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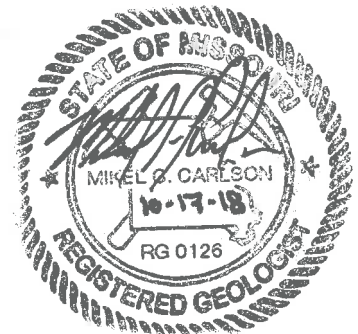
# GREDELL Engineering Resources, Inc.

## Sikeston Board of Municipal Utilities Sikeston Power Station Bottom Ash Pond Location Restrictions

*Prepared for:*



**Sikeston Power Station  
1551 West Wakefield Avenue  
Sikeston, MO 63801**



October 2018

**Sikeston Board of Municipal Utilities  
Sikeston Power Station  
Bottom Ash Pond  
Location Restrictions Assessment**

**October 2018**

**Table of Contents**

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 LOCATION RESTRICTIONS ASSESSMENT .....</b>	<b>3</b>
2.1 §257.60 Placement Above the Uppermost Aquifer .....	3
2.2 §257.61 Wetlands.....	4
2.3 §257.62 Fault Areas .....	7
2.4 §257.63 Seismic Impact Zones.....	8
2.5 §257.64 Unstable Areas .....	11
<b>3.0 MISCELLANEOUS REQUIREMENTS.....</b>	<b>13</b>
<b>4.0 REFERENCES.....</b>	<b>14</b>

**List of Appendices**

**Appendix A**      Figures

## Professional Engineer's Certification

### 40 CFR 257.60(b) Placement Above The Uppermost Aquifer

I, Thomas R. Gredell, P.E., GREDELL Engineering Resources, Inc., a professional engineer licensed in the State of Missouri, hereby certify in accordance with 40 CFR 257.60(b) that the Sikeston Board of Municipal Utilities, Sikeston Power Station, Bottom Ash Pond meets the location restrictions demonstration of 40 CFR 257.60(a) for placement above the uppermost aquifer as found in federal regulation 40 CFR 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. In addition, the demonstration has been prepared using good engineering, geologic, and environmental judgement, and standard accepted practices.

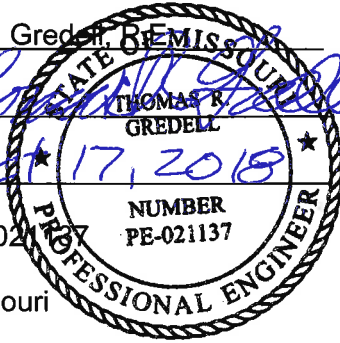
Name: Thomas R. Gredell, P.E. MISSOURI

Signature: 

Date: Oct 17, 2018

Registration Number: PE-021137

State of Registration: Missouri



## Professional Engineer's Certification

### 40 CFR 257.61(b) Wetlands

I, Thomas R. Gredell, P.E., GREDELL Engineering Resources, Inc., a professional engineer licensed in the State of Missouri, hereby certify in accordance with 40 CFR 257.61(b) that the Sikeston Board of Municipal Utilities, Sikeston Power Station, Bottom Ash Pond meets the location restrictions demonstration of 40 CFR 257.61(a) for wetlands as found in federal regulation 40 CFR 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. In addition, the demonstration has been prepared using good engineering and environmental judgement, and standard accepted practices.

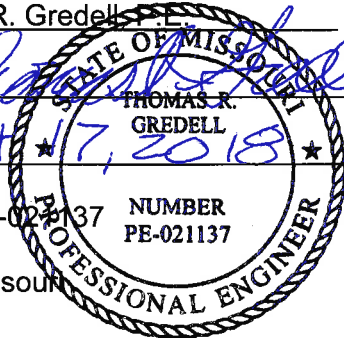
Name: Thomas R. Gredell, P.E.

Signature: 

Date: Oct 17, 2018

Registration Number: PE-021137

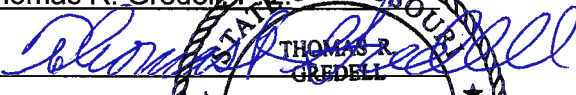
State of Registration: Missouri



## Professional Engineer's Certification

### 40 CFR 257.62(b) Fault Areas

I, Thomas R. Gredell, P.E., GREDELL Engineering Resources, Inc., a professional engineer licensed in the State of Missouri, hereby certify in accordance with 40 CFR 257.62(b) that the Sikeston Board of Municipal Utilities, Sikeston Power Station, Bottom Ash Pond meets the location restrictions demonstration of 40 CFR 257.62(a) for fault areas as found in federal regulation 40 CFR 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. In addition, the demonstration has been prepared using good engineering, geologic, and environmental judgement, and standard accepted practices.

Name: Thomas R. Gredell  
Signature:   
Date: Oct 17, 2018  
Registration Number: PE-021137  
State of Registration: Missouri



## Professional Engineer's Certification

### 40 CFR 257.63(b) Seismic Impact Zones

I, Thomas R. Gredell, P.E., GREDELL Engineering Resources, Inc., a professional engineer licensed in the State of Missouri, hereby certify in accordance with 40 CFR 257.63(b) that the Sikeston Board of Municipal Utilities, Sikeston Power Station, Bottom Ash Pond meets the location restrictions demonstration of 40 CFR 257.63(a) for seismic impact zones as found in federal regulation 40 CFR 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. In addition, the demonstration has been prepared using good engineering and environmental judgement, and standard accepted practices.

Name: \_\_\_\_\_ Thomas R. Gredell, P.E. of Missouri

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Registration Number: PE-021137


State of Registration: Missouri



**PROFESSIONAL ENGINEER'S CERTIFICATION**

**40 CFR 257.64(b) Unstable Areas**

I, Thomas R. Gredell, P.E., GREDELL Engineering Resources, Inc., a professional engineer licensed in the State of Missouri, hereby certify in accordance with 40 CFR 257.64(b) that the Sikeston Board of Municipal Utilities, Sikeston Power Station, Bottom Ash Pond meets the location restrictions demonstration of 40 CFR 257.64(a) for unstable areas as found in federal regulation 40 CFR 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. In addition, the demonstration has been prepared using good engineering and environmental judgement, and standard accepted practices.

Name: Thomas R. Gredell, P.E.  
Signature:   
Date: Oct 17, 2018  
Registration Number: PE-021137  
State of Registration: Missouri



## 1.0 INTRODUCTION

In accordance with the scope of services outlined in the Sikeston Board of Municipal Utilities (SBMU) Work Order No. 19 dated August 3, 2018, GREDELL Engineering Resources, Inc. (Gredell Engineering) conducted a location restrictions assessment for the SBMU Sikeston Power Station (SPS) Bottom Ash Pond, an existing coal combustion residual (CCR) surface impoundment. This report describes Gredell Engineering's assessment for the Bottom Ash Pond conducted in accordance with §257.60 through §257.64 and is accompanied by the required certifications by a qualified professional engineer.

SBMU-SPS is located west of the City of Sikeston, south of West Wakefield Avenue, and east of Route BB in Scott County, Missouri. The Bottom Ash Pond resides to the southeast of SPS, and directly south of SPS's coal pile and Fly Ash Pond (Appendix A - Figure 1).

The Bottom Ash Pond has a surface area of approximately 61 acres. According to the facility's construction record drawings, the berms were built with a crest elevation of 322 feet and capped with six inches of crushed rock. Sideslopes were graded to a 2:1 slope on both internal and external faces. The top-of-berm width is 20 feet on the eastern, southern and western sides of the Bottom Ash Pond. It is 25 feet wide on the northern side, where it abuts the coal storage area and the Fly Ash Pond. The finished subgrade elevation of the Bottom Ash Pond base was 300 feet. A section of Compress Road located within the footprint of the Bottom Ash Pond was removed during construction and dual culverts were installed between the eastern and western termination points of the road to convey stormwater run-on underneath the base of the Bottom Ash Pond. A two-foot-thick compacted clay liner was constructed on the floor and interior slopes. The bottom, interior, and exterior slopes of the pond berms were covered with four inches of topsoil, which was seeded, mulched and netted to protect against erosion. The construction record drawings therefore demonstrate that the base elevation of the Bottom Ash Pond is approximately 302 feet.

SPS and the Bottom Ash Pond are located at a transition between agricultural and urban areas. The Bottom Ash Pond is surrounded by residential, commercial, and agricultural areas. Residential areas are located approximately 150 feet east/southeast of the Bottom Ash Pond. Commercial areas are located approximately 700 feet south of the Bottom Ash Pond. The remaining area around the Bottom Ash Pond is agricultural land. There is City-owned property to the east, south, and west of the Bottom Ash Pond.

The Sikeston area is located in the Southeastern Lowland Province, a vast alluvial plain representing the northernmost point of the Mississippi River Embayment. Unlike other parts of the state, the geologic and hydrologic setting of the Southeastern Lowland Province is relatively straightforward. This is due to the relatively young geologic age of the region and to the consistency in depositional processes that have resulted in a thick accumulation of fluvial and deltaic sediments that range from Upper Mesozoic (Cretaceous) to Recent (Holocene) in age.



Groundwater movement within the unconfined alluvial aquifer underlying the Bottom Ash Pond is to the south and southwest flow toward Richland Drainage Ditch #4 (Appendix A - Figure 1), one of several north-south trending surface runoff control ditches in the area that flows to the south to a larger irrigation channel (Gredell Engineering, 2017). Movement is along a shallow hydraulic gradient estimated at between  $1.72 \times 10^{-4}$  to  $1.36 \times 10^{-3}$  ft./ft. Depth to the top of the water table varies from approximately 9 to 17 feet below ground surface, dependent on the topographic position of the monitoring well.

Unlike many coal-fired power plants, the Sikeston Power Station is not located adjacent to a major river (the Mississippi River is located approximately 16 miles northeast of the site). Therefore, short-term fluctuations or reversals in the water table surface due to river level changes do not occur. Rather, water levels in the alluvial aquifer fluctuate predominantly as a result of precipitation, which is the predominant source of recharge in the area (Miller and Vandike, 1997).

## 2.0 LOCATION RESTRICTIONS ASSESSMENT

The Federal CCR Rule requires a location restrictions assessment for existing CCR surface impoundments. The SBMU-SPS Bottom Ash Pond is an existing CCR surface impoundment. This location restrictions assessment documents the placement above the uppermost aquifer, wetlands, fault areas, seismic impact zones, and unstable areas. These assessments are described in the following subsections.

### 2.1 §257.60 Placement Above the Uppermost Aquifer

The pertinent parts of the Federal CCR Rule for placement above the uppermost aquifer are reiterated below and require the following:

*(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection 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). The owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer.*

*(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.*

*(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.*

*(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.*

*(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the internet requirements specified in §257.107(e).*

Evaluation: Gredell Engineering conducted an evaluation of the placement above the uppermost aquifer for the Bottom Ash Pond. The Bottom Ash Pond Groundwater Monitoring System consists of five wells, designated MW-3, MW-4, MW-5, MW-6, and MW-8 (Appendix A - Figure 2). MW-3 thru MW-6 were installed in April 2016 whereas MW-8 was installed in April 2017. Routine groundwater level measurements have been taken from these wells since installation. A summary of the static water levels from the uppermost aquifer for each well is depicted on the hydrograph presented in Appendix A as Figure 3. It shows the relationship between the recorded groundwater measurements in each well and the base of the CCR Unit. For most of the two-year monitoring period, a five-foot vertical separation is maintained between the uppermost aquifer

and the base of the CCR unit. However, during each of the three Spring seasons depicted on the hydrograph (2016, 2017, and 2018), groundwater levels in the two upgradient wells (MW-3 and MW-6) rise above the five-foot standard, with peak water levels rising to within approximately four feet of the base of the CCR unit. The estimated duration of these short-term seasonal cycles is between two and three months. The seasonal cycles of the recorded water levels represent a consistent pattern that is believed to be representative of future seasonal cycles.

The seasonal high water table portrayed on Figure 4 (Appendix A) is a summary of the data collected in May 2016, which represents the highest recorded groundwater levels for the uppermost aquifer. It demonstrates the extent to which groundwater in the uppermost aquifer has risen above the five-foot standard in the last three years of routine monitoring.

Based on the data presented and in accordance with §257.60(a) Placement Above the Uppermost Aquifer, it is concluded that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations, including the seasonal high water table.

## **2.2 §257.61 Wetlands**

The pertinent parts of the Federal CCR Rule for wetlands are reiterated below and require the following:

*(a) 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) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section.*

*(1) Where applicable under section 404 of the Clean Water Act or applicable state wetlands laws, a clear and objective rebuttal of the presumption that an alternative to the CCR unit is reasonably available that does not involve wetlands.*

*(2) The construction and operation of the CCR unit will not cause or contribute to any of the following:*

*(i) A violation of any applicable state or federal water quality standard;*

*(ii) A violation of any applicable toxic effluent standard or prohibition under section 307 of the Clean Water Act;*

*(iii) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973; and*

*(iv) A violation of any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.*

*(3) The CCR unit will not cause or contribute to significant degradation of wetlands by addressing all of the following factors:*

- (i) Erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the CCR unit;*
- (ii) Erosion, stability, and migration potential of dredged and fill materials used to support the CCR unit;*
- (iii) The volume and chemical nature of the CCR;*
- (iv) Impacts on fish, wildlife, and other aquatic resources and their habitat from release of CCR;*
- (v) The potential effects of catastrophic release of CCR to the wetland and the resulting impacts on the environment; and*
- (vi) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected.*

*(4) To the extent required under section 404 of the Clean Water Act or applicable state wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent reasonable as required by paragraphs (a)(1) through (3) of this section, then minimizing unavoidable impacts to the maximum extent reasonable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and reasonable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and*

*(5) Sufficient information is available to make a reasoned determination with respect to the demonstrations in paragraphs (a)(1) through (4) of this section.*

*(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.*

*(c) The owner or operator of the CCR unit must complete the demonstrations required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.*

*(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.*

*(d) The owner or operator must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the Internet requirements specified in §257.107(e).*

**Evaluation:** Gredell Engineering conducted an evaluation of the location restriction based on wetlands for the Bottom Ash Pond. To evaluate the location restriction, Gredell Engineering utilized the Missouri Department of Natural Resources (MDNR) National Pollutant Discharge Elimination Permit (Permit Number MO-0095575) which was reissued on March 28, 2018; the

United States Fish and Wildlife Service (U.S. Fish and Wildlife), National Wetlands Inventory; and U.S. Fish and Wildlife Endangered Species Inventory for Scott County.

Figure 1 in Appendix A is a map of the surrounding area to the SBMU facility. Using the U.S. Fish and Wildlife Wetlands Inventory, the locations of wetlands were identified and are depicted on Figure 5 in Appendix A. In addition to depicting locations, the Wetland Inventory also provides information on each of these symbols when the user clicks the symbol. The Bottom Ash Pond is identified as: "L1UBK", which is defined as Lacustrine, Subsystem Limnetic, indicating it has an unclassified bottom and is artificially flooded.

A Lacustrine System includes wetlands and deep water habitats with the following characteristics: 1) situated in a topographic depression; 2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens; and 3) has a total area of at least 20 acres. A Limnetic Subsystem includes all deep water habitats. An unclassified bottom includes deep water habitats with at least 25 percent (%) cover of particles smaller than stones (less than 6 to 7 centimeters), and a vegetative cover of less than 30%. Artificially Flooded indicates that the amount and duration of flooding are controlled by means of pumps or siphons in combination with dikes, berms or dams. The vegetation growing on these areas cannot be considered a reliable indicator of Water Regime. The Artificially Flooded Water Regime Modifier should not be used in the Riverine System or for impoundments or excavated wetland unless the inputs and outputs are controlled to achieve a specific depth and duration of flooding. The Bottom Ash Pond does not control the inputs and outputs to maintain a specific depth; therefore, it cannot be classified as a 'wetland'.

This description of the Bottom Ash Pond is consistent with the operation by SBMU of pumping sluiced bottom ash and water to an area that has a berm and returning process water for continued operation. The water level is inconsistent and potentially up to 16 feet in depth, which is incompatible with sustaining wetland growth. There is little to no cover, less than 30%, and the bottom ash pond is greater than 20 acres. Therefore, by classification, wetlands are not present in the area of the Bottom Ash Pond and the operation of the Bottom Ash Pond does not impact wetlands. Further, Gredell Engineering has not observed wetland plants during routine inspections.

In accordance with §257.61 Wetlands. (a)(1)(3)(4) and (5) the Bottom Ash Pond does not cause or contribute to significant degradation of wetlands. There will not be a net loss of wetlands or impacts to existing wetlands since wetlands are not present.

Using the U.S. Fish and Wildlife Information and Planning Consultation website, the area of the Bottom Ash Pond in Scott County, Missouri was evaluated for species listed under the Endangered Species Act which are identified as threatened and endangered. The following is a listing of the analysis presented:

- Mammals: Gray Bat, Indiana Bat, and Northern long-eared Bat; "There are no critical habitats at this location."
- Migratory Birds: Certain birds are protected under the Migratory Bird Treaty Act; "There are no migratory birds of conservation concern expected to occur at this location."

- Facilities: National Wildlife Refuge Lands; “There are no Refuge Lands at this location.”
- Fish Hatcheries: “There are no Fish Hatcheries at this location.”

In accordance with §257.61 Wetlands. (a)(2), based on this information, the Bottom Ash Pond does not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat.

SBMU-SPS operates under NPDES permit MO-0095575. The NDPEs permit process incorporates the requirements of the Clean Water Act and its subsection which are transferred by the United States Environmental Protection Agency to the State of Missouri which reviews those requirements in conjunction with Missouri State Water Quality Standards and issues a Missouri State Operating Permit under the Missouri Clean Water Law. Discharges from SBMU-SPS are controlled through outfall #003. The SBMU-SPS site is in compliance with the State of Missouri Operating Permit.

Figure 5 in Appendix A identifies the receiving stream; Richland Drainage Ditch #4, Ditch #4 (P) WBID #3046; located in United States Geological Service Basin Ash Slough Ditch 08020204-0604. The discharge from SBMU-SPS is in compliance with The Missouri State Operating Permit and does not impact fish, wildlife, and aquatic resources and their habitat as coal combustion residuals are not discharged above the permit limits.

The Marine Protection, Research, and Sanctuaries Act is not applicable to this site as the Act is directly applied to coastal facilities.

In accordance with §257.61 Wetlands. (a)(2) and (5), the Bottom Ash Pond does not cause or contribute to a violation of applicable state or federal water quality standards; a violation of applicable toxic effluent standards of the Clean Water Act; or violate the requirements of the Marine Protection, Research, and Sanctuaries Act. Therefore, the SBMU site meets the location restriction of §257.61 Wetlands.

### **2.3 §257.62 Fault Areas**

The pertinent parts of the Federal CCR Rule for fault areas are reiterated below and require the following:

*(a) 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.*

*(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.*

*(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.*

*(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.*

*(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the Internet requirements specified in §257.107(e).*

Evaluation: Gredell Engineering conducted an evaluation of the location restriction based on fault areas for the Bottom Ash Pond. To evaluate the location restriction, Gredell Engineering utilized the Missouri Department of Natural Resources (MDNR) Geosciences Technical Resource Assessment Tool (GeoSTRAT). The Missouri Geological Survey (MGS) has collected geologic data in Missouri for over 165 years. The MGS developed this web-based, interactive tool in order to provide on-line information and make that data accessible at all times to citizens, city planners, industry representatives, academia and others. GeoSTRAT can be used for data assessments in various disciplines such as hazards assessment, environmental consulting and engineering, local and regional planning, insurance assessment and others.

Appendix A - Figure 6 is an area map of the surrounding area to the SBMU facility developed using GeoSTRAT to depict the locations of faults and structural folds in relation to the site. In addition to depicting locations, GeoSTRAT also provides information on each of these symbols when the user left clicks the symbol. The northeast trending feature located to the south of the SBMU facility is the approximate northwest boundary of the Reelfoot Rift. The northeast trending feature located north of the SBMU facility is the Commerce Fault.

Both of these faults are associated with the New Madrid Seismic Zone (NMSZ) which covers parts of Arkansas, Illinois, Kentucky, Missouri, and Tennessee. The NMSZ is approximately 125 miles long and contains multiple faults that extend from Marked Tree, Arkansas, to Cairo, Illinois. More than 200 microseismic (magnitude less than 1.0 to about 2.0) earthquakes occur in the region each year, but most are of insufficient magnitude to be felt by humans.

The Commerce Fault is located approximately eight miles northwest of the SBMU facility and the Reelfoot Rift boundary is located approximately thirteen miles southeast of the site.

In accordance with §257.62(a) Fault Areas, these distances indicate the SBMU facility meets the location restriction criteria, and is located outside the required distance of 60 meters (200 feet) from the outermost damage zone of these faults.

## **2.4 §257.63 Seismic Impact Zones**

The pertinent parts of the Federal CCR Rule for seismic impact zones are reiterated below and require the following:

*(a) 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 resist the maximum horizontal acceleration in lithified earth material for the site.*

*(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.*

*(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.*

*(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.*

*(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the Internet requirements specified in §257.107(e).*

Evaluation: Gredell Engineering conducted an evaluation of the location restriction based on seismic impact zones for the Bottom Ash Pond. To evaluate the location, Gredell Engineering accessed the United States Geological Survey (USGS) National Seismic Hazard Maps website. Data and maps are available for download of the most recent long-term model update (Petersen et al., 2014).

§257.53 Definitions: 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 0.10 g in 50 years.

Appendix A - Figure 7 is a map of the surrounding area to the SBMU facility which incorporates data obtained from the USGS website indicating the facility is located in an area of chronic seismic activity known as the New Madrid Seismic Zone (NMSZ). This seismic activity is embedded in deeply buried Paleozoic and Precambrian basement rocks and reflects the vestiges of a failed rift system believed related to the early Pennsylvanian (Morrowan-Atokan) Oklahoma Aulocogen (e.g. Houseknecht, 1983). Spasmodic earthquakes generally of low magnitude (<2.0 Richter Scale) are therefore common and it is because of the seismic activity that the region is considered part of a seismic impact zone.

§257.63 states in part; “(a) 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 resist the maximum horizontal acceleration in lithified earth material for the site.”



There have been multiple geologic and geotechnical investigations completed at the SBMU that relate to seismic considerations. They are listed as follows:

- Burns & McDonnell (1977). *Report of Preliminary Subsurface Investigation for Board of Municipal Utilities, Sikeston, Missouri, 76-076-1*. (This is the original investigation for construction of the power station.)
- O'Brien & Gere Engineers (2010). *Dam Safety Assessment of CCW Impoundments, Sikeston Power Station*, a report to the U.S. EPA.
- Geotechnology (2011). *Global Stability Evaluation, Fly Ash and Bottom Ash Ponds, Sikeston Power Station, Sikeston, Missouri*, a report for Sikeston BMU.
- Haley & Aldrich (2016). *Detailed Initial Safety Factor Assessment, Sikeston Power Station, Bottom Ash Pond, Sikeston, Missouri*, a report for Sikeston BMU.

The Haley & Aldrich (2016) reference included a seismic evaluation as part of their safety factor assessment specifically for the Bottom Ash Pond. Data obtained during both the Burns & McDonnell (1977) subsurface investigation and the Geotechnology (2011) stability evaluation were used in conjunction with new data from field work conducted as part of their assessment. Haley and Aldrich contracted with the University of Memphis Center for Earthquake Research and Information to conduct a seismic survey to characterize shear wave velocity of subsurface soils at the site and develop a shear wave velocity profile for use in seismic response analysis and liquefaction evaluation.

The results of the Haley and Aldrich (2016) seismic response analysis indicated that the calculated site-specific peak ground acceleration (PGA) for a 2,500-year event ranges from 0.30g to 0.73g for top of bedrock and from 0.37g to 0.50g at the ground surface. Using these values, a Newmark displacement analysis was performed by Haley and Aldrich and the most conservative location of the failure plane was determined to be 10 to 12 feet below the top of slope for a magnitude 8 event. Materials used for construction of the pond embankments are susceptible to liquefaction if saturated. However, the groundwater table is located approximately 5 or more feet below the base of the embankments, which prevents them from being saturated, and therefore they are not susceptible to liquefaction.

The required safety factor for the Bottom Ash Pond in drained static condition is 1.5, in undrained static condition is 1.4, and for undrained, 2,500-year seismic condition is 1.0. The calculated safety factors for each of these conditions were 2.1, 2.5, and 1.2 respectively. The Haley and Aldrich (2016) report concludes that all required factors of safety were exceeded.

In accordance with §257.63(a) Seismic Impact Zones, based on the evidence provided above, Gredell Engineering concludes that the demonstration has been made by recent past analysis by others that all structural components are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

## 2.5 §257.64 Unstable Areas

The pertinent parts of the Federal CCR Rule for unstable areas are reiterated below and require the following:

*(a) 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.*

*(b) 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).*

*(c) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.*

*(d) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (d)(1) or (2) of this section.*

*(1) For an existing CCR landfill or existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.*

*(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the Internet requirements specified in §257.107(e).*

Evaluation: Gredell Engineering conducted an evaluation of the location restriction based on unstable areas for the Bottom Ash Pond. To evaluate the location restriction, Gredell Engineering utilized the Missouri Department of Natural Resources (MDNR) Geosciences Technical Resource Assessment Tool (GeoSTRAT). The Missouri Geological Survey (MGS) has collected geologic data in Missouri for over 165 years. The MGS developed this web-based, interactive tool in order to provide on-line information and make that data accessible at all times to citizens, city planners, industry representatives, academia and others. GeoSTRAT can be used for data assessments in various disciplines such as hazards assessment, environmental consulting and engineering, local and regional planning, insurance assessment and others.

Appendix A - Figure 8 is a map of the surrounding area to the SBMU facility developed using GeoSTRAT to depict the locations of features that may indicate unstable areas. Losing and gaining streams are often associated with a karst topography. The presence of springs may also be an indicator of a karst area. Sinkholes are often surface expressions of collapse features created from solution desiccation of the bedrock below the surface.

All of these features are co-located in an area of the map northwest of the SBMU facility associated with the increased density of caves. The southern boundary of cave density occurrence on this figure is a northeast trending line located approximately 20 miles from SBMU-SPS.

Not all indicators of unstable areas are naturally occurring. Mining activities below a site may also be responsible for sinkholes and losing streams. The depiction of mining activity on the map indicates a series of locations in a north-south orientation along Interstate I-55 to the east of the SBMU facility. In addition to depicting locations, GeoSTRAT also provides information on each of these symbols when the user left clicks the symbol. Each of these symbols located east of the site indicate they are sand and gravel open pit mines which do not affect the subsurface or create an unstable area below the site.

In accordance with §257.64(a) Unstable Areas, the information presented above indicates the Bottom Ash Pond is not located in an unstable area based on data obtained from GeoSTRAT and site specific information recorded on logs of borings and excavations located around the perimeter of the Bottom Ash Pond.

### **3.0 MISCELLANEOUS REQUIREMENTS**

§257.60(d), §257.61(d), §257.62(d), §257.63(d) and §257.64(d) state that SBMU must comply with:

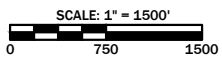
- The recordkeeping requirements specified in §257.105(e);
- The notification requirements specified in §257.106(e), and;
- The Internet requirements specified in §257.107(e).

## 4.0 REFERENCES

- Burns & McDonnell, 1977, Report of Preliminary Subsurface Investigation for Board of Municipal Utilities, Sikeston, Missouri (Investigation No.76- 076-1).
- Geotechnology, 2011, Global Stability Evaluation, Fly Ash and Bottom Ash Ponds, Sikeston Power Station, Sikeston, Missouri (a report for Sikeston BMU).
- GREDELL Engineering Resources, Inc., 2017, Sikeston Power Station Site Characterization for Compliance with Missouri State Operating Permit #MO-0095575, May 2017.
- Haley & Aldrich, 2016, Detailed Initial Safety Factor Assessment, Sikeston Power Station, Bottom Ash Pond, Sikeston, Missouri (a report for Sikeston BMU).
- Houseknecht, D. W., 1983, Tectonic-Sedimentary Evolution of the Arkoma Basin: Society of Economic Paleontologists and Mineralogists Mid-Continent Section (Vol. 1).
- Miller, D.E. and Vandike, J.E., 1997, *Groundwater Resources of Missouri*: Missouri Department of Natural Resources, Division of Geology and Land Survey, Water Resources Report 46, 210 p.
- Missouri Department of Natural Resources, 2010, Geologic Structures in Missouri Geological Survey Geosciences Technical Resource Assessment Tool (GeoSTRAT). Missouri Department of Natural Resources, Missouri Geological Survey. Retrieved from <http://dnr.mo.gov/geostrat/>. Accessed 8/27/2018.
- Missouri Department of Natural Resources, 2015, Losing-Gaining Streams; 2010, Springs; 2006, Cave Density; 2014, Sinkhole Points; 2017, Inventory of Mines; in Missouri Geological Survey Geosciences Technical Resource Assessment Tool (GeoSTRAT). Missouri Department of Natural Resources, Missouri Geological Survey. Retrieved from <http://dnr.mo.gov/geostrat/>. Accessed August 23, 2018.
- Missouri Department of Natural Resources, 2018, Missouri State Operating Permit for Sikeston Board of Municipal Utilities (Operating Permit MO-0095575). State of Missouri, Missouri Clean Water Commission.
- O'Brien & Gere Engineers, 2010, Dam Safety Assessment of CCW Impoundments, Sikeston Power Station (a report to the U.S. EPA).
- Petersen, M. D., Moschetti, M. P., Powers, P. M., Mueller, C. S., Haller, K. M., Frankel, A. D., Olsen, A. H., et al., 2014, Documentation for the 2014 update of the United States national seismic hazard maps (USGS Numbered Series No. 2014-1091) (p. 255). Reston, VA: U.S. Geological Survey. Retrieved from <http://pubs.er.usgs.gov/publication/ofr20141091>.
- U.S. Fish and Wildlife Service, 2018, National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Retrieved from <http://www.fws.gov/wetlands/>.
- U.S. Army Corp Engineer Research and Development Center, 2010, Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0) (Technical Report). Vicksburg, MS: U.S. Army Corps of Engineers, Waterways Experiment Station, Wetlands Research Program.
- U.S. Fish and Wildlife Service, 2018, Information for Planning and Consulting (IPaC). Environmental Conservation Online System, U.S. Fish and Wildlife Service.

# APPENDIX A

Figures



**SIKESTON POWER STATION  
LOCATION RESTRICTIONS  
AERIAL**

**GREDELL Engineering Resources, Inc.**

**ENVIRONMENTAL ENGINEERING LAND - AIR - WATER**

1505 East High Street  
Jefferson City, Missouri

Telephone: (573) 659-9078  
Facsimile: (573) 659-9079

MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

**FIGURE 1 - AERIAL VIEW**

DATE 10/2018	SCALE AS NOTED	PROJECT NAME SIKESTON	REVISION
DRAWN CP	APPROVED JB	FILE NAME LOCATION RESTRICTION	SHEET # 1 OF 1



**LEGEND**

PROPERTY LINE  
(APPROXIMATE)



MONITORING WELL



UP GRADIENT  
MONITORING LOCATION

UG

DOWN GRADIENT  
MONITORING LOCATION

DG

**NOTES:**

1. IMAGE PROVIDED BY BING MAPS.
2. MONITORING WELL LOCATIONS/ELEVATIONS SURVEYED BY BOWEN ENGINEERING & SURVEYING.

**SIKESTON POWER STATION  
LOCATION RESTRICTIONS - PLACEMENT  
ABOVE THE UPPERMOST AQUIFIER**

**GREDELL Engineering Resources, Inc.**

**ENVIRONMENTAL ENGINEERING LAND - AIR - WATER**

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Jefferson City, Missouri

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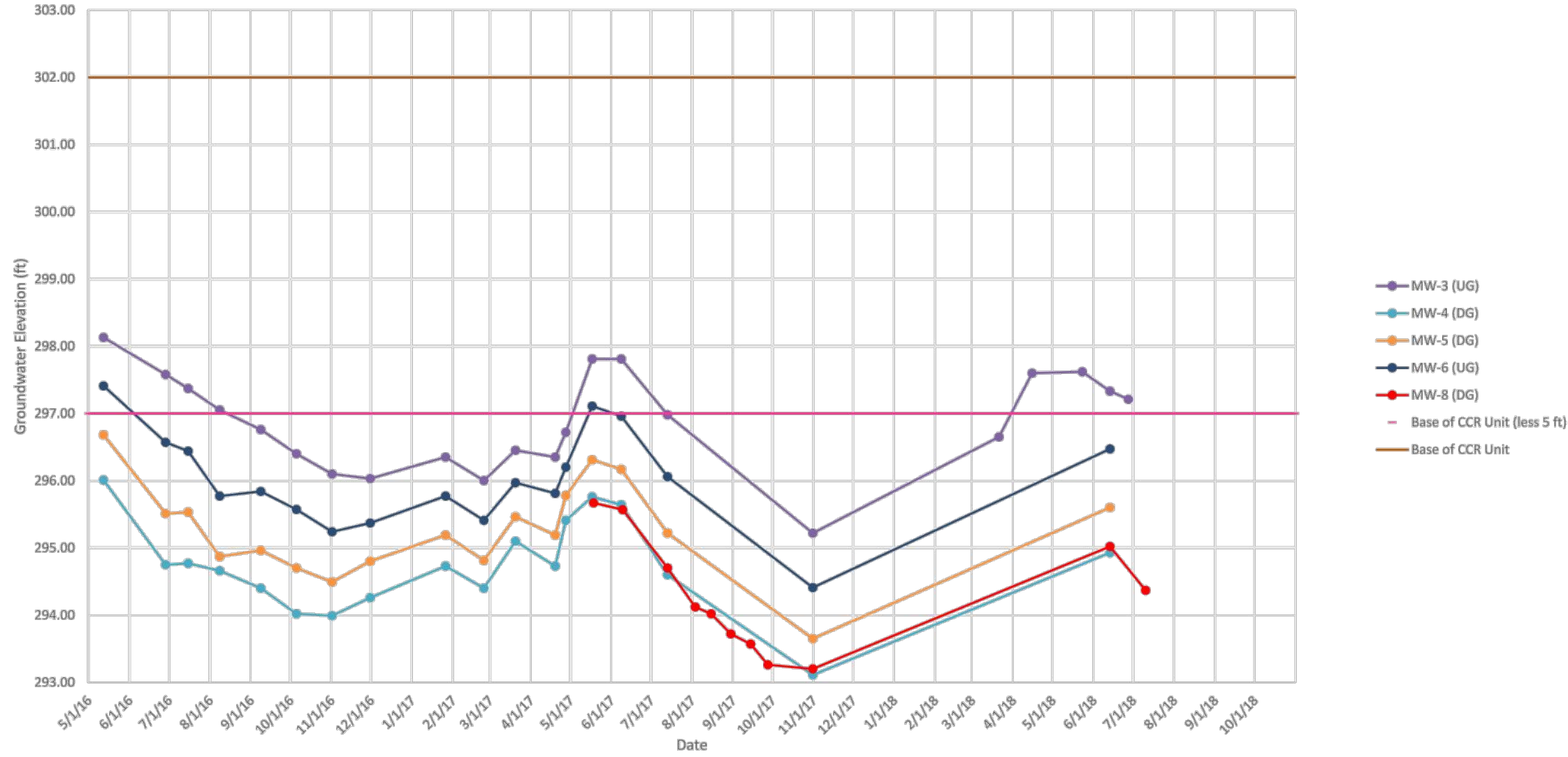
**FIGURE 2 - BOTTOM ASH POND  
MONITORING WELL NETWORK**

DATE	SCALE	PROJECT NAME	REVISION
10/2018	AS NOTED	SIKESTON	
DRAWN CP	APPROVED MCC	FILE NAME LOCATION RESTRICTION	SHEET # 1 OF 1



M:\5187\CAD\DWG\SIEKSTON\LOCATION RESTRICTIONS\CCR GW MON SYS - BAP\DWG-FIGURE 2 - GROUNDWATER MONITORING SYSTEM HYDROGRAPHS 9/28/2018 11:24:59 AM

**CCR Groundwater Monitoring System - Bottom Ash Pond  
Sikeston Power Station  
Sikeston, Missouri  
Monitoring Well Hydrographs**



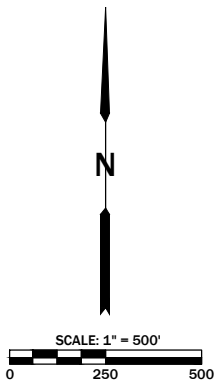
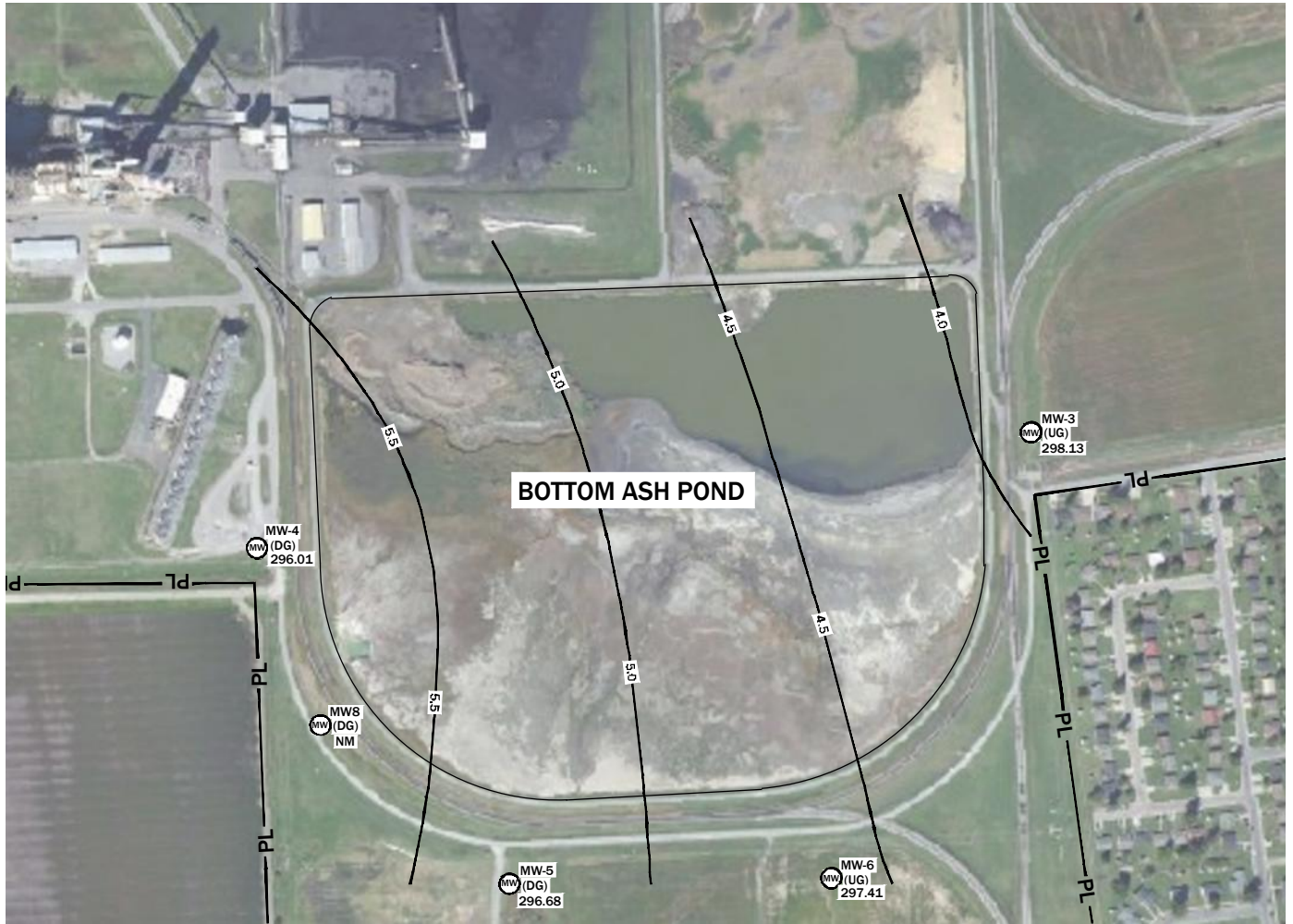
**GREDELL Engineering Resources, Inc.**  
 ENVIRONMENTAL ENGINEERING LAND - AIR - WATER  
 1505 East High Street  
 Jefferson City, Missouri  
 Telephone: (573) 659-9078  
 Facsimile: (573) 659-9079  
 MO CORP. ENGINEERING LICENSE NO. E-20010016690

**SIKESTON POWER STATION  
LOCATION RESTRICTIONS  
PLACEMENT ABOVE THE  
UPPERMOST AQUIFER**

**FIGURE 3 - GROUNDWATER  
MONITORING SYSTEM  
HYDROGRAPHS**

#	DATE	REVISION DESCRIPTION	BY

SURVEYED	DESIGNED	DRAWN	CHECKED	APPROVED	DATE	SCALE	FILE NAME	SHEET #
NA	NA	CP	MC	MCC	10/2018	AS NOTED	SIEKSTON	1 OF 1
							LOCATION RESTRICTION	



**LEGEND**

- PROPERTY LINE (APPROXIMATE) — PL —
- VERTICAL SEPARATION ISOPACH (BASED ON 5-12-16 MEASUREMENTS) — 5.0 —
- NOT MEASURED NM
- MONITORING WELL (MW)
- UP GRADIENT MONITORING LOCATION UG
- DOWN GRADIENT MONITORING LOCATION DG

**NOTES:**

1. IMAGE PROVIDED BY BING MAPS.
2. MONITORING WELL LOCATIONS/ELEVATIONS SURVEYED BY BOWEN ENGINEERING & SURVEYING.
3. GROUNDWATER ELEVATION MEASUREMENTS BY GREDELL ENGINEERING RESOURCES ON 5-12-16.
4. MAP DEVELOPMENT BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.

**SIKESTON POWER STATION  
LOCATION RESTRICTIONS - PLACEMENT  
ABOVE THE UPPERMOST AQUIFER**

**GREDELL Engineering Resources, Inc.**

**ENVIRONMENTAL ENGINEERING LAND - AIR - WATER**

1505 East High Street  
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Telephone: (573) 659-9078  
Facsimile: (573) 659-9079

MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

**FIGURE 4 - VERTICAL SEPARATION ISOPACH MAP**

DATE 10/2018	SCALE AS NOTED	PROJECT NAME SIKESTON	REVISION
DRAWN CP	APPROVED MCC	FILE NAME LOCATION RESTRICTION	SHEET # 1 OF 1



September 20, 2018

**Wetlands**

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond

- Lake
- Other
- Riverine



N.T.S.

**NOTES:**

1. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
2. ALL BOUNDARIES ARE APPROXIMATE.

**SIKESTON POWER STATION  
LOCATION RESTRICTIONS  
WETLANDS**

**GREDELL Engineering Resources, Inc.**

**ENVIRONMENTAL ENGINEERING LAND - AIR - WATER**

1505 East High Street  
Jefferson City, Missouri

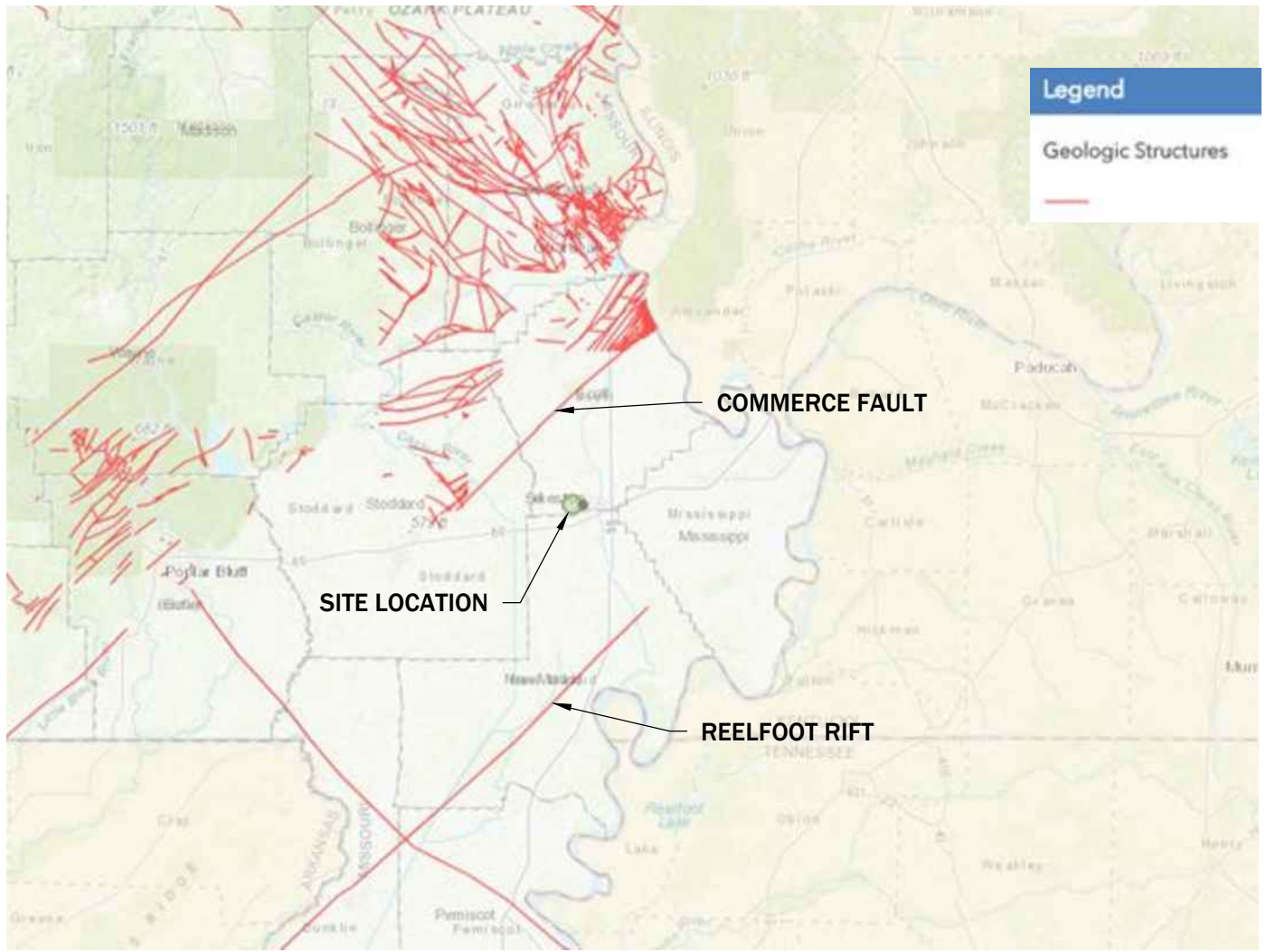
Telephone: (573) 659-9078  
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MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

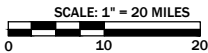
**FIGURE 5 - WETLANDS  
INVENTORY MAP**

DATE	SCALE	PROJECT NAME	REVISION
10/2018	AS NOTED	SIKESTON	
DRAWN FML	APPROVED MCC	FILE NAME LOCATION RESTRICTION	SHEET # 1 OF 1

M:\Share\CADDFiles\SIKESTON\LOCATION RESTRICTIONS\GEOLOGIC STRUCTURE.dwg, FIGURE 1 - FAULT LOCATION MAP, 9/28/2018 11:24:14 AM



SOURCE: GEOSTRAT (2018)



**SIKESTON POWER STATION  
LOCATION RESTRICTIONS  
FAULT AREAS**

**GREDELL Engineering Resources, Inc.**

**ENVIRONMENTAL ENGINEERING LAND - AIR - WATER**

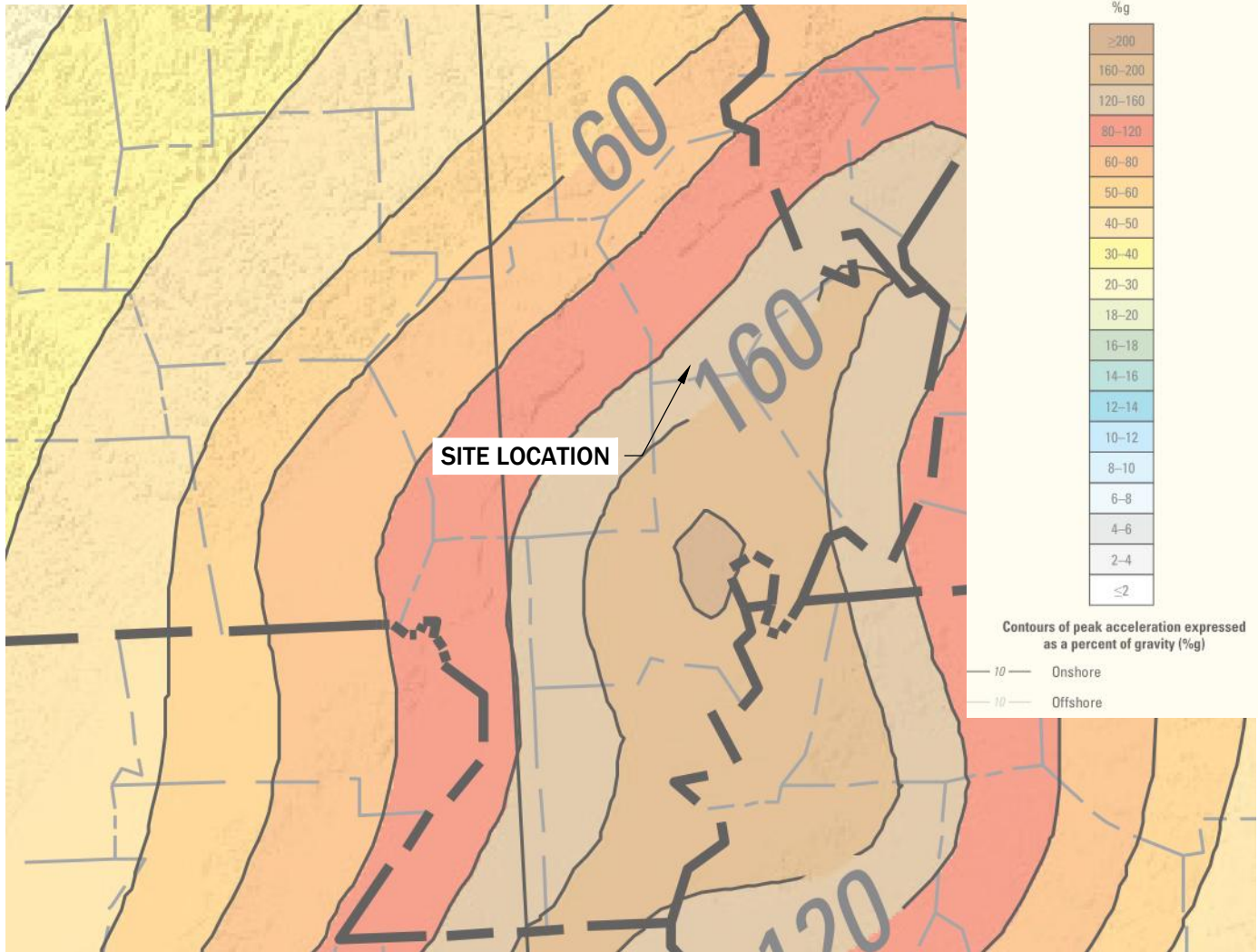
1505 East High Street  
Jefferson City, Missouri

Telephone: (573) 659-9078  
Facsimile: (573) 659-9079

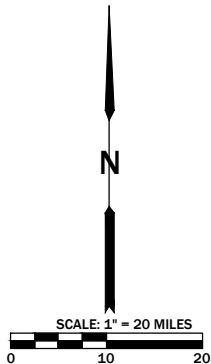
MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

**FIGURE 6 - FAULT LOCATION MAP**

DATE 10/2018	SCALE AS NOTED	PROJECT NAME SIKESTON	REVISION
DRAWN CP	APPROVED MCC	FILE NAME LOCATION RESTRICTION	SHEET # 1 OF 1



SOURCE : PETERSEN ET AL. (2015)



**NOTES:**

- MAP DEPICTS PEAK HORIZONTAL ACCELERATION WITH 2% PROBABILITY OF EXCEEDANCE IN 50 YEARS.

**SIKESTON POWER STATION  
LOCATION RESTRICTIONS  
SEISMIC IMPACT ZONES**

**GREDELL Engineering Resources, Inc.**

**ENVIRONMENTAL ENGINEERING LAND - AIR - WATER**

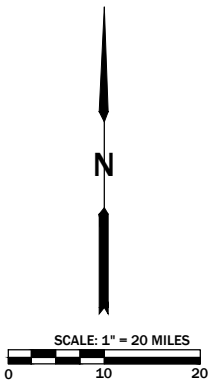
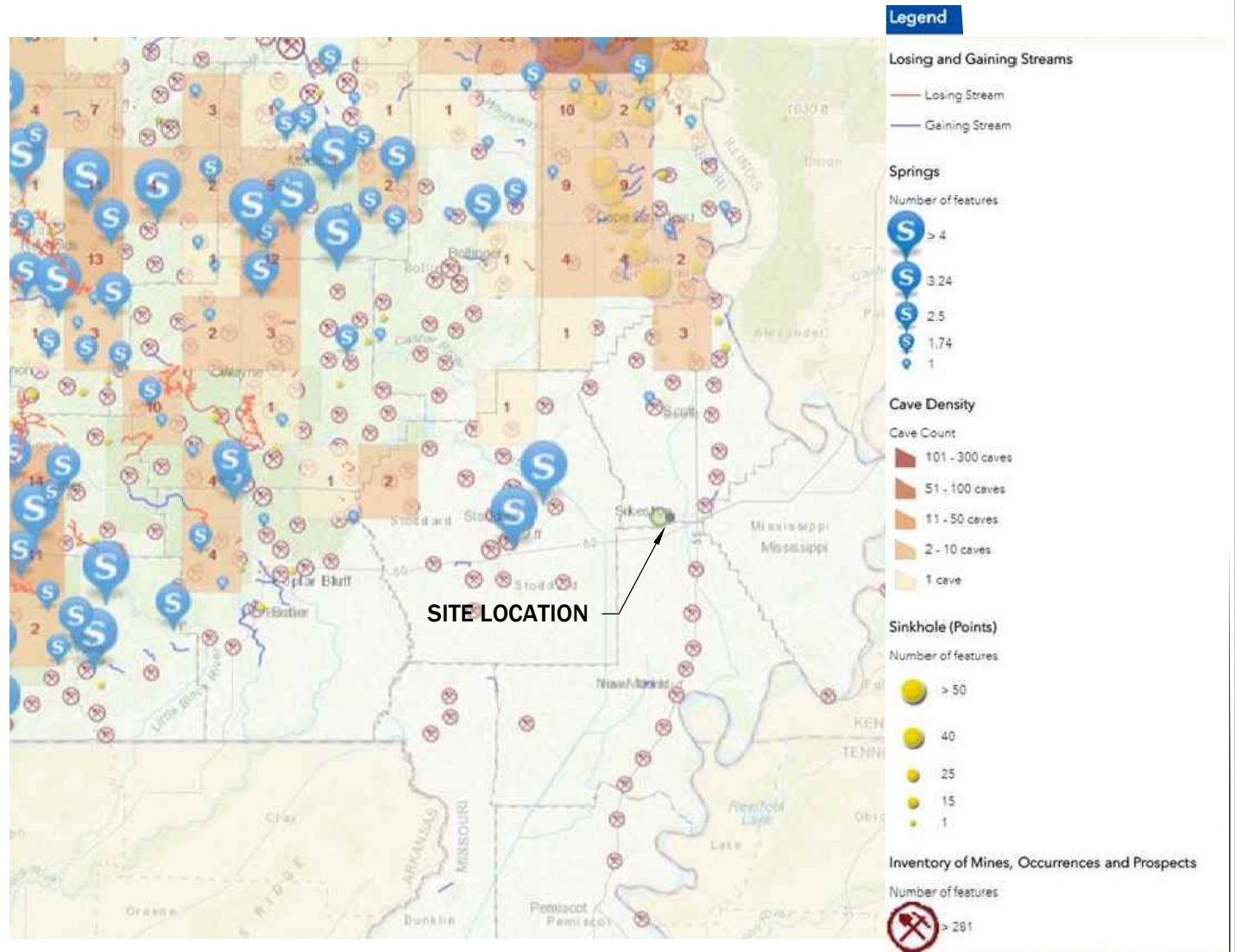
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**FIGURE 7 - SEISMIC IMPACT ZONE  
LOCATION MAP**

DATE	SCALE	PROJECT NAME	REVISION
10/2018	AS NOTED	SIKESTON	
DRAWN CP	APPROVED MCC	FILE NAME LOCATION RESTRICTION	SHEET # 1 OF 1



**SIKESTON POWER STATION  
LOCATION RESTRICTIONS  
UNSTABLE AREAS**

**GREDELL Engineering Resources, Inc.**

**ENVIRONMENTAL ENGINEERING LAND - AIR - WATER**

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Jefferson City, Missouri

Telephone: (573) 659-9078  
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**FIGURE 8 - UNSTABLE FEATURES MAP**

DATE 10/2018	SCALE AS NOTED	PROJECT NAME SIKESTON	REVISION
DRAWN CP	APPROVED MCC	FILE NAME LOCATION RESTRICTION	SHEET # 1 OF 1