Widows Creek CCR Facility Closures Lessons Learned

Chris Jones¹, Robert Fuller¹, James Mullins²

¹ Stantec, 3052 Beaumont Centre Circle, Lexington, KY 40513
² Tennessee Valley Authority, 1101 Market Street, Chattanooga, TN 37402

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ABSTRACT

The Tennessee Valley Authority has recently completed closure construction for their coal combustion residuals (CCR) disposal units at the retired Widows Creek Fossil Plant. The facilities included a gypsum stack, dredge cell, and ash pond. These units consisted of nearly 500 acres of disposal footprint and were closed in place. This paper discusses lessons learned from the closure of these facilities associated with dewatering, instrumentation monitoring, stormwater management, CCR handling, and CCR preparation.

The closure construction was completed between 2014 and 2018. The gypsum stack was the first unit closed and lessons learned from the closure of this unit were incorporated into the design and construction of the ash pond and dredge cell closures. Closure of the gypsum stack and dredge cell were aided by the implementation of a preclosure design package to initiate dewatering of the facility and promote positive drainage on units that had minimal drainage while in operation. Dewatering resulted in conditions suitable for subgrade preparation and cap construction by the closure contractor.

Piezometers were utilized to monitor the effects of the dewatering effort, monitor pore pressure response due to CCR placement, and identify areas with high phreatic surfaces that may lead to constructability issues. Magnetic extensometers were installed to monitor settlement during construction, which was used to predict the subgrade volume balance during construction and modify design grades as required to maintain a balanced site. The instrumentation was critical to the success of the project.
INTRODUCTION

The final three CCR disposal facilities were recently closed at the retired Widows Creek Fossil Plant located in Stevenson, Alabama. The facilities included a gypsum stack, dredge cell, and main ash pond (which includes the bottom ash stack, asbestos, and C&D landfill) (Figure 1). These units consisted of nearly 500 acres of disposal footprint and were closed in place.

The Gypsum Stack is a 160-acre unit consisting of an initial clay perimeter dike that was used to store comingled gypsum and fly ash. The stack was raised during operation using the upstream method of construction. At closure, the stack was approximately sixty feet tall, with a top area of 100 acres and was operated using the rim-ditch method to excavate, dry, and place CCR material. The northwestern half of the Gypsum Stack had a pool until closure construction.

The Dredge Cell and Main Ash Pond were closed concurrently following completion of the closure of the Gypsum Stack. These two units are adjacent with a combined area of 400 acres. Both units consist of a 35-foot tall perimeter clay dike with the Dredge Cell having an additional 10-foot tall dike constructed with bottom ash. The facilities were used to treat CCR consisting of fly ash transport water, bottom ash transport water, and minimum gypsum transport water.

Prior to closure, the Dredge Cell was inactive with a relatively flat top and minimal drainage features. The total area of the Dredge Cell was approximately 140 acres. The Ash Pond, with a total area of 260 acres, was active and continued to receive process flows from the retired plant during the first 9 months of closure construction. During operations, sluiced CCR was deposited into a central ditch. There were three pond areas from the end of the ditch at the eastern edge of the Ash Pond to the outlet pipes. Process water was then discharged through a series of Stilling Ponds prior to discharge into the Tennessee River.
Figure 1. Widows Creek Plant Overview
GYPSUM STACK CLOSURE PLAN

The closure plan for the Gypsum Stack consisted of regrading the perimeter slopes to 3H:1V, grading the top of the stack to drain to outlet pipes, and constructing a final cover system consisting of a geomembrane, geocomposite, and protective soil cover with vegetation. The cover system terminated in the perimeter clay dike. The subgrade plan utilized a balanced cut and fill scenario that minimized the total volume while eliminating the need for borrow material to achieve subgrade. Figure 2 depicts the pre-closure conditions, closure conceptual plan, and post-closure conditions of the Gypsum Stack.

ASH POND AND DREDGE CELL CLOSURE PLAN

The closure plan for the Dredge Cell and Ash Pond consisted of regrading the perimeter clay dike slopes to 3H:1V and grading the CCR material within the perimeter clay dikes to drain to stormwater ditches which flow to culverts and flumes located around the perimeter of the facility. The cover system consisted of a geomembrane, geocomposite, and protective soil cover that terminated in the crest of the clay perimeter dikes.

Closure of the Dredge Cell and Ash Pond was challenging due to a lack of equipment access on the Dredge Cell and ponded areas of the Ash Pond. The balanced subgrade design for the projects included excavation from the bottom ash stack area, knowing that bottom ash could be utilized as a bridging material to provide initial equipment access to previously ponded areas. Also, dewatering of the Ash Pond could not occur until process flows from the plant were eliminated or rerouted. By delaying the initial pond dewatering, ash handling and placement in the previously ponded areas was more difficult due to saturated conditions of the ash.

Due to the lack of relief and drainage at the Dredge Cell, the pre-closure phreatic surface was only three to four feet below the ground surface. A dewatering project was initiated prior to closure to construct dewatering ditches that drained to six sump locations. The material from the ditches was regraded in the center of the facility to
promote positive drainage and support future closure subgrade elevations. In order to construct the ditches, bottom ash was excavated from the Main Ash Pond and hauled to the Dredge Cell for use as bridging material for access roads.

At the Ash Pond, a drawdown of the operational pool was necessary as construction progressed. The operational permit required a minimum volume of free water. Once construction progressed to where this storage volume was no longer feasible, the regulatory agency required increased water quality monitoring. Drawdown was achieved by utilizing the existing siphon system at the facility for as long as possible, then switching to diesel pumps to pump the water to the Stilling Ponds prior to discharging through the permitted outfall. Figure 3 depicts the pre-closure conditions, closure conceptual plan, and post-closure conditions of the Ash Pond and Dredge Cell.

Figure 3. Ash Pond and Dredge Cell Closure Plan

LESSEONS LEARNED

There were many lessons learned throughout the design and closure of the three CCR facilities. The pre-closure grading plan that was implemented at the Gypsum Stack and Dredge Cell was a great benefit during project scoping and initial subgrade preparation. While in operation, these facilities were poorly drained, which resulted in relatively high phreatic levels. The pre-closure grading plans improved the site suitability for closure contractors to evaluate during the bidding process and work during closure construction. These plans consisted of regrading the CCR material so that stormwater would drain to a series of ditches. This reduced the recharge of the facility following storm events prior to closure and enabled the facility to begin dewatering. By preparing the site prior to closure construction, the closure contractor had better access to the site improving the overall closure schedule.

A second lesson learned was the use of multiple drainage areas in the final closure configuration. This grading design allowed the closure contractor to better sequence their work, discharge stormwater through outfalls as construction was completed in discrete watersheds, and balance subgrade as construction progressed by modifying grades in unique watersheds without affecting drainage in already completed areas.
A third lesson learned was to take full advantage of available instrumentation. Piezometers and magnetic extensometers were used to monitor the phreatic levels and settlement, respectively. Piezometers were monitored weekly in areas of active construction. This data was shared with the construction management team and contractor to help predict areas that could be worked efficiently (where phreatic levels were low) and areas where additional dewatering or other methods may be required (where phreatic levels were high). The effectiveness of dewatering efforts were also analyzed using the piezometer levels to determine if sumps needed to be lowered to reduce the phreatic surface to facility subgrade and cover system construction. The magnetic extensometers were used to monitor settlement. These were located where large fill placement was planned. The settlement data was compared to predicted values from the design to verify expected performance and confirm that final grades following settlement would be adequate. The data was also compared to reported volume numbers from the contractor to verify material loss percentages and modify the designed subgrade to maintain a balanced site. The closed configurations of the facilities is shown in Figure 4.

Figure 4. Widows Creek Closed CCR Facilities
CONCLUSIONS

TVA successfully closed over 500 acres of CCR facilities at Widows Creek Fossil Plant. The success of the closure projects was aided by the implementation of pre-closure grading projects that promoted positive drainage, worked towards planned subgrade elevations, and presented a more constructible site for closure contractors during the bidding and procurement process. The closure plans utilized a balanced subgrade design with flexibility in the final grades so that the design could be modified during closure construction. During construction, instrumentation was used to help the closure contractor predict the workability of subgrade areas and monitor settlement. This information was then used to modify the design to maintain a balanced site as construction progressed and actual subgrade loss percentages were calculated. These lessons can be implemented on future closure projects to create successful projects.