Long-term Sediment Toxicity Bioassays

Kingston Ecological Investigations: Results-to-Date

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http://www.flyash.info/
Background

• Dredge cell failed December 22, 2008
• 5.4 million cubic yards (cy) wet fly ash and bottom ash released
• Immediately Affected: Emory River, adjacent tributaries, sloughs, shorelines
• Upriver - ERM 5.75, downriver - TRM 564
• Emory River dredging: March 20, 2009 - May 29, 2010
• About 500,000 cy ash remain in the river system
Time-Critical Toxicity Monitoring Objectives

• Assess dredging/dewatering effects on surface water biota
  ➢ Elutriate Toxicity – 3 species 24 tests
  ➢ Dredge Plume Toxicity – 2 species 46 tests
  ➢ Stilling Pond Discharge Toxicity – 2 species 48 tests

• Characterize effects of ash on benthic biota
  ➢ Whole Sediment Toxicity – 5 species 18 tests
Time-Critical Toxicity Monitoring Results

- Assess dredging/dewatering effects on surface water biota
  - Elutriate – 17 of 24 tests – no toxicity
  - Dredge Plume – 46 tests – no toxicity
  - Stilling Pond Discharge – 47 of 48 tests – no toxicity

- Characterize effects of ash on benthic biota
  - Whole Sediment – 14 of 18 tests – no toxicity
Time-Critical Toxicity Monitoring

Conclusions

• Dredging/dewatering does not result in toxicity to surface water biota
• Only 1 benthic species (*Hyalella azteca*) exposed to ash from the Emory River consistently exhibits effects from exposures to fly ash
• Laboratory observations of *H. azteca* exposures indicate possible physical effects
ASH UNLIKE
NATURAL
SEDIMENTS

- Ash compacts in sample and exposure containers
- Porewater surfaces during sample storage
- Homogenization is problematic
- Laboratory benthic species unable to burrow in test exposures
Resin Study Conclusions

• Resin continually decreases Sb, As, Se more than other metals in ash over time
• Resin treatment of ash eliminates toxicity for *H. azteca* growth but not survival
• Resin decreases partitioning of Sb, As, Mo, Se, V to porewater and overlying water
• Resin treatment of porewater eliminates toxicity for *H. azteca* growth and survival
Example of Exposure-Response Curves

Growth

Survival

Concentration or Percent Ash

Percent Adverse Effect
Long-term Exposure Test Species

Ceriodaphnia dubia

Chironomus dilutus

Hyalella azteca
Long-term Exposure Sediment Toxicity Study Design

H. azteca
(8 site samples)
10-day Survival & Growth (screening)
28-day Survival & Growth Test (≈ 7 days) (definitive)

C. tentans
(8 site samples)
10-day Survival & Growth (screening)
PLC Survival, Growth, & Emergence Test (definitive)

C. dubia
(8 site samples)
10-day Survival & Growth (screening)
3-brood Survival & Reproduction Test (7 days) (definitive)
Long-term Exposure
Toxicity Endpoints

• Inhibition Concentration of 25% (IC$_{25}$)
• *C. dubia* – 3-brood survival and reproduction
• *H. azteca* – 28-d survival, growth, biomass
• *C. dilutus* – 20-d survival, growth, biomass and partial life-cycle survival and emergence
• Growth = total weight surviving / # surviving
• Biomass = total weight surviving / # initial
Timeline and Endpoints: *H. azteca & C. dilutus*
Screening and Definitive Tests

![Timeline Diagram](image-url)

- **H. azteca**
  - Exposure (d)
  - Screening Test Survival & Growth
  - Definitive Test Survival & Growth

- **C. dilutus**
  - Screening Test Survival & Growth
  - Definitive Test Survival & Growth; Emergence Begins

Definitive Test Survival & Emergence
Sampling-Transportation-Processing Logistics
Long-term Exposure Toxicity Results

*Ceriodaphnia dubia*

- Clinch River – no effects on survival or reproduction
- Emory River – no effects on survival or reproduction
Emory River *Hyalella azteca* IC$_{25}$ Values (%)

- 28-d Survival
- 28-d Growth
- 28-d Biomass

**Y-axis:** Values (%)

**X-axis:** ERM 1.0, ERM 2.5, ERM 3.5, ERM 5.5

- **ERM 1.0:** Blue bars for 28-d Survival, Red bars for 28-d Growth, Green bars for 28-d Biomass
- **ERM 2.5:** Blue bars for 28-d Survival, Red bars for 28-d Growth, Green bars for 28-d Biomass
- **ERM 3.5:** Blue bars for 28-d Survival, Red bars for 28-d Growth, Green bars for 28-d Biomass
- **ERM 5.5:** Blue bars for 28-d Survival, Red bars for 28-d Growth, Green bars for 28-d Biomass
Emory River *Chironomus dilutus* IC\textsubscript{25} Values (%)
Long-term Exposure
Conclusions

- Surface water invertebrates inhabiting the sediment-water interface are not at risk
- Minor effects observed in Clinch River exposures not attributed to ash
- *H. azteca* and *C. dilutus* exposures to Emory River sediments with > 40-50% ash suggest moderate risks
Long-term Monitoring Plan
Sediment Toxicity Sampling

- Sample collection: 2013 & 2017 (concurrent with benthic community sampling)
- ERM 6.0 (reference)
- ERM 1.0 (known ash deposits)
- CRM 8.0 (reference)
- CRM 3.0 (known ash deposits)
- Overbank areas only with suitable habitat
Long-term Monitoring Plan
Laboratory Toxicity Testing

- *H. azteca* 10-day Survival & Growth Test
- Definitive (0, 20, 40, 60, 80, 100%)
- River reference sample results compared to laboratory sediment sample results
- ERM 1.0 and CRM 3.0 sample results compared to river reference sample results
- River water used in all tests