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D'APPOLONIA

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REPORT

Structural Integrity Review for CCR Closure Plan
Plant Barry
Alabama Power Company
Bucks, AL

Prepared for

Mobile Bay National Estuary Program
Mobile, AL

Prepared by

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PREFACE

D'Appolonia Engineering Division of Ground Technology, Inc. (D'Appolonia) has prepared this report at the request of the Mobile Bay National Estuary Program to present the structural integrity review for the Coal Combustion Residuals (CCR) Closure Plan developed by Alabama Power Company for the Plant Barry Steam Plant near Bucks, Mobile County, Alabama. Our review services consisted of the tasks described in our proposal dated January 7, 2020, which was authorized by MBNEP on January 21, 2020.

D'Appolonia performed its review of the CCR Closure Plan with the expressed purpose of evaluating relevant aspects of the engineering, design, and permitting to identify potential areas of concern or gaps in information that may be important to decision making, with respect to structural integrity and performance. Public information on the facility has been reviewed and supplemented with engineering documents provided by Alabama Power Company to aid in understanding and assessing the closure design and anticipated performance. Many of these engineering documents are not public, such that the results of specific engineering analyses are not contained in this report.

EXECUTIVE SUMMARY

The Plant Barry Coal Ash Pond owned by Alabama Power Company (APC) consists of a 597-acre impoundment of Coal Combustion Residuals (CCR) located in Mobile County, on the Mobile River near Bucks. APC is planning closure of the Ash Pond, which will include removal of CCR materials in perimeter locations and maintaining the CCR materials in the central portion of the site. Concerns have been raised regarding the presence and safety of the Plant Barry Ash Pond adjacent the Mobile River. The Mobile Bay National Estuary Program (MBNEP) contracted for D'Appolonia Engineering Division of Ground Technology, Inc. (D'Appolonia) to perform a review of the APC closure plan for the Plant Barry Ash Pond relative to structural integrity. This executive summary presents D'Appolonia's findings and recommendations.

The Amended Closure Plan for Ash Pond (July 2019) was submitted to the Alabama Department of Environmental Management (ADEM) and presents the phased sequencing and procedures to meet the closure performance standards when leaving the CCR in place. The amended plan includes: dewatering of the pond to initiate stabilization of the saturated CCR; removal of CCR from the east, south, west, and a portion of the north perimeter and consolidating these materials within an approximate 330 acre footprint in the center of the disposal area; developing an equipment/material storage yard and access corridor on the balance of the north perimeter; constructing a soil containment berm and stormwater management facilities where CCR materials have been removed; and installation of a cap system to isolate the CCR materials and control infiltration.

Structural Assessment

Acceptable structural performance is demonstrated by the Amended CCR Closure Plan procedures, design, and engineering analyses that are supported by the site characterization and the design criteria adopted based on USEPA and ADEM regulations and other industry guidance.

Dewatering and stabilization procedures and excavation plans have been developed considering the saturated, loose nature of the CCR identified in exploration and testing programs. These steps in the closure process are critical for overall implementation. Additional exploration planned following dewatering and pre-loading should provide refined characterization of CCR shear strength and depth in excavation areas, allowing for adjustments in the design based on updated stability assessments if necessary. Geotechnical monitoring to confirm the behavior of the foundation and performance of the closure structures will be critical. In addition to focusing on foundation soils, the geotechnical monitoring program should also include the CCR material to confirm design expectations for interstitial (internal) drainage from the CCR, interim cut-slope stability, buildup of pore pressures at the base of the consolidated CCR area, and performance of the internal drainage system. It is recommended that a detailed monitoring program be documented as part of the closure plan.

The stability, seepage, and settlement analyses performed focus on critical areas along the east, southeast, and west perimeter dikes, the CCR soil containment berm, and consolidated CCR area in the central portion of the site. The development of an equipment/material storage yard and evacuation access corridor is planned in the northwest corner of the Ash Pond; it is recommended that the CCR saturation conditions and slope stability of the perimeter dike under closure conditions be assessed and anticipated performance established.

Stormwater Management and Slope Protection

The consolidated CCR area in the central portion of the facility, the soil containment berms and stormwater ponds, and the stormwater settling basin in the south portion of the facility include cover systems and channels, culverts, and ponds that should resist erosion and protect slopes within the closed facility based on industry design criteria and ADEM requirements. Overtopping of the perimeter dikes from floods whether occurring within the site, or on the Mobile River, including coastal storm surge, should not occur based on the established design criteria. Riverine floods on the Mobile River could inundate a substantial portion of the exterior slopes of the perimeter dikes. It is recommended that the potential for erosion of the exterior slopes of the perimeter dikes from riverine floods be evaluated and measures for protection and maintenance be considered if necessary.

Operation, Maintenance, & Inspections

APC conducts operation and maintenance activities under an Operation Plan that includes recordkeeping and updating of plans and structural assessment. These activities are required under ADEM rules, and updating of plans and assessments as closure progresses, and particularly following additional exploration and in response to monitoring, would communicate necessary changes to the closure plan and update the structural assessment to ADEM and other stakeholders.

The Amended CCR Closure Plan includes requirements for weekly inspection for structural weakness and for proper operation of outlet structures maintained for use during closure. Annual inspection reports by a qualified professional engineer throughout the closure process communicate the progress and performance relative to design criteria to ADEM and other stakeholders. It is recommended that the annual inspection reports include geotechnical instrumentation, monitoring, and interpretation content, along with structural and performance observations.

Hazard Potential Classification, Emergency Action Plan, and Risk Reduction

The Hazard Potential classification of Significant for the Ash Pond was appropriately considered for the design criteria of the Amended CCR Closure Plan and is consistent with the ADEM regulation for surface impoundments. The closure plan includes steps that will reduce potential off-site impacts and risks, and it is recommended that the hazard potential classification be reevaluated upon closure of the Ash Pond. With dewatering of the Ash Pond and as the CCR material drains and consolidates within the central portion of the site, it should ultimately achieve conditions that are resistant to mobility and no longer subject to hazard potential classification. The stormwater stilling basin planned for the south portion of the site should still be evaluated for hazard potential classification, and it likely can be reduced from Significant to Low Hazard Potential upon completion of modifications under closure.

The Emergency Action Plan should continue to be subject to annual review and update during the closure of the Ash Pond, with scheduled meetings with emergency management agencies concerning the scope and responsibilities of the parties, documenting participation, topics reviewed, and training or exercise activities. It is recommended that these aspects be addressed in the closure plan.

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REPORT

STRUCTURAL INTEGRITY REVIEW OF CCR CLOSURE PLAN

1.0 INTRODUCTION

The Coal Combustion Residual (CCR) Surface Impoundment (Ash Pond) serves Alabama Power Company's (APC's) Plant Barry Electric Generation Station located in Mobile County near Bucks, Alabama. APC is planning closure of the Ash Pond, which will include removal of CCR materials in perimeter locations and consolidating the CCR materials in the central portion of the site. Concerns have been raised regarding the presence and safety of the Plant Barry Ash Pond adjacent the Mobile River. The Mobile Bay National Estuary Program (MBNEP) contracted for D'Appolonia Engineering Division of Ground Technology, Inc. (D'Appolonia) to perform a review of the APC closure plan for the Plant Barry Ash Pond relative to structural integrity and considering the Alabama Department of Environmental Management (ADEM) CCR regulations. This report contains a description of the review, findings in terms of gaps in information that may be important to decision making, and recommendations. MBNEP also contracted for independent review of the hydrogeologic conditions and groundwater flow at the facility by Cook Hydrogeology LLC, which is referenced herein. MBNEP's role is to distill scientific and technical engineering information for elected officials and their constituencies.

The Ash Pond within the facility was formed by soil perimeter dikes on the east, south, and west sides, and adjoining the Plant Barry property on the north side comprising natural ground at about the same elevation as the perimeter dikes. APC established the extent of the CCR disposal area which occupies approximately 597 acres, with a minimum separation between the disposal area and the facility limits of 100 feet. The facility area as presented in the application and closure plan occupies approximately 670 acres, and contains the Ash Pond, perimeter dikes that are within the 100-foot separation corridor, and Existing Industrial Waste Landfill at the north end of the facility. The closure plan addresses the CCR disposal area, which is referenced as the Ash Pond, and does not extend to the Existing Industrial Waste Landfill.

The Ash Pond commenced operation in 1965 with the perimeter dikes constructed to El. 18, and a bottom pond level of about El. 3. Modifications to the Ash Pond were conducted in 1972, 1992, 1998, and 2005 to increase the capacity of the impoundment and height of the perimeter dikes. The perimeter dikes are approximately 20-feet high relative to grade adjacent the downstream toe, with a crest level of El. 24.5 on the east and west perimeters and an internal flow diversion dike which creates a separate stormwater settling basin in the southern portion of the property. The Ash Pond water pool north of the internal flow diversion dike has been about El. 18, and within the south stormwater stilling basin the pool has been maintained at about El. 15. The Mobile River located on the east and south perimeters, generally within about 100-feet of the perimeter dike, exhibits a typical stage equivalent to about El. 2 with recent flood levels reported at El. 15 partially inundating the perimeter dikes. The Mobile River bottom elevation is depicted at about El. -20 in the site vicinity.

The Amended Closure Plan for Ash Pond was submitted to ADEM in July 2019 and presents the phased sequencing and procedures to meet the closure performance standards when leaving the CCR in place. The amended plan includes: dewatering of the pond to initiate stabilization of the saturated CCR; removal of CCR from the east, south, west, and a portion of the north perimeter and consolidating these materials within an approximate 330 acre footprint in the center of the disposal area; developing an equipment/material storage yard and access corridor on the balance of the north perimeter; constructing a soil containment berm and stormwater management facilities where CCR materials have been removed; and installation of a cap system to isolate the CCR materials and control infiltration.

The review focused on the CCR Closure Plan (this term is used within the report to reference the Amended CCR Closure Plan) for the Ash Pond considering available plan descriptions, supporting studies and engineering analyses to identify potential areas of concern with respect to structural integrity and performance. Documentation received on the facility is presented in Section 2, and descriptions of the facility from permit application, closure plan submittals, and dam safety reports are presented in Section 3. Section 4 presents discussion of structural integrity criteria addressed in the facility application and closure plan. D'Appolonia's findings from the review and our recommendations are presented in Sections 5 and 6, respectively. Section 7 presents report conditions and closing discussion.

2.0 DOCUMENT REVIEW

2.1 Ash Pond Documents for Review

D'Appolonia obtained the following documents that APC submitted to ADEM for review:

- Barry Ash Pond Amended Closure Plan (July 2019), including
    - Written Closure Plan
    - Maximum Inventory of CCR
    - Largest Area Requiring Final Cover
    - Schedule for Completing Closure Activities
    - Organic Materials Management
    - Vegetative Plan
    - Record Keeping
    - Written Post-Closure Plan
    - Design Drawings (Draft 100% Design Drawing, Not for Construction)
- Barry Ash Pond Dewatering Plan (Oct. 2019)
- Permit Application for CCR Surface Impoundment (Dec. 2018), including:
    - Hazard Potential Classification and Emergency Action Plan
    - History of Construction and Structural Stability Assessments
    - Topographic Maps, Grading Plans and Stacking Plans
    - Quality Assurance/Quality Control Plan
    - Operational Plan
    - Written Closure and Post-Closure Plan

D'Appolonia also received the following documents from the Mobile Bay National Estuary Program that relate to the Ash Pond:

- Mobile Baykeeper Pollution Report; Coal Ash at Alabama Power's Plant Barry (Mar. 2018) prepared by Mobile Baykeeper, Waterkeeper Alliance, Southern Environmental Law Center, Burgess Environmental, including the Dam Safety Report by Burgess Environmental
- Plant Barry Hydrogeologic Conditions Summary (undated) prepared by Cook Hydrogeology LLC

A summary of the documents available in the public domain and obtained or provided to D'Appolonia is included as Appendix A. Each document was given a reference number and those reference numbers are used in this report to refer to project documents.

D'Appolonia received non-public information from APC for review in support of the CCR Closure Plan to aid in our understanding of the design and supporting engineering analyses. D'Appolonia's review and this report references such information relative to our assessment of the structural integrity of the plan, without presenting the specifics from calculations.

2.2 Document Review Limitations

D'Appolonia performed its review of the CCR Closure Plan with the expressed purpose of evaluating relevant aspects of the engineering, design, and permitting to identify potential areas of concern or gaps in information that may be important to decision making, with respect to structural integrity and performance. The volume of information available and our schedule constraints prohibited a review and evaluation of all information available; therefore, our services were completed by prioritizing information perceived to be the most relevant with respect to structural integrity and performance.

Public information on the Ash Pond has been reviewed and supplemented with engineering documents provided by AP to aid in understanding and assessing the closure design and anticipated performance. Many of these engineering documents are not public, such that the results of specific engineering analyses are not contained in this report.

The July 2019 Amended Closure Plan (CCR Closure Plan) is identified as DRAFT along with the Design Drawings. The Design Drawings Index indicates that some drawings are on hold relating to the internal drainage system, construction preloading, and construction sequencing. Additionally, the majority of information on engineering analyses made available for review on the CCR Closure Plan was prepared between 2017 and 2019, and labeled draft, such that changes may occur before or during implementation of closure.

3.0 PERMIT APPLICATION AND DAM SAFETY REVIEW DOCUMENTS

This section presents general description of the Plant Barry Ash Pond with observations from the permit documentation and previous dam safety reviews provided to D'Appolonia.

3.1 CCR Surface Impoundment Permit Application

The Plant Barry Ash Pond December 2018 CCR Surface Impoundment permit application (Reference 16) documents the facility configuration, CCR material, structural integrity assessment, operations plan, and closure plan, and incorporates information disclosed in October 2017 in accordance with the USEPA requirements under 40 CFR 257 on CCR Impoundments.

Figure 1 presents a plan of the Ash Pond, which is contained within an approximate 20-foot high soil perimeter dike situated about 100-feet from the Mobile River bank on the east side, and about 100-feet from the cooling water canal on the west side. CCR materials occupy approximately 597 acres within the perimeter dikes (El. 24.5), and fly ash deposits extend from the foundation base elevation of about El. -3 to a peak of about El. 24 in the central portion of the property. Bottom ash is also deposited at higher elevations in the central portion of the property, as well as being used on the in-board side of the perimeter dikes as part of previous dike expansions. A significant portion of the CCR deposits are above the normal pool within the perimeter dikes of about El. 15. Figure 1 presents the plan of the Ash Pond and shows the portion with normal pool within the south settling pond, which is divided by the separator dike that supports an additional ponded area.

The Mobile River and cooling water canal exhibit typical high-water tide levels of about El. 2, with the downstream toe and crest of the east and west perimeter dikes about El. 6 and 24.5, respectively. In the south vicinity of the Ash Pond, the separator dike (El. 24.5) establishes the northern extent of the south settling basin. The south perimeter dike crest level is about El. 21.5, with the normal pool in the south settling basin about El. 15. Stormwater from the property is directed to the south settling basin, and is discharged through the spillway outlet structure and NPDES outfall as shown in Figure 1, that ultimately leads to the Mobile River.

A wastewater treatment system is located near the north perimeter of the facility, providing treatment of contact water prior to conveyance and discharge at the NPDES outfall.

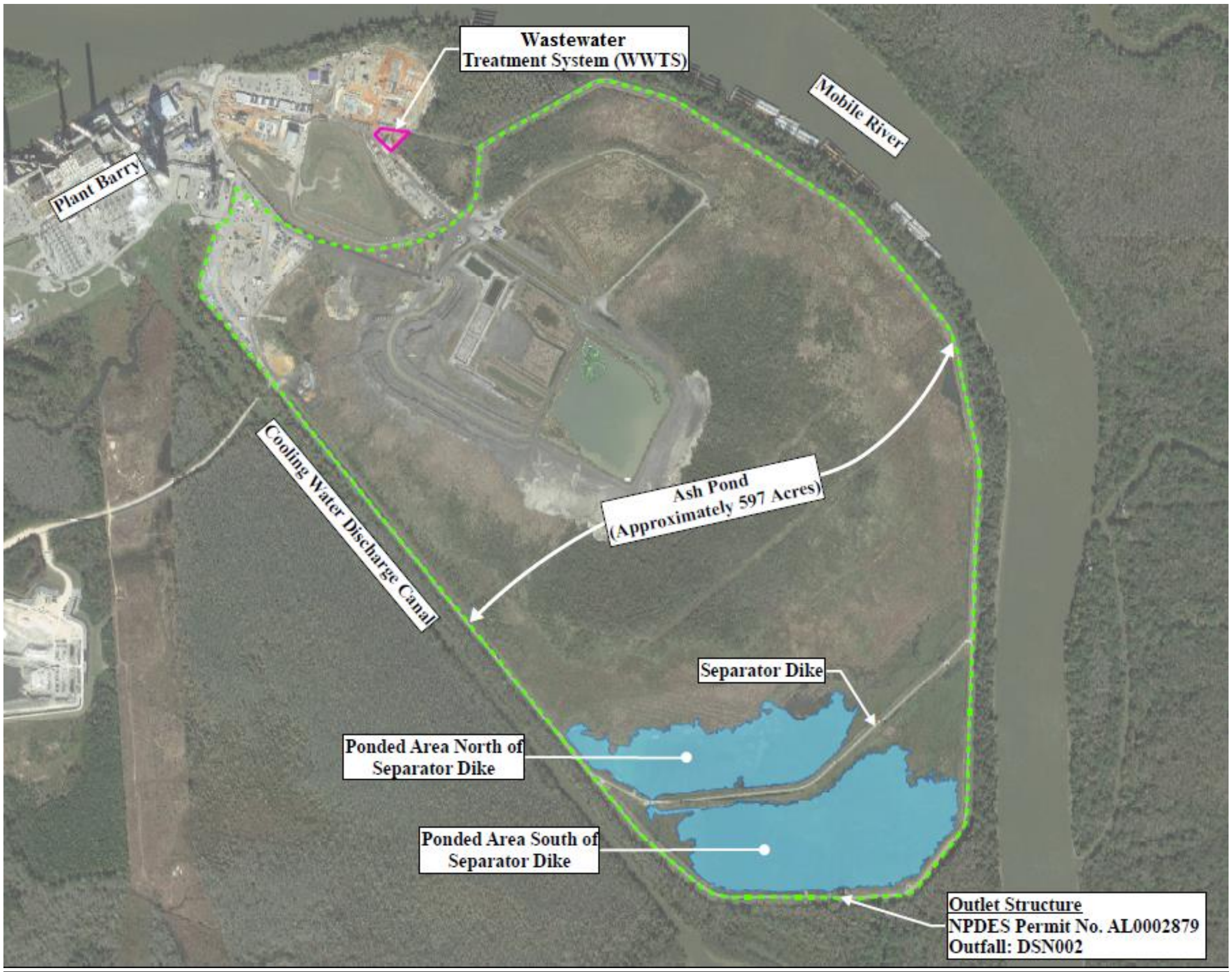

Figure 1: Ash Pond Overview (Reference 1)

Pursuant to ADEM Admin. Code 335-13-15-.04(4)(d), the structural stability assessment of the Ash Pond in the permit application included the following:

- Foundation and Abutments: generally consist of organic clay overlying medium dense to dense sands. Some low in-board embankments are founded on geogrid-reinforced bottom ash (used for raising the perimeter dike).
- Slope Protection: erosion control measures consist of grassy vegetation on both the interior and exterior dikes. The pond configuration and operation mitigate concern for wave action and rapid drawdown conditions which could induce erosion and slope instability.
- Perimeter Dike Compaction: the perimeter embankments consist of sandy clays and silty and clayey sands, compacted to a density to withstand the range of loading conditions based on the stability analyses.

- Vegetated Slopes: grasses are maintained at a height on the slopes to allow periodic inspection.
- Impoundment Spillway: inlet structure consists of a four-sided concrete weir box with sufficient capacity to manage flow during and following the peak discharge from the 1,000 year storm (peak stage El. 20.26) without risk of overtopping following restoration of the design crest level (El. 21.5).
- Hydraulic Structure Maintenance: spillway conduit consists of a 54-inch corrugated metal pipe connected to the inlet structure and extends beneath the south perimeter dike. Following inspection in 2015, a cementitious lining was installed reducing the diameter to 51-inch, although the flow capacity of the impoundment spillway was still reported as adequate to preclude overtopping under the design event.

The 2018 CCR Surface Impoundment permit application included a written closure plan that described how the facility would be closed by leaving CCR in place, with some consolidation of ash to reduce the closure footprint. The closure plan was developed to meet the requirements of ADEM Admin. Code 335-13-15-07, including the following:

- The Ash Pond will be dewatered sufficiently to remove the free liquids and to an extent to provide a stable base for the construction of an ash containment structure for the consolidated footprint, excavation of ash outside the footprint, and construction of the final cover system.
- Excavation of ash outside the footprint will include removing all visible CCR and over excavating into the subgrade soils. Excavated ash will be transported and disposed of within the consolidated footprint to create a subgrade for the final cover system.
- The final cover system will be constructed to control, minimize or eliminate, to the maximum extent feasible, post closure infiltration liquids into the waste and potential release of CCR from the facility.
- The final cover system will be designed to minimize infiltration and erosion, considering the requirements of 335-13-15-07(3)(d)3.(ii), Alternative Cover System. A synthetic turf incorporating a geomembrane will result in a permeability of the cover system of less than the permeability of the natural subsoils beneath the facility. The potential for disruption of the integrity of the cover system will be minimized through a final design the accommodates settlement and subsidence, in addition to providing an upper component for protection from wind and water erosion.

3.2 Burgess Environmental Dam Safety Report

The Mobile Baykeeper Pollution Report: Coal Ash at Alabama Power's Plant Barry (March 2018) contains a report by Burgess Environmental on the dam safety of the Ash Pond, which raises concerns about the structural integrity of the perimeter dikes and the plan for closure in place. The dam safety concerns raised by Burgess Environmental are associated with the perimeter dikes of the Ash Pond retaining saturated, loose CCR material and performance during floods. The closure plan addresses these concerns, and Table 1 provides a summary of the Burgess Environmental report concerns for structural integrity, and measures taken to address the concerns during closure. Other concerns associated with groundwater have been discussed in the Plant Barry Hydrogeologic Summary Report prepared by Cook Hydrogeology for MBNEP, such that Table 1 focuses on dam safety and structural integrity of the perimeter dikes.

Table 3.1: Burgess Environmental Dam Safety Concerns for Ash Pond

2018 Burgess Environmental Concerns for Dam Safety	2019 Amended CCR Closure Plan Features
Stability	
Differential settlement analyses were not included in the 2016 Structural Stability Assessment	The proposed closure of the Ash Pond will induce settlement, and an early step in the process includes preloading prior to construction of some of the containment and stormwater management elements. The closure plan is based on establishing specific grades and drainage meeting stability criteria, and supported by exploration, testing, and analysis.
Piping and internal erosion were not evaluated in the 2016 Structural Stability Assessment	Inspection and monitoring are critical to assess seepage and piping, and annual APC inspection reports for 2015 – 2018 do not include reference to seepage. The Burgess Environmental report references observations in 2016 and 2018 of a bulge in the toe of the south dike slope and sand deposits adjacent slope repairs. As part of initiation of closure, dewatering of the Ash Pond will be conducted lowering the hydraulic head, mitigating a seepage and piping failure mode. The failure mode was evaluated for the closure plan relative to flooding of the Mobile River and potential heave, internal erosion and piping into the south stormwater settling basin and seepage control measures were included in the closure plan.
Liquefaction failure modes were not evaluated in the 2016 Structural Stability Assessment	Liquefaction of the dike and foundation is a condition that generally occurs in loose sands with the buildup of pore pressures sufficient to cause rapid loss of significant strength, leading to instability following a strong earthquake. The Ash Pond is located in a low seismic hazard zone, and the foundation soils are generally characterized as soft clay and medium dense sands. Liquefaction analyses were conducted on the foundation materials and provisions for dewatering and internal drainage of the CCR are contained in the closure plan.

Erosion of exterior perimeter dike slopes or foundation from river or coastal flooding	The exterior perimeter dike slopes are susceptible to inundation during Mobile River flood stage, and while riverine and coastal flood levels have been evaluated, erosion potential of the perimeter dikes subject to inundation has not been addressed in the closure plan. Under the closure plan, the existing perimeter dikes will remain and support stormwater management within the site, although containment of the consolidated CCR material within the central portion of the property will be separately accomplished with a soil containment berm. Therefore, erosion of the exterior perimeter dike slopes or foundation that precipitated instability of the perimeter dikes would not directly threaten breach of CCR containment.
Flood Related Risks	
Inadequate perimeter dike freeboard for the Ash Pond under design storm conditions based on the 2016 Inflow Design Flood Control Plan	Following grading and maintenance to restore the south perimeter dike crest to its design level at El. 21.5 reported by APC, it would provide more than 1-foot of freeboard for the design storm condition, and was documented in the 2018 Updated Design Flood Control Plan. The closure plan includes construction of an auxiliary spillway that will provide significant additional capacity in the event of site flooding, such that overtopping should not occur for a storm event substantially in excess of the 1,000-year event.
Potential for erosion or overtopping of perimeter dikes from Mobile River floods were not evaluated in the 2016 Inflow Design Flood Control Plan	Riverine and coastal flood studies performed for the closure plan demonstrate that perimeter dikes would not be overtopped by significant floods (greater than the 1,000 year event); the closure plan includes soil containment berms and stormwater ponds within the site and upstream of the perimeter dikes providing additional protection and confinement of consolidated CCR material.
Closure	
River meandering and erosion of riverbank	The Plant Barry ash pond is located on a bend of the river inside the meander belt. However, cut banks on either side of the Plant Barry facility are 1.7 miles apart. Any potential channel cutoff and relocation of the river channel, that would threaten the pond, would occur in a geologic time scale. But more importantly, the pond is located on a point bar, with a cut bank on the opposite side of the river, which means that the river channel is migrating eastward, away from the pond. (cited from the Plant Barry Hydrogeologic Summary Report prepared by Cook Hydrogeology)

3.3 Amended Closure Plan for Ash Pond

APC submitted the Amended Closure Plan for Ash Pond to ADEM in July 2019 presenting the phased sequencing and procedures to meet the closure performance standards when leaving the CCR in place. The amended plan includes: dewatering of the pond to initiate stabilization of the saturated CCR; removal of CCR from the east, south, west, and a portion of the north perimeter and consolidating these materials within an approximate 330 acre footprint in the center of the disposal area; developing an equipment/material storage yard and access corridor on the balance of the north perimeter; constructing a soil containment berm and stormwater management facilities where CCR materials have been removed; and installation of a cap system to isolate the CCR materials and control infiltration.

The CCR Closure Plan is illustrated in plan and cross section in Figures 2 and 3, respectively. Figure 2 contains a plan view of the general arrangement for closure, with CCR material removed from much of the perimeters and placed as fill in the central portion of the property, within the soil containment berms. As indicated on Figure 2, closure of the northwest corner of the facility does not include the removal of CCR material but rather closure in-place with a cap system to establish an equipment/material storage yard and maintain the plant evacuation access corridor.

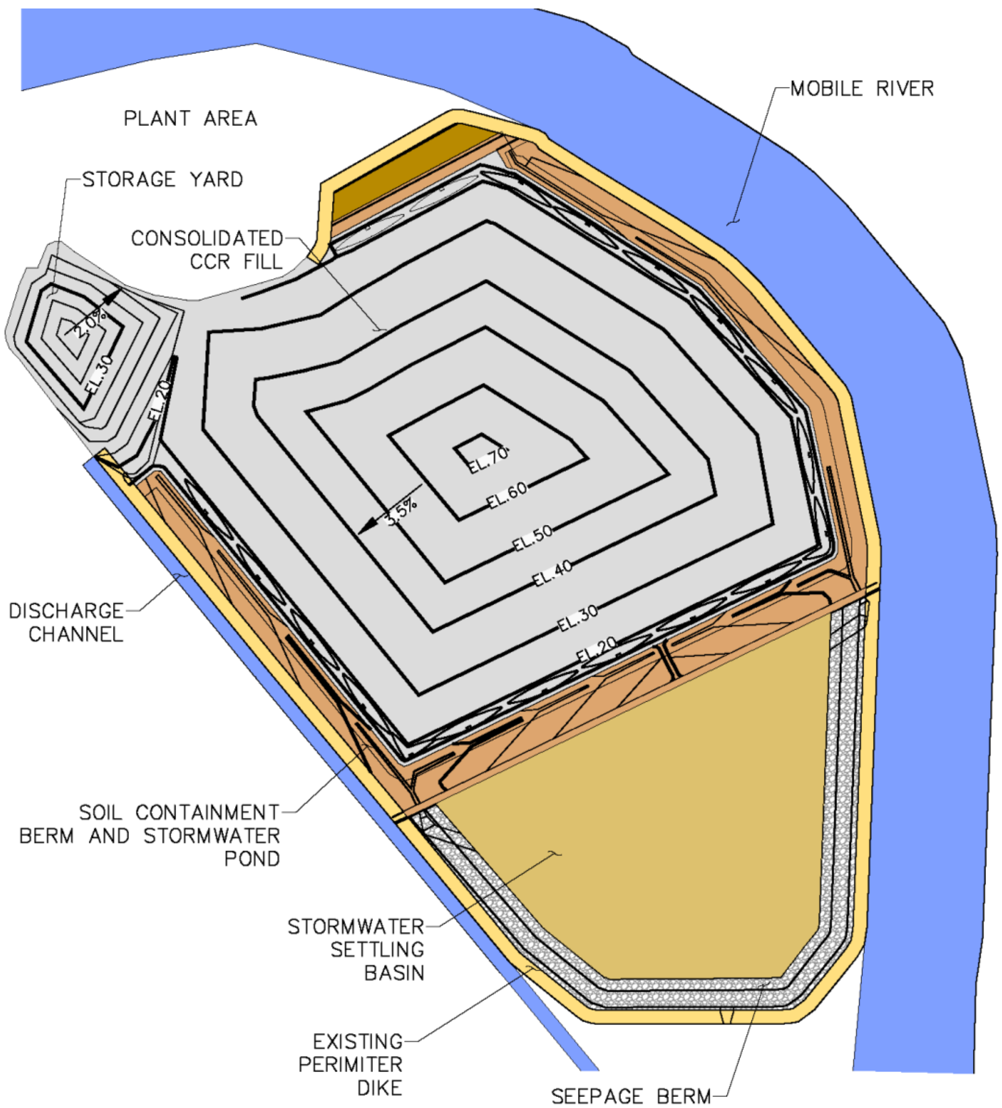

Figure 2: General Configuration Plan for Ash Pond Closure (Reference 2)

The cross section shown in Figure 3 contains an exaggerated vertical scale to illustrate the full site generally from west at the cooling water discharge channel to east at the Mobile River. In conjunction with removal of CCR at the perimeters, the soil containment berm and stormwater ponds will be constructed creating a buffer in excess of 500-feet from the adjacent waterways. As indicated in Figure 3, the excavated CCR material will be placed on the central portion of the property with a cover and cap system on the upper surface. The exaggerated vertical scale makes the slope of the proposed top surface of the CCR landfill and cover appear steep, but it is actually very mild at 3.5-percent.

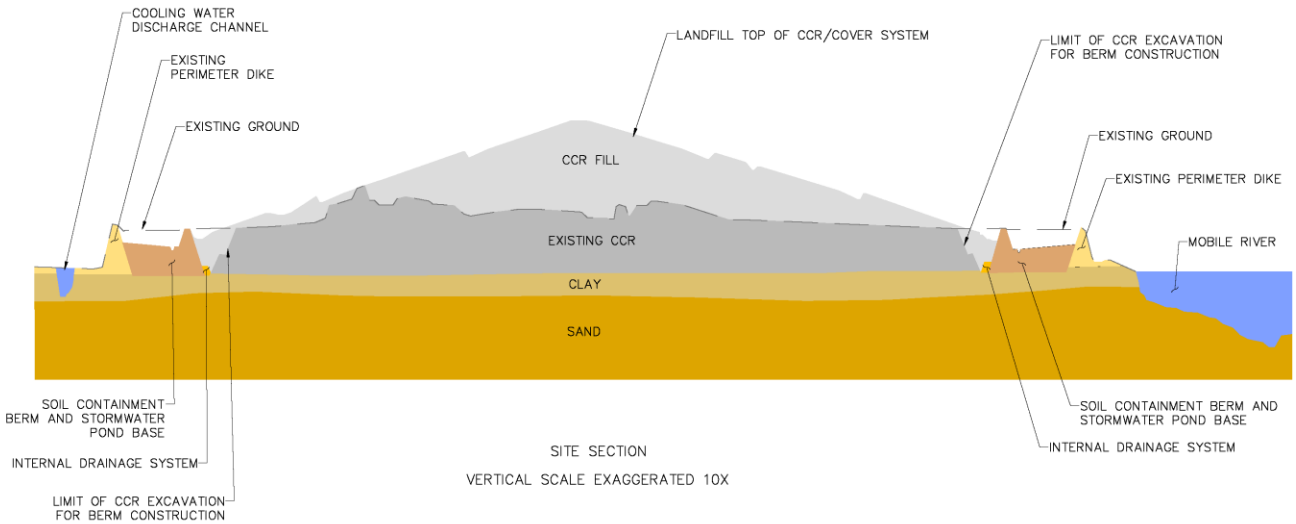

Figure 3: CCR Closure Plan Cross Section (Reference 2)

The Amended Closure Plan is anticipated to require a duration of approximately 12 years to complete, and is sequenced into phases to address different steps in the procedures, some of which need to be performed sequentially, while others allow multiple operations to proceed concurrently. The length of time to complete some of the tasks is dictated by the Ash Pond, CCR and foundation materials, such as dewatering, stabilization, preloading, and excavation. The phasing and procedures include measures to maintain structural integrity of the facility as well as stormwater control during the work.

3.3.1 Dewatering and Stabilization

Dewatering includes removal of the free water (e.g. open pooled water) and reducing the amount of interstitial water within the CCR (e.g., reducing pore water in the CCR) to facilitate excavation, relocation and consolidation of the CCR in the consolidated footprint for closure. Dewatering is also expected to increase geotechnical slope stability, reduce CCR consolidation settlement, improve constructability and allow safe equipment operation. The rate of free water removal will be controlled to maintain stability of exposed interior slopes.

Removal of interstitial water within the CCR will depend on gravity drainage to dewatered pond areas, sumps, and channels or pumping to the settling basin south of the consolidated CCR footprint (ponded areas north and south of the existing separator dike as shown in Figures 1). Ponded water and interstitial water will pass through a filter berm to reduce solids content and then pumped to an on-site temporary Wastewater Treatment System (WWTS) for treatment prior to discharge. Throughout closure, runoff and liquids that have come in contact with CCR (contact water) will be managed under the Stormwater and Contact Water Management Plan, routing flows through the WWTS if necessary, before discharge through the existing NPDES outfall.

In addition to the dewatering activities, the closure plan includes the other stabilization measures that will be implemented prior to, during, and following excavation of CCR materials as conditions warrant: preloading of the CCR removal areas; bridging lift placement over wet/soft or loose grades for equipment access; pressure relief well operations within foundation sand. Dewatering and stabilization measures will be initiated at the beginning of closure, and will continue over several years during excavation and placement of CCR in the consolidated CCR footprint of the site and construction of stormwater management facilities, in accordance with the construction phasing discussed in Section 3.2.7.

3.3.2 Excavation of CCR in Perimeter Areas

Under the CCR Closure Plan, CCR along the perimeter areas will be mechanically excavated following dewatering activities and transported using haul trucks to fill areas within the consolidated footprint. Prior to initiation of CCR excavation, a preloading program will be implemented as needed to promote consolidation, improve geotechnical stability, and reduce settlements. The preloading program consists of sequentially placing temporary soil fill on top of the CCR in one planned excavation area and allowing consolidation to proceed for a period of time prior to removal to another area.

The depth of CCR to be excavated is reported to range between 5 and 25-feet. Excavation is planned to be conducted in stages whereby the CCR will be removed in 5 to 10-foot vertical increments until the required depth is accomplished. A bridging lift of bottom ash or other granular material placed over exposed CCR is proposed to stabilize the material for excavator operation and hauling equipment. Figure 4 presents a cross section illustrating the CCR excavation area adjacent the existing perimeter dike (without exaggeration of vertical scale). As shown in the excavation sequence (before and after initial excavation of CCR) of Figure 4, as the excavation depth advances, interstitial drainage from the CCR will cause a decline in the water table, and this drainage will be collected in sumps and pumped to the WWTP.

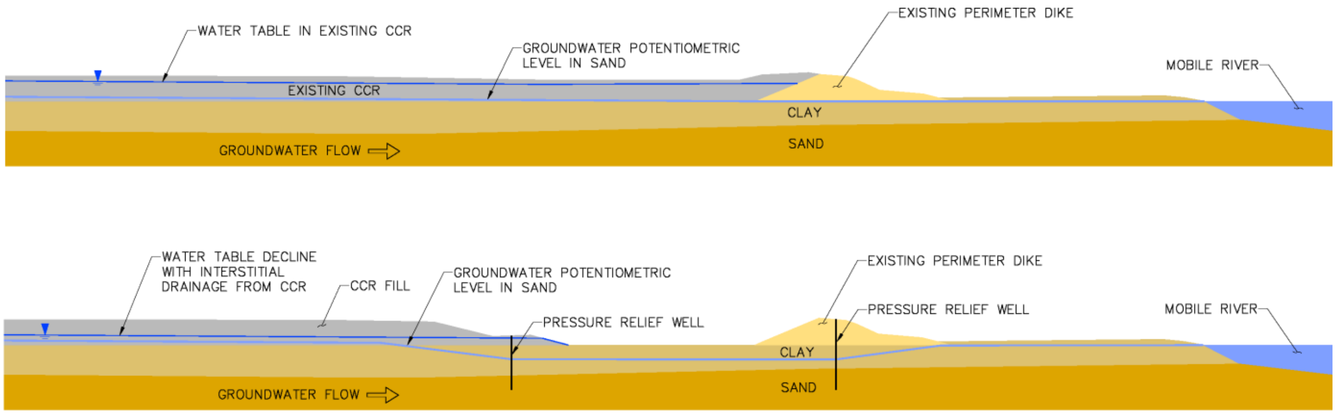

Figure 4: CCR Excavation Area Adjacent Perimeter Dike - Before (upper cross section) and After (lower cross section)

Pressure relief wells will be installed if needed to pump groundwater from the foundation sand and address the potential for sand boils and heave within the excavation, allowing improved construction conditions, and provide protection of the structural integrity of the existing perimeter dikes. This is illustrated in the lower cross section in Figure 4, where pressure relief wells would pump groundwater from the foundation sand, relieving pressure and lowering the potentiometric level (pressure level) in the sand, and lowering seepage induced forces on the clay that can cause sand boils and heave. Operation of the pressure relief wells is a temporary measure to enable excavation and construction at the clay surface. With advancement of CCR excavation to the underlying clay, a verification protocol will be implemented as discussed subsequently, and a granular (sand or similar fill) bridging layer may be placed as needed on the clay layer to maintain suitable construction conditions.

Excavation is planned to be performed in a phased approach with two distinct areas being excavated at a given time. Pressure relieve wells and preloading will likewise be conducted as necessary in areas of phased excavation activity. The CCR Closure Plan does not provide specific information on geotechnical monitoring or criteria for determination of these temporary stabilization measures.

3.3.3 CCR Removal Verification Protocol

The CCR Closure Plan includes elements to verify that visible CCR has been removed from areas outside the consolidated CCR footprint. A combination of procedures is planned to identify the CCR-foundation soil interface. Prior to CCR removal in an area, exploration borings and sampling on 300-foot centers will enable employing visual and tactile examination to distinguish the interface, and cone penetration tests on 100-foot grid considering penetration resistance/pore pressure measurements will establish the interface surface. The excavation depth will extend 6-inches below the interface. Excavation equipment will be guided by GPS and the excavation surface to achieve CCR removal.

Upon achieving CCR removal to the planned depth in an area, hand augers or other sampling equipment will be advanced 12-inches into the subgrade for visual classification and confirmation with a frequency of 1 sample per acre (approximate 200-foot grid).

3.3.4 CCR Placement, Compaction and Containment

CCR excavated from perimeter areas will be hauled, placed, and compacted within the consolidated footprint area. The CCR Closure Plan indicates that CCR will be placed in relatively horizontal lifts within phasing areas to manage compaction, stormwater runoff, dust control, and wet/soft/loose subgrade materials. The lift thickness is not specified, and the compaction requirements is firm and unyielding after several passes of compaction equipment.

The CCR Closure Plan assumes that excavated CCR is sufficiently dewatered to allow hauling, placement, and compaction in the consolidated footprint area. No provisions for wet CCR materials that cannot be compacted are included within the consolidated footprint (beyond subgrade material), such that presumably all moisture content adjustment must be accomplished within the perimeter areas.

A soil containment berm has been designed for the consolidated CCR material in the central portion of the property to provide a physical barrier at the consolidated footprint limits along the east, south, west, and a portion of the north perimeter. The northwest corner where the equipment/material storage yard and access corridor are located does not include a soil containment berm, relying on the existing perimeter dike.   This northwest corner will be graded to maintain drainage, but not receive significant additional CCR fill.

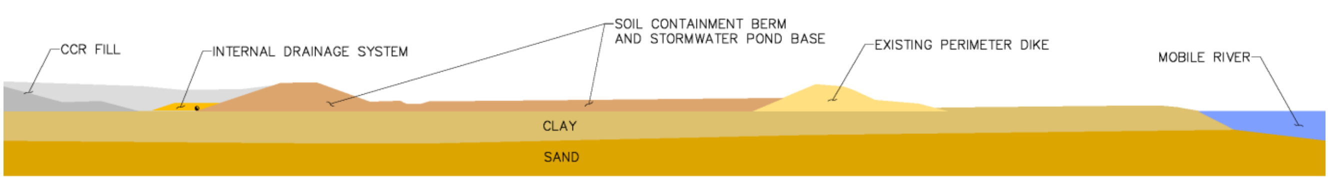

Figure 5: Soil Containment Berm and Stormwater Pond

The soil containment berm is to be constructed of compacted borrow material (sandy soils containing silt and/or clay), and a sand or soil fill placed to establish the stormwater pond base as shown in Figure 5. An internal drainage system will be installed on the upstream slope of the berm to collect interstitial water that drains from the CCR materials, as indicated in Figure 6. The drainage system will include a perforated pipe and granular stone collection corridor, sumps, and forcemains which will operate via pumps during and after closure as needed. The soil containment berm is designed to be approximately 20-feet in height, constructed of cohesive soils on the foundation clay layer or, if necessary due to soft conditions, on a granular material placed on the clay as a bridging lift. For such instances where a bridging lift is required, the physical barrier of the soil containment berm may be extended by a low permeability cutoff wall (specified as silty or clayey sand, silt, or clay backfill) into the foundation clay.

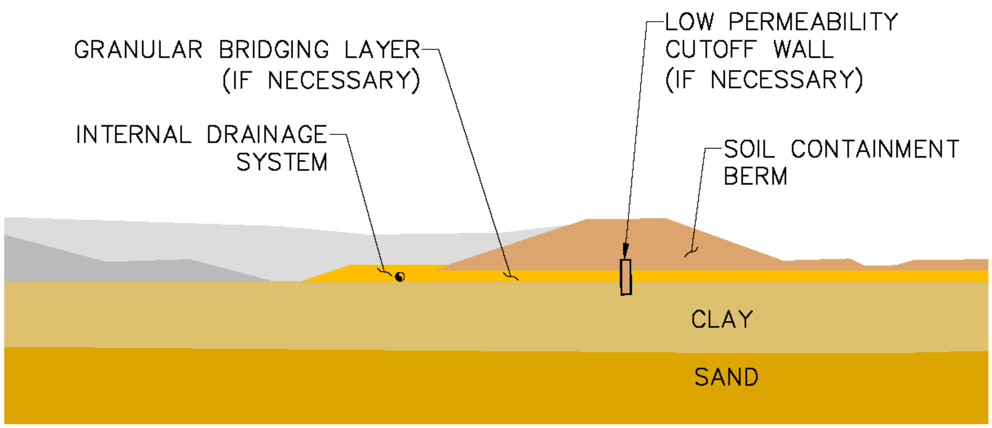

Figure 6: Soil Containment Berm, Internal Drainage System, and Cutoff through Bridging Lift

Interstitial water from the CCR material within the consolidated CCR area will be collected in the internal drainage system and pumped through forcemain piping to the WWTP. Upon completion of CCR fill placement and installation of the cover system, drainage to the internal drainage system will diminish, ultimately limited to groundwater seepage from the underlying sand up through the clay foundation layer.

3.3.5 CCR Closure Cover System

The CCR Closure cover system is designed to minimize infiltration and erosion, consisting of a ClosureTurf (synthetic engineered turf) over the majority of the consolidated CCR footprint (approximately 330 acres) and a stone and geomembrane composite system over an area to be reused as a laydown yard (approximately 30 acres in the northwest portion of the property). The geomembrane component of the cover system is manufactured to be relatively impermeable with a design life in excess of 100-years. The synthetic cover system for the consolidated CCR area is illustrated in Figure 7 and the majority of the consolidated CCR area will consist of the following:

- 6-inch thick CCR subgrade layer for support of the synthetic cover element
- 50-mil thick linear-low density polyethylene (LLDPE) MicroDrain geomembrane for a relatively impermeable layer to infiltration while controlling surface water drainage
- Engineered synthetic turf (ClosureTurf) which is ballasted by a sand layer 0.5 inch thick for durability, wind and runoff erosion control

The northwest area to be used as a laydown yard will consist of the following:

- 6-inch thick CCR subgrade layer for support of the synthetic cover element
- 100-mil thick LLDPE geomembrane for a relatively impermeable layer to infiltration
- HDPE drainage net (geonet) geocomposite with non-woven, needle-punched geotextile laminated on both sides
- 18-inches of No. 57 stone enclosing a 6-inch high density polyethylene (HDPE) geocell system to provide a wear surface and support

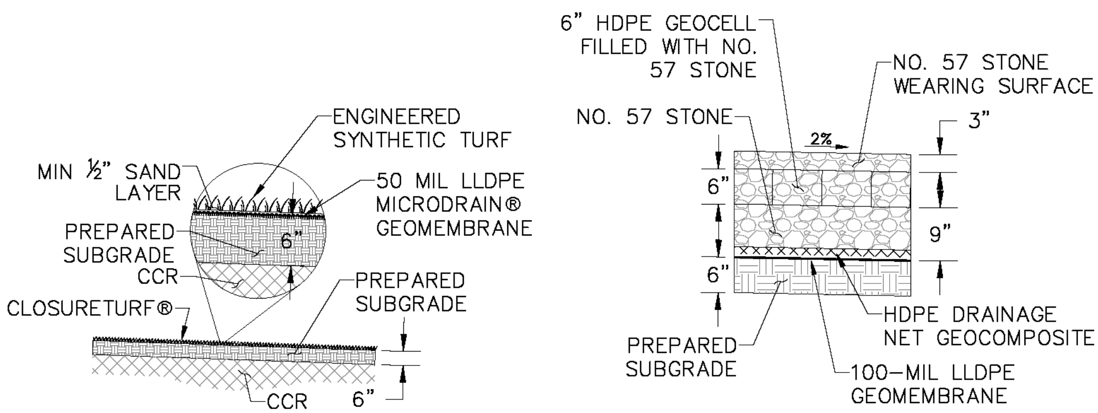

Figure 7: CCR Closure Plan Cover System for Consolidated CCR Area and Laydown Yard Area

3.3.6 Surface Water and Stormwater Management

The existing perimeter dikes of the Ash Pond prevent stormwater run-on from or run-off to areas outside the disposal area. During the closure activities, ash pond water will be managed as contact water collected and treated as required for discharge from the NPDES outfall. Any discharge from the Ash Pond will be routed through a 4,000 gallon per minute (gpm) WWTS prior to discharge.

The CCR Closure Plan includes provisions for managing stormwater from the 1,000 year, 24-hour storm event without overtopping of the perimeter dikes, and retention of the 25 year, 24-hour storm event without discharge through the NPDES outfall. Storm runoff exceeding the 25 year, 24-hour event may be discharged through the NPDES outfall but is anticipated to meet effluent quality parameters in the permit. The limits of active excavation areas within the plan phases will be established to allow dewatering such that construction can resume within 3-days of a 10 year, 24-hour storm event.

During active closure operations, non-contact stormwater will be diverted from CCR working areas to minimize the generation of contact water by diversion berms positioned on slopes situated upgradient from working areas, diversion channels positioned around working areas, pumps, and temporary or permanent cover systems. Non-contact water will be managed under stormwater and erosion control requirements and discharged without further treatment.

The final grades for the CCR Closure Plan incorporate features to prevent erosion and direct runoff into stormwater management structures. Channels are included on the final cover and perimeter of the consolidated footprint to divert run-on to and convey run-off from the site in a controlled manner. The final grades of 3.5 % established with synthetic turf, rock riprap lined channels, and flow energy dissipation structures provide erosion resistant surfaces of the closed Ash Pond, stormwater ponds, and settling basin.

The removal of CCR material from the stormwater basin in the southern portion of the site will ultimately allow this area to provide stormwater retention from the closed facility. Coupled with CCR removal and verification testing, a seepage berm will be constructed within the interior perimeter of the stormwater stilling basin as shown in plan in Figure 2, and cross section in Figure 8. The seepage berm will provide for stability of the perimeter dike under severe flooding conditions of the Mobile River, which could cause elevated pore pressures in the foundation sand beneath the basin.

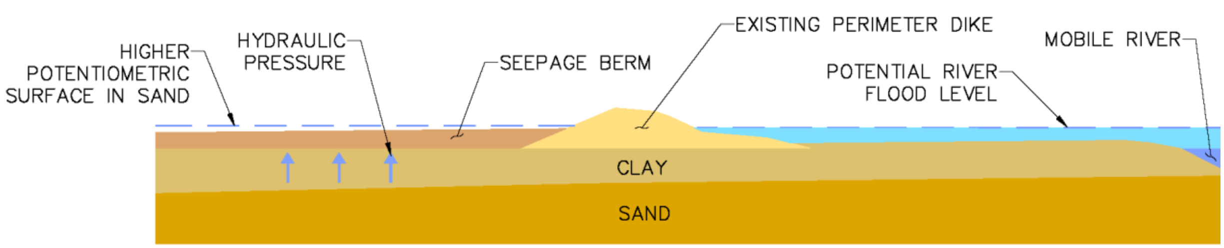

Figure 8: Seepage Berm within Stormwater Stilling Basin at Southeastern Perimeter Dike

3.3.7 Closure Plan Construction Sequence and Schedule

The CCR is saturated, loose material within the Ash Pond covering approximately 597 acres, and dewatering and excavation requires sequential steps to achieve closure requirements. The Amended CCR Closure Plan includes the construction sequence to perform the associated tasks in phases, including pond dewatering, CCR excavation, active CCR fill placement in the consolidated CCR fill area in the central portion of the property, soil or cover geomembrane placement, and completed cover system areas. The conceptual phasing plan is shown in Figure

9, which depicts the Ash Pond limits and anticipated sequencing of closure activities over the first five phases generally beginning in the north portion of the site and proceeding south. Areas labeled C1 through C6 roughly represent the location and sequence of initial CCR excavation or Cut (C) areas, while areas labeled F1 through F14 represent the consolidated CCR footprint where the excavated CCR Fill (F) will be placed and capped with the cover system. The laydown area in the northwest portion of the site will provide for equipment storage.

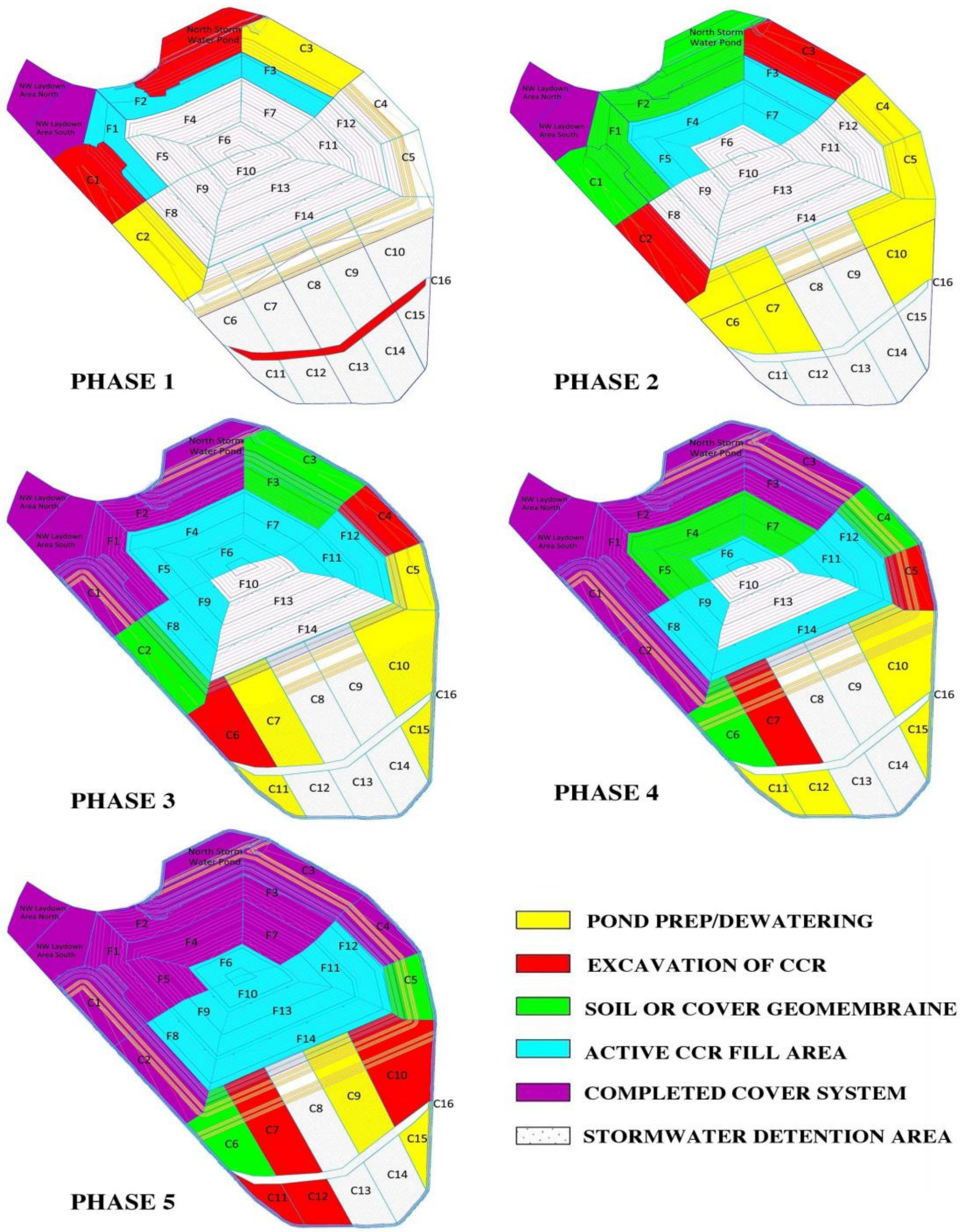

Figure 9: Closure Plan Construction Phasing Plan

The conceptual phasing plan is intended to be flexible, accomplish work in multiple areas, while meeting stormwater and contact water management requirements. The duration of each phase will be variable and depend on field and climatic conditions. During Phase 1, dewatering of ponded areas and removal of the separator dike in the south portion of the Ash Pond will be conducted. The area for the North Storm Water Pond and C1 will be excavated, while Areas C2 and C3 are dewatered in preparation for CCR excavation. Excavated CCR during Phase 1 will be placed as indicated in Areas F1 through F3, as shown in Figure 9.

Phases 2 through 5 are also shown in Figure 9, and illustrate the continued dewatering and CCR excavation and fill placement areas, followed by cover placement advancing from north to south. With completion of Phase 5, the northern slope and portions of the eastern and western slopes, soil containment berm, and stormwater ponds have been completed including the cover system comprising a geomembrane liner. The southern portion of the site is continuing to be dewatered during Phase 5 and the CCR excavated and placed as fill in the consolidated CCR footprint. Subsequent phases will be constructed until all CCR has been removed from the southern portion of the site completing the CCR fill and geomembrane cover system, the soil containment berm and stormwater ponds are completed, and the soil cover established for the stormwater stilling basin at the south end of the site.

The closure schedule is expected to require about 12 years to complete, which exceeds the ADEM requirement and thus will require allowable extensions under Admin. Code 335-13-15-07. The CCR is saturated, loose deposits within the Ash Pond, and dewatering and excavation requires sequential steps to achieve closure requirements. The following milestones have been established based on the Amended CCR Closure Plan:

- Remove ponded water, conduct dewatering, and stormwater management – approximately 11 years
- Excavate, place, compact and grade relocated CCR into the consolidated footprint – approximately 11 years
- Construct stormwater ponds, soil containment berm, and other soil-fill structures – approximately 11 years
- Install final cover system and stormwater management features – approximately 7.5 years

The Amended CCR Closure Plan notes that these time frames are estimates, and that some of the closure activities are not conducted on a continuous basis throughout their scheduled durations.

4.0 STRUCTURAL INTEGRITY CRITERIA

This section presents structural integrity criteria relative to ADEM Admin. Code 335-13-15-.04 for the CCR Closure Plan.

4.1 Hazard Potential Classification

The Hazard Potential is a measure of the possible adverse consequences that could result from a release of water and stored contents due to failure of the CCR diked surface impoundment or mis-operation of the diked surface impoundment or appurtenances. CCR impoundments may be classified as High, Significant, or Low. The classification does not reflect the structural condition or likelihood of a failure and release of impounded water and CCR but establishes requirements for dam safety and design of the facility.

A hazard potential classification was assigned by APC in the CCR Surface Impoundment Application (Reference 16) of Significant Hazard, which is consistent with the results of the USEPA's 2010 Dam Safety Assessment (Reference 13). For classification as a Significant Hazard Potential, the possible adverse consequences would include economic loss, environmental damage, disruption of lifeline facilities or impact to other concerns, but not probable loss of human life. The dam breach analysis performed for development of the Emergency Action Plan inundation limits under design storm conditions indicates that adverse consequences do not extend to structures in the Plant Barry vicinity, Bucks and Stockton, and supports this classification.

Significant Hazard Potential was considered for the design basis of the CCR Closure Plan as indicated in the Stormwater and Contact Water Management Narrative (Reference 1), and the corresponding design storm for pond and perimeter diking is the 1,000 year, 24 hour event, which is reported to be about 21.7 inches over 24 hours (Reference 11). This design criterion is consistent with the ADEM regulation for surface impoundments classified with Significant Hazard Potential. Maintaining the design criteria during implementation of the closure design will decrease the risk to downstream areas as the CCR drains and consolidates, and ultimately no longer represents a flowable material subject to hazard potential classification.

The stormwater settling basin planned for the closed facility in the south portion of the site will continue as an outfall for discharge from the site, but intended to be maintained with a normal pool at the base of the outfall structure, about El. 6.1. The stormwater settling basin can impound runoff from the closed Ash Pond facility to the top of the auxiliary weir spillway under large storm events.

4.2 Emergency Action Plan

The Emergency Action Plan (EAP) was developed April 17, 2017 to identify events or circumstances at the Ash Pond that represent a safety emergency, along with procedures to be followed to detect and respond to emergencies. Inundation maps are included in the EAP to indicate potential areas that could be impacted and are based on dam breach analyses for the Ash Pond considering industry accepted empirical formulas with flood modeling employing USACE software accepted by dam safety regulatory agencies. APC annually documents the review of the EAP with local emergency responders, with the most recent documented meeting conducted September 19, 2019 (Reference 18). The EAP must be amended when changes in conditions would have a significant effect on the plan, or every five years.

The EAP includes a list of potential emergency conditions, classification system relative to severity, detection monitoring, and response actions. Overtopping, seepage, and instability are addressed, and emergency repair measure identified.

Until the Closure Plan has been fully implemented and the CCR no longer represents materials that could flow if released, or the Hazard Potential Classification has been changed to Low, the EAP should be maintained and updated under the required schedule. While the presumption may be that with dewatering of the Ash Pond, the CCR will begin to consolidate and become more resistant to flow, analysis of the CCR drainage and consolidation behavior is not addressed and no instrumentation or confirmatory testing is discussed in the CCR Closure Plan. The CCR Closure Plan and Post-Closure Care Plan do not address maintenance of the EAP, or conditions or criteria that would support a reduction in the Hazard Potential Classification.

4.3 Maintenance of Vegetated Slopes

The CCR Surface Impoundment Application includes provisions for vegetation on dike slopes maintained to allow inspection and indicates that the slopes are not normally subject to inundation by downstream surface water bodies. Annual inspection records do not comment on conditions of the downstream slopes or toe of the Ash Pond dikes but include indication that no observations of weakness or conditions adverse to safety were detected.

While inundation of the downstream slope and toe of the perimeter diking by the Mobile River or Cooling Water Canal is not frequent, the 100-year floodplain does extend onto the slopes of the dikes with an estimated level at approximately El. 15 (FEMA, 2019b). Based on available river stage monitoring at Plant Barry (USGS), the Mobile River has reached a stage of 14-feet (El. 12) multiple times in the past four years, with the maximum stage recorded of 18.19 in 1961, which equates to about El. 16.28.

4.4 Structural Stability Assessments

4.4.1 Foundation and Abutment Conditions

The Ash Pond is contained within soil perimeter dikes constructed on a foundation generally consisting of soft organic clay underlain by dense sand. Exploration and field and laboratory testing of the geotechnical properties of the foundation soils, perimeter embankments and CCR has been conducted in support of slope stability analyses reported in the CCR Surface Impoundment Application (Reference 16). The exploration included approximately 20 borings on or near the perimeter dikes (about 19,000 feet in length) to characterize conditions and provide estimates of shear strength in support of slope stability analyses of the existing perimeter dikes. The perimeter dikes tie into terrain at the north end of the Ash Pond for Plant Barry, which is comprised of organic clay soil and underlain by dense sand.

The CCR Closure Plan is based on additional exploration and testing performed on the site, and includes approximately 75 borings within the disposal area to explore, characterize, and estimate shear strength properties of the foundation soils and CCR material layers, in support of the associated slope stability, seepage and settlement analyses.

4.4.2 Slope Stability Assessment

4.4.2.1 Material Properties, Critical Cross Sections, and Design Criteria

The parameters for the slope stability analyses from the CCR Surface Impoundment Application (Reference 16) are summarized in Table 4.1 and are based on the following:

- Perimeter dike and foundation soil properties of unit weight, effective angle of internal friction, and cohesion were obtained from historical laboratory and in-situ test results. Available in-situ testing from the 1998 geotechnical investigation support the assigned shear strengths for analyses of the exiting perimeter dikes.
- Ash properties were based on laboratory testing performed on undisturbed and remolded samples from other APC plants and engineering judgment. The assigned shear strength of the Bottom Ash is consistent with industry recognized values, while that for the Fly Ash is conservative (low shear strength which would provide minimal contribution to stability under static conditions).

APC identified the critical cross section at the northeast perimeter (Cross Section 5 from previous APC report) based on the exploration and testing. The cross section evaluated appears representative of conditions along the existing perimeter dikes, and the material properties were based on in-situ testing conducted at borings along the northeast, east and west perimeters. Table 4.1 summarizes the various slope stability conditions for the perimeter dikes of the Ash Pond that were presented in the CCR Surface Impoundment Application.

Table 4.1: Stability Analysis Conditions and Minimum Factor of Safety Criteria (Reference 16)

Facility Component and Analysis Condition	ADEM Minimum Factor of Safety Criteria for Existing Surface Impoundments	Critical Cross Section in Northeast Perimeter for Ash Pond
Perimeter Dikes		
Long Term, Max. Normal Storage Pool	1.5	1.6
Long Term, Max. Surcharge Pool	1.4	1.5
End-of-Construction (Short Term)	1.3	Not Applicable
Seismic Loading	1.0	1.5
Liquefaction of Susceptible Materials	1.2	Assumed Not Susceptible

The CCR Closure Plan considered cross sections and material properties/thicknesses from multiple locations along the perimeters and within the central portion of the Ash Pond based upon additional exploration and testing data on the CCR and foundation soils. The closure plan exploration and testing refined the material stratigraphy and properties previously characterized with more closely spaced borings and sampling, along with characterization and strength testing on CCR material samples from the Ash Pond. The refinements in material properties for the CCR Closure Plan design included:

- Perimeter dike and foundation clay and sand layers exhibited higher shear strength based on the additional exploration and testing, which was employed for the drained and undrained analysis.
- Ash properties were based on exploration to characterize the materials as free draining, and laboratory testing was performed on undisturbed and remolded samples from the Ash Pond sampling. No distinction between bottom ash and fly ash was assumed.
- Soil containment berms and bridging materials will be obtained from future borrow sites that meet project specifications and were assumed to provide relatively low strengths.

Critical cross sections selected for analysis include locations where the organic clay foundation layer exhibits the lowest strength and also locations where this layer exhibits the thickest strata. Similarly, critical cross sections for analysis considered locations which represented the longest and steepest final closure slope.

To implement the closure plan, excavation of CCR adjacent the perimeter dikes and placement of CCR to raise the interior grade also represent temporary, interim critical conditions and selected critical cross sections were analyzed to design temporary cut-slope geometry.

At the northwest corner of the Ash Pond, an equipment/material storage yard and access corridor are included in the closure plan. While not subject to significant placement of CCR fill, this area will not include the soil containment berm and internal drainage system and was not considered among the critical cross sections for analysis.

Required minimum factor of safety for the closed condition is not specifically addressed in the ADEM or USEPA rules. For closure, measures are required "that provide for major slope stability to prevent sloughing or movement of the final cover system during the closure and post-closure care period" (335-13-15-.07(3)). The required factor of safety for the operating condition can be expected to maintain stability if applied to the closed facility. The CCR Closure Plan does not report the stability analysis or design factor of safety, although information on the analyses was provided by APC for review.

Table 4.2 summarizes the cases evaluated for the CCR Closure Plan and factor of safety criteria considered for this review.

Table 4.2: Stability Analysis Cases and Minimum Factor of Safety

Facility Component and Analysis Condition	Factor of Safety Criteria Reference (1)	CCR Closure Plan
		Multiple Cross Sections Evaluated
Perimeter Dikes		
Long Term, Max. Normal Storage Pool	1.5	Satisfied
Long Term, Max. Surcharge Pool	1.4	Not Applicable (2)
End-of-Construction (Short Term)	1.3	Not Applicable (2)
Seismic Loading	1.0	Satisfied
Liquefaction and Strength Loss of Susceptible Materials	1.2	Liquefaction Not Triggered
Consolidated CCR		
Long Term, Static Analysis	1.5	Satisfied
Seismic Loading	1.0	Satisfied
Final Cover Veneer		
Long Term, Static Analysis, peak interface shear strength	1.5	Satisfied by material spec.
Long Term, Static Analysis, residual interface shear strength	1.2	Satisfied by material spec.
Seismic Loading, residual interface shear strength	1.0	Satisfied by material spec.
Soil Containment Berm		
Long Term, Static Analysis	1.5	Satisfied
Seismic Loading	1.0	Satisfied

Triggering of Liquefaction in Susceptible Foundation Zones		
Perimeter Dikes & Soil Containment Berms	1.1	Satisfied
Consolidated CCR Area	1.1	Satisfied
Interim Condition During Closure		
Interim CCR Slope Before Containment Berm Constructed (Short Term)	1.3	Satisfied
Interim Seepage Stability of Perimeter Dike in CCR Removal Zone Subject to Potential River Flooding Induced Pressures	1.6	Satisfied by Seepage Berm Design

(1) USEPA 40 CFR 257 for CCR Surface Impoundments for most cases; Triggering of Liquefaction in Susceptible foundation zones reference is USBR Design Standards No. 13 Embankment Dams, Chapter 13 Seismic Analysis and Design (2015); and Interim Seepage Stability reference is USACE Hurricane and Storm Damage Risk Reduction System Design Guidelines (Interim) (2012).

(2) The Perimeter Dike Long Term Max. Surcharge Pool case was not considered applicable due to the low permeability of the dike material which would limit response to the surcharge pool, and the Perimeter Dike End-of-Construction case was not considered applicable because significant modifications to the perimeter dikes are not part of the closure plan.

Interim conditions such as the removal and placement of CCR materials in the consolidated CCR area represents generally a short-term condition similar to end-of-construction with follow-on strength gain and increase in the factor of safety. Thus, reference to the end-of-construction criterion for interim condition is consistent with industry practice provided materials are appropriately characterized relative to undrained strength, gain strength with time, and the duration of the interim condition is short and subject to monitoring.

As discussed in the following sections, the features of the plan indicate long term stability based on the adopted design criteria.

4.4.2.2 Static Analyses and Loadings

Loadings for static stability analyses reported in the CCR Surface Impoundment permit application included the maximum normal pool level for the Ash Pond which reflects the impounded pool level for operation of the impoundment, and the maximum surcharge pool level which reflects the impounded pool level under the design storm (1,000 year recurrence interval storm, or approximately 21.7 inches in 24 hours).

With closure of the Ash Pond, CCR will be removed from adjacent the perimeter dikes and consolidated within the central portion of the property, no impoundment will be maintained on the consolidated CCR area, and channels will remove rainfall-runoff from the cover system. The static stability analyses consider loadings associated with the stacked CCR materials within the central portion of the property, along with levels of saturation considering the proposed containment berm, internal drainage system, and final cover. While not required for containment of CCR material after closure, the perimeter dikes will remain in support of stormwater pond structures. Loadings on the perimeter dikes under stormwater management design could result from flood events. Under classification as a significant hazard potential structure, the design basis for loading should be a significant flood event such as the 1,000-year event.

During implementation of the CCR Closure Plan, interim conditions will occur during excavation of CCR from perimeter areas, resulting in temporary cut-slopes in the existing CCR material located in the central portion of the property. The static stability analyses considered the potential of saturated materials in the CCR cut-slope to develop the temporary grading design until the proposed containment berm and final slopes are established.

4.4.2.3 Seismic Analyses and Loadings

Loadings for seismic stability analyses reported in the CCR Surface Impoundment permit application for the Ash Pond considered earthquake ground motion based on USGS Uniform Hazard Response Spectrum for Site Class B/C at a 2-percent probability of exceedance in 50 years (approximately 2,500 year return period). Considering the foundation soil conditions, the seismic loading on the perimeter dike was established for application in the stability analyses. A seismic pseudostatic horizontal coefficient of 0.012g was determined for perimeter dike stability analyses considering an allowable displacement of 0.5-feet.

For the CCR Closure Plan, updated USGS seismic hazard maps indicate the site has a 2-percent probability of exceeding a maximum horizontal acceleration of 0.05g in 50 years. This loading is less than the level considered to qualify the site as in a seismic impact zone under ADEM (0.1g). None-the-less, site-specific data from exploration and testing programs were used with surface acceleration response spectra to estimate pseudostatic coefficients for the consolidated CCR area and the perimeter dikes and containment berms under the closure plan. Tolerable displacement of 0.5-feet under seismic loading was adopted, consistent with tolerable levels established for solid waste landfills, and less than typical levels considered for dams and dikes. The pseudostatic coefficients established for closure seismic stability analyses considering critical potential failure surfaces for the perimeter dikes, soil containment berm, consolidated CCR area, and cover were similar to that estimated for the Ash Pond perimeter dikes in the Surface Impoundment Permit Application (Reference 16).

Seismic loadings can cause liquefaction and strength loss in loose or soft soils, and some foundation soils and CCR materials at the Ash Pond have been classified as potentially susceptible to strength loss. Triggering analyses for liquefaction were performed based on surface acceleration response spectra for the consolidated CCR area and the perimeter dikes/containment berms to determine cyclic stress. Cyclic resistance for the site materials was based on in-situ tests and determined to be sufficient within soil layers to preclude liquefaction and strength loss.

4.4.2.4 Perimeter Dike Stability Analysis

The CCR Surface Impoundment permit application presented the stability analysis for the perimeter dikes considering the impoundment of CCR materials and monitored water levels, based on available design information on embankment dike and foundation slopes and estimating CCR material shear strength. The configuration analyzed for the Ash Pond considered the perimeter dike, upstream raises in the dike elevation, and CCR levels in 2016, and maximum normal pool and flood surcharge pool cases. The application documents the analyses and the results indicated that static and seismic factor of safety criteria were met.

The CCR Closure Plan includes excavation and removal of CCR material immediately upstream of the perimeter dikes, and consolidation of the CCR materials in the central portion of the property within an upstream soil containment berm. Stormwater management ponds will be established between the containment berm and perimeter dikes. Information on the analyses conducted for the CCR Closure Plan was reviewed that indicate the perimeter dikes under static and seismic loadings, considering operation of the stormwater pond structures upstream of the dikes, are consistent with the ADEM criteria for existing surface impoundments.

4.4.2.5 Perimeter Dike / Stormwater Management Pond Analyses

The CCR Closure Plan includes the construction of stormwater management ponds adjacent the perimeter dikes which will control runoff from the consolidated CCR area once the final cover is complete. An initial step in the CCR Closure Plan is the dewatering of the Ash Pond, which includes removal of free water and draining of interstitial water from the CCR material. The stormwater ponds are designed to include compacted fill over the foundation clay layer, and the design and construction plans have been developed to address slope stability of the dikes and foundation. Analyses conducted for the CCR Closure Plan were reviewed that indicate the upstream slope of the perimeter dikes under static and seismic loadings are consistent with the ADEM criteria for existing surface impoundments. As part of construction planning, failure modes associated with seepage induced instability were evaluated considering the potential flood levels of the Mobile River which could cause high porewater pressures to be transmitted within the foundation sand layer to the area for CCR excavation and stormwater management pond construction. A seepage berm at the upstream toe of the perimeter dike within the stormwater settling basin is included in the closure plan to address these failure modes.

4.4.2.6 Soil Containment Berm and Consolidated CCR Area

Under the CCR Closure Plan, as CCR material is removed from the perimeter and placed in the consolidated CCR area in the central portion of the site, a soil containment berm will be constructed on the foundation clay layer. An initial step in the CCR Closure Plan is the dewatering of the Ash Pond, which includes removal of free water and draining of interstitial water from the CCR material. Information on static and seismic stability analyses were reviewed for the proposed soil containment berm and consolidated CCR area, considering draining of the CCR material, which indicated factors of safety consistent with the ADEM criteria for existing surface impoundments.

Seepage and groundwater analyses indicate that the dewatering, containment berm with internal drainage system, and cover system will result in drainage of the CCR within the central portion of the site such that residual saturation is limited to near the top of the foundation clay. These analyses incorporate the influence of the foundation sand layer and are based on steady state analysis. Planned geotechnical exploration following dewatering and preloading should provide information on the rate of drainage and duration to achieve steady state condition. Drainage could be confirmed with geotechnical instrumentation monitoring.

Interim conditions during removal of CCR material and development of a cut-slope prior to establishing the soil containment berm were evaluated and information on the stability analyses reviewed. These analyses provided guidance for the planned configuration of the cut-slope to maintain associated factors of safety.

4.4.2.7 Consolidated CCR Area Final Cover

The CCR Closure Plan includes the construction of a final cover over the consolidated CCR area in the central portion of the property, about 330 acres. The consolidated CCR area is designed to establish an approximate 3.5-percent slope extending from the soil confinement berm and will include benches and surface water drainage structures. The maximum slope height for the cover is approximately 22-feet. The proposed cover is a ClosureTurf system (by Agru America) consisting of: 50-mil thick textured geomembrane with spike down that is part of the MicroDrain drainage layer; and 0.5-inch thick sand infill and engineered turf. Veneer stability analyses were conducted on the proposed cover system to determine the required peak and residual interface shear strength between the subgrade CCR material and the cover system to meet associated factors of safety under static and seismic loadings (wind loading was also evaluated as part of the system design). The required interface shear strength values are considered achievable with commercially available products used for cover systems. Based on the manufacturers information, the proposed ClosureTurf system can be expected to meet the required interface shear strength values. Interface shear strength testing will be performed as part of the Construction Quality Assurance program to confirm acceptance of the material.

4.4.3 Settlement Assessment

Total and differential settlement was analyzed for the final cover and soil containment berms and associated stormwater structures to establish design requirements for the closure plan. The design criteria for the cover structures were established to limit post-settlement grades for the final cover to established minimums, avoid adverse slopes or grade reversal, and not cause tensile strains for the geosynthetic components of the final cover. The design criteria for the soil containment berms and associated stormwater structures included limiting post-settlement elevations to maintain culvert drainage, and limit tensile strains in HDPE internal drainage pipes to allowable values. The settlement analyses were based on the geotechnical exploration and testing program conducted on the site and indicated that design criteria were met. The design criteria and analyses are consistent with general engineering practice for these types of facilities.

4.4.4 Slope Protection

4.4.4.1 Perimeter Dike Overtopping from Site and Mobile River Floods

The CCR Closure Plan includes stormwater management on the site during implementation and upon closure to preclude overtopping of the perimeter dikes from events exceeding the 1,000 year 24-hour event within the site. The design criterion is consistent with the ADEM requirements for surface impoundments classified as Significant Hazard Potential.

Published flood levels for the Mobile River (FEMA, 2019b) indicate that the 500-year event stage at Plant Barry would inundate the perimeter dike slope but not overtop the crest at El. 21.5 for the south settling pond and containment berm. Flood frequency analyses performed in support of the closure plan indicate that flooding and overtopping of the perimeter dike crest from the Mobile River would not occur for the design criteria applied for on-site flooding (1,000-year event).

4.4.4.2 Perimeter Dike Overtopping from Coastal Storm Surge

Preliminary FEMA flood maps for coastal storm surge at Mobile Bay (FEMA, 2019a) do not extend to Plant Barry, such that coastal influence is likely to be insignificant. However, coastal hydrologic and hydraulic analyses were conducted in support of the Closure Plan to extend potential flooding and wave impacts to the Ash Pond. These analyses demonstrated that Ash Pond flooding from coastal storm surge for the 500-year event would not overtop the perimeter dikes, and would be less severe than the 500-year Mobile River flood level established in the FEMA study. Coastal flooding is less of a risk than riverine flooding and thus not expected to overtop the perimeter dikes for events such as the 1,000-year event and greater based on studies for the closure plan.

4.4.4.3 Susceptibility to Erosion

The CCR Surface Impoundment Permit Application cites that slope protection against surface erosion consists of grassy vegetation on both the perimeter dikes, and the limited size of areas of free water mitigate concern for wave action within the pond.

The CCR Closure Plan includes cover systems, stormwater ponds and culvers, and channels with materials that are resistant to erosion. Channels and culverts are designed to provide stable performance under 100-year events.

Erosion potential of perimeter dikes subject to inundation has not been addressed in the CCR Closure Plan. Riverine flooding has been characterized as slow, gradual rise in depth, and significant erosion due to observed flooding and inundation of perimeter dike slopes has not be reported.

4.4.5 Stormwater Management

Stormwater management for the closure plan is based on the ADEM design requirements for a structure classified as significant hazard potential, the Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas (2014), design guidelines manual for the ClosureTurf (2017), and project design criteria.

4.4.5.1 Spillway Capacity and Overtopping Protection

In 2016, the Inflow Flood Control Plan (Reference 11) indicated that the Ash Pond and perimeter dikes can route the established design storm for the Ash Pond's hazard potential determination (1,000 year, 24 hour design storm) without exceeding the crest of the south perimeter dike based on the capacity of the existing outlet works, although there was a risk of overtopping due to the lack of storm freeboard. Following maintenance of the south perimeter dike to restore the design crest elevation by placement of compacted fill, additional freeboard was provided, and the 2018 Updated Inflow Flood Control Plan (Reference 20) indicates that the risk of overtopping has been addressed.

The Stormwater and Contact Water Management Plan (Reference 1) indicates that the proposed CCR Closure Plan maintains the outlet works spillway capacity and freeboard for the 1,000-year design storm (approximately 21.7 inches of rain in 24 hours) during implementation and at the end of construction. Additionally, an auxiliary open channel spillway is included in the CCR Closure Plan design which would provide for significant additional discharge capacity should rainfall exceed the design basis. These provisions provide for overtopping protection of the perimeter dikes from rainfall and runoff on the facility.

4.4.5.2 Retention of Surface Runoff

During implementation of the CCR Closure Plan, stormwater and contact water within the Ash Pond will be retained within the south settling pond up to the 25-year storm event without discharge through the outlet works and NPDES outfall. The retained runoff will be pumped to the WWTS for treatment and discharge as necessary. Runoff generated by storms exceeding the 25-year event need not be contained for treatment within the south settling basin and will be discharged through the NPDES outfall, and is expected to meet effluent quality requirements of the NPDES permit.

With completion of closure and at a point when sedimentation is no longer required, the normal pool level of the outlet works for the south settling basin is planned to be lowered to reduce retention of water.

4.4.5.3 Permanent Drainage Channels, Culverts, and Stormwater Ponds

Channels and linings, culverts and outlet protection, and stormwater ponds for the final cover and related structures have been designed with a capacity to meet the 100-year event without overtopping, and resist erosion from peak velocities.

4.5 Operation Plans

APC conducts operation and maintenance activities and prepared an Operation Plan as part of the CCR Surface Impoundment Permit Application that addressed fugitive dust control, inflow design flood control, groundwater monitoring, recordkeeping and compliance procedures, and procedures for updating plans and assessments. The CCR Closure Plan included additional operation plan content as discussed in the following sections.

4.5.1 Operation and Maintenance

The Contact Water and Stormwater Management Plan contained in the CCR Closure Plan addresses the associated operating requirements during closure of the facility to control drainage and meet NPDES permit requirements. With construction of the soil containment berm and internal drainage system, interstitial water drainage from CCR that will remain in-place in the central portion of the site will be collected and pumped via forcemain piping for treatment at the WWTS. With installation of the cover system to intercept infiltration through the CCR fill in the central portion of the site, interstitial drainage will decline. Groundwater potentiometric level in the foundation sand layer, separated from the base of the CCR by a clay layer, is anticipated to cause some seepage into the CCR in the central portion of the site. Operation of the internal drainage system will provide for continued removal of interstitial drainage after closure as necessary.

Another operational element of the CCR Closure Plan is the CCR Removal Verification Protocol, which includes multiple exploration methods to characterize and define the depth of CCR to be removed on a minimum 100-foot grid, and upon visual confirmation of CCR removal during excavation (to a depth 6-inches below the CCR-clay interface), additional sampling and visual examination at a minimum frequency of every acre (approximately 200-foot grid). The exploration, excavation procedures, and additional grid sampling will document CCR depth, interface of CCR and clay, and removal. The exploration will use penetration resistance characteristics to aid in classifying materials, as well as visual examination procedures for classification by color, texture and tactile characteristics.

Weekly inspections are required under the closure plan and conducted by trained plant personnel to detect Ash Pond conditions that could indicate a potential issue, and report findings to APC's parent company, Southern Company as prescribed in the *Safety Procedure for Dams and Dikes*. This procedure document was also cited in the 2010 Dam Safety Assessment relative to operation and maintenance at that time, with examples of corrective actions implemented in response to inspections.

4.5.2 Construction Best Management Practices

The CCR Closure Plan included a Construction Best Management Practices (CBMP) Plan that addresses closure construction activities and measures to control surface drainage, erosion and sedimentation, and protect water quality. The CBMP Plan identifies the personnel responsible for implementation of best management practices, along with maintenance, inspection, and record keeping requirements.

4.5.3 Fugitive Dust Control Plan

Fugitive dust control measures include:

1. Spraying dewatered ash with water using water trucks as needed to promote the formation of a surface crust and minimize the potential for fugitive dust generation. Water and polymer tackifiers will be used as needed on roads to control fugitive dust on facility roads used to transport CCR and other CCR management areas. Trucks used to transport CCR will not be overfilled to reduce the potential for material spillage.
2. Access to the Ash Pond is minimized, allowing only necessary personnel to conduct operations, maintenance and inspection. During closure operations, CCR that is transported via truck will be conditioned to appropriate moisture content to reduce the potential for dust generation.
3. Areas with observed fugitive dust are sprayed with water using water truck or other means. Logs will be used to record utilization of water spray equipment.
4. Vehicle speed is limited. A speed limit sign is posted at access road entrances.

4.5.4 Surface Water Management

Surface water management for the CCR Closure Plan has been considered in the planned phasing of construction and addressed in the Stormwater and Contact Water Management

Plan. During the closure activities, ash pond water will be managed as contact water collected and treated as required for discharge from the NPDES outfall. Any discharge from the Ash Pond will be routed through a 4,000 gallon per minute (gpm) WWTS prior to discharge. Upon completion of free water drawdown, the stormwater controls and settling basin at the south end of the site provide for retention of the 25 year, 24-hour storm without discharge through the NPDES outfall. Storm runoff exceeding the 25 year, 24-hour event may be discharged through the NPDES outfall but is anticipated to meet effluent quality parameters in the permit.

No post-closure use of the facility is identified, and the Post-Closure Care Plan indicates that any future use of the property would be noted in an amendment to the Closure Plan and would not disturb the final cover, liner, or other component of the containment system, and maintain the functionality of the groundwater monitoring system. The Post-Closure Care Plan currently cites semi-annual maintenance, or more frequently if needed, to address erosion of the final cover system from run-on or run-off.

4.5.5 Groundwater Monitoring Plan

The Groundwater Monitoring Plan submitted with the CCR Surface Impoundment Permit Application describes the hydrogeology and upper most aquifer, monitoring well network, sampling and analysis program, and statistical analysis program. Groundwater monitoring will continue through closure and post-closure care periods.

4.5.6 Recordkeeping and Notification Compliance Procedures

APC maintains an electronic Operating Record for the Ash Pond that supports compliance notification requirements. In addition, a publicly accessible internet site has been established in compliance with the federal requirement.

4.5.7 Procedures for Updating Plans and Assessments

APC maintains an electronic Operating Record for the Ash Pond that supports procedures for updating plans and assessments in compliance with the regulations. This could include periodic structural assessments required under ADEM regulations on intervals not to exceed 5-years. Additionally, the closure plan must be amended and submitted to ADEM if a change in the facility that would affect the closure plan or unanticipated events necessitate a revision to the closure plan. Any amendment of the closure plan must include written certification of a qualified professional engineer that the amended plan meets the ADEM regulations.

4.6 Inspections

APC's parent company, Southern Company has performed annual inspections to assess the structural features of the Ash Pond and spillway, perimeter dikes, and diversion dike (Reference 13). Since 2015, APC has conducted annual inspections in response to 40CFR Part 257.83, which requires: review of the operating record including previous structural stability assessments); visual inspection for signs of distress or malfunction of the CCR facility and appurtenant structures; and visual inspection of the hydraulic structures passing through the perimeter dike for structural integrity and safe and reliable operation. The inspection reports are prepared by a registered professional engineer and address the following:

- Changes in geometry of the impounding structure since the previous annual inspection
- The location and type of existing instrumentation and the maximum recorded readings of each instrument since the previous annual inspection
- The approximate minimum, maximum, and present depth and elevation of impounded water and CCR since the previous annual inspection
- The storage capacity of the impounding structure at the time of the inspection
- The approximate volume of water and CCR at the time of the inspection
- Any appearances of an actual or potential structural weakness of the CCR facility, in addition to any existing conditions that are disrupting or have the potential to disrupt the operation and safety of the CCR facility and appurtenant structures
- Any other changes that may have affected the stability or operation of the impounding structure since the previous inspection

As documented in the Emergency Action Plan contained in the surface impoundment permit application (Reference 3), the qualified person conducting weekly inspections is trained by Southern Company dam safety personnel. Issues identified during the inspections are reported to Southern Company dam safety personnel as prescribed in Southern Company's *Safety Procedure for Dams and Dikes*. This procedure document was also cited in the 2010 Dam Safety Assessment relative to operation and inspection at that time.

The CCR Closure Plan includes requirements for inspection by a qualified person at intervals not to exceed 7 days for appearances of structural weakness and for proper operation of all outlet structures maintained for use during closure. The annual inspection will continue to be conducted by a qualified Professional Engineer throughout the closure process.

The inspection reports for 2015-2018 are available on APC's website and indicate that no conditions were observed that represent actual or potential structural weakness or changes that may have affected the stability or operation of the impounding structure. The reports document conclusions with respect to evidence of structural weakness, but do not include inspection observations.

5.0 SUMMARY OF FINDINGS

The following sections provide a summary of findings, including observations that APC should consider in finalizing and implementing the closure plan.

5.1 General Overview

Acceptable structural performance is demonstrated by the CCR Closure Plan procedures, design, and engineering analyses that are supported by the site characterization and the design criteria adopted based on USEPA and ADEM regulations and other industry guidance. Dewatering and stabilization procedures and excavation plans have been developed considering the saturated, loose nature of the CCR. Additional exploration planned following dewatering and pre-loading should provide refined characterization of CCR shear strength and depth in excavation areas and allow adjustments in the design based on updated stability assessments if necessary. Geotechnical monitoring to confirm the behavior of the foundation and performance of the closure structures will be critical. In addition to focusing on foundation soils, the geotechnical monitoring program should also include the CCR material to confirm design expectations for interstitial drainage from the CCR, interim cut-slope stability, buildup of pore pressures at the base of the consolidated CCR area, and performance of the internal drainage system.

5.2 Hazard Potential Classification, Emergency Action Plan and Risk Reduction

Significant Hazard Potential classification for the Ash Pond was appropriately considered for the design criteria of the CCR Closure Plan and is consistent with the ADEM regulation for surface impoundments. Adopting the associated design criteria for closure will decrease the risk to downstream areas as the CCR drains and consolidates, and ultimately the CCR material should no longer represent a flowable material subject to hazard potential classification.

The stormwater settling basin planned for the closed facility in the south portion of the site will continue as an outfall for discharge from the site, but with completion of closure the outlet works will be modified to maintain a normal pool near the bottom of the basin and thus water would not be impounded on the perimeter dikes except during storm events. The size of the contributing watershed and the stormwater settling basin, which can impound water to the top of the auxiliary weir spillway, indicate that this structure warrants a hazard potential classification, although it should be possible to demonstrate that the classification can ultimately be lowered from Significant to Low Hazard Potential.

The Emergency Action Plan should continue to be subject to annual review and update during the closure of the Ash Pond, with scheduled meetings with emergency management agencies concerning the scope and responsibilities of the parties, documenting participation, topics reviewed, and training or exercise activities.

With completion of the closure of the Ash Pond, significant risk reduction will be accomplished. The geotechnical instrumentation and monitoring conducted during implementation of closure, with some specific exploration prior to installation of the cover, should be considered to determine if the CCR no longer represents a flowable material, and thus does not need to be considered in assessing hazard potential classification.

5.3 Structural Assessment

5.3.1 Slope Stability

5.3.1.1 Factor of Safety Design Criteria

The CCR Closure Plan adopted factor of safety criteria consistent with the ADEM regulations for existing CCR surface impoundments and demonstrated that the design of the CCR Closure Plan meets these criteria and should provide for stability of closed facilities.

Long-term factor of safety criteria cited by ADEM and USEPA, as well as many dam safety organizations, recognize 1.5, with allowance for lower factor of safety for short-term conditions where the loading will not be sustained or shear strength conditions can be expected to improve. Implementation of the CCR Closure Plan adopts the long-term factor of safety criteria for final slopes; interim slopes such as established during excavation of CCR materials consider the referenced end-of-construction factor of safety criterion of 1.3. Because of the extended period required for closure, an ongoing process of interim slope excavation and backfill with new interim slopes subsequently established for several years. The existing ADEM criterion on end-of-construction factor of safety (1.3) is reasonable for interim stability analyses at the Ash Pond for Plant Barry provided the existing CCR material drains as anticipated and pore pressures are monitored in saturated materials during loadings, remain below the design basis, and exhibit declining trends following establishment of final CCR grades. Exploration and monitoring of foundation soils during implementation of the closure plan is cited in the closure plan and should extend to the saturated CCR materials that will remain in place.

5.3.1.2 Subsurface Characterization, Material Properties, and Critical Cross Sections

Extensive geotechnical exploration and testing has been performed to characterize the foundation and CCR materials and develop the closure plan. Material properties for slope stability analyses considered effective and total stress strength testing of the foundation and

CCR material. Stabilization measures and internal drainage systems are included in the CCR Closure Plan to improve the CCR characteristics and support the use of drained strengths for long-term conditions as a design basis. Additional, more refined exploration and testing is planned as part of the initial steps of the closure plan that will identify foundation conditions subject to the dewatering and preloading program and provide further characterization for detailed CCR excavation plans.

Multiple critical cross sections were selected for analyses based on foundation conditions and closure plan geometry. At the northwest corner of the Ash Pond, an equipment/material storage yard and access corridor are included in the closure plan. While not subject to significant placement of CCR fill, this area will not include the installation of the soil containment berm and internal drainage system. A cross section in this area was not selected for analysis and the saturation of the CCR and slope stability of the perimeter dike has not been evaluated.

5.3.1.3 Slope Stability Analyses

A range of loading conditions and slope stability cases have been analyzed for the proposed closure structures to prepare the design configuration and meet the reference design criteria in Table 2. These analyses focused on critical locations considering foundation conditions and closure configuration. Representative cross sections from the west, south, and east perimeters were analyzed and found to satisfy the design criteria. No information was provided to review slope stability in the northwest corner, where CCR materials will not be removed, but rather remain contained by the existing perimeter dike in that area, and covered with a cap system to address infiltration and support planned activities. While apparently not the focus of slope stability analysis, this portion of the site is expected to be less critical than those analyzed considering foundation conditions and the limited additional loading with establishing the equipment/material storage yard and plant evacuation access corridor.

As part of the excavation of CCR material in perimeter areas, interim cut-slopes have been designed based on slope stability analyses presuming that the CCR material will behave as a drained material with effective stress shear strength. Should additional exploration planned following preloading and geotechnical monitoring indicate that the material may behave in an undrained manner, with more limited drainage than anticipated in the design, additional slope stability analyses would be warranted to consider changes in the designed interim cut slopes.

5.3.2 Settlement

Total and differential settlement analyses were performed based on exploration and testing across the site to establish design requirements for the final cover and soil containment berms and associated stormwater structures of the closure plan. The design criteria for the cover structures were established to limit post-settlement grades for the final cover to established minimums, avoid adverse slopes or grade reversal, and not cause excessive tensile strains for the geosynthetic components of the final cover. The design criteria for the soil containment berms and associated stormwater structures included limiting post-settlement elevations to maintain culvert drainage, and limit tensile strains in HDPE internal drainage pipes to allowable values. The design criteria and analyses are consistent with general engineering practice for these types of structures.

5.4 Slope Protection and Stormwater Management

The CCR Closure Plan includes a cover system, stormwater ponds and culverts, and channels with materials that are resistant to erosion, considering the design criteria to provide stable performance under 100-year storm events.

Erosion potential of perimeter dikes subject to inundation has not been addressed in the CCR Closure Plan, and no erosion protection measures are identified for the exterior slopes of the perimeter dike. Riverine flooding has been characterized as slow, gradual rise/fall in depth over significant portions of the exterior slopes. While significant erosion due to past flooding and inundation of perimeter dike slopes has not been reported, the inspection reports between 2015 and 2018 do not include description of the observed conditions of the exterior perimeter dikes. Evaluation of the potential for erosion of the perimeter dikes subject to inundation from large flood events on the Mobile River would provide a basis to address slope protection, if necessary, and establish performance expectations for monitoring and inspection.

Post-closure care includes maintenance of slopes, ponds, and channels to address erosion and other disturbance.

5.5 Closure Operations and Maintenance

As required under ADEM rules, APC conducts operation and maintenance activities under an Operation Plan that addresses surface water management, fugitive dust control, construction best management practices, groundwater monitoring, recordkeeping and compliance procedures, and procedures for updating plans and assessments. Updating of plans and assessments as the closure progresses, particularly following additional subsurface exploration and in response to monitoring, would communicate necessary changes to ADEM and other stakeholders.

Under the closure plan, operations include stormwater and contact water management, and treatment if from CCR materials. An internal drainage system to collect interstitial drainage from the consolidated CCR material will include pumping for treatment, during and after closure as necessary.

5.6 Inspections

The CCR Closure Plan includes requirements for inspection by a qualified person at intervals not to exceed 7 days for appearances of structural weakness and for proper operation of all outlet structures maintained for use during closure. The annual inspection will continue to be conducted by a qualified Professional Engineer throughout the closure process, and should include geotechnical instrumentation, monitoring, and interpretation of monitoring data.

The inspection reports for 2015-2018 are available on APC's website and indicate that no conditions were observed that represent actual or potential structural weakness or changes that may have affected the stability or operation of the impounding structure. The reports document conclusions with respect to evidence of structural weakness, but do not include inspection observations or geotechnical instrumentation (no instrumentation is reported on the 2015-2018 reports). Without such objective observations, the reports provide limited background and value for future inspections and assessments of structural integrity. The geotechnical instrumentation anticipated with implementation of the closure plan will also be critical for the assessments of structural integrity.

6.0 RECOMMENDATIONS

D'Appolonia has prepared the recommendations presented below based on the findings discussed in Section 5. This report should be shared with APC for their consideration. The findings and recommendations reflect our judgment, and should be confirmed by exploration, testing, instrumentation, and engineering analyses if necessary.

Structural Assessment

The closure plan and supporting engineering assessments are based on predictions of CCR drainage and CCR and foundation material strengths as discussed in Section 5.3, which should be evaluated and monitored as closure proceeds. Geotechnical exploration, instrumentation and monitoring should confirm the design basis for the closure plan as work proceeds, or changes in the closure plan developed if warranted. The following relative to structural assessment is recommended:

- Assessment of the saturation of CCR and slope stability of the perimeter dike in the northwest corner where the equipment/material storage yard will be developed, considering that the CCR material is closed in-place without the soil containment berm and internal drainage system. This recommendation is supported by findings discussed in Section 5.3.1 Slope Stability.
- Geotechnical exploration planned following the initial steps of closure should be conducted and include activities required to confirm the characteristics, such as saturation and shear strength of CCR material (and including characteristics of foundation soils as planned) in response to Ash Pond dewatering and pre-loading. This recommendation is supported by findings discussed in Section 5.1 General Overview and 5.3.1 Slope Stability.
- Geotechnical instrumentation and monitoring should be conducted on CCR, foundation, and existing perimeter dike materials to confirm assumptions in the structural assessments. The focus should include the CCR material that will remain in-place, as well as the foundation and perimeter dike materials as the closure plan is implemented, to assess behavior during all loading conditions. Should saturated CCR material conditions and undrained behavior be indicated, reassessment of interim stability analyses for cut-slope conditions are recommended. This recommendation is supported by findings discussed in Section 5.1 General Overview, Section 5.2 Hazard Potential Classification, 5.3.1 Slope Stability, and 5.6 Inspections.

Stormwater Management and Slope Protection

Riverine floods on the Mobile River could inundate a substantial portion of the exterior slopes of the perimeter dikes, and while overtopping is not a significant threat, the following relative to slope protection is recommended:

- Evaluation of the potential for erosion of the exterior of the perimeter dikes due to Mobile River flooding, and consideration of slope protection if warranted. This recommendation is supported by findings discussed in Section 5.4 Slope Protection.

Operation, Maintenance and Inspections

Operation and maintenance plans must be maintained during closure and include recordkeeping and updating of plans and periodic structural assessments. Significant closure plan changes or response to unanticipated Ash Pond conditions, if they arise, need to be addressed in an amended closure plan submitted to ADEM and, when disclosed, provide an opportunity for public awareness. This recommendation is supported by findings discussed in Section 5.5 Closure Operations and Maintenance.

Periodic Structural Assessments performed by APC on the Ash Pond at intervals no longer than 5 years, as cited in the ADEM regulations, should be performed by APC and made available to stakeholders. These periodic structural assessments should continue during and after the closure process, until the hazard potential classification is changed to Low or is no longer applicable. This recommendation is supported by findings discussed in Section 5.5 Closure Operations and Maintenance.

Annual inspection reports providing information on the structural integrity of the Ash Pond should continue during closure and remain publicly disclosed. Inspection reports should include information on geotechnical instrumentation, monitoring, and interpretation, along with inspection observation, to confirm conclusions of structural assessment. This recommendation is supported by findings discussed in Section 5.6 Inspections.

Hazard Potential Classification, Emergency Action Plan and Risk Reduction

The Hazard Potential classification should be reevaluated upon completion of the closure plan. Upon completion of dewatering and consolidating the CCR material within the soil containment berm, a reduction in Hazard Potential from Significant to Low may be justified, particularly considering the modification of the south settling basin outlet structure. A reduction in the hazard potential classification would demonstrate risk reduction for the closed facility. The Emergency Action Plan should continue to be subject to annual review and update during the closure of the Ash Pond, with scheduled meetings with emergency management agencies concerning the scope and responsibilities of the parties, documenting participation, topics reviewed, and training or exercise activities. This recommendation is supported by findings discussed in Section 5.2 Hazard Potential Classification.

7.0 REPORT CONDITIONS AND CLOSING

This report has been prepared for MBNEP to present independent review findings on the CCR Closure Plan for the Plant Barry Ash Pond relative to structural integrity of the containment system in accordance with D'Appolonia's January 7, 2020 proposal which was authorized by MBNEP on January 21, 2020. In preparing this report, D'Appolonia's professional services have been performed, findings obtained, and recommendations prepared in accordance with generally accepted engineering principles and practices. This statement is in lieu of all warranties, either expressed or implied.

In the event that there are changes or differences in the design and construction from conditions described here, D'Appolonia should be advised and the relevant documents reviewed to the extent necessary to assess if such affect the findings and recommendations contained herein. D'Appolonia's evaluation has been conducted in a review capacity, and the findings and recommendations presented are intended to be followed by further engineering studies to confirm conditions and develop designs as necessary for implementation. D'Appolonia is not responsible for any claims, damages, or liability associated with evaluations or interpretation of the findings and recommendations presented herein by others.

Respectfully submitted,

Robert E. Snow, P.E.

Sr. Principal Engineer

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