“Finding Redemption” – Ash Pond Closures in Light of Proposed Federal CCR Rules

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ABSTRACT

Understanding that no one knows the future, learn how this Midwest utility turned a liability into an asset in a strategic management move that will position them to better weather the oncoming storms of the proposed CCR rules. In an environment where coal-fired utilities are at times short on cost-effective solutions for long-term management of wet handling systems, this western coal-fired plant converted old ash ponds into dry ash handling units in a permitting and construction schedule of under 2 years (concept to operation).

Using a strategic team consisting of plant, corporate and consultant resources, planning and execution of this project became a reality on a defined budget using proven operational controls and engineering common sense. Geotechnical principals and best CCR management practices were combined to build a new pond and landfill system that smartly manages leachate/contact water effluent discharge and other appurtenant systems in an environmentally protective manner. In an era of regulatory non-stop “over-regulation”, see how this utility is finding redemption that will help them survive in a post-CCR Regulated environment.

The 20-year solution discussed in this paper, has helped the client achieve multiple layers of compliance (satisfying both Subtitle D and C requirements and closing of an idle ash pond) and achieved a net cost-avoidance of approximately $45M: $40M in disposal avoidance, and $5M in avoided pond closure costs.
INTRODUCTION

This paper addresses the journey of a Midwest Utility faced with a problem common to many older coal-fired power stations – namely, waning wet pond capacities and a pressing need to create and implement a long-term cost-effective plan to manage their CCR’s. The plant featured in this case study burns Powder River Basin (PRB) coal and has a yearly production ranging from 50,000 to 60,000 tons per year of combined bottom and fly ash. Traditionally, up to 60% of this facility’s Class C fly ash was sold to the ready-mix market, and a lesser percentage of bottom ash was sold for snow and ice control and various low-volume beneficial reuses. The remaining CCRs were disposed of in on-site wet ponds. This provided a fairly low maintenance and relatively low-cost disposal management program for decades at the plant.

Like many good things, they come to an end. And so was the case when this plant’s wet pond started to show regular exceedances of total suspended solids (TSS). In the near-term, TSS exceedances were managed with “traditional fixes” including manipulation of the pond’s outlet structure, the installation of floating curtains, dosing with chemical flocculants, and ongoing relocation of the pond’s ash intake location. However, it was clear that the pond’s wet storage capacity had a limited future. In addition, recently installed air quality control devices were potentially impacting fly ash quality and the economic recession and associated slow-down of the construction market was resulting in reduced ash sales and considerably more ash being wet-sluiced into the facility’s wet ponds. As expected this further exacerbated the problem with pond discharge exceedances and those tried and true traditional fixes were now proving less effective.

This was the time that CEC was engaged to help this utility work through the evaluation and development of a new CCR management plan which is discussed in this paper.

PROJECT CHALLENGES

Like most of us, we like to do things “the way that we have always done it” and we hear from others, “that works just fine the way it is - thank you”. Even though the hope of plant staff and corporate management was to see relief from things like a revived economy (e.g., improved ash sales, increased power demand and/or increased rates), the advent of new cost-effective technology or management techniques (e.g., ash briquetting or say wet stacking on the existing ponds) etc., the reality was that the onsite wet-pond system was near capacity and some major shifts in ash management needed to occur to support cost-effective longer term CCR management. To add additional burden to the already stressed system, power sales/pricing was down (also due to the recession) and capital/operational budgets were tightening.
CEC, along with the company’s environmental and large projects team went to the drawing board to look at ways to update and enhance the facility’s ash management system. Both on-site wet and dry ash management systems along with off-site disposal options were explored using robust financial tools and an engineering assessment to ensure that we produced a defensible study which could be supported presented to and defended before company upper management.

Some site-specific challenges included constraints of developable space for new ash disposal facilities. Those constraints included:

- An appreciable portion of the plant’s contiguous property was within the 100-year flood plain;
- Older ash ponds previously filled during an era when the plant burned eastern coal were dormant and occupying critical real estate;
- Regulatory determinations were in place limiting use of former disposal areas on site; and
- Land surrounding the plant was not available for purchase or would not meet the state’s disposal facility siting criteria.

With these and other challenges being faced, the solution for the site needed to have a short permitting and development timeline (due to the limited on-site capacity remaining in the facility’s wet pond system) and needed to meet all state and federal regulations and other ancillary plant permits. In addition, proposed solutions could not adversely impact current plant management operations and needed to satisfy strict funding criteria.

**FINANCIAL ANALYSIS, FEASIBILITY& MANAGEMENT DECISION MAKING**

After other relevant criteria are assessed and weighed in the balance, bottom-line costs (both near-term capital and long-term operational costs) drive most, if not all discretionary business decisions. CEC performed a feasibility study to assess all viable CCR management options as mentioned previously including both wet and dry on-site handing and traditional off-site disposal.

As with all sound disposal plans, beneficial reuse/ash sales were acknowledged (regarding potential future impacts to disposal quantity variability), but were assumed zero for the purpose of estimating long-term disposal requirements (i.e., a worst-case scenario). The feasibility study was prepared with a senior management audience in mind, knowing that the management team would subject the plan to rigorous scrutiny and would be looking for the most cost-effective environmentally compliant solution.
In addition, cultural and material management hurdles were also in-place adding to the challenges of this project including the following:

- **Wet vs. Dry Ash Management** - this utility’s entire coal-fired fleet was engaged in wet ash disposal management and had not to date operated dry ash disposal systems (e.g., dry ash landfills). This lack of experience understandably created some inherent barriers to the idea of dry ash disposal;

- **Handling of Class C Ash** - problems associated with wet handling of Class C ash had been overcome with facility specific solutions (some of this client’s plants pneumatically trucked ash to ponds and then used water cannons to mix and discharge ash into wet ponds, other plants pug-milled ash and trucked/dumped ash into wet ponds). Although water cannons used to wet sluice ash were considered by the plants to be cost-effective, these practices had been conducted without a realization or detailed evaluation of the actual cost per ton (findings from the feasibility study proved otherwise);

- **Installation of Recent Air Quality Controls** – the plant had like many other US coal-fired plants, undergone several recent air quality control upgrades and installations which were changing the ash quality and handling standards posing ongoing operational challenges. The idea of adding additional changes to the plants ash management and disposal systems could have been interpreted by some as an unwelcome change.

For this and other reasons, the feasibility study not only needed to include sound engineering and financial analysis, but had to provide solid justification and a well thought out roadmap for potentially significant changes to the plants’ ash management status quo. In addition, the plan needed to:

- Manage liability & support environmental stewardship – the plan needed to be consistent with the clients’ liability and risk tolerance and had to promote environmental stewardship;
- Incorporate principles that reflected the clients’ business philosophy; and
- Consider all current and future regulatory mandates.

To achieve these goals, a project team was assembled that included CEC technical staff as well as the client’s plant and corporate staff. Engineering studies included on-site subsurface investigations, ash chemical characterization and geotechnical testing along with a regulatory and siting review to ensure that all recommended solutions met minimum threshold criteria. Cash flow and total capital costs were presented for all options including current dollar per ton costs and projected future costs with matching project timelines and permitting summaries. A few highlights from the financial analysis and feasibility study are presented in **Figures 1 and 2**.
### Comparison of Disposal Options

#### One time T&D of approximately 200,000 tons of ash from pond [Pond Clean-out]

<table>
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<tr>
<th>Item</th>
<th>Amount (tons)</th>
<th>Transportation Cost</th>
<th>Disposal Cost</th>
<th>T&amp;D Cost</th>
<th>Total Cost</th>
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#### Routine T&D of approximately 150,000 tons per year of fly ash [with current fly ash sales]

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<th>Item</th>
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<th>Disposal Cost</th>
<th>T&amp;D Cost</th>
<th>Total Cost</th>
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<tbody>
<tr>
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<td>$25.00</td>
<td>$25.50</td>
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<td>$7,575,000</td>
</tr>
</tbody>
</table>

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**FIGURE 1**

**Comparison of Disposal Options**

**FIGURE 2**

**Cash Flow Analysis of Options**
After due process and analysis, the conclusion and recommendations from the feasibility study included on-site dry ash landfilling with 20+ years of capacity in conjunction with installation of pin mixers to pre-condition the reactive Class C ash prior to landfilling. Landfilling will be achieved with an innovative use of an old 45-acre ash pond (Former Pond No. 2 – Figure 3) and a reconfiguring of existing operational wet ash ponds to better handle all plant wastewater streams. A new revetment-lined reclamation bottom ash pond was added to the overall solution as well.

Our 20-year solution helped the client achieve multiple layers of compliance - satisfying potential future Subtitle D and C requirements and closing of an idle ash pond and a net cost-avoidance of approximately $450M; $40M in disposal avoidance and $5M in avoided pond closure costs.

In addition, the plan achieved a net cost-avoidance of approximately $45M; $40M in disposal avoidance and an estimated $5M in avoided pond closure costs.

A schematic overview of the new ash management plan (landfill and pond combination) for the site is shown in Figure 4. The technical details of that recommended solution will be discussed in supplemental sections of this paper.
REGULATORY OVERVIEW AND PERMIT VENUE

Not the least of all other considerations for this project was the current potential future regulatory venue for CCR management solutions. This plant’s state solid waste regulatory framework provides for on-site CCR landfilling under “exempt status” as long as certain requirements are met (e.g., landfill is located on contiguous power plant property, only waste from that plant is disposed of in the landfill, etc). Not with-standing the conditions of that exemption, the state’s current CCR disposal regulations are compliant with federal Subtitle D requirements. The exempt status provides for a streamlined permit preparation and submittal requirements.

The TVA Kingston failure occurred in December 2008, changing dramatically the way the industry looks at ash disposal management. The ensuing draft federal regulations which propose a two-track Subtitle C or D approach to future regulation of CCRs caused the client and our project team to pause and consider how our recommended plan would meet either Subtitle C or D (as proposed by the US EPA in their draft regulations circa 2009/2010). The prospect of Subtitle C weighs heavy on the client as with most utilities’ that see the threat and stigma of “hazardous waste” as overwhelming. In that context, our client saw the opportunity to prepare for the “oncoming regulatory storm” and as a consequence, the landfill and ash handling system were designed to meet both Subtitle C and D requirements (composite liner, siting criteria satisfied, etc).
DESIGN & CONSTRUCTION

As mentioned earlier, the recommendation from the feasibility study was to pursue on-site dry ash landfilling and installation of pin mixers to pre-condition the reactive Class C ash prior to landfilling. It was determined that the most cost-effective approach would be to “close in place” and construct the new landfill over the former Pond No. 2 (45-acre ash pond footprint). That particular pond is located proximate to the active primary and secondary ash ponds (which will be kept in operation), and can be serviced by the existing network of plant roads and active NPDES discharge. In addition the overall updated ash management plan included maintaining intermediate-term operation of the plant’s primary pond for all other on-site periodic discharge flows (e.g., sump discharges, wash-out platforms, maintenance cleanings, etc). A small reclamation bottom ash pond is included in the overall plan; that pond will be built with the construction of a subsequent phase of the landfill build-out. To handle stormwater and leachate flows from the new landfill, a new pond was included in the design. The new 8-acre pond (Pond 2E) discharges back through the plant’s existing secondary (polishing) pond prior to discharging to the plant’s north-end NPDES.

Design and Subsurface Investigations

The footprint of former Pond No. 2 was idle for more than 10 years with some vegetative cover and low-lying areas that regularly collected and drained stormwater (Figure 5). A complete site investigation (Figure 6) was required to support all needed design and geotechnical assessments including slope stability (static and dynamic), settlement (elastic and consolidation), liner subgrade constructability (use of existing ash in the former No. 2 Pond) along with updated hydrogeologic and groundwater modeling (site already had groundwater monitoring network and groundwater management program in place).
Wet, unconsolidated ash subgrade layers were found during the subsurface investigations in the footprint of former Pond No. 2 was of concern (Figure 7a and 7b). Issues of foundation stability (i.e., deep seated failure potential considering the proximity of the Former Pond No. 2 exterior slopes proximate to a navigable waterway), settlement, liquefaction potential, and of course constructability (installation of a compacted liner system for the newly proposed landfill) were all potential issues associated with both short and long-term performance of the planned landfill. The presence of these hyper-saturated ash layers (at existing grade and at depth) added to the design and constructability challenges associated with building a dry ash landfill over former wet ash ponds.
Additional in-situ and laboratory geotechnical testing were performed to raise the level of confidence with the selection of appropriate design parameters including accommodations for predicted long-term settlements (estimated at 2 feet+/-) and subgrade stabilization. Supplemental groundwater monitoring and modeling were also performed to assess potential impacts of surcharge loadings associated with the landfill stack (up to 60-foot vertical dry stacking of ash in permit design) on underlying groundwater quality.

“The presence of these hyper-saturated ash layers (at existing grade and at depth) added to the design and constructability challenges associated with building a dry ash landfill over former wet ash ponds.”
Surprisingly, the presence of the wet foundation layers did not turn out to be as much of an issue as originally suspected for overall stability (Figure 8). A settlement crown as shown in Figure 9 was incorporated in the design to compensate for predicted elastic and consolidation settlements, and subgrade stabilization layers were added under liner systems (as shown in subsequent construction sequence photos presented in this case study).

Stormwater and leachate design and management was developed to address both short-term and peak long-term events as a function of the development plan for the new landfill. That plan included a four phase build out with 25-year total dry storage capacity (as shown in Figure 4), the initial three phase at grade and a final phase (Phase 4) to be built atop the previously completed three phases. All water management is designed as gravity feed with split-flow leachate collection/drainage minimizing fill required to combat settlement and minimize ongoing operation/maintenance and related costs. The leachate collection/conveyance network as designed allows each of the three base phases to operate independently should supplementary regulatory drivers require additional modifications to the landfill’s liner systems. As part of the new plan, a current bottom ash reclamation area would eventually be replaced with a revetment-lined bottom ash pond at the far end of the new landfill.

Construction Phase 1

In 2009, construction of the design/permit package began. Construction was worked from east to west in the former pond footprint. As such, the new stormwater/leachate pond (Pond 2E) was built first, which is where much of site-specific construction learning curve was developed by the contractor; in particular, the management and constructability of subgrades and use of ponded ash in the mass balance for the construction project. CEC provided full-time resident engineering and CQA for the duration of the project.
The following is a series of construction photos that illustrate the sequential build-out of the Phase 1 Landfill, Pond 2E and appurtenant structures.

Pond 2E Early Construction:
Site-specific learning curve with ponded ash subgrades

Pond 2E Construction:
Effective grading via tandems and large capacity track hoe
Pond 2E Construction:
Geogrid and subgrade improvement layer utilized to provide base for clay liner compaction

Pond 2E Construction:
Compacted clay liner installation
Phase 1 Landfill Construction:
Ash settlement crown and subgrade improvement layer construction

Phase 1 Landfill Construction:
Composite clay liner and FML installation
Phase 1 Landfill Construction:
Conveyance piping installation

Phase 1 Landfill Construction:
Leachate drainage layer installation over composite liner
LESSONS LEARNED AND APPLICATIONS FOR OTHERS

The following are practical applications and lessons learned from this innovative ash management project:

- In an era of regulatory non-stop “over-regulation”, our client was able to “find redemption” and save on long-term disposal and environmental management costs to the tune of $45M over the next 20 years (which will help them survive in a post-CCR Regulated environment).

- We would advise other utilities pursuing updated CCW management plans to look at construction/implementation costs carefully, assessing real costs not perceived costs. Guard against the mentality - “that’s the way we’ve always done it” – it is not always the most prudent or cost-effective solution.

- Permitted landfill airspace is money in the bank especially space that can accommodate draft or proposed regulations like the FederalSubtitle D and C regulations proposed in 2010.

- Guard against saving pennies but wasting dollars – commodity $’s (e.g., upfront planning and engineering monies invested) generally gets you commodity design. Sometimes that’s appropriate; and there are cases where that is not prudent. Significant company and construction dollars can be saved with good engineering and strategic planning.

- Keep in mind $1 of real (in hand) disposal avoidance cost is better than $2 prospected (promised) marketing revenues. Permitted, cost-effective on-site
disposal airspace requires strategic, forward-looking planning. Find your best internal resources and team them with a knowledgeable consultant with a proven track record in the CCR management arena.

For more information on this project and other strategic solutions and technical services that CEC can provide your company, contact:

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