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

October 11, 2016
File: 175534018
Revision 0

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

**RE: Run-on and Run-off Control System Plan
CCR Landfill
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 run-on and run-off control system plan for the Indiana-Kentucky Electric Corporation (IKEC) Clifty Creek Station's CCR landfill. Based on this assessment, the Clifty Creek CCR Landfill is in compliance with the run-on and run-off control system plan requirements specified in the Final CCR Rule at 40 CFR 257.81(a).

2.0 RUN-OFF AND RUN-ON CONTROL SYSTEM PLAN

As described in 40 CFR 257.81(c), a run-on and run-off control system plan must be prepared to document how the run-on and run-off control system has been designed and constructed to manage the 25-year, 24-hour storm.

3.0 SUMMARY OF FINDINGS

The attached plan documents the analysis of the run-on and run-off control system of the Clifty Creek CCR Landfill. The results show that the landfill meets the requirements set forth in 40 CFR 257.81(a).

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

Re: **Run-on and Run-off Control System Plan**
CCR Landfill
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

3. that the run-on and run-off control system plan for IKEC Clifty Creek Station's CCR Landfill meets the requirements of the run-on and run-off control system plan specified in 40 CFR 257.81(a) and (c)(1).

SIGNATURE ______________________ DATE 10/11/16

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

TELEPHONE: (513) 842-8200

ATTACHMENTS: Clifty Creek Station CCR Landfill Initial Run-On and Run-off Control System Plan

STAN A. HARRIS
REGISTERED
No. PE19700150
STATE OF INDIANA
PROFESSIONAL ENGINEER
10/11/16

Clifty Creek CCR Landfill Run-on and Run-off Control System Plan

EPA Final CCR Rule
Clifty Creek Station
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

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 document the existing run-on and run-off plan for the Clifty Creek Station's CCR Landfill and to evaluate compliance with §257.81 of the EPA Final CCR Rule.

1.2 OUTLINE OF RULE REQUIREMENTS

The objective of the review described herein is to evaluate compliance related to §257.81, specifically the following:

(1) Run-on: The run-on control system must prevent flow onto the active portion of the Clifty Creek Station's CCR Landfill during the peak discharge from a 25-year, 24-hour storm event.

(2) Run-off: The Clifty Creek Station's CCR Landfill run-off control system must collect and control at least the water volume resulting from a 25-year, 24-hour storm event.

(3) Run-off (permitted discharge): Run-off point sources that discharge into waters of the United States must discharge through a permitted outfall, in this case the National Pollutant Discharge Elimination System (NPDES).

2.0 RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Stantec personnel reviewed four design documents as a basis for the Clifty Creek CCR Landfill's run-on and run-off control system plan:

- *Type I Restricted Waste Landfill Permit Application for the Clifty Creek Power Plant Coal Ash Landfill* (FMSM, 2006a)
  - Volume II - Attachment 22, Design Report
  - Volume I - Attachment 6, Storm Water Discharges
- *Reservoir Routing Analysis, Landfill Runoff Collection Pond – Clifty Creek Power Station* (Stantec, 2010a)
- *Reservoir Routing Analysis, West Bottom Ash Pond – Clifty Creek Power Station* (Stantec, 2010b)

3.0 SUMMARY OF FINDINGS

3.1 RUN-ON AND RUN-OFF ANALYSIS

The following text presents the review of the CCR Landfill run-on and run-off analysis as described in Stantec (2006a).

Section 2.3 of the Design Report describes the surface drainage designed for the site's landfill as following:

> "A system of storm water run-on and run-off ditches will control surface water. Run-on ditches will divert off-site run-on away from the landfill working area. Run-off ditches will convey run-off from the active disposal area."

Section 4.4 of the Design Report details the hydraulic and hydrologic portion of the engineering analysis for the Clifty Creek Station's CCR Landfill. Key elements of the surface water control system are outlined below:

- "Separate flow paths will be maintained to isolate run-on from adjacent areas and run-off from within the facility. Run-on will be diverted away from the facility into a network of drainage pathways. Run-off from the facility will be controlled by internal management practices and be diverted to the existing ash pond (Landfill Runoff Collection Pond (LRCP) and west boiler slag pond (WBSP).
- Run-on and run-off quantities will be addressed by providing drainage control structures and channels capable of conveying discharge from a minimum of the 25-year, 24-hour storm event with an adequate freeboard."

As part of the design, hydrologic sub-watersheds have been delineated as summarized in Section 4.4.1 – Hydrology, so peak discharge values could be determined for channel and culvert designs. Maps of the watershed drainage areas are included in the Design Report in Appendix C – Hydrology and Hydraulics (Stantec, 2006a).

For the run-on and run-off analysis, appropriate hydrologic modeling methodologies are described in Section 4.4.1.1 – Methodology. Modeling software developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC) was used for the design. Peak discharges were calculated using the Hydrologic Modeling System (HEC-HMS). The peak discharges were determined using the Curve Number (CN) method (NEH-4, 1972). According to the Design Report, curve numbers were generated using Hydrologic Soils Groups (HSG) from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database and from the United States Department of Agriculture (USDA) LULC land use grid dataset. Exhibits in Appendix C – "Hydrology and Hydraulics" show the HSGs and Land Use values.

Time of concentration values were calculated for each sub-watershed using the TR-55 methodology (a combination of flow types including sheet flow (Manning's kinematic solution), shallow concentrated flow and open channel flow (Manning's equation)). The curve numbers, times of concentration, and lag times for each sub-watershed are shown in Appendix C with sample calculations. Rainfall data for the 25-year storm event was obtained from "U.S. Weather Bureau TP-40," (Hershfield, 1961) using a precipitation event duration of 24-hours. The SCS (1973) Type II distribution was used.

Section 4.4.1.2 of the Design Report provides a summary of structures used to handle the discharges for the site. The design of the run-on control system involves two perimeter ditches and a side perimeter basin. The ditches split flow from the sub-watersheds located northwest of the site. One ditch conveys flow to the WBSP while the other conveys flow to the LRCP. The side basin collects run-on and outlets into the LRCP. A storm sewer conveys flow from the basin to the pond. Peak flows were calculated for the sizing of drainage features at the outlet of each significant sub-watershed and outfalls of the two primary drainage ditches. A summary of the discharge flow values obtained from the HEC-HMS model, for the two primary diversion ditches and five secondary drains, is provided in Appendix C of the Design Report.

The run-off control system from the CCR Landfill site will be handled by a network of perimeter ditches that direct run-off either towards the WBSP or LRCP. Peak flows were calculated for the sizing of drainage features at the outfalls of the primary drainage ditches and critical sub-watersheds for sizing of the secondary ditches and diversion berms. A summary of the discharge flow values obtained from the HEC-HMS model are provided in Appendix C of the Design Report.

The hydraulic designs for the channels, storm sewers and culverts are discussed in Section 4.4.2 of the Design Report. For the channel design, Section 4.4.2.1 states that drainage ditches were sized to carry the peak flow for the 25-year, 24-hour precipitation event, with a minimum one-foot of freeboard. Riprap channel protection was designed using the methods suggested by the Indiana Department of Transportation and described in the Federal Highway Administration document "HEC 15 – Design of Roadside Channels with Flexible Lining." Typical ditch design calculations using Manning's equation and riprap design calculations are located in Appendix C of the Design Report.

Section 4.4.2.2 states that storm sewers were designed for the 25-years, 24-hour precipitation event using Manning's equation. The inlet structure was designed for the same event using weir and orifice equations. Design calculations for pipe and inlet sizing are located in Appendix C of the Design Report.

Section 4.4.2.3 states that culverts were designed using Federal Highway Administration (FHWA) equations for headwater control. Culverts were designed for the 25-year 24-hour precipitation event. The calculations were performed using HydroCALC "Hydraulics for Windows" by Dodson

& Associates, Inc. for corrugated metal pipe culverts and concrete box culverts. Software results for each culvert design are provided in Appendix C of the Design Report (Stantec, 2006a).

As part of the run-on and run-off control system plan, Stantec personnel also reviewed the Reservoir Routing Analysis reports for both the WBSP and the LRCP (Stantec, 2010a and 2010b). Those reports summarize the methodologies and results of the reservoir routing analyses. A HEC-HMS model was used to simulate the reservoir routing analysis for the WBSP using storage, principal spillway, and embankment characteristics of the dam. SEDCAD 4 models were used to simulate the reservoir routing analysis for the LRCP using storage, principal spillway, and embankment characteristics of the dam.

The analyses indicate that both ponds are capable of passing flows generated from the full and 50% Probable Maximum Precipitation (PMP) events maintaining freeboard without overtopping for both existing and proposed conditions. The downstream ponds are capable of routing the PMP event without overtopping. Therefore, they will also be capable of routing the 25-year, 24-hour storm event required by 40 CFR 257.81(a).

3.2 RUN-ON AND RUN-OFF ANALYSIS - DISCHARGES

Attachment 6, Volume I of Stantec (2006a) documents storm water discharges, addressing 329 Indiana Administrative Code (IAC) 10-11-2.5(a)(10) thru (13) concerning the discharge of storm water from the proposed facility boundary. The following addresses each sub rule, and as a result, 40 CFR 257.81(2)(b):

- **329 IAC 10-11-2.5(a)(10).** There are no known direct discharges of storm water to the groundwater from the site. A review of publicly available information did not indicate the presence of existing or abandoned wells or sinkholes on the subject property that would represent a discharge point. All existing piezometers and wells installed during previous explorations of the site that will be impacted by landfill development will be closed in accordance with Title 312 IAC 13-10-2.

- **329 IAC 10-11-2.5(a)(11).** No change to the current permitted storm water discharge locations is proposed. Storm water will be directed via open channels and culverts to the current fly ash pond *(LRCP)* and west boiler slag pond *(WBSP)* for discharge through outfall numbers NPDES 001 and NPDES 002, respectively.

- **329 IAC 10-11-2.5(a)(12).** Storm water will be discharged from the fly ash pond *(LRCP)* and west boiler slag pond *(WBSP)* to the Ohio River.

- **329 IAC 10-11-2.5(a)(13).** Storm water does not discharge to any regulated municipal separate storm sewer system.

3.3 CONSTRUCTION, OPERATION, AND MAINTENANCE

Construction certification reports (Stantec, 2012 and 2010c) document that the constructed cells of the CCR Landfill have been built in general accordance with the permit requirements. FMSM (2006b) plans for Phase 1 were compared to 2016 aerial imagery. The topography appears to reflect the design stormwater elements. Reference plans and figures are provided in Appendix A.

Station personnel perform weekly and monthly inspections of the landfill to note maintenance and operational concerns. Annual landfill and CCR surface impoundment dam and dike inspections are performed and documented in the Operating Record (Stantec, 2016; AEPSC, 2015). Concerns noted in the inspections and any necessary operational or maintenance adjustments to address the concerns are part of the Operating Record.

3.4 MODIFICATIONS TO THE EXISTING CONTROL SYSTEM

The existing run-on and run-off controls for Clifty Creek's CCR Landfill were designed and permitted in 2006. The design permitted is for the complete buildout of the landfill and its stormwater management system. As of this submittal, only Phase 1 (Subphases 1A, 1B, and 1C) are constructed and accepting CCRs. No portion of the landfill is considered capped and closed by the state of Indiana.

The watershed running onto the landfill area has not been subject to significant construction or land use modification.

The state of practice relies on Bonnin et al (2016) (NOAA Atlas 14) for point precipitation frequency estimates. The precipitation estimate for the 24-hour, 25-year storm event is 5.30 inches with 90% confidence intervals. FMSM (2006) modeled the 24-hour, 25-year storm event for run-on calculations as 5.00 inches, using the "U.S. Weather Bureau TP-40" (Hershfield, 1961). Run-off calculations were performed modeling the event as 5.40 inches. The HMS model was revisited to evaluate the existing design for the additional precipitation assumed for 2016. A summary table of the run-on hydraulic channels, showing freeboard based on 2016 precipitation values and the supporting model results are included in Appendix B. Freeboard within the channels ranges from 0.8 to 2.3 feet. The existing run-on and run-off control design meets current standards.

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.

Bonnin, G.M., D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley (2016). *NOAA Atlas 14*. "Point Precipitation Frequency Estimates." Volume 2, Version 3. Location name: Madison, Indiana, USA. Latitude: 38.732˚, Longitude: -85.4403˚, Elevation: 527.97 ft.

Environmental Protection Agency (2015). "Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities." Federal Register, Vol. 80, No. 74, April 17.

Fuller, Mossbarger, Scott, & May, Inc. (FMSM) (2006a). Type I Restricted Waste Landfill Permit Application for the Clifty Creek Power Plant Coal Ash Landfill. Volume I, Attachment 6; Volume II, Attachment 22. November.

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.

Stantec Consulting Services Inc. (2016). *2015 CCR Rule Inspection, Clifty Creek Landfill.* Clifty Creek Generating Station. Madison, Indiana. Jefferson County. January.

Stantec Consulting Services Inc. (2012). *Construction Certification Report, Phase 1 (Subphases 1A, 1B, 1C). Coal Ash and FGD By-Product Landfill, RWS I.* Madison, Jefferson County, Indiana. November. Project No. 175532002.

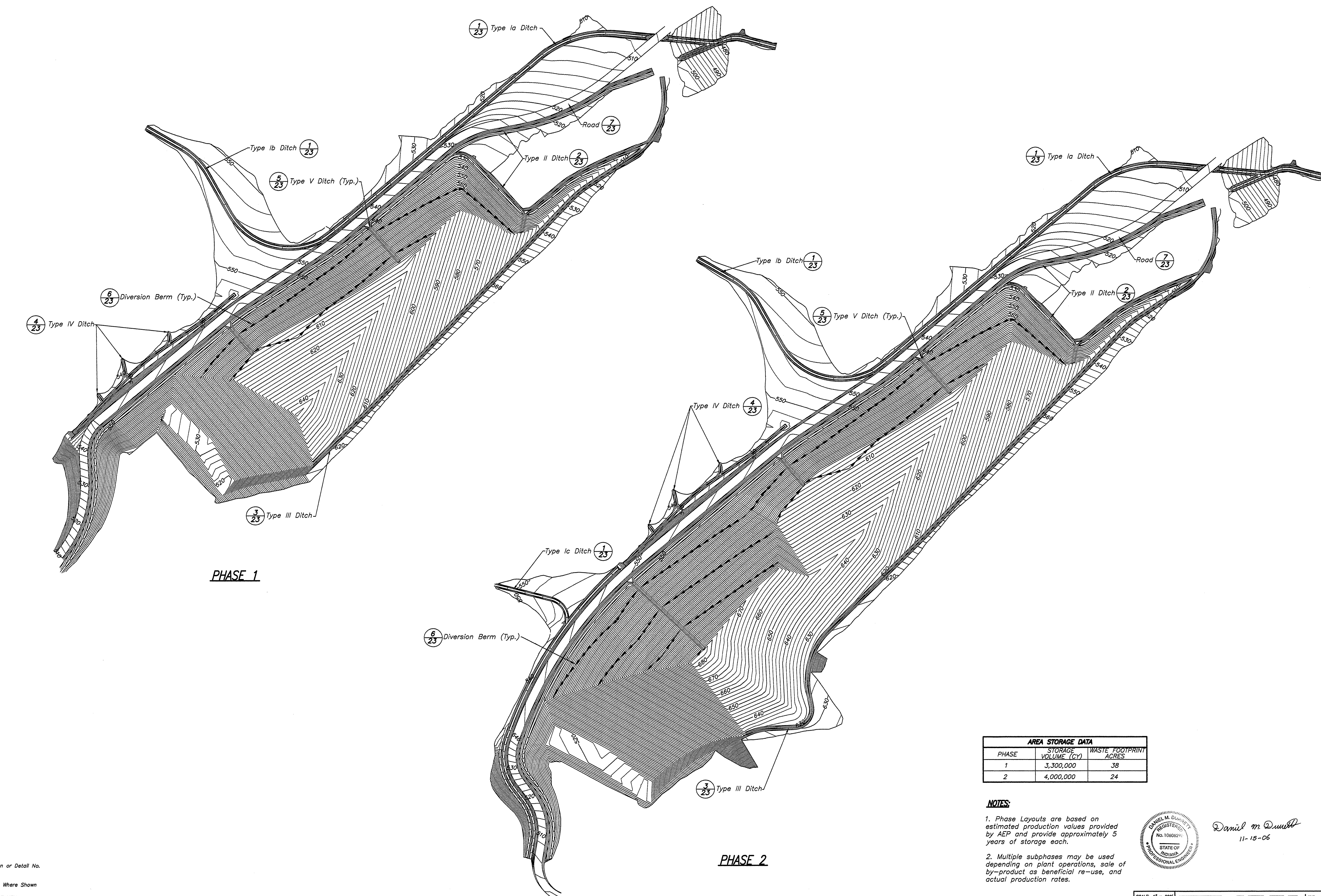
Stantec Consulting Services Inc. (2010a). *Reservoir Routing Analysis, Landfill Runoff Collection Pond – Clifty Creek Power Station.* February.

Stantec Consulting Services Inc. (2010b). *Reservoir Routing Analysis, West Bottom Ash Pond – Clifty Creek Power Station.* February.

Stantec Consulting Services Inc. (2010c). *Construction Certification Report, Phase 1 (Subphases 1A, 1B, 1C). Coal Ash and FGD By-Product Landfill, RWS I.* Madison, Jefferson County, Indiana. October. Project No. 174438101.

APPENDIX A
REFERENCE PLANS AND FIGURES

DWG. NO. 16-30500-20-A



AREA STORAGE DATA		
PHASE	STORAGE VOLUME (CY)	WASTE FOOTPRINT ACRES
1	3,300,000	38
2	4,000,000	24

NOTES:

1. Phase Layouts are based on estimated production values provided by AEP and provide approximately 5 years of storage each.

2. Multiple subphases may be used depending on plant operations, sale of by-product as beneficial re-use, and actual production rates.

DANIEL M. DURRETT REGISTERED No. 10606290 STATE OF INDIANA PROFESSIONAL ENGINEER

Daniel M. Durrett
11-15-06

Section or Detail No.
Sheet Where Shown
REFERENCE KEY

NOTES

REFERENCE DRAWINGS

ISSUED FOR PERMIT

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

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INDIANA - KENTUCKY ELECTRIC CO.

CLIFTY CREEK PLANT

MADISON INDIANA

COAL ASH LANDFILL
PHASES 1 and 2

DWG. NO. 16-30500-20-A

CN2005088\DESIGN\PHASES

SCALE: 1" = 200'
DR: CW
CH: DMD
ENGR: JSM
DATE: NOV. 2006

Fuller Mossbarger Scott & May
FMSM ENGINEERS
LEXINGTON • ST. LOUIS • LOUISVILLE • JEFFERSONVILLE • CINCINNATI • ATLANTA • COLUMBUS
FULLER MOSSBARGER SCOTT AND MAY ENGINEERS, INC.
11687 Lebanon Road
Cincinnati, Ohio
45241
513-842-8200

SCALE:	CIVIL ENGINEERING DIVISION
DR:	APPROVED BY
CH:	
ARCH:	
ENGR:	
DATE:	

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COLOR: WHICH COLOR.TBLXXXXXXXXXX
PEN: WHICH PEN.TBLXXXXXXXXXX

SYSTEM DATE- DD-MMM-YYYY
SYSTEM TIME- HOUR:MINUTE
PLOT DATE-__/__/__
PLOTTED BY-

1050694

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. 16-30500-20-A Phases 1 and 2.

0 700 Feet

1:8,400 (At original document size of 8.5x11)

Stantec

OVEC/IKEC

Project Location
Madison
Jefferson County, IN

175534018
Prepared by AP on 2016-10-10
Technical Review by JH on 2016-10-10
Independent Review by SH on 2016-10-10

Client/Project
Clifty Creek Plant
CCR Landfill
Run-on and Run-off Control Plan

Figure No.
A-1

Title
Plan View of CCR Landfill

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Notes

1. Coordinate System: NAD 1927 StatePlane Indiana East FIPS 1301
2. ESRI - 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.

0 700 Feet

1:8,400 (At original document size of 8.5x11)

Stantec OVEC/IKEC

Project Location 175534018
Madison
Jefferson County, IN

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

Client/Project
Clifty Creek Plant
CCR Landfill
Run-on and Run-off Control Plan

Figure No.
A-2

Title
Plan View of CCR Landfill

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APPENDIX B
RUN-ON CHANNEL SUMMARY

Appendix C – Hydrology and Hydraulics

Table C-4. Run-On Hydraulic Channel Design Summary

Peak Flow Point	Ditch Type	Q (cfs)	n	% Slope	Bottom Width (ft)	Side Slope (ft/ft)		Area (ft^2)	P (ft)	R (ft)	Normal Depth (ft)	Design Depth (ft)	Design Width (ft)	Freeboard (ft)	Velocity (ft/s)
						Z1	Z2								
A	Ia	426.0	0.040	1	10	2	2	63.6	26.4	2.41	3.7	5.5	32	1.8	6.7
B	Ib	288.3	0.040	0.5	10	2	2	61.6	26.0	2.37	3.6	4.5	28	0.9	4.7
C	IV	73.7	0.040	2	0	3	3	13.8	13.6	1.02	2.2	3.0	18	0.8	5.3
D	Ic	96.7	0.040	2	10	2	2	17.4	16.1	1.08	1.4	3.0	22	1.6	5.6
E	Ic	193.4	0.040	2	10	2	2	28.2	19.0	1.48	2.0	3.0	22	1.0	6.9
F	IV	50.9	0.040	1	0	3	3	13.6	13.5	1.01	2.1	3.0	18	0.9	3.8
G	Ia	322.6	0.040	1	10	2	2	52.0	24.2	2.15	3.2	5.5	32	2.3	6.2

Project: Run_On		Simulation Run: 25_yr_Atlas14			
Start of Run:	13Dec2005, 00:00	Basin Model:	Run On		
End of Run:	14Dec2005, 00:02	Meteorologic Model:	SCS_25_yr_24_hr_Atlas14		
Compute Time:	10Oct2016, 17:11:52	Control Specifications:	SCS_24_hr_Storm		
Volume Units:	AC-FT				
Hydrologic Element	**Drainage Area (MI2)**	**Peak Discharge (CFS)**	**Time of Peak**		**Volume (AC-FT)**
CS1	0.0677	107.6	13Dec2005,	12:08	8.5
CS10	0.4594	432.7	13Dec2005,	12:18	61.7
CS3	0.4444	426	13Dec2005,	12:20	66.2
CS4	0.2899	288	13Dec2005,	12:34	43.2
CS5	0.047	73.1	13Dec2005,	12:10	6.1
CS6	0.1955	108	13Dec2005,	12:56	26.7
CS7	0.3054	279.5	13Dec2005,	12:14	42.6
CS8	0.3377	321.3	13Dec2005,	12:14	46.6
CS9	0.3948	392.7	13Dec2005,	12:16	53.9
OF1	0.5067	231.6	13Dec2005,	13:14	64.8
OF10	0.3948	395.3	13Dec2005,	12:14	54
OF11	0.4594	435.5	13Dec2005,	12:16	61.7
OF12	0.4594	432.7	13Dec2005,	12:18	61.7
OF2	0.0677	108.5	13Dec2005,	12:06	8.5
OF3	0.4444	426	13Dec2005,	12:20	66.2
OF4	0.4444	426.4	13Dec2005,	12:18	66.2
OF5	0.2899	288.3	13Dec2005,	12:32	43.3
OF6	0.047	73.7	13Dec2005,	12:08	6.1
OF7	0.1955	108	13Dec2005,	12:52	26.7
OF8	0.3054	282.6	13Dec2005,	12:10	42.7
OF9	0.3377	322.6	13Dec2005,	12:12	46.7
SB1	0.439	221	13Dec2005,	13:16	56.3
SB10	0.0571	74.1	13Dec2005,	12:12	7.3
SB11	0.0646	53.6	13Dec2005,	12:30	7.8
SB2	0.0168	25.8	13Dec2005,	12:10	2.2
SB3	0.0509	83.8	13Dec2005,	12:06	6.3
SB4	0.1545	255.4	13Dec2005,	12:10	23
SB5	0.2899	288.3	13Dec2005,	12:32	43.3
SB6	0.047	73.7	13Dec2005,	12:08	6.1
SB7	0.1485	96.7	13Dec2005,	12:58	20.6
SB8	0.1099	193.4	13Dec2005,	12:08	16
SB9	0.0323	50.9	13Dec2005,	12:08	4.1
Sink-1	0.5067	231.6	13Dec2005,	13:14	64.8
Sink-2	0.4444	426	13Dec2005,	12:20	66.2
Sink-3	0.4594	432.7	13Dec2005,	12:18	61.7