At the time of the study, minimum hydraulic design criteria for Ash Pond No. 2 and Ash Pond No. 4 were derived from the KDOW's Engineering Memorandum No. 5 (EM No. 5), Section C. As such, the Freeboard Hydrograph formula, $P_A = P_{100} + [0.12 \times (PMP - P_{100})]$, for a Class (A) Low Hazard Structure was used. Since Ash Pond No. 4 was rated by the KDOW, S&ME used the KDOW design

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criteria. This was also completed for Ash Pond No. 2, although the pond was not rated by KDOW. Rainfall Frequency Values for Kentucky (EM No. 2) were used for the 6-hr, 100-year precipitation for Clark County. In the S&ME report these values were shown as a *minimum* freeboard requirement. AMEC stated that these methods were acceptable data sources.

4. As stated in 3 above, Mine Safety and Health Administration (MSHA) design criteria was not used for this study since the Kentucky Division of Water design guidelines were acceptable and met the scope of this project at the time of the study. Conversations between S&ME and KDOW confirmed KDOW's desire to use the criteria presented in their Engineering Memorandum No. 5 and No. 2. They do not recognize the USCAE or MSHA criteria.

5. A "routing hydrograph" was not done for Ash Pond No. 2 or Ash Pond No. 4 since a "worst-case" condition for storage of the design storm was determined. Also, a key objective of the study was to calculate the approximate storage capacity remaining in each pond for additional fly ash material. However, S&ME can provide an addendum to each report showing the routing hydrographs for each pond and noting that the volume of precipitation can be safely discharged using the existing outlet structure (80% lost volume within the allowable limit of 10 days).

6. On Page 24 of the AMEC report in reference to Table 3, the design pond bottom elevation for Ash Pond No. 2 of 572.0 is correct. The elevation of 579.0 referenced in the Stantec report was incorrect. The correct elevation was noted in Section 5.2 of the Stantec report. This was an apparent typographical error.

7. In reference to using runoff from dry Ash Pond No. 3 for determination of an acceptable freeboard/operating water surface elevation for Ash Pond No. 2, the ditch runoff was not included in the calculations since the inflow would be controlled by the inlet pipe. However, S&ME can provide an addendum to the report that shows the routing analysis through the proposed ditch structure and any effects this may have on the freeboard of the ash pond.

GEOTECHNICAL AND STABILITY RECOMMENDATIONS

4.2 Dale Ash Pond No. 2

Response to 4.2.2 Geotechnical and Stability Recommendations

AMEC: Program and Method of Analysis not provided

RESPONSE: PC Stabl using Modified Bishop method

AMEC: No Data provided showing analyses input and calculations

RESPONSE: S&ME Inc. provided two stability sections sheets for both the north and west slope for Ash Pond 2. These stability sections clearly show our borings, the soil profile and descriptions, our shear strength parameters, the analysis conditions, the factors of safety, the failure surfaces, and the ground surface. Our stability model is clearly defined on these drawings and represents the stability model input into the PC Stabl program.

AMEC: Statements of historical (sic) observed stability due to rapid drawdown conditions is not a substitute for the analysis.

RESPONSE: S&ME Inc. strongly disagrees with AMEC's assertion that relying on the observed (historic) performance of the existing embankment under design conditions (e.g. rapid drawdown or flood stage) is inappropriate. The fact that an embankment has performed adequately after experiencing the very conditions that the slope stability analysis seeks to model is clear evidence of its stability to withstand flood events. The AMEC report cites the U.S. Army Corps of Engineers (USACE) manual EM 1110-2-1902 Slope Stability as a design reference manual and they seem to rely heavily on that manual to set design criteria. We refer AMEC to USACE EM 1110-2-1902 Chapter 3 to see what the manual says about the use of actual performance to assess the embankment. In Chapter 3 the manual specifically states that historic or past performance of an existing embankment is more reliable than slope stability analyses. The manual further states in Section 3-3 Existing Embankment Dams:

> *"While the purpose of this manual is to provide guidance for correct use of analysis procedures, the use of slope stability analysis must be held in proper perspective. There is danger in relying too heavily on slope stability analyses for existing dams. Appropriate emphasis must be placed on the often difficult task of establishing the true nature of the behavior of the dam through field investigations and research into the historical design, construction records, and observed performance of the embankment. In many instances monitoring and evaluation of instrumentation are the keys to meaningful assessment of stability.*(emphasis added).

From EM 1110-2-1902 Section 3-1 Factor of Safety Guidance the manual states:

> *"What is considered an acceptable factor of safety should reflect the differences between new slopes, where stability must be forecast, and existing slopes, where information regarding past slope performance is available. A history free of signs of slope movements provides firm evidence that a slope has been stable under the conditions it has experienced."*(emphasis added)

AMEC: 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.

RESPONSE: S&ME asserts that both the S&ME and Bowser-Morner stability analyses and target factors of safety are reasonable. In their report, AMEC states that a minimum factor of safety is 1.5 for static and 1.2 for dynamic loading. AMEC cites Table 3-1 from the USACE EM 1110-2-1902 publication along with the MSHA publication as their recognized criteria. They emphasize that these values are minimum values. They also discount the design criteria presented in the Kentucky Division of Water Engineering Memorandum No. 5 which has somewhat lower target factors of safety.

It is the opinion of S&ME Inc. that the assignment of the appropriate factor of safety is based on engineering judgment and includes the consequence of failure and the level of uncertainty associated with the shear strength parameters, the subsurface conditions, and the loading conditions. When the uncertainty and the consequences are small it is acceptable to use a smaller factor of safety. When the uncertainties increase or the consequences of failure increase, larger factors of safety are appropriate.

Between Bowser-Morner, Stantec, and S&ME, a significant volume of information is available on the subsurface conditions for this project. This includes laboratory data, borings, stability analyses, and the long term performance of the embankments. While the consequence of failure is an impact to the Kentucky River, no loss of life or property is anticipated and our breach analysis shows that the house below Pond 2 is not impacted. Therefore, we feel that the Bowser-Morner and S&ME analyses are appropriate. Again citing from USACE EM 1110-2-1902 Chapter 3:

> *"Acceptable values of factors of safety for existing dams may be less than those for design of new dams, considering the benefits of being able to observe the actual performance of the embankment over a period of time. In selecting appropriate factors of safety for existing dam slopes, the considerations discussed in Section 3-1 should be taken into account. The factor of safety required will have an effect on determining whether or not remediation of the dam slope is necessary. Reliability analysis techniques can be used to provide additional insight into appropriate factors of safety and the necessity for remediation."*
>
> *"What is considered an acceptable factor of safety should reflect the differences between new slopes, where stability must be forecast, and existing slopes, where information regarding past slope performance is available. A history free of signs of slope movements provides firm evidence that a slope has been stable under the conditions it has experienced. Conversely, signs of significant movement indicate marginally stable or unstable conditions. In either case, the degree of uncertainty regarding shear strength and piezometric levels can be reduced through back analysis. Therefore, values of factors of safety that are*

lower than those required for new slopes can often be justified for existing slopes". (emphasis added)

AMEC: AMEC has concerns with the strength parameters used in the analyses and lack of adjustments for inconsistences or exhibited lower strength layers. Typical ash friction values are 28 degrees for compacted, 24 degrees for loosely compacted, and 11 degrees for uncompacted material.

RESPONSE: S&ME Inc. developed the shear strength parameters for our stability models using C-U triaxial shear strength testing on actual undisturbed samples of the encountered material recovered from our test borings. We also performed direct shear testing of fly ash samples recovered from the embankment. In addition to our laboratory testing, we reviewed the extensive laboratory test results from the Bowser-Morner report performed for the original construction. The Bowser-Morner testing was performed under ASTM protocol, In addition, we used laboratory test results of fly ash performed by S&ME on other fly ash facilities as well as recommended values for angle of internal friction by published researchers. Finally, we utilized the behavior of the existing embankments to back-calculate (or calibrate) our shear strength parameters and compared them to our laboratory test results and the observed performance of the embankment under design loading conditions. The shear strength parameters were then finalized after all of the above were completed. This is the very approach recommended by the U.S. Army Corps of Engineers manual USACE EM 1110-2-1902 referred to by AMEC. From Chapter 3, Section 3-1 paragraph C Shear strengths:

"Shear strengths of fill materials for new construction should be based on tests performed on laboratory compacted specimens. The specimens should be compacted at the highest water content and the lowest density consistent with specifications. Shear strengths of existing fills should be based on the laboratory tests performed for the original design studies if they appear to be reliable, on laboratory tests performed on undisturbed specimens retrieved from the fill, and/or on the results of in situ tests performed in the fill. Shear strengths of natural materials should be based on the results of tests performed on undisturbed specimens, or on the results of in situ tests."(emphasis added)

For fly ash, S&ME used an effective stress angle of internal friction of 32 degrees. AMEC asserts a more reasonable value is 28 degrees for compacted fly ash. S&ME disagrees with the AMEC value and considers it conservative based on the body of knowledge regarding the characteristics of fly ash and the performance of the existing embankments. Our value of 32 degrees is reasonable based on the results of the laboratory testing as well as testing performed by others. Our value was based on direct shear testing of an undisturbed sample and C-U triaxial shear testing of a remolded sample of the fly ash. These samples exhibited angle of internal friction values of 32 degrees and 34 degrees, respectively. We also compared our results with testing of

others. S&ME Charlotte has performed extensive laboratory shear strength testing of fly ash facilities across the southeast. For fly ash ponds where the constituency is similar to the Dale Plant (80 percent fly ash, 20 percent bottom ash) the effective stress angle of internal friction values are typically 31 degrees to 33 degrees. C-U triaxial shear strength tests performed on sluiced fly ash, which is loose and saturated, yields angle of internal friction values of 25 degrees to 27 degrees.

N.S. Pandian of the Department of Civil Engineering, Indian Institute of Science, has done extensive research on the engineering properties of fly ash. In his publication "*Fly Ash Characterization with Reference to Geotechnical Applications*' he summarized the following:

- *"The results show that fly ash is a free draining material with angle of internal friction of more than 30 degrees."*
- *"Age hardening occurs over time due to the presence of free lime in the fly ash."*
- *"Many researchers have conducted consolidated drained or undrained tests with pore pressure measurements and reported the mean value of angle of shearing resistance as 34 degrees (ranged from 29 to 40 degrees)."*

In his publication, Pandian presents five tables summarizing the research and results of the shear strength testing. We present some of the results below:

Table VI(a) Strength Parameters from Direct Shear Tests (peak values) (from Pandian)

Material	Conditions	Φ'(degrees)
Fly Ash	loose, dry	29-36
Pond Ash	loose, dry	29-34
Fly Ash	loose, saturated	27-37
Pond Ash	loose, saturated	25-40
Fly Ash	compacted	28-42
Pond Ash	compacted	29-38

Table VII Recommended Ratios for the Angle of Internal Friction (from Pandian)

Material	Φ'(degrees)
Pond Ash	32-35
Sand	32-40
Quarry Dust	40-45

For comparison purposes, Chapter 6 of the MSHA Impoundment Design Manual, Table 6.4 Fine Coal Refuse Characterization – Summary of Average/Range of Values, lists a range of 29-34 degrees for the angle of internal friction for fine coal refuse from PA, WV, KY and VA (Almes and Butail 1976).

Regarding the "lack of adjustments for inconsistencies" we fail to see how AMEC can possibly render an opinion to this level of detail regarding our stability model when they state categorically in their report that AMEC had "*insufficient information in this report to assess the stability of Ash Pond 2. Discussion was not provided on the program and its method used for analyses. In addition, no data was provided showing the analyses input and calculations.*" (excerpted directly from page 37 of the AMEC report).

S&ME asserts that the development of stability models, selection of shear strength parameters, and evaluation of the factor of safety were consistent with the recommendations presented in USACE EM 1110-2-1902 Slope Stability. Specific evidence of this was cited in the above discussions. In our opinion, S&ME is confident that the results of our work represent the condition of the embankments and our recommendations are prudent and reasonable.

4.4 Dale Ash Pond No. 4

Response to 4.4.2 Geotechnical and Stability Recommendations

AMEC: It is the assessing engineer's opinion that additional studies be performed for the slide occurring below the toe of Ash Pond No. 4.

RESPONSE: S&ME Inc. disagrees with the need for additional study of the slide at Ash Pond No. 4. If you conclude that the movement documented by the 2009 Stantec survey is due to additional progressive failure of the embankment and not simply erosion and movement along the existing failure surface, then the Stantec survey confirms the validity of the S&ME stability analysis for the slide where we predicted that the slide would propogate uphill 2 to 4 feet where it would stop. Based on our validated stability model, in our opinion, our recommendations are prudent and reasonable. It should be noted that we did not have the Stantec survey during the development of our stability analysis. For informational purposes we are providing the following excerpts from our report on the slide at Ash Pond No. 4:

- "... it is our opinion that it is unlikely that a slide would occur initially that would impact the embankment."
- "For the normal river pool elevation of 568 feet, the analysis yielded a factor of safety of 1.4 for a failure surface approaching the toe of the embankment."

- "The modeling and analyses also suggests that under the high water condition (595 feet) or the rapid drawdown condition, the existing slide may propagate uphill a few feet. The predicted failure surfaces range from two (2) to four (4) feet behind the existing scarp."

AMEC: The thirty year old design stability study for Ash Pond 4 was performed under different guidelines than recommended herein, and does not accurately represent the as-built structure. In the opinion of the assessing professional engineer, a current stability analyses (sic) for Ash Pond 4 should be performed in accordance with the recommended guidelines stated herein, and the following recommendations. The analysis should consider all critical stages over the life of the pond including pond full conditions.

RESPONSE: S&ME only performed a stability analysis for the slide at Ash Pond No. 4. S&ME did not perform a stability analysis for overall Ash Pond No. 4. The Bowser-Morner report extensively modeled the embankments for Pond No. 4 under various loading conditions during their initial design. Our laboratory testing and back-calculation confirmed the shear strength values used in the Bowser-Morner report. We have not compared the as-built embankment slopes against the design slopes to determine if significant differences exist between them. We would again refer to the value of observing the behavior of the embankment over the 30 year service life as testament to the actual stability of the embankment.

From Section 3-1 Factor of Safety Guidance the manual states:

> *"What is considered an acceptable factor of safety should reflect the differences between new slopes, where stability must be forecast, and existing slopes, where information regarding past slope performance is available. A history free of signs of slope movements provides firm evidence that a slope has been stable under the conditions it has experienced."*(emphasis added)

Should you have any questions regarding the information presented herein, please give us a call.

Sincerely,
S&ME, Inc.

Michael E. Merriman, P.E.
Senior Civil Engineer

Craig S. Lee, P.E.
Senior Geotechnical Engineer

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