U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
SUBCOMMITTEE ON WATER RESOURCES AND ENVIRONMENT HEARING – "THE ONE YEAR ANNIVERSARY OF THE TENNESSEE VALLEY AUTHORITY'S KINGSTON ASH SLIDE: EVALUATING CURRENT CLEANUP PROGRESS AND ASSESSING FUTURE ENVIRONMENTAL GOALS"

TESTIMONY OF JOHN S. MONTGOMERY, PE, SENIOR PRINCIPAL
STANTEC CONSULTING SERVICES INC.
1409 NORTH FORBES ROAD
LEXINGTON, KENTUCKY 40511
859-422-3000

Following the December 22, 2008 breach of the ash dredge cell at the Tennessee Valley Authority's (TVA) Kingston Fossil Plant, TVA requested Stantec to assess the condition of the active coal combustion product (CCP) disposal impoundments at its 11 fossil plants. Stantec proposed a four-phase approach for the assessment program.

Phase 1 consisted of an initial review of documentation and field reconnaissance to identify conditions that may affect the stability and functionality of the facilities reviewed; determine the need for short term or immediate corrective actions and engineering evaluations; and prioritize and schedule facilities for future engineering evaluations. Phase 1 was non-invasive and limited to field observations and reviews of historical documents. Phase 1 involved:

- Reviewing documents and records pertinent to the characterization, design, construction, operation, and maintenance of TVA's CCP disposal facilities and other ponds. These documents and records were provided by TVA and included reports, drawings, data, and memoranda.
- Site reconnaissance of disposal facilities and ponds including measurements of embankment slopes and crest widths, freeboard, observed seepage, and slope instabilities. Plant personnel were interviewed to gain additional information. Observations and measurements were recorded using dam safety inspection checklists customized for the types of CCP management units encountered. Additional follow-up visits were also made to some plants, as conditions warranted.
- Compiling exhibits to present the findings.

Phase 2 consists of engineering evaluations based on findings and issues determined during Phase 1. These engineering evaluations include geotechnical explorations, hydraulic and hydrologic evaluations, conceptual designs for renovations, and general engineering support. Tasks that have been or are to be performed include:

- Drilling, sampling and instrumentation of existing embankment and foundation materials to characterize subsurface conditions, and field and laboratory testing to determine engineering properties of these materials.
- Slope stability and seepage calculations.
- Hydrologic and hydraulic analyses of impoundments and spillway systems.
- Inventories and observations of spillways and drainage features.
- Additional field reconnaissance and observations.
- Compiling data and assembling exhibits to present results and findings.
- Developing conceptual designs to address identified issues.

Phase 3 consists of a variety of engineering tasks including planning assistance for short- and long-term CCP management, final design of conceptual renovations identified in Phase 2, preparing construction plans/specifications and cost opinions, providing construction observation, documentation, and quality assurance testing, developing applicable record drawings, and assisting TVA with environmental permitting.

Phase 4 involves assisting TVA with improving its dam safety program within the fossil power group, dam safety training for appropriate TVA CCP staff, preparing operation and maintenance manuals for selected facilities, and performing annual facility inspections.

CURRENT STATUS

Since January 2009, Stantec and TVA have assessed the stability of TVA's CCP disposal facilities and implemented opportunities to improve conditions as deficiencies have been identified. During this process, Stantec and TVA personnel have worked together to develop and adjust priorities and schedules based on the most current findings and observations. In certain instances, TVA has directed Stantec to proceed with engineering evaluations and mitigation designs for improvement of its facilities as deficiencies have been identified rather than wait until the completion of program phases and delivery of final reports.

Based on observations during Phase 1 and Phase 2, Stantec has developed recommendations and designs for renovations at various facilities. Stantec has recommended: installing seepage filters and collection systems; regrading slopes; abandoning conduits/spillways; installing stability buttresses and berms; lowering pool levels; improving surface drainage, adding instrumentation, installing revetment; eliminating animal burrows; and removing vegetation. At the time of this testimony, forty-five work plans that improve conditions of the impoundments have been issued. Thirty-one of these work plans have been implemented in the field and fourteen are in progress. Over 240,000 tons of rock have been installed to increase stability at several facilities, and a new spillway system has been installed at the Johnsonville Ash Pond.

PHASE 1

Phase 1 is complete and the final report was submitted to TVA on June 24, 2009. To date, no formal comments have been received by Stantec from any agency or reviewer regarding any aspect of the scope, content, findings, or recommendations provided during Phase 1 of the program.

PHASES 2, 3 AND 4

Phase 2, Phase 3, and Phase 4 are on-going. Phase 2 activities were initiated in early 2009 and it is anticipated that these engineering evaluations will be complete during the third quarter of 2010. However, the schedule may change depending on future findings or conditions not yet determined. Results of the Phase 2 evaluations will be presented in various engineering reports. At this time, it is anticipated that separate reports will be developed for each facility, and issued under the subject heading (geotechnical report, hydrologic/hydraulic report, etc.). The final format and organization of the Phase 2 reports have not been determined.

The schedule for completing Phase 3 activities can not be determined until Phase 2 is complete. The initial dam safety staff training for Phase 4 has been completed. Any additional Phase 4 work items will be as requested by TVA to support on-going programmatic efforts.

FINDINGS TO DATE

The remaining discussions of this testimony address the scope, findings and recommendations of Phase 1, including the status and findings of Phase 2, Phase 3, and Phase 4 activities that have been completed to date.

Over 8,000 documents were provided by TVA during Phase 1. These documents included: annual inspection reports; quarterly inspection reports; geotechnical and geological related reports, data and analyses; design and construction drawings; design, feasibility, and CCP management reports; permit documents; design calculations; project or internal correspondence; and aerial photography.

Stantec assembled six assessment teams to perform field reconnaissance and observe site conditions. Teams consisted of at least two engineers, one of which was a licensed professional engineer with experience in dam design, dam safety, and geotechnical engineering. Items of primary concern included: active seepage areas, evidence of slope instability, sinkholes, depressions, insufficient freeboard, steepness and height of slopes, and condition of spillways through embankments. During January and February 2009, Stantec reviewed and photographed conditions of TVA's CCP impoundments. As needed, follow-up visits occurred to further review and assess conditions.

Based on this review and assessment, Stantec identified the following system-wide concerns:

1) **Limited Record Drawings and Construction Testing/Observation Records.** Stantec found relatively few as-built construction records or construction testing records for the disposal facilities. These records are important to illustrate how facilities were actually constructed, compliance with project plans and specifications, and any design or construction adjustments made to deal with changes or unexpected conditions encountered during construction.

2) **Construction of Stacks over Ash Ponds and the Operation of Fly Ash Dredge Cells.** Hydraulically-placed fly ash in ponds and dredge cells is generally very loose in terms of relative density, and high in porosity and void ratio. These conditions can sometimes result in significant and sudden loss of shear strength within the sluiced ash at low strains due to embankment loading. TVA has several active facilities that have been constructed over ash ponds. Operating CCP disposal facilities on top of ash that has been sluiced into ponds is not an uncommon practice in the industry. While this practice can pose greater risk than constructing over natural earth materials, the risk is typically managed by performing appropriate geotechnical analyses to support design and operation, and by installing instrumentation to monitor pore pressures, settlement, and slope movement. Load rates must also be controlled to manage the build-up of excess pore pressures.

3) **Tall, Unsupported Weir Structures.** A number of the facilities have weir structures that are tall and unsupported. System-wide, weir structures are typically vertical, push-together, reinforced concrete pipe or manhole sections. This type of weir system is prone to developing leaking joints and leaning. In addition, outlet pipes from the weir structures are constructed of reinforced concrete culvert pipe. This type of pipe does not employ a restrained joint system and is also susceptible to developing leaking joints. Some past TVA inspection reports have documented such problems.

4) **Conduit and Weir Abandonment Procedures.** As various disposal facilities have been raised in the past to increase CCP storage capacity, process water conduits and weirs have been abandoned in place. The abandonment procedures have varied from site to site over the years and are not well documented. Improper abandonment can lead to internal piping and loss of embankment and/or foundation materials through joint separation in the conduits.

5) **Maintenance.** Annual dike inspection reports appear to be adequate in identifying items for maintenance. However, there is a trend of not executing all of the maintenance recommendations provided in these reports. In many instances, the same maintenance recommendations were made repeatedly in the annual reports from year to year. Tree and other vegetation removal from dikes and surface drainage ditches is an example of one of the typical recurring items.

6) **Limited Operation and Maintenance Manuals (OM) and Emergency Action Plans (EAP).** During the historical research/document review phase, Stantec found a general lack of Emergency Action Plans (EAP) for the disposal facilities. These plans are important for the safe operation of a dam/impoundment, and for the protection of downstream communities, as well as plant personnel.

7) **Limited Geotechnical Instrumentation.** Dam safety management of significant impoundments should include an instrumentation program to monitor performance and condition changes during operation of the facility. In general, instrumentation may consist of piezometers to monitor pore pressures within embankments and foundations, slope inclinometers and surface monuments to monitor movement, and plates for monitoring settlement. Only limited geotechnical instrumentation and related monitoring programs were observed at a majority of the facilities during Phase 1 reviews.

RECOMMENDATIONS AND ACTIONS TO ADDRESS OBSERVED SYSTEM WIDE CONCERNS

A. LIMITED RECORD DRAWINGS AND CONSTRUCTION TESTING/OBSERVATION RECORDS; CONSTRUCTION OF STACKS OVER ASH PONDS AND THE OPERATION OF FLY ASH DREDGE CELLS; AND LIMITED GEOTECHNICAL INSTRUMENTATION

Due to limited availability of record drawings, construction QA/QC documentation, and geotechnical instrumentation, Stantec recommended Phase 2 geotechnical explorations be performed on all significant CCP impoundments. Because of concerns with operating CCP facilities on top of sluiced ash, Stantec extended this recommendation to include stacks and landfills operating on top of identified sluiced ash ponds. The recommendations included installing instrumentation to assist with characterizing and monitoring subsurface conditions.

As of the date of this testimony, initial geotechnical drilling has been completed for impoundments at 10 of the 11 plants. Exploration of the remaining site (Shawnee Fossil Plant) is to be completed by February 28, 2010. Over 625 test borings have been completed and represent over 37,000 linear feet (over 7 miles) of drilling and sampling. Installed instrumentation includes 342 piezometers and 56 inclinometers. Over 15,000 soil samples have been retrieved and over 12,000 laboratory tests have been performed.

Slope stability analyses have been completed for nine impoundments: (1) Paradise Ash Pond; (2) Widows Creek Gypsum Stack; (3) Johnsonville Ash Pond; (4) Paradise Gypsum Stack; (5) Cumberland Gypsum Stack; (6) Kingston Ash Pond; (7) John Sevier Dry Ash Stack; (8) Widows Creek Ash Pond; and (9) Colbert Ash Pond. Analyses of the remaining impoundments are due to be completed by May 30, 2010.

1) **Paradise Ash Pond:** Stantec evaluated the "as-found" conditions and determined the Paradise Ash Pond meets generally accepted slope stability factors of safety ($FS \geq 1.5$).

   The remaining eight facilities, briefly discussed in items 2 through 9 below did not meet this criteria. This is generally a result of steep slopes and/or inadequate seepage controls.

2) **Widows Creek Gypsum Stack:** Stantec designed slope renovations and monitored construction of these renovations at the Widows Creek Gypsum Stack. These renovations involved regrading and buttressing the slope using rock, re-directing

process waters, and improving drainage. Photographs of pre- and post-conditions are included as Exhibit A. The current conditions at Widows Creek Gypsum Stack meet the acceptable slope stability criteria.

3) **Johnsonville Ash Pond:** New spillways have been constructed to lower the water surface at the Johnsonville Ash Pond. A siphon system has also been installed to enable further dewatering if necessary. Photographs of the spillway and siphon systems are included as Exhibit B. A seepage collection system has been installed along the south east toe of the pond. In addition, Stantec has designed a buttress for the most critical slopes. TVA is working to obtain proper environmental permits for the construction of this buttress. Pending issuance of the required permits, construction of the buttress is anticipated to begin in December, 2009 or early in 2010. Once the buttress is constructed, these slopes will meet the required factor of safety. Finally, Stantec has recommended closure of the Johnsonville Ash Pond and is currently developing a phased closure plan that will result in the entire facility meeting acceptable slope stability criteria.

4) **Paradise Gypsum Stack:** Rock armoring and buttressing of slopes is currently being constructed to improve slope stability at the Paradise Gypsum Stack. Once the armoring and buttressing are completed, it is anticipated slope stability will meet the accepted factor of safety criteria. Photographs of the armoring and buttress construction are included as Exhibit C. In addition, Stantec has prepared construction drawings to reduce the size of the operating pool to further improve stability. It is anticipated this construction will begin in December 2009 or early 2010. Finally, Stantec has recommended the gypsum stack be closed and is designing a phased closure plan.

5) **Cumberland Gypsum Stack:** The pool has been significantly reduced. Lining the operating pool, regrading the surface of the stack, and installing a buttress are being considered to further improve stability of the stack. TVA plans to close the Cumberland Gypsum Stack.

6) **Kingston Ash Pond:** Stantec is designing the downstream slope buttressing for the Kingston Ash Pond. Design of the initial stage is complete and construction is scheduled to begin December 2009. Stantec anticipates completing design of the remaining stages by June 2010. When buttress construction is complete, the facility should meet the accepted criteria for slope stability.

7) **John Sevier Dry Stack:** Stantec is designing plans to install a trench drain and regrade the slope along the toe of the John Sevier Dry Stack to improve slope stability. It is anticipated these plans will be completed by February 2010.

8 & 9) **Widows Creek Ash Pond and Colbert Ash Pond:** Buttressing and slope regrading are being considered to improve stability of the Widows Creek Ash Pond. Renovations have not yet been formulated for improvement of the Colbert Ash Pond.

Further, as part of Phase 2 geotechnical activities, Stantec continues to monitor the geotechnical instrumentation installed at all sites during the initial drilling. Readings are taken on a regular basis at all sites. Slope inclinometers installed at the Bull Run Gypsum Stack were useful in assessing recent movement at the toe of the south slope. The instrumentation allowed Stantec to determine that the movement is confined to a shallow slough and Stantec is designing mitigation of the slough. No other significant changes in subsurface conditions have been observed in the instrumentation data.

Stantec has prepared draft geotechnical reports for four impoundments: Johnsonville Ash Pond, Widows Creek Gypsum Stack, Paradise Gypsum Stack, and Kingston Ash Pond. As part of these geotechnical explorations, Stantec has also been tasked with determining the presence or absence of the four conditions which led to the failure of the Kingston Dredge Cell as identified by AECOM in its Root Cause Analysis report. It is Stantec's understanding of AECOM's conclusions presented in its report that all four must be present for conditions to be considered similar to the Kingston Dredge Cell facility. Based on findings presented in these draft reports, all four conditions are NOT present at the Johnsonville Ash Pond, Widows Creek Gypsum Stack, Paradise Gypsum Stack, or Kingston Ash Pond.

The Kingston Ash Pond geotechnical report has been reviewed by the Inspector General's Office, comments have been received by Stantec, and those comments have been addressed. Geotechnical reports for the Johnsonville Ash Pond, Widows Creek Gypsum Stack, and Paradise Gypsum Stack will be submitted to TVA by mid-March 2010. Geotechnical reports for all sites will be issued by June 30, 2010.

Stantec also recommended hydrologic and hydraulic analyses be performed on all active CCP impoundments to evaluate freeboard. Stantec has completed calculations for the Johnsonville Ash Pond. A new spillway system has been installed and the facility meets generally accepted freeboard requirements for dam safety. It is anticipated the hydrologic and hydraulic calculations for the remaining facilities will be complete by June, 2010.

Finally, Stantec recommended that TVA develop a program to ensure record drawings and construction documents are maintained. TVA is currently developing programmatic documents to address this issue. This work is being performed by another consultant and not Stantec.

B. TALL, UNSUPPORTED WEIR STRUCTURES

Stantec recommended that outlet weir structures and outlet pipes be prioritized, inspected, retrofitted or replaced as necessary. A new replacement spillway and siphon system has been designed and constructed at the Johnsonville Ash Pond. Photographs showing the new spillway are provided as Exhibit B. Stantec is currently designing spillway improvements at the Cumberland Ash Pond, Widows Creek Ash Pond, and Shawnee Ash Pond. Based on the current schedule, these designs will be complete by May 2010. Stantec is working with TVA to prioritize the inspection and evaluation of the remaining spillways. Scheduling for this task is being developed.

C. CONDUIT AND WEIR ABANDONMENT PROCEDURES

Stantec recommended developing an inventory of existing and abandoned conduits at each CCP impoundment including an assessment of abandonment procedures. Inventories are complete for 3 of the 11 sites with the remaining sites scheduled to be completed by January 31, 2010. Assessment of abandonment procedures has been completed at the Widows Creek Gypsum stack and conduits have been closed by grouting full or by removing.

D. MAINTENANCE

Stantec recommended that TVA develop a program to ensure annual inspection recommendations are tracked and addressed, and also recommended TVA review its dam safety program and include appropriate elements within its CCP facility management program. This recommendation also addressed on-going training.

TVA is currently developing programmatic documents to address these issues. This work is being performed by another consultant and not Stantec.

Stantec has provided dam safety inspection training to TVA staff including managers of its CCP program and staff at the plants who are involved in daily CCP management activities. Training has also been provided to TVA police staff. At the time of this testimony, training has been provided to over 300 people within TVA.

E. LIMITED OPERATION AND MAINTENANCE MANUALS (OM) AND EMERGENCY ACTION PLANS (EAP)

Stantec recommended that TVA review the dam safety hazard classification assigned to each CCP impoundment and reassign classifications as appropriate in accordance with state and federal dam safety guidelines. In addition, Stantec recommended that TVA develop Emergency Action Plans for all impoundments determined to be high hazard from a dam safety perspective.

TVA completed an initial reassessment of hazard classifications and determined four sites to have high hazard impoundments from a dam safety perspective (five impoundments). Those sites are Cumberland Fossil Plant, Widows Creek Fossil Plant, Bull Run Fossil Plant, and Colbert Fossil Plant. TVA has developed Emergency Action Plans for each of these sites and the initial breach analysis and inundation mapping have been prepared. Refinement of the breach analysis by Stantec is underway for the Bull Run and Widows Creek Fossil Plants and will be complete March 3, 2010.

Finally, Stantec recommended review and updates of its operation and maintenance manuals for each CCP impoundment. This work has not started.

END OF TESTIMONY

EXHIBIT A

WIDOWS CREEK GYPSUM STACK

SLOPE RENOVATIONS

Photo A-1: As Found Site Conditions of the West Slope of Gypsum Stack; Process Water Redirected Through Temporary Spillway Discharge Pipe (foreground)

Photo A-2: Construction of Rock Toe Buttress and Spillway Renovations Along West Slope of Gypsum Stack

Photo A-3: Completion of Rock Toe Buttress and Preparation of Vegetative Cover Along the West Slope of Gypsum Stack

EXHIBIT B

JOHNSONVILLE ASH POND

SPILLWAY REPLACEMENT AND SIPHON SYSTEM

Photo B-1: New Spillway and Siphon Systems
(viewed from downstream)

Photo B-2: New Spillway and Siphon Systems
(viewed from upstream)

Photo B-3: New Spillway System Outlet

Photo B-4: Old Spillway Weir
(to be abandoned)

EXHIBIT C

PARADISE GYPSUM STACK

SLOPE RENOVATIONS

Photo C-1: As Found Conditions of the Paradise Gypsum Stack South Slope

Photo C-2: March 2009 – Beginning Construction of Rock Buttress to Stabilize Slope

Photo C-3: April 2009 – West End of Rock Buttress Completed

Photo C-4: As Found Conditions of Paradise
Gypsum Stack South Slope

Photo C-5: May 2009 – Renovations Completed to Control Seepage and Surface Runoff