Allen Steam Station Ash Basin Closure Options Analysis

Summary Report

This summary report (Report) presents the Closure Options evaluation for the Ash Basins located at Duke Energy Carolinas, LLC's (Duke Energy's) Allen Steam Station, located in Gaston County, North Carolina. The Closure Options Evaluation involved developing ash basin closure strategies and evaluating these options relative to one another to determine which option to advance to more detailed engineering and closure plan development. The strategies discussed in the Closure Options evaluation are representative of the range of possible approaches for basin closure, and do not constitute final closure plans as described in N.C. Gen. Stat. sec. 130A-309.214(a)(4). Final closure plans will be submitted in 2019, as required by law, supported by detailed engineering designs and any necessary updates to groundwater modeling and related analysis.

Duke Energy developed programmatic guidance for the closure analysis effort in early 2016 to provide fleet-wide consistency to ash basin closure plan development. Duke Energy developed a relative weighting and scoring system with input from the National Ash Management Advisory Board. Using this system, Duke Energy evaluated and scored the alternatives using an options analysis framework designed to identify the best solution that balances environmental protection, cost, schedule and local community impacts. It is noted that internal working draft versions of these 2015-2016 Options Analyses for Allen, Belews Creek, Cliffside, Marshall, Mayo, and Roxboro were provided to NCDEQ at its request in May and June 2018.

The 2016 internal working draft Options Analysis identified Closure-In-Place as the preferred solution for Allen that is protective of the environment, safely closes the Ash Basins, minimizes the other associated risks, and was the least cost to customers. A permit-level design was developed for that option in 2016. The company then paused that work, pending determination that the site would meet the requirements for a low-risk impoundment classification pursuant to CAMA, as amended by House Bill 630. Duke Energy has completed those requirements at the Allen site for a low-risk classification and now has updated this analysis.

This updated Closure Options Evaluation includes updates to the Closure-In-Place option per the most recent design. In addition, unit costs and material quantities have been updated where appropriate for all options.

SITE BACKGROUND

Allen Station is located along the west shore of Lake Wylie, a man-made reservoir created by the impoundment of the Catawba River. Allen Station is a five-unit, 1,140 megawatts, coal-fired generating facility. Allen Station began commercial operation in 1957 with units 1 and 2. Unit 3 began operation in 1959, unit 4 in 1960, and unit 5 in 1961.

Allen Station historically wet sluiced coal combustion residual (CCR) products into two surface impoundments located on the property. These surface impoundments are known as the Retired Ash Basin (RAB) which is also referred to as the Inactive Ash Basin (IAB) and Active Ash Basin (AAB), which are impounded by the following dams:

- Retired Ash Basin (GASTO-016)
- Active Ash Basin (GASTO-061)

The RAB received CCR products from initial operation in 1957 until 1973, when it reached capacity and was retired. Allen Station then commissioned the AAB and began wet sluicing CCR products into this new basin. In 2009, Allen Station replaced its fly ash wet sluicing operation with a dry ash handling system and began placing dry fly ash into a landfill constructed over a portion of the RAB (Permit No. 36-12). Allen Station currently wet sluices only bottom ash into the AAB and this operation will cease once the dry bottom ash system becomes operational, which is scheduled to occur in early 2019.

Based on currently available information, the ash basins are estimated to contain a total of approximately 19,515,700 tons of ash (16,263,000 cubic yards) which includes ash associated with the landfill. This estimate is based on Duke's Ash Inventory dated July 31, 2018 and the 2017-2018 Annual Landfill Capacity Report (August 2, 2018) which includes data from an aerial survey obtained on May 9, 2018. The RAB Landfill is active at this time and is estimated to have capacity (Phase 1, Cells 1 and 2) until 2029 based on projected future ash generation from station operations. Figure 1 presents the Active and Retired Ash Basins and associated dams.

Figure 1. Active and Retired Ash Basins

CLOSURE OPTIONS

For the Allen Steam Station, under the direction of Duke Energy, AECOM developed the following conceptual closure options that remain under evaluation:

Option 1. Closure-in-Place: Closure-in-Place of AAB and RAB with limited footprint reduction in western CCR removal areas.

Option 2. Hybrid Option – Excavation of a portion of the ash basins while capping the remainder of the basins resulting in a reduced closure footprint within the ash basins compared to Option 1.

Option 4. Closure-by-Removal: Closure-by-Removal and construction of new onsite landfill within AAB footprint

Option 5. Closure-by-Removal: Closure-by-Removal and disposal of excavated ash in an offsite landfill

Option 1 consists of excavating ash from the southwestern portion of the RAB to fill and regrade the northern area of Ash Fill 2 and the area to the north of the RAB Landfill. In addition, ash from the western portion of the AAB will be excavated and used to fill and regrade the remaining area of the AAB. This excavation will focus on fingers of the basins closest to residential neighbors, moving the ash farther from them. Following these excavation and placement activities, the ash basins will be capped with an infiltration barrier/cover system meeting the requirements of the Federal Coal Combustion Residuals (CCR) Rule and N.C. Coal Ash Management Act (CAMA).

Option 2 consists of excavating ash from both the southwestern and northwestern portions of the RAB to fill and regrade Ash Fill 2 and the area to the north of the RAB Landfill. In addition, the western and southeastern portions of the AAB will be excavated and used to fill and regrade the remaining area of the AAB. This option further reduces/optimizes the footprint of the final AAB closure area in comparison to Option 1. Following these excavation and placement activities, the ash basins will be capped with an infiltration barrier/cover system meeting the requirements of the Federal CCR Rule and CAMA. This option also involves partial removal of the AAB dam.

Option 3 was an alternate hybrid option similar to Option 2 but it consolidated the ash into a footprint in the corner opposite from Option 2 and against the dam. Option 2 was preferable for the final footprint location so Option 3 was removed from this updated analysis.

Option 4 consists of the excavation of all ash materials from the RAB and AAB including the ash storage areas, structural fills, and double-lined landfill constructed within the RAB and the placement of these excavated materials into a new, on-site, lined landfill system. The new landfill would be built with a base liner system and an infiltration barrier/cover system meeting the requirements of the Federal CCR Rule and CAMA. The new onsite landfill would cover an area of approximately 91 acres and would rise to an elevation approximately 45 feet in height above the current grade. It is proposed that the new landfill system be located within the area of the current AAB to reduce the material handling and hauling effort. This option also involves full removal of the RAB and AAB dam. No siting or other studies

have been performed to verify the ability to permit this location but it appears feasible based on limited review during the options development work.

Option 5 consists of the same elements as Option 4, but the excavated ash materials are to be disposed in an existing, off-site, lined landfill facility. This option also involves full removal of the RAB and AAB dams.

Tables 1, 2, and 3 of this report present a tabulated summary of each evaluated closure option, estimated quantities of ash and soil materials associated with each closure option, and a more detailed overview of each closure option presented.

Attachment A of this report includes figures depicting conceptual plan drawings and cross sections/details for each closure option.

The figures included in Attachment A are as follows:

- Figure A1-1 – Option 1 Closure-In-Place Plan View
- Figure A1-2 – Option 1 Closure-In-Place Profile and Section Views
- Figure A2-1 – Option 2 Hybrid 1 Closure Plan View
- Figure A2-2 – Option 2 Hybrid 1 Closure Profile and Section Views
- Figure A4-1 – Option 4 Closure-by-Removal: Closure by Removal and Construction of New Onsite Landfill within AAB Footprint Plan View
- Figure A4-2 – Option 4 Closure-by-Removal: Closure by Removal and Construction of New Onsite Landfill within AAB Footprint Profile and Section Views
- Figure A5-1 – Option 5 Closure-by-Removal and Disposal of Excavated Ash in an Offsite Landfill Closure Plan View
- Figure A5-2 – Option 5 Closure-by-Removal and Disposal of Excavated Ash in an Offsite Landfill Profile and Section Views
- Figure A6 – Details

Attachment B includes rough order of magnitude (ROM) cost estimates for each closure option.

Attachment C contains the scoring matrix which summarizes the composite scores of the various closure options, the assumptions of which are outlined in Table 3 for each particular option.

METHODOLOGY

A scoring matrix was prepared to provide consistent evaluation of closure options for various site locations. This scoring evaluation tool can be found in Attachment C and considers the following primary criteria:

- Environmental Protection and Impacts
- Cost

- Schedule
- Regional Factors
- Constructability

Rough Order of Magnitude Costs

A rough order of magnitude (ROM) Class 5 cost estimate was prepared for each of the closure options, based on information and quantities developed during the conceptual design activities. The estimated costs include construction, permitting, engineering design, post-construction O&M, and groundwater monitoring. A tabulated summary of the preliminary closure cost estimates is provided below:

Summary of Current ROM Cost Estimates

Option	Closure Option	Estimated Construction Cost	Estimated O&M Cost (30 Years)
1	Closure-in-Place	$185,156,251	$63,558,594
2	Hybrid Option 1	$280,723,031	$44,995,340
4	Closure-by-Removal and Construction of New Onsite Landfill within AAB Footprint	$558,836,985	$34,596,491
5	Closure-by-Removal and Disposal of Excavated Ash in an Offsite Landfill	$1,229,189,724	$1,813,625

Option 1: Closure-in-Place has the lowest estimated construction cost based on a reasonable balance between ash excavation volume, final cover area, and geotechnical stabilization needs compared to other options. Detailed tabulated ROM cost estimates are included in Attachment B.

Schedule

Within the scoring evaluation, estimates of the length of time required to initiate closure activities and the anticipated construction duration are provided for each option. For the Closure-By-Removal options (4 and 5), a substantial amount of effort is anticipated for site preparation and dewatering activities, which dictates the longer estimated initiation times.

In terms of duration of work and closure time (i.e., initiation time and construction duration), the Closure-In-Place option (#1) would be expected to be completed in 8.8 years and Hybrid Option 1 (#2) in 10.3 years, while the two Closure-By-Removal options (#4 and #5) are expected to take 22 and 19.7 years, respectively. The two Closure-By-Removal options would extend beyond both the CAMA deadline of 2029 and the CCR deadline of 2034. The Closure-In-Place option and Hybrid option could be completed by the CAMA deadline of 2029 if work were to begin in early-2020.

A major driver in the estimated construction durations is the assumed material excavation/movement of 1,000,000 cubic yards/year. As a result, the Closure-By-Removal options have longer construction durations, as they require the movement of all ash materials, compared to the Hybrid and Closure-In-Place options.

Evaluation Criteria

This Options Analysis was developed as a decision-making tool in the selection of closure options when multiple methods are allowed under applicable regulations. The intent was to develop a decision framework that used weighted scorings to balance environmental factors, cost and the safety of workers and the public. The Options Analysis incorporates Duke Energy's obligation as a regulated utility to ensure that its closure decisions are protective of the environment and communities, while also being prudent from a cost-effectiveness perspective.

The analysis considered multiple aspects within each criterion, including surface water impacts, groundwater impacts, air emissions, greenfield disturbance, construction duration, imported soil needs, transportation and noise impacts, stormwater management, long-term maintenance needs and post-closure monitoring.

The company then combined these elements to provide a weighted sum for each criterion using the following weights: environmental considerations (30%), cost (35%), schedule (15%), regional/community factors (15%) and constructability (5%.) Duke Energy placed primary emphasis on environmental factors and cost, which were approximately equal in weight. When considering all of the criteria and associated weightings, the environmental considerations have a slightly higher weight than cost with the inclusion of certain regional/community factors (transportation impact, noise impact, view impact) which are effectively environmental considerations.

The scoring matrix provided in Attachment C, scores each option on a scale of 0 (least favorable) to 10 (most favorable) for each of the specified criteria. The scores for each option are then summed based on the specified criterion weighting, resulting in an overall weighted score for each option. The results of the scoring evaluation for the Allen closure options are summarized in the following table:

Summary of Closure Options Evaluation Scoring

Criterion	**Options**			
	1	**2**	**4**	**5**
Environmental Protection and Impacts	3.0	2.8	2.4	2.2
Cost	2.8	2.8	2.1	0.7
Schedule	1.5	1.3	0.0	0.5
Regional Factors	1.1	1.2	1.0	0.3
Constructability	0.3	0.0	0.2	0.5
Total Score	8.7	8.0	5.7	4.2

DISCUSSION

The options analysis finds relatively similar rankings for environmental protection and impacts which considers impacts to groundwater, surface water, and avoidance of greenfield disturbance.

The analysis incorporates the latest groundwater modeling for the Retired Ash Basin and Active Ash Basin that demonstrates groundwater response patterns are similar in all closure options modeled, but the times to reach 2L compliance vary. Note that only 3 of the 4 closure options were included in the current preliminary groundwater modeling; Option 1: Closure-in-Place, Option 2: Hybrid Option 1, and Option 5: Closure-by-Removal with Offsite Landfill. The Closure-in-Place design simulation indicates compliance with the 2L standard for boron will be achieved faster than the other closure options, followed by the Hybrid design and then Closure-by-Removal.

In terms of duration of work and closure time (i.e., initiation time and construction duration), the Closure-in-Place option (#1) would be expected to be completed in 8.8 years and Hybrid Option 1 (#2) in 10.3 years, while the two Closure-by-Removal options (#4 and #5) are expected to take 22 and 19.7 years, respectively. The two Closure-by-Removal options would extend beyond both the CAMA deadline of 2029 and the CCR deadline of 2034. They remain in the Options Analysis despite this for full transparency of the alternatives. The Closure-in-Place option and Hybrid option could be completed by the CAMA deadline of 2029 if work were to begin in early-2020.

Other aspects considered are regional impacts to the surrounding community related to traffic and noise generated by each of the options. Traffic to and from the site will occur through the duration for each option noted above. That will include workers, trucks for deliveries or movement of soil, topsoil, stone, geosynthetics, etc. For the Closure-in-Place option (#1) and Hybrid option (#2) traffic will be mingled with typical traffic on the main roads leading to Plant Allen and Canal Road in particular. Closure-By-Removal option (#5) requires a significant number of trucks entering Highway 273 per work day over the approx. 17-year excavation/construction period to access the chosen offsite landfill. The noise generated for each the options would be similar to someone near the site, but the duration of the work and the exposure to that noise varies directly with the time required for each option and would be longer for Closure-by-Removal. Along with increased duration and truck trips comes higher levels of emissions for the Closure-by-Removal option as well.

The Closure-by-Removal with disposal of ash in a new on-site landfill is three times the estimated cost of the Closure-in-Place option while the Closure-by-Removal with disposal of ash in an off-site landfill is over six times the estimated cost of the Closure-in-Place option. The Closure-by-Removal options cause other unnecessary community impacts with little compelling environmental benefit.

CONCLUSION

Based on the conceptual designs for the selected closure options and evaluation of the criteria established (environmental protection/impacts, cost, schedule, regional factors and constructability), Option #1: Closure-In-Place or Option #2: Hybrid were identified as the preferred options that best balance the various considerations associated with basin closure.

Attachments:

A – Closure Options Figures

B – Closure Options Cost Estimates

C – Closure Options Scoring Matrix and Groundwater Sub-Scoring Worksheet

Table 1 – Closure Options Summary

Ash Basin Closure Options Evaluation
Allen Steam Station
Duke Energy

Option	Description
1. Closure-in-Place with Limited Footprint Reduction	▪ Install stormwater controls. ▪ Install free water decanting and water treatment system. ▪ Decant free water. ▪ Perform interstitial dewatering of ash material as needed to provide stable working surfaces. Install temporary water treatment system, as needed. ▪ Excavate ash from the southwest finger of the RAB, and use the excavated ash to regrade Ash Fill 2 and the area to the north of the RAB Landfill. Excavate ash from the western portion of the AAB, and use the excavated ash to regrade the remaining area of the AAB. ▪ Backfill excavated areas with soil to promote positive surface water drainage. ▪ Construct cover system over the remaining Ash Basin footprint. ▪ Conduct groundwater corrective action and long-term monitoring pursuant to CAMA.
2. Hybrid Option	▪ Install stormwater controls. ▪ Install free water decanting and water treatment system. ▪ Decant free water. ▪ Perform interstitial dewatering of ash material as needed to provide stable working surfaces. Install temporary water treatment system, as needed. ▪ Excavate ash from the southwest finger and northwest finger and Ash Storage Area within the RAB, and use the excavated ash to fill and regrade the northern portion of Ash Fill 2 and the area to the north of the RAB Landfill. ▪ Excavate ash from the western and southeastern portions of the AAB, and use the excavated ash to fill and regrade the remaining area of the AAB. Stack the excavated ash away from the excavation slope. ▪ Construct a new perimeter berm for the Ash Basin closure areas. Construct a stabilized slope wedge or Deep Mixing Method (DMM) wall as needed. ▪ Backfill excavated areas in the RAB with soil to promote positive surface water drainage. ▪ Construct cover system over the remaining Ash Basin footprints. ▪ Perform partial dam removal and restore excavated areas to stable and non-erodible condition. Soils obtained from the partial dam removal will be used as cover material in closure areas. ▪ Conduct groundwater corrective action and long-term monitoring pursuant to CAMA.

4. Closure-by-Removal and Construction of New Onsite Landfill within AAB Footprint	▪ Install stormwater controls. ▪ Install free water decanting and water treatment system. ▪ Decant free water. ▪ Perform interstitial dewatering of ash material as needed to provide stable working surfaces. Install temporary water treatment system, as needed. ▪ Partially excavate ash from the AAB within the proposed Onsite Landfill footprint, construct the required sub base, construct the first lined cell and start placing ash. Continue the sequence until all ash from the AAB and RAB is excavated and placed in the proposed Onsite Landfill. Stack the excavated ash away from the excavation slope. ▪ Construct cover system over the Onsite Landfill when complete. ▪ Complete dam removal and restore excavated areas to stable and non-erodible condition. Soils obtained from the dam removal will be used as cover material for the Onsite Landfill. ▪ Conduct groundwater corrective action and long-term monitoring pursuant to CAMA.
5. Closure-by-Removal and Disposal of Excavated Ash in an Offsite Landfill.	▪ Install stormwater controls. ▪ Install free water decanting and water treatment system. ▪ Decant free water. ▪ Perform interstitial dewatering of ash material as needed to provide stable working surfaces. Install temporary water treatment system, as needed. ▪ Excavate ash from the AAB and RAB. Dewater ash sufficiently to facilitate handling, and transport to an approved Offsite Landfill assumed to be within a 50-mile radius of the site. Stack the excavated ash away from the excavation slope. 1,000,000 cubic yards per year assumed. Transport by truck is assumed due to limitations of space on site for developing rail infrastructure. ▪ Backfill excavated areas with soil to promote positive surface water drainage. ▪ Complete dam removal and restore excavated areas to stable and non-erodible condition. ▪ Conduct groundwater corrective action and long-term monitoring pursuant to CAMA.

Table 2 – Quantity Summary

Ash Basin Closure Options Evaluation
Allen Steam Station
Duke Energy

Item	Volume	Units	Area (Acres)
Existing Ash			
Ash Basin Area (regulatory boundary)	NA		293
In Place Ash Volume	19,515,700 16,263,100	Tons CY	293
Ash Basin Dam Soil Volume	1,650,000	CY	NA
Option 1: Closure-in-Place with Limited Footprint Reduction			
Ash Volume in Final Closure Footprint	16,263,100	CY	274
Ash Excavation Volume (Excavated Area)	530,000	CY	19
Over Excavation Volume (1 ft.)	31,000	CY	19
Ash Regrading	3,953,000	CY	NA
Dam Soil Cut Volume	0	CY	NA
Additional Soil Needed (Backfill Excavated Area and 18” Cover Soil)	865,000	CY	NA
Additional Topsoil Needed (6” for Final Cover)	215,000	CY	322
Option 2: Hybrid Option			
Ash Volume in Final Closure Footprint	16,263,100	CY	164
Ash Excavation Volume (Excavated Area)	4,230,900	CY	103
Over Excavation Volume (1 ft.)	166,000	CY	103
Ash Regrading	6,377,000	CY	NA
Dam Soil Cut Volume	740,000	CY	NA
Soil Needed (2’ Backfill in Excavated Area and 18” Cover Soil in Capped Area)	665,000	CY	164
Additional Topsoil Needed (6” for Excavated and Capped Areas)	194,000	CY	267
Option 4: Closure-by-Removal and Construction of New Onsite Landfill within AAB Footprint			
Ash Excavation Volume (Closure by Removal Area)	16,263,100	CY	267
Over Excavation Volume (1 ft.)	473,000	CY	293
Dam Soil Cut Volume	1,650,000	CY	NA
Soil Needed (2’ Backfill in Closure-by-Removal Area + Onsite Landfill: 2’ Soil Liner + 18” Cover Soil for Closure Cap)	1,206,000	CY	NA
Additional Topsoil Needed (6” over Closure-by-Removal Area and Onsite Landfill Closure Cap)	246,000	CY	305

Option 5: Closure-by-Removal and Disposal of Excavated Ash in an Offsite Landfill			
Ash Excavation Volume (Closure-by-Removal Area)	16,263,100	CY	293
Over Excavation Volume (1 ft.)	473,000	CY	293
Dam Soil Cut Volume	1,650,000	CY	NA
Soil Needed (2' Backfill in Closure-by-Removal Area)	947,400	CY	293
Additional Topsoil Needed (6" over Closure-by-Removal)	237,000	CY	293

*Volumes will be determined as part of the final design if the respective option is selected as the closure option.

Table 3.1 – Option 1 Overview: Closure-In-Place with Limited Footprint Reduction
Ash Basin Closure Options Evaluation
Allen Steam Station
Duke Energy

Subject	Description – Option 1
Description	1. Install stormwater controls. 2. Install dewatering/wastewater treatment system. 3. Decant & treat free water. 4. Remove & treat interstitial pore water in ash material as needed to provide stable working surfaces during construction within the Closure-In-Place area. 5. Excavate a limited amount of ash from the southwest finger of the RAB, and use the excavated ash to regrade Ash Fill 2 and the area to the north of the RAB Landfill. Excavate ash from the western portion of the AAB, and use the excavated ash to regrade the remaining area of the AAB. 6. Remove one foot of residual soil in excavated areas. 7. Backfill excavated areas with soil to promote positive surface water drainage. 8. Construct closure cap over the remaining Ash Basin footprint. 9. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA and CCR. 10. Dam remains in place.
Details	1. Install stormwater run-on controls to divert stormwater from the ash basin where possible. 2. Design and install temporary wastewater treatment system to manage dewatering activities and influent (contact) stormwater. 3. Decant & treatment of free water. 4. Removal & treatment of pore water in ash material within the close-in-place area as necessary for construction and placement of the cap. 5. Regrade the close-in-place area to direct stormwater to the existing permitted outfall. 6. Backfill excavated areas with soil to promote positive drainage. Excavate limited quantities of ash from the western areas of the RAB and AAB, and stack within the eastern Ash Basin. Cut and fill volumes are expected to be balanced. Estimated total cut and fill volume is 3,953,000 CY in the RAB and AAB. Limited removal of interstitial water may be needed at certain locations to support access and future placement of the cover system. 7. Grade closure area and construct cover system over ash basin areas using soils from onsite borrow source. Total soil cover volume is estimated to be about 1,080,000 CY based on 2-ft of backfill in excavated areas and a 2-ft thick soil cover system (in addition to geosynthetics), of which approximately 215,000 CY is topsoil. The total footprint of the closure area is 274 acres. Total in-place ash is approximately 19,515,700 tons.

Subject	Description – Option 1
	8. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA and CCR. 9. Decommission temporary wastewater treatment facility.
Environmental Protection and Impacts	1. Air emissions offsite (based on miles driven) – NA (not driving offsite). 2. Air emissions onsite (based on volume of material excavated/moved) from closure implementation – this will be the best option as the schedule is shorter than other options. 3. Avoidance of greenfield disturbance – On-site borrow area only.
Cost	1. Capital costs = $185,156,251 2. Long-term operations maintenance and monitoring = $2,118,620 per year over 30 years.
Schedule	1. Initiation time (to begin ash removal) = 30 months (includes design/permitting and dewatering). 2. Design and permitting = 12 months. 3. Construction = 76 months. 4. Total duration = 106 months = 8.8 years. 5. Post-closure = 30 years.
Regional Factors	1. Plan or potential for beneficial reuse of site – none. 2. Imported soil needs – Onsite soil is assumed to accommodate general soil needs. Topsoil will need to be imported. 3. CCR beneficial reuse - None 4. Transportation impact (based on miles driven) – No offsite miles. Onsite transportation limited within Ash Basin footprint – Minimal construction compared to other options. 5. Noise impact due to on-site activity (proximity to neighbors is approximately equivalent for all options; therefore, scoring is based on construction duration). 6. Visual impact (based on final height of storage facility, land uses within the viewshed) – Minimal increase in elevation for positive drainage.
Constructability	1. Relative to other options, this option is easier to construct due to the lower amount of ash that needs to be moved and shorter construction duration. 2. No deep excavations within the ash are necessary. 3. Dewatering will include free water removal and treatment and (as needed to provide a stable working surface) interstitial pore water removal and treatment as part of ash excavation and cover system placement.

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Table 3.2 – Option 2 Overview: Hybrid Option
Ash Basin Closure Options Evaluation
Allen Steam Station
Duke Energy

Subject	Description – Option 2
Description	1. Install stormwater controls. 2. Install dewatering/wastewater treatment system. 3. Decant & treat free water. 4. Remove & treat interstitial pore water in ash material as needed to provide stable working surfaces during construction within the Closure-In-Place area. 5. Excavate ash from the southwest finger and northwest finger of the RAB and the Ash Storage Areas within the RAB, and use the excavated ash to fill and regrade Ash Fill 2 and the area to the north of the RAB Landfill. 6. Excavate ash from the western and southeastern portions of the AAB, and use the excavated ash to fill and regrade the remaining area of the AAB. Stack the excavated ash away from the excavation slope. 7. Remove one foot of residual soil in excavated area. 8. Install stabilized ash wedge as needed 9. Backfill excavated areas with soil to promote positive surface water drainage. 10. Construct cover system over the remaining Ash Basin footprint. 11. Perform partial dam removal and restore excavated areas to stable and non-erodible condition. Soils obtained from the partial dam removal will be used as cover material in the Closure-In-Place areas. 12. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA and CCR.
Details	1. Install stormwater run-on controls to divert stormwater from the ash basin where possible. 2. Design and install temporary wastewater treatment system to manage dewatering activities and influent (contact) stormwater. 3. Decant & treatment of free water. 4. Dewatering of excavated ash material within ash basin waste boundary. 5. Excavate the southwest finger and northwest finger of the RAB and the Ash Storage Areas within the RAB. Excavate the western and southeastern portions of the AAB. Stack the excavated ash away from the excavation slope. Ash excavation volume estimated to be approximately 4,230,900 CY. 6. Construct new perimeter berm for the hybrid closure area. Construct a stabilized slope wedge or Deep Mixing Method (DMM) wall as needed. 7. Partially remove dam in the southeastern section of the AAB and restore excavated areas to stable and non-erodible condition. Final volume of soil to be removed from the dam is estimated to be approximately 740,000 CY.

Subject	Description – Option 2
	8. Grade closure area and construct closure cap over the Closure-In-Place area using onsite borrow sources. Total backfill volume is estimated to be about 333,000 CY, which will be obtained from onsite sources. Total soil cover volume is estimated to be about 442,000 CY based on a 2-ft thick soil cover system (in addition to geosynthetics), of which approximately 111,000 CY is topsoil. Total 2-D footprint of the closure area is 190 acres. Total closed contained ash volume is approximately 16,263,100 CY. 9. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA.
Environmental Protection and Impacts	1. Air emissions offsite (based on miles driven) – NA (not driving offsite). 2. Air emissions onsite (based on volume of material excavated/moved) from closure implementation – This will be better than most of the other options, but not as good as Option 1. 3. Avoidance of greenfield disturbance – On-site borrow area only.
Cost	1. Capital costs = $280,723,031 2. Long-term operations maintenance and monitoring = $1,499,845 per year for 30 years.
Schedule	1. Initiation time (to begin ash removal) = 36 months (includes dewatering and design/permitting, and is a function of the assumed DMM wall/stabilization construction). 2. Design and permitting = 18 months. 3. Construction = 88 months 4. Total duration = 124 months = 10.3 years. 5. Post-closure = 30 years
Regional Factors	1. Plan or potential for beneficial reuse of site – Partially restore to nature and use for hybrid closure footprint. 2. Imported soil needs – Reuse dam removal soil. 3. CCR beneficial reuse - None 4. Transportation impact (based on miles driven) – No offsite miles. Onsite limited within ash basin footprint. 5. Noise impact due to on-site activity (proximity to neighbors is approximately equivalent for all options; therefore, scoring is based on construction duration). 6. Visual impact (based on final height of storage facility, land uses within the viewshed) – minimal.
Constructability	1. Construction can be more challenging than other options. 2. Deep excavations within the ash will require stabilization. 3. Dewatering will include free water removal and treatment and (as needed to provide a stable working surface) interstitial pore water removal and treatment as part of ash excavation and cover system placement.

Table 3.4 – Option 4 Overview: Closure-by-Removal and Construction of New Onsite Landfill within AAB Footprint
Ash Basin Closure Options Evaluation
Allen Steam Station
Duke Energy

Subject	Description – Option 4
Description	1. Install stormwater controls 2. Install dewatering/wastewater treatment system 3. Decant & treat free water. 4. Remove & treat interstitial pore water in ash material as needed to provide stable working surfaces during construction within the Closure-by-Removal area. 5. Install stabilized ash wedge or another feature. 6. Partially excavate ash from the AAB within the proposed Onsite Landfill footprint, construct the first lined cell and start placing ash. 7. Remove one foot of residual soil in Closure-By-Removal area. 8. Construct cover system over the Onsite Landfill when complete. 9. Complete dam removal and restore excavated areas to stable and non-erodible condition. 10. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA and CCR.
Details	1. Install stormwater run-on controls to divert stormwater from the ash basin where possible. 2. Design and install temporary wastewater treatment system to manage dewatering activities and influent (contact) stormwater. 3. Decant & treatment of free water. 4. Dewatering of excavated ash material within ash basin waste boundary. 5. Partially excavate ash from the AAB within the proposed Onsite Landfill footprint. Stack the excavated ash away from the excavation slope. 6. Construct perimeter berm for the landfill area as part of the sequenced cell construction. Construct a stabilized slope wedge or Deep Mixing Method (DMM) wall as needed. 7. Construct the first cell of the Onsite Landfill. 8. Excavate ash from the remainder of the AAB and the RAB. Total ash excavation volume estimated to be approximately 16,263,100 CY. 9. Remove one foot of residual soil in Closure-By-Removal area. 10. Backfill and grade excavated areas with 2-ft of soil to promote positive drainage. 11. Place excavated ash and soil within the constructed cell of the proposed Onsite Landfill. 12. Constructed lined Onsite Landfill in the excavated AAB footprint is estimated to be 91 acres. Total liner soil volume is estimated to be about 293,000 CY based on a 2-ft thick soil liner system (in addition to geosynthetics). Total soil cover volume is estimated to be about 293,000 CY based on a 2-ft thick soil cover system (in addition to geosynthetics), of which approximately 73,000 CY is topsoil. Cover soil other than topsoil will be obtained from onsite sources.

Subject	Description – Option 4
	13. Complete dam removal and restore excavated areas to stable and non-erodible condition. Final volume of soil to be removed from the dam is estimated to be approximately 1,650,000 CY. 14. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA and CCR.
Environmental Protection and Impacts	1. Air emissions offsite (based on miles driven) – NA (not driving offsite). 2. Air emissions onsite (based on volume of material excavated/moved) from closure implementation – this will be fourth best option based on construction work. 3. Avoidance of greenfield disturbance – On-site borrow area only.
Cost	1. Capital costs ≈ $558,836,985 2. Long-term operations maintenance and monitoring ≈ $1,153,216 per year over 30 years.
Schedule	1. Initiation time (to begin ash placement in landfill) = 54 months (includes dewatering and design and permitting). 2. Design and permitting = 24 months. 3. Construction = 210 months. 4. Total duration = 264 months = 22 years. 5. Post-closure = 30 years.
Regional Factors	1. Plan or potential for beneficial reuse of site – Partially restore to natural setting and use for landfill footprint. 2. Imported soil needs – Reuse dam removal soil for common soil needs. Approximately 70,000 CY of topsoil needed for final cover system. Potential for additional soil needs to meet hydraulic conductivity requirements of landfill. 3. CCR beneficial reuse - None 4. Transportation impact (based on miles driven) – No offsite miles. Onsite transportation limited within Ash Basin footprint. 5. Noise impact due to on-site activity (proximity to neighbors is approximately equivalent for all options; therefore, scoring is based on construction duration). 6. Visual impact (based on final height of landfill inside of basin area) is minor.
Constructability	1. Most difficult option to construct due to complex construction sequencing and very large quantities of ash per year that need to be moved. 2. Deep excavations within the ash will require stabilization. 3. Landfill to be constructed adjacent to deep ash cut. 4. Dewatering will include free water removal and pore water removal as part of ash excavation.

Table 3.5 – Option 5 Overview: Closure-By-Removal and Disposal of Excavated Ash in an Offsite Landfill
Ash Basin Closure Options Evaluation
Allen Steam Station
Duke Energy

Subject	Description – Option 5
Description	1. Install stormwater controls 2. Install dewatering/wastewater treatment system 3. Decant & treat free water. 4. Remove & treat interstitial pore water in ash material as needed to provide stable working surfaces during construction within the Closure-by-Removal area. 5. Excavate ash from the AAB and RAB, moisture condition to be ready for hauling, to dispose of in an approved Offsite Landfill assumed to be within a 50-mile radius of the site. Stack the excavated ash away from the excavation slope. Transport by truck is assumed due to limitations of space on site for developing rail infrastructure. 6. Remove one foot of residual soil in the excavated area. 7. Backfill excavated areas with soil to promote positive surface water drainage. 8. Complete dam removal and restore excavated areas to stable and non-erodible condition. 9. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA and CCR.
Details	1. Install stormwater run-on controls to divert stormwater from the ash basin where possible. 2. Design and install temporary wastewater treatment system to manage dewatering activities and influent (contact) stormwater. 3. Decant & treatment of free water. 4. Dewatering of excavated ash material within ash basin waste boundary. 5. Excavate the ash from the Ash Basins and moisture condition as needed to prepare for offsite transport. Ash excavation volume estimated to be approximately 16,263,100 CY. 6. Haul and dispose of ash in an Offsite Landfill assumed to be within a 50 -mile radius of the site. 7. Complete dam removal and restore excavated areas to stable and non-erodible condition. Final volume of soil to be removed from the dam is estimated to be approximately 1,650,000 CY. 8. Conduct groundwater corrective action and long-term monitoring pursuant to CAMA and CCR.
Environmental Protection and Impacts	1. Air emissions offsite (based on miles driven) greater impacts than other options since it is only option that requires offsite transport of ash. 2. Air emissions onsite (based on volume of material excavated/moved) from closure implementation – This will have increased impacts due to excavation and hauling as well as relatively long construction duration.

Subject	Description – Option 5
	3. Greenfield disturbance – No impact onsite. Impacts may be offsite and are not known at this time. Assumed the total landfill acreage of 91 acres offsite, as greenfield disturbance.
Cost	1. Capital costs ≈ $1,229,189,724 2. Long-term operations maintenance and monitoring ≈ $60,454 per year over 30 years.
Schedule	1. Initiation time (to begin ash removal) = 36 months (includes dewatering and design and permitting). 2. Design and permitting = 24 months. 3. Construction = 200 months. 4. Total duration = 236 months = 19.7 years. 5. Post-closure = 30 years.
Regional Factors	1. Plan or potential for beneficial reuse of site – restore to natural setting. 2. Imported soil needs – None. 3. CCR beneficial reuse – None. 4. Transportation impact (based on miles driven) – Significant offsite miles. 5. Noise impact due to on-site activity (proximity to neighbors is approximately equivalent for all options; therefore, scoring is based on construction duration). 6. Visual impact (based on final height of storage facility, land uses within the viewshed) – None onsite.
Constructability	1. Relatively easy to construct, but requires large quantities of ash per year to be moved. 2. Excavation can be in layers and safer than other options. 3. Dewatering will include free water removal and pore water removal as part of ash excavation.

Attachment A

DISCHARGE CANAL
ALLEN STEAM STATION
COAL YARD
PLANT ALLEN RD
ASH STORAGE
ASH FILL 2
ASH FILL 1
ASH STORAGE
RETIRED ASH BASIN DIKE
LAKE WYLIE/ CATAWBA RIVER
NC 273
RIVER RUN
RETIRED ASH BASIN ASH LANDFILL PERMIT NO. 3612
DISCHARGE USING EXISTING OR MODIFIED SPILLWAY STRUCTURES
NORTH DIKE
HEATHER GLEN LN
ARMSTRONG RD
HIGHLAND WAY
CELL 1
CELL 2
CELL 3
EAST DIKE
ACTIVE ASH BASIN
POLISHING POND
WOODBEND DR
SOUTHPOINT RD
DISCHARGE USING PROPOSED CHANNEL (002 – NPDES OUTFALL)
LAKE WYLIE/ CATAWBA RIVER

N
0 300 600
GRAPHIC SCALE (IN FEET)

LEGEND:

- EXISTING MAJOR CONTOUR (25 FOOT)
- EXISTING MINOR CONTOUR (5 FOOT)
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- LIMITS OF BATHYMETRIC SURVEY
- EXISTING TRANSMISSION LINES
- BACKFILL AND REGRADE WITH SOIL
- RELOCATE EXCAVATED ASH
- EXCAVATED ASH RELOCATION AND REGRADE AREA
- ASH EXCAVATION AND CLOSURE BY REMOVAL AREA
- PROPOSED STORMWATER DITCH
- TRANSMISSION TOWERS / POLES

NOTES:

1) ASH EXCAVATION AND CLOSURE BY REMOVAL AREAS INCLUDE ADDITIONAL 1 FT. OF MATERIAL EXCAVATION FROM THE BOTTOM OF THE BASIN.

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REV. 1

AECOM

TITLE
CLOSURE OPTION #1
CLOSURE IN PLACE - PLAN VIEW
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

FOR
ALLEN STEAM STATION

SEAL

DUKE ENERGY®

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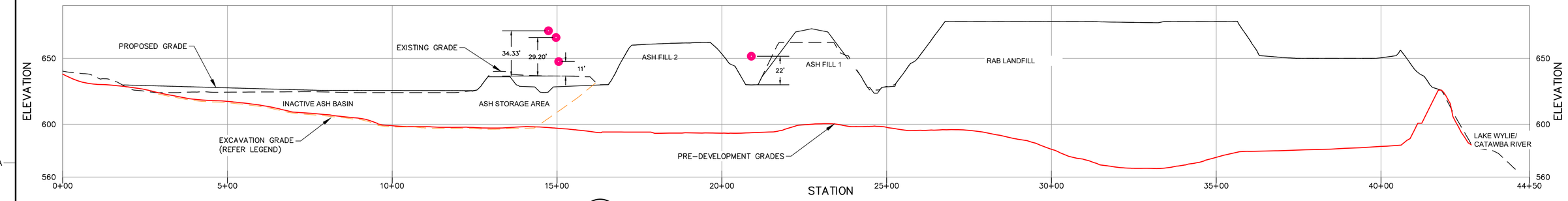
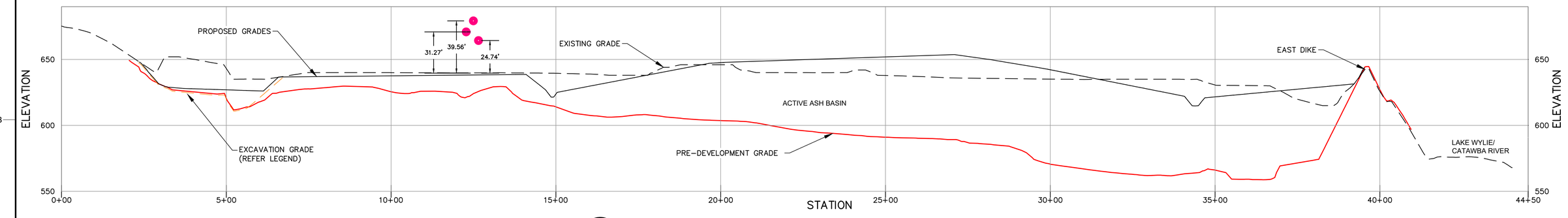
DWG TYPE: .DWG	DFTR: DMB
JOB NO: 60572629	CHKD: JDM
DATE: 10/26/2018	ENGR: ENGR
FILENAME: Figure A1-1.dwg	APPD: APPD

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	FIGURE A1-1	1

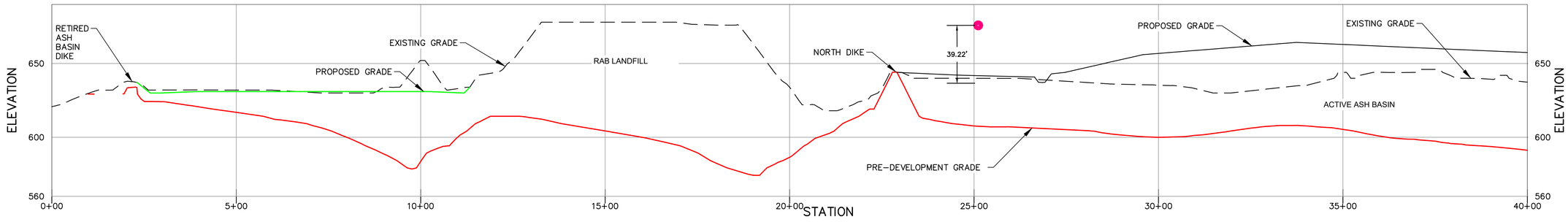


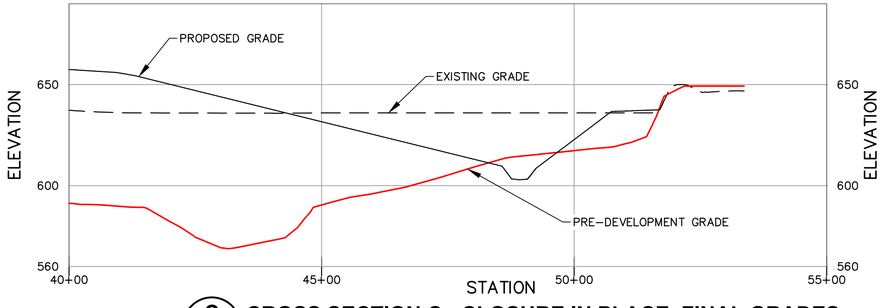
A 1 2 CROSS SECTION A - CLOSURE IN PLACE FINAL GRADES

Bednarcik Exhibit 4



B 1 2 CROSS SECTION B - CLOSURE IN PLACE FINAL GRADES





C 1 2 CROSS SECTION C - CLOSURE IN PLACE FINAL GRADES

LEGEND

- EXISTING GRADE
- PRE–DEVELOPMENT GRADE
- EXCAVATION GRADE (INCLUDES EXCAVATION OF ADDITIONAL 1 FT. FROM THE BOTTOM OF THE BASIN)
- PROPOSED GRADE

NOTES:

1) TRANSMISSION LINES SHALL HAVE THE FOLLOWING VERTICAL CLEARANCE FROM THE LOWEST SAG ELEVATION:

100 KV	22 FT.
230 KV	24.5 FT.
500 KV	30.5 FT.

HORIZ. SCALE

0 150 300

GRAPHIC SCALE (IN FEET)

VERT. SCALE

0 37.5 75

GRAPHIC SCALE (IN FEET)

DRAFT

NOT FOR CONSTRUCTION

AECOM

SEAL

TITLE

CLOSURE OPTION #1
CLOSURE IN PLACE - SECTIONS
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

FOR

ALLEN STEAM STATION

DUKE ENERGY®

SCALE: 1"=150'	DES: SSK
DWG TYPE: .DWG	DFTR: DMB
JOB NO: 60572629	CHKD: JDM
DATE: 10/26/2018	ENGR: ENGR
FILENAME: Appendix B2.dwg	APPD: APPD

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	**FIGURE A1-2**	**1**

REV. 1

DISCHARGE CANAL
ALLEN STEAM STATION
PLANT ALLEN RD
COAL YARD
ASH STORAGE
RETIRED ASH BASIN DIKE
LAKE WYLIE/ CATAWBA RIVER
NC 273
ASH FILL 2
ASH FILL 1
ASH STORAGE
RETIRED ASH BASIN ASH LANDFILL PERMIT NO. 3612
RIVER RUN
DISCHARGE USING EXISTING OR MODIFIED SPILLWAY STRUCTURES
NORTH DIKE
HEATHER GLEN LN
CELL 1
CELL 2
CELL 3
ARMSTRONG RD
HIGHLAND WAY
ACTIVE ASH BASIN
POLISHING POND
EAST DIKE
WOODBEND DR
SOUTHPOINT RD
EXISTING NPDES OUTFALL (002) TO BE DECOMMISSIONED
LAKE WYLIE/ CATAWBA RIVER

N

0 300 600
GRAPHIC SCALE (IN FEET)

LEGEND:

- EXISTING MAJOR CONTOUR (25 FOOT)
- EXISTING MINOR CONTOUR (5 FOOT)
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- LIMITS OF BATHYMETRIC SURVEY
- EXISTING TRANSMISSION LINES
- LIMITS OF IMPOUNDED ASH
- BACKFILL AND REGRADE WITH SOIL
- RELOCATE EXCAVATED ASH
- EXCAVATED ASH RELOCATION AND REGRADE AREA
- ASH EXCAVATION AND CLOSURE BY REMOVAL AREA
- PROPOSED STORMWATER DITCH
- TRANSMISSION TOWERS / POLES
- DAM REMOVAL AREA

NOTES:

1) ASH EXCAVATION AND CLOSURE BY REMOVAL AREAS INCLUDE ADDITIONAL 1 FT. OF MATERIAL EXCAVATION FROM THE BOTTOM OF THE BASIN.
2) SOIL OBTAINED FROM PARTIAL DAM REMOVAL WILL BE USED FOR RE-GRADING.

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TITLE
CLOSURE OPTION #2
HYBRID OPTION 1- PLAN VIEW
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

FOR
ALLEN STEAM STATION

SEAL

DUKE ENERGY®

SCALE: 1"=300'	DES: SSK
DWG TYPE: .DWG	DFTR: DMB
JOB NO: 60572629	CHKD: JDM
DATE: 10/26/2018	ENGR: ENGR
FILENAME: Figure A2-1.dwg	APPD: APPD

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ANSI D 22.0"x34.0"	FIGURE A2-1	1

REV. 1

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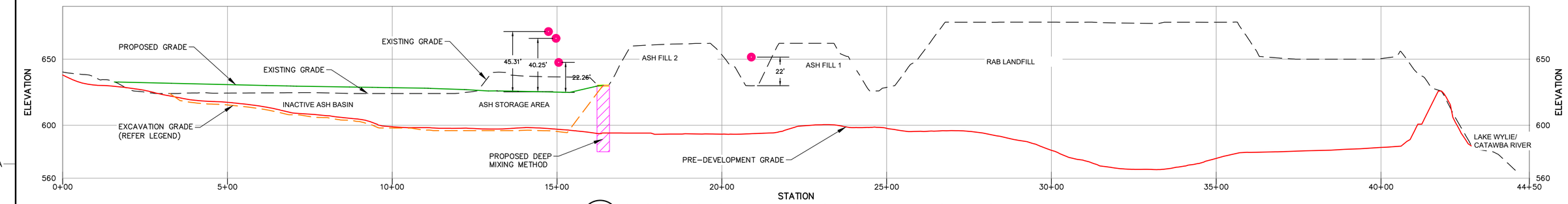
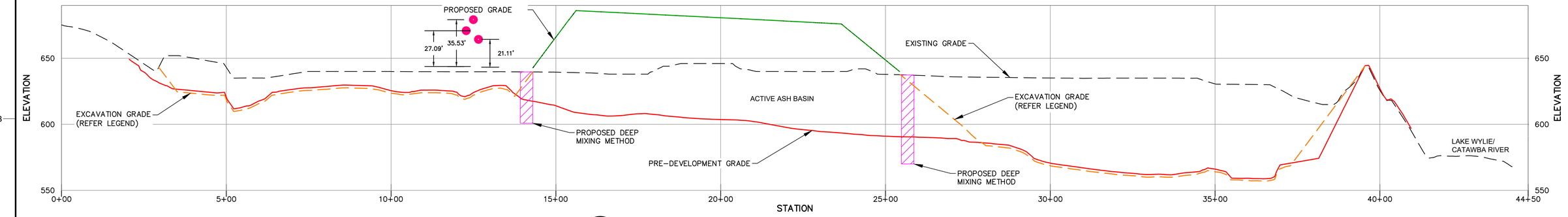


A 1 2 CROSS SECTION A - HYBRID OPTION 1 FINAL GRADES

Bednarcik Exhibit 4



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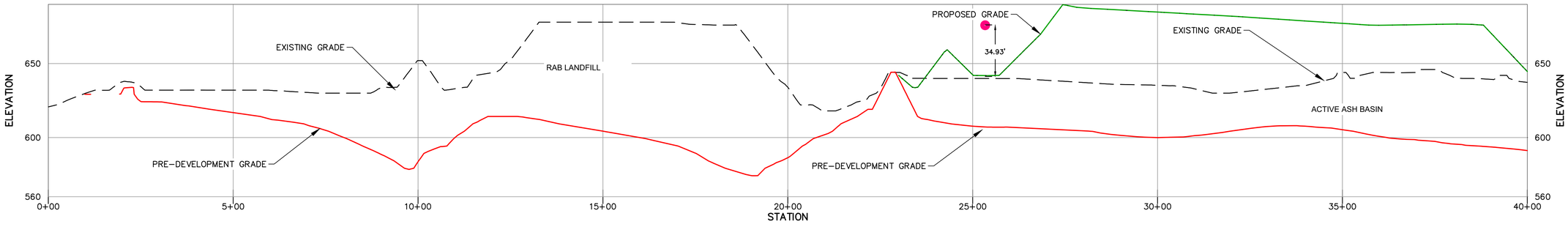

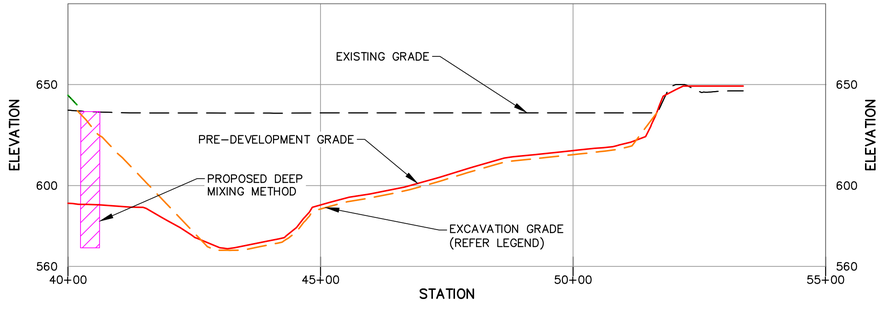

C 1 2 CROSS SECTION C - HYBRID OPTION 1 FINAL GRADES

LEGEND

- EXISTING GRADE
- PRE–DEVELOPMENT GRADE
- EXCAVATION GRADE (INCLUDES EXCAVATION OF AN ADDITIONAL 1 FT. FROM THE BOTTOM OF THE BASIN)
- PROPOSED DEEP MIXING METHOD
- PROPOSED GRADE

NOTES

1. TRANSMISSION LINES SHALL HAVE THE FOLLOWING VERTICAL CLEARANCE FROM THE LOWEST SAG ELEVATION:
   - 100 KV – 22 FT.
   - 230 KV – 24.5 FT.
   - 500 KV – 30.5 FT.

HORIZ. SCALE

0 150 300
GRAPHIC SCALE (IN FEET)

VERT. SCALE

0 37.5 75
GRAPHIC SCALE (IN FEET)

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SEAL

TITLE
CLOSURE OPTION #2
HYBRID OPTION 1- SECTIONS
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

FOR
ALLEN STEAM STATION

DUKE ENERGY®

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DWG SIZE: ANSI D 22.0"x34.0"	DRAWING NO.: FIGURE A2-2
	REVISION: 1

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REV. 1

LEGEND:

- EXISTING MAJOR CONTOUR (25 FOOT)
- EXISTING MINOR CONTOUR (5 FOOT)
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- LIMITS OF BATHYMETRIC SURVEY
- EXISTING TRANSMISSION LINES
- LIMITS OF IMPOUNDED ASH
- RELOCATE EXCAVATED ASH
- PROPOSED ONSITE LANDFILL
- ASH EXCAVATION AND CLOSURE BY REMOVAL AREA
- PROPOSED STORMWATER DITCH
- TRANSMISSION TOWERS / POLES
- DAM REMOVAL AREA

NOTES:

1) ASH EXCAVATION AND CLOSURE BY REMOVAL AREAS INCLUDE ADDITIONAL 1 FT. OF MATERIAL EXCAVATION FROM THE BOTTOM OF THE BASIN.
2) SOIL OBTAINED FROM DAM REMOVAL WILL BE REUSED FOR REGRADING.

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TITLE

CLOSURE OPTION #4
CLOSURE BY REMOVAL ONSITE LANDFILL - PLAN VIEW
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

FOR

ALLEN STEAM STATION

SEAL

DUKE ENERGY®

SCALE: 1"=300'	DES: SSK
DWG TYPE: .DWG	DFTR: DMB
JOB NO: 60572629	CHKD: JDM
DATE: 10/26/2018	ENGR: ENGR
FILENAME: Figure A4-1.dwg	APPD: APPD

DWG SIZE	DRAWING NO.	REVISION
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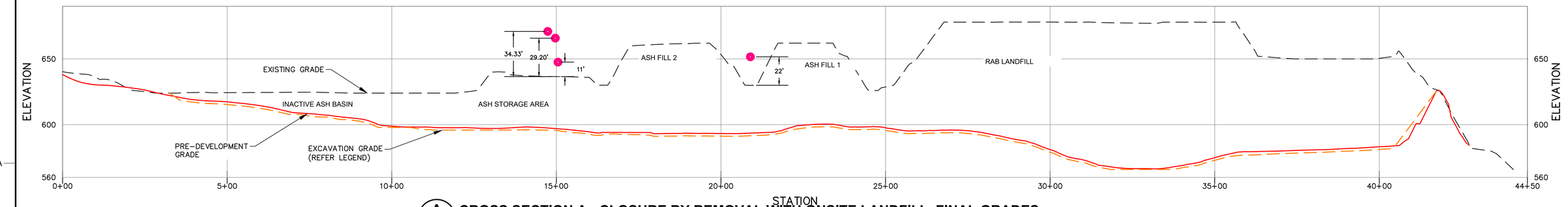
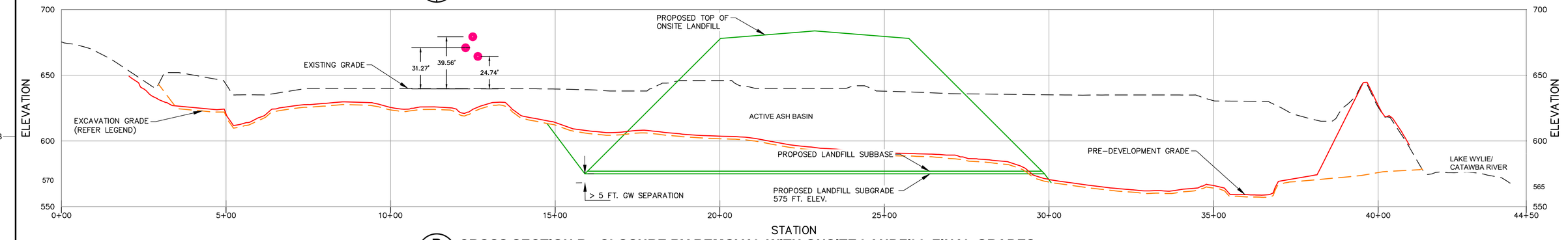
REV. 1

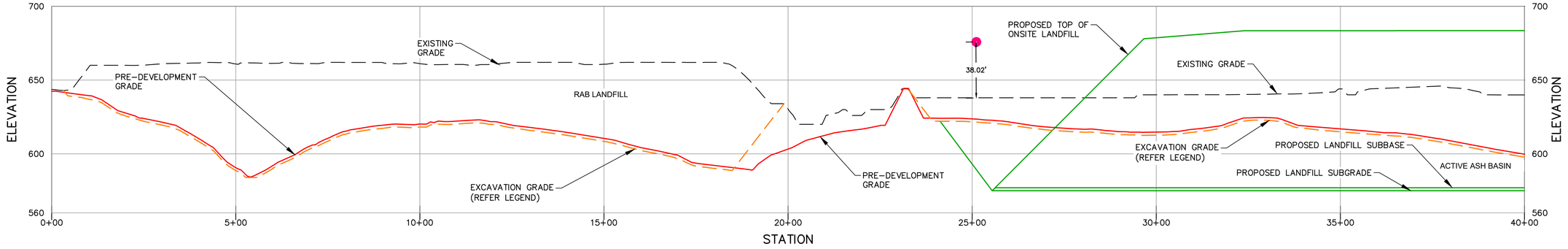


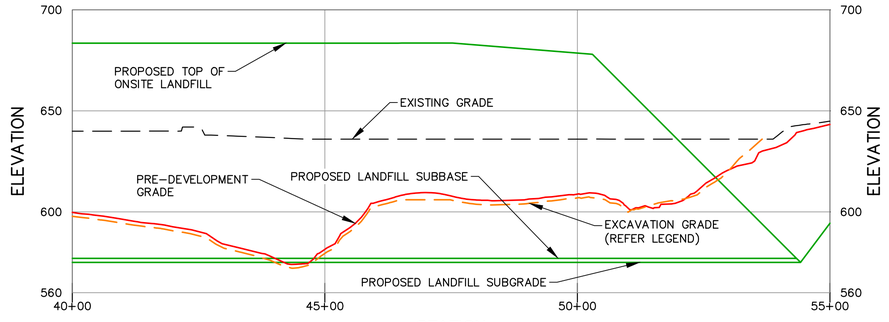
A (1 | 2) **CROSS SECTION A - CLOSURE BY REMOVAL WITH ONSITE LANDFILL FINAL GRADES**

Bednarcik Exhibit 4



B (1 | 2) **CROSS SECTION B - CLOSURE BY REMOVAL WITH ONSITE LANDFILL FINAL GRADES**





C (1 | 2) **CROSS SECTION C - CLOSURE BY REMOVAL WITH ONSITE LANDFILL FINAL GRADES**

LEGEND

- EXISTING GRADE
- PRE–DEVELOPMENT GRADE
- EXCAVATION GRADE (INCLUDES EXCAVATION OF AN ADDITIONAL 1 FT. FROM THE BOTTOM OF THE BASIN)
- PROPOSED GRADE

NOTES:

1) TRANSMISSION LINES SHALL HAVE THE FOLLOWING VERTICAL CLEARANCE FROM THE LOWEST SAG ELEVATION:

100 KV	22 FT.
230 KV	24.5 FT.
500 KV	30.5 FT.

HORIZ. SCALE
0 150 300
GRAPHIC SCALE (IN FEET)

VERT. SCALE
0 37.5 75
GRAPHIC SCALE (IN FEET)

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TITLE
CLOSURE OPTION #4
CLOSURE BY REMOVAL ONSITE LANDFILL - SECTIONS
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

FOR
ALLEN STEAM STATION

DUKE ENERGY®

SCALE: 1"=150'	DES: SSK
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DATE: 10/26/2018	ENGR: ENGR
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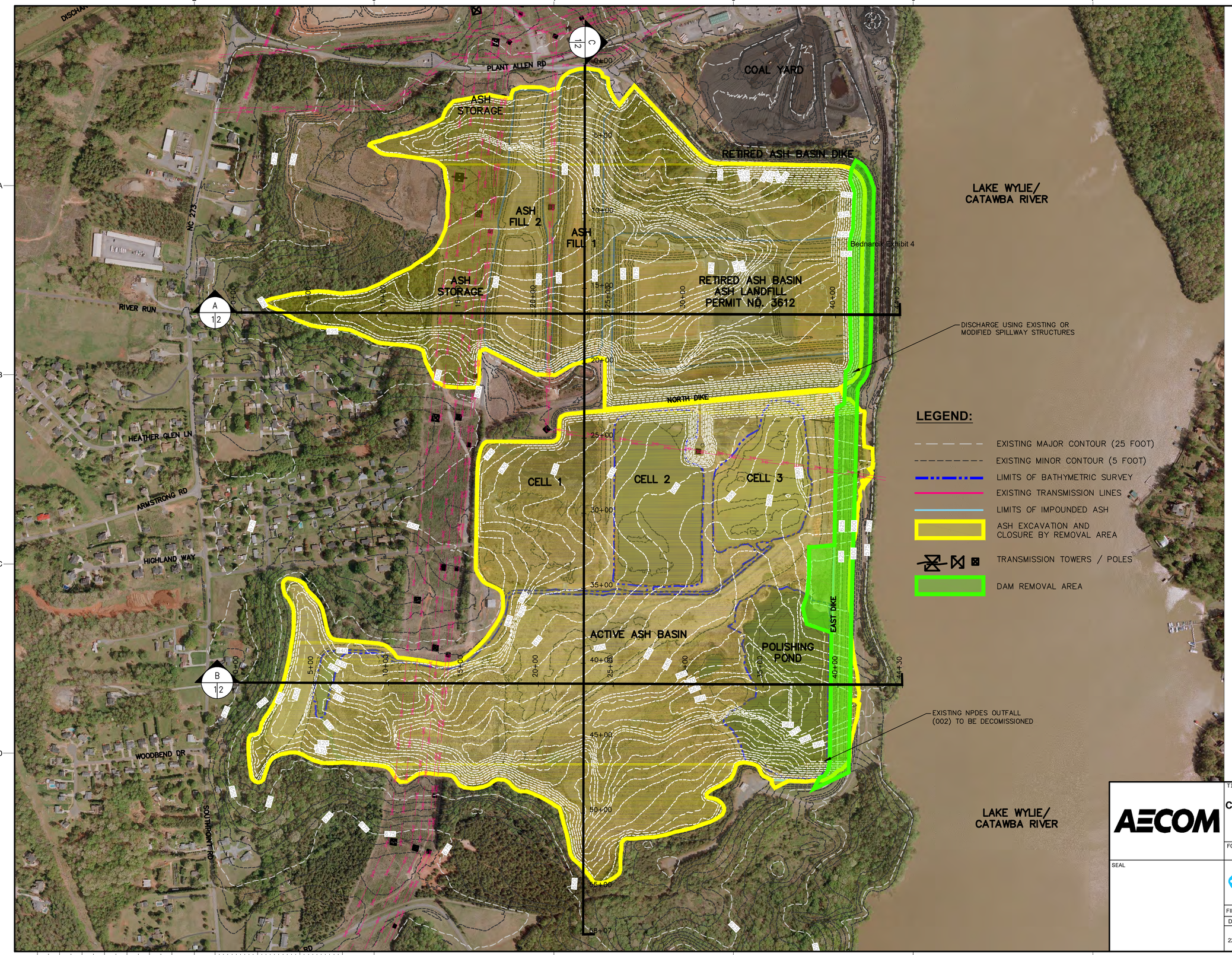
REV. 1



Bednarcik Exhibit 4

LEGEND:

- EXISTING MAJOR CONTOUR (25 FOOT)
- EXISTING MINOR CONTOUR (5 FOOT)
- LIMITS OF BATHYMETRIC SURVEY
- EXISTING TRANSMISSION LINES
- LIMITS OF IMPOUNDED ASH
- ASH EXCAVATION AND CLOSURE BY REMOVAL AREA
- TRANSMISSION TOWERS / POLES
- DAM REMOVAL AREA

NOTES:

1) ASH EXCAVATION AND CLOSURE BY REMOVAL AREAS INCLUDE ADDITIONAL 1 FT. OF MATERIAL EXCAVATION FROM THE BOTTOM OF THE BASIN.
2) SOIL OBTAINED FROM DAM REMOVAL WILL BE USED FOR RE-GRADING.

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TITLE

CLOSURE OPTION #5
CLOSURE BY REMOVAL OFFSITE LANDFILL- PLAN
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

FOR

ALLEN STEAM STATION

SEAL

DUKE ENERGY®

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DATE: 10/26/2018	ENGR: ENGR	
FILENAME: Figure A5-1.dwg	APPD: APPD	
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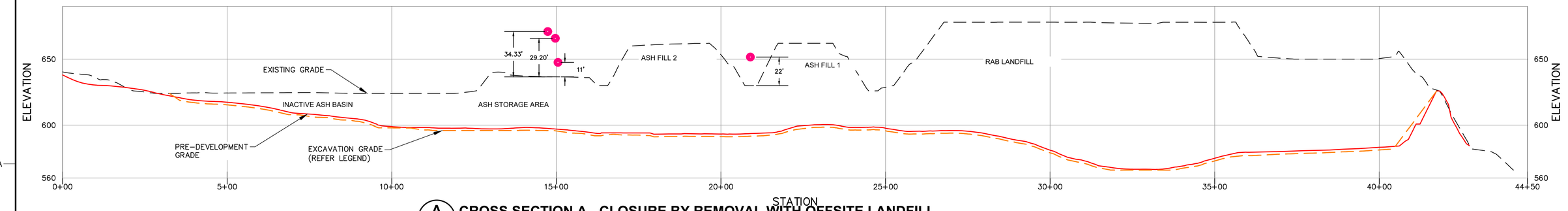
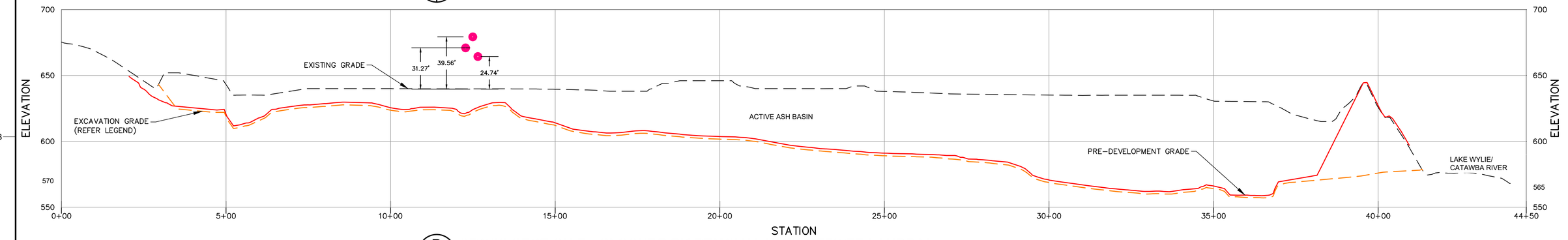
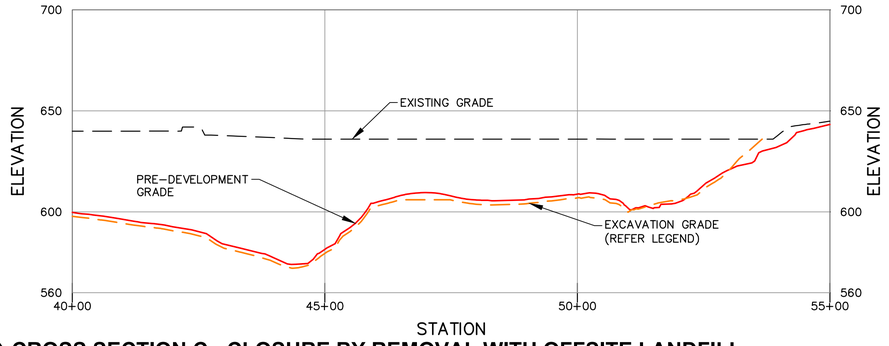
REV. 1



A 1 2 CROSS SECTION A - CLOSURE BY REMOVAL WITH OFFSITE LANDFILL



B 1 2 CROSS SECTION B - CLOSURE BY REMOVAL WITH OFFSITE LANDFILL



C 1 2 CROSS SECTION C - CLOSURE BY REMOVAL WITH OFFSITE LANDFILL

LEGEND

- EXISTING GRADE
- PRE–DEVELOPMENT GRADE
- EXCAVATION GRADE (INCLUDES EXCAVATION OF AN ADDITIONAL 1 FT. FROM THE BOTTOM OF THE BASIN)

NOTES:

1) TRANSMISSION LINES SHALL HAVE THE FOLLOWING VERTICAL CLEARANCE FROM THE LOWEST SAG ELEVATION:

100 KV	22 FT.
230 KV	24.5 FT.
500 KV	30.5 FT.

HORIZ. SCALE
0 150 300
GRAPHIC SCALE (IN FEET)

VERT. SCALE
0 37.5 75
GRAPHIC SCALE (IN FEET)

DRAFT
NOT FOR CONSTRUCTION

AECOM

SEAL

TITLE
CLOSURE OPTION #5
CLOSURE BY REMOVAL OFFSITE LANDFILL - SECTIONS
DUKE ENERGY
CLOSURE OPTIONS EVALUATION
GASTON COUNTY, NORTH CAROLINA

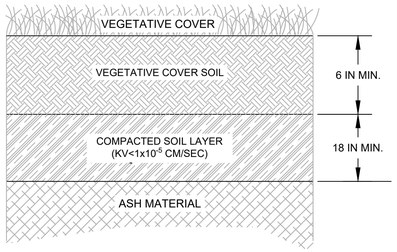
FOR
ALLEN STEAM STATION

DUKE ENERGY®

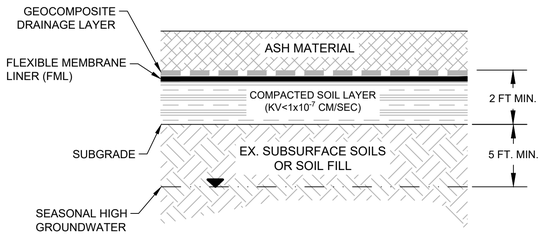
SCALE: 1"=150'	DES: SSK
DWG TYPE: .DWG	DFTR: DMB
JOB NO: 60572629	CHKD: JDM
DATE: 10/26/2018	ENGR: ENGR
FILENAME: Appendix B6.dwg	APPD: APPD

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	FIGURE A5-2	1

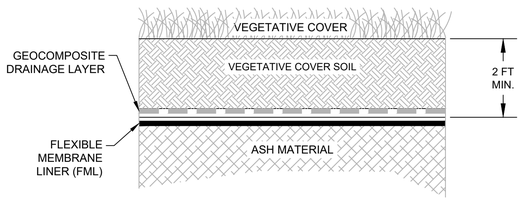
REV. 1



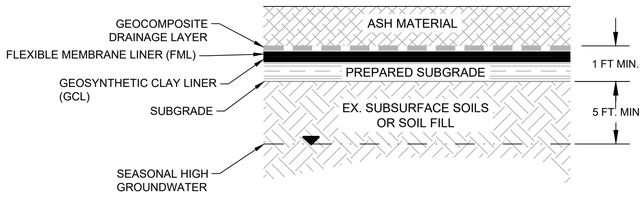
STANDARD ASH BASIN CLOSURE CAP SYSTEM
N.T.S



STANDARD LANDFILL LINER SYSTEM
N.T.S



ALTERNATE ASH BASIN CLOSURE CAP SYSTEM
N.T.S



ALTERNATE LANDFILL LINER SYSTEM
N.T.S

NOTE:

EITHER STANDARD ASH BASIN CLOSURE AND CAP SYSTEM OR ALTERNATE ASH BASIN CLOSURE AND CAP SYSTEM WILL BE USED IN:
- CLOSURE IN-PLACE OPTION
- HYBRID CLOSURE OPTION - 1
- HYBRID CLOSURE OPTION -2

LANDFILL COVER SYSTEM WILL BE DEVELOPED BASED ON SELECTED LINER SYSTEM

NOTE:

EITHER STANDARD LANDFILL LINER SYSTEM OR ALTERNATE LANDFILL LINER SYSTEM WILL BE USED IN:
- ONSITE LANDFILL INSIDE EXCAVATED ASH BASIN

DRAFT

NOT FOR CONSTRUCTION

AECOM

ENGINEERING LICENSE NO. F-0342

SEAL

TITLE

CLOSURE OPTIONS
CAP AND LINER DETAILS
DUKE ENERGY
CQA PLAN
GASTON COUNTY, NORTH CAROLINA

FOR

ALLEN STEAM STATION

DUKE ENERGY®

SCALE: 1"=300'		DES: SSK
DWG TYPE: .DWG		DFTR:
JOB NO: 60432103		CHKD:
DATE: 3/31/2016		ENGR:
FILENAME: Appendix B7.dwg		APPD:
DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	**FIGURE A6**	**A**

REV. A

Attachment B

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Duke Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Cost Summary	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure in Place		AECOM JOB NO.: 60572629
	ACTIVITY: Cost Summary: Closure in Place Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 1	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/2018	REVIEWED BY: JDM

ALLEN OPTION 1 -- CLOSURE IN PLACE
Closure & Post Closure Cost Summary

Closure Tasks	Cost (2018 Dollars)
Mobilization / Site Prep	**$4,989,882**
Dewatering / Earthwork / Subgrade Prep.	**$55,796,268**
Closure System Construction	**$25,933,670**
Stormwater Management / E&S Controls / Site Restoration	**$59,085,180**
Contingency (25%)	**$36,451,250**
Engineering Support (Design and CQA)	**$2,900,000**
Total Closure Cost of CCR Impoundment =	**$185,156,251**

Post-Closure Tasks	Cost (2018 Dollars)
Groundwater Monitoring	**$15,672,150**
Operations & Maintenance (O&M)	**$30,552,282**
Contingency (25%)	**$11,556,108**
Engineering Costs (10%)	**$5,778,054**
Total Post-Closure of CCR Impoundment =	**$63,558,594**

Total Closure & Post-Closure of CCR Impoundment Cost =	**$248,714,845**

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Duke Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Cost Summary	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure in Place		AECOM JOB NO.: 60572629
	ACTIVITY: Closure in Place Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 1	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2018		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	Not Used
TOTAL AREA TO BE RESTORED (AC)	293		EX. AREA OF RAB LANDFILL (LIMITS OF LINER)	26
TOTAL IMPOUNDMENT AREA (AC)	293		CLOSURE BY REMOVAL AREA (BUFFER AREA) (AC)	19
VOLUME OF ASH IN IMPOUNDMENT (CY)	16,263,083		PERIMETER OF IMPOUNDMENT (L.F.)	25,694

CLOSURE IN PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION/ SITE PREP	**MOBILIZATION / SITE PREP**						
	1	MOBILIZATION	LS	1	$1,472,327	$1,472,327	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	ABANDON OUTLET STRUCTURES / PIPING	LS	2	$200,000	$400,000	Modify existing outlet structures and piping.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	30.0	$103,919	$3,117,555	initiation time
DEWATERING / EARTHWORK / SUBGRADE PREP	**DEWATERING / EARTHWORK / SUBGRADE PREP**						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	76.0	$225,832	$17,163,232	construction time
	5	RING DRAIN INSTALLATION	L.F.	25,694	$58.00	$1,490,252	Linear feet around the proposed cap.
	6	ASH REGRADING TO ESTABLISH CROWN	CY	3,953,000	$9.24	$36,525,720.00	Quantity of earthwork (cut-to-fill) using existing ash to achieve min. 2% slope prior to installation of closure system. Quantity calculated using AutoCAD.
	7	OVER EXCAVATE SOIL FROM CLOSURE BY REMOVAL ARE	CY	30,874	$10.00	$308,736.30	Assume 1 foot of additional material to be removed over total Closure by Removal impoundment area.
	8	PERIMETER DITCH / TEMP. DIVERSION BERM GRADING	L.F.	25,694	$12.00	$308,328	Linear feet around the perimeter of impoundment.
CLOSURE SYSTEM CONSTRUCTION	**CLOSURE SYSTEM CONSTRUCTION**						
	9	FLEXIBLE MEMBRANE LINER (FML)	SQ. FT.	11,854,016	$0.42	$4,978,687	Flexible membrane liner placed over Closure in Place area. Assume quantity needed is 10% more than Closure in Place area.
	10	GEOCOMPOSITE DRAINAGE LAYER	SQ. FT.	11,854,016	$0.60	$7,112,409	Geocomposite drainage layer placed over Closure in Place area. Assume quantity needed is 10% more than Closure in Place area.
	11	GEOSYNTHETIC CLAY LINER (GCL)	SQ. FT.	0	$0.72	$0	not used
	12	18" PROTECTIVE COVER SOIL	CY	598,688	$13.00	$7,782,940	18 inches of common soil placed over Closure in Place area (assume onsite soils available).

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Duke Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Cost Summary	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure in Place		AECOM JOB NO.: 60572629
	ACTIVITY: Closure in Place Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 1	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
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VOLUME OF ASH IN IMPOUNDMENT (CY)	16,263,083		PERIMETER OF IMPOUNDMENT (L.F.)	25,694

CLOSURE IN PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
	13	6" TOPSOIL	CY	199,563	$13.00	$2,594,313	6 inches of topsoil (obtained offsite) placed over total impoundment area.
	14	COMPACTED LOW PERM. SOILS (Kv<1x10^-5 cm/sec)	CY	266,563	$13.00	$3,465,321	Backfill Excavation Areas (not including 6" of topsoil)
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	**STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION**						
	15	EROSION AND SEDIMENT CONTROL	ACRE	293	$2,000	$586,000	Assume total area to be restored will require site erosion and sediment control.
	16	6" TOPSOIL	CY	15,437	$13.00	$200,679	6 inches of topsoil (obtained offsite) placed over CbR areas.
	17	STORMWATER MANAGEMENT / CHANNELS / LET-DOWNS	L.F.	77,082	$742	$57,194,844	Assume rip-rap lined stormwater conveyance channels and rip-rap lined let-downs off of cap. Quantity assumed at 3 times perimeter.
	18	SEED / FERTILIZE / MULCH	ACRE	293	$3,767	$1,103,658	Assume total area to be restored will be mulched, fertilized, and seeded.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Duke Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Cost Summary	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure in Place		AECOM JOB NO.: 60572629
	ACTIVITY: Closure in Place Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 1	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
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VOLUME OF ASH IN IMPOUNDMENT (CY)	16,263,083		PERIMETER OF IMPOUNDMENT (L.F.)	25,694

CLOSURE IN PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
CONTINGENCY / ENGINEERING SUPPORT	**CONTINGENCY / ENGINEERING SUPPORT**						
		CONTINGENCY (25%)	LS	1	$36,451,250	$36,451,250	
		ENGINEERING SUPPORT (DESIGN & CQA)	LS	1	$2,900,000	$2,900,000	
POST-CLOSURE	**POST-CLOSURE**						
	19	GROUNDWATER MONITORING	ANNUAL	30	$522,405	$15,672,150	Annual groundwater monitoring costs for each CCR impoundment are based on current groundwater monitoring system.
	20	OPERATIONS & MAINTENANCE (O&M)	ANNUAL	30	$1,018,409	$30,552,282	Annual O&M costs are $3475/acre for the total impoundment area.
CONTINGENCY / ENGINEERING COST	**CONTINGENCY / ENGINEERING COST**						
		CONTINGENCY (25%)	LS	1	$11,556,108.00	$11,556,108.00	
		ENGINEERING COST (10%)	LS	1	$5,778,054.00	$5,778,054.00	
		TOTAL				**$248,714,845**	

AECOM CALCULATION SHEET	PROJECT	PLANT NAME:	CLOSURE TYPE:	SHEET	REV. NO.
	CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	Duke Allen	CCR Rule & CAMA Compliant	Close-in-Place Assumptions	3
	SUBJECT	IMPOUNDMENT NAME:	CLOSURE METHOD:		AECOM JOB NO.
	Preliminary Project Costs Sheets	AAB & RAB	Closure in Place		60572629
	ACTIVITY	CLOSURE OPTION:	LAST UPDATED BY:	DATE LAST MODIFIED:	REVIEWED BY:
	Close-in-Place Assumptions	Option 1	DMB	10/26/18	JDM

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:

1	The cost estimates were prepared using 2018 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	The unit rate costs are based on data provided by Duke Energy. If no data is available, AECOM supplemented with rates from our experience.
5	Free water removal and treatment was assumed to continue throughout the project initiation period.
6	Interstitial water treatment was assumed to continue until construction is completed.
7	Abandonment of existing structures/piping includes the demolition in-place or bulkheading of existing pipes and inlets/outlet structures, grouting of outlet pipes that extend beyond the limits of waste, and backfilling of existing structures in-place for the purposes of a close-in-place closure of an impoundment.
8	To establish the minimum top slopes of 2%, assume existing ash will be utilized to establish crown.
9	Cap cross section for the CCR impoundment will consist of flexible membrane liner, geocomposite drianage layer, and 18-inches of protective cover soil (Kv<1x10^{-5} cm/sec) overlain by 6-inches of
10	Common soil for embankment and protective cover soil construction are available onsite and topsoil would come from offsite.
11	Groundwater monitoring costs are for the existing network system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
12	O&M costs include, but are not limited to, the monitoring and maintenance/repair of the groundwater monitoring system, cap system, and storm water controls.
13	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Duke Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Cost Summary	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Hybrid Option		AECOM JOB NO.: 60572629
	ACTIVITY: Cost Summary: Hybrid Option 1 Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 2	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/2018	REVIEWED BY: JDM

ALLEN OPTION 2 -- HYBRID OPTION
Closure & Post Closure Cost Summary

Closure Tasks	Cost (2018 Dollars)
Mobilization / Site Prep / Demobilization	**$6,373,526**
Dewatering / Excavation for Closure by Removal / Convey Material	**$114,602,371**
Dewatering / Earthwork for Closure in Place	**$80,243,637**
Lateral Expansion Areas	**$0**
Closure System Construction	**$12,447,588**
Stormwater Management / E&S Controls / Site Restoration	**$7,311,304**
Contingency (25%)	**$55,244,606**
Engineering Support (Design & CQA)	**$4,500,000**
Total Closure Cost of CCR Impoundment =	**$280,723,031**

Post-Closure Tasks	Cost (2018 Dollars)	
Groundwater Monitoring	**$15,672,150**	
Operations & Maintenance (O&M)	**$17,051,734**	
Contingency (25%)	**$8,180,971**	
Engineering Costs (10%)	**$4,090,485**	
Total Post-Closure of CCR Impoundment =	**$44,995,340**	$1,499,844.67 for 30yrs
Total Closure & Post-Closure of CCR Impoundment Cost =	**$325,718,371**	

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Duke Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Hybrid Costs	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Hybrid Option		AECOM JOB NO.: 60572629
	ACTIVITY: Hybrid Option Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 2	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2018		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	Not Used
TOTAL IMPOUNDMENT AREA (AC)	267		AVG. DEPTH OF FREE WATER (FT)	Not Used
TOTAL AREA TO BE RESTORED (AC)	267		EX. AREA OF RAB LANDFILL (LIMITS OF LINER)	26.472
IMPOUNDMENT AREA TO BE CLOSED IN PLACE (AC)	164		IMPOUNDMENT AREA TO BE CLOSED BY REMOVAL (AC)	103
EXISTING ASH VOLUME IN AREA TO BE CLOSED IN PLACE (CY)	12,170,100		TOTAL ASH VOLUME FROM CLOSURE BY REMOVAL (CY)	4,230,900
TOTAL (FINAL) ASH VOLUME TO BE CLOSED IN PLACE (CY)	14,805,951		PERIMETER OF CLOSED IN PLACE IMPOUNDMENT (L.F.)	19,783
			LENGTH OF CUT-SLOPE AT CLOSURE IN PLACE / CLOSURE BY REMOVAL INTERFACE (L.F.)	3,700

HYBRID OPTION ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION/ SITE PREP/ DEMOBILIZATION	**MOBILIZATION / SITE PREP / DEMOBILIZATION**						
	1	MOBILIZATION / DEMOBILIZATION	LS	1	$2,232,460	$2,232,460	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	REMOVAL OF OUTLET STRUCTURES / PIPING	LS	2	$200,000	$400,000	Assume outlet structures and piping will be excavated and removed for AAB. Structure will be modified in RAB.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	36.0	$103,919	$3,741,066	Based on Initiation time
DEWATERING / EXCAVATION FOR CLOSURE BY REMOVAL / CONVEY MATERIAL	**DEWATERING / EXCAVATION FOR CLOSURE BY REMOVAL / CONVEY MATERIAL**						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH IN CLOSURE BY REMOVAL AREA	MONTHS	88.0	$225,832	$19,873,216	Step 1: Start dewatering for construction time. Based on Construction Time
	5	EXCAVATE ASH FOR CLOSURE BY REMOVAL / STOCKPILE ASH	CY	4,230,900	$8.00	$33,847,200	Step 2: Assume CCR material must be stockpiled within impoundment area to decant prior to loading. Done in conjunction with Step 1. Decant water collected and treated along with pore water from Step 1.
	6	EXCAVATE ASH FROM STOCKPILE / LOAD / HAUL ASH TO CLOSURE IN PLACE AREA	CY	2,635,851	$8.43	$22,220,221	Step 3: Once material has decanted, CCRs must be excavated out of stockpile, loaded on trucks and hauled to Closure in Place area. Quantity takes into consideration reduction of volume due to dewatering of ash down to 30% moisture content.
	7	OVER EXCAVATE SOIL FROM CLOSURE BY REMOVAL AREA / LOAD / HAUL CCR-IMPACTED SOIL TO CLOSURE IN PLACE AREA	CY	166,173	$10.00	$1,661,733	Assume 1 foot of additional material to be removed over total Closure by Removal impoundment area.
	8	DEEP MIXING METHOD (DMM) WALL TO STABILIZE CUT-SLOPE AT CLOSURE IN PLACE / CLOSURE BY REMOVAL INTERFACE	L.F.	3,700	$10,000	$37,000,000	Assume DMM wall for large ponds that require excavating a portion of the pond and stacking excavated material on remaining portion.
	9	EXCAVATE / LOAD / HAUL CCR MATERIAL (OFF-SITE)	CY	0	$57	$0	include if applicable
	10	EXCAVATE / LOAD / HAUL CCR-IMPACTED SOIL (OFF-SITE)	CY	0	$57	$0	include if applicable
DEWATERING / EARTHWORK FOR CLOSURE IN PLACE	**DEWATERING / EARTHWORK FOR CLOSURE IN PLACE**						
	11	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	0.0	$225,832	$0	This cost already accounted for in Item 4
	12	SPREAD AND COMPACT MATERIAL FROM CLOSURE BY REMOVAL AREA	CY	2,635,851	$7.56	$19,927,031	Spread dewatered ash excavated from Closure by Removal area in thin lifts over close-in-place area. Quantity takes into consideration reduction of volume due to dewatering of ash down to 30% moisture content.
	13	ASH REGRADING TO ESTABLISH CROWN	CY	6,377,900	$9.24	$58,931,796	Quantity of earthwork (cut-to-fill) using existing ash to achieve min. 2% slope prior to installation of closure system. Quantity calculated using AutoCAD.
	14	RING DRAIN INSTALLATION	L.F.	19,783	$58	$1,147,414	Linear feet around the close-in-place area
	15	PERIMETER DITCH / TEMP. DIVERSION BERM GRADING	L.F.	19,783	$12	$237,396	Linear feet around the perimeter of impoundment.

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	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Hybrid Option		AECOM JOB NO.: 60572629
	ACTIVITY: Hybrid Option Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 2	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
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TOTAL IMPOUNDMENT AREA (AC)	267		AVG. DEPTH OF FREE WATER (FT)	Not Used
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TOTAL (FINAL) ASH VOLUME TO BE CLOSED IN PLACE (CY)	14,805,951		PERIMETER OF CLOSED IN PLACE IMPOUNDMENT (L.F.)	19,783
			LENGTH OF CUT-SLOPE AT CLOSURE IN PLACE / CLOSURE BY REMOVAL INTERFACE (L.F.)	3,700

HYBRID OPTION ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
LATERAL EXPANSION AREAS	**LATERAL EXPANSION AREAS**						
	16	LATERAL EXPANSION AREAS	AC	0	$300,000	$0	In areas where ash will be placed outside of the existing ash basin waste boundary, this will be considered a Lateral Expansion per the CCR regulations and will require a composite liner system.
CLOSURE SYSTEM CONSTRUCTION	**CLOSURE SYSTEM CONSTRUCTION**						
	17	FLEXIBLE MEMBRANE LINER (FML)	SQ. FT.	6,567,189	$0.42	$2,758,219	Flexible membrane liner placed over Closure in Place area. Assume quantity needed is 10% more than Closure in Place area.
	18	GEOCOMPOSITE DRAINAGE LAYER	SQ. FT.	6,567,189	$0.60	$3,940,314	Geocomposite drainage layer placed over Closure in Place area. Assume quantity needed is 10% more than Closure in Place area.
	19	GEOSYNTHETIC CLAY LINER (GCL)	SQ. FT.	0	$0.72	$0	not used
	20	18" PROTECTIVE COVER SOIL	CY	331,676	$13	$4,311,791	18 inches of common soil placed over Closure in Place area (assume onsite soils available).
	21	6" TOPSOIL	CY	110,559	$13	$1,437,264	6 inches of topsoil (obtained offsite) placed over Closure by Removal area.
	22	COMPACTED LOW PERM. SOILS (Kv<1x10^-5 cm/sec)	CY	0	$13	$0	not used
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	**STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION**						
	23	PERMANENT RIPRAP STORMWATER CHANNELS	TON	7,250	$50	$362,500	Assume 10,000 lf x 10 ft wide x 1 ft thick, 145 pcf riprap lined stormwater channels.
	24	SITE EROSION AND SEDIMENT CONTROL	ACRE	267	$2,000	$533,060	Assume total area to be restored will require site erosion and sediment control.
	25	BACKFILL AND REGRADING OF CLOSURE BY REMOVAL AREA	CY	333,033	$13	$4,329,433	Assume 2 feet of additional soil material (obtained onsite) graded over total Closure by Removal area.
	26	TOPSOIL	CY	83,258	$13	$1,082,358	Assume 6-inches of topsoil needed (obtained offsite) to establish vegetative stabilization over total Closure by Removal area
	27	SEED / FERTILIZE / MULCH	ACRE	267	$3,767	$1,003,952	Assume total area of disturbance will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	**CONTINGENCY / ENGINEERING SUPPORT**						
		CONTINGENCY (25%)	LS	1	$55,244,606	$55,244,606.00	
		ENGINEERING SUPPORT (DESIGN & CQA)	LS	1	$4,500,000	$4,500,000.00	
POST-CLOSURE	**POST-CLOSURE**						
	28	GROUNDWATER MONITORING	ANNUAL	30	$522,405	$15,672,150	Annual groundwater monitoring costs for each CCR impoundment are based on current groundwater monitoring system
	29	OPERATIONS & MAINTENANCE (O&M)	ANNUAL	30	$568,391	$17,051,734	Annual O&M costs are 3475.80/ac/yr for closed area with cap. Based on Q3 2018 Post Closure Maintenance data.
CONTINGENCY / ENGINEERING COST	**CONTINGENCY / ENGINEERING COST**						
		CONTINGENCY (25%)	LS	1	$8,180,971	$8,180,971.00	

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Duke Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Hybrid Costs	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Hybrid Option		AECOM JOB NO.: 60572629
	ACTIVITY: Hybrid Option Cost Estimate for CCR Surface Impoundment	CLOSURE OPTION: Option 2	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2018		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	Not Used
TOTAL IMPOUNDMENT AREA (AC)	267		AVG. DEPTH OF FREE WATER (FT)	Not Used
TOTAL AREA TO BE RESTORED (AC)	267		EX. AREA OF RAB LANDFILL (LIMITS OF LINER)	26.472
IMPOUNDMENT AREA TO BE CLOSED IN PLACE (AC)	164		IMPOUNDMENT AREA TO BE CLOSED BY REMOVAL (AC)	103
EXISTING ASH VOLUME IN AREA TO BE CLOSED IN PLACE (CY)	12,170,100		TOTAL ASH VOLUME FROM CLOSURE BY REMOVAL (CY)	4,230,900
TOTAL (FINAL) ASH VOLUME TO BE CLOSED IN PLACE (CY)	14,805,951		PERIMETER OF CLOSED IN PLACE IMPOUNDMENT (L.F.)	19,783
			LENGTH OF CUT-SLOPE AT CLOSURE IN PLACE / CLOSURE BY REMOVAL INTERFACE (L.F.)	3,700

COST

HYBRID OPTION ESTIMATED COSTS

TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
	ENGINEERING COST (10%)	LS	1	$4,090,485	$4,090,485.00	
	TOTAL				**$325,718,371**	

AECOM CALCULATION SHEET	PROJECT	PLANT NAME:	CLOSURE TYPE:	SHEET	REV. NO.
	CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	Duke Allen	CCR Rule & CAMA Compliant	Hybrid Assumptions	3
	SUBJECT	IMPOUNDMENT NAME:	CLOSURE METHOD:		AECOM JOB NO.
	Preliminary Project Costs Sheets	AAB & RAB	Hybrid Option		60572629
	ACTIVITY	CLOSURE OPTION:	LAST UPDATED BY:	DATE LAST MODIFIED:	REVIEWED BY:
	Hybrid Option Assumptions	Option 2	DMB	10/26/18	JDM

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:

1	The cost estimates were prepared using 2018 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	The unit rate costs are based on data provided by Duke Energy. If no data is available, AECOM supplemented with rates from our experience.
5	Free water removal and treatment was assumed to continue throughout the project initiation period.
6	Interstitial water treatment was assumed to continue until construction is completed.
7	Ash to be moisture conditioned and compacted in the stack area.
8	Removal of existing structures/piping includes the excavation and disposal of existing structures within the limits of waste and the bulkheading or grouting of existing outlet pipes that extend beyond the limits of waste. This will be performed during the closure-by-removal of an impoundment.
9	AECOM has assumed all CCR material excavated must be stockpiled in close proximity to the impoundment to be decanted. After decanting, the material will be excavated, loaded, and hauled to an on-site impoundment to be closed-in-place.
10	AECOM has assumed all material excavated from areas to be closed by removal will be used for crown construction/soil regrading for closed-in-place areas.
11	AECOM has assumed an over-excavation of 1 foot is necessary to achieve closure-by-removal conditions.
12	Cap cross section for the CCR impoundment will consist of flexible membrane liner, geocomposite drianage layer, and 18-inches of protective cover soil (Kv<1x10-5 cm/sec) overlain by 6-inches of topsoil.
13	Common soil for embankment and protective cover soil construction are available onsite and topsoil would come from offsite
14	AECOM has assumed groundwater monitoring costs are for the existing network system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
15	O&M costs include, but are not limited to, the maintenance/repair of the groundwater monitoring system and general maintenance of the former CCR impoundment area.
16	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Cost Summary	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure by Removal Onsite		AECOM JOB NO.: 60572629
	ACTIVITY: Cost Summary: Closure by Removal with Onsite Landfill Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 4	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/2018	REVIEWED BY: JDM

ALLEN OPTION 4 -- CLOSURE BY REMOVAL ONSITE
Closure & Post Closure Cost Summary

Closure Tasks	Cost (2018 Dollars)
Mobilization / Site Prep / Demobilization	**$10,447,932**
Dewatering / Excavation / Convey Material	**$266,514,974**
Onsite Landfill Construction, Disposal and Closure	**$153,266,128**
Stormwater Management / E&S Controls / Site Restoration	**$12,840,555**
Contingency (25%)	**$110,767,397**
Engineering Support (Design & CQA)	**$5,000,000**
Total Closure Cost of CCR Impoundment =	**$558,836,985**

Post-Closure Tasks	Cost (2018 Dollars)	
Groundwater Monitoring	**$15,672,150**	
Operations & Maintenance (O&M)	**$9,488,934**	
Contingency (25%)	**$6,290,271**	
Engineering Costs (10%)	**$3,145,136**	
Total Post-Closure of CCR Impoundment =	**$34,596,491**	$1,153,216.35 for 30yrs
Total Closure & Post-Closure of CCR Impoundment Cost =	**$593,433,476**	

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Clean-Closure Costs	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure by Removal Onsite		AECOM JOB NO.: 60572629
	ACTIVITY: Closure by Removal with Onsite Landfill Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 4	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2018		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	Not Used
TOTAL AREA TO BE RESTORED (AC)	214		AVG. DEPTH OF FREE WATER (FT)	Not Used
TOTAL IMPOUNDMENT AREA (AC)	293		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	Not Used
VOLUME OF ASH IN IMPOUNDMENT (CY)	16,263,083		PERIMETER OF IMPOUNDMENT (L.F.)	25,694

CLOSURE BY REMOVAL W\ ONSITE LANDFILL ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION/ SITE PREP/ DEMOBILIZATION	**MOBILIZATION / SITE PREP / DEMOBILIZATION**						
	1	MOBILIZATION / DEMOBILIZATION	LS	1	$4,436,333	$4,436,333	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	REMOVAL OF OUTLET STRUCTURES / PIPING	LS	2	$200,000	$400,000	Assume outlet structures and piping will be excavated and removed.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	54.0	$103,919	$5,611,599	Based on Initiation Time
CLOSURE BY REMOVAL/ CONVEY MATERIAL	**DEWATERING / EXCAVATION / CONVEY MATERIAL**						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	210.0	$225,832	$47,424,720	Step 1: Start dewatering for construction time. Based on Construction Time
	5	EXCAVATE ASH FOR CLOSURE BY REMOVAL / STOCKPILE ASH	CY	16,263,083	$8.00	$130,104,667	Step 2: Assume CCR material must be stockpiled within impoundment area to decant prior to loading. Done in conjunction with Step 1. Decant water collected and treated along with pore water from Step 1.
	6	EXCAVATE ASH FROM STOCKPILE / LOAD / HAUL ASH (DISPOSE ON-SITE)	CY	10,131,901	$8	$85,411,925	Step 3: Once material has decanted, CCRs must be excavated out of stockpile, loaded on trucks and hauled to onsite disposal site. Quantity takes into consideration reduction of volume due to dewatering of ash down to 30% moisture content.
	7	EXCAVATE / LOAD / HAUL CCR-IMPACTED SOIL (ON-SITE)	CY	472,707	$8	$3,573,662	Assume 1 foot of additional material to be removed over total impoundment area.
	8	EXCAVATE / LOAD / HAUL CCR MATERIAL (OFFSITE LF)	TON	0	$57	$0	Only include if disposing CCRS at an off-site landfill (assume density of 1.2 tons/cy).
	9	EXCAVATE / LOAD / HAUL CCR-IMPACTED SOIL (OFFSITE LF)	TON	0	$57	$0	Only include if disposing CCRS at an off-site landfill (assume density of 1.2 tons/cy).

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Clean-Closure Costs	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure by Removal Onsite		AECOM JOB NO.: 60572629
	ACTIVITY: Closure by Removal with Onsite Landfill Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 4	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/18	REVIEWED BY: JDM

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2018		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	Not Used
TOTAL AREA TO BE RESTORED (AC)	214		AVG. DEPTH OF FREE WATER (FT)	Not Used
TOTAL IMPOUNDMENT AREA (AC)	293		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	Not Used
VOLUME OF ASH IN IMPOUNDMENT (CY)	16,263,083		PERIMETER OF IMPOUNDMENT (L.F.)	25,694

CLOSURE BY REMOVAL W\ ONSITE LANDFILL ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
ONSITE LANDFILL CONSTRUCTION, DISPOSAL AND CLOSURE	**ONSITE LANDFILL CONSTRUCTION, DISPOSAL AND CLOSURE**						
	10	CONSTRUCT ONSITE LANDFILL AND ASSOCIATED COMPONENTS	AC	91	$803,245	$73,095,295	Assume landfill designed and constructed in accordance with CAMA and CCR Rules. Cost includes landfill construction and all associated components, including: liner system, leachate management, stormwater management, access roads, closure system and all associated components,etc.
	11	DISPOSE/SPREAD/COMPACT ASH AND CCR-IMPACTED MATERIALS FROM CLOSURE BY REMOVAL AREA IN ONSITE LANDFILL	CY	10,604,608	$7.56	$80,170,833	Place, spread and compact in thin lifts dewatered ash and CCR-impacted materials excavated from Closure by Removal area into landfill.
	12	ONSITE LANDFILL CLOSURE SYSTEM	AC	0	$0	$0	Included with landfill construction (Item 10)
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	**STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION**						
	10	PERMANENT RIPRAP STORMWATER CHANNELS	TON	7,250	$50	$362,500	Assume 10,000 lf x 10 ft widex 1 ft thick, 145 pcf riprap lined stormwater channels.
	11	SITE EROSION AND SEDIMENT CONTROL	ACRE	214	$2,000	$428,000	Assume total area to be restored will require site erosion and sediment control.
	12	BACKFILL AND REGRADING	CY	691,933	$13	$8,995,133	Assume 2 feet of additional soil material (obtained onsite) graded over total Closure by Removal area. Soil obtained from the dam decommissioning can be used.
	13	TOPSOIL	CY	172,983	$13	$2,248,783	Assume 6-inches of top soil needed (obtained offsite) to establish vegetative stabilization over total Closure by Removal area + 10%. Does not include topsoil for onsite landfill closure cap
	14	SEED / FERTILIZE / MULCH	ACRE	214	$3,767	$806,138	Assume total area of disturbance will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	**CONTINGENCY / ENGINEERING SUPPORT**						
		CONTINGENCY (25%)	LS	1	$110,767,397	$110,767,397.09	
		ENGINEERING SUPPORT (DESIGN & CQA)	LS	1	$5,000,000	$5,000,000.00	
POST-CLOSURE	**POST-CLOSURE**						
	15	GROUNDWATER MONITORING	ANNUAL	30	$522,405	$15,672,150	Annual groundwater monitoring costs for each CCR impoundment after Closure by Removal assumed to be minimal.
	16	OPERATIONS & MAINTENANCE (O&M)	ANNUAL	30	$316,298	$9,488,934	Annual O&M costs are $3475/acre/yr for the total closed area with cap. Based on Q3 2018 Post Closure Maintenance data.
CONTINGENCY / ENGINEERING COST	**CONTINGENCY / ENGINEERING COST**						
		CONTINGENCY (25%)	LS	1	$6,290,271	$6,290,271.00	
		ENGINEERING COST (10%)	LS	1	$3,145,136	$3,145,135.50	
		TOTAL				**$593,433,476**	

AECOM CALCULATION SHEET	PROJECT	PLANT NAME:	CLOSURE TYPE:	SHEET	REV. NO.
	CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	Allen	CCR Rule & CAMA Compliant	Clean-Closure Assumptions	3
	SUBJECT	IMPOUNDMENT NAME:	CLOSURE METHOD:		AECOM JOB NO.
	Preliminary Project Costs Sheets	AAB & RAB	Closure by Removal Onsite		60572629
	ACTIVITY	CLOSURE OPTION:	LAST UPDATED BY:	DATE LAST MODIFIED:	REVIEWED BY:
	Closure by Removal Assumptions	Option 4	DMB	10/26/18	JDM

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:

1	The cost estimates were prepared using 2018 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	The unit rate costs are based on data provided by Duke Energy. If no data is available, AECOM supplemented with rates from our experience.
5	Free water removal and treatment was assumed to continue throughout the project initiation period.
6	Removal of existing structures/piping includes the excavation and disposal of existing structures within the limits of waste and the bulkheading or grouting of existing outlet pipes that extend beyond the limits of waste. This will be performed during the Closure-by-Removal of an impoundment.
7	Interstitial water treatment was assumed to continue until construction is completed.
8	Assumed all CCR material excavated must be stockpiled in close proximity to the impoundment to be decanted. After decanting, the material will be excavated, loaded, and hauled to the on-site landfill for disposal.
9	Costs for onsite landfill construction was based on a per acre basis as provided by Duke.
10	AECOM has assumed an over-excavation of 1 foot is necessary to achieve closure-by-removal conditions.
11	Groundwater monitoring costs are for a reduced groundwater network system as compared to the existing system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
12	O&M costs include, but are not limited to, the maintenance/repair of the groundwater monitoring system and general maintenance of the former CCR impoundment area.
13	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME: Allen	CLOSURE TYPE: CCR Rule & CAMA Compliant	SHEET: Cost Summary	REV. NO.: 3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: AAB & RAB	CLOSURE METHOD: Closure by Removal Offsite		AECOM JOB NO.: 60572629
	ACTIVITY: Cost Summary: Closure by Removal w\ Offsite Landfill Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 5	LAST UPDATED BY: DMB	DATE LAST MODIFIED: 10/26/2018	REVIEWED BY: JDM

ALLEN OPTION 5 -- CLOSURE BY REMOVAL OFFSITE
Closure & Post Closure Cost Summary

Closure Tasks	Cost (2018 Dollars)
Mobilization / Site Prep / Demobilization	**$25,146,057**
Dewatering / Excavation / Convey Material	**$936,758,856**
Stormwater Management / E&S Controls / Site Restoration	**$17,446,866**
Contingency (25%)	**$244,837,945**
Engineering Support (Design & CQA)	**$5,000,000**
Total Closure Cost of CCR Impoundment =	**$1,229,189,724**

Post-Closure Tasks	Cost (2018 Dollars)	
Groundwater Monitoring	**$0**	
Operations & Maintenance (O&M)	**$1,319,000**	
Contingency (25%)	**$329,750**	
Engineering Costs (10%)	**$164,875**	
Total Post-Closure of CCR Impoundment =	**$1,813,625**	$60,454.17 for 30yrs
Total Closure & Post-Closure of CCR Impoundment Cost =	**$1,231,003,349**	

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME:	CLOSURE TYPE:	SHEET:	REV. NO.:
		Allen	CCR Rule & CAMA Compliant	Clean-Closure Costs	3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME:	CLOSURE METHOD:		AECOM JOB NO.:
		AAB & RAB	Closure by Removal Offsite		60572629
	ACTIVITY: Closure by Removal w\ Offsite Landfill Cost Estimate for CCR Impoundment	CLOSURE OPTION:	LAST UPDATED BY:	DATE LAST MODIFIED:	REVIEWED BY:
		Option 5	DMB	10/26/18	JDM

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2018		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	Not Used
TOTAL AREA TO BE RESTORED (AC)	293		AVG. DEPTH OF FREE WATER (FT)	Not Used
TOTAL IMPOUNDMENT AREA (AC)	293		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	Not Used
VOLUME OF ASH IN IMPOUNDMENT (CY)	16,263,083		PERIMETER OF IMPOUNDMENT (L.F.)	25,694

CLOSURE BY REMOVAL W\ OFFSITE LANDFILL ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION/ SITE PREP/ DEMOBILIZATION	**MOBILIZATION / SITE PREP / DEMOBILIZATION**						
	1	MOBILIZATION / DEMOBILIZATION	LS	1	$9,746,057	$9,746,057	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	REMOVAL OF OUTLET STRUCTURES / PIPING	LS	2	$200,000	$400,000	Assume outlet structures and piping will be excavated and removed.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	36.0	$416,667	$15,000,000	Based on Initiation Time
CLOSURE BY REMOVAL/ CONVEY MATERIAL	**DEWATERING / EXCAVATION / CONVEY MATERIAL**						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	201.0	$225,832	$45,392,232	Step 1: Start dewatering for construction time. Based on Construction Time
	5	EXCAVATE ASH FOR CLOSURE BY REMOVAL / STOCKPILE ASH	CY	16,263,083	$8.00	$130,104,667	Step 2: Assume CCR material must be stockpiled within impoundment area to decant prior to loading. Done in conjunction with Step 1. Decant water collected and treated along with pore water from Step 1.
	6	EXCAVATE ASH FROM STOCKPILE / LOAD / HAUL ASH (DISPOSE ON-SITE)	CY	0	$8.43	$0	Step 3: Once material has decanted, CCRs must be excavated out of stockpile, loaded on trucks and hauled to offsite disposal site. Quantity takes into consideration reduction of volume due to dewatering of ash down to 30% moisture content.
	7	EXCAVATE / LOAD / HAUL CCR-IMPACTED SOIL (ON-SITE)	CY	472,707	$7.56	$3,573,662	Assume 1 foot of additional material to be removed over total impoundment area.
	8	EXCAVATE / LOAD / HAUL CCR MATERIAL (OFFSITE LF)	TON	12,158,281	$57	$693,022,023	Assumed cost (tipping fee) for disposing CCRs at an Offsite Landfill (assume density of 1.2 tons/cy).
	9	EXCAVATE / LOAD / HAUL CCR-IMPACTED SOIL (OFFSITE LF)	TON	1,134,496	$57	$64,666,272	Assumed cost (tipping fee) for disposing CCR-impacted soils at an Offsite Landfill (assume density of 1.2 tons/cy).

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	PLANT NAME:	CLOSURE TYPE:	SHEET:	REV. NO.:
		Allen	CCR Rule & CAMA Compliant	Clean-Closure Costs	3
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME:	CLOSURE METHOD:		AECOM JOB NO.:
		AAB & RAB	Closure by Removal Offsite		60572629
	ACTIVITY: Closure by Removal w\ Offsite Landfill Cost Estimate for CCR Impoundment	CLOSURE OPTION:	LAST UPDATED BY:	DATE LAST MODIFIED:	REVIEWED BY:
		Option 5	DMB	10/26/18	JDM

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2018		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	Not Used
TOTAL AREA TO BE RESTORED (AC)	293		AVG. DEPTH OF FREE WATER (FT)	Not Used
TOTAL IMPOUNDMENT AREA (AC)	293		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	Not Used
VOLUME OF ASH IN IMPOUNDMENT (CY)	16,263,083		PERIMETER OF IMPOUNDMENT (L.F.)	25,694

CLOSURE BY REMOVAL W\ OFFSITE LANDFILL ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	**STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION**						
	10	PERMANENT RIPRAP STORMWATER CHANNELS	TON	7,250	$50	$362,500	Assume 10,000 lf x 10 ft wide x 1 ft thick, 145 pcf riprap lined stormwater channels.
	11	SITE EROSION AND SEDIMENT CONTROL	ACRE	293	$2,000	$586,000	Assume total area to be restored will require site erosion and sediment control.
	12	BACKFILL AND REGRADING	CY	947,367	$13	$12,315,767	Assume 2 feet of additional soil material (obtained onsite) graded over total Closure by Removal area. Soil obtained from the dam decommissioning can be used.
	13	TOPSOIL	CY	236,842	$13	$3,078,942	Assume 6-inches of top soil needed (obtained offsite) to establish vegetative stabilization over total Closure by Removal area.
	14	SEED / FERTILIZE / MULCH	ACRE	293	$3,767	$1,103,658	Assume total area of disturbance will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	**CONTINGENCY / ENGINEERING SUPPORT**						
		CONTINGENCY (25%)	LS	1	$244,837,945	$244,837,945	
		ENGINEERING SUPPORT (DESIGN & CQA)	LS	1	$5,000,000	$5,000,000	
POST-CLOSURE	**POST-CLOSURE**						
	15	GROUNDWATER MONITORING	ANNUAL	30	$0	$0	Annual groundwater monitoring costs for each CCR impoundment after Closure by Removal assumed to be minimal.
	16	OPERATIONS & MAINTENANCE (O&M)	ANNUAL	30	$43,950	$1,318,500	Annual O&M costs are $150/acre for the total impoundment area.
CONTINGENCY / ENGINEERING COST	**CONTINGENCY / ENGINEERING COST**						
		CONTINGENCY (25%)	LS	1	$329,625	$329,625.00	
		ENGINEERING COST (10%)	LS	1	$164,813	$164,812.50	
		TOTAL				**$1,231,002,661**	

AECOM CALCULATION SHEET	PROJECT	PLANT NAME:	CLOSURE TYPE:	SHEET	REV. NO.
	CCR IMPOUNDMENT CLOSURE ESTIMATES FOR DUKE ENERGY	Allen	CCR Rule & CAMA Compliant	Clean-Closure Assumptions	3
	SUBJECT	IMPOUNDMENT NAME:	CLOSURE METHOD:		AECOM JOB NO.
	Preliminary Project Costs Sheets	AAB & RAB	Closure by Removal Offsite		60572629
	ACTIVITY	CLOSURE OPTION:	LAST UPDATED BY:	DATE LAST MODIFIED:	REVIEWED BY:
	Closure by Removal w\ Offsite Landfill Assumptions	Option 5	DMB	10/26/18	JDM

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:

1	The cost estimates were prepared using 2018 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	The unit rate costs are based on data provided by Duke Energy. If no data is available, AECOM supplemented with rates from our experience.
5	Free water removal and treatment was assumed to continue throughout the project initiation period.
6	Removal of existing structures/piping includes the excavation and disposal of existing structures within the limits of waste and the bulkheading or grouting of existing outlet pipes that extend beyond the limits of waste. This will be performed during the Closure-by-Removal of an impoundment.
7	Interstitial water treatment was assumed to continue until construction is completed.
8	Assumed all CCR material excavated must be stockpiled in close proximity to the impoundment to be decanted. After decanting, the material will be excavated, loaded, and hauled to the on-site landfill for disposal.
9	Costs for offsite landfill disposal was based on a per ton basis as provided by Duke.
10	AECOM has assumed an over-excavation of 1 foot is necessary to achieve closure-by-removal conditions.
11	Groundwater monitoring costs are for a reduced groundwater network system as compared to the existing system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
12	O&M costs include, but are not limited to, the maintenance/repair of the groundwater monitoring system and general maintenance of the former CCR impoundment area.
13	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

Attachment C

Scoring for Evaluation of Closure Options
Closure Options Evaluation Worksheet
Ash Basin Closure - Master Programmatic Document
Duke Energy

Site Name: Allen Steam Station

1	= Option-Specific User Input
1	= Calculated Value

Threshold Criteria: All closure options must comply with the following threshold criteria based on Duke Energy Guiding Principals for Ash Basin Closure
1. Provide continued geotechnical stability meeting appropriate safety factors under applicable loading conditions
2. Provide flow capacity and erosion resistance during design storm and flooding conditions
3. Effectively mitigate groundwater impacts (in conjunction with GW remediation where present)
4. Comply with applicable state and federal regulations (e.g. North Carolina Coal Ash Management Act)

Option	Description
1	Closure in Place
2	Hybrid Closure Option : Footprint Reduction Within the Ash Basin
3	Alternate Hybrid Closure Option : Additional Footprint Reduction Within the Ash Basin
4	Closure by Removal: Onsite Landfill Within the Active Ash Basin Footprint
5	Closure by Removal: Offsite Landfill Disposal

'Not carried through for further consideration"

Environmental Protection and Impacts	**Weight:**	**30%**		**User Input**					**Value that Scores 10**	**Value that Scores 0**	**Calculated or User Selected Score**				**Criterion Weight**	**Contribution to Total Score**
Criterion	**Scoring System**	**Required Input**	**Units**	**Option 1**	**Option 2**	**Option 4**	**Option 5**				**Option 1**	**Option 2**	**Option 4**	**Option 5**		
Modeled Plume Intersecting Surface Water	Refer to EM Sub-Scoring Sheet	This Area Not Used For Interpretation of Environmental Modeling Results									10	10	10	10	24%	7.2%
Groundwater Impact Beyond the Current Compliance Boundary	Refer to EM Sub-Scoring Sheet	This Area Not Used For Interpretation of Environmental Modeling Results									10	10	10	10	24%	7.2%
Modeled off-site groundwater impact	Refer to EM Sub-Scoring Sheet	This Area Not Used For Interpretation of Environmental Modeling Results									10	10	10	10	24%	7.2%
Relative rank based on visual interpretation of modeled boron plume	Refer to EM Sub-Scoring Sheet	This Area Not Used For Interpretation of Environmental Modeling Results									10	5	0	0	13%	3.9%
Air emissions off-site (based on miles driven hauling CCR and CCR contaminated soil)	Interpolation. Min value scores 10. Max value scores 0.	Truck miles driven	Miles	0	0	0	50		0	50	10	10	10	0	5%	1.5%
Air emissions on-site cubic yards of excavation/movement	Interpolation. Min value scores 10. Max value scores 0.	Volume of material excavation/movement	Cu.Yds	5,594,000	7,892,000	18,188,100	17,929,500		5,594,000	18,188,100	10	8	0	0	5%	1.5%
Avoidance of greenfield disturbance	Interpolation. Min value scores 10. Max value scores 0.	Disturbed acres of greenfield	Acres	20	5	25	91		5	91	8	10	8	0	5%	1.5%
Weighted Totals (Contribution to Total Score)											**3.0**	**2.8**	**2.4**	**2.2**		

Cost	**Weight:**	**35%**		**User Input**					**Value that Scores 10**	**Value that Scores 0**	**Calculated or User Selected Score**				**Criterion Weight**	**Contribution to Total Score**
Criterion	**Scoring System**	**Required Input**	**Units**	**Option 1**	**Option 2**	**Option 4**	**Option 5**				**Option 1**	**Option 2**	**Option 4**	**Option 5**		
Closure Cost	Interpolation. Min value scores 10. Max value scores 0.	Closure Cost	USD	$185,156,251	$280,723,031	$558,836,985	$1,229,189,724		$ 185,156,251	$ 1,229,189,724	10.0	9.1	6.4	0.0	80%	28.0%
Operation, Maintenance and Monitoring Cost		OM&M Cost	USD	$63,558,594	$44,995,340	$34,596,491	$1,813,625		$ 1,813,625	$ 63,558,594	0.0	3.0	4.7	10.0	20%	7.0%
Weighted Totals (Contribution to Total Score)											**2.8**	**2.8**	**2.1**	**0.7**		

Schedule	**Weight:**	**15%**		**User Input**					**Value that Scores 10**	**Value that Scores 0**	**Calculated or User Selected Score**				**Criterion Weight**	**Contribution to Total Score**
Criterion	**Scoring System**	**Required Input**	**Units**	**Option 1**	**Option 2**	**Option 4**	**Option 5**				**Option 1**	**Option 2**	**Option 4**	**Option 5**		
Initiation Time	Interpolation. Min value scores 10. Max value scores 0.	Time to move first ash	Months	30	36	54	36		30	54	10	8	0	8	30%	4.5%
Construction Duration		Estimated durations	Months	76	88	210	200		76	210	10	9	0	1	70%	10.5%
Weighted Totals (Contribution to Total Score)											**1.5**	**1.3**	**0.0**	**0.5**		

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Scoring for Evaluation of Closure Options
Closure Options Evaluation Worksheet
Ash Basin Closure - Master Programmatic Document
Duke Energy

Site Name: Allen Steam Station

1	= Option-Specific User Input
1	= Calculated Value

Regional Factors	Weight:	15%		User Input					Value that Scores 10	Value that Scores 0	Calculated or User Selected Score				Criterion	Contribution to
Criterion	Scoring System	Required Input	Units	Option 1	Option 2	Option 4	Option 5				Option 1	Option 2	Option 4	Option 5	Weight	Total Score
Plan or potential for beneficial reuse of site	Subjective	Not Used For Subjective Scoring									0	0	0	0	5%	0.8%
Imported soil needs	Interpolation. Min value scores 10. Max value scores 0.	Soil Imported	CY	215,000	194,000	246,000	237,000		194000	246,000	6	10	0	2	5%	0.8%
Beneficial reuse of CCR	Interpolation. Max value scores 10. Zero value scores 0.	Fraction Used	None	0	0	0	5		5	0	0	0	0	10	15%	2.3%
Transportation impact (based on miles driven)	Interpolation. Min value scores 10. Max value scores 0.	Miles Driven	Miles	0	0	0	50		0	50	10	10	10	0	65%	9.8%
Noise impact due to on-site activity (based on proximity of neighbors to on-site work areas)	Subjective 0 to 10: 10 is the least noise; 0 is the most noise.	Not Used For Subjective Scoring									10	7	0	2	5%	0.8%
View impact (based on final height of storage facility and land uses within viewshed)	Subjective 0 to 10; 10 is the least visual; 0 is the most visual.										6	8	0	10	5%	0.7%
Weighted Totals (Contribution to Total Score)											**1.1**	**1.2**	**1.0**	**0.3**		

Constructability	Weight:	5%		User Input					Value that Scores 10	Value that Scores 0	Calculated or User Selected Score					
Criterion	Scoring System	Required Input	Units	Option 1	Option 2	Option 4	Option 5				Option 1	Option 2	Option 4	Option 5		
Consider stormwater management, geotechnical, and dewatering	Subjective 0 to 10: 10 is the least commplicated; 0 is the most complicated	Not Used For Subjective Scoring									5	0	3	10	100%	5.0%
Weighted Totals (Contribution to Total Score)											**0.3**	**0.0**	**0.2**	**0.5**		
Total Score For Each Option (On a Scale of 0 to 10)											**8.7**	**8.0**	**5.7**	**4.2**		

Criteria for Evaluation of Closure Options
Closure Options Evaluation Worksheet
Ash Basin Closure - Master Programmatic Document
Duke Energy

Threshold Criteria: All closure options must comply with the following threshold criteria based on Duke Energy Guiding Principals for Ash Basin Closure
1. Provide continued geotechnical stability under applicable loading conditions and safety factors
2. Provide flow capacity and erosion resistance during design storm and flooding conditions
3. Effectively mitigate groundwater impacts
4. Comply with applicable state and federal regulations (e.g. North Carolina Coal Ash Management Act)

Category	Criterion	Guidance
Environmental Protection and Impacts	Modeled Plume Intersecting Surface Water	Refer to scoring system on Environmental Modeling (EM) Sub-Scoring worksheet.
	Groundwater Impact Beyond the Current Compliance Boundary	Refer to scoring system on Environmental Modeling (EM) Sub-Scoring worksheet.
	Modeled off-site groundwater impact	Refer to scoring system on Environmental Modeling (EM) Sub-Scoring worksheet.
	Relative rank based on visual interpretation of modeled boron plume	Refer to scoring system on Environmental Modeling (EM) Sub-Scoring worksheet.
	Air emissions off-site	Based on truck miles driven for hauling CCR and soil.
	Air emissions on-site from closure implementation	Based on total cubic yards of cut and fill on site as a surrogate for gallons of fuel consumed.
	Avoidance of greenfield disturbance	Refer to Scoring System and Required Input columns on scoring sheet.
Cost	Capital Cost	From rough order-of-magnitude cost estimate or detailed cost estimate.
	Operation, Maintenance and Monitoring Cost	
Schedule	Initiation Time	From preliminary schedule for designing, permitting, bidding and constructing the option.
	Construction Duration	
Regional Factors	Plan or potential for beneficial reuse of site	Refer to Scoring System and Required Input columns on scoring sheet.
	Imported soil needs	Refer to Scoring System and Required Input columns on scoring sheet.
	Beneficial reuse of CCR	Refer to Scoring System and Required Input columns on scoring sheet.
	Transportation impact	Based on truck miles driven for hauling CCR and soil.
	Noise impact due to on-site activity	Based on proximity of neighbors to specific on-site work areas.
	View impact	Based on final height of storage facility and land uses within viewshed.
Constructability	Consider stormwater management, geotechnical, and dewatering	Subjective and relative comparison to other options

Environmental Groundwater Sub-scoring Worksheet
Closure Options Evaluation
Duke Energy

Allen Active and Retired Ash Basin Groundwater Sub-Scoring Document

Station/Plant Name: Allen Steam Station

Scored by: TH, RC, CM

Evaluation Criteria:

Criteria 1. Modeled Plume Intersecting Surface Water	Score
Modeled plume[1] does not intersect surface waters after 10 years	10
Modeled plume[1] does not intersect surface waters after 100 years	5
Modeled plume[1] does not intersect surface waters after 200 years	0

	(Option 1)	(Option 2)	(Option 5)
	Closure In Place	Hybrid Closure Option1	Closure By Removal: Offsite Landfill
Criteria 1 Score	10	10	10

Criteria 2. Groundwater Impact Beyond the current[2] Compliance Boundary	Score
Modeled plume[1] is within current compliance boundary after 10 years	10
Modeled plume[1] is within current compliance boundary after 100 years	5
Modeled plume[1] is within current compliance boundary after 200 years	0

	(Option 1)	(Option 2)	(Option 5)
	Closure In Place	Hybrid Closure Option1	Closure By Removal: Offsite Landfill
Criteria 2 Score	10	10	10

Criteria 3. Modeled Off-site Impact	Score
Modeled plume[1] does not go off-site	10
Modeled plume[1] is predicted to remain off-site after 100 years	5
Modeled plume[1] is predicted to remain off-site after 200 years	0

	(Option 1)	(Option 2)	(Option 5)
	Closure In Place	Hybrid Closure Option1	Closure By Removal: Offsite Landfill
Criteria 3 Score	10	10	10

Criteria 4. Relative rank based on visual interpretation of modeled boron plume	Score
Ranked #1 among the three Closure Options based on visual interpretation of modeled boron plume	10
Ranked #2 among the three Closure Options based on visual interpretation of modeled boron plume	5
Ranked #3 among the three Closure Options based on visual interpretation of modeled boron plume	0

	(Option 1)	(Option 2)	(Option 5)
	Closure In Place	Hybrid Closure Option1	Closure By Removal: Offsite Landfill
Criteria 4 Score	10	5	0

Note 1: Based on available data at the time of scoring, the modeled plume considered boron at a concentration of 4,000 micrograms per liter (µg/L) or greater; 4,000 µg/L does not represent a remediation goal, however this concentration does represent the EPA Tap Water Regional Screening Level (RSL) in resident tapwater for boron. µg/L = parts per billion (ppb)

Note 2: The current compliance boundary is the compliance boundary found in the figure "Ash Basin Waste and Compliance Boundaries" provided to NCDEQ on 1/15/19

Note 3: Only 3 of the 4 closure options were included in current preliminary groundwater modeling; Option1: Closure-in-Place, Option 2: Hybrid Option 1, and Option 5: Closure-by-Removal with Offsite Landfill

Environmental Groundwater Sub-scoring Worksheet
Closure Options Evaluation
Duke Energy

Allen Active and Retired Ash Basin Groundwater Sub-Scoring Document Justification

	(Option 1)	(Option 2)	(Option 5)
Justification Notes	**Closure In Place**	**Hybrid Closure Option 1**	**Closure By Removal: Offsite Landfill**
Criteria 1. Modeled Plume Intersecting Surface Water	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the closure in place scenario with natural attenuation did not show boron of 4,000 ppb or greater intercepting a surface water body based on current permit status.	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the hybrid scenario with natural attenuation did not show boron of 4,000 ppb or greater intercepting a surface water body based on current permit status.	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the excavation scenario with natural attenuation did not show boron of 4,000 ppb or greater intercepting a surface water body based on current permit status.
Criteria 2. Groundwater Impact Beyond the Current Compliance Boundary	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the closure in place scenario with natural attenuation did not show boron of 4,000 ppb or greater outside of the current compliance boundary.	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the hybrid scenario with natural attenuation did not show boron of 4,000 ppb or greater outside of the current compliance boundary.	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the excavation scenario with natural attenuation did not show boron of 4,000 ppb or greater outside of the current compliance boundary.
Criteria 3. Modeled Off-site Impact	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the closure in place scenario with natural attenuation did not show boron of 4,000 ppb or greater outside of the current Duke Energy property boundary.	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the hybrid scenario with natural attenuation did not show boron of 4,000 ppb or greater outside of the current Duke Energy property boundary.	**10** Based on the predictive model through the year 2300, found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report for Allen Steam Station, simulated boron concentrations for the excavation scenario with natural attenuation did not show boron of 4,000 ppb or greater outside of the current Duke Energy property boundary.
Criteria 4. Relative rank based on visual interpretation of modeled boron plume	**10** Based on a review of boron concentrations found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report, Option 1 Closure In Place scenario is marginally better than both Option 2 Hybrid Closure and Option 5 Closure by Removal. The Option 1 Closure In Place modeled time to reach 2L at the compliance boundaries and modeled time that boron greater than 2L continues beneath Lake Wylie is less/shorter than respective times modeled with the other two options.	**5** Based on a review of boron concentrations found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report, Option 2 Hybrid Closure scenario is marginally worse than Option 1 Closure In Place and marginally better than Option 5 Closure by Removal. The Option 2 Hybrid Closure modeled time to reach 2L at the compliance boundaries and modeled time that boron greater than 2L continues beneath Lake Wylie is between those respective times modeled with the other two options.	**0** Based on a review of boron concentrations found in the November 2018 Preliminary Groundwater Flow and Transport Modeling Report, Option 5 Closure By Removal scenario is marginally worse than both Option 1 Closure In Place and Option 2 Hybrid Closure. The Option 5 Closure In Place modeled time to reach 2L at the compliance boundaries and modeled time that boron greater than 2L continues beneath Lake Wylie is more/longer than respective times modeled with the other two options.

Notes:
1. Based on available data at the time of scoring, the modeled plume considered boron at a concentration of 4,000 micrograms per liter (µg/L) or greater; 4,000 µg/L does not represent a remediation goal, however this concentration does represent the EPA Tap Water Regional Screening Level (RSL) in resident tapwater for boron. µg/L = parts per billion (ppb)
2. The current compliance boundary is the compliance boundary found in the figure "Ash Basin Waste and Compliance Boundaries" provided to NCDEQ on 1/15/18.

3. Only 3 of the 4 closure options were included in current preliminary groundwater modeling; Option1: Closure-in-Place, Option 2: Hybrid Option 1, and Option 5: Closure-by-Removal with Offsite Landfill.