Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241-2012

October 11, 2016
File: 175534018
Revision 0

Indiana-Kentucky Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Initial Hazard Potential Classification Assessment
West Boiler Slag Pond and Landfill Runoff Collection Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

1.0 PURPOSE

This letter documents Stantec's certification of the initial hazard potential classification assessment for the Indiana-Kentucky Electric Corporation (IKEC) Clifty Creek Station's West Boiler Slag Pond and Landfill Runoff Collection Pond. The EPA Final CCR Rule requires owners or operators of CCR surface impoundments to conduct initial and periodic hazard potential classification assessments of the unit, assign one of three potential hazard classification ratings to it, and provide the basis for the rating, as per 40 CFR 257.73(a)(2). Hazard potential classification ratings define the consequences in the event of a failure – the ratings have nothing to do with the likelihood of failure or the structural stability of the impoundment. Based on this assessment, the West Boiler Slag Pond and the Landfill Runoff Collection Pond have been assigned a significant hazard potential classification rating.

2.0 BASIS FOR CLASSIFICATION RATING

As described in the attached assessment report, the hazard potential classification rating of "significant" was assigned to the West Boiler Slag Pond and the Landfill Runoff Collection Pond because a failure or mis-operation would result in no probable loss of human life, but could cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. In 2009, breach inundation studies were completed that included modeling and routing of breach hydrographs. Loss of life was considered improbable due to the intermittent and transient nature of persons within these areas. However, a breach of the West Boiler Slag Pond or the Landfill Runoff Collection Pond would likely result in the release of CCR material to the Ohio River. Review of the analysis and current conditions at the West Boiler Slag Pond and the Landfill Runoff Collection Pond concluded that the existing hazard classification as applicable.

Re: **Initial Hazard Potential Classification Assessment**
West Boiler Slag Pond and Landfill Runoff Collection Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

3.0 SUMMARY OF FINDINGS

The attached report presents the analysis for the initial hazard potential classification assessment. The results demonstrate that the impoundment meets the hazard potential classification of "significant."

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the initial hazard potential classification assessment for the IKEC Clifty Creek Station's West Boiler Slag Pond and Landfill Runoff Collection Pond meet the requirements specified in 40 CFR 257.73(a)(2).

SIGNATURE [signature] DATE 10/11/16

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS: Clifty Creek Station Initial Hazard Potential Classification Assessment

STAN A. HARRIS
REGISTERED
No. PE-19700150
STATE OF INDIANA
PROFESSIONAL ENGINEER
10/11/16

Initial Hazard Potential Classification Assessment

Clifty Creek Station
West Boiler Slag Pond and Landfill
Runoff Collection Pond
Madison, Jefferson County, Indiana

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
Cincinnati, Ohio

October 11, 2016

Table of Contents

LIST OF FIGURES

1.0 INTRODUCTION

1.1 OBJECTIVE

On April 17, 2015 the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities rule (Environmental Protection Agency, 2015) was published in the Federal Register. Stantec Consulting Services Inc. (Stantec) was contracted by the Indiana-Kentucky Electric Corporation (IKEC) to provide engineering support evaluating existing design information to address a hazard potential classification for the Clifty Creek Station's West Boiler Slag Pond (WBSP) and Landfill Runoff Collection Pond (LRCP) as required per §257.73 of the EPA Final CCR Rule.

1.2 OUTLINE OF RULE REQUIREMENTS

As described in 40 CFR 257.73(a)(2) of the EPA Final CCR Rule, an owner or operator of an existing CCR surface impoundment must determine which of the following hazard potential classifications characterizes their particular CCR unit. Hazard potential classifications are based on the consequences of failure or mis-operation and are not a measure of the condition of the unit. From the EPA Final CCR Rule §257.53, the classifications are defined as follows:

1.) **High hazard potential CCR surface impoundment** means a diked surface impoundment where failure or mis-operation will probably cause loss of human life.

2.) **Significant hazard potential CCR surface impoundment** means a diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

3.) **Low hazard potential CCR surface impoundment** means a diked surface impoundment where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment's owner's property.

Based on these definitions, the Clifty Creek Station's WBSP and LRCP are classified as significant hazard potential CCR surface impoundments.

This report contains supporting documentation for the assessment. The hazard potential classifications were determined by a review of breach analyses for the WBSP and LRCP dams provided in the existing emergency action plans (EAPs) (Stantec, 2009a and 2009b).

2.0 SUMMARY OF FINDINGS

The Clifty Creek Station WBSP and LRCP are owned and operated by IKEC. They are located in Madison, Indiana along the northern bank of the Ohio River. The WBSP currently serves as a settling facility for sluiced boiler slag produced at the station. In addition to the process flows from the station, stormwater from approximately 510 acres drains to the facility. The LRCP is being converted into a runoff collection pond through the ongoing construction of the Type 1 Restricted Waste Site CCR Landfill. An approximately 508-acre area, including both contact water and stormwater runoff, currently drains to the LRCP. Upon the completion of the CCR Landfill, the area draining to the LRCP will be reduced to approximately 443 acres. Both ponds are formed by natural grade to the north, east, and west and to the south by a dam that runs along the bank of the Ohio River. Figure A-1 provides a plan view of the Clifty Creek Station and its surface impoundments.

The following text presents the review of the breach analyses as described in the WBSP and LRCP dams' EAPs. Annual dam and dike inspections have been performed on the two dams with no change in conditions that would substantially affect the original EAPs (AEPSC, 2015). Therefore, the existing documents reviewed would still be considered appropriate.

2.1 WEST BOILER SLAG POND DAM - EMERGENCY ACTION PLAN – BREACH ANALYSIS REVIEW

Stantec personnel reviewed Appendix B – "Investigation and Analysis of Dam Breach Floods" (WBSP Breach Analysis) from the WBSP dam EAP (Stantec, 2009a). The dam breach analyses conducted for the WBSP were performed to determine possible inundation limits for use in the EAP. Breach analyses included stormwater runoff calculations, reservoir pool routing and breach failure, and hydraulic routing of the floodwave along the Ohio River.

2.1.1 WBSP Facility Description

Per Section 3.1 of the WBSP Breach Analysis:

> "The WBSP spillway is a reinforced concrete box riser structure. One side of the structure has a 3-foot wide opening, which acts as a weir and allows for adjustment of the water level using stop logs. The riser structure outlets to the Ohio River at elevation 426.8 feet through a 36-inch diameter, 450-foot long reinforced concrete pipe. The existing elevation of the weir provided by IKEC was 442 feet. The WBSP does not have an emergency spillway."
>
> "The dam crest was set at elevation 475 and the downstream dam toe at elevation 430."

The WBSP report says physical dam characteristic information was obtained from the original construction drawings and was verified with a 2005 topographic survey (Stantec, 2009a).

2.1.2 Development of Hydrologic and Hydraulic Model

Section 2.0 of the WBSP Breach Analysis states:

> "Stormwater runoff calculations were performed using a model previously developed by Stantec (formerly FMSM) for the 2007 *West Bottom Ash Pond Hydrologic and Hydraulic Report* (FMSM, 2007). The previous project used HEC-HMS software (USACE, 2003) developed by the U.S. Army Corps of Engineers (USACE), Hydrologic Engineering Center (HEC). The methodology used to determine the watershed response, or runoff from a rainfall event, was the Soil Conservation Service (SCS) or Curve Number (CN) Method (SCS, 1972)."

Section 2.0 of the report shows that the Indiana Department of Natural Resources (IDNR, 2001) *General Guidelines for New Dams and Improvements to Existing Dams in Indiana* (IDNR, 2001) was followed in order to select the appropriate Probable Maximum Precipitation (PMP) rainfall depth (27.6 inches) from the National Weather Service (USACE, 1978), duration (6-hours), and distribution (6-hour SCS Type II). Methodology outlined in TR-55 Urban Hydrology for Small Watersheds (USDA, 1975) was used to populate the model with hydrologic properties for each sub-watershed (Table 1 of the WBSP Breach Analysis).

Section 3.1, Development of Model Geometry, outlines how the HEC-HMS models include physical characteristics of the reservoir, spillway, and dam embankment. The stage-storage information (calculated from 2005 topographic maps and the original WBSP construction drawings) input into the model was used in the calculation of the reservoir water levels (Table 2 of the WBSP Breach Analysis). To account for the full range of possible water surface elevations, the principal spillway was modeled assuming the maximum stop log position of 457.7 feet. A rating curve was developed for the principal spillway and input into the HEC-HMS model to replicate the hydraulic behavior of the spillway. The rating curve of the principal spillway used in the reservoir routing models assumes a normal high water surface elevation of 432.8 on the Ohio River. The WBSP does not have an emergency spillway, therefore none was modeled (Stantec, 2009a).

2.1.3 Breach Parameters

The Sunny Day and PMP events were modeled. Section 3.2 of the WBSP Breach Analysis describes the initiating water surface elevations. The elevation of the top of the riser structure, 457.7 feet, was used as the peak water surface elevation for the Sunny Day analysis, while an elevation of 468.4 feet, determined from routing the runoff hydrograph, was used for the PMP event. In addition to breach pool elevations, three key parameters are selected for a breach analysis: 1) failure mode, 2) time to breach, and 3) breach width.

Since flows from the PMP event do not overtop the structure, piping was selected as the most likely cause of failure for each event. The WBSP Breach Analysis states:

> "According to IDNR's guidelines, the complete breach time for earthen "engineered" dams usually range from 30 minutes to 1 hour. Thirty minutes was selected for these analyses to provide a more conservative flood inundation map."

A breach width of 135 feet was used for each of the analyses following IDNR guidelines that suggest a trapezoidal breach with a width of 0.5 to 5 times the height of the dam (45 feet). IDNR guidelines also indicate that the side slopes of the trapezoidal breach should range from 0.5H:1V to 1H:1V feet per feet. One to one side slopes were selected for all breach analyses. The breach location was selected along the southern side of the facility where failure would result in discharge to the Ohio River (Stantec, 2009a).

2.1.4 Dam Breach and Downstream Routing

Section 3.3 of the WBSP Breach Analysis report states:

> "HEC-HMS was run for each of the scenarios and breach outflow hydrographs were exported for use in routing the floodwave downstream."

Section 4.0 of the WBSP Breach Analysis describes how a HEC-RAS (USACE, 2006) hydraulic model of the Ohio River McAlpine Pool was obtained from the USACE Louisville District. Each of the outflow breach hydrographs were input into the model and the floodwaves routed using the Unsteady Flow function of HEC-RAS. The baseflow of the Ohio River (132,400 cfs) was determined from the average annual flow at USGS Gage 03277200, Ohio River at Markland Dam near Warsaw, Kentucky. The downstream starting water surface elevation was set at normal depth (Stantec, 2009a).

2.1.5 Flood Profiles and Floodplain Delineation

Section 4.1 of the WBSP Breach Analysis report describes the resulting flood profile and floodplain delineation. The results show a maximum of 0.8 feet rise in water surface elevation on the Ohio River. Figure 2 of Appendix B from the EAP shows the approximate limits of inundation for the modeled scenarios. The inundation mapping based on the analyses described shows no structures or roadways within the impact limits of the dam breach scenarios (Stantec, 2009a).

2.1.6 WBSP Hazard Classification

Should the WBSP dam fail, the likely flood wave will not significantly impact the water surface elevation of the Ohio River and thus will not impact the residential structures on either side of the bank. Also, no structures, roadways, or properties, except a small access road owned by IKEC, were identified within the paths of the identified potential breach scenarios for the WBSP at the Clifty Creek Station. Due to the limited expected impacts to property and potential at-risk populations, a breach of the WBSP dam does not represent a probable threat to human life. A breach, however, would likely result in the off-site release of CCRs into waters of the United

States. Therefore, the impoundment fits the definition for a significant hazard potential CCR surface impoundment (as defined in the EPA Final CCR Rule §257.53).

2.2 LANDFILL RUNOFF COLLECTION POND DAM - EMERGENCY ACTION PLAN – BREACH ANALYSIS REVIEW

Stantec personnel reviewed Appendix B – "Investigation and Analysis of Dam Breach Floods" (LRCP Breach Analysis) from Stantec (2009b). The dam breach analyses conducted for the LRCP were performed to determine possible inundation limits for use in the EAP. Breach analyses included stormwater runoff calculations, reservoir pool routing and breach failure, and hydraulic routing of the floodwave along the Ohio River.

2.2.1 LRCP Facility Description

According to Section 3.1 of the LRCP Breach Analysis:

> "The LRCP primary spillway consists of an inclined 6-feet x 3-feet reinforced concrete box culvert with a riser box structure containing grated inlets located at every 11 feet in elevation. Currently, the two uppermost sections of riser box structure are above the pond level and the lower riser section is the active outlet for the pond. The inclined box is connected to a 400-feet long, 72-inch diameter concrete pipe that discharges to the Ohio River. The LRCP does not have an emergency spillway."
>
> "The dam crest was set at elevation 504 and the dam downstream toe at elevation 430."

The LRCP report says physical dam characteristic information was obtained from the original construction drawings and was verified with a 2005 topographic survey (Stantec, 2009b).

2.2.2 Development of Hydrologic and Hydraulic Model

Section 2.0 of the LRCP Breach Analysis states:

> "Stormwater runoff calculations were performed using a hydrologic model previously developed for the *Clifty Creek Fly Ash Pond Sediment Evaluation and Dredging Plans Project* by Stantec (formerly FMSM) (FMSM, 2008). The previous report evaluated hydrologic conditions for existing field conditions, as well as proposed final landfill grade. The previous project used SEDCAD 4 for hydrologic and sediment transport modeling (Wagner et al, 1998). The methodology used to determine the watershed response, or runoff from a rainfall event, was the Curve Number Method (SCS, 1972)."

Section 2.0 of the report shows that IDNR (2001) was followed in order to select the appropriate Probable Maximum Precipitation (PMP) rainfall depth (27.6 inches) from the National Weather Service (USACE, 1978), duration (6-hours), and distribution (6-hour SCS Type II). Methodology outlined in TR-55 Urban Hydrology for Small Watersheds (USDA, 1975) was used to populate the model with hydrologic properties for each sub-watershed (Table 1 of the LRCP Breach Analysis).

Section 3.1, Development of Model Geometry, outlines how the SEDCAD 4 models include physical characteristics of the reservoir, spillway, and dam embankment. The stage-storage information (calculated from 2005 topographic maps, original LRCP construction drawings, soil borings, and proposed landfill permit drawings) input into the model is used in the calculation of the reservoir water levels and volume of material released following dam failure (Tables 2 and 3 of the LRCP Breach Analysis). A gate structure was created within the dam geometry to model the performance of the dam outlet structure. The LRCP does not have an emergency spillway; therefore, none was modeled (Stantec, 2009b).

2.2.3 Breach Parameters

The Sunny Day and PMP events were modeled for both existing and proposed final landfill grade conditions. Section 3.2 of the Breach Analysis describes the initiating water surface elevations. The normal pool elevation of 485.5 feet was used as the peak water surface elevation for the Sunny Day analysis, while elevations for existing and final conditions PMP models were 503.4 and 501.4 feet, respectively. These elevations were determined from routing the runoff hydrograph for the PMP event. In addition to breach pool elevations, three key parameters are selected for a breach analysis: 1) failure mode, 2) time to breach, and 3) breach width.

Since flows from the PMP event do not overtop the structure, piping was selected as the most likely cause of failure for each event. The LRCP Breach Analysis states:

> "According to IDNR's guidelines, the complete breach time for earthen "engineered" dams usually range from 30 minutes to 1 hour. Thirty minutes was selected for these analyses to provide a more conservative flood inundation map."

A breach width of 222 feet was used for each of the analyses following IDNR guidelines that suggest a trapezoidal breach with a width of 0.5 to 5 times the height of the dam (74 feet). IDNR guidelines also indicate that the side slopes of the trapezoidal reach should range from 0.5H:1V to 1H:1V feet per feet. One to one side slopes were selected for all breach analyses. The breach location was selected along the southern side of the facility where failure would result in discharge to the Ohio River (Stantec, 2009b).

2.2.4 Dam Breach and Downstream Routing

Section 3.3 of the LRCP Breach Analysis report states:

> "HEC-RAS was run for each of the scenarios and breach outflow hydrographs were exported for use in routing the floodwave downstream. "

Section 4.0 of the LRCP Breach Analysis describes how a HEC-RAS (USACE, 2006) hydraulic model of the Ohio River McAlpine Pool was obtained from the USACE Louisville District. Each of the outflow breach hydrographs were input into the model and the floodwaves routed using the Unsteady Flow function of HEC-RAS. The baseflow of the Ohio River (132,400 cfs) was determined from the average annual flow at USGS Gage 03277200, Ohio River at Markland Dam near Warsaw, Kentucky. The downstream starting water surface elevation was set at normal depth (Stantec, 2009b).

2.2.5 Flood Profiles and Floodplain Delineation

Section 4.0 of the Breach Analysis report describes the resulting flood profile and floodplain delineation. The results show a maximum of 2.4 feet rise in water surface elevation on the Ohio River with the floodwave dissipating to half a foot rise 11 miles downstream. Figure 3 of Appendix B from the EAP shows the approximate limits of inundation for the modeled scenarios. The inundation mapping based on the analyses described show no structures or roadways within the impact limits of the dam breach scenarios.

Additionally, for the future conditions PMP model, an analysis was run to determine the sensitivity of water surface elevations on the Ohio River with regards to the volume of material released from a slope failure of the proposed landfill. The initial volume of the landfill estimated to be carried away during a PMF failure of the LRCP Dam was gradually increased to a factor of six (from 451 acre-feet to 5,418 acre-feet), and the resultant flood waves were routed on the Ohio River. Table 4 of the LRCP Breach Analysis indicates that increasing the volume of the landfill slope failure by a factor of six results in a maximum rise in elevation on the Ohio River of 2.6 feet from an initial 1.6 feet (Stantec, 2009b).

2.2.6 LRCP Hazard Classification

Should the LRCP dam fail, the likely flood wave will not significantly impact the water surface elevation in the Ohio River and thus will not impact the residential structures on either side of the bank. Also, other than the local River Road, the review showed no structures or roadways within the impact limits of the dam breach scenarios. Due to the limited expected impacts to property and potential at-risk populations, a breach of the LRCP Dam does not represent a probable threat to human life. A breach, however, would likely result in the off-site release of CCRs into waters of the United States. Therefore, the impoundment fits the definition for a significant hazard potential CCR surface impoundment (as defined in the EPA Final CCR Rule §257.53).

3.0 CONCLUSION

Findings of this review and assessment demonstrate that a breach of the impoundments' dams result in no probable loss of human life, but could cause economic loss or environmental damage. It is Stantec's opinion that the impoundments fit the definition for a significant hazard potential CCR surface impoundment (as defined by the EPA Final CCR Rule §257.53).

4.0 REFERENCES

American Electric Power Service Corporation (AEPSC) (2015). 2015 Dam and Dike Inspection Report. GERS-15-018. Clifty Creek Plant. Madison, Indiana. Geotechnical Engineering. Revision 0. October.

Fuller, Mossbarger, Scott, and May Engineers, Inc. (FMSM) (2008). *Fly Ash Pond Sediment Evaluation and Dredging Plans*. Clifty Creek Plant. Madison, Indiana. February 8.

Fuller, Mossbarger, Scott, and May Engineers, Inc. (FMSM) (2007). *Hydrologic and Hydraulic Report, West Bottom Ash Pond Analysis.* Clifty Creek Plant. Madison, Indiana. July 25.

Indiana Department of Natural Resources (2001). *General Guidelines for New Dams and Improvements to Existing Dams in Indiana*. Division of Water. Indianapolis, Indiana. 2010 Appendix A, Appendix B revisions.

Soil Conservation Service (1972). *National Engineering Handbook (NEH)*. Section 4: Hydrology. August.

Stantec (2009a). *West Bottom Ash Pond Dam. Emergency Action Plan (EAP). Clifty Creek Power Station*. City of Madison, Jefferson County, Indiana. September. (West Boiler Slag Pond)

Stantec (2009b). *Landfill Runoff Collection Pond Dam. Emergency Action Plan (EAP). Clifty Creek Power Station*. City of Madison, Jefferson County, Indiana. September.

U.S. Army Corps of Engineers (2006). *HEC-RAS River Analysis System, Versions 4.0 Beta*. Hydrologic Engineering Center. Davis, California. November.

U.S. Army Corps of Engineers (2003). *HEC-HMS Hydrology Modeling System, Version 3.1.0.* Hydrologic Engineering Center. Davis, California. May.

U.S. Army Corps of Engineers (1978). *Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates, United States East of the 105th Meridian*.

U.S. Department of Agriculture (1975). *Technical Release No. 55, Urban Hydrology for Small Watersheds*. Soil Conservation Service. January.

Warner, Richard C., Pamela J. Schwab, and Dennis J. Marshall (1998). *SEDCAD 4 for Windows* (computer software).

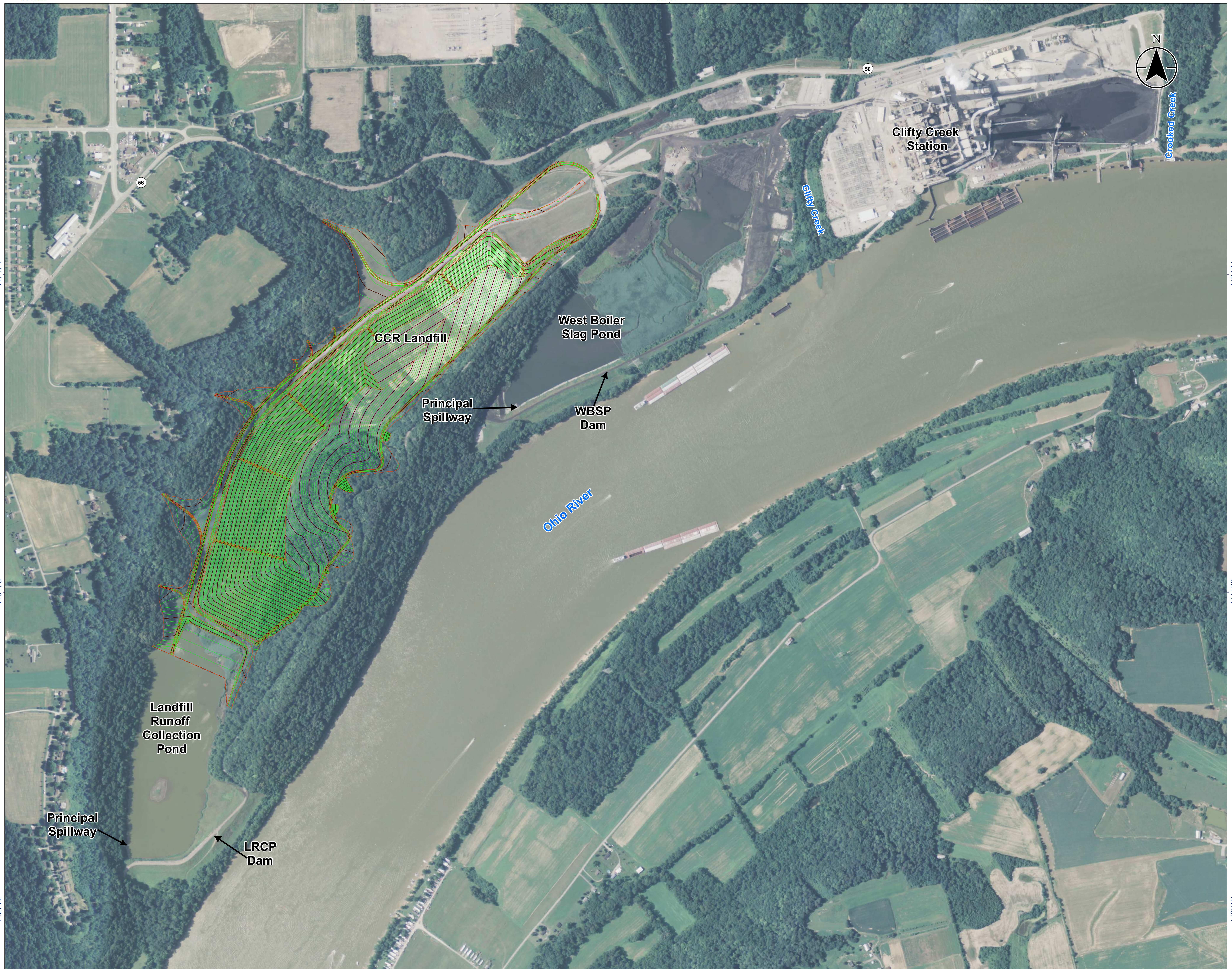

Figure No.
A-1

Title
Plan View of Clifty Creek Station

Client/Project
Clifty Creek Station
Landfill Runoff Collection Pond and
West Boiler Slag Pond

Project Location: Madison, Jefferson County, IN

175534018

Prepared by AP on 2016-10-13
Technical Review by JH on 2016-10-13
Independent Review by SH on 2016-10-13

0 500 1,000 Feet
1:6,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1927 StatePlane Indiana East FIPS 1301
2. USDA - NAIP 2014 Ortho-Imagery
3. Fuller, Mossbarger, Scott, & May, Inc. (FMSM) (2006b). Permit Drawings. Indiana-Kentucky Electric Corporation. Clifty Creek Coal Ash Landfill Modification. Jefferson County, Madison Township, Indiana. November. Dwg. No. 16-30500-09-A. Coal Ash Landfill. Top of Cover

Stantec OVEC IKEC

V:\1755\active\175534018\gis\image\clifty_22x34.mxd Revised: 2016-10-13 By: apooler