FILED
July 2, 2019
INDIANA UTILITY
REGULATORY COMMISSION

**STATE OF INDIANA**

**INDIANA UTILITY REGULATORY COMMISSION**

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| **PETITION OF DUKE ENERGY INDIANA, LLC PURSUANT TO IND. CODE §§ 8-1-2-42.7 AND 8-1-2-61, FOR (1) AUTHORITY TO MODIFY ITS RATES AND CHARGES FOR ELECTRIC UTILITY SERVICE THROUGH A STEP-IN OF NEW RATES AND CHARGES USING A FORECASTED TEST PERIOD; (2) APPROVAL OF NEW SCHEDULES OF RATES AND CHARGES, GENERAL RULES AND REGULATIONS, AND RIDERS; (3) APPROVAL OF A FEDERAL MANDATE CERTIFICATE UNDER IND. CODE § 8-1-8.4-1; (4) APPROVAL OF REVISED ELECTRIC DEPRECIATION RATES APPLICABLE TO ITS ELECTRIC PLANT IN SERVICE; (5) APPROVAL OF NECESSARY AND APPROPRIATE ACCOUNTING DEFERRAL RELIEF; AND (6) APPROVAL OF A REVENUE DECOUPLING MECHANISM FOR CERTAIN CUSTOMER CLASSES** | ) | **CAUSE NO. 45253** |

**VERIFIED DIRECT TESTIMONY**
**OF**
**TIMOTHY J. THIEMANN**

**On Behalf of Petitioner,**
**DUKE ENERGY INDIANA, LLC**

**Petitioner's Exhibit 21**

**July 2, 2019**

# TESTIMONY OF TIMOTHY J. THIEMANN
# GENERAL MANAGER OF CCP PROJECT MANAGEMENT MIDWEST
# DUKE ENERGY BUSINESS SERVICES, LLC
# ON BEHALF OF
# DUKE ENERGY INDIANA, LLC

## I. INTRODUCTION

**Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

A. My name is Tim Thiemann, and my business address is 139 East 4th Street, Cincinnati, Ohio.

**Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?**

A. I am employed as the General Manager of Coal Combustion Products ("CCP") Project Management Midwest for Duke Energy Business Services, LLC, a service company affiliate of Duke Energy Indiana, LLC ("Duke Energy Indiana," "Petitioner" or "Company").

**Q. WHAT ARE YOUR DUTIES AND RESPONSIBILITIES AS GENERAL MANAGER OF CCP PROJECT MANAGEMENT MIDWEST?**

A. My duties include oversight and management of the Coal Combustion Products projects on Duke Energy's existing ash impoundment facilities as they relate to the U.S. Environmental Protection Agency ("EPA") Coal Combustion Residuals ("CCR") rule, such as surface impoundment closure planning.

**Q. PLEASE BRIEFLY DESCRIBE YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND.**

A. I received a B.S. in Mechanical Engineering Technology from the University of Cincinnati. In addition, during the past thirty-three years, I have attended many seminars, workshops and forums on subject matters such as power plant maintenance and generation-specific technical training as well as other utility related topics. I began my career as a co-operative education student at The Cincinnati Gas and Electric Company (CG&E) – Miami Fort Station in 1986 and have progressed through several jobs of increasing responsibility over the last thirty years. These positions have included Engineering Manager for Ohio and Kentucky Generation assets, Station Manager at Miami Fort Station, General Manager Duke Energy Business Services Non-Regulated, Vice President of Operations for Midwest Commercial Generation, and most recently the General Manager of CCP Midwest O&M and Projects.

**Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?**

A. The purpose of my testimony is to describe the impact of the U.S. EPA's Coal Combustion Residuals Rule on the Company's generating facilities. In addition, I will discuss the Company's current plans for closing surface impoundments and other ash management areas in order to comply with the federally mandated CCR Rule, and the associated estimated costs, including a request for a federal mandate certificate of public convenience and necessity. My testimony will also describe projects and work undertaken from 2015 – 2018 to comply with the CCR Rule. My testimony will also describe coal ash-related remediation projects mandated by Indiana's Solid Waste Management Program, which is overseen by the Indiana Department of Environmental Management ("IDEM"). Finally, I support the operating and maintenance expense ("O&M") and capital in the test period for the coal combustion products group.

## II. THE CCR RULE

**Q. PLEASE DESCRIBE THE CCR RULE.**

A. The Resource Conservation and Recovery Act ("RCRA") provides the EPA with the authority to regulate coal combustion residuals, and it promulgated the CCR Rule in 2014 under Subtitle D of RCRA, meaning that coal combustion residuals are regulated as non-hazardous waste. The CCR Rule was self-implementing when originally finalized; however, in 2016, the Water Infrastructure Improvements for the Nation ("WIIN") Act was passed, allowing states to submit permit programs for regulating CCR units to the EPA for its approval. If no permit program is in effect for a state, CCR units must remain in compliance with the CCR Rule.

In 2016, the Indiana Environmental Rules Board adopted an emergency rule incorporating the CCR Rule requirements into Indiana Code. In 2017, IDEM adopted an amendment to Indiana's Solid Waste Management Plan describing IDEM's plan to update Indiana's regulations for regulating CCR disposal facilities to standards equivalent to the EPA's CCR Rule. IDEM has initiated a rulemaking to propose additional changes to the Indiana CCR standards, offer compliance alternatives and flexibility, while meeting the federal CCR standards, and establish a permit program for CCR units. IDEM's rulemaking remains underway as of the date of this testimony.

**Q. PLEASE DESCRIBE HOW THE CCR RULE APPLIES TO DUKE ENERGY INDIANA'S GENERATING FACILITIES.**

A. The CCR Rule applies to all coal combustion residuals generated by electric utilities and independent power producers. It applies to all new and existing coal combustion residual landfills, including any lateral expansions thereof, and all new and existing surface impoundments, again including any lateral expansions thereof, that dispose of or otherwise engage in solid waste management of coal combustion residuals. Specifically, existing landfills and surface impoundments that were receiving waste on the effective date of the rule (October 19, 2015) are covered under the regulation. Existing surface impoundments not receiving waste on the effective date of the rule, but still containing water, are considered "inactive." Inactive impoundments have the same requirements as active impoundments, but with extended timelines for compliance.

Compliance requirements include location restrictions, impoundment design criteria, operating criteria, groundwater monitoring and corrective action, closure and post-closure care and recordkeeping, notification and posting of information to the internet.

Under the CCR Rule, there are certain events that may cause a CCR unit to trigger closure. For example, if an existing, unlined CCR surface impoundment cannot demonstrate compliance with one of the location restrictions or structural integrity or safety factors. Certain of Duke Energy Indiana's surface impoundments triggered closure as a result of location restrictions and structural integrity and safety factor assessments. Notices of Intent to Close were then posted to the station operating record within thirty days of the flows to the impoundments being ceased. Specifically, Gallagher Primary Pond, Gibson North Ash Pond, and Cayuga Primary Ash Settling Pond and Lined Ash Disposal Area were each required to close as a result of not meeting the factors specified by the CCR Rule. Gallagher Ash Pond A had to undertake remediation activities to bring it into compliance with the structural integrity and safety factor requirements by October 17, 2016.

In addition to the location restrictions, CCR units may also trigger closure requirements by exceeding an applicable groundwater standard based on CCR Rule-required sampling. Specifically, Wabash River Ash Pond A, Wabash River Ash Pond B, Wabash River Secondary Setting Pond and the Wabash River South Ash Pond triggered groundwater standards. Finally, CCR units may also be required to initiate closure whenever a landfill or surface impoundment receives its last known quantity of coal combustion residuals and any other facility water streams managed by the landfill or surface impoundment have been removed. Generally speaking, when a generating facility retires, or a CCR unit is no longer used, the requirements for closure will take effect.

Duke Energy Indiana posted Notices of Intent to Close for certain facilities based on their receiving their last known quantities of CCR and station water – Cayuga Lined Ash Disposal Area, Cayuga Primary Ash Settling Pond, Cayuga Secondary Ash Settling Pond, Gallagher Secondary Settling Pond, Gallagher Primary Pond, Gibson North Ash Pond, Gibson North Settling Basin, Gibson East Ash Pond Settling Basin, and Gibson South Settling Basin.

**Q. HAVE THERE BEEN ANY RECENT DEVELOPMENTS RELATED TO THE CCR RULE?**

A. Yes. The EPA has revised the CCR Rule to change certain deadlines. Among other things, the EPA rule extends to October 31, 2020, two key closure-related deadlines applicable to coal ash units: (1) the deadline to cease receipt of coal ash in response to the detection of a leak from an unlined impoundment, and (2) the deadline to cease receipt of coal ash in a surface impoundment that fails to meet the uppermost aquifer location restriction.

According to the White House Office of Management and Budget's Spring 2019 Unified Agenda of Federal Regulatory and Deregulatory Actions published on May 22, 2019, EPA is planning to publish proposed rules in July 2019, and final rules in December 2019, addressing various court's orders. Duke Energy Indiana does not anticipate that these rule changes will materially alter the Company's CCR compliance plan schedule.

## III. CCR RULE COMPLIANCE

**Q. WHAT ACTIONS MUST DUKE ENERGY INDIANA TAKE TO CLOSE A CCR UNIT?**

A. There are significant closure and post-closure care requirements for CCR units. The CCR Rule provides for closure by leaving the coal combustion residuals in place (referred to as "closure in place") and for closure by removal.

Closure in place requires the removal of free liquids from the surface of the impoundment, as well as free liquids from within the impoundment (referred to as interstitial dewatering). Once the impoundment is dewatered, the remaining coal combustion residuals must be graded and stabilized. Sloping, grading and channeling must be done for positive storm water drainage. Finally, a final cover must be constructed. Then, a vegetative surface must be established.

In order to close by removal, the CCR Rule requires dewatering and removal of all coal combustion residuals from the CCR unit. Closure by removal is not complete until groundwater monitoring concentrations do not exceed groundwater protection standards.

**Q. IS THE UTILITY STILL RESPONSIBLE FOR A CCR UNIT AFTER CLOSURE IS COMPLETE?**

A. Yes. Once closure is complete, Duke Energy Indiana will be responsible for maintaining the integrity and effectiveness of the final cover system, the leachate collection system (if present), and the groundwater monitoring system. This includes making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover. The leachate collection system must be maintained and operated (if present), and the groundwater must continue to be sampled and monitored. If future groundwater sampling and analysis demonstrate an impact from the closed CCR unit, then additional remedial actions may be required. The duration of this post-closure care and monitoring period is thirty (30) years.

**Q. PLEASE PROVIDE AN OVERVIEW OF THE COMPANY'S ASH MANAGEMENT AREAS THAT WILL BE CLOSED.**

A. Table 1 below provides an overview of the Company's CCR closure plans, which have been submitted to IDEM for their review and approval. Table 2 provides an overview of IDEM agreed orders or previous IDEM approved closure plans.

**Table 1**

| Station | Asset Name | Closure Plan Footprint (Acres) | Closure Plan Volume of Waste (Cubic Yards) | Planned Closure Method |
|---|---|---|---|---|
| Cayuga: | | | | |
| | Lined Ash Disposal Area | 37 | 306,855 | Closure in Place |
| | Primary Ash Settling Pond | 26 | 17,890 | Closure in Place |
| | Secondary Ash Settling Pond | 5 | 3,375 | Closure by Removal |
| | Ash Disposal Area #1 | 119 | 7,456,380 | Closure in Place with an Isolated Area of Closure by Removal |
| Gallagher: | | | | |
| | North Ash Pond | 39.9 | 2,019,300 | Closure in Place |
| | Primary Pond | 10.1 | 401,085 | Closure in Place |
| | Primary Pond Ash Fill Area | 7.5 | 465,330 | Closure in Place |
| | Coal Pile Ash Fill Area | 11.1 | 377,145 | Closure by Removal |
| | Ash Pond A | 36 | 1,150,315 | Closure by Removal |
| | Secondary Settling Pond | 4.2 | 23,690 | Closure in Place |
| Gibson: | | | | |
| | North Ash Pond | 134.7 | 4,342,450 | Closure in Place |
| | North Settling Basin | 24.1 | 116,770 | Combination of In-Place Closure and Closure by Removal |
| | East Ash Pond Settling Basin | 41.6 | 69,000 | Closure by Removal |

| Station | Asset Name | Closure Plan Footprint (Acres) | Closure Plan Volume of Waste (Cubic Yards) | Planned Closure Method |
|---|---|---|---|---|
| | South Settling Basin | 50.2 | 252,485 | Closure by Removal With a limited area of In-place Closure |
| | South Ash Fill Area | 188.5 | 6,855,785 | Closure in Place |
| Wabash River: | | | | |
| | North Ash Pond | 43.1 | 1,592,470 | Closure in Place |
| | Ash Pond A | 80.2 | 3,510,755 | Closure by Removal |
| | Ash Pond B | 21.1 | 738,170 | Closure in Place |
| | Secondary Settling Pond | 7.8 | 35,100 | Closure by Removal |
| | South Ash Pond | 73 | 1,246,005 | Closure in Place |

**<u>Table 2</u>**

| Station | Asset Name | Closure Plan Footprint (Acres) | Closure Plan Volume of Waste (Cubic Yards) | Planned Closure Method |
|---|---|---|---|---|
| Dresser | Coal Ash Management Area<br>Mine Spoil Area | 18<br>19 | 522,129<br>400,000 | Consolidate and Cap in Place |
| Edwardsport[1] | Ash Stack | 15 | 765,000 | Consolidate and Cap in Place |
| Gibson | East Ash Pond | 343.2 | 16,267,674 | Cap in Place |
| Noblesville | Ash Stack | 16 | 582,500 | Consolidate and Cap in Place |

[1] Edwardsport legacy coal plant closure plan is currently in development and figures shown are preliminary and subject to change with final designs.

**Q. HAS DUKE ENERGY INDIANA ALREADY BEGUN WORK ON THE CLOSURE OF ITS CCR UNITS?**

A. Yes. In order to ensure compliance with the deadlines in the CCR Rule, Duke Energy Indiana began work on the necessary planning and engineering associated with its CCR Rule compliance in 2014. As soon as the EPA provided direction on its proposed CCR-related regulations, the Company began assessing its existing basins, landfills and other ash management areas to ensure timely compliance. The types of activities performed between 2014 and 2018 include geotechnical and site investigations, stability analyses, preliminary and proposed final designs for closure systems, excavation and dredging for closure of some CCR units to repurpose those areas for other uses, as well as dewatering, grading and placement of structural fill in other CCR units. In addition, Duke Energy Indiana has installed new process equipment and systems for managing station by-products and water once surface impoundments are removed from service.[2] Just as with any significant environmental rule implementation, compliance takes time and effort. Duke Energy Indiana reasonably began its compliance activities in 2014 to ensure compliance with the CCR Rule.

**Q. AS THE COMPANY DEVELOPED ITS CCR COMPLIANCE PLAN, DID IT CONSIDER ALTERNATE WAYS TO COMPLY?**

A. Yes. As the plans were developed, each ash management area was reviewed for the best and most cost-effective way to comply with the federal CCR requirements. This

[2] For example, see Cause No. 44765 for the major CCR-related projects at Gibson and Cayuga Stations. Additional smaller projects have also been performed at Gallagher and Wabash River to ensure CCRs and water are managed separately from any surface impoundments undergoing closure.

early analysis resulted in the list of proposed compliance plan closure activities for each coal ash management area.

**Q. WHY DID DUKE ENERGY INDIANA ULTIMATELY CHOOSE THE CLOSURE PLANS IT DID?**

A. Duke Energy Indiana used a third party to help develop the plans and criteria considered were cost, safety, schedule, constructability, regional factors, and environmental protection and impacts. The proposed plans met the guidelines of the CCR rule and best fulfilled these criteria.

**Q. DO ANY OF THE COMPLIANCE PROJECTS EXTEND THE USEFUL LIFE OF EXISTING ENERGY UTILITY FACILITIES?**

A. Yes. For the sites where Duke Energy Indiana plans to continue to operate, Gallagher, Gibson and Cayuga Stations, the CCR compliance activities are necessary for continued operation. Primarily these continued operations are the load, hauling and placement of ash and fixated material to the operating landfills as well as landfill management. The closure of a basin at a particular site does not extend the useful life of a generating facility.

**Q. PLEASE DESCRIBE THE ACTIVITIES PERFORMED AT CAYUGA GENERATING STATION FROM 2015 – 2018 FOR CCR COMPLIANCE.**

A. The Company has begun to execute on certain portions of its proposed closure plans. Petitioner's Exhibit 21-A (TJT) is an excerpt of the Company's closure plans for the ash management areas at Cayuga that were filed with IDEM. The full closure plans are quite large and can be located in IDEM's Virtual File Cabinet, VFC80399269. The main activities at Cayuga include: work related to ceasing all flows to the

Primary Ash Settling Pond and Lined Ash Disposal Area to meet our CCR federally mandated compliance date; bulk and interstitial dewatering of the Primary Ash Settling Pond; dewatering of the Lined Ash Disposal Area; subgrating, contouring and placements of fixated material in the Ash Disposal Area #1 as structural fill.

Cayuga Ash Disposal Area #1 closure was approved in 2012 with work continuing according to the engineered closure plan. The engineered closure plan requires that the Lined Ash Disposal Area and the Ash Disposal Area #1 be closed and completed as an integral unit. The final grade, liner and soil cover traverse both the Ash Disposal Area #1 and the Lined Ash Disposal Area. Both of these basins are integrated into one cap and closure design. We are currently placing structural fill within Ash Disposal Area #1 and preparing to recontour the Lined Ash Disposal Area, according to the engineering design. Future work required to complete the final closure will include maintenance of the current temporary soil cover; dust control; installation of the geomembrane; loading, hauling and placement of the borrow soil materials for soil fill and the soil cap; grading and contouring fill materials and final cover soils; and seeding and maintenance of the final cover vegetation.

Additional Cayuga Station activities include removal of ash for clean closure and re-constructing the former Secondary Ash Settling Basin into a previously approved lined retention basin for the non-CCR station water. This work supported the CCR rule requirement to cease all flows to the basins resulting in the previously approved capital installation of the dry bottom ash systems and the process and storm water rerouting projects.

The Company has submitted a closure plan to IDEM and is awaiting approval. Petitioner's Exhibit 21-F (TJT) provides the major project categories and expenditures associated with the Cayuga Station closure projects.

**Q. PLEASE DESCRIBE THE ACTIVITIES PERFORMED AT GALLAGHER GENERATING STATION FROM 2015 – 2018 FOR CCR COMPLIANCE.**

A. The Company has begun to execute on certain portions of its proposed closure plans. Petitioner's Exhibit 21-B (TJT) is an excerpt of the Company's closure plans for the ash management areas at Gallagher that were filed with IDEM. The full closure plans are quite large and can be located in IDEM's Virtual File Cabinet, VFC80398571. The main activities at Gallagher include: installation of a new lined ditch and piping to redirect process water flows to Ash Pond A away from the Primary Pond; installation of a partial dike for isolation of the Primary Pond from the discharge ditch and to allow dewatering of the Primary Pond such that it could be removed from service to meet the CCR rule deadline; and removal of weir box #2 from the Secondary Settling Pond and installation of piping to the stations permitted outfall. This work was required to allow the Secondary Settling Pond to be removed from service to meet the CCR Rule stability requirements for Pond A. The Secondary Settling Pond was then removed from service, most ash removed, and closed in place. Work also included modification of the eastern embankment of Ash Pond A to meet CCR rule stability requirements; installation of a new spillway from Ash Pond A; bulk dewatering of the Primary Pond; and dredging of the ash from Ash Pond A to support the future closure of Ash Pond A to meet the CCR Rule closure date.

Petitioner's Exhibit 21-F (TJT) provides the major project categories and expenditures associated with the Gallagher Station closure projects.

**Q. PLEASE DESCRIBE THE ACTIVITIES PERFORMED AT GIBSON GENERATING STATION FROM 2015 – 2018 FOR CCR COMPLIANCE.**

A. The Company has begun to execute on certain portions of its proposed closure plans. Petitioner's Exhibit 21-C (TJT) is an excerpt of the Company's closure plans for the ash management areas at Gibson that were filed with IDEM. The full closure plans are quite large and can be located in IDEM's Virtual File Cabinet, VFC80399262, VFC80398684, VFC80267058. The main activities at Gibson include: bulk and interstitial dewatering and removal of all ash to clean close the South Settling Basin (that basin was repurposed into a new lined retention basin for the non-CCR station water); bulk and interstitial dewatering, subgrading and contour preparation for the North Ash Pond and South Ash Fill Area; placement of fixated material in the North Ash Pond and South Ash Fill Area as structural fill in agreement with the proposed closure plan; and capping and closure of the Fixated Scrubber Sludge ("FSS") landfill.

Petitioner's Exhibit 21-F (TJT) provides the major project categories and expenditures associated with the Gibson Station closure projects.

**Q. PLEASE DESCRIBE THE ACTIVITIES PERFORMED AT WABASH RIVER GENERATING STATION FROM 2015 – 2018 FOR CCR COMPLIANCE.**

A. The Company has begun to execute on certain portions of its proposed closure plans. Petitioner's Exhibit 21-D (TJT) is an excerpt of the Company's closure plans for the ash management areas at Wabash River that were filed with IDEM. The full closure plans are quite large and can be located in IDEM's Virtual File Cabinet, VFC80398553. The main activities at Wabash River include: Movement of ash from Ash Pond A to Ash Pond B and the Secondary Settling Pond to eliminate environmental risk of ash overfill in Ash Pond A; slip lining the discharge pipe from weir box #4 to the permitted outfall as an engineering corrective action to mitigate a potential pipe failure; and bulk and interstitial dewatering of Ash Pond A to allow the excavation of ash and the construction of a portion of Ash Pond A as a lined non-CCR retention basin. Additionally, vegetation management and maintenance is necessary as an ongoing expense.

Petitioner's Exhibit 21-F (TJT) provides the major project categories and expenditures associated with the Wabash River Station closure projects.

**Q. MR. THIEMANN, WERE THE CCR RULE COMPLIANCE ACTIVITIES UNDERTAKEN BY THE COMPANY THROUGH 2018 REASONABLE AND NECESSARY TO ENSURE COMPLIANCE WITH FEDERALLY MANDATED OBLIGATIONS?**

A. Yes. Duke Energy Indiana must comply with the rules and regulations applicable to its generating facilities and its production and storage of ash. Duke Energy Indiana's closure-related activities undertaken through 2018 were specifically related to ensure compliance with federally mandated requirements, specifically the EPA's CCR Rule. As such, the Company is requesting in this proceeding to be issued a federal mandate certificate of public convenience and necessity, and to recover its reasonable and necessary compliance expenses incurred through 2018. Please see Petitioner's Exhibits 21-E (TJT) and 21-F (TJT) for a summary of these expenditures. To mitigate the impact on customer rates of these compliance projects, Duke Energy Indiana is proposing to recover its expenses through 2018 over eighteen (18) years, which is the estimated retirement date of the last operating Gibson Generating Facility unit.

**Q. WILL THERE BE ADDITIONAL CCR RULE-RELATED COMPLIANCE ACTIVITIES AFTER 2018?**

A. Yes. The Company anticipates that CCR Rule-mandated closure activities will be occurring between 2019 and approximately 2027 with post closure occurring for an additional 30 years. As mentioned above, Duke Energy Indiana has submitted its proposed closure plans to IDEM for its consideration. Those closure plans remain under review. In addition, the CCR Rule continues to be litigated. IDEM's rulemaking in which it intends to adopt its version of the CCR Rule into its Solid Waste Management Program and become the entity overseeing CCR Rule compliance for the State of Indiana also remains uncertain.

In the meantime, Duke Energy Indiana remains under the obligation to comply with the deadlines in the CCR Rule, but there is uncertainty over the timing of compliance and whether additional requirements may be added by IDEM through its rulemaking or other processes. The Company intends to continue work on federally mandated compliance projects in 2019 and going forward that will help ensure CCR Rule compliance, such as groundwater monitoring, dewatering, excavation, repurposing former ash basins to new uses, and managing reporting and other CCR Rule requirements. Although, the timing of these projects and activities remains uncertain, particularly during this period while IDEM is considering its options for adopting the CCR Rule requirements in Indiana.

**Q. IS DUKE ENERGY INDIANA PROPOSING TO RECOVER THE COSTS ASSOCIATED WITH CCR RULE COMPLIANCE INCURRED AFTER 2018 THROUGH BASE RATES IN THIS PROCEEDING?**

A. No. Duke Energy Indiana is not proposing to recover federally mandated CCR Rule compliance costs incurred *after* calendar year 2018 through base rates in this proceeding. Instead, the Company proposes to continue to defer these expenses (with carrying costs) for future consideration in either a proceeding under Indiana Code 8-1-8.4 (Federally Mandated Requirements for Energy Utilities) or through a future base rate proceeding.

**Q. DOES DUKE ENERGY INDIANA HAVE AN ESTIMATE OF POST 2018 COSTS TO COMPLY WITH THE CCR RULE?**

A. Yes. The current estimate for costs from 2019 through 2027 is $443 million. Please see Petitioner's Exhibit 21-G (TJT) for an estimate of the costs by station for 2019 – 2027. Duke Energy Indiana expects closure activities to be substantially complete by approximately 2027. This excludes landfill closures and post closure expenditures which will occur for an additional 30 years. Note that the timing of the expenditures and closure is subject to change depending on the timing of closure plan approvals, among other things.

## IV. <u>COAL ASH-RELATED REMEDIATION REQUIRED BY IDEM RULES</u>

**Q. DOES DUKE ENERGY INDIANA HAVE OTHER COAL ASH-RELATED REMEDIATION OBLIGATIONS?**

A. Yes. In addition to the CCR Rule-mandated requirements, Duke Energy Indiana has coal ash-related obligations under Indiana's Solid Waste Regulations. Specifically, the Company has been undertaking coal ash-related remediation at the Gibson Generating Facility East Ash Pond, the former Dresser Generating Facility in West Terre Haute, the Noblesville Generating Facility and the repurposed Edwardsport Generating Facility. The Gibson East Ash Pond is being conducted under previously approved closure plan (prior to the CCR rule) approved by the state. Closure of the legacy ash management area at Dresser Generating Facility in West Terre Haute is being addressed under an agreed order and a closure plan approved by the state. Closure of the Noblesville Station legacy ash management area is currently in progress under an agreed order, and pending an approved closure plan with the State. The Company is proposing to close the old Edwardsport Plant legacy ash management area following an agreed order and in accordance with IDEM regulations under an approved closure plan.

**Q. PLEASE DESCRIBE THE REMEDIATION WORK AT THE EAST ASH POND AT GIBSON GENERATING FACILITY.**

A. Duke Energy Indiana began closure of its Gibson East Ash Pond back in 2008 under Indiana's Solid Waste Management Program prior to the implementation of the CCR Rule. Cells 1 and 3 have completed closure. Cell 2 closure is currently in progress and is expected to complete in 2019. Closure activities include: engineering design and support; permitting; environmental compliance; water management during the closure activities; building the haul road infrastructure to support closure; placement of fixated material as structural fill to obtain final grades in accordance with the engineering design; installation of the geomembrane; loading, hauling and placement of the borrow soil materials for soil fill and the soil cap; installation of associated piping; grading and contouring fill materials and final cover soils; and seeding and maintenance of the final cover vegetation.

**Q. IS DUKE ENERGY INDIANA INCLUDING COSTS ASSOCIATED WITH THE GIBSON EAST ASH POND REMEDIATION ACTIVITIES IN THIS RATE CASE?**

A. Yes, it is. Please see Petitioner's Exhibits 21-E (TJT) and 21-F (TJT) for the cost to close East Ash Pond Cells 1, 2 and 3. The Company anticipates that this work will be completed in 2019 and has included expenditures in this proceeding.

**Q. PLEASE DESCRIBE THE RETIRED DRESSER GENERATING FACILITY.**

A. Dresser Generating Facility was in operation providing electric service to customers from 1924-1975. The Station's ash was historically deposited in numerous piles located on the Station property. Some of those piles also contain "mine spoils" (unusable coal remnants and other mined materials) from the Dresser Mine, which operated from the mid-1920s through the 1950s. In addition, the former Dresser site contains asbestos containing material that requires remediation.

**Q. IS DUKE ENERGY INDIANA CURRENTLY UNDERTAKING A REMEDIATION PLAN AT THE RETIRED DRESSER GENERATING FACILITY SITE?**

A. Yes. There are two separate areas at Dresser undergoing remediation activities under an approved order and an approved closure plan with IDEM. First is the mine refuse management area. In this area, the Company is excavating the mine spoils to move the material further away from the banks of the Wabash River. In addition, Duke Energy Indiana will be grading the remaining material and covering it with soil, riprap and vegetative cover layers.

Second is the coal ash management area. This area consists of approximately 48 acres and includes a 4.9-acre pond that has developed in a depressed portion of the area. In addition, Duke Energy Indiana has located asbestos containing material in two piles in this area. The average thickness of ash is approximately 5 feet. Duke Energy Indiana is eliminating the pond, transporting all asbestos containing material to an offsite landfill, and consolidating, grading and covering the remaining ash. The Company will also be installing groundwater monitors to ensure there are no impacts from the remediated areas, as well as plugging and removing from service certain drainage and storm water pipes located on the property.

**Q. IS DUKE ENERGY INDIANA INCLUDING COSTS ASSOCIATED WITH THE DRESSER REMEDIATION ACTIVITIES IN THIS RATE CASE?**

A. Yes, it is. Please see Petitioner's Exhibits 21-E (TJT) and 21-F (TJT) for the cost to support the Dresser remediation. The Company anticipates that this work will be completed in 2022, and has included expenditures through the 2020 test period in this proceeding. The Company proposes to continue to defer (with carrying costs) the costs associated with this remediation that occur after the 2020 test period for recovery in a future rate case or other proceeding.

**Q. PLEASE DESCRIBE THE NOBLESVILLE GENERATING FACILITY.**

A. Noblesville Generating Facility was built in 1950 as a coal-fired plant with an approximate capacity of 90 MW. In 2003, the coal-burning portion of the station was decommissioned and three new combustion turbines were installed that run on natural gas.

The coal-fired Noblesville Station placed dry ash into two contiguous dry ash disposal mounds on the northwest portion of the Station's property starting in the 1950s. There are some smaller ash mounds on the property as well. When the station ceased using the mounds for storage of ash, soil was placed on top of the ash, grass was sown and trees were planted.

**Q. IS DUKE ENERGY INDIANA CURRENTLY UNDERTAKING REMEDIATION ACTIVITIES AT THE NOBLESVILLE GENERATING FACILITY?**

A. Yes, it is. The Company has been working on installation and operation of groundwater interceptor wells, tree removal over the current ash management area and overall site assessment. In addition, a network of groundwater interceptor wells has been installed and are in operation. The Company has submitted a closure plan to IDEM and is awaiting approval.

**Q. IS DUKE ENERGY INDIANA INCLUDING COSTS ASSOCIATED WITH THESE NOBLESVILLE REMEDIATION ACTIVITIES IN THIS RATE CASE?**

A. Yes, it is. Please see Petitioner's Exhibits 21-E (TJT) and 21-F (TJT) for the cost associated with the site assessment, engineering design and the installation of groundwater monitoring and interceptor wells including testing activities undertaken through 2018. Once the Company receives IDEM approval of its proposed closure plan, Duke Energy Indiana will begin to execute the activities outlined in that plan.

The Company proposes to continue to defer (with carrying costs) the costs associated with this remediation that occur after 2018 for recovery in a future rate case or other future proceeding.

**Q. PLEASE DESCRIBE THE RETIRED EDWARDSPORT GENERATING FACILITY.**

A. The retired Edwardsport Station's original unit was built in 1918, with three other units added between 1944 and 1951. Those three coal units were retired in 2011, and the Station was demolished in 2012.

Prior to 1974, the retired Edwardsport Station deposited dry bottom ash in several areas on its property. In the early 1970s, the Station began wet sluicing bottom and fly ash to an onsite ash pond. Once the Station was removed from service, ash from the ash pond was excavated and disposed of at an offsite landfill.

**Q. HAS DUKE ENERGY INDIANA UNDERTAKEN REMEDIATION ACTIVITIES AT THE RETIRED EDWARDSPORT STATION?**

A. Yes, it has. Through the end of 2018 conducted the site assessment, engineering and groundwater monitoring and testing activities. Current activities include the development of the closure implementation plan to the Indiana Department of Environmental Management (IDEM) in the fall of 2019. The closure plan as currently formulated would entail excavating the ash from portions of the site and consolidating it into one pile. This consolidated pile would then be covered with two feet of compacted cohesive soil plus a one-foot vegetative layer with top grades promoting positive drainage off the pile. The areas where existing ash is removed, will be graded to drain and covered with a 6-inch vegetative layer. All plans and details are subject to IDEM review, comment and input. Upon IDEM approval of the proposed closure plan, detailed plans will be finalized for execution.

**Q. IS DUKE ENERGY INDIANA INCLUDING COSTS ASSOCIATED WITH THESE RETIRED EDWARDSPORT REMEDIATION ACTIVITIES IN THIS RATE CASE?**

A. Yes, it is. Please see Petitioner's Exhibits 21-E (TJT) and 21-F (TJT). The Company proposes to continue to defer (with carrying costs) the costs associated with this remediation that occur after 2018 for recovery in a future rate case or other future proceeding.

**Q. IS DUKE ENERGY INDIANA PROPOSING TO RECOVER THE COSTS ASSOCIATED WITH IDEM COMPLIANCE INCURRED AFTER 2018 THROUGH BASE RATES IN THIS PROCEEDING?**

A. With the exception of costs for the Gibson East Ash Pond through 2019 and Dresser Station through the 2020 test period, Duke Energy Indiana has not included costs expected to be incurred *after* calendar year 2018 through base rates in this proceeding. Instead, the Company proposes to continue to defer these expenses (with carrying costs) for future consideration through a future base rate or other proceeding.

**Q. DOES DUKE ENERGY INDIANA HAVE AN ESTIMATE FOR THE COSTS IT SEEKS TO DEFER RELATED TO THESE IDEM PROJECTS?**

A. Yes. The current estimate for costs from 2019 through 2027 is $60 million. Please see Petitioner's Exhibit 21-G (TJT) for an estimate of the costs by station for 2019 – 2027. Note that the timing of the expenditures and closure is subject to change depending on the timing of closure plan approvals, among other things.

## V. PRODUCTION O&M AND CAPITAL EXPENDITURES (COAL COMBUSTION PRODUCTS)

**Q. BEYOND THE COSTS DESCRIBED ABOVE, ARE YOU SPONSORING THE POWER PRODUCTION O&M AND CAPITAL EXPENDITURES IN THIS FORECAST?**

A. I am sponsoring only the portion of the Power Production O&M and Capital Expenditures related to Coal Combustion Products. Duke Energy Indiana Witnesses Mr. James Michael Mosley, Mr. Cecil Gurganus and Mr. Andrew Ritch will also be sponsoring portions of the Power Production O&M and Capital Expenditures forecast.

**Q. HOW DOES THE 2020 COAL COMBUSTION PRODUCTS ("CCP") POWER PRODUCTION O&M FORECAST COMPARE TO THE 2019 CCP POWER PRODUCTION O&M BUDGET AND THE ACTUAL 2018 CCP POWER PRODUCTION O&M EXPENDITURES?**

A. A comparison of the Forecasted 2020 CCP Power Production O&M expenses to the 2019 Budget and 2018 Actual CCP Power Production O&M expenses is shown in the table below.

**Table 3**

| *$ in Millions* | 2018 A | 2019 B | 2020 F |
|---|---|---|---|
| CCP - Power Production O&M | $3 | $9 | $12 |
| Increase / (Decrease) | | $6 | $3 |

**Q. PLEASE DESCRIBE THE MAJOR CHANGES BETWEEN THE 2018 ACTUAL, 2019 BUDGET AND 2020 FORECASTED CCP POWER**

**PRODUCTION O&M EXPENDITURES INCLUDING ANY MAJOR ASSUMPTIONS UTILIZED TO ARRIVE AT THE 2020 FORECAST.**

A. These expenditures are related to hauling of production ash to onsite landfills. As the beneficial use of production ash to close the stations' ash impoundment lessens, the ash will be disposed in the onsite landfill therefore being a production expense instead of an asset retirement obligation ("ARO") expense. During 2018 and portions of 2019 ash hauling activities of production ash and FGD by-products were directed toward structural fill of ash basins, developing proper slopes for final closure. As the final grades are reached, those CCR materials are redirected to on-site landfills and become an O&M expense.

**Q. DID YOU PROVIDE THE 2020 CCP POWER PRODUCTION O&M EXPENSES REFLECTED ABOVE, TO WITNESS MR. CHRISTOPHER M. JACOBI FOR INCLUSION IN THE DEI FORECASTED TEST PERIOD PROPOSED IN THIS CASE?**

A. Yes.

**Q. WHAT LEVEL OF CCP POWER PRODUCTION CAPITAL EXPENDITURES ARE REFLECTED IN DEI'S 2020 FORECAST?**

A. Duke Energy Indiana's 2020 CCP Power Production Capital Expenditures Forecast is $33 million.

**Q. HOW DOES THE 2020 CCP POWER PRODUCTION CAPITAL EXPENDITURES FORECAST COMPARE TO THE 2019 CCP POWER PRODUCTION CAPITAL EXPENDITURES BUDGET AND THE ACTUAL 2018 CCP POWER PRODUCTION CAPITAL EXPENDITURES?**

A. A comparison of the Forecasted 2020 CCP Power Production Capital expenditures to the 2019 Budget and 2018 Actual CCP Power Production Capital Expenditures is shown in the table below.

**Table 4**

| *$ in Millions* | 2018 A | 2019 B | 2020 F |
|---|---|---|---|
| CCP Power Production Capital Expenditures | $40 | $31 | $33 |
| Increase / (Decrease) | | ($9) | $2 |

**Q. PLEASE DESCRIBE THE MAJOR CHANGES BETWEEN THE 2018 ACTUAL, 2019 BUDGET AND 2020 FORECASTED CCP POWER PRODUCTION CAPITAL EXPENDITURES INCLUDING ANY MAJOR ASSUMPTIONS UTILIZED TO ARRIVE AT THE 2020 FORECAST.**

A. The major changes from 2018 to 2019 include:

- Reduction to the plan due to the completion of the Cayuga Station Dry Bottom Ash System installation
- Reduction to the plan due to the completion of the Cayuga Station Storm Water/ Process Water reroute
- Reduction to the plan due to the completion of the Gibson Station Storm Water/ Process Water reroute
- Reduction to the plan due to the near completion of the Gibson Station East Ash Pond Cell 2 Closure
- Addition to the plan for the Gibson Station South Aggregate Landfill Leachate Treatment System

- Addition to the plan as a result of shifting of the Closure for the Gibson Station North Ash Pond
- Addition to the plan for the inclusion of the Gallagher Station New Lined Retention Basin and Waste Water Treatment Process.

The changes from 2019 to 2020 include:

- Addition to the plan for the continuation of the Gibson Station South Aggregate Landfill Leachate Treatment System
- Addition to the plan for shifting of the Closure for the Gibson Station North Ash Pond Closure
- Reduction to the plan for completion of the Cayuga Station Dry Bottom Ash pH and Pond Water Treatment
- Addition to the plan for shifting of the Gibson Station Air Preheater Wash Water Project
- Addition to the plan for the continuation of the Gallagher Station the New Lined Retention Basin and Waste Water Treatment Process.

**Q. DID YOU PROVIDE THE 2020 CCP POWER PRODUCTION CAPITAL EXPENDITURES REFLECTED ABOVE, TO WITNESS MR. JACOBI FOR INCLUSION IN THE DEI FORECASTED TEST PERIOD PROPOSED IN THIS CASE?**

A. Yes.

## VI. CONCLUSION

**Q. IS DUKE ENERGY INDIANA UNDERTAKING THESE CLOSURE AND OTHER COAL ASH REMEDIATION-RELATED ACTIVITIES TO COMPLY WITH FEDERALLY MANDATED REQUIREMENTS?**

A. Yes, for the CCR required activities. The Company must comply with the federal rules and regulations applicable to its generating facilities and its production and storage of ash. Duke Energy Indiana's closure-related activities are related to the direct or indirect compliance with one or more federally mandated requirements. As such, Duke Energy Indiana requests that the Commission authorize it to recover the federally mandated costs associated with these compliance projects and grant it a certificate that states that public convenience and necessity will be served by the compliance projects proposed by Duke Energy Indiana in this proceeding.

**Q. WERE PETITIONER'S EXHIBITS 21-A (TJT) THROUGH 21-G (TJT) PREPARED BY YOU OR AT YOUR DIRECTION?**

A. Yes.

**Q. DOES THIS CONCLUDE YOUR PREFILED TESTIMONY?**

A. Yes, it does.

DUKE ENERGY.

*George T. Hamrick*
*Senior Vice President*
*Coal Combustion Products*

*400 S. Tryon Street, ST06A*
*Charlotte, NC 28202*

*Phone: 980-373-8113*
*Email: george.hamrick@duke-energy.com*

HAND DELIVERED

December 21, 2016

Mr. Nick Batton
Permit Manager
Office of Land Quality
Indiana Department of Environmental Management
MC 65-45 IGCN 1101
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Subject: Proposed Modification to Existing Closure and Post-Closure Plan
Ash Disposal Area #1, SW Program ID 83-UP-01
Cayuga Generating Station
Vermillion County, Cayuga, Indiana

Dear Mr. Batton:

Duke Energy Indiana, LLC. (DEI) respectfully submits to the Indiana Department of Environmental Management (IDEM) this modification to the existing Closure and Post Closure Plan for the Ash Disposal Area #1 (FP #83-UP-01) at Cayuga Generating Station located in Vermillion County, Indiana. This modification includes the addition of the West Ash Fill Area, Lined Ash Disposal Area, Primary Settling Basin, and the Secondary Settling Basin. The attached application, prepared by ATC Group Services LLC details the Closure and Post-Closure Plans for the Ash Pond System by providing the documentation requested in IDEM's "Surface Impoundment Closure Guidance."

I certify under penalty of law that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system or those persons directly responsible for developing the plan, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information. If you have any questions or require additional information regarding this submittal please contact either Owen Schwartz at 317-838-6027 or Dan Duffy at 513-287-2078.

Respectfully submitted,

George T. Hamrick
George T. Hamrick
Senior Vice President

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

**PROPOSED MODIFICATION TO EXISTING CLOSURE AND POST-CLOSURE PLANS**

ASH POND SYSTEM
CAYUGA GENERATING STATION
3300 North SR 63
CAYUGA, IN 47928

ATC PROJECT NO. 170LF00084

DECEMBER 16, 2016

PREPARED FOR:

DUKE ENERGY
139 EAST 4TH STREET
MC – EX320
CINCINNATI, OH 45202
ATTENTION: MR. CHARLES HINER, P.E.

ATC Group Services LLC

7988 Centerpoint Dr.
Suite 100
Indianapolis, IN 46256

**Phone** +1 317 849 4990
Fax +1 317 849 4278

www.atcgroupservices.com

December 16, 2016

Mr. Charles Hiner
Duke Energy
139 East 4th Street
Cincinnati, OH 45202

Re: **Proposed Modification to Existing Closure and Post-Closure Plans**
Ash Pond System
Cayuga Generating Station
Cayuga, IN
ATC Project No. 170LF00084

Dear Mr. Hiner:

In accordance with your request, ATC Group Services LLC (ATC) has prepared the enclosed proposed modification to the existing Closure and Post-Closure Plans for the Ash Pond System at the Cayuga Generating Station in Cayuga, Vermillion County, Indiana. As you are aware, portions of this report related to groundwater quality and the proposed groundwater monitoring program were prepared by M.S. Beljin & Associates.

We appreciate the opportunity to be of assistance with this project. If you have any questions regarding this information, please contact our office.

Sincerely,
**ATC Group Services LLC**

Eric Caldwell
Senior Project Manager

John R. Noel, L.P.G.
Senior Project Geologist

Brent A. Miller, CHMM
Senior Project Scientist

Donald L. Bryenton, P.E.
Principal Engineer

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# Introduction

The Cayuga Generating Station (Cayuga Station) is a coal-fired plant, commissioned in 1970, which is located on the Wabash River in Vermillion County, Vermillion Township, Indiana, in Township 17N, Range 9W, Section 15. A USGS topographic quadrangle map 7½ minute series is provided as Sheet 3 in Appendix A.

The original application of the Closure and Post-Closure Plans for a portion of the Cayuga Station Ash Pond System was submitted to the Indiana Department of Environmental Management (IDEM) on December 8, 2011 and approved by IDEM on June 7, 2012. The approved plans addressed the closure of approximately 109 acres within the general limits of Ash Disposal Area #1. Closure activities are currently underway within the limits of the approved closure plan.

The purpose of this proposed modification to the existing Closure and Post-Closure Plans is to expand the closure area to include the entire 251 acre area of the Ash Pond System which consists of the West Ash Fill Area, the Lined Ash Disposal Area, Ash Disposal Area #1, the Primary Ash Settling Pond, and the Secondary Ash Settling Pond. Three of these impoundments (i.e., the Primary Ash Settling Pond, the Secondary Ash Settling Pond and the Lined Ash Disposal Area) are regulated by the Federal Coal Combustion Residual (CCR) Rule. The remaining two surface impoundments (i.e., Ash Disposal Area #1 and the West Ash Fill Area) stopped receiving CCR materials and were drained prior to October 14, 2015. All five of the impoundments are regulated by the IDEM. The locations of the surface impoundments are provided on both the 2013 aerial photograph and the 2015 topographic map of the Cayuga Station on Sheets 4 and 5, respectively, in Appendix A.

The Cayuga Generating Station has an active permitted landfill which is located west of the ash pond system as noted on Sheets 4 and 5 in Appendix A. IDEM issued Solid Waste Facility Permit FP 83-12 to construct and operate a Restricted Waste Site Type I Landfill on March 16, 2006. The design of the landfill includes a composite base liner with leachate collection system. Leachate and surface water runoff from the landfill are currently discharged into the Primary Ash Settling Pond. The closure plan for the landfill is included in the landfill permit application which has been reviewed and approved by IDEM.

The objective of this report is to provide a detailed description of the work that will be performed to close the impoundments that are subject to the CCR Rule (i.e. the Secondary Ash Settling Pond, the Primary Ash Settling Pond, and the Lined Ash Disposal Area) in accordance with Federal CCR Rule §257.102(b)(1)(i-vi) and the requirements outlined in IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. In addition, this report provides a detailed description of the work that will be performed to close certain impoundments that are not subject to the CCR (i.e. Ash Disposal Area #1 and the West Fill Area). These impoundments will be closed in accordance with IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. To help facilitate IDEM's review of the proposed Closure and Post-Closure Plans, the following sections of this report have been formatted to provide the content of the IDEM guidance document in bold italics followed by our response.

# Surface Impoundment Closure Guidance

***The following guidance provides an outline of the information required by this office to approve the closure of a surface impoundment. This guidance is meant to provide general guidelines for obtaining closure approval. Approval for the closure of any specific impoundment must be coordinated through the Permit Branch of the Office of Land Quality (OLQ): for more information contact Solid Waste Permit Section at 317/232-7200.***

***Pursuant to 329 IAC 10-3-1(9), the operation of surface impoundments is excluded from regulation under the solid waste management regulations of 329 IAC 10. However, this exclusion goes on to state ". . . the final disposal of solid waste in such facilities at the end of their operation is subject to approval by the commissioner . . ." Impoundments which receive only coal ash and either (1) have a water pollution control facility construction permit under 327 IAC 3, or (2) receive less than 100 cubic yards of coal ash per year from generators who produced less than 100 cubic yards of coal ash per year, are exceptions and remain excluded pursuant to 329 IAC 10-3-1(8) and (10).***

***Two basic types of closures for surface impoundments are covered in this guidance: 1) Clean Closure, and 2) Closure In Place. The technical information that needs to be submitted along with a request for closure approval will vary depending on whether a clean closure or in-place closure is planned.***

Based on discussions with the IDEM technical staff, the agency has also agreed to allow two additional closure alternatives, described as follows:

- Alternative No. 1, Closure by Removal – IDEM identifies this closure alternative as the removal of all CCR materials, plus a minimum of 1 foot of the soils present immediately below the CCR materials, for proper treatment, disposal or beneficial use. IDEM guidance also suggests that a minimum of 18 inches of cover soil and a 6 inch vegetative layer will generally be required over the base of the excavation. This plan also requires the development of a groundwater monitoring program.

- Alternative No. 2, RISC Based Closure – Indiana's risk assessment program offers two options for risk-based assessment and closure. As described in IDEM's Remediation Closure Guide (IDEM, 2012), facilities may utilize IDEM's published screening levels for potential contaminants. Screening levels are concentrations calculated from standard equations and exposure assumptions. Sites are generally eligible for closure if concentrations do not exceed screening levels. As an alternative, facilities may perform a site specific risk assessment that more accurately predicts future potential human health and ecological exposures. In both cases it will likely be necessary to collect both background samples and samples of potentially impacted soil and groundwater in the vicinity of the surface impoundment. Both default screening levels and site-specific clean-up levels are negotiated with IDEM and are typically selected to meet risk levels associated with industrial exposure. This plan also requires the development of a groundwater monitoring program.

Closure options for the Cayuga Station's five surface impoundments include clean closure, closure in place, closure by removal, and RISC-based closure. The closure plans selected for each impoundment are as follows:

- West Ash Fill Area – Closure in Place
- Ash Disposal Area #1 – Closure in Place with an isolated area of Closure by Removal
- Primary Ash Settling Pond – Closure in Place
- Secondary Ash Settling Pond – Closure by Removal
- Lined Ash Disposal Area – Closure in Place

CCR materials generated from the Cayuga Station operations or removed from the Secondary Ash Settling Pond will be beneficially used as structural fill to form a portion of the subgrade for the final cover in one of the Closure in Place Areas. The material will be placed in compacted lifts to form a stable subgrade for the composite final cover system. Final cover areas will be vegetated and maintained, and a notation will be added to the property deed.

***IN-PLACE CLOSURE***

***This type of closure involves leaving waste residues within the impoundment and developing a plan designed to contain, control, and monitor the impoundment as a land disposal unit in a manner which is protective of public health and the environment. Waste residue characterization and site characterization, including information about both the general area and the impoundment design and construction, is required for in-place closure. The design and monitoring requirements for impoundments which are closed with the waste in place will be based on type of waste disposed of in an impoundment. The general requirements for nonmunicipal solid waste landfill and restricted waste site (RWS) Type I and Type II are found under 329 IAC 10-24 thru 10-31. (Any waste containing significant quantities of VOCs, or SVOCs will generally be required to close under nonmunicipal solid waste requirements.) The general requirements for Type III are found under 329 IAC 10-32 thru 10-38. In addition, if the applicable restricted waste site criteria are not at least as stringent, biosolid impoundments must meet the land disposal requirements of Federal rule 40 CFR 503.***

***Please be aware that this office may require clean closure if the waste, residue or site characteristics indicate that in-place closure will not be protective to human health and the environment.***

***The following additional information will be required for staff to review and consider the impoundment as a candidate for this type of closure approval:***

***1) Waste Characterization: A waste determination must be conducted pursuant to 40 CFR 262.11, and, if impoundments will be closed in the same manner as restricted waste sites, the waste must be classified as specified in 329 IAC 10-9-4. Additional parameters which may need to be evaluated will be determined on a case-by-case basis. The***

***following waste characterization information should be submitted as part of any in-place closure request.***

***(A) Identification of Physical Parameters: Any physical aspects of the residue that may pose an environmental or technical design problem should also be reported and quantified as necessary and applicable: i.e., low percent solids, high water content, etc.***

***(B) Identification/Quantification of Chemical Constituents: This evaluation generally involves the quantification of the amount of each chemical present within the residue that potentially poses an environmental concern, giving specific consideration to chemicals such as heavy metals, volatile and semi-volatile organic compounds, salts, polychlorinated biphenyls (PCBs), pesticides, neutral leachate parameters defined under 329 IAC 10-9-4, and other chemicals that may pose a public health or environmental threat. These analyses generally involve determining total amounts for these chemicals, but analyses of representative samples of the residue by Toxicity Characteristic Leaching procedure and neutral leachates may also be required to make regulatory status determinations and appropriate disposal decisions.***

***If the responsible party is uncertain as to the waste characterization, the Permit Branch of OLQ can arrange for an OLQ chemist to be consulted for guidance. This office may require that additional parameters be analyzed based on the review of the submitted information.***

For the surface impoundments that will be closed in accordance with the closure by removal procedures, it will not be necessary to perform waste classification testing because the CCR materials will be removed. At the surface impoundments that will be closed in accordance with closure in place procedures, Duke Energy will meet the requirements for a Type I Restricted Waste Landfill final cover. Therefore, it will not be necessary to perform waste classification testing for these units.

***2) <u>Site Characterization</u>: A narrative description of the impoundment must be provided and should include the following items at a minimum:***

***(A) Impoundment Design: A description of physical design/specifications such as dimensions (length, width, depth), liner construction, etc. of the impoundment. The narrative should include any design documentation that may exist such as drawings, field notes, etc.***

Prior to 2016, the Cayuga Station wet-sluiced fly ash and bottom ash to the ash pond system, while gypsum was dry stacked in an on-site restricted waste landfill permitted by the IDEM. The plant converted to a dry fly ash handling system in 2015 and is currently mixing the fly ash with gypsum and quick lime to create fixated gypsum. Currently, bottom ash continues to be wet-sluiced to the ash pond system. The following paragraphs provide a description of each of the five CCR surface impoundments included in this Closure and Post-Closure Plan.

Secondary Ash Settling Pond

The Secondary Ash Settling Pond was commissioned in 1970 and was constructed at the same time as the original ash pond system at the Cayuga Station. The ash pond system was built on an abandoned oxbow on the west bank of the Wabash River. The Secondary Ash Settling Pond has a surface area of 5 acres and a design volume of 36 acre-feet. The interior and exterior slopes of the Secondary Pond were constructed utilizing ~2(H):1(V) slopes to create a dike height of ~24 feet (~EL 500). Based on a review of the design drawings, this impoundment does not have an engineered liner system.

The purpose of the Secondary Ash Settling Pond is to receive decant water from the Primary Ash Settling Pond. This water then discharges through NPDES permitted outlets into the Wabash River. Water is transferred to the Wabash River via the pond's primary (Weir #3) and auxiliary (Weir #4) spillways, which are both located on the east embankment of the pond and are 6 feet square drop inlet weirs with a 24 inch corrugated metal pipe conduit outlet. The weir openings measure 6 feet tall and 2 feet wide. They are constructed using three reinforced concrete walls and one wall of reinforced concrete stop logs measuring 2 feet 7 inches wide, 1 foot deep and 6 inches thick. The weirs are built on spread footings embedded in the embankment and measure 29 feet high from bottom of footings to the top of the access platform. The crest of Weirs #3 and #4 are EL 489.4 feet and EL 488.8 feet, respectively. Normal operating water surface elevation is EL 485.3. The highest allowable water level at the maximum surcharge is EL 492.6.

Primary Ash Settling Pond

The east embankment of the Primary Ash Settling Pond was constructed in 1970, when the original Ash Pond of the Cayuga Station was commissioned. In 1998 a splitter dike was built on the west side of the ash pond, creating the Primary Ash Settling Pond. Soil structural fill was used to create the embankments starting at EL 480 to EL 486 depending on the location of the berm and extends to the crest at elevation EL 529.6. The Primary Ash Settling Pond has a surface area of approximately 26 acres and a design volume of approximately 225 acre-feet. Based on a review of the design drawings, this impoundment does not have an engineered liner system.

Previously, the purpose of the Primary Ash Settling Pond was to receive decant water from Ash Disposal Area #1 and to further separate the ash particles from the water before transferring the water into the Secondary Ash Settling Pond via Weirs #1 and #2. Ash Disposal Area #1 stopped receiving sluiced ash and was drained prior to October 14, 2015. The Primary Ash Settling Pond received sluiced ash during the period from October 2015 through March 2016. Currently, the Primary Ash Settling Pond receives decant water from the Lined Ash Disposal Area and contact water from Ash Disposal Area #1.

The pond's primary (Weir #2) and auxiliary (Weir #1) spillways are both 6 foot square drop inlet weirs with a 24 inch corrugated metal pipe conduit outlet. The weir openings measure 6 feet tall and 2 feet wide. They are constructed using three reinforced concrete walls and one wall of reinforced concrete stop logs measuring 2 feet 7 inches wide, 1 foot deep and 6 inches thick. Weirs #1 and #2 are built on spread footings embedded in the embankment and measure 37 feet high from the footings. The crest of Weirs #1 and #2 are EL 510.1 feet and EL 507.2 feet, respectively. Normal operating water surface elevation is EL 507.5 feet.

Ash Disposal Area #1

Ash Disposal Area #1 is located primarily in a pre-development, linear, topographic depression created by an abandoned river meander of the Wabash River. Ash Disposal Area #1 was built around 1970 by constructing berms to provide storage of fly ash and bottom ash produced at the Cayuga Station. The surface area of Ash Disposal Area #1 is approximately 119 acres (not including the area of the Lined Ash Disposal Area). Closure activities were initiated in this area in 2015 in accordance with the closure and post-closure plans previously approved by IDEM.

Lined Ash Disposal Area

The Lined Ash Disposal Area was constructed in 2007 and 2008 over a portion of the original ash pond to provide additional capacity to the ash pond system. The impoundment has an area of approximately 37 acres and a design volume of 1,400 acre-feet. This impoundment is lined with a 60 mil High Density Polyethylene (HDPE) liner that was installed directly over the soils and ash exposed in the base and sideslopes of the pond. The geomembrane was installed using a dual track welding system and the installation was monitored through a Construction Quality Assurance (CQA) program by a third party.

The embankments that form the Lined Ash Disposal Area were placed either directly on natural granular material or on sluiced ash and created a perimeter of 5,200 feet around the impoundment. Compacted ash fill was used to create the embankments with 3(H):1(V) designed slopes on the upstream and downstream slopes of the disposal area. Sluiced ash is received by the disposal area and ash settles from the water in the pond before discharging to the geomembrane lined south ditch.

Decant water is transferred via Weir #6 through the south ditch to the Primary Ash Settling Pond. The principal spillway and the emergency spillway are both on the west embankment. The principal spillway is a square weir into a drop inlet with a 24 in diameter reinforced concrete pipe outlet. The emergency spillway is a trapezoidal open channel armoured with riprap. Both the principal and emergency spillways direct water to the geomembrane lined south ditch.

West Ash Fill Area

The West Ash Fill Area is located south of the Cayuga Station and west of the Lined Ash Disposal Area. The West Ash Fill Area was constructed concurrently with the Cayuga Station around 1970 as part of the original ash pond and occupies a surface area of approximately 63.5 acres. Based on historic drawings, it appears the West Ash Fill Area was developed partly within a pre-development topographic depression with berms constructed on its north and west sides. The West Ash Fill Area was separated from Ash Disposal Area #1 by an ash dam constructed along its east side, and was filled with sluiced ash prior to 1998 and covered with soil. Numerous facility buildings and structures have been constructed over the area, including the Cayuga Station's flue gas desulfurization (FGD) system and portions of the new bottom ash handling system.

***(B) Volume of Waste: The amount of waste or any other residues or material remaining in the impoundment.***

The estimated volume of CCR materials present in the surface impoundments were prepared based on a compilation of data obtained from the results of April 2015 Bathymetry Surveys (performed by others), the design elevations of the various impoundments and the results of test borings drilled in the vicinity of the impoundments. The approximate depths of CCR materials in these ponds are noted on Sheet 11 in Appendix A. The estimated volume of CCR material in each of the ponds is as follows:

- Secondary Ash Settling Pond – ~ 3,375 cubic yards
- Primary Ash Settling Pond – ~17,890 cubic yards. (This estimate was prepared based on data obtained prior to the start of direct sluicing of ash in October 2015.)
- Ash Disposal Area #1 - ~7,456,380 cubic yards. (This estimate does not include any material sluiced to the pond after April 2015.) This estimate includes the volume of ash present below the footprint of the Lined Ash Disposal Area.
- Lined Ash Disposal Area – ~306,855 cubic yards. (This estimate does not include any material sluiced to the pond after April 2015.)
- West Ash Fill Area – ~ 2,901,105 cubic yards.

***(C) Discharges to The Impoundment: A detailed description of those Industrial processes, including raw materials used and their characteristics, that generated wastes which were placed in the surface impoundment.***

<u>Secondary Ash Settling Pond</u>

The Secondary Ash Settling Pond receives decant water from the Primary Ash Settling Pond. Decant water from the Secondary Ash Settling Pond is discharged to a small channel that conveys the water to the Wabash River through an NPDES permitted outfall.

<u>Primary Ash Settling Pond</u>

The Primary Ash Settling Pond currently receives decant water from the Lined Ash Disposal Area and surface water runoff from a portion of the West Ash Fill Area via the South Lined Ditch. It also receives surface water runoff from Ash Disposal Area #1. Prior to 2015, it received decant water from Ash Disposal Area #1. The North Lined Ditch also discharges surface water runoff from a portion of the West Ash Fill Area into the Primary Ash Settling Pond.

The Primary Ash Settling Pond also receives leachate and surface water runoff from the on-site landfill. The leachate is pumped to the Primary Ash Settling Pond through a force main, while the surface water runoff gravity flows from the landfill detention basin to the Primary Ash Settling Pond.

<u>Lined Ash Disposal Area</u>

The Lined Ash Disposal Area currently receives sluiced bottom ash, boiler slag, and FGD water from the plant. Prior to 2015 it also received fly ash, and still does receive fly ash when the fixated gypsum system in not operating. Surface water runoff from the coal yard is also currently pumped to this basin. Decant water from this basin is discharged to the South Lined Ditch and conveyed to the Primary Ash Settling Pond. A new lined process water pond is currently under construction at the approximate location noted on Sheet 12 in Appendix A. Once the new pond is completed, the Lined Ash Disposal Area will be taken out of service.

<u>West Ash Fill Area</u>

The West Fill Area was taken out of service as an impoundment prior to 1998. Therefore, there are no discharges into this area.

<u>Ash Disposal Area #1</u>

Ash Disposal Area #1 was taken out of service as an impoundment in 2015 and closure activities have been initiated. Therefore, there are no discharges into this area.

***(D) Site Description: Area maps indicating the location of the impoundment and all other relevant items. All drinking water wells within ½ mile of the impoundment area must be identified, both on and off the facility property. Sites with waste that test as restricted waste Type I or Type II should use the information requested in 329 IAC 10-24-2 as an outline in preparing the description. Sites with waste that test as restricted waste Type III should use the information requested in 329 IAC 10-32-2.***

The Cayuga Station is located on the Wabash River in Vermillion County, Vermillion Township, Indiana, in Township 17N, Range 9W, Section 15. A USGS topographic quadrangle map 7½ minute series is provided as Sheet 3 in Appendix A.

As shown on the drawings in Appendix A, a total of five CCR surface impoundments are present at the Cayuga Station. Three of these impoundments (i.e., the Primary Ash Settling Pond, the Secondary Ash Settling Pond and the Lined Ash Disposal Area) are regulated by the Federal Coal Combustion Residual (CCR) Rule. The remaining two surface impoundments (i.e., Ash Disposal Area #1 and the West Ash Fill Area) stopped receiving CCR materials and were drained prior to October 14, 2015. All five of the impoundments are regulated by the IDEM. The locations of the surface impoundments are provided on both the 2013 aerial photograph and the 2015 topographic map of the Cayuga Station on Sheets 4 and 5, respectively, in Appendix A.

Results from investigation and review of the Indiana Department of Natural Resources (IDNR) – Division of Water (DOW) Water Well Records database (IDNR, 2016), and review of information available from IDNR for Significant Water Withdrawal Facilities (SWWF) are summarized on Sheet 3 in Appendix A and provided in Appendix B. It should be noted that location information for IDNR's water well records and SWWFs varies depending on whether wells have been field located. Field located wells or SWWFs are associated with Universal Transverse Mercator (UTM) coordinates. Records without UTM coordinates are considered unlocated, however, they are geographically placed in IDNR's water well geographic information system based on description with respect to the public land survey system, driving direction, or address information on the well record.

Water well records that include UTM coordinates are plotted on Sheet 3 in Appendix A, and the well records are included in Appendix B.2. Water well records that do not include UTM coordinates are located based on driving direction and administrative information. These records are included in Appendix B.3. Appendix B.1 contains water well records that are associated with significant water withdrawal facilities.

As shown on Sheet 3, water well records are available from IDNR's well record database for four wells associated with registered significant water withdrawal facilities within a ½ mile radius from the perimeter of Cayuga's surface impoundments. Three of these wells (well reference numbers 164012, 164017, and 256112) are located south of the facility and are water supply wells for International Paper Company's Newport Mill. Well records 164012 and 164017 are shown at their associated UTM locations. Well record 256112 does not have UTM coordinates but has been placed on International Paper's plant site. The remaining well with reference number 162738 is owned by Duke Energy and supplies water for the power station. This well is not used as a potable water source for the station since Cayuga Station connected to Cayuga's municipal water line in 2011. Based on the subsurface logs for the three wells at Newport Mill, these wells produce water from unconsolidated sand and gravel. Well log information is less defined on well record number 162738 for the Duke Energy well. However, this well log notes that the well depth is 50 feet, and the comments section of the well record suggests the well is also screened in unconsolidated sand and gravel.

As noted on Sheet 3, there are four residential wells located within ½ mile east of the proposed closure limits. The nearest residence is 3032 E 200 N, followed by 3216 E 200 N and 100 E Wabash Acres. Two wells, an inactive shallow well and an active deep well, are located at the 100 E Wabash Acres property. Water well records are not available for these wells, however, it is believed that these wells produce water from the unconsolidated sand and gravel aquifer. These wells are not used as drinking water sources since the homes connected to a municipal water line in 2011.

Three wells with UTM coordinates (well records 162747, 394903 and 394904) are located northwest of the West Ash Fill Area boundary. Well record 162747 corresponds to a 1967 well drilled for Public Service Indiana. Record numbers 394903 and 394904 note that these wells were drilled for test purposes. Two water wells (270958 and 283735) do not have UTM coordinates but plot within the ½-mile radius on the IDNR Water Well Database Map. Well records suggest that well 283735 was drilled for test purposes and well 270958 use is noted as "other". Groundwater flow modeling results suggest that these locations are not downgradient of the Ash Pond System.

***(E) Site Geology: General information on the geology of the site such as:***

***(1) General direction of ground water flow.***

Regional flow directions in the area of the Ash Pond System are to the east toward the main Wabash River channel located northeast, east, and southeast of the ash pond system.

However, local groundwater flow in the unconsolidated alluvial aquifer under the surface impoundments is influenced by infiltration from the overlying impoundments. Additional discussion of groundwater flow directions is included with information summarizing the monitoring well sampling and testing results.

***(2) The depth of the water table across the entire site and the permeability of soils associated with the table.***

Based on water level measurements collected on April 25, 2016, the depth to groundwater ranges from approximately 2 to 45 feet bgs. Water levels vary depending on the ground surface elevation and location of wells or piezometers with respect to the ash ponds and the Wabash River.

In-situ slug test results were performed at each of the 19 groundwater monitoring wells that comprise the proposed groundwater monitoring well network. To run each test, a pressure transducer was lowered into the monitoring well. The transducer was connected to a data logger at ground surface that was used to start and stop the test and record water level recovery after stressing the well. Both rising head and falling head tests were run using a weighted PVC cylinder as a slug. Estimates of formation hydraulic conductivity were determined using the Bouwer-Rice analytical model (Bouwer and Rice, 1976) for unconfined aquifers implemented in AQTESOLV®. Well recovery diagrams are included in Appendix C and a summary of estimated hydraulic conductivities is attached in Table 1. In general, hydraulic conductivity values are consistent with the expected values for wells screened in outwash sand.

Hydraulic conductivities in the screened formations range from approximately 0.0187 to 0.133 centimeters per second (cm/s) at the West Ash Fill Area, 0.00225 to 0.044 cm/s at Ash Disposal Area #1, 0.00265 to 0.0158 cm/s at the Lined Ash Disposal Area, 0.000321 to 0.00656 cm/s at the Primary Ash Settling Pond, and 0.000321 to 0.00332 cm/s at the Secondary Ash Settling Pond. Unconfined aquifer conditions were present in a majority of the monitoring wells, although confined conditions were identified beneath the dikes between Ash Disposal Area #1, the Primary Ash Settling Pond, and the Secondary Ash Settling Pond.

***(3) Delineation of soil strata under the site (i.e., sand, silt, clay, etc.).***

**Geologic Setting.** The Cayuga Station is located in west-central Indiana, in the northern portion of Vermillion County, Indiana. Vermillion County is located west of the Cincinnati Arch, and within the eastern portion of the Illinois Basin. Bedrock beneath the site consists of the Pennsylvanian Raccoon Creek Group (Gray, Ault and Keller, 1987), which consists primarily of shale and sandstone (with coal and limestone) that dips to the west into the Illinois Basin at about 20 feet per mile (Doss, 1994). Based on review of regional structural bedrock features at the IndianaMap geographic information system (GIS) (IndianaMap, 2016), there are no faults present in the vicinity of the Wabash River Station.

The Cayuga Station is located on the west side of the Wabash River in the Central Wabash Valley portion of the Central Till Plain physiographic region (Gray, 2000). The Central Wabash Valley is bordered to the north by the Iroquois Till Plain, to the east by the Tipton Till Plain, and to the south by the Wabash Lowland. The Central Wabash Valley is distinguished by deep dissection of the Central Till Plain Region by the Wabash River and several tributaries. The tributaries were superposed from the till plains and were probably inherited from late Wisconsinan glacial drainageways. The Wabash River and tributaries in the Central Wabash Valley form entrenched valleys with depths up to 200 feet. The valleys have formed in areas of relatively high bedrock topography creating several rock-walled gorges. Areas between the dissected valleys however have generally low relief as the overall physiographic aspect of this section is that of a till plain.

**Unconsolidated Deposits.** Unconsolidated deposits at the Cayuga Station are classified as Holocene age alluvium and older Wisconsinan deposits considered undifferentiated outwash. Holocene alluvial deposits include silt, sand, and gravel along streams and rivers, fine grained overbank deposits on flood plains, and eroded earthen materials deposited by gravity along the base of slopes and bluffs. Wisconsinan outwash includes sands and gravels present in the Wabash River valley and in adjacent terraces. Unconsolidated deposits range from less than 50 to more than 100 feet thick in this part of Vermillion County.

**Bedrock.** Bedrock in the area of Cayuga Station is the Pennsylvanian age Raccoon Creek Group (Gray, Ault and Keller, 1987). The Raccoon Creek Group consists primarily of shale and sandstone (with coal and limestone) and varies in elevation from approximately EL 468 to EL 476. The generalized ground surface elevation is EL 530, and the general depth to bedrock is approximately 60 feet below ground surface (bgs). The Indiana Geological Survey has mapped the contact between the Raccoon Creek Group and the overlying Carbondale Group approximately one mile to the west of the site which suggests that the bedrock below the Ash Pond System may belong to the Staunton Formation, the uppermost unit of the Raccoon Creek Group. The Staunton Formation consists of 75 to 150 feet of sandstone and shale and has as many as eight coal beds each generally having little areal extent and variable quality and thickness. Described lithologies within the Staunton Formation include shales of various clastic and carbonate composition, sandstone, limestone, coal, and underclays (Shaver et al, 1986). Rock types encountered in rock cores obtained from prior investigations are consistent with descriptions of the Raccoon Creek Group formations. Based on review of historical soil boring data, a bedrock surface elevation map is provided as Figure 1.

**Regional Hydrogeology.** The site is located within the Middle Wabash River Basin, one of 12 water management basins defined by the Indiana Natural Resources Commission. The basins generally coincide with surface drainage divides of the major rivers of the state (Fenelon, Bobay and others, 1994). Regional water resources include bedrock aquifers and unconsolidated surficial and buried aquifers.

Regional aquifer conditions vary depending on topography and proximity to the Wabash River flood plain. The outwash sand and gravel aquifer is unconfined in areas located on river deposits. The aquifer is confined in areas on the modern flood plain associated with the Wabash River. In the vicinity of the Ash Pond System, the most significant aquifer system is the surficial sand and gravel aquifer that originates as outwash and alluvial valley fill. This aquifer type commonly has high water yields (300 to 2,700 gal/min) and the natural discharge for the aquifer is to adjoining rivers, i.e. the Wabash River (Doss, 1994; Watkins Jr. and Jordan, 1963).

**Soil Lithology.** Stratigraphic units underlying the surface impoundments generally are categorized as fine-grained unconsolidated deposits, granular unconsolidated deposits, fill, coal ash, and bedrock. Based on results from historic boring programs, fine-grained unconsolidated soils are considered non-aquifer deposits. Shallow non-aquifer soils are generally cohesive and include materials with sandy loam, loam, sandy clay loam, silt loam, and silty clay textures. Non-aquifer materials include the soil cover present at undeveloped portions of the site, particularly on the outwash terrace with a surface elevation of roughly 530 feet above mean sea level (MSL). Non-aquifer deposits also include silt and clay underlying portions of the eastern surface impoundments.

Granular, relatively high permeability outwash deposits underlie some areas of the surface impoundments. These deposits are very fine to very coarse sand as well as sand and gravel mixtures and/or fine gravel. Granular deposits have been described as medium to coarse sand, medium to coarse sand and gravel, and coarse sand in prior studies. Granular unconsolidated deposits are generally poorly sorted.

Site geologic and hydrogeologic information is available from numerous subsurface investigations and reports discussed below. Historical soil boring logs are provided in Appendix D. Soil boring, monitoring well, and piezometer locations are shown on Sheet 6. Hydraulic conductivity testing results are provided in Appendix C. Soil laboratory results are summarized in Table 2A and provided in Appendix E. Geological cross sections summarizing subsurface results along several transects across the impoundment system are included as Sheets 7 through 9 of Appendix A.

Supplementary subsurface information is also available from water well records on file at IDNR Division of Water or online (IDNR, 2016). The locations of water well records within a 1/2-mile distance from the perimeter of the impoundment system are shown on Sheet 3 in Appendix A.

**1967 Sargent and Lundy Engineering Soil Boring Logs.** A series of twenty-three geotechnical borings were drilled in 1967 in order to provide subsurface data to aid in design and construction of the generating station (Sargent and Lundy, 1970). The majority of these borings (B-1 through B-12, B-14, and B-22) were located in the area northwest of the Lined Ash Disposal Area, in the area of the footprint of the constructed power station. Borings B-15 through B-17 investigated a northwest – southeast trending drainage swale along the north side of the site, and two borings (B-20 and B-21) were located on the outwash terrace at locations that are southwest of the Ash Disposal Area #1 boundary. Borings B-13, B-18, B-19, and B-23 were drilled at locations that are within the boundaries of the Lined Ash Disposal Area and Ash Disposal Area #1. Boring B-18 describes silty and clayey topsoil and clayey and silty sand over the first 4.5 feet from the pre-development ground surface. Fine to coarse sand is described below 4.5 feet to the bottom of the boring. Unconsolidated deposits are thinner at boring B-13. This boring described clayey and silty topsoil and silty clay to a depth of 2.5 feet bgs. Fine to coarse sand was present to a depth of 7 feet bgs. The portion of the log from 7 feet to 10 feet bgs is not described, but bedrock is shown below 10 feet.

**1998 Patriot Engineering Soil Boring Logs.** Four borings were advanced in the east end of Ash Disposal Area #1 in 1998. All four borings (B-100 through B-103) encountered 20 to 30 feet of coarse grained granular unconsolidated deposits. Groundwater was not encountered in the boreholes during drilling, except for B-103 where groundwater encountered at 25.5 feet during drilling but not upon completion of the borehole.

**2003 Alt & Witzig Engineering Soil Boring Logs.** A series of seventeen soil borings were advanced within the West Ash Fill Area and in the areas immediately north and south of the West Ash Fill Area to provide subsurface data to design and construct the Flue Gas Desulfurization system. These borings were advanced to depths of 26 to 80 feet bgs. Borings advanced at locations near the Wabash River (B-7 through B-10, B-16, and B-17) encountered roughly 15 to 20 feet of granular and cohesive unconsolidated deposits (sand and gravel, sand, sandy clay, and silty clay) overlying bedrock. Other borings drilled at locations with higher ground elevations encountered thicker deposits of unconsolidated cohesive and granular soils. Borings B-19 through B-23 were advanced at relatively undisturbed locations southwest of the Ash Pond System in the area that was developed for Cayuga's Type I RWS Landfill. These borings show the presence of 3 to 5 feet of clayey sand or sandy clay deposited on sand and gravel.

**2004 ATC Associates Soil Boring Logs.** A series of eighteen soil borings were advanced in an area southwest of the West Ash Fill Area prior to construction of the restricted waste landfill in 2004. These borings were advanced 30 to 80 feet bgs. In general, these boring encountered a thin unit of sandy loam at the surface, underlain by a thick coarse sand unit. A shale bedrock was encountered between 56 to 65.5 feet bgs. Although these borings are located outside of the ash pond system, the soil boring log for P-113D was used during the interpretation and development of geologic cross sections and has been provided in Appendix D.

**2006 Patriot Engineering Soil Boring Logs.** A series of eighteen borings were advanced in the area immediately northwest of the Ash Disposal Area #1 prior to construction of the Lined Ash Disposal Area in 2008 (Patriot, 2006). These borings were advanced 45 to 55 feet bgs. Many of these borings were advanced through unconsolidated coal ash material typically described as gray, loose, and fine to medium grained. The coal ash typically occurred under a thin layer (1 to 3 inches) of topsoil. In one boring (C-7), approximately five feet of clayey sand separated seventeen feet of coal ash above from fifteen feet of coal ash below. However, in most borings there was limited non-ash material until the contact between overlying ash and underlying unconsolidated deposits. Soils that are present under ash are described generally as medium to coarse sand, medium to coarse sand and gravel, and coarse sand. Clayey gravel occurs under coal ash at boring C-8, and clayey sand is described below ash in boring C-10. Approximately three feet of peat below coal ash was described in borings C-7 and C-16.

**2007/2010 ATC Ash Disposal Area #1 Monitoring Well Boring Logs.** Five borings drilled in the proximity of Ash Disposal Area #1 in 2007 (ATC, 2008) were completed as monitoring wells MW-A12, MW-A13, MW-A14, MW-A15, and MW-A16. In 2010, two additional monitoring wells (MW-A17 and MW-A18) were installed (Cardno ATC, 2012). These wells comprise the current Ash Disposal Area #1 groundwater monitoring network. Material encountered from the surface to a depth of approximately 3.5 feet to 10 feet bgs consists of sandy loam and sandy clay loam. Below the loam, a sand unit was encountered to approximately 48 feet bgs. The sand unit contained discontinuous gravel and coarse sand lenses. In-situ slug testing are consistent with boring log descriptions of the unconsolidated granular outwash target groundwater monitoring zone.

**2010 ATC Ash Thickness Soil Boring Logs.** Six soil borings were completed in 2010 to evaluate the thickness of ash and depth to bedrock around the site (ATC, 2010). Soil borings AT-1 and AT-2 are located within the West Ash Fill Area while borings AT-3, AT-4, AT-5, and AT-6 are located near Ash Disposal Area #1. The depth to bedrock ranged from 50.1 to 64.0 feet bgs. Coal ash thicknesses in borings ranged from 21.1 to 48.6 feet. Coal ash was not present in the subsurface at boring location AT-6. The unconsolidated formation present below the coal ash is primarily sand and gravel.

**2011 Patriot Engineering Soil Boring Logs.** Five soil borings (B-1 through B-5) were drilled for the purposes of investigating the ash pond impoundment embankments along the north edge of the West Ash Fill Area and the Lined Ash Disposal Area, and east of the Primary and Secondary Ash Settling Ponds (Patriot, 2011). The soil borings were drilled to depths of 27.5 feet to 54 feet bgs, two of which terminated at bedrock. Wells were installed at four of the five boring locations. Materials encountered in the soil borings typically comprised very dense granular sands and gravel. Below the granular unconsolidated units, borings in the eastern portion of the site encountered a fine-grained cohesive clay and silty clay confining unit extending to depths of 26 feet to 48 feet bgs. Bedrock present below the unconsolidated units consisted of sandstone, coal and weathered shale. Groundwater depths in the borings ranged from 16 to 40 feet bgs during drilling.

**2014/2015 URS/AECOM Soil Boring Logs.** As part of the reconstitution of the engineering design for the ash basin impoundments, a geotechnical investigation for ash pond closure evaluations was conducted (AECOM, 2015). A total of twenty-seven geotechnical soil borings were drilled in 2014 and 2015, three of which were converted to permanent piezometers to measure groundwater elevations downgradient of Ash Disposal Area #1, the Primary Ash Settling Pond, and the Secondary Ash Settling Pond. The borings were advanced to depths of 4 to 65 feet bgs, all terminating at bedrock or refusal. Results from the borings show the presence of generally loose, moist to wet, coarse-grained sand and sand/gravel alluvial deposits. The presence of a fine-grained cohesive material exists in the southeastern portion of the site. Bedrock varied from weathered limestone to shale and coal.

**2015 Cardno ATC Monitoring Well Logs.** Fifteen soil borings were advanced across the site between August 2015 and November 2015 (ATC, 2016a). Eleven soil borings were completed as monitoring wells MW-A19, MW-A20, MW-A21, MW-A22, MW-A23, MW-A24, MW-A25, MW-A26, MW-A27, MW-A28, and MW-A29. Wells MW-A20, MW-A21, MW-A22, and MW-A23 are along the north boundaries of the West Ash Fill Area and the Lined Ash Disposal Area; MW-A19 is located within the West Ash Fill Area boundary; MW-A26, MW-A27, and MW-A28 border the Primary Ash Settling Pond; MW-A28 is located on the berm between the Primary Ash Settling Pond and the Secondary Ash Settling Pond; MW-A29 is located on the berm between Ash Disposal Area #1 and the Primary Ash Settling Pond; and MW-A24 and MW-A25 are located along the east boundary of the Secondary Ash Settling Pond.

Materials encountered in boreholes MW-A20, MW-A21, MW-A22, MW-A23, MW-A27, MW-A28, and MW-A29 generally consisted of loamy sand and gravel units underlain by a weathered shale at the bottom of each borehole. Some cohesive soils were encountered in the upper portions of MW-A22 and MW-A23. Materials encountered in boreholes MW-A24, MW-A25 and MW-A26, along the southeast portion of the facility, generally consisted of interbedded loams and silty clay units underlain by shallow weathered shale and coal bedrock. MW-A19 encountered a thick unit of coal ash underlain by a loamy sand and gravel unit.

**2015 Cardno ATC Ash Inventory Soil Boring Logs.** A series of borings (AI-1 through AI-29) were advanced in November 2015 to investigate the vertical and lateral extent of deposited ash in the West Ash Fill Area and Ash Disposal Area #1 (ATC, 2016b). In general, CCR material thickness encountered in soil borings ranged from 0.0 to 44.2 feet and is represented on the geological cross sections on Sheets 7-9. The unconsolidated formation present below the coal ash is primarily sand and gravel. The approximate horizontal CCR material boundaries are shown on Sheets 3-6. Two permanent piezometers, PZ-AI-14 and PZ-AI-26, were installed as part of the ash inventory investigation to evaluate saturated coal ash volumes in the West Ash Fill Area and Ash Disposal Area #1. PZ-AI-26 was abandoned in August 2016 due to closure by removal construction activities related to the Ash Disposal Area #1.

The results of laboratory tests performed on CCR material obtained from piston samples are provided on Table 2B. The results of these tests indicate that the moisture content of the sampled ash ranged from 11.5 to 29.2 percent, the dry density ranged from 74.1 to 94.7 pcf and the hydraulic conductivity ranged from $7.2 \times 10^{-6}$ to $5.7 \times 10^{-4}$ cm/sec.

***(4) If monitoring wells are currently in place, the following information concerning the wells must be provided:***

***(a) Site map indicating location of wells.***

The proposed ash pond groundwater monitoring well system includes nineteen (19) wells that were installed between 2007 and 2016 (MW-A12, MW-A13, MW-A14, MW-A15, MW-A16, MW-A17, MW-A18, MW-A19, MW-A20, MW-A21, MW-A22, MW-A23, MW-A24, MW-A25, MW-A26, MW-A27, MW-A28, MW-A29, and P-104) and are shown on Sheet 6 in Appendix A. Monitoring well construction details are listed in Table 3 and provided on construction diagrams in Appendix F.

***(b) Identification of upgradient and downgradient wells.***

Groundwater flow gradients and flow directions in the area of Cayuga's Ash Pond System are the result of the superimposed hydraulic effects of regional eastward flow toward the Wabash River and historic groundwater mounding associated with recharge from unlined impoundments within the Ash Pond System. As noted in the Groundwater Model Report included in the Proposed Closure and Post-Closure Plans for Ash Disposal Area #1 (ATC, 2011), infiltration associated with Ash Disposal Area #1 created radial flow, with limited westward flow and more extensive flow away from the Ash Pond System to the northeast, east, and southeast. Ash Disposal Area #1 stopped receiving sluiced material prior to October 14, 2015, and flow paths and flow gradients are expected to change as closure activities progress in Ash Disposal Area #1.

Based on water level measurements collected during groundwater events performed since September 2015, monitoring well MW-A18 is upgradient with respect to Ash Disposal Area #1 and the Lined Ash Disposal Area. Well MW-A12 is also upgradient of Ash Disposal Area #1 and wells MW-A13 and MW-A27 are upgradient of the Primary Ash Settling Pond. Monitoring wells MW-A27 and MW-A28 are upgradient of the Secondary Ash Settling Pond.

Monitoring well MW-A20 is downgradient of the West Ash Fill Area, and well MW-A23 is downgradient of the Lined Ash Disposal Area. Wells MW-A21 and MW-A22 serve as downgradient monitoring devices for both the West Ash Fill Area and the Lined Ash Disposal Area. Wells MW-A15, MW-A16, and MW-A17 are downgradient, with respect to the Ash Disposal Area #1 and wells MW-A26 and MW-A28 will be downgradient for the Primary Ash Settling Pond. MW-A28 will be the upgradient well for the Secondary Ash Settling Pond, while MW-A24, MW-A25, and P-104 will monitor groundwater downgradient of the impoundment. A groundwater potentiometric surface map for June 2016 is provided as Figure 3.

***(c) The type of stratum and the depth the wells are screened.***

Subsurface stratigraphy is discussed in Section 2(E)(3) above and was described in the Proposed Closure and Post-Closure Plans for Ash Disposal Area #1 (ATC, 2011). The type of stratum encountered in each monitoring well screen interval generally consists of granular unconsolidated sand and gravel units, with the exception of boreholes MW-A24, MW-A25 and MW-26, along the southeast portion of the facility, which encountered interbedded loams and silty clay units in addition to sands and gravel. Some cohesive soils were also encountered in the upper portions of MW-A22 and MW-A23. Based on in-situ slug tests, hydraulic conductivity values are generally consistent with the upper ranges of hydraulic conductivity cited in literature for coarse sand to gravel. Logs from borings advanced in, within, and around the Ash Pond System are included in Appendix D. Screened intervals for each monitoring well are depicted on cross sections, listed on Table 3, and shown on the monitoring well construction diagrams in Appendix F.

***(d) Description of well installations including a bore hole log.***

Five monitoring wells (MW-A12 through MW-A16) were installed by ATC from September 19-20, 2007 to monitor groundwater around Ash Disposal Area #1 (ATC, 2008). In 2010, two monitoring wells (MW-A17 and MW-A18) were installed (Cardno ATC, 2012). Eleven additional monitoring wells (MW-A19, MW-A20, MW-A21, MW-A22, MW-A23, MW-A24, MW-A25, MW-A26, MW-A27, MW-A28, and MW-A29) were installed between August 2015 and November 2015 (ATC, 2016a). Boreholes were advanced utilizing a Diedrich D-50 and a Mobile B-57 hollow stem auger drill rig. Soil samples were collected utilizing continuous split-spoon sampling technology. All eighteen monitoring wells were installed in accordance with 329 IAC 10-21-4 and constructed of 2 inch inside diameter PVC casing with a 0.010 inch slotted 5 or 10-foot screens. The zone around and approximately 2 feet above the well screen was backfilled with No. 4 sand pack. Approximately 1 foot of No. 7 sand pack was placed above the No. 4 sand pack. The remainder of the borehole was backfilled with bentonite grout with a side discharging tremie pipe to approximately 3 feet bgs. Each monitoring well was finished with either a stick-up riser protected by a 4 inch aluminum cover or a flush-mount cover set in a concrete pad. Additionally, four feet tall bollards were placed in concrete around each stick-up monitoring well riser for protection. As noted above, borehole logs and monitoring well construction diagrams are provided in Appendices D and F, respectively.

All of the monitoring wells were installed and developed in a manner consistent with 329 IAC 10-21-4. Representative samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits from significant lithological strata including aquifer material. Two slug tests (rising head and falling head) were performed on each monitoring well to estimate the hydraulic conductivity of the aquifer.

Piezometer P-104 was installed by AECOM in 2015 to monitor groundwater fluctuations near the Secondary Ash Settling Pond. It was developed and slug tested in 2016 by ATC and converted to a downgradient monitoring well location for the Secondary Ash Settling Pond.

All well locations and elevations were surveyed by a licensed surveyor. Horizontal locations and the ground surface elevations were measured to the nearest 0.1 foot. Well riser elevations were measured to the nearest 0.01 foot. Elevation data are recorded on the soil boring logs (Appendix D) and well construction diagrams in Appendix F. A summary table with well coordinates and elevations is included in Table 3.

***(e) Any ground water monitoring data that would indicate background water quality.***

Historical groundwater data collected from monitoring wells associated with the ash pond system are included on a CD provided in Appendix G. The information in the following section, prepared by M.S. Beljin and Associates, summarizes historical water quality results, and proposes semi-annual collection of groundwater samples.

## Cayuga Ash Pond System Water Quality

This section discusses and updates groundwater quality characterization for the five (5) impoundments:

1. West Ash Fill Area,
2. Ash Disposal Area #1,
3. Primary Ash Settling Pond,
4. Secondary Ash Settling Pond, and
5. Lined Ash Disposal Area

Water quality data collected from the monitoring wells is used to support the closure plan and to recommend a monitoring assessment process as the closure actions proceed.

The monitoring network includes both existing wells in the vicinity of the Ash Disposal Area #1 and new wells installed to characterize and monitor the five (5) impoundments to be closed. The overall monitoring network is illustrated in Figure 2 and a Water Level Map of the area for June 2, 2016 is presented in Figure 3.

The monitoring network includes a total of nineteen (19) monitoring wells. Of these wells, there are five (5) existing wells that have been monitored since 2008, and two (2) wells (MW-A17 and MW-A18) that were installed and sampled beginning in September 2012. Twelve (12) newly installed wells were installed from September of 2015 to November of 2015 with the initial sampling event occurring for the majority of new wells in September of 2015.

**Existing Wells:** MW-A12, MW-A13, MW-A14, MW-A15, MW-A16, MW-A17, and MW-A18.

**Newly Installed Wells:** MW-A19, MW-A20, MW-21, MW-A22, MW-A23, MW-A24, MW-A25, MW-A26, MW-A27, MW-A28, MW-A29, and P-104.

Surface water samples, identified as Ash Pond 1 and Ash Pond 2, will be collected from the Primary Ash Settling Pond and the Secondary Ash Settling Pond, respectively. Surface water samples will be collected and tested until these ponds are dewatered.

Data collected from the twelve (12) new wells can be used for comparison to data collected since 2008 from the existing wells.

Collectively the analysis of groundwater samples obtained from the monitoring locations for thirty-four (34) different parameters was used to examine the groundwater quality in the vicinity of the separate Cayuga impoundments. The analyzed parameters include (Table 5):

- Alkalinity
- Antimony
- Arsenic
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Fluoride
- Iron
- Lead
- Lithium
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nitrogen, Ammonia
- Nitrogen, Nitrate
- pH (field and Laboratory)
- Potassium
- Selenium
- Silver
- Sodium
- Specific Conductivity (field and Laboratory)
- Sulfate
- TDS
- Thallium
- Zinc
- Combined Radium 226 + 228

The analytical results of the sampling, for six (6) of the thirty-four (34) parameters are presented in Table 4. A number of the parameters had a relatively large number of non-detects in a majority of the monitoring wells and are not presented in the data tables. These included antimony, arsenic, beryllium, cadmium, chromium, cobalt, mercury, and thallium.

The characterization of the local groundwater quality will be used to evaluate the performance of the specified closure actions. To obtain sufficient data for determining the efficacy of the closure actions the available data from wells near the Cayuga Station ash ponds and settling ponds will be used to establish performance goals and for making statistical comparisons.

For purposes of evaluating the relationship between wells and characterizing the groundwater quality the following six (6) parameters were specifically considered:

- barium (MCL = 2 MG/L)
- boron,
- calcium,
- chloride, (SMCL = 250 mg/L),
- sulfate, (SMCL = 250 mg/L), and
- TDS, (SMCL = 500 mg/L)

These six (6) parameters provide a measure of the general water quality characterization in the vicinity of the Cayuga Station Ash Pond System. Data collected from the monitoring wells for the specified parameters are presented in Table 4.

The relationship between wells (locations) for a number of the parameters was evaluated using box plots (Figures 4 through 9) and the Student's t-distribution comparing each pair. These comparisons therefore represent an overall average of the water quality conditions over the time period January 2008 through April 2016.

An overall comparison is also made between the mean values, for each sampling location, and the Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels (SMCLs) as presented in 40CFR141 'National Primary Drinking Water Regulations' and 40CFR143 'National Secondary Drinking Water Regulations'.

The MCLs and SMCLs represent reasonable goals for drinking water quality. Figures 4 through 9 provide individual pair-wise comparisons at the 95% confidence level. For example, the comparison of boron by well (Figure 5), shows that well MW-A29 is statistically significantly greater than the other wells and has the highest overall mean boron concentrations at 19 mg/L. Other than wells MW-A29 and MW-A23 the new wells all have mean values lower than the existing wells MW-13 through MW-A17. The overall comparisons indicate there are at least six different sets where the mean boron concentrations are statistically the same. Figure 10 presents the Cation and Anion balances across the monitoring network.

The box plots in Figure 5 illustrate the overall differences between wells. The groundwater quality in the vicinity of Ash Disposal Area #1 and settling ponds is characterized by the groundwater flow below these units. For purposes of the groundwater quality characterization and future performance evaluations a "source", of the observations from the monitoring network is assumed to exist. The source is assumed to be the materials placed in the ash ponds and what may have been transported to the settling ponds. This relationship between the potential source and the observations from the monitoring wells forms the basis for the approach to assessment monitoring for the closure actions of the separate units.

As the hydraulic head is altered as a result of the closure actions the groundwater flow may change. In addition, as the closure actions proceed less ash material will contact the groundwater. Also a greater quantity of groundwater not impacted by the "source" will flow through the aquifer mixing with water that may enter through the ash pond. The combined effect, after closure, is expected to result in decreasing trends in key parameters over time.

Using this basic relationship between the hydraulic head and diminishing radial groundwater flow a set of "performance goals" can be established for each well and each of the specific water quality parameters (e.g., barium, boron, calcium, chloride, sulfate, and TDS).

## Assessment Monitoring Plan Overview

For the purposes of determining the effectiveness of the Cayuga Station closure actions an assessment-monitoring plan is being proposed. After an initial compressed sampling frequency, to collect at least eight independent data points, the monitoring wells will then be sampled on a semiannual basis. Annual groundwater reports will be submitted within sixty (60) days after the sampling event is completed on the schedule approved by IDEM. The data evaluation during the closure period will be used to better define the extent of the impact on water quality

## Data Review and Evaluation during Closure Activities

Over time, a statistical analysis of the specified parameters (including boron) will be performed to compare future observations against the existing groundwater quality to determine whether existing statistical differences are increasing or decreasing. This analysis is both "within well" and a "between well" comparison and using parametric and non-parametric techniques as appropriate. The within well comparison is performed to assess whether there are statistically significant trends and whether observed concentrations are above or below established "performance goals". The performance goals are based on the current conditions within individual wells for each parameter. The performance goals are then compared to existing contaminant limits (MCLs, SMCLs, or other).

For purposes of evaluating the effectiveness of the closure action, including the relationship between wells through the statistical analysis, Duke Energy proposes to conduct analysis on semi-annual sampling for the parameters shown in Table 5.

## Establishing Performance Goals for Post-Closure Monitoring

In place closure is planned for the West Ash Fill Area, the Lined Ash Disposal Area, Ash Disposal Area #1 and the Primary Ash Settling Pond. The Secondary Ash Settling Pond will be closed by removal of ash plus a minimum of 1 foot of soil. After removal the Secondary Ash Settling Pond will be repurposed for continued use as a lined process water pond.

Based on the closure approach for each unit specific performance goals will be established during the initial phases of the closure action for the purpose of determining the effectiveness of the closure action. To assure that the level of effectiveness desired from the closure action, Duke Energy proposes a period of post corrective construction for on- and off-site groundwater monitoring.

The data from future post closure semi-annual groundwater assessment monitoring will be used to assess the following:

- Monitor the hydraulic gradient and the overall change in flow;
- Monitor the decrease of site related constituent concentrations in on-site groundwater (projecting the decrease in concentration off-site) over the proposed monitoring time period (expected condition post remedy); and,
- Assure that site related constituent concentrations in on-site groundwater do not increase above the proposed groundwater performance goals (highly unexpected post remedy).

To address the third bullet, Duke Energy proposes the following:

- Groundwater monitoring data collected from each on-site monitoring well will be used as a benchmark against which any potential post remedy constituent increasing concentration shifts will be gauged. Following EPA guidance for intra-well comparisons (USEPA, 1989), a Shewhart control limit will be calculated for each well where at least eight sample results are available. These limits will serve as goals for each parameter (constituent) in each well. Control limits based on fewer than eight results only estimate an appropriate performance goal.
- Upon completion of the second semi-annual monitoring event, a well-by-well comparison of post corrective action groundwater monitoring results will be performed against the parameter goals as applicable. If the goal level is exceeded in a particular well or wells, Duke Energy will collect an additional groundwater sample from the well(s) exceeding goal(s) within thirty (30) days of receipt of validated analytical results to verify the detected concentration.
- If the concentration(s) exceeding goal(s) are verified, monitoring will continue on the schedule semi-annual and the event at the specific monitoring well will be labeled as "goal exceeded". (A potential indicator of a departure from remedy effectiveness is four (4) successive goal limits exceeded in a single monitoring well over the scheduled monitoring frequency).
- If after at least four (4) sampling events with fewer than four (4) goals in any specific well having been exceeded such that it is determined that no increasing concentration shift exists or, more likely, that the increase was temporary due to changing conditions post remedy construction, Duke Energy will remove the "goal

exceeded" designation and continue with the normal monitoring program as detailed.

- If after at least four (4) sampling events it is determined that an increasing concentration shift may exist, Duke Energy will increase the monitoring frequency to quarterly and assess the effectiveness of the closure action. As long as concentrations do not approach 95% of the groundwater monitoring goals presented above, Duke Energy will continue to monitor the shift. If the increasing concentration shift reverses and a pattern of decreasing concentrations is established, Duke Energy will resume the normal monitoring program as presented.

If the increasing shift continues and is determined to present an unacceptable condition for post closure of the specified units, then Duke Energy will take action to determine what steps to take to mitigate the degradation in effectiveness of the closure action.

The type of control limit or goal used for comparison to individual groundwater monitoring concentrations is the Shewhart control limit (EPA, 1989; Gibbons, 1994; Gilbert, 1987). These are derived as the mean (median value for non-parametric distributions) plus 4.5 times the standard deviation of the historical (baseline) well results or proxy substitutions of ½ the detection limit for non-detects. Post-baseline concentrations are compared directly to these limits. A pattern of exceedances will indicate that a group of concentrations are significantly different than the baseline data. However, this pattern may or may not indicate that actual concentrations are increasing due to an on-site release that continues to migrate off-site post remedy.

It is important to note that variability and shift changes post closure are likely to occur. Temporary increases in concentrations could result from construction activities or the change in hydrogeologic conditions due to operation of the hydraulic control system. In addition, groundwater flow velocities and directions are likely to change, based on the predictive runs of the current groundwater model. Therefore, the response of the constituent (parameter) concentrations in on-site groundwater as a result of corrective actions given the hydrogeologic conditions could take years to evaluate potential concentration shifts. For this reason, the actual amount of time to establish if an increasing concentration shift exists is not clear and post closure construction data will need to be evaluated as time progresses to allow for accurate evaluation of potential increasing concentration shifts.

Any ground water monitoring data collected after installation and operation of impoundment commenced which may be utilized to determine if there is any current groundwater contamination.

Historical groundwater data collected from monitoring wells associated with the ash pond system are included on compact discs in Appendix G. Due to the large volume of printed material associated with the historical groundwater data, hard copies are not being provided.

***Based on review of this data and the residue chemistry, more comprehensive and specific geology information may be required.***

> ***Sites with waste that test as restricted waste Type I or Type II can use the information requested in 329 IAC 10-24-3 and 10-24-4 as an outline in preparing the geology description. Sites with waste that test as restricted waste Type III can use the information requested in 329 IAC 10-32-3.***

***3) <u>Closure Plan</u>: A detailed proposal for closure design and construction and for post-closure care of the impoundment must be submitted. Sites will close under the applicable requirements for Restricted Waste Sites (RWS), as described in 329 IAC 10-24 thru 10-38, depending on the characteristics of the waste in the impoundments.***

***Please note, if the residue in the impoundment is determined to be hazardous waste, this guidance is not applicable; for more information consult the Permit Branch for guidance at (317)232-4462.***

***At a minimum, the proposed closure plan must include details of the following:***

> ***(1) Cap Design: A description of the cap including dimension, Slope, and description of materials to be used. Caps at sites that test as restricted waste site Type I or Type II must be designed in accordance with applicable requirements of 329 IAC 10-30-2 or 10-30-3. Sites that test as restricted waste site type III must be designed in accordance with 329 IAC 10-37-2. Sludges from wastewater treatment plants that test as restricted waste site Type III must also comply with the design requirements of 40 CFR 503.***

<u>Secondary Ash Settling Pond</u>

The Secondary Ash Settling Pond will be closed using closure by removal procedures. As a result, it will not be necessary to construct a final cover to meet the requirements noted above. However, once closure activities have been completed in the Secondary Ash Settling Pond, the area will be repurposed to serve as a lined process water basin.

<u>Primary Ash Settling Pond</u>

The Primary Ash Settling Pond will be closed in place. As shown on Sheet 12 in Appendix A, the grading of this unit will consist of the development of 3% final grades that slope to two drainage swales (aka, troughs). The troughs will also receive surface water runoff from the final cover from a portion of Ash Disposal Area #1.

Compacted structural fill required to form the final grades in the Primary Ash Settling Pond will be placed along the berm that separates Ash Disposal Area #1 from the Primary Ash Settling Pond. This material will serve to both stabilize the existing berm and form the subgrade for the final cover system.

Prior to placing compacted structural fill in the Primary Ash Settling Pond, the water present above the CCR materials will be pumped to a new process water treatment pond. Dewatering sumps and or wells will also be used as necessary to remove water from the ash present within the basin. Pumping will also be performed as necessary to remove rainwater that collects within the footprint of the basin during the closure activities. Liquids removed from the pond will be treated as necessary to maintain compliance with the facility's NPDES permit.

The final cover system will consist of a geomembrane (LLDPE, HDPE or PVC) overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in subsurface drains, which will be installed under the proposed troughs. Discharge from the subsurface drains and surface water runoff collected in the troughs formed in the final cover grading will discharge into the new geomembrane lined pond formed in the footprint of the Secondary Ash Settling Pond. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 12, and 17 through 20, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

Ash Disposal Area #1

The majority of Ash Disposal Area #1 will be closed in place. As noted on Sheet 12 in Appendix A, there is a small portion of Ash Disposal Area #1 located near the southwest corner of the Lined Ash Disposal Area that will be closed using closure by removal procedure. The portion of Ash Disposal Area #1 that will use closure by removal extends into the limits of the new process water pond that is currently under construction.

The final grading plan submitted as part of the 2011 Closure and Post-Closure Plan that was reviewed and approved by IDEM covered only a portion of the limits of Ash Disposal Area #1. That plan was generally based on a grading plan that utilized perimeter slopes of 25% up to El 532 (to provide a final cover thickness of approximately 3 ft) and then a 5% to a peak elevation of approximately 584. The proposed cover "piggybacked" onto the east and south berms that form the Lined Ash Disposal Area.

The final cover grading plan has been revised as shown on Sheet 12 in Appendix A. The perimeter slopes on the proposed modification remain at 25% up to EL 532 to provide a final cover thickness of approximately 3 ft. However, the slopes above El 532 have been reduced to a slope of 3.5% to create a peak elevation of approximately 568. Further, the grading plan for Ash Disposal Area #1 has been incorporated into the final grading plan for the Lined Ash Disposal Area as described in the following section.

The final cover system will consist of a geomembrane (LLDPE, HDPE or PVC) overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in perimeter toe drains, which will also serve as the geomembrane anchor trench. Discharge from the perimeter toe drains and surface water runoff from the final cover will discharge into the existing lined perimeter ditches and transported to the new geomembrane lined pond formed in the footprint of the Secondary Ash Settling Pond. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 12, and 17 through 20, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

Lined Ash Disposal Area

The Lined Ash Disposal Area will be closed in place. As shown on Sheet 12 in Appendix A, the existing 3H:1V berms that form the north and west sides of the pond will be regraded to form the 3.5% final cover grades. The maximum height of the revised berms on the north and west will be reduced from 30 feet to a maximum of 8 feet. The existing berms on the south and east sides of the pond will also be modified and incorporated into the final grading plan that includes Ash Disposal Area #1. Compacted structural fill required to form the final grades in Ash Disposal Area #1 will be placed along the exterior of the south and east berm to reinforce these berms during closure activities and reduce the existing 3H:1V slopes to 3.5% final cover grades.

Prior to modifying the perimeter berms, the water present above the CCR materials in the Lined Ash Disposal Area will be pumped to a new process water treatment pond. Dewatering sumps and or wells will also be used as necessary to remove water from the ash present within the basin. Pumping will also be performed as necessary to remove rainwater that collects within the footprint of the basin during the closure activities. Liquids removed from the pond will be treated as necessary to maintain compliance with the facility's NPDES permit.

The final cover system will consist of a geomembrane (LLDPE, HDPE or PVC) overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in perimeter toe drains, which will also serve as the geomembrane anchor trench. Discharge from the perimeter toe drains and surface water runoff from the final cover will discharge into the existing lined perimeter ditches and transported to the new geomembrane lined pond formed in the footprint of the Secondary Ash Settling Pond. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 12, and 17 through 20, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

West Ash Fill Area

As noted previously, the West Ash Fill Area was taken out of service prior to 1998. The area has been regraded and utilized for development of infrastructure critical to the operation of the generating station, including the flue gas desulfurization (FGD) system and portions of the new bottom ash handling system. Therefore, the West Ash Fill Area will be closed in place during decommissioning of the Cayuga Station. As shown on Sheet 13 in Appendix A, the grading of this unit will consist of the development of ~3% final grades that slope to two primary drainage swales (aka, troughs). The proposed final grades will require a combination of cuts and fills that nearly balance to form the proposed grading plan.

The final cover system will consist of a geomembrane (LLDPE, HDPE or PVC) overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in perimeter toe drains, which will also serve as the geomembrane anchor trench. Subsurface drains to collect and discharge infiltrated surface water will also be installed under the troughs. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 13, and 17 through 20, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

***(B) Final Contour Map: A plot plan that indicates the fill boundaries and the proposed final contours of the site at intervals of no more than two (2) feet.***

Drawings illustrating the proposed grades at the time of closure are provided in Appendix A. As noted above, the slope of the top of the closed ash pond will slope at approximately 3 to 3.5 percent over the majority of the area at the time of closure. It is anticipated that the ponded ash will settle in some areas under the weight of the structural fill needed to establish the required slopes as well as the final cover itself. It is anticipated that the final slope of the final cover system (i.e., following settlement) will exceed 2 percent.

***(C) Ground Water Monitoring: Sites that test as restricted waste site type I or Type II must prepare a Ground Water Monitoring and Corrective Action plan in accordance with applicable requirements of 329 IAC 10-29. For wastes which test as Type III, the responsible party must either document the lagoon has a barrier in accordance with 329 IAC 10-34 or it will be necessary to develop a similar program for monitoring ground water downgradient or at the facility boundary to detect any future release from the closed impoundment. Sludge from waste water treatment plants that test as restricted waste site Type III must also comply with the ground water requirements of 40 CFR 503. If monitoring is determined to be necessary, a plan should be submitted to this office which includes:***

***(1) the number and placement of monitoring wells;***

The proposed groundwater monitoring system is described in Section 2(E)(4)(a) and (b). Summarizing those sections, nineteen (19) monitoring wells are proposed for semi-annual groundwater monitoring. The proposed monitoring system is shown on Figure 2.

***(2) the number and frequency of samples;***

The proposed groundwater sampling program is described in section 2(E)(4)(e) above.

***(3) the chemical parameters to be monitored that should be consistent with those identified with the impoundment characterization;***

The proposed monitoring parameters are described in section 2(E)(4)(e) above. Following collection of eight rounds of groundwater monitoring results, the analytical parameter list may be revised if continued monitoring of specified parameters is not beneficial for assessing groundwater quality with respect to Ash Pond System closure.

***(4) sampling protocol; and,***

The proposed sampling protocols are outlined in section 2(E)(4)(e) above. A groundwater sampling and analysis plan that describes the sampling protocols, sampling methods, monitoring points, and monitoring parameters will be prepared within 90 days following IDEM's approval of this Closure Plan.

***(5) how the determination of releases will be made.***

Groundwater quality results will be evaluated according to the assessment monitoring program described in section 2(E)(4)(e) above.

***(D) Closure Certification: Sites that test as restricted waste site Type I or Type II must certify closure in accordance with applicable requirements of 329 IAC 10-30-7. Sites that test as restricted waste site Type III must certify closure in accordance with 329 IAC 10-37-7.***

Duke Energy will submit a closure certification report at the completion of the closure activities for the Ash Pond System. This report will be prepared to address the requirements of 329 IAC 10-30-7.

***(E) Post-Closure Requirements: Sites that test as restricted waste site Type I or Type II must comply with the applicable post-closure requirements of 329 IAC 10-31. Restricted waste site Type III closure must comply with the applicable post-closure requirements of 329 IAC 10-38. Post-closure care will extend for 30 years as specified by 329 IAC 10-31-2(b) or 329 IAC 10-38-2(b). Funding mechanisms to cover the post-closure requirements must be established in accordance with 329 IAC 10-39.***

Duke Energy will comply with the applicable post-closure requirements of 329 IAC 10-31.

***(F) Responsibilities after Post-Closure: After post-closure is certified as complete, the owner, operator and/or responsible party will still be responsible for the requirements of 329 IAC 10-31-5, 10-31-6 and 10-31-7 or 329 IAC 10-38-5, 10-38-65 and 10-38-7, as applicable.***

Duke Energy will comply with the responsibilities outlined above after completion of the post-closure period. Closure and Post-Closure Cost Estimates, presented on IDEM forms, are provided in Appendix H along with the legal description of the various ash pond solid waste boundaries.

*George T. Hamrick*
*Senior Vice President*
*Coal Combustion Products*

*400 S. Tryon Street, ST06A*
*Charlotte, NC 28202*

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*Email: george.hamrick@duke-energy.com*

HAND DELIVERED

December 21, 2016

Mr. Nick Batton
Permit Manager
Office of Land Quality
Indiana Department of Environmental Management
MC 65-45 IGCN 1101
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Subject: Closure and Post-Closure Plan Application
Ash Pond System
Gallagher Generating Station
Floyd County, New Albany, Indiana

Dear Mr. Batton:

Duke Energy Indiana, LLC. (DEI) respectfully submits to the Indiana Department of Environmental Management (IDEM) a Closure and Post Closure Plan application for the Ash Pond System at Gallagher Station located in Floyd County, Indiana. This system includes the North Ash Pond, Primary Pond, Primary Pond Ash Fill Area, Coal Pile Ash Fill Area, Ash Pond B, Ash Pond A and Secondary Settling Basin. Interim Closure and Post-Closure Plans for the Secondary Settling Basin were submitted to IDEM on February 29, 2016. A final letter of conceptual approval was issued by IDEM for the Secondary Settling Basin plans on August 30, 2016 and it was given the Solid Waste ID number 22-UP-01. The attached application, prepared by ATC Group Services LLC, supplements the Secondary Settling Basin Interim Plans and details the Closure and Post-Closure Plans for the remaining portions of the Ash Pond System by providing the documentation requested in IDEM's "Surface Impoundment Closure Guidance".

I certify under penalty of law that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for developing the plan, the information, submitted is to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information. If you have any questions or require additional information regarding this submittal please contact either Owen Schwartz at 317-838-6027 or Subha Chandrasekar at 513-287-2056.

Respectfully submitted,

George T. Hamrick
Senior Vice President

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

# PROPOSED CLOSURE AND POST-CLOSURE PLANS

ASH POND SYSTEM
GALLAGHER GENERATING STATION
30 JACKSON STREET
NEW ALBANY, INDIANA 47150

ATC PROJECT NO. 170LF00083

DECEMBER 16, 2016

PREPARED FOR:

DUKE ENERGY
139 EAST 4TH STREET
MC – EX320
CINCINNATI, OH 45202
ATTENTION: MR. CHARLES HINER, P.E.

ATC

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December 16, 2016

Mr. Charles Hiner
Duke Energy
139 East 4th Street
Cincinnati, OH 45202

Re: **Proposed Closure and Post-Closure Plans**
Ash Pond System
Gallagher Generating Station
New Albany, Indiana
ATC Project No. 170LF00083

Dear Mr. Hiner:

In accordance with your request, ATC Group Services LLC (ATC) has prepared the enclosed proposed Closure and Post-Closure Plans for the Ash Pond System at the Gallagher Generating Station in New Albany, Floyd County, Indiana. As you are aware, portions of this report related to groundwater quality and the proposed groundwater monitoring program were prepared by M.S. Beljin & Associates.

We appreciate the opportunity to be of assistance with this project. If you have any questions regarding this letter, please contact our office.

Sincerely,

Slawa Bruder
Project Geologist

John R. Noel, L.P.G.
Senior Project Geologist

Brent A. Miller, CHMM
Senior Project Scientist

Donald L. Bryenton, P.E.
Principal Engineer

LICENSED PROFESSIONAL GEOLOGIST
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PROFESSIONAL ENGINEER

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# Introduction

The Gallagher Generating Station (Gallagher Station) is a two-unit coal fired generating facility located in Floyd County, New Albany Township, Indiana, in Township 3S, Range 6E, in portions of Sections 10 and 15. The two active units, Unit 2 and Unit 4, began operating in 1958 and 1961, respectively. Retired Units 1 and 3, began operating in 1959 and 1960, respectively, and were both retired in 2012. The facility is located between the west bank of the Ohio River and SR 111 approximately one mile south of New Albany, Indiana and directly across the Ohio River from Louisville, Kentucky.

As shown on the drawings, a total of seven CCR surface impoundments are present at the Gallagher Station. Three of these impoundments (i.e., the Primary Pond, the Secondary Settling Pond and Ash Pond A) are regulated by the Federal Coal Combustion Residual Rule. The remaining four surface impoundments (i.e., Ash Pond B, the North Ash Pond, the Primary Pond Ash Fill Area and the Coal Pile Ash Fill Area) stopped receiving CCR materials and were drained prior to October 14, 2015. All seven of the impoundments are regulated by the Indiana Department of Environmental Management (IDEM). Current operation of the ash ponds consists of sluicing bottom ash through active sluice lines to discharge into Ash Pond A. Process water is also discharged to Ash Pond A. The approximate locations of all seven impoundments are noted on a USGS topographic quadrangle map 7½ minute series provided as Sheet 3 in Appendix A.

Ash Pond B was taken out of service around 2006. Approximately 49 of the 61.7 acres of Ash Pond B are currently approved for the development of a Type I Restricted Waste Landfill as noted in Solid Waste Facility Permit FP 22-01 issued by IDEM on March 1, 2007. IDEM is currently reviewing a minor permit modification which proposes to install a geomembrane final cover system over all of Ash Pond B as part of the closure of the landfill.

An Interim Closure and Post-Closure Plan for the Secondary Settling Pond was submitted to IDEM on February 29, 2016. Duke Energy Indiana, LLC (Duke Energy) received a letter from IDEM dated June 22, 2016 indicating IDEM's conceptual agreement with those Interim Plans. The original Interim Closure Plans were modified in a letter submitted to IDEM on July 27, 2016. Duke Energy received a letter from IDEM dated August 30, 2016 indicating IDEM's conceptual agreement with the modified Interim Plans. Subsequently, CCR materials present within the limits of the Secondary Settling Pond have been removed and compacted structural fill placed to establish the revised grades within the limit of the previous footprint of this unit. Documentation of the closure activities in this area will be submitted to IDEM under separate cover.

The objective of this report is to provide a detailed description of the work that will be performed to close the impoundments that are subject to the CCR Rule (i.e. the Secondary Settling Pond, the Primary Pond, and Ash Pond A) in accordance with Federal CCR Rule §257.102(b)(1)(i-vi) and the requirements outlined in IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. In addition, this report provides a detailed description of the work that will be performed to close certain units that are not subject to the CCR Rule (i.e. the North Ash Pond, the Primary Pond Ash Fill, the Coal Pile Ash Fill, and Ash Pond B). These units will be closed in accordance with IDEM's

Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. To help facilitate IDEM's review of the proposed Closure and Post-Closure Plans, the following sections of this report have been formatted to provide the content of the IDEM guidance document in bold italics followed by our response.

# Surface Impoundment Closure Guidance

***The following guidance provides an outline of the information required by this office to approve the closure of a surface impoundment. This guidance is meant to provide general guidelines for obtaining closure approval. Approval for the closure of any specific impoundment must be coordinated through the Permit Branch of the Office of Land Quality (OLQ): for more information contact Solid Waste Permit Section at 317/232-7200.***

***Pursuant to 329 IAC 10-3-1(9), the operation of surface impoundments is excluded from regulation under the solid waste management regulations of 329 IAC 10. However, this exclusion goes on to state ". . . the final disposal of solid waste in such facilities at the end of their operation is subject to approval by the commissioner . . ." Impoundments which receive only coal ash and either (1) have a water pollution control facility construction permit under 327 IAC 3, or (2) receive less than 100 cubic yards of coal ash per year from generators who produced less than 100 cubic yards of coal ash per year, are exceptions and remain excluded pursuant to 329 IAC 10-3-1(8) and (10).***

***Two basic types of closures for surface impoundments are covered in this guidance: 1) Clean Closure, and 2) Closure In Place. The technical information that needs to be submitted along with a request for closure approval will vary depending on whether a clean closure or in-place closure is planned.***

Based on discussions with the IDEM technical staff, the agency has also agreed to allow two additional closure alternatives, described as follows:

- Alternative No. 1, Closure by Removal – IDEM identifies this closure alternative as the removal of all CCR materials, plus a minimum of 1 foot of the soils present immediately below the CCR materials, for proper treatment, disposal or beneficial use. IDEM guidance also suggests that a minimum of 18 inches of cover soil and a 6 inch vegetative layer will generally be required over the base of the excavation. This plan requires a description of the grading plan that will be utilized to prevent the ponding of water over the final grades. This plan also requires the development of a groundwater monitoring program.

- Alternative No. 2, RISC Based Closure – Indiana's risk assessment program offers two options for risk-based assessment and closure. As described in IDEM's Remediation Closure Guide (IDEM, 2012), facilities may utilize IDEM's published screening levels for potential contaminants. Screening levels are concentrations calculated from standard equations and exposure assumptions. Sites are generally eligible for closure if concentrations do not exceed screening levels. As an alternative, facilities may perform a site specific risk assessment that more accurately predicts future potential human health and ecological exposures. In both cases it will likely be necessary to collect both background samples and samples of potentially impacted soil and groundwater in the vicinity of the surface impoundment. Both default screening levels and site-specific clean-up levels are negotiated with IDEM and are typically selected to meet risk levels associated with industrial exposure. This plan also requires the development of a groundwater monitoring program.

Closure options for the Gallagher Station's seven surface impoundments include clean closure, closure in place, closure by removal, and RISC-based closure. The closure plans selected for each impoundment are as follows:

- North Ash Pond – Closure in Place
- Primary Pond – Closure in Place
- Primary Pond Ash Fill – Closure in Place
- Coal Pile Ash Fill – Closure by Removal
- Ash Pond A – Closure by Removal
- Secondary Settling Pond – Closure in Place
- Ash Pond B – Closure in Place

CCR materials generated from the Gallagher Station operations or removed from either the Coal Pile Ash Fill or Ash Pond A will be beneficially used as structural fill to form a portion of the subgrade for the final cover in one of the Closure in Place Areas. The material will be placed in compacted lifts to form a stable subgrade for the composite final cover system. Final cover areas will be vegetated and maintained, and a notation will be added to the property deed.

***<u>IN-PLACE CLOSURE</u>***

***This type of closure involves leaving waste residues within the impoundment and developing a plan designed to contain, control, and monitor the impoundment as a land disposal unit in a manner which is protective of public health and the environment. Waste residue characterization and site characterization, including information about both the general area and the impoundment design and construction, is required for in-place closure. The design and monitoring requirements for impoundments which are closed with the waste in place will be based on type of waste disposed of in an impoundment. The general requirements for nonmunicipal solid waste landfill and restricted waste site (RWS) Type I and Type II are found under 329 IAC 10-24 thru 10-31. (Any waste containing significant quantities of VOCs, or SVOCs will generally be required to close under nonmunicipal solid waste requirements.) The general requirements for Type III are found under 329 IAC 10-32 thru 10-38. In addition, if the applicable restricted waste site criteria are not at least as stringent, biosolid impoundments must meet the land disposal requirements of Federal rule 40 CFR 503.***

***Please be aware that this office may require clean closure if the waste, residue or site characteristics indicate that in-place closure will not be protective to human health and the environment.***

***The following additional information will be required for staff to review and consider the impoundment as a candidate for this type of closure approval:***

***1) Waste Characterization: A waste determination must be conducted pursuant to 40 CFR 262.11, and, if impoundments will be closed in the same manner as restricted waste sites, the waste must be classified as specified in 329 IAC 10-9-4. Additional parameters which may need to be evaluated will be determined on a case-by-case basis. The following waste characterization information should be submitted as part of any in-place closure request.***

***(A) Identification of Physical Parameters: Any physical aspects of the residue that may pose an environmental or technical design problem should also be reported and quantified as necessary and applicable: i.e., low percent solids, high water content, etc.***

***(B) Identification/Quantification of Chemical Constituents: This evaluation generally involves the quantification of the amount of each chemical present within the residue that potentially poses an environmental concern, giving specific consideration to chemicals such as heavy metals, volatile and semi-volatile organic compounds, salts, polychlorinated biphenyls (PCBs), pesticides, neutral leachate parameters defined under 329 IAC 10-9-4, and other chemicals that may pose a public health or environmental threat. These analyses generally involve determining total amounts for these chemicals, but analyses of representative samples of the residue by Toxicity Characteristic Leaching procedure and neutral leachates may also be required to make regulatory status determinations and appropriate disposal decisions.***

***If the responsible party is uncertain as to the waste characterization, the Permit Branch of OLQ can arrange for an OLQ chemist to be consulted for guidance. This office may require that additional parameters be analyzed based on the review of the submitted information.***

For the surface impoundments that will be closed in accordance with the closure by removal procedures, it will not be necessary to perform waste classification testing because the CCR materials will be removed. At the surface impoundments that will be closed in accordance with closure in place procedures, Duke Energy will meet the requirements for a Type I Restricted Waste Landfill final cover. Therefore, it will not be necessary to perform waste classification testing for these units.

***2) Site Characterization: A narrative description of the impoundment must be provided and should include the following items at a minimum:***

***(A) Impoundment Design: A description of physical design/specifications such as dimensions (length, width, depth), liner construction, etc. of the impoundment. The narrative should include any design documentation that may exist such as drawings, field notes, etc.***

North Ash Pond

The North Ash Pond is located in the northern half of the original ash pond that was placed in service around 1958. This approximately 39.9 acre area was removed from service many years ago and has been covered with soil and vegetated. The area is often used as a construction lay-down area and is crossed by multiple active transmission lines.

Primary Pond

The Primary Pond was constructed by the placement of compacted ash to form an embankment around the perimeter of the pond. The berm elevation generally ranges from 446 to 449

The Primary Pond occupies an area of approximately 10.1 acres and previously pooled an average of 7 ft of water. Until recently, the Primary Pond and Ash Pond A were hydraulically connected by a channel which exited the Primary Pond at its southwest corner and flowed towards the northwest corner of Ash Pond A. Under those conditions the normal pool in both ponds was approximately EL 439. During the summer of 2016 the Primary Pond was removed from service, isolated from Ash Pond A and dewatered.

Primary Pond Ash Fill

The Primary Pond Ash Fill Area occupies approximately 7.5 acres at the southern end of the original limits of the initial ash pond placed in service in 1958. CCR materials removed to form the Primary Pond were placed in this area, covered with soil and vegetated. The existing top of the Primary Pond Ash Fill is approximately 10 ft above the perimeter berms that form the Primary Pond.

Ash Pond A

Ash Pond A, which was commissioned in 1970, occupies an area of approximately 36 acres. It currently receives bottom ash, the majority of the site's stormwater and discharges from the permitted landfill to the south. Ash Pond A previously discharged to the Secondary Settling Pond through a principal spillway and an emergency spillway, both of which were located in the embankment that separates Ash Pond A from the Secondary Settling Pond. Modifications have been made such that Ash Pond A now discharges through a revised piping system which discharges through the facility's NPDES outfall.

The embankments that form the pond were constructed with compacted silty clay. The typical upstream and downstream embankment slopes were initially constructed at 2H:1V. The exterior slopes and the crest of the embankments have been modified to both improve slope stability and reduce the potential of floodwaters from the Ohio River entering the pond.

Secondary Settling Pond

The Secondary Settling Pond was built in 1970 and removed from service in 2016. It was a rectangular pond approximately 150 to 220 ft wide and 950 ft in length. The entire pond occupied an approximate 4.2 acre area. This pond served as a secondary solids settling basin for Ash Pond A, located immediately to the west.

The Secondary Settling Pond was located west of the Ohio River and immediately east of Ash Pond A. The east embankment of Ash Pond A also served as the west embankment for the Secondary Settling Pond. Structural stability analyses, performed by others, indicated that the embankment located between Ash Pond A and the Secondary Settling Pond did not meet all of the CCR Rule stability requirements. Therefore, Duke Energy rerouted the discharge from Ash Pond A to a new outlet and closed the Secondary Settling Pond. The closure in place of this area included modifications to the eastern embankment of Ash Pond A to meet the requirements of 40 CFR 257.73.

Coal Pile Ash Fill

The Coal Pile Ash Fill Area is located in the southern half of the original limits of the Gallagher Station's coal pile. An embankment was constructed to isolate this area from the active coal pile located directly to the north. Following construction of the separation embankment, the Coal Pile Ash Fill Area was filled with ash excavated from other ponds. The area was later covered with soil and vegetated. The area has commonly been utilized as a construction lay-down area.

Ash Pond B

Ash Pond B, which occupies an area of approximately 61.7 acres, was constructed around 1987 with a base elevation of 415, a top of berm elevation of 452 and 3H:1V sideslopes (both internal and external). The pond operated with a normal pool at EL 447 and received sluiced ash until it was taken out of service around 2006 for the development of a Type I Restricted Waste Landfill as noted in Solid Waste Facility Permit FP 22-01 issued by IDEM on March 1, 2007.

***(B) Volume of Waste: The amount of waste or any other residues or material remaining in the impoundment.***

The estimated volumes of CCR materials present in the surface impoundments were prepared based on a compilation of data obtained from the results of August 2014 Bathymetry Surveys (performed by others), the design elevations of the various impoundments and the results of test borings drilled in the vicinity of the impoundments. The approximate depths of CCR materials in each of the areas are noted on Sheet 11 in Appendix A. The estimated volume of CCR material in each of the ponds is as follows:

- North Ash Pond – ~ 2,019,300 cubic yards
- Primary Pond – ~ 401,085 cubic yards
- Primary Pond Ash Fill - ~ 465,330 cubic yards
- Ash Pond A – ~ 1,150,315 cubic yards
- Secondary Settling Pond – ~ 23,690 cubic yards (prior to the start of closure activities)
- Coal Pile Ash Fill - ~ 377,145 cubic yards
- Ash Pond B - ~ 3,186,750 cubic yards

***(C) Discharges to The Impoundment: A detailed description of those Industrial processes, including raw materials used and their characteristics, that generated wastes which were placed in the surface impoundment.***

North Ash Pond

The North Ash Pond is part of the original ash pond which received bottom ash, fly ash and process waters prior to being reconfigured to form the North Ash Pond, the Primary Pond and the Primary Pond Ash Fill. The North Ash Pond Area has been drained, covered with soil and vegetated for many years.

Primary Pond

Initially the Primary Pond received bottom ash, fly ash and process water when it was part of the original ash pond. It continued to receive process flows from surface drains, station drains, an oil separator, roof drains, Waste Water Treatment Plant (WWTP) effluent and stack waste drains until the summer of 2016 when those flows were rerouted to Ash Pond A.

Primary Pond Ash Fill

Initially the Primary Pond Ash Fill Area received bottom ash, fly ash and process water when it was part of the original ash pond. The area was filled, covered with soil and vegetated during the development of the existing Primary Pond.

Ash Pond A

Prior to 2008, Ash Pond A received sluiced bottom ash and fly ash from all four units. Currently, it receives bottom ash from Units 2 and 4, process water from the Station, the majority of the site's stormwater and discharges from the permitted landfill located south of Ash Pond A.

Secondary Settling Pond

Prior to the summer of 2016 the Secondary Settling Pond received discharge from both Ash Pond A and Ash Pond B. This pond has been taken out of service and is currently undergoing closure.

Coal Ash Pile

The Coal Ash Pile has never received any sluiced ash or process water. This area, which was originally part of the Gallagher Station Coal Pile, was filled with ash excavated from other onsite ash ponds.

Ash Pond B

Ash Pond B received sluiced ash from approximately 1987 to 2006. The majority of this area is now permitted as a Type I Restricted Waste Disposal Facility.

***(D) Site Description: Area maps indicating the location of the impoundment and all other relevant items. All drinking water wells within ½ mile of the impoundment area must be identified, both on and off the facility property. Sites with waste that test as restricted waste Type I or Type II should use the information requested in 329 IAC 10-24-2 as an outline in preparing the description. Sites with waste that test as restricted waste Type III should use the information requested in 329 IAC 10-32-2.***

The Gallagher Station is located in Floyd County, New Albany Township, Indiana, in Township 3S, Range 6E, in portions of Sections 10 and 15. A USGS topographic quadrangle map 7½ minute series is provided as Sheet 3 in Appendix A. A second plot plan showing the impoundments superimposed on a 2013 aerial photograph is included as Sheet 4. A third plot plan showing the site topography is included as Sheet 5.

As noted on the drawings, a total of seven surface impoundments are present at the Gallagher Station. Three of these impoundments (i.e., the Primary Pond, Ash Pond A, and the Secondary Settling Pond) are regulated by the Federal Coal Combustion Residual Rule. The remaining four surface impoundments (i.e., Ash Pond B, the North Ash Pond, the Primary Pond Ash Fill area and the Coal Pile Ash Fill area) had stopped receiving CCR materials and were drained prior to October 14, 2015. All seven of the impoundments are regulated by the IDEM.

The Gallagher Generating Station has an active permitted landfill which is located south of the ash pond system as noted on Sheets 4 and 5 in Appendix A. The landfill was constructed within the limits of Ash Pond B. IDEM issued Solid Waste Facility Permit FP 22-01 to construct and operate a Restricted Waste Site Type I Landfill on March 1, 2007. The permit was based on the restricted waste site Type I landfill application submitted to the IDEM on March 7, 2006.

Results from investigation and review of the Indiana Department of Natural Resources (IDNR) – Division of Water (DOW) Water Well Records database, and review of information available from IDNR for Significant Water Withdrawal Facilities (SWWF) are summarized on Sheet 3 in Appendix A. It should be noted that location information for IDNR's water well records and SWWFs varies depending on whether wells have been field located. Field located wells or SWWFs are associated with Universal Transverse Mercator (UTM) coordinates. Records without UTM coordinates are considered unlocated, however, they are geographically placed in IDNR's water well geographic information system based on description with respect to the public land survey system, driving direction, or address information on the well record.

Water well records that include UTM coordinates are plotted on Sheet 3, and the well records are included in Appendix B.1. Water well records that do not include UTM coordinates are located based on driving direction and administrative information. These records are included in Appendix B.2. A copy of the boring log for Well No. 3, obtained from facility records, is included in Appendix B.3.

Sheet 3 shows five wells at locations in the vicinity of Gallagher Station. As shown on Sheet 3, water well records are available from IDNR's well record database for a well at location 389701 that is known in facility records as Well 4. Information for a second well, Well 3, was provided by the facility.

Also, there are two wells located northeast of the station building at locations 312194 and 251644. Well 312194 was drilled in 1955 and was known as Well 1 in facility records. Well 251644 was drilled in 1987 and was known as Well 2 in facility records. Both wells served as drinking water wells for the station but are now closed and are not registered as significant water withdrawal wells in IDNR's well records.

Based on information from IDNR records, well 206930 was drilled in 1961 for PSI and is described as a "Test" well. There is no well construction or test information associated with this well, and it is not believed to be a potential exposure pathway.

Two wells, records 206995 and 207000, are shown at apparent residential locations southwest of Gallagher's CCR surface impoundment system. These wells were reportedly drilled for "Home" use and produced groundwater from black shale and limestone bedrock.

***(E) Site Geology: General information on the geology of the site such as:***

***(1) General direction of ground water flow.***

The general direction of groundwater flow in the unconsolidated aquifer under the impoundment areas is eastward toward the Ohio River, however, local groundwater flow direction variations are possible in the western part of the site due to the presence of a drainage ditch and water levels in the impoundments.

***(2) The depth of the water table across the entire site and the permeability of soils associated with the table.***

Based on water level measurements collected on December 14, 2015, March 21, 2016, and August 1, 2016, the depth to groundwater ranges from approximately 6 to 69 feet bgs and approximate elevations range from 385 ft MSL to 443 ft MSL. Water levels vary depending on the ground surface elevation and location of wells or piezometers with respect to the ash ponds and the Ohio River.

In-situ slug test results were performed at nineteen (19) of twenty (20) groundwater monitoring wells that comprise the proposed groundwater monitoring well network. To run each test, a pressure transducer was lowered into the monitoring well. The transducer was connected to a data logger at ground surface that was used to start and stop the test and record water level recovery after stressing the well. Both rising head and falling head tests were run using a weighted PVC cylinder as a slug. Estimates of formation hydraulic conductivity were determined using the Bouwer-Rice analytical model for unconfined and confined aquifers implemented in AQTESOLV®. In some cases the Cooper-Bredehoeft-Papadopulos analytical model was applied and the calculated hydraulic conductivities were obtained from transmissivity and estimated thickness of the aquifer values. Well recovery diagrams are included in Appendix C and a summary of estimated hydraulic conductivities is attached in Table 1. In general, hydraulic conductivity values are consistent with the expected values for wells screened in silt and outwash sand and sand and gravel.

Hydraulic conductivities in the screened formations range from approximately $2x10^{-5}$ to $1.38x10^{-1}$ centimeters per second (cm/s). Both unconfined and confined aquifer conditions are present at the monitoring wells. Based on information collected during various investigations (listed below) the granular alluvial deposits (granular zone) are characterized as a confined aquifer. The fine-grained New Albany Shale serves as the lower confining unit, and fine grained unconsolidated cohesive deposits are the upper confining unit.

***(3) Delineation of soil strata under the site (i.e., sand, silt, clay, etc.).***

**Geologic Setting.** The Gallagher Station is located in southeastern Indiana, in the southern portion of Floyd County, Indiana. Floyd County is located on the western margin of the Cincinnati Arch where bedrock begins a relatively gentle dip (approximately 25 ft/mile) into the Illinois Basin. The site is located between Devonian-aged carbonate rocks of the Muscatatuck Group to the east and Mississippian-aged clay siltstones, shales and sandstones of the Borden Group. Upper portions of the late Devonian to early Mississippian New Albany Shale lay beneath the site (Fenelon et. al., 1994). Based on the online IndianaMap geographic information system (http://www.indianamap.org/index.html) bedrock elevation in this area varies approximately between EL 400 and 500.

The Gallagher Station lies within the southwestern margin of the Charlestown Hills physiographic region and very near the eastern margin of the Norman Upland (Gray, 2000). The Charlestown Hills region is characterized by low hills possibly formed by terminal margins of pre-Wisconsinan glacial advances.

The boundary between the Charlestown Hills and Norman Upland physiographic regions is marked by the Knobstone Escarpment, which is an abrupt northward trending region of distinct topographic relief. The southernmost Indiana portion of the Knobstone Escarpment includes the hills (Pine Hill and the surrounding area on the United States Geological Survey (USGS) 7.5 minute series New Albany, IN – KY quadrangle) that rise prominently immediately west of Gallagher's CCR surface impoundments.

There are no bedrock structural features or faults present in the vicinity of the site. The closest fault structures have been documented approximately 9 miles northwest from the site near Georgetown, Indiana.

**Unconsolidated Deposits.** The site is located in an area that is south and west of the pre-Wisconsinan glacial boundary. Unconsolidated deposits generally consist of alluvium, outwash and lake silt in and along the Ohio River valley. Throughout the Pleistocene the Ohio River valley was subject to repeated intense floods of glacial meltwater and interim deposits of outwash. Unconsolidated silt and clay deposits are present in tributary basins behind areas where outwash deposits formed dams.

Surficial deposits in the Charlestown Hills physiographic region consist of relatively thin pre-Wisconsinan loam and sandy loam tills. Upland areas west of the Knobstone Escarpment are covered with a veneer (less than 50 ft thick) of poorly sorted mixed silts and sands derived from weathered bedrock and windblown deposits (loess) (Gray, 1989).

Drainages formed by Silver Creek, Falling Run, Middle Creek, and French Creek in the vicinity of the site contain Wisconsinan age unconsolidated silt and clay lacustrine sediments.

The broad geomorphology and Quaternary geology of the Ohio River Valley from above Cincinnati, Ohio to below Louisville, Kentucky has been discussed in USGS Professional Paper 826 (Ray, 1974). As this study shows, the portion of the Ohio River Valley that was affected by Pleistocene glaciation is located upstream of the Gallagher Station area. Near and downstream of Gallagher Station, the Ohio River valley forms a “narrow, deep, and sinuous gorge-like valley”.

**Bedrock.** Bedrock in the area of the site is composed of Devonian-aged carbonate rocks of the Muscatatuck Group to the east and Mississippian-aged clay siltstones, shales and sandstones of the Borden Group. New Albany Shale of upper portions of the late Devonian to early Mississippian lay beneath the site. Based on review of historical soil boring data, a bedrock surface elevation map is provided as Figure 1.

**Regional Hydrogeology.** The site lies within the Ohio River Basin, which has two primary aquifer types. The first and most productive are aquifers of unconsolidated materials, primarily the buried sand and gravel aquifer associated with alluvium deposited in and along the Ohio River. Other relatively low-yield unconsolidated aquifers occur in the lower reaches of Ohio River tributaries but do not constitute reliable sources of groundwater.

The buried sand and gravel aquifer is generally 35 to 150 ft thick and thins towards the valley margins. The aquifer is generally covered by 10 to 30 of fine-grained sediments; however, fine-grained surface deposits can range from 0 to 100 ft thick. Texturally, the aquifer coarsens towards the river channel and with depth. Wells installed in the aquifer can produce as much as 2,000 gallons per minute although most wells yield several hundreds of gallons per minute. The Ohio River generally represents a discharge point for ground water within the aquifer; however, flood events may cause a reverse gradient allowing river water to flow into the aquifer. High capacity wells also have the potential to reverse natural ground water gradients near the river channel (Fenelon et. al., 1994).

Bedrock material provides the second type of aquifer in the region at considerably lower yields than the buried sand and gravel aquifers. Five bedrock aquifer systems are identified for Floyd County. These are Buffalo Wallow, Stephensport, and West Baden Groups of Mississippian age; the Blue River and Sanders Groups of Mississippian age; the Borden Group of Mississippian age; the New Albany Shale of Devonian age and Mississippian age; and the Silurian and Devonian Carbonates (Maier, 2006). The bedrock aquifers can be subdivided into four major types: carbonate; sandstone; complexly interbedded sandstone, shale, limestone and coal; and weathered bedrock in decreasing order of yield. Coal bearing formations are not present in the vicinity of Gallagher Station, however, weathered bedrock aquifers associated with the New Albany Shale and Borden Group are present. Groundwater is obtained through fractures and along bedding planes in this type of aquifer. In most cases, productive wells in this aquifer type are screened at or near the surface.

**Soil Lithology.** Stratigraphic units underlying the surface impoundments generally are categorized as fine-grained unconsolidated deposits, granular unconsolidated deposits, fill, coal ash, and bedrock. Alluvial granular and cohesive deposits associated with the Ohio River are the primary unconsolidated sediment types. Deposits of sandy loam, loamy sand and poorly sorted sand and sand and gravel form the majority of soil material present along the eastern portion of the site. These granular materials generally are present immediately above bedrock and thin to the west where they form thin layers or are not present. Fine-grained unconsolidated deposits observed at soil boring locations during drilling operations consisted of loam, sandy loam, sandy clay, silt loam, silty clay, and clay.

Site geologic and hydrogeologic information is available from numerous subsurface investigations and reports discussed below. Historical soil boring logs are provided in Appendix D. Soil boring, monitoring well, and piezometer locations are shown on Sheet 6. Hydraulic conductivity testing results are provided in Appendix C. Soil laboratory results are summarized in Table 2A and provided in Appendix E. Geological cross sections summarizing subsurface results along several transects across the impoundment system are included as Sheets 7 through 9 of Appendix A.

Supplementary subsurface information is also available from water well records on file at IDNR Division of Water or online (IDNR, 2016). The locations of water well records within a 1/2-mile distance from the perimeter of the impoundment system are shown on Sheet 3 in Appendix A.

**1955 Sargent and Lundy Engineering Soil Boring Logs.** A series geotechnical borings were advanced by Sargent and Lundy in 1955. These soil borings consisted of "C", "G", H, and "S" series. The "C" series were continuous Shelby tube samples advanced to approximately 15 ft bgs. The "G" series were advanced to ten (10) feet into underlying bedrock. The "H" series were advanced by collecting standard split spoon samples to terminal depth of 25 ft bgs and "S" series were continuous Shelby tube push samples carried to bedrock. The majority of these borings were advanced in the area located northeast of the Coal Pile Ash Fill and in the area of the footprint of the constructed power station. Borings C-33, S-32, S-40, and C-31 were located within or near the current North Ash Pond boundary. Soil borings S-34, S-65, S-66, S-68, S-69, S-71, and S-72 were advanced west of the North Ash Pond. Soil boring C-30 was located within the Primary Pond Ash Fill and soil borings S-35 and C-36 within the Coal Pile Ash Fill. Soil borings H-61 and H-62 were advanced east and northeast, respectively from the Coal Pile Ash Fill. Selected soil borings have been depicted on Sheet 6 and their locations are approximate and based on the 1955 Plan of Test Borings Units No.1 & 2. Copies of the 1955 soil borings together with the copy of the 1955 Sargent & Lundy plan are enclosed in Appendix D.

Soils encountered in soil borings within the North Ash Pond, the Primary Pond Ash Fill, and the Coal Pile Ash Fill consisted mainly of fine unconsolidated material, silty clay, with occasional trace of sand. A thin layer of granular unconsolidated material was encountered at soil boring S-32 at contact with the bedrock. Note that these are the historical records and current post-development grade elevations do not correspond to grades that were present at the site in 1955. These surface elevation changes has been depicted on Sheet 8 and Sheet 9 of Appendix A.

**1984 Pittsburgh Testing Laboratory Soil Boring Logs.** Ten borings were advanced south of Ash Pond A in the Ash Pond B area (RWS landfill). Ash Pond B has been closed under a separate cover and is not a part of this submittal; however four (4) of the ten (10) soil boring locations are depicted on Sheet 6 and therefore are included as reference in Appendix D.

**2004 ATC Baghouse Geotechnical Soil Boring Logs.** Nine soil borings (B-1 through B-9) and two offset locations (B-5A and B-A7) were advanced in 2004 prior to construction of the baghouse located east of the North Ash Pond and in proximity of the Ohio River. Although these borings are not located within the boundary of the ash pond system they have been depicted on Sheet 6 and used for preparation of geological cross section B. All nine soil borings were drilled to bedrock and rock cores were collected at seven locations. Bedrock was encountered at these locations between approximately 54 ft and 86 ft and was overlain from the ground surface by fill consisting of fine grained unconsolidated deposits, fine grained unconsolidated deposits, and granular unconsolidated material at the contact with bedrock. Depths of fill and fine grained unconsolidated deposits ranged between 21 and 57 ft. Soil boring logs for this drilling program are enclosed in Appendix D.

**2005 ATC Ash Pond B (RWS Type I Landfill) Soil Boring Logs.** A series of borings were advanced in 2005 and 2006 south of the Ash Pond A for the restricted waste site Type I landfill application. This area is not included in this Ash Basin Closure Plan. Since soil borings B-102 and B-104 and piezometers PZ-101 (B-101) and PZ-103 (B-103, now abandoned) are depicted on Sheet 6, soil boring logs for these four locations are included in Appendix D.

**2009 ATC Restricted Waste Site Type I Monitoring Well Installation Soil Boring Logs.** Five (5) monitoring wells, MW-201 through MW-205, were installed at the Gallagher Generating Station in 2009. Monitoring wells MW-201 and MW-202 are depicted on Sheet 6 of Appendix A in the area immediately south of the Ash Pond A (MW-201) and Secondary Settling Pond (MW-202) and soil information has been provided in this Closure Plan. In addition, monitoring well MW-202 has been incorporated into the monitoring well network for this Ash Basin Closure and it is associated with the Ash Pond A impoundment.

Monitoring well MW-202 was advanced to approximately 47 ft bgs through fine unconsolidated deposits and granular material. Granular deposits were encountered at 42 ft bgs and extended to the bedrock at approximately 46.4 ft bgs. A five (5) foot screen was installed in the granular zone from approximately 43.3 ft bgs to 48.3 ft bgs. The monitoring well MW-201 and MW-202 construction diagrams are provided in Appendix F and soil boring logs are enclosed in Appendix D.

**2010 ATC Monitoring Well Installation for Ash Pond Soil Boring Logs.** Two (2) borings drilled in the proximity of the Coal Pile Ash Fill and Secondary Settling Pond were completed as monitoring wells MW-A301 and MW-A302. Monitoring well MW-A301 was installed at the south-eastern edge of the Coal Pile Ash Fill boundary and monitoring well MW-302 was installed east of the Secondary Settling Pond.

Material encountered in these two soil borings from the surface to elevation of approximately 405 ft MSL consisted of loam and silt loam. Granular material was encountered in both borings below the fine unconsolidated deposits. The loamy sand layer at soil boring MW-A301 extended to the boring's terminal depth at 70 ft bgs and at soil boring MW-A302 to the bedrock that was encountered at approximately 37 ft bgs (401 ft MSL). In-situ slug testing results with the average hydraulic conductivity of $4.42x10^{-4}$ cm/sec correspond to sand material (Domenico and Schwartz, 1990). Detail information pertaining to hydraulic conductivity testing, soil boring information, laboratory testings and monitoring well installation is enclosed in Appendix C through Appendix F.

**2011 ATC Ash Pond A Stability Soil Boring Logs.** Nine soil borings were advanced in 2011 in the vicinity of Ash Pond A and the Secondary Settling Pond. The purpose of this investigation was to examine the nature and conditions of the materials within the embankments surrounding the ponds and the foundation soils below the embankments. Six soil borings, B-1, B-3, B-4, B-6, B-8, and B-9, were drilled from the crest and embankment fill observed at these locations reached to a depth of approximately 28 ft bgs. The fill material consisted primarily of silty clay. The natural foundation soils below the fill at soil borings B-4, B-6, B-8, and B-9 consisted of silty clay. The natural soils underlying the fill in soil borings B-1 and B-3 located on a berm between Ash Pond A and Secondary Settling Pond consisted of silty sand, sandy gravel, and sand. Soil boring B-2 was drilled near the Ohio River and the embankment fill at this location consisted of crushed stone and silty clay. The natural soil material included silty clay to approximately 35.5 ft and sand with gravel to a terminal depth of 63.8 ft. Soil borings B-5 and B-7 were drilled from the alignment of the old county road which was south of Ash Pond A. The fill material present at borings B-5 and B-7 extended to a depth of approximately 3.5 ft and then silty clay to depths of 28 ft and 30.5 ft, respectively. Soil boring B-5 had a thin layer of silty sand between 32 ft to the termination depth of 32.5 ft. Minor amounts of sand were encountered in soil boring B-7 between approximate depths of 30 ft to 35 ft (soil boring terminal depth).

The apparent bedrock surface in most soil borings was encountered at approximately EL 400 and the depth to bedrock ranged from 39 to 43 ft bgs in soil borings B-1, B-3, B-4, B-6, B-8, and B-9. Soil boring B-2 was drilled near the Ohio River and the bedrock at this location was at approximately EL 370 and approximately 64 ft bgs.

**2014/2015 AECOM Soil Boring Logs.** A series of soil borings were advanced in 2014 and 2015 as part of AECOM's evaluation of the design and current conditions of the ash impoundments and associated structures. A total of forty-three geotechnical soil borings were drilled in 2014 and 2015 within or near the six coal ash impoundments, eleven of which were converted to piezometers. Details related to the piezometer installation at each location are included on soil boring logs in Appendix D.

The borings were advanced to depths of approximately 4 to 80 feet bgs. Eighteen soil borings were advanced to bedrock and the remaining soil borings were terminated in coal ash and/or alluvium. Results from the borings show the presence of fine grained unconsolidated alluvial deposits that underlay the coal ash. The presence of a fine grained cohesive material dominates in the western portion of the site where there are none or just small layers of granular material. Thickness of granular unconsolidated deposits increases significantly in the eastern portion of the site. Bedrock encountered during this drilling program was described on soil boring logs as weathered shale. Results describing the thickness of coal ash encountered at each soil boring have been incorporated to create approximate bottom of ash contours and coal ash volumes as presented on Sheet 10 and Sheet 11 of Appendix A, respectively.

**2015 Cardno ATC Monitoring Well Soil Boring Logs.** Twenty-one soil borings were advanced across the site between October 2015 and December 2015 by ATC. Seventeen soil borings were completed as monitoring wells as depicted on Sheet 6 of Appendix A. These are MW-A303, MW-A304, MW-A305, MW-A306, MW-A307, MW-A308, MW-A309, MW-A310S, MW-A310I, MW-A311, MW-A312, MW-A313, MW-A314, MW-A315R, MW-A316, MW-A317 and MW-A318. Monitoring well MW-315R is in an assumed background position relative to the site. A few monitoring wells are shared between one or two impoundments. Monitoring wells MW-A312, MW-A313, MW-A314, and MW-A316 are located within the boundaries of the North Ash Pond impoundment. Monitoring wells MW-A309, MW-A316, MW-A317, and MW-A318 are located around the perimeter of the Primary Pond. Monitoring wells MW-A306, MW-A308, and MW-A318 serve as monitoring points at the Primary Pond Ash Fill. Monitoring wells MW-A303, MW-A305, MW-A306, and MW-A307 are located in areas surrounding Ash Pond A. Monitoring well MW-A304 was installed at the southeast corner of the Secondary Settling Pond. Monitoring wells MW-A307, MW-A309, MW-A310S, MW-A310I, and MW-A317 were installed around the Coal Pile Ash Fill area.

With the exception of soil boring MW-A310S, remaining soil borings were advanced to bedrock or auger refusal. Based on the soil boring information bedrock in the northwest, west, south, and southeast part of the site was encountered between approximately 36 ft and 46 ft bgs. These depths correspond to an elevation range between 400 and 403 ft. The bedrock erosional surface dips in the northeastern part of the site. Bedrock in the northeast part of the site at soil borings MW A309, MW-A310I, MW-A311, MW-A313, MW-A314, MW-A315, MW-A315R, and MW-A317 was recorded between approximately 50 ft and 87 ft bgs, with corresponding elevations of 403 ft to 366 ft.

Materials encountered in the boreholes consisted of generally cohesive deposits such as loam, silt loam, silty clay loam, clay loam, and silt. These deposits were underlain in selected borings by granular deposits such as sand, loamy sand, and sand and gravel units that have been deposited on top of bedrock. Granular deposits of varied thickness were encountered at monitoring wells MW-A303, MW-A304, MW-A305, MW-A307, MW-A310S, MW-A310I, MW-A311, MW-A312, MW-A314, and MW-A315R. In general, the thickness of granular deposits increased to the northeast. Coal combustion products were recorded at the soil boring locations MW-A306, MW-A309, MW-A312, MW-A313, MW-A314, MW-A316, MW-A317, and MW-A318. Results describing the thickness of coal ash encountered at each soil boring have been incorporated to create approximate bottom of ash contours and coal ash volumes as presented on Sheet 10 and Sheet 11 of Appendix A, respectively. The results of laboratory tests performed on soil material obtained from soil borings advanced in 2015 are provided in Table 2A.

**2016 ATC Ash Inventory Soil Boring Logs.** A series of borings (AI-1 through AI-21) were advanced in January 2016 and February 2016 to investigate the vertical and lateral extent of deposited ash in the North Ash Pond and the Coal Pile Ash Fill. Two temporary piezometers, PZ-AI-6 and PZ-AI-18 were installed in offset locations from the original borings to monitor water levels in coal ash. The piezometer construction diagrams for PZ-AI-6 and PZ-AI-18 are attached in Appendix F. In general, CCR material thickness encountered in soil borings ranged from 0.0 to 41.0 ft. Coal ash was not present at boring locations AI-1, AI-5, AI-13, and AI-14. The unconsolidated deposits present below the coal ash consisted of loam, silt loam, silty clay, silty clay loam, clay, sandy clay, sandy loam, and loamy sand.

The results of laboratory tests performed on CCR materials and soils present below the CCR materials are provided in Table 2B. The results of these tests indicate that the hydraulic conductivity of the CCR materials ranged from $8.4x10^{-5}$ to $3.8x10^{-7}$ cm/sec while the hydraulic conductivity of the underlying soil varied from $4.4x10^{-6}$ to $7.2x10^{-8}$ cm/sec.

***(4) If monitoring wells are currently in place, the following information concerning the wells must be provided:***

***(a) Site map indicating location of wells.***

The ash pond system groundwater monitoring well network includes twenty wells that were installed between 2009 and 2016 (MW-202, MW-A301, MW-A302, MW-A303, MW-A304, MW-A305, MW-A306, MW-A307, MW-A308, MW-A309, MW-A310S, MW-A310I, MW-A311, MW-A312, MW-A313, MW-A314, MW-A315R, MW-A316, MW-A317, and MW-A318) and are shown on Figure 2 and Sheet 6 of Appendix A. Monitoring well construction details are listed in Table 3 and provided on construction diagrams in Appendix F.

***(b) Identification of upgradient and downgradient wells.***

Based on its location, monitoring well MW-315R is a site-wide background well installed north of the coal ash impoundments and with no coal ash material present in the soil stratigraphy. Based on water level measurements collected during groundwater events performed since December 2015, monitoring well MW-A312, installed in the northwest part of the North Ash Pond, has an upgradient character with respect to the North Ash Pond, Primary Pond, and Coal Pile Ash Fill.

A groundwater potentiometric surface map prepared for August 1, 2016 is provided on Figure 3.

***(c) The type of stratum and the depth the wells are screened.***

Subsurface stratigraphy is discussed in section 2(E)(3) above. The type of stratum encountered in monitoring well screen intervals consists of both granular unconsolidated sand and gravel units and fine grained unconsolidated material. This is due to the discontinuous character of sand and sand and gravel strata in the west part of the site. Monitoring wells screened in cohesive material include MW-A306, MW-A308, MW-A309, MW-A313, MW-A316, MW-A317, and MW-A318. These wells are screened in silt loam and silty clay loam. Monitoring wells screened in granular deposits include MW-202, MW-A301, MW-A302, MW-A305, MW-310S, MW-A310I, and MW-A314. Soil deposits encountered at these locations included loamy sand, sand, and sand and gravel. Monitoring wells with screens installed across fine and granular unconsolidated deposits or with interbedded layers include MW-A303, MW-A304, MW-A307, MW-A311, MW-A312, and MW-A315R. In general soil material encountered in a screen zone at these locations included silt loam, clay loam, sandy clay loam, sandy loam, sand, and sand and gravel.

Based on in-situ slug tests, hydraulic conductivity values are generally consistent with ranges of hydraulic conductivity cited in literature for silt to coarse sand and gravel. Boring logs from borings advanced in, within, and around the impoundments are included in Appendix D. Table 3 includes a complete list of screen intervals at each monitoring well location and monitoring well construction diagrams are included in Appendix F. Also, screened intervals for selected monitoring wells are depicted on cross sections.

***(d) Description of well installations including a bore hole log.***

Two monitoring wells (MW-A301 and MW-A302) were installed by ATC in 2010 to monitor groundwater east of the Coal Pile Ash Fill area and east of the secondary Settling Pond impoundment (ATC, 2010). Seventeen additional monitoring wells (MW-A303, MW-A304, MW-A305, MW-A306, MW-A307, MW-A308, MW-A309, MW-A310S, MW-A310I, MW-A311, MW-A312, MW-A313, MW-A314, MW-A315R, MW-A316, MW-A317, and MW-A318) were installed between October 2015 and December 2015. In addition, one of the monitoring wells, MW-202 that was installed for the Ash Pond B (RWS Type I Landfill) in 2009, was incorporated into the proposed ash pond system monitoring well network.

Boreholes were advanced utilizing a Diedrich D-50 and a Mobile B-57 hollow stem auger drill rig. Soil samples were collected utilizing continuous split-spoon sampling technology. At locations where thickness of coal ash was significant an outer casing was installed one (1) to two (2) feet beyond the lower boundary of coal ash prior to drilling into native soils or cohesive fill. All twenty monitoring wells were installed in accordance with 329 IAC 10-21-4 and constructed of 2 inch inside diameter PVC casing with a 0.010 inch slotted 5 or 10-foot screens. The zone around and approximately 2 feet above the well screen was backfilled with No. 4 sand pack that was followed by No. 7 sand pack (placed above the No. 4 sand pack). The remainder of the borehole was backfilled with bentonite grout with a side discharging tremie pipe to approximately 3 feet bgs. Each monitoring well was finished with either a stick-up riser protected by a 4 inch aluminum cover or a flush-mount cover set in a concrete pad. Additionally, bollards were placed in concrete around each stick-up monitoring well riser for protection. As noted above, borehole logs and monitoring well construction diagrams are provided in Appendices D and F, respectively.

All of the monitoring wells were installed and developed in a manner consistent with 329 IAC 10-21-4. Representative samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits from significant lithological strata including aquifer material. Four slug tests (two rising head and two falling head) were performed on monitoring wells MW-A301 and MW-A302 installed in 2010. Two slug tests (rising head and falling head) were performed on each monitoring well installed in 2015 to estimate the hydraulic conductivity of the aquifer. No slug test data is available for monitoring well MW-202 that was installed in 2009 for Ash Pond B.

All well locations and elevations were surveyed by a licensed surveyor. Horizontal locations and the ground surface elevations were measured to the nearest 0.1 foot. Well riser elevations were measured to the nearest 0.01 foot. Dedicated equipment was installed at all monitoring well locations and a new reference point for groundwater level measurements was established. Elevation data are recorded on the soil boring logs (Appendix D) and well construction diagrams in Appendix F. A summary table with well coordinates and elevations is included in Table 3.

***(e) Any ground water monitoring data that would indicate background water quality.***

Historical groundwater data collected from monitoring wells associated with the ash pond system are included on CDs provided in Appendix G. The information in the following section, prepared by M.S. Beljin and Associates, summarizes historical water quality results, and proposes semi-annual collection of groundwater samples.

## Gallagher Ash Pond System Water Quality

This section presents the groundwater quality characterization for six (6) separate units:

1. Ash Pond A,
2. Secondary Settling Pond,
3. Primary Pond,
4. North Ash Pond,
5. Primary Pond Ash Fill, and
6. Coal Pile Ash Fill

Water quality data collected from the monitoring wells is used to support the closure plan and to recommend a monitoring assessment process as the closure actions proceed. To characterize the Gallagher Station Ash Pond System the monitoring network includes both existing wells and newly installed wells.

The overall monitoring network for the Gallagher Station Ash Pond System is illustrated in Figure 2. This figure depicts the historic existing wells along with the seventeen (17) newly installed (or sampled) wells for a total of twenty (20) monitoring wells for collecting groundwater quality data.

Figure 3 presents the water levels and approximate flow map for the monitoring network representing the wells across the Gallagher Station Ash Pond System.

Sampling from the existing wells dates back to August of 2009 for the purposes of characterizing the background groundwater quality.

The seventeen (17) new wells were installed with the initial sampling event occurring in December 2015. For purposes of the initial groundwater quality characterization there were separate sampling events conducted in December 2015 along with March and August of 2016.

**Existing Wells:** MW-202, MW-A301, and MW-A302.

**Newly Installed or Sampled Wells:** MW-A303, MW-A304, MW-A305, MW-A306, MW-A307, MW-A308, MW-A309, MW-A310I, MW-A310S, MW-A311, MW-A312, MW-A313, MW-A314, MW-A315R, MW-A316, MW-A317, and MW-A318.

Data collected from the new wells is compared to data collected since August 2009 from the existing well MW-202. Collectively the analysis of groundwater samples obtained from the monitoring locations for thirty-four (34) different parameters was used to examine the groundwater quality in the vicinity of the Gallagher Station Ash Pond System.

The analyzed parameters included (Table 5):

- Alkalinity
- Antimony
- Arsenic
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Fluoride
- Iron
- Lead
- Lithium
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nitrogen, Ammonia
- Nitrogen, Nitrate
- pH (field and Laboratory)
- Potassium
- Selenium
- Silver
- Sodium
- Specific Conductivity (field and Laboratory)
- Sulfate
- TDS
- Thallium
- Zinc
- Combined Radium 226 + 228

The analytical results of the sampling, for six of the thirty-four (34) parameters, are presented in Table 4. A number of the parameters had a relatively large number of non-detects in a majority of the monitoring wells and are not presented.

The characterization of the local groundwater quality will be used to evaluate the performance of the specified closure actions. To obtain sufficient data for determining the efficacy of the closure actions the available data from wells near the Gallagher Station Ash Pond System and its permitted landfill will be used to establish performance goals and for making statistical comparisons.

For purposes of evaluating the relationship between wells and characterizing the groundwater quality the following six (6) parameters were specifically considered:

- barium (MCL = 2 MG/L)
- boron,
- calcium,
- chloride, (SMCL = 250 mg/L),
- sulfate, (SMCL = 250 mg/L), and
- TDS, (SMCL = 500 mg/L)

These six (6) parameters provide a measure of the general water quality in the vicinity of the Gallagher Station Ash Pond System. Observations for the specified six (6) parameters from the monitoring wells are presented in Table 4.

The relationship between wells (locations) for a number of the parameters was evaluated using box plots and the Student's t-distribution comparing each pair. While there is insufficient data to perform powerful statistical analyses for the newly installed wells, the box plots do present an overall average of the water quality conditions over the time period represented by the observations December 2015 through August 2016.

An overall comparison is also made between the mean values, for each sampling location, and the Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels (SMCLs) as presented in 40CFR141 'National Primary Drinking Water Regulations' and 40CFR143 'National Secondary Drinking Water Regulations'.

The MCLs and SMCLs represent reasonable goals for drinking water quality. Figures 4 through 9 provide individual pair-wise comparisons at the 95% confidence level. For example, the comparison of boron by well (Figure 5), shows that wells MW-A309 and MW-A305 are statistically significantly greater than the other wells representing the area comprising the closure units. These two wells have the highest overall mean boron concentrations at 20.4 mg/L and 16.9 mg/L respectively. A number of the newly installed wells for the closure unit areas have mean values that are greater than the background wells represented by the new well MW-A315R. Figure 10 presents the Cation and Anion balances across the monitoring network.

The box plots in Figures 4 through 9 illustrate the overall differences between wells. The groundwater quality in the vicinity of the Gallagher Station Ash Pond System is characterized by the groundwater flow across the specific area (Figure 3). For purposes of the groundwater quality characterization and future performance evaluations a "source" of the observations from the monitoring network is assumed to exist. The source is assumed to be the materials placed in the specified units and what may have been transported to the settling ponds. This relationship between the potential source and the observations from the monitoring wells forms the basis for the approach to assessment monitoring for the closure actions of the separate units.

As the hydraulic head is altered as a result of the closure actions the groundwater flow may change. In addition, as the closure actions proceed less ash material may reach the groundwater. The combined effects, after closure, are expected to result in decreasing trends in key parameters over time.

Using the basic relationship between the hydraulic head and the groundwater flow a set of "performance goals" can be established for each well and each of the specific water quality parameters (e.g., barium, boron, calcium, chloride, sulfate, and TDS).

## Assessment Monitoring Plan Overview

For the purposes of determining the effectiveness of the Gallagher closure actions, an assessment-monitoring plan is being proposed. After an initial compressed sampling frequency, to collect at least eight independent data points, the monitoring wells will then be sampled on a semiannual basis. Annual groundwater reports will be submitted within sixty (60) days after the sampling event is completed on the schedule approved by IDEM. The data evaluation during the closure period will be used to better define the extent of the impact to water quality.

## Data Review and Evaluation during Closure Activities

Over time, a statistical analysis of specific parameters (including boron) will be performed to compare future observations against the existing groundwater quality to determine whether existing statistical differences are increasing or decreasing. This analysis relies on both "within well" and "between well" comparisons using parametric and non-parametric techniques as appropriate. These comparisons are to be performed to assess the whether there are statistically significant trends and whether observed concentrations are above or below established "performance goals". The performance goals are based on the current conditions within individual wells for each parameter. The performance goals are then compared to existing contaminant limits (MCLs, SMCLs, or other).

For purposes of evaluating the effectiveness of the closure action including the relationship between wells through the statistical analysis Duke Energy proposes to conduct analysis on semi-annual sampling for the following parameters:

## Establishing Performance Goals for Post-Closure Monitoring

The performance goals will be established during the initial phases of the closure action and after there is measurable decrease in the hydraulic head. At this point in time during the closure process where there is the greatest chance that any constituents, remaining in the solid matrix beneath the ash ponds, will be significantly mitigated from entering the groundwater. To assure that the level of effectiveness desired from the closure action of the Ash Pond, Duke Energy proposes a period of post corrective construction for on- and off-site groundwater monitoring.

The data from future post closure semi-annual groundwater assessment monitoring will be used to assess the following:

- Monitor the hydraulic gradient and the overall change in flow;
- Monitor the decrease of site related constituent concentrations in on-site groundwater (projecting the decrease in concentration off-site) over the proposed monitoring time period (expected condition post remedy); and,
- Assure that site related constituent concentrations in on-site groundwater do not increase above the proposed groundwater performance goals.

To address the third bullet, Duke Energy proposes the following:

- Groundwater monitoring data collected from each on-site monitoring well will be used as a benchmark against which any potential post remedy constituent increasing concentration shifts will be gauged. Following EPA guidance for intra-well comparisons (USEPA, 2009), a Shewhart control limit will be calculated for each well where at least eight sample results are available. These limits will serve as goals for each parameter (constituent) in each well. Control limits based on fewer than eight results only estimate an appropriate performance goal.
- Upon completion of the second semi-annual monitoring event, a well-by-well comparison of post corrective action groundwater monitoring results will be performed against the parameter goals as applicable. If the goal level is exceeded in a particular well or wells, Duke Energy will collect an additional groundwater sample from the well(s) exceeding goal(s) within thirty (30) days of receipt of validated analytical results to verify the detected concentration.
- If the concentration(s) exceeding goal(s) are verified, monitoring will continue on the schedule semi-annual and the event at the specific monitoring well will be labeled as "goal exceeded". (A potential indicator of a departure from remedy effectiveness is four (4) successive goal limits exceeded in a single monitoring well over the scheduled monitoring frequency).
- If after at least four (4) sampling events with fewer than four (4) goals in any specific well having been exceeded such that it is determined that no increasing concentration shift exists or, more likely, that the increase was temporary due to changing conditions post remedy construction, Duke Energy will remove the "goal exceeded" designation and continue with the normal monitoring program as detailed.
- If after at least four (4) sampling events it is determined that an increasing concentration shift may exist, Duke Energy will increase the monitoring frequency to quarterly and assess the effectiveness of the closure action. As long as concentrations do not approach 95% of the groundwater monitoring goals presented above, Duke Energy will continue to monitor the shift. If the increasing concentration shift reverses and a pattern

of decreasing concentrations is established, Duke Energy will resume the normal monitoring program as presented.

- If the increasing shift continues and is determined to present an unacceptable condition for post closure of the three specified units, then Duke Energy will take action to determine what steps to take to mitigate the degradation in effectiveness of the closure action.

The type of control limit or goal used for comparison to individual groundwater monitoring concentrations is the Shewhart control limit (EPA, 2009; Gibbons, 1994; Gibbons, 1987). These are derived as the mean (median value for non-parametric distributions) plus 4.5 times the standard deviation of the historical (baseline) well results or proxy substitutions of ½ the detection limit for non-detects. Post-baseline concentrations are compared directly to these limits. A pattern of exceedances will indicate that a group of concentrations are significantly different than the baseline data. However, this pattern may or may not indicate that actual concentrations are increasing due to an on-site release that continues to migrate off-site post remedy.

It is important to note that variability and shift changes post closure are likely to occur. Temporary increases in concentrations could result from construction activities or the change in hydrogeologic conditions due to operation of the hydraulic control system. In addition, groundwater flow velocities and directions are likely to change, based on the predictive runs of the current groundwater model. Therefore, the response of the constituent (parameter) concentrations in on-site groundwater as a result of corrective actions given the hydrogeologic conditions could take years to evaluate potential concentration shifts. For this reason, the actual amount of time to establish if an increasing concentration shift exists is not clear and post closure construction data will need to be evaluated as time progresses to allow for accurate evaluation of potential increasing concentration shifts.

***(f) Any ground water monitoring data collected after installation and operation of impoundment commenced which may be utilized to determine if there is any current ground water contamination.***

Historical groundwater data collected from monitoring wells associated with the ash pond system are included on compact discs in Appendix G. Due to the large volume of printed material associated with the historical groundwater data, hard copies are not being provided.

***Based on review of this data and the residue chemistry, more comprehensive and specific geology information may be required. Sites with waste that test as restricted waste Type I or Type II can use the information requested in 329 IAC 10-24-3 and 10-24-4 as an outline in preparing the geology description. Sites with waste that test as restricted waste Type III can use the information requested in 329 IAC 10-32-3.***

***3) <u>Closure Plan</u>: A detailed proposal for closure design and construction and for post-closure care of the impoundment must be submitted. Sites will close under the***

***applicable requirements for Restricted Waste Sites (RWS), as described in 329 IAC 10-24 thru 10-38, depending on the characteristics of the waste in the impoundments.***

***Please note, if the residue in the impoundment is determined to be hazardous waste, this guidance is not applicable; for more information consult the Permit Branch for guidance at (317)232-4462.***

***At a minimum, the proposed closure plan must include details of the following:***

***(A) Cap Design: A description of the cap including dimension, Slope, and description of materials to be used. Caps at sites that test as restricted waste site Type I or Type II must be designed in accordance with applicable requirements of 329 IAC 10-30-2 or 10-30-3. Sites that test as restricted waste site type III must be designed in accordance with 329 IAC 10-37-2. Sludges from wastewater treatment plants that test as restricted waste site Type III must also comply with the design requirements of 40 CFR 503.***

North Ash Pond

The North Ash Pond will be closed in place. As shown on Sheet 13 in Appendix A, the final grades will be constructed using 1 to 3 percent slopes. The peak elevation of the final grades within the limits of the North Ash Pond will be approximately 467. The 1 percent grades will be utilized in the vicinity of the transmission lines to help provide the necessary clearance to those lines. Perimeter slopes of 20 percent will be utilized to help establish the full 3 ft thick soil cover. Compacted structural fill required to form the final grades will be obtained from the material excavated to accomplish closure by removal of Ash Pond A and the Coal Pile Ash Fill.

The final cover system will consist of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 13, and 15 through 18, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

Primary Pond

The Primary Pond will be closed in place. As shown on Sheet 13 in Appendix A, the final grades will be constructed using 3 percent slopes. The peak elevation of the final grades within the limits of the Primary Pond will be approximately 468. Compacted structural fill required to form the final grades will be obtained from the material excavated to accomplish closure by removal of Ash Pond A and the Coal Pile Ash Fill.

The final cover system will consist of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 13, and 15 through 18, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

Primary Pond Ash Fill Area

The Primary Pond Ash Fill Area will be closed in place. As shown on Sheet 13 in Appendix A, the final grades will be constructed using 1 to 3 percent slopes. Perimeter slopes of 20 percent will be utilized to help establish the full 3 ft thick soil cover. The peak elevation of the final grades within the limits of the Primary Ash Fill Area will be approximately 468. Compacted structural fill required to form the final grades will be obtained from the material excavated to accomplish closure by removal of Ash Pond A and the Coal Pile Ash Fill.

The final cover system will consist of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 13, and 15 through 18, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

Ash Pond A

Ash Pond A will be closed using closure by removal procedures. As a result, it will not be necessary to construct a final cover to meet the requirements noted above.

Once the excavation of the CCR materials and 1 additional foot of material has been completed, up to 17 feet of compacted structural soil fill will be placed in the excavation to establish the proposed grades illustrated on Sheet 13 in Appendix A. As noted on Sheet 18, a 2 ft thick soil cover will be placed over the structural fill and the area will be reforested. Channels (troughs) formed in the revised base will be lined with grass or riprap (as needed).

The proposed final grades in Ash Pond A include removal of the existing berms on the west and south sides of the pond. The removal of the ash, in addition to the modifications of these berms, will allow this area to serve as a portion of the floodplain for the Ohio River. Details regarding the final alignment of the drainage channels and the type of trees and brush that will be planted to vegetate the area will be determined as part of the Construction in a Floodway Permit Application to be submitted to the Indiana Department of Natural Resources.

The proposed grading plan provided on Sheet 13 also includes the proposed modifications to establish a stabilization berm on the south sides of the Primary Pond Ash Fill Area and the Coal Pile Ash Fill Area to separate these locations from the proposed final grades within the closure by removal portion of Ash Pond A. The existing berm will be modified to create a 5H:1V sideslope utilizing compacted soils structural fill. Riprap will be placed on the exposed slope up to the 100 year flood elevation of the Ohio River to protect the berm when the regraded Ash Pond A area is inundated by floodwater.

Secondary Settling Pond

As noted in the Interim Closure and Post-Closure Plan submitted to IDEM on February 29, 2016, the original intent was to utilize closure by removal procedures across the entire footprint of the pond and then backfill the area to form the grades noted on AECOM Drawing No. GLS_C901.002.010, a copy of which is provided in Appendix A, Section A.2.

It was necessary to perform the closure activities in the Secondary Settling Pond while Ash Pond A remained in service to support the Gallagher Station operations. During the initial phases of excavation of the CCR materials from the Secondary Settling Pond seepage from Ash Pond A was noted in the excavation once a portion of the CCR materials were removed from the south end of the pond. The presence of this seepage made it extremely difficult to visually inspect the base of the excavation and there was concern that the seepage could jeopardize the stability of the embankment that separates Ash Pond A from the Secondary Settling Pond. After discussing these conditions with IDEM technical staff on July 20, 2016, it was agreed that Duke Energy would modify its plans and utilize in-place closure procedures for all of the Secondary Settling Pond closure.

As noted in the July 27, 2016 letter to IDEM, the modified closure plan still included the removal of the majority of the CCR materials from the excavation to help facilitate the completion of the stabilizing berm that was constructed on the east side of the embankment that separates Ash Pond A from the Secondary Settling Pond.

Following the removal of the CCR materials from the Secondary Settling Pond, the excavation was backfilled to form the final grades noted on AECOM Drawing No. GLS_C901.002.010, a copy of which is provided in Appendix A, Section A.2. The revised grades within the limits of the closed Secondary Settling Pond were established by placing 15 to 20 ft of structural fill to form the final grades that vary from approximately EL 432 to EL 427, sloping from north to south at approximately 0.5%. The structural fill material consists of natural soil containing a minimum of 25 percent fines and less than 5% organics. The fill was placed in 8 inch lifts and compacted with a minimum of three passes of the construction equipment.

The final cover system consists of a minimum of 18 inches of compacted cohesive soil placed over the 15 to 20 ft of compacted structural fill soil. The compacted cohesive soil layer, which is documented to have a maximum permeability of $1 \times 10^{-5}$ cm/sec, is overlain by a 6 inch vegetated layer. A full closure certification report for the Secondary Settling Pond will be submitted under separate cover.

As noted on Drawing No. GLS_C901.002.009, surface water from road ditches will be discharged onto the structural fill from culverts located in the northeast and southeast corners of the closed pond. This water, along with runoff from the surrounding slopes, will be conveyed to the outlet pipe located in the southwest corner of the closed pond. It is emphasized that the final grading plan is sloped to drain to this outlet pipe and water will not be impounded within the limits of the closed pond.

Coal Ash Fill Area

The Coal Ash Fill Area will be closed using closure by removal procedures. As a result, it will not be necessary to construct a final cover to meet the requirements noted above. However, once closure activities have been completed in the Coal Ash Fill Area, the area will be repurposed to serve as a lined pond to store leachate from the permitted landfill and runoff from the Station during decommissioning activities.

Ash Pond B

As noted previously, approximately 49 acres of the 61.7 acre ash pond have been permitted as a Type I Restricted Waste Landfill operating under IDEM Solid Waste Facility Permit FP 22-01. IDEM approved a minor modification to the landfill permit on November 1, 2016 to modify the landfill closure area to include the remainder of Ash Pond B. Therefore, no additional details regarding closure of Ash Pond B are included in this submittal.

***(B) Final Contour Map: A plot plan that indicates the fill boundaries and the proposed final contours of the site at intervals of no more than two (2) feet.***

Drawings illustrating the proposed grades at the time of closure are provided in Appendix A. As noted above, the slope of the top of areas which are closed in place will be approximately 3 percent over the majority of the area at the time of closure. It is anticipated that the ponded ash will settle in some areas under the weight of the structural fill needed to establish the required slopes as well as the final cover itself. The final slope of the cover system (i.e., following settlement) will provide positive drainage off of the closed units.

***(C) Ground Water Monitoring: Sites that test as restricted waste site type I or Type II must prepare a Ground Water Monitoring and Corrective Action plan in accordance with applicable requirements of 329 IAC 10-29. For wastes which test as Type III, the responsible party must either document the lagoon has a barrier in accordance with 329 IAC 10-34 or it will be necessary to develop a similar program for monitoring ground water downgradient or at the facility boundary to detect any future release from the closed impoundment. Sludge from waste water treatment plants that test as restricted waste site Type III must also comply with the ground water requirements of 40 CFR 503. If monitoring is determined to be necessary, a plan should be submitted to this office which includes:***

***(1) the number and placement of monitoring wells;***

The proposed groundwater monitoring system is described in Section 2(E)(4)(a) and (b). Summarizing those sections, twenty monitoring wells are proposed for semi-annual groundwater monitoring. Existing monitoring wells are shown on Sheet 6 of Appendix A.

***(2) the number and frequency of samples;***

The proposed groundwater sampling program is described in section 2(E)(4)(e) above.

***(3) the chemical parameters to be monitored that should be consistent with those identified with the impoundment characterization;***

The proposed monitoring parameters are described in section 2(E)(4)(e) above. Following collection of eight rounds of groundwater monitoring results, the analytical parameter list may be revised if continued monitoring of specified parameters is not beneficial for assessing groundwater quality with respect to Ash Pond System closure.

***(4) sampling protocol; and,***

The proposed sampling protocols are outlined in section 2(E)(4)(e) above. A groundwater sampling and analysis plan that describes the sampling protocols, sampling methods, monitoring points, and monitoring parameters will be prepared within 90 days following IDEM's approval of this Closure Plan.

***(5) how the determination of releases will be made.***

Groundwater quality results will be evaluated according to the assessment monitoring program described in section 2(E)(4)(e) above.

***(D) Closure Certification: Sites that test as restricted waste site Type I or Type II must certify closure in accordance with applicable requirements of 329 IAC 10-30-7. Sites that test as restricted waste site Type III must certify closure in accordance with 329 IAC 10-37-7.***

Duke Energy will submit a closure certification report at the completion of the closure activities at each of the ash ponds. These reports will be prepared to address the requirements of 329 IAC 10-30-7.

***(E) Post-Closure Requirements: Sites that test as restricted waste site Type I or Type II must comply with the applicable post-closure requirements of 329 IAC 10-31. Restricted waste site Type III closure must comply with the applicable post-closure requirements of 329 IAC 10-38. Post-closure care will extend for 30 years as specified by 329 IAC 10-31-2(b) or 329 IAC 10-38-2(b). Funding mechanisms to cover the post-closure requirements must be established in accordance with 329 IAC 10-39.***

Duke Energy will comply with the applicable post-closure requirements of 329 IAC 10-31.

***(F) Responsibilities after Post-Closure: After post-closure is certified as complete, the owner, operator and/or responsible party will still be responsible for the requirements of 329 IAC 10-31-5, 10-31-6 and 10-31-7 or 329 IAC 10-38-5, 10-38-65 and 10-38-7, as applicable.***

Duke Energy will comply with the responsibilities outlined above after completion of the post-closure period. Closure and Post-Closure Cost Estimates, presented on IDEM forms, are provided in Appendix H along with the legal description of the various ash pond solid waste boundaries.

*Duke Energy*
*WP994 / 1000 East Main Street*
*Plainfield, IN 46168*

**HAND DELIVERED**

March 21, 2016

Mr. Nick Batton
Permit Manager
Office of Land Quality
Indiana Department of Environmental Management
MC 65-45 IGCN 1101
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Subject: Proposed Modification to Existing Closure and Post-Closure Plan
East Ash Pond
Gibson Generating Station
Gibson County, Owensville, Indiana

Dear Mr. Batton:

Duke Energy Indiana, LLC. (DEI) respectfully submits to the Indiana Department of Environmental Management (IDEM) this modification to the Existing Closure and Post-Closure Plan for the East Ash Pond (FP# 26-UP-01) at Gibson Station located in Gibson County, Indiana. The attached application was prepared by ATC Group Services LLC.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for gathering the information, submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information.

Please contact me at 317-838-6027 if you have any questions.

Sincerely,
Duke Energy Indiana, LLC.

Owen R. Schwartz, L.P.G.
Lead Environmental Specialist
EHS CCP Waste & Groundwater Programs

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

# PROPOSED MODIFICATION TO EXISTING CLOSURE AND POST-CLOSURE PLAN

EAST ASH POND
GIBSON GENERATING STATION
1097 NORTH 950 W
OWENSVILLE, INDIANA, 47665

ATC PROJECT NO. 170LF00085

MARCH 21, 2016

PREPARED FOR:

DUKE ENERGY
139 EAST 4TH STREET
MC – EX320
CINCINNATI, OH 45202
ATTENTION: CHARLES HINER, P.E.

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

March 21, 2016

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Mr. Charles Hiner, P.E.
Manager, Closure Engineering – Midwest Region
Duke Energy
139 East 4th Street
MC EX320
Cincinnati, Ohio 45202

Re: **Proposed Modification to Existing Closure and Post-Closure Plans**
East Ash Pond
Gibson Generating Station
1097 North 950 W
Owensville, Indiana, 47665
ATC Project No. 170LF00085

Dear Mr. Hiner:

In accordance with your request, ATC Group Services LLC (ATC) prepared the enclosed Proposed Modification to the existing Closure and Post-Closure Plans for the East Ash Pond System at the Gibson Generating Station. The original application of the Closure and Post-Closure Plans for the East Ash Pond System was submitted on August 4, 2008 and approved by the Indiana Department of Environmental Management (IDEM) on March 11, 2009. The approved plans addressed the closure of 343.2 acres covered by Cells 1, 2 and 3 of the East Ash Pond System. To date, approximately 229.5 acres of that area have received Partial Closure Certification and the remainder of the area is scheduled to be completed by 2019.

The purpose of this proposed modification to the existing Closure and Post-Closure Plans is to expand the closure area to include the 41.6 acre East Ash Pond Settling Basin that is immediately south, and adjoins to, Cells 1 and 2 of the East Ash Pond System. Duke Energy intends to close the East Ash Pond Settling Basin as an inactive CCR surface impoundment. Barring unforeseen conditions, closure will be completed no later than April 17, 2018 to be in compliance with 40 CFR 257.100(b). This report is intended to include the information necessary for IDEM review and approval of the proposed modification based on closure by removal procedures.

We appreciate the opportunity to be of assistance with this project. If you have any questions regarding this letter, please contact our office.

Sincerely,

**ATC Group Services LLC**

| | | |
|---|---|---|
| Mark Breting, L.P.G | John R. Noel, L.P.G. | Donald L. Bryenton, P.E. |
| Senior Project Geologist | Senior Project Geologist | Principal Engineer |

Copies: (3) Charles Hiner
(1) Kevin Olivey
(1) Owen Schwartz
(1) Rebecca Warren
(1) Rebecca Sparks

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# Proposed Modification to Existing Closure and Post-Closure Plans

Gibson Generating Station
East Ash Pond Settling Basin

## 1 Introduction

Duke Energy Indiana, LLC (DEI) proposes to modify the Closure and Post-Closure Plans previously approved by IDEM for the East Ash Pond (EAP) at the Gibson Generating Station to expedite the closure of the adjoining East Ash Pond Settling Basin (EAP Settling Basin) in order to address requirements contained in 40 CFR Part 257 Subpart D, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (the CCR Rule). The EAP Settling Basin has been identified as an Inactive CCR Surface Impoundment as it stopped receiving CCR on or before October 19, 2015 but still contained both CCR and liquids after that date. As noted in the approved Closure Plan, Cells 1, 2 and 3 of the EAP will be closed utilizing in-place closure procedures. However, the EAP Settling Basin will be closed using closure by removal procedures as outlined in detail in the following application. Barring unforeseen conditions, closure certification will be completed no later than April 17, 2018.

## 2 East Ash Pond Settling Basin Summary

### 2.1 Impoundment Dimensions

The Gibson EAP Settling Basin surface impoundment is located in Gibson County, Montgomery Township, Indiana in portions of Sections 3 and 4, Township 2S, Range 12W. The EAP Settling Basin surface impoundment is located on portions of the East Mount Carmel, IND. – ILL. and Owensville, IND. Quadrangle maps. The impoundment ranges between approximately 630 feet in width, 2,750 feet in length, and encompasses approximately 41.6 acres.

The EAP Settling Basin is a single surface impoundment that originally served as the secondary settling basin for discharge from Cells 1, 2 and 3 of the EAP. Now that Cells 1, 2 and 3 no longer receive CCR materials and have been drained, the EAP Settling Basin currently only receives surface water runoff from portions of the closed areas in Cells 1 and 3, and all of Cell 2, which is currently being closed. Once closure activities have been completed in Cell 2, the EAP Settling Basin will no longer be needed.

The location of the EAP Settling Basin relative to Cells 1, 2 and 3 of the EAP is shown on Sheets 2R and 7 in Appendix A.

### 2.2 Waste Description

It is our understanding that the EAP Settling Basin has never directly received CCR or plant process waters. Solids present in the base of the pond are the result of secondary settling of discharge from Cells 1, 2 and 3 of the EAP or the result of runoff from adjacent roads. Currently, water impounded in the EAP Settling Basin is pumped into the Gibson Cooling Pond.

### 2.3 Volume of Waste

Based on bathymetry information provided by others, the anticipated volume of CCR materials and/or other solids that will be removed from the EAP Settling Basin is approximately 69,000 cubic yards.

## 3 Subsurface Geology and Hydrogeology at EAP Settling Basin

In general, the following geology and hydrogeology discussion will reference previously submitted EAP System reports including the August 4, 2008 East Ash Pond System Closure and Post-Closure Plans. Information from recent on-going geotechnical investigation at location ESB-08 is also discussed. A revised aerial photograph of the Site depicting monitoring wells and soil borings is shown on Sheet 2R of Appendix A. The geological cross sections previously submitted as part of the approved closure plan are still applicable, however, a fourth cross section (D-D') is provided as Sheet 6 in Appendix A. A topographical map of the Site is presented as Sheet 7 of Appendix A.

Cross section D-D' incorporates borings and wells along the south edge of the EAP Settling Basin, some of which were completed after submittal of the approved closure plan. Copies of boring logs at locations MW-21 and MW-22 were submitted to IDEM in a report dated September 24, 2008. A copy of boring log ESB-08 is provided in Appendix B.

### 3.1 Regional Geology and Hydrogeology Summary

The regional geology and hydrogeology for the Gibson EAP system is summarized in the 2008 East Ash Pond System Closure and Post-Closure Plans and is incorporated by reference.

### 3.2 Location and Summary of IDNR Water Well Records

Results from investigation of Indiana Department of Natural Resources (IDNR) water well records are summarized in the 2008 East Ash Pond System Closure and Post-Closure Plans and are incorporated by reference. No additional IDNR water well records were identified within a 1/2 mile distance after adjusting the perimeter to include the EAP Settling Basin.

### 3.3 Site Geology and Historical Boring Investigation Logs

The site geology was discussed in Section (E) of the 2008 EAP System Closure and Post-Closure Plans. The discussion summarized results from several historical boring investigations in the area of the EAP. This information is incorporated by reference and is not duplicated in this Proposed Modification to Existing Closure and Post-Closure Plans.

Subsurface information, including boring logs, for locations MW-21 and MW-22 was submitted to IDEM in a Monitoring Well and Piezometer Installation Report dated September 24, 2009. These results are incorporated by reference.

## **3.4** On-Going Geotechnical Investigation Boring Log ESB-08

As part of an ongoing geotechnical investigation for ash pond closure evaluations, soil borings associated with the EAP have been drilled by others. The geotechnical soil boring locations are depicted on Sheets 2R and 7 in Appendix A. One of these borings, ESB-08, is located on the south perimeter of the EAP Settling Basin. A copy of the ESB-08 boring log is included in Appendix B and the subsurface information at this location is incorporated on cross section D - D'. Results from boring ESB-08 show the presence of cohesive unconsolidated soils from the ground surface to a depth of 26.5 feet below ground surface (bgs). Brown sand was present below 26.5 feet to the bottom of this boring at 40.0 feet bgs.

## **3.5** Discussion of Cross Section D-D'

Site geology for the EAP System is depicted on a series of cross sections included in the 2008 EAP Closure and Post-Closure Plans. These cross sections are incorporated by reference. An additional cross section (D - D') is included in this Proposed Modification to Existing Closure and Post-Closure Plans using subsurface information from borings that were not previously available. Borings utilized to prepare cross section D - D' indicate that unconsolidated fine grained cohesive deposits extend to elevations ranging between approximately EL 372 and EL 378. These materials are interpreted as lower permeability alluvial deposits consisting of clay, silt loam, sandy loam, silty clay loam, clay, and silty clay.

Granular deposits consisting of sand or sand and gravel ranging up to at least 77 feet in thickness are present below the cohesive units. These relatively higher permeability unconsolidated materials are interpreted as glacial outwash deposits consisting of brown to gray sands. As the cross section indicates, thicker deposits of coarse sand are present in eastern portions of the transect relative to interpreted finer grained sand in western portions of the transect.

Bedrock was not encountered in the deepest boring (PZ-8; 92 ft-bgs) along the D – D' transect.

## **3.6** Summary of Anticipated Groundwater Monitoring System

Groundwater monitoring and statistical evaluation activities will be completed in accordance with Section E of the associated EAP Complex C/PC Plan approval letter dated March 11, 2009 and the Groundwater Sampling and Analysis Plan for the East Ash Pond System dated August 24, 2011. Since the existing, approved, groundwater monitoring system includes the area of the EAP Settling Pond, no additional monitoring wells are necessary.

# 4 Proposed Modification to Existing Closure Plan

The EAP Settling Basin has been identified as an Inactive CCR Surface Impoundment in accordance with the definitions provided in the CCR Rule. As such, closure of this unit must be certified by April 17, 2018 to be in compliance with 40 CFR 257.100(b). The following paragraphs outline details regarding the proposed modifications to incorporate the Settling Basin into the existing EAP closure plans.

## 4.1 Closure by Removal

As discussed in detail with IDEM's technical staff, DEI proposes to utilize a closure by removal program as the closure plan for the EAP Settling Basin. This program will consist of the following activities:

- Closure activities will progress in phases to allow approximately the western half of the pond to remain in service during the completion of the final closure of Cell 2. Closure activities for the eastern half of the Settling Basin are tentatively scheduled to begin in 2016.
- The EAP Settling Basin will be dewatered, with controls to prevent the transport of solids, utilizing the existing pumping system to discharge the water into the Gibson Cooling Pond.
- The sediment currently present in the EAP Settling Basin will be dewatered, excavated and transported to either the Gibson South Landfill or Cell 2 of the Gibson East Ash Pond Closure, where the material will be placed as structural fill. It is currently anticipated that the base of the initial CCR removal will be at approximately EL 388.
- Following removal of CCR materials from the EAP Settling Basin, the basin will be visually inspected by a third party engineer or geologist to verify that CCR materials have been removed. Following this visual inspection, and any subsequent removal required by the inspection, the surface of the excavation will be surveyed on 100 ft centers.
- A minimum of one (1) additional foot of material will be removed from the excavation and the material transported to and placed in either the Gibson South Landfill or the Gibson East Ash Pond Closure. Following removal of the additional one (1) ft of material, the excavation will be surveyed again using the same grid system to confirm the removal of a minimum of one (1) ft of material.

## 4.2 Proposed Closure Schedule

Closure activities are tentatively scheduled to begin in the eastern half of the EAP Settling Basin by July 2016. Certification of the closure of the entire EAP Settling Basin is required by April 17, 2018, to be in compliance with 40 CFR 257.100(b).

## 4.3 Proposed Closure Design

The anticipated base grades resulting from the removal of the existing CCR materials, non-CCR sediments, and the one (1) ft of soil underlying the CCR materials are illustrated on Sheet 6 in Appendix E. The final grades of the base of the excavation will be documented as part of the Closure Certification Report.

Following the removal of the CCR material and one (1) additional foot of the underlying soils from the EAP Settling Basin, the existing soil embankments on the east, south and west sides of the basin will be removed and the soil used as a portion of the compacted structural fill needed to form the final grades noted on Sheet 1R in Appendix E. The upper 24 inches of the backfill will consist of vegetative soils. The final grades are generally sloped at 1% to the south to prevent the ponding of water adjacent to Cells 1 and 2 of the EAP.

Surface water runoff from Cells 1, 2 and 3 will be discharged into a trapezoidal ditch that bisects the proposed grades of the final cover system in the EAP Settling Basin. The trapezoidal ditch will have a base width of 10 ft, 3H:1V sideslopes, and an average depth of 3 ft. In general, the base of the channel will be sloped at 0.5%, with the exception of the transition section from the south end of Cells 1 and 2 to the proposed final grades of the EAP Settling Basin where the average slope will be about 6.7%. The proposed ditch is designed to convey the 100 year, 24-hour storm event runoff to an existing pond located approximately 300 ft south of the south side of the EAP Settling Basin.

At a minimum, riprap will be utilized in the proposed ditch at the locations noted on Sheet 1R in Appendix E to minimize the potential for erosion of the proposed channel in transition sections. Further, a geomembrane liner will be utilized below the channel to help minimize the infiltration of surface water into the structural fill used to backfill the EAP Settling Basin. Details regarding the proposed riprap sections and the underlying geomembrane are provided on Sheet 5 in Appendix E.

The original closure plan for the EAP included the discharge of downdrains and toe drains on the south side of Cells 1 and 2 into the EAP Settling Basin. As noted on Sheet 1R in Appendix E, the proposed modifications to that closure plan include the discharge of those downdrains and toe drains into either the proposed drainage ditch that bisects the final cover grades of the closed EAP Settling Basin or the area east or west of the EAP Settling Basin.

## 4.4 Revised Closure and Post-Closure Plans

The Closure and Post-Closure Plans provided in Appendix J of the original closure application have been revised and are provided in Appendix C to this Closure Plan Amendment. The original Closure and Post-Closure Plans have been revised to include the additional 41.6 acre EAP Settling Basin and adjusted to remove the 229.5 acres of Cells 1 and 3 that have already obtained Partial Closure Certification.

## 4.5 Revised Legal Description of Solid Waste Boundary

The legal description of the solid waste boundary provided in the original closure application included Cells 1, 2 and 3. The area listed in that description was 343.2 acres. The original solid waste boundary was estimated from the physical limits noted on an air photo of the site because a topographic map of the area was not available at the time. A topographic map of the entire site was prepared in 2015 for the development of this amendment to the original plan. Based on this more detailed mapping, the area inside the solid waste boundary of Cells 1, 2 and 3 was determined to be 341.2 acres. The EAP Settling Basin adds an additional 41.6 acres to the solid waste boundary of the entire ash pond system, resulting in a total area of 382.8 acres. These revisions are reflected in the Revised Closure and Post-Closure Plans described in Section 4.4.

## Appendices

| | |
|---|---|
| **Appendix A:** | **Geologic and Hydrogeologic Sheets** |
| Sheet 2R: | Site Plan Aerial Photograph |
| Sheet 6: | Cross Section D – D' |
| Sheet 7 | Site Plan Topographic Map |

**Appendix B:** **On-Going Geotechnical Investigation Boring Log ESB-08**

**Appendix C:** **Revised Closure and Post-Closure Plans**

**Appendix D:** **Revised Legal Description of Solid Waste Boundary**

| | |
|---|---|
| **Appendix E:** | **Proposed Closure Plan Drawings** |
| Sheet 1R | Proposed Grading Plan for Settling Basin Final Cover |
| Sheet 5 | Typical Details |
| Sheet 6 | Excavation Plan |

*George T. Hamrick*
*Senior Vice President*
*Coal Combustion Products*

*400 S. Tryon Street, ST06A*
*Charlotte, NC 28202*

*Phone: 980-373-8113*
*Email: george.hamrick@duke-energy.com*

HAND DELIVERED

December 21, 2016

Mr. Nick Batton
Permit Manager
Office of Land Quality
Indiana Department of Environmental Management
MC 65-45 IGCN 1101
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Subject: Closure and Post-Closure Plan Application
North Ash Basin System
Gibson Generating Station
Gibson County, Owensville, Indiana

Dear Mr. Batton:

Duke Energy Indiana, LLC. (DEI) respectfully submits to the Indiana Department of Environmental Management (IDEM) a Closure and Post Closure Plan application for the North Ash Basin Area at Gibson Station located in Gibson County, Indiana. This system includes both the North Settling Basin and the North Ash Pond. Interim Closure and Post-Closure Plans for the North Ash Pond were submitted to IDEM on September 29, 2016. A Response to Comments Letter was sent to IDEM on December 13, 2016 regarding the interim plans for the North Ash Pond. The attached application, prepared by ATC Group Services LLC, supplements the North Ash Pond Interim Plans and details the North Settling Basin Closure and Post-Closure plans by providing the documentation requested in IDEM's "Surface Impoundment Closure Guidance."

I certify under penalty of law that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for developing the plan, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information. If you have any questions or require additional information regarding this submittal please contact either Owen Schwartz at 317-838-6027 or Charlie Hiner at 513-287-2076.

Respectfully submitted,

George T. Hamrick

George T. Hamrick
Senior Vice President
Coal Combustion Products

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

# PROPOSED CLOSURE AND POST-CLOSURE PLANS

NORTH ASH BASIN SYSTEM
GIBSON GENERATING STATION
1097 NORTH 950 W
OWENSVILLE, INDIANA 47665

ATC PROJECT NO. 170LF00085

DECEMBER 16, 2016

PREPARED FOR:

DUKE ENERGY
139 EAST 4TH STREET
MC – EX320
CINCINNATI, OH 45202
ATTENTION: MR. CHARLES HINER, P.E.

ATC

December 16, 2016

Mr. Charles Hiner
Duke Energy
139 East 4th Street
Cincinnati, OH 45202

ATC Group Services LLC

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Suite 100
Indianapolis, IN 46256

Phone +1 317 849 4990
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www.atcgroupservices.com

Re: **Proposed Closure and Post-Closure Plans**
North Ash Basin System
Gibson Generating Station
Owensville, Indiana 47665
ATC Project No. 170LF00085

Dear Mr. Hiner:

In accordance with your request, ATC Group Services LLC (ATC) has prepared the enclosed proposed final Closure and Post-Closure Plans for the North Ash Basin System at the Gibson Generating Station (Gibson Station) in Owensville, Gibson County, Indiana. As you are aware, portions of this report related to groundwater quality and the proposed groundwater monitoring program were prepared by M.S. Beljin & Associates.

We appreciate the opportunity to be of assistance with this project. If you have any questions regarding this letter, please contact our office.

Sincerely,

for Mark E. Breting, L.P.G.
Senior Project Geologist

Brent A. Miller, CHMM
Senior Project Scientist

John R. Noel, L.P.G.
Senior Project Geologist

Donald L. Bryenton, P.E.
Principal Engineer

LICENSED PROFESSIONAL JOHN R. NOEL No. 1681 STATE OF INDIANA GEOLOGIST

DONALD LEE BRYENTON REGISTERED No 17977 STATE OF INDIANA PROFESSIONAL ENGINEER

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### Tables



### Figures



### Appendices

# Introduction

The Gibson Station is a five-unit coal fired generating facility located in Gibson County, Montgomery Township, Indiana, in Township 1S, Range 12W, in portions of Sections 32, 33 and 34, and Township 2S, Range 12W, in portions of Sections 3, 4, 5, 7, 8 and 9. The facility, which began commercial operation in 1976, is located along the eastern bank of the Wabash River approximately 35 miles north of Evansville, Indiana and 2 miles east of Mt Carmel, Illinois.

A total of six CCR surface impoundments are present at the Gibson Station (i.e., the North Ash Pond, the North Settling Basin, the East Ash Pond, the East Settling Basin, the South Settling Basin and the South Ash Fill Area). Four of these impoundments (i.e., the North Ash Pond, the North Settling Basin, the South Settling Basin and the East Settling Basin) are regulated by the Federal Coal Combustion Residual (CCR) Rule. The remaining two surface impoundments (i.e., the South Ash Fill Area and the East Ash Pond) stopped receiving CCR materials and were drained prior to October 14, 2015. All six of the impoundments are regulated by the Indiana Department of Environmental Management (IDEM). Current operation of the ash ponds is limited to the sluicing of bottom ash and boiler slag through active sluice lines to discharge into the North Ash Pond. The approximate locations of all six surface impoundments are noted on the USGS topographic quadrangle map 7½ minute series provided as Sheet 3 in Appendix A.

The original Closure and Post-Closure Plans for Cells 1, 2 and 3 of the East Ash Pond were submitted to IDEM on August 20, 2008 and approved by IDEM on March 11, 2009. Those plans were recently modified to include the proposed Closure and Post-Closure Plans for the East Ash Pond Settling Basin in a document submitted to IDEM on March 21, 2016. The modified plans were approved by IDEM on October 25, 2016. To date, a total of 229.5 acres of the East Ash Pond System have received partial closure certification.

Interim Closure and Post-Closure Plans for the South Settling Basin were submitted to IDEM on March 10, 2016. Duke Energy received a letter from IDEM dated June 22, 2016 indicating that they agree conceptually with the proposed closure activities. In accordance with IDEM's request, Duke Energy also submitted a letter of notification dated July 18, 2016 to document the start of construction of the West Ditch within the limits of the South Ash Fill Area. Based on IDEM's conceptual agreement with the plans for both the South Settling Basin and the West Ditch, closure activities have been initiated in those areas. Interim Closure and Post-Closure Plans were submitted to IDEM for the South Ash Fill Area on September 15, 2016. The proposed final Closure and Post-closure Plans for the South Ash Basin System will be submitted under separate cover.

The following document was prepared to present the proposed final Closure and Post-Closure Plans for the North Ash Basin System, which consists of the North Settling Basin and the North Ash Pond. An Interim Closure and Post-Closure Plan for the North Ash Pond was submitted to IDEM on September 29. 2016.

The objective of this report is to provide a detailed description of the work that will be performed to close the impoundments that are subject to the CCR Rule (i.e. the North Settling Basin and the North Ash Pond) in accordance with Federal CCR Rule §257.102(b)(1)(i-vi) and the requirements outlined in IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. To help facilitate IDEM's review of the proposed Closure and Post-Closure Plans, the following sections of this report have been formatted to provide the content of the IDEM guidance document in bold italics followed by our response.

# Surface Impoundment Closure Guidance

***INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT***
***OFFICE OF LAND QUALITY***

***SURFACE IMPOUNDMENT CLOSURE GUIDANCE***

***The following guidance provides an outline of the information required by this office to approve the closure of a surface impoundment. This guidance is meant to provide general guidelines for obtaining closure approval. Approval for the closure of any specific impoundment must be coordinated through the Permit Branch of the Office of Land Quality (OLQ): for more information contact Solid Waste Permit Section at 317/232-7200.***

***Pursuant to 329 IAC 10-3-1(9), the operation of surface impoundments is excluded from regulation under the solid waste management regulations of 329 IAC 10. However, this exclusion goes on to state ". . . the final disposal of solid waste in such facilities at the end of their operation is subject to approval by the commissioner . . ." Impoundments which receive only coal ash and either (1) have a water pollution control facility construction permit under 327 IAC 3, or (2) receive less than 100 cubic yards of coal ash per year from generators who produced less than 100 cubic yards of coal ash per year, are exceptions and remain excluded pursuant to 329 IAC 10-3-1(8) and (10).***

***Two basic types of closures for surface impoundments are covered in this guidance: 1) Clean Closure, and 2) Closure In Place. The technical information that needs to be submitted along with a request for closure approval will vary depending on whether a clean closure or in-place closure is planned.***

Based on discussions with the IDEM technical staff, the agency has also agreed to allow two additional closure alternatives, described as follows:

- Alternative No. 1, Closure by Removal – IDEM identifies this closure alternative as the removal of all CCR materials, plus a minimum of 1 foot of the soils present immediately below the CCR materials, for proper treatment, disposal or beneficial use. IDEM guidance also suggests that a minimum of 18 inches of cover soil and a 6 inch vegetative layer will generally be required over the base of the excavation. This plan requires a description of the grading plan that will be utilized to prevent the ponding of water over the final grades. This plan also requires the development of a groundwater monitoring program.

- Alternative No. 2, RISC Based Closure – Indiana's risk assessment program offers two options for risk-based assessment and closure. As described in IDEM's Remediation Closure Guide (IDEM, 2012), facilities may utilize IDEM's published screening levels for potential contaminants. Screening levels are concentrations calculated from standard equations and exposure assumptions. Sites are generally eligible for closure if concentrations do not exceed screening levels. As an alternative, facilities may perform a site specific risk assessment that more accurately predicts future potential human health and ecological exposures. In both cases it will likely be necessary to collect both background samples and samples of potentially impacted soil and groundwater in the vicinity of the surface impoundment. Both default screening levels and site-specific clean-up levels are negotiated with IDEM and are typically selected to meet risk levels associated with industrial exposure. This plan also requires the development of a groundwater monitoring program.

Closure options for the Gibson Station surface impoundments discussed in this document include clean closure, closure in place, closure by removal, and RISC-based closure. The closure plans selected for each impoundment are as follows:

- North Ash Pond – In-place Closure
- North Settling Basin – Combination of In-Place Closure and Closure by Removal

CCR materials generated from the Gibson Station operations or removed from the North Settling Basin will be beneficially used as structural fill to form the subgrade for the final cover in the North Ash Pond. The material will be placed in compacted lifts to form a stable subgrade for the composite final cover system. Final cover areas will be vegetated and maintained, and a notation will be added to the property deed.

***IN-PLACE CLOSURE***

***This type of closure involves leaving waste residues within the impoundment and developing a plan designed to contain, control, and monitor the impoundment as a land disposal unit in a manner which is protective of public health and the environment. Waste residue characterization and site characterization, including information about both the general area and the impoundment design and construction, is required for in-place closure. The design and monitoring requirements for impoundments which are closed with the waste in place will be based on type of waste disposed of in an impoundment. The general requirements for nonmunicipal solid waste landfill and restricted waste site (RWS) Type I and Type II are found under 329 IAC 10-24 thru 10-31. (Any waste containing significant quantities of VOCs, or SVOCs will generally be required to close under nonmunicipal solid waste requirements.) The general requirements for Type III are found under 329 IAC 10-32 thru 10-38. In addition, if the applicable restricted waste site criteria are not at least as stringent, biosolid impoundments must meet the land disposal requirements of Federal rule 40 CFR 503.***

***Please be aware that this office may require clean closure if the waste, residue or site characteristics indicate that in-place closure will not be protective to human health and the environment.***

***The following additional information will be required for staff to review and consider the impoundment as a candidate for this type of closure approval:***

***1) <u>Waste Characterization</u>: A waste determination must be conducted pursuant to 40 CFR 262.11, and, if impoundments will be closed in the same manner as restricted waste sites, the waste must be classified as specified in 329 IAC 10-9-4. Additional parameters***

***which may need to be evaluated will be determined on a case-by-case basis. The following waste characterization information should be submitted as part of any in-place closure request.***

***(A) Identification of Physical Parameters: Any physical aspects of the residue that may pose an environmental or technical design problem should also be reported and quantified as necessary and applicable: i.e., low percent solids, high water content, etc.***

***(B) Identification/Quantification of Chemical Constituents: This evaluation generally involves the quantification of the amount of each chemical present within the residue that potentially poses an environmental concern, giving specific consideration to chemicals such as heavy metals, volatile and semi-volatile organic compounds, salts, polychlorinated biphenyls (PCBs), pesticides, neutral leachate parameters defined under 329 IAC 10-9-4, and other chemicals that may pose a public health or environmental threat. These analyses generally involve determining total amounts for these chemicals, but analyses of representative samples of the residue by Toxicity Characteristic Leaching procedure and neutral leachates may also be required to make regulatory status determinations and appropriate disposal decisions.***

***If the responsible party is uncertain as to the waste characterization, the Permit Branch of OLQ can arrange for an OLQ chemist to be consulted for guidance. This office may require that additional parameters be analyzed based on the review of the submitted information.***

For the surface impoundments that will be closed in accordance with the closure by removal procedures, it will not be necessary to perform waste classification testing because the CCR materials will be removed. At the surface impoundments that will be closed in accordance with closure in place procedures, Duke Energy will meet the requirements for a Type I Restricted Waste Landfill final cover. Therefore, it will not be necessary to perform waste classification testing for these units.

***2) <u>Site Characterization</u>: A narrative description of the impoundment must be provided and should include the following items at a minimum:***

***(A) Impoundment Design: A description of physical design/specifications such as dimensions (length, width, depth), liner construction, etc. of the impoundment. The narrative should include any design documentation that may exist such as drawings, field notes, etc.***

<u>North Ash Basin System</u>

The North Ash Basin System was commissioned in 1974, and consists of the North Ash Pond and the North Settling Basin. The complex was formed by constructing above-ground embankments that consist of compacted native soils. The embankments vary in height from approximately 10 ft to 30 ft with a crest elevation of between approximately 404.5 ft and 420.0 ft. The crest width of the embankments generally vary from 15 to 25 ft and the outside slopes are typically 3H:1V.

<u>North Ash Pond</u>

The area of the North Ash Pond at the completion of construction in 1974 is estimated to be approximately 183 acres. As noted on Sheet 4 in Appendix A, approximately 48 acres of the original pond were filled and included in the expansion of the FSS Landfill around 2000. The current area of the North Ash Pond is approximately 134.7 acres. The FSS Landfill expansion area was constructed with a leachate collection system. The approximate location of the outlets for that system are located within the North Ash Pond, as noted on Sheet 4. Discharge from those outlet pipes is currently pumped into the North Ash Pond.

Decant water from the North Ash Pond is discharged to the North Settling Basin via a 24 in. corrugated metal pipe installed through the intercell dike that separates the North Ash Pond from the North Settling Basin. The secondary overflow structure from the North Ash Pond to the North Settling Basin consists of a 30 in. corrugated plastic pipe set just below the normal operating level of the ash pond.

As noted on Sheet 4 in Appendix A, multiple transmission lines cross over the northwest side of the North Ash Pond. The transmission towers associated with these lines are located outside the limits of the ash pond. However, the elevation of this lines will influence the final cover grades in this area.

Also noted on Sheet 4, there are two existing parking areas located in the northwest corner of the North Ash Pond in portions of the pond that were removed from service many years ago.

<u>North Settling Basin</u>

The approximate original limits of the North Settling Basin, which are noted on Sheet 4 in Appendix A, occupy an area of approximately 24.1 acres. As noted on that drawing, the embankment on the northwest side of the North Settling Basin was an extension of Wabash River Levee No. 5, which was constructed by the US Army Corps of Engineers and is maintained by the Committee for the Care and Maintenance of Wabash Levee Unit #5. The top elevation of the levee in this area is 404.0, which corresponds to the 100 year flood level of the Wabash River.

Around 1981 an approximately 200 ft wide strip of the north side of the North Settling Basin was backfilled to form the subgrade for the rail line and roads that currently occupy this area. Test borings drilled within the limits of the previously backfilled strip did not encounter any CCR materials; however, there is no documentation of the removal of all of the CCR materials. The modified limits of the North Settling Basin occupy an area of approximately 16.7 acres.

The crest of the dike separating the North Settling Basin from the North Ash Pond has been widened and is currently serving as the primary access road for contractor parking at the Gibson Station.

***(B) Volume of Waste: The amount of waste or any other residues or material remaining in the impoundment.***

- North Ash Pond - The estimated volume of CCR materials present in the North Ash Pond was prepared based on a comparison of the results of the February 2015 Bathymetry Survey and the design elevations of the impoundment. The estimated volume of CCR material of 4,342,450 cubic yards does not include any material sluiced to the pond after February 2015 or removed from the pond following July 30, 2015. Further, this estimate does not include the volume of CCR material present below the portion of the pond that is now covered by the FSS Landfill. That portion of the original pond will be closed as part of the FSS Landfill.

- North Settling Basin – The estimated volume of 116,770 cubic yards does not include any material discharged to the pond after February 2015 and does not include any material that may have been covered during the construction of the existing rail line and access roads in 1981.

***(C) Discharges to The Impoundment: A detailed description of those Industrial processes, including raw materials used and their characteristics that generated wastes which were placed in the surface impoundment.***

North Ash Pond

The North Ash Pond currently receives sluiced bottom ash and boiler slag from all five units. Until the Station was substantially converted to a dry fly ash handling operation in 2013, the North Ash Pond also received fly ash sluice water. Prior to the conversion, bottom ash and fly ash were physically segregated in the North Ash Pond by sluicing fly ash to the north end of the basin and bottom ash to the south end of the basin. The fly ash was removed from the North Ash Pond by a hydraulic dredge with a booster pump that discharged to the East Ash Pond System, prior to it being removed from service in 2014.

The outflow from the North Ash Pond discharges to the North Settling Basin. The existing primary outflow structure for the North Ash Pond consists of a 3.5 ft by 4 ft (inside dimensions) reinforced concrete weir box (Weir Box #4). The water surface in the pond is controlled by a series of stop logs that can be added or removed to the weir box to adjust the pool elevation. Decant water that enters the weir box is discharged to the North Settling Basin via a 24 inch corrugated metal pipe located in the intercell dike that separates the North Ash Pond from the North Settling Basin. The secondary overflow structure from the North Ash Pond to the North Settling Basin consists of a 30 in. corrugated plastic pipe set just below the normal operating level of the ash pond.

North Settling Basin

As noted above, the North Settling Basin receives discharge from the North Ash Pond, as well as surface water runoff from the adjacent roads. Water is pumped from the North Settling Basin to the Gibson Cooling Pond via a dual pump station (i.e., the principal spillway) with an estimated pumping capacity of 20,000 gpm. The North Settling Basin does not have an emergency spillway.

***(D) Site Description: Area maps indicating the location of the impoundment and all other relevant items. All drinking water wells within ½ mile of the impoundment area must be identified, both on and off the facility property. Sites with waste***

> ***that test as restricted waste Type I or Type II should use the information requested in 329 IAC 10-24-2 as an outline in preparing the description. Sites with waste that test as restricted waste Type III should use the information requested in 329 IAC 10-32-2.***

The Gibson Station is located in Gibson County, Montgomery Township, Indiana, in Township 1S, Range 12W, in portions of Sections 32, 33 and 34, and Township 2S, Range 12W, in portions of Sections 3, 4, 5, 7, 8 and 9. A USGS topographic quadrangle map 7½ minute series is provided as Sheet 3 in Appendix A.

A second plot plan showing the impoundments superimposed on a 2013 aerial photograph is included as Sheet 4 in Appendix A. A third plot plan showing the site topography is included as Sheet 5 in Appendix A. The North Ash Pond and North Settling Basin are regulated by the CCR Rule and by IDEM's solid waste program.

Results from investigation and review of the Indiana Department of Natural Resources (IDNR) – Division of Water (DOW) Water Well Records database (IDNR, 2016), and review of information available from IDNR for Significant Water Withdrawal Facilities (SWWF) are summarized on Sheet 3 in Appendix A and provided in Appendix B. It should be noted that location information for IDNR's water well records and SWWFs varies depending on whether wells have been field located. Field located wells or SWWFs are associated with Universal Transverse Mercator (UTM) coordinates. Records without UTM coordinates are considered un-located, however, they are geographically placed in IDNR's water well geographic information system based on description with respect to the public land survey system, driving direction, or address information on the well record.

Water well records that include UTM coordinates are plotted on Sheet 3 in Appendix A, and the well records are included in Appendix B.1. Water well records that do not include UTM coordinates are located based on driving direction and administrative information and are included in Appendix B.2.

As depicted on Sheet 3, a group of five water well records from IDNR's well record database are shown at a generalized IDNR location within ½ mile of the southeast boundary of Gibson's North Ash Basin System. The well reference numbers are 346306, 346307, 346308, 346309, and 317218. Records 346306 through 345309 are for wells installed for PSI Energy for test purposes in November 2000. Well record 317218 is also a test well installed for PSI in 1993. Four water well records (204845, 204850, 204855, and 204860) are located in areas adjacent to Gibson Station's generating units. These four wells are associated with Gibson's IDNR significant water withdrawal facility registration number. These wells are not utilized as drinking water sources and are not potential receptors with respect to human health risk assessment.

IDNR's database includes well reference numbers 370425 and 370426. These wells are approximately shown at a generalized location in IDNR's GIS, however, they have been moved to the locations shown on Sheet 1 based on information from facility personnel. Both wells were drilled in 2002 to provide a water source for irrigation. The wells are in a presumed upgradient location and are not potential receptors with respect to the North Ash Basin System.

Copies of the IDNR water well records are presented in Appendix B.

***(E) Site Geology: General information on the geology of the site such as:***

***(1) General direction of ground water flow.***

The general direction of groundwater flow in the unconsolidated alluvial aquifer at the Gibson Station is directed toward the Wabash River, located to the west-northwest of the site. However, local groundwater flow in the unconsolidated alluvial aquifer under the surface impoundments is influenced by infiltration from the overlying impoundments. Additional discussion of groundwater flow directions is included with information summarizing the monitoring well sampling and testing results.

***(2) The depth of the water table across the entire site and the permeability of soils associated with the table.***

Based on water level measurements collected on December 15 and December 18, 2016, the depth to groundwater ranged from approximately 9.5 to 32.5 feet below ground surface (ft bgs). Based on water level measurements collected between March 7 and March 10, 2016, the depth to groundwater ranged from approximately 6.5 to 27 ft bgs. Based on water level measurements collected between August 29 and August 30, 2016, the depth to groundwater ranged from approximately 7.5 to 30 ft bgs. Water levels vary depending on the ground surface elevation and location of wells or piezometers with respect to the ash ponds and the Wabash River.

In-situ slug test results were performed at several of the 19 groundwater monitoring wells that comprise the North Ash Basin System groundwater monitoring well network. To run each test, a pressure transducer was lowered into the monitoring well. The transducer was connected to a data logger at ground surface that was used to start and stop the test and record water level recovery after stressing the well. Both rising head and falling head tests were run using a weighted PVC cylinder as a slug. Estimates of formation hydraulic conductivity were determined using the Bouwer-Rice analytical model (Bouwer and Rice, 1976) for confined or unconfined aquifers (as needed) implemented in AQTESOLV®. Well recovery diagrams are included in Appendix C and a summary of estimated hydraulic conductivities is attached in Table 1. In general, hydraulic conductivity values are consistent with the expected values for wells screened in outwash sand.

Based on in-situ slug tests conducted by ATC on October 1, 2015, hydraulic conductivities in the screened formations for the groundwater monitoring well network surrounding the North Ash Basin System range from approximately 0.0070 to 0.021 centimeters per second (cm/s). Based on conditions encountered during the slug tests, confined aquifer conditions were present in a majority of the monitoring wells, although unconfined conditions were identified at monitoring wells MW-34B, MW-34C, and MW-35C. The values of hydraulic conductivity (K) calculated for the rising and falling head tests are summarized in Table 1.

***(3) Delineation of soil strata under the site (i.e., sand, silt, clay, etc.).***

**Geologic Setting.** The Gibson Station is located in southwestern Indiana, in the western portion of Gibson County, Indiana. The site is located within the bedrock Paleozoic depositional and structural feature named the Illinois Basin, a depositional/structural feature located west of the Cincinnati Arch, an associated Paleozoic structural uplift feature. Shallow bedrock in Gibson County is assigned to the Pennsylvanian Carbondale and McLeansboro Groups (Gray and others, 1987), which are mostly composed of shale and sandstone, with lesser amounts of coal, limestone, and claystone. These rocks dip to the west-southwest into the Illinois Basin at about 25 ft/mile (Gray, 1979, p.3).

Near the site, the elevation of the bedrock surface is mapped by the IDNR-DOW, using publicly available data, as varying from less than El 250 to greater than El 375 (Barnhart and Middleman, 1990). The ground surface at the site is nearly level, and generally ranges from about El 387 in the southern portion to El 395 in the northern portion. Because of the nearly level ground surface and the variable bedrock elevation, the thickness of unconsolidated deposits at the site is variable.

Faulting is present in the vicinity of the site. The Wabash Valley Fault System passes through Gibson County. The New Harmony Fault is located more than two miles west of Gibson's surface impoundments, and the Owensville Fault is located several miles east of the site. The New Harmony Fault is called the Mt. Carmel Fault in Illinois, although the use of this name is confined to Illinois because the name Mt. Carmel fault is used for another major fault in Indiana. The New Harmony Fault is a compound fault to the south of the facility, although it appears to have a single fault plane where is passes closest to the site. Maximum displacement is about 450 vertical feet, and the fault is about 30 miles long. The Owensville Fault is about ten miles long (Ault and Sullivan, 1982).

The Gibson Station is situated in the Wabash Lowland Physiographic region. This region is bounded to the north by the Central Wabash Valley, to the east by the Martinsville Hills and the Crawford Upland, and to the southeast by the Boonville Hills. The facility is adjacent to the east bank of the Wabash River, at the western extent of the Wabash Lowland Physiographic region in Indiana.

**Unconsolidated Deposits.** The geology in the vicinity of the Gibson Station consists of a glacial outwash valley that underlies the present day Wabash River. The width of the valley is approximately 7 miles and the Wabash River flows in a southerly direction adjacent to the western valley wall along the river stretch adjacent to Gibson Station. Surficial unconsolidated material consists of glaciofluvial sand and gravel deposits overlain by a surficial deposit (up to 15 feet thick) of fluvial derived silt and clay. These materials extend to Pennsylvanian bedrock in Gibson County (AECOM, 2015).

The majority of Gibson County has been directly subjected to Pleistocene glaciation during pre-Wisconsinan glacial events (only the eastern-most portion of the county is unglaciated), and the entire county has been affected by either ice-contact or pro-glacial processes. This is manifested in the county by the presence of glacial till, loess, and outwash deposits. The last ice sheet to reach Gibson County was pre-Wisconsinan, although the extensive outwash and alluvial deposits along the Wabash River include Wisconsinan deposits. The site is located approximately 85 miles south of the boundary of the furthest Wisconsin-age glacial advance into Indiana. In addition, the site is located approximately 15 miles north of the Pre-Wisconsinan glacial limit boundary (AECOM, 2015).

**Bedrock.** The uppermost bedrock in Gibson County is assigned to the Pennsylvanian Carbondale and McLeansboro Groups (Gray and others, 1987), which are mostly composed of shale and sandstone, with lesser amounts of coal, limestone, and claystone.

**Regional Hydrogeology.** As summarized in Fenelon and others (1994), the site lies within the Lower Wabash River Basin, a broad, flat glacial drainage channel characterized by winding channels, a wide flood plain, and adjacent terrace levels. The valley floor ranges between 3 and 10 miles in width. The principal aquifer type present in the basin is the outwash and alluvial sand and gravel in the Wabash River Valley, reaching thickness of up to 150 ft. These thick sand sequences are generally clean, well sorted, and coarse grained. A secondary unconsolidated source is the buried sand and gravel of the tributary valleys. Other unconsolidated groundwater resources include sand and gravel lenses interbedded with lake sediments, glacial till, and dune sands.

Bedrock aquifers are also a source of water in the basin. The Inglefield Sandstone Member represents the thickest and most laterally extensive bedrock aquifer in Gibson County. Aquifers associated with complexly interbedded sandstone, shale, limestone, and coal are another source. Wells are typically open to the entire bedrock section below unconsolidated material, where typically the sandstone and coal are the primary water producing units. Groundwater yields from bedrock aquifers are generally less than yields from unconsolidated deposits in the area.

Regional groundwater flow near the site is typically southwest, toward the Wabash River. This flow direction is locally influenced by other drainage features (e.g., the Patoka River), and production of groundwater from wells.

**Soil Lithology.** The area of the North Settling Basin and North Ash Pond is in the former flood plain of the Wabash River. The impoundment system is located in an area with a surface elevation of approximately EL 405 to 410. The North Ash Basin System is bordered immediately to the northwest by United States Army Corp of Engineers Levee No. 5 followed by the modern flood plain and the Wabash River. Ground surface elevations increase in the areas west of the Wabash River toward the western valley wall.

The unconsolidated deposits at the site typically consist of sand and gravel (glacial outwash) of variable thickness overlain by cohesive soil that appears to be floodplain overbank deposits. The thickness of the unconsolidated deposits varies from about seven feet to over 130 feet, mostly as a function of the bedrock elevation.

Shale bedrock was reported in boring BW-1 (near historic production well PW-4, in the vicinity of the power generating units) at a depth of 77.5 feet.

Shale bedrock is reported on borings located southwest of the North Ash Basin System in the area near the power generating units. According to the Record of Water Well, Reference Number 204845, shale bedrock occurs at a depth of 107 feet. Water well record 204845 corresponds to production well PW-3.

The boring log for monitoring well MW-5A, located along the south side of the FSS landfill, describes "silty clay (CL), dark gray, consolidated" at a depth of 130 ft bgs. This consolidated silty clay was previously interpreted by ATC as bedrock at this location (ATC, 2008a).

Based on preliminary lithologic information collected as part of the CCR monitoring program, monitoring well MW-33A, installed in September 2015 along the west edge of the North Settling Basin, was drilled to a depth of 96 ft (El 311) and terminated in sand and gravel.

In summary, the evidence from existing borings shows the presence of shale bedrock at depths of approximately 77.5 to 130 ft bgs in the area of the North Ash Basin System. The information from site-specific borings is consistent with regional reports that show bedrock underlying the nearby East Ash Pond System is the Pennsylvanian age Patoka Formation. Shale bedrock noted in site-specific borings is interpreted as shale of the Patoka Formation. Vertical hydraulic conductivity in shale bedrock at the site is expected to be several orders of magnitude less than hydraulic conductivity in the overlying glaciofluvial sand and gravel aquifer. The available data show that shale bedrock defines the lower confining boundary of the overlying glaciofluvial sand and gravel aquifer.

Basin embankments are interpreted to consist of cohesive, granular, and ash fill materials. Silt loam, clayey silt, and ash, generally stiff to very stiff in upper portions, but softer in lower portions are typically identified in embankments of the North Ash Pond. Granular material appears to constitute a portion of embankment material of the North Settling Basin. The interpreted natural foundation soils below the embankments consist of a blanket of generally soft silt loam, silty clay loam, sandy loam, sandy clay, or clay loam soils that overlie very loose to very dense sand or sand and gravel.

Site geologic and hydrogeologic information is available from various subsurface investigations and reports discussed below. Historical soil boring logs are provided in Appendix D. Soil boring, monitoring well, and piezometer locations are shown on Sheet 6. Hydraulic conductivity testing results are provided in Appendix C. Soil laboratory results are summarized in Table 2A and provided in Appendix E. Geological cross sections summarizing subsurface results along several transects across the impoundment system are included as Sheets 7 and 8 of Appendix A.

Supplementary subsurface information is also available from water well records on file at IDNR Division of Water or online (IDNR, 2016). The locations of water well records within a 1/2-mile distance from the perimeter of the impoundment basins are shown on Sheet 3 in Appendix A.

## Sargent and Lundy Boring Logs

Several borings in the vicinity of the North Settling Basin and North Ash Pond were completed by Sargent and Lundy. Findings were summarized in a letter to Public Service Indiana (PSI) in February 1980. The borings in the vicinity of the North Ash Basin System include SB-4, SB-5, SB-7, SB-100, SB-201, SB-202, SB-203, SB-403, and SB-404.

## 1981 Layne Northern Borings

In 1981, soil borings for monitoring wells OW-3A, OW-3B, and OW-3C (now identified as MW-3A, MW-3B, and MW-3C respectively) were installed at the northeast corner of the FSS landfill, while soil borings for monitoring wells OW-4A, OW-4B, and OW-4C (now identified as MW-4A, MW-4B, and MW-4C respectively) were installed at the northwest corner of the FSS landfill.

## 1990 Dallas Consulting Inc. Boring Logs

Soil borings for monitoring wells MW-5A, MW-5B, and MW-5C were installed by Dallas Consulting Inc. in March and April 1990. As previously discussed, the boring log for monitoring well MW-5A describes "silty clay (CL), dark gray, consolidated" at a depth of 130 ft bgs, previously interpreted by ATC as bedrock at this location (ATC, 2008a).

## 1993 R.E. Blattert Piezometer Boring Logs

Subsurface information in the area of the North Ash Basin System is available in borings advanced for a Gibson Station Hydrogeology Study (R.E. Blattert, 1994). Boring logs are available at thirteen piezometer locations and four monitoring well locations investigated for this study. Boring results for two piezometer locations at the south side of the North Ash Pond, PZ-1 and PZ-13, are included on cross section B – B'. Both borings show fine-grained deposits described as silt and clayey silt overlying fine to medium grained sand. Boring PZ-1 suggests that bedrock occurs at a depth of 72 ft bgs.

## 1995 FMSM Boring Logs

Several borings in the vicinity of the North Ash Pond were completed by FMSM. The borings in the vicinity of the North Ash Pond include D-1, D-2, D-3, D-4, D-5, D-6, S-1, and S-5.

## 2000 FMSM Monitoring Well Boring Logs

Soil borings for monitoring wells MW-11A, MW-11B, and MW-11C were installed by FMSM in 2010. These borings provide subsurface information in the eastern portion of the North Ash Pond. As shown on the boring log for MW-11A, ash is present to a depth of 17 ft, followed by clay and sandy clay to a depth of 29 ft bgs. Outwash fine to very coarse sand and gravel occurs below 29 ft. Bedrock is encountered at a depth of 86.9 ft.

## 2004 Patriot Monitoring Well Boring Logs

Soil borings for replacement monitoring wells MW-5BR and MW-5CR were installed by Patriot Engineering in January 2004. The original wells had reportedly become defective, and were removed at this time.

## 2008 ATC Monitoring Well Boring Logs

Soil borings MW-15DR and MW-15SR (later renamed MW-15BR and MW-15CR, respectively), were installed by ATC in 2008 in association with the abandonment and subsequent replacement of monitoring wells MW-15S and MW-15D due to the extension of the existing haul road. These borings provide subsurface information along the northwest boundary of the North Settling Basin. As shown on the boring log for MW-15BR, interbedded loamy sand, sand, clay, and loam is present to a depth of 24 ft bgs. Outwash fine to very coarse sand and gravel occurs below 24 ft. The activities were summarized in a 2008 report prepared by ATC (2008b).

### 2014 AECOM Geotechnical Investigation Boring Logs

As part of an ongoing geotechnical investigation for ash pond closure evaluations, AECOM oversaw advancement of soil borings and cone penetrometer soundings in the vicinity of the North Ash Basin System. Geotechnical soil boring locations NSB-01, NSB-02, and NSB-03 are depicted on Sheet 3 in Appendix A. Results from the borings show the presence of cohesive unconsolidated soils from the ground surface to depths ranging from 30-37 ft bgs, underlain by sand and sand/gravel deposits to depths of at least 80 ft bgs. A piezometer was subsequently installed in the NSB-03 location.

### 2015 Monitoring Well Boring Logs

The 2015 monitoring well program included installation of 11 monitoring wells (MW-32B, MW-32C, MW-33A, MW-33B, MW-33C, MW-34B, MW-34C, MW-35A, MW-35B, MW-35C, and MW-40C) by Cardno ATC (ATC, 2016a). These wells are a part of the anticipated groundwater monitoring system for the eventual multi-unit monitoring program for the North Ash Basin System. The naming convention for the wells at the site is such that wells designated with an "A" suffix are wells typically screened 75 feet below top of the aquifer; wells designated as "B" wells are generally screened over the interval from 30 to 50 feet below top of the aquifer; and shallow "C" monitoring wells are typically screened within the first 20 feet of the aquifer.

Material encountered in the soil borings for the wells classified texturally as loam, silt loam, sandy clay loam, sandy loam, clay loam, silty clay loam, and silty clay to depths between 21 and 35 ft bgs. Granular units interpreted as glacial outwash deposits occur below overlying cohesive soils. Granular deposits consist of yellowish brown to gray loamy sands and sands. With increasing depth, grain size generally increases and sand and gravel deposits are more frequent.

While none of the borings advanced as part of this investigation extended to bedrock, as previously discussed, evidence from historic borings shows the presence of shale bedrock at depths of approximately 77.5 to 130 ft bgs in the area of the North Ash Basin System.

### ATC 2016 Ash Inventory Borings

Soil borings AI-1 through AI-10 were drilled in January 2016 in the vicinity of the North Ash Pond to investigate the extent and depth of deposited coal ash (ATC, 2016b). Logs for selected ash inventory locations either proximal to the North Ash Basin System or shown on cross section A-A' (AI-5) and cross-section C - C' (AI-6) are included in Appendix D. Based on a preliminary review of lithologic data, coal ash ranging up to 26.5 ft in thickness (associated with an ash base of approximately El 375) was identified, and is represented on the geological cross sections on

Sheets 7 and 8. Based on modelled thickness estimates, ash up to 46 feet thick is present in the North Ash Pond. The unconsolidated formation present below the coal ash of the North Ash Basin System is typically composed of cohesive deposits. Based on information obtained from historic drawings, the February 2015 Bathymetry Survey (performed by others), and ash inventory soil borings completed in 2016, the average thickness of coal ash within the limits of the North Ash Pond is approximately 20 feet. The results of laboratory tests performed on CCR material obtained from piston samples are provided on Table 2B.

***(4) If monitoring wells are currently in place, the following information concerning the wells must be provided:***

***(a) Site map indicating location of wells.***

Twenty-seven (27) monitoring wells (MW-4A, MW-4B, MW-4C, MW-5A, MW-5BR, MW-5CR, MW-6A, MW-6B, MW-10A, MW-10B, MW-10C, MW-11A, MW-11B, MW-11C, MW-15BR, MW-15CR, MW-32B, MW-32C, MW-33A, MW-33B, MW-33C, MW-34B, MW-34C, MW-35A, MW-35B, MW-35C, and MW-40C) comprise the proposed groundwater monitoring network in the vicinity of the North Ash Basin System. The MW-4 cluster wells were installed in 1981, the original MW-5 cluster wells were installed in 1990 (with replacement wells MW-5BR and MW-5CR installed in 2004), the MW-6 cluster wells were installed in 1993, the MW-10 cluster wells were installed in 1995, the MW-11 cluster wells were installed in 2000, the MW-15 cluster wells were installed in 2008, and the remaining wells (MW-32 through MW-40 numbered wells) were installed in September and October of 2015. The wells are screened within the outwash granular deposits, with nominal 2 inch PVC riser and 2 inch PVC well screens. Well screens are either ten or fifteen feet in length. The well locations are shown on Sheet 6 in Appendix A. Monitoring well construction details are listed in Table 3 and provided on construction diagrams in Appendix F.

### *(b) Identification of upgradient and downgradient wells.*

Groundwater flow gradients and flow directions in the area of Gibson's North Ash Basin System are the result of the superimposed hydraulic effects of regional flow toward the Wabash River and historic groundwater mounding associated with recharge from unlined impoundments and the Cooling Pond located at the station.

Based on water level measurements collected during groundwater events performed since December 2015, monitoring wells MW-35A, MW-35B, and MW-35C are typically located hydraulically upgradient with respect to the North Settling Basin. Based on limited mapping of potentiometric contours, MW-34B and MW-34C can be upgradient or somewhat sidegradient to flow with respect to the North Settling Basin. The MW-5 and MW-6 cluster wells are hydraulically upgradient relative to the North Ash Pond.

Monitoring wells MW-15BR, MW-15CR, MW-32B, MW-32C, MW-33A, MW-33B, and MW-33C represent downgradient monitoring points of the North Settling Basin, while monitoring wells MW-10A, MW-10B, MW-10C, MW-34B, MW-34C, MW-35A, MW-35B, MW-35C, and MW-40C are downgradient of the North Ash Pond. A groundwater potentiometric surface map is provided as Figure 3.

### *(c) The type of stratum and the depth the wells are screened.*

Subsurface stratigraphy is discussed in section 2(E)(3) above and was described in the Proposed Interim Closure and Post-Closure Plans previously submitted to IDEM for the North Ash Basin System. The type of stratum encountered in each monitoring well screen interval generally consists of granular unconsolidated sand and gravel units. Based on in-situ slug tests, hydraulic conductivity values are generally consistent with the range of hydraulic conductivity cited in literature for coarse sand to gravel. Boring logs from borings advanced in, within, and around the North Ash Basin System are included in Appendix D. Screened intervals for each monitoring well are depicted on cross sections, listed on Table 3, and shown on the monitoring well construction diagrams in Appendix F.

### *(d) Description of well installations including a bore hole log.*

Twenty seven monitoring wells (MW-4A, MW-4B, MW-4C, MW-5A, MW-5BR, MW-5CR, MW-6A, MW-6B, MW-10A, MW-10B, MW-10C, MW-11A, MW-11B, MW-11C, MW-15BR, MW-15CR, MW-32B, MW-32C, MW-33A, MW-33B, MW-33C, MW-34B, MW-34C, MW-35A, MW-35B, MW-35C, and MW-40C) comprise the proposed multi-unit groundwater monitoring network in the vicinity of the North Ash Basin System. The MW-10 cluster wells were installed in 1995, the MW-11 cluster wells were installed in 2000, the MW-15 cluster wells were installed in 2008, and the remaining wells (MW-32 through MW-40 numbered wells) were installed in September and October of 2015. The wells are screened within the outwash granular deposits. All of the wells were constructed in accordance with 329 IAC 10-21-4, with nominal 2 inch PVC riser and 2 inch PVC well screens. Well screens are ten feet in length.

As noted above, borehole logs and monitoring well construction diagrams are provided in Appendices D and F, respectively.

For MW-32 through MW-40 numbered wells, representative samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits from significant lithological strata including aquifer material. Two slug tests (rising head and falling head) were performed on each monitoring well to estimate the hydraulic conductivity of the aquifer.

All well locations and elevations were surveyed by a licensed surveyor. Horizontal locations and the ground surface elevations were measured to the nearest 0.1 foot. Well riser elevations were measured to the nearest 0.01 foot. Elevation data are recorded on the soil boring logs (Appendix D) and well construction diagrams in Appendix F. A summary table with well coordinates and elevations is included in Table 3.

***(e) Any ground water monitoring data that would indicate background water quality.***

Historical groundwater data collected from monitoring wells associated with the North Ash Basin System are included on CDs provided in Appendix G. The information in the following section, prepared by M.S. Beljin and Associates, summarizes historical water quality results, and proposes semi-annual collection of groundwater samples.

## Gibson Ash Pond System Water Quality

This section presents the groundwater quality characterization for two (2) separate units:

1. North Settling Basin
2. North Ash Pond

Water quality data collected from the monitoring wells is used to support the closure plan and to recommend a monitoring assessment process as the closure actions proceed. The proposed monitoring network includes both existing wells and newly installed wells for the North Ash Basin System.

The overall monitoring network is illustrated in Figure 2 for the closure units. This figure depicts the historic existing wells along with the sixteen (16) newly installed (or sampled) wells for a total of twenty-seven (27) monitoring wells for collecting groundwater quality data.

Figure 3 presents the water levels and approximate flow map for the monitoring network representing the wells across the North Ash Basin System.

Sampling from the existing wells dates back to 2001 for the purposes of characterizing the background groundwater quality.

The sixteen new wells were installed with the initial sampling event occurring in December 2015. For purposes of the initial groundwater quality characterization there were separate sampling events conducted in December 2015 along with March and August of 2016.

**Existing Wells:** MW-4A, MW-4B, MW-4C, MW-11A, MW-11B, MW-11C, MW-5A, MW-5BR, MW-5CR, MW-6A, and MW-6B.

**Newly Installed or Sampled Wells:** MW-10A, MW-10B, MW-10C, MW-15BR, MW-15CR, MW-32B, MW-32C, MW-33A, MW-33B, MW-33C, MW-34B, MW-34C, MW-35A, MW-35B, MW-35C, and MW-40C.

Data collected from the new wells is compared to data collected since May 2001 from the existing wells. Collectively the analysis of groundwater samples obtained from the monitoring locations for thirty-four (34) different parameters was used to examine the groundwater quality in the vicinity of the separate Gibson basins.

The analysed parameters included:

- Alkalinity
- Antimony
- Arsenic
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Fluoride
- Iron
- Lead
- Lithium
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nitrogen, Ammonia
- Nitrogen, Nitrate
- pH (field and Laboratory)
- Potassium
- Selenium
- Silver
- Sodium
- Specific Conductivity (field and Laboratory)
- Sulfate
- TDS
- Thallium
- Zinc
- Combined Radium 226 + 228

The analytical results of the sampling, for six of the thirty-four (34) parameters are presented in Table 4. A number of the parameters had a relatively large number of non-detects in a majority of the monitoring wells and are not presented.

The characterization of the local groundwater quality will be used to evaluate the performance of the specified closure actions. To obtain sufficient data for determining the efficacy of the closure actions the available data from wells near the Gibson Station ash ponds, landfills, and settling basins will be used to establish performance goals and for making statistical comparisons.

For purposes of evaluating the relationship between wells and characterizing the groundwater quality the following six (6) parameters were specifically considered:

- barium (MCL = 2 MG/L)
- boron,
- calcium,
- chloride, (SMCL = 250 mg/L),
- sulfate, (SMCL = 250 mg/L), and
- TDS, (SMCL = 500 mg/L)

These six (6) parameters provide a measure of the general water quality in the vicinity of the Gibson North Ash Basin System. Observations for the specified six (6) parameters from the monitoring wells are presented in Table 4.

The relationship between wells (locations) for a number of the parameters was evaluated using box plots and the Student's t-distribution comparing each pair. While there is insufficient data to perform powerful statistical analyses for the newly installed wells, the box plots do present an overall average of the water quality conditions over the time period represented by the observations May 2001 through March 2016.

An overall comparison is also made between the mean values, for each sampling location, and the Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels (SMCLs) as presented in 40CFR141 'National Primary Drinking Water Regulations' and 40CFR143 'National Secondary Drinking Water Regulations'.

The MCLs and SMCLs represent reasonable goals for drinking water quality. Figures 4 through 9 provide individual pair-wise comparisons at the 95% confidence level. For example, the comparison of boron by well (Figure 5), shows that wells MW-34B, MW-33C, MW-35C, MW-15CR, and MW-15BR are statistically significantly greater than the other wells representing the North Ash area. These three wells have the highest overall mean boron concentrations at 32.1 mg/L, 27.2 mg/L, 26.0 mg/L, 21.5 mg/L, and 20.7 mg/L, respectively. A number of the newly installed wells for the North Ash area have mean values that are greater than the background wells represented by clusters MW-5 and MW-6. Figure 12 presents the Cation and Anion balances across the monitoring network.

The box plots in Figure 5 illustrate the overall differences between wells. The groundwater quality in the vicinity of the North Ash Basin System is characterized by the groundwater flow across the specific area (Figure 3). For purposes of the groundwater quality characterization and future performance evaluations a "source" of the observations from the monitoring network is assumed to exist. The source is assumed to be the materials placed in the specified units and what may have been transported to the settling basin. This relationship between the potential source and the observations from the monitoring wells forms the basis for the approach to assessment monitoring for the closure actions of the separate units.

As the hydraulic head is altered as a result of the closure actions the groundwater flow may change. In addition, as the closure actions proceed less ash material may reach the groundwater. The combined effects, after closure, are expected to result in decreasing trends in key parameters over time.

Using the basic relationship between the hydraulic head and the groundwater flow a set of "performance goals" can be established for each well and each of the specific water quality parameters (e.g., barium, boron, calcium, chloride, sulfate, and TDS).

## Assessment Monitoring Plan Overview

For the purposes of determining the effectiveness of the North Ash Basin System closure actions, an assessment-monitoring plan is being proposed. After an initial compressed sampling frequency, to collect at least eight independent data points, the monitoring wells will then be sampled on a semiannual basis. Semi-annual groundwater reports will be submitted within sixty (60) days after the sampling event is completed on the schedule approved by IDEM. The data evaluation during the closure period will be used to better define the extent of the impact to water quality.

## Data Review and Evaluation during Closure Activities

Over time, a statistical analysis of specific parameters (including boron) will be performed to compare future observations against the existing groundwater quality to determine whether existing statistical differences are increasing or decreasing. This analysis relies on both "within well" and "between well" comparisons using parametric and non-parametric techniques as appropriate. These comparisons are to be performed to assess the whether there are statistically significant trends and whether observed concentrations are above or below established "performance goals". The performance goals are based on the current conditions within individual wells for each parameter. The performance goals are then compared to existing contaminant limits (MCLs, SMCLs, or other).

For purposes of evaluating the effectiveness of the closure action including the relationship between wells through the statistical analysis Duke Energy proposes to conduct analysis on semi-annual sampling for the parameters summarized in Table 5.

## Establishing Performance Goals for Post-Closure Monitoring

The performance goals will be established during the initial phases of the closure action and after there is measurable decrease in the hydraulic head. At this point in time during the closure process where there is the greatest chance that any constituents, remaining in the solid matrix beneath the ash ponds, will be significantly mitigated from entering the groundwater. To assure that the level of effectiveness desired from the closure action of the Ash Pond, Duke Energy proposes a period of post corrective construction for on- and off-site groundwater monitoring.

The data from future post closure semi-annual groundwater assessment monitoring will be used to assess the following:

- Monitor the hydraulic gradient and the overall change in flow;
- Monitor the decrease of site related constituent concentrations in on-site groundwater (projecting the decrease in concentration off-site) over the proposed monitoring time period (expected condition post remedy); and,
- Assure that site related constituent concentrations in on-site groundwater do not increase above the proposed groundwater performance goals.

To address the third bullet, Duke Energy proposes the following:

- Groundwater monitoring data collected from each on-site monitoring well will be used as a benchmark against which any potential post remedy constituent increasing concentration shifts will be gauged. Following EPA guidance for intra-well comparisons (USEPA, 2009), a Shewhart control limit will be calculated for each well where at least eight sample results are available. These limits will serve as goals for each parameter (constituent) in each well. Control limits based on fewer than eight results only estimate an appropriate performance goal.
- Upon completion of the second semi-annual monitoring event, a well-by-well comparison of post corrective action groundwater monitoring results will be performed against the parameter goals as applicable. If the goal level is exceeded in a particular well or wells, Duke Energy will collect an additional groundwater sample from the well(s) exceeding goal(s) within thirty (30) days of receipt of validated analytical results to verify the detected concentration.
- If the concentration(s) exceeding goal(s) are verified, monitoring will continue on the schedule semi-annual and the event at the specific monitoring well will be labeled as "goal exceeded". (A potential indicator of a departure from remedy effectiveness is four (4) successive goal limits exceeded in a single monitoring well over the scheduled monitoring frequency).
- If after at least four (4) sampling events with fewer than four (4) goals in any specific well having been exceeded such that it is determined that no increasing concentration shift exists or, more likely, that the increase was temporary due to changing conditions post remedy construction, Duke Energy will remove the "goal exceeded" designation and continue with the normal monitoring program as detailed.
- If after at least four (4) sampling events it is determined that an increasing concentration shift may exist, Duke Energy will increase the monitoring frequency to quarterly and assess the effectiveness of the closure action. As long as

concentrations do not approach 95% of the groundwater monitoring goals presented above, Duke Energy will continue to monitor the shift. If the increasing concentration shift reverses and a pattern of decreasing concentrations is established, Duke Energy will resume the normal monitoring program as presented.

- If the increasing shift continues and is determined to present an unacceptable condition for post closure of the three specified units, then Duke Energy will take action to determine what steps to take to mitigate the degradation in effectiveness of the closure action.

The type of control limit or goal used for comparison to individual groundwater monitoring concentrations is the Shewhart control limit (USEPA, 2009; Gibbons, 1994; Gibbons, 1987). These are derived as the mean (median value for non-parametric distributions) plus 4.5 times the standard deviation of the historical (baseline) well results or proxy substitutions of ½ the detection limit for non-detects. Post-baseline concentrations are compared directly to these limits. A pattern of exceedances will indicate that a group of concentrations are significantly different than the baseline data. However, this pattern may or may not indicate that actual concentrations are increasing due to an on-site release that continues to migrate off-site post remedy.

It is important to note that variability and shift changes post closure are likely to occur. Temporary increases in concentrations could result from construction activities or the change in hydrogeologic conditions due to operation of the hydraulic control system. In addition, groundwater flow velocities and directions are likely to change, based on the predictive runs of the current groundwater model. Therefore, the response of the constituent (parameter) concentrations in on-site groundwater as a result of corrective actions given the hydrogeologic conditions could take years to evaluate potential concentration shifts. For this reason, the actual amount of time to establish if an increasing concentration shift exists is not clear and post closure construction data will need to be evaluated as time progresses to allow for accurate evaluation of potential increasing concentration shifts.

***(f) Any ground water monitoring data collected after installation and operation of impoundment commenced which may be utilized to determine if there is any current ground water contamination.***

Historical groundwater data collected from monitoring wells associated with the ash pond system are included on compact discs in Appendix G. Due to the large volume of printed material associated with the historical groundwater data, hard copies are not being provided.

***Based on review of this data and the residue chemistry, more comprehensive and specific geology information may be required. Sites with waste that test as restricted waste Type I or Type II can use the information requested in 329 IAC 10-24-3 and 10-24-4 as an outline in preparing the geology description. Sites with waste that test as restricted waste Type III can use the information requested in 329 IAC 10-32-3.***

***3) Closure Plan: A detailed proposal for closure design and construction and for post-closure care of the impoundment must be submitted. Sites will close under the applicable requirements for Restricted Waste Sites (RWS), as described in 329 IAC 10-24 thru 10-38, depending on the characteristics of the waste in the impoundments.***

***Please note, if the residue in the impoundment is determined to be hazardous waste, this guidance is not applicable; for more information consult the Permit Branch for guidance at (317)232-4462.***

***At a minimum, the proposed closure plan must include details of the following:***

***(A) Cap Design: A description of the cap including dimension, Slope, and description of materials to be used. Caps at sites that test as restricted waste site Type I or Type II must be designed in accordance with applicable requirements of 329 IAC 10-30-2 or 10-30-3. Sites that test as restricted waste site type III must be designed in accordance with 329 IAC 10-37-2. Sludges from wastewater treatment plants that test as restricted waste site Type III must also comply with the design requirements of 40 CFR 503.***

It is currently anticipated that closure in place procedures will be utilized in the North Ash Pond while the closure of the North Settling Basin will consist of a combination of closure in place and closure-by-removal. The Interim Closure and Post-Closure Plan for closure in place of the North Ash Pond sought IDEM's concurrence with facility plans to begin placing coal combustion residual material as structural fill to help expedite the closure schedule.

North Ash Pond

As discussed in detail with IDEM's technical staff, Duke Energy proposes to utilize an in-place closure plan for the North Ash Pond. The proposed final grades for the North Ash Pond are provided on Sheet 11 in Appendix A.

Water present above the CCR materials in the North Ash Pond will be pumped to the North Settling Basin. Dewatering sumps and/or wells will also be used as necessary to remove water from the ash present within the pond. Pumping will also be performed as necessary to remove rainwater that collects within the footprint of the pond during construction.

The final cover system in North Ash Pond will be constructed with top slopes ranging from 1 to 6 percent as noted on Sheet 11. Perimeter slopes of 20 percent were utilized to help establish the full 3 ft thick soil cover and along ditch slopes to tie into the top slopes. The 1 percent grades will be utilized in the vicinity of the transmission towers to help provide the necessary clearance to those lines. One percent grades will also be used to establish a new parking area within the footprint of existing Parking Lot No. 1, at the location noted on Sheet 11. Details regarding the final cover within the new parking are provided in the following paragraphs. Parking Lot No. 2 will be taken out of service and the area incorporated into the final cover system. Final grades across the remainder of the final cover typically range from 3 to 4 percent. A limited area of 6 percent slope is proposed on the northwest side of the peak elevation (EL 447) to tie into the adjoining grades.

With the exception of the new parking area, the final cover system will consist of a geomembrane overlain by a combination of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 11, and 15 through 18, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

Parking Lot No. 1 will temporarily be taken out of service to allow the removal of the existing pavement section and the regrading of the area. The revised base grade will then be covered with a geomembrane, a cushion geotextile, a gravel base and asphalt to form a new parking area. The revised Parking Lot No. 1 will remain in service until the generating station is decommissioned. At that time, the asphalt will be removed and replaced with a protective layer of soil and vegetated.

The proposed final cover grading plan illustrated on Sheet 11 includes a storm water ditch that parallels the solid waste boundary of the FSS Landfill. Upon completion of the final cover for the North Ash Pond, this ditch will convey non-contact storm water from both the closed North Ash Pond and the closed FSS Landfill to the outfalls noted on Sheet 11.

The two outlets for the leachate collection system constructed in the portion of the FSS Landfill that was built over the North Ash Pond are located within the limits of the proposed in-place closure are for the North Ash Pond. As a result, it will be necessary to extend the existing manholes and riser pipes to reach the proposed top of the North Ash Pond final cover system. The leachate will be pumped to the new process water treatment pond located within the limits of the closed South Settling Basin.

As noted on Sheets 11 and 12 in Appendix A, there are areas (~ 2.7 acres) around the perimeter of the North Ash Pond that have been backfilled to allow for the widening of the access road to the contractor's parking lot and to form an access road to the FSS Landfill. The surface of these areas are also typically covered with asphalt pavement and gravel. Duke Energy proposed to use the existing asphalt pavement and gravel surfaces in these areas to serve as the interim cover until decommissioning of the Gibson Station. At that time, these areas will be graded to provide a minimum 2 percent slope and a 2.5 ft thick soil cover will be installed and vegetated to serve as the final cover.

North Settling Basin

The limits of the approximately 17.9 acre area of the North Settling Basin that will be closed using closure by removal procedures are noted on Sheet 12 in Appendix A. It will not be necessary to construct a final cover to meet the requirements noted above. Once closure activities have been completed in that portion of the basin, the area will be repurposed to serve as a lined contact water basin at the south end, a new parking area in the center and a lined storm water detention basin at the north end. The liner systems used in the contact water pond and the surface water detention basin will include a geomembrane.

The lined contact water pond will serve as the detention basin for the new parking area formed within the limits of the North Ash Pond closure and the new parking area formed within the limits of the repurposed section of the North Settling Basin. Water will be pumped from the lined contact water pond to the process water pond that is under construction within the limits of the South Settling Basin.

A portion of the surface water runoff from the final cover of the North Ash Pond will be discharged into the lined surface water detention basin formed at the north end of the repurposed section of the North Settling Basin. Discharge from this pond will gravity drain to an existing wetland located northeast of the North Settling Basin.

As noted previously, there is an approximately 200 ft wide strip (~ 5.8 acres) along the northwest side of the original limits of the North Settling Basin that was backfilled around 1981 to create the primary access way into the Gibson Station. This area contains a portion of the existing rail line used for coal deliveries and the primary access road for deliveries of coal and limestone. The area is bound on the west by Levee No. 5 and on the east by the active portion of the North Settling Basin.

A total of six test borings have been drilled within the limits of the backfilled portion of the North Settling Basin (i.e., S-5, MW-15BR, MW-15CR, MW-33A, MW-33B and MW-33C). None of these borings revealed any CCR in the materials that were sampled. Based on descriptions noted on the boring logs it appears that the soils used to backfill this portion of the North Settling Basin consisted or a mixture of fine-grained soils and loamy sand. Currently, the surface of the backfilled area is covered by a combination of railroad ballast, asphalt pavement and gravel.

As noted on Sheets 11 and 12 in Appendix A, there are other areas (~ 0.4 acres) around the perimeter of the original limits of the North Settling Basin that have been backfilled to allow for the construction of access roads to the contractor's parking lot. The surface of these areas are also typically covered with asphalt pavement and gravel.

Although it appears that the majority of the ash that once occupied these areas was either removed or displaced during the placement of the backfill, there are no formal records to document that all CCR materials were removed. As a result, Duke Energy proposes to utilize in-place closure procedures in these areas. The combination of the soil backfill, and surface coverings of pavement and gravel will serve as the interim closure of these areas. When the plant is decommissioned, the areas will be graded to provide a minimum 2 percent slope and a 2.5 ft thick soil layer will be installed and vegetated to serve as the final cover.

***(B) Final Contour Map: A plot plan that indicates the fill boundaries and the proposed final contours of the site at intervals of no more than two (2) feet.***

Drawings illustrating the proposed grades at the time of closure are provided in Appendix A. As noted above, the slope of the top of the North Ash Pond will slope at approximately 1 to 6 percent over the majority of the area at the time of closure.

***(C) Ground Water Monitoring: Sites that test as restricted waste site type I or Type II must prepare a Ground Water Monitoring and Corrective Action plan in***

***accordance with applicable requirements of 329 IAC 10-29. For wastes which test as Type III, the responsible party must either document the lagoon has a barrier in accordance with 329 IAC 10-34 or it will be necessary to develop a similar program for monitoring ground water downgradient or at the facility boundary to detect any future release from the closed impoundment. Sludge from waste water treatment plants that test as restricted waste site Type III must also comply with the ground water requirements of 40 CFR 503. If monitoring is determined to be necessary, a plan should be submitted to this office which includes:***

***(1) the number and placement of monitoring wells;***

The proposed groundwater monitoring system is described in Section 2(E)(4)(a) and (b). Summarizing those sections, twenty-seven (27) monitoring wells are proposed for semi-annual groundwater monitoring. Existing monitoring wells are shown on Sheet 6 of Appendix A.

***(2) the number and frequency of samples;***

The proposed groundwater sampling program is described in section 2(E)(4)(e) above.

***(3) the chemical parameters to be monitored that should be consistent with those identified with the impoundment characterization;***

The proposed monitoring parameters are described in section 2(E)(4)(e) above. Following collection of eight rounds of groundwater monitoring results, the analytical parameter list may be revised if continued monitoring of specified parameters is not beneficial for assessing groundwater quality with respect to North Ash Basin System closure.

***(4) sampling protocol; and,***

The proposed sampling protocols are outlined in section 2(E)(4)(e) above. A groundwater sampling and analysis plan that describes the sampling protocols, sampling methods, monitoring points, and monitoring parameters will be prepared within 90 days following IDEM's approval of this Closure Plan.

***(5) how the determination of releases will be made.***

Groundwater quality results will be evaluated according to the assessment monitoring program described in section 2(E)(4)(e) above.

***(D) Closure Certification: Sites that test as restricted waste site Type I or Type II must certify closure in accordance with applicable requirements of 329 IAC 10-30-7. Sites that test as restricted waste site Type III must certify closure in accordance with 329 IAC 10-37-7.***

Duke Energy will submit a closure certification report at the completion of the closure activities for the South Ash Basin System. This report will be prepared to address the requirements of 329 IAC 10-30-7.

***(E) Post-Closure Requirements: Sites that test as restricted waste site Type I or Type II must comply with the applicable post-closure requirements of 329 IAC 10-31. Restricted waste site Type III closure must comply with the applicable post-closure requirements of 329 IAC 10-38. Post-closure care will extend for 30 years as specified by 329 IAC 10-31-2(b) or 329 IAC 10-38-2(b). Funding mechanisms to cover the post-closure requirements must be established in accordance with 329 IAC 10-39.***

Duke Energy will comply with the applicable post-closure requirements of 329 IAC 10-31.

***(F) Responsibilities after Post-Closure: After post-closure is certified as complete, the owner, operator and/or responsible party will still be responsible for the requirements of 329 IAC 10-31-5, 10-31-6 and 10-31-7 or 329 IAC 10-38-5, 10-38-65 and 10-38-7, as applicable.***

Duke Energy will comply with the responsibilities outlined above after completion of the post-closure period. Closure and Post-Closure Cost Estimates, presented on IDEM forms, are provided in Appendix H along with the legal description of the various ash pond solid waste boundaries.

*George T. Hamrick*
*Senior Vice President*
*Coal Combustion Products*

*400 S. Tryon Street, ST06A*
*Charlotte, NC 28202*

*Phone: 980-373-8113*
*Email: george.hamrick@duke-energy.com*

**HAND DELIVERED**

December 21, 2016

Mr. Nick Batton
Permit Manager
Office of Land Quality
Indiana Department of Environmental Management
MC 65-45 IGCN 1101
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Subject: Closure and Post-Closure Plan Application
South Ash Basin System
Gibson Generating Station
Gibson County, Owensville, Indiana

Dear Mr. Batton:

Duke Energy Indiana, LLC. (DEI) respectfully submits to the Indiana Department of Environmental Management (IDEM) a Closure and Post Closure Plan Application for the South Ash Basin Area at Gibson Station located in Gibson County, Indiana. This system includes both the South Settling Basin and the South Ash Fill Area. Interim Closure and Post-Closure Plans for the South Settling Basin were submitted to IDEM on March 10, 2016. A letter of conceptual approval was issued by IDEM for this area on June 22, 2016 and it was given the Solid Waste ID number 26-UP-12. Interim Closure and Post-Closure Plans were also submitted to IDEM for the South Ash Fill Area on September 15, 2016. A Response to Comments Letter was sent to IDEM on December 13, 2016 regarding the interim plans for the South Ash Fill Area. The attached application, prepared by ATC Group Services LLC, supplements both the South Settling Basin and South Ash Fill Area Closure and Post-Closure plans by providing the remaining documentation requested in IDEM's "Surface Impoundment Closure Guidance."

I certify under penalty of law that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for developing the plan, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information. If you have any questions or require additional information regarding this submittal please contact either Owen Schwartz at 317-838-6027 or Charlie Hiner at 513-287-2076.

Respectfully Submitted,

George T. Hamrick
Senior Vice President

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

# PROPOSED CLOSURE AND POST-CLOSURE PLANS

SOUTH ASH BASIN SYSTEM
GIBSON GENERATING STATION
1097 NORTH 950 W
OWENSVILLE, INDIANA 47665

ATC PROJECT NO. 170LF00085

DECEMBER 16, 2016

PREPARED FOR:

DUKE ENERGY
139 EAST 4TH STREET
MC – EX320
CINCINNATI, OH 45202
ATTENTION: MR. CHARLES HINER, P.E.

December 16, 2016

Mr. Charles Hiner
Duke Energy
139 East 4th Street
Cincinnati, OH 45202

ATC Group Services LLC
7988 Centerpoint Dr.
Suite 100
Indianapolis, IN 46256
Phone +1 317 849 4990
Fax +1 317 849 4278
www.atcgroupservices.com

Re: **Proposed Closure and Post-Closure Plans**
South Ash Basin System
Gibson Generating Station
Owensville, Indiana 47665
ATC Project No. 170LF00085

Dear Mr. Hiner:

In accordance with your request, ATC Group Services LLC (ATC) has prepared the enclosed proposed final Closure and Post-Closure Plans for the South Ash Basin System at the Gibson Generating Station (Gibson Station) in Owensville, Gibson County, Indiana. As you are aware, portions of this report related to groundwater quality and the proposed groundwater monitoring program were prepared by M.S. Beljin & Associates.

We appreciate the opportunity to be of assistance with this project. If you have any questions regarding this letter, please contact our office.

Sincerely,

**ATC Group Services LLC**

for Mark E. Breting, L.P.G.
Senior Project Geologist

John R. Noel, L.P.G.
Senior Project Geologist

LICENSED PROFESSIONAL JOHN R. NOEL No. 1681 STATE OF INDIANA GEOLOGIST

Brent A. Miller, CHMM
Senior Project Scientist

Donald L. Bryenton, P.E.
Principal Engineer

DONALD LEE BRYENTON REGISTERED Nº 17877 STATE OF INDIANA PROFESSIONAL ENGINEER

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# Introduction

The Gibson Station is a five-unit coal fired generating facility located in Gibson County, Montgomery Township, Indiana, in Township 1S, Range 12W, in portions of Sections 32, 33 and 34, and Township 2S, Range 12W, in portions of Sections 3, 4, 5, 7, 8 and 9. The facility, which began commercial operation in 1976, is located along the eastern bank of the Wabash River approximately 35 miles north of Evansville, Indiana and 2 miles east of Mt Carmel, Illinois.

A total of six CCR surface impoundments are present at the Gibson Station (i.e., the North Ash Pond, the North Settling Basin, the East Ash Pond, the East Settling Basin, the South Settling Basin and the South Ash Fill Area). Four of these impoundments (i.e., the North Ash Pond, the North Settling Basin, the South Settling Basin and the East Settling Basin) are regulated by the Federal Coal Combustion Residual (CCR) Rule. The remaining two surface impoundments (i.e., the South Ash Fill Area and the East Ash Pond) stopped receiving CCR materials and were drained prior to October 14, 2015. All six of the impoundments are regulated by the Indiana Department of Environmental Management (IDEM). Current operation of the ash ponds is limited to the sluicing of bottom ash and boiler slag through active sluice lines to discharge into the North Ash Pond. The approximate locations of all six surface impoundments are noted on the USGS topographic quadrangle map 7½ minute series provided as Sheet 3 in Appendix A.1.

The original Closure and Post-Closure Plans for Cells 1, 2 and 3 of the East Ash Pond were submitted to IDEM on August 20, 2008 and approved by IDEM on March 11, 2009. Those plans were recently modified to include the proposed Closure and Post-Closure Plans for the East Settling Basin in a document submitted to IDEM on March 21, 2016. The modified plans were approved by IDEM on October 25, 2016. To date, a total of 229.5 acres of the East Ash Pond System have received partial closure certification.

An Interim Closure and Post-Closure Plan for the North Ash Pond was submitted to IDEM on September 29, 2016. The proposed final Closure and Post-Closure Plans for the North Ash Basin System, consisting of the North Ash Pond and the North Settling Basin, will be submitted under separate cover.

The following document was prepared to present the proposed final Closure and Post-Closure Plans for the South Ash Basin System, which consists of the South Settling Basin and the South Ash Fill Area. Interim Closure and Post-Closure Plans for the South Settling Basin were submitted to IDEM for the South Settling Basin on March 10, 2016. Duke Energy received a letter from IDEM dated June 22, 2016 indicating that they agree conceptually with the proposed closure activities. In accordance with IDEM's request, Duke Energy also submitted a letter of notification dated July 18, 2016 to document the start of construction of the West Ditch within the limits of the South Ash Fill Area. Based on IDEM's conceptual agreement with the plans for both the South Settling Basin and the West Ditch, closure activities have been initiated in those areas. Interim Closure and Post-Closure Plans were submitted to IDEM for the South Ash Fill Area on September 15, 2016.

The objective of this report is to provide a detailed description of the work that will be performed to close the impoundment that is subject to the CCR Rule (i.e. the South Settling Basin) in accordance with Federal CCR Rule §257.102(b)(1)(i-vi) and the requirements outlined in IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. In addition, this report provides a detailed description of the work that will be performed to close the unit that is not subject to the CCR Rule (i.e. South Ash Fill Area). This unit will be closed in accordance with IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. To help facilitate IDEM's review of the proposed Closure and Post-Closure Plans, the following sections of this report have been formatted to provide the content of the IDEM guidance document in bold italics followed by our response.

# Surface Impoundment Closure Guidance

***The following guidance provides an outline of the information required by this office to approve the closure of a surface impoundment. This guidance is meant to provide general guidelines for obtaining closure approval. Approval for the closure of any specific impoundment must be coordinated through the Permit Branch of the Office of Land Quality (OLQ): for more information contact Solid Waste Permit Section at 317/232-7200.***

***Pursuant to 329 IAC 10-3-1(9), the operation of surface impoundments is excluded from regulation under the solid waste management regulations of 329 IAC 10. However, this exclusion goes on to state ". . . the final disposal of solid waste in such facilities at the end of their operation is subject to approval by the commissioner . . ." Impoundments which receive only coal ash and either (1) have a water pollution control facility construction permit under 327 IAC 3, or (2) receive less than 100 cubic yards of coal ash per year from generators who produced less than 100 cubic yards of coal ash per year, are exceptions and remain excluded pursuant to 329 IAC 10-3-1(8) and (10).***

***Two basic types of closures for surface impoundments are covered in this guidance: 1) Clean Closure, and 2) Closure In Place. The technical information that needs to be submitted along with a request for closure approval will vary depending on whether a clean closure or in-place closure is planned.***

Based on discussions with the IDEM technical staff, the agency has also agreed to allow two additional closure alternatives, described as follows:

- Alternative No. 1, Closure by Removal – IDEM identifies this closure alternative as the removal of all CCR materials, plus a minimum of 1 foot of the soils present immediately below the CCR materials, for proper treatment, disposal or beneficial use. IDEM guidance also suggests that a minimum of 18 inches of cover soil and a 6 inch vegetative layer will generally be required over the base of the excavation. This plan requires a description of the grading plan that will be utilized to prevent the ponding of water over the final grades. This plan also requires the development of a groundwater monitoring program.

- Alternative No. 2, RISC Based Closure – Indiana's risk assessment program offers two options for risk-based assessment and closure. As described in IDEM's Remediation Closure Guide (IDEM, 2012), facilities may utilize IDEM's published screening levels for potential contaminants. Screening levels are concentrations calculated from standard equations and exposure assumptions. Sites are generally eligible for closure if concentrations do not exceed screening levels. As an alternative, facilities may perform a site specific risk assessment that more accurately predicts future potential human health and ecological exposures. In both cases it will likely be necessary to collect both background samples and samples of potentially impacted soil and groundwater in the vicinity of the surface impoundment. Both default screening levels and site-specific clean-up levels are negotiated with IDEM and are typically selected to meet risk levels associated with industrial exposure. This plan also requires the development of a groundwater monitoring program.

Closure options for the Gibson Station surface impoundments discussed in this document include clean closure, closure in place, closure by removal, and RISC-based closure. The closure plans selected for the two impoundments in the South Ash Basin System are as follows:

- South Ash Fill Area – In-place Closure
- South Settling Basin – Closure by Removal with a limited area of In-place Closure.

CCR materials generated from the Gibson Station operations or removed from the South Settling Basin will be beneficially used as structural fill to form the subgrade for the final cover in the South Ash Fill Area. The material will be placed in compacted lifts to form a stable subgrade for the composite final cover system. Final cover areas will be vegetated and maintained, and a notation will be added to the property deed.

***<u>IN-PLACE CLOSURE</u>***

***This type of closure involves leaving waste residues within the impoundment and developing a plan designed to contain, control, and monitor the impoundment as a land disposal unit in a manner which is protective of public health and the environment. Waste residue characterization and site characterization, including information about both the general area and the impoundment design and construction, is required for in-place closure. The design and monitoring requirements for impoundments which are closed with the waste in place will be based on type of waste disposed of in an impoundment. The general requirements for nonmunicipal solid waste landfill and restricted waste site (RWS) Type I and Type II are found under 329 IAC 10-24 thru 10-31. (Any waste containing significant quantities of VOCs, or SVOCs will generally be required to close under nonmunicipal solid waste requirements.) The general requirements for Type III are found under 329 IAC 10-32 thru 10-38. In addition, if the applicable restricted waste site criteria are not at least as stringent, biosolid impoundments must meet the land disposal requirements of Federal rule 40 CFR 503.***

***Please be aware that this office may require clean closure if the waste, residue or site characteristics indicate that in-place closure will not be protective to human health and the environment.***

***The following additional information will be required for staff to review and consider the impoundment as a candidate for this type of closure approval:***

***1) <u>Waste Characterization</u>: A waste determination must be conducted pursuant to 40 CFR 262.11, and, if impoundments will be closed in the same manner as restricted waste sites, the waste must be classified as specified in 329 IAC 10-9-4. Additional parameters which may need to be evaluated will be determined on a case-by-case basis. The following waste characterization information should be submitted as part of any in-place closure request.***

***(A) Identification of Physical Parameters: Any physical aspects of the residue that may pose an environmental or technical design problem should also be reported and quantified as necessary and applicable: i.e., low percent solids, high water content, etc.***

***(B) Identification/Quantification of Chemical Constituents: This evaluation generally involves the quantification of the amount of each chemical present within the residue that potentially poses an environmental concern, giving specific consideration to chemicals such as heavy metals, volatile and semi-volatile organic compounds, salts, polychlorinated biphenyls (PCBs), pesticides, neutral leachate parameters defined under 329 IAC 10-9-4, and other chemicals that may pose a public health or environmental threat. These analyses generally involve determining total amounts for these chemicals, but analyses of representative samples of the residue by Toxicity Characteristic Leaching procedure and neutral leachates may also be required to make regulatory status determinations and appropriate disposal decisions.***

***If the responsible party is uncertain as to the waste characterization, the Permit Branch of OLQ can arrange for an OLQ chemist to be consulted for guidance. This office may require that additional parameters be analyzed based on the review of the submitted information.***

For the closure by removal section of the South Settling Basin, it will not be necessary to perform waste classification testing because the CCR materials will be removed. A portion of the South Settling Basin and all of the South Ash Fill Area will be closed in accordance with closure in place procedures. At those locations Duke Energy will meet the requirements for a Type I Restricted Waste Landfill final cover. Therefore, it will not be necessary to perform waste classification testing for these units.

***2) <u>Site Characterization</u>: A narrative description of the impoundment must be provided and should include the following items at a minimum:***

***(A) Impoundment Design: A description of physical design/specifications such as dimensions (length, width, depth), liner construction, etc. of the impoundment. The narrative should include any design documentation that may exist such as drawings, field notes, etc.***

<u>South Ash Fill Area</u>

The South Ash Fill Area historically operated as a surface impoundment that received sluiced coal ash. Based on information obtained from historic drawings and ash inventory soil borings completed in 2016, coal ash is present at depths of up to approximately 35 feet below ground surface (ft bgs) across the fill area.

South Settling Basin

The South Settling Basin is a single surface impoundment that previously collected runoff from the South Ash Fill Area and the coal pile through culverts and ditches that convey water through the intercell berm. It is ATC's understanding that the South Settling Basin has never directly received CCR. Solids deposited in the base of the pond were the result of secondary settling of discharge from the operationally closed South Ash Pond (currently known as the South Ash Fill Area), runoff from the South Ash Fill Area and the coal pile through culverts or the result of runoff from adjacent roads.

***(B) Volume of Waste: The amount of waste or any other residues or material remaining in the impoundment.***

South Ash Fill Area

Based on a review of original design drawings, recent borings drilled within the limits of the South Ash Fill Area and the 2015 topographic mapping of the area, the volume of CCR materials present in this unit is estimated to be approximately 6,855,785 cubic yards (8,226,942 tons).

South Settling Basin

Based on bathymetry information provided by others, the anticipated volume of CCR materials and/or other solids that will be removed from the South Settling Basin is approximately 252,485 cubic yards (302,982 tons).

***(C) Discharges to The Impoundment: A detailed description of those Industrial processes, including raw materials used and their characteristics that generated wastes which were placed in the surface impoundment.***

South Ash Fill Area

The South Ash Fill Area historically received sluiced ash from plant operations. It has not actively received ash since the late 1990's and the majority of the area was covered with soil and vegetated in 2005. Therefore, there are no discharges into this area.

South Settling Basin

It is ATC's understanding that the South Settling Basin has never directly received CCR. Solids present in the base of the pond were the result of secondary settling of discharge from the operationally closed South Ash Pond (currently known as the South Ash Fill Area), runoff from the South Ash Fill Area and the coal pile through culverts or the result of runoff from adjacent roads. Recently the South Settling Basin was removed from service, drained and the removal of CCR materials initiated to facilitate the repurposing of the area as a lined process water pond.

***(D) Site Description: Area maps indicating the location of the impoundment and all other relevant items. All drinking water wells within ½ mile of the impoundment area must be identified, both on and off the facility property.***

***Sites with waste that test as restricted waste Type I or Type II should use the information requested in 329 IAC 10-24-2 as an outline in preparing the description. Sites with waste that test as restricted waste Type III should use the information requested in 329 IAC 10-32-2.***

The Gibson Station is located in Gibson County, Montgomery Township, Indiana, in Township 1S, Range 12W, in portions of Sections 32, 33 and 34, and Township 2S, Range 12W, in portions of Sections 3, 4, 5, 7, 8 and 9. A USGS topographic quadrangle map 7½ minute series is provided as Sheet 3 in Appendix A.1.

A second plot plan showing the approximate locations of the South Settling Basin and the South Ash Fill Area superimposed on a 2013 aerial photograph is included as Sheet 4 in Appendix A.1. A third plot plan showing the site topography in the vicinity of the South Ash Basin System is included as Sheet 5 in Appendix A.1.

Results from investigation and review of the Indiana Department of Natural Resources (IDNR) – Division of Water (DOW) Water Well Records database (IDNR, 2016), and review of information available from IDNR for Significant Water Withdrawal Facilities (SWWF) are summarized on Sheet 3 in Appendix A.1 and provided in Appendix B. It should be noted that location information for IDNR's water well records and SWWFs varies depending on whether wells have been field located. Field located wells or SWWFs are associated with Universal Transverse Mercator (UTM) coordinates. Records without UTM coordinates are considered un-located, however, they are geographically placed in IDNR's water well geographic information system based on description with respect to the public land survey system, driving direction, or address information on the well record.

Water well records that include UTM coordinates are plotted on Sheet 3 in Appendix A.1, and the well records are included in Appendix B.2. Water well records that do not include UTM coordinates are located based on driving direction and administrative information were not identified in the ½-mile distance search area. Appendix B.1 contains water well records that are associated with significant water withdrawal facilities.

As depicted on Sheet 3, six (6) Indiana Department of Natural Resources (IDNR) water well records have been identified within a 1/2-mile distance from the perimeter of the South Ash Basin System. Their approximate locations are depicted on Sheet 3 in Appendix A.1. Two water well records (206831 and 206836) are production water wells associated with the Gibson Station intake valve pumps for the Cooling Pond and are screened in unconsolidated deposits. Four water well records (204845, 204850, 204855, and 204860) are located in areas adjacent to Gibson Station's generating units. These four wells are associated with Gibson's IDNR significant water withdrawal facility registration number. Copies of the IDNR water well records are presented in Appendix B. None of these wells are used for drinking water proposes, they are all used to provide production water.

### *(E) Site Geology: General information on the geology of the site such as:*

#### *(1) General direction of ground water flow.*

The general direction of groundwater flow in the unconsolidated alluvial aquifer at the Gibson Station is directed toward the Wabash River, located to the west-northwest of the site. However, local groundwater flow in the unconsolidated alluvial aquifer under the surface impoundments is influenced by infiltration from the overlying impoundments. Additional discussion of groundwater flow directions is included with information summarizing the monitoring well sampling and testing results.

#### *(2) The depth of the water table across the entire site and the permeability of soils associated with the table.*

Based on water level measurements collected on December 15 and December 18, 2015, the depth to groundwater ranged from approximately 9.5 to 32.5 ft bgs. Based on water level measurements collected between March 7 and March 10, 2016, the depth to groundwater ranged from approximately 6.5 to 27 ft bgs. Based on water level measurements collected between August 29 and August 30, 2016, the depth to groundwater ranged from approximately 7.5 to 30 ft bgs. Water levels vary depending on the ground surface elevation and location of wells or piezometers with respect to the ash ponds and the Wabash River.

In-situ slug test results were performed at each of the 12 groundwater monitoring wells that comprise the proposed South Ash Basin System groundwater monitoring well network. To run each test, a pressure transducer was lowered into the monitoring well. The transducer was connected to a data logger at ground surface that was used to start and stop the test and record water level recovery after stressing the well. Both rising head and falling head tests were run using a weighted PVC cylinder as a slug. Estimates of formation hydraulic conductivity were determined using the Bouwer-Rice analytical model (Bouwer and Rice, 1976) for confined or unconfined aquifers (as needed) implemented in AQTESOLV®. Well recovery diagrams are included in Appendix C and a summary of estimated hydraulic conductivities is attached in Table 1. In general, hydraulic conductivity values are consistent with the expected values for wells screened in outwash sand.

Based on in-situ slug tests conducted by ATC between September 29, 2015 and February 4, 2016, hydraulic conductivities in the screened formations for the groundwater monitoring well network surrounding the South Ash Fill Area and South Settling Basin range from approximately 0.0049 to 0.022 centimeters per second (cm/s). Based on conditions encountered during the slug tests, confined aquifer conditions were present in a majority of the monitoring wells, although unconfined conditions were identified at South Ash Fill Area monitoring wells MW-31B and MW-31C. The values of hydraulic conductivity (K) calculated for the rising and falling head tests are summarized in Table 1.

#### *(3) Delineation of soil strata under the site (i.e., sand, silt, clay, etc.).*

**Geologic Setting.** The Gibson Station is located in southwestern Indiana, in the western portion of Gibson County, Indiana. The site is located within the bedrock Paleozoic depositional and structural feature named the Illinois Basin, a depositional/structural feature located west of the Cincinnati Arch, an associated Paleozoic structural uplift feature. Shallow bedrock in Gibson County is assigned to the Pennsylvanian Carbondale and McLeansboro Groups (Gray and others, 1987), which are mostly composed of shale and sandstone, with lesser amounts of coal, limestone, and claystone. These rocks dip to the west-southwest into the Illinois Basin at about 25 ft/mile (Gray, 1979).

Near the site, the elevation of the bedrock surface is mapped by the IDNR-DOW, using publicly available data, as varying from less than El 250 to greater than El 375 (Barnhart and Middleman, 1990). The ground surface at the site is nearly level, and generally ranges from about El 387 in the southern portion to El 395 in the northern portion. Because of the nearly level ground surface and the variable bedrock elevation, the thickness of unconsolidated deposits at the site is variable.

Faulting is present in the vicinity of the site. The Wabash Valley Fault System passes through Gibson County. The New Harmony Fault is located more than two miles west of Gibson's CCR surface impoundments, and the Owensville Fault is located several miles east of the site. The New Harmony Fault is called the Mt. Carmel Fault in Illinois, although the use of this name is confined to Illinois because the name Mt. Carmel Fault is used for another major fault in Indiana. The New Harmony Fault is a compound fault to the south of the facility, although it appears to have a single fault plane where is passes closest to the site. Maximum displacement is about 450 vertical feet, and the fault is about 30 miles long. The Owensville Fault is about ten miles long (Ault and Sullivan, 1982).

The Gibson Station is situated in the Wabash Lowland Physiographic region. This region is bounded to the north by the Central Wabash Valley, to the east by the Martinsville Hills and the Crawford Upland, and to the southeast by the Boonville Hills. The facility is adjacent to the east bank of the Wabash River, at the western extent of the Wabash Lowland Physiographic region in Indiana.

**Unconsolidated Deposits.** The geology in the vicinity of the Gibson Station consists of a glacial outwash valley that underlies the present day Wabash River. The width of the valley is approximately 7 miles and the Wabash River flows in a southerly direction adjacent to the western valley wall along the river stretch adjacent to Gibson Station. Surficial unconsolidated material consists of glaciofluvial sand and gravel deposits overlain by a surficial deposit (up to 15 feet thick) of fluvial derived silt and clay. These materials extend to Pennsylvanian bedrock in Gibson County (AECOM, 2015).

The majority of Gibson County has been directly subjected to Pleistocene glaciation during pre-Wisconsinan glacial events (only the eastern-most portion of the county is unglaciated), and the entire county has been affected by either ice-contact or pro-glacial processes. This is manifested in the county by the presence of glacial till, loess, and outwash deposits. The last ice sheet to reach Gibson County was pre-Wisconsinan, although the extensive outwash and alluvial deposits along the Wabash River include Wisconsinan deposits. The site is located approximately 85 miles south of the boundary of the furthest Wisconsin-age glacial advance into Indiana. In addition, the site is located approximately 15 miles north of the Pre-Wisconsinan glacial limit boundary (AECOM, 2015).

**Bedrock.** The uppermost bedrock in Gibson County is assigned to the Pennsylvanian Carbondale and McLeansboro Groups (Gray and others, 1987), which are mostly composed of shale and sandstone, with lesser amounts of coal, limestone, and claystone.

**Regional Hydrogeology.** As summarized in Fenelon and others (1994), the site lies within the Lower Wabash River Basin, a broad, flat glacial drainage channel characterized by winding channels, a wide flood plain, and adjacent terrace levels. The valley floor ranges between 3 and 10 miles in width. The principal aquifer type present in the basin is the outwash and alluvial sand and gravel in the Wabash River Valley, reaching thickness of up to 150 ft. These thick sand sequences are generally clean, well sorted, and coarse grained. A secondary unconsolidated source is the buried sand and gravel of the tributary valleys. Other unconsolidated groundwater resources include sand and gravel lenses interbedded with lake sediments, glacial till, and dune sands.

Bedrock aquifers are also a source of water in the basin. The Inglefield Sandstone Member represents the thickest and most laterally extensive bedrock aquifer in Gibson County. Aquifers associated with complexly interbedded sandstone, shale, limestone, and coal are another source. Wells are typically open to the entire bedrock section below unconsolidated material, where typically the sandstone and coal are the primary water producing units. Groundwater yields from bedrock aquifers are generally less than yields from unconsolidated deposits in the area.

Regional groundwater flow near the site is typically southwest, toward the Wabash River. This flow direction is locally influenced by other drainage features (e.g., the Patoka River), and production of groundwater from wells.

**Soil Lithology.** The South Ash Fill Area and South Settling Basin impoundments are located between approximately 600 and 1,400 feet southeast of the Wabash River. Borings in this vicinity indicate that unconsolidated fine grained cohesive deposits extend to elevations ranging between EL 367 and EL 376. In disturbed or developed areas, including along the embankment separating the South Ash Fill Area from the South Settling Basin, materials are described as fill/topsoil. Cohesive, lower permeability alluvial deposits consisting of loam, silt loam, sandy loam, silty clay loam, and silty clay extend to depths between 22 and 38 ft bgs.

A granular sand and gravel deposit ranging between approximately 10 to at least 44 feet in thickness is present below the cohesive units. These relatively higher permeability unconsolidated materials are interpreted as glacial outwash deposits consisting of yellowish brown to gray loamy sands and sands. As the cross sections show, grain size generally increases with depth (sand and gravel deposits more frequent), and may change laterally as well sorted deposits grade into poorly sorted sands with relatively higher percentages of very coarse sand and gravel. The sand deposits typically became more dense at depth.

Bedrock in this area ranges between 43.5 ft bgs to at least 70.9 ft bgs with elevations ranging from a minimum elevation of approximately EL 335 to EL 359. It is noted that the bedrock surface drops off to the northeast and east of the South Ash Basin System.

Basin embankments consist of silt loam and sandy loam, generally stiff to very stiff in upper portions, but are softer in lower portions (below approximately EL 379 to EL 381). The interpreted natural foundation soils below the embankments consist of a blanket of generally soft silt loam, silty clay loam, or clay loam soils that overlie very loose to very dense sand or sand and gravel.

Site geologic and hydrogeologic information is available from various subsurface investigations and reports discussed below. Historical soil boring logs are provided in Appendix D. Soil boring, monitoring well, and piezometer locations are shown on Sheet 6. Hydraulic conductivity testing results are provided in Appendix C. Soil laboratory results are summarized in Table 2A and provided in Appendix E. Geological cross sections summarizing subsurface results along several transects across the impoundment system are included as Sheets 7 and 8 of Appendix A.1.

Supplementary subsurface information is also available from water well records on file at IDNR Division of Water or online (IDNR, 2016). The locations of water well records within a 1/2-mile distance from the perimeter of the impoundment basins are shown on Sheet 3 in Appendix A.1.

### Sargent and Lundy Boring Logs.

Several borings in the vicinity of the South Ash Fill Area and South Settling Basin were completed by Sargent and Lundy. Findings were summarized in a letter to Public Service Indiana (PSI) in February 1980. The borings include DB-16, DB-17, DB-18, HA-74-1, HA-74-2, HA-74-3, S-1, S-2, S-9, S-10, SB-2, SB-3, SB-5, SB-204, SB-315, SB-401, VS-19, VS-20, and VS-21.

### 2014 AECOM Geotechnical Investigation Boring Logs

As part of an ongoing geotechnical investigation for ash pond closure evaluations, AECOM oversaw advancement of soil borings and cone penetrometer soundings. Geotechnical soil boring locations SSB-01, SCP-02, SSB-03, SCP-04, SSB-05, and SSB-06 are depicted on Sheet 6. Results from the borings advanced in berm areas show the presence of cohesive unconsolidated soils from the ground surface to depths ranging from 22.0-33.0 ft bgs. Cohesive deposits are underlain by sand and sand/gravel deposits to depths between 72.5 and 80 ft bgs. Shale bedrock was encountered below 72.5 ft bgs at SSB-06. A piezometer was subsequently installed in the SSB-03 location.

### 2015 Monitoring Well Boring Logs

The 2015 Monitoring Well Installation Program included the installation of twelve monitoring wells (MW-27C, MW-28B, MW-28C, MW-29B, MW-29C, MW-30C, MW-31B, MW-31C, MW-41C, MW-42C, MW-43B, and MW-43C) which are a part of the anticipated groundwater monitoring system for the South Ash Basin System. The naming convention for the wells at the site is such that wells named with an "A" suffix are wells typically screened 75 feet below top of the aquifer; wells named as "B" wells are generally screened over the interval from 30 to 50 feet below top of the aquifer; and shallow "C" monitoring wells are typically screened within the first 20 feet of the aquifer.

Cohesive material encountered in the soil borings for the wells classified texturally as loam, silt, silt loam, sandy loam, silty clay loam, sandy clay, and silty clay to depths between 20 and 38 ft bgs. Granular units interpreted as glacial outwash deposits occur below overlying cohesive soils. Granular deposits consist of yellowish brown to gray loamy sands and sands. With increasing depth, grain size generally increases and sand and gravel deposits are more frequent.

Below the unconsolidated deposits, bedrock is encountered in the borings for wells MW-27C, MW-29B, MW-30C, MW-31B, MW-41C, MW-42C, and MW-43B, at depths ranging between 43.5 and 70.9 ft bgs. These depths correspond to a bedrock elevation ranging approximately between EL 335 to EL 359.

## ATC 2016 Ash Inventory Borings

A series of borings were advanced at the South Ash Fill Area (AI-11 through AI-22) to investigate the extent and depth of deposited ash (ATC, 2016b). Logs for ash inventory locations either proximal to the South Ash Fill Area or shown on cross section B – B' (AI-12, AI-18, AI-21, and AI-22) and cross-section C - C' (A-17) are included in Appendix D. In general, CCR material thickness encountered in soil borings across the South Ash Fill Area ranged from 13.5 to 22.5 feet and is represented on the geological cross sections on Sheets 7 and 8. The unconsolidated formation present below the coal ash consists primarily of cohesive deposits. Based on a review of historical design drawings for this area and the results of all test borings drilled in this area, the base grade of the CCR materials in the South Settling Basin appears to be approximately EL 380, while the base of the CCR in the South Ash Fill Area ranges from approximately EL 376 to EL 386. Approximate bottom of ash contours are depicted on Sheet 9, and ash thicknesses are depicted on Sheet 10, both in Appendix A.1.

The results of laboratory tests performed on CCR material obtained from piston samples are provided on Table 2B. The results of these tests indicate that the moisture content of the sampled ash ranged from 19.0 to 92.1 percent, the dry density ranged from 30.0 to 91.3 pcf and the hydraulic conductivity ranged from $2.25 \times 10^{-8}$ to $4.07 \times 10^{-5}$ cm/sec.

***(4) If monitoring wells are currently in place, the following information concerning the wells must be provided:***

***(a) Site map indicating location of wells.***

The proposed groundwater monitoring well system for the South Ash Basin System includes twelve (12) wells that were installed in 2015 (MW-27C, MW-28B, MW-28C, MW-29B, MW-29C, MW-30C, MW-31B, MW-31C, MW-41C, MW-42C, MW-43B, and MW-43C) and are shown on Sheet 6 in Appendix A.1. Monitoring well construction details are listed in Table 3 and provided on construction diagrams in Appendix F.

***(b) Identification of upgradient and downgradient wells.***

Groundwater flow gradients and flow directions in the area of Gibson's South Ash Basin System are the result of the superimposed hydraulic effects of regional flow toward the Wabash River and historic groundwater mounding associated with recharge from unlined impoundments and the Cooling Pond located at the station.

Based on water level measurements collected during groundwater events performed since December 2015, monitoring wells MW-43B and MW-43C are located hydraulically upgradient with respect to the South Settling Basin, while monitoring wells MW-29B and MW-29C are upgradient of the South Ash Fill Area. These locations are the closest monitoring points adjacent to the Cooling Pond, which is interpreted to represent a localized hydraulic high; The Cooling Pond water level is reportedly maintained at approximately EL 400.

Monitoring wells MW-41C and MW-42C represent downgradient monitoring points of the South Settling Basin, while monitoring wells MW-28B, MW-28C, MW-30C, MW-31B, and MW-31C are downgradient of the South Ash Fill Area. Monitoring well MW-27C serves as a downgradient monitoring device for both impoundments. A groundwater potentiometric surface map for August 23, 2016 is provided as Figure 3.

***(c) The type of stratum and the depth the wells are screened.***

Subsurface stratigraphy is discussed in section 2(E)(3) above. The type of stratum encountered in each monitoring well screen interval generally consists of granular unconsolidated sand and gravel units. Based on in-situ slug tests, hydraulic conductivity values are generally consistent with the upper ranges of hydraulic conductivity cited in literature for coarse sand to gravel. Boring logs from borings advanced in, within, and around the South Ash Basin System are included in Appendix D. Screened intervals for each monitoring well are depicted on cross sections, listed on Table 3, and shown on the monitoring well construction diagrams in Appendix F.

***(d) Description of well installations including a bore hole log.***

Twelve monitoring wells (MW-27C, MW-28B, MW-28C, MW-29B, MW-29C, MW-30C, MW-31B, MW-31C, MW-41C, MW-42C, MW-43B, and MW-43C) were installed by ATC between September 1 and October 22, 2015 to monitor groundwater around the South Ash Fill Area and South Settling Basin (ATC, 2016a).

Boreholes were advanced utilizing either a Diedrich D-50 or Mobile B-53 (both track mounted) hollow stem auger drill rig. Soil samples were collected utilizing continuous split-spoon sampling technology. Monitoring wells MW-27C, MW-29B, MW-31B, MW-41C, MW-42C, and MW-43B were screened in saturated unconsolidated river outwash deposits lying immediately above the bedrock, which was encountered at depths ranging from 43.5 ft bgs (MW-41C) to 71.0 ft bgs (MW-29B).

Each monitoring well was constructed with a two-inch inside diameter Schedule 40 PVC casing with either a five- (5), or 10-foot long 0.010-inch slotted screen. The zone around and approximately two (2) feet above the screen was backfilled either with unconsolidated sediments that cave into the boring when the augers are removed or with granular material supplied by ATC. The upper one (1) to two (2) feet of the filter pack consists of fine, inert sand. The remainder of the borehole was backfilled with bentonite grout. A lockable stick-up protective casing was installed at the ground surface, and set into a (5 foot x 5 foot) concrete pad at MW-27C, MW-28B, MW-28C, MW-29B, MW-29C, MW-42C, MW-43B, and MW-43C. Each of these wells was completed with a stick-up protective casing which is protected with 3-inch diameter steel, concrete-filled bollards that extend approximately four (4) feet from the ground surface.

Flush-mount steel manways were installed at the ground surface, and set into a 5 foot x 5 foot concrete pad at wells MW-30C, MW-31B, MW-31C, and MW-41C. As noted above, borehole logs and monitoring well construction diagrams are provided in Appendices D and F, respectively.

All of the monitoring wells were installed and developed in a manner consistent with 329 IAC 10-21-4. Representative samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits from significant lithological strata including aquifer material. Two slug tests (rising head and falling head) were performed on each monitoring well to estimate the hydraulic conductivity of the aquifer.

All well locations and elevations were surveyed by a licensed surveyor. Horizontal locations and the ground surface elevations were measured to the nearest 0.1 foot. Well riser elevations were measured to the nearest 0.01 foot. Elevation data are recorded on the soil boring logs (Appendix D) and well construction diagrams in Appendix F. A summary table with well coordinates and elevations is included in Table 3.

***(e) Any ground water monitoring data that would indicate background water quality.***

Historical groundwater data collected from monitoring wells associated with the South Ash Basin System are included on CDs provided in Appendix G. The information in the following section, prepared by M.S. Beljin & Associates, summarizes historical water quality results, and proposes semi-annual collection of groundwater samples.

## Gibson Ash Pond System Water Quality

This section presents the groundwater quality characterization for two (2) separate units:

1. South Settling Basin,
2. South Ash Fill Area

Water quality data collected from the monitoring wells is used to support the closure plan and to recommend a monitoring assessment process as the closure actions proceed. The proposed monitoring network consists of the twelve (12) newly installed wells for the South Ash Basin System.

The overall monitoring network is illustrated in Figure 2 for the two (2) closure units. This figure depicts the twelve (12) newly installed monitoring wells for collecting groundwater quality data. There are no existing wells associated with these units.

Figure 3 presents the water levels and approximate flow map for the monitoring network representing the wells across the South Ash Basin System.

The twelve (12) new wells were installed with the initial sampling event occurring in December 2015. For purposes of the initial groundwater quality characterization there were separate sampling events conducted in December 2015, March 2016, and August 2016.

**Newly Installed Wells:** MW-27C, MW-28B, MW-28C, MW-29B, MW-29C, MW-30C, MW-31B, MW-31C, MW-41C, MW-42C, MW-43B, and MW-43C.

Collectively the analysis of groundwater samples obtained from the monitoring locations for thirty-four (34) different parameters was used to examine the groundwater quality in the vicinity of the separate South Ash Fill Area and the South Ash Settling Basin.

The analysed parameters included:

- Alkalinity
- Antimony
- Arsenic
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Fluoride
- Iron
- Lead

- Lithium
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nitrogen, Ammonia
- Nitrogen, Nitrate
- pH (field and Laboratory)
- Potassium
- Selenium
- Silver
- Sodium
- Specific Conductivity (field and Laboratory)
- Sulfate
- TDS
- Thallium
- Zinc
- Combined Radium 226 + 228

The analytical results of the sampling, for six of the thirty-four (34) parameters are presented in Table 4. A number of the parameters had a relatively large number of non-detects in a majority of the monitoring wells and are not presented.

The characterization of the local groundwater quality will be used to evaluate the performance of the specified closure actions. To obtain sufficient data for determining the efficacy of the closure actions the available data from wells near the Gibson Station ash ponds, landfills, and settling basins will be used to establish performance goals and for making statistical comparisons.

For purposes of evaluating the relationship between wells and characterizing the groundwater quality the following six (6) parameters were specifically considered:

- barium (MCL = 2 MG/L)
- boron,
- calcium,
- chloride, (SMCL = 250 mg/L),
- sulfate, (SMCL = 250 mg/L), and
- TDS, (SMCL = 500 mg/L)

These six (6) parameters provide a measure of the general water quality in the vicinity of the Gibson South Ash Basin System. Observations for the specified six (6) parameters from the monitoring wells are presented in Table 4.

The relationship between wells (locations) for a number of the parameters was evaluated using box plots and the Student's t-distribution comparing each pair. While there is insufficient data to perform powerful statistical analyses for the newly installed wells, the box plots do present an overall representation of the current water quality conditions.

An overall comparison is also made between the mean values, for each sampling location, and the Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels (SMCLs) as presented in 40CFR141 'National Primary Drinking Water Regulations' and 40CFR143 'National Secondary Drinking Water Regulations'.

The MCLs and SMCLs represent reasonable goals for drinking water quality. Figures 4 through 9 provide individual pair-wise comparisons at the 95% confidence level. For example, the comparison of boron by well (Figure 5), shows that wells MW-41C and MW-42C are statistically significantly greater than the other wells representing the South Ash Basin System. These two wells have the highest overall mean boron concentrations at 70.5 mg/L and 64.5 mg/L respectively. Figure 10 presents the Cation and Anion balances across the monitoring network.

The box plots in Figure 5 illustrate the overall differences between wells. The groundwater quality in the vicinity of the South Ash Basin System is characterized by the groundwater flow across the specific area (Figure 3). For purposes of the groundwater quality characterization and future performance evaluations a "source" of the observations from the monitoring network is assumed to exist. The source is assumed to be the materials placed in the specified units and what may have been transported to the settling basin. This relationship between the potential source and the observations from the monitoring wells forms the basis for the approach to assessment monitoring for the closure actions of the separate units.

As the hydraulic head is altered as a result of the closure actions the groundwater flow may change. In addition, as the closure actions proceed less ash material may reach the groundwater. The combined effects, after closure, are expected to result in decreasing trends in key parameters over time.

Using the basic relationship between the hydraulic head and the groundwater flow a set of "performance goals" can be established for each well and each of the specific water quality parameters (e.g., barium, boron, calcium, chloride, sulfate, and TDS).

## Assessment Monitoring Plan Overview

For the purposes of determining the effectiveness of the South Ash Basin System closure actions, an assessment-monitoring plan is being proposed. After an initial compressed sampling frequency, to collect at least eight independent data points, the monitoring wells will then be sampled on a semi-annual basis. Annual groundwater reports will be submitted within sixty (60) days after the sampling event is completed on the schedule approved by IDEM. The data evaluation during the closure period will be used to better define the extent of the impact to water quality.

## Data Review and Evaluation during Closure Activities

Over time, a statistical analysis of specific parameters (including boron) will be performed to compare future observations against the existing groundwater quality to determine whether existing statistical differences are increasing or decreasing. This analysis relies on both "within well" and "between well" comparisons using parametric and non-parametric techniques as appropriate. These comparisons are to be performed to assess the whether there are statistically significant trends and whether observed concentrations are above or below established "performance goals". The performance goals are based on the current conditions within individual wells for each parameter. The performance goals are then compared to existing contaminant limits (MCLs, SMCLs, or other).

For purposes of evaluating the effectiveness of the closure action including the relationship between wells through the statistical analysis Duke Energy proposes to conduct analysis on semi-annual sampling for the parameters summarized in Table 5.

## Establishing Performance Goals for Post-Closure Monitoring

The performance goals will be established during the initial phases of the closure action and after there is measurable decrease in the hydraulic head. At this point in time during the closure process where there is the greatest chance that any constituents, remaining in the solid matrix beneath the ash ponds, will be significantly mitigated from entering the groundwater. To assure that the level of effectiveness desired from the closure action of the Ash Pond, Duke Energy proposes a period of post corrective construction for on- and off-site groundwater monitoring.

The data from future post closure semi-annual groundwater assessment monitoring will be used to assess the following:

- Monitor the hydraulic gradient and the overall change in flow;
- Monitor the decrease of site related constituent concentrations in on-site groundwater (projecting the decrease in concentration off-site) over the proposed monitoring time period (expected condition post remedy); and,
- Assure that site related constituent concentrations in on-site groundwater do not increase above the proposed groundwater performance goals.

To address the third bullet, Duke Energy proposes the following:

- Groundwater monitoring data collected from each on-site monitoring well will be used as a benchmark against which any potential post remedy constituent increasing concentration shifts will be gauged. Following EPA guidance for intra-well comparisons (USEPA, 2009), a Shewhart control limit will be calculated for each well where at least eight sample results are available. These limits will serve as goals for each parameter (constituent) in each well. Control limits based on fewer than eight results only estimate an appropriate performance goal.
- Upon completion of the second semi-annual monitoring event, a well-by-well comparison of post corrective action groundwater monitoring results will be performed against the parameter goals as applicable. If the goal level is exceeded in a particular well or wells, Duke Energy will collect an additional groundwater sample from the well(s) exceeding goal(s) within thirty (30) days of receipt of validated analytical results to verify the detected concentration.
- If the concentration(s) exceeding goal(s) are verified, monitoring will continue on the schedule semi-annual and the event at the specific monitoring well will be labeled as "goal exceeded". (A potential indicator of a departure from remedy

effectiveness is four (4) successive goal limits exceeded in a single monitoring well over the scheduled monitoring frequency).

- If after at least four (4) sampling events with fewer than four (4) goals in any specific well having been exceeded such that it is determined that no increasing concentration shift exists or, more likely, that the increase was temporary due to changing conditions post remedy construction, Duke Energy will remove the "goal exceeded" designation and continue with the normal monitoring program as detailed.
- If after at least four (4) sampling events it is determined that an increasing concentration shift may exist, Duke Energy will increase the monitoring frequency to quarterly and assess the effectiveness of the closure action. As long as concentrations do not approach 95% of the groundwater monitoring goals presented above, Duke Energy will continue to monitor the shift. If the increasing concentration shift reverses and a pattern of decreasing concentrations is established, Duke Energy will resume the normal monitoring program as presented.
- If the increasing shift continues and is determined to present an unacceptable condition for post closure of the two specified units, then Duke Energy will take action to determine what steps to take to mitigate the degradation in effectiveness of the closure action.

The type of control limit or goal used for comparison to individual groundwater monitoring concentrations is the Shewhart control limit (EPA, 2009; Gibbons, 1994; Gibbons, 1987). These are derived as the mean (median value for non-parametric distributions) plus 4.5 times the standard deviation of the historical (baseline) well results or proxy substitutions of ½ the detection limit for non-detects. Post-baseline concentrations are compared directly to these limits. A pattern of exceedances will indicate that a group of concentrations are significantly different than the baseline data. However, this pattern may or may not indicate that actual concentrations are increasing due to an on-site release that continues to migrate off-site post remedy.

It is important to note that variability and shift changes post closure are likely to occur. Temporary increases in concentrations could result from construction activities or the change in hydrogeologic conditions due to operation of the hydraulic control system. In addition, groundwater flow velocities and directions are likely to change, based on the predictive runs of the current groundwater model. Therefore, the response of the constituent (parameter) concentrations in on-site groundwater as a result of corrective actions given the hydrogeologic conditions could take years to evaluate potential concentration shifts. For this reason, the actual amount of time to establish if an increasing concentration shift exists is not clear and post closure construction data will need to be evaluated as time progresses to allow for accurate evaluation of potential increasing concentration shifts.

***(f) Any ground water monitoring data collected after installation and operation of impoundment commenced which may be utilized to determine if there is any current ground water contamination.***

Historical groundwater data collected from monitoring wells associated with the South Ash Basin System are included on compact discs in Appendix G. Due to the large volume of printed material associated with the historical groundwater data, hard copies are not being provided.

> ***Based on review of this data and the residue chemistry, more comprehensive and specific geology information may be required. Sites with waste that test as restricted waste Type I or Type II can use the information requested in 329 IAC 10-24-3 and 10-24-4 as an outline in preparing the geology description. Sites with waste that test as restricted waste Type III can use the information requested in 329 IAC 10-32-3.***

***3) Closure Plan: A detailed proposal for closure design and construction and for post-closure care of the impoundment must be submitted. Sites will close under the applicable requirements for Restricted Waste Sites (RWS), as described in 329 IAC 10-24 thru 10-38, depending on the characteristics of the waste in the impoundments.***

***Please note, if the residue in the impoundment is determined to be hazardous waste, this guidance is not applicable; for more information consult the Permit Branch for guidance at (317)232-4462.***

***At a minimum, the proposed closure plan must include details of the following:***

***(A) Cap Design: A description of the cap including dimension, Slope, and description of materials to be used. Caps at sites that test as restricted waste site Type I or Type II must be designed in accordance with applicable requirements of 329 IAC 10-30-2 or 10-30-3. Sites that test as restricted waste site type III must be designed in accordance with 329 IAC 10-37-2. Sludges from wastewater treatment plants that test as restricted waste site Type III must also comply with the design requirements of 40 CFR 503.***

South Settling Basin

As noted in the Interim Closure Plans submitted to IDEM in March 2016, the majority of the South Settling Basin will be closed using closure by removal procedures. As a result, it will not be necessary to construct a final cover to meet the requirements noted above in those areas where closure by removal procedures are completed. Once the closure by removal activities have been completed in the South Settling Basin, that area will be repurposed to serve as a lined process water basin. The approximate limits and proposed grading of the new process water basin are noted on Sheet 11 in Appendix A.1. The repurposed Non-CCR basin will be divided into three cells formed using 4H:1V interval sideslopes and will be lined with GCL, a 60 mil HDPE geomembrane, and a 16 oz/sy cushion geotextile. The surface of the geotextile will be covered with a minimum of 12 inches of INDOT No. 12 crushed stone across the base with an additional 15 inches of riprap on the sideslopes.

Following submittal of the Interim Closure Plans for the South Settling Basin, it was discovered that there is an approximately 50 ft to 150 ft section of the south end of the South Settling Basin that was taken out of service previously to allow for the construction of the existing South

Settling Basin pumping station and a haul road. CCR materials in this section of the pond were displaced during placement of the structural fill used to establish the revised grades in this section of the pond. However, removal of the CCR was not verified at the time of construction. As a result, this portion of the pond will be closed in place at the time the Gibson Station is decommissioned. At that time, the grades will be modified as necessary to establish a minimum 2% slope and a vegetated final cover with a minimum thickness of 2.5 ft will be established.

***Closure by Removal Area*** - Closure by removal activities in the South Settling Basin will include the following:

- Discharge from adjacent sources will be temporarily diverted from the South Settling Basin, or to a subdivided, hydraulically separate, portion of the basin as necessary before closure activities are initiated in each phase of closure. Water that collects in the South Settling Basin is currently pumped to the Gibson Cooling Pond via a pumping station located at the south end of the basin. That pumping system will be utilized during the closure of the South Settling Basin to both remove water discharged to the pond and any storm water that enters the pond.

- An NPDES permit is not required for the current operation of the South Settling Basin or the dewatering of the basin during the closure activities. Duke Energy intends to monitor the total suspended solids concentration during the dewatering of the basin, and treat as necessary, to ensure that CCR solids do not enter the cooling pond.

- The dewatered sediment currently present in the South Settling Basin will be excavated and placed as waste in the Gibson South Landfill or placed as structural fill within the limits of the final cover for the South Ash Fill Area. Based on recent observations made within the South Settling Basin following the initial stages of dewatering, it is anticipated that the base of the initial CCR removal will vary from approximately EL 380 to EL 388.

- Following removal of CCR materials from the South Settling Basin, the basin will be visually inspected by a third party engineer or geologist to verify that CCR materials have been removed. Following this visual inspection, and any subsequent removal required by the inspection, the surface of the excavation will be surveyed on 100 ft centers. The proposed 100 ft survey grid is consistent with the survey frequency provided for landfill final cover projects. The visual inspection will be of the entire basin, while the survey will only be done on the 100 ft grid pattern.

- A minimum of one (1) additional foot of material will be removed from the excavation and the material transported to and placed in either the Gibson South Landfill (as waste) or the South Ash Fill Area (as structural fill). Following removal of the additional one (1) ft of material, the excavation will be surveyed again using the same grid system to confirm the removal of a minimum of one (1) ft of material. Although the surveyor will not be required to determine elevations between the 100 ft grid points, he/she will be instructed to look for any evidence that the 1 ft undercut of soil was not uniformly performed across the base of the excavation.

- Following the completion of the closure by removal activities a closure certification report will be prepared and submitted to IDEM. The closure certification report will include a summary of the visual inspection findings, photographs of the area following removal of the CCR materials and a minimum of 1 ft of the underlying soil, and a summary of the survey data obtained to document the removal of these materials. The report will be prepared and certified by a licensed Professional Engineer.

Based on IDEM's conceptual agreement with the proposed closure activities in this area, closure was initiated in this area in September 2016. To date, closure activities have included dewatering of the South Settling Basin, as well as the removal of a portion of the CCR materials.

***Closure In Place Area*** – In-place closure activities in the South Settling Basin, which will be performed during decommissioning of the station, include the following:

- Regrading of areas within the limits of the South Settling Basin which were not included in the closure certification report prepared to document the completion of the closure by removal area. The final grades will establish a minimum 2% slope.
- A minimum of 2.5 ft of soil cover and 0.5 ft vegetative layer will be established.
- The area will be vegetated.
- Following the completion of the in-place closure activities a closure certification report will be prepared and submitted to IDEM. The closure certification report will include a verification of the final grades and photographs of the area. The report will be prepared and certified by a licensed Professional Engineer.

<u>South Ash Fill Area</u>

Duke Energy proposes to utilize an in-place closure plan for the South Ash Fill Area. In general, the closure will consist of three phases as outlined in the following paragraphs.

***West Ditch Area*** – It will be necessary to construct the "West Ditch", noted on Sheets 11 and 12 in Appendix A.1, prior to closure of the entire South Ash Fill Area. The West Ditch will be used to convey process water from the Gibson Station to the lined process water pond that will be constructed within the limits of the South Settling Basin. As noted on the detail prepared by others provided on Drawing No. GBS00-CVL-0021 in Appendix A.2, the concrete-lined ditch will be underlain (from top to bottom) by a 12 inch drainage layer of No. 8 crushed stone, a 16 oz/sq yd geotextile and a 60 mil dual textured HDPE geomembrane. Once the West Ditch has been completed, the existing unlined ditch and the areas adjacent to the West Ditch will be backfilled with CCR structural fill compacted in lifts to establish the subgrade of the final cover system. The final cover system on either side of the ditch will consist of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. The areas adjoining the ditch will slope towards the ditch at a minimum slope of 1%.

Once the West Ditch has been constructed and the final cover system completed in the adjoining areas, a partial closure certification report will be prepared and submitted to IDEM. The report, which will contain survey data to document the horizontal limits of this portion of the closure area, will be certified by a licensed Professional Engineer.

***Interim Closure*** – As discussed with IDEM, the primary access road from the generating station to the Gibson South Landfill crosses the South Ash Fill Area from the northeast to the southwest. That road, as well as stacker pads for Units 1, 2 and 3, conveyors, and maintenance buildings will remain in service until the decommissioning of the Gibson Station. Therefore, interim closure of the South Ash Fill Area will consist of establishing the grades noted on Sheet 11 in Appendix A.1. This interim closure area includes the area currently occupied by the auxiliary coal pile. The remainder of the interim closure area of the South Ash Fill Area was graded to drain, covered with approximately 18 inches of soil, and vegetated when the South Landfill Haul Road was constructed around 2007. The existing soil cover will be removed prior to placing the CCR structural fill needed to establish the interim cover grades noted on Sheet 11.

The 3 percent slopes noted on west and south sides of the South Ash Fill Area on Sheet 11 are for the final cover system. The 3 percent slopes noted on the east and north sides of the South Ash Fill Area are the interim grades that will be formed to allow the landfill haul road and the infrastructure described above to remain in service until the Gibson Station is taken out of service. It is currently anticipated that these interim grades will remain for approximately 20 years. Therefore, Duke Energy proposes to install the final cover system across the entire interim closure area to reduce the infiltration of surface water into the area during the interim closure period. The cover will consist of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water runoff from the west and south slopes will be routed to either the West Ditch or the process water pond constructed following closure of the South Settling Basin. Surface water runoff from the interim slopes on the north and the east will be discharged to a geomembrane lined ditch installed adjacent to the haul road.

Surface water which infiltrates through the cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 11, and 15 through 18, in Appendix A.1. The proposed Quality Assurance Manual (QAM) for the construction of the cover is provided in Appendix J.

***Final Closure*** – The proposed final grading plan for this area is noted on Sheet 12 in Appendix A.1. Upon completion of the placement of the structural fill, the 3 percent slopes will be capped with the final cover system consisting of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 12, and 15 through 18, in Appendix A.1. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

***(B) Final Contour Map: A plot plan that indicates the fill boundaries and the proposed final contours of the site at intervals of no more than two (2) feet.***

Drawings illustrating the proposed grades at the time of closure are provided in Appendix A.1. As noted above, the final grades in the South Ash Fill Area will slope at approximately 3 percent over the majority of the area at the time of closure. It is anticipated that the ponded ash will settle in some areas under the weight of the structural fill needed to establish the required slopes as well as the final cover itself. The final slope of the final cover system (i.e., following settlement) will generally exceed 2 percent. Lesser slopes, which include a geomembrane in the final cover system, will be utilized to tie the grades from the West Ditch Area into the remainder of the South Ash Fill Area final cover.

***(C) Ground Water Monitoring: Sites that test as restricted waste site type I or Type II must prepare a Ground Water Monitoring and Corrective Action plan in accordance with applicable requirements of 329 IAC 10-29. For wastes which test as Type III, the responsible party must either document the lagoon has a barrier in accordance with 329 IAC 10-34 or it will be necessary to develop a similar program for monitoring ground water downgradient or at the facility boundary to detect any future release from the closed impoundment. Sludge from waste water treatment plants that test as restricted waste site Type III must also comply with the ground water requirements of 40 CFR 503. If monitoring is determined to be necessary, a plan should be submitted to this office which includes:***

***(1) the number and placement of monitoring wells;***

The proposed groundwater monitoring system is described in Section 2(E)(4)(a) and (b). Summarizing those sections, twelve (12) monitoring wells are proposed for semi-annual groundwater monitoring. Existing monitoring wells are shown on Sheet 6 of Appendix A.1.

***(2) the number and frequency of samples;***

The proposed groundwater sampling program is described in section 2(E)(4)(e) above.

***(3) the chemical parameters to be monitored that should be consistent with those identified with the impoundment characterization;***

The proposed monitoring parameters are described in section 2(E)(4)(e) above. Following collection of eight rounds of groundwater monitoring results, the analytical parameter list may be revised if continued monitoring of specified parameters is not beneficial for assessing groundwater quality with respect to South Ash Basin System closure.

***(4) sampling protocol; and,***

The proposed sampling protocols are outlined in section 2(E)(4)(e) above. A groundwater sampling and analysis plan that describes the sampling protocols, sampling methods, monitoring points, and monitoring parameters will be prepared within 90 days following IDEM's approval of this Closure Plan.

***(5) how the determination of releases will be made.***

Groundwater quality results will be evaluated according to the assessment monitoring program described in section 2(E)(4)(e) above.

***(D) Closure Certification: Sites that test as restricted waste site Type I or Type II must certify closure in accordance with applicable requirements of 329 IAC 10-30-7. Sites that test as restricted waste site Type III must certify closure in accordance with 329 IAC 10-37-7.***

Duke Energy will submit a closure certification report at the completion of the closure activities for the South Ash Basin System. This report will be prepared to address the requirements of 329 IAC 10-30-7.

***(E) Post-Closure Requirements: Sites that test as restricted waste site Type I or Type II must comply with the applicable post-closure requirements of 329 IAC 10-31. Restricted waste site Type III closure must comply with the applicable post-closure requirements of 329 IAC 10-38. Post-closure care will extend for 30 years as specified by 329 IAC 10-31-2(b) or 329 IAC 10-38-2(b). Funding mechanisms to cover the post-closure requirements must be established in accordance with 329 IAC 10-39.***

Duke Energy will comply with the applicable post-closure requirements of 329 IAC 10-31.

***(F) Responsibilities after Post-Closure: After post-closure is certified as complete, the owner, operator and/or responsible party will still be responsible for the requirements of 329 IAC 10-31-5, 10-31-6 and 10-31-7 or 329 IAC 10-38-5, 10-38-65 and 10-38-7, as applicable.***

Duke Energy will comply with the responsibilities outlined above after completion of the post-closure period. Closure and Post-Closure Cost Estimates, presented on IDEM forms, are provided in Appendix H along with the legal description of the various ash pond solid waste boundaries.

DUKE ENERGY.

*George T. Hamrick*
*Senior Vice President*
*Coal Combustion Products*

*400 S. Tryon Street, ST06A*
*Charlotte, NC 28202*

*Phone: 980-373-8113*
*Email: george.hamrick@duke-energy.com*

**HAND DELIVERED**

December 21, 2016

Mr. Nick Batton
Permit Manager
Office of Land Quality
Indiana Department of Environmental Management
MC 65-45 IGCN 1101
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Subject: Closure and Post-Closure Plan Application
Ash Pond System
Wabash River Generating Station
Vigo County, West Terre Haute, Indiana

Dear Mr. Batton:

Duke Energy Indiana, LLC. (DEI) respectfully submits to the Indiana Department of Environmental Management (IDEM) a Closure and Post Closure Plan application for the Ash Pond System at Wabash River Generating Station located in Vigo County, Indiana. This system includes the North Ash Pond, Ash Pond A, Ash Pond B, South Ash Pond, and the Secondary Settling Basin. The attached application, prepared by ATC Group Services LLC details the Closure and Post-Closure Plans for the Ash Pond System by providing the documentation requested in IDEM's *"Surface Impoundment Closure Guidance"*. At the time of this submission, the legal description of the impoundments has not been finalized; this documentation will be provided as an addendum to the Closure and Post-Closure Plan application.

I certify under penalty of law that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for developing the plan, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information. If you have any questions or require additional information regarding this submittal please contact either Owen Schwartz at 317-838-6027 or Dan Duffy at 513-287-2078.

Respectfully submitted,

George T. Hamrick

George T. Hamrick
Senior Vice President

**PROPOSED ASH BASIN CLOSURE AND POST-CLOSURE PLANS**

ASH POND SYSTEM
WABASH RIVER GENERATING STATION
WEST TERRE HAUTE, IN 47885

ATC PROJECT NO. 170LF00082

DECEMBER 16, 2016

PREPARED FOR:

DUKE ENERGY
139 EAST 4TH STREET
CINCINNATI, OH 45202
ATTENTION: MR. CHARLES HINER, P.E.

ATC Group Services LLC

7988 Centerpoint Dr.
Suite 100
Indianapolis, IN 46256

Phone +1 317 849 4990
Fax +1 317 849 4278

www.atcgroupservices.com

December 16, 2016

Mr. Charles Hiner
Duke Energy
139 East 4th Street
Cincinnati, OH 45202

Re: **Proposed Ash Basin Closure and Post-Closure Plans**
Ash Pond System
Wabash River Generating Station
West Terre Haute, IN
ATC Project No. 170LF00082

Dear Mr. Hiner:

In accordance with your request, ATC Group Services LLC (ATC) has prepared the enclosed proposed Closure and Post-Closure Plans for the Ash Basin System at the Wabash River Generating Station in West Terre Haute, Vigo County, Indiana. As you are aware, portions of this report related to groundwater quality and the proposed groundwater monitoring program were prepared by M.S. Beljin & Associates.

We appreciate the opportunity to be of assistance with this project. If you have any questions regarding this letter, please contact our office.

Sincerely,

**ATC Group Services LLC**

Eric Caldwell
Senior Project Manager

Brent A. Miller, CHMM
Senior Project Scientist

John R. Noel, L.P.G.
Senior Project Geologist

Donald L. Bryenton, P.E.
Principal Engineer

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### Tables



### Figures



### Appendices

# Introduction

The Wabash River Generating Station (Wabash River Station) is located on the Wabash River in Vigo County, Fayette Township, Indiana, in Township 12N, Range 9W, Sections 4 and 5, and Township 13N, Range 9W, Sections 28 and 33. The station, which began commercial production in 1953 and ceased operation in April 2016, is located on the Wabash River, approximately 5.5 miles north of Terre Haute. A drawing showing portions of the New Goshen and Terre Haute, Ind. 7½ minute USGS topographic quadrangle maps is provided as Sheet 3 in Appendix A.

The purpose of these proposed Closure and Post-Closure Plans is to address closure activities related to the entire approximately 225 acre area of the Ash Pond System which consists of the North Ash Pond, Ash Pond A, Ash Pond B, Secondary Settling Pond, and South Ash Pond. Four of these impoundments (i.e., Ash Pond A, Ash Pond B, Secondary Settling Pond, and South Ash Pond) are regulated by the Federal Coal Combustion Residual (CCR) Rule. The remaining surface impoundment (i.e., North Ash Pond) stopped receiving CCR materials and was drained prior to October 14, 2015. All five of the impoundments are regulated by the IDEM. The locations of the surface impoundments are provided on both the 2013 aerial photograph and the 2015 topographic map of the Wabash River Station on Sheets 4 through 8, in Appendix A.

The objective of this report is to provide a detailed description of the work that will be performed to close the impoundments that are subject to the CCR Rule (i.e. Ash Pond A, Ash Pond B, the Secondary Settling Pond, and the South Ash Pond) in accordance with Federal CCR Rule §257.102(b)(1)(i-vi) and the requirements outlined in IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. In addition, this report provides a detailed description of the work that will be performed to the unit that is not subject to the CCR Rule (i.e. North Ash Pond). This unit will be closed in accordance with IDEM's Surface Impoundment Closure Guidance document, as amended by recent guidance obtained from IDEM's Office of Land Quality. To help facilitate IDEM's review of the proposed Closure and Post-Closure Plans, the following sections of this report have been formatted to provide the content of the IDEM guidance document in bold italics followed by our response.

# Surface Impoundment Closure Guidance

***The following guidance provides an outline of the information required by this office to approve the closure of a surface impoundment. This guidance is meant to provide general guidelines for obtaining closure approval. Approval for the closure of any specific impoundment must be coordinated through the Permit Branch of the Office of Land Quality (OLQ): for more information contact Solid Waste Permit Section at 317/232-7200.***

***Pursuant to 329 IAC 10-3-1(9), the operation of surface impoundments is excluded from regulation under the solid waste management regulations of 329 IAC 10. However, this exclusion goes on to state ". . . the final disposal of solid waste in such facilities at the end of their operation is subject to approval by the commissioner . . ." Impoundments which receive only coal ash and either (1) have a water pollution control facility construction permit under 327 IAC 3, or (2) receive less than 100 cubic yards of coal ash per year from generators who produced less than 100 cubic yards of coal ash per year, are exceptions and remain excluded pursuant to 329IAC 10-3-1(8) and (10).***

***Two basic types of closures for surface impoundments are covered in this guidance: 1) Clean Closure, and 2) Closure In Place. The technical information that needs to be submitted along with a request for closure approval will vary depending on whether a clean closure or in-place closure is planned.***

Based on discussions with the IDEM technical staff, the agency has also agreed to allow two additional closure alternatives, described as follows:

- Alternative No. 1, Closure by Removal – IDEM identifies this closure alternative as the removal of all CCR materials, plus a minimum of 1 foot of the soils present immediately below the CCR materials, for proper treatment, disposal or beneficial use. IDEM guidance also suggests that a minimum of 18 inches of cover soil and a 6 inch vegetative layer will generally be required over the base of the excavation. This plan requires a description of the grading plan that will be utilized to prevent the ponding of water over the final grades. This plan also requires the development of a groundwater monitoring program.

- Alternative No. 2, RISC Based Closure – Indiana's risk assessment program offers two options for risk-based assessment and closure. As described in IDEM's Remediation Closure Guide (IDEM, 2012), facilities may utilize IDEM's published screening levels for potential contaminants. Screening levels are concentrations calculated from standard equations and exposure assumptions. Sites are generally eligible for closure if concentrations do not exceed screening levels. As an alternative, facilities may perform a site specific risk assessment that more accurately predicts future potential human health and ecological exposures. In both cases it will likely be necessary to collect both background samples and samples of potentially impacted soil and groundwater in the vicinity of the surface impoundment. Both default screening levels and site-specific clean-up levels are negotiated with IDEM and are typically selected to meet risk levels associated with industrial exposure. This plan also requires the development of a groundwater monitoring program.

Closure options for the Wabash River Station's five surface impoundments include clean closure, closure in place, closure by removal, and RISC-based closure. The closure plans selected for each impoundment are as follows:

- North Ash Pond – Closure in Place
- Ash Pond A – Closure by Removal
- Ash Pond B – Closure in Place
- Secondary Settling Pond – Closure by Removal
- South Ash Pond – Closure in Place

CCR materials removed from Ash Pond A and the Secondary Settling Pond will be beneficially used as structural fill to form a portion of the subgrade for the final cover in one of the closure in place areas. The material will be placed in compacted lifts to form a stable subgrade for the composite final cover system. Final cover areas will be vegetated and maintained, and a notation will be added to the property deed.

***IN-PLACE CLOSURE***

***This type of closure involves leaving waste residues within the impoundment and developing a plan designed to contain, control, and monitor the impoundment as a land disposal unit in a manner which is protective of public health and the environment. Waste residue characterization and site characterization, including information about both the general area and the impoundment design and construction, is required for in-place closure. The design and monitoring requirements for impoundments which are closed with the waste in place will be based on type of waste disposed of in an impoundment. The general requirements for nonmunicipal solid waste landfill and restricted waste site (RWS) Type I and Type II are found under 329 IAC 10-24 thru 10-31. (Any waste containing significant quantities of VOCs, or SVOCs will generally be required to close under nonmunicipal solid waste requirements.) The general requirements for Type III are found under 329 IAC 10-32 thru 10-38. In addition, if the applicable restricted waste site criteria are not at least as stringent, biosolid impoundments must meet the land disposal requirements of Federal rule 40 CFR 503.***

***Please be aware that this office may require clean closure if the waste, residue or site characteristics indicate that in-place closure will not be protective to human health and the environment.***

***The following additional information will be required for staff to review and consider the impoundment as a candidate for this type of closure approval:***

***1) Waste Characterization: A waste determination must be conducted pursuant to 40 CFR 262.11, and, if impoundments will be closed in the same manner as restricted waste sites, the waste must be classified as specified in 329 IAC 10-9-4. Additional parameters which may need to be evaluated will be determined on a case-by-case basis. The following waste characterization information should be submitted as part of any in-place closure request.***

***(A) Identification of Physical Parameters: Any physical aspects of the residue that may pose an environmental or technical design problem should also be reported and quantified as necessary and applicable: i.e., low percent solids, high water content, etc.***

***(B) Identification/Quantification of Chemical Constituents: This evaluation generally involves the quantification of the amount of each chemical present within the residue that potentially poses an environmental concern, giving specific consideration to chemicals such as heavy metals, volatile and semi-volatile organic compounds, salts, polychlorinated biphenyls (PCBs), pesticides, neutral leachate parameters defined under 329 IAC 10-9-4, and other chemicals that may pose a public health or environmental threat. These analyses generally involve determining total amounts for these chemicals, but analyses of representative samples of the residue by Toxicity Characteristic Leaching procedure and neutral leachates may also be required to make regulatory status determinations and appropriate disposal decisions.***

***If the responsible party is uncertain as to the waste characterization, the Permit Branch of OLQ can arrange for an OLQ chemist to be consulted for guidance. This office may require that additional parameters be analyzed based on the review of the submitted information.***

For the surface impoundments that will be closed in accordance with the closure by removal procedures, it will not be necessary to perform waste classification testing because the CCR materials will be removed. At the surface impoundments that will be closed in accordance with closure in place procedures, Duke Energy will meet the requirements for a Type I Restricted Waste Landfill final cover. Therefore, it will not be necessary to perform waste classification testing for these units.

***2) <u>Site Characterization</u>: A narrative description of the impoundment must be provided and should include the following items at a minimum:***

***(A) Impoundment Design: A description of physical design/specifications such as dimensions (length, width, depth), liner construction, etc. of the impoundment. The narrative should include any design documentation that may exist such as drawings, field notes, etc.***

The Wabash River Generating Station operated as a coal-fired plant from 1953 to April 2016. The plant wet-sluiced the majority of the fly ash and bottom ash to the ash pond system. The following paragraphs provide a description of each of the CCR surface impoundments included in this Closure Plan.

<u>North Ash Pond</u>

The North Ash Pond is located on the north side of the generating station and was the first pond placed in operation, around 1953. The original pond footprint occupied an area of approximately 43.1 acres. The pond was taken out of service prior to 1990.

As noted on the drawings in Appendix A, approximately 7.0 acres of the central portion of the pond were sold to the Wabash Valley Power Association, Inc. (WVPA) who operates the adjoining IGCC Plant. The majority of that area is now occupied by grey water ponds that have been operated by WVPA. The base of the grey water ponds reportedly consists of 10 ft of compacted soil fill overlain by a 4 ft thick clay liner. Further, the majority of the southern portion of the footprint of the North Ash Pond is covered with a petroleum coke (aka, pet coke) storage area which was also utilized by WVPA. In 2016 WVPA ceased operation of the IGCC and sold the facility, including the area located within the footprint of the original ash pond and the rights to the pet coke storage area, to Quasar SynGas LLC. Details regarding Quasar's future operations of this facility are unclear at this time. However, Quasar has indicated that it plans to continue to use the pet coke storage area and the process water ponds.

The top of the original embankment elevation was constructed to 481 with a 10 ft wide crest and typically 1.5H:1V interior and 2H:1V exterior slopes. As noted on the drawings in Appendix A, an 84 inch diameter storm culvert is present under the pond at the south end.

<u>Ash Pond A</u>

Ash Pond A was commissioned around 1968, occupies an area of approximately 80.2 acres immediately south of the Wabash Station and immediately west of the Wabash River. The basin had an original capacity of approximately 1350 ac-ft. Prior to being removed from service in 2016, sluiced ash and other station effluent waters entered the north end of Pond A. In the later years of its operation, the discharge into Pond A was routed into a sluice channel that discharged into Ash Pond B.

The top of embankment elevation was constructed to 483.5, with a 10 ft wide crest and typically 1.5H:1V interior slopes and 2H:1V exterior slopes. The embankments were constructed with compacted clay soils excavated from within the basin boundary.

The original design of Ash Pond A included two decant Weir Box structures. When in operation, Weir Box #1 discharged directly to the Wabash River via an open channel, while Weir Box #2 discharged into an 84 inch CMP culvert beneath Ash Pond A via a 24 in. CMP. Both of these structures have been abandoned. The outlet from Weir Box #1 is connected to the pipe system for the currently permitted outfall (Weir Box #4) located in the Secondary Settling Pond. As noted on the drawings in Appendix A, a 54 inch diameter slip lined storm culvert is present under the center portion of this pond.

<u>Ash Pond B</u>

Ash Pond B was commissioned in 1984 and occupies an area of approximately 21.1 acres immediately south of Ash Pond A and immediately west of the Secondary Settling Pond. The basin had an original capacity of approximately 530 ac-ft. In general, sluiced ash and other station effluent waters enter in the northwest corner of Ash Pond B.

The top of embankment elevation was constructed to 483.5, with a 10 ft wide crest and typically 3H:1V interior and exterior slopes. The embankments were constructed with compacted clay soils excavated from within the basin boundary.

Ash Pond B was constructed with one decant Weir Box structure (Weir Box #3) which discharges into the Secondary Settling Pond via a 36 in. CMP.

Secondary Settling Pond

The Secondary Settling Pond was also commissioned in 1984 and occupies an area of approximately 7.8 acres immediately east of Ash Pond B. The basin had an original capacity of approximately 73 ac-ft.

The top of embankment elevation was constructed to 483.5, with a 10 ft wide crest and typically 3H:1V interior and exterior slopes. The embankments were constructed with compacted clay soils excavated from within the basin boundary. Water enters the Secondary Settling Pond from Ash Pond B via Weir Box #3 and exits via Weir Box #4 where it is transported via a 36 in. CMP to the Wabash River.

South Ash Pond

The South Ash Pond was commissioned in 2005, occupies an area of approximately 73 acres and shares a divider dike with both Ash Pond B and the Secondary Settling Pond. The basin had an original capacity of approximately 1450 ac-ft. Sluiced CCR materials were mechanically dredged and pumped into the South Ash Pond from either the Sluice Channel in Ash Pond A or from Ash Pond B. Water pumped into the South Ash Pond is returned to Ash Pond B through four 24 in. dia. HDPE pipes in the divider dike.

The top of embankment elevation was constructed to 484.25, with an 18 feet wide crest and typically 3H:1V interior and exterior slopes. The embankments were constructed using CCR structural fill in the core with a 5 feet thick layer of cohesive soils placed over the CCR structural fill. The interior of the basin is covered with a composite liner consisting of a 2 feet thick compacted soil liner overlain with an 80 mil HDPE on the interior slopes and a 60 mil HDPE on the bottom.

Undeveloped Portion of South Ash Pond

The original design of the South Ash Pond included a total area of approximately 131 acres. As noted on the drawings in Appendix A, the facility constructed the perimeter berms to form the entire footprint of that pond. However, before the pond was placed into service the plans were modified to reduce the footprint of the lined area to approximately 73 acres. The undeveloped area (aka, Dry South Pond) was left for future development of the second phase of the ash pond. This area has remained idle and will not be placed in service. The embankments which form the outline of this undeveloped area were also constructed using CCR structural fill in the core with a 5 feet thick layer of cohesive soils placed over the CCR structural fill.

***(B) Volume of Waste: The amount of waste or any other residues or material remaining in the impoundment.***

The approximate depths of CCR materials in the north and south impoundments are noted on Sheets 17 and 19, respectively. The estimated total volume of CCR materials present in the surface impoundments is 7,122,500 cubic yards. Volume estimates of CCR materials in each of the impoundments (and the CCR structural fill in the perimeter berms of the undeveloped portion of the South Ash Pond) are as follows:

- North Ash Pond ~1,592,470 cubic yards (based on original footprint)
- Ash Pond A ~3,510,755 cubic yards
- Ash Pond B ~738,170 cubic yards
- Secondary Settling Pond ~ 35,100 cubic yards
- South Ash Pond ~1,246,005 cubic yards
- Perimeter Berms of Undeveloped Portion of South Ash Pond ~ 250,000 cubic yards

***(C) Discharges to The Impoundment: A detailed description of those Industrial processes, including raw materials used and their characteristics, that generated wastes which were placed in the surface impoundment.***

The Ash Pond System has received coal ash, a combination of fly ash and bottom ash that was produced at the Wabash River Generating Station. Although coal ash is the most significant waste stream that was discharged to the ponds, other wastewaters from the facility were also discharged to the Ash Pond System. Discharge from the Secondary Settling Pond is monitored through Weir Box #4 where it is transported via a 36 in. CMP to the Wabash River.

***(D) Site Description: Area maps indicating the location of the impoundment and all other relevant items. All drinking water wells within ½ mile of the impoundment area must be identified, both on and off the facility property. Sites with waste that test as restricted waste Type I or Type II should use the information requested in 329 IAC 10-24-2 as an outline in preparing the description. Sites with waste that test as restricted waste Type III should use the information requested in 329 IAC 10-32-2.***

The Wabash River Station is located in Vigo County, Fayette Township, Indiana in Township 12N, Range 9W, Sections 4 and 5, and Township 13N, Range 9W, Sections 28 and 33. A drawing showing portions of the New Goshen and Terre Haute, Ind. 7½ minute USGS topographic quadrangle maps is provided as Sheet 3 in Appendix A. A second plot plan showing the impoundments superimposed on an aerial photograph is included as Sheet 4. Sheet 5 shows the Ash Pond System with respect to current site topography.

As shown on the drawings in Appendix A, a total of five surface impoundments are present at the Wabash Station. The proposed closure limits for each of the five ponds are shown on the drawings in Appendix A. Four of these impoundments (i.e., Ash Pond A, Ash Pond B, the Secondary Settling Pond and the South Ash Pond) are regulated by the Federal Coal Combustion Residual (CCR) Rule. The remaining former surface impoundment (i.e., the North Ash Pond) stopped receiving CCR materials and was drained prior to October 14, 2015. All five of the impoundments are regulated when removed from service by the IDEM Office of Land Quality.

Results from investigation and review of the Indiana Department of Natural Resources (IDNR) – Division of Water (DOW) Water Well Records database (IDNR, 2016a) are summarized on Sheet 3. Water well records that include UTM coordinates are plotted, and the well records are included in Appendix B.1. Water well records that do not include UTM coordinates are located based on driving direction and administrative information. These records are included in Appendix B.2. According to water well records available from IDNR's DOW well database, there are no registered significant water withdrawal facilities (SWWF) within a ½ mile radius from the perimeter of the Ash Pond System (IDNR, 2016b).

***(E) Site Geology: General information on the geology of the site such as:***

***(1) General direction of ground water flow.***

The general direction of groundwater flow in the unconsolidated alluvial aquifer under the impoundment areas is eastward to the Wabash River. Regional flow directions in the area of the Ash Pond System are controlled by recharge to unconsolidated flow zones in topographically elevated upland areas west of the ash ponds and expected discharge to the main Wabash River channel located east of the ash ponds. Regional groundwater flow is locally influenced by infiltration from the impoundments. Additional discussion of groundwater flow directions is included with information summarizing the monitoring well sampling and testing results.

***(2) The depth of the water table across the entire site and the permeability of soils associated with the table.***

Based on water level measurements collected from June 7-9, 2016, the depth to groundwater ranges from approximately 7.5 to over 34.5 ft. bgs. Water levels vary depending on the ground surface elevation and location of wells or piezometers with respect to the ash ponds and the Wabash River.

In-situ slug test results were performed at each of the 35 groundwater monitoring wells that comprise the groundwater monitoring well network. To run each test, a pressure transducer was lowered into the monitoring well. The transducer was connected to a data logger at ground surface that was used to start and stop the test and record water level recovery after stressing the well. Both rising head and falling head tests were run using a weighted PVC cylinder as a slug. Estimates of formation hydraulic conductivity were determined using the Bouwer-Rice analytical model (Bouwer and Rice, 1976) for confined aquifers implemented in AQTESOLV®. Well recovery diagrams are included in Appendix C and a summary of estimated hydraulic conductivities is attached in Table 1. In general, hydraulic conductivity values are consistent with the expected values for wells screened in outwash sand.

Hydraulic conductivities in the screened formations range from approximately 0.00393 to 0.0384 centimeters per second (cm/s) beneath the North Ash Pond, 0.00054 to 0.03 cm/s beneath Ash Pond A, 0.00137 to 0.04237 cm/s beneath Ash Pond B, 0.00164 to 0.01786 cm/s beneath the Secondary Settling Pond, and 0.00014 to 0.02841 cm/s beneath the South Ash Pond. Confined aquifer conditions are present in a majority of the monitoring wells, although unconfined conditions are identified in the vicinity of the eastern side of the South Ash Pond at monitoring wells MW-19S, MW-19I, MW-20S, MW-20I, and MW-20D.

### *(3) Delineation of soil strata under the site (i.e., sand, silt, clay, etc.).*

**Geologic Setting.** The Wabash Station is located in western Indiana, in the northern portion of Vigo County, Indiana. The site is located within the bedrock Paleozoic depositional and structural feature named the Illinois Basin and is west of the Cincinnati Arch. Bedrock beneath the site consists of the Dugger Formation of the Pennsylvanian Carbondale Group (Gray et al, 1987; Hartke et al., 1983). The Carbondale Group is composed of mostly shales and sandstones with beds of limestone and coal. Except for some thin layers, the clastic sediments of the Carbondale Group are generally no larger than coarse grained sand sized (Chen and Shaffer, 1979). This unit averages about 300 feet in thickness and thins northwestward. Near the site, the elevation of the bedrock surface is mapped by the online IndianaMap geographic information system (GIS; IndianaMap, 2016) as varying from approximately El 400 to greater than El 500. The ground surface at the site is generally level, and generally ranges from about El 500 in the northern portion to El 480 in the southern portion.

Based on review of regional structural bedrock features at the IndianaMap GIS, there are no faults present in the vicinity of the Wabash River Station.

As described in *Physiographic Divisions of Indiana* (Gray, 2000), the Site is located in the Wabash Lowlands Physiographic Unit, which is bounded to the north by the Central Wabash Valley and on the east by the Martinsville Hills and the Crawford Upland. This physiographic region is characterized by broad, terraced valley bottoms and undulating uplands. Almost the entirety of the physiographic region was glaciated during one or more of the pre-Wisconsinan glacial events causing modification of the pre-glacial topographic features. In addition to a partial blanket of glacial till, the region is underlain by widespread lacustrine, outwash and alluvial sediments (Schneider, 1966). The extensive floodplains of the Wabash Lowlands are commonly flanked by broad terraces underlain by outwash sand (Gray, 2000). Beneath the surficial deposits, the bedrock is relatively soft and not as resistant to erosion causing the overall region to contain relatively low relief and low altitude in contrast to other physiographic regions. The overall subdued topography is controlled dominantly by the underlying fine-grained bedrock (Doss, 1994).

**Unconsolidated Deposits.** Unconsolidated deposits in the vicinity of the Site consist of glacial and alluvial deposits that overlie the Pennsylvanian bedrock. The total thickness of unconsolidated deposits ranges from zero to greater than 350 feet (Doss, 1994).

Along the Wabash River, large deposits of glaciofluvial sand and gravel are present, deposited by glacial melt water during the time the Wabash valley was a major discharge channel (Watkins Jr. and Jordan, 1963). In the northern portion of the county, the glaciofluvial deposits are more commonly interbedded with clayey and sandy-clayey tills. In the vicinity of the generating station, loamy tills of pre-Wisconsinan age are present at the land surface. Other surficial deposits may include thin deposits of Holocene alluvium and colluvium in the valleys of the Wabash River and scattered loess and dune-sand deposits (Doss, 1994; Watkins Jr. and Jordan, 1963).

The generating station is near the southernmost boundary of the Wisconsinan glaciations. Glacial deposits in the vicinity of the generating station may be from either the advances of the Lake Michigan Lobe during Late Wisconsinan time or from older, pre-Wisconsinan glacial advances.

According to the Quaternary Geologic Map of Indiana, pre-Wisconsinan age loam till is deposited over bedrock on western portions of the site that occur above the present-day floodplain.

**Bedrock**. As noted above, bedrock beneath the site consists of the Dugger Formation of the Pennsylvanian Carbondale Group. The Carbondale Group is composed of mostly shales and sandstones with beds of limestone and coal. Except for some thin layers, the clastic sediments of the Carbondale Group are generally no larger than coarse grained sand sized. Based on review of historical soil boring data, a bedrock surface elevation map is provided as Figure 1.

**Regional Hydrogeology.** The site is located within the Middle Wabash River Basin, one of 12 water management basins defined by the Indiana Natural Resources Commission. The basins generally coincide with surface drainage divides of the major rivers of the state (Fenelon, Bobay and Others, 1994). Regional water resources include bedrock aquifers and unconsolidated surficial and buried aquifers. In the vicinity of the surface impoundment system, the most significant aquifer system is the surficial sand and gravel aquifer that originates as outwash and alluvial valley fill. This aquifer type commonly has high water yields (300 to 2,700 gal/min) and the natural discharge for the aquifer is to adjoining rivers, i.e. the Wabash River (Doss, 1994; Watkins Jr. and Jordan, 1963).

In the vicinity of the Wabash Station the bedrock aquifer is complexly interbedded sandstones, shales, limestones and coals of the Carbondale Group. Wells drilled into the Pennsylvanian rocks are generally left uncased due to high variability in water-bearing capacities of the interbedded strata.

**Soil Lithology.** The area of the surface impoundments is located within the flood plain of the Wabash River with a surface elevation of approximately 460 feet mean sea level (MSL). The impoundment system is bordered to the east and south by flood plain and the Wabash River. Ground surface elevations increase in the areas west and north of the impoundment system where till- and loess-mantled bedrock forms hills and bluffs.

Site geologic and hydrogeologic information is available from numerous subsurface investigations and reports discussed below. Soil boring logs are provided in Appendix D. Soil boring, monitoring well, and piezometer locations are shown on Sheets 9, 10, and 11. Slug testing results are provided in Appendix C. Grain size analysis results are provided in Appendix E. Geological cross sections summarizing subsurface results along several transects across the impoundment system are included as Sheets 9 through 11 of Appendix A.

Supplementary subsurface information is also available from water well records on file at Indiana's Department of Natural Resources (IDNR) Division of Water or online (IDNR, 2016a). The locations of water well records within a 1/2-mile distance from the perimeter of the impoundment system are shown on Sheet 3 of Appendix A.

**1992-1993 ATEC Associates Soil Borings.** A total of 45 soil borings were drilled north and west of the generating plant in 1992-1993 as part of the proposed coal gasification project (ATEC, 1993). Borings B-303 through B-307 typically encountered silty clay fill or coal ash material as thick as 28 feet, generally underlain by a native silty clay unit. Bedrock in the area ranged from 11 feet to 50 feet in depth.

**1999 Patriot Engineering Soil Borings.** A total of eight soil borings were drilled around the perimeter of Ash Pond A in 1999 (Patriot, 1999). The borings were drilled to depths of 37.2 to 50 feet below ground surface (bgs). These boring logs show coal ash generally underlain by a silt or silty clay unit generally 20 feet thick with the western-most boring terminating in bedrock shale at 39 feet bgs. Four boreholes were completed as temporary piezometers, with depths to groundwater ranging from 9.5 to 22 feet bgs.

**2000 Patriot Engineering Soil Borings.** Fifteen soil borings were advanced in areas within the vicinity of the proposed South Ash Pond in 2000 (Patriot, 2000). Borings over the western portion of the South Ash Pond area were drilled to depths of 20 to 30 feet bgs. These boring logs show predominately fine-grained, non-aquifer soils described primarily as silty clay. Sand and silty sand were present as interbeds in Patriot borings B-3 and B-5. The western Patriot borings terminated in bedrock described as claystone, shale, and weathered shale.

Patriot borings located further to the east showed the presence of fine-grained materials (clay, silty clay, and silty sand) from the ground surface to approximately 20 feet bgs. Brown, wet, medium dense sand was present below the fine-grained material to the bottom of the borings. The deepest borings were advanced to 55 feet bgs.

**2000/2001 Burns and McDonnell Soil Borings.** Additional subsurface investigation of the South Ash Pond area was performed during late 2000 and early 2001 (Burns and McDonnell, 2001). During the investigation, fifteen test pits were excavated to depths of approximately 8 to 12 feet. Borings were advanced at 4 locations and 8 piezometers were constructed. Subsurface boring logs are consistent with results from the 2000 Patriot investigation and with boring logs prepared in 2004 by ATC that are discussed below. Clay, sandy clay, and silty clay is described from the ground surface to the contact with bedrock in borings in the western part of the new ash pond area. Clay and silty or sandy clay is present over sand or gravel in borings located in the central and eastern part of the subsurface under the South Ash Pond.

**2004 ATC Soil Borings.** Twenty-three soil borings were drilled in the area of the South Ash Pond and an undeveloped area to the south in 2004 and two were completed as piezometers (ATC, 2005). These borings show that unconsolidated deposits immediately below the ground surface are cohesive materials texturally classified as silt loam, clay loam, loam, and silty clay loam. This cohesive unit is generally 15 to 25 feet thick and is deposited directly over shale bedrock in the western portion of the South Ash Pond. In the central and eastern part of the South Ash Pond, cohesive materials are deposited on top of sand and gravel interpreted as deposits associated with the Wabash River.

**2008 ATC Monitoring Well Installations.** Five monitoring wells and one piezometer were installed in 2008 to monitor groundwater downgradient of the South Ash Pond and an undeveloped area to the south (ATC, 2009). A cohesive material classified texturally as silt loam, silty clay loam to loam was encountered from the surface to a depth of approximately 7.5 feet (ft) to 20 ft bgs in each borehole. A loamy sand or sand was encountered in each of the boreholes beneath the cohesive unit. The granular unit contained discontinuous gravelly sand lenses.

**2014 Cardno ATC Soil Borings.** Eleven soil borings were drilled in 2014 in order to investigate the depth to the contact between overlying coal ash and the underlying soil (Cardno ATC, 2014).

Piezometers were installed at each boring location to allow measurement of static water levels of the former impoundment. Eight piezometers were installed in Ash Pond A and three piezometers were installed in the southern portion of the North Ash Pond. The soil borings were blank drilled to 10 feet bgs and continuous split-spoon samples were collected to the bottom of each boring. Boring depths ranged from 26 to 46 feet bgs in Ash Pond A while boring depths in North Ash Pond were 16 ft bgs, 18.2 ft bgs, and 30 ft bgs for piezometers P-1, P-2, and P-3, respectively. In Ash Pond A, coal ash was typically encountered to a depth ranging from 21.8 to 42 feet bgs, with an underlying silty clay unit. At North Ash Pond, coal ash was typically encountered to a depth ranging from 14.5 to 26 feet bgs, with an underlying sandstone or silty clay unit.

**2014 AECOM Soil Borings.** As part of an ongoing geotechnical investigation for ash pond closure evaluations, oversight of soil borings and cone penetrometer test (CPT) soundings was conducted (AECOM, 2015). A total of 46 geotechnical soil borings and 10 CPTs were performed in 2014. The borings were advanced to depths ranging between 10 to 106 ft bgs. Results from the borings show the presence of cohesive unconsolidated fine-grained alluvial soils from the ground surface to depths ranging from 30-37 feet, underlain by generally loose, moist to wet, coarse-grained sand and sand/gravel alluvial deposits to depths of at least 80 feet bgs. Where bedrock was encountered, the boreholes were advanced using NQ core barrels and tooling. In addition, 10 borings were converted to piezometers to measure groundwater levels.

**2015 Marino Soil Borings.** Four soil borings were drilled across the site in 2015 as part of a preliminary evaluation of the potential for mine subsidence in the vicinity of the ash ponds (Marino, 2015). WRS-1, located along the western boundary of the North Ash Pond, encountered coal ash to a depth of 29 feet bgs. The bedrock generally consisted of interbedded shale, coal and limestone, with interspersed sandstone units to a depth of 238 feet bgs. WRS-2, located on the western edge between Ash Pond A and South Ash Pond, encountered a fine-grained cohesive material to a depth of 29 feet bgs. The underground coal mine void was encountered between 175 and 183 feet bgs. WRS- 3 and WRS-4, located along the toe of the western berm of an undeveloped area to the south, encountered a fine-grained cohesive material to a depth of 11 and 12 feet bgs, respectively. The bedrock generally consisted of interbedded shale, coal and limestone, with interspersed sandstone units to a depths of over 204 feet bgs.

The Subsidence Engineering Investigation (Marino, 2015) confirmed that portions of the Wabash River CCR surface impoundments lie over historic room-and-pillar coal workings which are approximately 205 to 285 feet below the proposed final closure elevations. Borings WRS-1 through WRS-4 show the former mined coal is separated from the base of unconsolidated deposits by 90 to 155 feet of interbedded siltstone and shale. Mine voids encountered in this investigation were flooded and no evidence of roof instability was found above 17 feet from the roof line. The study concludes pillar loads will remain below their pre-flooded condition despite the additional ash weight and the likelihood of sinkhole or pit development is remote. The mine stability analysis suggests a low risk of future subsidence.

**2015/2016 Cardno ATC Monitoring Well Installations.** Thirty-five soil borings were advanced and 34 were completed as monitoring wells between October 2015 and February 2016 to evaluate groundwater quality surrounding the North Ash Pond, Ash Pond A, Ash Pond B, Secondary Settling Pond, and South Ash Pond areas (ATC, 2016a). Material encountered in the soil borings classified texturally as loamy sand and gravel units (fill) and to native loams, sand, gravel, and silt units. Material encountered in soil borings MW-6 and MW-9 contained a significant unit of coal ash underlain by interbedded sand and clay units. Soil boring location B-13 was advanced to bedrock and logged but was not completed as a monitoring well due to fine grained cohesive soils immediately above the bedrock surface. MW-13 was installed in a borehole offset five (5) feet from boring location B-13 and advanced to a screen interval within the non-cohesive soils. Monitoring wells MW-6, MW-7S, MW-8, MW-9, MW-10S, MW-11S, MW-12, MW-13, MW-14S, MW-15S, MW-16S, MW-17S, MW-18S, MW-19S, MW-20S, MW-21S, MW-22 and MW-23 were screened in shallow saturated unconsolidated granular deposits interpreted as river outwash. Monitoring wells MW-7I, MW-10I, MW-11I, MW-14I, MW-15I, MW-16I, MW-17I, MW-18I, MW-19I, MW-20I, and MW-21I were screened at intermediate depths in saturated unconsolidated granular deposits. Monitoring wells MW-10D, MW-11D, MW-16D, MW-20D, and MW-21D were screened in deep saturated unconsolidated river outwash deposits.

**2015/2016 Cardno ATC Ash Inventory Borings.** A series of borings (AI-1 through AI-36) were advanced between December 2015 and April 2016 to investigate the vertical and lateral extent of deposited ash across the Site (ATC, 2016b). Based on review of lithologic data, coal ash up to 30 feet in thickness (corresponding to an ash base elevation ranging between El 456.8 and El 473.7) was identified in the North Ash Pond. Coal ash ranging up to 41 feet in thickness (corresponding to an ash base elevation of El 456) was identified in the Ash Pond A. Coal ash up to 28.5 feet in thickness (corresponding to an ash base elevation of El 453.5) was identified in the Ash Pond B. Two permanent piezometers were installed as part of the ash inventory investigation to evaluate saturated coal ash volumes in the surface impoundments. The results of all soil laboratory tests performed on samples obtained from the ash inventory borings are summarized in Table 2B and laboratory report plots are provided in Appendix E. The tests indicate that the hydraulic conductivity of the CCR materials ranges from $9.2 \times 10^{-6}$ to $1.5 \times 10^{-5}$ cm/sec. The hydraulic conductivity of the natural soils present below the CCR materials was noted to range from approximately $2.6 \times 10^{-8}$ to $1.0 \times 10^{-4}$ cm/sec.

**2016 ATC Borrow Area Borings.** A series of borings (BA-1 through BA-8) were advanced in June 2016 to investigate a potential borrow area for final cover soils generally located between the South Ash Pond and the Wabash River. The borings generally revealed cohesive-like materials (i.e., loam and sandy loam) from the ground surface to depths ranging from 6 to 8.5 ft. Isolated sand layers were present within the zone of cohesive soils in some borings. The soils present below the cohesive-like materials were generally noted to be sand to a depth of 12 ft. The results of all soil laboratory tests performed on samples obtained from the borrow area borings are summarized in Table 2C and laboratory report plots are provided in Appendix E.

**Grain Size Analysis Results.** Soil samples from significant lithologies encountered during the groundwater monitoring well installations by ATC in 2008 and in 2015/2016 were analyzed for grain size and hydrometer analysis, and cation exchange capacity. Samples were also collected and tested for Atterberg limits. At least one grain size analysis was performed on a sample from the unconsolidated formation at the screen depth of each monitoring well. Grain size testing results confirmed the target lithologic units for groundwater monitoring are the granular unconsolidated deposits beneath the impoundments. The results of these analyses are summarized in Table 2A and grain size laboratory report plots are provided in Appendix E.

**Hydrogeologic Units.** Saturated outwash sand and gravel occurs as a generally confined aquifer underlying the surface impoundments. Unconfined conditions appear to be present at least periodically in the vicinity of the eastern and southeast portions of the South Ash Pond. This non-cohesive deposit is the uppermost aquifer and is the target zone for groundwater monitoring.

The bedrock lithology (shale) is expected to have lower permeability than the overlying sand and gravel. Bedrock is the confining unit serving as the lower boundary and hydraulic barrier to downward flow of groundwater. The cohesive soil that overlies the aquifer has reported hydraulic conductivities, measured on native and remolded samples, ranging from $1.3 \times 10^{-8}$ to $8.9 \times 10^{-7}$ cm/sec (Patriot, 2000). This cohesive soil serves as an upper semi-confining layer.

***(4) If monitoring wells are currently in place, the following information concerning the wells must be provided:***

***(a) Site map indicating location of wells.***

The proposed ash pond groundwater monitoring well system includes 35 monitoring wells that were installed between 2008 and 2016 (MW-5C, MW-6, MW-7S, MW-7I, MW-8, MW-9, MW-10S, MW-10I, MW-10D, MW-11S, MW-11I, MW-11D, MW-12, MW-13, MW-14S, MW-14I, MW-15S, MW-15I, MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-18S, MW-18I, MW-19S, MW-19I, MW-20S, MW-20I, MW-20D, MW-21S, MW-21I, MW-21D, MW-22, and MW-23) and are shown on Sheets 9 through 11 in Appendix A. Four wells (MW-1C, MW-2C, MW-3C, and MW-4C) are currently in use as groundwater gauging points to aid in the generation of groundwater elevation flow maps. Historical groundwater quality data is available from these four wells along with well MW-5C. Monitoring well construction details are listed in Table 3 and provided on construction diagrams in Appendix F.

***(b) Identification of upgradient and downgradient wells.***

As discussed below in Section 2(E)(4)(e), background groundwater quality is characterized by results from monitoring well MW-5C. Installing a groundwater monitoring well at an upgradient location for the granular unconsolidated deposit that is the target monitoring zone is not feasible at Wabash River Station. This deposit is absent under areas to the west where the buried bedrock surface is relatively shallow, and an upgradient drilling location was not available to the north where the property boundary is adjacent to the railroad right-of-way. Wells MW-6, MW-7S, MW-7I, MW-8, and MW-23 are downgradient wells for the North Ash Pond. Wells MW-10S, MW-10I, MW-10D, MW-11S, MW-11I, MW-11D, and MW-12 are downgradient wells for Ash Pond A. Wells MW-13, MW-14S, MW-14I, MW-15S, and MW-15I are downgradient wells for Ash Pond B, and wells MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-21S, MW-21I, and MW-21D are downgradient wells for the Secondary Settling Pond. Monitoring wells MW-18S, MW-18I, MW-19S, MW-19I, MW-20S, MW-20I, and MW-20D are downgradient wells for the South Ash Pond. The locations of the ash ponds and monitoring wells are shown on Sheets 9 through 11.

***(c) The type of stratum and the depth the wells are screened.***

Subsurface stratigraphy is discussed in section 2(E)(3) above. Material encountered in the soil borings for the wells classified texturally as loamy sand and gravel units (fill) and to native loams, sand, gravel, and silt units. Material encountered in soil boring MW-9 contained a significant unit of coal ash underlain by interbedded sand and clay units. Soil boring location B-13 was advanced to bedrock and logged but was not completed as a monitoring well due to fine grained cohesive soils immediately above the bedrock surface. Monitoring wells MW-5C, MW-6, MW-7S, MW-8, MW-9, MW-10S, MW-11S, MW-12, MW-13, MW-14S, MW-15S, MW-16S, MW-17S, MW-18S, MW-19S, MW-20S, MW-21S, MW-22, and MW-23 are screened in shallow saturated unconsolidated granular deposits. Monitoring wells MW-7I, MW-10I, MW-11I, MW-14I, MW-15I, MW-16I, MW-17I, MW-18I, MW-19I, MW-20I, and MW-21I are screened in intermediate depth saturated unconsolidated outwash deposits. Monitoring wells MW-10D, MW-11D, MW-16D, MW-20D, and MW-21D are screened in deep saturated unconsolidated outwash deposits. Well MW-13 was installed in a borehole offset five (5) feet from boring location B-13 and advanced to a screen interval within the non-cohesive soils. Boring logs from historical subsurface investigations are included in Appendix D. Screened interval depths for each monitoring well in the groundwater monitoring well network are depicted on cross sections, listed on Table 3, and shown on the monitoring well construction diagrams provided in Appendix F.

### *(d) Description of well installations including a bore hole log.*

Five monitoring wells (MW-1C through MW-5C) were installed by ATC from October 20 to October 23, 2008 to monitor groundwater downgradient of the South Ash Pond and an undeveloped area to the south (ATC, 2009). All monitoring wells were installed in accordance with 329 IAC 10-21-4 and constructed of 2 inch inside diameter PVC casing with a 0.010 inch slotted 10 feet screen. The zone around and approximately 2 feet above the well screen was backfilled with No. 4 sand pack. Approximately 1 foot of No. 7 sand pack was placed above the No. 4 sand pack. The remainder of the borehole was backfilled with bentonite grout with a side discharging tremie pipe to approximately 3 feet bgs. Each monitoring well was finished with a stick-up riser protected by a 4 inch aluminum cover. The 4 inch cover was set in a concrete pad that extends approximately 2.5 feet from the monitoring well riser. Additionally, four feet tall bollards were placed in the concrete around the monitoring well for protection.

Soil samples were collected for grain size and CEC analyses from significant lithological strata including aquifer material. Two slug tests (rising head and falling head) were performed on each monitoring well to estimate the hydraulic conductivity of the aquifer.

Groundwater monitoring wells were developed in accordance with 312 IAC 13-8-3. The monitoring wells were developed by bailing, and by pumping water for a period of approximately 1 hour using a portable Grundfos RediFlo2 pump. Development details are provided on the Monitoring Well Construction Diagrams provided in Appendix F.

Hennessy Surveying provided the monitoring well and piezometer location and riser elevation information. Elevation data are recorded on the soil boring logs provided in Appendix D and well construction diagrams provided in Appendix F. A summary table with well coordinates and elevations is included as Table 3.

Thirty-two monitoring wells were installed between October 2015 and February 2016 to evaluate groundwater quality surrounding the North Ash Pond, Ash Pond A, Ash Pond B, Secondary Settling Pond, and South Ash Pond areas (ATC, 2016a). Prior to clearing underground utilities and mobilizing a drilling crew, ATC personnel staked the boring locations utilizing a hand-held, mapping grade global positioning system (GPS) receiver. Drill rig access, topography, and ground conditions were considered during the final staking locations.

Boreholes were advanced utilizing a Diedrich D-50 and a Mobile B-57 hollow stem auger drill rig. Soil samples were collected utilizing continuous split-spoon sampling technology. Monitoring wells MW-6, MW-7S, MW-8, MW-9, MW-10S, MW-11S, MW-12, MW-13, MW-14S, MW-15S, MW-16S, MW-17S, MW-18S, MW-19S, MW-20S, MW-21S, MW-22 and MW-23 were screened in shallow saturated unconsolidated river outwash deposits. Monitoring wells MW-7I, MW-10I, MW-11I, MW-14I, MW-15I, MW-16I, MW-17I, MW-18I, MW-19I, MW-20I, and MW-21I were screened in intermediate saturated unconsolidated river outwash deposits. Monitoring wells MW-10D, MW-11D, MW-16D, MW-20D, and MW-21D were screened in deep saturated unconsolidated river outwash deposits above the bedrock interface.

Soil boring location B-13 was advanced to bedrock and logged but was not completed as a monitoring well due to fine grained cohesive soils immediately above the bedrock surface. MW-13 was installed in a borehole offset five (5) feet from boring location B-13 and advanced to a screen interval within the non-cohesive soils.

ATC personnel returned to the Site beginning on December 11, 2015 to install four additional monitoring wells, MW-21S, MW-21I, MW-21D, and MW-22. Boreholes were advanced utilizing a Diedrich D-50 and a Mobile B-57 hollow stem auger drill rig. Soil samples were collected utilizing continuous split-spoon sampling technology. An additional soil boring was advanced at the Site from February 1-3, 2016 and completed as monitoring well MW-23. Each well was screened in saturated unconsolidated river outwash deposits ranging over depths of 34 feet to 98.5 feet.

Each monitoring well was constructed with a two-inch inside diameter Schedule 40 PVC casing with either a five- (5), or 10-foot long 0.010-inch slotted screen. The zone around and approximately two (2) feet above the screen was backfilled either with unconsolidated sediments that cave into the boring when the augers are removed or with granular material supplied by ATC. The upper one (1) to two (2) feet of the filter pack consists of fine, inert sand. The remainder of the borehole was backfilled with bentonite grout. A lockable stick-up protective casing was installed at the ground surface, and set into a concrete pad at MW-6, MW-7S, MW-7I, MW-8, MW-9, MW-22, and MW-23. Flush-mount steel manways were installed at the ground surface, and set into a concrete pad at MW-10S, MW-10I, MW-10D, MW-11S, MW-11I, MW-11D, MW-12, MW-13, MW-14S, MW-14I, MW-15S, MW-15I, MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-18S, MW-18I, MW-19S, MW-19I, MW-20S, MW-20I, MW-20D, MW21S, MW-21I, MW-21D. A vented cap was installed on each PVC casing. Each well completed with a stick-up protective casing is protected with 3-inch diameter steel, concrete-filled bollards that extend approximately four (4) feet from the ground surface.

All of the monitoring wells were installed and developed in a manner consistent with 329 IAC 10-21-4. Soil lithologies encountered varied from loamy sand and gravel units (fill) and coal ash to native loams, sand, gravel, and silt units. Representative samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits.

ATC subcontracted Regional Services Corporation (RSC) to survey the well locations, ground elevations, and well riser elevations. Horizontal locations and the ground surface elevation were measured to the nearest 0.1 foot. The elevation of the well riser was measured to the nearest 0.01 foot. Elevation data are recorded on the soil boring logs (Appendix D) and well construction diagrams (Appendix F). A summary table with well coordinates and elevations is included as Table 3.

***(e) Any ground water monitoring data that would indicate background water quality.***

Historical groundwater data collected from monitoring wells associated with the ash pond system are included on CDs provided in Appendix G. The information in the following sections, prepared by M.S. Beljin and Associates, summarizes historical water quality results, and proposed semi-annual collection of groundwater samples.

**Wabash Ash Pond System Water Quality**

This section presents the groundwater quality characterization for five (5) separate impoundments:

1. North Ash Pond,
2. Ash Pond A,
3. Ash Pond B,
4. Secondary Settling Pond, and
5. South Ash Pond.

Water quality data collected from the monitoring wells is used to support the closure plan and to recommend a monitoring assessment process as the closure actions proceed. To characterize the five (5) separate impoundments the monitoring network includes both an existing background well (MW-5C) in the vicinity of the South Ash Pond and thirty-four (34) newly installed wells for the overall system at the Wabash Station.

The overall monitoring network is illustrated in Figure 2 for the North Ash Pond and Figure 3 for the other four (4) impoundments. Figure 3 depicts the historic background well MW-5C in the vicinity of the South Ash Pond. Both Figure 2 and 3 delineate the thirty-four (34) new wells. The proposed monitoring network consists of a total of thirty-five (35) monitoring wells (MW-1C, MW-2C, MW-3C, and MW-4C are not included in the monitoring network for the closure units but are included for characterization of current water quality conditions). Figures 4 and 5 present the water levels measured on June 7, 8, and 9, 2016 and the approximate groundwater flow for the shallow wells across the five closure impoundments.

The background well MW-5C was initially sampled in August of 2009 and currently has data from fourteen separate sampling events for purposes of characterizing the background groundwater quality. The thirty-four (34) new wells were installed with the initial sampling event occurring in March 2016. For purposes of the initial characterization there were separate sampling events conducted in March, June and August of 2016 with the at least two (2) sampling events for each well.

**Existing Well:** MW-5C (background)

**Newly Installed Wells:**

MW-6, MW-7S, MW-7I, MW-8, MW-9, MW-10S, MW-10I, MW-10D, MW-11S, MW-11I, MW-11D, MW-12, MW-13, MW-14S, MW-14I, MW-15S, MW-15I, MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-18S, MW-18I, MW-19S, MW-19I, MW-20S, MW-20I, MW-20D, MW-21S, MW-21I, MW-21D, MW-22, and MW-23.

Data collected from the new wells is compared to data collected since 2009 from the existing wells MW-1C, MW-2C, MW-3C, MW-4C, and MW-5C.

Collectively the analysis of groundwater samples obtained from the monitoring locations for thirty-four (34) different parameters was used to examine the groundwater quality in the vicinity of the separate Cayuga impoundments. The analyzed parameters include (Table 5):

- Alkalinity
- Antimony
- Arsenic
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Fluoride
- Iron
- Lead
- Lithium
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nitrogen, Ammonia
- Nitrogen, Nitrate
- pH (field and Laboratory)
- Potassium
- Selenium
- Silver
- Sodium
- Specific Conductivity (field and Laboratory)
- Sulfate
- TDS
- Thallium

- Zinc
- Combined Radium 226 + 228

The analytical results of the sampling, for six (6) of the thirty-four (34) parameters are presented in Table 4. A number of the parameters had a relatively large number of non-detects in a majority of the monitoring wells and are not presented. These included antimony, arsenic, beryllium, cadmium, chromium, cobalt, mercury, and thallium.

The characterization of the local groundwater quality will be used to evaluate the performance of the specified closure actions. To obtain sufficient data for determining the efficacy of the closure actions the available data from wells near the Wabash ash ponds and settling pond will be used to establish performance goals and for making statistical comparisons.

For purposes of evaluating the relationship between wells and characterizing the groundwater quality the following six (6) parameters were specifically considered:

- barium (MCL = 2 mg/L)
- boron,
- calcium,
- chloride, (SMCL = 250 mg/L),
- sulfate, (SMCL = 250 mg/L), and
- TDS, (SMCL = 500 mg/L)

These six (6) parameters provide a measure of the general water quality in the vicinity of the Wabash ash ponds and settling pond. Observations for the specified six (6) parameters from the monitoring wells are presented in Table 4.

The relationship between wells (locations) for a number of the parameters was evaluated using box plots (Figures 6 through 11) and the Student's t-distribution comparing each pair. While there is insufficient data to perform powerful statistical analyses, the box plots do present an overall average of the water quality conditions over the time period represented by the observations January 2009 through August 2016.

An overall comparison is also made between the mean values, for each sampling location, and the Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels (SMCLs) as presented in 40 CFR 141 'National Primary Drinking Water Regulations' and 40 CFR 143 'National Secondary Drinking Water Regulations'.

The MCLs and SMCLs represent reasonable goals for drinking water quality. Figures 6 through 11 provide individual pair-wise comparisons at the 95% confidence level. For example, the comparison of boron by well (Figure 7), shows that wells MW-12, MW-11D, and MW-10I are statistically significantly different from all of the other wells and these three wells have the highest overall mean boron concentrations at 44.6 mg/L, 41.9 mg/L, and 33.6 mg/L respectively. In general, the newly installed wells all have mean values higher than the background well MW-5C (0.26 mg/L).

The box plots in Figure 7 illustrate the overall differences between wells. The groundwater quality in the vicinity of the four closure units is characterized by the groundwater flow across the region. For purposes of the groundwater quality characterization and future performance evaluations a "source" of the observations from the monitoring network is assumed to exist. The source is assumed to be the materials placed in the four specified units and what may have been transported to the settling pond. This relationship between the potential source and the observations from the monitoring wells forms the basis for the approach to assessment monitoring for the closure actions of the separate units.

As the hydraulic head is altered as a result of the closure actions the groundwater flow may change. In addition, as the closure actions proceed less ash material may reach the groundwater. The combined effects, after closure, are expected to result in decreasing trends in key parameters over time.

Using the basic relationship between the hydraulic head and the groundwater flow a set of "performance goals" can be established for each well and each of the specific water quality parameters (e.g., barium, boron, calcium, chloride, sulfate, and TDS).

**Assessment Monitoring Plan Overview**

For the purposes of determining the effectiveness of the Wabash closure actions an assessment-monitoring plan is being proposed. After an initial compressed sampling frequency, to collect at least eight independent data points, the monitoring wells will then be sampled on a semi-annual basis. Semi-annual groundwater reports will be submitted within sixty (60) days after the sampling event is completed on the schedule approved by IDEM. The data evaluation during the closure period will be used to better define the extent of the impact to water quality.

**Data Review and Evaluation during Closure Activities**

Over time, a statistical analysis of specific parameters (including boron) will be performed to compare future observations against the existing groundwater quality to determine whether existing statistical differences are increasing or decreasing. This analysis relies on both "within well" and "between well" comparisons using parametric and non-parametric techniques as appropriate. These comparisons are to be performed to assess the whether there are statistically significant trends and whether observed concentrations are above or below established "performance goals". The performance goals are based on the current conditions within individual wells for each parameter. The performance goals are then compared to existing contaminant limits (MCLs, SMCLs, or other).

For purposes of evaluating the effectiveness of the closure action including the relationship between wells through the statistical analysis Duke Energy proposes to conduct analysis on semi-annual sampling for the parameters shown in Table 5.

**Establishing Performance Goals for Post-Closure Monitoring**

The performance goals will be established during the initial phases of the closure action and after there is measurable decrease in the hydraulic head. At this point in time during the closure process where there is the greatest chance that any constituents, remaining in the solid matrix beneath the ash ponds, will be significantly mitigated from entering the groundwater. To assure that the level of effectiveness desired from the closure action of the Ash Pond, Duke Energy proposes a period of post corrective construction for on- and off-site groundwater monitoring.

The data from future post closure semi-annual groundwater assessment monitoring will be used to assess the following:

- Monitor the hydraulic gradient and the overall change in flow;
- Monitor the decrease of site related constituent concentrations in on-site groundwater (projecting the decrease in concentration off-site) over the proposed monitoring time period (expected condition post remedy); and,
- Assure that site related constituent concentrations in on-site groundwater do not increase above the proposed groundwater performance goals.

To address the third bullet, Duke Energy proposes the following:

- Groundwater monitoring data collected from each on-site monitoring well will be used as a benchmark against which any potential post remedy constituent increasing concentration shifts will be gauged. Following EPA guidance for intra-well comparisons (USEPA, 2009), a Shewhart control limit will be calculated for each well where at least eight sample results are available. These limits will serve as goals for each parameter (constituent) in each well. Control limits based on fewer than eight results only estimate an appropriate performance goal.
- Upon completion of the second semi-annual monitoring event, a well-by-well comparison of post corrective action groundwater monitoring results will be performed against the parameter goals as applicable. If the goal level is exceeded in a particular well or wells, Duke Energy will collect an additional groundwater sample from the well(s) exceeding goal(s) within thirty (30) days of receipt of validated analytical results to verify the detected concentration.
- If the concentration(s) exceeding goal(s) are verified, monitoring will continue on the schedule semi-annual and the event at the specific monitoring well will be labeled as "goal exceeded". (A potential indicator of a departure from remedy effectiveness is four (4) successive goal limits exceeded in a single monitoring well over the scheduled monitoring frequency).
- If after at least four (4) sampling events with fewer than four (4) goals in any specific well having been exceeded such that it is determined that no increasing concentration shift exists or, more likely, that the increase was temporary due to changing conditions post remedy construction, Duke Energy will remove the "goal exceeded" designation and continue with the normal monitoring program as detailed.

- If after at least four (4) sampling events it is determined that an increasing concentration shift may exist, Duke Energy will increase the monitoring frequency to quarterly and assess the effectiveness of the closure action. As long as concentrations do not approach 95% of the groundwater monitoring goals presented above, Duke Energy will continue to monitor the shift. If the increasing concentration shift reverses and a pattern of decreasing concentrations is established, Duke Energy will resume the normal monitoring program as presented.

- If the increasing shift continues and is determined to present an unacceptable condition for post closure of the three specified units, then Duke Energy will take action to determine what steps to take to mitigate the degradation in effectiveness of the closure action.

The type of control limit or goal used for comparison to individual groundwater monitoring concentrations is the Shewhart control limit (USEPA, 2009; Gibbons, 1987; Gibbons, 1994). These are derived as the mean (median value for non-parametric distributions) plus 4.5 times the standard deviation of the historical (baseline) well results or proxy substitutions of ½ the detection limit for non-detects. Post-baseline concentrations are compared directly to these limits. A pattern of exceedances will indicate that a group of concentrations are significantly different than the baseline data. However, this pattern may or may not indicate that actual concentrations are increasing due to an on-site release that continues to migrate off-site post remedy.

It is important to note that variability and shift changes post closure are likely to occur. Temporary increases in concentrations could result from construction activities or the change in hydrogeologic conditions due to operation of the hydraulic control system. In addition, groundwater flow velocities and directions are likely to change, based on the predictive runs of the current groundwater model. Therefore, the response of the constituent (parameter) concentrations in on-site groundwater as a result of corrective actions given the hydrogeologic conditions could take years to evaluate potential concentration shifts. For this reason, the actual amount of time to establish if an increasing concentration shift exists is not clear and post closure construction data will need to be evaluated as time progresses to allow for accurate evaluation of potential increasing concentration shifts.

***(f) Any ground water monitoring data collected after installation and operation of impoundment commenced which may be utilized to determine if there is any current ground water contamination.***

Historical groundwater data collected from monitoring wells associated with the ash pond system are included on compact discs in Appendix G. Due to the large volume of printed material associated with the historical groundwater data, hard copies are not being provided.

***Based on review of this data and the residue chemistry, more comprehensive and specific geology information may be required. Sites with waste that test as restricted waste Type I or Type II can use the information requested in 329 IAC 10-24-3 and 10-24-4 as an outline in preparing the geology description. Sites with waste that***

***test as restricted waste Type III can use the information requested in 329 IAC 10-32-3.***

***3) <u>Closure Plan</u>: A detailed proposal for closure design and construction and for post-closure care of the impoundment must be submitted. Sites will close under the applicable requirements for Restricted Waste Sites (RWS), as described in 329 IAC 10-24 thru 10-38, depending on the characteristics of the waste in the impoundments.***

***Please note, if the residue in the impoundment is determined to be hazardous waste, this guidance is not applicable; for more information consult the Permit Branch for guidance at (317)232-4462.***

***At a minimum, the proposed closure plan must include details of the following:***

***(A) Cap Design: A description of the cap including dimension, Slope, and description of materials to be used. Caps at sites that test as restricted waste site Type I or Type II must be designed in accordance with applicable requirements of 329 IAC 10-30-2 or 10-30-3. Sites that test as restricted waste site type III must be designed in accordance with 329 IAC 10-37-2. Sludges from wastewater treatment plants that test as restricted waste site Type III must also comply with the design requirements of 40 CFR 503.***

<u>North Ash Pond</u>

Based on the results of test borings drilled along the north end of the North Ash Pond, it appears that the railroad embankment owned by the Indiana Railroad Company also served as the northern embankment for the ash pond while it was in service. As a result, it appears that ash extends beyond the property boundary. Duke Energy is working with the Indiana Railroad Company to establish an easement to allow in place closure of the ash that extends beyond the property boundary using the grading plan illustrated on Sheet 22 in Appendix A. In the event that it is not possible to reach an agreement regarding an easement, ash that extends past the property line will be removed and a revised closure plan will be submitted to IDEM for review and approval before construction is initiated.

The proposed grading plan presented on Sheet 22 is limited to approximately the northern half of the North Ash Pond. The property within the central portion of the original ash pond is no longer owned by Duke Energy. Further, the southern end of the original ash pond footprint that was previously leased to WVPAand is currently leased to Quasar for use as a pet coke storage area. The portion of the ash pond noted on Sheet 22 that is currently owned and/or leased to Quasar will be closed at the time the area is taken out of service. A modification to this closure plan will be submitted to IDEM for review and approval at that time.

The proposed in-place closure grading plan for the closure of the northern half of the North Ash Pond is provided on Sheet 22 in Appendix A. The cover will generally consist of the development of 3% final grades that slope to a peak of EL 498. Compacted structural fill required to form the final grades in the North Ash Pond will be obtained from the material excavated to accomplish closure by removal of Ash Pond A.

The final cover system will consist of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 22 and 29 through 33, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

Ash Pond A

Ash Pond A will be closed using closure by removal procedures. As a result, it will not be necessary to construct a final cover to meet the requirements noted above. Closure by removal of this area will also facilitate removal of the existing 54 inch diameter slip lined pipe that currently crosses under the ash pond.

Once the excavation of the CCR materials and a minimum of 1 additional foot of the underlying soil has been completed, up to 16 feet of compacted structural soil fill will be placed in the excavation to establish the proposed grades illustrated on Sheets 24 and 25 in Appendix A. As noted on Sheet 32, a 2 ft thick soil cover will be placed over the structural fill and the area will be reforested. Riprap will be utilized to line portions of the channels formed in the final grades in this area.

The proposed final grades in Ash Pond A include removal of portions of the existing berms on the east side of the pond. The removal of the ash, in addition to the modifications of these berms, will allow this area to serve as a portion of the floodplain for the Wabash River. Details regarding the final alignment of the drainage channels and the type of trees and brush that will be planted to vegetate the area will be determined as part of the Construction in a Floodway Permit Application to be submitted to the Indiana Department of Natural Resources.

The proposed grading plan provided on Sheet 23 also includes the proposed modifications to establish a stabilization berm on the north sides of Ash Pond B and the Secondary Settling Pond to separate these areas from the proposed final grades within the closure by removal portion of Ash Pond A. The existing berm will be modified to create a 5H:1V sideslope utilizing compacted soil structural fill. Riprap will be placed on the exposed slope up to the 100 year flood elevation of the Wabash River to protect the berm when the regraded Ash Pond A area is inundated by flood water from the Wabash River.

Ash Pond B

The majority of Ash Pond B will be closed in place. As shown on Sheet 24 in Appendix A, the existing berm on its north side will be modified to serve as a stabilizing berm between the in-place closure area of Ash Pond B and the new floodplain area created by the closure by removal of Ash Pond A. This will require the removal of existing CCR materials present in the northwest corner of Ash Pond B to allow the construction of the berm in the area where there is no existing berm to separate Pond A from Pond B. The removal of the CCR materials in this portion of Ash Pond B will result in a small closure by removal area in the northwest corner of Ash Pond B, where it adjoins with Ash Pond A. In areas where a separation berm already exists between Ash Pond A and Ash Pond B, the northern slope of the berm will be flattened to 5H:1V. Riprap will be placed on the exposed slope up to the 100 year flood elevation of the Wabash River to protect the berm when the regraded Ash Pond A area is inundated by flood water from the Wabash.

Prior to modifying the perimeter berms, the water present above the CCR materials in Ash Pond B will be pumped to the lined repurposed pond developed within the limits of the Secondary Settling Pond. Dewatering sumps and or wells will also be used as necessary to remove water from the ash present within the basin. Pumping will also be performed as necessary to remove rainwater that collects within the footprint of the basin during the construction of the stabilizing berm. Liquids removed from the pond will be treated as necessary to maintain compliance with the facility's NPDES permit.

The final cover system in Ash Pond B will be constructed with a 5 percent slope and incorporated into the final cover installed over the South Ash Pond, as noted on Sheet 24. The peak elevation of the final grades within the limits of Ash Pond B will be approximately 512. Compacted structural fill required to form the final grades will be obtained from the material excavated to accomplish closure by removal of Ash Pond A.

The final cover system will consist of a geomembrane overlain by a combination of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 24, and 29 through 31, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

<u>Secondary Settling Pond</u>

The Secondary Settling Pond will be closed using closure by removal procedures. As a result, it will not be necessary to construct a final cover to meet the requirements noted above. However, once closure activities have been completed in the Secondary Settling Pond, the area will be repurposed to serve as a lined process water basin.

As noted above, the existing berm on the north side of the Secondary Settling Pond will be modified to serve as a stabilizing berm between the repurposed Secondary Settling Pond Area and the new floodplain area created by the closure by removal of Ash Pond A.

<u>South Ash Pond</u>

The South Ash Pond will be closed in place. As shown on Sheet 25 in Appendix A, the final grades will be constructed using a 5 percent slope. The peak elevation of the final grades within the limits of the South Ash Pond will be approximately 523 ft. Compacted structural fill required to form the final grades will be obtained from the both the material excavated to accomplish closure by removal of Ash Pond A and the removal of the CCR structural fill present in the existing berms that form the undeveloped portion of the South Ash Pond.

Prior to placing any structural fill, the water present above the CCR materials in the South Ash Pond will be removed. Dewatering sumps and/or wells will also be used as necessary to remove water from the ash present within the basin. Pumping will also be performed as necessary to remove rainwater that collects within the footprint of the basin during the construction of the stabilizing berm. Liquids removed from the pond will be treated as necessary to maintain compliance with the facility's NPDES permit.

The final cover system will consist of a geomembrane overlain by a system of geocomposite and geotextile, 30 inches of protective soils and a 6 inch vegetative layer. Surface water which infiltrates through the final cover soils will be collected in a perimeter toe drain, which will also serve as the geomembrane anchor trench. All surface water control systems have been designed to control runoff from a 25 year – 24 hour storm event. Calculations related to the surface water control systems are provided in Appendix I and details are provided on Sheets 25, and 29 through 31, in Appendix A. The proposed Quality Assurance Manual (QAM) for the construction of the final cover is provided in Appendix J.

***(B) Final Contour Map: A plot plan that indicates the fill boundaries and the proposed final contours of the site at intervals of no more than two (2) feet.***

Drawings illustrating the proposed grades at the time of closure are provided in Appendix A. As noted above, the slope of the final cover system in areas closed in place will range from approximately 3 to 5 percent over the majority of the area at the time of closure. It is anticipated that the ponded ash will settle in some areas under the weight of the structural fill needed to establish the required slopes as well as the final cover itself. It is anticipated that the final slope of the final cover system (i.e., following settlement) will exceed 2 percent.

***(C) Ground Water Monitoring: Sites that test as restricted waste site Type I or Type II must prepare a Ground Water Monitoring and Corrective Action plan in accordance with applicable requirements of 329 IAC 10-29. For wastes which test as Type III, the responsible party must either document the lagoon has a barrier in accordance with 329 IAC 10-34 or it will be necessary to develop a similar program for monitoring ground water downgradient or at the facility boundary to detect any future release from the closed impoundment. Sludge from waste water treatment plants that test as restricted waste site Type III must also comply with the ground water requirements of 40 CFR 503. If monitoring is determined to be necessary, a plan should be submitted to this office which includes:***

***(1) the number and placement of monitoring wells;***

The proposed groundwater monitoring system is described in Section 2(E)(4)(a) and (b). Summarizing those sections, thirty five (35) monitoring wells are proposed for semi-annual groundwater monitoring. Existing monitoring wells are shown on Sheets 9 through 11 of Appendix A.

***(2) the number and frequency of samples;***

The proposed groundwater sampling program is described in section 2(E)(4)(e) above.

***(3) the chemical parameters to be monitored that should be consistent with those identified with the impoundment characterization;***

The proposed sampling protocols are outlined in section 2(E)(4)(e) above. Following collection of eight rounds of groundwater monitoring results, the analytical parameter list may be revised if continued monitoring of specified parameters is not beneficial for assessing groundwater quality with respect to Ash Pond System closure. In general, the monitored parameters will be consistent with other Restricted Waste Sites.

***(4) sampling protocol; and,***

The proposed sampling protocols are outlined in section 2(E)(4)(e) above. A groundwater sampling and analysis plan that describes the sampling protocols, sampling methods, monitoring points, and monitoring parameters will be prepared within 90 days following IDEM's approval of this Closure Plan.

***(5) how the determination of releases will be made.***

Groundwater quality results will be evaluated according to the assessment monitoring program described in section 2(E)(4)(e) above.

***(D) Closure Certification: Sites that test as restricted waste site Type I or Type II must certify closure in accordance with applicable requirements of 329 IAC 10-30-7. Sites that test as restricted waste site Type III must certify closure in accordance with 329 IAC 10-37-7.***

Duke Energy will submit a closure certification report at the completion of the closure activities for the Ash Pond System. This report will be prepared to address the requirements of 329 IAC 10-30-7.

***(E) Post-Closure Requirements: Sites that test as restricted waste site Type I or Type II must comply with the applicable post-closure requirements of 329 IAC 10-31. Restricted waste site Type III closure must comply with the applicable post-closure requirements of 329 IAC 10-38. Post-closure care will extend for 30 years as specified by 329 IAC 10-31-2(b) or 329 IAC 10-38-2(b). Funding mechanisms to cover the post-closure requirements must be established in accordance with 329 IAC 10-39.***

Duke Energy will comply with the applicable post-closure requirements of 329 IAC 10-31.

***(F) Responsibilities after Post-Closure: After post-closure is certified as complete, the owner, operator and/or responsible party will still be responsible for the requirements of 329 IAC 10-31-5, 10-31-6 and 10-31-7 or 329 IAC 10-38-5, 10-38-65 and 10-38-7, as applicable.***

Duke Energy will comply with the responsibilities outlined above after completion of the post-closure period. Closure and Post-Closure Cost Estimates, presented on IDEM forms, are provided in Appendix H along with the legal description of the various ash pond solid waste boundaries.

# Duke Energy Indiana, LLC

Coal Ash Closure Expenditures
(Dollars in Thousands)

| Line No. | Station | | Total Company Amount 1/ | Line No. |
|---|---|---|---|---|
| | (A) | | (C) | |
| | **CCR** | | | |
| 1 | Cayuga Station | $ | 24,766 | 1 |
| 2 | Gallagher Station | | 32,180 | 2 |
| 3 | Gibson Station | | 54,898 | 3 |
| 4 | Wabash River Station | | 21,091 | 4 |
| 5 | COR | | (5,139) | 5 |
| 6 | Total CCR | | 127,796 | 6 |
| | **IDEM** | | | |
| 7 | Dresser Station | | 13,967 | 7 |
| 8 | Legacy Edwardsport Station | | 1,175 | 8 |
| 9 | Gibson East Ash Pond | | 59,401 | 9 |
| 10 | Noblesville Station | | 6,001 | 10 |
| 11 | Total IDEM | | 80,544 | 11 |
| 12 | Grand Total Company | $ | 208,340 | 12 |
| 13 | Retail Portion | | 91.790% | 13 |
| 14 | | $ | 191,235 | 14 |

1/ Excludes expenditures requested in Cause No. 44765
Gibson is net of partner reimbursement

# Duke Energy Indiana, LLC

Coal Ash Closure Expenditures
(Dollars in Thousands)

| Line No. | Station | Category | | Expenditures [1/] | Line No. |
|---|---|---|---|---|---|
| | (A) | (B) | | (C) | |
| | **Actual thru 2018** | | | | |
| 1 | Cayuga Station | Ash Removal/Movement/Placement/Closure | $ | 14,583 | 1 |
| 2 | | EHS/Permitting/Groundwater/Wells | | 660 | 2 |
| 3 | | Engineering | | 78 | 3 |
| 4 | | Duke Labor/Indirect/Support | | 5,325 | 4 |
| 5 | | Maintenance/Veg Mgmnt | | 538 | 5 |
| 6 | | Water Reroute | | 3,582 | 6 |
| 7 | Cayuga Station Total | | | 24,766 | 7 |
| 8 | Gallagher Station | Ash Removal/Movement/Placement/Closure | | 16,548 | 8 |
| 9 | | EHS/Permitting/Groundwater/Wells | | 554 | 9 |
| 10 | | Engineering | | 989 | 10 |
| 11 | | Duke Labor/Indirect/Support | | 6,904 | 11 |
| 12 | | Maintenance/Veg Mgmnt | | 679 | 12 |
| 13 | | Water Reroute | | 6,506 | 13 |
| 14 | Gallagher Station Total | | | 32,180 | 14 |
| 15 | Gibson Station | Ash Removal/Movement/Placement/Closure | | 25,890 | 15 |
| 16 | | EHS/Permitting/Groundwater/Wells | | 835 | 16 |
| 17 | | Engineering | | 3,192 | 17 |
| 18 | | Duke Labor/Indirect/Support | | 3,734 | 18 |
| 19 | | Landfill - Closure/Final Cover/Maintenance | | 13,955 | 19 |
| 20 | | Maintenance/Veg Mgmnt | | 4,187 | 20 |
| 21 | | Water Reroute | | 3,105 | 21 |
| 22 | Gibson Station Total | | | 54,898 | 22 |
| 23 | Wabash River Station | Ash Removal/Movement/Placement/Closure | | 3,132 | 23 |
| 24 | | EHS/Permitting/Groundwater/Wells | | 1,372 | 24 |
| 25 | | Engineering | | 2,178 | 25 |
| 26 | | Duke Labor/Indirect/Support | | 2,787 | 26 |
| 27 | | Maintenance/Veg Mgmnt | | 3,743 | 27 |
| 28 | | Water Reroute | | 7,879 | 28 |
| 29 | Wabash River Coal Total | | | 21,091 | 29 |
| 30 | Dresser Station | Ash Removal/Movement/Placement/Closure | | 1,927 | 30 |
| 31 | | EHS/Permitting/Groundwater/Wells | | 201 | 31 |
| 32 | | Engineering | | 2,175 | 32 |
| 33 | | Duke Labor/Indirect/Support | | 267 | 33 |
| 34 | | Maintenance/Veg Mgmnt | | 30 | 34 |
| 35 | Dresser Station Total | | | 4,600 | 35 |
| 36 | Legacy Edwardsport Station | Ash Removal/Movement/Placement/Closure | | 34 | 36 |
| 37 | | EHS/Permitting/Groundwater/Wells | | 810 | 37 |
| 38 | | Engineering | | 245 | 38 |
| 39 | | Duke Labor/Indirect/Support | | 86 | 39 |
| 40 | Legacy Edwardsport Station Total | | | 1,175 | 40 |
| 41 | Gibson East Ash Pond | Ash Removal/Movement/Placement/Closure | | 56,663 | 41 |
| 42 | | EHS/Permitting/Groundwater/Wells | | 1 | 42 |
| 43 | | Engineering | | 2,737 | 43 |
| 44 | Gibson East Ash Pond Total | | | 59,401 | 44 |
| 45 | Noblesville Station | Ash Removal/Movement/Placement/Closure | | 2,004 | 45 |
| 46 | | EHS/Permitting/Groundwater/Wells | | 1,465 | 46 |
| 47 | | Engineering | | 2,514 | 47 |
| 48 | | Duke Labor/Indirect/Support | | 18 | 48 |
| 49 | Noblesville Station Total | | | 6,001 | 49 |
| 50 | COR | Adjustment for amount customer paid via depreciation[2/] | | (5,139) | 50 |
| 51 | Total Actual Expenditures | | $ | 198,973 | 51 |
| 52 | Projected Dresser and Gibson East Ash Pond (2019/2020) | Ash Removal/Movement/Placement | | 9,044 | 52 |
| 53 | | EHS/Permitting/Groundwater/Wells | | 323 | 53 |
| 54 | | | | 9,367 | 54 |
| 55 | Total Requested Expenditures | | $ | 208,340 | 55 |

1/ Excludes expenditures requested in Cause No. 44765 and Gibson is net of partner reimbursement

2/ See Diana Douglas Testimony for additional description

# Duke Energy Indiana, LLC

Coal Ash Closure Expenditures for Deferral
(Dollars in Millions)

| Line No. | Station | | Total Company Projected 2019 - 2027 1/ | Line No. |
|---|---|---|---|---|
| | (A) | | (B) | |
| | **CCR** | | | |
| 1 | Cayuga Station | $ | 107 | 1 |
| 2 | Gallagher Station | | 117 | 2 |
| 3 | Gibson Station | | 102 | 3 |
| 4 | Wabash River Station | | 125 | 4 |
| 5 | COR | | (8) | 5 |
| 6 | Total CCR | | 443 | 6 |
| | **IDEM** | | | |
| 7 | Dresser Station | | 10 | 7 |
| 8 | Legacy Edwardsport Station | | 22 | 8 |
| 9 | Gibson East Ash Pond | | - | 9 |
| 10 | Noblesville Station | | 28 | 10 |
| 11 | Total IDEM | | 60 | 11 |
| 12 | Grand Total Company | $ | 503 | 12 |
| 13 | Retail Portion | | 91.790% | 13 |
| 14 | | $ | 462 | 14 |

1/ Excludes expenditures requested in Cause No. 44765
Gibson is net of partner reimbursement

**VERIFICATION**

I hereby verify under the penalties of perjury that the foregoing representations are true to the best of my knowledge, information and belief.

Signed: ______________________
Tim Thiemann

Dated: 7/2/2019