Hughes, Michael

From: Smith, Daniel R [Daniel.R.Smith@worleyparsons.com]

Sent: Monday, February 14, 2005 10:29 AM

To: Purkey, Ronald E.; Petty, Harold L.; Hughes, Michael

Subject: KIF - review of sensitivity analysis by Ash Group

Ron/Lynn/Mike:

Sorry it took me so long to complete this. I needed some uninterrupted time to digest this. Attached are a number of files. Two files (the word file and the revised summary (XL) file) should be reviewed first. The word file basically contains comments, and the revised summary file shows their summary, with a new table that I created that is below the table created by Missy/Steve.

What took me awhile is that I didn't merely just make comments. I went into their spreadsheets and made some changes, because of errorenous assumptions made by Steve and Missy. For instance, scenarios that assume 100% marketing should only compare this evenly between both the gypsum peninsula disposal (Option 1) and the pond only (Option 3). In that case, Missy still assumed dry fly ash conversion (for Option 3), when that will not occur within the study period. Also, for Option 1, it is unreasonable to assume that a 70 ac site will be built if you are going to market 100% of the material; therefore, I assume 10% of the facility footprint and 10% of the costs.

I also looked at a case where the "doughnut" drainage layer is built and with 100% marketing, it is the only Option that competes with the peninsula option (Option 1). This scenario would be hard (or impossible) to justify technically for the reasons given.

Another topic is addressed. During the phase 1 study, some of the borings revealed the existence of a potentially weaker layer of soil at the peninsula. With the available data at the time, the extent of this could not be determined. Attached to the email is an excerpt from the Phase 1 Study, as well as the Full Attachment 4 from the study that addresses this issue in more detail. We did not add any costs for this due to the fact that we don't know the full extent, and any thing we say is only a guess at this time. This uncertainty is mitigated by the fact that Missy has added over $2 million to the original estimate (this is what I assumed in my revised scenario) and the other fact that there are 2 possible footprints for the peninsula location (7 million cy capacity and 9.2 million cy capacity). We used the larger facility for cost comparisons, and the 7 million cy facility has sufficient capacity for 20 yrs of disposal, but will cost less. Yet, we used the more expensive facility in the cost comparison.

I'll be in the office tomorrow if you want to dicuss, or you can call my cell phone today.

Dan

Parsons E&C Review of Sensitivity Analysis Performed by Ash Disposal Group

(Please refer to the Sensitivity Analysis Summary Table)

1. During the 10% design review meeting, Cherie Miller discussed that the best that KIF could hope for is 50% marketing. The 100% marketing scenarios presented by the Ash Group in their sensitivity analysis does not provide any evidence that anything has changed. In fact, in a recent meeting, Steve Baugh said that in about 5-10 years the market would be saturated. Anyway, scenarios involving 100% marketing were re-reviewed by PE&C.
2. Any scenario that involves a comparison of marketing for one option should involve the same marketing for the other option. Also, no costs were determined by the Ash Group for additional infrastructure costs for marketing ash.
3. 5# coal did not seem to (in and of itself) significantly change costs, and would not affect the outcome when Options 1 and 3 are compared. These were not evaluated further.
4. Only the 25-year NPV analysis was assumed for these options.
5. Options 1-1 and 3-2 (blue) should be compared head to head. Both options assume 100% marketing. It should be noted that the cost analysis performed for the sensitivity analysis (by the ash disposal group) made assumptions regarding lower gypsum disposal costs, when no gypsum disposal is being assumed. The option was re-vamped for this analysis. Lower ash disposal costs were assumed in accordance with sensitivity analysis (by the ash group). Option 1-1 should consider a smaller footprint for the gypsum disposal, because 100% marketing is the plan going in. All construction costs were reduced to 10% (7 ac footprint vs 70 ac). This is a reasonable assumption to allow gypsum bypass to occur. Option 1-1 is still less expensive based on a 25-yr NPV analysis.
6. To extend the sensitivity analysis further, another option (3-2A) was created to further evaluate Option 3-2. 3-2A extends 3-2 by assuming 100% marketing (this means all ash in the pond), and a reduced drainage layer. The cost difference is very slight (favoring Option 3-2A by less than $0.5 million). See Item 6 below for an explanation of conservatism used in the Peninsula Options. However, there are a number of technical hurdles to overcome. These are:
   a. Stability of ash without the full drainage layer is less certain. Ash has a lower hydraulic conductivity, and the footprint of the drainage layer may need to be larger than with gypsum (possibly full footprint). Also, gypsum has higher strength than ash, so the use of ash only in concert with a reduced drainage layer may be problematic.
   b. The maximum elevation of wet-placed ash was 870 (assuming a full drainage layer). This could be reduced without the full drainage layer and would require greater dry flyash, thus moving dry flyash conversion up in the schedule (higher NPV).
   c. The hydrogeological report submitted to TDEC would have to be amended to evaluate the smaller drainage layer. This has two drivers – (1) If the

reduced drainage layer is less effective in protecting groundwater, it will be rejected, and (2) Increasing the likelihood of dry flyash would have negative consequences for approval of a facility without a liner.

7. Options 1-2 and 3-1 (red) should be compared head to head. Costs for Option 1-2 were increased for karst remediation, as suggested ($1.9 million). However, the assumptions that the existing clay is not suitable are unfounded. Although hydraulic conductivity testing has been done, geotechnical testing (atterberg limit testing) indicates that the clay would most likely meet the 1 x 10^{-6} cm/s hydraulic conductivity buffer standard set by TDEC. The peninsula is located in the Knox formation, and typically this formation has limestone bedrock (greater potential for karst), and the rock weathers to a clay soil classified as CL or CH. Plasticity index values are usually greater than 20 (needs to be verified). The data from the Singleton soil borings in 1988 showed a great deal of consistency between borings (as I recall). The Law Engineering Report may have hydraulic conductivity values. TVA may be able to make the case for the geologic buffer (without modifications), but the cost estimate assumes a 3-ft recompacted liner. Option 1-2 is about $1.5 million less than Option 3-2.
8. The largest footprint for the Peninsula was used as the base case for comparison with the Pond disposal options. A reduced footprint was developed during the Phase 1 Study, that has lower capital costs and 7 million cy of capacity (this provides greater than 20 years of capacity with 2.8# coal). Furthermore, the costs are about 21% less than the option (9.1 million cy capacity) assumed for the comparison. This would further reduce the costs for the Peninsula, and avoid what is likely the most problematic karst areas of the Peninsula. A lateral expansion could be effected by moving up the hill later on.
9. The peninsula site does have some inherent uncertainties, including karst, as well as a potential soft zone. It was not possible to fully characterize this soft layer during the phase 1 Study. No additional costs have been included for this, although including at nearly $2.5 million added to the estimate for karst remediation, coupled with the fact that the smaller footprint will provide 20 years of gypsum disposal capacity (assuming 2.8# coal), reduces this uncertainty a great deal. Attached is an excerpt from the Phase 1 Study for the Peninsula (Attachment 4). The entire attachment is appended to the email.

Specifically for Peninsula Site

Based on Reference 2 data, an approximately 20-foot thick soft soil layer (soil layer 4 in the STED model) may exist approximately 20 feet below existing ground surface. This layer, if large in extent may have a significant effect on the overall stack stability. Future investigation should verify the extent, in-situ strength and deformation characteristics of this soil as well as those of the overlying stiffer soil. The top of rock contours should also be closely verified, along with the presence of solution cavities. Measures such as gravel columns along with a stone blanket below the impervious liner may be required to stiffen the soft soil if its extent is large and significant to the stack stability.

The design of a dry stack system to the configurations shown on the drawings should be feasible from a global stability standpoint.

A wet stacking system should be feasible at the Peninsula site; however, the wet stack may need to be modified from the stack configurations currently shown on the drawings. The final design of a wet stack may include flatter slopes and/or a shorter stack to obtain an adequate global factor of safety during a design seismic event, especially if the soft foundation soil beneath the stack extends over a significantly large area.

Option	Description	25 year Present Worth	10 year Present Worth	5 year Present Worth	2008 Cash Flow	Gypsum Marketing	Dry Ash Conversion	Drainage Layer	Coal	Other considerations
1	Peninsula, Base Case	$ 23,751,838				No	N/A	N/A	2.8 #	
1-1	Peninsula with marketing	$ 16,435,017				Yes	N/A	N/A	2.8 #	100% marketing after 2011
1-2	Peninsula with cost escalation	$ 25,160,922				No	N/A	N/A	2.8 #	
1-3	5# coal, no marketing, peninsula	$ 24,342,282				No	N/A	N/A	**5 #**	
1-4	5# coal with marketing, peninsula	$ 23,751,838				No	N/A	N/A	**5 #**	
3	In pond, Base Case	$ 30,166,737				No	2016	Parsons	2.8 #	
3-1	In pond, reduced drainage layer, marketing and other considerations	$ 26,585,681				No	2019	50% Cost of Parsons	2.8 #	Reduced fly ash handling cost per JEA; reduced gypsum handling cost (same as Option 1)
3-2	In pond, marketing and other considerations	$ 18,458,723				Yes	2019	Parsons	2.8 #	Marketing 100% gypsum enables dry flyash conversion to be postponed beyond study period. Lower ash costs assumed.
3-2A	In pond, marketing, reduced drainage layer, and other considerations	$ 16,030,613				Yes	2019	50% Cost of Parsons	2.8#	Marketing 100% gypsum enables dry flyash conversion to be postponed beyond study period. Lower ash costs assumed. Lack of full drainage layer has not been evaluated for structural stability, and hydrogeo report would have to be revised.
3-3	5# coal, no marketing, in pond	$ 31,925,701				No	2015	Parsons	5 #	
3-4	5# coal with marketing, in pond	$ 28,962,461				Yes	2017	Parsons	5 #	

KIF Pond vs Peninsula - Sensitivity Analysis Summary

Option	Description	25 year Present Worth	10 year Present	5 year Prese	2008 Cash	Gypsum Marketing	Dry Ash Conversion	Drainage Layer	Coal	Other considerations
1	Peninsula, Base Case	$ 23,751,838	#######	####	###	No	N/A	N/A	2.8 #	
1-1	Peninsula with marketing	$ 22,966,026	#######	####	###	Yes	N/A	N/A	2.8 #	100% marketing after 2011
1-2	Peninsula with cost escalation	$ 26,079,479	#######	####	###	No	N/A	N/A	2.8 #	
1-3	5# coal, no marketing, peninsula	$ 24,342,282	#######	####	###	No	N/A	N/A	**5 #**	
1-4	5# coal with marketing, peninsula	$ 23,751,838	#######	####	###	No	N/A	N/A	**5 #**	
3	In pond, Base Case	$ 30,166,737	#######	####	###	No	2016	Parsons	2.8 #	
3-1	In pond, reduced drainage layer, marketing and other considerations	$ 21,279,352	#######	####	###	Yes	2019	50% Cost of Parsons	2.8 #	Reduced fly ash handling cost per JEA; reduced gypsum handling cost (same as Option 1)
3-2	In pond, marketing and other considerations	$ 23,707,462	#######	####	###	Yes	2019	Parsons	2.8 #	Reduced fly ash handling cost per JEA; reduced gypsum handling cost (same as Option 1)
3-3	5# coal, no marketing, in pond	$ 31,925,701	#######	####	###	No	2015	Parsons	5 #	
3-4	5# coal with marketing, in pond	$ 28,962,461	#######	####	###	Yes	2017	Parsons	5 #	