Tennessee Valley Authority
Regulatory Submittal for Kingston Fossil Plant

Documents submitted:

Ash Leaching Test Plan

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Document No. RAWP-072

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

Ash Leaching Test Plan

Prepared by:
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for the Tennessee Valley Authority

Revision	Description	Date
00	Draft for TVA, EPA, and TDEC review	24 May 2010
01	Final	04 June 2010

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List of Acronyms

EPA	U.S. Environmental Protection Agency
HAZWOPER	Hazardous Waste Operations and Emergency Response
ICP-AES	Inductivity Coupled Plasma Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
mL	milliliter
mm	millimeter
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
WBS	work breakdown structure

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1. SITE BACKGROUND

This plan describes the sampling, bench-scale testing, and analysis for testing the leaching behavior of ash, lime-treated ash, and cement-treated ash at the Kingston Ash Recovery Project site.

Groundwater modeling will be conducted as part of the River System Sampling and Analysis Plan using the Visual MODFLOW suite of coupled numerical groundwater flow and transport codes to analyze the groundwater transport of ash-related constituents to the Watts Bar reservoir. An important aspect of transport model development involves representation of changes in groundwater chemical characteristics, as ash deposits are continually leached by infiltrating precipitation and/or lateral groundwater flow. Mathematical relationships (e.g., an exponential decay function) will be used to describe ash constituent leaching behavior. In order to better define the leaching functions for each modeled constituent, leaching tests are to be performed on ash samples. Results of the leaching tests will be used to quantify constituent concentration variations as a function of leaching from the ash.

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. Addition of approximately 6% lime to the ash has been considered as one method to assist in controlling the moisture content and drying out the ash. Results of the leaching tests will be used to quantify constituent concentration variations as a function of leaching from the lime-treated ash.

In 2009, TVA conducted a bench-scale study of lime-treated ash to determine whether lime treatment could unexpectedly release metals from the ash. Results of standard Toxicity Characteristic Leaching Procedure (TCLP) testing of the lime-treated ash were compared to results of testing using a deionized water extract. Test specimens were tumbled for the standard TCLP time, temperature, and liquid:solid ratio of 20:1. Although detection limits were higher for the TCLP dataset, results did not show any appreciable difference between the TCLP results and deionized water extract results. The results did not quantify the leaching functions for lime-treated ash.

Closure of the Dredge Cell and Ash Pond will also involve construction of a soil-cement foundation stabilization zone around the landfill perimeter. Lateral groundwater flow through the cement-treated stabilization zone could affect the leaching functions of the ash-related constituents. Therefore, results of the leaching tests will be used to quantify constituent concentration variations as a function of leaching from the cement-treated ash monolith.

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 lime or cement 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 lime or cement 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 those areas where ash may be disposed onsite, namely within the Dredge Cell or Ash Pond. The temporal boundaries for the fate and transport modeling include the time following closure until peak concentrations are predicted by the model to occur in groundwater.

Ash leaching behavior is to be characterized to support groundwater transport modeling by collecting two ash composite samples for laboratory bench-scale testing. Four different types of leaching tests will be done: (1) batch (shake) tests with varying pH, (2) batch (shake) tests with varying liquid:solid ratio, (3) column tests, and (4) monolith tests.

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. 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 lime-treated ash; however, the leaching characteristics should be evaluated relative to the specific environmental (pH and redox) conditions expected for the Kingston site.

2.1 TEST PLAN

2.1.1 Batch (Shake) Tests with Varying pH (Method 1313)

Site-specific pH conditions at the Kingston site do not vary over a large range, with a mean of 6.7 and a range of 4.5 to 8.7. Therefore, leaching characteristics will be tested at a pH of 5.0, 7.0, and 9.0. Each sample will be prepared at a single liquid:solid ratio of 10:1. A composite sample of both untreated ash and ash mixed with lime (at 6% by weight) will be tested. Method blank samples (not containing any solids) will also be tested, at a pH of 5.0, 7.0, and 9.0.

Placement of materials in the Dredge Cell will likely result in layering of untreated dry ash and lime-treated dry ash. Therefore, a third set of tests will be conducted on untreated ash using the leachate from a lime-treated ash batch test. The leachate will be produced using lime-treated ash, un-buffered deionized water as reagent water, a liquid:solid ratio of 10:1, and a 48-hour hold time. The leachate will then be used as the reagent water in the untreated ash batch test, at full strength (no dilution) and at 2x, 4x, 6x, 8x, and 10x dilution. The pH of the reagent water will therefore vary based on this dilution. This dilution series test using leachate from the lime-treated ash batch test will be conducted first to ensure that pH 9.0 sufficiently brackets the upper end of the pH range.

Samples will be prepared in accordance with Method 1313. Samples of ash will be sieved through a 2 millimeter (mm) sieve to remove the larger-grained materials. A mortar and pestle may be used to break up any clumps of material, but samples should not be ground so as not to change the grain size characteristics of the material. Batch tests will be conducted in covered vessels (e.g., covered Erlenmeyer flasks or capped centrifuge tubes) to limit evaporation of liquid.

Batch test samples will be placed on a tumbler (shaker) and gently tumbled for 48 hours. A sufficient volume (approximately 5 milliliter [mL]) of clear, unpreserved supernatant will be decanted into a clean container for measurement of pH, specific conductivity, and oxidation-reduction potential. Accuracy of pH measurements is important, so the pH meters should be calibrated shortly before measurements begin and checked against appropriate pH standards following completion of measurements to ensure confidence in the readings. The eluate will then be extracted by centrifugation, preserved with nitric acid, and submitted for Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analysis for arsenic and selenium. In addition, one random sample will be submitted for Inductivity Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) analysis and anion analysis (SO_4^{2-}, Cl^-, PO_4^{3-}, and CO_3^{2-}). To determine whether arsenic is in the arsenate or arsenite form, which could influence sorption behavior, one sample from the untreated ash batch test and one sample from the lime-treated batch test will be analyzed for arsenic speciation.

2.1.2 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. Un-buffered deionized water will be used as reagent water for each test. A composite sample of both ash and ash mixed with lime (at 6% by weight) will be tested. 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, a third set of tests will be conducted on untreated ash using the leachate from the lime-treated ash column tests described below. The leachate will be produced using lime-treated ash, un-buffered deionized water as reagent water, a liquid:solid ratio of 10:1, and a 48-hour hold time. The pH of the leachate will not be adjusted, but will be measured prior to conducting the test and again following test completion.

Samples will be prepared in accordance with Method 1316; the procedure will be similar to that described for batch tests with varying pH. Ash samples will be sieved through a 2mm sieve. Batch test samples will be gently tumbled for 48 hours. Supernatant will be decanted for measurement of pH, specific conductivity, and oxidation-reduction potential. The eluate will then be extracted by centrifugation, preserved with nitric acid, and submitted for ICP-MS analysis for arsenic and selenium.

2.1.3 Column Tests (Method 1314)

Leaching characteristics will be tested by passing reagent water through prepared columns of ash and lime-treated ash in an upflow configuration. The flow rate through the columns will be set to simulate the flow through the ash in the Dredge Cell and Ash Pond, approximately 15 mL/day through the column. Leachate fractions will be collected for each 0.2 liquid:solid ratio eluted, up to a cumulative 2.0 liquid:solid ratio. Un-buffered deionized water will be used as reagent water for each test.

A composite sample of both ash and ash mixed with lime (at 6% by weight) will be tested. Samples will be prepared at a compacted density of approximately 90% of standard Proctor density as determined by ASTM D-698, which has been specified for the ash stacking in the Dredge Cell. The column will be loaded with at least 600 grams of solids. Quality control will include analysis of one leachate duplicate sample taken from each test for analytical validation.

Placement of materials in the Dredge Cell will likely result in layering of untreated dry ash and lime-treated dry ash. Therefore, a third set of tests will be conducted using a column half-filled with ash and half-filled with lime-treated ash (at 6% by weight). The reagent water will be the same as for the other column tests.

Samples will be prepared and tests conducted generally in accordance with Method 1314. Ash samples will be sieved through a 2 mm sieve. Flow through the column (15 mL/day) will be much slower than flow rates in the Method 1314 procedure, so as to be representative of the flow rate through the ash in the Dredge Cell and Ash Pond. Therefore, the test will be discontinued after a 2.0 liquid:solid ratio, rather than a 10.0 liquid:solid ratio as in the Method 1314. Total duration of each test is estimated at 43 days.

2.1.4 Monolith Tests (Method 1315)

Construction of the foundation stabilization zone around the perimeter of the Dredge Cell and Ash Pond will involve deep soil mixing of cement with the subsurface ash and native soil materials. Therefore, a monolith test will be conducted on core samples taken from the soil-cement columns constructed during

the upcoming Deep Soil Mixing Pilot Test. Core samples are expected to be collected for testing in late July 2010, after a 28-day cure time.

Samples will be prepared and tests conducted in accordance with Method 1315 using intact cores. Tests will be conducted on two cores (taken at different depths within the subsurface ash interval). Un-buffered deionized water will be used as reagent water for each test.

3. REPORTING

Because the column tests will be conducted over a long duration, the results of the leaching tests will be presented in two draft reports. A preliminary draft report will present the results of the batch tests. The final draft report will also include the results of the column tests and monolith tests.

4. QUALITY ASSURANCE

The Kingston Ash Recovery Project has developed a comprehensive Quality Assurance Project Plan (QAPP), 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 following "cross-walk" summarizes the document location where the task-specific QAPP-required elements may be found.

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 *Soil Sampling* TVA-KIF-SOP-20 *Bulk Ash Homogenization* TVA-KIF-SOP-07 *Sample Labeling, Packing, and Shipping* TVA-KIF-SOP-08 *Decontamination of Equipment*
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 Test Plan. Analytical data review and validation 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*. 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. Collection of the soil-cement monolith cores will be by others under the Deep-Soil Mixing Pilot Test task.

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 Bruce Haas, 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.

The projected cost of this testing is $7,500 analytical cost and $24,500 labor cost, for a total of $32,000.

The anticipated schedule for this task is as follows:

Task	Duration	Milestone (Due Date)
Readiness Review	1 day	14 June 2010
Collect samples (ash and lime)	5 days	21 June 2010
Conduct bench-scale shake tests	10 days	6 July 2010
Conduct chemical analytical testing	20 days	3 August 2010
Prelim Draft Report (Rev. 0)	5 days	10 August 2010
Conduct bench-scale column tests	43 calendar days	3 August 2010
Conduct chemical analytical testing	20 days	31 August 2010
Final Draft Report (Rev. 1)	5 days	7 September 2010
TVA Review	5 days	14 September 2010
Final Report (Rev. 2)	5 days	21 September 2010
Submit to EPA/TDEC	1 day	22 September 2010

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