TVA – Kingston Fossil Plant and Bull Run Fossil Plant

Presentation to TDEC

December 5, 2007

TVA

Geosyntec consultants

Meeting Agenda

- Kingston Fossil Plant (KIF) – update on Swan Pond Road dike improvements
- KIF Peninsula Site – update on permit application
- Bull Run Fossil Plant (BRF) – dry ash stack permit status
- BRF – Gypsum Stack: alternative bottom drainage layer
- KIF – Dredge Cell Lateral Expansion: alternative bottom drainage layer

TVA

Geosyntec consultants


KIF - Aerial View of the Site
Seepage Area (2006)
Cell II
Existing Dredge Cells
Cell III
Cell I

Swan Pond Road Dike – Seepage Issues (2006)

- Excessive seepage and piping observed near toe of dike on November 1, 2006 (two locations, similar location to 2005)
- Decision made to lower water levels in Ash Pond, conduct dye test, install "temporary patch"
- The patch coupled with weather improvements minimized the immediate threat
- Suspended Dredging Operations
- Lowered Water Table

TVA

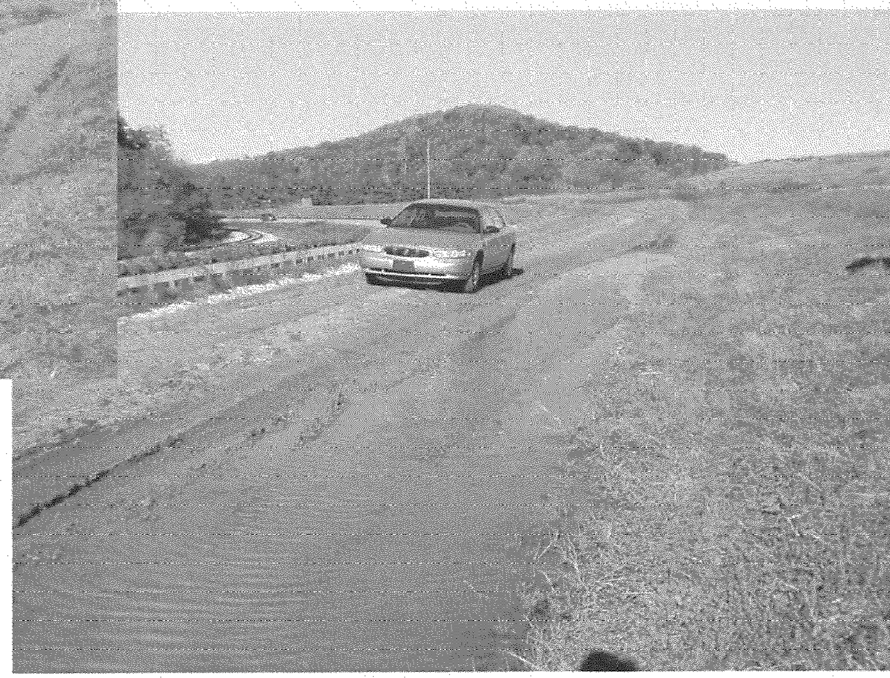
Geosyntec consultants

TVA-00010613

Swan Pond Road Dike – Seepage Issues (2006)

- Geosyntec performed an inspection on 2 November 2006 and concurred with the actions taken by TVA
- TVA initiated inspections every 2-hours to monitor the situation
- Geosyntec commenced planning for additional investigations and short-term repairs
- In the seep areas, water was observed to be flowing below the geonet drainage layer; water was also observed to be flowing through the geonet
- Surface water was observed on benches
- Underdrains currently discharge to benches

Situation Analysis (cont.)



Photos taken November 2, 2006
(dry weather conditions)
Note water on benches in
general vicinity of seeps

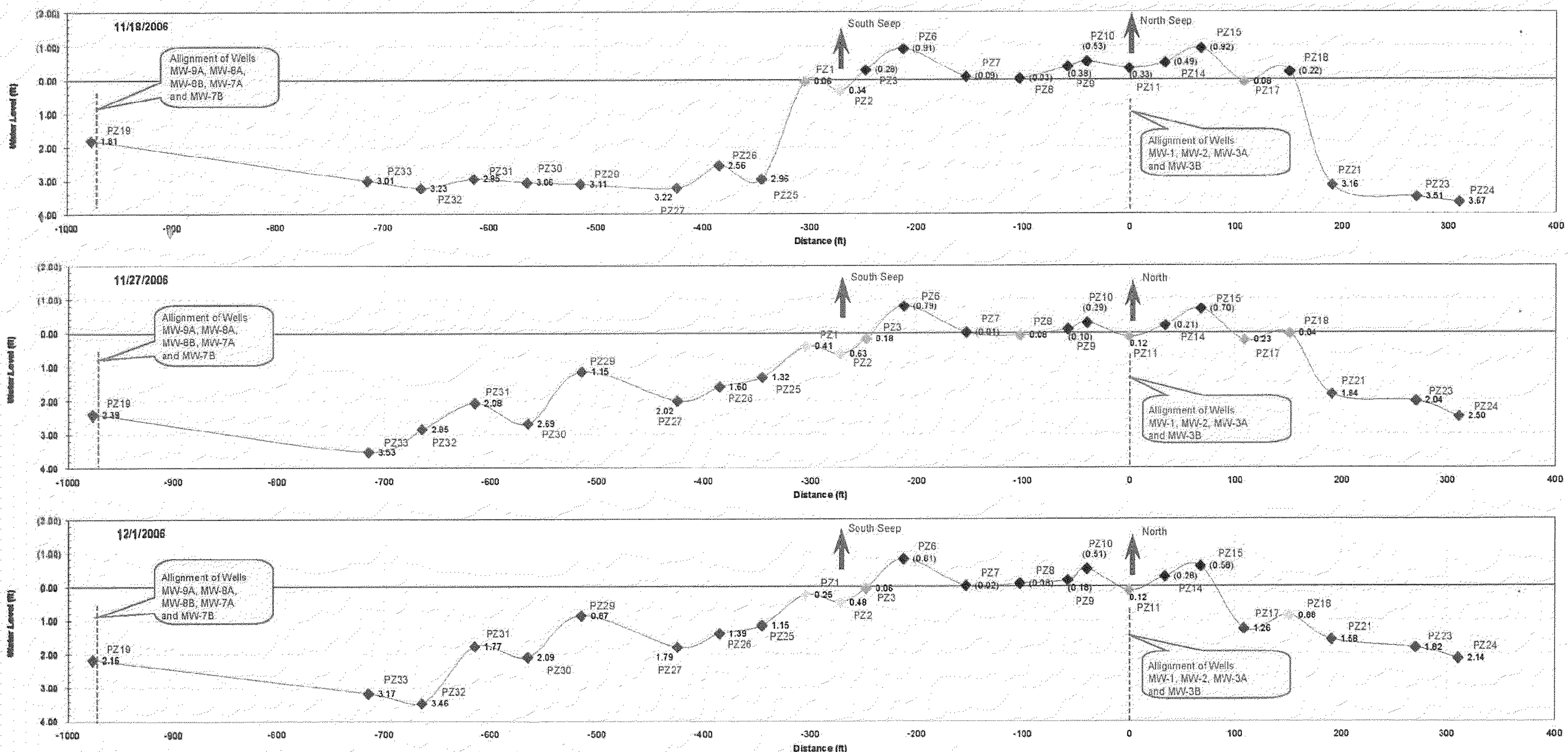
Investigation Results

- Installed 33 drive-point piezometers along the toe of the slope
- Measured water levels and developed a water level profile
- Identified the area of concern based on the water levels that are within a foot or less of the ground surface
- In some instances water levels in piezometers were above the ground surface

TVA

Geosyntec consultants

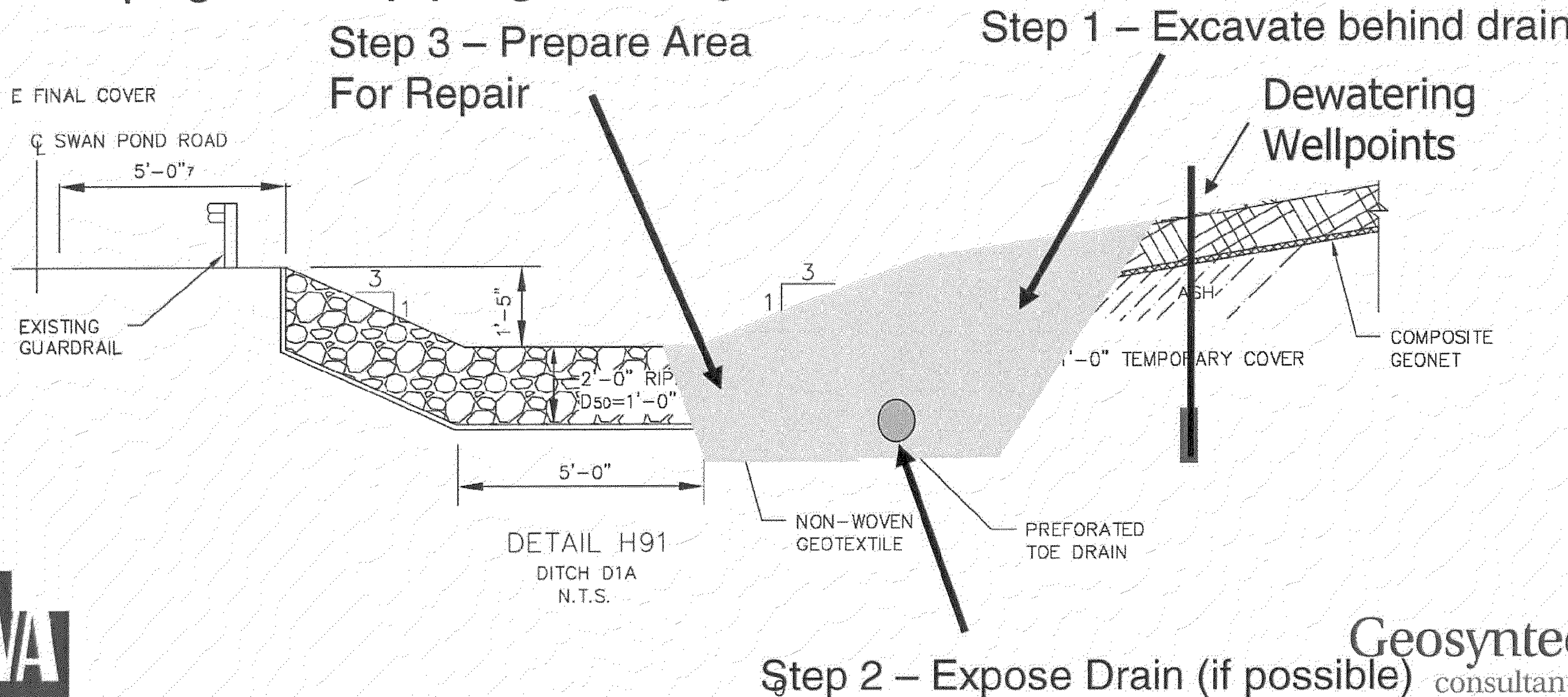
Investigation Results (cont.)



TVA-00010617

Investigation Results (cont.)

- Developed an intrusive investigation plan that could be coupled with temporary or permanent repair activities
- Identified southern seep area as the preferred location for the intrusive investigation due to continued observation of seepage, ash piping and high water levels

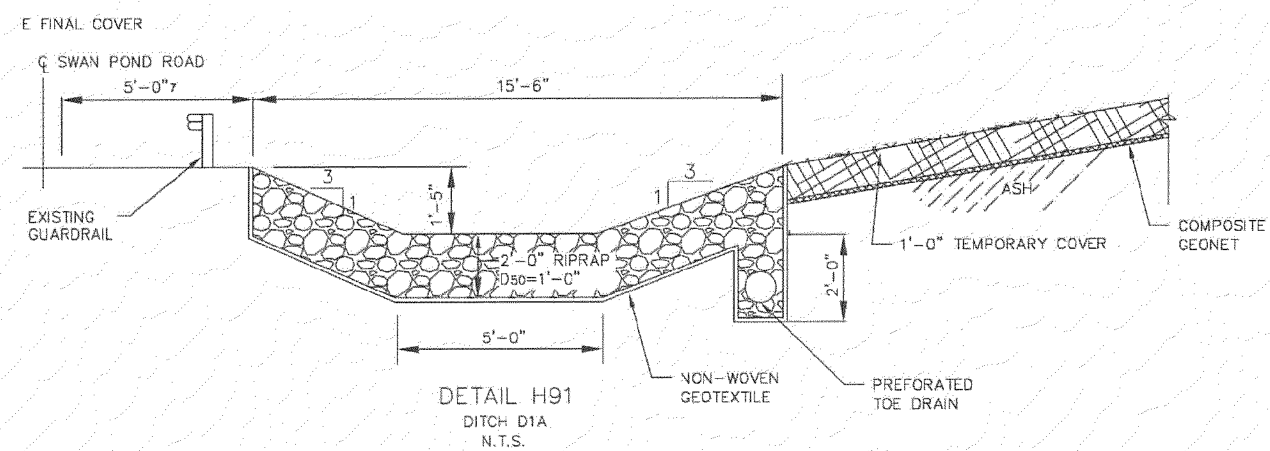


TVA

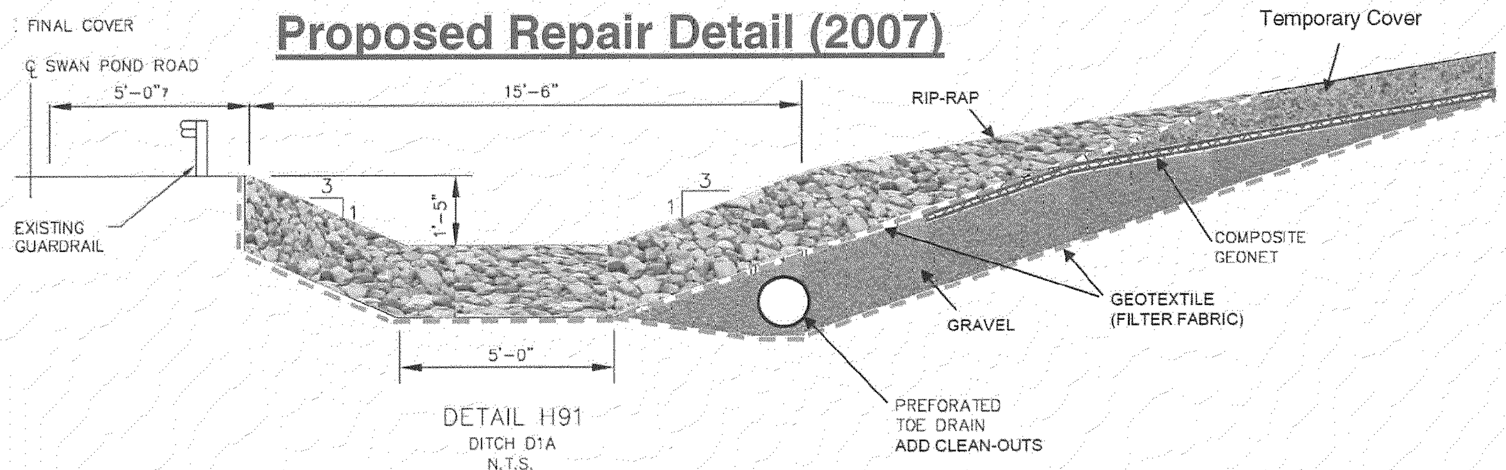
Geosyntec consultants

Investigation Results (cont.)

Original Detail (2005)



Proposed Repair Detail (2007)



TVA

Geosyntec consultants

Investigation Results (cont.)

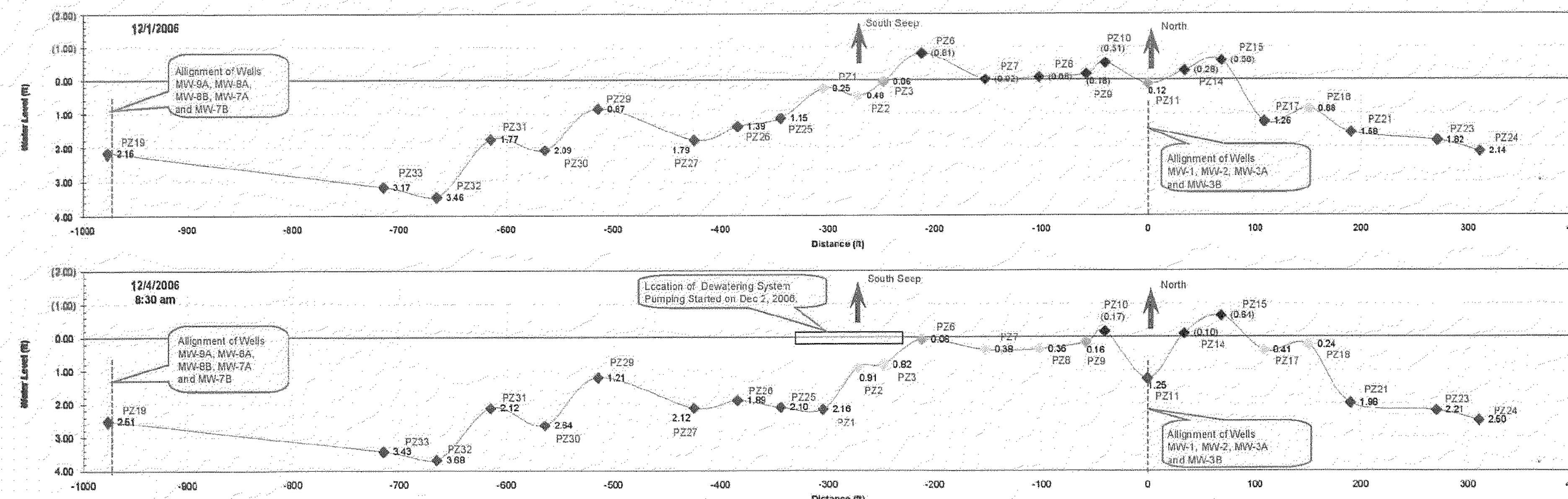
- Installed 100-ft long well-point dewatering system near southern seep area

TVA

Geosyntec consultants

Investigation Results (cont.)

- Monitored water level response to dewatering
- Initiated intrusive investigation once water levels were below ground surface

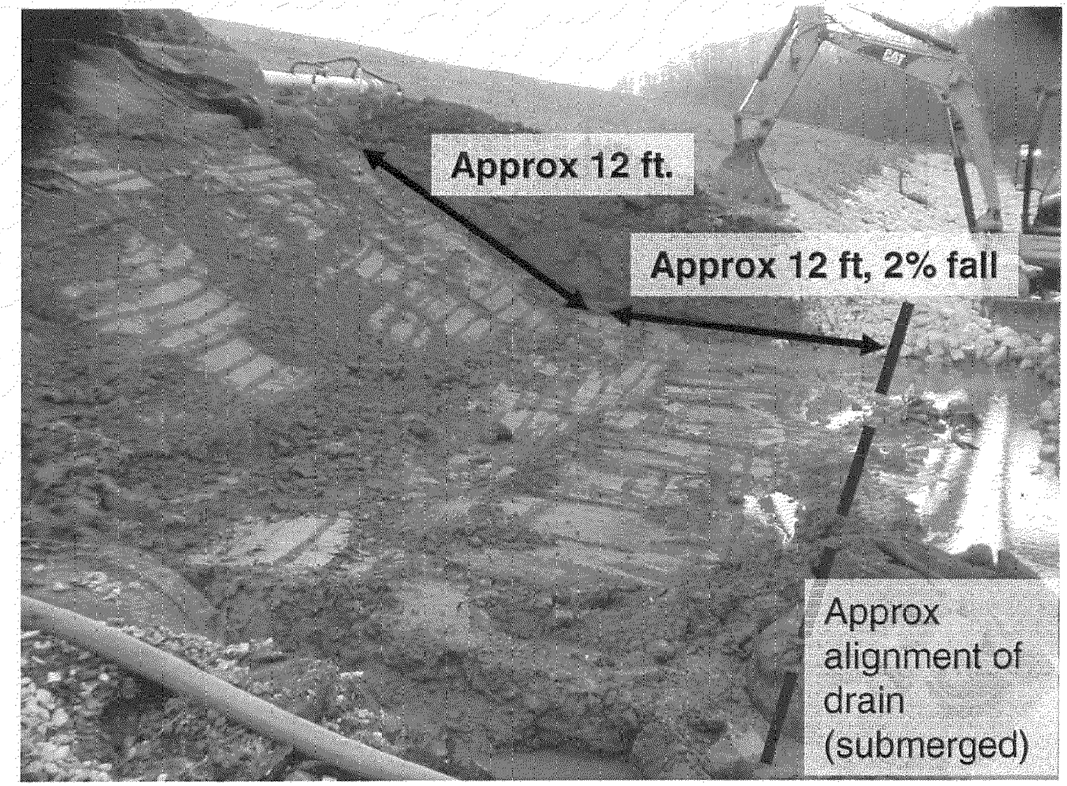


TVA

Geosyntec consultants

Investigation Results (cont.)

- Conditions immediately prior to repair/placement of new buttress drain



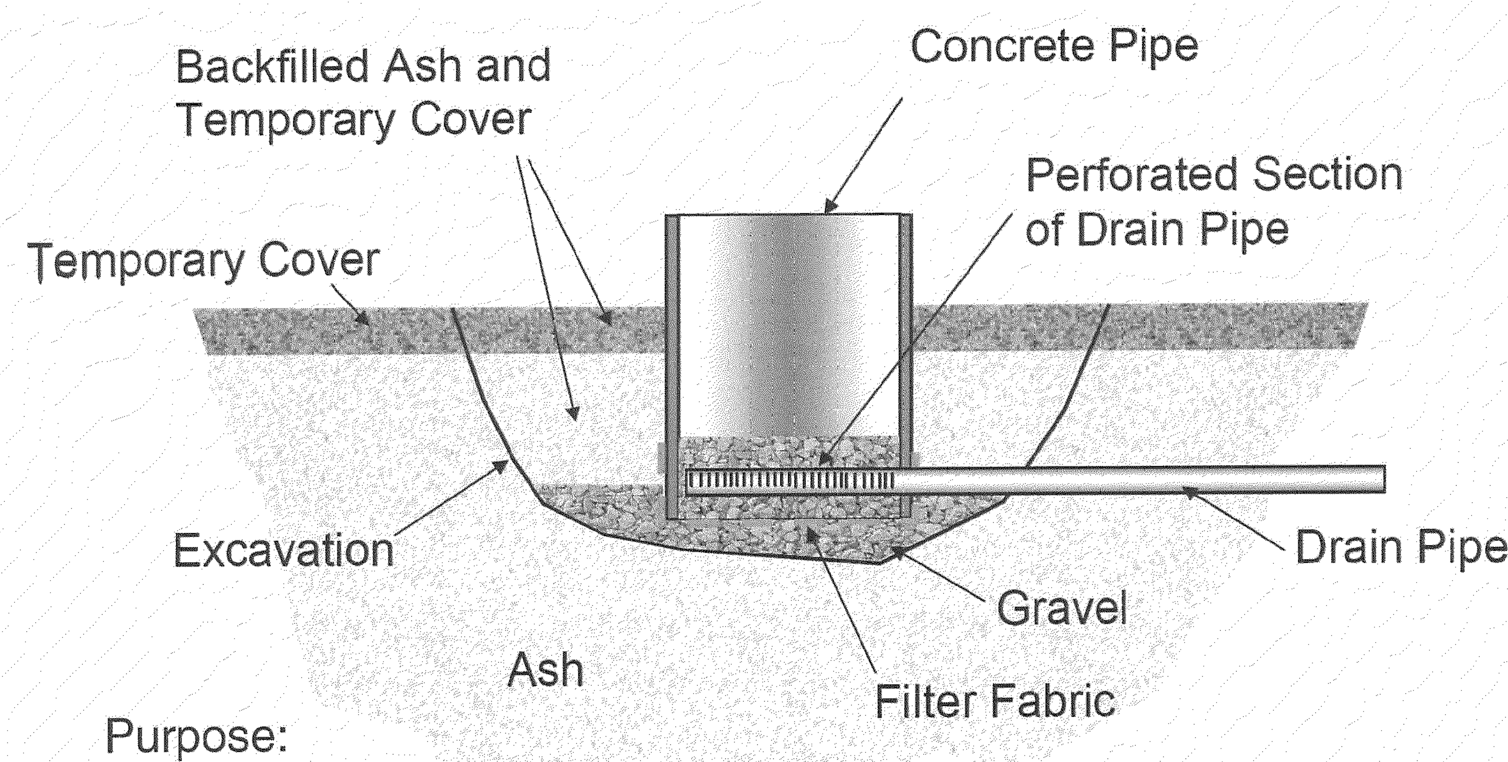
- Overall goal:
  - Improve toe drain
  - Contain ash to prevent piping

TVA

Geosyntec consultants

Investigation Results (cont.)

Spring Box Detail (used for localized pressure relief)



Purpose:

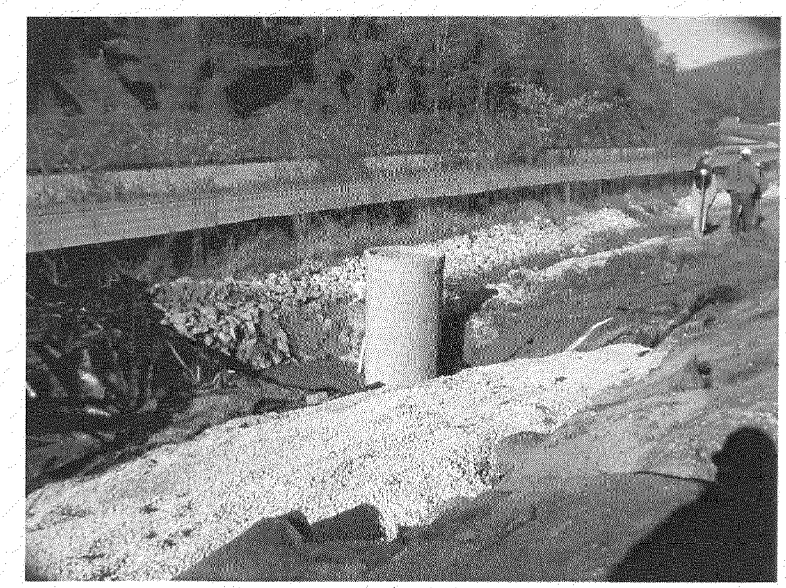
- Provides controlled relief of excess water pressure
- Allows release of water from localized anomalies while containing fines (ash)

TVA

Geosyntec consultants

Investigation Results (cont.)

- Attempts to dewater and expose the toe drain pipe were not successful due to pump capacity and excess water.
- Placed gravel over the pipe and a layer of geotextile over gravel.
- Groundwater level was at about 1 ft below ditch invert.



- Placed the spring box (36-in concrete pipe) over the geotextile (see next slide).
- Backfilled the area surrounding the concrete pipe with gravel.
- Placed gravel inside the concrete pipe (~1 to 2 ft)
- Completed the placement of gravel blanket layer.

TVA

Geosyntec consultants

Investigation Results (cont.)

- Geonet that was peeled back during the removal of top soil was put back over the gravel blanket layer.
- Geotextile was rolled back over the gravel blanket layer.

- Rip-rap at the toe was placed back to re-form the ditch.
- Top soil was placed over the geotextile and lightly tamped with backhoe bucket.
- The first segment of the repair area was completed on the morning of December 9.

Due to the success of the fist area, a decision was made to continue and address the 500 ft. length of dike

TVA

Geosyntec consultants

Dredge Cell Dike Improvements

- Based on the success of the 50 ft. long pilot area, a decision was made to continue implementation of toe drain improvements along the problem area
  - Wellpoint dewatering system extended towards north for the entire length of the area of concern (~ 500 ft)
  - Repairs implemented along the entire problem area in a similar manner.

TVA

Geosyntec consultants

Dike Rehabilitation

- ***Rehabilitation procedure continued similar to other areas***
  - Geotextile was placed over the slope.
  - Gravel blanket layer was placed over geotextile starting from the toe and progressing up slope to buttress ash and minimize movement
- ***Approximately 500 Linear feet of dike along Swan Pond Road was rehabilitated***

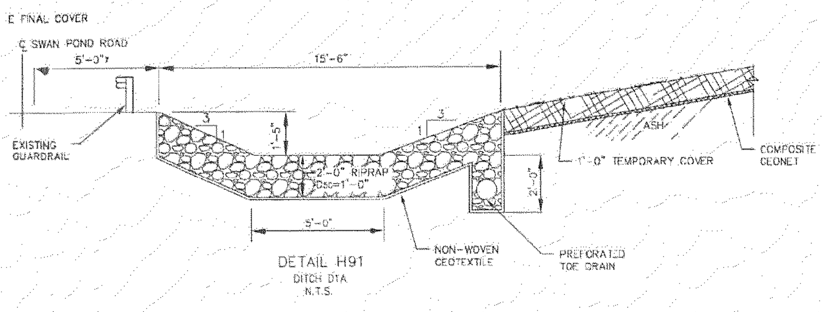
TVA

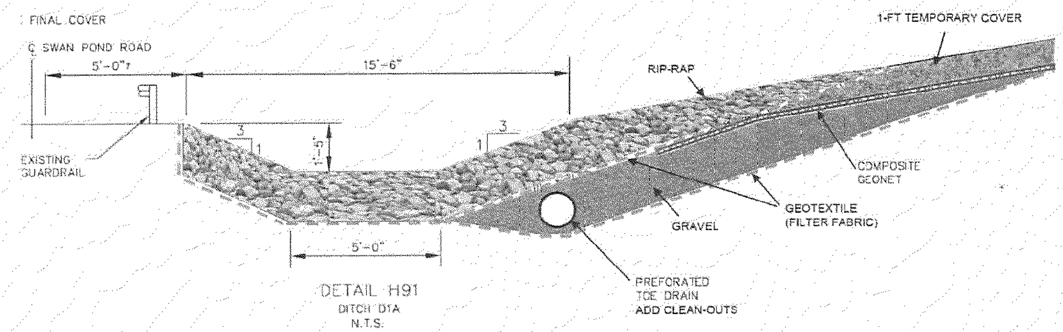
Geosyntec consultants

TVA-00010627

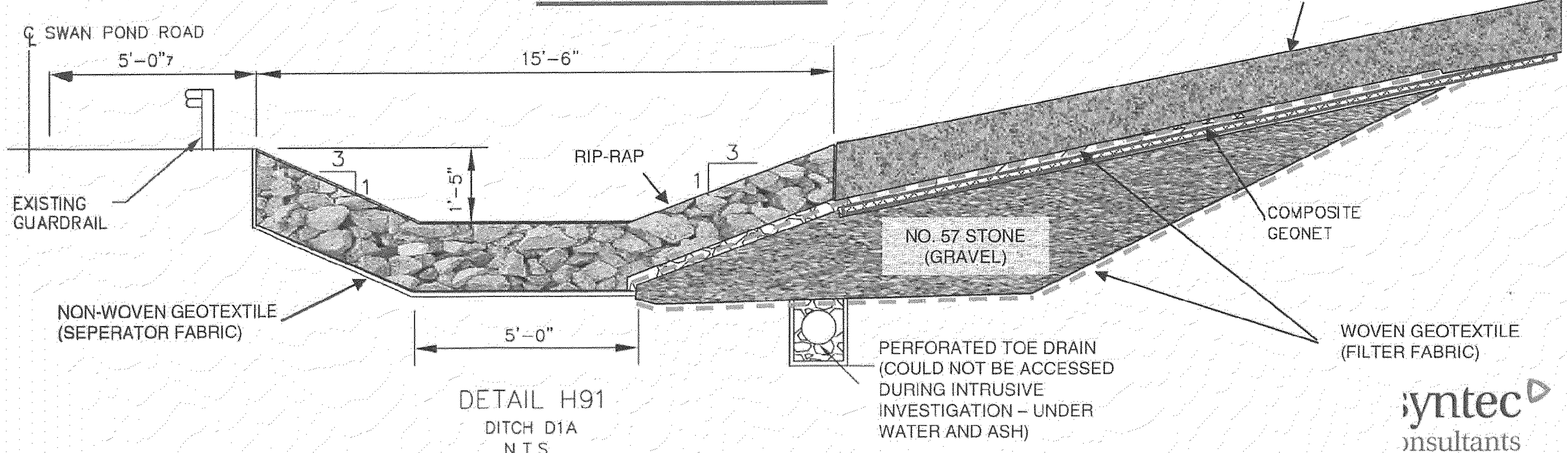
Dike Rehabilitation

Proposed Repair Detail





As Constructed



syntec consultants

Findings and Conclusions from Investigation

- Drainage pipe – ineffective
  - No free outlet
  - Almost flat gradient
  - Poor water conductivity between ash and drain/ditch
  - Ash possibly present in pipe trench
- Small surface area of the drain as designed was not adequate to capture flow from lenses and anomalies identified during the investigation
- Zones of variable material observed
  - Results in preferential flow paths and wet areas
  - Original fix (global) did not anticipate local anomalies
- Standing water observed on benches
  - Provides a constant source of water to infiltrate dike
  - Some underdrains discharge to benches

TVA

Geosyntec consultants

Findings and Conclusions

- Working hypothesis
  - Localized preferential flow paths present in seepage area; these were not anticipated in original design
  - Water on benches provides an additional source of water during wet weather
  - Clay embankment and presence of a shale layer beneath Swan Pond Road has a dam effect
  - Toe drain not adequate to capture anomalies and does not adequately contain ash

TVA

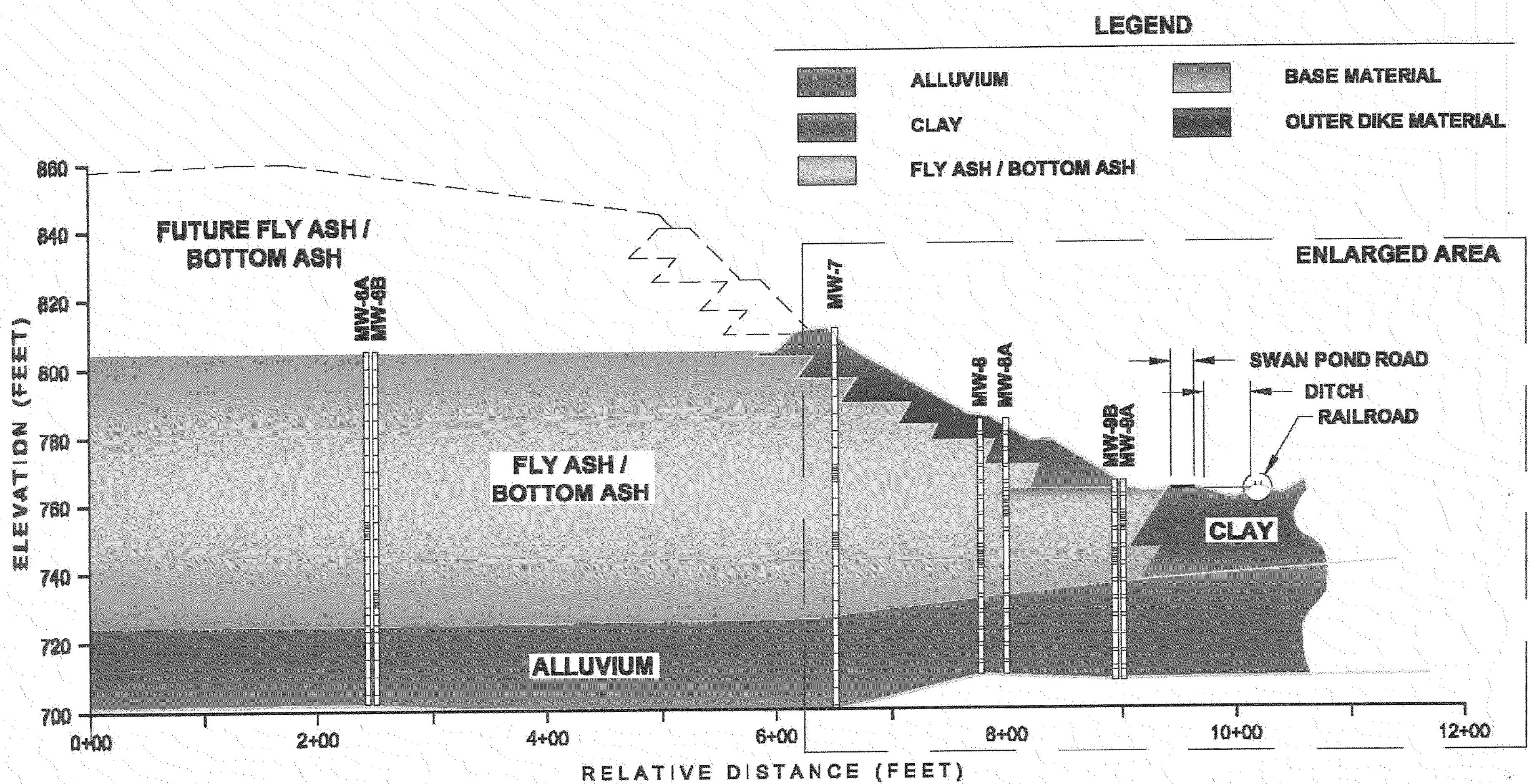
Geosyntec consultants

Development of Seepage Model

A mathematical flow model was also used to assess the situation

- Model developed using SEEP/W (finite element seepage model)
- Model geometry and material properties developed from 2005 geotechnical investigation
- Purpose of model – simulate conditions before and after rehabilitation

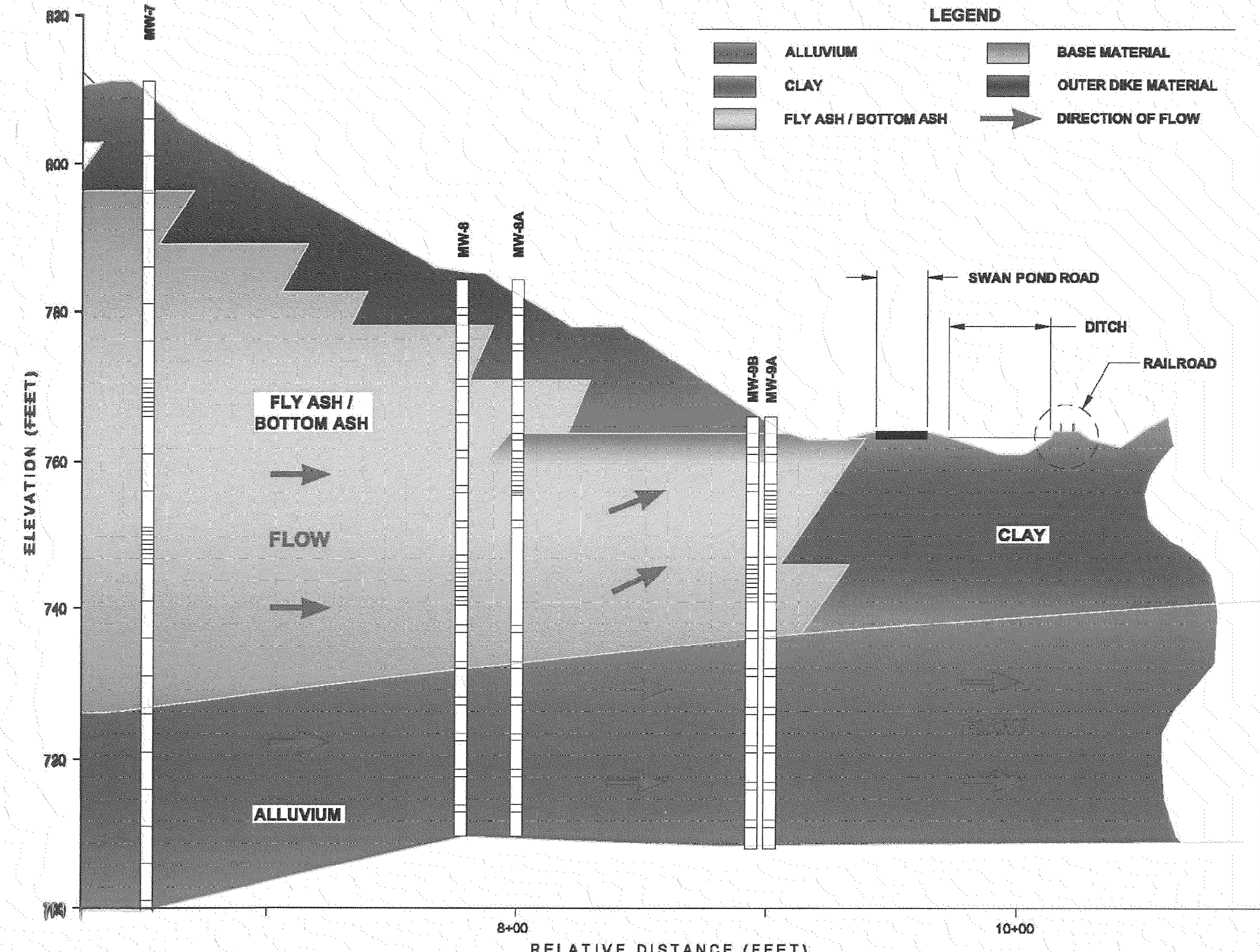
Geosyntec consultants



Cell 1 Cross Section (No Problem Area)

TVA

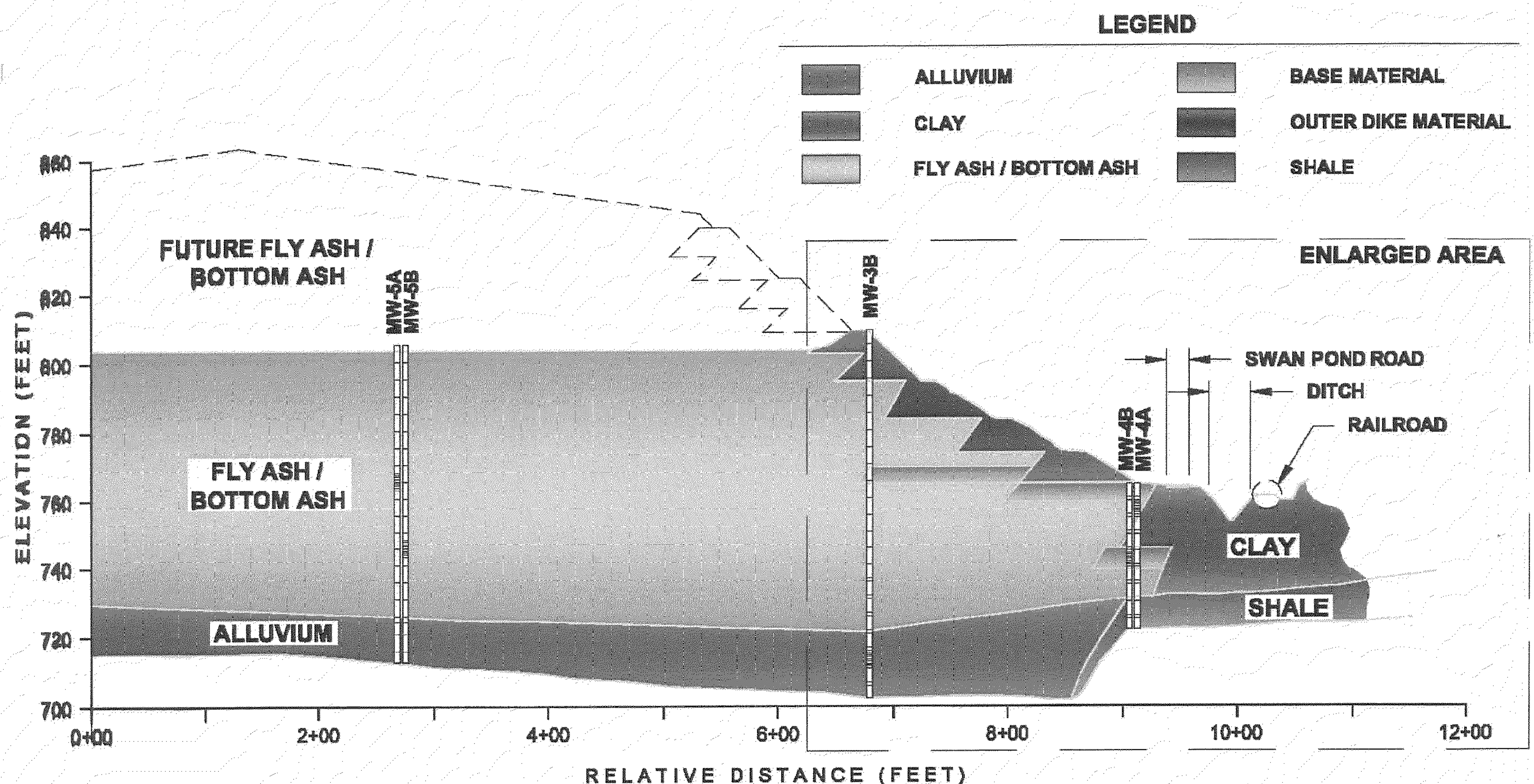
Geosyntec consultants



Cell 1 Cross Section (No Problem Area)

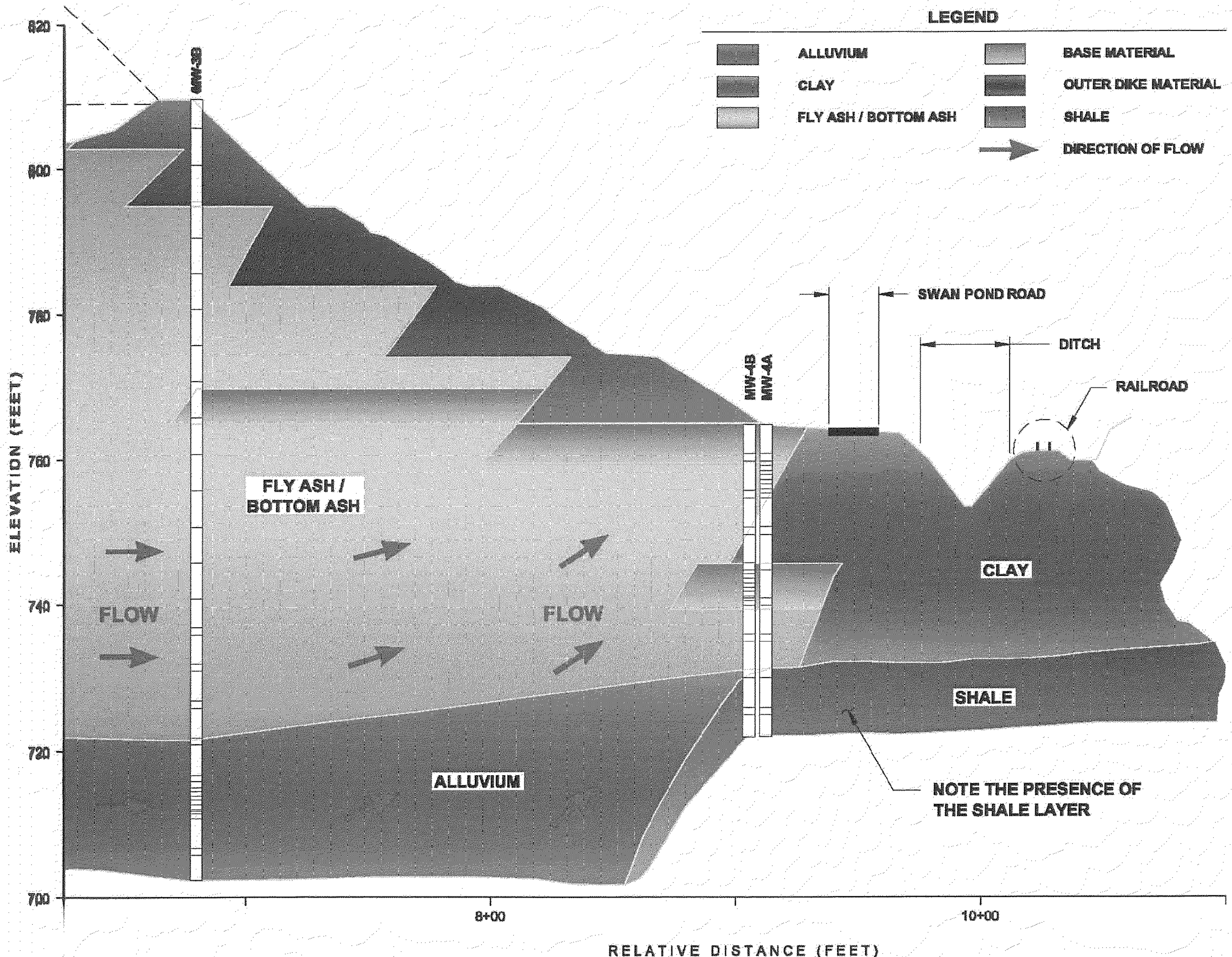
TVA

Geosyntec consultants



Cell 3 Cross Section (Seepage Area)

Geosyntec consultants



Cell 3 Cross Section (Seepage Area)

TVA

Geosyntec consultants

Differences - Seepage Area

Key differences between the seepage area (former Cell 3) and the control area (former Cell 1):

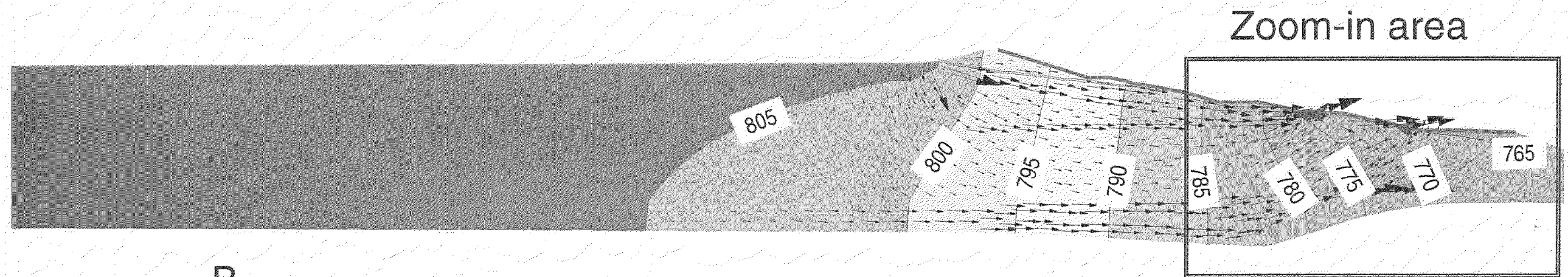
- Localized anomalies found in seepage area during intrusive investigation
- Presence of shale layer identified at seepage area during 2005 geotechnical investigation
- Seepage model constructed using Cell 3 geometry and properties

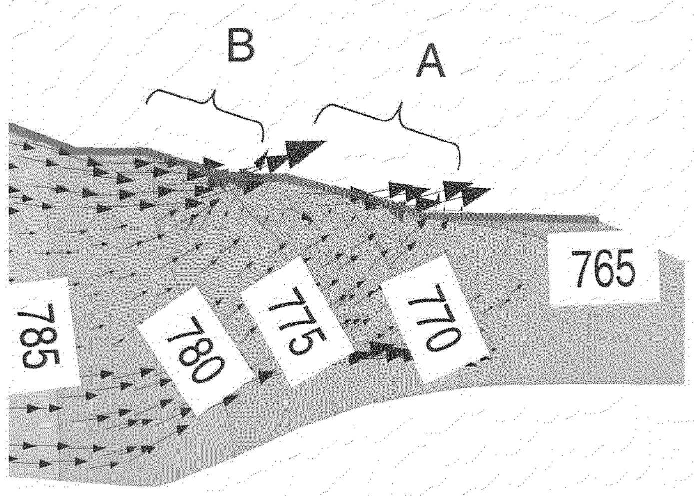
TVA

Geosyntec consultants

Model Predictions Prior to 2005 Improvements

Model-predicted Total Head Distribution (equipotential lines)





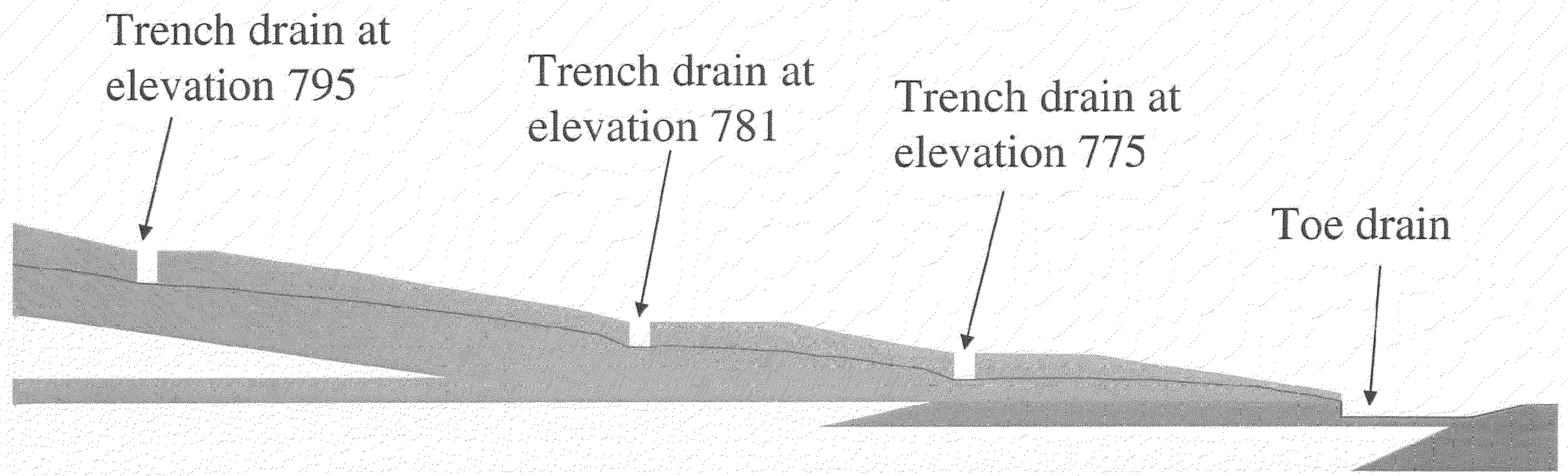
- Model clearly illustrates that without adequate drainage, seepage water will exit the lower portion of the slope
- The exact location is difficult to predict and is highly sensitive to localized zones of more permeable material (e.g., bottom ash which had been identified in borings)

TVA

Geosyntec consultants

Summary of Improvements – 2005-2007

Proposed Improvements (2005)



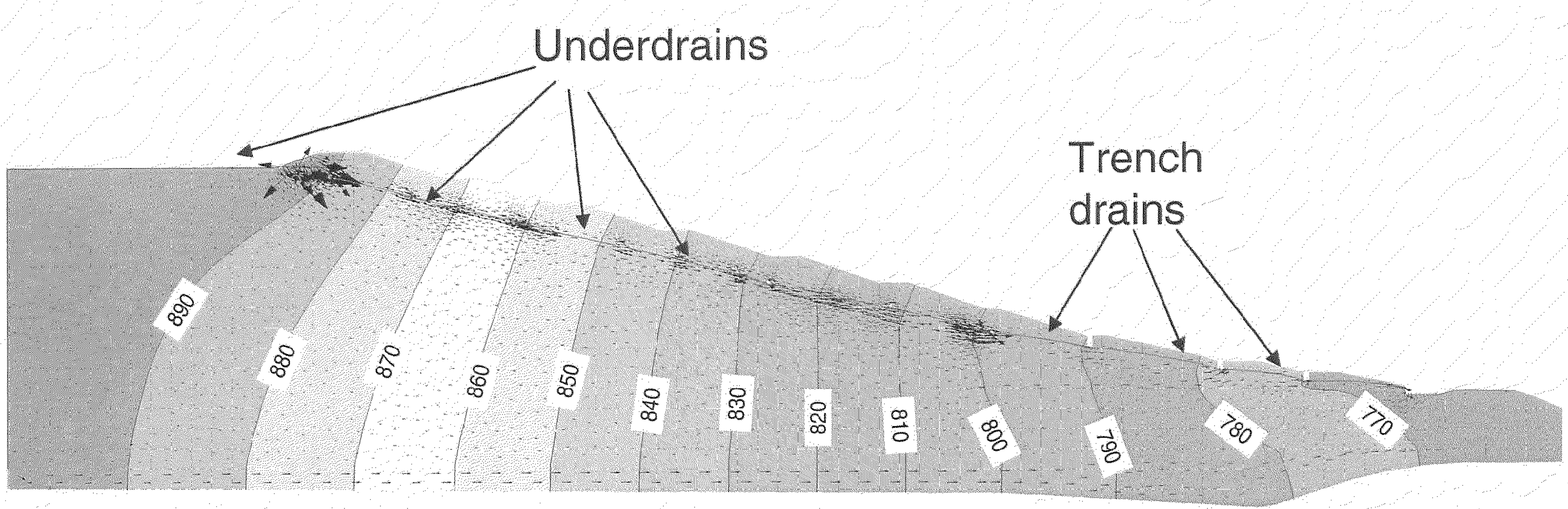
A series of drainage improvements were developed, analyzed, and implemented (2005) with the goal of lowering the phreatic surface and controlling seepage at the toe

TVA

Geosyntec consultants

Model Predictions After 2005 & 2007 Improvements

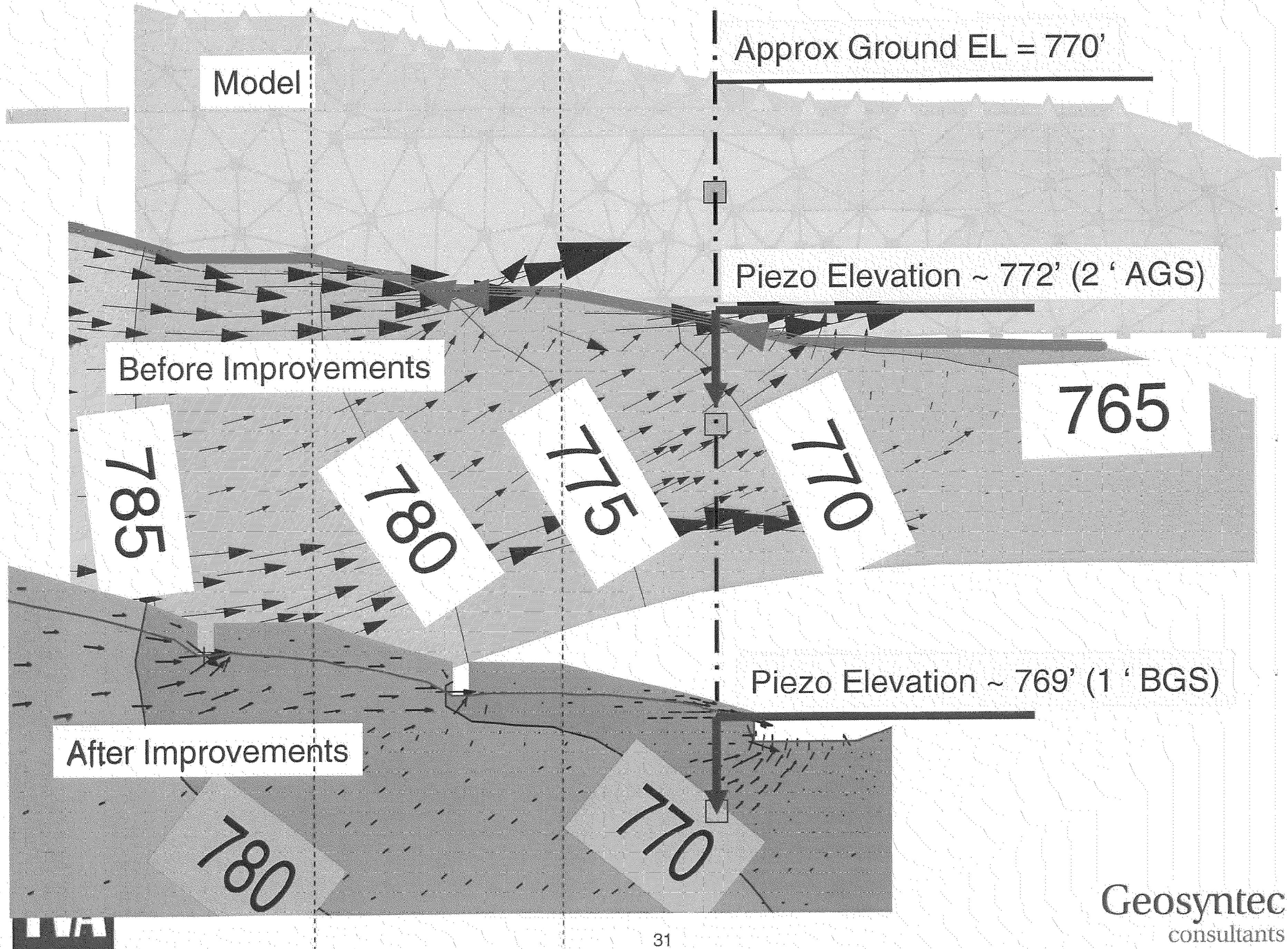
Model-predicted Total Head Distribution (Future Conditions)



Model simulations indicated that the phreatic surface would be reduced and seepage will be controlled effectively

TVA

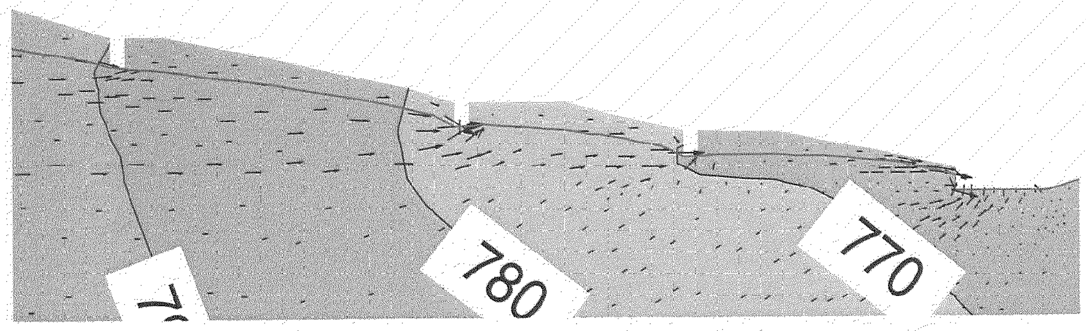
Geosyntec consultants



Geosyntec consultants

TVA-00010640

Model Predictions



Why did the 2005 recommended drainage improvements not solve the problem?

- Model prediction indicates that seepage can be effectively controlled with a system of properly functioning trench drains and toe drain
- More monitoring points and periodic maintenance required to ensure proper function

TVA

Geosyntec consultants

Model Predictions

- Two alternatives were developed in 2005:
  - (a) Rip-rap ditch improvements with integral toe drain
  - (b) Buttress drain set into lower slope
- TVA selected (a) based on the need to address general improvements to surface water conveyance
- While alternative (a) has worked well over the majority of the dike, it does not address seepage from localized lenses and anomalies that have since been identified during the intrusive investigation
- The improvements to the toe drain now address the problem area:
  - Greater surface area
  - Better connectivity to ash
  - Improved containment of ash

TVA

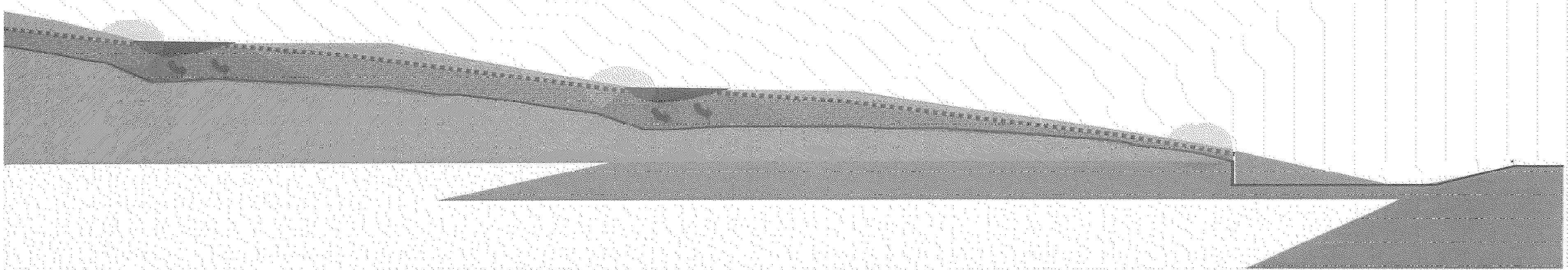
Geosyntec consultants

Dredge Cell Restoration

- Short-term (Completed)
  - Improve toe drain to control seepage through lower slope, lower phreatic surface, and improve containment of ash
- Resume normal dredge cell operation, subject to implementation of more structured monitoring program (On-going)
- Longer-term actions (planned for Q1/Q2 2008)
  - Address surface water drainage on benches
  - Extend underdrain outlets to perimeter ditch
  - Develop and implement a more structured monitoring and maintenance program

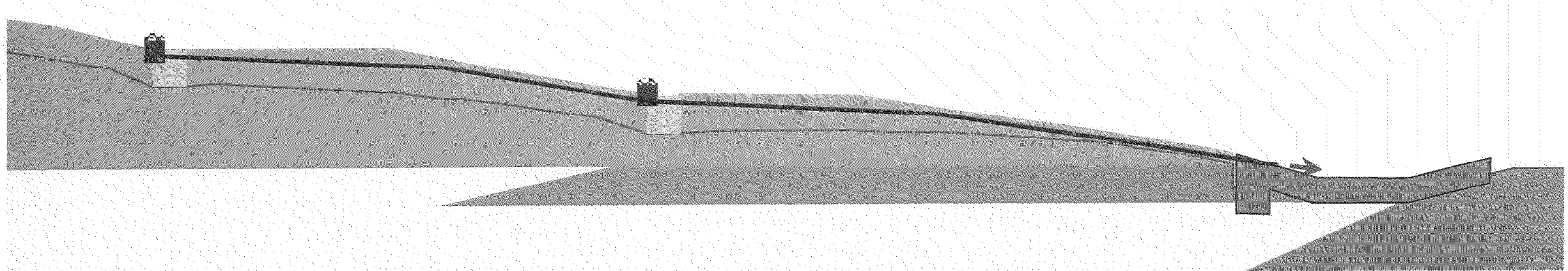
Longer-Term Considerations

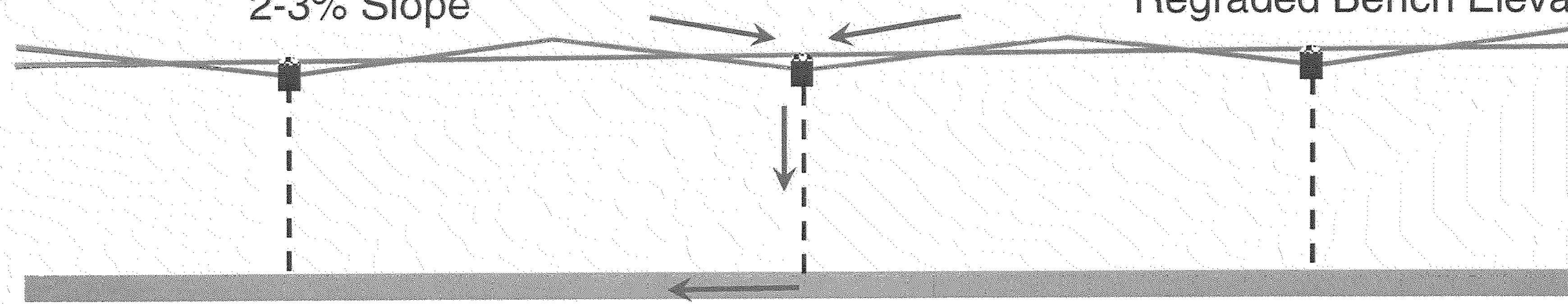
- Implement bench drain improvements



Longer-term Considerations

- Implement bench drain improvements





TVA

Geosyntec consultants

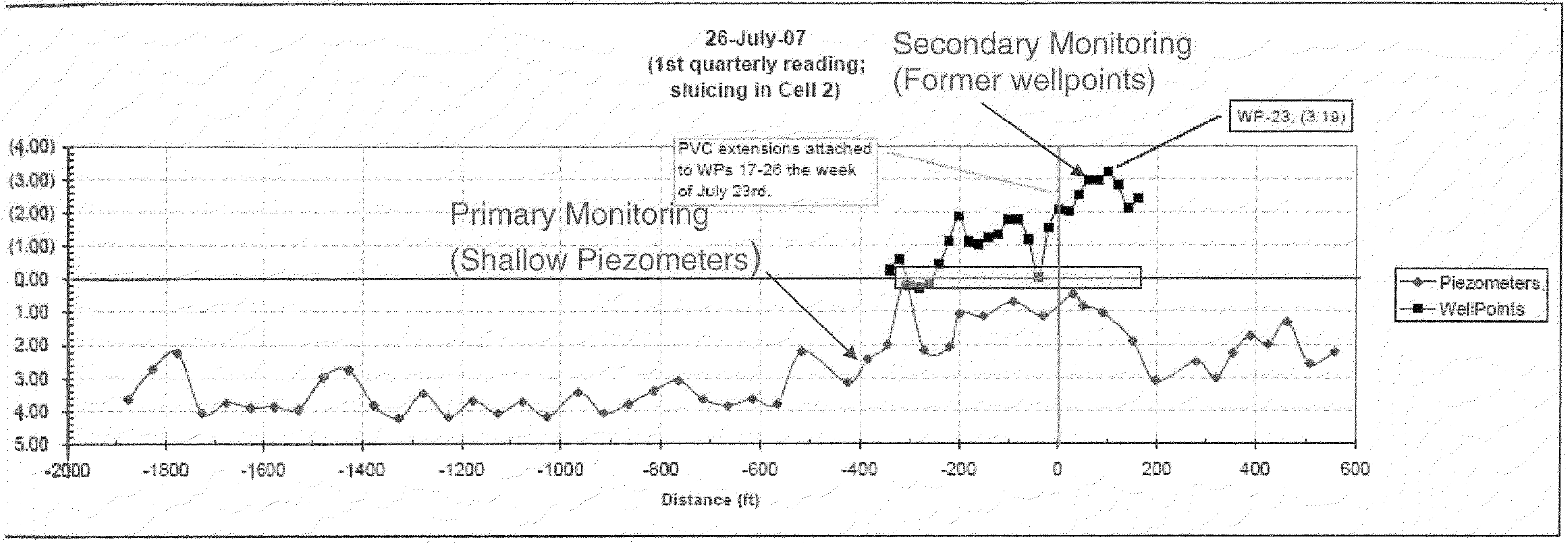
Monitoring and Maintenance Plan

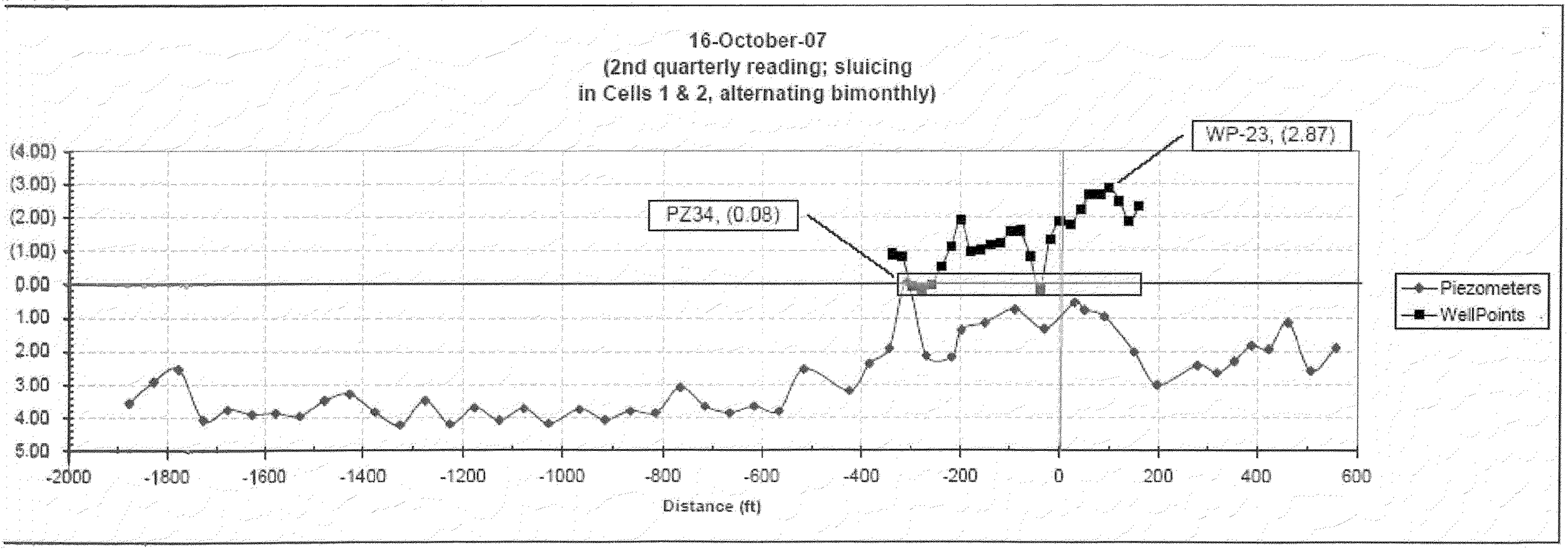
- Elements:
  - Piezometers – expanded the existing network of strategically located permanent piezometers for regular monitoring
  - Contingency Planning – develop/document actions and repair procedures to address specific eventualities (automated spreadsheet)
  - Frequency of monitoring – establish seasonal baselines, operational changes, etc., include option to reduce frequency based on data/experience (ongoing)

TVA

Geosyntec consultants

TVA - KINGSTON
Swan Pond Road Dike
2007 Water Level Monitoring





Kingston Peninsula Site

Discussion:

- Status of Permit Application

TVA

Geosyntec consultants

Bull Run Fossil Plant

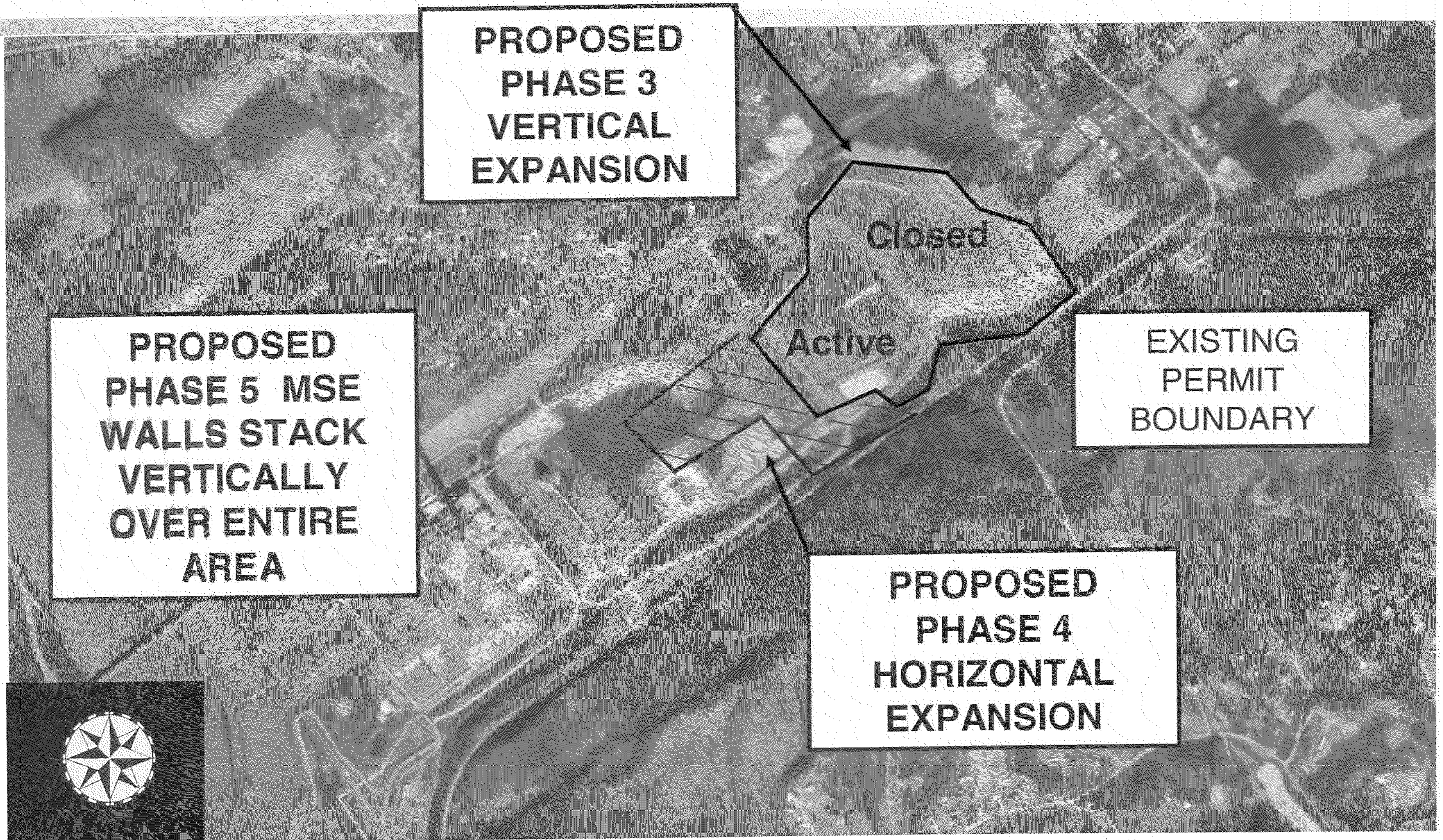
Dry Ash Stack Permit Status

BRF 255 – Develop New Fly Ash Disposal Capacity

TVA

Geosyntec consultants

Bull Run Fossil Plant - BRF255



TVA

BRF255

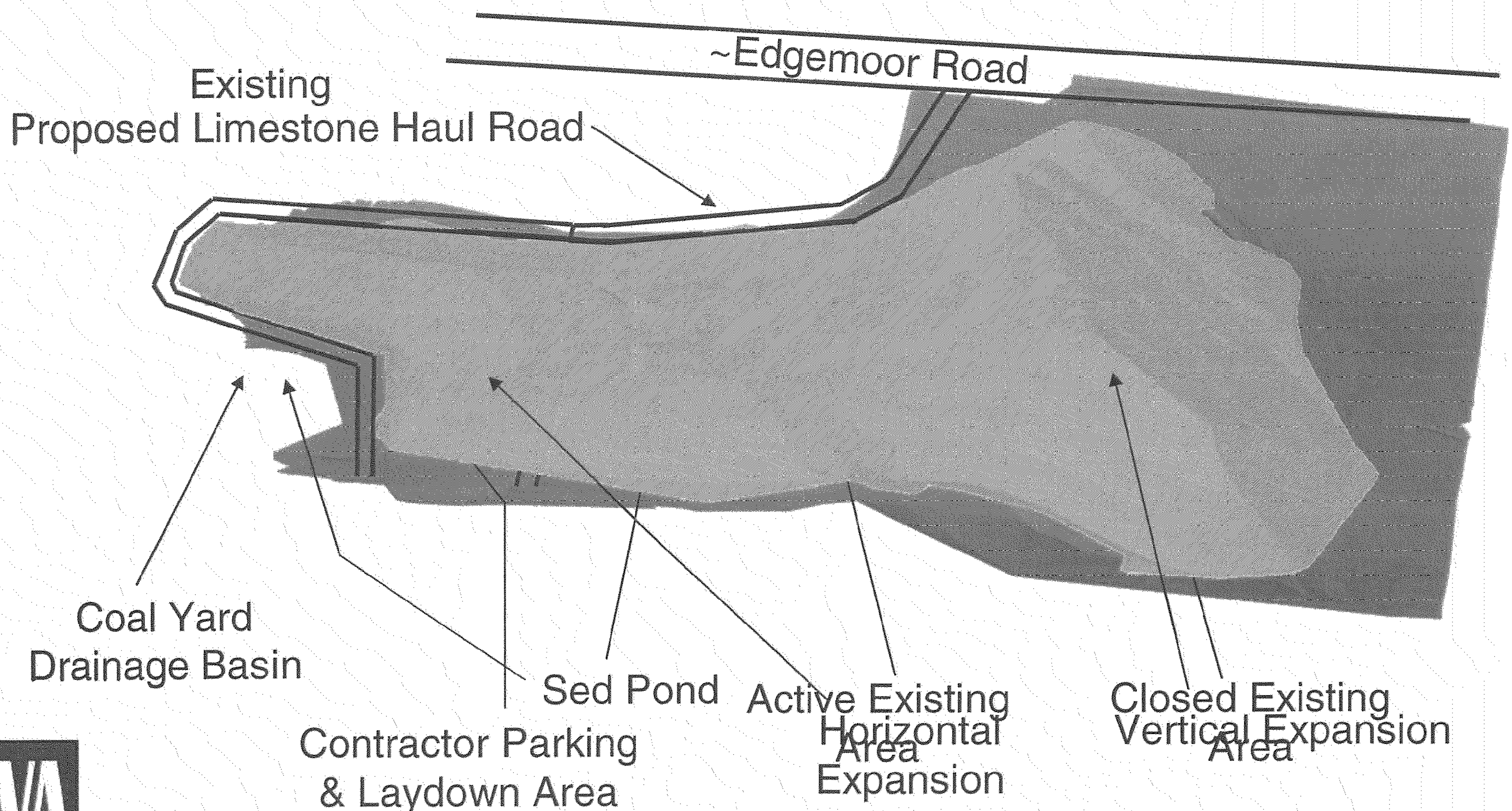
- Phase 3 – Existing Stacks
  - Stack using 3:1 side slopes with 15' benches - NO MSE slopes initially
- Phase 4 – Horizontal Expansion
  - Install HDPE liner Step in ~80 LF from perimeter of horizontal expansion area
  - Stack to a height of 50' above Existing Closed Stack
- Phase 5 – Vertical Expansion
  - Construct MSE slopes with minimal excavation Stack to a height of 80' above Existing Closed Stack

TVA

BRF255

***13 Years of Storage**

***36 Total Years of Storage**



TVA-00010652

Submitting Part II Permit Application in Feb 2008

TVA

Bull Run Fossil Plant

Gypsum Stack
Alternative Drainage Layer Proposal

TVA

Geosyntec consultants

Background

- Current design indicates the use of a blanket drain at the base of the stack to provide drainage
- Current configuration indicates the use of bottom ash produced at BRF as material for construction of the drainage layer
- As construction of the cell has proceeded it has become apparent that insufficient bottom ash meeting hydraulic conductivity requirements will be available for use as drainage layer
- Geosyntec performed an evaluation of alternative materials and methodologies to provide equivalent performance

TVA

Geosyntec consultants

Summary of Current Design

- 2-ft thick bottom ash layer
- 1 percent slope
- Hydraulic conductivity = 1.2×10^{-3} cm/sec

TVA

Geosyntec consultants

Alternatives Considered

1. Gravel Layer (2 ft. thick)
2. Sand Layer (2 ft. thick)
3. Tire Chip Layer (3 to 4 ft. thick to allow for compression)
4. Gravel finger drain network
5. Tire chip finger drain network
6. Geocomposite drainage layer

Note: Alternative 6 was eliminated due to the potential for blinding/clogging of the geotextile under long-term conditions

TVA

Geosyntec consultants

Procedure

- SEEP/W was used to establish the "baseline flow rate" in the as-designed drainage layer
- The same model was used to estimate the flow rate and heads developed using each of the alternatives considered
- An alternative was judged to be "equivalent" or "better" than the original design if the flow rate through the drainage layer is higher

TVA

Geosyntec consultants

Comparison of Drainage Layer Flow Rates

Alternative	Estimated Flow Rate [1]
Original Design (bottom ash blanket drain)	930,943 ft^3/yr
Alt. 1: 2 ft thick gravel layer	10,652,861 ft^3/yr
Alt. 2: 2 ft. thick course sand layer	3,328,625 ft^3/yr
Alt. 3: 3 to 4 ft. thick tire chip layer	10,915,398 ft^3/yr
Alt. 4: Gravel finger drains (spaced at 50 ft. o/c)	2,639,284 ft^3/yr
Alt. 5: Tire Chip finger drains (spaced at 50 ft. o/c)	~2,639,284 ft^3/yr

TVA

Notes: (1) calculated using SEEP/W, based on 900 LF of dike
All alternatives exceed performance of original

Geosyntec consultants

Cost Implications

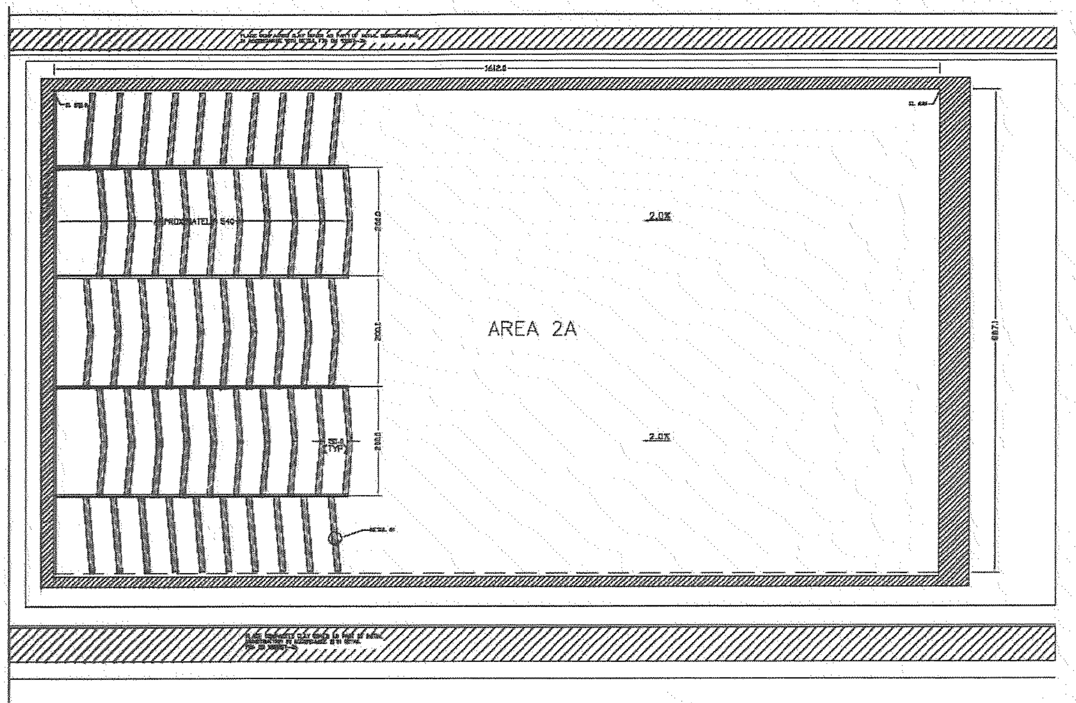
Alternative	Drainage Material or Configuration	Material Quantities			Total Relative Cost
		Drainage Material (cy)	Geotextile (sy)	4-inch HDPE Pipe (ft)	
1	Gravel	110,000	160,000	NA	$2.15M
2	Coarse Sand	110,000	160,000	NA	$5.5M
3	Tire Chips (3 to 4-ft thick layer)	160,000 to 220,000	160,000	NA	$2.57M to $3.48M
4	Gravel Finger Drain Network	9,000	35,200	18,400	$0.24M (2)
5	Tire Chips Finger Drain Network	12,600	49,280	18,400	$0.26M (2)

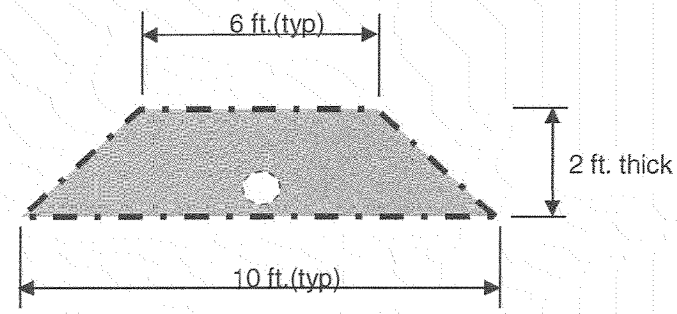
- All alternatives (other than baseline) involve purchase of materials
- Finger drains constructed of either gravel or tire chips provide a cost-effective solution

TVA

Geosyntec consultants

Summary





- TVA proposes to move forward with a finger drain alternative (Alternative 4 or 5)
- Final design details will be developed prior to implementation

TVA

Geosyntec consultants

Kingston Fossil Plant – Dredge Cell Lateral Expansion

Status and Upcoming Activities

TVA

Geosyntec consultants

Dredge Cell Lateral Expansion

- TVA anticipates moving forward with the cell expansion
- Current design indicates the use of a blanket drain at the base of the stack to provide drainage
- It has become apparent that insufficient bottom ash will be available for use as drainage layer; TVA is currently developing an alternative approach, similar to BRF

TVA

Geosyntec consultants

Questions?

- Thank you

Geosyntec consultants