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REPORT ON

SELECTION OF REMEDY REPORT
F.B. CULLEY GENERATING STATION EAST ASH POND
NEWBURGH, WARRICK COUNTY, INDIANA

by
Haley & Aldrich, Inc.
Greenville, South Carolina

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

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Executive Summary

Southern Indiana Gas and Electric Company (SIGECO) retained Haley & Aldrich, Inc. (Haley & Aldrich) to prepare this Selection of Remedy (SOR) Report for the East Ash Pond (EAP), which is a Coal Combustion Residuals (CCR) surface impoundment at the F.B. Culley Generating Station (FBC or Site) in Newburgh, Warrick County, Indiana.

The primary purpose of this SOR Report is to select a remedy to address statistically significant levels (SSLs) of molybdenum above the Groundwater Protection Standard (GWPS) in groundwater near the EAP. The remedy was selected in accordance with evaluation criteria outlined in Code of Federal Regulations Title 40 (40 CFR) §257.97(b) and (c) of the CCR Rule based on the results of the Corrective Measures Assessment (CMA) Report developed in September 2019 (CMA Report), and with consideration of the results from additional monitoring and technical evaluations conducted since 2019.

In addition to the CMA results, this SOR Report considered supplemental information collected since 2019, which includes additional monitoring data, groundwater investigations, conceptual site model development, geochemical evaluations, groundwater flow and transport modeling updates, and groundwater risk evaluations. This supplemental information is summarized in this SOR Report, and appendix reports are included to further document the CMA alternative assessment analysis updates, geochemical evaluations, groundwater flow and transport modeling, and groundwater risk evaluations, including the results of those evaluations.

The re-evaluation of the alternative assessment analysis is presented in Appendix A, and it evaluated and compared eight corrective measures alternatives, each of which included a source control and groundwater treatment component to address molybdenum SSLs in groundwater near the EAP. Those alternatives were evaluated in the CMA Report based on factors defined in 40 CFR §257.97(b) and (c) to inform the selection of remedy. In addition, SIGECO completed the required public meeting in accordance with 40 CFR §257.96(e) in October 2021 and received no verbal comments from the public during the public meeting or written comments through its publicly available CCR website related to the CMA. As a result of these efforts, SIGECO has selected a remedy for the EAP with the following components (identified as CMA Alternative 8 in the CMA Report):

- Source control: closure by removal (CBR); with
- Targeted In-situ treatment via redox manipulation (ISRM) to treat areas of persistent exceedances of the GWPS.

CBR source control and ISRM are expected to reduce constituent concentrations in groundwater at and downgradient of the EAP over time, as demonstrated by the flow and transport model and geochemical evaluation results. CBR of the EAP began in March 2023 and is expected to be completed in 2026. Primary closure activities include removing free water from the EAP, performing substantial dewatering (gradient control) along the dam to intercept water flowing into the pond from the Ohio River during pond closure, and excavating CCR material from the EAP. After EAP closure is complete, molybdenum concentrations detected in groundwater above the GWPS will be addressed by altering the subsurface geochemical conditions through targeted ISRM, which can reduce concentrations and control downgradient migration.

In combination with targeted ISRM, monitored natural attenuation (MNA) can effectively manage isolated and low-level molybdenum concentrations in groundwater near the EAP and reduce concentrations to less than the GWPS. MNA includes routine monitoring and data evaluation to confirm that attenuation processes are active and effectively reducing the area of impacted groundwater.

The selected remedy is expected to be effective and protective in both the short and long term with a high degree of certainty that the GWPS will be achieved and that potential future releases from the EAP will not occur. Although the selected remedy is a technically complex solution, CBR and dewatering are already ongoing. CBR entails removal of free water and impounded CCR material from the EAP to eliminate future potential releases of CCR-related constituents to the environment. Key aspects of the CBR source control closure include:

- CBR will reduce molybdenum concentrations in groundwater through removal of source material and pore volume exchange induced through gradient control that supports the closure process. In addition to CBR, targeted ISRM spot treatment of persistently elevated molybdenum concentrations in groundwater through the addition of an organic substrate (such as sawdust, wood chips, and/or emulsified vegetable oil [EVO]) enhances precipitation and helps to attain the GWPS.
- The CCR material removed from the EAP is sent off Site for disposal at a permitted landfill in accordance with applicable regulatory requirements.

Factors supporting the determination that ISRM appropriately and effectively addresses Appendix IV SSLs related to the EAP and meets the requirements of 40 CFR §257.97(b)(1) of the CCR Rule include:

- Groundwater risk evaluation results indicate that the presence of molybdenum SSLs in groundwater downgradient of the EAP do not pose unacceptable risks to human health or the environment. The selected remedy is protective of human health and the environment and further reduces the potential for future exposure to constituents in groundwater.
- Groundwater flow and transport modeling and geochemical evaluation results indicate that implementation of the selected remedy is expected to reduce molybdenum concentrations in groundwater during closure to less than the GWPS at and beyond the EAP boundary.

Based on the evaluations conducted and summarized in the CMA Report and other technical reports referenced in this SOR Report, the selected remedy effectively addresses impacts related to the EAP and meets the requirements of 40 CFR §257.97(b). The evaluation factors listed in 40 CFR §257.97(c) were considered in selecting CBR with targeted ISRM as the appropriate remedy for the EAP. The selected remedy will be implemented in a manner consistent with consideration of the factors listed in 40 CFR §257.97(d).

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1. Introduction

Southern Indiana Gas and Electric Company (SIGECO) retained Haley & Aldrich, Inc. (Haley & Aldrich) to prepare this Selection of Remedy (SOR) Report for the East Ash Pond (EAP), which is a Coal Combustion Residuals (CCR) surface impoundment at the F.B. Culley Generating Station (FBC or Site) in Newburgh, Warrick County, Indiana.

The selection of remedy for the EAP has been completed according to the requirements of the U.S. Environmental Protection Agency's (USEPA's) rule entitled Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule).

In accordance with Code of Federal Regulations Title 40 (40 CFR) §257.97(b), a remedy must:

- Be protective of human health and the environment;
- Attain the Groundwater Protection Standards (GWPSs);
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further release of Appendix IV constituents;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as feasible; and
- Manage CCR material in a manner that complies with applicable requirements under the Resource Conservation and Recovery Act (RCRA).

In September 2019, SIGECO completed the Corrective Measures Assessment (CMA) Report for the EAP. The CMA considered a series of corrective measure alternatives, all of which were demonstrated to meet these threshold criteria listed above. The CMA Report also included the results of numerous technical evaluations conducted by consultants, which include groundwater modeling, human health and ecological risk assessments, and the nature and extent of CCR constituents in groundwater assessments. The CMA compared the corrective measure alternatives to one another with respect to three of the four balancing criteria identified in the CCR Rule under 40 CFR §257.97(c), including: 1) long- and short-term effectiveness; 2) source control; and 3) the ease or difficulty of implementing the remedy.

As required by the CCR Rule (40 CFR §257.105 through §257.107), SIGECO published the CMA Report to its publicly available CCR website and held a public meeting to discuss the results of the CMA with interested and affected parties. No one from the public attended the public meeting that SIGECO held on October 18, 2021, and no separate verbal or written comments were received on or following the public meeting or through the SIGECO CCR email address. In addition, SIGECO did not receive written comments from the Indiana Department of Environmental Management (IDEM) or from USEPA.

This SOR Report incorporates the latest supplemental information collected since 2019 that is sourced from additional monitoring data, groundwater intrusive investigations, conceptual site model (CSM) development, geochemical and Site-specific investigations, groundwater modeling updates, risk evaluations, and potential corrective measures evaluations. The selection of the remedy for the EAP is based on the corrective measures alternatives analysis (Haley & Aldrich, 2019) provided in the CMA Report, including the in-situ treatment via redox manipulation (ISRM) alternative assessment provided

in Appendix A. The updated analysis incorporates the latest supplemental information collected since 2019 and provides a more detailed examination of Alternative 8 (Closure by removal [CBR] and ISRM).

1.1 SITE DESCRIPTION

The Site is located on the northern bank of the Ohio River approximately 3 miles east of the town of Newburgh. The Site varies in elevation with natural ground surface elevations varying from 430 to 359 feet above mean sea level (msl). Higher elevations are to the north of the EAP, with surface topography sloping to the west and south toward the Ohio River. Surface water runoff occurs via sheet flow into low-lying areas toward the Ohio River and Little Pigeon Creek. Figure 1 shows the location of the Site and the EAP.

The Site has been in operation since 1953, and CCR material was managed on the Site in the 10-acre EAP impoundment, commissioned circa 1971. Plant development involved excavating a portion of the hillside to the north and placing the material as fill to the south. Little Pigeon Creek originally flowed from east to west across the Site property. To facilitate construction of the generating station, Little Pigeon Creek was diverted, joining the Ohio River near the southeastern property boundary. The east and southern embankments are earthen dikes constructed during the diversion of Little Pigeon Creek in 1953. From 1992 to 1993, the EAP was modified by filling an approximate 14,000-square-foot area in the southwestern corner to build a pad for new scrubber silos.

The EAP operated as an unlined CCR impoundment. Within the EAP, there were three pools that were being utilized for treatment and separation of CCR material. Water discharged from the impoundment through a pump station located at the western side of the EAP. The pump discharge connected to a manhole that discharged to an underground discharge tunnel, which collects stormwater and other process water from throughout the Site, then discharges it to the Ohio River through National Pollutant Discharge Elimination System (NPDES)-permitted Outfall 001.

The EAP had previously received bottom ash via sluice water from both of the facility's generating units. In addition, the EAP received outlet water from the flue-gas desulfurization (FGD) wastewater treatment system, the oil separation tank, eastern side yard sump, air heater wash, boiler seal-throughs, floor drains, greensand water treatment filter regenerant and backwash, softener regenerant streams and reverse osmosis (RO) reject water, and rejects from the FGD system. Any present-day CCR material that is produced is sent off Site for beneficial use or disposal. Any excess wastewaters are directed to a lined pond designed and constructed to receive the wastewaters, with all CCR material captured and contained prior to discharging to the pond.

By April 2023, the EAP was no longer accepting CCR materials, and operations to close the EAP commenced.[1] SIGECO currently owns the land and operates the station for supplying electric power to industrial, commercial, and residential customers within its service territory.

[1] F.B. Culley Generating Station – East Ash Pond: 40 CFR §257.102(g) Notification of Intent to Close, dated May 13, 2023.

2. Assessment Approach and Timeline – CCR Rule

2.1 REGULATORY FRAMEWORK

This SOR Report is the culmination of a comprehensive process of conducting groundwater monitoring, technical evaluations, and CMAs in accordance with CCR Rule requirements outlined in 40 CFR §257.90 through §257.97. This process has included:

- Designing and installing a certified groundwater monitoring system;
- Conducting baseline and detection monitoring with a primary focus on Appendix III constituents;
- Determining background concentrations for Appendix III and Appendix IV constituents and GWPSs for Appendix IV constituents;
- Establishing an assessment monitoring program and conducting assessment monitoring with a primary focus on Appendix IV constituents;
- Posting a public notification of Appendix IV statistically significant levels (SSLs) identified during assessment monitoring;
- Performing an Alternative Source Demonstration (ASD) for SSLs of Appendix IV constituents that are demonstrated to be caused by a source other than the CCR unit (e.g., naturally occurring arsenic);
- Installing additional monitoring wells and conducting a nature and extent investigation for Appendix IV SSLs associated with the CCR unit;
- Evaluating potential corrective measures as part of a CMA evaluation;
- Communicating results of the CMA evaluation as part of a public meeting; and
- Selecting a remedy that appropriately and effectively addresses Appendix IV SSLs related to the EAP and requirements of the CCR Rule.

The CCR groundwater monitoring network for the EAP is described in Section 2.3. Results of detection and assessment monitoring and the nature and extent investigation are summarized in Section 2.4.

Based on monitoring data and results of technical evaluations available at the time, the initial CMA Report was prepared in September 2019 and was amended in November 2020. Results from the CMA are summarized in Section 7. The CCR Rule requires that semiannual reports be prepared to document progress toward remedy selection and design per 40 CFR §257.97(a). Since completion of the initial CMA Report in 2019, semiannual reports have been prepared to document progress toward the remedy selection and design.

Remedy selection and implementation, including a description of the selected remedy and an anticipated schedule for remedy implementation, are described in Sections 8 through 10, with a certification by a professional engineer registered in the state of Indiana provided in Section 11.

2.2 CCR RULE COMPLIANCE SUMMARY

A timeline of important EAP CCR Rule implementation milestones is summarized below:

- October 17, 2017 – certified groundwater monitoring system (40 CFR§257.91(i)) and submitted the Groundwater Monitoring Program (Haley & Aldrich, 2017b);
- November 2017 to January 2018 – performed baseline and detection monitoring;
- August 2018 – established assessment monitoring program (40 CFR§257.94(e)(3)) and conducted an evaluation of possible alternative sources for Appendix III statistically significant increases (SSIs) (40 CFR§257.94(e)(2));
- January 2019 – performed an initial evaluation to determine Appendix IV SSLs (40 CFR§257.93(h));
- June 2019 – conducted a successful ASD for arsenic SSLs that determined naturally occurring arsenic as the source of the SSLs (40 CFR§257.95(g)(3)(ii));
- September 2019 – completed the CMA Report (40 CFR §257.96);
- June 2020 – initiated an assessment monitoring program (40 CFR §257.95);
- November 2020 – completed a CMA Report addendum (including groundwater flow and transport modeling);
- October 2021 – hosted a public meeting to provide the public with an opportunity to review and comment on the CMA (40 CFR §257.96(e)); and
- October 2021 to Present – continued assessment monitoring and various evaluations, as discussed earlier, to support the remedy selection (40 CFR §257.97).

Groundwater monitoring continues, and annual groundwater monitoring and corrective action reports (since 2018 under 40 CFR §257.90(e)) and semiannual remedy selection progress reports (since 2020 under 40 CFR §257.97(a)) are completed as required. Semiannual progress reports will no longer be required after a remedy is selected (via the development of this SOR Report, certification of the report by a qualified professional engineer, and posting to the facility's publicly available CCR website).

2.3 CCR MONITORING NETWORK

The certified groundwater monitoring system at the EAP consists of six downgradient monitoring wells (CCR-AP-2, CCR-AP-3, CCR-AP-4, CCR-AP-5, CCR-AP-6, and CCR-AP-8) and three upgradient monitoring wells (CCR-AP-1R, CCR-AP-7, and CCR-AP-9). The downgradient monitoring wells were constructed at the boundaries of the EAP and are screened in the uppermost aquifer to satisfy the requirements described in 40 CFR §257.91(c). Upgradient background monitoring wells (not influenced by the EAP) are located to the north of the EAP and are also installed in the uppermost aquifer. The location of these six downgradient wells, three upgradient wells, and nature and extent wells are shown on Figure 2. The three upgradient wells provide spatial variability in the background groundwater quality and increase the statistical power of the data analyses.

Monitoring wells to define the vertical extent of affected groundwater were installed and screened at greater depths to assess potential impacts to the intermediate aquifer, where applicable. These wells include CCR-AP-5I, CCR-AP-6I, CCR-AP-8I, and CCR-AP-11 (where the "I" designation represents "intermediate").

A summary of the established groundwater monitoring network for the EAP, along with well construction details, is provided in Table 1. Additional monitoring well data and aquifer characterics data are provided in Appendix B.

2.4 MONITORING RESULTS

2.4.1 Detection Monitoring

Detection monitoring per 40 CFR §257.94 consisted of nine sampling events completed between June 2016 and November 2017. Statistical evaluation determined that SSIs of Appendix III constituent concentrations had occurred in downgradient monitoring wells. No alternative source was identified for the SSI constituents during this period. Accordingly, the groundwater assessment monitoring program was initiated.

2.4.2 Assessment Monitoring

Assessment monitoring events per 40 CFR §257.95 began in June 2018 with a resampling assessment monitoring event completed in August 2018. Samples were analyzed for Appendix III and Appendix IV constituents as required by 40 CFR §257.95(b) and §257.95(d)(1). Concurrent with the second assessment sampling round, and as required by 40 CFR §257.95(h), GWPSs were established for the detected Appendix IV constituents. Based on the established GWPSs, it was determined that arsenic and molybdenum were present in groundwater at SSLs above their respective GWPSs. An arsenic ASD was completed on June 12, 2019 demonstrating that arsenic in groundwater wells downgradient of the EAP is naturally occurring. The molybdenum ASD indicated that the naturally occurring coal was a contributing source of molybdenum but that the CCR material in the EAP was the primary source. Consequently, molybdenum was carried forward into the assessment of corrective measures.

Semiannual reporting that describes the progress in selecting and designing the remedy are completed in March and September of each year (since 2020 after completion of the CMA Report) as required by the CCR Rule. These reports are posted to SIGECO's publicly available CCR website.[2] Additionally, pursuant to 40 CFR §257.93 and §257.95, a memorandum summarizing the statistical evaluation of the analytical results has been completed following receipt of the analytical results from the May and November semiannual sampling events to determine if Appendix IV constituents had been detected in groundwater samples collected in downgradient wells at SSLs greater than the GWPSs.

2.4.3 Nature and Extent Investigation

SIGECO undertook a comprehensive investigation to assess the presence and extent of molybdenum and arsenic at the EAP. Several monitoring wells were installed to better understand the vertical and lateral extent of the constituents. This investigation was conducted in compliance with the CCR Rule, which requires thorough monitoring and delineation of the contaminants.

SIGECO initiated an investigation in November 2018 to define the horizontal and vertical nature and extent of detected Appendix IV SSLs by installing five additional monitoring wells (CCR-AP-10, CCR-AP-11, CCR-AP-5I, CCR-AP-6I, and CCR-AP-8I). Monitoring wells CCR-AP-10 and CCR-AP-11 were installed to horizontally delineate molybdenum SSLs detected in groundwater samples collected from CCR AP-5,

[2] CCR Reporting (centerpointenergy.com)

while CCR-AP-5I was installed to vertically delineate the extent of molybdenum SSLs near CCR-AP-5. Monitoring wells CCR-AP-6I and CCR-AP-8I were installed to vertically delineate arsenic SSLs detected along the southern side of the EAP. As mentioned in Section 2.4.2 above, an arsenic ASD was completed on June 12, 2019.

The location of all the monitoring wells is shown on Figure 2, and the extent of the affected groundwater is further discussed in Section 3.1.1. The nature and extent of affected groundwater has been defined sufficiently to proceed with the selection of remedy.

3. Conceptual Site Model

CSMs are developed to guide identification of exposure pathways, exposure routes, and potential receptors for evaluation. The CSM describes the sources and potential pathways through which constituents migrate to other environmental media, and in turn, to potential human and ecological receptors. Significant subsurface geotechnical and/or hydrogeological investigations have been completed at the Site. These studies generated subsurface data characterizing the Site geology and hydrogeology which were used to support the development of a hydrogeologic CSM. The Site geology and hydrogeology was initially described in the Groundwater Monitoring Plan (GWMP; Haley & Aldrich, 2017a) and the CMA Report (Haley & Aldrich, 2019).

The CSM has been refined with ongoing CCR groundwater monitoring and supplemental subsurface investigation activities. The following sections summarize and update the sources and affected media, migration pathways, aquifer conditions, and receptors that are identified for the Site based on the information collected from previous and current assessments.

3.1 SOURCES AND AFFECTED MEDIA

CCR material placed in the EAP has been determined to be a contributing source of molybdenum to groundwater, resulting in SSLs greater than the GWPS. Constituents present in the CCR material can be dissolved into infiltrating water (either from precipitation or from groundwater intrusion) that flows to groundwater, and those constituents may then be present in shallow groundwater.

The EAP contained approximately 400,000 cubic yards of CCR material. Dewatering and excavation is in progress to support complete removal of the CCR material. Excavation is currently ongoing and expected to be completed during the first quarter of 2026.

3.1.1 Extent of Affected Groundwater

The spatial distribution of groundwater analytical results was reviewed to evaluate the extent of affected groundwater and whether horizontal and vertical delineation is complete. Findings regarding the horizontal and vertical extents are discussed below.

3.1.1.1 Horizontal Extent

Groundwater sampling results from monitoring wells indicate the extent of molybdenum is limited to the vicinity of CCR-AP-6I, CCR-AP-8I (along the southern berm of the EAP), and CCR-AP-5 (north of the EAP). Molybdenum has not been detected in well CCR-AP-11 at concentrations above the GWPS. Source removal activities are expected to reduce molybdenum concentrations in groundwater, resulting in a decrease in the lateral extent of the molybdenum plume. Maps showing concentration distribution for molybdenum for the May 2024 sampling event are included as Figures 3A and 3B.

3.1.1.1.1 North

Based on historical data, the spatial and temporal distribution of the molybdenum plume broadly aligned with the EAP, suggesting its origin. Recent groundwater analytical results indicate that

monitoring wells CCR-AP-1R, CCR-AP-7, and CCR-AP-9 define the northern and hydraulicly upgradient extent of the plume with concentrations less than the GWPS (100 micrograms per liter [µg/L]).

3.1.1.1.2 South

The southern extent of affected groundwater is bounded to the south by the Ohio River and Little Pigeon Creek. Risk evaluations completed to evaluate groundwater discharge to surface water downgradient of the EAP found no adverse impacts to the Ohio River or Little Pigeon Creek.

3.1.1.1.3 East

Results from groundwater samples collected from monitoring wells CCR-AP-2 and CCR-AP-11 indicate molybdenum concentrations less than the GWPS. Therefore, to the east, affected groundwater is contained within the EAP unit boundary. Molybdenum concentrations greater than the GWPS detected at CCR-AP-5 (140 µg/L) have persisted in that localized area (Figure 3A) over time. This may be due to the lower-permeability silts and clays observed to be present in the shallow flow system at this monitoring location.

3.1.1.1.4 West

Monitoring well CCR-AP-4R delineates the western extent of the plume. Trace concentrations of molybdenum have been detected at CCR-AP-4R since 2016. However, no detected concentrations exceeded the GWPS. There are no wells to the southwest of the Site and downgradient of CCR-AP-4R due to the Site's infrastructure.

3.1.1.2 Vertical Extent

Molybdenum has been detected above the GWPS in the shallow and intermediate zones. In November and December 2023, the highest molybdenum concentrations were detected in the intermediate zone (CCR-AP-8I and CCR-AP-5I). The extent of affected groundwater is bounded vertically by the underlying shale bedrock, which is laterally continuous and competent across the complete Site monitoring well network area, as illustrated on cross-section Figures 4A through 4D.

The United States Geological Survey defines a no-flow boundary as one in which groundwater flow does not cross the boundary (Heath, 1983). Such boundaries exist where aquifers terminate against less permeable materials, such as a sand aquifer adjacent to clay beds or shale bedrock. The same publication (Heath, 1983) provides hydraulic conductivity values for these materials that have an approximate difference of three orders of magnitude or more. Accordingly, since more than three orders of magnitude difference in hydraulic conductivity is observed in the overlying alluvium aquifer (intermediate aquifer with an estimated average hydraulic conductivity of 54 feet per day[3]) compared to the expected vertical hydraulic conductivity of bedrock (Shale: 10^{-4} to 10^{-8} feet per day [Heath, 1983]), the shale bedrock represents a no-flow boundary defining the bottom of the plume. The shale bedrock is the confining layer that restricts downward vertical groundwater flow and constituent migration into the bedrock formation.

[3] Site-specific slug test data.

3.2 MIGRATION PATHWAYS

Groundwater generally flows from the upland areas north of the EAP toward the south and Ohio River. Groundwater elevations vary seasonally but the direction of groundwater flow patterns remains consistent. Therefore, dissolved constituents in groundwater could be introduced to adjacent surface water bodies (Ohio River and/or Little Pigeon Creek) through hydraulic downgradient migration.

3.3 AQUIFER CHARACTERISTICS

In the vicinity of the EAP, the uppermost aquifer occurs within unconsolidated Ohio River alluvial deposits consisting of silt and clay with discontinuous interbedded layers of sand. To the north of the EAP, the uppermost aquifer occurs in the shale and sandstone bedrock units. Recharge to the surficial aquifer occurs through direct surface infiltration.

Piezometric data recorded from the monitoring wells installed on Site shows that the configuration of the uppermost aquifer is primarily controlled by surface topography with some influence from the underlying weathered bedrock. At the time when the EAP was operational, groundwater in the immediate vicinity of the EAP flowed radially (mounding effect). Since operations at the EAP have ceased and dewatering and source removal activities are underway, groundwater flow has reverted back to a natural state, flowing from the upland areas north of the EAP to the south toward the Ohio River and Little Pigeon Creek. The Ohio River (south) and Pigeon Creek (east) both serve as hydrogeological divides. Groundwater elevations vary seasonally but the groundwater flow patterns remain consistent.

Groundwater flow velocity in the uppermost aquifer beneath the EAP was estimated to vary from 3.7 feet per day adjacent to the northern boundary of the EAP to 0.16 feet per day in the upland area north of the EAP. The estimated hydraulic gradient north of the EAP is 0.06 feet per foot. South of the EAP, the hydraulic gradient steepens to 0.1 feet per foot down to the Ohio River. Using the Site-specific hydraulic conductivity and hydraulic gradients, and assuming an effective porosity of 25 percent, the groundwater flow north of the EAP is estimated to be 325 feet per year. To the south of the EAP, groundwater flow is estimated to be 25 feet per year.

An additional aquifer performance assessment (Haley & Aldrich, 2022) was completed during October 2022. The test concluded the following:

- Semi-confined or leaky confined aquifer conditions were identified for the area south of the EAP. Those conditions suggest an interbedded system of permeable and less permeable units that form a multilayered flow system. Boring logs from the EAP also support the presence of a multilayered flow system, including a laterally extensive clay unit immediately beneath the pond. That clay unit likely contributes to the limited connection between the shallow water table associated with the EAP and deeper groundwater, as indicated by observed drawdown in the observation well network during the pumping test.
- The shallow groundwater elevation associated with ponded water was not influenced during pumping, indicating limited connectivity between groundwater beneath the clay unit at the base of the pond and water impounded in the EAP. The observation wells signal a hydraulic connection to the Ohio River.
- Generally, transmissivity, storability, and hydraulic conductivity values were observed to be within the range of expected values for the soil types present at the Site.

3.4 RECEPTORS

The Site is surrounded by industrial and greenfield sites. The Site is bounded to the north and west by the Alcoa Warrick Power Plant, to the south/southwest by the Ohio River, and to the east by a coal transfer station, Little Pigeon Creek, a wetland, and wooded areas. The nearest residents are approximately 1 to 1.3 miles to the northeast of the Site. A search of the Indiana Department of Natural Resources (IDNR) databases identified a total of 18 wells within a one-half-mile radius of the Site (Figure 5). Of the 18 wells identified, two locations were confirmed as potential significant water supply wells (IDNR, 2024a; IDNR, 2024b). The two nearest significant water withdrawal wells, "Well 1A" and "Well 2," are approximately 1,000 feet west of the EAP and supply water for an on-Site water storage tank used for various Site operations. The two wells are screened at depths less than 70 feet below land surface with pump rates between 400 and 700 gallons per minute (gpm) and are alternated approximately eight times per day, pumping one at a time to fill the on-Site water storage tank. Based on their location and direction(s) of local groundwater flow (from the upland areas north of the EAP to the south toward the Ohio River and Little Pigeon Creek), these wells are upgradient/side-gradient of the EAP. Based on this setting, the following potential receptors were identified:

- On-Site workers;
- Off-Site workers (of the Alcoa Warrick Power Plant) and residents;
- recreational users of the Ohio River or Little Pigeon Creek; and
- aquatic ecological receptors in the Ohio River or Little Pigeon Creek.

The groundwater risk evaluation is further discussed in Section 6.

4. Flow and Transport Model

A groundwater flow and solute transport model was initially constructed in 2019 to evaluate and compare potential corrective measures to support the EAP CMA in response to a SSL of molybdenum, an Appendix IV constituent exceeding the GWPS. The numerical model MODFLOW-2005 (Harbaugh, 2005) was selected for the modeling effort and is a three-dimensional, finite difference groundwater flow and transport model capable of simulating the groundwater conditions under various scenarios, including pumping and changes to infiltration over time. Solute transport modeling was conducted utilizing the three-dimensional, numerical model MT3DMS (Version 5 of MT3D; Zheng and Wang, 1999).

The MT3DMS model used the flow regime from the steady-state, calibrated Site groundwater flow and transport model to simulate the transport of molybdenum. The steady-state model was transformed into a transient model to evaluate the effects of CCR unit closure on concentrations of molybdenum in groundwater over time. An updated groundwater flow and transport modeling report has been developed and is provided as Appendix C, with a summary of the updates and results provided below.

4.1 MODEL UPDATES

The updated 2024 groundwater model was used to simulate the effects of the selected closure method (CBR with targeted ISRM; Alternative 8 in the CMA Report and the remedy selected in this SOR Report). Updated simulations account for gradient control plans that support CCR removal and the resulting effect on groundwater quality over time.

Molybdenum is the only Appendix IV constituent with SSLs greater than the GWPS at the EAP.[4] Therefore, molybdenum was used for the solute transport portion of the model. Updates to the flow and transport model in support of selection of remedy included:

- Incorporation of additional pumping test[5] to refine model flow calibration in preparation for selection of remedy.
- Incorporation of groundwater elevation data collected in May 2024.
- Use of starting concentrations for molybdenum based on the May 2024[6] analytical results collected from EAP CCR monitoring network wells.
- Planned gradient control was implemented to support dewatering of the EAP by using 28 gradient control wells along the southern portion of the dam, which is between the pond and the Ohio River, that are spaced approximately 30 feet apart and have the capacity to pump up to 22,000 gpm as shown in the *F.B. Culley East Ash Pond Perimeter Deep Well Pilot Test 2.0* design drawing produced by Keller on December 11, 2023. Pumping began in July 2024, with daily pumping rates averaging between 3,000 and 6,000 gpm.

[4] An ASD was successfully submitted for arsenic.
[5] Keller Industrial, Inc. (Keller), completed a pumping test at the Site in August of 2023 (Attachment A of Keller, 2023) to determine the field saturated hydraulic conductivity of the sand aquifer at the Site prior to the CBR dewatering program.
[6] Groundwater concentrations recoded during the May 2024 sampling event are similar to and in the same order of magnitude as molybdenum concentrations measured in November 2023.

- Simulating groundwater flow patterns and molybdenum concentrations through the closure process by removal with dewatering (with completion of closure assumed in 2026).
- Simulating groundwater flow patterns and concentrations for a 20-year period after EAP closure (from 2025 to 2045).

Model updates and results are summarized below, and a detailed summary of model construction, assumptions, calibration, and results is included in Appendix C.

4.2 MODEL RESULTS

Model simulated groundwater contours during the closure period are shown on Figure 6A, and model results for molybdenum concentration flow and transport are shown on Figure 6B.

During the CBR dewatering/closure period from 2023 to 2026, the model indicates that constituent mass that is in contact with the sand unit is predicted to achieve the GWPS for molybdenum within approximately one year of dewatering initiation. However, molybdenum concentrations adsorbed to lower-hydraulic-conductivity silts and clays will most likely persist above the GWPS beyond the end of the closure period.

Model simulations indicate that molybdenum concentrations will be reduced to less than the GWPS in CCR monitoring network wells located along the EAP boundary during the closure period and remain less than the GWPS after closure. Simulations also indicate isolated concentrations of molybdenum greater than the GWPS that remain within the EAP boundary will be reduced to less than the GWPS within approximately 20 years after closure. It is within these isolated areas where molybdenum concentrations persist that ISRM can be an effective remedial alternative as described in section 5 (below).

5. Geochemical Evaluation

Site-specific geochemical conditions were evaluated to develop a geochemical CSM to determine if ISRM is an appropriate remedial alternative to reduce molybdenum concentrations in groundwater at the EAP. The updated geochemical CSM documents Site-specific geochemical conditions influencing the flow and transport of CCR-related constituents[7] that are above the GWPS. The geochemical evaluation for molybdenum and other constituents is attached in Appendix D and includes the assessment and modeling of geochemical data presented in the annual groundwater monitoring reports and additional microbial and solid-phase analyses described therein. Key findings of the geochemical evaluation related to molybdenum are summarized below.

5.1 PLUME STABILITY

As part of the tiered approach set forth in USEPA, 2015b, a plume stability assessment describing the trends and spatial distribution of the molybdenum plume at the EAP was performed. The assessment describes:

- the change in geometry of impacted groundwater over time;
- the mechanisms and rate of the attenuation; and
- the capacity of the aquifer to attenuate the constituent mass in groundwater and the stability of molybdenum to resist re-mobilization (USEPA, 2015b).

5.1.1 Trend Assessment

Mann-Kendall statistical analysis was completed for analytical results from the CCR groundwater monitoring network to determine statistically significant trends. Table 2 compares the maximum historical molybdenum concentrations to recent concentrations. The GWPS for molybdenum at this Site represents the maximum value between the background threshold value and the maximum contaminant level (MCL)/regional screening level (RSL) as reported in the *Statistical Evaluation of the November 2023 Semi-annual Groundwater Assessment Monitoring Data Technical Memorandum* (Haley & Aldrich, 2024d). Mann-Kendall trend analysis was completed at downgradient and background wells using both the comprehensive dataset and the 12 most recent data points[8] to determine the statistical significance of the observed trends (data collected since 2018).

Mann-Kendall trend analysis plots shown in Figure 7 demonstrate that, in general, the recent concentrations of molybdenum exhibit either decreasing or stable trends. Recent measured molybdenum concentrations were greater than the GWPS in groundwater from wells CCR-AP-5, CCR-AP-6I, and CCR-AP-8I. Molybdenum data from groundwater show a decreasing trend at CCR-AP-5, stable trend at CCR-AP-6I, and no trend at CCR-AP-8I. The more recent November 2023 measured molybdenum value at CCR-AP-6I is approximately 1.5 times greater than the previous maximum in 2019 (0.83 milligrams per liter [mg/L]) and two times greater than the June 2023 value (0.56 mg/L); the more recent value is significantly greater than the previous values. No trend was determined at CCR-AP-8I

[7] Although the selection of remedy is focused on remediating molybdenum, the geochemical assessment included other compounds to evaluate appropriate speciation and chemical activities.
[8] Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, March 2009 (Unified Guidance) recommends a minimum of eight data points.

using the Mann-Kendall trend analysis, but concentrations have decreased from 0.83 mg/L in 2019 to 0.34 mg/L in 2023, and further decreased to 0.29 mg/L in 2024. Molybdenum concentrations are increasing when compared to historical values at CCR-AP-2 and CCR-AP-4; however, the concentrations are well below the GWPS of 0.1 mg/L.

Overall, molybdenum trends in the majority of the wells are stable or decreasing, indicating a stable plume. Concentrations of molybdenum are less than the GWPS, with the exception of concentrations detected within the region of CCR-AP-6I, CCR-AP-8I, and CCR-AP-5. Significant decreases in molybdenum concentrations is expected as a result of source removal and gradient control activities to support EAP closure (Section 4). These anticipated decreases would be synonymous with a shrinking area of impacted groundwater.

5.2 ATTENUATION MECHANISMS

Groundwater quality at the Site is affected by numerous attenuation processes, including dispersion, adsorption, precipitation/dissolution, and microbial activity. The measured effects of these processes can help to explain the observed transport behavior of molybdenum in groundwater and may indicate the degree of attenuation of CCR constituents.

5.2.1 Dispersion and Dilution

Dispersion and dilution result from areas of unimpacted groundwater mixing with impacted groundwater and influent precipitation. This physical attenuation mechanism applies to constituents regardless of geochemical reactivity. Dilution and dispersion reduce concentrations through dispersal of contaminant mass rather than destruction or immobilization of contaminant mass and therefore may be an appropriate attenuation mechanism for distal portions of a plume when an active remedy is being used at a site (USEPA, 2015b).

The flow and transport model can be used to evaluate this attenuation mechanism. Model simulations indicate dispersion is likely a significant attenuation mechanism after closure that will continue to reduce remaining molybdenum concentrations. Some localized concentrations of molybdenum are predicted to persist at localized areas near CCR-AP-05 and CCR-AP-08, constrained to the lower-hydraulic-conductivity silts and clays.

5.2.2 Adsorption on the Surfaces of Aquifer Solids

The interaction between dissolved constituents and the surface of certain surface media of the aquifer solids may influence constituent concentration and mobility. These interactions control the conditions and degrees to which the constituents and their compounds are mobile in the subsurface. This adsorption and desorption process is reversible and is considerably affected by the types of constituents, composition of aquifer solid surfaces, pH, and Eh (which is the oxidation-reduction potential [ORP] based on the standard hydrogen potential) of groundwater.

Sequential extraction is a common analytical method used to identify elements associated with solid phases in environmental media based on their reactivity with specific solutions. Sequential extraction test results indicate that molybdenum has a moderate to weak association with organic and sulfide attenuation outside the pond area and a strong attenuation signature within the pond area, primarily controlled by organic material and sulfides present in the aquifer solids. These results also indicate that

a majority of the solid-phase molybdenum within the pond area may not be integrated within crystal structures and could be remobilized.

Additional laboratory testing (leachate analysis) indicates that the aquifer solids in the downgradient area are not expected to provide a long-term source to sustain groundwater impacts.

5.2.3 Molybdenum Precipitation (Chemical Speciation)

Eh-pH diagram calculations were used to identify chemical speciation of molybdenum. The results show that dissolved species are primarily present at the Site. Molybdenum speciation in Site groundwater is predicted to currently exist entirely in the dissolved phase, speciating as aqueous calcium molybdate ($CaMoO_4$). Solid-phase molybdenum is only favored to form under more reduced conditions (sulfate-reducing conditions) as molybdenum disulfide (molybdenite). Figure 8 presents the Eh-pH diagrams for CCR-related constituents.

5.3 MICROBIAL EVALUATION

Microbial data collected from wells downgradient of the EAP screened between approximately 59 and 69 feet below ground surface (bgs; i.e., CCR-AP-6I and CCR-AP-8I) were used to identify and determine the abundance of indigenous microorganisms. This data showed a significant fraction of the bacterial population found in deeper aquifer zones at the Site were identified as anoxic/anaerobic bacteria. The notable presence of sulfate-reducing bacteria and the detection of sulfide suggest that some degree of molybdenum attenuation has occurred. This indicates the potential for further promotion of sulfate-reducing conditions at the Site, which could be beneficial for in-situ metal treatment.

Microcosm results indicate that indigenous sulfate-reducing bacteria could be readily stimulated to facilitate the immobilization of molybdenum through the formation of molybdenum disulfide. Aerobic desorption (leaching) results indicate that molybdenum will mobilize if reducing conditions are changed. However, the extent of mobilization under the current low dissolved oxygen concentrations in areas with molybdenum concentrations exceeding the GWPS is likely limited and would not result in a rebound concentration higher than the GWPS.

To further investigate the potential for molybdenum precipitation, an additional laboratory microcosm study was conducted to assess the feasibility of in-situ molybdenum precipitation through redox manipulation. Results show the indigenous microbial community was receptive to amendment with an organic substrate resulting in an approximate 92 to 100 percent decrease in measured concentrations of molybdenum after a 78-day incubation. Aerobic desorption testing was completed on microcosms after treatment to assess the stability of molybdenum. Molybdenum was found to desorb/mobilize in the first 24-hour elution. These results confirmed that while precipitated molybdenum at the Site will mobilize if reducing conditions change to aerobic conditions, and the extent of mobilization depends on the oxidation rate of reduced minerals containing molybdenum and may not result in a concentration higher than the GWPS of molybdenum (100 µg/L).

5.4 GEOCHEMICAL MODEL RESULTS

The geochemical model setup and results are discussed in detail in Section 6 of Appendix D.

The geochemical equilibrium model was developed using available CCR-AP-6I groundwater data collected on June 13, 2023. The result of the geochemical modeling predicts molybdenum treatment using redox manipulation is feasible through reductive precipitation of molybdenum disulfide.

5.5 GEOCHEMICAL EVALUATION SUMMARY

Geochemical evaluations were performed to determine if targeted ISRM will be a viable post-closure step to reduce concentrations of molybdenum in groundwater at the EAP to below the GWPS. The geochemical framework is summarized as follows:

- The molybdenum concentration trends are generally stable, indicating minimal expansion of the molybdenum plume under current Site geochemical conditions.
- Sequential extraction results indicate inorganic adsorption of molybdenum onto aquifer solids is predominantly controlled by organic matter and sulfide mineralization. Organic matter may have a moderate effect on molybdenum mobility, given that moderate to high total organic carbon concentrations are present at the Site.
- A significant fraction of the bacterial population found in deeper aquifer zones of the Site were identified as anoxic/anaerobic bacteria. The significant fraction of sulfate-reducing bacteria among the indigenous microbial population and the detection of sulfide indicates some degree of molybdenum attenuation has occurred and the potential of further promoting sulfate-reducing conditions at the Site for in-situ metal treatment.
- Microcosm results indicate that indigenous sulfate-reducing bacteria could be readily stimulated to facilitate the immobilization of molybdenum through the formation of molybdenum disulfide.
- Aerobic desorption (leaching) results indicate that molybdenum can mobilize if reducing conditions are changed. However, the extent of mobilization under the current low dissolved oxygen concentrations in areas with molybdenum concentrations exceeding the GWPS is likely limited and would not result in a rebound concentration higher than the GWPS.

Therefore, laboratory testing suggests that molybdenum treatment through redox manipulation including the addition of an organic substrate (such as emulsified vegetable oil [EVO]) is feasible through precipitation as stable molybdenum disulfide. Geochemical modeling predicts this treatment can be successful because there is enough sulfide available to support molybdenum disulfide precipitation.

6. Groundwater Risk Evaluation

A groundwater risk evaluation report was initially developed in 2019 (and included as an appendix to the CMA Report) to evaluate the potential risks to potential receptors related to constituents present in groundwater impacted by the EAP and address the evaluation criteria outlined in the CCR Rule. An updated groundwater risk evaluation report has been developed and is provided as Appendix E, with a summary of the report and evaluation of the results provided below.

6.1 APPROACH

A brief description of the sources, pathways, and receptors was discussed in Section 3. The groundwater risk evaluation was completed by reviewing the CSM to identify the potential for human or ecological exposure to constituents that may have been released to the environment. The CSM identifies chemical sources, potentially impacted media, migration pathways, exposure routes, and possible exposure scenarios (USEPA, 1988). These source-pathway-receptor relationships provide the basis for a quantitative exposure assessment.

Using the CSM, the human health risk assessment (HHRA) process was used to estimate the potential that contact with constituents in the environment may result in harm to human health. Generally, there are four components to the HHRA process (USEPA, 1989): 1) Hazard Identification/Data Evaluation; 2) Toxicity Assessment; 3) Exposure Assessment; and 4) Risk Characterization. To support this process, the USEPA and other regulatory agencies, includijng IDEM, develop “screening levels” of constituent concentrations in groundwater (and other media) that are considered protective of specific human exposures.

6.2 SITE-SPECIFIC DATA EVALUATION

Groundwater data collected in accordance with the CCR Rule provide the basis for the risk evaluation dataset. Section 2 provides an overview of monitoring well installation and sampling events for the different phases of groundwater monitoring at FBC. The data from these groundwater monitoring events are provided in annual groundwater monitoring and corrective action reports required by the CCR Rule.[9]

6.3 EXPOSURE ASSESSMENT

Exposure assessment is the process of describing, measuring, or estimating the intensity, frequency, and duration of potential exposure to chemicals of potential concern in environmental media (e.g., groundwater, surface water, etc.). An exposure assessment is best conducted within the context of a risk-based CSM. A CSM is used to show the relationships between a chemical source, exposure pathway, and potential receptor. The CSM identifies chemical sources, potentially impacted media, migration pathways, exposure routes, and possible exposure scenarios (USEPA, 1988). These source-pathway-receptor relationships provide the basis for the quantitative exposure assessment. Only potentially complete source-pathway-receptor relationships are included in the risk evaluation.

[9] Groundwater analytical results are provided in annual groundwater monitoring and corrective action reports required by the CCR Rule, which are posted on the publicly available CCR website for FBC: CCR Reporting (centerpointenergy.com).

6.3.1 Potentially Complete and Incomplete Exposure Pathways

Potentially complete exposure pathways through which potential receptors are assumed to be potentially exposed to CCR constituents are limited to the following, assuming CCR constituents in groundwater could potentially be introduced into the adjacent surface water bodies, the Ohio River and Little Pigeon Creek:

- consumption of Ohio River surface water as drinking water (by off-Site residents);
- recreational exposure to Ohio River/Little Pigeon Creek surface water (dermal contact and incidental ingestion by swimmers or waders and/or dermal contact by boaters);
- consumption of fish from the Ohio River/Little Pigeon Creek (by recreational fishermen); and
- aquatic receptor exposure to Ohio River/Little Pigeon Creek surface water.

6.4 RISK SCREENING RESULTS

The comparison of maximum detected groundwater concentrations against target screening levels demonstrates that detected groundwater concentrations (conservatively, maximum concentrations from the monitoring period 2016 to 2024 were used) do not pose an adverse impact to the Ohio River or Little Pigeon Creek. In fact, there is a wide margin of safety between the screening levels and detected concentrations, which is shown in the attached Table 3. To illustrate, concentrations of arsenic and molybdenum would need to be more than six and 15 times higher, respectively, than currently measured levels before a potential adverse impact to either surface water body might occur. The detailed Risk Evaluation Report that describes the rationale, risk screening levels and criteria, and results of the groundwater risk evaluation is presented in Appendix E.

6.5 RISK EVALUATION SUMMARY

The risk evaluation therefore demonstrated that there are no unacceptable adverse impacts to human health or the environment from groundwater affected by the EAP.

7. Corrective Measures Assessment Summary

The overall goal of the CMA was to identify and evaluate the appropriateness of potential corrective measures to:

- prevent further releases of Appendix IV constituents to groundwater above their GWPS;
- remediate releases of Appendix IV constituents detected during groundwater monitoring above their GWPS that have already occurred; and
- restore groundwater in the affected area to conditions where Appendix IV constituents are present at concentrations below the GWPS.

Eight corrective measures alternatives were evaluated that included various source control methods (closure in place with in-situ solidification [ISS] and CBR) and groundwater remedies (hydraulic containment using pumping with or without treatment, in-situ treatment, and monitored natural attenuation [MNA]). Those eight alternatives were determined to meet the threshold criteria provided in the CCR Rule in 40 CFR §257.97(b). Corrective measures alternatives were then compared based on evaluation of the following balancing criteria, provided in the CCR Rule in 40 CFR §257.97(c):

- long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
- effectiveness of the remedy in controlling the source to reduce further releases;
- ease or difficulty of implementing a potential remedy; and
- degree to which community concerns are addressed by a potential remedy (public participation/comment).

No community concerns were provided during or after the October 2021 public meeting (Section 7.3).

7.1 POTENTIAL APPLICABLE TECHNOLOGIES

Four corrective measures alternatives evaluated in the CMA included CBR as the primary means of source control (Alternatives 5 through 8). SIGECO has selected CBR with disposal at an off-Site permitted facility as the primary means of source control. Groundwater remedies evaluated to supplement CBR included:

- MNA;
- hydraulic containment without groundwater treatment;
- hydraulic containment with groundwater treatment; and
- in-situ groundwater treatment.

7.2 COMPARISON OF ALTERNATIVES

Based on the supplementary information collected since 2019, the alternatives assessment was re-evaluated and provided in Appendix A and a summary of findings is provided in Table 4. That summary provides a relative comparison of the corrective measure alternatives with respect to balancing criteria to support the selection of a remedy that is technologically feasible, relevant, and readily

implementable, provides adequate protection to human health and the environment and minimizes impacts to the community.

7.3 PUBLIC ENGAGEMENT

SIGECO submitted a CMA Report for public review in September 2019 and an addendum (including flow and transport modeling) in November 2020. In October 2021, a public meeting was conducted to discuss findings of the CMA (40 CFR §257.96(e)). No public comments pertaining to the CMA were received. Therefore, based on the results of the CMA and multiple additional technical analysis (i.e., evaluation of analytical data trends, aquifer material analysis and evaluation, bench-scale testing, flow and transport, and geochemical analysis), selection and implementation of a remedy can proceed.

8. Remedy Selection Summary

Pursuant of § 257.97 Selection of Remedy
"(a) Based on the results of the corrective measures assessment conducted under § 257.96, the owner or operator must, as soon as feasible, select a remedy that, at a minimum, meets the standards listed in paragraph (b) of this section. This requirement applies in addition to, not in place of, any applicable standards under the Occupational Safety and Health Act. The owner or operator must prepare a semiannual report describing the progress in selecting and designing the remedy. Upon selection of a remedy, the owner or operator must prepare a final report describing the selected remedy and how it meets the standards specified in paragraph (b) of this section. 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 that the remedy selected meets the requirements of this section. The report has been completed when it is placed in the operating record as required by § 257.105(h)(12)."

SIGECO submitted a CMA for public review in 2019. In October 2021, a public meeting was conducted to discuss the findings of the CMA (40 CFR §257.96(e)). No comments were received regarding the selection of remedy. Therefore, based on the results of the CMA, multiple additional technical analyses, and in conformance with 40 CFR §257.97(a), SIGECO has selected the following corrective action for the EAP: CBR with targeted in-situ treatment (CMA Alternative 8).

8.1 CLOSURE BY REMOVAL WITH IN-SITU TREATMENT

The selected remedy consists of the removal of CCR material from the EAP, followed by in-situ treatment using targeted ISRM to treat molybdenum concentrations greater than the GWPS.[10] Source control through CBR effectively mitigates groundwater impacts, as it removes the source of contamination and reduces or eliminates, to the maximum extent feasible, future releases of constituents into the environment. Because the volume of impounded CCR material in the EAP is relatively small (less than 400,000 cubic yards), excavation is expected to take less than two years to complete. Additionally, gradient control activities at the EAP to support the closure remove substantial constituent mass supporting naturally occurring attenuation processes during the closure process, such as precipitation, dilution, and dispersion to achieve the GWPS.

Upon completion of the removal activities, targeted treatment of localized persistent molybdenum concentrations in groundwater can commence using ISRM. Manipulating subsurface conditions through ISRM by adding organic substrates, such as EVO, can create favorable conditions for natural chemical and biological processes that result in constituent attenuation onto aquifer solids. This approach can reduce contaminant concentrations below the GWPS (Sections 4 and 5).

Due to the relatively small size of the EAP, potential community impacts, safety concerns, and construction challenges associated with CBR (CMA Alternatives 5 through 8) are not anticipated to be significantly different than those posed by the alternative closure in place options identified within the CMA Report that included closure in place with ISS (CMA Alternatives 1 through 4).

[10] MNA will be used as a post-closure step as defined in USEPA, 2015b.

8.1.1 Monitored Natural Attenuation

MNA may be considered after closure and completion of ISRM treatment at the EAP for distal portions of the molybdenum plume. The USEPA's longstanding policy (2015) is that "*MNA is generally not an appropriate response action if a receptor is currently being exposed to a contaminant or the contaminant plume is expanding. In addition, MNA, whether selected as the sole remedial action or as a finishing step, may be appropriate when it can achieve a site's remedial action objectives in a reasonable timeframe; thus, MNA remedies should not extend over very long timeframes, and the anticipated timeframes should be reasonable compared with other potential alternatives being considered.*"

8.2 REMEDY REQUIREMENTS

As described in Section 7, the September 2019 CMA Report (and the alternative assessment evaluation presented in Appendix A) for the EAP evaluated eight corrective measures alternatives against CCR Rule selection of remedy threshold criteria (40 CFR §257.97(b)) and balancing criteria (40 CFR §257.97(c)). The following sections outline those criteria, which are satisfied for the selected remedy (CMA Alternative 8: CBR with targeted in-situ treatment).

8.2.1 Demonstration of 40 CFR §257.97(b) Requirements

In accordance with 40 CFR §257.97(b), a remedy must meet the following requirements (i.e., "threshold criteria"):

> *"(1) Be protective of human health and the environment;*
>
> *(2) Achieve the groundwater protection standard pursuant to 40 CFR §257.95(h);*
>
> *(3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV [of the CCR Rule] into the environment;*
>
> *(4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and*
>
> *(5) Comply with certain standards for management of wastes as specified in [40 CFR] §257.98(d)."*

In September 2019, SIGECO completed the CMA Report for the EAP and posted the report to its publicly available CCR website. Results of technical evaluations indicated each of the eight corrective measures alternatives considered satisfied the threshold criteria requirements under 40 CFR §257.97(b) that are listed above. Evaluation of the selected remedy using updated analytical results confirms that in-situ remediation using targeted ISRM in areas of persistently elevated molybdenum concentrations above the GWPS is appropriate and effectively addresses the requirements of 40 CFR §257.97(b):

- Groundwater risk evaluation results indicate that molybdenum concentrations in groundwater near the EAP do not pose unacceptable risks to human health or the environment. The selected remedy is protective of human health and the environment by reducing molybdenum concentrations in groundwater.
- Groundwater flow and transport modeling and geochemical evaluation results indicate that implementation of the selected remedy can reduce molybdenum concentrations in groundwater to less than the GWPS at and beyond the EAP boundary during closure.

- CBR entails complete removal of free water and CCR material from the EAP to eliminate future potential releases of CCR-related constituents to the environment.
- CBR supports reducing molybdenum concentrations in groundwater through removal of source material and pore volume exchange induced through gradient control that supports the closure process. In addition to CBR, targeted ISRM spot treatment of persistently elevated molybdenum concentrations above the GWPS in groundwater through the addition of an organic substrate (such as wood chips and/or EVO) enhances precipitation and helps to attain the GWPS.
- The majority of the CCR material removed from the EAP is sent off Site for disposal at a permitted facility in accordance with applicable regulatory requirements.

Based on the CMA evaluation[11] and consideration of results from additional assessment monitoring, updated flow and transport modeling (Section 4), geochemical evaluation (Section 5), and updated groundwater risk evaluation (Section 6), the remedy selected for the EAP meets the requirements of the 40 CFR §257.97(b) threshold criteria. CBR source control and targeted ISRM in areas of persistently elevated molybdenum concentrations above the GWPS are expected to sufficiently reduce constituent concentrations in groundwater downgradient of the EAP to below the GWPS.

8.2.2 Demonstration of 40 CFR §257.97(c) Considerations

In accordance with 40 CFR §257.97(c), the owner of a CCR unit must consider the following evaluation factors (i.e., "balancing criteria") when selecting a remedy that satisfies the threshold criteria under 40 CFR §257.97(b):

> *"(1) The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on consideration of the following:*
>
> *(i) Magnitude of reduction of existing risks;*
>
> *(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;*
>
> *(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance;*
>
> *(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;*
>
> *(v) Time until full protection is achieved;*
>
> *(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;*
>
> *(vii) Long-term reliability of the engineering and institutional controls; and*
>
> *(viii) Potential need for replacement of the remedy.*
>
> *(2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:*
>
> *(i) The extent to which containment practices will reduce further releases; and*

[11] Including the updated alternative assessment presented in Appendix A.

(ii) The extent to which treatment technologies may be used.

(3) The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:

(i) Degree of difficulty associated with constructing the technology;

(ii) Expected operational reliability of the technologies;

(iii) Need to coordinate with and obtain necessary approvals and permits from other agencies;

(iv) Availability of necessary equipment and specialists; and

(v) Available capacity and location of needed treatment, storage, and disposal services.

(4) The degree to which community concerns are addressed by a potential remedy(s).”

The CMA Report and the alternative assessment evaluation presented in Appendix A compared the eight corrective measures alternatives relative to one another with respect to three of the four primary balancing criteria identified in the CCR Rule: 1) long-term and short-term effectiveness; 2) source control; and 3) feasibility of implementation. The fourth balancing criterion, community concerns, was considered after the public meeting was held in October 2021 and the period of public comment was completed.

The analysis provided in Appendix A ranks Alternative 8 as “favorable” or “less favorable” relative to other remedial alternatives for each of the balancing criteria. Based on these favorability ratings, the selected remedy of CBR with targeted in-situ treatment is considered relatively highly favorable, with the highest overall rating of the eight evaluated alternatives (Table 4).

Based on the prior CMA evaluation and consideration of results from additional assessment monitoring, updated flow and transport modeling (Section 4), geochemical evaluation (Section 5), and updated groundwater risk evaluation (Section 6), the remedy selected for the EAP effectively addresses the 40 CFR §257.97(c) balancing criteria. CBR source control (including removal of free water and CCR material) and in-situ treatment using targeted ISRM are expected to reduce constituent concentrations in groundwater downgradient of the EAP over time.

9. Remedy Selection and Implementation

9.1 REMEDY DESCRIPTION

The selected remedy consists of a combination of source control (CBR) and groundwater treatment (targeted in-situ treatment using ISRM) components to mitigate groundwater impacts at the EAP.

9.1.1 Source Control – CBR

Closure of the EAP was initiated in March 2023 and is scheduled to be completed in early 2026. Based on the September 10, 2021 Closure Plan prepared for the EAP (posted to the publicly available CCR website), and subsequent conversations with and submittals to IDEM, CBR at the EAP consists of five main elements:

1. Dewatering the impoundment;
2. Excavation and removal of CCR materials;
3. Placement of cover soil;
4. Dike breach and outfall construction; and
5. Seeding and final vegetative stabilization.

Gradient control dewatering to facilitate CCR excavation via operation of a line of pumping wells between the EAP and the Ohio River lowers the groundwater elevation within the EAP. The entire footprint of the EAP is excavated to remove CCR material to historical/pre-development grades. Excavated CCR materials are being disposed of at a permitted third-party disposal site. Once historical/pre-developed grades are achieved, a visual inspection will be conducted to identify any remnants of CCR materials. If any remnants are identified, the material will be removed by additional excavations. This process may be supplemented by analytical testing or other Site activities to satisfy any state-specific regulatory protocols.

Upon completion of CCR removal, the existing southern embankment will be breached to allow collected stormwater to flow to the Ohio River via a NPDES-permitted outfall.[12] Once the dike breach construction is completed, the entire disturbed area will be seeded and mulched to allow for final Site vegetation and soil stabilization.

9.1.2 Groundwater Treatment – ISRM

Molybdenum concentrations detected in groundwater at concentrations above the GWPS can be reduced by altering the subsurface geochemical conditions through targeted ISRM.

[12] NPDES Permit No. IN0002259 (May 3, 2024) – The discharge is limited to condenser cooling unit wastewater, contact stormwater pond discharge (internal Outfall 101 – low volume wastewater, coal pile runoff, treated metal cleaning wastewater from internal Outfall 401, bottom ash transport water filtrate, EAP water [filtrate], and stormwater), and EAP perimeter gradient control wells (internal Outfall 201).

Geochemical manipulation of subsurface conditions for remediating inorganic constituents in groundwater has been proven to be an effective remedial technology for localized treatment under certain site conditions. This technique can be applied in three main ways:

- Redox manipulation: Altering the oxidation-reduction conditions to transform contaminants into less harmful forms.
- Adsorption to metal oxyhydroxides: Using iron or other metal oxyhydroxides to adsorb contaminants under oxidizing conditions.
- Adsorption to or coprecipitation with metal sulfides: Under reducing conditions, contaminants can be adsorbed to or coprecipitated with iron or other metal sulfides, effectively sequestering them.

Due to the geochemical conditions at the Site, targeted ISRM treatment of molybdenum is considered feasible by means of catalyzing reductive precipitation of molybdenum disulfide onto aquifer solids, thereby reducing molybdenum concentrations in groundwater (as described in Section 5). Several technical evaluations (provided in Appendices A through E) provide sufficient lines of evidence that demonstrate targeted ISRM is a viable remedial measure to address molybdenum SSLs near the EAP.

9.1.3 ISRM Implementation

Redox manipulation would occur in-situ. Reagent (organic substrate such as wood chips and/or EVO) would most likely be introduced into the subsurface using injection wells, trenches, and/or the use of direct-push injections into the aquifer for targeted ISRM treatment. Additionally, ISRM can be completed by the application of amendments to an open, exposed targeted area prior to backfilling. Because the technology has limited proven demonstration across large, wide areas, its optimum application is likely treatment of isolated areas (e.g., in the vicinity of a few targeted impacted wells) and would be completed to inform the full-scale design and construction. Operations and maintenance requirements are dependent on the substrate delivery system. No secondary waste is anticipated to result from the targeted ISRM treatment process.

The estimated timeline to begin pilot testing of the ISRM treatment is approximately one year, including engineering design, construction procurement, permitting, procuring in-situ treatment components, and construction. In the areas where targeted ISRM treatment is implemented, ISRM would be the primary means of active groundwater remediation.

If additional reduction of molybdenum concentrations in groundwater is necessary beyond reductions resulting from targeted ISRM treatment, MNA may be used to manage remaining concentrations until the GWPS is achieved. After EAP closure and ISRM construction, SIGECO would implement post-closure care activities, including operations and maintenance of the ISRM system and corrective action groundwater monitoring consistent with 40 CFR §257.98.

In accordance with 40 CFR §257.98(a), within 90 days of selecting a remedy, SIGECO will:

- Establish and implement a corrective action groundwater monitoring program;
- Implement the corrective action remedy selected; and
- Take any necessary interim measures.

Based on available data and technical evaluations performed to date, the selected remedy is deemed sufficient to meet the objectives of the CCR Rule for addressing molybdenum SSLs in groundwater near the EAP. Because remedial actions are iterative and adaptive in nature, SIGECO will continue to evaluate updated groundwater monitoring data and conditions (as part of the long-term performance monitoring program) to determine whether supplemental corrective measures are warranted to achieve effective remediation of molybdenum SSLs in groundwater near the EAP.

9.2 PLAN AND ACTION STEPS FOR THE IMPLEMENTATION OF THE SELECTED REMEDY

SIGECO plans to take the following steps to implement the selected remedy:

- Cease operation of EAP and commence closure of the EAP. (completed)
- Perform CBR of CCR material within the impoundment to control the source of CCR-related constituents in the unit and to support the groundwater remedy. (ongoing)
- Establish and implement a corrective action groundwater monitoring program (within 90 days of selecting the remedy outlined in this SOR Report) that, in accordance with 40 CFR §257.98(a)(1):
  - Meets the requirements of an assessment monitoring program under 40 CFR §257.95;
  - Documents the effectiveness of the corrective action remedy; and
  - Demonstrates compliance with the GWPS.
- Implement targeted ISRM to treat localized areas of elevated molybdenum concentrations that persist above the GWPS. Results from corrective action groundwater monitoring and periodic modeling evaluations will be used to document the change in concentrations of CCR constituents in groundwater allowing for adaptive management of the selected remedy. (anticipated to begin in 2026)
- Post-ISRM, if necessary, consider MNA to evaluate the effectiveness of natural attenuation processes to address remnant concentrations of persistent molybdenum in groundwater near the EAP. (anticipated to begin in 2026)
- Incorporate results from the corrective action groundwater monitoring program into Annual Groundwater Monitoring and Corrective Action Reports to document the effectiveness of the selected CBR with in-situ treatment remedy. (anticipated to begin in 2026)

9.3 IMPLEMENTATION OF REMEDY

SIGECO is currently implementing closure of the EAP by complete excavation of the CCR materials. Receipt of CCR materials into the EAP was ceased and CCR excavation commenced in 2023. Excavation is estimated to be completed in 2026. The majority of the material removed from the EAP is sent for off-Site disposal at a permitted landfill in accordance with applicable regulatory requirements.

Technical and logistical challenges of implementing a large-scale CCR removal project have already been addressed by SIGECO through the planning and development phase. Removal activities require dewatering and temporary staging/stockpiling of material for drying prior to transportation, which may affect productivity and extend the time frame to complete the removal.

During periods of rain and inclement weather, the removal schedule will be potentially impacted. Excavation and construction safety during the removal activities is another scheduling factor due to

heavy equipment (e.g., bulldozers, excavators, front-end loaders, and off-road trucks) and dump truck operation within the active Site.

10. Schedule

In accordance with 40 CFR §257.97(d), the owner of a CCR unit must specify schedule(s) for implementing and completing remedial activities, requiring completion of remedial activities within a reasonable time frame that considers the following factors:

> *"(1) Extent and nature of contamination, as determined by the characterization required under §257.95(g);*
>
> *(2) Reasonable probabilities of remedial technologies in achieving compliance with the groundwater protection standards established under §257.95(h) and other objectives of the Remedy;*
>
> *(3) Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;*
>
> *(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;*
>
> *(5) Resource value of the aquifer including:*
>
> *(i) Current and future uses;*
>
> *(ii) Proximity and withdrawal rate of users;*
>
> *(iii) Groundwater quantity and quality;*
>
> *(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents;*
>
> *(v) The hydrogeologic characteristic of the facility and surrounding land; and*
>
> *(6) Other relevant factors."*

The anticipated schedule for implementation of the selected remedy is as follows:

Table 10-1: Estimated Remedy Implementation Schedule

Activity	Estimated Completion Time Frame
EAP closure began	March 2023 (completed)
EAP SOR completed	September 2025 (completed)
Establish/implement corrective action groundwater monitoring program	December 2025 (within 90 days of SOR)
Complete EAP closure	Q1 2026
Implement ISRM	2026 to 2027
Initiate post-closure MNA	2026 (anticipated based on assumption of EAP closure in 2026)
Achievement of molybdenum GWPS	TBD (anticipated based on success of ISRM and updated groundwater flow and transport modeling)
Remedy considered complete	TBD (anticipated based on assumption of three consecutive years of no Appendix IV SSLs)
Complete post-closure care period	TBD (anticipated based on assumption the EAP will not be operating under assessment monitoring)

**Dates are estimated. Closure will be achieved once all CCR material has been removed from the EAP, and post-closure MNA will be initiated upon the completion of closure. In accordance with 40 CFR §257.98(c), the remedy will be considered complete when monitoring of EAP groundwater demonstrates compliance with GWPSs in groundwater monitoring system wells and that concentrations of Appendix IV constituents have not exceeded GWPSs for a period of three consecutive years. Once these terms have been satisfied, a notification stating that the remedy has been completed will be prepared.*

Annual groundwater monitoring and corrective action reports will continue to document groundwater analytical results and constituent concentration trends over time. Updated Site data and available modeling results will be used to confirm model-simulated durations for achievement of the GWPSs. Supplemental or alternative corrective measures may be considered if results or modeling indicate constituent concentration reductions are not sufficient to achieve GWPSs within a reasonable time frame. In such a case, potential supplemental or alternative corrective measures that may be considered would likely be similar to the measures and alternatives developed and evaluated in the CMA Report and in Appendix A.

Based on the information presented in this SOR Report and other related documents, the selected remedy is being implemented and is anticipated to be completed in a manner consistent with consideration of the factors listed in 40 CFR §257.97(d).

11. Selection of Remedy Report Certification Statement

I, Steven F. Putrich, am a professional engineer and licensed in the state of Indiana. I have reviewed this Selection of Remedy (SOR) Report for the East Ash Pond (EAP) coal combustion residuals surface impoundment at the Southern Indiana Gas and Electric Company (SIGECO) F.B. Culley Generating Station located in Warrick County, Indiana. I hereby certify that this report has been prepared in general conformance with and meets the requirements of Title 40 Code of Federal Regulations (40 CFR) §257.97 of the U. S. Environmental Protection Agency's Rule entitled "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities." 80 Fed. Reg. 21302 (April 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (July 30, 2018; amending 40 CFR §257.61) (the CCR Rule).

Signed: _____
Certifying Engineer

Print Name:	Steven F. Putrich, P.E.
Indiana License No.:	PE11200566
Title:	Project Principal
Company:	Haley & Aldrich, Inc.

Professional Engineer's Seal:



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TABLES

TABLE 1

GROUNDWATER MONITORING WELL LOCATION AND CONSTRUCTION DETAILS

F.B. CULLEY GENERATING STATION

EAST ASH POND

Well	Date Installed	Intended Purpose	Easting	Northing	Top of Pad Elevation (ft)	Top of Riser Elevation* (ft)	Screen Zone (ft bgs)			Top of Screen (ft)	Bottom of Screen (ft)	Screen Length (ft)	Well Radius (in)	Status
Background Wells														
CCR-AP-1R	March 2016	CMA	2883429.69	969939.69	438.50	441.64	55.00	-	65.00	383.50	373.50	10	2	Active
CCR-AP-7	March 2016	CMA	2883090.34	970774.64	429.50	434.11	20.00	-	30.00	409.50	399.50	10	2	Active
CCR-AP-9	February 2017	CMA	2883998.96	969768.61	445.58	448.69	60.00	-	70.00	385.58	375.58	10	2	Active
Ash Pond Wells														
CCR-AP-2	December 2015	CMA	2884168.88	969117.46	394.40	394.02	36.00	-	46.00	358.40	348.40	10	2	Active
CCR-AP-3	December 2015	CMA	2883542.17	969007.88	395.00	394.55	35.00	-	45.00	360.00	350.00	10	2	Active
CCR-AP-4	December 2015	CMA	2883281.67	969641.72	395.40	394.98	25.50	-	35.50	369.90	359.90	10	2	Active
CCR-AP-5	December 2015	CMA	2884016.86	969379.74	394.90	394.38	34.00	-	44.00	360.90	350.90	10	2	Active
CCR-AP-5I	January 2019	N&E	2884022.40	969377.37	394.90	394.59	75.30	-	85.30	319.60	309.29	10	2	Active
CCR-AP-6	March 2016	CMA	2883285.02	969122.07	397.10	396.75	35.50	-	45.50	361.60	351.60	10	2	Active
CCR-AP-6I	November 2018	N&E	2883289.37	969119.68	397.20	396.88	64.70	-	74.70	332.50	322.18	10	2	Active
CCR-AP-8	February 2017	CMA	2883846.86	969045.93	394.00	393.68	35.50	-	45.50	358.50	348.50	10	2	Active
CCR-AP-8I	November 2018	N&E	2883853.30	969046.82	393.80	393.46	58.70	-	68.70	334.76	324.76	10	2	Active
CCR-AP-10	January 2019	N&E	2883772.84	969536.11	--	402.40	40.20	-	50.20	362.20	352.20	10	2	Abandoned
CCR-AP-11	January 2019	N&E	2884485.51	969352.71	--	385.10	44.40	-	54.40	340.70	330.70	10	2	Active

Notes:

bgs = below ground surface

--- = was not surveyed

ft = feet

in = inches

Datum of Elevations in NAVD 88

**Elevations measured on 12 September and 26 October 2022 - background wells were not resurveyed*

CCR = Groundwater Monitoring Plan

N&E = Nature and extent wells

AP-10 abandoned in place (February 2022) - Dry

TABLE 2
STATISTICAL TREND ASSESSMENT - MOLYBDENUM
F.B. CULLEY GENERATING STATION
EAST ASH POND

Sampling Location	Monitoring Well	GWPS (mg/L)	Overall[1] Trend	Recent[2] Trend	Molybdenum (mg/L)	
					Historical Maximum[3]	May 2024 Sample Results[4]
Background	CCR-AP-7	0.1	Decreasing	Stable	0.013	0.0013 J
	CCR-AP-1R		Stable	Decreasing	0.023	0.0053
	CCR-AP-9		Decreasing	Decreasing	0.050 U	0.0017 J
North of EAP	CCR-AP-4		Increasing	Probably Increasing	0.010	0.017
	CCR-AP-5		Stable	Probably Decreasing	**0.53**	**0.15**
	CCR-AP-5I		No Trend	No Trend	0.0084	0.0026 J
East of EAP	CCR-AP-11		No Trend	No Trend	0.0050 U	0.0050 U
South of EAP	CCR-AP-6		No Trend	Stable	0.037	0.043
	CCR-AP-6I		No Trend	Stable	**1.3**	**0.86**
	CCR-AP-3		Decreasing	Stable	0.025	0.0093
	CCR-AP-8		Stable	No Trend	0.029	0.012
	CCR-AP-8I		Stable	No Trend	**0.86**	**0.29**
	CCR-AP-2		Increasing	No Trend	0.010	0.0065

Notes:

1. Overall trend analysis of available data points since 2018.

2. Recent trend represents 12 most recent data points.

3. Historical Maximum = maximum value reported for primary samples collected prior to May 2024. In some cases, the maximum value is a reporting limit quantified for a non-detect result (denoted by a "U" flag).

4. Recent concentrations measured in May 2024 samples. Note that a sample was also collected in July 2024 from CCR-AP-7 with molybdenum detected at 0.0013 J mg/L.

EAP = East Ash Pond

mg/L = milligrams per liter

J = sample result is a low-level estimated value, detected between the method detection limit and reporting limit.

U = analyte was not detected in the sample, the reporting limit value is shown.

***Bold** = exceeding the groundwater protection standard (GWPS) as determined by the Statistical Eva luation of the May 2024 Semiannual Groundwater Assessment Monitoring Data Technical Memorandum (Haley & Aldrich, 2024). GWPS is the maximum value between the Background Threshold Values and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL).*

Underline = statistically significant trend (increasing, decreasing, or stable) identified by Mann Kendall test following Aziz (2003) guidance.

TABLE 3

COMPARISON OF GROUNDWATER CONCENTRATIONS AGAINST SCREENING LEVELS PROTECTIVE OF OHIO RIVER AND LITTLE PIGEON CREEK SURFACE WATER

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

Constituent	CAS RN	Target Groundwater Screening Level - Ohio River/Little Pigeon Creek (a) (mg/L)	Maximum Groundwater Concentration - All Wells (mg/L)		Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration (b) (all wells)	Maximum Groundwater Concentration - Wells Closest to the Ohio River/Little Pigeon Creek (c) (mg/L)		Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration (b) (wells closest to the Ohio River/Little Pigeon Creek)
Detection Monitoring - USEPA Appendix III Constituents (d)								
Boron	7440-42-8	820	68	CCR-AP-5	> 12	33	CCR-AP-8I	> 24
Fluoride	16984-48-8	550	2.3	CCR-AP-5	> 230	1.5	CCR-AP-8	> 360
Assessment Monitoring - USEPA Appendix IV Constituents								
Antimony	7440-36-0	1.2	0.028	CCR-AP-4	> 43	0.018	CCR-AP-6	> 68
Arsenic	7440-38-2	2.0	0.33	CCR-AP-4	> 6	0.12	CCR-AP-6, CCR-AP-8	> 17
Barium	7440-39-3	45	1.4	CCR-AP-4	> 32	0.83	CCR-AP-2	> 54
Beryllium	7440-41-7	0.82	0.0077	CCR-AP-2	> 100	0.0077	CCR-AP-2	> 100
Cadmium	7440-43-9	0.06	0.0066	CCR-AP-2	> 9	0.0066	CCR-AP-2	> 9
Chromium (Total)	7440-47-3	19	0.16	CCR-AP-1R	> 110	0.14	CCR-AP-2	> 130
Cobalt	7440-48-4	1.2	0.091	CCR-AP-2	> 13	0.091	CCR-AP-2	> 13
Lead	7439-92-1	0.7	0.1	CCR-AP-2	> 7	0.1	CCR-AP-2	> 7
Lithium	7439-93-2	8.2	0.44	CCR-AP-8I	> 18	0.44	CCR-AP-8I	> 18
Mercury	7439-97-6	0.031	0.0016	CCR-AP-5	> 19	0.00071	CCR-AP-2	> 43
Molybdenum	7439-98-7	20	1.3	CCR-AP-6I	> 15	1.3	CCR-AP-6I	> 15
Selenium	7782-49-2	0.63	0.031	CCR-AP-4	> 20	0.026	CCR-AP-2	> 24
Thallium	7440-28-0	0.096	0.0076	CCR-AP-2	> 12	0.0076	CCR-AP-2	> 12
Radiological (pCi/L)								
Radium-226 & 228	7440-14-4	1,020	30	CCR-AP-4	> 34	10	CCR-AP-6	> 100

Notes:

CAS RN - Chemical Abstracts Service Registry Number.

mg/L - milligram per liter.

ND - Not Detected.

pCi/L - picoCuries/liter.

(a) - From Table 5

(b) - Ratio = Target Groundwater Screening Level / Maximum Groundwater Concentration.

(c) - Maximum groundwater concentrations from monitoring wells CCR-AP-2, CCR-AP-3, CCR-AP-6, CCR-AP-6I, CCR-AP-8, and CCR-AP-8I.

(d) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

TABLE 4
SUMMARY OF EVALUATED CORRECTIVE MEASURES - UPDATES TO CMA REPORT (2019)
F.B. CULLEY GENERATING STATION
EAST ASH POND

Alternative Number[1]	Corrective Measures Alternative Description[1]	THRESHOLD CRITERIA - 40 CFR §257.97(b)					BALANCING CRITERIA - 40 CFR §257.97(c)			
							CATEGORY 1[2]	CATEGORY 2[2]	CATEGORY 3[2]	CATEGORY 4[3]
		Be protective of human health and the environment	Attain the groundwater protective standard	Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment	Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems	Management of waste to comply with all applicable RCRA requirements	Long- and short-term effectiveness, protectiveness, and certainty of success that the remedy will prove successful	Effectiveness in controlling the source to reduce further releases	Ease or difficulty of implementation	Degree to which community concerns are addressed
1	Monitored Natural Attenuation (MNA) with In-Situ Solidification (ISS) and Closure in Place (CIP)	✓	✓	✓	✓	✓				NE[3]
2	Hydraulic Containment with No Treatment, ISS and CIP	✓	✓	✓	✓	✓				NE[3]
3	Hydraulic Containment with Treatment, ISS and CIP	✓	✓	✓	✓	✓				NE[3]
4	In-Situ Treatment, ISS and CIP	✓	✓	✓	✓	✓				NE[3]
5	MNA with Closure by Removal (CBR)	✓	✓	✓	✓	✓				NE[3]
6	Hydraulic Containment with No Treatment and CBR	✓	✓	✓	✓	✓				NE[3]
7	Hydraulic Containment with Treatment and CBR	✓	✓	✓	✓	✓				NE[3]
8	In-Situ Treatment and CBR	✓	✓	✓	✓	✓				NE[3]

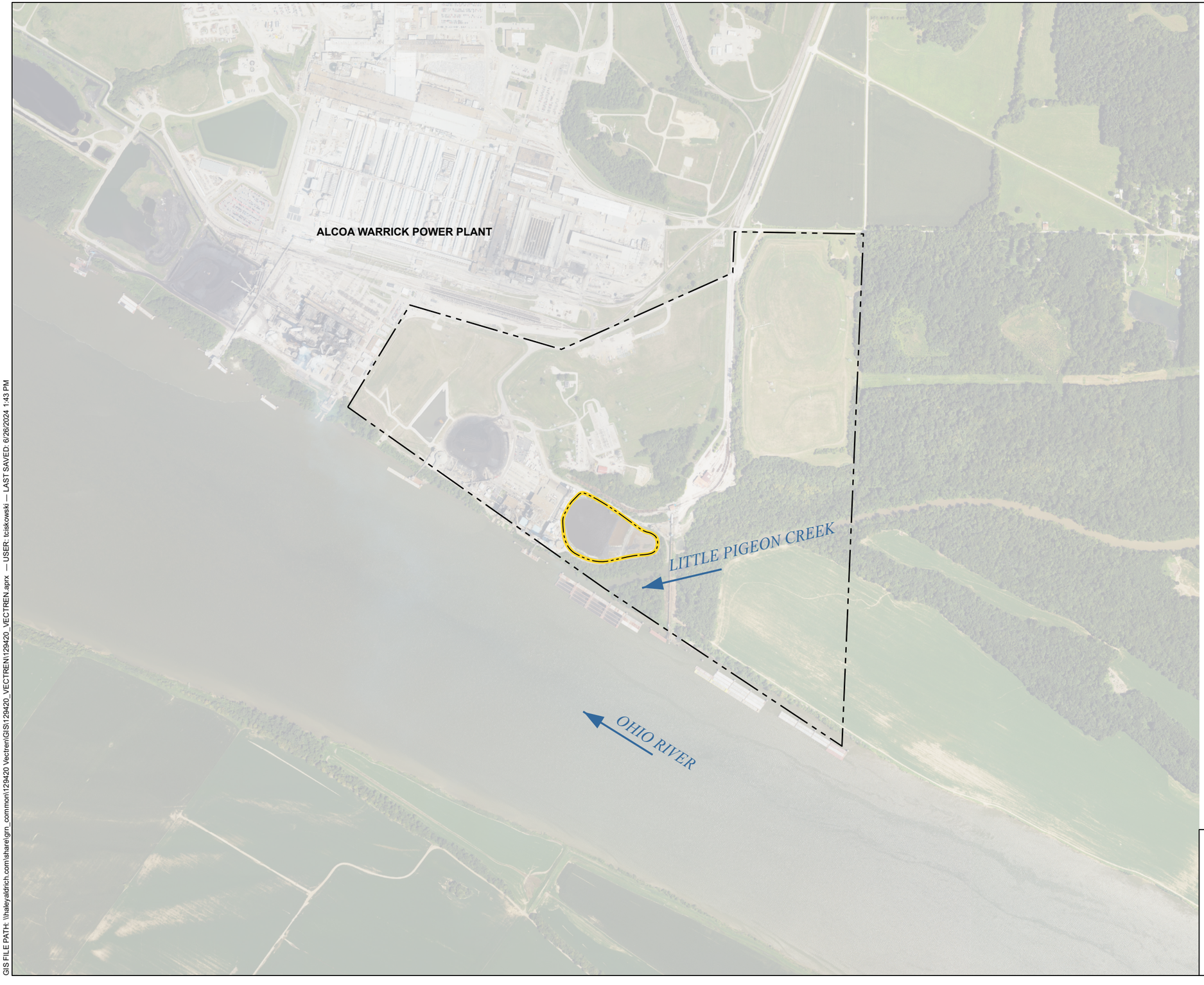
Notes:

1. The corrective measures alternatives summarized in this table are as presented in the Updated CMA Report (Original CMA produced in September 2019).
2. The favorability ratings summarized in this table are as determined for each of the corrective measures alternatives in the Updated CMA Report. These ratings are summarized for each of the primary categories of balancing criteria listed in 40 CFR §257.97(c). The CMA Report provides further details summarizing the favorability ratings for each of the sub-criteria listed under 40 CFR §257.97(c)(1), (2), and (3).
3. Balancing criteria Category 4 related to community concerns was not evaluated (NE) in the CMA Report. The required public meeting was completed in accordance with 40 CFR §257.96(e) in October 2021 . No verbal comments from the public during the public meeting or written comments through its publicly available CCR website were received related to the corrective measures assessment. Therefore, each of the corrective measures alternatives are considered "most favorable" in this table.
4. CCR - coal combustion residuals
5. CFR - Code of Federal Regulations
6. CMA - Corrective Measures Assessment
7. RCRA - Resource Conservation and Recovery Act

Color Legend

Most favorable when compared to other alternatives
Less favorable when compared to other alternatives
Least favorable when compared to other alternatives

FIGURES



LEGEND

PROPERTY BOUNDARY

FB CULLEY EAST ASH POND BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. AERIAL IMAGERY SOURCE: HEXAGON, 21 JULY 2022

N

0 1,000 2,000

SCALE IN FEET

HALEY ALDRICH

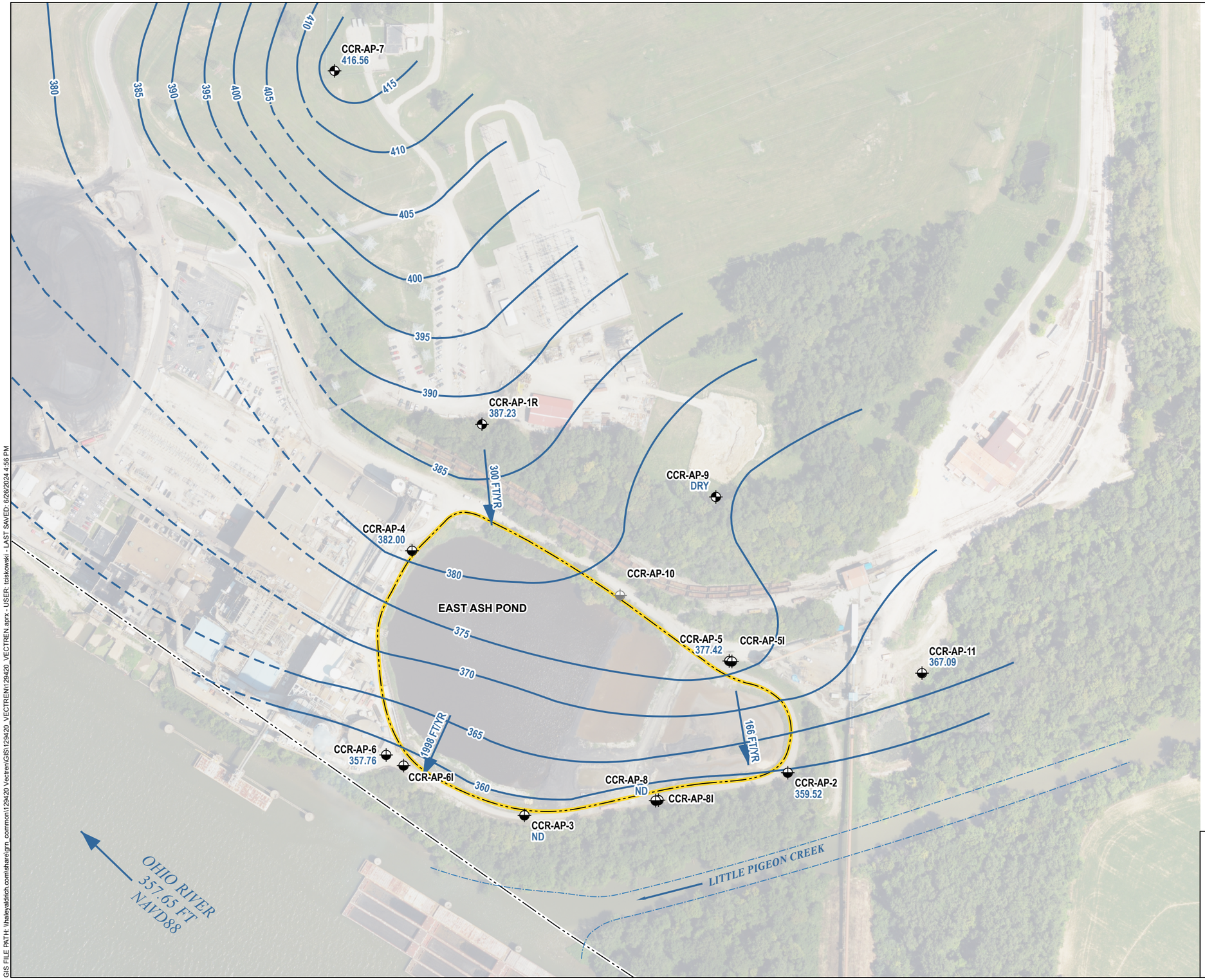
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

SITE LAYOUT

AUGUST 2024

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN\129420_VECTREN.aprx — USER: tciskowski — LAST SAVED: 6/26/2024 1:43 PM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL WITH **GROUNDWATER ELEVATION** IN FEET
- DOWNGRADIENT GROUNDWATER MONITORING WELL WITH **GROUNDWATER ELEVATION** IN FEET
- ABANDONED GROUNDWATER MONITORING WELL
- GROUNDWATER FLOW DIRECTION
- CREEK BOUNDARY
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL, DASHED WHERE INFERRED
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
ND = NO DATA
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

3. WATER LEVELS GAGED ON 1 NOVEMBER 2023

4. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 1 NOVEMBER 2023 AT 12:00 PM

5. GROUNDWATER VELOCITY SHOWN IN FEET PER YEAR

6. $V = \frac{k(i)}{n_e}$

V = GROUNDWATER VELOCITY (FT/YR)
K = HYDRAULIC CONDUCTIVITY (FT/YR)
i = GROUNDWATER GRADIENT
n_e = EFFECTIVE POROSITY

7. AERIAL IMAGERY SOURCE: HEXAGON, 25 JULY 2023

N

0 230 460
SCALE IN FEET

HALEY ALDRICH

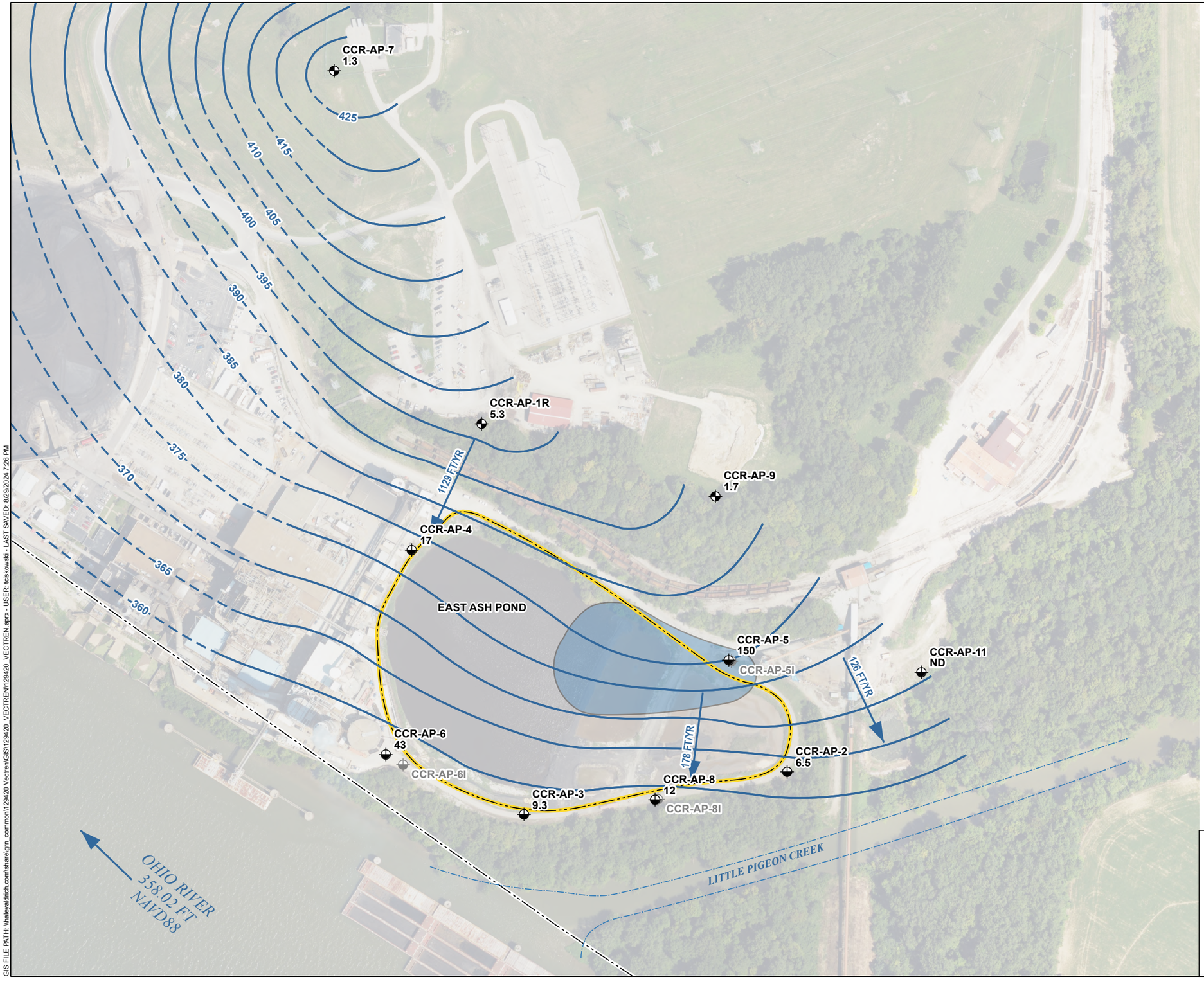
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL NETWORK MAP

AUGUST 2024

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN\129420_VECTREN aprx - USER: toskowski - LAST SAVED: 6/26/2024 4:56 PM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL, DASHED WHERE INFERRED
- CREEK BOUNDARY
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

MOLYBDENUM CONCENTRATION IN MICROGRAMS PER LITER (ug/L)

- 100 TO 400 (APPROXIMATED BASED ON PERIMETER WELL DATA)

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. SAMPLES COLLECTED FROM GROUNDWATER MONITORING WELLS BY ATLAS BETWEEN 6 MAY AND 3 JUNE 2024.
3. WELLS IN GREY NOT USED IN DEVELOPING CONSTITUENT CONCENTRATION CONTOURS.
4. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
ND = NON DETECT
5. WATER LEVELS GAGED ON 6 MAY 2024
6. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 6 MAY 2024 AT 12:00 PM
7. GROUNDWATER VELOCITY SHOWN IN FEET PER YEAR
8.GROUNDWATER PROTECTION STANDARD FOR MOLYBDENUM IS 100 MICROGRAMS PER LITER (ug/L)
9. $V = \frac{k(i)}{n_e}$

V = GROUNDWATER VELOCITY (FT/YR)
K = HYDRAULIC CONDUCTIVITY (FT/YR)
i = GROUNDWATER GRADIENT
n_e = EFFECTIVE POROSITY
10. AERIAL IMAGERY SOURCE: HEXAGON, 25 JULY 2023

N

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SCALE IN FEET

HALEY ALDRICH

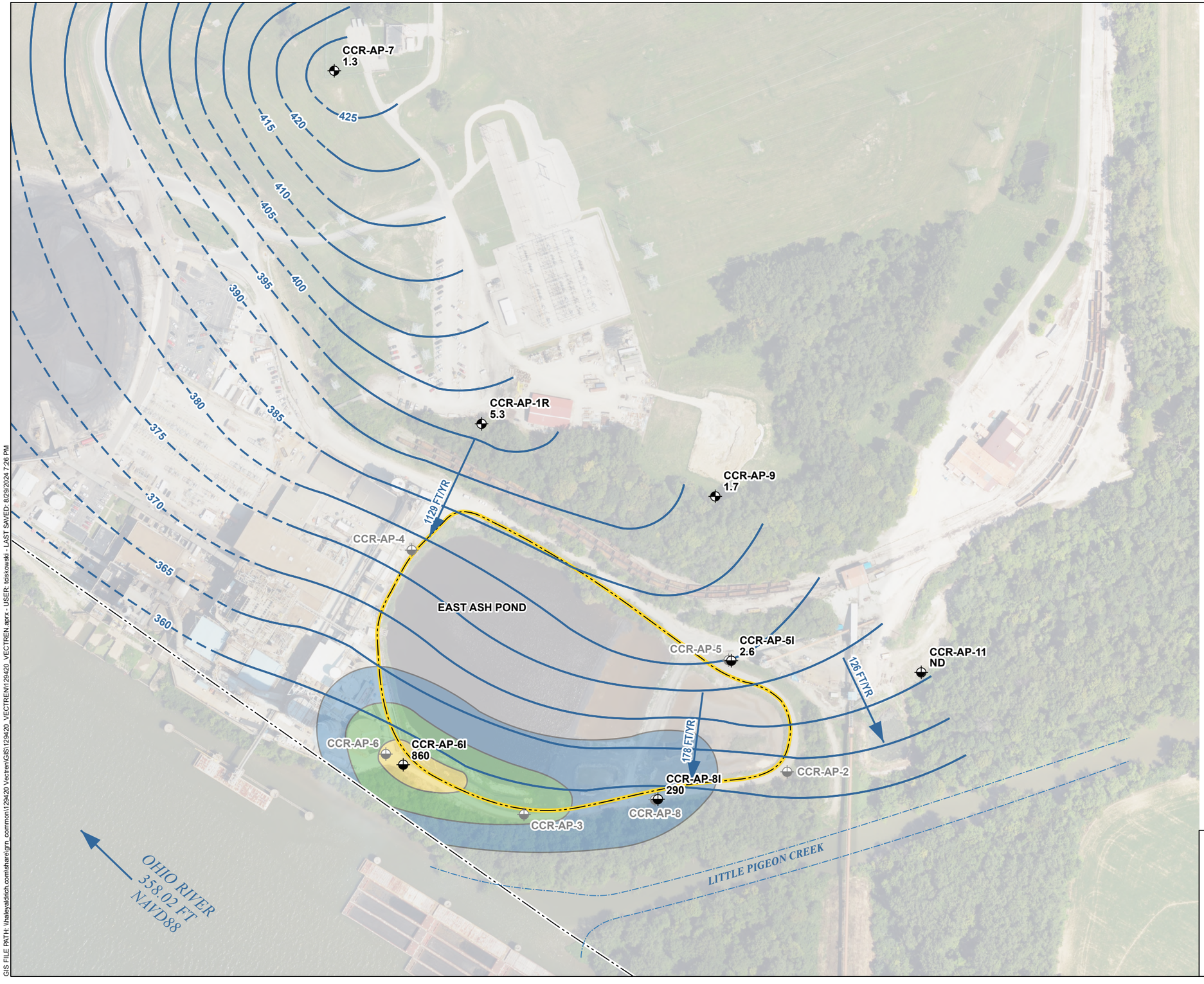
F.B. CULLEY GENERATING STATION - EAST ASH POND
WARRICK COUNTY, INDIANA

MOLYBDENUM ISOCONCENTRATION MAP - SHALLOW AQUIFER MAY 2024

AUGUST 2024

FIGURE 3A

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN1129420_VECTREN.aprx - USER: tciskowski - LAST SAVED: 8/29/2024 7:26 PM



GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN1129420_VECTREN.aprx - USER: tciskowski - LAST SAVED: 8/29/2024 7:26 PM

LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL, DASHED WHERE INFERRED
- CREEK BOUNDARY
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

MOLYBDENUM CONCENTRATION IN MICROGRAMS PER LITER (ug/L)

- 100 TO 400
- 400 TO 700
- 700 TO 1000

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. SAMPLES COLLECTED FROM GROUNDWATER MONITORING WELLS BY ATLAS BETWEEN 6 MAY AND 3 JUNE 2024.
3. WELLS IN GREY NOT USED IN DEVELOPING CONSTITUENT CONCENTRATION CONTOURS.
4. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
ND = NON DETECT
5. WATER LEVELS GAGED ON 6 MAY 2024
6. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 6 MAY 2024 AT 12:00 PM
7. GROUNDWATER VELOCITY SHOWN IN FEET PER YEAR
8.GROUNDWATER PROTECTION STANDARD FOR MOLYBDENUM IS 100 MICROGRAMS PER LITER (ug/L)
9. $V = \frac{k(i)}{n_e}$

V = GROUNDWATER VELOCITY (FT/YR)
K = HYDRAULIC CONDUCTIVITY (FT/YR)
i = GROUNDWATER GRADIENT
n_e = EFFECTIVE POROSITY

10. AERIAL IMAGERY SOURCE: HEXAGON, 25 JULY 2023

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SCALE IN FEET

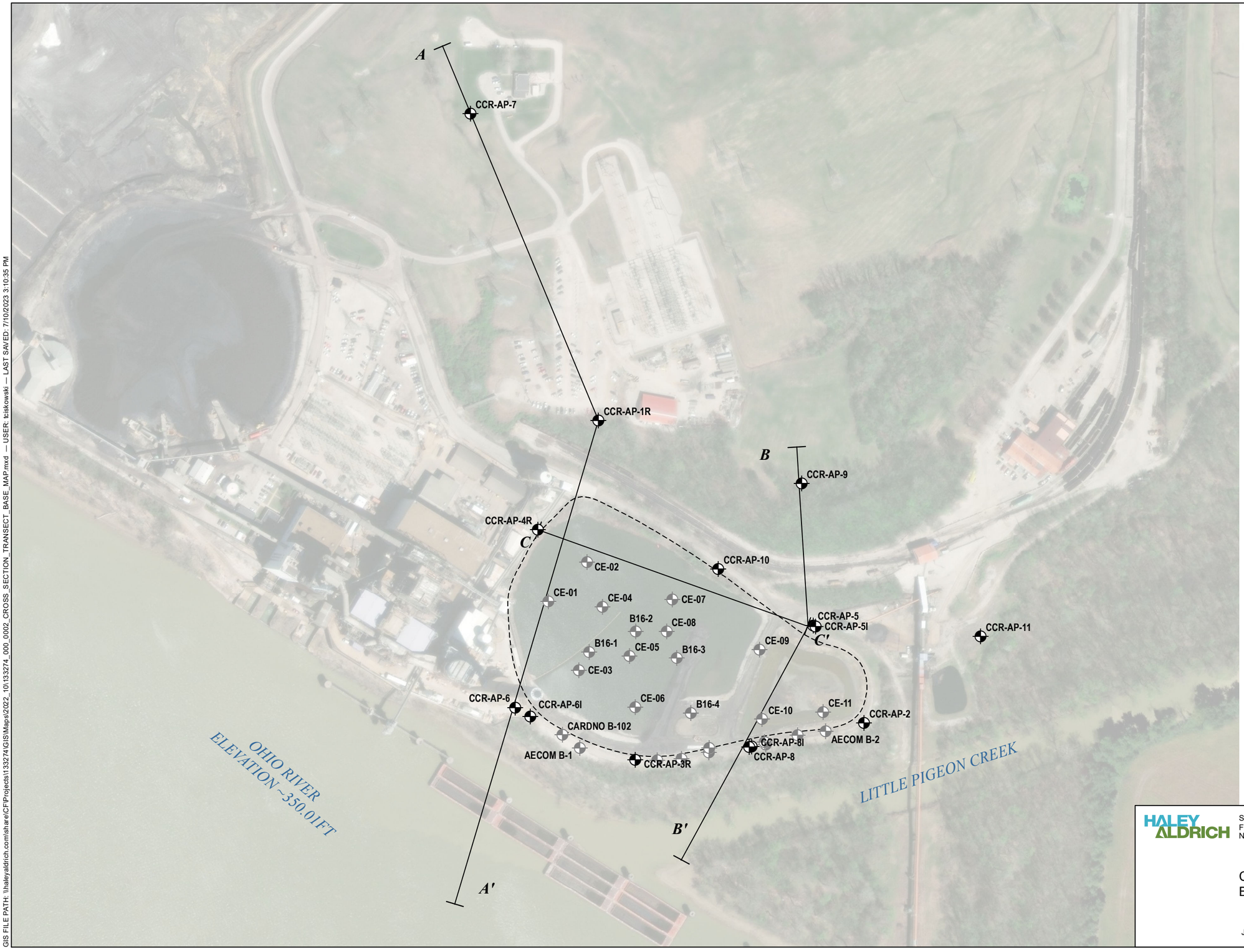
HALEY ALDRICH

F.B. CULLEY GENERATING STATION - EAST ASH POND
WARRICK COUNTY, INDIANA

MOLYBDENUM ISOCONCENTRATION MAP - DEEP AQUIFER MAY 2024

AUGUST 2024

FIGURE 3B



LEGEND

- MONITORING WELL
- AECOM BORING
- CROSS SECTION
- EAST ASH POND

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. AERIAL IMAGERY SOURCE: ESRI

N

0 260 520

SCALE IN FEET

HALEY ALDRICH

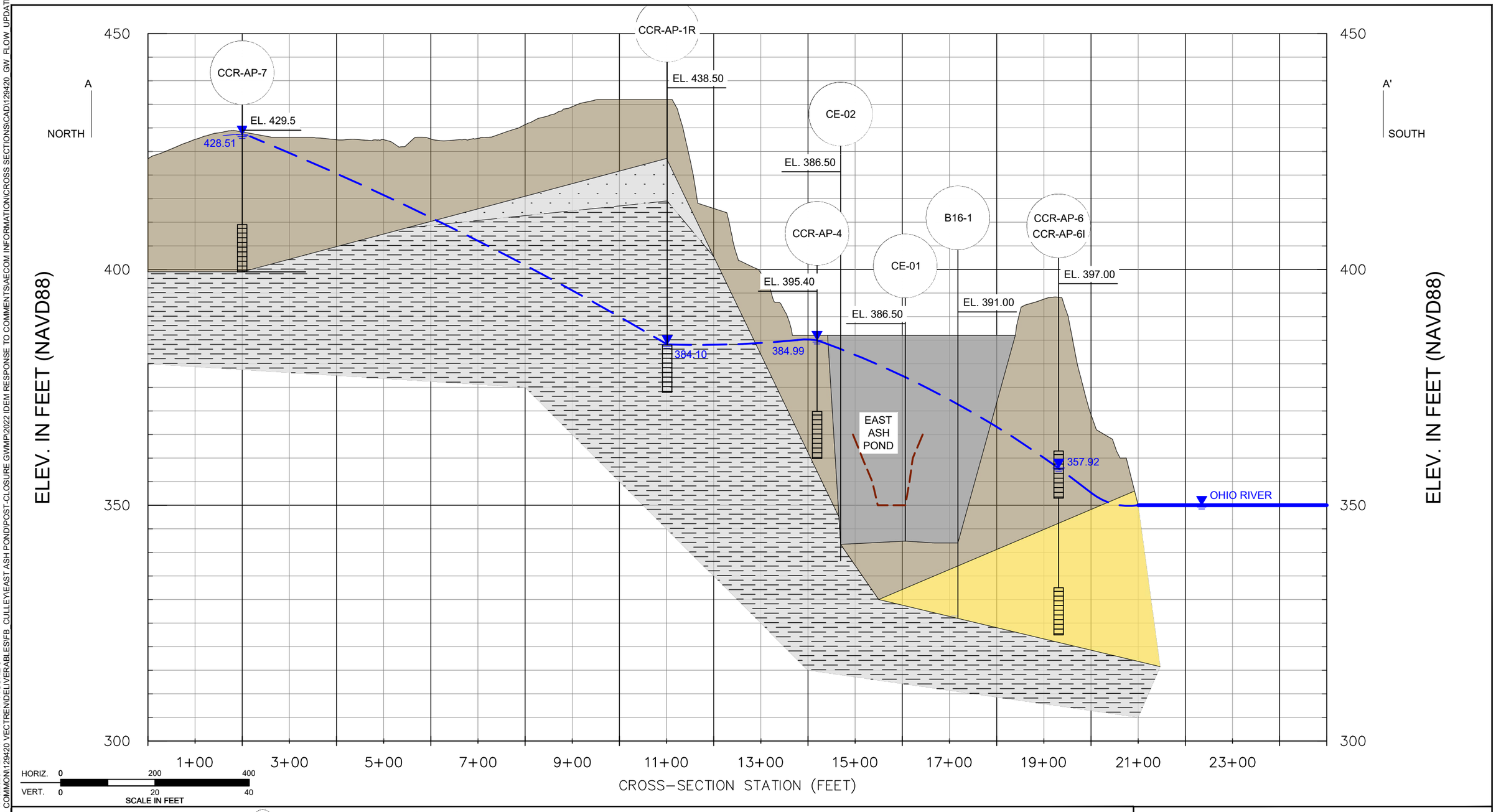
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

CROSS SECTION TRANSECT BASE MAP

JULY 2023

FIGURE 4a

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\133274\GIS\Maps\2022_10\133274_000_0002_CROSS_SECTION_TRANSECT_BASE_MAP.mxd — USER: teiskowski — LAST SAVED: 7/10/2023 3:10:35 PM



LEGEND

BEDROCK
- SANDSTONE
- SHALE
- LIMESTONE

ALLUVIUM
- CLAY/SILT
- SAND

- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION
- SCREEN LOCATION
- COAL ASH (IN THE PROCESS OF BEING REMOVED)
- WATER LEVEL
- INTERPRETED SOIL/ BEDROCK LEVELS
- HISTORICAL STREAM BANK PROFILE

NOTES:

1. EXISTING GRADE BASED ON TOPOGRAPHICAL MAP DEVELOPED BY CT CONSULTANTS JANUARY 31, 2022
2. ASH POND LIMITS OF CCR ARE APPROXIMATE AND BASED BASED ON BORINGS AND LOGS CONDUCTED BY HALEY & ALDRICH AND BORINGS AND LOGS BY AECOM CONDUCTED FOR THE F.B. EAST ASH POND CLOSURE.
3. APPROXIMATE ELEVATIONS OF SOIL LAYERS BETWEEN BORINGS ARE BASED ON INTERPOLATED DATA.
4. GROUNDWATER ELEVATIONS ARE BASED ON BORINGS AND LOGS CONDUCTED BY HALEY & ALDRICH AND BORINGS AND LOGS BY AECOM CONDUCTED FOR THE F.B. EAST ASH POND CLOSURE.

HALEY ALDRICH

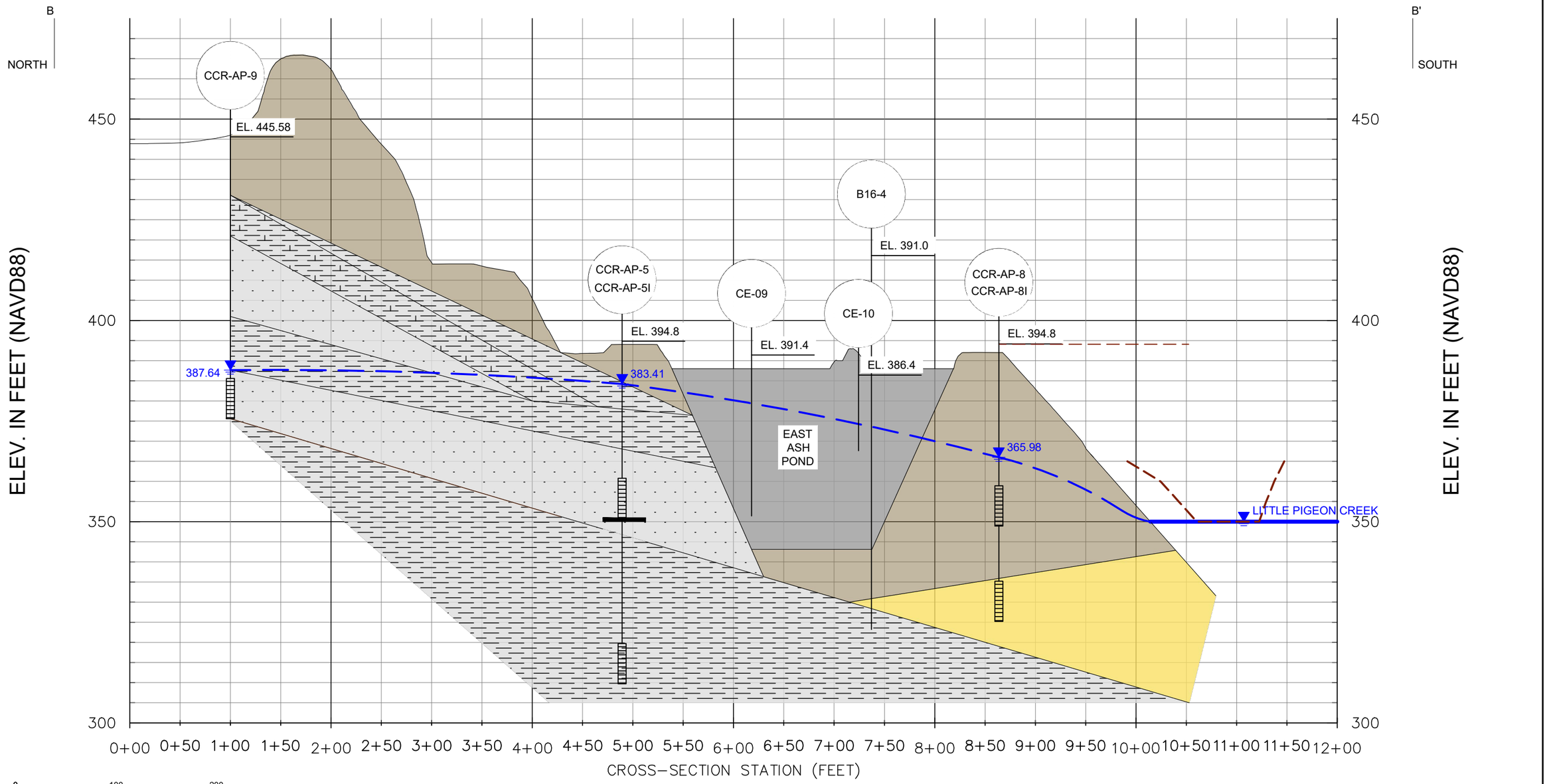
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

CROSS-SECTION A-A'

SCALE: AS SHOWN
JUNE 2023

FIGURE - 4b

\\HALEYALDRICH.COM\SHARE\GRN_COMMON\129420 VECTREN\DELIVERABLES\FB_CULLEY\EAST ASH POND\POST-CLOSURE GWMP\2022 IDEM RESPONSE TO COMMENTS\AECOM INFORMATION\CROSS SECTIONS\CAD\129420_GW_FLOW_UPDATE.DWG
Printed: 7/10/2023 1:27 PM Sheet: FIGURE-3
RYEOMAN



LEGEND

BEDROCK: SANDSTONE; SHALE; LIMESTONE

ALLUVIUM: CLAY/SILT; SAND

BORING ID/LOCATION WITH GROUND SURFACE ELEVATION

SCREEN LOCATION

COAL ASH (IN THE PROCESS OF BEING REMOVED)

WATER LEVEL

INTERPRETED SOIL/ BEDROCK LEVELS

COAL

HISTORICAL STREAM BANK PROFILE

NOTES:

1. EXISTING GRADE BASED ON TOPOGRAPHICAL MAP DEVELOPED BY CT CONSULTANTS JANUARY 31, 2022
2. ASH POND LIMITS OF CCR ARE APPROXIMATE AND BASED BASED ON BORINGS AND LOGS CONDUCTED BY HALEY & ALDRICH AND BORINGS AND LOGS BY AECOM CONDUCTED FOR THE F.B. EAST ASH POND CLOSURE.
3. APPROXIMATE ELEVATIONS OF SOIL LAYERS BETWEEN BORINGS ARE BASED ON INTERPOLATED DATA.
4. GROUNDWATER ELEVATIONS ARE BASED ON BORINGS AND LOGS CONDUCTED BY HALEY & ALDRICH AND BORINGS AND LOGS BY AECOM CONDUCTED FOR THE F.B. EAST ASH POND CLOSURE.

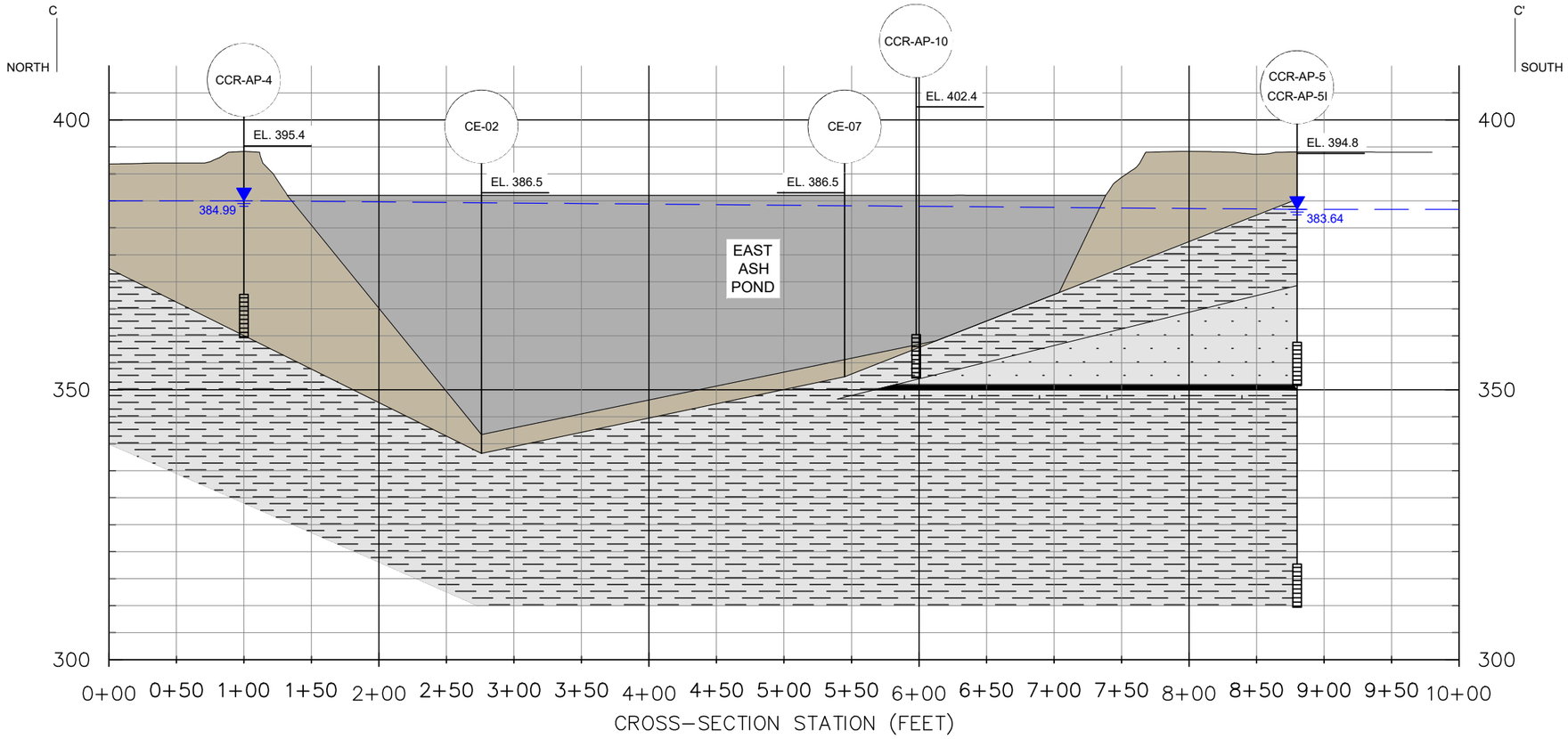
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

CROSS-SECTION B-B'

SCALE: AS SHOWN
JUNE 2023

FIGURE - 4c

\\HALEYALDRICH.COM\SHARE\GRN_COMMON\129420 VECTREN\DELIVERABLES\FB_CULLEY\EAST ASH POND\POST-CLOSURE GWMP\2022 IDEM RESPONSE TO COMMENTS\AECOM INFORMATION\CROSS SECTIONS\CAD\129420_GW_FLOW_UPDATE.DWG
Printed: 7/10/2023 4:24 PM RYEOMAN
Sheet: FIGURE-4



HORIZ. 0 100 200
VERT. 0 25 50
SCALE IN FEET

LEGEND

BEDROCK

- SANDSTONE
- SHALE
- LIMESTONE

ALLUVIUM

- CLAY/SILT

- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION
- SCREEN LOCATION
- COAL ASH (BEING REMOVED)
- WATER LEVEL
- INTERPRETED SOIL/ BEDROCK LEVELS
- COAL

NOTES:

1. EXISTING GRADE BASED ON TOPOGRAPHICAL MAP DEVELOPED BY CT CONSULTANTS JANUARY 31, 2022
2. ASH POND LIMITS OF CCR ARE APPROXIMATE AND BASED BASED ON BORINGS AND LOGS CONDUCTED BY HALEY & ALDRICH AND BORINGS AND LOGS BY AECOM CONDUCTED FOR THE F.B. EAST ASH POND CLOSURE.
3. APPROXIMATE ELEVATIONS OF SOIL LAYERS BETWEEN BORINGS ARE BASED ON INTERPOLATED DATA.
4. GROUNDWATER ELEVATIONS ARE BASED ON BORINGS AND LOGS CONDUCTED BY HALEY & ALDRICH AND BORINGS AND LOGS BY AECOM CONDUCTED FOR THE F.B. EAST ASH POND CLOSURE.

HALEY ALDRICH

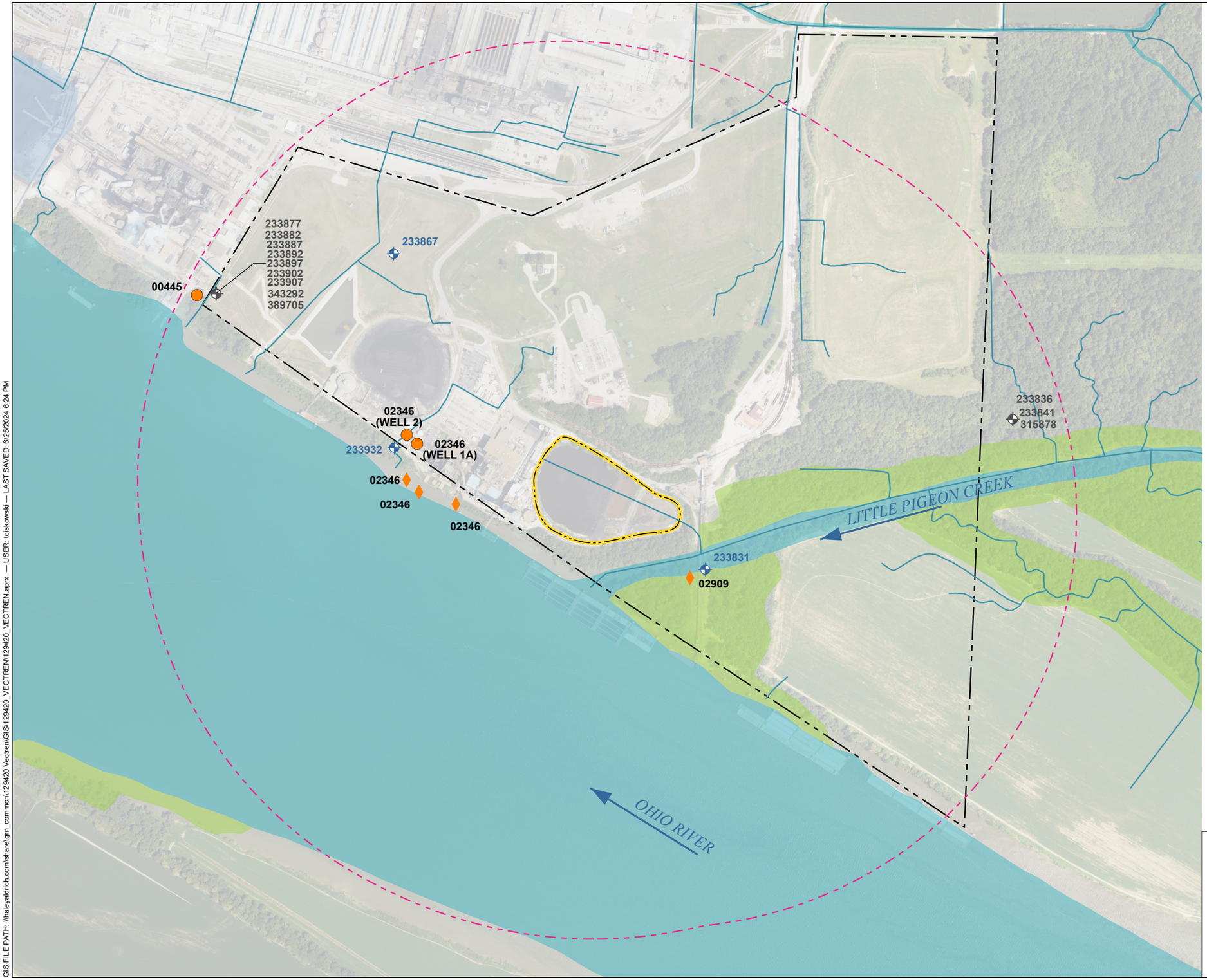
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

CROSS-SECTION C-C'

SCALE: AS SHOWN
JUNE 2023

FIGURE - 4d

\\HALEYALDRICH.COM\SHARE\GRN_COMMON\129420 VECTREN\DELIVERABLES\FB CULLEY\EAST ASH POND\POST-CLOSURE GWMP\2022 IDEM RESPONSE TO COMMENTS\AECOM INFORMATION\CROSS SECTIONS\CAD\129420_GW_FLOW_UPDATE.DWG
RYEOMAN Printed: 7/10/2023 1:28 PM Sheet: FIGURE-5



LEGEND

WATER SUPPLY WELL - NOT SIGNIFICANT WITHDRAWAL

- ESTIMATED LOCATION PER INDIANA DEPARTMENT OF NATURAL RESOURCES (IDNR)
- FIELD LOCATED PER IDNR

SIGNIFICANT WATER WITHDRAWAL

- SURFACE WATER INTAKE
- WELL

NATIONAL HYDROGRAPHY DATASET (NHD)

- STREAM

NATIONAL WETLANDS INVENTORY (NWI)

- FRESHWATER FORESTED/SHRUB WETLAND
- FRESHWATER POND
- RIVERINE

- ASH POND HALF MILE RADIUS
- PROPERTY BOUNDARY
- FB CULLEY EAST ASH POND BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. WATER WELL DATA SOURCE: IDNR RECORD DATABASE, https://www.in.gov/dnr/water/ground-water-wells/water-well-record-database, ACCESSED 13 MARCH 2024
3. SIGNIFICANT WATER WITHDRAWL DATA SOURCE: IDNR, https://www.in.gov/dnr/water/water-availability-use-rights/significant-water-withdrawal-facility-data, AUGUST 2023
4. NATIONAL WETLANDS INVENTORY DATA SOURCE: UNITED STATES FISH AND WILDLIFE SERVICE, https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper, ACCESSED 13 MARCH 2024
5. SIGNIFICANT WITHDRAWAL AND WATER WELLS OUTSIDE OF ASH POND HALF MILE RADIUS ARE NOT SHOWN
6. NHD DATA SOURCE: https://prd-tnm.s3.amazonaws.com/index.html?prefix=StagedProducts/Hydrography/NHD/State/GDB/, ACCESSED 5 APRIL 2024
7. AERIAL IMAGERY SOURCE: HEXAGON, 21 JULY 2022

N

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SCALE IN FEET

HALEY ALDRICH

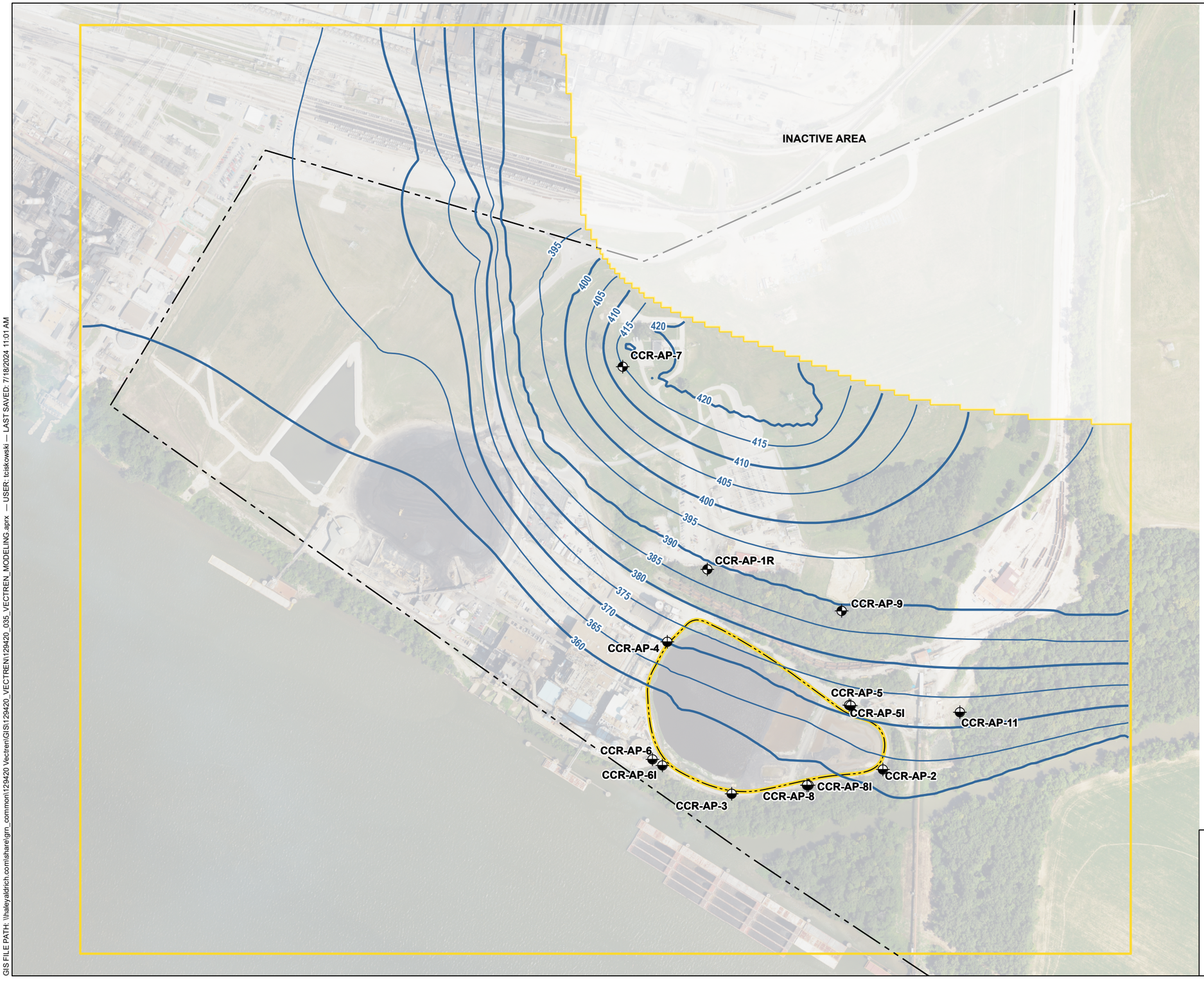
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

WATER WELL LOCATIONS WITHIN A HALF-MILE OF EAST ASH POND

AUGUST 2024

FIGURE 5

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN129420_VECTREN.aprx — USER: tciskowski — LAST SAVED: 6/25/2024 6:24 PM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- GROUNDWATER ELEVATION CONTOUR, 5-FT
- GROUNDWATER ELEVATION CONTOUR, 10-FT
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

2. WELL DESIGNATION:
CCR = COAL COMBUSTION RESIDUALS
AP = ASH POND
R = REPLACED
I = INTERMEDIATE

3. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

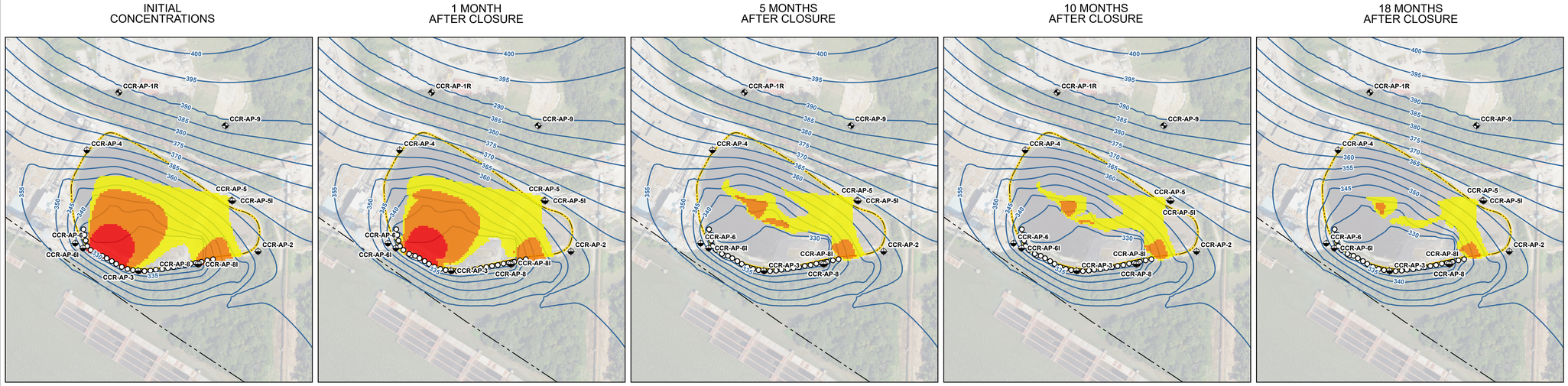
SIMULATED STEADY-STATE GROUNDWATER CONTOUR PLAN

AUGUST 2024

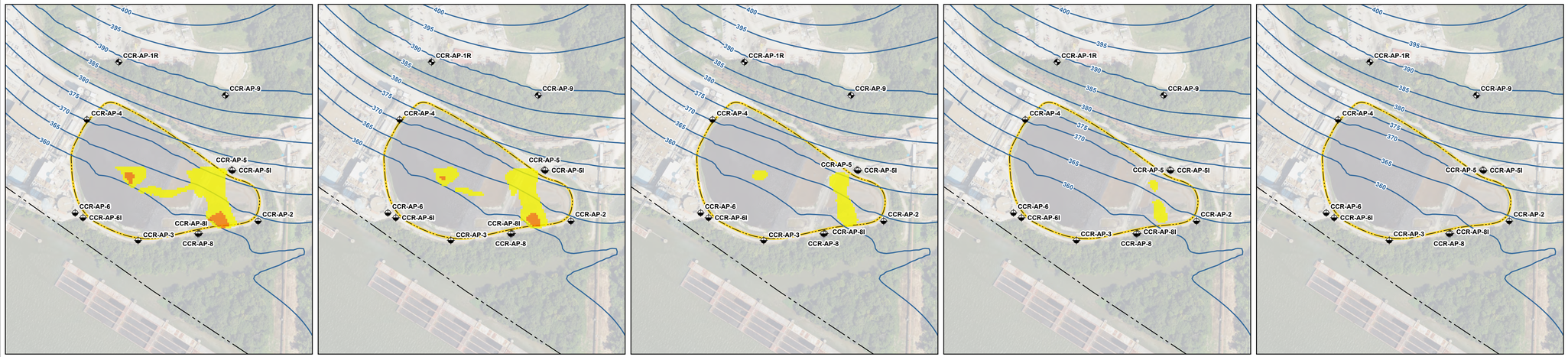
FIGURE 6A

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN\129420_035_VECTREN_MODELING.aprx — USER: tciskowski — LAST SAVED: 7/18/2024 11:01 AM

RUN 1: ASH POND CLOSURE BY REMOVAL WITH DEWATERING



RUN 2: AFTER POND CLOSURE POST-DEWATERING



LEGEND

- PROPOSED DEWATERING WELL
- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- TRANSIENT CONTOUR
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

MOLYBDENUM CONCENTRATION IN ug/L

- 100 TO 150
- 150 TO 300
- > 300

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. WELL DESIGNATIONS:
CCR = COAL COMBUSTION RESIDUALS
R = REPLACED
I = INTERMEDIATE

3. ug/L = MICROGRAMS PER LITER

4. AERIAL IMAGERY SOURCE:
HEXAGON 25 JULY, 2023

N

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SCALE IN FEET

HALEY ALDRICH

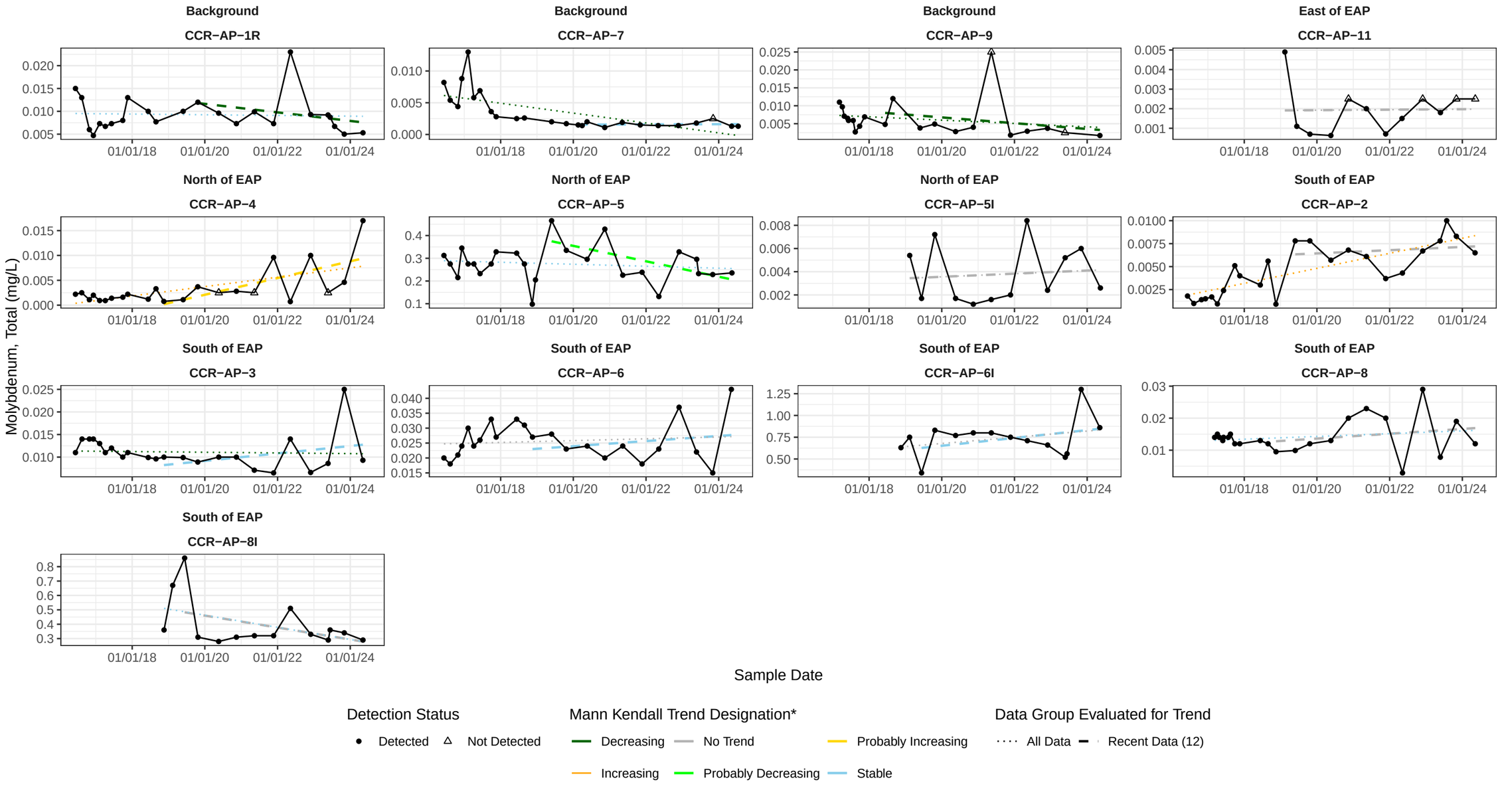
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

TRANSPORT MODEL SIMULATED MOLYBDENUM CONCENTRATIONS OVER TIME

AUGUST 2024

FIGURE 6B

GIS FILE PATH: I:\engdata\cincinnati\engrgrp - xxxxxxx\13N53\Vernon\GIS\13N53_VERNON MXDS\13N53_GW_MOLYBDENUM_MXDS.aprx — LAST SAVED: 7/19/2024 11:01 AM



Notes: mg/L = milligrams per liter

* Presented trend analysis performed on the overall dataset (all available data) and on the 12 most recent data points.

- The Mann−Kendall trend test determines the presence of any existing trends, and trend classification is based on guidance from the Monitoring and Remediation Optimization System (MAROS; Aziz, 2003).
- Non−detect results were substituted with one half the reporting limit value for trend analysis.
- Statistically significant trends include those classified as increasing, decreasing, or stable.
- Trends classified as probably increasing, probably decreasing, or no trend indicate variability in the dataset, such that a significant trend cannot be determined with a reasonable degree of confidence.

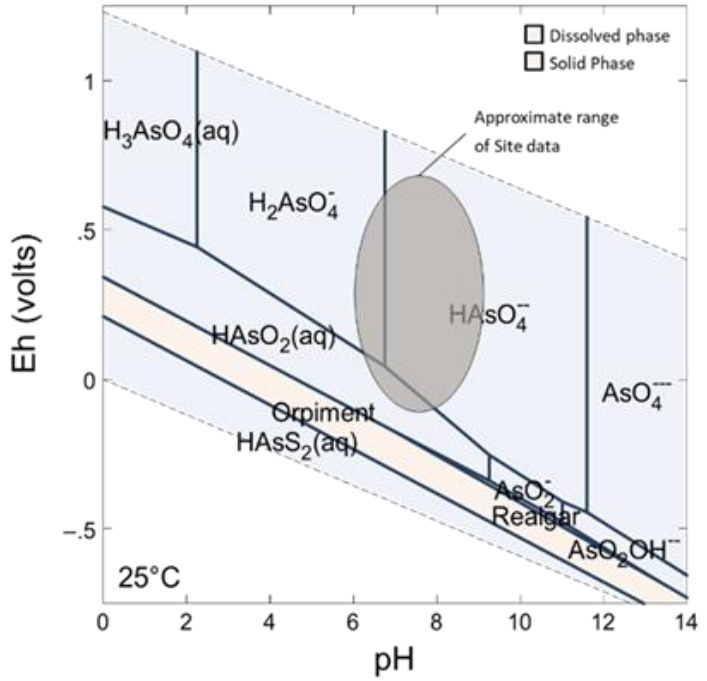
HALEY ALDRICH

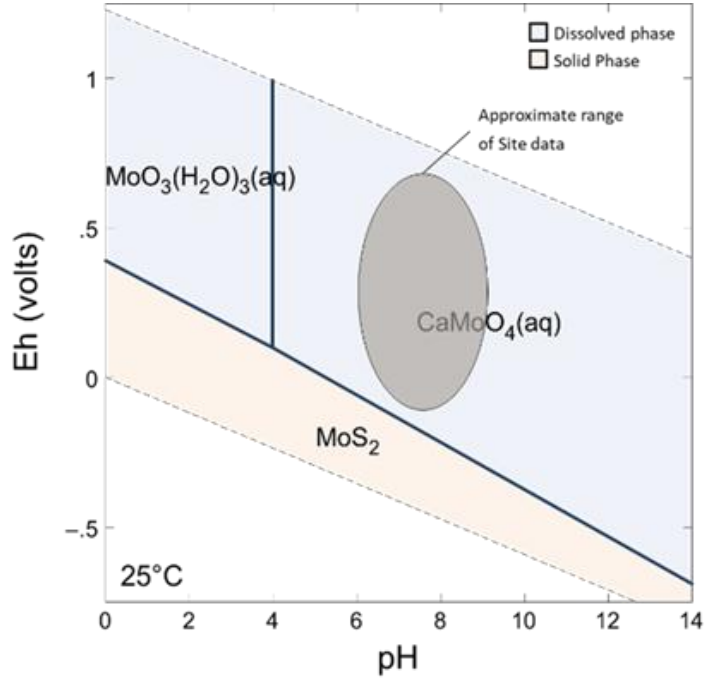
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

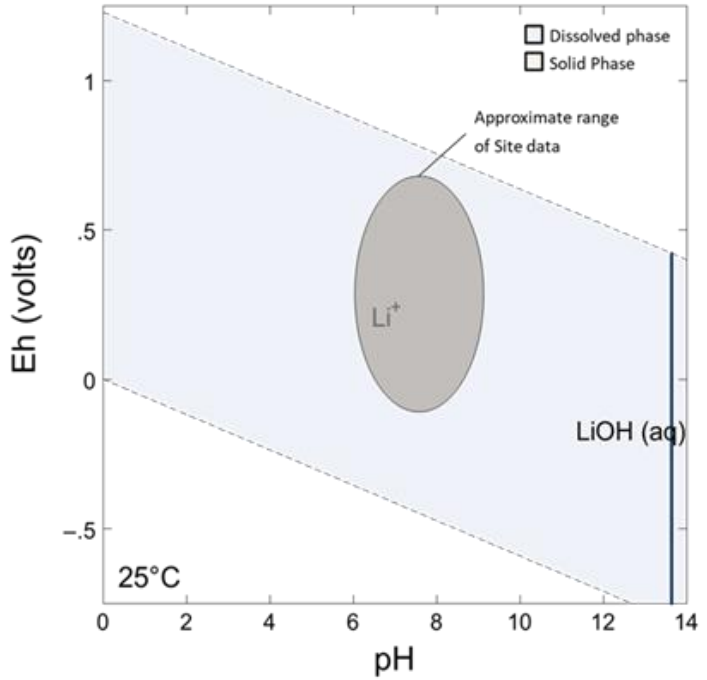
MOLYBDENUM MANN-KENDALL TREND PLOTS FOR SELECT MONITORING WELLS

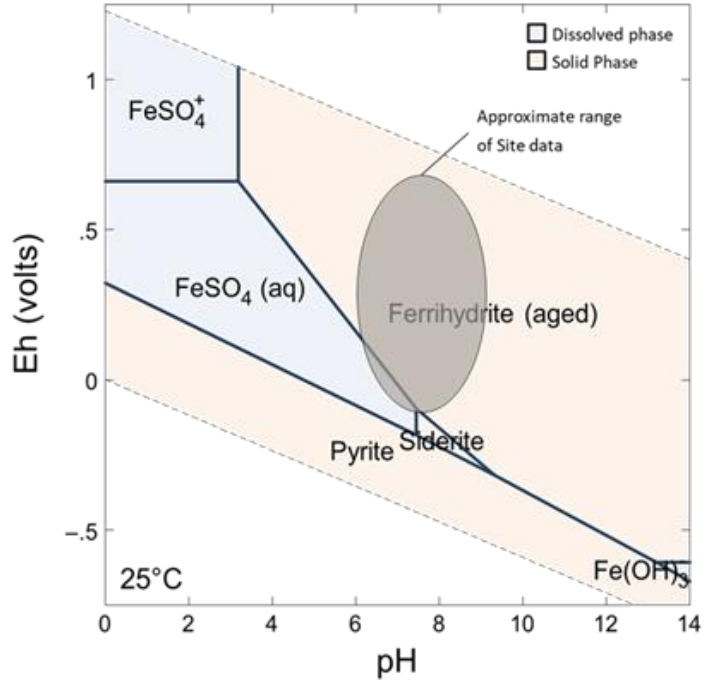
DECEMBER 2024

FIGURE 7









Notes:

Diagram shows chemical speciation of MW-6I from 13 June 2023.

Diagrams were created using GWB with the thermo.com. V8.R6+ database.

Kinetically limited iron minerals suppressed.

HALEY ALDRICH

F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

EH-PH DIAGRAMS

December 2024

Figure 8

APPENDIX A
ISRM Alternative Assessment

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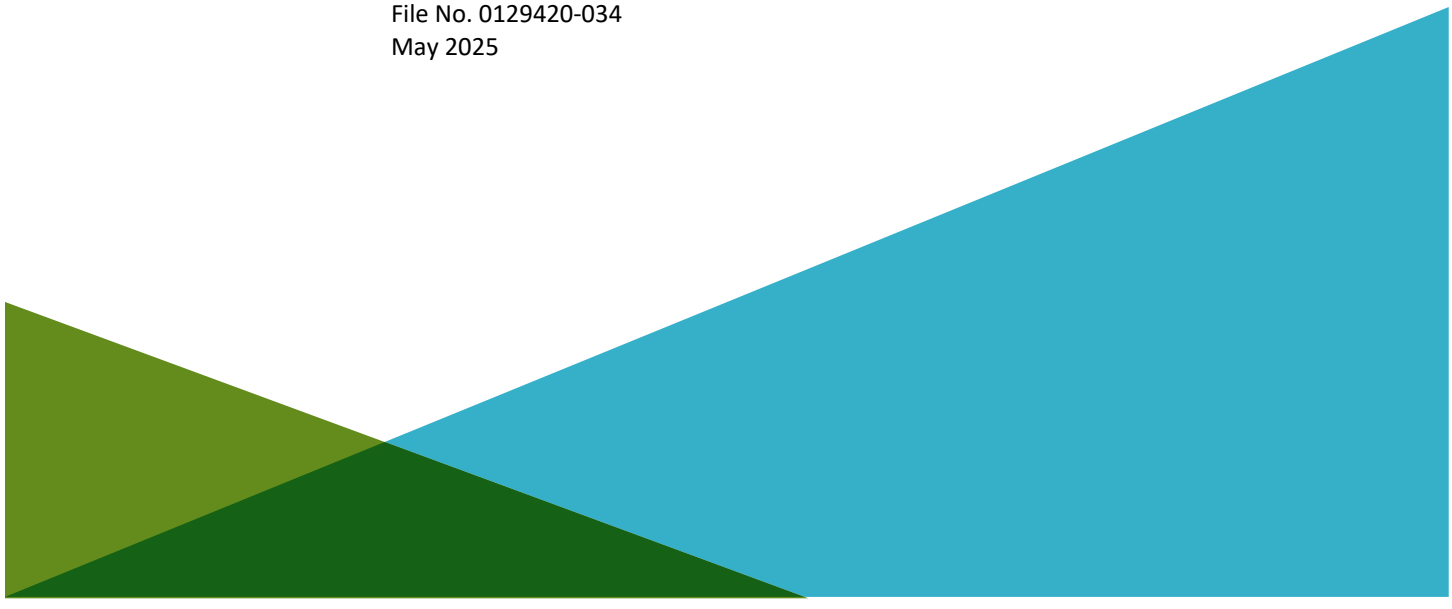
REPORT ON

IN-SITU REDOX MANIPULATION ALTERNATIVE ASSESSMENT ANALYSIS F.B. CULLEY GENERATING STATION WARRICK COUNTY, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 0129420-034
May 2025



Overview

Southern Indiana Gas and Electric Company (SIGECO) retained Haley & Aldrich, Inc. to prepare this *In-Situ Redox Manipulation Alternative Assessment Analysis* to supplement the 2019 Corrective Measures Assessment (CMA) for the coal combustion residual (CCR) management unit, referred to as the East Ash Pond (EAP), located at F.B. Culley Generating Station in Newburgh, Indiana.

The purpose of this report is to update the corrective measures alternatives analysis (for Alternative 8) based on information collected since 2019, including monitoring data, groundwater investigations, conceptual site model (CSM) development, geochemical investigations and groundwater modeling updates, and risk evaluations. Corrective measures assessments have been updated with a focused evaluation of Alternative 8, which involves closure by removal (CBR) and in-situ treatment through targeted redox manipulation.

As required by the CCR Rule (Title 40 Code of Federal Regulations [40 CFR] §257.105 through §257.107), SIGECO published the 2019 CMA Report to its publicly available CCR website and held a public meeting on October 18, 2021 to discuss the results of the CMA with interested parties. No one from the public attended the public meeting, and no verbal or written comments were received during or following the public meeting or through the SIGECO CCR email address. Additionally, SIGECO did not receive written comments from the Indiana Department of Environmental Management (IDEM) or from the United States Environmental Protection Agency.

The following observations are made regarding CBR and groundwater remedial alternatives for the EAP and are described more fully in this report:

- **Groundwater Compliance and Risk:** Risk assessment evaluations confirm that the EAP, even prior to closure, presents no unacceptable risk to human health or the environment. In fact, concentration levels of molybdenum would need to be more than ~1,000 times higher than currently measured levels in groundwater before an adverse impact to human health or the environment exists. Since no adverse risk currently exists, implementation of any of the remedies considered herein will not result in a meaningful reduction in risk to groundwater-related exposures but may reduce the time frame for the presence of elevated constituents in groundwater.
- **Groundwater Treatment:** In order to implement a groundwater alternative that includes treatment, laboratory testing would be required to demonstrate effective treatment of molybdenum using in-situ and ex-situ treatment methods, such as redox manipulation and ion exchange or reverse osmosis (RO). Laboratory-scale testing and geochemical evaluations[1] indicate that in-situ treatment via redox manipulation is a viable option to address the molybdenum concentrations in groundwater. Pilot-scale treatment evaluations for the constituents would be required if such remedies were selected as part of the Corrective Action process.

In accordance with 40 CFR §257.98, SIGECO will implement a groundwater monitoring program to document the effectiveness of the selected remedial alternative. Corrective measures are considered

[1] Haley & Aldrich, Inc., 2025. *Selection of Remedy Report, F.B Culley Generating Station Newburgh, Indiana*.

complete when concentrations of molybdenum in groundwater monitoring wells downgradient of the EAP do not exceed Appendix IV Groundwater Protection Standards for three consecutive years.

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List of Abbreviations

Abbreviation	Definition
40 CFR	Title 40 Code of Federal Regulations
CBR	closure by removal
CCR	coal combustion residual(s)
CCR Rule	40 CFR §257.105 through §257.107
CMA	Corrective Measures Assessment
CSM	conceptual site model
EAP	East Ash Pond
FBC	F.B. Culley Generating Station, Newburgh, Warrick County, Indiana
FGD	flue-gas desulfurization
GWPS	Groundwater Protection Standards
IDEM	Indiana Department of Environmental Management
ISRM	in-situ redox manipulation
MNA	monitored natural attenuation
msl	above mean sea level
RO	reverse osmosis
SIGECO	Southern Indiana Gas and Electric Company
Site	F.B. Culley Generating Station, Newburgh, Warrick County, Indiana
SOR	Selection of Remedy
WAP	West Ash Pond

1. Introduction

Southern Indiana Gas and Electric Company (SIGECO) retained Haley & Aldrich, Inc. to prepare a Selection of Remedy (SOR) Report for the East Ash Pond (EAP), which is a coal combustion residuals (CCR) surface impoundment at the F.B. Culley Generating Station (FBC or Site) in Newburgh, Warrick County, Indiana.

This *In-Situ Redox Manipulation* (ISRM) *Alternative Assessment Analysis* report supports the SOR by refining discussion of Alternative 8 presented in the Corrective Measures Assessment (CMA)[2] analysis to specify the use of targeted redox manipulation as the in-situ treatment method. Monitoring data, conceptual site model (CSM) development, geochemical investigation, groundwater modeling updates, and risk evaluations indicate redox manipulation can effectively reduce molybdenum concentrations to less than the Groundwater Protection Standards (GWPS) and meet the requirements of Title 40 Code of Federal Regulations (40 CFR) §257.97.

1.1 BACKGROUND

In September 2019, SIGECO completed the CMA Report for the EAP. The CMA considered a series of corrective measures alternatives, all of which were demonstrated to meet the threshold criteria listed in 40 CFR §257.97. Additionally, the CMA compared the corrective measure alternatives to one another with respect to three of the four balancing criteria identified in the CCR Rule (40 CFR §257.105 through §257.107) under 40 CFR §257.97(c): 1) long- and short-term effectiveness; 2) source control; and 3) the ease or difficulty of implementing the remedy. The fourth balancing criterion (regarding public comment) was not directly evaluated in the CMA Report; however, it could be evaluated after a public meeting was held in October 2021.

As required by the CCR Rule, SIGECO published the 2019 CMA Report to its publicly available CCR website and held a public meeting on October 18, 2021 to discuss the results of the CMA with interested and affected parties. No one from the public attended the public meeting, and no verbal or written comments were received during or after the public meeting or through the SIGECO CCR email address. Additionally, SIGECO did not receive written comments from the Indiana Department of Environmental Management (IDEM) or from the United States Environmental Protection Agency.

Since 2019, information collected from additional monitoring data, groundwater intrusive investigations, CSM development, Site-specific investigations, groundwater modeling updates, and risk evaluations have necessitated the need to re-evaluate the analysis of each corrective measures alternative.

1.2 CORRECTIVE MEASURE ASSESSMENT REPORT SUMMARY (2019)

Eight corrective measures alternatives were evaluated that included various source control methods (closure in place with in-situ solidification and closure by removal [CBR]) and groundwater remedies (hydraulic containment using pumping with or without treatment, in-situ treatment, and monitored natural attenuation [MNA]). Those eight alternatives were determined to meet the threshold criteria provided in the CCR Rule in 40 CFR §257.97(b). Corrective measures alternatives were then compared based on evaluation of the balancing criteria provided in the CCR Rule in 40 CFR §257.97(c).

[2] Haley & Aldrich, Inc, 2019. *Corrective Measures Assessment Report – Remedial Alternatives*. September.

1.2.1 Potential Applicable Technologies Evaluated

SIGECO has selected CBR with disposal at an off-Site permitted facility as the primary means of source control. Groundwater remedies evaluated to complement CBR included in-situ groundwater treatment.

Section 3 examines the updated alternative analysis based on the testing results and technical evaluation completed since 2019.

1.2.2 Public Engagement

SIGECO submitted a CMA Report for public review in September 2019 and an addendum (that includes flow and transport modeling) in November 2020.[3] Based on the results of the CMA and technical analysis of recent data (i.e., evaluation of analytical data trends, aquifer material analysis and evaluation, bench-scale testing, flow and transport, and geochemical analysis), the selection of a remedy can proceed.

1.3 FACILITY DESCRIPTION

The Site is located on the northern bank of the Ohio River approximately 3 miles east of the town of Newburgh. The Site varies in elevation, with natural ground surface elevations varying from 430 to 359 feet above mean sea level (msl). Higher elevations are north of the EAP with surface topography sloping to the west and south toward the Ohio River. Surface water runoff occurs via sheet flow into low-lying areas toward the Ohio River and Little Pigeon Creek. Figure 1 shows the location of the Site and the EAP.

The Site has been in operation since 1953, and CCR materials were managed on the Site in a 32-acre impoundment known as the West Ash Pond (WAP) and the 10-acre East Ash Pond (EAP) impoundment. The EAP was commissioned circa 1971 and is the subject of this report. Plant development involved excavating a portion of the hillsides to the north and placing the material as fill to the south. Little Pigeon Creek originally flowed east to west across the property. To facilitate construction of the generating station, Little Pigeon Creek was diverted, joining the Ohio River near the southeastern property boundary. The eastern bank is an earthen dike constructed during the diversion of Little Pigeon Creek in 1953. Modifications to the EAP occurred from 1992 to 1993 by filling an approximately 14,000-square-foot area in the southwestern corner to build a pad for new scrubber silos.

The EAP had previously received bottom ash via sluice water from both of the facility's generating units. In addition, the EAP received outlet water from the flue-gas desulfurization (FGD) wastewater treatment system, the oil separation tank, east side yard sump, air heater wash, boiler seal-throughs, floor drains, greensand water treatment filters regenerant and backwash, softener regenerant streams and reverse osmosis (RO) reject water, and rejects from the FGD system. Any present-day CCR material produced is sent off Site for beneficial use or disposal. Any excess wastewaters are directed to a lined pond designed and constructed to receive the wastewaters, with all CCR material captured and contained prior to discharge to the pond.

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[3] Haley & Aldrich, Inc., 2019. *Corrective Measures Assessment Addendum for F.B. Culley Generating Station, Newburgh, Indiana*. September.
Haley & Aldrich, Inc., 2024a. *Groundwater Flow Modeling Addendum to Corrective Measures Assessment F.B. Culley Generating Station East Ash Pond Newburgh, Indiana*.

2. Corrective Measures Alternatives

2.1 CORRECTIVE MEASURES ASSESSMENT GOALS

The overall goal of the CMA analysis is to:

- Identify and evaluate the appropriateness of potential corrective measures to prevent further releases of Appendix IV constituents to groundwater above their GWPS.
- Remediate releases of Appendix IV constituents detected during groundwater monitoring above their GWPS that have already occurred.
- Restore groundwater in the affected area to conditions where Appendix IV constituents are present to concentrations below their respective GWPS.

Remedial alternatives evaluated in the 2019 corrective measures assessment are summarized on Figure 2. This report provides a more detailed examination of Alternative 8, which involves CBR and in-situ treatment through targeted redox manipulation. By meeting these requirements, this assessment also meets the requirements promulgated in 40 CFR §257.96, which includes an evaluation of:

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;
- The time required to complete the remedy; and
- The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy.

The criteria listed above are included in the balancing criteria considered during the corrective measures evaluation as described in Section 3.

2.1.1 Alternative 8: In-Situ Treatment and CBR

The EAP will undergo CBR. Under Alternative 8, molybdenum would be addressed through in-situ addition of groundwater treatment amendments targeting hot spot areas within and downgradient of the EAP with the objective of accelerating the time required to achieve the GWPS within the treatment zone.

Approvals and permitting would be required for the construction and installation of the treatment system and injection/application of amendments to the subsurface. Implementation of an in-situ treatment system will require a detailed, lengthy design effort with additional bench-scale testing to verify the efficacy of groundwater treatment. Bench-scale testing will evaluate the efficacy of treating molybdenum in-situ, while factoring in potential changes in groundwater geochemistry which may adversely affect the stability of other CCR-related constituents.

Following installation of the in-situ treatment system, SIGECO would implement post-closure care activities that may include periodic amendment injections or periodic replenishment of the treatment

reagents within the treatment zone or reactive barrier, long-term groundwater sampling to monitor treatment system performance, and cover system maintenance.

2.1.1.1 Treatment through In-situ Redox Manipulation

Under Alternative 8, molybdenum detected in groundwater at concentrations above the GWPS will be addressed by altering the subsurface geochemical conditions through ISRM, which aims to reduce molybdenum concentrations and control downgradient constituent migration in groundwater.

Geochemical manipulation of subsurface conditions for remediating inorganic constituents in groundwater is a proven remedial technology for localized treatment under certain Site conditions. This technique can be applied in three main ways:[4]

- Redox manipulation: Altering the oxidation-reduction conditions to transform to reduce the concentration dissolved in groundwater.
- Adsorption to metal oxyhydroxides: Using iron or other metal oxyhydroxides to adsorb constituents under oxidizing conditions.
- Adsorption to or coprecipitation with metal sulfides: Under reducing conditions, constituents can be adsorbed to or coprecipitated with iron or other metal sulfides, effectively sequestering them.

Due to the Site's geochemical conditions (based on geochemical evaluation and modeling), localized ISRM treatment of molybdenum is considered feasible by means of catalyzing reductive precipitation of molybdenum disulfide onto aquifer solids, thereby reducing molybdenum concentrations in groundwater.

Redox manipulation would occur in-situ, which may require the installation of injection wells, trenches, and/or the use of direct-push injections that would need to deliver reactive agents into the aquifer for ISRM treatment. Additionally, ISRM can be completed by applying amendments to targeted areas prior to any backfill. Laboratory treatability studies and/or field pilot tests are typically completed before full-scale implementation to support the remedial design. Similar to other active remedial alternatives, system operations and maintenance are necessary with specific requirements dependent on the substrate delivery system. No secondary waste is anticipated to result from the ISRM treatment process.

Depending on the delivery system that is chosen, design and construction would require additional development, which may add complexity to this alternative. Pilot test planning for ISRM treatment can begin once the remedy is selected with field testing to begin within a year of selection.

[4] Haley & Aldrich, Inc., 2024b. *Groundwater Geochemical Conceptual Site Model for F.B. Culley Generation Station – East Ash Pond, Newburgh, Indiana*.

3. Corrective Measures Alternative Assessment – Alternative 8: In-situ Treatment Through Redox Manipulation

The purpose of this section is to evaluate and compare Alternative 8 using the balancing criteria described in 40 CFR §257.97(c).

3.1 EVALUATION CRITERIA

In accordance with 40 CFR §257.97, remedial alternatives that satisfy the threshold criteria are then compared to four balancing (evaluation) criteria. The balancing criteria allow a comparative analysis for each corrective measure thereby providing the basis for final corrective measure selection. As outlined in 40 CFR §257.97(c), the four balancing criteria include the following:

- Long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
- Effectiveness of the remedy in controlling the source to reduce further releases;
- Ease or difficulty of implementing a potential remedy; and
- Degree to which community concerns are addressed by a potential remedy.

Regarding the fourth balancing criterion (i.e., community concerns), no verbal or written comments were received during or after the public meeting held in October 2021.

3.2 COMPARISON OF ALTERNATIVES

Each of the balancing criteria consists of several sub-criteria listed in the CCR Rule that have been considered in this assessment. The goal of this analysis is to confirm that Alternative 8 is technologically feasible, relevant, and readily implementable, provides adequate protection of human health and the environment, and minimizes impacts to the community.

A color-coded graphic that is part of a comprehensive visual comparison tool (see Table 1) is presented within each subsection below. These graphics provide a visual snapshot of the favorability of Alternative 8, where green represents “highly favorable,” yellow represents “moderately favorable,” and red represents “low favorability.”

3.2.1 Balancing Criterion 1 - The Long- and Short-Term Effectiveness and Protectiveness of the Potential Remedy, along with the Degree of Certainty that the Remedy Will Prove Successful

This balancing criterion takes into consideration the relative long-term and short-term effectiveness of the remedy, along with the anticipated success of the remedy. Based on the discussion in Sections 3.2.1.1 through 3.2.1.8, Alternative 8 scored a “moderate” overall rating for this criterion.

3.2.1.1 Magnitude of Reduction of Existing Risks

As indicated by the nature and extent evaluation and the most recent groundwater sampling results and risk evaluation, no unacceptable risk to human health and the environment exists with respect to the EAP. Therefore, all proposed remedies are considered protective of human health and the environment.

Alternative 8, which includes CBR, is considered a highly favorable option because the source will be removed from the environment and in-situ treatment of impacted groundwater can further reduce constituent concentrations to less than the GWPS.

3.2.1.2 Magnitude of Residual Risks in Terms of Likelihood of Further Releases Due to CCR Remaining Following Implementation of a Remedy

Alternative 8 is considered to have a low magnitude of residual risk because no CCR material will remain in place after the remedy has been implemented.

3.2.1.3 The Type And Degree Of Long-Term Management Required, Including Monitoring, Operations, and Maintenance

Since Alternative 8 is an active remedy that includes the application of amendments to reduce constituent concentrations, system operations, maintenance, and performance monitoring. Unlike standard groundwater extraction systems, ISRM treatments are periodic and therefore do not require continued operations or maintenance. Alternative 8 is considered moderately favorable due to the effort involved in setting up and operating the system and monitoring the requirements necessary to confirm that the treatments are effective.

3.2.1.4 Short-Term Risks That Might be Posed to the Community or the Environment During Implementation of Such a Remedy

Short-term risks to the community are primarily related to the source control component of Alternative 8. Increased truck traffic near FBC may impact the community for a period of approximately 18 months on public roads during the ash pond closure.

3.2.1.5 Time Until Full Protection is Achieved

As previously stated, there is currently no unacceptable exposure to groundwater impacted by molybdenum associated with the EAP; therefore, protection is already achieved. The time frames to achieve the GWPS were evaluated using a predictive groundwater flow model (Section 4 of the SOR Report). Based upon predictive modeling, Alternative 8, which includes an in-situ remediation component, are predicted to achieve the GWPS in the shortest amount of time.

3.2.1.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated With Excavation, Transportation, Re-Disposal, or Containment

Alternative 8, which includes excavation, transportation, and off-Site disposal of CCR material, has a potential risk for exposure to humans and environmental receptors due to construction and transportation.

3.2.1.7 Long-Term Reliability of the Engineering and Institutional Controls

Relatively low-magnitude concentrations, generally stable to decreasing concentration trends, existing geochemical conditions, and simulated effects of closure to reduce molybdenum concentrations support ISRM as an appropriate remedial alternative with an expected long-term benefit. Bench-scale testing using soil and groundwater samples collected from the Site demonstrate this technology can reliably

reduce molybdenum concentrations to less than the GWPS. The application of the in-situ technology is an appropriate alternative for treatment of isolated areas (e.g., in the vicinity of a few targeted impacted wells). Alternative 8 is considered to be moderately favorable.

3.2.1.8 Potential Need For Replacement of the Remedy

The potential need to replace CBR and ISRM as the selected remedy is low. Removal of CCR material mitigates the source, and precipitation of molybdenum using ISRM can reduce molybdenum concentrations to less than the GWPS. Performance monitoring will be planned to evaluate ISRM effectiveness and determine if additional application would be beneficial.

3.2.2 Balancing Criterion 2 - The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases

This balancing criterion takes into consideration the ability of the remedy to control a future release and the degree of complexity of treatment technologies that would be required. Alternative 8 is considered "highly favorable" for Criterion 2.

3.2.2.1 The Extent to Which Containment Practices Will Reduce Further Releases

Alternative 8 includes removal of CCR material from the ash pond and off-Site placement in a lined permitted landfill in accordance with applicable regulatory requirements. Therefore, the likelihood for further release is low.

3.2.2.2 The Extent to Which Treatment Technologies May Be Used

Alternative 8 includes in-situ treatment of groundwater through redox manipulation to reduce molybdenum concentrations in groundwater. These treatments would be targeted to areas of the Site where elevated molybdenum persists post-closure.

3.2.3 Balancing Criterion 3 - The Ease or Difficulty of Implementing a Potential Remedy

This balancing criterion takes into consideration the following technical and logistical challenges required to implement a remedy:

- Degree of difficulty associated with constructing the technology;
- Expected operational reliability of the technologies;
- Need to coordinate with and obtain necessary approvals and permits from other agencies;
- Availability of necessary equipment and specialists; and
- Available capacity and location of needed treatment, storage, and disposal services.

Alternative 8 is considered "moderately favorable" as an overall rating for Criterion 3.

3.2.3.1 Degree of Difficulty Associated With Constructing the Technology

Alternative 8 relies on in-situ treatment of groundwater that will require groundwater well installation, delivery system construction, and field-scale pilot testing. Groundwater wells and components of the

system can be completed using standard tools and methods; therefore, the difficulty of construction is expected to be limited.

3.2.3.2 Expected Operational Reliability of the Technologies

Pilot testing is necessary to evaluate the extent and durability of in-situ treatments. Results of the pilot test will be used to inform the final design of the delivery system, amendment selection, and the application schedule. Since pilot testing is necessary to support the final design, and geochemical conditions can change, operational reliability of ISRM is considered moderate.

3.2.3.3 Need To Coordinate With and Obtain Necessary Approvals and Permits From Other Agencies

Alternative 8 may require additional permitting and approvals for treatability testing, field-scale pilot testing, groundwater recirculation, groundwater treatment, and/or disposal of secondary waste streams.

3.2.3.4 Availability of Necessary Equipment and Specialists

Alternative 8 will require groundwater well installation, field-scale pilot testing and laboratory analysis, and construction contractor support. Standard construction methods and tooling can be used to support ISRM.

3.2.3.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services

Alternative 8, which include CBR, requires adequate capacity, storage, and disposal service for off-Site receiving facilities. The relatively small size of the EAP should not adversely impact CBR with respect to this criterion.

3.2.3.6 Balancing Criterion 3 Summary

Although Alternative 8 may have some complexities in the design phase, permitting is anticipated to be straightforward for completing the CBR and delivery of ISRM. ISRM is a well understood remedial technique and is considered relatively straightforward to implement.

4. Summary

Alternative 8, CBR and ISRM, meets the following threshold criteria:

- Be protective of human health and the environment;
- Attain the GWPS;
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of contaminants of concern to the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- Comply with standards (regulations) for waste management.

In addition, in accordance with 40 CFR §257.97(c), Alternative 8 has been evaluated in the context of the following balancing criteria:

- The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
- The effectiveness of the remedy in controlling the source to reduce further releases;
- The ease or difficulty of implementing a potential remedy; and
- The degree to which community concerns are addressed by a potential remedy.

Building on the results of the 2019 CMA Report, the addition of this alternative analysis report supports selection of a final corrective measure for implementation at the EAP.

References

1. USEPA, 2015a. Final Rule: Disposal of Coal Combustion Residuals (CCRs) for Electric Utilities. 80 FR 21301-21501. U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.govinfo.gov/content/pkg/FR-2015-04-17/pdf/2015-00257.pdf

2. USEPA, 2015b. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites.

TABLE

TABLE 1
SUMMARY OF CORRECTIVE MEASURES
CORRECTIVE MEASURES ASSESSMENT
F.B. CULLEY GENERATING STATION - EAST ASH POND

Alternative Number	Remedial Alternative Description	THRESHOLD CRITERIA					BALANCING CRITERIA																	
								Sub-Category 1									Sub-Cat. 2			Sub-Category 3				
								1	2	3	4	5	6	7	8		1	2		1	2	3	4	5
		Be protective of human health and the environment	Attain the groundwater protective standard	Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment	Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems	Management of waste to comply with all applicable RCRA requirements	CATEGORY 1 Long- and Short-Term Effectiveness, Protectiveness, and Certainty of Success that the remedy will prove successful	*Magnitude of reduction of existing risks*	*Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy*	*Type and degree of long-term management required including monitoring, operation and maintenance*	*Short-term risk to community or environment during implementation of remedy*	*Time until full protection is achieved*	*Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment*	*Long-term reliability of engineering and institutional controls*	*Potential need for replacement of the remedy*	CATEGORY 2 Effectiveness in controlling the source to reduce further releases	*Extent to which containment practices will reduce further releases*	*Extent to which treatment technologies may be used*	CATEGORY 3 The ease or difficulty of implementation	*Degree of difficulty associated with constructing the technology*	*Expected operational reliability of the technologies*	*Need to coordinate with and obtain necessary approvals and permits from other agencies*	*Availability of necessary equipment and specialists*	*Available capacity and location of needed treatment, storage, and disposal services*
8	In-Situ Treatment and CBR	✓	✓	✓	✓	✓																		

COLOR LEGEND

	Highly favorable when compared to other alternatives
	Moderately favorable when compared to other alternatives
	Low favorability when compared to other alternatives

Notes:

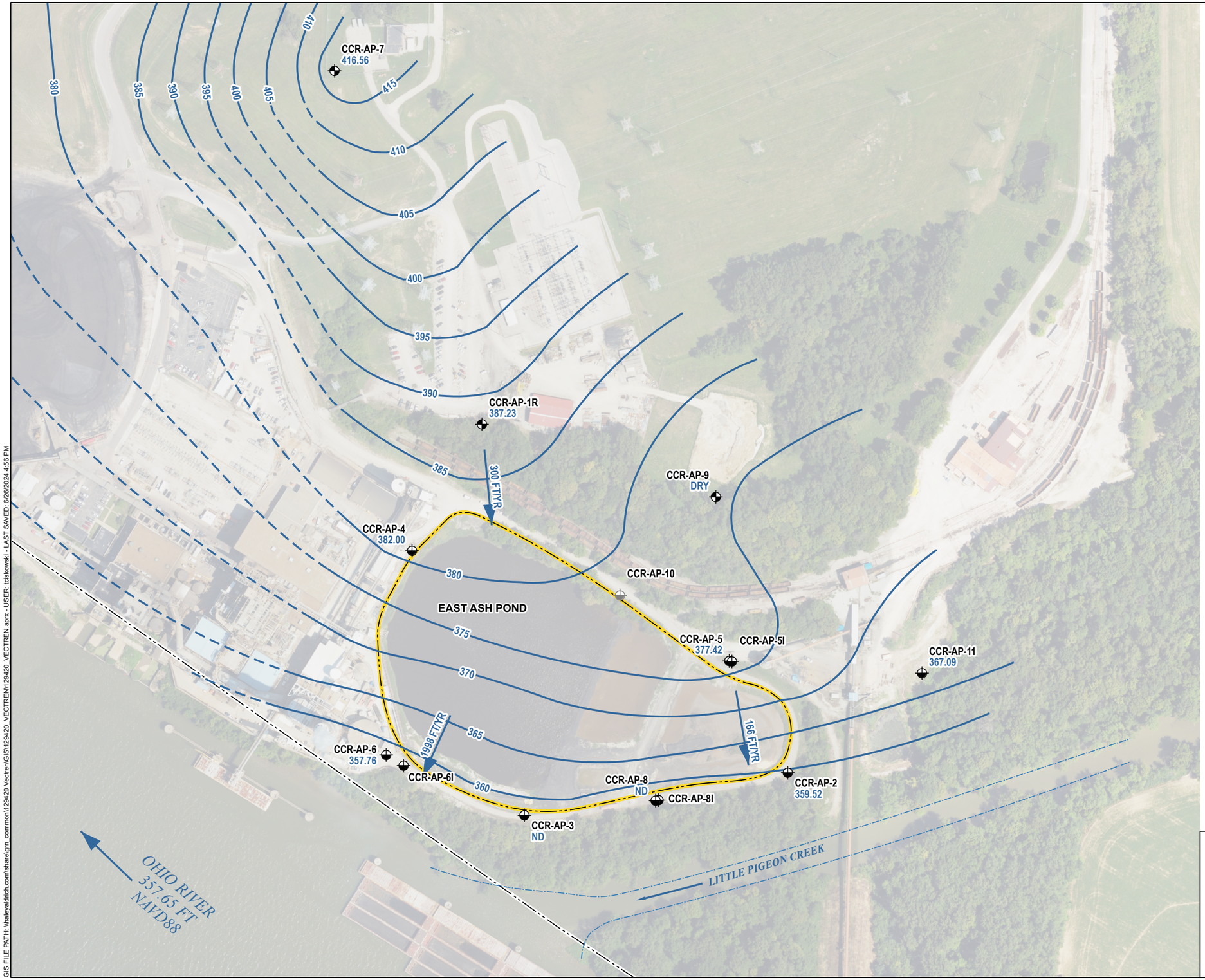
1. The long- and short- term effectiveness evaluation considered the following criteria:
(i) Magnitude of reduction of existing risks;
(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;
(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance;
(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;
(v) Time until full protection is achieved;
(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;
(vii) Long-term reliability of the engineering and institutional controls; and
(viii) Potential need for replacement of the remedy.

2. The effectiveness in controlling the source to reduce further releases considered the following criteria:
(i)The extent to which containment practices will reduce further releases.
(ii)The extent to which treatment technologies may be used.

3. The ease or difficulty of implementation considered the following criteria:
(i)Degree of difficulty associated with constructing the technology.
(ii)Expected operational reliability of the technologies.
(iii)Need to coordinate with and obtain necessary approvals and permits from other agencies.
(iv) Availability of necessary equipment and specialists.
(v) Available capacity and location of needed treatment, storage, and disposal services.

4. For context, this a relative comparison of remedial options for this site. Site conditions, weather, and site-specific considerations are made in this table. This is not a comparison to all options at all sites.

FIGURES



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL WITH **GROUNDWATER ELEVATION** IN FEET
- DOWNGRADIENT GROUNDWATER MONITORING WELL WITH **GROUNDWATER ELEVATION** IN FEET
- ABANDONED GROUNDWATER MONITORING WELL
- GROUNDWATER FLOW DIRECTION
- CREEK BOUNDARY
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL, DASHED WHERE INFERRED
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
ND = NO DATA
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

3. WATER LEVELS GAGED ON 1 NOVEMBER 2023

4. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 1 NOVEMBER 2023 AT 12:00 PM

5. GROUNDWATER VELOCITY SHOWN IN FEET PER YEAR

6. $V = \frac{k(i)}{n_e}$

V = GROUNDWATER VELOCITY (FT/YR)
K = HYDRAULIC CONDUCTIVITY (FT/YR)
i = GROUNDWATER GRADIENT
n_e = EFFECTIVE POROSITY

7. AERIAL IMAGERY SOURCE: HEXAGON, 25 JULY 2023

N

0 230 460
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL NETWORK MAP

AUGUST 2024

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN1129420_VECTREN aprx - USER: toskowski - LAST SAVED: 6/26/2024 4:56 PM

FIGURE 2
REMEDIAL ALTERNATIVES ROADMAP
CORREECTIVE MEAASURES ASSESSMENT
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B.CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Alternative Number	Remedial Alternative Description	Ash Pond Closure Method	Interim Measure Options for Groundwater	Post-Closure Options for Groundwater
1	Monitored Natural Attenuation (MNA) with In-Situ Solidification (ISS) and Closure in Place (CIP)	Closure in Place with ISS (or equivalent - e.g., Fully Encapsulated Slurry Wall) and Cap	MNA	MNA Post-closure groundwater monitoring to confirm reduction of CCR constituents following completion of ISS and capping
2	Hydraulic Containment with No Treatment, ISS and CIP		Hydraulic Containment with No Treatment* Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells, direct discharge of effluent	
3	Hydraulic Containment with Treatment, ISS and CIP		Hydraulic Containment with Ex-Situ Treatment Mitigate off-site migration of groundwater with CCR constituents above Groundwater Protection Standards (GWPS) using extraction wells, ex-situ treatment of effluent prior to discharge	
4	In-Situ Treatment, ISS and CIP		In-Situ Treatment Subsurface treatment to reduce CCR constituents in groundwater	
5	MNA with Closure by Removal (CBR)	Closure by Removal	MNA	MNA Post-closure groundwater monitoring to confirm reduction of CCR constituents following removal
6	Hydraulic Containment with No Treatment and CBR		Hydraulic Containment with No Treatment Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells, direct discharge of effluent	
7	Hydraulic Containment with Treatment and CBR		Hydraulic Containment with Ex-Situ Treatment Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells, ex-situ treatment of effluent prior to discharge	
8	In-Situ Treatment and CBR		In-Situ Treatment Subsurface treatment to reduce CCR constituents in groundwater	

* To be determined based on ELG/NPDES permit updates

HALEY ALDRICH

APPENDIX B
Aquifer Characteristics Data Analysis Outputs

HALEY ALDRICH

www.haleyaldrich.com

REPORT ON

AQUIFER PERFORMANCE TEST RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Greenville, South Carolina

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420
December 2022

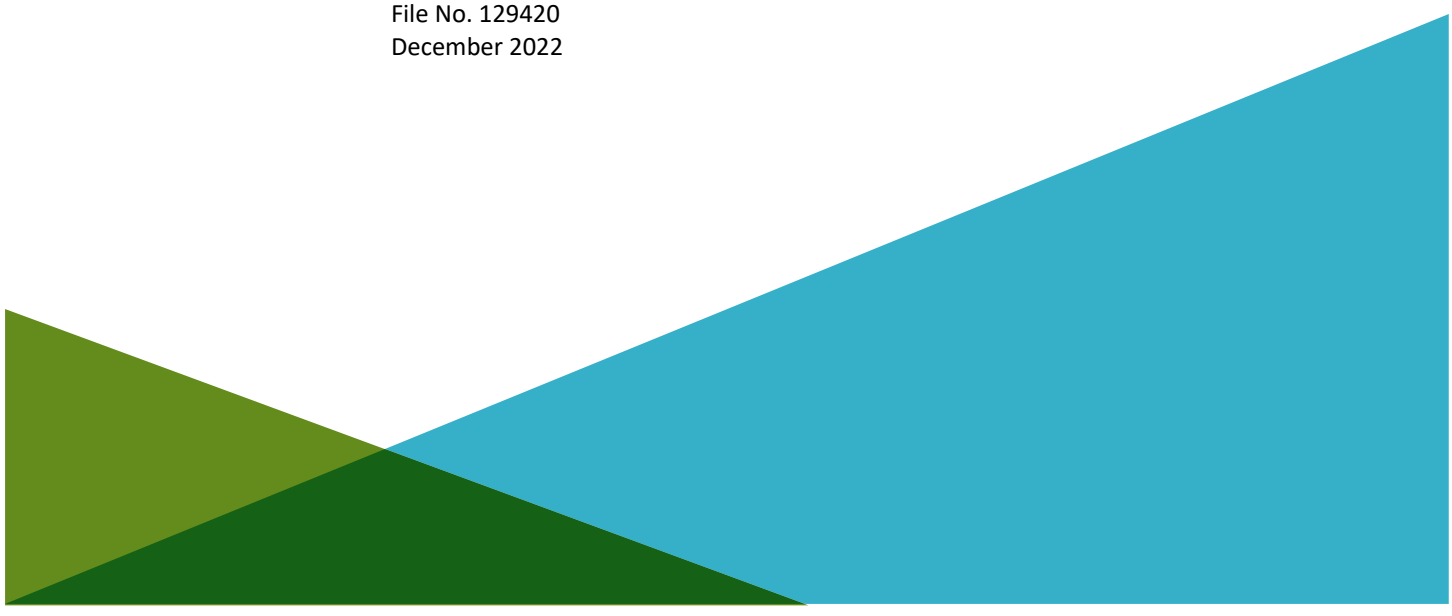


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1. Introduction

Southern Indiana Gas and Electric Company (SIGECO) contracted Haley & Aldrich, Inc. (Haley & Aldrich) to characterize aquifer conditions beneath and downgradient of the F.B. Culley Generating Station East Ash Pond (EAP). The overall goal of the aquifer testing program was to adequately stress the aquifer to evaluate maximum sustainable pumping rates, measure water level response in nearby wells, calculate the hydraulic properties (transmissivity and storage) of the aquifer system, and record changes in groundwater quality parameters during the testing period. Aquifer characterization data were collected and analyzed to refine the groundwater flow and solute transport model in support of EAP closure planning and implementation. Activities to complete this work were performed in three phases:

- Phase One: Installation of nested observation wells by National Water Services, LLC (NWS)
- Phase Two: Installation of a pumping well by NWS
- Phase Three: Aquifer testing conducted by Haley & Aldrich with support from Cascade Environmental

2. Aquifer Test Field Methods

This section of the report drilling, samplings, and well installation procedures and data gathering activities conducted to characterize aquifer conditions beneath and downgradient of the EAP.

2.1 PUMPING WELL INSTALLATION

NWS installed the aquifer performance test pumping well (CCR-PW-1) using a bucket drill rig on the southerly berm of the EAP in a location that allowed for the strategic siting and installation of aquifer test observation wells. A 30-inch diameter borehole was drilled to a depth of approximately 70 feet at the contact with shale bedrock. Hydrostatic pressure was used to prevent borehole collapse. The pumping well was constructed with a 16-inch diameter, 20-foot-long, 0.07-inch machine-slotted stainless-steel screen and steel casing to surface. The well was constructed in place by welding 20-foot sections together before lowering into place by crane. Filter sand was added by gravity from the bottom of the borehole to approximately 43 feet followed by a six-foot-thick bentonite seal. The remaining annular space of the well was filled to the surface with a cement-bentonite grout slurry. After grout was cured, the steel well casing was cut to a level below grade and a concrete vault with manhole was installed at the surface to provide access and protection for the well.

After well completion, the pumping well was developed to remove fines from the well screen and promote an optimum hydraulic connection with the surrounding aquifer formation. Development was completed using twin disc surge and purge methods.

2.2 OBSERVATION WELL INSTALLATION

Observation wells were constructed between 10 feet and 100 feet to the east, west, and north of the pumping well as presented in Figure 1. These observations wells were installed to provide an array of locations to monitor response within the aquifer during the pumping test. NWS completed the drilling and construction of observation wells using conventional hollow stem auger drilling methods. The terminal depth of the observation wells was designed to correlate with nearby monitoring wells CCR-AP-8 and CCR-AP-8I. Observation well boring logs are provided in Appendix A.

Observation wells were constructed with 2-inch inner diameter schedule 40 polyvinyl chloride (PVC) casing; a 10-foot-long, 0.01-inch machine-slotted PVC screen; and a locking steel vault with a flush-mount cover. Filter sand was added by gravity from the bottom of the borehole to approximately 2 feet above the top of the well screen. A minimum of 2 feet of bentonite pellets was added by gravity above the sand pack to seal the well screen. The bentonite seal at location CCR-OW-5I, which was constructed within the footprint of the EAP, was placed across the contact between the pond ash and underlying alluvium with a minimum of 5 feet overlap. The annular space of each well was grouted to the surface to seal the well and prevent vertical migration of groundwater and/or surface water into the well.

After completion, the observation wells were developed to remove fines from the well screen and promote an optimum connection between the sand pack and surrounding aquifer. Development for observation wells was completed by surging and purging each well with a submersible pump.

2.3 PRESSURE TRANSDUCERS AND MULTIPARAMETER SONDES

Nineteen data logging pressure transducers and two multiparameter geochemical sondes were deployed prior to initiating the aquifer performance test on 18 October 2022. Because the transducers were non-vented units, a barometric pressure transducer was installed near CCR-OW-5I in the open air to measure barometric pressure changes before, during, and after the pumping test. Those measurements allow for groundwater level measurement to be adjusted for changes in barometric pressure before evaluating data to determine aquifer properties.

Nineteen data logging pressure transducers were installed in the following wells:

CCR-OW-1	CCR-OW-3I	CCR-AP-3	CCR-AP-6I
CCR-OW-1I	CCR-OW-4	CCR-AP-4	CCR-AP-8
CCR-OW-2	CCR-OW-4I	CCR-AP-5	CCR-AP-8I
CCR-OW-2I	CCR-OW-5I	CCR-AP-5I	CCR-PW-1
CCR-OW-3	CCR-AP-2	CCR-AP-6	

Multiparameter sondes were installed to monitor changes to the geochemical environment in the subsurface throughout pumping. Each sonde measured water level, specific conductivity, total dissolved solids, oxidation/reduction potential (ORP), dissolved oxygen, pH, and temperature.

Multiparameter sondes were installed at two observation wells (CCR-OW-2I and CCR-OW-3I).

2.4 INVESTIGATION DERIVED WASTE MANAGEMENT

Investigation derived wastes (IDW) were managed in accordance with requests of the Indiana Department of Natural Resources. Soil cuttings produced from drilling activities were collected and contained at the drilling location prior to being removed from within the designated flood plain area. Solid IDW were then relinquished to SIGECO for management.

Groundwater purged from the pumping well throughout the duration of the aquifer test was directly discharged into the EAP and thereafter managed by SIGECO. Additionally, water levels in the pond were monitored by SIGECO over the duration of the project to account for any hydraulic loading which could influence test results.

2.5 STEP TEST

Before initializing the 72-hour aquifer test, a step-drawdown test was conducted to determine an optimal pumping rate for the constant rate pumping test. The step-drawdown test consisted of four steps, each with a one-hour duration and included:

- Step 1: 3 gallons per minute (GPM)
- Step 2: 7 GPM
- Step 3: 12 GPM
- Step 4: 15 GPM

The pump was shut off after the conclusion of the fourth step and the aquifer was allowed to recover to 98 percent of initial starting conditions. A total of 2,192.5 gallons of groundwater was pumped during

the step-drawdown test. Figure 2 presents the drawdown and recovery curves associated with the step-drawdown test. Haley & Aldrich reviewed the results and determined a target pumping rate of 11 GPM to be optimal to sufficiently stress the aquifer system over the 72-hour aquifer test.

2.6 AQUIFER TEST

After groundwater levels recovered to pre-step-drawdown test levels, the 72-hour aquifer test was initialized with a target pumping rate of 11 GPM. Flow was monitored using an in-line digital flow meter and totalizer, recording flow in GPM and total flow in gallons. Water levels were monitored at one-minute intervals by the network of in-Situ pressure transducers in place and manually by on-site personnel using Solinst water level meters. Additionally, SIGECO facilities monitored and recorded the Ohio River stage elevation and EAP water levels on an hourly basis for the duration of the test.

Groundwater samples were collected from CCR-PW-1 purge water at regular intervals as specified in the work plan (Haley & Aldrich, Inc., 2022) via an in-line sampling port. Fourteen samples were collected in total over the duration of the 72-hours. A total of 47,922.1 gallons of groundwater was pumped during the test.

3. Data Evaluation

3.1 DATA PROCESSING

Measurements from data logging pressure transducers and a barometric pressure logger were exported into Microsoft Excel. Each data set was adjusted to a common time axis with one minute measurement frequency, relative to the start of the aquifer test. Measured barometric pressure was used to subtract barometric pressure from the total pressure recorded by the transducer to determine the hydrostatic pressures in each well. Hydrostatic pressure in each well was converted to water level elevations relative to mean sea level. Baseline water level data collected using transducers was compared with manually collected water level data and was found to be consistent and reliable.

Water level data was converted to feet of drawdown by choosing an index water level immediately prior to pumping that is consistent with baseline measurements collected over a period of 14 hours prior to testing. Two data sets were corrected for a disturbance to the transducer which caused an offset of sensor positioning in the well. The dataset for CCR-OW-3I was corrected for an offset of 0.35 feet and CCR-AP-8I was corrected for an offset of 0.09 feet.

Variability within the dataset was reviewed and confirmed to be related to the Ohio River stage. Figure 3 shows a correlation between Ohio River stage elevation and fluctuations observed in groundwater elevation. When compared with the variability of barometric pressure, river stage was found to be the primary influence on natural groundwater elevation variability.

3.2 PRESSURE TRANSDUCERS AND WATER LEVEL MEASUREMENTS

Data from the pressure transducers were downloaded on 23 October 2022. Barometric pressure changes during the pumping test were measured using an In-Situ BarroTROLL. After correcting the data sets to remove effects of barometric pressure, results were evaluated.

Groundwater elevation over time, barometric pressure, and Ohio River elevation are plotted on Figure 3. Findings from the time series data evaluation include:

- Instrumented monitoring wells and observation wells show a hydraulic connection to the Ohio River, indicated by a corresponding variation in groundwater to river stage fluctuation
- Six observations wells indicated a response to pumping at CCR-PW-1 including:

CCR-OW-1I	CCR-OW-4I
CCR-OW-2I	CCR-05I
CCR-OW-3I	CCR-AP-8I

3.3 DISTANCE DRAWDOWN AND RADIUS OF INFLUENCE

Depth to groundwater was measured continuously during the test to evaluate drawdown in the pumping well and surrounding observations wells. Those data along with the pumping rate (continuously monitored throughout the test) are presented on Figure 4. Maximum drawdown measured at the end of the 72-hour pumping period was plotted and contoured to determine the radius of influence (ROI) imparted by pumping at CCR-PW-1 (Figure 5). Measured drawdown versus distance from the pumping well were plotted to evaluate the theoretical drawdown in the pumping well and the

potential maximum ROI (Figure 6). Projection of the best fit line indicates a theoretical ROI of 3,060 feet. Based on measurements from surrounding observation wells, projected maximum drawdown at the pumping well appears to be approximately 1.6 feet. Actual measured drawdown during the pumping test was approximately 22 feet indicating a low efficiency pumping well. Additional evaluation of well efficiency to determine well skin effects or aquifer loss may be needed.

Spatial variability of pumping influence was evaluated by contouring the amount of drawdown measured in observation wells (Figure 5). The following observations were identified through this analysis:

- Pumping influence appears to be generally symmetrical with some potential horizontal anisotropy attributed to the extent of the sand unit associated with the pumping well screened interval.
- Pumping primarily influenced the intermediate groundwater zone, with no noteworthy influence measured in shallow observation wells.
- Drawdown in surrounding monitoring wells was relatively small compared to drawdown in the pumping well.

A constant head boundary condition (Ohio River) was observed at CCR-OW-1I, the most distant observation well. AQTESOLV analysis plots show potential recharge at CCR-OW-1I beginning approximately 100 minutes after pumping began (Appendix B).

3.4 AQUIFER PROPERTIES

Response to pumping at CCR-PW-1 occurred in the nearby intermediate observation wells within ten minutes of initiating the test. The farthest observed response was noted in CCR-OW-1I, approximately 100 feet from the pumping well. Water level response through time in observation wells, presented in Figure 4 and Figure 5, illustrates the ROI at 72 hours after the onset of pumping. Changes in water levels compared to the pre-pumping static water level before the start of the test were calculated in 1-minute intervals for the full duration of the test (pumping and recovery), approximately 90 hours.

Data was processed using the hydrologic analysis software AQTESOLV. A combined drawdown and recovery curve was plotted for each well that demonstrated a response to the pumping. The resulting curve was matched to solution curves generated based on inputted aquifer and well construction information. Drawdown/recovery curves from the observation wells best matched solutions for leaky confined aquifer systems, such as the Hantush-Jacob (1955)/Hantush (1964) without aquitard storage solutions. Matching drawdown/recovery curves using solution methods provide values for Transmissivity (T) and Storativity (S) of the aquifer system at the well locations, along with qualitative indications of the leakiness of the confining aquitard (Attachment B). Transmissivity was used to calculate hydraulic conductivity values (K) by dividing the calculated T by the aquifer thickness at the well location. A range of values determined for T, S, and K is provided below.

Aquifer Parameter	T (cm^2/S)	S (dimensionless)	K (cm/s)
Minimum	2.753	9.02×10^{-4}	1.06×10^{-2}
Maximum	21.870	1.33×10^{-2}	4.78×10^{-2}

These values are consistent with the type of soils observed during installation (silty to clean poorly graded sands). A summary of the T and S values for each well is provided in Table 1.

3.5 GROUNDWATER CONTOUR AND VELOCITY CALCULATIONS

Pumping test results indicate semi-confined conditions are present at the site. Groundwater elevation measurements collected before the start of pumping were used to develop groundwater flow maps for the shallow flow system (Figure 7) and the intermediate flow system (Figure 8). Hydraulic gradients for each flow system were determined to be 20.5 feet for the shallow flow system and 18.84 feet per foot for the intermediate flow system.

Groundwater seepage velocity for the intermediate flow system was calculated using gradients derived from groundwater elevation maps and properties calculated from pumping test results (geometric mean K value for intermediate wells of 45.81 feet per day).

$$V = Ki/ne$$

V = groundwater seepage velocity in feet per day
K = horizontal hydraulic conductivity in feet per day
i = horizontal groundwater gradient in feet per foot
ne = assumed effective porosity (0.25)

Intermediate flow system seepage velocity is estimated to be approximately 3,350 feet per day. Seepage velocity for the shallow system is estimated to be 218 feet per day (assuming K value of 2.65 feet per day derived for CCR-AP-5).

3.6 GROUNDWATER CONCENTRATION OVER TIME

Groundwater samples were collected from the pumping well and submitted for analysis of metals via United States Environmental Protection Agency method 6020 and geochemical parameters. Samples were collected every 3 hours during the first day of the test, every 6 hours during the second day of the test, and every 12 hours during the final day of the test. Constituent concentrations remained relatively stable throughout the pumping test. Time series plots of analytical results for arsenic are presented in Figure 9, boron in Figure 10 and molybdenum in Figure 11. Initial and final concentrations for those constituents are summarized below, and analytical results for all samples and constituents are summarized in Table 2.

CCR-PW-1 Groundwater Analytical Results	Initial (mg/L)	Final (mg/L)
Arsenic	0.0033 J	0.0035 J
Boron	22	20 ^-
Molybdenum	1.6	1.3

J: value is estimated
^-: Continuing Calibration Verification is outside acceptance limits, low biased

Multiparameter geochemical sondes measured water quality parameters pH and ORP continuously throughout the pumping test. pH remained stable in both CCR-OW-2I and CCR-OW-3I during the test as shown on Figure 12. ORP began to decline approximately 7 hours after pumping began and continued to decline throughout the duration of the test at both CCR-OW-2I and CCR-OW-3I, as shown on Figure 13.

4. Summary

Haley & Aldrich initiated a 72-hour pumping test on 19 October 2022 and concluded the test on 22 October 2022, pumping approximately 47,922 gallons of groundwater during the test. The pumping test successfully influenced the water level in the vicinity of the pumping well to allow for the calculation of aquifer properties, such as T, S, and K. In addition to measuring groundwater elevation and quantity, water quality was measured by collecting groundwater samples and monitoring geochemical changes in groundwater continuously throughout the test.

Semi-confined or leaky confined aquifer conditions were identified for the area near the pumping test. Those conditions suggest an interbedded system of permeable and less permeable units that form a multilayered flow system. Boring logs from the EAP also support the presence of a multilayered flow system, including a laterally extensive clay unit immediately beneath the pond. That clay unit likely contributes to the limited connection between the shallow water table associated with the EAP and deeper groundwater, as indicated by observed drawdown in the observation well network during the test. These conditions will be considered when designing water management strategies for pond closure, when evaluating corrective measure alternatives, and when selecting a groundwater remedy. Additionally, specific aquifer parameters (such as T, S, and K) calculated from pumping test data will be incorporated into the EAP groundwater flow model. That model can be used to simulate and evaluate the effectiveness of dewatering strategies, various groundwater remedial alternative designs, and ultimately help inform selection of a groundwater remedy.

Aquifer performance test findings are summarized below:

- Observations and analytical solutions indicate the intermediate flow system near the EAP behaves as a semi-confined or leaky confined aquifer system.
- Shallow groundwater elevation associated with ponded water was not influenced during pumping, indicating limited connectivity between groundwater beneath the clay unit at the base of the pond and water impounded in the EAP.
- Instrumented observation wells show a hydraulic connection to the Ohio River.
- In general, T, S, and K values are within the range of expected values for the soil types present at the site.
- Hydraulic conductivities determined for the intermediate flow zone are similar to but greater than values used in previous groundwater modeling efforts.
- The pumping well appears to be a low efficiency pumping well; potentially due to well skin effects.
- Constituent concentrations in groundwater, such as arsenic, boron, and molybdenum remained stable throughout the pumping test.
- While pH remained stable at both CCR-OW-2I and CCR-OW-3I throughout the pumping test, ORP began to decrease approximately 7 hours after pumping began and continued to decline throughout the remainder of the test.

References

1. Haley & Aldrich, Inc., 2022. Aquifer Characterization Work Plan

2. Hantush, M.S. and C.E. Jacob, 1955. Non-steady radial flow in an infinite leaky aquifer, Am. Geophys. Union Trans., vol. 36, no. 1, pp. 95-100.

3. Hantush, M.S., 1964. Hydraulics of wells, in: *Advances in Hydroscience*, V.T. Chow (editor), Academic Press, New York, pp. 281-442.

TABLES

TABLE 1

SUMMARY OF AQUIFER CHARACTERISTICS

F.B. CULLEY GENERATING STATION

NEWBURGH, INDIANA

Well ID	Transmissivity (cm^2/s)	Storativity	Leakage Parameter (*r/B*)	Saturated Thickness (ft)	Hydraulic Conductivity (cm/sec)
CCR-OW-1I	21.870	2.29E-03	0.1738	15	4.78E-02
CCR-OW-2I	3.630	6.19E-03	0.3236	10	1.19E-02
CCR-OW-3I	3.466	1.33E-02	0.3715	10	1.14E-02
CCR-OW-4I	4.364	8.13E-04	0.3981	10	1.43E-02
CCR-OW-5I	2.753	9.02E-04	0.5248	5	1.81E-02
CCR-AP-8I	3.889	1.68E-03	0.4898	12	1.06E-02

cm - centimeters

s - seconds

r/B - leakage parameter

ft - feet

TABLE 2
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Name	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1	CCR-PW-1
Sample Name	AT-1-101922	AT-2-101922	AT-3-102022	AT-4-102022	AT-5-102022	AT-6-102022	AT-7-102022	AT-8-102022	AT-9-102022	AT-10-102122	AT-11-102122	AT-12-102122	AT-13-102222	AT-14-102222
Sample Date	10/19/2022	10/19/2022	10/20/2022	10/20/2022	10/20/2022	10/20/2022	10/20/2022	10/20/2022	10/20/2022	10/21/2022	10/21/2022	10/21/2022	10/22/2022	10/22/2022
Lab Sample ID	180-146720-2	180-146720-1	180-146720-3	180-146720-4	180-146720-5	180-146720-6	180-146720-7	180-146720-8	180-146810-1	180-146810-2	180-146810-3	180-146810-4	180-146810-5	180-146810-6
Inorganic Compounds (ug/L)														
Iron, Dissolved	**230**	100 U	100 U	100 U	100 U	**97 J**	**310**	**170**	**75 J^+**	**150**	**440**	**990**	**16000**	**15000**
Inorganic Compounds (mg/L)														
Arsenic, Total	**0.0033 J**	**0.0031 J**	**0.0058**	**0.0038 J**	**0.0029 J**	**0.0041 J**	**0.0027 J**	**0.003 J**	**0.0029 J**	**0.0027 J**	**0.0025 J**	**0.0034 J**	**0.0031 J**	**0.0035 J**
Barium, Total	**0.16**	**0.18**	**0.18**	**0.18**	**0.2**	**0.2**	**0.21**	**0.21**	**0.22**	**0.22**	**0.21**	**0.22**	**0.22**	**0.2**
Boron, Total	**22**	**22**	**22**	**21**	**22**	**22**	**22**	**21**	**25 ^-**	**22 ^-**	**22 ^-**	**22 ^-**	**21 ^-**	**20 ^-**
Cadmium, Total	**0.00046 J**	**0.00044 J**	**0.00046 J**	**0.00037 J**	**0.00045 J**	**0.00035 J**	**0.00042 J**	**0.00037 J**	**0.00035 J**	**0.00038 J**	**0.00032 J**	**0.00033 J**	**0.00032 J**	**0.00028 J**
Calcium, Total	**520**	**530**	**540**	**500**	**530**	**530**	**530**	**510**	**500**	**500**	**500**	**490**	**500**	**490**
Copper, Total	**0.0017 J**	0.002 U	0.002 U	0.002 U	0.002 U	**0.0074**	0.002 U	**0.0061**	0.002 U	0.002 U	**0.0077**	**0.013**	**0.0047**	**0.033**
Iron, Total	**17**	**17**	**18**	**17**	**18**	**18**	**18**	**17**	**16**	**16**	**16**	**16**	**16**	**16**
Magnesium, Total	**34**	**36**	**36**	**33**	**36**	**35**	**36**	**35**	**35**	**35**	**35**	**35**	**35**	**34**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	**1.6**	**1.7**	**1.6**	**1.5**	**1.6**	**1.6**	**1.6**	**1.5**	**1.4**	**1.4**	**1.4**	**1.4**	**1.3**	**1.3**
Nickel, Total	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Potassium, Total	**88**	**92**	**95**	**90**	**98**	**99**	**100**	**100**	**110**	**110**	**110**	**110**	**120**	**120**
Quartz, Total	**20**	**20**	**20**	**18**	**19**	**19**	**19**	**19**	**20**	**20**	**20**	**20**	**19**	**20**
Selenium, Total	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Silver, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Sodium, Total	**94**	**97**	**99**	**94**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**110**	**110**
Strontium, Stable, Total	**2.1**	**2.1**	**2.1**	**2**	**2.1**	**2.1**	**2.1**	**2.1**	**2**	**2**	**2**	**2**	**2**	**2**
Zinc, Total	**0.13**	**0.1**	**0.098**	**0.097**	**0.08**	**0.094**	**0.093**	**0.13**	**0.086**	**0.089**	**0.1**	**0.082**	**0.076**	**0.08**
Cyanide (free)	**0.0011 J**	**0.0016 J**	**0.0011 J**	**0.007**	**0.0039**	**0.0011 J**	**0.0048**	**0.005**	0.002 U	**0.0018 J**	**0.002**	**0.0089**	**0.0026**	0.002 U
Other														
Alkalinity, Bicarbonate (as CaCO3) (mg/L)	**240**	**240**	**230**	**230**	**230**	**230**	**220**	**230**	**230**	**230**	**240**	**240**	**230**	**240**
Alkalinity, Total (as CaCO3) (mg/L)	**240**	**240**	**230**	**230**	**230**	**230**	**220**	**230**	**230**	**230**	**240**	**240**	**230**	**240**
Chloride (mg/L)	**190**	**190**	**200**	**220**	**200**	**220**	**220**	**240**	**260**	**270**	**260**	**260**	**250**	**280**
Fluoride (mg/L)	**0.2 J**	**0.25**	**0.16 J**	**0.39**	**0.32**	**0.32**	**0.15 J**	**0.16 J**	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Sulfate (mg/L)	**1200**	**1300**	**1200**	**1300**	**1100**	**1200**	**1200**	**1300**	**1300**	**1300**	**1200**	**1200**	**1100**	**1200**
Total Dissolved Solids (TDS) (mg/L)	**2600**	**2600**	**2500**	**2600**	**2600**	**2600**	**2600**	**2600**	**2600 H**	**2600**	**2600**	**2600**	**2600**	**2600**

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
ug/L: microgram per liter.
^-: Continuing Calibration Verification (CCV) is outside acceptance limits, low biased.
^+: Continuing Calibration Verification (CCV) is outside acceptance limits, high biased.
J: value is estimated
U: not detected, value is the reporting limit
USEPA: United States Environmental Protection Agency.
Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

FIGURES



LEGEND

- MONITORING WELL
- OBSERVATION WELL
- PRODUCTION WELL
- EAST ASH POND

NOTES

1. ALL LOCATIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 80 160

SCALE IN FEET

HALEY ALDRICH

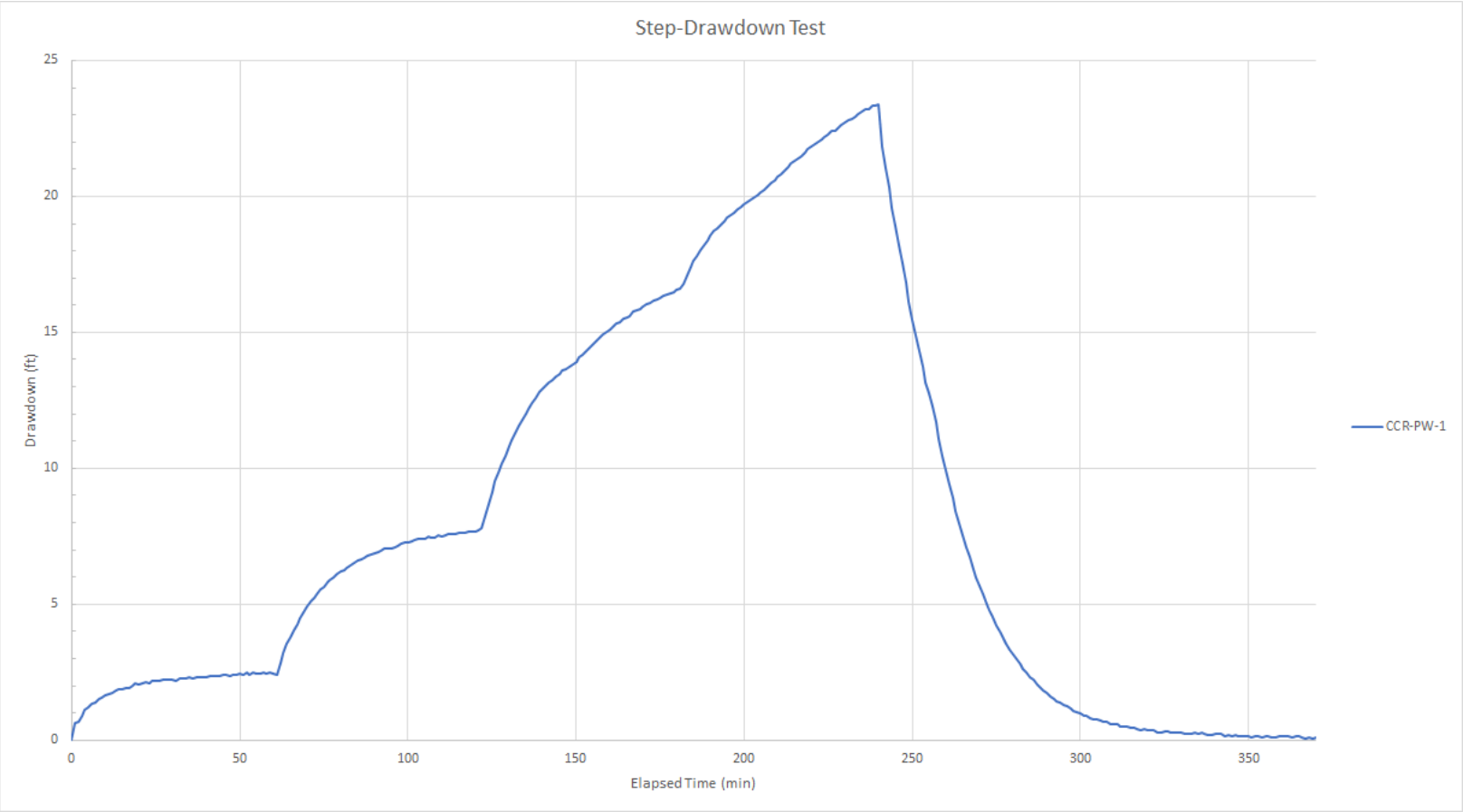
SOUTHERN INDIANA GAS AND ELECTRIC
COMPNAY F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

AQUIFER PERFORMANCE TEST CONFIGURATION

DECEMBER 2022

FIGURE 1

GIS FILE PATH: C:\Users\hwachholz\Documents\working\superseded\442796_EVANSVILLEIG\SIMaps\2022_04\133274_000_0001_PROPOSED_WELL_LOCATIONS.mxd — USER: hwachholz — LAST SAVED: 4/7/2022 12:29:59 PM



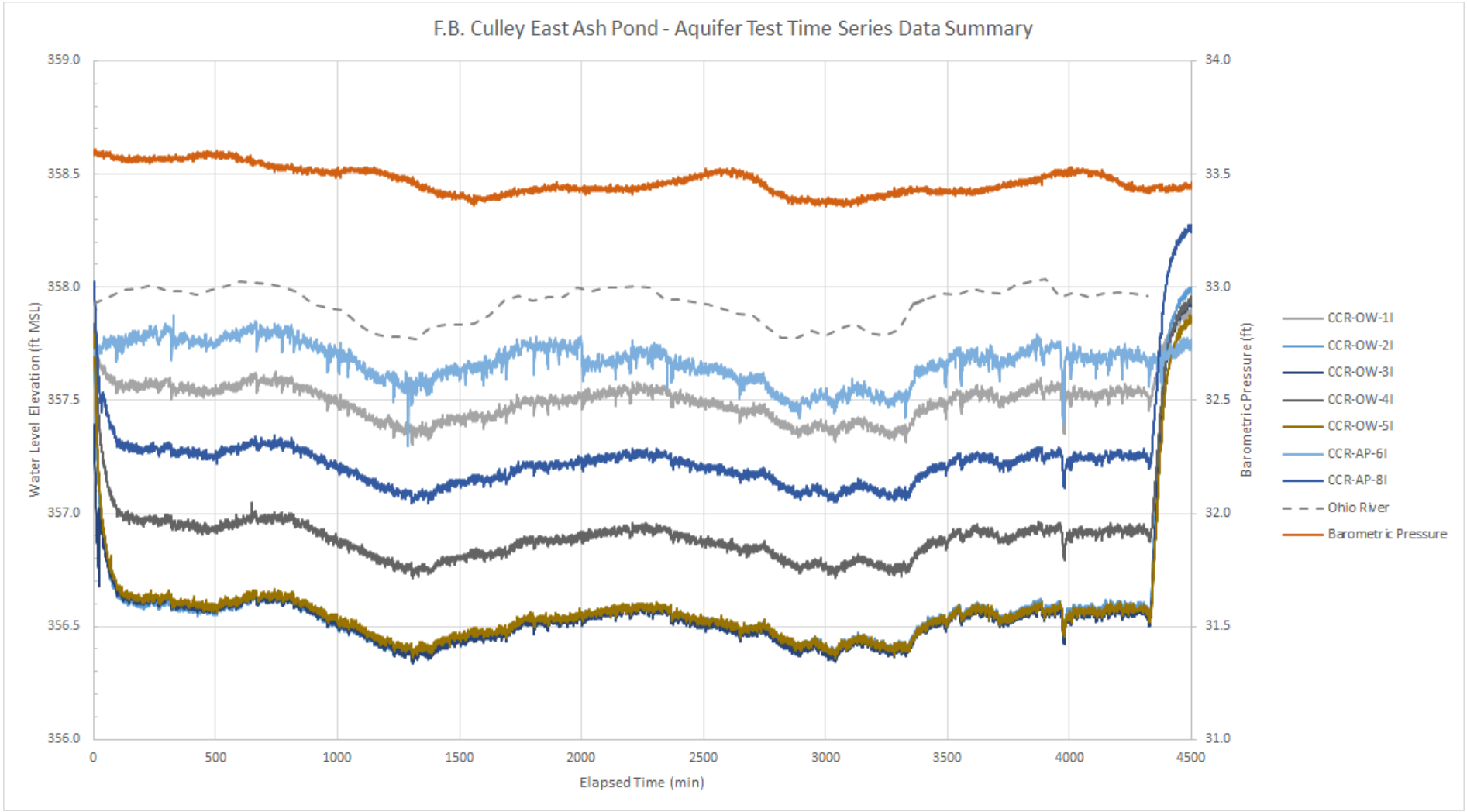
HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

CCR-PW-1 STEP-DRAWDOWN TEST

DECEMBER 2022

FIGURE 2



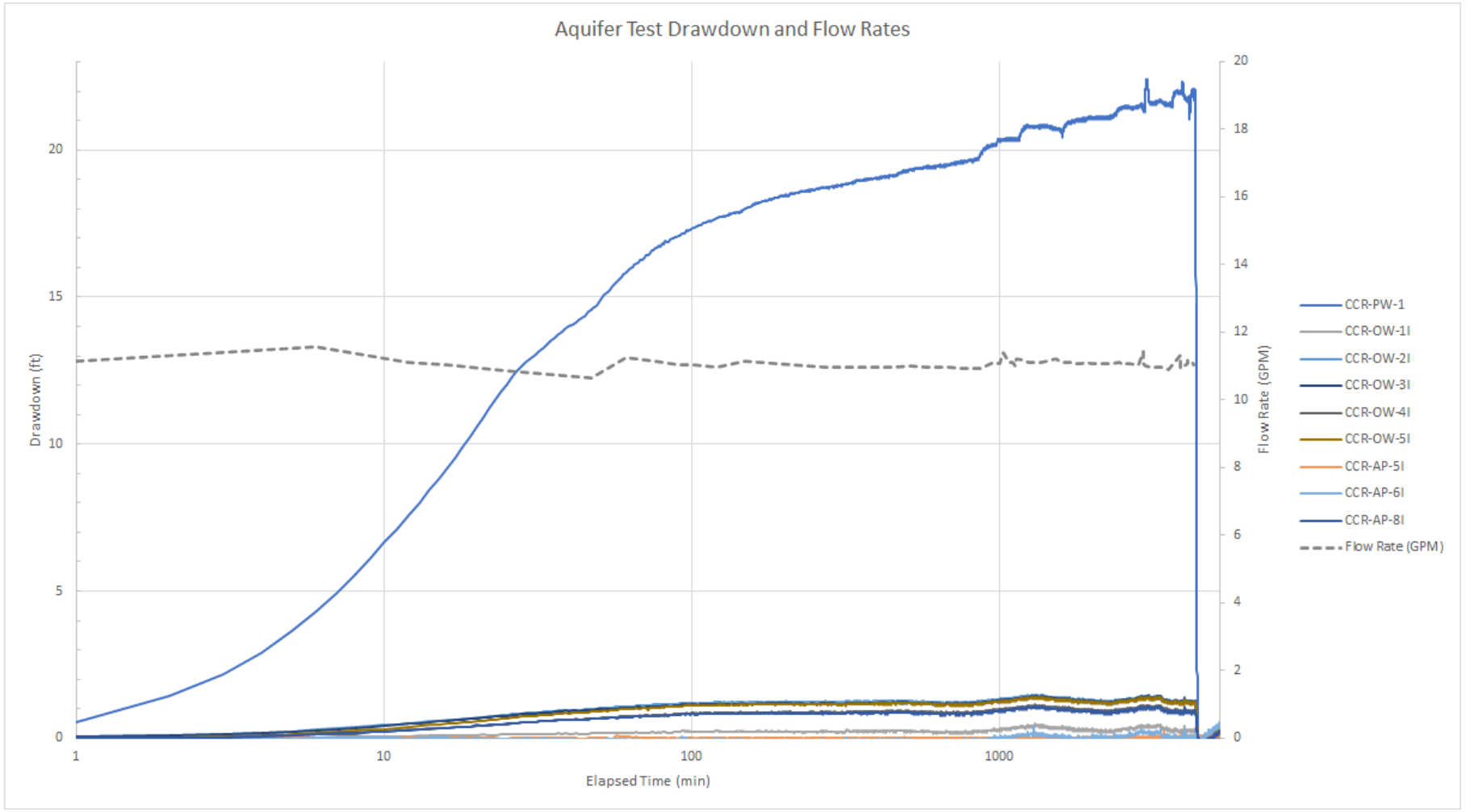
HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

AQUIFER PERFORMANCE TEST TIME SERIES DATA SUMMARY

DECEMBER 2022

FIGURE 3



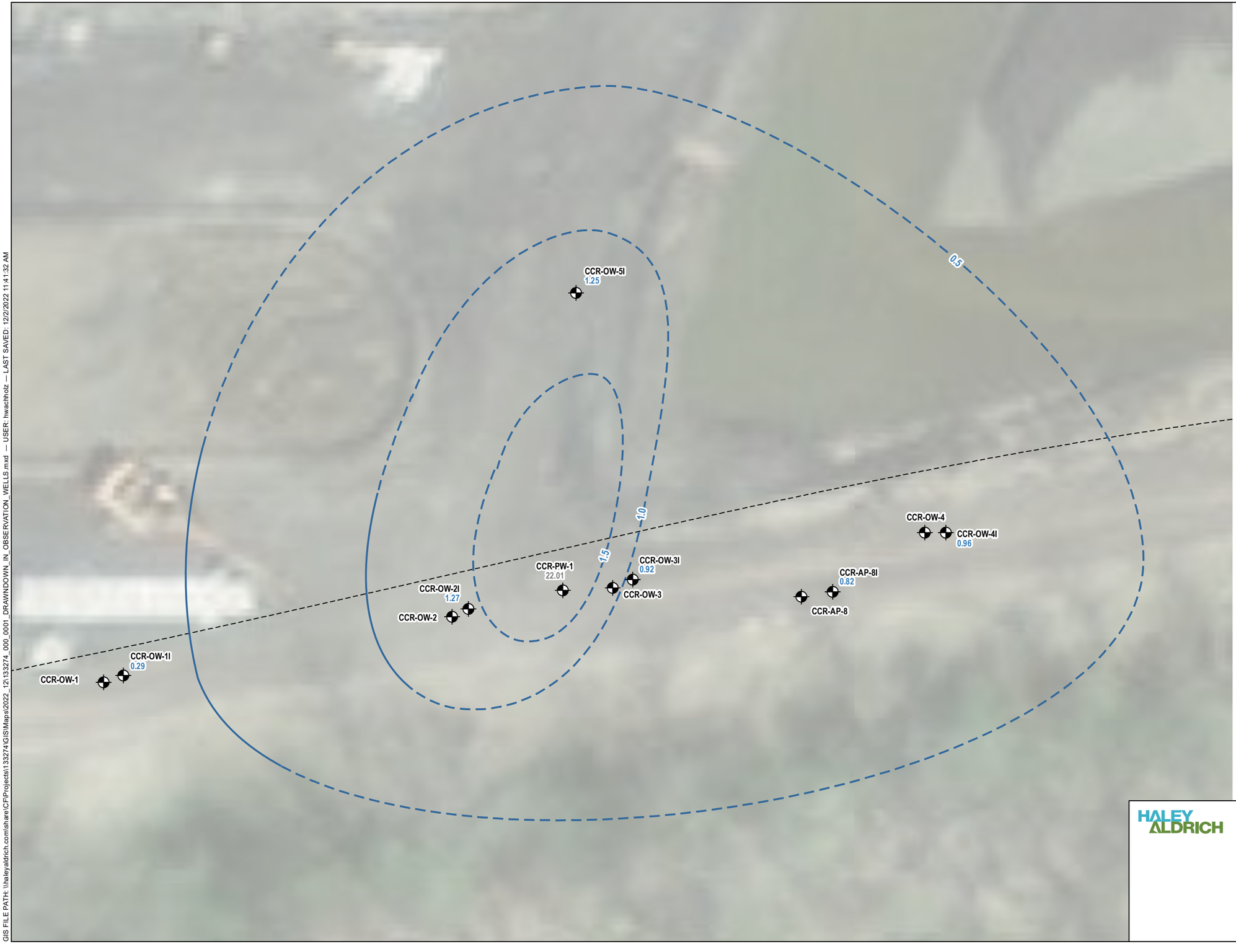
HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

AQUIFER PERFORMANCE TEST DRAWDOWN CURVES AND PUMPING RATE

DECEMBER 2022

FIGURE 4



LEGEND

- MONITORING WELL
- FEET OF DRAWDOWN IN OBSERVATION WELL
- EAST ASH POND

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. DRAWDOWN OBSERVED ON 22 OCTOBER 2022 AT 1510 CST.
3. AERIAL IMAGERY SOURCE: ESRI

N

0 20 40
SCALE IN FEET

HALEY ALDRICH

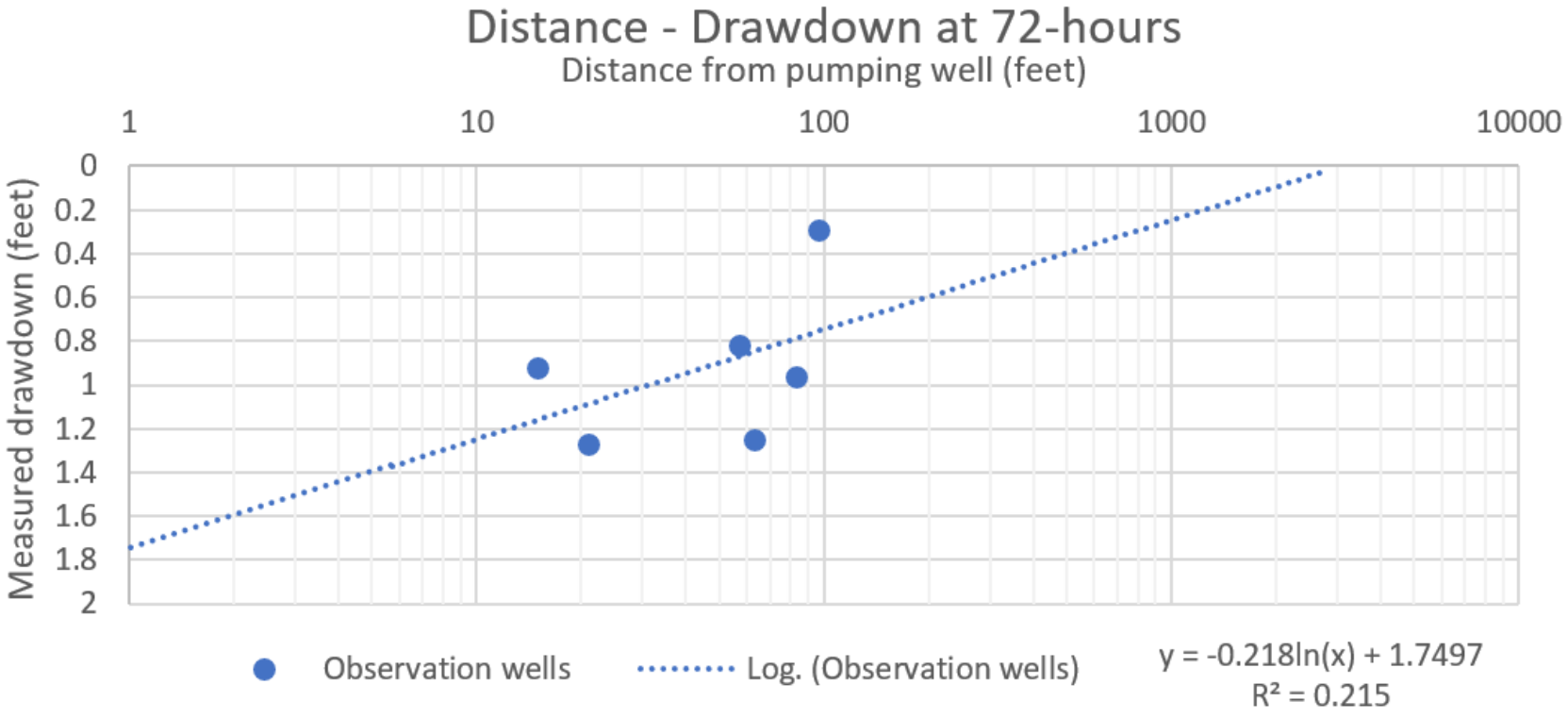
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

RADIUS OF INFLUENCE AT 72-HOURS

DECEMBER 2022

FIGURE 5

GIS FILE PATH: \\haleyaldrich.com\share\CPProjects\133274\GIS\Maps\2022_12\133274_000_0001_DRAWNDOWN_IN_OBSERVATION_WELLS.mxd — USER: hwachholz — LAST SAVED: 12/2/2022 11:41:32 AM



Theoretical Maximum Radius of Influence: 3060 feet

Theoretical drawdown at pumping well: 1.6 feet

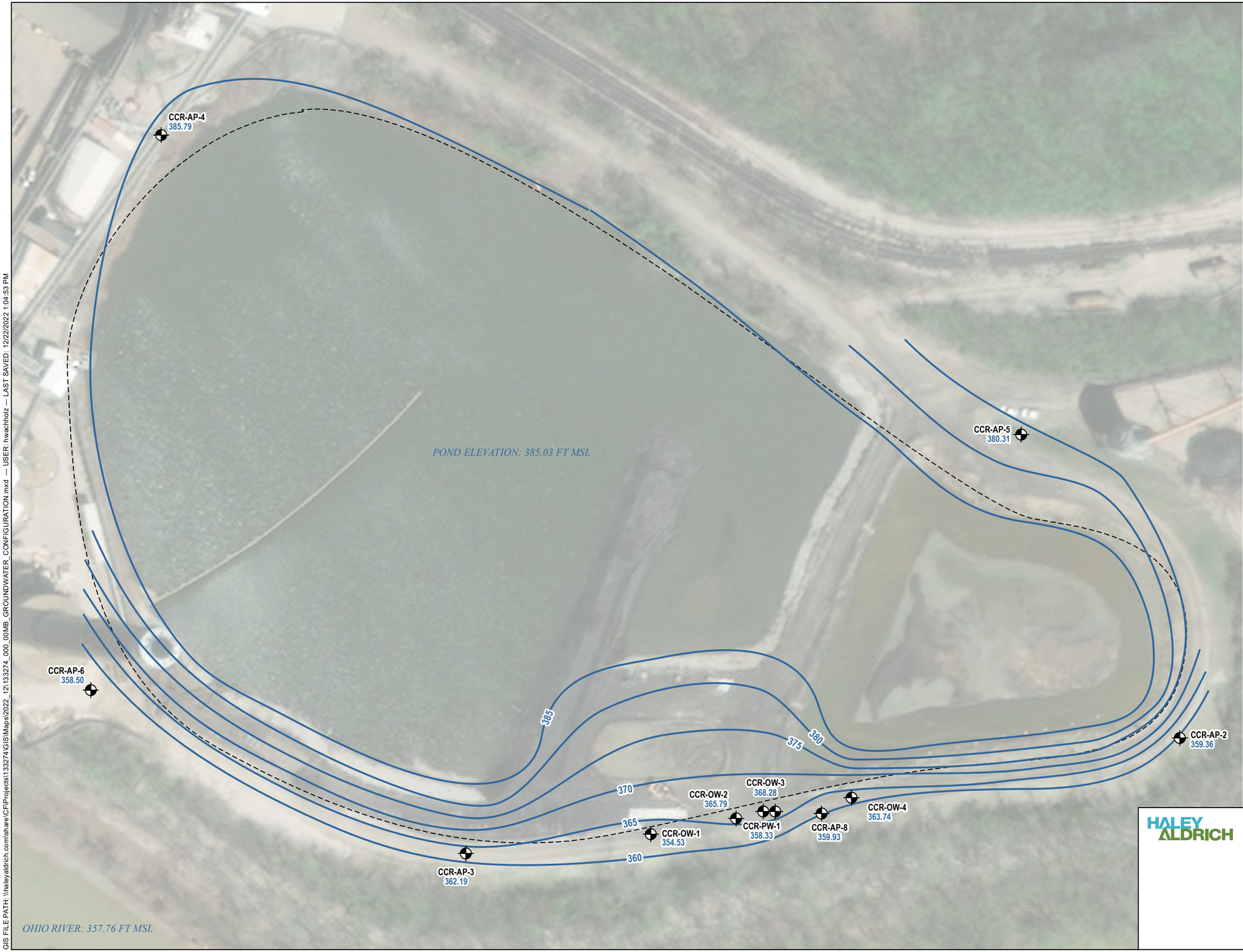
HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

DISTANCE DRAWDOWN AT 72-HOURS

DECEMBER 2022

FIGURE 6



LEGEND

- MONITORING WELL
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- EAST ASH POND

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVEL DATA COLLECTED BY A NETWORK OF PRESSURE TRANSDUCERS.
3. RIVER STAGE DATA COLLECTED BY CENTERPOINT FACILITY.
4. POND STAGE DATA COLLECTED BY CENTERPOINT FACILITY.
5. WATER LEVELS WERE COLLECTED ON 18 OCTOBER 2022 AT 18:00.
6. AERIAL IMAGERY SOURCE: ESRI

N

0 80 160
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

SHALLOW GROUNDWATER CONFIGURATION - OCTOBER 2022

DECEMBER 2022

FIGURE 7

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\133274\GIS\Maps\2022_12\133274_000_00MB_GROUNDWATER_CONFIGURATION.mxd — USER: hwachholz — LAST SAVED: 12/22/2022 1:04:53 PM



LEGEND

- MONITORING WELL
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL
- EAST ASH POND

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. WATER LEVEL DATA COLLECTED BY A NETWORK OF PRESSURE TRANSDUCERS.
3. RIVER STAGE DATA COLLECTED BY CENTERPOINT FACILITY.
4. POND STAGE DATA COLLECTED BY CENTERPOINT FACILITY.
5. WATER LEVELS WERE COLLECTED ON 18 OCTOBER 2022 AT 18:00.
6. AERIAL IMAGERY SOURCE: ESRI

N

0 80 160
SCALE IN FEET

HALEY ALDRICH

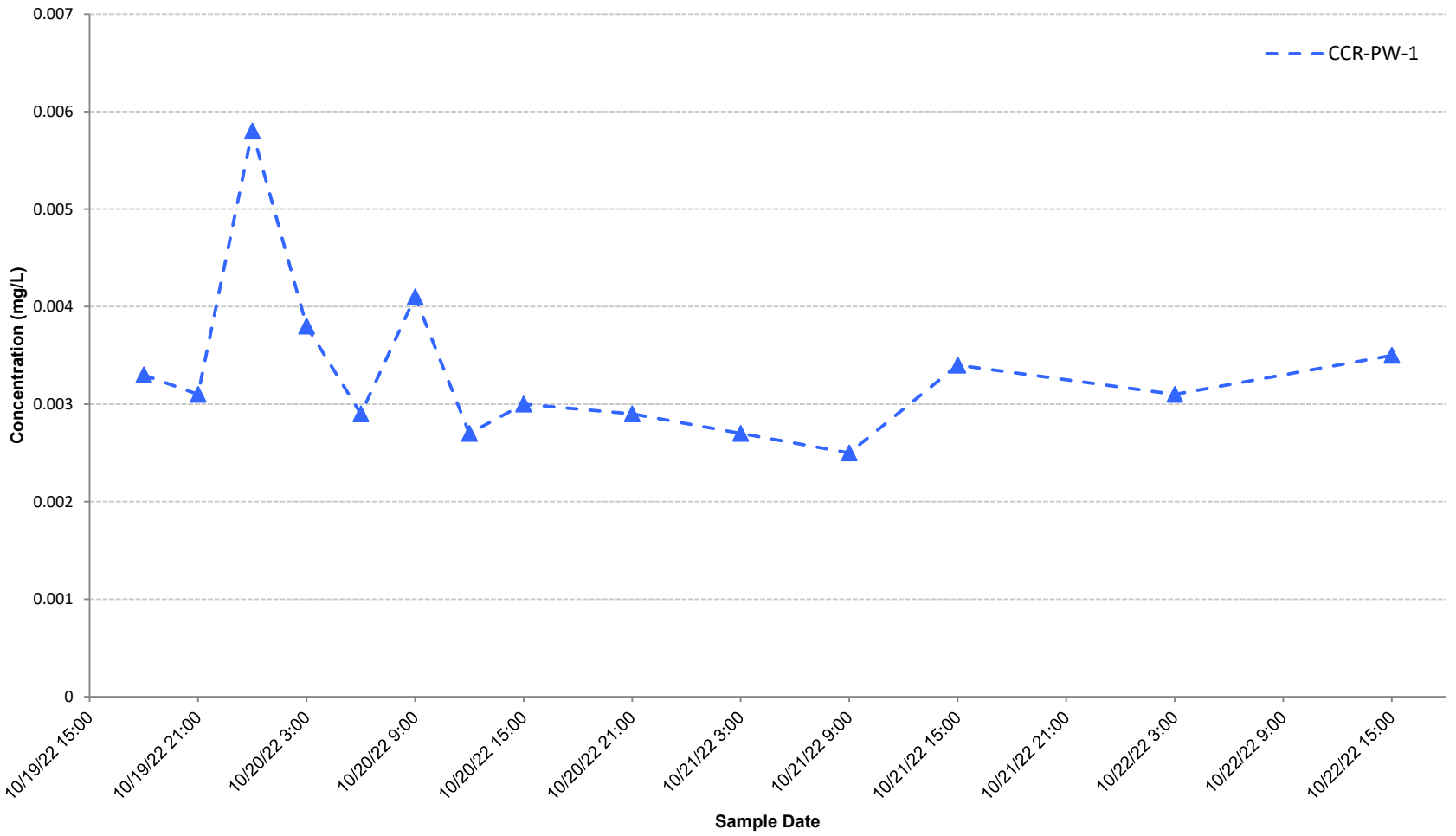
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

INTERMEDIATE GROUNDWATER CONFIGURATION - OCTOBER 2022

DECEMBER 2022

FIGURE 8

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\133274\GIS\Maps\2022_12\133274_000_00MB_GROUNDWATER_CONFIGURATION.mxd — USER: hwachholz — LAST SAVED: 12/22/2022 1:04:53 PM



NOTES:

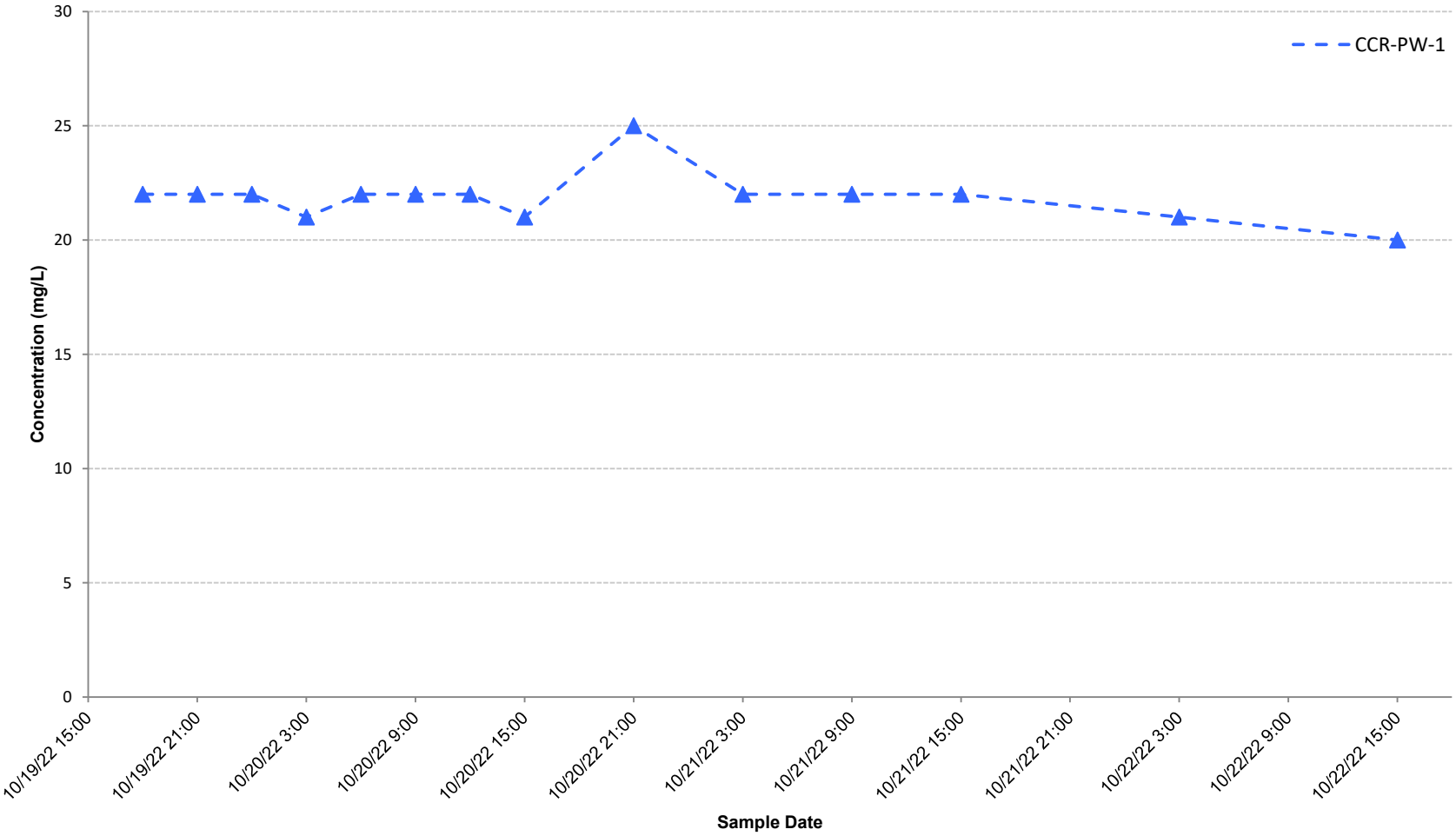
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

ARSENIC CONCENTRATION OVER TIME

DECEMBER 2022 FIGURE 9



NOTES:

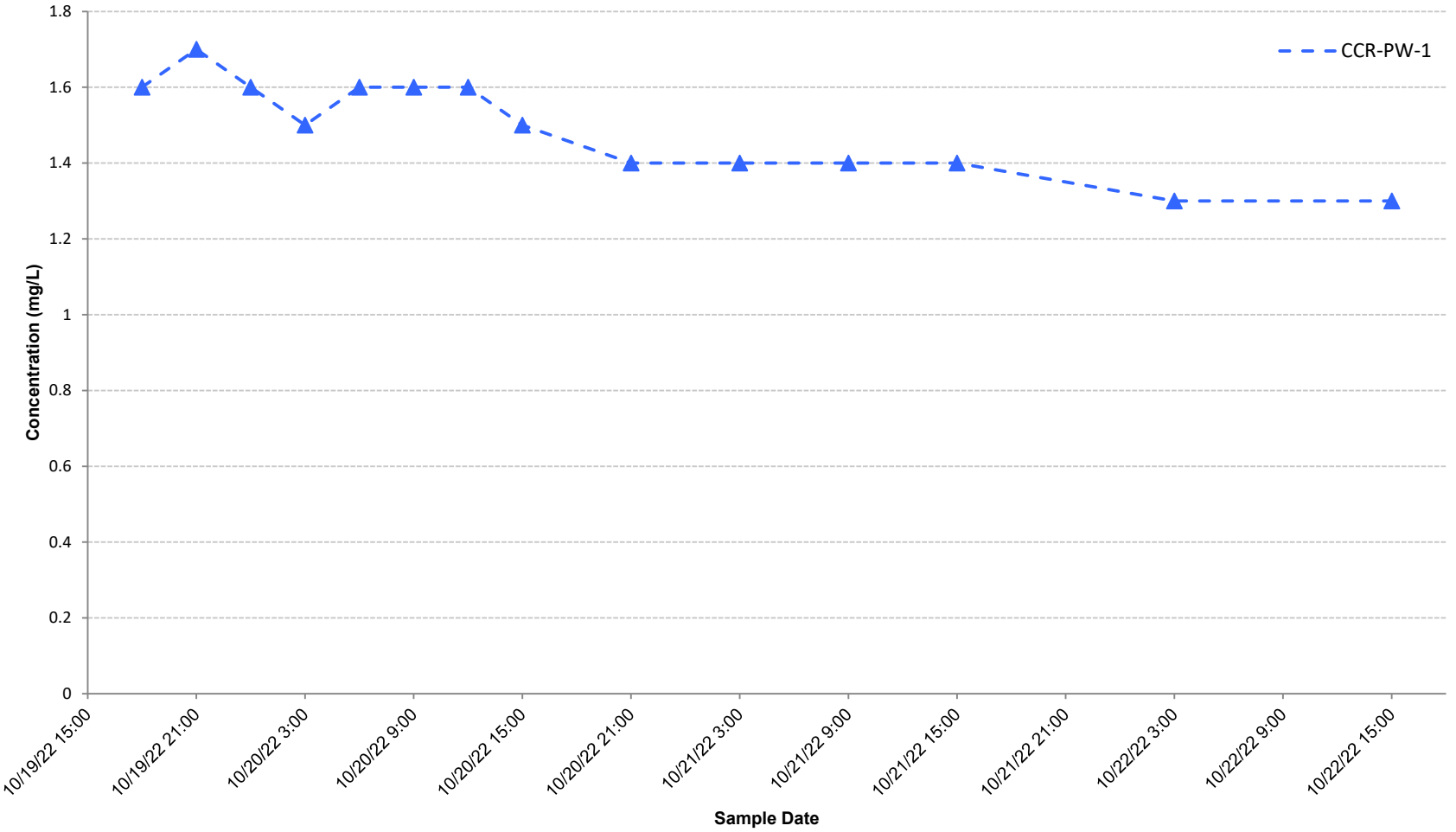
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

BORON CONCENTRATION OVER TIME

DECEMBER 2022 FIGURE 10



NOTES:

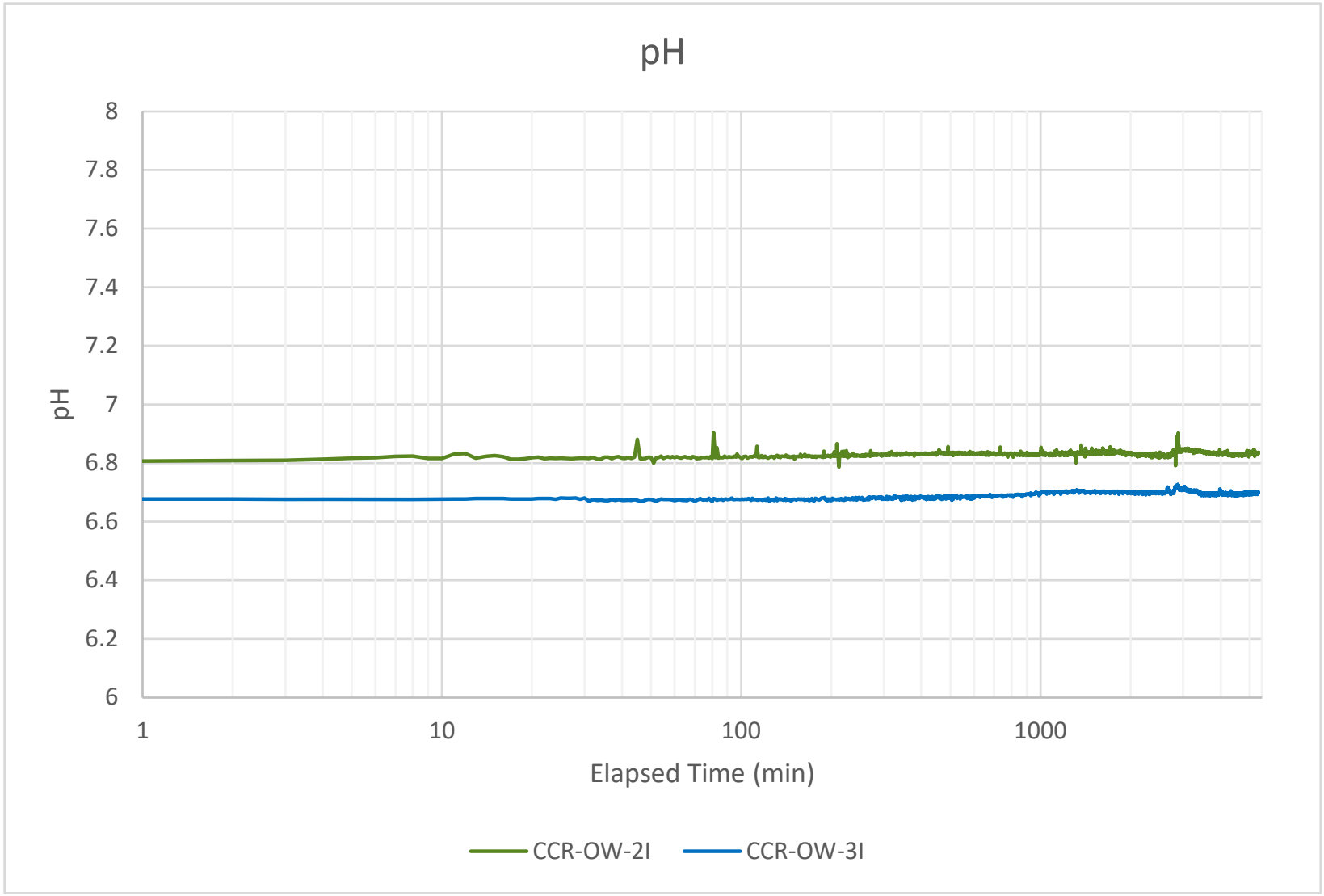
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

MOLYBDENUM CONCENTRATION OVER TIME

DECEMBER 2022 FIGURE 11



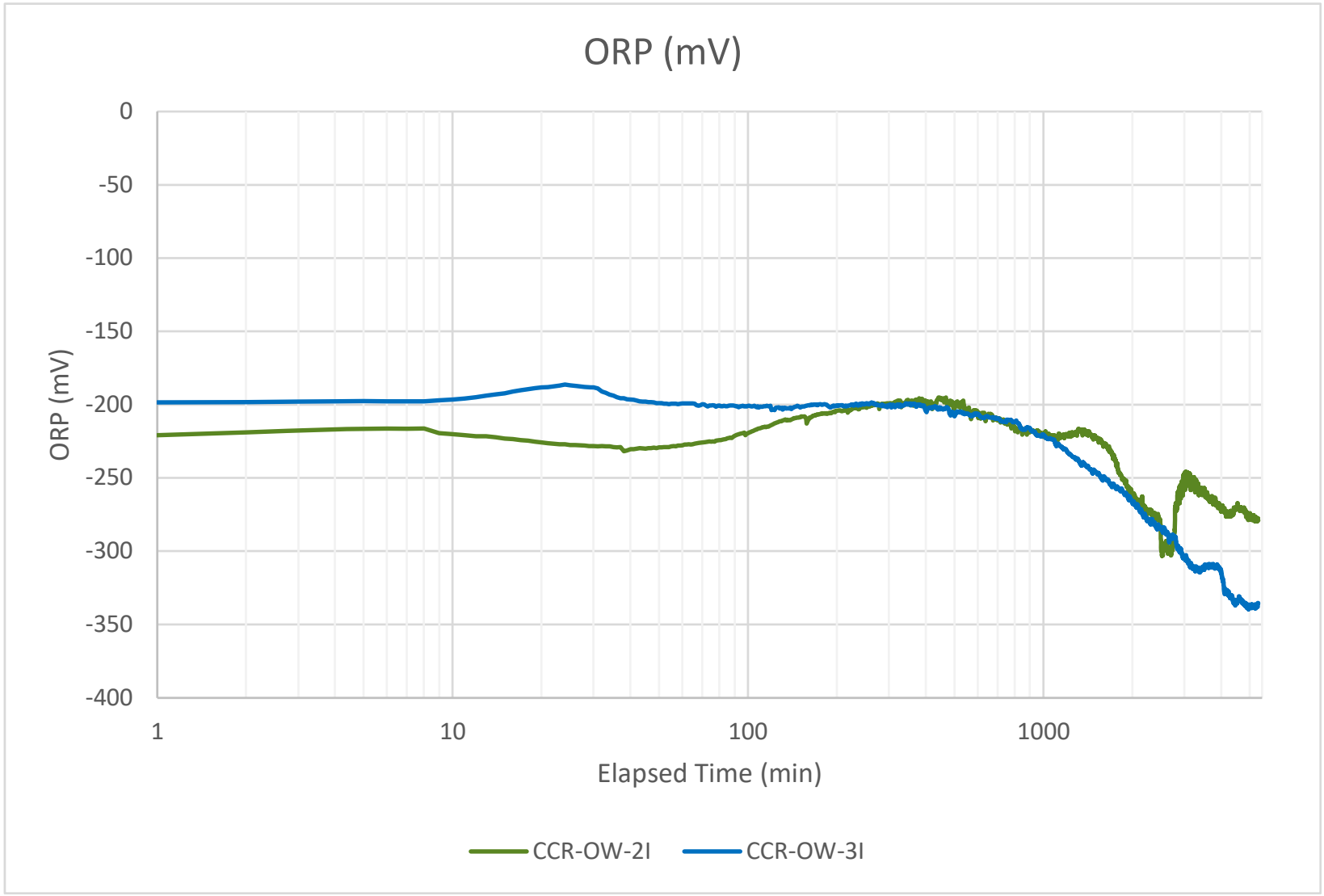
HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

pH OVER TIME

DECEMBER 2022

FIGURE 12



HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

ORP OVER TIME

DECEMBER 2022

FIGURE 13

APPENDIX A
Boring Logs

TEST BORING REPORT

Boring No. CCR-OW-1

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

File No. 129420-034
Sheet No. 1 of 2
Start June 21, 2022
Finish June 21, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation 395.0 (est.)
Datum
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							GRAVEL and SAND roadbase material -FILL-	50	40	5			5				
5				ML			Stiff dark brown SILT (ML), no structure, no odor					10	90				
10				ML		385.0 10.0	Dense dark brown SILT (ML), no structure, no odor					10	90				
15				MH		380.0 15.0	Dark brown elastic SILT with sand (ML), no structure, no odor				5	10	85				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 48.0
Rock Cored (ft) -
Samples -

Boring No. CCR-OW-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-1
File No. 129420-034
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				MH			Same as above				5	10	85				
						370.0											
25				CL		25.0	Soft brown lean CLAY with sand (CL), no structure, no odor, wet				5	10	85				
30				CL			Same as above				5	10	85				
35				CL			Same as above				5	10	85				
40				CL			Soft dark brown CLAY (CL), no structure, no odor, wet				5	10	85				
45				ML		350.0 45.0	Dark brown sandy SILT (ML), no structure, no odor, very wet					30	50				
						347.0 48.0	BOTTOM OF EXPLORATION 48.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-1

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-1I

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

File No. 129420-034
Sheet No. 1 of 3
Start June 20, 2022
Finish June 20, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation Datum 397.0 (est.)
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							GRAVEL and SAND roadbase material -FILL-	50	40	5			5				
5				ML			Stiff dark brown SILT (ML), no structure, no odor				5	5	90				
10				ML		387.0 10.0	Dense dark brown SILT (ML), no structure, no odor				5	5	90				
15				MH		382.0 15.0	Dark brown elastic SILT with sand (ML), no structure, no odor				5	10	85				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 70.4
Rock Cored (ft) -
Samples -

Boring No. CCR-OW-1I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-1I
File No. 129420-034
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				MH			Same as above				5	10	85				
						372.0											
25				CL		25.0	Soft brown lean CLAY (CL), no structure, no odor, wet				5	5	85				
30				CL			Same as above				5	5	85				
35				CL			Same as above				5	5	85				
40				CL			Soft dark brown lean CLAY (CL), no structure, no odor, wet				5	5	85				
						352.0											
45				ML		45.0	Dark brown sandy SILT (ML), no structure, no odor, very wet				20	30	50				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-1I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-1I
File No. 129420-034
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50						344.0											
				MH		53.0	Dense dark brown elastic SILT with sand (MH), no structure, no odor, wet, trace wood fragments				10	15	75				
55																	
60				MH			Same as above				10	15	75				
65				MH			Dark brown sandy elastic SILT, no structure, no odor, wet				10	20	70				
70						326.6											
						70.4	BOTTOM OF EXPLORATION 70.4 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-1I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-2

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

File No. 129420-034
Sheet No. 1 of 2
Start June 30, 2022
Finish June 30, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation Datum 397.0 (est.)
Location See Plan

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0				GW			Hard well graded GRAVEL (GW), no structure, no odor										
5				CL		392.0 5.0	Brown CLAY (CL), no structure, no odor					10	90				
10				CL			Same as above					10	90				
15				CL			Same as above					10	90				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 46.0
Rock Cored (ft) -
Samples -

Boring No. CCR-OW-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-OW-2
File No. 129420-034
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				CL			Same as above					10	90				
25				CL			Same as above, except moist					10	90				
30				CL			Same as above, except moist					10	90				
35				CL			Brown compact lean CLAY with sand (CL), no structure, no odor, wet				5	10	85				
40				CL			Same as above				5	10	85				
45				CL			Same as above				5	10	85				
						351.0 46.0	BOTTOM OF EXPLORATION 46.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-2

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-2I

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

File No. 129420-034
Sheet No. 1 of 3
Start July 5, 2022
Finish July 5, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation 397.0 (est.) Datum
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Thick GRAVEL -FILL-										
5				CL			Brown compact lean CLAY (CL), no structure, no odor, dry/moist					10	90				
10				CL			Same as above					10	90				
15				CL			Same as above					10	90				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 68.0
Rock Cored (ft) -
Samples -

Boring No. CCR-OW-2I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-OW-2I

File No. 129420-034
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				CL			Same as above					10	90				
25				CL			Same as above					10	90				
30				CL			Same as above					10	90				
35				CL			Brown compact lean CLAY (CL), no structure, no odor, moist, increasing wetness					10	90				
40				CL			Same as above					10	90				
45				CL			Same as above					10	90				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-2I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-2I
File No. 129420-034
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50				CL			Same as above					10	90				
				CL			Brownish-gray compact lean CLAY (CL), no odor, wet, trace organic					10	90				
55				CL			Brown lean CLAY (CL), no odor, very wet					10	90				
						339.0											
				SC		58.0	Clayey SAND (SP), very wet				20	40	40				
60																	
				SC			Same as above				20	40	40				
65																	
						329.0	-TOP OF BEDROCK AT 68.0 FT-										
						68.0	BOTTOM OF EXPLORATION 68.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-2I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-3

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

File No.	129420-034
Sheet No.	1 of 2
Start	June 28, 2022
Finish	June 28, 2022
Driller	J. Hackney
H&A Rep.	K. Henning
Elevation Datum	397.0 (est.)
Location	See Plan

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0				GP			Thick GRAVEL (GP), no structure, no odor -FILL-										
						391.0 6.0											
				CL			Dense dark brown lean CLAY (CL), no structure, no odor, moist					10	90				
10				CL			Same as above					10	90				
15				CL			Same as above					10	90				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	47.0
Rock Cored (ft)	-
Samples	-

Boring No. CCR-OW-3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-3
File No. 129420-034
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				CL			Same as above					10	90				
25				CL			Dense brown lean CLAY (CL), no structure, no odor, moist/wet					10	90				
30				CL			Same as above					10	90				
35				CL			Same as above					10	90				
40				CL			Dense dark brown lean CLAY (CL), no structure, no odor, wet					10	90				
45				CL			Same as above					10	90				
						350.0 47.0	BOTTOM OF EXPLORATION 47.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-3

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-3I

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

File No. 129420-034
Sheet No. 1 of 3
Start June 20, 2022
Finish June 20, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation 397.0 (est.)
Datum
Location See Plan

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0				GW			Gray well graded GRAVEL (GW), no structure, no odor, dry										
							-FILL-										
						390.0											
				CL		7.0	Brown lean CLAY (CL), no structure, no odor, dry					10	90				
5																	
10																	
15				CL			Brown lean CLAY (CL), no structure, no odor					10	90				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	70.0
Rock Cored (ft)	-
Samples	-

Boring No. CCR-OW-3I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-3I
File No. 129420-034
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				CL			Same as above					10	90				
25				CL			Same as above					10	90				
30				CL			Same as above					10	90				
35				CL			Same as above					10	90				
40				CL			Same as above					10	90				
45				CL			Brown lean CLAY with sand (CL), no structure, no odor, moist				5	10	85				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-3I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-3I
File No. 129420-034
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50				CL			Brown lean CLAY with sand (CL), no structure, no odor, dry/moist, some fine sand				10	10	80				
				CL			Brown lean CLAY with sand (CL), no structure, no odor				5	15	80				
55																	
						337.0											
60				SC		60.0	Clayey SAND (SC), no structure, organic odor, with pebbles and wood			15	20	20	45				
65																	
						327.0	-TOP OF SHALE AT 70.0 FT-										
70						70.0	BOTTOM OF EXPLORATION 70.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-3I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-4

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

File No. 129420-034
Sheet No. 1 of 2
Start June 27, 2022
Finish June 27, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation Datum 397.0 (est.)
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							GRAVEL and SAND roadbase material -FILL-										
				ML			Stiff dark brown SILT with sand (ML), no structure, no odor, moist				5	15	80				
						390.0 7.0											
				MH			Brown elastic SILT (MH), no structure, no odor				5	5	90				
10																	
				MH			Stiff brown elastic SILT (ML), no structure, no odor, moist					10	90				
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 47.0
Rock Cored (ft) -
Samples -

Boring No. CCR-OW-4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-OW-4
File No. 129420-034
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				MH			Medium dense gray-brown elastic SILT (ML), no structure, no odor, moist, trace wood fragments				5	5	90				
25				MH			Medium dense brownish-gray elastic SILT with sand (ML), no structure, no odor, very wet				5	10	85				
30																	
35				MH			Dense brownish-gray elastic SILT with sand (ML), no structure, no odor, wet				5	10	85				
40																	
45				MH			Dense brown elastic SILT with sand (ML), no structure, no odor, wet				5	10	85				
						350.0 47.0	BOTTOM OF EXPLORATION 47.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-4

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-4I

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

File No. 129420-034
Sheet No. 1 of 3
Start June 27, 2022
Finish June 27, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation Datum 397.0 (est.)
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	-	Rig Make & Model: Direct Rotary
Inside Diameter (in.)	-	1 3/8	4	Bit Type: Hollow Stem Auger
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: Open Hole
				Hoist/Hammer:
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							GRAVEL and SAND roadbase material -FILL-										
				ML			Stiff dark brown SILT with sand (ML), no structure, no odor, moist				5	15	80				
						390.0 / 7.0											
				MH			Brown elastic SILT (MH), no structure, no odor					10	90				
10																	
				MH			Stiff brown elastic SILT (ML), no structure, no odor, moist					10	90				
15																	
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 69.0
Rock Cored (ft) -
Samples -

Boring No. CCR-OW-4I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-OW-4I

File No. 129420-034

Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				MH			Medium dense gray-brown elastic SILT (ML), no structure, no odor, moist, trace wood fragments					10	90				
25				MH			Medium dense brownish-gray elastic SILT with sand (ML), no structure, no odor, very wet				5	10	85				
30																	
35				MH			Dense brownish-gray elastic SILT with sand (ML), no structure, no odor, wet				5	10	85				
40																	
45				MH			Dense brown elastic SILT with sand (ML), no structure, no odor, wet				5	10	85				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-4I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-4I
File No. 129420-034
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																	
55				CL		342.0 55.0	Dark brown lean CLAY with sand (CL), no structure, no odor, very wet				10	15	75				
60																	
65				CL			Same as above				10	15	75				
						328.0 69.0	BOTTOM OF EXPLORATION 69.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-4I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-5I

Project	F.B. Culley, Indiana
Client	SIGECO
Contractor	National Water Services, LLC

File No. 129420-034
Sheet No. 1 of 3
Start July 6, 2022
Finish July 6, 2022
Driller J. Hackney
H&A Rep. K. Henning
Elevation Datum 397.0 (est.)
Location See Plan

	Casing	Sampler	Barrel
Type	-	S	-
Inside Diameter (in.)	-	1 3/8	4
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Direct Rotary
Bit Type: Hollow Stem Auger
Drill Mud: None
Casing: Open Hole
Hoist/Hammer:
PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0				ASH			Loose black coal ASH, no structure, no odor, moist				30	20	50				
				ASH			Medium stiff brownish-black coal ASH, no structure, no odor, moist				30	20	50				
5				ASH			Medium stiff brownish-black coal ASH, no structure, no odor, moist				30	20	50				
10				ASH			Loosely stiff brownish-black coal ASH, no structure, no odor, moist				30	20	50				
15				ASH			Loosely brownish-black coal ASH, no structure, no odor, wet				30	20	50				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 63.0
Rock Cored (ft) -
Samples -

Boring No. CCR-OW-5I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

TEST BORING REPORT

Boring No. CCR-OW-5I
File No. 129420-034
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				ASH			Loose brown-black coal ASH, no structure, no odor, wet				30	20	50				
25				ASH			Very loose black-brown coal ASH, increasingly wet				20	20	60				
30				ASH			Very loose black-brown coal ASH, very wet				20	20	60				
35				ASH			Same as above										
						358.0											
40				CL		39.0	Dark brown lean CLAY with silt (CL)					10	90				
45				CL			Brown lean CLAY (CL), very wet					10	90				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-5I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-OW-5I

File No. 129420-034
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50				CL			Thin 1/2 in. layer clayey SAND				10	50	40				
						338.0											
55				SW-SC		59.0	Well-graded SAND with clay (SW-SC), fines upwards, inclusions of rounded pebbles			10	30	20	40				
						334.0	-TOP OF BEDROCK AT 63.0 FT-										
60						63.0	BOTTOM OF EXPLORATION 63.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-OW-5I

H&A-TEST BORING-09 REV 129420.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Jan 3, 23

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-1

Project	F.B. Culley
Location	Indiana
Client	SIGECO
Contractor	NWS
Driller	J. Hackney
Initial Water Level (depth bgs)	ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	129420-034
Date Installed	21 Jun 2022
H&A Rep.	K. Henning
Location	See Plan
Ground El.	395.0 (est.)
Datum	

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
				0.0	395.0
FILL	48.0			1.5	393.5
				4.4	390.6
				36.0	359.0
				46.0	349.0
				46.3	348.7
				48.0	347.0

WELL CONSTRUCTION DETAILS

Type of protective cover	Bolted - 9/16" hex.
Depth of below ground surface	0.0 ft
Depth of top of riser below ground surface	0.0 ft
Type of protective casing	
Length	
Inside diameter	
Depth of bottom of	ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	36.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	2.9
Sand	34.0	14.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	36.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Pack Sand
Depth to bottom of well screen	46.0 ft
Bottom of silt trap	46.4 ft
Depth of bottom of well	48.0 ft
Depth of bottom of borehole	48.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-1I

Project	F.B. Culley
Location	Indiana
Client	SIGECO
Contractor	NWS
Driller	J. Hackney
Initial Water Level (depth bgs)	ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	129420-034
Date Installed	20 Jun 2022
H&A Rep.	K. Henning
Location	See Plan
Ground El.	397.0 (est.)
Datum	

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
				0.0	397.0
				1.5	395.5
FILL				56.5	340.5
				60.0	337.0
	70.4			70.0	327.0

WELL CONSTRUCTION DETAILS

Type of protective cover	Bolted - 9/16" hex.
Depth of below ground surface	0.0 ft
Height of top of riser above ground surface	0.5 ft
Type of protective casing	
Length	
Inside diameter	
Depth of bottom of	ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	60.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	56.5
	-	-
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	60.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Pack Sand
Depth to bottom of well screen	70.0 ft
Bottom of silt trap	70.3 ft
Depth of bottom of well	70.4 ft
Depth of bottom of borehole	70.4 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-2

Project F.B. Culley
Location Indiana
Client SIGECO
Contractor NWS
Driller J. Hackney

Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 129420-034
Date Installed 30 Jun 2022
H&A Rep. K. Henning
Location See Plan

Ground El. 397.0 (est.)
Datum

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
				0.0	397.0
FILL				1.5	395.5
				33.0	364.0
				34.0	363.0
				44.0	353.0
				45.7	351.3
	46.0				

WELL CONSTRUCTION DETAILS

Type of protective cover: Bolted - 9/16" hex.
Depth of below ground surface: 0.0 ft
Depth of top of riser below ground surface: 0.0 ft
Type of protective casing:
Length:
Inside diameter:
Depth of bottom of: ft
Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe: 2.0 in.
Depth of bottom of riser pipe: 34.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	31.5
Sand	33.0	13.0
	-	-

Diameter of borehole: 8.0 in.
Depth to top of well screen: 34.0 ft
Type of screen: Machine slotted Sch 40 PVC
Screen gauge or size of openings: 0.010 in.
Diameter of screen: 2.0 in.
Type of Backfill around Screen: Filter Pack
Depth to bottom of well screen: 44.0 ft
Bottom of silt trap: 45.7 ft
Depth of bottom of well: 46.0 ft
Depth of bottom of borehole: 46.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-2I

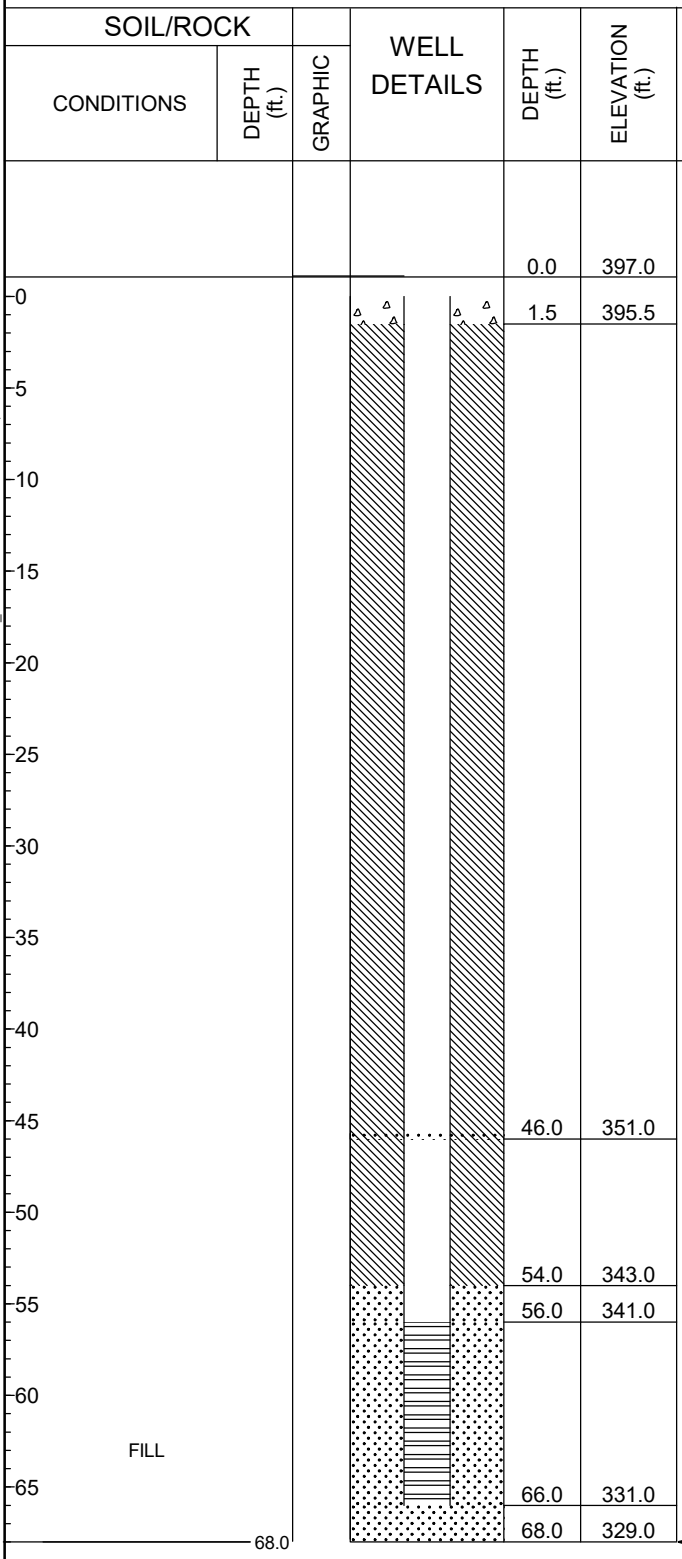
Project F.B. Culley
Location Indiana
Client SIGECO
Contractor NWS
Driller J. Hackney

Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 129420-034
Date Installed 5 Jul 2022
H&A Rep. K. Henning
Location See Plan

Ground El. 397.0 (est.)
Datum



WELL CONSTRUCTION DETAILS

Type of protective cover: Bolted - 9/16" hex.
Depth of below ground surface: 0.0 ft
Depth of top of riser below ground surface: 0.0 ft
Type of protective casing:
Length:
Inside diameter:
Depth of bottom of: ft
Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe: 2.0 in.
Depth of bottom of riser pipe: 56.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	52.5
Sand	54.0	14.0
	-	-

Diameter of borehole: 8.0 in.
Depth to top of well screen: 56.0 ft
Type of screen: Machine slotted Sch 40 PVC
Screen gauge or size of openings: 0.010 in.
Diameter of screen: 2.0 in.
Type of Backfill around Screen: Filter Pakc
Depth to bottom of well screen: 66.0 ft
Bottom of silt trap: 0.0 ft
Depth of bottom of well: 68.0 ft
Depth of bottom of borehole: 68.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-3

Project F.B. Culley
Location Indiana
Client SIGECO
Contractor NWS
Driller J. Hackney

Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 129420-034
Date Installed 28 Jun 2022
H&A Rep. K. Henning
Location See Plan

Ground El. 397.0 (est.)
Datum

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
				0.0	397.0
FILL	0			1.5	395.5
	5				
	10				
	15				
	20				
	25				
	30			34.0	363.0
	35			35.0	362.0
	40				
	45			45.0	352.0
	47.0			46.7	350.3

WELL CONSTRUCTION DETAILS

Type of protective cover: Bolted - 9/16" hex.
Depth of below ground surface: 0.0 ft
Depth of top of riser below ground surface: 0.0 ft
Type of protective casing:
Length:
Inside diameter:
Depth of bottom of: ft
Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe: 2.0 in.
Depth of bottom of riser pipe: 35.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	32.5
Sand	34.0	13.0
	-	-

Diameter of borehole: 8.0 in.
Depth to top of well screen: 35.0 ft
Type of screen: Machine slotted Sch 40 PVC
Screen gauge or size of openings: 0.010 in.
Diameter of screen: 2.0 in.
Type of Backfill around Screen: Filter Pack Sand
Depth to bottom of well screen: 45.0 ft
Bottom of silt trap: 46.6 ft
Depth of bottom of well: 47.0 ft
Depth of bottom of borehole: 47.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

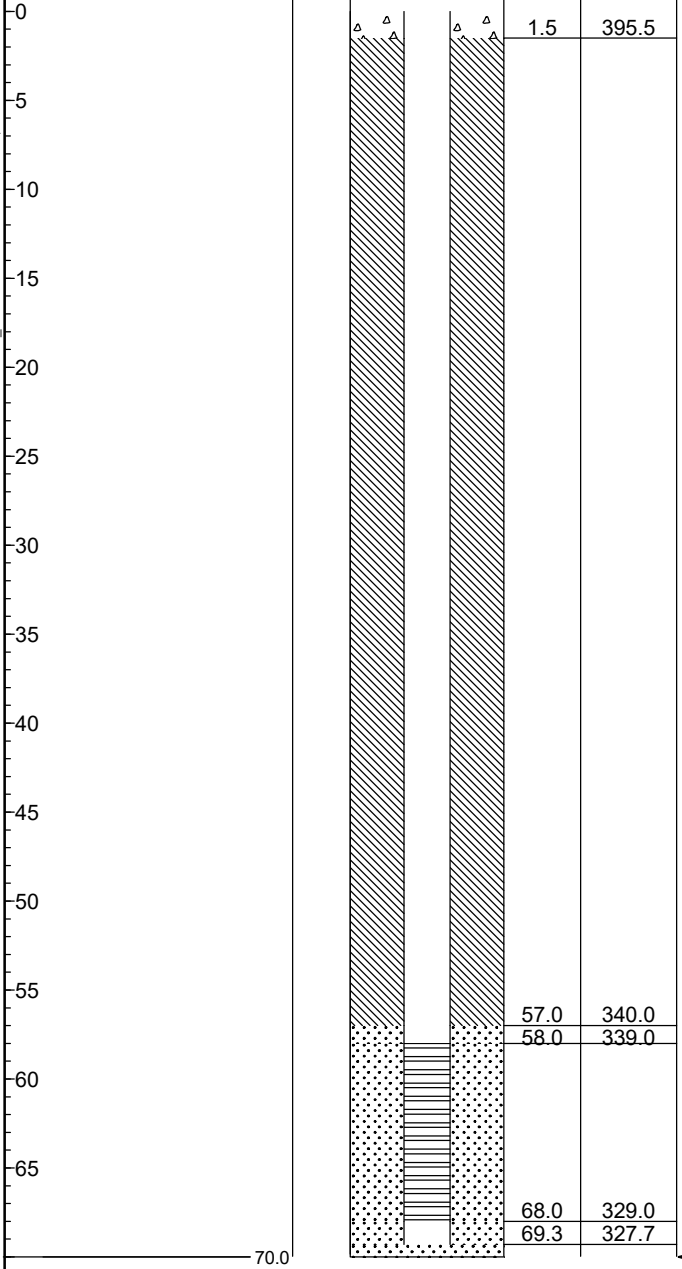
Well No. CCR-OW-3I

Project	F.B. Culley
Location	Indiana
Client	SIGECO
Contractor	NWS
Driller	J. Hackney
Initial Water Level (depth bgs)	ft

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	129420-034
Date Installed	20 Jun 2022
H&A Rep.	K. Henning
Location	See Plan
Ground El.	397.0 (est.)
Datum	



WELL CONSTRUCTION DETAILS

Type of protective cover	Bolted - 9/16" hex.
Depth of below ground surface	0.0 ft
Depth of top of riser below ground surface	0.0 ft
Type of protective casing	
Length	
Inside diameter	
Depth of bottom of	ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	68.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	55.5
Sand	57.0	13.0
	-	-

Diameter of borehole	8.0 in.
Depth to top of well screen	68.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Pack Sand
Depth to bottom of well screen	68.0 ft
Bottom of silt trap	69.3 ft
Depth of bottom of well	70.0 ft
Depth of bottom of borehole	70.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-4

Project F.B. Culley
Location Indiana
Client SIGECO
Contractor NWS
Driller J. Hackney

Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 129420-034
Date Installed 27 Jun 2022
H&A Rep. K. Henning
Location See Plan

Ground El. 397.0 (est.)
Datum

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)
				0.0	397.0
				1.5	395.5
FILL				34.0	363.0
				36.0	361.0
				46.0	351.0
	47.0			46.3	350.7

WELL CONSTRUCTION DETAILS

Type of protective cover: Bolted - 9/16" hex.
Depth of below ground surface: 0.0 ft
Depth of top of riser below ground surface: 0.0 ft
Type of protective casing:
Length:
Inside diameter:
Depth of bottom of: ft
Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe: 2.0 in.
Depth of bottom of riser pipe: 36.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	32.5
Sand	34.0	13.0
	-	-

Diameter of borehole: 8.0 in.
Depth to top of well screen: 36.0 ft
Type of screen: Machine slotted Sch 40 PVC
Screen gauge or size of openings: 0.010 in.
Diameter of screen: 2.0 in.
Type of Backfill around Screen: Filter Pack Sand
Depth to bottom of well screen: 46.0 ft
Bottom of silt trap: 46.3 ft
Depth of bottom of well: 47.0 ft
Depth of bottom of borehole: 47.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-4I

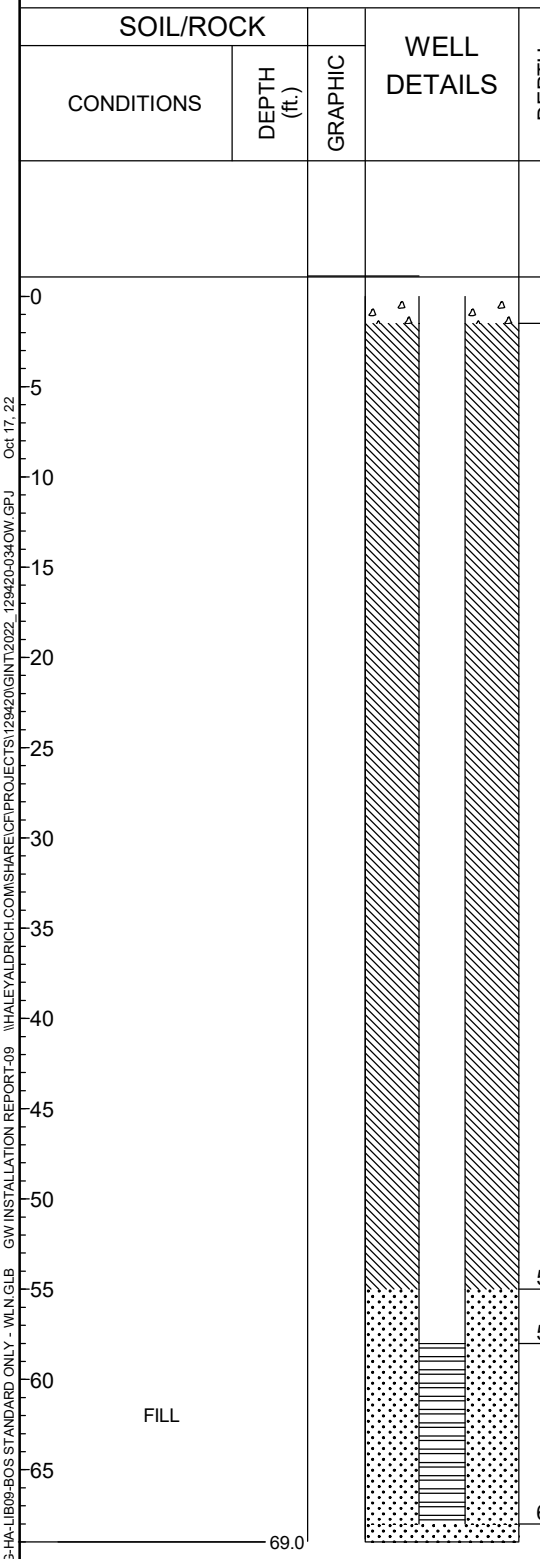
Project F.B. Culley
Location Indiana
Client SIGECO
Contractor NWS
Driller J. Hackney

Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 129420-034
Date Installed 27 Jun 2022
H&A Rep. K. Henning
Location See Plan

Ground El. 397.0 (est.)
Datum



WELL CONSTRUCTION DETAILS

Type of protective cover: Bolted - 9/16" hex.

Depth of below ground surface: 0.0 ft

Depth of top of riser below ground surface: 0.0 ft

Type of protective casing:

Length:

Inside diameter:

Depth of bottom of: ft

Type of riser pipe: Schedule 40 PVC

Inside diameter of riser pipe: 2.0 in.

Depth of bottom of riser pipe: 58.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	53.5
Sand	55.0	14.0
	-	-

Diameter of borehole: 8.0 in.

Depth to top of well screen: 58.0 ft

Type of screen: Machine slotted Sch 40 PVC

Screen gauge or size of openings: 0.010 in.

Diameter of screen: 2.0 in.

Type of Backfill around Screen: Filter Pack Sand

Depth to bottom of well screen: 68.0 ft

Bottom of silt trap: 0.0 ft

Depth of bottom of well: 69.0 ft

Depth of bottom of borehole: 69.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. CCR-OW-5I

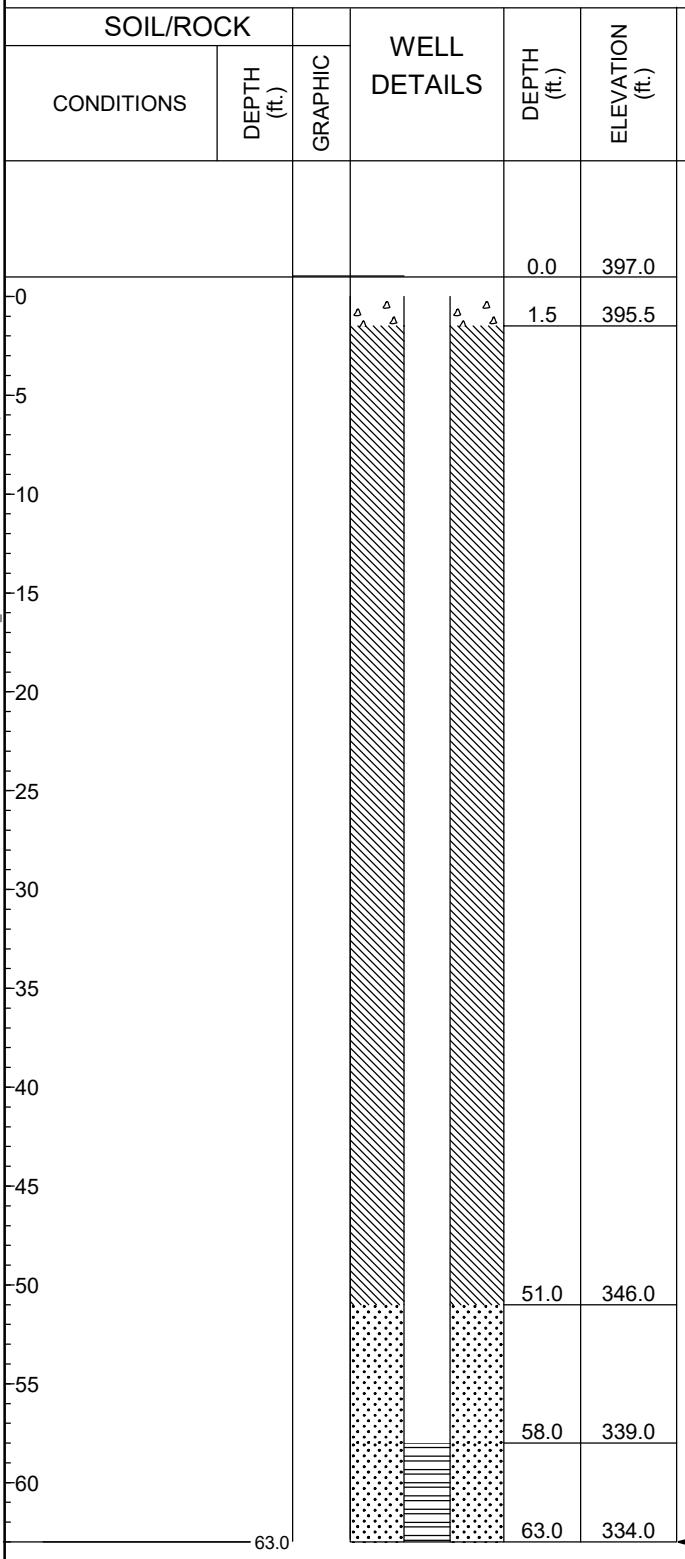
Project F.B. Culley
Location Indiana
Client SIGECO
Contractor NWS
Driller J. Hackney

Initial Water Level (depth bgs) ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 129420-034
Date Installed 6 Jul 2022
H&A Rep. K. Henning
Location See Plan

Ground El. 397.0 (est.)
Datum



WELL CONSTRUCTION DETAILS

Type of protective cover: Bolted - 9/16" hex.

Depth of below ground surface: 0.0 ft

Height of top of riser above ground surface: 0.4 ft

Type of protective casing:

Length:

Inside diameter:

Depth of bottom of: ft

Type of riser pipe: Schedule 40 PVC

Inside diameter of riser pipe: 2.0 in.

Depth of bottom of riser pipe: 58.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.5
Bentonite	1.5	51.0
Sand	51.0	12.0
	-	-

Diameter of borehole: 8.0 in.

Depth to top of well screen: 58.0 ft

Type of screen: Machine slotted Sch 40 PVC

Screen gauge or size of openings: 0.010 in.

Diameter of screen: 2.0 in.

Type of Backfill around Screen: Filter Pack Sand

Depth to bottom of well screen: 63.0 ft

Bottom of silt trap: 0.0 ft

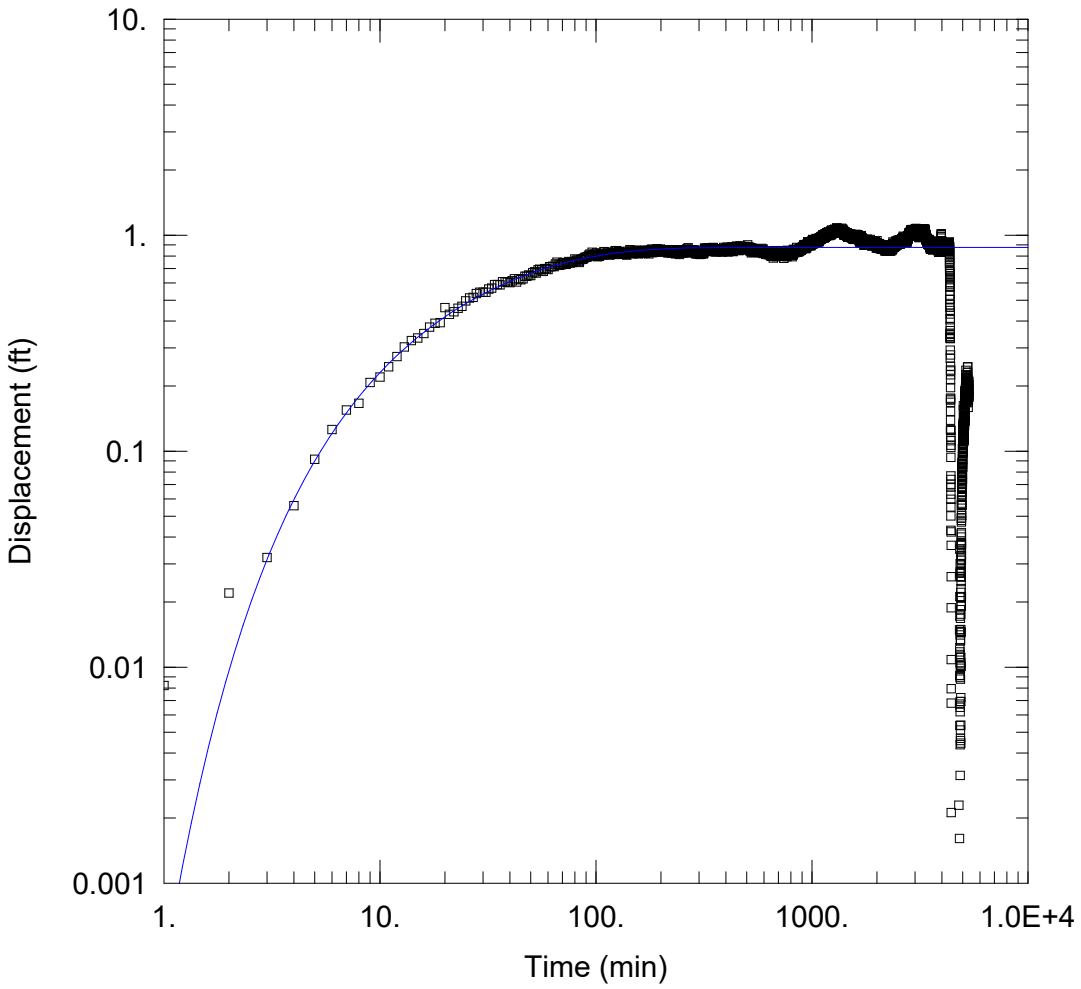
Depth of bottom of well: 63.0 ft

Depth of bottom of borehole: 63.0 ft

COMMENTS:

PLOG-HA-LIB09-BOS STANDARD ONLY - WLN.GLB GW INSTALLATION REPORT-09 \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\129420\GINT\2022_129420-034OW.GPJ Oct 17, 22

APPENDIX B
AQTESOLV Outputs



WELL TEST ANALYSIS

Data Set: C:\...\CCR-AP-8I.aqt
Date: 11/29/22 Time: 15:14:39

PROJECT INFORMATION

Company: Haley & Aldrich
Client: SIGECO
Project: 0129420-034
Location: F.B.Culley East Ash Pond
Test Well: CCR-PW-1
Test Date: 10-19-2022

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
CCR-PW-1	0	0

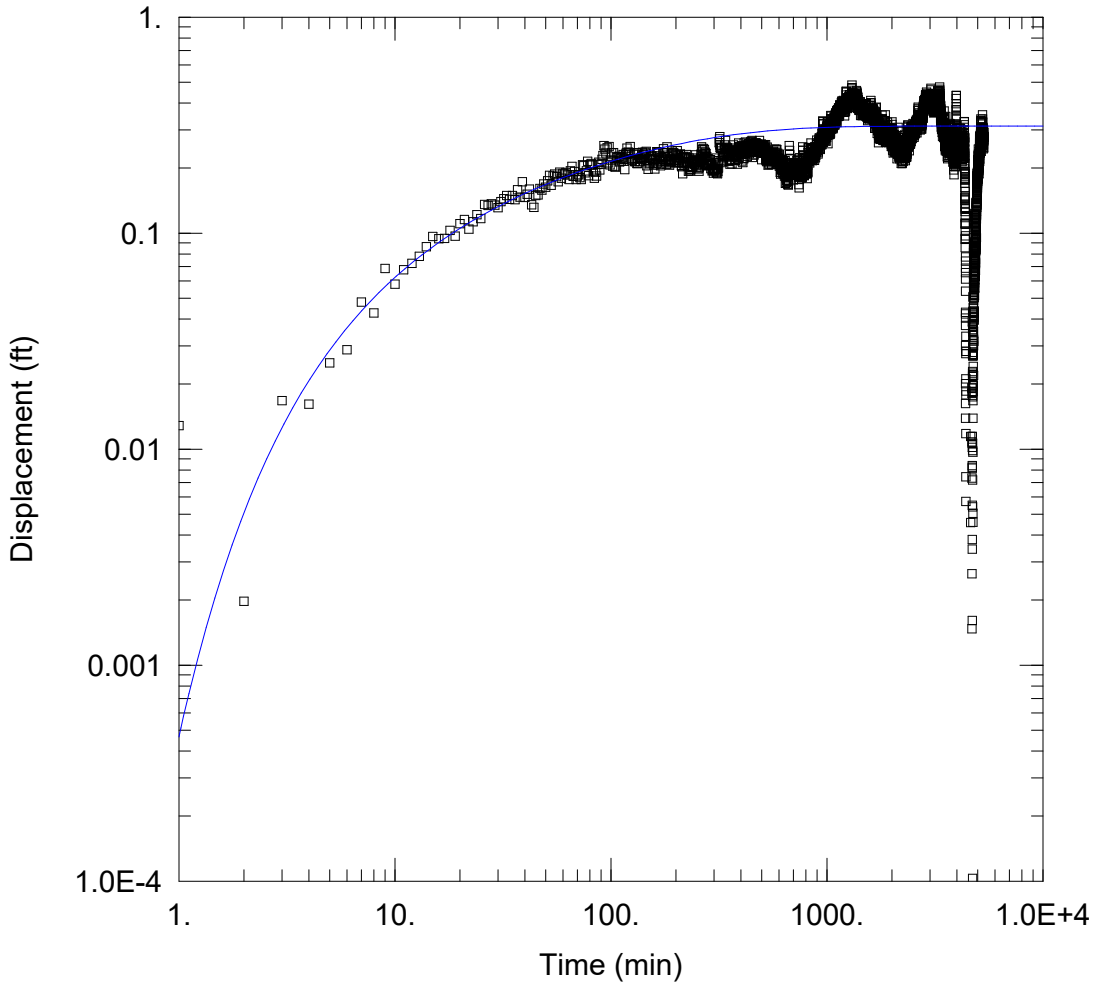
Observation Wells

Well Name	X (ft)	Y (ft)
□ CCR-AP-8I	56.09	0.27

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 3.889 cm^2/sec
S = 0.001679
r/B = 0.4898
Kz/Kr = 1.
b = 12. ft



WELL TEST ANALYSIS

Data Set: C:\...\CCR-OW-1I.aqt
Date: 11/29/22 Time: 14:42:39

PROJECT INFORMATION

Company: Haley & Aldrich
Client: SIGECO
Project: 0129420-034
Location: F.B.Culley East Ash Pond
Test Well: CCR-PW-1
Test Date: 10-19-2022

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
CCR-PW-1	0	0

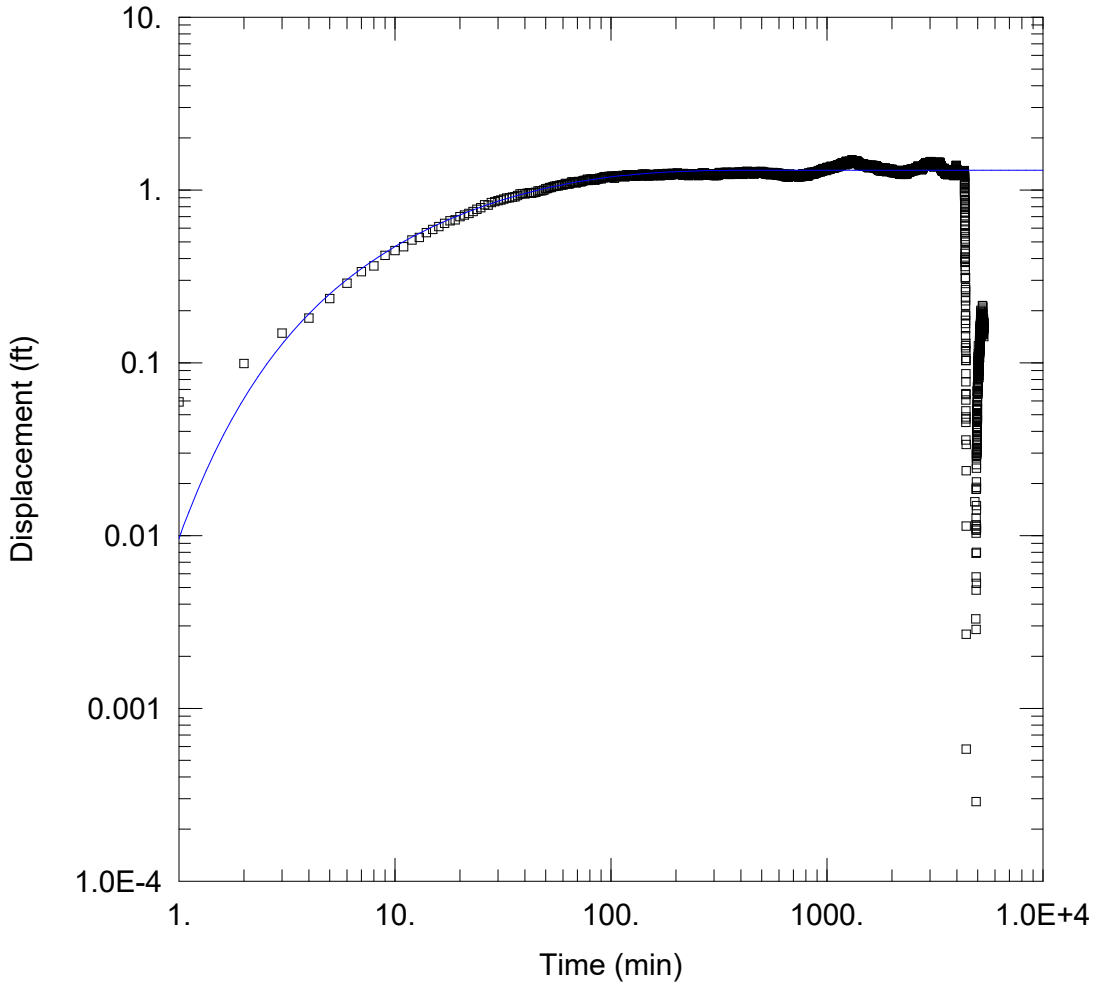
Observation Wells

Well Name	X (ft)	Y (ft)
▫ CCR-OW-1I	-93.19	-19.38

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 21.87 cm^2/sec
S = 0.002291
r/B = 0.1738
Kz/Kr = 1.
b = 15. ft



WELL TEST ANALYSIS

Data Set: C:\...\CCR-OW-2I.aqt
Date: 11/29/22 Time: 14:49:55

PROJECT INFORMATION

Company: Haley & Aldrich
Client: SIGECO
Project: 0129420-034
Location: F.B.Culley East Ash Pond
Test Well: CCR-PW-1
Test Date: 10-19-2022

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
CCR-PW-1	0	0

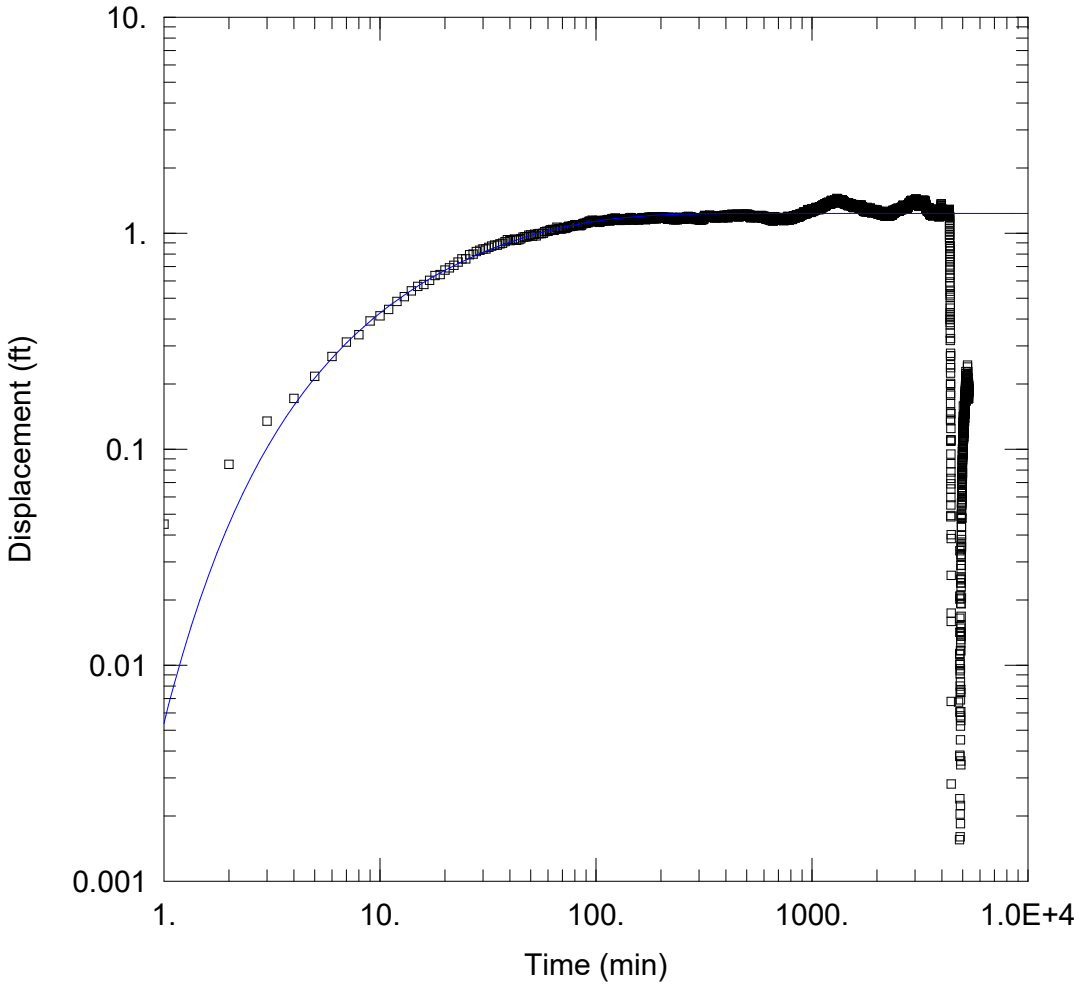
Observation Wells

Well Name	X (ft)	Y (ft)
□ CCR-OW-2I	-19.81	-3.97

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 3.63 cm^2/sec
S = 0.006185
r/B = 0.3236
Kz/Kr = 1.
b = 10. ft



WELL TEST ANALYSIS

Data Set: C:\...\CCR-OW-3I.aqt
Date: 11/29/22 Time: 14:53:33

PROJECT INFORMATION

Company: Haley & Aldrich
Client: SIGECO
Project: 0129420-034
Location: F.B.Culley East Ash Pond
Test Well: CCR-PW-1
Test Date: 10-19-2022

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
CCR-PW-1	0	0

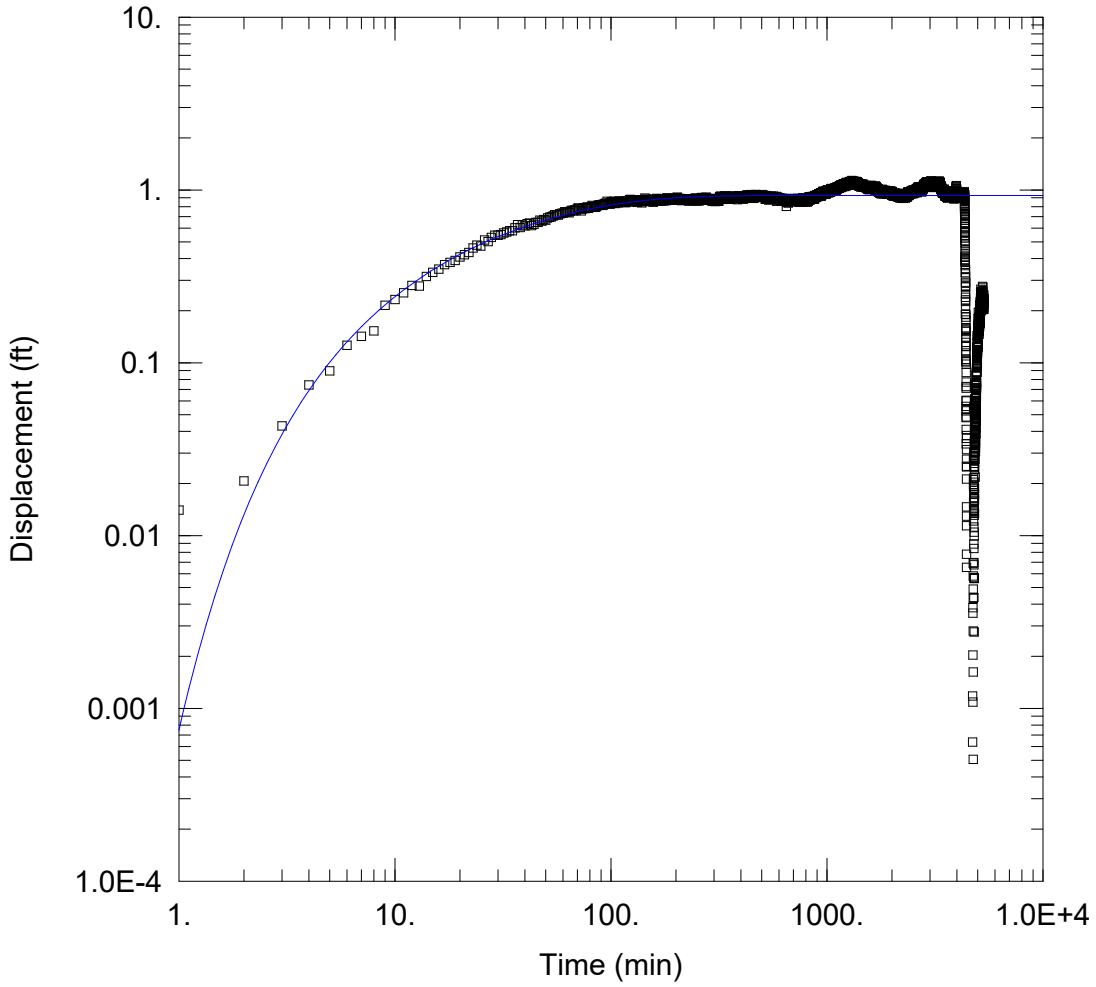
Observation Wells

Well Name	X (ft)	Y (ft)
▫ CCR-OW-3I	14.45	2.2

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 3.466 cm^2/sec
S = 0.01334
r/B = 0.3715
Kz/Kr = 1.
b = 10. ft



WELL TEST ANALYSIS

Data Set: C:\...\CCR-OW-4I.aqt
Date: 11/29/22 Time: 14:55:27

PROJECT INFORMATION

Company: Haley & Aldrich
Client: SIGECO
Project: 0129420-034
Location: F.B.Culley East Ash Pond
Test Well: CCR-PW-1
Test Date: 10-19-2022

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
CCR-PW-1	0	0

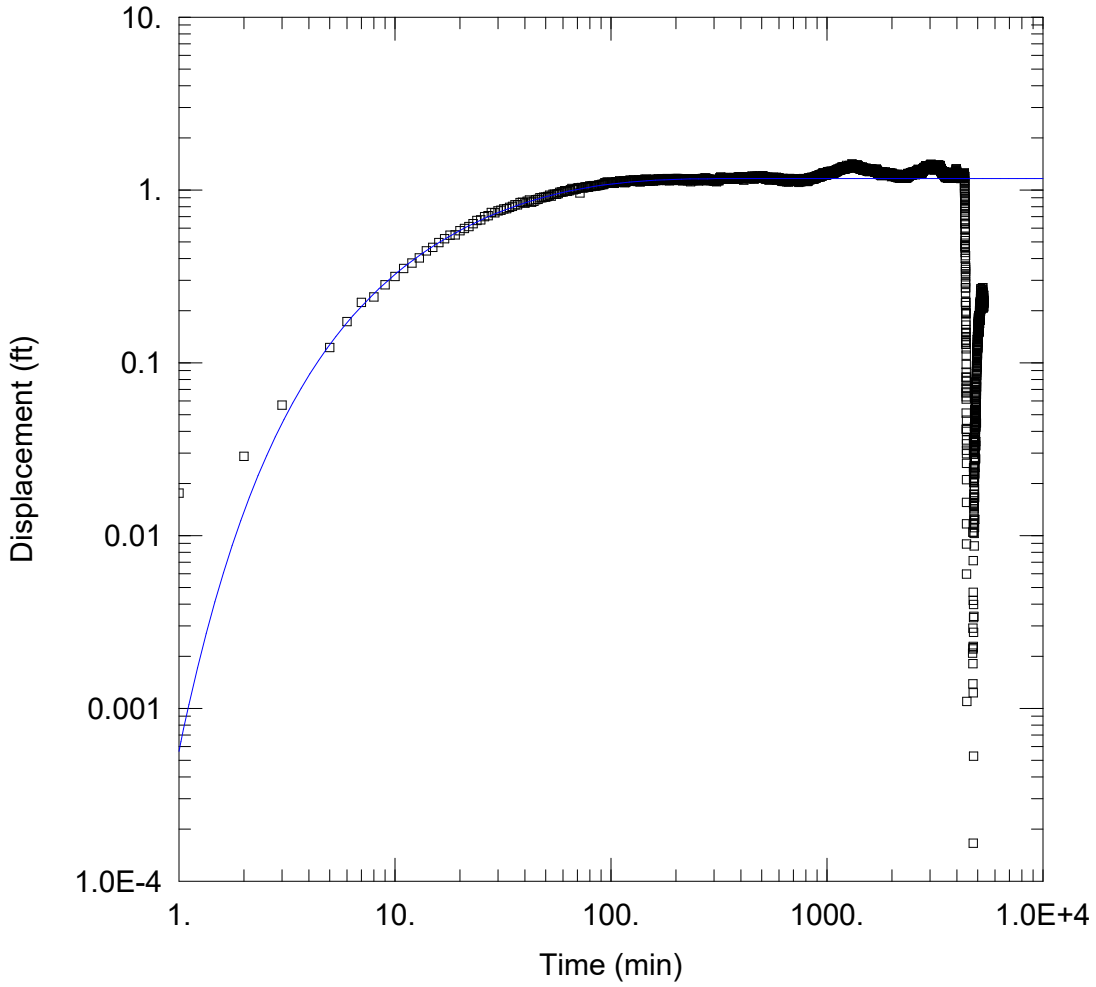
Observation Wells

Well Name	X (ft)	Y (ft)
▫ CCR-OW-4I	78.91	13.12

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 4.364 cm^2/sec
S = 0.0008128
r/B = 0.3981
Kz/Kr = 1.
b = 10. ft



WELL TEST ANALYSIS

Data Set: C:\...\CCR-OW-5I.aqt
Date: 11/29/22 Time: 14:56:06

PROJECT INFORMATION

Company: Haley & Aldrich
Client: SIGECO
Project: 0129420-034
Location: F.B.Culley East Ash Pond
Test Well: CCR-PW-1
Test Date: 10-19-2022

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
CCR-PW-1	0	0

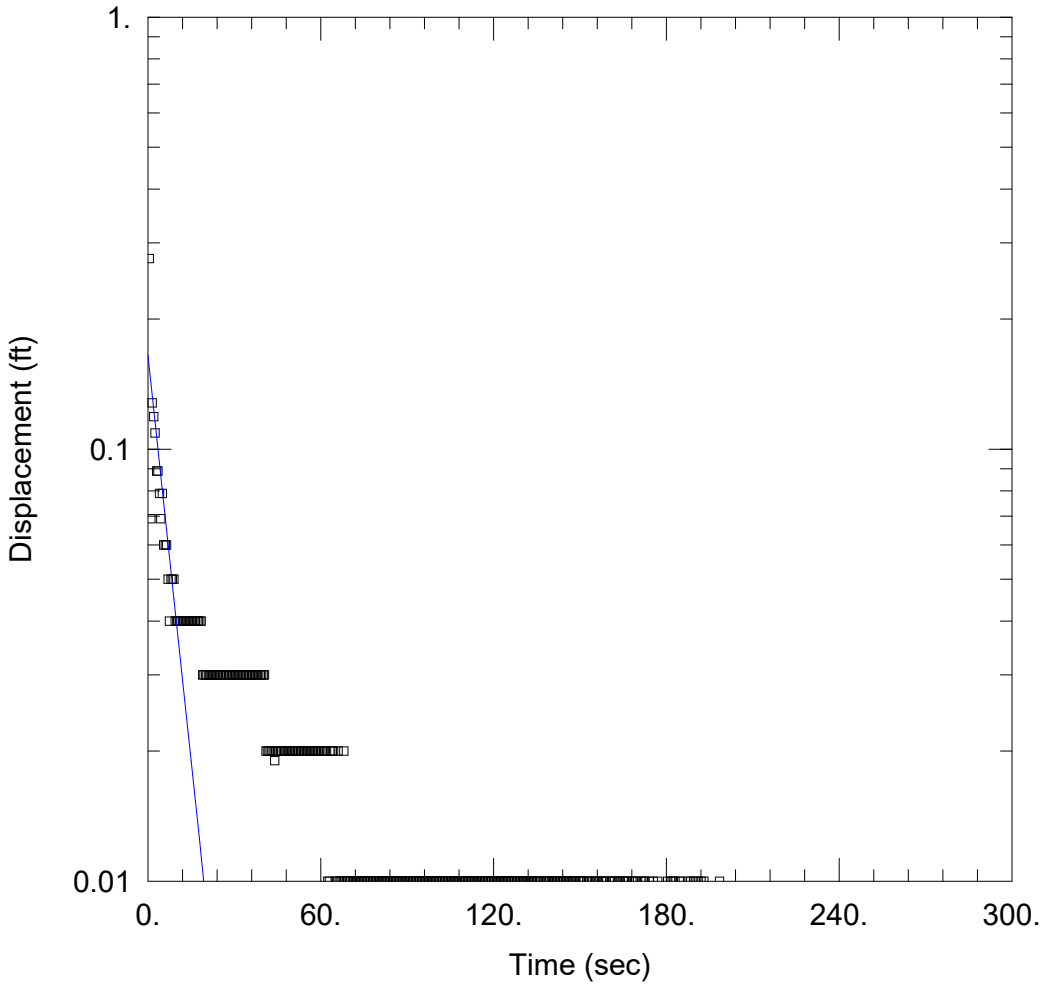
Observation Wells

Well Name	X (ft)	Y (ft)
□ CCR-OW-5I	2.48	64.25

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 2.753 cm^2/sec
S = 0.0009016
r/B = 0.5248
Kz/Kr = 1.
b = 5. ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-1R_F1.aqt
Date: 06/15/23 Time: 20:50:28

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-1R
Test Date: 5/24/23

AQUIFER DATA

Saturated Thickness: 8.39 ft Anisotropy Ratio (Kz/Kr): 1.

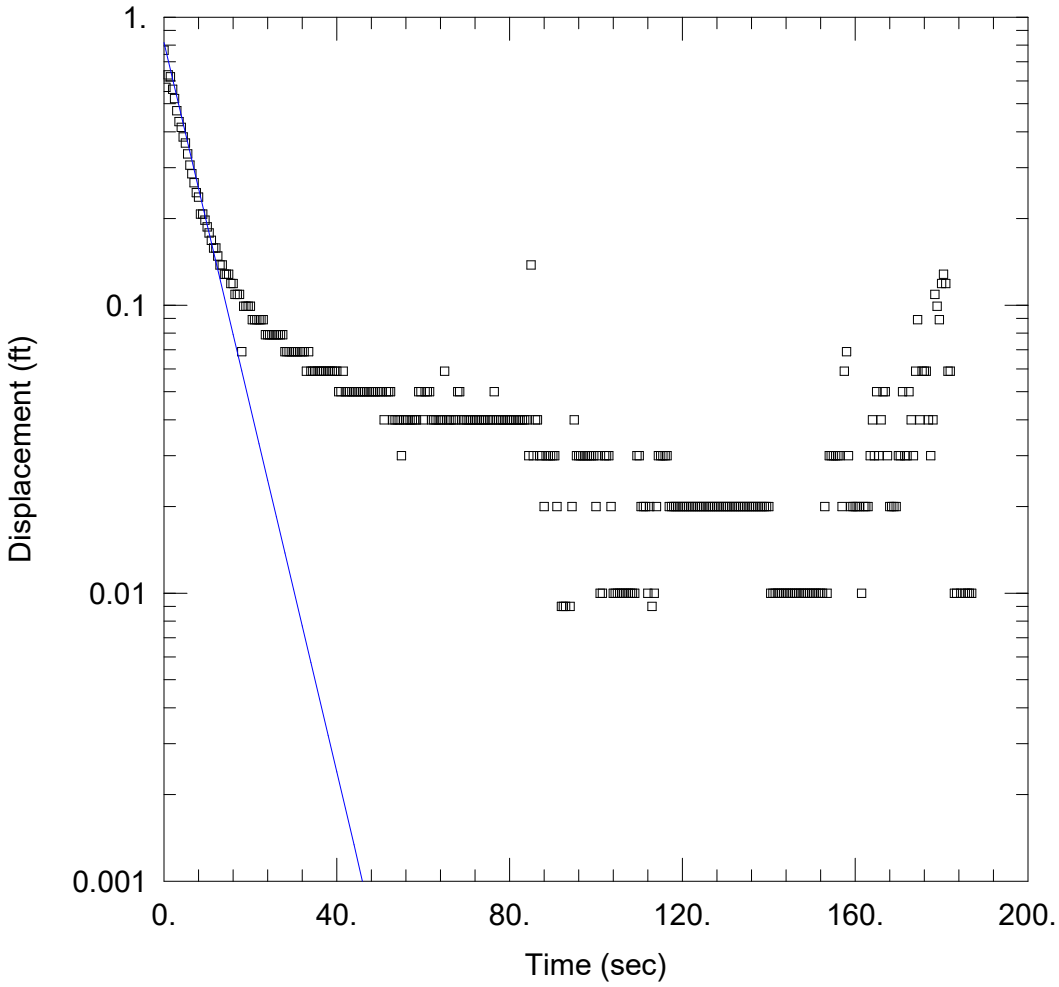
WELL DATA (CCR-AP-1R)

Initial Displacement: 1.378 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 12.93 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.005044 cm/sec y0 = 0.1647 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-1R_R1.aqt
Date: 06/15/23 Time: 20:51:03

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-1R
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 8.39 ft Anisotropy Ratio (Kz/Kr): 1.

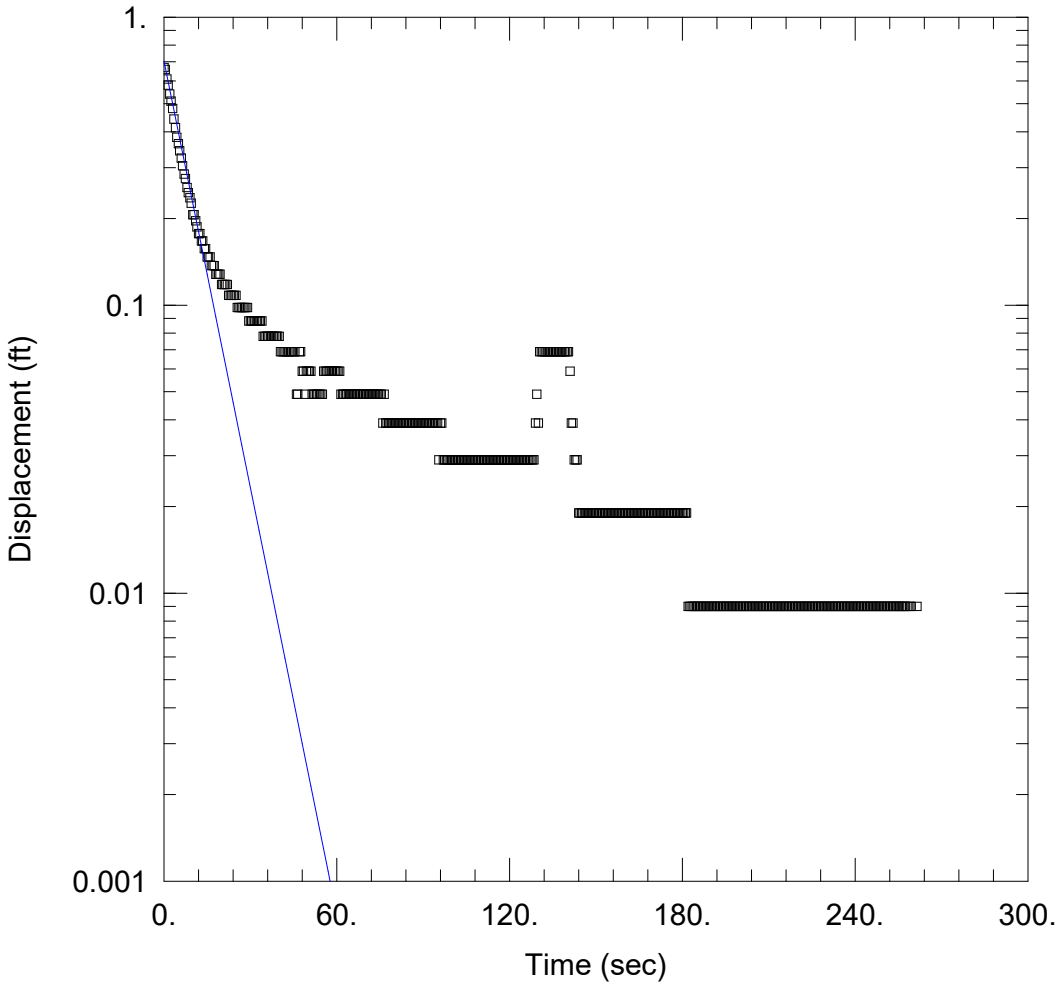
WELL DATA (CCR-AP-1R)

Initial Displacement: 0.768 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 12.93 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.005099 cm/sec y0 = 0.8152 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-1R_R2.aqt
Date: 06/15/23 Time: 20:51:39

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-1R
Test Date: 5/24/23

AQUIFER DATA

Saturated Thickness: 8.39 ft Anisotropy Ratio (Kz/Kr): 1.

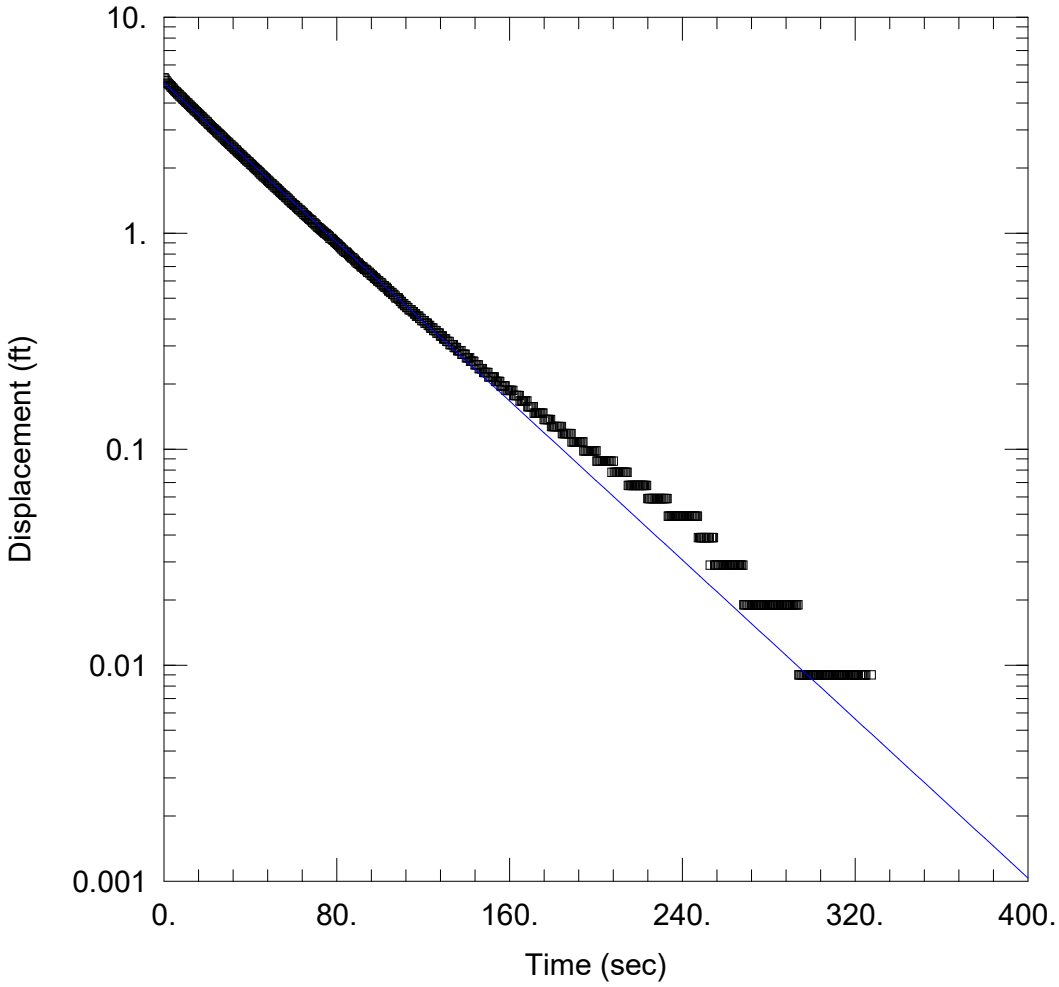
WELL DATA (CCR-AP-1R)

Initial Displacement: 0.669 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 12.93 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.003977 cm/sec y0 = 0.7034 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-5_R1.aqt
Date: 06/15/23 Time: 20:51:54

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-5
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

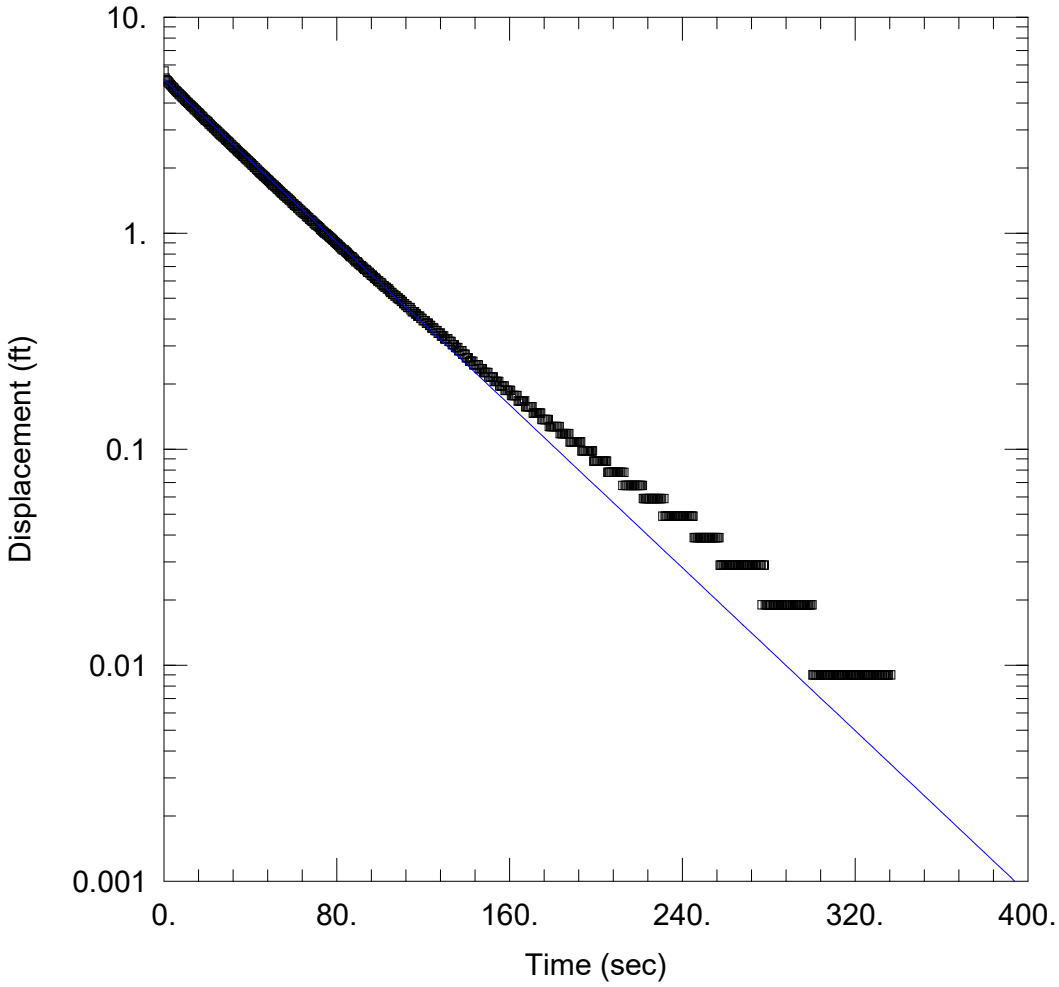
WELL DATA (CCR-AP-5)

Initial Displacement: 5.236 ft
Total Well Penetration Depth: 18.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 30.98 ft
Screen Length: 11. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0006551 cm/sec y0 = 4.948 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-5_R2.aqt
Date: 06/15/23 Time: 20:52:05

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-5
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

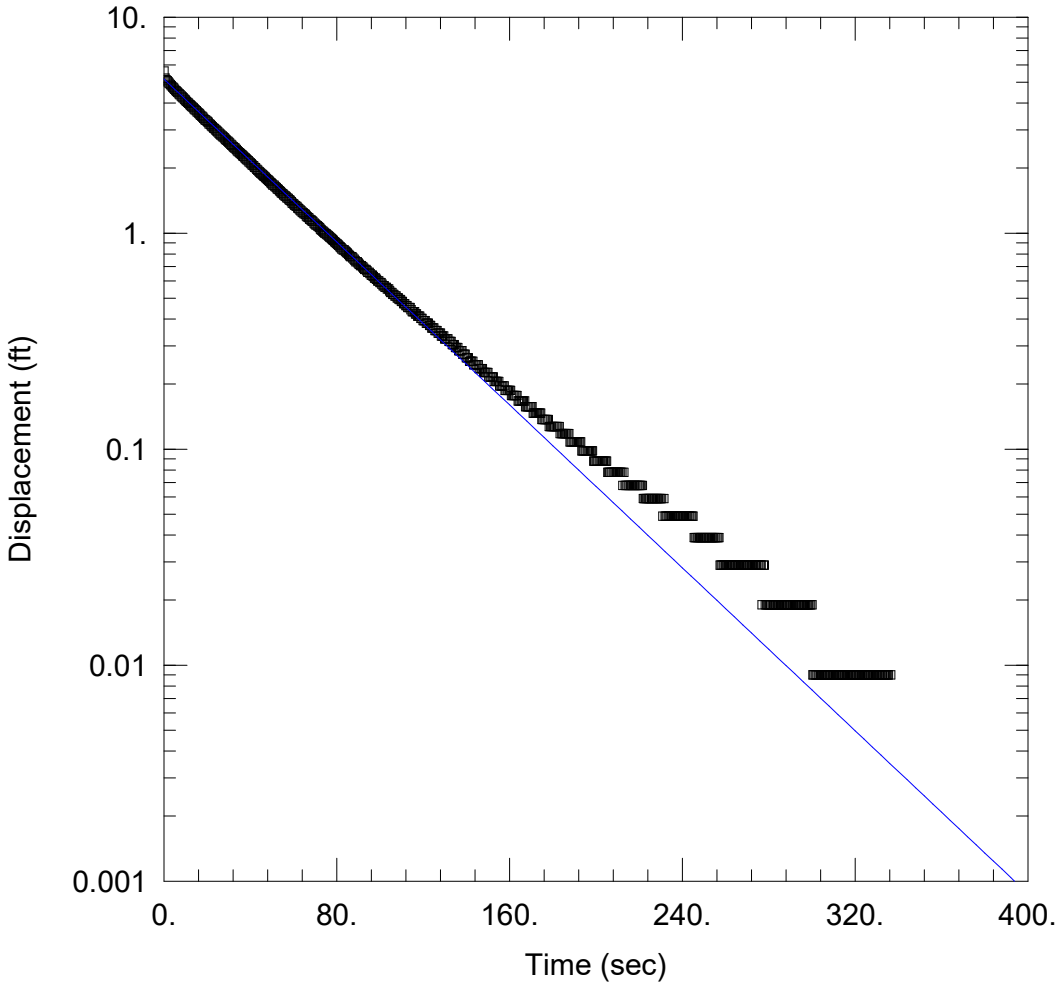
WELL DATA (CCR-AP-5)

Initial Displacement: 5.629 ft
Total Well Penetration Depth: 18.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 30.98 ft
Screen Length: 11. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0006711 cm/sec y0 = 5.157 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-5_R3.aqt
Date: 06/15/23 Time: 20:52:18

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-5
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

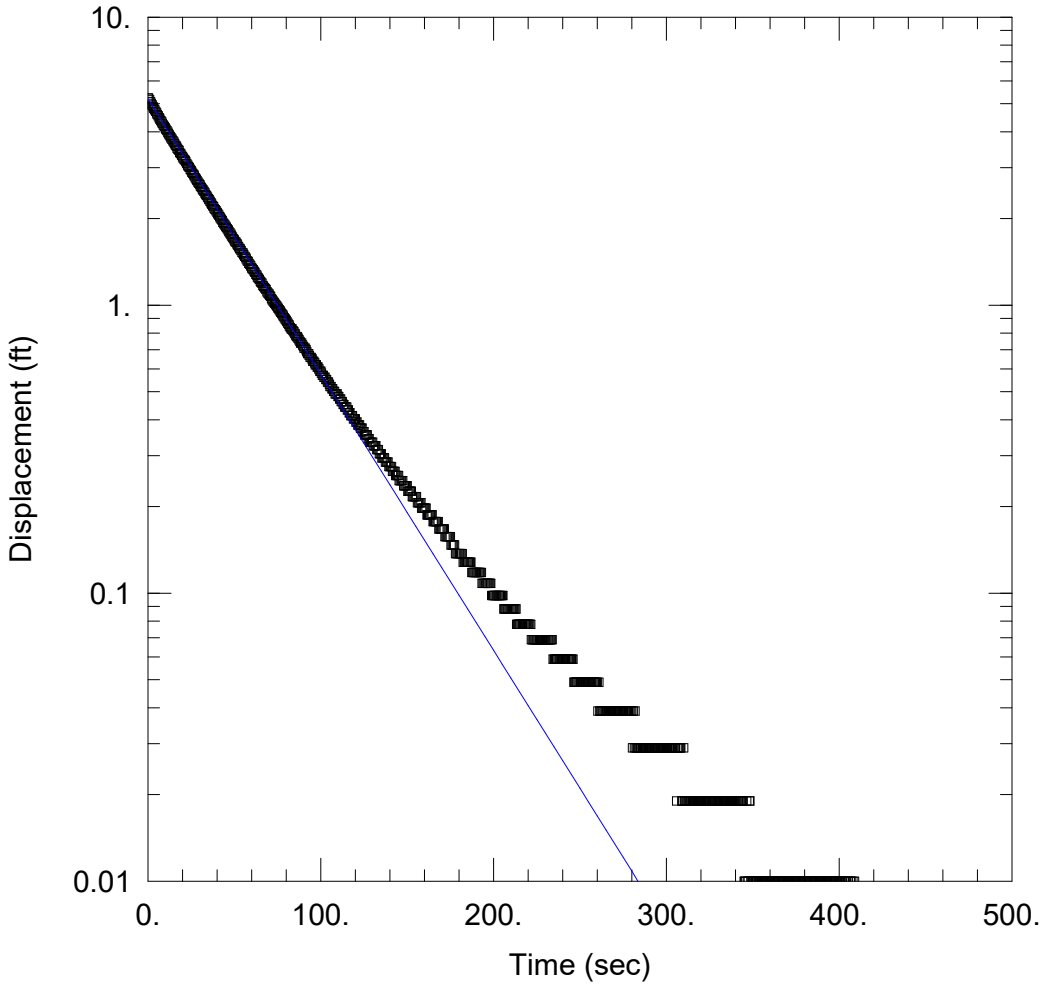
WELL DATA (CCR-AP-5)

Initial Displacement: 5.629 ft
Total Well Penetration Depth: 18.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 30.98 ft
Screen Length: 11. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0006713 cm/sec y0 = 5.164 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-5_R4.aqt
Date: 06/15/23 Time: 20:52:31

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-5
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

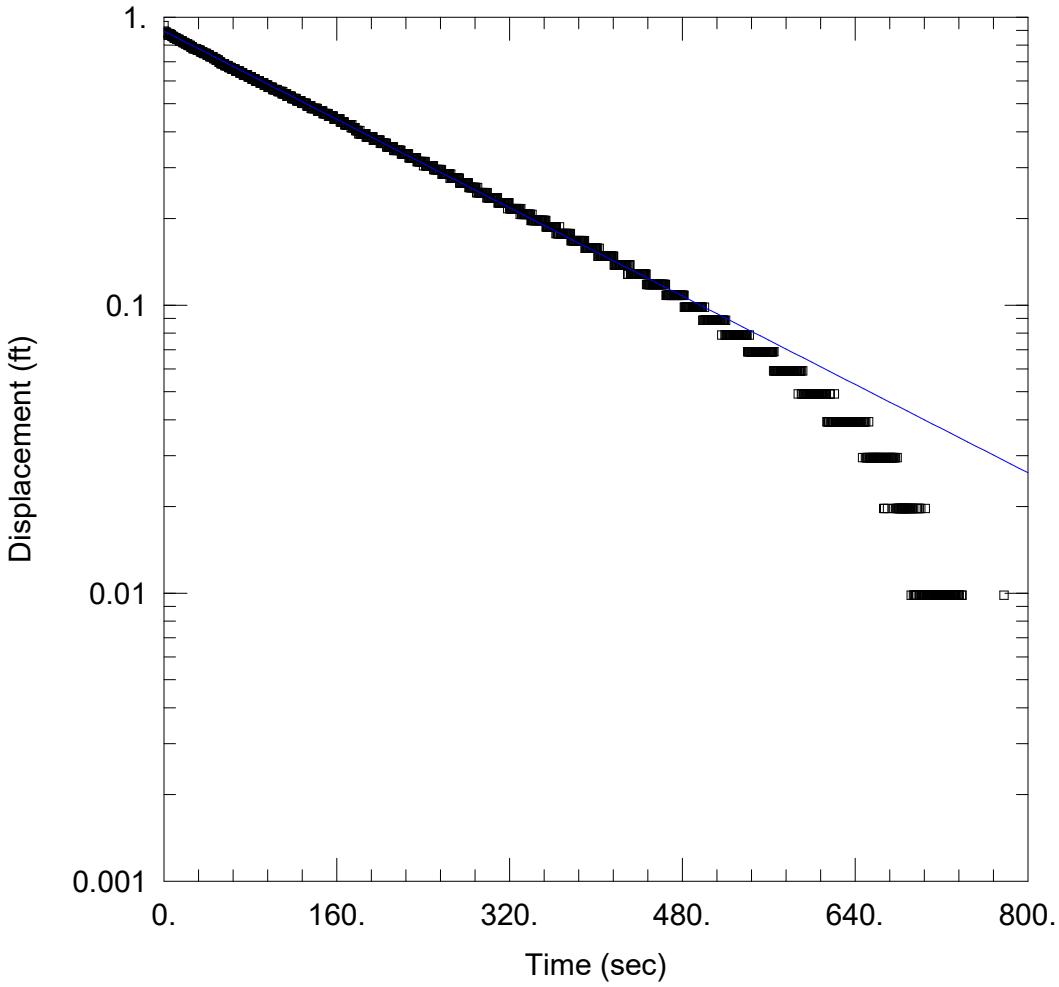
WELL DATA (CCR-AP-5)

Initial Displacement: 5.236 ft
Total Well Penetration Depth: 18.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 30.98 ft
Screen Length: 11. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.000682 cm/sec y0 = 5.207 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-5I_F1.aqt
Date: 06/15/23 Time: 20:52:45

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-5I
Test Date: 5/24/23

AQUIFER DATA

Saturated Thickness: 35. ft Anisotropy Ratio (Kz/Kr): 1.

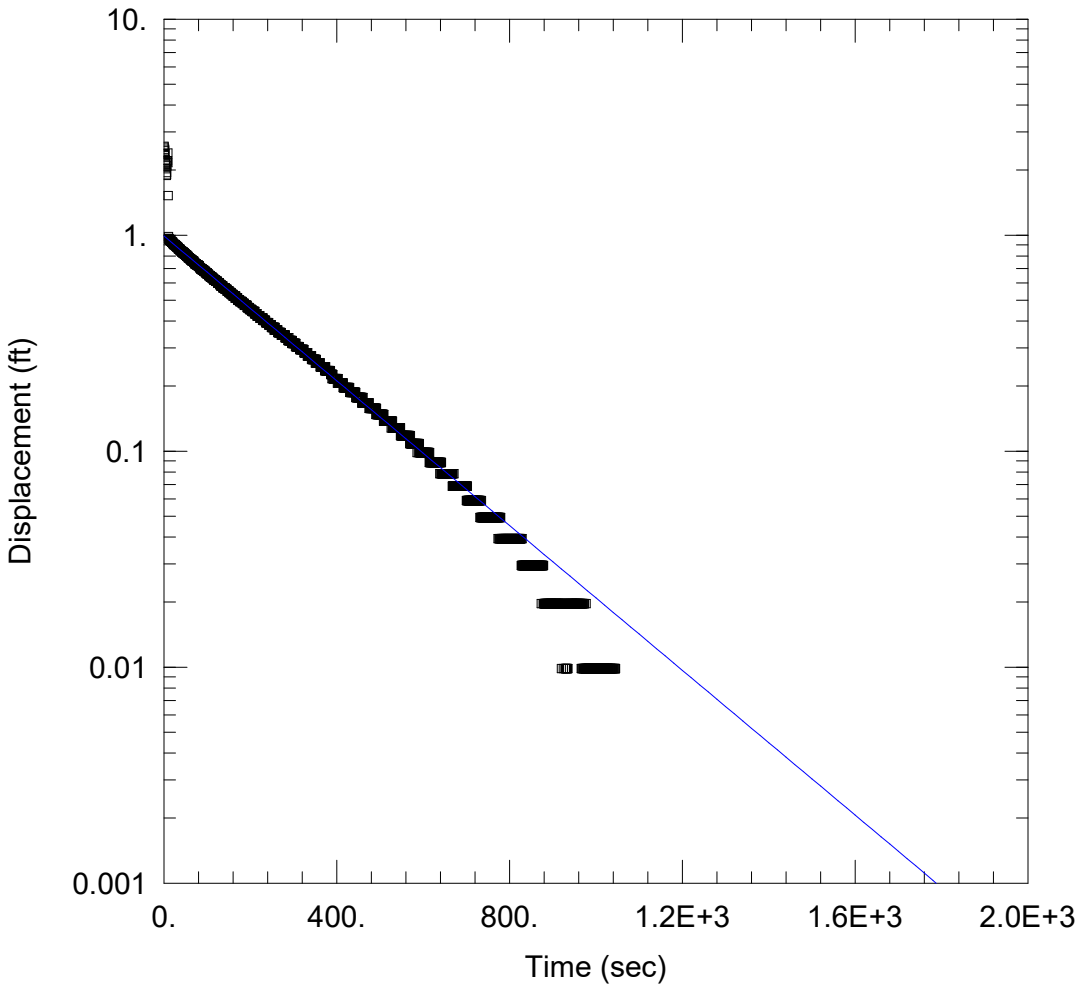
WELL DATA (CCR-AP-5I)

Initial Displacement: 0.9348 ft
Total Well Penetration Depth: 71.47 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.77 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.0001853 cm/sec y0 = 0.8944 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-5I_R1.aqt
Date: 06/15/23 Time: 20:53:09

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-5I
Test Date: 5/24/23

AQUIFER DATA

Saturated Thickness: 35. ft Anisotropy Ratio (Kz/Kr): 1.

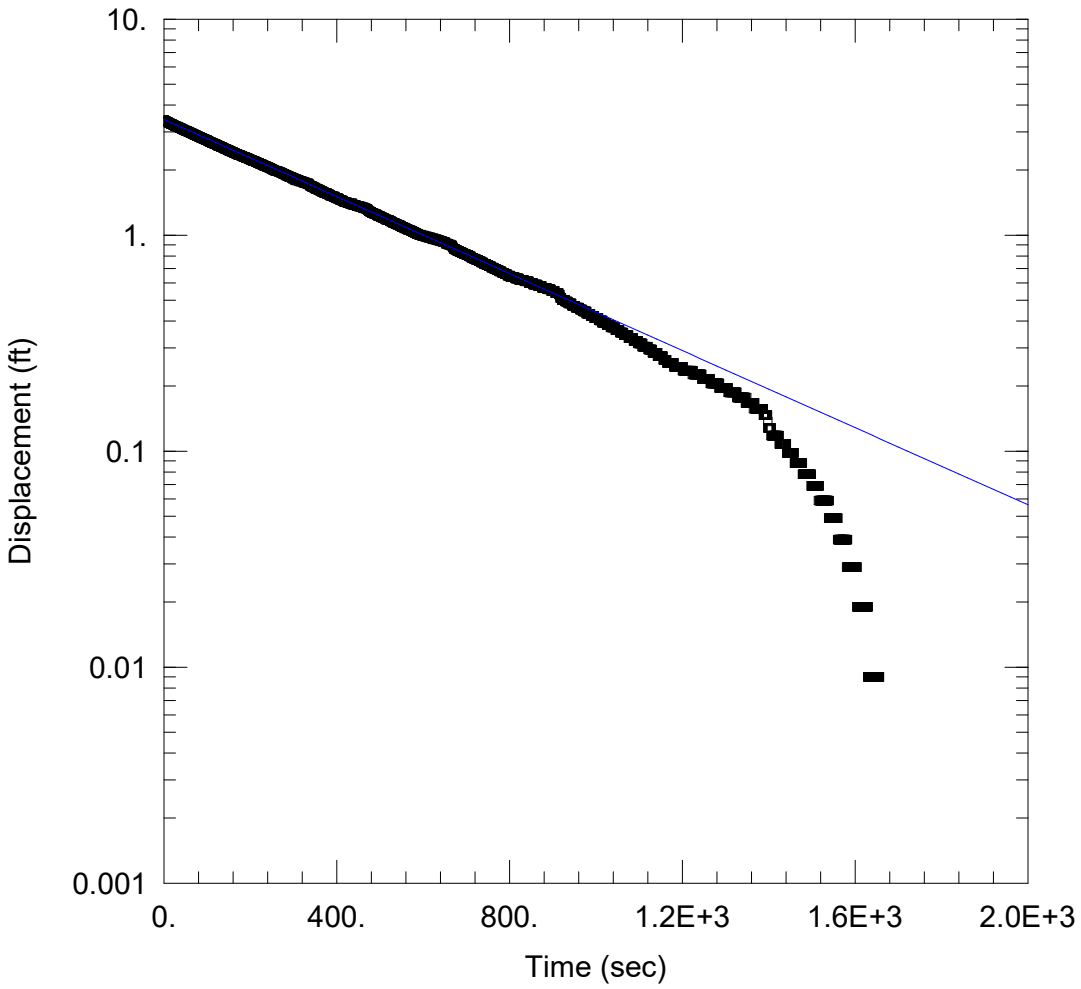
WELL DATA (CCR-AP-5I)

Initial Displacement: 2.578 ft
Total Well Penetration Depth: 71.47 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.77 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.000162 cm/sec y0 = 0.9902 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-5I_R2_Pneumatic.aqt
Date: 06/15/23 Time: 20:53:31

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-5I
Test Date: 5/24/23

AQUIFER DATA

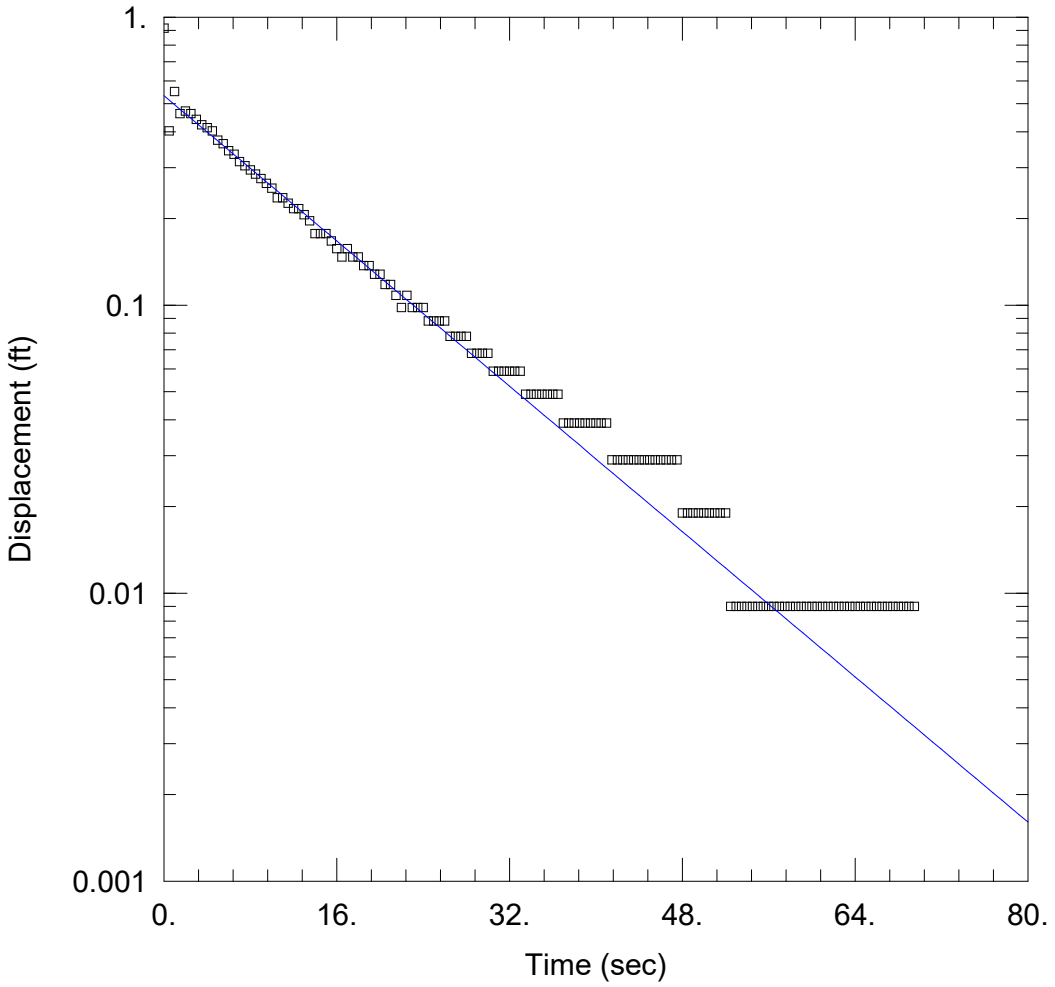
Saturated Thickness: 35. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CCR-AP-5I)

Initial Displacement: 3.415 ft
Static Water Column Height: 71.77 ft
Total Well Penetration Depth: 71.47 ft
Screen Length: 10. ft
Casing Radius: 0.0833 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 8.625E-5 cm/sec
y0 = 3.436 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6_R1.aqt
Date: 06/15/23 Time: 20:55:37

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6
Test Date: 5/24/23

AQUIFER DATA

Saturated Thickness: 6.53 ft Anisotropy Ratio (Kz/Kr): 1.

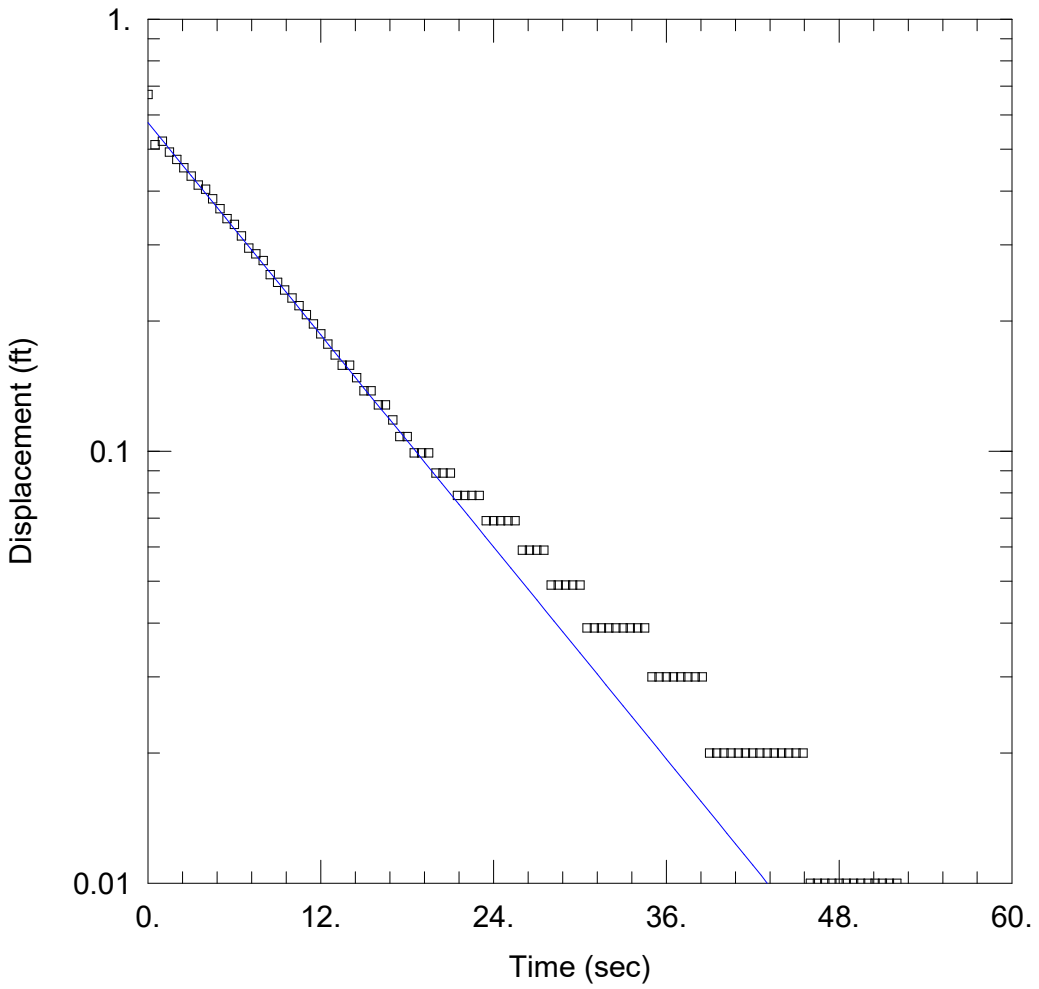
WELL DATA (CCR-AP-6)

Initial Displacement: 0.915 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 6.13 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.2

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.008287 cm/sec y0 = 0.5333 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6_R2.aqt
Date: 06/15/23 Time: 20:55:52

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6
Test Date: 5/24/23

AQUIFER DATA

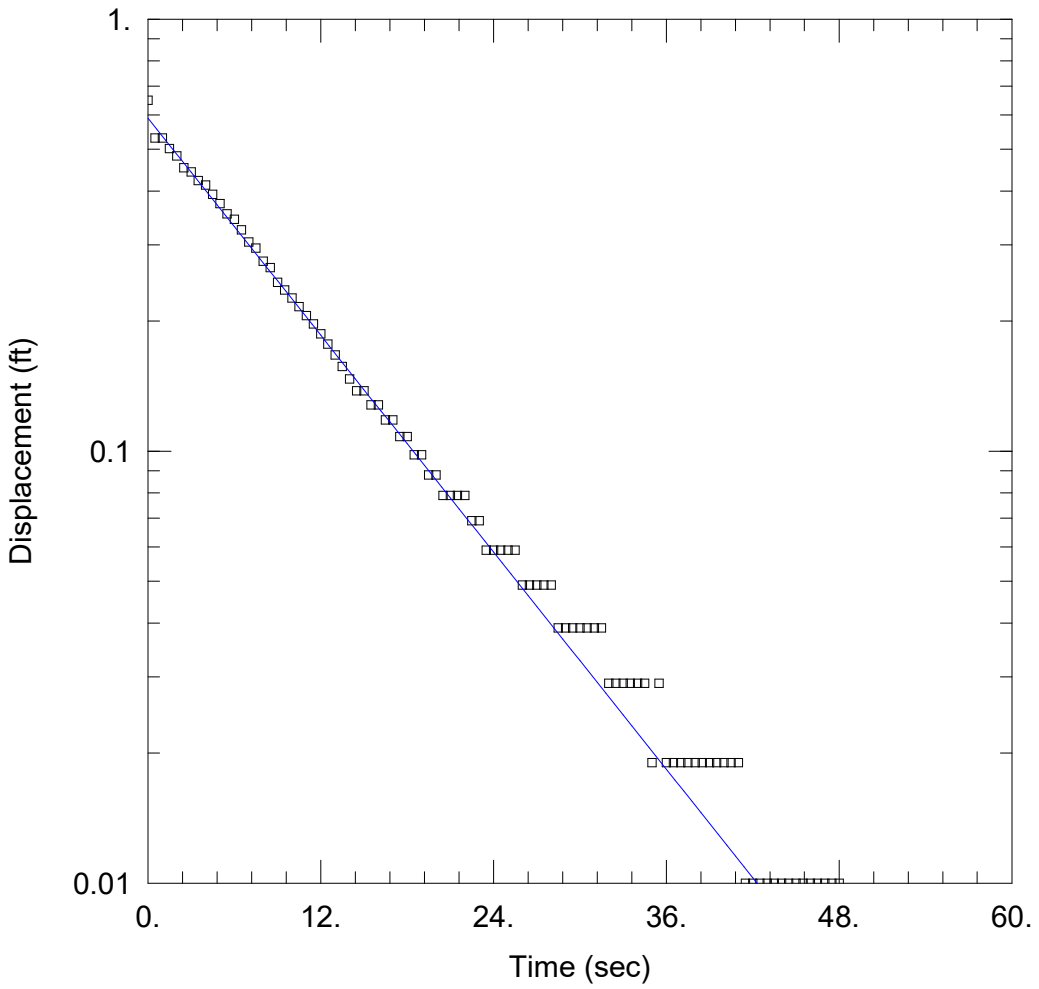
Saturated Thickness: 6.53 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CCR-AP-6)

Initial Displacement: 0.669 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 6.13 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.2

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 0.01076 cm/sec y0 = 0.5759 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6_R3.aqt
Date: 06/15/23 Time: 20:56:11

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6
Test Date: 5/24/23

AQUIFER DATA

Saturated Thickness: 6.53 ft Anisotropy Ratio (Kz/Kr): 1.

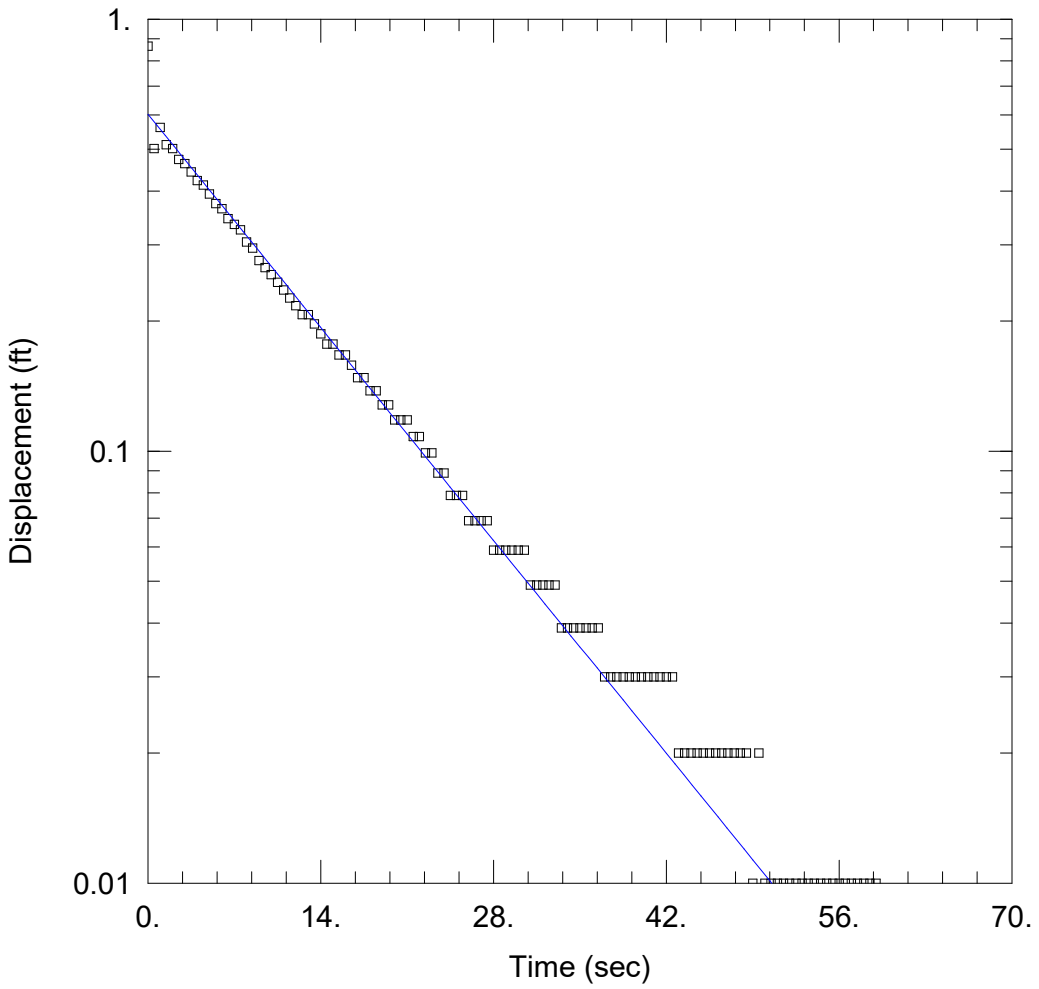
WELL DATA (CCR-AP-6)

Initial Displacement: 0.649 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 6.13 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.2

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.01101 cm/sec y0 = 0.59 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6_R4.aqt
Date: 06/15/23 Time: 20:56:26

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6
Test Date: 5/24/23

AQUIFER DATA

Saturated Thickness: 6.53 ft Anisotropy Ratio (Kz/Kr): 1.

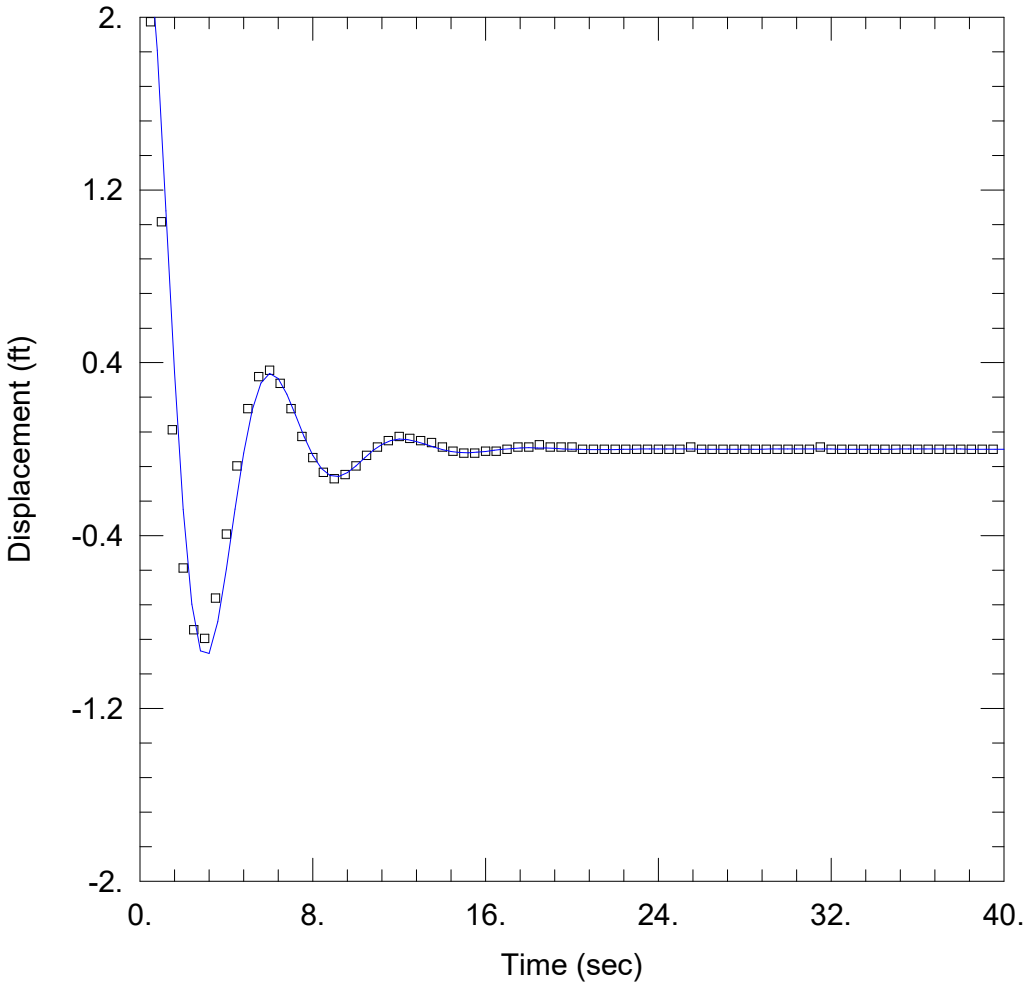
WELL DATA (CCR-AP-6)

Initial Displacement: 0.866 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 6.13 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.2

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.009261 cm/sec y0 = 0.6025 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6I_R1.aqt
Date: 06/15/23 Time: 20:58:30

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6I
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 11. ft Anisotropy Ratio (Kz/Kr): 1.

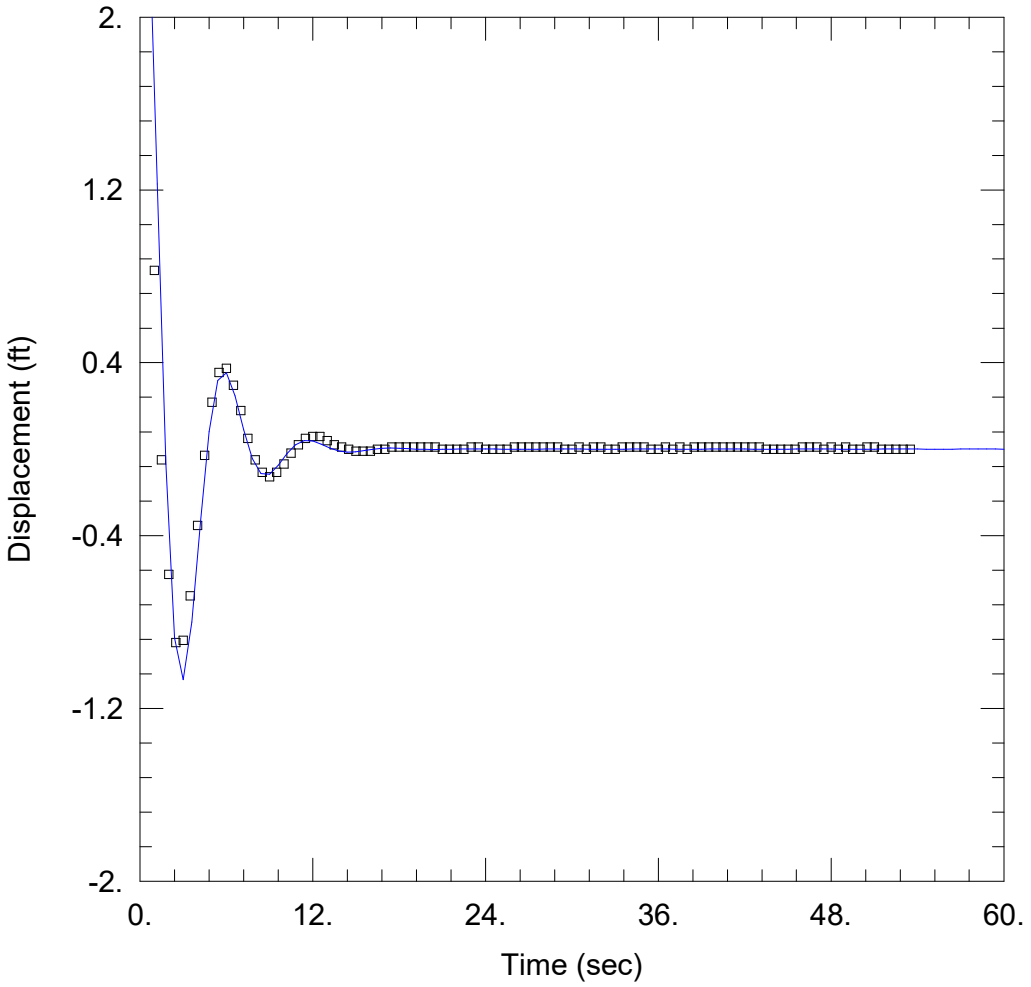
WELL DATA (CCR-AP-6I)

Initial Displacement: 2.648 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 34.26 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Butler

K = 0.08435 cm/sec Le = 26.97 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6I_R2.aqt
Date: 06/15/23 Time: 20:58:44

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6I
Test Date: 5/23/23

AQUIFER DATA

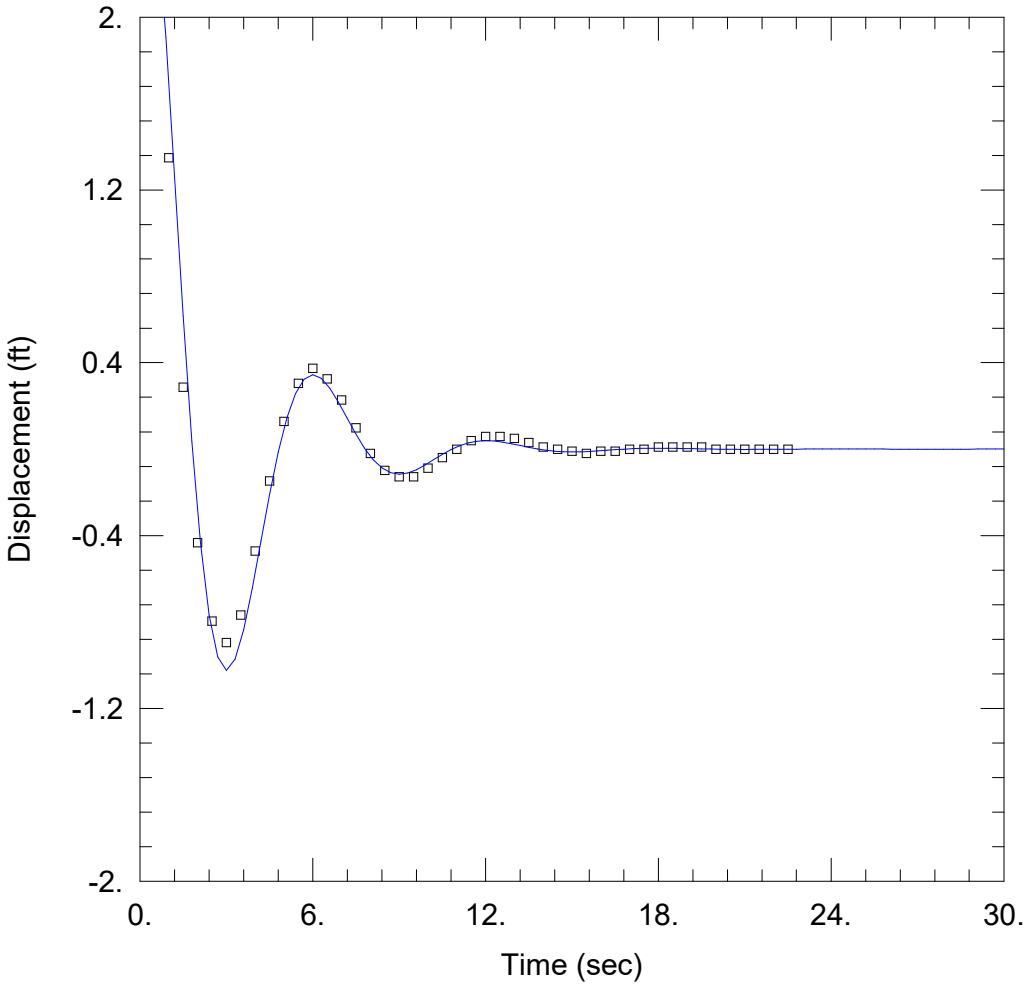
Saturated Thickness: 11. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CCR-AP-6I)

Initial Displacement: 3.189 ft Static Water Column Height: 34.26 ft
Total Well Penetration Depth: 11. ft Screen Length: 10. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Butler
K = 0.08258 cm/sec Le = 24.57 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6I_R3.aqt
Date: 06/15/23 Time: 20:59:05

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6I
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 11. ft Anisotropy Ratio (Kz/Kr): 1.

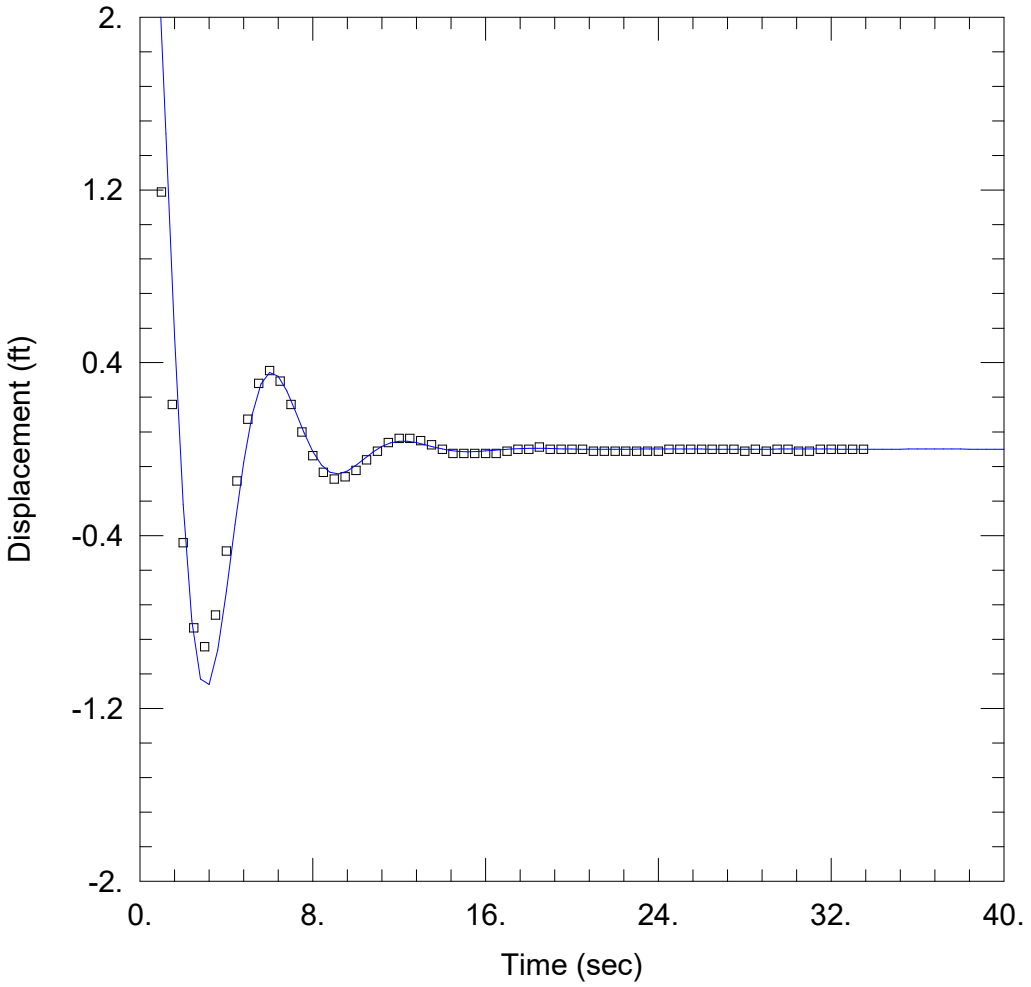
WELL DATA (CCR-AP-6I)

Initial Displacement: 3.042 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 34.26 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Butler

K = 0.07984 cm/sec Le = 26.25 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-6I_R4.aqt
Date: 06/15/23 Time: 20:59:18

PROJECT INFORMATION

Company: Haley & Aldrich
Client: AES
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-6I
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 11. ft Anisotropy Ratio (Kz/Kr): 1.

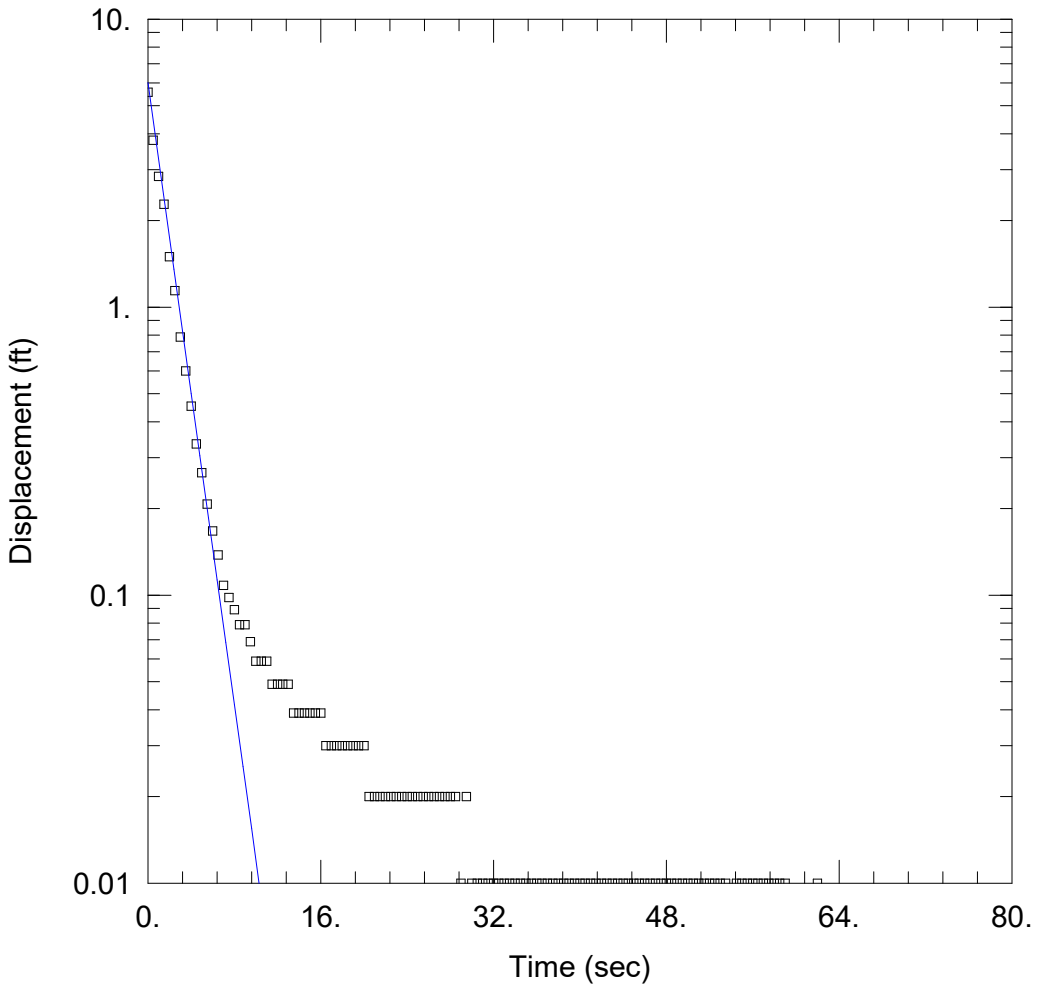
WELL DATA (CCR-AP-6I)

Initial Displacement: 3.425 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 34.26 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Butler

K = 0.07648 cm/sec Le = 26.71 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-8I_R1.aqt
Date: 06/15/23 Time: 20:59:37

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-8I
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 12. ft Anisotropy Ratio (Kz/Kr): 1.

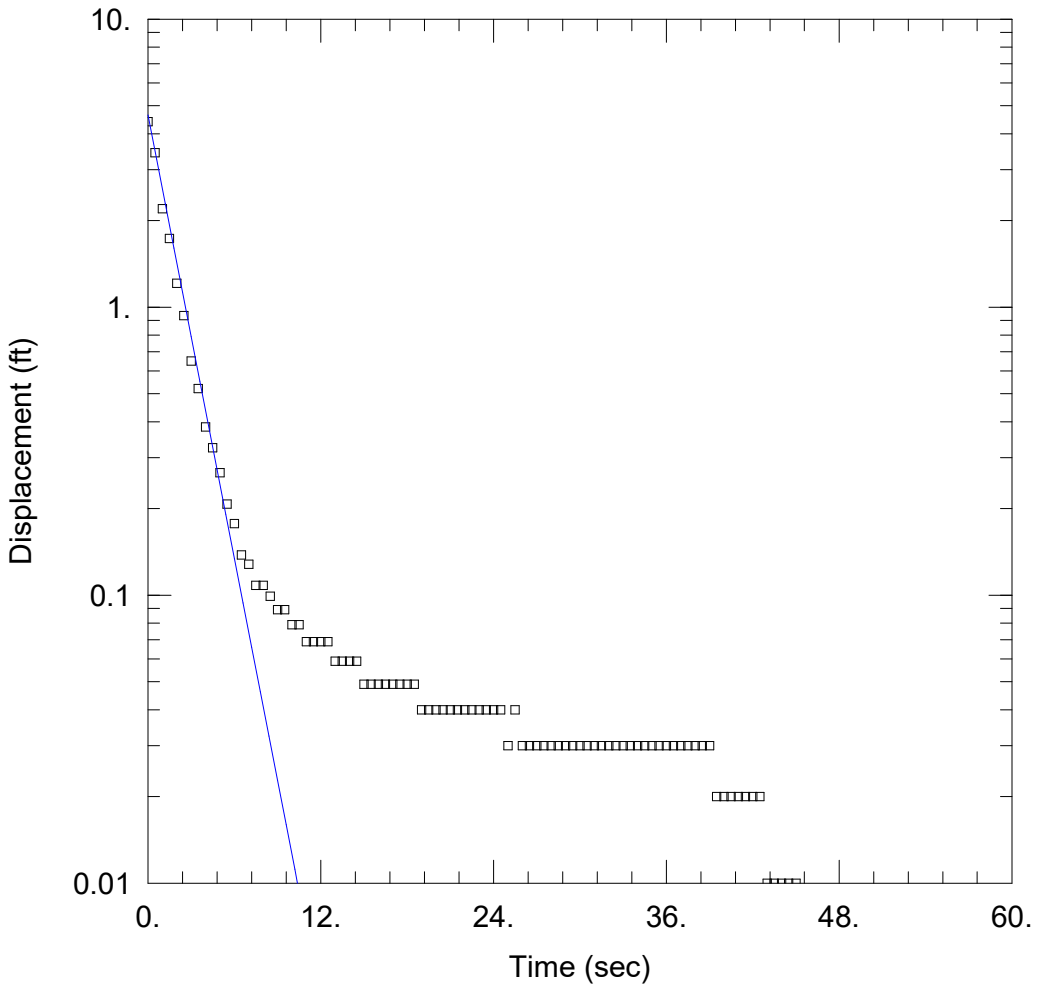
WELL DATA (CCR-AP-8I)

Initial Displacement: 5.571 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 33.39 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.01751 cm/sec
y0 = 6.013 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-8I_R2.aqt
Date: 06/15/23 Time: 20:59:52

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-8I
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 12. ft Anisotropy Ratio (Kz/Kr): 1.

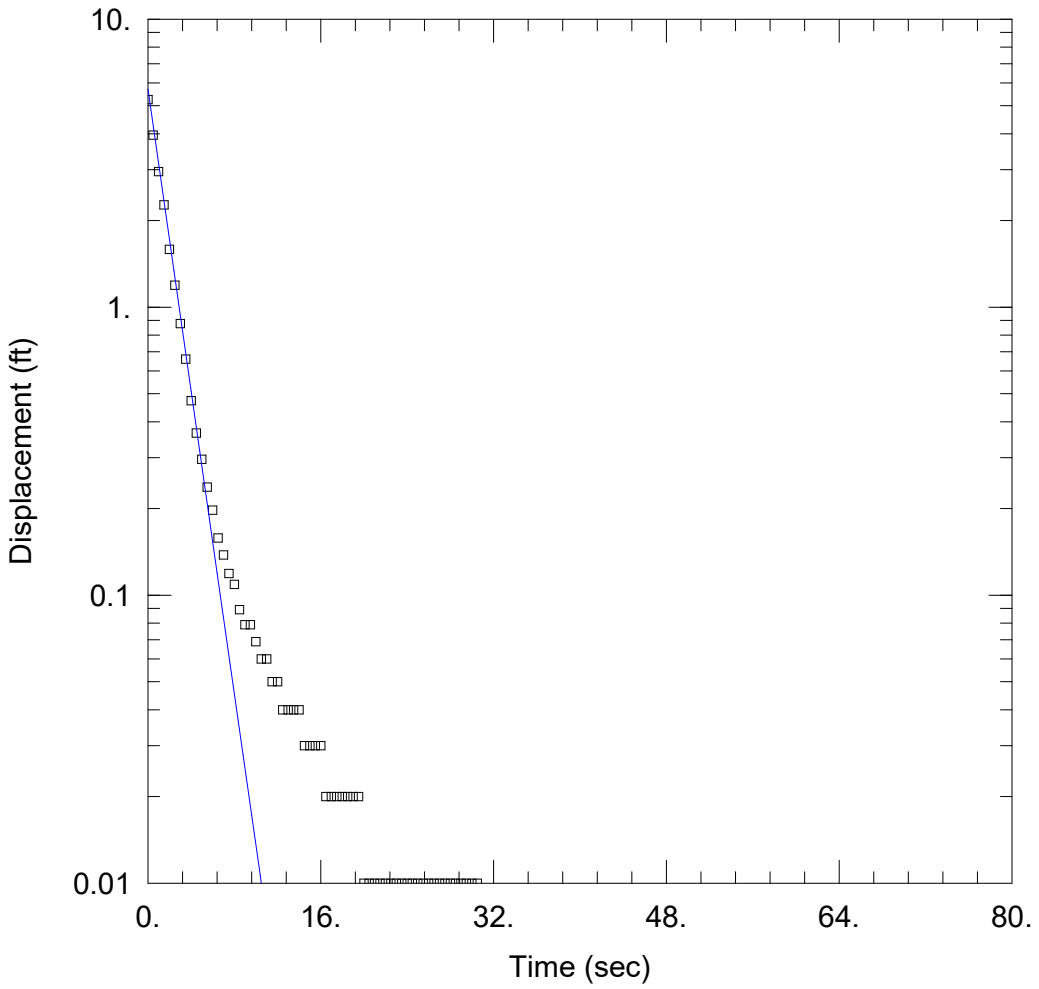
WELL DATA (CCR-AP-8I)

Initial Displacement: 4.4 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 33.39 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.01667 cm/sec
y0 = 4.652 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-8I_R3.aqt
Date: 06/15/23 Time: 21:00:05

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-8I
Test Date: 5/23/23

AQUIFER DATA

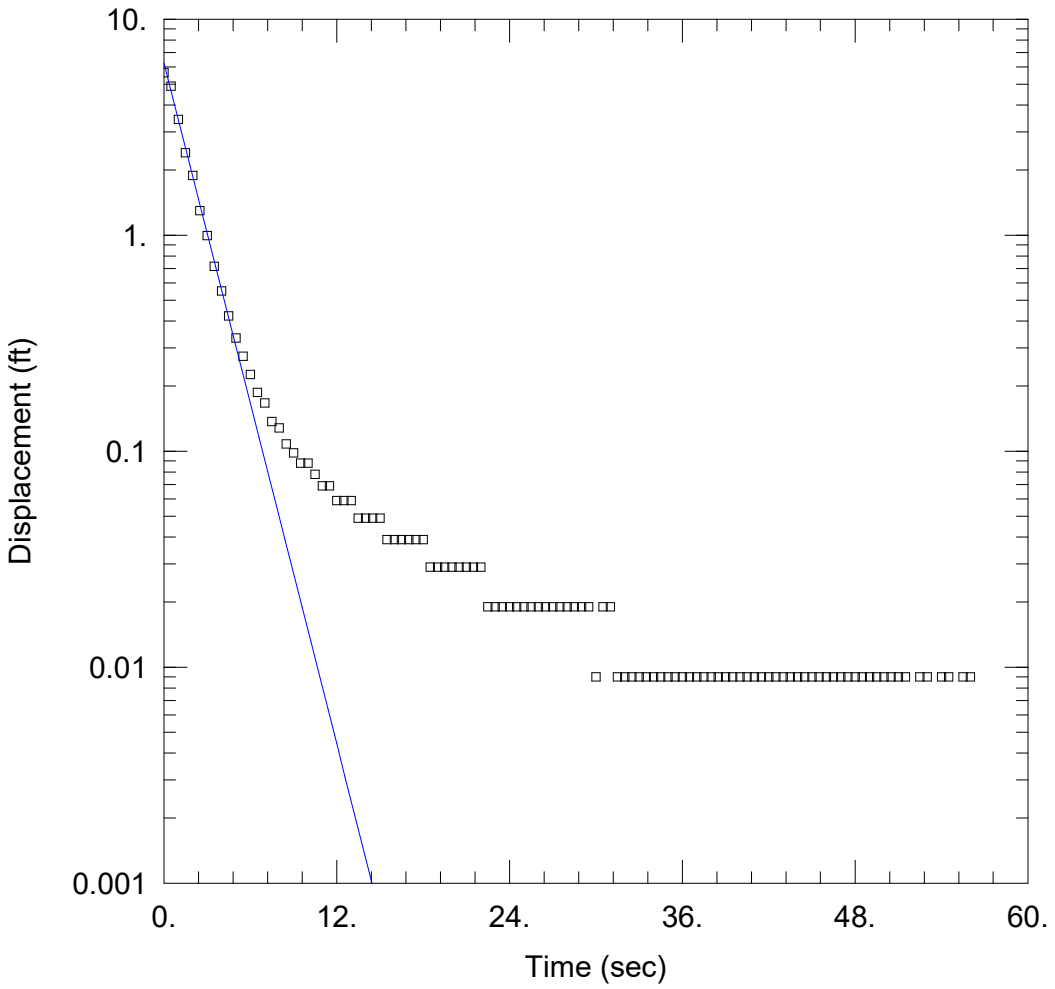
Saturated Thickness: 12. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CCR-AP-8I)

Initial Displacement: 5.256 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 33.39 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.01704 cm/sec
y0 = 5.714 ft



WELL TEST ANALYSIS

Data Set: \...\CCR-AP-8I_R4.aqt
Date: 06/15/23 Time: 21:00:27

PROJECT INFORMATION

Company: Haley & Aldrich
Client: Vectren
Project: 0129420-034
Location: FB Culley EAP
Test Well: CCR-AP-8I
Test Date: 5/23/23

AQUIFER DATA

Saturated Thickness: 12. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CCR-AP-8I)

Initial Displacement: 5.639 ft
Total Well Penetration Depth: 11. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 33.39 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01703 cm/sec y0 = 6.247 ft

August 29, 2023 Serial Letter 002

Charah, LLC
12601 Plantside Drive
Louisville, KY 40299

Attn: Jay Albright
E: jalbright@charah.com

Re: FB Culley
SL-002 – Perimeter Well Pump Test Summary

Mr. Albright,

Keller has concluded the perimeter well pump testing activities. As indicated in serial letter 001, the coarse alluvium (native sand) stratum underlying the East Ash Pond (EAP) has produced more water than originally anticipated. Within this letter is a summary of the pump test results, information from the Geotechnical Data Report upon which the test was developed, and a few potential paths forward.

I. Summary of Geotechnical Data Report Information

The geology along the south embankment generally consists of fine-grained embankment fill overlying native fine-grained alluvium and native alluvial sand. The alluvial sand was not encountered in all borings that penetrated the native soil and varies greatly in thickness. It is assumed that the alluvial aquifer directly communicates with the Ohio River and that groundwater levels in the aquifer will fluctuate accordingly.

The geotechnical data report (dated August 2022) provided did not include any slug test, pump test or sieve analysis of the lower alluvial sands and gravels. These three items are the primary methods of determining the hydraulic conductivity, how easily water moves through the soil, of the soil layers. Without that information prior to performing the below tests, the amount and rate of water extraction required to

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Rockaway, NJ 07866

t: 973-627-2100

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dewater the aquifer was unknown. Therefore, Keller elected to propose a base perimeter well system including the number of wells shown in plan view in the contract drawings and a 2-horsepower pump in each well. The selection of the 2-horsepower pump was based on Keller's experience in aquifers with similar characteristics to this one.

II. Pump Test and Design Development

Due to the limited information provided in the GDR for the native alluvial sand, Keller was to conduct a pilot study pump test to develop parameters for future design of the full-scale perimeter dewatering system. The purpose of the perimeter dewatering system is to lower the phreatic surface in the alluvial layer to mitigate the possibility of bottom instability when the EAP excavation nears the pond bottom.

The discharge for this pump test and future full-scale perimeter well system was to be routed to the existing 10-inch HDPE pipe that would in turn convey the water to the existing EAP pump station. This discharge point has the capacity to accept up to 2,650 gallons per minute (gpm) as indicated in RFI-044.

Due to these limitations in the discharge, the pilot study was designed with a 6-inch diameter well and 2-horsepower pump. When the pumping capacity of the 2-horsepower pump is extended across the AECOM conceptual well layout of 15 wells, shown on drawing C-25, the cumulative discharge rate is approximately half of the allowable discharge rate per RFI-044.

III. Summary of Perimeter Well Pump Test

The perimeter well pump test involved the installation of one (1) pumping deep well and seven (7) observation wells on the south embankment of the EAP. The eight (8) wells were installed from approximately El. 395 at varying distances across the berm as shown in the attached drawing, KNA-100. Pump testing was then performed on the test well (TW-01) to determine the hydrogeologic properties of the underlying alluvial sand stratum.

On Friday August 11, 2023, the 2-horsepower pump was activated to establish the desired pumping rate for the subsequent test. After pumping for 8 hours at approximately 80 gpm, the maximum output for the pump, it was evident that the pump was not capable of pumping enough water to stress the aquifer and generate adequate drawdown in the observation wells. The total drawdown in the pumping well was approximately 1.1 feet from the static water level during this period. In turn,

Keller mobilized a larger 10-horsepower pump, the largest that could be installed in the existing 6-inch well.

Following the installation of the larger pump, the pump test was performed from Tuesday, August 15, 2023 (pumping started at 5:32 PM CST) to Friday, August 18, 2023, (pumping stopped at 7:47 AM CST) for a total duration of 62 hours. The pumping rate during the test was approximately 300 gpm, the maximum output of the pump. This resulted in 3.3 feet of drawdown in the pumping well (TW-1). Figure 1 below shows the groundwater elevations versus time for this pump test.

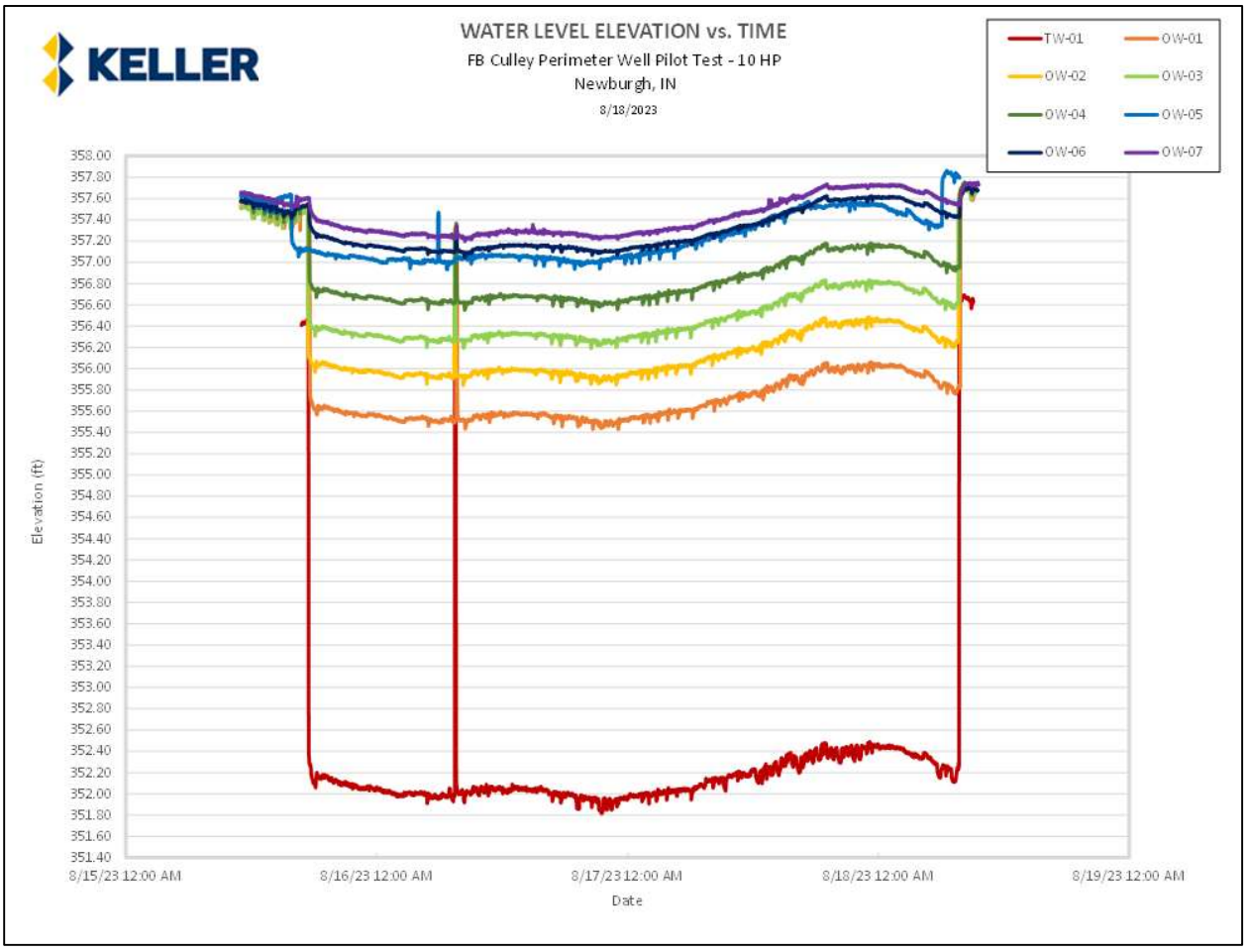


Figure 1 – 62 hr Pump Test – Groundwater Elevation versus Time

In the case of the 300 gpm test, most of the observation wells experienced less than 0.5 feet of drawdown over the course of the test. Observation wells OW-04 (100 feet away from TW-01) and OW-01 experienced maximum drawdown of approximately 1 foot and 2 feet respectively during the test. Keller's preliminary analysis indicates

that the hydraulic conductivity of the sandy alluvium is on the order of 4 x 10^{-1} to 10^{0} cm/s. These values are not characteristic of the SP, SP-SM, and SW-SM soils indicated on the detailed boring logs.

The rise in water levels beginning on August 17 coincided with an observed rise in river level. This leads Keller to conclude two things:

1. That the water level in the alluvium is directly related to the river level, and
2. That the test's pumping rate was not sufficient to maintain hydraulic control over the alluvium.

Based on the test results, Keller believes that the flow rate required to depressurize the alluvial aquifer will be much larger than originally anticipated and much larger than what could reasonably be expected based on the information provided during the bidding process.

IV. Recommended Path Forward

As stated above, the results of the pump test indicate that a larger volume of water than originally anticipated must be pumped to effectively depressurize the native sand underlying the EAP and mitigate bottom instability of the excavation during construction.

Preliminarily, the results can be used to estimate the potential scale of the dewatering efforts required. A full scale design has not been performed yet and will be complicated by the fact that the aquifer appears to become thinner as one moves east and north of the test site, and the fact that the proposed deep piezometer sealed below the EAP has not been installed yet.

An early estimate indicates that with individual well devices capable of pumping approximately 1,200 gpm with a combined system discharge on the order of 10,000 – 20,000 gpm may be necessary to achieve project goals. This is a significantly higher discharge rate than what was anticipated by the GDR and will require a reevaluation of the discharge point or methods to mitigate the water in the native sand underlying the EAP.

In reevaluation of the path forward, there are a few options to consider:

1. Conduct another pump test in a new, larger well for a future large-scale system of wells along the EAP levee. The pumping well would be equipped with a pump capable of a discharge flowrate of 1,200 gpm. Given a base system of 15 wells, the total discharge could be on the order of magnitude of 10,000 – 20,000 gpm or greater. This test should incorporate the deep EAP piezometer to gauge the aquifer's response to pumping directly beneath the pond.
2. Installation of a cutoff wall between the pond and Ohio River supplemented by a dewatering system.
3. Permeation Grouting of the coarse alluvium supplemented by a dewatering system.

Please let us know when you are available to discuss further.

Sincerely,

Keller Industrial Inc.



Andrew Chegwidden

Assistant Project Manager

Attachments:

1. KNA-100 - Perimeter Well Pump Test Layout

APPENDIX C
Groundwater Flow and Transport Modeling Report

HALEY ALDRICH

www.haleyaldrich.com

REPORT ON
GROUNDWATER FLOW MODELING IN SUPPORT OF THE SELECTION OF REMEDY
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-032
April 2025



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A	SL-002 – Perimeter Well Pump Test Summary R1
B	Proposed Perimeter Dewatering Plan Keller

1. Introduction

The Southern Indiana Gas and Electric Company (SIGECO) initiated an assessment of corrective measures for the East Ash Pond (EAP) located at the F.B. Culley Generating Station (FBC or Site) in response to a statistically significant level of an Appendix IV constituent exceeding Groundwater Protection Standards (GWPS), completed a Corrective Measures Assessment (CMA) Report and placed it in the facility operating record on 13 September 2019.

Discussions between Haley & Aldrich, Inc. and SIGECO representatives pertaining to updated construction details and the impact of various closure by removal alternatives outlined in the CMA has been completed. This Groundwater Flow and Transport Modeling report has been updated to reflect the outcome of those discussions and the resulting effect on post-closure groundwater flow and groundwater quality over time.

For the modeling updates described in this report, the closure by removal alternative assumes that the coal combustion residuals material in the EAP will be removed, with the southern berms mostly remaining intact. Keller Industrial, Inc. (Keller), completed a pumping test at the Site in August of 2023 (Keller, 2023; **Attachment A**) to determine the field saturated hydraulic conductivity of the sand aquifer at the Site prior to the closure by removal dewatering program. The pumping test consisted of extracting a constant rate of approximately 300 gallons per minute (gpm) from a test well and monitoring drawdown within the test well and seven observation wells for a period of 62 hours. The hydraulic conductivity values of the sand unit reported by Keller are estimated to range between 4.0 x 10^{-1} centimeters per second (cm/sec) to 1.0 x 10^{-0} cm/sec. Planned gradient control to support dewatering of the EAP includes using 28 dewatering wells along the southern portion of the dam, which is between the pond and the Ohio River, that are spaced approximately 30 feet apart with the capacity to cumulatively extract approximately 22,000 gpm as shown in the *Proposed Perimeter Dewatering Plan* produced by Keller on 11 December 2023, and provided in **Attachment B**. The groundwater flow and solute transport model has been updated to evaluate how this closure design influences groundwater flow and concentrations during the planned 18-month closure by removal dewatering period. Concentrations at the end of the 18-month dewatering period were then simulated forward in time for 20-years to evaluate the timeline for concentrations to achieve the GWPS.

A summary of the updates to the flow and transport model in support of selection of remedy include:

- Incorporation of additional pumping test data to refine model flow calibration in preparation for selection of remedy.
- Incorporation of groundwater elevation data collected in May 2024.
- Starting concentrations for molybdenum were based on the May 2024 analytical results collected from EAP CCR monitoring network wells.
- Integrating planned gradient control to support dewatering of the EAP (*F.B. Culley East Ash Pond Perimeter Deep Well Pilot Test 2.0* design drawing produced by Keller Industrial, Inc.).
- Simulating groundwater flow patterns and molybdenum concentrations through the closure process by removal with dewatering (with completion of closure assumed in 2025).
- Simulating groundwater flow patterns and concentrations for a 20-year period after EAP closure (from 2025 to 2045).

2. Groundwater Flow Modeling

A groundwater flow and solute transport model was constructed to evaluate and compare potential corrective measures in support of the EAP Closure for the FBC in Warrick County, Indiana. Molybdenum is currently the only Appendix IV constituent that exceeds the GWPS at the EAP. Therefore, molybdenum was used for the solute transport portion of the model. The following text describes the model construction, calibration, and subsequent simulations of remedy alternatives for molybdenum above the GWPS.

The numerical model MODFLOW-2005 (Harbaugh, 2005) was selected for the modeling effort and is a three-dimensional, finite difference groundwater flow model capable of simulating the groundwater conditions under various scenarios including pumping and changes to infiltration over time. The numerical model was built using available information and for the purpose of aiding decision making in the CMA process. The level of accuracy is directly dependent on the data available to construct the model and should not be construed by the user as a definitive predictor of the future.

2.1 MODEL DOMAIN

The model domain was established to encompass the Site and surrounding areas that represented model boundaries including the nearby Ohio River located south of the EAP.

MODFLOW-2005 uses a rectangular grid within the domain and allows for establishing irregular groundwater flow boundary conditions that represent actual and Site-specific features in the study area. The setup is facilitated by assigning boundary types and values to specific grid cells. **Figure 1** depicts the model domain boundary overlain on an aerial photograph of the Site.

Figure 2 depicts the model domain with the grid spacing selected for the model. Grid size in the vicinity of the pond was reduced to focus the model and improve simulation efficiency. The updated three-dimensional, finite difference groundwater flow model domain covers a length of 4,300 feet in the xdirection (west to east), 3,800 feet in the y-direction (north to south), and approximately 200 feet in the z-direction (vertical). The model consists of 246 rows, 282 columns, and eight layers for a total of 554,976 cells covering an approximate area of 375 acres. In MODFLOW-2005, the groundwater-flow system is subdivided laterally and vertically into rectilinear blocks called cells. The hydraulic properties of the material in each cell are assigned and assumed to be uniform within each cell. The row and column dimension of each cell is variable based on proximity to the Site. This variability was created to allow for finer resolution within the vicinity of the primary flow pathway for the Site.

A Digital Elevation Model was obtained from the United States Geological Survey (USGS) website to create the ground surface of the model for the Site. Lithologic descriptions contained in the boring logs generated during various phases of geo-environmental investigations as well as cross-sections were used to develop formation geometry and hydraulic properties. The Site was divided into three vertical lithologic units to represent geologic conditions underlying the EAP and to account for vertical heterogeneities within the model. A summary of each geologic unit is as follows:

- Unconsolidated slackwater lake sediments consisting of silt and clay.
- Fluvial terrace deposits consisting of sand and gravel.

- Shale and sandstone bedrock units underlie the unconsolidated alluvial soil deposits (Haley & Aldrich, 2019).

Ground surface elevations used in the model were determined from digital elevation models for the area. The topography of the ground surface is mimicked in the subsequent lower layers; however, the elevation has been reduced by the layer thickness. Layer thicknesses were determined through the review of the above-mentioned Site geology.

2.2 BOUNDARY CONDITIONS

Boundary conditions define the locations and manner in which water enters and exits the active model domain. The conceptual model for the groundwater system that forms the basis for the model boundaries are as follows:

- The Ohio River is used to estimate southern boundary elevations and is the major groundwater discharge feature.
- A specified head boundary condition is used to simulate recharge along the topographic high north of the EAP.

The specified boundaries of the model coincide with predicted natural hydrologic boundaries. To recreate observed groundwater flow, two types of model boundaries were used: specified head boundaries, and the MODFLOW-2005 River Package. The locations of these boundary conditions in the model are illustrated on **Figure 3**.

2.2.1 Specified Head Boundaries

The MODFLOW-2005 Time Variant Specified Head Package (Harbaugh, 2005) also known as the Constant Head Package, was used to simulate boundaries presented on **Figure 3**. The package is used to fix the head values in selected grid cells regardless of the conditions in the surrounding grid cells. The cell with the assigned constant head acts either as a source of water entering or a sink of water leaving the system. Three separate constant head boundaries are used in the model. All constant head boundaries are referenced to the North American Vertical Datum of 1988 and are active in Layer 2 through Layer 8. Constant head boundary one is set to 420.22 feet. Constant head boundary two is set to 390.50 feet. These values were estimated based on topography, the depths to water in wells at the Site, the pattern of groundwater flow, elevations of nearby water bodies, and through calibration of the groundwater flow model as described in Section 3.3 below.

2.2.2 River Boundaries

River boundaries in MODFLOW-2005 are a special form of the head-dependent boundary condition. In a head-dependent boundary, the model computes the difference in head between the boundary and the model cell to calculate the amount of water flowing into or out of the model through the boundary. **Figure 3** shows the river boundary condition representing the Ohio River, and Little Pigeon Creek near the Site. The head assigned to the Ohio River boundary, reach set to zero (0), was 358.02 feet based on the nearby Ohio River USGS gauge at Newburgh, Indiana under baseflow conditions. Little Pigeon Creek, reach one (1), was assigned a head value of 362.00 feet.

2.2.3 Recharge Boundaries

Recharge in the model is simulated using constant head boundary one along the topographic high north of the EAP.

2.3 HYDRAULIC MODEL PROPERTIES

Hydraulic properties were initially assigned consistent with observations presented in the *2019 Groundwater Monitoring Program Report* (Haley & Aldrich, 2019). Values were assigned for horizontal hydraulic conductivity and vertical hydraulic conductivity. These parameters were iteratively varied during model calibration to achieve the best fit to observed hydraulic patterns including head elevations, hydraulic gradients, and flow directions.

For calibration, hydraulic properties were applied within discrete model layers to present hydrogeologic units present at the Site. Results of the initial calibration indicated that hydraulic conductivities in the range of those values associated with material described in boring logs and the field-measured values during the August 2023 Keller aquifer test were representative with regard to groundwater flow observed at the Site. The hydraulic conductivity values used in the model are presented below for the three hydrogeologic units underlying at the Site:

- Bedrock – 0.1 feet per day (ft/day) or 3.5 x 10^{-5} cm/s
- Fine-grained soils – 0.15 ft/day or 5.3 x 10^{-5} cm/s
- Coarse-grained sand – 669.3 ft/day or 2.4 x 10^{-1} cm/s

2.3.1 Calibrated Horizontal and Vertical Hydraulic Conductivity

The calibrated horizontal (K_X and K_Y) and vertical (K_Z) hydraulic conductivity values in Model Layer 1 through Layer 8 were distributed uniformly across the model domain as shown on **Figures 4 through 10**. Vertical hydraulic conductivity values were estimated at 1/10^{th} of the horizontal hydraulic conductivity values. This ratio between horizontal and vertical conductivities represents resultant hydraulic conductivity when stratification typical of alluvial sediments is evident.

2.3.2 Porosity, Storage, and Yield

Effective porosity values are needed for particle tracking and solute transport simulations. The effective porosity values were conservatively estimated based on the soil type through the examination of boring logs. For areas that are generally alluvial silty clay, a porosity of 0.25, specific storage of 0.001 foot^{-1}, and specific yield of 0.001 were utilized.

2.4 METHODS OF EVALUATING MODEL CALIBRATION QUALITY

Model calibration is the process of refining the model representation of the hydrogeologic framework, hydraulic properties, and boundary conditions to minimize the difference between the simulated heads and fluxes to the measured data. Construction of a complex model with more parameters than the data support may reduce the residuals (difference between measured and simulated values) but does not ensure a more accurate model. Therefore, calibrated model parameters also need to be checked for their validity. Throughout the calibration process, no adjustments were made that conflicted with the general understanding of the groundwater system and previously documented information.

The iterative calibration process of "trial and error" was used for model calibration. It involves making changes to the input values, running MODFLOW-2005, and assessing the impact of the changes. Beside the trial-and-error approach, a model independent parameter optimization software tool (PEST) was used to adjust selected input values to further improve model calibration (Doherty, 2016).

The quality of model fit can be assessed from many statistical and graphical methods. One method is based on the difference between simulated and observed heads and flows, or residuals. The overall magnitude of the residuals is considered, but the distribution of those residuals, both statistically and spatially, can be equally important. The magnitude of residuals can initially point to gross errors in the model, the data (measured quantity), or how the measured quantity is simulated (Hill, 2000). A useful graphical analysis is a simple scatter plot of all simulated values as a function of all observed values.

For the flow calibration, the statistics of the mean error (ME), mean absolute error (MAE), and the root mean square (RMS) error were used to assess the calibration quality. They are defined as follows:

$$ME = \frac{\sum_{i=1}^{n}(O_i - C_i)}{n}$$

$$MAE = \frac{\sum_{i=1}^{n}|O_i - C_i|}{n}$$

$$RMS = \frac{\sum_{i=1}^{n}(O_i - C_i)^2}{n}$$

Where:

Oi = Observed head at observation point i

Ci = Calculated head at observation point i

n = Number of observation points

The ME is the average of the differences between the observed and calculated heads (or residuals) and can indicate the overall comparison between computed and observed data. Negative and positive residuals can cancel each other out, resulting in a mean error close to zero even when the calibration is not good. The sign of the ME is an indication of the overall comparison of the model to the data (e.g., a positive mean error indicates the model is generally computing heads that are too high).

The MAE is the average of the absolute values of the residuals. The absolute value prevents positive and negative residuals from canceling each other, providing a clearer picture of the magnitude of errors across the model, without an indication of the direction (high or low) of the errors.

The RMS error is the square root of the average of the squares of the residuals. The RMS adds additional weight to points where the residual is greatest. If the residuals at all points are very similar, the RMS will be close to the mean absolute error. Alternatively, a few points with high errors can add significantly to the RMS for an otherwise well calibrated model. For all three of these criteria the optimal value is zero.

The numerical goals for the groundwater flow model calibration are to (1) minimize the ME and MAE errors and (2) achieve the ratio of the RMS error of the head residuals to the range of observed heads (i.e., normalized RMS error) to be at least less than 10 percent (Anderson and Woessner, 1992).

Groundwater flow field calibration for the Site has been conducted to provide a reasonable representation of the groundwater flow field in the vicinity of the Site, which forms the basis of assessing molybdenum migration potential through the fate and transport process. To accomplish this objective, a MODFLOW numerical model was calibrated to simulate observed groundwater conditions at the Site. The evaluation of collected groundwater elevation data resulted in the selection of May 2024 water level data, which is considered representative for the Site (**Table 1**).

Based on the outcome of this quality of model fit evaluation, it is concluded that the numerical calibration goals have been achieved for the Site. The ME in head was 7.37 feet or 10 percent of the head observation range, 72.75 feet. The MAE residual is +5.65 feet. The RMS error for the calibrated model was +7.37 feet and the normalized RMS error was 10 percent. Presented below is the scatter plot of the observed versus simulated heads, which generally fall along the theoretical slope of 1 to 1. **Table 1** provides the observed heads at the Site for multiple dates, as discussed above, which are used to generate the plot below. The quality of the flow model calibration meets the calibration goals as described herein. Observed versus computed target values are shown in **Figure 2.4-1**, and model simulated groundwater contours for the steady-state simulation are shown on **Figure 11**.

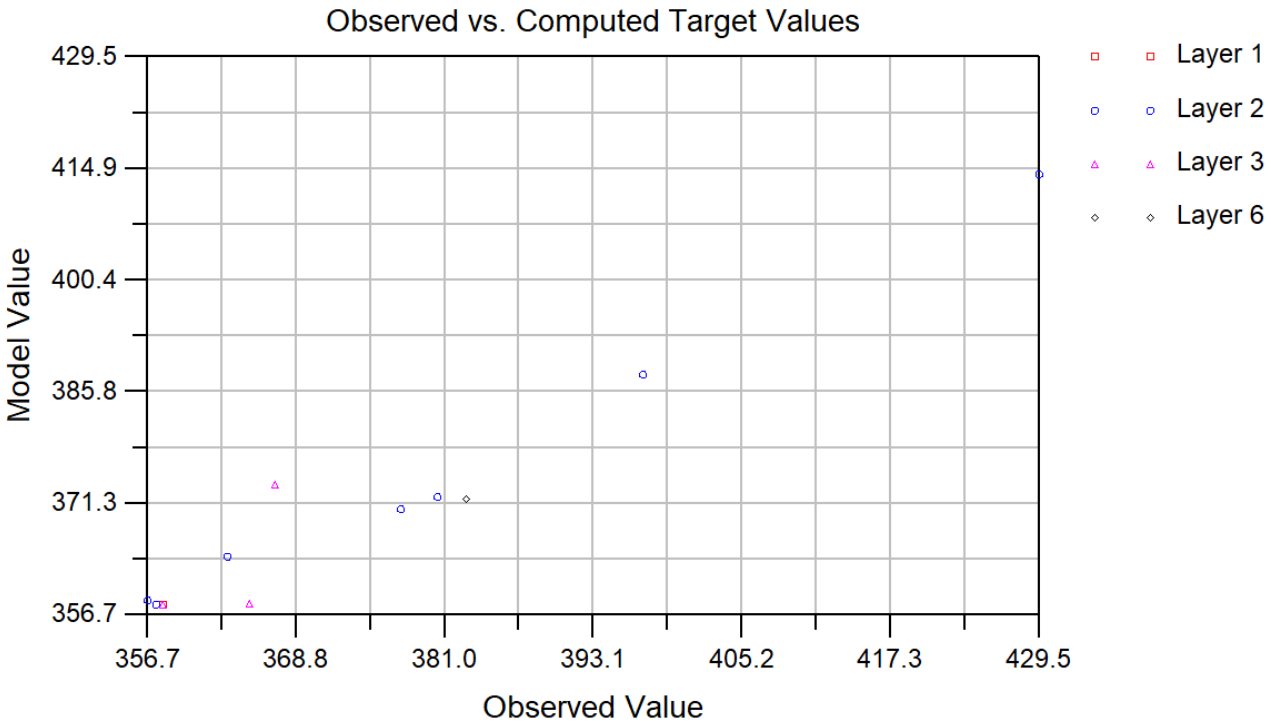


Figure 2.4-1: Calibration Scatter Plot. Values represent steady-state targets.

Furthermore, the calibration assessment has met the acceptable calibration goals; therefore, the groundwater flow model is considered to be usable for the development of the molybdenum fate and transport models described in Section 3.

3. Fate and Transport Modeling

Contaminant fate and transport modeling was conducted utilizing the three-dimensional, numerical model MT3DMS (Version 5 of MT3D; Zheng and Wang, 1999). MT3DMS simulates advection, dispersion, adsorption and decay of dissolved constituents in groundwater using a modular structure similar to MODFLOW to permit simulation of transport components independently or jointly. MT3D interfaces directly with MODFLOW for the head solution and supports all the hydrologic and discretization features of MODFLOW. The MT3D code has a comprehensive set of solution options, including the method of characteristics, the modified method of characteristics, a hybrid of these two methods, and the standard finite-difference method. MT3D was originally released in 1990 as a public domain code from the United States Environmental Protection Agency and has been widely used and accepted by federal and state regulatory agencies.

For this modeling effort, the MT3DMS model utilized the flow regime from the steady-state, calibrated Site groundwater flow model presented in Section 2 to simulate transport of molybdenum. The steady state model was transformed into a transient model so various CMA options could be evaluated with respect to time. The strength and locations of the potential molybdenum sources specified in the transport models were based on surface water concentrations from the Site.

The following sections describe the adsorption effects on solute transport based on the geochemical properties and published empirical data, as well as the choice of the linear adsorption coefficient for each contaminant used for transport modeling.

3.1 TRANSPORT MODELING APPROACH

The solute transport portion of the modeling effort focused mainly on the future flow pathway for molybdenum at the Site. As such, the current plume extent is used for initial concentrations, and is modeled without a constant source since ash is removed during closure by removal and is no longer in contact with groundwater. Calibration of the concentrations through time was not performed on the predictive model as initial model concentrations used are the current concentrations observed at the Site as of May 2024. Initial concentration data is further discussed in Section 3.2.6. .

The calibrated flow model simulates a period of 18-months to represent the closure by removal (with gradient control to support dewatering) period that includes extraction wells along the perimeter of the southern berm (Run 1). Concentrations in the model domain at the conclusion of the 18-month dewatering period are then transferred to a post-closure scenario model. The post-closure scenario model simulates groundwater flow and transport for a 20-year period after closure by removal is completed (Run 2).

3.2 KEY PARAMETERS FOR TRANSPORT MODELING

The following sections describe the key input parameters of the transport model and how they were derived. Note that these parameters were selected for the purpose of comparative evaluation of relative benefits of various corrective measures. The parameters and conditions used for the modeling are selected based on the data available to date. Therefore, simulated remedial timeframes using the parameters described in this section should not be construed as absolute predictions of remedial time frames for various corrective measures.

3.2.1 Effective Porosity

The effective porosities used in the model were presented in previous Section 2.3.2.

3.2.2 Dispersivity

Dispersion incorporates the effects of fluid mixing that result from heterogeneities within the groundwater system and molecular diffusion, which is the random movement of ions or molecules. If the molecules of water and dissolved constituents traveled at the average seepage velocity, there would be an abrupt interface and dispersion would be negligible. However, in natural systems water molecules and dissolved contaminants do not all travel at the same rate; some travel faster and some slower. Dispersion in the model accounts for the spreading of the dissolved plume. Diffusion is time dependent and is significant at low velocities. In general, dispersion acts to decrease the contaminant concentration on the leading edge of the plume, while increasing the size and rate of transport of the dissolved plume. Longitudinal dispersion occurs in the direction of advective groundwater flow, while transverse dispersion occurs perpendicular to groundwater flow.

The groundwater modeling generally accepted longitudinal dispersity value (α_L) estimate is 1 to 100. The horizontal transverse dispersivity (α_T) can be estimated as approximately one-tenth of the α_L, and vertical transverse (α_v) dispersivity can be estimated as one-hundredth of the α_L. The values utilized for dispersivity values are as follows:

- α_L – 100 feet
- α_T – 10 feet
- α_V – 1 foot

3.2.3 Retardation Effects

Chemical retardation occurs when a solute (contaminant) reacts with the porous media and its rate of movement is retarded relative the advective groundwater velocity. Retardation can occur by a variety of processes including adsorption and mass transfer in porous media. The effects of retardation are often related to Site-specific adsorption isotherms. For this modeling purpose, a liner adsorption isotherm is used to account for the effects of transport retardation that may occur for Site-related contaminants. The effect of retardation on contaminant mobility is usually expressed in terms of a retardation factor (R), which is the ratio of the groundwater velocity to contaminant transport velocity (Bedient et al., 1994). When a linear adsorption isotherm is used to characterize contaminant mobility, the linear adsorption coefficient (K_d) can be linked to the retardation factor with the mathematical relationship below:

$$R = \frac{v_{gw}}{v_c} = 1 + \frac{\rho_b}{n} \times K_d$$

Where:

R = Retardation factor
v_{gw} = Groundwater velocity
v_c = Contaminant transport
ρ_b = Aquifer solid bulk density
n = Effective transport porosity of the medium
K_d = Linear adsorption coefficient

The following sections describe the adsorption effects of molybdenum based on geochemical properties and the published empirical data, as well as the choice of the linear adsorption coefficient for the constituent used for transport modeling.

3.2.4 Adsorption of Molybdenum on Aquifer Solids

Molybdenum (atomic number 42) is a transition metal in Group VI of the periodic classification of the elements. The affinity for molybdenum to adsorb to the geologic matrix can be affected by factors such as pH, redox conditions, mineral contents of aquifer solids, organic matter abundance, and the presence of organic ligands in the groundwater system.

The aqueous speciation of molybdenum and potential formation of molybdenum-related minerals under a spectrum of the electro-potential (Eh) and pH conditions are shown below (**Figure 3.2.5-1**). Based on Site groundwater monitoring results, the predominant pH values are within the neutral pH range (between 6.5 and 7.5) except at the locations of CCR-AP-2 and CCR-AP-3. The values of oxidation-reduction potential (Eh) vary widely among locations and sampling events. The main molybdenum species in groundwater is expected to be molybdenum species of a valence state of +6. No molybdenum associated precipitation is expected under the current geochemical conditions.

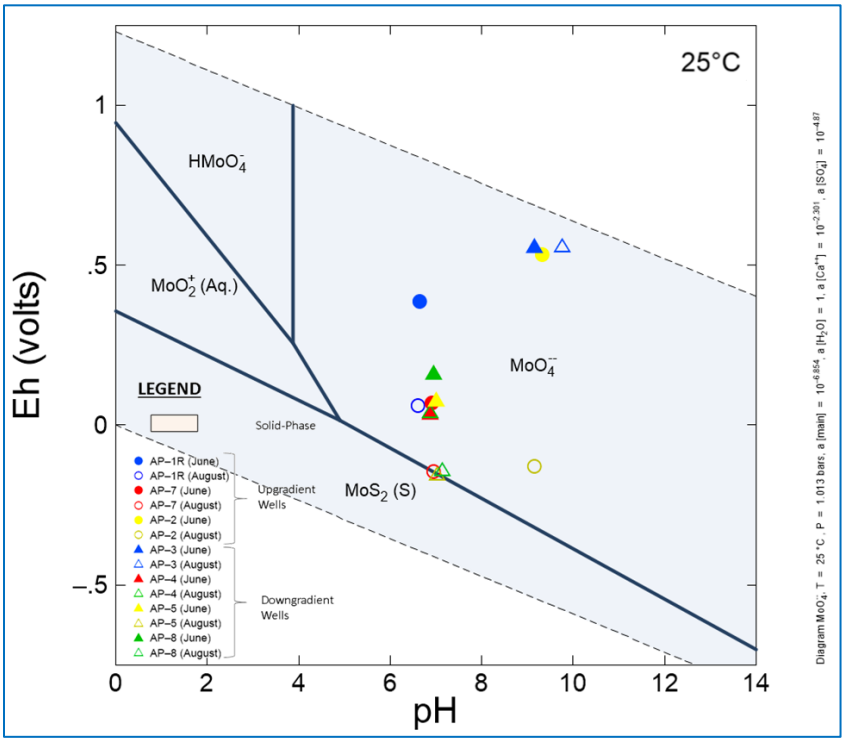


Figure 3.2.5-1: Molybdenum Eh-pH Diagram for a molybdenum-sulfur-oxygen-hydrogen system; groundwater monitoring data collected in June and August 2018 used; field oxidation-reduction potential measurements converted to the Standard Hydrogen Electrode; field pH measurements plotted; assumptions: solute activities = measured concentrations in mols/L; analytical concentration results for CCR-AP-2 used to generate stability diagram. Thermodynamic database used: thermo.com.V8.R6+, fully modified with molybdenum solubility data from Vlek and Lindsay (1977).

3.2.4.1 *Empirical data on adsorption*

The adsorption of molybdenum has been studied on a variety of minerals, sediments, soils, and crushed rock materials. The extent of adsorption is greatly influenced by pH; generally, the degree of adsorption decreases with an increase in pH (Sheppard at al., 2009). Metal oxides (iron, manganese, and aluminum oxides) in aquifer solids are shown to play a major role in molybdenum adsorption; the K_d values reported by Goldberg et al. (1996) for oxide minerals range from 10 to 10^3 liter per kilogram (L/kg). Adsorption on a weight basis of iron oxide minerals increased in the order: hematite< goethite < amorphous Fe oxide < poorly crystalline goethite; adsorption on a weight basis for clay minerals increases in the order: well crystallized kaolinite < poorly crystallized kaolinite < illite < montmorillonite.

3.2.4.2 *K_d value used for molybdenum transport modeling*

Based on the total iron concentrations found at the Site, a total iron concentration of 24,000 milligrams per kilogram (mg/kg) is considered the representative. Site aquifer solids likely possess a wide range of redox states and are predominately coarse-grained material. The geometric mean of the published Kd values for iron oxide minerals for more weathered iron oxides (e.g., hematite and goethite) are approximately 100 L/kg at pH of 7. Assuming that only 10,000 mg/kg of iron oxide minerals in aquifer solids is available for adsorption, a nominal K_d value of 1 L/kg for bulk aquifer solids is estimated (10,000 mg/kg x 10^{-6} kg/mg x 100 L/kg). This value is considered a representative, yet conservative value for evaluation of molybdenum transport in the saturated zone.

3.2.5 Source Initial Concentration Data

To conservatively predict the transport of molybdenum and preserve the mass transported through the Site, the source area was defined utilizing initial concentration. The current extent of the groundwater plume for molybdenum was generated based on groundwater concentrations in the monitoring well network.

Table 2 shows the concentrations observed in the monitoring well network from May 2024. Three discrete areas with concentrations of molybdenum above the GWPS are present at the Site within the vicinity of the EAP. Initial concentrations were created near the following wells at concentrations observed from groundwater sampling events conducted in May 2024.

- CCR-AP-5 – 150 micrograms per liter (µg/L)
- CCR-AP-6l – 860 µg/L
- CCR-AP-8l – 290 µg/L

3.3 TRANSPORT MODEL RESULTS – MOLYBDENUM

Model simulated groundwater contours during the dewatering period are shown on **Figure 12**, and model results for molybdenum concentration fate and transport are shown on **Figure 13**.

During the closure by removal dewatering period, the model estimates that constituent mass that is in contact with the sand unit will achieve GWPS for molybdenum within approximately one year of dewatering. Molybdenum concentrations adsorbed to lower hydraulic conductivity silts and clays are persistent above GWPS at the end of the closure by removal dewatering period. Model Run 2 simulating the post-closure scenario estimates that molybdenum concentrations throughout the entire model

domain will achieve GWPS within approximately 20 years following closure. A detailed discussion of the CMA remedial option is presented in the selection of remedy report (Haley & Aldrich, 2024).

4. Assumptions and Limitations

Groundwater flow and transport models are simplified representations of a natural system developed to address specific project objectives. Model limitations are reflected within the uncertainties associated with the conceptual model, input parameters, and the ability of the numerical model to adequately simulate real world conditions. During the modeling process, uncertainty has been minimized by documenting assumptions and justifying these assumptions based on site-specific data wherever possible.

5. References

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TABLES

Table 1
May 2024 Groundwater Elevations
FB Culley Generating Station
Evansville, Indiana

Well Location	Easting Feet	Northing Feet	Screen Top Feet AMSL	Screen Bottom Feet AMSL	Groundwater Elevation Feet (NAVD88)
CCR-AP-1R*	2883429.69	969939.69	383.5	373.5	397.18
CCR-AP-2	2884168.67	969117.52	358.4	348.4	363.24
CCR-AP-3	2883542.09	969007.98	360.1	350.1	357.42
CCR-AP-4	2883281.93	969641.7	369.9	359.9	377.42
CCR-AP-5	2884016.66	969379.68	360.8	350.8	380.37
CCR-AP-5I	2884022.4	969377.37	319.7	309.7	382.71
CCR-AP-6	2883285.03	969122.16	361.5	351.5	357.96
CCR-AP-6I	2883289.32	969119.72	332.5	322.5	357.95
CCR-AP-7*	2883090.34	970774.64	409.5	399.5	429.46
CCR-AP-8	2883846.87	969046.03	358.649	348.649	356.715
CCR-AP-8I	2883853.25	969047	335.2	325.2	365.08
CCR-AP-9I*	2883998.96	969768.61	385.6	375.6	388.775
CCR-AP-11	2884485.51	969352.71	340.7	330.7	367.09

Note:

** Wells resurveyed in 2024.*

Table 2
May 2024 Molybdenum Concentrations
FB Culley Generating Station
Evansville, Indiana

Well Location	Easting	Northing	Screen Top	Screen Bottom	Molybdenum Concentration
	Feet	Feet	Feet AMSL	Feet AMSL	(ug/L)
CCR-AP-1R	2883429.69	969939.69	383.5	373.5	5.3
CCR-AP-2	2884168.67	969117.52	358.4	348.4	6.5
CCR-AP-3	2883542.09	969007.98	360.1	350.1	9.3
CCR-AP-4	2883281.93	969641.7	369.9	359.9	17
CCR-AP-5	2884016.66	969379.68	360.8	350.8	150
CCR-AP-5i	2884022.4	969377.37	319.7	309.7	2.6
CCR-AP-6	2883285.03	969122.16	361.5	351.5	43.0
CCR-AP-6i	2883289.32	969119.72	332.5	322.5	860
CCR-AP-7	2883090.34	970774.64	409.5	399.5	1.3
CCR-AP-8	2883846.87	969046.03	358.649	348.649	12.0
CCR-AP-8i	2883853.25	969047	335.2	325.2	290
CCR-AP-11	2884485.51	969352.71	340.7	330.7	5

Notes:

ug/L =micrograms per liter

ND = non-detect

FIGURES



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

2. WELL DESIGNATION:
CCR = COAL COMBUSTION RESIDUALS
AP = ASH POND
R = REPLACED
I = INTERMEDIATE

3. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH MODEL DOMAIN

JULY 2024

FIGURE 1

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LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY
- MODEL GRID

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

2. WELL DESIGNATION:
CCR = COAL COMBUSTION RESIDUALS
AP = ASH POND
R = REPLACED
I = INTERMEDIATE

3. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

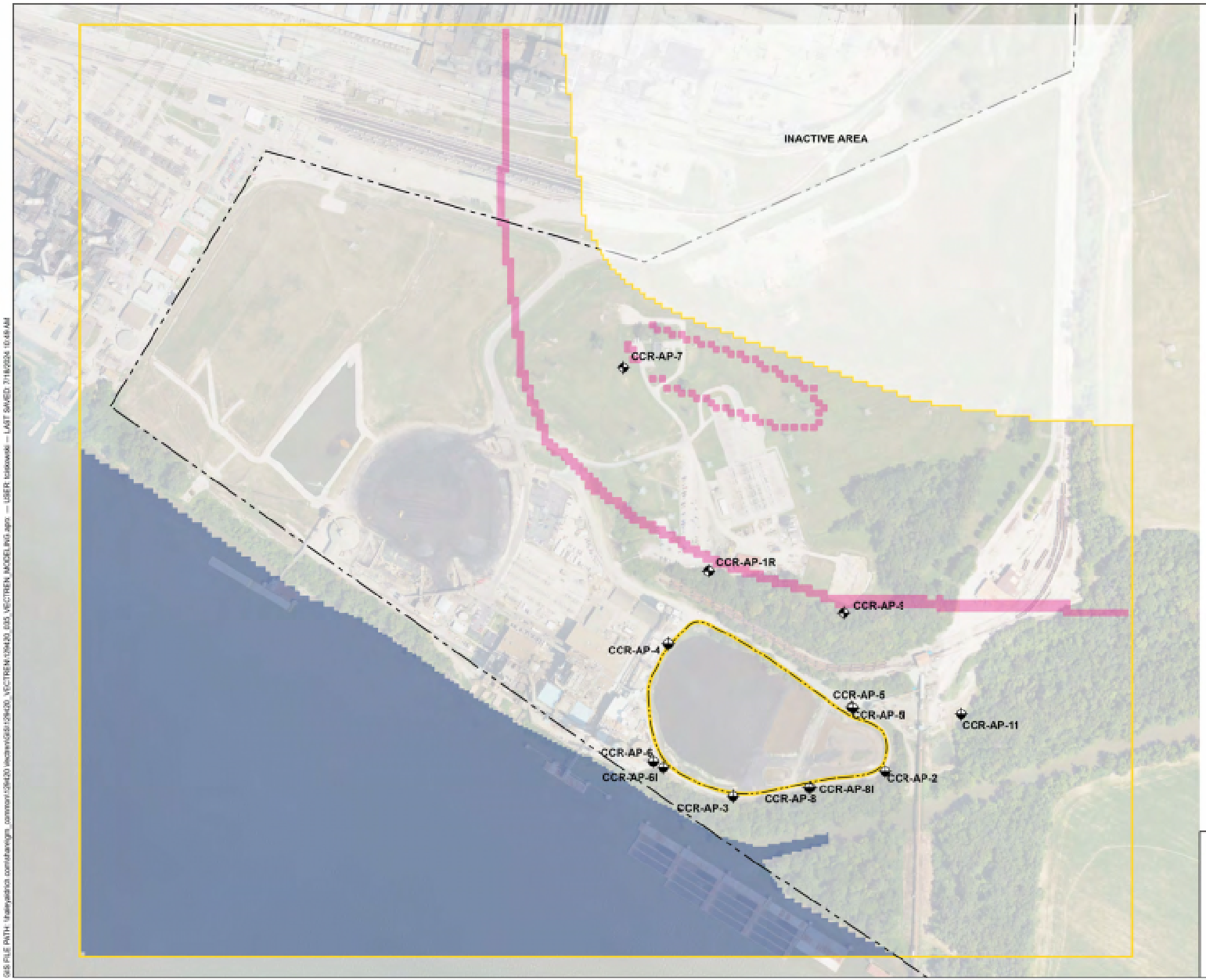
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH MODEL GRID

JULY 2024

FIGURE 2

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LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY
- CONSTANT HEAD

RIVER BOUNDARY

- REACH 0, OHIO RIVER

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

2. WELL DESIGNATION:
CCR = COAL COMBUSTION RESIDUALS
AP = ASH POND
R = REPLACED
I = INTERMEDIATE

3. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

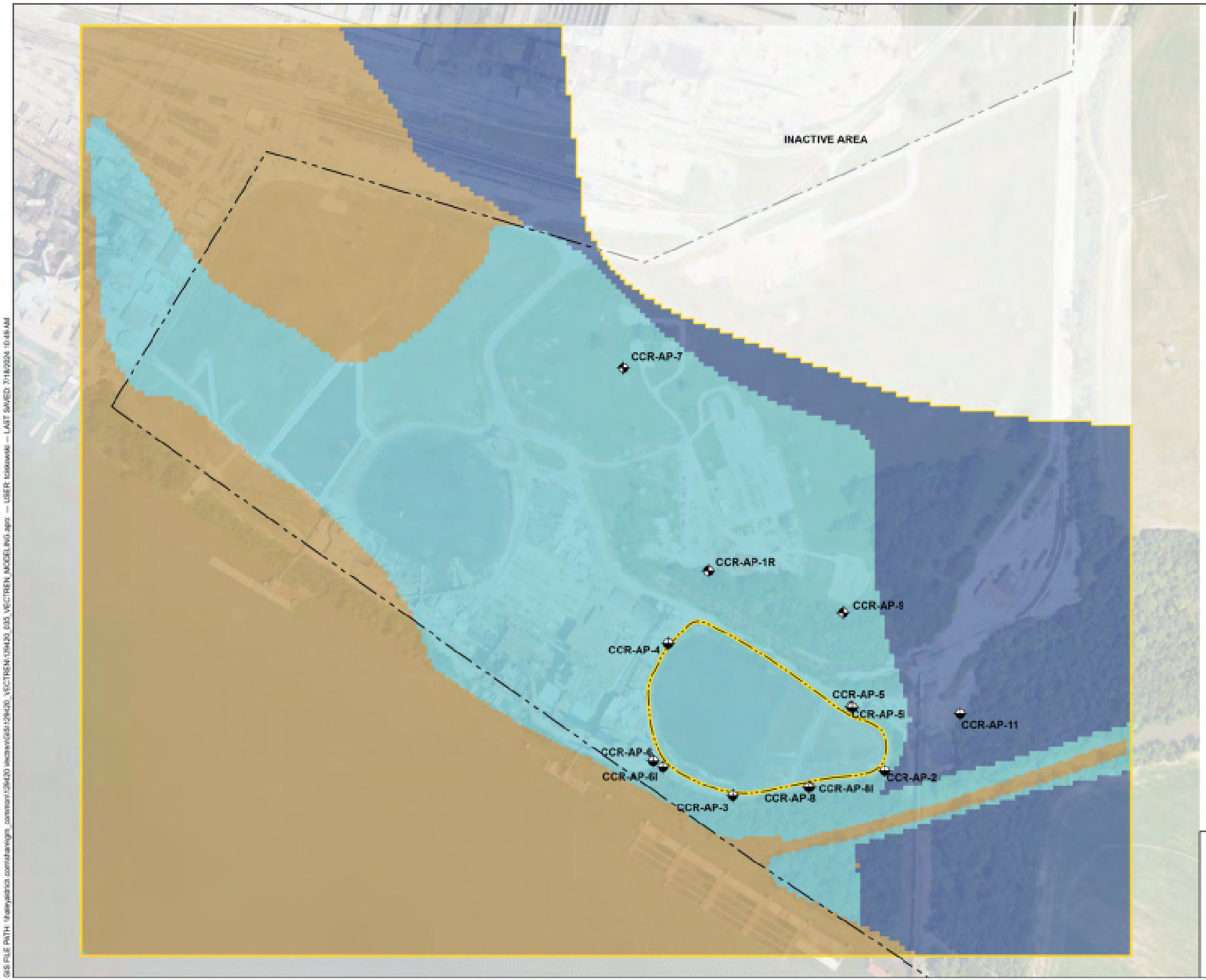
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH BOUNDARY CONDITIONS

JULY 2024

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\shares\gis_common\129420\Vectren\GIS\129420_VECTREN 129420_033_VECTREN_MODELING.aprx — USER: kstewarski — LAST SAVED: 7/18/2024 10:48 AM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

SIMULATED HYDRAULIC CONDUCTIVITY VALUE (FEET/DAY)

- 0.1
- 0.15
- 669.3

NOTES

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3. THE SIMULATED HYDRAULIC CONDUCTIVITY VALUE OF THE SAND IS EQUAL TO THE HYDRAULIC CONDUCTIVITY VALUE DETERMINED DURING THE KELLER PUMPING TEST (KELLER, 2023)

4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

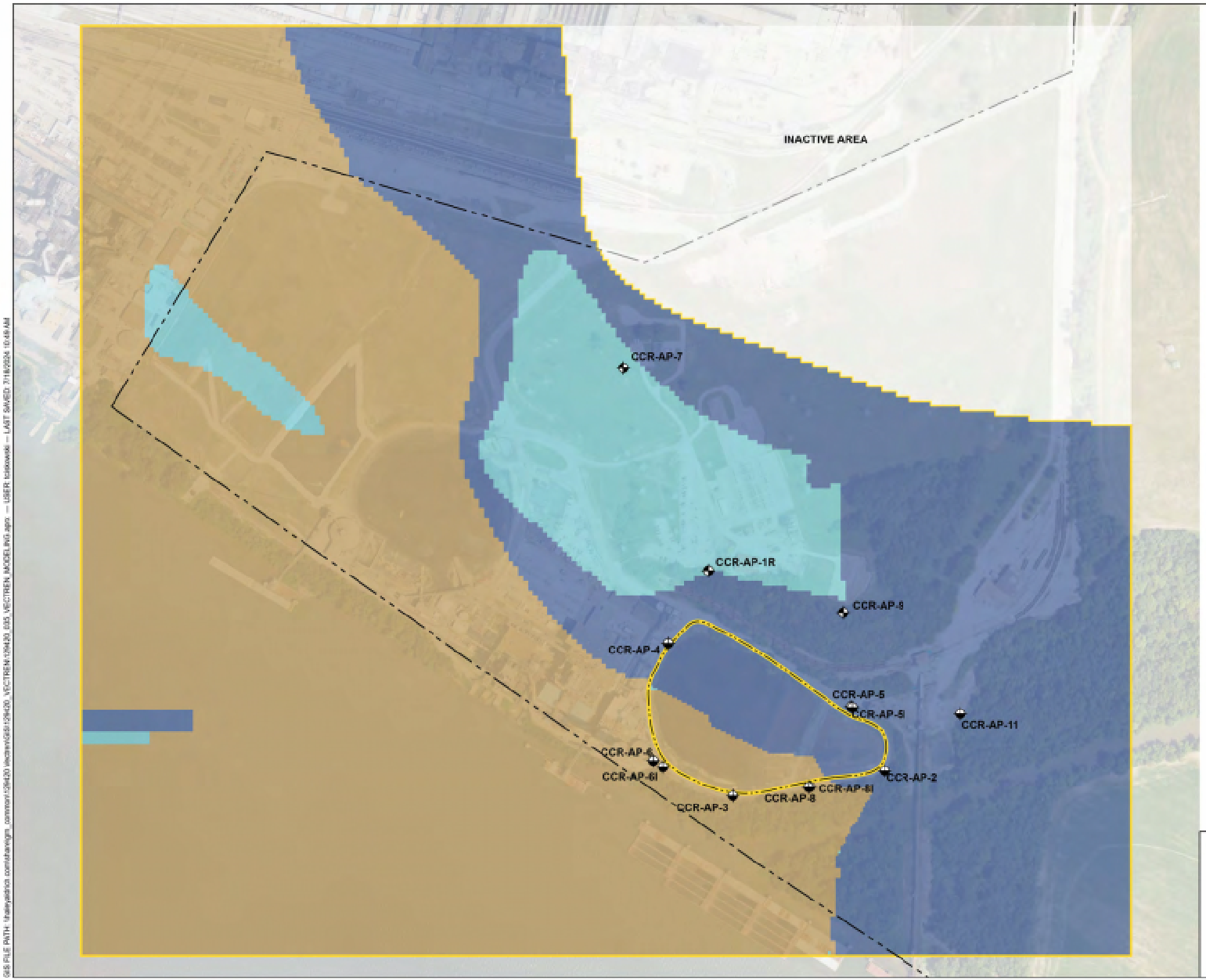
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH SIMULATED HYDRAULIC CONDUCTIVITY IN LAYER 1 AND 2

JULY 2024

FIGURE 4

GIS FILE PATH: \\haleyaldrich.com\shares\gis_common\129420\Vectren\GIS\129420_VECTREN_MODELING.aprx — USER: kstewart — LAST SAVED: 7/18/2024 10:46 AM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

SIMULATED HYDRAULIC CONDUCTIVITY VALUE (FEET/DAY)

- 0.1
- 0.15
- 669.3

NOTES

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4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

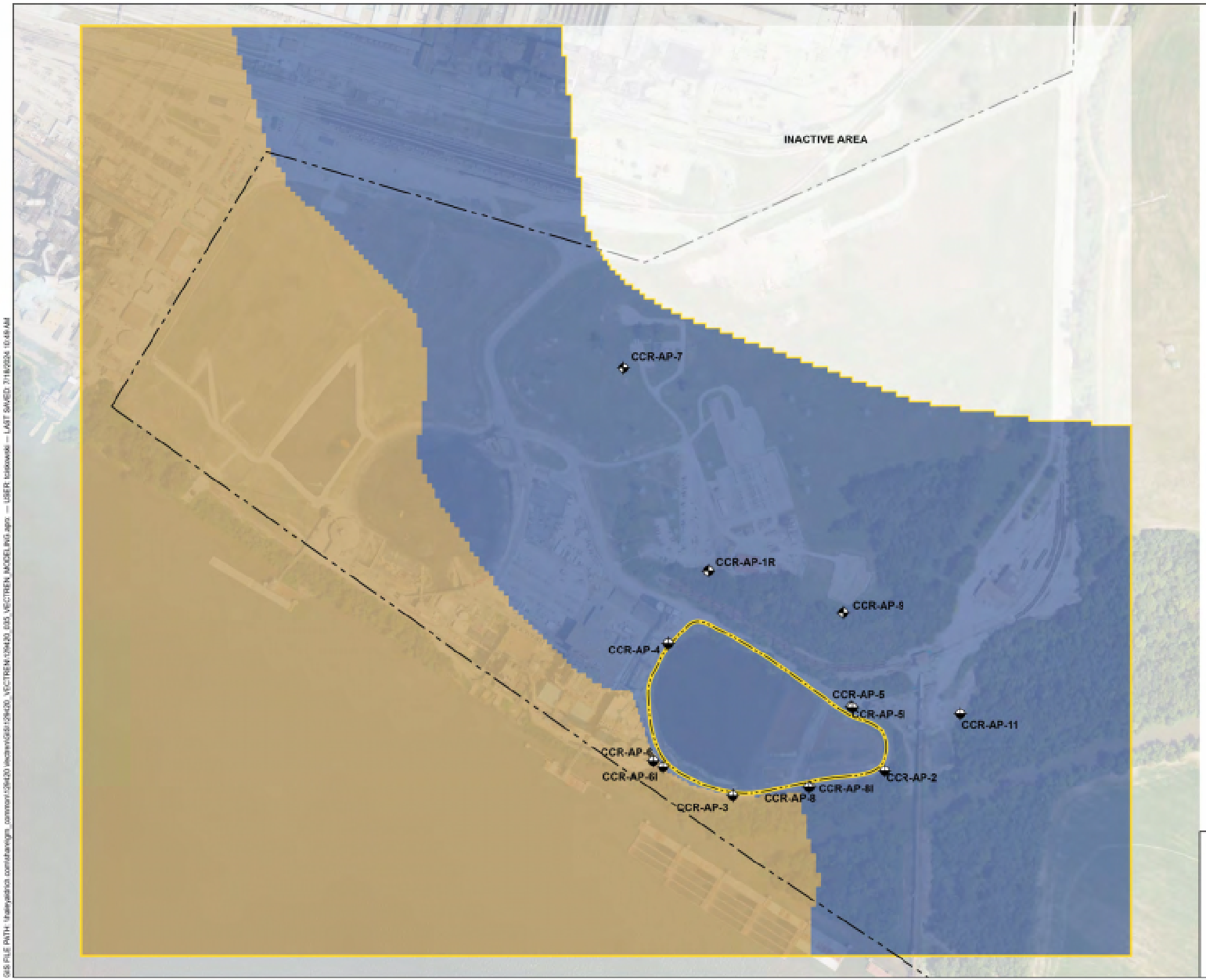
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH SIMULATED HYDRAULIC CONDUCTIVITY IN LAYER 3

JULY 2024

FIGURE 5

GIS FILE PATH: \\haleyaldrich.com\shares\gis_common\129420\Vectren\GIS\129420_VECTREN_MODELING.aprx — USER: kstewart — LAST SAVED: 7/18/2024 10:46 AM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

SIMULATED HYDRAULIC CONDUCTIVITY VALUE (FEET/DAY)

- 0.1
- 669.3

NOTES

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4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

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0 400 800
SCALE IN FEET

HALEY ALDRICH

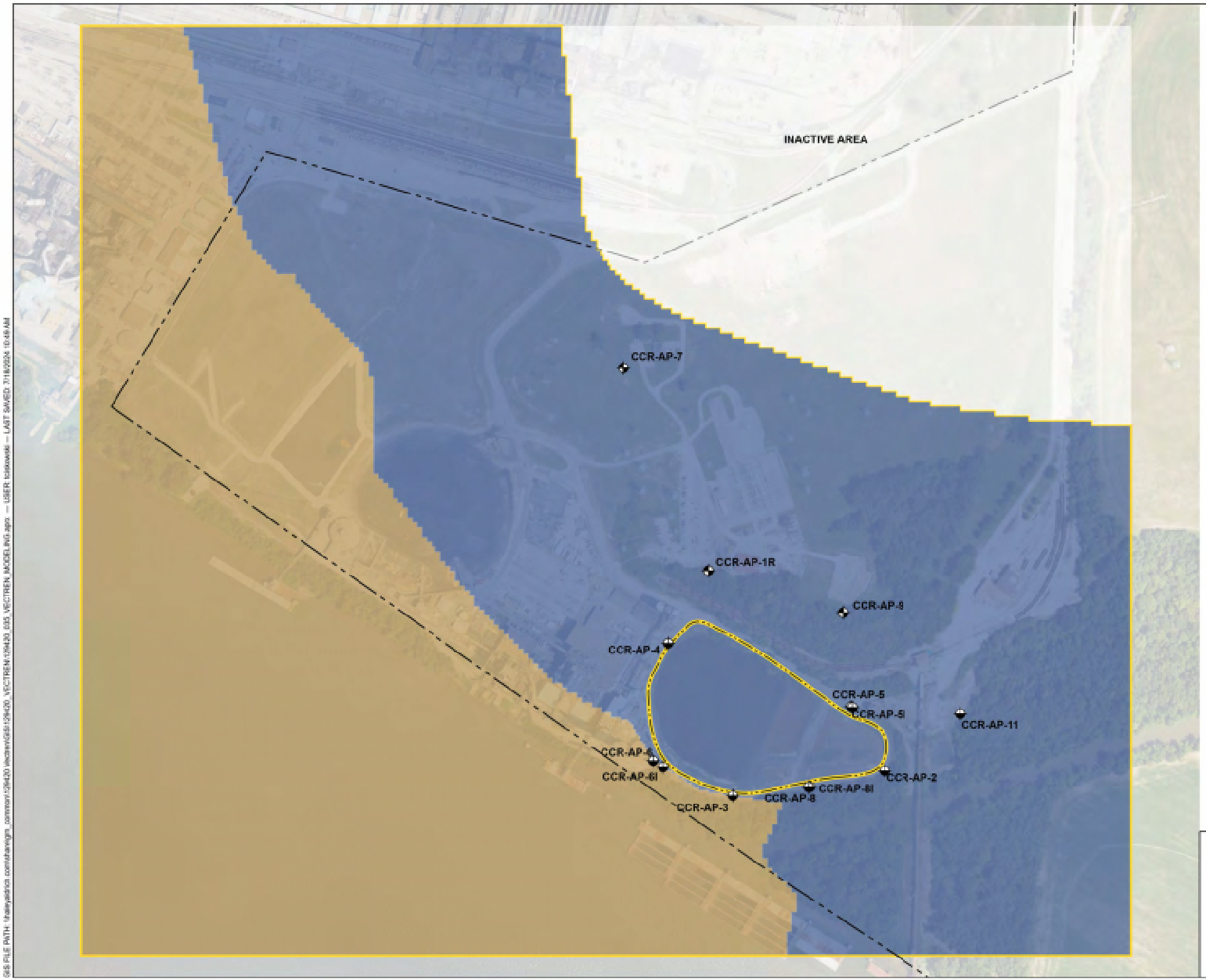
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH SIMULATED HYDRAULIC CONDUCTIVITY IN LAYER 4

JULY 2024

FIGURE 6

GIS FILE PATH: \\haleyaldrich.com\shares\gis_common\129420\Vectren\GIS\129420_VECTREN_MODELING.aprx — USER: kstewart — LAST SAVED: 7/18/2024 10:46 AM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

SIMULATED HYDRAULIC CONDUCTIVITY VALUE (FEET/DAY)

- 0.1
- 669.3

NOTES

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I = INTERMEDIATE

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4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

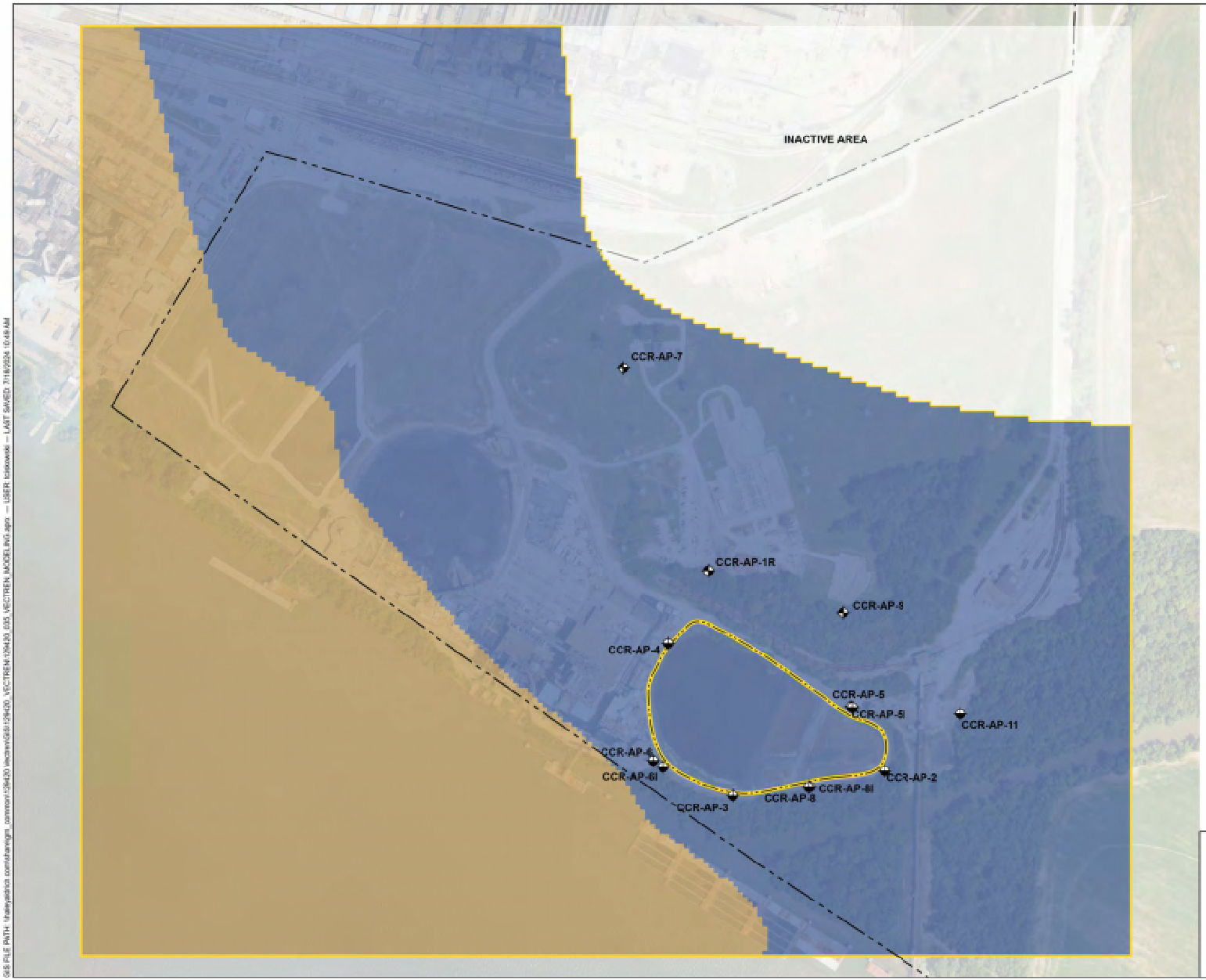
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH SIMULATED HYDRAULIC CONDUCTIVITY IN LAYER 5

JULY 2024

FIGURE 7

GIS FILE PATH: \\haleyaldrich.com\shares\gis_common\129420\Vectren\GIS\129420_VECTREN_MODELING.aprx — USER: kstewart — LAST SAVED: 7/18/2024 10:46 AM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

SIMULATED HYDRAULIC CONDUCTIVITY VALUE (FEET/DAY)

- 0.1
- 669.3

NOTES

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4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

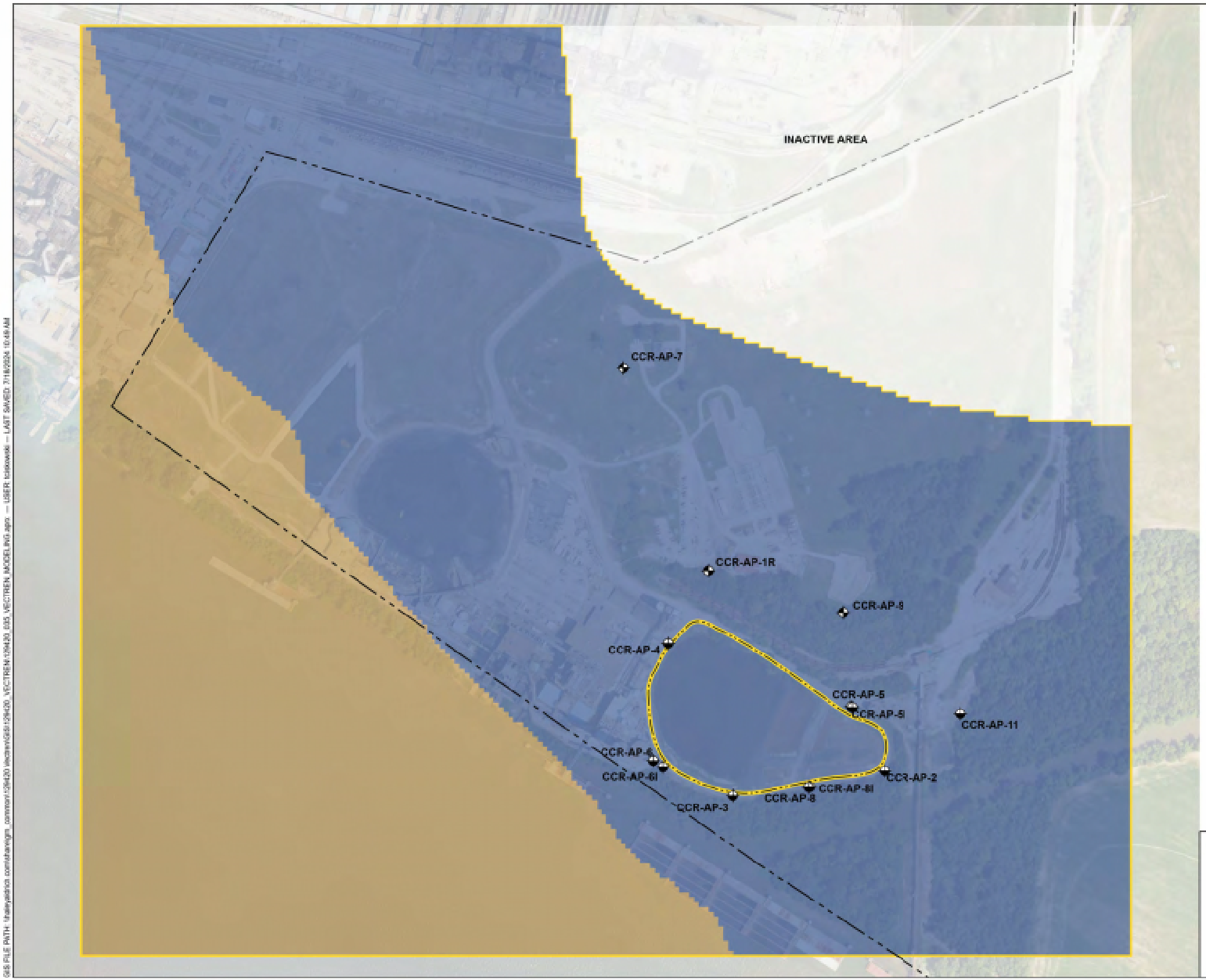
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH SIMULATED HYDRAULIC CONDUCTIVITY IN LAYER 3

JULY 2024

FIGURE 8

GIS FILE PATH: \\haleyaldrich.com\shares\gis_common\129420\Vectren\GIS\129420_VECTREN_MODELING.aprx — USER: kstewart — LAST SAVED: 7/18/2024 10:46 AM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

SIMULATED HYDRAULIC CONDUCTIVITY VALUE (FEET/DAY)

- 0.1
- 669.3

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4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH SIMULATED HYDRAULIC CONDUCTIVITY IN LAYER 7

JULY 2024

FIGURE 9

GIS FILE PATH: \\haleyaldrich.com\shares\gis_common\129420\Vectren\GIS\129420_VECTREN 135430_033_VECTREN_MODELING.aprx — USER: kstewart — LAST SAVED: 7/18/2024 10:46 AM



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

SIMULATED HYDRAULIC CONDUCTIVITY VALUE (FEET/DAY)

- 0.1
- 669.3

NOTES

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4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

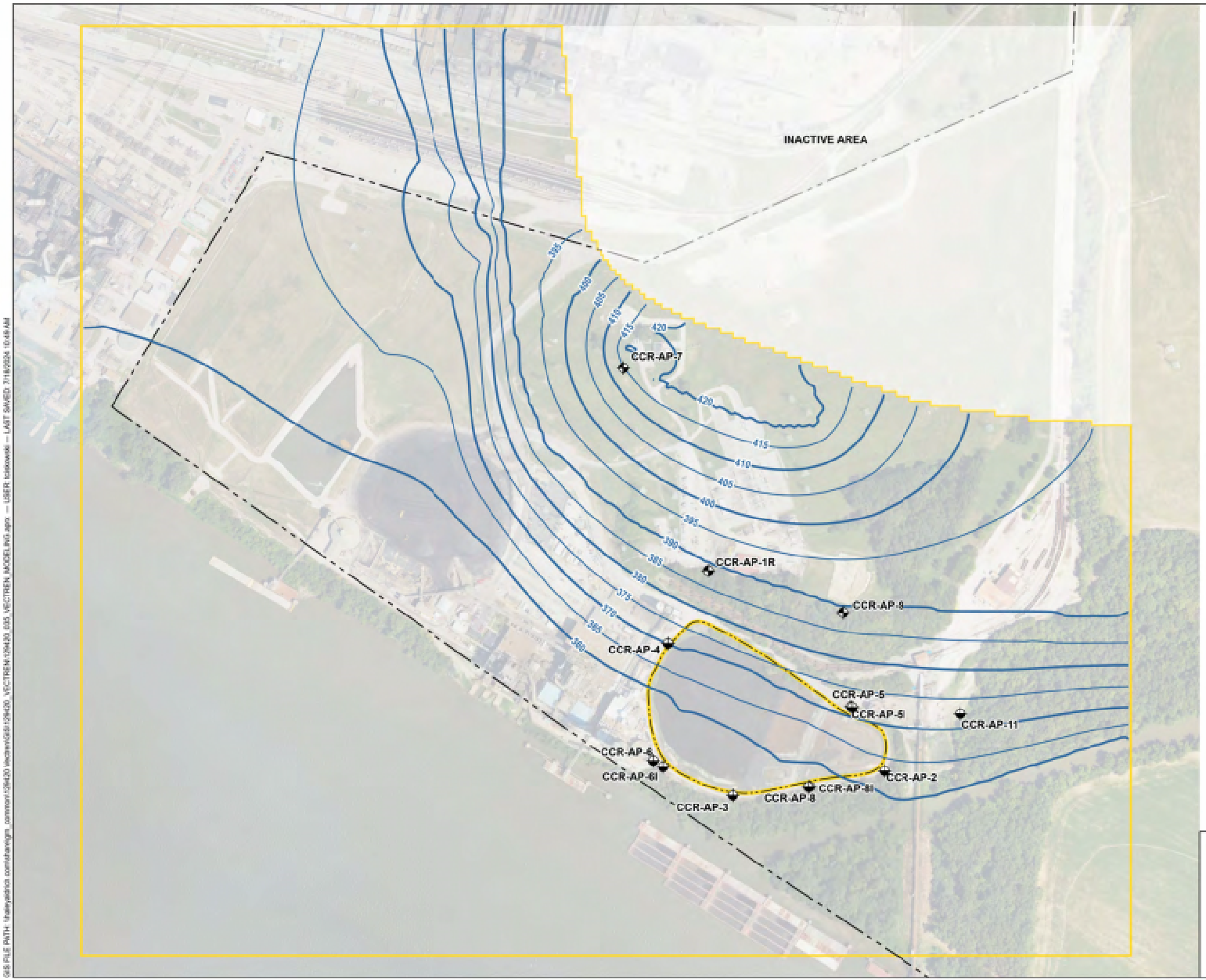
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SITE PLAN WITH SIMULATED HYDRAULIC CONDUCTIVITY IN LAYER 3

JULY 2024

FIGURE 10

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LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- GROUNDWATER ELEVATION CONTOUR, 5-FT
- GROUNDWATER ELEVATION CONTOUR, 10-FT
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

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AP = ASH POND
R = REPLACED
I = INTERMEDIATE

3. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SIMULATED STEADY-STATE GROUNDWATER CONTOUR PLAN

JULY 2024

FIGURE 11

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LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- GROUNDWATER ELEVATION CONTOUR, 5-FT
- GROUNDWATER ELEVATION CONTOUR, 10-FT
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

NOTES

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R = REPLACED
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3. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

SIMULATED GROUNDWATER CONTOUR PLAN DURING DEWATERING

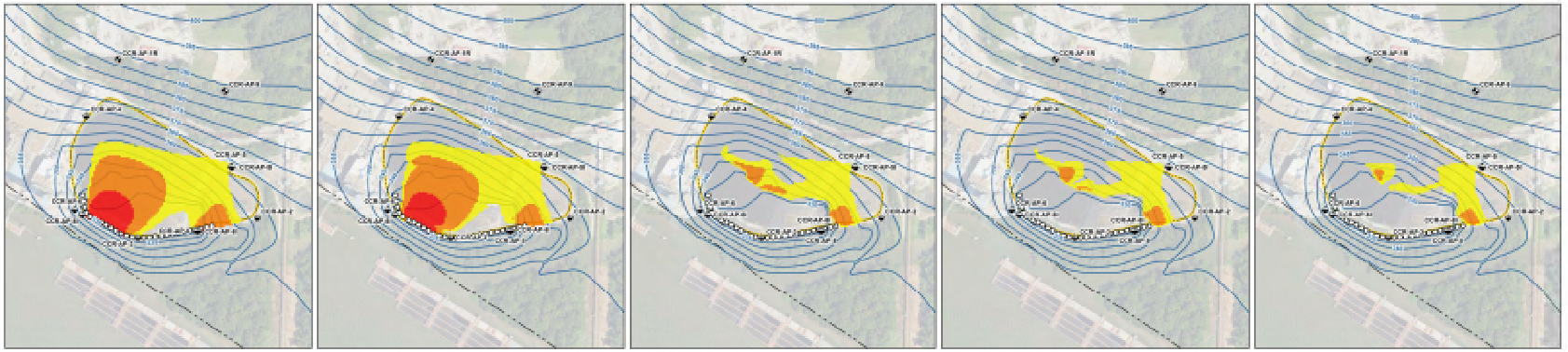
JULY 2024

FIGURE 12

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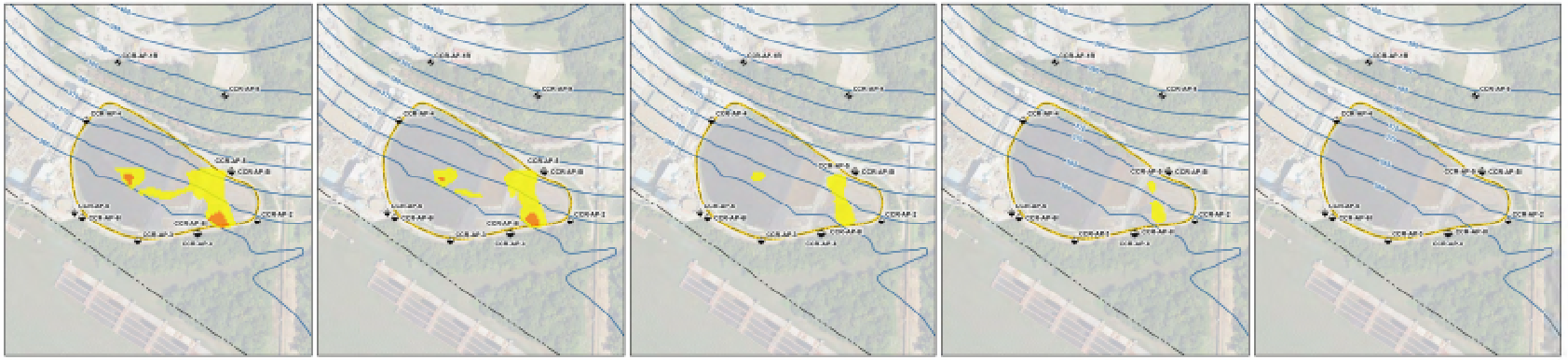
RUN 1: ASH POND CLOSURE BY REMOVAL WITH DEWATERING

INITIAL CONCENTRATIONS | 1 MONTH AFTER CLOSURE | 5 MONTHS AFTER CLOSURE | 10 MONTHS AFTER CLOSURE | 18 MONTHS AFTER CLOSURE



RUN 2: AFTER POND CLOSURE POST-DEWATERING

INITIAL CONCENTRATIONS | 1 YEAR AFTER CLOSURE | 5 YEARS AFTER CLOSURE | 10 YEARS AFTER CLOSURE | 20 YEARS AFTER CLOSURE



LEGEND

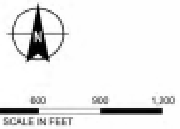
- PROPOSED DEWATERING WELL
- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- TRANSIENT CONTOUR
- ACTIVE AREA
- ASH POND BOUNDARY
- PROPERTY BOUNDARY

MOLYBDENUM CONCENTRATION IN ug/L

- 100 TO 150
- 150 TO 300
- > 300

NOTES

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2. WELL DESIGNATIONS:
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   R = REPLACED
   I = INTERMEDIATE
3. ug/L = MICROGRAMS PER LITER
4. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023



HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
A.B. BROWN GENERATING STATION
MOUNT VERNON, INDIANA

TRANSPORT MODEL SIMULATED MOLYBDENUM CONCENTRATIONS OVER TIME

JULY 2024

FIGURE 13

ATTACHMENTS

August 29, 2023 Serial Letter 002

Charah, LLC
12601 Plantside Drive
Louisville, KY 40299

Attn: Jay Albright
E: jalbright@charah.com

Re: FB Culley
SL-002 – Perimeter Well Pump Test Summary

Mr. Albright,

Keller has concluded the perimeter well pump testing activities. As indicated in serial letter 001, the coarse alluvium (native sand) stratum underlying the East Ash Pond (EAP) has produced more water than originally anticipated. Within this letter is a summary of the pump test results, information from the Geotechnical Data Report upon which the test was developed, and a few potential paths forward.

I. Summary of Geotechnical Data Report Information

The geology along the south embankment generally consists of fine-grained embankment fill overlying native fine-grained alluvium and native alluvial sand. The alluvial sand was not encountered in all borings that penetrated the native soil and varies greatly in thickness. It is assumed that the alluvial aquifer directly communicates with the Ohio River and that groundwater levels in the aquifer will fluctuate accordingly.

The geotechnical data report (dated August 2022) provided did not include any slug test, pump test or sieve analysis of the lower alluvial sands and gravels. These three items are the primary methods of determining the hydraulic conductivity, how easily water moves through the soil, of the soil layers. Without that information prior to performing the below tests, the amount and rate of water extraction required to

Keller Industrial Inc.
100 Stickle Avenue
Rockaway, NJ 07866

t: 973-627-2100

Equal Opportunity Employer

dewater the aquifer was unknown. Therefore, Keller elected to propose a base perimeter well system including the number of wells shown in plan view in the contract drawings and a 2-horsepower pump in each well. The selection of the 2-horsepower pump was based on Keller's experience in aquifers with similar characteristics to this one.

II. Pump Test and Design Development

Due to the limited information provided in the GDR for the native alluvial sand, Keller was to conduct a pilot study pump test to develop parameters for future design of the full-scale perimeter dewatering system. The purpose of the perimeter dewatering system is to lower the phreatic surface in the alluvial layer to mitigate the possibility of bottom instability when the EAP excavation nears the pond bottom.

The discharge for this pump test and future full-scale perimeter well system was to be routed to the existing 10-inch HDPE pipe that would in turn convey the water to the existing EAP pump station. This discharge point has the capacity to accept up to 2,650 gallons per minute (gpm) as indicated in RFI-044.

Due to these limitations in the discharge, the pilot study was designed with a 6-inch diameter well and 2-horsepower pump. When the pumping capacity of the 2-horsepower pump is extended across the AECOM conceptual well layout of 15 wells, shown on drawing C-25, the cumulative discharge rate is approximately half of the allowable discharge rate per RFI-044.

III. Summary of Perimeter Well Pump Test

The perimeter well pump test involved the installation of one (1) pumping deep well and seven (7) observation wells on the south embankment of the EAP. The eight (8) wells were installed from approximately El. 395 at varying distances across the berm as shown in the attached drawing, KNA-100. Pump testing was then performed on the test well (TW-01) to determine the hydrogeologic properties of the underlying alluvial sand stratum.

On Friday August 11, 2023, the 2-horsepower pump was activated to establish the desired pumping rate for the subsequent test. After pumping for 8 hours at approximately 80 gpm, the maximum output for the pump, it was evident that the pump was not capable of pumping enough water to stress the aquifer and generate adequate drawdown in the observation wells. The total drawdown in the pumping well was approximately 1.1 feet from the static water level during this period. In turn,

Keller mobilized a larger 10-horsepower pump, the largest that could be installed in the existing 6-inch well.

Following the installation of the larger pump, the pump test was performed from Tuesday, August 15, 2023 (pumping started at 5:32 PM CST) to Friday, August 18, 2023, (pumping stopped at 7:47 AM CST) for a total duration of 62 hours. The pumping rate during the test was approximately 300 gpm, the maximum output of the pump. This resulted in 3.3 feet of drawdown in the pumping well (TW-1). Figure 1 below shows the groundwater elevations versus time for this pump test.

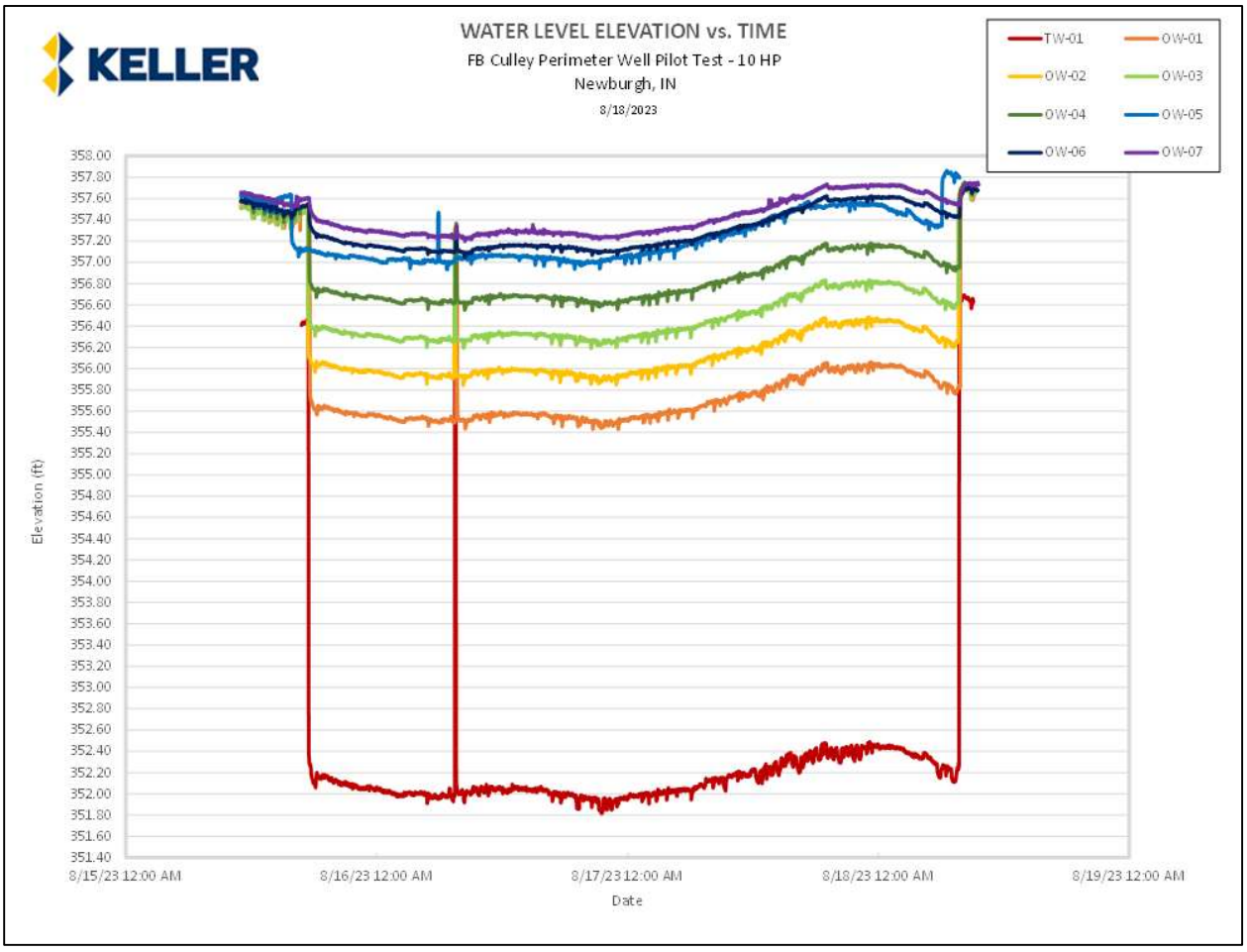


Figure 1 – 62 hr Pump Test – Groundwater Elevation versus Time

In the case of the 300 gpm test, most of the observation wells experienced less than 0.5 feet of drawdown over the course of the test. Observation wells OW-04 (100 feet away from TW-01) and OW-01 experienced maximum drawdown of approximately 1 foot and 2 feet respectively during the test. Keller's preliminary analysis indicates

that the hydraulic conductivity of the sandy alluvium is on the order of 4 x 10^{-1} to 10^{0} cm/s. These values are not characteristic of the SP, SP-SM, and SW-SM soils indicated on the detailed boring logs.

The rise in water levels beginning on August 17 coincided with an observed rise in river level. This leads Keller to conclude two things:

1. That the water level in the alluvium is directly related to the river level, and
2. That the test's pumping rate was not sufficient to maintain hydraulic control over the alluvium.

Based on the test results, Keller believes that the flow rate required to depressurize the alluvial aquifer will be much larger than originally anticipated and much larger than what could reasonably be expected based on the information provided during the bidding process.

IV. Recommended Path Forward

As stated above, the results of the pump test indicate that a larger volume of water than originally anticipated must be pumped to effectively depressurize the native sand underlying the EAP and mitigate bottom instability of the excavation during construction.

Preliminarily, the results can be used to estimate the potential scale of the dewatering efforts required. A full scale design has not been performed yet and will be complicated by the fact that the aquifer appears to become thinner as one moves east and north of the test site, and the fact that the proposed deep piezometer sealed below the EAP has not been installed yet.

An early estimate indicates that with individual well devices capable of pumping approximately 1,200 gpm with a combined system discharge on the order of 10,000 – 20,000 gpm may be necessary to achieve project goals. This is a significantly higher discharge rate than what was anticipated by the GDR and will require a reevaluation of the discharge point or methods to mitigate the water in the native sand underlying the EAP.

In reevaluation of the path forward, there are a few options to consider:

1. Conduct another pump test in a new, larger well for a future large-scale system of wells along the EAP levee. The pumping well would be equipped with a pump capable of a discharge flowrate of 1,200 gpm. Given a base system of 15 wells, the total discharge could be on the order of magnitude of 10,000 – 20,000 gpm or greater. This test should incorporate the deep EAP piezometer to gauge the aquifer's response to pumping directly beneath the pond.
2. Installation of a cutoff wall between the pond and Ohio River supplemented by a dewatering system.
3. Permeation Grouting of the coarse alluvium supplemented by a dewatering system.

Please let us know when you are available to discuss further.

Sincerely,

Keller Industrial Inc.



Andrew Chegwidden

Assistant Project Manager

Attachments:

1. KNA-100 - Perimeter Well Pump Test Layout

December 15, 2023

Project Name: CenterPoint Energy F.B. Culley New Lined Pond and East Ash Pond Closure Project
Project No.: 60586569
Subcontract No.: 14751
Specification: 312319
Filename: 312319.005
Revision: A
LOT: 129

Charah Solutions

Attn: Jay Albright
P: 502-873-8421
E: jalbright@charah.com

Re: New Lined Pond and East Ash Pond Closure
Newburgh, IN
Construction Dewatering Proposal

Dear Mr. Albright:

This proposal is based on the results of the second series of perimeter well pump tests conducted by Keller (October 24 to October 26 and November 6 to November 10, 2023). The project drawings issued for construction dated August 5, 2022, and on the Site Information and Data Report – Issued for Construction dated August 2022 have also been reviewed.

The geology along the south embankment generally consists of fine-grained embankment fill overlying native fine-grained alluvium and native alluvial sand. The alluvial sand was not encountered in all borings that penetrated the native soil and varies greatly in thickness. Keller assumes that the alluvial aquifer directly communicates with the Ohio River and that groundwater levels in the aquifer will fluctuate accordingly.

Keller understands that the intent of the perimeter dewatering system is to depressurize and dewater the coarse alluvium such that it does not present a stability concern during excavation of the pond. The lowest pond excavation level is El. 329.

Keller has already performed the first series of pump tests at the site. The pump test flow rate was approximately 300 gpm but did not produce sufficient drawdown in the test well or adjacent observation wells to be confident of using the resulting data in a full-scale design of the perimeter well dewatering system. After discussion with Charah, AECOM and Centerpoint in August 2023, Keller installed two additional deep wells to conduct a second series of constant rate pump tests at a higher flow rate to better quantify aquifer properties. Based on the results of these tests, described in Serial Letter 4 dated November 21, 2023, the system described herein is a good faith estimate of the full-scale perimeter dewatering system needed to meet the project goals.

SCOPE OF WORK

Based on the results of the second pump test and contract geotechnical report, an array of 27 deep wells with varying capacity on the southern embankment will be required to achieve the project goals. The two large diameter test wells (TW-2 and TW-3) will be incorporated into the full-scale system. However, since they are placed close together, Keller is relying on them to act as a single well. This requires installing an additional 26 wells.

Deep Well Drilling

Keller proposes to install an array of 26 deep wells, spaced approximately 30 feet on center, on the southern embankment as shown on KNA-100D attached. The wells will be installed by drilling methods using biodegradable mud as a drilling fluid. The wells will be installed to an approximate depth of 80 feet, practical drill refusal or to the top of bedrock, whichever is encountered first. Each well will be constructed using nominal 12-inch diameter well casing and screen with an accompanying filter pack installed in the annulus of the borehole.

Submersible Pump and In-Well Discharge Piping Installation

The second series of pump tests were performed in a thicker, more favorable area of the underlying alluvial sand aquifer. Going east along the southern embankment, the native alluvial sand stratum becomes thinner and may decrease the yield of each deep well device. The reduced well yields were considered when determining the well quantity and pump sizing for the full scale deep well system.

In general, Keller has identified three ranges of well yields to achieve the target cumulative system discharge rate. The flow ranges below have an assigned submersible pump size capable of evacuating the well to the pump intake. The quantity and anticipated locations of these pumps is summarized below and on KNA-100D attached, respectively.

Flow Range	Quantity of Pumps	Pump Size	Electrical Requirement (per pump)
200 – 500 gpm	5 ea	30 HP	46 A
500 – 750 gpm	7 ea	40 HP	63 A
750 – 1,100 gpm	14 ea	60 HP	93 A
Total	26 ea		

In addition to the two test well pumps already onsite, Keller will provide an additional 26 each submersible pumps and motors as detailed in the above table. The submersible pumps will be connected to a 6-inch PVC in well discharge line and in turn to one of the 18-inch HDPE common discharge lines (see below). Each pump will have a surface-mounted control panel adjacent to the well location. We have assumed your forces will provide power directly to each control panel.

Keller suggests including an additional 25 % capacity for power in case additional pump capacity is required.

An additional two backup 60 HP submersible pumps and motors have been included in the mobilization price. If more pump redundancy is required, they can be procured on a cost-plus basis.

18-inch HDPE Discharge Pipe

The in-well discharge pipe will be connected to a network of four (4) individual common HDPE header and discharge pipes as shown in KNA-100D. The discharge pipes will be run at grade along the well alignment on the southern embankment. At the approximate location of DW-17 and DW-18, the discharge pipe will turn and be conveyed up to 200 feet from the embankment to the future outfall apron (constructed by others). Keller has also included up to 100 feet of 10-inch PVC discharge pipe to convey a portion of the well flow to the existing 10-inch HDPE outfall located on the southeast portion of the pond.

If additional pumping capacity is required, a new common HDPE header may be required to convey the discharge to the outfall apron.

Upon completion of the work, and with written direction from you, Keller will remove the system and abandon the wells by tremie grouting them in place.

The system described herein is a good faith estimate of the dewatering effort required at this site. Additional devices and/or pumping capacity may be required based on the actual conditions encountered in the field.

Very truly yours,
Keller Industrial Inc.



Andrew Chegwidden
Assistant Project Manager

Attachments

A. KNA-100D – Perimeter Well System Layout

DISCHARGE 1

DW-1	→	1,000gpm
DW-4	→	1,000gpm
DW-7	→	1,000gpm
DW-10	→	1,000gpm
DW-13	→	1,000gpm
DW-16	→	667gpm
		5,667gpm

DISCHARGE 2

DW-2	→	1,000gpm
DW-5	→	1,000gpm
DW-8	→	1,000gpm
DW-11	→	1,000gpm
DW-14	→	1,000gpm
DW-17	→	667gpm
		5,667gpm

DISCHARGE 3

DW-3	→	1,000gpm
TW-3	→	1,000gpm
TW-2	→	1,000gpm
DW-9	→	1,000gpm
DW-12	→	1,000gpm
DW-15	→	1,000gpm
		6,000gpm

DISCHARGE 4

DW-18	→	667gpm
DW-19 to DW-22	→	2,268gpm
DW-23 to DW-25	→	1,299gpm
DW-26 & DW-27	→	466gpm
		4,700gpm

WELL SCHEDULE

I.D.	APPROX. FLOW	QTY.
TYPE A	1,000	16 (2 test wells)
TYPE B	667	3
TYPE C	567	4
TYPE D	433	3
TYPE E	233	2

B16-2

B16-3

28 DEWATERING WELLS SPACED @ 30ft O.C

DW-1 DW-2 DW-3 DW-4 DW-5 TW-3 TW-2 DW-7 DW-8 DW-9 DW-10 DW-11 DW-12 DW-13 DW-14 DW-15 DW-16 DW-17 DW-18 DW-19 DW-20 DW-21 DW-22 DW-23 DW-24 DW-25 DW-26 DW-27

DISCHARGE POINT

PERIMETER WELL PILOT STUDY
SCALE: 1" = 100'

SCALE: 1" = 100'
0 50' 100' 200'
IF SHEET IS LESS THAN 17" X 11" SCALE ACCORDINGLY

12/14/2023 3:31:48 PM Created By:Robert R Chamberland

KELLER
100 STICKLE AVENUE
ROCKAWAY, NJ 07866
973-627-2100

WWW.KELLER-NA.COM

PERIMETER WELL PILOT STUDY BY
F.B. CULLEY

F.B. Culley East Ash Pond Perimeter Deep Well Pilot Test 2.0

Dewatering
3711 Darlington Rd.
Newburgh, IN 47630

Engineer of Record:

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OP0000000	12/11/2023

Sheet No.
KNA-100D

APPENDIX D
Groundwater Geochemical Site Model Evaluation

HALEY ALDRICH

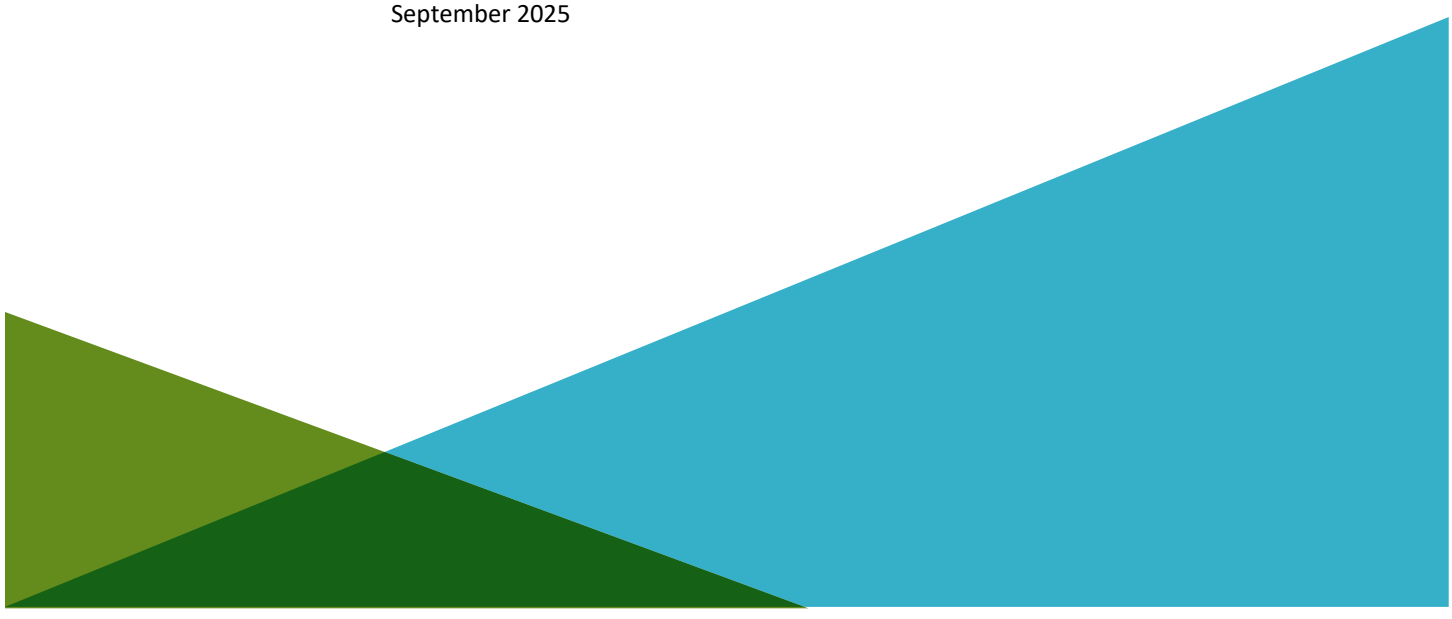
www.haleyaldrich.com

GEOCHEMICAL CONCEPTUAL SITE MODEL
F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 0129420-034
September 2025



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REPORT ON

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F.B. CULLEY GENERATING STATION
WARRICK COUNTY, INDIANA

PREPARED FOR

SOUTH INDIANA GAS AND ELECTRIC COMPANY
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PREPARED BY:



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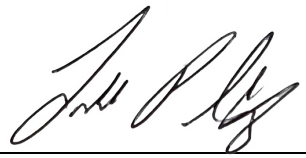


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Executive Summary

This Geochemical Conceptual Site Model report has been prepared to support the corrective measures process being completed at the F.B. Culley Generating Station (Site) in Evansville, Indiana. The geochemical evaluations include assessments and modeling of geochemical data presented in the annual groundwater monitoring reports, as well as additional microbial and solid phase analyses described herein. The purpose of this summary report is to document Site-specific geochemical conditions influencing the fate and transport of coal combustion residual (CCR)-related constituents such as lithium, molybdenum, and arsenic, which are above their respective groundwater protection standard (GWPS). Although the selection of remedy is based around the elevated presence of molybdenum (since a successful alternative source demonstration was submitted for arsenic), the presence of all constituents was included in the geochemical discussion.

Generally, groundwater from background monitoring wells (CCR-AP-1R, CCR-AP-7, and CCR-AP-9) exhibit near neutral pH with a lower pH range at CCR-AP-7 (farthest upgradient well) and a higher pH range at CCR-AP-1R. Historical oxidation-reduction potential and dissolved oxygen (DO) measurements of groundwater classify CCR-AP-7 as anaerobic and CCR-AP-1R and CCR-AP-9 as aerobic. Observed values of pH in groundwater with CCR-related constituent concentrations above their respective GWPS are near neutral. Groundwater with CCR-related constituent concentrations above their respective GWPS exhibit a range of aerobic to anaerobic conditions; groundwater from CCR-AP-4, CCR-AP-6, CCR-AP-3, CCR-AP-8, and CCR-AP-2 exhibit aerobic conditions and generally lower concentrations of sulfate. Additionally, conditions at monitoring wells CCR-AP-6, CCR-AP-3, CCR-AP-8, and CCR-AP-2 appear to be influenced by the Ohio River with DO concentrations above 0.5 milligrams per liter.

Sequential extraction testing indicated that molybdenum had a minor association with sulfide mineralization from CMA-SB-01, demonstrating the potential of molybdenum uptake by sulfides present in aquifer solids. All sequential extraction samples, except CCR-SB-AP1R, show a moderate association to organics, demonstrating the potential for molybdenum uptake by organic matter. Analytical soil concentrations generally show substantial levels of molybdenum, averaging 18.5 milligrams per kilogram (mg/kg), within the pond area, which is higher than the average molybdenum soil concentration of 5.6 mg/kg at downgradient locations. Background molybdenum concentrations from nearby United States Geologic Survey samples average 4.4 mg/kg, suggesting that the sampled molybdenum soil concentrations downgradient of the East Ash Pond are predominantly naturally occurring (USGS, 2024).

Eh-pH diagram calculations were used to identify chemical speciation of arsenic, molybdenum, and lithium; the results show that these chemicals are primarily present in the form of dissolved species at the Site. Iron is predicted to primarily speciate as solid phase ferric iron when oxygen is available. Molybdenum is predicted to speciate as the mineral molybdenite under sulfate reducing conditions.

Microbial data collected from wells downgradient of the EAP (CCR-AP-6I and CCR-AP-8I) with screening zones between approximately 59.7 and 74.7 feet below ground surface were used to identify and determine the types and abundance of indigenous microorganisms. This data showed anaerobic/anoxic bacteria in groundwater from these locations are more abundant than aerobic and/or microaerophilic bacteria.

A significant percentage of the anaerobic/anoxic bacterial population was identified as sulfate-reducing bacteria and iron-reducing bacteria. The dominant population of sulfate-reducing bacteria, together

with the observation of high sulfate concentrations in groundwater, indicate that some extent of microbially mediated sulfate-reducing reactions could occur, which is consistent with the detection of sulfide at CCR-AP-6I. However, the lack of sulfide detections in groundwater at many monitoring wells do not rule out that the reactions may be occurring to the extent that cannot be detected at some locations. In such a case, sulfate reduction would be limited by the availability of organic carbon that can be used by sulfate reducing bacteria, which is often associated with the degree of total organic carbon concentrations in aquifer solids. Under sulfate-reducing conditions, molybdenum could be immobilized through the formation of molybdenum disulfide.

The laboratory desorption test results showed that molybdenum is adsorbed and lithium is not substantially adsorbed by native soils. The adsorption partitioning constant for molybdenum ranged from 1.8 to 1.6 liters per kilogram.

To further investigate the potential for molybdenum precipitation, a laboratory microcosm study was conducted to assess the feasibility of in-situ molybdenum precipitation through redox manipulation. Results show the indigenous microbial community was receptive to amendment with an organic substrate resulting in an approximate 96 to 100 percent decrease in measured concentration of molybdenum after a 78-day incubation. Aerobic desorption (or leaching) testing was completed on microcosms after treatment to assess the stability of molybdenum. Molybdenum was found to desorb/mobilize in the first 24-hour elution under the exposure of dissolved oxygen. Results show that, while Site precipitated molybdenum will mobilize if reducing conditions change to aerobic conditions, the extent of mobilization likely depends on the level of DO, which affects the oxidation rate of reduced minerals containing molybdenum. Therefore, molybdenum mobilization due to a low DO concentration may not result in a concentration higher than the GWPS of molybdenum (100 micrograms per liter).

Geochemical modeling was used for the evaluation of potential treatment approaches and performance requirements. Stoichiometric calculations indicate feasible molybdenum treatment with the induction of sulfate reducing conditions through the precipitation of molybdenum disulfide. A Site-specific Eh threshold for sulfate reduction was calculated to be approximately -110 millivolts, below which the precipitation of molybdenum disulfide is thermodynamically favored to occur.

The geochemical evaluation concluded that under current Site conditions the molybdenum plume is generally stable. Sulfate reducing conditions within the aquifer inferred from the presence of sulfate-reducing bacteria and detection of sulfide will aid in attenuation of molybdenum through mineralization, as supported by the sequential extraction results. Laboratory testing suggest that molybdenum treatment through redox manipulation via the addition of an organic substrate (such as EVO) is feasible through precipitation as stable molybdenum disulfide. Geochemical modeling predicts this treatment is feasible given there is enough sulfide available to facilitate molybdenum disulfide precipitation.

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List of Abbreviations

Abbreviation	Definition
µg/L	micrograms per liter
bgs	below ground surface
CCR	coal combustion residual (*rule)*
CMA	Corrective Measures Assessment
DO	dissolved oxygen
EAP	East Ash Pond
EVO	Edible Vegetable Oil
g/L	grams per liter
GWB	Geochemist's Work Bench
GWPS	groundwater protection standard
Kd	partition coefficient
MCL	maximum contaminant level
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mL	milliliter
mV	millivolts
ORP	oxidation-reduction potential
S.U.	standard units
SIGECO	Southern Indiana Gas and Electric Company
Site	F.B. Culley Generating Station
SSI	statistically significant increase
SSLs	statistically significant level
TOC	total organic carbon
USEPA	US Environmental Protection Agency

1. Introduction

On behalf of Southern Indiana Gas and Electric Company (SIGECO), Haley & Aldrich, Inc., has prepared this Geochemical Conceptual Site Model for the regulated coal combustion residual (CCR) units for the East Ash Pond (EAP) located at the F.B. Culley Generating Station (Site). SIGECO has completed comprehensive geologic and hydrogeologic investigations in accordance with the U.S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. *80 Fed. Reg. 21302 (effective 17 April 2015)* (USEPA, 2023*)* and subsequent regulatory revisions (CCR Rule). Data summarized in this report are intended to support the Corrective Measures Assessment (CMA), fate and transport modeling, and selection of remedy for the Site.

The assessment presented in this report includes:

- An evaluation of general biogeochemical conditions (aquifer matrix composition, pH and redox conditions, major ion chemistry, general mineralogy, major groundwater constituent trends, and microbial community).
- Geochemical evaluation of molybdenum, lithium, and arsenic (speciation, specific mineralogy, advanced geochemical interpretation, and sorption).
- Feasibility of biogeochemical in-situ redox manipulation treatment for molybdenum and subsequent aerobic desorption (leaching) testing.

2. Background Information

2.1 SITE DESCRIPTION

SIGECO owns and operates the Site, which is located adjacent to the northern bank of the Ohio River west of the confluence of the Ohio River and Little Pigeon Creek approximately three miles east of the town of Newburgh. In general, surface topography across the site slopes to the south towards the Ohio River. Surface water runoff occurs via sheet flow to low lying areas which eventually lead to the Ohio River and Little Pigeon Creek. The Site began operations in 1953. The Site is an active energy production facility that generates electricity through the combustion of mainly Illinois Basin coal. The Site supplies electric power to industrial, commercial, and residential customers in its service territory. CCRs are products of the combustion process and include bottom ash, fly ash, and flue gas desulfurization sludge. CCR is currently managed through beneficial re-use and on the Site in a 10-acre impoundment known as the EAP. Site features are shown on **Figure 1**.

2.2 GEOLOGICAL AND HYDROLOGICAL SETTING

Within the EAP, CCR is managed in an impoundment at depths that range from zero feet to approximately 60 feet below ground surface (bgs). The alluvial aquifer beneath the EAP is approximately 80 feet in thickness. Although flow within the alluvial aquifer is directly controlled by the river stages of the Ohio River, groundwater flow is generally from the upland area north of the EAP toward the Ohio River.

The EAP is located within the Ohio River valley which contains naturally occurring alluvial (stream) and loess (windblown) deposits derived indirectly from continental ice sheets. These sediments were transported in meltwater, heavily loaded with entrained sediments that accumulated on top of the Pennsylvanian age shale, limestone and sandstone bedrock. Westerly winds simultaneously deposited silty sediments in the upland areas adjacent to the stream valley. As a result, base levels of the valley floor increased in elevation and created natural levees and terraces. These natural levees produced slack-water lakes which deposited thick sequences of silt and clay adjacent to the river channel.

Soil types described in boring logs from monitoring wells installed in the vicinity of the EAP, as well as boring logs generated from geotechnical explorations conducted by AECOM indicated that the uppermost aquifer is comprised of a layered sequence of unconsolidated deposits consisting primarily of clay and silt associated with the slack-water lakes. Abundant black wood fragments are present in the uppermost aquifer along the southern berm of the EAP associated with former Little Pigeon Creek. This unconsolidated overburden overlies Pennsylvanian-age sandstone which overlies shale. During construction of the facility and EAP, the northern portion of the pond was incised into bedrock. In the vicinity of the EAP, the uppermost aquifer occurs within unconsolidated Ohio River and Little Pigeon Creek alluvial deposits consisting of silt and clay with discontinuous interbedded layers of sand. To the north of the EAP the uppermost aquifer occurs in the shale and sandstone bedrock units. Recharge to the surficial aquifer occurs through direct surface infiltration. Piezometric data recorded from the monitoring wells installed on-Site indicated that the configuration of the uppermost aquifer is primarily controlled by the Ohio River.

2.3 SUMMARY OF BACKGROUND CONCENTRATION CONDITIONS AND STATISTICALLY SIGNIFICANT LEVELS

Monitoring wells were installed in December 2015, March 2016, February 2017, November 2018, and January 2019. The monitoring well network includes three background wells (CCR-AP-1R, CCR-AP-7 and CCR-AP-9) and 10 downgradient monitoring wells (CCR-AP-2, CCR-AP-3, CCR-AP-4, CCR-AP-5, CCR-AP-5I, CCR-AP-6, CCR-AP-6I, CCR-AP-8, CCR-AP-8I, and CCR-AP-11) located around the perimeter of the EAP. Monitoring well locations are shown on **Figure 1**. Detection monitoring events occurred in 2016 and 2017. The results obtained from downgradient monitoring wells were compared to background wells using statistical methods to determine if constituents were present at concentrations above the background, called statistically significant increases (SSIs) downgradient of the EAP. The result of the statistical analysis identified SSIs thereby triggering assessment monitoring.

3. Materials Sampling and Analysis

3.1 SOIL SAMPLING AND ANALYSIS

Soil samples were collected on 14 June 2023 and 16 June 2023 from wells CCR-AP-06I and CCR-AP-08I, respectively. Soil samples were collected at a sampling depth of 65 to 67 feet bgs and 60 to 63 feet bgs from CCR-AP-06I and CCR-AP-08I, respectively. Samples were stored and shipped in vacuum sealed bags, and extractions were performed under anoxic conditions in an attempt to preserve in-situ oxidations states. Soil samples were analyzed for molybdenum and lithium using an inductively Coupled Plasma – Atomic Emission Spectrophotometer and the following methods:

- Composition analysis using hot nitric acid.
- Sorption analysis using a 1:10 soil to groundwater ratio.
- Desorption analysis using a 1:4 soil to groundwater ratio. Groundwater was analyzed for molybdenum and lithium at each elution step. Soil was analyzed for molybdenum and lithium after the three elution steps.
- In-situ redox manipulation treatment for molybdenum using substrate, macro-nutrients, sulfate and sulfate-reducing cultures in soil and groundwater microcosms.
- Aerobic desorption (or leaching) testing of residual soils from microcosms with oxygenated groundwater.

Additional analysis details are included in Appendix A.

3.2 GROUNDWATER SAMPLING AND ANALYSIS

Prior to groundwater sample collection using the low-flow sampling procedure, static water level readings and field parameters were collected and recorded in field sampling logs included in Appendix B. Sampled groundwater was carefully filled into sample containers and capped to limit the contact of oxygen with groundwater samples. Groundwater samples were collected on 14 June 2023 from well CCR-AP-1R. Groundwater from well CCR-AP-1R was used to make the soil and groundwater slurries for the analysis listed above.

3.2.1 Additional Groundwater Analysis

The total organic carbon (TOC) content of four groundwater samples collected from background well CCR-AP-1R and downgradient wells CCR-AP-5, CCR-AP-6I, and CCR-AP-8I were measured to better understand the potential effect these Site typical concentrations of TOC may have on the fate and transport of the CCR constituents, particularly their attenuation. TOC was detected at a concentration of 1,200 micrograms per liter (µg/L) in the background groundwater and ranged from 1,600 to 3,500 µg/L with an average of approximately 2,700 µg/L in downgradient groundwater. These reported concentrations of TOC found in groundwater indicate that TOC in groundwater at the Site will likely have a minimal effect on constituent mobility. The presence of TOC that can be metabolized by indigenous bacteria can contribute to the creation of the sulfate reducing conditions favorable for molybdenum treatment through molybdenum disulfide precipitation.

4. Geochemical Data Evaluation

Groundwater monitoring at the Site began in 2016 and continues today, with the most recent sampling event occurring November 2023. A comprehensive groundwater data table is included in Appendix C. Collected data include Appendix III and IV constituents (as defined by the USEPA). Investigations into the nature and extent of Site significant statistical levels (SSLs), initiated in accordance with Title 40 Code of Federal Regulations §257.95(g) of the CCR Rule, have characterized Site conditions relevant to the CMA.

Groundwater quality at the Site is affected by numerous geochemical processes, including adsorption, precipitation/dissolution, and microbial activity. The measured effects of these processes can help explain the observed transport behavior of molybdenum in groundwater and may indicate the degree of attenuation of CCR constituents. On the contrary, lithium is expected to be minimally influenced by these effects.

The following geochemical reactions or processes are likely mechanisms influencing the fate and transport of molybdenum in groundwater:

- **Adsorption on the surfaces of aquifer solids** – an interaction between dissolved constituents and the surface of certain surface media of the aquifer solids may influence constituent concentration and mobility. This adsorption and desorption process is reversible and considerably affected by the constituent of interest, composition of aquifer solid surfaces, pH, and Eh (which is the oxidation-reduction potential [ORP] based on the standard hydrogen potential) of groundwater.
- **Mineral precipitation or dissolution** – under certain groundwater pH and redox conditions, constituents in groundwater combine to form a soil mineral, which is called precipitation, or soil minerals may also completely or partially dissolve into the aqueous phase, which is called dissolution. These processes are reversible and considerably affected by the pH and Eh.
- **Microbially mediated reactions** – many redox reactions that occur in groundwater and aquifer solids are mediated by microorganisms. The consequences of these microbially mediated reactions may generate sufficient chemical products that control groundwater pH and Eh. The rates of these redox reactions depend on the availability of organic or inorganic electron donors (e.g., organic matter and ferrous iron) and electron acceptors (e.g., oxygen, nitrate, iron oxides, and sulfate) for the indigenous microbial population.

4.1 GROUNDWATER CHEMISTRY

4.1.1 pH and Redox

Historical pH measurements of groundwater from background wells (CCR-AP-1R, CCR-AP-7, and CCR-AP-9) exhibit near neutral pH. The measured pH range is slightly lower at CCR-AP-7 and slightly higher at CCR-AP-1R, see **Table 4.1.1-1** below summarizing historical data. ORP and dissolved oxygen (DO) measurements of groundwater from background wells classify conditions as anaerobic at CCR-AP-7 and aerobic at CCR-AP-1R and CCR-AP-9. Background wells CCR-AP-1R and CCR-AP-9 are less than 350 feet north of the EAP; their upgradient vicinity to the EAP make them a better representation of upgradient conditions than CCR-AP-7. Recent data collected in 2022 and 2023 from background wells show similar pH and redox condition trends when compared to historical trends.

Historical pH measurements of groundwater from downgradient wells show near neutral pH. ORP, and DO measurements from downgradient wells exhibit a range of aerobic to anaerobic conditions; groundwater from CCR-AP-4, CCR-AP-6, CCR-AP-3, CCR-AP-8, and CCR-AP-2 exhibit aerobic conditions and generally lower concentrations of sulfate. Measured DO concentrations well above 0.5 milligrams per liter (mg/L) at downgradient wells CCR-AP-6 (screen zone: 35.5 to 45.5 feet), CCR-AP-3 (screen zone: 35.0 to 45.0 feet), CCR-AP-8 (screen zone: 35.5 to 45.5 feet), and CCR-AP-2 (screen zone: 36.0 to 46.0 feet) south of the EAP show potential influence by the Ohio River. Notably, influence by the Ohio River does not appear to extend to downgradient wells CCR-AP-6I and CCR-AP-8I (that have screening depths between 58.7 and 74.7 feet below bgs) based on measured ORP, DO, and sulfate values.

Table 4.1.1-1. Historical pH, ORP, and DO Measurements at Various Locations

Sampling Location	Monitoring Well	pH[1]	ORP (mV)[1]	DO (mg/L)[1]	Sulfate (mg/L)[1]
Background	CCR-AP-7	7.01 to 7.28	-145.63 to -49.71	0.05 to 0.47	70 to 99
	CCR-AP-1R	7.46 to 8.03	-75.77 to 79.42	1.09 to 6.45	150 to 250
	CCR-AP-9	6.97 to 7.85	-34.09 to 73.96	2.53 to 7.27	100 to 123
North of EAP	CCR-AP-4	6.58 to 7.13	-129.18 to -59.52	0.98 to 3.97	1.00 to 19
	CCR-AP-5	6.85 to 7.29	-90.00 to 69.25	0.05 to 1.11	431 to 1600
	CCR-AP-5I	6.79 to 7.16	-89.7 to 98.20	0.12 to 1.11	390 to 715
East of EAP	CCR-AP-11	6.50 to 7.53	-156.14 to -40.03	0.06 to 3.73	4.5 to 448
South of EAP	CCR-AP-6	7.06 to 7.43	-167.63 to -90.77	1.02 to 5.22	0.71 to 7.9
	CCR-AP-6I	6.99 to 7.29	-62.80 to -11.94	0.10 to 0.47	1212 to 1500
	CCR-AP-3	6.94 to 7.43	-150.01 to -33.74	1.05 to 4.98	0.65 to 2.2
	CCR-AP-8	6.73 to 7.09	-139.14 to -59.97	0.59 to 3.16	1.33 to 15
	CCR-AP-8I	6.73 to 6.98	-144.80 to -94.63	0.02 to 0.38	958 to 1100
	CCR-AP-2	6.55 to 7.72	-11.55 to 125.63	1.99 to 7.06	268 to 609

Notes:

1. Listed ranges are values within the 15th and 85th percentile.

EAP = East Ash Pond

ORP = oxidation-reduction potential

DO = dissolved oxygen

mV = millivolt

mg/L = milligrams per liter

I (AP-8I) = intermediate well

4.1.2 Groundwater Major Ion Composition

Geochemical signatures indicated by major ion composition can be used to evaluate groundwater recharge sources, discharge zones, and other inputs to constituent concentrations in groundwater. Geochemical signatures of background groundwater that has not been affected by the EAP system and of the CCR-affected groundwater are primarily differentiated by relative sulfate, chloride, and calcium concentrations. Each endmember represents a distinct geochemical signature that can be useful in understanding groundwater flow paths and mixing zones.

Geochemical characteristics of each endmember are as follows, as based on relative sulfate, chloride, and calcium concentrations:

- Background groundwater (groundwater that has not been affected by the EAP) is monitored at well clusters CCR-AP-7, CCR-AP-1R, and CCR-AP-9. CCR-AP-7 and CCR-AP-9 both demonstrate

relatively low sulfate and high calcium concentrations. CCR-AP-1R shows relatively low chloride concentrations.

- CCR-affected groundwater is monitored downgradient of the EAP, generally identified by relatively high sulfate and chloride concentrations and relatively low calcium concentrations.

Ternary diagrams displaying data of three key Appendix III constituents, sulfate, chloride, and calcium, are included on **Figures 2 and 3**. Samples containing all three constituents from locations associated with the EAP are plotted. The samples are displayed in units of percent milliequivalents per liter, which shows proportional concentrations of the plotted ions while taking the various ion charges into account. These units make the ions directly comparable, allowing them to be plotted on the same diagram. Approximate areas of upgradient and pond-adjacent wells are notated as colored fields on the ternary. **Figure 2** contains all samples that have sulfate, chloride, and calcium data and has been annotated to show the major endmembers, while **Figure 3** only contains samples from the November 2023 sampling event, and depicts boron concentration as circles of various diameters determined by the associated concentration.

Generally, the wells adjacent to the EAP split into two endmembers differentiated by relative sulfate, chloride, and calcium concentrations, with one group plotting near background and another representing the CCR-impacted groundwater endmember. Upgradient wells also show two endmembers differentiated by relative sulfate and calcium concentrations, with one group plotting near background and another plotting near the CCR-impacted signature. The presence of two apparent background signatures is likely due to the chemical difference between river water and groundwater, with the low sulfate background endmember representing the river water. Boron concentrations (circles) are used here as a tracer for CCR-impacted groundwater, and identify CCR-AP-2, CCR-AP-5/5I, CCR-AP-6I, and CCR-AP-8I as the most impacted locations.

4.1.3 Groundwater Quality Trends

Maximum values for historical concentrations and recent concentrations for lithium, molybdenum, and arsenic of select locations have been summarized in **Table 4.1.3-1** below. The groundwater protection standard (GWPS) for constituents at this Site were determined as the maximum value between the background threshold value and the maximum contaminant level (MCL)/regional screening level (RSL) as reported in the *Statistical Evaluation of the November 2023 Semi-annual Groundwater Assessment Monitoring Data Technical Memorandum* (Haley & Aldrich, 2024). Mann-Kendall trend analysis of lithium, molybdenum, and arsenic concentrations was completed at downgradient and background wells using the 12 most recent data points and all available data to determine statistical significance of observed trends. Plots are shown below in **Figures 4.1.3-1 to 4.1.3-3**. Generally, concentrations of lithium, molybdenum, and arsenic in downgradient groundwater have been stable or increasing over time. Among the downgradient wells, data of groundwater from CCR-AP-5 show strong decreasing lithium and molybdenum concentration trends.

Lithium concentrations in groundwater measured in November 2023 were highest in deeper wells (CCR-AP-6I and CCR-AP-8I). Lithium concentrations exceeded the GWPS of 0.04 mg/L (using MCL) at downgradient well CCR-AP-8I, which also shows an increasing lithium trend using the Mann-Kendall trend analysis. Lithium concentrations are identified as probably increasing at CCR-AP-2; however, concentrations were well below the respective GWPS of 0.23 mg/L (using interwell analysis). Decreasing lithium trends in downgradient wells were only identified at CCR-AP-5, which is located on the northern

border of the EAP. [1]No trends and [2]stable trends were identified in the remaining wells (CCR-AP-3, CCR-AP-4, CCR-AP-5I, CCR-AP-6, CCR-AP-6I, CCR-AP-8, and CCR-AP-11).

Recent measured molybdenum concentrations were highest and above the GWPS in groundwater from wells CCR-AP-5, CCR-AP-6I, and CCR-AP-8I. Molybdenum data from groundwater show a decreasing trend at CCR-AP-5, stable trend at CCR-AP-6I, and no trend at CCR-AP-8I. The most recent November 2023 measured molybdenum value at CCR-AP-6I is approximately 1.5-fold greater than the previous maximum in 2019 (0.83 mg/L) and two-fold greater than the June 2023 value (0.56 mg/L); the most recent value is significantly greater than previous values. No trend was determined at CCR-AP-8I using Mann-Kendall trend analysis, but concentrations have decreased from 0.83 mg/L in 2019 to 0.34 mg/L in 2023. Molybdenum concentrations are increasing at CCR-AP-2; however, concentrations are well below the GWPS of 0.1 mg/L (using MCL).

Recent measured arsenic concentrations were highest and show increasing trends at downgradient wells CCR-AP-4, CCR-AP-6, and CCR-AP-3. Concentrations at CCR-AP-4, CCR-AP-5, CCR-AP-6, CCR-AP-3, CCR-AP-8, and CCR-AP-2 are above the MCL of 0.01 mg/L but are well below their respective GWPS (using intrawell analysis). Increasing arsenic trends were also observed at CCR-AP-2, CCR-AP-5I, and CCR-AP-8. Arsenic concentrations exceeded the GWPS of 0.01 mg/L at downgradient well CCR-AP-11, which shows a stable arsenic trend using the Mann-Kendall trend analysis.

Table 4.1.3-1. Historical and Recent Concentrations of Lithium, Molybdenum, and Arsenic at Various Locations

Sampling Location	Monitoring Well	Lithium (mg/L)		Molybdenum (mg/L)		Arsenic (mg/L)		Boron (mg/L)	
		Historical Max	Nov 2023	Historical Max	Nov 2023	Historical Max	Nov 2023	Historical Max	Nov 2023
Background	CCR-AP-7	0.039	0.011	0.013	0.005	0.018	0.002	0.28	0.05
	CCR-AP-1R	0.23	0.12	0.023	0.005	0.038	**0.015***	0.86	0.74
	CCR-AP-9[1]	0.12	0.04	0.05	0.005	0.032	0.007	1	0.38
North of EAP	CCR-AP-4	0.05	0.007	0.01	0.005	0.33	0.19	1.6	1.6
	CCR-AP-5	0.15	0.07	0.53	**0.17**	0.025	0.022	68	7.5
	CCR-AP-5I	0.043	0.039	0.008	0.006	0.005	0.004	22	19
East of EAP	CCR-AP-11	0.057	0.003	0.03	0.005	0.059	**0.024***	1.3	0.37
South of EAP	CCR-AP-6	0.25	0.002	0.037	0.015	0.12	0.096	2.2	0.62
	CCR-AP-6I	0.33	**0.15***	1.3	**1.3**	0.005	0.005	24	24
	CCR-AP-3	0.05	0.004	0.025	0.025	0.095	0.089	0.27	0.21
	CCR-AP-8	0.05	0.005	0.15	0.019	0.12	0.065	8.4	0.035
	CCR-AP-8I	0.44	**0.43***	0.86	**0.34**	0.005	0.003	18	12
	CCR-AP-2	0.25	0.11	0.01	0.008	0.048	0.04	15	6.6

Notes:

1. Recent concentrations from 23 May 2023.

EAP = East Ash Pond

mg/L = milligrams per liter

Bold = exceeding the groundwater protection standard (GWPS) as determined by the Statistical Evaluation of the November 2023 Semi-annual Groundwater Assessment Monitoring Data Technical Memorandum (Haley & Aldrich, 2024). GWPS is the maximum value between the Background Threshold Values and the Maximum Contaminant Level/Regional Screening Level (MCL/RSL).

** = well data not used in November 2023 statistical evaluation, exceedance based on Maximum Contaminant Level.*

[1] A "no trend" was identified by a confidence in trend less than 90 percent and a Mann-Kendall Statistic trend analysis greater than 0 or a confidence in trend less than 90 percent, Mann-Kendall less than or equal to 0, and a coefficient of variation greater than or equal to 1

[2] A "stable trend" was identified by a confidence in trend less than 90 percent and a coefficient of variation less than 1.

Based on the Mann-Kendall trend analysis of measured lithium and molybdenum concentrations, it is possible increasing concentrations are a result of plume mobility from the EAP to the Little Pigeon Creek and the Ohio River. Concentrations of lithium and molybdenum are increasing at CCR-AP-2 which is downgradient of CCR-AP-5 where concentrations are decreasing. Overall lithium and molybdenum trends are stable and show a stable plume. Regarding arsenic, concentrations generally show increasing trends regardless of location. Therefore, arsenic concentration trends observed so far do not show an overall stable or shrinking plume. Additional sampling events are advised to strengthen trend observations and to determine the extent of plume potential.

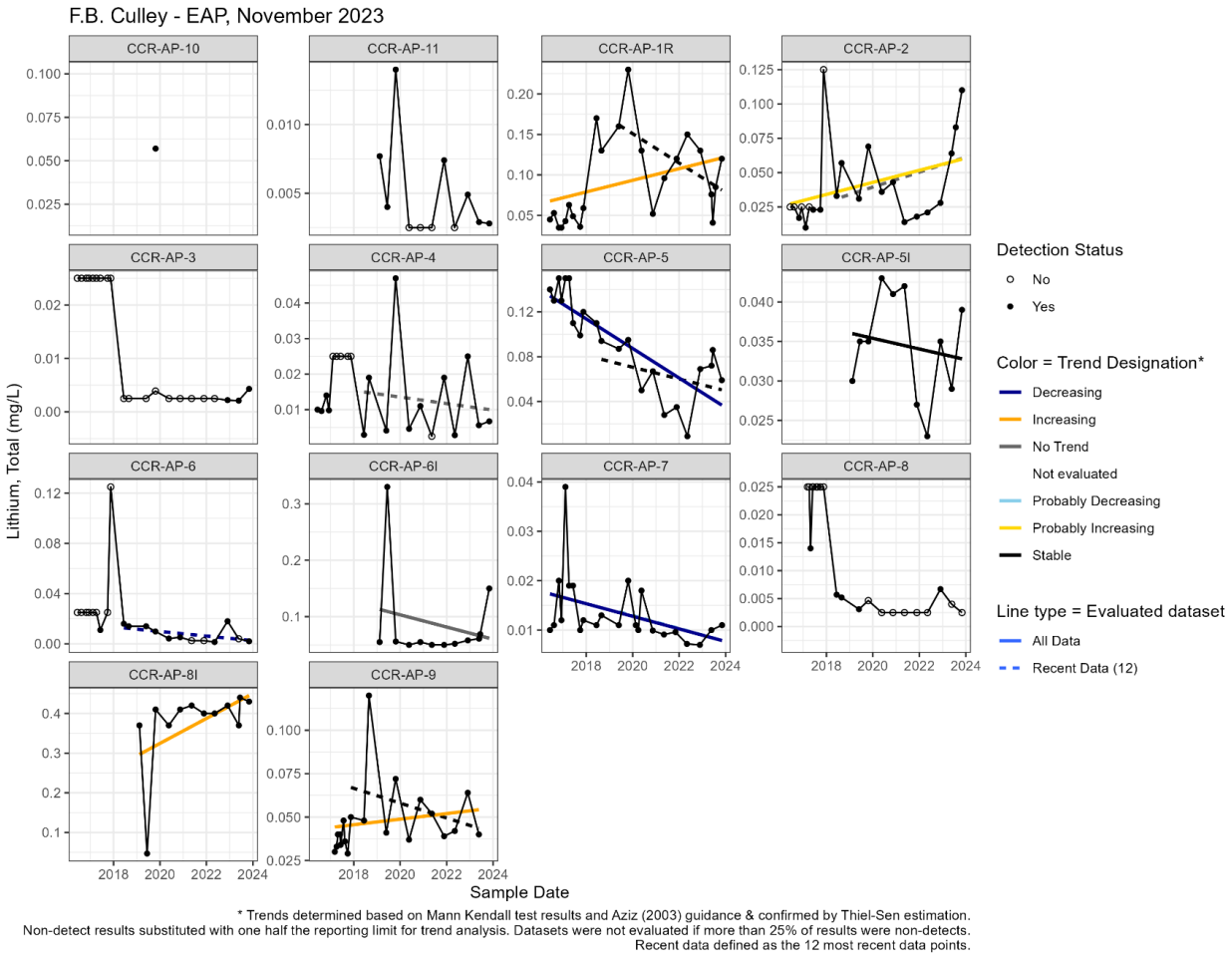


Figure 4.1.3-1. *Lithium Mann-Kendall Analysis Plots for Select Monitoring Wells*

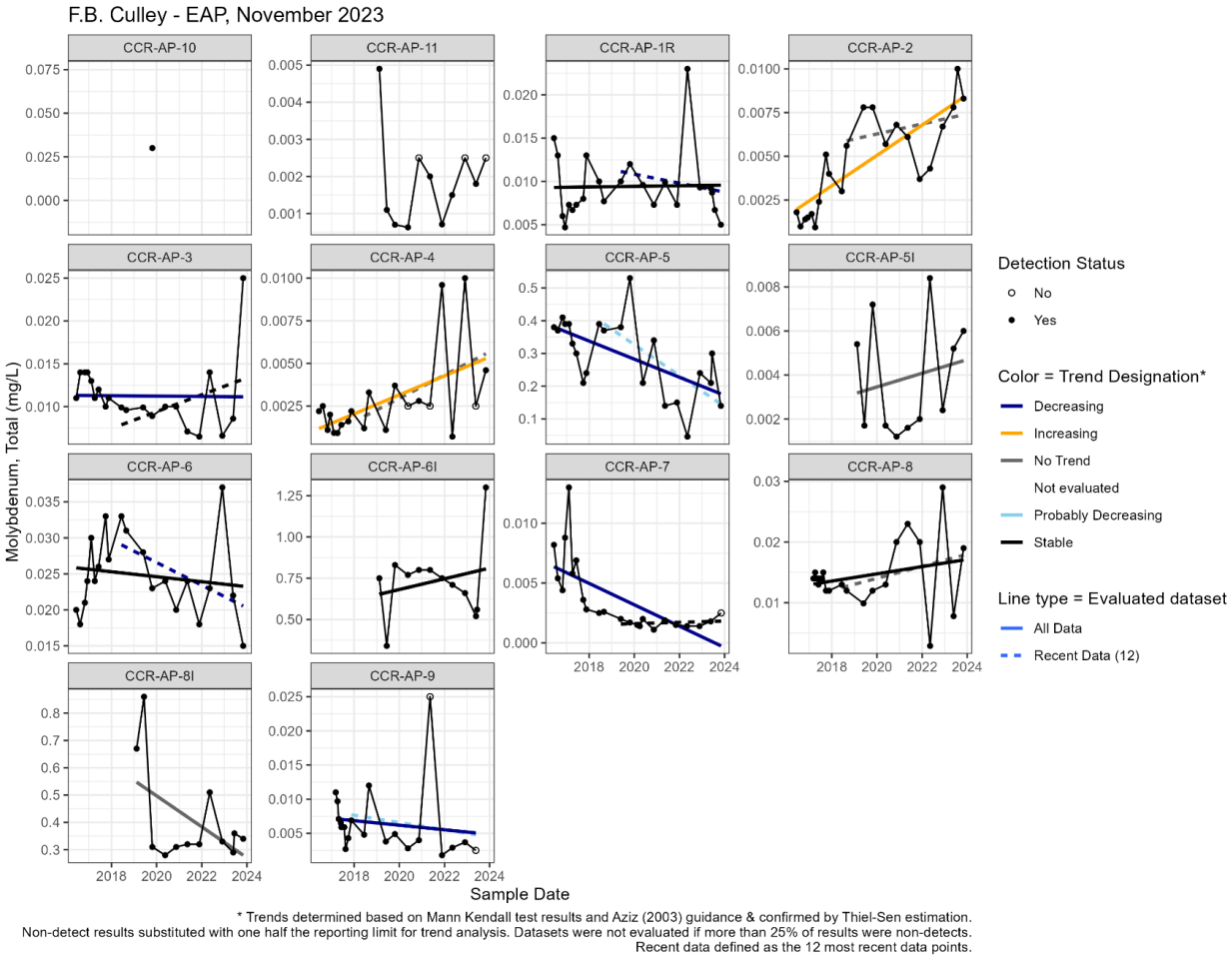


Figure 4.1.3-2. *Molybdenum Mann-Kendall Analysis Plots for Select Monitoring Wells*

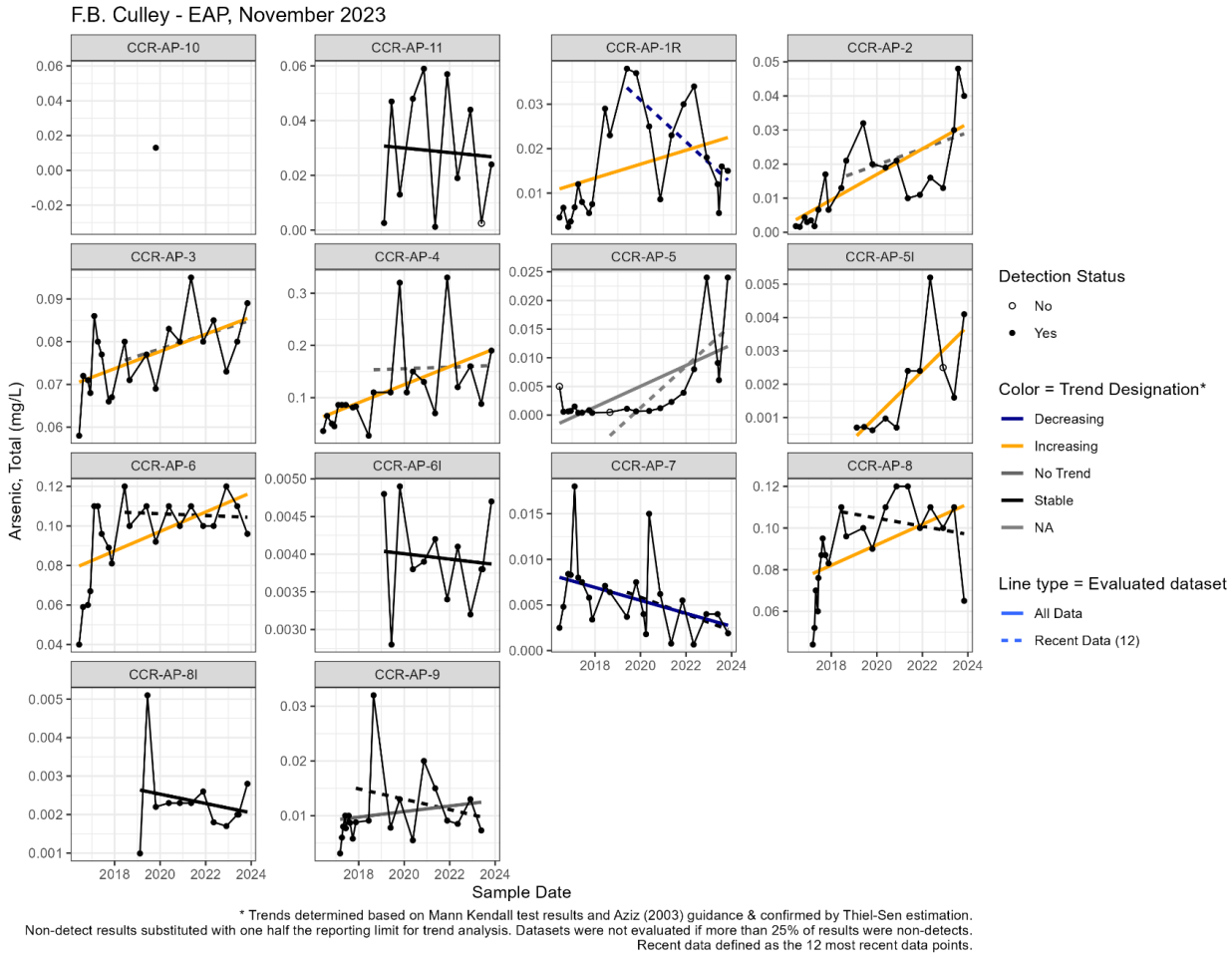


Figure 4.1.3-3. *Arsenic Mann-Kendall Analysis Plots for Select Monitoring Wells*

4.2 GEOCHEMISTRY OF AQUIFER SOLIDS

4.2.1 Sequential Extraction

Identification of the constituents that are liberated, locked, or adsorbed on sediment particles is fundamental to understanding their chemical and physical characteristics. These characteristics control the conditions and degrees to which the constituents and their compounds are mobile in the subsurface.

Sequential extraction is a common analytical method used to identify elements associated with solid phases in environmental media based on their reactivity with specific solutions. These techniques consist of a sequence of chemical methods that employ different extractants (of growing strength in each step) that allow for the correlation of each partial concentration with a mode of occurrence of the metal/metalloid in the soil (bound to iron oxides, carbonates, and organic matter).

The sequential extraction process employed involves six extraction steps as follows:

- Step 0: deionized water to flush readily mobilized metals.
- Step 1: extraction of exchangeable ions, (Tessier Method Step 1, Tessier et al., 1979).

- Step 2: extraction of metals bound to organic matter (Liang and Zhu, 2016) or that can desorb under a higher pH conditions (pH >8).
- Step 3: extraction of metals associated with carbonate minerals, (Tessier Method Step 2, Tessier et al., 1979).
- Step 4: extraction of metals associated with iron, aluminum, and manganese oxides (Chao and Zhou, 1983).
- Step 5: extraction of metals bound to sulfides (Liang and Zhu, 2016).
- Step 6: uses the USEPA Method 3050 solid digestion method to extract the remaining metals.

Soil samples were collected from five locations and were shipped to the ACZ Laboratories, Inc., for analysis. One sample, CMA-SB-01, was collected from within the pond area, while the other four samples were collected from the EAP perimeter. CMA-SB-01 contained elevated total molybdenum concentrations likely indicating a strong CCR chemical signature, further supported by the sample depth (54 to 55 feet) placing the sample in close proximity to CCR material. Laboratory reports are included in Appendix D, and graphical results of the sequential extraction analyses are presented on **Figure 4**.

All samples demonstrated weak aluminum and iron extractability, with the majority (greater than 75 percent) extracted during the solid digestion (Step 6). Molybdenum at CMA-SB-01 was primarily extracted from deionized water (Step 1), organics (Step 2), and sulfides (Step 5), with a combined extraction of approximately 75 percent of the total molybdenum. CCR-SB-AP8I showed moderate molybdenum combined extractability of approximately 54 percent from the deionized water and organic fractions. All other sample locations show low molybdenum extractability at less than 20 percent.

These results indicate that molybdenum has a moderate to weak association with organic and sulfide attenuation outside the pond area, and a strong attenuation signature within the pond area primarily controlled by organic material and sulfides present in aquifer solids. These results also indicate that a majority of the solid phase molybdenum within the pond area may not be integrated within crystal structures, and may possibly be remobilized.

4.2.2 Additional Chemical Data for Aquifer Solids

Additional analysis of aquifer solid chemical composition was completed at 6 locations, with the results presented in **Table 4.2.2-1**. Generally, metal concentrations are high within the pond area (HASB-1 and CMA-SB-01). Molybdenum soil concentrations within the pond area average 18.5 milligrams per kilogram (mg/kg), while the downgradient locations average 5.6 mg/kg. Background molybdenum concentrations from nearby United States Geologic Survey National Geochemical Database samples average 4.4 mg/kg possibly indicating that the sampled molybdenum soil concentrations downgradient of the EAP are naturally occurring, and may be contributing to concentrations in groundwater.

TOC results from HASB-1 are very high due to the sample material being coal ash. Other TOC values collected from CCR-AP-6I and CCR-AP-8I average 5,000 mg/kg, and is considered to be moderate to high in concentration. These TOC data show a moderate TOC-related adsorption capacity downgradient of the EAP and are consistent with sequential extraction results.

Table 4.2.2-1. Summary of Soil Analytical Results						
Analyte (mg/kg)	**CCR-AP-6I** (68-70 ft) 11/16/2018	**CCR-AP-8I** (68-70 ft) 11/15/2018	**HASB-1** (35-38 ft) 11/16/2018	**CCR-SB-AP6I** (68.5-70 ft) 06/16/2023	**CCR-SB-AP8I** (63-64 ft) 06/14/2023	**CMA-SB-01** (50-51 ft) 06/15/2023
Aluminum	--	--	--	**1400**	**1000**	**13000**
Antimony	0.24	0.24	**0.96**	--	--	--
Arsenic	**3.3**	**3.3**	**18**	--	--	--
Barium	**18**	**8**	**32**	--	--	--
Beryllium	**0.14**	**0.13**	**0.93**	--	--	--
Cadmium	**0.06**	**0.04**	**3.5**	--	--	--
Chromium	**4.9**	**4.7**	**29**	--	--	--
Cobalt	**4**	**2.5**	**13**	--	--	--
Iron	--	--	--	**10000**	**3000**	**29000**
Lead	**2.8**	**2.6**	**23**	--	--	--
Lithium	--	--	--	**2.4**	**2**	**19**
Manganese	--	--	--	**220**	**59**	**840**
Mercury	0.037	0.039	0.064	--	--	--
Molybdenum	**3.1**	**12**	**25**	**6.7**	**0.77**	**12**
Selenium	0.59	**0.089**	**9.8**	--	--	--
Thallium	**0.039**	**0.035**	**1.1**	--	--	--
TOC	**3,600**	**6,400**	**200,000**	--	--	--

Notes:
mg/kg = milligrams per kilogram
ft = feet
TOC = Total Organic Carbon
-- = Not Analyzed
Bold = detected value

Molybdenum soil concentrations were compared to other measured soil constituents, and no apparent correlations were observed. Additional sampling of background soil and Site soil where reduced groundwater may be present may reveal natural mineralization relevant to CCR constituents, such as molybdenite. The presence of such mineralization would have implications for CMA as evidence of past natural attenuation, and improved feasibility for implementation of attenuation though treatment methods.

4.2.3 Constituents of Concern Desorption from Aquifer Solids

Two soil slurry samples were used to conduct a three-step abiotic desorption study to evaluate soil as a potential secondary source. All slurry samples were prepared in an argon-purged glove box to minimize the exposure to oxygen during the experiment. The desorption test procedure is briefly described below and additional details are included in Appendix A:

1. Each slurry sample was prepared using 10 grams of aquifer solids and 40 milliliters (mL) of groundwater. This mass and volume filled the sample bottle completely, thus eliminating any headspace in the bottle during extraction. Solids from CCR-AP-6I and CCR-AP-8I and groundwater from CCR-AP-1R were used to construct Slurry Sample 1 and Slurry Sample 2, respectively.
2. The slurry samples were subject to agitation for 24 hours to enhance mass transfer between the aqueous and solid phase. After 24 hours, the liquid fraction was extracted and filtered using a 0.45-micron filter to measure the molybdenum and lithium concentrations in the extracted liquid (or leachate) to assess the extent of the first-step desorption of aquifer solids. Slurry Sample 1 and

Slurry Sample 2 were replenished with fresh groundwater from CCR-AP-1R to prepare for the second-step desorption.

3. The step above was repeated to assess the molybdenum, lithium, and boron concentrations in the extracted liquid to assess the extent of the second-step and third-step desorption of aquifer solids.

The desorption test is summarized in **Table 4.2.3-1**. The key findings are summarized below:

- The first-step leachate concentrations for lithium, and molybdenum are near or well below the lithium and molybdenum MCL of 0.04 mg/L and 0.1 mg/L, respectively. This indicates that the aquifer solids in the downgradient area are not expected to serve as a long-term source to sustain groundwater impact. Elution lithium concentrations were below concentrations observed in groundwater from CCR-AP-1R; therefore, lithium adsorption partitioning constant (Kd) values were not determined.
- Using the method presented on **Figure 4.2.3-1**, the estimated molybdenum Kd values are between 1.6 and 1.8 liters per kilogram. The equivalent solid phase molybdenum concentration is calculated by subtracting the groundwater concentration from the third step leachate concentration and multiplying by the volume of groundwater (0.04 liters) over the weight of soil (0.01 kilograms) used in the slurry.

Table 4.2.3-1. Desorption Test Results

Desorption Testing, mg/L	Testing Step	Analyte	CCR-AP-1R	Slurry 1	Slurry 2
	Desorption Step 1 Elution 1 (24 hours later)	**Mo**	<0.010	0.16	0.080
		Li	0.039	0.027	0.036
		B	0.56	1.07	1.11
		pH, S.U.	7.34	8.13	7.83
	Desorption Step 2 Elution 2 (48 hours later)	**Mo**	<0.010	0.057	0.030
		Li	0.039	0.032	0.029
		B	0.56	0.63	0.68
		pH, S.U.	7.34	7.96	7.96
	Desorption Step 3 Elution 3 (72 hours later)	**Mo**	<0.010	0.050	0.022
		Li	0.039	0.034	0.027
		B	0.56	0.62	0.65
		pH, S.U.	7.34	8.08	8.05

Notes:
B: boron
Li = lithium
Mo = molybdenum
S.U. = standard units

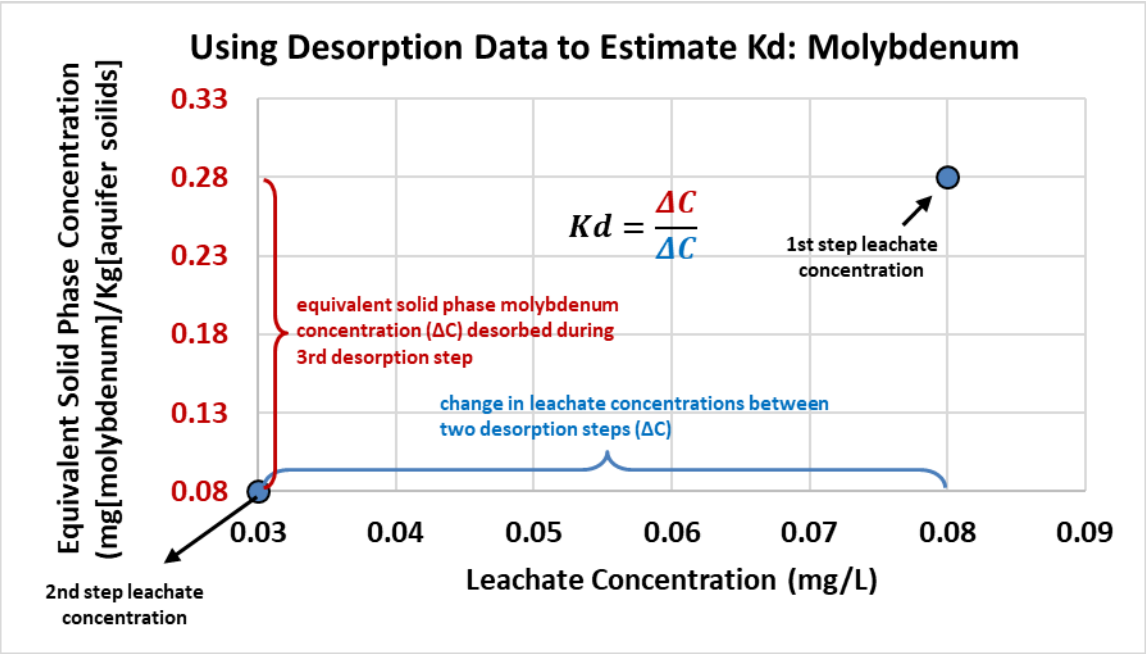


Figure 4.2.3-1. *Example Molybdenum Kd Estimations Using Desorption Data for Slurry 2*

4.2.4 Constituents of Concern Sorption to Aquifer Solids

Two soil slurry samples were used to conduct a 72-hour sorption test to measure adsorption by native soils. Prior to tumbling samples during testing, Slurry 2 was spiked with a target concentration of 1.5 mg/L of molybdenum, resulting in a baseline molybdenum concentration of 1.33 mg/L.

The sorption test showed lithium was weakly adsorbed by native soils when groundwater from CCR-AP-6I was used for the Slurry 1 test. Testing of Slurry 1 did not show molybdenum or lithium adsorption to soils, as the tested aquifer solids released lithium and molybdenum to increase the lithium and molybdenum concentrations in the liquid phase. The Slurry 2 test resulted in 0.11 micrograms of lithium adsorbed per gram of soil, which was 28 percent lithium adsorbed; negligible molybdenum mass in the liquid phase was partitioning to the aquifer solids in Slurry 2. The results show that only minimal to negligible molybdenum attenuation is expected to occur under tested conditions (i.e. no active treatment).

4.3 CHEMICAL SPECIATION

4.3.1 Field Analysis

Dissolved arsenic in groundwater systems is typically stable in the trivalent state As(III) (arsenite, often expressed as $HAsO_2$) or the pentavalent state As(V) (arsenate, often expressed as the oxyanions $HAsO_4^{--}$ and $H_2AsO_4^-$). In general, As(V) is less mobile and more readily attenuated compared to As(III) under acidic to circumneutral pH; however, this generalization is dependent on other variables such as the presence of other ionic species (Campbell and Nordstrom, 2014).

Samples collected from eight monitoring locations during the fall 2018 sampling event were analyzed for arsenic speciation, with the results included in **Table 4.3.1-1**. Arsenic is primarily speciated as arsenite;

however, substantial concentrations of arsenate were also detected. These results indicate that arsenic speciation may be susceptible to kinetic limitations of arsenic oxidation (the time it takes for arsenite in CCR porewater to oxidize in an arsenic-oxidizing environment) or the precision of field redox measurements. Arsenite is less strongly attenuated to aquifer solids when compared to arsenate.

Table 4.3.1-1. Arsenic Results

Monitoring Location	As(III) (µg/L)	As(V) (µg/L)
CCR-AP-2	3.1	2.1
CCR-AP-3	5	1.2
CCR-AP-4	5.2	0.76
CCR-AP-5	1.2	1.7
CCR-AP-5	1.2	0.85
CCR-AP-6	14	2.2
CCR-AP-6I	5	1.9
CCR-AP-8	6.7	0.86
CCR-AP-8I	1.2	1.4

Notes:
µg/L = micrograms per liter
ND = Not Detected
As(III) = arsenite
As(V) = arsenate

4.3.2 General Pourbaix (Eh-pH) Diagrams

A Pourbaix diagram, also known as an Eh-pH diagram, is a plot of thermodynamically stable phases (at chemical equilibrium) of a sampled geochemical system. The diagrams use chemical activities of chemical species to determine the range of Eh and pH at which a species is stable, which is then represented by a labeled polygon or region. Both solid phase and liquid phase (light orange and blue regions, respectfully, as shown on **Figure 4.3.2-1**) are considered as based on availability of thermodynamic data and the thermodynamic database used.

Eh-pH diagrams are a well-established and useful tool for understanding geochemical aspects of a system. They are subject to some limitations described here. Most predominately, species shown in Eh-pH diagrams are limited by the thermodynamic database used. This limitation is minimized by using databases that best apply to the geochemical system analyzed. Eh-pH diagrams only represent chemical equilibrium. Additional kinetic analysis would increase model certainty, allowing for the simulation of non-idealized scenarios. Furthermore, while any sample with an Eh and pH can be plotted on any diagram, the plotted locations of those samples may not be exactly accurate. This is because the diagram itself is defined by a specific chemical system (i.e., the input chemical activities), which may not apply to the plotted samples. Due to this uncertainty, the scatter data of samples collected from different locations/times than the sample used to define the diagram are recommended to be understood as estimations. This uncertainty is addressed through the use of visually displaying estimated sample fields (as opposed to points), that represent approximate ranges of conditions found at the Site.

All Eh-pH diagrams were created with Geochemist's Workbench ([GWB]; Bethke, 2008). Eh values are calculated from field ORPs based on instrument manufacturer specification. The thermo_minteq database was used to produce all diagrams. The chemical activities used in development of the Eh-pH diagrams were calculated from CCR-AP-6I data collected on 13 June 2023 using GWB. This specific

sample was chosen through consideration of both data availability and the age of the data used. Given the kinetic limitations of the precipitation of hematite, magnetite, and goethite, these minerals were suppressed in the formation of the iron Eh-pH diagram. The Eh-pH diagrams for arsenic molybdenum, lithium, and iron are included on **Figure 4.3.2-1**.

Arsenic speciation in Site groundwater is predicted to currently exist entirely in the dissolved phase, speciating as protonated arsenate ($H_2AsO_4^-$, $HAsO_4^{--}$), and protonated arsenite ($HAsO_{2(aq)}$) in the more reduced samples. This is generally consistent with the arsenic speciation results (**Table 4.3.1-1**). Further decrease in ORP of the groundwater may result in direct arsenic precipitation in the form of the minerals orpiment or arsenopyrite; however, the stability of precipitation of these minerals is tightly constrained by a narrow Eh range. Therefore, observed arsenic concentrations in groundwater will likely be primarily dependent on other processes such as dilution/dispersion and adsorption.

Molybdenum speciation in Site groundwater is predicted to currently exist entirely in the dissolved phase, speciating as aqueous calcium molybdate. Solid phase molybdenum is only favored to form under more reduced conditions (sulfate reducing conditions) as molybdenum disulfide (molybdenite).

Lithium speciation in Site groundwater is predicted to currently exist entirely in the dissolved phase, speciating as lithium cation. No solid phase lithium is favored to form at any Eh or pH conditions. The reactivity of lithium will not likely be a substantial contributor to constituent removal. Lithium attenuation will likely instead rely on physical processes such as dilution.

Iron speciation in Site groundwater is thermodynamically favored to exist in the solid ferric phase as ferrihydrite, with the predominant liquid phase being ferrous sulfate in the more reduced/acidic subsurface locations. While iron precipitation is thermodynamically favored, mineral formation may be kinetically limited. Further decrease in the groundwater Eh is expected to result in the formation of pyrite or siderite. The precipitation of iron oxides provides adsorption sites for molybdenum and arsenic; however, this process is limited by the amount of iron or oxygen available to form iron oxides. Adsorption of CCR-constituents onto iron oxides would reduce their concentrations in groundwater.

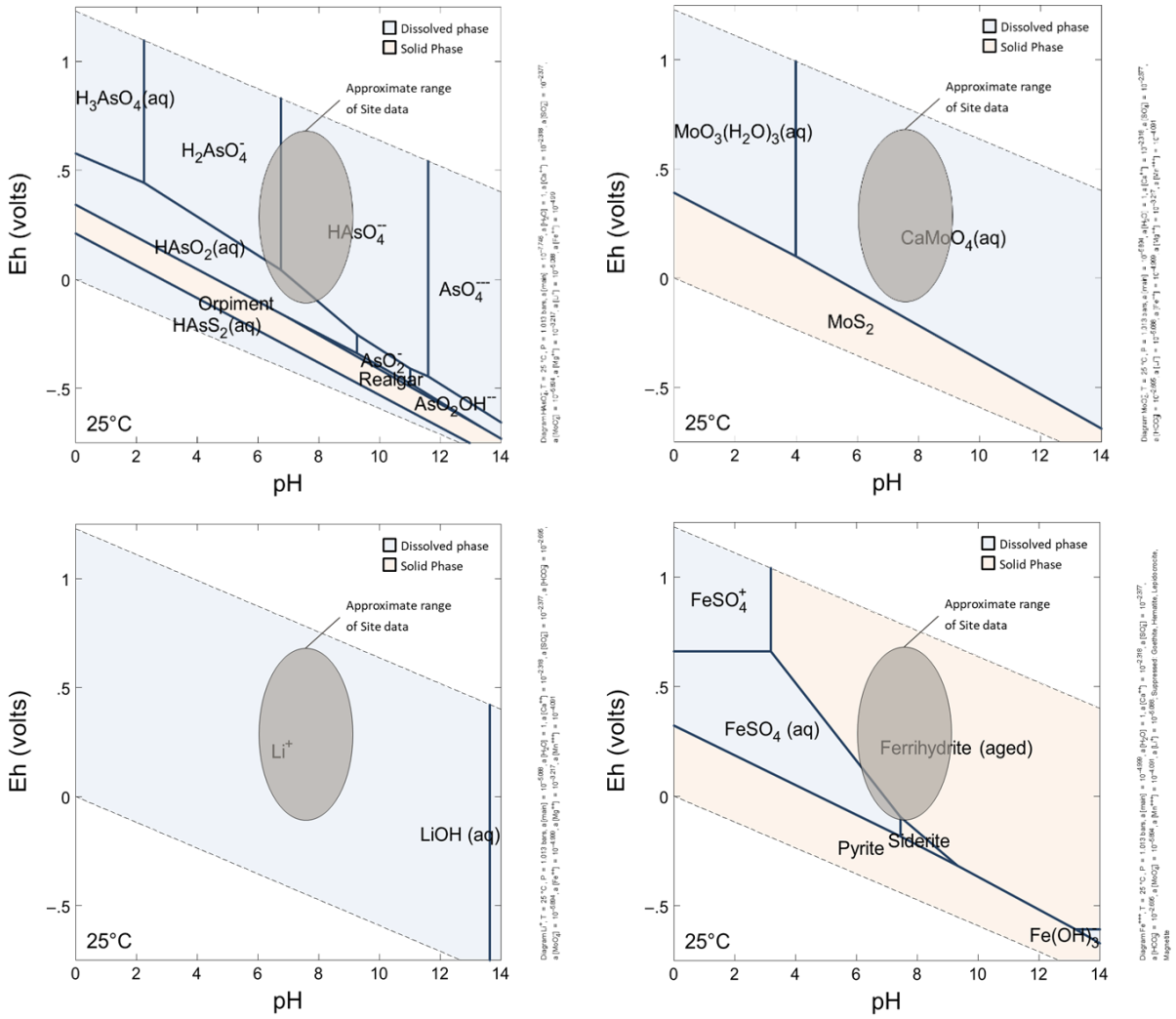


Figure 4.3.2-1. *Eh-pH Diagrams*

Notes:

Diagrams show chemical speciation of MW-6I from 13 June 2023.
Diagrams were created using GWB with the thermo.com.V8.R6+ database.
Kinetically limited iron minerals suppressed.

4.4 MICROBIOLOGICAL EVALUATION

4.4.1 Microbial Community and Functional Genes Analysis

Groundwater geochemical conditions are often a result of both abiotic and biotic reactions occurring in aquifers. The knowledge of the indigenous microbial community composition in the Site aquifer may help identify and support key biogeochemical processes responsible for attenuation of the Site constituents of concern such as molybdenum.

Groundwater samples were collected as previously discussed in Section 3.2 from wells CCR-AP-6I and CCR-AP-8I for the microbial community and functional genes assessment. The rationale of microbial sample collection is provided below:

- Aquifer biogeochemical conditions downgradient of the EAP at a screening zone between approximately 59 and 69 feet.
  - CCR-AP-6I is on the southwest boundary of the EAP. In a sample collected in November 2023, the total lithium and molybdenum concentration in CCR-AP-6I were 0.15 and 1.3 mg/L, respectively.
  - CCR-AP-8I is on the southeast boundary of the EAP. In a sample collected in November 2023, the total lithium and molybdenum concentration in CCR-AP-8I were 0.43 and 0.34 mg/L, respectively.

Microbial community analysis using the Next Generation Sequencing was conducted on groundwater samples from monitoring wells to detect sequences of certain genes and help identify types of microorganisms present in the samples down to the genus and/or species level. These results are discussed in Section 4.4.2.

4.4.2 Microbiological Results

The detailed microbial testing results produced by Microbial Insights, Inc. are provided in Appendix E. The key results are summarized in **Table 4.4.2-1**. The microbial results were assessed according to the spatial variations of microbial community compositions and the potential of microbial processes that currently help or may be enhanced for arsenic and molybdenum attenuation.

Table 4.4.2-1. Microbial Community Assessment

Sampling Location / Microbial Parameter	CCR-AP-6I	CCR-AP-8I
% of Anaerobic and/or Anoxic Bacteria[1]	32.3	33.6
% of Sulfate Reducing Bacteria[2]	11.1	11.7
% of Iron Reducing Bacteria[2]	1.8	2.3
% of Aerobic and Microaerophilic Bacteria[3]	9.0	17.3

Notes:

1) *The percentages only contain identified genera exceeding 0.2 percent (%) of total sequence reads through the next generation sequencing; only bacterial genera that are primarily obligately anaerobic or anoxic are included; facultatively anaerobic bacteria are excluded.*
2) *Genera are included in percent of anaerobic and/or anoxic bacteria.*
3) The percentages only contain identified genera exceeding 0.2 percent of total sequence reads through the next generation sequencing; only bacterial genera that are primarily aerobic or microaerophilic are included; facultatively anaerobic bacteria are excluded.
4) *% = Percent*

Table 4.4.2-1 summarizes that the population percentages of anaerobic/anoxic bacteria are considerably more abundant than the populations percentages of aerobic and/or microaerophilic bacteria; further supporting that redox conditions in groundwater from wells CCR-AP-6I and CCR-AP-8I are anoxic/anaerobic. These results are consistent with the low DO concentrations and negative ORP values observed at these deeper wells.

A considerable percentage, above 11 percent, of the identified microbial population were classified as sulfate-reducing bacteria in groundwater samples from CCR-AP-6I and CCR-AP-8I. The significant percentage of sulfate-reducing bacterial populations at both sampling locations suggests the presence of

some baseline sulfate-reducing activity within the deeper aquifer zones of the downgradient area. Soluble sulfides, the terminal products of microbially-mediated sulfate reducing reactions, were not directly measured at either location. However, a total sulfide concentration of 43 mg/L was measured at CCR-AP-6I; this supports the presence of sulfate-reducing activity. Sulfate-reducing activity would likely not be limited by sulfate concentration given that both locations have measured concentrations greater than 0.5 mg/L (general minimum requirement for sulfate-reduction). Sulfate-reducing activity would likely be limited by availability of readily degradable organic compounds in groundwater.

The percentages of the iron reducing bacterial populations were significantly lower than sulfate reducing bacterial populations at these two locations. The identified percentages of iron reducing bacteria were 1.8 and 2.3 percent in CCR-AP-6I and CCR-AP-8I, respectively. Measurements of ferrous iron, a product of microbially-mediated iron reduction, were not available to support the occurrence of iron reduction at these locations. Dissolved iron measurements, containing bioavailable forms of iron such as soluble ferrous iron and ferric iron, were observed on 13 June 2023 at CCR-AP-6I and CCR-AP-8I at concentrations of 1.1 and 17 mg/L, respectively. Under reducing conditions, ferrous iron is the dominant form in the dissolved phase further indicating the potential for iron reducing activity in the downgradient area. Dissolved iron has also been measured in shallow groundwater at these location (42 mg/L at CCR-AP-6 on November 2018 and 88 mg/L at CCR-AP-8 on 16 November 2018) and upgradient of the EAP (2.6 mg/L at CCR-AP-5 on 13 June 2023) indicating iron reducing reaction may occur in shallower aquifer zones and upgradient areas. The presence of iron-reducing populations in downgradient wells CCR-AP-6I and CCR-AP-8I suggests that iron reducing reactions may occur throughout the EAP area.

The stable populations of sulfate-reducing bacteria in addition to high sulfate concentrations in groundwater indicate that some extent of microbially mediated sulfate-reducing reactions may occur. The detection of sulfide in downgradient groundwater suggests that molybdenum in the plume may have been attenuated through the formation of molybdenum disulfides in impacted areas where the sulfate reducing activity is stronger.

Limitations on sulfate reduction, if any, are likely caused by organic substrate availability which are required for the growth of many sulfate-reducing bacteria. Since the presence of sulfate-reducing bacteria in the deeper impacted groundwater is common, it is expected that an addition of organic substrate to impacted groundwater can enhance precipitation formation of molybdenum disulfides, thereby, lowering molybdenum concentrations.

The microbial data collected from CCR-AP-6I and CCR-AP-8I provide the evidence below to support the occurrence and potential enhancement of attenuation processes for molybdenum in downgradient groundwater.

- A stable population of sulfate reducing bacteria was found in downgradient groundwater; sulfate-reducing conditions may occur and attenuate molybdenum in impacted groundwater through precipitation formation of molybdenum disulfides.
- Addition of organic substrate to impacted groundwater is expected to increase the sulfate reducing bacterial population and result in more attenuation of molybdenum through promoting the formation of molybdenum disulfides.

5. Laboratory Treatability Tests

5.1 MICROCOSM TEST OF MOLYBDENUM PRECIPITATION

Several different redox manipulation methods for immobilization of molybdenum were tested using microcosm containing Site groundwater from CCR-AP-1R (see details in Appendix A) and soil from two different locations (CCR-AP-6I and CCR-AP-8I; see details in Appendix A). The soil sampling locations south of the EAP were selected due to their downgradient location and concentrations of molybdenum and lithium. The purpose of testing was to evaluate in-situ anaerobic sulfate-reducing activity for molybdenum precipitation, as well as potential lithium attenuation.

5.1.1 Materials and Methods

Soil and groundwater samples were sampled as previously discussed in Sections 3.1 and 3.2. The samples were prepared under non-aerobic conditions (in an inert gas-purged anaerobic chamber) and were kept under these conditions for the duration of the test. To assess precipitation of molybdenum and attenuation of lithium, two soil and groundwater slurries were established as described in **Table 5.1.1-1**. The two slurries were tested under the following four conditions as follows:

- **Microcosm 1**: Control (No molybdenum, no nutrient added).
- **Microcosm 2**: Molybdenum spiked (approximately 1.5 mg/L) with edible vegetable oil (EVO) (1 gram per liter [g/L]) and macro-nutrients (1 g/L).
- **Microcosm 3**: Molybdenum spiked (approximately 1.5 mg/L) with EVO (1 g/L), macro-nutrients (1 g/L), and sulfate (250 mg/L).
- **Microcosm 4**: Molybdenum spiked (approximately 1.5 mg/L) with EVO (1 g/L), macro-nutrients (1 g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture.

Table 5.1.1-1. Microcosm Conditions

Microcosm ID	Groundwater Location	Soil Location	Soil Depth (feet)	Mo	EVO and Macro-Nutrients	Sulfate	Sulfate-Reducing Microbial Culture
Slurry 1 Microcosm 1	CCR-AP-6I	CCR-AP-1R	65 to 67	No	No	No	No
Slurry 1 Microcosm 2				Yes	Yes	No	No
Slurry 1 Microcosm 3				Yes	Yes	Yes	No
Slurry 1 Microcosm 4				Yes	Yes	Yes	Yes
Slurry 2 Microcosm 1	CCR-AP-8I	CCR-AP-1R	60 to 63	No	No	No	No
Slurry 2 Microcosm 2				Yes	Yes	No	No
Slurry 2 Microcosm 3				Yes	Yes	Yes	No
Slurry 2 Microcosm 4				Yes	Yes	Yes	Yes

Notes:
Mo = molybdenum
EVO = edible vegetable oil

Microcosms were prepared as described in Appendix A and were periodically sampled for molybdenum and lithium. Secondary parameters indicative of iron and sulfate-reducing conditions were also measured, including iron, sulfur, and pH.

5.1.2 Treatability Test Results

Anaerobic sulfate-reducing activity for arsenic and molybdenum precipitation and potential lithium attenuation was assessed under various conditions. Generally, measured pH values from the treated microcosms conditions were between 4.89 and 5.86 standard units (S.U.) on day seven and increased to between 6.29 and 7.36 S.U. by day 78. Lower pH values were observed in microcosms containing soil from CCR-AP-6I than the CCR-AP-8I equivalents. The initial measured lower pH values likely resulted from fast fermentation of EVO by native (bacteria contained in the soil and groundwater) and bioaugmented (bacteria contained in the sulfate-reducing culture) bacterial communities. Samples from treated microcosms containing soil from CCR-AP-8I showed generally decreasing concentrations of sulfur indicative of sulfate reducing activity.

The addition of EVO, macro-nutrients, sulfate, and sulfate-reducing bacteria created reducing conditions for stabilization of molybdenum. Addition of each amendment (EVO, sulfate, and sulfate-reducing culture) had a compounding impact on treatment time in microcosms containing soil from CCR-AP-8I but did not affect the final concentration of molybdenum (less than or equal to 0.010 mg/L on day 36). Slower treatment times and higher final molybdenum concentrations were observed in microcosms with soil from CCR-AP-6I. DO, ORP, and sulfide indicators of redox conditions were not measured during the experiment; therefore, it cannot be confirmed that redox conditions may have affected the extent of molybdenum precipitation in microcosms containing soil from CCR-AP-6I. Removal below the molybdenum detection limit (0.01 mg/L) was observed in microcosms containing soil from CCR-AP-8I in 36 days, while greater than 96 percent molybdenum removal was achieved in microcosms containing soil from CCR-AP-6I in 78 days.

Regarding lithium attenuation, final lithium concentrations were lower than starting concentrations in the microcosm that received amendments (Microcosms 2-4). However, lithium concentrations in the microcosms without amendments (Microcosm 1) also decreased; therefore, lithium removal was likely not a result of microbial activity.

Microcosms containing soil from CCR-AP-6I and CCR-AP-8I and groundwater from CCR-AP-1R were receptive to biostimulation (addition of amendments) alone and in combination with bioaugmentation (addition of sulfate-reducing culture) showing an approximate 96 to 100 percent decrease in measured concentration of molybdenum. These preliminary results indicate locations downgradient of the EAP in the deeper aquifer zones may be receptive to biostimulation with an organic substrate. An official laboratory report is included in Appendix A.

5.1.3 Aerobic Desorption (Leaching) Testing for Microcosms

After 78 days of treatment, microcosm samples (4 grams of soil and 40 mL of groundwater) underwent aerobic desorption (or leaching) testing to assess the stability of molybdenum in an aerobic environment using aerated groundwater from CCR-AP-1R with a DO concentration of 8.83 mg/L. The liquid from each microcosm was decanted and discarded, and a subsample of the remaining solids was collected and measured for total metal concentrations following the soil compositional analysis test outlined in Appendix A.

The desorption test is summarized in **Table 5.1.3-1** and **Table 5.1.3-2**. The key findings are summarized below:

- If both slurries molybdenum continued to leach out of solids at each step; the results indicates that if anaerobic conditions change to aerobic, molybdenum will re-mobilize.
- When exposed to groundwater with 8.83 mg/L DO, molybdenum desorbed/mobilized between approximately 47 and 73 percent when introduced to aerated groundwater.
- The amounts of mobilized/desorbed molybdenum during the second and third aerobic desorption steps were considerably lower than the amounts during the first elution.
- DO concentrations where molybdenum concentrations exceed the GWPS (CCR-AP-5, CCR-AP-6I, and CCR-AP-8I) are significantly lower (15 to 85 percentile DO range: 0.02 to 1.11 mg/L); therefore, a lower percentage of molybdenum remobilization can be expected at these locations. Assuming a representative DO concentration in the 85th percentile, approximately 9 percent reduced molybdenum would desorb/mobilized. Therefore, concentration of desorbed/mobilized molybdenum due to aerobic conditions are not expected to exceed GWPS throughout the whole desorption/mobilization process under the Site conditions.

Table 5.1.3-1. Aerobic Desorption (Leaching) Test Results for Slurry 1

Desorption Testing (mg/L)	Desorption Step	Analyte	CCR-AP-1R	Microcosm 1	Microcosm 2	Microcosm 3	Microcosm 4
	Elution 1 (24 hours later)	**Mo**	0.010	0.25	0.66	0.66	0.56
		pH, S.U.	7.34	8.05	8.28	8.15	8.30
	Elution 2 (48 hours later)	**Mo**	0.010	0.16	0.16	0.16	0.13
		pH, S.U.	7.34	8.00	7.96	8.07	8.15
	Elution 3 (72 hours later)	**Mo**	0.010	0.095	0.098	0.086	0.074
		pH, S.U.	7.34	7.95	7.86	7.82	7.96

Notes:
mg/L = milligrams per liter, Mo = molybdenum, and S.U. = standard units.

Table 5.1.3-2. Aerobic Desorption (Leaching) Test Results for Slurry 2

Desorption Testing (mg/L)	Desorption Step	Analyte	CCR-AP-1R	Microcosm 1	Microcosm 2	Microcosm 3	Microcosm 4
	Elution 1 (24 hours later)	**Mo**	0.010	0.21	0.27	0.23	0.25
		pH, S.U.	7.34	7.89	7.85	7.88	7.77
	Elution 2 (48 hours later)	**Mo**	0.010	0.057	0.064	0.060	0.053
		pH, S.U.	7.34	8.04	8.00	8.01	7.81
	Elution 3 (72 hours later)	**Mo**	0.010	0.034	0.033	0.034	0.029
		pH, S.U.	7.34	7.94	7.71	7.71	7.73

Notes:
mg/L = milligrams per liter, Mo = molybdenum, and S.U. = standard units.

6. Evaluation Using Geochemical Modeling

6.1 MODELING APPROACH

A basic geochemical equilibrium model was developed using available CCR-AP-6I aqueous data collected on 13 June 2023. The model consists of reaction balancing and precipitation threshold determination based on controlling variables such as species activities, temperature, pH, and Eh. The geochemical model has incorporated available Site-specific conditions to support the corrective measures process. This information was completed using the following GWB applications: GSS (used to hold, manipulate, and graph the results of water chemistry analyses); SpecE8 (used to calculate chemical activities), and Rxn (used for reaction balancing and equilibrium constant calculation).

6.2 MODEL RESULTS

Stoichiometric calculations were completed to assess chemical proportions of ions potentially used in corrective measures. Removal of CCR-affected constituents through precipitation depends on the chemical availability of the chemical components involved in the desired precipitation reaction, and aquifer pH and Eh. Ions evaluated in this assessment include molybdate, sulfate, hydrogen (pH), and oxygen (Eh). Molybdenite precipitation is a known remedy for molybdenum in groundwater, which requires abundant sulfide (sulfate reducing conditions) and molybdate in order to form. The following chemical reaction produced by GWB Rxn describes the components involved in the precipitation of molybdenite:

$$MoO_4^{--} + 24H^+ + 18e^- + 2SO_4^{--} \rightleftharpoons MoS_{2(molybdenite)} + 12H_2O$$

When molar concentrations are converted to mg/L, this reaction indicates that the precipitation of 1 mg/L molybdenum (in the form of molybdenite) requires approximately 2 mg/L sulfate (reduced to sulfide). The amount of sulfide available for molybdenite precipitation will be lowered by other competing sulfide minerals, particularly ferrous iron mineralization such as pyrite. However, given the large concentration of sulfate present in groundwater, when sulfate reducing conditions are present molybdenum is thermodynamically favored to be completely removed from groundwater.

As discussed in Section 4.3, sulfur does not speciate as sulfide in all portions of the Site, and instead predominately speciates as sulfate. The reduction of sulfate to sulfide is expected to be the limiting factor in the reaction above. This also indicates that the removal of molybdenum from groundwater through molybdenite precipitation is not currently widespread across the Site, and would likely need to be anthropogenically induced if used as a corrective measure. An iterative approach was used through Rxn to determine a desirable Eh needed at CCR-AP-6I to reduce sulfate to sulfide, which was determined to be approximately -110 millivolts (mV). These results indicate thermodynamically favored treatment of molybdenum in the subsurface is feasible when groundwater conditions are reduced below -110 mV. This redox threshold is consistent with the molybdenite field presented in the molybdenum Eh-pH diagram (Section 4.3.2).

7. Summary of Geochemical Data Evaluation

The geochemical evaluation has been conducted using a combination of knowledge of groundwater chemistry (Section 4.1), aquifer solid geochemistry (Section 4.2), chemical speciation under current Site conditions (Section 4.3), microbiological assessments and treatability studies (Sections 4.4 and 5), and geochemical modeling (Section 6).

Understanding of the Site geochemical framework is integral to effectively develop and evaluate potential corrective measures alternatives to address Appendix IV SSLs above GWPSs beyond the boundary of the EAP. Developed based on key findings from the information and conclusions presented in this report, the geochemical framework is summarized as follows:

- CCR-affected groundwater water type generally shows elevated sulfate and chloride and lower calcium concentrations when compared to background concentrations.
- The molybdenum concentration trends are generally stable with limited increasing trends to the east and west of the EAP, indicating minimal expansion of the molybdenum plume under current Site geochemical conditions. Regarding lithium concentration, trends are generally stable with increasing trends to the east of the EAP which may be a result of plume mobility. By contrast, arsenic trends are generally increasing in shallow aquifer zones regardless of location, indicating expansion of the arsenic plume under current Site geochemical conditions.
- Sequential extraction results indicate inorganic adsorption of molybdenum onto aquifer solids is predominantly controlled by organic matter and sulfide mineralization. Organic matter may have a moderate effect on molybdenum mobility, given that moderate to high TOC concentrations are present at the Site.
- A significant fraction of the bacterial population found in deeper aquifer zones of the Site were identified as anoxic/anaerobic bacteria. The significant fraction of sulfate-reducing bacteria among the indigenous microbial population and the detection of sulfide indicates some degree of molybdenum attention has occurred and the potential of further promoting sulfate-reducing conditions at the Site for in-situ metal treatment.
- Microcosm results indicate that indigenous sulfate-reducing bacteria could be readily stimulated to facilitate the immobilization of molybdenum through the formation of molybdenum disulfide.
- Aerobic desorption (leaching) results indicate that molybdenum will mobilize if reducing conditions are changed. However, the extent of mobilization under the current low DO concentrations in areas with molybdenum concentrations exceeding the GWPS is likely limited and would not result in a rebound concentration higher than the GWPS.
- Geochemical modeling predicts molybdenum treatment through redox manipulation is feasible through reductive precipitation of molybdenum disulfide.
- Aquifer solids have little sorption capacity for lithium attenuation; the primary attenuation mechanism for lithium is expected to be dilution.

8. Conclusion

Under current Site conditions the molybdenum plume is generally stable. Sulfate reducing conditions within the aquifer inferred from the presence of sulfate-reducing bacteria and detection of sulfide will aid in attenuation of molybdenum through mineralization, as supported by the sequential extraction results. Laboratory testing suggest that molybdenum treatment through redox manipulation via the addition of an organic substrate (such as EVO) is feasible through precipitation as stable molybdenum disulfide. Geochemical modeling predicts this treatment is feasible given there is enough sulfide available to facilitate molybdenum disulfide precipitation.

References

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FIGURES



LEGEND

- UPGRADIENT GROUNDWATER MONITORING WELL WITH **GROUNDWATER ELEVATION** IN FEET
- DOWNGRADIENT GROUNDWATER MONITORING WELL WITH **GROUNDWATER ELEVATION** IN FEET
- SOIL BORING
- CREEK BOUNDARY
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

3. WATER LEVELS GAGED ON 6 MAY 2024

4. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 6 MAY 2024 AT 12:00 PM

5. AERIAL IMAGERY SOURCE: HEXAGON, 25 JULY 2023

N

0 230 460
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL AND SOIL BORING LOCATIONS - EAST ASH POND

JUNE 2024

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\grn_common\129420 Vectren\GIS\129420_VECTREN1129420_VECTREN.aprx - USER: tciskowski - LAST SAVED: 6/19/2024 10:18 AM

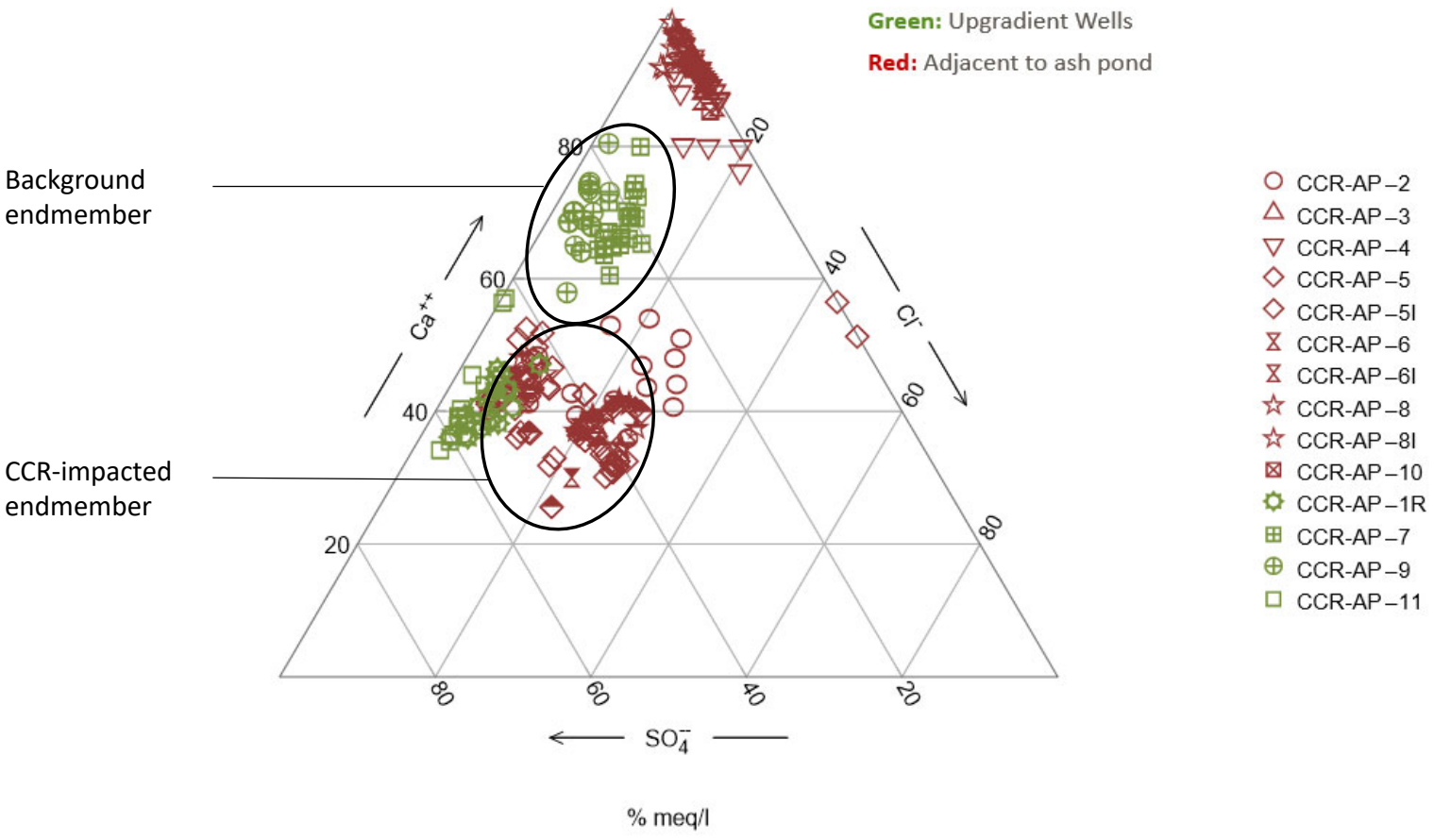


FIGURE 2
Ternary Diagram – Sulfate, Chloride, and Calcium
JULY 2024

HALEY ALDRICH

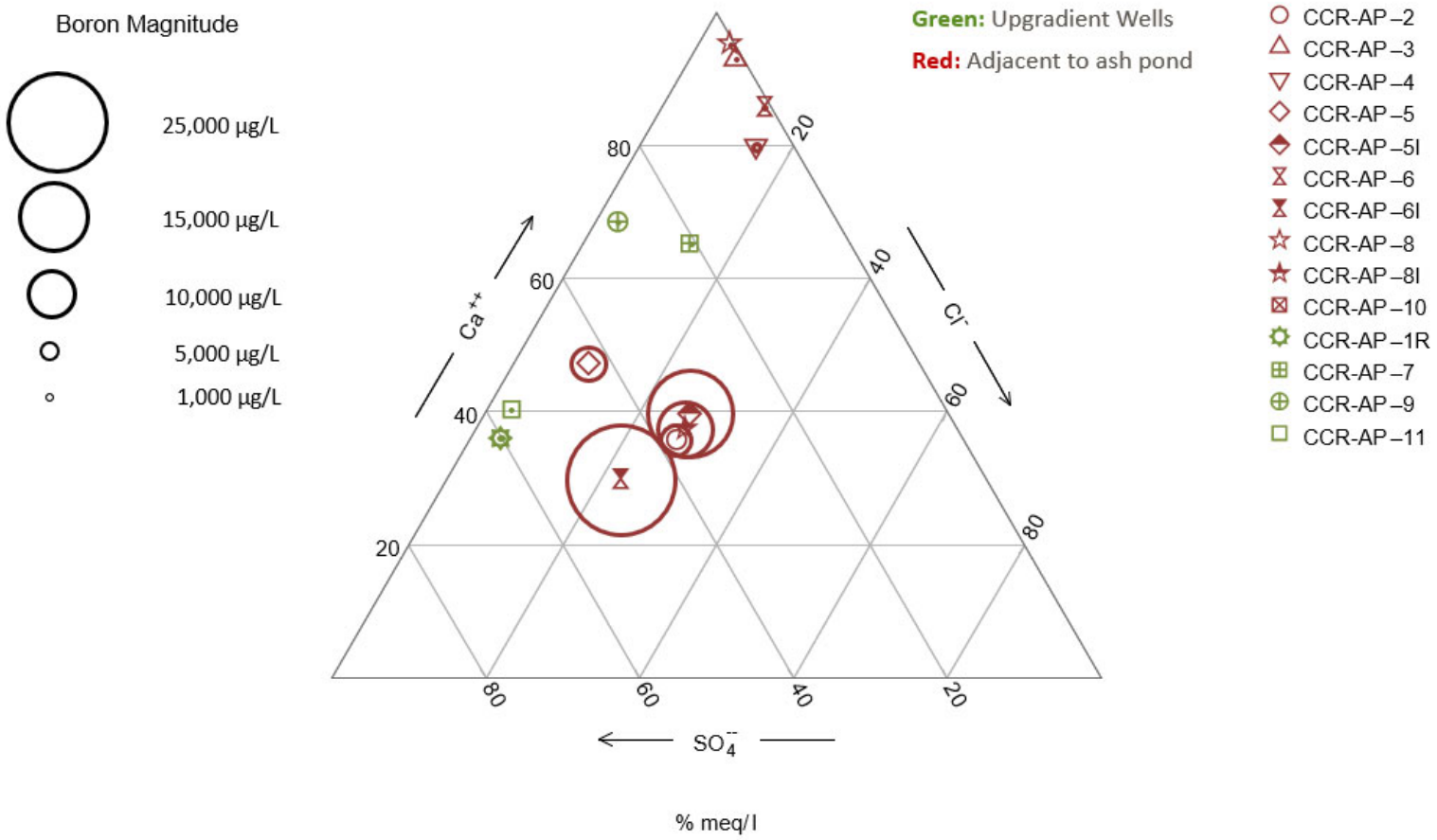


FIGURE 3
Ternary Diagram – November 2023 Sampling
JULY 2024

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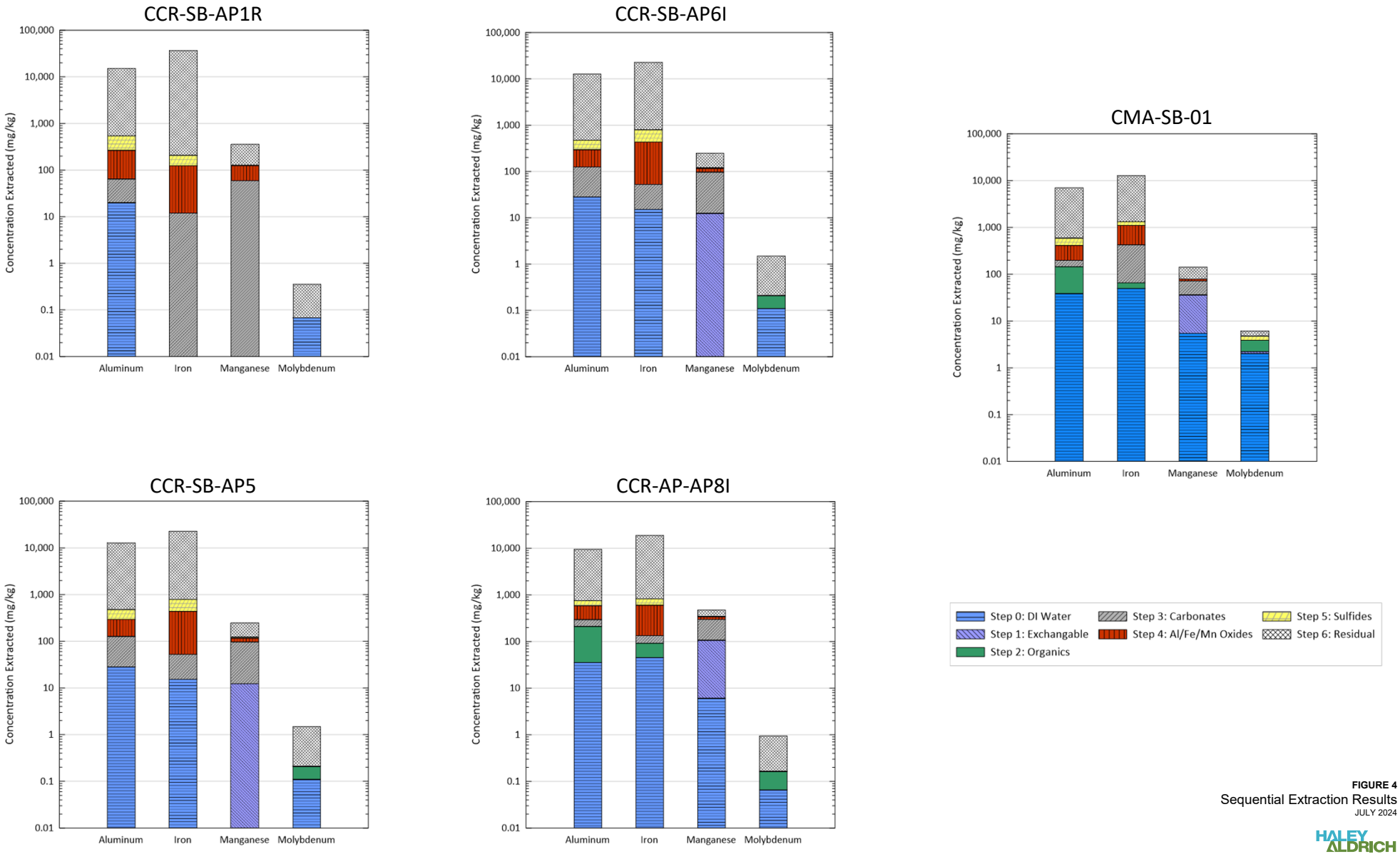


FIGURE 4
Sequential Extraction Results
JULY 2024

HALEY ALDRICH

APPENDIX A
Ursus Report

1204 Springdale Street
Mount Horeb, WI 53572
(608) 437-7413

April 11, 2024 Final Report

Todd Plating
Haley & Aldrich, Inc.

RE: Bench Level Treatability Study for Partitioning and Bioremediation of Molybdenum, Boron, and Lithium at the FB Culley Site.

Mr. Plating,

Ursus Remediation Testing & Technologies, LLC (Ursus) is pleased to provide Haley & Aldrich, Inc. (Haley & Aldrich) this draft final report for the sorption phase testing of molybdenum (Mo), Boron (B), and Lithium (Li) from the FB Culley site.

OBJECTIVE

The purpose of the study is to (1) characterize sorption and desorption behavior for native soils and (2) evaluate in situ anaerobic sulfate reducing activity (microcosm study) for molybdenum, boron, and lithium precipitation.

EXECUTIVE SUMMARY

Native soils and groundwater were tested to measure the behavior of molybdenum and lithium sorption and desorption behavior and to evaluate if bioredution is an effective means to stabilize molybdenum at the FB Culley site.

Sorption and desorption testing for molybdenum, boron, and lithium on native soil was tested. No significant adsorption or desorption of these elements was observed, except for slight lithium adsorption in Slurry 2 and the observed lithium reduction is likely due to equilibrium/ion exchange.

Microcosm testing for molybdenum, boron, and lithium bioreduction in two soil slurries using EVO and nutrients were tested. Molybdenum bioreduction was observed in both slurries, while boron reduction was not observed, and lithium reduction was slightly observed in Slurry 2.

Aerobic desorption testing for molybdenum, boron, and lithium in the soil from each microcosm was tested. Most of the molybdenum was desorbed in the first elution, while boron and lithium remained stable throughout the test.

EVO and nutrients are effective in producing reducing conditions that stabilize molybdenum in the slurries, but not boron. The reducing conditions have minimal effect on lithium and the effectiveness may be sample-dependent. The data shows that bioreduction is effective in reducing dissolved molybdenum concentration, but if conditions become aerobic, molybdenum will mobilize.

Haley & Aldrich, Inc.
FB Culley
April 11, 2024

BACKGROUND

Four soil samples and two groundwater samples were received by Ursus on June 21, 2023. The samples were received on ice. Soil was received in vacuum sealed plastic bags and groundwater was received in HDPE bottles and vacuum sealed. Groundwater and soil samples were not chemically preserved. Sample received, descriptions, and comments are shown in Table 1.

Table 1.
Soil and Groundwater Received for Testing

Sample Name	Sample Date	Matrix	Sample Comments
CMA-SB-01(61.5-64)-061523	6/15/2023	Soil	Sample received in vacuum sealed bag
CMA-SB-01(52-54)-061523	6/15/2023	Soil	Sample received in vacuum sealed bag
CCR-SB-AP6I (65-67)-061623	6/16/2023	Soil	Sample received in vacuum sealed bag
CCR-SB-AP8I (60-63)-061423	6/14/2023	Soil	Sample received in vacuum sealed bag
CCR-SB-AP-IR-061423	6/14/2023	GW	3 bottles no headspace, vacuum sealed. Solids present in GW
CCR-SB-AP-6I-061323	6/13/2023	GW	5 bottles no headspace, vacuum sealed

For the study, soil sample CCR-SB-AP6I (65-67)-061623was slurried with groundwater CCR-SB-AP-6I-061323 (Slurry 1) and soil sample CCR-SB-AP8I (60-63)-061423 was slurried with groundwater CMA-AP-4R-00123-1132 (Slurry 2) (Table 2).

Table 2.
Soil Slurries Prepared for the Study

Slurry Name	Soil Used	Groundwater Used
Slurry 1	CCR-SB-AP6I (65-67)-061623	CCR-SB-AP-6I-061323
Slurry 2	CCR-SB-AP8I (60-63)-061423	CCR-SB-AP-IR-061423

MATERIALS & METHODOLOGY

Materials

1. Emulsified Vegetable Oil (EVO) – Newman Zone and Newman Zone HRO. Provided by RNAS Remediation Products.

2. Macro-Nutrient – Newman QR95. Provided by RNAS Remediation Products.
3. Sulfate Reducing Microbial Culture – Cow manure.
4. Sulfate Source – Magnesium Sulfate
5. Molybdenum Spike – Sodium Molybdate Dihydrate

Soil Compositional Analysis

Soil samples were digested with hot nitric acid, brought to volume, and analyzed for molybdenum, boron, and lithium using an Inductively Coupled Plasma – Atomic Emission Spectrophotometer (ICP-AES). Results are reported on a dry weight basis.

Soil Sorption Testing

For each slurry (Table 2) a 1:10 soil to groundwater ratio (5g soil:50mls GW) was prepared for testing in an argon purged glove box. Individual soil samples were re-vacuumed sealed in the argon purged glove box. Groundwater was re-sealed under argon purged conditions.

The slurried samples were mixed on a TCLP rotary tumbler and periodically sampled, centrifuged, filtered through a 0.45µ filter, and analyzed for pH and molybdenum, boron, and lithium on an ICP-AES.

Soil Sample Desorption Testing

Slurry samples (Table 2) were used for desorption testing. Individual soil samples were re-vacuumed sealed in the argon purged glove box. Groundwater was re-sealed under argon purged conditions.

The slurried samples were mixed at a 1:4 soil to groundwater ratio (10g soil:40mls GW) in an argon purged glove box. The slurried samples were mixed on a TCLP rotary tumbler and sampled at 24 hours. The slurries were centrifuged, filtered through a 0.45µ filter, and the filtrate was analyzed for molybdenum, boron, and lithium on an ICP-AES. The soil was retained, and the leaching was repeated two more times at 48 and 72 hours at the same soil to groundwater ratio. After the three elution tests, the remaining soil was measured for total molybdenum, boron, and lithium on an ICP-AES.

Microcosm Testing

Anaerobic conditions will be tested to demonstrate if molybdenum, boron, and lithium can be immobilized under sulfate-reducing conditions. The slurries described in Table 2 were used in the microcosm test. If necessary, groundwater was spiked with molybdenum to achieve a concentration representing the site and analytically measurable. Four conditions were tested in the microcosms, as follows:

- **Microcosm 1:** control (GW No Mo spike, no nutrient added).
- **Microcosm 2:** Mo spiked (~3 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)

- **Microcosm 3:** Mo spiked (~3 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)
- **Microcosm 4:** Mo spiked (~3 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture.

Aerobic Desorption Testing

After the microcosm testing was complete, the residual microcosm soils were exposed to aerated groundwater using groundwater CCR-SB-AP-IR-061423. Groundwater sample CCR-SB-AP-IR-061423 has a molybdenum concentration below the detection limit of 0.010 mg/L and is low enough to measure if molybdenum is desorbed from the soil. The groundwater was oxygenated prior to the desorption testing by removing some of the water from the sample bottles and vigorously shaking the bottle for a few minutes. The dissolved oxygen was measured in the oxygenated groundwater.

The microcosm soil to groundwater ratio of 1:10 was prepared and mixed on a TCLP rotary tumbler and sampled at 24 hours (4g soil: 40mls groundwater). The TCLP bottle was vacuum sealed to minimize exposure to air during the tumbling period. Sample preparation was not done under anaerobic conditions. After 24 hours, the slurries were centrifuged , filtered through a 0.45µ filter, and the filtrate was analyzed for pH, and molybdenum and boron on an ICP-AES. A total of 3 elutions were tested 24 hours apart. The molybdenum and boron concentrations in soil for each microcosm before and after the elution procedure were also characterized.

RESULTS

Soil and Groundwater Compositional Analysis

The soil and groundwater molybdenum, boron, and lithium concentrations are shown in Table 3.

Table 3.
Baseline Molybdenum, Boron, and Lithium Concentrations of Soil and Groundwater Samples

Sample Name	Units	Mo	B	Li	pH
CMA-SB-01(61.5-64)-061523	mg/kg dry wt.	32.2	9.73	3.26	NA
CMA-SB-01(52-54)-061523	mg/kg dry wt.	<0.29	7.55	4.43	NA
CCR-SB-AP6I (65-67)-061623	mg/kg dry wt.	0.68	3.32	0.68	NA
CCR-SB-AP8I (60-63)-061423	mg/kg dry wt.	0.18	2.59	0.66	NA
CCR-SB-AP-IR-061423	mg/L	<0.010	0.56	0.039	7.34
CCR-SB-AP-6I-061323	mg/L	0.49	18.0	0.059	7.76

NA = Not analyzed

Adsorption and Isotherm Testing

Sorption testing was used to measure molybdenum, boron, and lithium adsorption on native soil and to measure the kinetics for the study. The groundwater for Slurry 2 sample was

spiked with a 1.5 mg/L molybdenum as sodium molybdate dihydrate since there was no detectable molybdenum in the sample. Groundwater sample CCR-SB-AP-6I-061323 was not spiked since it had a detectable concentration of molybdenum.

The spiked groundwater sample CCR-SB-AP-IR-061423 (Slurry 2) had a baseline molybdenum concentration of 1.33 mg/L, which is slightly lower than the target spike concentration of 1.5 mg/L.

Sorption kinetics was measured periodically over a 120-hour period. During that time molybdenum, boron, lithium was not absorbed by native soils in Slurry 1 (Table 4). Adsorption was not observed in Slurry 2 for molybdenum and boron, but a slight lithium adsorption was observed (Table 5).

Table 4.
Molybdenum, Boron, and Lithium Sorption Kinetics on Slurry 1

		Measured Concentration						Adsorbed			% Adsorbed		
Sampling Hrs	pH	Baseline Mo, mg/L	Baseline Li, mg/L	Baseline B, mg/L	Sample Mo, mg/L	Sample Li, mg/L	Sample B, mg/L	Mo, ug/g	Li, ug/g	B, ug/g	Mo	Li	B
1	7.39	0.49	0.059	18.0	0.51	0.074	19.2	-0.23	-0.15	-11.80	-5%	-25%	-7%
3	7.35	0.49	0.059	18.0	0.52	0.073	19.2	-0.28	-0.14	-11.60	-6%	-24%	-6%
7	7.37	0.49	0.059	18.0	0.52	0.076	19.2	-0.30	-0.17	-11.50	-6%	-28%	-6%
23	7.29	0.49	0.059	18.0	0.51	0.074	18.5	-0.23	-0.15	-5.30	-5%	-25%	-3%
49	7.32	0.49	0.059	18.0	0.50	0.070	18.1	-0.11	-0.11	-1.00	-2%	-19%	-1%
72	7.28	0.49	0.059	18.0	0.53	0.072	18.7	-0.38	-0.13	-7.00	-8%	-22%	-4%

Table 5.
Molybdenum, Boron, and Lithium Sorption Kinetics on Slurry 2

		Measured Concentration						Adsorbed			% Adsorbed		
Sampling Hrs	pH	Baseline Mo, mg/L	Baseline Li, mg/L	Baseline B, mg/L	Sample Mo, mg/L	Sample Li, mg/L	Sample B, mg/L	Mo, ug/g	Li, ug/g	B, ug/g	Mo	Li	B
1	7.84	1.33	0.039	0.56	1.34	0.033	0.91	-0.09	0.06	-3.54	-1%	16%	-63%
3	7.71	1.33	0.039	0.56	1.35	0.033	0.92	-0.19	0.06	-3.64	-1%	15%	-65%
7	7.74	1.33	0.039	0.56	1.36	0.032	0.90	-0.31	0.07	-3.41	-2%	19%	-61%
23	7.70	1.33	0.039	0.56	1.29	0.031	0.86	0.41	0.08	-3.03	3%	20%	-54%
49	7.73	1.33	0.039	0.56	1.31	0.029	0.86	0.17	0.10	-2.96	1%	26%	-53%
72	7.73	1.33	0.039	0.56	1.31	0.028	0.85	0.14	0.11	-2.93	1%	28%	-52%

Soil Sample Desorption Testing

The soil desorption was tested to measure desorption behavior of the soil when slurried with site groundwater. Soil samples CCR-SB-AP6I (65-67)-061623 and CCR-SB-AP8I (60-63)-061423 each had detectable concentrations of molybdenum, boron, and lithium (Table 3).

Tables 6 and 7 show the desorption of the two slurry samples and the background concentrations of the groundwaters used in the slurries. Molybdenum, boron, and lithium were measured after each of the three elution's.

Elution data for Slurry 1 and Slurry 2 showed desorption of molybdenum and boron in each of the three elution's (Table 6 and Table 7). Lithium concentrations in each elution were slightly lower than the groundwater lithium concentration, suggesting minimal adsorption (Table 6 and Table 7).

Table 6.
Elution Results for Slurry 1

	Elution Testing, mg/L								
	Elution 1 (24 hrs)			Elution 2 (48 hrs)			Elution 3 (72 hrs)		
Sample Name	Mo	Li	B	Mo	Li	B	Mo	Li	B
CCR-SB-AP-IR-061423 (GW)	<0.010	0.039	0.56	<0.010	0.039	0.56	<0.010	0.039	0.56
Slurry 1	0.16	0.027	1.07	0.057	0.032	0.063	0.050	0.034	0.62

Table 7.
Elution Results for Slurry 2

	Elution Testing, mg/L								
	Elution 1 (24 hrs)			Elution 2 (48 hrs)			Elution 3 (72 hrs)		
Sample Name	Mo	Li	B	Mo	Li	B	Mo	Li	B
CCR-SB-AP-IR-061423 (GW)	<0.010	0.039	0.56	<0.010	0.039	0.56	<0.010	0.039	0.56
Slurry 2	0.080	0.036	1.11	0.030	0.029	0.68	0.022	0.027	0.65

Microcosm Testing

The microcosm data, as shown in Table 8 for Slurry 1 and Table 9 for Slurry 2, shows that the groundwater for each slurry was spiked with 1.5 mg/L molybdenum. The spiked groundwater samples for Slurry 1 and Slurry 2 had baseline molybdenum concentrations of 1.96 mg/L and 1.46 mg/L, respectively, which are close to their respective theoretical spike concentrations. The microcosms consisted of 183g soil to 445 mls of groundwater and were allowed to react at ambient temperatures on the laboratory bench with periodic mixing.

Microcosms were set up to assess the effectiveness of molybdenum, boron, and lithium bioreduction in the Slurry 1 and Slurry 2 samples. The study found that molybdenum bioreduction was observed in both slurries, with Slurry 1 (Table 8) showing slower kinetics than Slurry 2 (Table 9). The addition of a sulfate-reducing bacteria culture reduced the lag time in microcosm 4

compared to microcosms 2 and 3 in both slurries. Over time, effective reducing conditions and subsequent molybdenum reduction were observed in Microcosms 2 and 3 for both slurries.

Boron reduction was not observed in either Slurry 1 or Slurry 2 under anaerobic conditions, indicating that boron reduction would not be observed with EVO and nutrient amendments. Lithium reduction was not observed in Slurry 1 for any of the microcosms, while a slight reduction in lithium was observed for Slurry 2 in microcosms 2, 3, and 4. However, this reduction may be due to adsorption/ion exchange rather than bioreduction, as adsorption testing also found lithium to be weakly adsorbed in Slurry 2 (Table 5).

Dissolved iron increased in microcosms 2, 3, and 4, likely due to the formation of ferrous iron as the microcosms became anaerobic. For Slurry 1, microcosm 4, the iron decreased in the last two samples, suggesting the ferrous iron is being further reduced to iron sulfide in this slurry. Sulfur initially increased then decreased over time in microcosms 2, 3, and 4 as the microcosms became anaerobic and formed sulfide reducing conditions.

The addition of EVO and nutrients proved effective in producing reducing conditions that stabilize molybdenum in the slurries. However, these reducing conditions are not conducive to lowering boron, and the data suggests that reducing conditions have minimal effect on lithium and the effectiveness may be sample-dependent.

Aerobic Desorption Testing

After 78 days of treatment, the microcosm samples underwent aerobic desorption to assess the stability of molybdenum boron, and lithium in an aerobic environment. The liquid from each microcosm was decanted and discarded, and a sample of the remaining solids was collected to determine the concentration of these elements in the soil prior to aerobic desorption.

The groundwater sample CCR-SB-AP-IR-061423 was aerated by shaking, and its dissolved oxygen (DO) level was found to be 8.83 mg/L. This aerated groundwater was then mixed with the soil from each microcosm for 24 hours. The filtrate was subsequently analyzed for molybdenum, boron, lithium, and pH. This process was repeated three times with fresh aliquots of aerated CCR-SB-AP-IR-061423, resulting in three elution's.

Table 10 presents the concentrations of molybdenum, boron, and lithium for the three elution's for Slurry 1. The majority of the molybdenum and boron was desorbed in the first 24-hour elution, with minimal desorption in the subsequent two. Lithium concentrations remained stable throughout the three elution's and the pH was neutral and consistent across all elution's.

The total micrograms in wet weight was calculated based on the amount of soil used (10 grams) and the volume of CCR-SB-AP-IR-061423 groundwater added (40 ml) for each elution (Table 11). The pre-aerobic total molybdenum desorbed in the solids was greater in the treated microcosms (2, 3, and 4) than the control (microcosm 1). This observation is expected since the pre-aerobic molybdenum concentrations were higher in microcosms 2, 3, and 4 than microcosm 1. The post-aerobic solids total molybdenum concentration for

microcosm 1 was similar to microcosms 2, 3, and 4, suggesting the solids have come to equilibrium with the groundwater and the leachable molybdenum leached from the solids.

The boron and lithium concentrations in the pre-aerobic solids were similar across all microcosms, whether treated with EVO, nutrients, and sulfate, or left untreated. This supports the observation that boron and lithium are not effectively stabilized under anaerobic conditions (Table 11).

As shown in Table 12, the molybdenum and lithium concentrations for the three elution's for Slurry 2 were recorded. The testing procedure was identical to that of Slurry 1, and the observations for Slurry 2 mirrored those of Slurry 1. The majority of the molybdenum was desorbed in the first 24-hour elution, with minimal desorption in the subsequent two elution's. Boron and lithium concentrations remained stable throughout the three elution's and the pH was neutral and consistent across all elution's.

The pre-aerobic total molybdenum in the solids showed similar concentrations across all microcosms, regardless of whether they were treated with EVO, nutrients, sulfate, or left untreated (Table 13). The percentage of molybdenum desorbed from the solids in microcosms 1-4 was unexpectedly similar. Microcosm data (Table 9) indicates anaerobic stabilization of molybdenum, presumably in the solids, suggesting higher concentrations of molybdenum in the anaerobic microcosms 2-3 solids. However, this was not observed. The post-aerobic solids total molybdenum concentration for microcosm 1 was similar to microcosms 2, 3, and 4, suggesting equilibrium between the solids and the groundwater, and that the leachable molybdenum had been leached from the solids.

Similar to the findings in Table 11, boron and lithium concentrations in the pre-aerobic solids found similar concentrations of boron and lithium in the microcosms that were treated with EVO, nutrients, and sulfate and the control, supporting the observation that lithium is not effectively stabilized under anaerobic conditions (Table 13).

Table 8.
Microcosm Results for Slurry 1

Test Day	Molybdenum, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	Mo, mg/L	pH	Mo, mg/L	pH	Mo, mg/L	pH	Mo, mg/L	pH
Day 7	1.53	6.69	1.41	5.03	1.11	4.89	1.41	5.07
Day 21	1.23	6.86	0.39	5.15	0.41	5.26	0.52	5.41
Day 36	1.11	6.76	0.33	5.30	0.25	5.23	0.46	5.77
Day 49	0.98	6.98	0.38	5.63	0.31	5.37	0.056	5.73
Day 78	1.06	7.38	0.058	6.86	0.035	6.29	0.036	6.72

Test Day	Boron, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	B, mg/L	pH	B, mg/L	pH	B, mg/L	pH	B, mg/L	pH
Day 7	18.0	6.69	17.9	5.03	15.1	4.89	17.3	5.07
Day 21	17.9	6.86	17.2	5.15	16.7	5.26	16.6	5.41
Day 36	18.4	6.76	18.1	5.30	17.7	5.23	17.6	5.77
Day 49	18.0	6.98	17.6	5.63	17.7	5.37	16.9	5.73
Day 78	17.2	7.38	16.0	6.86	16.1	6.29	16.0	6.72

Table 8 (cont.).
Microcosm Results for Slurry 1

Test Day	Lithium, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	Li, mg/L	pH	Li, mg/L	pH	Li, mg/L	pH	Li, mg/L	pH
Day 7	0.058	6.69	0.062	5.03	0.051	4.89	0.066	5.07
Day 21	0.053	6.86	0.052	5.15	0.052	5.26	0.053	5.41
Day 36	0.051	6.76	0.057	5.30	0.057	5.23	0.060	5.77
Day 49	0.051	6.98	0.057	5.63	0.051	5.37	0.039	5.73
Day 78	0.044	7.38	0.039	6.86	0.047	6.29	0.039	6.72

Test Day	Iron, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	Fe, mg/L	pH	Fe, mg/L	pH	Fe, mg/L	pH	Fe, mg/L	pH
Day 7	<1.0	6.69	<1.0	5.03	<1.0	4.89	<1.0	5.07
Day 21	<1.0	6.86	<1.0	5.15	8.45	5.26	6.82	5.41
Day 36	<1.0	6.76	6.95	5.30	15.1	5.23	20.4	5.77
Day 49	<1.0	6.98	25.0	5.63	23.0	5.37	<1.0	5.73
Day 78	<1.0	7.38	<1.0	6.86	<1.0	6.29	<1.0	6.72

Table 8 (cont.).
Microcosm Results for Slurry 1

Test Day	Sulfur, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	S, mg/L	pH	S, mg/L	pH	S, mg/L	pH	S, mg/L	pH
Day 7	561	6.69	574	5.03	618	4.89	700	5.07
Day 21	765	6.86	764	5.15	939	5.26	1058	5.41
Day 36	788	6.76	867	5.30	1021	5.23	1635	5.77
Day 49	412	6.98	524	5.63	518	5.37	1356	5.73
Day 78	416	7.38	2967	6.86	1467	6.29	3029	6.72

Table 9.
Microcosm Results for Slurry 2

Test Day	Molybdenum, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	Mo, mg/L	pH	Mo, mg/L	pH	Mo, mg/L	pH	Mo, mg/L	pH
Day 7	1.28	7.36	1.05	5.86	1.03	5.82	1.17	5.83
Day 21	1.18	7.21	0.16	6.31	0.24	6.34	0.030	6.45
Day 36	1.35	7.25	<0.010	6.28	<0.010	6.26	<0.010	6.14
Day 49	1.25	6.98	0.012	6.05	0.014	6.26	0.014	6.36
Day 78	1.32	7.09	0.087	7.36	<0.010	6.59	<0.010	6.55

Test Day	Boron, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	B, mg/L	pH	B, mg/L	pH	B, mg/L	pH	B, mg/L	pH
Day 7	1.59	7.36	1.41	5.86	1.45	5.82	1.37	5.83
Day 21	1.60	7.21	1.48	6.31	1.47	6.34	1.48	6.45
Day 36	1.69	7.25	1.53	6.28	1.46	6.26	1.53	6.14
Day 49	1.69	6.98	1.49	6.05	1.44	6.26	1.46	6.36
Day 78	1.68	7.09	1.43	7.36	1.36	6.59	1.45	6.55

Table 9 (cont.).
Microcosm Results for Slurry 2

Test Day	Lithium, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	Li, mg/L	pH	Li, mg/L	pH	Li, mg/L	pH	Li, mg/L	pH
Day 7	0.021	7.36	0.043	5.86	0.041	5.82	0.037	5.83
Day 21	0.021	7.21	0.033	6.31	0.035	6.34	0.030	6.45
Day 36	0.016	7.25	0.031	6.28	0.030	6.26	0.032	6.14
Day 49	0.012	6.98	0.022	6.05	0.020	6.26	0.023	6.36
Day 78	0.015	7.09	0.024	7.36	0.025	6.59	0.025	6.55

Test Day	Iron, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	Fe, mg/L	pH	Fe, mg/L	pH	Fe, mg/L	pH	Fe, mg/L	pH
Day 7	<1.0	7.36	<1.0	5.86	<1.0	5.82	<1.0	5.83
Day 21	<1.0	7.21	14.7	6.31	15.3	6.34	<1.0	6.45
Day 36	<1.0	7.25	9.55	6.28	0.53	6.26	<1.0	6.14
Day 49	<1.0	6.98	18.6	6.05	5.40	6.26	5.39	6.36
Day 78	<1.0	7.09	2.63	7.36	4.20	6.59	2.85	6.55

Table 9 (cont.).
Microcosm Results for Slurry 2

Test Day	Sulfur, mg/L							
	Microcosm 1: Control		**Microcosm 2**: Mo spiked (1.5 mg/L) with EVO (1g/L) and macro-nutrients (1g/L)		**Microcosm 3**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L)		**Microcosm 4**: Mo spiked (1.5 mg/L) with EVO (1g/L), macro-nutrients (1g/L), and sulfate (250 mg/L) and a sulfate-reducing microbial culture	
	S, mg/L	pH	S, mg/L	pH	S, mg/L	pH	S, mg/L	pH
Day 7	157	7.36	153	5.86	275	5.82	265	5.83
Day 21	216	7.21	246	6.31	593	6.34	1950	6.45
Day 36	240	7.25	140	6.28	1257	6.26	1191	6.14
Day 49	118	6.98	60.1	6.05	264	6.26	257	6.36
Day 78	143	7.09	63.2	7.36	53.0	6.59	15.6	6.55

Table 10.
Aerobic Desorption Elution Results for Slurry 1

	Aerobic Desorption Testing, mg/L											
	Elution 1 (24 hrs)				Elution 2 (48 hrs)				Elution 3 (72 hrs)			
Sample Name	Mo	B	Li	pH	Mo	B	Li	pH	Mo	B	Li	pH
CCR-SB-AP-IR-061423	0.010	0.56	0.039	7.34	0.010	0.56	0.039	7.34	0.010	0.56	0.039	7.34
Microcosm 1	0.25	1.39	0.027	8.05	0.16	0.66	0.028	8.00	0.095	0.61	0.029	7.95
Microcosm 2	0.66	1.50	0.029	8.28	0.16	0.65	0.029	7.96	0.098	0.62	0.032	7.86
Microcosm 3	0.66	1.35	0.028	8.15	0.16	0.65	0.029	8.07	0.086	0.61	0.030	7.82
Microcosm 4	0.56	1.38	0.028	8.30	0.13	0.66	0.029	8.15	0.074	0.62	0.031	7.96

Table 11.
Aerobic Desorption Mass Balance Results for Slurry 1

	Soil, wet wt.												Elution's			Mass Balance		
	Pre Aerobic Desorption Total, ug, wet wt.			Post Aerobic Desorption Total, ug wet wt.			Desorbed Total, ug wet wt.			Percent Desorbed			Sum of Elution's 1-3, ug			Desorbed Recovered in Elution's		
Sample Name	Mo	B	Li	Mo	B	Li	Mo	B	Li	Mo	B	Li	Mo	B	Li	Mo	B	Li
Microcosm 1	464.5	689.6	122.4	205.7	520.3	155.8	258.8	169.3	-33.4	56%	25%	-27%	21.4	174.0	8.0	8%	-24%	-24%
Microcosm 2	580.9	668.0	160.7	307.9	477.9	141.6	273.0	190.1	19.1	47%	28%	12%	37.7	177.6	8.3	14%	43%	43%
Microcosm 3	618.3	633.7	144.3	169.0	437.3	121.4	449.3	196.4	22.9	73%	31%	16%	37.4	171.2	8.1	8%	36%	36%
Microcosm 4	518.9	681.0	175.7	245.6	482.0	139.3	273.3	199.0	36.4	53%	29%	21%	32.0	173.4	8.2	12%	23%	23%

Table 12.
Aerobic Desorption Elution Results for Slurry 2

	Aerobic Desorption Testing, mg/L											
	Elution 1 (24 hrs)				Elution 2 (48 hrs)				Elution 3 (72 hrs)			
Sample Name	Mo	B	Li	pH	Mo	B	Li	pH	Mo	B	Li	pH
CCR-SB-AP-IR-061423	0.010	0.56	0.039	7.34	0.010	0.56	0.039	7.34	0.010	0.56	0.039	7.34
Microcosm 1	0.21	0.68	0.021	7.89	0.057	0.59	0.025	8.04	0.034	0.60	0.027	7.94
Microcosm 2	0.27	0.64	0.022	7.85	0.064	0.61	0.025	8.00	0.033	0.60	0.027	7.71
Microcosm 3	0.23	0.62	0.023	7.88	0.060	0.60	0.028	8.01	0.034	0.59	0.027	7.71
Microcosm 4	0.25	0.64	0.022	7.77	0.053	0.60	0.027	7.81	0.029	0.60	0.027	7.73

Table 13.
Aerobic Desorption Mass Balance Results for Slurry 2

	Soil, wet wt.												Elution's			Mass Balance		
	Pre Aerobic Desorption Total, ug, wet wt.			Post Aerobic Desorption Total, ug wet wt.			Desorbed Total, ug wet wt.			Percent Desorbed			Sum of Elution's 1-3, ug			Desorbed Recovered in Elution's		
Sample Name	Mo	B	Li	Mo	B	Li	Mo	B	Li	Mo	B	Li	Mo	B	Li	Mo	B	Li
Microcosm 1	185.4	291.4	193.9	93.7	359.6	135.1	91.7	-68.2	58.8	49%	-23%	30%	13.4	141.9	7.6	15%	13%	13%
Microcosm 2	216.3	296.8	172.1	85.8	349.7	123.4	130.5	-52.9	48.7	60%	-18%	28%	15.7	141.3	7.6	12%	16%	16%
Microcosm 3	190.0	268.3	160.1	80.0	511.7	131.7	110.0	-243.4	28.4	58%	-91%	18%	14.0	139.5	7.8	13%	27%	27%
Microcosm 4	188.5	272.1	163.8	51.3	302.8	127.2	137.2	-30.7	36.6	73%	-11%	22%	14.6	140.7	7.7	11%	21%	21%

SUMMARY

The Purpose of the study was to characterize sorption and desorption behavior for native soils and evaluate in situ anaerobic sulfate reducing activity for molybdenum boron, and lithium precipitation.

The study involved sorption testing to measure the adsorption of molybdenum, boron, and lithium on native soil and to study the kinetics. The groundwater for Slurry 2 was spiked with 1.5 mg/L molybdenum as sodium molybdate dihydrate due to the absence of detectable molybdenum. However, Groundwater sample CCR-SB-AP-6I-061323 was not spiked as it had a detectable molybdenum concentration. Sorption kinetics were measured over a 120-hour period. During this time, no adsorption of molybdenum, boron, or lithium was observed in Slurry 1. In Slurry 2, no adsorption was observed for molybdenum and boron, but slight lithium adsorption was noted.

Desorption testing was performed to measure the desorption behavior molybdenum, boron, and lithium from the soil when mixed with site groundwater. The elution data for Slurry 1 and Slurry 2 showed desorption of molybdenum and boron in each of the three elution's. The lithium concentrations in each elution were slightly lower than the groundwater lithium concentration, suggesting minimal adsorption or ion exchange behavior.

Microcosms were set up to assess the effectiveness of molybdenum, boron, and lithium bioreduction in two soil slurries using EVO and nutrients. Molybdenum bioreduction was observed in both slurries, with Slurry 2 showing faster kinetics than Slurry 1. Adding a sulfate-reducing bacteria culture reduced the lag time in microcosm 4.

Boron reduction was not observed in either slurry under anaerobic conditions, while lithium reduction was slightly observed in Slurry 2, but not in Slurry 1. The lithium reduction may be due to adsorption/ion exchange rather than bioreduction.

Dissolved iron increased in microcosms 2, 3, and 4 as the microcosms became anaerobic and formed ferrous iron. For Slurry 1, microcosm 4, iron decreased in the last two samples, indicating the formation of iron sulfide. Sulfur initially increased then decreased over time in microcosms 2, 3, and 4 as sulfide reducing conditions were established.

The study found that EVO and nutrients are effective in producing reducing conditions that stabilize molybdenum in the slurries, but not boron. The study also found that reducing conditions have minimal effect on lithium and the effectiveness may be sample-dependent.

Aerobic desorption testing was performed to assess the stability of molybdenum boron, and lithium in an aerobic environment. The soil from each microcosm is mixed with aerated groundwater and analyzed for the elements. The results show that most of the molybdenum is desorbed in the first elution, while boron and lithium remains stable. The data shows bioreduction is effective in reducing dissolved molybdenum concentration, However, if conditions become aerobic, molybdenum will mobilize.

Haley & Aldrich, Inc.
FB Culley
April 11, 2024

Sincerely,



Andrew Wenzel
Principal

APPENDIX B
Groundwater Sampling

LOW-FLOW SAMPLING FIELD FORM

HALEY ALDRICH

Monitoring Well I.D.: CCR-AP-1R	Date: 6-13-23	Time Started: 10:10	File Number: 0129420
Weather Conditions: 75° Sunny		Time Ended:	Field Personnel: Britton Hundley, Francis Reed

Initial Readings

Measured Well Bottom (TOR-ft) —	Riser Pipe Diameter (in.) 2"
Measured Water Level (TOR-ft) 56.82	PID background (ppm) —
Notes: Transducer removed from well at 10:15 am.	PID headspace (ppm) —

Well Condition

Well Riser Type (place an X in one box)			Stainless Steel		Carbon Steel		PVC
Casing Condition:	OK	✓	Repair Required:				
Cap Condition:	OK	✓	Repair Required:				
Paint Condition:	OK	✓	Repair Required:				
Lock Condition:	OK	✓	Repair Required:				
Inner Casing Condition:	OK	✓	Repair Required:				
Surface Seal Condition:	OK	✓	Repair Required:				
Other:	OK		Repair Required:				

Purge Information

Purging Method:		Peristaltic Pump		Bladder Pump		Grundfos Pump		Other: Hydrostleeve	
Purge Start Time: —									
Water Level Prior to Purging (TOR ft.)						Water Level After Purging (TOR ft.)			
Amount Purged: —						Flow Rate (mL per minute): —			
Comments: Sampled via Hydrastleeve									

Time	Temperature (deg C) +/-0.5	pH +/-0.2	Conductivity (mS/cm) +/-3%	Turbidity (NTUs) +/-10%	Dissolved Oxygen (mg/L) +/-0.2 or 10%	Redox (ORP) +/-20	Water Level (TOR ft) +/-0.1	Comments
	Fe_{2+}	2 ppm.						

Sampling Information

Date: 6-13-23	Time Sampled:				Field Personnel: Britton Hundley		
Measured Water Level (TOR ft):							
Sampling Method: (place X in box)		Stainless Steel Bailer		Peristaltic Pump		Grundfos Pump	Teflon Bailer
		Polyethylene Bailer		Bladder Pump		Other: Hydrostleeve	
Analysis: Appx III & IV, Sulfide, Fe, Mn, Al, TOC, Alkalinity, General Ions, MNA + EVal							
Sample ID: CCR-AP-1R-061323							
Odor:				Appearance:			
QA/QC Samples Taken: None							
Comments:							
Sampler (Print) Britton Hundley			Sampler (signature):			Date: 6-13-23	

LOW-FLOW SAMPLING FIELD FORM

HALEY ALDRICH

Monitoring Well I.D.: CCR-AP-5	Date: 06/13/23	Time Started: 1548	File Number:
Weather Conditions: Sunny		Time Ended: 1830	Field Personnel: Francis Reed

Initial Readings

Measured Well Bottom (TOR-ft)	-	Riser Pipe Diameter (in.)	2
Measured Water Level (TOR-ft)	13.24	PID background (ppm)	-
Notes: Pump set @ 39.5'		PID headspace (ppm)	-

Well Condition

Well Riser Type (place an X in one box)		Stainless Steel		Carbon Steel	X	PVC	
Casing Condition:	OK		Repair Required:				
Cap Condition:	OK		Repair Required:				
Paint Condition:	OK		Repair Required:				
Lock Condition:	OK		Repair Required:				
Inner Casing Condition:	OK		Repair Required:				
Surface Seal Condition:	OK		Repair Required:				
Other:	OK		Repair Required:				

Purge Information

Purging Method:		Peristaltic Pump	X	Bladder Pump		Grundfos Pump		Other:	
Purge Start Time: 1710									
Water Level Prior to Purging (TOR ft.) 13.24					Water Level After Purging (TOR ft.) 13.29				
Amount Purged: 5 gal.					Flow Rate (mL per minute): 300				
Comments: 1555 pulled Transducer									

Time	Temperature (deg C) +/-0.5	pH +/-0.2	Conductivity (mS/cm) +/-3%	Turbidity (NTUs) +/-10%	Dissolved Oxygen (mg/L) +/-0.2 or 10%	Redox (ORP) +/-20	Water Level (TOR ft) +/-0.1	Comments
0	19.47	7.33	2.24	288	6.40	-71	13.45	
5	18.80	7.20	2.28	184	0.00	-85	13.50	
10	18.59	7.18	2.29	152	0.00	-87	13.46	
15	18.40	7.16	2.32	109	0.00	-89	13.49	
20	18.29	7.14	2.32	79.4	0.00	-89	13.44	Grey turbid
25	18.16	7.13	2.33	60.0	0.00	-91	13.49	
30	18.13	7.13	2.34	48.4	0.00	-91	13.50	
35	18.10	7.14	2.35	41.9	0.00	-92	13.50	
40	18.08	7.10	2.36	37.1	0.00	-91	13.52	
45	18.01	7.11	2.36	28.9	0.00	-92	13.51	
50	17.99	7.10	2.36	25.5	0.00	-91	13.50	
55	18.00	7.09	2.37	23.1	0.00	-91	13.48	
60	17.94	7.08	2.37	20.4	0.00	-90	13.51	

Sampling Information

Date: 6/13/23	Time Sampled: 1815				Field Personnel: FR		
Measured Water Level (TOR ft): 13.48							
Sampling Method: (place X in box)		Stainless Steel Bailer		Peristaltic Pump		Grundfos Pump	Teflon Bailer
		Polyethylene Bailer	X	Bladder Pump		Other:	
Analysis: CCR-AP-5-061323, see below for analysis							
Sample ID: CCR-AP-5-061323							
Odor: None Detected				Appearance: Clear in sampling block			
~~QA/QC Samples Taken~~: App. III, App. IV, Fe^{2+}, TOC, Alk, Tot. Metals, Diss Metals, General Ions							
Comments: Fe^{2+} read 2-3 ppm							
Sampler (Print) Francis Reed	Sampler (signature): Francis Reed				Date: 6/13/23		

LOW-FLOW SAMPLING FIELD FORM

HALEY ALDRICH

Monitoring Well I.D.: CCR-AP-6I	Date: 6/13/23	Time Started: 1110	File Number: 0129420
Weather Conditions: 80°F Sunny		Time Ended:	Field Personnel: Francis Reed, Britton Hundley

Initial Readings

Measured Well Bottom (TOR-ft) –	Riser Pipe Diameter (in.) 2"
Measured Water Level (TOR-ft) 39.12	PID background (ppm) –
Notes: Dedicated pump	PID headspace (ppm) –

Well Condition

Well Riser Type (place an X in one box)		Stainless Steel		Carbon Steel	X	PVC

Casing Condition:	OK		Repair Required:
Cap Condition:	OK		Repair Required:
Paint Condition:	OK		Repair Required:
Lock Condition:	OK		Repair Required:
Inner Casing Condition:	OK		Repair Required:
Surface Seal Condition:	OK		Repair Required:
Other:	OK		Repair Required:

Purge Information

Purging Method:		Peristaltic Pump	X	Bladder Pump		Grundfos Pump		Other:

Purge Start Time: 1116 11:16	
Water Level Prior to Purging (TOR ft.) 39.12	Water Level After Purging (TOR ft.)
Amount Purged:	Flow Rate (mL per minute): ~400 mL/min
Comments:	

Time	Temperature (deg C) +/-0.5	pH +/-0.2	Conductivity (mS/cm) +/-3%	Turbidity (NTUs) +/-10%	Dissolved Oxygen (mg/L) +/-0.2 or 10%	Redox (ORP) +/-20	Water Level (TOR ft) +/-0.1	Comments
1120	19.43	6.67	3.04	12.7	2.16	60	transducer	1.6 L purged
1128	19.06	7.00	3.02	12.3	~~3.00~~ 0.24	-65	down hole	4 L purged
1133	19.05	7.02	3.04	6.1	0.14	-69		5.3 L purged
1141	19.11	7.03	3.05	2.6	0.04	-71		7.8 L purged
1144	19.12	7.03	3.07	1.5	0.01	-72		9 L purged
~~1147~~						-		
1152	19.05	7.26	3.06	1.2	0.11	-73		11 L purged
	Fe2+ reading: 1 ppm							

Sampling Information

Date: 6-13-23	Time Sampled: 1150	Field Personnel: Britton Hundley
Measured Water Level (TOR ft):		

Sampling Method: (place X in box)		Stainless Steel Bailer		Peristaltic Pump		Grundfos Pump		Teflon Bailer
		Polyethylene Bailer	X	Bladder Pump		Other:		

Analysis: Appx III & IV, MNA + Eval, Microbiological (12:40)	
Sample ID: CCR-AP-6I-061323	
Odor: None	Appearance: Clear
QA/QC Samples Taken: None	
Comments:	

Sampler (Print) Britton Hundley	Sampler (signature):	Date: 6-13-23

LOW-FLOW SAMPLING FIELD FORM

HALEY ALDRICH

Monitoring Well I.D.: CCR-AP-8I	Date: 6-13-23	Time Started: 13:20	File Number: 0129420
Weather Conditions: 80s Sunny		Time Ended:	Field Personnel: Francis Read, Britton Hundley

Initial Readings

Measured Well Bottom (TOR-ft) –	Riser Pipe Diameter (in.) 2"
Measured Water Level (TOR-ft) 35.52	PID background (ppm) –
Notes: Dedicated pump	PID headspace (ppm) –

Well Condition

Well Riser Type (place an X in one box)		Stainless Steel		Carbon Steel	X	PVC
Casing Condition:	OK	✓	Repair Required:			
Cap Condition:	OK	✓	Repair Required:			
Paint Condition:	OK	✓	Repair Required:			
Lock Condition:	OK		Repair Required:			
Inner Casing Condition:	OK	✓	Repair Required:			
Surface Seal Condition:	OK	✓	Repair Required:			
Other:	OK		Repair Required:			

Purge Information

Purging Method:		Peristaltic Pump	X	Bladder Pump		Grundfos Pump		Other:

Purge Start Time: 13:25

Water Level Prior to Purging (TOR ft.)	Water Level After Purging (TOR ft.)
Amount Purged: 10 Liters	Flow Rate (mL per minute): 360 mL/min
Comments:	

Time	Temperature (deg C) +/-0.5	pH +/-0.2	Conductivity (mS/cm) +/-3%	Turbidity (NTUs) +/-10%	Dissolved Oxygen (mg/L) +/-0.2 or 10%	Redox (ORP) +/-20	Water Level (TOR ft) +/-0.1	Comments
1334	18.57	6.84	3.69	1.6	0.00	-136	transducer	
1345	18.46	6.87	3.71	0.0	0.00	-142		
1350	18.44	6.87	3.71	0.0	0.00	-142		
1353	18.41	6.87	3.69	0.0	0.00	-142	10	L purged.

Fe^{2+} reading: > 10 ppm

Sampling Information

Date: 6-13-23	Time Sampled: 1400	Field Personnel: BH

Measured Water Level (TOR ft):

Sampling Method: (place X in box)		Stainless Steel Bailer		Peristaltic Pump		Grundfos Pump		Teflon Bailer
		Polyethylene Bailer	X	Bladder Pump		Other:		

Analysis: Appx III, ~~IV~~, Microbiological

Sample ID: CCR-AP-8I-061323

Odor: none	Appearance: Clear

QA/QC Samples Taken: None

Comments: None

Sampler (Print)	Sampler (signature)	Date
Britton Hundley		6-13-23

APPENDIX C
Comprehensive Data Table

SUMMARY OF ANALYTICAL RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, IN

Monitoring Well ID		Sample Date	Inorganic Compounds	Speciation		Field Parameters			Other		Inorganic Compounds					Other	Speciation				
			Iron, Dissolved	Arsenic (III)-	Arsenic (V)	Dissolved Oxygen, Field	ORP, Field	pH, Field	Sulfate	Organic Carbon (TOC) -	Arsenic, Total	Boron, Total	Iron, Total	Lithium, Total	Molybdenum, Total	Sulfide, Total	Arsenic	Arsenic (III)-	Arsenic (III)+	Arsenic (V)	Arsenic (V)
			ug/L	ug/L	ug/L	ug/L	mv	pH units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Background	CCR-AP-1R	06/10/2016				1280	-148.68	7.38	180000 J-		4.5	510		45 J	15						
		08/12/2016				130	-11.7	7.87	180000		6.7	540		53	13						
		10/28/2016				600	-171.8	7.85	110000 J+		2.4	650		35 J	6						
		12/07/2016				11680	-247.3	8.12	130000		3.6	680 J+		35 J	4.7 J						
		02/08/2017				8290	-60.52	8	140000		6.8	690 J+		43 J	7.3						
		04/06/2017				3130	15.79	8.01	150000		12	620		63	6.7						
		06/07/2017				3200	90.06	8.33	150000		8	720 J+		49 J	7.3						
		09/28/2017				1010	-41.88	7.46	160000		5.5	440		36 J	8						
		11/17/2017				8880	-14.37	7.72	170000 J-		7.5	820 J+		59 J	13 J						
		06/11/2018				2110	339	7.68			29			170	10 J						
		08/28/2018				1100	35.98	7.6	150000		23	610 J		130	7.7 J						
		05/28/2019				4510	79.4	7.82	190000		38	720 J-		160	10						
		10/23/2019				2010	-48.7	7.48	180000		37	430		230	12 J						
		05/19/2020				1370	-33.7	7.61	180000		25	740		130	9.6 J						
		11/13/2020				6070	-54.1	8.2	220000 J+		8.6	770		52	7.3						
		05/13/2021				2040	-6.8	7.56	210000		23	820		96	9.9 J						
		11/22/2021				3370	-62.9	7.43	210000		30	860		120	7.3						
		05/10/2022				6130	79.5	7.72	210000		34	690 J+		150	23						
		11/29/2022				4890	-0.6	7.64	250000		18	650		130	9.3						
		05/23/2023							250000		12	730		76	9.2						
		06/13/2023	20000						260000	1200	5.5	680		41	8.7	3000 U					
		07/28/2023							300000		16	690		85	6.7						
		11/02/2023				4190	14.88	7.19	340000		15	740		120	5						
		12/22/2023																			
Background	CCR-AP-7	06/10/2016				210	-105.35	7.05	93000 J-		2.5	34 J+		10 J	8.2						
		08/12/2016				150	-152	7.13	73000		4.8	34 U		11 J	5.4						
		10/28/2016				690	-141.57	7.77	66000 J+		8.4	20 J+		20 J	4.4 J						
		12/07/2016				230	-146.4	7.34	96000		8.3	71 U		12 J	8.8						
		02/08/2017				-20	-80.23	7.21	110000		18	34 U		39 J	13						
		04/06/2017				-20	-115.03	7.24	110000		8	80 U		19 J	5.8						
		06/07/2017				90	-143.84	7.18	100000		7.5	150 U		19 J	6.9						
		09/28/2017				130	-153.3	7.11	82000		5.8	56 J		10 J	3.6 J						
		11/17/2017				210	-103.98	7.02	77000 J-		3.4	91 U		12 J	2.8 J						
		06/11/2018				90	157	6.96			7.1			11	2.5 J						
		08/28/2018				370	-147.12	7.14	70000		6.4	80 U		13	2.6 J						
		05/28/2019				30	-131.2	7.42	82000		3.7	280 J		11	2 J						
		10/23/2019				180	-111.5	7.01	65000		7.5	80 U		20 J+	1.7 J						
		02/19/2020				1610	-75.1	7.13	45000 J+		4	82 U		11	1.5 J						
		03/30/2020				130	-44.2	7.12	76000		1.8	47 J		10	1.4 J						
		05/18/2020				50	-129.6	7.29	76000		15	120		18	2 J						
		11/12/2020				490	-85.4	6.82	78000 J+		6.2	120 U		9.9	1.1 J						
		05/07/2021				170	22.6	6.99	95000		0.77 J	160 U		9.1	1.9 J						
		11/04/2021				260	-120.3	7.19	75000 J		5.5	130 J		9.6	1.5 J						
		05/03/2022				310	-53.7	7.03	86000		0.66 J	66 J		7.2	1.4 J						
		11/22/2022				680	-48	7.1	76000		4 J	49 J-		7 J	1.4 J						
		05/22/2023				420	-74.8	7.13	110000		4 J	100 U		10	1.8 J						
		11/06/2023				50	-111.4	7.26	84000		1.9 J	50 U		11	5 U						
Background	CCR-AP-9	03/09/2017				3720	-33.4	7.61	130000		3.1	200		30 J	11						
		04/07/2017				4250	-38	8.25	120000		6	230		33 J	9.7						
		04/26/2017				4360	-4.1	7.38	120000		8	260 J+		40 J	7.1						
		05/30/2017				3160	72.93	6.09	110000		10	260		40 J	6.5						
		06/08/2017				2560	15.83	9.11	110000		7.7	290 U		34 J	5.9						
		07/25/2017				990	107.35	7.78	90000		10	250		48 J	5.9						
		08/15/2017				3390	66.57	7.73	110000		8.7	220		36 J	2.7 J						
		09/28/2017				3760	-25.8	7.44	120000		5.8	290		29 J	4.3 J						
		11/17/2017				2380	-38.27	7.31	120000 J-		8.8	340 U		50 J	6.9 J						
		06/11/2018				1960	381	7.25			9.1			48	4.8 J						
		08/28/2018				3690	42.91	7.63	99000		32	340 J		120	12 J						
		05/28/2019				3750	-32.9	7.56	100000		7.8	410 J		41	3.8 J						
		10/22/2019				7720	-8.3	7.51	120000		13	360 J		72	4.9 J						
		05/19/2020				4090	-8.2	7.76	120000		5.5	550 J+		37	2.8 J						

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APPENDIX D
Sequential Extraction Results

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

August 16, 2023

Report to:
Todd Plating
Haley Aldrich
400 Augusta Street
Suite 100
Greenville, SC, 29601, SC 29601

cc: Britton Hundley

Bill to:
Accounts Payable
Haley Aldrich
70 Blanchard Rd, Ste. 204

Burlington, MA 01803

Project ID: 0129420-032-001-01
ACZ Project ID: L81964

Todd Plating:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on July 24, 2023. This project has been assigned to ACZ's project number, L81964. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L81964. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after August 15, 2024. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Madeleine Murray
Madeleine Murray has reviewed and approved this report.

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523

ACZ Sample ID: ***L81964-01***
Date Sampled: *06/15/23 11:30*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Sequential Batch Extraction	Tessier, et al.								06/27/23 8:00	jpb

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523 STEP-0

ACZ Sample ID: ***L81964-02***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	10	2.58		*	mg/L	0.5	2.5	08/09/23 9:31	wtc
Iron, dissolved	M200.7 ICP	10	3.33		*	mg/L	0.6	1.5	08/09/23 9:31	wtc
Manganese, dissolved	M200.7 ICP	10	0.366	B	*	mg/L	0.1	0.5	08/09/23 9:31	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	0.135		*	mg/L	0.004	0.01	08/09/23 15:46	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523 STEP-1

ACZ Sample ID: ***L81964-03***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	20	<1	U	*	mg/L	1	5	08/09/23 9:40	wtc
Iron, dissolved	M200.7 ICP	20	<1.2	U	*	mg/L	1.2	3	08/09/23 9:40	wtc
Manganese, dissolved	M200.7 ICP	20	3.04		*	mg/L	0.2	1	08/09/23 9:40	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	0.0191		*	mg/L	0.004	0.01	08/09/23 16:07	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523 STEP-2

ACZ Sample ID: ***L81964-04***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	5.26		*	mg/L	0.25	1.25	08/09/23 9:43	wtc
Iron, dissolved	M200.7 ICP	5	0.797		*	mg/L	0.3	0.75	08/09/23 9:43	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/09/23 9:43	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	0.0848		*	mg/L	0.002	0.005	08/09/23 16:30	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523 STEP-3

ACZ Sample ID: ***L81964-05***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	2.76		*	mg/L	0.25	1.25	08/09/23 9:46	wtc
Iron, dissolved	M200.7 ICP	5	17.8		*	mg/L	0.3	0.75	08/09/23 9:46	wtc
Manganese, dissolved	M200.7 ICP	5	1.82		*	mg/L	0.05	0.25	08/09/23 9:46	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 17:17	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523 STEP-4

ACZ Sample ID: ***L81964-06***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	4.22		*	mg/L	0.25	1.25	08/09/23 9:49	wtc
Iron, dissolved	M200.7 ICP	5	13.7		*	mg/L	0.3	0.75	08/09/23 9:49	wtc
Manganese, dissolved	M200.7 ICP	5	0.141	B	*	mg/L	0.05	0.25	08/09/23 9:49	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 17:38	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523 STEP-5

ACZ Sample ID: ***L81964-07***
Date Sampled: *06/30/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	4.51		*	mg/L	0.25	1.25	08/09/23 9:52	wtc
Iron, dissolved	M200.7 ICP	5	5.63		*	mg/L	0.3	0.75	08/09/23 9:52	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/09/23 9:52	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	0.0212	B	*	mg/L	0.01	0.025	08/09/23 17:59	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CMA-SB-01(54-55)-061523 STEP-6

ACZ Sample ID: ***L81964-08***
Date Sampled: *06/15/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, total (3050)	M6010D ICP	100	6430		*	mg/Kg	5	25	08/08/23 13:20	aeh
Iron, total (3050)	M6010D ICP	100	11500		*	mg/Kg	6	15	08/08/23 13:20	aeh
Manganese, total (3050)	M6010D ICP	100	63.4		*	mg/Kg	1	5	08/08/23 13:20	aeh
Molybdenum, total (3050)	M6020B ICP-MS	500	1.36		*	mg/Kg	0.1	0.25	08/07/23 23:00	kja

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Digestion - Hot Plate	M3050B ICP-MS								08/02/23 12:50	mgg
Digestion - Hot Plate	M3050B ICP								08/02/23 12:50	mgg

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click:
https://acz.com/wp-content/uploads/2019/04/Ext-Qual-List.pdf

REP001.03.15.02

HALEYALD

ACZ Project ID: ***L81964***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Aluminum, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		2.028	mg/L	101	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.15	0.15			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.001		1.016	mg/L	101	85	115			
L81964-02AS	AS	08/09/23 9:34	II230801-2	10.01	2.58	16.51	mg/L	139	85	115			M1
L81964-02ASD	ASD	08/09/23 9:37	II230801-2	10.01	2.58	17.27	mg/L	147	85	115	4	20	M1

Aluminum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.026	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.15	0.15			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-15	15			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	8040		7114	mg/Kg		3830	12200			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	8040		8177	mg/Kg		3830	12200	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.1	3990	14280	mg/Kg	10280	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.1	3990	15270	mg/Kg	11269	75	125	7	20	M3

Arsenic, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	4		3.914	mg/L	98	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.12	0.12			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-12	12			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	183		148.6	mg/Kg		152	214			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	183		163.6	mg/Kg		152	214	10	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.18	91.5	204.9	mg/Kg	113	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.18	91.5	202.5	mg/Kg	111	75	125	1	20	

Boron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.013	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.09	0.09			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-9	9			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	95.3		84.06	mg/Kg		67.7	123			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	95.3		92.32	mg/Kg		67.7	123	9	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	3.95	65.39	mg/Kg	123	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	3.95	56.91	mg/Kg	106	75	125	14	20	

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.944	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.18	0.18			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.004		.987	mg/L	98	85	115			
L81964-02AS	AS	08/09/23 9:34	II230801-2	10.04	3.33	15.17	mg/L	118	85	115			M1
L81964-02ASD	ASD	08/09/23 9:37	II230801-2	10.04	3.33	15.47	mg/L	121	85	115	2	20	M1

HALEYALD

ACZ Project ID: ***L81964***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Iron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.939	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.18	0.18			
WG571490PBS	PBS	08/08/23 13:09				7.98	mg/Kg		-18	18			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	14000		12330	mg/Kg		8420	19600			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	14000		14300	mg/Kg		8420	19600	15	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.4	8710	8237	mg/Kg	-411	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.4	8710	9388	mg/Kg	735	75	125	13	20	M3

Lithium, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.027	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.024	0.024			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-2.4	2.4			
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.3	1.06	83.24	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.3	1.06	97.55	mg/Kg	96	75	125	16	20	

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.939	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.03	0.03			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	.4995		.499	mg/L	100	85	115			
L81964-02AS	AS	08/09/23 9:34	II230801-2	4.995	.366	5.39	mg/L	101	85	115			
L81964-02ASD	ASD	08/09/23 9:37	II230801-2	4.995	.366	5.39	mg/L	101	85	115	0	20	

Manganese, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.942	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.03	0.03			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-3	3			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	381		297.5	mg/Kg		311	450			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	381		341.3	mg/Kg		311	450	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	49.95	10.9	76.52	mg/Kg	131	75	125			MA
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	49.95	10.9	72.93	mg/Kg	124	75	125	5	20	

HALEYALD

ACZ Project ID: ***L81964***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Molybdenum, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571954													
WG571954ICV	ICV	08/09/23 15:39	MS230712-3	.02		.02011	mg/L	101	90	110			
WG571954ICB	ICB	08/09/23 15:41				U	mg/L		-0.00044	0.00044			
WG571954LFB	LFB	08/09/23 15:44	MS230724-2	.05005		.04916	mg/L	98	85	115			
L81964-02AS	AS	08/09/23 15:48	MS230724-2	1.001	.135	1.1487	mg/L	101	70	130			
L81964-02ASD	ASD	08/09/23 15:51	MS230724-2	1.001	.135	1.18622	mg/L	105	70	130	3	20	
WG571986													
WG571986ICV	ICV	08/09/23 17:10	MS230712-3	.02		.01893	mg/L	95	90	110			
WG571986ICB	ICB	08/09/23 17:12				U	mg/L		-0.00044	0.00044			
WG571986LFB	LFB	08/09/23 17:14	MS230724-2	.05005		.04652	mg/L	93	85	115			
L81964-05AS	AS	08/09/23 17:19	MS230724-2	2.5025	U	2.49646	mg/L	100	70	130			
L81964-05ASD	ASD	08/09/23 17:21	MS230724-2	2.5025	U	2.45733	mg/L	98	70	130	2	20	

Molybdenum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.948	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.06	0.06			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-6	6			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	179		146.3	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	179		163.9	mg/Kg		143	215	11	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	U	40.92	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	U	47.38	mg/Kg	95	75	125	15	20	

Molybdenum, total (3050) M6020B ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571829													
WG571829ICV	ICV	08/07/23 22:38	MS230712-3	.02		.02191	mg/L	110	90	110			
WG571829ICB	ICB	08/07/23 22:40				U	mg/L		-0.0006	0.0006			
WG571490PBS	PBS	08/07/23 22:49				U	mg/Kg		-0.3	0.3			
WG571490LCSS	LCSS	08/07/23 22:51	PCN624760	179		172.42348	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/07/23 22:53	PCN624760	179		183.0353	mg/Kg		143	215	6	20	
L81676-01MS	MS	08/07/23 22:57	MS230504-4	25.77575	1.05	20.44554	mg/Kg	75	75	125			
L81676-01MSD	MSD	08/07/23 22:59	MS230504-4	25.77575	1.05	19.63632	mg/Kg	72	75	125	4	20	MA

Haley Aldrich

ACZ Project ID: ***L81964***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L81964-02	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
L81964-03	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
L81964-04	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
L81964-05	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81964-06	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81964-07	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81964-08	WG571824	Aluminum, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, total (3050)	M6010D ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
			M6010D ICP	RL	Recovery for either the LCS or LCS duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571829	Molybdenum, total (3050)	M6020B ICP-MS	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.

Certification Qualifiers

Haley Aldrich

ACZ Project ID: ***L81964***

Metals Analysis

The following parameters are not offered for certification or are not covered by NELAC certificate #ACZ.

Aluminum, dissolved	M200.7 ICP
Iron, dissolved	M200.7 ICP
Manganese, dissolved	M200.7 ICP
Molybdenum, dissolved	M200.8 ICP-MS

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich

ACZ Project ID: L81964
Date Received: 07/25/2023 08:50
Received By:
Date Printed: 8/9/2023

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?		X	
4) Are any samples NRC licensable material?			X
5) If samples are received past hold time, proceed with requested short hold time analyses?	X		
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?		X	

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

NA indicates Not Applicable

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
NA40828	5	NA	15	N/A
UNKNOWN		NA		

Was ice present in the shipment container(s)?

No - Wet or gel ice was not present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich

ACZ Project ID:	L81964
Date Received:	07/25/2023 08:50
Received By:	
Date Printed:	8/9/2023

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ LABORATORIES | Accredited Environmental Testing | 2773 Downhill Drive Steamboat Springs, CO 80487 (970) 879-6590 | ~~L81307~~

CHAIN of CUSTODY

Report to:

Name: Todd Plating
Company: Haley and Aldrich
E-mail: tplating@haleyaldrich.com
Address: 400 Augusta Street Suite 100
Greenville, SC 29601
Telephone: 864-420-8656

Copy of Report to:

Name: Jacob Chu
Company: Haley and Aldrich
E-mail: jchu@haleyaldrich.com
Telephone:

Invoice to:

Name: Accounts Payable
Company: Haley and Aldrich
E-mail: accountspayable@haleyldrich.com
Address: 70 Blanchard Road Suite 204
Burlington, Massachusetts 01803
Telephone: 617-886-7400

Copy of Invoice to:

Name: Neal Kochis
Company: Haley and Aldrich
E-mail: Nkochis@haleyaldrich.com
Address:
Telephone: 216-399-3075

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? YES ☐ NO ☐

If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes ☐ No ☑

If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: Britton Hundley **Sampler's Site Information** State IN Zip code _____ Time Zone CST

***Sampler's Signature:** _____

*I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: FB Culley EAP NA FFE
PO#: 0129420-032-001-01
Reporting state for compliance testing: NA
Check box if samples include NRC licensed material? ☐

ANALYSES REQUESTED *(attach list or use quote number)*

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	7 Step SE								
CMA-SB-01(54-55)-061523	6/15/23 11:30	SO	1	✓								Hold
CLR-SB-AP4R(14-15)-061423	6/14/23 8:25	SO	1	✓								
CLR-SB-AP5(14-15)-061423	6/14/23 9:30	SO	1	✓								
CLR-SB-AP6I(48.7-49.7)-061523	6/15/23 16:40	SO	1	✓								
CLR-SB-AP8I(53.5-54.5)-061423	6/14/23 15:00	SO	1	✓								
		S	1	✓								
		S	1	✓								
		S	1	✓								

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

~~Hold for analysis pending project manager approval.~~ Metals analysis (Al, Fe, Mn, Mo) via 6020 (ICP-MS)

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
[signature]	6/20/23 17:00	[signature]	6/21/23 11:33

Qualtrax ID: 1984 Revision #: 2 White - Return with sample. Yellow - Retain for your records.

L81307 Chain of Custod

Casey Portela, P.G.
Haley & Aldrich
Office: (864) 214-8753
Mobile: (607) 349-9162

4/5/2023

Quote# Haley & Aldrich 6 Step-Tessier FB Culley Site April 2023

Re: Modified Six Step Tessier Sequential Batch Testing: 4 Samples
Project is: FB Culley Site

Parameter	Cost/ Sample
Six Step Sequential Extraction ($95.00 per step)	570.00
6 steps for metals: Fe, Mn, Al, and Mo via ICP/ICPMS ($135 per step)	810.00
Sample prep: Samples air-dry and sieve <60	40.00
Total Cost / Sample	**$1,420.00**

Total cost for 4 Samples for 6 step Tessier: $5,680.00

Sample Prep: ACZ will be prepping 20 grams of <.25 mm sieved, air-dried sample.

Extraction Step	Molybdenum Sequential Extraction Method Modified from Tessier and BCR		Extraction Details		Analytes
	Fractions	Reagents	Extraction Protocol	Method Reference	EPA 6010/ 6020
F1	Exchangeable, water soluble	1M $MgCl_2$ (pH~7.0) 10mL	0.5 gram of solid sample, room temperature, continuous agitation for 2 hours.	(1)	As, Mn, Mo, V
F2	Bound to organic matter	0.1M NaOH 10mL	This step will be applied only when the TOC soil concentration (mg/Kg) is > 0.2%. Residue from Step F1 be washed with 10 mL Milli-Q or DI water first; shaking rinsed solids in a tube with reagents at room temperature for 30 mins. Bathe the tube in ultrasonic cleaner for 2 hours	(2)	As, Mn, Mo, V
F3	Bound to carbonate	1.0M CH_3COONa adjust to pH 5 with CH_3COOH 10 mL	Solid residue from Step F2, room temperature, continuous agitation for 4 hours.	(3)	Al, As, Ca, Fe Mn, Mo, V
F4	HFO/ HAO/ HMO	0.25M NH_2OH HCl & 0.25M HCl combined solution 75 mL	Solids from the last step washed by Milli-Q or DI water first. Shaking rinsed solids with reagents under 50°C for 2 hours	(3)	Al, As, Fe, Mn, Mo, V
F5	Bound to sulfides	[1] 10mL 30% H_2O_2 (pH 2-3, adjusted by HNO_3) & [2] 20 mL CH_3COONH_4 (pH 2, adjusted by HNO_3)	Mix reagent [1] with residue from F4 at 40°C in a tube. Bathe the tube in ultrasonic cleaner for an hour with loose cap, followed by another 1 hour bath in ultrasonic cleaner at 80°C without cap. Repeat the process above. After cooled, Reagent [2] is added and shake for 2 hours.	(2)	Al, As, Fe, Mn, Mo, V
F6	Final Extraction	EPA total metals digest 3050B (SW-846)	Per EPA method	EPA 6020A/EPA 3050B (SW-846)	As, Fe, Mn, Mo, V

Notes:
(1) Tessier, A., Campbell, P.G. and Bisson, M., 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical chemistry, 51(7), pp.844-851.
(2) Liang, L. and Zhu, J.M., 2018. An optimized sequential extraction scheme for molybdenum association in environmental samples. Acta Geochimica, 37(2), pp.111-119.
(3) Chao, T.T. and Zhou, L., 1983. Extraction techniques for selective dissolution of amorphous iron oxides from soils and sediments. Soil Sci. Soc. Am. J., 47(2), pp.225-232.

Modified Tessier Specified by Client

Sequence 1: Water Soluble, DI Water, 30 mL to 2 gram of solid, Continuous Agitation

Sequence 2: Exchangeable, Cliend Mod

Sequence 3: Bound to Carbonates, Cleint Mod

Sequence 4: Bound to Fe-Mn Oxides, Client Mod

Sequence 5: Bound to Organic Matter, Client Mod

Sequence 6: Residual, Tessier Method (v) This is via EPA 3050 Digestion Client Mod

Quote expires in six months from date on quote .

This bid is based on standard T/A and standard reporting formats via PDF emailed reports.

Soils turn-around is ~ three to four weeks and varies with workload

Electronic Data Deliverables (EDD's) will be supplied at no extra charge if needed.

This quotation must be signed and returned (fax or mail) to ACZ Laboratories, Inc. before the project is received. The authorized signature represents acceptance of the pricing as well as ACZ's General Terms & Conditions.

ACZ Representative (Authorized Signature) / Date:

Client Representative (Authorized Signature) / Date:

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

August 16, 2023

Report to:
Todd Plating
Haley Aldrich
400 Augusta Street
Suite 100
Greenville, SC, 29601, SC 29601

cc: Britton Hundley

Bill to:
Accounts Payable
Haley Aldrich
70 Blanchard Rd, Ste. 204

Burlington, MA 01803

Project ID: 0129420-032-001-01
ACZ Project ID: L81965

Todd Plating:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on July 24, 2023. This project has been assigned to ACZ's project number, L81965. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L81965. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after August 15, 2024. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Madeleine Murray
Madeleine Murray has reviewed and approved this report.

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423

ACZ Sample ID: ***L81965-01***
Date Sampled: *06/14/23 08:25*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Sequential Batch Extraction	Tessier, et al.								06/27/23 8:00	jpb

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423 STEP-0

ACZ Sample ID: ***L81965-02***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	10	1.33	B	*	mg/L	0.5	2.5	08/09/23 9:55	wtc
Iron, dissolved	M200.7 ICP	10	<0.6	U	*	mg/L	0.6	1.5	08/09/23 9:55	wtc
Manganese, dissolved	M200.7 ICP	10	<0.1	U	*	mg/L	0.1	0.5	08/09/23 9:55	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	0.00455	B	*	mg/L	0.002	0.005	08/09/23 15:53	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423 STEP-1

ACZ Sample ID: ***L81965-03***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	20	<1	U	*	mg/L	1	5	08/09/23 10:05	wtc
Iron, dissolved	M200.7 ICP	20	<1.2	U	*	mg/L	1.2	3	08/09/23 10:05	wtc
Manganese, dissolved	M200.7 ICP	20	<0.2	U	*	mg/L	0.2	1	08/09/23 10:05	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 16:09	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423 STEP-2

ACZ Sample ID: ***L81965-04***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	<0.25	U	*	mg/L	0.25	1.25	08/09/23 10:08	wtc
Iron, dissolved	M200.7 ICP	5	<0.3	U	*	mg/L	0.3	0.75	08/09/23 10:08	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/09/23 10:08	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	<0.002	U	*	mg/L	0.002	0.005	08/09/23 16:33	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423 STEP-3

ACZ Sample ID: ***L81965-05***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	2.19		*	mg/L	0.25	1.25	08/09/23 10:11	wtc
Iron, dissolved	M200.7 ICP	5	0.599	B	*	mg/L	0.3	0.75	08/09/23 10:11	wtc
Manganese, dissolved	M200.7 ICP	5	2.95		*	mg/L	0.05	0.25	08/09/23 10:11	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 17:24	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423 STEP-4

ACZ Sample ID: ***L81965-06***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	4.01		*	mg/L	0.25	1.25	08/09/23 10:14	wtc
Iron, dissolved	M200.7 ICP	5	2.23		*	mg/L	0.3	0.75	08/09/23 10:14	wtc
Manganese, dissolved	M200.7 ICP	5	1.32		*	mg/L	0.05	0.25	08/09/23 10:14	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 17:40	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423 STEP-5

ACZ Sample ID: ***L81965-07***
Date Sampled: *06/30/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	6.94		*	mg/L	0.25	1.25	08/09/23 10:17	wtc
Iron, dissolved	M200.7 ICP	5	2.09		*	mg/L	0.3	0.75	08/09/23 10:17	wtc
Manganese, dissolved	M200.7 ICP	5	0.079	B	*	mg/L	0.05	0.25	08/09/23 10:17	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 18:01	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP1R(14-15)-061423 STEP-6

ACZ Sample ID: ***L81965-08***
Date Sampled: *06/15/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, total (3050)	M6010D ICP	100	14500		*	mg/Kg	5	25	08/08/23 13:24	aeh
Iron, total (3050)	M6010D ICP	100	36300		*	mg/Kg	6	15	08/08/23 13:24	aeh
Manganese, total (3050)	M6010D ICP	100	229		*	mg/Kg	1	5	08/08/23 13:24	aeh
Molybdenum, total (3050)	M6020B ICP-MS	500	0.286		*	mg/Kg	0.1	0.25	08/07/23 23:06	kja

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Digestion - Hot Plate	M3050B ICP-MS								08/02/23 13:04	mgg
Digestion - Hot Plate	M3050B ICP								08/02/23 13:04	mgg

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click:
https://acz.com/wp-content/uploads/2019/04/Ext-Qual-List.pdf

REP001.03.15.02

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ACZ Project ID: ***L81965***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Aluminum, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		2.028	mg/L	101	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.15	0.15			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.001		1.016	mg/L	101	85	115			
L81964-02AS	AS	08/09/23 9:34	II230801-2	10.01	2.58	16.51	mg/L	139	85	115			M1
L81964-02ASD	ASD	08/09/23 9:37	II230801-2	10.01	2.58	17.27	mg/L	147	85	115	4	20	M1
L81967-02AS	AS	08/09/23 10:47	II230801-2	10.01	2.39	14.81	mg/L	124	85	115			M1
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	10.01	2.39	14.96	mg/L	126	85	115	1	20	M1

Aluminum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.026	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.15	0.15			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-15	15			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	8040		7114	mg/Kg		3830	12200			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	8040		8177	mg/Kg		3830	12200	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.1	3990	14280	mg/Kg	10280	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.1	3990	15270	mg/Kg	11269	75	125	7	20	M3

Arsenic, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	4		3.914	mg/L	98	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.12	0.12			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-12	12			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	183		148.6	mg/Kg		152	214			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	183		163.6	mg/Kg		152	214	10	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.18	91.5	204.9	mg/Kg	113	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.18	91.5	202.5	mg/Kg	111	75	125	1	20	

Boron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.013	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.09	0.09			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-9	9			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	95.3		84.06	mg/Kg		67.7	123			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	95.3		92.32	mg/Kg		67.7	123	9	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	3.95	65.39	mg/Kg	123	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	3.95	56.91	mg/Kg	106	75	125	14	20	

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ACZ Project ID: ***L81965***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.944	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.18	0.18			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.004		.987	mg/L	98	85	115			
L81964-02AS	AS	08/09/23 9:34	II230801-2	10.04	3.33	15.17	mg/L	118	85	115			M1
L81964-02ASD	ASD	08/09/23 9:37	II230801-2	10.04	3.33	15.47	mg/L	121	85	115	2	20	M1
L81967-02AS	AS	08/09/23 10:47	II230801-2	10.04	3.03	13.82	mg/L	107	85	115			
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	10.04	3.03	15.12	mg/L	120	85	115	9	20	MA

Iron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.939	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.18	0.18			
WG571490PBS	PBS	08/08/23 13:09				7.98	mg/Kg		-18	18			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	14000		12330	mg/Kg		8420	19600			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	14000		14300	mg/Kg		8420	19600	15	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.4	8710	8237	mg/Kg	-411	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.4	8710	9388	mg/Kg	735	75	125	13	20	M3

Lithium, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.027	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.024	0.024			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-2.4	2.4			
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.3	1.06	83.24	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.3	1.06	97.55	mg/Kg	96	75	125	16	20	

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.939	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.03	0.03			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	.4995		.499	mg/L	100	85	115			
L81964-02AS	AS	08/09/23 9:34	II230801-2	4.995	.366	5.39	mg/L	101	85	115			
L81964-02ASD	ASD	08/09/23 9:37	II230801-2	4.995	.366	5.39	mg/L	101	85	115	0	20	
L81967-02AS	AS	08/09/23 10:47	II230801-2	4.995	.403	5.391	mg/L	100	85	115			
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	4.995	.403	5.455	mg/L	101	85	115	1	20	

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ACZ Project ID: ***L81965***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Manganese, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.942	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.03	0.03			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-3	3			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	381		297.5	mg/Kg		311	450			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	381		341.3	mg/Kg		311	450	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	49.95	10.9	76.52	mg/Kg	131	75	125			MA
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	49.95	10.9	72.93	mg/Kg	124	75	125	5	20	

Molybdenum, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571954													
WG571954ICV	ICV	08/09/23 15:39	MS230712-3	.02		.02011	mg/L	101	90	110			
WG571954ICB	ICB	08/09/23 15:41				U	mg/L		-0.00044	0.00044			
WG571954LFB	LFB	08/09/23 15:44	MS230724-2	.05005		.04916	mg/L	98	85	115			
L81964-02AS	AS	08/09/23 15:48	MS230724-2	1.001	.135	1.1487	mg/L	101	70	130			
L81964-02ASD	ASD	08/09/23 15:51	MS230724-2	1.001	.135	1.18622	mg/L	105	70	130	3	20	
WG571986													
WG571986ICV	ICV	08/09/23 17:10	MS230712-3	.02		.01893	mg/L	95	90	110			
WG571986ICB	ICB	08/09/23 17:12				U	mg/L		-0.00044	0.00044			
WG571986LFB	LFB	08/09/23 17:14	MS230724-2	.05005		.04652	mg/L	93	85	115			
L81964-05AS	AS	08/09/23 17:19	MS230724-2	2.5025	U	2.49646	mg/L	100	70	130			
L81964-05ASD	ASD	08/09/23 17:21	MS230724-2	2.5025	U	2.45733	mg/L	98	70	130	2	20	

Molybdenum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.948	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.06	0.06			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-6	6			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	179		146.3	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	179		163.9	mg/Kg		143	215	11	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	U	40.92	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	U	47.38	mg/Kg	95	75	125	15	20	

Molybdenum, total (3050) M6020B ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571829													
WG571829ICV	ICV	08/07/23 22:38	MS230712-3	.02		.02191	mg/L	110	90	110			
WG571829ICB	ICB	08/07/23 22:40				U	mg/L		-0.0006	0.0006			
WG571490PBS	PBS	08/07/23 22:49				U	mg/Kg		-0.3	0.3			
WG571490LCSS	LCSS	08/07/23 22:51	PCN624760	179		172.42348	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/07/23 22:53	PCN624760	179		183.0353	mg/Kg		143	215	6	20	
L81676-01MS	MS	08/07/23 22:57	MS230504-4	25.77575	1.05	20.44554	mg/Kg	75	75	125			
L81676-01MSD	MSD	08/07/23 22:59	MS230504-4	25.77575	1.05	19.63632	mg/Kg	72	75	125	4	20	MA

Haley Aldrich

ACZ Project ID: ***L81965***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L81965-02	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81965-03	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81965-04	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81965-05	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81965-06	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81965-07	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81965-08	WG571824	Aluminum, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, total (3050)	M6010D ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
			M6010D ICP	RL	Recovery for either the LCS or LCS duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571829	Molybdenum, total (3050)	M6020B ICP-MS	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.

Certification Qualifiers

Haley Aldrich

ACZ Project ID: ***L81965***

Metals Analysis

The following parameters are not offered for certification or are not covered by NELAC certificate #ACZ.

Aluminum, dissolved	M200.7 ICP
Iron, dissolved	M200.7 ICP
Manganese, dissolved	M200.7 ICP
Molybdenum, dissolved	M200.8 ICP-MS

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID: L81965
Date Received: 07/25/2023 08:50
Received By:
Date Printed: 8/9/2023

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?		X	
4) Are any samples NRC licensable material?			X
5) If samples are received past hold time, proceed with requested short hold time analyses?	X		
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?		X	

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

NA indicates Not Applicable

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
NA40828	5	NA	15	N/A
UNKNOWN		NA		

Was ice present in the shipment container(s)?

No - Wet or gel ice was not present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID:	L81965
Date Received:	07/25/2023 08:50
Received By:	
Date Printed:	8/9/2023

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ LABORATORIES | Accredited Environmental Testing | 2773 Downhill Drive Steamboat Springs, CO 80487 (970) 879-6590 | ~~L81307~~

CHAIN of CUSTODY

Report to:

Name: Todd Plating
Company: Haley and Aldrich
E-mail: tplating@haleyaldrich.com
Address: 400 Augusta Street Suite 100
Greenville, SC 29601
Telephone: 864-420-8656

Copy of Report to:

Name: Jacob Chu
Company: Haley and Aldrich
E-mail: jchu@haleyaldrich.com
Telephone:

Invoice to:

Name: Accounts Payable
Company: Haley and Aldrich
E-mail: accountspayable@haleyldrich.com
Address: 70 Blanchard Road Suite 204
Burlington, Massachusetts 01803
Telephone: 617-886-7400

Copy of Invoice to:

Name: Neal Kochis
Company: Haley and Aldrich
E-mail: Nkochis@haleyaldrich.com
Address:
Telephone: 216-399-3075

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? YES ☐ NO ☐

If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes ☐ No ☑

If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: Britton Hundley **Sampler's Site Information** State IN Zip code _____ Time Zone CST

***Sampler's Signature:** _____

*I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: FB Culley EAP NA FFE
PO#: 0129420-032-001-01
Reporting state for compliance testing: NA
Check box if samples include NRC licensed material? ☐

ANALYSES REQUESTED *(attach list or use quote number)*

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	7 Step SE								
CMA-SB-01(54-55)-061523	6/15/23 11:30	SO	1	✓								Hold
CLR-SB-AP4R(14-15)-061423	6/14/23 8:25	SO	1	✓								
CLR-SB-AP5(14-15)-061423	6/14/23 9:30	SO	1	✓								
CLR-SB-AP6I(48.7-49.7)-061523	6/15/23 16:40	SO	1	✓								
CLR-SB-AP8I(53.5-54.5)-061423	6/14/23 15:00	SO	1	✓								
		S	1	✓								
		S	1	✓								
		S	1	✓								

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

~~Hold for analysis pending project manager approval.~~ Metals analysis (Al, Fe, Mn, Mo) via 6020 (ICP-MS)

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
[signature]	6/20/23 17:00	[signature]	6/21/23 11:33

Qualtrax ID: 1984 Revision #: 2 White - Return with sample. Yellow - Retain for your records.

L81307 Chain of Custod

Casey Portela, P.G.
Haley & Aldrich
Office: (864) 214-8753
Mobile: (607) 349-9162

4/5/2023

Quote# Haley & Aldrich 6 Step-Tessier FB Culley Site April 2023

Re: Modified Six Step Tessier Sequential Batch Testing: 4 Samples
Project is: FB Culley Site

Parameter	Cost/ Sample
Six Step Sequential Extraction ($95.00 per step)	570.00
6 steps for metals: Fe, Mn, Al, and Mo via ICP/ICPMS ($135 per step)	810.00
Sample prep: Samples air-dry and sieve <60	40.00
Total Cost / Sample	**$1,420.00**

Total cost for 4 Samples for 6 step Tessier: $5,680.00

Sample Prep: ACZ will be prepping 20 grams of <.25 mm sieved, air-dried sample.

Extraction Step	Molybdenum Sequential Extraction Method Modified from Tessier and BCR		Extraction Details		Analytes
	Fractions	Reagents	Extraction Protocol	Method Reference	EPA 6010/ 6020
F1	Exchangeable, water soluble	1M $MgCl_2$ (pH~7.0) 10mL	0.5 gram of solid sample, room temperature, continuous agitation for 2 hours.	(1)	As, Mn, Mo, V
F2	Bound to organic matter	0.1M NaOH 10mL	This step will be applied only when the TOC soil concentration (mg/Kg) is > 0.2%. Residue from Step F1 be washed with 10 mL Milli-Q or DI water first; shaking rinsed solids in a tube with reagents at room temperature for 30 mins. Bathe the tube in ultrasonic cleaner for 2 hours	(2)	As, Mn, Mo, V
F3	Bound to carbonate	1.0M CH_3COONa adjust to pH 5 with CH_3COOH 10 mL	Solid residue from Step F2, room temperature, continuous agitation for 4 hours.	(3)	Al, As, Ca, Fe Mn, Mo, V
F4	HFO/ HAO/ HMO	0.25M NH_2OH HCl & 0.25M HCl combined solution 75 mL	Solids from the last step washed by Milli-Q or DI water first. Shaking rinsed solids with reagents under 50°C for 2 hours	(3)	Al, As, Fe, Mn, Mo, V
F5	Bound to sulfides	[1] 10mL 30% H_2O_2 (pH 2-3, adjusted by HNO_3) & [2] 20 mL CH_3COONH_4 (pH 2, adjusted by HNO_3)	Mix reagent [1] with residue from F4 at 40°C in a tube. Bathe the tube in ultrasonic cleaner for an hour with loose cap, followed by another 1 hour bath in ultrasonic cleaner at 80°C without cap. Repeat the process above. After cooled, Reagent [2] is added and shake for 2 hours.	(2)	Al, As, Fe, Mn, Mo, V
F6	Final Extraction	EPA total metals digest 3050B (SW-846)	Per EPA method	EPA 6020A/EPA 3050B (SW-846)	As, Fe, Mn, Mo, V

Notes:
(1) Tessier, A., Campbell, P.G. and Bisson, M., 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical chemistry, 51(7), pp.844-851.
(2) Liang, L. and Zhu, J.M., 2018. An optimized sequential extraction scheme for molybdenum association in environmental samples. Acta Geochimica, 37(2), pp.111-119.
(3) Chao, T.T. and Zhou, L., 1983. Extraction techniques for selective dissolution of amorphous iron oxides from soils and sediments. Soil Sci. Soc. Am. J., 47(2), pp.225-232.

Modified Tessier Specified by Client

Sequence 1: Water Soluble, DI Water, 30 mL to 2 gram of solid, Continuous Agitation

Sequence 2: Exchangeable, Cliend Mod

Sequence 3: Bound to Carbonates, Cleint Mod

Sequence 4: Bound to Fe-Mn Oxides, Client Mod

Sequence 5: Bound to Organic Matter, Client Mod

Sequence 6: Residual, Tessier Method (v) This is via EPA 3050 Digestion Client Mod

Quote expires in six months from date on quote .

This bid is based on standard T/A and standard reporting formats via PDF emailed reports.

Soils turn-around is ~ three to four weeks and varies with workload

Electronic Data Deliverables (EDD's) will be supplied at no extra charge if needed.

This quotation must be signed and returned (fax or mail) to ACZ Laboratories, Inc. before the project is received. The authorized signature represents acceptance of the pricing as well as ACZ's General Terms & Conditions.

ACZ Representative (Authorized Signature) / Date:

Client Representative (Authorized Signature) / Date:

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

August 16, 2023

Report to:
Todd Plating
Haley Aldrich
400 Augusta Street
Suite 100
Greenville, SC, 29601, SC 29601

cc: Britton Hundley

Bill to:
Accounts Payable
Haley Aldrich
70 Blanchard Rd, Ste. 204

Burlington, MA 01803

Project ID: 0129420-032-001-01
ACZ Project ID: L81966

Todd Plating:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on July 24, 2023. This project has been assigned to ACZ's project number, L81966. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L81966. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after August 15, 2024. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Madeleine Murray
Madeleine Murray has reviewed and approved this report.

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423

ACZ Sample ID: ***L81966-01***
Date Sampled: *06/14/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Sequential Batch Extraction	Tessier, et al.								06/27/23 8:00	jpb

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423 STEP-0

ACZ Sample ID: ***L81966-02***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	10	1.89	B	*	mg/L	0.5	2.5	08/09/23 10:20	wtc
Iron, dissolved	M200.7 ICP	10	1.02	B	*	mg/L	0.6	1.5	08/09/23 10:20	wtc
Manganese, dissolved	M200.7 ICP	10	<0.1	U	*	mg/L	0.1	0.5	08/09/23 10:20	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	0.00731		*	mg/L	0.002	0.005	08/09/23 15:55	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423 STEP-1

ACZ Sample ID: ***L81966-03***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	20	<1	U	*	mg/L	1	5	08/09/23 10:23	wtc
Iron, dissolved	M200.7 ICP	20	<1.2	U	*	mg/L	1.2	3	08/09/23 10:23	wtc
Manganese, dissolved	M200.7 ICP	20	1.24		*	mg/L	0.2	1	08/09/23 10:23	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 16:12	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423 STEP-2

ACZ Sample ID: ***L81966-04***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	<0.25	U	*	mg/L	0.25	1.25	08/09/23 10:26	wtc
Iron, dissolved	M200.7 ICP	5	<0.3	U	*	mg/L	0.3	0.75	08/09/23 10:26	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/09/23 10:26	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	0.00498	B	*	mg/L	0.002	0.005	08/09/23 16:35	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423 STEP-3

ACZ Sample ID: ***L81966-05***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	4.86		*	mg/L	0.25	1.25	08/09/23 10:29	wtc
Iron, dissolved	M200.7 ICP	5	1.88		*	mg/L	0.3	0.75	08/09/23 10:29	wtc
Manganese, dissolved	M200.7 ICP	5	4.17		*	mg/L	0.05	0.25	08/09/23 10:29	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 17:26	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423 STEP-4

ACZ Sample ID: ***L81966-06***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	3.36		*	mg/L	0.25	1.25	08/09/23 10:32	wtc
Iron, dissolved	M200.7 ICP	5	7.66		*	mg/L	0.3	0.75	08/09/23 10:32	wtc
Manganese, dissolved	M200.7 ICP	5	0.398		*	mg/L	0.05	0.25	08/09/23 10:32	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 17:42	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423 STEP-5

ACZ Sample ID: ***L81966-07***
Date Sampled: *06/30/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	4.54		*	mg/L	0.25	1.25	08/09/23 10:41	wtc
Iron, dissolved	M200.7 ICP	5	8.98		*	mg/L	0.3	0.75	08/09/23 10:41	wtc
Manganese, dissolved	M200.7 ICP	5	0.158	B	*	mg/L	0.05	0.25	08/09/23 10:41	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 18:03	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP5(14-15)-061423 STEP-6

ACZ Sample ID: ***L81966-08***
Date Sampled: *06/15/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, total (3050)	M6010D ICP	100	12300		*	mg/Kg	5	25	08/08/23 13:28	aeh
Iron, total (3050)	M6010D ICP	100	21900		*	mg/Kg	6	15	08/08/23 13:28	aeh
Manganese, total (3050)	M6010D ICP	100	125		*	mg/Kg	1	5	08/08/23 13:28	aeh
Molybdenum, total (3050)	M6020B ICP-MS	500	1.28		*	mg/Kg	0.1	0.25	08/07/23 23:08	kja

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Digestion - Hot Plate	M3050B ICP								08/02/23 13:18	mgg
Digestion - Hot Plate	M3050B ICP-MS								08/02/23 13:18	mgg

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click:
https://acz.com/wp-content/uploads/2019/04/Ext-Qual-List.pdf

REP001.03.15.02

HALEYALD ACZ Project ID: ***L81966***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Aluminum, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		2.028	mg/L	101	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.15	0.15			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.001		1.016	mg/L	101	85	115			
L81967-02AS	AS	08/09/23 10:47	II230801-2	10.01	2.39	14.81	mg/L	124	85	115			M1
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	10.01	2.39	14.96	mg/L	126	85	115	1	20	M1

Aluminum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.026	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.15	0.15			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-15	15			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	8040		7114	mg/Kg		3830	12200			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	8040		8177	mg/Kg		3830	12200	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.1	3990	14280	mg/Kg	10280	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.1	3990	15270	mg/Kg	11269	75	125	7	20	M3

Arsenic, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	4		3.914	mg/L	98	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.12	0.12			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-12	12			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	183		148.6	mg/Kg		152	214			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	183		163.6	mg/Kg		152	214	10	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.18	91.5	204.9	mg/Kg	113	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.18	91.5	202.5	mg/Kg	111	75	125	1	20	

Boron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.013	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.09	0.09			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-9	9			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	95.3		84.06	mg/Kg		67.7	123			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	95.3		92.32	mg/Kg		67.7	123	9	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	3.95	65.39	mg/Kg	123	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	3.95	56.91	mg/Kg	106	75	125	14	20	

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.944	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.18	0.18			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.004		.987	mg/L	98	85	115			
L81967-02AS	AS	08/09/23 10:47	II230801-2	10.04	3.03	13.82	mg/L	107	85	115			
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	10.04	3.03	15.12	mg/L	120	85	115	9	20	MA

HALEYALD

ACZ Project ID: ***L81966***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Iron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.939	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.18	0.18			
WG571490PBS	PBS	08/08/23 13:09				7.98	mg/Kg		-18	18			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	14000		12330	mg/Kg		8420	19600			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	14000		14300	mg/Kg		8420	19600	15	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.4	8710	8237	mg/Kg	-411	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.4	8710	9388	mg/Kg	735	75	125	13	20	M3

Lithium, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.027	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.024	0.024			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-2.4	2.4			
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.3	1.06	83.24	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.3	1.06	97.55	mg/Kg	96	75	125	16	20	

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.939	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.03	0.03			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	.4995		.499	mg/L	100	85	115			
L81967-02AS	AS	08/09/23 10:47	II230801-2	4.995	.403	5.391	mg/L	100	85	115			
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	4.995	.403	5.455	mg/L	101	85	115	1	20	

Manganese, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.942	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.03	0.03			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-3	3			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	381		297.5	mg/Kg		311	450			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	381		341.3	mg/Kg		311	450	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	49.95	10.9	76.52	mg/Kg	131	75	125			MA
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	49.95	10.9	72.93	mg/Kg	124	75	125	5	20	

HALEYALD

ACZ Project ID: ***L81966***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Molybdenum, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571954													
WG571954ICV	ICV	08/09/23 15:39	MS230712-3	.02		.02011	mg/L	101	90	110			
WG571954ICB	ICB	08/09/23 15:41				U	mg/L		-0.00044	0.00044			
WG571954LFB	LFB	08/09/23 15:44	MS230724-2	.05005		.04916	mg/L	98	85	115			
L81964-02AS	AS	08/09/23 15:48	MS230724-2	1.001	.135	1.1487	mg/L	101	70	130			
L81964-02ASD	ASD	08/09/23 15:51	MS230724-2	1.001	.135	1.18622	mg/L	105	70	130	3	20	
WG571986													
WG571986ICV	ICV	08/09/23 17:10	MS230712-3	.02		.01893	mg/L	95	90	110			
WG571986ICB	ICB	08/09/23 17:12				U	mg/L		-0.00044	0.00044			
WG571986LFB	LFB	08/09/23 17:14	MS230724-2	.05005		.04652	mg/L	93	85	115			
L81964-05AS	AS	08/09/23 17:19	MS230724-2	2.5025	U	2.49646	mg/L	100	70	130			
L81964-05ASD	ASD	08/09/23 17:21	MS230724-2	2.5025	U	2.45733	mg/L	98	70	130	2	20	

Molybdenum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.948	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.06	0.06			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-6	6			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	179		146.3	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	179		163.9	mg/Kg		143	215	11	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	U	40.92	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	U	47.38	mg/Kg	95	75	125	15	20	

Molybdenum, total (3050) M6020B ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571829													
WG571829ICV	ICV	08/07/23 22:38	MS230712-3	.02		.02191	mg/L	110	90	110			
WG571829ICB	ICB	08/07/23 22:40				U	mg/L		-0.0006	0.0006			
WG571490PBS	PBS	08/07/23 22:49				U	mg/Kg		-0.3	0.3			
WG571490LCSS	LCSS	08/07/23 22:51	PCN624760	179		172.42348	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/07/23 22:53	PCN624760	179		183.0353	mg/Kg		143	215	6	20	
L81676-01MS	MS	08/07/23 22:57	MS230504-4	25.77575	1.05	20.44554	mg/Kg	75	75	125			
L81676-01MSD	MSD	08/07/23 22:59	MS230504-4	25.77575	1.05	19.63632	mg/Kg	72	75	125	4	20	MA

Haley Aldrich

ACZ Project ID: ***L81966***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L81966-02	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
L81966-03	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81966-04	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81966-05	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81966-06	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81966-07	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81966-08	WG571824	Aluminum, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, total (3050)	M6010D ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
			M6010D ICP	RL	Recovery for either the LCS or LCS duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571829	Molybdenum, total (3050)	M6020B ICP-MS	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.

Certification Qualifiers

Haley Aldrich

ACZ Project ID: ***L81966***

Metals Analysis

The following parameters are not offered for certification or are not covered by NELAC certificate #ACZ.

Aluminum, dissolved	M200.7 ICP
Iron, dissolved	M200.7 ICP
Manganese, dissolved	M200.7 ICP
Molybdenum, dissolved	M200.8 ICP-MS

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID: L81966
Date Received: 07/24/2023 11:32
Received By:
Date Printed: 8/9/2023

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?		X	
4) Are any samples NRC licensable material?			X
5) If samples are received past hold time, proceed with requested short hold time analyses?	X		
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?		X	

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

NA indicates Not Applicable

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
NA40828	5	NA	15	N/A
UNKNOWN		NA		

Was ice present in the shipment container(s)?

No - Wet or gel ice was not present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID:	L81966
Date Received:	07/24/2023 11:32
Received By:	
Date Printed:	8/9/2023

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ LABORATORIES | Accredited Environmental Testing | 2773 Downhill Drive Steamboat Springs, CO 80487 (970) 879-6590 | L81307

CHAIN of CUSTODY

Report to:

Name: Todd Plating
Company: Haley and Aldrich
E-mail: tplating@haleyaldrich.com
Address: 400 Augusta Street Suite 100
Greenville, SC 29601
Telephone: 864-420-8656

Copy of Report to:

Name: Jacob Chu
Company: Haley and Aldrich
E-mail: jchu@haleyaldrich.com
Telephone:

Invoice to:

Name: Accounts Payable
Company: Haley and Aldrich
E-mail: accountspayable@haleyldrich.com
Address: 70 Blanchard Road Suite 204
Burlington, Massachusetts 01803
Telephone: 617-886-7400

Copy of Invoice to:

Name: Neal Kochis
Company: Haley and Aldrich
E-mail: Nkochis@haleyaldrich.com
Address:
Telephone: 216-399-3075

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? YES ☐ NO ☐

If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes ☐ No ☑

If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: Britton Hundley **Sampler's Site Information** State IN Zip code _____ Time Zone CST

***Sampler's Signature:** _____

*I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: FB Culley EAP NA FFE
PO#: 0129420-032-001-01
Reporting state for compliance testing: NA
Check box if samples include NRC licensed material? ☐

ANALYSES REQUESTED *(attach list or use quote number)*

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	7 Step SE								
CMA-SB-01(54-55)-061523	6/15/23 11:30	SO	1	✓								Hold
CLR- SB-AP4R(14-15)-061423	6/14/23 8:25	SO	1	✓								
CLR- SB-AP5(14-15)-061423	6/14/23 9:30	SO	1	✓								
CLR- SB-AP6I(48.7-49.7)-061523	6/15/23 16:40	SO	1	✓								
CLR- SB-AP8I(53.5-54.5)-061423	6/14/23 15:00	SO	1	✓								
		S	1	✓								
		S	1	✓								
		S	1	✓								

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

~~Hold for analysis pending project manager approval.~~ Metals analysis (Al, Fe, Mn, Mo) via 6020 (ICP-MS)

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
[signature]	6/20/23 17:00	[signature]	6/21/23 11:33

Qualtrax ID: 1984 Revision #: 2 White - Return with sample. Yellow - Retain for your records.

L81307 Chain of Custod

Casey Portela, P.G.
Haley & Aldrich
Office: (864) 214-8753
Mobile: (607) 349-9162

4/5/2023

Quote# Haley & Aldrich 6 Step-Tessier FB Culley Site April 2023

Re: Modified Six Step Tessier Sequential Batch Testing: 4 Samples
Project is: FB Culley Site

Parameter	Cost/ Sample
Six Step Sequential Extraction ($95.00 per step)	570.00
6 steps for metals: Fe, Mn, Al, and Mo via ICP/ICPMS ($135 per step)	810.00
Sample prep: Samples air-dry and sieve <60	40.00
Total Cost / Sample	**$1,420.00**

Total cost for 4 Samples for 6 step Tessier: $5,680.00

Sample Prep: ACZ will be prepping 20 grams of <.25 mm sieved, air-dried sample.

Extraction Step	Molybdenum Sequential Extraction Method Modified from Tessier and BCR		Extraction Details		Analytes
	Fractions	Reagents	Extraction Protocol	Method Reference	EPA 6010/ 6020
F1	Exchangeable, water soluble	1M $MgCl_2$ (pH~7.0) 10mL	0.5 gram of solid sample, room temperature, continuous agitation for 2 hours.	(1)	As, Mn, Mo, V
F2	Bound to organic matter	0.1M NaOH 10mL	This step will be applied only when the TOC soil concentration (mg/Kg) is > 0.2%. Residue from Step F1 be washed with 10 mL Milli-Q or DI water first; shaking rinsed solids in a tube with reagents at room temperature for 30 mins. Bathe the tube in ultrasonic cleaner for 2 hours	(2)	As, Mn, Mo, V
F3	Bound to carbonate	1.0M CH_3COONa adjust to pH 5 with CH_3COOH 10 mL	Solid residue from Step F2, room temperature, continuous agitation for 4 hours.	(3)	Al, As, Ca, Fe Mn, Mo, V
F4	HFO/ HAO/ HMO	0.25M NH_2OH HCl & 0.25M HCl combined solution 75 mL	Solids from the last step washed by Milli-Q or DI water first. Shaking rinsed solids with reagents under 50°C for 2 hours	(3)	Al, As, Fe, Mn, Mo, V
F5	Bound to sulfides	[1] 10mL 30% H_2O_2 (pH 2-3, adjusted by HNO_3) & [2] 20 mL CH_3COONH_4 (pH 2, adjusted by HNO_3)	Mix reagent [1] with residue from F4 at 40°C in a tube. Bathe the tube in ultrasonic cleaner for an hour with loose cap, followed by another 1 hour bath in ultrasonic cleaner at 80°C without cap. Repeat the process above. After cooled, Reagent [2] is added and shake for 2 hours.	(2)	Al, As, Fe, Mn, Mo, V
F6	Final Extraction	EPA total metals digest 3050B (SW-846)	Per EPA method	EPA 6020A/EPA 3050B (SW-846)	As, Fe, Mn, Mo, V

Notes:
(1) Tessier, A., Campbell, P.G. and Bisson, M., 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical chemistry, 51(7), pp.844-851.
(2) Liang, L. and Zhu, J.M., 2018. An optimized sequential extraction scheme for molybdenum association in environmental samples. Acta Geochimica, 37(2), pp.111-119.
(3) Chao, T.T. and Zhou, L., 1983. Extraction techniques for selective dissolution of amorphous iron oxides from soils and sediments. Soil Sci. Soc. Am. J., 47(2), pp.225-232.

Modified Tessier Specified by Client

Sequence 1: Water Soluble, DI Water, 30 mL to 2 gram of solid, Continuous Agitation

Sequence 2: Exchangeable, Cliend Mod

Sequence 3: Bound to Carbonates, Cleint Mod

Sequence 4: Bound to Fe-Mn Oxides, Client Mod

Sequence 5: Bound to Organic Matter, Client Mod

Sequence 6: Residual, Tessier Method (v) This is via EPA 3050 Digestion Client Mod

Quote expires in six months from date on quote .

This bid is based on standard T/A and standard reporting formats via PDF emailed reports.

Soils turn-around is ~ three to four weeks and varies with workload

Electronic Data Deliverables (EDD's) will be supplied at no extra charge if needed.

This quotation must be signed and returned (fax or mail) to ACZ Laboratories, Inc. before the project is received. The authorized signature represents acceptance of the pricing as well as ACZ's General Terms & Conditions.

ACZ Representative (Authorized Signature) / Date:

Client Representative (Authorized Signature) / Date:

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

August 16, 2023

Report to:
Todd Plating
Haley Aldrich
400 Augusta Street
Suite 100
Greenville, SC, 29601, SC 29601

cc: Britton Hundley

Bill to:
Accounts Payable
Haley Aldrich
70 Blanchard Rd, Ste. 204

Burlington, MA 01803

Project ID: 0129420-032-001-01
ACZ Project ID: L81967

Todd Plating:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on July 24, 2023. This project has been assigned to ACZ's project number, L81967. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L81967. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after August 15, 2024. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Madeleine Murray
Madeleine Murray has reviewed and approved this report.

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523

ACZ Sample ID: ***L81967-01***
Date Sampled: *06/15/23 16:40*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Sequential Batch Extraction	Tessier, et al.								06/27/23 8:00	jpb

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523 STEP-0

ACZ Sample ID: ***L81967-02***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	10	2.39	B	*	mg/L	0.5	2.5	08/09/23 10:44	wtc
Iron, dissolved	M200.7 ICP	10	3.03		*	mg/L	0.6	1.5	08/09/23 10:44	wtc
Manganese, dissolved	M200.7 ICP	10	0.403	B	*	mg/L	0.1	0.5	08/09/23 10:44	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	0.00438	B	*	mg/L	0.002	0.005	08/09/23 15:58	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523 STEP-1

ACZ Sample ID: ***L81967-03***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	20	<1	U	*	mg/L	1	5	08/09/23 10:53	wtc
Iron, dissolved	M200.7 ICP	20	<1.2	U	*	mg/L	1.2	3	08/09/23 10:53	wtc
Manganese, dissolved	M200.7 ICP	20	10.00		*	mg/L	0.2	1	08/09/23 10:53	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 16:14	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523 STEP-2

ACZ Sample ID: ***L81967-04***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	8.68		*	mg/L	0.25	1.25	08/08/23 17:07	wtc
Iron, dissolved	M200.7 ICP	5	2.31		*	mg/L	0.3	0.75	08/08/23 17:07	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/08/23 17:07	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	0.00491	B	*	mg/L	0.004	0.01	08/09/23 16:37	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523 STEP-3

ACZ Sample ID: ***L81967-05***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	4.18		*	mg/L	0.25	1.25	08/08/23 17:17	wtc
Iron, dissolved	M200.7 ICP	5	2.13		*	mg/L	0.3	0.75	08/08/23 17:17	wtc
Manganese, dissolved	M200.7 ICP	5	9.53		*	mg/L	0.05	0.25	08/08/23 17:17	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 17:28	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523 STEP-4

ACZ Sample ID: ***L81967-06***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	5.75		*	mg/L	0.25	1.25	08/08/23 17:20	wtc
Iron, dissolved	M200.7 ICP	5	9.23		*	mg/L	0.3	0.75	08/08/23 17:20	wtc
Manganese, dissolved	M200.7 ICP	5	0.809		*	mg/L	0.05	0.25	08/08/23 17:20	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 17:45	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523 STEP-5

ACZ Sample ID: ***L81967-07***
Date Sampled: *06/30/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	4.45		*	mg/L	0.25	1.25	08/08/23 17:23	wtc
Iron, dissolved	M200.7 ICP	5	5.84		*	mg/L	0.3	0.75	08/08/23 17:23	wtc
Manganese, dissolved	M200.7 ICP	5	0.174	B	*	mg/L	0.05	0.25	08/08/23 17:23	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 18:06	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-APGI(48.7-49.7)-061523 STEP-6

ACZ Sample ID: ***L81967-08***
Date Sampled: *06/15/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, total (3050)	M6010D ICP	100	8720		*	mg/Kg	5	25	08/08/23 13:31	aeh
Iron, total (3050)	M6010D ICP	100	18000		*	mg/Kg	6	15	08/08/23 13:31	aeh
Manganese, total (3050)	M6010D ICP	100	127		*	mg/Kg	1	5	08/08/23 13:31	aeh
Molybdenum, total (3050)	M6020B ICP-MS	500	0.776		*	mg/Kg	0.1	0.25	08/07/23 23:10	kja

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Digestion - Hot Plate	M3050B ICP								08/02/23 13:32	mgg
Digestion - Hot Plate	M3050B ICP-MS								08/02/23 13:32	mgg

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click:
https://acz.com/wp-content/uploads/2019/04/Ext-Qual-List.pdf

REP001.03.15.02

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ACZ Project ID: ***L81967***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Aluminum, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		2.026	mg/L	101	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.15	0.15			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	1.001		1.017	mg/L	102	85	115			
L81967-04AS	AS	08/08/23 17:10	II230801-2	5.005	8.68	13.71	mg/L	100	85	115			
L81967-04ASD	ASD	08/08/23 17:14	II230801-2	5.005	8.68	13.865	mg/L	104	85	115	1	20	
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		2.028	mg/L	101	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.15	0.15			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.001		1.016	mg/L	101	85	115			
L81967-02AS	AS	08/09/23 10:47	II230801-2	10.01	2.39	14.81	mg/L	124	85	115			M1
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	10.01	2.39	14.96	mg/L	126	85	115	1	20	M1

Aluminum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.026	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.15	0.15			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-15	15			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	8040		7114	mg/Kg		3830	12200			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	8040		8177	mg/Kg		3830	12200	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.1	3990	14280	mg/Kg	10280	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.1	3990	15270	mg/Kg	11269	75	125	7	20	M3

Arsenic, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	4		3.914	mg/L	98	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.12	0.12			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-12	12			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	183		148.6	mg/Kg		152	214			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	183		163.6	mg/Kg		152	214	10	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.18	91.5	204.9	mg/Kg	113	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.18	91.5	202.5	mg/Kg	111	75	125	1	20	

Boron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.013	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.09	0.09			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-9	9			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	95.3		84.06	mg/Kg		67.7	123			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	95.3		92.32	mg/Kg		67.7	123	9	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	3.95	65.39	mg/Kg	123	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	3.95	56.91	mg/Kg	106	75	125	14	20	

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ACZ Project ID: ***L81967***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		1.978	mg/L	99	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.18	0.18			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	1.004		1.01	mg/L	101	85	115			
L81967-04AS	AS	08/08/23 17:10	II230801-2	5.02	2.31	7.01	mg/L	94	85	115			
L81967-04ASD	ASD	08/08/23 17:14	II230801-2	5.02	2.31	7.115	mg/L	96	85	115	1	20	
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.944	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.18	0.18			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	1.004		.987	mg/L	98	85	115			
L81967-02AS	AS	08/09/23 10:47	II230801-2	10.04	3.03	13.82	mg/L	107	85	115			
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	10.04	3.03	15.12	mg/L	120	85	115	9	20	MA

Iron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.939	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.18	0.18			
WG571490PBS	PBS	08/08/23 13:09				7.98	mg/Kg		-18	18			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	14000		12330	mg/Kg		8420	19600			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	14000		14300	mg/Kg		8420	19600	15	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.4	8710	8237	mg/Kg	-411	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.4	8710	9388	mg/Kg	735	75	125	13	20	M3

Lithium, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.027	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.024	0.024			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-2.4	2.4			
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.3	1.06	83.24	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.3	1.06	97.55	mg/Kg	96	75	125	16	20	

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		1.932	mg/L	97	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.03	0.03			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	.4995		.502	mg/L	101	85	115			
L81967-04AS	AS	08/08/23 17:10	II230801-2	2.4975	U	2.446	mg/L	98	85	115			
L81967-04ASD	ASD	08/08/23 17:14	II230801-2	2.4975	U	2.495	mg/L	100	85	115	2	20	
WG571873													
WG571873ICV	ICV	08/09/23 9:10	II230729-1	2		1.939	mg/L	97	95	105			
WG571873ICB	ICB	08/09/23 9:16				U	mg/L		-0.03	0.03			
WG571873LFB	LFB	08/09/23 9:28	II230801-2	.4995		.499	mg/L	100	85	115			
L81967-02AS	AS	08/09/23 10:47	II230801-2	4.995	.403	5.391	mg/L	100	85	115			
L81967-02ASD	ASD	08/09/23 10:50	II230801-2	4.995	.403	5.455	mg/L	101	85	115	1	20	

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ACZ Project ID: ***L81967***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Manganese, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.942	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.03	0.03			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-3	3			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	381		297.5	mg/Kg		311	450			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	381		341.3	mg/Kg		311	450	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	49.95	10.9	76.52	mg/Kg	131	75	125			MA
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	49.95	10.9	72.93	mg/Kg	124	75	125	5	20	

Molybdenum, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571954													
WG571954ICV	ICV	08/09/23 15:39	MS230712-3	.02		.02011	mg/L	101	90	110			
WG571954ICB	ICB	08/09/23 15:41				U	mg/L		-0.00044	0.00044			
WG571954LFB	LFB	08/09/23 15:44	MS230724-2	.05005		.04916	mg/L	98	85	115			
L81964-02AS	AS	08/09/23 15:48	MS230724-2	1.001	.135	1.1487	mg/L	101	70	130			
L81964-02ASD	ASD	08/09/23 15:51	MS230724-2	1.001	.135	1.18622	mg/L	105	70	130	3	20	
L81967-04AS	AS	08/09/23 16:40	MS230724-2	1.001	.00491	.90836	mg/L	90	70	130			
L81967-04ASD	ASD	08/09/23 16:42	MS230724-2	1.001	.00491	.97148	mg/L	97	70	130	7	20	
WG571986													
WG571986ICV	ICV	08/09/23 17:10	MS230712-3	.02		.01893	mg/L	95	90	110			
WG571986ICB	ICB	08/09/23 17:12				U	mg/L		-0.00044	0.00044			
WG571986LFB	LFB	08/09/23 17:14	MS230724-2	.05005		.04652	mg/L	93	85	115			
L81964-05AS	AS	08/09/23 17:19	MS230724-2	2.5025	U	2.49646	mg/L	100	70	130			
L81964-05ASD	ASD	08/09/23 17:21	MS230724-2	2.5025	U	2.45733	mg/L	98	70	130	2	20	
L81967-06AS	AS	08/09/23 17:47	MS230724-2	1.001	U	.90193	mg/L	90	70	130			
L81967-06ASD	ASD	08/09/23 17:49	MS230724-2	1.001	U	.9418	mg/L	94	70	130	4	20	

HALEYALD

ACZ Project ID: ***L81967***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Molybdenum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.948	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.06	0.06			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-6	6			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	179		146.3	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	179		163.9	mg/Kg		143	215	11	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	U	40.92	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	U	47.38	mg/Kg	95	75	125	15	20	

Molybdenum, total (3050) M6020B ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571829													
WG571829ICV	ICV	08/07/23 22:38	MS230712-3	.02		.02191	mg/L	110	90	110			
WG571829ICB	ICB	08/07/23 22:40				U	mg/L		-0.0006	0.0006			
WG571490PBS	PBS	08/07/23 22:49				U	mg/Kg		-0.3	0.3			
WG571490LCSS	LCSS	08/07/23 22:51	PCN624760	179		172.42348	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/07/23 22:53	PCN624760	179		183.0353	mg/Kg		143	215	6	20	
L81676-01MS	MS	08/07/23 22:57	MS230504-4	25.77575	1.05	20.44554	mg/Kg	75	75	125			
L81676-01MSD	MSD	08/07/23 22:59	MS230504-4	25.77575	1.05	19.63632	mg/Kg	72	75	125	4	20	MA

Inorganic Extended Qualifier Report

Haley Aldrich

ACZ Project ID: ***L81967***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L81967-02	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81967-03	WG571873	Aluminum, dissolved	M200.7 ICP	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81967-04	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81967-05	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81967-06	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81967-07	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81967-08	WG571824	Aluminum, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, total (3050)	M6010D ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
			M6010D ICP	RL	Recovery for either the LCS or LCS duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571829	Molybdenum, total (3050)	M6020B ICP-MS	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.

Haley Aldrich

ACZ Project ID: ***L81967***

Metals Analysis

The following parameters are not offered for certification or are not covered by NELAC certificate #ACZ.

Aluminum, dissolved	M200.7 ICP
Iron, dissolved	M200.7 ICP
Manganese, dissolved	M200.7 ICP
Molybdenum, dissolved	M200.8 ICP-MS

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID: L81967
Date Received: 07/24/2023 11:34
Received By:
Date Printed: 8/9/2023

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?		X	
4) Are any samples NRC licensable material?			X
5) If samples are received past hold time, proceed with requested short hold time analyses?	X		
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?		X	

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

NA indicates Not Applicable

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
NA40828	5	NA	15	N/A
UNKNOWN		NA		

Was ice present in the shipment container(s)?

No - Wet or gel ice was not present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID: L81967
Date Received: 07/24/2023 11:34
Received By:
Date Printed: 8/9/2023

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ LABORATORIES | Accredited Environmental Testing | 2773 Downhill Drive Steamboat Springs, CO 80487 (970) 879-6590 | L81307

CHAIN of CUSTODY

Report to:

Name: Todd Plating
Company: Haley and Aldrich
E-mail: tplating@haleyaldrich.com
Address: 400 Augusta Street Suite 100
Greenville, SC 29601
Telephone: 864-420-8656

Copy of Report to:

Name: Jacob Chu
Company: Haley and Aldrich
E-mail: jchu@haleyaldrich.com
Telephone:

Invoice to:

Name: Accounts Payable
Company: Haley and Aldrich
E-mail: accountspayable@haleyldrich.com
Address: 70 Blanchard Road Suite 204
Burlington, Massachusetts 01803
Telephone: 617-886-7400

Copy of Invoice to:

Name: Neal Kochis
Company: Haley and Aldrich
E-mail: Nkochis@haleyaldrich.com
Address:
Telephone: 216-399-3075

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? YES ☐ NO ☐

If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes ☐ No ☑

If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: Britton Hundley **Sampler's Site Information** State IN Zip code _____ Time Zone CST

***Sampler's Signature:** _____

*I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: FB Culley EAP NA FFE
PO#: 0129420-032-001-01
Reporting state for compliance testing: NA
Check box if samples include NRC licensed material? ☐

ANALYSES REQUESTED *(attach list or use quote number)*

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	7 Step SE								
CMA-SB-01(54-55)-061523	6/15/23 11:30	SO	1	✓								Hold
CLR- SB-AP4R(14-15)-061423	6/14/23 8:25	SO	1	✓								
CLR- SB-AP5(14-15)-061423	6/14/23 9:30	SO	1	✓								
CLR- SB-AP6I(48.7-49.7)-061523	6/15/23 16:40	SO	1	✓								
CLR- SB-AP8I(53.5-54.5)-061423	6/14/23 15:00	SO	1	✓								
		S	1	✓								
		S	1	✓								
		S	1	✓								

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

~~Hold for analysis pending project manager approval.~~ Metals analysis (Al, Fe, Mn, Mo) via 6020 (ICP-MS)

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
[signature]	6/20/23 17:00	[signature]	6/21/23 11:33

Qualtrax ID: 1984 Revision #: 2 White - Return with sample. Yellow - Retain for your records.

L81307 Chain of Custod

Casey Portela, P.G.
Haley & Aldrich
Office: (864) 214-8753
Mobile: (607) 349-9162

4/5/2023

Quote# Haley & Aldrich 6 Step-Tessier FB Culley Site April 2023

Re: Modified Six Step Tessier Sequential Batch Testing: 4 Samples
Project is: FB Culley Site

Parameter	Cost/ Sample
Six Step Sequential Extraction ($95.00 per step)	570.00
6 steps for metals: Fe, Mn, Al, and Mo via ICP/ICPMS ($135 per step)	810.00
Sample prep: Samples air-dry and sieve <60	40.00
Total Cost / Sample	**$1,420.00**

Total cost for 4 Samples for 6 step Tessier: $5,680.00

Sample Prep: ACZ will be prepping 20 grams of <.25 mm sieved, air-dried sample.

Extraction Step	Molybdenum Sequential Extraction Method Modified from Tessier and BCR		Extraction Details		Analytes
	Fractions	Reagents	Extraction Protocol	Method Reference	EPA 6010/ 6020
F1	Exchangeable, water soluble	1M $MgCl_2$ (pH~7.0) 10mL	0.5 gram of solid sample, room temperature, continuous agitation for 2 hours.	(1)	As, Mn, Mo, V
F2	Bound to organic matter	0.1M NaOH 10mL	This step will be applied only when the TOC soil concentration (mg/Kg) is > 0.2%. Residue from Step F1 be washed with 10 mL Milli-Q or DI water first; shaking rinsed solids in a tube with reagents at room temperature for 30 mins. Bathe the tube in ultrasonic cleaner for 2 hours	(2)	As, Mn, Mo, V
F3	Bound to carbonate	1.0M CH_3COONa adjust to pH 5 with CH_3COOH 10 mL	Solid residue from Step F2, room temperature, continuous agitation for 4 hours.	(3)	Al, As, Ca, Fe Mn, Mo, V
F4	HFO/ HAO/ HMO	0.25M NH_2OH HCl & 0.25M HCl combined solution 75 mL	Solids from the last step washed by Milli-Q or DI water first. Shaking rinsed solids with reagents under 50°C for 2 hours	(3)	Al, As, Fe, Mn, Mo, V
F5	Bound to sulfides	[1] 10mL 30% H_2O_2 (pH 2-3, adjusted by HNO_3) & [2] 20 mL CH_3COONH_4 (pH 2, adjusted by HNO_3)	Mix reagent [1] with residue from F4 at 40°C in a tube. Bathe the tube in ultrasonic cleaner for an hour with loose cap, followed by another 1 hour bath in ultrasonic cleaner at 80°C without cap. Repeat the process above. After cooled, Reagent [2] is added and shake for 2 hours.	(2)	Al, As, Fe, Mn, Mo, V
F6	Final Extraction	EPA total metals digest 3050B (SW-846)	Per EPA method	EPA 6020A/EPA 3050B (SW-846)	As, Fe, Mn, Mo, V

Notes:
(1) Tessier, A., Campbell, P.G. and Bisson, M., 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical chemistry, 51(7), pp.844-851.
(2) Liang, L. and Zhu, J.M., 2018. An optimized sequential extraction scheme for molybdenum association in environmental samples. Acta Geochimica, 37(2), pp.111-119.
(3) Chao, T.T. and Zhou, L., 1983. Extraction techniques for selective dissolution of amorphous iron oxides from soils and sediments. Soil Sci. Soc. Am. J., 47(2), pp.225-232.

Modified Tessier Specified by Client

Sequence 1: Water Soluble, DI Water, 30 mL to 2 gram of solid, Continuous Agitation

Sequence 2: Exchangeable, Cliend Mod

Sequence 3: Bound to Carbonates, Cleint Mod

Sequence 4: Bound to Fe-Mn Oxides, Client Mod

Sequence 5: Bound to Organic Matter, Client Mod

Sequence 6: Residual, Tessier Method (v) This is via EPA 3050 Digestion Client Mod

Quote expires in six months from date on quote .

This bid is based on standard T/A and standard reporting formats via PDF emailed reports.

Soils turn-around is ~ three to four weeks and varies with workload

Electronic Data Deliverables (EDD's) will be supplied at no extra charge if needed.

This quotation must be signed and returned (fax or mail) to ACZ Laboratories, Inc. before the project is received. The authorized signature represents acceptance of the pricing as well as ACZ's General Terms & Conditions.

ACZ Representative (Authorized Signature) / Date:

Client Representative (Authorized Signature) / Date:

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

August 16, 2023

Report to:
Todd Plating
Haley Aldrich
400 Augusta Street
Suite 100
Greenville, SC, 29601, SC 29601

cc: Britton Hundley

Bill to:
Accounts Payable
Haley Aldrich
70 Blanchard Rd, Ste. 204

Burlington, MA 01803

Project ID: 0129420-032-001-01
ACZ Project ID: L81968

Todd Plating:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on July 24, 2023. This project has been assigned to ACZ's project number, L81968. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L81968. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after August 15, 2024. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Madeleine Murray
Madeleine Murray has reviewed and approved this report.

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423

ACZ Sample ID: ***L81968-01***
Date Sampled: *06/14/23 15:00*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Sequential Batch Extraction	Tessier, et al.								06/27/23 8:00	jpb

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423 STEP-0

ACZ Sample ID: ***L81968-02***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	10	9.56		*	mg/L	0.5	2.5	08/08/23 17:27	wtc
Iron, dissolved	M200.7 ICP	10	6.42		*	mg/L	0.6	1.5	08/08/23 17:27	wtc
Manganese, dissolved	M200.7 ICP	10	<0.1	U	*	mg/L	0.1	0.5	08/08/23 17:27	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	0.0104		*	mg/L	0.002	0.005	08/09/23 16:00	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423 STEP-1

ACZ Sample ID: ***L81968-03***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	20	<1	U	*	mg/L	1	5	08/08/23 17:30	wtc
Iron, dissolved	M200.7 ICP	20	<1.2	U	*	mg/L	1.2	3	08/08/23 17:30	wtc
Manganese, dissolved	M200.7 ICP	20	0.402	B	*	mg/L	0.2	1	08/08/23 17:30	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 16:16	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423 STEP-2

ACZ Sample ID: ***L81968-04***
Date Sampled: *06/27/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	7.56		*	mg/L	0.25	1.25	08/08/23 17:33	wtc
Iron, dissolved	M200.7 ICP	5	0.532	B	*	mg/L	0.3	0.75	08/08/23 17:33	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/08/23 17:33	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	0.0124		*	mg/L	0.002	0.005	08/09/23 16:44	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423 STEP-3

ACZ Sample ID: ***L81968-05***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	5.90		*	mg/L	0.25	1.25	08/08/23 17:43	wtc
Iron, dissolved	M200.7 ICP	5	66.6		*	mg/L	0.3	0.75	08/08/23 17:43	wtc
Manganese, dissolved	M200.7 ICP	5	2.32		*	mg/L	0.05	0.25	08/08/23 17:43	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 17:31	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423 STEP-4

ACZ Sample ID: ***L81968-06***
Date Sampled: *06/28/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	7.23		*	mg/L	0.25	1.25	08/08/23 17:46	wtc
Iron, dissolved	M200.7 ICP	5	35.0		*	mg/L	0.3	0.75	08/08/23 17:46	wtc
Manganese, dissolved	M200.7 ICP	5	1.80		*	mg/L	0.05	0.25	08/08/23 17:46	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 17:52	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423 STEP-5

ACZ Sample ID: ***L81968-07***
Date Sampled: *06/30/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	8.86		*	mg/L	0.25	1.25	08/08/23 17:49	wtc
Iron, dissolved	M200.7 ICP	5	12.1		*	mg/L	0.3	0.75	08/08/23 17:49	wtc
Manganese, dissolved	M200.7 ICP	5	0.068	B	*	mg/L	0.05	0.25	08/08/23 17:49	wtc
Molybdenum, dissolved	M200.8 ICP-MS	50	<0.01	U	*	mg/L	0.01	0.025	08/09/23 18:08	gjl/scp

Haley Aldrich
Project ID: 0129420-032-001-01
Sample ID: CCR-SB-AP8I(53.5-54.5)-061423 STEP-6

ACZ Sample ID: ***L81968-08***
Date Sampled: *06/15/23 00:00*
Date Received: *07/24/23*
Sample Matrix: *Soil*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, total (3050)	M6010D ICP	100	11700		*	mg/Kg	5	25	08/08/23 13:39	aeh
Iron, total (3050)	M6010D ICP	100	13200		*	mg/Kg	6	15	08/08/23 13:39	aeh
Manganese, total (3050)	M6010D ICP	100	79.5		*	mg/Kg	1	5	08/08/23 13:39	aeh
Molybdenum, total (3050)	M6020B ICP-MS	500	0.470		*	mg/Kg	0.1	0.25	08/07/23 23:12	kja

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Digestion - Hot Plate	M3050B ICP								08/02/23 13:46	mgg
Digestion - Hot Plate	M3050B ICP-MS								08/02/23 13:46	mgg

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click:
https://acz.com/wp-content/uploads/2019/04/Ext-Qual-List.pdf

REP001.03.15.02

HALEYALD ACZ Project ID: ***L81968***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Aluminum, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		2.026	mg/L	101	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.15	0.15			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	1.001		1.017	mg/L	102	85	115			
L81967-04AS	AS	08/08/23 17:10	II230801-2	5.005	8.68	13.71	mg/L	100	85	115			
L81967-04ASD	ASD	08/08/23 17:14	II230801-2	5.005	8.68	13.865	mg/L	104	85	115	1	20	

Aluminum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.026	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.15	0.15			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-15	15			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	8040		7114	mg/Kg		3830	12200			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	8040		8177	mg/Kg		3830	12200	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.1	3990	14280	mg/Kg	10280	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.1	3990	15270	mg/Kg	11269	75	125	7	20	M3

Arsenic, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	4		3.914	mg/L	98	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.12	0.12			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-12	12			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	183		148.6	mg/Kg		152	214			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	183		163.6	mg/Kg		152	214	10	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.18	91.5	204.9	mg/Kg	113	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.18	91.5	202.5	mg/Kg	111	75	125	1	20	

Boron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.013	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.09	0.09			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-9	9			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	95.3		84.06	mg/Kg		67.7	123			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	95.3		92.32	mg/Kg		67.7	123	9	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	3.95	65.39	mg/Kg	123	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	3.95	56.91	mg/Kg	106	75	125	14	20	

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		1.978	mg/L	99	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.18	0.18			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	1.004		1.01	mg/L	101	85	115			
L81967-04AS	AS	08/08/23 17:10	II230801-2	5.02	2.31	7.01	mg/L	94	85	115			
L81967-04ASD	ASD	08/08/23 17:14	II230801-2	5.02	2.31	7.115	mg/L	96	85	115	1	20	

HALEYALD

ACZ Project ID: ***L81968***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Iron, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.939	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.18	0.18			
WG571490PBS	PBS	08/08/23 13:09				7.98	mg/Kg		-18	18			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	14000		12330	mg/Kg		8420	19600			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	14000		14300	mg/Kg		8420	19600	15	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.4	8710	8237	mg/Kg	-411	75	125			M3
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.4	8710	9388	mg/Kg	735	75	125	13	20	M3

Lithium, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		2.027	mg/L	101	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.024	0.024			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-2.4	2.4			
L81976-01MS	MS	08/08/23 13:53	II230801-2	100.3	1.06	83.24	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	100.3	1.06	97.55	mg/Kg	96	75	125	16	20	

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		1.932	mg/L	97	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.03	0.03			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	.4995		.502	mg/L	101	85	115			
L81967-04AS	AS	08/08/23 17:10	II230801-2	2.4975	U	2.446	mg/L	98	85	115			
L81967-04ASD	ASD	08/08/23 17:14	II230801-2	2.4975	U	2.495	mg/L	100	85	115	2	20	

Manganese, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.942	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.03	0.03			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-3	3			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	381		297.5	mg/Kg		311	450			RL
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	381		341.3	mg/Kg		311	450	14	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	49.95	10.9	76.52	mg/Kg	131	75	125			MA
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	49.95	10.9	72.93	mg/Kg	124	75	125	5	20	

HALEYALD

ACZ Project ID: ***L81968***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Molybdenum, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571954													
WG571954ICV	ICV	08/09/23 15:39	MS230712-3	.02		.02011	mg/L	101	90	110			
WG571954ICB	ICB	08/09/23 15:41				U	mg/L		-0.00044	0.00044			
WG571954LFB	LFB	08/09/23 15:44	MS230724-2	.05005		.04916	mg/L	98	85	115			
L81967-04AS	AS	08/09/23 16:40	MS230724-2	1.001	.00491	.90836	mg/L	90	70	130			
L81967-04ASD	ASD	08/09/23 16:42	MS230724-2	1.001	.00491	.97148	mg/L	97	70	130	7	20	
WG571986													
WG571986ICV	ICV	08/09/23 17:10	MS230712-3	.02		.01893	mg/L	95	90	110			
WG571986ICB	ICB	08/09/23 17:12				U	mg/L		-0.00044	0.00044			
WG571986LFB	LFB	08/09/23 17:14	MS230724-2	.05005		.04652	mg/L	93	85	115			
L81967-06AS	AS	08/09/23 17:47	MS230724-2	1.001	U	.90193	mg/L	90	70	130			
L81967-06ASD	ASD	08/09/23 17:49	MS230724-2	1.001	U	.9418	mg/L	94	70	130	4	20	

Molybdenum, total (3050) M6010D ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571824													
WG571824ICV	ICV	08/08/23 12:42	II230628-1	2		1.948	mg/L	97	90	110			
WG571824ICB	ICB	08/08/23 12:46				U	mg/L		-0.06	0.06			
WG571490PBS	PBS	08/08/23 13:09				U	mg/Kg		-6	6			
WG571490LCSS	LCSS	08/08/23 13:13	PCN624760	179		146.3	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/08/23 13:17	PCN624760	179		163.9	mg/Kg		143	215	11	20	
L81976-01MS	MS	08/08/23 13:53	II230801-2	50.05	U	40.92	mg/Kg	82	75	125			
L81976-01MSD	MSD	08/08/23 13:57	II230801-2	50.05	U	47.38	mg/Kg	95	75	125	15	20	

Molybdenum, total (3050) M6020B ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571829													
WG571829ICV	ICV	08/07/23 22:38	MS230712-3	.02		.02191	mg/L	110	90	110			
WG571829ICB	ICB	08/07/23 22:40				U	mg/L		-0.0006	0.0006			
WG571490PBS	PBS	08/07/23 22:49				U	mg/Kg		-0.3	0.3			
WG571490LCSS	LCSS	08/07/23 22:51	PCN624760	179		172.42348	mg/Kg		143	215			
WG571490LCSSD	LCSSD	08/07/23 22:53	PCN624760	179		183.0353	mg/Kg		143	215	6	20	
L81676-01MS	MS	08/07/23 22:57	MS230504-4	25.77575	1.05	20.44554	mg/Kg	75	75	125			
L81676-01MSD	MSD	08/07/23 22:59	MS230504-4	25.77575	1.05	19.63632	mg/Kg	72	75	125	4	20	MA

Inorganic Extended Qualifier Report

Haley Aldrich

ACZ Project ID: ***L81968***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L81968-03	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81968-05	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81968-06	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81968-07	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81968-08	WG571824	Aluminum, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Iron, total (3050)	M6010D ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, total (3050)	M6010D ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
			M6010D ICP	RL	Recovery for either the LCS or LCS duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
	WG571829	Molybdenum, total (3050)	M6020B ICP-MS	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.

Haley Aldrich

ACZ Project ID: ***L81968***

Metals Analysis

The following parameters are not offered for certification or are not covered by NELAC certificate #ACZ.

Aluminum, dissolved	M200.7 ICP
Iron, dissolved	M200.7 ICP
Manganese, dissolved	M200.7 ICP
Molybdenum, dissolved	M200.8 ICP-MS

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID: L81968
Date Received: 07/24/2023 11:36
Received By:
Date Printed: 8/9/2023

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?		X	
4) Are any samples NRC licensable material?			X
5) If samples are received past hold time, proceed with requested short hold time analyses?	X		
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?		X	

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

NA indicates Not Applicable

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
NA40828	5	NA	15	N/A
UNKNOWN		NA		

Was ice present in the shipment container(s)?

No - Wet or gel ice was not present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Haley Aldrich
0129420-032-001-01

ACZ Project ID:	L81968
Date Received:	07/24/2023 11:36
Received By:	
Date Printed:	8/9/2023

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ LABORATORIES | Accredited Environmental Testing | 2773 Downhill Drive, Steamboat Springs, CO 80487, (970) 879-6590 | L81307

CHAIN of CUSTODY

Report to:

Name: Todd Plating
Company: Haley and Aldrich
E-mail: tplating@haleyaldrich.com
Address: 400 Augusta Street Suite 100, Greenville, SC 29601
Telephone: 864-420-8656

Copy of Report to:

Name: Jacob Chu
Company: Haley and Aldrich
E-mail: jchu@haleyaldrich.com
Telephone:

Invoice to:

Name: Accounts Payable
Company: Haley and Aldrich
E-mail: accountspayable@haleyldrich.com
Address: 70 Blanchard Road Suite 204, Burlington, Massachusetts 01803
Telephone: 617-886-7400

Copy of Invoice to:

Name: Neal Kochis
Company: Haley and Aldrich
E-mail: Nkochis@haleyaldrich.com
Address:
Telephone: 216-399-3075

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? YES ☐ NO ☐
If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes ☐ No ☑
If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: Britton Hundley **Sampler's Site Information** State IN Zip code _____ Time Zone CST
***Sampler's Signature:** _____
*I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: FB Culley EAP NA FFE
PO#: 0129420-032-001-01
Reporting state for compliance testing: NA
Check box if samples include NRC licensed material? ☐

ANALYSES REQUESTED (attach list or use quote number)

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	7 Step SE	
CMA-SB-01(54-55)-061523	6/15/23 11:30	SO	1	✓	Hold
CLR-SB-AP4R(14-15)-061423	6/14/23 8:25	SO	1	✓	
CLR-SB-AP5(14-15)-061423	6/14/23 9:30	SO	1	✓	
CLR-SB-AP6I(48.7-49.7)-061523	6/15/23 16:40	SO	1	✓	
CLR-SB-AP8I(53.5-54.5)-061423	6/14/23 15:00	SO	1	✓	
		S	1	✓	
		S	1	✓	
		S	1	✓	

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

~~Hold for analysis pending project manager approval.~~ Metals analysis (Al, Fe, Mn, Mo) via 6020 (ICP-MS)

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
[signature]	6/20/23 17:00	[signature]	6/21/23 11:33

Qualtrax ID: 1984 Revision #: 2 White - Return with sample. Yellow - Retain for your records.

L81307 Chain of Custod

Casey Portela, P.G.
Haley & Aldrich
Office: (864) 214-8753
Mobile: (607) 349-9162

4/5/2023

Quote# Haley & Aldrich 6 Step-Tessier FB Culley Site April 2023

Re: Modified Six Step Tessier Sequential Batch Testing: 4 Samples
Project is: FB Culley Site

Parameter	Cost/ Sample
Six Step Sequential Extraction ($95.00 per step)	570.00
6 steps for metals: Fe, Mn, Al, and Mo via ICP/ICPMS ($135 per step)	810.00
Sample prep: Samples air-dry and sieve <60	40.00
Total Cost / Sample	**$1,420.00**

Total cost for 4 Samples for 6 step Tessier: $5,680.00

Sample Prep: ACZ will be prepping 20 grams of <.25 mm sieved, air-dried sample.

Extraction Step	Molybdenum Sequential Extraction Method Modified from Tessier and BCR		Extraction Details		Analytes
	Fractions	Reagents	Extraction Protocol	Method Reference	EPA 6010/ 6020
F1	Exchangeable, water soluble	1M $MgCl_2$ (pH~7.0) 10mL	0.5 gram of solid sample, room temperature, continuous agitation for 2 hours.	(1)	As, Mn, Mo, V
F2	Bound to organic matter	0.1M NaOH 10mL	This step will be applied only when the TOC soil concentration (mg/Kg) is > 0.2%. Residue from Step F1 be washed with 10 mL Milli-Q or DI water first; shaking rinsed solids in a tube with reagents at room temperature for 30 mins. Bathe the tube in ultrasonic cleaner for 2 hours	(2)	As, Mn, Mo, V
F3	Bound to carbonate	1.0M CH_3COONa adjust to pH 5 with CH_3COOH 10 mL	Solid residue from Step F2, room temperature, continuous agitation for 4 hours.	(1)	Al, As, Ca, Fe Mn, Mo, V
F4	HFO/ HAO/ HMO	0.25M NH_2OH HCl & 0.25M HCL combined solution 75 mL	Solids from the last step washed by Milli-Q or DI water first. Shaking rinsed solids with reagents under 50°C for 2 hours	(3)	Al, As, Fe, Mn, Mo, V
F5	Bound to sulfides	[1] 10mL 30% H_2O_2 (pH 2-3, adjusted by HNO_3) & [2] 20 mL CH_3COONH_4 (pH 2, adjusted by HNO_3)	Mix reagent [1] with residue from F4 at 40°C in a tube. Bathe the tube in ultrasonic cleaner for an hour with loose cap, followed by another 1 hour bath in ultrasonic cleaner at 80°C without cap. Repeat the process above. After cooled, Reagent [2] is added and shake for 2 hours.	(2)	Al, As, Fe, Mn, Mo, V
F6	Final Extraction	EPA total metals digest 3050B (SW-846)	Per EPA method	EPA 6020A/EPA 3050B (SW-846)	As, Fe, Mn, Mo, V

Notes:
(1) Tessier, A., Campbell, P.G. and Bisson, M., 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical chemistry, 51(7), pp.844-851.
(2) Liang, L. and Zhu, J.M., 2018. An optimized sequential extraction scheme for molybdenum association in environmental samples. Acta Geochimica, 37(2), pp.111-119.
(3) Chao, T.T. and Zhou, L., 1983. Extraction techniques for selective dissolution of amorphous iron oxides from soils and sediments. Soil Sci. Soc. Am. J., 47(2), pp.225-232.

Modified Tessier Specified by Client

Sequence 1: Water Soluble, DI Water, 30 mL to 2 gram of solid, Continuous Agitation

Sequence 2: Exchangeable, Cliend Mod

Sequence 3: Bound to Carbonates, Cleint Mod

Sequence 4: Bound to Fe-Mn Oxides, Client Mod

Sequence 5: Bound to Organic Matter, Client Mod

Sequence 6: Residual, Tessier Method (v) This is via EPA 3050 Digestion Client Mod

Quote expires in six months from date on quote .

This bid is based on standard T/A and standard reporting formats via PDF emailed reports.

Soils turn-around is ~ three to four weeks and varies with workload

Electronic Data Deliverables (EDD's) will be supplied at no extra charge if needed.

This quotation must be signed and returned (fax or mail) to ACZ Laboratories, Inc. before the project is received. The authorized signature represents acceptance of the pricing as well as ACZ's General Terms & Conditions.

ACZ Representative (Authorized Signature) / Date:

Client Representative (Authorized Signature) / Date:

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

August 16, 2023

Report to:
Todd Plating
Haley Aldrich
400 Augusta Street
Suite 100
Greenville, SC, 29601, SC 29601

cc: Britton Hundley

Bill to:
Accounts Payable
Haley Aldrich
70 Blanchard Rd, Ste. 204

Burlington, MA 01803

Project ID:
ACZ Project ID: L81978

Todd Plating:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on July 25, 2023. This project has been assigned to ACZ's project number, L81978. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L81978. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after August 15, 2024. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Madeleine Murray
Madeleine Murray has reviewed and approved this report.

Haley Aldrich
Project ID:
Sample ID: L81964-L81968 TESS PBS STEP-0

ACZ Sample ID: ***L81978-01***
Date Sampled: *06/27/23 00:00*
Date Received: *07/25/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	<0.25	U	*	mg/L	0.25	1.25	08/09/23 20:54	aeh
Iron, dissolved	M200.7 ICP	5	<0.3	U	*	mg/L	0.3	0.75	08/09/23 20:54	aeh
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/09/23 20:54	aeh
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 18:10	gjl/scp

Haley Aldrich
Project ID:
Sample ID: L81964-L81968 TESS PBS STEP-1

ACZ Sample ID: ***L81978-02***
Date Sampled: *06/27/23 00:00*
Date Received: *07/25/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	20	<1	U	*	mg/L	1	5	08/08/23 17:56	wtc
Iron, dissolved	M200.7 ICP	20	<1.2	U	*	mg/L	1.2	3	08/08/23 17:56	wtc
Manganese, dissolved	M200.7 ICP	20	<0.2	U	*	mg/L	0.2	1	08/08/23 17:56	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	<0.002	U	*	mg/L	0.002	0.005	08/09/23 16:19	gjl/scp

Haley Aldrich
Project ID:
Sample ID: L81964-L81968 TESS PBS STEP-2

ACZ Sample ID: ***L81978-03***
Date Sampled: *06/27/23 00:00*
Date Received: *07/25/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	<0.25	U	*	mg/L	0.25	1.25	08/08/23 17:59	wtc
Iron, dissolved	M200.7 ICP	5	<0.3	U	*	mg/L	0.3	0.75	08/08/23 17:59	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/08/23 17:59	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	<0.002	U	*	mg/L	0.002	0.005	08/09/23 16:21	gjl/scp

Haley Aldrich
Project ID:
Sample ID: L81964-L81968 TESS PBS STEP-3

ACZ Sample ID: ***L81978-04***
Date Sampled: *06/28/23 00:00*
Date Received: *07/25/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	10	<0.5	U	*	mg/L	0.5	2.5	08/08/23 18:02	wtc
Iron, dissolved	M200.7 ICP	10	<0.6	U	*	mg/L	0.6	1.5	08/08/23 18:02	wtc
Manganese, dissolved	M200.7 ICP	10	<0.1	U	*	mg/L	0.1	0.5	08/08/23 18:02	wtc
Molybdenum, dissolved	M200.8 ICP-MS	10	<0.002	U	*	mg/L	0.002	0.005	08/09/23 16:23	gjl/scp

Haley Aldrich
Project ID:
Sample ID: L81964-L81968 TESS PBS STEP-4

ACZ Sample ID: ***L81978-05***
Date Sampled: *06/28/23 00:00*
Date Received: *07/25/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	<0.25	U	*	mg/L	0.25	1.25	08/08/23 18:05	wtc
Iron, dissolved	M200.7 ICP	5	<0.3	U	*	mg/L	0.3	0.75	08/08/23 18:05	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/08/23 18:05	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 18:13	gjl/scp

Haley Aldrich
Project ID:
Sample ID: L81964-L81968 TESS PBS STEP-5

ACZ Sample ID: ***L81978-06***
Date Sampled: *06/30/23 00:00*
Date Received: *07/25/23*
Sample Matrix: *Leachate*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Aluminum, dissolved	M200.7 ICP	5	<0.25	U	*	mg/L	0.25	1.25	08/08/23 18:09	wtc
Iron, dissolved	M200.7 ICP	5	<0.3	U	*	mg/L	0.3	0.75	08/08/23 18:09	wtc
Manganese, dissolved	M200.7 ICP	5	<0.05	U	*	mg/L	0.05	0.25	08/08/23 18:09	wtc
Molybdenum, dissolved	M200.8 ICP-MS	20	<0.004	U	*	mg/L	0.004	0.01	08/09/23 18:15	gjl/scp

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click:
https://acz.com/wp-content/uploads/2019/04/Ext-Qual-List.pdf

REP001.03.15.02

HALEYALD

ACZ Project ID: ***L81978***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Aluminum, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		2.026	mg/L	101	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.15	0.15			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	1.001		1.017	mg/L	102	85	115			
L82002-01AS	AS	08/08/23 18:28	II230801-2	1.001	U	1.012	mg/L	101	85	115			
L82002-01ASD	ASD	08/08/23 18:31	II230801-2	1.001	U	.995	mg/L	99	85	115	2	20	
WG571982													
WG571982ICV	ICV	08/09/23 20:33	II230729-1	2		2.024	mg/L	101	95	105			
WG571982ICB	ICB	08/09/23 20:39				U	mg/L		-0.15	0.15			
WG571982LFB	LFB	08/09/23 20:51	II230804-2	1.001		1.047	mg/L	105	85	115			
L82126-02AS	AS	08/09/23 21:00	II230804-2	10.01	U	10.69	mg/L	107	85	115			
L82126-02ASD	ASD	08/09/23 21:03	II230804-2	10.01	U	10.52	mg/L	105	85	115	2	20	

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		1.978	mg/L	99	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.18	0.18			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	1.004		1.01	mg/L	101	85	115			
L82002-01AS	AS	08/08/23 18:28	II230801-2	1.004	U	.969	mg/L	97	85	115			
L82002-01ASD	ASD	08/08/23 18:31	II230801-2	1.004	U	.962	mg/L	96	85	115	1	20	
WG571982													
WG571982ICV	ICV	08/09/23 20:33	II230729-1	2		1.939	mg/L	97	95	105			
WG571982ICB	ICB	08/09/23 20:39				U	mg/L		-0.18	0.18			
WG571982LFB	LFB	08/09/23 20:51	II230804-2	1.004		1.088	mg/L	108	85	115			
L82126-02AS	AS	08/09/23 21:00	II230804-2	10.04	U	10.27	mg/L	102	85	115			
L82126-02ASD	ASD	08/09/23 21:03	II230804-2	10.04	U	10.1	mg/L	101	85	115	2	20	

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571887													
WG571887ICV	ICV	08/08/23 16:45	II230729-1	2		1.932	mg/L	97	95	105			
WG571887ICB	ICB	08/08/23 16:51				U	mg/L		-0.03	0.03			
WG571887LFB	LFB	08/08/23 17:04	II230801-2	.4995		.502	mg/L	101	85	115			
L82002-01AS	AS	08/08/23 18:28	II230801-2	.4995	U	.48	mg/L	96	85	115			
L82002-01ASD	ASD	08/08/23 18:31	II230801-2	.4995	U	.478	mg/L	96	85	115	0	20	
WG571982													
WG571982ICV	ICV	08/09/23 20:33	II230729-1	2		1.924	mg/L	96	95	105			
WG571982ICB	ICB	08/09/23 20:39				U	mg/L		-0.03	0.03			
WG571982LFB	LFB	08/09/23 20:51	II230804-2	.4995		.505	mg/L	101	85	115			
L82126-02AS	AS	08/09/23 21:00	II230804-2	4.995	U	5.164	mg/L	103	85	115			
L82126-02ASD	ASD	08/09/23 21:03	II230804-2	4.995	U	5.072	mg/L	102	85	115	2	20	

HALEYALD

ACZ Project ID: ***L81978***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Molybdenum, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG571954													
WG571954ICV	ICV	08/09/23 15:39	MS230712-3	.02		.02011	mg/L	101	90	110			
WG571954ICB	ICB	08/09/23 15:41				U	mg/L		-0.00044	0.00044			
WG571954LFB	LFB	08/09/23 15:44	MS230724-2	.05005		.04916	mg/L	98	85	115			
L81967-04AS	AS	08/09/23 16:40	MS230724-2	1.001	.00491	.90836	mg/L	90	70	130			
L81967-04ASD	ASD	08/09/23 16:42	MS230724-2	1.001	.00491	.97148	mg/L	97	70	130	7	20	
WG571986													
WG571986ICV	ICV	08/09/23 17:10	MS230712-3	.02		.01893	mg/L	95	90	110			
WG571986ICB	ICB	08/09/23 17:12				U	mg/L		-0.00044	0.00044			
WG571986LFB	LFB	08/09/23 17:14	MS230724-2	.05005		.04652	mg/L	93	85	115			
L81967-06AS	AS	08/09/23 17:47	MS230724-2	1.001	U	.90193	mg/L	90	70	130			
L81967-06ASD	ASD	08/09/23 17:49	MS230724-2	1.001	U	.9418	mg/L	94	70	130	4	20	

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Extended Qualifier Report

Haley Aldrich

ACZ Project ID: ***L81978***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L81978-01	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81978-02	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81978-03	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81978-04	WG571954	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81978-05	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.
L81978-06	WG571986	Molybdenum, dissolved	M200.8 ICP-MS	D1	Sample required dilution due to matrix.

Certification Qualifiers

Haley Aldrich

ACZ Project ID: ***L81978***

No certification qualifiers associated with this analysis

APPENDIX E
Microbiological Results

10515 Research Drive
Knoxville, TN 37932
Phone: 865.573.8188
Fax: 865.573.8133
Web: www.microbe.com

SITE LOGIC Report

Next Generation Sequencing (NGS) Report

Contact: Todd Plating
Phone:

Address: Haley & Aldrich
400 Augusta St.
Ste 100
Greenville, SC 29601

Email: TPlating@haleyaldrich.com

MI Identifier: 038UF

Report Date: 07/11/2023

Project: FB Culley East Ash Pond, 0129420-034-001-01
Comments:

NOTICE: This report is intended only for the addressee shown above and may contain confidential or privileged information. If the recipient of this material is not the intended recipient or if you have received this in error, please notify Microbial Insights, Inc. immediately. The data and other information in this report represent only the sample(s) analyzed and are rendered upon condition that it is not to be reproduced without approval from Microbial Insights, Inc. Thank you for your cooperation.

Sample Overview

Table 1: Sample information for 038UF.

MI Identifier	Sample Name	Sample Date	Reads Passing Quality Filtering	% Reads Classified to Genus
038UF-1	CCR-AP-6I-061323	06/13/2023	400,843	67.7%
038UF-2	CCR-AP-8I-061323	06/13/2023	222,822	74.2%

Table 2: Genus diversity indices for 038UF. Please refer to the Interpretation section for more information on what these diversity indices mean.

MI Identifier	Sample Name	Shannon	Simpson	Chao1 Predicted Genera	Total Genera Observed	Total Eubacteria (cells/mL)
038UF-1	CCR-AP-6I-061323	4.75	0.97	1615.34	1439	2.38e+05
038UF-2	CCR-AP-8I-061323	4.86	0.98	1445.26	1266	3.28e+05

10515 Research Drive
Knoxville, TN 37932
Phone: 865.573.8188
Fax: 865.573.8133
Web: www.microbe.com

Results for CCR-AP-6I-061323

Table 3: Sequencing Statistics for CCR-AP-6I-061323

Total Reads	Reads Passing Quality Filtering	% Reads Passing Quality Filtering
400,843	400,843	100.0%

Table 4: Classification Rate Summary CCR-AP-6I-061323

Taxonomic Level	Reads Classified to Taxonomic Level	% Total Reads Classified to Taxonomic Level
Kingdom	372,013	92.8%
Phylum	320,422	79.9%
Class	314,424	78.4%
Order	308,779	77.0%
Family	300,158	74.9%
Genus	271,319	67.7%
Species	173,443	43.3%

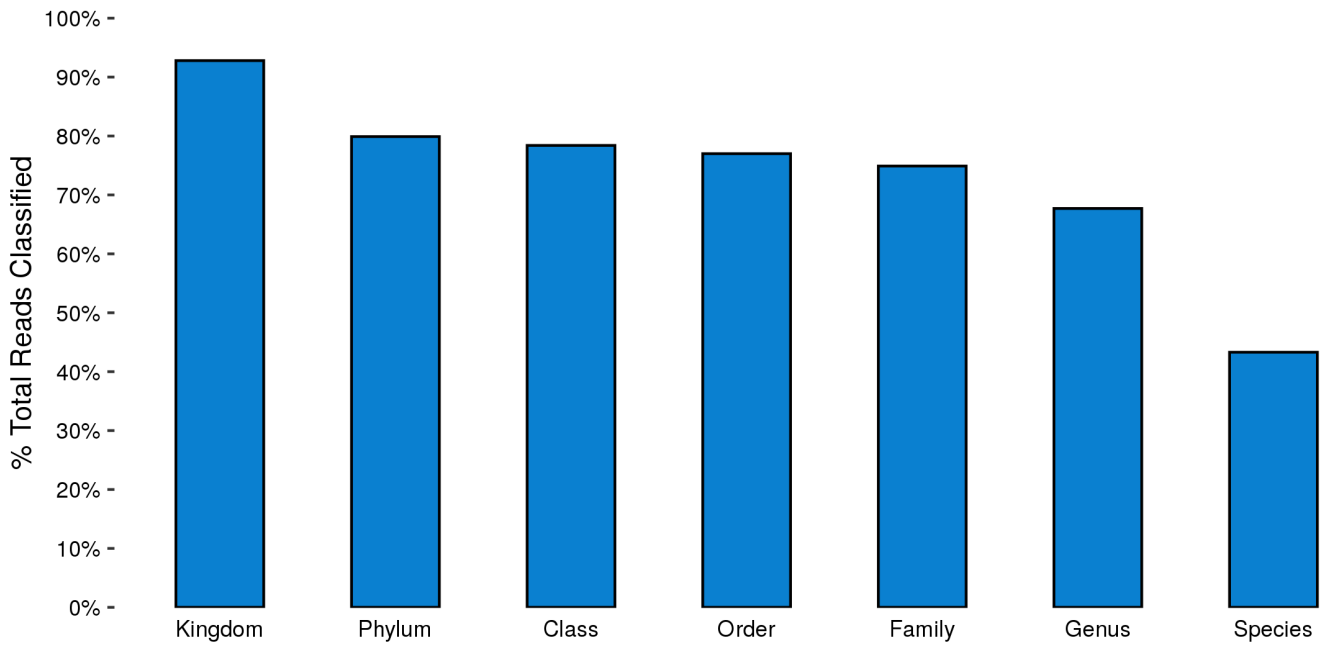


Figure 1: Classification Rate by Taxonomic Level for CCR-AP-6I-061323

10515 Research Drive
Knoxville, TN 37932
Phone: 865.573.8188
Fax: 865.573.8133
Web: www.microbe.com

CCR-AP-6I-061323 Classification Results by Taxonomic Level

Table 5: Top phyla classification results for CCR-AP-6I-061323. Additional identified phyla are included in the accompanying Excel data file.

Phylum	Reads	Percent
Proteobacteria	153,476	47.9%
Parcubacteria	37,129	11.6%
Firmicutes	21,604	6.7%
Acidobacteria	15,699	4.9%
Verrucomicrobia	13,418	4.2%
DeinococcusUnclassifiedThermus	13,010	4.1%
Chloroflexi	11,956	3.7%
Actinobacteria	6,529	2.0%
Planctomycetes	4,396	1.4%
Bacteroidetes	4,153	1.3%
Omnitrophica	4,081	1.3%
Chlamydiae	3,924	1.2%
Thermodesulfobacteria	3,154	1.0%
Fusobacteria	3,117	1.0%
Latescibacteria	2,484	0.8%
Nitrospirae	2,484	0.8%
Armatimonadetes	2,353	0.7%

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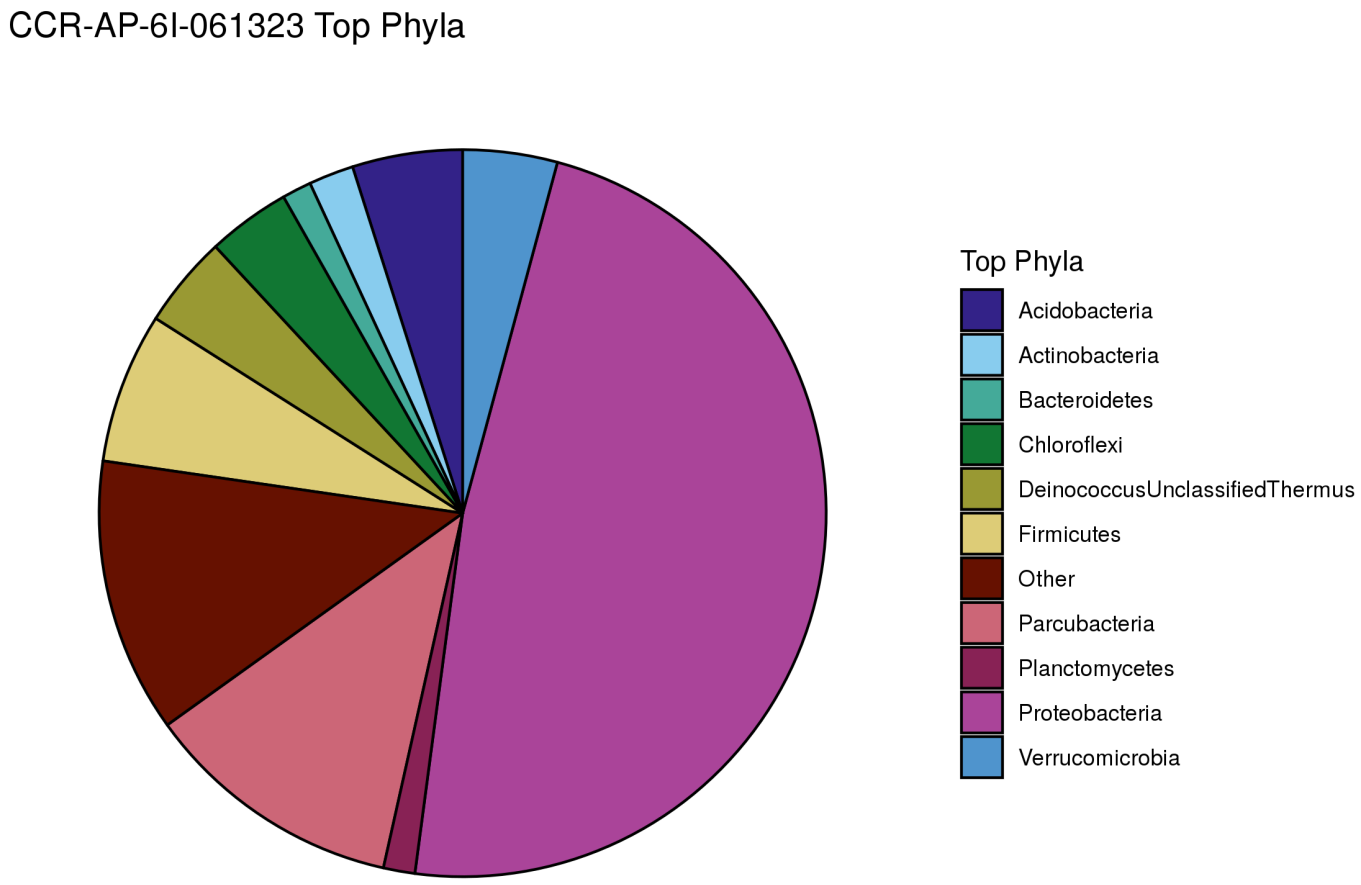


Figure 2: Top Phylum Classification Results for CCR-AP-6I-061323

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Table 6: Top genera classification results for sample CCR-AP-6I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Parcubacteria genera incertae sedis	37,129	13.7%	Genus of unclassified bacteria. It is proposed that Parcubacteria obligately ferments simple sugars to organic acids and can also degrade complex carbon sources. Species have also been implicated in hydrogen and sulfur cycles in anoxic sediments. These bacteria are found in exclusively anoxic environments.
Deinococcus	12,395	4.6%	Aerobic genus of chemoorganotrophs. Some species may be facultatively anaerobic. Carbohydrates and amino acids are utilized as growth substrates. All species are resistant to ionizing-radiation. The type species, D. radiodurans also reduce and are heavy metal tolerant. Some species are thermophilic and proteolytic. Recent studies have characterized Deinococcus as efficient primary biofilm formers. Deinococcus is found in a number of different habitats.
Aquabacterium	11,662	4.3%	Capable of microaerophilic growth, Aquabacterium uses nitrate and oxygen as electron acceptors. A broad range of organic acids but not carbohydrates are metabolized. This genus was originally isolated from biofilms in drinking water.
Desulforegula	11,569	4.3%	Anaerobic genus of sulfate-reducing bacteria. Straight-chain carboxylic acids are utilized as the sole energy sources and are oxidized to acetate and propionate. No growth occurs without sulfate as the electron acceptor. Desulforegula is found in freshwater sediment.
Pseudomonas	10,338	3.8%	Genus of metabolically versatile, chemoorganotrophic aerobes. Generally, oxygen is the terminal electron acceptor, though growth by nitrate reduction or complete denitrification may also occur under anerobic conditions by many species. Growth conditions vary greatly between species. Pseudomonas is ubiquitous in nature but may be less tolerant of acidic environments.
Subdivision3 genera incertae sedis	7,620	2.8%	This is a subgroup of Verrucomicrobia that includes bacteria isolated from soils, vinyl chloride degrading enrichments, river biofilms, hot springs, and nitrifying-denitrifying activated sludge.
Chitinimonas	6,337	2.3%	Members of this genus include some strictly aerobic organisms and some organisms that can also grow under anaerobic conditions. They have been isolated from freshwater and soil environments and are capable of utilizing chitin as a carbon, nitrogen, and energy source. Some strains are capable of fermenting glucose and other carbohydrates to produce acids.
Undibacterium	6,291	2.3%	Motile genus of aerobic chemoorganotrophs. Cell morphology is characterized by the presence of pili that aid in motility. Carbohydrates and starch are generally utilized as carbon and energy sources. This bacterium is sensitive to salt and has been isolated from fresh and purified water.
Sulfurisoma	5,912	2.2%	Facultatively anaerobic genus of sulfur-oxidizers. Thiosulfate, sulfur and hydrogen are utilized for autotrophic growth. Organic acids serve as carbon and energy sources under heterotrophic growth. Nitrate is reduced. Sulfurisoma is found in freshwater sediment.

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Table 6: Top genera classification results for sample CCR-AP-6I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Geobacter	4,892	1.8%	Anaerobic genus of chemoorganotrophs. Fe(III) is used as the sole electron acceptor and acetate as an electron donor. Several Geobacter species also utilize hydrogen as an electron donor. While Geobacter spp. are known as iron reducing bacteria, some species can also utilize a variety of other growth supporting electron acceptors such as elemental sulfur, Mn(IV), and U(VI). Some species have been shown to degrade toluene and benzene. Strains of one species, G. lovleyi, contain a pceA gene and are capable of reductive dechlorination of PCE to cis-DCE. Geobacter species are ubiquitous in nature.
Rhodoferax	4,886	1.8%	Genus of purple nonsulfur bacteria. Species are capable of growth under photosynthetic, aerobic or fermentative conditions. Simple carbon compounds are utilized as carbon and energy sources including lactate, acetate, butyrate, and ethanol. One species, R. fermentans, can grow anaerobically in the light or under aerobic conditions in the dark. Rhodoferax have been isolated from marine environments with some psychrophilic species located in polar environments.
Opitutus	4,728	1.7%	Chemoorganotrophic genus of facultatively anaerobic bacteria. Carbohydrates are solely utilized as carbon and energy sources. Metabolism is mostly fermentative with acetate, propionate, CO2 and H2 as the main products. Opitutus is found in rice paddy soil.
Thermomarinilinea	4,097	1.5%	Filamentous and multicellular anaerobic genus of thermophilic heterotrophs. Carbohydrates and amino acids are fermented. Sea water is required for growth. Thermomarinilinea was originally isolated from a hydrothermal vent.
Omnitrophica genera incertae sedis	4,081	1.5%	Genus of the unclassified Omnitrophica phylum. Not much is known about this group except that they live in anoxic environments. This phylum is part of the Planctomycetes/Verrucomicrobia/Chlamydiae (PVC) superphylum.
Silanimonas	2,844	1.0%	Genus of aerobic chemoorganotrophs. Carbohydrates and organic acids are utilized as carbon and energy sources. Silanimonas hydrolyzes some proteins. Species have been isolated from hot springs and mangrove sediment.
Novosphingobium	2,693	1.0%	Strictly aerobic genus of chemoorganotrophs. A sub-genus of Sphingomonas. Some species reduce nitrate and degrade aromatic compounds with one species capable of polychlorophenol degradation. Novosphingobium is ubiquitous in nature.
Rheinheimera	2,608	1.0%	Genus of aerobic or facultatively anaerobic chemoheterotrophs. Various carbohydrates and sugars are utilized as carbon and energy sources but is species-dependent. Some strains produce acid from sugars oxidatively. Rheinheimera has been isolated from marine environments.
Latescibacteria genera incertae sedis	2,484	0.9%	Unclassified genus of anaerobic bacteria. Metabolic reconstruction suggests a fermentative type of metabolism as well as the capability to degrade multiple polysaccharides and glycoproteins composing green and brown algae cell walls, storage molecules, and extracellular polymeric substances. Latescibacteria can be found in terrestrial, aquatic, and marine ecosystems.

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Table 6: Top genera classification results for sample CCR-AP-6I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Moorella	2,440	0.9%	Thermophilic genus of homoacetogens possessing a fermentative type of metabolism. C1 carbon compounds, sugars and other compounds are utilized to produce acetate as the main fermentation product. Chemolithoautotrophic growth is also possible by using CO or H2 as electron donors to form aromatic compounds. Some species of Moorella have been employed commercially to produce a more environmentally friendly alternative to road salt. Moorella has been isolated from hot springs, animal feces, in sewage sludge and freshwater sediments.
Gp18	2,431	0.9%	Unclassified Acidobacteria.
Desulfobacterium	2,268	0.8%	Strictly anaerobic genus of chemoorganotrophic or chemoautotrophic bacteria. A variety of compounds are utilized as electron donors and energy sources including carboxylates, organic acids, alcohols and hydrogen and carbon dioxide. Sulfate and other oxidized sulfur compounds are reduced to hydrogen sulfide. Growth can also occur fermentatively. Carbon dioxide fixation is also possible, but seawater or magnesium chloride are required. Desulfobacterium is generally found in marine environments.
Desulfovibrio	2,247	0.8%	Anerobic genus of halophilic sulfate reducers. Metabolism is respiratory but fermentative growth is possible. Sulfate and other sulfur compounds are reduced to hydrogen sulfide. Under fermentative growth, organic compounds are oxidized incompletely to acetate. Some species can use hydrogen as an electron donor with acetate and CO2 as carbon sources. The species D. desulfuricans has been linked to heavy metal reduction and microbial induced corrosion. Desulfovibrio is found in a variety of environments including anoxic sediment and in mammals.
Thermodesulfatator	2,027	0.7%	Genus of strictly anaerobic sulfate reducing thermophiles. Hydrogen is used as the sole electron donor with sulfate as the sole electron acceptor. Growth is stimulated by methanol and other organic compounds. Ammonium is utilized as the nitrogen source. Thermodesulfatator has been isolated from a hydrothermal vent in the deep sea.
Pelobacter	1,979	0.7%	Genus of strictly anaerobic chemoorganotrophs with a fermentative type of metabolism. A small range of simple organic compounds are utilized for fermentation such as acetoin, butanediol and ethylene glycol. One species, P. carbinolicus, reduces Fe(III) and oxidizes H2. Fermentation products are generally acetate and ethanol. This genus has been isolated from sediment.
Gp17	1,944	0.7%	Unclassified Acidobacteria.
Desulfatiferula	1,915	0.7%	Genus of sulfate-reducing facultatively anaerobic bacteria. Sulfate and other sulfur compounds serve as electron acceptors, depending on the species. Alkenes and fatty acids are utilized as carbon sources and electron donors. Vitamins are required for growth. Desulfatiferula is found in sediment.

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Table 6: Top genera classification results for sample CCR-AP-6I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Desulfocapsa	1,811	0.7%	Genus of strictly anaerobic sulfate-reducing bacteria. Sulfate reduction is coupled to the incomplete oxidation of simple organic compounds. Alternatively, certain alcohols are oxidized to fatty acids with sulfate as an electron acceptor. Disproportionation of inorganic sulfur compounds (thiosulfate, sulfite) also support growth with carbon dioxide as a carbon source. Desulfocapsa is found in anoxic freshwater sediment.
Azospira	1,727	0.6%	Generally aerobic genus of chemoorganotrophic nitrogen-fixers. Organic acids and alcohols are used as carbon and energy sources. Acetylene is reduced to ethylene. Oxygen and nitrate are utilized as electron acceptors with some species additionally using nitrate and perchlorate. Azospira species have been isolated from groundwater and rice paddies.
BRC1 genera incertae sedis	1,632	0.6%	Unclassified organism containing the BRC1 gene, associated with branching signals and bud development.
Desulfonatronum	1,620	0.6%	Genus of anaerobic sulfate-reducing alkaliphiles. Litho-heterotrophic growth occurs with sulfate and other oxidized sulfur compounds being reduced to hydrogen sulfide. Molecular hydrogen, ethanol and certain carboxylates are utilized as electron donors. Members of this genus are found in highly alkaline environments such as manure and sediments of soda lakes.
Dehalogenimonas	1,552	0.6%	Genus of strictly anaerobic chemoheterotrophs. Species reductively dehalogenate chlorinated alkanes by using molecular hydrogen as an electron donor. Isolated from contaminated groundwater, these bacteria are of particular use in bioremediation due to their dechlorination capabilities. QuantArray-Chlor and CENSUS qPCR assays are available to quantify Dehalogenimonas.
Georgfuchsia	1,467	0.5%	Genus of anaerobic chemoorganoheterotrophs. Fe(III), Mn (IV) and nitrate are used as electron acceptors. Aromatic compounds are degraded. Species possess the gene benzylsuccinate synthase A (bssA) which allows for the degradation of toluene anoxically. Georgfuchsia was originally isolated from a landfill aquifer.
Desulfovirga	1,387	0.5%	Strictly anaerobic genus of chemoorganoheterotrophs. Formate, adipate, alcohols, organic acids and some fatty acids serve as carbon and energy source and are oxidized completely to carbon dioxide. Sulfate and other sulfur compounds are used as electron acceptors. Species are found in soil and freshwater.
Sideroxydans	1,378	0.5%	Genus of microaerophilic chemolithoautotrophs. Fe(II) is utilized as the sole energy source and carbon dioxide as the carbon source. Sideroxydans is found in soil.
Pseudorhodobacter	1,366	0.5%	Chemoorganotrophic genus of aerobic or facultatively anaerobic bacteria. Organic acids are the preferred substrate though some species can utilize carbohydrates as well. Some species are capable of fermentation. Stains have been isolated from a variety of marine environments.

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Genus	Reads	Percent	Description
Leptotrichia	1,357	0.5%	Aerobic or anaerobic genus of chemoorganotrophs. Carbohydrates are generally utilized as carbon and energy sources. Under anaerobic conditions, lactic acid is produced from glucose fermentation with trace amounts of acetic and succinic acids. Many diverse species are contained within the genus. Leptotrichia is generally found in the oral cavity and other clinical samples.
Gp16	1,316	0.5%	Unclassified Acidobacteria.
Leptospirillum	1,287	0.5%	Genus of chemolithotrophic iron-oxidizers. Ferrous oxide and other iron-containing minerals are oxidized. Carbon dioxide is fixed. Exopolysaccharides are secreted which may lead to microbial induced corrosion. Acidophilic and sometimes thermophilic, Leptospirillum is found in metal-rich environments throughout nature.
Phaeospirillum	1,255	0.5%	Genus of purple non-sulfur bacteria. Photoorganotrophic growth occurs in the light under anoxic conditions but limited growth in the dark under oxic conditions is also possible. Phaeospirillum has been isolated from freshwater environments.
Microgenomates genera incertae sedis	1,053	0.4%	Unclassified genus within the Microgenomates phylum that is thought to be comprised of heterotrophic and fermentative bacteria found in eutrophic water and soil.
Gp22	1,027	0.4%	Unclassified Acidobacteria.
WPSUnclassified2 genera incertae sedis	1,008	0.4%	Unclassified candidate phylum of Archaea.
Sulfuritalea	986	0.4%	Genus of facultatively anaerobic sulfur-oxidizing bacteria (SOB). Thiosulfate and elemental sulfur are oxidized with hydrogen serving as the electron donor while nitrate is reduced to nitrogen. Growth can also occur heterotrophically with certain carboxylates and organic acids as carbon and energy sources. A recent study has shown that in nitrate-depleted waters, arsenate can also be utilized as an electron acceptor. Species have been isolated from freshwater environments.
Hydrogenophaga	983	0.4%	Genus of aerobic mixotrophs. This genus can grow chemoorganotrophically using hydrogen as the electron donor and carbon dioxide as the carbon source. Chemolithoautotrophic growth occurs with multiple organic compounds as the carbon source and oxygen as the electron acceptor. Two species, H. pseudoflava and H. taeniospiralis can heterotrophically denitrify nitrate and one species has been shown to degrade MTBE. Hydrogenophaga is widely distributed in soils and aquatic habitats including a waste-oil contaminated site.
Chlamydophila	974	0.4%	Genus of anaerobic gram-negative nonmotile, obligate intracellular organisms in the Chlamydiaceae family.
Desulfomonile	972	0.4%	Genus of strictly anaerobic, sulfate reducing bacteria. Some species can grow autotrophically on hydrogen and carbon dioxide with sulfate or thiosulfate as terminal electron acceptors. Acetate and lactate are fermentation products from glucose. Some species are capable of reductive dehalogenation of some chlorophenols or chlorobenzoates. Desulfomonile has been isolated from sediment, soil and sludge.

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Table 6: Top genera classification results for sample CCR-AP-6I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Syntrophus	941	0.3%	Genus of strictly anerobic chemoorganotrophs. Crotonate is generally fermented though other aromatic compound may be used. In co-culture with sulfate-reducing bacteria or a methanogen that utilizes H2/formate, benzoate and fatty acids are oxidized. Syntrophus is found in freshwater.
Clostridium sensu stricto	906	0.3%	Obligately anaerobic genus possessing a fermentative type of metabolism. Some species are aerotolerant. Growth requirements vary greatly between species, utilizing a range of compounds. Fermentation end products are usually a combination of alcohols and organic acids. Some species are acetogens.
Desulfoprunum	888	0.3%	Strictly anaerobic genus of sulfate reducing bacteria. Short-chain fatty acids and alcohols (with the exception of methanol) and benzoate are utilized as carbon and energy sources. Substrates are oxidized completely to carbon dioxide with the reduction of sulfate and DMSO to sulfide. Desulfoprunum was originally isolated from wastewater.
Streptococcus	849	0.3%	Facultatively anaerobic genus of chemoorganotrophs. Carbohydrates are fermented to lactic, acetic and small amounts of formic acid. Some strains of Streptococcus are also able to utilize petroleum hydrocarbons as carbon and energy sources.
Smithella	845	0.3%	Strictly anaerobic genus of chemoorganoheterotrophs. Crotonate and propionate are the main energy sources. Some additional organic acids may be fermented in syntrophic growth with H2 or formate utilizing organisms such as Methanospirillum hungateii. Smithella was originally isolated from a methanogenic digester.
Altererythrobacter	844	0.3%	Aerobic genus of chemoorganotrophs. Many diverse species are contained within the genus. A variety of organic compounds are utilized as energy and carbon sources but is species-dependent. NaCl is required by most species for growth. Degradation of epoxides and production of astaxanthin (a type of carotenoid) is performed by some species. Altererythrobacter is found in a number of environments including tidal flats, deep sea sediment, crude oil, wild rice and deserts.
Aeromonas	843	0.3%	Genus of facultatively anaerobic chemoorganotrophs. Carbohydrates are fermented. Acids and gas may be produced from fermentation, depending on the species. A number of species are contained within the genus and all are generally resistant to the vibriostatic agent O/129. Aeromonas is ubiquitous in nature, often associated with fish, and clinical samples.
Thermodesulfovibrio	803	0.3%	Thermophilic genus of anaerobic sulfate-reducing bacteria. Sulfate and thiosulfate are generally utilized as electron acceptors but sulfite, nitrate, and Fe (III) may also be used depending on the species. Syntrophic growth with a hydrogenotrophic methanogen is also possible. Organic compounds are oxidized completely to acetate. Members of this genus have been isolated from hot springs and sludge.

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Table 6: Top genera classification results for sample CCR-AP-6I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Azospirillum	796	0.3%	Microaerobic genus of nitrogen-fixing chemoorganotrophs. Metabolism is generally respiratory but can be fermentative also. Carboxylates and certain carbohydrates are utilized as carbon and energy sources. Some strains exhibit autotrophic growth facultatively with hydrogen. This plant growth-promoting rhizobacteria has been isolated from soil or plant material.
Desulfobulbus	786	0.3%	Strictly anaerobic genus of chemoorganotrophic sulfate reducing bacteria. Metabolism can be respiratory or fermentative. A limited number of organic acids and alcohols are utilized as carbon sources and electron donors which are oxidized incompletely to acetate. Sulfate and other sulfur compounds serve as electron acceptors and are reduced to hydrogen sulfide. Desulfobulbus is found in low oxygen aquatic environments and in mammals.
Gp9	772	0.3%	Unclassified Acidobacteria.
Chthonomonas/ Armatimonadetes gp3	771	0.3%	Unclassified thermophilic genus of aerobic chemoorganotrophs. A number of organic compounds are utilized for growth and energy including polysaccharides and amide derivatives. Chthonomonas is found in geothermal soil.
Desulfonatronobacter	764	0.3%	Genus of anaerobic sulfate-reducing heterotrophs. Short-chain fatty acids serve as carbon and energy sources and most are incompletely oxidized to acetate. Sulfate and thiosulfate are utilized as electron acceptors. Species are extremely halotolerant and alkaliphilic and have been isolated from soda lakes.
Saccharibacteria genera incertae sedis	761	0.3%	Unclassified genus of aerobic or facultatively anaerobic bacteria. A limited range of organic compounds are utilized as carbon and energy sources but specific type varies under anaerobic, anoxic, or aerobic conditions though aerobic conditions are most favorable. Nitrate is reduced under anoxic conditions. This genus is ubiquitous in nature.
Gp6	755	0.3%	Unclassified Acidobacteria.
Nitrolancea	754	0.3%	Aerobic genus of chemolithoautotrophic nitrite-oxidizing and thermotolerant bacteria. Nitrite and formate are oxidized to nitrate and CO2, respectively. The only known species, N. hollandica, was originally isolated from a nitrifying bioreactor.
Rhizobium	749	0.3%	Genus of aerobic chemoorganotrophic symbiotic nitrogen-fixers. A variety of carbohydrates and carboxylates are utilized as carbon and energy sources and nitrates, amino acids and ammonium salts are used as nitrogen sources. Slime is produced from carbohydrates. Vitamins are required for growth. Rhizobium induces hypertrophisms in root nodules of plants.
Desulfuromonas	707	0.3%	Strictly anaerobic genus of sulfur reducing chemoorganotrophs. Elemental sulfur is reduced to H2S in a dissimilatory fashion. Organic acids are fermented and oxidized completely to CO2. Desulfuromonas is found in anoxic sediment.
Marinobacterium	694	0.3%	Strictly anaerobic genus of chemoorganotrophs. A wide variety of carbon sources are utilized for growth including C1 compounds such as methanol and formate and organic acids including acetate. Sea salt is required for growth. One species, M. nitratireducens reduces nitrate. Marinobacterium is found in aquatic environments.

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Table 6: Top genera classification results for sample CCR-AP-6I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Halanaerobium	693	0.3%	Strictly anaerobic genus of halophilic chemoorganotrophs possessing a fermentative type of metabolism. Generally, acetate, ethanol, H2 and CO2 are produced from carbohydrates fermentatively with some species also producing additional carboxylates. Some species utilize thiosulfate and elemental sulfur as electron acceptors, producing sulfide. Halanaerobium species are generally found in hypersaline environments but are also found in salted fermented foods and in oil wells and petroleum reservoirs.
Blastomonas	680	0.3%	Genus of strictly aerobic, photosynthetic bacteria. Chemoorganotrophic growth is preferred but facultatively photoorganoheterotrophic growth can also occur. A wide range of organic compounds are utilized as carbon sources, but the specific type is species-dependent. Blastomonas form rosette-like aggregates and are found in freshwater.
Desulfatiglans	667	0.2%	Strictly anaerobic genus of sulfate-reducing chemoorganoheterotrophs. Organic acids, phenols and benzoates are used as electron donors and carbon sources. Sulfate is reduced to H2S with the use of sulfite and thiosulfate varying across species. Desulfatiglans species are found in freshwater and marine environments.
Natranaerovirga	641	0.2%	Obligately anaerobic genus of fermenters. Galacturonic acid and its polymers are the preferred growth substrate though organic acids may also be fermented in the presence of thiosulfate. Natranaerovirga species are obligately alkaliphilic and halotolerant and have been isolated from soda lakes and soils.
Perlucidibaca	635	0.2%	Facultatively aerobic genus of chemoheterotrophs. A limited range of organic compounds are utilized as carbon and energy sources. Perlucidibaca was originally isolated from a eutrophic pond.
Sandaracinus	608	0.2%	Aerobic genus of chemoorganotrophic myxobacteria. In general, Myxobacteria move by gliding, produce fruiting bodies during starvation conditions and are social - growing in cell communities called swarms. Myxobacteria are generally are thought to live from the degradation products of biopolymers such as proteins, cellulose, and other cellular constituents. The type species, S. amylolyticus, was originally isolated from soil.
Aminicenantes genera incertae sedis	606	0.2%	Not much is known about this candidate organism except that it is found in hydrocarbon-impacted environments as well as marine locations.

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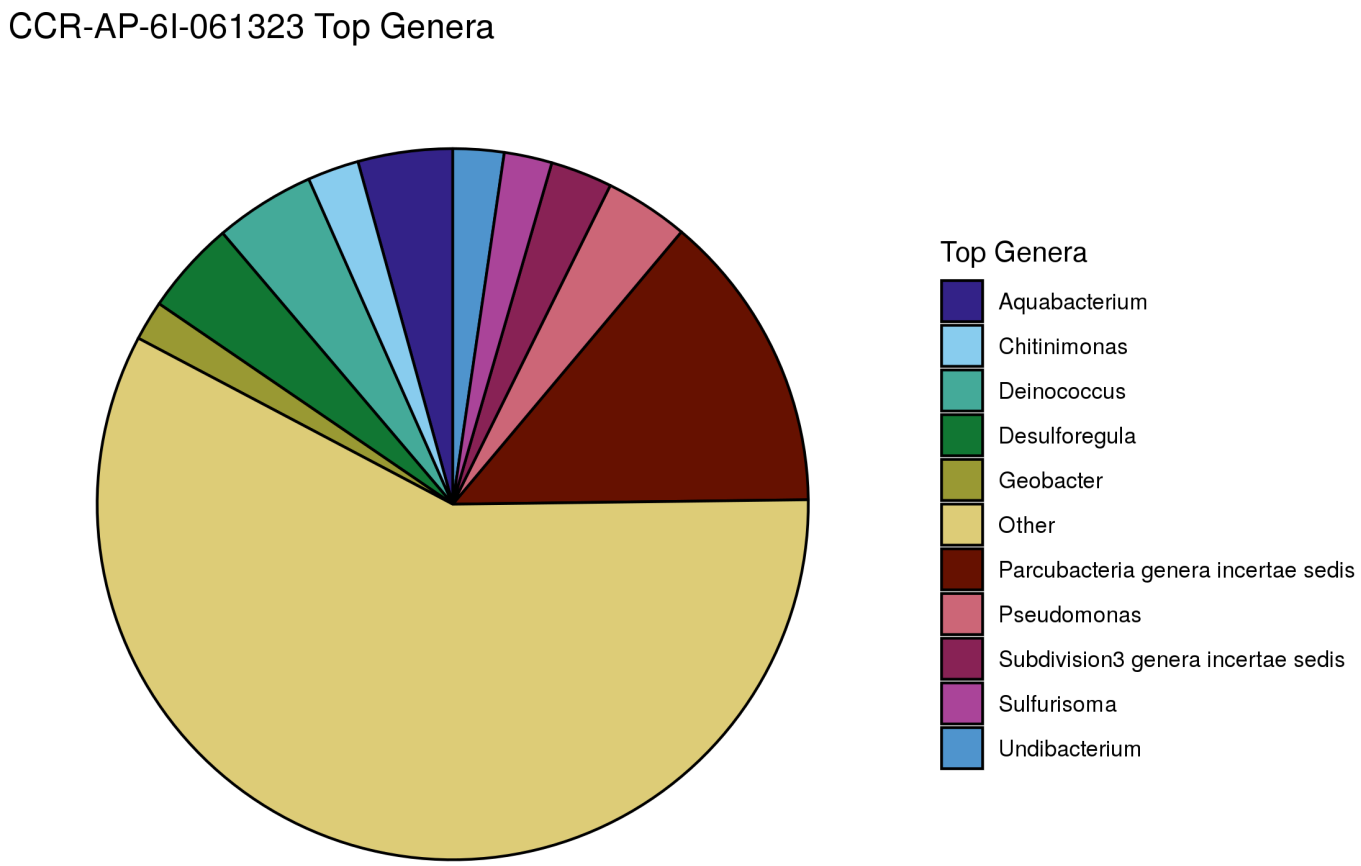


Figure 3: Top Genus Classification Results for CCR-AP-6I-061323

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Results for CCR-AP-8I-061323

Table 7: Sequencing Statistics for CCR-AP-8I-061323

Total Reads	Reads Passing Quality Filtering	% Reads Passing Quality Filtering
222,822	222,822	100.0%

Table 8: Classification Rate Summary CCR-AP-8I-061323

Taxonomic Level	Reads Classified to Taxonomic Level	% Total Reads Classified to Taxonomic Level
Kingdom	213,135	95.7%
Phylum	189,145	84.9%
Class	185,643	83.3%
Order	182,773	82.0%
Family	179,505	80.6%
Genus	165,223	74.2%
Species	112,691	50.6%

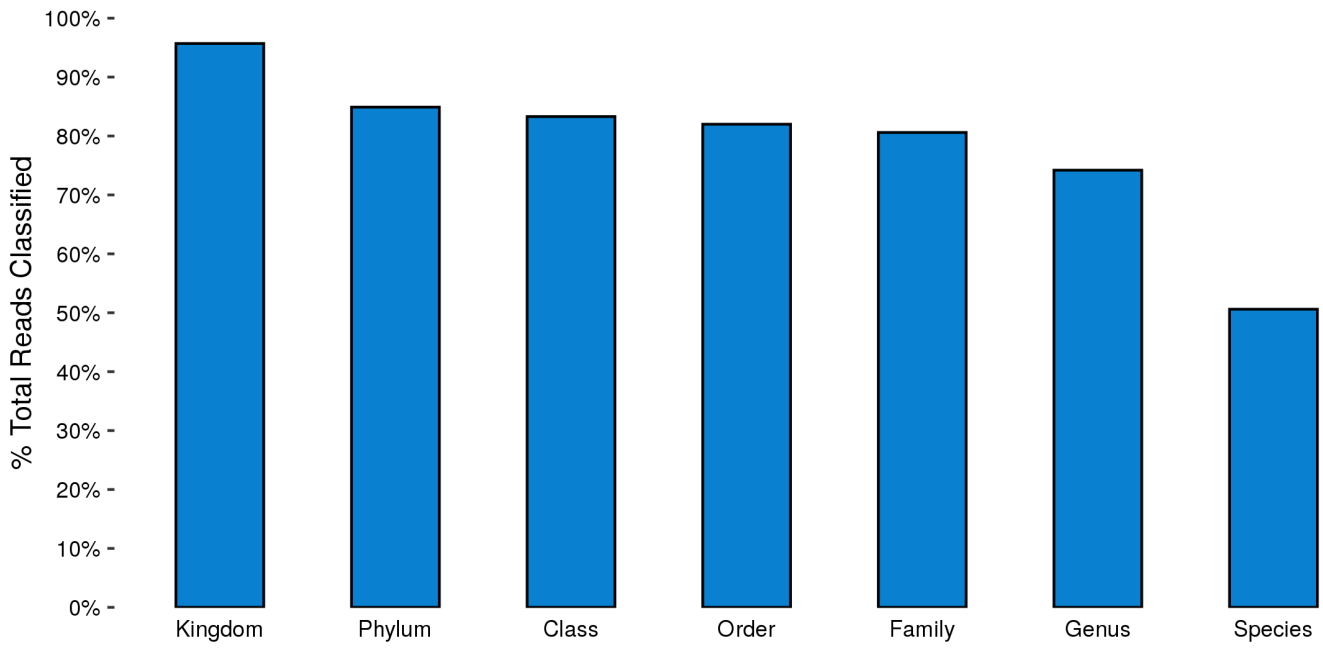


Figure 4: Classification Rate by Taxonomic Level for CCR-AP-8I-061323

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CCR-AP-8I-061323 Classification Results by Taxonomic Level

Table 9: Top phyla classification results for CCR-AP-8I-061323. Additional identified phyla are included in the accompanying Excel data file.

Phylum	Reads	Percent
Proteobacteria	81,766	43.2%
Parcubacteria	17,244	9.1%
Chloroflexi	14,142	7.5%
Acidobacteria	13,572	7.2%
Firmicutes	9,930	5.2%
Bacteroidetes	6,999	3.7%
Planctomycetes	5,960	3.2%
Verrucomicrobia	5,027	2.7%
Actinobacteria	4,790	2.5%
Nitrospirae	4,066	2.1%
DeinococcusUnclassifiedThermus	3,638	1.9%
Aminicenantes	2,958	1.6%
Synergistetes	1,985	1.0%
Omnitrophica	1,859	1.0%
Latescibacteria	1,775	0.9%
Armatimonadetes	1,699	0.9%
Thermodesulfobacteria	1,428	0.8%

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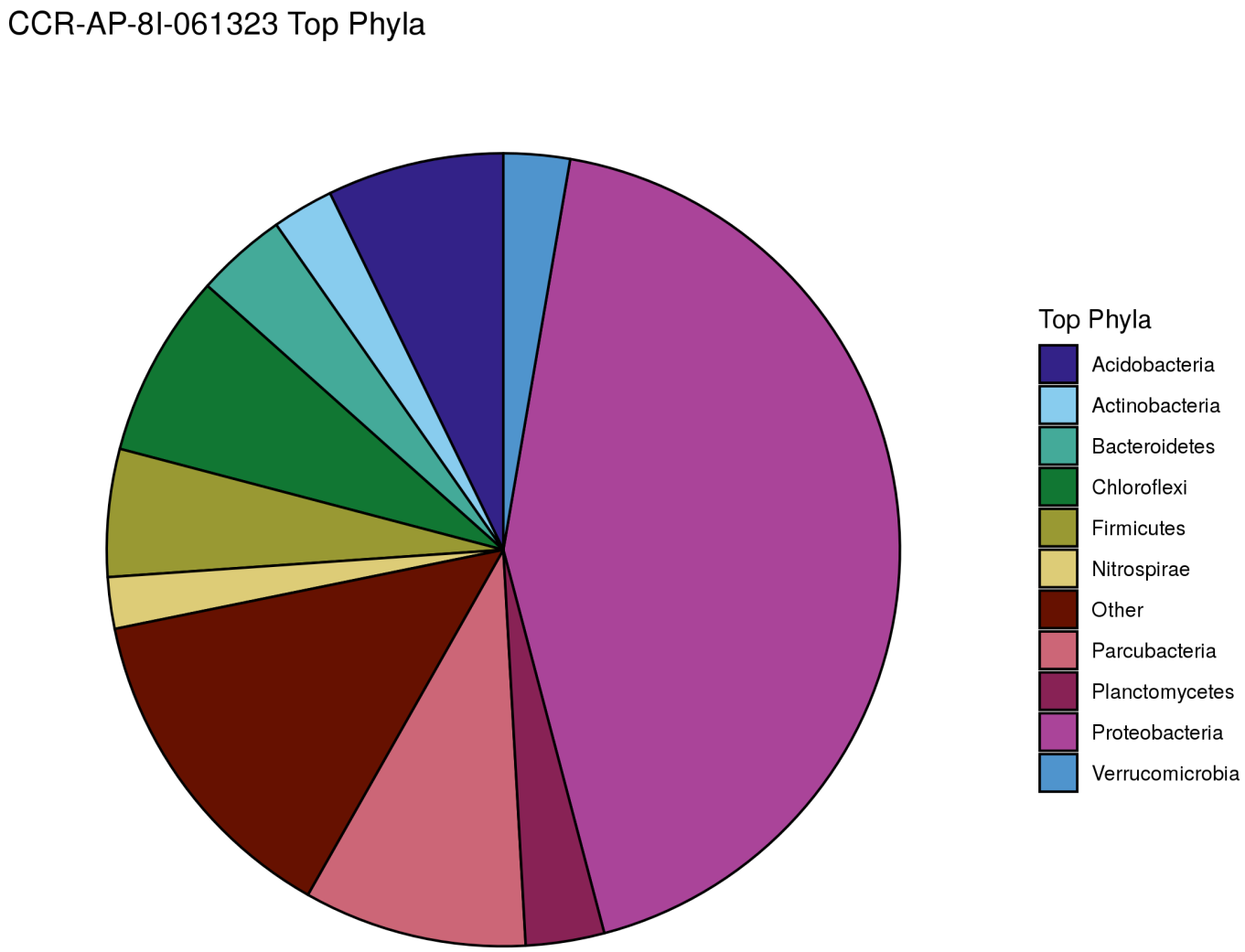


Figure 5: Top Phylum Classification Results for CCR-AP-8I-061323

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Table 10: Top genera classification results for sample CCR-AP-8I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Parcubacteria genera incertae sedis	17,244	10.4%	Genus of unclassified bacteria. It is proposed that Parcubacteria obligately ferments simple sugars to organic acids and can also degrade complex carbon sources. Species have also been implicated in hydrogen and sulfur cycles in anoxic sediments. These bacteria are found in exclusively anoxic environments.
Pseudomonas	10,939	6.6%	Genus of metabolically versatile, chemoorganotrophic aerobes. Generally, oxygen is the terminal electron acceptor, though growth by nitrate reduction or complete denitrification may also occur under anerobic conditions by many species. Growth conditions vary greatly between species. Pseudomonas is ubiquitous in nature but may be less tolerant of acidic environments.
Thermomarinilinea	7,611	4.6%	Filamentous and multicellular anaerobic genus of thermophilic heterotrophs. Carbohydrates and amino acids are fermented. Sea water is required for growth. Thermomarinilinea was originally isolated from a hydrothermal vent.
Thermodesulfovibrio	3,660	2.2%	Thermophilic genus of anaerobic sulfate-reducing bacteria. Sulfate and thiosulfate are generally utilized as electron acceptors but sulfite, nitrate, and Fe (III) may also be used depending on the species. Syntrophic growth with a hydrogenotrophic methanogen is also possible. Organic compounds are oxidized completely to acetate. Members of this genus have been isolated from hot springs and sludge.
Simplicispira	3,592	2.2%	Genus of aerobic and facultatively anaerobic chemoorganoheterotrophs. Neutrophilic and mesophilic, Simplicispira are capable of denitrification. Species have been reclassified from Aquaspirillum.
Deinococcus	3,587	2.2%	Aerobic genus of chemoorganotrophs. Some species may be facultatively anaerobic. Carbohydrates and amino acids are utilized as growth substrates. All species are resistant to ionizing-radiation. The type species, D. radiodurans also reduce and are heavy metal tolerant. Some species are thermophilic and proteolytic. Recent studies have characterized Deinococcus as efficient primary biofilm formers. Deinococcus is found in a number of different habitats.
Aminicenantes genera incertae sedis	2,958	1.8%	Not much is known about this candidate organism except that it is found in hydrocarbon-impacted environments as well as marine locations.
Rhodoferax	2,870	1.7%	Genus of purple nonsulfur bacteria. Species are capable of growth under photosynthetic, aerobic or fermentative conditions. Simple carbon compounds are utilized as carbon and energy sources including lactate, acetate, butyrate, and ethanol. One species, R. fermentans, can grow anaerobically in the light or under aerobic conditions in the dark. Rhodoferax have been isolated from marine environments with some psychrophilic species located in polar environments.

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Table 10: Top genera classification results for sample CCR-AP-8I-061323. Additional identified genera are included in the accompanying Excel data file.

Genus	Reads	Percent	Description
Geobacter	2,776	1.7%	Anaerobic genus of chemoorganotrophs. Fe(III) is used as the sole electron acceptor and acetate as an electron donor. Several Geobacter species also utilize hydrogen as an electron donor. While Geobacter spp. are known as iron reducing bacteria, some species can also utilize a variety of other growth supporting electron acceptors such as elemental sulfur, Mn(IV), and U(VI). Some species have been shown to degrade toluene and benzene. Strains of one species, G. lovleyi, contain a pceA gene and are capable of reductive dechlorination of PCE to cis-DCE. Geobacter species are ubiquitous in nature.
Desulfocapsa	2,636	1.6%	Genus of strictly anaerobic sulfate-reducing bacteria. Sulfate reduction is coupled to the incomplete oxidation of simple organic compounds. Alternatively, certain alcohols are oxidized to fatty acids with sulfate as an electron acceptor. Disproportionation of inorganic sulfur compounds (thiosulfate, sulfite) also support growth with carbon dioxide as a carbon source. Desulfocapsa is found in anoxic freshwater sediment.
Desulfobacterium	2,610	1.6%	Strictly anaerobic genus of chemoorganotrophic or chemoautotrophic bacteria. A variety of compounds are utilized as electron donors and energy sources including carboxylates, organic acids, alcohols and hydrogen and carbon dioxide. Sulfate and other oxidized sulfur compounds are reduced to hydrogen sulfide. Growth can also occur fermentatively. Carbon dioxide fixation is also possible, but seawater or magnesium chloride are required. Desulfobacterium is generally found in marine environments.
Sulfuricurvum	2,511	1.5%	Genus of facultatively anaerobic, sulfur-oxidizing bacteria. Molecular oxygen and nitrate are used as electron acceptors. Sulfide, elemental sulfur and thiosulfate are oxidized. The type species, S. kujiense was originally isolated from crude-oil.
Desulfomonile	2,508	1.5%	Genus of strictly anaerobic, sulfate reducing bacteria. Some species can grow autotrophically on hydrogen and carbon dioxide with sulfate or thiosulfate as terminal electron acceptors. Acetate and lactate are fermentation products from glucose. Some species are capable of reductive dehalogenation of some chlorophenols or chlorobenzoates. Desulfomonile has been isolated from sediment, soil and sludge.
Perlucidibaca	2,460	1.5%	Facultatively aerobic genus of chemoheterotrophs. A limited range of organic compounds are utilized as carbon and energy sources. Perlucidibaca was originally isolated from a eutrophic pond.
Rheinheimera	2,446	1.5%	Genus of aerobic or facultatively anaerobic chemoheterotrophs. Various carbohydrates and sugars are utilized as carbon and energy sources but is species-dependent. Some strains produce acid from sugars oxidatively. Rheinheimera has been isolated from marine environments.
Holophaga	2,368	1.4%	Strictly anaerobic genus of homoacetogenic fermenters. Methylated and aromatic compounds are fermented. Holophaga was originally isolated from anoxic water.

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Genus	Reads	Percent	Description
Desulfovibrio	2,244	1.4%	Anerobic genus of halophilic sulfate reducers. Metabolism is respiratory but fermentative growth is possible. Sulfate and other sulfur compounds are reduced to hydrogen sulfide. Under fermentative growth, organic compounds are oxidized incompletely to acetate. Some species can use hydrogen as an electron donor with acetate and CO2 as carbon sources. The species D. desulfuricans has been linked to heavy metal reduction and microbial induced corrosion. Desulfovibrio is found in a variety of environments including anoxic sediment and in mammals.
Dehalogenimonas	2,036	1.2%	Genus of strictly anaerobic chemoheterotrophs. Species reductively dehalogenate chlorinated alkanes by using molecular hydrogen as an electron donor. Isolated from contaminated groundwater, these bacteria are of particular use in bioremediation due to their dechlorination capabilities. QuantArray-Chlor and CENSUS qPCR assays are available to quantify Dehalogenimonas.
Subdivision3 genera incertae sedis	1,908	1.2%	This is a subgroup of Verrucomicrobia that includes bacteria isolated from soils, vinyl chloride degrading enrichments, river biofilms, hot springs, and nitrifying-denitrifying activated sludge.
Omnitrophica genera incertae sedis	1,859	1.1%	Genus of the unclassified Omnitrophica phylum. Not much is known about this group except that they live in anoxic environments. This phylum is part of the Planctomycetes/Verrucomicrobia/Chlamydiae (PVC) superphylum.
Latescibacteria genera incertae sedis	1,775	1.1%	Unclassified genus of anaerobic bacteria. Metabolic reconstruction suggests a fermentative type of metabolism as well as the capability to degrade multiple polysaccharides and glycoproteins composing green and brown algae cell walls, storage molecules, and extracellular polymeric substances. Latescibacteria can be found in terrestrial, aquatic, and marine ecosystems.
Opitutus	1,662	1.0%	Chemoorganotrophic genus of facultatively anaerobic bacteria. Carbohydrates are solely utilized as carbon and energy sources. Metabolism is mostly fermentative with acetate, propionate, CO2 and H2 as the main products. Opitutus is found in rice paddy soil.
Desulfatiferula	1,625	1.0%	Genus of sulfate-reducing facultatively anaerobic bacteria. Sulfate and other sulfur compounds serve as electron acceptors, depending on the species. Alkenes and fatty acids are utilized as carbon sources and electron donors. Vitamins are required for growth. Desulfatiferula is found in sediment.
Gp16	1,523	0.9%	Unclassified Acidobacteria.
Vogesella	1,514	0.9%	Aerobic genus of bacteria capable of denitrification. Poly-b-hydroxybutyrate granules are formed under limited nitrogen conditions. Citrate, amino acids and some sugars are utilized as carbon and energy sources. Vogesella strains have been isolated from freshwater and pond sediments.

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Genus	Reads	Percent	Description
Methylocystis	1,432	0.9%	Genus of aerobic methanotrophic chemolithotrophs. Methane and methanol are utilized as carbon and energy sources. Atmospheric nitrogen and formaldehyde are fixed. Methylocystis possesses the gene encoding particulate methane monooxygenase (PMMO) with some species also possessing sMMO. Poly-b-hydroxybutyrate (PHB) and polyphosphate are accumulated by some species. Methylocystis species are found in a wide variety of environments including soil, freshwater sediments, a peat bog, forest and arctic wetland soil and a polluted aquifer.
Desulfatiglans	1,357	0.8%	Strictly anaerobic genus of sulfate-reducing chemoorganoheterotrophs. Organic acids, phenols and benzoates are used as electron donors and carbon sources. Sulfate is reduced to H2S with the use of sulfite and thiosulfate varying across species. Desulfatiglans species are found in freshwater and marine environments.
Acidovorax	1,245	0.8%	Generally chemoorganotrophic, utilizing O2 as the terminal electron acceptor, this aerobic genus can also grow lithoautotrophically with H2 as the energy source. Organic and amino acids are the main carbon and energy sources. Some strains have also been shown to denitrify nitrate heterotrophically. Acidovorax has been isolated in multiple environments including water, soil and activated sludge.
Sulfuritalea	1,180	0.7%	Genus of facultatively anaerobic sulfur-oxidizing bacteria (SOB). Thiosulfate and elemental sulfur are oxidized with hydrogen serving as the electron donor while nitrate is reduced to nitrogen. Growth can also occur heterotrophically with certain carboxylates and organic acids as carbon and energy sources. A recent study has shown that in nitrate-depleted waters, arsenate can also be utilized as an electron acceptor. Species have been isolated from freshwater environments.
Flavobacterium	1,178	0.7%	Genus of chemoorganotrophs with numerous species having varying growth conditions. Generally aerobic, some species grow under microaerobic to anaerobic conditions. Carbohydrates are usually utilized as carbon and energy sources and certain species are capable of reducing nitrate. Ubiquitous in nature, Flavobacterium has been isolated from soil and marine environments.
Gp17	1,161	0.7%	Unclassified Acidobacteria.
Chitinivorax	1,159	0.7%	Members of this genus are facultatively anaerobic organisms that have been isolated from freshwater environments and are capable of hydrolysis of starch and chitin. They are also capable of utilizing glucose, fructose, and lactose as well as various other carbohydrates, organic acids, and amino acids as carbon sources.
Poribacteria genera incertae sedis	1,129	0.7%	Genus of aerobic mixotrophs of the candidate phylum Poribacteria. This bacterium is found in aquatic environments, associated with sea sponges.

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Genus	Reads	Percent	Description
Fusibacter	1,120	0.7%	Genus of mostly anaerobic sulfur-reducing chemoorganotrophs. Some species are microaerophilic. A limited amount of carbohydrates are fermented to acetate, CO2, H2 and butyrate. Sulfide is produced from the reduction of thiosulfate and sulfur. Fusibacter species have been found in a variety of environments including in springs and wastewater, oil producing wells and a corroded kerosene tank.
Litorilinea	1,009	0.6%	Aerobic genus of thermophilic and filamentous chemooganotrophs. Carbohydrates are the main carbon and energy source. Litorilinea was originally isolated from a hot spring.
Desulfosporosinus	977	0.6%	Anaerobic genus of sulfate-reducing bacteria. In the presence of some volatile fatty acids, sulfate and thiosulfate are reduced to sulfide. Desulfosporosinus also utilizes hydrogen as an electron donor coupled to sulfate reduction. Acetate is produced from fermentation. Some species have bssA genes and can utilize toluene and other substituted aromatic hydrocarbons as energy sources. Some strains can also reduce Fe(III) and arsenate. Desulfosporosinus is found in many types of soil environments.
Ferritrophicum	970	0.6%	Microaerophilic genus of lithotrophs. Fe(II) is the sole energy source. Ferritrophicum was originally found in wetland sediment.
Leptotrichia	948	0.6%	Aerobic or anaerobic genus of chemoorganotrophs. Carbohydrates are generally utilized as carbon and energy sources. Under anaerobic conditions, lactic acid is produced from glucose fermentation with trace amounts of acetic and succinic acids. Many diverse species are contained within the genus. Leptotrichia is generally found in the oral cavity and other clinical samples.
Undibacterium	920	0.6%	Motile genus of aerobic chemoorganotrophs. Cell morphology is characterized by the presence of pili that aid in motility. Carbohydrates and starch are generally utilized as carbon and energy sources. This bacterium is sensitive to salt and has been isolated from fresh and purified water.
Geothrix	914	0.6%	Chemoorganotrophic genus of obligate anaerobes possessing a fermentative or respiratory type of metabolism. Though generally iron reducing bacteria, Geothrix also utilizes nitrate and Mn(IV) as electron acceptors. Organic acids are used as electron donors. Acetate and succinate are fermentation products from organic acids. The type species, G. fermentans was isolated from a petroleum-contaminated aquifer.
Sideroxydans	901	0.5%	Genus of microaerophilic chemolithoautotrophs. Fe(II) is utilized as the sole energy source and carbon dioxide as the carbon source. Sideroxydans is found in soil.
Sunxiuqinia	880	0.5%	Aerobic genus of chemoorganoheterotrophs. Metabolism can be respiratory or fermentative. Proteinous substrates are fermented under anaerobic conditions. Species have been isolated from marine sediment.
Gp9	860	0.5%	Unclassified Acidobacteria.
Gp18	818	0.5%	Unclassified Acidobacteria.

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Genus	Reads	Percent	Description
Lutibacter	776	0.5%	Heterotrophic genus of aerobic or facultatively anaerobic Flavobacteriaceae. A limited range of organic compounds are used as growth substrates and varies between species. Carotenoid pigments are produced. Lutibacter is found in marine environments, tidal flat sediment, in particular.
Piscinibacter	770	0.5%	These are facultatively aerobic chemoheterotrophs that have been isolated from freshwater and activated sludge. The type strain can utilize methanol, glycerol, ribose, and a few other sugars as well as various organic acids and amino acids as carbon sources.
BRC1 genera incertae sedis	763	0.5%	Unclassified organism containing the BRC1 gene, associated with branching signals and bud development.
Gallionella	703	0.4%	Iron-oxidizing genus of chemolithotrophic bacteria with a mixotrophic type of metabolism. Precipitated ferric iron oxide encrusts bacterial sheaths in environments with low organic content and high ferrous iron. Iron-oxidizing bacteria like Gallionella are associated with tubercle formation, under deposit corrosion and formation of differential aeration cells. Species have been isolated from aquatic environments.
Subdivision5 genera incertae sedis	654	0.4%	This is a subgroup of Verrucomicrobia that includes organisms that were isolated from a hydrocarbon and chlorinated-solvent-contaminated aquifer.
Desulforegula	641	0.4%	Anaerobic genus of sulfate-reducing bacteria. Straight-chain carboxylic acids are utilized as the sole energy sources and are oxidized to acetate and propionate. No growth occurs without sulfate as the electron acceptor. Desulforegula is found in freshwater sediment.
Arthrobacter	634	0.4%	Genus of aerobic, chemoorganotrophs containing species that are biochemically and physiologically diverse. Some Arthrobacter species have been shown to degrade phenols, xenobiotics and other contaminants. This genus has been isolated from a very wide range of environments.
Sphingomonas	630	0.4%	This aerobic genus is metabolically versatile. Most species are chemoheterotrophs though some are capable of photosynthetic growth. Sphingomonas is particularly useful in bioremediation of soils due to the ability of some species to degrade various aromatic compounds. Sphingomonas is ubiquitous in nature.
Blastopirellula	623	0.4%	Aerobic genus of chemoheterotrophs. Morphology is characterized by ovoid or pear-shaped rosettes with a pirellulosome forming in cells. Carbohydrates are the main carbon and energy source though amides may be utilized as carbon and nitrogen sources. Sea water is required for growth and Blastopirellula is found in marine environments.
Clostridium sensu stricto	591	0.4%	Obligately anaerobic genus possessing a fermentative type of metabolism. Some species are aerotolerant. Growth requirements vary greatly between species, utilizing a range of compounds. Fermentation end products are usually a combination of alcohols and organic acids. Some species are acetogens.

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Genus	Reads	Percent	Description
Armatimonadetes gp4	590	0.4%	Unclassified organism of the Armatimonadetes phylum. The phylum is characterized by the ability to degrade polysaccharides, oligotrophic ability and pinkish pigments in cells. Species are generally found in hot springs or geothermal soils.
Gp13	557	0.3%	Unclassified Acidobacteria.
Mariniphaga	543	0.3%	Genus of facultatively anaerobic chemoorganotrophic bacteria. Metabolism can be respiratory or fermentative. A limited range of organic compounds are utilized as growth substrates with oxygen serving as the terminal electron acceptor. Carbohydrates are fermented with succinic acid as the main product from glucose fermentation. Mariniphaga was originally isolated from tidal flat sediment.
Solirubrobacter	528	0.3%	Genus of aerobic mesophiles. Amino acids and sugars are utilized as carbon sources. Solirubrobacter species have been isolated from soil environments including ginseng fields.
Rubrobacter	525	0.3%	Aerobic genus of chemoorganotrophs. Some species are thermophilic and at least one species is resistant to radiation. Rubrobacter has been isolated from a number of environments including wastewater, from hot springs, from biodeteriorated monuments, soil and lime walls.
Reyranella	523	0.3%	Genus of microaerophilic to aerobic rods. A variety of organic compounds are utilized for growth and energy. Nitrate is reduced by some species. Reyranella is found in aquatic and soil environments.
Thermogutta	494	0.3%	Thermophilic genus of facultatively anaerobic planctomycetes. Nitrate and nitrate are used as electron acceptors. Carbohydrates are utilized as growth substrates for fermentation and anaerobic respiration. Thermogutta species are found in terrestrial and subterranean environments.
Phaselicystis	481	0.3%	Genus of aerobic chemoheterotrophic myxobacteria. In general, Myxobacteria move by gliding, are known to produce fruiting bodies during starvation conditions, are social - growing in cell communities called swarms. Carbohydrates are utilized as carbon and energy source but Myxobacteria as a characterization are thought to live from the degradation products of biopolymers such as proteins, cellulose, and other cellular constituents. Phaselicystis is found in soil and is resistant to various antibiotics.
Defluviimonas	479	0.3%	Facultatively anaerobic genus of chemoorganotrophs. Metabolism is strictly respiratory. Carbohydrates, organic acids and some amino acids are utilized as carbon and energy sources. Most species are capable of denitrification. Defluviimonas is found in marine sediment.
Sediminibacterium	474	0.3%	Genus of aerobic or facultatively anaerobic chemoorganotrophs. Carbohydrates are utilized as carbon and energy sources. Sediminibacterium is found in sediment.

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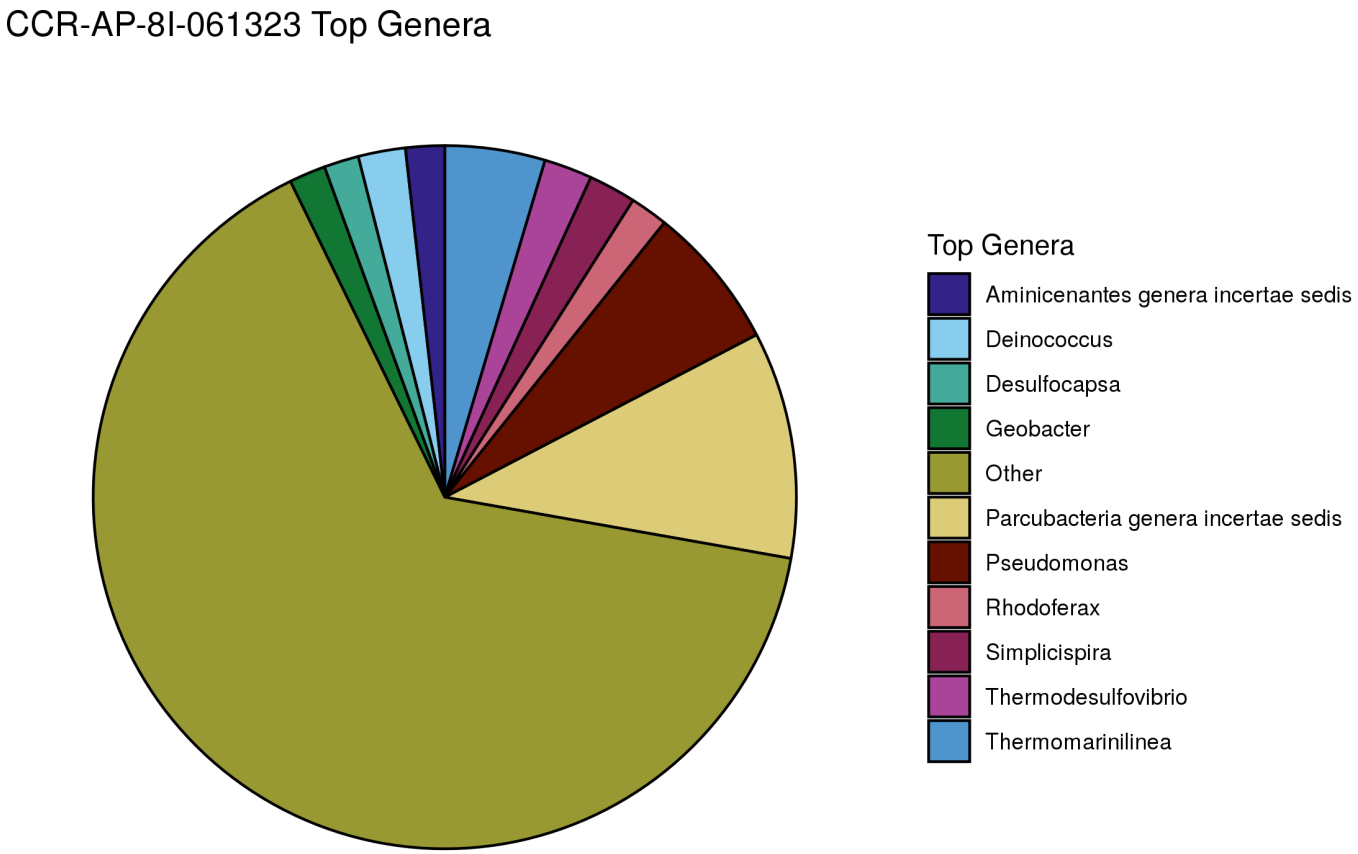


Figure 6: Top Genus Classification Results for CCR-AP-8I-061323

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Interpretation

Diversity Indices

The Shannon diversity index is a quantitative measurement that characterizes how many different genera are present in the sample and takes into account the distribution of the number of organisms classified to each genus present in the sample (commonly referred to as species eveness) [1, 2]. Shannon's diversity index increases in value as the number of genera increases and as the number of organisms present per genera becomes even. Simpson's index measures the probability that two individuals selected randomly from the sample would belong to different genera: the greater the value, the greater the sample diversity. The Chao1 index is an excellent indicator of species richness and is based on the number of reads when one (singleton) or two (doubleton) operational taxonomic units (OTUs) are observed. This value is the predicted number of genera based on the number of singletons and doubletons. The total genera observed is presented here, but does not include reads unclassified at genus species.

Principal Coordinate Analysis

Principal coordinate analysis (PCoA) is an excellent tool for visualizing differences in microbial communities between samples [3]. Unlike more traditional methods such as principal component analysis (PCA), PCoA calculates complex functions for the axes rather than dimensional scaling used in PCA. Therefore, PCoA is able to better demonstrate dissimilarities that may be nuanced in PCA tests. PCoA accomplishes this by using a dissimilarity matrix to assign each sample a location in dimensional space, then changes the coordinate system to display the data in two dimensions.

Hierarchical Clustering Dendrogram

Hierarchical clustering is accomplished by comparing dissimilarities between the samples using complete agglomeration of the Bray-Curtis dissimilarity. This groups samples which are the least dissimilar together. The length of the branches indicate the amount of dissimilarity between samples. Therefore, shorter branches are more similar. The stacked bar chart below each leaf of the tree represents the relative abundance of genus-level classifications.

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APPENDIX E
Groundwater Risk Evaluation

HALEY ALDRICH

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GROUNDWATER RISK EVALUATION
F.B. CULLEY GENERATING STATION – EAST ASH POND
NEWBURGH, INDIANA

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
Southern Indiana Gas and Electric Company
Evansville, Indiana

File No. 129420-034
April 2025



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PREPARED FOR
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EVANSVILLE, INDIANA

PREPARED BY:

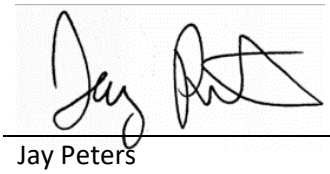


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Executive Summary

This Groundwater Risk Evaluation report was prepared by Haley & Aldrich, Inc. for the F.B. Culley Generating Station (FBC or Site), a coal-fired power plant located on the northern bank of the Ohio River (and Little Pigeon Creek) approximately 3 miles east of the town of Newburgh, Indiana, in Warrick County. Coal combustion residuals (CCR) were historically managed on the Site in a 32-acre impoundment knows as the West Ash Pond (WAP) and a 10-acre impoundment known as the East Ash Pond (EAP). The EAP was commissioned around 1971 and is the subject of this report. By 2023, the EAP was no longer accepting CCR material, and operations to close the EAP commenced. Southern Indiana Gas and Electric Company currently owns the land and operates the station for supplying electric power to industrial, commercial, and residential customers in its service territory.

The purpose of this report is to review the analytical data collected from groundwater monitoring at the EAP, identify the pathways by which human and ecological receptors could potentially contact groundwater, and evaluate if the pathways could pose an adverse human health or ecological effect. Potential risks to human health or the environment were evaluated by comparing analytical results from groundwater monitoring to screening levels drawn or derived from United States Environmental Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM) sources. Due to the conservative methods used to derive screening levels, exposures to concentrations below screening levels will not result in adverse health effects, and no further evaluation is necessary. Concentrations above conservative screening levels do not necessarily indicate that a potential risk exists but indicate that further evaluation may be warranted.

Groundwater data collected in accordance with the CCR Rule from the certified groundwater monitoring system at the EAP was used for the risk evaluation dataset.

Offsite areas consist of the Ohio River to the south/southwest, the Alcoa Warrick Power Plant to the north and west, and wetland and wooded areas to the east. The nearest residents are approximately 1 to 1.3 miles northeast of the Site. Environmental media of interest for the risk evaluation include groundwater as well as Ohio River and Little Pigeon Creek surface water, assuming CCR constituents in groundwater could potentially be introduced into these neighboring surface water bodies with groundwater flow. Potentially exposed receptors identified for the risk evaluation include onsite workers, offsite workers (of the Alcoa Warrick Power Plant) and residents, recreational users of the Ohio River or Little Pigeon Creek, and aquatic ecological receptors.

Potentially complete exposure pathways through which receptors are assumed to be exposed to CCR constituents in groundwater consist of the following, assuming such constituents could migrate to water withdrawal wells west of the EAP (e.g., Well 1A and Well 2) and be introduced into the adjacent surface water bodies, including the Ohio River and Little Pigeon Creek:

- Direct contact exposure to groundwater (dermal contact, and potentially ingestion) at water withdrawal wells west of the EAP (by on- or offsite workers);
- Consumption of Ohio River surface water as drinking water (by offsite residents);
- Recreational exposure to Ohio River and/or Little Pigeon Creek surface water (dermal contact and incidental ingestion by swimmers or waders and/or dermal contact by boaters);

- Consumption of fish from the Ohio River and/or Little Pigeon Creek (by recreational fishermen); and
- Aquatic receptor exposure to Ohio River and/or Little Pigeon Creek surface water.

Potential migration of groundwater from beneath the EAP to other water wells, located either across Little Pigeon Creek or to the northeast/upgradient of the EAP, is considered incomplete.

Risks associated with potential onsite worker exposure to CCR constituents in groundwater at water withdrawal wells Well 1A and Well 2 were evaluated by: a) conducting groundwater flow modeling to estimate the portion of well water at these wells that originates from beneath the EAP; b) using the results of the groundwater flow modeling and maximum groundwater constituent concentrations (from the EAP wells closest to Well 1A and Well 2 dating back to initial sampling events in June 2016) to estimate potential CCR constituent concentrations in groundwater at Well 1A and Well 2; and c) comparing the resulting estimated groundwater concentrations at Well 1A and Well 2 to screening levels protective for direct contact exposure to water. The evaluation demonstrates that detected concentrations of CCR constituents in groundwater beneath the EAP do not pose an adverse impact to onsite workers who use water pumped from Well 1A and Well 2. Detected concentrations would need to be eight to 1,500 times higher than measured levels before a potential adverse impact might occur. This means that the present concentrations of constituents in groundwater do not pose an unacceptable risk to onsite workers, and even higher concentrations than the present concentrations in groundwater are unlikely to be harmful. Furthermore, the evaluation demonstrates that detected concentrations do not pose an adverse impact to on- or offsite workers who may use water in wells further west/northwest of Well 1A and Well 2 because potential contributions of groundwater from beneath the EAP would be even less for those wells.

Screening levels applicable to the evaluation of groundwater migration to surface water were compiled from USEPA and IDEM sources (or derived using the USEPA Regional Screening Level calculator) protective of the types of potential exposures identified as potentially complete above. From the selected or derived surface water screening levels, groundwater screening levels were then calculated from the lowest (most protective) surface water screening levels based upon the amount of dilution and attenuation estimated to occur as groundwater flows into the two surface water bodies. To be conservative, and protective of the surface water environments of both the Ohio River and Little Pigeon Creek, target screening levels for groundwater were calculated based upon the lower amount of dilution and attenuation estimated to occur as groundwater flows into Little Pigeon Creek.

Risks associated with the potential introduction of CCR constituents in groundwater to the Ohio River and Little Pigeon Creek were evaluated by conservatively comparing maximum groundwater constituent concentrations (from all EAP monitoring wells dating back to initial sampling events in June 2016) to the target screening levels for groundwater that are protective of Ohio River and Little Pigeon Creek surface water. The comparison demonstrates that detected groundwater concentrations do not pose an adverse impact to the Ohio River or Little Pigeon Creek. Detected concentrations would need to be six to 230 times higher than measured levels before a potential adverse impact to either surface water body might occur. This means that the present concentrations of constituents in groundwater do not pose an unacceptable risk to human health or the environment, and even higher concentrations in groundwater are unlikely to be harmful.

This is further illustrated by comparing the maximum groundwater concentrations from the wells closest to the Ohio River and Little Pigeon Creek to the derived target groundwater screening levels. This

comparison shows an even wider margin of safety between the two values. The ratios between the target groundwater screening levels and maximum groundwater concentrations from the wells closest to the Ohio River and Little Pigeon Creek range from seven to 360 for detected constituents. This means that concentrations of detected constituents in these wells could be more than seven times higher than currently measured levels before a potential adverse impact to either surface water body might occur. The results of these comparisons demonstrate that detected concentrations of CCR constituents in groundwater do not pose an adverse impact to the Ohio River and Little Pigeon Creek and do not pose an unacceptable risk to human health or ecological receptors.

In conclusion, the completed groundwater risk evaluation demonstrates that there are no adverse impacts on human health or the environment from groundwater affected by the EAP at the FBC.

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List of Abbreviations

Abbreviation	Definition
CCR	coal combustion residuals
CCR Rule	USEPA's final rule for "Disposal of Coal Combustion Residuals from Electric Utilities"
CFR	Code of Federal Regulations
CSM	Conceptual Site Model
DAF	Dilution-Attenuation Factor
EAP	East Ash Pond
FBC	F.B. Culley Generating Station
GWPS	Groundwater Protection Standard
Haley & Aldrich	Haley & Aldrich, Inc.
HHRA	Human Health Risk Assessment
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IWPCD	Indiana Water Pollution Control Division
MCL	Maximum Contaminant Level
RBSL	Risk-based Screening Level
RSL	Regional Screening Level
SIGECO	Southern Indiana Gas and Electric Company
Site	F.B. Culley Generating Station
USEPA	United States Environmental Protection Agency

1. Introduction

The F.B. Culley Generating Station (FBC) is a coal-fired power plant located on the Ohio River in Warrick County, Indiana (Site). The Site is located on the northern bank of the Ohio River (and Little Pigeon Creek) approximately three miles east of the town of Newburgh, Indiana. The facility has been in operation since 1953, and coal combustion residuals (CCR) were managed on the Site in a 32-acre impoundment known as the West Ash Pond (WAP) and a 10-acre impoundment known as the East Ash Pond (EAP). The East Ash Pond was commissioned around 1971 and is the subject of this report. By 2023, the EAP was no longer accepting CCR material, and operations to close the EAP commenced. Southern Indiana Gas and Electric Company (SIGECO) currently owns the land and operates the station for supplying electric power to industrial, commercial, and residential customers in its service territory. **Figure 1** shows the location of the facility, and the location of the EAP.

The United States Environmental Protection Agency's (USEPA's) final rule for "Disposal of Coal Combustion Residuals from Electric Utilities" (CCR Rule) requires the evaluation of groundwater monitoring data from CCR units using groundwater protection standards (GWPSs), which are the federal primary drinking water standards, also known as Maximum Contaminant Levels (MCLs; USEPA, 2024a)[1], or Site-specific background concentrations. Analyses of groundwater results against GWPSs are presented in annual and semiannual groundwater monitoring reports.[2] This Groundwater Risk Evaluation report has been prepared by Haley & Aldrich, Inc. (Haley & Aldrich) to provide a risk-based analysis of the groundwater results, identifying the pathways by which human and ecological receptors could potentially contact groundwater, and evaluating if the pathways could pose an adverse human health or ecological effect. As discussed in this report, potential exposures evaluated consist of potential direct contact exposure to CCR constituents in groundwater, assuming such constituents could migrate from beneath the EAP to water wells approximately 1,000 feet west (side-gradient) of the EAP, and potential exposure to CCR constituents in surface water, assuming CCR constituents in groundwater could be introduced into the Ohio River or Little Pigeon Creek. While a risk-based evaluation of such exposures is not required by the CCR Rule, the risk-based analysis provides relevant context for the groundwater monitoring results.

[1] MCLs are enforceable for municipal drinking water supplies.

[2] SIGECO has been conducting groundwater monitoring and reporting the monitoring data publicly as required by the CCR Rule (USEPA, 2015). SIGECO has posted the required information in annual and semiannual groundwater monitoring reports on the publicly available website for FBC: https://www.centerpointenergy.com/en-us/corporate/about-us/ccr-reporting

2. Approach

The analysis presented in this report was conducted by evaluating the environmental setting of the Site and Site vicinity, including the EAP where CCR management has occurred at the Site. Information on where groundwater is located at the Site, the rate(s) and direction(s) of groundwater flow, and where waterbodies may intercept groundwater flow were reviewed and assessed.

A conceptual site model (CSM) was developed based on the environmental setting, and the CSM was used to identify human populations that could be in contact with groundwater and/or surface water at the Site or Site vicinity. This information was also used to identify where ecological populations could come into contact with nearby surface water.

Using the CSM, the human health risk assessment (HHRA) process was used to estimate the potential that contact with constituents in the environment may result in harm to people. Generally, there are four components to the HHRA process (USEPA, 1989): (1) Hazard Identification/Data Evaluation; (2) Toxicity Assessment; (3) Exposure Assessment; and (4) Risk Characterization. To support this process, the USEPA and other regulatory agencies, including the Indiana Department of Environmental Management (IDEM), develop "screening levels" of constituent concentrations in groundwater (and other media) that are considered protective of specific human exposures. In developing screening levels, USEPA uses a specific target risk level, combined with an assumed exposure scenario and toxicity information from USEPA, to derive an estimate of a concentration of a constituent in an environmental medium, for example groundwater, that is protective of a person in that exposure scenario (e.g., drinking water). Similarly, ecological screening levels for surface water are developed by USEPA and IDEM to be protective of the wide range of potential aquatic ecological resources, or receptors.

Analytical results from the groundwater monitoring events completed at the Site and Site vicinity were then compared to screening levels developed by USEPA and IDEM, or Site-specific risk-based screening levels (RBSLs) derived by Haley & Aldrich (further discussion of the RBSLs is provided in Section 5.1.3). Screening levels are designed to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive screening levels, exposures to concentrations below screening levels will not result in adverse health effects, and no further evaluation is necessary. Concentrations above conservative screening levels do not necessarily indicate that a potential risk exists, but rather indicate that further evaluation may be warranted. Human health and ecological screening levels are used with groundwater data in this report to determine if the concentrations of constituents in groundwater could pose a risk to human health or the environment that warrants further evaluation.

2.1 REPORT ORGANIZATION

The remaining sections of this report are organized according to the typical steps in a risk assessment, as outlined below:

- Section 3: summarizes the analytical groundwater data included in the risk evaluation.
- Section 4: presents the exposure assessment, including the sources and migration pathways for CCR constituents in groundwater, identification of potentially exposed populations, and specific pathways through which populations could become exposed to CCR constituents in groundwater.

- Section 5: presents the screening levels used to evaluate the constituent concentrations for potential risks to human health or the environment.
- Section 6: presents the results of the evaluation.
- Section 7: presents a summary of the evaluation.

The following attachments are included in the evaluation:

- Attachment A – Groundwater modeling and dilution attenuation factor (DAF) calculations: Groundwater migration from beneath the EAP to onsite water withdrawal wells Well 1A and Well 2
- Attachment B – Derivation of RBSLs for recreational use of surface water
- Attachment C – DAF calculations: Groundwater discharge to Ohio River and Little Pigeon Creek
- Attachment D – Preparer resumes

3. Available Site Data

Groundwater data collected in accordance with the CCR Rule provides the basis for the risk evaluation dataset. Sections 3.1 and 3.2 provide an overview of monitoring well installation and sampling events for the different phases of groundwater monitoring at the FBC. The data from these groundwater monitoring events are provided in annual and semiannual groundwater monitoring reports required by the CCR Rule.

3.1 MONITORING WELLS

The certified groundwater monitoring system at the EAP is comprised of six downgradient monitoring wells (CCR-AP-2, CCR-AP-3, CCR-AP-4, CCR-AP-5, CCR-AP-6, and CCR-AP-8) and three upgradient monitoring wells to represent background conditions (CCR-AP-1R, CCR-AP-7, and CCR-AP-9). The downgradient monitoring wells were constructed at the boundary of the EAP in December 2015 (CCR-AP-2, CCR-AP-3, CCR-AP-4, and CCR-AP-5), March 2016 (CCR-AP-6), and February 2017 (CCR-AP-8) and are screened in the uppermost aquifer to exceed the minimum requirement described in Title 40 Code of Federal Regulations (40 CFR) §257.91(c). The upgradient (unaffected by the CCR unit) background monitoring wells were constructed north of the EAP in March 2016 (CCR-AP-1R and CCR-AP-7) and February 2017 (CCR-AP-9) and are also installed in the uppermost aquifer. The location of these six downgradient wells and three upgradient wells are shown on **Figure 2**.

Three nature and extent monitoring wells (CCR-AP-5I, CCR-AP-6I, and CCR-AP-8I) were constructed in November 2018 (CCR-AP-6I and CCR-AP-8I) and January 2019 (CCR-AP-5I) adjacent to CCR-AP-5, CCR-AP-6, and CCR-AP-8, respectively, and are screened at a deeper level to investigate impacts, if any, to the intermediate aquifer. Two additional nature and extent monitoring wells (CCR-AP-10 and CCR-AP-11) were constructed in January 2019 for additional horizontal delineation in the uppermost aquifer.[3] The location of these five nature and extent monitoring wells are shown on **Figure 2**.

3.2 MONITORING EVENTS

Detection monitoring events of the CCR Rule groundwater monitoring system per 40 CFR §257.94 were initiated in June 2016 at CCR-AP-1R through CCR-AP-7, and March 2017 at CCR-AP-8 and CCR-AP-9. Samples collected from wells in the CCR Rule monitoring system were analyzed for the constituents listed below, as required by the CCR Rule:

Table 3-1 – Appendix III and Appendix IV Constituents Analyzed

Appendix III		Appendix IV		
Boron	Sulfate	Antimony	Chromium	Mercury
Calcium	Total dissolved solids	Arsenic	Cobalt	Molybdenum
Chloride		Barium	Fluoride	Selenium
Fluoride	--	Beryllium	Lead	Thallium
pH	--	Cadmium	Lithium	Radium 226/228

The results of these sampling events were then compared to statistically derived background concentrations to determine if statistically significant increases above background concentrations for Appendix III constituents occurred downgradient of the EAP, indicating the possibility of leaching of CCR

[3] CCR-AP-10 was subsequently abandoned-in-place in February 2022 due to repeatedly dry conditions.

constituents from the EAP to groundwater. The result of this statistical analysis triggered assessment monitoring and respective notification of the same.

Assessment monitoring events were conducted in June and August 2018. Samples were analyzed for the Appendix III and Appendix IV constituents as required by 40 CFR §257.95(b) and 40 CFR §257.95(d)(1). Concurrent with the second assessment sampling round, and as required by 40 CFR §257.95(h), GWPSs were established for detected Appendix IV constituents, and it was determined that arsenic and molybdenum were present in groundwater at statistically significant levels above the GWPSs. As described in the Corrective Measures Assessment Report (Haley & Aldrich, 2019) for the EAP, it was subsequently determined that arsenic in the downgradient monitoring wells is naturally occurring and not attributed to the EAP.

Assessment monitoring continues at the Site (semi-annually and included in the annual Groundwater Monitoring and Corrective Action reports in January of each year since 2018), while semiannual reporting describing the progress in selecting and designing a remedy for the EAP are completed in March and September of each year (since 2020) as required by the CCR Rule (40 CFR §§ 257.90 - 257.98). The data from all groundwater monitoring events through the November 2024 sampling event (which includes data collected through January 2025), dating back to the initial sampling events in June 2016, are provided in **Table 1**.

4. Exposure Assessment

Exposure assessment is the process of describing, measuring, or estimating the intensity, frequency, and duration of potential exposure to chemicals of potential concern in environmental media (e.g., groundwater, surface water, etc.). This section discusses the mechanisms by which human or ecological receptors might come in contact with the CCR constituents present in groundwater, concluding with the identification of potentially complete and incomplete exposure pathways.

An exposure assessment is best conducted within the context of a risk-based CSM. A CSM is used to show the relationships between a chemical source, exposure pathway, and potential receptor. The CSM identifies chemical sources, potentially impacted media, migration pathways, exposure routes, and possible exposure scenarios (USEPA, 1988). These source-pathway-receptor relationships provide the basis for the quantitative exposure assessment. Only potentially complete source-pathway-receptor relationships are included in the risk evaluation.

4.1 CHEMICAL SOURCES, POTENTIAL RELEASE MECHANISMS, AND ENVIRONMENTAL MEDIA OF INTEREST

For the CSM, the CCR stored in the EAP is the potential source. Constituents present in the CCR can be dissolved into infiltrating water that could flow into groundwater. Constituents could move with the groundwater, usually in a downgradient/downhill direction. Groundwater flow in the immediate vicinity of the EAP is predominantly to the south toward the Ohio River and Little Pigeon Creek, as shown on **Figure 2**. Groundwater elevations vary seasonally but the direction of groundwater flow patterns remain consistent. Assuming CCR constituents in groundwater could potentially be introduced into the Ohio River or Little Pigeon Creek with groundwater flow, the environmental media of interest for this evaluation includes groundwater as well as Ohio River and Little Pigeon Creek surface water.

4.2 POTENTIAL RECEPTORS

Populations identified in this risk evaluation include those who could potentially be exposed to CCR constituents present in groundwater. As discussed above in Section 1, SIGECO currently owns and operates the FBC Generating Station for supplying electric power to industrial, commercial, and residential customers in its service territory. The Site is bounded to the north and west by the Alcoa Warrick Power Plant, to the south/southwest by the Ohio River, and to the east by wetland and wooded areas. The nearest residents are approximately 1 to 1.3 miles northeast of the Site.

Based on this setting, potentially exposed receptors identified for this risk evaluation include:

- onsite workers;
- offsite workers (of the Alcoa Warrick Power Plant) and residents;
- recreational users of the Ohio River and/or Little Pigeon Creek; and
- aquatic ecological receptors in the Ohio River or Little Pigeon Creek.

4.3 POTENTIALLY COMPLETE AND INCOMPLETE EXPOSURE PATHWAYS

A plot of water wells within a half-mile of the EAP is presented on **Figure 3**. Locations for identified wells were obtained from the Indiana Department of Natural Resources (IDNR) databases for water wells and significant water supply (IDNR, 2025a and 2025b). A total of 18 wells were identified, none of which are adjacent to the EAP. The two nearest significant water withdrawal wells (Well 1A and Well 2) are approximately 1,000 feet west of the EAP and are believed to supply water to the FBC where the water is used for showering and handwashing. The two wells are screened at depths less than 70 feet below land surface with pump rates between 400 and 700 gallons per minute, and are alternated approximately eight times a day, pumping one at a time to fill an onsite water storage tank. Based on their location and direction(s) of local groundwater flow (from the upland areas north of the EAP to the south toward the Ohio River and Little Pigeon Creek), these wells were identified as side gradient of the EAP. In an abundance of caution, a field investigation was performed from June to July 2024 to refine the hydraulic gradients around the EAP and better understand the potential for groundwater to migrate from beneath the EAP to the water withdrawal Well 1A and Well 2. The results of the investigation, involving the use of pressure transducers surrounding the EAP, coupled with groundwater flow modeling, determined groundwater could migrate from beneath the EAP to these wells, and it was therefore assumed that onsite workers could be potentially exposed to CCR constituents in groundwater from the use of water pumped from these wells. Details regarding the groundwater flow modeling conducted to estimate the portion of well water discharge at Well 1A and Well 2 coming from beneath the EAP is presented in **Attachment A**.

The additional wells plotted by IDNR within one-half mile of the EAP are located either further west/northwest of Well 1A and Well 2 (wells 00445, 233867, 233877, 233882, 233887, 233892, 233897, 233902, 233907, 233932, 343292, and 389705), east of the EAP across Little Pigeon Creek (well 233831), or northeast of the EAP (wells 233836, 233841, and 315878). Potential migration of groundwater from beneath the EAP to wells across Little Pigeon Creek (a hydraulic divide) or to the northeast (i.e., upgradient) is considered incomplete. Potential migration of groundwater from beneath the EAP to the wells further west-northwest of Well 1A and Well 2 may be potentially complete and is addressed by the evaluation of potential exposures at Well 1A and Well 2.

The Ohio River is used for water supply and potentially used for recreation (wading, swimming, boating, fishing, etc.). Little Pigeon Creek is not used for water supply, but is potentially used for recreation, although its small size likely limits its recreational use to mostly wading and fishing. Both the Ohio River and Little Pigeon Creek serve as habitat for aquatic species (i.e., fish, amphibians, etc.). Four surface water intakes for significant water withdrawal were identified within a half mile of the EAP. Three are along the Ohio River within 900 feet of the EAP, to the southwest, and are owned by SIGECO, with a reported capacity to pump between 44,000 and 138,000 gallons per minute (surface water intake 02346 on **Figure 3**). One surface water intake is plotted approximately 350 feet southeast of the EAP, on the south side of Little Pigeon Creek (surface water intake 02909 on **Figure 3**), listed as owned by Midwest Coal Reserves of Indiana, LLC with a capacity of 1,500 gallons per minute. The closest surface water intakes for significant “public water supply” (i.e., with the aggregate capacity to withdraw more than 100,000 gallons in one day) were identified approximately 1.8 miles upstream from the EAP along the Ohio River. There are no surface water intakes for significant public water supply within 20 miles downstream along the Ohio River from the EAP based on the IDNR’s map of “Significant Water Withdrawal Facilities” (IDNR, 2025a). However, in an abundance of caution, exposure to river surface water as a potential source of drinking water was evaluated as if it were complete for offsite residents. In total, exposure pathways to river or creek surface water are evaluated as potentially complete for

offsite residents through use of the river water as drinking water, recreational users through direct contact with the water and consumption of fish, and aquatic life in the river or creek.

Potential wetland areas identified by the National Wetland Inventory are shown on **Figure 3**, consisting of areas adjacent to Little Pigeon Creek to the south and east of the EAP. As the wetland areas downgradient (south) of the EAP are across Little Pigeon Creek, migration of groundwater from beneath the EAP towards these areas is considered incomplete.

In summary, potentially complete exposure pathways through which receptors are assumed to be exposed to CCR constituents in groundwater consist of the following, assuming such constituents could migrate to water withdrawal wells west of the EAP (e.g., Well 1A and Well 2), and be introduced into the adjacent surface water bodies, the Ohio River and Little Pigeon Creek:

- Direct contact exposure to groundwater (dermal contact, and potentially ingestion) at water withdrawal wells west of the EAP (by on- or offsite workers);
- Consumption of Ohio River surface water as drinking water (by offsite residents);
- Recreational exposure to Ohio River and/or Little Pigeon Creek surface water (dermal contact and incidental ingestion by swimmers or waders and/or dermal contact by boaters);
- Consumption of fish from the Ohio River and/or Little Pigeon Creek (by recreational fishermen); and
- Aquatic receptor exposure to Ohio River and/or Little Pigeon Creek surface water.

A depiction of the CSM illustrating the identified chemical source(s), release mechanisms/migration pathways, exposure media, potential receptors, and the potentially complete exposure pathways listed above is shown on **Figure 4**.

5. Screening Levels

Screening levels have been compiled or derived for this evaluation for the types of potential exposures identified in the CSM discussion above:

- Dermal contact and potential ingestion exposure to groundwater at water withdrawal wells west of the EAP;
- Drinking water consumption;
- Recreational exposure to surface water;
- Consumption of fish (from the Ohio River and/or Little Pigeon Creek); and
- Aquatic receptor exposure to surface water.

This section outlines the human health screening levels for direct contact exposure to groundwater at on- and offsite water withdrawal wells, and the human health and ecological screening levels that are protective of Ohio River and Little Pigeon Creek surface water in accordance with the CSM presented in Section 4 and on **Figure 4**. For Appendix III and Appendix IV constituents detected in groundwater, **Table 2** provides in addition to MCLs, published human health screening levels for drinking water and surface water available from IDEM and USEPA sources; **Table 3** provides Site-specific RBSLs derived for recreational exposure to surface water; and **Table 4** provides published ecological screening levels for surface water from USEPA and IDEM sources.

Human health screening levels for surface water are identified for the following exposure settings: 1) use of surface water as a drinking water source, 2) the consumption of fish from a surface water body, and 3) recreational uses of surface water.

5.1 SCREENING LEVELS FOR DIRECT CONTACT EXPOSURE TO GROUNDWATER AND DRINKING WATER EXPOSURES

The human health screening levels for direct contact exposure to groundwater and exposure to surface water as drinking water are from IDEM and USEPA sources. The IDEM criteria for these types of exposures are the same as the federal primary drinking water standards (MCLs). USEPA Regional Screening Levels (RSLs; USEPA, 2024d) for tap water (drinking water, or untreated groundwater used as potable water) have also been included for constituents which do not have promulgated IDEM/MCL criteria. The tap water RSLs are RBSLs based on USEPA default assumptions for residential exposure to tap water.

These sources, in the order in which they were used, are:

- USEPA MCLs (USEPA, 2024a).
- USEPA RSLs, November 2024, values for tap water (USEPA, 2024d).
- Indiana Administrative Code (IAC) Title 327 – Water Pollution Control Division (IWPCD), 327 IAC 2-11-6, Criteria for drinking water class groundwater (IWPCD, 2025b).

Human health screening levels for direct contact exposure to groundwater and exposure to surface water as drinking water are provided in **Table 2**.

5.2 PUBLISHED RECREATIONAL SCREENING LEVELS

Published human health screening levels for surface water are derived to be protective of the use of surface water as a drinking water source and the consumption of fish from a surface water body. The drinking water screening levels are also protective of, but highly conservative for recreational uses of a surface water body (such as swimming, wading, or boating) because drinking water is of a higher magnitude and frequency than incidental water consumption exposures which may occur during recreational uses.

The human health screening levels for surface water are from federal and state sources. Values that address use of surface water as drinking water are the values for drinking water provided in **Table 2**. Values that address the fish consumption pathway are USEPA values for human health for "the consumption of organism only," and IDEM surface water quality criteria for protection of human health (where the surface water body is not within the Great Lakes System).

These screening level sources, in the order in which they were used, are:

- USEPA Ambient Water Quality Criteria for Human Health Consumption of Organisms. (USEPA, 2024c)
- IWPCD. 327 IAC 2-1-6. Minimum Surface Water Quality Standards, surface water quality criteria for protection of human health (continuous criterion concentrations outside of mixing zone). (IWPCD, 2025a)

The published human health screening levels for surface water are provided in **Table 2**.

5.3 CALCULATED RISK-BASED SCREENING LEVELS FOR RECREATIONAL USE

In accordance with USEPA and IDEM guidance (USEPA, 1989; USEPA, 2024e; IDEM, 2022), Site-specific information may warrant the development of Site-specific RBSLs, which are refined values from RBSLs for default exposure scenarios that account for Site-specific receptor population characteristics and exposure pathways. Site-specific RBSLs are more representative of Site-specific conditions than published RBSLs based on default assumptions and; therefore, are useful for evaluating whether constituents may have the potential to pose adverse health effects. For example, whereas surface water that is used as a recreational body of water for swimming and it could be evaluated using drinking water standards which assumes that people are drinking and bathing in the water daily; Site-specific RBSLs for surface water will reflect incidental ingestion and dermal contact at an exposure rate and magnitude commensurate with swimming activities.

Potential exposures to constituents in surface water could, in general, occur through ingestion and dermal contact. However, the specific nature of the potential exposures is dependent on the type of water body. Specifically:

- Incidental ingestion and dermal contact with shallow surface water (e.g., less than 2 feet in depth) can only occur via wading because the water is not deep enough to permit swimming. Exposures during wading could be potentially complete in the Ohio River and Little Pigeon Creek.

- Incidental ingestion and dermal contact with deeper surface water (e.g., more than 3 feet in depth) could occur via swimming. Exposures during swimming could be potentially complete in the Ohio River.
- Dermal contact with surface water could occur during boating or fishing activities in the Ohio River and Little Pigeon Creek. Since these types of activities are not associated with intense exposures to water (such as is the case with swimming), incidental ingestion of surface water would be insignificant.

Site-specific RBSLs derived for recreational exposures to surface water for a recreational swimmer, wader, and boater are presented in **Table 3**. The RBSLs were calculated using USEPA-derived exposure factors and equations, as well as Site-specific inputs where appropriate, using the USEPA RSL calculator (USEPA, 2025). The RSL calculator output, including the exposure parameters used, is provided in **Attachment B**.

5.4 ECOLOGICAL SCREENING LEVELS

Ecological screening levels for surface water are published to provide a conservative estimate of the concentration to which an ecological receptor can be exposed without experiencing adverse effects. Due to the conservative methods used to derive published reference screening levels, it can be assumed with reasonable certainty that concentrations at or below screening levels will not result in any adverse effects to survival, growth, and/or reproduction. Concentrations above published ecological screening levels for surface water; however, do not necessarily indicate that a potential ecological risk exists, but rather that further evaluation may be warranted.

Table 4 presents the published ecological screening levels for surface water. Some of the screening levels are expressed as a function of the hardness of water, specifically the criteria for cadmium, chromium, and lead. Values presented in **Table 4** for these constituents are based on a Site-specific hardness value of 128 milligrams per liter (mg/L), derived from hardness data collected by the Ohio River Valley Water Sanitation Commission (2025).

Water quality criteria are concentrations calculated from controlled laboratory tests on freshwater or marine organisms that are protective of the most sensitive organism (often zooplankton such as daphnids) for the most sensitive life stage (typically reproduction).

The screening level sources, in the order in which they were used, are:

- USEPA National Recommended Water Quality Criteria, Freshwater Chronic and Acute. (USEPA, 2024b)
- IWPCD. 327 IAC 2-1-6. Minimum Surface Water Quality Standards; acute aquatic criteria and chronic aquatic criteria. Additional water quality criteria not in 327 IAC 2-1-6 derived by IDEM using methodologies at 327 IAC 2-1-8.2 and 8.3 were also used. (IWPCD, 2025a; IDEM, 2023)
- USEPA Region 4 Ecological Risk Assessment Supplemental Guidance, Surface Water Screening Values. (USEPA, 2018)

5.5 SELECTED SURFACE WATER SCREENING LEVELS

Table 5 presents a summary of the selected surface water screening levels (**Tables 2 through 4**), identifying the lowest selected screening levels for: 1) the use of surface water as a drinking water

source; 2) the consumption of fish from a surface water body; 3) Site-specific recreational uses of surface water; and 4) potential ecological exposure scenarios.

5.6 SCREENING LEVELS FOR GROUNDWATER PROTECTIVE OF OHIO RIVER AND LITTLE PIGEON CREEK SURFACE WATER

Impacts to groundwater do not mean that Ohio River and Little Pigeon Creek surface waters are impaired. The degree to which groundwater, which is a fraction of the volume and flow rate of the adjacent water bodies, may interact with the Ohio River or Little Pigeon Creek is variable and complex, and dependent upon a variety of factors including gradient and flow rate. It is possible, however, to determine maximum concentration levels in onsite groundwater that would be sufficiently protective of the surface water environments of the Ohio River and Little Pigeon Creek, assuming gradient and flow rates are such that groundwater flows into these water bodies. Groundwater and surface waters flow at very different rates and volumes. The Ohio River is a large river system and as depicted in **Attachment C**, as groundwater flows into the river, it is estimated to be diluted by more than 270,000 times. However, groundwater that enters Little Pigeon Creek is estimated to only be diluted by more than 200 times.

To be protective of the surface water environments of both the Ohio River and Little Pigeon Creek, screening levels for groundwater were calculated based upon the lower amount of dilution and attenuation estimated to occur as groundwater flows into Little Pigeon Creek. **Table 5** shows the application of the DAF estimated for potential groundwater discharge to Little Pigeon Creek to the lowest selected surface water screening levels (selected as described in Sections 5.1 through 5.5 above) to calculate these screening levels.

6. Results

6.1 POTENTIAL DIRECT CONTACT EXPOSURE TO GROUNDWATER AT WATER WITHDRAWAL WELLS WELL 1A AND WELL 2

As discussed in Section 4.3, direct contact exposure to CCR constituents in groundwater was assumed to be potentially complete for onsite workers who may use water pumped from water withdrawal wells Well 1A and Well 2. Groundwater flow modeling was conducted as presented in **Attachment A** to estimate the portion of water within these wells that is contributed from beneath the EAP. As presented, this was estimated to be approximately 0.37 percent, equivalent to a DAF of 270. To evaluate risks associated with potential onsite worker exposure to CCR constituents in groundwater at Well 1A or Well 2, the DAF of 270 was applied to maximum groundwater constituent concentrations from the EAP wells closest to Well 1A and Well 2 (i.e., CCR-AP-4, CCR-AP-6, and CCR-AP-6I, through the November 2024 sampling event, dating back to the initial sampling event from June 2016) to estimate potential CCR constituent concentrations in groundwater at the withdrawal wells, and then the resulting estimated groundwater concentrations were compared to screening levels for potential direct contact exposure.

Table 6 presents a comparison of the groundwater concentrations estimated at Well 1A and Well 2 to the screening levels selected as presented in **Table 2** for direct contact groundwater exposure. A summary of the resulting comparison is presented in the in-text **Table 6-1** below. For the described use of water withdrawn from Well 1A and Well 2 (i.e., worker showering and handwashing), this comparison is conservative, given that the screening levels used are protective of residential drinking water/tap water exposures. The comparison demonstrates that the estimated groundwater concentrations do not pose an adverse impact to onsite workers, as there is a wide margin of safety between the screening levels and estimated concentrations, which is shown in the last column of the table. Notably, the estimated concentrations of arsenic and molybdenum are more than eight and 20 times lower, respectively, than the selected screening levels for direct contact exposure.

Table 6-1 – Comparison of Estimated Groundwater Concentrations at Well 1A and Well 2 against Screening Levels for Direct Contact Exposure

Constituents	Selected Screening Level (mg/L)	Maximum Groundwater Concentration – CCR-AP-4, CCR-AP-6, CCR-AP-6I (mg/L)		Estimated Groundwater Concentration at Well 1A and Well 2 (mg/L)	Ratio Between Screening Level and Estimated Groundwater Concentration
Detection Monitoring - USEPA Appendix III Constituents					
Boron	4	24	CCR-AP-6I	0.089	>45
Fluoride	4	0.89	CCR-AP-4	0.0033	>1,200
Assessment Monitoring - USEPA Appendix IV Constituents					
Antimony	0.006	0.028	CCR-AP-4	0.0001	>57
Arsenic	0.01	0.33	CCR-AP-4	0.0012	>8
Barium	2	1.4	CCR-AP-4	0.0052	>380
Beryllium	0.004	0.0017	CCR-AP-4	0.0000063	>630
Cadmium	0.005	0.0011	CCR-AP-6	0.0000041	>1,200
Chromium (Total)	0.1	0.058	CCR-AP-4	0.00021	>460

Cobalt	0.006	0.021	CCR-AP-4	0.000078	>77
Lead	0.015	0.047	CCR-AP-4	0.00017	>86
Lithium	0.04	0.33	CCR-AP-6I	0.0012	>32
Mercury	0.002	0.00041	CCR-AP-6	0.0000015	>1,300
Molybdenum	0.1	1.3	CCR-AP-6I	0.0048	>20
Selenium	0.05	0.031	CCR-AP-4	0.00011	>430
Thallium	0.002	0.00047	CCR-AP-4	0.0000017	>1,100
Radiological Constituent (pCi/L)					
Radium	5	30	CCR-AP-4	0.11	>45
Notes: *mg/L = milligrams per liter* *pCi/L = picocuries per liter* *USEPA = United States Environmental Project Agency*					

The results of the comparison demonstrate that detected concentrations of CCR constituents in groundwater beneath the EAP do not pose an adverse impact to onsite workers who use water pumped from Well 1A and Well 2, and furthermore indicate that such detected concentrations do not pose an adverse impact to on- or offsite workers who may use water in wells further west/northwest of Well 1A and Well 2 because potential contributions of groundwater from beneath the EAP would be even less for those wells.

6.2 POTENTIAL IMPACTS ON OHIO RIVER AND LITTLE PIGEON CREEK SURFACE WATER

Table 7 presents a comparison of the maximum groundwater constituent concentrations from all EAP monitoring wells (through the November 2024 sampling event, dating back to the initial sampling event from June 2016) to the screening levels for groundwater protective of Ohio River and Little Pigeon Creek surface water, derived as discussed in Section 5.6 above. A summary of this comparison is presented in the in-text **Table 6-2** below. The comparison demonstrates that detected groundwater concentrations (conservatively, maximum concentrations) do not pose an adverse impact to the Ohio River or Little Pigeon Creek. In fact, there is a wide margin of safety between the screening levels and detected concentrations, which is shown in the last column of the table. To illustrate, concentrations of arsenic and molybdenum would need to be more than six and 15 times higher, respectively, than currently measured levels before a potential adverse impact to either surface water body might occur.[4]

[4] As indicated earlier in Section 3.2, arsenic in downgradient monitoring wells has been determined to be naturally occurring and not attributed to the EAP.

Table 6-2 – Comparison of Maximum Groundwater Concentrations against Screening Levels Protective of Ohio River and Little Pigeon Creek Surface Water				
Constituents	**Groundwater Screening Level – Ohio River/Little Pigeon Creek (mg/L)**	**Maximum Groundwater Concentration (mg/L)**		**Ratio Between Groundwater Screening Level and the Maximum Groundwater Concentration**
Detection Monitoring - USEPA Appendix III Constituents				
Boron	820	68	CCR-AP-5	>12
Fluoride	550	2.3	CCR-AP-5	>230
Assessment Monitoring - USEPA Appendix IV Constituents				
Antimony	1.2	0.028	CCR-AP-4	>43
Arsenic	2.0	0.33	CCR-AP-4	>6
Barium	45	1.4	CCR-AP-4	>32
Beryllium	0.82	0.0077	CCR-AP-2	>100
Cadmium	0.06	0.0066	CCR-AP-2	>9
Chromium (Total)	19	0.16	CCR-AP-1R	>110
Cobalt	1.2	0.091	CCR-AP-2	>13
Lead	0.7	0.1	CCR-AP-2	>7
Lithium	8.2	0.44	CCR-AP-8I	>18
Mercury	0.031	0.0016	CCR-AP-5	>19
Molybdenum	20	1.3	CCR-AP-6I	>15
Selenium	0.63	0.031	CCR-AP-4	>20
Thallium	0.096	0.0076	CCR-AP-2	>12
Radiological Constituent (pCi/L)				
Radium	1,020	30	CCR-AP-4	>34
Notes: *mg/L = milligrams per liter* *pCi/L = picocuries per liter* *USEPA = United States Environmental Project Agency*				

This means that the present concentrations of constituents in groundwater do not pose an unacceptable risk to human health or the environment and even higher concentrations in groundwater than what has been detected to this point in time are unlikely to be harmful. This is further illustrated by the second comparison presented in **Table 7**, between the maximum groundwater concentrations from the wells closest to the Ohio River and Little Pigeon Creek to the derived screening levels. This comparison, which is summarized in the in-text **Table 6-3** below, shows an even wider margin of safety between the two values. As presented, the ratios between the screening levels and maximum groundwater concentrations from the monitoring wells closest to the Ohio River and Little Pigeon Creek range from seven to 360 for detected constituents. This means that concentrations of detected constituents in these wells could be more than seven times higher than currently measured levels before a potential adverse impact to either surface water body might occur.

Table 6-3 – Comparison of Maximum Groundwater Concentrations from Monitoring Wells Closest to the Ohio River and Little Pigeon Creek against Screening Levels Protective of Ohio River and Little Pigeon Creek Surface Water				
Constituents	**Groundwater Screening Level – Ohio River/Little Pigeon Creek (mg/L)**	**Maximum Groundwater Concentration (mg/L)**		**Ratio Between Groundwater Screening Level and the Maximum Groundwater Concentration**
Detection Monitoring - USEPA Appendix III Constituents				
Boron	820	33	CCR-AP-8I	>24
Fluoride	550	1.5	CCR-AP-8	>360
Assessment Monitoring - USEPA Appendix IV Constituents				
Antimony	1.2	0.018	CCR-AP-6	>68
Arsenic	2.0	0.12	CCR-AP-6, CCR-AP-8	>17
Barium	45	0.83	CCR-AP-2	>54
Beryllium	0.82	0.0077	CCR-AP-2	>100
Cadmium	0.06	0.0066	CCR-AP-2	>9
Chromium (Total)	19	0.14	CCR-AP-2	>130
Cobalt	1.2	0.091	CCR-AP-2	>13
Lead	0.7	0.1	CCR-AP-2	>7
Lithium	8.2	0.44	CCR-AP-8I	>18
Mercury	0.031	0.00071	CCR-AP-2	>43
Molybdenum	20	1.3	CCR-AP-6I	>15
Selenium	0.63	0.026	CCR-AP-2	>24
Thallium	0.096	0.0076	CCR-AP-2	>12
Radiological Constituent (pCi/L)				
Radium	1,020	10	CCR-AP-6	>100

Notes:
mg/L = milligrams per liter
pCi/L = picocuries per liter
USEPA = United States Environmental Project Agency

The results of these comparisons demonstrate that detected concentrations of CCR constituents in groundwater do not pose an adverse impact to the Ohio River and Little Pigeon Creek and do not pose an unacceptable risk to human health or ecological receptors.

7. Summary

This comprehensive evaluation demonstrates that there are no adverse impacts on human health or the environment from groundwater affected by the EAP at the FBC Generating Station.

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TABLES

TABLE 1
GROUNDWATER MONITORING RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well	Sample Date	Sample Type	Appendix III Constituents							Appendix IV Constituents																
			Boron Total ug/L	Calcium Total ug/L	Chloride ug/L	Fluoride ug/L	pH (lab) SU	Sulfate ug/L	Total Dissolved Solids (TDS) ug/L	Antimony Total ug/L	Arsenic Total ug/L	Barium Total ug/L	Beryllium Total ug/L	Cadmium Total ug/L	Chromium Total ug/L	Cobalt Total ug/L	Fluoride ug/L	Lead Total ug/L	Lithium Total ug/L	Mercury Total ug/L	Molybdenum Total ug/L	Selenium Total ug/L	Thallium Total ug/L	Radium-226 pCi/L	Radium-228 pCi/L	Radium-226 & 228 pCi/L
CCR-AP-1R	6/10/2016	-	510 -	53000 -	19000 -	810 -	7.74 J	180000 J-	740000 -	2 U	4.5 -	77 -	0.53 J	1 U	11 -	8.1 -	810 -	7.4 -	45 J	0.2 U	15 -	0.71 J	0.082 J	0.607 J	0.344 U	0.95 U
	8/12/2016	-	540 -	51000 -	18000 -	480 -	8.1 J	180000 -	760000 -	2 U	6.7 -	120 -	0.74 J	1 U	20 -	14 -	480 -	13 -	53 -	0.2 U	13 -	1.4 J	0.12 J	3.13 -	3.2 -	6.32 -
	10/28/2016	-	650 -	50000 J-	19000 J+	500 -	7.6 J	110000 J+	740000 -	2 U	2.4 -	50 -	0.11 J	1 U	1.9 J	1.5 J	500 -	1.1 J	35 J	0.2 U	6 -	5 U	1 U	0.353 U	0.509 U	0.862 U
	12/7/2016	-	680 J+	44000 -	19000 -	550 -	7.7 J	130000 -	710000 -	0.72 J	3.6 -	81 -	0.49 J	1 U	9.2 -	5 -	550 -	5.7 -	35 J	0.2 U	4.7 J	0.45 J	0.079 J	1.75 U	0.34 U	2.09 U
	2/8/2017	-	690 J+	42000 J-	18000 -	530 -	7.5 J	140000 -	750000 -	0.77 J	6.8 -	110 -	0.58 J	0.081 J	12 -	8.3 -	530 -	8.3 -	43 J	0.2 U	7.3 -	5 U	0.33 J	2.99 -	3.58 -	6.56 -
	4/6/2017	-	620 -	55000 J+	17000 -	570 -	7.8 J	150000 -	730000 -	0.55 J	12 -	160 -	1.4 -	0.18 J	30 -	17 -	570 -	20 J+	63 -	0.2 U	6.7 -	1.4 J-	1 U	2.28 -	4.45 -	6.73 J
	6/7/2017	-	720 J+	55000 -	18000 -	580 -	7.7 J	150000 -	840000 -	0.53 J	8 -	110 -	0.73 J	1 U	15 -	8.8 -	580 -	9.3 -	49 J	0.2 U	7.3 -	5 U	0.12 J	1.74 -	3.25 -	5 -
	9/28/2017	-	440 -	48000 -	18000 -	490 -	7.7 J	160000 -	770000 -	2.5 -	5.5 -	86 -	0.35 J	1 U	10 -	5.9 -	490 -	6.8 -	36 J	0.2 U	8 -	5 U	0.088 J	1.94 -	4.52 -	6.46 -
	11/17/2017	-	820 J+	57000 -	18000 -	480 -	7.9 J	170000 J-	770000 -	10 U	7.5 -	150 -	1.3 J	5 U	21 -	13 -	480 -	14 -	59 J	0.2 U	13 J	25 U	1.4 J	3.33 -	2.93 R	6.25 R
	6/11/2018	-	- -	- -	- -	470 -	- -	- -	- -	20 U	29 -	550 -	5.6 J	10 U	120 -	47 -	470 -	63 -	170 -	0.2 U	10 J	50 U	1 J	2.01 -	2.14 -	4.15 -
	8/28/2018	-	610 J	47000 -	11000 -	470 -	7.8 J	150000 -	820000 -	20 U	23 -	470 -	3.3 J	10 U	130 -	36 -	470 -	49 -	130 -	- -	7.7 J	50 U	0.94 J	2.42 -	2.65 -	5.07 -
	5/28/2019	-	720 J-	67000 -	17000 -	570 J+	7.8 J	190000 -	890000 -	0.57 J	38 -	380 -	5 -	0.52 J	110 -	75 -	570 J+	76 -	160 -	0.2 U	10 -	5 U	0.74 J	0.564 -	1.91 -	2.47 -
	10/23/2019	-	430 -	70000 -	16000 -	340 -	7.8 J	180000 -	300000 -	1.9 J	37 -	590 -	6.6 -	0.87 J	160 -	81 -	340 -	94 -	230 -	0.2 U	12 J	25 U	1.4 J	0.561 J	1.37 -	1.93 -
	5/19/2020	-	740 -	64000 -	17000 -	520 -	7.8 J	180000 -	980000 -	2 J	25 -	300 -	4.3 J	5 U	84 -	48 -	520 -	50 -	130 -	0.2 U	9.6 J	25 -	5 U	1.47 -	1.34 U	2.81 J+
	11/13/2020	-	770 -	57000 -	18000 -	500 -	8 J	220000 J+	850000 -	1 J	8.6 -	94 -	0.77 J	1 U	18 -	10 -	500 -	11 -	52 -	0.2 U	7.3 -	5 U	1 U	1.09 -	0.833 -	1.92 -
	5/13/2021	-	820 -	70000 -	17000 -	480 J+	7.8 J	210000 -	890000 -	2.6 J	23 -	280 -	4.8 J	5 U	70 -	39 -	480 J+	40 -	96 -	2 U	9.9 J	25 U	2.7 J	1.04 -	1.74 -	2.77 -
	11/22/2021	-	860 -	83000 -	16000 J-	630 J	7.6 J	210000 -	880000 -	1 J	30 -	260 -	6.1 -	0.37 J	84 -	68 -	630 J	71 -	120 -	0.5 U	7.3 -	5 U	0.46 J	2.37 -	5.16 J	7.53 J
	5/10/2022	-	690 J+	79000 -	17000 -	480 -	7.6 J	210000 -	890000 -	4.1 -	34 -	320 -	5.3 -	0.43 J	110 -	80 -	480 -	78 -	150 -	0.2 U	23 -	2.4 J	0.56 J	2.69 U	4.24 -	6.92 J+
	11/29/2022	-	650 -	70000 -	17000 -	470 -	7.9 J	250000 -	930000 -	1.4 J	18 -	270 -	4 -	0.28 J	88 -	44 -	470 -	56 -	130 -	0.2 U	9.3 -	2.1 J	0.54 J	3.05 -	5.5 J	8.55 J
	5/23/2023	-	730 -	65000 -	18000 -	430 -	7.4 J	250000 -	910000 -	1.5 J	12 -	140 -	2 -	0.22 J	36 -	19 -	430 -	19 -	76 -	0.2 U	9.2 -	1.5 J	0.86 J	- -	- -	- -
	6/13/2023	-	680 -	73000 -	17000 -	460 -	- -	260000 -	- -	2 U	5.5 -	60 -	1 U	1 U	7.3 -	4.1 -	460 -	4.2 -	41 -	0.2 U	8.7 -	5 U	1 U	- -	- -	- -
	7/28/2023	-	690 -	87000 -	17000 -	400 -	7.5 J	300000 -	980000 -	1.1 J	16 -	200 -	2.2 -	0.31 J	55 -	36 -	400 -	36 -	85 -	0.2 U	6.7 -	1.3 J	1 U	1.08 -	0.361 U	1.44 J
	11/2/2023	-	740 -	85000 -	17000 -	380 -	7.4 J	340000 -	990000 -	0.87 J	15 -	210 -	3.1 -	0.24 J	65 -	35 -	380 -	37 -	120 -	0.5 U	5 -	4.6 J	2 U	14.5 -	1.91 U	16.4 -
	12/22/2023	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	5.36 -	9.08 J-	14.4 J-
	5/8/2024	-	750 -	61000 -	32000 -	250 J	7.4 J	100000 -	480000 J	0.73 J	5.9 -	350 -	0.95 J	1 U	21 -	13 -	250 J	13 -	36 -	0.2 U	5.3 -	5 U	1 U	2.32 -	4.98 -	7.3 -
	11/14/2024	-	790 -	55000 -	28000 -	400 -	7.4 J	160000 -	700000 -	1 J	11 -	200 -	1.5 -	0.34 J	34 -	18 -	400 -	18 -	67 -	0.2 U	5.6 -	1.3 J	0.92 J+	1.1 J	2.28 U	3.38 UJ
	12/19/2024	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.815 -	0.853 U	1.67 J
CCR-AP-2	6/10/2016	-	15000 -	200000 -	72000 -	160 J+	7.26 J	530000 J-	1700000 -	2 -	1.8 -	55 -	0.14 J	0.55 J	3.5 -	7.3 -	160 J+	2.3 -	50 U	0.2 U	1.8 J	0.44 J	0.048 J	0.222 J	0.542 U	0.764 U
	8/12/2016	-	12000 -	230000 -	73000 -	280 -	7.4 J	730000 -	1700000 -	2 U	1.6 -	38 -	0.15 J	0.23 J	3 -	9.6 -	280 -	2.8 -	50 U	0.2 U	0.99 J	0.76 J	0.048 J	1.22 -	1.09 U	2.32 -
	10/28/2016	-	11000 -	220000 J-	73000 J+	230 -	6.7 J	540000 J+	1600000 -	2 U	4.4 -	90 -	0.66 J	0.53 J	13 -	16 J	230 -	9.6 J	17 J	0.2 U	1.4 J	1.3 J	0.14 J	0.731 -	0.648 U	1.38 J
	12/7/2016	-	12000 -	240000 -	75000 -	300 J+	6.8 J	680000 -	1600000 -	0.24 J	3 -	140 -	0.56 J	0.48 J	11 -	12 -	300 J+	6 -	50 U	0.2 U	1.5 J	5 U	0.16 J	2.01 -	0.707 U	2.72 J
	2/8/2017	-	12000 -	260000 J-	83000 -	260 J+	7 J	570000 -	1500000 -	2 U	3.5 -	120 -	0.38 J	0.38 J	8.4 -	14 -	260 J+	5.7 -	10 J	0.2 U	1.7 J	5 U	0.17 J	0.672 -	1 -	1.68 -
	4/6/2017	-	12000 -	240000 J+	89000 -	290 -	6.8 J	600000 -	1600000 -	2 U	1.8 -	52 -	0.32 J	0.11 J	3.7 -	11 -	290 -	2.6 J+	50 U	0.2 U	0.94 J	5 UJ	1 U	1.03 -	1.44 -	2.47 J
	6/7/2017	-	12000 -	240000 -	81000 -	300 J	6.8 J	510000 -	1600000 -	2 U	6.6 -	270 -	0.99 J	0.78 J	25 -	21 -	300 J	16 -	23 J	0.2 U	2.4 J	5 U	0.26 J	0.894 -	2.4 -	3.29 -
	9/28/2017	-	7800 -	220000 -	110000 -	280 -	6.9 J	610000 -	1700000 -	1.7 J	17 -	440 -	2.7 -	0.73 J	56 -	38 -	280 -	51 -	23 J	0.2 U	5.1 -	4.4 J	0.68 J	0.73 -	1.18 U	1.91 J+
	11/17/2017	-	14000 -	260000 -	120000 -	110 -	7 J	680000 J-	1600000 -	10 U	6.6 -	170 -	1.2 J	5 U	21 -	18 -	110 -	12 -	250 U	0.2 U	4 J	25 U	0.79 J	0.266 -	0.585 U	0.85 J+
	6/11/2018	-	- -	- -	- -	280 -	- -	- -	- -	2 U	13 -	270 -	2.1 -	0.89 J	42 -	23 -	280 -	30 -	33 -	0.2 U	3 J	2.6 J	0.48 J	0.597 -	0.294 U	0.891 J
	8/28/2018	-	9600 -	220000 -	150000 -	250 -	6.9 J	510000 -	1500000 -	20 U	21 -	520 -	2 J	10 U	82 -	29 -	250 -	35 -	57 -	- -	5.6 J	50 U	0.99 J	1.04 R	0.88 -	1.92 R
	11/15/2018	-	- -	- -	160000 -	320 -	- -	450000 -	1500000 -	2 U	1.2 -	43 B	1 U	0.15 J	1.9 J	8.4 -	320 -	0.53 J	5 U	0.2 U	0.91 J	5 U	1 U	- -	- -	- -
	5/28/2019	-	6800 J-	190000 -	160000 -	400 J+	7 J	490000 -	1300000 -	1.1 J	32 -	260 -	2.1 -	2.3 -	52 -	26 -	400 J+	38 -	31 -	0.38 -	7.8 -	6.5 -	0.9 J	2.57 -	2.81 U	5.38 J
	10/22/2019	-	5300 -	220000 -	120000 -	510 -	6.8 J	310000 -	440000 -	10 U	20 -	280 -	1.9 J	1.6 J	54 -	26 -	510 -	26 -	69 -	0.19 J	7.8 J	26 J+	0.96 J	0.56 J	0.217 U	0.778 J
	5/20/2020	-	12000 -	260000 -	230000 -	350 -	6.9 J	400000 -	1400000 -	2.1 J	19 -	240 -	2 J	5 U	51 -	31 -	350 -	43 -	36 -	0.2 U	5.7 J	16 J	5 U	0.355 -	0.581 U	0.936 J
	11/12/2020	-	800 U	220000 -	210000 -	320 -	7.5 J	460000 J+	1700000 -	1.2 J	21 -	260 -	2.2 -	1.2 -	58 -	34 -	320 -	35 -	43 -	0.15 J	6.8 -	3.4 J	1 U	1.34 -	0.114 U	1.46 J
	5/12/2021	-	9600 -	240000 -	250000 -	340 J+	7 J	410000 -	1400000 -	0.69 J	10 -	97 -	7.7 -	6.6 -	16 -	19 -	340 J+	12 -	14 -	0.2 U	6.1 -	7.5 -	7.6 -	0.0542 U	0.628 U	0.682 U
	11/22/2021	-	8500 -	220000 -	150000 J-	690 J	6.7 J	250000 -	1600000 -	0.87 J	11 -	140 -	0.91 J	0.59 J	24 -	18 -	690 J	17 -	18 -	0.2 U	3.7 J	5 U	0.38 J	1.75 J	3.78 UJ	5.53 UJ
	5/9/2022	-	6900 -	190000 -	190000 -	630 -	6.8 J	240000 -	1100000 -	2.1 -	16 -	220 -	1.7 -	0.86 J	33 -	32 -	630 -	30 -	21 -	0.15 J	4.3 J	1.9 J	0.5 J	1.3 U	1.15 -	2.45 J+
	11/29/2022	-	6200 -	180000 -	240000 -	550 -	6.9 J	310000 -	1300000 -	7.9 -	13 -	230 -	1.3 -	0.7 J	35 -	21 -	550 -	19 -	28 -	0.17 J	6.7 -	2.6 J	0.86 J	1.09 -	1.06 U	2.16 UJ
	5/23/2023	-	5800 -	170000 -	200000 -	470 -	6.9 J	250000 -	790000 -	4.1 -	30 -	400 -	3.1 -	1.2 -	79 -	40 -	470 -	49 -	64 -	0.71 -	7.8 -	4.2 J	1.3 -	- -	- -	- -
	7/28/2023	-	10000 -	240000 -	220000 -	500 -	7 J	260000 -	1100000 -	1.3 J	48 -	560 -	4.9 -	1.4 -	100 -	72 -	500 -	74 -	83 -	0.33 -	10 -	3.5 J	1.3 -	0.265 U	0.179 U	0.444 U
	11/2/2023	-	6600 -	180000 -	240000 -	550 -	6.7 J	450000 -	1300000 -	1.3 J	40 -	640 -	7.2 -	2.3 -	140 -	91 -	550 -	100 -	110 -	0.42 J	8.3 -	13 -	1.2 J	1.18 -	2.06 U	3.23 J+
	5/8/2024	-	8100 -	230000 -	250000 -	270 -	6.7 J	340000 -	1500000 J	1.1 J	25 -	830 -	3.7 -	3 -	110 -	48 -	270 -	56 -	85 -	0.16 J	6.5 -	2.7 J	1 -	1.65 -	1.57 U	3.22 J+
	11/14/2024	-	9200 -	230000 -	190000 -	240 -	6.8 J	420000 -	1500000 -	2 U	2.1 J	45 -	1 U	0.11 J	2.4 J	8 -	240 -	1.3 -	3.8 J	0.2 U	5 U	5 U	1 U	0.401 U	1.42 U	1.82 U
	12/19/2024	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.92 -	1.05 U	1.97 J

TABLE 1
GROUNDWATER MONITORING RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well	Sample Date	Sample Type	Appendix III Constituents							Appendix IV Constituents																
			Boron Total ug/L	Calcium Total ug/L	Chloride ug/L	Fluoride ug/L	pH (lab) SU	Sulfate ug/L	Total Dissolved Solids (TDS) ug/L	Antimony Total ug/L	Arsenic Total ug/L	Barium Total ug/L	Beryllium Total ug/L	Cadmium Total ug/L	Chromium Total ug/L	Cobalt Total ug/L	Fluoride ug/L	Lead Total ug/L	Lithium Total ug/L	Mercury Total ug/L	Molybdenum Total ug/L	Selenium Total ug/L	Thallium Total ug/L	Radium-226 pCi/L	Radium-228 pCi/L	Radium-226 & 228 pCi/L
CCR-AP-3	6/10/2016	-	180 -	160000 -	26000 -	100 U	7.17 J	1300 J-	1000000 -	2 U	58 -	410 -	1 U	1 U	2.1 -	9.4 -	100 U	0.41 J	50 U	0.2 U	11 -	1.5 J	1 U	0.657 J	1.1 -	1.75 -
	8/15/2016	-	150 J+	170000 -	26000 -	930 -	7.6 J	1700 R	1000000 -	2 U	72 -	380 -	1 U	1 U	1.8 J	8 -	930 -	0.39 J	50 U	0.2 U	14 -	0.62 J	1 U	0.865 -	0.784 U	1.65 -
	10/28/2016	-	160 -	190000 J-	27000 J+	310 -	7 J	1100 J+	1000000 -	2 U	71 -	400 -	1 U	1 U	2 -	7.6 J	310 -	1 UJ	50 U	0.2 U	14 -	1.8 J	1 U	1.15 -	0.819 -	1.97 -
	12/7/2016	-	170 J+	190000 -	26000 -	500 -	7.2 J	1000 U	970000 -	0.31 J	68 -	430 -	1 U	1 U	2.3 -	7 -	500 -	0.66 J	50 U	0.2 U	14 -	1.9 J	1 U	0.789 -	0.932 -	1.72 -
	2/8/2017	-	180 J+	190000 J-	23000 -	390 -	7.2 J	670 J	1000000 -	2 U	86 -	460 -	1 U	1 U	2 -	7.2 -	390 -	0.35 J	50 U	0.2 U	13 -	2 J	1 U	0.373 U	0.489 U	0.862 U
	4/6/2017	-	200 -	180000 J+	25000 -	570 -	7.1 J	1000 U	1000000 -	2 U	80 -	420 -	1 U	1 U	2.1 -	6.3 -	570 -	0.48 J+	50 U	0.2 U	11 -	1.8 J-	1 U	0.45 -	0.644 -	1.09 -
	6/7/2017	-	270 U	200000 -	25000 -	550 -	7.2 J	560 J	1200000 -	2 U	77 -	440 -	1 U	1 U	2 U	6.2 -	550 -	1 U	50 U	0.2 U	12 -	1.8 J	1 U	0.582 -	1.25 -	1.83 -
	9/28/2017	-	120 -	180000 -	25000 -	450 -	7.1 J	480 J	1000000 -	0.58 J	66 -	390 -	1 U	1 U	2 U	5.7 -	450 -	0.98 J	50 U	0.2 U	10 -	1.6 J	1 U	0.411 -	0.769 R	1.18 R
	11/17/2017	-	190 U	190000 -	25000 -	140 -	7.4 J	820 J-	970000 -	2 U	67 -	400 -	1 U	1 U	2.1 -	5.6 -	140 -	0.51 J	50 U	0.2 U	11 -	1.7 J	0.1 J	0.626 -	0.955 R	1.58 R
	6/11/2018	-	- -	- -	- -	560 -	- -	- -	- -	2 U	80 -	470 -	1 U	1 U	4.1 J+	5.2 -	560 -	0.92 J	5 U	0.2 U	9.9 -	2.3 J	1 U	0.475 -	0.292 U	0.768 J
	8/28/2018	-	140 -	180000 -	12000 -	330 -	7.3 J	1000 U	1000000 -	2 U	71 -	430 -	1 U	1 U	4.1 J+	4.6 -	330 -	0.78 J	5 U	- -	9.6 -	2.1 J	1 U	0.756 R	0.946 -	1.7 J+
	11/16/2018	-	- -	- -	26000 -	370 -	- -	650 J	990000 -	2 U	76 -	450 -	1 U	1 U	2.9 -	5.5 -	370 -	0.18 J	5 U	0.2 U	10 -	2.1 J	1 U	- -	- -	- -
	5/28/2019	-	240 J	190000 -	25000 -	530 J+	7.3 J	500 J	1000000 -	2 U	77 -	440 -	1 U	1 U	2 U	5.4 -	530 J+	0.33 J	5 U	0.2 U	9.9 -	5 U	1 U	0.404 -	1.83 -	2.24 -
	10/22/2019	-	97 -	190000 -	23000 -	390 -	7.2 J	910 J	990000 -	2 U	69 -	480 -	1 U	1 U	2.5 -	4.8 -	390 -	1 U	7.8 U	0.2 U	8.9 -	6.8 J+	1 U	0.116 UJ	0.477 U	0.593 -
	5/20/2020	-	240 -	180000 -	24000 -	360 -	7.4 J	2200 J+	950000 -	2 U	83 -	420 -	1 U	1 U	2.9 -	5.1 -	360 -	1.4 J+	5 U	0.2 U	10 -	1.9 J	1 U	0.77 -	0.252 U	1.02 J
	11/13/2020	-	160 J+	200000 -	26000 -	280 -	7.6 J	1200 J+	970000 -	2 U	80 -	430 -	1 U	1 U	2.1 -	4.9 -	280 -	1 U	5 U	0.2 U	10 -	1.9 J	1 U	0.544 U	0.248 U	0.792 U
	5/12/2021	-	160 J+	190000 -	24000 -	300 J+	7.2 J	1900 -	1000000 -	2 U	95 -	490 -	1 U	1 U	2 -	4.3 -	300 J+	0.65 J	5 U	0.2 U	7.1 -	1.8 J	1 U	0.208 U	0.73 U	0.938 -
	11/22/2021	-	160 J+	190000 -	23000 J-	570 J	7 J	1000 U	990000 -	2 U	80 -	410 -	1 U	1 U	2 U	4.4 -	570 J	0.21 J	5 U	0.2 U	6.5 -	1.7 J	1 U	0.692 U	3.26 UJ	3.95 UJ
	5/9/2022	-	190 J+	190000 -	26000 -	530 -	7.1 J	3900 -	950000 -	2 U	85 -	460 -	1 U	1 U	3.3 -	6.9 -	530 -	1.6 -	5 U	0.2 U	14 -	1.8 J	1 U	0.583 U	0.112 U	0.695 U
	11/29/2022	-	150 -	180000 -	27000 -	210 -	7.4 J	1300 -	1000000 -	2.1 -	73 -	400 -	1 U	1 U	2.8 J	4 -	210 -	1.3 -	2.2 J	0.2 U	6.6 -	1.9 J	1 U	1.26 -	3.6 -	4.87 -
	5/23/2023	-	160 -	180000 -	27000 -	250 J+	7.1 J	3200 -	990000 -	0.86 J	80 -	420 -	1 U	1 U	2.1 J	4.7 -	250 J+	0.55 J	2.1 J	0.2 U	8.6 -	1.9 J	1 U	0.777 -	2.2 U	2.98 U
	11/2/2023	-	210 -	250000 -	29000 -	230 -	7.2 J	6300 -	960000 J	5 -	89 -	480 -	0.56 -	0.38 J	14 -	9.2 -	230 -	10 -	4.3 J	0.5 U	25 -	3 J	2 U	0.363 -	2.28 U	2.64 U
	5/7/2024	-	280 -	150000 -	27000 -	350 -	7.1 J	32000 -	730000 J	2 U	51 -	380 -	1 U	1 U	3.1 J	6.1 -	350 -	0.97 J	2.8 J	0.2 U	9.3 -	1.6 J	1 U	0.4 -	0.495 U	0.896 J
CCR-AP-4	6/10/2016	-	160 -	160000 -	25000 -	290 J+	6.95 J	20000 J-	1000000 -	2 U	36 -	520 -	0.49 J	0.18 J	12 -	7.8 -	290 J+	9.9 -	10 J	0.2 U	2.2 J	1.8 J	0.084 J	1.07 J	0.417 U	1.49 -
	8/12/2016	-	160 J+	190000 -	24000 -	430 -	7.3 J	1200 R	1000000 -	2 U	65 -	750 -	0.33 J	0.18 J	8.1 -	7.1 -	430 -	6.3 -	9.6 J	0.2 U	2.5 J	1.6 J	0.061 J	1.53 -	1.37 U	2.9 -
	10/28/2016	-	180 -	170000 J-	85000 J+	300 -	6.7 J	15000 J+	890000 -	2 U	50 -	630 -	0.25 J	1 U	3.7 -	4.5 J	300 -	5.7 J	14 J	0.4 U	1.1 J	1.1 J	0.11 J	1.54 -	0.864 -	2.4 -
	12/7/2016	-	160 J+	160000 -	70000 -	490 -	7 J	3900 J+	880000 -	0.4 J	45 -	610 -	0.46 J	0.23 J	14 -	8.6 -	490 -	11 -	9.8 J	0.2 U	2 J	0.98 J	0.15 J	2.11 -	2.17 -	4.28 -
	2/8/2017	-	140 U	180000 J-	49000 -	320 J+	6.9 J	1000 U	900000 -	2 U	86 -	640 -	0.14 J	1 U	2.6 -	3.9 -	320 J+	1.8 -	50 U	0.2 U	0.93 J	5 U	0.063 J	0.984 -	1.03 -	2.01 -
	4/6/2017	-	170 -	180000 J+	48000 -	360 -	6.7 J	1000 U	960000 -	2 U	86 -	630 -	0.15 J	1 U	2.8 -	4.5 -	360 -	1.8 J+	50 U	0.2 U	0.92 J	5 UJ	1 U	0.789 -	0.37 U	1.16 J
	6/8/2017	-	180 U	190000 -	46000 -	460 -	6.7 J	640 J	1000000 -	2 U	86 -	660 -	0.26 J	0.14 J	6.6 -	6.8 -	460 -	4.5 -	50 U	0.2 U	1.4 J	5 U	0.061 J	1.6 -	2 -	3.6 -
	9/29/2017	-	85 -	170000 -	41000 -	350 -	6.8 J	630 J	980000 -	0.66 J	81 -	580 -	0.17 J	0.16 J	7.6 -	5.5 -	350 -	4.8 -	50 U	0.2 U	1.6 J	5 U	1 U	1.26 -	2.01 R	3.26 R
	11/17/2017	-	140 U	180000 -	40000 -	350 -	7.1 J	1100 J-	910000 -	2 U	83 -	570 -	0.28 J	1 U	10 -	6.4 -	350 -	4.6 -	50 U	0.2 U	2.2 J	5 U	0.12 J	1.15 -	1.22 R	2.36 R
	6/11/2018	-	- -	- -	- -	410 -	- -	- -	- -	2 U	27 -	450 -	1 U	1 U	2.1 R	2 -	410 -	0.52 J	2.9 J	0.2 U	1.2 J	0.9 J	1 U	0.83 -	0.458 U	1.29 J
	8/28/2018	-	100 -	190000 -	16000 -	290 -	6.8 J	2600 -	950000 -	2 U	110 -	780 -	0.84 J	0.48 J	28 -	13 -	290 -	21 -	19 -	- -	3.3 J	1.6 J	0.26 J	2.47 -	1.06 U	3.53 J
	11/15/2018	-	- -	- -	28000 -	340 -	- -	8900 -	880000 -	2 U	88 -	580 -	0.18 J	1 U	6.2 -	3 -	340 -	2.9 -	6.2 -	0.2 U	0.76 J	1.1 J	1 U	- -	- -	- -
	5/28/2019	-	130 J	180000 -	30000 -	370 J+	6.8 J	2800 -	940000 -	2 U	110 -	660 -	1 U	1 U	3.4 U	3.1 -	370 J+	4.3 -	4.1 J	0.2 U	1.1 J	5 U	1 U	0.846 -	1.54 -	2.38 -
	10/22/2019	-	400 U	180000 -	26000 -	100 U	6.8 J	4800 -	910000 -	10 U	320 -	1300 -	1.1 J	5 U	26 -	12 -	100 U	20 -	47 -	0.2 U	3.7 J	31 J+	5 U	0.606 J	1.18 -	1.78 -
	2/12/2020	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	110 -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
	5/20/2020	-	100 -	130000 -	16000 -	640 -	6.8 J	6000 -	660000 -	2 U	150 -	570 -	1 U	1 U	2 U	1.4 -	640 -	1.5 J+	4.6 J	0.2 U	5 U	1.8 J	1 U	1.03 -	0.395 U	1.43 J
	11/13/2020	-	100 U	170000 -	28000 -	260 -	7.1 J	1200 J+	840000 -	1.1 J	130 -	630 -	0.61 J	0.37 J	15 -	10 -	260 -	14 -	11 -	0.2 U	2.8 J	5 U	1 U	0.628 U	0.778 U	1.41 -
	5/12/2021	-	96 U	170000 -	17000 -	400 J+	7 J	16000 -	810000 -	2 U	70 -	470 -	1 U	1 U	1.5 J	0.71 -	400 J+	4.6 -	5 U	0.2 U	5 U	5 U	1 U	0.293 U	0.778 -	1.07 J
	11/22/2021	-	180 J+	200000 -	20000 J-	520 J+	6.7 J	11000 -	820000 -	2 -	330 -	1400 -	1.7 -	0.71 J	58 -	21 -	520 J+	47 -	19 -	0.2 U	9.6 -	1.8 J	0.4 J	3.01 UJ	27 J-	30 J-
	5/9/2022	-	120 U	150000 -	20000 -	310 -	6.6 J	2300 -	810000 -	2 U	120 -	570 -	1 U	1 U	3.4 -	2.4 -	310 -	3.8 -	2.8 J	0.2 U	0.71 J	5 U	1 U	1.05 U	1.55 -	2.61 J+
	11/29/2022	-	92 -	170000 -	20000 -	390 -	7 J	19000 -	830000 -	28 -	160 -	890 -	1.3 -	0.79 J	40 -	20 -	390 -	41 -	25 -	0.2 U	10 -	2 J	0.47 J	0.636 -	2.18 -	2.82 -
	5/23/2023	-	1400 -	160000 -	43000 -	430 -	6.8 J	39000 -	870000 -	0.74 J	88 -	530 -	1 U	1 U	3.3 J	1.7 -	430 -	1.9 -	5.6 J	0.2 U	5 U	5 U	1 U	1.09 -	1.53 U	2.62 J
	11/2/2023	-	1600 -	160000 -	55000 -	480 -	6.7 J	24000 -	890000 J	3.1 J	190 -	920 -	0.47 J	0.3 J	12 -	4.9 -	480 -	11 -	6.7 -	0.5 U	4.6 J	3.6 J	2 U	1.44 -	3.82 U	5.26 U
	5/8/2024	-	1100 -	130000 -	32000 -	610 -	7 J	73000 -	690000 J	2 U	27 -	530 -	1 U	1 U	5 U	2.8 -	610 -	1 U	4.5 J	0.2 U	17 -	5 U	1 U	0.337 -	0.869 U	1.21 J
	11/14/2024	-	580 -	140000 -	26000 -	890 -	6.9 J	12000 -	740000 -	0.96 J	89 -	520 -	0.99 J	0.45 J	27 -	14 -	890 -	19 -	20 -	0.2 U	7.3 -	1.8 J	1 U	0.852 U	0.598 U	1.45 UJ
	12/19/2024	-	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.221 U	-0.777 U	0.221 U

TABLE 1
GROUNDWATER MONITORING RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well	Sample Date	Sample Type	Appendix III Constituents							Appendix IV Constituents																
			Boron Total ug/L	Calcium Total ug/L	Chloride ug/L	Fluoride ug/L	pH (lab) SU	Sulfate ug/L	Total Dissolved Solids (TDS) ug/L	Antimony Total ug/L	Arsenic Total ug/L	Barium Total ug/L	Beryllium Total ug/L	Cadmium Total ug/L	Chromium Total ug/L	Cobalt Total ug/L	Fluoride ug/L	Lead Total ug/L	Lithium Total ug/L	Mercury Total ug/L	Molybdenum Total ug/L	Selenium Total ug/L	Thallium Total ug/L	Radium-226 pCi/L	Radium-228 pCi/L	Radium-226 & 228 pCi/L
CCR-AP-5	6/10/2016	-	53000 -	520000 -	880000 -	580 -	7.09 J	2500 UJ	4600000 -	20 U	10 U	32 J	10 U	10 U	20 U	6.9 -	580 -	10 U	140 -	0.2 U	380 -	50 U	10 U	0.224 J	0.55 -	0.774 -
	6/10/2016	Duplicate	58000 -	620000 -	850000 -	500 -	7.11 J	2500 UJ	4500000 -	20 U	10 U	39 J	10 U	10 U	20 U	8.1 -	500 -	10 U	140 -	0.2 U	450 -	50 U	10 U	0.176 J	0.634 -	0.81 -
	8/12/2016	-	54000 -	480000 -	750000 -	990 -	7.4 J	1500000 -	4400000 -	2 U	0.59 J	30 -	1 U	0.16 J	2 U	6.3 -	990 -	1 U	130 -	0.2 U	370 -	5 U	1 U	0.106 U	0.523 -	0.629 -
	8/12/2016	Duplicate	56000 -	460000 -	720000 -	920 -	7.5 J	1500000 -	4500000 -	2 U	0.78 J	30 -	1 U	0.19 J	2 U	6.1 -	920 -	1 U	130 -	0.2 U	370 -	5 U	1 U	0.23 -	0.748 J	0.978 J
	10/28/2016	-	68000 -	550000 J-	860000 J+	1100 -	7 J	1600000 J+	4000000 -	2 U	0.65 J	34 -	1 U	0.15 J	2 U	6.5 J	1100 -	1 UJ	150 -	0.2 U	410 -	5 U	1 U	0.449 U	0.462 U	0.911 -
	10/28/2016	Duplicate	64000 -	550000 J-	860000 J+	1100 -	7 J	1700000 J+	4000000 -	2 U	0.8 J	34 -	1 U	0.16 J	2 U	6.6 J	1100 -	1 UJ	150 -	0.2 U	420 -	0.7 J	1 U	0.398 U	0.557 -	0.955 J
	12/7/2016	-	64000 -	570000 -	860000 -	1300 -	7 J	1700000 -	4200000 -	0.058 J	0.73 J	36 -	0.96 J	1 U	2 U	6.1 -	1300 -	1 U	130 -	0.2 U	390 -	5 U	1 U	0.0176 U	0.714 -	0.732 J
	12/7/2016	Duplicate	62000 -	550000 -	880000 -	1300 -	7 J	1800000 -	4200000 -	2 U	0.73 J	36 -	0.77 J	0.16 J	2 U	5.8 -	1300 -	1 U	130 -	0.2 U	380 -	5 U	1 U	0.683 -	0.618 U	1.3 J
	2/8/2017	-	59000 -	580000 J-	780000 -	980 -	7.2 J	1500000 -	4000000 -	2 U	1.5 -	46 -	0.19 J	1.2 -	2 U	7 -	980 -	1 U	150 -	0.2 U	390 -	5 U	0.065 J	0.0782 U	0.562 U	0.64 U
	2/8/2017	Duplicate	61000 -	580000 J-	850000 -	1200 -	7.3 J	1700000 -	4200000 -	2 U	1.8 -	48 -	0.14 J	1 -	2 U	6.6 -	1200 -	1 U	150 -	0.2 U	390 -	5 U	0.056 J	-0.0195 U	0.452 U	0.452 U
	4/7/2017	-	56000 -	550000 J+	880000 -	960 -	7 J	1900000 -	4200000 -	2 U	0.39 J	34 -	0.58 J	0.4 J	2 U	6.3 -	960 -	1 U	150 -	0.2 U	330 -	5 UJ	1 U	0.186 -	0.209 U	0.396 J
	4/7/2017	Duplicate	56000 -	550000 J+	810000 -	1000 -	7 J	1700000 -	4200000 -	0.82 J	0.47 J	35 -	0.68 J	0.42 J	2 U	6.4 -	1000 -	1 U	140 -	0.2 U	330 -	5 UJ	1 U	0.123 -	0.0557 U	0.179 UJ
	6/8/2017	-	58000 -	510000 -	560000 -	1100 -	7.1 J	1400000 -	4200000 -	2 U	0.42 J	36 -	0.17 J	0.37 J	2 U	5.3 -	1100 -	1 U	110 -	0.2 U	300 -	5 U	1 U	0.193 -	1.01 -	1.21 -
	6/8/2017	Duplicate	62000 -	510000 -	570000 -	1100 -	7.4 J	1400000 -	4100000 -	2 U	0.38 J	35 -	0.17 J	0.44 J	2 U	5.4 -	1100 -	1 U	110 -	0.2 U	300 -	5 U	0.056 J	0.143 -	0.578 -	0.721 -
	9/28/2017	-	33000 -	470000 -	640000 -	760 J	7 J	1400000 -	3300000 -	2 U	0.84 J	41 -	0.47 J	0.75 J	2 U	4.1 -	760 J	1 U	99 -	0.2 U	210 -	5 U	0.16 J	0.184 -	0.663 R	0.846 R
	9/28/2017	Duplicate	34000 -	500000 -	660000 -	490 J	7 J	1500000 -	3200000 -	2 U	0.9 J	41 -	0.46 J	0.81 J	2 U	4.7 -	490 J	1 U	99 -	0.2 U	220 -	5 U	0.17 J	0.15 -	-0.0776 UJ	0.15 UJ
	11/17/2017	-	52000 -	510000 -	770000 -	1000 -	7 J	1600000 J-	3500000 -	2 U	0.39 J	38 -	1 U	0.35 J	2 U	4.6 -	1000 -	1 U	120 -	0.2 U	240 -	5 U	0.18 J	0.25 -	0.234 U	0.483 J+
	11/17/2017	Duplicate	51000 -	520000 -	790000 -	900 -	6.9 J	1600000 J-	3700000 -	2 U	0.5 J	40 -	1 U	0.36 J	2 U	4.9 -	900 -	1 U	120 -	0.2 U	250 -	5 U	0.23 J	0.294 -	0.76 R	1.05 R
	6/11/2018	-	- -	- -	- -	1400 -	- -	- -	- -	2 U	1.1 R	68 -	1 U	0.57 J	1.4 U	2.8 -	1400 -	0.099 J	110 -	0.2 U	390 -	5 U	1 U	0.261 -	0.213 U	0.474 J
	6/11/2018	Duplicate	- -	- -	- -	1500 -	- -	- -	- -	2 U	1.2 R	73 -	1 U	0.6 J	2.1 R	3.3 -	1500 -	0.096 J	96 -	0.2 U	420 -	5 U	0.076 J	0.231 -	0.605 -	0.836 -
	8/28/2018	-	41000 -	320000 -	340000 -	1300 -	7.2 J	1200000 -	2700000 -	2 U	1 U	33 -	1 U	0.24 J	2 U	2.8 -	1300 -	1 U	94 -	- -	370 -	5 U	1 U	0.415 R	0.252 U	0.667 R
	8/28/2018	Duplicate	42000 -	340000 -	350000 -	1300 -	7.2 J	1200000 -	2700000 -	2 U	0.82 J	34 -	1 U	0.27 J	3.3 U	3.6 -	1300 -	1 U	98 -	- -	380 -	5 U	1 U	0.3 R	0.13 U	0.43 R
	11/15/2018	-	- -	- -	3000 -	1400 -	- -	150000 -	310000 -	2 U	2.7 -	50 -	0.081 J	0.23 J	4.1 -	0.52 -	1400 -	1.6 -	8.5 -	0.2 U	9.4 -	1.7 J	0.066 J	- -	- -	- -
	12/17/2018	-	- -	- -	170000 -	1100 -	- -	700000 -	1600000 -	2 U	1.4 -	80 -	1 U	0.77 J	0.67 J	0.71 -	1100 -	0.21 J	67 -	0.2 U	250 -	1 J	0.073 J	- -	- -	- -
	5/28/2019	-	35000 J-	260000 -	160000 -	1200 J+	7.3 J	860000 -	2100000 -	2 U	1.1 -	40 -	1 U	0.51 J	2.7 U	3.1 -	1200 J+	1.1 -	87 -	0.2 U	380 -	5 U	1 U	0.107 -	0.257 U	0.364 UJ
	5/28/2019	Duplicate	34000 J-	270000 -	170000 -	1300 J+	7.3 J	930000 -	2000000 -	2 U	1.3 -	42 -	1 U	0.53 J	2.8 U	3.1 -	1300 J+	1.7 -	86 -	0.2 U	380 -	5 U	1 U	0.146 -	0.435 U	0.581 UJ
	10/23/2019	-	16000 J	220000 -	59000 -	1300 -	7.5 J	670000 -	1500000 -	2 U	0.66 J	42 -	1 U	0.16 J	2 U	2.3 -	1300 -	1 U	95 -	0.2 U	530 -	7 J+	1 U	0.103 J	0.497 -	0.599 -
	10/23/2019	Duplicate	8800 J	220000 -	61000 -	1300 -	7.5 J	680000 -	1500000 -	2 U	0.79 J	43 -	1 U	1 U	2 U	2.2 -	1300 -	1 U	91 -	0.2 U	520 -	7.5 J+	1 U	0.0299 UJ	0.588 -	0.617 J
	5/19/2020	-	14000 -	170000 -	73000 -	1400 -	7.5 J	440000 -	1100000 -	2 U	0.73 J	59 -	1 U	1 U	2 U	0.36 J	1400 -	1 U	50 -	0.2 U	210 -	1.8 J	1 U	0.113 U	0.254 U	0.367 U
	5/19/2020	Duplicate	13000 -	170000 -	76000 -	1500 -	7.5 J	430000 -	1100000 -	2 U	0.71 J	58 -	1 U	0.27 J	2 U	0.34 J	1500 -	1 U	49 -	0.2 U	210 -	2 J	1 U	0.194 -	0.041 U	0.235 UJ
	11/13/2020	-	16000 -	210000 -	98000 -	1200 -	7.4 J	560000 J+	1400000 -	0.44 J	1.2 -	73 -	1 U	0.57 J	1.6 J	1.4 -	1200 -	1 U	67 -	0.2 U	340 -	5 U	1 U	0.0749 U	0.217 U	0.292 U
	11/13/2020	Duplicate	16000 -	210000 -	95000 -	1200 -	7.5 J	620000 J+	1300000 -	2 U	1.2 -	74 -	1 U	0.53 J	1.6 J	1.4 -	1200 -	1 U	66 -	0.2 U	330 -	5 U	1 U	0.125 U	0.494 U	0.619 -
	5/12/2021	-	6900 -	230000 -	75000 -	1500 -	7.3 J	500000 -	1100000 -	2 U	2.3 -	69 -	1 U	0.31 J	2 U	0.52 -	1500 -	0.19 J	28 -	0.2 U	140 -	2.1 J	0.18 J	0.346 -	0.106 U	0.453 J
	5/12/2021	Duplicate	6700 -	240000 -	72000 -	1600 -	7.4 J	490000 -	1000000 J	0.44 J	2.4 -	68 -	1 U	0.29 J	2 U	0.51 -	1600 -	0.24 J	30 -	0.2 U	130 -	2.4 J	0.29 J	0.405 U	0.0701 U	0.475 U
	11/22/2021	-	9100 -	200000 -	91000 J-	1500 J-	7.2 J	430000 -	1000000 -	0.63 J	3.9 -	92 -	1 U	1 U	2 U	1.4 -	1500 J-	0.18 J	35 -	0.2 U	150 -	5 U	0.15 J	0.571 U	2.24 UJ	2.81 UJ
	5/10/2022	-	1500 -	130000 -	25000 -	2300 -	7.5 J	270000 -	580000 -	2 U	8 -	29 -	1 U	1 U	2 U	0.44 J	2300 -	0.28 J	9 -	0.2 U	46 -	2.9 J	1 U	0.864 U	0.462 U	1.33 UJ
	5/10/2022	Duplicate	1500 -	140000 -	27000 -	2300 -	7.5 J	270000 -	590000 -	2 U	8.5 -	33 -	1 U	1 U	1.5 J	0.45 J	2300 -	0.39 J	9.8 -	0.2 U	48 -	3.1 J	1 U	0.464 U	0.0919 U	0.556 UJ
	11/29/2022	-	11000 -	260000 -	140000 -	2000 -	7.6 J	630000 -	1500000 -	4.7 -	24 -	150 -	1 U	0.8 J	27 -	4.1 -	2000 -	8.2 -	69 -	0.9 -	240 -	7.3 -	0.27 J	2.08 -	0.0411 U	2.12 UJ
	11/29/2022	Duplicate	10000 -	250000 -	130000 -	1900 -	7.6 J	600000 -	1500000 -	4.6 -	25 -	150 -	1 U	0.79 J	29 -	4 -	1900 -	8.5 -	69 -	1 -	230 -	7.2 -	0.23 J	4.19 -	1.55 U	5.74 J
	5/25/2023	-	16000 -	290000 -	220000 -	910 -	7.6 J	650000 -	1800000 -	1.1 J	9.1 -	120 -	1 U	0.38 J	9.1 -	3.2 -	910 -	3 -	72 -	0.32 -	210 -	3.4 J	1 U	1.38 -	2.33 U	3.71 U
	5/25/2023	Duplicate	16000 -	290000 -	220000 -	920 -	7.5 J	650000 -	1800000 -	1.3 J	9.5 -	130 -	1 U	0.46 J	10 -	3.5 -	920 -	3.4 -	72 -	0.34 -	210 -	3.4 J	1 U	1.11 -	-0.197 U	1.11 UJ
	6/13/2023	-	17000 -	290000 -	220000 -	1300 -	- -	650000 -	- -	2 U	6.1 -	99 -	1 U	1 U	1.7 J	2.3 -	1300 -	0.5 J	86 -	0.2 U	300 -	5 U	1 U	- -	- -	- -
	11/2/2023	-	6600 -	310000 -	86000 -	2300 -	7.5 J	580000 -	1200000 -	2.4 J	24 -	200 -	1.6 -	1.4 -	56 -	10 -	2300 -	20 -	59 -	1.6 -	140 -	20 -	0.96 J	2.95 -	2.59 U	5.54 J+
	11/2/2023	Duplicate	7500 -	270000 -	100000 -	2200 -	7.6 J	590000 -	1300000 -	2.4 J	22 -	210 -	1.6 -	1.5 -	57 -	9.9 -	2200 -	19 -	66 -	1.5 -	170 -	22 -	1 J	2.41 -	0.637 U	3.05 J
	5/13/2024	-	17000 -	260000 -	150000 -	840 -	7.1 J	620000 -	1600000 J	2 U	0.85 J	46 -	1 U	1 U	2 J	2.5 -	840 -	0.68 J	56 -	0.2 U	150 -	0.95 J	1 U	0.424 -	0.452 U	0.877 J
	5/13/2024	Duplicate	17000 -	260000 -	160000 -	830 -	7.1 J	640000 -	1700000 -	2 U	5 U	45 -	1 U	1 U	5 U	2.2 -	830 -	1 U	58 -	0.2 U	150 -	5 U	1 U	0.182 U	0.983 -	1.17 J
	11/14/2024	-	11000 -	200000 -	51000 -	1700 -	7.7 J	450000 -	1200000 -	2 U	1.3 J	53 -	1 U	0.1 J	5 U	2.3 -	1700 -	1 U	80 -	0.2 U	340 -	5 U	1 U	0.158 U	-0.153 U	0.158 UJ
	11/14/2024	Duplicate	12000 -	200000 -	54000 -	1800 -	7.6 J	450000 -	1200000 -	2 U	1.5 J	51 -	1 U	0.088 J	5 U	2.3 -	1800 -	1 U	83 -	0.2 U	340 -	5 U	1 U	0.212 U	0.46 U	0.673 UJ

TABLE 1
GROUNDWATER MONITORING RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well	Sample Date	Sample Type	Appendix III Constituents							Appendix IV Constituents															
			Boron Total ug/L	Calcium Total ug/L	Chloride ug/L	Fluoride ug/L	pH (lab) SU	Sulfate ug/L	Total Dissolved Solids (TDS) ug/L	Antimony Total ug/L	Arsenic Total ug/L	Barium Total ug/L	Beryllium Total ug/L	Cadmium Total ug/L	Chromium Total ug/L	Cobalt Total ug/L	Fluoride ug/L	Lead Total ug/L	Lithium Total ug/L	Mercury Total ug/L	Molybdenum Total ug/L	Selenium Total ug/L	Thallium Total ug/L	Radium-226 pCi/L	Radium-228 pCi/L	Radium-226 & 228 pCi/L
CCR-AP-5I	2/13/2019	-	3700 -	120000 -	82000 -	340 -	7.3 HF	390000 -	960000 -	0.75 J	0.7 J	37 -	1 U	1 U	2 U	0.64 -	340 -	1 U	30 -	- -	5.4 -	5 U	1 U	0.274 -	0.189 U	0.463 -
	6/12/2019	-	14000 -	250000 -	240000 -	310 -	7 J	700000 -	1700000 -	2 U	0.72 J	85 -	1 U	1 U	2 U	0.48 J	310 -	0.23 J	35 -	0.2 U	1.7 J	5 U	1 U	0.85 -	0.4 U	1.25 J
	10/23/2019	-	2500 -	120000 -	80000 -	250 U	7.4 J	390000 -	980000 -	0.39 J	0.62 J	35 -	1 U	1 U	2 U	0.47 J	250 U	1 U	35 J+	0.2 U	7.2 -	9 J+	1 U	0.0924 UJ	-0.0597 U	0.092 U
	5/19/2020	-	13000 -	230000 -	250000 -	350 -	7.1 J	670000 -	1900000 -	2 U	0.97 J	90 -	0.2 J	1 U	3.8 -	2.2 -	350 -	2.6 J+	43 -	0.2 U	1.7 J	2.8 J	1 U	0.944 -	0.256 U	1.2 J
	11/13/2020	-	12000 -	240000 -	240000 -	340 -	7.1 J	690000 J+	1700000 -	2 U	0.7 J	80 -	1 U	1 U	1.8 J	0.99 -	340 -	1.1 U	41 -	0.2 U	1.2 J	5 U	1 U	0.572 -	0.295 U	0.866 J
	5/12/2021	-	13000 -	260000 -	250000 -	400 J+	7.1 J	650000 -	1500000 J	0.47 J	2.4 -	88 -	0.31 J	1 U	6.2 -	3.7 -	400 J+	3.8 -	42 -	0.2 U	1.6 J	5 U	1 U	1.04 -	0.853 U	1.9 J
	11/22/2021	-	5400 -	77000 -	120000 J-	710 J	7.4 J	380000 -	1200000 -	2 U	2.4 -	88 -	1 U	1 U	2 U	0.77 -	710 J	1.7 -	27 -	0.2 U	2 J	5 U	1 U	0.932 J	1.91 UJ	2.84 UJ
	5/6/2022	-	12000 -	210000 -	210000 -	1100 -	7.3 J	460000 -	1300000 -	1.7 J	5.2 -	64 -	1 U	0.7 J	5.3 -	3.4 -	1100 -	2.4 -	23 -	0.2 -	8.4 -	1.4 J	1 U	0.813 -	0.544 U	1.36 J
	11/29/2022	-	11000 -	230000 -	280000 -	580 -	7.4 J	660000 -	1700000 -	2 U	5 U	51 -	1 U	1 U	5 U	0.5 J	580 -	1 U	35 -	0.2 U	2.4 J	5 U	1 U	0.316 -	1.14 -	1.45 -
	5/25/2023	-	22000 -	390000 -	440000 -	280 J+	7.5 J	790000 -	2300000 -	2 U	1.6 J	38 -	1 U	0.3 J	5 U	2.8 -	280 J+	0.5 J	29 -	0.2 U	5.2 -	5 U	1 U	0.391 -	-0.0568 U	0.391 UJ
	11/2/2023	-	19000 -	360000 -	430000 -	260 -	7.2 J	730000 -	2100000 -	5 U	4.1 J	59 -	0.32 J	0.62 -	8.4 J	4.6 -	260 -	3.1 -	39 -	0.5 U	6 -	5 U	2 U	0.422 -	0.645 U	1.07 UJ
	5/13/2024	-	12000 -	270000 -	280000 -	320 -	6.9 J	640000 -	1800000 J	2 U	5 U	27 -	1 U	1 U	5 U	0.51 J	320 -	1 U	35 -	0.2 U	2.6 J	5 U	1 U	0.249 -	1.08 -	1.33 -
	12/19/2024	-	13000 -	240000 -	240000 -	420 -	7 J	710000 -	1700000 -	2 U	0.86 J	38 -	1 U	0.97 J	5.2 -	2.5 -	420 -	2.5 -	39 -	0.2 U	3.4 J	5 U	1 U	0.308 -	0.603 U	0.911 UJ
CCR-AP-6	6/10/2016	-	1100 -	180000 -	40000 -	430 -	7.35 J	570 J-	1100000 -	2 U	40 -	510 -	1 U	1 U	3.1 -	4.2 -	430 -	2.1 -	50 U	0.2 U	20 -	1 J	1 U	0.652 J	0.543 -	1.2 -
	8/12/2016	-	830 -	190000 -	39000 -	670 -	7.8 J	2000 R	1100000 -	2 U	59 -	580 -	0.26 J	0.16 J	9.2 -	9.5 -	670 -	7.1 -	50 U	0.2 U	18 -	1.4 J	0.047 J	1.32 -	0.811 U	2.13 -
	10/28/2016	-	740 -	190000 J-	38000 J+	420 -	7.2 J	980 J+	1000000 -	2 U	60 -	550 -	0.11 J	1 U	5 -	7.5 J	420 -	3.5 J	50 U	0.2 U	21 -	1.5 J	1 U	1.38 -	0.663 U	2.05 J
	12/7/2016	-	790 J+	190000 -	36000 -	620 -	7.3 J	1000 U	1000000 -	0.48 J	67 -	620 -	0.36 J	0.29 J	15 -	10 -	620 -	10 -	50 U	0.2 U	24 -	1.4 J	0.1 J	-0.236 U	1.58 U	1.58 U
	2/8/2017	-	890 J+	200000 J-	42000 -	500 -	7.4 J	670 J	1000000 -	0.47 J	110 -	610 -	0.25 J	0.27 J	11 -	9 -	500 -	7.9 -	50 U	0.2 U	30 -	5 U	0.063 J	0.929 -	0.755 U	1.68 J
	4/6/2017	-	2200 -	210000 J+	46000 -	450 -	7.2 J	500 J	1100000 -	2 U	110 -	640 -	0.24 J	0.19 J	9.8 -	6.9 -	450 -	7.4 J+	50 U	0.2 U	24 -	1.8 J-	1 U	0.73 -	0.455 U	1.19 J
	6/7/2017	-	1300 J+	200000 -	40000 -	630 -	7.3 J	1100 -	1200000 -	0.59 J	96 -	600 -	0.42 J	0.24 J	14 -	11 -	630 -	9.6 -	11 J	0.2 U	26 -	1.4 J	0.09 J	2.33 -	3.61 -	5.93 -
	9/29/2017	-	440 -	180000 -	38000 -	550 -	7.3 J	710 J	1100000 -	1.4 J	89 -	550 -	0.39 J	0.52 J	20 -	12 -	550 -	14 -	50 U	0.2 U	33 -	2.3 J	0.13 J	0.815 -	0.991 R	1.81 R
	11/17/2017	-	2100 J+	180000 -	42000 -	240 -	7.6 J	740 J-	1000000 -	10 U	81 -	490 -	5 U	0.39 J	14 -	8.7 -	240 -	11 -	250 U	0.2 U	27 -	25 U	5 U	0.695 -	1.26 R	1.95 R
	6/11/2018	-	- -	- -	- -	600 -	- -	- -	- -	1.2 J	120 -	690 -	0.65 J	0.51 J	29 -	14 -	600 -	20 -	16 -	0.2 U	33 -	2.3 J	0.22 J	1.15 -	1.12 -	2.27 -
	8/28/2018	-	510 -	190000 -	19000 -	420 -	7.4 J	1100 -	1000000 -	2 U	100 -	640 -	0.46 J	0.5 J	31 -	13 -	420 -	20 -	14 -	- -	31 -	1.9 J	0.2 J	1.71 J	0.929 U	2.64 J
	11/17/2018	-	- -	- -	43000 -	440 -	- -	1600 -	1000000 -	2 U	110 -	580 -	0.083 J	1 U	4.8 -	4.4 -	440 -	2.2 -	3.5 J	0.2 U	27 -	1.6 J	1 U	- -	- -	- -
	5/28/2019	-	850 J-	190000 -	39000 -	670 J+	7.4 J	7500 -	1000000 -	0.83 J	110 -	690 -	0.69 J	0.6 J	28 -	18 -	670 J+	24 -	14 -	0.2 U	28 -	5 U	0.18 J	6.34 J-	3.9 UJ	10.2 J-
	10/22/2019	-	280 -	200000 -	37000 -	460 -	7.4 J	3900 -	1000000 -	2 U	92 -	600 -	1 U	0.18 J	7.5 -	6 -	460 -	4.9 -	9.8 J+	0.2 U	23 -	5.3 J+	1 U	0.567 J	0.675 -	1.24 -
	5/20/2020	-	670 -	200000 -	40000 -	440 -	7.5 J	7900 -	950000 -	0.49 J	110 -	630 -	0.19 J	1 U	7.5 -	5.2 -	440 -	4.6 -	4.2 J	0.2 U	24 -	2.1 J	1 U	0.345 -	0.988 -	1.33 -
	11/13/2020	-	540 J+	200000 -	39000 -	370 -	7.6 J	3200 J+	1000000 -	1 J	100 -	570 -	0.23 J	1 U	9.8 -	7.3 -	370 -	6.5 -	5.2 -	0.2 U	20 -	1.5 J	1 U	0.351 U	-0.27 U	0.351 U
	5/12/2021	-	650 -	210000 -	40000 -	360 J+	7.4 J	5600 -	1000000 -	0.42 J	110 -	540 -	1 U	1 U	6.9 -	5.8 -	360 J+	4.4 -	5 U	0.2 U	24 -	5 U	1 U	0.679 -	0.922 -	1.6 -
	11/22/2021	-	520 J+	200000 -	34000 J-	640 J	7.3 J	1000 U	960000 -	2 U	100 -	530 -	1 U	1 U	2 U	3.9 -	640 J	0.39 J	5 U	0.2 U	18 -	1.9 J	1 U	0.718 J	2.49 UJ	3.21 UJ
	5/9/2022	-	690 J+	190000 -	42000 -	690 -	7.2 J	13000 -	970000 -	2 U	100 -	510 -	1 U	1 U	1.9 J	3.4 -	690 -	0.78 J	1.4 J	0.2 U	23 -	1.1 J	1 U	0.91 -	0.646 U	1.56 J
	11/29/2022	-	640 -	430000 -	42000 -	480 -	7.6 J	15000 -	1000000 -	18 -	120 -	690 -	0.96 J	1.1 -	43 -	19 -	480 -	41 -	18 -	0.17 J	37 -	3 J	1 U	0.699 -	2 -	2.7 -
	5/23/2023	-	590 -	210000 -	42000 -	270 J+	7.6 J	10000 -	1000000 -	1.7 J	110 -	510 -	1 U	1 U	6.7 -	5.5 -	270 J+	6.6 -	8 U	0.41 -	22 -	1.4 J	1 U	0.605 -	0.758 U	1.36 J
	11/2/2023	-	620 -	180000 -	50000 -	510 -	7.3 J	4300 -	980000 -	0.66 J	96 -	480 -	0.5 U	0.094 J	4.7 J	4.7 -	510 -	2.7 J	2 J	0.5 U	15 -	1.2 J	2 U	0.863 -	1.86 U	2.72 U
	5/7/2024	-	660 -	110000 -	36000 -	370 -	7.2 J	46000 -	530000 -	0.82 J	57 -	430 -	1 U	1 U	2.7 J	3.4 -	370 -	1.2 -	5.7 J	0.2 U	43 -	5 U	1 U	0.541 -	0.169 U	0.71 UJ
CCR-AP-6I	11/17/2018	-	- -	- -	120000 -	130 -	- -	790000 -	1500000 -	2 U	3.7 -	110 -	1 U	0.15 J	2 -	1.7 -	130 -	0.84 J	43 -	0.2 U	630 -	5 U	1 U	- -	- -	- -
	2/12/2019	-	16000 -	510000 -	170000 -	160 J	7.5 HF	1300000 -	2300000 -	2 U	4.8 -	52 -	1 U	0.19 J	2 U	1.9 -	160 J	0.3 J	55 -	- -	750 -	5 U	1 U	0.203 -	0.46 -	0.664 -
	6/12/2019	-	12000 -	340000 -	350000 -	190 J+	6.9 J	860000 -	2300000 -	2 U	2.8 -	280 -	0.19 J	1 U	2.6 U	0.62 J+	190 J+	1 U	330 -	0.2 U	340 -	5 U	1 U	1.31 -	1.76 -	3.07 -
	10/24/2019	-	12000 -	560000 -	170000 -	250 U	7.3 J	1400000 -	2600000 -	2 U	4.9 -	67 -	1 U	0.22 J	2 U	2.5 -	250 U	1.1 U	56 -	0.2 U	830 -	5 U	1 U	0.0977 UJ	0.282 U	0.38 U
	5/19/2020	-	19000 -	510000 -	160000 -	86 J	7.4 J	1500000 -	2300000 -	2 U	3.8 -	36 -	1 U	1 U	2 U	1.8 -	86 J	1.8 J+	50 -	0.2 U	770 -	5 U	1 U	0.212 U	0.565 U	0.776 U
	11/13/2020	-	18000 -	570000 -	180000 -	250 U	7.4 J	1700000 J+	2500000 -	2 U	3.9 -	33 -	1 U	1 U	2 U	1.6 -	250 U	1 U	55 -	0.2 U	800 -	5 U	1 U	0.178 U	0.489 U	0.668 -
	5/13/2021	-	20000 -	560000 -	170000 -	140 U	7.3 J	1500000 -	2600000 -	2 U	4.2 -	34 -	1 U	1 U	2 U	2 -	140 U	0.32 J	50 -	0.2 U	800 -	5 U	1 U	0.272 U	0.499 -	0.771 J
	11/22/2021	-	19000 -	590000 -	190000 J-	180 J	7.2 J	1500000 -	2600000 -	2 U	3.4 -	29 -	1 U	1 U	2 U	1.8 -	180 J	1 U	50 -	0.2 U	750 -	5 U	1 U	0.364 U	2.37 UJ	2.74 UJ
	5/10/2022	-	20000 -	520000 -	180000 -	120 J	7.2 J	1300000 -	2600000 -	2 U	4.1 -	31 -	1 U	1 U	2 U	2 -	120 J	1 U	52 -	0.2 U	710 -	5 U	1 U	0.269 U	0.481 -	0.75 J
	11/30/2022	-	18000 -	540000 -	260000 -	120 J	7.7 J	1500000 -	2600000 -	2 U	3.2 J	35 -	1 U	1 U	5 U	1.8 -	120 J	1 U	58 -	0.2 U	660 -	5 U	1 U	0.193 -	1.06 -	1.25 -
	5/26/2023	-	21000 -	580000 -	230000 -	110 U	7.5 J	1400000 -	2700000 -	2 U	3.8 J	39 -	1 U	1 U	5 U	2.3 -	110 U	0.53 J	61 -	0.2 U	520 -	5 U	1 U	0.056 U	0.252 U	0.308 U
	6/13/2023	-	21000 -	580000 -	250000 -	160 J	- -	1400000 -	- -	2 U	3.8 J	33 -	1 U	1 U	5 U	2 -	160 J	1 U	69 -	0.2 U	560 -	5 U	1 U	- -	- -	- -
	11/2/2023	-	24000 -	340000 -	460000 -	98 J	7.8 J	1300000 -	2900000 -	5 U	4.7 J	29 -	0.5 U	0.27 J	10 U	2 U	98 J	3 U	150 -	0.5 U	1300 -	5 U	2 U	0.0824 U	0.536 U	0.618 U
	5/7/2024	-	15000 -	250000 -	87000 -	130 -	7.4 J	430000 -	1200000 J	2 U	5.7 -	41 -	1 U	0.28 J	5 U	0.62 J	130 -	1 U	83 -	0.2 U	860 -	5 U	1 U	0.159 U	0.536 U	0.695 UJ
	11/13/2024	-	140 -	46000 -	31000 -	200 -	7.6 J	140000 -	350000 -	2 U	5 U	210 -	1 U	1 U	5 U	0.85 J	200 -	1 U	4.9 J	0.2 U	20 -	5 U	1 U	0.0927 U	0.844 U	0.937 UJ

TABLE 1
GROUNDWATER MONITORING RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well	Sample Date	Sample Type	Appendix III Constituents							Appendix IV Constituents															
			Boron Total ug/L	Calcium Total ug/L	Chloride ug/L	Fluoride ug/L	pH (lab) SU	Sulfate ug/L	Total Dissolved Solids (TDS) ug/L	Antimony Total ug/L	Arsenic Total ug/L	Barium Total ug/L	Beryllium Total ug/L	Cadmium Total ug/L	Chromium Total ug/L	Cobalt Total ug/L	Fluoride ug/L	Lead Total ug/L	Lithium Total ug/L	Mercury Total ug/L	Molybdenum Total ug/L	Selenium Total ug/L	Thallium Total ug/L	Radium-226 pCi/L	Radium-228 pCi/L	Radium-226 & 228 pCi/L
CCR-AP-7	6/10/2016	-	34 J+	86000 -	31000 -	110 R	7.37 J	93000 J-	590000 -	2 U	2.5 -	100 -	1 U	1 U	0.48 J	1.2 -	110 R	0.62 J	10 J	0.2 U	8.2 -	0.35 J	1 U	0.33 J	0.166 U	0.496 -
	8/12/2016	-	34 U	88000 -	26000 -	240 -	7.9 J	73000 -	580000 -	2 U	4.8 -	120 -	1 U	1 U	0.47 J	2.3 -	240 -	0.99 J	11 J	0.2 U	5.4 -	5 U	1 U	0.39 -	0.625 J	1.02 J
	10/28/2016	-	20 J+	120000 J-	25000 J+	250 -	7.1 J	66000 J+	530000 -	2 U	8.4 -	160 -	0.17 J	1 U	2.6 -	5.3 J	250 -	8.2 J	20 J	0.2 U	4.4 J	0.73 J	0.08 J	1.28 -	0.434 U	1.72 J
	12/7/2016	-	71 U	99000 -	26000 -	370 J+	7.4 J	96000 -	620000 -	0.16 J	8.3 -	140 -	0.12 J	1 U	3.9 -	3.7 -	370 J+	3.6 -	12 J	0.2 U	8.8 -	5 U	0.066 J	0.439 U	0.558 U	0.997 -
	2/8/2017	-	34 U	150000 J-	25000 -	280 J+	7.4 J	110000 -	630000 -	0.62 J	18 -	190 -	0.75 J	0.32 J	19 -	15 -	280 J+	20 -	39 J	0.2 U	13 -	5 U	0.61 J	0.744 -	0.365 U	1.11 J
	4/6/2017	-	80 U	110000 J+	27000 -	290 -	7.3 J	110000 -	640000 -	2 U	8 -	150 -	0.22 J	0.14 J	4.8 -	5.4 -	290 -	8.7 J+	19 J	0.2 U	5.8 -	5 UJ	1 U	0.719 -	0.83 -	1.55 -
	6/7/2017	-	150 U	100000 -	28000 -	340 -	7.3 J	100000 -	620000 -	2 U	7.5 -	150 -	0.15 J	1 U	3.9 J+	3.2 -	340 -	4.1 -	19 J	0.2 U	6.9 -	5 U	0.088 J	0.398 -	0.895 -	1.29 -
	9/28/2017	-	56 J	94000 -	29000 -	190 -	7.3 J	82000 -	570000 -	2 U	5.8 -	120 -	1 U	1 U	2 U	0.54 -	190 -	1 U	10 J	0.2 U	3.6 J	5 U	1 U	0.308 -	0.369 R	0.677 R
	11/17/2017	-	91 U	96000 -	31000 -	250 -	7.2 J	77000 J-	550000 -	2 U	3.4 -	110 -	1 U	1 U	2 U	0.3 J	250 -	1 U	12 J	0.2 U	2.8 J	5 U	1 U	0.312 -	0.405 R	0.717 R
	6/11/2018	-	- -	- -	- -	310 -	- -	- -	- -	2 U	7.1 -	140 -	1 U	1 U	1.4 U	0.65 -	310 -	0.41 J	11 -	0.2 U	2.5 J	5 U	1 U	0.48 -	0.0986 U	0.579 J
	8/28/2018	-	80 U	100000 -	27000 -	310 -	7.5 J	70000 -	580000 -	2 U	6.4 -	140 -	0.067 J	1 U	6.1 J+	1.4 -	310 -	1.4 -	13 -	- -	2.6 J	5 U	1 U	0.52 R	0.307 U	0.827 R
	5/28/2019	-	280 J	100000 -	28000 -	270 J+	7.5 J	82000 -	590000 -	2 U	3.7 -	130 -	1 U	1 U	2 U	0.47 J	270 J+	1 U	11 -	0.2 U	2 J	5 U	1 U	0.423 -	0.112 U	0.535 J
	10/23/2019	-	80 U	110000 -	27000 -	140 J+	7.4 J	65000 -	530000 -	2 U	7.5 -	150 -	1 U	1 U	1.8 J	1 -	140 J+	1.4 J+	20 J+	0.2 U	1.7 J	5 U	1 U	0.194 J	1.02 -	1.21 -
	2/19/2020	-	82 U	110000 -	16000 J+	220 -	7.4 J	45000 J+	570000 -	2 U	4 -	120 -	1 U	1 U	1.8 J	1.1 -	220 -	1.5 -	11 -	- -	1.5 J	- -	1 U	0.309 J-	0.111 U	0.419 J-
	3/30/2020	-	47 J	110000 -	27000 -	300 -	7.3 J	76000 -	560000 -	2 U	1.8 -	110 -	1 U	1 U	2 U	0.29 J	300 -	1 U	10 -	- -	1.4 J	- -	1 U	0.243 -	0.197 U	0.441 UJ
	5/18/2020	-	120 -	130000 -	28000 -	290 -	7.5 J	76000 -	650000 -	0.83 J	15 -	190 -	0.27 J	1 U	6.2 -	4.9 -	290 -	6 -	18 -	0.2 U	2 J	2.8 J	1 U	0.0602 U	0.242 U	0.302 U
	11/12/2020	-	120 U	110000 -	29000 -	330 -	7.5 J	78000 J+	510000 -	2 U	6.2 -	130 -	1 U	1 U	2 U	0.21 J	330 -	1 U	9.9 -	0.2 U	1.1 J	5 U	1 U	0.0646 U	0.0611 U	0.126 U
	5/7/2021	-	160 U	110000 -	26000 -	570 -	7.4 J	95000 -	870000 -	2 U	0.77 J	92 -	1 U	1 U	2 U	0.76 -	570 -	1 U	9.1 -	0.2 U	1.9 J	5 U	1 U	0.239 -	0.249 U	0.487 J
	11/4/2021	-	130 J	110000 -	32000 J	420 J	7.4 J	75000 J	530000 -	2 U	5.5 -	120 -	1 U	1 U	2 U	0.54 -	420 J	0.13 J	9.6 -	0.2 U	1.5 J	5 U	1 U	0.354 -	0.313 U	0.668 UJ
	5/3/2022	-	66 J	94000 -	22000 -	720 -	7.6 J	86000 -	510000 -	2 U	0.66 J	76 -	1 U	1 U	2 U	0.5 U	720 -	1 U	7.2 -	0.2 U	1.4 J	5 U	1 U	0.227 U	0.219 U	0.447 U
	11/22/2022	-	49 J-	110000 -	30000 -	480 -	7.7 J	76000 -	580000 -	2 U	4 J	100 -	1 U	1 U	5 U	0.87 J	480 -	0.82 J	7 J	0.2 U	1.4 J	5 U	1 U	0.25 -	1.08 U	1.33 U
	5/22/2023	-	100 U	120000 -	35000 -	490 -	7.3 J	110000 -	590000 -	2 U	4 J	110 -	1 U	1 U	5 U	0.39 J	490 -	1 U	10 -	0.2 U	1.8 J	5 U	1 U	0.269 -	0.495 U	0.764 J
	11/6/2023	-	50 U	110000 -	42000 -	290 -	7.5 J	84000 -	590000 -	5 U	1.9 J	100 -	0.5 U	0.5 U	10 U	2 U	290 -	3 U	11 -	0.5 U	5 U	5 U	2 U	0.217 U	1.22 U	1.44 UJ
	5/10/2024	-	100 U	120000 -	43000 -	310 -	7.2 J	110000 -	630000 -	2 U	0.9 J	100 -	1 U	1 U	5 U	0.3 J	310 -	1 U	11 -	0.2 U	1.3 J	5 U	1 U	0.337 -	0.529 U	0.866 J
	7/15/2024	-	100 U	120000 -	43000 -	360 -	- -	99000 -	- -	0.79 J	3.1 J	120 -	1 U	1 U	5 U	0.59 J	360 -	1 U	11 -	0.2 U	1.3 J	5 U	0.24 J	0.242 -	0.443 U	0.685 J
	11/15/2024	-	100 U	120000 -	43000 -	410 -	7.1 J	86000 -	600000 -	2 U	4.2 J	120 -	1 U	0.097 J	5 U	0.36 J	410 -	1 U	9.8 -	0.32 J-	1.1 J	5 U	1 U	0.496 -	0.358 U	0.854 J
CCR-AP-8	3/9/2017	-	37 J	300000 -	21000 -	130 -	7.2 J	37000 -	1400000 -	1.8 J	44 -	570 -	1 U	1 U	1.2 J	15 -	130 -	0.58 J	50 U	0.2 U	14 -	5 U	1 U	0.893 -	1.07 U	1.96 J
	4/6/2017	-	80 U	320000 J+	19000 -	350 -	6.9 J	16000 -	1400000 -	0.66 J	52 -	590 -	1 U	1 U	2.2 -	12 -	350 -	1.1 J+	50 U	0.2 U	15 -	1.7 J-	1 U	1.34 -	0.677 -	2.01 -
	4/26/2017	-	80 U	320000 -	18000 -	280 -	7 J	1600 -	1400000 -	1 J	70 -	590 -	1 U	1 U	1.9 J	11 -	280 -	0.81 J	14 J	0.2 U	14 -	1.5 J	1 U	0.883 -	0.778 -	1.66 -
	5/30/2017	-	34 J	340000 -	17000 -	240 -	7.3 J	6200 -	1500000 -	0.82 J	60 -	580 -	1 U	1 U	2.8 -	11 -	240 -	2.2 -	50 U	0.2 U	13 -	1.7 J	1 U	0.72 -	0.457 -	1.18 -
	6/7/2017	-	80 U	330000 -	13000 -	210 J	7 J	4000 J	1500000 -	1.1 J	76 -	600 -	1 U	1 U	2.1 R	11 -	210 J	1 -	50 U	0.2 U	14 -	1.7 J	0.068 J	0.721 J	1.6 J	2.32 J
	7/25/2017	-	80 U	350000 -	17000 -	240 J	7 J	3800 -	1500000 -	2 U	87 -	670 -	0.2 J	1 U	4.1 -	12 -	240 J	2.5 -	50 U	0.2 U	14 -	1.5 J	0.058 J	0.704 -	0.889 U	1.59 J
	8/15/2017	-	80 U	340000 -	16000 -	260 -	7.3 J	5000 -	1400000 -	1.4 J	95 -	640 -	0.39 J	0.16 J	12 -	17 -	260 -	7.6 -	50 U	0.2 U	15 -	2.2 J	0.15 J	0.513 -	0.316 U	0.829 J
	9/28/2017	-	25 J	320000 -	17000 -	340 -	7 J	2300 -	1400000 -	2 U	87 -	560 -	1 U	1 U	2.1 J+	9.8 -	340 -	1.1 -	50 U	0.2 U	12 -	2 J	1 U	0.529 -	0.534 R	1.06 R
	11/17/2017	-	43 U	300000 -	16000 -	400 -	7 J	1900 J-	1300000 -	2 U	83 -	530 -	1 U	1 U	2.1 -	8.2 -	400 -	1.1 -	50 U	0.2 U	12 -	5 U	0.29 J	0.64 -	1.43 R	2.07 R
	6/11/2018	-	- -	- -	- -	410 -	- -	- -	- -	2 U	110 -	680 -	0.22 J	1 U	6.9 J+	8.6 -	410 -	3.3 -	5.7 -	0.2 U	13 -	2.1 J	0.083 J	0.544 -	0.502 -	1.05 -
	8/28/2018	-	80 U	280000 -	6000 -	210 -	7 J	1300 -	1300000 -	2 U	96 -	580 -	0.16 J	1 U	6.8 J+	7.7 -	210 -	2.1 -	5.2 -	- -	12 -	1.8 J	1 U	0.985 R	0.367 U	1.35 R
	11/16/2018	-	- -	- -	16000 -	250 -	- -	1100 -	1200000 -	2 U	100 -	580 -	1 U	1 U	2.4 -	5.9 -	250 -	0.5 J	5 U	0.2 U	9.5 -	1.9 J	1 U	- -	- -	- -
	5/28/2019	-	120 J	270000 -	15000 -	510 J+	6.9 J	990 J	1200000 -	0.46 J	100 -	490 -	1 U	1 U	3.4 U	4.4 -	510 J+	1.2 -	3.1 J	0.2 U	9.9 -	5 U	1 U	0.443 -	0.0635 UJ	0.506 UJ
	10/22/2019	-	80 U	310000 -	15000 -	100 U	7.1 J	2000 -	1300000 -	0.43 J	90 -	650 -	1 U	0.19 J	6.7 -	5.4 -	100 U	3 -	9.3 U	0.2 U	12 -	7 J+	1 U	0.295 J	0.431 U	0.726 J
	5/20/2020	-	100 U	260000 -	16000 -	300 -	7.3 J	2400 J+	1100000 -	0.4 J	110 -	530 -	0.25 J	0.28 J	2.9 -	6.4 -	300 -	1.7 J+	5 U	0.2 U	13 -	3.2 J	1 U	0.572 -	0.519 U	1.09 J
	11/12/2020	-	99 U	290000 -	16000 -	190 -	7.3 J	2500 J+	1300000 -	1.1 J	120 -	540 -	0.3 J	0.28 J	4.7 -	7.8 -	190 -	2.5 -	5 U	0.2 U	20 -	2.1 J	1 U	0.678 -	1.19 -	1.87 -
	5/12/2021	-	88 U	320000 -	16000 -	200 J+	7 J	2100 -	1200000 -	0.48 J	120 -	570 -	1 U	1 U	4.8 -	7.7 -	200 J+	2.7 -	5 U	0.2 U	23 -	1.8 J	1 U	0.379 U	0.0702 U	0.449 U
	11/23/2021	-	70 UJ	250000 -	16000 J-	410 J	6.8 J	900 J	1000000 -	2 U	100 J	430 J	1 U	1 U	2.9 -	12 J	410 J	1.4 J	5 UJ	0.2 U	20 J	1.7 J	1 U	0.789 J	2.09 UJ	2.88 UJ
	11/23/2021	Duplicate	8400 J	200000 -	89000 J-	1500 J	7.2 J	450000 J	1000000 -	2 U	4 J	92 J	1 U	1 U	2 U	1.4 J	1500 J	0.21 J	35 J	0.2 U	150 J	5 U	0.31 J	0.612 U	1.21 UJ	1.82 UJ
	5/10/2022	-	100 U	250000 -	15000 -	420 -	7 J	32000 -	1100000 -	0.85 J	110 -	500 -	1 U	1 U	2 U	3.1 -	420 -	0.27 J	5 U	0.2 U	2.9 J	1.4 J	1 U	0.899 -	0.637 -	1.54 -
	11/29/2022	-	50 -	190000 -	18000 -	360 -	7.3 J	10000 -	1100000 -	4.6 -	100 -	370 -	1 U	0.64 J	14 -	8 -	360 -	6.1 -	6.7 J	0.26 -	29 -	5.1 -	1 U	0.557 -	0.512 U	1.07 UJ
	5/25/2023	-	100 U	250000 -	17000 -	190 J+	7.4 J	1500 -	1100000 -	0.66 J	110 -	430 -	1 U	1 U	1.4 J	2.6 -	190 J+	0.52 J	8 U	0.2 U	7.8 -	1.9 J	1 U	0.23 U	1.21 U	1.43 UJ
	11/2/2023	-	35 J	220000 -	17000 -	1100 -	7.4 J	3800 -	1000000 J	0.57 J	65 -	310 -	0.5 U	0.16 J	1.6 J	3.2 -	1100 -	3 U	5 U	0.5 U	19 -	1.6 J	2 U	0.318 -	1.78 U	2.1 U
	5/10/2024	-	130 -	140000 -	25000 -	220 -	7.1 J	2700 -	770000 -	0.64 J	13 -	270 -	1 U	1 U	3.9 J	4.4 -	220 -	3 -	3.9 J	0.2 U	12 -	2.1 J	1 U	0.489 -	0.589 U	1.08 J
	1/24/2025	-	1000 -	210000 -	18000 -	520 -	6.8 J	300000 -	1100000 -	2 U	76 -	370 -	1 U	0.12 J	4.1 J	2.3 -	520 -	2.3 -	8 U	0.2 U	6.4 -	1.3 J	1 U	0.419 -	-0.0226 U	0.419 UJ

TABLE 1
GROUNDWATER MONITORING RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well	Sample Date	Sample Type	Appendix III Constituents							Appendix IV Constituents																
			Boron Total ug/L	Calcium Total ug/L	Chloride ug/L	Fluoride ug/L	pH (lab) SU	Sulfate ug/L	Total Dissolved Solids (TDS) ug/L	Antimony Total ug/L	Arsenic Total ug/L	Barium Total ug/L	Beryllium Total ug/L	Cadmium Total ug/L	Chromium Total ug/L	Cobalt Total ug/L	Fluoride ug/L	Lead Total ug/L	Lithium Total ug/L	Mercury Total ug/L	Molybdenum Total ug/L	Selenium Total ug/L	Thallium Total ug/L	Radium-226 pCi/L	Radium-228 pCi/L	Radium-226 & 228 pCi/L
CCR-AP-8I	11/17/2018	-	- -	- -	300000 -	260 -	- -	1000000 -	2200000 -	2 U	4 -	300 -	0.078 J	1 U	2.9 -	1.6 -	260 -	1 -	440 -	0.2 U	360 -	5 U	1 U	- -	- -	- -
	2/12/2019	-	9700 -	390000 -	370000 -	270 -	7 HF	1100000 -	2300000 -	2 U	0.99 J	210 -	1 U	0.22 J	2 U	0.14 J	270 -	1 U	370 -	- -	670 -	5 U	1 U	1.25 -	1.87 -	3.12 -
	6/12/2019	-	18000 -	490000 -	130000 -	120 J+	7.4 J	1100000 -	2200000 -	2 U	5.1 -	63 -	0.18 J	0.22 J	3.3 U	3.1 -	120 J+	1 U	47 -	0.2 U	860 -	5 U	0.13 J	0.46 -	0.88 -	1.34 -
	10/24/2019	-	8000 -	380000 -	350000 -	250 U	6.9 J	1000000 -	2400000 -	2 U	2.2 -	270 -	1 U	0.18 J	2 U	0.37 J	250 U	1 U	410 -	0.2 U	310 -	6.2 J+	1 U	1.14 J	1.28 -	2.42 -
	5/19/2020	-	12000 -	380000 -	390000 -	250 U	7 J	960000 -	2200000 -	2 U	2.3 -	240 -	1 U	1 U	2 U	0.14 J	250 U	1 U	370 -	0.2 U	280 -	5 U	1 U	0.887 -	1.76 -	2.64 -
	11/13/2020	-	13000 -	420000 -	420000 -	170 J	6.9 J	970000 J+	2400000 -	2 U	2.3 -	240 -	1 U	1 U	2 U	0.17 J	170 J	1 U	410 -	0.2 U	310 -	5 U	1 U	1.68 -	1.04 -	2.73 -
	5/13/2021	-	13000 -	430000 -	430000 -	270 J+	6.8 J	990000 -	2400000 -	2 U	2.3 -	220 -	1 U	1 U	2 U	0.5 U	270 J+	1 U	420 -	0.2 U	320 -	5 U	1 U	1.27 -	1.61 -	2.88 -
	11/22/2021	-	13000 -	450000 -	420000 J-	300 J	6.8 J	1100000 -	2400000 -	2 U	2.6 -	240 -	1 U	1 U	2 U	0.5 U	300 J	1 U	400 -	0.2 U	320 -	5 U	1 U	1.34 -	2.41 UJ	3.74 UJ
	5/10/2022	-	13000 -	440000 -	430000 -	330 -	6.8 J	900000 -	2600000 -	2 U	1.8 -	220 -	1 U	1 U	2 U	0.5 U	330 -	1 U	400 -	0.2 U	510 -	5 U	1 U	1.7 J	1.88 -	3.58 J
	11/30/2022	-	12000 -	410000 -	560000 -	210 J	7.3 J	1100000 -	2800000 -	2 U	1.7 J	190 -	1 U	1 U	5 U	1 U	210 J	1 U	420 -	0.2 U	330 -	5 U	1 U	1.35 -	2.05 -	3.41 -
	5/25/2023	-	13000 -	470000 -	500000 -	210 J+	7.3 J	950000 -	2700000 -	2 U	2 J	220 -	1 U	1 U	5 U	0.3 J	210 J+	1 U	370 -	0.23 -	290 -	5 U	1 U	1.48 -	1.75 U	3.24 J
	6/13/2023	-	12000 -	490000 -	520000 -	310 -	- -	990000 -	- -	2 U	2 J	230 -	1 U	1 U	1.2 J	1 U	310 -	1 U	440 -	0.2 U	360 -	5 U	1 U	- -	- -	- -
	11/2/2023	-	12000 -	440000 -	570000 -	200 J	7 J	1000000 -	2600000 J	0.38 J	2.8 J	220 -	0.5 U	0.15 J	2.7 J	2 U	200 J	1 J	430 -	0.5 U	340 -	0.91 J	2 U	1.53 -	2.94 J	4.47 J
	5/8/2024	-	33000 -	490000 -	180000 -	120 J	7.3 J	1100000 -	2400000 J	2 U	1.3 J	340 -	1 U	1 U	5 U	0.65 J	120 J	1 U	170 -	0.2 U	290 -	5 U	1 U	0.804 -	1.15 U	1.95 J+
	12/19/2024	-	380 -	90000 -	24000 -	210 J	6.8 J	82000 -	470000 -	2 U	5 U	53 -	1 U	1 U	5 U	1 U	210 J	1 U	8 U	0.2 U	7.4 -	5 U	1 U	0.172 -	0.133 U	0.305 UJ
CCR-AP-9	3/9/2017	-	200 -	92000 -	23000 -	140 -	7.5 J	130000 -	550000 -	4.4 -	3.1 -	130 -	0.17 J	0.079 J	4.2 -	6.2 -	140 -	2.5 -	30 J	0.2 U	11 -	5.8 -	1 U	0.532 R	0.401 U	0.934 UJ
	4/7/2017	-	230 -	110000 J+	21000 -	360 -	7.4 J	120000 -	610000 -	1.4 J	6 -	230 -	0.53 J	0.095 J	8.8 -	12 -	360 -	7.3 J+	33 J	0.2 U	9.7 -	5 UJ	1 U	1.62 -	1.61 -	3.23 J
	4/26/2017	-	260 J+	110000 -	21000 -	350 -	7.5 J	120000 -	590000 -	1.2 J	8 -	230 -	0.66 J	0.11 J	12 -	13 -	350 -	6.9 -	40 J	0.2 U	7.1 -	5 U	0.098 J	1.91 -	2.11 -	4.02 -
	5/30/2017	-	260 -	120000 -	19000 -	330 -	7.7 J	110000 -	600000 -	1.1 J	10 -	270 -	0.92 J	0.15 J	14 -	13 -	330 -	12 -	40 J	0.2 U	6.5 -	5 U	0.18 J	0.614 -	0.619 U	1.23 J
	6/8/2017	-	290 U	120000 -	20000 -	420 -	7.6 J	110000 -	600000 -	1.4 J	7.7 -	210 -	0.47 J	0.11 J	8.8 -	9.6 -	420 -	5.6 -	34 J	0.2 U	5.9 -	5 U	0.1 J	1.43 -	2.06 -	3.49 -
	7/25/2017	-	250 -	130000 -	19000 -	300 -	7.4 J	90000 -	650000 -	2 U	10 -	280 -	1.1 -	0.22 J	20 -	14 -	300 -	11 -	48 J	0.2 U	5.9 -	5 U	0.16 J	0.962 -	0.644 -	1.61 -
	8/15/2017	-	220 -	130000 -	18000 -	330 -	7.5 J	110000 -	600000 -	0.78 J	8.7 -	240 -	0.73 J	0.14 J	13 -	16 -	330 -	9.8 -	36 J	0.2 U	2.7 J	1.4 J	0.11 J	1.68 -	1.45 R	3.13 R
	9/28/2017	-	290 -	110000 -	17000 -	300 -	7.5 J	120000 -	620000 -	2 U	5.8 -	210 -	0.17 J	1 U	6.7 -	7.2 -	300 -	3.3 -	29 J	0.2 U	4.3 J	5 U	1 U	2.05 -	1.47 U	3.52 J+
	11/17/2017	-	340 U	130000 -	16000 -	360 -	7.4 J	120000 J-	620000 -	7.9 J+	8.8 -	290 -	0.95 J	5 U	19 -	15 -	360 -	9.8 -	50 J	0.2 U	6.9 J	25 U	0.62 J	1.38 -	1.2 R	2.58 R
	6/11/2018	-	- -	- -	- -	370 -	- -	- -	- -	1.2 J	9.1 -	320 -	1 -	0.17 J	25 -	13 -	370 -	11 -	48 -	0.2 U	4.8 J	1.1 J	0.21 J	1.18 -	0.108 U	1.29 J
	8/28/2018	-	340 J	190000 -	9300 -	340 -	7.2 J	99000 -	650000 -	20 U	32 -	720 -	4.1 J	10 U	150 -	47 -	340 -	41 -	120 -	- -	12 J	9.9 J	0.98 J	1.35 J	1.25 -	2.6 J
	5/28/2019	-	410 J	130000 -	12000 -	330 J+	7.5 J	100000 -	650000 -	0.61 J	7.8 -	290 -	0.66 J	0.14 J	16 J+	12 -	330 J+	10 -	41 -	0.2 U	3.8 J	5 U	0.16 J	1.02 -	1.3 -	2.32 -
	10/22/2019	-	360 J	130000 -	9700 -	210 J+	7.6 J	120000 -	600000 -	10 U	13 -	350 -	1.1 J	5 U	33 -	17 -	210 J+	17 -	72 -	0.2 U	4.9 J	25 U	5 U	1.67 J	1.47 -	3.13 -
	5/19/2020	-	550 J+	120000 -	9700 -	370 -	7.5 J	120000 -	650000 -	0.69 J	5.5 -	190 -	0.58 J	1 U	11 -	8 -	370 -	6.6 J+	37 -	0.2 U	2.8 J	3.7 J	1 U	1.22 -	0.795 U	2.01 J
	11/13/2020	-	530 J+	150000 -	11000 -	390 -	7.6 J	140000 J+	640000 -	1.7 J	20 -	390 -	1.7 -	0.4 J	39 -	23 -	390 -	25 -	60 -	0.2 U	4 J	5 U	1 U	1.08 -	1.08 -	2.16 -
	5/13/2021	-	1000 -	160000 -	11000 -	320 J+	7.4 J	120000 -	680000 -	20 U	15 -	380 -	10 U	10 U	45 -	18 -	320 J+	17 -	52 -	0.2 U	50 U	50 U	10 U	1.93 -	2.13 -	4.06 -
	11/22/2021	-	430 J+	150000 -	10000 J-	380 J	7.2 J	110000 -	660000 -	1.4 J	9.1 -	240 -	1 -	1 U	15 -	14 -	380 J	13 -	39 -	0.2 U	1.8 J	5 U	1 U	5 -	7.55 J	12.6 J
	5/9/2022	-	470 J+	130000 -	10000 -	260 -	7.3 J	100000 -	650000 -	7.5 -	8.5 -	270 -	0.9 J	1 U	20 -	14 -	260 -	14 -	42 -	0.2 U	2.9 J	5 U	1 U	0.363 U	0.999 U	1.36 U
	11/29/2022	-	380 -	160000 -	11000 -	390 -	7.7 J	120000 -	830000 -	1.2 J	13 -	390 -	1.8 -	0.2 J	45 -	19 -	390 -	24 -	64 -	0.2 U	3.7 J	1 J	1 U	6.01 -	2.39 U	8.41 J
	5/23/2023	-	380 -	140000 -	11000 -	350 J+	7.6 J	140000 -	710000 -	0.83 J	7.3 -	230 -	0.74 J	1 U	18 -	14 -	350 J+	9.2 -	40 -	0.2 U	5 U	5 U	1 U	2.08 -	3.96 J	6.04 J
	5/8/2024	-	390 -	130000 -	9600 -	300 -	7.2 J	130000 -	2400000 J	2 U	3.9 J	170 -	1 U	1 U	10 -	6.1 -	300 -	4.7 -	38 -	0.2 U	1.7 J	5 U	1 U	3.35 -	2.98 J	6.33 J
	11/14/2024	-	410 -	120000 -	2500 -	150 J	7.2 J	2500 U	710000 -	2 U	2.2 J	160 -	1 U	0.077 J	6.5 -	2.5 -	150 J	2.4 -	35 -	0.2 U	1.7 J	5 U	1 U	2.63 -	3.7 U	6.33 -
CCR-AP-10	10/24/2019	-	1300 -	82000 -	22000 -	490 -	7.5 J	4500 -	1000000 -	0.52 J	13 -	170 -	1 U	1 U	1.7 J	0.7 -	490 -	1 U	57 -	0.2 U	30 -	5.3 J+	1 U	0.543 J	0.535 -	1.08 -

TABLE 1
GROUNDWATER MONITORING RESULTS
SOUTHERN INDIANA ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Monitoring Well	Sample Date	Sample Type	Appendix III Constituents							Appendix IV Constituents																			
			Boron Total ug/L	Calcium Total ug/L	Chloride ug/L	Fluoride ug/L	pH (lab) SU	Sulfate ug/L	Total Dissolved Solids (TDS) ug/L	Antimony Total ug/L	Arsenic Total ug/L	Barium Total ug/L	Beryllium Total ug/L	Cadmium Total ug/L	Chromium Total ug/L	Cobalt Total ug/L	Fluoride ug/L	Lead Total ug/L	Lithium Total ug/L	Mercury Total ug/L	Molybdenum Total ug/L	Selenium Total ug/L	Thallium Total ug/L	Radium-226 pCi/L	Radium-228 pCi/L	Radium-226 & 228 pCi/L
CCR-AP-11	2/13/2019	-	580 -	130000 -	11000 -	970 -	7.1 HF	360000 -	680000 -	2 U	2.6 -	92 -	1 U	1 U	2 U	1.6 -	970 -	0.18 J	7.7 -	- -	4.9 J	5 U	1 U	0.283 -	0.0228 U	0.305 U
	6/13/2019	-	220 J+	110000 -	20000 -	320 -	6.5 J	310000 -	870000 -	2 U	47 -	340 -	0.17 J	1 U	3.2 U	25 -	320 -	1 U	4 J	0.2 U	1.1 J	5 U	1 U	0.56 -	0.6 U	1.16 J
	10/23/2019	-	210 -	94000 -	15000 -	300 U	6.7 J	330000 -	680000 -	2 U	13 -	120 -	1 U	1 U	2 U	4.9 -	300 U	1 U	14 J+	0.2 U	0.7 J	6.6 J+	1 U	0.0634 UJ	0.246 U	0.31 U
	5/20/2020	-	210 J+	110000 -	23000 -	340 -	6.7 J	430000 -	840000 -	2 U	48 -	290 -	1 U	1 U	2 U	30 -	340 -	1 U	5 U	0.2 U	0.63 J	5 U	1 U	0.255 -	0.412 U	0.666 J
	11/13/2020	-	220 J+	130000 -	25000 -	270 -	6.7 J	480000 J+	890000 -	2 U	59 -	320 -	1 U	1 U	2 U	39 -	270 -	1 U	5 U	0.2 U	5 U	5 U	1 U	0.385 U	0.244 U	0.629 -
	5/12/2021	-	390 J+	60000 -	1200 -	730 -	7 J	110000 -	260000 -	2 U	1.2 -	26 -	1 U	1 U	2 U	0.46 J	730 -	0.68 J	5 U	0.2 U	2 J	2 J	1 U	0.0194 U	-0.0103 U	0.0194 U
	11/22/2021	-	280 J+	130000 -	23000 J-	430 J	6.5 J	460000 -	890000 -	0.45 J	57 -	240 -	0.41 J	0.23 J	6.5 -	56 -	430 J	5.3 -	7.4 -	0.2 U	0.71 J	5 U	1 U	0.528 U	2.14 UJ	2.66 UJ
	5/5/2022	-	390 J+	73000 -	14000 -	530 -	6.3 J	320000 -	910000 -	2 U	19 -	100 -	1 U	1 U	2 U	29 -	530 -	1 U	5 U	0.2 U	1.5 J	5 U	1 U	1.27 -	0.233 U	1.51 J
	11/29/2022	-	210 -	110000 -	24000 -	370 -	7 J	450000 -	860000 -	2 U	44 -	200 -	1 U	1 U	5 U	37 -	370 -	0.97 J	4.9 J	0.2 U	5 U	5 U	1 U	0.223 -	0.289 U	0.512 UJ
	5/26/2023	-	410 -	56000 -	1200 -	570 -	7.3 J	100000 -	240000 -	2 U	5 U	21 -	1 U	1 U	5 U	0.33 J	570 -	1 U	2.9 J	0.2 U	1.8 J	2.1 J	1 U	0.0208 U	-0.104 U	0.0208 U
	11/2/2023	-	370 -	110000 -	16000 -	800 -	6.7 J	370000 -	660000 -	5 U	24 -	130 -	0.5 U	0.5 U	1.4 J	37 -	800 -	3 U	2.8 J	0.5 U	5 U	1.4 J	2 U	0.213 U	0.315 U	0.528 U
	5/10/2024	-	300 -	120000 -	26000 -	300 -	6.5 J	450000 -	900000 -	2 U	5.6 -	150 -	1 U	1 U	1.6 J	36 -	300 -	0.59 J	4.8 J	0.2 U	5 U	5 U	1 U	0.292 -	0.562 U	0.854 J+
	11/15/2024	-	450 -	140000 -	29000 -	340 -	6.2 J	610000 -	1200000 -	2 U	51 -	230 -	1 U	1 U	2.1 J	65 -	340 -	0.51 J	4.3 J	0.2 U	5 U	5 U	1 U	0.243 U	0.965 U	1.21 UJ
Maximum concentration, all wells			**68,000**	**620,000**	**880,000**	**2,300**	**8.1**	**1,900,000**	**4,600,000**	**28**	**330**	**1,400**	**7.7**	**6.6**	**160**	**91**	**2,300**	**100**	**440**	**1.6**	**1,300**	**31**	**7.6**	**14.5**	**27**	**30**
Maximum concentration, wells closest to the Ohio River/Little Pigeon Creek (i.e., CCR-AP-2, CCR-AP-3, CCR-AP-6, CCR-AP-6I, CCR-AP-8, and CCR-AP-8I)			**33,000**	**590,000**	**570,000**	**1,500**	**7.8**	**1,700,000**	**2,900,000**	**18**	**120**	**830**	**7.7**	**6.6**	**140**	**91**	**1,500**	**100**	**440**	**0.71**	**1,300**	**26**	**7.6**	**6.3**	**3.6**	**10**
Maximum concentration, wells closest to Well 1A and Well 2 (i.e., CCR-AP-4, CCR-AP-6, and CCR-AP-6I)			**24,000**	**590,000**	**460,000**	**890**	**7.8**	**1,700,000**	**2,900,000**	**28**	**330**	**1,400**	**1.7**	**1.1**	**58**	**21**	**890**	**47**	**330**	**0.41**	**1,300**	**31**	**0.47**	**6.3**	**27**	**30**

Notes:
U: Constituent not detected, value is the reporting limit
UJ: Constituent not detected, value is the estimated reporting limit
J: Estimated Result
J+: Estimated Result, biased high
J-: Estimated Result, biased low
R: Data rejected by validator
HF: Field parameter analyzed outside of holding time
ug/L - micrograms per liter
SU - Standard Units
pCi/L - picoCurie per liter

TABLE 2

PUBLISHED HUMAN HEALTH SCREENING LEVELS FOR DIRECT CONTACT EXPOSURE TO GROUNDWATER/EXPOSURE TO SURFACE WATER AS DRINKING WATER, AND RECREATIONAL USE OF SURFACE WATER (FISH CONSUMPTION)

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

		Published Human Health Screening Levels - Direct Contact Exposure to Groundwater/Exposure to Surface Water as Drinking Water			Published Human Health Screening Levels - Recreational Use of Surface Water (Fish Consumption)		Selected Screening Levels for Direct Contact Exposure to Groundwater/Exposure to Surface Water as Drinking Water, and Recreational Use of Surface Water (Fish Consumption)	
Constituent	**CAS RN**	**USEPA MCL (a) (mg/L)**	**USEPA RSL Tap Water (b) (mg/L)**	**IDEM Criteria for Drinking Water Class Groundwater (c) (mg/L)**	**USEPA NRWQC Consumption of Organism Only (d) (mg/L)**	**IDEM CCC HLSC Consumption of Organism Only (e) (mg/L)**	**Selected Screening Level - Direct Contact Exposure to Groundwater/ Exposure to Surface Water as Drinking Water (f) (mg/L)**	**Selected Screening Level - Surface Water, Consumption of Organism Only (g) (mg/L)**
Detection Monitoring - USEPA Appendix III Constituents (h)								
Boron	7440-42-8	NA	4	NA	NA	NA	4	NA
Fluoride	16984-48-8	4	0.8	4	NA	NA	4	NA
Assessment Monitoring - USEPA Appendix IV Constituents								
Antimony	7440-36-0	0.006	0.0078	0.006	0.64	0.64	0.006	0.64
Arsenic	7440-38-2	0.01	0.0052 (i)	0.01	0.014 (i, j)	0.00175 (i,k)	0.01	0.014
Barium	7440-39-3	2	3.8	2	NA	NA	2	NA
Beryllium	7440-41-7	0.004	0.025	0.004	NA	NA	0.004	NA
Cadmium	7440-43-9	0.005	0.0018	0.005	NA	NA	0.005	NA
Chromium (Total)	7440-47-3	0.1	22 (l)	0.1	NA	NA	0.1	NA
Cobalt	7440-48-4	NA	0.006	NA	NA	NA	0.006	NA
Lead	7439-92-1	0.015 (m)	0.01 (m)	0.015 (m)	NA	NA	0.015	NA
Lithium	7439-93-2	NA	0.04	NA	NA	NA	0.04	NA
Mercury	7439-97-6	0.002 (n)	0.0057 (o)	0.002 (n)	NA	0.00015	0.002	0.00015
Molybdenum	7439-98-7	NA	0.1	NA	NA	NA	0.1	NA
Selenium	7782-49-2	0.05	0.1	0.05	4.2	4.2	0.05	4.2
Thallium	7440-28-0	0.002	0.0002	0.002	0.00047	0.048	0.002	0.00047
Radiological (pCi/L)								
Radium-226 & 228	7440-14-4	5	NA	5	NA	NA	5	NA

Notes:

CAS RN - Chemical Abstracts Service Registry Number.

CCC HLSC - Continuous Criterion Concentration. Human Life-Cycle Safe Concentration.

IDEM - Indiana Department of Environmental Management.

MCL - Maximum Contaminant Level.

mg/L - milligrams/liter.

NA - Not Available.

NRWQC - National Recommended Water Quality Criteria.

pCi/L - picoCuries/liter.

RSL - Regional Screening Level.

USEPA - United States Environmental Protection Agency.

TABLE 2

PUBLISHED HUMAN HEALTH SCREENING LEVELS FOR DIRECT CONTACT EXPOSURE TO GROUNDWATER/EXPOSURE TO SURFACE WATER AS DRINKING WATER, AND RECREATIONAL USE OF SURFACE WATER (FISH CONSUMPTION)

F.B. CULLEY GENERATING STATION - EAST ASH POND

Additional Notes:

(a) - USEPA National Primary Drinking Water Regulations.
https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

(b) - USEPA Regional Screening Levels (November 2024). Values for Tap Water, Hazard Index = 1.0. TR = 1E-06.
https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

(c) - IDEM Water Quality Standards. Title 327 of the Indiana Administrative Code (IAC). Article 2. Water Quality Standards. Rule 11. Ground Water Quality Standards. Part 327 IAC 2-11-6. Criteria for Drinking Water Class Ground Water.
http://iac.iga.in.gov/iac//title327.html

(d) - USEPA National Recommended Water Quality Criteria - Human Health Criteria Table. USEPA NRWQC - Human Health Criteria for the Consumption of Organism Only apply to total concentrations.
https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table

(e) - IDEM Water Quality Standards. Title 327 of the IAC. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters of the State Within the Great Lakes System. Part 327 IAC 2-1-6 Minimum Surface Water Quality Standards. Table 6-4. Surface Water Quality Criteria for Protection of Human Health, Continuous Criterion Concentrations Outside of Mixing Zone. For metals, surface water quality criteria apply to total recoverable concentrations. For carcinogenic substances, criteria are to protect human health from unacceptable cancer risk of greater than one (1) additional occurrence of cancer per one hundred thousand (100,000) population.
http://iac.iga.in.gov/iac//title327.html

(f) - The hierarchy for the selection of published human health screening levels for drinking water is:
1) USEPA MCL
2) USEPA RSL - Tap Water
3) IDEM Criteria for Drinking Water Class Groundwater

(g) - The hierarchy for selection of published human health screening levels for surface water - "consumption of organisms only" is:
1) USEPA NRWQC - Consumption of Organism Only.
2) IDEM CCC HLSC - Consumption of Organism Only.

(h) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

(i) - Value based on a target lifetime excess cancer risk of 1E-04, the cancer risk per the CCR Rule (USEPA, 2015) generally "considered to pose a substantial present or potential hazard to human health and the environment and generally will be regulated," and the cumulative target cancer risk that should not be exceeded per IDEM risk assessment guidance (2022). Cancer risk-based screening levels for arsenic (based on a target cancer risk of 1E-05 or 1E-06) were adjusted to values based on a target cancer risk of 1E-04 as arsenic is the only constituent evaluated that is carcinogenic (via the oral and/or dermal pathways accounted for in the screening levels).

(j) - Value for inorganic arsenic.

(k) - Value for inorganic arsenic as arsenite, As(III), derived from nonthreshold cancer risk.

(l) - Value for chromium (III).

(m) - Federal Lead Action Level. This is a drinking water treatment action level applicable to regulated Community and Non-Transient Non-Community public water systems.
https://www.federalregister.gov/documents/2024/10/30/2024-23549/national-primary-drinking-water-regulations-for-lead-and-copper-improvements-lcri

(n) - Value for inorganic mercury.

(o) - Value for mercuric chloride.

References:

Indiana Department of Environmental Management (IDEM). 2022. Risk-based Closure Guide. Office of Land Quality. July 8.

United States Environmental Protection Agency (USEPA). 2015. Final Rule: Disposal of Coal Combustion Residuals (CCRs) for Electric Utilities. 80 FR 21301-21501. U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/coalash/coal-ash-rule.

TABLE 3

SITE-SPECIFIC, RISK-BASED SCREENING LEVELS FOR RECREATIONAL USE OF SURFACE WATER

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

Constituent	CAS RN	Human Health Calculated RBSL - Recreational Use of Surface Water (a)						Selected Human Health Calculated RBSL - Recreational Use of Surface Water (c) (mg/L)
		Current/Future Offsite Recreational Swimmer Age-Adjusted (Ages 1 - 26) (b) (mg/L)		Current/Future Recreational Wader Age-Adjusted (Ages 1 - 26) (b) (mg/L)		Current/Future Offsite Recreational Boater (Adult) (b) (mg/L)		
Detection Monitoring - USEPA Appendix III Constituents (d)								
Boron	7440-42-8	216		235		10,700		216
Fluoride	16984-48-8	43		47		2,140		43
Assessment Monitoring - USEPA Appendix IV Constituents								
Antimony	7440-36-0	0.26		0.395		3.2		0.26
Arsenic	7440-38-2	0.02	(e, f)	0.035	(e, g)	1.2	(e, h)	0.02
Barium	7440-39-3	86		162		748		86
Beryllium	7440-41-7	0.13		0.41		0.75		0.13
Cadmium	7440-43-9	0.034		0.072		0.27		0.034
Chromium (Total)	7440-47-3	169	(i)	494	(i)	1040	(i)	169
Cobalt	7440-48-4	0.35		0.36		40		0.35
Lead	7439-92-1	0.015	(j)	0.015	(j)	0.015	(j)	0.015
Lithium	7439-93-2	2.2		2.4		107		2.2
Mercury	7439-97-6	0.13	(k)	0.243	(k)	1.12	(k)	0.13
Molybdenum	7439-98-7	5.4		5.9		267		5.4
Selenium	7782-49-2	5.4		5.9		267		5.4
Thallium	7440-28-0	0.0108		0.0118		0.534		0.011
Radiological (pCi/L)								
Radium-226 & 228	7440-14-4	NA		NA		NA		NA

Notes:

CAS RN - Chemical Abstracts Service Registry Number.

mg/L - micrograms/liter.

NA - Not Available.

pCi/L - picoCuries/liter.

RBSL - Risk-Based Screening Level.

USEPA - United States Environmental Protection Agency.

TABLE 3

SITE-SPECIFIC, RISK-BASED SCREENING LEVELS FOR RECREATIONAL USE OF SURFACE WATER

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

Additional Notes:

(a) - Some calculated values may be above solubility limits.

(b) - Documentation for the risk-based screening level (RBSL) calculations for recreational use of surface water is provided in Attachment B. RBSLs calculated using the USEPA RSL calculator (USEPA, 2025b).

(c) - The selected RBSL for recreational use of surface water is the minimum value from amongst the Current/Future Offsite Recreational Swimmer, Current/Future Recreational Wader, and Current/Future Offsite Recreational Boater RBSLs.

(d) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

(e) - Arsenic RBSLs are based on the lower of the values based on a hazard index of 1 and an excess lifetime cancer risk of 1E-04. Per the CCR Rule (USEPA, 2015), a cancer risk level of 1E-04 is generally "considered to pose a substantial present or potential hazard to human health and the environment and generally will be regulated," and per the Indiana Department of Environmental Management (IDEM) risk assessment guidance (IDEM, 2022), cumulative cancer risk should not exceed 1E-04. Cancer RBSLs for arsenic were therefore calculated using a target cancer risk of 1E-04 as arsenic is the only constituent evaluated that is carcinogenic via the oral and/or dermal pathways accounted for in the RBSLs. RBSLs for arsenic were also calculated using the recently promulgated oral cancer slope factor of 32 per milligrams per kilogram per day (mg/kg-day) and oral reference dose of 0.00006 mg/kg-day (USEPA, 2025a).

(f) - RBSL based on cancer endpoint (noncancer-based RBSL is 0.065 mg/L).

(g) - RBSL based on cancer endpoint (noncancer-based RBSL is 0.071 mg/L).

(h) - RBSL based on cancer endpoint (noncancer-based RBSL is 3.2 mg/L).

(i) - Value for chromium (III).

(j) - USEPA lead action level of 0.015 mg/L for lead in drinking water (USEPA, 2024a) is used as the RBSL.

(k) - Value for mercuric chloride.

References:

Indiana Department of Environmental Management (IDEM). 2022. Risk-based Closure Guide. Office of Land Quality. July 8.

United States Environmental Protection Agency (USEPA). 2015. Final Rule: Disposal of Coal Combustion Residuals (CCRs) for Electric Utilities. 80 FR 21301-21501. U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/coalash/coal-ash-rule

USEPA. 2024. National Primary Drinking Water Regulations. Available at: https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Last updated on 12 December 2024.

USEPA. 2025a. Integrated Risk Information System. Available at: https://epa.gov/iris

USEPA. 2025b. RSL Calculator. Available at: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

TABLE 4

PUBLISHED ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

		Published Ecological Screening Levels - Surface Water												Selected Ecological Screening Level (acute) (e) (mg/L)		Selected Ecological Screening Level (chronic) (e) (mg/L)	
		USEPA NRWQC Aquatic Life Criteria CMC - Freshwater (acute) (a) (mg/L)		USEPA NRWQC Aquatic Life Criteria CCC - Freshwater (chronic) (a) (mg/L)		IDEM AAC Aquatic Life Criterion (acute) (b)(c) (mg/L)		IDEM CAC Aquatic Life Criterion (chronic) (b)(c) (mg/L)		USEPA Region 4 Surface Water Screening Values for Hazardous Waste Sites (freshwater - acute) (d) (mg/L)		USEPA Region 4 Surface Water Screening Values for Hazardous Waste Sites (freshwater - chronic) (d) (mg/L)					
Constituent	**CAS RN**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**
Detection Monitoring - USEPA Appendix III Constituents (f)																	
Boron	7440-42-8	NA	NA	NA	NA	41	NA	7.7	NA	34	34	7.2	7.2	41	34	7.7	7.2
Fluoride	16984-48-8	NA	NA	NA	NA	NA	NA	NA	NA	9.8	NA	2.7	NA	9.8	NA	2.7	NA
Assessment Monitoring - USEPA Appendix IV Constituents																	
Antimony	7440-36-0	NA	NA	NA	NA	0.72	NA	0.21	NA	0.9	NA	0.19	NA	0.72	NA	0.21	NA
Arsenic	7440-38-2	0.34 (g)	0.34 (g)	0.15 (g)	0.15 (g)	0.34	0.34	0.15	0.15	0.34	0.34	0.15	0.15	0.34	0.34	0.15	0.15
Barium	7440-39-3	NA	NA	NA	NA	NA	NA	NA	NA	2	NA	0.22	NA	2	NA	0.22	NA
Beryllium	7440-41-7	NA	NA	NA	NA	0.091 (h)	NA	0.004 (h)	NA	0.093	NA	0.011	NA	0.091	NA	0.004	NA
Cadmium	7440-43-9	0.0024 (h)	0.0023 (h)	0.00032 (h, i)	0.00029 (h, i)	0.0024 (h)	0.0023 (h)	0.00096 (h)	0.00086 (h)	0.0024 (h)	0.0023 (h)	0.0010 (h)	0.00086 (h)	0.0024	0.0023	0.00032	0.000292
Chromium (Total)	7440-47-3	2.2 (h)	0.70 (h)	0.11 (h)	0.091 (h)	2.2 (h)	0.7 (h)	0.11 (h)	0.091 (h)	2.2 (h, j)	0.7 (h)	0.11 (h, j)	0.091 (h)	2.2	0.7	0.11	0.091
Cobalt	7440-48-4	NA	NA	NA	NA	0.14	NA	0.053	NA	0.12	NA	0.019	NA	0.14	NA	0.053	NA
Lead	7439-92-1	0.11 (h)	0.084 (h)	0.0044 (h)	0.0033 (h)	0.11 (h)	0.084 (h)	0.0044 (h)	0.0033 (h)	0.11 (h)	0.08 (h)	0.0044 (h)	0.0033 (h)	0.11	0.084	0.0044	0.0033
Lithium	7439-93-2	NA	NA	NA	NA	0.91	NA	0.91	NA	0.91	NA	0.44	NA	0.91	NA	0.91	NA
Mercury	7439-97-6	0.0016 (k)	0.0014 (k)	0.00091 (k)	0.00077 (k)	0.0024	NA	0.000012	NA	0.0014 (k)	0.0014 (k)	0.00077 (k)	0.00077 (k)	0.0016	0.0014	0.0009059	0.00077
Molybdenum	7439-98-7	NA	NA	NA	NA	84	NA	3.8	NA	7.2	NA	0.8	NA	84	NA	3.8	NA
Selenium	7782-49-2	NA	NA	NA	0.0031 (l)	NA	NA	NA	0.0031 (l)	0.02	NA	0.005	NA	0.02	NA	0.005	0.0031
Thallium	7440-28-0	NA	NA	NA	NA	0.086	NA	0.035	NA	0.054	NA	0.006	NA	0.086	NA	0.035	NA
Radiological (pCi/L)																	
Radium-226 & 228	7440-14-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

AAC - Acute Aquatic Criterion

CAC - Chronic Aquatic Criterion

CAS RN - Chemical Abstracts Service Registry Number.

CCC - Continuous Criterion Concentration

CMC - Criterion Maximum Concentration

IDEM - Indiana Department of Environmental Management

mg/L - micrograms/liter.

NA - Not Available

NRWQC - National Recommended Water Quality Criteria

pCi/L - picoCuries/liter.

USEPA - United States Environmental Protection Agency

TABLE 4
PUBLISHED ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Additional Notes:

(a) - USEPA Water Quality Criteria. Current Water Quality Criteria Tables. National Recommended Water Quality Criteria - Aquatic Life Criteria Table.
https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

(b) - IDEM Water Quality Standards. Title 327 of the IAC. Article 2. Water Quality Standards. Rule 1. Water Quality Standards Applicable to All State Waters Except Waters of the State Within the Great Lakes System. Part 327 IAC 2-1-6 Minimum Surface Water Quality Criteria. Tables 6-1, 6-2, and 6-3.
http://iac.iga.in.gov/iac//title327.html
Additional water quality criteria not in Part 327 IAC 2-1-6 derived by IDEM using the methodologies at 327 IAC 2-1-8.2 and 8.3:
https://www.in.gov/idem/cleanwater/files/wqs_non_qlb.pdf

(c) - IDEM. Water Quality Standards.
https://www.in.gov/idem/cleanwater/resources/water-quality-standards/

(d) - USEPA Region 4 Ecological Risk Assessment Supplemental Guidance. Table 1a: Region 4 Surface Water Screening Values for Hazardous Waste Sites. Freshwater Screening Values.
https://www.epa.gov/sites/default/files/2018-03/documents/era_regional_supplemental_guidance_report-march-2018_update.pdf

(e) - The hierarchy for the selection of ecological screening levels is:
1) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
2) IDEM Aquatic Life Criterion.
3) USEPA Region 4. Freshwater Screening Values.

(f) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

(g) - Value for inorganic arsenic only.

(h) - Criterion expressed as a function of total hardness. Value displayed is based on a Site-specific total hardness value of 128 mg/L, obtained from the Ohio River Valley Water Sanitation Commission (2025). Total hardness value of 128 mg/L is the average total hardness from the 2023 surface water samples collected from the Newburgh station.

(i) - Per the USEPA National Recommended Water Quality Criteria - Aquatic Life Criteria Table, the current national recommended chronic freshwater cadmium aquatic life criteria are from EPA's 2001 Update of Ambient Water Quality Criteria for Cadmium.

(j) - Value for chromium (III).

(k) - Aquatic Life Criterion for metallic mercury (CAS RN 7439-97-6) and/or methylmercury (CAS RN 22967-92-6).

(l) - USEPA Office of Water. Final Criterion: Aquatic Life Ambient Water Quality Criterion for Selenium - Freshwater. 30 June 2016. Freshwater value for chronic (30 day) water column concentration (mg/L) of dissolved selenium in lotic (flowing) surface water. The criterion is based on fish ovary concentrations, and in lieu of that, the water column values are used.
https://www.epa.gov/sites/production/files/2016-07/documents/aquatic_life_awqc_for_selenium_-_freshwater_2016.pdf

Reference:

Ohio River Valley Water Sanitation Commission. 2025. Hardness data. https://www.orsanco.org/data/hardness/.

TABLE 5

SELECTED SURFACE WATER SCREENING LEVELS AND DERIVATION OF SCREENING LEVELS FOR GROUNDWATER PROTECTIVE OF OHIO RIVER AND LITTLE PIGEON CREEK SURFACE WATER

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

									Dilution-Attenuation Factor for Ohio River/Little Pigeon Creek (e)	**204**
Constituent	**CAS RN**	**HH DW SL (a) (mg/L)**	**HH REC SL - Consumption of Organism Only (b) (mg/L)**	**HH Recreational Calculated RBSL (c) (mg/L)**	**ECO SL - Total (acute) (d) (mg/L)**	**ECO SL - Dissolved (acute) (d) (mg/L)**	**ECO SL - Total (chronic) (d) (mg/L)**	**ECO SL - Dissolved (chronic) (d) (mg/L)**	**Lowest of the Human Health and Ecological Screening Levels (mg/L)**	**Target Groundwater Screening Level - Ohio River/Little Pigeon Creek (f) (mg/L)**
Detection Monitoring - USEPA Appendix III Constituents (g)										
Boron	7440-42-8	4	NA	216	41	34	7.7	7.2	4	820
Fluoride	16984-48-8	4	NA	43	9.8	NA	2.7	NA	2.7	550
Assessment Monitoring - USEPA Appendix IV Constituents										
Antimony	7440-36-0	0.006	0.64	0.26	0.72	NA	0.21	NA	0.006	1.2
Arsenic	7440-38-2	0.01	0.014	0.02	0.34	0.34	0.15	0.15	0.01	2.0
Barium	7440-39-3	2	NA	86.3	2	NA	0.22	NA	0.22	45
Beryllium	7440-41-7	0.004	NA	0.13	0.091	NA	0.004	NA	0.004	0.82
Cadmium	7440-43-9	0.005	NA	0.034	0.0024	0.0023	0.00032	0.00029	0.00029	0.06
Chromium (Total)	7440-47-3	0.1	NA	169	2.2	0.7	0.11	0.09	0.091	19
Cobalt	7440-48-4	0.006	NA	0.35	0.14	NA	0.053	NA	0.006	1.2
Lead	7439-92-1	0.015	NA	0.015	0.11	0.08	0.0044	0.0033	0.0033	0.67
Lithium	7439-93-2	0.04	NA	2.2	0.91	NA	0.91	NA	0.04	8.2
Mercury	7439-97-6	0.002	0.00015	0.129	0.0016	0.0014	0.000906	0.00077	0.00015	0.031
Molybdenum	7439-98-7	0.1	NA	5.4	84	NA	3.8	NA	0.1	20
Selenium	7782-49-2	0.05	4.2	5.4	0.02	NA	0.005	0.0031	0.0031	0.63
Thallium	7440-28-0	0.002	0.00047	0.0108	0.086	NA	0.035	NA	0.00047	0.096
Radiological (pCi/L)										
Radium-226 & 228	7440-14-4	5	NA	NA	NA	NA	NA	NA	5	1,020

TABLE 5

SELECTED SURFACE WATER SCREENING LEVELS AND DERIVATION OF SCREENING LEVELS FOR GROUNDWATER PROTECTIVE OF OHIO RIVER AND LITTLE PIGEON CREEK SURFACE WATER

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

Notes:

CAS RN - Chemical Abstracts Service Registry Number.

ECO SL - Ecological Screening Level.

HH DW SL - Human Health Drinking Water Screening Level.

HH REC SL - Human Health Recreational Use Screening Level.

mg/L - milligram per liter.

NA - Not Available.

pCi/L - picoCuries/liter.

RBSL - Risk-Based Screening Level.

(a) - Human health screening levels for drinking water selected in Table 2 using the following hierarchy:

1) United States Environmental Protection Agency (USEPA) Maximum Contaminant Levels

2) USEPA Regional Screening Level - Tap Water

3) Indiana Department of Environmental Management (IDEM) Criteria for Drinking Water Class Groundwater

(b) - Human health screening levels for surface water, "consumption of organism only," selected in Table 2 using the following hierarchy:

1) USEPA National Recommended Water Quality Criteria (NRWQC) - Consumption of Organism Only.

2) IDEM Continuous Criterion Concentration. Human Life-Cycle Safe Concentration - Consumption of Organism Only.

(c) - Minimum human health risk-based screening level (RBSL) for current/future offsite recreational swimmer, current/future recreational wader, and current/future offsite recreational boater, obtained from Table 3.

(d) - Ecological Screening Levels selected in Table 4 using the following hierarchy:

1) USEPA NRWQC. Aquatic Life Criteria - Freshwater.

2) IDEM Aquatic Life Criterion.

3) USEPA Region 4. Freshwater Screening Values.

(e) - Estimated value, see Attachment C for derivation.

(f) - The Target Groundwater Screening Level = Minimum Screening Level x Dilution-Attenuation Factor (204).

(g) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

TABLE 6

COMPARISON OF ESTIMATED GROUNDWATER CONCENTRATIONS AT WATER WITHDRAWAL WELLS WELL 1A AND WELL 2 AGAINST SCREENING LEVELS FOR DIRECT CONTACT EXPOSURE

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

Constituent	CAS RN	Selected Screening Level - Direct Contact Exposure to Groundwater (a) (mg/L)	Maximum Groundwater Concentration - AP-4, AP-6, AP-6I (mg/L)		Estimated Groundwater Concentration at Well 1A and Well 2 (b) (mg/L)	Ratio Between Selected Screening Level and Estimated Groundwater Concentration at Well 1A and Well 2 (c)
Detection Monitoring - USEPA Appendix III Constituents (d)						
Boron	7440-42-8	4	24	CCR-AP-6I	0.089	> 45
Fluoride	16984-48-8	4	0.89	CCR-AP-4	0.0033	> 1,200
Assessment Monitoring - USEPA Appendix IV Constituents						
Antimony	7440-36-0	0.006	0.028	CCR-AP-4	0.0001	> 57
Arsenic	7440-38-2	0.01	0.33	CCR-AP-4	0.0012	> 8
Barium	7440-39-3	2	1.4	CCR-AP-4	0.0052	> 380
Beryllium	7440-41-7	0.004	0.0017	CCR-AP-4	0.0000063	> 630
Cadmium	7440-43-9	0.005	0.0011	CCR-AP-6	0.0000041	> 1,200
Chromium (Total)	7440-47-3	0.1	0.058	CCR-AP-4	0.00021	> 460
Cobalt	7440-48-4	0.006	0.021	CCR-AP-4	0.000078	> 77
Lead	7439-92-1	0.015	0.047	CCR-AP-4	0.00017	> 86
Lithium	7439-93-2	0.04	0.33	CCR-AP-6I	0.0012	> 32
Mercury	7439-97-6	0.002	0.00041	CCR-AP-6	0.0000015	> 1,300
Molybdenum	7439-98-7	0.1	1.3	CCR-AP-6I	0.0048	> 20
Selenium	7782-49-2	0.05	0.031	CCR-AP-4	0.00011	> 430
Thallium	7440-28-0	0.002	0.00047	CCR-AP-4	0.0000017	> 1,100
Radiological (pCi/L)						
Radium-226 & 228	7440-14-4	5	30	CCR-AP-4	0.11	> 45

Notes:

CAS RN - Chemical Abstracts Service Registry Number.

mg/L - milligram per liter.

ND - Not Detected.

pCi/L - picoCuries/liter.

(a) - From Table 2

(b) - Estimated Groundwater Concentration = Maximum Groundwater Concentration / Dilution-Attenuation Factor (270)

(c) - Ratio = Screening Level / Estimated Groundwater Concentration.

(d) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

TABLE 7

COMPARISON OF GROUNDWATER CONCENTRATIONS AGAINST SCREENING LEVELS PROTECTIVE OF OHIO RIVER AND LITTLE PIGEON CREEK SURFACE WATER

F.B. CULLEY GENERATING STATION - EAST ASH POND

NEWBURGH, INDIANA

Constituent	CAS RN	Target Groundwater Screening Level - Ohio River/Little Pigeon Creek (a) (mg/L)	Maximum Groundwater Concentration - All Wells (mg/L)		Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration (b) (all wells)	Maximum Groundwater Concentration - Wells Closest to the Ohio River/Little Pigeon Creek (c) (mg/L)		Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration (b) (wells closest to the Ohio River/Little Pigeon Creek)
Detection Monitoring - USEPA Appendix III Constituents (d)								
Boron	7440-42-8	820	68	CCR-AP-5	> 12	33	CCR-AP-8I	> 24
Fluoride	16984-48-8	550	2.3	CCR-AP-5	> 230	1.5	CCR-AP-8	> 360
Assessment Monitoring - USEPA Appendix IV Constituents								
Antimony	7440-36-0	1.2	0.028	CCR-AP-4	> 43	0.018	CCR-AP-6	> 68
Arsenic	7440-38-2	2.0	0.33	CCR-AP-4	> 6	0.12	CCR-AP-6, CCR-AP-8	> 17
Barium	7440-39-3	45	1.4	CCR-AP-4	> 32	0.83	CCR-AP-2	> 54
Beryllium	7440-41-7	0.82	0.0077	CCR-AP-2	> 100	0.0077	CCR-AP-2	> 100
Cadmium	7440-43-9	0.06	0.0066	CCR-AP-2	> 9	0.0066	CCR-AP-2	> 9
Chromium (Total)	7440-47-3	19	0.16	CCR-AP-1R	> 110	0.14	CCR-AP-2	> 130
Cobalt	7440-48-4	1.2	0.091	CCR-AP-2	> 13	0.091	CCR-AP-2	> 13
Lead	7439-92-1	0.7	0.1	CCR-AP-2	> 7	0.1	CCR-AP-2	> 7
Lithium	7439-93-2	8.2	0.44	CCR-AP-8I	> 18	0.44	CCR-AP-8I	> 18
Mercury	7439-97-6	0.031	0.0016	CCR-AP-5	> 19	0.00071	CCR-AP-2	> 43
Molybdenum	7439-98-7	20	1.3	CCR-AP-6I	> 15	1.3	CCR-AP-6I	> 15
Selenium	7782-49-2	0.63	0.031	CCR-AP-4	> 20	0.026	CCR-AP-2	> 24
Thallium	7440-28-0	0.096	0.0076	CCR-AP-2	> 12	0.0076	CCR-AP-2	> 12
Radiological (pCi/L)								
Radium-226 & 228	7440-14-4	1,020	30	CCR-AP-4	> 34	10	CCR-AP-6	> 100

Notes:

CAS RN - Chemical Abstracts Service Registry Number.

mg/L - milligram per liter.

ND - Not Detected.

pCi/L - picoCuries/liter.

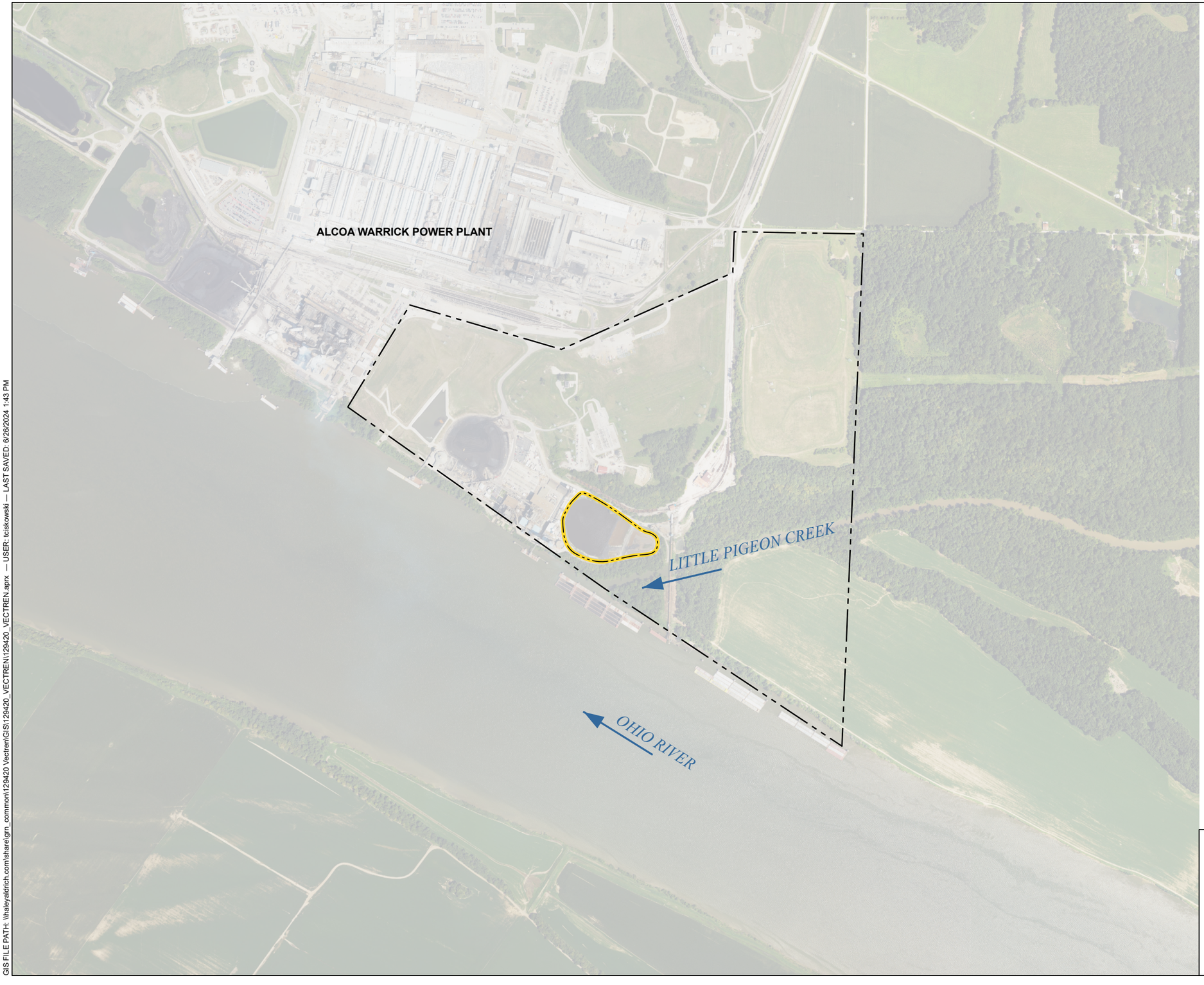
(a) - From Table 5

(b) - Ratio = Target Groundwater Screening Level / Maximum Groundwater Concentration.

(c) - Maximum groundwater concentrations from monitoring wells CCR-AP-2, CCR-AP-3, CCR-AP-6, CCR-AP-6I, CCR-AP-8, and CCR-AP-8I.

(d) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

FIGURES



LEGEND

PROPERTY BOUNDARY

FB CULLEY EAST ASH POND BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. AERIAL IMAGERY SOURCE: HEXAGON, 21 JULY 2022

N

0 1,000 2,000

SCALE IN FEET

HALEY ALDRICH

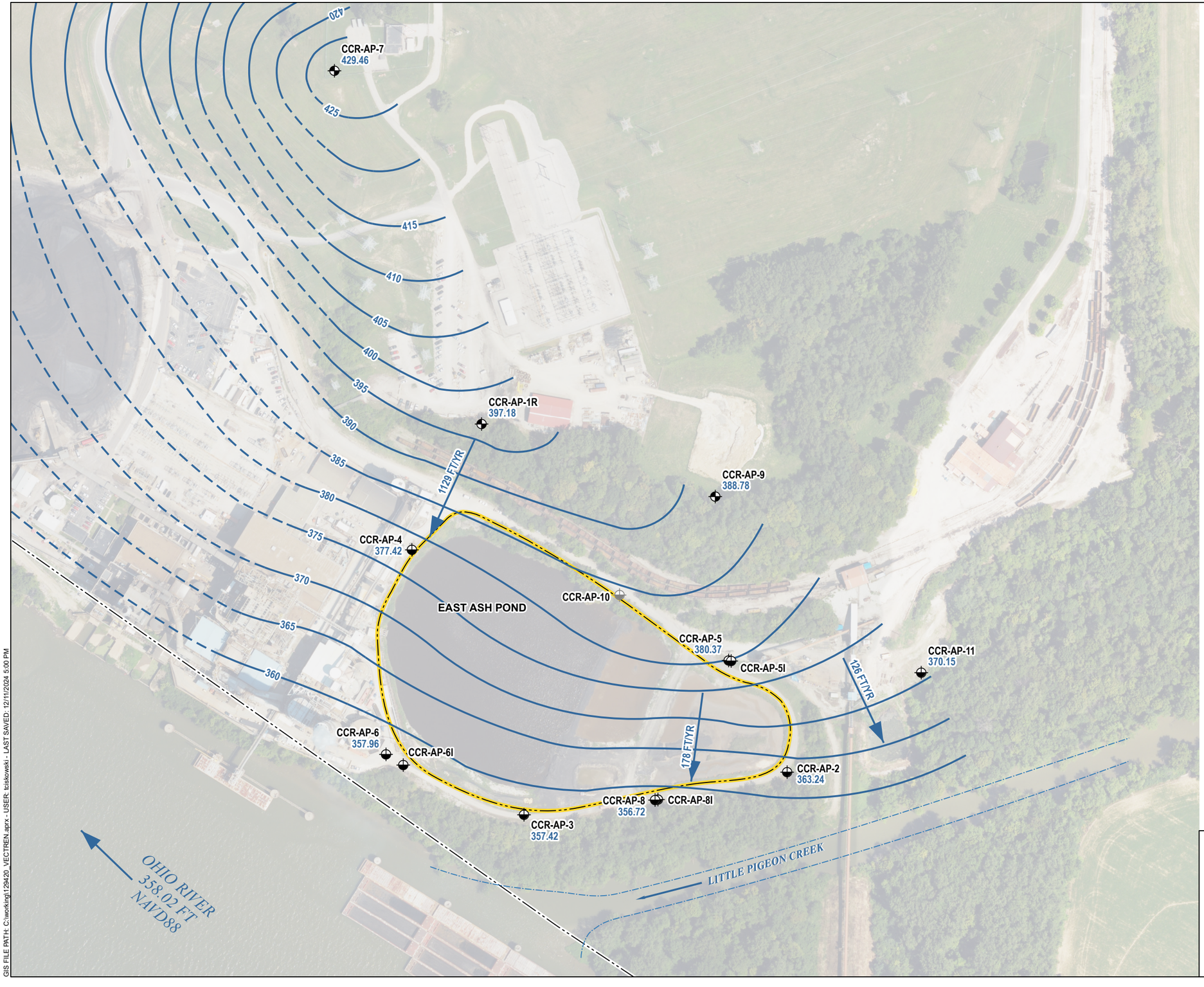
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

SITE LAYOUT

JUNE 2024

FIGURE 1

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LEGEND

- CREEK BOUNDARY
- GROUNDWATER ELEVATION CONTOUR, 5-FT INTERVAL, DASHED WHERE INFERRED
- APPROXIMATE UNIT BOUNDARY
- APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. DEFINITIONS:
CCR = COAL COMBUSTION RESIDUALS
ND = NO DATA
NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988

3. WATER LEVELS GAGED ON 6 MAY 2024

4. OHIO RIVER LEVEL COLLECTED BY USGS OWENSBORO GAGE #03303502 ON 6 MAY 2024 AT 12:00 PM

5. GROUNDWATER VELOCITY SHOWN IN FEET PER YEAR

6. $V = \frac{K(i)}{n_e}$

V = GROUNDWATER VELOCITY (FT/YR)
K = HYDRAULIC CONDUCTIVITY (FT/YR)
i = GROUNDWATER GRADIENT
n_e = EFFECTIVE POROSITY

7. AERIAL IMAGERY SOURCE: HEXAGON, 25 JULY 2023

N

0 230 460
SCALE IN FEET

HALEY ALDRICH

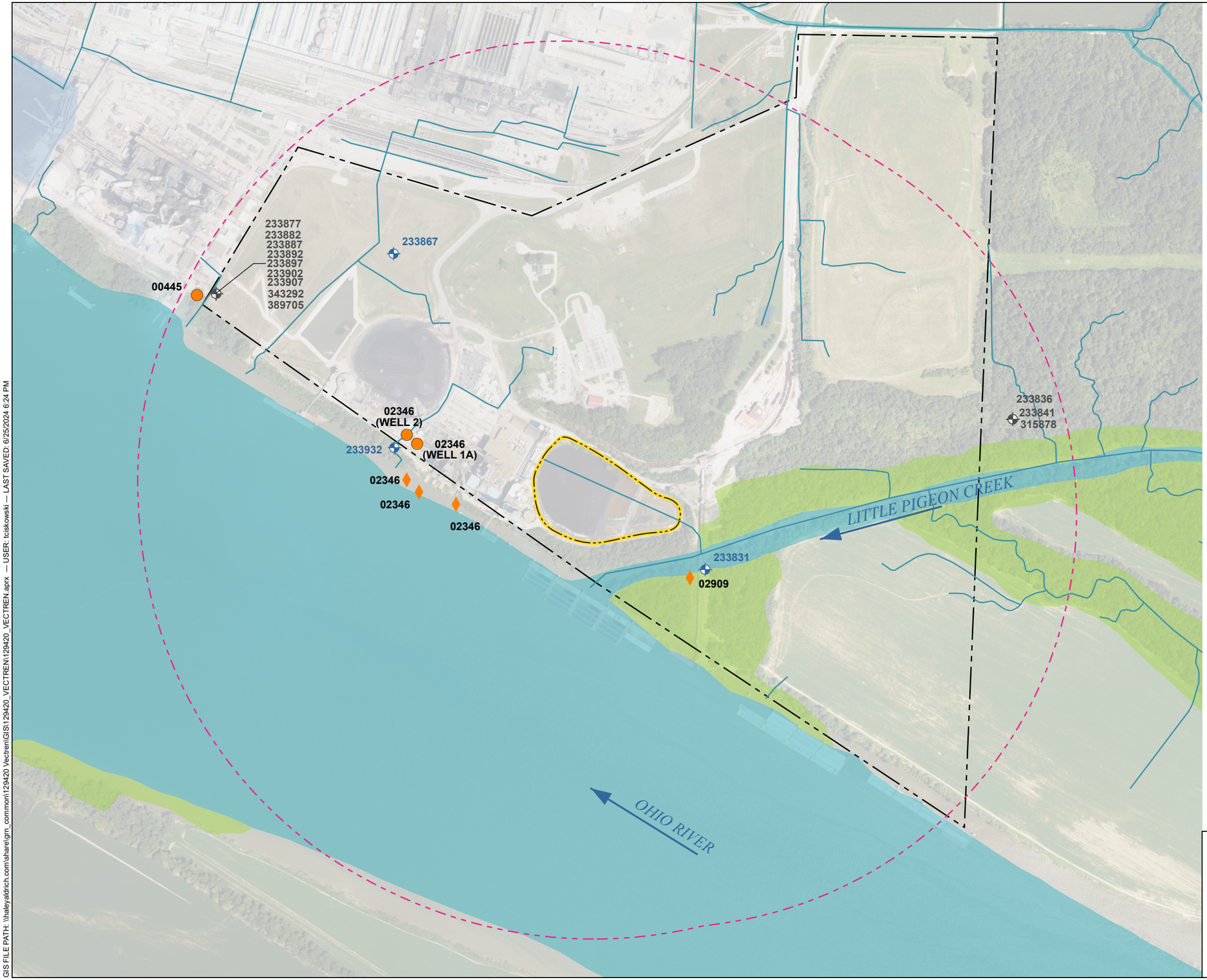
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL NETWORK MAP

DECEMBER 2024

FIGURE 2

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LEGEND

WATER SUPPLY WELL - NOT SIGNIFICANT WITHDRAWAL

- ESTIMATED LOCATION PER INDIANA DEPARTMENT OF NATURAL RESOURCES (IDNR)
- FIELD LOCATED PER IDNR

SIGNIFICANT WATER WITHDRAWAL

- SURFACE WATER INTAKE
- WELL

NATIONAL HYDROGRAPHY DATASET (NHD)

- STREAM

NATIONAL WETLANDS INVENTORY (NWI)

- FRESHWATER FORESTED/SHRUB WETLAND
- FRESHWATER POND
- RIVERINE
- ASH POND HALF MILE RADIUS
- PROPERTY BOUNDARY
- FB CULLEY EAST ASH POND BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. WATER WELL DATA SOURCE: IDNR RECORD DATABASE, https://www.in.gov/dnr/water/ground-water-wells/water-well-record-database, ACCESSED 13 MARCH 2024
3. SIGNIFICANT WATER WITHDRAWL DATA SOURCE: IDNR, https://www.in.gov/dnr/water/water-availability-use-rights/significant-water-withdrawal-facility-data, AUGUST 2023
4. NATIONAL WETLANDS INVENTORY DATA SOURCE: UNITED STATES FISH AND WILDLIFE SERVICE, https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper, ACCESSED 13 MARCH 2024
5. SIGNIFICANT WITHDRAWAL AND WATER WELLS OUTSIDE OF ASH POND HALF MILE RADIUS ARE NOT SHOWN
6. NHD DATA SOURCE: https://prd-tnm.s3.amazonaws.com/index.html?prefix=StagedProducts/Hydrography/NHD/State/GDB/, ACCESSED 5 APRIL 2024
7. AERIAL IMAGERY SOURCE: HEXAGON, 21 JULY 2022

N

0 650 1,300
SCALE IN FEET

HALEY ALDRICH

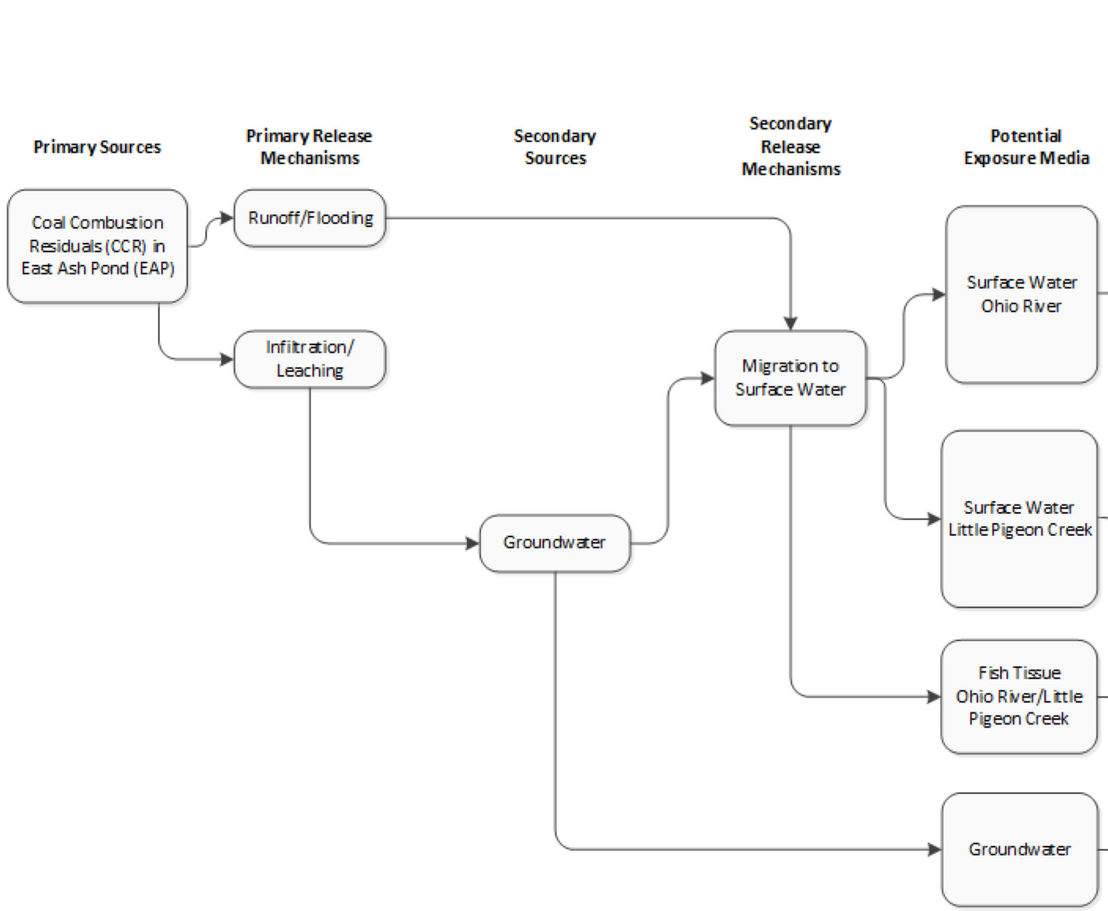
F.B. CULLEY GENERATING STATION
EAST ASH POND
NEWBURGH, INDIANA

WATER WELL LOCATIONS WITHIN A HALF-MILE OF EAST ASH POND

JUNE 2024

FIGURE 3

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	Potential Human Health Receptors						Potential Ecological Receptors
Potential Exposure Route	Current/Future Onsite/Offsite Worker	Current/Future OffSite Resident Adult/Child	Current/Future OffSite Recreational Swimmer	Current/Future Recreational Wader	Current/Future OffSite Recreational Boater	Current/Future Recreational Fisher	Aquatic Receptors
Surface Water Ohio River							
Ingestion	O	●	●	●	O	O	NA
Dermal Contact	O	●	●	●	●	O	NA
Aquatic Exposure	NA	NA	NA	NA	NA	NA	●
Surface Water Little Pigeon Creek							
Ingestion	O	O (b)	O (d)	●	O (d)	O	NA
Dermal Contact	O	O (b)	O (d)	●	O (d)	O	NA
Aquatic Exposure	NA	NA	NA	NA	NA	NA	●
Fish Tissue Ohio River/Little Pigeon Creek							
Ingestion	O	O	O	O	O	●	NA
Groundwater							
Ingestion	●(a)	O (c)	O	O	O	O	NA
Dermal Contact	●(a)	O (c)	O	O	O	O	NA
Aquatic Exposure	NA	NA	NA	NA	NA	NA	O (e)

Notes:

● Pathway evaluated and found potentially complete.

O Pathway evaluated and found incomplete.

(a) Direct contact exposure to groundwater is assumed to be potentially complete for onsite workers at water withdrawal wells Well 1A and Well 2, and onsite/offsite workers at wells further west/northwest (side gradient) Well 1A and Well 2.
(b) Little Pigeon Creek is not used for water supply.
(c) As groundwater does not flow from the EAP towards offsite residential areas, potential exposures to CCR constituents in groundwater in these areas is incomplete.
(d) The size of Little Pigeon Creek precludes swimming and boating activities.
(e) Ecological receptors are not exposed to groundwater.

NA – Not Applicable.

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION EAST ASH POND
NEWBURGH, INDIANA

CONCEPTUAL SITE MODEL

DECEMBER 2024

FIGURE 4

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ATTACHMENT A

Modeling and Dilution-Attenuation Factor Calculations: Groundwater Migration from beneath the East Ash Pond to Onsite Water Withdrawal Wells Well 1A and Well 2

Groundwater Modeling

INTRODUCTION

The Conceptual Site Model (CSM) for the F.B. Culley Generating Station (FBC) located on the Ohio River in Warrick County, Indiana (Site) includes the potential for coal combustion residuals (CCRs) in groundwater to migrate from beneath the East Ash Pond (EAP) to on-Site water withdrawal wells Well 1A and Well 2, where on-Site workers may be potentially exposed to the CCRs via dermal contact or ingestion pathways through the use of water from these wells. This appendix describes the modeling methodologies employed to estimate the percentage of groundwater at these wells that originates from beneath the EAP. This percentage is then converted to a dilution attenuation factor (DAF; USEPA, 1987) that may be used to estimate CCR concentrations in groundwater at the withdrawal wells from measured CCR concentrations in groundwater at the EAP. The following text describes the methods, model construction, assumptions, model calibration, and subsequent calculations.

METHODS AND ASSUMPTIONS

The numerical model MODFLOW-2005 (Harbaugh, 2005) was selected for the modeling effort and is a three-dimensional, finite difference groundwater flow model capable of simulating the groundwater conditions under various scenarios, including pumping and changes to infiltration over time. The model domain of MODFLOW consists of a rectangular grid and allows for establishing groundwater flow boundary conditions that represent actual and Site-specific features in the study area. The setup is facilitated by assigning boundary types and values to specific grid cells.

The three-dimensional finite difference groundwater flow model domain covers a length of 4,300 feet in the x-direction (west to east), 3,800 feet in the y-direction (north to south), and approximately 200 feet in the z-direction (vertical). The model consists of 246 rows, 282 columns, and eight layers, for a total of 554,976 cells that cover an approximate area of 375 acres.

Boundary conditions define the locations and manner in which water enters and exits the active model domain. The following boundary conditions were utilized in the MODFLOW-2005 model:

- The Ohio River is used to estimate the southern boundary head elevations and is the major groundwater discharge feature.
- A specified head boundary condition is used to simulate recharge along the topographic high, north of the EAP.
- The receptor withdrawal wells are simulated in the transient condition and assigned a constant discharge rate of 627 gallons per minute (gpm), based on the higher of the average pumping rates for the two wells (for Well 1A).[1]

The groundwater model domain and the locations of Well 1A and Well 2 are shown in the attached **Figure A1**. As shown in the figure, most of the approximate 375-acre model domain (approximately 300 acres) is assigned as active model cells. Areas upgradient of the specified head boundary condition along the topographic high north of the EAP (approximately 75 acres) are assigned as inactive model cells.

[1] By comparison, the average pumping rate for Well 2 is 422 gpm. Use of the higher average pumping rate for Well 1A as a constant discharge rate is conservative given that actual pumping is alternated between the two wells approximately eight times per day, one at a time, to fill an on-Site water storage tank. For conservatism, the groundwater flow model assumes the withdrawal wells are operating without interruption for the entire model simulation period.

Hydraulic properties were applied within discrete model layers to present hydrogeologic units present at the Site. Results of the initial calibration indicated that hydraulic conductivities in the range of those values associated with material described in boring logs and the field-measured values during the August 2023 Keller aquifer test were representative with regard to groundwater flow observed at the Site. The hydraulic conductivity values used in the model are presented below for the three hydrogeologic units underlying the Site:

- Bedrock – 0.1 feet per day (ft/day) or 3.5 x 10^{-5} centimeters per second (cm/s)
- Fine-grained soils – 0.15 ft/day or 5.3 x 10^{-5} cm/s
- Coarse-grained sand – 669.3 ft/day or 2.4 x 10^{-1} cm/s

CALIBRATION

Model calibration is the process of refining the model representation of the hydrogeologic framework, hydraulic properties, and boundary conditions to minimize the difference between the simulated groundwater elevations to the measured data. Groundwater flow field calibration for the Site has been conducted to provide a reasonable representation of the groundwater flow field in the vicinity of the Site, which forms the basis of assessing the direction and magnitude of groundwater flow at the Site. To accomplish this objective, the numerical model was calibrated to simulate observed May 2024 Site groundwater levels. Flow calibration metrics are used to assess the model calibration quality. Root mean square (RMS) error is the square root of the average of the squares of the differences in simulated and observed groundwater levels, and normalized RMS error is the ratio of the RMS error of the groundwater levels to the range of observed groundwater levels. RMS error for the calibrated model was +7.37 feet and the normalized RMS error was 10.0 percent. The numerical goals for the groundwater flow model are to achieve a normalized RMS error to be at least 10 percent or less (Anderson and Woessner, 1992). The calibration has met calibration targets, and the groundwater flow model is considered to be usable for the DAF calculation described below.

DILUTION ATTENUATION FACTOR

Using the calibrated flow model described above, a model simulation was performed to estimate the ratio of well water discharge at the receptor withdrawal wells coming from beneath the aquifer beneath the EAP unit. To perform this calculation, a constant unit concentration of 1,000 is applied to the groundwater model grid cells underlying the EAP. The model simulation was run for a period of 100 years, assuming a constant groundwater extraction rate of 627 gpm at the receptor withdrawal wells. The groundwater concentration trend is monitored at the receptor withdrawal wells until groundwater concentrations reach the steady-state condition. The ratio of the steady-state concentration at the receptor withdrawal wells compared to the unit concentration applied to the grid cells is then calculated as the DAF. Table 1 below summarizes the model's estimated DAF:

Table I – Estimated Dilution Attenuation Factor

C_{unit} Constant Concentration Applied to Grid Cells Beneath the East Ash Pond (unitless)	**C_{well} Steady-State Groundwater Concentration in Receptor Well Water (unitless)**	**Dilution Attenuation Factor (DAF)**
1,000	3.7	270

Note: *DAF is calculated using the formula, DAF = $C_{unit} \div C_{well}$.*

LIMITATIONS

Models were built using the available information to support evaluations and conclusions. The model's level of accuracy is directly dependent on the data available to construct the model and should not be construed by the user as a definitive answer. Instead, the model should be used in comparison with other calculations to provide a range of values to be considered in the risk assessment.

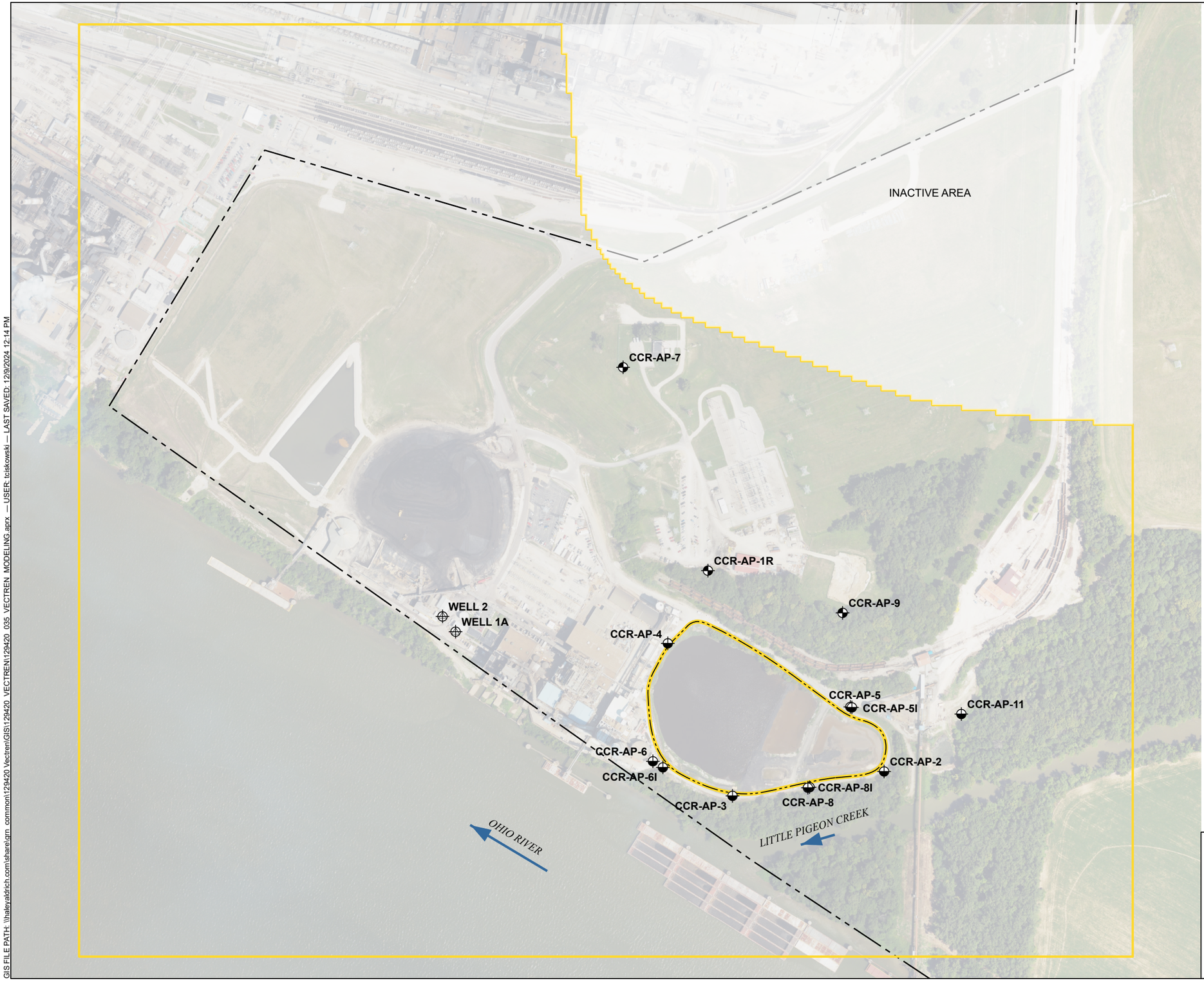
References

1. Anderson, M.P., Woessner. WW, 1992. Applied Groundwater Modeling. Simulation of Flow and Advective Transport.

2. Harbaugh, A.W., 2005, MODFLOW-2005, the US Geological Survey modular ground-water model: the ground-water flow process (Vol. 6). Reston, VA, USA: US Department of the Interior, US Geological Survey.

3. United States Environmental Protection Agency, 1987. Alternative Concentration Limit Guidance, Part 1, ACL Policy and Information Requirement, Interim Final, OSWER Directive 9481.00-6C, EPA/530-SW-87-017, July.

https://haleyaldrich.sharepoint.com/sites/VectrenCorporation/Shared Documents/0129420.Culley/Deliverables/East Ash Pond/Culley Remedy Selection Report/Appendix E - Groundwater Risk Evaluation/Attachments/Attachment A - GW Modeling/2024-12_HAI_FP Culley EAP GW Risk Eval_AttAText.docx



LEGEND

- EXTRACTION WELL
- UPGRADIENT GROUNDWATER MONITORING WELL
- DOWNGRADIENT GROUNDWATER MONITORING WELL
- SURFACE WATER FLOW DIRECTION
- ASH POND BOUNDARY
- ACTIVE AREA
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

2. WELL DESIGNATION:
CCR = COAL COMBUSTION RESIDUALS
AP = ASH POND
R = REPLACED
I = INTERMEDIATE

3. AERIAL IMAGERY SOURCE: HEXAGON 25 JULY, 2023

N

0 400 800
SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

EAST ASH POND MODEL DOMAIN

DECEMBER 2024

FIGURE 1

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ATTACHMENT B
Derivation of Risk-Based Screening Levels for Recreational Use of Surface Water

TABLE B-1
EXPOSURE PARAMETERS FOR DERIVATION OF RISK-BASED SCREENING LEVELS FOR RECREATIONAL USE OF SURFACE WATER
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Exposure Parameter		Units	Current/Future Off-Site Recreational Swimmer				Current/Future Off-Site Recreational Wader				Current/Future Off-Site Recreational Boater Adult
			Child (Age <6)	Adolescent (6-<16 years)	Adult	Child, Adolescent and Adult (Ages 1 - 26)	Child (Age <6)	Adolescent (6-<16 years)	Adult	Child, Adolescent and Adult (Ages 1 - 26)	
			Value / Source	Value / Source	Value / Source	Value / Source	Value / Source	Value / Source	Value / Source	Value / Source	Value / Source
Standard Parameters											
Body Weight	BW	kg	15 USEPA, 2014a	44 USEPA, 2011 [1]	80 USEPA, 2014a	NA	15 USEPA, 2014a	44 USEPA, 2011 [1]	80 USEPA, 2014a	NA	80 USEPA, 2014a
Exposure Duration	ED	years	6 Ages <6	10 Ages 6 - <16	10 Balance of 26-yr exposure	26	6 Ages <6	10 Ages 6 - <16	10 Balance of 26-yr exposure	26	10 Balance of 26-yr exposure
Non–carcinogenic Averaging Time	ATnc	days	2190 ED expressed in days	3650 ED expressed in days	3650 ED expressed in days	9490 ED expressed in days	2190 ED expressed in days	3650 ED expressed in days	3650 ED expressed in days	9490 ED expressed in days	3650 ED expressed in days
Carcinogenic Averaging Time	ATc	days	25550 70 year lifetime	25550 70 year lifetime	25550 70 year lifetime	25550 70 year lifetime	25550 70 year lifetime	25550 70 year lifetime	25550 70 year lifetime	25550 70 year lifetime	25550 70 year lifetime
Incidental Ingestion of Surface Water											
Exposure Frequency	EF	days/year	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	NA
Water Ingestion Rate	IR	L/day	0.10 USEPA, 2014b [3]	0.10 USEPA, 2014b [3]	0.10 USEPA, 2014b [3]	NA	0.10 USEPA, 2014b [4]	0.02 USEPA, 2014b [4]	0.02 USEPA, 2014b [4]	NA	NA
Fraction Ingested	FI	unitless	1.0 Assumption	1.0 Assumption	1.0 Assumption	1.0 Assumption	1.0 Assumption	1.0 Assumption	1.0 Assumption	1.0 Assumption	NA
Age-Adjusted Water Ingestion Factor	IFWadj	L/kg	NA	NA	NA	3.39	NA	NA	NA	2.12	NA
Age-Adjusted Water Ingestion Factor-Mutagenic	IFWM	L/kg	NA	NA	NA	13.23	NA	NA	NA	10.33	NA
Dermal Exposure with Surface Water											
Exposure Frequency	EF	days/year	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]	45 USEPA, 2018 [2]
Exposed Skin Surface Area	SA	cm^2	6365 USEPA, 2014a	13350 USEPA, 2011 [5]	19652 USEPA, 2014a	NA	1749 USEPA, 2011 [6]	3944 USEPA, 2011 [6]	6075 USEPA, 2011 [6]	NA	6075 USEPA, 2011 [6]
Exposure Time	t-event	hr/event	2 Site-specific [7]	2 Site-specific [7]	2 Site-specific [7]	2 Site-specific [7]	2 Site-specific [7]	2 Site-specific [7]	2 Site-specific [7]	2 Site-specific [7]	2 Site-specific [7]
Events per Day	EV	event/day	1 Site-specific [7]	1 Site-specific [7]	1 Site-specific [7]	1 Site-specific [7]	1 Site-specific [7]	1 Site-specific [7]	1 Site-specific [7]	1 Site-specific [7]	1 Site-specific [7]
Age-Adjusted Dermal Contact Factor	DFWadj	events-cm^2/kg	NA	NA	NA	361647	NA	NA	NA	105990	NA
Age-Adjusted Dermal Contact Factor-Mutagenic	DFWM	events-cm^2/kg	NA	NA	NA	1131185	NA	NA	NA	323085	NA

TABLE B-1
EXPOSURE PARAMETERS FOR DERIVATION OF RISK-BASED SCREENING LEVELS FOR RECREATIONAL USE OF SURFACE WATER
F.B. CULLEY GENERATING STATION - EAST ASH POND
NEWBURGH, INDIANA

Notes and Abbreviations:

NA = not applicable
USEPA, 2011 - Exposure Factors Handbook. USEPA/600/R-10/030. October, 2011.
USEPA, 2014a - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER 9200.1-120. February 6, 2014.
USEPA, 2014b - Region 4 Human Health Risk Assessment Supplemental Guidance. January 2014. Draft Final.
USEPA, 2018 - Region 4 Human Health Risk Assessment Supplemental Guidance. March 2018 Update.
[1] - Table 8-1 of USEPA (2011); weighted average of mean body weights (6 to <16 years)
[2] - Default exposure frequency for swimming in the southeast
[3] - Based on USEPA Region 4-recommended ingestion rate of 50 mL/hour for exposures to water during swimming (USEPA, 2014b), site-specific exposure time (2 hours per event), and site-specific events per day (1).
The water ingestion rate in liters/day is calculated as follows: ingestion (mL/hr) x exposure time (hr/event)/1000 (mL/L) x events per day (1)
[4] - Based on USEPA Region 4-recommended ingestion rates of 50 mL/hour for children (age <6) and 10 mL/hour for adolescents and adults for exposures to water during wading (USEPA, 2014b), site-specific exposure time (2 hours per event), and site-specific events per day (1).
The water ingestion rate in liters/day is calculated as follows: ingestion (mL/hr) x exposure time (hr/event)/1000 (mL/L) x events per day (1)
[5] - Table 7-1 of USEPA (2011); weighted average of mean skin surface area (6 to <16 years)
[6] - Based on surface area of hands, forearms, lower legs, and feet
[7] - Assumes 2 hours per event, 1 event per day, and that on days when recreation in water occurs, all daily exposure to water is derived from locations at the Site.

Values based on a time-weighted average of child, adolescent, and adult exposure values are calculated as follows:
Water
IFWadj = (child ED [0-2] x child EF [0-2] x child IR [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] / child BW [2-6]) + (older child ED [6-16] x older child EF [6-16] x older child IR [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR / adult BW)
DFWadj = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] / older child BW [6-16]) + (adult EF x adult ED x adult SA x adult EV / adult BW)
Water - mutagenic
IFWM = (child ED [0-2] x child EF [0-2] x child IR [0-2] x ADAF [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] x ADAF [2-6] / child BW [2-6]) + (older child ED [6-16] x child EF [6-16] x older child IR [6-16] x ADAF [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR x adult ADAF / adult BW)
DFWM = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] x ADAF [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] x ADAF [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] x ADAF [6-16] / older child BW [6-16]) +
(adult EF x adult ED x adult SA x adult EV x adult ADAF / adult BW)
USEPA guidance for early life exposure to carcinogens (USEPA, 2005) requires that risks for potentially carcinogenic constituents that are presumed to act by a mutagenic mode of action be calculated differently than for constituents that do not act via a mutagenic mode of action.
Therefore, the age-dependent adjustment factors (ADAF) will be applied for calculations involving children under the age of 16. The ADAFs are as follows:
Age 0 to 2 years (2 year interval from birth until 2nd birthday) – ADAF = 10
Ages 2 to 16 years (14 year interval from 2nd birthday to 16th birthday) – ADAF = 3
Ages 16 and up (after 16th birthday) – no adjustment - ADAF = 1
The exposure parameters for children ages <6 are applied to children 0 - 2 and 2- 6.

ATTACHMENT B
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGIONAL SCREENING LEVEL CALCULATOR
INPUT VALUES - RECREATIONAL SWIMMER

Variable	Recreator Surface Water Default Value	Site-Specific Value
BW_{0-2} (body weight) kg	15	15
BW_{2-6} (body weight) kg	15	15
BW_{6-16} (body weight) kg	80	44
BW_{16-26} (body weight) kg	80	80
BW_{rec-c} (body weight - adult) kg	15	15
BW_{rec-a} (body weight - adult) kg	80	62
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	354100.645
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	1131184.77
ED_{rec} (exposure duration - recreator) years	26	26
ED_{0-2} (exposure duration) years	2	2
ED_{2-6} (exposure duration) years	4	4
ED_{6-16} (exposure duration) years	10	10
ED_{16-26} (exposure duration) years	10	10
ED_{rec-a} (exposure duration - adult) years	20	20
EF_{rec} (exposure frequency) days/year	0	45
EF_{2-6} (exposure frequency) days/year	0	45
EF_{6-16} (exposure frequency) days/year	0	45
EF_{16-26} (exposure frequency) days/year	0	45
EF_{rec-a} (adult exposure frequency) days/year	0	45
ET_{0-2} (exposure time) hours/event	0	2
ET_{2-6} (exposure time) hours/event	0	2
ET_{6-16} (exposure time) hours/event	0	2
ET_{16-26} (exposure time) hours/event	0	2
ET_{rec-a} (adult exposure time) hours/event	0	2
EV_{0-2} (events) events/day	0	1
EV_{2-6} (events) events/day	0	1
EV_{6-16} (events) events/day	0	1
EV_{16-26} (events) events/day	0	1
EV_{rec-a} (adult) events/day	0	1
THQ (target hazard quotient) unitless	0.1	1
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	3.252
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	13.231
IRW_{0-2} (water intake rate) L/hour	0.12	0.05
IRW_{2-6} (water intake rate) L/hour	0.12	0.05
IRW_{6-16} (water intake rate) L/hour	0.124	0.05
IRW_{16-26} (water intake rate) L/hour	0.0985	0.05
IRW_{rec-a} (water intake rate - adult) L/hr	0.11	0.05
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2	6365	6365
SA_{2-6} (skin surface area) cm^2	6365	6365
SA_{6-16} (skin surface area) cm^2	19652	13350
SA_{16-26} (skin surface area) cm^2	19652	19652
SA_{rec} (skin surface area - adult) cm^2	19652	16501
SA_{rec-a} (skin surface area - adult) cm^2	19652	16501
Apparent thickness of stratum corneum (cm)	0.001	0.001
TR (target risk) unitless	0.000001	0.0001

Output generated 21FEB2025:14:03:26

ATTACHMENT B
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGIONAL SCREENING LEVEL CALCULATOR
OUTPUT VALUES - RECREATIONAL SWIMMER

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$	$DA_{event\ (nc\ adult)}$	Ingestion SL TR=0.0001 (ug/L)	Dermal SL TR=0.0001 (ug/L)	Carcinogenic SL TR=0.0001 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)	Screening Level (ug/L)
Antimony (metallic)	7440-36-0	No	No	Inorganics	Inorganics	-		4.00E-04	U	3.00E-04	U	1.50E-01	1.00E-03	1.22E+02	1.00E+00	Yes	-	1.15E-03	1.83E-03	-	-	-	4.87E+02	5.73E+02	2.63E+02	2.01E+03	9.14E+02	6.29E+02	2.63E+02 nc
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	Inorganics	3.20E+01	U	6.00E-05	U	1.50E-05	U	1.00E+00	1.00E-03	7.49E+01	1.00E+00	Yes	2.25E-04	1.15E-03	1.83E-03	2.46E+01	1.13E+02	2.02E+01	7.30E+01	5.73E+02	6.48E+01	3.02E+02	9.14E+02	2.27E+02	2.02E+01 ca
Barium	7440-39-3	No	No	Inorganics	Inorganics	-		2.00E-01	U	5.00E-04	U	7.00E-02	1.00E-03	1.37E+02	1.00E+00	Yes	-	2.68E-01	4.27E-01	-	-	-	2.43E+05	1.34E+05	8.63E+04	1.01E+06	2.13E+05	1.76E+05	8.63E+04 nc
Beryllium and compounds	7440-41-7	No	No	Inorganics	Inorganics	-		2.00E-03	U	2.00E-05	U	7.00E-03	1.00E-03	9.01E+00	1.00E+00	Yes	-	2.68E-04	4.27E-04	-	-	-	2.43E+03	1.34E+02	1.27E+02	1.01E+04	2.13E+02	2.09E+02	1.27E+02 nc
Boron And Borates Only	7440-42-8	No	No	Inorganics	Inorganics	-		2.00E-01	U	2.00E-02	U	1.00E+00	1.00E-03	1.38E+01	1.00E+00	Yes	-	3.82E+00	6.10E+00	-	-	-	2.43E+05	1.91E+06	2.16E+05	1.01E+06	3.05E+06	7.56E+05	2.16E+05 nc max
Cadmium (Water)	7440-43-9	No	No	Inorganics	Inorganics	-		1.00E-04	U	1.00E-05	U	5.00E-02	1.00E-03	1.12E+02	1.00E+00	Yes	-	9.56E-05	1.52E-04	-	-	-	1.22E+02	4.78E+01	3.43E+01	5.03E+02	7.62E+01	6.62E+01	3.43E+01 nc
Chromium(III), Insoluble Salts	16065-83-1	No	No	Inorganics	Inorganics	-		1.50E+00	U	-		1.30E-02	1.00E-03	5.20E+01	1.00E+00	Yes	-	3.73E-01	5.94E-01	-	-	-	1.83E+06	1.86E+05	1.69E+05	7.54E+06	2.97E+05	2.86E+05	1.69E+05 nc max
Cobalt	7440-48-4	No	No	Inorganics	Inorganics	-		3.00E-04	U	6.00E-06	U	1.00E+00	4.00E-04	5.89E+01	1.00E+00	Yes	-	5.73E-03	9.14E-03	-	-	-	3.65E+02	7.17E+03	3.47E+02	1.51E+03	1.14E+04	1.33E+03	3.47E+02 nc
Fluoride	16984-48-8	No	No	Inorganics	Inorganics	-		4.00E-02	U	1.30E-02	U	1.00E+00	1.00E-03	3.80E+01	1.00E+00	Yes	-	7.65E-01	1.22E+00	-	-	-	4.87E+04	3.82E+05	4.32E+04	2.01E+05	6.10E+05	1.51E+05	4.32E+04 nc
Lithium	7439-93-2	No	No	Inorganics	Inorganics	-		2.00E-03	U	-		1.00E+00	1.00E-03	6.94E+00	1.00E+00	Yes	-	3.82E-02	6.10E-02	-	-	-	2.43E+03	1.91E+04	2.16E+03	1.01E+04	3.05E+04	7.56E+03	2.16E+03 nc
Mercuric Chloride	7487-94-7	No	No	Inorganics	Inorganics	-		3.00E-04	U	3.00E-04	U	7.00E-02	1.00E-03	2.72E+02	1.00E+00	Yes	-	4.01E-04	6.40E-04	-	-	-	3.65E+02	2.01E+02	1.29E+02	1.51E+03	3.20E+02	2.64E+02	1.29E+02 nc
Molybdenum	7439-98-7	No	No	Inorganics	Inorganics	-		5.00E-03	U	2.00E-03	U	1.00E+00	1.00E-03	9.59E+01	1.00E+00	Yes	-	9.56E-02	1.52E-01	-	-	-	6.08E+03	4.78E+04	5.40E+03	2.51E+04	7.62E+04	1.89E+04	5.40E+03 nc
Selenium	7782-49-2	No	No	Inorganics	Inorganics	-		5.00E-03	U	2.00E-02	U	1.00E+00	1.00E-03	7.90E+01	1.00E+00	Yes	-	9.56E-02	1.52E-01	-	-	-	6.08E+03	4.78E+04	5.40E+03	2.51E+04	7.62E+04	1.89E+04	5.40E+03 nc
Thallium (Soluble Salts)	7440-28-0	No	No	Inorganics	Inorganics	-		1.00E-05	U	-		1.00E+00	1.00E-03	2.04E+02	1.00E+00	Yes	-	1.91E-04	3.05E-04	-	-	-	1.22E+01	9.56E+01	1.08E+01	5.03E+01	1.52E+02	3.78E+01	1.08E+01 nc

Output generated 21FEB2025:14:03:26

ATTACHMENT B
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGIONAL SCREENING LEVEL CALCULATOR
INPUT VALUES - RECREATIONAL WADER

Variable	Recreator Surface Water Default Value	Site-Specific Value
BW_{0-2} (body weight) kg	15	15
BW_{2-6} (body weight) kg	15	15
BW_{6-16} (body weight) kg	80	44
BW_{16-26} (body weight) kg	80	80
BW_{rec-c} (body weight - adult) kg	15	15
BW_{rec-a} (body weight - adult) kg	80	62
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	104200.548
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	323084.966
ED_{rec} (exposure duration - recreator) years	26	26
ED_{0-2} (exposure duration) years	2	2
ED_{2-6} (exposure duration) years	4	4
ED_{6-16} (exposure duration) years	10	10
ED_{16-26} (exposure duration) years	10	10
ED_{rec-a} (exposure duration - adult) years	20	20
EF_{rec} (exposure frequency) days/year	0	45
EF_{2-6} (exposure frequency) days/year	0	45
EF_{6-16} (exposure frequency) days/year	0	45
EF_{16-26} (exposure frequency) days/year	0	45
EF_{rec-a} (adult exposure frequency) days/year	0	45
ET_{0-2} (exposure time) hours/event	0	2
ET_{2-6} (exposure time) hours/event	0	2
ET_{6-16} (exposure time) hours/event	0	2
ET_{16-26} (exposure time) hours/event	0	2
ET_{rec-a} (adult exposure time) hours/event	0	2
EV_{0-2} (events) events/day	0	1
EV_{2-6} (events) events/day	0	1
EV_{6-16} (events) events/day	0	1
EV_{16-26} (events) events/day	0	1
EV_{rec-a} (adult) events/day	0	1
THQ (target hazard quotient) unitless	0.1	1
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	2.09
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	10.326
IRW_{0-2} (water intake rate) L/hour	0.12	0.05
IRW_{2-6} (water intake rate) L/hour	0.12	0.05
IRW_{6-16} (water intake rate) L/hour	0.124	0.01
IRW_{16-26} (water intake rate) L/hour	0.0985	0.01
IRW_{rec-a} (water intake rate - adult) L/hr	0.11	0.01
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2	6365	1749
SA_{2-6} (skin surface area) cm^2	6365	1749
SA_{6-16} (skin surface area) cm^2	19652	3944
SA_{16-26} (skin surface area) cm^2	19652	6075
SA_{rec} (skin surface area - adult) cm^2	19652	5009.5
SA_{rec-a} (skin surface area - adult) cm^2	19652	5009.5
Apparent thickness of stratum corneum (cm)	0.001	0.001
TR (target risk) unitless	0.000001	0.0001

Output generated 21FEB2025:14:19:50

ATTACHMENT B
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGIONAL SCREENING LEVEL CALCULATOR
OUTPUT VALUES - RECREATIONAL WADER

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$	$DA_{event\ (nc\ adult)}$	Ingestion SL TR=0.0001 (ug/L)	Dermal SL TR=0.0001 (ug/L)	Carcinogenic SL TR=0.0001 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)	Screening Level (ug/L)
Antimony (metallic)	7440-36-0	No	No	Inorganics	Inorganics	-		4.00E-04	U	3.00E-04	U	1.50E-01	1.00E-03	1.22E+02	1.00E+00	Yes	-	4.17E-03	6.02E-03	-	-	-	4.87E+02	2.09E+03	3.95E+02	1.01E+04	3.01E+03	2.32E+03	3.95E+02 nc
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	Inorganics	3.20E+01	U	6.00E-05	U	1.50E-05	U	1.00E+00	1.00E-03	7.49E+01	1.00E+00	Yes	7.66E-04	4.17E-03	6.02E-03	3.82E+01	3.83E+02	3.47E+01	7.30E+01	2.09E+03	7.05E+01	1.51E+03	3.01E+03	1.01E+03	3.47E+01 ca
Barium	7440-39-3	No	No	Inorganics	Inorganics	-		2.00E-01	U	5.00E-04	U	7.00E-02	1.00E-03	1.37E+02	1.00E+00	Yes	-	9.74E-01	1.41E+00	-	-	-	2.43E+05	4.87E+05	1.62E+05	5.03E+06	7.03E+05	6.17E+05	1.62E+05 nc max
Beryllium and compounds	7440-41-7	No	No	Inorganics	Inorganics	-		2.00E-03	U	2.00E-05	U	7.00E-03	1.00E-03	9.01E+00	1.00E+00	Yes	-	9.74E-04	1.41E-03	-	-	-	2.43E+03	4.87E+02	4.06E+02	5.03E+04	7.03E+02	6.93E+02	4.06E+02 nc
Boron And Borates Only	7440-42-8	No	No	Inorganics	Inorganics	-		2.00E-01	U	2.00E-02	U	1.00E+00	1.00E-03	1.38E+01	1.00E+00	Yes	-	1.39E+01	2.01E+01	-	-	-	2.43E+05	6.96E+06	2.35E+05	5.03E+06	1.00E+07	3.35E+06	2.35E+05 nc max
Cadmium (Water)	7440-43-9	No	No	Inorganics	Inorganics	-		1.00E-04	U	1.00E-05	U	5.00E-02	1.00E-03	1.12E+02	1.00E+00	Yes	-	3.48E-04	5.02E-04	-	-	-	1.22E+02	1.74E+02	7.16E+01	2.51E+03	2.51E+02	2.28E+02	7.16E+01 nc
Chromium(III), Insoluble Salts	16065-83-1	No	No	Inorganics	Inorganics	-		1.50E+00	U	-		1.30E-02	1.00E-03	5.20E+01	1.00E+00	Yes	-	1.36E+00	1.96E+00	-	-	-	1.83E+06	6.78E+05	4.94E+05	3.77E+07	9.79E+05	9.54E+05	4.94E+05 nc max
Cobalt	7440-48-4	No	No	Inorganics	Inorganics	-		3.00E-04	U	6.00E-06	U	1.00E+00	4.00E-04	5.89E+01	1.00E+00	Yes	-	2.09E-02	3.01E-02	-	-	-	3.65E+02	2.61E+04	3.60E+02	7.54E+03	3.76E+04	6.28E+03	3.60E+02 nc
Fluoride	16984-48-8	No	No	Inorganics	Inorganics	-		4.00E-02	U	1.30E-02	U	1.00E+00	1.00E-03	3.80E+01	1.00E+00	Yes	-	2.78E+00	4.02E+00	-	-	-	4.87E+04	1.39E+06	4.70E+04	1.01E+06	2.01E+06	6.70E+05	4.70E+04 nc
Lithium	7439-93-2	No	No	Inorganics	Inorganics	-		2.00E-03	U	-		1.00E+00	1.00E-03	6.94E+00	1.00E+00	Yes	-	1.39E-01	2.01E-01	-	-	-	2.43E+03	6.96E+04	2.35E+03	5.03E+04	1.00E+05	3.35E+04	2.35E+03 nc
Mercuric Chloride	7487-94-7	No	No	Inorganics	Inorganics	-		3.00E-04	U	3.00E-04	U	7.00E-02	1.00E-03	2.72E+02	1.00E+00	Yes	-	1.46E-03	2.11E-03	-	-	-	3.65E+02	7.30E+02	2.43E+02	7.54E+03	1.05E+03	9.25E+02	2.43E+02 nc
Molybdenum	7439-98-7	No	No	Inorganics	Inorganics	-		5.00E-03	U	2.00E-03	U	1.00E+00	1.00E-03	9.59E+01	1.00E+00	Yes	-	3.48E-01	5.02E-01	-	-	-	6.08E+03	1.74E+05	5.88E+03	1.26E+05	2.51E+05	8.38E+04	5.88E+03 nc
Selenium	7782-49-2	No	No	Inorganics	Inorganics	-		5.00E-03	U	2.00E-02	U	1.00E+00	1.00E-03	7.90E+01	1.00E+00	Yes	-	3.48E-01	5.02E-01	-	-	-	6.08E+03	1.74E+05	5.88E+03	1.26E+05	2.51E+05	8.38E+04	5.88E+03 nc
Thallium (Soluble Salts)	7440-28-0	No	No	Inorganics	Inorganics	-		1.00E-05	U	-		1.00E+00	1.00E-03	2.04E+02	1.00E+00	Yes	-	6.96E-04	1.00E-03	-	-	-	1.22E+01	3.48E+02	1.18E+01	2.51E+02	5.02E+02	1.68E+02	1.18E+01 nc

Output generated 21FEB2025:14:19:50

ATTACHMENT B
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGIONAL SCREENING LEVEL CALCULATOR
INPUT VALUES - RECREATIONAL BOATER

Variable	Recreator Surface Water Default Value	Site-Specific Value
BW_{0-2} (body weight) kg	15	0
BW_{2-6} (body weight) kg	15	0
BW_{6-16} (body weight) kg	80	0
BW_{16-26} (body weight) kg	80	80
BW_{rec-c} (body weight - adult) kg	15	0
BW_{rec-a} (body weight - adult) kg	80	80
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	34171.875
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	34171.875
ED_{rec} (exposure duration - recreator) years	26	10
ED_{0-2} (exposure duration) years	2	0
ED_{2-6} (exposure duration) years	4	0
ED_{6-16} (exposure duration) years	10	0
ED_{16-26} (exposure duration) years	10	10
ED_{rec-a} (exposure duration - adult) years	20	10
EF_{rec} (exposure frequency) days/year	0	45
EF_{2-6} (exposure frequency) days/year	0	0
EF_{6-16} (exposure frequency) days/year	0	0
EF_{16-26} (exposure frequency) days/year	0	45
EF_{rec-a} (adult exposure frequency) days/year	0	45
ET_{0-2} (exposure time) hours/event	0	0
ET_{2-6} (exposure time) hours/event	0	0
ET_{6-16} (exposure time) hours/event	0	0
ET_{16-26} (exposure time) hours/event	0	2
ET_{rec-a} (adult exposure time) hours/event	0	2
EV_{0-2} (events) events/day	0	0
EV_{2-6} (events) events/day	0	0
EV_{6-16} (events) events/day	0	0
EV_{16-26} (events) events/day	0	1
EV_{rec-a} (adult) events/day	0	1
THQ (target hazard quotient) unitless	0.1	1
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	0
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	0
IRW_{0-2} (water intake rate) L/hour	0.12	0
IRW_{2-6} (water intake rate) L/hour	0.12	0
IRW_{6-16} (water intake rate) L/hour	0.124	0
IRW_{16-26} (water intake rate) L/hour	0.0985	0
IRW_{rec-a} (water intake rate - adult) L/hr	0.11	0
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2	6365	0
SA_{2-6} (skin surface area) cm^2	6365	0
SA_{6-16} (skin surface area) cm^2	19652	0
SA_{16-26} (skin surface area) cm^2	19652	6075
SA_{rec} (skin surface area - adult) cm^2	19652	6075
SA_{rec-a} (skin surface area - adult) cm^2	19652	6075
Apparent thickness of stratum corneum (cm)	0.001	0.001
TR (target risk) unitless	0.000001	0.0001

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ATTACHMENT B
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGIONAL SCREENING LEVEL CALCULATOR
OUTPUT VALUES - RECREATIONAL BOATER

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	DA_{event} (nc child)	DA_{event} (nc adult)	Ingestion SL TR=0.0001 (ug/L)	Dermal SL TR=0.0001 (ug/L)	Carcinogenic SL TR=0.0001 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)	Screening Level (ug/L)
Antimony (metallic)	7440-36-0	No	No	Inorganics	Inorganics	-		4.00E-04	U	3.00E-04	U	1.50E-01	1.00E-03	1.22E+02	1.00E+00	Yes	-	-	6.41E-03	-	-	-	-	-	-	-	3.20E+03	3.20E+03	3.20E+03 nc
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	Inorganics	3.20E+01	U	6.00E-05	U	1.50E-05	U	1.00E+00	1.00E-03	7.49E+01	1.00E+00	Yes	2.34E-03	-	6.41E-03	-	1.17E+03	1.17E+03	-	-	-	-	3.20E+03	3.20E+03	1.17E+03 ca
Barium	7440-39-3	No	No	Inorganics	Inorganics	-		2.00E-01	U	5.00E-04	U	7.00E-02	1.00E-03	1.37E+02	1.00E+00	Yes	-	-	1.50E+00	-	-	-	-	-	-	-	7.48E+05	7.48E+05	7.48E+05 nc max
Beryllium and compounds	7440-41-7	No	No	Inorganics	Inorganics	-		2.00E-03	U	2.00E-05	U	7.00E-03	1.00E-03	9.01E+00	1.00E+00	Yes	-	-	1.50E-03	-	-	-	-	-	-	-	7.48E+02	7.48E+02	7.48E+02 nc
Boron And Borates Only	7440-42-8	No	No	Inorganics	Inorganics	-		2.00E-01	U	2.00E-02	U	1.00E+00	1.00E-03	1.38E+01	1.00E+00	Yes	-	-	2.14E+01	-	-	-	-	-	-	-	1.07E+07	1.07E+07	1.07E+07 nc max
Cadmium (Water)	7440-43-9	No	No	Inorganics	Inorganics	-		1.00E-04	U	1.00E-05	U	5.00E-02	1.00E-03	1.12E+02	1.00E+00	Yes	-	-	5.34E-04	-	-	-	-	-	-	-	2.67E+02	2.67E+02	2.67E+02 nc
Chromium(III), Insoluble Salts	16065-83-1	No	No	Inorganics	Inorganics	-		1.50E+00	U	-		1.30E-02	1.00E-03	5.20E+01	1.00E+00	Yes	-	-	2.08E+00	-	-	-	-	-	-	-	1.04E+06	1.04E+06	1.04E+06 nc max
Cobalt	7440-48-4	No	No	Inorganics	Inorganics	-		3.00E-04	U	6.00E-06	U	1.00E+00	4.00E-04	5.89E+01	1.00E+00	Yes	-	-	3.20E-02	-	-	-	-	-	-	-	4.01E+04	4.01E+04	4.01E+04 nc
Fluoride	16984-48-8	No	No	Inorganics	Inorganics	-		4.00E-02	U	1.30E-02	U	1.00E+00	1.00E-03	3.80E+01	1.00E+00	Yes	-	-	4.27E+00	-	-	-	-	-	-	-	2.14E+06	2.14E+06	2.14E+06 nc max
Lithium	7439-93-2	No	No	Inorganics	Inorganics	-		2.00E-03	U	-		1.00E+00	1.00E-03	6.94E+00	1.00E+00	Yes	-	-	2.14E-01	-	-	-	-	-	-	-	1.07E+05	1.07E+05	1.07E+05 nc max
Mercuric Chloride	7487-94-7	No	No	Inorganics	Inorganics	-		3.00E-04	U	3.00E-04	U	7.00E-02	1.00E-03	2.72E+02	1.00E+00	Yes	-	-	2.24E-03	-	-	-	-	-	-	-	1.12E+03	1.12E+03	1.12E+03 nc
Molybdenum	7439-98-7	No	No	Inorganics	Inorganics	-		5.00E-03	U	2.00E-03	U	1.00E+00	1.00E-03	9.59E+01	1.00E+00	Yes	-	-	5.34E-01	-	-	-	-	-	-	-	2.67E+05	2.67E+05	2.67E+05 nc max
Selenium	7782-49-2	No	No	Inorganics	Inorganics	-		5.00E-03	U	2.00E-02	U	1.00E+00	1.00E-03	7.90E+01	1.00E+00	Yes	-	-	5.34E-01	-	-	-	-	-	-	-	2.67E+05	2.67E+05	2.67E+05 nc max
Thallium (Soluble Salts)	7440-28-0	No	No	Inorganics	Inorganics	-		1.00E-05	U	-		1.00E+00	1.00E-03	2.04E+02	1.00E+00	Yes	-	-	1.07E-03	-	-	-	-	-	-	-	5.34E+02	5.34E+02	5.34E+02 nc

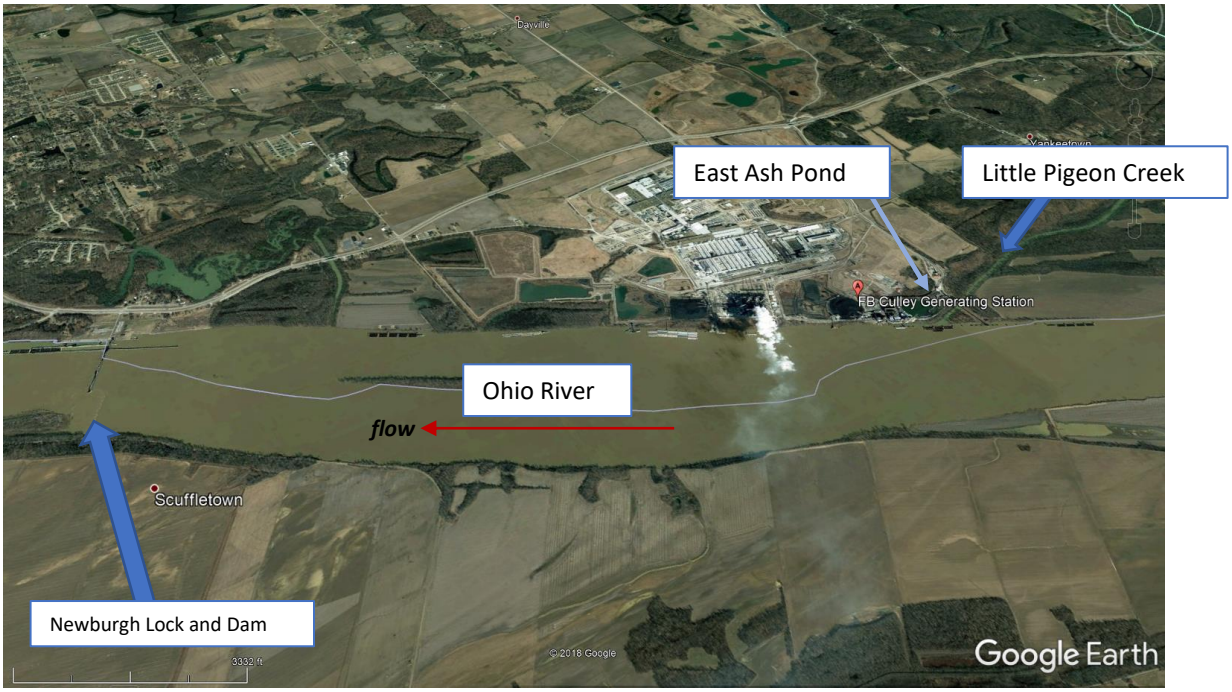
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ATTACHMENT C
Dilution-Attenuation Factor Calculations

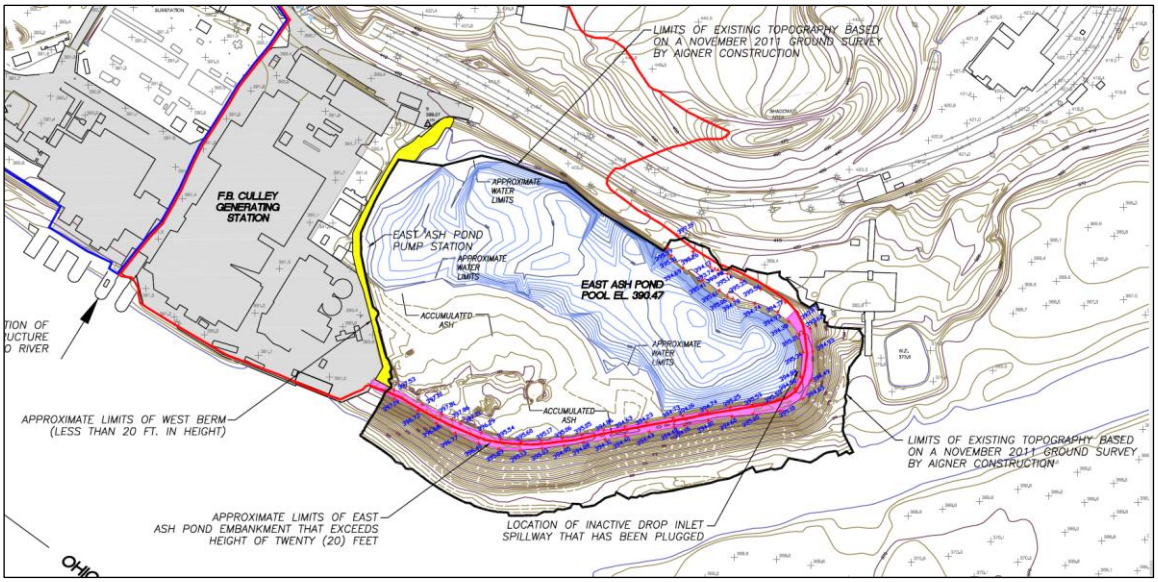
HALEY ALDRICH

CALCULATIONS

Client	Vectren	File No.	0129420-017
Project	F.B. Culley Generation Station East Ash Pond	Sheet	1 of 8
Subject	Dilution-Attenuation Factor Calculations	Date	15 March 2024
		Computed By	John Blue
		Checked By	Dimitri Quafisi



Google Earth Perspective View, Facing North



From ATC Group Services, East Ash Pond Visual Site Inspection Report, 2015

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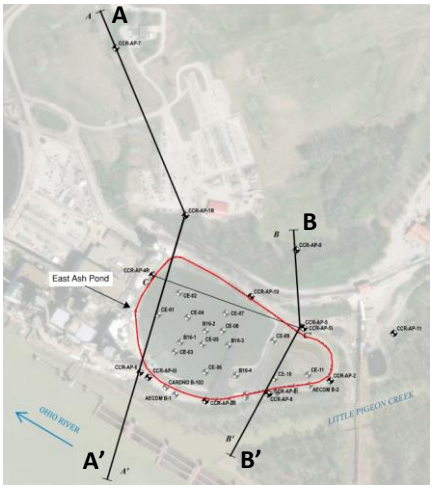
HALEY ALDRICH

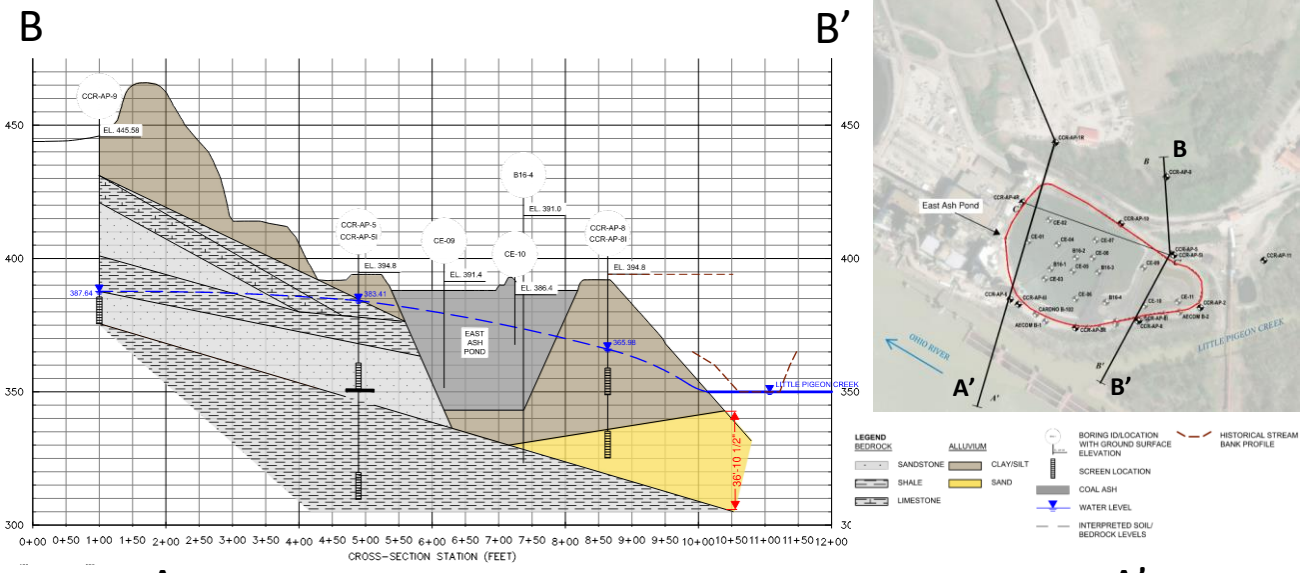
CALCULATIONS

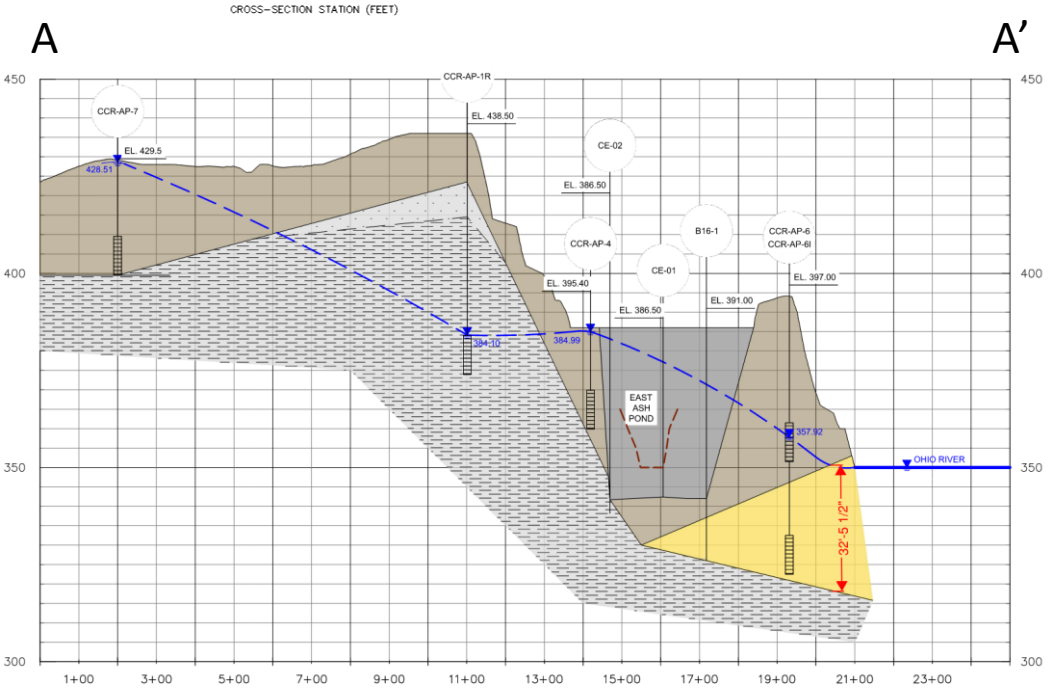
Client	Vectren	File No.	0129420-017
Project	F.B. Culley Generation Station East Ash Pond	Sheet	2 of 8
Subject	Dilution-Attenuation Factor Calculations	Date	15 March 2024
		Computed By	John Blue
		Checked By	Dimitri Quafisi

A Conceptual Model was developed for the FB Culley East Ash Pond using subsurface cross section interpretations from boring logs, and surveyed elevations. Four simplified subsurface units were identified: bedrock, silts/clays, sands, and pond material (coal combustion residuals or "ash").

The sand is the primary flow pathway at the Site and was utilized for this calculation. The thickness was calculated using the depth to bedrock at its deepest point below the groundwater table. For flow towards the Ohio River a difference of approximately 32 feet is used as shown in A-A' cross-section. For flow towards the Little Pigeon Creek a difference of approximately 36 feet is used as shown in B-B' cross-section.



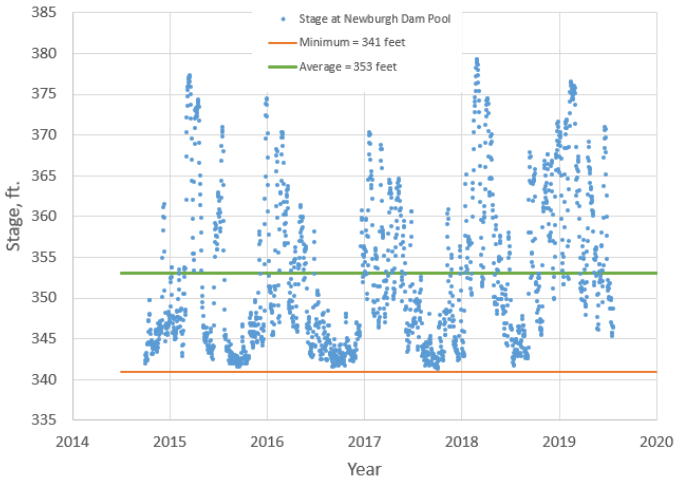




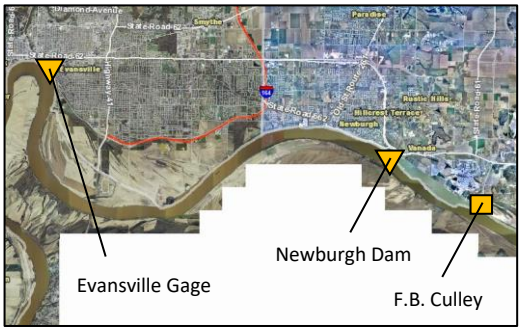
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Based on gaging data, water surface elevation (stage) of the Newburgh Dam Pool ranges from 341 to 379 feet above the NGVD29 vertical datum. The average stage is 353 feet.

Discontinuous discharge data is available at the Evansville Gage (USGS 03322000; below the Newburgh Dam) from 1940-1996. Although minimum instantaneous flow was approximately 100,000 cfs after the dam was completed in 1975, flow durations will depend on operation of the Dam and Locks and are not presently known. The pre-1975 minimum of approximately 10,000 cfs is used as a most conservative assumption of low flow conditions on the Ohio River. This may be improved to less conservative values if information can be obtained from the Army Corps of Engineers hydrologic model or dam release data.

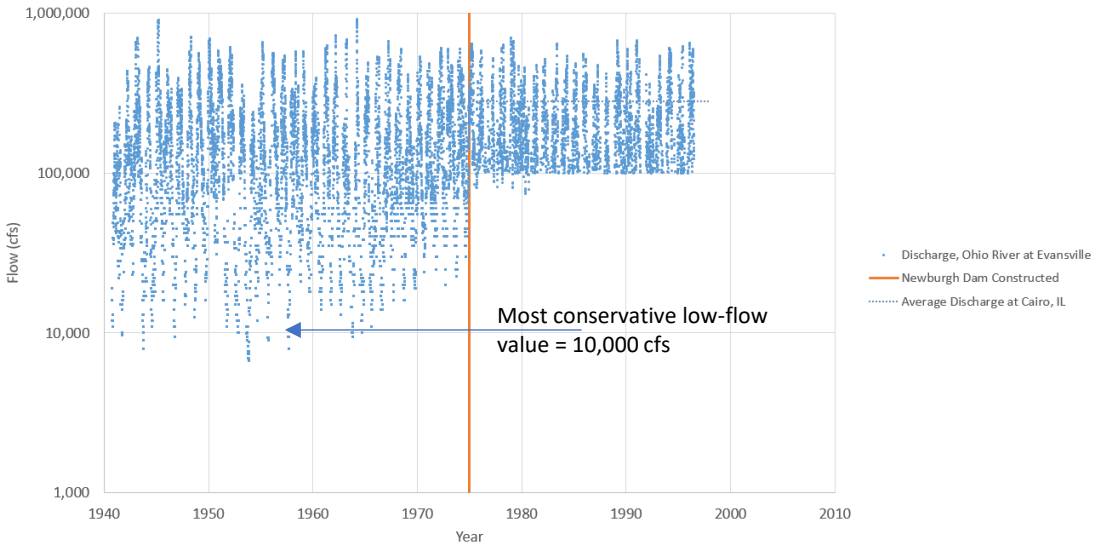


https://waterdata.usgs.gov/nwis/inventory/?site_no=03304300



https://maps.indiana.edu/previewMaps/Hydrology/Monitoring_Streamflow_Gauges.html

Datum = 329.18 feet NGVD29



https://waterdata.usgs.gov/nwis/inventory/?site_no=03322000

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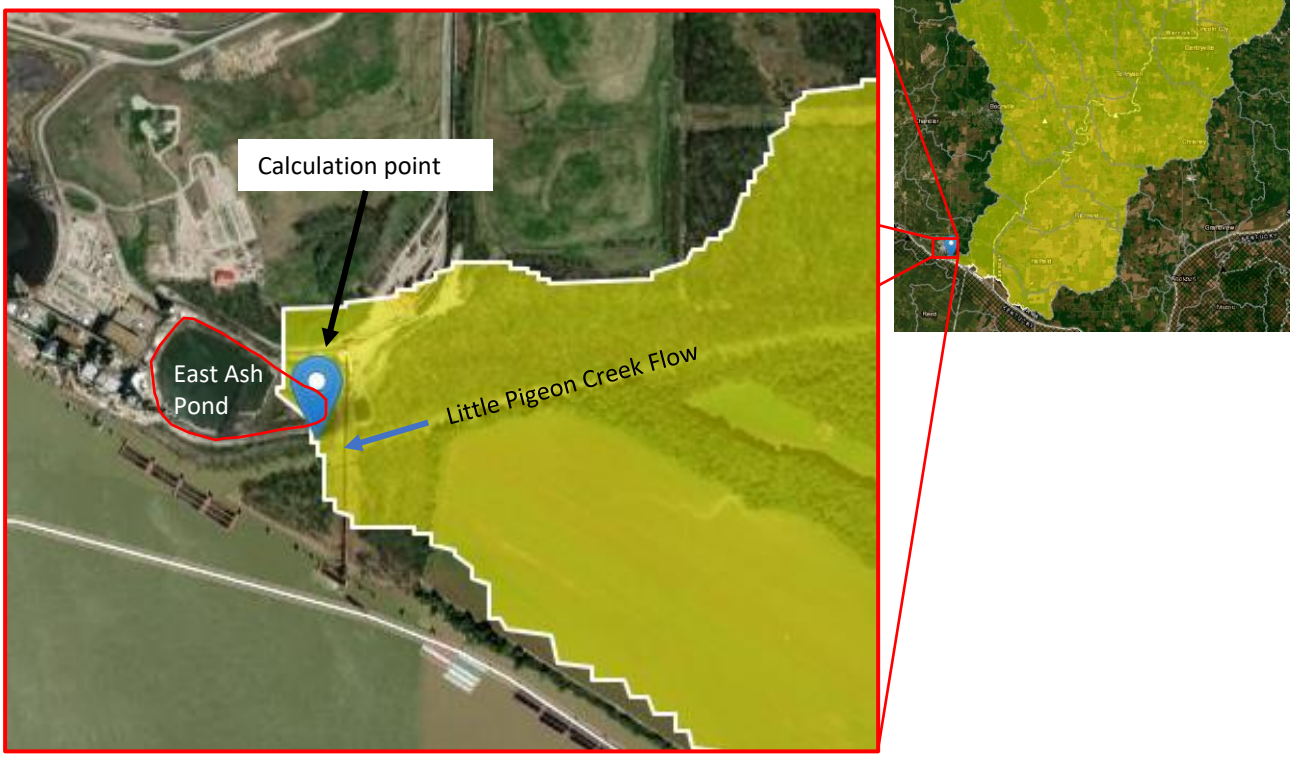
HALEY ALDRICH

CALCULATIONS

Client	Vectren	File No.	0129420-017
Project	F.B. Culley Generation Station East Ash Pond	Sheet	4 of 8
Subject	Dilution-Attenuation Factor Calculations	Date	15 March 2024
		Computed By	John Blue
		Checked By	Dimitri Quafisi

Since some groundwater is flowing towards the Little Pigeon Creek just before it discharges to the Ohio River, a 7Q10 low-flow statistic is calculated at the portion of the creek that passes the site using the USGS StreamStats tool. StreamStats uses a basin wide area-averaged statistical approach to estimate the 7Q10 low-flow statistic for unregulated streams that do not have a USGS gage.

StreamStats 7Q10 = **26.9 ft³/s**



Low-Flow Statistics Flow Report [Area-Averaged]

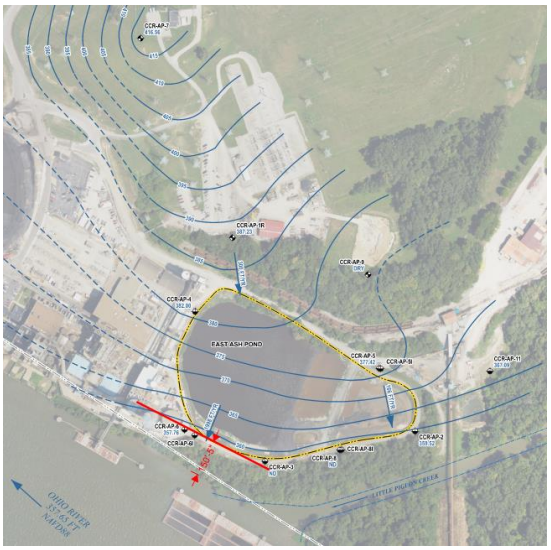
PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
1 Day 10 Year Low Flow	25.6	ft^3/s	10.3	63.5	58.8
7 Day 10 Year Low Flow	26.9	ft^3/s	11.3	64	55.7
30 Day 10 Year Low Flow	28.3	ft^3/s	11	72.9	61.5

Martin, G.R., Fowler, K.K., and Arihood, L.D., 2016, Estimating selected low-flow frequency statistics and harmonic-mean flows for ungaged, unregulated streams in Indiana (ver 1.1, October 2016): U.S. Geological Survey Scientific Investigations Report 2016–5102, 45 p., http://dx.doi.org/10.3133/sir20165102

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Groundwater Flow Towards Ohio River



Hydraulic Conductivity values from CCR-AP-6I, since it is screened in the sand unit

Groundwater Flux Calculations:

$$Q = KAI$$

$$K = Hydraulic\ Conductivity$$

Unit	Horizontal K (cm/s)	Horizontal K (ft/day)
Near CCR-AP-6	8.08×10^{-2}	230

$$A = Area$$

Cross-section	Length (ft)	Thickness (ft)	Area (ft^2)
Red Line	615	32	19,680

Cross-sectional Area Used for Calculations. Groundwater flow map from the November 1, 2023, gauging event. Arrows indicate groundwater flow direction.

Length of cross-sectional area

$$I = Gradient$$

Cross-section	Head (ft)	Distance (ft)	Gradient (ft/ft)
Ohio River	0.11	150	0.0007

$$Q = Groundwater\ Flux$$

Cross-section	Horizontal K (ft/day)	Area (ft^2)	Gradient (ft/ft)	Groundwater Flux (ft^3/day)
Near CCR-AP-6	230	19,680	0.0007	3,200

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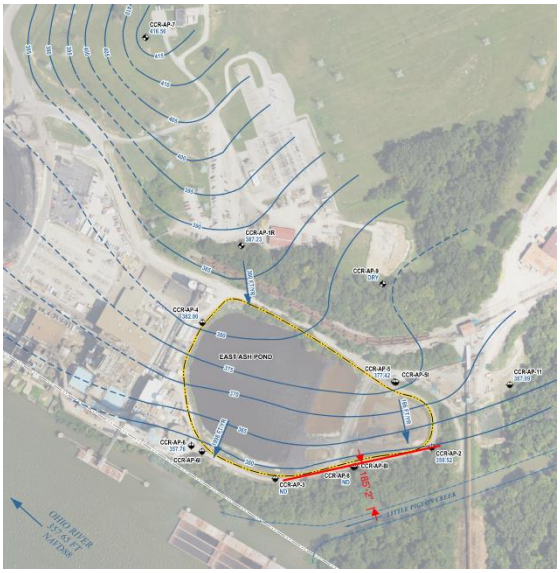
Groundwater Flow Towards Little Pigeon Creek

Groundwater Flux Calculations:

$$Q = KAI$$

$$K = Hydraulic\ Conductivity$$

Unit	Horizontal K (cm/s)	Horizontal K (ft/day)
Near CCR-AP-8	1.71×10^{-2}	50



Hydraulic Conductivity values from CCR-AP-8I since it is screened in the sand unit

$$A = Area$$

Cross-section	Length (ft)	Thickness (ft)	Area (ft^2)
Red Line	635	36	22,860

Cross-sectional Area Used for Calculations. Groundwater flow map from the November 1, 2023, gauging event. Arrows indicate groundwater flow direction.

Length of cross-sectional area

$$I = Gradient$$

Cross-section	Head (ft)	Distance (ft)	Gradient (ft/ft)
Little Pigeon Creek	1.87	185	0.01

Since the water level in the creek is not known, the Ohio River level was used for the gradient as a conservative estimate

$$Q = Groundwater\ Flux$$

Cross-section	Horizontal K (ft/day)	Area (ft^2)	Gradient (ft/ft)	Groundwater Flux (ft^3/day)
Near CCR-AP-8	50	22,860	0.01	11,400

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Ohio River Flow Calculations:

$Q_R =$ Discharge of Ohio River near FB Culley, at Low-Flow conditions.

$Q_R =$ 10,000 ft^3/sec = 864,000,000 ft^3/day

Little Pigeon Creek Flow Calculations:

$Q_R =$ Discharge of Little Pigeon Creek near FB Culley, at Low-Flow conditions.

$Q_R =$ 26.9 ft^3/sec = 2,324,160 ft^3/day

DAF Calculations:

$$DAF = \frac{Q_R}{Q_G}$$

Where:

$Q_R =$ Discharge of River/creek near FB Culley, at Low-Flow conditions.

$Q_G =$ Calculated Discharge from East Ash Pond to Ohio River

Scenario 1: Discharge to Ohio River

Pond Elevation (feet)83,	Q_G(ft³/day)	Q_R (ft³/day)	DAF
Near-CCR-AP-6	3,200	864,000,000	**270,000**

Scenario 2: Discharge to Little Pigeon Creek

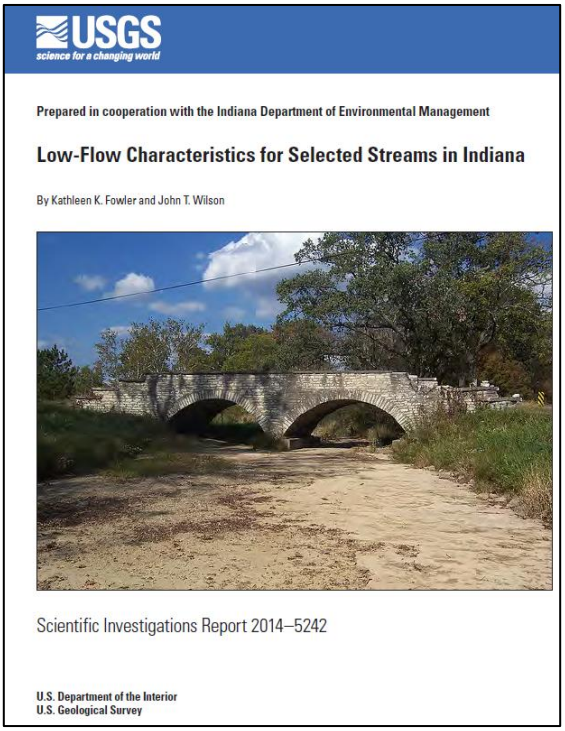
Pond Elevation (feet)83,	Q_G(ft³/day)	Q_R (ft³/day)	DAF
Near-CCR-AP-8	11,400	2,324,160	**204**

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The confluence of Little Pigeon Creek and the Ohio River is adjacent to the east side of the East Ash Pond. The lowest reach of the Creek runs parallel to the Ohio River.

As reported by the USGS, higher reaches of the Creek have weak aquifer support and are dry during periods of low precipitation (7Q10 flow is zero). Flow in the terminal reach of the Creek is controlled by fluctuations of the Newburgh Dam pool.

Relevant Publications:


USGS
science for a changing world

Prepared in cooperation with the Indiana Department of Environmental Management

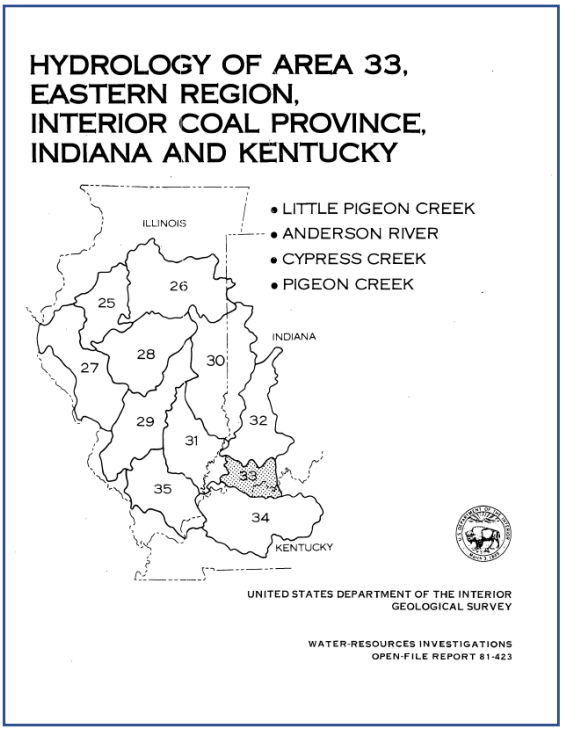
Low-Flow Characteristics for Selected Streams in Indiana

By Kathleen K. Fowler and John T. Wilson

Scientific Investigations Report 2014–5242

U.S. Department of the Interior
U.S. Geological Survey

https://pubs.usgs.gov/sir/2014/5242/


HYDROLOGY OF AREA 33,
EASTERN REGION,
INTERIOR COAL PROVINCE,
INDIANA AND KENTUCKY

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS
OPEN-FILE REPORT 81-423

https://pubs.usgs.gov/of/1981/0423/report.pdf

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ATTACHMENT D
Preparer Resumes

TODD BERNHARDT

Technical Expert | Risk Assessor

EDUCATION

M.S., Environmental Toxicology and Risk Assessment, Duke University
B.A., Biochemistry, Occidental College

Todd is a technical expert with over 24 years of experience in the fields of human health risk assessment (HHRA), site investigation and characterization, fate and transport modeling, toxic tort litigation support, and toxics regulation compliance. He has served as the HHRA lead on projects for over 20 years, leveraging prior work experience and expertise in the realm of multi-chemical, multi-pathway exposure assessment, and regulatory compliance under both federal and state programs. Todd's cross-regional experience includes extensive project work in California, under regulatory oversight of the California Environmental Protection Agency, Department of Toxic Substances Control and Regional Water Quality Control Boards or United States Environmental Protection Agency Region 9, plus project work in Arizona, Indiana, Kansas, Louisiana, Ohio, Puerto Rico, South Carolina, and Texas. Specific areas of project experience include vapor intrusion, power plant sites, utility service stations, petroleum sites, former manufactured gas plant sites, coal combustion residuals, and sites with heavy metals (including firing ranges). Todd has also been the lead human health risk assessor for multiple naval installations, and currently serves as the lead oversight consultant for a multi-site, multi-year risk-based corrective action pilot program in Puerto Rico, serving as the primary client and agency point of contact for all site characterization and risk-related issues. Todd has also performed several third-party technical reviews of HHRAs and has provided technical support for testimony in toxics-related litigation.

JAY PETERS

Principal Consultant | Risk Assessment Practice Leader

EDUCATION

M.S., Environmental Engineering, Tufts University
B.S., Toxicology, Northeastern University

PROFESSIONAL SOCIETIES

American Nuclear Society, Decommissioning and Environmental Services Division
Massachusetts Licensed Site Professionals Association, Technical Practices Committee
Society of Risk Analysis

Jay develops risk-based regulatory strategies for commercial and industrial clients, as well as legal professionals. With 30 years of experience as a risk assessor, he has successfully managed large and complex risk assessment projects for state and federal Superfund and Resource Conservation and Recovery Act sites, as well as brownfield redevelopment and property transfer sites under the regulatory frameworks of more than twenty state cleanup programs and seven Environmental Protection Agency (EPA) regions.

Jay's extensive cross-regional experience conducting risk assessments allows his clients to take advantage of risk-based strategies that stem from an in-depth insight into the latitude that can be afforded by EPA and state risk assessment procedures and the directions that agencies are taking on various initiatives. He has used this experience to leverage risk-based strategies that achieve his clients' end vision goals while also gaining approval by regulators, thereby substantially reducing his client's remedial liabilities.

Jay's specialized areas of risk assessment expertise include radiological risk and dose assessments, Toxic Substances Control Act 761.61(c) risk-based approaches for polychlorinated biphenyl (PCB) sites, application of bioavailability assessments, and developing risk-based site investigation and closure strategies that contribute to the cost-benefit analysis of remedial alternatives. Jay's areas of project experience include mixed chemical/radiological, coal combustion residuals, mining and smelting, petroleum, vapor intrusion, chemical manufacturing, foundry, and manufactured gas plant sites, as well as sites and heavy metals (including firing ranges). Jay has provided litigation support by performing third party technical reviews, developing expert opinions, and giving testimony.

Jay routinely communicates to community groups and regulatory stakeholders on numerous topics ranging from conceptual site models and nature and extent delineation to human health and ecological risk assessment. His ability to communicate technically complicated information in terms that are understandable to these entities has been successful in resolving comments and in facilitating concurrence with his clients end vision strategies.

DIMITRI QUAFISI, PG

Technical Expert |Geologist

EDUCATION

M.S., Geology, East Carolina University
B.S., Marine Science, Coastal Carolina University

PROFESSIONAL REGISTRATIONS

PA: Professional Geologist (PG Reg No. PG005284)

PROFESSIONAL SOCIETIES

Geological Society of America

Dimitri has over 10 years of experience completing Site related data evaluations for Hydrogeologic and geologic conceptual Site Modeling. He has also provided groundwater fate and transport modeling efforts in support of Corrective Measures Assessment evaluations at various CCR Sites around the country. IN addition to technical support for projects, Dimitri has been a task manager and assistant project manager helping to shepherd projects through regulatory programs to closure.

Dimitri's previous work experience includes completing Phase I, II, and III site assessments and attainment sampling. He has extensive experience working with State agencies such as the Pennsylvania Department of Environmental Protection, the Pennsylvania Department of Transportation, and the New Jersey Department of Environmental Protection. He has also acted as a liaison between several clients and their respective agencies.

Dimitri routinely communicates to community groups and regulatory stakeholders on numerous topics ranging from conceptual site models, nature and extent delineation, contaminate fate and transport, and remedial effort evaluations.