A & M Engineering and Environmental Services, Inc.
Consulting - Design - Construction - Remediation

October 16, 2018

Mr. Mike Bednar
Superintendent of Environmental Compliance
GRDA-Ecosystems and Education Center
PO Box 70
420 Hwy 28
Langley, OK 74350-0070

RE: GRDA CCR Landfill Compliance Report
Grand River Dam Energy Center
8142 Hwy 412B PO Box 609
Chouteau, OK 74337-0609

Dear Mr. Bednar,

A & M Engineering and Environmental Services, Inc. (A & M) has completed the GRDA CCR Landfill Compliance Report, and that report is attached for your records. This report was prepared in accordance with the requirements of 40 CFR §257 and OAC 252:517.

A & M concluded the CCR Landfill at the GREC Complex in Chouteau, Oklahoma is not located in unstable areas, and four (4) of the 40 CFR §257 / OAC 252:517 sections do not apply to the existing CCR Landfill as no new CCR Landfill or lateral expansion is proposed.

Please feel free to contact me at tolga@aandmengineering.com or (918) 665-6575 should you have any questions or concerns.

Thank you,

Tolga M. Ertugrul, P.E.
President
A & M Engineering and Environmental Services, Inc.

CCR RULE 40 CFR §257.60 – 64 COMPLIANCE CERTIFICATION REPORT

FOR THE

COAL COMBUSTION RESIDUAL LANDFILL

GRAND RIVER DAM AUTHORITY
GRAND RIVER ENERGY CENTER
CHOUTEAU, OKLAHOMA

PROJECT NO. 1986-034

OCTOBER 2018

PREPARED FOR:

GRDA
Grand River Dam Authority

GRAND RIVER DAM AUTHORITY.
226 WEST DWAIN WILLIS AVENUE
VINITA OK 74301

PREPARED BY:

A & M Engineering and
Environmental Services, Inc.
Consulting · Design · Construction · Remediation

OKLAHOMA CERTIFICATE OF AUTHORIZATION NO. 1326
10010 E. 16TH STREET
TULSA, OKLAHOMA 74128-4813
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Contents

PROFESSIONAL ENGINEER CERTIFICATION

I, hereby certify, as a Professional Engineer in the State of Oklahoma, that the information in this document was assembled under my direct supervisory control. This report is not intended or represented to be suitable for reuse by Grand River Dam Authority or others without specific verification or adaptation by the Engineer.

I hereby certify, as a Professional Engineer in the State of Oklahoma that this report has been prepared in accordance with requirements of 40 Code of Federal Regulations §257 and Oklahoma Administrative Code 252:517-5-1 to 252:517-5-5. I further certify that a satisfactory demonstration of the requirements of 40 CFR Sections §257.60, §257.61, §257.62, §257.63, §257.64 as well as the requirements of Oklahoma Administrative Code 252:517-5-1, 252:517-5-2, 252:517-5-3, 252:517-5-4, and 252:517-5-5 have been made.

Respectfully,

10-16-2018

Tolga M, Ertugrul, P.E.
Oklahoma Licenses Professional Engineer No. 30017
A & M Engineering and Environmental Services, Inc.

Date

1.0 INTRODUCTION

This Certification report has been prepared for the Coal Ash Disposal Facility (CADF) located at the Grand River Dam Authority (GRDA) Grand River Energy Center Complex (GREC, the Site). This report conforms to 40 Code of Federal Regulations (CFR) Part 257. This report was prepared in response to the new Federal Coal Combustion Residual (CCR) regulations for the disposal of ash under subtitle D of the Resource Conservation and Recovery Act (RCRA). The State of Oklahoma also approved new regulations for the disposal of CCRs from Electrical Utilities under Oklahoma Administrative Code (OAC), Title 252, Chapter 517, which went into effect on September 15, 2016. The requirements of OAC 252:517 largely mirror the requirements of the Federal Regulations 40 CFR 257.

1.1 GENERAL INFORMATION

The Site is located at the Grand River Energy Center in Choteau, Oklahoma near the west bank of the Grand River, approximately two (2) miles east of the City of Chouteau, Oklahoma, on the north side of U.S. 412 between Chouteau Creek and the Grand River. Refer to **Appendix A** for the Site Location Map. The GRDA CCR landfill is permitted by the Oklahoma Department of Environmental Quality (DEQ) as a Non-Hazardous Industrial Waste Landfill that is allowed to accept fly ash, bottom ash, and spent powdered activated carbon used to control flue gas emissions generated at the GREC (DEQ, 2015). The CCR landfill is situated south of the coal-fired boiler units within the GREC complex and has been in operation since 1981. The total landfill permit area consists of approximately 67 acres, of which only 47 acres have been utilized for CCR disposal. The GRDA CCR landfill remains active to date. The CCR landfill is bordered by surface impoundments to the west and south. To date, over 60 percent of the landfill's airspace capacity has been used, resulting in areas with over 70 feet of disposed fill. A review of historical drawings indicates the bottom of the CCR landfill is irregular and varies in elevation from 597 feet to over 605 feet above Mean Sea Level (MSL).

1.2 SITE GEOLOGY AND SITE SUBSURFACE SOIL CONDITIONS

The geologic formations around the Site are consistent with the Ozark Uplift, which dips away from the Site to the west and northwest. The dominant surficial deposits in the area of the CCR landfill are Quaternary terrace and alluvial deposits. The CCR landfill is lined with a low permeability clayey gravel to gravelly lean clay stratum of varying thickness ranging from 5 feet to 12 feet in thickness. The clay stratum is underlain by well graded, water bearing gravel stratum, underlain by sand, then well graded gravel, which is ultimately deposited on bedrock consisting of limestone and chert. The Site is not located in a karst area.

1.3 ON SITE HUMAN-MADE CONDITIONS

The CCR landfill site grades gently to the southeast towards the Grand River. Storm water surface impoundments, created from borrow sources for the construction of Highway 412, border the West and South sides of the CCR landfill. Primary access to the Site is a paved road, Highway 412B, extending

North from Highway 412 on the east side of the GREC. The CCR landfill can be accessed through gravel roads on the Site.

The CCR landfill was designed so that all surface water drainage is routed around and/or away from the landfill area. Minimal watershed areas impact the outer perimeter of the CCR landfill as the general site topography promotes drainage away from the perimeter of the CCR landfill, especially on the south, east, and west sides of the CCR landfill. The majority of surface water on the north side of the landfill naturally drains around the CCR landfill in a direction parallel to the perimeter dike to natural drainages within the site. Potential run-on is controlled primarily by the perimeter landfill dike which ranges in height from 3 to 30 feet above the surrounding topography. On the north and east sides of the CCR landfill, drainage ditches also help convey potential run-on flow around the perimeter dike of the CCR landfill. On the western and southern sides of the CCR landfill, diversion channels are not required because the topography promotes drainage away from the perimeter of the landfill and directly into a series of permitted Class III industrial wastewater treatment impoundments regulated by an Oklahoma Pollutant Discharge Elimination System (OPDES) permit.

The project site is fenced and monitored by security to prevent access by unauthorized personnel.

1.4 GROUNDWATER

The average top of groundwater varies from a high point elevation of 609.8 feet MSL at MW93-01 to a low point of 591.2 feet MSL at MW03-02, for a total vertical difference of 18.6 feet. The top of groundwater elevation varies uniformly between the wells. The aquifer saturated thickness varies from 5.6 feet at MW93-01 to 21.2 feet at MW03-02, although the variation in thickness is not uniform across the site. The groundwater generally flows to the southeast. Refer to the groundwater monitoring well location map in **Appendix A**.

Table 1: Historical Groundwater Elevations

Uppermost Aquifer Thickness						
		MW93-1	MW93-2	MW93-3	MW03-1	MW03-2
T.O. Grade Elev. (ft)		617.7	605.0	605.4	595.6	595.0
Depth to Bedrock (ft)		13.5	23.0	25.0	9.3	25.0
T.O. GW Elev. (ft)	Jul-12	610.1	599.4	594.8	592.7	591.1
	Dec-12	609.1	599.3	594.0	DRY	590.4
	Jun-13	610.9	599.8	594.9	595.3	592.0
	Dec-13	609.6	598.9	594.7	593.5	590.8
	Jun-14	611.3	599.5	595.3	595.6	592.1
	Dec-14	609.7	599.4	594.7	593.5	591.1
	Jun-15	610.0	599.5	596.6	594.8	593.2
	Dec-15	610.3	599.7	598.3	595.6	592.3
	Jun-16	608.5	599.8	594.8	594.0	595.0
	Dec-16	608.4	599.3	594.2	591.1	580.9
	Jun-17	609.5	599.9	596.6	594.9	593.8
Avg. GW Elev. (ft)		609.8	599.5	595.4	594.1	591.2
T.O. Bedrock (ft)		604.2	582.0	580.4	586.4	570.0
Saturated Aquifer Thickness (ft)		5.6	17.5	15.0	7.8	21.2

Elevations shown are relative to MSL

2.0 LOCATION RESTRICTIONS

2.1 PLACEMENT ABOVE THE UPPERMOST AQUIFER 40 CFR §257.60 & OAC 252:517-5-1

40 CFR §257.60 states the following:

> "*New CCR landfill, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less the 1.52 meters (5 feet) above the upper limits of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connections between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table).*"

40 CFR §257.60 and OAC 252:517-5-1 place restrictions on locating the base of the CCR landfill or surface impoundment within 5 feet of the uppermost aquifer.

Compliance with Uppermost Aquifer Restriction

No new CCR landfill or lateral expansion of the existing CCR landfill is proposed. In addition, there are no existing or proposed CCR surface impoundments. Therefore, 40 CFR §257.60 and OAC 252:517-5-1 is not applicable to the existing CCR landfill at GREC.

2.2 WETLANDS 40 CFR §257.61 and OAC 252:517-5-2

40 CFR §257.61 states the following:

> *"New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in §232.2 of this chapter; unless the owner or operator demonstrates by the dates specified in paragraph (c) if this section that the CCR meets the requirements of paragraphs (a)(1) through (5) of this section."*

40 CFR §257.61 and OAC 252:517-5-2 place restrictions on locating CCR landfills and surface impoundment in areas designated as wetlands.

Wetlands Definition

According to the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) the definition of a wetland is:

> *"Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of*

vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Compliance with Wetlands Restriction

No new CCR landfill or lateral expansion of the existing CCR landfill is proposed. In addition, there are no existing or proposed CCR surface impoundments. Therefore, 40 CFR §257.61 and OAC 252:517-5-2 is not applicable to the existing CCR landfill at GREC.

2.3 FAULT AREAS 40 CFR §257.62 and OAC 252:517-5-3

40 CFR §257.62 states the following:

"New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit."

40 CFR §257.62 and OAC 252:517-5-3 place restrictions on locating CCR landfills and surface impoundments in close proximity to active fault areas.

Compliance with Fault Area Restriction

No new CCR landfill or lateral expansion of the existing CCR landfill is proposed. In addition, there are no existing or proposed CCR surface impoundments. Therefore, 40 CFR §257.62 and OAC 252:517-5-3 is not applicable to the existing CCR landfill at GREC.

2.4 SEISMIC IMPACT ZONES 40 CFR §257.63 and OAC 252:517-5-4

40 CFR §257.63 states the following:

"New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to restrict the maximum horizontal acceleration in lithified earth material for the site."

40 CFR §257.63 and OAC 252:517-5-4 place restrictions on locating CCR landfills and surface impoundments in seismic impact zones.

Definition of Seismic Impact Zone

According to the Federal Register Volume 80 No. 74, a seismic impact zone is the following:

> *"A Seismic impact zone means an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 50 years."*

Compliance with Seismic Impact Zones Restriction

No new CCR landfill or lateral expansion of the existing CCR landfill is proposed. In addition, there are no existing or proposed CCR surface impoundments. Therefore, 40 CFR §257.63 and OAC 252:517-5-4 is not applicable to the existing CCR landfill at GREC.

2.5 UNSTABLE AREAS 40 CFR §257.64 and OAC 252:517-5-5

40 CFR §257.64 states the following:

> *"An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted. The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable: (1) On-site or local soil conditions that may result in significant differential settling; (2) On-site or local geologic or geomorphologic features; and (3) On-site or local human-made features or events (both surface and subsurface)."*

40 CFR §257.64 and OAC 252:517-5-5 place restrictions on locating CCR landfills and surface impoundments in unstable areas.

Compliance with Unstable Areas Restriction

To determine if the expected settlement due to the induced loading from ongoing fly ash in the CCR landfill could compromise the integrity of the structural components of the landfill, settlement and the time rate of consolidation of the compressible layer underlying the CCR landfill were evaluated using the extensive boring and laboratory soil testing data from the 1978 geotechnical report prepared by Holway-United and the 1995 subsurface investigation report prepared by Bentley Environmental Engineering, Inc. As discussed in Section 1.2, the CCR landfill is lined with a compressible clay layer that is underlain by a well graded gravel stratum. Due to the greatest amount of fill being placed in the center of the landfill, the induced stress on the underlying soils will be greatest in the middle of the CCR landfill and decrease towards the exterior limits of CCR landfill. Therefore, the greatest amount of settlement should occur in the middle of the landfill where highest stresses are induced, resulting in a settlement profile that is

shaped like a trough. The compressible clay layer that the CCR landfill is founded on is only about 10 feet thick. Based on detailed analysis of oedometer test results from undisturbed soil specimens collected within this stratum, 100 percent of primary consolidation should be reached within approximately 6 months of loading in this stratum. Since the CCR landfill has already received over 60 percent of its permitted capacity, and the compressible clay stratum should have essentially reached total primary consolidation resulting from this induced loading, physical indications of differential settlement that result in unstable areas should be currently present at the landfill. This is especially true since this stratum is not overconsolidated, as the referenced laboratory test results indicate that the clay layer has a preconsolidation pressure of 4,000 pounds per square feet. Landfill reconnaissance and inspection on September 27, 2018 did not identify unstable areas. While a limited amount of differential settlement will occur between the edges of the landfill and the center, it will occur relatively quickly and thus the ongoing disposal activities in the CCR landfill should be able to easily minimize any potential loss in grade due to consolidation.

Based on the information presented in Section 1.1 – 1.4, no on-site or local geologic or geomorphologic features or human-made conditions exist at the CCR landfill site that would be considered as an unstable condition. It should be noted that the surface impoundments adjacent to the landfill should not have an appreciable effect on the effective strength of landfill subsurface soils because these soils are mostly saturated.

Based upon site reconnaissance and review of the geotechnical and subsurface investigations, there is no evidence of unstable conditions that may result in differential settling resulting from the geologic/geomorphologic features and/or man-made features at the Site in accordance with 40 CFR §257.64 **and OAC 252:517-5-5.**

3.0 SUMMARY

The Grand River Dam Authority CADF meets and/or exceeds all location restriction requirements detailed in 40 CFR §257 and OAC §252:517-5-1 to §252:517-5-5:

40 CFR §257.60 and OAC 252:517-5-1 Uppermost Aquifer	40 CFR §257.60 and OAC 252:517-5-1 not applicable to the existing CCR landfill
40 CFR §257.61 and OAC 252:517-5-2 Wetlands	40 CFR §257.61 and OAC 252:517-5-2 not applicable to the existing CCR landfill
40 CFR §257.62 and OAC 252:517-5-3 Fault Areas	40 CFR §257.62 and OAC 252:517-5-3 not applicable to the existing CCR landfill
40 CFR §257.63 and OAC 252:517-5-4 Seismic Impact Zones	40 CFR §257.63 and OAC 252:517-5-4 not applicable to the existing CCR landfill
40 CFR §257.64 and OAC 252:517-5-5 Unstable Areas	Based upon the unstable areas criteria specified in 40 CFR §257.64 and OAC 252:517-5-5, and specific data from investigations of the area, it has been concluded the CCR landfill is not located in unstable areas.

REFERENCES

Holway-United, *Grand River Dam Authority 490 MW Coal – Fired Unit GRDA No. 1 Geotechnical Report.* February 26, 1978

Manzer, Gary K, Ph.D. *Subsurface Investigation, Upgrade Application for Ash Disposal Area, Grand River Dam Authority, Coal Fired Complex, Chouteau, Oklahoma.* Bentley Environmental Engineering, Inc. April 27, 1995.

Oklahoma State Department of Health (OSDH), Permit for a *Coal Ash Disposal Site*. January 13, 1981.

Oklahoma Department of Environmental Quality (DEQ), *Permit Modification to add an additional Solid Waste Stream, Grand River Dam Authority, Mayes County, Permit 3549012.* February 20, 2015.

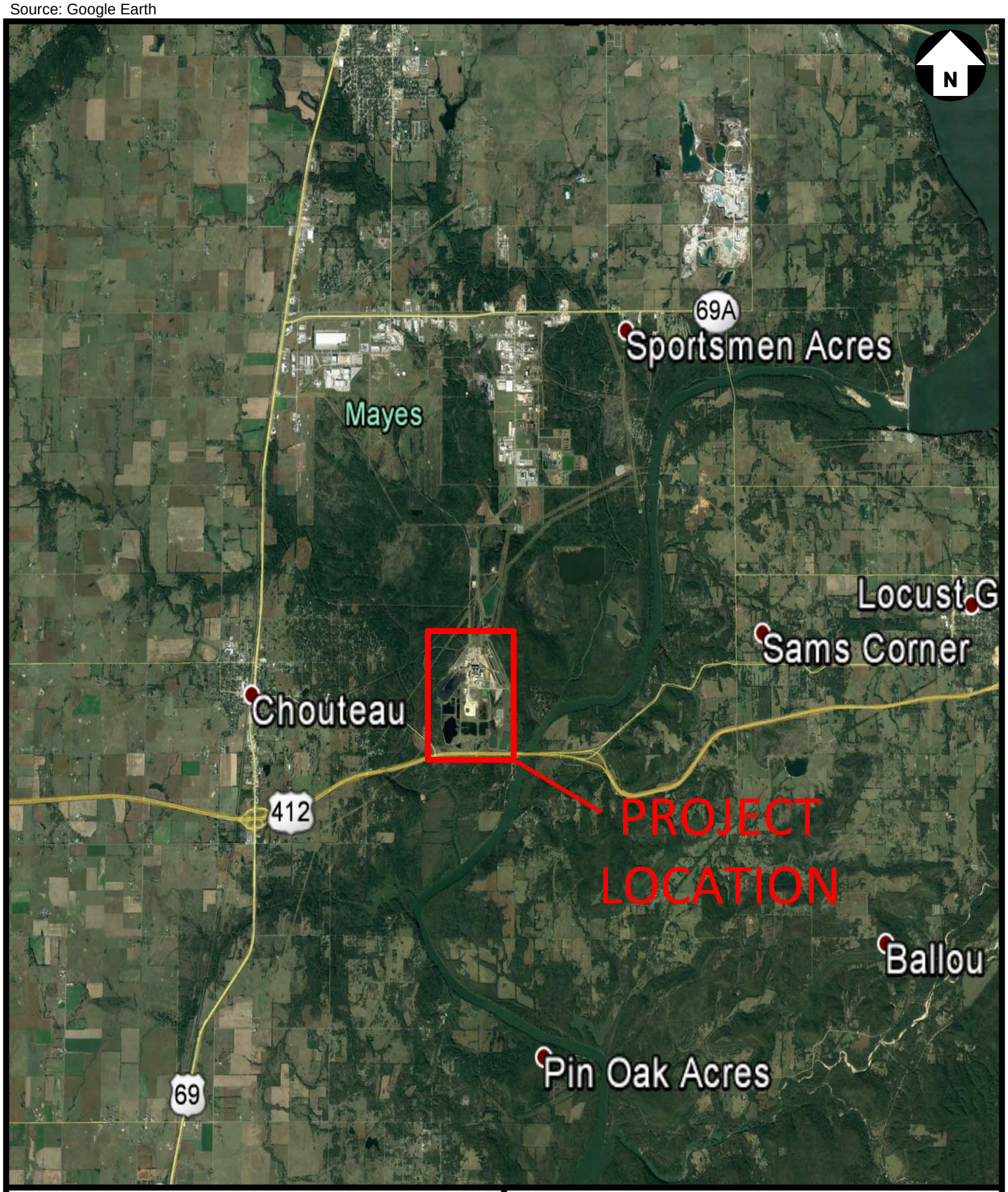
State of Oklahoma, *Oklahoma Administrative Code, Title 252, Chapter 517, Disposal of CCR from Electric Utilities.* September 15, 2016.

United States Environmental Protection Agency (USEPA), *40 CFR Part 257, Subpart D, Disposal of CCR from Electric Utilities.* April 17, 2015.

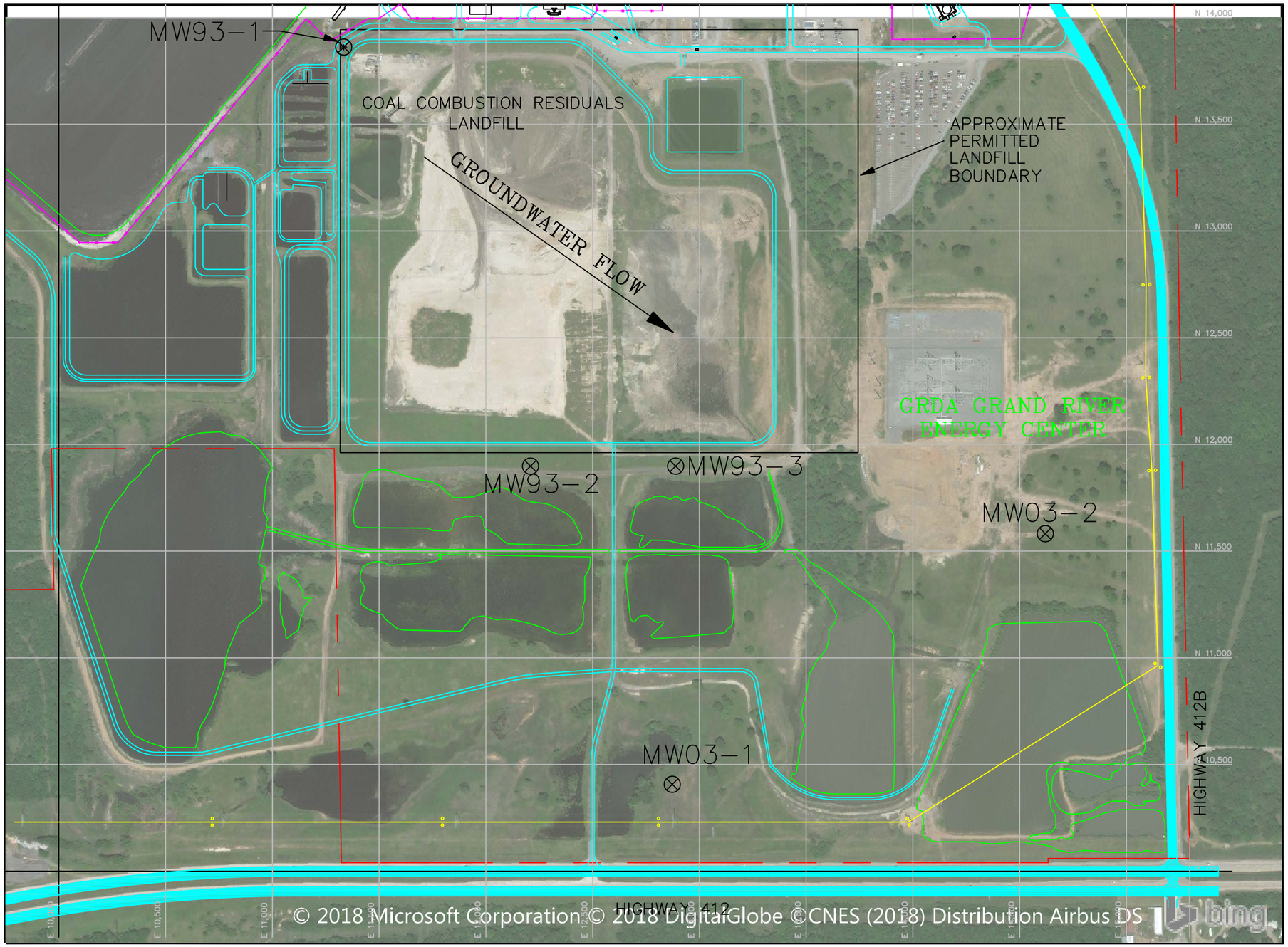
APPENDIX A

SITE LOCATION MAP & GROUNDWATER MONITORING WELL LOCATION MAP

Source: Google Earth



A & M Engineering and Environmental Services, Inc. Consulting - Design - Construction - Remediation	**Project Location Map**	
	Grand River Energy Center	
	8142 Highway 412B Chouteau, Oklahoma 74337	
	TME	10/08/2018	**Appendix A**



NORTH

SCALE

0 500′ 1000′

LEGEND

⊗ MW93-1 GROUNDWATER MONITORING WELL

DJR 4/13/06

GENERAL NOTES

1) AERIAL BACKGROUND FROM BING MAPS.

REVISIONS

NO.	DESCRIPTION	BY	CHECKED	DATE	NO.	DESCRIPTION	BY	CHECKED	DATE

A & M Engineering and Environmental Services, Inc.
Consulting - Design - Construction - Remediation

CCR LANDFILL AND WELL LOCATION MAP

GRAND RIVER DAM AUTHORITY LANDFILL CHOUTEAU, OK

DRAWN:	CHECKED BY:	MATERIALS BY:	ENGINEER:	APPROVED BY:	SCALE:	PROJECT NUMBER:	DRAWING NUMBER:	REV.:
OPC	TAT			TAT	AS SHOWN	1986-034	APPENDIX A	
DATE: 10/08/2018	DATE: 10/08/2018	DATE:	DATE:	DATE: 10/08/2018				