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2018 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
ASH POND SYSTEM
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

by Haley & Aldrich, Inc.
Cleveland, Ohio

for Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 128064-006
January 2019

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1/31/2019
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1. Introduction

This 2018 Annual Groundwater Monitoring and Corrective Action Report (Annual Report) addresses the Ash Pond System at the Thomas Hill Energy Complex (THEC), operated by the Associated Electric Cooperative, Inc. (AECI). This Annual Report was developed in accordance with the United States Environmental Protection Agency Coal Combustion Residual (CCR) Rule effective 19 October 2015 (Rule), specifically Code of Federal Regulations Title 40 (40 CFR), subsection § 257.90(e). The Annual Report documents the groundwater monitoring system for the Ash Pond System consistent with applicable sections of § 257.90 through 257.98, and describes activities conducted in the prior calendar year (2018) and documents compliance with the Rule. The specific requirements listed in § 257.90(e)(1)-(5) of the Rule are provided in Section 2 of this Annual Report and are in bold italic font, followed by a short narrative describing how each Rule requirement has been met.

2. 40 CFR § 257.90 Applicability

2.1 40 CFR § 257.90(a)

Except as provided for in §257.100 for inactive CCR surface impoundments, all CCR landfills, CCR surface impoundments, and lateral expansions of CCR units are subject to the groundwater monitoring and corrective action requirements under §257.90 through 257.98.

AECI has installed and certified a groundwater monitoring system multi-unit groundwater monitoring system at the Cell 001, Cell 003, and Cell 004 (Ash Pond System) at the THEC. The THEC Ash Pond System is subject to the groundwater monitoring and corrective action requirements described under 40 CFR § 257.90 through 257.98. This document addresses the requirement for the Owner/Operator to prepare an Annual Report per § 257.90(e) (Rule).

2.2 40 CFR § 257.90(e) – SUMMARY

Annual groundwater monitoring and corrective action report. For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by §257.105(h)(1).

This Annual Report describes monitoring completed and actions taken at the THEC Ash Pond System as required by the Rule. Groundwater sampling and analysis was conducted in accordance with requirements described in § 257.93, and the status of the groundwater monitoring program described in § 257.94 and § 257.95 is also provided in this report. This Annual Report documents the activities completed in the calendar year 2018.

2.2.1 Status of the Groundwater Monitoring Program

Statistical analyses completed in January 2018 using detection monitoring analytical data received in October 2017 showed a statistically significant increase (SSI) above background concentrations of boron, sulfate, and total dissolved solids at wells MW-3, MW-5, and MW-6. An alternative source demonstration (ASD) was completed and certified on 15 April 2018, which is within 90 days of the completion of statistical analyses that indicated the SSI. The ASD demonstrated that the SSI was the result of natural variability of groundwater quality. Because the ASD was completed and certified within 90 days of the SSI being identified, the Ash Pond System remained in the detection monitoring program.

2.2.2 Key Actions Completed

The 2017 Annual Groundwater Monitoring and Corrective Action Report was completed in January 2018. Statistical analysis was completed in January 2018 on analytical data from the first detection monitoring sampling event (laboratory data finalized in October 2017). A successful Alternate Source Demonstration was completed for all SSIs. The first semi-annual detection monitoring event including sampling and laboratory analyses was completed in April 2018. It was determined that a sampling error occurred in the February 2018 sampling event, and a re-sampling event was completed in May 2018. Statistical analysis was completed within 90 days of receipt of finalized laboratory data. No SSIs were determined for this sampling event. The second semi-annual detection monitoring sampling and final laboratory analyses were completed in October 2018. Statistical analysis of the results from the second semi-annual detection monitoring sampling event are due to be completed in January 2019 and will be reported in the next annual report.

2.2.3 Problems Encountered

One problem (i.e., problems could include damaged wells, issues with sample collection or lack of sampling, and problems with analytical analysis) was encountered at the THEC Ash Pond System in 2018. It was determined that a sampling error occurred in the first semi-annual detection monitoring sampling event in February 2018, and a re-sampling event was completed in May 2018.

2.2.4 Actions to Resolve Problems

No problems were encountered at the THEC Ash Pond System in 2018; therefore, no actions to resolve problems were required.

2.2.5 Project Key Activities for Upcoming Year

Key activities to be completed in 2019 include statistical analysis of detection monitoring analytical data from October 2018 and conducting semi-annual detection monitoring and subsequent statistical analysis.

2.3 40 CFR § 257.90(e) – INFORMATION

At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available:

2.3.1 40 CFR § 257.90(e)(1)

A map, aerial image, or diagram showing the CCR unit and all background (or up gradient) and down gradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit;

As required by § 257.90(e)(1), a map showing the locations of the CCR unit and associated upgradient and downgradient monitoring wells for the Ash Pond System is included in this report as Figure 1. In addition, this information is presented in the CCR Groundwater Monitoring Network Description Report prepared for AECI, which was placed in the facility's operating record by 17 October 2017 as required by § 257.105(h)(2).

2.3.2 40 CFR § 257.90(e)(2) – Monitoring System Changes

Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

No monitoring wells were installed or decommissioned during 2018.

2.3.3 40 CFR § 257.90(e)(3) – Summary of Sampling Events

In addition to all the monitoring data obtained under §257.90 through §257.98, a summary including the number of groundwater samples that were collected for analysis for each background and down gradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs;

In accordance with § 257.94(b), three independent detection monitoring samples from each background and downgradient monitoring well were collected in 2018. Detection monitoring samples are summarized in Table I. Table I includes the sample names, sample dates, and analytical results.

2.3.4 40 CFR § 257.90(e)(4) – Monitoring Transition Narrative

A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels); and

Initial detection monitoring statistical analyses were completed in January 2018 in accordance with § 257.94(b). The analyte concentrations from the downgradient wells for each of the Appendix III constituents from the 2017 detection monitoring sampling event from each location were compared to their respective prediction limit (PL). A sample concentration greater than the PL is considered to represent a SSI. A SSI over background levels for one or more constituents listed in Appendix III were identified. A summary of the Appendix III SSIs identified in January 2018 is provided in Table II.

A successful demonstration that a source other than the CCR unit caused the SSI over background levels was completed within 90 days of the SSI determination in accordance with 40 CFR §257.94(e)(2), and the Ash Pond System remained in detection monitoring.

2.3.5 40 CFR § 257.90(e)(5) – Other Requirements

Other information required to be included in the annual report as specified in §257.90 through §257.98.

This Annual Report documents activities conducted to comply with § 257.90 through § 257.95 of the Rule. It is understood that there are supplemental references in § 257.90 through § 257.98 to information that must be placed in the Annual Report. The following requirements include relevant and required information in the Annual Report for relevant activities completed in calendar year 2018.

2.3.5.1 40 CFR § 257.94(d)(3) – Demonstration for Alternative Detection Monitoring Frequency

The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration for an alternative groundwater sampling and analysis frequency meets the requirements of this section. The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer or the approval from the Participating State Director or approval from EPA where EPA is the permitting authority in the annual groundwater monitoring and corrective action report required by § 257.90(e).

An alternative groundwater detection monitoring sampling and analysis frequency has not been established for this CCR unit; therefore, no demonstration or certification is required at this time.

2.3.5.2 40 CFR § 257.94(e)(2) – Detection Monitoring Alternate Source Demonstration

The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority verifying the accuracy of the information in the report. If a successful demonstration is completed within the 90-day period, the owner or operator of the CCR unit may continue with a detection monitoring program under this section. If a successful demonstration is not completed within the 90-day period, the owner or operator of the CCR unit must initiate an assessment monitoring program as required under § 257.95. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority.

An ASD was completed and certified on 15 April 2018, which is within 90 days of the completion of statistical analyses that indicated the Appendix III SSI. Since the ASD was completed and certified by a qualified professional engineer within 90 days of the SSI being identified, the Ash Pond System remained in the detection monitoring program. The ASD is included as Attachment 1 to this report.

2.3.5.3 40 CFR § 257.95(c)(3) – Demonstration for Alternative Assessment Monitoring Frequency

The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration for an alternative groundwater sampling and analysis frequency meets the requirements of this section. The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer or the approval from the Participating State Director or approval from EPA where EPA is the permitting authority in the annual groundwater monitoring and corrective action report required by § 257.90(e).

An alternative groundwater assessment monitoring sampling and analysis frequency has not been established for this CCR unit; therefore, no demonstration or certification is required at this time.

2.3.5.4 40 CFR § 257.95(d)(3) – Assessment Monitoring Concentrations and Groundwater

Include the recorded concentrations required by paragraph (d)(1) of this section, identify the background concentrations established under § 257.94(b), and identify the groundwater protection standards established under paragraph (d)(2) of this section in the annual groundwater monitoring and corrective action report required by § 257.90(e).

The Ash Pond System has not transitioned into assessment monitoring, and no assessment monitoring samples were collected or analyzed in 2018. Consequently, AECI is not required to establish groundwater protection standards for this CCR unit and this criterion is not applicable to the unit at this time.

2.3.5.5 40 CFR § 257.95(g)(3)(ii) – Assessment Monitoring Alternate Source Demonstration

Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section and may return to detection monitoring if the constituents in appendices III and IV to this part are at or below background as specified in paragraph (e) of this section. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer or the approval from the Participating State Director or approval from EPA where EPA is the permitting authority.

Assessment monitoring statistical analyses were not completed in 2018. Therefore, this criterion is not applicable to the unit at this time.

2.3.5.6 40 CFR § 257.96(a) – Demonstration for Additional Time for Assessment of Corrective Measures

Within 90 days of finding that any constituent listed in appendix IV to this part has been detected at a statistically significant level exceeding the groundwater protection standard defined under § 257.95(h), or immediately upon detection of a release from a CCR unit, the owner or operator must initiate an assessment of corrective measures to prevent further releases, to remediate any releases and to restore affected area to original conditions. The assessment of corrective measures must be completed within 90 days, unless the owner or operator demonstrates the need for additional time to complete the assessment of corrective measures due to site-specific conditions or circumstances. The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority attesting that the demonstration is accurate. The 90-day deadline to complete the assessment of corrective

measures may be extended for no longer than 60 days. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by § 257.90(e), in addition to the certification by a qualified professional engineer or the approval from the Participating State Director or approval from EPA where EPA is the permitting authority.

Assessment monitoring statistical analyses were not completed in 2018. Therefore, this criterion is not applicable to the unit at this time.

2.4 40 CFR § 257.90(f)

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

In order to comply with the Rule recordkeeping requirements, the following actions must be completed:

- Pursuant to § 257.105(h)(1), this Annual Report must be placed in the facility's operating record.
- Pursuant to § 257.106(h)(1), notification must be sent to the relevant State Director and/or Tribal authority within 30 days of this Annual Report being placed on the facility's operating record [§ 257.106(d)].
- Pursuant to § 257.107(h)(1), this Annual Report must be posted to the AECI CCR website within 30 days of this Annual Report being placed on the facility's operating record [§ 257.107(d)].

TABLES

TABLE I
SUMMARY OF ANALYTICAL RESULTS
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
ASH POND SYSTEM
CLIFTON HILL, MISSOURI

Location	Upgradient						Downgradient											
	MW-1			MW-2R			MW-3			MW-4			MW-5			MW-6		
Measure Point (TOC)	746.94			779.96			692.190			683.48			687.53			705.05		
Sample Name	MW1	MW-1-052318	MW-1	MW2R	MW-2R-052318	MW-2R	MW3	MW-3-052318	MW-3	MW4	MW-4-052318	MW-4	MW5	MW-5-052318	MW-5	MW6	MW-6-052318	MW-6
Sample Date	2/27/2018	5/23/2018	9/10/2018	2/27/2018	5/23/2018	9/10/2018	2/27/2018	5/23/2018	9/10/2018	2/27/2018	5/23/2018	9/10/2018	2/27/2018	5/23/2018	9/10/2018	2/27/2018	5/23/2018	9/10/2018
Lab Data Reviewed and Accepted	4/16/2018	6/25/2018	10/15/2018	4/16/2018	6/25/2018	10/15/2018	4/16/2018	6/25/2018	10/15/2018	4/16/2018	6/25/2018	10/15/2018	4/16/2018	6/25/2018	10/15/2018	4/16/2018	6/25/2018	10/15/2018
Depth to Water (ft btoc)	10.25	2.91	2.30	42.25	42.13	42.30	4.15	4.09	3.86	3.93	5.18	5.25	0.00	0.00	1.55	9.53	10.52	10.30
Temperature (Deg C)	12.74	15.40	16.30	13.70	15.30	14.40	13.06	15.60	15.54	13.26	14.10	14.19	12.34	15.10	14.95	14.77	16.10	16.71
Conductivity (µS/cm)	371	2829	3640	1860	1542	2030	4230	3425	4450	847	634	733	995	778	957	1122	833	985
Turbidity (NTU)	3.81	0.81	3.21	1.86	1.08	3.06	3.83	1.96	2.71	4.99	7.38	4.52	1.96	0.73	3.51	1.14	4.03	2.36
Boron, Total (mg/L)	**0.113**	**0.089**	**0.089**	**0.200**	**0.194**	**0.201**	**0.404**	**0.366**	**0.420**	<0.050	**0.034**	**0.052**	**0.533**	**0.478**	**0.476**	**0.498**	**0.409**	**0.460**
Calcium, Total (mg/L)	**631**	**583**	**587**	**266**	**253**	**270**	**516**	**473**	**520**	**130**	**116**	**107**	**159**	**147**	**145**	**190**	**153**	**154**
Chloride (mg/L)	**24.5**	**23.8**	**33.8**	**5.64**	<5.00	**6.77**	**11.6**	**10.4**	**15.7**	**6.67**	<5.00	**7.49**	**5.39**	<5.00	**6.66**	**10.0**	**7.70**	**10.9**
Fluoride (mg/L)	**0.532**	<0.065	**1.48**	**0.634**	<0.065	**1.00**	<0.500	<0.065	**<0.500**	**0.820**	<0.065	<0.500	<0.500	<0.065	<0.500	**0.530**	<0.065	<0.500
Sulfate (mg/L)	**1900**	**1990**	**2180**	**457**	**563**	**645**	**1970**	**2200**	**4830**	**179**	**157**	**101**	**259**	**293**	**329**	**426**	**317**	**313**
pH (su)	--	**6.65**	**6.87**	--	**7.12**	**6.92**	--	**6.51**	**6.55**	--	**6.83**	**6.96**	--	**6.93**	**6.92**	--	**6.88**	**6.93**
TDS (mg/L)	**3560**	**3630**	**3570**	**1460**	**1540**	**1500**	**3790**	**4010**	**3970**	**573**	**558**	**380**	**965**	**758**	**311**	**847**	**794**	**627**

Notes:

Bold value: Detection above laboratory reporting limit
µS/cm = micro Siemens per centimeter
ft btoc = feet below top of casing
Deg C = degrees Celsius
mg/L = milligrams per liter
NTU = Nephelometric Turbidity Unit
su = standard unit
TDS = total dissolved solids
TOC = top of casing

TABLE II
SUMMARY OF APPENDIX III SSIs
ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
ASH POND SYSTEM
CLIFTON HILL, MISSOURI

Well ID	Statistical Analysis Completed	Constituent
MW-3	January 2018	Boron
	January 2018	Sulfate
	January 2018	TDS
MW-5	January 2018	Boron
MW-6	January 2018	Boron

Notes:
SSIs = statistically significant increases
TDS = total dissolved solids

FIGURE

LEGEND

- THEC CCR MONITORING WELL
- PIEZOMETRIC OBSERVATION ONLY
- CELL 001
- CELL 002 WEST (INACTIVE)
- CELL 003
- CELL 004

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. THEC CCR MONITORING ACCOMPLISHED VIA A MULTI-UNIT GROUNDWATER MONITORING SYSTEM, REFERRED TO AS THE ASH POND SYSTEM, THAT INCLUDES: CELL 001, CELL 003, AND CELL 004. CELL 002 WEST IS AN INACTIVE CCR IMPOUNDMENT.
3. AERIAL IMAGERY SOURCE: ESRI, 15 JANUARY 1999. IMAGERY AT THIS SCALE MAY NOT REFLECT CURRENT SURFACE FEATURES.

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

THOMAS HILL ENERGY CENTER
ASH POND SYSTEM
MONITORING WELL LOCATION MAP

aeci

JANUARY 2019
SCALE: AS SHOWN

FIGURE 1

ATTACHMENT 1

Appendix III SSI Alternate Source Demonstration for Ash Pond System

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

15 April 2018
File No. 128064-006

SUBJECT: Thomas Hill Energy Center – Multi-Unit Groundwater Monitoring System
Appendix III Statistically Significant Increase
Alternate Source Demonstration Certification
Associated Electric Cooperative, Inc.

Associated Electric Cooperative, Inc. (AECI) operates a multi-unit groundwater monitoring system at the Thomas Hill Energy Center (THEC) located in Clifton Hill, Missouri for compliance monitoring under the United States Environmental Protection Agency (EPA) Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, set forth at Code of Federal Regulations Title 40 (40 CFR) Part 257 Subpart D (CCR Rule), effective 19 October 2015. The multi-unit groundwater monitoring system includes wells installed to monitor groundwater quality downgradient of the coal combustion residuals (CCR) management units referred to as Cell 001, Cell 003, and Cell 004 (Ash Pond System).

Haley & Aldrich, Inc. (Haley & Aldrich) understands that AECI has initiated detection monitoring for constituents listed in Appendix III of the CCR Rule pursuant to Section 257.94 of the CCR Rule. AECI has finalized statistical analysis of the groundwater quality data generated from the Detection Monitoring program pursuant to 40 CFR 257.93. The statistical analyses completed on 15 January 2018 have identified statistically significant increases (SSIs) in downgradient concentrations above background at the Ash Pond System for Boron, Sulfate and TDS at MW-3, Boron at MW-5, and Boron at MW-6.

Section 257.94(e)(2) of the CCR Rule includes provisions for the facility owner to conduct an alternate source demonstration (ASD) to demonstrate that an SSI over background levels for an Appendix III constituent originated from a source other than the CCR management unit, or that the SSI resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The Rule provides for a period of 90 days to complete an ASD for Appendix III constituents after an SSI has been identified. Haley & Aldrich has completed an evaluation and developed a written demonstration titled "Summary Report, Appendix III SSI Alternate Source Demonstration for the Ash Pond System, Thomas Hill Energy Center, Clifton Hill, Missouri" which summarizes the data evaluated and the results of the evaluation.

Pursuant to 40 CFR §257.94(e)(2), AECI conducted an alternate source evaluation to demonstrate that a source other than the Ash Pond System caused the statistically significant increase over background identified during detection monitoring. I certify that I have reviewed the ASD written demonstration and all attachments and verify the accuracy of the information in the report. The information contained in the evaluation is, to the best of my knowledge, true, accurate, and complete.

This certification and the underlying data support the conclusion that a source other than the CCR unit is the cause of the SSI over background levels for Appendix III constituents detected during detection monitoring of this multi-unit system. That alternate source is naturally occurring coal seams underlying the Ash Pond System and mining activities including mine spoils located adjacent to the Ash Pond System. The ASD written demonstration and this certification apply to the previously detected SSIs for Boron, Sulfate and TDS at MW-3, Boron at MW-5, and Boron at MW-6 at the Ash Pond System downgradient monitoring wells.

HALEY & ALDRICH, INC.

Signed:________________________________
Certifying Engineer

Print Name: Steven F. Putrich
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineer's Seal

www.haleyaldrich.com

SUMMARY REPORT
APPENDIX III SSI
ALTERNATE SOURCE DEMONSTRATION
FOR THE ASH POND SYSTEM
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

By Haley & Aldrich, Inc.
Cleveland, Ohio

For Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 128064-006
April 2018

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HALEY ALDRICH

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1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) was retained by Associated Electric Cooperative Inc. (AECI) to perform an evaluation of groundwater quality at the multi-unit coal combustion residual (CCR) management unit referred to as the Ash Pond System, which is composed of Cell 001, Cell 003, and Cell 004 at the Thomas Hill Energy Center (THEC) located in Clifton Hill, Missouri. The purpose of the evaluation is to identify the source of elevated boron, sulfate, and TDS concentrations detected in groundwater samples collected from monitoring wells located down-gradient of the Ash Pond System.

1.1 BACKGROUND

Consistent with Code of Federal Regulations Title 40 (40 CFR) §257.90 through §257.94, AECI has installed and certified a groundwater monitoring network for the Ash Pond System at THEC and has collected groundwater samples for the analysis of Appendix III baseline constituents. AECI conducted statistical analyses of the groundwater quality results to determine if any of the Appendix III constituents were present in groundwater samples collected from down-gradient monitoring wells at concentrations with a statistically significant increase (SSI) above background. Statistical evaluation of the Appendix III constituents detected SSIs above background levels down-gradient of the Ash Pond System for boron, sulfate, and total dissolved solids (TDS) at MW-3, boron at MW-5, and boron at MW-6. The analyses described in this report were conducted to identify the source of the elevated boron, sulfate, and TDS concentrations in CCR monitoring wells downgradient of the Ash Pond System.

Pursuant to 40 CFR §257.94(e)(2), ***The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality***. The Rule provides 90 days from determination that a SSI over background exists to complete an Alternate Source Demonstration (ASD) for Appendix III constituents. If a successful demonstration is completed and certified by a qualified professional engineer, the CCR unit may continue in detection monitoring. If, however, an alternate source of the Appendix III SSI is not identified, the owner or operator must initiate an assessment monitoring program within 90-days following the ASD period. This report documents the findings and conclusions of an ASD completed for boron, sulfate, and TDS at the Ash Pond System at THEC.

1.2 SITE SETTING

The THEC is located approximately 7 miles north of Clifton Hill in Randolph County, Missouri. The location of THEC is shown on Figure 1. The site is located within the Central Lowlands physiographic province. The Ash Pond System is a series of surface impoundments that encompasses approximately 90 acres and is located south of the THEC power plant site and immediately adjacent to the Prairie Hill Coal Mine (currently being reclaimed). The Ash Pond System has ground surface elevations varying from 700 to 760 feet above mean sea level. The Ash Pond System and associated groundwater monitoring network are shown on Figure 1.

1.3 SITE DESCRIPTION

THEC is an active coal-fired energy production facility located near Clifton Hill, Missouri. CCRs produced by THEC are managed in the subject Ash Pond System. CCR material managed at the Ash Pond System is boiler slag. The adjacent Prairie Hill Mine site includes former coal mine pits that have been or are actively being reclaimed by AECI. The Ash Pond System is shown on Figure 1 and a broader relationship of the Ash Pond system and Prairie Hill Coal Mine are shown on Figure 2.

The operational sequence in the THEC Ash Pond System is as follows:

- Boiler slag is sluiced from the power generating System to Cell 001, where the majority of slag is settled out using a primary settling/baffled pond;
- The fluid is then decanted to Cell 003 where remaining sediment is settled out;
- Cell 003 water is then decanted into Cell 004 which is the final polishing pond; and
- Settled boiler slag is removed from Cell 001 and dried in the staging area adjacent to Cell 001 before being shipped from the unit for beneficial re-use.

Cell 002 is an inactive impoundment and not considered part of the Ash Pond System.

2. Site Geology and Hydrogeology

Geologic and hydrogeologic conditions beneath the Ash Pond System have been characterized based on information obtained during installation and testing of the monitoring wells and piezometers installed around the Ash Pond System in conjunction with the establishment of a CCR groundwater monitoring network in compliance with the CCR Rule.

2.1 SITE GEOLOGY

The THEC plant site and Ash Pond System are located in the eastern portion of the Western Interior Coal Province of the Central Lowlands physiographic province. The Central Lowland is characterized by horizontal sequences of predominantly marine sedimentary rocks that span more than 400 million years of deposition from the Paleozoic and Mesozoic eras. The CCR area is within an area of Pleistocene glacial activity. Several of the sedimentary formations of the Central Lowland constitute regional scale hydrogeologic units with widely variable groundwater production and groundwater quality characteristics.

Geologic units that underlie the THEC Ash Pond System are principally horizontal with a slight regional dip northwest about 2 to 3 feet per mile (Association of Missouri Geologists, 1995). In order from ground surface downward, the THEC Ash Pond System is underlain by the Lagonda, Bevier, Verdigris, Croweburg, and Fleming formations. Each of these formations is described below.

Surficial geologic materials in the vicinity of and beneath the THEC Ash Pond System include Pleistocene glacial till, loess deposits, and Holocene alluvium. The poorly sorted glacial deposits are composed of Kansan and Nebraskan age clays, silts, and sands; lenses of gravel, cobbles, and boulders may be present (Association of Missouri Geologists, 1995). The till varies from approximately 8.5 to 80 feet thick near the Ash Pond System. Aeolian deposited loess occurs above the till, on hilltops near the units at thicknesses up to 10 feet. The glacial till directly underlies most of the THEC Ash Pond System.

The Pleistocene glacial deposits are underlain by strata representing transgressions and regressions of marine and onshore depositional environments. The uppermost Pennsylvanian rock unit is the Lagonda formation consisting of calcareous shale interbedded with thin limestone layers (Shell, 1981). The Lagonda formation is 40 feet thick at the Site and stratigraphically overlies the Bevier formation.

The Bevier formation is approximately 3 to 4 feet in thickness near the Ash Pond System. The Bevier is composed predominantly of the Bevier coal and the Bevier underclay (Association of Missouri Geologists, 1995). The Bevier underclay is a groundwater flow barrier and barrier to infiltration (Westphal, 1981). The Bevier formation overlies the Verdigris Formation.

The Verdigris Formation has a total thickness of approximately 25 feet near the Ash Pond System and is composed of the Wheeler coal, Wheeler coal underclay, grey shale with small amounts of embedded limestone, Ardmore limestone, and silty grey shales (Shell, 1981). The Wheeler underclay is a barrier to vertical groundwater flow and infiltration.

The Croweburg formation is predominantly a soft black shale, which is often pyritized, and overlain by a hard, grey shale (Association of Missouri Geologists, 1995). The Croweburg formation is approximately 55 feet thick in the vicinity of the Ash Pond System (Shell, 1981). The Croweburg formation overlies the Fleming formation which is composed of the Fleming coal. The Fleming represents the bottom of the lithology described near the THEC facility (Shell, 1981).

2.2 SITE HYDROGEOLOGY AND HYDROLOGY

The combined Pleistocene glacial till and Prairie Hill Coal Mine spoils constitute the uppermost aquifer beneath the Ash Pond System, hereafter referred to as the glacial till or till aquifer, as well as the Lagonda formation and the Breezy Hill Limestone member of the Lagonda formation, where present. Groundwater occurs in the sand and gravel lenses of the glacial till (Association of Missouri Geologists, 1995) and generally within the spoil materials that are composed of excavated glacial material and limited amounts of Lagonda and Verdigris Formation materials including mined coal residuals. The glacial till is underlain by the Lagonda formation which constitute a local limestone and shale aquifer. Although the glacial till and Lagonda are not continuous at the Site they are in hydraulic communication, are primarily unconfined, and act as one aquifer.

Based on groundwater elevations measured between August 2016 and July 2017 as part of the CCR Rule compliance activities, the groundwater gradient in the uppermost aquifer unit is approximately 0.016 to 0.017 feet per foot and is primarily unconfined. Although the uppermost aquifer unit is primarily unconfined, the heterogeneity of the material may cause isolated areas with confined or semi-confined conditions. The groundwater flow in the uppermost aquifer is to the southwest.

Hydraulic conductivity of the uppermost aquifer is based on data collected during development of the CCR monitoring network and published values. The hydraulic conductivity of the glacial till ranges from 1.1×10^{-5} feet per day (feet/day) in gray till to 0.57 feet/day in the sandy till (Shell, 1981) with conductivities of other types of material present in the upper aquifer unit falling between these values.

The uppermost aquifer unit is underlain by the Bevier coal and the Verdigris Formation with the upper portion of the Verdigris Formation being comprised of an underclay beneath the coal. The permeability of the underclay below the Bevier coal is approximately 2×10^{-6} feet/day (Shell, 1981). This value is a geometric mean of several hydraulic permeameter tests conducted by Shell site characterization. The combined Bevier coal and underclay have a thickness of between 3 and 5 feet. Wells completed below the Bevier coal and underclay, in the limestone portion of the Verdigris Formation, have piezometric groundwater elevations that extend above the coal throughout the site, indicating an upward hydraulic gradient. Hydraulic potentials encountered in water-bearing rocks in the competent Verdigris present below the Bevier coal and underclay have hydraulic potential approximately 60 feet or more above the coal (Shell, 1981). The Verdigris Formation has a very low transmissivity of 0.007 gallons per day per foot (Shell, 1981), and is therefore not suitable for water supply production.

3. Alternative Source Demonstration

Haley & Aldrich conducted an evaluation of potential alternative sources that included review of sampling procedures, laboratory procedures, and statistical analyses to determine if potential errors may have been made that would result in the apparent SSI of boron, sulfate, and TDS in the CCR wells located down-gradient of the Ash Pond System. Haley & Aldrich also evaluated potential point and non-point sources of contamination in the vicinity of the Ash Pond System and evaluated natural geologic conditions and the effect of those conditions on native groundwater chemistry. Each of these analyses and the resulting findings are described below.

3.1 REVIEW OF SAMPLING, ANALYSIS, AND STATISTICAL PROCEDURES

3.1.1 Field Sampling Procedures

AECI and Haley & Aldrich conducted the field sampling activities in accordance with a Groundwater Sampling and Analysis Plan (SAP) (Haley & Aldrich, 2017) that was prepared in accordance with §257.93 of the CCR Rule. The SAP prescribes the site-specific activities and methodologies for groundwater sampling and included procedures for field data collection, sample collection, sample preservation and shipment, interpretation, laboratory analytical methods, and reporting for groundwater sampling for the Ash Pond System. The administrative procedures and frequency for collection of groundwater elevation measurements, determination of flow directions, and gradients were also provided in the SAP.

Haley & Aldrich reviewed the field sampling and equipment calibration logs and the field indicator parameters and did not identify apparent deviations or errors in sampling that would result in a potential SSIs for boron, sulfate, and TDS in the CCR wells down-gradient of the Ash Pond System.

3.1.2 Laboratory Quality Control

The groundwater samples collected down-gradient of the Ash Pond System were analyzed by using standard analytical methods. The data generated from these laboratory analyses are stored in a project database that incorporates hydrogeologic and groundwater quality data and was established to allow efficient management of chemical and physical data collected in the field and produced in the laboratory.

Haley & Aldrich conducted a quality assurance/quality control review of each groundwater quality dataset generated for the Ash Pond System and has not identified apparent errors that would result in potential SSIs for boron, sulfate, and TDS in the CCR wells down-gradient of the Ash Pond System.

3.1.3 Statistical Evaluation

AECI and Haley & Aldrich collected a total of 12 groundwater samples from each of the up-gradient (MW-1 and MW-2R) and down-gradient (MW-3, MW-4, MW-5, and MW-6) monitoring wells at the Ash Pond System over a period spanning from August 2016 through September 2017. Statistical analysis of the analytical results was completed using the Prediction Limits statistical method.

Haley & Aldrich has reviewed the statistical analysis of groundwater quality data for the up-gradient and down-gradient wells at the Ash Pond System and has not identified any errors that would result in a potential SSI for boron, sulfate, and TDS in the CCR wells down-gradient of the Ash Pond System. The statistical test method used met the performance standard established in the CCR Rule, and statistical evaluation complies with the requirements of the CCR Rule.

3.2 POTENTIAL POINT AND NON-POINT SOURCES

Haley & Aldrich conducted a review of potential point and non-point sources of elevated boron, sulfate, and TDS values in the vicinity of the Ash Pond System to determine if previous or adjacent site activities, land uses, or practices might have caused SSIs to occur down-gradient of the Ash Pond System. Potential point sources would include discharging activities or other activities occurring at a discrete location in the vicinity of the observed SSI that may potentially concentrate boron, sulfate, and TDS in that area. Non-point sources would include diffuse discharging activities or practices that may result in a low level but wide-spread increase in CCR constituents detected at the down-gradient side of the Ash Pond System.

3.2.1 Point Sources

Prior to construction of the Ash Pond System, land uses near the pond System site and the surrounding vicinity consisted of agricultural land and coal mining. Review of historical United States Geological Survey (USGS) topographic maps show undeveloped land prior to the construction of the plant site and the Ash Pond System. No known industrial activities were conducted at the Ash Pond System site prior to construction of the ponds.

The Prairie Hill Coal Mine was an active surface coal mine adjacent to and surrounding the Ash Pond System and plant site. Mine spoils were placed in and adjacent to the pits and at other locations throughout the site. The site conditions exhibit conditions consistent with coal mining and reclamation.

Agricultural land use is not expected to constitute a point source of boron, sulfate, and TDS at the locations of the apparent SSI's. However, coal mining activities surrounding the Ash Pond System do constitute a potential point source for boron, sulfate, and TDS at the locations of the observed SSIs.

3.2.2 Non-Point Sources

Agricultural activities have been identified near the Ash Pond System but are not expected to constitute a non-point source of boron, sulfate, and TDS at the locations of the observed SSIs in CCR wells. Surface coal mining occurred adjacent to the Ash Pond System; these coal mining activities and the existence of natural occurring coal seams present in areas not mined represent non-point sources of boron, sulfate, and TDS at the locations of the observed SSIs. Coal seams and coal mine spoils are potential sources for boron, sulfate, and TDS at the locations of the observed SSIs in CCR wells.

3.3 HISTORICAL LAND USE REVIEW

Haley & Aldrich reviewed past usage of the site and adjoining properties based on the following records:

- Environmental Risk Information Services (ERIS) – Aerial Photographs, dated 1949, 1977, 1980, 1991, 1995, 2004, 2007, 2010, 2014, and 2016 (Appendix A);
- ERIS – Topographic Maps, dated 1953, 1979, and 2014 (Appendix B); and
- Personal communication with THEC Staff.

Unless otherwise noted below, sources were reviewed dating back to 1940 or first developed use, whichever is earlier, and at 5-year intervals if the use of the property has changed within the time period.

3.3.1 Historical Aerial Photographs

Haley & Aldrich reviewed aerial photographs depicting the development of the site and vicinity, as summarized in Table I. The historical aerial photograph search included photographs from the Agriculture and Soil Conservation Service, USGS (USGS, 1953; 1979; and 2014), National Aerial Photography Program, and the National Agriculture Information Program (ERIS, 2018) and are included in Appendix A.

Photographs suggest that the Ash Pond System was undeveloped in 1949. Buildings and structures on the power plant site are visible in 1977, along with open surface mine pits in what is now the Ash Pond System area. By 1991, the mine pits appear to have been transitioned to their current use.

3.3.2 Historical Topographic Maps

Haley & Aldrich reviewed historical topographic maps depicting the development of the site and vicinity, as summarized in the Table II. The topographic maps were provided for review by ERIS. Copies of the topographic maps are included in Appendix B.

3.4 GEOLOGIC AND MINING EFFECTS ON GROUNDWATER QUALITY

3.4.1 Groundwater Quality in Un-Mined Portions of the THEC Property

The Site is located in the eastern portion of the Western Interior Coal Province of the Central Lowlands physiographic province. The THEC Ash Pond System is located in an unmined area immediately abutting the Prairie Hill Mine [1]. As is the case with the surrounding area, the Ash Pond System is underlain by shallow, thin coal seams (and deeper underlying coal deposits) of variable thickness and spatial coverage. The shallower coal seams range in thickness between 1 to 2.5 feet, based on observations from historical site mining and site characterization activities and recently completed confirmatory site characterization piezometers TPZ-16 and TPZ-17. Those investigation points were installed near the Ash Pond System by AECI in support of these ASD efforts as shown in Figure 1. Water quality results in groundwater samples from these piezometers, which were screened in and adjacent to the shallow coal seams, include boron concentrations ranging from 0.39 to 1.27 mg/L; sulfate concentrations ranging from 220 mg/l to 326mg/L; and TDS concentrations ranging from 776 mg/l to 963 mg/L.

As a point of comparison, AECI also regularly monitors wells located in un-mined portions of the Prairie Hill Mine which are in a buffer zone near the outer perimeter, outside of the mine permit footprint. Those wells include; MW-202, MW-205, MW-211, MW-214 which are screened in coal seams/coal deposits at these locations. Water quality results in groundwater samples from these wells included boron concentrations ranging from 0.961 to 2.08 mg/L; sulfate ranging from 67.1 mg/l to 1,300 mg/L; and TDS ranging from 580 mg/l to 2,506 mg/L. It is noted that the boron, sulfate, and TDS

[1] The limits of the Prairie Hill Mine permitted land relative to the THEC Ash Pond System and the THEC power block are is shown on Figure 2. Although the majority of the land comprising the Prairie Hill Mine permitted space has been effectively mined in the past to support the THEC power production, there is a buffer zone on the perimeter of the mine permit footprint that has been left unmined. Other significant portions of the THEC property which are outside of the Prairie Hill Mine permit area and are un-mined, have been used for plant operations and CCR management facilities.

concentrations in these Prairie Hill Mine wells were similar and/or exceeded the concentrations of boron, sulfate, and TDS in the previously mentioned supplemental site characterization piezometers TPZ-16 and TPZ-17 installed in un-mined land just west of the Ash Pond System.

Similarly, the boron concentrations observed in MW-202, MW-205, MW-211, MW-214, exceed the concentrations of boron in down-gradient CCR monitoring wells MW-3, MW-5 and MW-6 which have a maximum boron concentration of 0.545 mg/L (found in MW-6). Wells MW-3, MW-5 and MW-6 were installed with well screens straddling/or placed immediately above coal seams immediately downgradient of the Ash Pond System.

A summary of boron, sulfate, and TDS concentrations for the wells and piezometers located in the non-mined portions of the THEC property are presented in Table III. The locations of the subject piezometers are shown in Figure 3.

3.4.2 Groundwater Quality in Mined/Mine Spoil/Reclaimed Portions of the THEC Property

As part of the Prairie Hill Mine permit, AECI also monitors wells installed proximate to/in previously mined areas which contain mine spoils and have in part, been reclaimed. Representative wells from those areas include wells MW-216, MW-217, MW-220, MW-221, MW-226, and MW-227. Supplemental piezometers TPZ-9 and TPZ-11 were added by AECI on the east side of the Ash Pond System to evaluate the potential effects of the adjacent Prairie Hill Mine spoils on the Ash Pond System CCR groundwater network [2]. Based on data from the most recent sampling event, maximum boron concentrations observed in these wells and piezometers range from 0.244 to 5.1 mg/L, maximum sulfate concentrations range from 867 to 3,750 mg/L, and maximum TDS concentrations range from 1,738 to 6,008 mg/L. Boron, sulfate, and TDS concentrations observed in groundwater from piezometers and monitoring wells completed in or near proximity to mine spoils are comparable to and/or greater than concentrations observed in the CCR down-gradient monitoring wells (MW-3, MW-4, MW-5, and MW-6) at the Ash Pond System. The maximum boron, sulfate, and TDS concentrations from those downgradient CCR wells were 0.545 mg/L (MW-6), 2,360 mg/L (MW-3), and 4,138 mg/L (MW-3), respectively.

A summary of boron, sulfate, and TDS concentrations for these wells and piezometers is presented in Table IV, and the locations are also shown in Figure 3.

3.5 THEC ASH POND SYSTEM WATER QUALITY OBSERVATIONS

Pond water samples were collected from the Ash Pond System Cell 001, Cell 003, and Cell 004, as well as the conveyance channel between Cell 001 and Cell 003. The samples were analyzed for boron, sulfate, and TDS. Concentrations of boron ranged between 0.034 to 0.300 mg/L. Concentrations of sulfate ranged between 38.1 to 103 mg/L. Concentrations of TDS ranged between 159 to 378 mg/L. Boron, sulfate, and TDS concentrations observed in water samples collected from the Ash Pond System is

[2] In particular, elevated concentrations of sulfate and TDS were seen in CCR downgradient monitoring well MW-3 and are suspected to be sourced from mine spoils located immediately adjacent to the Ash Pond System. TPZ-9 and TPZ-11 were installed by AECI in similar proximity to mine spoil to mirror the conditions at MW-3 (along the western boundary of the Ash Pond System) to illustrate the common effects of nearby mine spoil on groundwater quality. The THEC mine wells cited above (MW-216, 217, 220, 221, 226 and 227) show comparable effects.

significantly lower than concentrations observed in down-gradient monitoring wells MW-3, MW-5, and MW-6 at the Ash Pond System.

Analytical results for boron, sulfate, and TDS concentrations in pond water from the Ash Pond System are presented in Table V.

4. Findings and Conclusions

Haley & Aldrich conducted an evaluation of groundwater quality at the THEC Ash Pond System to identify the source of SSIs of boron, sulfate, and TDS values detected in groundwater samples collected from three CCR monitoring wells (MW-3, MW-5, and MW-6) located down-gradient of the Ash Pond System. The evaluation included review of sampling procedures, laboratory procedures, and statistical analyses to determine if potential errors may have been made that would result in the subject SSIs of boron, sulfate, and TDS in down-gradient CCR wells. Haley & Aldrich also evaluated potential point and non-point sources of contamination in the vicinity of the Ash Pond System and evaluated natural geologic conditions and historic coal-mining activities and the potential effects of those conditions on both the native groundwater chemistry and groundwater quality in the Ash Pond System CCR well network.

Haley & Aldrich found no errors in sampling, laboratory analysis, data management, or statistical analysis that would result in a potential SSIs for boron, sulfate, and TDS down-gradient of the Ash Pond System.

The existence for natural coal seams present in shallow subsurface geology beneath the Ash Pond System and throughout the area and the former Prairie Hill Coal Mine surface mining activities adjacent to the Ash Pond System are known point and non-point sources of boron, sulfate, and TDS values. Key findings and conclusions regarding the geologic effects on groundwater quality and the CCR well groundwater quality of those site features is summarized below:

- <u>The Occurrence of Boron SSIs in CCR Wells MW-3, MW-5, and MW-6:</u>
  - The Ash Pond System is underlain by naturally occurring coal seams which vary in thickness and spatial coverage beneath the Ash Pond System. The maximum boron concentrations observed in CCR wells with SSIs down-gradient of the Ash Pond System (MW-3, MW-5, and MW-6) are lower than the average boron concentrations observed in groundwater samples collected from recently installed wells and piezometers (and Prairie Hill Mine wells) screened in the same formation where known coal seams/deposits are present (see report Table III); and
  - The boron concentrations detected in water samples collected from the Ash Pond System Cell 001, Cell 003, Cell 004, and the conveyance channel between Cell 001 and Cell 003 are significantly lower than those detected in wells with SSIs down-gradient of the Ash Pond System. Consequently, the concentrations of boron detected at the down-gradient monitoring wells do not appear to be sourced from surface water in the Ash Pond System.
- <u>The Occurrence of Sulfate and TDS SSIs in CCR Well MW-3:</u>
  - The maximum sulfate and TDS concentrations observed at MW-3 down-gradient of the Ash Pond System is significantly higher than the average sulfate concentrations observed in water samples collected from the Ash Pond System Cell 001, Cell 003, Cell 004, and the conveyance channel between Cell 001 and Cell 003, indicating that MW-3 has greater potential to be influenced by water in contact with mine spoils than by CCR material placed in the Ash Pond System. Maximum sulfate and TDS concentrations in MW-3 are within the range of average sulfate and TDS concentrations detected in wells and piezometers (and Prairie Hill Mine wells) installed adjacent to or in mine spoils (see report Table IV), indicating that MW-3 has greater potential to be

influenced by water in contact with nearby mine spoils than by CCR material in the Ash Pond System.

Based on the facts presented above, it is our conclusion that the occurrence of elevated boron concentrations (and associated boron SSIs) in CCR wells MW-3, MW-5, and MW-6 are not related to the ongoing operation of the subject Ash Pond System, but rather are the result of naturally occurring coal seams, which vary in thickness and spatial coverage beneath and surrounding the Ash Pond System. Also, based on the facts presented above, it is our conclusion that the occurrence of elevated sulfate and TDS concentrations (and associated SSIs) in CCR well MW-3 are not related to the ongoing operation of the subject Ash Pond System. CCR monitoring well MW-3 is located in close proximity to an area of known mine spoil placement and is influenced by groundwater in contact with mine spoils. These findings indicate that the SSIs in the downgradient wells from the Ash Pond System are associated with an alternate source and do not reflect the performance of the Ash Pond System.

In accordance with 257.94(e)(2) of the CCR Rule, if the owner or operator of a CCR unit (in this case the THEC Ash Pond System) successfully demonstrates a source for Appendix III SSIs other than the CCR unit (which is then certified by a qualified professional engineer), the CCR unit can continue in detection monitoring. A certification for this ASD has been prepared and certified by a Haley & Aldrich qualified professional engineer dated 15 April 2018. The ASD written demonstration and this certification apply to the previously detected SSIs for boron, sulfate and TDS at MW-3, boron at MW-5, and boron at MW-6 at the Ash Pond System downgradient CCR monitoring wells.

5. Closing

Pursuant to 40 CFR §257.94(e)(2), AECI conducted an alternate source evaluation to demonstrate that a source other than the Ash Pond System caused the statistically significant increase over background identified during detection monitoring. This demonstration and the underlying data support the conclusion that a source other than the CCR unit is the cause of the SSI over background levels for Appendix III constituents detected during detection monitoring of this unit.

The information contained in this evaluation is, to the best of our knowledge, true, accurate and complete.

HALEY & ALDRICH, INC.

Steven F. Putrich, P.E.
Project Principal

Mark Nicholls, P.G.
Lead Hydrogeologist

6. References

1. Association of Missouri Geologists, 1995. Field Trip Guide Book, Mining and Mine Reclamation in North Central Missouri near Moberly, Missouri. 29 September.

2. Environmental Risk Information Services. 2018. Database Report, March 2018.

3. Haley & Aldrich, 2017. Groundwater Sampling and Analysis Plan, Thomas Hill Energy Center, Clifton Hill, Missouri. October.

4. Shell Engineering and Associates, 1981. Engineering Study and Report for Solid Waste Disposal Permit, Thomas Hill Operation. 15 June.

5. USGS, 1953. Topographic Map, Prairie Hill, 7.5-minute series.

6. USGS, 1979. Topographic Map, Prairie Hill, 7.5-minute series.

7. USGS, 2014. Topographic Map, Prairie Hill, 7.5-minute series.

8. Westphal, 1981. Letter report from Jerome Westphal describing geologic conditions at Thomas Hill Energy Center in response to MDNR comments dated 27 October 1981.

TABLES

TABLE I
HISTORICAL AERIAL PHOTOGRAPH REVIEW SUMMARY
THOMAS HILL ENERGY CENTER – ASH POND SYSTEM
CLIFTON HILL, MISSOURI

Dates	Description of Site and Adjacent Properties	Sources
1949	Agricultural use of site and adjacent properties with some road use.	Aerial photos – ASCS
1977 – 1991	The plant site is active. The Ash Pond System is active. Active coal mining to the west, east, and south of the Ash Pond System.	Aerial photos – USGS, NAPP
1995 – 2016	The plant site and the Ash Pond System are active. Mine pits to the south and west are filled, and the mine pit to the east is actively being filled.	Aerial photos – NAIP, USGS

Notes:

ASCS = Agriculture and Soil Conservation Service
NAIP = National Agriculture Information Program
NAPP = National Aerial Photography Program
USGS = United States Geological Survey

TABLE II
HISTORICAL TOPOGRAPHIC MAP REVIEW SUMMARY
THOMAS HILL ENERGY CENTER – ASH POND SYSTEM
CLIFTON HILL, MISSOURI

Dates	Description of Site and Adjacent Properties	Map Name
1953	The map shows the site as undeveloped land with several roads within the site vicinity.	7.5-Minute Series, Prairie Hill, Missouri Quadrangle
1979	Development of roads and a rail line. The plant site is indicated as power plant.	7.5-Minute Series, Prairie Hill, Missouri Quadrangle
2014	Further development of rail line to the northeast.	7.5-Minute Series, Prairie Hill, Missouri Quadrangle

TABLE III
SUMMARY OF BORON, SULFATE, and TDS ANALYTICAL RESULTS -
MONITORING WELLS WITH UN-MINED AMBIENT CONDITIONS
THOMAS HILL ENERGY CENTER - ASH POND SYSTEM
CLIFTON HILL, MISSOURI

Location	Media Screened	Sample Date	Boron, Total mg/L	Sulfate mg/L	TDS mg/L	Notes
TPZ-16	Coal Seam/Limestone	3/21/2018	0.39	326	776	West of Pond 004/Located in Un-Mined Area
TPZ-17	Coal Seam/Limestone	3/22/2018	1.27	220	963	West of Pond 004/Located in Un-Mined Area
MW-1 (average)	Limestone	Varies (8/16 - 7/17)	0.1	1958	3463	Upgradient of Ash Pond System
MW-1 (peak)			0.133	2100	3577	
MW-2R (average)	Till	Varies (8/16 - 7/17)	0.201	447	1253	Upgradient of Ash Pond System
MW-2R (peak)			0.241	474	1343	
201	Floor	5/4/2017	2.35	665	1556	Upgradient of Prairie Hill Mine
202	Coal	5/4/2017	2.08	753	1622	
204	Floor	5/4/2017	2.6	696	1318	Upgradient of Prairie Hill Mine
205	Coal	5/4/2017	1.56	1300	2506	
210	Floor	5/4/2017	2.25	441	1156	Upgradient of Prairie Hill Mine
211	Coal	5/4/2017	0.961	67.1	580	
213	Floor	5/4/2017	0.899	1130	2160	Upgradient of Prairie Hill Mine
214	Coal	5/4/2017	0.965	583	1188	
			1.1	797	1676	Average, All
			2.6	2100	3577	Peak, All

Notes:

mg/L = milligrams per liter

TDS = total dissolved solids

TABLE IV
SUMMARY OF BORON, SULFATE, and TDS ANALYTICAL RESULTS - MONITORING WELLS WITH MINING/MINING SPOIL IMPACTS
THOMAS HILL ENERGY CENTER - ASH POND SYSTEM
CLIFTON HILL, MISSOURI

Location	Media Screened	Sample Date	Boron, Total mg/L	Sulfate mg/L	TDS mg/L	Notes
TPZ-9 (average)	Limestone above Coal Seam	Varies (8/15 - 3/18)	2.12	2455	4136	East of Pond 004/Adjacent to Mine Spoils
TPZ-9 (peak)		3/8/2018	2.26	2650	4350	
TPZ-11 (average)	Limestone	Varies (8/15 - 3/18)	0.269	2820	5097	East of Pond 004/Adjacent to Mine Spoils
TPZ-11 (peak)		8/28/2015	0.294	2860	5313	
216	Mine Spoils	5/5/2017	4.52	2400	4038	Monitoring Mine Spoils
217	Mine Floor	5/5/2017	5.1	2930	2930	
220	Mine Spoils	5/4/2017	1.81	1810	2000	Monitoring Mine Spoils
221	Mine Floor	5/4/2017	3.09	867	1738	
226	Mine Spoils	5/5/2017	3.72	3750	6008	Monitoring Mine Spoils
227	Mine Floor	5/5/2017	3.98	3610	5556	
			2.7	2615	4117	Average, All
			5.1	3750	6008	Peak, All

Notes:
mg/L = milligrams per liter
TDS = total dissolved solids

TABLE V
SUMMARY OF BORON, SULFATE, and TDS ANALYTICAL RESULTS - ASH POND SYSTEM CELLS SURFACE WATER
THOMAS HILL ENERGY CENTER - ASH POND SYSTEM
CLIFTON HILL, MISSOURI

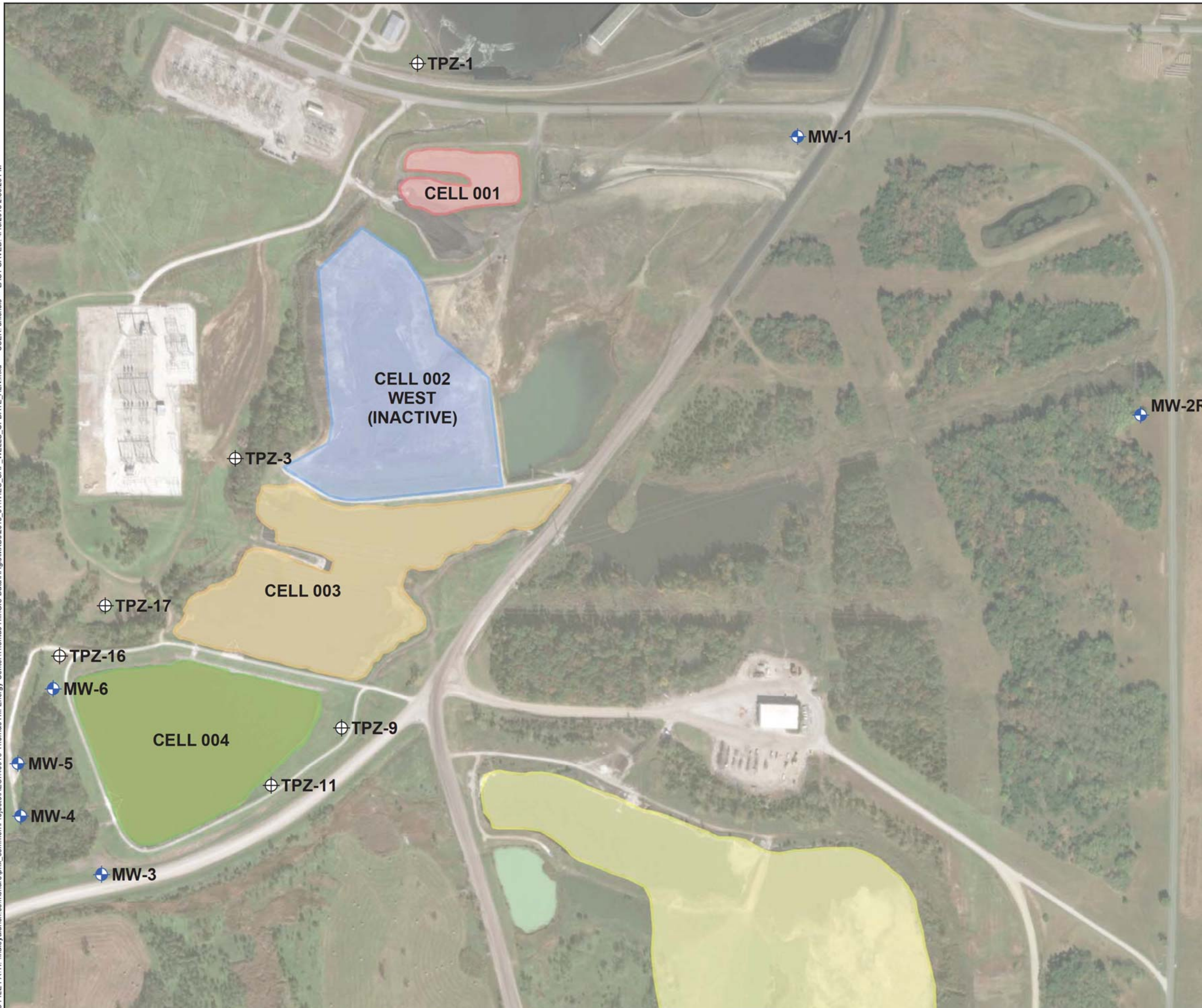
Location	Sample Date	Boron, Total mg/L	Sulfate mg/L	TDS mg/L
Cell 001	3/8/2018	0.045	38.1	256
Convey 001-003	3/8/2018	0.034	43.1	251
Cell 003	8/28/2015	0.300	96.5	358
	3/8/2018	0.073	103	261
Cell 004	8/28/2015	0.219	72	378
	3/8/2018	0.067	98.6	159

Notes:

mg/L = milligrams per liter

TDS = total dissolved solids

FIGURES



LEGEND

THEC CCR MONITORING WELL

PIEZOMETRIC OBSERVATION ONLY

CELL 001

CELL 002 WEST (INACTIVE)

CELL 003

CELL 004

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. THEC CCR MONITORING ACCOMPLISHED VIA A MULTI-UNIT GROUNDWATER MONITORING SYSTEM, REFERRED TO AS THE ASH POND SYSTEM, THAT INCLUDES: CELL 001, CELL 003, AND CELL 004. CELL 002 WEST IS AN INACTIVE CCR IMPOUNDMENT.

3. AERIAL IMAGERY SOURCE: ESRI, 15 JANUARY 1999. IMAGERY AT THIS SCALE MAY NOT REFLECT CURRENT SURFACE FEATURES.

N

0 400 800

SCALE IN FEET

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
THOMAS HILL ENERGY CENTER
CLIFTON HILL, MISSOURI

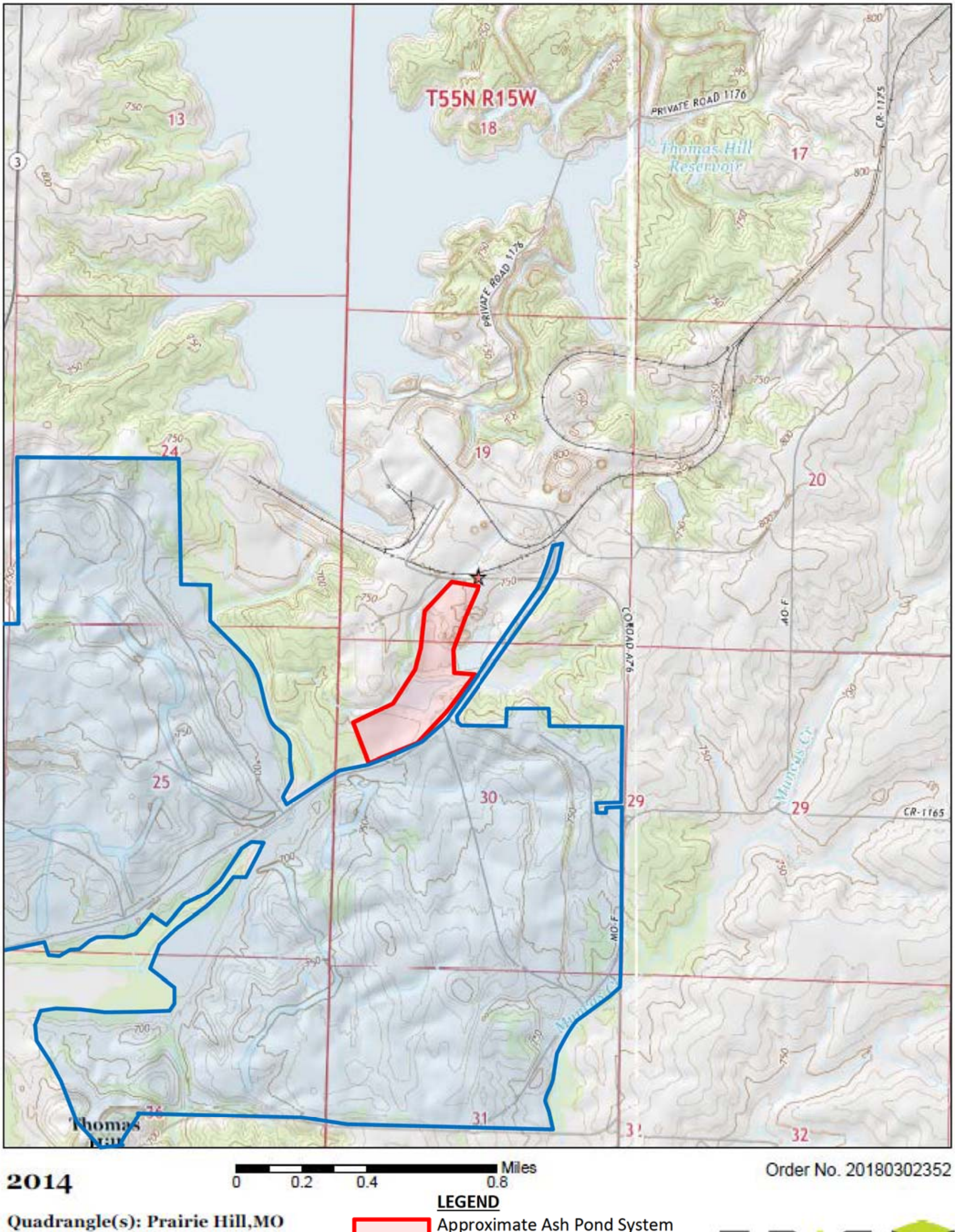
THOMAS HILL ENERGY CENTER
ASH POND SYSTEM
MONITORING WELL LOCATION MAP

aeci

APRIL 2018
SCALE: AS SHOWN

FIGURE 1

Figure 2 – THEC Ash Pond System and Prairie Hill Coal Mine Locations

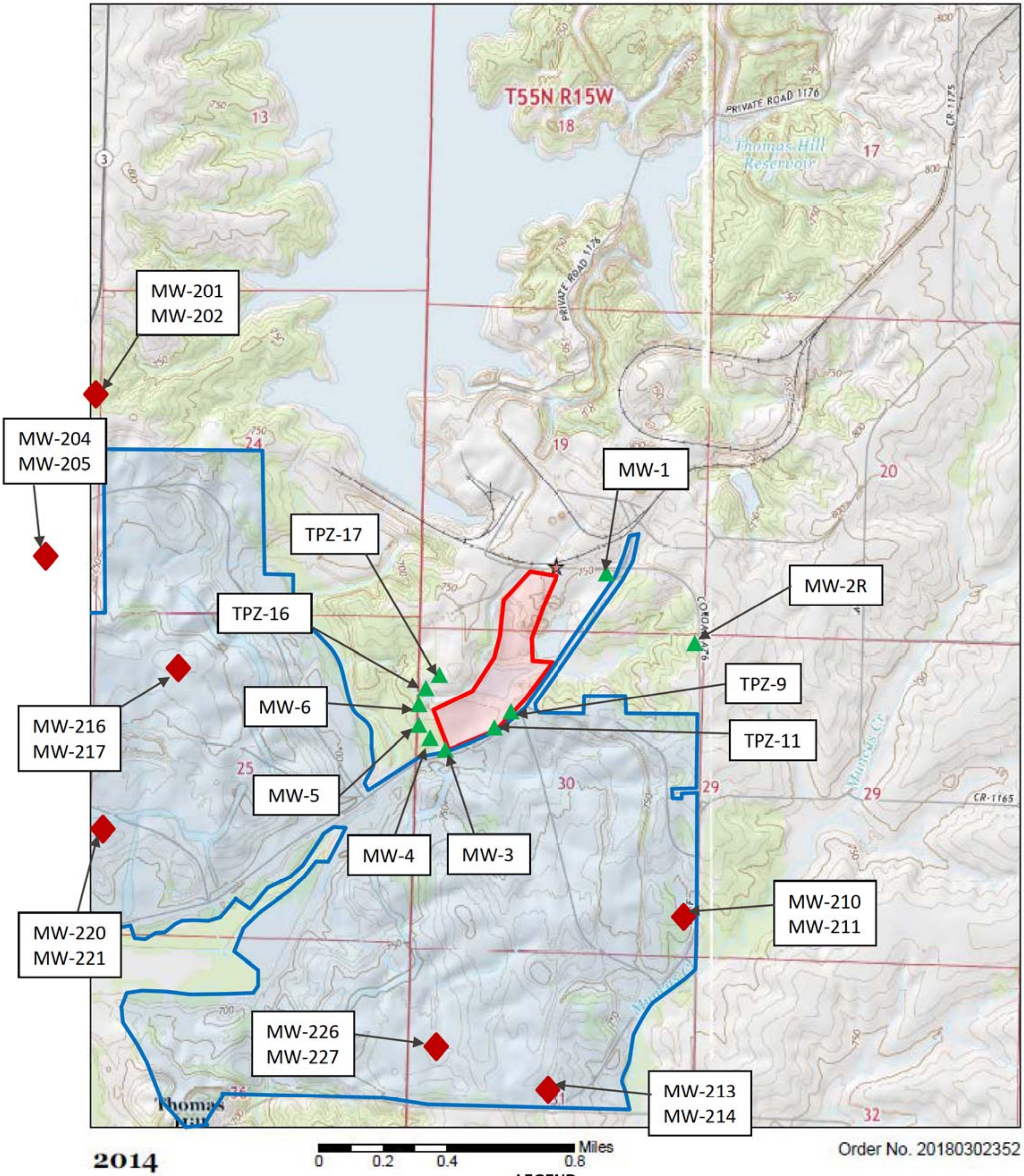


LEGEND

Approximate Ash Pond System Boundary

Approximate Prairie Hill Mine Permit Boundary

Figure 3 – THEC Ash Pond System and Prairie Hill Coal Mine Referenced Well Locations



LEGEND

- Approximate Ash Pond System Boundary
- Approximate Prairie Hill Mine Permit Boundary
- Mine Well Location Number
- CCR Compliance/Site Exploratory Wells

APPENDIX A

ERIS Historical Aerial Photograph Report

ENVIRONMENTAL RISK INFORMATION SERVICES

HISTORICAL AERIAL REPORT

for the site:
THEC
5693 Highway F
Clifton Hill, MO 65244
PO #:

Report ID: 20180302352
Completed: 3/14/2018

ERIS Information Inc.
Environmental Risk Information Services (ERIS)
A division of Glacier Media Inc.
T: 1.866.517.5204
E: info@erisinfo.com

www.erisinfo.com

Search Results Summary

Date	Source	Scale	Comment
2016	**NAIP** - National Agriculture Information Program	1"=1300'	
2014	**NAIP** - National Agriculture Information Program	1"=1300'	
2010	**NAIP** - National Agriculture Information Program	1"=1300'	
2007	**NAIP** - National Agriculture Information Program	1"=1300'	
2004	**NAIP** - National Agriculture Information Program	1"=1300'	
1995	**USGS** - US Geological Survey	1"=1300'	
1991	**NAPP** - National Aerial Photography Program	1"=1300'	*BEST COPY AVAILABLE*
1980	**USGS** - US Geological Survey	1"=1300'	
1977	**USGS** - US Geological Survey	1"=1300'	
1949	**ASCS** - Agriculture and Soil Conservation Service	1"=1300'	

Date: **2016**
Source: **NAIP**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **2014**
Source: **NAIP**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **2010**
Source: **NAIP**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **2007**
Source: **NAIP**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **2004**
Source: **NAIP**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **1995**
Source: **USGS**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **1991**
Source: **NAPP**
Scale: **1" to 1300'**
Comments: *BEST COPY AVAILABLE*

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **1980**
Source: **USGS**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
www.erisinfo.com | 1.866.517.5204

Date: **1977**
Source: **USGS**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

Date: **1949**
Source: **ASCS**
Scale: **1" to 1300'**
Comments:

Subject: 5693 Highway F Clifton Hill MO
Approx Center: 39.54810 / -92.63469

N

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICES
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APPENDIX B

ERIS Topographic Map Research Results

ENVIRONMENTAL RISK INFORMATION SERVICES

TOPOGRAPHIC MAP RESEARCH RESULTS

Date: 2018-03-02

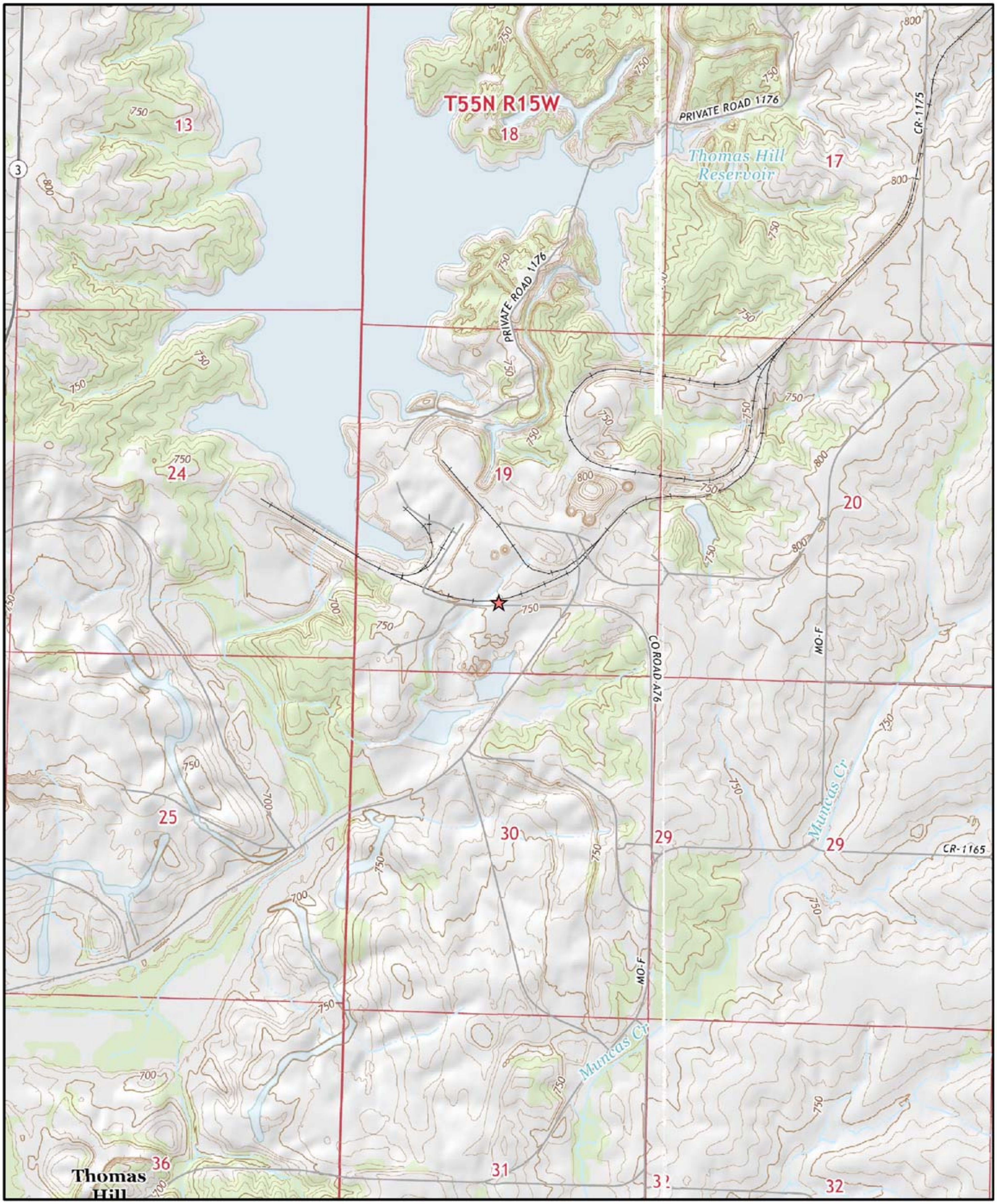
Project Property: 5693 Highway F, Clifton Hill, MO

ERIS Order Number: 20180302352

We have searched USGS collections of current topographic maps and historical topographic maps for the project property. Below is a list of maps found for the project property and adjacent area. Maps are from 7.5 and 15 minute topographic map series, if available.

Year	Map Series
2014	7.5
1979	7.5
1953	7.5

Topographic Maps included in this report are produced by the USGS and are to be used for research purposes including a phase I report. Maps are not to be resold as commercial property.



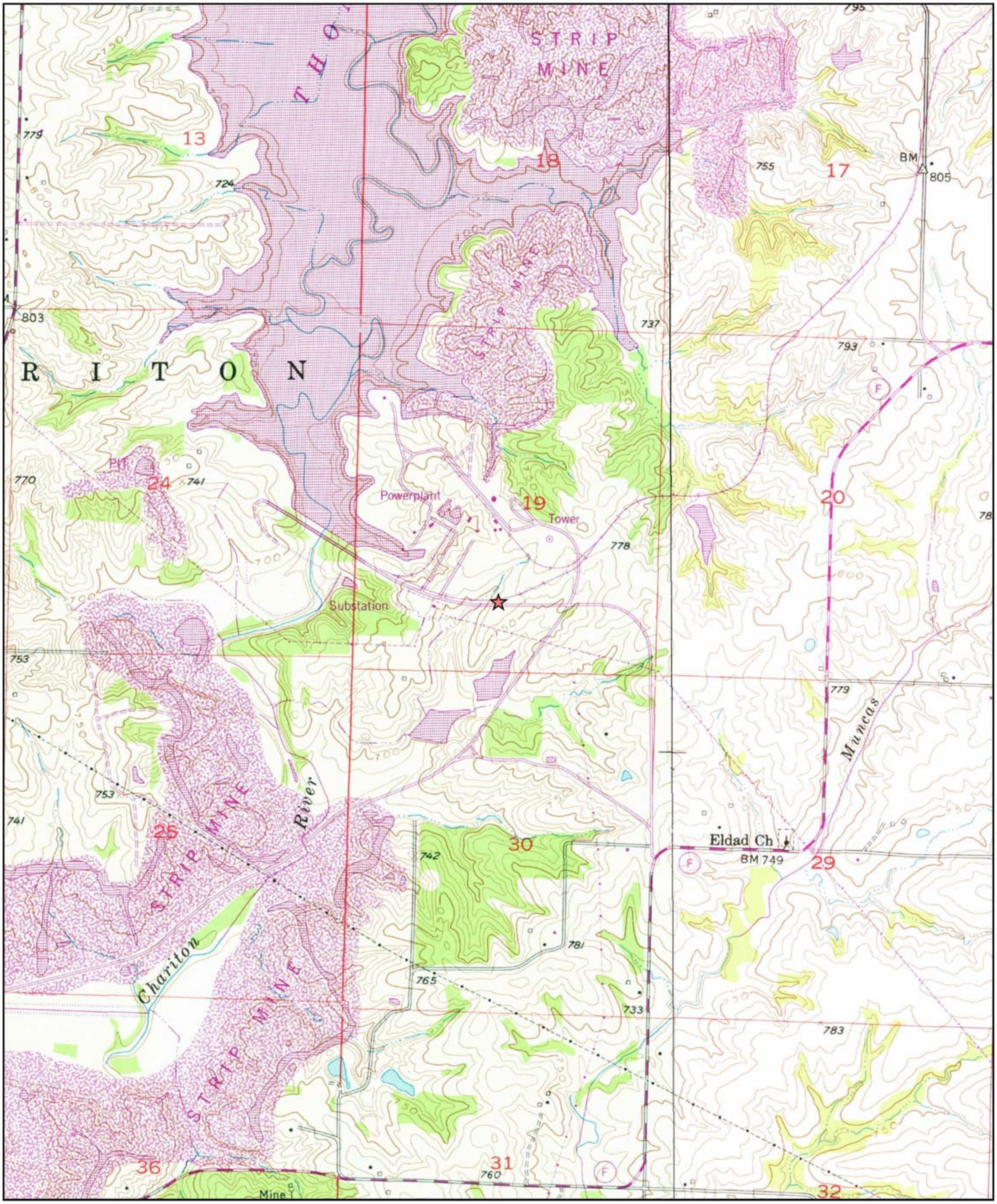
2014

Miles
0 0.2 0.4 0.8

Order No. 20180302352

Quadrangle(s): Prairie Hill,MO

Source: USGS 7.5 Minute Topographic Map



1979

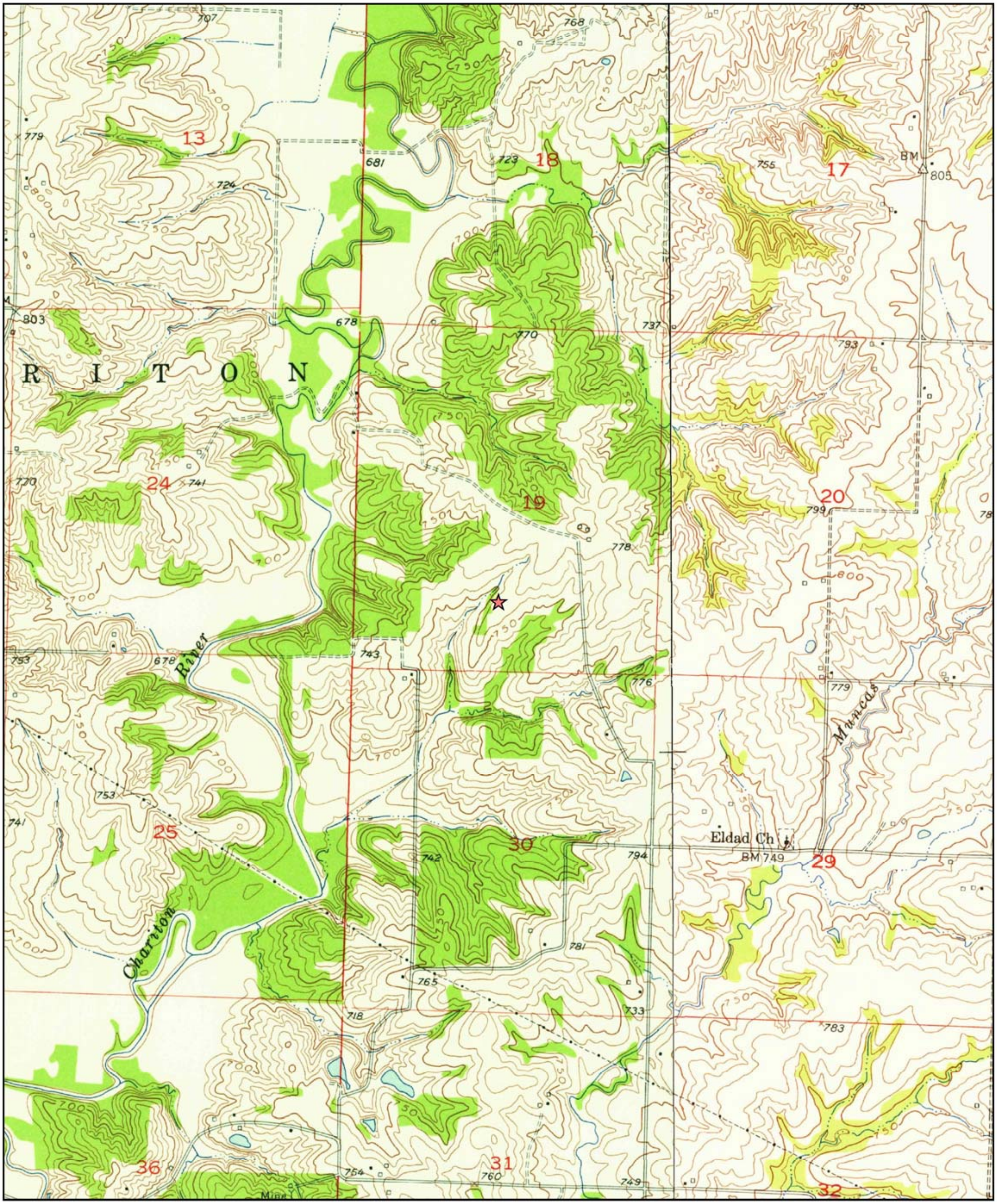
Miles
0 0.2 0.4 0.8

Order No. 20180302352

Quadrangle(s): Prairie Hill,MO

Source: USGS 7.5 Minute Topographic Map

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICE



1953

0 0.2 0.4 0.8 Miles

Order No. 20180302352

Quadrangle(s): Prairie Hill,MO

Source: USGS 7.5 Minute Topographic Map