



**Sebree Generating Station
Reid/HMP&L CCR Surface Impoundment**

Final Report on Selection of Groundwater Remedy

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14665 West Lisbon Road, Suite #1A
Brookfield, WI 53005
262-781-0475
www.kprginc.com



55 East Monroe Street
Chicago, IL 60603
312-269-2000
www.sargentlundy.com

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1.0 PURPOSE & SCOPE

On behalf of Big Rivers Electric Corporation (BREC), KPRG Associates, Inc. (KPRG) and Sargent & Lundy (S&L) have prepared this final report documenting the corrective measures BREC has selected for remediating groundwater impacts at the Reid/Henderson Municipal Power & Light (Reid/HMP&L) CCR Surface Impoundment (the Unit) at the Sebree Generating Station (the Station) located in Webster County, Kentucky (see Figure 1).

1.1 BACKGROUND

In accordance with the United States Environmental Protection Agency's (EPA) Coal Combustion Residuals (CCR) Rule, 40 CFR Part 257 Subpart D, BREC initially installed four monitoring wells (MW-7 through MW-10; see Figure 2) around the Reid/HMP&L CCR Surface Impoundment to monitor the Unit's performance relative to potential impacts to groundwater. Assessment monitoring results indicate the presence of lithium at a Statistically Significant Level (SSL) above the Ground Water Protection Standard (GWPS) in one monitoring well (MW-10) at the Unit.

In response to the SSL exceedance of the GWPS for lithium in well MW-10, BREC initiated evaluation of the nature and extent of groundwater impacts as required by 40 CFR 257.95(g)(1) for characterization monitoring. Three additional monitoring wells were ultimately installed to assist in defining the nature and extent of impacts. These wells are MW-110, MW-111, and MW-112, located as shown on Figure 2. In addition, BREC performed an Assessment of Corrective Measures (ACM) to identify applicable remedial technologies to address the documented lithium impacts in groundwater pursuant to 40 CFR 257.96. A notice of ACM initiation dated January 14, 2019 was posted to BREC's publicly-accessible CCR reporting website. A report summarizing the results of the ACM (AECOM, 2019b) was posted to BREC's publicly-accessible CCR reporting website on June 14, 2019.

After completing the ACM in June 2019, BREC continued to evaluate the potential remedies identified in the ACM for the SSL exceedance of the GWPS for lithium identified at MW-10. As documented in the six semi-annual progress reports prepared pursuant to 40 CFR 257.97(a), BREC performed additional site investigations, collected additional groundwater data, developed conceptual designs for remedial alternatives identified in the ACM, and developed a basic numerical groundwater flow and contaminant fate and transport model with first order calibration for the site to conduct a thorough evaluation of each potential remedy identified in the ACM.

1.2 PURPOSE

Pursuant to 40 CFR 257.97(a), this final report describes the final remedy that BREC selected to address the concentrations of lithium observed at SSLs above the GWPS in MW-10 and documents the engineering and

hydrogeological evaluations on which that selection was based. In addition, this final report documents how the selected remedy will, per 40 CFR 257.97(b):

- (1) Be protective of human health and the environment;
- (2) Attain the GWPS for lithium;
- (3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment;
- (4) Remove from the environment as much of the contaminated material that was released from the Unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;
- (5) Comply with standards for management of wastes as specified in 40 CFR 257.98(d).

This final report is structured to provide (1) an overall site background which includes a characterization of the nature and extent of groundwater impacts, (2) a conceptual site model, (3) an evaluation of the potential remedies identified in the June 2019 ACM, and (4) the remedy selected in accordance with the results of that evaluation. In accordance with 40 CFR 257.97(d), this final report also includes a schedule for implementing and completing the selected remedy.

2.0 SITE BACKGROUND

2.1 SITE LOCATION & DESCRIPTION

BREC operates the Sebree Generating Station located on the Green River northeast of Sebree, Kentucky (see Figure 1) with Interstate 69 located to the west. Three former coal-fired power plants are co-located at the Sebree Generating Station: the Robert D. Green Station, the Robert A. Reid Station ("Reid"), and Henderson Municipal Power & Light (HMP&L) Station Two. Reid Unit 1 began commercial operation in 1966 and was retired on September 30, 2020. HMP&L Station Two Units 1 and 2 began commercial operation in 1973 and 1974, respectively; both units were retired as of February 1, 2019. Green Station Units 1 and 2 began commercial operation in 1979 and 1981, respectively, and were recently converted to natural gas fuel.

The location of the Reid/HMP&L CCR Surface Impoundment is shown on Figure 2. The Unit is currently inactive, has been in place for more than 40 years, and was used previously for the placement of CCR material. As stated in the published CCR groundwater monitoring well network certification, available on BREC's publicly-accessible CCR reporting website¹, the Reid/HMP&L CCR Surface Impoundment is a combined incised / earthen embankment structure. It is diked on the west, south, and east sides, while the north side is incised. The south dike has the greatest height, reaching approximately 20 feet. Most of the central portion of the south dike was constructed on a subdued ridge.

¹ <https://www.bigrivers.com/ccr-rule-compliance-and-data-informationsebree-station/>

2.2 GROUNDWATER INVESTIGATION SUMMARY

Monitoring wells were installed around the perimeter of the Unit in December 2015 as part of the implementation of the EPA CCR Rule. These wells meet the requirements of 40 CFR 257.90 for installation of a groundwater monitoring system with one upgradient well (MW-7) and three downgradient wells (MW-8 through MW-10), all located at the waste boundary. The installed groundwater monitoring well system adequately represents the quality of background groundwater and groundwater representing the downgradient waste boundary. The monitoring wells were installed in the uppermost saturated portion of the sandstone bedrock aquifer (interbedded sandstone and shale of the Shelburn Formation) which has been determined to be the "uppermost aquifer" as defined in § 257.53 of the EPA CCR Rule.

In accordance with 40 CFR 257.94, nine rounds of baseline groundwater sampling for Appendix III detection monitoring constituents were conducted between March 2016 and October 2017. Subsequent statistical evaluation of Appendix III detection monitoring constituents indicated that statistically significant increases (SSIs) over background had occurred in the downgradient monitoring well water quality, and, therefore, assessment monitoring was triggered and implemented in accordance with 40 CFR 257.95. Monitoring activities and data are presented in the annual reports that have been prepared to date (AECOM 2018, 2019a, 2020, 2021a, and 2022).

As part of initial assessment monitoring, upgradient and downgradient wells for the Unit were sampled for Appendix IV constituents in April, July, and September 2018. Groundwater Protection Standards (GWPSs) were established for the Appendix IV constituents occurring at SSIs (lithium only), and statistical evaluation of the lithium concentrations indicated exceedances of GWPSs at SSLs only at well location MW-10, as detailed in Table 1 below.

Table 1. Reid/HMP&L Surface Impoundment Constituents of Concern

Monitoring Well (Sample Date)	Parameter
	Lithium GWPS 0.04 (mg/L)
MW-10 (Apr 2018)	0.694
MW-10 (Jul 2018)	0.630
MW-10 (Sep 2018)	0.570

Note: GWPSs are the greater of the site-specific background concentrations, the EPA primary drinking water standard maximum contaminant limits (MCL), or GWPS provided in 40 CFR 257.95(h)(2). Source: AECOM, 2021b.

Three additional characterization wells were subsequently installed to evaluate the downgradient extent of groundwater impacts. These “characterization wells” have been designated with “100-series” number nomenclature (wells MW-110, MW-111 and MW-112) to distinguish them from the monitoring wells installed around the Unit’s solid waste boundary (MW-7 through MW-10) which gauge Unit performance. Initial characterization well MW-110 (see Figure 2) was installed by AECOM in February 2019 and subsequently sampled on a routine basis for Appendix III and IV parameters. In February 2022, KPRG installed two additional characterization monitoring wells, MW-111 and MW-112 (see Figure 2) for the purposes of assisting with defining the extent of potential lithium impacts to the southwest and south-southeast of well MW-10. Boring logs for these two new characterization wells are provided in Appendix A. These wells, along with the previously installed monitoring wells, were most recently sampled in November/December 2022 for Appendix III and IV parameters. The analytical results for lithium in all three characterization wells were below the GWPS. All characterization data to date for lithium (the only parameter detected above GWPSs) are summarized in Table 2 below.

Table 2. Reid/HMP&L Surface Impoundment Characterization Sample Results

Monitoring Well (Sample Date)	Parameter
	Lithium GWPS 0.04 (mg/L)
MW-110 (March 2019)	0.0299
MW-110 (April 2019)	0.0303
MW-110 (October 2019)	0.02
MW-110 (April 2020)	0.02
MW-110 (October 2020)	0.02
MW-110 (May 2021)	0.02
MW-110 (October 2021)	0.02
MW-110 (March 2022)	0.02
MW-111 (March 2022)	0.014
MW-112 (March 2022)	0.011
MW-110 (June 2022)	0.0217
MW-111 (June 2022)	0.0099
MW-112 (June 2022)	0.0319
MW-110 (December 2022)	0.01 J

Monitoring Well (Sample Date)	Parameter
	Lithium GWPS 0.04 (mg/L)
MW-111 (December 2022)	0.008 J
MW-112 (December 2022)	0.007 J

Symbols:

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit, and the concentration is an approximate value.

The results from these characterization sampling events indicate that the noted lithium GWPS exceedance is limited in downgradient extent to the general vicinity of monitoring well MW-10. Semi-annual assessment monitoring at these well locations will continue at this time in accordance with 40 CFR 257.95.

2.3 CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) was presented in previous AECOM reports and is necessary to support remedy selection for the Unit. A CSM is established by developing an understanding of the surface and subsurface physical site conditions and how these conditions affect natural groundwater flow and quality beneath the site. This provides for a working hypothesis regarding how constituents of concern (COCs) enter the environment at a site, how they may be transported through various media, what the potential routes of exposure are, and who may be exposed, including both human and ecological receptors. As such, a robust CSM is not a static model but rather a dynamic model which needs to be revisited on a regular basis as new site data becomes available and/or when there are measurable or known changes to physical site conditions.

The CSM for the Unit was first provided in the June 2019 ACM for the Unit (AECOM 2019b). The various components of the CSM are discussed below and have been updated with new information developed as part of the expanded nature and extent of impacts characterization, as appropriate. The initial descriptions developed by AECOM that continue to be consistent with new data being generated have not been substantively altered.

2.3.1 PHYSICAL SETTING

From a regional standpoint, the Unit is located within the Interior Low Plateaus physiographic province. The province is part of the Interior Plains division of the United States. Characteristic features of the province include unglaciated rolling limestone plains with alluvial valleys and entrenched rivers and streams. Several large rivers are in the region, including the Green, Ohio, Kentucky, Tennessee, and Cumberland Rivers. The geology underlying the Unit consists of unconsolidated sediments, including loess and alluvial deposits, which are in turn underlain by Upper to Middle Pennsylvanian-age clastic and carbonate bedrock consisting

primarily of sandstone and shale. The unconsolidated materials can also include fill, silty and clayey residuum, and minor amounts of sandy, clayey channel fill alluvium.

Locally, the Unit is situated on an upland area near the west bank of the Green River. The uppermost edge of the earthen embankment is at an elevation of approximately 429 feet above mean sea level (amsl). Although the Green River is located less than 0.5 mile from the Unit, the structure does not extend significantly into the floodplain. Underlying preconstruction soils consisted of Loring-Grenada, Loring-Zanesville-Wellston (Henderson County) and Loring-Wellston-Zanesville (Webster County) soil associations which are generally characterized as well-drained to moderately well-drained soils on nearly level to sloping uplands (Associated Engineers, Inc., 2016). The immediate watershed that drains to the Unit, and in which the Unit is considered to be located, is unnamed and approximately 25.5 acres in size. The unnamed watershed discharges from the Unit outflow structure and is routed, under a Kentucky Pollutant Discharge Elimination System (KPDES) permit, to the Green River.

2.3.2 GEOLOGY

The Unit lies in the Western Kentucky Coalfields section, characterized by rolling uplands underlain by coal-bearing, Pennsylvanian-age bedrock. Near the Unit, maximum topographic relief is on the order of 80 feet. The geologic quadrangle (Fairer, 1973) for the area published by the Kentucky Geologic Survey (KGS) shows the surficial material in portions of the western half of the Unit to be unconsolidated loess of Pleistocene age. The loess consists of sandy and clayey silt. Underlying the loess deposits and exposed at the surface on the eastern half of the Unit are broadly distributed Pleistocene and Holocene alluvium deposits consisting of intermixed and/or interlayered lenses of clay, silt, sand, and gravel. In close proximity to the Unit, the alluvium is generally a low permeability layer that forms terraces along the Green River at elevations of roughly 380 and 395 feet amsl. The unconsolidated surficial materials range from approximately 24 feet (MW-7) to 47 feet (MW-110) in thickness surrounding the Unit.

The unconsolidated materials are underlain by bedrock of the Upper Pennsylvanian Shelburn Formation [formerly identified as the Lisman Formation (Fairer, 1973)] and the Middle Pennsylvanian Carbondale Formation. The Shelburn and Carbondale formations consist of cyclic sequences of sandstones, shales, siltstones, and coals. These sediments were deposited in a fluvial-deltaic system and, as a result of this depositional environment, the lithologic units tend to be discontinuous lenticular bodies rather than continuous sheet-like strata. As such, gradational and/or abrupt horizontal changes in lithology are often encountered.

2.3.3 GROUNDWATER HYDROGEOLOGY

For purposes of compliance with the EPA CCR Rule's groundwater monitoring requirements, the interbedded sandstone and shale of the Shelburn Formation has been identified as the "uppermost aquifer" underlying the Unit as defined in 40 CFR 257.53. The uppermost aquifer is hydraulically confined and first

encountered at an elevation of approximately 428 feet amsl at the northeast end of the Unit (at MW-7) and at an elevation of approximately 389 feet amsl at the west end of the Unit (at MW-9). Although previous site-specific investigations have noted the presence of perched zones of saturation in the overlying unconsolidated materials, these discontinuous zones do not qualify as an uppermost aquifer under the EPA CCR Rule because they do not produce usable quantities of groundwater.

The most recent round of groundwater level data, which includes the newly installed characterization monitoring wells (MW-111 and MW-112), collected in December 2022 are summarized in Table 3 below along with previous water levels collected in 2022. This most recent round of groundwater level data was used to develop an updated piezometric surface map for the uppermost aquifer (see Figure 3). Flow direction beneath the Unit is to the southwest towards an unnamed tributary to Groves Creek located west-southwest of the impoundment. This is consistent with previous groundwater flow interpretations.

**Table 3. Reid/HMP&L Surface Impoundment – March/June/December 2022
 Groundwater Elevation Data**

Monitoring Well	Top of Casing Elevation (ft, amsl)	Groundwater Elevation (ft, amsl) March 2022	Groundwater Elevation (ft, amsl) June 2022	Groundwater Elevation (ft, amsl) December 2022
MW-7	444.43	428.18	424.13	424.44
MW-8	394.29	390.59	390.44	387.96
MW-9	395.40	389.81	389.39	387.47
MW-10	422.27	390.63	390.29	388.37
MW-110	388.70	385.52	384.71	382.84
MW-111	403.57	389.98	389.53	387.75
MW-112	427.77	394.17	395.01	393.17

Note: Reference elevations of monitoring wells MW-7 through MW-10 and MW-110 were surveyed by Associated Engineers, Inc., Madisonville, Kentucky, in January 2015. Reference elevations of monitoring wells MW-111 and MW-112 were surveyed by Associated Engineers, Inc., Madisonville, Kentucky, in March 2022. All elevations shown in this table are based on the local plant vertical datum which is based on the North American Vertical Datum of 1988 (NAVD88). Base table from AECOM, 2021b.

Slug tests were performed by AECOM between April 24, 2019 and April 25, 2019 at monitoring wells MW-10 and MW-110 to assess the hydraulic characteristics of the uppermost aquifer in the vicinity of each of the well screens. The estimated hydraulic conductivity of the monitoring wells tested ranged from 3×10^{-6} to 5×10^{-4} centimeters per second (cm/sec). Slug tests were also completed by KPRG on new characterization wells MW-111 and MW-112 in March 2022. The estimated hydraulic conductivities in the vicinities of the screened intervals for these wells were approximately 3.43×10^{-4} cm/sec and 1.49×10^{-6} cm/sec, respectively. These estimates are consistent with the previous study results.

2.3.4 CONSTITUENTS OF CONCERN

Previous groundwater analytical data and statistical analysis indicate that lithium is the only Appendix IV COC detected at SSLs above its GWPS in groundwater associated with this Unit. Lithium has been detected at SSLs only in monitoring well MW-10 southwest of the Unit. The most recent round of sampling in November/December 2022 is consistent with this observation and lithium, therefore, remains the only COC at this time.

2.3.5 IMPACTED MEDIA

Groundwater is the single impacted media of concern identified as requiring corrective measures at the Unit.

2.3.6 DISTRIBUTION OF COCS

The most recent groundwater sampling event at the Unit for which data is currently available was performed in November/December 2022. The new lithium data collected during this sampling event are summarized below in Table 4. A summary data table with all new and historic Appendix III and IV data is provided in Appendix B.

Table 4. Reid/HMP&L Surface Impoundment – November/December 2022 Lithium Analytical Results

Monitoring Well	Parameter
	Lithium GWPS 0.04 (mg/L)
MW-7	0.008 J
MW-8	0.03
MW-9	0.006 J
MW-10	0.50
MW-110	0.01 J
MW-111	0.008 J
MW-112	0.007 J

Symbols:

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit, and the concentration is an approximate value.

The areal distribution of lithium impacts is provided on Figure 4. This illustrates the distribution extent of impacts above the GWPS for lithium that has been defined, and the impacts appear to be limited to the general vicinity of well MW-10. This distribution of COCs in groundwater suggests that impacts to groundwater likely originate as seepage from beneath the southern portion of the surface impoundment, possibly due to the added driving head associated with the ponded water within this portion of the Unit. Although there is currently no feasible means of directly tracing that potential under the footprint of the Unit at this time, numerical groundwater modeling (as discussed below and in Section 3.3) corroborates this hypothesis.

A simple numerical groundwater flow and contaminant fate and transport model was developed to assist with engineering evaluations of remedial alternatives and their relative effectiveness on addressing the noted groundwater quality impacts. As part of model runs, the driving head from the impoundment was removed as part of remedial alternative evaluations to provide additional insight on whether the ponded water is the main driving factor for the localized lithium impacts noted at well MW-10. The modeling effort and results are

discussed in further detail in Section 3.3, and the detailed description of the modeling is provided in Appendix C.

2.3.7 POTENTIAL RECEPTORS / EXPOSURE PATHWAYS

Contact with water (e.g., shallow groundwater or surface water) impacted by COCs at levels above the GWPS (groundwater) or Water Quality Criteria (surface water) is regarded as the potential pathway for exposure of potential receptors. Based on data published by KGS, there are no known groundwater wells used for drinking water within a 1-mile radius of the Unit, thus limiting the potential receptors to the groundwater. The impacts associated with this site are limited to the area around well MW-10 and therefore do not extend off-site, thus limiting the potential receptor impacts relative to the surface water (i.e., the Green River and its tributary, Groves Creek). The pathways to these receptors include seepage of water from the Unit through manmade and natural hydraulic conduits (AECOM, 2021b).

Other potential exposure pathways (e.g., soil or vapor) are not considered complete as the CCR material is isolated in the Unit. This isolation prevents direct access by individuals that might result in direct contact or ingestion. In addition, the inherent non-volatile nature of the Unit-specific COCs eliminates the potential for a complete vapor pathway (i.e., vapor intrusion to indoor air).

2.4 INTERIM CORRECTIVE MEASURES

No interim corrective measures have been performed at the Unit for groundwater impacts.

3.0 EVALUATION OF POTENTIAL REMEDIES

3.1 ASSESSMENT OF CORRECTIVE MEASURES SUMMARY

In June 2019, BREC performed an ACM for the Unit to identify remedial alternatives to address the concentrations of lithium at SSLs above the GWPS at MW-10. The ACM is provided in its entirety in Appendix D. Pursuant to 40 CFR 257.96(c), the ACM analyzed the effectiveness of potential corrective measures in meeting the EPA CCR Rule's corrective action objectives (CAOs) by addressing at least the following:

- (1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- (2) The time required to begin and complete the remedy; and
- (3) 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(s).

The June 2019 ACM evaluated several potential remedial technologies to identify which ones could be carried forward as components of corrective measures alternatives for the Unit. Table 5 summarizes the

results of that evaluation. The full evaluation is provided in Appendix A of the ACM (Appendix C of this report).

Table 5. Potential Remedial Technologies for Groundwater Impacts

Potentially Applicable Technology	Status	Description/Overview
No Action	Not retained as stand-alone technology, but carried forward for baseline comparisons	This technology has been included in the preliminary evaluation/screening but is not retained because it will not meet the established corrective action objectives (CAOs).
Institution Controls (ICs)	Retained as supplement to corrective measures alternatives	The use of ICs (e.g., Environmental Covenants, groundwater use restrictions, etc.) is retained as a useful technology. However, it is noted the ICs are not anticipated to be used as a stand-alone technology. Environmental Covenants, groundwater use restrictions, etc., are expected to be combined with other applicable technologies as part of corrective measures alternatives.
Groundwater Monitoring (Assessment and/or Detection Modes)	Retained as supplement to corrective measures alternatives	The use of groundwater monitoring (Assessment and/or Detection Modes as appropriate) when combined with other applicable technologies as part of any proposed corrective measures alternative is retained to address the CAO and to track the effectiveness of the overall remedy. However, it is not retained as a stand-alone technology.
Hydraulic Containment	Retained	The use of hydraulic containment is retained because it is an effective means of preventing off-site migration of soluble contaminants. Hydraulic containment requires management and potential ex-situ treatment of extracted groundwater, so it is not a stand-alone technology. The CSM will guide the design of any groundwater extraction system to optimize the total discharge of groundwater needed to provide hydraulic containment.
Physical Containment	Retained	The use of physical containment is retained because it can be an effective means of managing groundwater flow. Physical containment often requires pairing with hydraulic containment and/or in-situ treatment (funnel and gate style) to manage the flux of groundwater flow into the system. The CSM will guide the design of any physical barrier system, but technology limitations may increase implementation difficulty with scale.

Potentially Applicable Technology	Status	Description/Overview
Ex-Situ Physical / Chemical / Biological Treatment	Retained	Ex-situ treatment technologies are retained as a way of removing contaminants from extracted groundwater from a hydraulic containment system. Ex-situ treatment may be paired with wastewater treatment, non-groundwater release treatment systems, or with permitted discharge to manage groundwater contamination. The CSM and data gap investigations will guide the design of any ex-situ treatment.
Closure in Place (CiP) (of the Regulated Unit)	Retained	The use of CiP as a source control technology is amenable with respect to CAO attainment.
Closure by Removal (CbR) (of the Regulated Unit)	Retained	The use of CbR as a source control technology is amenable with respect to CAO attainment.
Other Source Control Technologies	Retained	Control of source area non-groundwater related releases. For the purposes of this groundwater ACM, management of non-groundwater releases are not included in the alternatives evaluation. Engineering measures, including leachate collection, lining of trenches and/or ponds, and other isolation methods are regarded as part of closure technologies selected by other means.

Note: Technologies that were retained may be used as components of a corrective action alternative, but when evaluated in conjunction with other available technologies any single technology may not be utilized. Source: AECOM, 2021b.

Based on (1) the evaluation of potential groundwater remedies and (2) site-specific and regional geology and groundwater conditions, the following five corrective measures alternatives were developed for the Reid/HMP&L CCR Surface Impoundment from the applicable remedial technologies listed in Table 5 above:

- Alternative #1: No Action and Groundwater Monitoring
- Alternative #2a: Closure in Place (CiP), Institutional Controls (ICs), and Groundwater Monitoring
- Alternative #2b: Closure by Removal (CbR), ICs, and Groundwater Monitoring
- Alternative #3: CiP, ICs, Hydraulic Containment, Other Source Control, Ex-Situ Treatment, and Groundwater Monitoring
- Alternative #4: CiP, ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring

As documented in the June 2019 ACM, this initial list of corrective measures alternatives was, at that time, considered to be preliminary and subject to revision following additional evaluation during the remedy selection process and/or following comment from the regulatory community and public. Indeed, as reported in the December 2019 Semi-Annual Remedy Selection Progress Report (AECOM, 2019c), BREC initially

eliminated Alternatives #1 and #2b from consideration. In addition, as documented in the June 2022 Semi-Annual Remedy Selection Progress Report (S&L and KPRG, 2022a), BREC started evaluating a second physical containment technology in 2022 as a potential groundwater remedy under Alternative #4. Accordingly, BREC split Alternative #4 into Alternatives #4a and #4b to account for the differences in implementing physical containment of impacted groundwater at the Unit. Finally, as documented in the December 2022 Semi-Annual Remedy Selection Progress Report (S&L and KPRG, 2022b), BREC revisited Alternative #2b as a potential corrective measure following the additional site investigations that were conducted in early 2022. Although this alternative was originally eliminated from consideration, BREC's further study of CbR for the Reid/HMP&L CCR Surface Impoundment warranted re-introducing it as a potential remedy for impacted groundwater at the Unit. Alternative #1 remains eliminated from further consideration since it would not control or remove COCs from the environment and, therefore, would not achieve the CAOs.

3.2 CORRECTIVE MEASURES ALTERNATIVES

Based on the initial corrective measures alternatives identified in the June 2019 ACM and the subsequent site investigations and evaluations performed to select a groundwater remedy, BREC ultimately identified the following five potential corrective measures alternatives as viable options to address lithium impacts in groundwater at the Unit:

- Alternative #2a: CiP, ICs, and Groundwater Monitoring
- Alternative #2b: CbR, ICs, and Groundwater Monitoring
- Alternative #3: CiP, ICs, Hydraulic Containment, Ex-Situ Treatment, and Groundwater Monitoring
- Alternative #4a: CiP, ICs, Physical Containment (Funnel and Gate), Ex-Situ Treatment, and Groundwater Monitoring
- Alternative #4b: CiP, ICs, Physical Containment (In-Situ Stabilization), and Groundwater Monitoring

Each of these corrective measures alternatives is discussed in more detail in the following sub-sections.

3.2.1 ALTERNATIVE #2A – CIP, ICS, AND GROUNDWATER MONITORING

Alternative #2a would employ a combination of the following three remedial technologies from Table 5:

- Implementing source control measures by closing the Reid/HMP&L CCR Surface Impoundment via closure in-place (CiP);
- Implementing ICs designed to restrict the property to industrial use and to prohibit groundwater use for potable purposes; and
- Groundwater monitoring (Assessment mode) to document the effectiveness of the selected remedy.

Under this alternative, the source of COCs in the impacted groundwater would be controlled by closing the Unit in-place in accordance with 40 CFR 257.102(d) either in whole or in part as further detailed below. First, free water remaining in the impoundment would be removed, which would eliminate the current driving head of COCs into the groundwater. Then, after the CCR remaining in the Unit has been regraded and compacted, an engineered final cover system meeting the requirements of 40 CFR 257.102(d)(3) would be installed to (1) minimize the infiltration of storm water into the closed impoundment and (2) prevent the ponding of water over the closed Unit, thereby minimizing the future leaching of COCs into the groundwater.

Since retaining CiP as a potential remedial technology in the June 2019 ACM, BREC has evaluated two general CiP design concepts for the Reid/HMP&L CCR Surface Impoundment: (1) capping the Unit's entire footprint (Alternative #2a – Entire Footprint) or (2) consolidating the stored CCR into a smaller footprint within the Unit's storage area, which is effectively a hybrid closure method involving both CiP and CbR (Alternative #2a – Consolidated Hybrid). Under this hybrid closure scenario, the CCR within the consolidated footprint would be excavated, the excavation would then be backfilled with natural soil to an elevation above saturated conditions (i.e., no ash in contact with groundwater), and then the impoundment's CCR would be placed over the natural soil base, compacted, and capped. It should be noted that about 38% of excavated ash would be transported to a landfill to facilitate this hybrid closure scenario due to space constraints within the Unit for a temporary stockpile of CCR. Subsequently, the numerical groundwater flow and contaminant fate and transport model introduced in Section 2.3.6 was used to evaluate the relative effectiveness of each of these CiP designs. The results of this evaluation are summarized in Section 3.3 and presented in detail in Appendix C. Based on these results, it would be unlikely that the GWPS for lithium would be met under the first alternative, and, thus, the hybrid closure method would be utilized under this corrective measures alternative to close the Unit in-place under 40 CFR 257.102(d).

During closure activities and post-closure care period for the Reid/HMP&L CCR Surface Impoundment, the noted ICs will be implemented to maintain the performance of the CiP design and to limit potential exposure to COCs.

Finally, groundwater monitoring would be used to evaluate the effectiveness of the corrective action remedy to ensure (1) measured concentrations of the identified COCs are trending towards compliance with the GWPS and (2) the CAOs are going to be met. It is currently anticipated that the CAOs will be met via natural attenuation after the source control measures have been implemented, which will be confirmed in subsequent groundwater sampling events. Regardless of when the CAOs are met, groundwater monitoring will continue at the site as a means of evaluating the performance of the Unit's final cover system for a minimum of 30 years after the Unit is closed in accordance with 40 CFR 257.104(c)(1).

3.2.2 ALTERNATIVE #2B – CBR, ICS, AND GROUNDWATER MONITORING

Under Alternative #2b, the Unit would be closed by removing all CCR and CCR-laden soils from the impoundment in accordance with 40 CFR 257.102(c). It is anticipated that the CCR and CCR-laden soils would be removed by standard earthmoving equipment which may include excavators, scrapers, bulldozers, and/or loaders (or a combination of these). Excavated material would then be placed into dump trucks which would then transport the CCR for disposal in a permitted landfill or for beneficial use elsewhere. Excavation would proceed within the limits of the impoundment until it has been confirmed that all CCR and CCR-laden soils have been removed from the Unit. Because this potential remedy involves decontaminating the Unit, it is expected that this corrective measures alternative will minimize or eliminate the source of COCs observed in the groundwater.

During closure activities and the subsequent groundwater monitoring period, the property will continue to be restricted to industrial use and groundwater use will be prohibited for potable purposes. These ICs will limit potential exposure to COCs while the corrective action remedy is being implemented and its performance is being evaluated.

Finally, groundwater monitoring will be used to evaluate the effectiveness of the corrective action remedy to ensure (1) measured concentrations of the identified COCs are trending towards compliance with the GWPS and (2) the CAOs are going to be met. It is currently anticipated that the CAOs will be met via natural attenuation after the source control measures have been implemented, which will be confirmed in subsequent groundwater sampling events. Pursuant to 40 CFR 257.98(c)(2) and 257.102(c), groundwater monitoring will continue at the site until the GWPS have been met for a period of at least three consecutive years.

3.2.3 ALTERNATIVE #3 – CIP, ICS, HYDRAULIC CONTAINMENT, EX-SITU TREATMENT, AND GROUNDWATER MONITORING

Alternative #3 supplements Alternative #2a by adding two additional corrective measures technologies retained from the June 2019 ACM: hydraulic containment and ex-situ treatment of groundwater:

- Implementing source control measures by closing the Reid/HMP&L CCR Surface Impoundment via closure in-place (CiP);
- Establishing hydraulic containment via one or more vertical wells designed to prevent the movement of impacted groundwater beyond the limits of the Unit to the downgradient groundwater environmental and potential points of exposure;
- Extracting groundwater from the hydraulic containment for ex-situ treatment, which involves above-ground physical/chemical treatment methods and/or permitted discharge until the CAOs are achieved;
- Implementing ICs designed to restrict the property to industrial use and to prohibit groundwater use for potable purposes; and

- Groundwater monitoring to document the effectiveness of the remedy performance.

As stated in the June 2019 ACM, hydraulic containment of the COCs would be established by installing vertical groundwater extraction well(s) near the downgradient limit of the Unit and upgradient of MW-10. Groundwater extracted from these well(s) would then be treated and new piping would be installed to convey the treated groundwater to an existing pond at the Station to ultimately be discharged in accordance with the Station's KPDES permit.

Given the proposed locations for the groundwater extraction well(s) for this alternative and the capping of the CCR stored in the Unit (which minimizes infiltration of precipitation for future leaching of COCs into the groundwater), COC concentrations in MW-10 would be expected to decrease with time via natural attenuation. BREC would continue monitoring the groundwater at the site to evaluate the effectiveness of the hydraulic containment system to ensure (1) the COC concentrations in MW-10 indeed decrease and trend towards compliance with the GWPS and (2) the CAOs are going to be met. As noted in the June 2019 ACM, additional monitoring wells may need to be installed in order to effectively monitor the performance of this potential corrective action remedy.

3.2.4 ALTERNATIVE #4A – CIP, ICS, PHYSICAL CONTAINMENT (FUNNEL AND GATE), EX-SITU TREATMENT, AND GROUNDWATER MONITORING

Alternative #4a is similar to Alternative #3 except that a physical containment system would be installed to control the impacted groundwater. In this scenario, the impacted groundwater would be contained by two grout curtains installed in a funnel-and-gate arrangement that would focus the flow of groundwater to a single extraction point or "gate." A single vertical well would be installed at this location to allow for groundwater to be extracted, then treated, then conveyed via new piping to an existing pond at the Station, and finally discharged in accordance with the Station's KPDES permit. Like Alternative #3, the groundwater extraction well would be installed at the southeast corner of the Unit, near its downgradient limit and upgradient of MW-10. Meanwhile, the grout curtains would be installed by drilling lines of ground injection points, one extending northwestward and one extending northeastward.

Given the proposed location for the groundwater extraction well for this alternative and the capping of the CCR stored in the Unit (which minimizes future leaching of COCs into the groundwater), COC concentrations in MW-10 would be expected to decrease with time via natural attenuation. BREC would continue monitoring the groundwater at the site to evaluate the effectiveness of the physical containment system to ensure (1) the COC concentrations in MW-10 indeed decrease and trend towards compliance with the GWPS and (2) the CAOs are going to be met. As noted above for Alternative #3, additional monitoring wells may need to be installed in order to effectively monitor the performance of this potential corrective action remedy.

3.2.5 ALTERNATIVE #4B – CIP, ICS, PHYSICAL CONTAINMENT (IN-SITU STABILIZATION), AND GROUNDWATER MONITORING

In lieu of the funnel-and-gate system proposed above, Alternative #4b would physically contain impacted groundwater and stabilize the CCR mass to preclude continued leaching of the CCR materials. This would be accomplished via in-situ solidification / stabilization (ISS), which involves the mechanical mixing of CCR material with a dry reagent (e.g., bentonite, Portland cement) or by injecting a grout mixture to create a containment structure around and under the CCR stored in the Unit. Given the physical containment around and under the CCR stored in the Unit and the engineered final cover system being installed over that CCR, COC concentrations in MW-10 would be expected to decrease with time via natural attenuation. In addition, unlike in Alternative #2a, it is expected that this alternative could meet the GWPS for lithium without excavating deeper deposits of CCR, backfilling the excavation with natural soil, and consolidating and capping the CCR within a smaller footprint. Moreover, unlike in Alternative #4a, it is expected that this alternative would not require ex-situ treatment of groundwater; however, this determination would ultimately be made based on the results from continued groundwater monitoring at the site. Accordingly, BREC would continue monitoring the groundwater at the site to evaluate the effectiveness of the physical containment system to ensure (1) the COC concentrations in MW-10 indeed decrease and trend towards compliance with the GWPS and (2) the CAOs are going to be met.

3.3 GROUNDWATER FLOW & CONTAMINANT FATE & TRANSPORT MODEL

For each of the five corrective measures alternatives discussed above, closing the Reid/HMP&L CCR Surface Impoundment is the primary means of controlling the source of lithium impacts at monitoring MW-10. Alternatives #3 and #4a would provide a secondary means of source control through groundwater extraction and ex-situ treatment, but closing the Unit in-place and installing a final cover system would be expected to remain the primary source control measure under those alternatives. Amongst the five corrective measures alternatives, there are three general closure methods being considered for the Unit: (1) closure in-place, (2) closure by removal, and (3) closure in-place with ISS.

To assist with the evaluation of these different closure methods – and, by extension, the evaluation of the five corrective measures alternatives being considered for the Unit – a simple three-dimensional, groundwater flow and contaminant fate and transport model was developed for the area of the surface impoundment. The model was developed using MODFLOW-NWT, an advanced version of the widely used MODFLOW software. Groundwater Vistas, a graphical user interface, was used to parameterize the model input, write MODFLOW files, and visualize results. A more detailed description of the model, parameterization, calibration, and results is provided in Appendix C. Below is a brief description of the modeling effort and the pertinent modeling results used to assist in BREC's evaluation of closure methods being considered for the Unit, evaluation of groundwater corrective measures, and selection of the preferred remedy to address the lithium impacts observed at monitoring well MW-10.

The model covers an area of approximately 0.5 mile by 0.4 mile, centered on the surface impoundment. The model area includes the surface impoundment's upgradient monitoring well MW-7; downgradient monitoring wells MW-8, -9, and -10; and assessment downgradient monitoring wells MW-110, -111, and -112. The model was developed with uniform, square 25-foot grid cells and five model layers. The top surface of the model was created as a simplified representation of topographical data obtained from a May 2022 survey of the site to represent the overall topographic gradients without small-scale variations. For the purposes of model simplification, a surface was created to represent the thickness of ash deposits in the surface impoundment that varies from a thickness of five feet at the northeast side to 45 feet at the southwest side, which was based on a review of boring logs, historical as-builts, and recent survey data. This ash thickness was divided into two top layers of the model (model layers 1 and 2), so each layer increases in thickness from 2.5 feet at the northeast side to 22.5 feet at the southwest side of the model domain. The remaining model layers (model layers 3 through 5) each have a thickness of 25 feet.

The model was oriented 37 degrees to the northwest to be aligned with the general direction of groundwater flow across the site. Constant head boundaries were used along the upgradient (northeast) and downgradient (southwest) edges of the model, and no-flow boundaries were used on the two other model edges to generally represent a groundwater flow line. The upgradient (northeast) constant head boundary was defined in each model cell as 10 feet below the top of the model, consistent with depth to water measurements at MW-7. The downgradient (southwest) constant head boundary was defined from the measured water levels in MW-110 and -112, and linearly increases from 383 feet amsl at the northwest corner to 388 feet amsl at the southwest corner.

Zones of hydraulic conductivity (K) were used to represent the varying lithology across the site. The approach was to keep the zonation as simplistic as possible, adding complexity only as needed to achieve the calibration goal of matching the overall groundwater flow and hydraulic gradient across the site. Lithologic logs from the onsite monitoring wells were used to guide the zones of K in the model layer structure as well as K estimates from single well slug tests performed at well locations MW-10, -110, -111, and -112. In addition, geotechnical permeability testing of representative ash samples collected via Shelby tubes were used for K estimates of the ash.

Recharge was added to the model to represent seepage from the surface impoundment in the area where recent aerial photos show ponded water. The recharge rate was adjusted as part of model calibration and resulted in a flux into the model of 6 gallons per minute (gpm). This was also compared to a model run in which the pond was represented in the model as a general head boundary (GHB) with an elevation equal to the surveyed pond elevation of 423.85 feet amsl and conductance values consistent with the modeled K. The model estimated seepage from the pond under these assumptions using the hydraulic gradient between the pond and the underlying water table and resulted in a seepage rate between 4 and 25 gpm, consistent with the recharge flux.

The model developed for this evaluation is a simplified, initial representation of the groundwater system, and as such, calibration goals were limited to generally representing groundwater flow directions and hydraulic gradients. The modeled water table is shown on Figure 5 in Appendix C along with the water level contours drawn from the water levels measured in the monitoring wells during the June 2022 sampling event. The match between the modeled and measured water level contours is reasonable for this simplified model, and the model appropriately represents the southwestern hydraulic gradient, the relatively flat hydraulic gradient downgradient of the surface impoundment, and the overall hydraulic gradient through the surface impoundment, making this groundwater model appropriate for use in evaluating the closure methods – and, by extension, the groundwater corrective measures alternatives – being considered for the Reid/HMP&L CCR Surface Impoundment.

To provide an initial comparative baseline to evaluate the effectiveness of each closure alternative in reducing the extent of groundwater impacts, a distribution of impacted groundwater was established with the model and was used as the initial concentrations for predictive model scenarios. The initial distribution of impacted groundwater for comparative baseline purposes was established from a 100-year model scenario of a surrogate mass with a concentration of “1” (i.e., 100%) in groundwater beneath the surface impoundment. A constant concentration boundary of “1” was defined in the footprint of the surface impoundment in model layers 1 and 2, and the mass was allowed to move in groundwater by advection and dispersion until an equilibrium (steady state) distribution of impacted groundwater was achieved (typically within 30 years for most monitoring well locations). This initial hypothetical, steady state baseline condition is shown on Figure 6 in Appendix C.

In alignment with the source control measures proposed in the five groundwater corrective measures alternatives being considered for the Reid/HMP&L CCR Surface Impoundment, the following four closure scenarios were evaluated:

- Closure Scenario 1 (Alternative #2b) – Closure by removal whereby all CCR and CCR-laden soils would be removed from the impoundment. In this scenario, the remaining pit would not be backfilled. Rather, the bottom would be sloped to west and the dike breached to allow for drainage of stormwater run-off.
- Closure Scenario 2 (Alternative #2a – Entire Footprint) – Close the Unit in-place by installing an engineered final cover system over the CCR being left in-place. In this scenario, the cap would consist of a geosynthetic clay liner (GCL) covered with vegetated topsoil. The GCL would have a maximum permeability of 2×10^{-9} cm/sec.
- Closure Scenario 3 (Alternative #2a – Consolidated Hybrid) – Close the Unit in-place with partial closure by removal. In this hybrid closure scenario, deeper ash deposits in the southern part of the pond would be excavated and temporarily stockpiled at the northern end within the impoundment boundary. The base of this excavation would then be backfilled to 2 feet above the high-water level with natural soil and compacted. The permeability of the new base was assumed to be 10^{-3} cm/sec.

The previously excavated ash would then be placed back on top of the backfill and capped as in Closure Scenario 2 but with a smaller, consolidated footprint. It should be noted that about 38% of excavated ash will be transported to a landfill due to space constraints within the Unit for the temporary stockpile required to execute this closure strategy.

- Closure Scenario 4 (Alternative #4b) – Close the Unit in-place as in Closure Scenario 2 and supplement with in-situ stabilization (ISS) of the Unit's base and sidewalls. For the stabilization, a 4-foot-thick stabilized base and 3-foot-thick stabilized walls were assumed, each with a permeability of 10^{-7} cm/sec.

To evaluate each closure alternative, the appropriate changes were made in the model to represent the given closure scenario, and then the model was run incrementally for 100 years as generally required in such environmental evaluations. The concentrations of the surrogate mass in groundwater were evaluated at 25, 50, and 100 years. In addition, the relative change in concentrations were evaluated at the downgradient monitoring wells and then compared to the GWPS for lithium, the only constituent for which concentrations were detected at SSLs above the GWPS at the site. It is further noted that lithium concentrations at SSLs above the GWPS have only been measured at MW-10. To illustrate the decay of lithium concentrations over time under each closure alternative, the lithium concentration measured in each of the six downgradient monitoring wells during the June 2022 sampling event (most recent data) was assumed as the starting concentration in each well, and the percent change in relative concentration predicted by the model for each closure scenario was applied to those concentrations to create a curve of concentrations over time.

Figures 8, 10, 12, and 14 in Appendix C provide the time versus decay curves for lithium at each of the six downgradient monitoring well locations for Closure Scenarios 1 through 4, respectively. In all closure scenarios, the dissolved mass downgradient of the surface impoundment decreased to below 10 to 20 percent relative to the starting concentration within 100 years in most areas and remains higher in isolated areas of lower permeability sediments. Ultimately, all closure scenarios were effective in reducing lithium concentrations in monitoring well MW-10 below the GWPS except for Closure Scenario 2 (Alternative #2a – Entire Footprint) in which the lithium concentration was not projected to drop below the GWPS of 0.04 mg/L.

Based on an evaluation of the time versus decay curves for lithium at monitoring well MW-10, Closure Scenario 1 (Alternative #2b) appears to achieve the GWPS in the shortest timeframe (slightly less than 10 years) followed by Closure Scenarios 4 and 3 (Alternatives #4b and #2a – Consolidated Hybrid), respectively. These results also corroborate the supplemental site characterization conclusion noted in Section 2.3.6 that the subject lithium impacts above the GWPS at monitoring well location MW-10 likely originate as seepage from beneath the southern portion of the surface impoundment due to the added driving head associated with the ponded water within this portion of the Unit. As such, with modeled Closure Scenarios 1, 3, and 4 all addressing the seepage from the Unit, implementation of any of these three closure scenarios would provide a groundwater remedy that meets the CAOs within a reasonable timeframe without

the need for additional, more direct groundwater remediation technologies such as groundwater extraction and ex-situ treatment (i.e., Alternatives #3 and #4a) or other hydraulic control measures. Conversely, Closure Scenario 2 (Alternative #2a – Entire Footprint) would not be an appropriate source control measure under any of the corrective measures alternatives because it is unlikely to meet the groundwater CAOs.

3.4 EVALUATION

To determine the most appropriate remedy of the potential options identified in the ACM, BREC performed an evaluation in accordance with the guidance promulgated by EPA's "Fact Sheet #3: Final Remedy Selection for Results-Based RCRA Corrective Action" (EPA, 2000). Per this guideline, a final remedy under RCRA may be selected using the following methodology:

1. Evaluate all identified corrective measures alternatives against the established environmental performance standards (i.e., CAOs). Alternatives that do not meet these "threshold criteria" are then "filtered out" and removed from further consideration.
2. Compare the remaining corrective measures alternatives against balancing criteria to identify the preferred solution for the specific situation. For the situation where multiple alternatives can meet the CAOs, the EPA guideline notes, "The alternative that ranks highest under the greatest number of balancing criteria will stand out as a superior solution relative to the others."

The EPA CCR Rule prescribes specific threshold and balancing criteria for selecting a remedy to correct groundwater impacts under §§ 257.97(b) and 257.97(c), respectively. The following subsections present these evaluation criteria and summarize BREC's evaluation of each corrective measures alternative considered for the Reid/HMP&L CCR Surface Impoundment against those criteria. Further details of BREC's evaluation are provided in Appendix E.

3.4.1 THRESHOLD CRITERIA

Pursuant to 40 CFR 257.97(b), any groundwater remedy shall meet the following CAOs or "threshold criteria:"

- (1) Be protective of human health and the environment;
- (2) Attain the GWPS as determined under 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 Appendix IV constituents;
- (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 standards for management of wastes as specified in 40 CFR 257.98(d)².

² "All CCR that are managed pursuant to a remedy required under § 257.97...shall be managed in a manner that complies with all applicable RCRA requirements." 40 CFR 257.98(d).

As demonstrated in Table 6 below, all five corrective measures alternatives being considered for the Reid/HMP&L CCR Surface Impoundment would be expected to meet these CAOs prescribed by the EPA CCR Rule. Further details on BREC's evaluation of these threshold criteria are provided in Appendix E, Table E-1. Based on these results, all five alternatives were further evaluated using the Rule's balancing criteria for potential groundwater remedies.

Table 6. Summary of Threshold Criteria Evaluation

Evaluation Criteria						
40 CFR 257.97 Ref.	Criterion	#2a	#2b	#3	#4a	#4b
Threshold Criteria (Corrective Action Objectives)						
(b)(1)	Be protective of human health and the environment.	✓	✓	✓	✓	✓
(b)(2)	Attain the groundwater protection standard.	✓	✓	✓	✓	✓
(b)(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 to 40 CFR Part 257 into the environment.	✓	✓	✓	✓	✓
(b)(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.	✓	✓	✓	✓	✓
(b)(5)	Comply with standards for management of wastes as specified in 40 CFR 257.98(d).	✓	✓	✓	✓	✓
Descriptions of Corrective Measures Alternatives						
#2a	CiP with CbR (Modeled Closure Scenario 3), ICs, and Groundwater Monitoring					
#2b	CbR (Modeled Closure Scenario 1), ICs, and Groundwater Monitoring					
#3	CiP with CbR (Modeled Closure Scenario 3), ICs, Hydraulic Containment, Ex-Situ Treatment, and Groundwater Monitoring					
#4a	CiP with CbR (Modeled Closure Scenario 3), ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring					
#4b	CiP with ISS (Modeled Closure Scenario 4), ICs, ISS, and Groundwater Monitoring					

3.4.2 BALANCING CRITERIA

Pursuant to 40 CFR 257.97(c), the following balancing criteria shall be considered when evaluating potential groundwater remedies for a CCR unit:

- (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
 - (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).

In accordance with the EPA CCR Rule, the five corrective measures alternatives being considered for the Unit were evaluated against each of the above balancing criteria and compared to each other. This comparison was performed by assigning a value from 1 to 5 to each alternative under each balancing criterion. In this scoring system, a "5" means the given remedy was considered to be the best at achieving the subject criterion amongst the five corrective measures alternatives. Conversely, a "1" means the given

remedy was considered to be the worst relative to the other alternatives. Where more than one potential remedy was considered to be equal under a given balancing criterion, the average score was assigned to each of the subject corrective measures alternatives.

Table 7 presents the results from BREC's evaluation of the five corrective measures alternatives being considered for the Unit against the EPA CCR Rule's balancing criteria for potential groundwater remedies. Further details on BREC's evaluation of these balancing criteria are provided in Appendix E, Table E-1.

Table 7. Summary of Balancing Criteria Evaluation

Evaluation Criteria						
40 CFR 257.97 Ref.	Criterion	#2a	#2b	#3	#4a	#4b
Balancing Criteria						
(c)(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.					
(c)(1)(i)	Magnitude of reduction of existing risks.	1	5	2.5	2.5	4
(c)(1)(ii)	Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy.	1	5	2.5	2.5	4
(c)(1)(iii)	The type and degree of long-term management required, including monitoring, operation, and maintenance.	3.5	5	1.5	1.5	3.5
(c)(1)(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.	4	1	2.5	2.5	5
(c)(1)(v)	Time until full protection is achieved.	1	5	3.5	3.5	2
(c)(1)(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.	1	5	2.5	2.5	4
(c)(1)(vii)	Long-term reliability of the engineering and institutional controls.	4	5	1.5	1.5	3
(c)(1)(viii)	Potential need for replacement of the remedy.	2	5	2	2	4
(c)(2)	The effectiveness of the remedy in controlling the source to reduce further releases.					
(c)(2)(i)	The extent to which containment practices will reduce further releases.	1	5	2.5	2.5	4
(c)(2)(ii)	The extent to which treatment technologies may be used.	2	2	4.5	4.5	2

Evaluation Criteria						
40 CFR 257.97 Ref.	Criterion	#2a	#2b	#3	#4a	#4b
Balancing Criteria						
(c)(3)	The ease or difficulty of implementing a potential remedy(s).					
(c)(3)(i)	Degree of difficulty associated with constructing the technology.	4	5	3	2	1
(c)(3)(ii)	Expected operational reliability of the technologies.	1	5	2.5	2.5	4
(c)(3)(iii)	Need to coordinate with and obtain necessary approvals and permits from other agencies.	4	5	2	2	2
(c)(3)(iv)	Availability of necessary equipment and specialists.	4	5	3	2	1
(c)(3)(v)	Available capacity and location of needed treatment, storage, and disposal services.	4	1	2.5	2.5	5
(c)(4)	The degree to which community concerns are addressed by a potential remedy(s).	3	3	3	3	3
TOTALS:		40.5	67	41.5	39.5	51.5
Descriptions of Corrective Measures Alternatives						
#2a	CiP with CbR (Modeled Closure Scenario 3), ICs, and Groundwater Monitoring					
#2b	CbR (Modeled Closure Scenario 1), ICs, and Groundwater Monitoring					
#3	CiP with CbR (Modeled Closure Scenario 3), ICs, Hydraulic Containment, Ex-Situ Treatment, and Groundwater Monitoring					
#4a	CiP with CbR (Modeled Closure Scenario 3), ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring					
#4b	CiP with ISS (Modeled Closure Scenario 4), ICs, and Groundwater Monitoring					
Ranking Definitions						
5	Best relative to all other corrective measures alternatives passing threshold criteria.					
1	Worst relative to all other corrective measures alternatives passing threshold criteria.					

Based on the above results, Alternative #2b (CbR, ICs, and Groundwater Monitoring) scored the highest of the five corrective measures alternatives evaluated for remediating the lithium concentrations observed at SSLs above the GWPS in the vicinity of monitoring well MW-10 downgradient of the Reid/HMP&L CCR Surface Impoundment.

4.0 SELECTED REMEDY

Based on the balancing criteria evaluation results presented in Table 7 above, Alternative #2b (CbR, ICs, and Groundwater Monitoring) stands out as the best performing remedy among the five corrective measures alternatives considered to address the GWPS exceedances of lithium observed at the Reid/HMP&L CCR Surface Impoundment. Accordingly, BREC has selected Alternative #2b as the remedy to address the noted groundwater impacts at the Unit.

4.1 SOURCE CONTROL

Under Alternative #2b, BREC will close the Reid/HMP&L CCR Surface Impoundment by removing all CCR and CCR-laden soils from the impoundment in accordance with 40 CFR 257.102(c). Because this remedy would decontaminate the Unit (*i.e.*, all CCR constituents are removed), this corrective measure is expected to minimize or eliminate the source of lithium impacts observed in the groundwater at MW-10. As demonstrated by the groundwater flow and contaminant fate and transport analysis for this closure scenario (Closure Alternative #1, Section 3.3 and Appendix C; referred to as Closure Scenario 1 in discussions above), it is expected that the GWPS for lithium will ultimately be met via natural attenuation within a reasonable timeframe, estimated at less than 10 years after removing CCR constituents from the Unit. As discussed in Section 4.3, this will be confirmed via continued groundwater sampling after closure is completed.

4.2 INSTITUTIONAL CONTROLS

During closure activities and the subsequent groundwater monitoring period, the property will continue to be restricted to industrial use and groundwater use will be prohibited for potable purposes. These ICs will limit potential exposure to COCs while the corrective action remedy is being implemented and its performance is being evaluated.

4.3 GROUNDWATER MONITORING

Groundwater monitoring will continue at the Reid/HMP&L CCR Surface Impoundment to evaluate the effects that removing CCR and CCR-laden soils from the impoundment have on the lithium impacts observed in the groundwater at MW-10. Sampling events conducted after closure is completed will be used to (1) ensure lithium concentrations are trending towards compliance with the GWPS, (2) confirm the GWPS for lithium is ultimately met, and (3) verify further releases of other Appendix IV constituents are minimized or eliminated. Pursuant to 40 CFR 257.98(c)(2) and 257.102(c), groundwater monitoring will continue at the site until the GWPS for lithium has been met for a period of at least three consecutive years.

5.0 SCHEDULE FOR IMPLEMENTING SELECTED REMEDY

BREC's schedule for implementing and completing groundwater remedial activities at the Reid/HMP&L CCR Surface Impoundment is provided in Section 5.2. Per this schedule, and in alignment with the forecast by the groundwater flow and contaminant fate and transport model developed for this remedy (see Figure 8 in Appendix C), it is expected that the GWPS for lithium will be met by April 2032, approximately 8 years after removing the CCR and CCR-laden soils from the Unit. This is considered to be a reasonable period of time to complete remedial activities at this site when considering the following factors set forth by 40 CFR 257.97(d):

- (1) Extent and nature of contamination, as determined by the characterization required under 40 CFR 257.95(g);
- (2) Reasonable probabilities of remedial technologies in achieving compliance with the groundwater protection standards established under 40 CFR 257.95(h) and other objectives of the remedy;
- (3) Availability of treatment or disposal capacity of 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 rates 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
 - (vi) The availability of alternative water supplies; and
- (6) Other relevant factors.

The following subsection discusses each of the above factors in further detail relative to the lithium impacts observed at the Reid/HMP&L CCR Surface Impoundment site and the corrective measures that BREC intends to take.

5.1 SCHEDULE DEVELOPMENT FACTORS

5.1.1 EXTENT & NATURE OF CONTAMINATION

As noted in Section 2.3.6, and as shown on Figure 4, the distribution of lithium concentrations at SSLs above the GWPS appear to be limited to the general vicinity of monitoring well MW-10 and therefore do not extend off-site. Moreover, per Appendix C, the groundwater flow and contaminant fate and transport model developed for this site indicate that removing the CCR and CCR-laden soils from the Unit will ultimately cause the lithium concentrations near monitoring well MW-10 to meet the GWPS within a reasonable timeframe. As discussed in Section 4.3, groundwater monitoring will continue at the site to verify the nature

and extent of contamination continues to be limited to the Station's property and to confirm that the lithium concentrations observed at monitoring well MW-10 eventually meet the established GWPS.

5.1.2 PROBABILITY OF ACHIEVING COMPLIANCE

The selected groundwater remedy is expected to have a high probability of achieving the CAOs. Based on the supplemental site characterization work performed and the groundwater flow and contaminant fate and transport model in Appendix C, the lithium impacts observed at monitoring well MW-10 likely originated from seepage from beneath the southern portion of the surface impoundment. Dewatering associated with closing the Reid/HMP&L CCR Surface Impoundment will remove the primary driving force for seepage, and removing the CCR and CCR-laden soils from the impoundment will remove the source of contamination. As documented on Figure 8 in Appendix C, the GWPS is expected to be met under the selected groundwater remedy in approximately 8 years.

5.1.3 AVAILABILITY OF DISPOSAL CAPACITY FOR EXCAVATED CCR

CCR and CCR-laden soils excavated from the Unit will be placed into dump trucks and transported to the Green Landfill on-site for permanent disposal. The Green Landfill is permitted to receive CCR waste and has available disposal capacity for this one-time waste volume.

5.1.4 POTENTIAL RISKS TO HUMAN HEALTH & THE ENVIRONMENT

As noted in Section 2.3.7, the noted lithium impacts at the Unit are generally limited to the area around monitoring well MW-10 and do not extend off-site. During excavation of CCR and transport to the Station's Green Landfill, appropriate CCR fugitive dust control measures will be implemented to effectively minimize CCR from becoming airborne and contaminating the surrounding environment. It is also noted that the relatively short haul distance to the landfill (less than one mile) further limits the risk of CCR exposure to the environment. Therefore, the risks to human health and the environment caused by exposure to CCR contamination prior to completion of the selected remedy are considered to be minimal.

5.1.5 RESOURCE VALUE OF AQUIFER

As noted in Section 2.3.7, KGS data does not indicate the presence of any groundwater wells used for drinking water within a 1-mile radius of the Reid/HMP&L CCR Surface Impoundment. Future use of this aquifer near the site for drinking water is not expected.

5.2 IMPLEMENTATION SCHEDULE

Milestone	Start Date	End Date
Bid Period for Closing Unit	May 8, 2023	June 12, 2023
Public Meeting on Corrective Measures Alternatives & Proposed Remedy	May 24, 2023	May 24, 2023
Evaluation of Contractor Bids for Closing Unit	June 12, 2023	July 12, 2023
Award Contract for Closing Unit	July 12, 2023	July 14, 2023
Contractor Mobilization to Station	July 17, 2023	July 28, 2023
Unit Closure Construction	July 28, 2023	March 31, 2024
Post-Closure Groundwater Monitoring	April 1, 2024	~ April 2032
GWPS for Lithium Met / Remedy Complete	~ April 2032	~ April 2032
Groundwater Monitoring to Verify GWPS for Lithium is Met	~ April 2032	~ April 2035

6.0 CERTIFICATION

I certify that:

- This final report on selection of groundwater remedy for the Reid/HMP&L CCR Surface Impoundment was prepared by me or under my direct supervision.
- The groundwater remedy selected for the Reid/HMP&L CCR Surface Impoundment meets the requirements of 40 CFR 257.97.
- I am a registered professional engineer under the laws of the Commonwealth of Kentucky.

Certified By: Thomas J. Dehlin Date: July 25, 2023

Seal:

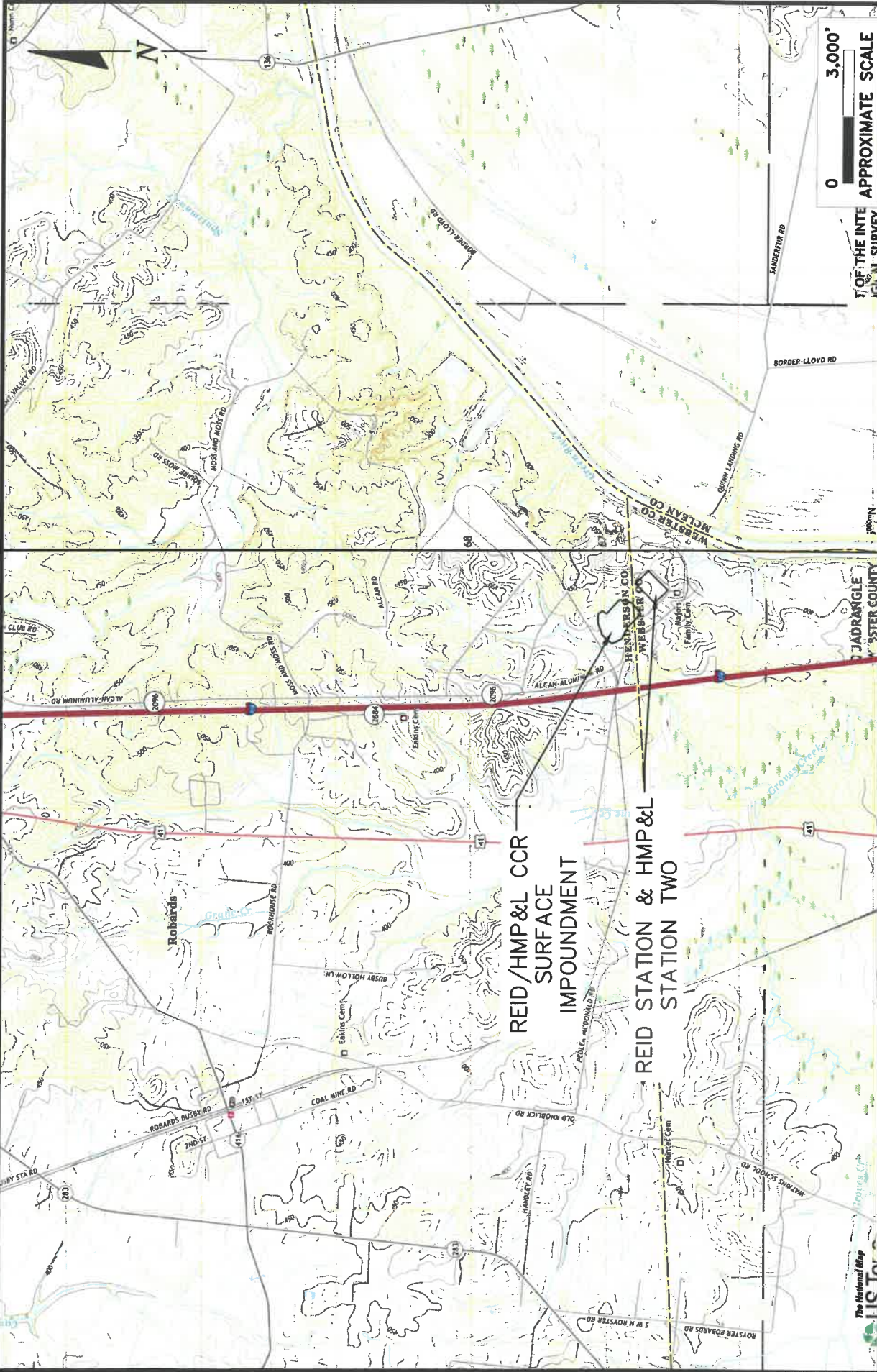


th Dehlin
Thomas Dehlin
2023.07.25
15:49:17-05'00'

7.0 REFERENCES

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- AECOM, 2019a. 2018 Annual Groundwater Monitoring and Corrective Action Report, Sebree Generating Station, Webster County, Kentucky, January 2019.
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- Associated Engineers, Inc., 2016. Hydrologic and Hydraulic Capacity Assessment and Initial Inflow Design Flood Control System Plan. October 2016.
- EPA, 2000. "Fact Sheet #3: Final Remedy Selection for Results-Based RCRA Corrective Action." *RCRA Corrective Action Workshop On Results-Based Project Management: Fact Sheet Series*. March 2000.
- Fairer, G.M., 1973. Geologic Map of the Robards Quadrangle, Henderson and Webster Counties, Kentucky, U.S. Geological Survey.
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FIGURES



GENERAL LOCATION MAP	
BIG RIVERS ELECTRIC CORPORATION ROBARDS, KENTUCKY	
Scale: 1" = 3,000'	Date: August 8, 2022
KPRG Project No. 21021	FIGURE 1

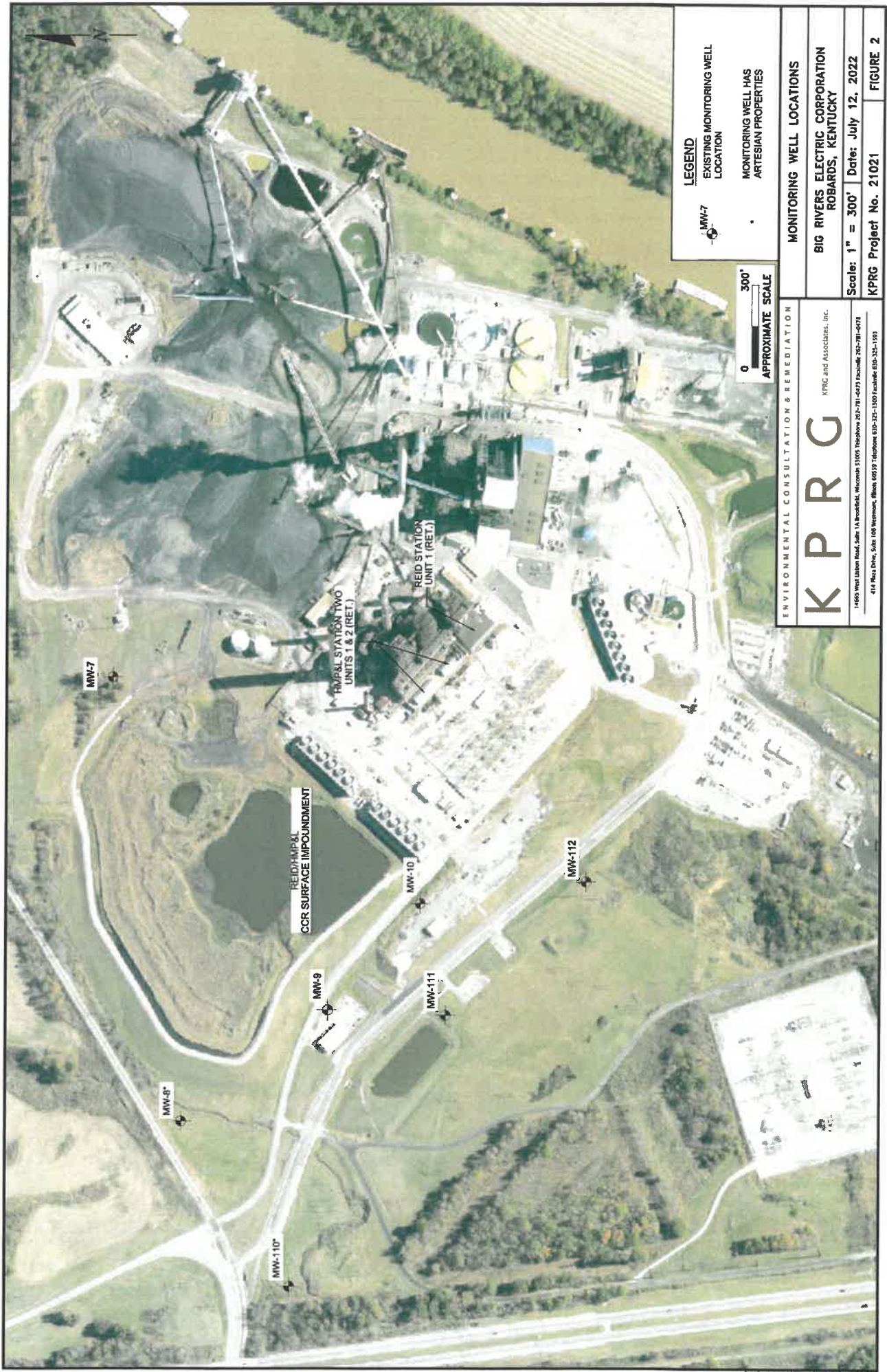
ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

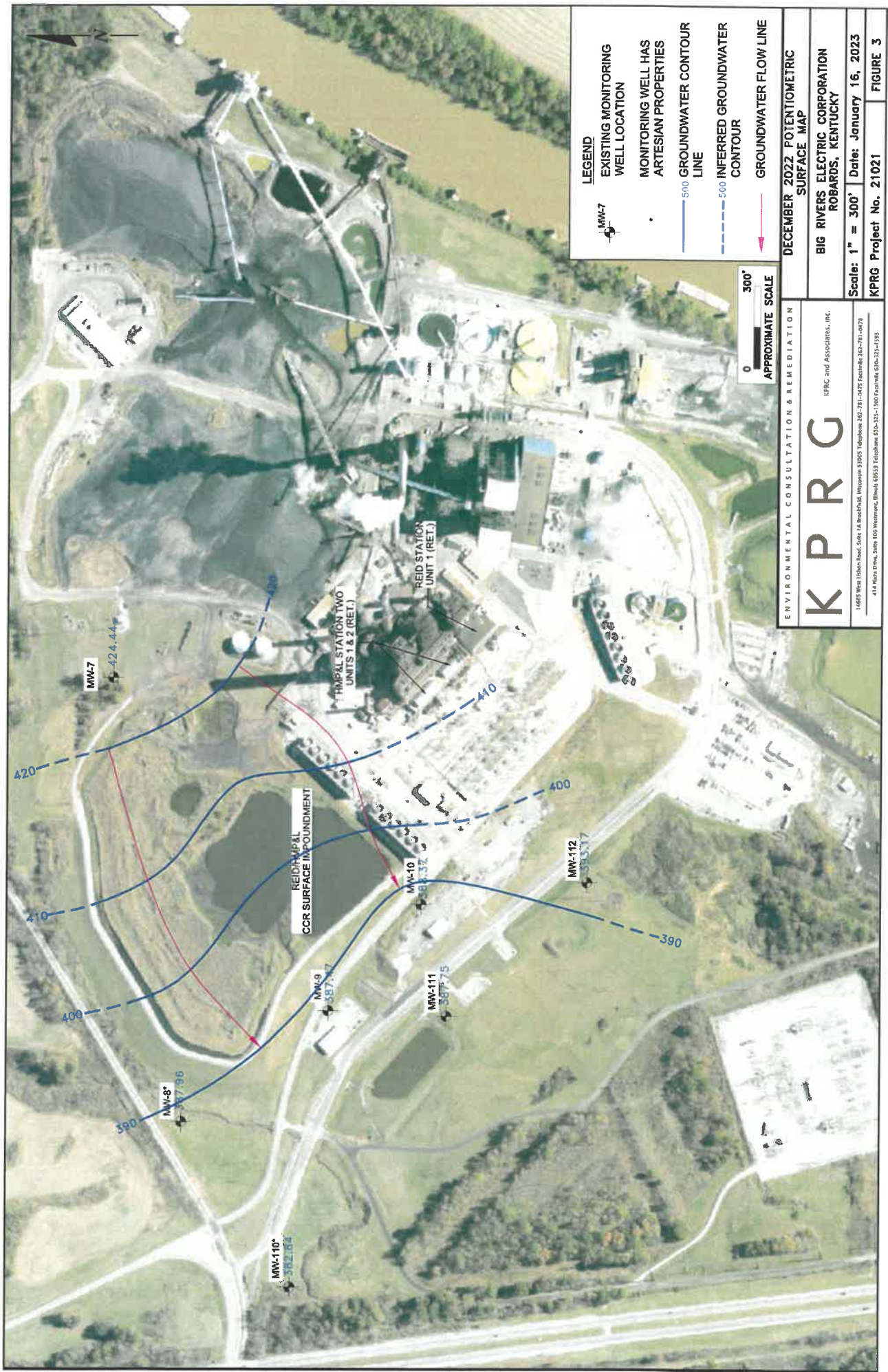
KPRG and Associates, Inc.

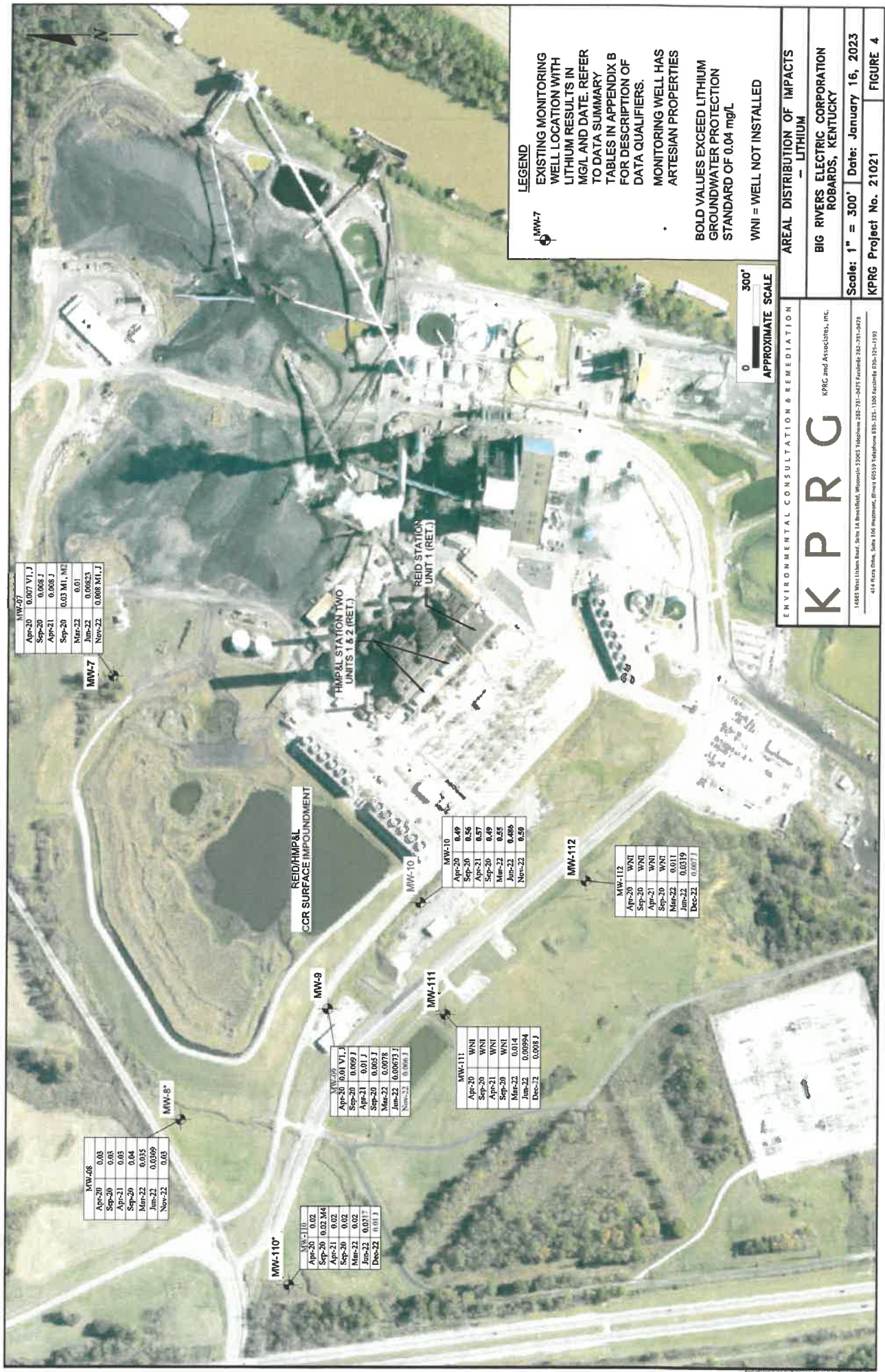
14665 West Lisbon Road, Suite 1A Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 100 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593



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KPRG	
KPRG and Associates, Inc.	
1455 West Union Road, Suite 1A, Brookfield, Wisconsin 53005 Telephone 262-781-4473 Facsimile 262-781-4478	
414 West Drive, Suite 100 Westmont, Illinois 60093 Telephone 815-325-1200 Facsimile 815-325-1593	
MONITORING WELL LOCATIONS	
BIG RIVERS ELECTRIC CORPORATION ROBARDS, KENTUCKY	
Scale: 1" = 300'	Date: July 12, 2022
KPRG Project No. 21021	
FIGURE 2	





APPENDIX A

Characterization Well Boring Logs – MW-111 and MW-112

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

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Geologic Log of MW-111

(Page 1 of 4)

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Boring Depth : 66 feet

Coordinate N : 482645.64

Coordinate E : 1491263.82

Top of Casing Elev : 403.57

Ground Elevation : 400.93

Date Started : 02/15/2022

Date Completed : 02/16/2022

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Depth in Feet	Recovery (in.)	RQD	Sampler Type	Sampler Type: SS - Split Spoon ST - Shelby Tube RS - Rotary-Sonic PQ - PQ Core	REMARKS
				DESCRIPTION	
0				Dark brown SILTY CLAY, organics, very moist	
				Black SILTY CLAY, gray mottling, trace gravel, moist	
54	54	NA	RS	- some rust mottling	
				Brown SILTY CLAY, trace medium gravel, moist	
5					
				Brown SILTY CLAY, black mottling, trace medium gravel, moist	
	54	NA	RS	Brown SILTY CLAY, some gray mottling, moist	
10					
				Brown SILTY CLAY, gray mottling, very stiff, slightly moist	
	54	NA	RS		
15					
				- less stiff	
48	48	NA	RS		
20					

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

Geologic Log of MW-111

(Page 2 of 4)

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Boring Depth : 66 feet

Coordinate N : 482645.64

Coordinate E : 1491263.82

Top of Casing Elev : 403.57

Ground Elevation : 400.93

Date Started : 02/15/2022

Date Completed : 02/16/2022

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Depth in Feet	Recovery (in.)	RQD	Sampler Type	Sampler Type: SS - Split Spoon ST - Shelby Tube RS - Rotary-Sonic PQ - PQ Core	REMARKS
				DESCRIPTION	
20	48	NA	RS	Light gray SANDSTONE AND SHALE, interbedded, highly weathered, abundant arg, very moist	
25	48	NA	RS		
30				Dark gray SHALE, highly weathered, with no infilling	
35	48	NA	RS	Dark Gray SANDSTONE	
40					

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRE and Associates, Inc.

Geologic Log of MW-111

(Page 3 of 4)

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Boring Depth : 66 feet

Coordinate N : 482645.64

Coordinate E : 1491263.82

Top of Casing Elev : 403.57

Ground Elevation : 400.93

Date Started : 02/15/2022

Date Completed : 02/16/2022

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Depth in Feet	Recovery (in.)	RQD	Sampler Type	Sampler Type: SS - Split Spoon ST - Shelby Tube RS - Rotary-Sonic PQ - PQ Core	REMARKS
				DESCRIPTION	
40				Black and gray SHALE and SANDSTONE, banded	
	57	V Poor	PQ	SHALE, banded light and dark gray	
				Gray SANDSTONE, some thin dark gray banding	
45				Light Gray SANDSTONE interbedded with Dark Gray SHALE	
	60	V Poor	PQ	Gray SANDSTONE, some black layering	
50					
	60	V Poor	PQ		
55				- argillaceous layer.	
	58	V Poor	PQ	Gray and dark gray banded SANDSTONE	
60					

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRC and Associates, Inc.

Geologic Log of MW-111

(Page 4 of 4)

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Boring Depth : 66 feet

Coordinate N : 482645.64

Coordinate E : 1491263.82

Top of Casing Elev : 403.57

Ground Elevation : 400.93

Date Started : 02/15/2022

Date Completed : 02/16/2022

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Sampler Type:

SS - Split Spoon

ST - Shelby Tube

RS - Rotary-Sonic

PQ - PQ Core

DESCRIPTION

REMARKS

60

58

V Poor

PQ

60

V Poor

PQ

- mostly dark gray

65

End of boring at 66 ft

70

75

80

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

Geologic Log of MW-112

(Page 1 of 4)

Boring Depth : 81 ft

Coordinate N : 482265.20

Coordinate E : 1491665.25

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Top of Casing Elev : 427.77

Ground Elevation : 424.93

Date Started : 02/18/2022

Date Completed : 02/19/2022

Depth in Feet	Recovery (in.)	RQD	Sampler Type	Sampler Type: SS - Split Spoon ST - Shelby Tube RS - Rotary-Sonic PQ - PQ Core	REMARKS
				DESCRIPTION	
0				Brown CLAY, organics, plastic, mod stiff, moist	
				-some gray mottling.	
5	108	NA	RS	Brown SILTY CLAY, moderate soft, moderate plasticity, moist	
				Brown SANDY CLAY, fine sand, moderate stiff, moist	
10					
				Reddish brown SILTY SAND, little clay, stiff, slightly moist	
15	108	NA	RS		
				Tan reddish brown SILTY SAND, little clay, stiff, slightly moist - some black lenses.	
				Light and Dark Brown CLAY, stiff	
20				Light gray, fine SAND and SILT, stiff, dry	
	72	NA	RS		
25					

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRC and Associates, Inc.

Geologic Log of MW-112

(Page 2 of 4)

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Boring Depth : 81 ft

Coordinate N : 482265.20

Coordinate E : 1491665.25

Top of Casing Elev : 427.77

Ground Elevation : 424.93

Date Started : 02/18/2022

Date Completed : 02/19/2022

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Depth in Feet	Recovery (in.)	RQD	Sampler Type	Sampler Type: SS - Split Spoon ST - Shelby Tube RS - Rotary-Sonic PQ - PQ Core	REMARKS
				DESCRIPTION	
25					
	72	NA	RS		
30					
				Brown SILTY SAND, with gray layers, very stiff, moist	
	44	NA	RS	- brown and black, clayey	
				Gray SILTY SAND with CLAY, moist	
35					
	72	NA	RS	- black, 3 in coal layer, dry, crumbly	
				Greenish gray, SHALE, highly weathered	
40					
				- increasing competent rock	
45	84	NA	RS		
				Greenish Gray SHALE	
50					

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

Geologic Log of MW-112

(Page 3 of 4)

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Boring Depth : 81 ft

Coordinate N : 482265.20

Coordinate E : 1491665.25

Top of Casing Elev : 427.77

Ground Elevation : 424.93

Date Started : 02/18/2022

Date Completed : 02/19/2022

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Depth in Feet	Recovery (In.)	RQD	Sampler Type	Sampler Type: SS - Split Spoon ST - Shelby Tube RS - Rotary-Sonic PQ - PQ Core	REMARKS
				DESCRIPTION	
50	16	NA	RS		
				Light Greenish Gray SANDSTONE and SHALE, banded, arg filling	
	36	V Poor	PQ		
55					
				Light gray/gray SANDSTONE, some occasional shale, thin arg seams	
	50	Fair	PQ		
60					
				Gray, SHALEY SANDSTONE, some dark gray layers	
	50	V Poor	PQ		
65					
	55	V Poor	PQ		
70					
				Gray SANDSTONE, moderately platy	
	60	V Poor	PQ		
				- some thin black seams	
75					

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRC and Associates, Inc.

Geologic Log of MW-112

(Page 4 of 4)

Logged By : P. Allenstein

Driller Name/Co. : Jason Greer / Cascade

Drilling Method : Sonic / PQ Core

Drill Rig : Boart Longyear

Boring Depth : 81 ft

Coordinate N : 482265.20

Coordinate E : 1491665.25

Top of Casing Elev : 427.77

Ground Elevation : 424.93

Date Started : 02/18/2022

Date Completed : 02/19/2022

Big Rivers Electric Corporation
Sebree Generating Station
Robards, Kentucky

Project # 21021

Depth in Feet	Recovery (in.)	RQD	Sampler Type	Sampler Type: SS - Split Spoon ST - Shelby Tube RS - Rotary-Sonic PQ - PQ Core	REMARKS
				DESCRIPTION	
75	60	V Poor	PQ		
	60	V Poor	PQ	Gray SHALEY SANDSTONE with thin, black seams	
80					
				End of Boring at 81 feet.	
85					
90					
95					
100					

Thank you for submitting your information via the Kentucky Energy and Environment Cabinet eForms website. Please save a copy of this submittal for your records. We recommend saving a copy as a .mht, .html, or .htm file. Your Submittal ID and Transaction ID will be included in an email after EEC Staff have reviewed your submittal. The Submittal ID for this transaction is 274971 and was submitted on March 14, 2022 04:56 PM Eastern Time. If you need to contact EEC regarding your submission, please reference your Submittal ID.

The eForm Submittal ID allows you to use the data from this submittal as a template and/or download a copy of your submittal.

UNIFORM KENTUCKY WATER/MONITORING WELL REPORTING RECORD

Use this form to report installation, modification or decommissioning of any temporary or permanent monitoring or water wells

Form must be completed and submitted to the Division of Water within 60 days of completion of work

(*) indicates a required field; (✓) indicates a field may be required based on user input or is an optionally required field

Purpose of the application(*) ⓘ Note: If you are reporting anything other than a new installation and have no AKGWA number, search for it here: (https://kgs.uky.edu/kgsweb/DataSearching/Water/WaterWellSearch.asp) If you still need one, contact DOWDrillersProgram@ky.gov (mailto:DOWDrillersProgram@ky.gov?subject=Need%20AKGWA%20for%20eForm%20submittal) for an AKGWA number before proceeding.		
Install only ▼		
Kentucky Well ID (AKGWA) Number(*) ⓘ Be sure to check the AKGWA Number against the Owner Well ID# before submitting this record. 8007-8617	Owner Well ID# MW-111 Reference Point Downgradient ▼	Well use(*) Monitoring well - co ▼
Monitoring Well Info		
Wellhead		
Manhole cover and gasket ?(*) No ▼	if so, diameter (in):(✓) diameter (in)	Dedicated pump(*) No pump ▼
Flush mount(*) No ▼	Cap(*) Water-tight and lockable ▼	

Owner Name and Address Information

Owner Name and Address Information

Enter business name if owner is an organization. Enter first name/middle initial/last name if owner is an individual

Owner Business name(✓) Big Rivers Electric Corp	Owner first name(✓) Owner first nam	Owner middle initial Middle i	Owner last name(✓) Owner last nam
Owner address(*) 201 Third Street	Owner city(*) Henderson	Owner state(*) Kentucky ▼	Owner zipcode(*) 42420
Owner telephone:(*) 270-827-2561			

Site Name, Address and Agency Information

Please check the checkbox if site address is same as the owner address

Agency Interest (AI) Number: 4196	Program type Solid Waste ▼	Permit or ID Number	
Site Name(*) Big Rivers Electric Corp - Reid HMP&L		Site telephone: ###-###-####	
Site Address(*) 9000 KY 2096	Site city(*) Robards	Site state(*) Kentucky ▼	Site zipcode(*) 42452

Supporting Documentation

Site Map/Sketch Map(✓)	Upload file
Well location	Upload file
Well Diagram (monitoring well)	Upload file
Bacteria analysis (if applicable)	Upload file
Approved variance (if applicable)	Upload file
Drilling log (optional)	Upload file
Other laboratory analysis report (optional)	Upload file
Aquifer test results (optional)	Upload file
Casing/Screen Supplemental Info (if applicable)	Upload file
Other documentation (optional)	Upload file

Well Specifications

Active(*) Yes		Unsuitable for Intended use(*) No	
Discharge permit required?(*) No		Withdrawal permit required?(*) No	
Artesian/flowing(*) No	If so, height (in):(✓)	Nested wells(*) No	If so, number:(✓)
Well Location			
Well latitude(decimal degrees) (*)Driller Viewer (http://watermaps.ky.gov/well) 37.646059	Well longitude(decimal degrees) (*) -87.507219	Method(*) Driller Viewer	
USGS 7.5' quadrangle(*) ROBARDS	County(*) Webster	Physiographic region(*) W. Coal Field	
Surface elevation(ft)(*) 401	Surface elevation method(*) GPS	Well in flood zone?(*) No	
Construction			
Install start date(*) 2/15/2022		Install end date(*) 2/16/2022	
Drilling method(*) Sonic		Specify drilling method combinations(✓) 4x6 sonic drilling to 40', PQ diamond core to 66'.	
Drilling method has no annular space(*) No	Multiple screens ?(*) No	Well development method(*) Combination	Specify development method combinations(✓) Surge and pump
Surface Completion :			
Protective surface casing(*) Yes	Protective surface casing type(✓) Steel	Protective surface casing height above surface(in)(✓) 34	Water-tight locking cap(*) Yes
Concrete pad?(*) if Yes, enter length(in) X Width(in) X height(in) in textbox below	Bumper guards?(*) if so, enter number below: Yes	Weep holes(*) if yes, enter number below Yes	

Yes 36x36x6		4	2
Outer casing(*) No	Outer casing type(✓) ✓	Outer casing height above surface(in)(✓)	Outer casing 2 foot above flood level?(✓) ✓
Inner casing(*) Yes	Inner casing type(✓) PVC	Inner casing height above surface(in)(✓) 30	Inner casing 2 foot above flood level?(✓) Yes
Please report depths in feet below ground surface,			
Total depth (ft bgs):(*) 65		Depth to bedrock (ft bgs):(✓) 23	
Static water level (ft bgs):		SWL method(✓) ✓	
Casing/open borehole: (*)Note: When entering a row of data, From Depth, To Depth, Borehole diameter and Casing Type are required fields			
<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Borehole diameter (in)</u>	<u>Casing OD (in)</u>
40.	55.	5.	2.37
0.	40.	6.	2.37
			2.06
			2.06
			PVC
			PVC
Screen:			
<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Borehole diameter (in)</u>	<u>Screen OD (in)</u>
55.	65.	5.	2.37
.01			2.06
			PVC
Annulus fill and seal			
<u>Section</u>	<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Material</u>
Grout	3.	51.	Bentonite
Seal	51.	53.	Bentonite pellets
Filterpack	53.	66.	Sand
Lithologic log			

<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Description</u>
0	23	Brown Silty Clay
55	66	Sandstone
23	55	Shale

Comments**Affirmation**

I certify under penalty of law that this document/electronic submittal and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. By submitting data, this transmission constitutes my signature and I am responsible for any and all content submitted either by me or by the people I represent.

Date affirmed(*)**3/14/2022****Driller first name(*)****Jason****Driller middle initial****A****Driller last name(*)****Greer****Driller suffix****Driller suffix****Certification number(*)****0492-0608-00****Certification company(*)****Cascade Drilling, L.P.**[Click to Save Values for Future Retrieval](#)[Click to Submit to EEC](#)

Thank you for submitting your information via the Kentucky Energy and Environment Cabinet eForms website. Please save a copy of this submittal for your records. We recommend saving a copy as a .mht, .html, or .htm file. Your Submittal ID and Transaction ID will be included in an email after EEC Staff have reviewed your submittal. The Submittal ID for this transaction is 281220 and was submitted on March 14, 2022 05:08 PM Eastern Time. If you need to contact EEC regarding your submission, please reference your Submittal ID.

The eForm Submittal ID allows you to use the data from this submittal as a template and/or download a copy of your submittal.

UNIFORM KENTUCKY WATER/MONITORING WELL REPORTING RECORD

Use this form to report installation, modification or decommissioning of any temporary or permanent monitoring or water wells

Form must be completed and submitted to the Division of Water within 60 days of completion of work

(*) indicates a required field; (✓) indicates a field may be required based on user input or is an optionally required field

Purpose of the application(*)  Note: If you are reporting anything other than a new installation and have no AKGWA number, search for it here: (https://kgs.uky.edu/kgsweb/DataSearching/Water/WaterWellSearch.asp) If you still need one, contact DOWDrillersProgram@ky.gov (mailto:DOWDrillersProgram@ky.gov?subject=Need%20AKGWA%20for%20eForm%20submittal) for an AKGWA number before proceeding.		
Install only 		
Kentucky Well ID (AKGWA) Number(*)  Be sure to check the AKGWA Number against the Owner Well ID# before submitting this record. 8007-8618	Owner Well ID# MW-112 Reference Point Downgradient 	Well use(*) Monitoring well - co 
Monitoring Well Info		
Wellhead		
Manhole cover and gasket ?(*) No 	if so, diameter (in):(✓) diameter (in)	Dedicated pump(*) No pump 
Flush mount(*) No 	Cap(*) Water-tight and lockable 	
Owner Name and Address Information		

Owner Name and Address Information

Enter business name if owner is an organization. Enter first name/middle initial/last name if owner is an individual

Owner Business name(✓) Big Rivers Electric Corp	Owner first name(✓) Owner first nan	Owner middle initial Middle i	Owner last name(✓) Owner last nan
Owner address(*) 201 Third Street	Owner city(*) Henderson	Owner state(*) Kentucky ▼	Owner zipcode(*) 42420
Owner telephone(*) 270-827-2561			

Site Name, Address and Agency Information

Please check the checkbox if site address is same as the owner address

Agency Interest (AI) Number: 4196	Program type Solid Waste ▼	Permit or ID Number	
Site Name(*) Big Rivers Electric Corp - Reid HMP&L		Site telephone: ###-###-####	
Site Address(*) 9000 KY 2096	Site city(*) Robards	Site state(*) Kentucky ▼	Site zipcode(*) 42452

Supporting Documentation

Site Map/Sketch Map(✓)	Upload file
Well location	Upload file
Well Diagram (monitoring well)	Upload file
Bacteria analysis (if applicable)	Upload file
Approved variance (if applicable)	Upload file
Drilling log (optional)	Upload file
Other laboratory analysis report (optional)	Upload file
Aquifer test results (optional)	Upload file
Casing/Screen Supplemental Info (if applicable)	Upload file
Other documentation (optional)	Upload file

Well Specifications

Active(*) Yes		Unsuitable for Intended use(*) No	
Discharge permit required?(*) No		Withdrawal permit required?(*) No	
Artesian/flowing(*) No	If so, height (in):(✓)	Nested wells(*) No	If so, number:(✓)
Well Location			
Well latitude(decimal degrees) (*) <u>Driller Viewer</u> (http://watermaps.ky.gov/well) 37.644862	Well longitude(decimal degrees) (*) -87.505636	Method(*) Driller Viewer	
USGS 7.5' quadrangle(*) ROBARDS	County(*) Webster	Physiographic region(*) W. Coal Field	
Surface elevation(ft)(*) 426	Surface elevation method(*) GPS	Well in flood zone?(*) No	
Construction			
Install start date(*) 2/18/2022		Install end date(*) 2/19/2022	
Drilling method(*) Sonic		Specify drilling method combinations(✓) 4x6 sonic drilling to 50', PQ diamond core to 81'.	
Drilling method has no annular space(*) No	Multiple screens ?(*) No	Well development method(*) Combination	Specify development method combinations(✓) Surge and pump
Surface Completion :			
Protective surface casing(*) Yes	Protective surface casing type(✓) Steel	Protective surface casing height above surface(in):(✓) 34	Water-tight locking cap(*) Yes
Concrete pad?(*) if Yes, enter length(in) X Width(in) X height(in) in textbox below	Bumper guards?(*) if so, enter number below: Yes	Weep holes(*) if yes, enter number below Yes	

Yes 36x36x6		4	2	
Outer casing(*) No	Outer casing type(✓) ✓	Outer casing height above surface(in)(✓)	Outer casing 2 foot above flood level?(✓) ✓	
Inner casing(*) Yes	Inner casing type(✓) PVC	Inner casing height above surface(in)(✓) 30	Inner casing 2 foot above flood level?(✓) Yes	
Please report depths in feet below ground surface,				
Total depth (ft bgs):(*) 80		Depth to bedrock (ft bgs):(✓) 40		
Static water level (ft bgs):		SWL method(✓) ✓		
Casing/open borehole:				
(*)Note: When entering a row of data, From Depth, To Depth, Borehole diameter and Casing Type are required fields				
<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Borehole diameter (in)</u>	<u>Casing OD (in)</u>	<u>Casing ID (in)</u>
0.	70.	6.	2.37	2.06
				PVC
Screen:				
<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Borehole diameter (in)</u>	<u>Screen OD (in)</u>	<u>Screen ID (in)</u>
<u>Screen Slot Size (in)</u>				
70.	80.	6.	2.37	2.06
.01				PVC
Annulus fill and seal				
<u>Section</u>	<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Material</u>	
Grout	3.	66.	Bentonite	
Seal	66.	68.	Bentonite pellets	
Filterpack	68.	81.	Sand	
Lithologic log				
<u>From Depth (ft)</u>	<u>To Depth (ft)</u>	<u>Description</u>		

0	40.	Brown Silty Clay
70	81	Sandstone
40.	70.	Shale

Comments

Affirmation

I certify under penalty of law that this document/electronic submittal and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. By submitting data, this transmission constitutes my signature and I am responsible for any and all content submitted either by me or by the people I represent.

Date affirmed(*)	3/14/2022
Driller first name(*)	Jason
Driller middle initial	A
Driller last name(*)	Greer
Driller suffix	Driller suffix
Certification number(*)	0492-0608-00
Certification company(*)	Cascade Drilling, L.P.

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APPENDIX B

Groundwater Quality Data Summary Tables

REDHILL SURFACE IMPOUNDMENT - ANALYTICAL SUMMARY

RMV (lb=metric)

APPENDIX III CONSTITUENTS	GWPS	DATE										
		3/30/2018	5/11/2018	10/12/2018	11/12/2017	11/12/2017	11/12/2017	11/12/2017	11/12/2017	11/12/2017	11/12/2017	
APPENDIX III CONSTITUENTS	Boron	NA	0.246	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	
	Cadmium	NA	41.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	
	Chloride	NA	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28	
	4 mg/L Nitrate	NA	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	
	25.7 mg/L Sulfate	NA	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	
	7.47 mg/L pH (Field Measurement)	NA	233	241	243	243	243	243	243	243	243	
	Total Dissolved Solids	NA	233	241	243	243	243	243	243	243	243	
	APPENDIX IV CONSTITUENTS	Arsenic	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
		Barium	2 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
		Beryllium	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium		0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Chromium		0.1 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Cobalt		0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Fluoride		4 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Lead		0.015 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Lithium		0.040 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Mercury		0.002 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Molybdenum	0.1 mg/L	0.0109	0.0195	0.0195	0.0195	0.0195	0.0195	0.0195	0.0195	0.0195		
Radium 226	5 pCi/L	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695		
Radium 228	0.05 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND		
Thallium	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND		

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

ND = Not Detected at or above Method Detection Limit

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approach B = Compound was found in the blank and sample

C1 = Field and/or MSD recovery is outside acceptance limits

M1 = Matrix spike recovery was high, the method control sample recovery was acceptable

M2 = Matrix spike recovery was low, the method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD = Exceeded GWPS

NA = Not Analyzed

pCi/L = picocuries per liter

C1 = Field and/or MSD recovery is outside acceptance limits

M1 = Matrix spike recovery was high, the method control sample recovery was acceptable

M2 = Matrix spike recovery was low, the method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD = Exceeded GWPS

REDHMPA SURFACE IMPONDEMENT - ANALYTICAL SUMMARY

MM-3 (dimer) (mg/L)

APPENDIX B: CONSTITUENTS	GWPS	DATE									
		3/1/2018	5/1/2018	6/1/2018	7/1/2018	8/1/2018	9/1/2018	10/1/2018	11/1/2018	12/1/2018	1/1/2019
Boron	NA	1.45	1.07	1.1	1.04	1.74	1.60	1.32	1.54	1.41	1.41
Cadmium	NA	283	242	228	194	251	251	228	235	242	242
Chloride	NA	46.7	38.2	41.4	69.1	43.8	43.8	47.1	38.4	46.3	46.3
Copper	NA	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Sulfate	NA	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
pH (Field Measurement)	NA	7.13	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14
Total Dissolved Solids	NA	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830
APPENDIX IV: CONSTITUENTS											
Arsenic	0.05 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	0.1 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoride	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium	0.045 mg/L	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Mercury	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Molybdenum	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL).

GWPS = Groundwater Protection Standard

NA = Not Analyzed

ND = Not Detected at or above Method Detection Limit

PC/L = picCuries per Liter

D1 = Sample required dilution due to high concentration of target analyte.

D2 = Sample required dilution due to matrix interference.

M1 = Matrix spike recovery was high; the method control sample recovery was acceptable.

M2 = Matrix spike recovery was low; the method control sample recovery was acceptable.

U = Target analyte was analyzed for, but was below detection limit.

VM = CCL recovery was above method acceptance limits. This target analyte not detected in the sample.

GC/L = Groundwater GWPS

NA = Not Analyzed

PC/L = picCuries per Liter

D1 = Sample required dilution due to high concentration of target analyte.

D2 = Sample required dilution due to matrix interference.

M1 = Matrix spike recovery was high; the method control sample recovery was acceptable.

M2 = Matrix spike recovery was low; the method control sample recovery was acceptable.

U = Target analyte was analyzed for, but was below detection limit.

VM = CCL recovery was above method acceptance limits. This target analyte not detected in the sample.

GC/L = Groundwater GWPS

REDHMPA SURFACE IMPOUNDMENT - ANALYTICAL SUMMARY

HW-9 (down-gradient)

APPENDIX III CONSTITUENTS	GWPS	DATE											
		3/12/2018	5/17/2018	6/17/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018
Boron	NA	0.316	0.333 J	0.333 J	0.333 J	0.333 J	0.333 J	0.333 J	0.333 J	0.333 J	0.333 J	0.333 J	0.333 J
Cadmium	NA	64.1	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5
Chloride	NA	26.5 B	30.5 B	30.5 B	30.5 B	30.5 B	30.5 B	30.5 B	30.5 B	30.5 B	30.5 B	30.5 B	30.5 B
Copper	NA	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B	42.4 B
Sulfate	NA	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51	3.51
pH (Field Measurement)	NA	7.32	7.32	7.32	7.32	7.32	7.32	7.32	7.32	7.32	7.32	7.32	7.32
Total Dissolved Solids	NA	353	406	406	406	406	406	406	406	406	406	406	406
APPENDIX IV CONSTITUENTS													
Antimony	0.009 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.01 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	2 mg/L	1.1	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
Beryllium	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	0.1 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	0.015 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium	0.005 mg/L	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J	0.0126 J
Mercury	0.002 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Molybdenum	0.1 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Radium 226	5 pCi/L	2.87	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94
Selenium	0.05 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	0.002 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

*All results listed in milligrams per liter (mg/L), unless otherwise noted by the Maximum Contaminant Level (MCL).

GWPS = Groundwater Protection Standard

ND = Not Detected at or above Method Detection Limit

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate 1/2 B = Compound was found in the blank and sample.

M1 = Matrix spike recovery was low; the method control sample recovery was acceptable

M2 = Matrix spike recovery was low; the method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD = Exceeds GWPS

NA = Not Analyzed

pCi/L = picocuries per liter

1/2 B = Compound was found in the blank and sample.

M1 = Matrix spike recovery was low; the method control sample recovery was acceptable

M2 = Matrix spike recovery was low; the method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD = Exceeds GWPS

REID/HMPL SURFACE IMPOUNDMENT - ANALYTICAL SUMMARY

MM-10 (down-gradient)

GWPS		DATE												
		3/30/2014	8/5/2014	8/17/2014	1/16/2015	2/9/2015	5/11/2015	8/23/2015	9/22/2015	10/11/2015	12/2/2015	Measurement	4/17/2016	8/19/2016
		Baseline Events												
Boron	NA	0.418 J	0.348 J	0.462 J	0.408 J	0.540 J	0.679 J	0.565 J	0.528 J	0.437 J	0.348 J	0.418 J	0.464 J	0.498 J
Chlorine	NA	16.5 J	21.3 J	28.8 J	38.1 J	44.5 J	55.1 J	33.7 J	21.4 J	26.8 J	25.8 J	9.54 J	10.5 J	9.76 J
Chloride	NA	31.5 J	24.8 J	28.8 J	31.5 J	29.4 J	25.1 J	32.3 J	29.7 J	29.7 J	29.7 J	26.6 J	26.5 J	26.5 J
Copper	4 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	27.9 J	27.9 J
Iron	NA	259 J	115 J	144 J	162 J	145 J	158 J	177 J	226 J	147 J	16.8 J	0.376 J	0.6 J	0.6 J
pH (Field Measurement)	NA	7.2	7.2	7.2	7.53	7.08	9.24	8.14	8.14	9.18	7.46	8.98 J	9.38 J	9.38 J
Total Dissolved Solids	NA	644	834	834	652	673	733	732	783	728	271	942 J	548 J	548 J
APPENDIX IV CONSTITUENTS														
Arsenic	0.005 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Barium	0.01 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Beryllium	2 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Cadmium	0.005 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Chromium	0.1 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Cobalt	0.005 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Fluoride	4 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Lead	0.015 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Lithium	0.05 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Manganese	0.02 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Mercury	0.002 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Molybdenum	0.1 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Radium 226	5 pCi/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Radium 228	5 pCi/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Selenium	0.05 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J
Thallium	0.02 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL).

GWPS = Groundwater Protection Standard

ND = Not Detected at or above Method Detection Limit

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value B = Compound was found in the blank and sample.

D1 = Sample required dilution due to high concentration of target analyte

D2 = Sample required dilution due to high concentration of target analyte

R2 = Matrix spike recovery was less than 80% and sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD = Exceeds GWPS

NA = Not Analyzed

pCi/L = picocuries per liter

F1 = MS order MSD Recovery is outside acceptance limits.

Q2 = Sample required dilution due to matrix interference

NA = The recovery of the spike sample was less than 80% and sample recovery was acceptable

MA = The analysis of the spike sample yielded a dilution such that the spike concentration was detected below the reporting limit. The method control sample recovery was acceptable

MA = The analysis of the spike sample yielded a dilution such that the spike concentration was detected below the reporting limit. The method control sample recovery was acceptable

REID/HMPL SURFACE IMPOUNDMENT - ANALYTICAL SUMMARY
 MW-110 (down-gradient)

APPENDIX III CONSTITUENTS		GWPS		DATE						
		3/29/2019	4/10/2019	10/24/2019	4/17/2020	10/1/2020	5/26/2021	10/1/2021	3/15/2022	
		Characterization								
Boron	NA	0.484 JB	0.498 JB	ND D2, U	0.54 M4	0.53 D2, M1, M4	0.54	0.52	0.60	
Calcium	NA	171 JB	178	204 D1	181 D1	162 D1, M2	163 D1	155 D1	151	
Chloride	NA	26.0	30.4 B	30.0	22.1	19.9	21.6	21.1	20	
Fluoride	4 mg/L	0.279 J	0.255 JB	0.3	0.3	0.3	0.3	0.3	0.36	
Sulfate	NA	56.3	59.6 B	ND M1	480 D	411 D	428 D	451 D	440	
pH (Field Measurement)	NA	7.25	7.50	6.84	7.17	7.56	7.73	6.69	7.19	
Total Dissolved Solids	NA	110	1200	1270	1150	1080	1140	1090	930	
APPENDIX IV CONSTITUENTS										
Arsenic	0.005 mg/L	0.000240 JB	0.000204 JB	ND U	<0.005	<0.005 M4	<0.005 U	<0.001 U	<0.00051	
Barium	0.01 mg/L	0.00534	0.00238 J	ND U	0.0012	0.0004 J	<0.0010 U	<0.001 U	0.0011	
Beryllium	2 mg/L	0.118 J	0.107 JB	0.065	0.065	0.056 M1	0.055	0.049	0.059	
Cadmium	0.005 mg/L	0.000716 J	0.000314 J	ND U	<0.0020 M2	<0.0020 M4	<0.0020 U	<0.0020 U	<0.00027	
Chromium	0.005 mg/L	ND	ND	ND U	<0.0010	<0.0010	<0.0010 U	<0.0010 U	<0.00022	
Cobalt	0.1 mg/L	0.0160 B	0.0115	0.0010 J	0.0047	0.0016 J	0.0009 J	0.0020 U	0.0035	
Copper	0.005 mg/L	0.00911 B	0.00384 J	ND U	<0.004	<0.004 M4	<0.004 U	<0.004 U	0.0017	
Fluoride	4 mg/L	0.275 J	0.255 JB	0.3	0.3	0.3	0.3	0.3	0.36	
Lead	0.015 mg/L	0.00661	0.00398 J	ND U	0.002	0.0008 J	<0.002 U	<0.002 U	0.0017	
Lithium	0.040 mg/L	0.0294 J	0.0303 J	0.02	0.02	0.002 M4	0.02	0.02	0.02	
Mercury	0.002 mg/L	ND	ND	ND U	0.0002 J	<0.0005 M1, M4	<0.0005 U	<0.00013 U	0.00051 H	
Molybdenum	0.1 mg/L	0.00153 J	0.00120 J	ND U	<0.01	<0.01 M4	<0.01 U	<0.01 U	<0.00061	
Radium 226	5 pCi/L	1.84	1.93	0.195	1.37	0.941	0.636	0.652	1.590	
Radium 228	0.05 mg/L	ND	ND	ND U	<0.003	<0.003 M4	<0.003 U	<0.003 U	<0.00074	
Selenium	0.005 mg/L	0.000112 J	0.0000840 J	ND U	<0.0020	<0.0020	<0.0020 U	<0.0020 U	<0.00047	
Thallium										

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

ND = Not Detected at or above Method Detection Limit

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

D1 = Sample required dilution due to high concentration of target analyte

M1 = Matrix spike recovery was high, the method control sample recovery was acceptable

M2 = Matrix spike recovery was low, the method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD -Exceeds GWPS

NA = Not Analyzed

pCi/L = picocuries per liter

B = Compound was found in the blank and sample.

F1 = MS and/or MSD Recovery is outside acceptance limits.

D2 = Sample required dilution due to matrix interference

M3 = The accuracy of the spike recovery value is reduced since the analysis concentration in the sample is disproportionate to spike level. The method control sample recovery was acceptable

M4 = The analysis of the spike sample required a dilution such that the spike concentration was diluted below the reporting limit. The method control sample recovery was acceptable

REID/HMPL SURFACE IMPOUNDMENT - ANALYTICAL SUMMARY
MW-111 (down-gradient)

APPENDIX III CONSTITUENTS	GWPS	DATE	
		3/16/2022	
		Characterization	
Boron	NA	0.54	
Calcium	NA	19	
Chloride	NA	18	
Fluoride	4 mg/L	0.55	
Sulfate	NA	6.7	
pH (Field Measurement)	NA	8.00	
Total Dissolved Solids	NA	310	

APPENDIX IV CONSTITUENTS			
Arsimony	0.006 mg/L	0.0014 J	
Arsenic	0.01 mg/L	0.0014	
Barium	2 mg/L	0.89	
Beryllium	0.004 mg/L	<0.00077	
Cadmium	0.005 mg/L	<0.00022	
Chromium	0.1 mg/L	<0.0015	
Cobalt	0.006 mg/L	0.00045	
Fluoride	4 mg/L	0.55	
Lead	0.015 mg/L	0.00654 J	
Lithium	0.040 mg/L	0.014	
Mercury	0.002 mg/L	0.00031	
Molybdenum	0.1 mg/L	0.0044 J	
Radium 226	5 pCi/L	0.67 U	
Radium 228			
Selenium	0.05 mg/L	<0.00074	
Thallium	0.002 mg/L	<0.00047	

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

ND = Not Detected at or above Method Detection Limit

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

D1 = Sample required dilution due to high concentration of target analyte

M1 = Matrix spike recovery was high; the method control sample recovery was acceptable

M2 = Matrix spike recovery was low; the method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD - Exceeds GWPS

NA = Not Analyzed

pCi/L = picocuries per liter

B = Compound was found in the blank and sample.

F1 = MS and/or MSD Recovery is outside acceptance limits.

D2 = Sample required dilution due to matrix interference

M3 = The accuracy of the spike recovery value is reduced since the analyte concentration in the sample is disproportionate to spike level. The method control sample recovery was acceptable

M4 = The analysis of the spike sample required a dilution such that the spike concentration was diluted below the reporting limit. The method control sample recovery was acceptable

REID/HMPL SURFACE IMPOUNDMENT - ANALYTICAL SUMMARY

MW-112 (down-gradient)

APPENDIX III CONSTITUENTS		GWPS	DATE 3/17/2022	
			Characterization	
Boron		NA	0.39	
Calcium		NA	239	
Chloride		NA	8.4	
Fluoride		4 mg/L	0.31	
Sulfate		NA	12.4	
pH (Field Measurement)		NA	7.76	
Total Dissolved Solids		NA	246	
APPENDIX IV CONSTITUENTS				
Antimony		0.005 mg/L	0.00056 J	
Arsenic		0.01 mg/L	0.00089 J	
Barium		2 mg/L	0.34	
Beryllium		0.004 mg/L	<0.00027	
Cadmium		0.005 mg/L	<0.00022	
Chromium		0.1 mg/L	0.0024	
Cobalt		0.005 mg/L	0.002	
Fluoride		4 mg/L	0.31	
Lead		0.015 mg/L	0.001	
Lithium		0.040 mg/L	0.011	
Mercury		0.002 mg/L	<0.00013	
Molybdenum		0.1 mg/L	0.0062	
Radium 226				
Radium 228		5 pCi/L	0.71 U	
Selenium		0.05 mg/L	<0.00074	
Thallium		0.002 mg/L	<0.00047	

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

ND = Not Detected at or above Method Detection Limit

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

D1 = Sample required dilution due to high concentration of target analyte

M1 = Matrix spike recovery was high; the method control sample recovery was acceptable

M2 = Matrix spike recovery was low; the method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

BOLD - Exceeds GWPS

NA = Not Analyzed

pCi/L = picoCuries per Liter

B = Compound was found in the blank and sample.

F1 = MS and/or MSD Recovery is outside acceptance limits.

D2 = Sample required dilution due to matrix interference

M3 = The accuracy of the spike recovery value is reduced since the analyte concentration in the sample is disproportionate to spike level. The method control sample recovery was acceptable

M4 = The analysis of the spike sample required a dilution such that the spike concentration was diluted below the reporting limit. The method control sample recovery was acceptable

APPENDIX C

Groundwater Flow & Contaminant Fate & Transport Model



DATE October 12, 2022

Project No. 22212101

TO Richard Gnat, P.G.
KPRG and Associates, Inc.

FROM Betsy Semmens, R.G.
BAS Groundwater Consulting Inc.

EMAIL betsy@basgc.com

This technical memorandum (TM) documents groundwater modeling performed on behalf of Big Rivers Electric Cooperation (BREC) to assist the engineering evaluations of closure alternatives under requirements of the federal coal combustion residuals (CCR) rule under 40 CFR 257.95(g) at the Reid/Henderson Municipal Power & Light (HMP&L) Surface Impoundment (surface impoundment or impoundment) at the Sebree Generating Station (Sebree Station), located in Robards, Kentucky (Site).

This TM documents the development of the groundwater model and its results for use in assisting with the closure alternatives evaluations.

1.0 MODEL DEVELOPMENT

A three-dimensional, groundwater flow and contaminant transport model was developed for the area of the surface impoundment (Figure 1). The model was developed using MODFLOW-NWT¹, an advanced version of the widely used MODFLOW software. Groundwater Vistas², a graphical user interface, was used to parameterize the model input, write MODFLOW files, and visualize results. MODFLOW-NWT was considered over MODFLOW-2000, MODFLOW-2005, or MODFLOW-USG because it has enhanced solvers that employ upstream weighting for non-linear problems, it is a relatively recent, widely used, and non-proprietary release of MODFLOW. It was coupled with the widely used and non-proprietary transport model MT3D-USGS³, which was used for the transport simulations.

The model covers an area of approximately 0.5 miles by 0.4 miles, centered on the surface impoundment (Figure 1). The model area includes the surface impoundment's upgradient monitoring well MW-7, and downgradient monitoring wells MW-8, -9, and -10, and new assessment downgradient monitoring wells MW-110, -111, and -112. The model was developed with uniform, square 25-foot grid cells and five model layers. The top surface of

¹ Niswonger, R. P. (2011). MODFLOW-NWT, A Newton formulation for MODFLOW-2005. In USGS Survey, Techniques and Methods 6-A37(p. 44). Reston, Virginia: U.S. Department of the Interior

² Environmental Simulations Inc. (ESI). (2020). Groundwater Vistas v.8.0

³ Bedekar, V., Morway, E.D., Langevin, C.D., and Tonkin, M., 2016, MT3D-USGS version 1: A U.S. Geological Survey release of MT3DMS updated with new and expanded transport capabilities for use with MODFLOW: U.S. Geological Survey Techniques and Methods 6-A53, 69 p.

the model was created as a simplified representation of recent topographical survey data (Figure 2) to represent the overall topographic gradients without small-scale variations. For the purposes of model simplification, a surface was created to represent the thickness of ash deposits at the surface impoundment that varies from a thickness from five feet at the northeast side of the surface impoundment to 45 feet at the southwest side of the surface impoundment based on review of boring logs, historical as-builts and recent survey data (Figure 2). This thickness was divided into the top two layers of the model (model layers 1 and 2), so each layer increases in thickness from 2.5 feet at the northeast side to 22.5 feet at the southwest side of the model domain. The remaining model layers (model layers 3 through 5) each have a thickness of 25 feet.

The model is oriented 37 degrees to the northwest to be aligned with the general direction of groundwater flow across the site. Constant head boundaries were used along the upgradient (northeast) and downgradient (southwest) edges of the model and no-flow boundaries were used on the two other model edges to generally represent a groundwater flow line. The upgradient (northeast) constant head boundary was defined in each model cell as 10 feet below the top of the model, consistent with depth to water measurements at MW-7. The downgradient (southwest) constant head boundary was defined from the measured water levels in MW-110 and -112, and linearly increases from 383 ft at the northwest corner to 388 feet at the southwest corner.

Zones of hydraulic conductivity (K) were used to represent the varying lithology across the site. The approach was to keep the zonation as simplistic as possible, adding complexity only as needed to achieve the calibration goal of matching the overall hydraulic gradient across the Site. Lithologic logs from the onsite monitoring wells were used to guide the zones of K in the model layer structure and are the reason behind the boundaries of K zones in the five model layers (Figures 3 and 4). Furthermore, the modeled value of K was defined from aquifer tests at specific monitor well locations:

- MW-110 test data has a geometric mean of 1.47 feet per day (ft/d) in interbedded shale and sandstone
- MW-111 test data has a geometric mean of 0.96 ft/d in sandstone
- MW-112 test data has a geometric mean of 0.00425 ft/d in interbedded shale and sandstone
- MW-10 test data has a value of 0.0095 ft/d in interbedded shale and sandstone
- Permeability tests in ash samples from borings B-3 and B-4, which are representative of the ash collected as part of the geotechnical investigation completed as part of the larger overall engineering evaluation of closure alternatives, have average values of 1.58 ft/d and 1.18 ft/d, respectively. The ash material in the model was simulated with the higher value of 1.58 ft/d as this provided for better model calibration results.

Key definitions of K that had the most influence on model results included:

- Low K of clay at MW-9, consistent with test data from MW-112 was important to limit the movement of impacted water from the surface impoundment in model layers 1 through 3 at this location, consistent with the unimpacted water quality measured at MW-9.
- Relatively high K values downgradient of the monitor wells and at MW-110 to replicate the relatively lower hydraulic gradient observed from water level measurements in the downgradient monitor wells.

- Low K of clay in the upper layers around MW-7, with higher K in the deeper model layers to encourage regional flow into the model domain and create the relatively higher hydraulic gradient in the upgradient portion of the model domain.

Inclusion of the ash as a separate zone of K which, from the model layering, has a wedge shape with total thickness in model layers 1 and 2 from 5 feet on the upgradient side of the surface impoundment to 45 feet on the downgradient side. Recharge was added to the model to represent seepage from the surface impoundment, in the area that shows ponded water in recent aerial photos in Google Earth. The recharge rate was adjusted as part of model calibration and resulted in flux into the model of 6 gallons per minute (gpm). This was also compared to a model run in which the pond was represented in the model as a general head boundary (GHB) with an elevation equal to the surveyed pond elevation of 423.85 feet and conductance values consistent with the modeled K. The model estimated seepage from the pond under these assumptions using the hydraulic gradient between the pond and the underlying water table and resulted in a seepage range between 4 and 25 gpm, consistent with the recharge flux.

The model developed for this project is a simplified, initial representation of the groundwater system, and as such, calibration goals were limited to generally representing groundwater flow directions and hydraulic gradients. The modeled water table is shown on Figure 5 along with the water level contours drawn from the measured water levels in the monitor wells from June 2022. The match between the modeled and measured water level contours is reasonable for this simplified model, and the model appropriately represents the southwestern hydraulic gradient, the relatively flat hydraulic gradient downgradient of the surface impoundment, and the overall hydraulic gradient through the surface impoundment, making this groundwater model appropriate for use in evaluating closure engineering alternatives for the Site.

2.0 CLOSURE ALTERNATIVES

Four closure alternatives were evaluated with the groundwater model. A distribution of impacted groundwater was established with the model and was used as the initial concentrations for predictive model scenarios to evaluate the effectiveness of the engineered closure alternatives in reducing the extent of impacted groundwater.

The distribution of impacted groundwater was established from a 100-year model scenario of a surrogate mass with a concentration of "1" (100%) in groundwater beneath the surface impoundment. A constant concentration boundary of "1" was defined in the footprint of the surface impoundment in model layers 1 and 2 and the mass was allowed to move in groundwater by advection and dispersion, until an equilibrium (steady state) distribution of impacted groundwater was achieved (typically within about 30 years for most monitor well locations). A longitudinal dispersivity coefficient of 3 feet was used, consistent with literature values for comparable scaled

problems⁴. Transverse and vertical dispersivity were decreased by a factor of 10 and 100, respectively, consistent with best practices in contaminant transport hydrology. Porosity was assumed at 10 percent, consistent with literature values for shaley limestone⁵. The resulting distribution of the maximum, percentage surrogate concentrations (the maximum percentage concentration from any layer in each model cell) is shown on Figure 6. Concentrations are highest (greater than 0.9 (90%)) southwest of the surface impoundment, where the model has higher K units including sand in the upper model layers. Concentrations are relatively lower (typically 0.1 to 0.5 (10 to 50%)) to the northwest of the surface impoundment. The variable distribution of concentrations downgradient of the surface impoundment are from plotting the vertical maximum concentration in each model cell, reflecting the heterogeneous K values in the model. It is noted that the vertical maximum concentration may be within a higher portion of the system that is above the defined upper-most aquifer. For example, the relative, maximum concentrations near MW-112 are high (>0.9 or 90%) but this is in the upper model layers not within the defined upper-most aquifer and, therefore, above the screened interval of the well. Within the layer where well MW-112 is screened (in the upper-most aquifer), the predicted concentrations are below Groundwater Protection Standards (GWPS) which is consistent with data from this well. It is also noted that while there is ash material in the northeast portion of the surface impoundment, the thickness of the ash material thins in that direction and it is projected to be unsaturated based on water levels measured within well MW-7. The source term addition to groundwater quality in this area is considered generally negligible as compared to the point at which the ash intersects the groundwater surface becoming saturated. The outline of the modeled "1" surrogate concentrations as depicted on Figure 6, therefore, is coincident with the projected start of saturated ash conditions. The small area of concentration contours in this area is where there are a few saturated model cells from extrapolation of the water table and the variable surface topography.

It must be noted that this distribution of impacted does not represent calibration to measured contaminants in groundwater at monitor well locations but is simply a hypothetical scenario if mass has been present in connection with groundwater for a sufficient time as to create an equilibrated plume of impacted groundwater downgradient of the surface impoundment, based on model-estimated groundwater flow directions. With a mass of "1", concentration contours in groundwater represent the relative percentage of the mass downgradient of the impoundment. This is done to provide a starting point from which to evaluate engineering alternatives performance, using the model to determine the relative percentage of decrease in concentrations from each scenario.

The steady state distribution of the surrogate concentrations in groundwater (Figure 6) was used as the initial condition for the engineering alternative model scenarios and are referred to as the "initial surrogate concentrations" or "the initial surrogate distribution" for the remainder of this document. The appropriate changes

⁴ Zheng, C. a. (1995). *Applied Contaminant Transport Modeling*. NY: Van Nostrand Reinhold

⁵ Freeze, R.A., and Cherry, J.A., 1979. *Groundwater*. Prentice-Hall Inc., Englewood Cliffs, Vol 7632, 604p.

were made in the model to represent the alternatives and the model was run incrementally for 100 years as generally required in such environmental evaluations. The concentrations of the surrogate mass in groundwater were evaluated at 25, 50, and 100 years. Additionally, the relative change in concentrations was evaluated at the downgradient monitor wells compared to the Groundwater Protection Standards (GWPS) for lithium, the only constituent for which concentrations are detected above the GWPS at the site. It is further noted that concentrations above GWPS have only been measured at MW-10 for lithium. To illustrate the decay of concentrations over time from the closure alternatives, the lithium concentrations measured in the downgradient monitor wells in June 2022 (most recent data) was assumed as the starting concentration in each well, and the percent change in relative concentration predicted by the model for each scenario was applied to the concentrations to create a curve of concentrations over time. The modeled, relative concentration from model layer 2 was used for MW-10 because the modeled distribution of contaminants to the southwest of the surface impoundment best represents the field measured data at this location in the shallower model layers. The four engineering alternatives evaluated are:

- Alternative 1 – Full ash removal. The remaining pit will not be filled in. Bottom will be sloped to west and dike breached to allow drainage.
- Alternative 2 – Leave ash in place and place cap/cover system over top. The cap will include a geosynthetic clay liner (GCL) covered with soil and seeded. The GCL will have a maximum permeability of 2×10^{-9} centimeters per second (cm/sec).
- Alternative 3 – Hybrid scenario where ash will be moved from the southern part of the pond and temporarily staged to the north within the impoundment boundary, the base will be backfilled to 2 feet above the high-water level (i.e., ash no longer in contact with groundwater) with clean natural soil backfill and compacted. The permeability of the new base is assumed to be 10^{-3} cm/sec. Then ash will be placed back on top of the fill (about 38% of ash will be sent off site for disposal due to volume constraints on how high to build the mound) and capped as in Alternative 2 but with a smaller, consolidated footprint.
- Alternative 4 – In-situ stabilization (ISS) of base and sidewalls followed by capping. For the stabilization, we assumed a 4-foot-thick stabilized base and 3-foot-thick stabilized walls with permeability of 10^{-7} cm/sec. Then place cap over it as defined in Option 2.

Each alternative evaluation is discussed below.

2.1 CLOSURE ALTERNATIVE 1

Closure Alternative 1 is a scenario in which the ash is removed from the surface impoundment. For this model simulation, the constant concentration boundary of "1" was removed from the surface impoundment in both model layers 1 and 2. The starting conditions for the model simulation were the steady-state water levels and the initial

surrogate concentrations from the calibrated model. As previously stated, the simulation was run for up to 100 years. The results of the simulation are shown as contours of the maximum surrogate concentrations (vertical maximum in each model cell) at 25, 50, and 100 years on Figures 7 and 8. By 25 years, concentrations have decreased the most off the southwest corner of the surface impoundment, in the higher K units in the model, and have changed the least northwest and west of the surface impoundment in the clay sediments. By 50 years, concentrations have decreased further everywhere downgradient of the impoundment, and are typically less than a relative concentration of 0.3 (30%). By 100 years, concentrations have decreased below 0.1 (10%) at MW-8 and -110 and are less than approximately 0.2 to 0.3 (20 to 30%) beneath the surface impoundment and to the southwest. Concentrations remain highest (up to about 0.4 (40%)) in the clay sediments west of the surface impoundment.

Concentrations were calculated over time at the downgradient monitor wells by applying the June 2022 measured lithium concentrations as the starting concentration and reducing the concentration by the percent decrease of the surrogate concentration predicted by the model at each time step at this location. The concentration decay curves are included on Figure 8. Current starting concentrations are already below GWPS for lithium in all downgradient monitor wells except MW-10. Concentrations further decrease in MW-8 and -110 northwest of the surface impoundment and decrease with less variation in MW-9, -111, and -112. Concentrations decrease below the GWPS within slightly less than 10 years in monitor well MW-10.

2.2 CLOSURE ALTERNATIVE 2

Closure Alternative 2 is a scenario in which the surface impoundment is capped with the ash in place. For this model simulation, the constant concentration boundary of "1" remains defined in the footprint of the surface impoundment in model layers 1 and 2. To represent the cap, the recharge rate through the pond was reduced to the planned vertical permeability of the cap (2×10^{-9} cm/s). The starting conditions for the model simulation were the steady-state water levels and the initial surrogate concentrations from the calibrated model. The simulation was again run for 100 years. The results of the simulation are shown as contours of the maximum surrogate concentrations (vertical maximum in each model cell) at 25, 50, and 100 years on Figures 9 and 10. By 25 years, concentrations have not decreased substantially downgradient of the surface impoundment. By 50 years, concentrations have decreased by approximately 40 percent southwest of the surface impoundment at MW-10 and have not significantly changed at MW-111 or -112. Concentrations have decreased by approximately 65 percent west of the surface impoundment at MW-9 and have decreased below a relative concentration of 0.1 (10%) at MW-8 and -110 to the northwest. By 100 years, concentrations have only slightly, additionally decreased, having mostly reached a new steady-state distribution.

As with Closure Alternative 1 concentrations were calculated over time at downgradient monitoring wells. The concentration decay curves are shown on Figure 10. Concentrations are below GWPS for lithium in all downgradient monitor wells except MW-10. Concentrations decrease the most in MW-8 and -110 northwest of the surface impoundment and at a faster rate than with Scenario 1 from the reduction of recharge through the surface

impoundment. Concentrations decrease similarly in MW-9 and -111 as they did in Scenario 1 and are relatively steady with a slight increasing trend in MW-112 but remain below GWPS. Concentrations decrease by about half in MW-10 and level off in about 10 years and remain above the GWPS.

2.3 CLOSURE ALTERNATIVE 3

Closure Alternative 3 is a hybrid scenario in which the ash from the southern portion of the impoundment is temporarily removed and staged to the north within the impoundment boundary. The base of the excavated area is then backfilled with natural soil fill material to approximately 2-feet above the high-water table elevation. The ash is then consolidated back over this smaller area with the surface mound contoured for subsequent capping as in Scenario 2. The overall footprint of the remaining ash material will be smaller, and the base of the ash will be above the saturated zone (i.e., unsaturated). It is noted that some portion of ash (approximately 38%) would need to be transported for off-site disposal as there will not be sufficient space to facilitate keeping all ash on site with this scenario. For this model simulation, the constant concentration boundary of "1" remains defined in the footprint of the surface impoundment in model layer 1 and was removed from model layer 2. The bottom of model layer 1 was raised to no lower than 402 feet, which is approximately 2 feet higher than the water level elevations at the downgradient end of the ash deposits. This dewateres the ash in model layer 1 (the water table is below the bottom of model layer 1), as intended. The K value in the footprint of the ash deposits was increased to 1×10^{-3} cm/s in model layer 2 to represent the clean natural soil fill that will be placed beneath the ash. To represent the cap, the recharge rate through the pond was reduced to the planned vertical permeability of the cap (2×10^{-9} cm/s). The starting condition for the model simulation were the steady-state water levels and the initial surrogate concentrations from the calibrated model. The simulation was run for 100 years. The results of the simulation are shown as contours of the maximum surrogate concentrations (vertical maximum in each model cell) at 25, 50, and 100 years on Figures 11 and 12. By 25 years, concentrations have decreased the most to the southwest of the surface impoundment, with concentrations between 0.1 and 0.6 (10% and 60%). Concentrations at MW-10 have decreased by approximately 65 percent to a relative concentration of about 0.25 (25%). Concentrations to the west and northwest of the impoundment have decreased, and concentrations at MW-8 and -110 are below 0.1 (10%). By 50 years concentrations have decreased more southwest and west of the surface impoundment. Concentrations at MW-112 are reduced approximately 70 percent to a relative concentration about 0.3 (30%), and at MW-111 by approximately 50 percent to a relative concentration of about 0.4 (40%). Concentrations west and northwest of the surface impoundment have also continued to decline, with relative concentrations at MW-9 decreasing below 0.1 (10%). By 100 years relative concentrations have decreased below 0.1 to 0.2 (10% to 20%) in most places downgradient of the surface impoundment, except in the shallow clay and sandy clay deposits near MW-111 and -112 which remain at relative concentrations of about 0.3 (30%).

As with Closure Alternative 1 concentrations were calculated over time at the downgradient monitor wells. The concentration decay curves are shown on Figure 12. Concentrations are below GWPS for lithium in all downgradient

monitor wells and reduce below GWPS in MW-10 in about 10 years. Concentrations show similar trends over time as in Scenario 2 except in MW-10 which shows concentrations should decline below GWPS over time, reducing concentrations in MW-112, and more complete reduction of concentrations in MW-111, which reflects removing the bottom of the ash from direct contact with groundwater.

2.4 CLOSURE ALTERNATIVE 4

Closure Alternative 4 is a scenario in which the surface impoundment is capped with the ash in place but hydraulically isolated from the surrounding water table with a barrier wall created using ISS technology on all sides and below the ash. For this model simulation, the constant concentration boundary of "1" remains defined in the footprint of the surface impoundment in model layers 1 and 2. To represent the cap, the recharge rate through the pond was reduced to the planned vertical permeability of the cap (2×10^{-9} cm/s). To represent hydraulic isolation with a barrier wall, MODFLOW's Horizontal Flow Boundary (HFB) was employed along all sides of the surface impoundment. The HFB was given a thickness of 3 feet and a K of 1×10^{-7} cm/s, per the engineering design. To represent the barrier beneath the ash, the vertical K of model layer 2 was decreased to 1×10^{-7} cm/s. The starting conditions for the model simulation were the steady-state water levels and the initial surrogate concentrations from the calibrated model. The simulation was run for 100 years. The results of the simulation are shown as contours of the maximum surrogate concentrations (vertical maximum in each model cell) at 25, 50, and 100 years on Figures 13 and 14. By 25 years, concentrations have decreased downgradient of the surface impoundment. To the southwest of MW-112, maximum concentrations are still approximately 0.8 (80%), but this concentration covers a much smaller area than the initial concentrations and it is noted that the starting concentrations of constituents are already below GWPSs. At MW-10 relative concentrations have decreased approximately 70 percent. At MW-111, relative concentrations remain at approximately 0.7 (70%) but the area covered by this relative concentration has significantly shrunk. Relative concentrations have decreased below 0.1 (10%) at MW-8, -9, and -110. By 50 years relative concentrations have further decreased west of the impoundment by approximately 40 percent at MW-111. By 100 years relative concentrations have decreased below 0.1 to 0.3 (10 to 30 percent) at all downgradient monitor well locations. Areas of higher concentrations (approximately 0.5 (50%)) remain in isolated areas southwest of the surface impoundment where bound by clay sediments.

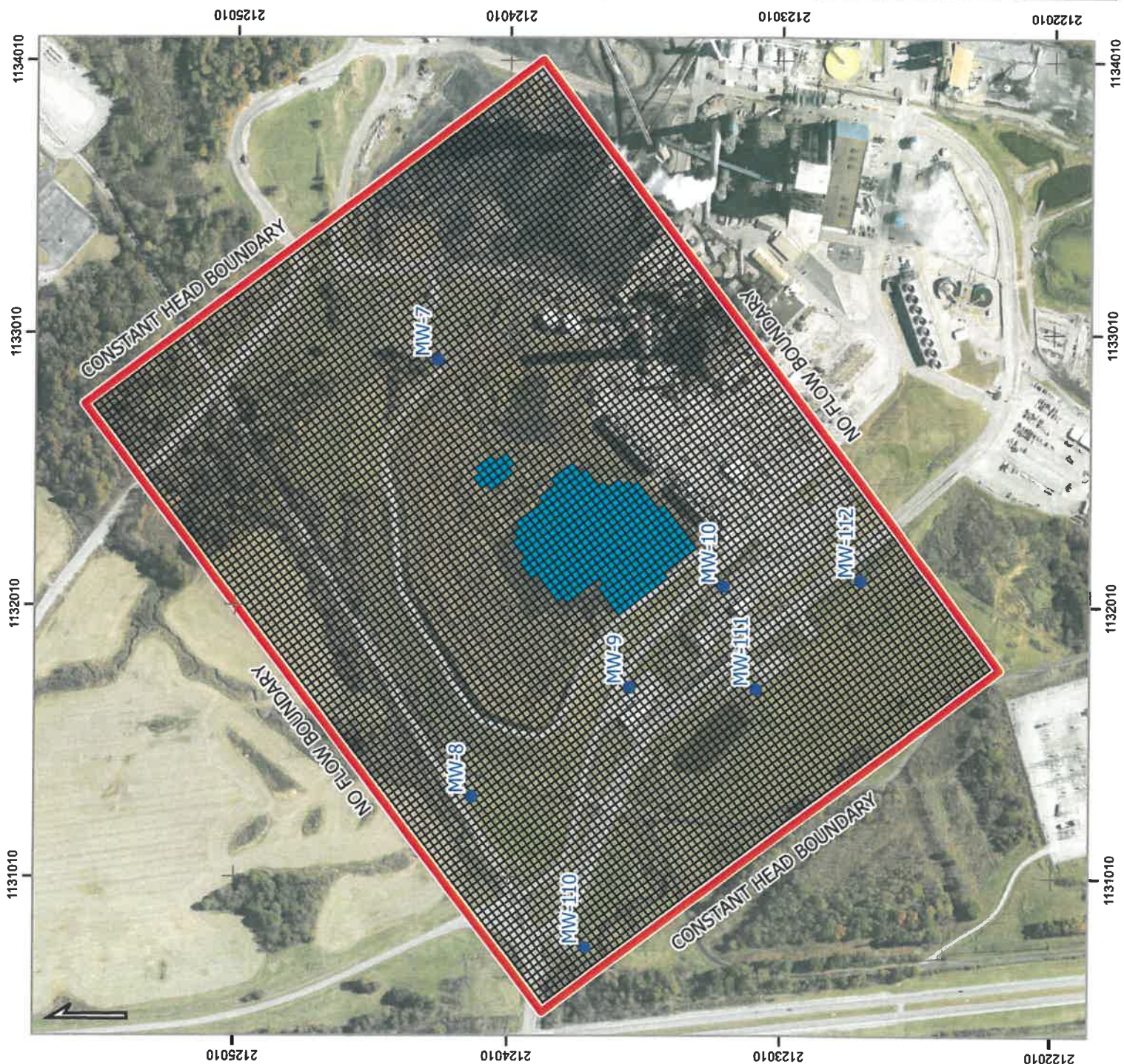
As with Closure Alternative 1 concentrations were calculated over time at the downgradient monitor wells. The concentration decay curves are shown on Figure 14. Concentrations are below GWPS for lithium in all downgradient monitor wells and reduce below GWPS in monitor well MW-10 within slightly less than 10 years.

3.0 SUMMARY

A three-dimensional groundwater flow and contaminant transport model was developed for the Reid/HMP&L CCR Surface Impoundment at the Sebree Generating Station located in Robards, Kentucky. The model was developed

to be a simplified representation of the groundwater system beneath the surface impoundment, and to generally represent groundwater flow paths and hydraulic gradients. The model reproduces measured water levels and general patterns of impacted groundwater at the site and was used to evaluate the performance of engineering closure alternatives relative to improvement of defined existing groundwater impacts within the upper-most aquifer.

A distribution of a surrogate mass emanating from the surface impoundment was determined from the calibrated groundwater flow directions and hydraulic gradients. A mass with a concentration of "1" was defined within the ash deposits and forward tracked to a steady distribution with advection and dispersion. The 100-year surrogate distribution was then compared to four engineering closure alternatives at 25, 50, and 100 years to compare the relative effectiveness of the alternatives at removing mass downgradient of the surface impoundment. In all alternatives, dissolved mass downgradient of the surface impoundment is decreased to below 10 to 20 percent of starting relative concentration within 100 years in most areas and remains higher in isolated areas of lower permeability sediments. All alternatives were effective in reducing lithium concentrations in monitor well MW-10 below GWPS except Alternative 2 in which the lithium concentration was not projected to drop below the GWPS of 0.04 mg/l. Based on an evaluation of the time versus decay curves for lithium at well MW-10, Alternative 1 appears to achieve meeting the GWPS in the shortest timeframe (slightly less than 10 years) followed by Alternatives 4 and 3, respectively.



LEGEND

- MONITOR WELL
- POND RECHARGE
- MODEL DOMAIN
- GRID

NOTE(S)
 PROFILE OF MODEL LAYERING THROUGH ROW 45
 IS SHOWN ON FIGURE 5

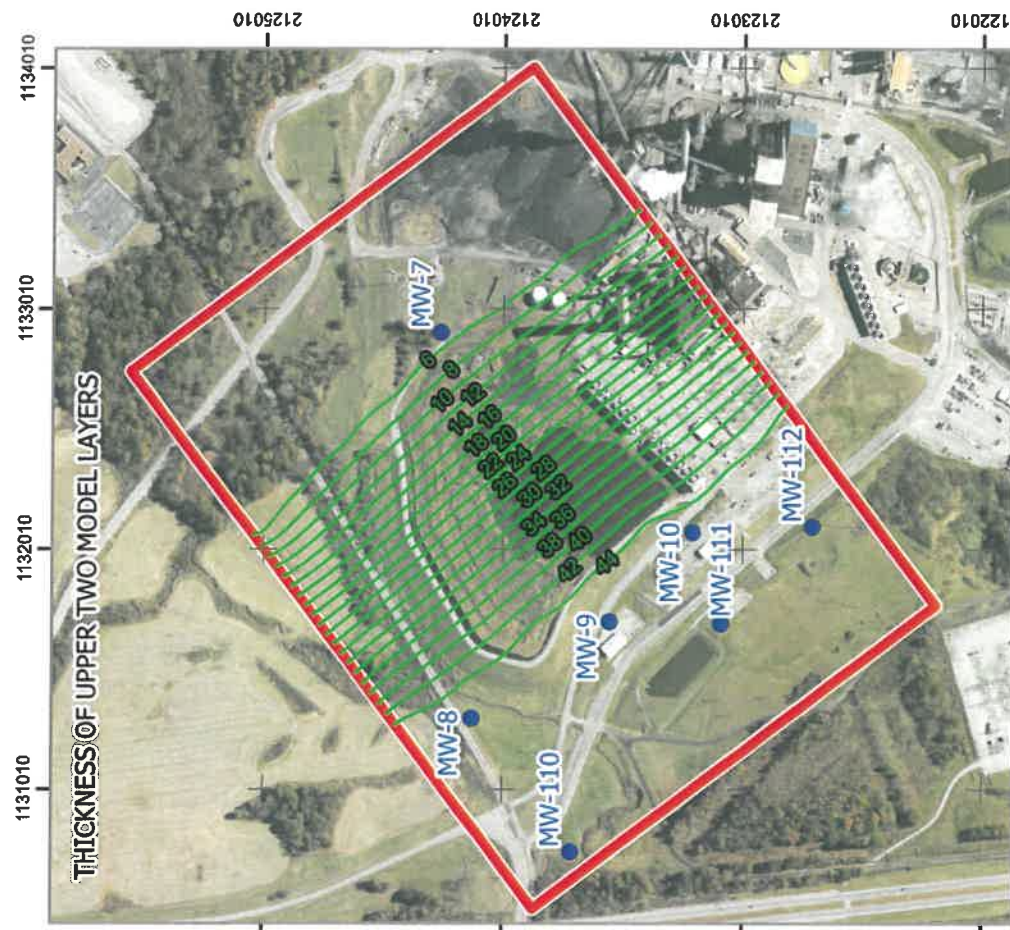
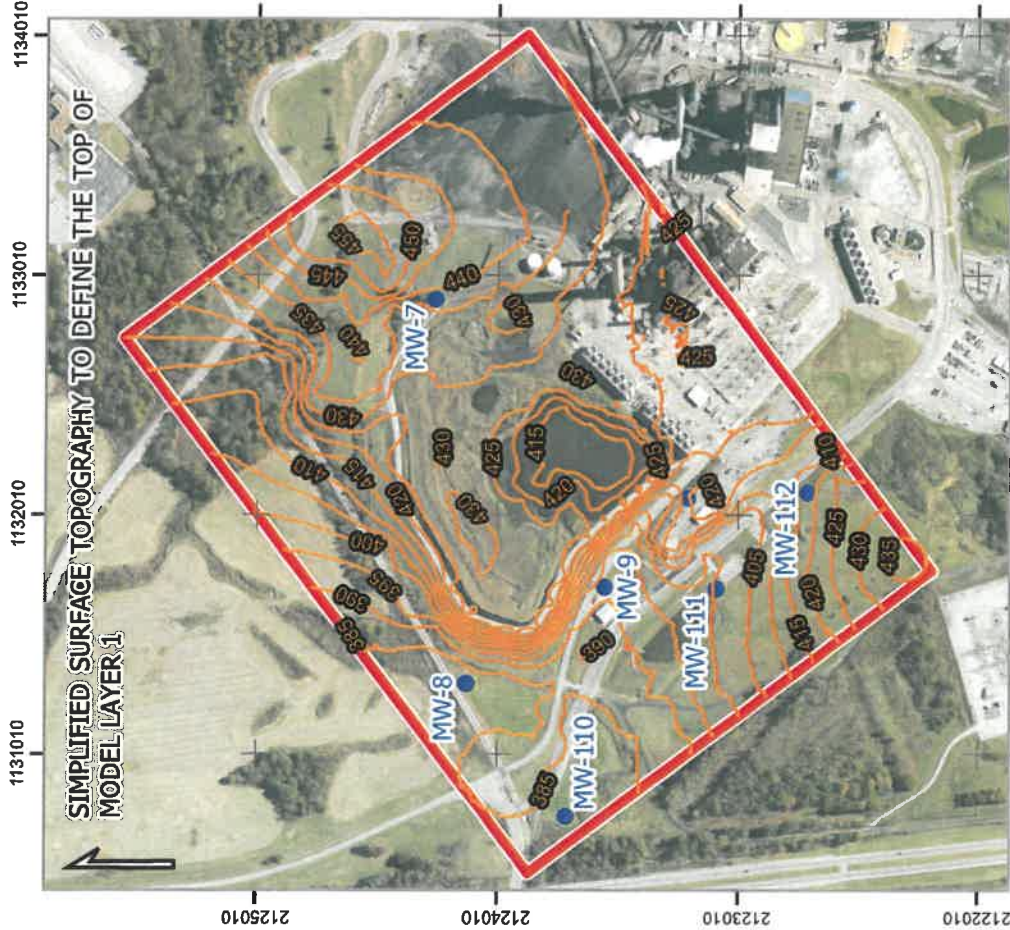


Coordinate System:
 NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
 Project File: Figure1_ModelGridAndBoundary.qgz



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CLIENT		BIG RIVERS ELECTRIC CORP.	
SITE		SEBREE GENERATING STATION ROBARDS, KY	
TITLE		MODEL GRID AND BOUNDARY CONDITIONS	
SCALE AT ANSI A	DRAWN	DZF	08/16/2022
1:6,000	CHECKED	BAS	08/16/2022
BAS PROJECT No.	22212101		FIGURE: 1



LEGEND

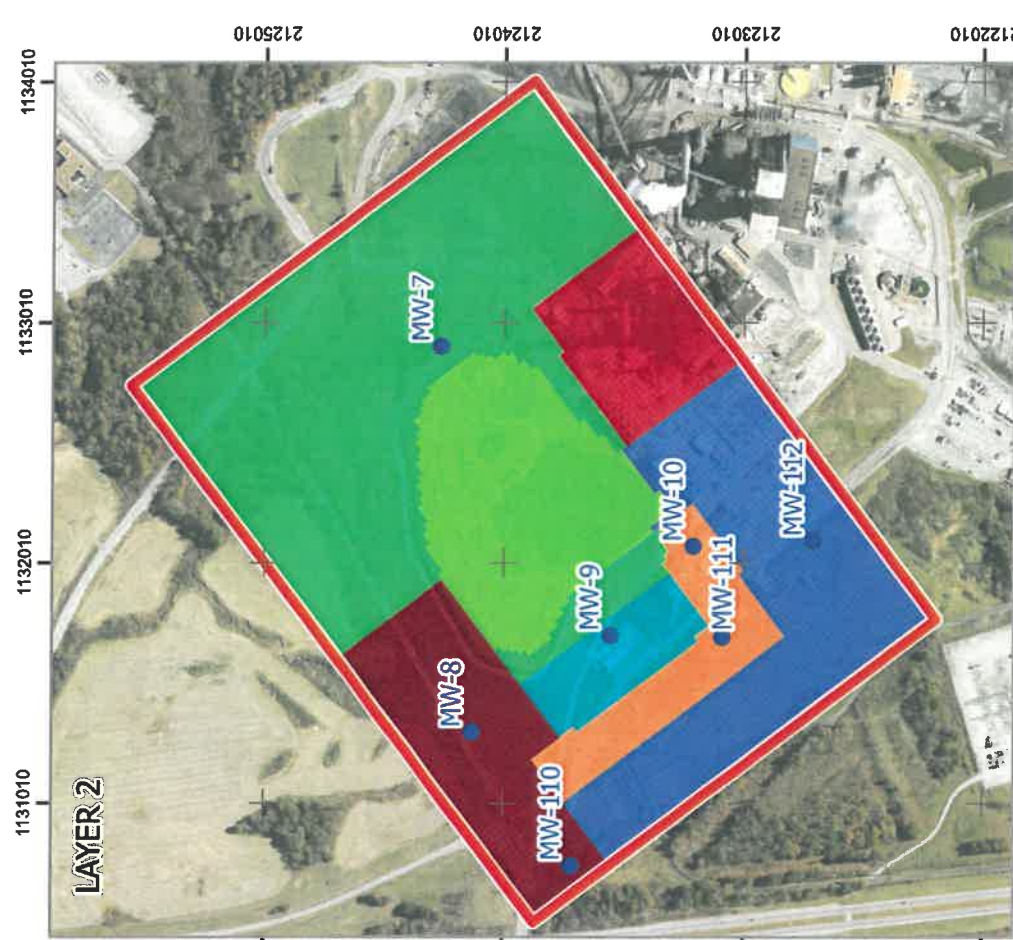
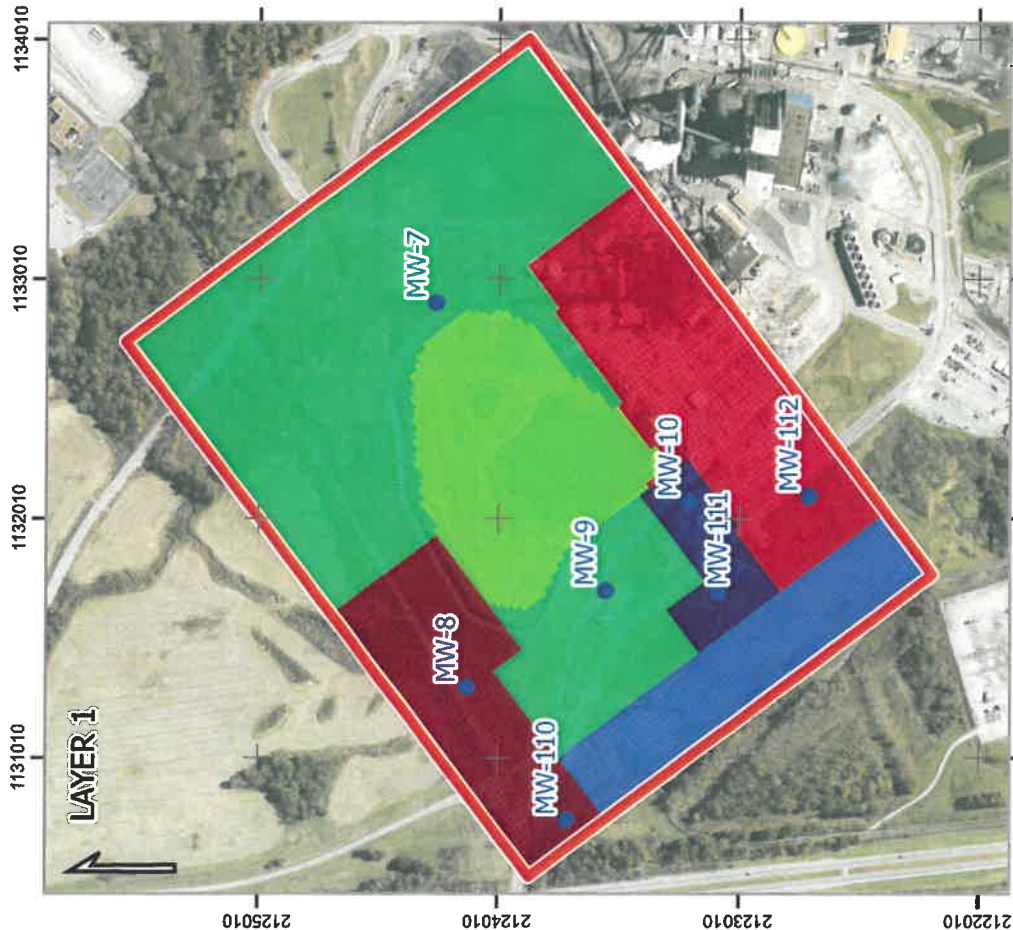
- MONITOR WELL
- MODEL DOMAIN



CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	MODEL TOP SURFACE AND THICKNESS OF SHALLOW LAYERS		
SCALE AT ANSI A	DRAWN	DZF	08/25/2022
1:9,200	CHECKED	BAS	08/25/2022
BAS PROJECT No.	22212101		FIGURE: 2



Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File:
Figure2_ModelTopSurfaceandThicknessofShallowLayers.qgz



LEGEND

- MONITOR WELL
- MODEL DOMAIN

K zone	Lithology Group	K Value (ft/d)
1	Sandy Clay	0.10
2	Silty Sand	5.00
3	Shale and Sandstone	2.95
4	Sandstone	0.96
5	Clay	4.25E-03
6	Fill	1.58
7	Silt and Sand	0.10
8	Shale and Sandstone	4.25E-03
9	Shale and Sandstone	1.47
10	Shale and Sandstone	0.01
11	Sand and Clay	3.00
12	Silty Clay	1.30

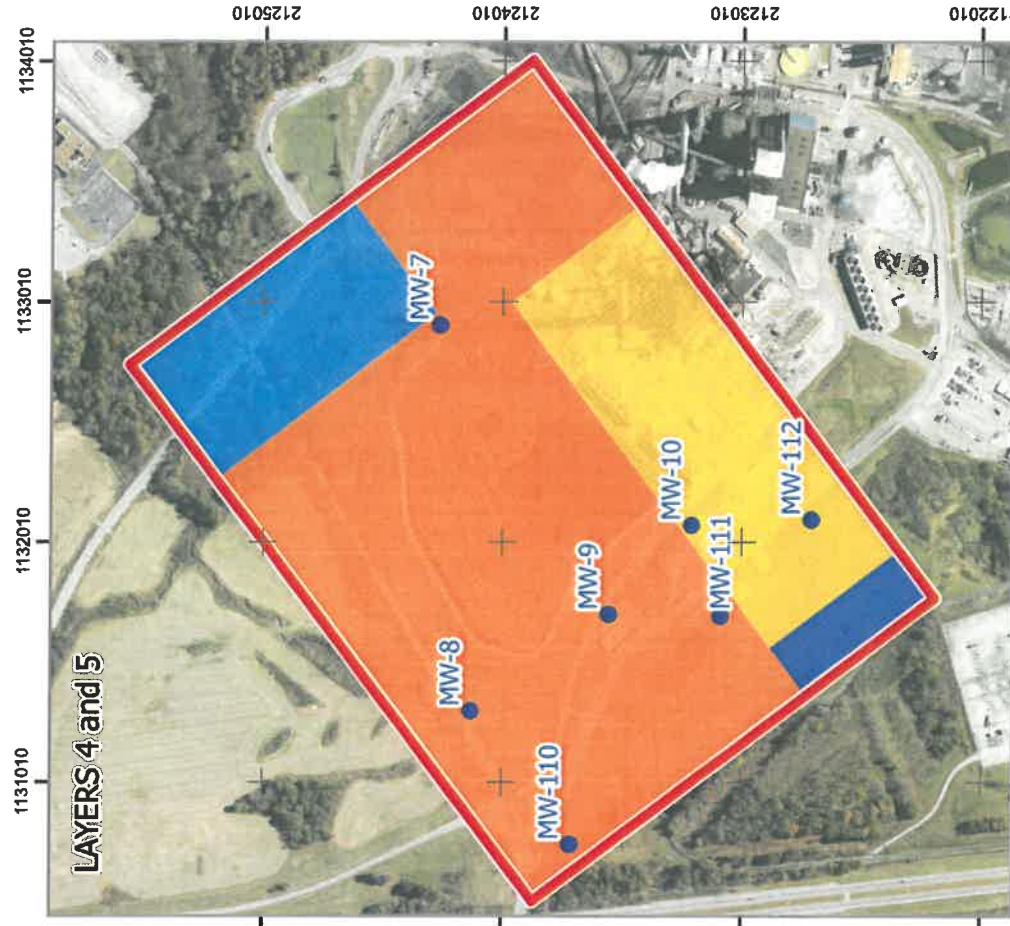
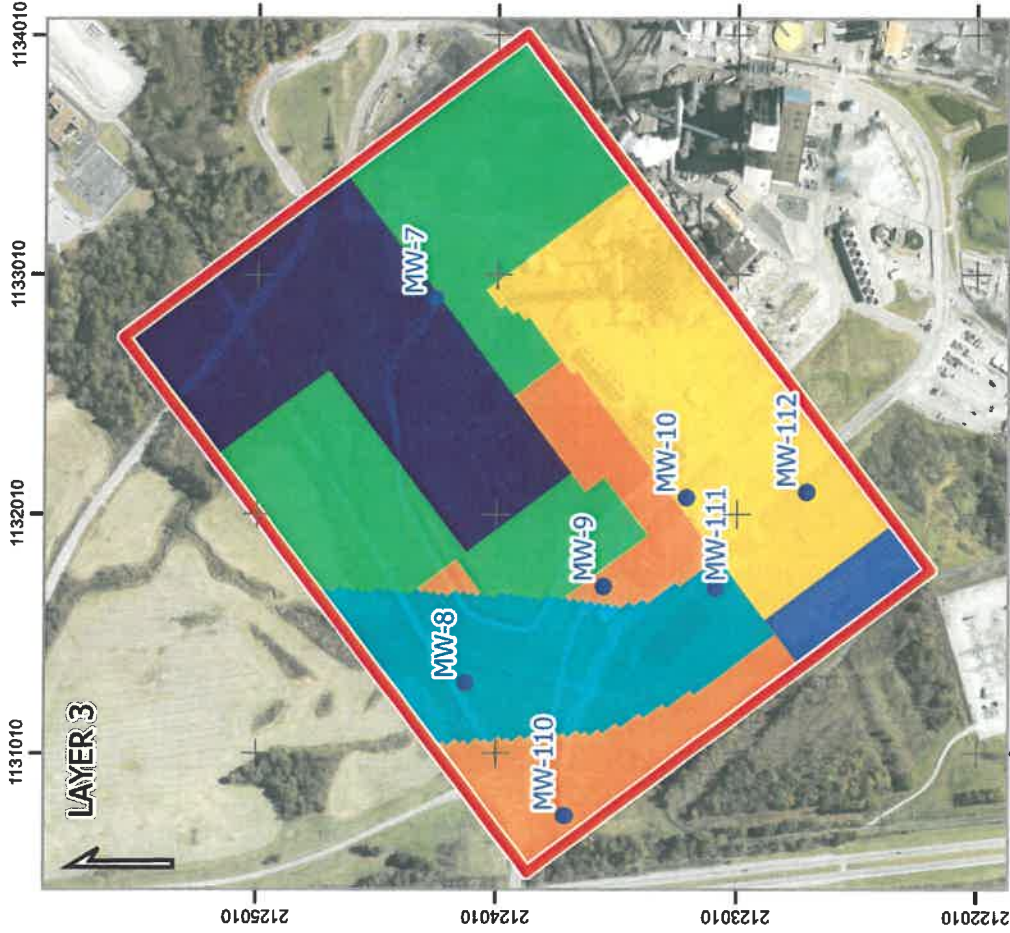


Sargent & Lundy



Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File: Figures_HydraulicConductivityZonesLayers1and2.qgz

CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	HYDRAULIC CONDUCTIVITY ZONES LAYERS 1 AND 2		
SCALE AT ANSI/A 1:9,200	DRAWN/	DZF	08/03/2022
	CHECKED	BAS	08/03/2022
BAS PROJECT No.	22212101		FIGURE: 3



LEGEND

- MONITOR WELL
- MODEL DOMAIN

NOTE(S)

The zones of Hydraulic Conductivity are the same for model layers 4 and 5

K zone	Lithology Group	K Value (ft/d)
1	Sandy Clay	0.10
2	Silty Sand	5.00
3	Shale and Sandstone	2.95
4	Sandstone	0.96
5	Clay	4.25E-03
6	Fill	1.58
7	Silt and Sand	0.10
8	Shale and Sandstone	4.25E-03
9	Shale and Sandstone	1.47
10	Shale and Sandstone	0.01
11	Sand and Clay	3.00
12	Silty Clay	1.30



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Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File: Figure4_HydraulicConductivityZonesLayers3and4.qgz

CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	HYDRAULIC CONDUCTIVITY ZONES LAYERS 3 THROUGH 5		
SCALE AT ANSI A	DRAWN	DZF	08/24/2022
1:9,200	CHECKED	BAS	08/24/2022
BAS PROJECT No.	22212101		FIGURE: 4

- LEGEND**
- MONITOR WELL
 - JUNE 2022 GROUNDWATER CONTOURS (10 FT. INTERVALS, DASHED WHERE INFERRED)
 - MODELED GROUNDWATER CONTOURS (10 FT. INTERVALS)
 - MODEL DOMAIN

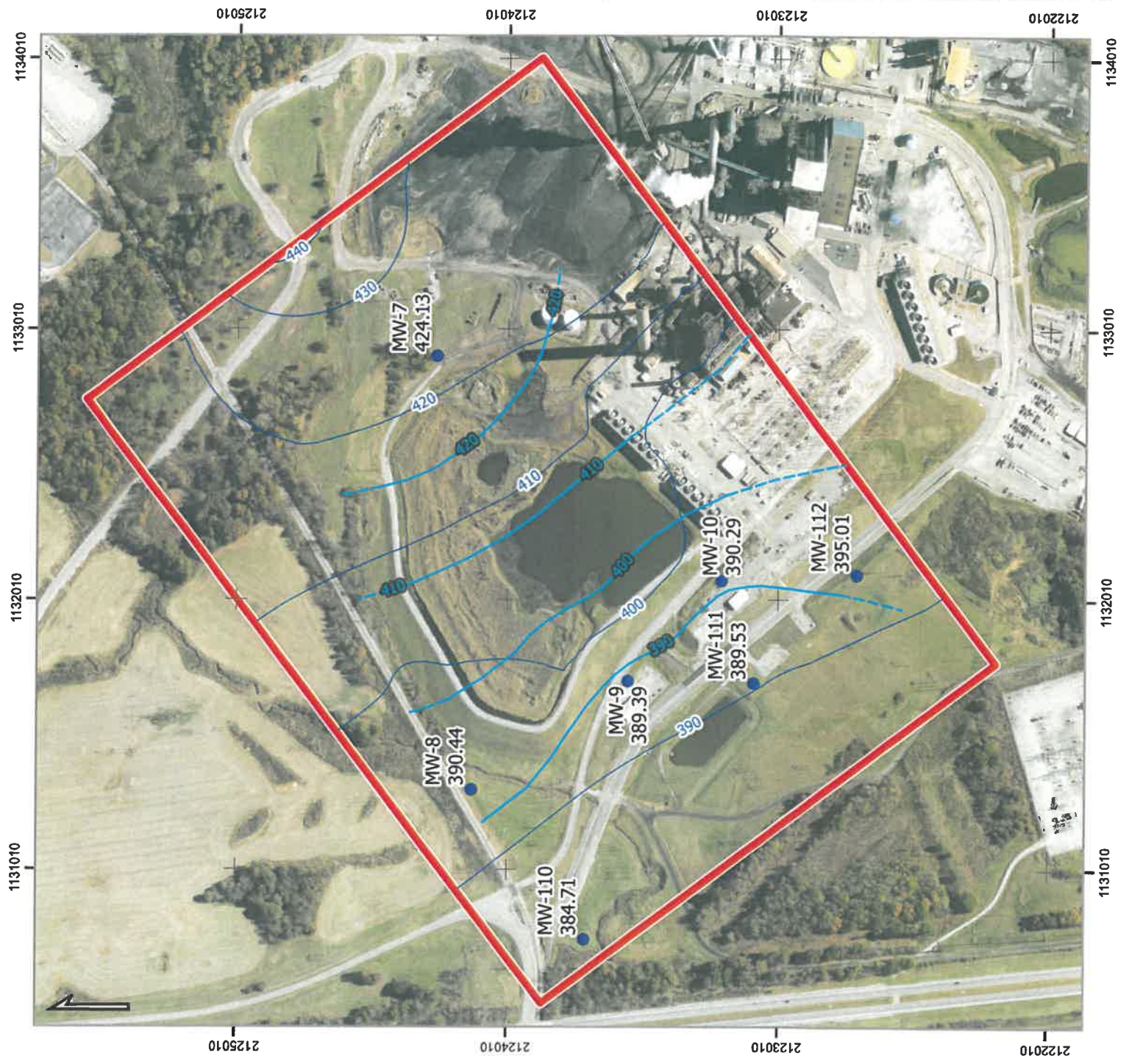
NOTE(S)
 PROFILE OF MODEL LAYERING THROUGH ROW 45
 IS SHOWN ON FIGURE 5

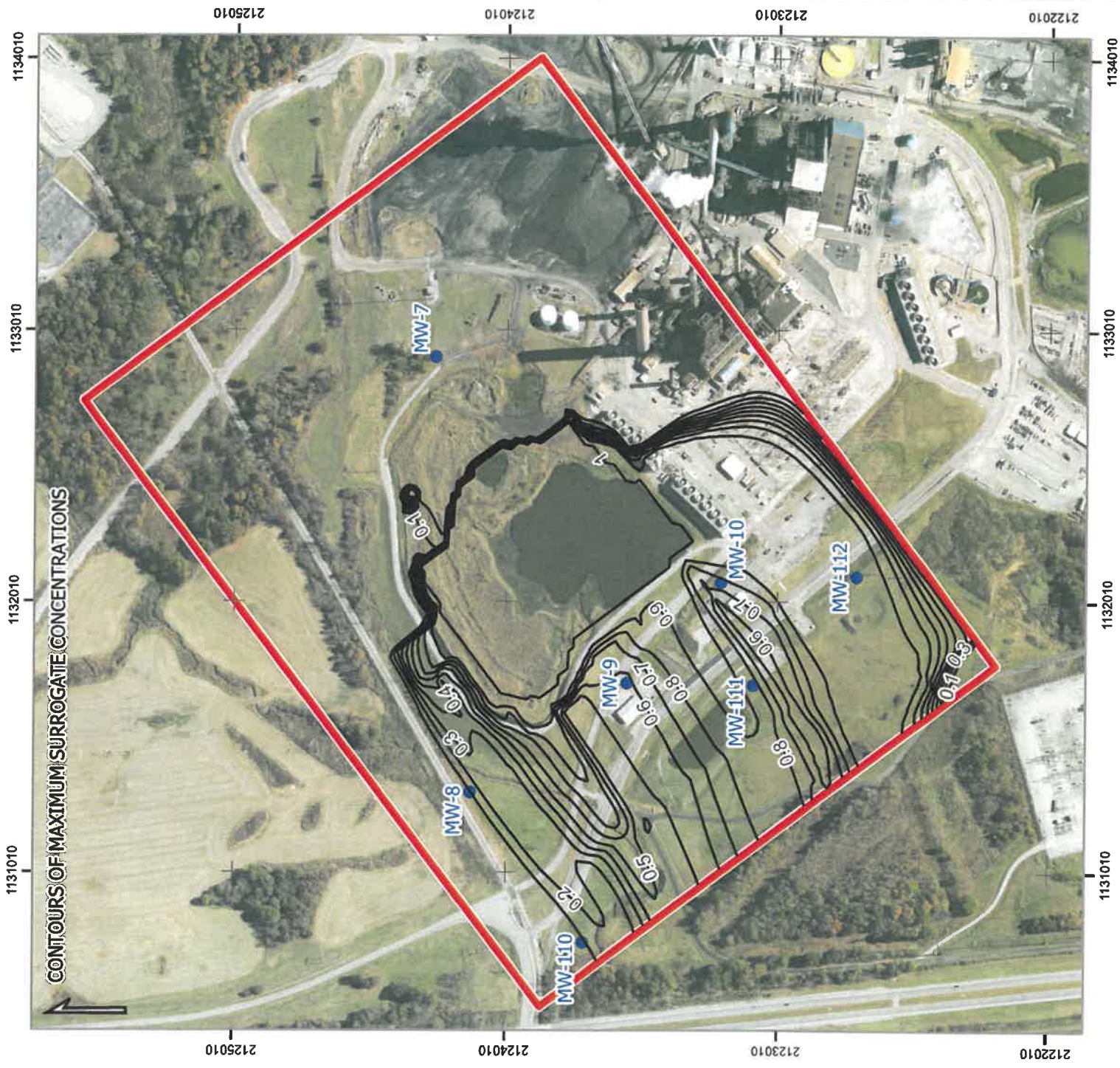


Coordinate System:
 NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
 Project File: Figure5_SiteWaterLevels.qgz



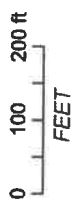
CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	SITE WATER LEVELS		
SCALE AT ANS I A	DRAWN	DZF	08/11/2022
1:6,000	CHECKED	BAS	08/11/2022
BAS PROJECT No.	22212101		FIGURE: 5





LEGEND

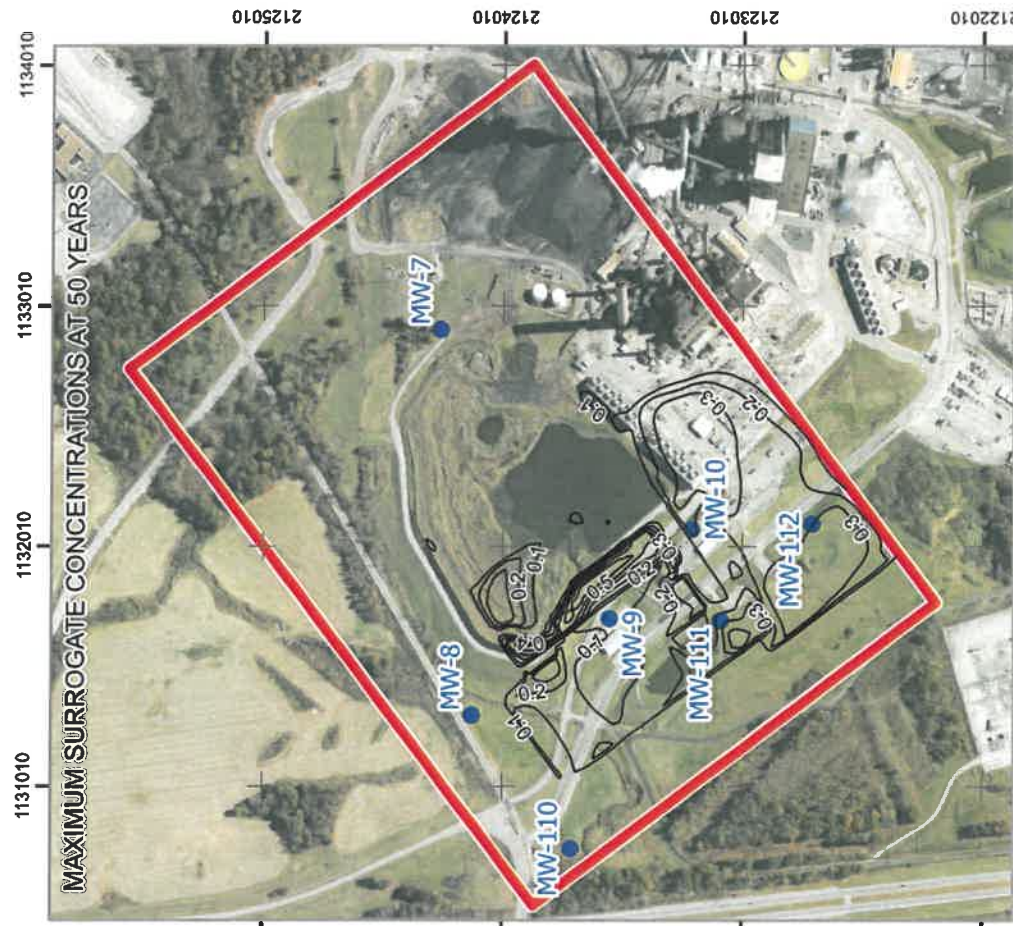
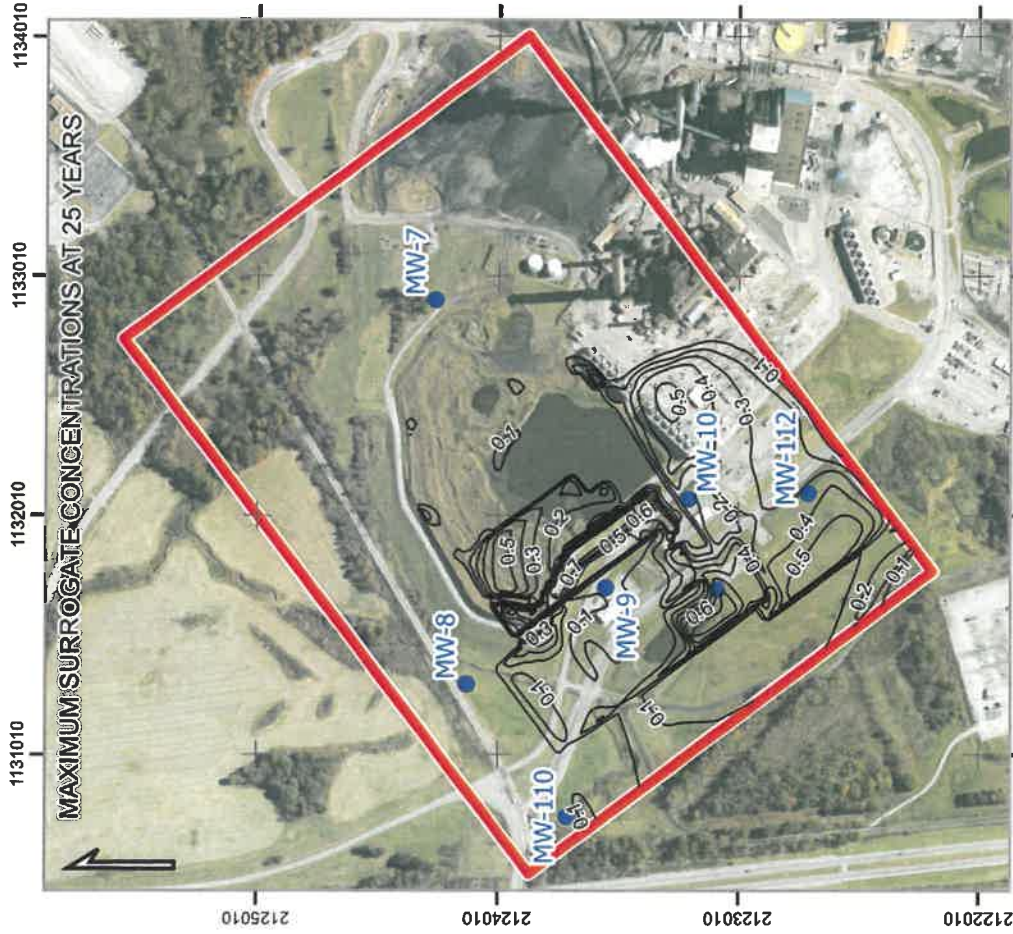
- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS



Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File: Figure6_SurrogateConcentrationsat100years.qgz



CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	HYPOTHETICAL STEADY STATE SURROGATE CONCENTRATION DISTRIBUTION		
SCALE AT ANS I A	DRAWN	DZF	08/16/2022
1:6,000	CHECKED	BAS	08/16/2022
BAS PROJECT No.	22212101		FIGURE: 6



LEGEND

- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS



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Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File: Figure7_Scenario1_SurrogateConcentrations_25
and_50_years.qgz

CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	SCENARIO 1, SURROGATE CONCENTRATIONS AT 25 AND 50 YEARS		
SCALE AT ANSI/A	DRAWN	DZF	08/17/2022
1:9,200	CHECKED	BAS	08/17/2022
BAS PROJECT No.	22212101		FIGURE: 7



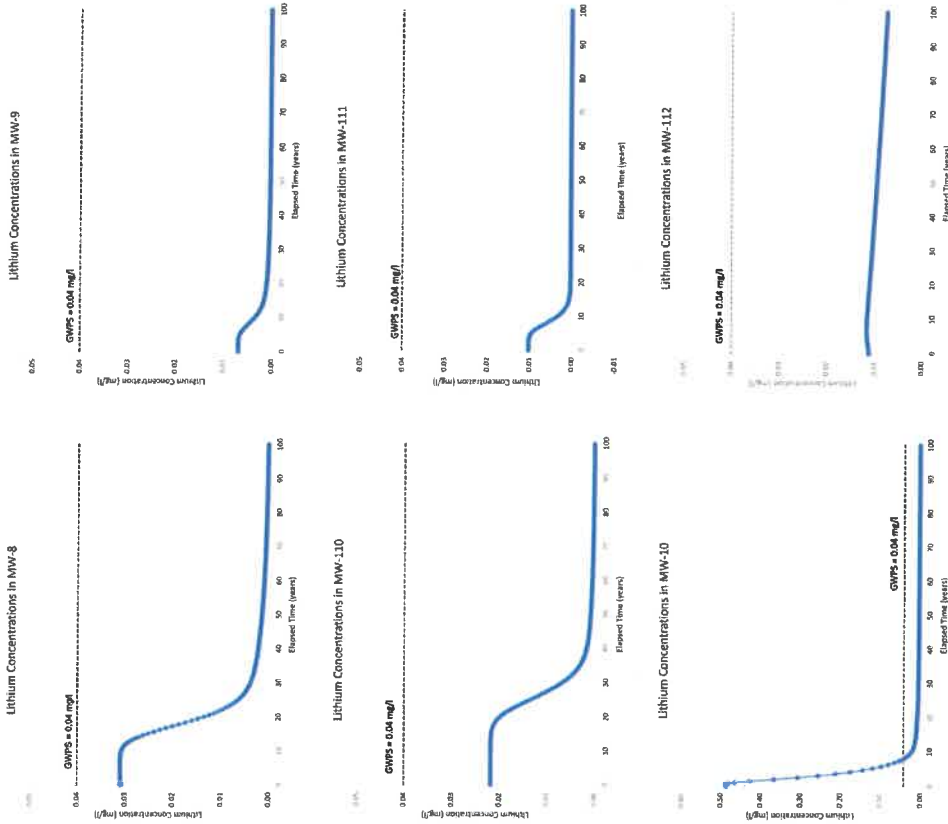
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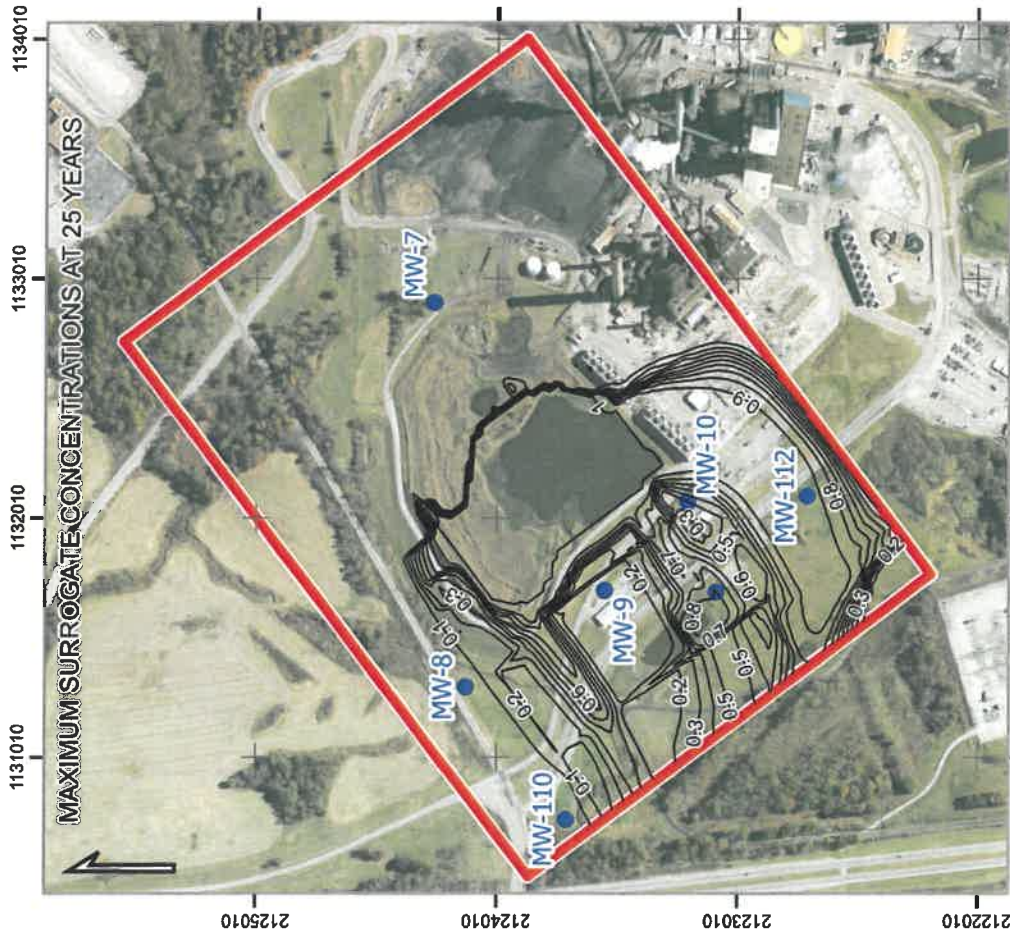
- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS



Coordinate System:
 NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
 Project File:
 Figure8_Scenario1_SurrogateConcentrations_100Years.qgz

CLIENT		BIG RIVERS ELECTRIC CORP.	
SITE		SEBREE GENERATING STATION ROBARDS, KY	
TITLE		SCENARIO 1, SURROGATE CONCENTRATIONS AT 100 YEARS, DECAY CURVES	
SCALE AT ANSI A		DRAWN	DZF
1:9,200		CHECKED	BAS
BAS PROJECT No.		22212101	
		FIGURE: 8	





LEGEND

- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS



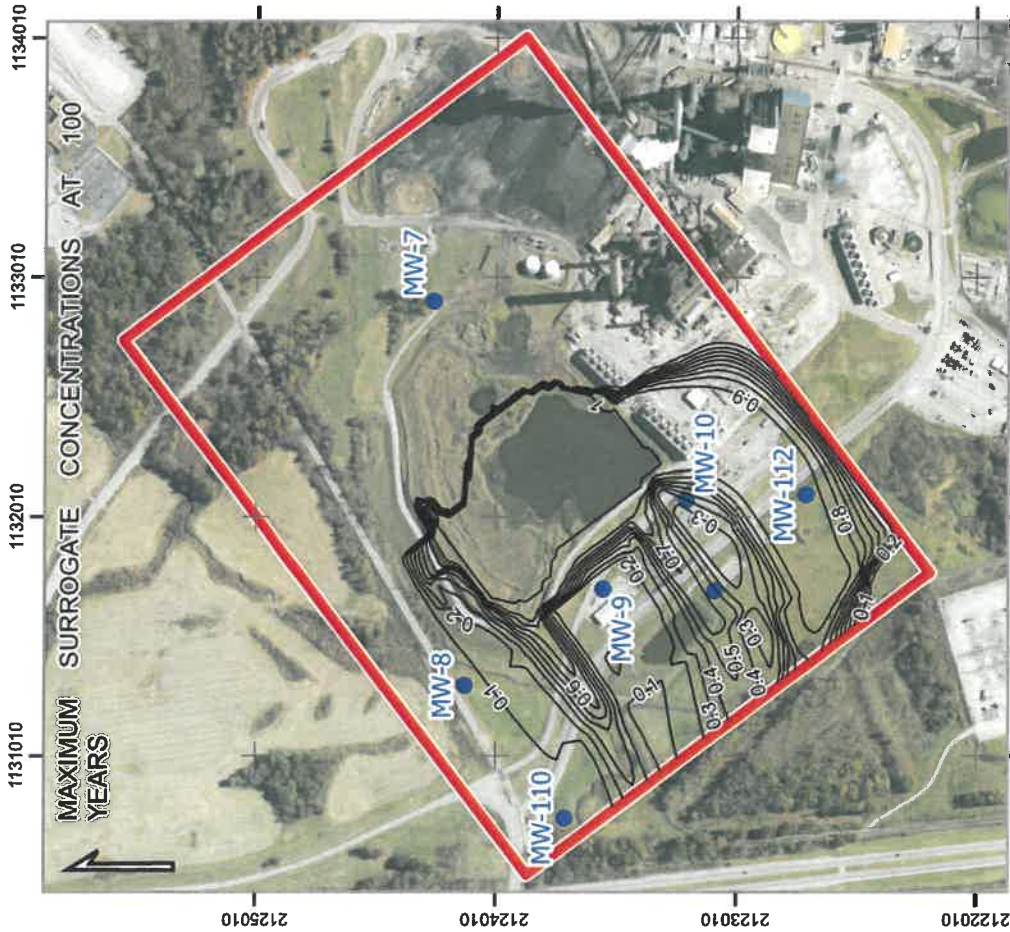
K P R G



CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	SCENARIO 2, SURROGATE CONCENTRATIONS AT 25 AND 50 YEARS		
SCALE AT ANS/A	DRAWN	DZF	08/17/2022
1:9,200	CHECKED	BAS	08/17/2022
BAS PROJECT No.	22212101		FIGURE: 9



Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File: Figure9_Scenario2_SurrogateConcentrations_25
and_50_years.qgz



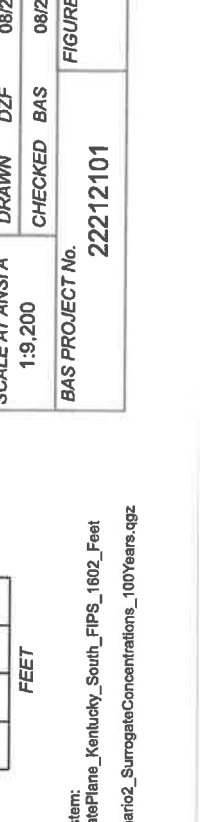
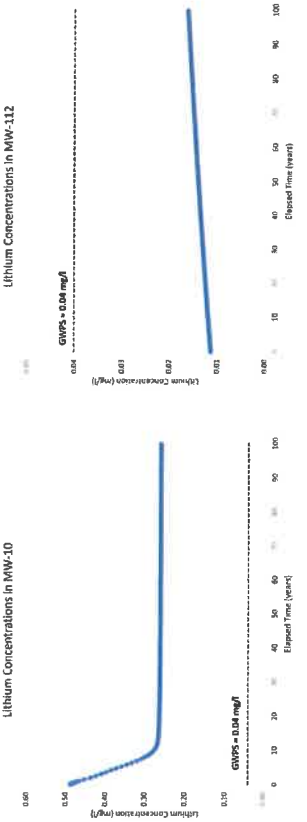
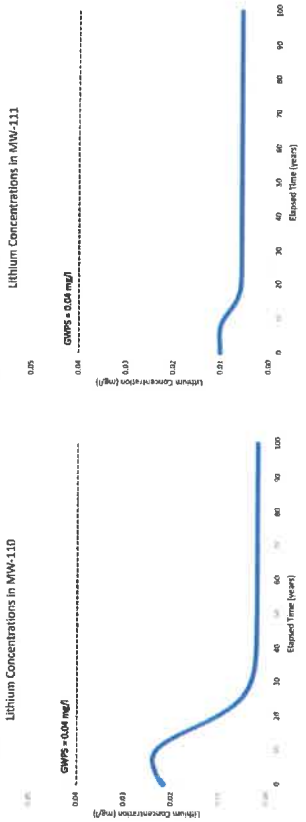
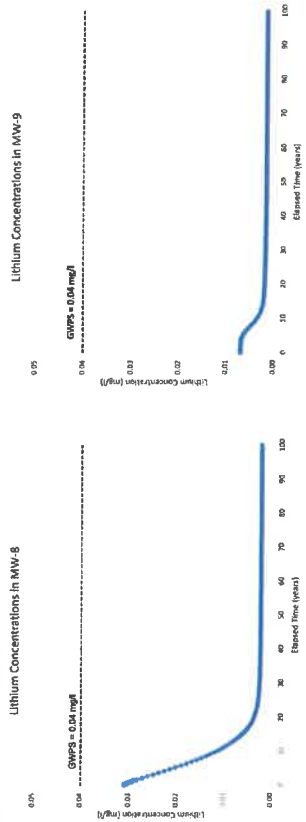
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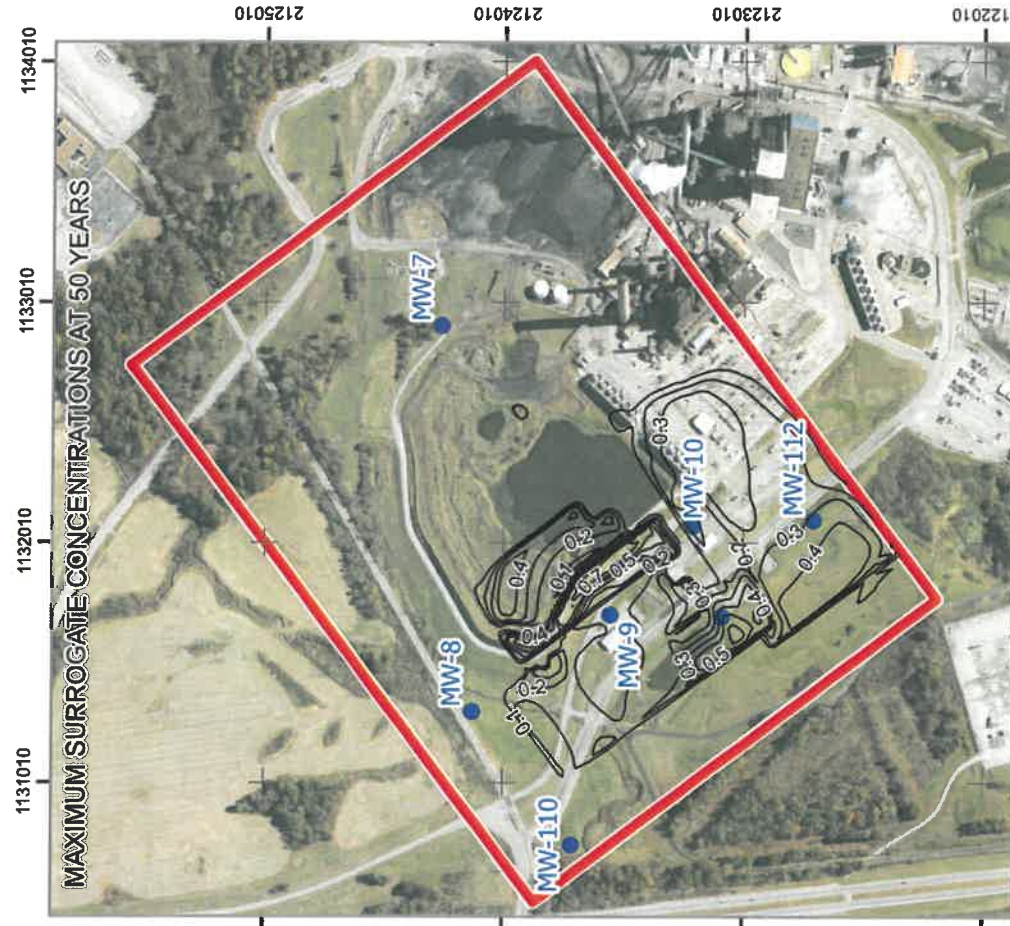
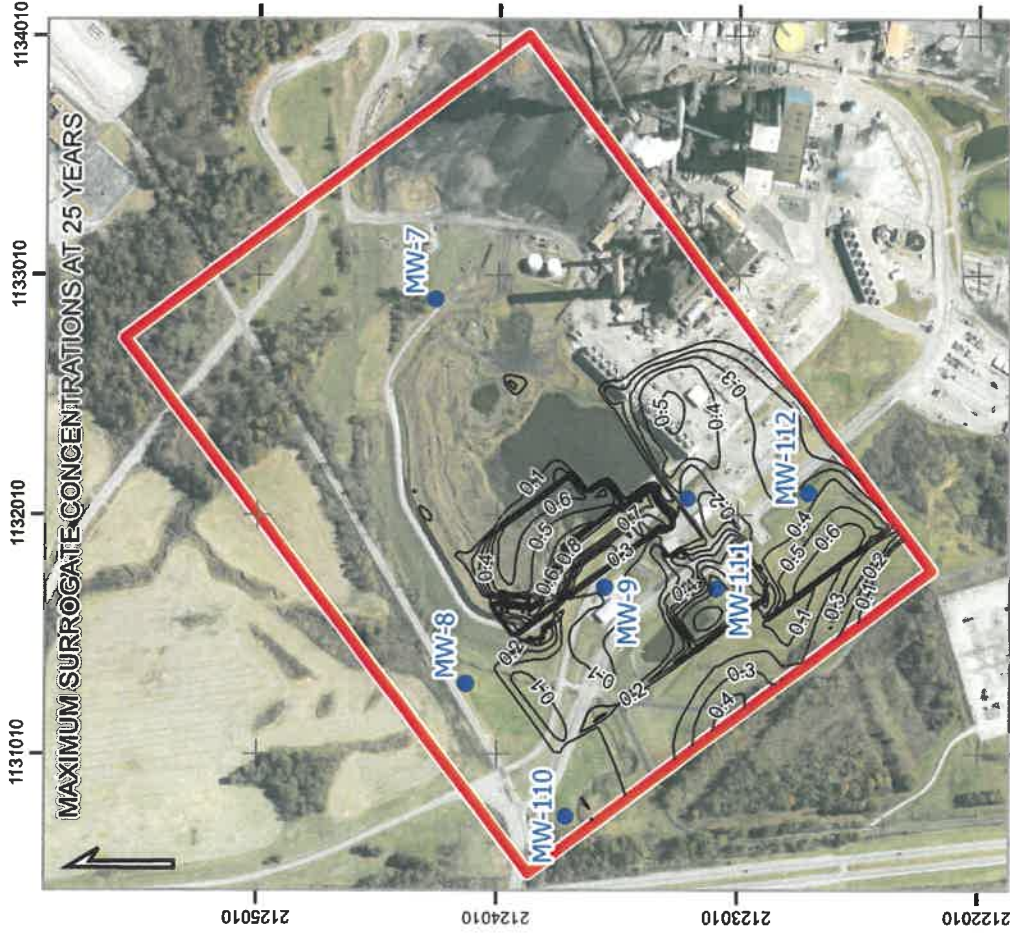
- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS



Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File:
Figure10_Scenario2_SurrogateConcentrations_100Years.qgz

CLIENT		BIG RIVERS ELECTRIC CORP.	
SITE		SEBREE GENERATING STATION ROBARDS, KY	
TITLE		SCENARIO 2, SURROGATE CONCENTRATIONS AT 100 YEARS, DECAY CURVES	
SCALE AT ANSI A	DRAWN	DZF	08/24/2022
1:9,200	CHECKED	BAS	08/24/2022
BAS PROJECT No.		22212101	FIGURE: 10





LEGEND

● MONITOR WELL

— MODEL DOMAIN

— SURROGATE CONCENTRATIONS



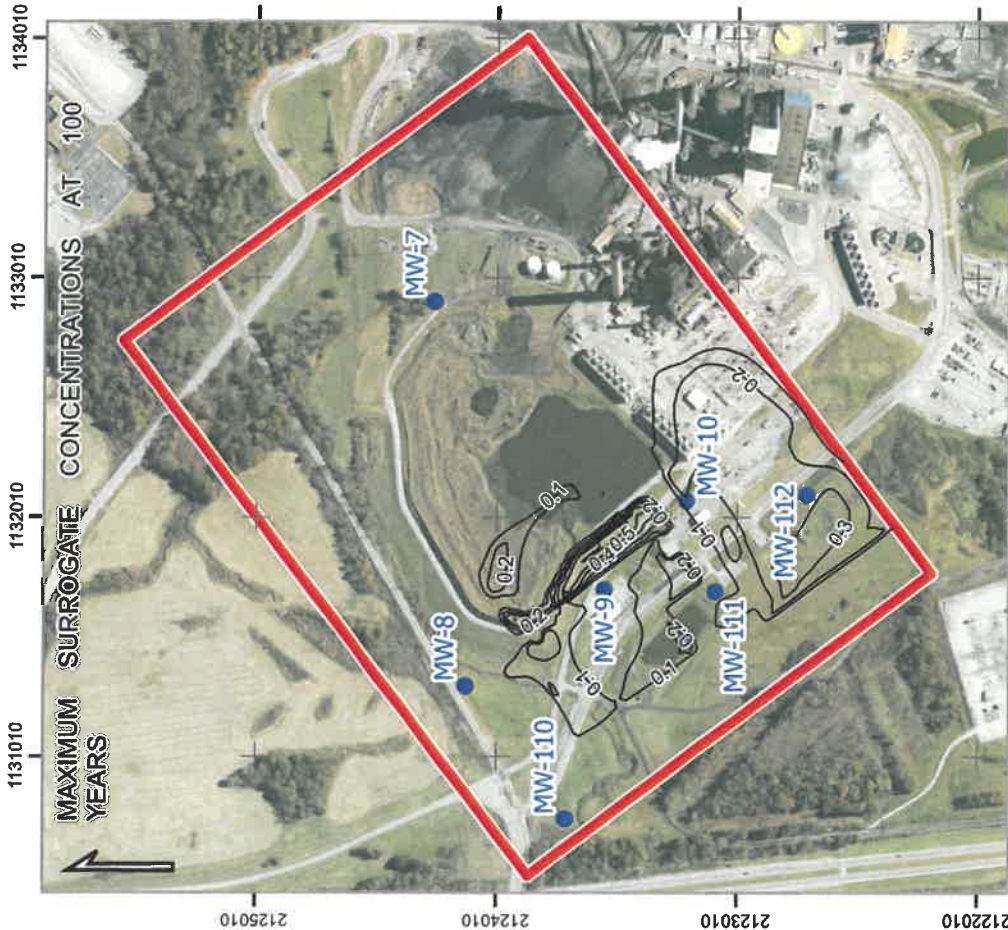
K P R G

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Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File: Figure11_Scenario3_SurrogateConcentrations_25
and_50_years.qgz

CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	SCENARIO 3, SURROGATE CONCENTRATIONS AT 25 AND 50 YEARS		
SCALE AT ANSI/A 1:9,200	DRAWN DZF	CHECKED BAS	DATE 08/17/2022
BAS PROJECT No.	22212101		FIGURE: 11



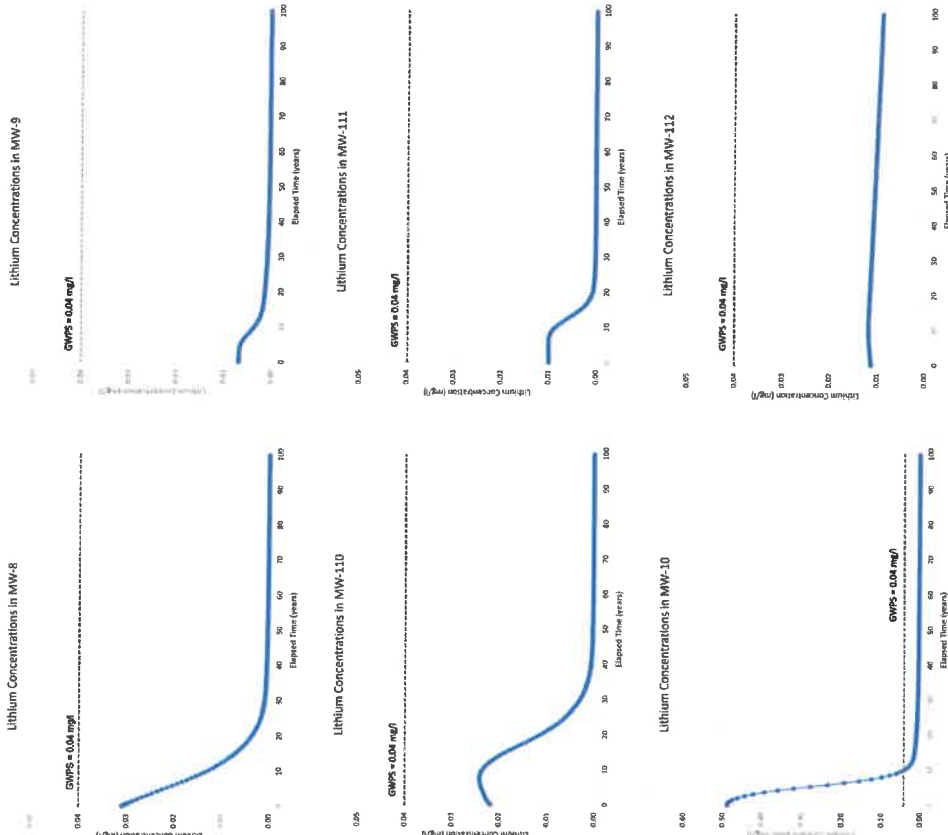
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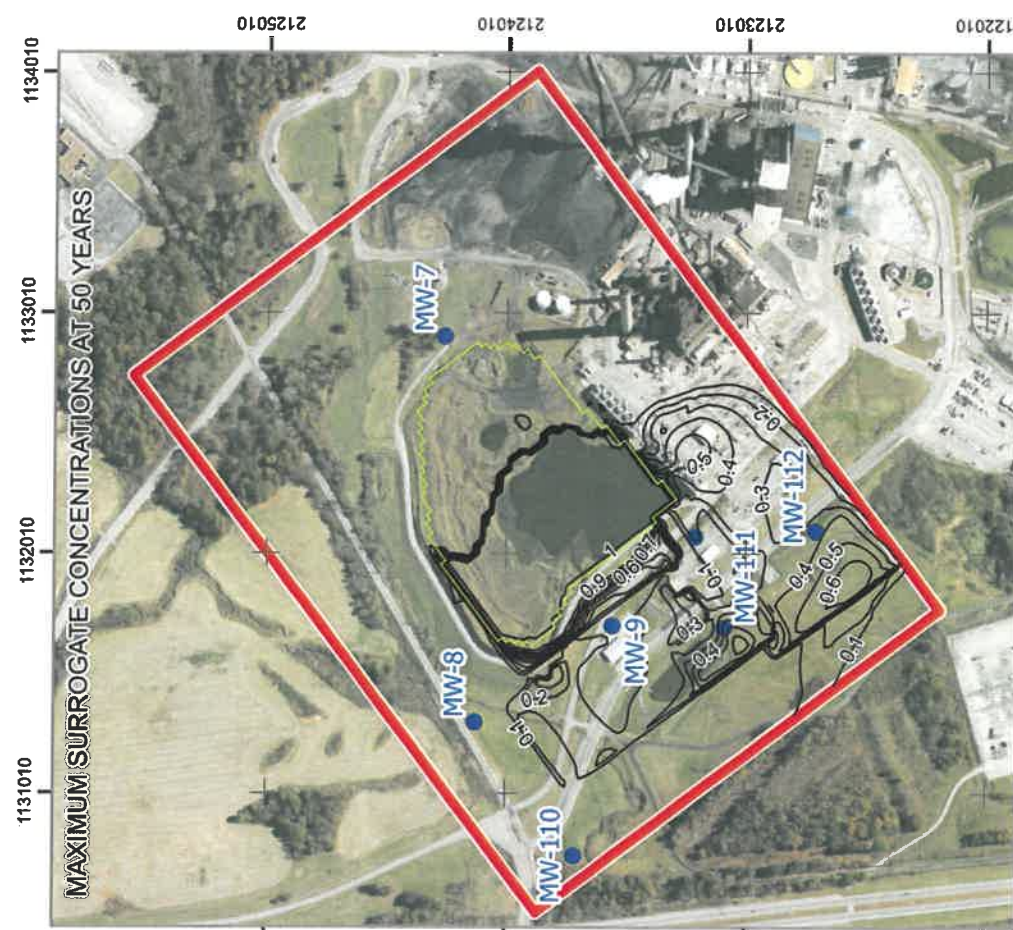
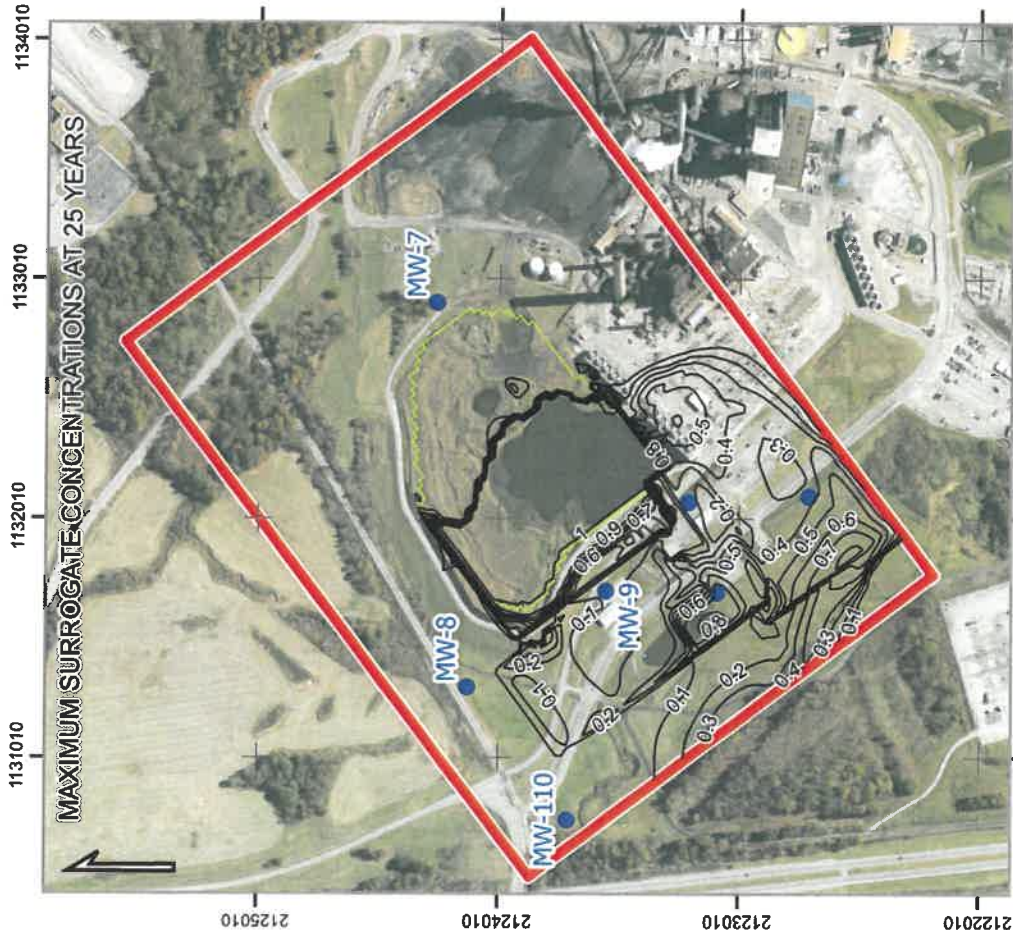
- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS



Coordinate System:
 NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
 Project File:
 Figure12_Scenario3_SurrogateConcentrations_100Years.qgz

CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	SCENARIO 3, SURROGATE CONCENTRATIONS AT 100 YEARS, DECAY CURVES		
SCALE AT ANSI A	DRAWN	DZF	08/24/2022
1:9,200	CHECKED	BAS	08/24/2022
BAS PROJECT No.	22212101		FIGURE: 12





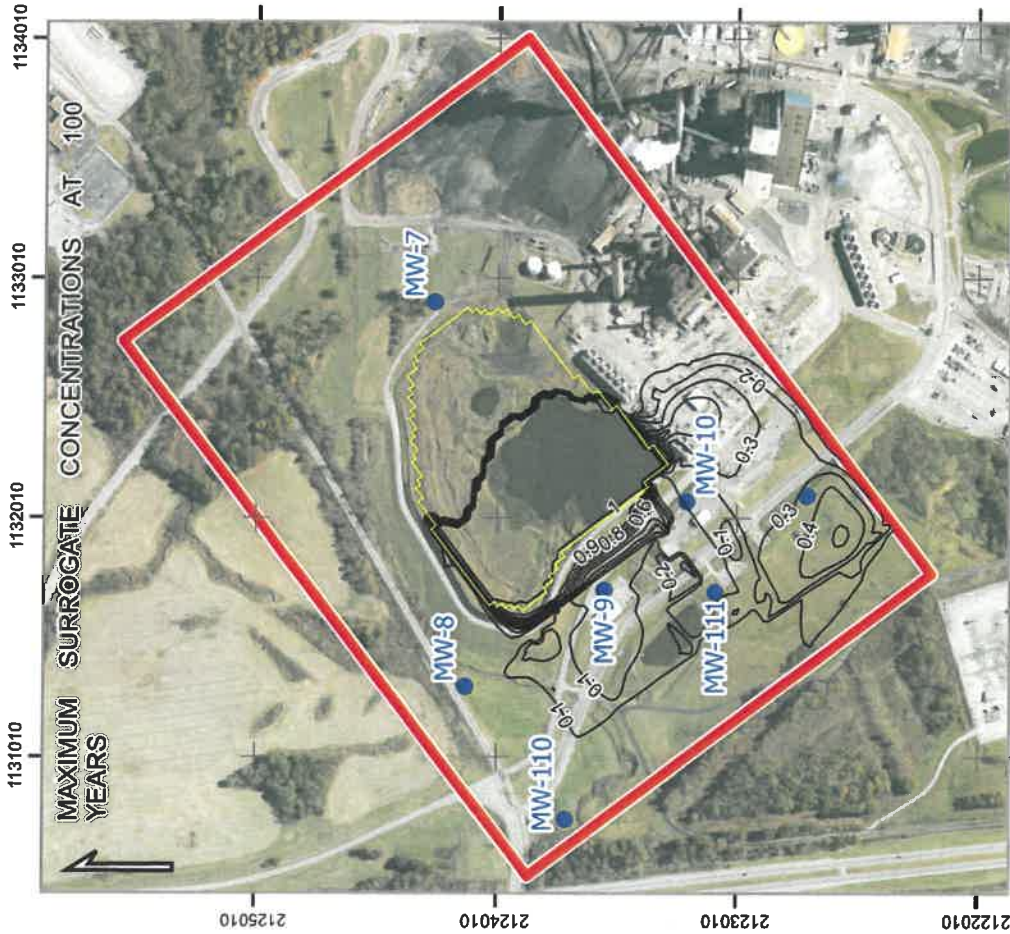
LEGEND

- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS
- BARRIER WALL



Coordinate System:
 NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
 Project File: Figure13_Scenario4_SurrogateConcentrations_25
 and_50_years.qgz

CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	SCENARIO 4, SURROGATE CONCENTRATIONS AT 25 AND 50 YEARS		
SCALE AT ANSI A	DRAWN	DZF	08/17/2022
1:9,200	CHECKED	BAS	08/17/2022
BAS PROJECT No.	22212101		FIGURE: 13



LEGEND

- MONITOR WELL
- MODEL DOMAIN
- SURROGATE CONCENTRATIONS
- BARRIER WALL

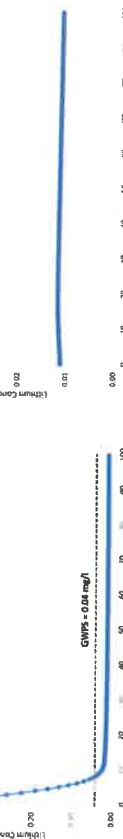
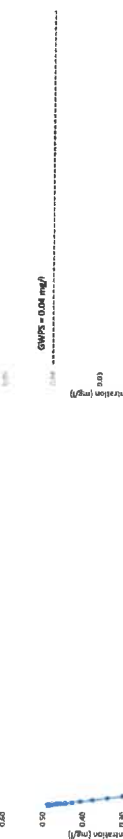
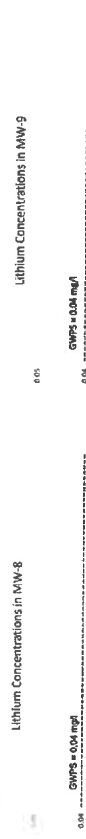


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Coordinate System:
NAD_1983_StatePlane_Kentucky_South_FIPS_1602_Feet
Project File:
Figure14_Scenario4_SurrogateConcentrations_100Years.qgz

CLIENT	BIG RIVERS ELECTRIC CORP.		
SITE	SEBREE GENERATING STATION ROBARDS, KY		
TITLE	SCENARIO 4, SURROGATE CONCENTRATIONS AT 100 YEARS, DECAY CURVES		
SCALE AT ANSI A	DRAWN	DZF	08/24/2022
1:9,200	CHECKED	BAS	08/24/2022
BAS PROJECT No.	22212101		FIGURE: 14



APPENDIX D

June 2019 Assessment of Corrective Measures for Reid/HMP&L CCR Surface Impoundment

Assessment of Corrective Measures Under the CCR Rule

CCR SURFACE IMPOUNDMENT REID/HMP&L STATION WEBSTER COUNTY, KENTUCKY

June 13, 2019

Prepared For:

**Big Rivers Electric Corporation
Sebree Generating Station
9000 Highway 2096
Robards, Kentucky 42452**

Prepared by:



AECOM Technical Services

525 Vine Street
Suite 1800
Cincinnati, Ohio 45202
Phone: (513) 651-3440
Fax: (877) 660-7727

Job Number: 60602365

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Reid/HMP&L Station Surface Impoundment
Assessment of Corrective Measures

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- A. Corrective Measures Technologies and Alternatives Evaluation Process

ACRONYMS

ACM	Assessment of Corrective Measures
AECOM	AECOM Technical Services, Inc.
ARARs	Applicable or Relevant and Appropriate Requirements
BREC	Big Rivers Electric Corporation
°C	Degrees Celsius
CAO	Corrective Action Objectives
CbR	Closure by Removal
CCR	Coal Combustion Residuals
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CiP	Closure in Place
cm/sec	Centimeters per second
COCs	Constituents of Concern
CSM	Conceptual Site Model
DO	Dissolved Oxygen
ft., amsl	Feet above mean sea level
GWPS	Groundwater Protection Standards
ICs	Institutional Controls
KGS	Kentucky Geological Survey
KPDES	Kentucky Pollution Discharge Elimination System
Li	Lithium
µS/cm	MicroSiemens per centimeter
MCL	Maximum Contaminant Level
mg/L	Milligrams per liter
mV	Millivolt
O&M	Operation and Maintenance
ORP	Oxidation Reduction Potential
PRB	Permeable Reactive Barrier
RCRA	Resource Conservation and Recovery Act
Sebree Station	Sebree Generating Station
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

AECOM Technical Services, Inc. (AECOM) was retained by Big Rivers Electric Corporation (BREC) to prepare an Assessment of Corrective Measures (ACM) to identify appropriate corrective measures for groundwater impacted by coal combustion residuals (CCR). The subject groundwater impacts are associated with the CCR that has been historically managed within the Reid/HMP&L Station CCR Surface Impoundment (Reid/HMP&L Station Surface Impoundment) at the Sebree Generating Station (Sebree Station), located near Sebree, Kentucky (Site).

Groundwater monitoring was conducted for the CCR management unit in accordance with the United States Environmental Protection Agency's (USEPA) CCR Rule (40 Code of Federal Regulations (CFR) Section 257.90 through Section 257.95). Detection and Assessment groundwater monitoring are complete at the Reid/HMP&L Station Surface Impoundment, and one constituent of concern (COC), lithium (Li), has been identified based on exceedance of the applicable Groundwater Protection Standard (GWPS) at a statistically significant level (SSL).

Section 257.96(c) requires this assessment to include an analysis of the effectiveness of potential corrective measures in meeting the objectives for remedies identified under Section 257.97(b), by addressing at least the following:

- (1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- (2) The time required to begin and complete the remedy;
- (3) 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(s).

Several potential corrective measures technologies were evaluated to identify which ones could be carried forward as components of corrective measures alternatives. The results of the corrective measures technology evaluation are presented below:

Potentially Applicable Technology	Status	Description/Overview
No Action	Not retained as standalone technology, but carried forward for baseline comparisons	This technology has been included in the preliminary evaluation/screening but is not retained because it will not meet the established CAOs.
Institutional Controls (ICs)	Retained as supplement to corrective measures alternatives	The use of ICs (i.e., Environmental Covenants, groundwater use restrictions, etc.) is retained as a useful technology. However, it is noted the ICs are not anticipated to be used as a stand-alone technology. Environmental Covenants, groundwater use restrictions, etc., are expected to be combined with other applicable technologies as part of corrective measures alternatives.

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Groundwater Monitoring (Assessment and Detection modes)	Retained as supplement to corrective measures alternatives	The use of groundwater monitoring (Assessment and/or Detection modes as appropriate) when combined with other applicable technologies as part of any proposed corrective measures alternative is retained to address the CAO and to track the effectiveness of the overall remedy. However, it is not retained as a stand-alone technology.
Hydraulic Containment	Retained	The use of hydraulic containment is retained because it is an effective means of preventing off-site migration of soluble contaminants. Hydraulic containment requires management and potential ex-situ treatment of extracted groundwater, so it is not a stand-alone technology. The Conceptual Site Model (CSM) will guide the design of any groundwater extraction system to optimize the total discharge of groundwater needed to provide hydraulic containment.
Physical Containment	Retained	The use of physical containment is retained because it can be an effective means of managing groundwater flow. Physical containment often requires pairing with hydraulic containment and/or in-situ treatment (funnel and gate style) to manage the flux of groundwater flow into the system. The CSM will guide the design of any physical barrier system, but technology limitations may increase implementation difficulty with scale.
Ex-situ Physical/Chemical/Biological Treatment	Retained	Ex-situ treatment technologies are retained as a way of removing contaminants from extracted groundwater from a hydraulic containment system. Ex-situ treatment may be paired with wastewater treatment, non-groundwater release treatment systems, or with permitted discharge to manage groundwater contamination. The CSM and data gaps investigations will guide the design of any ex-situ treatment.
Closure in Place (CiP) (of the regulated unit)	Retained	The use of CiP as a source control technology and is amenable with respect to CAO attainment.
Closure by Removal (CbR) (of the regulated unit)	Retained	The use of CbR as a source control technology is amenable with respect to CAO attainment
Other Source Control Technologies	Retained	Control of source area non-groundwater related releases. For the purposes of this groundwater ACM, management of non-groundwater releases are not included in the alternatives evaluation. Engineering measures, including leachate collection, lining of trenches and/or ponds, and other isolation methods are regarded as part of closure technologies selected by other means.

Note: Technologies that were retained may be used as components of a corrective action alternative, but when evaluated in conjunction with other available technologies, any single technology may not be utilized.

Preliminary assembly of corrective measures alternatives was performed based on site-specific and regional geology and groundwater conditions. For the Reid/HMP&L Station Surface Impoundment, five corrective measures alternatives were developed from this list of applicable corrective measures technologies:

- Alternative #1 – No Action, and Groundwater Monitoring
- Alternative #2a – Closure in Place (CiP), Institutional Controls (ICs), and Groundwater Monitoring

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- Alternative #2b – Closure by Removal (CbR), ICs, and Groundwater Monitoring
- Alternative #3 – CiP, ICs, Hydraulic Containment, Other Source Control, Ex-Situ Treatment, and Groundwater Monitoring
- Alternative #4 – CiP, ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring

The assembly of corrective measures alternatives is preliminary and could be revised at a later date following detailed analysis during the remedy selection process and/or following comment from the regulatory community and public. Specifically, a public meeting is required under Section 257.96(e) at least 30 days prior to the selection of remedy so that the owner or operator may discuss the results of the corrective measures assessment with interested and affected parties.

Following submittal of the ACM, the Site will begin the remedy selection process that is set forth in Section 257.97. The selected remedy must:

- Meet the requirements of Section 257.97(b) of the CCR Rule;
- Consider the standards in Section 257.97(c), and;
- Address the schedule and other factors specified in Section 257.97(d).

Upon remedy selection, a remedy selection report will be prepared that documents details of the selected remedy and how the selected remedy meets Section 257.97 requirements. As needed to accommodate further investigation(s) and/or evaluation, Section 257.97 requires the preparation of a semiannual report that documents progress toward remedy selection and design.

1.0 INTRODUCTION

The following report presents the Assessment of Corrective Measures (ACM) for groundwater impact identified at the Reid/HMP&L Station CCR Surface Impoundment (Reid/HMP&L Station Surface Impoundment), which is a coal combustion residuals (CCR) management unit located at the Big Rivers Electric Corporation (BREC) at the Sebree Generating Station (Sebree Station), located near Sebree, Kentucky (Site).

Groundwater monitoring was conducted for the unit in accordance with the United States Environmental Protection Agency's (USEPA) CCR Rule (40 Code of Federal Regulations [CFR] Section 257.90 through Section 257.95). The results of Detection Monitoring (per Section 257.94) identified the presence of one or more indicator constituents (Appendix III to Section 257) with downgradient concentrations representing a statistically significant increase(s) (SSI) over background or upgradient conditions. The detection of one or more SSI required the implementation of Assessment Monitoring following the requirements of Section 257.95, which was initiated in April 2018. Assessment Monitoring results indicated the downgradient presence of one or more constituents of concern [COCs] (Appendix IV to Section 257) at concentrations that represent an SSI over background concentration, and that represent a statistically significant level (SSL) over the groundwater protection standard(s) established in accordance with to Section 257.95(h).

For the Reid/HMP&L Station Surface Impoundment unit, the following SSL was identified:

- Lithium (Li) in MW-10

The identification of the SSL requires characterization of the nature and extent of impact (sufficient to support the ACM) in accordance with Section 257.95(g)(1) and the initiation of an ACM following the requirements of Section 257.96. Notice of ACM initiation dated January 14, 2019 was posted to BREC's publicly-accessible CCR reporting website.

Section 257.96(c) requires this ACM to include an analysis of the effectiveness of potential corrective measures in meeting the objectives for remedies identified under Section 257.97(b), by addressing at least the following:

- (1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- (2) The time required to begin and complete the remedy;
- (3) 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(s).

This report presents the ACM evaluation in the following five sections, along with their associated appendices and attachments.

2.0 DESCRIPTION OF CURRENT CONDITIONS

This section provides information related to the current use of the site, as well as the history of activities relevant to the ACM for the Reid/HMP&L Station Surface Impoundment at the Sebree Station.

2.1 Site Background

BREC owns and operates the Sebree Station, which is a coal-fired power generating facility located on the Green River northeast of Sebree, Kentucky. Sebree Station is composed of Green Station and Reid/HMP&L Station. The Sebree Station is bounded by Interstate-69 to the west and the Green River to the east (see **Figure 1**). Reid Unit 1 (66 Megawatts) began commercial operation in 1966 and it will be converted from coal to natural gas in the future. The Reid Combustion Turbine (72 MW) was commercialized in 1976. HMP&L Station 2, Units 1 (167 MW) and 2 (168 MW) began commercial operation in 1973 and 1974 respectively. Both HMP&L units were retired as of February 1, 2019. Green Station Units 1 (242 MW) and 2 (242 MW) began commercial operation in 1979 and 1981, respectively.

The location of the Reid/HMP&L Station Surface Impoundment is illustrated in **Figure 2**. The CCR Surface Impoundment has been in place for more than 40 years and is used for the placement of CCR material. As stated in the published CCR monitoring well network certification, available on the BREC website, the Reid/HMP&L Station Surface Impoundment is a combined incised/dike earthen embankment structure. It is diked on the west, south and east sides, while the north side is incised. The south dike has the greatest height, reaching approximately 20 feet. The original ground surface within the pond footprint was irregular and the dominant features were small stream valleys draining eastward to the Green River. Most of the central portion of the south dike was constructed on a subdued ridge.

2.2 Site Investigation and Interim Measures

Monitoring wells were installed in the vicinity of the Reid/HMP&L Station Surface Impoundment in December 2015 prior to the implementation of the CCR Rule. These wells meet the requirements of §257.90 of the CCR Rule for installation of a groundwater monitoring system. These requirements are that wells must adequately represent the quality of background groundwater and groundwater representing the downgradient waste boundary. The wells are located along the perimeter of the footprint for the Reid/HMP&L Station Surface Impoundment. One upgradient monitoring well (MW-7) and three downgradient monitoring wells (MW-8, MW-9, and MW-10) were installed adjacent to the Reid/HMP&L Station Surface Impoundment to determine the general direction of groundwater movement and to monitor groundwater at the Site. The monitoring wells were installed in the uppermost saturated portion of the sandstone bedrock aquifer.

Hydraulic testing (slug tests) was performed in April 2019, and nine rounds of Baseline groundwater sampling for Appendix III constituents was conducted between March 2016 and October 2017. Statistical evaluation for Detection monitoring indicated that SSIs over background have occurred, and therefore, Assessment monitoring was triggered. Detection monitoring activities and data are presented in the annual reports that have been prepared to date, (AECOM 2018 and 2019. Annual Groundwater Monitoring).

As part of Assessment monitoring, upgradient and downgradient wells for the CCR Surface Impoundment were sampled for Appendix IV constituents in April, July, and September 2018. GWPSs were established for Assessment monitoring of the Appendix IV constituents, and statistical evaluation indicated exceedances of GWPSs at SSLs.

For the purposes of this ACM, the COC that exceeds GWPSs at SSLs is Li (see **Table 1**).

Table 1 – Reid/HMP&L Station Surface Impoundment Constituents of Concern (COCs)

Monitoring Well (Date)	Parameter
	Lithium UPL 0.008 GWPS 0.04 (mg/L)
MW-10 (Apr 2018)	0.694
MW-10 (Jul 2018)	0.630
MW-10 (Sep 2018)	0.570

NOTES:

GWPSs are the greater of the site-specific background concentrations, the USEPA primary drinking water standard maximum contaminant limits (MCL), or GWPS provided in 40 CFR 257.95(3)(h)(2)

Bold red values exceed the GWPS by direct comparison; yellow shaded indicates an SSL above the GWPS (i.e., 95 LCL > GWPS) UPL = Upper Prediction Limit; mg/L = milligrams per liter; < = constituent concentration is less than laboratory reporting limit.

No formal interim corrective measures have been performed at the Reid/HMP&L Station Surface Impoundment but waste is no longer placed in the unit and closure activities have been initiated.

2.3 Conceptual Site Model (CSM)

The main purpose of a CSM is to support the decision-making process for groundwater corrective action at the Reid/HMP&L Station Surface Impoundment.

2.3.1 Physical Setting

The Site is mapped within the Interior Low Plateaus physiographic province (<https://www.nps.gov/subjects/geology/physiographic-provinces.htm>). The province is part of the Interior Plains division of the United States. Characteristic features of the province include unglaciated rolling limestone plains with alluvial valleys and entrenched rivers and streams. Several large rivers are in the region, including the Green, the Ohio, the Kentucky, the Tennessee, and the Cumberland Rivers. The geology underlying the Site consists of unconsolidated materials, including loess and alluvial deposits, underlain by Upper to Middle Pennsylvanian-age clastics and carbonates consisting primarily of sandstone and shale. The unconsolidated material also include fill, silty and clayey residuum, and minor amounts of sandy, clayey channel fill alluvium.

The Reid/HMP&L Station Surface Impoundment is located on upland adjacent to the west bank of the Green River at an elevation of approximately 389 feet, above mean sea level [ft., amsl] (at the west corner) and 400 ft., amsl (at the northeast corner). Although the Green River is located less than 0.5 miles from the site, the structure does not extend significantly into the floodplain. Underlying preconstruction soils consisted of Loring-Grenada, Loring-Zanesville-Wellston (Henderson County) and Loring-Wellston-Zanesville (Webster County) soil associations which are generally characterized as well drained to moderately well drained soils on nearly level to sloping uplands (Associated Engineers 2016, Hydrologic and Hydraulic Capacity Assessment and Initial Inflow Design Flood Control System Plan). The immediate watershed that drains to the unit, and in which the unit is considered to be located, is unnamed and 25.45 acres in size. The unnamed watershed discharges from the Reid/HMP&L Station Surface Impoundment outflow structure and is routed, under a Kentucky Pollution Discharge and Elimination System (KPDES) permit, to the Green River.

2.3.2 Geology

Figure 3 presents a geologic map of the site and vicinity. The site lies in the Western Kentucky Coalfields, characterized by rolling uplands underlain by coal-bearing bedrock of the Pennsylvanian Period. In the vicinity of the site, maximum topographic relief is on the order of 80 feet. The geologic quadrangle (Geologic map of the Robards quadrangle, Henderson and Webster Counties, Kentucky, 1973) for the Site vicinity published by the Kentucky Geological Survey (KGS) shows the surficial material to be unconsolidated loess representing the Pleistocene and Holocene geologic epoch. The loess consists of sandy and clayey silt. The unconsolidated surficial materials, which include silty and sandy clay units, are approximately 25 feet in thickness.

The unconsolidated surficial materials are underlain by bedrock of the Upper Pennsylvanian Shelburn Formation (formerly identified as the Lisman Formation [Fairer, 1973]) and the Middle Pennsylvanian Carbondale Formation. At the base of the Shelburn Formation is the Providence Limestone Member, consisting of limestone and interbedded shale, but this unit is absent in much of the area due to erosional channeling. Due to its discontinuous character and the presence of interbedded shale, hydrologically significant karst features are not present in the Providence Limestone Member. The underlying Carbondale Formation consists of cyclic sequences of sandstones, shales, siltstones and coals. The Carbondale sediments were deposited in a fluvial-deltaic system. As a result of this depositional environment, the lithologic units of the Carbondale tend to be lenticular bodies rather than continuous sheet-like strata. Gradational and abrupt horizontal changes in lithology are often encountered.

Cross-sections were prepared during development of this ACM, and cross-section locations are shown on **Figure 2**. The individual cross-sections are presented on **Figures 4** and **5**. These sections illustrate the sequence of geologic units present under the Reid/HMP&L Station Surface Impoundment as evidenced by the currently available data.

2.3.3 Hydrogeology

For purposes of compliance with the CCR Rule groundwater monitoring requirements, the interbedded sandstone and shale of the Carbondale Formation is considered to be the uppermost aquifer underlying the Reid/HMP&L Station Surface Impoundment. The uppermost aquifer is unconfined and first encountered at an elevation of approximately 413.4 ft., amsl at the northeast end (at MW-7), and 341.6 ft. amsl at the west end of the Surface Impoundment (at MW-8). Flow direction beneath the site is typically to the southwest towards an unnamed tributary to Groves Creek located west/southwest of the impoundment.

Slug tests were performed between April 24, 2019 and April 25, 2019 at monitoring wells MW-10, and MW-110 to assess the hydraulic characteristics of the uppermost aquifer. The estimated hydraulic conductivity of the monitoring wells tested ranged from 3×10^{-6} to 5×10^{-4} centimeters per second (cm/sec).

Although previous site-specific investigations have noted the presence of perched zones of saturation in the overlying unconsolidated materials, these discontinuous zones do not qualify as an uppermost aquifer under the CCR Rule because they do not produce usable quantities of groundwater.

2.3.4 Constituents of Concern (COCs)

As described in Section 2.2, a single Appendix IV constituent, Li, was detected at concentrations exceeding GWPS at one monitoring well location: Li was detected at SSLs above the GWPS at the monitoring well MW-10 location.

2.3.5 Impacted Media

Groundwater is the sole impacted media of concern addressed by this ACM.

2.3.6 COCs Distribution

Groundwater analytical data from the site investigations through 2018 indicate that COC concentrations above GWPSs are present in the vicinity of the Reid/HMP&L Station Surface Impoundment along the southwest edge (**Figure 6**). COC concentrations at MW-7, MW-8, and MW-9 were not above GWPSs at SSLs. Due to this, the area of projected corrective measures is confined to the area at and adjacent to MW-10.

An additional characterization well, MW-110, was subsequently installed to estimate the downgradient extent of impacted groundwater. Sample collection for Appendix III and IV parameters took place in March and April 2019. The analytical results for Li were below the GWPS. The characterization data are summarized in **Table 2**.

Table 2 – Reid/HMP&L Station Surface Impoundment Characterization Sample Results

Monitoring Well (Date)	Parameter
	Lithium UPL 0.008 GWPS 0.04 (mg/L)
MW-110 (March 2019)	0.0299
MW-110 (April 2019)	0.0303

The two sampling event results from the characterization well helps confirm the downgradient (southwestern) extent of COC impacts above the GWPS at the Reid/HMP&L Station Surface Impoundment.

2.3.7 Groundwater Quality

In addition to the presence of COCs above GWPSs, other geochemical characteristics of the uppermost aquifer consist of the following:

- The temperature of the samples taken at the downgradient wells during the September 2018 sampling event ranged from 18.53 degrees Celsius (°C) to 18.62 °C.
- Specific conductance ranged from 0.534 to 2.64 microSiemens (µS/cm).
- Dissolved Oxygen (DO) concentration ranged from 0.41 to 0.44 mg/L.
- Oxidation Reduction Potential (ORP) ranged from -74 to -95 millivolts (mV).
- The pH of the samples ranged from 6.69 to 8.98.
- Total Dissolved Solids (TDS) concentration of the samples ranged from 293 to 1,990 mg/L.

2.3.8 Potential Receptors / Pathways

Contact with water (e.g., shallow groundwater or surface water) impacted by COCs at levels above GWPS is regarded as the potential pathway for exposure of potential receptors. Based on data published by KGS, there are no known groundwater wells used for drinking water within a 1-mile radius of the Reid/HMP&L Station, thus limiting the potential receptors to the surface water, i.e., tributaries to the Green River. The pathways to these receptors include seepage of water from the Reid/HMP&L Station Surface Impoundment through manmade and natural hydraulic barriers.

Other potential exposure pathways (e.g., soil or vapor) are not considered complete as the CCR material is isolated in the unit. This isolation prevents direct access by individuals that might result in direct contact or ingestion. In addition, the inherent non-volatile nature of the unit-specific COCs eliminates the potential for a complete vapor pathway (i.e., vapor intrusion to indoor air). Therefore, soil and vapor pathways will not be considered within the context of this ACM.

3.0 Corrective Action Objective (CAO)

For CCR units, 40 CFR Parts 257.90 through 257.98 outlines the groundwater monitoring programs (Detection and Assessment) and the corrective action evaluation process, which provide the basis for the development of the site-specific CAO. Detection and Assessment groundwater monitoring are complete at the Reid/HMP&L Station Surface Impoundment, and the COC Li has been identified based on exceedance of the GWPS.

Section 257.96(c) requires this assessment to include an analysis of the effectiveness of potential corrective measures to meet the objectives for remedies identified under Section 257.97(b), by addressing at least the following:

- (1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- (2) The time required to begin and complete the remedy;
- (3) 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(s).

The subsequent remedy selection process will evaluate the following objectives for remedies, as required under Section 257.97(b):

- Protect human health and the environment;
- Attain the COC-specific GWPS as specified pursuant to Section 257.95(h);
- Control the source(s) of releases to reduce or eliminate, to the maximum extent feasible, further releases of Appendix III and 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, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems (applicable to material releases only); and
- Comply with standards for management of wastes as specified in Section 257.98(d).

Together, these requirements comprise the site-specific CAO that will be used during the remedy selection process.

4.0 TECHNOLOGY IDENTIFICATION AND SCREENING

As required under Section 257.97(b), source control is one element of the CAO that is intended to prevent further releases from the source, i.e., the Reid/HMP&L Surface Impoundment. In adherence with the BREC's permit conditions, the Site will continue to operate through the end of its life cycle and will be closed in accordance with the requirements of the permit. Source control through pond closure will include installation of final cover that will prevent infiltration and contribute to groundwater quality restoration.

The identification and screening of potentially applicable corrective measures technologies for groundwater downgradient of the Reid/HMP&L Surface Impoundment is presented in **Appendix A** to this report. The findings of that screening are summarized in the table below.

Table 3 – Potential Corrective Measures Options Technology Description/Overview

Potentially Applicable Technology	Status	Description/Overview
No Action	Not retained as standalone technology, but carried forward for baseline comparisons	This technology has been included in the preliminary evaluation/screening but is not retained because it will not meet the established CAOs.
Institutional Controls (ICs)	Retained as supplement to corrective measures alternatives	The use of ICs (i.e., Environmental Covenants, groundwater use restrictions, etc.) is retained as a useful technology. However, it is noted the ICs are not anticipated to be used as a stand-alone technology. Environmental Covenants, groundwater use restrictions, etc., are expected to be combined with other applicable technologies as part of corrective measures alternatives.
Groundwater Monitoring (Assessment and Detection modes)	Retained as supplement to corrective measures alternatives	The use of groundwater monitoring (Assessment and/or Detection modes as appropriate) when combined with other applicable technologies as part of any proposed corrective measures alternative is retained to address the CAO and to track the effectiveness of the overall remedy. However, it is not retained as a stand-alone technology.
Hydraulic Containment	Retained	The use of hydraulic containment is retained because it is an effective means of preventing off-site migration of soluble contaminants. Hydraulic containment requires management and potential ex-situ treatment of extracted groundwater, so it is not a stand-alone technology. The CSM will guide the design of any groundwater extraction system to optimize the total discharge of groundwater needed to provide hydraulic containment.

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Potentially Applicable Technology	Status	Description/Overview
Physical Containment	Retained	The use of physical containment is retained because it can be an effective means of managing groundwater flow. Physical containment often requires pairing with hydraulic containment and/or in-situ treatment (funnel and gate style) to manage the flux of groundwater flow into the system. The CSM will guide the design of any physical barrier system, but technology limitations may increase implementation difficulty with scale.
Ex-situ Physical/Chemical/Biological Treatment	Retained	Ex-situ treatment technologies are retained as a way of removing contaminants from extracted groundwater from a hydraulic containment system. Ex-situ treatment may be paired with wastewater treatment, non-groundwater release treatment systems, or with permitted discharge to manage groundwater contamination. The CSM and data gaps investigations will guide the design of any ex-situ treatment.
Closure in Place (CiP) (of the regulated unit)	Retained	The use of CiP as a source control technology and is amenable with respect to CAO attainment.
Closure by Removal (CbR) (of the regulated unit)	Retained	The use of CbR as a source control technology is amenable with respect to CAO attainment.
Other Source Control Technologies	Retained	Control of source area non-groundwater related releases. For the purposes of this groundwater ACM, management of non-groundwater releases are not included in the alternatives evaluation. Engineering measures, including leachate collection, lining of trenches and/or ponds, and other isolation methods are regarded as part of closure technologies selected by other means.

References: Technology descriptions referenced from 1) FRTR: Federal Remediation Technologies Roundtable, CLU-IN, and/or AECOM reference materials.

5.0 Corrective Action Alternatives Assembly

Applicable corrective measures technologies identified in Section 4.0 above were assembled into corrective measures alternatives for evaluation (see Section 6.0). Each corrective measures alternative consists of one or more corrective measures technologies assembled into a strategy for the groundwater remedy. Five corrective measures alternatives for the Reid/HMP&L Station Surface Impoundment were assembled and are described below:

- **Alternative #1** – No Action, and Groundwater Monitoring
- **Alternative #2a** – Closure in Place (CiP), Institutional Controls (ICs), and Groundwater Monitoring
- **Alternative #2b** – Closure by Removal (CbR), ICs, and Groundwater Monitoring
- **Alternative #3** – CiP, ICs, Hydraulic Containment, Other Source Control, Ex-Situ Treatment, and Groundwater Monitoring
- **Alternative #4** – CiP, ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring

5.1 Assumptions for Corrective Measure Alternatives Development

In developing the corrective measures alternatives, a number of assumptions have been made based on the data available to AECOM at the time of this report and operational plans as reported by the owner/operator. The specific assumptions include:

- The currently observed dissolved-phase groundwater impacts are limited to the area adjacent to monitoring well location MW-10 along the southeastern corner of the Reid/HMP&L Station Surface Impoundment; groundwater impacts do not extend offsite from the Sebree Station property.
- Groundwater impacts are limited to the saturated zone between the observed water table at approximate elevation 390 feet mean sea level (ft-msl) and an assumed depth below the MW-10 well screen of approximately 325 ft-msl.
- Ex-situ treatment of groundwater may involve physical/chemical methods and/or discharge to a permitted National Pollution Discharge and Elimination System (NPDES) outfall.
- Groundwater corrective measures will be conducted until the CAOs are met. The objectives may be met at an earlier date, but the alternatives analysis is based on the conservative assumption that corrective measures and the associated monitoring of groundwater conditions will be required for up to 30 years following the initiation of the corrective measures.

5.2 Groundwater Corrective Measures Alternatives Overview

The developed groundwater corrective measures alternatives, outlined above, are detailed in the following sections.

5.2.1 Alternative #1 – No Action and Groundwater Monitoring

Alternative #1 consists of taking no action to remedy the CCR impacts observed in the Reid/HMP&L Station Surface Impoundment groundwater monitoring system. Under the No Action alternative, no corrective measures would be implemented to remove, control, mitigate, or minimize exposure to

impacted groundwater. Groundwater monitoring (Assessment) is required by the CCR Rule during the nominal performance period of 30 years to track the effectiveness of the alternative and to identify conditions that allow the return to Detection monitoring. The No Action alternative establishes a baseline, or reference point against which each of the developed corrective measures alternatives may be compared.

5.2.2 Alternative #2a – CiP, ICs, and Groundwater Monitoring

Alternative #2a employs a combination of three of the retained corrective measures technologies:

- CiP source control, which consists of planned Reid/HMP&L Station Surface Impoundment closure activities;
- Implementation of ICs designed to restrict the property to industrial use and to prohibit groundwater use for potable purposes; and
- Groundwater Monitoring (Assessment) to track the effectiveness of the corrective measures and to identify conditions that allow the return to Detection monitoring and ultimately to cessation of corrective measures.

CiP was selected as the source control technology because the site's operational planning includes closure-related activities that will eventually result in placement of an engineered cap. CiP via CCR stabilization and capping would serve to control the source of constituents of concern (COCs) and thereby reduce contaminant loading to the surrounding environment.

Implementation of ICs is employed to help maintain the CiP and associated corrective measures by limiting the accessibility of the unit to unauthorized users and restricting future use of the property to those activities that may result in exposure potentials.

Groundwater monitoring of the unit is required by 40 CFR Section 257.90 through .98. The unit triggered Assessment-mode monitoring by the detection of indicator parameters (Appendix III of 40 CFR 257) in downgradient monitoring wells at concentrations representing a SSI over background. Continued groundwater monitoring is required under 40 CFR 257.95 until the CAOs are met. The CAOs are anticipated to be met as the effect of source control technologies are realized and as natural attenuation mechanisms (advection, dilution and dispersion) take effect.

5.2.3 Alternative #2b – CbR, ICs, and Groundwater Monitoring

Alternative #2b is similar to Alternative #2a except that CiP is replaced by CbR, which consists of excavation and removal of the Reid/HMP&L Station Surface Impoundment, implementation of ICs and an Environmental Covenant intended to restrict the unit to industrial use and prohibit groundwater use for potable purposes. The excavation of impacted CCR material would typically be completed using standard construction equipment (e.g., backhoe, excavator, wheel loader, dump trucks). The excavated materials are then placed directly into dump trucks for transport/disposal or beneficial use. Excavation limits would typically be verified with confirmation sampling to demonstrate that the underlying soil is not impacted above applicable standards.

Groundwater monitoring of the unit is required by 40 CFR 257.90 through .98. The unit triggered Assessment-mode monitoring by the detection of indicator parameters (Appendix III of 40 CFR 257) in downgradient monitoring wells at concentrations representing a SSI over background. Continued groundwater monitoring is required under 40 CFR 257.95 until the CAOs are met. The CAOs are

anticipated to be met as the effect of source control technologies are realized and as natural attenuation mechanisms (advection, dilution and dispersion) take effect.

5.2.4 Alternative #3 – CiP, Hydraulic Containment, Ex-Situ Treatment, ICs, and Groundwater Monitoring

Alternative #3 builds on Alternative #2a to also include the addition of Hydraulic Containment and Ex-Situ Treatment of groundwater:

- CiP source control, which consists of planned Surface Impoundment closure activities;
- Implementation of ICs designed to restrict the property to industrial use and to prohibit groundwater use for potable purposes;
- Hydraulic Containment using one or more vertical wells designed to prevent the movement of impacted groundwater past the limits of the unit to the downgradient groundwater environment and potential points of exposure;
- Ex-Situ Treatment of groundwater extracted for hydraulic containment, which involves above-ground physical/chemical treatment methods and/or permitted discharge until the CAOs are achieved;
- Implementation of ICs designed to restrict the property to industrial use and to prohibit groundwater use for potable purposes; and
- Groundwater Monitoring (Assessment mode) to track the effectiveness of the corrective measures and to identify conditions that allow the return to Detection-mode monitoring and ultimately to cessation of corrective measures.

Vertical groundwater recovery wells for Hydraulic Containment would be installed near the downgradient limit of the unit in the vicinity of MW-10. Due to the low hydraulic conductivity of the uppermost aquifer, Pre-Design Studies are anticipated to be needed to identify the appropriate number, design, and spacing of the extraction well system. For the purposes of this ACM, preliminary specifications are as follows:

- Two vertical groundwater extraction wells;
- Extraction wells would be placed at the southeast corner of the Reid/HMP&L Station Surface Impoundment and upgradient of monitoring well MW-10;
- Wells screen depths would be approximately 50-100 feet-below ground surface (ft-bgs);
- Estimated groundwater extraction rates of 20 gallons per minute (gpm) per well.

Alternative #3 incorporates treatment of extracted groundwater before it can be discharged to an outfall. Treatment will consist of piping the extracted groundwater to an existing surface water impoundment at the Sebree Station, which will allow for compliance with discharge permits through an established NPDES outfall.

The COC concentrations downgradient of the hydraulic containment would also be expected to decrease over time through natural attenuation mechanisms including advection, dilution, and dispersion. As such, groundwater monitoring would be modified to include system performance monitoring, which may require installation of wells at new locations to evaluate the efficacy of hydraulic containment and to identify when CAOs have been achieved.

5.2.5 Alternative #4 – CiP, ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring

Alternative #4 consists of BREC's planned unit closure activities, physical containment of impacted groundwater via installation of a funnel-gate system, and ex-situ treatment of contained groundwater via an extraction well installed at the containment gate. Impacted groundwater would be contained by grout curtain constructed in a funnel-and-gate arrangement that directs the flow of groundwater to an extraction point. The grout curtain would be installed by drilling two lines of grout injection points that extend northwestward and northeastward from the southeast corner of the unit. The length of each limb of the barrier would be 500 feet, and the target depth would be approximately 325 ft-amsl. A single extraction well would be installed at the "gate" with a screened interval of 50 to 100 ft-bgs and a pumping capacity of up to 20 gpm. Groundwater will be pumped and conveyed to an existing surface water impoundment at the Sebree Station, which will allow for compliance with discharge permits through an established NPDES outfall.

CiP via ash stabilization and capping would control the source of COCs and thereby reduce contaminant loading to the extraction system. Concentrations downgradient of the physical barrier would be expected to decrease over time through several natural attenuation mechanisms including advection, dilution, and dispersion. Groundwater Monitoring (Assessment) would continue to track the effectiveness of the corrective measures and to identify conditions that allow the return to Detection monitoring and ultimately to cessation of corrective measures.

6.0 ALTERNATIVE EVALUATION

The formal remedy selection process, in accordance with the CCR Rule 40 CFR Section 257.97, will begin following submission of the ACM Report. The subsequent remedy selection process will evaluate the following objectives for remedies, as required under Section 257.97(b):

- Protect human health and the environment;
- Attain the COC-specific GWPSs as specified pursuant to Section 257.95(h);
- Control the source(s) 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 (applicable to material releases only); and
- Comply with standards for management of wastes as specified in Section 257.98(d).

6.1 Potential Data Gaps

No data gap investigation is projected at this time.

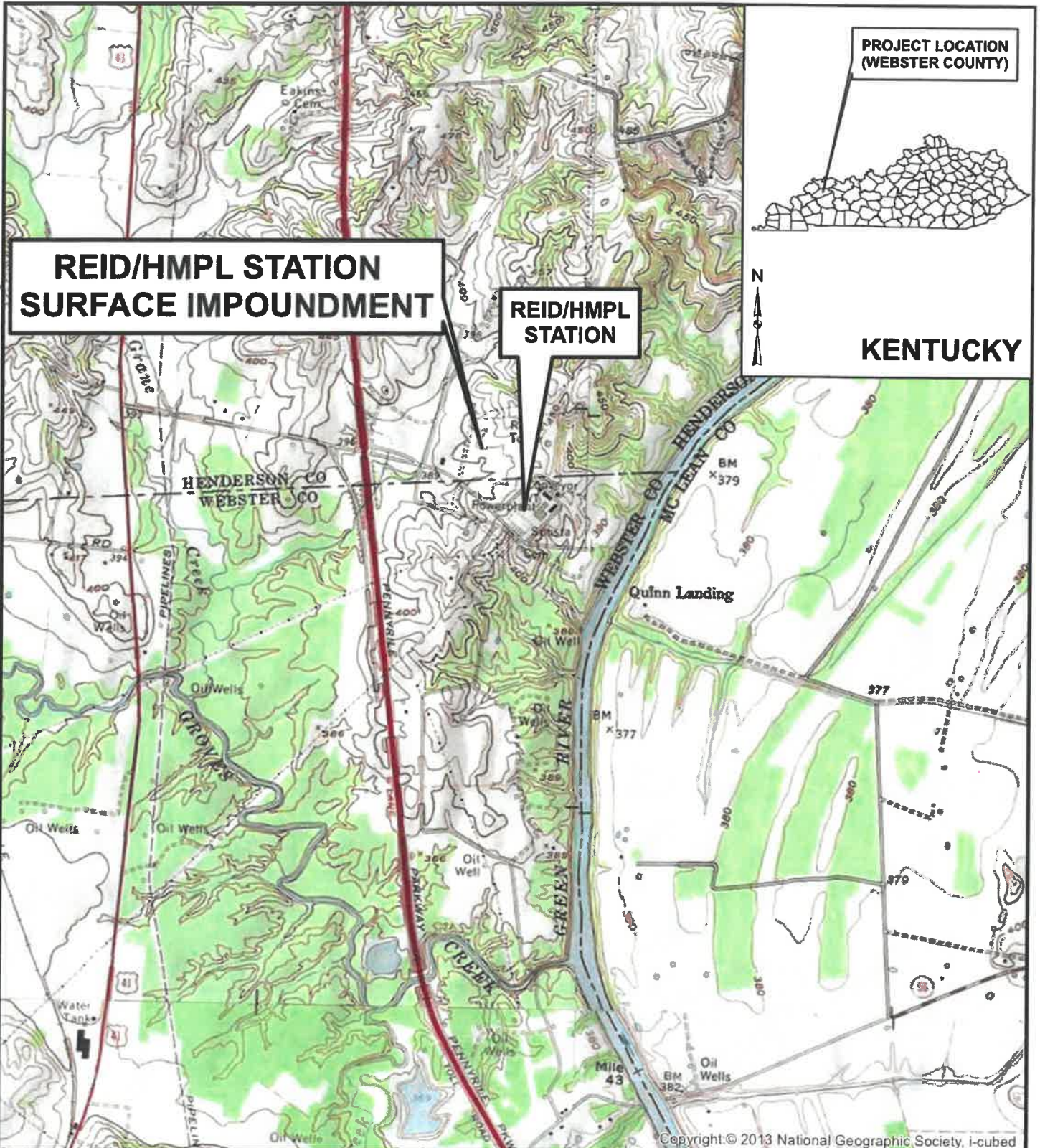
Depending on which alternative is selected, a data gap investigation may be needed to further refine the targeted areas for corrective measures,. Potential data gaps may include the following:

- 1) Supplemental Groundwater Investigation – This investigation may consist of additional monitoring well installation and sampling to refine the existing CSM as well as to provide data related to the hydraulic characteristics of the subsurface.
- 2) Groundwater Treatment Amendment Evaluation – This evaluation may involve the completion of bench-scale testing of potentially applicable treatment amendments to determine their efficacy and loading rates to address the observed groundwater impacts from site-specific COCs. Additionally, testing on the pilot-scale may also be completed in the field to demonstrate that the groundwater treatment system could be successfully installed and operated at the Site.
- 3) Physical Containment Profile – Prior to committing to a physical barrier design, it may be necessary to probe the subsurface along the proposed alignment to:
 - Establish the character of the materials through which the barrier would be installed;
 - The depth to confinement where the barrier would terminate;

7.0 REFERENCES

- AECOM, 2018. Annual Groundwater Monitoring and Corrective Action Report, 2016-2017; Reid/HMP&L Station CCR Surface Impoundment, Webster County, Kentucky.
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- EPA, 40 CFR Part 257. [EPA-HQ-RCRA-2015-0331; FRL-9928-44-OSWER]. RIN-2050-AE81. Technical Amendments to the Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities—Correction of the Effective Date. Federal Register / Vol. 80, No. 127 / Thursday, July 2, 2015 / Rules and Regulations.
- Fairer, G.M., Geologic Map of the Robards Quadrangle, Henderson and Webster Counties, Kentucky, U.S. Geological Survey, 1973.

Figures



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ROBARDS QUADRANGLE
DELAWARE QUADRANGLE

(FROM ARCGIS ONLINE Copyright © 2011 National Geographic Society, i-cubed)

0 2,000 4,000
Feet



Big Rivers
ELECTRIC CORPORATION

Reid/HMPL Station
Webster County, Kentucky

**FIGURE 1
SITE LOCATION MAP**

DATE: 4/30/2019

SCALE: 1IN = 2,000 FEET

CREATED BY: ALW

JOB NO. 60602365



Legend

- Unit Boundary
- Property Line
- ⊕ Downgradient CCR Monitoring Well
- ⊕ Upgradient CCR Monitoring Well
- ⊕ Proposed Characterization Well

A ——— A'
Transect Line

0 300 600
Feet



Big Rivers

Reid/HMPL Station
Webster County, Kentucky

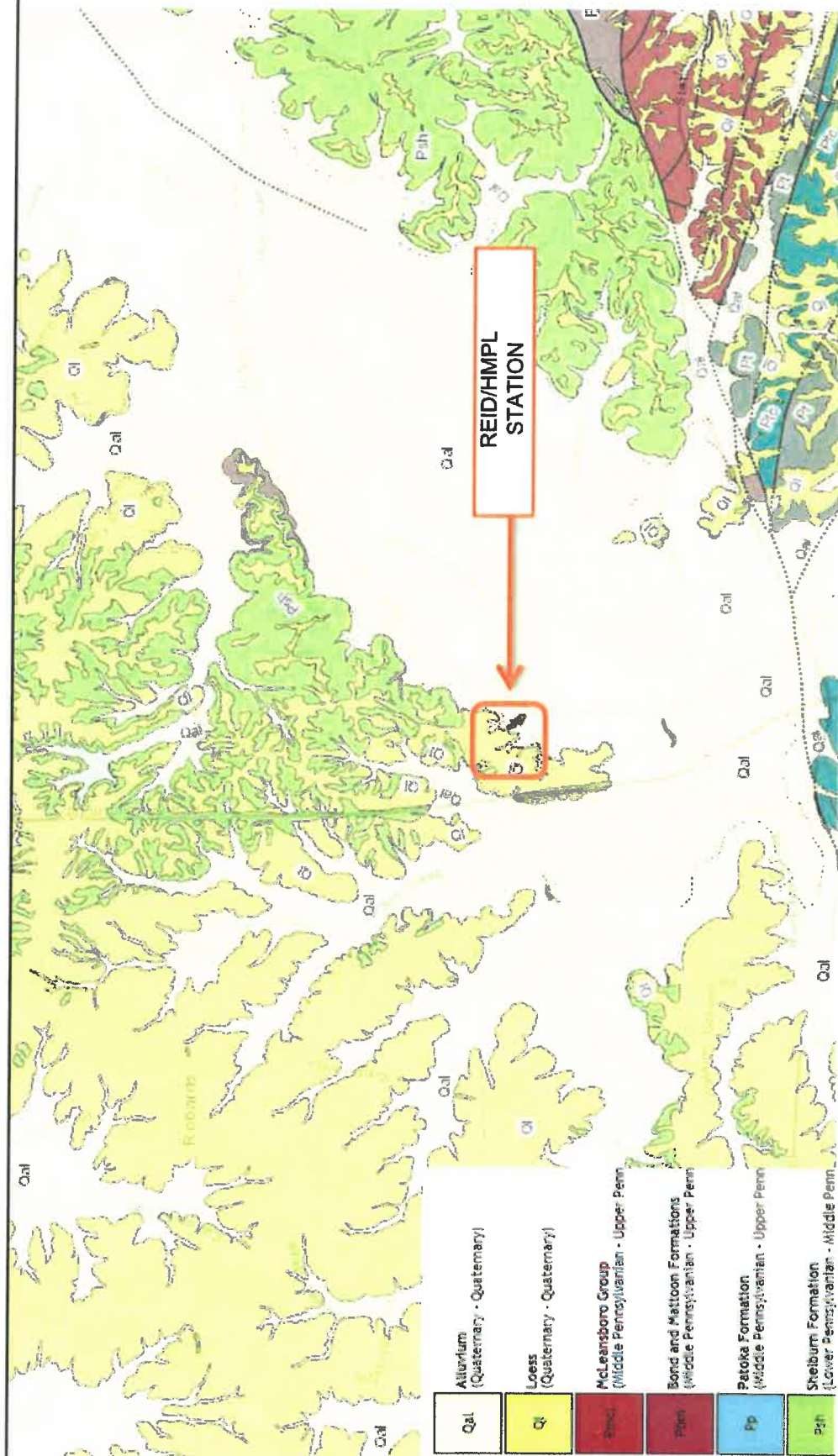
FIGURE 2
WELL LOCATION MAP

DATE: 5/16/2019

SCALE: 1IN = 200 FEET

CREATED BY: ALW

JOB NO. 60802365



REID/HMPL
STATION

Qal	Alluvium (Quaternary - Quaternary)
Ql	Loess (Quaternary - Quaternary)
Smc	McLeansboro Group (Middle Pennsylvanian - Upper Pennsylvanian)
Pms	Bond and Mattoon Formations (Middle Pennsylvanian - Upper Pennsylvanian)
Pp	Petoka Formation (Middle Pennsylvanian - Upper Pennsylvanian)
ash	Shelburn Formation (Lower Pennsylvanian - Middle Pennsylvanian)

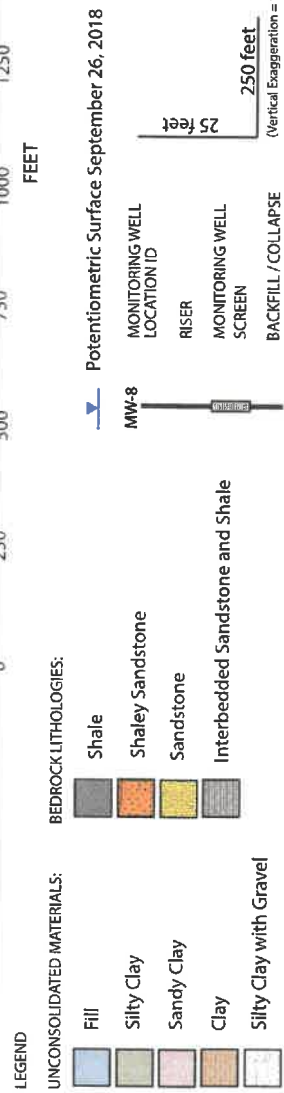
ROAD

Reid/HMPL Station
Webster County, Kentucky

FIGURE 3
SITE GEOLOGIC MAP
(KENTUCKY GEOLOGICAL SURVEY)

DATE: 4/30/2019
CREATED BY: DAS
JOB NO. 60602385

SCALE: AS SHOWN



Big Rivers
ELECTRIC CORPORATION

FIGURE 4
CROSS SECTION A - A'

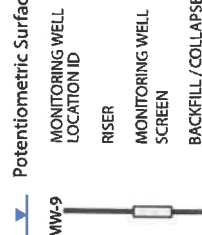
DATE: 4/30/2019	SCALE: 1 IN = 25 x 250 FEET
CREATED BY: MRH	
JOB NO. 60602365	



Big Rivers

DATE: 4/30/2019	SCALE: 1IN = 25 x 250 FEET
CREATED BY:MRH	
JOB NO. 80602365	

Potentiometric Surface September 26, 2018



25 feet

250 feet

Vertical Exaggeration

(Vertical Exaggeration = $10\times$)

IN:\a_arc.com\net.com\GFS\AMERICAN\cincinnati\DCSIP\Project\ENV\60402365_BREC_RI\ACNH000-CAD-GIS\920-GIS or Graphics



Legend

- Unit Boundary
- Property Line
- ✕ Downgradient CCR Monitoring Well
- ✕ Upgradient CCR Monitoring Well
- ◆ Proposed Characterization Well

0 300 600
Feet



Big Rivers
WATER COMPANY

Reid/HMPL Station
Webster County, Kentucky

FIGURE 6
COC DISTRIBUTION

DATE: 5/16/2019

SCALE: 1IN = 200 FEET

CREATED BY: ALW

JOB NO. 60602365

Appendix A
Corrective Measures Technologies and
Alternatives Evaluation Process

Appendix A

Corrective Measures Technologies and Alternatives Evaluation Process

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Table A2	Screened Corrective Measures Technologies

A1.0 CORRECTIVE MEASURES EVALUATION PROCESS

This appendix describes the overall process used in the selection and screening of remedial technologies that are considered potentially applicable to Coal Combustion Residuals (CCR) groundwater impacts at the subject Site. This appendix also describes the process for assembling preliminary corrective measures alternatives from one or more applicable technologies and evaluating these alternatives.

A1.1 Potential Remedial Technologies

Section 257.96(c) requires this assessment to include an analysis of the effectiveness of potential corrective measures to meet the objectives for remedies under Section 257.97(b), addressing at least the following:

- (1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- (2) The time required to begin and complete the remedy;
- (3) 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(s).

The following remedial technologies are regarded as potentially applicable to corrective measures for CCR groundwater impact:

- No Action (Included as a baseline case)
- Institutional Controls (ICs)
- Groundwater Monitoring
- Hydraulic Containment
- Physical Containment
- Ex-situ Physical/Chemical/Biological Treatment
- In-situ Physical/Chemical/Biological Treatment
- Permeable Reactive Barrier (PRB)
- Closure in Place (CiP) (of the regulated unit)
- Closure by Removal (CbR) (of the regulated unit)

A brief overview of these technologies is provided below in **Table A1**.

Table A1 – Potential Remedial Technologies

Potential Technology	Description/Overview
No Action	Default baseline approach against which other options are evaluated. No corrective action would be taken to remove, control, mitigate or minimize exposure to impacted media.
Institutional Controls (ICs)	Non-engineering measures, such as administrative and/or legal controls that help to minimize the potential for human exposure to contamination, and/or to protect the integrity of a remedy by limiting land or resource use (United States Environmental Protection Agency [USEPA], <i>Institutional Control Data Standard</i> EX000015.1, January 6, 2006).
Groundwater Monitoring	Groundwater monitoring (Assessment and/or Detection modes) to assess effectiveness of corrective measures performance, as well as natural subsurface processes such as dilution, adsorption, and chemical reactions that together serve to reduce inorganic COC concentrations to acceptable levels.
Hydraulic Containment	Hydraulic containment is a common method for remediating groundwater impacted with metals and other inorganics. Groundwater is pumped from wells or collection trenches to aboveground discharge point or to a treatment system that removes the contaminants. The extraction network would be designed to provide hydraulic containment of the impacted groundwater, preventing it from flowing downgradient towards surface water or other receptors.
Physical Containment	Physical barriers are walls constructed below the ground surface to control or restrict the flow of groundwater. They are constructed by injection grouting or by the use of excavator or deep trenching equipment to insert and thoroughly mix a selected amendment to create a homogenized impermeable wall that prevents impacted groundwater from flowing downgradient. The bottom of the physical containment structure is typically keyed into a low-permeability soil or bedrock (confining layer) to keep groundwater from seeping beneath the wall. To provide hydraulic control of the impacted groundwater behind (upgradient of) the physical barrier and to prevent impacted water from flowing around the edges of the wall, extraction wells would be installed behind the vertical barrier (VB) and the extracted groundwater processed through a treatment system.
Ex-situ Physical/Chemical/Biological Treatment	Ex-situ treatment requires pumping of groundwater and engineering for equipment, possible permitting, and material handling. Physical/chemical treatment uses the physical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert), separate, or contain the contamination. Physical/chemical treatment can be completed in short time periods (in comparison with biological treatment). Equipment is readily available. Treatment residuals from separation techniques will require treatment or disposal.

Potential Technology	Description/Overview
In-situ Physical/Chemical Treatment	With in-situ treatment, groundwater is treated without being brought to the surface. In-situ processes, however, generally require longer time periods. Physical/chemical treatment uses the physical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert), or separate the contamination.
Permeable Reactive Barriers (PRB)	A PRB is a constructed subsurface barrier designed to intercept groundwater flow and react with the entrained COCs. PRBs can be established through trench injection or direct-push injection (on closely spaced grids) of reactive material. PRBs are typically installed to the depth of impacted groundwater (often the bottom of the shallow aquifer) and along the length of the impacted zone. The amendment used to generate the PRB is generally permeable as or more permeable than the surrounding material, encouraging impacted groundwater to flow through the reactive material. The reactive material then causes chemical reactions to occur, resulting in adsorption, precipitation, or degradation of the COC. PRBs are commonly used to control organic contamination in groundwater and have been successfully used to remediate metals.
Closure in Place (CiP) (of the regulated unit)	Landfill caps can be installed to minimize generation of leachate and to minimize infiltration into underlying waste. Landfill caps also may be applied to waste masses that are so large that other treatment is impractical. By providing a suitable base for the establishment of vegetation. In conjunction with water diversion and detention structures, landfill caps may be designed to route surface water away from the waste area while minimizing erosion.
Closure by Removal (CbR) (of the regulated unit)	Removal of contaminated media for disposal in off-site facility or alternate on-site facility. Media would likely require characterization for proper disposal. Pre-treatment may be necessary to meet land disposal restrictions (LDRs). Once excavated, confirmatory samples would be collected to verify clean-up criteria have been met; the excavation would then be backfilled and covered.

References: Technology descriptions referenced from 1) FRTR: Federal Remediation Technologies Roundtable, CLU-IN, and/or AECOM reference materials.

A1.2 Other Source Control Technologies

In addition to the groundwater corrective measures technologies summarized above, CCR impacts are also mitigated through a variety of engineering measures, including leachate collection, lining of trenches and/or ponds, and other isolation methods for source control.

A1.3 No Action

No Action is included in the evaluation as a baseline against which other technologies are evaluated. With this option, no corrective action would be taken to remove, control, mitigate or minimize exposure to impacted media. In the event that the other identified alternatives do not offer substantial benefits, No Action is the default baseline approach.

Under this alternative, existing impacted media (i.e., CCR materials and impacted soil/groundwater along the exposure pathway) would remain. No capital costs would be incurred, and no cleanup standards would be considered.

No Action does not meet the performance requirement of attaining the established Corrective Action Objective (CAO). Although implementation would be very easy, the required state approval for "No Action" would likely not occur. Safety impacts, cross-media impacts, and residual CCR exposure control

would be no different from current conditions. Therefore, No Action is not an appropriate standalone technology. However, it is retained for use as a baseline against which other technologies and alternatives are evaluated.

A1.4 Institutional Controls (ICs)

The potential use of ICs is considered the least aggressive corrective action technology for CCR impacts.

ICs would not change the concentration or mobility of COCs and therefore would not meet the performance requirement of attaining the established CAO as a standalone technology unless it can be demonstrated that impacted groundwater is not leaving the facility. ICs would be used in combination with other corrective measures to limit human exposures and would be easy to implement, consisting of preparation and recording of Environmental Restrictive Covenants [ERC(s)]. Safety impacts and cross-media impacts would be identical to current conditions. Because ICs would control exposure and thus enhance protection of human health and the environment, the use of ICs can be a component of corrective measures alternatives. The use of ICs as a standalone technology will not be considered.

A1.5 Groundwater Monitoring

The use of groundwater monitoring is only applicable for dissolved-phase groundwater impacts, and it will take place in Assessment and/or Detection modes as appropriate for the current phase of CCR activity. Groundwater monitoring is not a standalone technology, but instead will be combined with other remedial technologies in order to track progress of the overall remedy, which also incorporates natural attenuation processes.

The use of groundwater monitoring as a stand-alone remedial technology will not be considered; instead the incorporation of groundwater monitoring in conjunction with other technologies will be used to monitor effectiveness of a given corrective measures alternative to attain the CAO at points immediately downgradient over an extended period of time. Data reliability is controlled by adherence to the site's groundwater monitoring plan. Implementation of the existing groundwater monitoring plan is easy because it is currently underway. Safety impacts are minimized by use of the existing Health and Safety Plan and there are no construction activities required. There are no cross-media impacts or institutional requirements, nor is there any residual CCR exposure control.

A1.6 Hydraulic Containment

The use of hydraulic containment as a potential remedial technology is considered. The use of groundwater extraction can be effective at hydraulically controlling long-term downgradient dissolved phase impacts.

Hydraulic containment through groundwater extraction and subsequent treatment has historically been a common method for management of groundwater impacted with metals and other inorganics. Groundwater is pumped from wells (vertical or horizontal) or collection trenches to a discharge point (e.g., a permitted outfall) or to an aboveground treatment system. The extraction network would be designed, constructed and operated to provide a hydraulic barrier between the impacted groundwater and the migration pathway to potential receptors.

This technology attains the established CAO because hydraulic containment rapidly eliminates the offsite migration of impacted groundwater, thereby eliminating the exposure pathway. Performance and reliability would be controlled by adherence to the operations and maintenance plan prepared for the extraction and treatment systems. Implementation would be difficult because of areas of limited access

for drilling equipment and uneven groundwater flow in the uppermost aquifer materials that consist of interbedded sandstone and shale having hydraulic conductivity values spanning several orders of magnitude. Potential safety impacts during construction, operation, and maintenance of the system would be mitigated by health and safety plans prepared for these tasks. There would be no cross-media impacts. Hydraulic containment will reduce mobility due to COCs capture provided by the groundwater extraction system and treatment to remove COCs from the environment. The time period for CAO attainment may be relatively short, but system operation will need to continue until CCR source loading of COCs to groundwater ceases. For institutional requirements, treated discharge would occur under existing or modified National Pollution Discharge Elimination System (NPDES) permit.

Based on the preliminary screening, hydraulic containment is a potentially viable remedial technology and will be retained for further consideration.

A1.7 Physical Containment

The use of physical containment to isolate the impacted materials associated with a CCR unit is considered. Physical containment typically consists of a barrier or wall (i.e., slurry wall, sheet pile wall, or injection grouting) constructed below the ground surface to control or restrict the flow of groundwater. The barrier is typically constructed by excavators and/or deep trenching equipment that thoroughly mix bentonite/cement slurry to create a homogenized impermeable wall, or by driving sheet pile. The construction of the barrier would prevent impacted groundwater from flowing downgradient. Where possible, the bottom of the barrier would be keyed into the low-permeability soil or bedrock (confining layer) at the bottom of the aquifer, keeping groundwater from seeping beneath it. To provide hydraulic control of the impacted groundwater behind the barrier and prevent impacted water from flowing around the edges, a hydraulic containment system would be installed behind the wall. Extracted groundwater would then be discharged or processed through a groundwater treatment system, as needed. Extraction flow rates for this option will generally be lower than in a standalone hydraulic containment option, because the pumping rates will only need to accommodate natural groundwater flow rates, rather than providing a hydraulic barrier. However, pumping would need to be performed indefinitely to maintain water levels behind the barrier. It is also noted that physical barriers can also be utilized in a funnel-and-gate arrangement to direct the flow of groundwater to a small, more permeable area (i.e., the gate) where reactive material can be used to treat the metals in-situ. The "gate" can also be configured as a single extraction point for impacted groundwater directed to it by the "funnel."

This technology attains the established CAO after combined physical and hydraulic containment eliminates the offsite migration of impacted groundwater, thereby eliminating the exposure pathway. In the long term, this technology will maintain compliance with the established CAO after final cover construction at the Green Landfill, which will end the source loading to the groundwater, and groundwater flushes through the aquifer. Performance and reliability would be controlled by adherence to the operations and maintenance plan prepared for the extraction and treatment systems. The technology would pose substantial challenges to the installation and operation of the physical barrier such as areas of limited access and highly variable depths to bedrock. Potential safety impacts during construction, operation, and maintenance of the system would be mitigated by health and safety plans prepared for these tasks. Cross-media impacts include the potential for airborne fugitive dust issues during construction, which would be mitigated by construction contingency planning. The time period for attainment is based on construction of the barrier. For institutional requirements, treated discharge would occur under existing or modified National Pollution Discharge Elimination System (NPDES) permit.

Based on the preliminary screening, physical containment is potentially viable as a potential corrective measures alternative component, when combined with supplemental groundwater extraction and

treatment. However, physical containment does not appear to add value to a stand-alone hydraulic containment approach.

A1.8 Ex-Situ Physical/Chemical/Biological Treatment

Ex-situ treatment requires the use of groundwater extraction with related engineering, equipment, permitting, and material handling necessary to convey the waste stream to above-ground treatment. Treatment technologies would be designed to remove the specific constituents from groundwater to meet regulatory discharge requirements; treatment options for the varied constituents may include pH adjustment, filtration, coagulation/chemical precipitation, membrane filtration, ion exchange, carbon adsorption, reverse osmosis, chemical reduction, and other potential treatment technologies. Multiple treatment technologies would potentially be needed to effectively remove the different types of contaminants. If this technology is incorporated into a corrective action alternative, further detailed evaluation and/or bench- and pilot-scale studies would be necessary to identify technically effective treatment technologies given the inorganic COCs.

This is not a standalone technology, but would be used in combination with hydraulic containment. System reliability would be controlled by adherence to an operation and maintenance plan prepared for the system. Implementation is expected to be straightforward based on well-established water treatment principles and experience. Potential safety impacts during construction, operation, and maintenance of the system would be mitigated by health and safety plans prepared for these tasks. There would be no cross-media impacts, nor would there be exposure to residual CCR materials. The time period for attainment is based on performance of the overall corrective measure, of which ex-situ treatment would be a component. For institutional requirements, treated discharge would occur under existing or modified National Pollution Discharge Elimination System (NPDES) permit.

Based on the preliminary screening, ex-situ treatment is a potentially viable remedial technology and will be retained for further consideration.

A1.9 In-Situ Physical/Chemical/Biological Treatment

For the inorganic COCs at CCR site, in-situ treatment involves enhancement of natural attenuation processes such as dilution, adsorption, and chemical reactions to reduce concentrations to acceptable levels. This technology is appropriate for site in which groundwater flow volumes are low, source controls are effective, and impacted groundwater is not expected to be long-lived.

Lithium (Li) is the sole COC for the ACM at the Reid/HMPL Surface Impoundment, and in-situ treatment methods are ineffective for Li. Therefore, this technology will not meet the performance requirement, and it will not be retained for further consideration.

A1.10 Permeable Reactive Barriers (PRB)

A PRB is an in-situ treatment method consisting of a subsurface trench filled with reactive material installed to intercept and react with impacted groundwater. PRBs can be established through direct-push injection (on closely spaced grids) or emplaced as a continuous trench of reactive material. PRBs are typically installed to the depth of impacted groundwater (often the bottom of the shallow aquifer) and are oriented perpendicular to the flow of impacted groundwater. The amendment used to generate the PRB is generally as permeable as or more permeable than the surrounding material, encouraging impacted groundwater to flow through the reactive material. The reactive material then causes chemical reactions to occur within the PRB, resulting in adsorption, precipitation, or degradation.

PRBs are commonly used to control organic contamination in groundwater, and have been successfully used to remediate some metals. However, because Li is the sole COC for the ACM at the Reid/HMPL Surface Impoundment, and in-situ methods are ineffective for Li, PRB will not meet the performance requirement, and it will not be retained for further consideration.

A1.11 Closure-in-Place (CiP) [of the regulated unit]

CiP would entail capping and restoration of the unit that contains the CCR material. Capping would minimize infiltration into the CCR material, thereby minimizing the potential for leachate to impact underlying soil and shallow groundwater. Capping would reduce potential exposure pathways and thus enhance protection of human health and the environment.

CiP will help attain the established CAO after final cap construction ends the source loading to the groundwater, and impacted groundwater flushes through the aquifer. This technology is easily implemented, as CiP is required by conditions of the solid waste permit. Potential safety impacts during construction, operation, and maintenance of the final cover are governed by conditions of the solid waste permit and are mitigated by health and safety plans prepared for these tasks. There are no cross-media impacts associated with CiP, and it will provide for significant reduction in mobility of COCs upon implementation of the CiP source control. Final cover for the Reid/HMPL Surface Impoundment is anticipated as part of facility operations. Institutional requirements will consist of solid waste permit renewal(s) and state and community acceptance of the final remedy.

Based on the preliminary screening, CiP is retained for further consideration.

A1.12 Closure by Removal (CbR) [of the regulated unit]

CbR is a proven remedy that can effectively remove the source of contamination. The excavation of impacted CCR material would typically be completed using standard construction equipment (e.g., backhoe, excavator, wheel loader, dump trucks). The excavated materials are then placed directly into dump trucks for transport/disposal or beneficial use. Excavation limits would typically be verified with confirmation sampling to demonstrate that the underlying soil is not impacted above applicable standards.

This technology would help attain the established CAO after CCR removal ends and the source loading to groundwater is eliminated. This technology would be difficult to implement, because of the large-scale construction effort required and resulting disruption to station operations and community impact. Potential safety impacts during excavation and backfilling would be mitigated by health and safety planning. However, the volume of truck traffic for waste and fill hauling would be a significant community safety issue. Potential airborne fugitive dust issues during excavation and hauling would be significant, but would be mitigated by construction contingency planning. CbR will eliminate exposure through removal of the CCR. CbR would begin following state and community approvals, and duration of excavation activities is anticipated to be many years. In addition to state and community acceptance of the proposed remedy, excavation and backfilling may require local building permits and local municipality input and approval. Excavation dewatering discharge would occur under existing or modified NPDES permit.

Based on the preliminary screening, CbR is retained for further consideration.

A1.13 Screened Remedial Technologies Summary

A summary of the results of the remedial technologies screening is presented below in **Table A2**. The design and specific application of the retained technologies, either as stand-alone or part of a treatment train, will be crucial in the success of the corrective action.

Table A2 – Screened Corrective Measures Technologies

Potentially Applicable Technology	Status	Description/Overview
No Action	Not retained as standalone technology, but carried forward for baseline comparisons	This technology has been included in the preliminary evaluation/screening but is not retained because it will not meet the established CAOs.
Institutional Controls (ICs)	Retained as supplement to corrective measures alternatives	The use of ICs (i.e., Environmental Covenants, groundwater use restrictions, etc.) is retained as a useful technology. However, it is noted the ICs are not anticipated to be used as a stand-alone technology. Environmental Covenants, groundwater use restrictions, etc., are expected to be combined with other applicable technologies as part of corrective measures alternatives.
Groundwater Monitoring (Assessment and Detection modes)	Retained as supplement to corrective measures alternatives	The use of groundwater monitoring (Assessment and/or Detection modes as appropriate) when combined with other applicable technologies as part of any proposed corrective measures alternative is retained to address the CAO and to track the effectiveness of the overall remedy. However, it is not retained as a stand-alone technology.
Hydraulic Containment	Retained	The use of hydraulic containment is retained because it is an effective means of preventing off-site migration of soluble contaminants. Hydraulic containment requires management and potential ex-situ treatment of extracted groundwater, so it is not a stand-alone technology. The CSM will guide the design of any groundwater extraction system to optimize the total discharge of groundwater needed to provide hydraulic containment.
Physical Containment	Retained	The use of physical containment is retained because it can be an effective means of managing groundwater flow. Physical containment often requires pairing with hydraulic containment and/or in-situ treatment (funnel and gate style) to manage the flux of groundwater flow into the system. The CSM will guide the design of any physical barrier system, but technology limitations may increase the difficulty with scale.

Ex-situ Physical/Chemical/Biological Treatment	Retained	Ex-situ treatment technologies are retained as a way of removing contaminants from extracted groundwater from a hydraulic containment system. Ex-situ treatment may be paired with wastewater treatment, non-groundwater release treatment systems, or with permitted discharge to manage groundwater contamination. The CSM and data gaps investigations will guide the design of any ex-situ treatment.
Closure in Place (CiP) (of the regulated unit)	Retained	The use of CiP as a source control technology and is amenable with respect to CAO attainment.
Closure by Removal (CbR) (of the regulated unit)	Retained	The use of CbR as a source control technology is amenable with respect to CAO attainment.
Other Source Control Technologies	Retained	Control of source area non-groundwater related releases. For the purposes of this groundwater ACM, management of non-groundwater releases are not included in the alternatives evaluation. Engineering measures, including leachate collection, lining of trenches and/or ponds, and other isolation methods are regarded as part of closure technologies selected by other means.

Note: Technologies that were retained may be used as components of a corrective action alternative, but when evaluated in conjunction with other available technologies, any single technology may not be utilized.

A2.0 CORRECTIVE MEASURES ALTERNATIVES

Corrective measures technologies from the initial screening and evaluation (see **Table A2**) were utilized to create corrective measures alternatives. Professional judgment was used to assemble technically efficient pairings of technologies for each corrective measures alternative in consideration of the range of site-specific COCs and concentrations.

The corrective measures alternatives typically incorporate the use of technologies that will require additional investigation needed to 1) finalize the alternative selection, 2) delineate the assumed corrective action areas, 3) provide for full-scale cost estimation and design, and 4) demonstrate alternative efficacy. To this end, data gaps will be identified and addressed as needed.

It should be emphasized that the technology screening and alternatives assembly employed for this ACM is qualitative in nature. The formal remedy selection process, in accordance with the CCR Rule 40 CFR Section 257.97, will begin following submission of the ACM Report. The subsequent remedy selection process will evaluate the following objectives for remedies, as required under Section 257.97(b):

- Protect human health and the environment;
- Attain the COC-specific GWPS as specified pursuant to Section 257.95(h);
- Control the source(s) 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 (applicable to material releases only); and
- Comply with standards for management of wastes as specified in Section 257.98(d).

APPENDIX E

Evaluation of Corrective Measures Alternatives

Table E-1. Evaluation of Potential Groundwater Remedies for Reid/HMPL CCR Surface Impoundment

Descriptions of Corrective Measures Alternatives						
#2a	CIP with CCR (Modelled Closure Scenario 3), ICS, and Groundwater Monitoring					
#2b	CCR (Modelled Closure Scenario 1), ICS, and Groundwater Monitoring					
#3	CIP with CCR (Modelled Closure Scenario 3), ICS, Hydraulic Containment, Ex-Situ Treatment, and Groundwater Monitoring					
#4a	CIP with CCR (Modelled Closure Scenario 3), ICS, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring					
#4b	CIP with ICS (Modelled Closure Scenario 4), ICS, and Groundwater Monitoring					
Ranking Definitions						
5	Best relative to all other corrective measures alternatives passing threshold criteria.					
1	Worst relative to all other corrective measures alternatives passing threshold criteria.					
Evaluation Criteria						
40 CFR 257.97 Ref.	Criterion	#2a	#2b	#3	#4a	#4b
Threshold Criteria (Corrective Action Objectives)						
(b)(1)	Be protective of human health and the environment.	✓	✓	✓	✓	✓
(b)(2)	Attain the groundwater protection standard.	✓	✓	✓	✓	✓
(b)(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 to 40 CFR Part 257 into the environment.	✓	✓	✓	✓	✓
(b)(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.	✓	✓	✓	✓	✓
(b)(5)	Comply with standards for management of wastes as specified in 40 CFR 257.98(d).	✓	✓	✓	✓	✓
Balancing Criteria						
(c)(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.					
(c)(1)(i)	Magnitude of reduction of existing risks.	1	5	2.5	2.5	4
(c)(1)(ii)	Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy.	1	5	2.5	2.5	4
(c)(1)(iii)	The type and degree of long-term management required, including monitoring, operation, and maintenance.	3.5	6	1.5	1.5	3.5
(c)(1)(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.	4	1	2.5	2.5	5
(c)(1)(v)	Time until full protection is achieved.	1	5	3.5	3.5	2
(c)(1)(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.	1	5	2.5	2.5	4
(c)(1)(vii)	Long-term reliability of the engineering and institutional controls.	4	5	1.5	1.5	3
(c)(1)(viii)	Potential need for replacement of the remedy.	2	5	2	2	4

Threshold Criteria Analysis	
All five potential corrective measures are expected to be protective of human health and the environment.	Based on the numerical groundwater flow and contaminant fate and transport model for the site, all five potential corrective measures are expected to attain the groundwater protection standard for lithium.
Based on the numerical groundwater flow and contaminant fate and transport model for the site, all five potential corrective measures provide source control measures to reduce or eliminate further releases of lithium into the environment.	
All five potential corrective measures remove contamination from the environment through natural attenuation and/or active remedial measures.	
All five potential corrective measures are expected to comply with the waste management standards promulgated by RCRA.	
Balancing Criteria Analysis	
Alt. #2a is expected to be the minimum technology required to meet the CACOs and, therefore, scores the lowest. Alts. #3, #4a, and #4b supplement Alt. #2a with additional remedial technologies that further reduce existing risks; therefore, these alternatives are ranked higher than Alt. #2a. Because Alt. #4b would fully encapsulate the CCR stored in the Impoundment (top, bottom, and sides), Alt. #4b scores higher than Alts. #3 and #4a. Meanwhile, Alts. #3 and #4a are expected to provide a similar reduction of existing risks and, therefore, score the same. Finally, Alt. #2b would remove all CCR from the Impoundment (the source of lithium contamination) and, therefore, score the highest.	
Alt. #2a is expected to be the minimum technology required to meet the CACOs and, therefore, scores the lowest. Alts. #3, #4a, and #4b supplement Alt. #2a with additional remedial technologies that further reduce existing risks; therefore, these alternatives score higher than Alt. #2a. Because Alt. #4b would fully encapsulate the CCR stored in the Impoundment (top, bottom, and sides), Alt. #4b scores higher than Alts. #3 and #4a. Meanwhile, the magnitude of residual risks with groundwater extraction and ex-situ treatment under Alt. #3 and #4a is expected to be similar; therefore, these alternatives score the same. Finally, Alt. #2b would remove all CCR from the Impoundment (the source of lithium contamination) and, therefore, score the highest.	
Because Alt. #2b would remove all CCR from the Impoundment, groundwater monitoring would only need to continue at the site under Alt. #2b until compliance with the GWPS has been demonstrated in accordance with 40 CFR 257.98(c). Meanwhile, the remaining options would require maintenance of a final cover system and longer operation and maintenance of the Impoundment's CCR groundwater monitoring network. In addition to those operation and maintenance requirements, Alts. #3 and #4a would require operation and maintenance of groundwater extraction wells and operation of the ex-situ treatment program. Thus, Alts. #3 and #4a score the lowest, Alt. #2b the highest, and Alts. #2a and #4b are in the middle.	
To meet the CACOs, Alt. #2a is expected to require excavating deeper ash deposits and then (1) temporarily stockpiling some of the ash in the Impoundment and (2) transporting the rest of the ash to a landfill for disposal. Alts. #3 and #4a would require the same excavation, temporary stockpiling, and partial disposal strategy, but both alternatives would also require ex-situ treatment which introduces additional short-term risks to exposure. Therefore, Alt. #2a scores higher than Alts. #3 and #4a. Because Alt. #4b is not expected to require any mass excavation, handling, and transportation of CCR, Alt. #4b scores the highest. Conversely, Alt. #2b scores the lowest because Alt. #2b would require excavating all of the CCR stored in the Impoundment and transporting it to a landfill for disposal.	
Based on the numerical groundwater flow and contaminant fate and transport model for the site, Alt. #2b would meet the GWPS for lithium the earliest, Alt. #2a the latest, and Alt. #4b in between Alts. #2a and #2b. Although the ex-situ treatment in Alts. #3 and #4a was not explicitly modeled, this active remedial measure would be expected to achieve the GWPS for lithium faster than the passive remedial measures under Alts. #2a and #4b. Because Alt. #2b would fully remove the source of lithium contamination from the site, Alt. #2b is still considered to be the potential remedy that would achieve full protection fastest and, therefore, scores the highest.	
Because Alt. #2b is the only alternative where all CCR would be removed from the Impoundment, Alt. #2b has the lowest potential for exposing human and environmental receptors to remaining wastes and, therefore, scores the highest. Alt. #4b would fully encapsulate the CCR in the Impoundment (top, bottom, and sides) and, therefore, scores the second-highest. Finally, the partial containment measure and supplemental ex-situ treatment measures implemented under Alts. #3 and #4a are expected to have lower potentials for exposure than Alt. #2a, which is expected to be the minimum technology required to meet the CACOs. Therefore, Alt. #2a scores the lowest.	
Alt. #2b is the only alternative where neither engineering controls nor ICS would be required; therefore, Alt. #2b scores the highest. The remaining alternatives would utilize a final cover system that would need to be maintained throughout the Impoundment's post-closure life. Because Alt. #4b would fully encapsulate the CCR in the Impoundment (top, bottom, and sides), it scores lower than Alt. #2a. Finally, because Alts. #3 and #4a would include operating and maintaining vertical groundwater extraction wells in addition to maintaining a final cover system, it has two alternatives score the lowest.	
Because Alt. #2b is the only alternative where all CCR is removed from the Impoundment, the potential need to replace this corrective measure is expected to be the lowest. Alt. #2a would not be expected to require full replacement but may need to be supplemented to meet the GWPS for lithium. Because Alt. #4b involves fully encapsulating the CCR stored in the Impoundment, the potential need for supplementing that remedy is expected to be less than the potential for supplementing Alt. #2a. Therefore, Alt. #4b scores higher than Alt. #2a. Finally, Alts. #3 and #4a have active remedial components that will need to be evaluated to ensure they are performed as designed and therefore may require modification or even full replacement.	

Threshold Criteria Analysis

All five potential corrective measures are expected to be protective of human health and the environment.

Based on the numerical groundwater flow and contaminant fate and transport model for the site, all five potential corrective measures are expected to attain the groundwater protection standard for lithium.

Based on the numerical groundwater flow and contaminant fate and transport model for the site, all five potential corrective measures provide source control measures to reduce or eliminate further releases of lithium into the environment.

All five potential corrective measures remove contamination from the environment through natural attenuation and/or active remedial measures.

All five potential corrective measures are expected to comply with the waste management standards promulgated by RCRA.

Balancing Criteria Analysis

Alt. #2a is expected to be the minimum technology required to meet the CROs and, therefore, scores the lowest. Alts. #3, #4a, and #4b supplement Alt. #2a with additional remedial technologies that further reduce existing risks; therefore, these alternatives are ranked higher than Alt. #2a. Because Alt. #4b would fully encapsulate the CCR stored in the impoundment (top, bottom, and sides), Alt. #4b scores higher than Alts. #3 and #4a. Meanwhile, Alts. #3 and #4a are expected to provide a similar reduction of existing risks and, therefore, score the same. Finally, Alt. #2b would remove all CCR from the impoundment (the source of lithium contamination) and, therefore, scores the highest.

Alt. #2a is expected to be the minimum technology required to meet the CROs and, therefore, scores the lowest. Alts. #3, #4a, and #4b supplement Alt. #2a with additional remedial technologies that further reduce existing risks; therefore, these alternatives score higher than Alt. #2a. Because Alt. #4b would fully encapsulate the CCR stored in the impoundment (top, bottom, and sides), Alt. #4b scores higher than Alts. #3 and #4a. Meanwhile, the magnitude of residual risks with groundwater extraction and ex-situ treatment under Alts. #3 and #4a is expected to be similar; therefore, these alternatives score the same. Finally, Alt. #2b would remove all CCR from the impoundment (the source of lithium contamination) and, therefore, scores the highest.

Because Alt. #2b would remove all CCR from the impoundment, groundwater monitoring would only need to continue at the site under Alt. #2b until compliance with the GWPS has been demonstrated in accordance with 40 CFR 257.98(c). Meanwhile, the remaining options would require maintenance of a final cover system and longer operation and maintenance of the impoundment's CCR groundwater monitoring network, in addition to those operation and maintenance requirements. Alts. #3 and #4a would require operation and maintenance of groundwater extraction wells and operation of the ex-situ treatment program. Thus, Alt. #3 and 4a score the lowest, Alt. #2b the highest, and Alts. #2a and #4b in the middle.

To meet the CROs, Alt. #2a is expected to require excavating deeper ash deposits and then (1) temporarily stockpiling some of the ash in the impoundment and (2) transporting the rest of the ash to a landfill for disposal. Alts. #3 and #4a would require the same excavation, temporary stockpiling, and partial disposal strategy, but both alternatives would also require ex-situ treatment which introduces additional short-term risks to exposure. Therefore, Alt. #2a scores higher than Alts. #3 and #4a. Because Alt. #4b is not expected to require any mass excavation, handling, and transportation of CCR, Alt. #4b scores the highest. Conversely, Alt. #2b scores the lowest because Alt. #2b would require excavating all of the CCR stored in the impoundment and transporting it to a landfill for disposal.

Based on the numerical groundwater flow and contaminant fate and transport model for the site, Alt. #2b would meet the GWPS for lithium the earliest. Alt. #2a the latest, and Alt. #4b in between Alts. #2a and #2b. Although the ex-situ treatment in Alts. #3 and #4a was not explicitly modeled, this active remedial measure would be expected to achieve the GWPS for lithium faster than the passive remedial measures under Alts. #2a and #4b. Because Alt. #2b would fully remove the source of lithium contamination from the site, Alt. #2b is still considered to be the potential remedy that would achieve full protection fastest and, therefore, scores the highest.

Because Alt. #2b is the only alternative where all CCR would be removed from the impoundment, Alt. #2b has the lowest potential for exposing human and environmental receptors to remaining wastes and, therefore, scores the highest. Alt. #4b would fully encapsulate the CCR in the impoundment (top, bottom, and sides) and, therefore, scores the second-highest. Finally, the partial containment measures and supplemental ex-situ treatment measures implemented under Alts. #3 and #4a are expected to have lower potentials for exposure than Alt. #2a, which is expected to be the minimum technology required to meet the CROs. Therefore, Alt. #2a scores the lowest.

Alt. #2b is the only alternative where neither engineering controls nor ICS would be required; therefore, Alt. #2b scores the highest. The remaining alternatives would utilize a final cover system that would need to be maintained throughout the impoundment's post-closure life. Because Alt. #4b would fully encapsulate the CCR in the impoundment (top, bottom, and sides), it scores lower than Alt. #2a. Finally, because Alts. #3 and #4a would include operating and maintaining vertical groundwater extraction wells in addition to maintaining a final cover system, these two alternatives score the lowest.

Because Alt. #2b is the only alternative where all CCR is removed from the impoundment, the potential need to replace this corrective measure is expected to be the lowest. Alt. #2a would not be expected to require full replacement but may need to be supplemented to meet the GWPS for lithium. Because Alt. #4b would fully encapsulate the CCR stored in the impoundment, the potential need for supplementing that remedy is expected to be less than the potential for supplementing Alt. #2a. Therefore, Alt. #4b scores higher than Alt. #2a. Finally, Alts. #3 and #4a have active remedial components that will need to be evaluated to ensure they are performing as designed and therefore may require modification or eventual full replacement.

Table E-1. Evaluation of Potential Groundwater Remedies for Reid/HMPL CCR Surface Impoundment

Descriptions of Corrective Measures Alternatives						
#2a	#2b	#3	#4a	#4b		
CIP with CCR Modified Closure Scenario 3), ICs, and Groundwater Monitoring						
CIP with CCR Modified Closure Scenario 1), ICs, and Groundwater Monitoring						
CIP with CCR Modified Closure Scenario 3), ICs, Hydraulic Containment, Ex-Situ Treatment, and Groundwater Monitoring						
CIP with ISS (Modified Closure Scenario 4), ICs, and Groundwater Monitoring						
Ranking Definitions						
5	Best relative to all other corrective measures alternatives passing threshold criteria.					
1	Worst relative to all other corrective measures alternatives passing threshold criteria.					
Evaluation Criteria						
40 CFR 257.97 Ref.	Criterion	#2a	#2b	#3	#4a	#4b
Balancing Criteria (Cont.)						
(c)(2)	The effectiveness of the remedy in controlling the source to reduce further releases.					
(c)(2)(i)	The extent to which containment practices will reduce further releases	1	5	2.5	2.5	4
(c)(2)(ii)	The extent to which treatment technologies may be used.	2	2	4.5	4.5	2
(c)(3)	The ease or difficulty of implementing a potential remedy(s).					
(c)(3)(i)	Degree of difficulty associated with constructing the technology.	4	5	3	2	1
(c)(3)(ii)	Expected operational reliability of the technologies.	1	5	2.5	2.5	4
(c)(3)(iii)	Need to coordinate with and obtain necessary approvals and permits from other agencies.	4	5	2	2	2
(c)(3)(iv)	Availability of necessary equipment and specialists.	4	5	3	2	1
(c)(3)(v)	Available capacity and location of needed treatment, storage, and disposal services.	4	1	2.5	2.5	5
(c)(4)	The degree to which community concerns are addressed by a potential remedy(s).	3	3	3	3	3
TOTALS:		40.5	57	41.5	39.5	51.5

Balancing Criteria Analysis (Cont.)						
Because Alt. #2b is the only alternative where all CCR would be removed from this impoundment, ALT #2b is expected to reduce the potential for further releases the most and, therefore, scores the highest. Conversely, because Alt. #2a is expected to be the minimum technology required to meet the CAO's, Alt. #2a scores the lowest. Meanwhile, Alt. #4b would fully encapsulate CCR in the impoundment (top, bottom, and sides), thereby reducing the potential for further releases more than the partial containment measures provided under Alts. #3 and #4a. However, the ex-situ treatment program under Alts. #3 and #4a would be an active remedial measure that would be expected to reduce the potential for further releases under Alts. #3 and #4a.						
Alts. #3 and #4a are the only alternatives wherein active remedial technologies (groundwater extraction and ex-situ treatment) would be utilized and are therefore scored the highest. Meanwhile, the other three alternatives, which would only feature passive remedial technologies, are scored equally.						
Alt. #2b is expected to be the easiest to construct because CCR removal could be accomplished with standard earthmoving equipment like excavators, scrapers, bulldozers, loaders, and/or dump trucks. The remaining alternatives would involve installing geosynthetic materials for the impoundment's final cover system and coordinating temporary stockpiles of CCR removed from deeper excavations in the impoundment. Alt. #3 is expected to be more difficult to implement than Alt. #2a because it would also require installing groundwater excavation wells, piping to an on-site stormwater pond, and an ex-situ treatment program. Alt. #4a would require these measures and a "tunnel" comprised of grout curtain walls. Finally, Alt. #4b is expected to be the hardest to install because it would involve installing a grout curtain wall around the entire impoundment and drilling multiple grout columns through the impoundment's base to implement the ISS component of the remedy.						
Because Alt. #2b is the only alternative where all CCR would be removed from the impoundment, ALT #2b is expected to be the most reliable and, therefore, scores the highest. Meanwhile, Alt. #4b is expected to be the second-most reliable because it would fully encapsulate the CCR stored in the impoundment (top, bottom, and sides). Although the final cover system installed under Alt. #2a would be constructed of materials with proven environmental performance records in the solid waste disposal industry, Alt. #2a is expected to be the minimum technology required to meet the CAO's and, therefore, scores the lowest. Meanwhile, the ex-situ treatment program that would be implemented under Alts. #3 and #4a would provide more reliability than Alt. #2a, but the active groundwater extraction wells inherently have more reliability concerns than the physical containment that would be constructed under Alt. #4b.						
All five potential corrective measures would require permits from KDWI. However, more coordination with the agency is expected to be required to receive approval for ex-situ treatment (Alts. #3 and #4a) and ISS (Alt. #4b) than CIP (Alt. #2a) and CCR (Alt. #2b). Because Alt. #2a would require constructing a final cover system that meets specific environmental performance standards, Alt. #2b is expected to require less coordination with KDWI than Alt. #2a.						
Only standard earthmoving equipment is expected to be needed to excavate Alt. #2b. Meanwhile, a contractor specializing and experienced in installing geosynthetic materials would be needed for the other four alternatives. Moreover, Alts. #3 and #4a would require well drilling to install the vertical groundwater extraction wells, and Alt. #4a would further require equipment to install the grout curtains for the "tunnel-and-gate" containment system. Finally, Alt. #4b would require a contractor specializing and experienced in ISS and special equipment that can verify full coverage of the impoundment area.						
Because Alt. #4b is not expected to require mass excavation and re-disposal of the impoundment's CCR, Alt. #4b has the least need for additional treatment, storage, and disposal services. Meanwhile, Alt. #2a would require some CCR to be transported to another disposal facility. Alts. #3 and #4a would require the same disposal services as Alt. #2a as well as ex-situ treatment services. Finally, Alt. #2b would require the most alternative disposal capacity and corresponding disposal services to facilitate complete removal of CCR from the impoundment.						
A public meeting was held on May 24, 2023 in Henderson, Kentucky, to discuss BREC's evaluation of the five corrective measures alternatives being considered for the Impoundment. No members of the public attended the meeting, and no comments were received. Given the absence of direct community feedback, all corrective measures alternatives were scored equally for this criterion.						

Acronyms and Abbreviations:

CIP = Closure In-Place
CCR = Closure by Removal
GWPS = Groundwater Protection Standards
ICs = Institutional Controls
ISS = In-Situ Stabilization
RCRA = Resource Conservation and Recovery Act

Balancing Criteria Analysis (Cont.)

Because Alt. #2b is the only alternative where all CCR would be removed from the impoundment, Alt. #2b is expected to reduce the potential for further releases the most and, therefore, scores the highest. Conversely, because Alt. #2a is expected to be the minimum technology required to meet the CROs, Alt. #2a scores the lowest. Meanwhile, Alt. #4b would fully encapsulate the CCR in the impoundment (top, bottom, and sides), thereby reducing the potential for further releases more than the partial containment measures provided under Alts. #3 and #4a. However, the ex-situ treatment program under Alts. #3 and #4a would be an active remedial measure that would be expected to reduce the potential for future releases more than under Alt. #2a.

Alts. #3 and #4a are the only two alternatives wherein active remedial technologies (groundwater extraction and ex-situ treatment) would be utilized and are therefore scored the highest. Meanwhile, the other three alternatives, which would only feature passive remedial technologies, are scored equally.

Alt. #2b is expected to be the easiest to construct because CCR removal could be accomplished with standard earthmoving equipment like excavators, scrapers, bulldozers, loaders, and/or dump trucks. The remaining alternatives would involve installing geosynthetic materials for the impoundment's final cover system and coordinating temporary stockpiles of CCR removed from deeper excavations in the impoundment. Alt. #3 is expected to be more difficult to implement than Alt. #2a because it would also require installing groundwater excavation wells, piping to an on-site stormwater pond, and an ex-situ treatment program. Alt. #4a would require these measures and a "tunnel" comprised of grout curtain walls. Finally, Alt. #4b is expected to be the hardest to install because it would involve installing a grout curtain wall around the entire impoundment and drilling multiple grout columns through the impoundment's base to implement the ISS component of the remedy.

Because Alt. #2b is the only alternative where all CCR would be removed from the impoundment, Alt. #2b is expected to be the most reliable and, therefore, scores the highest. Meanwhile, Alt. #4b is expected to be the second-most reliable because it would fully encapsulate the CCR stored in the impoundment (top, bottom, and sides). Although the final cover system installed under Alt. #2a would be constructed of materials with proven environmental performance records in the solid waste disposal industry, Alt. #2a is expected to be the minimum technology required to meet the CROs and, therefore, scores the lowest. Meanwhile, the ex-situ treatment program that would be implemented under Alts. #3 and #4a would provide more reliability than Alt. #2a, but the active groundwater extraction wells inherently have more reliability concerns than the physical containment that would be constructed under Alt. #4b.

All five potential corrective measures would require permits from KOWM. However, more coordination with the agency is expected to be required to receive approval for ex-situ treatment (Alts. #3 and #4a) and ISS (Alt. #4b) than CIP (Alt. #2a) and CCR (Alt. #2b). Because Alt. #2a would require constructing a final cover system that meets specific environmental performance standards, Alt. #2b is expected to require less coordination with KOWM than Alt. #2a.

Only standard earthmoving equipment is expected to be needed to execute Alt. #2b. Meanwhile, a contractor specializing and experienced in installing geosynthetic materials would be needed for the other four alternatives. Moreover, Alts. #3 and #4a would require well drillers to install the vertical groundwater extraction wells, and Alt. #4a would further require equipment to install the grout curtains for the "tunnel-and-gate" containment system. Finally, Alt. #4b would require a contractor specializing and experienced in ISS and special equipment that can verify full coverage of the impoundment area.

Because #4b is not expected to require mass excavation and re-deposit of the impoundment's CCR, Alt. #4b has the least need for additional treatment, storage, and disposal services. Meanwhile, Alt. #2a would require some CCR to be transported to another disposal facility. Alts. #3 and #4a would require the same disposal services as Alt. #2a as well as ex-situ treatment services. Finally, Alt. #2b would require the most alternative disposal capacity and corresponding disposal services to facilitate complete removal of CCR from the impoundment.

A public meeting was held on May 24, 2023 in Henderson, Kentucky, to discuss BRECs' evaluation of the five corrective measures alternatives being considered for the impoundment. No members of the public attended the meeting, and no comments were received. Given the absence of direct community feedback, all corrective measures alternatives were scored equally for this criterion.



Final Groundwater and Non-Groundwater Corrective Action Remedy Selection Report

Green Landfill
Sebree Station
Webster County, Kentucky

Prepared for:



Big Rivers Electric Corporation
Sebree Generating Station
9000 Highway 2096
Robards, KY 42452

Prepared by:

AECOM Technical Services
525 Vine Street, Suite 1800
Cincinnati, Ohio 45202

AECOM PN 60626688

November 18, 2020

Certification Statement 40 CFR § 257.97(a) – Selection of a Remedy for the Corrective Action Program for Green Station CCR Landfill

Big Rivers Electric Corporation Sebree Generating Station, Green CCR Landfill

AECOM ("Consultant") has been retained by Big Rivers Electric Corporation to certify whether the selected groundwater remedy presented herein for the Green Station coal combustion residuals (CCR) landfill meets the requirements of Chapter 40 of the Code of Federal Regulations (CFR) §257.97.

LIMITATIONS

The signature of Consultant's authorized representative on this document represents that to the best of Consultant's knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant's experience, qualifications, and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

CERTIFICATION

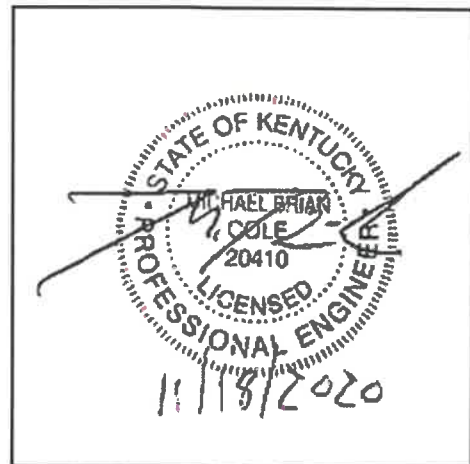
I, Brian Cole, being a Registered Professional Engineer in the State of Kentucky, certify to the best of my knowledge, information, and belief, that the remedy selected by Big Rivers Electric Corporation for the Green Station CCR Landfill meets the requirements of 40 CFR § 257.97, and that this certification is true and correct and has been prepared in accordance with generally accepted good engineering practices.

M. Brian Cole

Printed Name

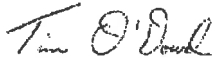
11/18/2020

Date



Quality information

Prepared by



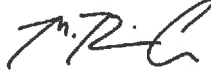
Timothy P. O'Dowd, PG
Project Manager

Checked by



Doug Gray, CGWP
Principal Project Manager

Verified by



M. Brian Cole, PE
Senior Civil Engineer

Approved by



Dennis P. Connair, PG
Principal Geologist

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1. Introduction

In accordance with provisions of the United States Environmental Protection Agency's (USEPA) coal combustion residual (CCR) rule, Title 40 of the Code of Federal Regulations (CFR) Part 257.97, Big Rivers Electric Corporation (BREC) is required to select a remedy to address groundwater impacts identified at the Green Station CCR Landfill (the Unit) at the Sebree Generating Station located in Webster County, Robards, Kentucky (**Figure 1**). Previous monitoring results indicate the presence of lithium at a Statistically Significant Level (SSL) above the Ground Water Protection Standard (GWPS) in four monitoring wells (MW-3A, MW-4, MW-5, and MW-6) at the Unit. In June 2019, BREC performed an Assessment of Corrective Measures (ACM) for the Unit to identify remedial alternatives to address groundwater impacts. A public meeting was held on July 16, 2020 in Henderson, Kentucky to discuss the results of the ACM. No public input was received at this meeting. Additional technical assessment has been utilized by BREC to select the final remedy for the Unit in accordance with 40 CFR Part 257.97, which is presented in this report.

On December 16, 2019, an Agreed Order was filed with the Kentucky Office of Administrative Hearings between BREC and the Commonwealth of Kentucky, Energy and Environment Cabinet, Division of Waste Management (KDWM) to address Notices of Violation (NOVs) received in regard to unpermitted discharges and seepage emanating from the Unit (see Section 1.2). Within the AGREED ORDER are requirements for remedy selection reporting, including a timeline for review by the KDWM. These requirements are discussed in Paragraphs 18 and 23 of the Agreed Order and listed in Exhibit 4 to the Agreed Order. This report has been prepared to address these requirements in the Agreed Order and Exhibit 4 to the Agreed Order, in addition to the Federal CCR Rule requirements.

In parallel with addressing groundwater impacts, BREC performed an ACM for non-groundwater release surface seeps at the Unit in June 2019. In September and October 2019, BREC initiated interim corrective measures (ICMs) to address non-groundwater releases at the Unit. The ICMs are currently being evaluated through performance monitoring and are expected to benefit corrective action as a whole for the Unit. As a result, no separate remedy selection report is currently being developed for non-groundwater releases. BREC intends for this report to address the remedy selection requirements for both groundwater and non-groundwater impacts under 40 CFR Part 257.

1.1 Regulatory Background

Kentucky Revised Statute (KRS) Chapter 224.50-760 governs the disposal of special waste, including utility wastes. The Commonwealth of Kentucky, Energy and Environment Cabinet (The Cabinet) promulgated regulations under Title 401 of the Kentucky Administrative Regulations (KAR) Chapters 45 and 46 to regulate the disposal of special wastes. The Unit is a Kentucky permitted landfill (Permit No. SW11700007) subject to permitting requirements for special wastes established under 401 KAR Chapter 45.

In 2015 the USEPA promulgated 40 CFR Parts 257.50 through 257.107 which established national standards to govern the location, design, construction, and operation of landfills and surface impoundments utilized to manage CCR. In 2017, the Cabinet promulgated 401 KAR 46:110 which incorporates the federal CCR standards by reference into Kentucky regulations. As noted in the Agreed Order, the Unit is an existing CCR landfill under the Federal CCR rule and therefore subject to the operating criteria and corrective action standards of 401 KAR 46:110.

Corrective actions at the Unit are being performed to address both the federal requirements in 40 CFR Part 257 and state requirements in 401 KAR Chapter 46 as described below.

1.1.1 Federal CCR Background

In response to SSL exceedances in groundwater at the Unit, BREC evaluated the nature and extent of groundwater impacts as required by Title 40 CFR Part 257.95(g) for characterization monitoring.

Following characterization monitoring, BREC performed an ACM, to identify potential corrective measures to address lithium impacts in groundwater pursuant to Title 40 CFR Part 257.96. A notice of ACM initiation dated January 14, 2019 was posted to BREC's publicly-accessible CCR reporting website. A report summarizing the results of the groundwater ACM (AECOM, June 2019) was posted to BREC's publicly-accessible CCR reporting website on June 14, 2019.

On March 15, 2018, the USEPA proposed a modification to the federal CCR regulations to address four provisions within 40 CFR Section 257 that were remanded back to the USEPA on June 14, 2016 by the United States Court of Appeals for the District of Columbia Circuit. The proposed modifications to 40 CFR 257 (also known as the Remand Rule) also included provisions for owners and operators of CCR units in states that have approved CCR permit programs. Title 40 CFR Part 257.99 established procedures for owners and operators of CCR units to perform corrective action for eligible non-groundwater releases at a CCR unit. In alignment with corrective actions being performed to address the NOV's received from the KDWM for unpermitted discharges and seepage emanating from the Unit, BREC performed an ACM for non-groundwater releases in addition to the ACM for groundwater impacts. A report summarizing the results of the groundwater ACM (AECOM, June 2019) was posted to BREC's publicly-accessible CCR reporting website on June 28, 2019. In 2019, pursuant to 40 CFR Parts 257.90(d) and 257.84(b)(5), BREC initiated design of ICMs (i.e., containment systems) intended to reduce and prevent non-groundwater releases from reaching the Green River. In September and October 2019, BREC initiated construction of ICMs to address non-groundwater releases at the Unit (which are referred to herein as river seeps), including:

- Construction of a collection trench along the east side of the Green Landfill (referred to as the Deep Seep Collection Trench) to address seeps adjacent to the Green River; and
- Construction of a series of collection trenches along the north side of the Green Landfill (referred to as the Northwest Seep Collection Trench) to address seeps near the northwest corner of the landfill discharging toward an east-flowing unnamed tributary to the Green River.

Construction of the ICMs was functionally completed in January 2020, within the 180 day required timeframe required under proposed 40 CFR Part 257.99, although piping, pumping, and control system installation, and installation of supplemental collector systems were not completed until later in 2020. The ICMs completed to address non-groundwater releases under 40 CFR Part 257 and the Agreed Order are expected to benefit groundwater corrective action and are discussed collectively within this report (see Section 2.4).

Title 40 CFR Section 257.97(a) requires that progress reports be prepared on a semi-annual basis describing progress made in selecting and designing a remedy. The first Remedy Selection Progress Report was finalized on December 9, 2019 and posted to BREC's publicly-accessible CCR reporting website on December 12, 2019.

BREC held a public meeting on July 16, 2020 in Henderson, Kentucky to discuss the results of the Groundwater ACM in accordance with 40 CFR Part 257.96(e). No public input influencing the remedy for the Unit was received during the meeting. BREC has selected the remedy for groundwater and non-groundwater impacts at the Unit in accordance with 40 CFR Part 257.97 as detailed within this report.

1.1.2 Kentucky Division of Waste Management Background

On December 6, 2019, BREC signed Agreed Order #18-3-0138 with the KDWM to address NOV's received regarding unpermitted discharges and seepage emanating from the Unit. The Agreed Order was filed on December 16, 2019. Under the Agreed Order the following actions were required:

- Development of Standard Operating Procedures (SOPs) to characterize and mitigate leachate and seep releases to the surface (Exhibit 1);
- Development of construction and post-construction plans for implementing the Northwestern Seep Collection Trench Remedy (Exhibit 2);

- Development of construction and post-construction plans for implementing the Eastern "Deep Seep" Collection Trench Remedy (Exhibit 3); and
- Establishment of the process to complete the evaluation of groundwater corrective action remedies at the Unit pursuant to 401 KAR 46:110 (Exhibit 4).

Within Exhibit 4 of the Agreed Order, the following milestones for groundwater corrective action were identified:

- 1) Within 180 days of the entry of the Agreed Order, BREC shall conduct a public meeting as required by 40 CFR 257.96(e) and 401 KAR 46:110.
- 2) Within 90 days of the public meeting, BREC shall submit a draft groundwater remedy selection report for submittal to KDWM for a 30-day review and comment period.
- 3) As soon as possible, following receipt of KDWM comments on the draft groundwater remedy selection report, select the final groundwater corrective action remedy.
- 4) Posting of the Final *Groundwater and Non-Groundwater Corrective Action Remedy Selection Report* to BREC's CCR Rule compliance website in accordance with 40 CFR 257.97 and 257.107 (no timeline specified).

Although the milestone schedule has been adjusted due to the COVID-19 pandemic, which prevented BREC from holding the public meeting at an earlier date, BREC has moved forward with the activities required in the Agreed Order as documented in this report. A revised schedule for corrective action implementation is discussed in Section 5.0.

2. Site Background

2.1 Site Description

BREC owns and operates Sebree Station, which is a coal-fired power generating facility located on the Green River northeast of Sebree, Kentucky. Sebree Station is composed of Green Station and Reid/Henderson Municipal Power & Light (HMP&L) Station. The Sebree Station is bounded by Interstate-69 to the west and the Green River to the east (see **Figure 1**). Reid Unit 1 (65 Megawatts [MW]) began commercial operation in 1966 and is scheduled to be retired in 2020 pending regulatory approval from the Kentucky Public Service Commission and Rural Utilities Service. The Reid Combustion Turbine (65 MW) was commercialized in 1976. HMP&L Station 2, Units 1 (167 MW) and 2 (168 MW) began commercial operation in 1973 and 1974 respectively. Both HMP&L units were retired as of February 1, 2019. Green Station Units 1 (250 MW) and 2 (242 MW) began commercial operation in 1979 and 1981, respectively.

The location of the Green Landfill is illustrated on **Figure 1**. The Green Landfill is located directly south of Sebree Station, situated south of the Green Station CCR Surface Impoundment. The Green Landfill is a Kentucky permitted landfill (Permit No. SW11700007) that receives special wastes generated by burning coal (CCRs) from Green and Reid/HMP&L Stations. The landfill began receiving CCR wastes in 1980. The current Green Landfill footprint is approximately 170 acres.

As stated in the published CCR monitoring well network certification, available on the BREC website (<http://www.bigrivers.com/>), the original ground surface within the landfill footprint was irregular and the dominant features were small stream valleys draining towards the Green River, which is located just east of the landfill; and towards Groves Creek, which is located just south of the landfill. There was also historic oil and gas production at and in the immediate vicinity of the Green Landfill. A review of the records from the Kentucky Geological Survey (KGS) showed that at or immediately adjacent to the Site, there were a number of dry exploratory oil/gas exploration holes, oil production wells, one gas production well, and one secondary recovery injection well. There were also former brine ponds at the Site. Most of these wells were abandoned in accordance with applicable regulations by BREC in 1997 and 1998. The last existing oil well was decommissioned in 2019.

2.2 Groundwater Investigation Summary

Monitoring wells were installed at the Unit beginning in November 1996 prior to the implementation of the CCR Rule. However, the existing wells meet the requirements of Title 40 CFR Section 257.90 of the CCR Rule for installation of a groundwater monitoring system. These regulations require that monitoring wells adequately represent the quality of background groundwater and groundwater representing the downgradient waste boundary. The existing wells are located along the perimeter of the landfill footprint. One upgradient monitoring well (MW-1) and five downgradient monitoring wells (MW-2, MW-3A, MW-4, MW-5 and MW-6) were installed at the Unit to determine the general direction of groundwater movement and to monitor groundwater impacts. One additional characterization monitoring well (MW-104) was installed downgradient of the Unit in 2018. All monitoring wells were installed in the uppermost saturated portion of the sandstone bedrock aquifer. A map illustrating the location of all program monitoring wells is presented as **Figure 2**.

Nine rounds of Baseline groundwater sampling for Appendix III constituents were conducted between March 2016 and October 2017. Statistical evaluation for Detection monitoring indicated that statistically significant increases (SSIs) over background had occurred, and therefore, Assessment monitoring was triggered. Detection monitoring activities and data are presented in the annual reports that have been prepared to date, (AECOM 2018, 2019, and 2020).

As part of Assessment monitoring, upgradient and downgradient wells for the Unit were sampled for Appendix IV constituents in June, July, and September 2018. GWPSs were established for the Appendix IV constituents occurring at SSIs (lithium only), and statistical evaluation of the lithium concentrations indicated exceedances of GWPSs at SSLs, as detailed in **Table 1** below.

Table 1. Green Landfill Constituents of Concern

Monitoring Well (Date)	Parameter
	Lithium GWPS 0.04 (mg/L)
MW-3A (Jun 2018)	0.699
MW-3A (Jul 2018)	0.790
MW-3A (Sep 2018)	0.766
MW-4 (Jun 2018)	1.81
MW-4 (Jul 2018)	1.91
MW-4 (Sep 2018)	1.81
MW-5 (Jun 2018)	0.459
MW-5 (Jul 2018)	0.481
MW-5 (Sep 2018)	0.425
MW-6 (Jun 2018)	0.0650
MW-6 (Jul 2018)	0.0590
MW-6 (Sep 2018)	0.0558

GWPSs are the greater of the site-specific background concentrations, the USEPA primary drinking water standard maximum contaminant limits (MCL), or GWPS provided in 40 CFR 257.95(3)(h)(2)

An additional characterization well, MW-104, was subsequently installed to estimate the downgradient extent of impacted groundwater. Sample collection from MW-104 for Appendix III and IV parameters took place in March and April 2019. The analytical results for lithium were below the GWPS. The additional characterization data are summarized in **Table 2** below.

Table 2. Green Landfill -2019 Characterization Sample Results

Monitoring Well (Date)	Parameter
	Lithium GWPS 0.04 ^a (mg/L)
MW-104 (March 2019)	0.0281
MW-104 (April 2019)	0.0288

^a The Upper Prediction Limit for lithium was calculated as 0.008 mg/L.

The results from both characterization sampling events helped to confirm the downgradient (southwestern) extent of constituent of concern (COC) impacts above GWPS at the Unit.

Semi-annual Assessment monitoring continued at the Unit in 2019 and 2020 in accordance with 40 CFR 257.95.

2.3 Conceptual Site Model

Development and refinement of a Conceptual Site Model (CSM) is necessary to support remedy selection for the Unit. A CSM is based on a set of working hypotheses regarding how contaminants of concern (COCs) entered the environment at a site, how they were and continue to be transported to various media, what the potential routes of exposure are, and who may be exposed, including both human and ecological receptors. As such, the CSM is a “living” model. As new data become available or site conditions change, a CSM should be evaluated and updated as necessary.

The CSM for the Unit was first provided in the June 2019 ACM for the Unit (AECOM 2019). The CSM presents the physical setting of the Unit (adjacent to the Green River), the unconsolidated and bedrock geologic strata underlying the Unit, the occurrence and movement of groundwater, the distribution of COCs in groundwater, and the potential receptors (or lack thereof) for impacted groundwater. These elements are described in detail below and have been updated with new information for this report as appropriate.

2.3.1 Physical Setting

The Unit is located within the Interior Low Plateaus physiographic province. The province is part of the Interior Plains division of the United States. Characteristic features of the province include unglaciated rolling limestone plains with alluvial valleys and entrenched rivers and streams. Several large rivers are in the region, including the Green, Ohio, Kentucky, Tennessee, and the Cumberland Rivers. The geology underlying the Unit consists of unconsolidated materials, including loess and alluvial deposits, underlain by Upper to Middle Pennsylvanian-age clastic and carbonate bedrock consisting primarily of sandstone and shale. The unconsolidated materials also include fill, silty and clayey residuum, and minor amounts of sandy, clayey channel fill alluvium.

The Unit is located on an upland adjacent to the west bank of the Green River at an elevation of approximately 436 feet, above mean sea level [ft., amsl] (at the north end of the landfill) and 397 ft., amsl (at the south end of the landfill), with a maximum elevation of 608 ft., amsl at the landfill crest. Precipitation falling within the Green Landfill is directed to ponds on the north and south sides of the Unit and then to the river under Kentucky Pollution Discharge and Elimination System (KPDES) permit No. KY0001929. Underlying preconstruction soils consisted of Loring-Grenada, Loring-Zanesville-Wellston (Henderson County) and Loring-Wellston-Zanesville (Webster County) soil associations which are generally characterized as well drained to moderately well drained soils on nearly level to sloping uplands (Associated Engineers 2016, Hydrologic and Hydraulic Capacity Assessment and Initial Inflow Design Flood Control System Plan).

2.3.2 Geology

The Unit lies in the Western Kentucky Coalfields section, characterized by rolling uplands underlain by coal-bearing bedrock of the Pennsylvanian Period. Near the Unit, maximum topographic relief is on the order of 80 feet. The geologic quadrangle (Geologic map of the Robards quadrangle, Henderson and Webster Counties, Kentucky, 1973) for the area published by the Kentucky Geologic Survey (KGS) shows the surficial material in portions of the western half of the Unit to be unconsolidated loess representing the Pleistocene geologic epoch. The loess consists of sandy and clayey silt. Underlying the loess deposits and exposed at the surface on the eastern half of the Unit are broadly distributed Pleistocene and Holocene alluvium deposits consisting of intermixed and interlensing clay, silt, sand, and gravel. In close proximity to the Unit, the alluvium is generally a low permeability unit that forms terraces along the Green River at elevations of roughly 380 and 395 ft., amsl. The unconsolidated surficial materials range from approximately 10 feet (MW-5) to 52 feet (MW-104) in thickness surrounding the Unit. **Figure 3** provides an excerpt from the geologic quadrangle for the immediate area surrounding the Unit.

The unconsolidated materials are underlain by bedrock of the Upper Pennsylvanian Shelburn Formation [formerly identified as the Lisman Formation (Fairer, 1973)] and the Middle Pennsylvanian Carbondale Formation. At the base of the Shelburn Formation is the Providence Limestone Member, consisting of two distinct limestone beds separated by a sandy shale. The member is exposed in a streambed near the northwest corner of the Unit but is absent beneath much of the Unit footprint due to erosional channeling.

The underlying Carbondale Formation consists of cyclic sequences of sandstones, shales, siltstones and coals. The Carbondale sediments were deposited in a fluvial-deltaic system. As a result of this depositional environment, the lithologic units of the Carbondale tend to be lenticular bodies rather than continuous sheet-like strata. Gradational and abrupt horizontal changes in lithology are often encountered.

Cross-sections have been developed to support the CSM and are presented as **Figures 4, 5, 6 and 7**. Cross-section locations are shown on **Figure 2**. These sections illustrate the sequence of geologic materials present under the Unit as interpreted using the currently available data.

2.3.3 Groundwater Hydrogeology

For purposes of compliance with the CCR Rule groundwater monitoring requirements, the interbedded sandstone and shale of the Carbondale Formation is considered the uppermost aquifer underlying the Unit. The uppermost aquifer is hydraulically confined and first encountered at an elevation of approximately 401 ft., amsl at the northwest end of the landfill, and 367 ft., amsl at the southeast end of the landfill (AECOM, 2019).

Groundwater elevation data collected in April 2020 are summarized on **Table 3** below. These data were utilized to construct a piezometric surface map illustrating groundwater flow conditions for the uppermost aquifer (see **Figure 8**). Overall groundwater flow beneath the footprint of the Unit is to the east towards the Green River and south-southeast towards Groves Creek.

Table 3. Green Landfill -April 2020 Groundwater Elevation Data

Monitoring Well	Top of Casing Elevation (ft) ¹	Depth to Groundwater (ft)	Groundwater Elevation (ft, amsl)
MW-1	423.23	19.52	403.71
MW-2	392.37	16.24	376.13
MW-3A	386.48	12.08	374.40
MW-4	391.33	17.90	373.43
MW-5	390.18	17.62	372.56
MW-6	388.17	15.62	372.55
MW-12 ²	395.54	22.15	373.39

1 Reference elevation of monitoring wells surveyed by Fuller, Mossbarger, Scott and May, Civil Engineers, Inc., Lexington, Kentucky, December 1996, December 1999. Survey coordinates were based on the Kentucky State Plane, Kentucky Southern Zone, NAD27 datum.

2. MW-12 is utilized for collection of piezometric data only and is not part of the CCR monitoring well network for the Green Landfill.

Slug tests were performed on April 25, 2019 at monitoring wells MW-3A, MW-4, MW-6, and MW-104 to assess the hydraulic characteristics of the uppermost aquifer. The estimated hydraulic conductivity of the monitoring wells tested ranged from 2×10^{-5} to 3×10^{-3} centimeters per second (cm/sec).

Although previous site-specific investigations have noted the presence of perched zones of saturation in the overlying unconsolidated materials, these discontinuous zones do not qualify as an uppermost aquifer under the CCR Rule because they do not produce usable quantities of groundwater (40CFR Part 257.53).

2.3.4 Non-Groundwater Hydrogeology

Two types of non-groundwater releases have been identified through inspection and investigation of the Unit: river seeps and perimeter seeps. The river seeps are those found along the Green River and its tributary streams. River seeps have been observed on the bank of the river/tributary and on the slope between the river/tributary and the landfill perimeter road. The river seeps on the northwest side of the

landfill drain to a KPDES permitted outfall, whereas the river seeps on the Green River side do not. Perimeter seeps are more surficial in nature and have been observed in various surface ditches located around the perimeter of the Green Landfill, all of which drain to sedimentation basins that discharge to a KPDES permitted outfall.

2.3.4.1 River Seeps

An investigation of the seeps along the Green River was conducted in July 2018 and was reported in a Technical Memorandum from AECOM to BREC dated September 6, 2018. The results of laboratory analysis of seep samples collected during this investigation are summarized in **Appendix A**. During this investigation, the banks of the Green River were surveyed by boat for evidence of seepage. The survey was conducted when the river stage had retreated to a low pool after a prolonged elevated stage so that the maximum number of seeps might be surveyed, and seepage rates might be high enough to allow sampling. Samples of seeps having visible flow were collected and tested for CCR indicator parameters (40 CFR Part 257 Appendix III), CCR constituents of concern (40 CFR Part 257 Appendix IV), and general chemistry parameters. The data from these analyses were used to evaluate whether individual seeps were likely associated with the Landfill.

Riverbank seeps were identified at sixteen discrete locations in the vicinity of Sebree Station. Seeps were recorded at locations on both the east and west banks of the river over two miles upstream of the landfill footprint and over 1.5 miles downstream of the landfill footprint. Some seeps appeared to potentially be associated with a surface water drainage feature, such as RS-11 where there appears to be a beaver pond beyond the riverbank, but most emanated from otherwise nondescript sections of riverbank. Some of the seeps resulted in a green discoloration of the riverbank, but most had orange staining.

Of the seven seeps tested, only three, RS-05, RS-07, and RS-08 as illustrated on Figure 1 in **Appendix A**, were found to have similar chemistry to leachate generated by the Green Landfill. These seeps did not differ greatly from the majority of the other riverbank seeps in that they were broadly seeping from the bank sediments and had a general orange discoloration, except that RS-07 had a some relatively discrete seepage points emanating from a few feet higher on the bank and RS-08 appeared to be emanating from on top of bedrock outcropping on the river bank. Seeps RS-05 and RS-07 are located near the center of the Landfill between monitoring wells MW-2 and MW-3A. This is the same area in which seeps have been observed higher on the slope between the river and the perimeter road, suggesting that they have a similar origin. Seep RS-08 is located adjacent to the South Sediment Basin and appears to be tied to that surface water feature. The approximate vertical position of the river seep locations relative to the Green Landfill are shown on **Figure 4**. It should be noted that the seep designated RS-06, located between RS-05 and RS-07, is likely to be of similar character and origin but was not generating enough flow to be sampled at the time of the survey.

The analytical results from the July 2018 river seep samples were compared to Kentucky Water Quality criteria for warm water aquatic habitat identified in 401 KAR 10:031 Section 6. Where there are no Kentucky Water Quality criteria for a specific constituent, the USEPA Region 4 surface water screening values were utilized for comparison. It should be noted that the Region 4 screening values are not compliance criteria, but rather values used to determine whether further evaluation is warranted. Samples from RS-05, -07 and -08 were found to exceed the 600 milligrams per liter (mg/L) limit for chloride. RS-05 also exceeded the current criteria for cadmium (0.00029 mg/L) and lead (0.0036 mg/L), but Kentucky has introduced a new cadmium criterion that may bring RS-05 back into compliance. Follow-up sampling conducted in December 2018 by the Kentucky Division of Water (KDoW) and BREC confirmed the exceedance of the chloride criteria. Accordingly, this parameter (chloride) is regarded as the primary COC for non-groundwater releases at the Unit requiring corrective action. Addressing the river seeps was included as a stipulation in the Agreed Order signed between BREC and the KDWM.

The analytical results for the river seep samples are summarized in **Appendix A**. Presented in parallel with the river seep results are deep in-stream river samples that were collected immediately adjacent to the river seeps to characterize the river water quality that is most likely to be impacted by seepage. The

deep samples were collected within 1 foot of the riverbed within 3 to 5 feet of the water line. None of the river sample results exceed the water quality or screening criteria suggesting that the identified river seeps are not impacting the Green River.

Additional data regarding the river seeps is provided in the *Assessment of Corrective Measures Non-Groundwater Release Under the CCR Rule, Green Station CCR Landfill* (AECOM June 28, 2019).

In April 2019, inspection of the Landfill site by the KDWM and KDoW identified an area of seepage outside the perimeter road on the northwest side of the Landfill (see **Figure 2**). This seepage (herein identified as the NW Seep) is adjacent to a tributary ditch that flows eastward to an unnamed outfall which has a KPDES discharge permit. The outfall was sampled by KDoW and BREC on April 2, 2019. A sample from this seep area (identified as sample 023) was collected by BREC personnel on April 11, 2019. The results indicated that the seep sample exceeded Kentucky Warm Water Aquatic Habitat criteria for Chronic Exposure for chloride and cadmium. As a result, this area was identified for corrective action. Addressing this seep area was included as a stipulation in the Agreed Order signed between BREC and the KDWM.



Photo 1: Bedrock outcrop located west of the NW Seep as observed on April 2, 2019.

The NW Seep appears to emanate from a horizon in or above a natural limestone ledge adjacent to the ditch. This conclusion is based on the observation of natural springs of groundwater upstream from the seep that clearly flows from fractures in the ledge. A series of three soil borings drilled between the landfill and the NW Seep area in May 2019 further suggest the seepage is controlled by this feature. **Figure 7** provides a cross-section illustrating the sequence of geologic materials present within the NW seep area as interpreted using the currently available data.

2.3.4.2 Perimeter Seeps

During the July 2018 investigation of Green River seeps, the area inside the Landfill perimeter road was also inspected for seeps. Four areas of perimeter seepage were identified (see **Figure 2**): along the west side of the landfill (LS-01), the southwest corner (LS-04), the south end adjacent to the South Sediment Basin (LS03), and the east side north of MW-2 vicinity (LS02). LS-01, LS-02 LS-03, and LS-04 are directed to the South Sediment Basin, which is pumped to the Northeast Sediment Basin and then further to the Green surface impoundment and eventually discharged to the Green River under KPDES permitted outfall #001.

Samples of a select set of these perimeter seeps were collected in July 2018 and tested for the Appendix III, Appendix IV, and general chemistry parameters. As previously noted, these seeps do not directly discharge to surface waters, but they may have the potential to influence groundwater and other non-groundwater releases. As such, they will be addressed by future corrective action to manage those potentials (see Section 4).

Additional data regarding the perimeter seeps is provided in the *Assessment of Corrective Measures Non-Groundwater Release Under the CCR Rule, Green Station CCR Landfill* (AECOM June 28, 2019).

2.3.5 Constituents of Concern

Groundwater analytical data obtained from groundwater sampling events performed at the Unit through 2019 are summarized in **Appendix B**. A summary of the statistical evaluation conducted on the Appendix III and Assessment Appendix IV parameters for the Green Landfill is provided in **Appendix C**. Combined, these data indicate that the only COC detected at SSLs above its GWPS in groundwater at the Unit is lithium. Lithium has been detected at SSLs in the wells MW-4, MW-5, and MW-6 surrounding the South Sediment Basin and in MW-3A located north (downstream on the Green River) of MW-4.

Chloride is regarded as the primary COC for non-groundwater releases at the Unit requiring corrective action. Although there have been Appendix IV (Part 257) constituents detected in the surface seeps identified within the perimeter footprint of the landfill, these seeps are contained within a KPDES permitted discharge area that are monitored routinely to ensure compliance with applicable surface water quality standards.

2.3.6 Impacted Media

Both groundwater and surface water have been identified as impacted media of concern requiring corrective measures at the Unit.

2.3.7 Distribution of COCs

Groundwater sampling was performed at the Unit most recently in April 2020. Laboratory analytical data from the April 2020 sampling event is provided in **Appendix D**. The additional lithium data collected during this event are summarized below in **Table 4**.

Table 4. Green Landfill - April 2020 Lithium Analytical Results

Monitoring Well (Date)	Parameter
	Lithium GWPS 0.04 (mg/L)
MW-1	0.03
MW-2	0.007
MW-3A	0.68
MW-4	0.82
MW-5	0.38
MW-6	0.05

Figure 9 illustrates the distribution of COCs and other groundwater quality constituents in groundwater at the Unit. This distribution of COCs in groundwater suggests that impacts to groundwater likely originate from two primary source area. Impacts observed at MW-4, MW-5 and MW-6 likely originated as infiltration from the South Sediment Basin where storm water and landfill seepage accumulate on the south side of the landfill before being pumped to the Green Surface Impoundment. Data from characterization well MW-104 indicate that MW-3A may be effectively separated from the South Sediment Basin by a buried valley in the bedrock aquifer where groundwater does not appear to be impacted. This suggests that the impact observed at MW-3A may have instead originated from a different source, potentially from localized landfill seepage, which is now captured by the Deep Seep Collection Trench (see Section 2.4). It is possible that the MW-3A impact originates from the western end of the South Sediment Basin, but there is currently no feasible means of directly tracing that potential under the footprint of the landfill. It is, however, possible to evaluate this potential by monitoring MW-3A over time after the South Sediment Basin is rehabilitated as is currently planned (see Section 4). Ongoing monitoring of MW-3A also has the potential to demonstrate whether the landfill seepage intercepted by the Deep Seep Collection Trench is the source of impact.

2.3.8 Potential Receptors/Exposure Pathways

Contact with water (e.g., shallow groundwater or surface water) impacted by COCs at levels above GWPS or Water Quality Criteria is regarded as the potential pathway for exposure of potential receptors. Based on data published by KGS, there are no known groundwater wells used for drinking water within a 1-mile radius of the Unit, thus limiting the potential receptors to the surface water, i.e., the Green River and its tributary, Groves Creek. The potential pathways to these receptors include seepage of water from the Unit through manmade and natural hydraulic conduits.

Other potential exposure pathways (e.g., soil or vapor) are not considered a risk as the CCR material is isolated in the Unit. This isolation prevents direct access by individuals that might result in direct contact or ingestion. In addition, the inherent non-volatile nature of the Unit-specific COCs eliminates the potential for a complete vapor pathway (i.e., vapor intrusion to indoor air).

2.4 Interim Corrective Measures

In September and October 2019, BREC initiated design and construction of two containment systems intended as an interim corrective measure to reduce and prevent non-groundwater releases at the Unit from reaching the Green River. The containment systems are identified as the Deep Seep Collection Trench (also known as the Eastern Collection Trench) and the Northwest Seep Collection Trench.

No formal interim corrective measures have been performed at the Green Landfill to address groundwater impacts. However, the interim corrective measures for known non-groundwater releases completed at the Unit are expected to benefit corrective action for groundwater impacts. The compatibility of those corrective measures with potential groundwater remedies is currently being evaluated as part of the Unit's assessment monitoring and will continued to be evaluated in the future as part of systematic performance reviews (see Section 5.2).

2.4.1 Deep Seep Collection Trench

BREC began construction of the Deep Seep Collection Trench on October 7, 2019. The installation of four partially overlapping trenches and corresponding individual sumps was completed on November 11, 2019. This completion allowed removal of collected seepage using temporary pumping and piping until the permanent system components were completed.

The Deep Seep Collection Trench is located on the eastern side of the landfill, adjacent to the Green River. This collection system consists of 1,065 lineal feet of perforated (HDPE) pipe and four (4) stainless steel sumps. The HDPE perforated pipe is surrounded by a washed river gravel, with profiles set at a 0.5% slope toward the associated pumping (sump) station. Each section of HDPE pipe overlaps at the sump interconnection to prevent seepage bypass and to ensure all deep seeps are properly captured. Each sump was set at an elevation of 352 ft., amsl. The approximate vertical position of the



Photo 2: Installation of the Deep Seep Collection Trench in October 2019.

Deep Seep Collection Trench relative to the Green Landfill is shown on **Figure 4**. The location of the trench in plan view is provided on **Figure 10**.

The electrical and mechanical portion of the project that allows the system to become fully automated was finalized on May 29, 2020.

2.4.2 Northwest Seep Collection Trench

BREC began construction of the Northwest Seep Collection Trench on September 3, 2019. The construction of the collection trench was completed on January 22, 2020. The system is located in the northwest corner of the landfill and consists of 357 lineal feet of HDPE perforated pipe within the primary collection trench installed at an elevation of 391.4 ft, amsl. The HDPE perforated pipe is surrounded by a washed river gravel, with profiles set at a 0.5% slope toward the associated pumping (sump) station. Since the installation of the primary trench, BREC has installed two relay stations to ensure all possible seeps are captured and pumped to a permitted KPDES outfall. The Northwest Seep Collection Trench is configured to pump the incoming flow to a target manhole, which is located on the northeast corner of the landfill. The target manhole subsequently discharges to KPDES permitted outfall #009. The approximate vertical position of the Northwest Seep Collection Trench relative to the Green Landfill is shown on **Figure 7**. The location of the trench in plan view is provided on **Figure 10**.



Photo 3: Installation of the Northwest Seep Collection Trench in September 2019.

2.5 Assessment of Corrective Measures Summary

2.5.1 Assessment of Corrective Measures for Groundwater Impacts

In June 2019, BREC performed an ACM for the Unit to identify remedial alternatives to address groundwater impacts. Title 40 CFR Section 257.96(c) requires that the ACM include an analysis of the effectiveness of potential corrective measures in meeting the objectives for remedies identified under Section 257.97(b), by addressing at least the following:

- 1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- 2) The time required to begin and complete the remedy; and
- 3) 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(s).

As part of the groundwater ACM, several potential corrective measures technologies were evaluated to identify which ones could be carried forward as components of corrective measures alternatives. The results of the corrective measures technology evaluation are presented below in **Table 5**.

Table 5 – Potential Corrective Measures Options for Groundwater Impacts

Potentially Applicable Technology	Status	Description/Overview
No Action	Not retained as standalone technology, but carried forward for baseline comparisons	This technology has been included in the preliminary evaluation/screening but is not retained because it will not meet the established Corrective Action Objectives (CAOs).
Institutional Controls (ICs)	Retained as supplement to corrective measures alternatives	The use of ICs (i.e., Environmental Covenant, groundwater use restrictions, etc.) is retained as a useful technology. However, it is noted the ICs are not anticipated to be used as a stand-alone technology. Environmental Covenants, groundwater use restrictions, etc., are expected to be combined with other applicable technologies as part of corrective measures alternatives.
Groundwater Monitoring (Assessment and Detection mode)	Retained as supplement to corrective measures alternatives	The use of groundwater monitoring (Assessment and/or Detection modes as appropriate) when combined with other applicable technologies as part of any proposed corrective measures alternative is retained to address the CAO and to track the effectiveness of the overall remedy. However, it is not retained as a standalone technology.
Hydraulic Containment	Retained	The use of hydraulic containment is retained because it is an effective means of preventing offsite migration of soluble contaminants. Hydraulic containment requires management and potential ex-situ treatment of extracted groundwater, so it is not a stand-alone technology. The CSM will guide the design of any groundwater extraction system to optimize the total discharge of groundwater needed to provide hydraulic containment.
Physical Containment	Retained	The use of physical containment is retained because it can be an effective means of managing groundwater flow. Physical containment often requires pairing with hydraulic containment and/or in-situ treatment (funnel and gate style) to manage the flux of groundwater flow into the system. The CSM will guide the design of any physical barrier system, but technology limitations increase implementation difficulty with scale.
Ex-situ Treatment (Physical, Chemical or Biological)	Retained	Ex-situ treatment technologies are retained as a way of removing contaminants from extracted groundwater from a hydraulic containment system. Ex-situ treatment may be paired with wastewater treatment, non-groundwater release treatment systems, or with permitted discharge to manage groundwater contamination. The CSM and data gaps investigations will guide the design of any ex-situ treatment
Closure in Place (CiP) (of the regulated unit)	Retained	The use of CiP as a source control technology and is amenable with respect to CAO attainment.
Closure by Removal (CbR) (of the regulated unit)	Retained	The use of CbR as a source control technology is amenable with respect to CAO attainment.

Potentially Applicable Technology	Status	Description/Overview
Other Source Control Technologies	Retained	Control of source area non-groundwater related releases. For the purposes of this groundwater ACM, management of non-groundwater releases are not included in the alternatives evaluation. Engineering measures, including leachate collection, lining of trenches and/or ponds, and other isolation methods are regarded as part of closure technologies selected by other means.

Note: Technologies that were retained may be used as components of a corrective action alternative, but when evaluated in conjunction with other available technologies any single technology may not be utilized.

Preliminary assembly of corrective measures alternatives was performed based on site-specific and regional geology and groundwater conditions. For the Unit, six corrective measures alternatives were developed from this list of applicable corrective measures technologies during the ACM screening process:

- Alternative #1 – No Action and Groundwater Monitoring
- Alternative #2a – Closure in Place (CiP), Institutional Controls (ICs), and Groundwater Monitoring
- Alternative #2b – Closure by Removal (CbR), ICs, and Groundwater Monitoring
- Alternative #3 – CiP, Hydraulic Containment, Other Source Control (consisting of seepage collection and treatment), Ex-Situ Treatment, ICs, and Groundwater Monitoring
- Alternative #4 – CiP, Physical Containment, Ex-Situ Treatment, ICs, and Groundwater Monitoring
- Alternative #5 – CiP, Other Source Control, ICs, and Groundwater Monitoring

The assembly of corrective measures alternatives presented in the ACM was considered preliminary and subject to revision following additional evaluation during the remedy selection process and/or following comment from the regulatory community and public. Further evaluation of the alternatives is discussed in the following sections.

2.5.2 Assessment of Corrective Measures for Non-Groundwater Impacts

Pursuant to Title 40 of the Code of Federal Regulations (CFR) parts 257.90(d) and 257.84(b)(5), BREC initiated design of containment systems intended to reduce and prevent non-groundwater releases from reaching the Green River as an interim corrective measure. Plans for these measures were submitted to the KDWM for review and comment in 2019. KDWM conditionally approved the interim corrective measures for implementation at the Unit and they were constructed in 2019 and 2020 (see Section 2.4).

In June 2019, BREC performed an ACM to evaluate whether additional remedial measures, that would be supplemental to the ICMs already planned, were warranted to address non-groundwater releases. Several potential corrective measures technologies were evaluated in order to identify which ones could be carried forward as components of corrective measure alternatives for non-groundwater releases, if required. The results of the corrective measures technology evaluation are presented below in **Table 6**.

Table 6 – Potential Corrective Measures Options for Non-Groundwater Impacts

Potentially Applicable Technology	Status	Description/Overview
No Action	Not retained as stand-alone technology, but carried forward for baseline comparisons	This technology has been included in the preliminary evaluation/screening but is not retained because it will not meet the established CAOs.

Potentially Applicable Technology	Status	Description/Overview
Hydraulic Containment	Retained	Hydraulic containment in the form of pumping of vertical or horizontal wells would potentially be used to provide spot control of seepage if the interim corrective measures are unable to fully capture the seepage.
Physical Containment	Retained	Physical containment in the form of a cutoff wall would potentially be used to re-direct or otherwise intercept seepage that was not adequately captured by the interim corrective measures.
Ex-situ Physical/Chemical/Biological Treatment	Retained	Ex-situ treatment is retained as a potential supplement to the interim corrective measures in the event that discharge via the station's KPDES permit is not possible.
In-situ Physical/Chemical Treatment	Retained	In-situ treatment is retained in the form of spot treatment or fixation of seepage areas in the event that the interim corrective measures do not adequately address all seepage areas.
Permeable Reactive Barriers (PRB)	Retained	The use of PRBs is retained in the form of a reactive cell in the event that interim measures result in seepage concentrations that require pre-treatment in-situ prior to discharge.
Closure in Place (CiP) (of the regulated unit)	Retained	The use of CiP as a source control technology and is amenable with respect to CAO attainment.
Closure by Removal (CbR) (of the regulated unit)	Retained	The use of CbR as a source control technology is amenable with respect to CAO attainment.
Other Source Control Technologies	Retained	Control of source area non-groundwater releases is being implemented as interim corrective measures but is retained in the event that interim measures need to be evaluated for expansion.

The ICMs implemented at the Unit in 2019 were designed to address river seepage and divert it to KPDES outfalls, eliminating any potential exposure to public health or the environment. During ACM development, it was anticipated that the ICMs would meet the CAOs by effectively eliminating any future river seepage through source control, and as a result, no supplemental remedies were considered warranted. Data collected at the Unit since installation of the ICMs suggests that the CAOs are being met and in compliance with the conditions of the Agreed Order.

Performance monitoring is ongoing and will continue to be performed in the future to demonstrate source control and evaluate the ability of the ICMs to meet the CAO. The ICMs implemented at the Unit in 2019 and 2020 are considered the final remedy for non-groundwater releases and are expected to benefit corrective action as a whole for the Unit. As a result, no separate remedy selection report is currently being developed for non-groundwater releases. If warranted based on performance monitoring results, additional evaluation of the non-groundwater corrective measures will be performed consistent with 40 CFR 257.98(b).

3. Corrective Measure Evaluation

To address the remedy selection requirement under 40 CFR Part 257.97, a corrective measure evaluation was performed to address groundwater impacts at the Unit. Currently, no separate corrective measure evaluation is planned for non-groundwater releases, as the ICMs implemented at the Unit in 2019 and 2020 are considered the final remedy for non-groundwater releases. The discussion included below details the evaluation performed to address groundwater impacts at the Unit.

3.1 Corrective Action Objectives

Corrective Action Objectives (CAOs) for the Unit were identified during the groundwater ACM completed for the Unit in June 2019. CAOs are overall descriptions of what remedial action is expected to accomplish at a given site. CAOs also provide a basis for evaluating the performance of a corrective measure. Title 40 CFR Section 257.97 (b) outlines the CAOs for corrective measures under the CCR Rule as follows:

- (1) Be protective of human health and the environment;
- (2) Attain the GWPS as specified pursuant to Section 257.95(h);
- (3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents 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;
- (5) Comply with standards for management of wastes as specified in Section 257.98(d). [note: this statute references all applicable requirements under the Resource Conservation and Recovery Act (RCRA)].

The corrective measure alternative selected for the Unit must ultimately demonstrate attainment of the CAOs. Compliance with the CAOs will be a primary factor in determining the effectiveness of the corrective measure alternative selected for the Unit during future systematic performance reviews.

Each of the CAOs have been adopted as Threshold Criteria (see Section 3.3.1 below) for evaluating potential corrective measures in alignment with 40 CFR Part 257.97 (b).

3.2 Corrective Measures Alternatives Assembly

The groundwater ACM performed for the Unit in June 2019 identified a total of six (6) corrective measures alternatives to be carried forward into the remedy selection process. In December 2019, BREC provided a *Semi-annual Remedy Selection Progress Report* (AECOM, December 2019) as required under 40 CFR 257.97(a). As part of this submittal, two (2) corrective measures alternatives were eliminated from further consideration, including:

- Alternative #1 (No Action and Groundwater Monitoring) – This alternative does not control or remove COCs from the environment and therefore does not achieve the RAOs.
- Alternative #2b – (CbR, ICs, and Groundwater Monitoring) – Implementing a CbR approach is considered cost prohibitive. In addition, any CbR approach would require relocating waste to an existing disposal unit or construction of a new waste disposal unit, which does not align with the one of the fundamental goals of RCRA (conserving energy and natural resources).

Four (4) potential corrective measures alternatives have been identified by BREC as viable options to address lithium impacts in groundwater and non-groundwater releases at the Unit, including:

- Alternative #2a (Alt 2a): CiP, ICs, and Groundwater Monitoring

- Alternative #3 (Alt 3): CiP, Hydraulic Containment, Other Source Control (consisting of seepage collection and treatment), Ex-Situ Treatment, ICs, and Groundwater Monitoring
- Alternative #4 (Alt 4): CiP, Physical Containment, Ex-Situ Treatment, ICs, and Groundwater Monitoring
- Alternative #5 (Alt 5): CiP, Other Source Control, ICs, and Groundwater Monitoring

Each of the remaining 4 corrective measures alternatives was evaluated against the threshold, balancing, and modifying criteria as discussed below.

3.3 Corrective Measures Criteria Evaluation

40 CFR Part 257.97(a) outlines the criteria for evaluating corrective measures under the Federal CCR Rule. Although not specifically stated as such, these criteria mirror the criteria outlined for the National Oil and Hazardous Substance Contingency Plan, more commonly referred to as the National Contingency Plan (NCP), established under 40 CFR 300. 40 CFR 300.430 identifies 9 criteria for evaluating remedial alternatives which are further divided into 3 categories:

- 1) Threshold Criteria;
- 2) Balancing Criteria, and
- 3) Modifying Criteria.

These criteria were utilized by BREC to evaluate the potential corrective measures alternatives for the Unit. Each of the remaining 4 corrective measures alternatives was evaluated against each other and scored on a scale from 1 to 4 (1 being lowest and 4 being highest). Where multiple corrective measures alternatives were considered equal with respect to a given criteria, the available points were combined and divided equally. The results of analysis performed to evaluate each of the corrective measures alternative is discussed below and summarized in **Appendix E**.

3.3.1 Threshold Criteria Evaluation

Title 40 CFR Part 257.97 (b) outlines the threshold criteria (also viewed as CAOs) for evaluating corrective measures under the CCR Rule, and these criteria were presented in Section 3.1 above. The results of the threshold criteria evaluation are summarized below in **Table 7**.

Table 7. Threshold Criteria Evaluation Summary

40 CFR 257.97 Reference	Alternative 2a	Alternative 3	Alternative 4	Alternative 5
(b)(1)	1	3	3	3
(b)(2)	1	3.5	2	3.5
(b)(3)	1	3	2	4
(b)(4)	1	3	2	4
(b)(5)	2.5	2.5	2.5	2.5

Further detail regarding how threshold criteria were evaluated is provided on Table E-2 in **Appendix E**.

3.3.2 Balancing Criteria Evaluation

Title 40 CFR Section 257.97 (c) outlines the balancing criteria for evaluating corrective measures under the CCR Rule as follows:

- 1) The long and short-term effectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on a 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
 - 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.

The results of the threshold criteria evaluation are summarized below in **Table 8**.

Table 8. Balancing Criteria Evaluation Summary

40 CFR 257.97 Reference	Alternative 2a	Alternative 3	Alternative 4	Alternative 5
(c)(1)(i)	1	4	3	2
(c)(1)(ii)	1	3.5	3.5	2
(c)(1)(iii)	1	2.5	2.5	4
(c)(1)(iv)	1	3	2	4
(c)(1)(v)	1	3	2	4
(c)(1)(vi)	1	3	2	4
(c)(1)(vii)	1	3	2	4
(c)(1)(viii)	4	2	1	3
(c)(2)(i)	1	3	2	4
(c)(2)(ii)	1	4	3	2
(c)(3)(i)	4	2	1	3
(c)(3)(ii)	4	2	1	3
(c)(3)(iii)	2.5	2.5	2.5	2.5
(c)(3)(iv)	4	2	1	3

(c)(3)(v)	1	2	3	4
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Further detail regarding how threshold criteria were evaluated in provided on Table E-3 in **Appendix E**.

3.3.3 Modifying Criteria Evaluation

Title 40 CFR Section 257.97 (c) defines modifying criteria as “the degree to which community concerns are addressed by a potential remedy(s)”. Given that an Agreed Order was signed between BREC and the KDWM for the Unit, the modifying criteria were expanded as part of this evaluation to include separate criteria for state and community acceptance (40 CFR 300.430 divides modifying criteria into two categories).

The results of the modifying criteria evaluation are summarized below in **Table 9**.

Table 9. Modifying Criteria Evaluation Summary

40 CFR 257.97 Reference	Alternative 2a	Alternative 3	Alternative 4	Alternative 5
NA - state acceptance	1	3.5	3.5	2
(c)(4)	1	3.5	3.5	2

Further detail regarding how threshold criteria were evaluated in provided on Table E-4 in **Appendix E**.

3.3.4 Corrective Measures Alternative Evaluation Summary

The cumulative scoring of the criteria evaluation is summarized below in **Table 10**.

Table 10. Cumulative Criteria Evaluation Scoring Summary

40 CFR 257.97 Reference	Alternative 2a	Alternative 3	Alternative 4	Alternative 5
Total Score	37	63.5	50	69.5

Further detail regarding the cumulative scoring criteria is provided on Table E-1 in **Appendix E**.
Alternative 5 scored highest of all the alternatives during the evaluation.

4. Remedy Selection

In alignment with the scoring completed as part of the corrective measure evaluation (see **Appendix E**), BREC has selected Alternative #5 (CiP, Other Source Control, ICs, and Groundwater Monitoring) as the remedy to address groundwater and non-groundwater impacts at the Unit. A description of each corrective measure technology incorporated into the selected remedy is provided below.

4.1 Closure in Place

In adherence with the BREC's permit conditions, the Site will continue to operate as a solid waste disposal facility through its life cycle and will be closed in accordance with the requirements of the permit. The current life cycle estimates for the Green Landfill predict that the Unit will reach capacity in approximately 2041. Source control through landfill closure will include installation of final cover that will prevent infiltration and contribute to groundwater quality restoration.

4.2 Source Control

To comply with the Agreed Order signed by BREC and KDWM for the Unit, additional source control measures will be implemented in 2020 and 2021 to reduce/eliminate the downward migration of COC into groundwater. As currently planned, these measures will include the following:

- Landfill perimeter collection trenches; and
- Removal of CCR material from the South Sediment Basin.

Interim corrective measures for the perimeter seeps are being planned in a phased approach. The first step is to divert the seepage to the Northeast Sediment Basin which is routed to the KPDES outfall of the Green Surface Impoundment. Removing the seeps from stormwater channels will prevent mixing with impounded stormwater. The use of the South Sediment Basin requires that CCR materials be removed so that the seepage does not have the potential to impact groundwater. Corrective measures for the South Sediment Basin will involve the removal of any residual CCR material and creation of two lined sump areas, one on the east end to collect the South and East perimeter seeps and one on the west end to collect Southwest corner perimeter seeps. Additionally, perimeter seeps on the north side of the landfill will be similarly controlled but will be directly routed to the collector sump on the north side of the landfill.

Design of the additional source control remedies is currently being performed by BREC. A draft design package will be provided to KDWM as part of a separate submittal to comply with the conditions of Agreed Order #18-3-0138. The implementation schedule for source control measures is discussed in Section 5.

4.3 Institutional Controls

The use of ICs (i.e., Environmental Covenant, groundwater use restrictions, etc.) is retained as a useful technology. However, it is noted the ICs are not anticipated to be used as a stand-alone technology. Environmental Covenants, groundwater use restrictions, etc., are expected to be combined with other applicable technologies as part of the remedy for the Unit.

4.4 Groundwater Monitoring

Assessment monitoring is expected to continue at the Unit until the CAOs have been met.

5. Remedy Implementation Schedule

5.1 Schedule Evaluation Factors

The schedule for remedy implementation is provided in **Appendix F**. 40 CFR Part 257.97(d) outlines the factors that must be considered in specifying a schedule to remedial implementation at a CCR unit as follows.

- 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 withdraw 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;
 - vi. The availability of alternative water supplies; and
- 6) Other relevant factors.

Each of these factors was considered by BREC as part of the remedy selection process as described below.

5.1.1 Nature and Extent of Contamination

The data obtained during characterization monitoring performed at the Unit under 40 CFR Part 257.95(g) indicates that the extent of groundwater and non-groundwater impacts is confined to Sebree Station. Source control measures implemented to date will ensure that non-groundwater releases are captured and will not migrate beyond the functional perimeter of the Unit and the property controlled by BREC.

Assessment monitoring will continue at the Unit to confirm that the nature and extent of contamination is defined and progressing in accordance with the CAOs.

5.1.2 Compliance Probability

Implementation of the selected remedy is expected to have a high probability of meeting the CAOs. There is firm evidence of a relatively direct connection between infiltration of co-mingled leachate and stormwater at the South Sediment Basin and the observed impact to monitoring wells MW-4, -5, and -6. Consequently, removal of that infiltration by the planned corrective measures (excavating CCR from the South Sediment Basin and containing leachate in a series of sumps and piped conveyance) is expected to have a direct influence on groundwater quality. The time required to achieve GWPSs at the affected wells has not been modeled but is expected to be on the order of one to five years if the remedy is implemented as planned.

Impacts observed at MW-3A may be tied to the nearby non-groundwater release captured by the Deep Seep Collection Trench, in which case, the time to achieve CAOs may be relatively quick now that the

seepage is being hydraulically controlled. However, there are unknowns regarding the nature of how lithium is transported to that well location. Those uncertainties cannot be evaluated given the physical constraints of the site (proximity of the landfill to the river), so the time frame required to meet CAOs cannot be predicted until additional Assessment monitoring data are available.

5.1.3 CCR Treatment and Disposal Capacity

Wastes generated by the groundwater corrective measures activities will include residual CCR content removed from the South Sediment Basin and seepage collected from the perimeter seepage controls. Wastes generated by the non-groundwater corrective measures activities will be seepage collected from the Deep Seep Collection Trench and the Northwest Seep Collection Trench.

The solids (dredged material from the South Sediment Basin) will be interred in the Landfill as allowed under the existing solid waste permit. The Landfill has sufficient capacity for this one-time waste stream volume. The liquid wastes will be managed under the KPDES permit for the station.

5.1.4 Exposure Risk

As detailed in Section 2.3.8, there is no data to suggest that human health and the environment are currently being exposed to COC emanating from the Unit. This condition is not expected to change prior to implementation of the remedy but will continue to be evaluated through Assessment monitoring and systematic performance reviews.

5.1.5 Aquifer Resource Value

Based on data published by KGS, there are no known groundwater wells used for drinking water within a 1-mile radius of the Unit. This is not expected to change in the future but will be re-examined during future performance reviews. Therefore, the significance of aquifer resource value is not considered pertinent to this evaluation or the resulting schedule.

5.1.6 Other Relevant Factors

Within Exhibit 4 of the Agreed Order, a milestone schedule was provided for groundwater corrective action. Although the milestone schedule has been adjusted due to the work conditions imposed by the COVID-19 pandemic, which includes holding the public meeting at an earlier date, BREC has moved forward with the activities required in the Agreed Order.

5.2 Performance Review

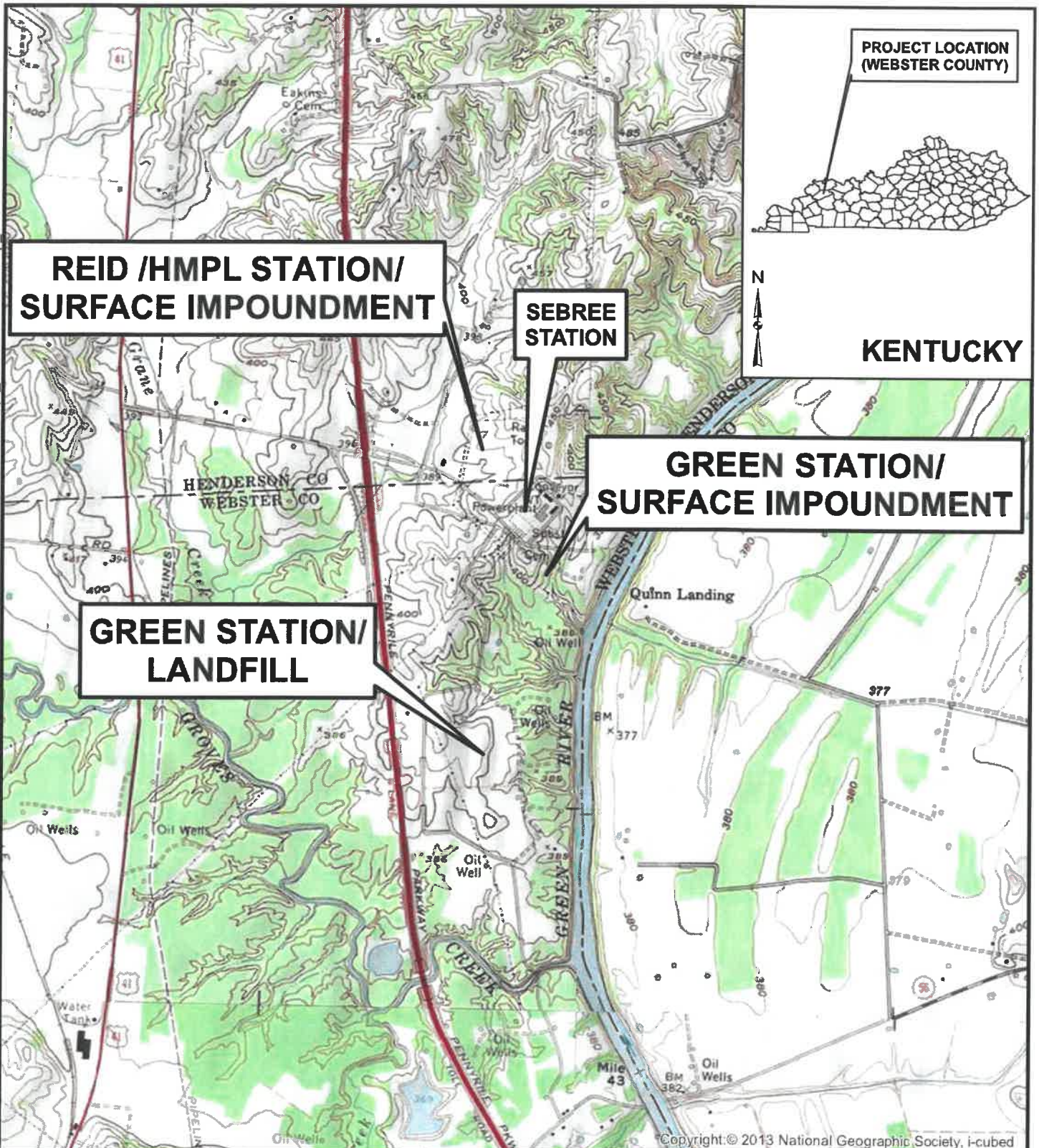
Source control measures are viewed as the remedial component likely to have the most significant short- and long-term benefit on reducing groundwater and non-groundwater impacts at the Unit. As such, evaluating the performance of source control measures constructed at the Unit should be evaluated through systematic review.

Although not specifically mandated under the CCR Rule, five-year reviews are generally required by the regulatory agency under corrective action programs (i.e. CERCLA) when hazardous substances remain at a site above levels that permit unlimited use and unrestricted exposure. Five-year reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. Generally, reviews take place five years following the start of corrective action and are repeated every succeeding five years so long as future uses remain restricted. BREC will perform a five-year review to evaluate compliance with the CAOs and evaluate the effectiveness of the remedy selected for the Unit five years after construction completion (approximately 2026).

6. References

- AECOM, 2018. Annual Groundwater Monitoring and Corrective Action Report, 2016-2017; Green Station CCR Landfill, Webster County, Kentucky.
- AECOM, 2019. Annual Groundwater Monitoring and Corrective Action Report, 2018; Green Station CCR Landfill, Webster County, Kentucky.
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- Associated Engineers 2016. Hydrologic and Hydraulic Capacity Assessment and Initial Inflow Design Flood Control System Plan.
- Fairer, G.M., Geologic Map of the Robards Quadrangle, Henderson and Webster Counties, Kentucky, U.S. Geological Survey, 1973.
- USEPA, 40 CFR Part 257. [EPA-HQ-RCRA-2015-0331; FRL-9928-44-OSWER]. RIN-2050-AE81. Technical Amendments to the Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities—Correction of the Effective Date. Federal Register / Vol. 80, No. 127 / Thursday, July 2, 2015 / Rules and Regulations.
- USEPA, 40 CFR Part 257. [EPA-HQ-OLEM-2017-0286; FRL-9973-31-OLEM]. RIN-2050-AG88. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Amendments to the National Minimum Criteria (Phase One); Proposed Rule. Federal Register / Vol. 83, No. 51 / Thursday, March 15, 2018 / Proposed Rules.

Figures



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ROBARDS QUADRANGLE
DELAWARE QUADRANGLE

(FROM ARCGIS ONLINE Copyright: © 2011 National Geographic Society, i-cubed)

0 2,000 4,000
Feet



Big Rivers
ELECTRIC CORPORATION

*Sebree Station
Webster County, Kentucky*

**FIGURE 1
GENERAL LOCATION MAP**

DATE: 1/8/2019	SCALE: 1IN = 2,000 FEET
CREATED BY: ALW	
JOB NO. 60579938	



Legend

- Property Line
- KAR Permit Area
- CCR Fill Area
- + Downgradient CCR Monitoring Well
- x Upgradient CCR Monitoring Well
- ♦ Characterization Well
- A — A' — Transect Line
- Seeps Investigation Borings
- Landfill Seep Sample
- River Seep Sample

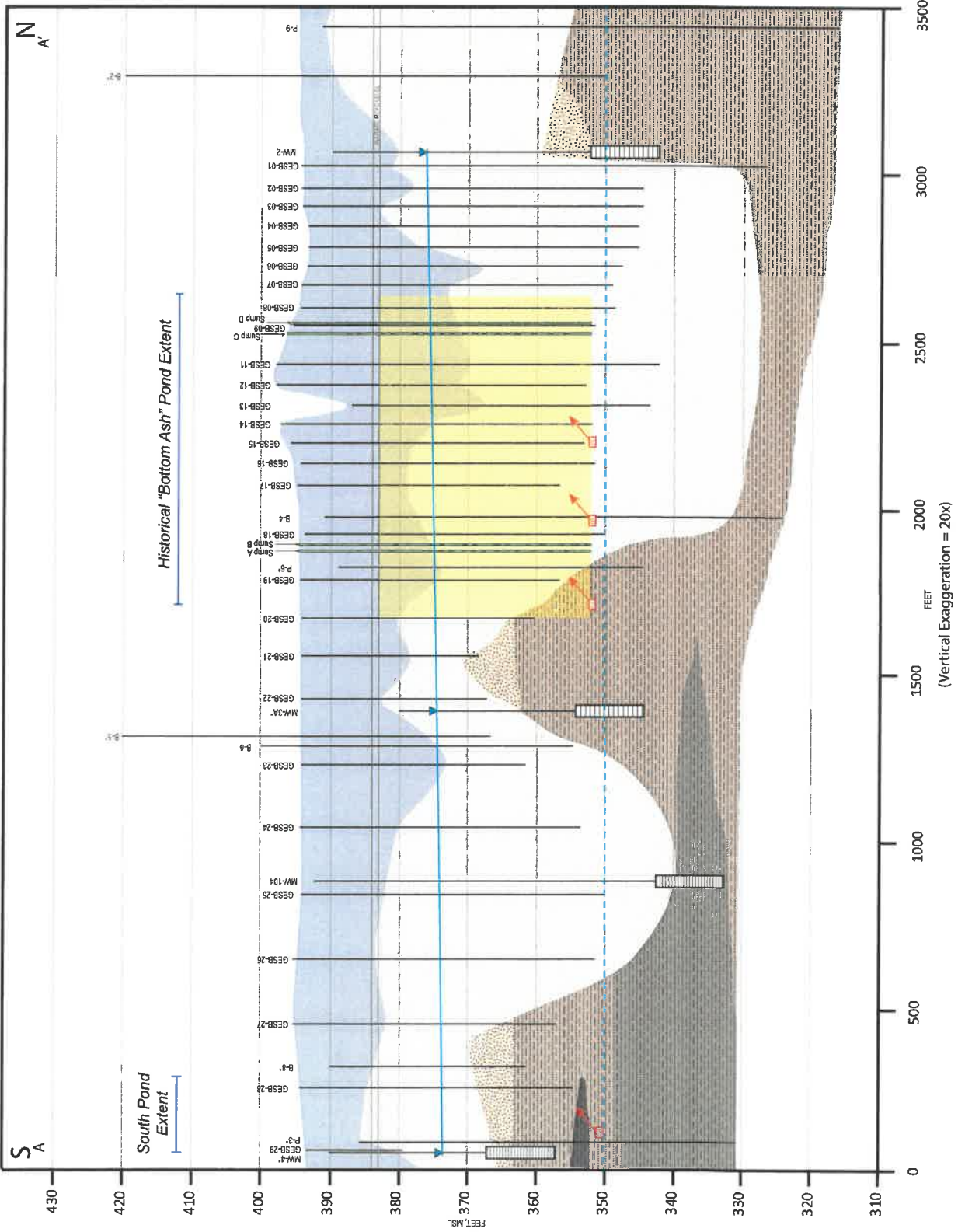
0 400 800
Feet

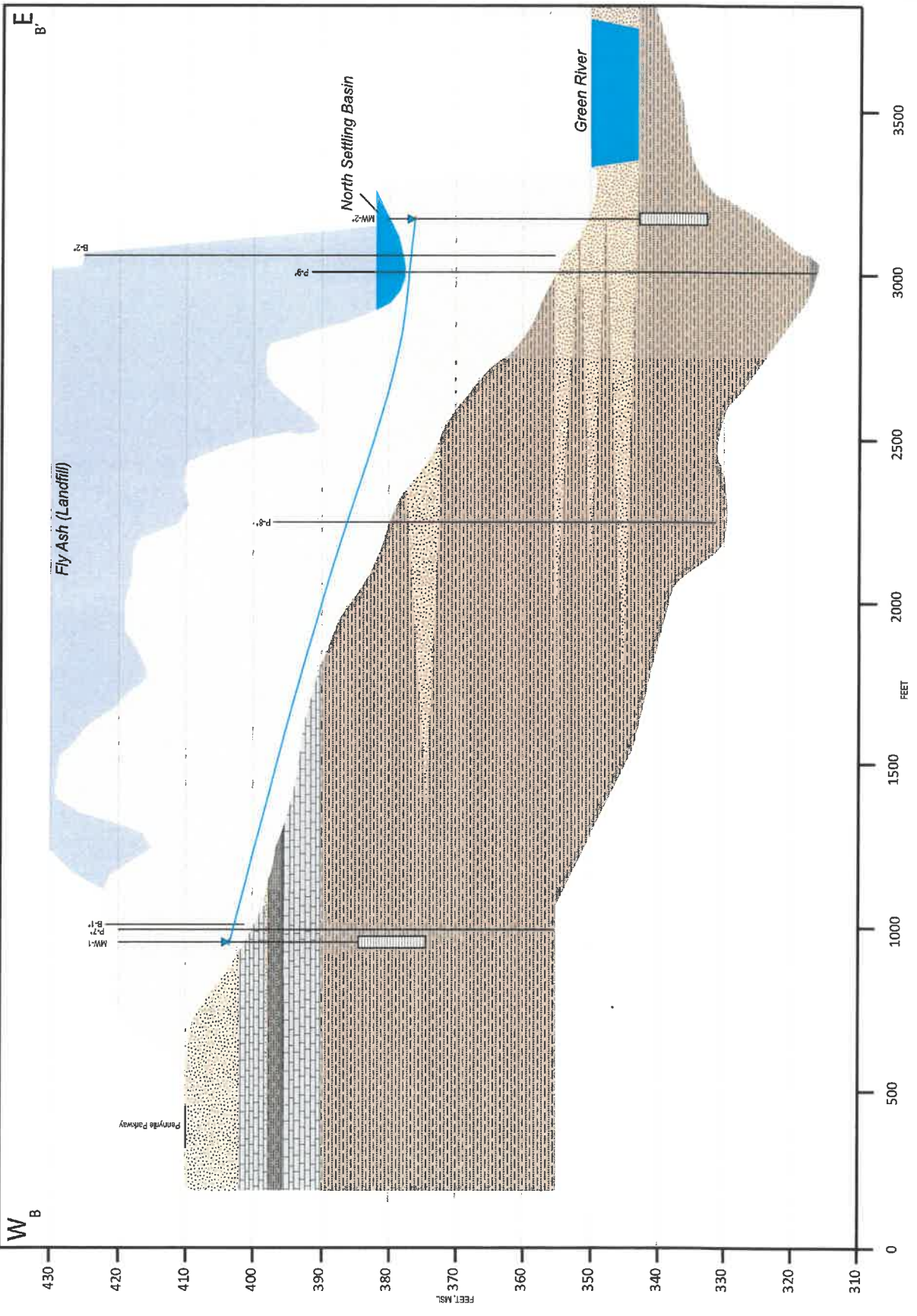
Big Rivers
Water Management Co.

Green Station
Webster County, Kentucky

FIGURE 2
WELL LOCATION MAP

DATE: 06/04/2019	SCALE: 1IN = 300 FEET
CREATED BY: DAS	
JOB NO. 60902384	





Bedrock Lithologies:

- Sandstone
- Shale
- Limestone
- Interbedded Sandstone and Shale
- Interbedded Shale and Sandstone

Unconsolidated Materials:

- Silty Clay
- Fill

Potentiometric Surface

11/11/2019 - 11/12/2019

MW-2— Well ID

Boring (*Projected)

Riser

Screen

Green Station

Big Rivers

Webster County, Kentucky

FIGURE 5

CROSS SECTION B - B'

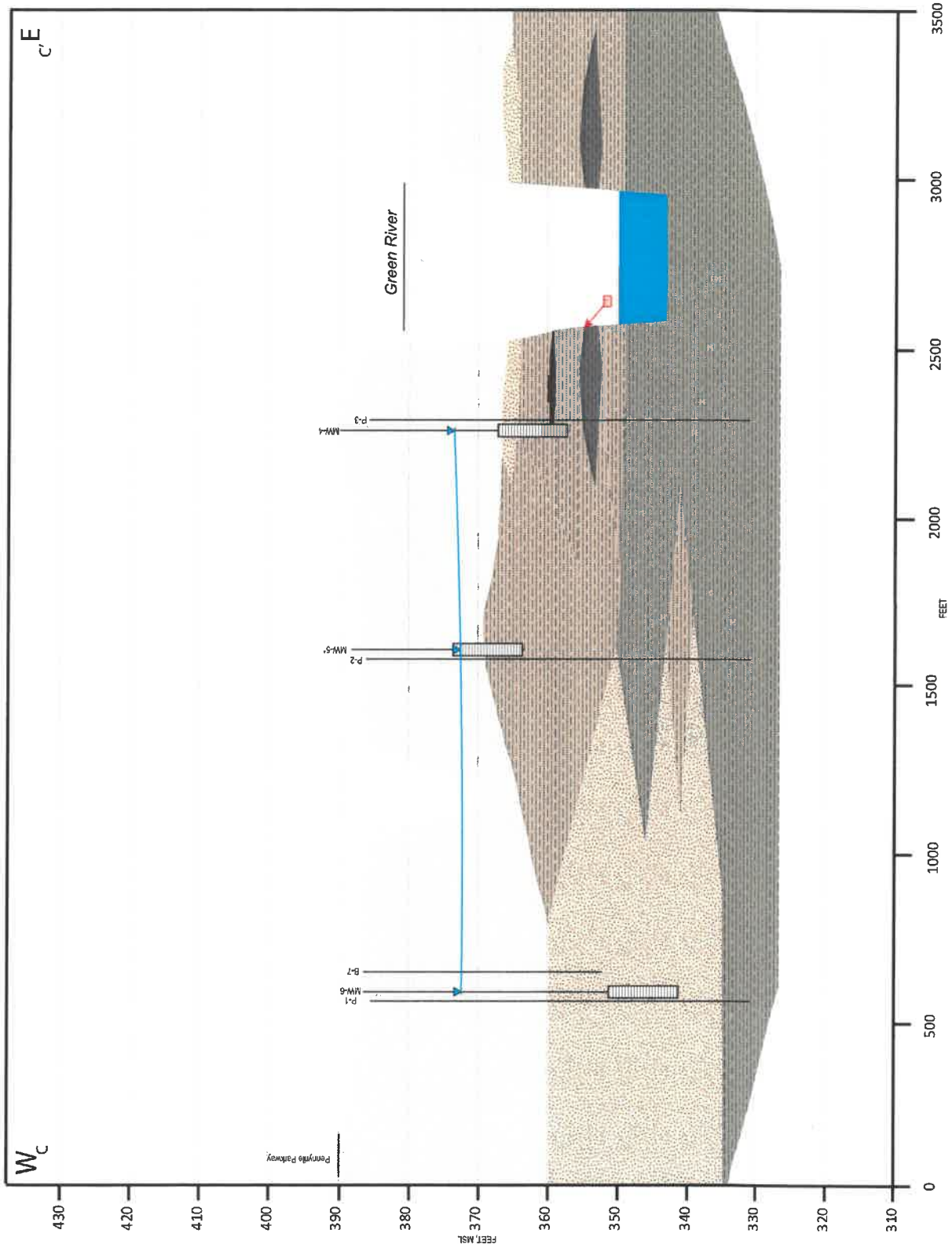
North Side of Ash Pile

DATE: 05/01/2020

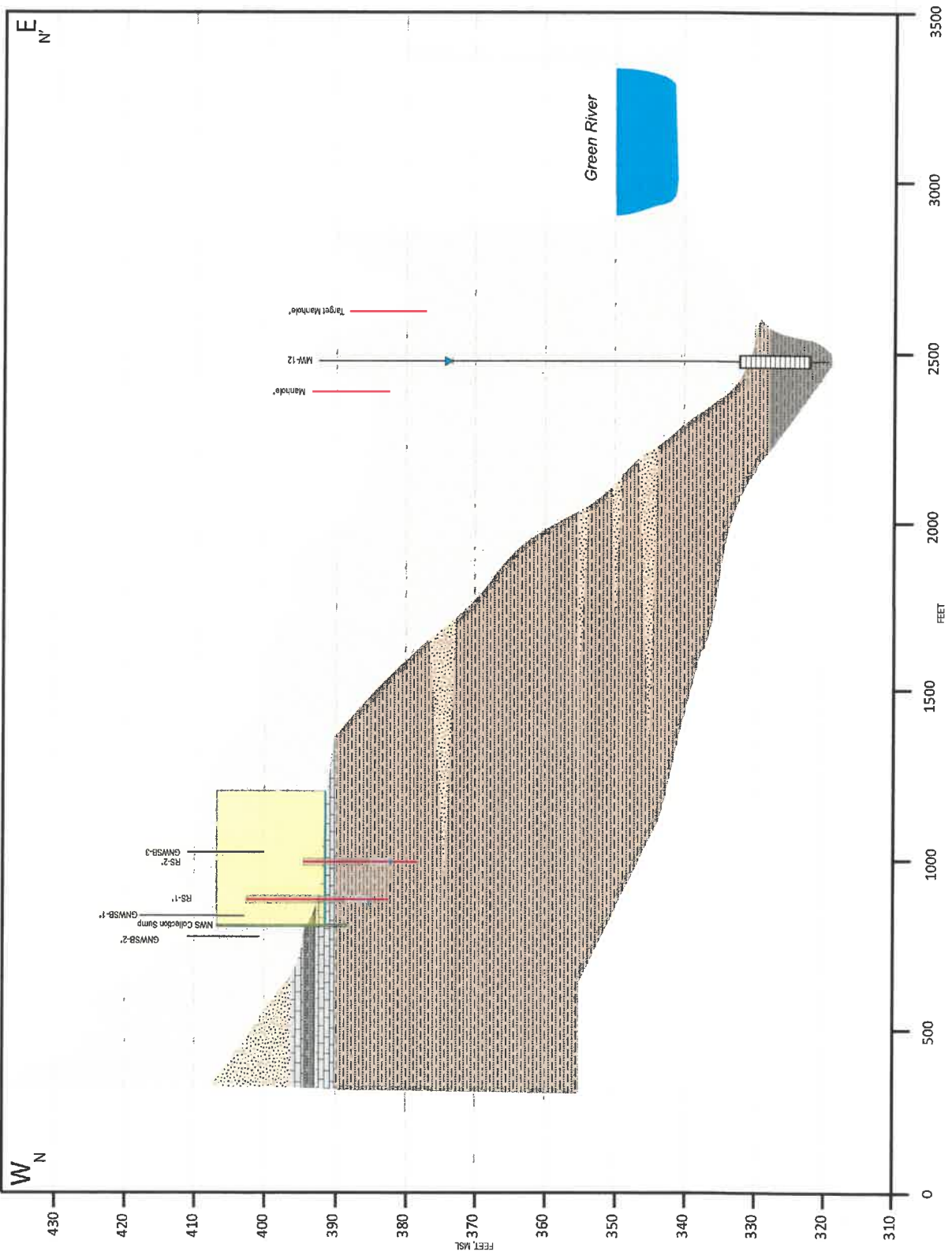
SCALE: AS SHOWN

CREATED BY: ALY

JOB NO. 606192B3



		Green Station Webster County, Kentucky	
FIGURE 6 CROSS SECTION C - C' South Side of Ash Pile			
DATE: 05/01/2020	SCALE: AS SHOWN		
CREATED BY: ALY	JOB NO. 60619283		



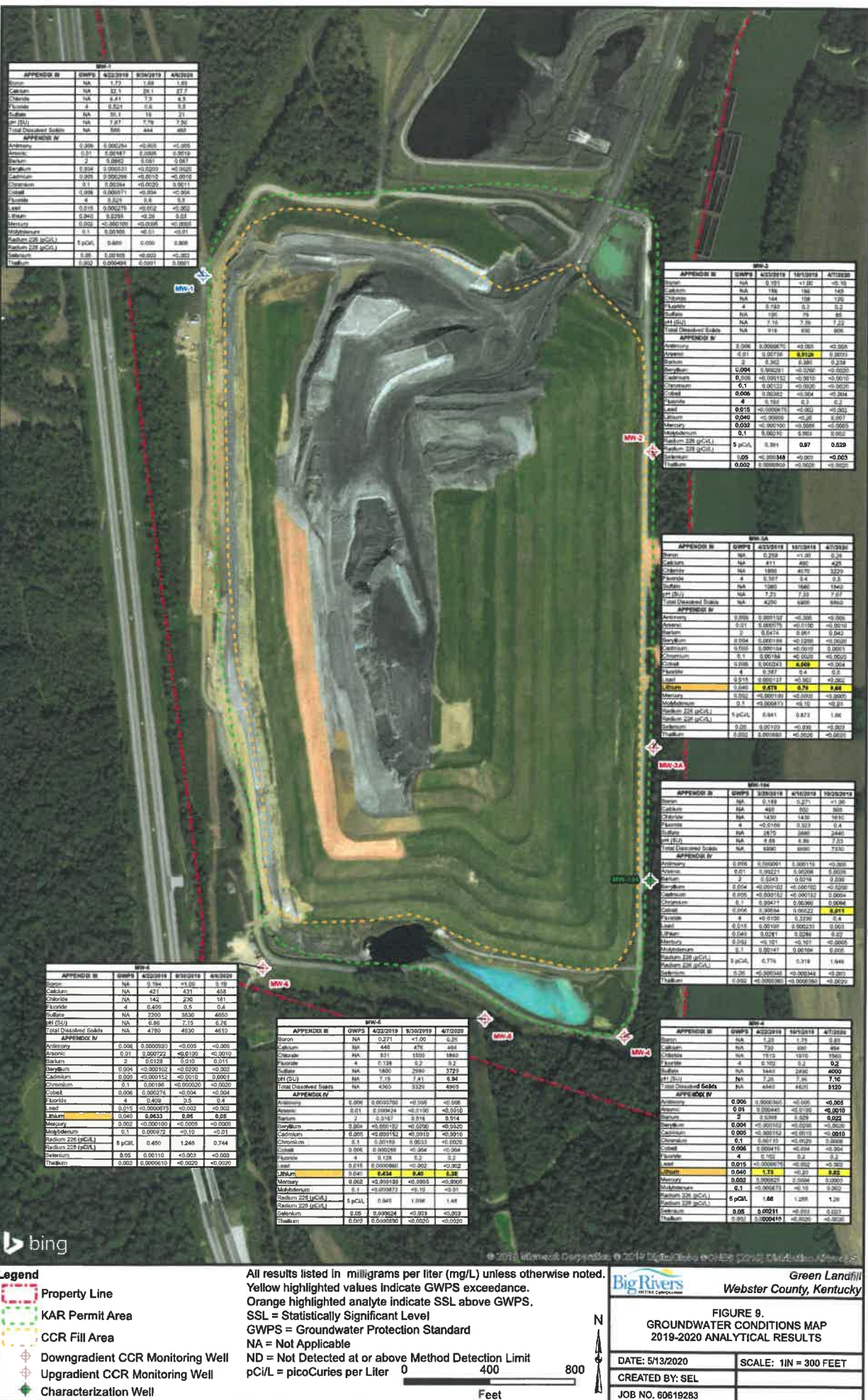


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373.43

SCALE: 1IN = 400 FEET

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Document Path: G:\Cincinnati\DCS\GIS\AreaMap_GeoDB_Points\ENR\605792311_REC_GMSW920-GIS or Simulation\Fig2_REC_Green.mxd



Legend

- Property Line
- KAR Permit Area
- CCR Fill Area
- Downgradient CCR Monitoring Well
- Upgradient CCR Monitoring Well
- Characterization Well
- Northwest Seep Collection Trench
- Deep Seep Collection Trench

0 400 800
Feet



Big Rivers
WATER CONSTRUCTION

Green Landfill
Webster County, Kentucky

FIGURE 10 SEEP COLLECTION TRENCH LOCATION MAP

DATE: 05/14/2020

SCALE: 1IN = 300 FEET

CREATED BY: SEL

JOB NO. 60626688

Appendix A

July 2018 River and Seep Sampling and Analysis Data



Legend

-  Pond Sample
-  River Seep Sample
-  River Sample
-  Downgradient Monitoring Well
-  Upgradient Monitoring Well

A horizontal number line is shown with three tick marks labeled 0, 1,450, and 2,900. The segment of the line between 0 and 1,450 is shaded gray. Below the line, the word "Feet" is centered.



Big Rivers
2011-2012

**Green Station Landfill
Webster County, Kentucky**

**FIGURE 1
RIVER AND SEEP
SAMPLING LOCATIONS**

DATE: 9/6/2018

CREATED BY: MRH

JOB NO. 60579938

SCALE: 1IN = 1800 FEET

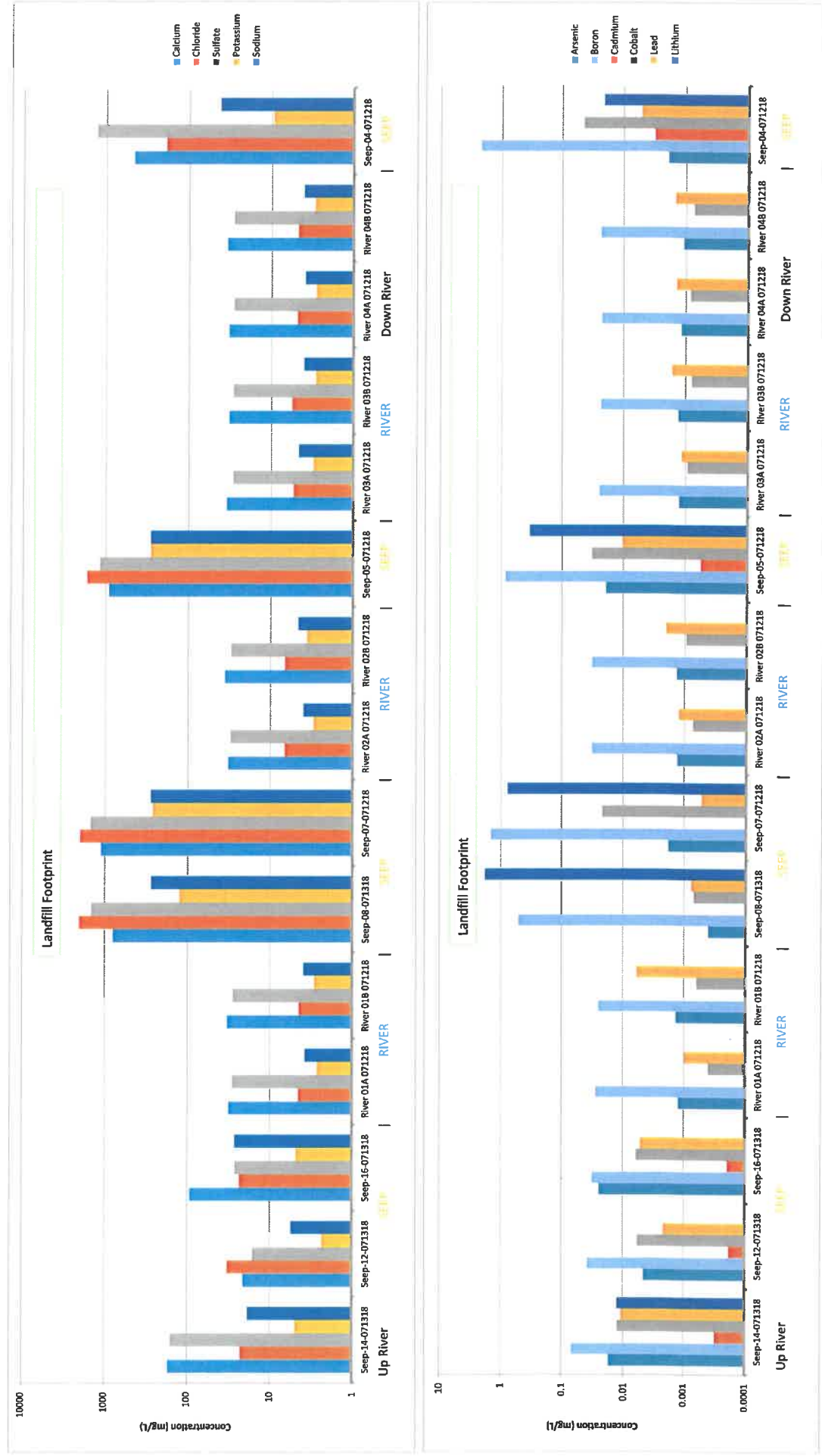


FIGURE 2
CCR ANALYTICAL SUMMARY - GREEN STATION LANDFILL
RIVER SEEP AND RIVER SAMPLE EVALUATION, JULY 2018

Appendix B

Green Landfill Analytical Summary Tables

GREEN LANDFILL ANALYTICAL SUMMARY TABLES

GREEN LANDFILL - CCR ANALYTICAL SUMMARY
MW-1

APPENDIX III CONSTITUENTS			GWPS		Detection Limit	DATE												Assessment		9/30/2019	
			3/26/2016	5/23/2016	8/18/2016	10/26/2016	2/1/2017	5/2/2017	8/7/2017	9/5/2017	10/5/2017	6/4/2018	7/10/2018	9/28/2018	4/22/2019	9/30/2019					
Baseline Events																					
Boron	0.08		1.67	1.49	2.25	1.70	1.71 J	1.68	1.85 B	1.79	1.92		1.41	1.94 B	1.73 B	1.68 D2 M4					
Calcium	0.5		29.1	31.8 B	33.0	30.9	20.8	27.1	27.1	28.9 B	26.4			28.5 B	32.1	29.1 D2					
Chloride	3		9.03 JB	0.501 JB	6.60 B	6.02 B	5.66 B F1	5.30 B	5.12 B F1	5.71 B	4.07 F1 B		6.34 B	6.17 B	6.41 B F1	7.5					
Fluoride	1		ND J	ND JB	ND J	ND JB	ND J F1	ND JB	ND J F1	ND J	ND J F1		ND J	ND JB	0.521 J	0.6					
Sulfate	5		25.2	22.8 JB	22.9	20.7 B	28.4	24.0 B	25.3 B	23.4	24.9 JB		23.5	22.5 B	35.1 B F1	19					
pH (SU)	0.10		7.39	7.24	7.57	7.19	7.63	7.54	7.45	7.48	7.63		7.08	8.43	7.79 H3	7.79 H3					
Total Dissolved Solids	10		598	588	585	585	605	630	614	627	636		585	616	568 B	444 H1					
APPENDIX IV CONSTITUENTS																					
Antimony	0.002	0.006 mg/L	ND	ND J	ND B	ND	ND	ND JB	0.00297 B	ND JB	ND JB	ND JB	ND J	NA	0.000254 B	ND M1 V1 U					
Arsenic	0.005	0.01 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J F1	ND JB	ND JB	ND JB	ND J	ND JB	0.00167 B	0.0005 V1 J					
Barium	0.2	2 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J F1	ND JB	ND JB	ND JB	ND J	ND J	0.0862 J	0.091 D2					
Beryllium	0.002	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0.000533 J	ND D2 U					
Cadmium	0.001	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0.000299 J	ND V1 U					
Chromium	0.003	0.1 mg/L	ND	ND J	ND	ND	ND	ND	ND	ND J	ND JB	ND JB	ND	NA	0.00354 B	ND U					
Cobalt	0.005	0.006 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND JB	ND J	NA	0.000571 J	ND U					
Fluoride	1	4 mg/L	ND J	ND J	ND J	ND JB	ND J F1	ND JB	ND J F1	ND J	ND J	ND JB	ND J	ND JB	0.521 J	0.6					
Lead	0.005	0.015 mg/L	ND J	ND J	ND J	ND J	ND	ND	ND	ND J	ND J	ND	ND J	NA	0.000279 J	ND V1 U					
Lithium	0.05	0.040 mg/L	0.0293 J	0.0317 J	0.0326 J	0.0286 J	0.0342 J	0.0396 J	0.0314 J	0.0315 J	0.0319 J	0.0319 J	0.0299 J	0.0279 J	0.0295 J	ND D2 M3 U					
Mercury	0.0002	0.002 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND V1 U					
Molybdenum	0.01	0.1 mg/L	ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	NA	0.00105 J	ND J					
Radium 226																					
Radium 228	1	5 pCi/L	1.05	1.02	0.676	1.02	0.694	0.666	0.491	0.601		1.92	0.882	0.905	0.689	0.782					
Selenium	0.01	0.05 mg/L	ND	ND	ND	ND	ND	ND	ND J	ND		ND	ND	NA	0.00105 J	ND U					
Thallium	0.001	0.002 mg/L	ND	ND J	ND	ND J	ND	ND	ND J	ND		ND	ND	NA	0.000498 J	0.0001 V1 J					

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

NA = Not Analyzed

ND = Not Detected at or above Method Detection Limit

pCi/L = picocuries per liter

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

B = Compound was found in the blank and sample.

F1 = MS and/or MSD Recovery is outside acceptance limits.

D2 = Sample required dilution due to matrix interference

H1 = Sample analysis performed pasts holding time

H3 = Sample received and analyzed past holding time

M3 = The accuracy of the spike recovery value is reduced since the analyte concentration in the sample is disproportionate to spike level. The method control sample recovery was acceptable

M4 = The analysis of the spike sample required a dilution such that the spike concentration was diluted below the reporting limit. The method control sample recovery was acceptable

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

GREEN LANDFILL - CCR ANALYTICAL SUMMARY
MW-2

APPENDIX III CONSTITUENTS	Detection Limit	GWPS	DATE														
			Baseline Events										Re-Sampling				
			3/26/2016	5/23/2016	8/18/2016	11/14/2016	2/1/2017	5/2/2017	8/8/2017	9/7/2017	10/6/2017	6/5/2018	7/11/2018	9/28/2018	4/23/2019	10/1/2019	
Boron	0.08		ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	0.0630 JB	0.101 JB		
Calcium	0.5		119	116 B	140	140 B	126	152	154	121	150	150	155	165 B	156		ND D2 U
Chloride	3		126 B	125 B	129 B	133	142 B	128 B	145 B	136 B	129 B	129 B	154 B	159 B	144		108 D
Fluoride	1		ND/J	ND/J	ND/J	ND JB F1	ND/J	ND JB	ND JB	ND JB	ND JB F1	ND JB	ND JB	ND JB	0.193 J		0.3
Sulfate	5		80.0	84.5 J	85.5 J	90.1	89.8	83.2	92.0 JB	90.8	88.6 JB	88.6 JB	107	108 B	105		79.0 B
pH (SU)	0.10		6.81	6.59	6.7	6.78	7.12	7.04	6.77	6.69	6.86	6.64	6.40	7.02	7.15		7.39 H3
Total Dissolved Solids	10		764	780	830	880	862	918	913	818	970		884	937	918 B		930 H1
APPENDIX IV CONSTITUENTS																	
Antimony	0.002	0.006 mg/L	ND	ND/J	ND JB	ND JB	ND	ND JB	ND JB	ND JB	ND JB	ND JB	ND JB	ND JB	0.000670 JB		ND V1 U
Arsenic	0.005	0.01 mg/L	0.00763 J	0.00633	0.0110	0.0159	0.0462	0.00755	0.0381	0.00527		0.0327 B	0.0119	0.0211 B	0.00718 JB		0.0129 D2
Barium	0.2	2 mg/L	ND/J	ND/J	0.280	0.319	0.347	0.332	0.308	ND/J	ND/J	0.369	0.323	0.367	0.362		0.390 D2
Beryllium	0.002	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0.007281 J		ND D2 U
Cadmium	0.001	0.005 mg/L	ND/J	ND/J	ND	ND	ND	ND	ND	ND	ND	ND JB	ND	NA	ND		ND V1 U
Chromium	0.003	0.1 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND JB	ND	NA	0.00712 JB		ND D2 U
Cobalt	0.005	0.006 mg/L	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND JB	ND JB	NA	0.00382 J		ND D2 U
Fluoride	1	4 mg/L	ND/J	ND/J	ND/J	ND JB F1	ND/J	ND/J	ND JB	ND JB	ND JB F1	ND JB	ND JB	ND JB	0.193 J		0.3
Lead	0.005	0.015 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND		ND V1 U
Lithium	0.05	0.040 mg/L	ND/J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND D2 V1 U
Mercury	0.0002	0.002 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND V1 U
Molybdenum	0.01	0.1 mg/L	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND/J	ND JB	ND JB	ND JB	ND JB	NA	0.00710 J		0.003 J
Radium 226																	
Radium 228	1	5 pCi/L	0.533	ND	0.46	ND	0.856	0.73	0.968	0.537		1.18	0.733	0.803	0.391		0.136
Selenium	0.01	0.05 mg/L	ND	ND	ND	ND JB	ND	ND	ND JB	ND	ND	ND	ND	ND	0.834		0.834
Thallium	0.001	0.002 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0.000800 J		ND V1 U

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

NA = Not Analyzed

ND = Not Detected at or above Method Detection Limit

pCi/L = picoCuries per Liter

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

B = Compound was found in the blank and sample.

D1 = MS and/or MSD Recovery is outside acceptance limits.

D2 = Sample required dilution due to high concentration of target analyte

H1 = Sample analysis performed pasts holding time

H3 = Sample received and analyzed past holding time

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

GREEN LANDFILL - CCR ANALYTICAL SUMMARY
MW-3A

APPENDIX III CONSTITUENTS		DATE												10/1/2019	
Detection Limit	GWPS	3/28/2016	5/23/2016	8/18/2016	11/14/2016	2/1/2017	5/2/2017	8/8/2017	9/6/2017	10/6/2017	6/5/2018	7/11/2018	9/28/2018	4/23/2019	10/1/2019
Boron	0.08	0.145	0.135 J	0.279 J	0.213 J	0.235 JB	0.232 J	0.304 JB	0.376 J	0.313		0.177 J	0.257 JB	0.259 JB	ND D2 U
Calcium	0.5	431	322 B	362	365 B	327	420	421	478 B	408		469	447 B	411	490 D1
Chloride	3	2630 H1	3070	2150 B	2150 B	2220 B	2120 B	1790 B	2270 B	1870 B		2180 B	2040 B	1850	4570 D
Fluoride	1	ND J	ND J	ND J	ND JB	ND J	ND JB	ND JB	3.16	ND J		ND J	ND JB	0.387 J	0.4
Sulfate	5	1330	1330	1190	1660	1080	1030 B	942	1130	1030 B		1010	1130 B	1080	1680 D
pH (SU)	0.10	6.92	6.86	6.95	6.75	7.17	7.11	6.81	6.9	6.85	6.84	6.55	7.98	7.23	7.33 H3
Total Dissolved Solids	10	4440	5010	4170	4450	4270	5170	5010	5020	5300		4540	4940	4250 B	6900 H1
APPENDIX IV CONSTITUENTS															
Antimony	0.002	ND	ND J	ND JB	ND JB	ND	ND JB	ND JB	ND JB	ND JB	ND JB	ND	NA	0.000102 JB	ND V1 U
Arsenic	0.005	0.01 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND JB	ND JB	ND J	ND JB	0.000575 JB	ND D2 U
Barium	0.2	2 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	0.0474 J	0.051 D2 U
Beryllium	0.002	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0.000199 J	ND D2 U
Cadmium	0.001	0.005 mg/L	ND J	ND J	ND	ND J	ND J	ND	ND	ND J	ND J	ND J	ND J	0.000164 J	ND V1 U
Chromium	0.003	0.1 mg/L	ND J	ND J	ND	ND	ND	ND	ND	ND J	ND JB	ND	NA	0.00168 JB	ND D2 U
Cobalt	0.005	0.006 mg/L	ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND JB	ND J	NA	0.000243 J	0.008
Fluoride	1	4 mg/L	ND J	ND J	ND J	ND J	ND JB	ND JB	3.16	ND J	ND J	ND J	ND JB	0.387 J	0.4
Lead	0.005	0.015 mg/L	ND J	ND	ND	ND	ND	ND J	ND J	ND J	ND	ND J	NA	0.000137 J	ND V1 U
Lithium	0.05	0.040 mg/L	0.516	0.648	0.677	0.689	0.746	0.767	0.762		0.699	0.790	0.766	0.878	0.79 D1
Mercury	0.0002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND V1 U
Molybdenum	0.01	0.1 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND D2 U
Radium 226															
Radium 228	1	1.3%	0.386	0.472	1.15	1.15	0.923	1.53	1.03		1.18	1.43	1.21	0.641	0.139
Selenium	0.01	0.05 mg/L	ND	ND	ND J	ND JB	ND	ND	ND				NA	0.00103 J	ND D2 U
Thallium	0.001	0.002 mg/L	ND	ND J	ND	ND	ND	ND	ND J		ND	ND	NA	0.00080 J	ND V1 U

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

NA = Not Analyzed

ND = Not Detected at or above Method Detection Limit

pCi/L = picocuries per liter

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

B = Compound was found in the blank and sample.

H1 = Sample was prepared or analyzed beyond the specified holding time

D1 = Sample required dilution due to high concentration of target analyte

D2 = Sample required dilution due to matrix interference

H1 = Sample analysis performed pasts holding time

H3 = Sample received and analyzed past holding time

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

GREEN LANDFILL - CCR ANALYTICAL SUMMARY
MW-4

APPENDIX III CONSTITUENTS		GWPS	Detection Limit	DATE												
				Baseline Events												
		3/29/2016	5/23/2016	8/18/2016	10/26/2016	2/1/2017	5/2/2017	8/18/2017	9/7/2017	10/6/2017	6/5/2018	7/11/2018	9/28/2018	4/22/2019	Assessment	10/1/2019
Boron	0.08	0.602	0.498 J	1.58	1.7	1.54 B	2.09	2.51 B	2.87 B	1.36		0.751 J	1.33 B	1.25 B	1.75 D2	
Calcium	0.5	660	386 B	464	558	591	774	743	739	828		822	722 B	730	680 D1	
Chloride	3	1450 B	939 B	952 B	1000 B	1420 B	1320 B	1360 B	1890 B	1730 B		1430 B	1310 B	1510 D	1910 D	
Fluoride	1	ND J	ND J	ND J	ND JB	ND J	1.06 B	ND J	ND JB	ND J		ND J	ND JB	0.102 J	0.2	
Sulfate	5	1830	1840	1420	1420 B	1620	1430 B	1600 B	2020	1590 B		1460	1400 B	1440	2490 D	
pH (SU)	0.10	6.36	6.83	7.08	6.61	7.28	7.1	6.84	6.84	6.93	6.86	6.58	8.06	7.25	7.38 H3	
Total Dissolved Solids	10	3700	4250	3440	3250	4420	4550	4690	4700 H	6220		4880	5170	4840 B	4820 H1	
APPENDIX IV CONSTITUENTS																
Antimony	0.002	ND	ND J	ND JB	ND	ND	ND JB	ND JB	ND JB		ND JB	ND	NA	0.000360 JB	ND V1 U	
Arsenic	0.005	ND	ND J	ND J	ND J	ND J	ND J	ND J	ND JB		ND JB	ND J	ND JB	0.000445 JB	ND D2 U	
Barium	0.2	2 mg/L	ND J	ND J	ND JB	ND J	ND J	ND J	ND JB		ND J	ND	NA	0.0308 JB	0.029 D2 J	
Beryllium	0.002	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND		ND	ND	NA	ND	ND D2 U	
Cadmium	0.001	0.005 mg/L	ND J	ND	ND	ND	ND	ND	ND		ND	ND	NA	ND	ND V1 U	
Chromium	0.003	0.1 mg/L	ND	ND	ND	ND	ND	ND	ND		ND JB	ND	NA	0.00110 JB	ND D2 U	
Cobalt	0.005	0.006 mg/L	ND	ND	ND	ND	ND	ND	ND		ND JB	ND J	NA	0.000415 J	ND U	
Fluoride	1	4 mg/L	ND	ND J	ND JB	ND J	ND B	ND	ND JB		ND J	ND J	ND JB	0.102 J	0.2	
Lead	0.005	0.045 mg/L	ND J	ND J	ND	ND	ND	ND	ND		ND J	ND J	ND	NA	ND V1 U	
Lithium	0.05	0.040 mg/L	1.39	0.838	1.25	1.35	1.59	1.77	1.66		1.81	ND	1.81	1.73	ND D2 V1 U	
Mercury	0.002	0.002 mg/L	0.00027	0.00224	0.00248	0.00302	0.00717	0.00825	0.00845		0.00632	0.00680	0.00680	0.0004 V1 J	0.0004 V1 J	
Molybdenum	0.01	0.1 mg/L	ND J	ND J	ND	ND	ND	ND	ND		ND	ND	NA	ND	ND D2 U	
Radium 226																
Radium 228	1	5 pCi/L	1.26	0.592	0.536	1.22	1.43	1.94	1.19		1.62	2.00	1.51	1.66	0.451	
Selenium	0.01	0.05 mg/L	ND J	ND J	ND J	ND J	ND	ND	ND J		ND J	ND	NA	0.00211 J	ND U	
Thallium	0.001	0.002 mg/L	ND	ND	ND	ND	ND	ND	ND		ND	ND	NA	0.000410 J	ND V1 U	

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

NA = Not Analyzed

ND = Not Detected at or above Method Detection Limit

pCi/L = picoCuries per Liter

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

B = Compound was found in the blank and sample.

H = Sample was prepared or analyzed beyond the specified holding time

D1 = Sample required dilution due to high concentration of target analyte

D2 = Sample required dilution due to matrix interference

H1 = Sample analysis performed pasts holding time

H3 = Sample received and analyzed past holding time

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

GREEN LANDFILL - CCR ANALYTICAL SUMMARY
MW-5

APPENDIX III CONSTITUENTS		Detection Limit		GWPS		DATE										Assessment		9/30/2019	
						3/29/2016	5/23/2016	8/18/2016	10/26/2016	2/1/2017	5/2/2017	8/7/2017	9/7/2017	10/6/2017	6/5/2018	7/1/2018	9/28/2018	4/22/2019	9/30/2019
						Baseline Events										Re-Sampling			
						0.217	0.0896 J	0.216 J	0.214 J	0.222 JB	0.241 J	0.257 JB	0.276 B	0.262	0.207 J	0.263 JB	0.271 JB	0.271 JB	ND D2 U
Boron		0.08		0.006 mg/L		452	189 B	374	399	335	464	423	407 B	383	469	441 B	446	476 D1	ND D2 U
Calcium		0.5		0.01 mg/L		163 ^U B	521	688 B	755 B	734 B	722 B	945 B	779 B	608 B	941 B	1140 B	931	1500 D	ND D2 U
Chloride		3		2 mg/L		ND J	ND J	ND J	ND J	ND J	ND J	ND J	3.69	ND J	ND J	ND J	ND J	0.128 J	0.2
Fluoride		1		0.004 mg/L		1760 ^H HB	576	1780	1740 B	1860	1760 B	2060 B	1920	1600 B	1800	1890 B	1800	2990 D	ND D2 U
Sulfate		5		0.005 mg/L		6.76	6.74	6.99	6.61	7.14	7.44	6.87	7.13	7.06	6.88	6.40	7.98	7.15	7.41 H3
pH (SU)		0.10		0.1 mg/L		4210	1660	3470	3610	3680	4250	4130	4120	4390	4100	4540	4360 B	5320 H1	5320 H1
Total Dissolved Solids		10		0.006 mg/L															
APPENDIX IV CONSTITUENTS																			
Antimony		0.002		0.006 mg/L		ND	ND J	ND JB	ND J	ND J	ND JB	ND JB	ND JB	ND JB	ND JB	ND JB	0.000700 JB	0.000700 JB	ND V1 U
Arsenic		0.005		0.01 mg/L		ND	ND J	ND JB	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	0.00424 JB	0.00424 JB	ND D2 U
Barium		0.2		2 mg/L		ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	0.0167 J	0.0167 J	0.016 D2 J
Beryllium		0.002		0.004 mg/L		ND	ND	ND J	ND J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND D2 U
Cadmium		0.001		0.005 mg/L		ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND	ND	ND V1 U
Chromium		0.003		0.1 mg/L		ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND	ND	ND	ND V1 U
Cobalt		0.005		0.006 mg/L		ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND	0.00159 JB	0.00159 JB	0.0033
Fluoride		1		4 mg/L		ND J	ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	0.000288 J	0.000288 J	ND J
Lead		0.005		0.015 mg/L		ND J	ND J	ND J	ND J	ND J	ND J	ND J	3.69	ND J	ND J	ND J	0.128 J	0.128 J	0.2
Lithium		0.05		0.040 mg/L		0.521	0.136	0.305	0.325	0.368	0.415	0.405	0.353	ND	ND J	ND J	0.0000860 J	0.0000860 J	ND V1 U
Mercury		0.0002		0.002 mg/L		ND	ND	ND	ND	ND	ND	0.00351	ND	ND	ND	0.481	0.425	0.434	0.40 D1
Molybdenum		0.01		0.1 mg/L		ND	ND J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND V1 U
Radium 226		1		5 pCi/L		1.16	0.736	0.959	0.957	0.765	0.888	1.54	0.773	ND	ND	ND	ND	ND	ND D2 U
Radium 228																			0.368
Selenium		0.01		0.05 mg/L		ND	ND	ND	ND	ND J	ND J	ND	ND	ND	ND J	1.42	1.37	0.845	0.730
Thallium		0.001		0.002 mg/L		ND	ND	ND J	ND J	ND	ND J	ND	ND	ND J	ND J	ND	ND	0.000824 J	0.000824 J
																			ND V1 U

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

NA = Not Analyzed

ND = Not Detected at or above Method Detection Limit

pCi/L = picocuries per liter

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

B = Compound was found in the blank and sample.

H = Sample was prepped or analyzed beyond the specified holding time

D1 = Sample required dilution due to high concentration of target analyte

D2 = Sample required dilution due to matrix interference

H1 = Sample analysis performed pasts holding time

H3 = Sample received and analyzed past holding time

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

GREEN LANDFILL - CCR ANALYTICAL SUMMARY
MW-6

APPENDIX III CONSTITUENTS	Detection Limit	GWPS	DATE												Assessment	Re-Sampling	9/28/2018	4/22/2019	9/30/2019
			Baseline Events						DATE										
			3/29/2016	5/23/2016	8/18/2016	10/26/2016	2/1/2017	5/2/2017	8/7/2017	9/5/2017	10/5/2017	6/4/2018	7/10/2018	9/28/2018	4/22/2019	9/30/2019			
Boron	0.08		0.156	0.137 J	0.193 J	0.168 J	0.173 B	0.179 J	0.167 J/B	0.199 J	0.178		0.155 J	0.196 J/B	0.194 J/B				
Calcium	0.5		467	374 B	373	400	320	415	365	382 B	376		386	356 B	421	ND D2 U			
Chloride	3		167 B	149 B	136 B	150 B	125 B	129 B	120 B	123 B	138 B		147 B	142 B	142	431 D1			
Fluoride	1		ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J		ND J	ND J/B	ND	230 D			
Sulfate	5		2250 HB	3340	2550	2610 B	2700	2600 B	2820 B	2490	2700 B		2120	2420	2200	0.5			
pH (SU)	0.10		6.66	6.65	6.96	6.6	6.92	6.97	6.76	6.95	6.86		6.50	7.94	€ 86	3830 D			
Total Dissolved Solids	10		4060	4280	4350	4470	4720	4700	4530	4890	4970		4500	4820	4780 B	7.15 H3			
APPENDIX IV CONSTITUENTS																			
Antimony	0.002	0.006 mg/L	ND	ND J	ND J/B	ND J	ND J	ND J/B	ND J/B	ND J/B	ND J/B	ND J/B	ND J/B	NA	0.0008920 J/B	ND V1 U			
Arsenic	0.005	0.01 mg/L	ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J/B	ND J/B	ND J/B	ND J/B	ND J/B	0.000722 J/B	ND V1 U			
Barium	0.2	2 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	0.0728 J	0.010 D2 J			
Beryllium	0.002	0.004 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND D2 U			
Cadmium	0.001	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND V1 U			
Chromium	0.003	0.1 mg/L	ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J/B	ND J/B	NA	0.00196 J/B	ND J			
Cobalt	0.005	0.006 mg/L	ND	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J/B	ND J/B	NA	0.000276 J	ND U			
Fluoride	1	4 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	0.409 J	0.5			
Lead	0.005	0.015 mg/L	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J	ND J/B	ND	ND V1 U			
Lithium	0.05	0.040 mg/L	0.047% J	0.0527	0.0555	0.0524	0.0607	0.0724	0.0589	0.0554		0.0550	0.0592	0.0558	0.0633	0.05 D2 V1 J			
Mercury	0.0002	0.002 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND V1 U			
Molybdenum	0.01	0.1 mg/L	ND J	ND J	ND J	ND B	ND J	ND J	ND J	ND J	ND J	ND J	ND J	NA	0.000972 J	ND D2 U			
Radium 226																			
Radium 228	1	5 pCi/L	0.741	0.386	ND	0.751	ND	ND	0.462	ND		0.392	0.532	ND U	0.450	0.548			
Selenium	0.01	0.05 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0.00110 J	ND J			
Thallium	0.001	0.002 mg/L	ND	ND J	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0.000610 J	ND V1 U			

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

NA = Not Analyzed

ND = Not Detected at or above Method Detection Limit

pCi/L = picocuries per liter

J or U = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

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D2 = Sample required dilution due to matrix interference

H1 = Sample analysis performed pasts holding time

H3 = Sample received and analyzed past holding time

U = Target analyte was analyzed for, but was below detection limit

V1 = CCV recovery was above method acceptance limits. This target analyte not detected in the sample

GREEN LANDFILL - CCR ANALYTICAL SUMMARY
NW-104

APPENDIX III CONSTITUENTS	Detection Limit	GWPS	DATE		
			3/29/2019	4/10/2019	10/25/2019
			Characterization		
Boron	0.08		0.1880 JB	0.2710 JB	ND D2, U
Calcium	0.5		465 B	502	505 D1
Chloride	3		1430	1430 B	1610 D
Fluoride	1		ND	0.3230 JB	0.4
Sulfate	5		2870	2880 B	2440 D
pH (Field Measurement)	0.10		6.88	6.99	6.86
Total Dissolved Solids	10		6690	6690	7330
APPENDIX IV CONSTITUENTS					
Antimony	0.002	0.006 mg/L	0.0001 JB	0.0001 JB	ND U
Arsenic	0.005	0.01 mg/L	0.0022 J	0.0021 J	0.0039
Barium	0.2	2 mg/L	0.0243 J	0.0216 JB	0.030
Beryllium	0.002	0.004 mg/L	ND	ND	ND U
Cadmium	0.001	0.005 mg/L	ND	ND	0.0004 J
Chromium	0.003	0.1 mg/L	0.0047 B	0.0036	0.0066
Cobalt	0.005	0.006 mg/L	0.0059 B	0.0052	0.011
Fluoride	1	4 mg/L	ND	0.3230 JB	0.4
Lead	0.005	0.015 mg/L	0.0011 J	0.0002 J	0.003
Lithium	0.05	0.040 mg/L	0.0281 J	0.0286 J	0.02
Mercury	0.0002	0.002 mg/L	ND	ND ^	ND U
Molybdenum	0.01	0.1 mg/L	0.0015 J	0.0010 J	0.005 J
Radium 226	1	5 pCi/L	0.7760	0.3190 U	0.126
Radium 228					1.52
Selenium	0.01	0.05 mg/L	ND	ND	ND U
Thallium	0.001	0.002 mg/L	ND	ND	ND U

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)

GWPS = Groundwater Protection Standard

ND = Not Detected at or above Method Detection Limit

pCi/L = picoCuries per Liter

J = Result is less than the Reporting Limit but greater than or equal to the Method Detection Limit and the concentration is an approximate value.

B = Compound was found in the blank and sample.

D1 = Sample required dilution due to high concentration of target analyte

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U = Target analyte was analyzed for, but was below detection limit

Appendix C

Green Landfill Statistical Procedures and Results

1.0 GREEN LANDFILL STATISTICAL PROCEDURES AND RESULTS

The Appendix III and IV groundwater quality data for the Green Landfill were evaluated using an interwell approach that statistically compared constituent concentrations at downgradient compliance monitoring wells to those present at a background monitoring well. For the Green Landfill, monitoring well MW-1 is designated as the background well because it is located upgradient, whereas monitoring wells MW-2, MW-3A, MW-4, MW-5, and MW-6 are designated as compliance wells because they are located downgradient.

The statistical analyses were performed in accordance with the U.S. Environmental Protection Agency's Final CCR Rule 40 CFR Parts 257.93(f), 257.93(g), and 257.93(h) and the Groundwater Monitoring System and Statistical Methods Certification. Prediction limits (i.e., parametric or nonparametric) with 1 of 2 retesting were developed for each constituent based on the frequency of non-detect values and whether the background data for that constituent exhibited a normal, lognormal, or nonparametric distribution. For the statistical analysis, non-detect values were represented as one-half the detection limit. No outliers were identified in the background data. Analytical data from the background monitoring wells collected between March 2016 and October 2019 were used to develop an upper prediction limit (UPL) for the Appendix III and IV background data at 95 percent confidence. Data from the downgradient monitoring wells for the same time period were compared to the UPL to identify statistically significant increases (SSIs) over background. Mann-Kendall trend analysis was used to identify statistically significant increasing trends for constituents with SSIs. ProUCL Version 5.1 was used to store the data and run the statistical analyses. The results of the analyses, including the UPLs, are provided in **Tables C1** and **C2**.

The statistical analysis results indicate that Appendix III constituents calcium, chloride, sulfate, and total dissolved solids (TDS) at monitoring wells MW-2, MW-3A, MW-4, MW-5, and MW-6 have SSIs over background (**Table C3**) that were confirmed by subsequent sampling events. Boron, fluoride, and pH did not have any verified SSIs over background. pH at MW-6 had a verified SSI below the background lower prediction limit (LPL). Based on these results, assessment monitoring was conducted at the landfill. Statistical analysis of the April and October 2019 Appendix IV assessment monitoring results indicate that arsenic and barium at monitoring well MW-2, lithium at monitoring wells MW-3A, MW-4, MW-5, and MW-6, and mercury at monitoring well MW-4 have verified SSIs over background (**Table C4**).

The Appendix IV constituents with SSIs were further evaluated to determine whether they are present at statistically significant levels (SSLs) over the groundwater protection standards (GWPS) by calculating the lower confidence limit at 95% confidence (95LCL) for each well and constituent identified as a SSI using the baseline, detection, and assessment monitoring results collected to date. For a constituent to be present at a SSL over the GWPS, its 95LCL must be greater than the GWPS. **Table C5** provides a summary of the 95LCLs and GWPS for arsenic, barium, lithium, and mercury at monitoring wells MW-2, MW-3A, MW-4, MW-5, and MW-6. The results indicate that lithium at monitoring wells MW-3A, MW-4, MW-5, and MW-6 (yellow highlight) is present as a SSL above the GWPS. The LCLs for the remaining wells and constituents (arsenic, barium, and mercury) are less than the GWPS and thus are not considered SSLs.

Table C1. Well MW-1 Appendix III Constituents Background Upper Prediction Limits

Parameter (Units)	Number of Samples	Percent Non-detects	Normal or Lognormal Distribution?	Statistical Test	Background Limit
Boron (mg/L)	13	0	Yes/Yes	Parametric	2.122
Calcium (mg/L)	13	0	Yes/Yes	Parametric	35
Chloride (mg/L)	13	0	Yes/No	Parametric	9.3
Fluoride (mg/L)	13	0	No/No	Nonparametric	0.89
pH (std units)	13	0	Yes/Yes	Parametric	6.99/7.93
Sulfate (mg/L)	13	0	Yes/Yes	Parametric	33
TDS (mg/L)	13	0	No/No	Nonparametric	636

Note: pH has both a lower prediction limit (LPL) and upper prediction limit (UPL); all other constituents are represented as UPLs

Table C2. Well MW-1 Appendix IV Constituents Background Upper Prediction Limits

Parameter (Units)	Number of Samples	Percent Non-detects	Normal or Lognormal Distribution?	Statistical Test	Background Limit
Antimony (mg/L)	13	31	No/No	Nonparametric	0.003
Arsenic (mg/L)	12	0	No/No	Nonparametric	0.0026
Barium (mg/L)	12	0	Yes/Yes	Parametric	0.098
Beryllium (mg/L)	12	92	No/No	Nonparametric	0.002
Cadmium (mg/L)	12	92	No/No	Nonparametric	0.001
Chromium (mg/L)	12	62	Yes/Yes	Parametric	0.0024
Cobalt (mg/L)	12	8	Yes/Yes	Parametric	0.0014
Fluoride (mg/L)	13	0	No/No	Nonparametric	0.89
Lead (mg/L)	13	46	Yes/No	Parametric	0.0003
Lithium (mg/L)	12	8	Yes/Yes	Parametric	0.037
Mercury (mg/L)	13	100	No/No	Nonparametric	0.0002
Molybdenum (mg/L)	13	31	No/No	Nonparametric	0.01
Ra-226+228 (pCi/L)	12	0	No/Yes	Parametric	1.74
Selenium (mg/L)	12	85	No/No	Nonparametric	0.01
Thallium (mg/L)	13	61	No/No	Nonparametric	0.0006

Note: The UPL for constituents with 100 percent nondetects (Be, Cd, and Hg) is established as the maximum laboratory analytical reporting limit.

Table C3. Big Rivers Green Landfill Appendix III SSI Summary

Well	Location	B	Ca	Cl	F	pH (LPL/UPL)		SO4	TDS
MW-1	Upgradient	P	P	P	NP	P	P	P	NP
MW-2	Downgradient								
MW-3A	Downgradient								
MW-4	Downgradient								
MW-5	Downgradient								
MW-6	Downgradient								

Notes:

SSIs determined using interwell prediction limits; MW-8 is upgradient background well

P = parametric prediction limit; NP = nonparametric prediction limit

Less than or equal to background upper prediction limit (UPL) or greater than lower prediction limit (LPL) for pH

Statistically significant increase (SSI) over background UPL or below background LPL for pH

Table C5. Summary of LCLs and GWPS for Arsenic, Barium, Lithium, and Mercury

Well	Parameter	95%LCL (mg/L)	GWPS (mg/L)
MW-2	Arsenic	0.008	0.01
MW-2	Barium	0.25	2.0
MW-3A	Lithium	0.65	0.04
MW-3A	Mercury	0.0001	0.002
MW-4	Lithium	1.04	0.04
MW-5	Lithium	0.32	0.04
MW-6	Lithium	0.055	0.04

95%LCL = lower confidence limit at 95% confidence. Yellow highlighted results exhibit a statistically significant level (SSL) above the GWPS.

Appendix D

Green Landfill – April 2020 Groundwater Analytical Data



Pace Analytical Services, LLC
P.O. Box 907
Madisonville, KY 42431
270.821.7375
www.pacelabs.com

Certificate of Analysis 0041376

Chad Phillips
Big Rivers Electric Corporation Reid/Green Station
PO Box 24
Henderson KY, 42419

Customer ID: 44-102032
Report Printed: 04/30/2020 14:59

Project Name: Green Landfill Semiannual Groundwater

Workorder: 0041376

Dear Chad Phillips

Enclosed are the analytical results for samples received at one of our laboratories on 04/07/2020 15:49.

Pace Analytical Services LLC Kentucky is a commercial laboratory accredited by various state and national authorities, including Indiana, Kentucky, Tennessee, and Virginia's National Environmental Laboratory Accreditation Program (NELAP). With the NELAP accreditation, applicable test results are certified to meet the requirements of the National Environmental Laboratory Accreditation Program.

If you have any questions concerning this report please contact the individual listed below.

Please note that this certificate of analysis may not be reproduced without the written consent of Pace Analytical Services, LLC Kentucky.



#460210 Madisonville, KY
#460293 Pikeville, KY

Rob Whittington, Project Manager

This page is included as part of the Analytical Report and must be retained as a permanent record thereof.

SAMPLE SUMMARY

Lab ID	Client Sample ID/Alias	Matrix	Date Collected	Date Received	Sampled By
0041376-01	MW1/	Groundwater	04/06/2020 13:05	04/07/2020 15:49	Phillip Hill
0041376-02	MW2/	Groundwater	04/07/2020 11:40	04/07/2020 15:49	Phillip Hill
0041376-03	MW3A/	Groundwater	04/07/2020 13:55	04/07/2020 15:49	Phillip Hill
0041376-04	MW4/	Groundwater	04/07/2020 09:55	04/07/2020 15:49	Phillip Hill
0041376-05	MW5/	Groundwater	04/07/2020 10:10	04/07/2020 15:49	Phillip Hill
0041376-06	MW6/	Groundwater	04/06/2020 14:20	04/07/2020 15:49	Phillip Hill
0041376-07	DUPLICATE/	Groundwater	04/07/2020 10:20	04/07/2020 15:49	Phillip Hill
0041376-08	FIELD BLANK/	Water	04/07/2020 11:50	04/07/2020 15:49	Phillip Hill
<u>LabNumber</u>	<u>Measurement</u>	<u>Value</u>			
0041376-01	Field Conductance	867			
	Field pH	7.22			
	Field Temp (C)	18.23			
0041376-02	Field Conductance	1590			
	Field pH	6.92			
	Field Temp (C)	16.86			
0041376-03	Field Conductance	8090			
	Field pH	6.92			
	Field Temp (C)	16.86			
0041376-04	Field Conductance	6770			
	Field pH	6.70			
	Field Temp (C)	16.47			
0041376-05	Field Conductance	6250			
	Field pH	6.77			
	Field Temp (C)	14.85			
0041376-06	Field Conductance	5010			
	Field pH	6.36			
	Field Temp (C)	20.50			
0041376-07	Field Conductance	6770			
	Field pH	6.70			
	Field Temp (C)	16.47			



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ANALYTICAL RESULTS

Lab Sample ID: **0041376-01**
Description: **MW1**

Sample Collection Date Time: 04/06/2020 13:05
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	u	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Arsenic	0.0019		mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Barium	0.087		mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Beryllium	ND	u	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Boron	1.69	D1, M3	mg/L	1.00	1.00	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:42	DMH
Cadmium	ND	u	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Calcium	27.7	D1, M3	mg/L	4.00	1.30	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:42	DMH
Chromium	0.0011	J	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Cobalt	ND	u	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Copper	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Iron	1.57		mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:39	DMH
Lead	ND	u	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Lithium	0.03		mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Mercury	ND	u	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Molybdenum	ND	u	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Selenium	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH
Sodium	206	D1, M3	mg/L	26.0	10.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:46	DMH
Thallium	0.0001	J	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:13	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	ND	u	mg/L	8	8	HACH 8000	04/10/2020 13:13	04/10/2020 13:13	ALT
Specific Conductance (Lab)	962		umhos/cm	1	1	2510 B-2011	04/09/2020 15:52	04/09/2020 15:52	JLW
pH (Lab)	7.50	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:14	04/09/2020 16:14	GAT
Total Dissolved Solids	488		mg/L	50	50	2540 C-2011	04/13/2020 10:14	04/14/2020 12:26	MAG
Total Organic Carbon	1.0		mg/L	0.5		5310 C-2011	04/14/2020 10:27	04/14/2020 10:27	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.340	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	0.468	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	0.808	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	6.5		mg/L	2.0	1.3	SW846 9056	04/16/2020 00:56	04/16/2020 00:56	CSC
Fluoride	0.5		mg/L	0.2	0.1	SW846 9056	04/16/2020 00:56	04/16/2020 00:56	CSC
Sulfate	21		mg/L	1	0.5	SW846 9056	04/16/2020 00:56	04/16/2020 00:56	CSC



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ANALYTICAL RESULTS

Lab Sample ID: **0041376-02**
Description: **MW2**

Sample Collection Date Time: 04/07/2020 11:40
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	u	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Arsenic	0.0033		mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Barium	0.238		mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Beryllium	ND	u	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Boron	ND	u	mg/L	0.10	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:49	DMH
Cadmium	ND	u	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Calcium	145	D1	mg/L	40.0	13.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:55	DMH
Chromium	ND	u	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Cobalt	ND	u	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Copper	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Iron	0.459		mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:49	DMH
Lead	ND	u	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Lithium	0.007	J	mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Mercury	ND	u	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Molybdenum	0.002	J	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Selenium	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH
Sodium	66.5	D1	mg/L	26.0	10.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 16:55	DMH
Thallium	ND	u	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:16	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	12		mg/L	8	8	HACH 8000	04/10/2020 13:13	04/10/2020 13:13	ALT
Specific Conductance (Lab)	1530		umhos/cm	1	1	2510 B-2011	04/09/2020 15:53	04/09/2020 15:53	JLW
pH (Lab)	7.22	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:15	04/09/2020 16:15	CML
Total Dissolved Solids	806		mg/L	50	50	2540 C-2011	04/13/2020 10:18	04/14/2020 12:26	MAG
Total Organic Carbon	1.0		mg/L	0.5		5310 C-2011	04/14/2020 10:48	04/14/2020 10:48	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.513	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	0.016	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	0.529	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	120	D	mg/L	100	64.0	SW846 9056	04/16/2020 01:29	04/16/2020 01:29	CSC
Fluoride	0.2		mg/L	0.2	0.1	SW846 9056	04/16/2020 01:12	04/16/2020 01:12	CSC
Sulfate	85	D	mg/L	50	25	SW846 9056	04/16/2020 01:29	04/16/2020 01:29	CSC



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ANALYTICAL RESULTS

Lab Sample ID: **0041376-03**
Description: **MW3A**

Sample Collection Date Time: 04/07/2020 13:55
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	u	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Arsenic	ND	u	mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Barium	0.042		mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Beryllium	ND	u	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Boron	0.26		mg/L	0.10	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:11	DMH
Cadmium	0.0001	J	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Calcium	425	D1	mg/L	40.0	13.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:17	DMH
Chromium	ND	u	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Cobalt	ND	u	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Copper	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Iron	ND	u	mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:11	DMH
Lead	ND	u	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Lithium	0.68		mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Mercury	ND	u	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Molybdenum	ND	u	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Selenium	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH
Sodium	352	D1	mg/L	26.0	10.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:17	DMH
Thallium	ND	u	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:20	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	160		mg/L	8	8	HACH 8000	04/10/2020 13:14	04/10/2020 13:14	ALT
Specific Conductance (Lab)	7660		umhos/cm	1	1	2510 B-2011	04/09/2020 15:54	04/09/2020 15:54	JLW
pH (Lab)	7.07	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:16	04/09/2020 16:16	CML
Total Dissolved Solids	5860		mg/L	50	50	2540 C-2011	04/13/2020 10:22	04/14/2020 12:26	MAG
Total Organic Carbon	ND	u	mg/L	0.5		5310 C-2011	04/14/2020 12:15	04/14/2020 12:15	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.603	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	0.460	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	1.06	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	3220	D	mg/L	200	128	SW846 9056	04/16/2020 02:02	04/16/2020 02:02	CSC
Fluoride	0.5		mg/L	0.2	0.1	SW846 9056	04/16/2020 01:45	04/16/2020 01:45	CSC
Sulfate	1840	D	mg/L	100	50	SW846 9056	04/16/2020 02:02	04/16/2020 02:02	CSC



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ANALYTICAL RESULTS

Lab Sample ID: 0041376-04
Description: MW4

Sample Collection Date Time: 04/07/2020 09:55
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	u	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Arsenic	ND	u	mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Barium	0.022		mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Beryllium	ND	u	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Boron	0.83		mg/L	0.10	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:20	DMH
Cadmium	ND	u	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Calcium	464	D1	mg/L	40.0	13.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:27	DMH
Chromium	0.0008	J	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Cobalt	ND	u	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Copper	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Iron	ND	u	mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:20	DMH
Lead	ND	u	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Lithium	0.82		mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Mercury	0.0003	J	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Molybdenum	0.002	J	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Selenium	0.023		mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH
Sodium	433	D1	mg/L	26.0	10.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:27	DMH
Thallium	ND	u	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:24	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	44		mg/L	8	8	HACH 8000	04/10/2020 13:14	04/10/2020 13:14	ALT
Specific Conductance (Lab)	6460		umhos/cm	1	1	2510 B-2011	04/09/2020 15:55	04/09/2020 15:55	JLW
pH (Lab)	7.10	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:17	04/09/2020 16:17	CML
Total Dissolved Solids	5120		mg/L	50	50	2540 C-2011	04/13/2020 10:26	04/14/2020 12:26	MAG
Total Organic Carbon	0.6		mg/L	0.5		5310 C-2011	04/14/2020 12:37	04/14/2020 12:37	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.476	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	0.787	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	1.26	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	1560	D	mg/L	200	128	SW846 9056	04/16/2020 02:34	04/16/2020 02:34	CSC
Fluoride	0.2		mg/L	0.2	0.1	SW846 9056	04/16/2020 02:18	04/16/2020 02:18	CSC
Sulfate	4000	D	mg/L	100	50	SW846 9056	04/16/2020 02:34	04/16/2020 02:34	CSC



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ANALYTICAL RESULTS

Lab Sample ID: **0041376-05**
Description: **MW5**

Sample Collection Date Time: 04/07/2020 10:10
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	u	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Arsenic	ND	u	mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Barium	0.014		mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Beryllium	ND	u	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Boron	0.25		mg/L	0.10	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:30	DMH
Cadmium	ND	u	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Calcium	464	D1	mg/L	40.0	13.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:36	DMH
Chromium	ND	u	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Cobalt	ND	u	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Copper	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Iron	ND	u	mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:30	DMH
Lead	ND	u	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Lithium	0.38		mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Mercury	ND	u	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Molybdenum	ND	u	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Selenium	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH
Sodium	217	D1	mg/L	26.0	10.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:36	DMH
Thallium	ND	u	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:28	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	463		mg/L	8	8	HACH 8000	04/10/2020 13:14	04/10/2020 13:14	ALT
Specific Conductance (Lab)	5950		umhos/cm	1	1	2510 B-2011	04/09/2020 15:56	04/09/2020 15:56	JLW
pH (Lab)	6.94	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:18	04/09/2020 16:18	CML
Total Dissolved Solids	4960		mg/L	50	50	2540 C-2011	04/13/2020 10:30	04/14/2020 12:26	MAG
Total Organic Carbon	0.6		mg/L	0.5		5310 C-2011	04/16/2020 21:48	04/16/2020 21:48	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.302	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	1.18	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	1.48	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	1860	D	mg/L	200	128	SW846 9056	04/16/2020 03:07	04/16/2020 03:07	CSC
Fluoride	0.2		mg/L	0.2	0.1	SW846 9056	04/16/2020 02:51	04/16/2020 02:51	CSC
Sulfate	3720	D	mg/L	100	50	SW846 9056	04/16/2020 03:07	04/16/2020 03:07	CSC



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ANALYTICAL RESULTS

Lab Sample ID: 0041376-06
Description: MW6

Sample Collection Date Time: 04/06/2020 14:20
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	U	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Arsenic	ND	U	mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Barium	0.011		mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Beryllium	ND	U	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Boron	0.19		mg/L	0.10	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:49	DMH
Cadmium	0.0001	J	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Calcium	458	D1	mg/L	40.0	13.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:55	DMH
Chromium	ND	U	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Cobalt	ND	U	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Copper	ND	U	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Iron	0.078	J	mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:49	DMH
Lead	ND	U	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Lithium	0.05		mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Mercury	ND	U	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Molybdenum	ND	U	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Selenium	ND	U	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH
Sodium	435	D1	mg/L	26.0	10.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:55	DMH
Thallium	ND	U	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:32	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	22		mg/L	8	8	HACH 8000	04/10/2020 13:14	04/10/2020 13:14	ALT
Specific Conductance (Lab)	4960		umhos/cm	1	1	2510 B-2011	04/09/2020 15:57	04/09/2020 15:57	JLW
pH (Lab)	6.76	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:19	04/09/2020 16:19	CML
Total Dissolved Solids	4610		mg/L	50	50	2540 C-2011	04/13/2020 10:34	04/14/2020 12:26	MAG
Total Organic Carbon	2.0		mg/L	0.5		5310 C-2011	04/16/2020 22:11	04/16/2020 22:11	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.061	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	0.683	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	0.744	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	181	D	mg/L	100	64.0	SW846 9056	04/16/2020 04:13	04/16/2020 04:13	CSC
Fluoride	0.4		mg/L	0.2	0.1	SW846 9056	04/16/2020 03:57	04/16/2020 03:57	CSC
Sulfate	4650	D	mg/L	100	50	SW846 9056	04/16/2020 12:57	04/16/2020 12:57	CSC



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ANALYTICAL RESULTS

Lab Sample ID: 0041376-07
Description: DUPLICATE

Sample Collection Date Time: 04/07/2020 10:20
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	u	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Arsenic	ND	u	mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Barium	0.022		mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Beryllium	ND	u	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Boron	0.86		mg/L	0.10	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:58	DMH
Cadmium	ND	u	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Calcium	503	D1	mg/L	40.0	13.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 18:05	DMH
Chromium	0.0009	J	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Cobalt	ND	u	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Copper	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Iron	ND	u	mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 17:58	DMH
Lead	ND	u	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Lithium	0.84		mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Mercury	0.0003	J	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Molybdenum	0.003	J	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Selenium	0.025		mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH
Sodium	468	D1	mg/L	26.0	10.0	SW846 6010 B	04/09/2020 07:40	04/12/2020 18:05	DMH
Thallium	ND	u	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:36	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	62		mg/L	8	8	HACH 8000	04/10/2020 13:14	04/10/2020 13:14	ALT
Specific Conductance (Lab)	6410		umhos/cm	1	1	2510 B-2011	04/09/2020 15:58	04/09/2020 15:58	JLW
pH (Lab)	7.12	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:20	04/09/2020 16:20	CML
Total Dissolved Solids	4700		mg/L	50	50	2540 C-2011	04/13/2020 10:38	04/14/2020 12:26	MAG
Total Organic Carbon	0.8		mg/L	0.5		5310 C-2011	04/16/2020 22:34	04/16/2020 22:34	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.371	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	1.10	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	1.47	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	1480	D	mg/L	100	64.0	SW846 9056	04/21/2020 14:14	04/21/2020 14:14	CSC
Fluoride	0.2		mg/L	0.2	0.1	SW846 9056	04/16/2020 04:46	04/16/2020 04:46	CSC
Sulfate	4050	D	mg/L	100	50	SW846 9056	04/23/2020 12:44	04/23/2020 12:44	CSC



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ANALYTICAL RESULTS

Lab Sample ID: 0041376-08
Description: FIELD BLANK

Sample Collection Date Time: 04/07/2020 11:50
Sample Received Date Time: 04/07/2020 15:49

Metals by SW846 6000 Series Methods

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Antimony	ND	u	mg/L	0.005	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Arsenic	ND	u	mg/L	0.0010	0.0004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Barium	ND	u	mg/L	0.004	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Beryllium	ND	u	mg/L	0.0020	0.0010	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Boron	ND	u	mg/L	0.10	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 18:08	DMH
Cadmium	ND	u	mg/L	0.0010	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Calcium	ND	u	mg/L	0.40	0.13	SW846 6010 B	04/09/2020 07:40	04/12/2020 18:08	DMH
Chromium	ND	u	mg/L	0.0020	0.0006	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Cobalt	ND	u	mg/L	0.004	0.004	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Copper	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Iron	ND	u	mg/L	0.100	0.050	SW846 6010 B	04/09/2020 07:40	04/12/2020 18:08	DMH
Lead	ND	u	mg/L	0.002	0.0005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Lithium	ND	u	mg/L	0.02	0.005	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Mercury	ND	u	mg/L	0.0005	0.0002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Molybdenum	ND	u	mg/L	0.01	0.002	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Selenium	ND	u	mg/L	0.003	0.001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH
Sodium	ND	u	mg/L	0.26	0.10	SW846 6010 B	04/09/2020 07:40	04/12/2020 18:08	DMH
Thallium	ND	u	mg/L	0.0020	0.0001	SW846-6020 A	04/09/2020 07:40	04/12/2020 16:55	DMH

Conventional Chemistry Analyses Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chemical Oxygen Demand	ND	u	mg/L	8	8	HACH 8000	04/10/2020 13:15	04/10/2020 13:15	ALT
Specific Conductance (Lab)	8		umhos/cm	1	1	2510 B-2011	04/09/2020 15:59	04/09/2020 15:59	JLW
pH (Lab)	7.62	H3	Std. Units	0.10	0.10	4500-H+ B-2000	04/09/2020 16:21	04/09/2020 16:21	CML
Total Dissolved Solids	ND	u	mg/L	50	50	2540 C-2011	04/13/2020 10:42	04/14/2020 12:26	MAG
Total Organic Carbon	ND	u	mg/L	0.5		5310 C-2011	04/16/2020 22:57	04/16/2020 22:57	HMF

Subcontracted Analyses

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Radium-226	0.224	_Sub	pCi/L			EPA 903.1	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium-228	0.262	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW
Radium	0.486	_Sub	pCi/L			EPA 904.0 Radium Sum Calc	04/30/2020 14:07	04/30/2020 14:09	RCW

Ion Chromatography Madisonville

Analyte	Result	Flag	Units	MRL	MDL	Method	Prepared	Analyzed	Analyst
Chloride	ND	M1, U	mg/L	2.0	1.3	SW846 9056	04/16/2020 05:03	04/16/2020 05:03	CSC
Fluoride	ND	M1, U	mg/L	0.2	0.1	SW846 9056	04/16/2020 05:03	04/16/2020 05:03	CSC
Sulfate	ND	M1, U	mg/L	1	0.5	SW846 9056	04/16/2020 05:03	04/16/2020 05:03	CSC



Notes for work order 0041376

- Samples collected by MMLI personnel are done so in accordance with procedures set forth in MMLI field services SOPs.
 - Results contained in this report are only representative of the samples received.
 - MMLI does not provide interpretation of these results unless otherwise stated.
 - All Waste Water analyses comply with methodology requirements of 40 CFR Part 136.
 - All Drinking Water analyses comply with methodology requirements of 40 CFR Part 141.
 - Unless otherwise noted, all quantitative results for soils are reported on a dry weight basis.
 - The Chain of Custody document is included as part of this report.
 - All Library Search analytes should be regarded as tentative identification based on the presumptive evidence of the mass spectra.
- Concentrations reported are estimated values.

Qualifiers

_Sub	See subcontractors report.
D	Results reported from dilution.
D1	Sample required dilution due to high concentration of target analyte.
D2	Sample required dilution due to matrix interference.
H3	Sample received and analyzed past holding time.
J	Estimated value.
M1	Matrix spike recovery was high; the method control sample recovery was acceptable.
M3	The accuracy of the spike recovery value is reduced since the analyte concentration in the sample is disproportionate to spike level. The method control sample recovery was acceptable.
U	Target analyte was analyzed for, but was below detection limit (the value associated with the qualifier is the laboratory method detection limit in our LIMS system).

Standard Qualifiers/Acronyms

MDL	Method Detection Limit
MRL	Minimum Reporting Limit
ND	Not Detected
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
DUP	Sample Duplicate
% Rec	Percent Recovery
RPD	Relative Percent Difference
>	Greater than
<	Less than



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Metals by SW846 6000 Series Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch B015276 - EPA 200.2

Blank (B015276-BLK1)

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 16:05

Molybdenum	ND	0.01	mg/L							U
Antimony	ND	0.005	mg/L							U
Mercury	ND	0.0005	mg/L							U
Arsenic	ND	0.0010	mg/L							U
Barium	ND	0.004	mg/L							U
Beryllium	ND	0.0020	mg/L							U
Cadmium	ND	0.0010	mg/L							U
Chromium	ND	0.0020	mg/L							U
Cobalt	ND	0.004	mg/L							U
Copper	ND	0.003	mg/L							U
Lead	ND	0.002	mg/L							U
Lithium	ND	0.02	mg/L							U
Selenium	ND	0.003	mg/L							U
Thallium	ND	0.0020	mg/L							U

Blank (B015276-BLK2)

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 16:33

Boron	ND	0.10	mg/L							U
Calcium	ND	0.40	mg/L							U
Iron	ND	0.100	mg/L							U
Sodium	ND	0.26	mg/L							U

LCS (B015276-BS1)

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 16:09

Molybdenum	0.07	0.01	mg/L	0.0625		105	85-115			
Antimony	0.068	0.005	mg/L	0.0625		109	85-115			
Mercury	0.0025	0.0005	mg/L	0.00250		98.3	85-115			
Arsenic	0.0645	0.0010	mg/L	0.0625		103	85-115			
Barium	0.062	0.004	mg/L	0.0625		99.5	85-115			
Beryllium	0.0613	0.0020	mg/L	0.0625		98.1	85-115			
Cadmium	0.0621	0.0010	mg/L	0.0625		99.4	85-115			
Chromium	0.0641	0.0020	mg/L	0.0625		103	85-115			
Cobalt	0.064	0.004	mg/L	0.0625		102	85-115			
Copper	0.060	0.003	mg/L	0.0625		95.6	85-115			
Lead	0.062	0.002	mg/L	0.0625		98.7	85-115			
Lithium	0.06	0.02	mg/L	0.0625		96.9	85-115			
Selenium	0.065	0.003	mg/L	0.0625		104	85-115			
Thallium	0.0632	0.0020	mg/L	0.0625		101	85-115			



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Metals by SW846 6000 Series Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch B015276 - EPA 200.2

LCS (B015276-BS2)

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 16:36

Boron	0.12	0.10	mg/L	0.125		94.1	85-115			
Calcium	5.92	0.40	mg/L	6.25		94.8	85-115			
Iron	6.27	0.100	mg/L	6.25		100	85-115			
Sodium	6.12	0.26	mg/L	6.25		97.9	85-115			

Matrix Spike (B015276-MS1)

Source: 0041376-01

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 16:59

Molybdenum	0.06	0.01	mg/L	0.0625	ND	102	80-120			
Antimony	0.066	0.005	mg/L	0.0625	ND	106	80-120			
Mercury	0.0023	0.0005	mg/L	0.00250	ND	93.6	80-120			
Arsenic	0.0634	0.0010	mg/L	0.0625	0.0019	98.3	80-120			
Barium	0.150	0.004	mg/L	0.0625	0.087	101	80-120			
Beryllium	0.0547	0.0020	mg/L	0.0625	ND	87.4	80-120			
Cadmium	0.0562	0.0010	mg/L	0.0625	ND	89.9	80-120			
Chromium	0.0656	0.0020	mg/L	0.0625	0.0011	103	80-120			
Cobalt	0.063	0.004	mg/L	0.0625	ND	101	80-120			
Copper	0.056	0.003	mg/L	0.0625	ND	89.6	80-120			
Lead	0.056	0.002	mg/L	0.0625	ND	90.2	80-120			
Lithium	0.09	0.02	mg/L	0.0625	0.03	95.1	80-120			
Selenium	0.055	0.003	mg/L	0.0625	ND	88.1	80-120			
Thallium	0.0579	0.0020	mg/L	0.0625	0.0001	92.5	80-120			

Matrix Spike (B015276-MS2)

Source: 0041376-01

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 16:58

Boron	1.85	1.00	mg/L	0.125	1.69	132	80-120			D2, M3
Calcium	34.4	4.00	mg/L	6.25	27.7	106	80-120			D2
Iron	7.68	1.00	mg/L	6.25	1.57	97.8	80-120			D2
Sodium	205	2.60	mg/L	6.25	206	NR	80-120			D2, M3

Matrix Spike Dup (B015276-MSD1)

Source: 0041376-01

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 17:03

Antimony	0.071	0.005	mg/L	0.0625	ND	114	80-120	7.69	20	
Mercury	0.0025	0.0005	mg/L	0.00250	ND	99.2	80-120	5.81	20	
Molybdenum	0.07	0.01	mg/L	0.0625	ND	107	80-120	4.09	20	
Arsenic	0.0677	0.0010	mg/L	0.0625	0.0019	105	80-120	6.64	20	
Barium	0.157	0.004	mg/L	0.0625	0.087	111	80-120	4.16	20	
Beryllium	0.0585	0.0020	mg/L	0.0625	ND	93.6	80-120	6.82	20	
Cadmium	0.0610	0.0010	mg/L	0.0625	ND	97.6	80-120	8.15	20	
Chromium	0.0684	0.0020	mg/L	0.0625	0.0011	108	80-120	4.12	20	
Cobalt	0.066	0.004	mg/L	0.0625	ND	106	80-120	4.34	20	
Copper	0.059	0.003	mg/L	0.0625	ND	94.0	80-120	4.78	20	
Lead	0.061	0.002	mg/L	0.0625	ND	97.1	80-120	7.36	20	
Lithium	0.09	0.02	mg/L	0.0625	0.03	98.1	80-120	2.10	20	
Selenium	0.061	0.003	mg/L	0.0625	ND	97.1	80-120	9.79	20	
Thallium	0.0613	0.0020	mg/L	0.0625	0.0001	97.8	80-120	5.64	20	



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Metals by SW846 6000 Series Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch B015276 - EPA 200.2

Matrix Spike Dup (B015276-MSD2) Source: 0041376-01

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 18:11

Boron	1.80	1.00	mg/L	0.125	1.69	88.6	80-120	2.95	20	D2
Calcium	35.3	4.00	mg/L	6.25	27.7	121	80-120	2.64	20	D2, M3
Iron	8.28	1.00	mg/L	6.25	1.57	107	80-120	7.50	20	D2
Sodium	208	2.60	mg/L	6.25	206	23.5	80-120	1.56	20	D2, M3

Post Spike (B015276-PS1) Source: 0041376-01

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 17:06

Antimony	65.3		ug/L	62.5	0.087	104	75-125			
Mercury	2.49		ug/L	2.50	0.0595	97.1	75-125			
Molybdenum	62.9		ug/L	62.5	1.02	99.0	75-125			
Arsenic	63.0		ug/L	62.5	1.92	97.7	75-125			
Barium	153		ug/L	62.5	87.2	105	75-125			
Beryllium	55.2		ug/L	62.5	-0.0177	88.4	75-125			
Cadmium	57.4		ug/L	62.5	0.0329	91.8	75-125			
Chromium	63.2		ug/L	62.5	1.10	99.4	75-125			
Cobalt	61.3		ug/L	62.5	0.695	96.9	75-125			
Copper	54.1		ug/L	62.5	-2.87	86.6	75-125			
Lead	56.6		ug/L	62.5	0.013	90.6	75-115			
Lithium	85.9		ug/L	62.5	28.0	92.7	75-125			
Selenium	56.3		ug/L	62.5	0.072	89.9	75-125			
Thallium	57.4		ug/L	62.5	0.118	91.7	75-125			

Post Spike (B015276-PS2) Source: 0041376-01

Prepared: 4/9/2020 7:40, Analyzed: 4/12/2020 18:14

Boron	1820		ug/L	125	1690	107	75-125			D2
Calcium	33800		ug/L	6250	27700	96.6	75-125			D2
Iron	7590		ug/L	6250	1570	96.4	75-125			D2
Sodium	202000		ug/L	6250	206000	NR	75-125			D2, M3

Conventional Chemistry Analyses Madisonville - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B015432 - Default Prep Wet Chem										
Blank (B015432-BLK1)										
Prepared: 4/14/2020 1:48, Analyzed: 4/14/2020 1:48										
Total Organic Carbon	ND	0.5	mg/L							U
LCS (B015432-BS1)										
Prepared: 4/14/2020 2:09, Analyzed: 4/14/2020 2:09										
Total Organic Carbon	4.8	0.5	mg/L	5.00		95.5	80-120			
Duplicate (B015432-DUP1) Source: 0040539-01										
Prepared: 4/14/2020 7:34, Analyzed: 4/14/2020 7:34										
Total Organic Carbon	2.0	0.5	mg/L		2.0			1.22	25	
Duplicate (B015432-DUP2) Source: 0041286-01										
Prepared: 4/14/2020 12:59, Analyzed: 4/14/2020 12:59										
Total Organic Carbon	1.1	0.5	mg/L		1.1			5.36	25	
Matrix Spike (B015432-MS1) Source: 0040539-02										
Prepared: 4/14/2020 7:55, Analyzed: 4/14/2020 7:55										
Total Organic Carbon	3.6	0.5	mg/L	2.50	1.1	102	80-120			
Matrix Spike (B015432-MS2) Source: 0041286-02										
Prepared: 4/14/2020 13:20, Analyzed: 4/14/2020 13:20										
Total Organic Carbon	5.9	0.5	mg/L	5.00	0.9	100	80-120			
Batch B015433 - Default Prep Wet Chem										
Blank (B015433-BLK2)										
Prepared: 4/16/2020 20:16, Analyzed: 4/16/2020 20:16										
Total Organic Carbon	ND	0.5	mg/L							U
LCS (B015433-BS2)										
Prepared: 4/16/2020 20:39, Analyzed: 4/16/2020 20:39										
Total Organic Carbon	4.9	0.5	mg/L	5.00		98.4	80-120			
Duplicate (B015433-DUP1) Source: 0041409-01										
Prepared: 4/14/2020 23:44, Analyzed: 4/14/2020 23:44										
Total Organic Carbon	1.0	0.5	mg/L		1.0			2.11	25	



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Conventional Chemistry Analyses Madisonville - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B015433 - Default Prep Wet Chem										
Duplicate (B015433-DUP3)		Source: 0042383-01								
Prepared: 4/15/2020 12:23, Analyzed: 4/15/2020 12:23										
Total Organic Carbon	2.2	0.5	mg/L		2.2			1.81	25	
Matrix Spike (B015433-MS1)		Source: 0041409-02								
Prepared: 4/15/2020 0:07, Analyzed: 4/15/2020 0:07										
Total Organic Carbon	3.4	0.5	mg/L	2.50	0.9	99.6	80-120			
Matrix Spike (B015433-MS3)		Source: 0042383-02RE1								
Prepared: 4/15/2020 12:46, Analyzed: 4/15/2020 12:46										
Total Organic Carbon	6.4	0.5	mg/L	5.00	1.4	101	80-120			
Batch B015469 - Default Prep Wet Chem										
LCS (B015469-BS1)										
Prepared: 4/9/2020 16:08, Analyzed: 4/9/2020 16:08										
pH (Lab)	7.98		Std. Units	8.00		99.8	98.8-101.2			
LCS (B015469-BS2)										
Prepared: 4/9/2020 16:26, Analyzed: 4/9/2020 16:26										
pH (Lab)	8.04		Std. Units	8.00		100	98.8-101.2			
Duplicate (B015469-DUP1)		Source: 0041388-02								
Prepared: 4/9/2020 16:24, Analyzed: 4/9/2020 16:24										
pH (Lab)	7.29	0.10	Std. Units		7.27			0.275	10	
Duplicate (B015469-DUP2)		Source: 0060028-01								
Prepared: 4/9/2020 16:34, Analyzed: 4/9/2020 16:34										
pH (Lab)	7.77	0.10	Std. Units		7.76			0.129	10	
Batch B015470 - Default Prep Wet Chem										
Blank (B015470-BLK1)										
Prepared: 4/9/2020 15:46, Analyzed: 4/9/2020 15:46										
Specific Conductance (Lab)	ND	1	umhos/cm							U



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Conventional Chemistry Analyses Madisonville - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B015470 - Default Prep Wet Chem										
LCS (B015470-BS1)										
Prepared: 4/9/2020 15:47, Analyzed: 4/9/2020 15:47										
Specific Conductance (Lab)	1410		umhos/cm	1410		99.9	80-120			
Duplicate (B015470-DUP1) Source: 0042630-01										
Prepared: 4/9/2020 16:02, Analyzed: 4/9/2020 16:02										
Specific Conductance (Lab)	202	1	umhos/cm		202			0.148	1.24	
Batch B015517 - Default Prep Wet Chem										
Blank (B015517-BLK1)										
Prepared: 4/10/2020 13:09, Analyzed: 4/10/2020 13:09										
Chemical Oxygen Demand	ND	8	mg/L							U
LCS (B015517-BS1)										
Prepared: 4/10/2020 13:09, Analyzed: 4/10/2020 13:09										
Chemical Oxygen Demand	116	8	mg/L	125		93.0	90-110			
Duplicate (B015517-DUP1) Source: 0041376-01										
Prepared: 4/10/2020 13:18, Analyzed: 4/10/2020 13:18										
Chemical Oxygen Demand	ND	8	mg/L		ND				25	U
Matrix Spike (B015517-MS1) Source: 0041376-01										
Prepared: 4/10/2020 13:18, Analyzed: 4/10/2020 13:18										
Chemical Oxygen Demand	262	8	mg/L	250	ND	105	90-110			
Matrix Spike Dup (B015517-MSD1) Source: 0041376-01										
Prepared: 4/10/2020 13:18, Analyzed: 4/10/2020 13:18										
Chemical Oxygen Demand	256	8	mg/L	250	ND	102	90-110	2.46	10	
Batch B016032 - Default Prep Wet Chem										
Blank (B016032-BLK1)										
Prepared: 4/13/2020 9:34, Analyzed: 4/14/2020 12:26										
Total Dissolved Solids	ND	25	mg/L							U



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Conventional Chemistry Analyses Madisonville - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC Limits	RPD	RPD Limit	Notes
Batch B016032 - Default Prep Wet Chem									
LCS (B016032-BS1)									
Prepared: 4/13/2020 9:38, Analyzed: 4/14/2020 12:26									
Total Dissolved Solids	1480	25	mg/L	1500		98.7 80-120			
Duplicate (B016032-DUP1) Source: 0040819-01									
Prepared: 4/13/2020 10:50, Analyzed: 4/14/2020 12:26									
Total Dissolved Solids	206	50	mg/L		226		9.26	10	
Duplicate (B016032-DUP2) Source: 0041376-08									
Prepared: 4/13/2020 10:54, Analyzed: 4/14/2020 12:26									
Total Dissolved Solids	ND	50	mg/L		ND			10	U



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Ion Chromatography Madisonville - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B016360 - Default Prep IC										
Blank (B016360-BLK1)										
Prepared: 4/16/2020 0:39, Analyzed: 4/16/2020 0:39										
Chloride	ND	2.0	mg/L							U
Fluoride	ND	0.2	mg/L							U
Sulfate	ND	1	mg/L							U
LCS (B016360-BS1)										
Prepared: 4/16/2020 0:23, Analyzed: 4/16/2020 0:23										
Fluoride	9.5		mg/L	10.0		95.0	90-110			
Chloride	9.5		mg/L	10.0		94.9	90-110			
Sulfate	10		mg/L	10.0		98.1	90-110			
Matrix Spike (B016360-MS1) Source: 0041376-08										
Prepared: 4/16/2020 5:20, Analyzed: 4/16/2020 5:20										
Fluoride	13.2		mg/L	10.0	0.0	132	75-125			M1
Chloride	13.1		mg/L	10.0	0.1	130	75-125			M1
Sulfate	14		mg/L	10.0	0.1	139	75-125			M1
Matrix Spike Dup (B016360-MSD1) Source: 0041376-08										
Prepared: 4/16/2020 5:37, Analyzed: 4/16/2020 5:37										
Chloride	12.3		mg/L	10.0	0.1	122	75-125	6.11	15	
Fluoride	12.5		mg/L	10.0	0.0	125	75-125	5.37	15	
Sulfate	13		mg/L	10.0	0.1	125	75-125	10.7	15	
Batch B016418 - Default Prep IC										
Blank (B016418-BLK1)										
Prepared: 4/16/2020 12:41, Analyzed: 4/16/2020 12:41										
Sulfate	ND	1	mg/L							U
LCS (B016418-BS1)										
Prepared: 4/16/2020 12:24, Analyzed: 4/16/2020 12:24										
Sulfate	10		mg/L	10.0		98.8	90-110			



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Ion Chromatography Madisonville - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch B016418 - Default Prep IC

Matrix Spike (B016418-MS1) Source: 0043228-02

Prepared: 4/16/2020 14:36, Analyzed: 4/16/2020 14:36

Sulfate	30	mg/L	10.0	17	121	75-125
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Matrix Spike Dup (B016418-MSD1) Source: 0043228-02

Prepared: 4/16/2020 14:52, Analyzed: 4/16/2020 14:52

Sulfate	30	mg/L	10.0	17	130	75-125	2.87	15	M1
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Certified Analyses included in this Report

Analyte	Certifications
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2510 B-2011 in Water

Specific Conductance (Lab)	KY Drinking Water Mdv (00030)
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2540 C-2011 in Water

Total Dissolved Solids	KY Drinking Water Mdv (00030)
------------------------	-------------------------------

4500-H+ B-2000 in Water

pH (Lab)	KY Drinking Water Mdv (00030) TN Drinking Water (02819)
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5310 C-2011 in Water

Total Organic Carbon	KY Drinking Water Mdv (00030)
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HACH 8000 in Water

Chemical Oxygen Demand	KY Wastewater Mdv (00030)
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SW846 6010 B in Water

Sample Acceptance Checklist for Work Order 0041376

Shipped By: Client

Temperature: 1.90° Celcius

Condition

Check if Custody Seals are Present/Intact	☐
Check if Custody Signatures are Present	☒
Check if Collector Signature Present	☒
Check if bottles are intact	☒
Check if bottles are correct	☒
Check if bottles have sufficient volume	☒
Check if samples received on ice	☒
Check if VOA headspace is acceptable	☐
Check if samples received in holding time.	☒
Check if samples are preserved properly	☒

Chain of Custody

Scheduled for: 04/01/2020



Client: **Big Rivers Electric Corporation**
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: **Green Landfill Semiannual Groundwater**

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#: _____

Quote# _____

Please Print Legibly

Collected by (Signature): [Signature]

Compliance Monitoring? Yes ☒ No ☐

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Samples Chlorinated? Yes ☐ No ☐

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-01 A	<u>4/6/20</u>	<u>1305</u>	Plastic 500mL pH<2 w/HNO3	1	MW1	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
			Preservation Check: pH: <u>✓</u>				
0041376-01 B	<u>4/6/20</u>	<u>1305</u>	Plastic 500mL pH<2 w/HNO3	1	MW1	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
			Preservation Check: pH: <u>✓</u>				
0041376-01 C	<u>4/6/20</u>	<u>1305</u>	Plastic 1L	1	MW1	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056
			Preservation Check: pH: <u>✓</u>				

Preservation Check Performed by: CLH

Field data collected by: Phillie Hill Date (mm/dd/yy) 4/6/20 Time (24 hr) 1305
pH 7.22 Cond (umho) 0.867 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 18.23 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
Tren' Lund

[Signature]
(1.9)

4/7/20
4-7-20

1443
1549

Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#:

Quote#:

Please Print Legibly

Collected by (Signature): [Signature]

Compliance Monitoring? Yes ☒ No ☐

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Samples Chlorinated? Yes ☐ No ☐

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder #	Date (mm/dd/yy)	Collection Time (24 hr)	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376							
Sample ID#							
0041376-01 D	4/6/20	1305	Plastic 500mL pH<2 w/H2SO4 Preservation Check: pH: ☒	1	MW1	g / c	COD TOC
0041376-01 E	4/6/20	1305	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) Preservation Check: pH: ☒	1	MW1	g / c	Radium 226 (sub)
0041376-01 F	4/6/20	1305	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: ☒	1	MW1	g / c	Radium 228 (sub)
0041376-01 G	4/6/20	1305	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: ☒	1	MW1	g / c	Radium 228 (sub)
0041376-01 H	4/6/20	1305	AG 250mL pH<2 w/H2SO4 Preservation Check: pH: ☒	1	MW1	g / c	TOC

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) _____ Time (24 hr) _____
pH 7.22 Cond (umho) 0.867 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 18.23 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1443
1548

Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
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PO Box 24
Henderson, KY 42419

Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#:

Quote#

Please Print Legibly

Collected by (Signature): [Signature]

required information

Compliance Monitoring? Yes ☒ No ☐

Samples Chlorinated? Yes ☐ No ☐

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-02 A	4/7/20	1140	Plastic 500mL pH<2 w/HNO3	1	MW2	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
			Preservation Check: pH: ☒				
0041376-02 B	4/7/20	1140	Plastic 500mL pH<2 w/HNO3	1	MW2	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
			Preservation Check: pH: ☒				
0041376-02 C	4/7/20	1140	Plastic 1L	1	MW2	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056
0041376-02 D	4/7/20	1140	Plastic 500mL pH<2 w/H2SO4	1	MW2	g / c	COD TOC
			Preservation Check: pH: ☒				

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 1140
pH 6.92 Cond (umho) 1.59 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 16.86 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature) [Signature]

Received by: (Signature) [Signature]

Date (mm/dd/yy) 4/7/20

Time (24 hr) 1443

4-7-20

1549

Chain of Custody

Scheduled for: 04/01/2020



Client: **Big Rivers Electric Corporation**
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: **Green Landfill Semiannual Groundwater**

Phone: (270) 844-6000
PWS ID#:
State: KY

PO#:
Quote#

Please Print Legibly

Collected by (Signature): [Signature]
required information

Compliance Monitoring? Yes ☒ No ☐

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Samples Chlorinated? Yes ☐ No ☐

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*		Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
Workorder #	Date Collection (mm/dd/yy): Time (24 hr):					
0041376						
Sample ID#						
0041376-02 E	<u>4/7/20</u> <u>1140</u>	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) Preservation Check: pH: ☒	1	MW2	g / c	Radium 226 (sub)
0041376-02 F	<u>4/7/20</u> <u>1140</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: ☒	1	MW2	g / c	Radium 228 (sub)
0041376-02 G	<u>4/7/20</u> <u>1140</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: ☒	1	MW2	g / c	Radium 228 (sub)
0041376-02 H	<u>4/7/20</u> <u>1140</u>	AG 250mL pH<2 w/H2SO4 Preservation Check: pH: ☒	1	MW2	g / c	TOC
0041376-03 A	<u>4/7/20</u> <u>1355</u>	Plastic 500mL pH<2 w/HNO3 Preservation Check: pH: ☒	1	MW3A	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B

Preservation Check Performed by: C LH

Field data collected by: <u>Phillip Hill</u>	Date (mm/dd/yy) <u>4/7/20</u>	Time (24 hr) <u>1140</u>
pH <u>6.92</u>	Cond (umho) <u>1.59</u>	Res Cl (mg/L) _____
Temp (oC) <u>16.84</u>	or (oF) _____	Tot Cl (mg/L) _____
Flow (MGD) _____	or (CFS) _____	Free Cl (mg/L) _____
Static Water Level _____	DO (mg/L) _____	Turb. (NTU) _____
or (g/min) _____		

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1143
1549

Chain of Custody

Scheduled for: 04/01/2020



Client: **Big Rivers Electric Corporation**
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: **Green Landfill Semiannual Groundwater**

Phone: (270) 844-6000
PWS ID#:
State: KY

PO#:
Quote#

Please Print Legibly

Collected by (Signature): [Signature]
required information

Compliance Monitoring? Yes ☒ No ☐

Samples Chlorinated? Yes ☐ No ☐

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-03 B	<u>4/7/20</u>	<u>1355</u>	Plastic 500mL pH<2 w/HNO3	1	MW3A	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
			Preservation Check: pH: ☒				
0041376-03 C	<u>4/7/20</u>	<u>1355</u>	Plastic 1L	1	MW3A	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056
0041376-03 D	<u>4/7/20</u>	<u>1355</u>	Plastic 500mL pH<2 w/H2SO4	1	MW3A	g / c	COD TOC
			Preservation Check: pH: ☒				
0041376-03 E	<u>4/7/20</u>	<u>1355</u>	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)	1	MW3A	g / c	Radium 226 (sub)
			Preservation Check: pH: ☒				
0041376-03 F	<u>4/7/20</u>	<u>1355</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)	1	MW3A	g / c	Radium 228 (sub)
			Preservation Check: pH: ☒				

Preservation Check Performed by: [Signature]

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 1350
pH 6.86 Cond (umho) 8.09 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 16.32 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1445
1549

Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#:

Quote#

Please Print Legibly

Collected by (Signature): [Signature]

Compliance Monitoring? Yes ☒ No ☐

*For composite samples please indicate begin time, end time and temp (oC) at end time below:

Samples Chlorinated? Yes ☐ No ☐

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder # 0041376 Sample ID#	Date (mm/dd/yy):	Collection Time (24 hr):	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376-03 G	4/7/20	1758	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: ☒	1	MW3A	g / c	Radium 228 (sub)
0041376-03 H	4/7/20	1755	AG 250mL pH<2 w/H2SO4 Preservation Check: pH: ☒	1	MW3A	g / c	TOC
0041376-04 A	4/7/20	955	Plastic 500mL pH<2 w/HNO3 Preservation Check: pH: ☒	1	MW4	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B

Preservation Check Performed by: CLH

Field data collected by: <u>Phillip Hill</u>	Date (mm/dd/yy) _____	Time (24 hr) _____
pH <u>6.86</u>	Cond (umho) <u>8.09</u>	Res Cl (mg/L) _____
Temp (oC) <u>16.32</u>	or (oF) _____	Static Water Level _____
Flow (MGD) _____	or (CFS) _____	or (g/min) _____
DO (mg/L) _____		Turb. (NTU) _____
Free Cl (mg/L) _____		

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1443
1549

☐ PACE- Check here if trip charge applied to associated COC

Printed: 3/25/2020 2:51:08PM

Page 26 of 51

Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
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Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#:

Quote#:

Please Print Legibly

Collected by (Signature): [Signature]

required information

Compliance Monitoring? Yes ☒ No ☐

Samples Chlorinated? Yes ☐ No ☐

*For composite samples please indicate begin time, end time and temp (oC) at end time below:

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-04 B	4/7/20	955	Plastic 500mL pH<2 w/HNO3	1	MW4	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
			Preservation Check: pH : ☒				
0041376-04 C	4/7/20	955	Plastic 1L	1	MW4	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056
0041376-04 D	4/7/20	955	Plastic 500mL pH<2 w/H2SO4	1	MW4	g / c	COD TOC
			Preservation Check: pH : ☒				
0041376-04 E	4/7/20	955	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)	1	MW4	g / c	Radium 226 (sub)
			Preservation Check: pH : ☒				
0041376-04 F	4/7/20	955	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)	1	MW4	g / c	Radium 228 (sub)
			Preservation Check: pH : ☒				

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 955
pH 6.70 Cond (umho) 6.77 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 16.47 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature) [Signature]

Received by: (Signature) [Signature]

Date (mm/dd/yy) 4/7/20

Time (24 hr) 1443

4-7-20

1549

Chain of Custody

Scheduled for: 04/01/2020



Client: **Big Rivers Electric Corporation**
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: **Green Landfill Semiannual Groundwater**

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#: _____

Quote# _____

Please Print Legibly

Collected by (Signature): [Signature]
required information

Compliance Monitoring? Yes 1 No _____

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Samples Chlorinated? Yes _____ No _____

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-04 G	<u>4/7/20</u>	<u>955</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: <u>✓</u>	<u>1</u>	MW4	g / c	Radium 228 (sub)
0041376-04 H	<u>4/7/20</u>	<u>955</u>	AG 250mL pH<2 w/H2SO4 Preservation Check: pH: <u>✓</u>	<u>1</u>	MW4	g / c	TOC
0041376-05 A	<u>4/7/20</u>	<u>1010</u>	Plastic 500mL pH<2 w/HNO3	<u>1</u>	MW5	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B

Preservation Check: pH: ✓

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 955
pH 6.70 Cond (umho) 6.77 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 16.47 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

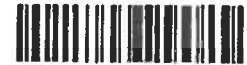
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4/7/20
4-7-20

1447
1549

Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#:

Quote#

Please Print Legibly

Collected by (Signature): [Signature]

required information

Compliance Monitoring? Yes ☒ No ☐

Samples Chlorinated? Yes ☐ No ☐

*For composite samples please indicate begin time, end time and temp (oC) at end time below:

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-05 B	<u>4/7/20</u>	<u>1010</u>	Plastic 500mL pH<2 w/HNO3	1	MW5	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
0041376-05 C	<u>4/7/20</u>	<u>1010</u>	Plastic 1L	1	MW5	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 COD TOC
0041376-05 D	<u>4/7/20</u>	<u>1010</u>	Plastic 500mL pH<2 w/H2SO4	1	MW5	g / c	
0041376-05 E	<u>4/7/20</u>	<u>1010</u>	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)	1	MW5	g / c	Radium 226 (sub)
0041376-05 F	<u>4/7/20</u>	<u>1010</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)	1	MW5	g / c	Radium 228 (sub)

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 1010
pH 6.77 Cond (umho) 6.25 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 14.85 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1443
1549

Chain of Custody

Scheduled for: **04/01/2020**



Client: **Big Rivers Electric Corporation**
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: **Green Landfill Semiannual Groundwater**

Phone: **(270) 844-6000**

PWS ID#:

State: **KY**

PO#:

Quote#

Please Print Legibly

Collected by (Signature): [Signature]

Compliance Monitoring? Yes ☒ No ☐

*For composite samples please indicate begin time, end time and temp (oC) at end time below:

Samples Chlorinated? Yes ☐ No ☐

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY		*required information*		Containers	Sample Description	Composite	Sample Analysis Requested
Workorder #	Date	Collection	Bottle and Preservative				
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-05 G	<u>4/7/20</u>	<u>1010</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: <u>~</u>	1	MW5	g / c	Radium 228 (sub)
0041376-05 H	<u>4/7/20</u>	<u>1010</u>	AG 250mL pH<2 w/H2SO4 Preservation Check: pH: <u>✓</u>	1	MW5	g / c	TOC
0041376-06 A	<u>4/6/20</u>	<u>1420</u>	Plastic 500mL pH<2 w/HNO3	1	MW6	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B

Preservation Check: pH: ✓

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 1010
pH 6.77 Cond (umho) 6.25 Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) 14.85 or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1443
1549

☐ PACE- Check here if trip charge applied to associated COC

Printed: 3/25/2020 2:51:08PM

Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
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Chad Phillips
PO Box 24
Henderson, KY 42419

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Henderson, KY 42419

Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000
PWS ID#:
State: KY

PO#:
Quote#

Please Print Legibly

Collected by (Signature): [Signature]
required information

Compliance Monitoring? Yes 1 No

Samples Chlorinated? Yes No

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Influent: Start Date Start time End Date End Time Temp (oC)

Effluent: Start Date Start time End Date End Time Temp (oC)

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-06 B	4/6/20	1420	Plastic 500mL pH<2 w/HNO3	1	MW6	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
0041376-06 C	4/6/20	1420	Plastic 1L	1	MW6	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 COD TOC
0041376-06 D	4/6/20	1420	Plastic 500mL pH<2 w/H2SO4	1	MW6	g / c	
0041376-06 E	4/6/20	1420	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)	1	MW6	g / c	Radium 226 (sub)
0041376-06 F	4/6/20	1420	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)	1	MW6	g / c	Radium 228 (sub)

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/6/20 Time (24 hr) 1420
pH 6.26 Cond (umho) 5.01 Res Cl (mg/L) Tot Cl (mg/L) Free Cl (mg/L)
Temp (oC) 20.50 or (oF) Static Water Level DO (mg/L) Turb. (NTU)
Flow (MGD) or (CFS) or (g/min)

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

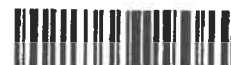
1449
1549

☐ PACE- Check here if trip charge applied to associated COC

Printed: 3/25/2020 2:51:08PM

Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
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Henderson, KY 42419

Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#:

Quote#:

Please Print Legibly

Collected by (Signature): [Signature]
required information

Compliance Monitoring? Yes 2 No

Samples Chlorinated? Yes No

*For composite samples please indicate begin time, end time and temp (oC) at end time below:

Influent: Start Date Start time End Date End Time Temp (oC)

Effluent: Start Date Start time End Date End Time Temp (oC)

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-06 G	<u>4/6/20</u>	<u>1430</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: <u> </u>	<u>1</u>	MW6	g / c	Radium 228 (sub)
0041376-06 H	<u>4/6/20</u>	<u>1420</u>	AG 250mL pH<2 w/H2SO4 Preservation Check: pH: <u> </u>	<u>1</u>	MW6	g / c	TOC
0041376-07 A	<u>4/7/20</u>	<u>1020</u>	Plastic 500mL pH<2 w/HNO3 Preservation Check: pH: <u> </u>	<u>1</u>	DUPLICATE	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/6/20 Time (24 hr) 1420
pH 6.36 Cond (umho) 5.01 Res Cl (mg/L) Tot Cl (mg/L) Free Cl (mg/L)
Temp (oC) 20.50 or (oF) Static Water Level DO (mg/L) Turb. (NTU)
Flow (MGD) or (CFS) or (g/min)

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1443
1549

Chain of Custody

Scheduled for: 04/01/2020



Client: **Big Rivers Electric Corporation**
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: **Green Landfill Semiannual Groundwater**

Phone: (270) 844-6000
PWS ID#:
State: KY

PO#:
Quote#

Please Print Legibly

Collected by (Signature): [Signature]

required information

Compliance Monitoring? Yes L No ___

Samples Chlorinated? Yes ___ No ___

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Influent: Start Date Start time End Date End Time Temp (oC)

Effluent: Start Date Start time End Date End Time Temp (oC)

MMLI USE ONLY *required information*

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-07 B	<u>4/7/20</u>	<u>1020</u>	Plastic 500mL pH<2 w/HNO3	<u>1</u>	DUPLICATE	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
0041376-07 C	<u>4/7/20</u>	<u>1020</u>	Plastic 1L	<u>1</u>	DUPLICATE	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 COD TOC
0041376-07 D	<u>4/7/20</u>	<u>1020</u>	Plastic 500mL pH<2 w/H2SO4	<u>1</u>	DUPLICATE	g / c	
0041376-07 E	<u>4/7/20</u>	<u>1020</u>	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)	<u>1</u>	DUPLICATE	g / c	Radium 226 (sub)
0041376-07 F	<u>4/7/20</u>	<u>1020</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)	<u>1</u>	DUPLICATE	g / c	Radium 228 (sub)

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 1020
pH 6.70 Cond (umho) 677 Res Cl (mg/L) Tot Cl (mg/L) Free Cl (mg/L)
Temp (oC) 16.47 or (oF) Static Water Level DO (mg/L) Turb. (NTU)
Flow (MGD) or (CFS) or (g/min)

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1443
1549

Chain of Custody

Scheduled for: 04/01/2020



Client: **Big Rivers Electric Corporation**
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: **Green Landfill Semiannual Groundwater**

Phone: (270) 844-6000

PWS ID#:

State:

PO#:

Quote#:

Please Print Legibly

Collected by (Signature): [Signature]

required information

Compliance Monitoring? Yes No

Samples Chlorinated? Yes No

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Influent: Start Date Start time End Date End Time Temp (oC)

Effluent: Start Date Start time End Date End Time Temp (oC)

MMLI USE ONLY

required information

Workorder #	Date	Collection	Bottle and Preservative	Containers	Sample Description	Composite	Sample Analysis Requested
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-07 G	<u>4/7/20</u>	<u>1020</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) Preservation Check: pH: <u>✓</u>	<u>1</u>	DUPLICATE	g / c	Radium 228 (sub)
0041376-07 H	<u>4/7/20</u>	<u>1020</u>	AG 250mL pH<2 w/H2SO4 Preservation Check: pH: <u>✓</u>	<u>1</u>	DUPLICATE	g / c	TOC
0041376-08 A	<u>4/7/20</u>	<u>1150</u>	Plastic 500mL pH<2 w/HNO3 Preservation Check: pH: <u>✓</u>	<u>1</u>	FIELD BLANK	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B

Preservation Check Performed by: CLH

Field data collected by: Phillip Hill

Date (mm/dd/yy) 4/7/20 Time (24 hr) 1020

pH 6.20 Cond (umho) 6.77 Res Cl (mg/L) Tot Cl (mg/L) Free Cl (mg/L)

Temp (oC) 16.47 or (oF) Static Water Level DO (mg/L) Turb. (NTU)

Flow (MGD) or (CFS) or (g/min)

Relinquished by (Signature): [Signature]

Received by (Signature): [Signature]

Date (mm/dd/yy)

Time (24 hr)

4/7/20

1447

4-7-20

1549

☐ PACE- Check here if trip charge applied to associated COC

Printed: 3/25/2020 2:51:08PM

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Chain of Custody

Scheduled for: 04/01/2020



Client: Big Rivers Electric Corporation
Reid/Green Station

Report To:
Big Rivers Electric Corporation Reid/Green
Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Invoice To:
Big Rivers Electric Corporation Reid/Green Station
Chad Phillips
PO Box 24
Henderson, KY 42419

Project: Green Landfill Semiannual Groundwater

Phone: (270) 844-6000

PWS ID#:

State: KY

PO#: _____

Quote# _____

Please Print Legibly

Collected by (Signature): [Signature]
required information

Compliance Monitoring? Yes ☒ No ☐

Samples Chlorinated? Yes ☐ No ☐

*For composite samples please indicate begin time, end time and temp(oC) at end time below:

Influent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

Effluent: Start Date _____ Start time _____ End Date _____ End Time _____ Temp (oC) _____

MMLI USE ONLY		*required information*		Containers	Sample Description	Composite	Sample Analysis Requested
Workorder #	Date	Collection	Bottle and Preservative				
0041376	(mm/dd/yy):	Time (24 hr):					
Sample ID#							
0041376-08 B	<u>4/7/20</u>	<u>1150</u>	Plastic 500mL pH<2 w/HNO3	1	FIELD BLANK	g / c	Beryllium Tot 6020 Cadmium Tot 6020 Calcium Tot 6010B Barium Tot 6020 Chromium Tot 6020 Cobalt Tot 6020 Arsenic Tot 6020 Boron Tot 6010B Copper Tot 6020 Antimony Tot 6020 Lead Tot 6020 Lithium Tot 6020 Mercury Tot 6020 Molybdenum Tot 6020 Sodium Tot 6010B
			Preservation Check: pH: <u>✓</u>				
0041376-08 C	<u>4/7/20</u>	<u>1150</u>	Plastic 1L	1	FIELD BLANK	g / c	pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 COD TOC
0041376-08 D	<u>4/7/20</u>	<u>1150</u>	Plastic 500mL pH<2 w/H2SO4	1	FIELD BLANK	g / c	
			Preservation Check: pH: <u>✓</u>				
0041376-08 E	<u>4/7/20</u>	<u>1150</u>	Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)	1	FIELD BLANK	g / c	Radium 226 (sub)
			Preservation Check: pH: <u>✓</u>				
0041376-08 F	<u>4/7/20</u>	<u>1150</u>	Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)	1	FIELD BLANK	g / c	Radium 228 (sub)
			Preservation Check: pH: <u>✓</u>				

Preservation Check Performed by: C.L.H.

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/7/20 Time (24 hr) 1150
pH _____ Cond (umho) _____ Res Cl (mg/L) _____ Tot Cl (mg/L) _____ Free Cl (mg/L) _____
Temp (oC) _____ or (oF) _____ Static Water Level _____ DO (mg/L) _____ Turb. (NTU) _____
Flow (MGD) _____ or (CFS) _____ or (g/min) _____

Relinquished by: (Signature)

Received by: (Signature)

Date (mm/dd/yy)

Time (24 hr)

[Signature]
[Signature]

[Signature]
[Signature]

4/7/20
4-7-20

1443
1549

April 30, 2020

Rob Whittington
Pace Analytical Madisonville
825 Industrial Rd
Madisonville, KY 42431

RE: Project: 41376
Pace Project No.: 30358430

Dear Rob Whittington:

Enclosed are the analytical results for sample(s) received by the laboratory on April 10, 2020. The results relate only to the samples included in this report. Results reported herein conform to the applicable TNI/NELAC Standards and the laboratory's Quality Manual, where applicable, unless otherwise noted in the body of the report.

The test results provided in this final report were generated by each of the following laboratories within the Pace Network:

- Pace Analytical Services - Greensburg

If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Carin Ferris
carin.ferris@pacelabs.com
724-850-5615
Project Manager

Enclosures

cc: Doug Wolfe, Pace Analytical Madisonville



REPORT OF LABORATORY ANALYSIS

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CERTIFICATIONS

Project: 41376
Pace Project No.: 30358430

Pace Analytical Services Pennsylvania

1638 Roseytown Rd Suites 2,3&4, Greensburg, PA 15601

ANAB DOD-ELAP Rad Accreditation #: L2417

Alabama Certification #: 41590

Arizona Certification #: AZ0734

Arkansas Certification

California Certification #: 04222CA

Colorado Certification #: PA01547

Connecticut Certification #: PH-0694

Delaware Certification

EPA Region 4 DW Rad

Florida/TNI Certification #: E87683

Georgia Certification #: C040

Florida: Cert E871149 SEKS WET

Guam Certification

Hawaii Certification

Idaho Certification

Illinois Certification

Indiana Certification

Iowa Certification #: 391

Kansas/TNI Certification #: E-10358

Kentucky Certification #: KY90133

KY WW Permit #: KY0098221

KY WW Permit #: KY0000221

Louisiana DHH/TNI Certification #: LA180012

Louisiana DEQ/TNI Certification #: 4086

Maine Certification #: 2017020

Maryland Certification #: 308

Massachusetts Certification #: M-PA1457

Michigan/PADEP Certification #: 9991

Missouri Certification #: 235

Montana Certification #: Cert0082

Nebraska Certification #: NE-OS-29-14

Nevada Certification #: PA014572018-1

New Hampshire/TNI Certification #: 297617

New Jersey/TNI Certification #: PA051

New Mexico Certification #: PA01457

New York/TNI Certification #: 10888

North Carolina Certification #: 42706

North Dakota Certification #: R-190

Ohio EPA Rad Approval: #41249

Oregon/TNI Certification #: PA200002-010

Pennsylvania/TNI Certification #: 65-00282

Puerto Rico Certification #: PA01457

Rhode Island Certification #: 65-00282

South Dakota Certification

Tennessee Certification #: 02867

Texas/TNI Certification #: T104704188-17-3

Utah/TNI Certification #: PA014572017-9

USDA Soil Permit #: P330-17-00091

Vermont Dept. of Health: ID# VT-0282

Virgin Island/PADEP Certification

Virginia/VELAP Certification #: 9526

Washington Certification #: C868

West Virginia DEP Certification #: 143

West Virginia DHHR Certification #: 9964C

Wisconsin Approve List for Rad

Wyoming Certification #: 8TMS-L

REPORT OF LABORATORY ANALYSIS

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SAMPLE SUMMARY

Project: 41376
Pace Project No.: 30358430

Lab ID	Sample ID	Matrix	Date Collected	Date Received
30358430001	0041376-01	Water	04/06/20 13:05	04/10/20 09:15
30358430002	0041376-02	Water	04/07/20 11:40	04/10/20 09:15
30358430003	0041376-03	Water	04/07/20 13:55	04/10/20 09:15
30358430004	0041376-04	Water	04/07/20 09:55	04/10/20 09:15
30358430005	0041376-05	Water	04/07/20 10:10	04/10/20 09:15
30358430006	0041376-06	Water	04/06/20 14:20	04/10/20 09:15
30358430007	0041376-07	Water	04/07/20 10:20	04/10/20 09:15
30358430008	0041376-08	Water	04/07/20 11:50	04/10/20 09:15

REPORT OF LABORATORY ANALYSIS

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SAMPLE ANALYTE COUNT

Project: 41376
Pace Project No.: 30358430

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
30358430001	0041376-01	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA
30358430002	0041376-02	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA
30358430003	0041376-03	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA
30358430004	0041376-04	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA
30358430005	0041376-05	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA
30358430006	0041376-06	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA
30358430007	0041376-07	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA
30358430008	0041376-08	EPA 903.1	MK1	1	PASI-PA
		EPA 904.0	VAL	1	PASI-PA
		Total Radium Calculation	CMC	1	PASI-PA

PASI-PA = Pace Analytical Services - Greensburg

REPORT OF LABORATORY ANALYSIS

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 41376
Pace Project No.: 30358430

Sample: 0041376-01 Lab ID: 30358430001 Collected: 04/06/20 13:05 Received: 04/10/20 09:15 Matrix: Water
PWS: Site ID: Sample Type:

Comments: • Sample collection dates and times were not present on the sample containers.
• Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.340 ± 0.473 (0.799) C:NA T:94%	pCi/L	04/30/20 11:27	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	0.468 ± 0.409 (0.828) C:72% T:87%	pCi/L	04/28/20 11:04	15262-20-1	
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	0.808 ± 0.882 (1.63)	pCi/L	04/30/20 14:19	7440-14-4	

Sample: 0041376-02 Lab ID: 30358430002 Collected: 04/07/20 11:40 Received: 04/10/20 09:15 Matrix: Water
PWS: Site ID: Sample Type:

Comments: • Sample collection dates and times were not present on the sample containers.
• Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.513 ± 0.402 (0.472) C:NA T:88%	pCi/L	04/30/20 11:27	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	0.0161 ± 0.343 (0.794) C:70% T:88%	pCi/L	04/28/20 11:04	15262-20-1	
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	0.529 ± 0.745 (1.27)	pCi/L	04/30/20 14:19	7440-14-4	

Sample: 0041376-03 Lab ID: 30358430003 Collected: 04/07/20 13:55 Received: 04/10/20 09:15 Matrix: Water
PWS: Site ID: Sample Type:

Comments: • Sample collection dates and times were not present on the sample containers.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.603 ± 0.577 (0.878) C:NA T:77%	pCi/L	04/30/20 11:27	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	0.460 ± 0.444 (0.914) C:68% T:85%	pCi/L	04/28/20 11:04	15262-20-1	
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	1.06 ± 1.02 (1.79)	pCi/L	04/30/20 14:19	7440-14-4	

REPORT OF LABORATORY ANALYSIS

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 41376
Pace Project No.: 30358430

Sample: 0041376-04 **Lab ID: 30358430004** Collected: 04/07/20 09:55 Received: 04/10/20 09:15 Matrix: Water
PWS: **Site ID:** **Sample Type:**

Comments: • Sample collection dates and times were not present on the sample containers.
• Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.476 ± 0.455 (0.693) C:NA T:95%	pCi/L	04/30/20 11:27	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	0.787 ± 0.428 (0.770) C:74% T:84%	pCi/L	04/28/20 11:04	15262-20-1	
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	1.26 ± 0.883 (1.46)	pCi/L	04/30/20 14:19	7440-14-4	

Sample: 0041376-05 **Lab ID: 30358430005** Collected: 04/07/20 10:10 Received: 04/10/20 09:15 Matrix: Water
PWS: **Site ID:** **Sample Type:**

Comments: • Sample collection dates and times were not present on the sample containers.
• Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.302 ± 0.371 (0.605) C:NA T:95%	pCi/L	04/30/20 11:27	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	1.18 ± 0.498 (0.824) C:71% T:90%	pCi/L	04/28/20 11:05	15262-20-1	
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	1.48 ± 0.869 (1.43)	pCi/L	04/30/20 14:19	7440-14-4	

Sample: 0041376-06 **Lab ID: 30358430006** Collected: 04/06/20 14:20 Received: 04/10/20 09:15 Matrix: Water
PWS: **Site ID:** **Sample Type:**

Comments: • Sample collection dates and times were not present on the sample containers.
• Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.0612 ± 0.279 (0.166) C:NA T:90%	pCi/L	04/30/20 11:27	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	0.683 ± 0.478 (0.939) C:68% T:88%	pCi/L	04/28/20 11:05	15262-20-1	

REPORT OF LABORATORY ANALYSIS

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 41376
Pace Project No.: 30358430

Sample: 0041376-06 Lab ID: 30358430006 Collected: 04/06/20 14:20 Received: 04/10/20 09:15 Matrix: Water
PWS: Site ID: Sample Type:

Comments: • Sample collection dates and times were not present on the sample containers.
• Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	0.744 ± 0.757 (1.11)	pCi/L	04/30/20 14:19	7440-14-4	

Sample: 0041376-07 Lab ID: 30358430007 Collected: 04/07/20 10:20 Received: 04/10/20 09:15 Matrix: Water
PWS: Site ID: Sample Type:

Comments: • Sample collection dates and times were not present on the sample containers.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.371 ± 0.345 (0.455) C:NA T:83%	pCi/L	04/30/20 11:27	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	1.10 ± 0.486 (0.817) C:74% T:84%	pCi/L	04/28/20 11:05	15262-20-1	
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	1.47 ± 0.831 (1.27)	pCi/L	04/30/20 14:19	7440-14-4	

Sample: 0041376-08 Lab ID: 30358430008 Collected: 04/07/20 11:50 Received: 04/10/20 09:15 Matrix: Water
PWS: Site ID: Sample Type:

Comments: • Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Pace Analytical Services - Greensburg						
Radium-226	EPA 903.1	0.224 ± 0.515 (0.933) C:NA T:94%	pCi/L	04/30/20 11:40	13982-63-3	
Pace Analytical Services - Greensburg						
Radium-228	EPA 904.0	0.262 ± 0.427 (0.928) C:74% T:84%	pCi/L	04/28/20 11:05	15262-20-1	
Pace Analytical Services - Greensburg						
Total Radium	Total Radium Calculation	0.486 ± 0.942 (1.86)	pCi/L	04/30/20 14:19	7440-14-4	

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 41376
Pace Project No.: 30358430

QC Batch:	392089	Analysis Method:	EPA 904.0
QC Batch Method:	EPA 904.0	Analysis Description:	904.0 Radium 228
		Laboratory:	Pace Analytical Services - Greensburg
Associated Lab Samples:	30358430001, 30358430002, 30358430003, 30358430004, 30358430005, 30358430006, 30358430007, 30358430008		

METHOD BLANK:	1898525	Matrix:	Water
Associated Lab Samples:	30358430001, 30358430002, 30358430003, 30358430004, 30358430005, 30358430006, 30358430007, 30358430008		

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Radium-228	0.230 ± 0.329 (0.705) C:78% T:76%	pCi/L	04/28/20 11:05	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 41376
Pace Project No.: 30358430

QC Batch:	392088	Analysis Method:	EPA 903.1
QC Batch Method:	EPA 903.1	Analysis Description:	903.1 Radium-226
		Laboratory:	Pace Analytical Services - Greensburg
Associated Lab Samples:	30358430001, 30358430002, 30358430003, 30358430004, 30358430005, 30358430006, 30358430007, 30358430008		

METHOD BLANK:	1898523	Matrix:	Water
Associated Lab Samples:	30358430001, 30358430002, 30358430003, 30358430004, 30358430005, 30358430006, 30358430007, 30358430008		

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Radium-226	0.176 ± 0.366 (0.660) C:NA T:95%	pCi/L	04/30/20 11:27	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

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QUALIFIERS

Project: 41376
Pace Project No.: 30358430

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.
ND - Not Detected at or above adjusted reporting limit.
TNTC - Too Numerous To Count
J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
MDL - Adjusted Method Detection Limit.
PQL - Practical Quantitation Limit.
RL - Reporting Limit - The lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.
S - Surrogate
1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.
Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.
LCS(D) - Laboratory Control Sample (Duplicate)
MS(D) - Matrix Spike (Duplicate)
DUP - Sample Duplicate
RPD - Relative Percent Difference
NC - Not Calculable.
SG - Silica Gel - Clean-Up
U - Indicates the compound was analyzed for, but not detected.
N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.
Act - Activity
Unc - Uncertainty: For Safe Drinking Water Act (SDWA) analyses, the reported Unc. is the calculated Count Uncertainty (95% confidence interval) using a coverage factor of 1.96. For all other matrices (non-SDWA), the reported Unc. is the calculated Expanded Uncertainty (aka Combined Standard Uncertainty, CSU), reported at the 95% confidence interval using a coverage factor of 1.96.
Gamma Spec: The Unc. reported for all gamma-spectroscopy analyses (EPA 901.1), is the calculated Expanded Uncertainty (CSU) at the 95.4% confidence interval, using a coverage factor of 2.0.
(MDC) - Minimum Detectable Concentration
Trac - Tracer Recovery (%)
Carr - Carrier Recovery (%)
Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.
TNI - The NELAC Institute.

SAMPLE QUALIFIERS

Sample: 30358430007
[2] Upon receipt at the laboratory, 5 mls of nitric acid were added to the sample to meet the sample preservation requirement of pH <2 for radiochemistry analysis.
Sample: 30358430008
[1] Sample collection dates and times were not present on the sample containers.

REPORT OF LABORATORY ANALYSIS

SUBCONTRACT ORDER
Pace Analytical Services, LLC Kentucky
0041376

- 30358430

SENDING LABORATORY:

Pace Analytical Services, LLC Kentucky
PO BOX 907
Madisonville, KY 42431
Phone: (270) 821-7375
Fax: 844-270-7904
Project Manager: Rob Whittington

RECEIVING LABORATORY:

Pace Analytical Services LLC Greensburg PA
1638 Rosey Town Rd Suite 2,3,4
Greensburg, PA 15601
Phone : (724) 850-5615
Fax:

Please return shipping cooler to return address on shipping label.

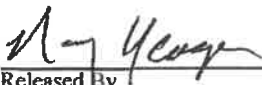
Analysis		Expires	Laboratory ID	Comments
Sample ID: 0041376-01	Water	Sampled: 04/06/2020 13:05	Specific Method	
Radium 228 (sub)		10/03/2020 13:05	EPA 904.0 Radium Sum C	
Radium Total (sub)		10/03/2020 13:05	EPA 904.0 Radium Sum C	
Radium 226 (sub)		10/03/2020 13:05	EPA 903.1	
Sample ID: 0041376-02	Water	Sampled: 04/07/2020 11:40	Specific Method	
Radium 226 (sub)		10/04/2020 11:40	EPA 903.1	
Radium 228 (sub)		10/04/2020 11:40	EPA 904.0 Radium Sum C	
Radium Total (sub)		10/04/2020 11:40	EPA 904.0 Radium Sum C	
Sample ID: 0041376-03	Water	Sampled: 04/07/2020 13:55	Specific Method	
Radium Total (sub)		10/04/2020 13:55	EPA 904.0 Radium Sum C	
Radium 226 (sub)		10/04/2020 13:55	EPA 903.1	
Radium 228 (sub)		10/04/2020 13:55	EPA 904.0 Radium Sum C	
Sample ID: 0041376-04	Water	Sampled: 04/07/2020 09:55	Specific Method	
Radium 226 (sub)		10/04/2020 09:55	EPA 903.1	
Radium 228 (sub)		10/04/2020 09:55	EPA 904.0 Radium Sum C	
Radium Total (sub)		10/04/2020 09:55	EPA 904.0 Radium Sum C	
Sample ID: 0041376-05	Water	Sampled: 04/07/2020 10:10	Specific Method	
Radium 228 (sub)		10/04/2020 10:10	EPA 904.0 Radium Sum C	
Radium Total (sub)		10/04/2020 10:10	EPA 904.0 Radium Sum C	
Radium 226 (sub)		10/04/2020 10:10	EPA 903.1	
Sample ID: 0041376-06	Water	Sampled: 04/06/2020 14:20	Specific Method	
Radium 226 (sub)		10/03/2020 14:20	EPA 903.1	
Radium 228 (sub)		10/03/2020 14:20	EPA 904.0 Radium Sum C	
Radium Total (sub)		10/03/2020 14:20	EPA 904.0 Radium Sum C	

Released By		Date	04-09-20	Received By		Date	
Released By		Date		Received By		Date	

SUBCONTRACT ORDER
Pace Analytical Services, LLC Kentucky
0041376

30358430

Analysis	Expires	Laboratory ID	Comments
Sample ID: 0041376-07	Water	Sampled:04/07/2020 10:20	Specific Method
Radium 226 (sub)	10/04/2020 10:20	EPA 903.1	
Radium 228 (sub)	10/04/2020 10:20	EPA 904.0 Radium Sum C	
Radium Total (sub)	10/04/2020 10:20	EPA 904.0 Radium Sum C	
Sample ID: 0041376-08	Water	Sampled:04/07/2020 11:50	Specific Method
Radium Total (sub)	10/04/2020 11:50	EPA 904.0 Radium Sum C	
Radium 226 (sub)	10/04/2020 11:50	EPA 903.1	
Radium 228 (sub)	10/04/2020 11:50	EPA 904.0 Radium Sum C	

Released By	Date	Received By	Date
	04-09-20		
Released By	Date	Received By	Date

Sample Custody

By Nancy Yeager

Printed 04/09/2020 09:05

30358430

Lab ID	Container	Cooler	Last Own	Department	Location	Home Locat	Status	Disposition	Custody Date
0041376-01	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-01	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-02	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-02	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-03	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-03	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-04	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-04	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-05	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-05	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-06	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-06	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-07	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-07	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-08	Elastic 1L pH<2 w/HNO3 Rad 226	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05
0041376-08	Plastic 1L pH<2 w/HNO3 Rad 228	(Set)ult Cool	NDY	Wet Chem	In-Transit		Batched Active (Out)		04/09/2020 09:05

Relinquished By

Date

Received By

Date

Relinquished By

Date

Received By

Date

Pittsburgh Lab Sample Condition Upon Receipt



Client Name: McCoy & McCoy

Project # 30350450

Courier: ☒ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other _____

Tracking #: 110733861178

Label	<u>BUM</u>
LIMS Login	<u>BUM</u>

Custody Seal on Cooler/Box Present: ☐ yes ☒ no Seals Intact: ☐ yes ☐ no

Thermometer Used 11 Type of Ice: Wet Blue None

Cooler Temperature Observed Temp 5.1 °C Correction Factor: -0.4 °C Final Temp: 4.7 °C

Temp should be above freezing to 6°C

Comments:	Yes	No	N/A	pH paper Lot# <u>10D0391</u>	Date and Initials of person examining contents: <u>NMR 4/10/2020</u>
Chain of Custody Present:	☒	☐	☐	1.	
Chain of Custody Filled Out:	☒	☐	☐	2.	
Chain of Custody Relinquished:	☒	☐	☐	3.	
Sampler Name & Signature on COC:	☐	☒	☐	4.	
Sample Labels match COC: -Includes date/time/ID Matrix: <u>WT</u>	☐	☒	☐	5.	<u>no date & time on labels</u>
Samples Arrived within Hold Time:	☒	☐	☐	6.	
Short Hold Time Analysis (<72hr remaining):	☐	☒	☐	7.	
Rush Turn Around Time Requested:	☐	☒	☐	8.	
Sufficient Volume:	☒	☐	☐	9.	
Correct Containers Used: -Pace Containers Used:	☒	☐	☐	10.	
Containers Intact:	☒	☐	☐	11.	
Orthophosphate field filtered	☐	☐	☒	12.	
Hex Cr Aqueous sample field filtered	☐	☐	☒	13.	
Organic Samples checked for dechlorination:	☐	☐	☒	14.	
Filtered volume received for Dissolved tests	☐	☐	☒	15.	
All containers have been checked for preservation. exceptions: VOA, coliform, TOC, O&G, Phenolics, Radon, Non-aqueous matrix	☒	☐	☐	16.	<u>added 5.0mL HNO₃ to each sample</u>
All containers meet method preservation requirements.	☐	☒	☐	Initial when completed: <u>NMR</u>	Date/time of preservation: <u>4/10/2020 1610</u>
				Lot # of added preservative: <u>DL20-0362</u>	
Headspace in VOA Vials (>6mm):	☐	☐	☒	17.	
Trip Blank Present:	☐	☒	☐	18.	
Trip Blank Custody Seals Present	☐	☐	☒		
Rad Samples Screened < 0.5 mrem/hr	☒	☐	☐	Initial when completed: <u>NMR</u>	Date: <u>4/10/2020</u>

Client Notification/ Resolution:

Person Contacted: _____ Date/Time: _____ Contacted By: _____

Comments/ Resolution: _____

☐ A check in this box indicates that additional information has been stored in reports.

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e. out of hold, incorrect preservative, out of temp, incorrect containers)

*PM review is documented electronically in LIMS. When the Project Manager closes the SRF Review schedule in LIMS. The review is in the Status section of the Workorder Edit Screen.

Appendix E

Remedy Selection Evaluation Criteria

TABLE E-1. Summary of Evaluation Criteria
Groundwater Remedy Selection
Big Rivers Electric Corporation - Green Landfill

40 CFR 257.97 Reference	Corrective Measure Evaluation Criteria under 40 CFR 257.97	Corrective Measure Alternative			
		Alt 2a	Alt 3	Alt 4	Alt 5
Threshold Criteria					
(b)(1)	Be protective of human health and the environment	1	3	3	3
(b)(2)	Attain the Groundwater Protection Standards	1	3.5	2	3.5
(b)(3)	Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment	1	3	2	4
(b)(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	1	3	2	4
(b)(5)	Comply with standards for management of wastes as specified in Section 257.98(d)	2.5	2.5	2.5	2.5
Balancing Criteria					
(c)(1)	The long and short-term effectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on a consideration of the following:				
(c)(1)(i)	Magnitude of reduction of existing risks	1	4	3	2
(c)(1)(ii)	Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy	1	3.5	3.5	2
(c)(1)(iii)	The type and degree of long-term management required, including monitoring, operation, and maintenance	1	2.5	2.5	4
(c)(1)(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	1	3	2	4
(c)(1)(v)	Time until full protection is achieved	1	3	2	4
(c)(1)(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;	1	3	2	4
(c)(1)(vii)	Long-term reliability of the engineering and institutional controls	1	3	2	4
(c)(1)(viii)	Potential need for replacement of the remedy	4	2	1	3
(c)(2)	The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:				
(c)(2)(i)	The extent to which containment practices will reduce further releases	1	3	2	4
(c)(2)(ii)	The extent to which treatment technologies may be used	1	4	3	2
(c)(3)	The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors				
(c)(3)(i)	Degree of difficulty associated with constructing the technology	4	2	1	3
(c)(3)(ii)	Expected operational reliability of the technologies	4	2	1	3
(c)(3)(iii)	Need to coordinate with and obtain necessary approvals and permits from other agencies	2.5	2.5	2.5	2.5
(c)(3)(iv)	Availability of necessary equipment and specialists	4	2	1	3
(c)(3)(v)	Available capacity and location of needed treatment, storage, and disposal services	1	2	3	4
Modifying Criteria					
(c)(4)	The degree to which community concerns are addressed by a potential remedy(s)				
NA (Agreed Order)	State Acceptance	1	3.5	3.5	2
(c)(4)	Community Acceptance	1	3.5	3.5	2
Total Score =		37	63.5	50	69.5

TABLE E-2. Threshold Criteria Evaluation
Groundwater Remedy Selection
Big Rivers Electric Corporation - Green Landfill

40 CFR 257.97 Reference	Corrective Measure		Corrective Measure Alternative					Benefit Analysis
	Evaluation Criteria under 40 CFR 257.97		Alt 2a	Alt 3	Alt 4	Alt 5		
Threshold Criteria								
(b)(1)	Be protective of human health and the environment (HH&E)		1	3	3	3	All 4 alternatives are expected to be protective of HH&E. Alt 2a is considered to be the minimum corrective action that would be required to achieve the CAOs, with the other 3 alternatives building to some degree upon Alt 2a. However Alt 2a relies upon natural attenuation to achieve and ultimately meet the CAOs and therefore has been scored lower for this criteria. The other 3 alternatives are expected to be protective of HH&E to the same degree and have been scored equally.	
(b)(2)	Attain the Groundwater Protection Standards (GWPS)						All 4 alternatives are expected to meet the GWPS, however the time frame for attainment is expected to vary based upon the degree to which the alternative employs an active component and how long the active component will take to design and implement. Alt 2a employs no active remedial component and has been scored lowest. Implementation of other source control measures (included with Alt 3 and Alt 5) is viewed as the corrective measure likely to provide a benefit in the shortest time frame. Addition of hydraulic/physical containment technologies combined with ex-situ treatment associated with Alt 3 and Alt 4 will require additional engineering and pilot testing, likely extending the time required for implementation. Alt 4 would require enhanced engineering and testing compared to Alt 3 so it was ranked lower than Alt 3. The Alt 3 and Alt 5 alternatives are likely to attain the GWPS in the shortest time frame and have been scored highest.	
(b)(3)	Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment						All 4 alternatives are expected to reduce or eliminate further releases of Appendix IV constituents. Alt 2a is considered to be the minimum corrective action that would be required to achieve the CAOs, with the other 3 alternatives building to some degree upon Alt 2a. However Alt 2a relies upon natural attenuation to achieve ultimately meet the CAOs and therefore has been scored lowest for this criteria. Alt 3 and Alt 4 incorporate active remedial components to remove COCs from the environment. Given that Alt 3 and Alt 4 incorporate an ex-situ component, both represent slightly higher potential for further releases into the environment compared with Alt 5. Given that Alt 3 contains a source control component it scores higher than Alt 4. Alt 5 will prevent further releases by removing source material from the South Sediment Basin and is not seen to represent as much of an environmental risk via a release to surface water receptors as Alt 3 and Alt 4.	
(b)(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		1	3	2	4	All 4 alternatives are expected to remove contamination from the environment. Alt 2a employs no active remedial component and has been scored lowest of all. Both Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, but incorporate engineering and ex-situ components, representing a slight probability of impacting sensitive ecosystems and have been scored lower compared to Alt 5. Both Alt 3 and Alt 5 incorporate removing source material from the South Sediment Basin and other source control measures, in addition to addressing groundwater impacts. Due to the lack of an ex-situ component, Alt 5 has been scored highest of all.	
(b)(5)	Comply with standards for management of wastes as specified in Section 257.98(d) (See Notes)		2.5	2.5	2.5	2.5	All 4 alternatives are expected to comply with waste management standards to the same degree and have been scored equally.	

notes:

- 1) Alternative #2a (A2a): C/P, ICs, and Groundwater Monitoring
- 2) Alternative #3 (A3): C/P, Hydraulic Containment, Other Source Control (consisting of seepage collection and treatment), Ex-Situ Treatment, ICs, and Groundwater Monitoring
- 3) Alternative #4 (A4): C/P, Physical Containment, Ex-Situ Treatment, ICs, and Groundwater Monitoring
- 4) Alternative #5 (A5): C/P, Other Source Control, ICs, and Groundwater Monitoring
- 5) Ranking scores range from 1 to 4; 1 = lowest ranking score; 4 = highest ranking score
- 6) When alternatives are all equivalent the ranking is assigned as the average value of all possible ranking (i.e., (1+2+3+4)/4 = 2.5)

TABLE E-3. Balancing Criteria Evaluation
Groundwater Remedy Selection
Big Rivers Electric Corporation - Green Landfill

40 CFR 257.97 Reference	Corrective Measure Evaluation Criteria under 40 CFR 257.97	Corrective Measure Alternative					Benefit Analysis
		Alt 2a	Alt 3	Alt 4	Alt 5		
Balancing Criteria							
(c)(1)	The long and short-term effectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on a consideration of the following: Magnitude of reduction of existing risks	1	4	3	2	All 4 alternatives are expected to result in a reduction of existing risks. Alt 2a is considered to be the minimum corrective action that would be required to achieve the CAOs, with the other 3 alternatives building to some degree upon Alt 2a. However Alt 2a relies upon natural attenuation to ultimately achieve the CAOs and therefore has been scored lowest for this criteria. Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, which is considered to be effective at reducing existing risks. Given that Alt 4 incorporates an ex-situ component, it does represent slightly higher existing risk than Alt 3. Alt 5 on its own provides for some reduction of existing risks by removing source material from the South Sediment Basin, but scores lower than Alt 3 and Alt 4.	
(c)(1)(i)	Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy ^(See Note)	1	3.5	3.5	2	All 4 alternatives are expected to result in a reduction of residual risks due to further releases but allow for CCR to remain in place indefinitely. Alt 2a employs no active component for containing further releases and has been scored lowest of all. Alt 3 will reduce further releases due to the hydraulic containment provided by a groundwater extraction system and the ability of treatment to remove COCs from the environment. Alt 4 will reduce further releases due to the implementation of physical containment and treatment of groundwater to remove COCs from the environment. Alt 5 would also reduce further releases to the environment, but due to the uncertainty with regard to the impacts observed at MW-3A scored slightly lower. Alt 3 and Alt 4 are considered to be equal with regard to this criteria.	
(c)(1)(ii)	The type and degree of long-term management required, including monitoring, operation, and maintenance ^(See Note)	1	2.5	2.5	4	Alt 2a will only achieve the established CAO at the end of the Unit operational lifecycle after cap construction, which is estimated to be at least 100 years after CIP construction. As a result, Alt 2a will require the most long-term management and has been scored lowest of all. Although the source control component included with Alt 5 will require some longer term maintenance, both Alt 3 and Alt 4 incorporate treatment components requiring considerable expenditure of resources and energy during construction, implementation, and long-term operation. Therefore, Alt 5 has been scored highest of all the alternatives. Alt 3 and Alt 4 are considered to be equal with regard to this criteria.	
(c)(1)(iii)	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	1	3	2	4	All 4 alternatives contain some level of short-term risk. Alt 2a employs no active remedial component and has been scored lowest of all. Given that Alt 3 and Alt 4 incorporate an ex-situ component, both represent slightly higher potential for further releases into the environment compared with Alt 5. Given that Alt 3 contains a source control component it scores higher than Alt 4. Alt 5 does require removing source material from the South Sediment Basin but is not seen to represent as much risk to the environment during excavation compared to Alt 3 and Alt 4.	
(c)(1)(iv)	Time until full protection is achieved					Alt 2a will achieve the established CAO at the end of the Unit operational lifecycle after cap construction, which would halt source loading to groundwater, and further allow uncompacted groundwater to flush through the aquifer. The time period for attainment of Alt 2a is estimated to be at least 100 years after CIP construction. Alt 3 would attain the established CAO for the Unit after hydraulic containment eliminates the offsite migration of impacted groundwater, thereby eliminating the exposure pathway. The time period for attainment is relatively short (i.e., <30 years). In the long term, Alt 3 will maintain compliance with the established CAO after cap construction at the end of the Unit operational lifecycle, and removing source material of the South Sediment Basin which will end the source loading to groundwater, as uncompacted groundwater flushes through the aquifer. Alt 4 would attain the established CAO for the landfill after physical containment and extraction eliminates the offsite migration of impacted groundwater, thereby eliminating the exposure pathway. The time period for attainment is based on construction of the grout curtain and groundwater extraction system and is expected to be protracted. In the long term, Alt 4 will maintain compliance with the established CAO after cap construction at the end of the Unit operational lifecycle, which will end the source loading to the groundwater, as uncompacted groundwater flushes through the aquifer. Alt 5 would attain the established CAO for the Unit after removing source material from the South Sediment Basin which will end the source loading to groundwater, as uncompacted groundwater flushes through the aquifer, thereby eliminating the exposure pathway. The time period for attainment via Alt 5 is relatively short. In the long term, Alt 5 will maintain compliance with the established CAO after cap construction at the end of the Unit operational lifecycle. Alt 5 has been scored higher than Alt 3, as design of the source control measures is underway as required by the AO.	

TABLE E-3. Balancing Criteria Evaluation
Groundwater Remedy Selection
Big Rivers Electric Corporation - Green Landfill

40 CFR 257.97 Reference	Corrective Measure Evaluation Criteria under 40 CFR 257.97	Corrective Measure Alternative ----- Alt 2a Alt 3 Alt 4 Alt 5					Benefit Analysis
		Balancing Criteria					
(c)(1)(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;	1	3	2	4		Alt 4 alternatives allow for CCR to remain in place indefinitely. Alt 2a employs no active remedial component and has been scored lowest of all. Given that Alt 3 and Alt 4 incorporate an ex-situ component, both represent slightly higher potential for further releases into the environment compared with Alt 5. Given that Alt 3 contains a source control component it scores higher than Alt 4. Alt 5 does require removing source material from the South Sediment Basin but is not seen to represent as much risk to the environment during excavation compared to Alt 3 and Alt 4.
(c)(1)(vii)	Long-term reliability of the engineering and institutional controls	1	3	2	4		Alt 4 alternatives incorporate institutional controls. Alt 2a is considered to be the minimum corrective action that would be required to achieve the CAOs, relying upon natural attenuation to achieve ultimately meet the CAOs and therefore has been scored lowest for this criteria. Given that Alt 3 and Alt 4 incorporate an engineering component, both represent slightly higher reliability concerns compared with Alt 5. Given that Alt 3 contains a source control component it scores higher than Alt 4.
(c)(1)(viii)	Potential need for replacement of the remedy	4	2	1	3		With the exception of Alt 2a, each alternative employs treatment technologies. Alt 2a employs no active remedial component requiring replacement, and has been scored highest of all. Both Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, including engineering and ex-situ components, and have been scored lower than Alt 5.
(c)(2)	The effectiveness of the remedy in controlling the source to reduce further releases						Alt 3 incorporates source control measures, and has been scored higher than Alt 4.
(c)(2)(i)	The extent to which containment practices will reduce further releases						Alt 4 alternatives are expected to reduce or eliminate further releases of Appendix IV constituents. Alt 2a is considered to be the minimum corrective action that would be required to achieve the CAOs, with the other 3 alternatives building to some degree upon Alt 2a. However Alt 2a relies upon natural attenuation to achieve ultimately meet the CAOs and therefore has been scored lowest for this criteria. Alt 3 and Alt 4 incorporate active remedial components to remove COCs from the environment. Given that Alt 3 and Alt 4 incorporate an Ex-Situ component, both represent slightly higher potential for further releases into the environment than Alt 5. Given that Alt 3 contains a source control component it scores higher than Alt 4. Alt 5 will prevent further releases by removing source material from the South Sediment Basin and is not seen to represent as much risk to the environment as Alt 3 and Alt 4.
(c)(2)(ii)	The extent to which treatment technologies may be used	1	4	3	2		With the exception of Alt 2a, each alternative employs treatment technologies. Alt 2a employs no active remedial component and has been scored lowest of all. Both Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, including engineering and ex-situ components, and have been scored higher than Alt 5. Alt 3 incorporates source control measures, and has been scored highest of all.
(c)(3)	The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors						
(c)(3)(i)	Degree of difficulty associated with constructing the technology	4	2	1	3		With the exception of Alt 2a, each alternative employs treatment technologies. Alt 2a employs no active remedial component and has been scored highest of all. Alt 3 would pose some challenges to the installation and operation of the extraction wells. The proximity to the river will require substantially higher extraction rates in order to provide hydraulic containment. The proximity to the river may pose accessibility issues and result in inflated costs. Alt 4 would be very difficult to implement and is expected to pose some challenges with respect to the installation of the grout curtain and extraction system along the perimeter of the Landfill. The proximity to the river may pose accessibility issues and result in inflated costs. Trenching equipment may be able to meet the depth required for an effective Physical Containment barrier. Alt 4 has been scored lowest of all options with regard to the criteria. Draining and lining the South Sediment Basin requires nominal engineering and construction efforts. Both Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, including engineering and ex-situ components, and have been scored lower than Alt 5.
(c)(3)(ii)	Expected operational reliability of the technologies	4	2	1	3		With the exception of Alt 2a, each alternative employs treatment technologies. Alt 2a employs no active remedial component requiring operation, and has been scored highest of all. Both Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, including engineering and ex-situ components, and have been scored lower than Alt 5.
(c)(3)(iii)	Need to coordinate with and obtain necessary approvals and permits from other agencies (See Note)	2.5	2.5	2.5	2.5		Alt 3 incorporates source control measures, and has been scored higher than Alt 4. Alt 4 alternatives are expected to require permitting and approval from KDWM to the same degree and have been scored equally.

TABLE E-3. Balancing Criteria Evaluation
Groundwater Remedy Selection
Big Rivers Electric Corporation - Green Landfill

40 CFR 257.97 Reference	Corrective Measure Evaluation Criteria under 40 CFR 257.97	Corrective Measure Alternative					Benefit Analysis
		Alt 2a	Alt 3	Alt 4	Alt 5		
Balancing Criteria							
(c)(3)(iv)	Availability of necessary equipment and specialists	4	2	1	3	With the exception of Alt 2a, each alternative employs treatment technologies. Alt 2a employs no active remedial component requiring operation, and has been scored highest of all. Both Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, including engineering and ex-situ components, and have been scored lower than Alt 5. Alt 4 would be very difficult to implement and is expected to pose some challenges with respect to the installation of the grout curtain and extraction system along the perimeter of the Landfill. Alt 4 is expected to require the most equipment and specialists and has been scored lowest of all.	
(c)(3)(v)	Available capacity and location of needed treatment, storage, and disposal services	1	2	3	4	With the exception of Alt 2a, each alternative employs treatment technologies. Alt 2a employs no active remedial component requiring operation, and has been scored lowest of all. Both Alt 3 and Alt 4 incorporate an active remedial component to remove COCs from the environment, including engineering and ex-situ components, and have been scored lower than Alt 5 due to the need for treatment. Alt 3 is expected to require the most treatment requirements and has been scored lower than Alt 4.	
SUBTOTALS		28.5	41.5	31.5	48.5		

notes:

- 1) Alternative #2a (A2a): CIP, ICs, and Groundwater Monitoring
- 2) Alternative #3 (A3): CIP, Hydraulic Containment, Other Source Control (consisting of seepage collection and treatment), Ex-Situ Treatment, ICs, and Groundwater Monitoring
- 3) Alternative #4 (A4): CIP, Physical Containment, Ex-Situ Treatment, ICs, and Groundwater Monitoring
- 4) Alternative #5 (A5): CIP, Other Source Control, ICs, and Groundwater Monitoring
- 5) Ranking scores range from 1 to 4; 1 = lowest ranking score; 4 = highest ranking score
- 6) When alternatives are all equivalent the ranking is assigned as the average value of all possible ranking (i.e., $(1+2+3+4)/4 = 2.5$)

TABLE E-4. Modifying Criteria Evaluation
Groundwater Remedy Selection
Big Rivers Electric Corporation - Green Landfill

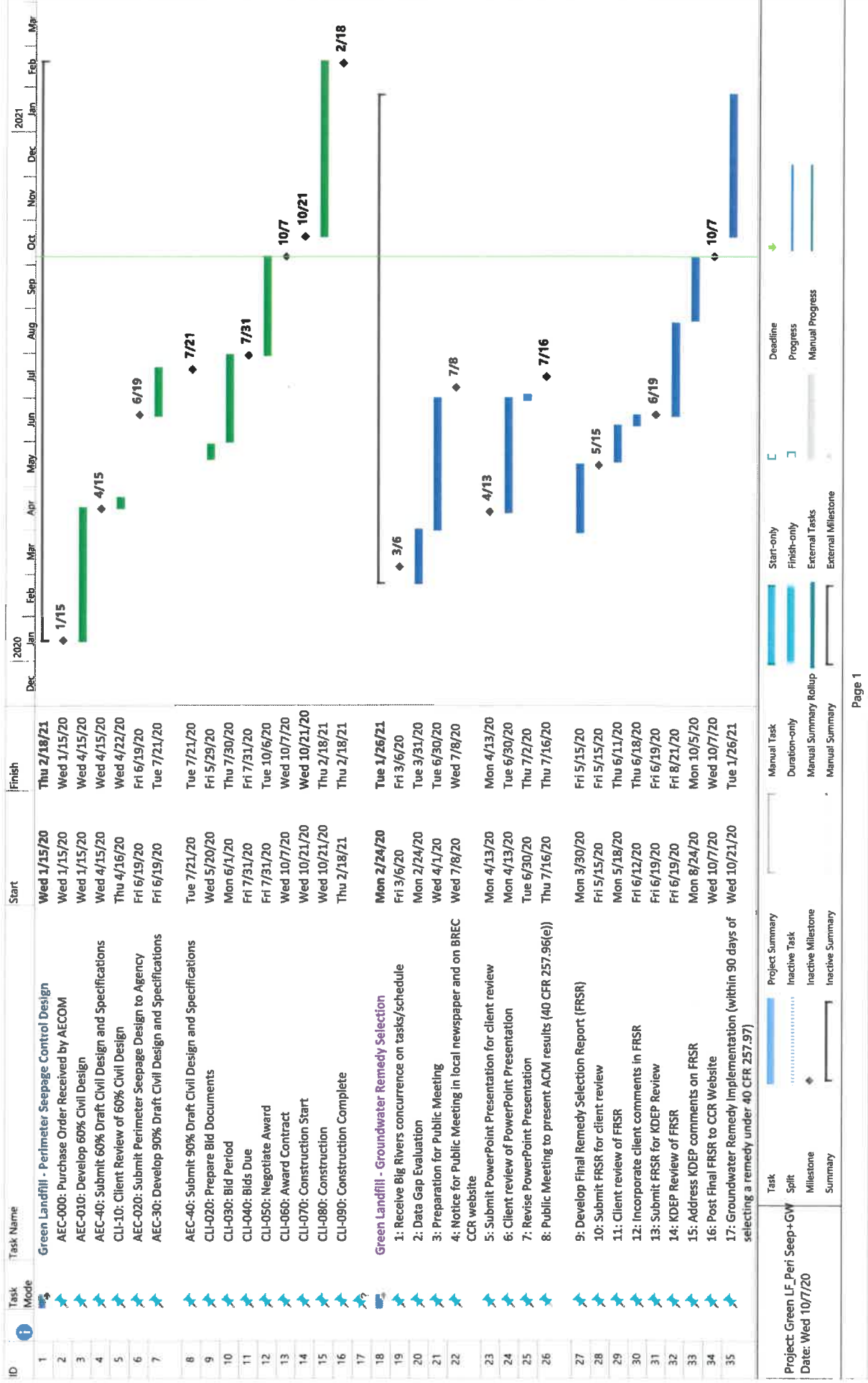
40 CFR 257.97 Reference	Corrective Measure		Corrective Measure Alternative					Benefit Analysis
	Evaluation Criteria under 40 CFR 257.97		Alt 2a	Alt 3	Alt 4	Alt 5		
(c)(4)	The degree to which community concerns are addressed by a potential remedy(ies)		Modifying Criteria					Alt 2a is expected to be met with limited state acceptance due to the protracted remedy time frame. Alt 3 and Alt 4 will both minimize the potential impacts to the receptors upon implementation of the extraction system, and the potential for permitting would be relatively straightforward following the completion of the design, thus increasing the regulatory acceptance of the overall remedy. Alt 5 is expected to receive moderate acceptance from the state with respect to additional control of other potential sources of groundwater contamination. Alt 2a is expected to be met with limited community acceptance due to the protracted remedy time frame. Alt 3 leaves waste in place but provides for active, short-term effective measures that would likely meet with moderate acceptance from the community. Alt 4 would likely meet with moderate acceptance from the community with respect to the established CAO and the addition of the grout curtain and extraction system; however, the remedy timeframe and the discharge of treated groundwater may be an issue. Alt 5 would potentially meet with limited acceptance from the community due to the remedy time frame, which will be complete only after completion of the Landfill's operational lifecycle. However Alt 5 is expected to be more acceptable to the community compared to Alt 2a due to the inclusion of an active corrective measure component.
NA (Agreed Order)	State Acceptance	(See Notes)	1	3.5	3.5	2		
(c)(4)	Community Acceptance	(See Notes)	1	3.5	3.5	2		
SUBTOTALS			2	7	7	4		

notes:

- 1) Alternative #2a (A2a): CIP, ICs, and Groundwater Monitoring
- 2) Alternative #3 (A3): CIP, Hydraulic Containment, Other Source Control (consisting of seepage collection and treatment), Ex-Situ Treatment, ICs, and Groundwater Monitoring
- 3) Alternative #4 (A4): CIP, Physical Containment, Ex-Situ Treatment, ICs, and Groundwater Monitoring
- 4) Alternative #5 (A5): CIP, Other Source Control, ICs, and Groundwater Monitoring
- 5) Ranking scores range from 1 to 4; 1 = lowest ranking score; 4 = highest ranking score
- 6) When alternatives are all equivalent the ranking is assigned as the average value of all possible ranking (i.e., $(1+2+3+4)/4 = 2.5$)

Appendix F

Remedy Implementation Schedule



AECOM
525 Vine Street
Cincinnati, OH 45202
www.aecom.com