Semi-Annual Remedy Selection Progress Report

Green Landfill
Sebree Station
Webster County, Kentucky

Prepared for:

Big Rivers Electric Corporation
Sebree Generating Station
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Distribution List

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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 Cooperation (BREC) is in the process of selecting a remedy for groundwater impacts at the Green Station CCR Landfill (the Unit) at the Sebree Generating Station located in Webster County, Robards, Kentucky **(Figure 1)**.

Assessment 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. A map illustrating the site with location of all program monitoring wells is presented as **Figure 2**.

In response to the SSL exceedance, BREC evaluated the nature and extent of groundwater impacts as required by Title 40 CFR Part 257.95(g) for characterization monitoring. In addition, BREC performed an Assessment of Corrective Measures (ACM), to identify applicable remedial technologies to address lithium impacts in groundwater pursuant to Tile 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 ACM (AECOM, June 2019) was posted to BREC's publicly-accessible CCR reporting website on June 14, 2019.

Title 40 CFR Part 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 semi-annual *Remedy Selection Progress Report* (AECOM, December 2019) was posted to BREC's publicly-accessible CCR reporting website on December 9, 2019. In alignment with the CCR rule requirement, the following sections included within this semi-annual progress report provide an overview of BREC's activities previously performed, currently underway, and planned in the future to select a remedy that meets the requirement of Title 40 CFR Section 257.97 (b) 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).

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 (66 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 (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 (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 currently receives special waste generated by burning coal (CCRs) from Green Stations. The Reid and HMP&L stations historically disposed special waste in the Green Landfill. 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. However, it should be stated that downgradient characterization is limited due to the presence of the Green River immediately adjacent to 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.

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 3**). 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.

2.3.4 Constituents of Concern

Current groundwater analytical data and statistical analysis 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 Pond and in MW-3A located north (downstream on the Green River) of MW-4.

2.3.5 Impacted Media

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

2.3.6 Distribution of COCs

Groundwater sampling was performed at the Unit most recently in April 2020. 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 4 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 Pond 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 Pond 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 Pond, 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 Pond is rehabilitated as is currently planned. 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.

2.3.7 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 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 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

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 an individual sump 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 system became fully operational on May 29, 2020.

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.

Liquids collected within the Deep Seep Collection Trench are conveyed to a series of pumping stations/ponds that eventually discharge to the plant's main KPDES Outfall (#001).

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.

2.5 Assessment of Corrective Measures Summary

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.

3. Remedy Selection Progress

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: CiP, 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

Each of the remaining 4 corrective measures alternatives is discussed in more detail below.

3.1 Potential Corrective Action Alternatives

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

Alternative #2a as currently envisioned would employ a combination of three corrective measures technologies:

- CiP source control, which consists of which consists of routine cover management during landfill operation, and planned closure activities for the Green Landfill;
- Implementation of ICs designed to restrict the property to industrial use and to prohibit groundwater use for potable purposes; and
- Groundwater monitoring (Assessment) to document the effectiveness of the corrective measures.

Alternative #2a is recommended for further evaluation.

3.1.2 Alternative #3 – CiP, ICs, Hydraulic Containment, Other Source Control, Ex-Situ Treatment, and Groundwater Monitoring

Alternative #3 as currently envisioned would build upon Alternative #2a to also include the addition of hydraulic containment, using vertical groundwater recovery wells, other source control (i.e., rehabilitation of the South Pond, and managing existing non-groundwater seeps), and ex-situ treatment of groundwater, which involves above-ground physical/chemical treatment methods and/or permitted discharge until CAOs are achieved.

Alternative #3 is recommended for further evaluation.

3.1.3 Alternative #4 – CiP, ICs, Physical Containment (Funnel-Gate), Permeable Reactive Barrier, and Groundwater Monitoring

Alternative #4 as currently envisioned would consist of CiP (BREC's planned unit closure activities), physical containment of impacted groundwater via installation of a grout curtain with an extraction well at the gate, and ex-situ treatment of extracted groundwater by physical/chemical treatment methods and/or permitted discharge.

Alternative #4 is recommended for further evaluation.

3.1.4 Alternative #5 – CiP, ICs, Other Source Control, and Groundwater Monitoring

Alternative #5 is similar to Alternative #2a except for the addition of other source control, in the form of draining and lining the South Pond and managing existing non-groundwater seeps.

Alternative #5 is recommended for further evaluation.

3.2 Remedy Evaluation

Currently BREC considers four (4) potential corrective action alternatives as viable options to address groundwater impacts at the Unit, including:

- Alternative #2a;
- Alternative #3;
- Alternative #4; and
- Alternative #5.

To evaluate each alternative, additional data collection will likely be required. BREC is currently evaluating data collection needs in the following areas to assist with remedy selection:

1) Nature and Extent – groundwater trends, influence of non-groundwater remedies, etc.
2) Physical Characteristics – available data on the physical characteristics of the landfill and retention pond
3) Performance Modeling – data needed to develop digital models demonstrating the effectiveness of potential alternatives
4) Engineering – feasibility, cost estimates, etc.

BREC is working to establish a comprehensive list of data collection needs to proceed forward with remedy evaluation and anticipates providing additional data in future semi-annual remedy selection progress reports.

In Fall 2019, BREC constructed a series of collection trenches around the perimeter of the Unit to address non-groundwater releases. The 2020 groundwater monitoring program will assist in evaluating the success of the non-groundwater release remedies and provide relevant and important information to be considered in the final groundwater remedy selection.

3.3 Public Meeting

At the beginning of 2020, BREC had initiated preparation to conduct a public meeting to discuss the results of the Groundwater ACM as required by 40 CFR 257.96(e). However, due to the onset of the COVID-19 pandemic, BREC has been prevented from holding the public meeting so far in 2020. BREC plans to hold a public meeting once the mass gathering restrictions related to COVID-19 are lifted in Kentucky.

4. Conclusion

Additional updates regarding remedy selection, including any additional corrective measures being considered, will be presented twice a year in future remedy selection progress reports. Once sufficient data has been collected to select an effective comprehensive remedy for the Unit, a public meeting will be held 30 days prior to formal remedy selection, followed by a detailed Remedy Selection Report describing the remedy and proposed schedule for implementation.

If needed, the next remedy selection progress report for the Unit is expected in December 2020.

5. References

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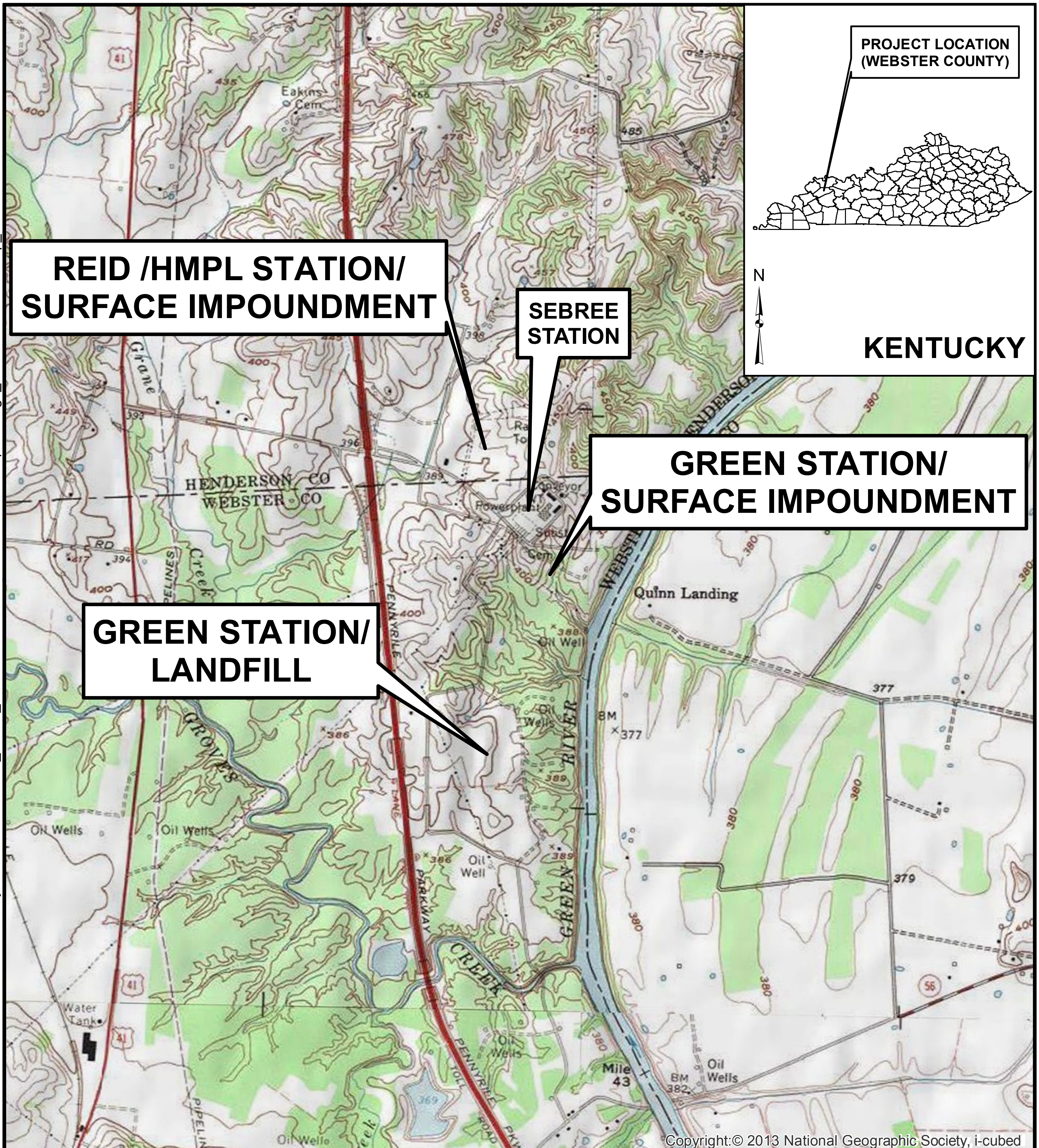
Figures



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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

N

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	

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Legend

- Property Line
- KAR Permit Area
- CCR Fill Area
- Downgradient CCR Monitoring Well
- Upgradient CCR Monitoring Well
- Characterization Well

0 400 800
Feet

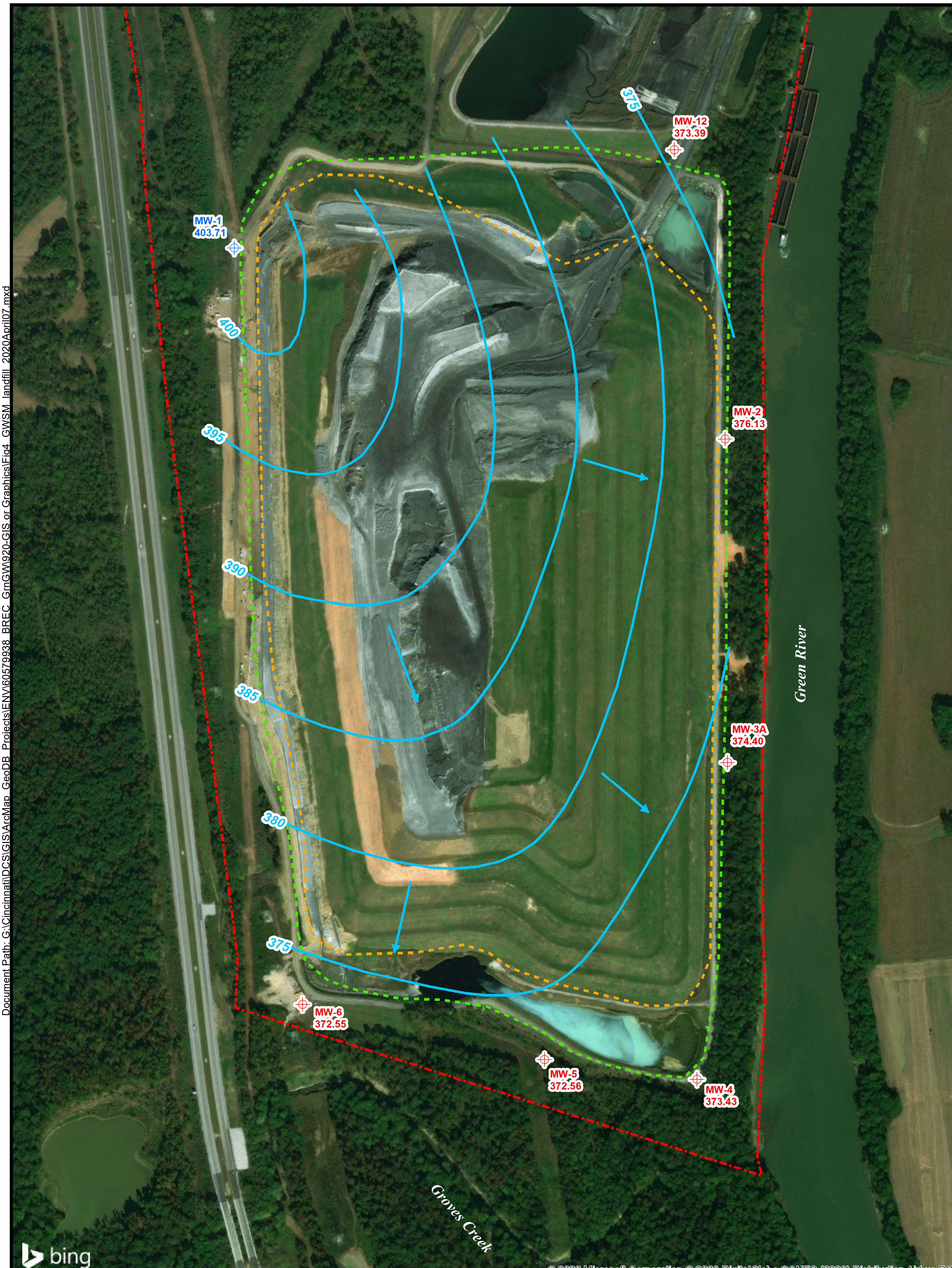
N

Big Rivers ELECTRIC CORPORATION

Green Station
Webster County, Kentucky

FIGURE 2
WELL LOCATION MAP

DATE: 12/9/2019	SCALE: 1IN = 300 FEET
CREATED BY: ALW	
JOB NO. 60602364	



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Legend

- Property Line
- KAR Permit Area
- CCR Fill Area
- Downgradient CCR Monitoring Well
- Upgradient CCR Monitoring Well
- Water Table Contour (Dashed where Inferred from Available Monitoring Data)
- Groundwater Flow Direction
- 373.43 Groundwater Elevation (Feet, MSL) Measured April 7, 2020
- NM - not measured

0 400 800
Feet

N

Big Rivers ELECTRIC CORPORATION

Green Station Landfill
Webster County, Kentucky

FIGURE 3
POTENTIOMETRIC SURFACE MAP
APRIL 7, 2020

DATE: 4/20/2020	SCALE: 1IN = 400 FEET
CREATED BY: TMJ	
JOB NO. 60579938	

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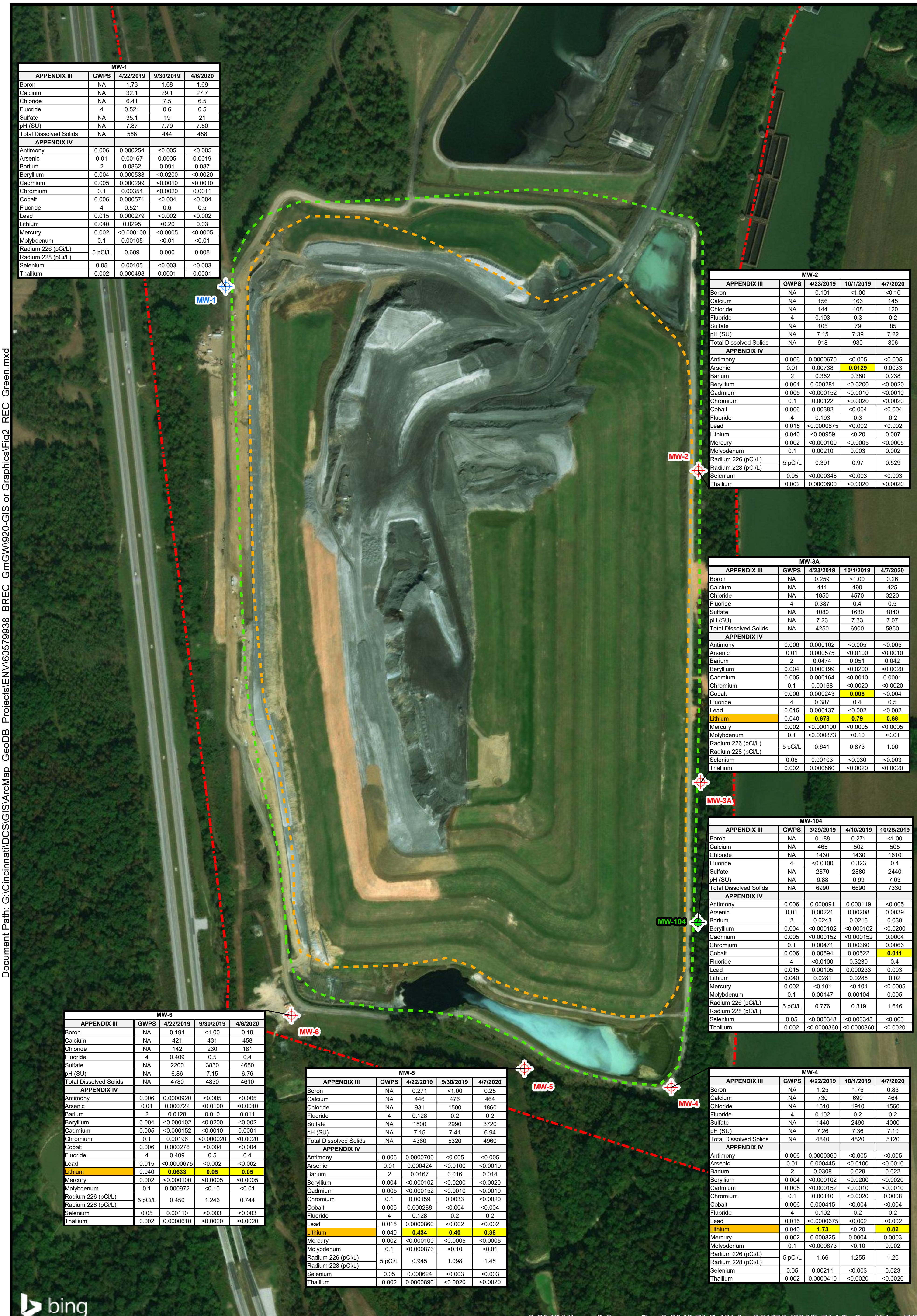

MW-1				
APPENDIX III	**GWPS**	**4/22/2019**	**9/30/2019**	**4/6/2020**
Boron	NA	1.73	1.68	1.69
Calcium	NA	32.1	29.1	27.7
Chloride	NA	6.41	7.5	6.5
Fluoride	4	0.521	0.6	0.5
Sulfate	NA	35.1	19	21
pH (SU)	NA	7.87	7.79	7.50
Total Dissolved Solids	NA	568	444	488
APPENDIX IV				
Antimony	0.006	0.000254	<0.005	<0.005
Arsenic	0.01	0.00167	0.0005	0.0019
Barium	2	0.0862	0.091	0.087
Beryllium	0.004	0.000533	<0.0200	<0.0020
Cadmium	0.005	0.000299	<0.0010	<0.0010
Chromium	0.1	0.00354	<0.0020	0.0011
Cobalt	0.006	0.000571	<0.004	<0.004
Fluoride	4	0.521	0.6	0.5
Lead	0.015	0.000279	<0.002	<0.002
Lithium	0.040	0.0295	<0.20	0.03
Mercury	0.002	<0.000100	<0.0005	<0.0005
Molybdenum	0.1	0.00105	<0.01	<0.01
Radium 226 (pCi/L) Radium 228 (pCi/L)	5 pCi/L	0.689	0.000	0.808
Selenium	0.05	0.00105	<0.003	<0.003
Thallium	0.002	0.000498	0.0001	0.0001

MW-2				
APPENDIX III	**GWPS**	**4/23/2019**	**10/1/2019**	**4/7/2020**
Boron	NA	0.101	<1.00	<0.10
Calcium	NA	156	166	145
Chloride	NA	144	108	120
Fluoride	4	0.193	0.3	0.2
Sulfate	NA	105	79	85
pH (SU)	NA	7.15	7.39	7.22
Total Dissolved Solids	NA	918	930	806
APPENDIX IV				
Antimony	0.006	0.0000670	<0.005	<0.005
Arsenic	0.01	0.00738	**0.0129**	0.0033
Barium	2	0.362	0.380	0.238
Beryllium	0.004	0.000281	<0.0200	<0.0020
Cadmium	0.005	<0.000152	<0.0010	<0.0010
Chromium	0.1	0.00122	<0.0020	<0.0020
Cobalt	0.006	0.00382	<0.004	<0.004
Fluoride	4	0.193	0.3	0.2
Lead	0.015	<0.0000675	<0.002	<0.002
Lithium	0.040	<0.00959	<0.20	0.007
Mercury	0.002	<0.000100	<0.0005	<0.0005
Molybdenum	0.1	0.00210	0.003	0.002
Radium 226 (pCi/L) Radium 228 (pCi/L)	5 pCi/L	0.391	0.97	0.529
Selenium	0.05	<0.000348	<0.003	<0.003
Thallium	0.002	0.0000800	<0.0020	<0.0020

MW-3A				
APPENDIX III	**GWPS**	**4/23/2019**	**10/1/2019**	**4/7/2020**
Boron	NA	0.259	<1.00	0.26
Calcium	NA	411	490	425
Chloride	NA	1850	4570	3220
Fluoride	4	0.387	0.4	0.5
Sulfate	NA	1080	1680	1840
pH (SU)	NA	7.23	7.33	7.07
Total Dissolved Solids	NA	4250	6900	5860
APPENDIX IV				
Antimony	0.006	0.000102	<0.005	<0.005
Arsenic	0.01	0.000575	<0.0100	<0.0010
Barium	2	0.0474	0.051	0.042
Beryllium	0.004	0.000199	<0.0200	<0.0020
Cadmium	0.005	0.000164	<0.0010	0.0001
Chromium	0.1	0.00168	<0.0020	<0.0020
Cobalt	0.006	0.000243	**0.008**	<0.004
Fluoride	4	0.387	0.4	0.5
Lead	0.015	0.000137	<0.002	<0.002
Lithium	0.040	**0.678**	**0.79**	**0.68**
Mercury	0.002	<0.000100	<0.0005	<0.0005
Molybdenum	0.1	<0.000873	<0.10	<0.01
Radium 226 (pCi/L) Radium 228 (pCi/L)	5 pCi/L	0.641	0.873	1.06
Selenium	0.05	0.00103	<0.030	<0.003
Thallium	0.002	0.000860	<0.0020	<0.0020

MW-104				
APPENDIX III	**GWPS**	**3/29/2019**	**4/10/2019**	**10/25/2019**
Boron	NA	0.188	0.271	<1.00
Calcium	NA	465	502	505
Chloride	NA	1430	1430	1610
Fluoride	4	<0.0100	0.323	0.4
Sulfate	NA	2870	2880	2440
pH (SU)	NA	6.88	6.99	7.03
Total Dissolved Solids	NA	6990	6690	7330
APPENDIX IV				
Antimony	0.006	0.000091	0.000119	<0.005
Arsenic	0.01	0.00221	0.00208	0.0039
Barium	2	0.0243	0.0216	0.030
Beryllium	0.004	<0.000102	<0.000102	<0.0200
Cadmium	0.005	<0.000152	<0.000152	0.0004
Chromium	0.1	0.00471	0.00360	0.0066
Cobalt	0.006	0.00594	0.00522	**0.011**
Fluoride	4	<0.0100	0.3230	0.4
Lead	0.015	0.00105	0.000233	0.003
Lithium	0.040	0.0281	0.0286	0.02
Mercury	0.002	<0.101	<0.101	<0.0005
Molybdenum	0.1	0.00147	0.00104	0.005
Radium 226 (pCi/L) Radium 228 (pCi/L)	5 pCi/L	0.776	0.319	1.646
Selenium	0.05	<0.000348	<0.000348	<0.003
Thallium	0.002	<0.0000360	<0.0000360	<0.0020

MW-6				
APPENDIX III	**GWPS**	**4/22/2019**	**9/30/2019**	**4/6/2020**
Boron	NA	0.194	<1.00	0.19
Calcium	NA	421	431	458
Chloride	NA	142	230	181
Fluoride	4	0.409	0.5	0.4
Sulfate	NA	2200	3830	4650
pH (SU)	NA	6.86	7.15	6.76
Total Dissolved Solids	NA	4780	4830	4610
APPENDIX IV				
Antimony	0.006	0.0000920	<0.005	<0.005
Arsenic	0.01	0.000722	<0.0100	<0.0010
Barium	2	0.0128	0.010	0.011
Beryllium	0.004	<0.000102	<0.0200	<0.002
Cadmium	0.005	<0.000152	<0.0010	0.0001
Chromium	0.1	0.00196	<0.000020	<0.0020
Cobalt	0.006	0.000276	<0.004	<0.004
Fluoride	4	0.409	0.5	0.4
Lead	0.015	<0.0000675	<0.002	<0.002
Lithium	0.040	**0.0633**	**0.05**	**0.05**
Mercury	0.002	<0.000100	<0.0005	<0.0005
Molybdenum	0.1	0.000972	<0.10	<0.01
Radium 226 (pCi/L) Radium 228 (pCi/L)	5 pCi/L	0.450	1.246	0.744
Selenium	0.05	0.00110	<0.003	<0.003
Thallium	0.002	0.0000610	<0.0020	<0.0020

MW-5				
APPENDIX III	**GWPS**	**4/22/2019**	**9/30/2019**	**4/7/2020**
Boron	NA	0.271	<1.00	0.25
Calcium	NA	446	476	464
Chloride	NA	931	1500	1860
Fluoride	4	0.128	0.2	0.2
Sulfate	NA	1800	2990	3720
pH (SU)	NA	7.15	7.41	6.94
Total Dissolved Solids	NA	4360	5320	4960
APPENDIX IV				
Antimony	0.006	0.0000700	<0.005	<0.005
Arsenic	0.01	0.000424	<0.0100	<0.0010
Barium	2	0.0167	0.016	0.014
Beryllium	0.004	<0.000102	<0.0200	<0.0020
Cadmium	0.005	<0.000152	<0.0010	<0.0010
Chromium	0.1	0.00159	0.0033	<0.0020
Cobalt	0.006	0.000288	<0.004	<0.004
Fluoride	4	0.128	0.2	0.2
Lead	0.015	0.0000860	<0.002	<0.002
Lithium	0.040	**0.434**	**0.40**	**0.38**
Mercury	0.002	<0.000100	<0.0005	<0.0005
Molybdenum	0.1	<0.000873	<0.10	<0.01
Radium 226 (pCi/L) Radium 228 (pCi/L)	5 pCi/L	0.945	1.098	1.48
Selenium	0.05	0.000624	<0.003	<0.003
Thallium	0.002	0.0000890	<0.0020	<0.0020

MW-4				
APPENDIX III	**GWPS**	**4/22/2019**	**10/1/2019**	**4/7/2020**
Boron	NA	1.25	1.75	0.83
Calcium	NA	730	690	464
Chloride	NA	1510	1910	1560
Fluoride	4	0.102	0.2	0.2
Sulfate	NA	1440	2490	4000
pH (SU)	NA	7.26	7.36	7.10
Total Dissolved Solids	NA	4840	4820	5120
APPENDIX IV				
Antimony	0.006	0.0000360	<0.005	<0.005
Arsenic	0.01	0.000445	<0.0100	<0.0010
Barium	2	0.0308	0.029	0.022
Beryllium	0.004	<0.000102	<0.0200	<0.0020
Cadmium	0.005	<0.000152	<0.0010	<0.0010
Chromium	0.1	0.00110	<0.0020	0.0008
Cobalt	0.006	0.000415	<0.004	<0.004
Fluoride	4	0.102	0.2	0.2
Lead	0.015	<0.0000675	<0.002	<0.002
Lithium	0.040	**1.73**	<0.20	**0.82**
Mercury	0.002	0.000825	0.0004	0.0003
Molybdenum	0.1	<0.000873	<0.10	0.002
Radium 226 (pCi/L) Radium 228 (pCi/L)	5 pCi/L	1.66	1.255	1.26
Selenium	0.05	0.00211	<0.003	0.023
Thallium	0.002	0.0000410	<0.0020	<0.0020

Legend

- Property Line
- KAR Permit Area
- CCR Fill Area
- Downgradient CCR Monitoring Well
- Upgradient CCR Monitoring Well
- Characterization Well

All results listed in milligrams per liter (mg/L) unless otherwise noted.
Yellow highlighted values indicate GWPS exceedance.
Orange highlighted analyte indicate SSL above GWPS.
SSL = Statistically Significant Level
GWPS = Groundwater Protection Standard
NA = Not Applicable
ND = Not Detected at or above Method Detection Limit
pCi/L = picoCuries per Liter

0 400 800
Feet

N

Big Rivers ELECTRIC CORPORATION

Green Landfill
Webster County, Kentucky

FIGURE 4
GROUNDWATER CONDITIONS MAP
2019-2020 ANALYTICAL RESULTS

DATE: 5/13/2020	SCALE: 1IN = 300 FEET
CREATED BY: SEL	
JOB NO. 60619283	

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