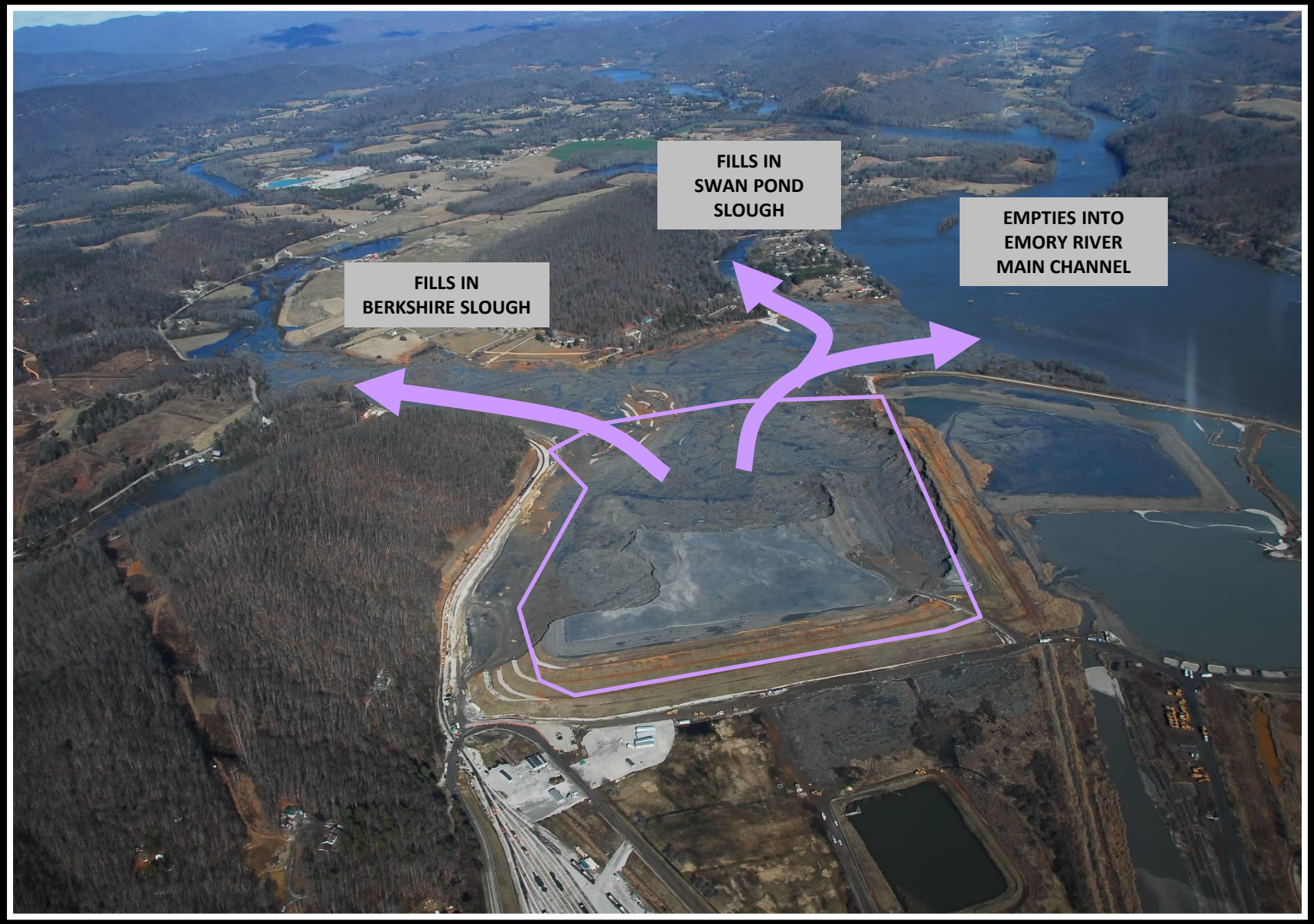
# TVA Kingston Ash Recovery Project
# Roane County, TN
# Project Completion Meeting
# June 4, 2015

# Dredge Cell Area Pre-Spill

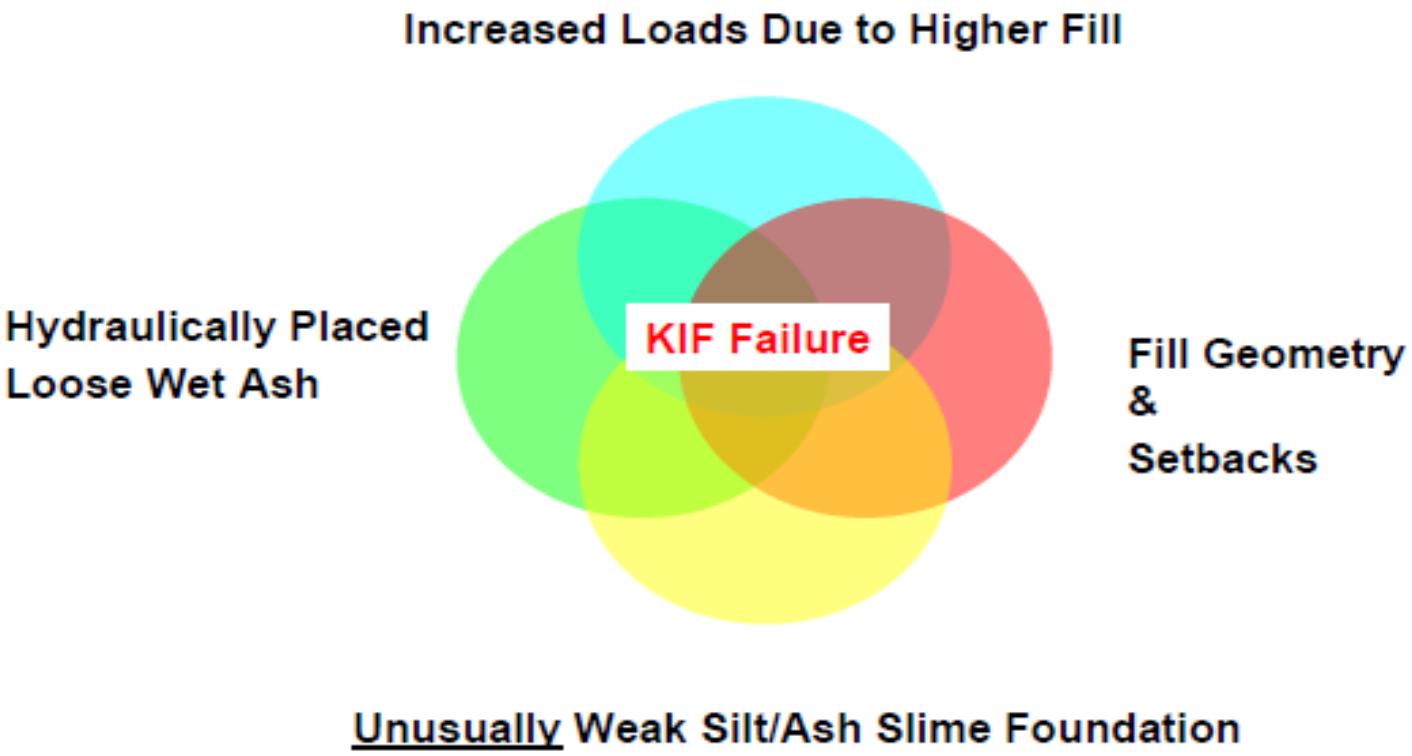
# Spill Progression – 12/22/08



# Dredge Cell Area Post-Spill

# Root Cause Analysis

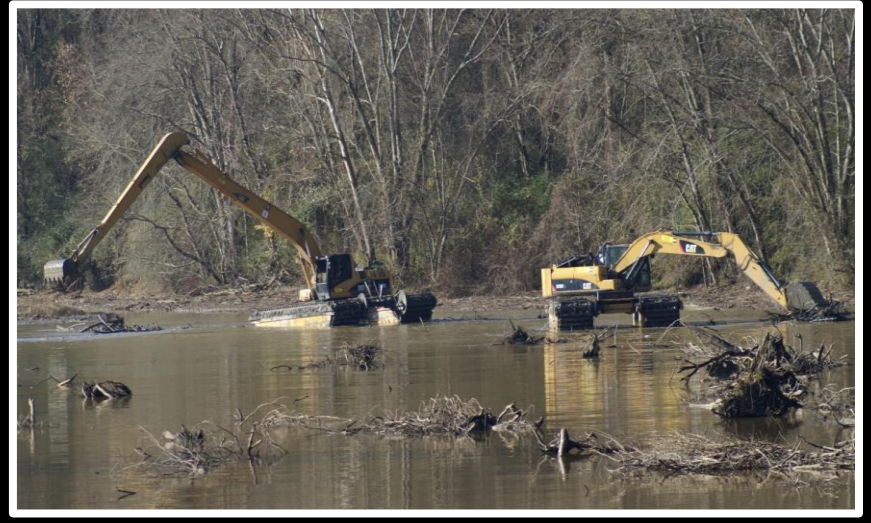
## Kingston Dredge Cell Failure Conditions



# CERCLA Removal Action Strategy
## (May 12, 2009 AOC)

- **Phase 1 (Time-Critical Action Removal)**
  - 3.5 million CYS removed (excavated and dredged)
  - 4.0 million tons disposed at Perry County, AL (completed 12/01/10)
  - May 29, 2010 Emory River reopened
- **Phase 2 (Non-Time Critical Action Removal)**
  - 2.3 million CYS removed from north and middle embayment
  - Consolidate in reinforced, on-site disposal area
  - Construct robust subsurface perimeter containment system to withstand earthquake loads
- **Phase 3 (Residual Ash Study)**
  - River ecosystem and human health risk assessments
  - Long-term monitoring (5-year reviews)

# Mechanical + Hydraulic Dredging



# Ash Processing

# Loading and Disposal

# Phase 2 Work Description

- Excavate Ash (Armada of Yellow Iron)
  - Pan & Tractor Scrapers
  - Excavators/ar-tic dump trucks
- Short-Term Storage
  - Dry to Optimum Moisture Content
  - Lime (Wet, Winter Months)
- Long-Term Storage in Dredge Cell
  - Placed in 1 foot lifts
  - Compacted to 90% proctor
  - In-situ density/Piezos/Inclinometers
  - Final Cap & Closure
- Perimeter Containment System
- Perimeter Air & IH Monitoring
- Storm Water Mgmt & Monitoring
- Health & Safety Program

# Mechanical Excavation


- **North Embayment**
  - 1, 010,000 million CYs excavated
  - November 2010 – November 2011 (13 months)
- **Middle Embayment**
  - 1,059,000 million CYs excavated
  - December 2011 – June 2013 (17 months)
- **Sediment Basin/Dike 2**
  - 224,000 Cys excavated
- **Production Rates**
  - Average: 2,600-5,600 CYs/Day
  - Max: 10,200 CYs/Day
- **Excavation Outside of Cell Finished in Late June 2013**
  - 2.3 million cubic yards
  - Minor cleaned out pass needed

# Ash Stacking

- **Volumes Placed (Compacted)**
- Dredge Cell = 1,488,000 CYs
- Lateral Expansion = 1,189,000 CYs
- Ash Pond = 918,000 CYs
- Wall Spoils = 475,000 CYs
- Total Volume ≈ 4,000,000 CYs
- Completed July 2014 (≈ 4 yrs)

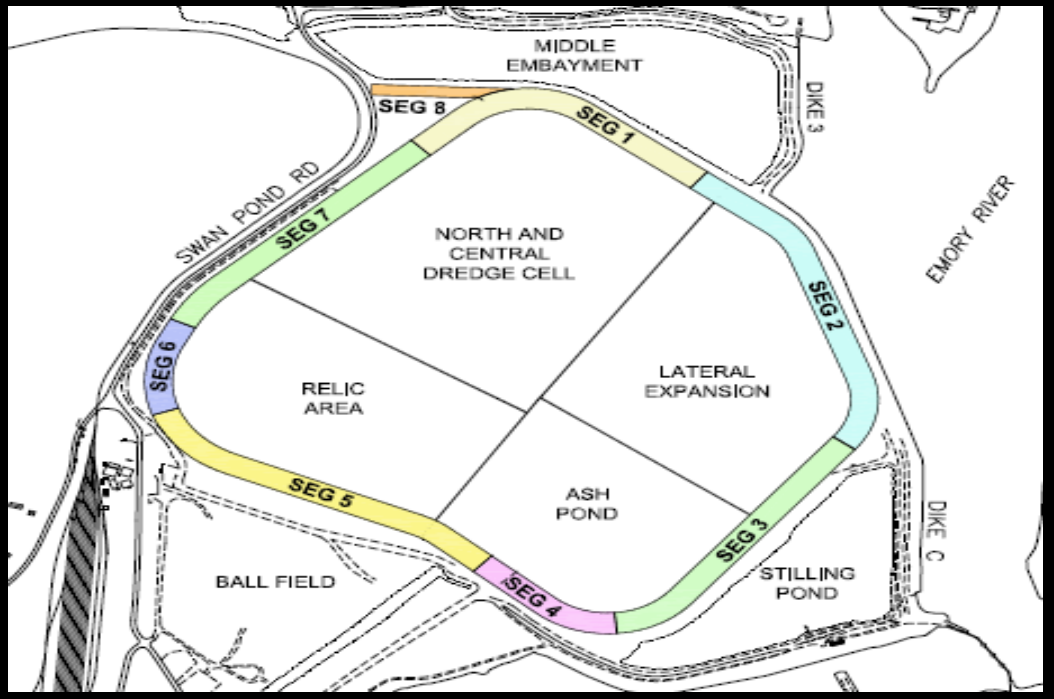
# Perimeter Wall Stabilization

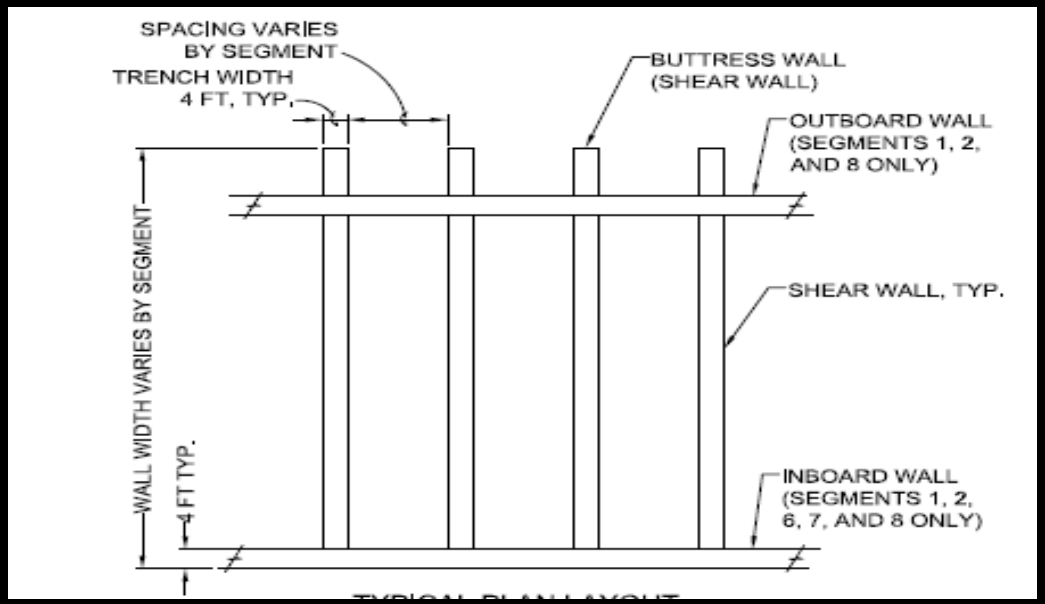
- Design based on 3-D Seismic Model (FLAC)
  - 6.0 earthquake on East TN fault
  - 7.6 earthquake on New Madrid fault
- ≈12,000 linear feet of cell perimeter
- 45-75 feet BGS/Keyed 2-7 ft into bedrock
- Target Average UCS = 200 to 265 psi
- Slurry Recipe = 22% blast furnace slag + 3% bentonite + 0.5% Portland + Water
- 1250 excavator/4'wide bucket with teeth
- Productivity: 540 – 1,130 CY/day
- NEW wall  100% complete 08/06/13



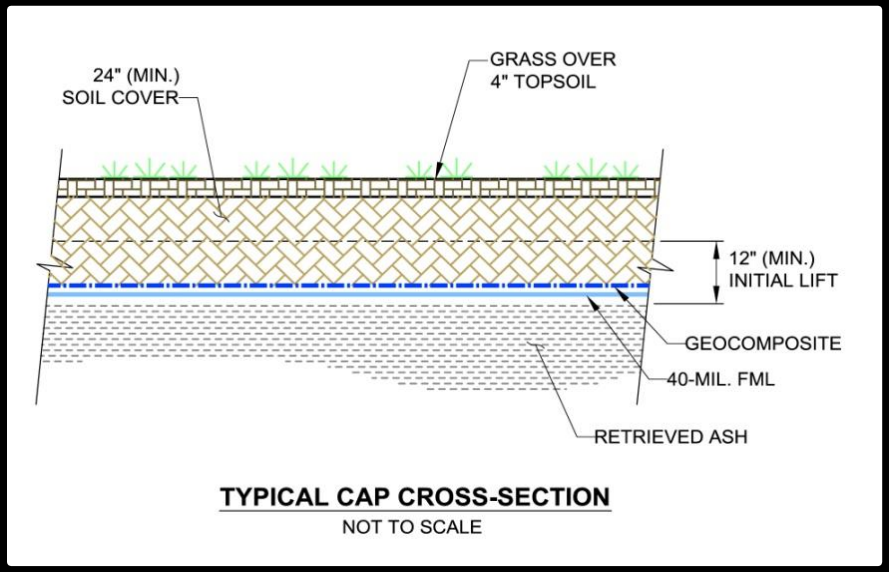
# Perimeter Wall Stabilization

- QA/QC for uniformity & strength
  - 20 vertical miles of cores
- 18% of wall required mitigation
  - 5,490 linear feet of adjacent wall panel
  - 3,275 pressure grout columns
- Rock buttress on outside of wall
  - Layers of sand, gravel, stone rip rap
  - 2,050 linear feet along Middle Embayment
- Earthen-berm around perimeter
  - 12 inch sand layer
  - Compacted clay borrow material
- PWS completed February 2014
  - Including repairs + buttress+earthern berm
  - 69,000 linear feet of slurry trench



# Cap and Cover

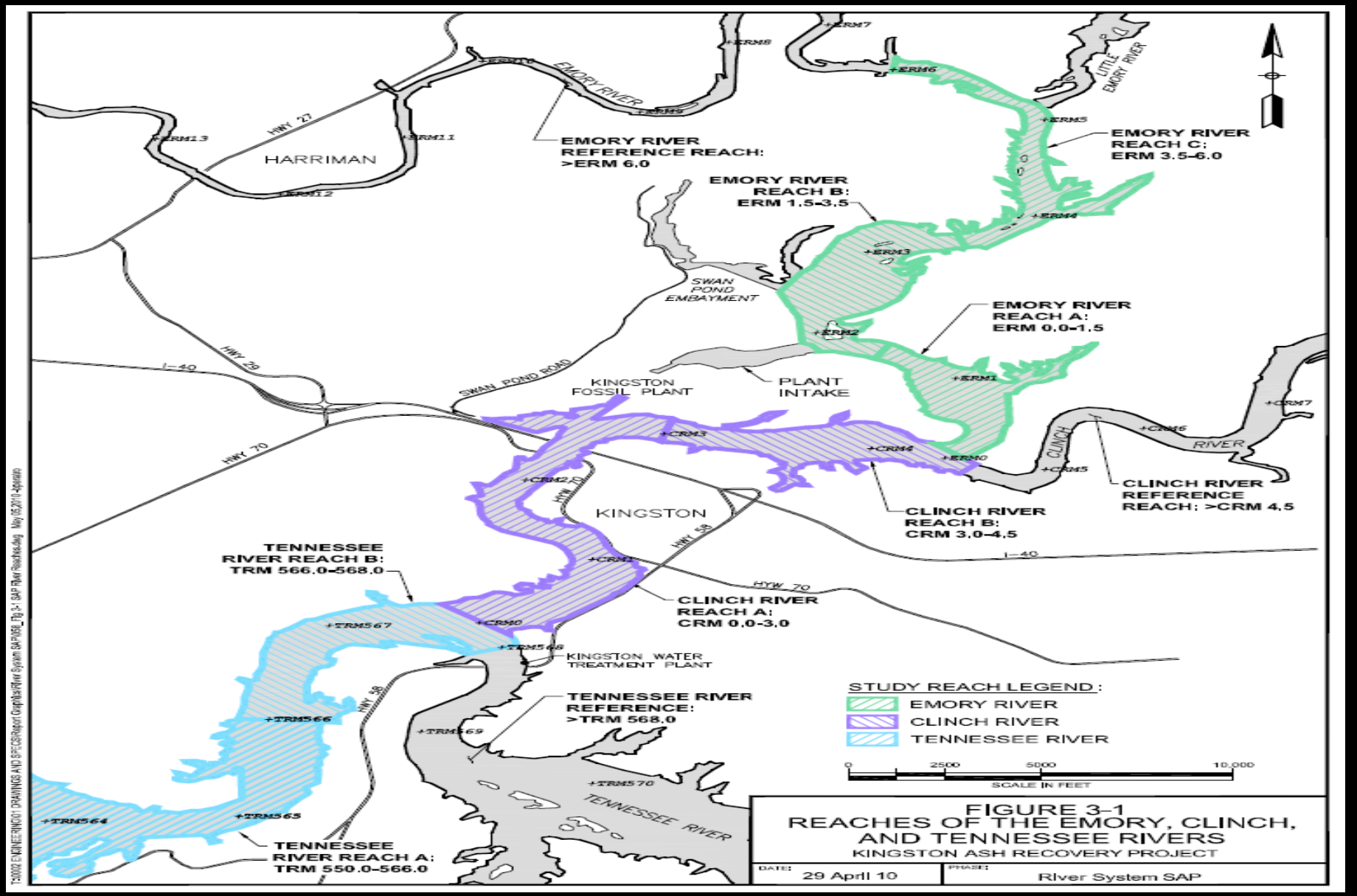



# Cap and Cover



NOV 18 2014

# Phase 3 – River System SAP



# Sampling & Analysis Plan – June 2010

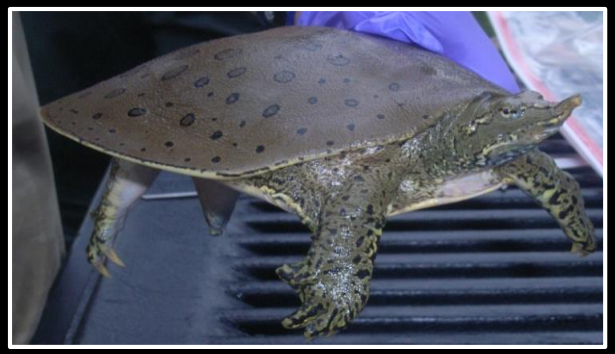
- 2 year, $40M ecological study within CERCLA Eco Risk Framework
- >16,000 samples collected; >400,000 analyses
- Multiple State/Federal Agencies (TDEC, TWRA, USGS, USACE, ORNL, USFWS) and 10 Universities (NGOs)

ABIOTIC

- Nature & Extent of Sediment/Ash
  - Residual ash/submerged/seasonally exposed
  - 2 Dimensional Fate/Transport Modeling
- Surface Water
- Groundwater/Aquifer Testing/MODFLOW
- Sediment Porewater & Bioassays

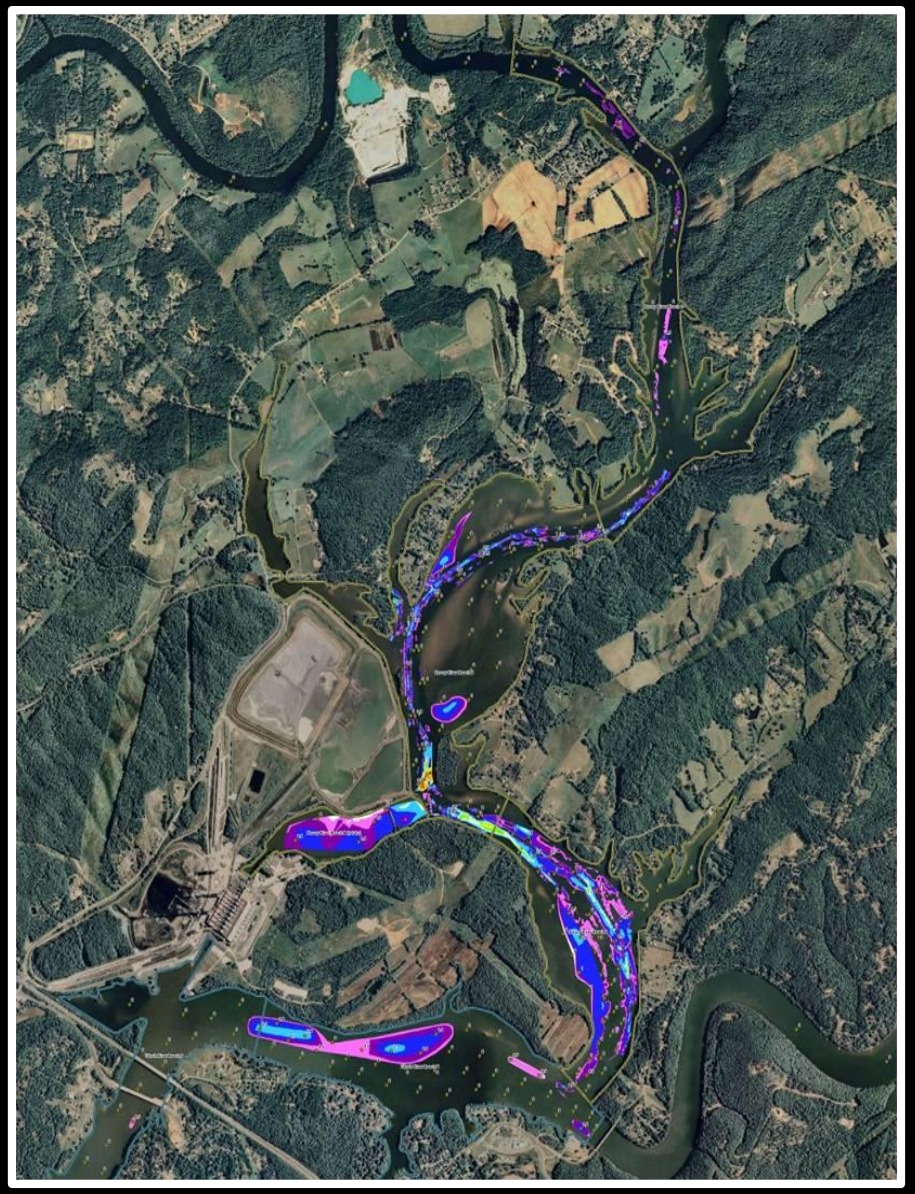
BIOTIC

- Fish (bass/catfish/blue gill/ gizz shad/crappie/redear sun)
- Birds (Heron/Osprey/Tree Swallows/Canada Goose)
- Amphibs (Spring Peeper/Upland Chorus/American Toad)
- Turtles (Musk/Snappers/Softshell)
- Benthic Invertebrates (Growth/Survival & Community Structure)
- Racoons
- Aquatic Vegetation & Periphyton
- Snails and Mayflies



# Phase 3 River System Findings

- ≈ 510,000 CYs of residual ash dispersed over 200 acres
- Co-mingled with DOE legacy contaminants (CS-137/Hg/PCBs)
- System is Net Depositional
  - 1 to 5 feet accumulation over 30 years
  - Natural mixing/burial expected to reach sediment cleanup goals in 10 to 15 years
- Human Health Risks Acceptable
  - Confirmed need for pre-existing fish consumption advisories
- Moderate to Low Ecological Risks
  - Limited to Laboratory Sediment Toxicity tests for *H. Azteca* and *C. Dilutus* (survival/growth)
  - SE & AS accumulation Larval/Adult Mayflies
  - Potential food chain risks for birds that prey on those bugs (killdeer/tree swallows)
  - Benthic abundance and diversity similar at all study sites

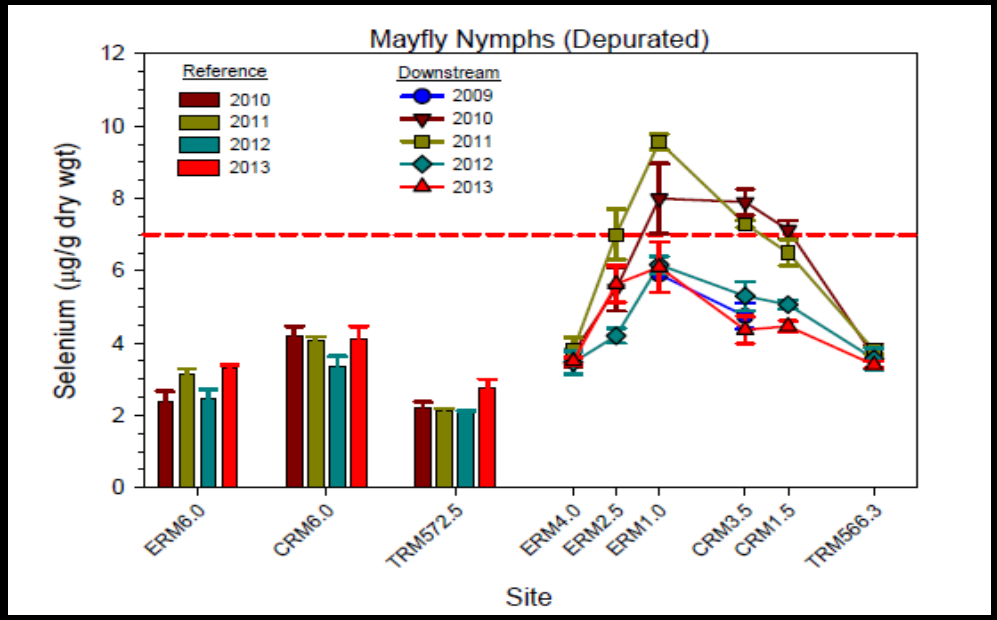


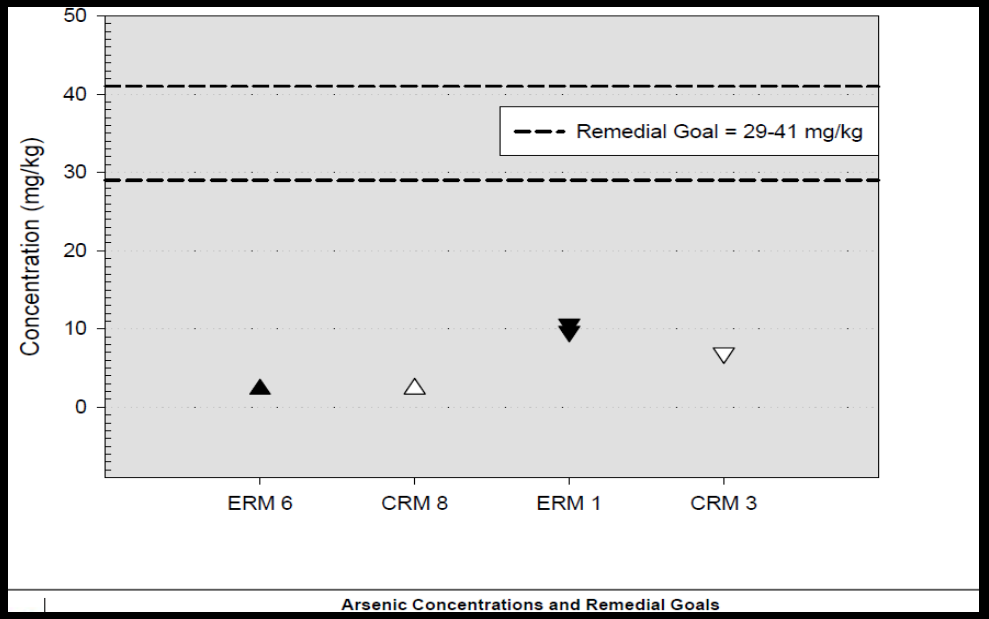
# 2014 River System Monitoring Summary

| Sample Task | Sample Point | Sample Frequency | Analytical |
|---|---|---|---|
| **Bathymetry and Sediment Transport Modeling** | Re-run model for storm events >110,000 cfs as needed | | Modeling |
| **Ash Deposit Characterization**<br>(Sampling to support sediment transport modeling) | As needed for confirmation of depositional areas after >110,000 cfs storm events. Sampling at the direction of Steve Scott (ERDC). | | Ash thickness<br>% ash (offsite lab)<br>Grain size distibution<br>Metals (As and Se only) |
| **Sediment Contaminant Monitoring**<br>Discrete, co-located sediment samples.<br>10 points per transect, co-located with each benthic community sample. | ERM 1.0<br>ERM 0.7 | 10 samples/transect; two transects (where suitable benthic invertebrate substrate is present) | % ash (offsite lab) |
| **Sediment Contaminant Monitoring**<br>Composite sediment samples. Multiple ponar samples per transect area. (left, center, right - where possible of upper 6" of sediment) focused on areas with suitable benthic habitat. | ERM 1.0<br>ERM 0.7 | Up to 3 samples/transect; two transects | % ash (offsite lab)<br>Grain Size Distibution<br>Metals (As and Se only) |
| **Benthic Invertebrate Community Sampling**<br>Benthic invertebrate population abundance and diversity. 10 discrete points per transect. | ERM 1.0<br>ERM 0.7 | 10 samples/transect; two transects | Population abundance and diversity |
| **Benthic Invertebrate Bioaccumulation**<br>Mayfly nymphs (depurated and non-depurated) composited at 3 points per transect (right, center, left). | ERM 1.0 | 3 samples/transect; one transect | Metals (TVA list of 13 metals) |
| **Benthic Invertebrate Bioaccumulation**<br>Mayfly adults composited at 3 points per transect (right, center, left) of each male and female and imagos and subimagos. | ERM 1.0 | Up to 12 samples/transect<br>(3 samples/transect of each; male imago, male subimago, female imago, and female subimago); one transect | Metals (TVA list of 13 metals) |
| **Aerial-feeding Insectivores Bioaccumulation**<br>Tree swallow monitoring at two locations (35 boxes at each location). | ERM 1.0<br>TRM 572 | 25 egg samples/site; two locations<br><br>Reproductive competence: clutch size, hatching & fledgling success | Metals (TVA list of 13 metals)<br><br>Field Observations |
| **Fish Bioaccumulation Monitoring**<br>Collection of 6 female of each species per site. Test fillets, ovaries, and liver. | ERM 1.0 | 6 females of each species; 1 site (analysis of fillets, ovaries, and livers) | Metals (TVA list of 13 metals) |

# Long Term Monitoring

- 5 Years of monitoring indicate river ecosystem has returned to “pre-spill” conditions (vs. the 10 to 15 year time frame predicted by model)
- Fish health, tree swallows, mayflies, sediment concentrations & toxicity similar to reference stations
- Annual river monitoring thru 2017 Five Year Review
- Monitoring of Groundwater and Instrumentation in Ash Landfill
- O&M of Ash Landfill



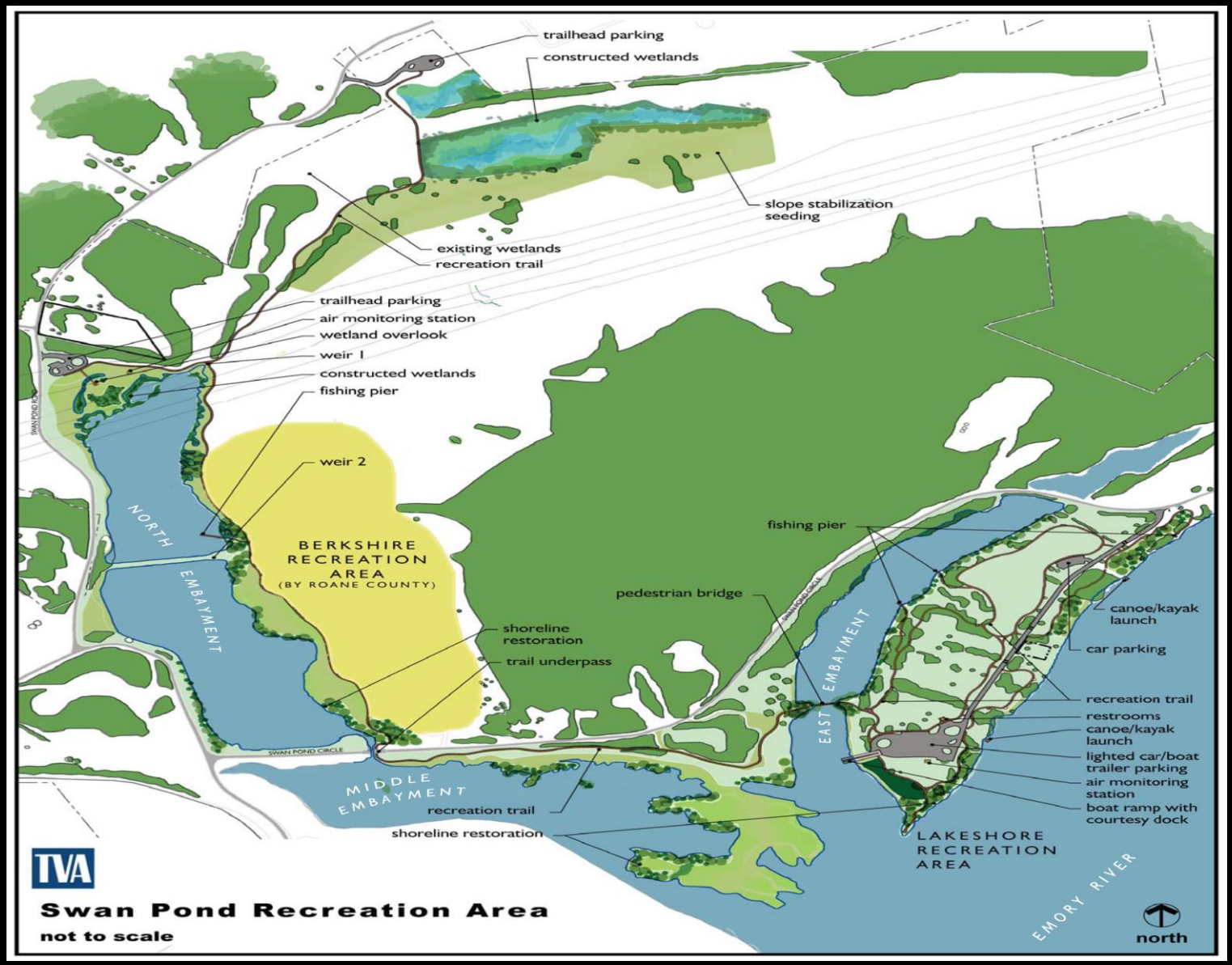
# Community Involvement

- $43 Million to Roane County Economic Development Foundation
- $4 Million Swan Pond Circle Bridge
- Community Outreach Center
- Project specific web sites (184,000 hits)
- 6 River System (Phase 3) Workshops at Roane State CC
- Lakeshore Park (32 acres)
- Roane County Multi-use Sports Complex (60 acres)
- Roane County EMS/Volunteer Fire Department (10 acres)
- 50+ Public Meetings/100+ Site Tours
- 400+ Community Updates
- $50,000 to Roane County Community Advisory Group
- $500,000 of surplus material to Roane County
- $350,000 for repaving Swan Pond Road/Circle

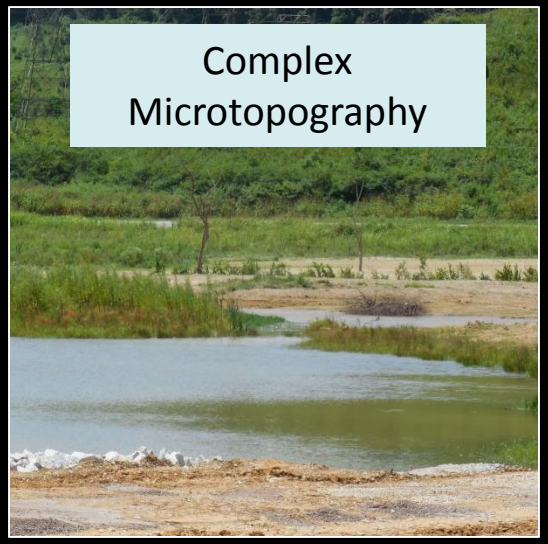
# Project Costs Highlights

- Time Critical Removal Action (Phase 1 Dredging)
  - $597.6 Million
    - $290.8 Million (≈50%) on Ash Dredging & Disposal
- Non Time Critical Removal Actions (Phase 2/3)
  - $537.7 Million
    - $43 Million for Ash Stacking
    - $13 Million for Ash Processing/Stacking
    - $130 Million for Perimeter Wall
    - $34 Million for Ash Landfill
- Total Project Costs
  - $1.134 Billion
  - ≈$44 Million under $1.178 Billion Projection

# Swan Pond Embayment Restoration



# Ecological Restoration







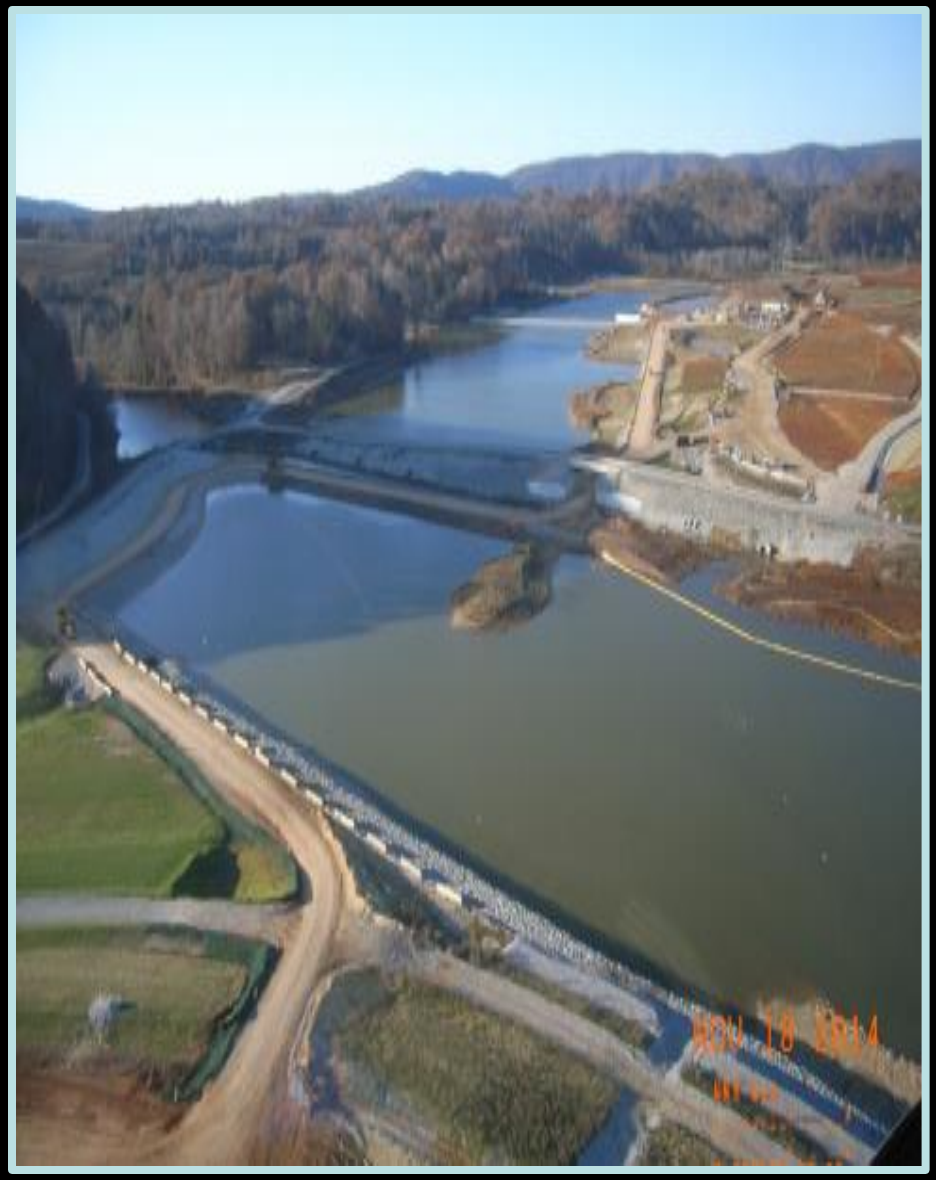

# Aerial Photos

12/28/2008

11/03/2014

# North & Middle Embayment

THEN



NOW

# East Embayment

THEN

NOW

# East Embayment

THEN

NOW

# Middle Embayment

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# Swan Pond Road Intersection

THEN

NOW

# Questions & Answers

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- THANK YOU!