Kingston Ash Release – Potential Exposure Pathways and Associated Environmental Investigations

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Image taken June 2007

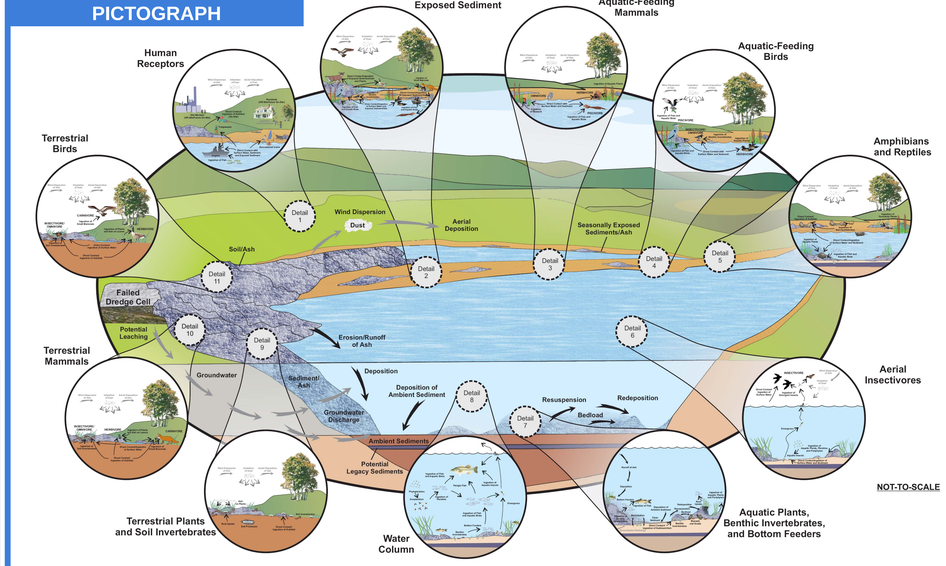
ABSTRACT

The release of fly ash at the Tennessee Valley Authority (TVA) Kingston Fossil Plant (KIF) on December 22, 2008 discharged approximately 5.4 million cubic yards of coal slurry into the adjacent aquatic and terrestrial systems. The initial response focused on public protection and stabilization of the released ash, but rapidly evolved to include comprehensive monitoring of ambient media and ecological receptors. Metals including arsenic and selenium are the primary constituents of potential concern for fly ash.

The KIF is located on the Emory River near the confluence of the Clinch and Tennessee Rivers. This portion of the Tennessee River Valley is bounded by ridges and impounded by Watts Bar Dam. The reach of Watts Bar Reservoir at the KIF transitions from the upstream riverine reaches of the Emory River and the Clinch River to the more lacustrine conditions found in the impounded portions of the Clinch River and Emory River backwaters of Watts Bar Reservoir. This multi-use reservoir supports a diversity of aquatic and terrestrial wildlife. The size and complexity of the potentially affected ecosystems necessitates a comprehensive environmental sampling and monitoring program, which TVA has implemented in cooperation with numerous federal, state, and academic organizations.

A Conceptual Site Model (CSM) was developed to summarize and illustrate the ecological receptors and potential exposure pathways associated with the Kingston fly ash release. The direct exposure pathways being evaluated at this site include exposures to ash as soil, as ash sediment, sediment pore water, groundwater discharging to surface water, surface water, and seasonally exposed sediment. Dietary exposures are also a concern for some ash-related metals, including arsenic and selenium. The ecological receptors for which bioaccumulation and food web pathways are being studied at this site include fish, benthos, emergent insects, piscivorous birds and mammals, aerial-feeding insectivores, herbivorous birds, omnivorous mammals, amphibians, reptiles, and others. The conceptual site model is used to organize and evaluate the numerous field and laboratory studies being performed by TVA and others at the site, many of which presented in this special poster session.

CONCEPTUAL SITE MODEL: PICTOGRAPH



CONCEPTUAL SITE MODEL: FLOWCHART

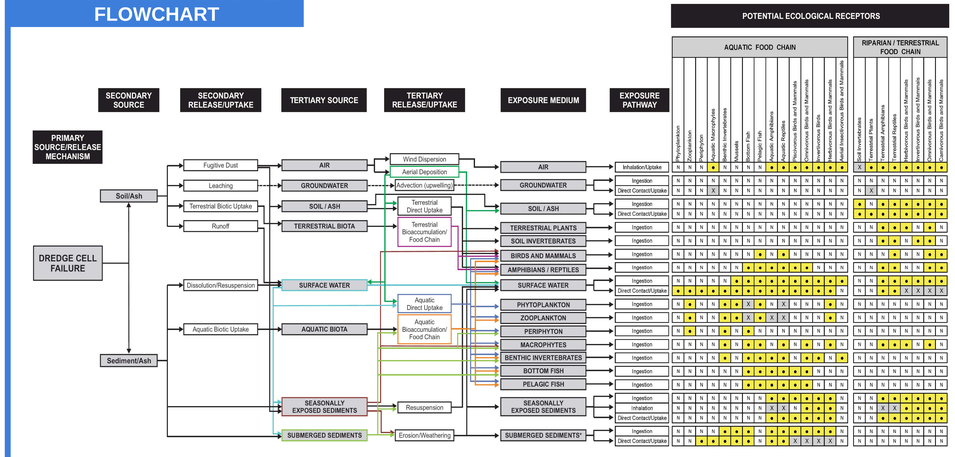


Image taken August 14, 2009

SETAC 2009 POSTERS

		Biota Studies
1	Carriker, N., W. Rogers, D. Yankee, R. Vitale, J. Gable, R. Forman, P. Lee, M. Houck, P. Clay, and R. Crawford. 2009. Kingston Ash Release – Initial Water and Sediment Monitoring Response and Subsequent Refinements.	NA
2	Zeller, C. and L. Francendese. 2009. Regulatory Framework – TVA Kingston Ash Recovery Effort.	NA
3	Jones, D., S. Young, T. Henry, and N. Carriker. 2009. Kingston Ash Release – Potential Exposure Pathways and the Associated Environmental Investigations.	NA
4	Sherrard, R. and N. Carriker. 2009. A Multi-phased Toxicity Study for Evaluating Potential Risks of Kingston Fossil Plant Fly Ash Exposures to Benthic and Aquatic Biota.	TX1-TX7, TX10-TX13
5	Baker, T., K. Lakin, D. Lowery, and J. Smith. 2009. The effects of fly ash release from the TVA Kingston Steam Plant on fish and benthic macroinvertebrates: community effects and contaminant exposure.	FS1, FS4-FS6, FS10, IS1-IS4
6	Adams, M., T. Baker, and M. Greeley. 2009. Fish health and bioaccumulation studies for evaluating fly ash exposure and effects in aquatic ecosystems.	FS4, FS5, FS8
7	Henry, T.H. and W.A. Hopkins. 2009. An overview of ecological studies on wildlife potentially impacted by the Kingston ash spill.	BS1, RS1, RS3
8	Henry, T.H. and W.A. Hopkins. 2009. Initial assessment of trace element exposure in insectivorous birds nesting near the Kingston ash spill.	BS2
9	Wang, N., J. Kunz, C. Ivey, W. Brumbaugh, C. Ingersoll, J. Steevens, and S. Alexander. 2009. Evaluation of potential toxicity of fly ash released to the Emory River, TN, to benthic invertebrates in whole-sediment and elutriate exposures.	TX8
10	Stanley, J., A. Kennedy, A. Bednar, M. Chappell, J. Seiter, K. Willett, C. Thornton, A. Wells, D. Averett, S. Hendrix, and J. Steevens. 2009. Investigating TVA Kingston Fossil Plant coal fly ash toxicity to larval and juvenile fathead minnows using extended elutriate bioassays.	TX9
11	Chappell, M., J. Seiter, A. Bednar, J. Stanley, A. Kennedy, D. Averett, and J. Steevens. 2009. Geochemical speciation of selenium and other heavy metals in coal fly ash after prolonged submersion in the Emory River at the Kingston Fossil Plant site.	NA
12	Sidle, R.C., K.C. Seramur, C. M. Babyak, A. H. Pruitt, and K. B. Gassaway. 2009. Distribution and chemical characterization of fly ash bottom sediments.	NA
13	Ruhl, L., A. Vengosh, G.S. Dwyer, A. Deonarine, and H. Hsu-Kim. 2009. Water quality monitoring of the Emory and Clinch River: the impact of the Tennessee Valley Authority coal ash spill, Kingston, TN.	NA

FIELD INVESTIGATIONS

Fish Studies

FS1: TVA - Reservoir Fish Assemblage Index Survey
Electrofishing, gill nets; 3 sites; community metrics, fish condition
Sampled January 2009; Annual fall sampling

FS2: TDEC - Fish Tissue Concentration Study
LMB, CHC, blue catfish (fillets; n=5); 4 sites; bioaccumulation, health bioindicators
Sampled January-April 2009; Annual monitoring proposed

FS3: TVA,ORNL - TDEC Requested Whole Fish Analysis - Spring 2009
LMB, redear (whole; n=4); 1 site; bioaccumulation
Sampled March 2009

FS4: TVA,ORNL - Fish Health & Bioaccumulation - Spring
LMB, bluegill, CHC (fillets, organs; n=6-8); 4 sites; bioaccumulation, health bioindicators
Sampled January-April 2009; Annual monitoring proposed

FS5: TVA,ORNL - Fish Health & Bioaccumulation - Fall
LMB, bluegill, CHC (fillets, organs; n=6-8); 5 sites; bioaccumulation, health bioindicators
Sampled September 2009; Annual monitoring proposed

FS6: TVA,ORNL - Whole Forage Fish Analysis
Gizzard shad (whole; n=30); 5 sites; bioaccumulation
Sampled June 2009; Expanded annual monitoring proposed

FS7: TVA,ORNL,TDEC - Stilling Pond Fish Tissue Concentration Study
Bluegill, carp, green sunfish (fillets, organs, whole; n=3-5); 1 site; bioaccumulation, health and reproduction bioindicators
Sampled April 2009

FS8: TVA,ORNL - Reproductive Study of Female Fish - Spring
LMB, bluegill, white crappie (fillets, organs; n=6-8); 5 sites; bioaccumulation, health and reproduction bioindicators
Sampled April 2009; Annual monitoring proposed

Fish Studies (continued)

FS9: TVA,ORNL - Kingston East Embayment Fish Removal
Gizzard shad, redear sunfish, bluegill, LMB (whole, fillets; n=1-10 fish per species); 1 site; bioaccumulation
Sampled June 2009

FS10: TVA,ORNL - Reservoir Spring Sportfish Survey
Black bass spp., crappie; electrofishing (n=12, 30 minutes), 2 sites; population metrics, fish condition
Sampled Spring 2009; Annual monitoring proposed

FS11: TWRA - Fish Tissue Concentration Study
Black crappie (whole; n=5); 4 sites; bioaccumulation
Sampled April 2009

FS12: TWRA - Fish Tissue Concentration Study
CHC (fillets, organs; n=5); 2 sites; bioaccumulation, reproduction bioindicators
Sampled June 2009

Wildlife Studies

WS1: TVA,UT - Mammal Tissue Concentration Study
Raccoon, muskrat (blood, tissue; n=10); 2 sites; bioaccumulation, health bioindicators
Sampled August-September, 2009; Annual monitoring proposed

Bird Studies

BS1: TVA - Piscivore and Herbivore Egg Concentration Study
Osprey, great blue heron, Canada goose (n=1 per nest); 1-6 sites; bioaccumulation
Sampled April 2009; Annual monitoring proposed

BS2: TVA,VA Tech - Insectivorous Bird Tissue Concentration Study
Tree swallow (contents of egg with no shell, whole-body nestling; n=10); 5 sites; bioaccumulation
Sampled April-August 2009; Annual monitoring proposed

Reptile and Amphibian Studies

RS1: TVA,VA Tech,TWRA - Turtle Tissue Concentration Study
Snapping turtle, musk turtle (blood; n=10); 5 sites; bioaccumulation
Sampled August-September, 2009; Annual monitoring proposed

RS2: TWRA - Turtle Tissue Concentration Study
Snapping turtle (whole; n=3); 2 sites and multi ref site; bioaccumulation
Sampled August-September, 2009; Annual monitoring proposed

RS3: TVA - Amphibian Tissue Concentration Study
Upland chorus frog, northern cricket frog, American toad (whole; n=10); 4 sites and 1 ref site; bioaccumulation
Sampled March-April 2009; Annual monitoring proposed

Invertebrate Studies

IS1: TVA,ORNL - Mayfly Larvae Collection
Hexagenia bilineata (n=4-6 composites); 6 sites; bioaccumulation
Sampled Spring/Summer 2009; Annual monitoring proposed

IS2: TVA,ORNL - Emerging Adult Mayflies
Hexagenia bilineata (n=2-4 composites); 6 sites; bioaccumulation
Sampled Summer 2009; Annual monitoring proposed

IS3: TVA, ORNL - Snail Tissue Concentration Study
Pleurocera canaliculatum (n=4); 5 sites; bioaccumulaton
August 2009

IS4: TVA - Assessment of Benthic Macroinvertebrate Community Survey
Cross-channel transects (n=10 grabs per transect); 11 sites; community metrics
Sampled January 2009; Scheduled sampling December 2009; Annual monitoring proposed

Notes

LMB - Largemouth bass

CHC - Channel catfish

LABORATORY BIOASSAYS

Sediment

TX1: TVA - Vibracore Whole Ash Bioassays: Mussel Tissue Concentration Study
Corbicula fluminea; 2 sites; 28-d bioaccumulation
VB 1 and VB 2 sampled March 2009; VB 3 and VB 4 sampled June 2009

TX2: TVA - Vibracore Whole Ash Bioassays: Benthic Invertebrate Tissue Concentration Study
Lumbriculus variegatus; 2 sites; 4-d bioaccumulation
VB 1 and VB 2 sampled March 2009; VB 3 and VB 4 sampled June 2009

TX3: TVA - Vibracore Whole Ash Bioassays: Amphipod Toxicity Test
Hyalella azteca; 2 sites; 10-d growth and survival
VB 1 and VB 2 sampled March 2009; VB 3 and VB 4 sampled June 2009

TX4: TVA - Vibracore Whole Ash Bioassays: Mussel Toxicity Test
Freshwater Juvenile Mussel; 2 sites; 5d, 10-d survival
VB 1 and VB 2 sampled March 2009; VB 3 and VB 4 sampled June 2009

TX5: TVA - Vibracore Ash Elutriate Bioassays: Mussel Toxicity Test
Freshwater Juvenile Mussel; 2 sites; 10-d survival
VB 1 and VB 2 sampled March 2009; VB 3 and VB 4 sampled June 2009

TX6: TVA - Vibracore Ash Elutriate Bioassays: Zooplankton Toxicity Test
Ceriodaphnia dubia; 1 site; 96-h survival
VB 1 and VB 2 sampled March 2009; VB 3 and VB 4 sampled June 2009

TX7: TVA - Vibracore Ash Elutriate Bioassays: Fish Toxicity Test
Pimephales promelas; 1 site; 96-h survival
VB 1 and VB 2 sampled March 2009; VB 3 and VB 4 sampled June 2009

Sediment (continued)

TX8: USGS,USFWS - Benthic Invertebrate Studies, Whole-Sediment and Elutriate Exposures
Hyalella azteca, Villosa iris, Lampsilis fasciola, Chironomus dilutes; 10-d, 28-d survival
Sampled Winter/Spring 2009

TX9: ERDC - Extended Elutriate Bioassays, Larval and Juvenile Fathead Minnows
Pimephales promelas; 10-d bioaccumulation (juveniles only), health bioindicators
Sampled Summer 2009

Surface Water

TX10: TVA - Emory River Plume Bioassays: Zooplankton Toxicity Test
Ceriodaphnia dubia; 1 site; 7-d survival, reproduction; 96-h survival
Sampled weekly or biweekly during dredging

TX11: TVA - Emory River Plume Bioassays: Fish Toxicity Test
Pimephales promelas; 1 site; 7-d survival, reproduction; 96-h survival
Sampled weekly or biweekly during dredging

TX12: TVA - Outfall 001 Bioassays: Zooplankton Toxicity Test
Ceriodaphnia dubia; 1 site; 7-d survival, reproduction; 96-h survival
Sampled weekly or biweekly during dredging

TX13: TVA - Outfall 001 Bioassays: Fish Toxicity Test
Pimephales promelas; 1 site; 7-d survival, reproduction; 96-h survival
Sampled weekly or biweekly during dredging

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