

**Tennessee Valley Authority
Regulatory Submittal for Kingston Fossil Plant**

**Documents submitted:
Supplemental Leaching Test Plan – For Ash Stabilization Demonstration**

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Document No. RAWP-072A

**Kingston Ash Recovery Project
Non-Time-Critical Removal Action
for the River System**

Supplemental Ash Leaching Test Plan

**Prepared by:
Jacobs**

for the Tennessee Valley Authority

Revision	Description	Date
0	Draft for TVA Review	March 8, 2011
1	Removed analysis for arsenic and selenium by EPA method 200.8. Added analysis for TVA metals and EPA SW-846 methods at TestAmerica Nashville. Added Table 1.	March 10, 2011
2	Revised per TVA comments and transmittal to EPA/TDEC	March 23, 2011

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Attachment

Attachment 1 Data Quality Objectives Table

List of Acronyms

EPA	U.S. Environmental Protection Agency
mL	milliliter
ORP	oxidation-reduction potential
QAPP	Quality Assurance Project Plan
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environmental Conservation
TVA	Tennessee Valley Authority
WBS	work breakdown structure

1. SITE BACKGROUND

This plan is a supplement to the Ash Leaching Test Plan (TVA 2010b), describing the bench-scale testing, and analysis for testing the leaching behavior of the vendors proposed dewatering material and ash mixtures at the Kingston Ash Recovery Project site.

1.1 PURPOSE OF TEST

Control of moisture content in the ash is critical to the successful dry ash stacking operations during closure of the former Dredge Cell and Ash Pond. The addition of drying agents such as Portland cement or EZ Sorb™ to the ash has been proposed to assist in controlling the moisture content and drying out the ash.

Groundwater modeling will be conducted as part of the River System Sampling and Analysis Plan (TVA 2010A) to analyze the groundwater transport of ash-related constituents to the Watts Bar reservoir. Results of the leaching tests presented in this report will be used to quantify constituent concentration variations as a function of leaching from the ash.

1.2 TEST OBJECTIVES (DATA QUALITY OBJECTIVES)

Ash-related constituents, such as arsenic, may be mobilized as a result of infiltration of precipitation and may be transported downgradient in the groundwater to the Emory River, where exposure by humans or ecological receptors may occur. Addition of Portland cement or EZ Sorb™ may alter the mobilization potential. The principal study question is: Does the flux of ash-related constituents from groundwater to the Emory River result in unacceptable risk to these human or ecological receptors? The correlating study question is: Does this predicted flux change as a result of adding Portland cement or EZ Sorb™ to the ash?

Results of leaching tests will be used as inputs to the groundwater modeling, which will support the decision on acceptable risk. The spatial boundaries of the study are a 3-composite sample of ash from the North Embayment. The temporal boundaries for the fate and transport modeling include the time following closure out to 100 years. Refer to Attachment 1, Data Quality Objectives Table, for the formal development of data quality objectives for this task.

The U.S. Environmental Protection Agency (EPA) has proposed four new methods (Methods 1313 through 1316) for determining the leaching characteristics from coal ash and other landfilled materials. This plan will only utilize three of the four tests, as the monolith test (1315) is not necessary since the material is not being evaluated for stabilization properties. The proposed new EPA leach tests are alternate leaching procedures that are under development in EPA research studies and have not yet been formally adopted. The tests provide a useful standardized method for testing the leaching response of a material, such as ash or treated ash; however, the leaching characteristics should be evaluated relative to the specific environmental (pH and redox) conditions expected for the Kingston Ash Recovery Project site.

Toxicity Characteristic Leaching Procedure (TCLP) limits do not apply to these new methods. However, the TCLP limits may be useful in putting the results in perspective, and are therefore referenced in this report. The TCLP limits for arsenic and selenium are 5 milligrams per liter (mg/L) and 1 mg/L, respectively.

2. TEST PLAN

Two vendors are proposing to use a 5% Portland cement mixture, and a third vendor is using EZ Sorb™ a proprietary material. Ash leaching behavior will be characterized by collecting one 3-point ash composite sample from the North Embayment for laboratory bench-scale testing. Ash from three locations in the North Embayment will be collected with a shovel and composited in a 5 gallon bucket. The ash composite sample will be mixed in the 5 gallon bucket and containerized into twelve 1-liter glass jars for shipment to the laboratory. The dewatering agents (Portland cement and EZ Sorb™) will also be containerized into 6 one liter glass jars for shipment to the laboratory. The laboratory performing the testing will create the test mixtures; 5% mixture of Portland cement and ash, and a 5% mixture of EZ Sorb™ and ash.

Three different types of leaching tests will be performed: (1) batch (shake) tests with varying pH, (2) batch (shake) tests with varying liquid:solid ratio, and (3) column tests. Samples will be submitted to TVA's contracted laboratory for chemical analysis under TVA Chain-of-Custody procedures specified in TVA-KIF-SOP-07 *Sample Labeling, Packing, and Shipping*.

2.1 BATCH (SHAKE) TESTS WITH VARYING PH (METHOD 1313)

Site-specific pH conditions at the Kingston Ash Recovery Project site do not vary over a large range, with a mean of 6.7 and a range of 4.5 to 8.7. Previous leaching tests have shown sensitivity to leaching of arsenic at pH greater than 9. Therefore, leaching characteristics will be tested at a pH of 5.0, 7.0, 8.0, 9.0, 10.0, 11.0, and 12.0. Each sample will be prepared at a single liquid:solid ratio of 10:1. The ash will be tested on an as received basis with moisture content determination performed separately on a small aliquot of the ash. A sample of untreated ash and ash mixed with each vendors dewatering agent will be tested. This equates to three sets of tests, each at seven pH levels. Method blank samples (not containing any solids) will also be tested at the same range of pH levels as the ash mixtures.

Samples will be prepared in accordance with Method 1313. Batch test samples will be placed on a tumbler (shaker) and gently tumbled for 48 hours. The eluate will then be extracted, filtered through 0.45 micron filter, and analyzed at TestAmerica Nashville for the TVA metals analytes and the EPA SW-846 methods specified Table 1.

Table 1. TVA Metals Analyte List

Analyte	SW-846 Method	Analyte	SW-846 Method
Aluminum	6010	Magnesium	6010
Antimony	6020	Manganese	6020
Arsenic	6020	Mercury	7470
Barium	6010	Molybdenum	6020
Beryllium	6020	Nickel	6020
Boron	6010	Potassium	6010
Cadmium	6020	Selenium	6020
Calcium	6010	Silver	6020
Chromium	6020	Sodium	6010
Cobalt	6020	Strontium	6010
Copper	6020	Thallium	6020
Iron	6010	Vanadium	6020
Lead	6020	Zinc	6020

2.2 BATCH (SHAKE) TESTS WITH VARYING LIQUID-SOLID RATIO (METHOD 1316)

Leaching characteristics will be tested over a range of liquid:solid ratios. A total of five liquid:solid ratios will be tested: 0.5, 1, 2, 5, and 10. Unbuffered deionized water will be used as reagent water for each test. A sample of untreated ash and ash mixed with each vendors dewatering agent will be tested. This equates to three sets of tests, each at five liquid:solid ratios. One method blank sample will also be tested.

Placement of materials in the Dredge Cell will likely result in layering of untreated dry ash and lime-treated dry ash. Therefore, an additional set of tests will be conducted on untreated ash using the leachate from each vendors' dewatering agent treated ash batch test. This equates to two additional sets of tests, each at five liquid:solid ratios. The leachate will be produced using the vendors ash and dewatering agent mixtures, unbuffered deionized water as reagent water, a liquid:solid ratio of 10:1, and a 48-hour hold time.

Samples will be prepared in accordance with Method 1316. Batch test samples will be gently tumbled for 48 hours. The eluate will be extracted, filtered through a 0.45 micron filter, and analyzed at TestAmerica Nashville for the TVA metals analytes and the EPA SW-846 methods specified Table 1, Section 2.1.

2.3 COLUMN TESTS (METHOD 1314)

Leaching characteristics of ash from the Kingston Ash Recovery Project site will be tested by passing reagent water (unbuffered deionized water) through prepared columns of ash in an upflow configuration. Untreated ash and ash mixed with each vendors dewatering agent will be tested. An additional set of columns half-filled with untreated ash and half-filled with each vendors' ash and dewatering agent mixture will also be tested, with water passing first through each vendors' ash and dewatering agent mixture. This equates to a total of five tests. The column tests will be conducted in accordance with Method 1314.

The ash will be filtered through a 2 millimeter sieve before being packed into the columns. Each column (5 centimeter inner diameter) will be packed with approximately 600 grams of ash on a dry weight basis. Density of ash in each column will be calculated based on the column volume and dry ash weight. The packed columns will be filled with water for a 24-hour equilibration period, as specified in the procedure. Flow rate through the columns will be set at 1.3 milliliters (mL)/hour using syringe pumps, for a flow of 31.2 mL/day; this rate will be used in order to simulate the flow through the ash in the closed Dredge Cell and Ash Pond. Water will be bubbled with nitrogen before use to remove dissolved oxygen. Samples will be collected every four days, to provide a volume of 125 mL for each sample. This volume gives a liquid:solid ratio of approximately 0.2 (125 mL/600 grams ash). The columns will be run for 40 days, which provides a cumulative liquid:solid ratio of 2.0 and a total of 10 samples taken from each column. A 10 mL aliquot from each sample will be used to measure pH, conductivity, and oxidation-reduction potential. The samples will be filtered through a 0.45 micron filter and put into sample bottles containing nitric acid as a preservative. Samples will be analyzed at TestAmerica Nashville for the TVA metals analytes and the EPA SW-846 methods specified Table 1, Section 2.1.

3. REPORTING

Results of the leaching tests will be presented in a draft and final report. Results of the chemical analysis for metals analyses will require a Level 1 deliverable, a Level 4 deliverable, and EQUIS electronic data deliverable which will be submitted through TVA's standard data reporting process.

4. QUALITY ASSURANCE

The Kingston Ash Recovery Project has developed a comprehensive Quality Assurance Project Plan (QAPP) (TVA 2009, 2010c), which governs the collection, analysis, reporting, and use of environmental data associated with the overall project. The QAPP was prepared in accordance with EPA’s *Guidance for Quality Assurance Project Plans*, EPA QA/G-5. The QAPP has been approved by EPA and the Tennessee Department of Environment and Conservation (TDEC). The Table 2 “cross-walk” summarizes the document location where the task-specific QAPP-required elements may be found.

Table 2. Document Cross-Walk

QAPP Element	Location in QAPP	Location in Test Plan	Standard Operating Procedure (SOP) Location
Data Quality Objectives		§2.0	
Sampling Design		§2.0	
Testing Methods		§3.0	
Sample Collection			TVA-KIF-SOP-04 <i>Soil Sampling</i> TVA-KIF-SOP-20 <i>Bulk Ash/Sediment Homogenization</i> TVA-KIF-SOP-07 <i>Sample Labeling, Packing, and Shipping</i> TVA-KIF-SOP-08 <i>Decontamination of Equipment</i> TVA-KIF-SOP-11 <i>Field Quality Control Sampling</i> TVA-KIF-SOP-18 <i>Management and Implementation of EQUIS Based Chain of Custody</i>
Data Review and Validation	§21.0	§4.0 §5.0	
Assessments and Response Actions	§19.0		

A quality assurance surveillance will be conducted of the bench scale testing to verify procedures are in conformance with this Supplemental Plan. Quality control samples will be submitted for chemical analysis in accordance with the QAPP. Analytical data review will be conducted in accordance with the QAPP; only data verification is to be done as part of this bench-scale testing (no validation is required).

5. SAFETY AND HEALTH

Collection of the ash samples will be conducted in accordance with the TVA Site Wide Safety and Health Plan (TVA 2010d). The job hazard analysis, step-by-step analysis, and pre-job briefing for this specific activity will be completed prior to sample collection. The work will be within the exclusion zone thereby requiring personnel have the appropriate HAZWOPER training. The vendor proposing to use EZ Sorb™ will provide a sample of the material for mixture with the composited ash sample. The 5% Portland cement mixture proposed by the other two contractors will also be mixed at the laboratory using ash and Portland cement provided by TVA.

Sampling equipment will be decontaminated prior to use in accordance with TVA-KIF-SOP-08 *Decontamination of Equipment*. Vehicles and personnel (boots) will be decontaminated by washing with water and visually inspected prior to leaving the site.

6. WASTE MANAGEMENT

No wastes are expected to be generated during sampling other than sanitary wastes. Sample residuals remaining after bench-scale testing are to be returned to the Kingston Ash Recovery Site for disposal with the ash.

7. TRANSPORTATION MANAGEMENT

No wastes or materials will be transported to or from the site during this activity. Sample shipments to and from the laboratory will follow TVA-KIF-SOP-07 *Sample Labeling, Packing, and Shipping*.

8. PROJECT MANAGEMENT

The test program will be overseen by Jim Sells, Project Manager. Sample collection will be directed by Paul Clay, Environmental Project Manager and Sampling Coordinator. Quality assurance will be overseen by Dr. Bill Rogers, Quality Assurance Officer for TVA. Bench-scale testing will be conducted by Paul Pier, TVA, in Muscle Shoals, Alabama. Chemical analytical sampling will be through one of the project's approved analytical laboratories.

The ash leaching tests will be conducted under Work Breakdown Structure (WBS) 01.15.04, River Restoration – Environmental Data Collection. Project staff must verify proper charge codes for labor hours and analytical laboratory testing that align with this WBS. Table 3 presents the anticipated milestone duration and dates for this task.

The projected cost of this testing is \$10,600 analytical and equipment cost and \$31,300 labor cost, for a total of \$41,900.

Table 3. Anticipated Schedule for the River Restoration – Environmental Data Collection

Task	Duration	Milestone (Due Date)
Collect and ship samples (untreated ash)	5 days	07 March 2011
Conduct bench-scale shake tests	21 days	01 April 2011
Conduct chemical analytical testing	20 days	21 April 2011
Prelim Draft Report (Rev. 0)	5 days	26 April 2011
Conduct bench-scale column tests	43 calendar days	04 May 2011
Conduct chemical analytical testing	20 days	24 May 2011
Final Draft Report (Rev. 1)	5 days	29 May 2011
TVA Review	5 days	08 June 2011
Final Report (Rev. 2)	5 days	15 June 2011
Submit to EPA/TDEC	1 day	16 June 2011

9. REFERENCES

TVA 2009. December 18, 2009 (EPA approval). *Quality Assurance Project Plan for the Tennessee Valley Authority Kingston Ash Recovery Project, TVA-KIF-QAPP*. Prepared by Environmental Standards, Inc.

TVA 2010a. June 1, 2010 (EPA approval). *Kingston Ash Recovery Project Non-Time-Critical Removal Action for the River System, Sampling and Analysis Plan*. Document No. EPA-AO-021. Prepared by Jacobs Engineering Group Inc.

TVA 2010b. June 9, 2010 (EPA approval). *Kingston Ash Recovery Project Non-Time-Critical Removal Action for the River System, Ash Leaching Test Plan*. Document No. RAWP-072. Prepared by Jacobs Engineering Group Inc.

TVA 2010c. October 12, 2010 (EPA approval). *Quality Assurance Project Plan for the Tennessee Valley Authority Kingston Ash Recovery Project, TVA-KIF-QAPP*. Revised August 2010. Prepared by Environmental Standards, Inc.

TVA 2010d. October 21, 2010 (EPA approval). *Site Wide Safety and Health Plan for the TVA Kingston Fossil Plant Ash Release Response, Revision 5*. Document No. EPA-AO-003. Prepared by Jacobs Engineering Group Inc.

Attachment 1

Data Quality Objectives Table

Data Quality Objectives Table

DQO Step	Ash Deposits
State the Problem	Control of moisture content in the ash is critical to the successful dry ash stacking operations during closure of the Dredge Cell and Ash Pond. Ash-related constituents, such as arsenic, may be mobilized as a result of infiltration of precipitation and may be transported downgradient in the groundwater to the Emory River, where exposure by humans or ecological receptors may occur. Addition of Portland cement or EZ Sorb™ may alter the mobilization potential.
Identify the Decision	The principal study question is: Does the flux of ash-related constituents from groundwater to the Emory River result in unacceptable risk to the human or ecological receptors? The correlating study question is: Does this predicted flux change as a result of adding Portland cement or EZ Sorb™ to the ash?
Identify Inputs to the Decision	Site-specific pH conditions at the Kingston Ash Recovery Project site do not vary over a large range, with a mean of 6.7 and a range of 4.5 to 8.7. Previous leaching tests have shown sensitivity to leaching of arsenic at pH greater than 9. Therefore, leaching characteristics will be tested at a pH of 5.0, 7.0, 8.0, 9.0, 10.0, 11.0, and 12.0. Each sample will be prepared at a single liquid-solid ratio of 10:1. Additional tests will be performed using A total of five liquid-solid ratios will be tested: 0.5, 1, 2, 5, and 10.
Define the Study Boundaries	The spatial boundaries of the study are a 3-composite sample of ash from the North Embayment. The temporal boundaries for the fate and transport modeling include the time following closure out to 100 years.
Develop the Analytic Approach	Three different types of leaching tests will be performed: (1) batch (shake) tests with varying pH (EPA Method 1313), (2) batch (shake) tests with varying liquid-solid ratio (EPA Method 1316), and (3) column tests (EPA Method 1314).
Specify Limits on Decision Errors	There are decisions to be made as a direct outcome of this testing. The purpose of the test is to understand the leaching behavior of the inorganic constituents in ash and as such there are no limits on decision errors.
Optimize the Design	This is a follow-on to a previous series of similar tests. The difference being the drying agent(s) being tested. The test design was optimized in the previous study.