Engineering Peer Review of Coal Byproduct Disposal Plans

Kingston Fossil Plant

Prepared By:

GeoSyntec Consultants

GeoSyntec Consultants

Scope of Work

Requested Scope of Work:

- Read the Operations Manual, Hydrogeologic Report, and review the Engineering Drawings
- Visit the Site and become familiar with current site conditions and future development plans
- Perform an in-depth peer review of the entire disposal and operation plans
- Provide a report that includes;
  - an exact description of each review component;
  - summary of findings; and
  - recommendations for improvement
- Participate in weekly teleconferences
- Present peer review findings to TVA

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Report Organization

GeoSyntec's report is organized to align with Operations Manual and supporting appendices:

- Chapter 1 – Introduction
- Chapter 2 – Operations Manual
- Chapters 3 through 13 – Appendix A through K
- Chapter 14 – Consistency/Completeness of Drawings
- Chapter 15 - References

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Report Organization (cont.)

Each section of the report is organized with:

- A description of each review component
- Summary of findings
- Recommendations for improvement

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Findings and Recommendations General

Three generalized categories of findings and recommendations:

- *"areas where in our professional opinion, we believe that additional detail would be beneficial in terms of securing regulatory approvals and making the documents more defensible……."*
- *"areas where inconsistencies exist that should be addressed before completing the design"*
- *"areas where in our professional opinion, we believe that the engineering evaluations are incomplete and/or additional engineering is needed for the purpose of completing the design"*

Most fall into (i) and (ii); most items in (iii) are centered around geotechnical issues (i.e., stability and seepage)

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Chapter	Description	(i) More Detail Suggested	(ii) Inconsistencies	(iii) Additional Evaluation Needed
2	Operations Manual	X	X	X
2.4	Alternative Disposal Strategy			suggested
3	Ash and Gypsum Testing	N/A	N/A	N/A
4	Vegetation Specification	-	-	-
5	DSWM Policy Memorandum	-	-	-
6	Stormwater Management	X		
7	Hydrogeology	X		Re-organize report format
8	Work Plan for Groundwater Monitoring	X		
9	Stability Evaluations	X		X
10	Closure/Post Closure Plan	X		X
11	QA/QC Plan	X	X	
12	Specifications (addressed in Section 11)	X	X	
13	Seepage Analysis	X		X

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2. Operations Manual

- ***Section 1.4*** – provides a good discussion of hydraulic conductivity of in-situ ash; however values and not consistent with seepage analyses (see Section 13 comments)
- ***Section 2.2*** – incorrect conversions factors for material densities
- ***Section 3.1.3*** – "slope drains": the report (and Appendix K) does not provide a sufficient basis for the design of these drains. See Section 13 comments

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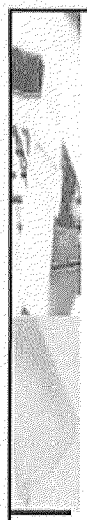

2. Operations Manual (cont.)

- ***Section 3.1.4*** – (Drainage Layer): (i) we agree with the need for drainage, but have concerns regarding the constructability and long-term operation of this layer as presented; and (ii) additional design evaluations are needed (see detailed comments)
- ***Section 3.6*** – we recommend that leachate management practices are implemented, even if this means passive conveyance from the cell

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2.4 Alternative Disposal Strategy

- The concept for the proposed facility is feasible and we believe that the facility can be constructed, but that it will be more complex to operate than two monofills
- After discussions with TVA, GeoSyntec developed a concept-level alternative design for consideration by TVA with the following objectives:
  - Address and resolve seepage and stability concerns that may have imposed restraints on the original design
  - Develop a configuration that allows disposal within essentially separate ash and gypsum monofills
- Increase both ash and gypsum storage relative to current proposed system…increased operational life of the facility
- Details of the alternative are presented at the end of the technical review summary

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7. Hydrogeology

- Checklist prepared by GeoSyntec to be consistent with TDECs "Guidance Document for Performing Hydrogeologic Investigations" (1991) and TDECs "Rules for Permitting Solid Waste Disposal Facilities" (Rule 1200-1-7-.04)
- Checklist transmitted to TVA in advance of report.

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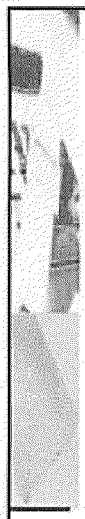

9. Stability – Evaluations

To complete the slope stability evaluations, additional technical elements must be provided and/or considered. These include:

- Establishment of strength parameters
- Selection of additional analysis cross-sections
- Confirmation of average seismic accelerations
- Evaluation of veneer stability
- Assessment of liquefaction potential
- Assessment of bottom ash drainage layer

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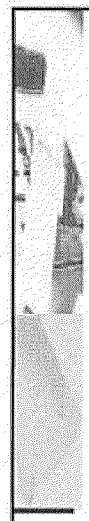

9. Stability – Evaluations (cont.)

Strength Parameters

- Establish undrained and drained strength parameters
- Use undrained or drained parameters where appropriate
- Review approach for establishing shear strength parameters
- If above review indicates that parameters need to be adjusted, reanalyze as needed

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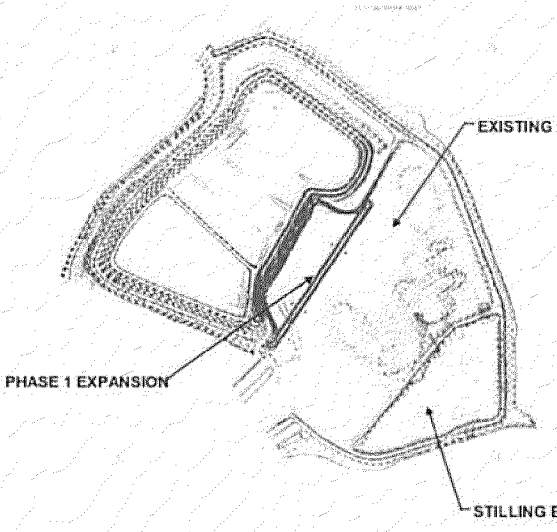
Additional Cross Sections



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9. Stability – Evaluations (cont.)

Seismic Acceleration

- Approach for establishing the selected average acceleration (i.e., 0.11 g) is unclear
  - Common practice for simplified pseudo-static analysis is to use peak acceleration (i.e., 0.22 g) unless formal analysis to account for damping is performed
- Need to provide technical basis for selecting 0.11g in the seismic analyses
- If other values of seismic acceleration can be technically supported, then calculations need to be reconfirmed

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9. Stability – Evaluations (cont.)

Veneer Stability

- Need to provide analysis for alternate cover incorporating geosynthetics
- Need to account for build-up of water on cover system (i.e., account for seepage pressures)
- Need to analyze stability of geosynthetic liner on side slope of Phase 1

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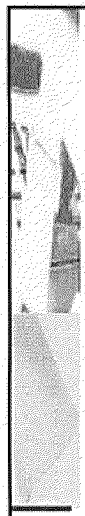

9. Stability – Evaluations (cont.)

Liquefaction Potential

- Use USEPA guidance to assess likelihood of liquefaction
- Implement potential ground improvement strategies as needed
- Confirm that proposed bottom ash drain columns can effectively discharge into bottom ash drainage layer

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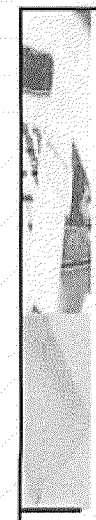

Bottom Ash Drainage Layers

- Bottom ash drainage layers are proposed to be installed at the base of proposed gypsum stack, and at the elevations 810 ft, 870 ft, and 930 ft.
- GeoSyntec concurs that internal drainage and seepage control measures will help to improve stability.
- The drainage layers within the stack are introduced in Section 3.6 of Operations Manual to "…collect and channel drainage from within the stack". However, no calculations are provided to support this design premise
- Drainage control at the base of the stack will enhance the hydraulic separation of the overlying material from the underlying material and can reduce the head on the underlying compacted fly ash.

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Bottom Ash Drainage Layers (cont.)

- GeoSyntec's comments on Section 3.6 includes "..recommend that leachate management practices be implemented"
  - Increase slope
  - Confirm hydraulic transmissivity and conveyance
  - Reduce potential for ponding
- Design calculations for the drainage layer were not provided and are needed
- Need calculations to demonstrate that the impact of settlement is addressed and that the overall hydraulic capacity of the drainage layer is sufficient for the design flows

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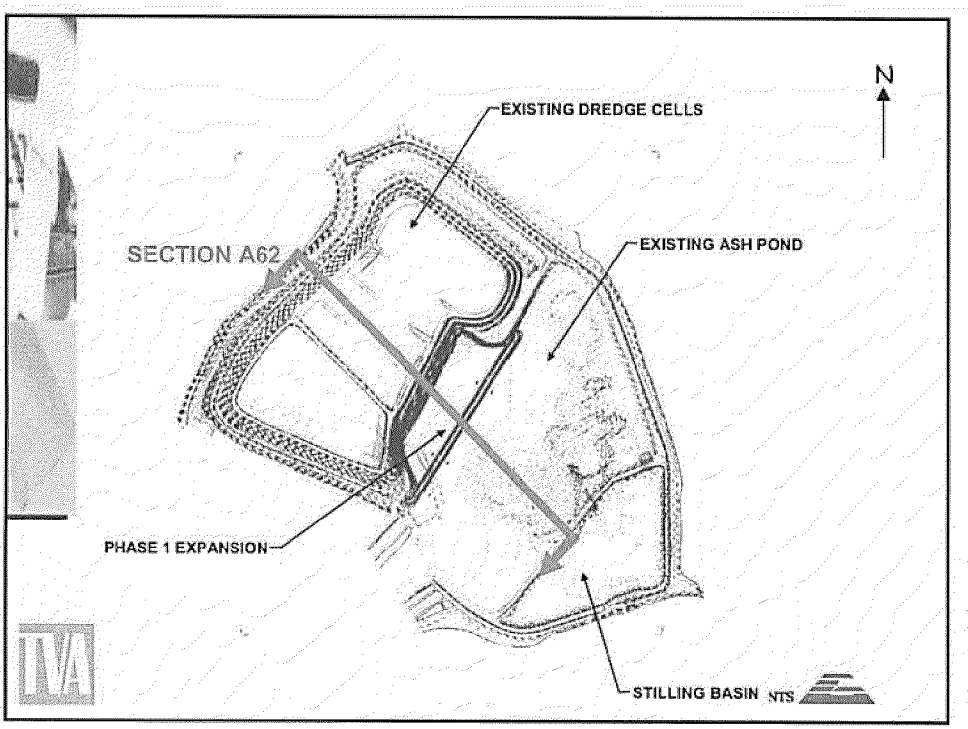
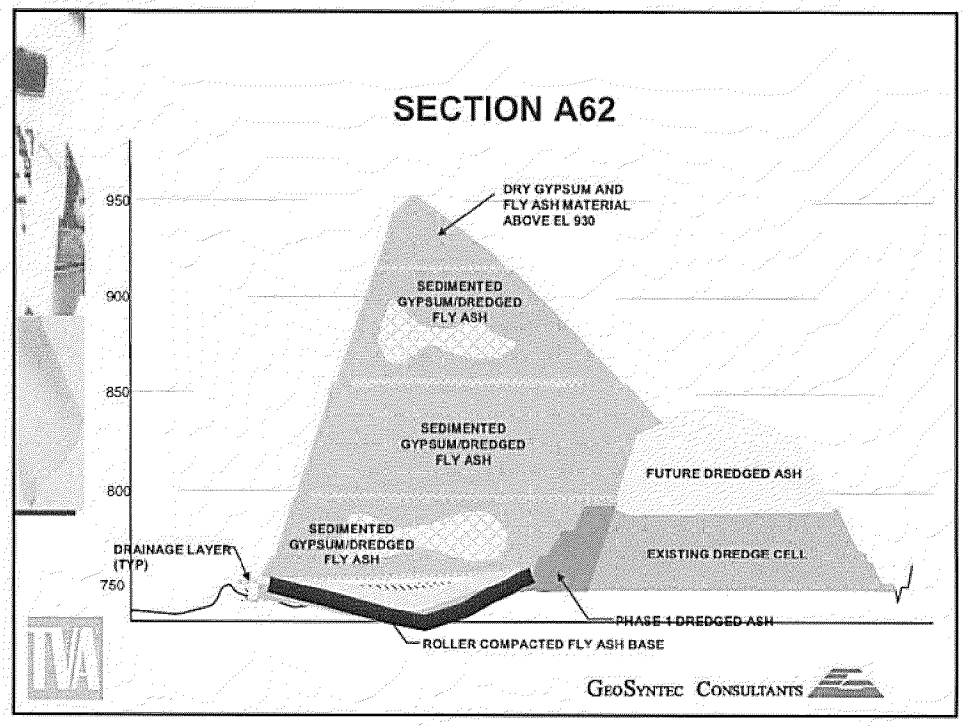

N
EXISTING DREDGE CELLS
SECTION A62
EXISTING ASH POND
PHASE 1 EXPANSION
STILLING BASIN
NTS


SECTION A62
950
900
850
800
750
DRY GYPSUM AND FLY ASH MATERIAL ABOVE EL 930
SEDIMENTED GYPSUM/DREDGED FLY ASH
SEDIMENTED GYPSUM/DREDGED FLY ASH
FUTURE DREDGED ASH
SEDIMENTED GYPSUM/DREDGED FLY ASH
DRAINAGE LAYER (TYP)
EXISTING DREDGE CELL
PHASE 1 DREDGED ASH
ROLLER COMPACTED FLY ASH BASE
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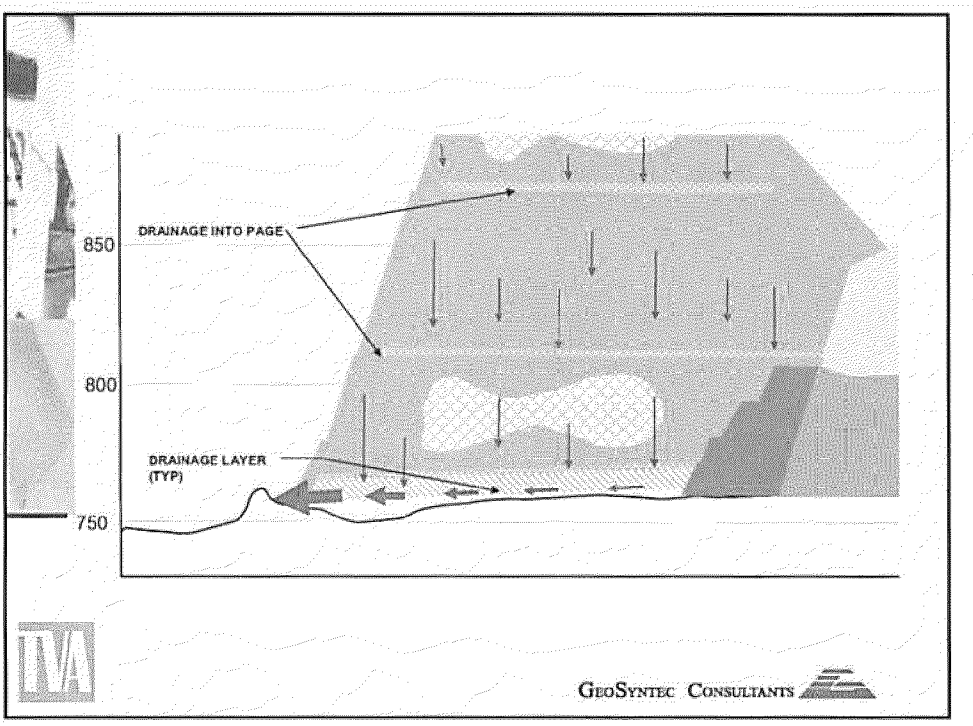

Bottom Ash Drainage Layers (cont.)

- JLT's 14 June 2004 memorandum reports the 60:40 filter layer is compatible with the gypsum and the bottom ash drainage layer
- Operation Plan calls for in-place mixing of 6 in. of fly ash into 6 in. of bottom ash (50:50 mixture by volume)
- Need to confirm that specified ratio:
  - at a minimum, meets JLT's recommendation
  - provides adequate hydraulic capacity under design flow
  - Is internally stable and not susceptible to internal piping
- GeoSyntec concurs with JLT observation that "…it will be difficult to construct these layers due to their sensitivity to moisture content and prevailing weather condition
- GeoSyntec concurs with JLT recommendation to construct test pad and verify constructability and stability

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Bottom Ash Drainage Layers (cont.)

- Several concept-level design enhancements were developed as part of recommendations for improvement. (See following schematics)
  - steepened base grades
  - perimeter drainage blanket at inside edge of berm
  - "sawtooth construction at base of cell
  - herringbone construction and drainage corridor along base of cell
- Other design enhancements may include the use of geocomposite drainage layer in place of bottom ash along steepened base
- GeoSyntec recognizes that the preferred/selected approach is usually dictated by an assessment of performance objectives and economics

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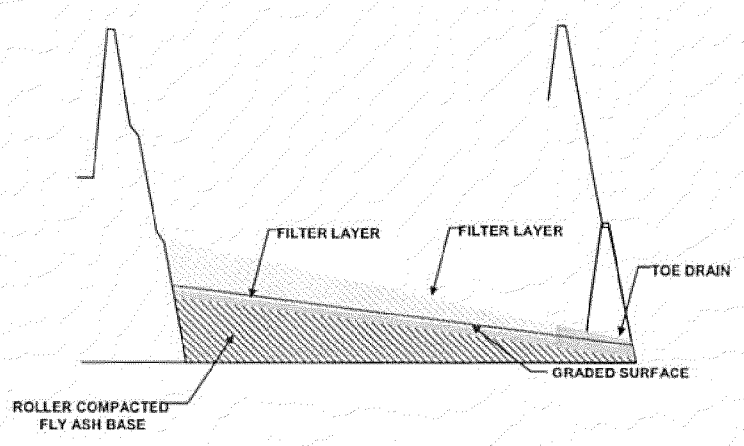
Conceptual Level Cross Section



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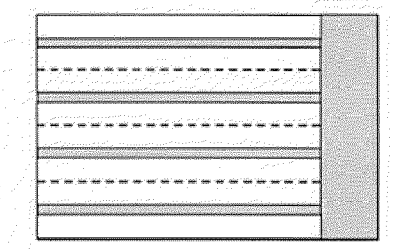
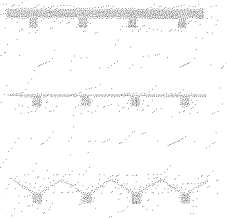
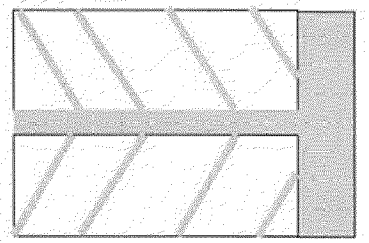
Conceptual Level Plan







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10. Closure/Post Closure Plan

- Recommend including analyses to address the design and performance of final cover system. This will include equivalency demonstrations for:
  - stability
  - infiltration
  - drainage system
  - erosion control
- Recommend including a discussion of post-closure monitoring program

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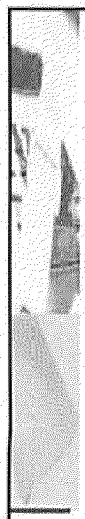

13. Seepage Analyses

Procedure:

- "Spot check" of subsurface data
- "Spot check" of selected critical section
- Review of materials properties used in seepage analysis (i.e., information presented in Table 2, Appendix K)
- Detailed review of graphical output from TIMES model (detailed input/output files not provided)

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13. Seepage Analyses (cont.)

Significant findings and comments:

- Construction of critical section appears reasonable
- Hydraulic conductivity values used in model appear extremely high:
  - derived from CPT data that utilized Soil Behavior Type Classifications (SBT) for typical soils
  - resulting values are not consistent with in-situ tests performed in vicinity of "blowout"
  - selected parameters consistent with gravel and/or coarse sand

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13. Seepage Analyses (cont.)

- Graphical output
  - Peculiar results that are not typical of conventional seepage analyses
    - no change (or non-typical change) in slope of pressure head contours as they pass through different strata
    - pressure head contours exit slope
    - non-typical flow-line regimes
- Authors concur with the recommended use of slope drains and geonet composite drains, but no details are provided regarding the depths of the drains used in the model
- Surficial drains can help control water near the surface of the slope, but do little to dissipate high subsurface water pressures (if they exist)

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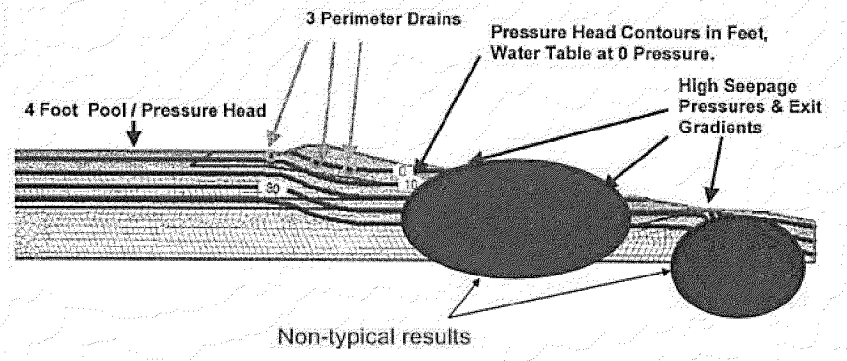
13. Seepage Analyses (cont.)



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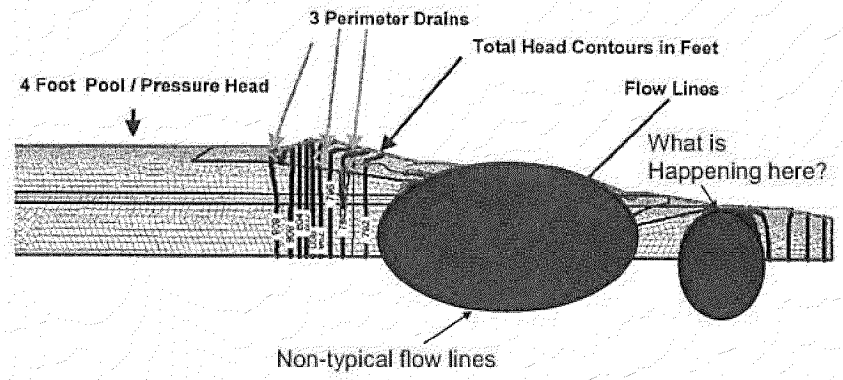
13. Seepage Analyses (cont.)



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13. Seepage Analyses (cont.)

Recommendations

- Address specific issues identified
- Review input data, specifically hydraulic conductivity values
- Construct independent model using conventional seepage model (e.g., SEEP/W, SLIDE)
- Run simulations and calibrate to known conditions
- Run series of simulations for different drain configurations
- Incorporate calculated pore water pressures into dike stability evaluations

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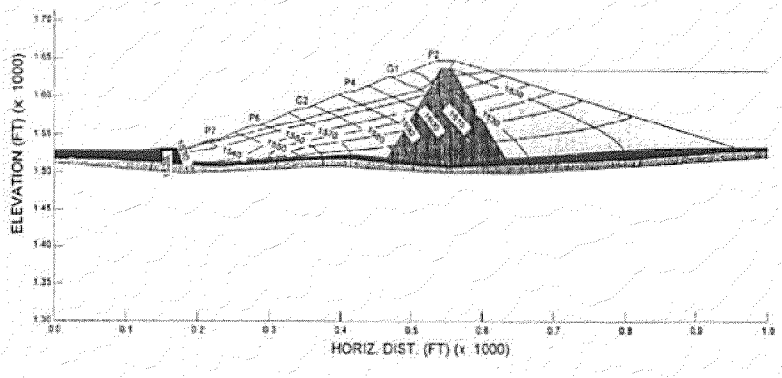
Example Output from SEEP/W



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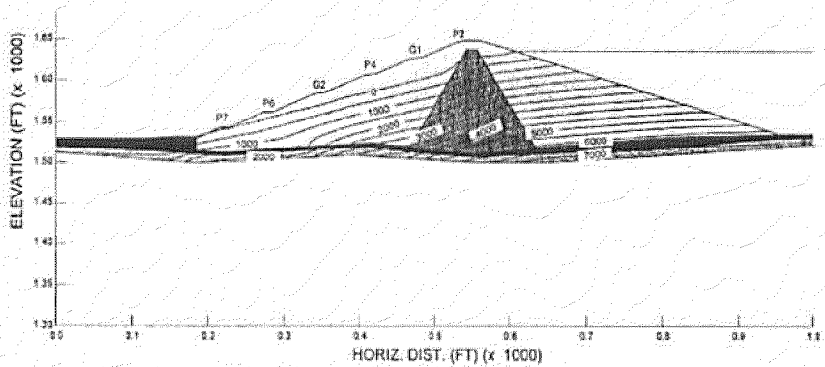
Example Output from SEEP/W



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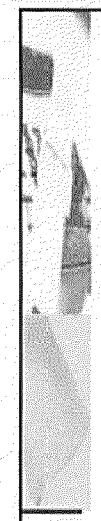

2.4 Alternative Disposal Strategy

- The concept for the proposed facility is feasible and we believe that the facility can be constructed, but that it will be more complex to operate than two monofills
- After discussions with TVA, GeoSyntec developed a concept-level alternative design for consideration by TVA with the following objectives:
  - Address and resolve seepage and stability concerns that may have imposed restraints on the original design to allow increased disposal capacity in existing dredge cells
  - Develop a configuration that allows disposal within essentially separate ash and gypsum monofills
- Increase both ash and gypsum storage relative to current proposed system…increases operational life of the facility and minimizes environmental concerns regarding base drainage layer
- Details and discussion of the alternatives are presented in the following slides

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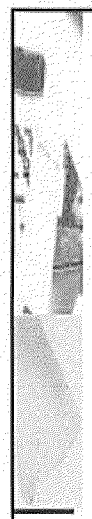

2.4 Alternative Disposal Strategy

- Alternative includes two major components
  - Enhance capacity of existing dredge cells
    - Install seepage control systems in existing cells
    - Control water infiltration via operations
    - Monitor performance
  - Develop conventional two-pond gypsum stacks
    - Maintain wet ash disposal as long as possible
    - Construct and operate following conventional practices
    - Minimize potential for disposing two waste simultaneously in close proximity to each other

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2.4 Alternative Disposal Strategy

- Enhance Capacity of Existing Dredge Cells (report Figure 1):
  - Provide internal drainage galleries at toe of slope and at selected vertical intervals
  - Develop operations to minimize infiltration into dredge cells
  - Provides disposal capacity of 10,400,000 cy of wet ash (additional 6.7 years of life in existing cells compared to proposed plan)

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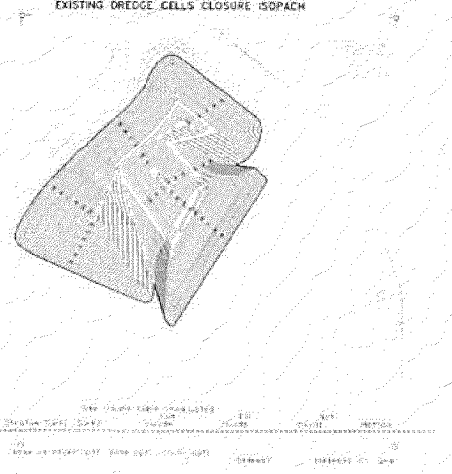
Enhance Capacity of Existing Dredge Cells (report Fig. 1)



Capacity = 10,400,000 cy

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Add some 3 million to what was planned

2.4 Alternative Disposal Strategy

- Option 1 (report Figure 2):
  - Maintains 25-acre ash pond within northwest portion of existing ash pond
  - Provides approximately 3,000,000 cy of gypsum (allows 9 years of disposal before making decision on ash pond)
- Option 2 (report Figure 3)
  - Also maintains 25-acre ash pond but limits gypsum disposal to the northeastern portion of the existing pond
  - Provides approximately 7,400,000 cy of gypsum (allows 22 years of disposal before making decision on ash pond and provides 5 additional years of capacity compared to current plan)
- Both plans result in increased life when the ash ponds are decommissioned and dry ash disposal commences

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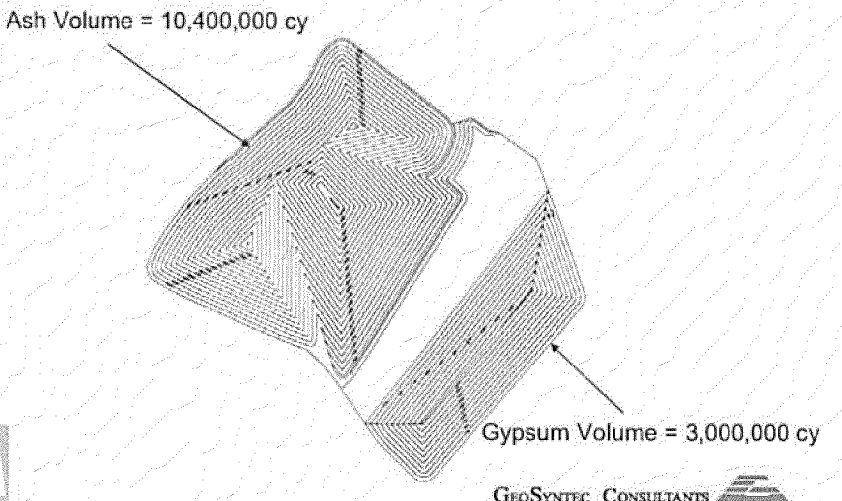
Option 1 (report Fig. 2)



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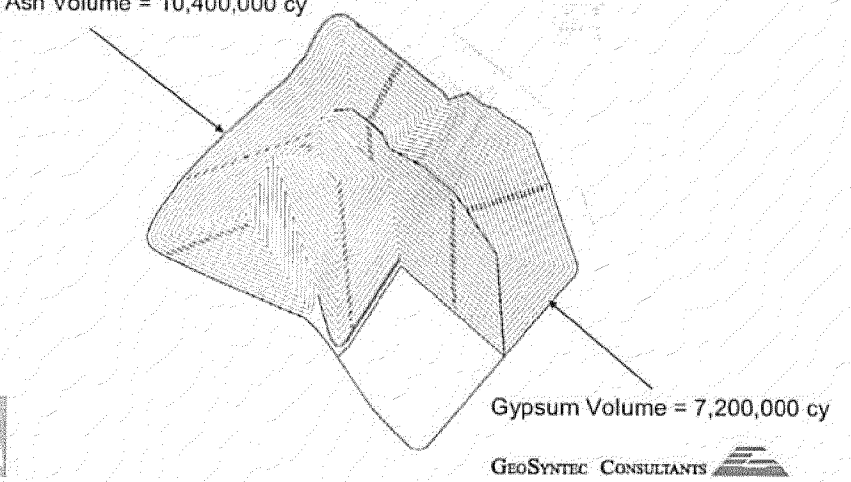
Option 2 (report Fig. 3)



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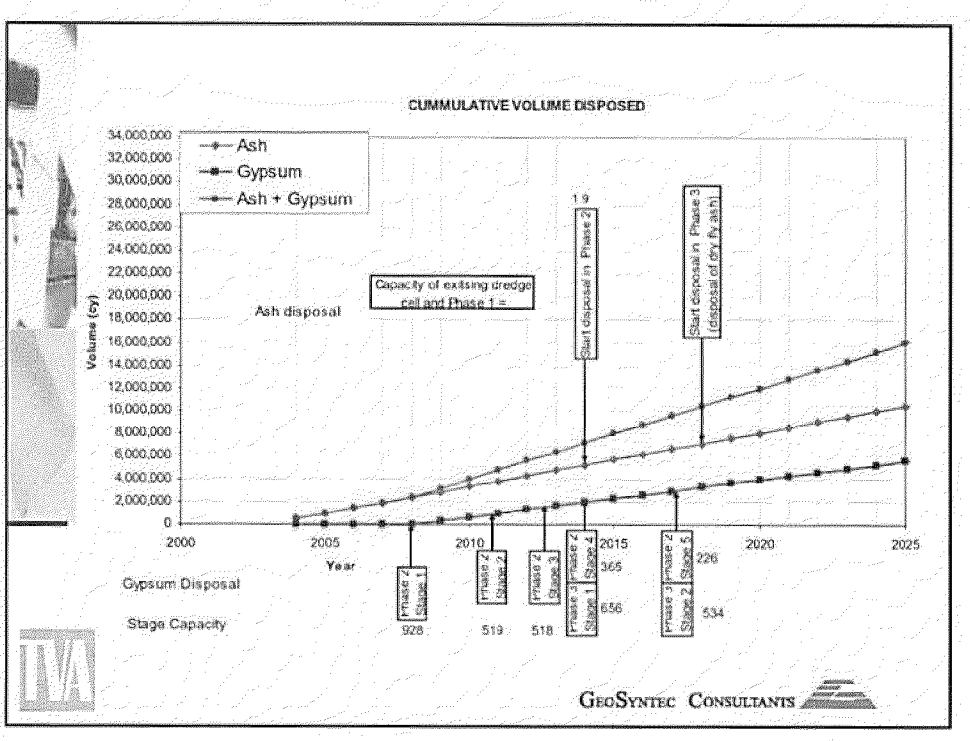

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2.4 Alternative Disposal Strategy

- When decision is made to proceed with dry fly ash management, pond is decommissioned and final build-out can be completed
- Final disposal isopach provided in report Figure 4 (provides disposal capacity for 31,460,000 cy…potential operational life to 2044 or 41 years)

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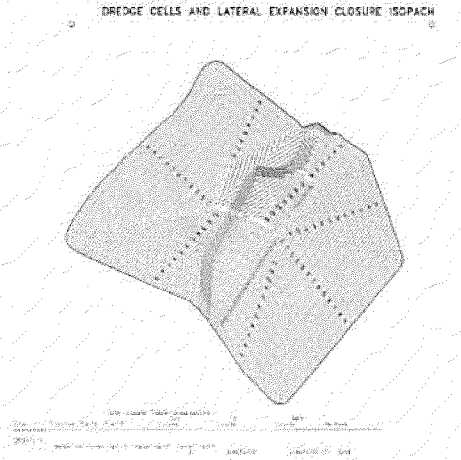
Final Site Development (report Fig. 4)



Total Potential Capacity = 31,460,000 cy

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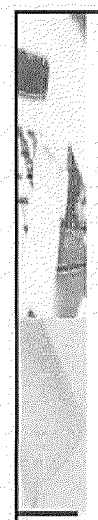

Summary and Conclusions

- Original scope of work completed
- Project is permitable and constructable
- Recommendations are provided to facilitate permitting by providing technical demonstrations
- Suggestions provided regarding techniques to enhance drainage layer performance and increase slope stability
- Alternative conceptual-level designs developed to simplify construction and operations while increasing operational life of facility

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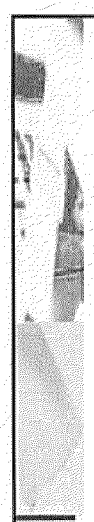

Closing

- GeoSyntec appreciates the opportunity to work with the TVA engineering, environmental, and plant operations team on the Kingston Fossil Plant project
- Questions, Comments, and Suggestions??

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Kingston Fossil Plant - By-Product Disposal
Path Forward - Taking the Geosyntec Peer Review and Move Forward
Engineering Team Recommendations:

I Pursue the Immediate Needs

A. Restore Dredging Capability for existing cells in 2005
   1. Phase 1 - Complete modeling & Prelim Engineering 28Feb05
   2. Phase 2 - 01Mar05 - 30Apr05
   3. Phase 3 - 30Jun05 - 30Sep05

B. Develop Minor Modification Request to Permit for French Drain
   1. Allows us to revise things in the permit application that is currently in the state's hands.
   2. Submit an additional drawing in the package to address Gypsum only in Phase 2/3 (see item II. D below)

II. TVA Responses to Review Comments

A. "NOD Type" Comments on Operations Manual and Drawings - Environmental Affairs to advise which of the following categories each comment would fall.
   1. Editorial comments (like Al Majors Name etc.) will be revised.
   2. Other potential NOD comments (Example: Financial Assurance) will be responded to if noted by TDEC.

B. Stability Comments
   1. Review and address all comments including:
      a. Revisit to ensure identified stability parameters are defensible
      b. Evaluate additional cross section in area that was suspected to be critical
      c. Provide basis for 0.11g acceleration in the Document
      d. Revise Veneer Stability for Defensibility
      e. Address Concerns about Liquefaction Analysis
      f. Revisit Upper Blanket Drainage Layers
      g. Resolve Differing Stratification between Models
   2. In conclusion to ensure the stability of the design we will share Parson's calculations with GeoSyntec to get total by-in that the stack is stable.

C. Seepage Comments

1. The level of the detail presented in the permit application was conceptual. Both consultants agree with the approach for correcting the seepage failure. Differences in the methodology were expressed by GeoSyntec. To insure consensus between TVA Hydrologists, Parsons, and GeoSyntec on model inputs and boundaries:
    a. Both consultants are to be tasked with analyzing the French Drain (using differing methods)
    b. Reconcile differences (if any) in model results and impacts to design
    c. Utilize the results of these analyses as the basis for the detailed to insure the optimum fix is designed.

2. The results of these analyses will be used as the basis for the detail design to be submitted to TDEC as part of the Minor Modification

D. Proposed Alternative Operating Scenario

1. All parties agree that keeping ash and gypsum separate is the preferred approach if economically defendable; no co-managing will occur until 2016.
2. TDEC has concerns about stack heights.
3. Make Minor Plans Revision to Reflect an All FGD Pond Option - Delay Permitting for Vertical Expansion until 2012.
    a. Allows time to demonstrate that design works
    b. Permitting tall by-product stacks in phases has a higher probability of success with TDEC; TDEC will likely become more comfortable as successful experience with tall stacks on existing ponds is demonstrated by TVA.